Climate Data and Monitoring
WCDMP-No. 75

Regional Association VI Workshop on Climate Monitoring including the Implementation of Climate Watch Systems

(Offenbach, Germany, 25–28 October 2010)

World Meteorological Organization
Weather • Climate • Water

WMO/TD No. 1565

© World Meteorological Organization, 2011

The right of publication in print, electronic and any other form and in any language is reserved by WMO. Short extracts from WMO publications may be reproduced without authorization, provided that the complete source is clearly indicated. Editorial correspondence and requests to publish, reproduce or translate this publication in part or in whole should be addressed to:

Chair, Publications Board
World Meteorological Organization (WMO)
7 bis, avenue de la Paix
P.O. Box 2300
CH-1211 Geneva 2, Switzerland

Tel.: +41 (0) 22 730 84 03
Fax: +41 (0) 22 730 80 40
E-mail: Publications@wmo.int

NOTE

The designations employed in WMO publications and the presentation of material in this publication do not imply the expression of any opinion whatsoever on the part of the Secretariat of WMO concerning the legal status of any country, territory, city or area, or of its authorities, or concerning the delimitation of its frontiers or boundaries.

Opinions expressed in WMO publications are those of the authors and do not necessarily reflect those of WMO. The mention of specific companies or products does not imply that they are endorsed or recommended by WMO in preference to others of a similar nature which are not mentioned or advertised.

RA VI (Europe) Workshop on Climate Monitoring including the Implementation of Climate Watch Systems

(Offenbach, Germany, 25 - 28 October 2010)

WCDMP No. 75
WMO TD No. 1565

World Meteorological Organization

Geneva, March 2011

Edited by: Omar Baddour and Karolin Eichler

© World Meteorological Organization, 2011

The right of publication in print, electronic and any other form and in any language is reserved by WMO. Short extracts from WMO publications may be reproduced without authorization, provided that the complete source is clearly indicated. Editorial correspondence and requests to publish, reproduce or translate these publication in part or in whole should be addressed to:

Chairperson, Publications Board
World Meteorological Organization (WMO)
7 bis, avenue de la Paix
P.O. Box No. 2300
CH-1211 Geneva 2, Switzerland

Tel.: +41 (0)22 730 84 03
Fax: +41 (0)22 730 80 40
E-mail: Publications@wmo.int

NOTE
The designations employed in WMO publications and the presentation of material in this publication do not imply the expression of any opinion whatsoever on the part of the Secretariat of WMO concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries.
Opinions expressed in WMO publications are those of the authors and do not necessarily reflect those of WMO. The mention of specific companies or products does not imply that they are endorsed or recommended by WMO in preference to others of a similar nature which are not mentioned or advertised.
This document (or report) is not an official publication of WMO and has not been subjected to its standard editorial procedures. The views expressed herein do not necessarily have the endorsement of the Organization.

****

Contents

	Page
Roadmap for the implementation of a Climate Watch System (CWS) in the WMO region of Europe (RA VI)	
Workshop statement	1
Key issues and specific recommendations	1
Action plan	2
General recommendations	3
Session 1 - Key lectures on rising awareness	
The needs and requirements for an efficient climate early warning system – the agrometeorological perspective	4
The need and requirements for an efficient climate early warning system - hydrological perspectives	9
Components of the GFCS Climate Services Information System	12
Session 2 - International and regional projects and activities relevant to Climate Watch Systems	
WMO Climate Watch System	15
Global reanalysis for climate monitoring at ECMWF	23
Climate monitoring and analyses in the European context	26
The WMO RA VI Pilot Regional Climate Centre node on Climate Monitoring (RCC-CM): Products and services	29
The SEECOF mechanism	32
South-East European Virtual Climate Change Centre Initiative - Climate watch preoperational phase	36
Session 3 - Country presentations on the status and priority needs of monitoring and predicting climate anomalies and extremes	
Climate monitoring in Austria	42
Recent Belgian activities	45
Role of METEO B&H in state observing, forecasting and information system	49
A review of climate monitoring in Croatia	52
Climate monitoring activities of the Cyprus Meteorological Service	60
Status of climate monitoring and predicting in Finland	65
Initial validation study of satellite derived monthly cloudiness data for Georgian territory	67
Air temperature and precipitation distribution peculiarities in Georgia	70
Status and priority needs of monitoring and prediction of climate anomalies and extremes in Germany	74
Climate data, climate monitoring and long-range forecasts at the Hungarian Meteorological Service	76

The Italian Climatological Service: monitoring and predicting climate anomalies and extremes 79

Jordan climate 83

The weather center of Kazakhstan 86

Climate monitoring in Lithuania 93

Monitoring and prediction climate anomalies and extremes (Moldova) 96

Status and priority needs in monitoring and predicting climate anomalies and extremes in Montenegro 99

Climate data, climate information and weather warnings available on the web from The Norwegian Meteorological Institute 103

Climate monitoring and products at IM-Portugal 106

Status and priority needs of monitoring and prediction of climate anomalies and extremes in Russia 109

Status and priority needs of monitoring and predicting climate anomalies and extremes in Serbia 112

Climate monitoring in Spain 115

Status of the monitoring and forecasting of climate anomalies and extremes in the United Kingdom 118

Session 4 - Climate watch implementation in RA VI (Parallel working group sessions)

Group 1: Format, content and dissemination of (national) climate advisories 126

Group 2: User aspects of (national) climate advisories 129

Group 3: Basic infrastructure requirements and needs for (national) climate watch implementation, incl. role of the RA VI Pilot RCC-Network and the SEECOF mechanisms 131

Group 4: Research and development aspects including capacity building 134

Annexes

A: Opening remarks of the President of the WMO regional association RA VI 138

B: Agenda 139

C: List of participants 142

D: Group photo 147

Roadmap for the implementation of a Climate Watch System (CWS) in the WMO region of Europe (RA VI)

I. Workshop statement

Noting the various aspects of vulnerability in the WMO Region of Europe (RA-VI) and the WMO efforts for enabling Nations to better deal with climate extremes in a changing climate, participants agreed to establish a CWS in RA VI as an element of Early Warning System based on the general guidelines provided within the WMO/ CCl technical document on climate watches (WCDMP No. 58/WMO/TD-No. 1269) and the WMO brochure on *''Climate Watch System/ Early Warning against Climate Anomalies and Extremes''* http://www.wmo.int/pages/publications/showcase/documents/CWS_EN_v1.pdf

The participants recognized that climate watch activities fit well in the new international and regional context of climate services and adaptation such as the GFCS, the Nairobi Work Programme of UNFCCC, the Strategy Plan of RA VI and the National Adaptation Plans of Actions (NAPAs) in the region.

A Climate Watch System (CWS) is an operational cooperative system for climate early warning based on existing meteorological facilities and infrastructure at regional and national level. It involves user in its design, operation and evaluation. A CWS builds on existing weather early warning systems by adding advisories on climate extreme events such as heat waves, cold waves, extended heavy precipitations leading to flooding, rainfall / soil moisture deficiency leading to drought conditions, severe wind storms extending beyond weather scales, extended snowfall, etc. A CWS purpose is to support sector Early Warning System particularly water resources, agriculture and health sectors by providing timely climate monitoring and long range forecasting information.

II. Key issues and specific recommendations

II.1 Format, content & dissemination of climate advisories (climate watches)

i. Definition of the time scale addressed by a climate watch: starts when weather warnings end (after 3-5 days), and extends up to several months ahead;
ii. A climate watch will be issued based on observed and/ or expected climate anomalies with indication of duration, update and termination of the advisory;
iii. Two formats are proposed for RA-VI:
   - Generalised advisory for public use,
   - Specialised advisory for specific sector users including additional information such as uncertainty and potential impacts;

II.2 User aspects of (national) climate watches

i. Establish an inventory of extreme weather events and their impacts;
ii. Establish a formal mechanism for evaluation of the advisories and user feedbacks, as part of Quality Management System (QMS);
iii. Adopt a multidisciplinary approach to enable users to make best use of climate information including climate watches

II.3 Consider basic infrastructure requirements and needs for (national) climate watch implementation, including the role of RA VI (Pilot) RCC-Network and the SEECOF mechanism

i. Address the need for practical tools for downscaling LRF
ii. Availability and accessibility of data and products including quality information
iii. Best use of existing capabilities and infrastructure such as RCC, GPCs, RCOFs, NMHSs (meteorological and hydrological [services] [authorities]), ECMFW, EUMETNET, EUMETSAT, etc. …

II.4 Research and development aspects including capacity building

i. Limited predictive skill on monthly to seasonal timescales in most of RA-VI region
ii. There is a need for standardization of definition and characterisation of extreme events
iii. Further development and improvement of meteorological and hydrological models;
iv. Determining climate indices for both monitoring and predicting at different time scales;
v. Lack of human and technical capacity at NMHS level in some parts of the Region

III. Action Plan

The following actions were proposed for the short and medium term

Action	**Who/ responsibility**	**Timeline**
Make presentations in the workshop available as PDF on the Internet.	Host	Soon
Make the report of this workshop available to the members.	WMO	6 months
Develop a RA VI Climate Watch template.	Group 1	6 months
Establish a Task Team on the implementation of CWS in RA VI. WGCH to draft Terms of Reference.	MG via WGCH	6 months
RCC-CM to liaise with RC-LRF and RCC-CD on development of appropriate guidance material and products, including a knowledge data base on climate extremes and their impacts in the region, to support national CW Advisories.	RCC-CM	2 years
NMHSs to develop criteria, in cooperation with users, for issuing CW Advisories.	NMHSs	
To finalize through communication with all RA VI members regional and sub-regional inventories of hazards to be addressed by CW in our region. Based on the outcomes of this workshop and analyses done in for the 2003 CLIPS workshop (Erfurt), and on WMO DRR data bases.	RCC-CM	6 months
RCC-Network to coordinate establishment of a standard reference period for CWS in the Region.	RCC-Network	6 months
RCC-Network to extend their products beyond the border of RA VI. This might need some coordination with neighbouring RAs.	RCC-Network	2 years
RCC-CM to also make available underlying gridded data of their monitoring products.	RCC-CM	6 months
RCC-Network to liaise with the research community (CCl, WCRP, EU FP7, …) to address research issues relevant for implementing a CWS.	RCC-Network	2 years
Improvement of hydrological models and modelling systems.	WCRP, CHy	Long-term (beyond 2 Years)
Training on Climate Watch and user related aspects, including communication.	WMO	6 years

IV. General recommendations

1. Ensure that appropriate liaison mechanisms are established between GMES (Global Monitoring for Environment and Security) and the CWS in the region.
2. To encourage LRF providers, RCCs and observational data owners to consider providing access to daily data;
3. To identify a set of requirements for necessary data and indices that should be made available by LRF, GPCs and RCCs to support implementation of CWS.
4. Undertake implementation of CWS as a voluntary pilot phase to develop initial best practices (countries volunteering: Turkey, Serbia, Finland);
5. Extend RCOF mechanism to other sub-regions of RA VI such as SW-Europe and the polar region;
6. CCl accelerates its work on extreme weather and climate events to support implementation of CWS;
7. Encourage NMSs and NHSs to establish a dialogue with users and stakeholders.

Session 1 - Key lectures on rising awareness

- The needs and requirements for an efficient climate early warning system - the agrometeorological perspective
- The need and requirements for an efficient climate early warning system - hydrological perspectives
- Components of the GFCS Climate Services Information System

The needs and requirements for an efficient climate early warning system – the agrometeorological perspective.

Kurt Christian Kersebaum

Leibniz-Centre for Agricultural Landscape Research, Institute of Landscape Systems Analysis, Eberswalder Str. 84, D-15374 Müncheberg, Germany

1. Introduction

Agriculture is one of the most climate sensitive sectors due to the large impact of climate factors on crop and animal production including forestry. Climate factors such as temperature, radiation and CO_2 concentration of the atmosphere define in combination with site conditions (soil, water regime) and physiological characteristics of crops (physiology, canopy architecture and phenology) the potential production level of crops. The projected increase of temperature in climate change scenarios will prolong the length of the climatic vegetation period. However, for many crops an increase of temperature will accelerate the phenological development which might lead to a shortened growing season and grain filling period. Depending on the crop specific optimum and the present conditions photosynthesis might be increased or decreased. Actual yields are usually below the potential production level due to limiting and reducing factors, which are to a large extent of climatic nature. Seasonal forecast of risks for agricultural production provide to support decision making of agricultural actors to improve their preparedness for climatically induced damages and risks and to help closing the gap between potential and actual yields.

2. Main climatic risks for agriculture

The potential crop production is limited by water and nutrient availability which both depends significantly on the amount and distribution of precipitation and the evapotranspiration. Heat stress and drought can significantly reduce crop yields. Extreme events like frost, heat, drought, hail, heavy rain can lead to yield reductions, e.g. through lodging or complete losses e.g. by flooding or fire. Furthermore, yields scan be reduced by weeds, pests and diseases which are fostered by increasing temperatures due to increasing generation frequency per year. Additionally, climate induced increase of pollutants such as ozone can damage crop canopies and reduce crop yields. Heat stress can reduce crop yields if the actual temperature is beyond a critical temperature during thermal sensitive phases of a crop, e.g. during anthesis of cereals. Accumulated heat stress during this period can be used as an indicator for the increasing risk of extreme heat periods for agricultural crops under climate change scenarios.

Heat affects not only crop production. Animal health depends also on optimal relations of heat and humidity. Several animal heath indices with defined critical values for cattle, pig and poultry production like the temperature humidity index (THI) or the enthalpy can be used in forecast systems to initialise measures, like inside barn irrigation and provision of drinking water to avoid the excess beyond the critical values.

3. Climate induced damages in agriculture

The important role of climate on agricultural productions is documented in several statistics mainly from insurance companies. Statistics of insurance companies like Munich-Re show an increase of weather induced damages in total number of events as well as in the economic amount across all sectors during the last three decades. Table 1 shows a selection of climatic events with significant impacts on agriculture in Germany from 1992-2002 (Lindloff 2002).

The heat summer of 2003 caused large economic losses in European agriculture from heat stress and drought which are particularly estimated for Italy, France, Germany, Spain and Austria in the order of magnitude of 4-5000, 4000, 1500, 810 and 197 million Euro, respectively (UNEP/DEWA 2004). Main production losses occurred in fodder production across all countries, maize in Italy and

France and poultry in Spain. The United Hail insurance estimated that in Germany on average 51% (389 million Euro per year) of yield losses are caused by drought followed by hail with 26% (dlz 2003). In their expert estimates of climate impact on production of important agricultural crops across environmental zones across Europe Olesen et al. (2011) identified wet conditions during sowing and harvest,

year	event	region	area	damage (Euro)
1991	Late frost (sugar beet)	Germany	44.000 ha	17,5 Mio €
1992	Early summer drought	N. and E. Germany	3.2 Mio. ha	1.750,0 Mio €
1993	Early summer drought	E. Germany	1,5 Mio. ha	600,0 Mio €
1996	Winter frost damage	NE Germany	236.000 ha	50,0 Mio €
1996	Early summer drought	E. Germany	500.000 ha	150,0 Mio €
1997	Flood	Odra lowlands	47.000 ha	15,5 Mio €
1998	Flood	Lower Rhine	15.000 ha	30,0 Mio ha
1999	Flood	Danube	35.000 ha	25,0 Mio e
2000	Early summer drought	E. Germany	1,6 Mio ha	326,0 Mio €
2002	Late frost (sugar beet)	S. Germany	19.000 ha	8.0 Mio €
2002	Late frost (rapeseed)	Altmark	20.000 ha	4,0 Mio €
2002	Heavy rain, storm	Germany	2,7 Mio ha	570,0 Mio €
2002	flood	Danube, Elbe, Mulde	196.000 ha	200,0 Mio €

Table 1: Examples for climate induced damages in agriculture 1991-2002 (Lindloff 2002)

overwintering in the northern areas and drought as main causes of limited winter wheat production while for maize drought and a limited growing season were estimated as main factors. However, there are regional differentiations as frost for maize and overwintering for wheat plays only a significant role in the Northern zones while heat stress for maize is mainly significant in the Mediterranean and Panonian zones. For the future climate change conditions experts expected an increase of risk for drought across nearly all zones, of pest and diseases in the Northern zones and weeds and a shortened growing season in the Southern parts of Europe for winter wheat and except weed risk the same holds for maize (Olesen et al. 2011). An increase of heat stress was mainly expected for the Panonian zone. Beside the direct impacts on crop yields indirect losses and damages of important production factors like increase of erosion and nitrogen losses are expected for many zones.

4. Options for preparedness

A prerequisite to benefit from an early forecast system is that the early knowledge of climatic trends opens options for a better preparedness of agriculture. While for some events, especially hazards, the options for farmers to react are very limited, e.g. for heavy rain and flooding, there are several options for others like drought, frost, hail or pest and diseases through irrigation, frost irrigation, hail nets and pest control. Table 2 shows some options to be prepared for different events and estimates for the required time of reaction. Preparedness for hail can be best achieved with hail nets. However, these measures are expensive and require a timely installation. Short term measures against hail like cloud injections are highly controversial because their on-site effects are not sufficiently proved and their off-site effects are unknown. Although the time to activate measures for protection in some cases are short, e.g. for irrigation, they require some basic investments which have to be based on a long term assessment of probabilities of their occurrence, e.g. of drought or frost events from climate change scenarios. Additionally, water availability within a landscape has to be assessed on a long term basis to ensure water management which balances the requirements of different sectors. Insurances against multiple risks in agriculture also require an assessment of their future probability based on long term scenarios. Agriculture can not only benefit from forecast of extreme events, like heat, hail or drought which is implied in the term “early warning”. There are also other options to generally reduce production risks through management decisions based on early forecasts. This include decisions on the time schedule of cultivation, e.g. modification of sowing date can consider the probability of late or early frost for spring and autumn sown crops, respectively. Early forecast may also open the option to modify the

time of harvest or hay removal within some limited time windows to prevent lodging or costs of grain or hay drying. Moreover, the change of climate factors may affect decisions on other agricultural management options. Winter frost for example plays an important role on soil structure removing soil compaction with consequences also on green house gas emissions like N_2O. Therefore, a decrease of winter frost might have consequences on soil tillage planning in agricultural management. The selection of crop cultivars which are better adapted to changed winter conditions like less snow cover which requires more frost hardiness or increasing temperatures leading to the use of cultivars with lower vernalisation requirements are possibilities of agriculture to react on a reliable seasonal forecast system. Especially for nitrogen fertilisation a forecast over several weeks would be helpful for timing and apportioning. Adeqate timing of fertiliser can avoid leaching losses through following heavy rains or reduced efficiency during dry periods. It can also help for a timely assessment of yield reductions to adapt fertilizer supply to actual nutrient demand.

event	possible measure	reaction time
Drought	Irrigation water management	1 week 3 month
Hail	cloud injection, hail net insurance	Days, weeks years
Heat (crops)	irrigation crop calendar, cultivar selection	1 week 3-6 month
Heat (animals)	drinking water, inside irrigation, air conditioning	Days, week
Frost	frost irrigation cultivation (sowing, harvest)	1 week 1-6 month
Heavy rain	fertilisation, earlier harvest (if possible)	Days, week
Floods	early hay removal, sand bags water management	Days, week month
Overwintering	cultivar selection	5-6 month
Mild winters	cultivar selection, tillage	5-6 month
Length growing season	cultivar selection	6 month
Fire index	early monitoring, personal management	Week, month
Pests/deseases	early monitoring, crop protection	Days, week, month

Table 2: weather events, possible measures and their reaction time

Regarding options for early warning there are typical measures for different time horizons of forecast. A four week forecast can be used for example for planning cultivation, irrigation against frost and drought, fertilisation (especially nitrogen), hail protection and pest monitoring and protection, fire monitoring and protection. A seasonal forecast of several months would be suitable for cultivar selection, planning of crop rotation, cultivation, water management, fertiliser and pesticide acquisition, hail nets and manure management.

4.1 Requirements on early warning systems

Efficient early warning for agriculture needs first of all that they are regularly and timely updated and disseminated. This requires a well established information infrastructure which uses multiple media for dissemination (broadcast, TV, fax, mobile phone, internet). Furthermore, the indicators which are used should be easy to understand for farmers. This requires that pure climate information has to be transformed into end users (farmers) interests e.g., by using models (e.g. for soil water availability, pest development, crop growth). Options for protective actions should be given and recommendations for actions should be linked to the forecast which have to be sufficiently proved in reality. To develop such a system the participation of the end users is an important prerequisite.

References

DLZ. 2003. Gegen Dürre versichern. Deutsche Landwirtschaftszeitung 10/2003, 116-121.

Lindloff, V. 2002. Konsequenzen aus dem Erntedebakel 2002. Neue Landwirtschaft 11(2002), 78-81.

Olesen, JE, M. Trnka, K.C. Kersebaum, A.O. Skjelvåg, B. Seguin, P. Peltonen-Sainio, F. Rossi, J. Kozyra, F. Micale. 2011. Impacts and adaptation of European crop production systems to climate change. Eur. J. Agronomy (in press).

UNEP/DEWA 2004. Impacts of summer 2003 heat wave in Europe. United Nations Environment Programme. DEWA/GRID Europe. Environment Alert Bulletin 2. http://www.grid.unep.ch/product/publication/download/ew_heat_wave.en.pdf

The need and requirements for an efficient climate early warning system - hydrological perspectives

Markku Puupponen

Finnish Environment Institute

The starting point should be stressed strongly: meteorological and hydrological communities must cooperate closely in order to produce and develop predictions and warnings on water resources. Here the meteorological input is observations and forecasts on the atmosphere processes, whereas the hydrological contribution is observations and forecasts on water resources, and also assessment of related risks. Often the development of water resources can be controlled by management. You can hardly manage the atmosphere, but you can manage water use and reservoir outflows.

Hydrological models, forecasts and warnings use both meteorological data and forecasts. In many hydrological applications, long-term or seasonal water resources predictions are needed – even if weather/climate products were nor available for that time span. Meteorological contribution is highly important for most hydrological services, and for the quality forecasting and prediction services they are crucial.

Water related hazards or damages can be developed due to natural processes such as momentary extremes (short-term forecast) or prolonged exceptional conditions (long-term forecast). But they can be also caused by human failures like poor land use planning, forecasting or management.

Long-term weather forecast has significant value for water management, if (1) there are major artificial or natural reservoirs that can be regulated, (2) there is significant water use, and the resource is scarce, or (3) prolonged exceptional hydrological conditions lead into significant potential damages. It should be noted that in densely populated areas, exceptional conditions always lead into very serious consequences. Important fields of long-term weather forecast application in hydrology are dry spells (low water levels and drought), heat waves (high water temperatures and ecological impacts), cold spells (ice and economic impacts), and high precipitations (high inflow volumes into reservoirs).

Application of long-term weather forecasts to hydrological models has been tested in large Finnish lake systems, where seasonal hydrological predictions are highly relevant and important due to large reservoir capacities and related possibilities for lake regulation. In these studies, the performance of seasonal weather forecast (90 days ECMWF Ensemble Prediction System forecast) was compared with traditional statistical weather forecast (10 days EPS plus 80 days statistical forecast based on 50 years climate, and including a temperature correction for climate change).

Figures 1 and 2 show some results of seasonal forecasts for the Lake Saimaa water level (Lake Saimaa is the largest lake of Finland). Figure 1 gives an example of a successful seasonal weather forecast and its application. A seasonal (90 day) weather forecast, made in late November 2008, proposed much higher air temperatures and precipitations than a traditional statistical forecast. As the early winter was warm and rainy, the water level forecast based on the seasonal weather forecast was very close to the observed value in late February. The rest of 2009 (air temperatures, precipitation) was rather close to long time statistical means, and therefore, the performance of statistical weather forecasts in hydrological applications was better than that of seasonal forecasts (figure 2).

It is clear that in the case of extreme conditions and biased seasonal forecasts, uncertainties of seasonal predictions are higher than inaccuracies of statistical forecasts. The more reliable seasonal weather forecasts are, the better is their performance in hydrological forecasting applications.

Water level forecasts done 25. Nov 2008

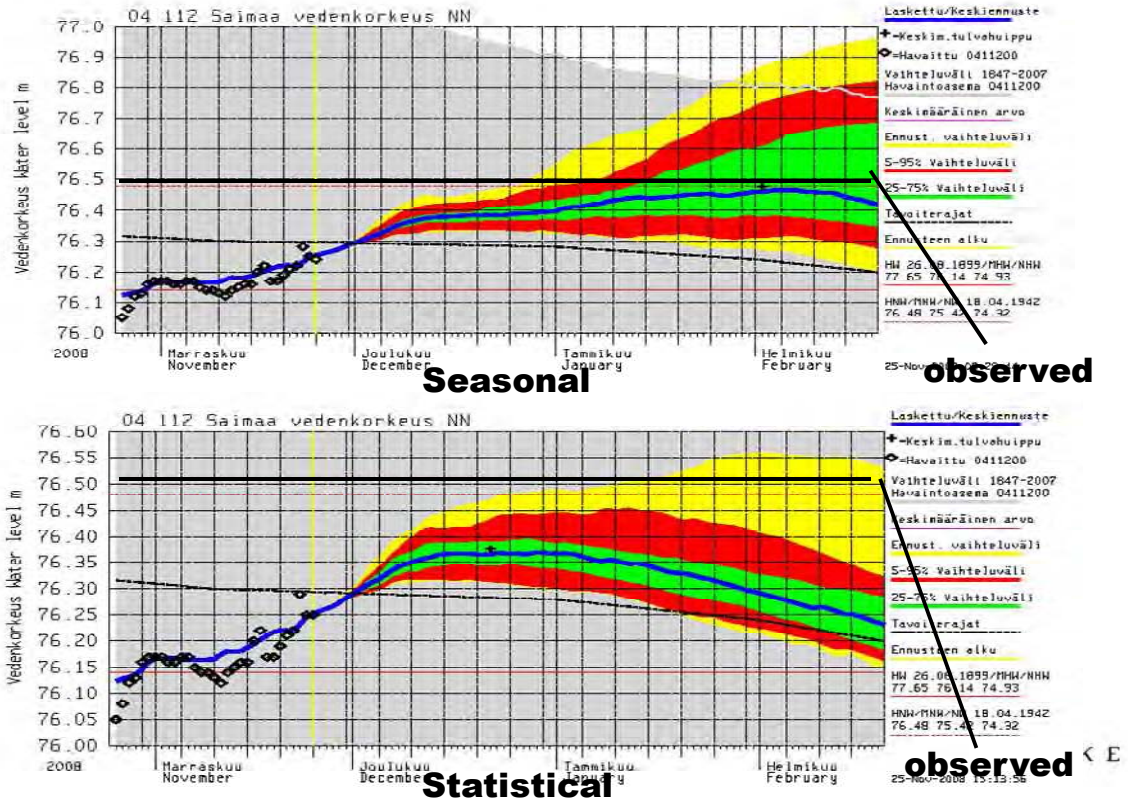


Figure 1: Comparison between two water level forecasts for the Lake Saimaa, Finland. They are based on a seasonal and a statistical weather forecast. The blue line is the mean (50 %) forecast, and in the case of seasonal forecast, the predicted water level in late February is very close to the observed value. In the case of statistical forecast, the deviation is large, as the statistical model is proposing a much too low water level.

Follow-up of the inflow forecast inaccuracy (Lake Saimaa 2009)

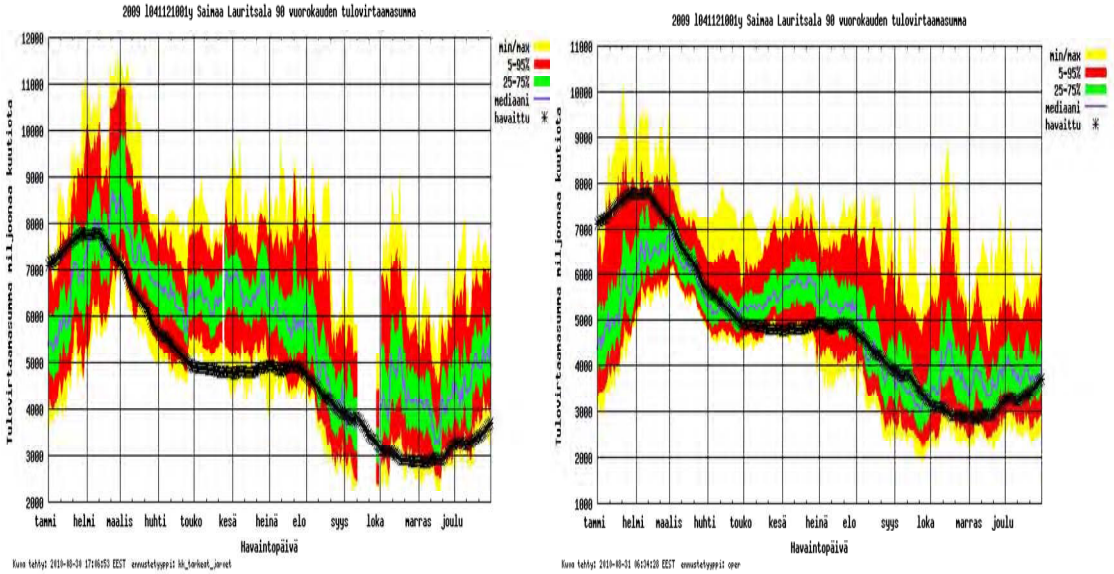


Figure 2: Daily values of 90 day inflow forecasts and the observed inflows of the Lake Saimaa in 2009. The thin blue line is the mean (50 %) the forecast, and the thick black line is the observed value. The left graph shows seasonal forecasts, and the right graph includes statistical forecasts. In the early 2009, the performance of seasonal forecasts was better, but during the rest of the year, the statistical forecast was more successful.

Components of the GFCS Climate Services Information System

Peer Hechler

WMO, Geneva, Switzerland

World Climate Conference-3 (31 August – 4 September 2009, Geneva/Switzerland) decided to establish a Global Framework for Climate Services (GFCS) to strengthen the production, availability, delivery and application of science-based climate prediction and services. The GFCS consists of five pillars mainly following the cycle of climate service generation and delivery: (i) Observations component, (ii) Research, Modelling and Prediction component, (iii) Climate Services Information System component, (iv) Climate User Interface Programme component and – as a cross-cutting component- (v) capacity building.

The Climate Services Information System (CSIS) is the component of the framework that is designed to routinely generate climate information which users need for the decisions they have to make. WMO is -and will be- contributing significantly to this GFCS component. Relevant current strengths include (i) WMO's Global Data Processing and Forecasting System (GDPFS) with twelve WMO Global Producing Centres for Long-range Forecasting (WMO GPCs) and two associated Lead Centres on Long-range Forecasting Multi-Model Ensembles (LC-LRFMME) and on Standard Verification System for Long-range Forecasts (LC-SVSLRF) as well as two designated WMO Regional Climate Centres (WMO RCCs), (ii) regional institutions, such as Drought Management Centres, the African Centre of Meteorological Applications for Development (ACMAD), the IGAD Climate Prediction and Applications Centre (ICPAC), the Centro Internacional para la Investigación del Fenómeno de El Niño (CIIFEN) etc., (iii) provision of standards and best practices, e.g. through its Technical Commissions for Basic Systems (CBS) and for Climatology (CCl), and (iv) WMO El Niño/La Niña Updates. Future WMO contributions to the CSIS comprise (i) elaboration of concepts on National Climate Services (NCSs) and National Climate Centres (NCCs), (ii) extension of WMO GPCs and WMO RCCs to cover all climatic regions, (iii) expansion of RCC operations to cover regional climate change scenarios, and (iv) development of additional global climate updates.

The following paragraphs provide a brief overview of some of the components mentioned above.

The function of WMO Global Producing Centres for Long-range Forecasting (WMO GPCs) is to provide global-scale long-range (mostly seasonal) prediction information for WMO RCCs, RCOFs and NMHSs. Their services are provided according to defined WMO standards and criteria. WMO GPC minimum products comprise probabilities for tercile categories of 2m temperatures, precipitation and sea surface temperatures (all global coverage) for forecast ranges of at least 4 months, issued at least quarterly. Associated Lead Centres on Long-range Forecast Multi-Model Ensembles and on Standard Verification System for Long-range Forecasts provide WMO GPC-related ensemble products and verification information respectively.

WMO Regional Climate Centres (WMO RCCs) are Centres of Excellence, which perform operational regional-scale climate functions in the domains of Long-range Forecasting, climate monitoring, climate data and training (all mandatory functions). Highly recommended functions comprise domains of climate projections, co-ordination, capacity building and Research & Development. RCCs are complementary to, and supportive of, NMHSs, which will deliver all warnings and national-scale products. Mandatory WMO RCC products comprise assessment of WMO GPC products, regional and sub-regional seasonal outlooks, consensus outlook statements, verification datasets, climate diagnostic bulletins, reference climatologies, regional climate data sets etc.

Regional Climate Outlook Forums (RCOFs) bring together national, regional and international climate experts, on a regular basis, to produce regional climate outlooks, based on input from global and regional producers of climate information (such as WMO GPCs and WMO RCCs) as well as from NMHSs from the region concerned. The RCOF mechanism (i) covers regions of

common climate characteristics, (ii) ensures consistency in access to, and interpretation of, climate information, (iii) facilitates close user interaction to jointly assess the likely implications of the outlooks, and (iv) provides training on Long-range Forecasting, communication of climate information etc. Currently, more than a dozen RCOFs are active around the world.

WMO El Niño/La Niña Updates have been issued on a quasi-regular basis over the past more than a decade, providing useful information on these events of significant importance to regional climate impacts around the globe. Efforts are under way to expand these Updates to a quarterly publication on the observed status and potential evolution of the global climate in terms of 2m temperatures, precipitation, Sea Surface Temperatures and significant events.

Regional WMO Climate Watch Systems are designed to detect, monitor and predict climate anomalies and related extremes, which might have a negative impact on societies. Fed by global and regional guidance products such as from WMO GPCs, WMO RCCs, RCOFs, WMO Climate Watch Systems enable NMHSs to issue related national climate advisories to users as a climate service.

WMO RA VI existing capabilities relevant to CSIS include, beside others, the WMO RA VI Pilot RCC-Network, the Southeast European Climate Outlook Forum (SEECOF) mechanism and four WMO GPCs situated in the region.

Session 2 - International and regional projects and activities relevant to Climate Watch Systems

- WMO Climate Watch System
- Global reanalysis for climate monitoring at ECMWF
- Climate monitoring and analyses in the European context
- The WMO RA VI Pilot Regional Climate Centre node on Climate Monitoring (RCC-CM): Products and Services
- The SEECOF mechanism
- South-East European Virtual Climate Change Centre Initiative - Climate watch preoperational phase

WMO Climate Watch System

Omar Baddour,
Chief Data Management Applications Division

Observing and Information System Department, WMO, Geneva, Switzerland

1. Introduction

Inter-annual variations can affect global and regional atmospheric and oceanic circulation. Many of these variations are recurrent and are usually depicted with well known climatic patterns such as the El Niño Southern Oscillation (ENSO), the North Atlantic Oscillation (NAO), warming/cooling of Sea Surface Temperatures (SST) in the tropical oceans, strengthening/weakening of the upper level Jets, etc. They correlate significantly with the departures from the mean state of climate parameters at monthly, seasonal and annual time scales and with the onset of extreme climate and weather events leading to direct and indirect consequences on lives, goods, properties and the well being of societies. Droughts, heat waves, cold waves, flooding, extreme wind storms, land slides, bush and forest fires, costal erosions to list just these are the most popular induced impacts which may be triggered by one or several of such anomalies. In the context of global warming these extremes are expected to become in the future more frequent, more severe and gaining more geographical extend than usually known (IPCC 4AR). Some of the observed increase in climate extremes already fit in these projections.

Setting up an efficient warning system against climate anomalies and related extremes has been for more than a decade a focus of the WMO and the NMHSs to improve climate risk management capabilities among nations. Such climate warning system e.g. climate watch systems are designed to provide advisories (climate watches) to inform the users, particularly those involved in natural hazards preparedness, mitigation and response on ongoing, pending and/or expected climate anomalies and their negative impacts. To this effect, National Meteorological and Hydrological Services (NMHSs) should be adequately equipped and prepared to continuously monitor and assess the state of the climate, evaluate available long range forecasts, and where conditions warrant provide to the users concise and understandable climate early warning information at weekly, 10-day, monthly, and seasonal time scale.

The Commission for Climatology in its thirteenth session (CCl-XIII) in 2001 recognized the need for enabling the delivery reliable warnings and monitoring products, of extreme events related to climate and investigating the development of climate watch systems.
WMO Congress-XIV, 2003 emphasized the importance of eliminating confusion and of minimizing duplication in the provision of operational products related to warning services and requested CCl with CBS to develop a guideline for climate watch systems. The guideline was published in 2004 and aimed at providing the essential elements of a climate watch system including its technical components as well as organizational aspects (WCDMP-No.58, WMO-TD No. 1269). Furthermore the commission for climatology in its fourteenth session clarified some definition aspects of a climate watch and made clarification about responsibilities for issuing climate watches:

(a) Climate watch was a system consisting of a set of functions and responsibilities, providing information on the status of climate, and foremost on its possible negative impacts;

(b) The climate watch system did not imply or require creation of new entities to run climate watch activities;

(c) Climate watch advisories were to be issued by NMHSs to their users;

(d) Regional climate entities would assist NMHSs by providing regional climate products to NMHSs.

The guidelines and the clarification of CCl paved the way toward the start of implementation of the system at regional and national levels. In this regards, WMO congress issued Resolution 12 (Cg-XV) 2007 on WMO priorities on climate monitoring which included the implementation of climate watch systems.

The need for moving from "crisis management" to implementing anticipatory measures "risk management" against extreme climate events with high socio-economic impacts, the major advance in the scientific understanding of the processes and causes of inter-annual climate variability, and the improved technical ability in observing, monitoring and predicting the state of the climate constitute the main justification of proceeding with climate watch implementation.

Example of annual average impacts during the period 1980-2008 caused by heat waves and cold waves recorded (source http://www.preventionweb.net)

Impacts	Heat wave	Cold wave
Average number of people affected per year	159,118	6,875,103
Average economic damage per year (US$)	758,000,000	203,000,000

2. Concept of Climate Watch System

A- Purpose of an operational Climate Watch System:

- To monitor climate anomalies and related extremes;
- To produce and disseminate climate advisories (climate alert bulletins) on significant ongoing or foreseen climate anomalies;
- To heighten awareness among relevant users to initiate preparedness measures;
- To interact with the users prior, during and after the Alert episode

The routine tasks are based on climate monitoring, long range forecasting and producing outputs and services enclosing the issuance and dissemination of climate advisories (climate watches) to the user communities on ongoing or foreseen climate anomalies. The characterizations of these tasks are considered below:

2.1 Climate monitoring

The availability of quasi-real-time and historical climate observations is necessary for an efficient monitoring and forecasting of extreme climate events. Monitoring climate extremes usually requires high-quality and high resolution data. Therefore a good quality observation network able to capture the space and time features of climate events is necessary. At national level, such network should be manageable in an integrated way including central real time data collection system and robust climate data management facilities. This infrastructure should enable a quick access and retrieval of current and historical data along with adequate applications to perform climate analysis to the required accuracy. Climate data bases and users data bases need to be set up together to analyze climate hazards and related impacts; the use of GIS helps integrating both data bases in an efficient manner and allows customized criteria for climate watches. Climate monitoring has been strengthened by using space based observations which provide useful environmental information needed to assess the intensity and the extent of climate related hazards. In RA-VI there are advanced infrastructure and facilities providing useful climate monitoring products and services; e.g ECMWF in Reading, UK, the RA-VI RCC network including climate monitoring node at the Deutscher Wetterdienst (DWD) in Germany as well as the Eumetsat-Satellite Climate Monitoring Facilities, CM-SAF at DWD

2.2 Long range forecasting

The system uses also long range forecasting products which are provided by Global Producing Centres (GPCs), Regional Climate Centres (RCCs); and consensus forecasts provided by the existing regional mechanisms such as the Regional Climate Outlook Forums (RCOFs) should be considered whenever made available. Adaptation and downscaling of these products at the scale pertinent to the geographical scope covered by climate watches are also required and should be based on scientifically sound techniques and methods. For RA-VI, some of these facilities and mechanisms have been operating for several decades, including the ECMWF and the RCC Network including a node on Long range Forecasting, and the establishment recently of the South Eastern Europe Climate Outlook forum (SEECOF)

2.3 Outputs

The outputs of a climate watch system include initial climate watches outlining the ongoing and/or expected climate anomaly; updating statements at users-agreed time intervals informing them on the progress of the anomaly; and final statements stating the expiration of the warning. The content, format and dissemination plan of climate watches should consider specific purposes and geographical scope as required by the target users. It is also important that the system includes a verification procedure of its performance and that verification should be carried systematically as an integral part of the system operation. Users should be informed on the verification results on regular basis. This enables building a trust between the issuing organization and the users and to assess the effectiveness of the criteria which were jointly set up with them. On the long term the verification allows a knowledge asset needed for performance improvement.

Example of a climate watch

Australian Government
Bureau of Meteorology

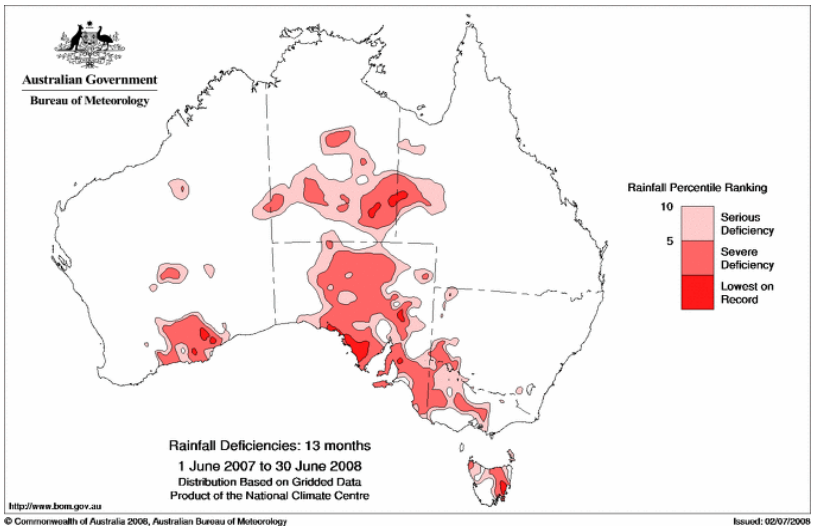
INITIAL CLIMATE WATCH
Bureau of Meteorology National Climate Centre

CLIMATE WATCH FOR RAINFALL DEFICIENCY
Climate Watch valid for South Australia and western Victoria.
Issued on 3rd July 2008
Valid until 4th August 2008

Areas of serious to severe rainfall deficiencies across South Australia and western Victoria are likely to persist during the coming season. Most of SA and western Victoria have recorded rainfall totals in the lowest decile range for the thirteen-month period from 1st June 2007 to 30th June 2008. The outlook for the next three months, July to September, derived from the Bureau of Meteorology's statistical forecast model, shows that the chance of exceeding the median rainfall is only between 30 and 40% for these areas affected by rainfall deficits. Outlook confidence for this forecast is moderate over northern and central SA, with a skill level of around 60%. The confidence level for western Victoria low, although in several areas the July to September rainfall total would need to be decile 8 or higher for the deficits to be removed.
These figures meet or exceed the criteria for a rainfall deficit Climate Watch for this region, being:

- Rainfall for the past three or more months: decile one or lower.
- Chance of rainfall being greater than the median: 40% or lower.
- Forecast skill score: 55% or greater.

Climate situation: Sea surface temperatures in the central equatorial Pacific have gradually increased over the previous two months and are now generally close to average. The final remnants of the 2007/08 La Niña event continue to linger in the western Pacific, although the overall ENSO state is rated as neutral. A majority of computer models in a recent survey indicated that neutral conditions are likely to persist for the next three to six months. However, these same models show that a positive dipole of Indian Ocean temperatures (IOD) may persist for a few more months. This phase of the IOD has been linked with reduced rainfall over central and southeastern Australia. This Climate Watch is expected to be updated on or before 4th August 2008. For further information please contact Grant Beard (03) 9669 4527



Warning message

The heading

INITIAL CLIMATE WATCH

Issuing organization

Bureau of Meteorology
National Climate Centre

Name of warning, Area affected, Date and time issued, Period of validity

CLIMATE WATCH FOR RAINFALL DEFICIENCY
Climate Watch valid for southwest Queensland, northwest New South Wales.
Issued on 2 March 2004
Valid until 2 April 2004

Text

Please be aware of expected severe rainfall deficiency over the area of southwest Queensland and northwest New South Wales. This region has experienced rainfall in the lowest decile range averaged over the last three months. The outlook for the next three months, derived from the Bureau of Meteorology's statistical forecast model, suggest that the chance of exceeding the median rainfall is 30% for this region. Outlook confidence for this forecast is particularly high, with a skill level above 65%.

These figures meet or exceed the criteria for a rainfall deficit Climate Watch for this region, being:

- Rainfall for the previous three months: decile one or lower.
- Chance of rainfall being greater than the median: 40% or lower.
- Forecast skill score: 55% or greater.

Climate situation

Climate situation: Sea surface temperatures in the central equatorial Pacific have increased over the previous two months. There is the strong chance that warm state ENSO conditions are likely to eventuate. Eight out of twelve computer models surveyed suggest the likelihood of El Niño by June 2004. There is a strong relationship between El Niño and low rainfall in this region for this time of the year.

Information on update advice, NMS contact details

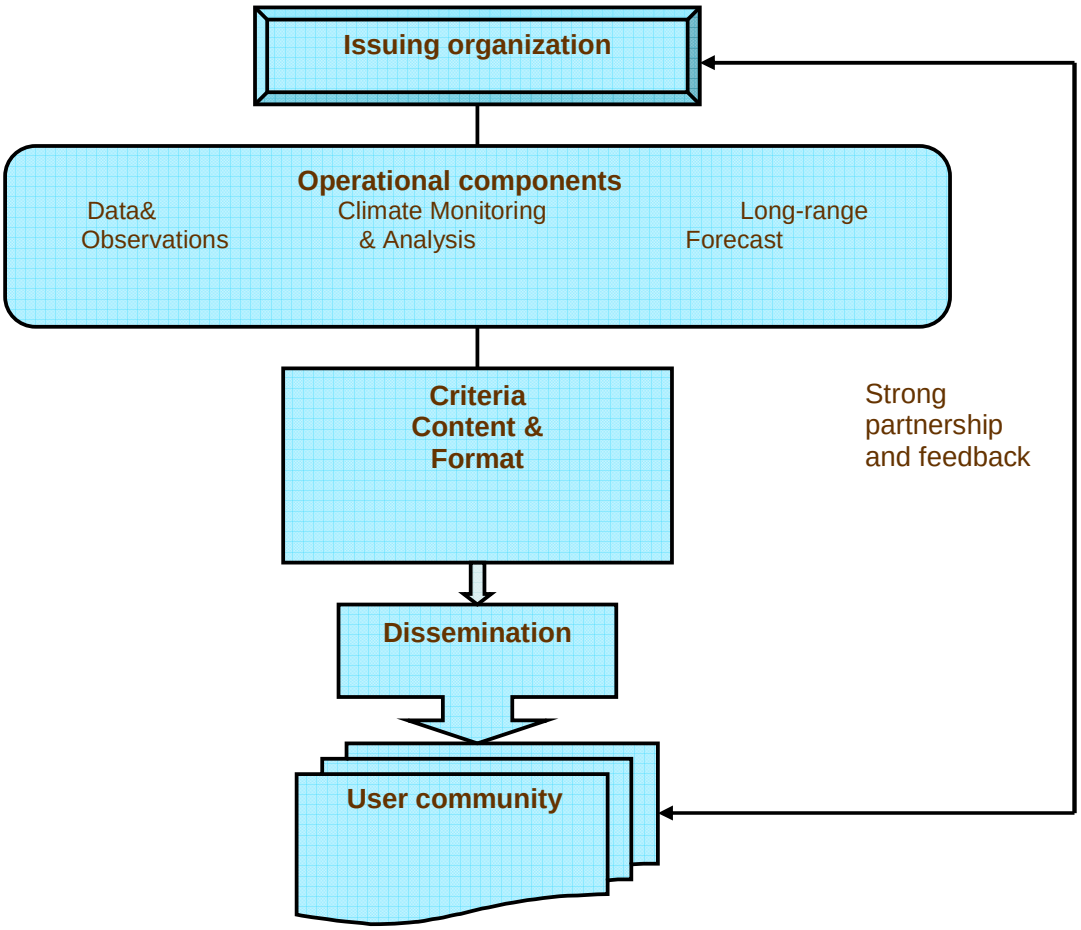
This Climate Watch is expected to be updated on or before 2 April 2004.
For further information please contact Grant Beard (03) 9669 4527

List of attachments

Attachments:

- Regional map highlighting the area covered by this Climate Watch
- Rainfall decile map of Australia for the most recent three months
- Latest seasonal climate outlook
- Rainfall skill map covering the coming three months
- Map of recent weekly sea surface temperature anomalies for the Pacific
- Plumes of forecast Nino3.4 sea surface temperature anomalies

B - Requirements of a CWS



The issuing organization (NMHS) needs to meet a minimum set of requirements for operating climate watch. It should be able to run the following climate functions on operational basis:

- Provide timely observations of current climate conditions for their areas of responsibility and adequate historical climate data;
- Perform timely monitoring and analyses of current climate anomalies;
- Access to current global climate forecasts and the technical capabilities to interpret and downscale them to their region;
- Deliver probabilistic climate forecast products that are understandable by the user community;
- Continuously update records of past forecasts and analyses of past forecast performance;
- Employ effective methods for the routine dissemination of climate information to user groups and sectors;
- Develop active collaboration and feedback mechanism with the user community to provide guidance for the design of climate watches and evaluate their effectiveness.

If some aspects of these requirements are lacking, they need to be developed. There are two aspects to consider simultaneously when planning for building capacity in climate watch systems. One aspect includes those activities required to ensure that NMHS personnel have the capabilities to operate climate watch system. The second is building capacity of the users which requires dedicated and sustained efforts that are best achieved by regular interaction and partnership. This aspect needs a parallel outreach program to ensure an adequate use of the system outputs and understand its limitation and where improvements are expected to be made.

4. WMO Supporting programmes and activities

4.1 Global products

At global level, the WMO World Climate Data and Monitoring Programme (WCDMP) facilitate the international efforts in climate data and climate monitoring. It produces the WMO annual statements on the status of the global climate which highlight major global and regional climate anomalies occurring during the year. This publication and others provide users which operate at global, regional and national level useful information with respect to the geographical extent and time frame of various climate extremes such as droughts, heat waves, flooding, heavy precipitations and tropical cyclones. In parallel, efforts have been taken to build NMHSs capacities in climate data management, data rescue and, currently in implementing climate watches in developing and least developed countries.

Since 1997 WMO has been issuing the “El Niño Update”, it is the fruit of cooperation between WMO and the International Research Institute for Climate and Society, with contributions from many meteorological services and regional centres and organizations. The El Niño updates are coordinated by the WMO World Climate Applications and Services Program (WCASP). On another hand, WMO has established procedures and guidelines for the designation of WMO Regional Climate Centers (RCCs). These centres are the main regional WMO operational climate institutions which provide regional products e.g. climate analysis, long range forecasts as well as regional data sets and maps. These products serve as input to operate climate watch systems by NMHSs at national levels. RCC designation process has already started in region II and VI.

4.2 WMO regional workshops on climate monitoring including the implementation of climate watch systems

The WMO executive Council (EC-58, 2006) called WMO to assist in developing regional seminars and workshops on climate monitoring and watch systems in the regions. The goal is to ensure that NMHSs and regional climate institutions make use of best practices in delivery, provision and evaluation of climate watch advisories, and implement best practices in managing efficiently and seamlessly the interaction among the three involved parties: Regional institutions, NMHSs and Users. The workshops have typical structure of 4 days agenda covering global, regional and national presentations. The structure includes parallel working group session to address the implementation aspects considering the regions specific concerns and requirements.

DAY 1
Key lectures on rising awareness
Climate variability and climate change; key issues Climate variability and climate change; regional perspective Extreme climate events risk assessment and management including user need Climate Watch Systems: Concept, purpose and requirements
International and Regional projects and activities relevant to Climate Watch Systems.
Climate monitoring, available products and ENSO Alert Systems Long range forecasting; Methodologies and available products Regional climate institutions
Day 2
Countries presentations on the status and priority needs of monitoring and predicting climate anomalies and extremes
- Climate Data and Observation, Climate Monitoring, Long range forecasting systems and methods - User activities in support of Climate Risk management and early warning systems including - Data bases and, preparedness and mitigation procedures (for drought, flooding, heat waves, heavy precipitations, dry spells, cold waves, etc…)
Panel Session: Addressing sector vulnerability, needs and requirements for early warning, communication mechanisms, and timeliness of climate advisories. Focus is made on the following extremes: > Extreme precipitations including snow extremes and flooding > Extreme wind storms > Heat waves > Dry spells and droughts
DAY 3
Parallel Group session
GROUP I: Format, content and dissemination of climate advisories
GROUP II: Basic infrastructure requirements and needs for climate watch implementation
GROUP III: User aspects
GROUP IV: Research and development
DAY 4
Presentations of the WGs conclusions and adoption of the action plan

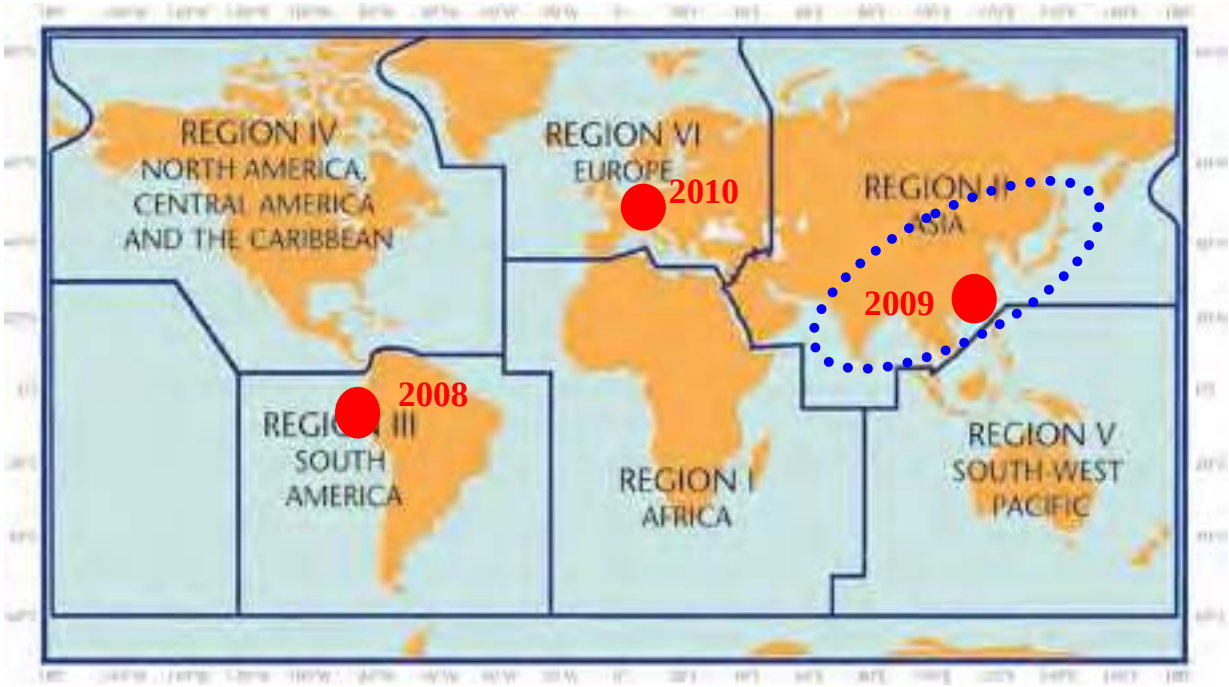


Figure: Workshops organized in 2008 - 2011

4.3 Perspective for 2011-2014

1 - Complete the Workshop series to cover all regions
2 - Follow-up on implementation of CWS through RA WGs and review workshops
3 - Development of knowledge w.r.t definitions, methodologies and standards for climate extreme events
4 - Development of standard template for national climate monitoring products

Global reanalysis for climate monitoring at the European Centre for Medium-range Weather Forecasts (ECMWF)

Paul Poli and Dick Dee

ECMWF, Shinfield Park, Reading, RG2 9AX, United Kingdom
http://www.ecmwf.int/research/era

1. Introduction

Since its creation more than thirty years ago, the European Centre for Medium-range Weather Forecasts (ECMWF) has consistently improved its capacity to monitor and predict the weather to serve the needs and requirements of its Member States, partners, and clients. At the core of this capacity are a numerical weather prediction model and a data assimilation system, supplied with observations, collected world-wide and exchanged under the auspices of the WMO and then archived at ECMWF, using large computing and data storing facilities. Monitoring and predicting the weather has resulted in long time-series of products, increasingly used as proxies for long-term records, reaching beyond the traditional synoptic weather community of founding members.

2. Global reanalysis

2.1 Rationale

Monitoring the global weather at ECMWF is achieved by the continuous operation of a real-time data assimilation and prediction system. However, the succession of revised and improved practices in this area over time means that the products generated in this fashion also inherit upward jumps in quality over time. This hinders their application in climate studies. To alleviate that problem, the analysis of past observations up to the present times is regularly repeated in a consistent fashion, using a method called reanalysis, whereby a fixed version of a data assimilation and prediction system reanalyses several decades of observations.

2.2 Methodology

The data assimilation methodology used to extract information from the observations in reanalysis brings about various advantages. The observation error assumptions on precision (standard deviation of the error) and accuracy (bias of the error) are explicit (i.e., not ignored) in the data assimilation methodology; we note that it is otherwise generally difficult to account for such uncertainties in climate studies in a comprehensive and systematic way. The quality control rules to screen observations are set for the entire duration of a reanalysis and decisions are mostly observable-dependent; this guarantees an equal treatment of all observations of a given type. The reanalysis gridded products feature no gaps in time or in space and are consistent in space and between the various analyzed variables (wind, temperature, humidity, surface pressure); these products are thus used to better understand climate variability and explore spatial/time/cross-variable relationships. One may point for example to the great recent improvements regarding weather variability in Europe and the influence and regimes of the North-Atlantic Oscillation – such research greatly relied on reanalysis datasets. Finally, the residual fit of the reanalysis to assimilated observations is a very good indicator of the quality of the gridded products and the observations; these residuals can thus be exploited to further understand discrepancies in the observing system, and also to isolate natural phenomena that are not understood (observed, but not present in the gridded products)

2.3 Reanalysis projects and ERA-Interim

Past reanalyses at ECMWF include the First Global Atmospheric Research Program Global Experiment (FGGE, covering 1979-1980), ERA-15 (covering 1979-1993), ERA-40 (covering 1957-2002), and now ERA-Interim (covering 1989 to the present). The extension of ERA-Interim in near-

real-time runs twice: a first-look with a one-day lag catches possible observation ingest problems, while the production runs ten days later. That production can be rerun in case of problem before the products are disseminated. The products are released with a lag of two to three months. This procedure yields one month of verification available ahead of each additional month validated for release. Overall this procedure means that products are inspected three times.

2.4 Applications and users

The continuation of ERA-Interim products into the present allows users to rely on a 21+-year product depth. This makes it possible for them to develop applications for further downstream users who need to put weather events into the climate context. Overall, as of November 2010 there are more than 5000 registered users of ERA-Interim, working in various fields, such as weather, climate, insurance, disasters, health, industry, water, energy, ecosystems, agriculture, biodiversity. A user survey will be planned to determine the proportions of these various applications.

2.5 Climate monitoring application

One indication of the recognition of reanalysis as a viable tool for climate monitoring is given by the climate community itself. The State of the Climate, published yearly by the American Meteorological Society and the U.S. National Oceanic and Atmospheric Administration (NOAA) features in 2010, for the first time, maps of anomalies for the previous year (2009) for lower-tropospheric temperatures generated by a reanalysis (ERA-Interim). Table 1 shows the essential climate variables (ECVs) considered in that issue for global maps. Reanalysis can in fact produce 10 out of the 12 ECVs considered. So far, only 4 of them have been compared to in situ observations.

Essential Climate Variable	Reanalysis product?	Comparison of reanalysis product to in situ data conducted?
Lower stratospheric temperature	Yes	No
Lower tropospheric temperature	Yes	Yes
Surface temperature	Yes	Yes
Cloudiness	Yes	No
Total column water vapour	Yes	No
Precipitation	Yes	Yes
River discharge	Yes	Yes (a few basins)
Mean sea-level pressure	Yes	No
Wind speed	Yes	No
Ozone	Yes	No
Fraction absorbed photosynthetically active radiation	No	N/A
Fire radiative power	No	N/A

Table 1: Essential Climate Variables (ECVs) shown in State of the Climate in 2009, Plate 2.1

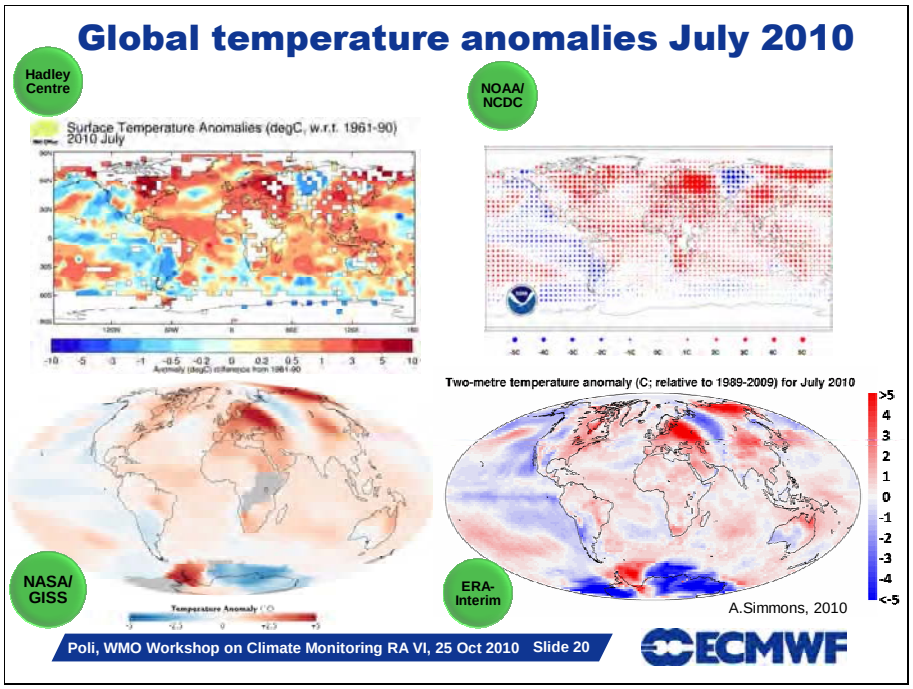


Figure 1: Temperature anomalies from various sources (in situ data for the Hadley Center, NOAA/NCDC, and NASA/GISS), and ERA-Interim. Note the great similarities between the patterns (though the climatology reference time periods are different), such as, for example, the heat wave over Western Russia, and the cool pattern over central Russia

2.6 Conclusions and future directions

Reanalysis leverages on past investments and practices in meteorology; this activity consequently increases the value returned to societies in their maintaining and operating a Global Observing System (GOS). Thanks to studies that have demonstrated its viability to reconstruct observed climate variability, the awareness of the importance of reanalysis to complement traditional climatology is rising. However, plans for sustained global reanalysis are yet to be finalized. Also, the quality of reanalyses is ultimately limited by the availability of good quality observations and so depends on continued observation collection practice.

The continuation of reanalysis in near-real-time enables users to quickly realize the climate importance of weather events, and could become a resource to help develop tools to assist in hedging weather risks, including in the framework of a changing climate.

Improving the quality of reanalysis for dates before the well-observed satellite era (1979-onwards) has led reanalysis communities to engage and promote data recovery efforts. An example is the 20th Century Reanalysis project with the ACRE initiative. The ERA-CLIM proposal (tentative dates 2011-2013) coordinated by ECMWF will also engage in this direction with partners including Russia, focusing on upper-air observations before the International Geophysical Year (1957).

References

Arndt, D. S., Baringer, M. O., and Johnson, M. R., Eds., (2010) 2010: State of the Climate in 2009. Bull. Am. Meteorol. Soc., 91 (7), S1-S224

Dee, D. P., and Co-authors (2009) ERA-Interim for climate monitoring. ECMWF Newsletter, 119, pp 5-6

Uppala, S. M., and Co-authors (2005) The ERA-40 re-analysis. Quart. J. Roy. Meteorol. Soc., 131, pp 2961-3012

Climate monitoring and analyses in the European context

Gé Verver and Albert Klein Tank

Royal Netherlands Meteorological Institute (KNMI)

Systematic observations of climate variables are critical for our understanding of the processes that determine the climate. Knowledge on long term trends and climate extremes are increasingly needed because of the potential impacts on society. Long series of observational data are used to put extreme events in historical perspective. Observations are also needed to verify and calibrate models and satellite instruments. Reliable model projections of future climate can only be made with models showing good skill in representing current and past climate, demonstrated by a comparison of model data with observations.

An illustrative example is the exceptionally hot European summer in 2003 (figure 1), which led to a large number of heat-related deaths. These high temperatures did not occur in a control run by a regional climate model covering the last 30 years and also not in European observations over the last 140 years (Schär et al. 2004). Climate models however project that these temperatures will be close to normal by the end of the 21st century.

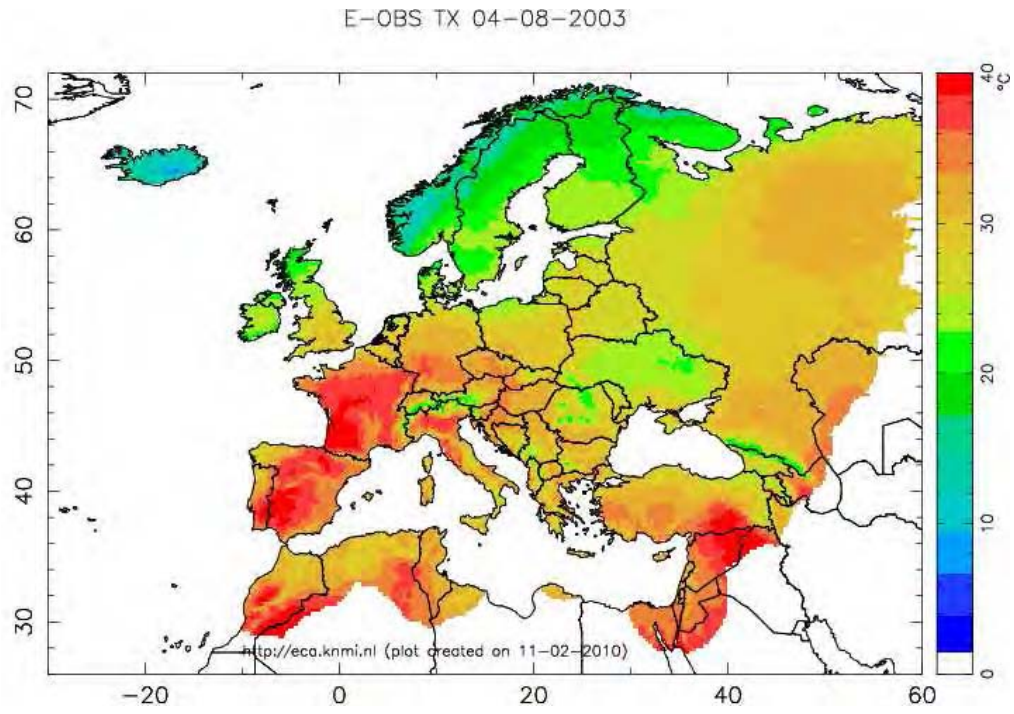


Figure 1: Maximum temperature on the warmest day (averaged over the entire domain) in Europe: 4 August, 2003. (Source: E-OBS, KNMI).

<u>European Climate Assessment and Dataset</u>

Current surface in-situ data provide information often with high precision and time resolution. Even in the satellite era, surface observations contain essential information that cannot be provided by other platforms. Valuable information on the history of European climate is provided by the European Climate Assessment and Dataset (ECA&D, http://eca.knmi.nl). Extreme events in Europe with large impacts are put in their historical context. For every ECA&D station, a total of 50 indices have been calculated that can be accessed via the web in a user-friendly way. Each index describes a particular characteristic of climate change (both changes in the mean and the

extremes). An example product is given in figure 2, showing the anomaly of the number of frost days in January, 2009.

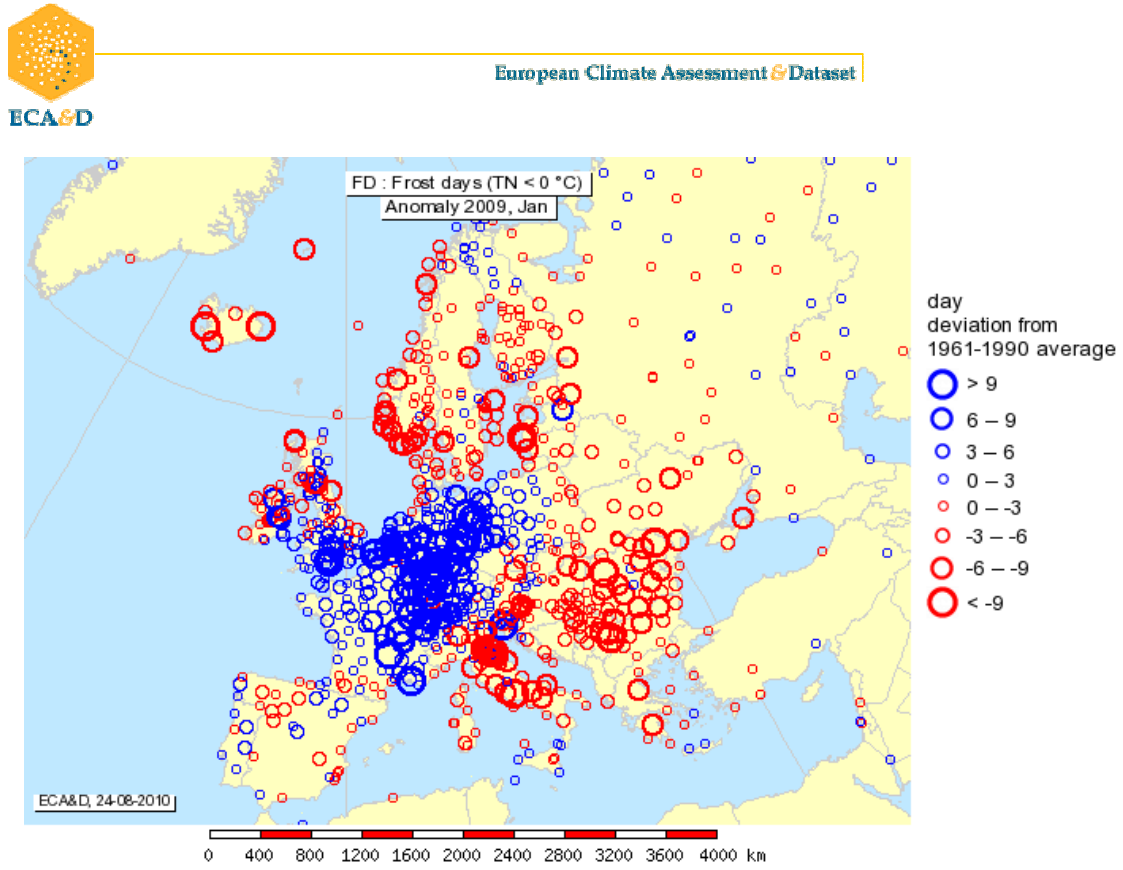


Figure 2: A particularly cold spell over western Europe occurred in the winter of 2008/09. This picture shows the number of frost days in January, 2009, where the minimum temperature is below 0℃. Large parts of Central Western Europe show 10 more frost days in January 2009 compared to the long term average (Source: ECA&D)

E-OBS

Daily gridded observational datasets for precipitation and temperature in Europe are made available in the E-OBS database (http://eca.knmi.nl). It has originally been developed as part of the ENSEMBLES project (EU-FP6) and is now maintained and elaborated as part of the EURO4M project (EU-FP7, see below). European temperature depicted in figure 1 is an example of such a gridded data product.

Observations from space

Satellites provide a vital means of obtaining observations from the climate system. Over the oceans and sparsely populated areas satellite instruments are often the only data source. An example of a high-resolution precipitation product for Europe from the Meteosat SEVIRI imager is given in figure 3.

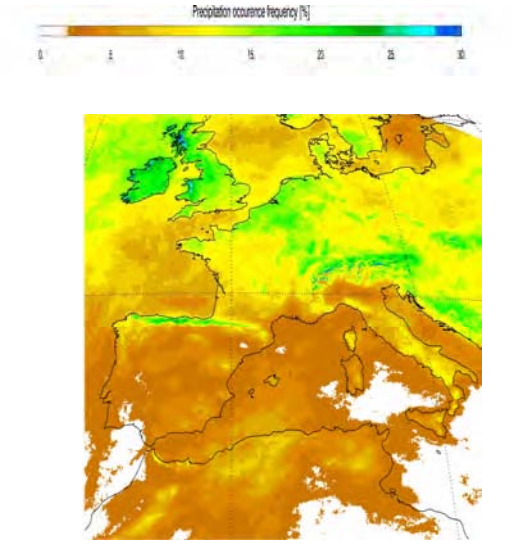


Figure 3: The percentage of time in which precipitation occurred, as derived from SEVIRI for the period May to August 2006. Western Europe and mountainous regions stand out with a relatively high percentage of wet days (Source: KNMI).

EURO4M (European Reanalysis and Observations for Monitoring, http://www.euro4m.eu) is an EU funded project that combines observations from satellites, ground-based stations and results from comprehensive model-based high-resolution regional reanalyses. EURO4M is a collaboration of 9 European partners, lead by KNMI, and runs from April 2010 until March 2014.

The innovative and tailored products and the high-resolution datasets that are produced by the EURO4M project improve the climate change services for society and support adaptation to a changing environment. Whilst EURO4M provides time series showing the changes in climate over time, the project also enables to report in near-real-time during emerging extreme events.

EURO4M is an important building block for GMES (Global Monitoring for Environment and Security), the European initiative for the establishment of a European capacity for Earth Observation.

The WMO RA VI Pilot Regional Climate Centre node on Climate Monitoring (RCC-CM): Products and services

Peter Bissolli

Deutscher Wetterdienst (DWD), Offenbach, Germany

1. Introduction

Regional Climate Centres (RCCs) are centres of excellence that assist WMO Members in a given region to deliver better climate services and products and to strengthen their capacity to meet national climate information needs. The RCC node on Climate Monitoring (RCC-CM) in WMO RA VI offers the following kinds of products:

- ➔ climate maps (visualisation)
- ➔ climate time series, trends, diagrams, statistics
- ➔ reports (reviews, significant weather events, climate assessments)
- ➔ climate watch (warnings of upcoming climate events, in development)

This means that the RCC-CM does not provide "raw" climate data (this is done by the RCC node on Climate Data), but evaluated products which show information of added value compared to the data themselves.

The services of RCC-CM comprise the production and distribution of climate monitoring products and information. These can be products concerning the whole WMO RA VI or a sub region of it. National climate monitoring products (concerning only one country of RA VI) are not generated by the RCC-CM as this is already done by the National Meteorological and Hydrological Services (NMHSs) themselves, but these national products can be distributed via the RCC-CM to other NMHSs, other RCC-nodes, RCCs of other Regions, global monitoring centres, or, if agreed by the NMHSs, also to the general public. In addition, the RCC-CM services also include information and guidance on methods and products, co-operation with other RA VI activities and training, research and development of new products.

In RA VI, the RCC is a network with each node consisting of a consortium of RA VI Members and one or two Members acting as a leading centre. In the case of RCC-CM, the NMHS of Germany (Deutscher Wetterdienst, DWD) has been nominated as the leading centre. The other consortium members (in alphabetical order of the countries) are the following NMHSs: Armstatehydromet (Armenia), Météo France (France), KNMI (Netherlands), the Republic Hydrometeorological Service of Serbia (RHMS) and the Turkish State Meteorological Service (TSMS).

2. Product overview

RCC-CM products are defined in detail in the implementation plan of the RA VI RCC network. In the following, just an overview of already existing products shall be given.

2.1 Web distribution platform

A new RCC-CM website has been set up under the DWD domain www.dwd.de/rcc-cm . It contains the relevant documents, recent news, contact details of the consortium members, information about meetings, some further links and, last but not least, an access to the products.

Part of this new site is the portal ECSM (European Climate System Monitoring): www.dwd.de/ecsm. This portal gives access to most of the RCC-CM products which are distributed by DWD. Here one can find the annual and monthly RA VI Bulletins, reports of significant weather events, maps for the whole RA VI (generated at DWD) and national maps (generated by NMHSs and mostly linked with national web servers). Presently (November 2010), 24 countries contribute regularly to ECSM with monthly, seasonal and annual maps of temperature, precipitation and sunshine duration (actual means/sums, anomalies and normals). These national maps are based on the national station networks and show more details than the maps for the whole RA VI.

2.2 Annual and Monthly Bulletins

Monthly Bulletins are based on information compiled from monthly maps and data available at DWD and web sites of the NMHSs of RA VI. They comprise maps and descriptions of anomalies of temperature, precipitation, sunshine duration, air pressure, sea surface temperature and circulation indices, a list of monthly data and significant weather events. They can be seen as a first overview about the preceding month. A first version is issued on the 15th of the following month, which can be updated later in the month if additional information becomes available. The Monthly Bulletins are distributed via the web only (ECSM website, see above) as PDF files. Seasonal bulletins are in development.

After a year has passed, the monthly bulletins are compiled to the “Annual Bulletin on the Climate in RA VI”, and supplemented by additional information from contributions provided annually by the NMHSs via mail. The Annual Bulletin is distributed both via the web and as a printed version to all NMHSs of RA VI each summer for the preceding year. DWD has co-ordinated this WMO publication for more than 15 years now.

A shorter and more preliminary version of the Annual Bulletin (due to a shorter deadline) is provided to the publication “State of the Climate”, issued via the Bulletin of the American Meteorological Society (BAMS). This BAMS article, which is peer-reviewed, is an annual climate review for the whole globe. RCC-CM co-ordinates the Europe section together with the UK Met Office by compiling contributions of NMHSs and some co-authors from various countries of RA VI.

A first overview about the climate of the preceding year is given in the “WMO Statement on the Status of the Global Climate”, issued by the WMO at the end of March of the following year. A press release is given already at the end of the preceding year with a first outlook. RCC-CM also contributes to this publication based on information as far as available at DWD and from other countries. As requested by German speaking authorities, the WMO Statement is also translated into German by DWD.

2.3 Monitoring maps

Monthly, seasonal and annual maps for the whole RA VI are generated by DWD for various climate elements, based either on in situ station data internationally available (CLIMAT, SYNOP) and spatial interpolation, or on satellite data. Precipitation maps are contributed by the Global Precipitation Climatology Centre (GPCC), and from these gridded data also maps of drought (a modified Standardized Precipitation Index) are derived.

In addition, a large number of maps are provided by the other consortium members of RCC-CM. Météo France generates global maps of various climate elements based on model data, including wind and humidity. KNMI provides various maps for Europe based on the known ECA&D data and

the E-OBS gridded dataset; this also includes a large variety of climate indices such as the number of summer days, frost days etc. and also trends of these indices.

The other consortium members (Serbia, Turkey and Armenia) are specialised to sub regional products. Serbia provides maps for southeast Europe, Turkey for the eastern Mediterranean and Armenia for the south Caucasus region. These maps are valuable supplements to the products for the whole Region because the climate of RA VI is much diverse and the sub regional maps provide a focus to the special details and peculiarities of the corresponding sub regions.

2.4 Reports of significant weather events

Significant weather events, although occurring often on a short timescale, are an important part of climate variability and can contribute considerably to monthly and even seasonal anomalies. The event monitoring is still in development at DWD, but some assessments of selected outstanding events (e.g. heavy rain, cold and heat waves) are already provided and distributed via the ECSM web site, based on national web information or own evaluations.

2.5 Training and capacity building

The Turkish State Meteorological Service offers some training courses on various climate-related fields. A recent example was a course of climatological applications in Alanya in June 2010,

3. Future plans: Climate watch

Climate Watches are an important mandatory product of RCC-CM. These are warnings of upcoming dangerous climate events on the basis of both monitoring and forecast products. During the WMO Climate Watch Workshop in Offenbach (October 2010), a first framework has been elaborated. It is planned to organise some pilot climate watch activities to gain experience with this quite new matter. Climate watches should be issued on a national level, satisfying the various users' needs, but RCC-CM should offer some guidance based on solid climate diagnostics. The main challenge is that the predictability of climate events is limited, particularly for Europe, and that various time scales (middle range forecast up to seasonal and climate forecasts) are to be considered.

The South – Eastern Europe Climate Outlook Forum (SEECOF) mechanism

Anahit Hovsepyan

Co-chair of the RAVI Working Group on Climate and Hydrology

1. Regional Climate Outlook Forum (RCOF): General concept

RCOF is a major component of WMO Climate Information and Prediction Services (CLIPS) project activities. RCOF Concept was pioneered in Africa in 1995 and spread worldwide. Its' growth and expansion was supported by WMO, national, regional and international organizations such as NOAA, IRI, Meteo France, World Bank, etc.
At present RCOFs operate in many parts of the world, serving mainly developing countries. These are as follows:

GHACOF	Greater Horn of Africa COF
SARCOF	Southern African Regional COF
PRESAO	Prévision saisonnière en Afrique de l'Ouest (Seasonal Prediction for West Africa)
PRESAC	Prévision saisonnière en Afrique Centrale (Seasonal Prediction for Central Africa)
FOCRAII	Forum on Regional Climate Monitoring, Assessment and Prediction for Regional Association II (Asia)
SSACOF	South-east of South America COF
WCSACOF	Western Coast of South America COF
FCCA	Foro Regional del Clima de America Central (Regional Climate Outlook Forum for Central America)
PICOF	Pacific Islands COF
SEECOF	South-eastern Europe COF

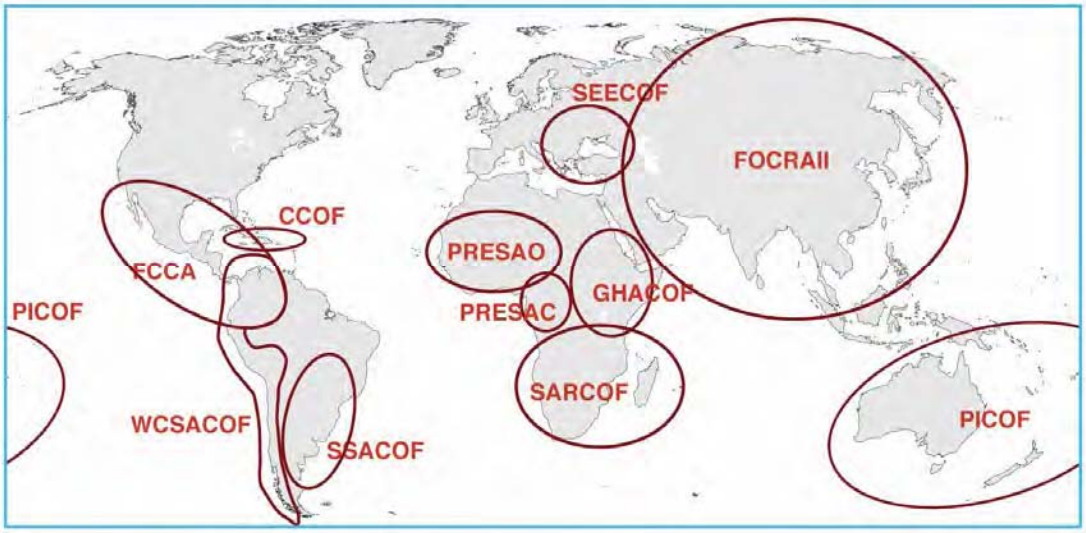


Figure 1: Regional Climate Outlook For a worldwide

Climate information including predictions/outlooks could be of substantial benefit to many parts of the world in adapting to and mitigating the impacts of climate variability and change. RCOFs across the world have the overarching responsibility to produce and disseminate a regional assessment (using a predominantly consensus-based approach) of the state of the regional climate for the upcoming season. Participating countries recognize the potential of climate prediction and seasonal forecasting as a powerful development tool to help populations and

decision-makers face the challenges posed by climatic variability and change. National and Regional capacities are varied but certainly inadequate to face the task alone.
RCOFs bring together national, regional and international climate experts, on an operational basis, to produce regional climate outlooks based on input from NMHSs, regional institutions, Regional Climate Centres (RCCs), Global Producing Centres of long range forecasts (GPCs) and other climate prediction centres.

Through interaction with sectoral users, extension agencies and policy makers, RCOFs assess the likely implications of the outlooks on the most vulnerable socio-economic sectors in the given region and explore the ways in which these outlooks could be made use of. The RCOFs then lead to national forums to develop detailed national-scale climate outlooks and risk information including warnings for communication to decision-makers and the public.

The RCOF process has facilitated a better understanding of the links between the climate system and socio-economic activities. An increasing demand for climate services has been recorded in many parts of the world as a result of these developments. Awareness has been created that climate information, including short-range climate predictions, is an essential element in mitigating against the impacts of climate variations. RCOFs have fostered interactions and exchange of information between the climate scientists and users of climate information.

2. Southeast European Climate Outlook Forum (SEECOF)

In European region the RCOF process was launched in 2008. The South-East European Climate Outlook Forum (SEECOF) mechanism covers mainly countries of South East Europe and Caucasus (Fig.2), namely Albania, Armenia, Azerbaijan, Bosnia and Herzegovina, Bulgaria, Croatia, Georgia, Greece, Hungary, Israel, Macedonia, Moldova, Montenegro, Romania, Slovenia, Serbia, Turkey.

Figure 2: Countries involved in SEECOF

Three SEECOFs have been successfully conducted. SEECOF-I took place in Zagreb/Croatia in June 2008 at the kind invitation of the Government of Croatia, hosted by Croatian Meteorological and Hydrological Service. It was attended by around 70 participants from NMHSs of 18 countries, representatives from WMO, UNDP, from user community. SEECOF I consisted of two sessions: Session I was devoted to the general concepts of RCOF, seasonal prediction and applications, as well as discussion of current climate and development of consensus based seasonal outlook. During second session regional climate change scenarios over Southeastern Europe and Caucasus, as well as downscaled projections for the region were discussed.

Figure 3: Participants of SEECOF I, Zagreb 2008

It is worth noting that RCOFs worldwide have been set up so far with the main focus on seasonal prediction. However, the same RCOF mechanisms can be effectively expanded to cater to the needs of developing and disseminating regional climate change information products. Regional assessments of observed and projected climate change, including the development of downscaled climate change scenario products for impact assessments can be successfully included in the product portfolio of RCOFs. This approach is supported by WMO and UNFCCC. Therefore, strengthening of a climate change section in the RCOF is one of the issues need to be tackled.

Thus, during SEECOF I an attempt has been made to develop regional climate change scenarios for SEE, but it showed that there is considerable diversity in approaches. SEECOF processes can play a crucial role in promoting a collaborative and complementary approach, thereby facilitating consensus and consistency in generating climate change information in support of climate adaptation. SEECOF promotes regional ownership of climate knowledge base, and supports region-driven climate change actions.

SEECOF-II was hosted by Hungary, Budapest, in November 2009 attended by 35 participants from 15 countries. This forum was conducted in a regular way, as it is usually conducted in other parts of the world, i.e. consisted of the session for capacity building: training session on seasonal climate predictions (CPT) and session for the development of consensus-based user-relevant seasonal outlook.

Figure 4: Participants of SEECOF II, Budapest, 2009

SEECOF III was conducted as an online forum during April-May 2010 under the overall coordination of WMO Secretariat. It was moderated and facilitated by the Co-chair of RA VI Working Group on Climate and Hydrology and representatives of the Republic Hydrometeorological Service of Serbia (RHMSS). The communication among all the participants was realized through e-mail correspondence as well as through the SEECOF–3 Forum (http://www.seevccc.rs/forum), which was opened within SEEVCCC. Representatives from NMHSs of Albania, Armenia, Azerbaijan, Bosnia and Herzegovina, Bulgaria, Croatia, Cyprus, Georgia, Greece, Hungary, Israel, Moldova, Montenegro, Romania, Slovenia, Serbia, The FYR of Macedonia and Turkey actively participated in the online COF. Climate experts and representatives from South Eastern Europe Virtual Climate Change Centre-SEEVCCC (Serbia), Meteo France (France), Roshydromet (Russian Federation), DWD (Germany) provided their valuable contribution to the successful implementation of the SEECOF-3, developing the relevant documents and providing scientific guidance and recommendations. The SEECOF-3 comprised of three Steps, i.e. i) qualitative verification of the SEECOF-II winter forecast, ii) assessment of the current state of the climate including large-scale climate patterns worldwide and assessments of its likely evolution in the course of the next months and iii) building the consensus forecast for summer 2010.

<u>Lessons learnt</u>

Online COF: proved to be very productive.

Several lessons were learnt while conducting the online COF:

- There is a need of standardized approach on assessment of previous outlook,
- A reference climatology period should be selected for the assessment of current climate,
- The criteria have to be defined for high impact events,
- It is necessary to improve visibility, delivery of outlooks to wide user society

- These and several other issues are to be addressed during the upcoming SEECOFs. For more effective work with participants SEECOF Focal Points network is being established.
- It is planned in future to have two COFs per year – one physical meeting and one online COF.

Way ahead

The RCOF mechanism in RA VI still needs substantial support in order

- to strengthen the process,
- to better involve the participating countries and users,
- to expand the SEECOF involving other sub-regions (south-west Europe),
- to sharpen the communication of the consensus forecasts to build trust amongst the user communities,
- to strengthen a climate change section in the RCOF
- and importantly to achieve sustainability.

RAVI Working Group on Climate and Hydrology through the Task Team on RCOF will coordinate and facilitate the implementation and strengthening of RCOF in European region.
Efforts are under way to build a sustained RCOF capability in Europe, linking with RAVI Regional Climate Centres Network, established in the European region.

South-East European Virtual Climate Change Center Initiative
– Climate watch preoperational phase –

Milan Dacić
Permanent Representative of Serbia with the WMO

Republic Hydrometeorological Service of Serbia – RHMSS, host of the South East European Virtual Climate Change Center (SEEVCCC)

1. Background – Belgrade SEE Climate Change Initiative

Following the invitation by the World Meteorological Organization to its member States to intensify their international cooperation through appropriate national, sub-regional and regional climate centers, the Republic Hydrometeorological Service of Serbia (RHMSS) launched in 2006 the initiative for establishment of the sub-regional center for climate change for South East Europe (SEE).

This initiative received full support of the National Meteorological and Hydrological Services of the SEE countries at the 6th (2006) and 7th (2007) Informal Conference of South-East European National Meteorological and Hydrological Services (NMHSs) Directors (ICEED).

The Initiative was also included as priority for sub-regional cooperation under the United Nations Economic for Europe (UNECE) «Environment for Europe» process. This process resulted in adoption of the so-called Belgrade Initiative for enhancement of the SEE sub-regional cooperation in the field of climate change by the Sixth UNECE Ministerial Conference “Environment for Europe” which was held in Belgrade, 10-12 October 2007. The essence of the Initiative can be summarized with its three recommendations: (i) Developing a South East European Climate Change Framework Action Plan for Adaptation (SEE/CCFAP-A) in accordance with the SEE countries common interest with the final aim to implement the Capacity Building Framework, Article 5 and Article 6, and Nairobi Work Programme of the United Nations Framework Convention on Climate Change (UNFCCC); (ii) Establishment of a SEE sub-regional, Virtual Climate Change Related Centre in Belgrade for Research and Systematic Observation, Education, Training, Public Awareness, and Capacity Building and support the SEE pilot project aimed at setting up functions of the sub-regional Virtual Climate Change Centre in Belgrade which will provide coordination and implementation of the SEE/CCFAP-A; and (iii) Developing partnerships in the development and implementation of the SEE/CCFAP-A programmes with relevant international organizations, and promoting close relationship with the Secretariats of UNFCCC, WMO, GEF, as well as with UNDP, UNEP, EU and capacity building initiatives under relevant environmental agreements.

According to the Belgrade climate change Initiative, the sub-regional South East European Virtual Climate Change Centre (SEEVCCC) was established in Belgrade in late 2007, and is thereafter hosted by the Republic Hydrometeorological Service of Serbia (RHMSS).

2. SEEVCCC Objectives

The goals of the sub-regional South-East European Virtual Climate Change Centre are as follows: (a) providing operational functions in climate monitoring, generating sub-regional analysis and seasonal and inter-annual prediction products, and sharing climate information including modelled data sets; (b) performing research and advancing scientific understanding of climate change impacts, vulnerabilities and adaptation opportunities; (c) providing training and sharing the best experience and practice in climate change, particularly in climate modelling and interpretation of model outputs; (d) building capacities of the NMHSs in terms of human resources and improvements of climate change products and services; (e) connecting the science and policy communities for adaptation planning and climate risk management; (f) facilitating partnerships between the NMHSs in the region and other interested institutions dealing with climate change, as well as with relevant international organizations, regional climate centers, donor community, etc.

The action in setting up the above-mentioned SEEVCCC functions proceeded simultaneously in two directions: (i) through intensive implementation of the Belgrade Initiative on climate change; and (ii) through participation in the activities of the WMO related to the establishment of a Regional Climate Centre Network in RA-VI (Europe) to support the NMHSs in the SEE region in providing more accurate climate predictions and assessments and strengthening their capacities to meet national climate change information needs.

3. SEEVCCC operational functions and R&D activitties within WMO RA VI RCC Pilot Regional Climate Centre (RCC) Network

The WMO RA VI RCC Network is envisaged to provide mandatory regional-scale tailored climate services on climate data, climate monitoring, long range forecasting, capacity building, as well as coordination functions and highly recommended research and development activities.

In present pilot phase the WMO RA VI RCC-Network defined by the Resolution 1 (XV-RA VI) – «Establishment of a Regional Climate Centre Network in Regional Association VI (Europe)» consists of three nodes: climate data, climate monitoring and long range forecasting. Each of the mentioned nodes is represented by a consortium coordinated by the appointed lead center. SEEVCCC center hosted by RHMSS participates in each of the above nodes with all mandatory operational functions, but also with some of the highly recommended functions related to research and development.

Within RA VI RCC Climate Data Node (Lead: KNMI/Netherlands), the SEEVCCC provide regional climate projections data covering SEE and the Mediterranean area. The model database includes: 1961-1990 (present climate), 2001-2030 (A1B scenario), and 2071-2100 (A1B and A2 scenarios). The downscaling was realized using the SEEVCCC interactively coupled atmosphere-ocean regional climate model EBU-POM (resolution: ~35 km for atmosphere; ~20km for ocean).

Main activities of SEEVCCC under the RA VI RCC Climate Monitoring Node (Lead: DWD/Germany) relates to: (i) collection of actual climate data for around 400 to 500 meteorological stations within the SEE sub-region which are included in the international data exchange. The principal data sources are KNMI-ECA&D, NCDC, SYNOP, CLIMAT and other reports and climate bulletins; (ii) climate data processing and operational issuing of monthly and three-monthly climate monitoring maps for SEE sub-region (mean 2m temperature and accumulated precipitation, and temperature anomaly and precipitation as percentage of normal 1961-1990).

Under the RA VI RCC Long Range Forecasting Node (Lead: Météo-France & Roshydromet) the SEEVCCC center performs the operational functions of issuing the SEE seasonal predictions for 7 months ahead which are produced by dynamical downscaling of ECMWF 41 LRF ensemble members using the SEEVCCC interactively coupled atmosphere-ocean regional climate model. Horizontal resolution is 0.25 degrees for atmospheric model and 0.2 degrees for the ocean model. Atmosphere is resolved with 32 and ocean with 21 vertical levels. The connection between the two components is through a coupler that performs the exchange of atmospheric surface fluxes and SST after every atmospheric physical time step. Exchanged fluxes are calculated using the atmospheric component and are used directly, without any additional parameterization. The products are available from the web site (http://www.seevccc.rs - Operational products/Seasonal forecast) in form of maps (monthly/three-monthly precipitation and temperature and their anomalies, and Mediterranean monthly SSTs) and in binary form (GRIB), which is to be accessible in early 2011 via MARS-archive software obtained from and implemented jointly with the ECMWF. The above sub-regional seasonal prediction system is operational as of June 2009.

In its climate monitoring and LRF operational work the SEEVCCC supports the future activities of NMHSs in issuing Climate Watches, based on monthly climate diagnostics bulletins, anomaly maps, climate extremes indices and seasonal predictions.

Contributing to elaboration of a strategy to implement operational Climate Watch in the Region, whilst the two pillars of a Climate Watch System – operational climate monitoring and LRF – are

already available, the SEEVCCC performs an experimental climate warning system (CWS), i.e., climate watch system, which is designed to provide advisories (climate watches) informing the partner NMHSs on ongoing, pending or expected climate anomalies and their possible negative impacts. In order to establish the operational CWS, it is required to link climate monitoring with the long-term (seasonal) forecast updated on monthly or preferably on a weekly basis. Experimental work in this area is based on the connection of probabilistic long-term forecast of SPI (standardized precipitation index) obtained from SEEVCCC seasonal prediction modelling system with the SPI index calculated from observations.

4. SEEVCCC R&D highly recommended functions: Integrated Earth Climate Modelling System

In persuing with the highly recommended functions related to research and development, the SEEVCCC Center is particularly interested in application and further development of a NCEP unified nonhydrostatic multiscale NMM-B model designed for a broad range of spatial (global to sub-regional and local) and temporal scales. This model is considered well suited for the mission of the Center, and the Center is being adopting it and investing effort in its further development.

SEEVCCC will strive to contribute in defining the R&D agenda related to continuing development of a multiscale, unified, computationally efficient atmospheric model that can be run on global and regional scales. Such model will serve as a driver to other environment modelling components (atmospheric composition, ocean, hydrology) and will be designed following the principles proven in regional climate studies. This agenda will also include problems related to, inter alia, interactive coupling of different environment systems:

- coupled NMM-B - ocean model;
- coupled NMM-B - Numerical Hydrology Prediction Model (HYPROM); HYPROM is consisting of two sub-models: 2-D river formation model and 1-D river routing model;
- interactive NMM-B – DREAM aerosol transport model; with direct radiation effects included;
- interactive NMM-B – aerosol – cloud microphysics scheme; with indirect aerosol effects included.

R&D agenda will also include development of high-resolution climate change experiments for different SRES and new IPCC scenarios using both, dynamical (above coupled atmosphere-ocean-hydrological model – as a second generation climate cimulations in SEEVCCC) and statistical downscaling approaches.

5. SEEVCCC support to SEECOF mechanism and other capacity building activities

WMO Regional Climate Outlook Forum (RCOF) is a regional mechanism for the formulation and dissemination of climate outlooks. RCOF Consensus Forecast Process stimulates the development of capacity in the NMHSs, and supports decisions and activities, which mitigate adverse impacts of climate helping the communities in adaptation to climate variability. In European region the RCOF process was launched in 2008 by establishing the South-East European Climate Outlook Forum (SEECOF) covering countries of South-East Europe and Caucasus region. The first SEECOF was held in Zagreb, Croatia in June 2008 and the second (SEECOF-2) took place in Budapest, Hungary in November 2009. The SEECOF-3, focussing at Summer 2010, was carried out as an online collaborative exercise for the first time since the RCOF mechanism was established. This exercise was co-facilitated by South-East European Virtual Climate Change Centre (SEEVCCC), the RA VI Working Group on Climate and Hydrology, and the WMO Secretariat. It proved that the online collaboration could be used as an efficient and effective alternative to physical meetings in the RCOF mechanism. However, taking into consideration the capacity-building component of the RCOFs, it has been agreed that face-to-face meetings of regional experts moderated by leading climate experts should be continued to be organized at least once per year. As a follow-up of the XV-RA VI recommendation, the SEEVCCC/RHMSS hosted SEECOF-4 focussing on the winter season 2010/2011 (http://www.seevccc.rs, International

Collaboration). Efforts are under way to strengthen a climate change section in the SEECOF and to achieve sustainability by linking COF with RCCs and promote its role in Global Framework for Climate Services (GFCS) bridging the gap between providers and users of climate information.

Other SEEVCCC capacity building activities cover sub-regional training workshops and user-awareness development through the participation in regional projects and joint or cosponsored workshops, think/tank and brainstorming events (REC and SEEVCCC; FAO and SEEVCCC):

- Regional South-East European Ministerial Conference Climate Change and Energy, 25-26 November 2009, Belgrade, Serbia;
- Sub-regional Seminar "Mapping of and Policy Orientation for Adaptation to Climate Change in South-Eastern Europe", (FAO and SEEVCCC), 27-28 April, 2010, Belgrade, Serbia;
- 2nd CEE/SEE Regional Colloquium Capacity Building on Global Governance and the UN System, Teaching Climate Change and the United Nations System, 17-18 May, 2010, (Law Faculty), Belgrade, Serbia;
- Regional Environmental Center for Central and Eastern Europe and SEEVCCC Capacity Building Workshop "Adaptation to Climate Change in the Agricultural Sector of South-East Europe", 4 November 2010, Budapest, Hungary.

6. SEEVCCC role and responsibilities within UNFCCC Framework

The basic mission of the SEEVCCC within the Belgrade climate change initiative is to support the SEE countries in meeting the needs for information on sub regional climate change projections, impacts, vulnerability and adaptation options on a continuous basis, through its operational, research, coordination and educational functions and participation in development and implementation of the South-East European Climate Change Framework Action Plan for Adaptation (SEE/CCFAP-A, http://www.seevccc.rs/CCFAP-A/CCFAP-A.pdf). The SEE/CCFAP-A was prepared jointly by the representatives of the ministries of environment and national meteorological and hydrological services from the Republic of Albania, Bosnia and Herzegovina, the former Yugoslav Republic of Macedonia, Montenegro, and the Republic of Serbia and with the support and coordination of SEE Virtual Climate Change Center, and Regional Environmental Center for Central and Eastern Europe (http://www.rec.org/). It was considered and adopted at the Ministerial Conference "Combating Climate Change in SEE" which took place in Sarajevo, Bosnia and Herzegovina in 2008, organized by Regional Cooperation Council (http://www.rcc.int/). The Framework Action Plan will run from 2009 to 2015.

7. SEEVCCC priorities

Long-term vision in research and development activities is focused on creation of regional center of excellence in the frame of the European network of WMO climate centers. This vision will be achieved through: strengthening of research and development capacities in SEE; setting-up of its own sub-regional climate prediction system in collaboration with scientific diaspora from SEE; joining in new world climate systems (Global Framework for Climate Services, WMO/AREP Sand and Dust Storm Warning Advisory and Assessment System, SDS-WAS; World Climate Research Programme-WCRP); adhering to the activities of the IPCC; as well as through further enhancement of partnerships with regional and international organizations active in climate related matters.

8. Conclusion

By implementing its functions, including involving, educating and training a critical number of young scientists from developing countries of the SEE region, in improving skills in long-range forecasting, seasonal, inter-annual, and decadal predictions, the SEEVCCC will contribute in enabling the NMHSs from the SEE sub-region to adequately participate in the implementation of their commitments related to national adaptation programmes. The SEEVCCC, as a network of participating NMHSs and other interested stakeholders in climate change, will serve as a science-

to-policy interface that shall support SEE economies in building resilience to the consequences of climate change in SEE. Both SEEVCCC functions, under WMO and UNFCCC, may be considered as follow up actions of World Climate Conference – 3 (WCC-3) that are in line with further development and implementation of the Global Framework for Climate Services established by the WCC-3. The functions which are in accordance with the SEE Climate Change Framework Action Plan for Adaptation (SEE-CCFAP-A), and the action plan itself may be also seen as an implementation of the GFCS at the sub-regional SEE level.

Session 3 - Country presentations on the status and priority needs of monitoring and predicting climate anomalies and extremes

- Climate monitoring in Austria
- Recent Belgian activities
- Role of METEO B&H in state observing, forecasting and information system
- A review of climate monitoring in Croatia
- Climate monitoring activities of the Cyprus Meteorological Service
- Status of climate monitoring and prediction in Finland
- Initial validation study of satellite derived monthly cloudiness data for Georgian territory
- Air temperature and precipitation distribution peculiarities in Georgia
- Status and priority needs of monitoring and prediction of climate anomalies and extremes in Germany
- Climate data, climate monitoring and long-range forecasts at the Hungarian Meteorological Service
- The Italian Climatological Service: monitoring and predicting climate anomalies and extremes
- Jordan climate
- The weather center of Kazakhstan
- Climate monitoring in Lithuania
- Monitoring and prediction climate anomalies and extremes (Moldova)
- Status and priority needs in monitoring and predicting climate anomalies and extremes in Montenegro
- Climate data, climate information and weather warnings available on the web from The Norwegian Meteorological Institute
- Climate monitoring and products at IM-Portugal
- Status and priority needs of monitoring and prediction of climate anomalies and extremes in Russia
- Status and priority needs of monitoring and predicting climate anomalies and extremes in Serbia
- Climate monitoring in Spain
- Status of the monitoring and forecasting of climate anomalies and extremes in the United Kingdom

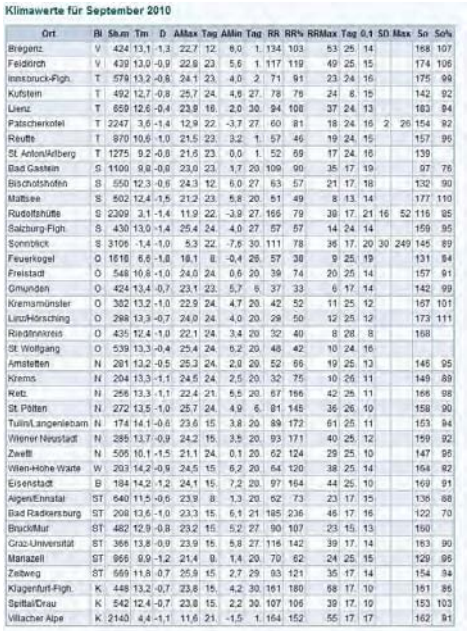
Climate monitoring in Austria

Mag. Gerhard Hohenwarter

Central Institute for Meteorology and Geodynamics, Austria (ZAMG)

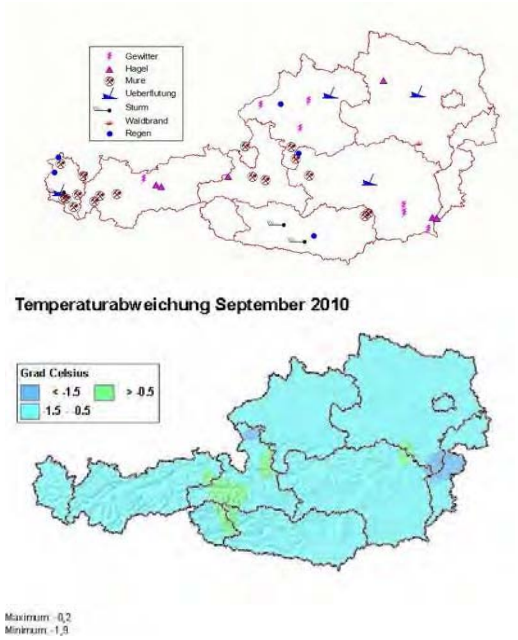
1. Climate monitoring

Technical overview: 250 automatically weather stations, 80 phenology stations, 2 times per day radio sounding (Vienna), glacier monitoring at Großglockner and Sonnblick.
The ZAMG provides monthly maps, charts and tables on the website www.zamg.ac.at, where the last month is described just a few days after the next month started. This information is just an offer for the public and the media. The applied data are corrected but not further homogenized.



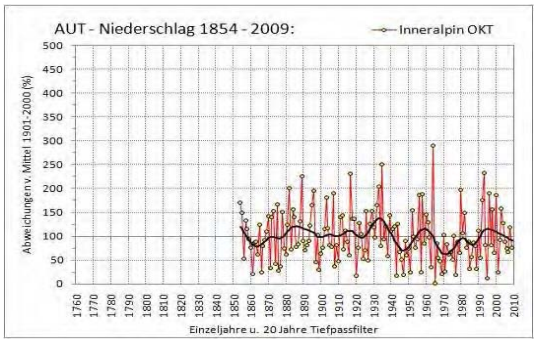
Klimawerte für September 2010

Ort	Bl	Sh.m	Tm	D	AMax	Tag	AMin	Tag	RR	RR%	RRMax	Tag	0,1	SD	Max	So	So%
Bregenz	V	424	13,1	-1,3	22,7	12.	6,0	1.	134	103	53	25.	14			168	107
Feldkirch	V	439	13,0	-0,9	22,8	23.	5,6	1.	117	119	49	25.	15			174	106
Innsbruck-Figh.	T	579	13,2	-0,8	24,1	23.	4,0	2.	71	91	23	24.	16			175	99
Kufstein	T	492	12,7	-0,8	25,7	24.	4,6	27.	78	76	24	6.	15			142	92
Lienz	T	659	12,6	-0,4	23,8	18.	2,0	30.	94	108	37	24.	13			183	94
Patscherkofel	T	2247	3,6	-1,4	12,9	22.	-3,7	27.	60	81	18	24.	16	2	26	154	92
Reutte	T	870	10,6	-1,0	21,5	23.	3,2	1.	57	46	19	24.	15			157	96
St. Anton/Arlberg	T	1275	9,2	-0,8	21,6	23.	0,0	1.	52	69	17	24.	16			139	
Bad Gastein	S	1100	9,9	-0,8	23,0	23.	1,7	20.	109	90	35	17.	19			97	76
Bischofshofen	S	550	12,3	-0,6	24,3	12.	6,0	27.	63	57	21	17.	18			132	90
Mattsee	S	502	12,4	-1,5	21,2	23.	5,8	20.	51	49	8	13.	14			177	110
Rudolfshütte	S	2309	3,1	-1,4	11,9	22.	-3,9	27.	166	79	38	17.	21	16	52	116	85
Salzburg-Figh.	S	430	13,0	-1,4	25,4	24.	4,0	27.	57	57	14	24.	14			159	95
Sonnblick	S	3106	-1,4	-1,0	5,3	22.	-7,6	30.	111	78	36	17.	20	30	249	145	89
Feuerkogel	O	1618	6,6	-1,8	18,1	8.	-0,4	26.	57	38	9	25.	19			131	84
Freistadt	O	548	10,8	-1,0	24,0	24.	0,6	20.	39	74	20	25.	14			157	91
Gmunden	O	424	13,4	-0,7	23,1	23.	5,7	6.	37	33	6	17.	14			142	99
Kremsmünster	O	382	13,2	-1,0	22,9	24.	4,7	20.	42	52	11	25.	12			167	101
Linz/Hörsching	O	298	13,3	-0,7	24,0	24.	4,0	20.	29	50	12	25.	12			173	111
Riedtmkreis	O	435	12,4	-1,0	22,1	24.	3,4	20.	32	40	8	28.	8			168	
St. Wolfgang	O	539	13,3	-0,4	25,4	24.	6,2	20.	48	42	10	24.	16				
Amstetten	N	281	13,2	-0,5	25,3	24.	2,0	20.	52	66	19	25.	13			146	95
Krems	N	204	13,3	-1,1	24,5	24.	2,5	20.	32	75	10	26.	11			149	89
Retz	N	256	13,3	-1,1	22,4	21.	5,5	20.	67	186	42	25.	11			166	98
St. Pölten	N	272	13,5	-1,0	25,7	24.	4,9	6.	81	145	36	26.	10			158	90
Tulln/Langenlebarn	N	174	14,1	-0,6	23,6	15.	3,8	20.	89	172	61	25.	11			153	94
Wiener Neustadt	N	285	13,7	-0,9	24,2	15.	3,5	20.	93	171	40	25.	12			159	92
Zwettl	N	505	10,1	-1,5	21,1	24.	0,1	20.	62	124	29	25.	10			147	95
Wien-Hohe Warte	W	203	14,2	-0,9	24,5	15.	6,2	20.	64	120	38	25.	14			164	82
Eisenstadt	B	184	14,2	-1,2	24,1	15.	7,2	20.	97	164	44	25.	10			169	91
Aigen/Ennstal	ST	640	11,5	-0,6	23,9	8.	1,3	20.	62	73	23	17.	15			136	88
Bad Radkersburg	ST	208	13,6	-1,0	23,3	15.	6,1	21.	185	236	46	17.	16			122	70
Bruck/Mur	ST	482	12,9	-0,8	23,2	15.	5,2	27.	90	107	23	15.	13			160	
Graz-Universität	ST	366	13,8	-0,9	23,9	15.	5,8	27.	116	142	39	17.	14			163	90
Mariazell	ST	866	9,9	-1,2	21,4	9.	1,4	20.	70	62	24	25.	15			129	96
Zeltweg	ST	669	11,8	-0,7	25,9	15.	2,7	29.	93	121	35	17.	14			154	94
Klagenfurt-Figh.	K	448	13,2	-0,7	23,8	15.	4,2	30.	161	180	68	17.	10			161	86
Spittal/Drau	K	542	12,4	-0,7	23,8	15.	2,2	30.	107	106	39	17.	10			153	103
Villacher Alpe	K	2140	4,4	-1,1	11,6	21.	-1,5	1.	164	152	55	17.	17			162	91



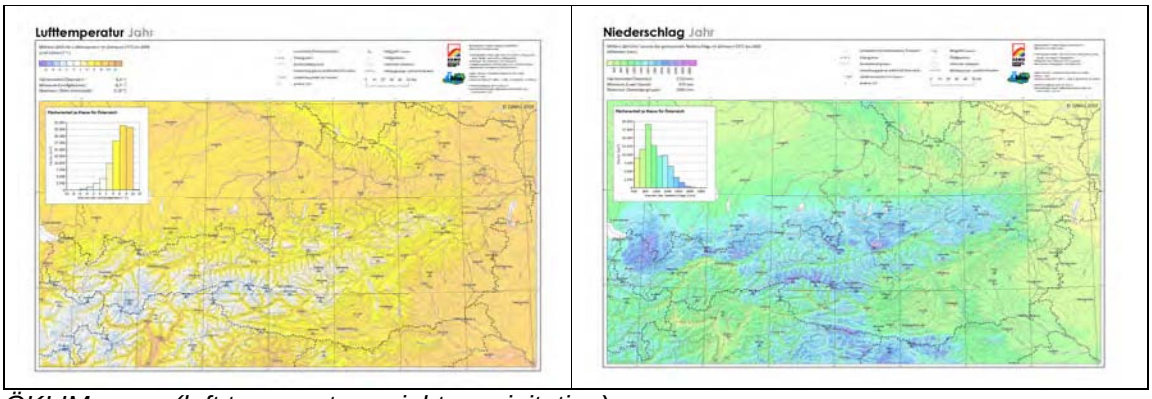
Part of the monthly climate report (September 2010)

For scientific use the ZAMG provides homogenized station data from the project HISTALP (temperature, sunshine duration, pressure and precipitation). On a monthly base homogenized data are available for the GAR (Greater Alpin Region) on the website http://www.zamg.ac.at/histalp/ . For Austria the data are always up to date and are used for scientific work and for public information.
In the last months the ZAMG started to homogenize daily data from Austria. This work will be continued and extended in the following years.



Homogenized precipitation data for the inner alpine region

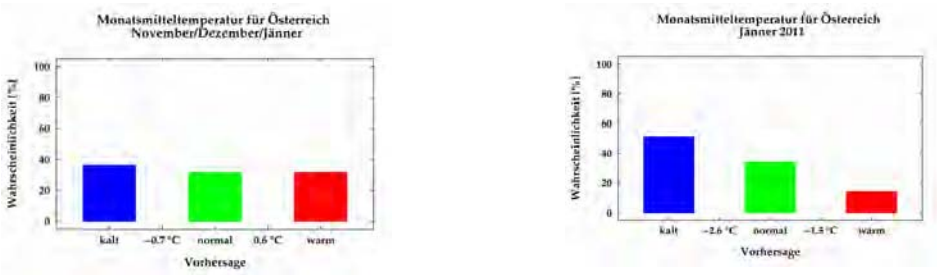
For the period between 1971 and 2000 the ZAMG developed climate maps for several parameters as temperature, precipitation or snow height for whole Austria.



ÖKLIM maps (left temperature, right precipitation)

2. Long term forecast

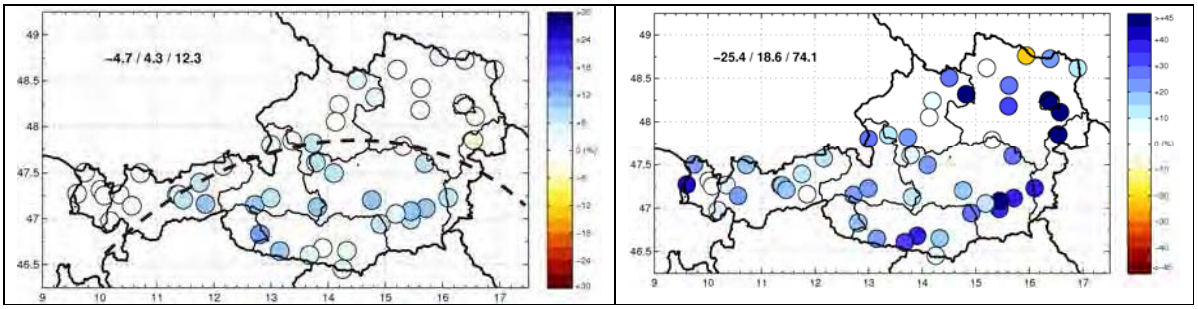
Since March 2010 the ZAMG provides a seasonal forecast for the next three month on the website http://www.zamg.ac.at/klima/saison-vorhersage/ . This forecast is just focused on a mean temperature for the greater Austrian region, precipitation forecast for longer periods are in Austria very difficult. Due to the Alps there are several different precipitation regimes in Austria. The effect of a low is totally different, if it is just situated a few kilometers north or south. Basis for the forecast are the data from the ECWMF.



Seasonal forecast November to January (left) and January (right)

3. Extreme events

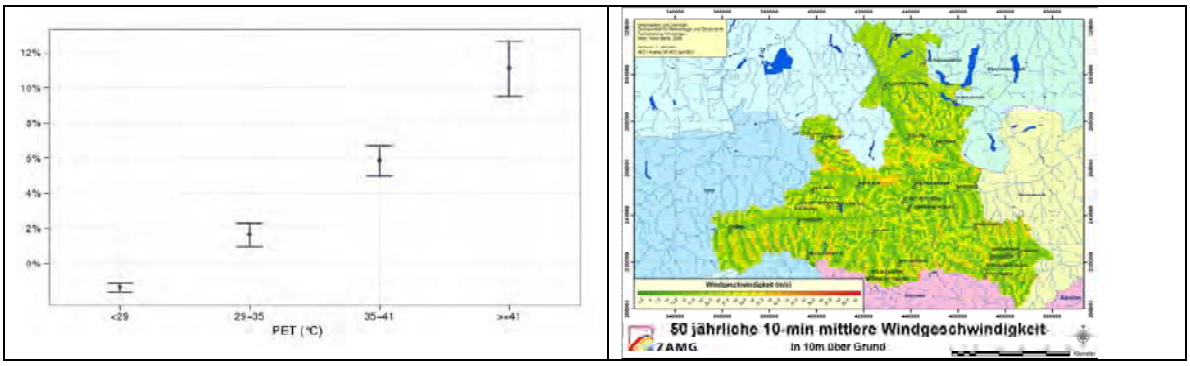
During the last years an Extreme Value Analysis (EVA) was develop at the ZAMG. A tool was created to determine the return period for several meteorological parameters for all climate stations in Austria. Tables show the single events and the return period. Plots give information about the uncertainty of the return period.
The ZAMG made a study to analyze the changes of total precipitation and daily heavy precipitation (return period 30 years) in the period 2007-2051 compared to 1963-2006.



Scenario B1 winter precipitation (left) and change of heavy precipitation (right); the numbers displayed in the pictures show minimum, median and maximum

4. Warnings

The ZAMG provides daily warnings on the website for the following parameters: rain, snow, thunderstorms, wind and black ice; further more additional warnings are made for early snowfall, snow bank and heat waves (more than 3 days Tmax >30℃).
Two projects to the topic heat wave (MORTKLIM) and strong winds (BEAUVORT) were realized at the ZAMG in the last year.
MORTKLIM was a study to analyze correlation between heat waves and mortality rate in Austria. The results showed that due to heat waves the death rate rises up to 12% (without a harvester effect). With global warming heat waves will occur more often and this will be a huge challenge for the health system in Austria.
The second project defined the wind potential in 70m and the wind hazard in 10m for whole Austria. The aim was to define regions for further wind power plants and regions with the highest wind hazard.



Additional death during heat waves (left), 10min average wind with return period of 50 years (right)

For the future it is planned to create maps with the endangered regions in whole Austria on the basis of postal codes and damage reports. These maps should be correlated with the results of Extreme Value Analysis (EVA).
The existing hail probability map (1951- 1985) will be over-worked with radar data from the last years.

Recent Belgian activities

Mr. Luc Debontridder

Royal Meteorological Institute of Belgium

I have been representing the Royal Meteorological Institute of Belgium at the WMO RA VI Pilot RCC – Network which took place between the 25th and the 28th of October 2010 in the offices of the DWD (Deutscher Wetterdienst).

Presently the RMIB is mainly focusing on the gathering, validation and delivering of meteorological data, whether they are obtained manually or automatically. Climate monitoring and long Range Forecasting are at present not our main objectives.

In the following presentation we show some examples of what is presently done in Belgium regarding climate data collecting and transmission. As you might well know, Belgium is a monarchy, and the RMIB is a Federal Institution which provides forecasts for The Dutch speaking part, the French speaking and the German speaking part of our country.

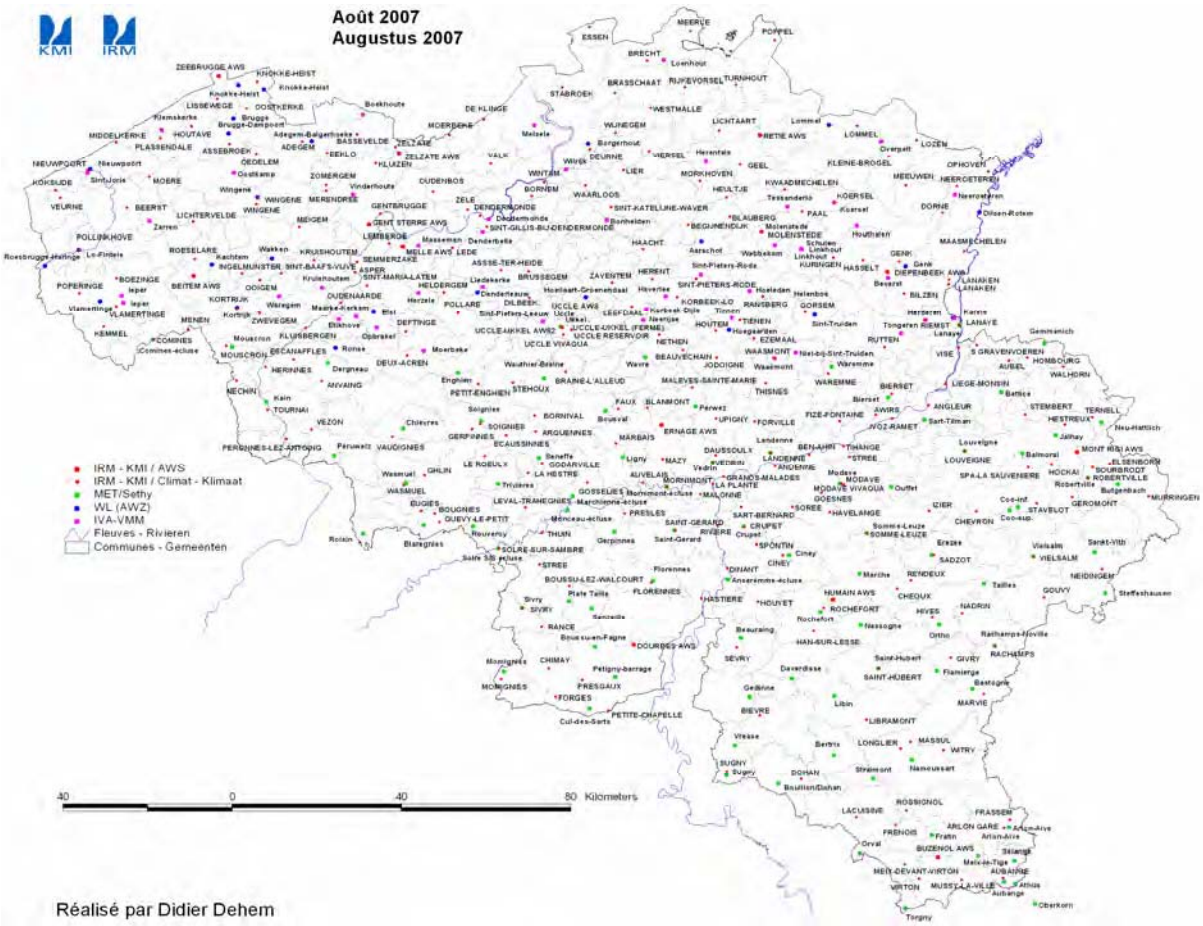
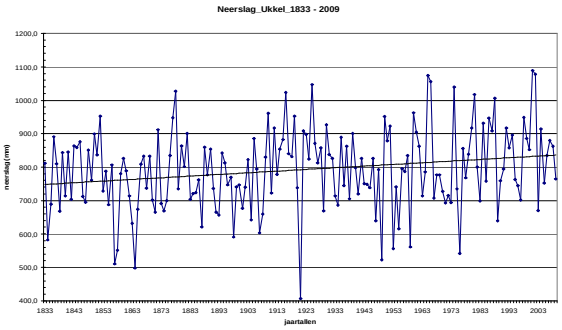


*Figure: Stations of Belgium (**IRM – KMI / AWS** = automatic weather stations belonging to the Royal Meteorological Institute of Belgium; **IRM – KMI / Climat – Klimaat** = manual climatological network belonging to the Royal Meteorological Institute of Belgium; **MET/Sethy** = raingauges belonging to the French speaking community and the French speaking government; **WL (AWZ)** = rain gauges belonging to the Flemish Government and situated at navigable rivers or canals; **IVA – VMM** = rain gauges belonging to the Flemish government and situated at non navigable rivers or canals)*

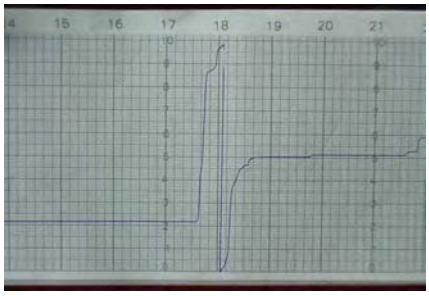
Pluviometric data available daily for the RMI from other hydrological services in our country

- an additional automatic rain gauge measurement net (about 30 automatic rain gauges will be installed in 2011 by the RMI)
- RMI ↔ Regional pluviometric measurements carried out by Service of Mobility and Public works in Flanders (water laboratorium) which possesses 30 automatic rain gauges and the Department Environment, Nature and Energy (IVA – VMM) which exploits 58 automatic rain gauges.(Exchange of data)
- RMI ↔ In the French speaking part we exchange and correct data of the Ministry of Equipment and Transport which exploits 92 automatic rain gauges.
- RMI ↔ In Brussels, the Société bruxelloise de la Gestion de l'Eau (SBGE) has automatic measurements in 15 automatic rain gauges.
- These automatic rain gauges send us 5 minutes, 15 minutes or hourly data in exchange of our radar images and data from our AWS.

Precipitation measurements in Brussel - Ukkel – long series



Manual rain gauge measurement every 24h, since 1950 for this type)



Pluviographic measurements (every 10min, since 1898)

Project goal: establishing IDF (Intensity Duration Frequency) curves for Belgium

Interface giving information about rainfall extreme values

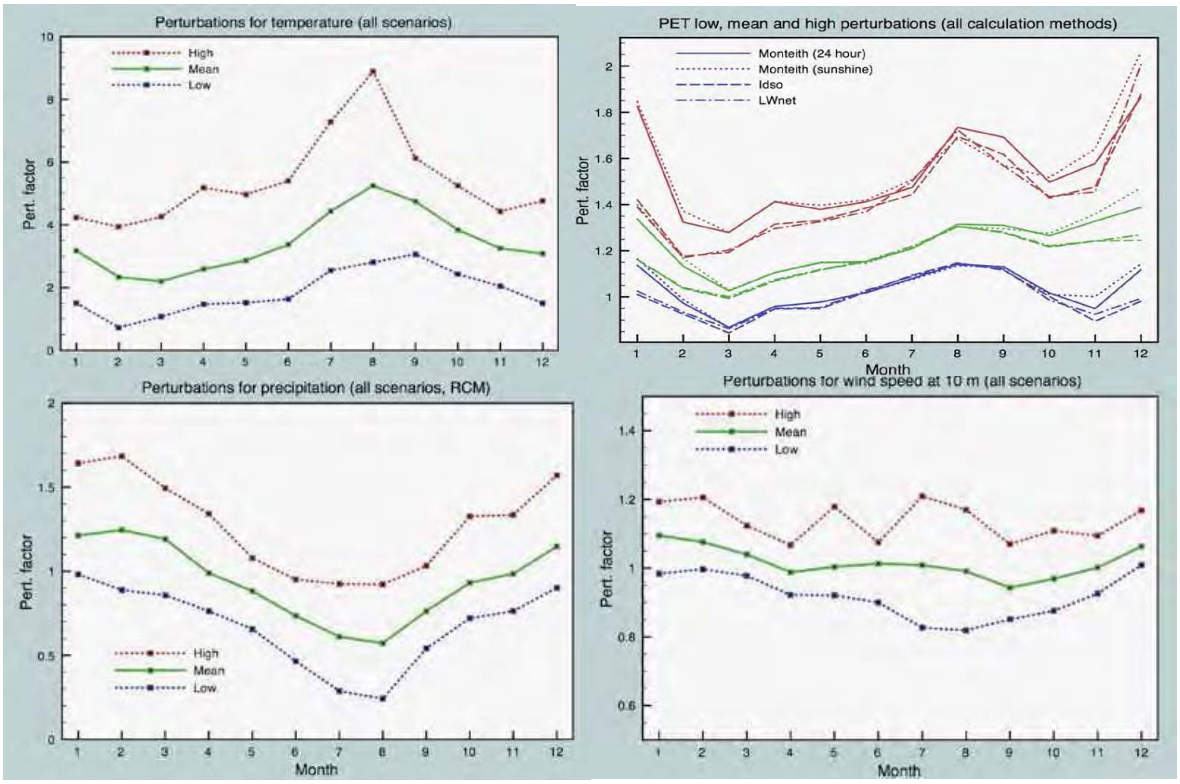
1. Visualization of a chart showing spatial variation of rainfall extremes in Belgium.

2. In a given place, give us the IDF curve or a table with return periods.

→ Necessary information for dimensioning of water drainage systems and local sewerage

Current status

- **Generalized Extreme Value (GEV)** distribution for annual maxima:
- **Classical theory**: data is assumed to be independent and **stationary**. Parameters are constant.
- **Climate change: non-stationary** data. Parameters are time-dependent. For example, extreme temperature:
  - Linear growth: summer extremes maximum temperatures
  - NAO-dependency: observed in minimum temperatures (DJF)



The CCI-HYDR (Climate Change Impact on Hydrological Extremes along Rivers and Urban Drainage Systems in Belgium) and KNMI'06 comparison has demonstrated that the range of expected change is not certain and that it depends on the assessment and selection of the climate models. It is not clear which of the two scenarios is better as there is no possibility of ascertaining the realism of the two scenarios. However, similar conclusions may be made about the seasonal changes in Belgium.

In winter the mean precipitation will increase while the summer mean precipitation will decrease. The complementarily of the two scenarios has been a positive outcome of the comparison. The KNMI'06 scenarios provide a climatological explanation of the wet and dry atmospheric conditions while the CCI-HYDR scenarios provide other possible scenarios based on the impact perspective.

Future KNMI and Belgian scenarios would find the results useful.

Role of METEO B&H in state observing, forecasting and information system

Zeljko Majstorovic

Federal Hydrometeorological Institute B&H, Sarajevo, Bosnia and Herzegovina
www.fhmzbih.gov.ba

Meteorological network in B&H consists currently of:

Federal Hydrometeorological Institute B&H

- 12 synoptic and
- 5 climatological stations.
- 14 automatic meteorological stations with real - time data transfer

Republic Hydrometeorological Institute of Republic of Serbska, B&H

- 1 synoptic and
- 25 climatological stations.
- 8 automatic meteorological stations

The coverage of the territory of the Federation is acceptable regarding the WMO requirements for synoptic stations, but the expansion of climatological network is imperative.

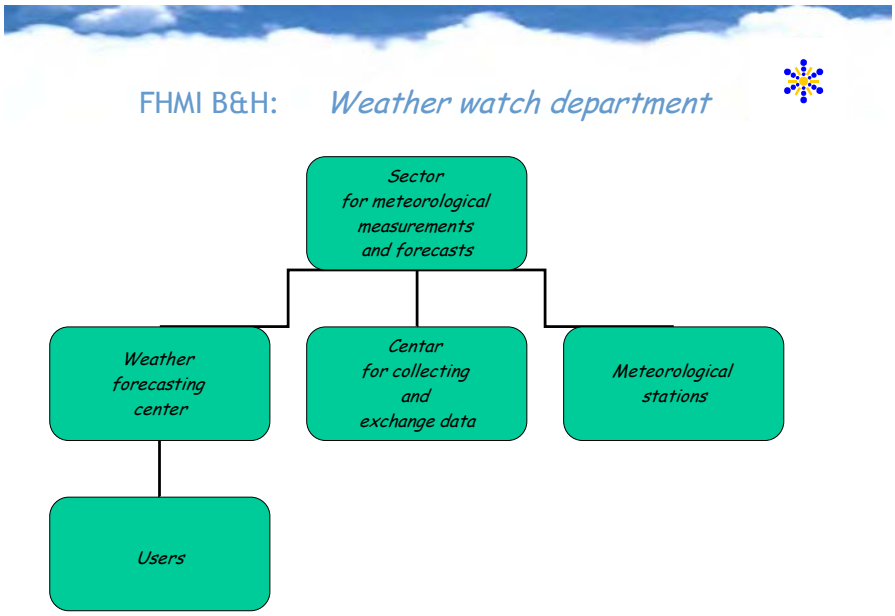


Figure 1: FHMI B&H: Weather watch department

Meteorological products

- The weather forecast Department practices reception and analysis analytic, prognostic maps and satellite captures and weather casts daily.
- Weather forecast is based on observations (15 meteorological stations, satellite data, synoptic weather charts), products of numerical weather prediction models (HRM,WRF-NMM and WRF-ARW)
- By media, publicity is informed about weather cast daily. Actual data about Institute works may see on the web page www.fmzbih.gov.ba

- daily bulletins,
- weather forecast for 3 days and 7 days
- detailed warning information in case of natural disaster (floods, hail, heavy rain, etc.)

Numerical weather prediction models:

- HRM
- WRF-ARW
- WRF-NMM

Long range forecast:

We participate in online discussions about CPT – model (IRI) –SEECOF project and participate in project SEEVCCC.

Seasonal forecast

Federal Hydrometeorological Institute B&H make monthly and seasonal forecasts by statistical method.

Seasonal forecast is given only in verbal form for ex.:

"Winter 2009/2010 will be warmer than multi-year average. Precipitation sum will be greater than the multi-year average. Weather will be very variable with distinct cold and warm periods. Per month: January... etc."

This method proved to be quite reliable for Sarajevo region, but forecast is still not provided in the form of maps because we have problem:

Besides MS Sarajevo, all other meteorological stations have more or less interruptions during the wars of the twentieth century. This precludes complete statistical analysis – we do not have enough points reliable for map. Therefore, the last few years we strive to consult with other models. Of course, forecast for winter 2009/2010 (accuracy of about 90 %) we worked in consultation CPT model – after the meeting SEECOF in Budapest last year.

Floods and droughts

Although the rivers are characterized by relatively high runoff there is a great variation in flow and much of the water volume (57%) leaves the territory unused.
Significant spatial and time variation results in areas that experience heavy flooding in winter months (especially in Northern part of the country) and suffer from droughts in the summer (Southern part of country).

One of the basic roles of the National Hydrometeorological Service is to supply the civil protection system, public and socio-economic sectors with all hydro-meteorological data and products needed to prepare the emergency interventions and to produce alerts in case of extreme weather conditions, in order to save lives and property, and to prevent hazards from becoming disasters.

Extreme weather conditions in January 2010 in B&H

Near Future plans

- By year's 2010 end, within project DRR SEE, B&H become member of EUMETNET and start full participation in the METEOALARM (early warning for seven parameters)
- We continue online discussion within project SEECOF about CPT (IRI) and discussion within project SEE-VCCC initiative

A Review of climate monitoring in Croatia

Dr. Kreso Pandzic

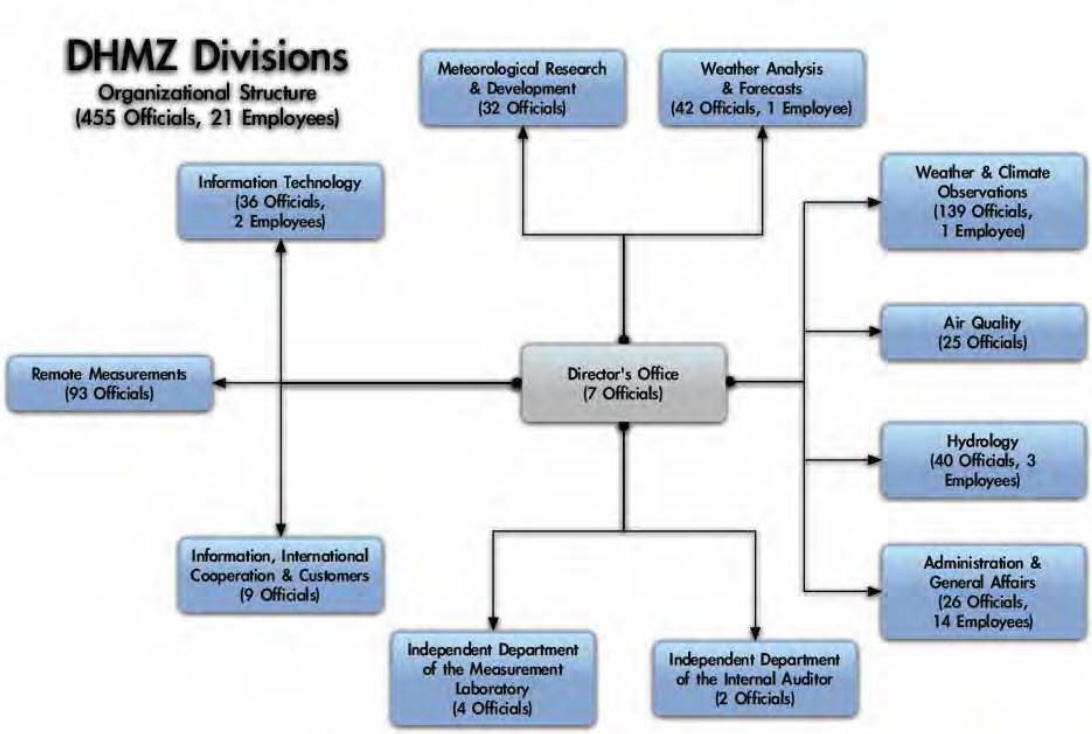
Meteorological and Hydrological Service, Zagreb, Croatia

1. History of Meteorological and Hydrological Service (DHMZ)

- The mainland area of the Republic of Croatia is 56 594 km2.
- The highest mountain peak in Croatia is Dinara (1 831 m).
- According to the 2001 census the total number of inhabitants in the Republic of Croatia is 4.437.560.
- 1861 - Observatory at Zagreb-Gric has been established.
- 1901 - Weather observation network of “Croatia and Slavonia” joined.
- 1911 - Royal Country Institute for Meteorology and Geodynamics was established.

Building of the high school on the Gric in Zagreb in 19th century

Building of DHMZ which has been established in 1947



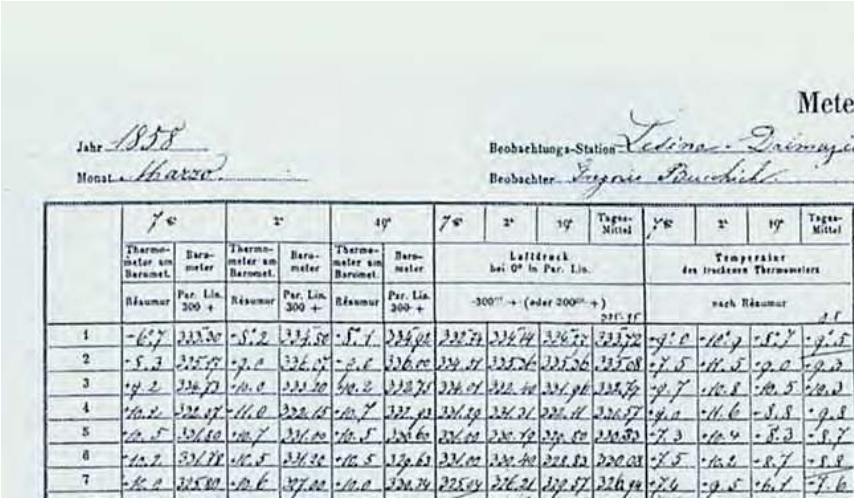
Current DHMZ structure established in 2008

<u>Basic activities of DHMZ:</u>

- weather and climate observations
- data transmission
- data quality control
- weather and climate monitoring
- weather and climate forecasting
- applications: economy, tourism etc.

2. Meteorological observation network

- The oldest weather station in Croatia was established in Dubrovnik, 1851



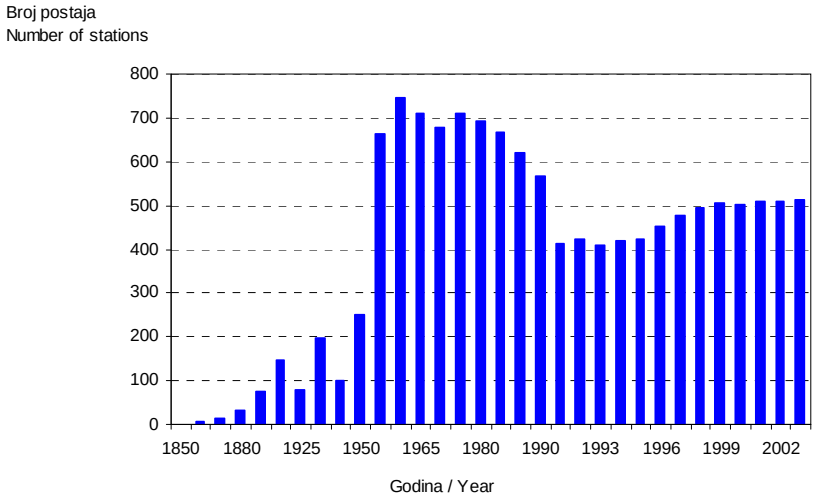
The oldest climate report for Croatia

- The longest continuous time series is for Zagreb Gric weather station, since 1861, without break.

Number of meteorological stations:

• Main weather stations	40
• Ordinary weather stations	114
• Rain gauges	337
• Totalizators	23
• Automatic weather stations	61
• Upper air radio sounding systems	2
• Radar network	3+5
• Sodar	1

Zagreb-Maksimir weather station

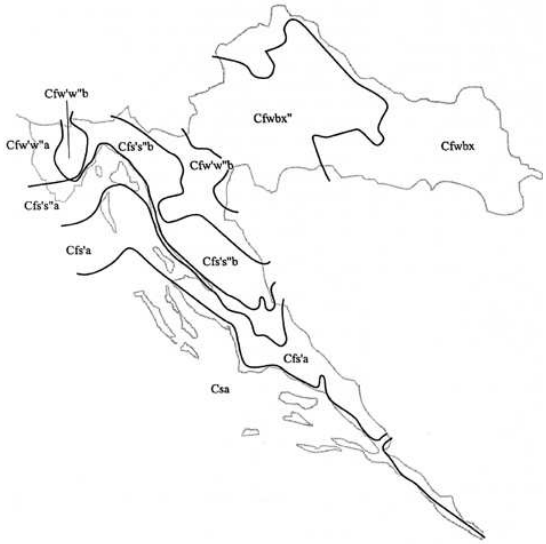


History of the weather station number in Croatia

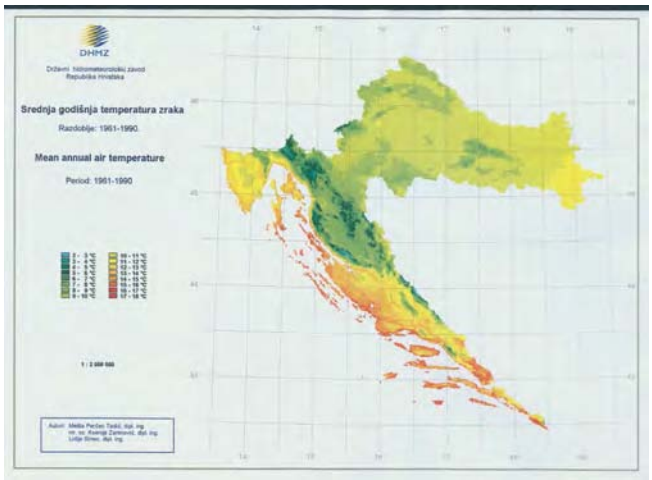
Spatial distribution of weather stations in Croatia

Special weather observation at a bridge

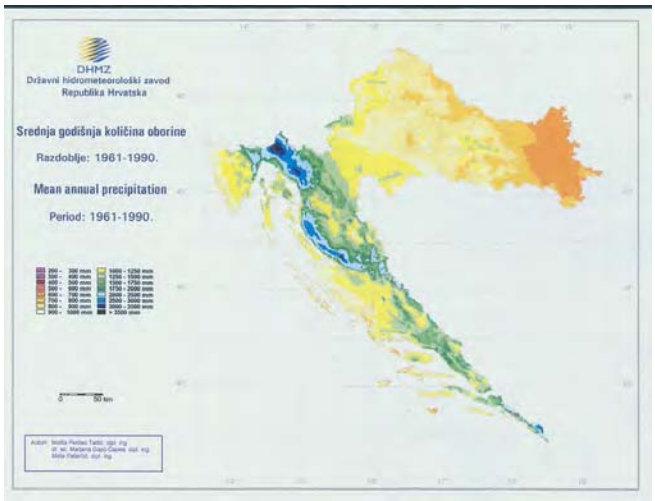
3. Climate monitoring in Croatia



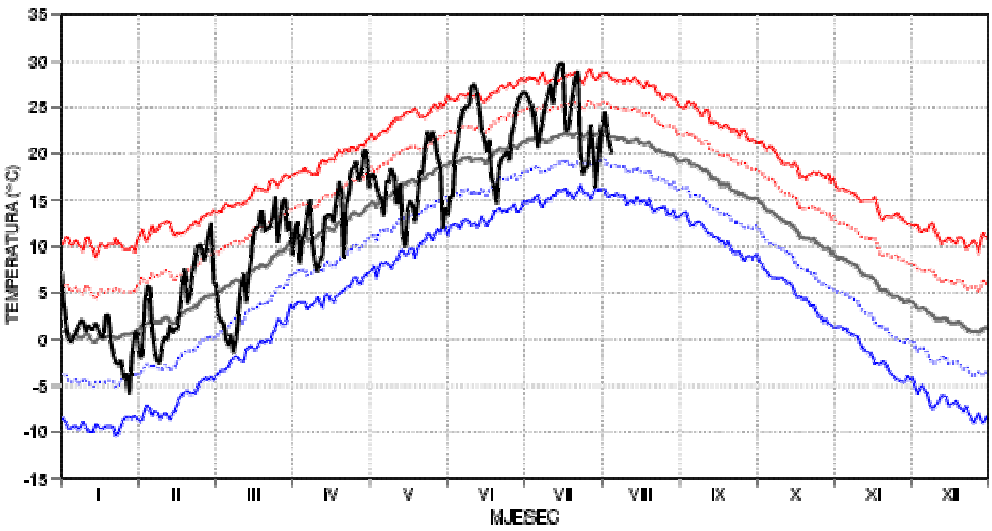
Climate zones in Croatia according to Köppen classification



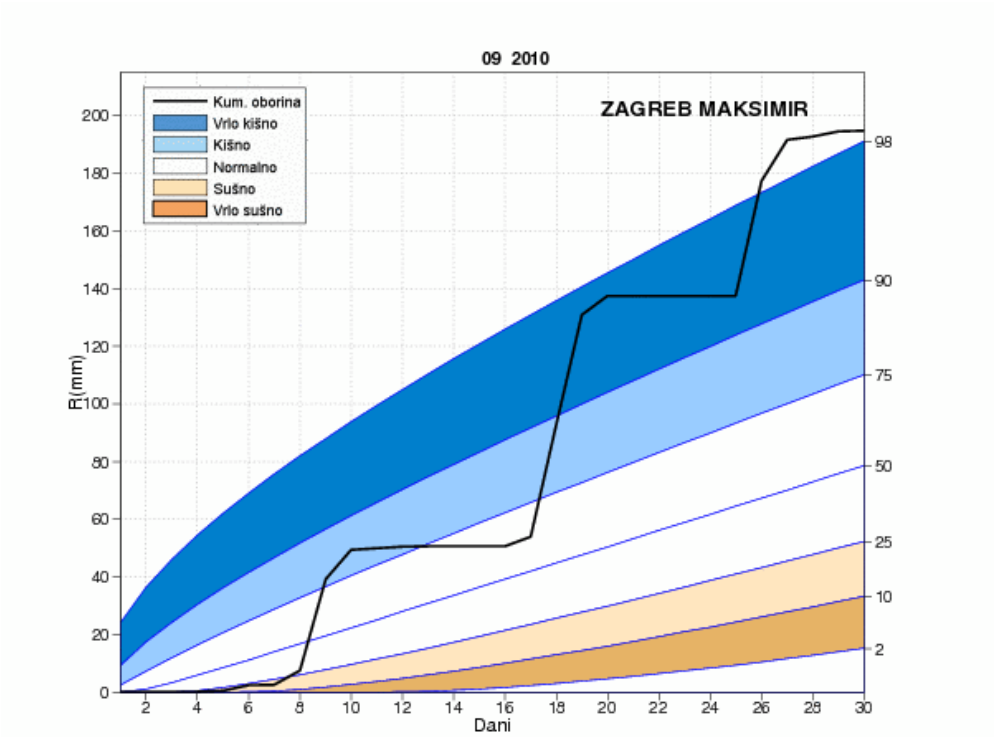
Annual average air temperature for the period 1961-1990



Average annual precipitation amounts for the period 1961-1990

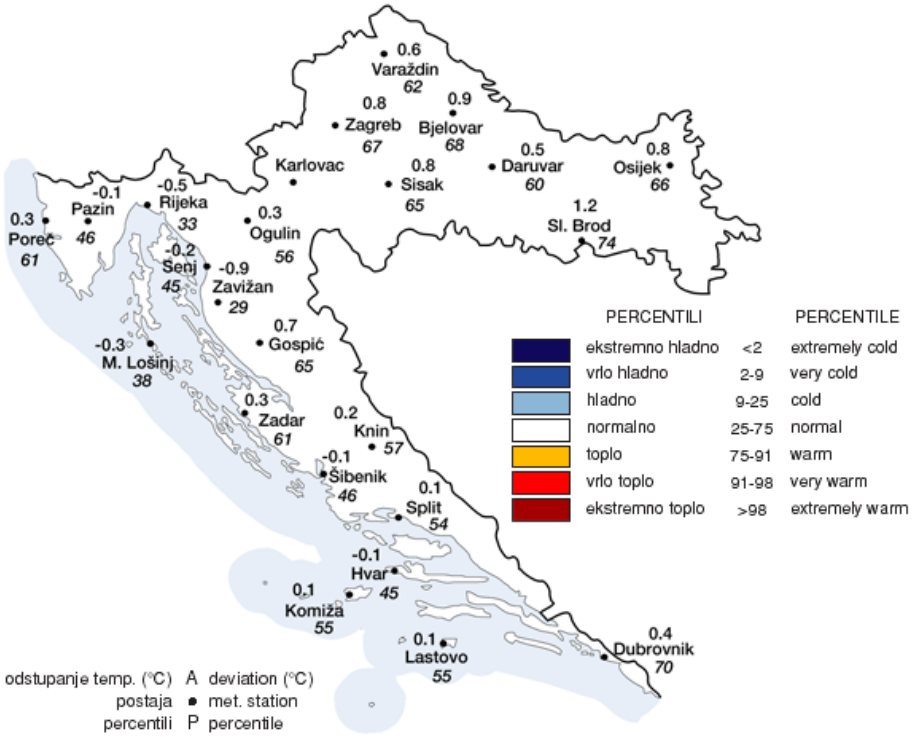


Monitoring of air temperature at Zagreb-Gric weather station on daily scale for 2010



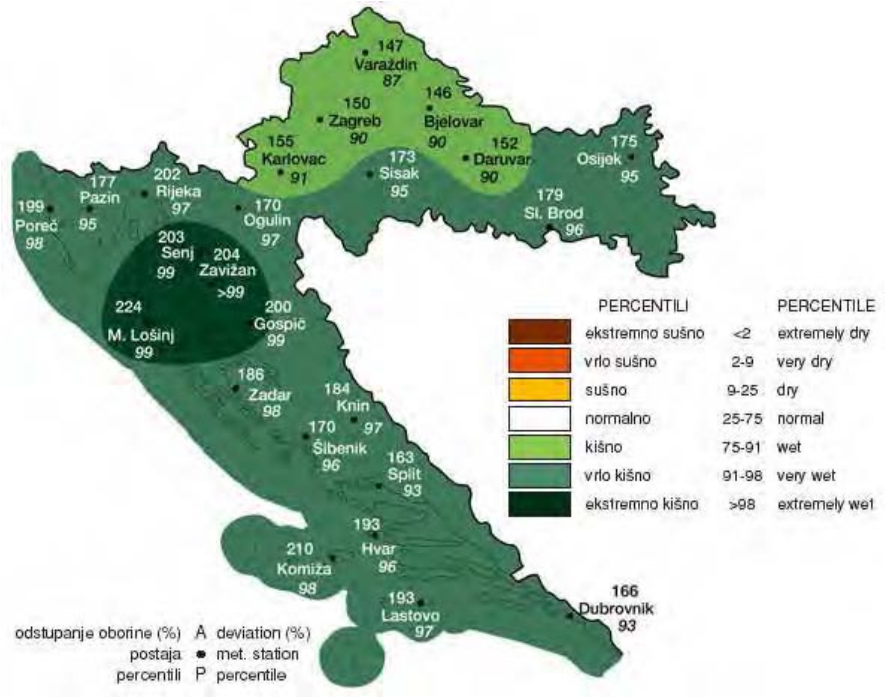
Monitoring of precipitation amounts at Zagreb-Maksimir weather station on a daily scale for September 2010

Average seasonal air temperature for Croatia for winter (December, January and February; DJF) 2009/2010 over the most part of the territory have been slightly above long-term average. Exceptions are weather stations Zavizan and Pazin in hinterland and Rijeka, Senj, Mali Losinj, Sibenik and Hvar in Eastern Adriatic coastal region. Air temperature anomalies in reference to 1961 -1990 period have been in range from -0.9℃ fo r Zavizan and 1.2℃ for Slavonski Brod.
According to percentile classification, air temperature for Croatia for winter season 2009/2010 has been classified into a **normal** category.

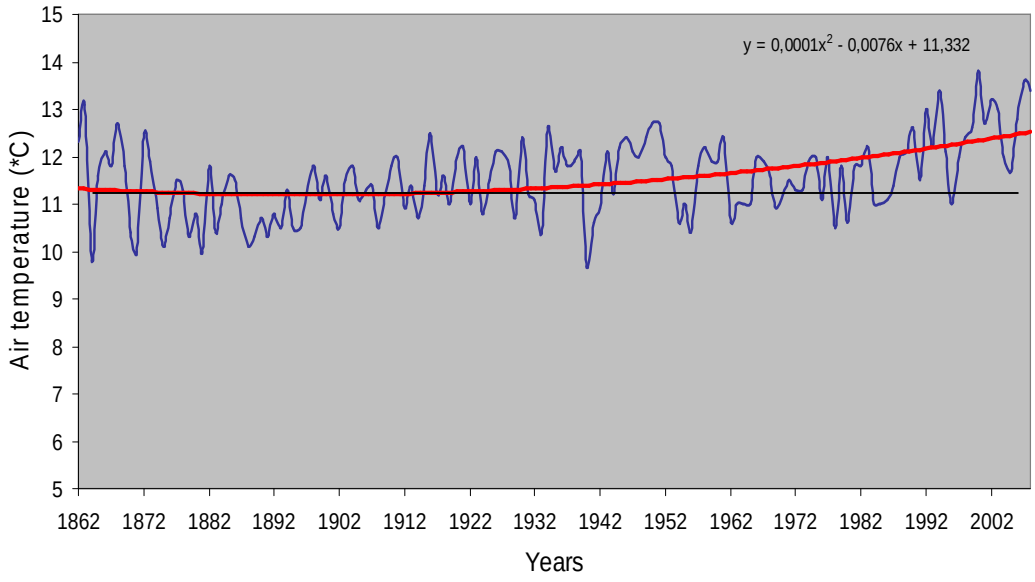


Winter (DJF) 2009/2010 air temperature anomalies for Croatia

An analysis of seasonal winter (DJF) 2009/2010 precipitation amounts, in percentages (%) of 1961 - 1990 average, have been above normal over the whole territory of Croatia. The amounts have been in range from 146% of winter long-term average for Bjelovar to 224% for Mali Losinj.
According to percentile classification, over the most part of the territory of Croatia seasonal precipitation amounts for winter 2009/2010 have been in **very wet** category, followed by **wet** and **extremely wet** categories (e.g. for Zavizan, Senj, Mali Losinj).



Winter (DJF) 2009/2010 precipitation anomalies for Croatia



Annual mean air temperature trend for Zagreb-Gric in period 1862-2009

4. Conclusion

- Observation climate network in Croatia is at satisfactory level.
- Collection of data in near real-time should be improved.
- Climate monitoring is also at satisfactory level.
- Strengthening of climate monitoring applications in Disaster Risk Reduction is required.
- Strengthening of collaboration in SEE and RA-VI is recommendable.

Climate monitoring activities of the Cyprus Meteorological Service

Stelios Pashiardis, Senior Meteorological Officer

Meteorological Service Cyprus

1. Introduction

The Meteorological Service of Cyprus handles matters that concern the weather and climate. Its mission is to provide information related to weather to all economical and social activities of the country in order to achieve high quality of services, the general welfare of the public and the protection of life and property of its citizens. In order to achieve the aforementioned goals, the Meteorological Service operates a network of 105 rain-gauges, 37 climatological stations, 2 synoptic stations, one station performing radio sondes for observations in the upper atmosphere, 1 actinometric station, a radar and a land-based meteorological satellite station (Fig.1). At the same time, a network of 35 Automatic Meteorological Stations is in use which includes a telemetry system for the collection of measurements and the creation of a special database.

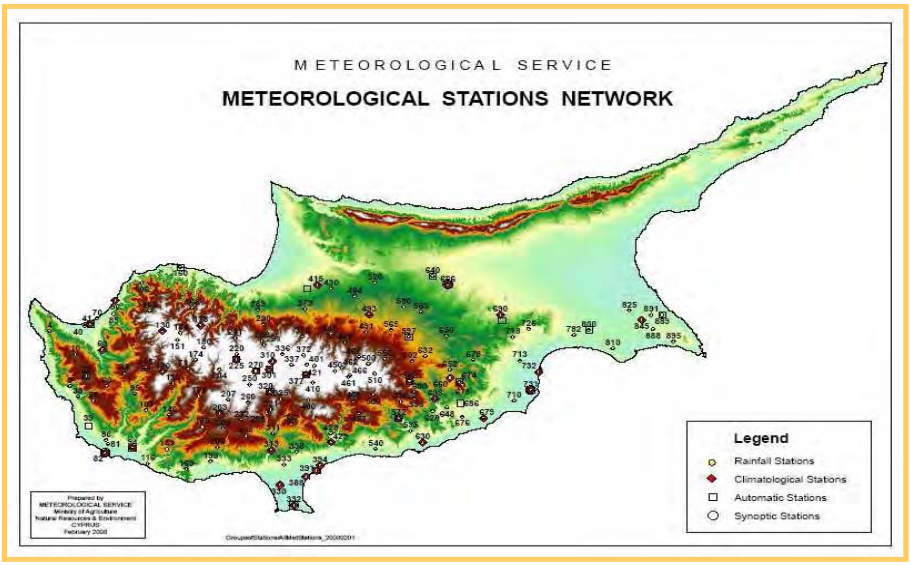


Figure 1

The main activities of the Meteorological Service can be summarized as follows:

- The operation and the maintenance of the network of the meteorological stations for the collection of essential meteorological data.
- The qualitative control, computerization and processing of the data.
- The statistical analysis of the meteorological variables and the publication of reports and studies on weather and climate.
- The provision of meteorological information and advisory services for the needs of various sectors of economy; in agriculture, in the development and management of water resources, in tourism and industry, in technical studies and constructions, in renewable sources of energy and in environmental studies.
- The issuances of general weather forecasts for Cyprus which are uploaded on the official web page and are distributed to the local media.
- The issuance of weather forecasts and warnings for the needs of nautical and aeronautical operations.

Climate watch systems are designed to provide advisories to inform the users about climate related matters and expected climate anomalies and their negative impacts. The climate watch

system consists of the following components: Data and observations, climate monitoring and analysis and long-range forecasting. Additionally, the format of the products and their dissemination is taken into consideration.

2. Climate data and climate monitoring and analysis

The availability of real-time and historical observations is necessary for an efficient monitoring and forecasting of extreme climate events. For this purpose we require a robust climate data management system. The existing database system (ENVIS) is an SQL database and it will be replaced soon by CLIDATA which is an Oracle database. The digitized precipitation data start since October 1916, while temperature data are mainly available from 1960. A data rescue program is running to digitize data from various met forms for a number of climatological stations running since 1866 (Pashiardis, 2008).

To perform climate analysis, statistical packages and various application packages, including modeling are required. Climate modeling has been strengthened by using GIS techniques to provide useful environmental information needed to assess the intensity and the extent of climate related hazards. The current climate monitoring system consists of the following elements:

- Daily/monthly/seasonal and annual climatological summaries
- Climatological statistics (normals, extremes)
- Climate surfaces
- Climate and agrometeorological modeling
- Climate change detection

An example of the climate change detection is presented in the next section.

2.1 Climate change detection over Cyprus

In the eastern Mediterranean, studies have shown significant decreases in the diurnal temperature range (DTR), due to significant increases in minimum temperature. Long term temperature data from two stations in Cyprus (one inland and one coastal location) have shown an increasing trend of approximately 1°C/100 years in the annual mean temperatures (Price et al., 1999). However, the study showed that the minimum daily temperatures have generally increased at a larger rate than the maximum daily temperatures, resulting in a decrease in the long-term diurnal temperature range (Fig.2). The changes in the diurnal temperature range can be possibly be explained by the increase in cloud cover and/or tropospheric aerosols. Furthermore, these changes are caused by local land–use changes, primarily by the increasing urbanization of Cyprus.

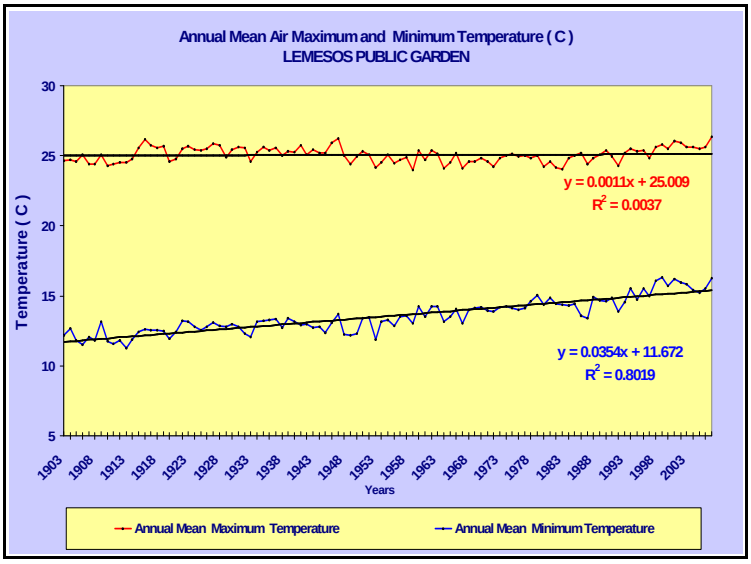


Figure 2

Temperatures in the last 20 years showed that this period was the warmest in the instrumental record of global surface temperature. Similarly, temperature data over various locations over the island showed significant increase of temperature during the period 1991-2010. Mean annual temperature differences of about 1.2^{o}C from the normal value of 1961-90, were recorded. Table 1 shows the mean annual minimum and maximum temperatures during the last 3 decades. An increase of about 0.8^{o}C is evident.

Temperature(^{o}C)	Period		
	1981-1990	1991-2000	2001-2008
Mean Daily Minimum Temp.	9.05	9.30	9.92
Mean Daily Maximum Temp.	20.84	21.04	21.57

Table 1 Mean annual temperatures over the island in each decade

The spatial distribution of the differences between the mean annual temperatures during the period 2001-2008 and the period 1981-1990 is shown in Fig. 3. The map shows that the western part of the island is warmer by 2 to 3°C than the rest of the island during the last decade.

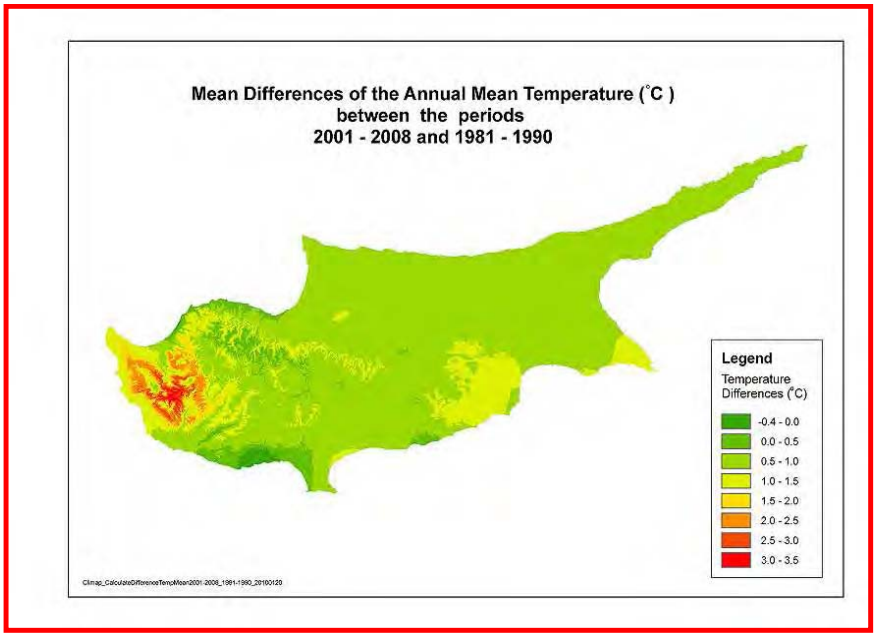


Figure 3

Widespread changes in extreme temperatures have been also observed over the last 30 years. Cold days, cold nights and frost have become less frequent, while hot days and hot nights and heat waves have become more frequent.

Reduction of precipitation has been observed in many parts of Mediterranean area. A decreased trend has been also observed for the area average precipitation over Cyprus. The rate of decrease is about 1 mm/year (Fig.4). The mean annual value of the area average precipitation for the period 1901-1930 is 556 mm, while for the most recent 30 year period of 1971-2000 it is 462 mm, i.e. there is a reduction of about 100 mm.

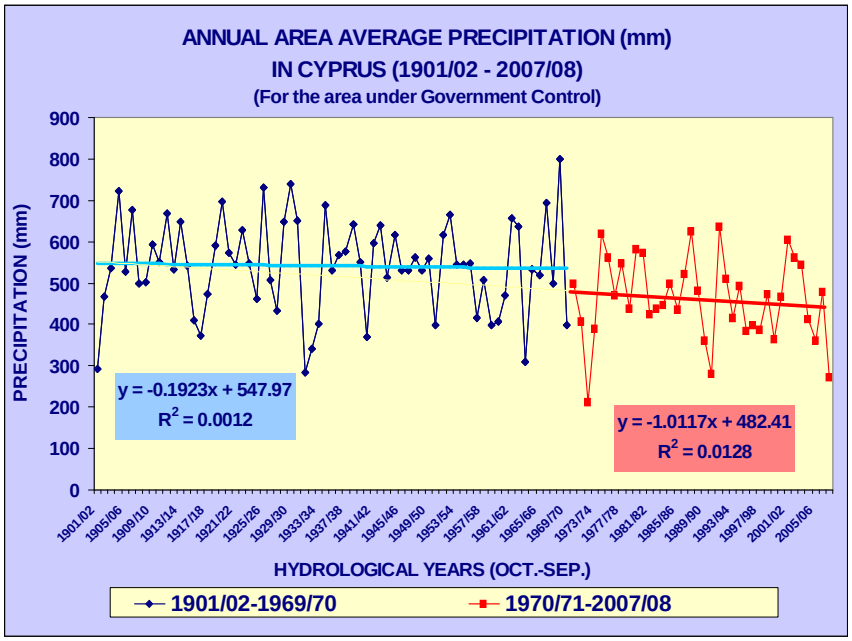


Figure 4

More intense and longer droughts have been also observed since 1970 (Fig 5). The frequency of heavy precipitation events has increased, consistent with warming and observed increases of the atmospheric water vapour. Long period of records have also shown that the number of rain days with precipitation greater than 2 mm have decreased showing that the number of weather systems affecting the island have been reduced. In contrast to the above, the number of systems originated from Sahara which are associated with dust, has significantly increased causing considerable allergic problems and affecting negatively human health.

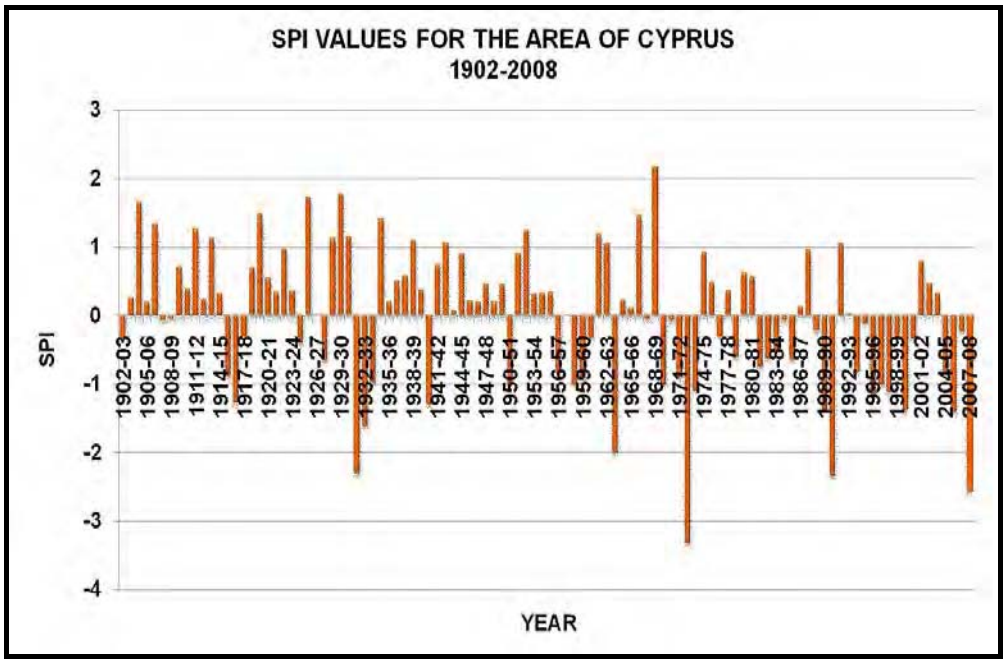


Figure 5

Climate change in Cyprus is very likely to affect ecosystem by reducing soil fertility and water availability. The stability of forest ecosystems will be negatively affected by accelerating tree mortality. The natural disturbances (fire, insects) will have a negative impact on forests. Under climate change conditions, it is expected that irrigation water demand will further increase

aggravating the competition with other sectors whose demand is also projected to increase. In addition, an expected lowering of the groundwater table will make irrigation more expensive. As the evaporative demand will increase due to higher temperatures, it is expected that capillary rise will increase the salinisation of soils which leads to desertification which is now evident in the island (Iacovides et al., 2008).

For the next two decades IPCC has estimated that a warning of about 0.2^{o}C per decade is projected for a range of various emission scenarios. Even if the concentrations of all greenhouse gases and aerosols had been kept constant at year 2000 levels, a further warming of about 0.1^{o}C per decade would be expected. According to various studies which are based on regional climate models and the impact of climate change on crops, it is expected that in Cyprus by 2080 there will be a reduction of crop yields by about 10 to 30% based on scenario A2, i.e. no action is taken to reduce GHG emissions (PRUDENCE, PESETA).

3. Long – range forecasts

An efficient climate watch system uses long-range forecasts provided by the Global and Regional Climate Centres, including consensus forecasts provided by Regional Outlook Forums. Capacity building is required to interpret the outputs.

4. Conclusions

Measurements of surface air temperature over Cyprus show an approximate increase of about 0.8 ^{0}C during the last century, which is at the same level of the warming of the planet. In contrast to that, precipitation has decreased by about 15% with respect to the mean value of precipitation during the period 1901-1930. The presented case studies show how effectively climate information can be used to assess the impacts of climate change on Cyprus society and economy.
Therefore, for an efficient climate watch system it is necessary to run the following climate functions on operational basis:

Assessment of the current weather conditions with adequate historical data.
Perform climate monitoring and analysis using climate models.
Use of probabilistic climate products for long-range forecasting and updating them continually

References

Iacovides et. al , 2008. National Action Plan for Combating the Desertification in Cyprus.
IPCC, 2007. Climate Change 2007. The Physical Science Basis. Summary for Policymakers, Technical Summary, Frequently Asked Questions.
Pashiardis, S. 2008. Rescue and digitization of climate data in Cyprus. In MEDARE Proceedings of the International Workshop on rescue and digitization of climate records in the Mediterranean Basin. Pp 185-192. Ed. M. Brunet and F. Kuglitsch.
PESETA, 2006. Projection of Economic impacts of climate change in Sectors of the European Union based on bottom-up Analysis. http:/peseta.jrc.es/docs/Agriiculture.html
C. Price, S. Michaelides, S. Pashiardis, P. Alpert, 1999. Long term changes in diurnal temperature range in Cyprus. Atmospheric Research 51, 85-98.
PRUDENCE, 2005. Prediction of Regional scenarios and Uncertainties for Defining EuropeaN Climate change risks and Effects. Final Report (http:/prudence.dmi.dk).

Status of climate monitoring and prediction in Finland

Reija Ruuhela

Climate Service Centre, Finnish Meteorological Institute

The demand for various climate services is rapidly increasing due to the growing climate change interest in society and the need to prepare to climate related risks. Finnish authorities, media and other users expect the national climate service to be readily able to comment and monitor climate variability and change not only in Finland but also elsewhere in Europe and even globally, especially in case of extreme climate events. Therefore it is important that in the years ahead the Global Framework of Climate Service would be able to help NHMSs to widen the set of climate information that they can provide to their respective communities.

In November 2009 a Climate Service Centre was established in the Finnish Meteorological Institute (FMI) according to the recommendations of WCC-3. The base of the Climate Service Centre is the traditional climate service with gradually widening set of services. One important aim of the service is to increase climate change awareness among decision-makers and general public in Finland. Therefore climate change issues will be included more frequently in regular climate communication like press releases and Climate Bulletins. By the end of 2011 FMI will release Climateguide.fi – portal in collaboration with Finnish Environment Institute and Aalto University Centre for Urban and Regional Studies. The portal will provide a comprehensive set of information on climate change and its impacts as well as mitigation and adaptation aspects. Climate data and scenario data will also be available via the portal.

In order to improve the utilization of climate data and climate change scenario data we aim to provide more value added climate services and actively participate in multi-disciplinary applied climate research projects. Effective, high quality climate service and climate change monitoring also set high requirements for the infrastructure of NHMS data processing. Long homogenous time series should be easily available in a climate database together with metadata. Yet, presently the development is towards the opposite direction with automatization and frequent changes in the observation network. On the other hand the use of gridded data is rapidly increasing in various applications and therefore interpolation methods should be further improved. The statistics of the new normal period 1981-2010 in Finland will be calculated based on both appropriate observation station data and gridded data. The mean annual temperature in Finland between 1847 and 2008 is presented in figure 1. The observed trend from this gridded data in 100 years is 0,93 ^{o}C (Tietäväinen et al., 2010).

Seasonal and decadal predictions have great expectations. However the feasibility of long-range forecasts in Finland is still quite low according to the recent three year verification of ECMWF seasonal forecasts. There is no predictable signal in half of the forecasts for Northern Finland and in quarter of the forecasts for Southern Finland. If there is a signal the anomaly is predicted for the temperature (3 months) relatively well but the changes in weather patterns are seldom predicted. The precipitation forecasts are poorer than temperature forecasts. Even though the predictability of the long-range forecasts is still low they could be useful for certain purposes and for professional users who understand the uncertainty related to these forecasts.

FMI issues seasonal forecasts “as a follow-up” product on the web pages, but otherwise their use is very limited in the weather or climate services. The time scale of operational weather warnings vary from 12 hours up to 3 days according the forecasted phenomena. A special “Severe Weather Outlook” is issued when necessary for rescue authorities and government organizations. The Severe Weather Outlook consists of two parts. When severe weather is expected an alert e-mail is sent out to subscribers with preliminary information about the severe weather and its predicted impacts. More detailed information is available on a special web page which includes e.g. a risk area and timing of the severe weather. According to user surveys different organisations have implemented various preparedness measures and the service improves their ability to cope in

difficult weather situations (Punkka and Rauhala, 2010). In the future this preparedness system could possibly be utilized also in the dissemination of Climate Watches.

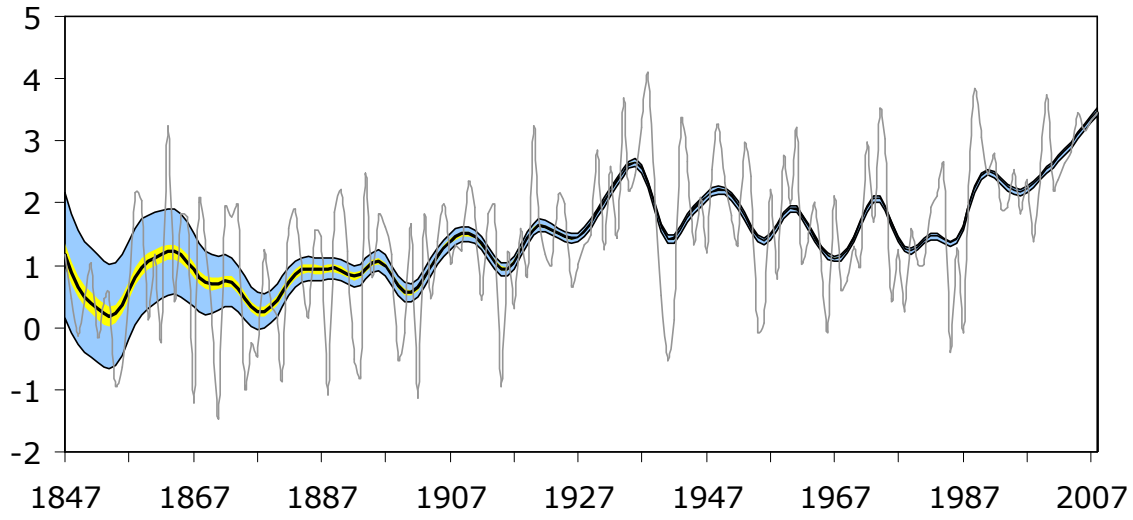


Figure 1: Annual mean temperature in Finland 1847-2008 with 10-year moving average. The uncertainty envelope is due to scattered observation network (blue coloured) and homogenisation adjustment (yellow). (Tietäväinen et al., 2010)

References

Punkka A.-J., Rauhala, J., 2010: Severe weather outlooks and their use for damage prevention and civil protection in Finland. 25th Conference on Severe Local Storms. http://ams.confex.com/ams/25SLS/techprogram/paper_175812.htm

Tietäväinen, H, Tuomenvirta, H, Venäläinen, A., 2010. Annual and seasonal mean temperatures in Finland during the last 160 years based on gridded temperature data. Int. J. Climatol Vol 30: 2247–2256. doi: 10.1002/joc.2046

Initial validation study of satellite derived monthly cloudiness data for Georgian territory

L. Megrelidze
N. Kutaladze
N. Dekanozishvili

The National Environmental Agency, Georgia

1. Abstract

The goal of the article is validation of satellite derived climate information for Georgian territory, which was performed by comparison of cloud fractional cover monthly data obtained from geostationary and polar-orbiting satellites and surface observations for the period 2005-2008.
Key words: climate monitoring, cloud cover, satellite observation, validation

2. Introduction

Long-range monitoring of meteorological parameters is the necessary step for study of various processes in climate system and then for assessment of the potential climate change and/or estimation of already revealed change. Nowadays very sparse coverage of the territory with meteorological stations (only 15 are functioning) can not provide enough information for substantial monitoring of weather and climate taking into consideration the complex physical-geographical and climate conditions of Georgia. So the satellite-based information is getting quite significant especially for investigation of high-mountainous regions and vertical profiles of atmosphere. However, for properly usage of satellite information, it is necessary to validate the mentioned data i.e. comparison them to surface observations.

3. Data and methodology

The comparison of satellite-derived climate data with observations for Georgian territory was performed based on EUMETSAT CM-SAF (Satellite Application Facility on Climate Monitoring) 4 year database of 2005-2008 period and according to methodology and recommendations elaborated with the purpose of their validation (www.cm-saf.eu).

For 2005-06 the data from geostationary satellite (MSG) received by SEVIRI (Spinning Enhanced Visible and Infrared Imager) for 2007-08 data from polar-orbiting satellite (MetOp/NOAA) received by AVHHR (Advanced Very High Resolution Radiometer) was used.

The cloud fractional cover (CFC) is computed as the cloudy fraction of all pixels within a 15x15 km grid square. Fractional cloud cover is expressed in percent. CM-SAF final product is calibrated for 26 climate regions of Europe by selected representative SYNOP stations (results computed as areal means over the studied area), whilst it is needed to make more detailed verification for each country i.e. define where the target accuracy has been reached.

For this study CFC monthly mean values have been used. The accuracy is defined as the mean error (i.e. defined in % cloud amount units) and precision is defined as the bias-corrected RMS error. The target accuracies are: ±10% (in units of cloudiness amount), ±15% over the ocean and tropical regions (±15^{0}N and S), for more then 70^0 viewing angles less accuracies are acceptable.

The surface observations were provided by database of regional observations of hydrometeorological network of the National Environmental Agency of Georgia. For 2005 data of total cloudiness (measured in balls i.e. tenth part of the sky covered by clouds) from 22 meteorological stations, for 2006 data from 38 meteorological stations, for 2007/08 – 14 meteorological stations have been found available.

Cloudiness values time series of 2005-08 have been compared for each station (fig.1), mean and standard deviations and their frequency distribution, also correlations between satellite and surface observations have been evaluated. All mentioned quantities have been estimated for the whole territory in average, as well for the Black Sea costal zone, plain and lowlands and mountainous and high-mountainous parts separately, in the same way, for the whole investigation period as well separate years independently. The obtained results are presented in fig.2-3 and the table 1.

4. Results

After comparison of satellite-derived cloudiness climatic data to SYNOP observations it has been found that the bias is mostly positive for data received by SEVIRI (2005-06) and negative for AVHHR (2007-08). The best coincidence has been found for Geostationary satellite data for the year 2006 (fully coverage of the territory by SYNOP stations). It also has been revealed the correlation dependence on season: the best in summer and autumn, the least reliable – in winter due to reduction of contrast between cloudy and clear skies over the land. The difference between costal, plain and mountainous regions has been revealed as well: in costal and mountainous regions overestimation of cloud cover by satellites is remarkable especially in winter season (to 10-20%) and in plains and lowlands relatively non-significant are negative biases.

5. Conclusions and perspectives

Taking into consideration the difference between satellite and surface observations, as well outermost position of investigation territory in base-line area, it can be concluded that initial validation of satellite-derived CFC data is satisfying (mainly not exceeded 10-15%). In the future validation of other satellite climatic data is planned and it will give the possibility of fulfilment of long-term monitoring of surface and upper-air fields for any point of Georgian territory.

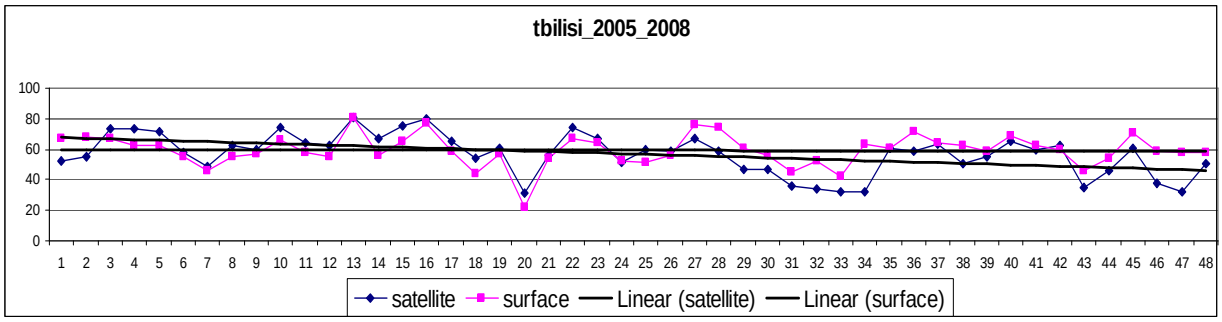


Figure 1: Cloud Fraction Cover of Satellite and surface observations (Tbilisi)

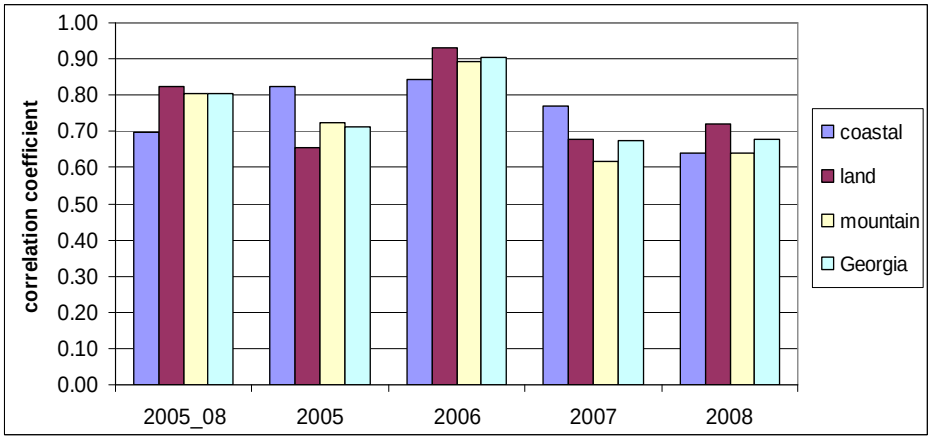


Figure 2: Correlation coefficients between satellite and surface observation series

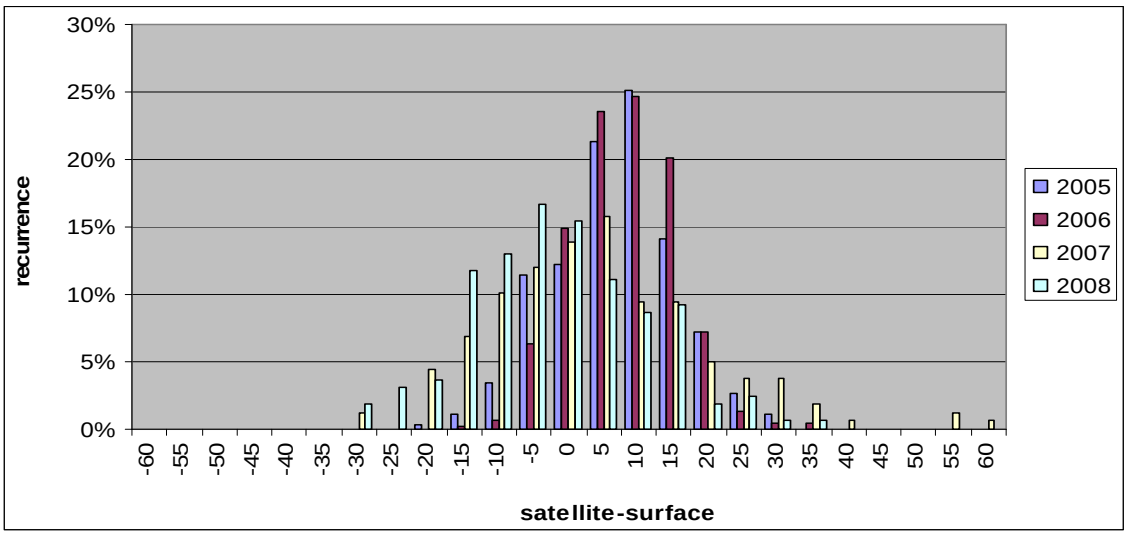


Figure 3: Frequency distribution of bias between satellite and surface observations

RMS	2005_08	2005	2006	2007	2008
Coast	9.8	5.9	10.6	12.4	11.4
Land	10.5	9.5	8.9	11.2	14.2
Mountain	10.0	10.8	9.2	18.3	10.0
Averall	10.3	9.5	9.1	13.8	12.3

Table 1: Root mean square error (RMS) of satellite and surface data series

References

1. Elizbarashvili e., Megrelidze l., 2003: Mathematical Modeling Issues of Cloudiness Fields in East Georgia. Transactions of the Institute of Geography, vol. 21, p.p.150-155.
2. CM-SAF UMP, 2008: User Manual of Products of the Climate Monitoring SAF (included in the ORR V2 documentation).
3. Karlsson et al., 2007: Validation of CM-SAF cloud products derived from MSG/SEVIRI data. CM-SAF Scientific Report, SAF/CM/DWD/KNMI/SMHI/SR/CLOUDS-ORR/3, 93 pp.
4. Roebeling R.A., A.J. Feijt, and P. Stammes, 2006: Cloud property retrievals for climate monitoring: implications of differences between SEVIRI on METEOSAT-8 and AVHRR on NOAA-17, J.Geophys. Res., 111, D20210, doi: 10.1029/2005JD006990.

Air temperature and precipitation distribution peculiarities in Georgia

Doctor of Geographical Sciences, Prof. Liana Kartvelishvili
Nato Kutaladze P.H.D

National Environmental Agency / Hydromet of Georgia

In current state the expected climate change may has significant influence as from ecological as well as material point of view on different natural ecosystems and also on the development of quite of number branches of economy. For the mitigation of mentioned impact preliminary assessment of possible change of climatic elements, expected influence of this change on various systems has to be needed and adaptation measures should be planned, which's implementation would avoid or mitigate negative impact of climate change. Consideration of climatic conditions is necessary especially by climate change in last decade.

The investigations showed that against the background of climate global change the regional climate variations have been revealed and of course our country is no exception. Georgian climate is characterized by unique manifold that is preconditioned by its geographical location, complex relief of hypsometrical development and collection of other climate forming factors. As the result of complex relation of those factors on the small territory of Georgia (69.7 000km^2) there exist almost every climatic type (except equatorial and tropical). Consequently it is safe to say that Georgia represents the classical sample of polyclimatic country. Thus the climatic variations on the small territory as Georgia coursed more painfully than in countries with large territory.

For the characterization of variety of climatic conditions and for provision of relevant scientific or practical industrial-societal activity the regular meteorological observation net is functioning in the state for too long period. By regular meteorological observation Georgia belongs to the number of leading countries because here in 1844 was established magnetic-meteorological regular observation organization founded in world practice and from here begins integration of Georgia in international data exchange system. On the base of processed multiyear for most of stations and posts- century and more continuous regular meteorological observation material the climatic characters for Georgia as for whole country also for regions and separate populated areas and heavy industrial centers (cities) have been ascertained. Fig.1 shows the developing dynamic of observation stations and posts in Georgia from 1900 till present.

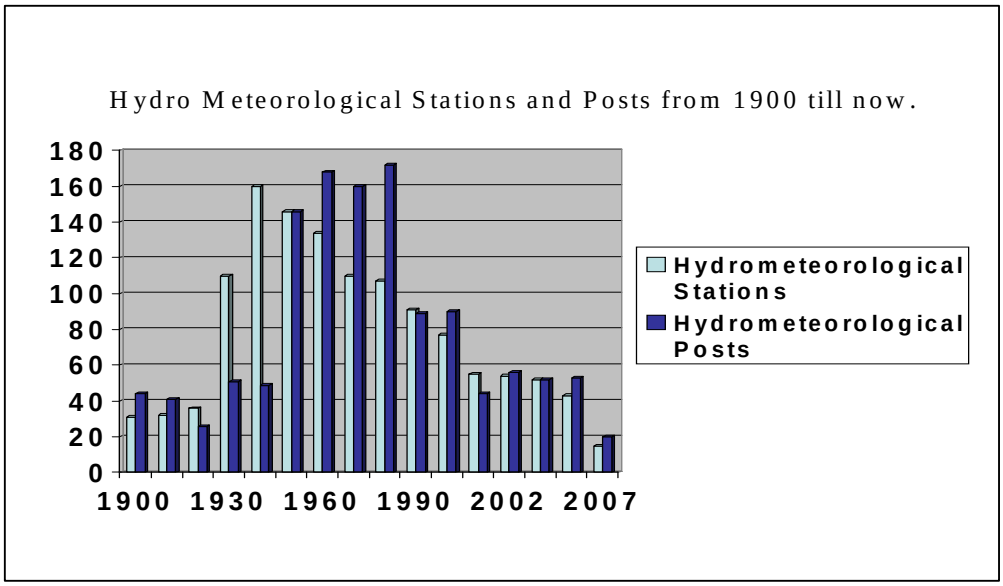


Figure 1

For the identification in which region and the power of climatic changes have been taken place to conduct relevant measures for avoidance of negative impact the change regulations o climatic parameters in space-time by separate regions have to be needed. Long period observation series are the factual material to study modern climate change. The study the century change of air temperature, precipitation and other meteorological elements gives possibility to reveal modern climate change nature.

For characterization of the climate course climatic trends have been used. The interpretation of high order trends is connected with series of difficulties. Thus to identify climate change tendency for some time period linear trends are quite sufficient.

The aim of present study is the identification of factual nature of climatic characters of Georgian diverse territory for century period and revealing their change tendency including the last 15 years. It has to be marked that in already conducted studies the modeled climatic data have been used for last years. This was preconditioned by the matter that in Georgia for above said period the regular meteorological monitoring initial data haven't been treated and correspondingly there exist no factual climatic cadastral data for separate territories and for last years the lengthened climatic series were used.

Air temperature is that basic element that is widely used in climate change investigation because its definition accuracy is higher than other climatic ones and what's the most important it has long observation series.

As data analyze shows despite that the temperature significantly modifies from year to year for whole period as seasonally as well as annually it is noted its regularly growth, reduction or stability. The temperature background growth is well expressed in Tbilisi Fig.1.and Telavi, considerably smaller in Pasanauri, Sakara and Zugdidi. On other stations the stability is maintained or temperature has been slightly changed as in negative as in positive tendency direction.

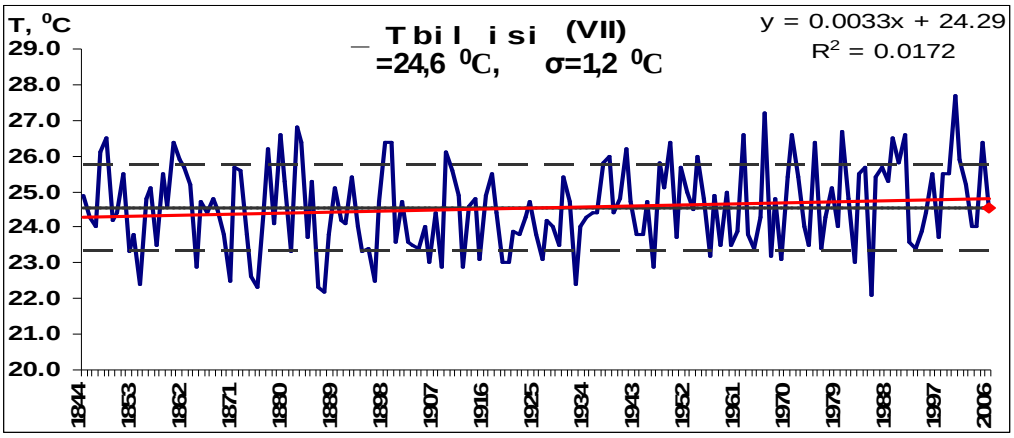


Figure 2: Average monthly air temperature and its deviations from the norms from 1844 to 2007 of Tbilisi

From the chart analyzes it has been revealed that temperature series change is not strictly linear and for given period is not directed towards warming. It has been periodically noted the impact as of warm as cold waves, that are the reason of temperature deviation from normal mode.

Atmospheric precipitations are significant climate forming factors. As air temperature also precipitation are one of indicators of climate change, but it is important only after temperature in climate study. It may be said that the regulation which gives the global character to the temperature doesn't spread on precipitation, which has heterogeneous nature in our country. Precipitation is variable element because experienced strong variations in space-time, as

horizontally also vertically, thus the investigation of its multiyear regime like temperature needs long and homogeneous observation series.

Except the fact that some stations have short period observation data also several ones have heterogeneous series, and else mountain and especially high mountain stations measuring accuracy is too low because of imperfect measurement methodology. Thus almost all of stations observation data have to been examined on homogeneity using relevant method.
For such small territory as Georgia the atmospheric circulation processes causing rich precipitation and draughts would be the same. But in fact it reveals from table 1. In Tbilisi, Poti and Sakara not only extreme wet and dry years but also extreme decades doesn't coincide with each other. It has been explained by complex orographic and hypsometric conditions of Georgia.

The location of Georgia in south of Caucasus Ridge increases the air masses flow intrusion frequency from the west. Because of growth of convergence and elevation this intruded from the west air mass ascends by force and preconditions rich precipitation and temperature decreasing in the territory of west Georgia. By oozing on the west of Likhi-Imereti Ridge the same air mass while moving towards east, by descending on the east slope is characterized with dry adiabatic processes, which cause precipitation reduction and temperature increasing. That's why the precipitation multiyear norm in Tbilisi is 500mm that is approximately 2, 5 times less than in Sakara and in 3, 3 times less than in Poti. Such distinctive amount of precipitations and course is preconditioned because of transformation of precipitation forming synoptic processes.

Met. Station	Year	Precipitation, mm	Multiyear anomaly %	Decade	Precipitation mm	Multiyear anomaly %
			Extreme wet			
Tbilisi	1972	812	+61%	1972-1981	565	+12%
Sakara	1978	1598	+34	1970-1979	1310	+10
Poti	1967	2474	+49	1966-1975	1870	+13
			Extreme dry			
Tbilisi	1962	241	-52%	1953-1962	438	-13%`
Sakara	1929	827	-27	1909-1918	1076	-9
Poti	1909	939	-43	1909-1918	1450	-13

Table 1: Extreme wet and dry years and decades

From the analyzes of last ten year precipitation data it reveals that in last period (1936-2007) in precipitation amount increases as well as decreases. But generally in west Georgia there prevail precipitation growth tendency. In west Georgia especially in high humid regions, Poti and Zugdidi [fig.2] the annual precipitation trend is characterized by growth tendency, that is sharply exposed from the beginning of 21^{-th} century. But in some places precipitations stay unchanged Samtredia, Senaki or decreases.

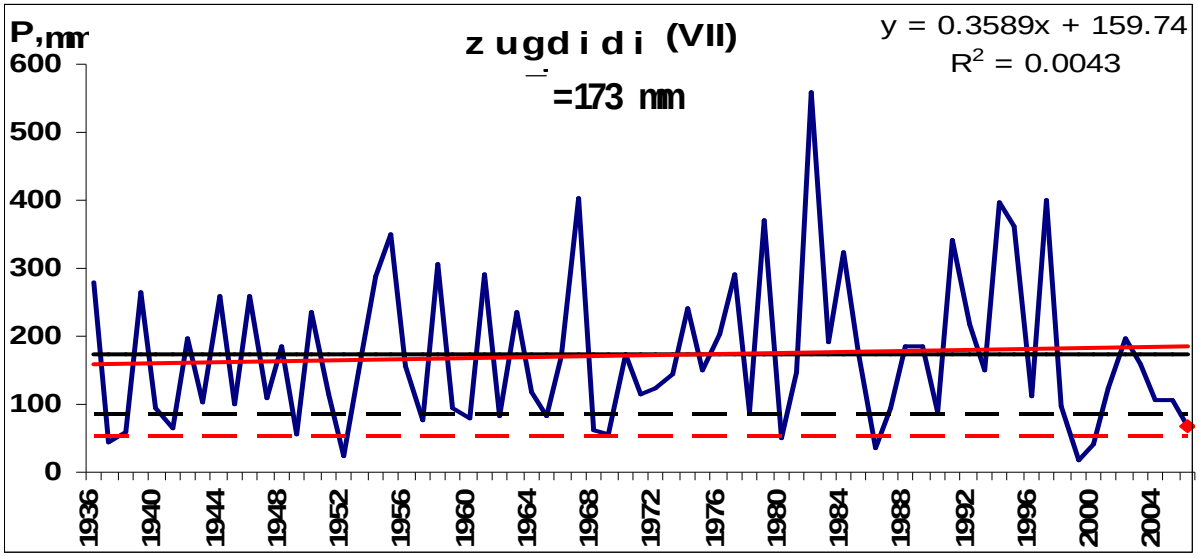


Figure 3: Change of precipitations monthly sum from 1881 to 2007 of Zugdidi (VII)

In Sakara by the east of Kolkheti precipitation increases again and reaches maximum in 1970-1980 years. At it is shown from data processing the December was especially wet, when the precipitation amount was more than the month norm 151mm on 111%. In west Georgia despite of the east precipitation maximum comes in May-June and in east precipitation maximum is fixed in late autumn and first half of winter. Those variations of basic climatic parameters have to be the basic in climate change studies.

Status and priority needs of monitoring and prediction of climate anomalies and extremes in Germany

Tobias Fuchs

Deutscher Wetterdienst (DWD), Offenbach, Germany

1. Status of national activities

Major goal of the German activities related to monitoring and prediction of climate anomalies and extremes is the prevention and risk reduction of human casualties and economic losses associated with weather-related natural disasters. Climate Change is expected to increase the number and intensity of weather extremes in Central Europe. Therefore, Germany is developing until summer 2011 a National Adaptation Action Plan, that goes with the German adaptation strategy to Climate Change (DAS, http://www.anpassung.net). The latter feeds also the development of a comprehensive EU climate change adaptation strategy. DWD contributes to the German climate change adaptation strategy by widening the knowledge base by reference information on the impact of regional climate change in Germany for specific sectors such as transport, construction, energy, agriculture, health, and waterways management.

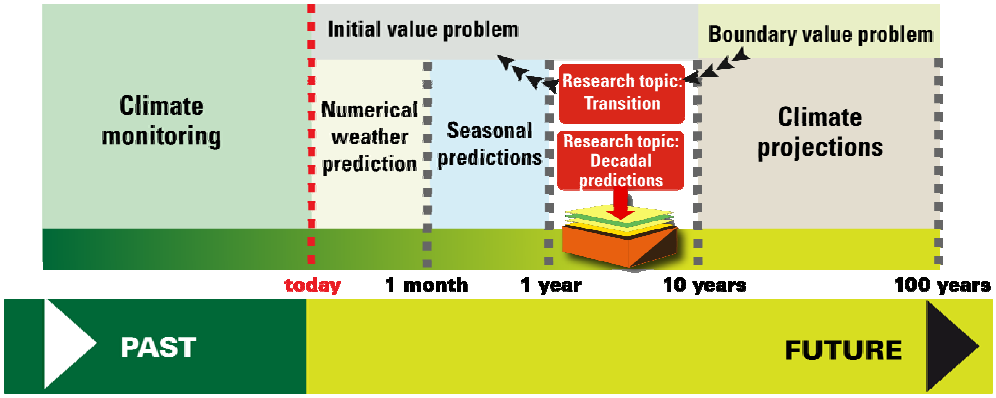
The WMO RA VI RCC-CM (www.dwd.de/rcc-cm) component hosted by DWD comprises several DWD operated climate monitoring centres, which support climate analysis and diagnosis by provision of data and related products for several essential climate variables (ECVs):

- the Global Precipitation Climatology Centre (GPCC) gpcc.dwd.de;
- the EUMETSAT SAF on Climate Monitoring (CM-SAF) www.cmsaf.eu;
- the Global Collection Center for Maritime climatological data (GCC) www.dwd.de/gcc;
- a Global Atmosphere Watch (GAW) global station www.dwd.de/gaw;
- a Baseline Surface Radiation Network (BSRN) reference station;
- the GCOS Reference Upper Air Network (GRUAN) Lead Center www.dwd.de/gruan;
- a GCOS Surface Network Monitoring Center (GSNMC) www.gsnmc.dwd.de;
- a CBS Lead Center for GCOS data in WMO RA VI.

These monitoring centres feed their data and products into the DWD Climate Data Center (CDC) www.dwd.de/cdc, which is the access point for user-related provision of data and products. A new user-related climate information product of DWD is the online Climate Atlas Germany (www.dwd.de/klimaatlas), which combines climate monitoring data and reference data from the past with climate projection data up to year 2100.

An example German project is 'KLIWAS (Consequences of climate change for navigable waterways and options for the economy and inland navigation)" that introduces the ensemble approach, well known in context of numerical weather prediction (NWP) to climate impact assessment research. In doing so DWD utilises results from the combination of a variety of different global and regional climate models with global emission scenarios to properly account for the uncertainties inherent in high resolution climate model projections for the area of Germany.

Another DWD-lead climate impact research activity assesses regional climate projections for Germany with focus on changes of intensity and frequency of extreme events for temperature, precipitation, and wind. Key users of the results of this project are governmental civil protection agencies of Germany needing to adjust their strategies to comprise climate change adaptation.



With regard to prediction, DWD is about to significantly enhance its activities by development of a uniform "seamless prediction" ensemble modeling framework for time-scales ranging from numerical weather prediction to climate projections. This includes the closure of gaps in the temporal coverage of predictions. In this context the further development of decadal prediction systems – linking the classical NWP and the climate projection time scales – and the improvement of the seasonal prediction systems for the region of Europe by increasing the ECMWF EUROSIP Ensemble are of special importance.

2. Gaps and needs

The applicability of WMO RA VI RCC climate monitoring data sets for evaluation of regional climate model simulations could be further enhanced by:

- Enhancement of spatial grid resolution of climate monitoring data sets up to 0.1°(~10 km);
- Increase of the number of cross-border exchanged climate stations (in order to support further enhancement of the quality of gridded observation data sets);
- Provision of more statistical measures in climate observation data sets (variance, relative deviation, etc.);
- Provision of gridded RCC climate observation data sets for additional ECVs (e.g. wind, radiation, humidity).

The applicability of WMO RA VI RCC long range forecast (LRF) products for development of regional climate watch products could be further enhanced by:

- Provision of a single user-friendly WMO RA VI RCC LRF Website in order to provide information on all LRF activities and products;
- Further improvement of the LRF quality (e.g. concerning seasonal forecasts in Central Europe);
- Long overlapping hind-cast periods of the different members of the EUROSIP multi-model seasonal forecasts (the hind cast dates of the EUROSIP ensemble members currently differ quite largely);
- Further improvement of the communication of probabilistic LRF information to end-users.

Climate data, climate monitoring and long-range forecast at the Hungarian Meteorological Service

Zita Bihari
Gergő Kiss
Tamás Kovács

Hungarian Meteorological Service

1. Climate data

1.1 Current status

Digital data base of Hungarian Meteorological Service:

According to the current status Hungarian Meteorological Service (HMS) stores data in the digital database (Oracle) from 1951 generally. Before the automatization of measurements these data mean daily values. Number of the rain gauge stations decreased from 800 to 500 between 1951 and our days. Number of stations with measurements at least temperature beside the precipitation is about 80 in this period.

In the 1990's years the automatization of measurements has begun at HMS. Recently the number of AWSs are about 100. In the data base we store 10 minutes data of these stations.

Climate data on HMS homepage:

We publish daily data for 4 stations in Hungary between 1901 and 2000 (temperature, precipitation, sunshine duration) on HMS webpage. Beside the data the station history, description of measurements and climatic analyses of data series can also be read (http://www.met.hu/eghajlat/eghajlati_adatsorok/bp/Navig/Index2_EN.htm).

Homogenized climate data:

Beside the original data we prepare long time homogenized data series for climate researches. For this purpose we use the MASH homogenization method, which was developed at HMS (Szentimrey, 1999). Recently we have homogenized daily data series from 1901 for 15 stations in the case of temperature and for 58 stations in the case of precipitation. We calculate the homogenized series for the stations and for a 0.1° resolution grid as well. Homogenization procedure is executed at the beginning of every year, but recently they aren't reloaded to the digital data base.

1.2 Ongoing activities, plans

According to the human resources of HMS, digitization of daily data is in progress for the period before 1951. The process includes the revision of metadata of course.
Reloading of homogenized data series to digital data base will be fulfilled in next year.

2. Climate monitoring

2.1 Products

In every month maps compiled by the MISH method (Szentimrey, Bihari 2007) of mean temperature and precipitations are published online on the HMS and ECSM web page (*Fig.1.*).
We regularly publish our reports on the weather of the last month, season, and year on the HMS web page. The Hungarian translations of the WMO annual statements on the status of the global

climate are published on the HMS webpage, and in print. We make specific climate studies for end users.

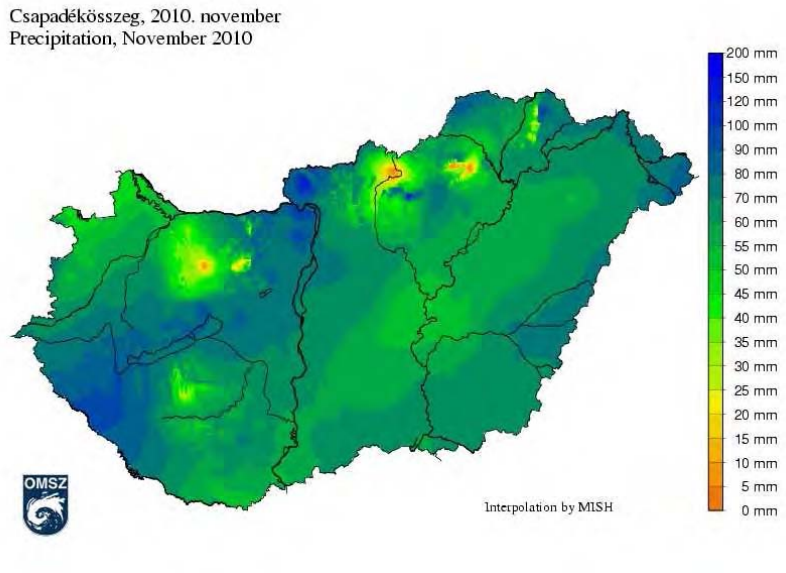


Figure 1: Precipitation in Hungary, November 2010
(http://www.met.hu/eghajlat/visszatekinto/elmult_honapok/index.php?ev=2010&ho=05)

2.2 Projects

Hungarian Meterological Service considers participating in international projects as an honour. We participated in GAR project, recently we've joined to EUMETGRID.
We are one of the founding countries of the DMCSEE (Drought Management Centre for Southeastern Europe) project. The mission of this project is to coordinate and facilitate the development, assessment, and application of drought risk management tools and policies in South-Eastern Europe with the goal of improving drought preparedness and reducing drought impacts. We are participating in various calculations, including SPI and PDSI drought indices (www.dmcsee.eu).

2.3 Plans

Our Climate of the Carpathian region tender is currently under consideration. We form a consortium with the following members: Austria, Bulgaria, Czech Republic, Croatia, Poland, Romania, Serbia, Slovakia, Slovenia and Ukraine. Our aim is to provide gridded daily data series of temperature, precipitation, sunshine duration, cloud cover and various extreme indices.

3. Seasonal forecasts

Since 2001 our long range forecasts are based on the seasonal forecasting system of ECMWF, currently System3. We use the mean, maximum and minimum temperature and the precipitation as well. Information is given for six regions of Hungary and meteogram style forecasts are produced for ten cities.

We make verification for every month and for every six months.
Testing of a new system by ECMWF is going on.

4. Monitoring of extreme events

Trends of extreme indices are published on different forums (*Fig. 2.*). In the case of extreme events we prepare draft reports on our homepage and in other media.

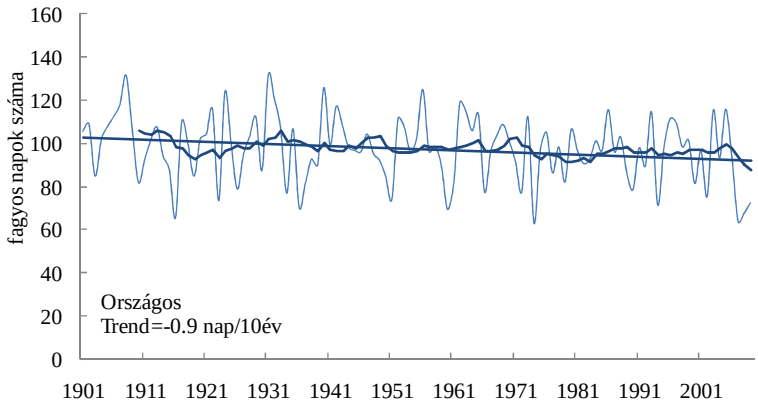


Figure 2: Number of frost days in Hungary (Lakatos et al, 2010)

5. Early warning system

Our Service is participating in Meteoalarm, providing the most relevant information needed to prepare for extreme weather, expected to occur in Hungary. Our alarm system was renewed in November, and it consists of different levels of warnings, and a special forecast in text. We give out three levels of warnings for 6 regions, for 3 and 24 hours on severe thunderstorms, excessive rainfall, wind, sleet and snowing, snowdrift, fog, extreme cold and heat waves.

The heat wave warning is based on a 5 day forecast. The first level of warning is given if the daily mean temperature exceeds 25℃, the second level if occurs on at least three consecutive days, or exceeds 27℃ on a single day. The third level is gi ven is the mean temperature exceeds 27℃ on at least three consecutive days.

6. References

Lakatos, M., Bihari, Z., Szentimrey, T. (2010): „Observed trends” in: Climate change – 2010, ed.Bartholy et al, HMS, (under publ)

Szentimrey T. (1999). "Multiple analysis of series for homogenization (MASH)". In: Proceedings of the Second Seminar for Homogenization of Surface Climatological Data, Budapest, Hungary, WMO-TD No. 962, WCDMP No. 41, 27-46.

Szentimrey, T., Bihari, Z. (2007): "Mathematical background of the spatial interpolation methods and the software MISH (Meteorological Interpolation based on Surface Homogenized Data Basis)", Proceedings of the Conference on Spatial Interpolation in Climatology and Meteorology, COST Office, Luxemburg, 259pp, pp.17-28

http://www.met.hu

The Italian Climatological Service: monitoring and predicting climate anomalies and extremes

Filippo Maimone

Italian Air Force - Centro Nazionale di Meteorologia e Climatologia Aeronautica, Servizio di Climatologia, Aeroporto "De Bernardi", via di Pratica di Mare 45, 00040 Pomezia (ROME)

1. Abstract

Italian Climate Department activity is briefly illustrated, concerning climate monitoring, studies on climate extremes and their applications, and current developments in the field of climate projections.

2. Italian Met-Service Climate Department: the archive

The Climate Department of CNMCA is operating inside the airport structure of Pratica di Mare, Pomezia (Rome), and is one of the four Divisions of CNMCA, heart of operational meteorology in Italy. The Department manages a central archive, feed every day by thousands of meteorological and climatic messages coming from about one hundred of weather stations and airport meteorological offices, 6 upper air stations, meteorological radars and satellites.

Stations locations range from mountain, interior land, and coasts, making Italy a complex place from a climatological viewpoint, but at the same time (and for the same reason) a good place to test climatic models!

Electronic archive includes about 60 years-long data, and is managed through a web-interface system allowing for many different statistical elaborations (like homogenization procedures) and direct climate indices calculations. Historical data from about 1925 are still in paper format, and have being digitalized.

Electronic archive is under a routinely-performed quality control, and is used both to fulfil the many user requirements of climatic data (and their elaborations), and also to make studies, for example on climatic extremes. These last are updated every month, and events (meteorological data and information about consequences) with major socio-economic impacts are stored in a special archive called REMEMBER.

3. The activity on climate monitoring: an example of intense event

Climate monitoring, particularly on decadal and monthly time scale, is made by using several sources of information, and taking into account a number of factors, from the Euro-Atlantic forcings (NAO, for example) to local scale responses of main meteorological parameters.

In particular, a monthly bulletin is compiled, which includes a detailed analysis of the observations, synoptic analysis, intense meteorological events, climate extremes and anomalies (figure 1).

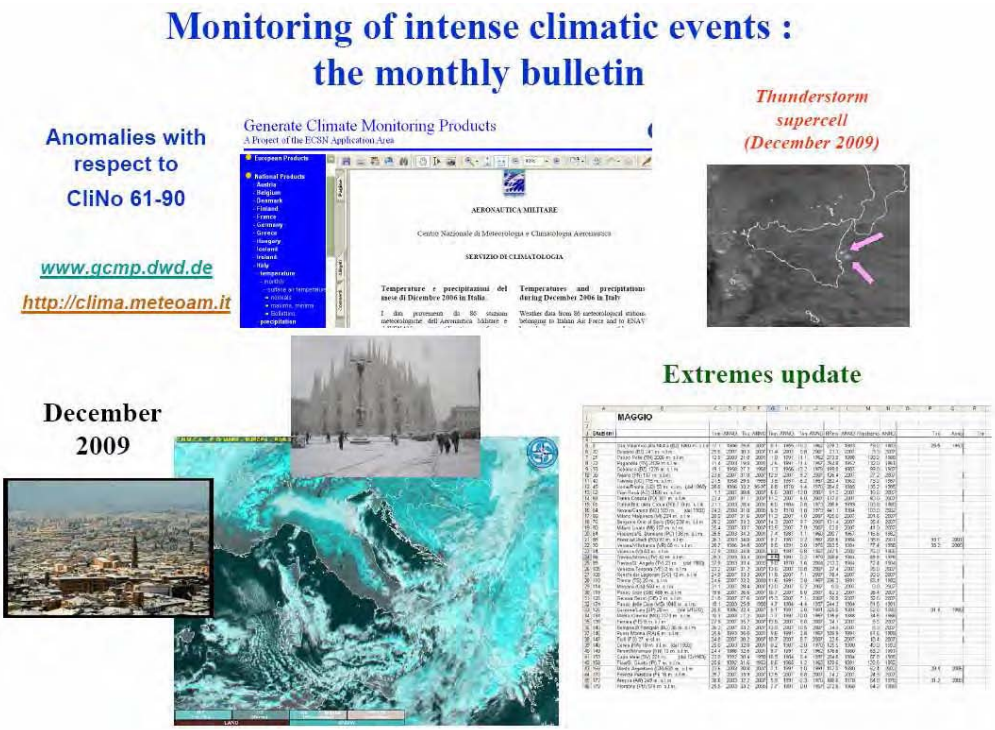


Figure 1

Often our Department is asked to reconstruct for various purposes (legal, aeronautical, etc.) a particular intense event of the past. During the winter 2008-2009, for example, different intense wind events interested the area of Rome. Figure 2 shows the behaviour of daily maximum wind in that period, as measured by weather stations of the same area.

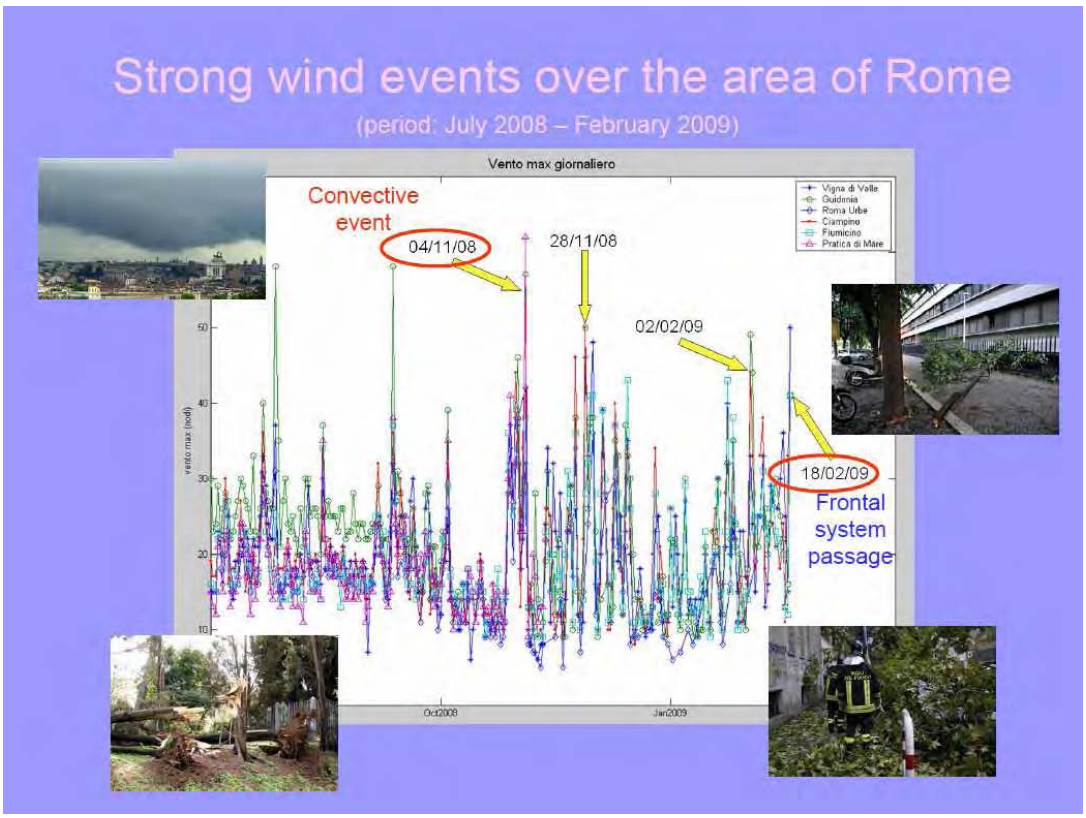


Figure 2

We briefly illustrate here the event of 04/11/2008, corresponding to a mesoscale convective system impacting violently on the central coasts of Lazio. The associated *downburst* over Rome caused many inconveniences, as the death of a 10 years old child under a wind thrown tree.
The general synoptic situation was that of a pressure low centred over Spain, conveying a southern flow towards Italian peninsula. Such a configuration was associated with an area of instability between Sardinia and central Tyrrhenian coast, which was presumably powered by a positive sea surface temperature anomaly over Central Tyrrhenian Sea of about 2℃, lasting some days.

From the analysis of satellite images, integrated by radar maps and synoptic observations, it was possible to establish the following elements:

- At *15.30 (local time)* system presented nuclei of thunderstorm activity over the sea acting in its interior and associated with intense winds, having a mean radial component of about 72 Km/h;

- At *16.30* system, passed over city of Rome, moving towards the interior from the coast and conserving the same morphology.

An estimation of ascending velocities in the interior of convective cells results from the thermodynamic diagram elaborated with radio-sounding of 12:00 over Pratica di Mare (Rome), from which it is possible to estimate a maximum vertical velocity of about 26 m/s. Wind data in the following table shows a synchrony of events on the coastal stations of Pratica di Mare and Fiumicino, at 16:00 local time, and later on the interior ones. Estimating a distance of about 24 Km between segments of Pratica-Ciampino and Fiumicino-Urbe, it can be also deduced (within a reasonable error) that the velocity of passage over Rome was about 72 Km/h, keeping its previous velocity over the sea, as estimated by radars.

Weather Station	Direction of coming	Intensity Max wind (Km/h)	Local time
Pratica Di Mare	S	114.82	16.00
Fiumicino	SW	70.38	16.00
Ciampino	SW	98.16	16.20
Roma Urbe	SW	77.8	16.20
Guidonia	SW	105.56	16.30

Table: data of maximum wind

From maximum wind velocity records, it can be seen besides an increased power of the system in its southern branch (line Pratica-Ciampino).

The signature of downburst was evident also from the tracks of barogram, from which it is evident a rapid pressure variation of 4 hPa over Roma Ciampino. Along its trajectory, while keeping its destructing power, this convective system has caused damages (tens of thrown trees) mainly on the South-Eastern part of Rome.

At present our Climate Department is doing an effort to collect and integrate more climatic databases, from different instrumental measurements (satellite, radar, refined station measurements, lightening net, etc), and elaborated using several statistical/modelling techniques (re-analisys, non-linear statistical tools, etc.).

4. Developments in extreme data analysis and usage and climate projections

Studies on climatic extremes in our Department are at present addressed to try to answer the following problems, which could have a remarkable practical impact:

1) detection of (statistically) significant changes in the extreme distributions during the last decades;
2) how to cope with non stationary climate time-series?

A particular attention has been devoted, in these studies, to aeronautical METAR-type hourly data, that are available since 1973, and then form an appealing source of climatic information..

Practical applications of these studies include, for example, the update of extreme wind maps for engineering normative and Civil Protection purposes.

Concerning climate projections, the implementation of a coupled model Ocean+Atmosphere called PROTHEUS system for seasonal forecasting, in collaboration with ENEA, is currently under work. Model outputs will be supplemented by techniques of statistical and stochastic (for precipitation only) downscaling, based also on neural networks

Jordan climate

Mohammad Samawi
Deputy Director-General

Jordan Meteorological Department

Jordan is a Mediterranean country that depends mostly on rain as its main water resource. Jordan is also experiencing harsh water shortage in different parts of the country due to high fluctuations in annual precipitation; the only source of water. In addition, heat waves are becoming more frequent in the region. Precipitation decrement and summer heat waves are being blamed on global warming.

Recent years have witnessed shortage in the rainfall in different parts of the country. As a result, numerous streams have dried out, underground water level has fallen to critical levels and most water aquifers are experiencing high concentrations of Total Dissolved Solids (TDS), which makes them unsuitable for domestic or irrigation uses.

In addition, extreme weather conditions such as flash floods during winter and heat waves during summer are becoming more frequent in the region. These conditions are direct consequences of global climatic changes that have recently been affecting several locations, which are dramatically impacting wide ranges of ecosystems. The Fourth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC), issued in 2007, has pointed out that decreases in the amount of precipitation and other extreme climate events, including hot extremes, heat waves are very likely to become more frequent in multitudes and subtropical land regions.

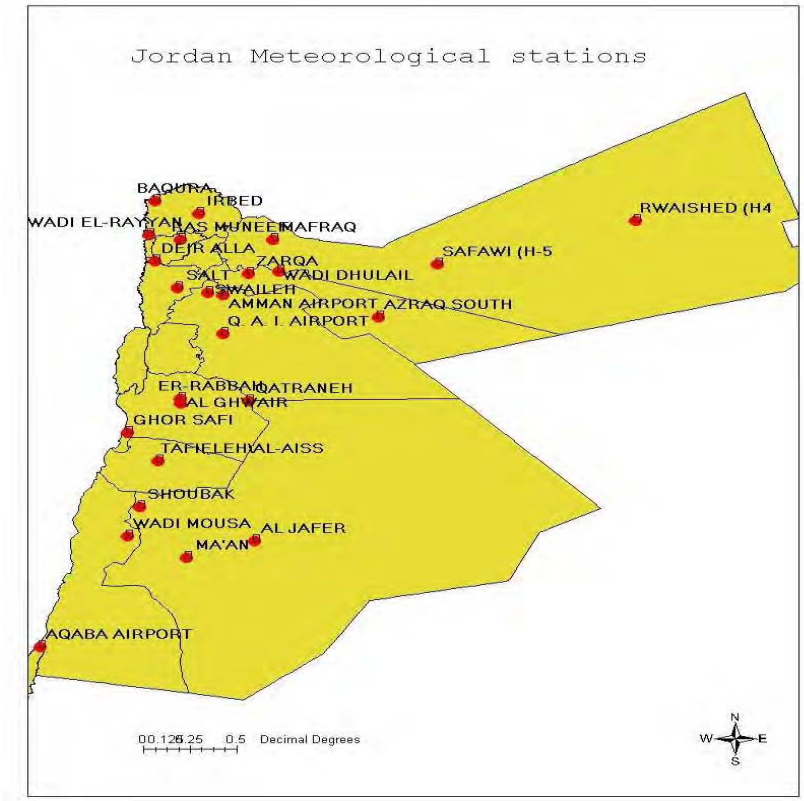
There are many natural processes that influence the climate on the earth. These processes include volcanic activity, which is known to cause cooling of the surface temperature, variations in solar activity such as sunspots and length of their cycle and orbital changes that affect the interception of sunlight by the earth.

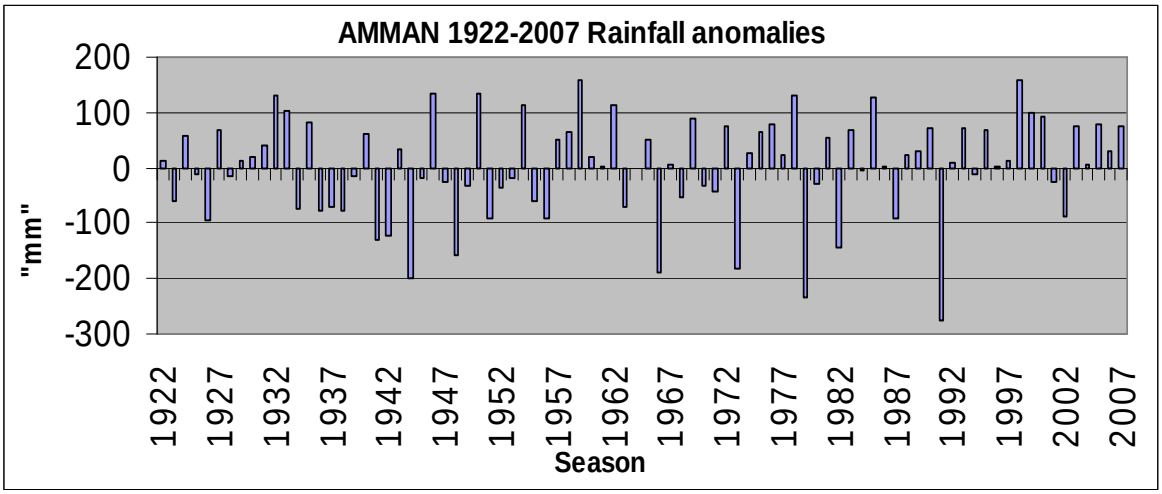
Such impacts are beyond human influence and will continue to affect the climate in the future. In addition, there are significant anthropogenic climate changes that result from human activity, particularly the unusual increase in the concentration of greenhouse gasses in the atmosphere, mainly carbon dioxide from burning fossil fuel. The Fourth IPCC came up with solid conclusions that most of the global warming that has been observed over the last 50 years is attributed to human activities.

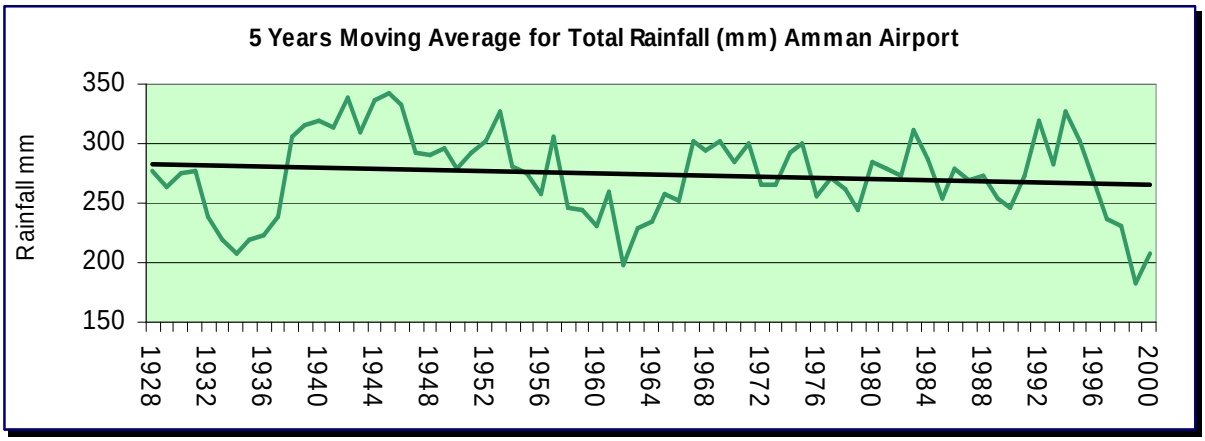
Climate regions of Jordan have been described with emphasize on geography and topography and characterized by variability of precipitation and temperature. Climate variables such as precipitation, wind, relative humidity, etc. are described and quantified. Analysis of climate trend for the climate factors mainly temperature and precipitation's for a number of stations in the area are performed.

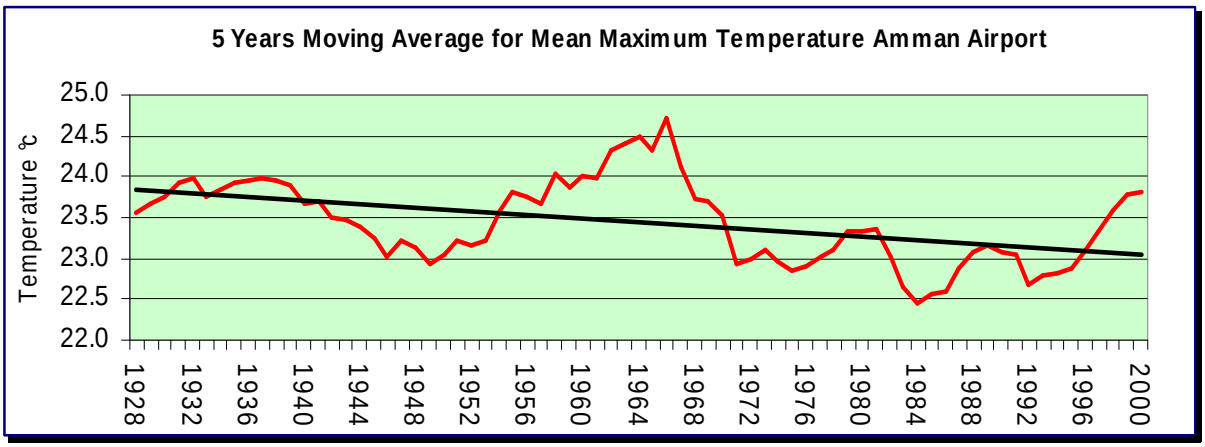
The simple linear regression and the five years moving average time series are used to identify the possible trends in these climate variables. Trend analysis for precipitation and mean, maximum temperature for 4 stations show a downward trend in maximum temperature. On the other hand, an upward trend was found in the minimum temperature. The upward trend in minimum temperature has culminated to 0.5 C^0 at some sites in Jordan. Downward trends in maximum temperature and in the mean surface temperature have been observed at most stations. The year 1992 was the nearest coldest one where maximum temperature was below normal with 1.8°C in most sites.

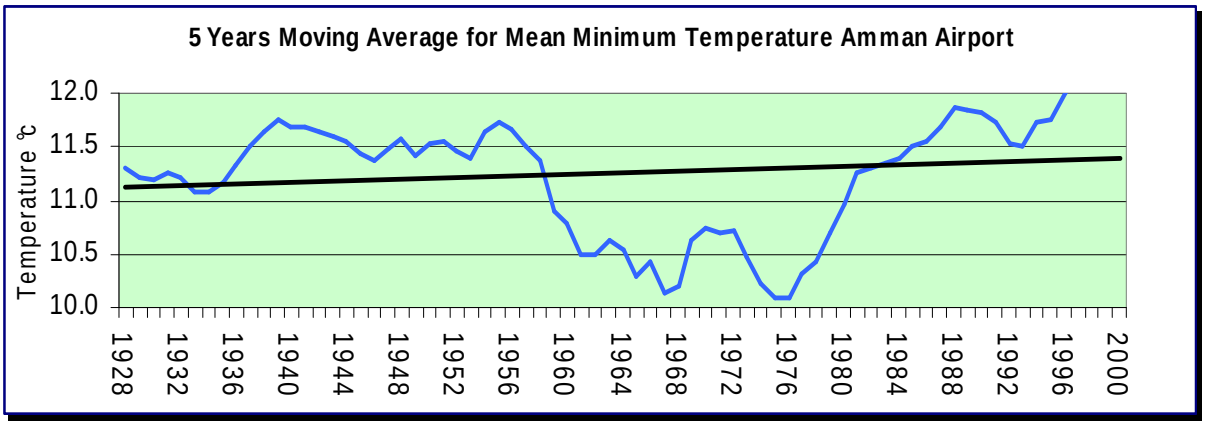
However, there is a slight decrease in annual precipitation beyond the rainy season 1970/1971 as shown in the ten years moving average of precipitation for Amman Airport. Furthermore Irbid, Dear Alla and Aqapa show slight decrease in annual precipitation.

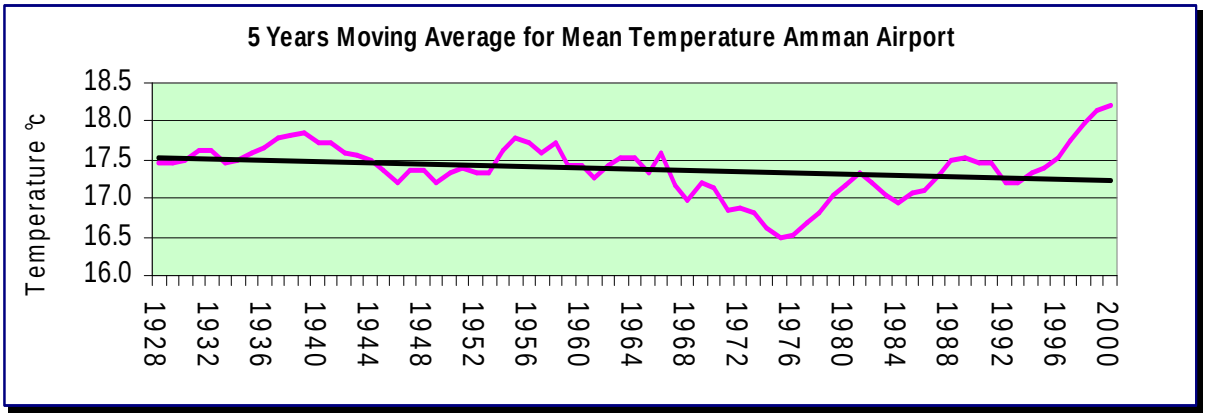





5 Years Moving Average for Total Rainfall (mm) Amman Airport
Rainfall mm
350
300
250
200
150
1928
1932
1936
1940
1944
1948
1952
1956
1960
1964
1968
1972
1976
1980
1984
1988
1992
1996
2000


5 Years Moving Average for Mean Maximum Temperature Amman Airport
Temperature ℃
25.0
24.5
24.0
23.5
23.0
22.5
22.0
1928
1932
1936
1940
1944
1948
1952
1956
1960
1964
1968
1972
1976
1980
1984
1988
1992
1996
2000


5 Years Moving Average for Mean Minimum Temperature Amman Airport
Temperature ℃
12.0
11.5
11.0
10.5
10.0
1928
1932
1936
1940
1944
1948
1952
1956
1960
1964
1968
1972
1976
1980
1984
1988
1992
1996
2000


5 Years Moving Average for Mean Temperature Amman Airport
Temperature ℃
18.5
18.0
17.5
17.0
16.5
16.0
1928
1932
1936
1940
1944
1948
1952
1956
1960
1964
1968
1972
1976
1980
1984
1988
1992
1996
2000

The weather center of Kazakhstan

Mrs.Abenova Ainur, Lead engineer of long range forecasting division
Mrs.Sazanova Bayan, Director Hydrometcentre
Mrs.Dolgih Svetlana, Head of Climate Change Department

Republican State Enterprise Kazgidromet of the Republic of Kazakhstan

1. Geographical position

Kazakhstan in the occupied area is in ninth place in the world, among the top ten largest in the territory of the world - after Russia, Canada, China, USA, Brazil, Australia, India and Argentina. Kazakhstan occupies an area of 2724.9 thousand square meters km. (1,048.3 ths. Miles) and is located in the Central Asia.

In the east, north and north-west Kazakhstan borders with Russia (6477 km long border) to the south - the Central Asian states - Uzbekistan (2300 km), Kyrgyzstan (980 km) and Turkmenistan (380 km) and south-east - with China (1460 km). The total length of the borders of Kazakhstan amounts to almost 12,2 thousand km, including 600 km along the Caspian Sea (west).

On the territory of Kazakhstan, located between two very different by nature regions of Eurasia - Central Asia and Siberia, crossed influence of air masses cold north and sultry south. That is why the basic properties of the climate in Kazakhstan its sharp continentality and the uneven distribution of natural precipitation.

The average annual temperature increases southward from around 2-4℃ in the north to around 12-14℃ in the south. The average annual precipitat ion varies between 40-100 mm in the southwest and the center and 400-680 mm in the east and the south.

Geographical position of the Republic of Kazakhstan determines great frequency of adverse weather events that cause significant damage to national economy. There are 23 kind of dangerous weather events in Kazakhstan. Most dangerous are: Wind (> 30 m/sec), Floods, Heavy snowfalls, Landslides, Heavy rainfalls, Avalanche, Thunderstorm, Dusty Storm, Droughts, Heavy Fog, Ground Frosts, Hail, Very high/low temperature.

2. Main events in the history of the hydrometeorological activity in Kazakhstan

1854 the first instrumental meteorological observations
1878 the first hydrological measurements
1972 the first observations of the air and soil pollution and of the radiation background
1993 Republic of Kazakhstan becomes a member of the World Meteorological Organization
2004 several automatic meteorological systems are being installed at the meteorological stations of Kazakhstan
2009 the system EUMETCast is installed at the Weather Forecasting Center
2010 operating 260 stations implement systematic meteorological observations in Kazakhstan and on 52 of them was installed an automatic meteorological system

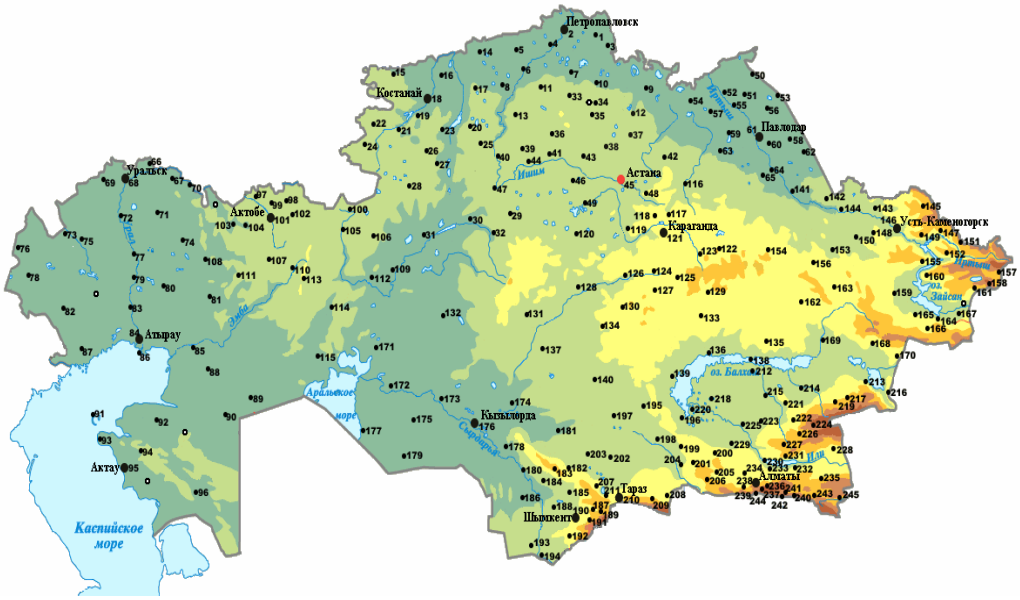


Figure: Quantity of meteorological stations: 260

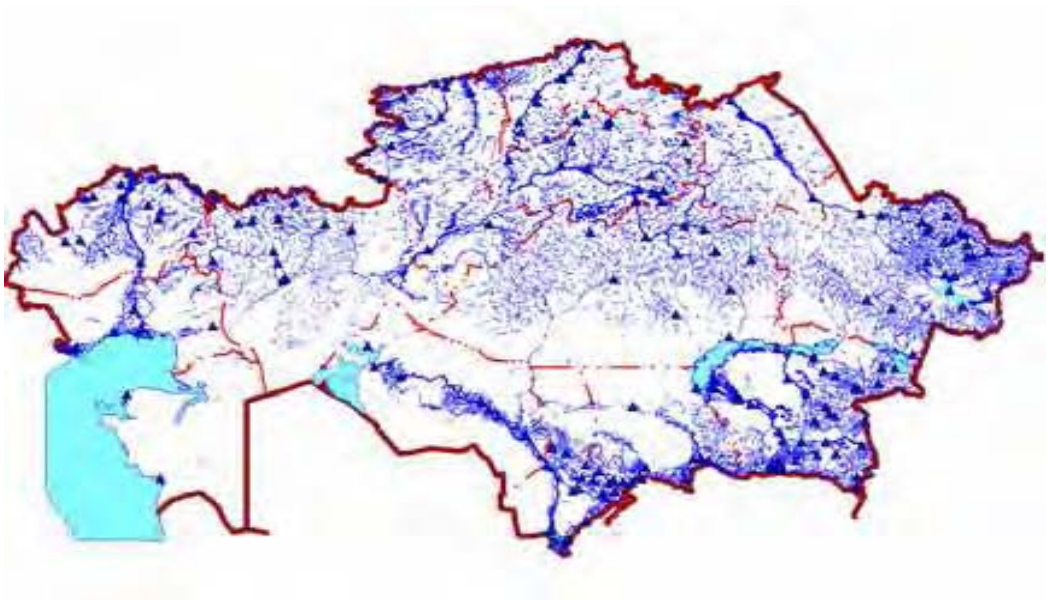


Figure: Quantity of hydrological posts: 256

- the information from 65 stations of Kazakhstan comes into the Global Telecommunication Network (GTS) with daily reports by meteorological elements,
- including 46 stations, which provide CLIMAT reports for climate studies on the global climate status,
- 14 meteorological stations are the ones of the Global climate change observing system.
- 291 the hydrological posts
- 185 agrometeorological posts
- 78 the air and soil pollution and of the radiation background
- 33 the frame climate stations
- 13 the actinometrical stations
- 5 the ozone stations
- 8 the upper-air stations

3. The major divisions of the Republican State Enterprise Kazgidromet

- Department for the State Observation Network
- Department for the Development of Hydrometeorological and Ecological Services
- Department for Climate Change and Water Problem
- Department for Ecological Monitoring
- Department for Agrometeorology
- Department for Hydrology
- **Hydrometcentre**

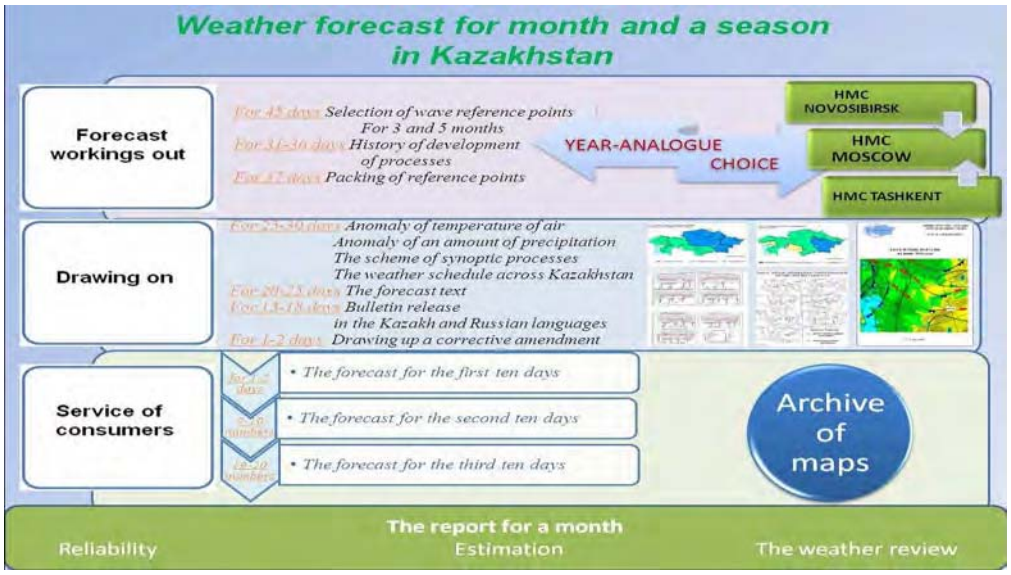
Climatology Division - the main tasks include:
1. Forming and maintaining a database of meteorological information. The planning and coordination of the archiving of climate data in electronic format.
2. Handbooks on climate in Kazakhstan.

Meteorology Division - the main tasks include:
1. Ensure the standardization of methods of observation on the weather, actinometric and upperair network, by Kazhydromet.
2. A critical and spatial control of the results of meteorological, actinometric and upper-air observations.

Long range forecasting Division is the operation and production in a structured and methodical way by the unit meteorologist, the main tasks include:
1. Predicting the weather common in Kazakhstan per 10 days, month and season.
2. Drawing on a contractual basis or at the request of individual enterprises and organizations, specialized long-term weather forecasts.

Short range forecasting Division is the operation and production in a structured and methodical way by the unit meteorologist, the main tasks include:
1. Compilation and dissemination of approved schemes storm warnings about the expected natural phenomena and sudden weather changes in the territory of the Republic of Kazakhstan.
2. Forecasting the weather common on areas of Kazakhstan for 24-168 hours.

16 Regional Hydrometeorological Centers



Observations are performed every 3 hours by the following meteorological elements:

- atmosphere pressure (at sea level and station level),
- air temperature (minimum and maximum temperature),
- air moisture (partial pressure, relative moisture, saturation deficit),
- wind (direction, speed),
- cloudiness (shape and height),
- precipitation (type and quantity),
- meteorological visibility range,
- surface soil temperature,
- soil temperature on the areas without vegetation cover,
- snow cover (depth, density, water stock),
- atmospherical phenomena.

Communication tools:

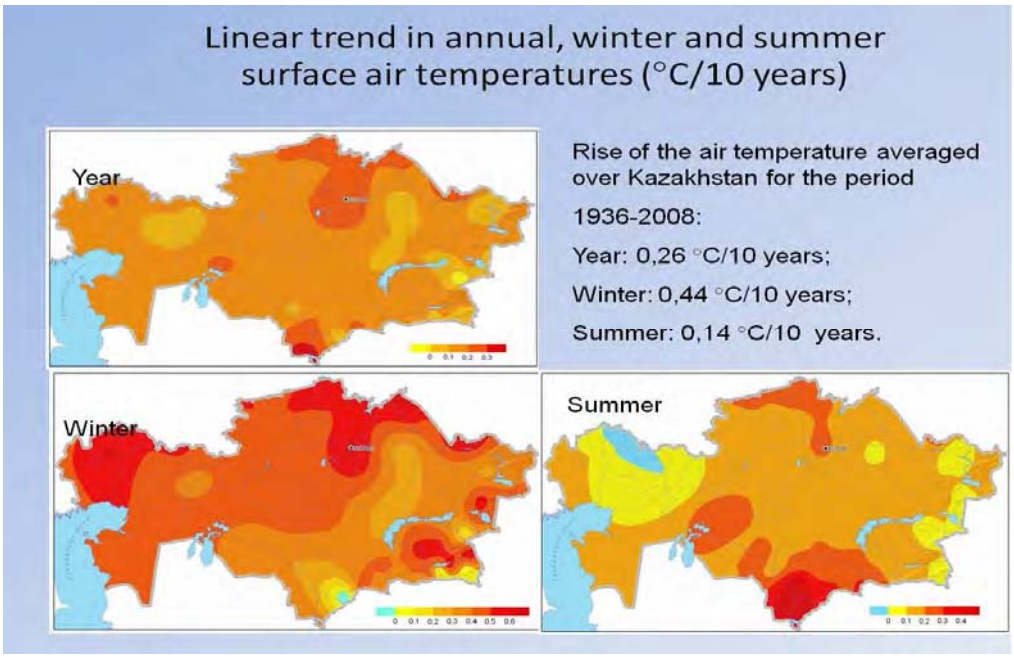
- Direct communication channels to RTH Moscow (Russia)
- Satellite communication system EUMETCast
- Internet resources
- GSM modem for communication between the stations of the national observation network nowadays provides meteorological, hydrological, agrometeorological and air quality information.

Meteorological products:

- weather forecasts for 1-7 days,
- extreme weather warnings,
- specialized forecasts for the mass-media and for several organizations of national,
- daily meteorological report,
- Long-range forecasts (for 10 days, for a month, for the season).

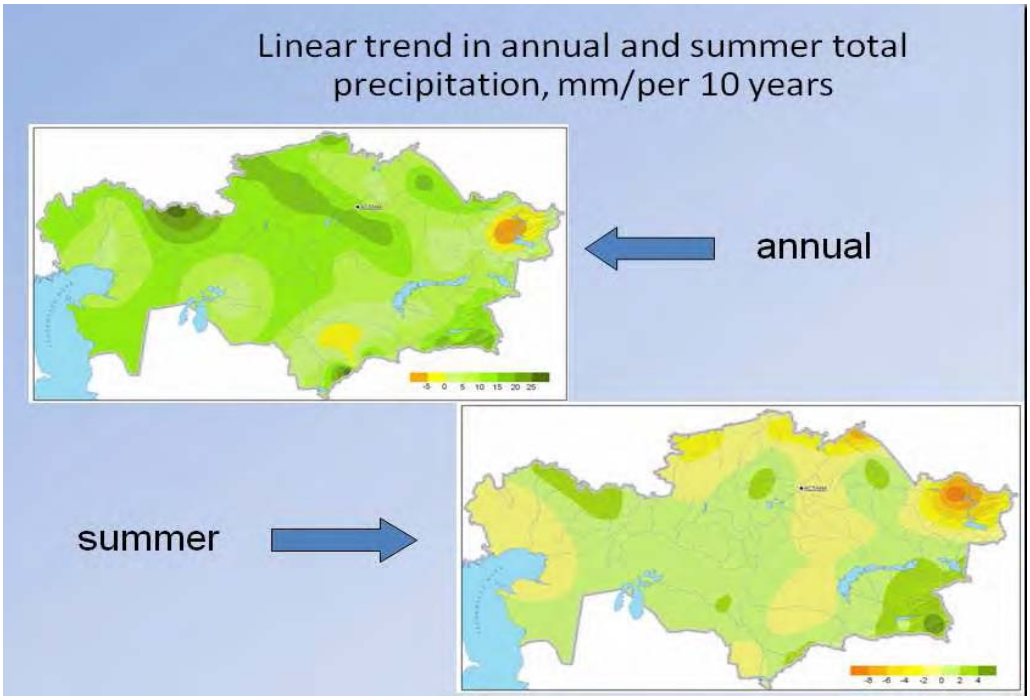
In case of occurrence of extreme events the information is forwarded immediately to state authorities, economic agents, media in order to protect people and national economy against extreme weather events, to avoid or mitigate damage. Every forecast related information is transmitted operatively, according to official schemes, to all interested organizations by phone, fax, e-mail.

The basic consumers of hydrometeorological production are the state bodies, civil aircraft, the mass media, and such branches of economy of Kazakhstan as agriculture, construction, transport, and heat power complex.



Changes in temperature extremes

- substantial increase in quantity of extremely warm days and warm nights;
- considerably reduce of the quantity of extremely cold days and extremely cold nights;
- essentially increase in the duration of hot waves in most part of the territory of Kazakhstan
- substantially reducing of the duration of cold waves;
- considerably reducing of daily range of surface temperature (on the average on 0,18 °C/10 years);
- increase in duration of vegetation period;
- reducing of the maximum duration of dry weather practically everywhere across the Kazakhstan. This reduce was essential in the north and south-east regions of Kazakhstan.



Changes in precipitation extremes

- considerably increase in the intensity of precipitations;
- essentially increase in the daily maximum of precipitations in winter period in north regions of Kazakhstan. In summer months the daily maximum of precipitations has not changed.
- considerable increase in portion of extreme precipitation (particularly in Caspian sea and Aral sea regions)

Current climate change: summary

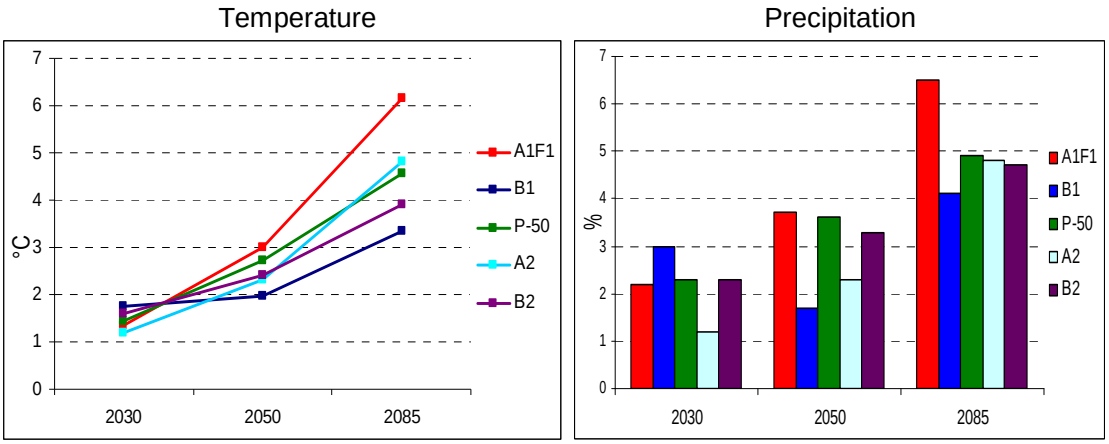
- Increase in annual and seasonal surface air temperature overall Kazakhstan
- increase in annual and winter total precipitation in the most parts of Kazakhstan
- There is no change in summer total precipitations
- On the most part of the territory of Kazakhstan increase in precipitation does not compensate increase in surface air temperature. As result the strengthening aridity of climate is observed in the most part of flat areas of Kazakhstan
- Increased irregularity of precipitation has negative effect, when heavy precipitation period changes into period of drought.

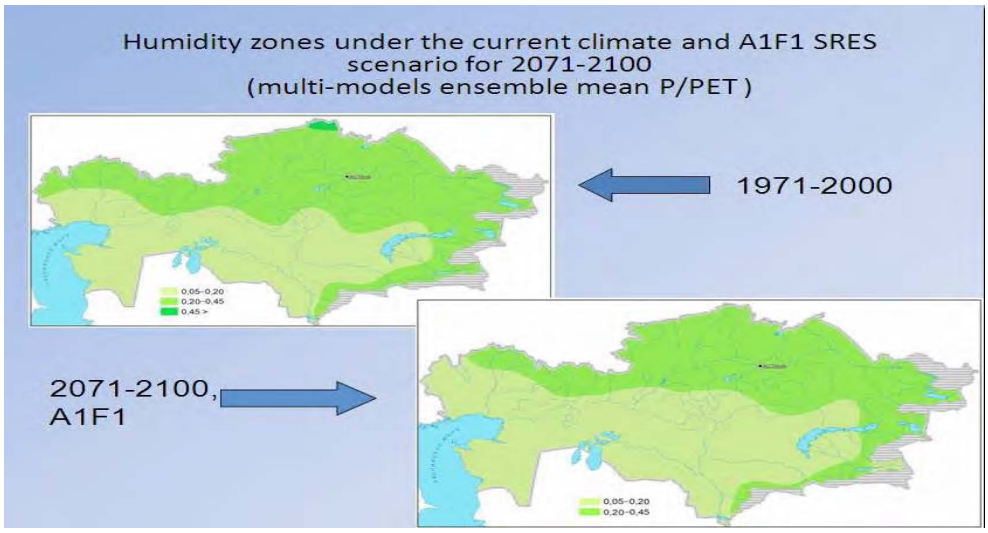
Climate change scenarios for Kazakhstan

- To develop climate change scenarios for Kazakhstan the following were used:
  - Recent versions of 17 global climate models;
  - SRES scenarios of GHG concentration change (Spatial report of МГЭИК on emission scenarios) ;
  - Program complex MAGICC/SCENGEN.

- Climate change scenarios were constructed for three time periods: 2016-2045, 2036-2065, 2071-2100

Changes in annual surface air temperature and precipitation averaged over the Kazakhstan under different SRES scenarios and P-50 (median of SRES Scenarios)





- The analyses of changes were done for:
  - Surface air temperature;
  - Precipitation amounts;
  - Humidity conditions.

Difficulties in the Long range forecasting Division

The analogs' method for the long-term predictions is not the best all time for the territory of Kazakhstan – it has a average skill. Additionally, for the seasonal forecasting we look different European models.

Necessary resources for long-term prediction:

- Necessity of a new technique for forecasting for month and season
- Lack of expertise in statistics
- Lack of budget (development, equipment, maintenance…)
- Training and training possibility, exchange of experience with other countries
- Lack of human resources

Climate monitoring in Lithuania

Donatas Valiukas

Lithuanian Hydrometeorological Service

Lithuania is a country in Northern Europe, situated along the south-eastern shore of the Baltic Sea. Also, Lithuania is the geographical centre of Europe. It covers an area of about 65,200 square kilometres. The country lies at the edge of the East European Plain. Lithuania's terrain is an alternation of moderate lowlands and highlands. The highest elevation is 297 meters above sea level, found in the eastern part of the country and separated from the uplands of the western region of Žemaija (Samorgitia) by the very fertile plains of the southwestern and central regions.

The climate of the country is transitional between maritime and continental. Mean annual temperature in Lithuania is close to +6,1 ℃ (peri od 1961-1990) and +6,6 ℃ (period 1971-2000) , and mean annual amount of precipitation is about 675 mm (period 1961-1990) and 680 mm (period 1971-2000).

1. Meteorological observation network in Lithuania

Our observation network covers all Lithuanian territory and includes 18 meteorological stations and 3 aviation meteorology stations. It includes also 9 climatological stations with reduced variety of observation (see Fig. 1).

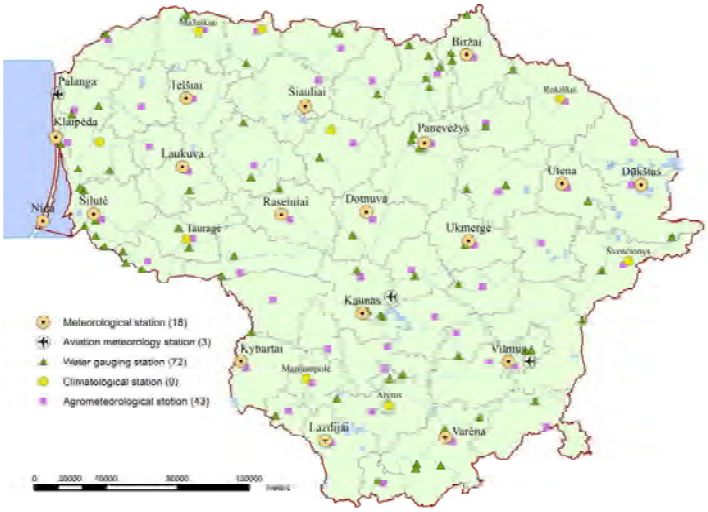


Figure 1: Meteorological observation network in Lithuania

The origin of Lithuanian meteorology is traced back to the first air temperature observations at the Vilnius University in 1777.

At present, besides 3-hourly synoptic meteorological observations, we also monitor the solar radiation at the two stations (Kaunas and Šilutė), recording five different radiation components every 4 hours. Since 2000, we monitor also the ultraviolet solar radiation at these two meteorological stations. The total ozone measurements are carried out also in Kaunas.

Since 2008, we also have 43 agrometeorological stations network.
Since 2010, we have the first meteorological Doppler radar.

Hydrological observations: the oldest-existing water gauging station (WGS) was established in 1811. By 1 October 2010, totally we operated 74 WGS, 72 of them already upgraded (automated).

By 2012, upon completion of the modernization program, the hydrological network will comprise 93 WGSs including 21 newly-established ones.

2. Main activities

Weather forecasting (short range, medium range):

- Advanced warnings about hazardous, severe and disastrous weather for government institutions, media and customers under contracts.
- Numerical weather prediction group are adopting the HIRLAM NWP model to Lithuania.
- Biometeorological forecasts in LHMT website include: wind chill forecast (in winter) and heat index and UVI forecasts (in summer).
- Hydrological, agrometeorological, forest fire risk information.
- Monthly hydrometeorological bulletins, annual reviews of the past year, various reports, brochures, books.
- Assessment of the climate variability and assessment of the climate change.

Climate monitoring in Lithuania consists of:

- Surface observations
- Upper-air soundings
- Meteorological radar observations
- Satellite data (Satellite Application Facility on Climate Monitoring (CMSAF))

2.1 Climate monitoring of extremes

Hydrometeorological hazardous phenomena observed in Lithuania are: heavy rain, hail, strong wind, blizzard, heavy snow, icing, dense fog, floods, droughts, heat waves, cold waves.
The most frequent hazardous phenomena are heavy rain, hail, strong wind.

Hazardous phenomena	Amount
Dense fog	51
Frost	82
Heavy rain	171
Strong wind	76
Hail	72
Cold wave	60
Heat wave	2
Drought	7
Icing	29
Heavy snow	13
Blizzard	10

Table: Amount of severe meteorological phenomena in Lithuania in 1961-2007

2.2 Future climate projection

For future climate projections, we use data from some global models (ECHAM4, GDFDL-R31; A and B scenarios) and regional climate model RegCm.

In the pictures, we can see temperature changes from 1777 until now, and two different temperature change scenarios (most optimistic and most pessimistic) for the city of Vilnius until 2080.

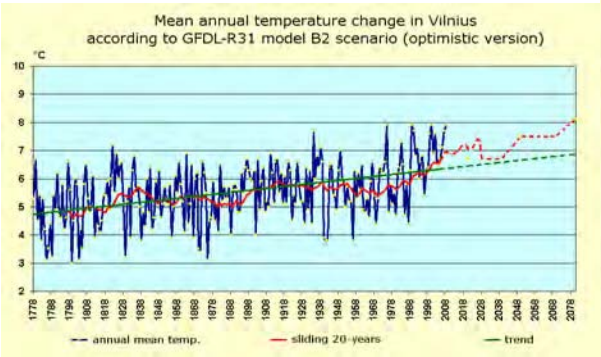


Figure 2: Temperature change in Vilnius according to optimistic version

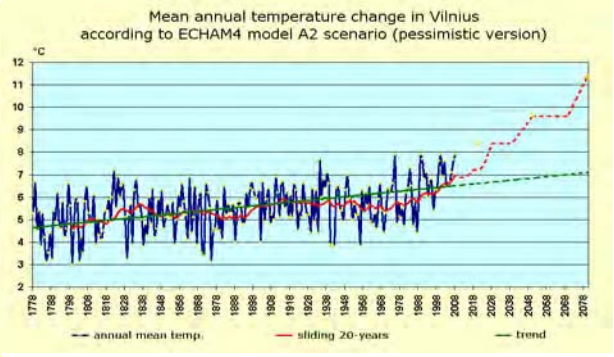


Figure 3: Temperature change in Vilnius according to pessimistic version

2.3 Future plans related to better climate monitoring

Further modernization of meteorological observation network provides for upgrading of 24 MSs and upper-air sounding equipment, establishing a lightning detection system (comprising 3 sites), installation of the second meteorological Doppler radar (in the vicinity of Vilnius), upgrading the data acquisition system and more effective use of satellite data.

2.4 Plans related to early warning systems

A project 'Creation and implementation of an early warning system for natural disasters' jointly financed from the Norwegian Financial Mechanism and the State Budget of the Republic of Lithuania.
Implementation period: 2009–2011
Upon successful completion of this project, Lithuania will join the Meteoalarm EU system

Monitoring and prediction climate anomalies and extremes

Lidia Trescilo, Chief of the Meteorology Department
Tatiana Linih, Engineer of the Centre on Meteorology and Climate Forecasting

State Hydrometeorological Service, Republic of Moldova

1. State Hydrometeorological Service of the Republic of Moldova

The Republic of Moldova lies in the central part of Europe in the northeastern Balkans. Moldova occupies an area of 33,843.5 km^2. On the North, East and South Moldova is surrounded by Ukraine, and on the West it is separated from Romania by the Prut River. The physical and geographical position of the Republic of Moldova has determined the specific features of its natural conditions. The climate of the Republic of Moldova is moderately continental mostly affected by the Black Sea. It is characterized by a lengthy frost-free period, short mild winters, lengthy hot summers, modest precipitation, and long dry periods in the south. The average annual temperature increases southward from around 8-9℃ in the north to around 10-11℃ in the south. The average annual precipitation varies between 600-650 mm in the north and the center and 500-550 mm in the south and the southeast.

Geographical position of the Republic of Moldova determines great frequency of adverse weather events that cause significant damage to national economy. Most dangerous weather events: heavy rainfalls, ground frosts, heavy snowfalls, very low temperatures, very high temperatures, floods, droughts, wind storm, hail.

Main events in the history of the hydrometeorological activity in Moldova:

1844 the first instrumental meteorological observations,
1878 the first hydrological measurements,
1964 the first observations of the air and soil pollution and of the radiation background,
1994 Republic of Moldova becomes a member of the World Meteorological Organization,
2004 several automatic meteorological systems are being installed at the meteorological stations of Moldova,
2008 at every meteorological station in Moldova was installed an automatic meteorological system,
2010 the system EUMETCast is installed at the Weather Forecasting Center.

In the actual formula the Service comprises three main fields of activity:

- Meteorology Department
- Hydrology Department
- Environment Quality Monitoring Department

The Meteorology Department is the operative subdivision of the State Hydrometeorological Service. The Meteorology Department includes: Centre on Meteorological Forecasting, Centre on Long-Range Meteorological Forecasting, Centre on Meteorology and Climate Forecasting, Centre on Agrometeorological Forecasting, Informational Management Division, Network.

Meteorological and agrometeorological monitoring in the republic is performed by 18 meteorological stations, 12 meteorological and 20 agrometeorological posts. Observations are performed every 3 hours by the following meteorological elements:

- atmosphere pressure (at sea level and station level),
- air temperature (minimum and maximum temperature),
- air moisture (partial pressure, relative moisture, saturation deficit),
- wind (direction, speed),

- cloudiness (shape and height),
- precipitation (type and quantity),
- meteorological visibility range,
- surface soil temperature,
- soil temperature on the areas without vegetation cover,
- snow cover (depth, density, water stock),
- atmospherical phenomena.

Communication tools:

- Direct communication channels to RTH Moscow (Russia)
- Satellite communication system EUMETCast
- Internet resources
- GSM modem for communication between the stations of the national observation network nowadays provides meteorological, hydrological, agrometeorological and air quality information.

Meteorological products:

- weather forecasts for 1-7 days,
- extreme weather warnings,
- specialized forecasts for the mass-media and for several organizations of national,
- daily meteorological report,
- Long-range forecasts.

Increase of the frequency and intensity of the hydrometeorological hazards enforced the society to find other ways to mitigate the consequences of the destructive consequences, caused by these disasters. One of this ways is the early warning of the population.

Main users of meteorological and agrometeorological information:

- Central and local public authorities.
- The population – through the media.
- The authorities responsible for warning, prevention and mitigation of extreme events.
- Companies of the energy sector.
- Municipal institutions.
- Road and rail-road institutions.
- Agriculture and forestry related organizations.
- Scientific and research institutions.
- Building companies.
- The authorities from the natural resources sector.
- Other structures of different forms of property.

In case of occurrence of extreme events the information is forwarded immediately to state authorities, economic agents, media in order to protect people and national economy against extreme weather events, to avoid or mitigate damage.

Every forecast related information is transmitted operatively, according to official schemes, to all interested organizations by phone, fax, e-mail.

In the 2010 year, together with the World Bank was prepared a project "Disaster and Climate Risk Management in Moldova".

A part of the project funding provides the modernization and technical re-equipment of the State Hydrometeorological Service.

The upgrade program includes:

- The acquisition of weather radar.
- Installation of the automatic hydrological stations on the river Nistru.
- The equipments replacement at the agrometeorological observation networks of soil moisture identification.
- Acquisition of the sensors for the rainfall automatically measure.
- Purchase of the mobile laboratory for the equipment testing.
- Software acquisition for flood forecasting and Nowcasting.

The Long-Range Meteorological Forecasting Centre provides monthly or seasonal meteorological forecasts for the territory of the Republic of Moldova. The “analogy” forecasting method is adjusted to the local conditions and in order to reduce the material losses of some economical agents it is foreseen to implement other methods of long-range forecasting.

Long-range forecasts at the moment:

- The analogs’ method for the long-term predictions is not the best for the territory of Moldova – it has a low skill.
- At the present time for creating the long-term forecasts there are used other opportunities.
- For example, for the seasonal forecasting very helpful is the mechanism of SEECOF.

Necessary resources for long-term prediction:

- The specialists training.
- Software.
- The possibility of obtaining the necessary information for the monthly and seasonal forecast of the ECMWF.

Status and priority needs in monitoring and predicting climate anomalies and extremes in Montenegro

Sanja Pavicevic, MSc Physics

Hydrometeorological Institute of Montenegro

1. Climate of Montenegro

The central and northern regions of Montenegro have certain characteristics of mountain climate, although the influence of the Mediterranean Sea is also evident. The north part has continental climate characterized by large daily and annual temperature ranges, in addition to low annual precipitation.

The southern parth of Montenegro and the Zeta-Bjelopavlići plain have Mediterranean climate, with long, hot and dry summers and relatively mild, rainy winters.

The average annual air temperatures vary from approximately 15.8^0 C in the south to 4.6^0 C in Zabljak.The duration of the sunny periods varies from 2,400 to 2,600 h/year on the coast, i.e. from 1,600-1,900 hours in the mountains.
Annual precipitation is very uneven, ranging from approx 800 mm (north) to about 5,000 mm (south). On the slopes of Mount Orjen, at the village of Crkvice (940m above the sea level), precipitation may even reach 7,000 mm in record years (*Source:The 1st National Communication of Montenegro to UNFCCC*).

2. National meteorological observing system

Systematic meteorological measurements and observations in Montenegro have started in 1949. Today, on Montenegro territory there is a great number of meteorological stations, which are equipped by the standards of WMO. By their purpose and working programme meteorological stations are classified in three groups:

Group of stations	No.	Place
Synoptic/ Principal Climatological/ Principal Agrometeorological	10	Ulcinj, Bar, H.Novi, Podgorica, Nikšić, Kolašin, Žabljak, Pljevlja, Cetinje, Berane
Ordinary climatological		Plužine, Krstac, Šavnik, Velimlje, Ž. Nikšićka,Danilovgrad,B.Polje,Petnjica, Mojkovac, Rožaje, Andrijevica, Plav, Grahovo, Crkvice,Kotor, Budva, Virpazar, Petrovac
Precipitation	55	
Phenological	25	

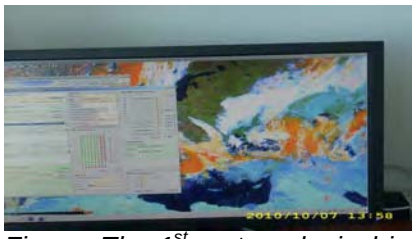
It is important to emphasize that currently there are 9 Automatic weather stations AWS in operational use at the same place where are main weather stations. According to the plan for 2011 it will be installed another one in Berane municipality, northern part of Montenegro.

3. Climate data aspects, climate monitoring and forecasting

HMI keeps and processes meteorological database, while the outcomes are published in the annuals. Since 2008 the new CLIDATA software is in operational use which use Oracle data base with historical meteorological data (previous CLICOM). Department for climatology prepares reports, bulletins, analysis, as regularly activities also special analysis, studies, projects, upon request of users.

Forecasts by HMI are provided for coastal area, region of Podgorica – Scadar basin and valley of rivers Zeta and Moraca, region of Niksic valley, region of north part of Montenegro.

Numerical models that in use in HMI are Global forecast models (ECMWF - European model and GFS - USA model and regional forecast models (Worketa Slop, NMM, and WRF V2.2 from NCEP Washington, ETA model with dust transport from Sahara, WAM – Wave Atmospheric Model). Both models, ETA and NMM, provide very fine horizontal and vertical resolution (nested models), and as a result, a highly accurate and reliable meteorological data are obtained. Starting and boundary conditions are taken from ECMWF NCEP. This model provides good forecast in average.



Recently, forecast quality and monitoring are improved by new satellite weather station. In the period from 5 - 7 October 2010 in HMI of Montenegro has installed Satellite weather station MSG 2nd generation DAWBEE drawn from the EU grant through the IPA Disaster Risk Reduction project conducted by WMO and UNDP.

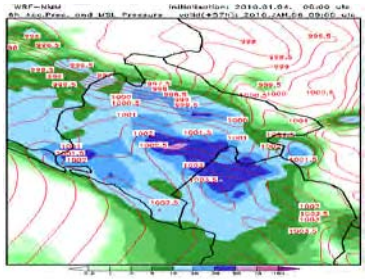
Figure: The 1st meteorological image received 7 October 2010 from meteorological satellites that are the property of EUMETSAT (geostationary at an altitude of 38.000km and three polar orbits at an altitude around 850km).

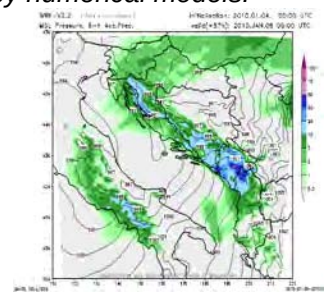
Under ongoing DRR project HMI received also 2 Personal Computers with sofware for Metview and Meteoalarm.

4. Extreme meteorological events (EMEs)

EMEs in Montenegro are high precipitation (river flooding and erosion); severe winters with temperature below –20^{0}C in mountain areas and furthermost north parts; snowstorms, frost; heat waves, droughts, forest fires; wind storms - affect coastal zone and Podgorica–Scadar basin; frequently within bora wind; heavy clouds with hail and thunder strike; wind storms and forest fires occur frequently.

Figures show the results of numerical models that predict floods on 4 January 2010 in the region of Skadar Lake, Bojana River and Ulcinj Municipality, which are caused by extreme rainfall on 12 January 2010 appeared floods in the region of Skadar Lake from the previous weather situations forecasted by numerical models.





In November 2007 northern parts of Montenegro have been affected by flooding with heavy rainfall and melting snow caused the sudden rise in temperature (*Figure: Consequences of the huge floods in the north part of Montenegro: a road between the places of Jabuka and Uvac, 28 November 2007*)

These pictures show floods in the Southern part of Montenegro (Left: Daily amount of precipitation measured 201 mm in Bar , 6 October 2010; Right: Daily amount of precipitation measured 124 mm in Bar, 22 October 2006).

In addition to rainfall and extreme snow precipitation and snow avalanches are significant (*Figure: Heavy snow fall with more than 50cm of snowcover in short time, Žabljak, 20 March 2007*).

According to the first national communication of Montenegro to UNFCCC the trend of increasing air temperature in the second half of the twentieth century has been evident in most of the territory of Montenegro. Summers have become very hot, especially in the last 18 years. On 24 August 2007 in Podgorica it is measured 44.8^0 C and became new absolute maximum at the state level. The old maximum was 42.2^0 C in August 2003.

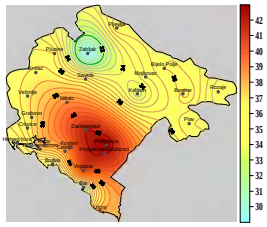


Figure:Extreme temperature, 18 July 2007

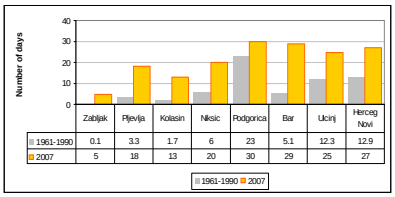


Figure:The number of tropical days

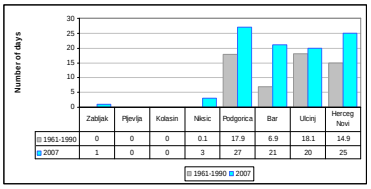


Figure: The number of tropical nights

Stronger droughts and increased summer temperature were recorded in the period 1981-1990, especially from 2000-2009, both in the south and in the northern region of Montenegro, which had a negative impact on the existing condition of forest funds. In the last 15 years in Montenegro, there were more than thousand major forest fires, more than 300 fires were registered in Montenegro only in 2003, when nearly 2500 ha of forest areas were burned (*Figure: The fire near the Tara River Canyon, Source: "Pobjeda", July 2007)*

5. Gaps, needs and priorities

HMI of Montenegro as governmental institution under the Ministry in charge for environment recognized the need for improvement of technical and human capacities especially special weather forecast meteorologists, meteorologists, technical specialists and scientific workers. Most of the employees are with secondary school while lack of specialists is evident.

Also there is need for purhase at least one Meteoradar for nowcasting forecast because no one of the Montenegrin areas are covered by meteorological radar.

There is need for help in implementing specific model for hydrology forecast that is based on the operative forecast of maximum precipitation. None of the hydrological models are in use. Namely, classical hydrology forecast models that use only hydrological parameters, are not successful for the nature (torrential water course) of the river runoff at the northern part of Montenegro. In that sense, to mitigate the impact of natural disaster, most important is to implement and apply weather forecast and disseminate early warnings to the public and to the various sector of the economy and

other sectors. Also, developments for visualization and dissemination to end – users by multi media devices are increasingly needed.

Since 22 April 2010 there are two new Montenegrin laws: Law on hydrometeorological matters and Law on hydrographic activities. According to mentioned legislation, hydrometeorological matters are activities of interest for Montenegro. To better enable NMHS to serve the Montenegro economy, investments in developing weather forecast service must have the highest priority as it belongs.

Climate data, climate information and weather warnings available on the web from The Norwegian Meteorological Institute

Knut A. Iden, Head of Section, Climatology Department

Norwegian Meteorological Institute (NMI)

In Norway, meteorological surface observations are loaded directly into the database called Kvalobs in real time. All data are automatically checked by QC1 in Kvalobs before the data are transferred to the Climate Data Warehouse. This is an iterative process as different controls will be run afterwards at different time as automatic QC2 checks, and manually by Human Quality Control (HQC).

Real time production of SYNOP to GTS is based on QC1 checked data in Kvalobs.

Users have access to observations in real time, and statistics when produced; through the interactive application eKlima (scheduled delivery is possible). To use eKlima one has to register and receive a password. The use of eKlima is gratis. Users may also request the same deliveries by machine request to the Web Service wsKlima. This application does not require registration.

First work day in a month, a summary of the last month is prepared containing a brief description of the temperature and precipitation in terms of anomaly from the normal and percentage of the normal. Smoothed maps are given and more details are presented in tables. For 6 stations with long series (RCS stations), the long time development regarding temperature is also given.

The information for the year up to present is given in the same way as for the month. By the end of each season, a summary of the season is added to the monthly report. This is also done regarding the Growing season which in Norway means May-September. A summary of new temperature and precipitation records on stations with more than 10 year of observations is also a part of the report. A gridded database is established back to 1900 and this is used to identify the development of temperature and precipitation on a regional basis and for the country as a whole.

It is of interest to present other elements in this monthly summary. We plan to have wind speed included, however, the quality control of this element has to be improved first. Unfortunately the monthly report is prepared in Norwegian only. It is available via the link:

http://met.no/Klima/Klimastatistikk/Varet_i_Norge/

The data policy of The Norwegian Meteorological institute is that Climate data, general Climate products, weather forecasts and web services are free. If special data handling from NMI is needed, one has to pay for this. As mentioned above, all our Climate data is available through the web portal www.eKlima.no,which is English spoken. Besides withdrawal of data for further analysis, eKlima offer a menu containing several reports based on the data. In Fig.1 the front page, after in logging is shown. It contains a description of the system and gives some examples of possible reports available. Links to other portals that may be of interest, is also given

Figure 1: The front page of the web portal eKlima, after on logging.

In Fig.2 Intensity-Duration-Frequency curves for precipitation based on data from the station Oslo-Blindern is given as an example of a report available in eKlima.

Figure 2: Intensity-Duration-Frequency curves based on data from Oslo-Blindern, 1968-2009.

Together with the Norwegian Water Resources and Energy directorate and The Norwegian Mapping Services, NMI have established the web portal www.senorge.no The portal is English spoken and contains maps on different themes regarding temperature, precipitation, snow, snow

depths etc. The time aggregations for the maps are day, week, month and year. It is possible to navigate in time and in a menu containing several themes. The maps cover the period 1961 to present and are updated daily. There is also a part showing scenarios.

The web portal yr.no is a joint online weather service from the Norwegian Meteorological Institute (met.no) and the Norwegian Broadcasting Corporation. These two public institutions have worked together for more than 70 years in the area of weather forecasting service in Norway. Detailed weather forecasts both in time and space, 1-10 days ahead is presented. Some statistical information is also available on the web site. Yr.no was released in September 2007 and quickly became a popular web site. Over 3 million unique users have been registered on a weekly basis. At present, a revision of the web site is performed.

Each 15th of the month, the seasonal outlook for the mean temperature for the next 3 months is given for the North-western part of Europe. The outlook is based on computations from ECMWF and adjusted to show bias versus the 1961-1990 normal. The result is presented both as map and text.
In 1994 an Extreme Weather Warning was established. An Extreme Weather Warning is issued when one or more criterions were exceeded. There are criterions to wind speed, precipitations amount, water level, significant wave height. Life and values may be in danger if the society does not take actions to be prepared. One of the criterions is also that the area threatened shall be of the order of county or greater.

When an Extreme Weather Warning is issued, a message is sent via e-mail or SMS via a distribution list to:

- The two main rescue centrals in Norway (Stavanger, Bodø)
- The national flood warning service given by the Norwegian Water Resources and Energy Directorate
- The Ministry of justice
- The stand by service of the administrative officers for the counties where the extreme weather conditions are expected to happen
- The Police and local authorities in the actual area.
- The Department with responsibility for communications (road, railway) and the electricity supply.
- Media

The number of Extreme Weather Warnings pr. year has varied between 0 and 7. After 1994 the Extreme Weather has been named. The name is chosen from an alphabetic list with male and female names in turn. A new list is defined when all the names in the old one is used.

Climate monitoring and products at IM-Portugal

Vanda Pires

Instituto de Meteorologia, Lisboa, Portugal

1. National activities related to climate data aspects

The climate monitoring at Meteorological Institute of Portugal is made on a daily, decadal, monthly, annual and seasonal basis, especially through charts and maps, which are disseminated in bulletins, like for example the monthly climate bulletin or the agriculture meteorological 10-day-Bulletin (Figure 1).

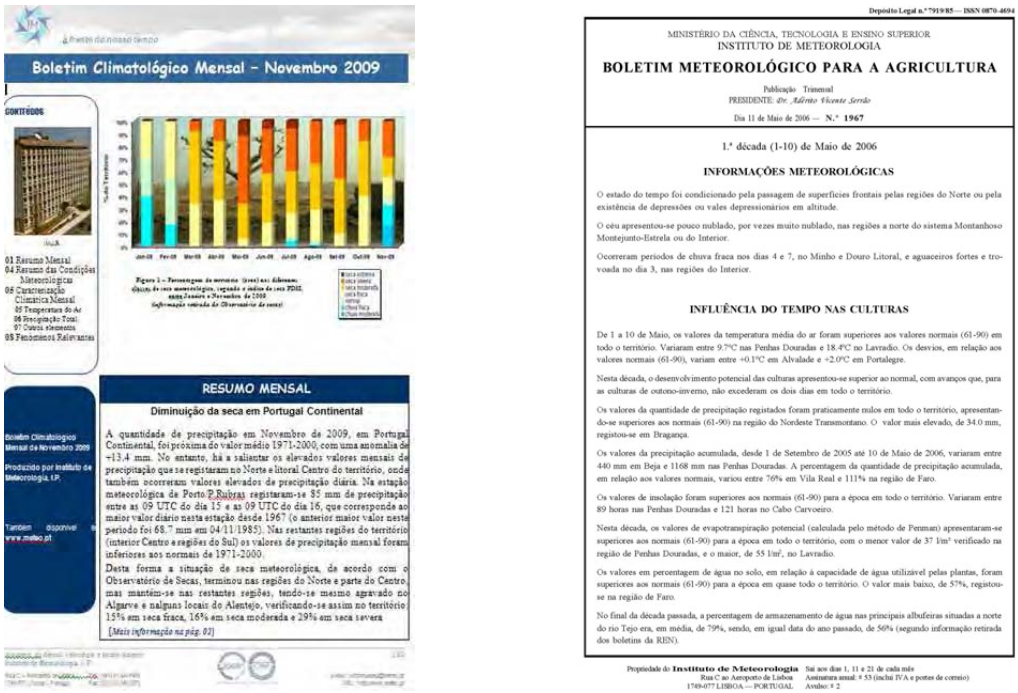


Figure 1: On the left: the monthly climate bulletin. On the right: the agriculture meteorological 10-day-Bulletin

IM have tools for the monitoring of extreme events, like for example heat waves, phenomenon that is very frequent in Portugal with an identified tendency of increase in the last years.

The forest fires are also monitored, trough the FWI Index, within a strong relation with the Portuguese civil protection in the exchange of meteorological information. Monthly bulletins are also elaborated from May to October which corresponds to the fire season.

Studies about the variability and climate changes in Portugal are also made, as it is shown on Figure 3. The temperature in Portugal as increased in the last 30 years and the 7 warmest years occurred after 1990: 1997, 1995, 1996, 2006, 1990, 1998 and 2003. Also in precipitation is observed that in the last 30 years there is a frequency for more dry years, than rainy years (Figure 2).

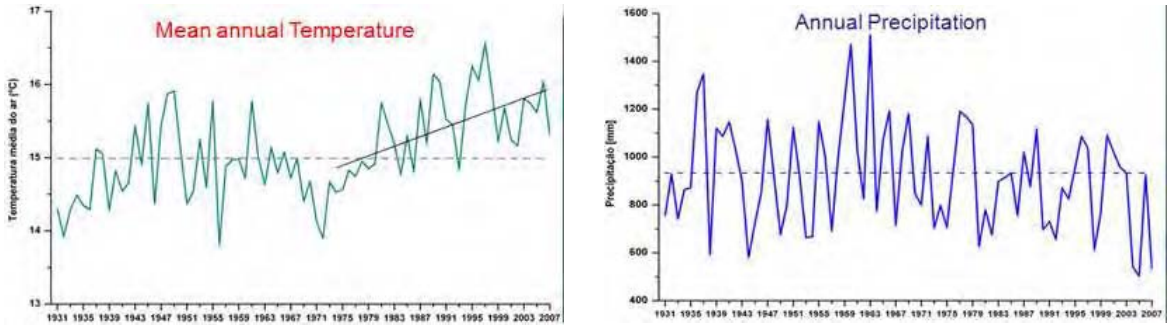


Figure 2: Left: Average annual maximum temperatures in mainland Portugal. Right: Annual total precipitations in mainland Portugal

2. National activities related to climate data aspects

Recently a drought observatory was developed (Figure 3) that monitories drought through PDSI index, giving information on the drought situation at the end of the month for the whole country and by regions. Also scenarios of PDSI for the next month are elaborated using the deciles of precipitation (2, 5 and 8) and ECWMF monthly predictions.

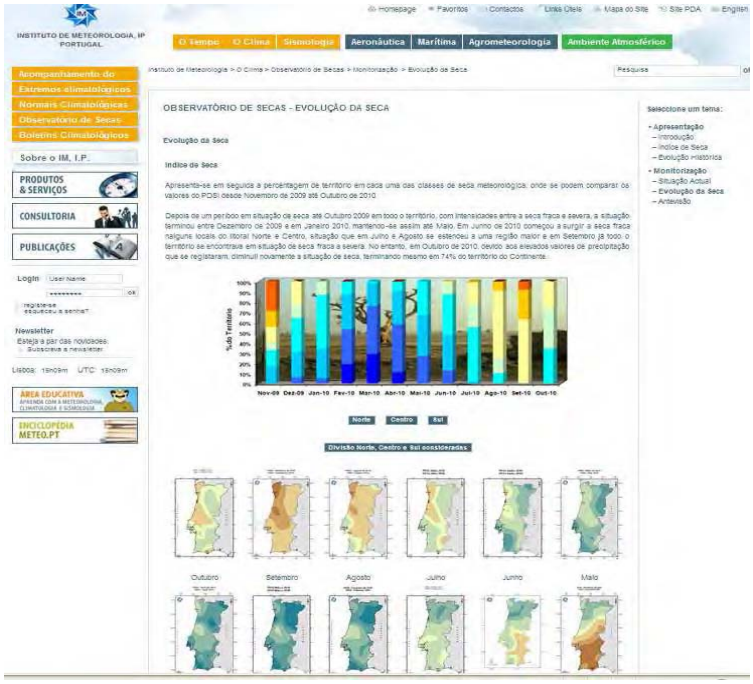


Figure 2: Drought Observatory on website of meteorological institute of Portugal (www.meteo.pt)

3. Extreme events: Current plans for improvements

To be included in the drought observatory is the implementation of the SPI Index to monitor drought in hydrological basins.

Related to prediction of extreme events it has being under developing an application for the prediction of black frost/dry freeze, based on analysis of climate data and also the predictions of the ECWMF and Aladdin.

In the International Cooperation, we participate in the CISCLIMA, cooperation between the Meteorological services of Portugal and Spain that are now elaborating the Iberian Atlas for the period of 1971-2000.

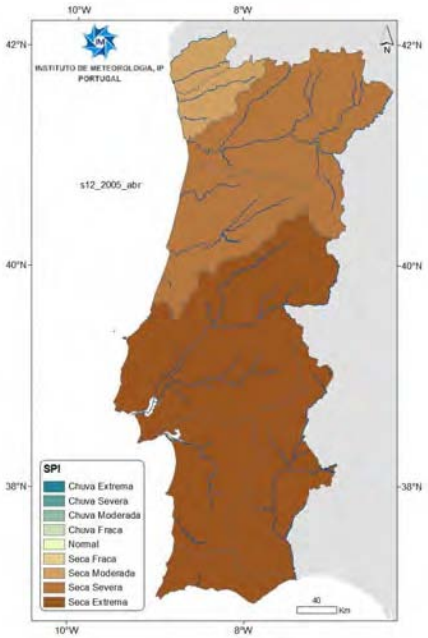


Figure 3: SPI 12-m in April 2005 in Portugal

4. National activities in support of user needs for information on extreme events

One good example of the national activities support of user's extreme events is the case study of drought 2004/05. Year 2004 was characterized as being a very dry year. The annual precipitation amount was below the 1961-90 normal, being the lowest value recorded since 1931. Over the year 2004, only the months of August and October were above the mean. Low rainfall values during 2004 and very low values in 2005 (mainly during winter 2004/05 – the driest winter since 1931) worsened the conditions existing, decreasing the reservoir levels, already affecting agriculture and livestock activities and water supplies. In order to monitor and to prevent and mitigate drought consequences, was nominated by the Government, in March 2005, a Commission for 2005 Drought, which IM was a member of that Commission chaired by Water Institute. The conclusions on impacts were disseminated in website of Government's Water Institute in a twice-monthly Report prepared in the framework of the established Commission. This Commission was a very good example of the interaction and capabilities that several institutes and organizations could do in these drought crises.

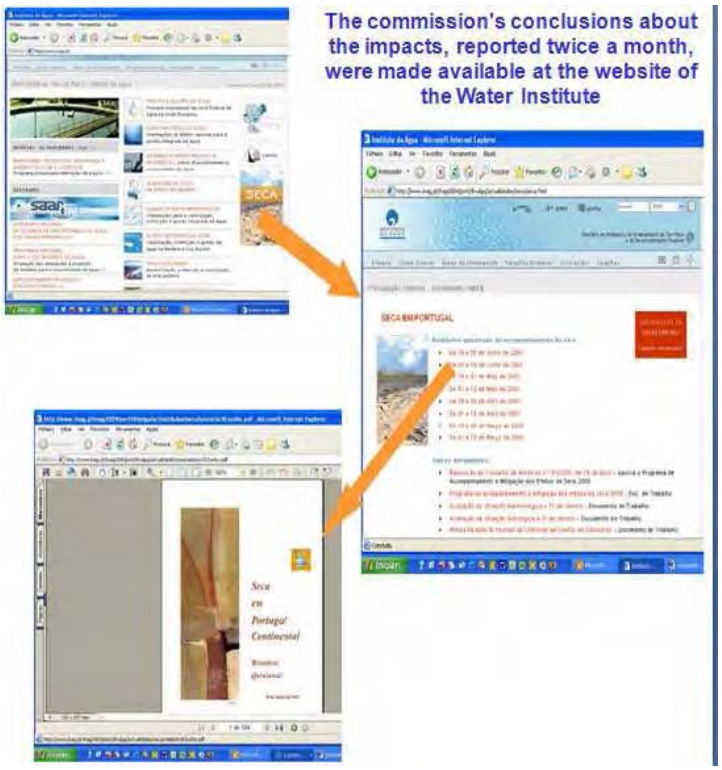


Figure 4: Conclusions on impacts in a twice-monthly Report prepared in the framework of a Commission for 2005 drought (website of Government's Water Institute - http://www.inag.pt/inag2004/port/divulga/actualidades/seca/seca.html)

Status and priority needs of monitoring and prediction of climate anomalies and extremes in Russia

Dmitry Kiktev

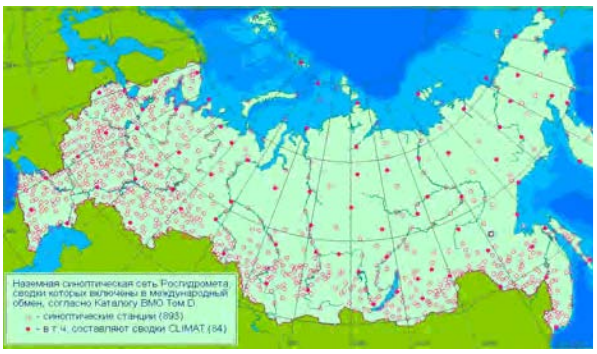
Hydrometcentre of Russia, Roshydromet

1. Rationale for climate watch in the Russian Federation

Due to her vast territory Russia is subjected to a large number and wide spectrum of unfavourable weather and climate phenomena of different space and time scale. The total direct national losses associated with dangerous hydro-meteorological events are estimated to be USD 1-2 bn.

In 2010 multiple human casualties and economic losses associated with extremely hot summer over the European territory of Russia one more time demonstrated how vulnerable the country is with respect to hydro-meteorological hazards.

2. Existing climate-related infrastructure



SYNOP network of Roshydromet for international data exchange. Red circles – SYNOP stations; filled red circles – SYNOP and CLIMAT stations.

Surface aerological network of Roshydromet

It is difficult for one centre to cover the whole spectrum of climate issues for such a big territory. That is why today's climate-related infrastructure of Roshydromet (Federal Service for Hydrometeorology and Environmental Monitoring) is quite complex. There are several institutions dealing with climate-related matters:

Centres	Climate-related aspects concerned
Research Institute for Hydrometeorological Information – World Data Centre (RHMI-WDC)	Data archives, Climate Monitoring, Data quality, Applied Climatology
Main Geophysical Observatory (MGO)	Applied climatology, Climate Change Projections; Climate Change Downscaling, Long-Range Forecasting, Guidance on Development of Observational Network
Institute of Global Climate and Ecology	Climate monitoring, Historical Climate Change, Anthropogenic Climate Change Issues, Adaptation and Mitigation
Main Hydrological Institute	Climate Change in Hydrology
Research Institute for Agricultural Meteorology	Climate Change Impacts on Agriculture, Adaptation Strategies for Agriculture
State Centre for Space Hydrometeorology «Planeta»	Satellite Monitoring
Arctic and Antarctic Research Institute	Climate change in polar regions
Hydrometeorological Research Centre of the Russian Federation (Hydrometcentre of Russia)	Long-Range Forecasting

3. Some recent climate-related national initiatives

- Climate Doctrine of the Russian Federation was signed by President Medvedev on 17 Dec 2009. The Doctrine implies development and realization of corresponding national strategy and – on its basis – federal, regional and sectorial programs and action plans. The plans include development of Russian National Weather and Climate Research Program;

- In 2009 a position of Advisor to the President of Russia on Climate Issues was established.

4. Gaps and needs

Russian national needs for monitoring and prediction of climate anomalies and extremes are thought to be quite common. Besides of development of observational network and institutional strengthening with respect to long-range forecasting (LRF) and climate watch the following more specific gaps and needs in climate-related services might be marked out:

- LRF quality (Big gap between user demands and forecast skill);

- Lack of qualified users capable of using probabilistic information of very modest skill;

- Different “languages” of meteorologists and end-users (Forecasts in terms of end-users are needed);

- Lack of long-term series of applied data for development of LRF-tailored models;

- More flexible operation cycle is needed (once a month is insufficient).

5. Extreme Forecast Index for seasonal time scales? (An example of activity in support of early warning systems)

Various kinds of statistical post-processing are developed worldwide for dynamical seasonal model output. Some centres today pay substantial attention to subseasonal variability. This activity is of substantial interest for the purposes of Climate Watch. As for other centres prediction of subseasonal variability is also a subject of interest for the Hydrometcentre of Russia. Experiments with Extreme Forecast Index (EFI) are carried out for the purposes for seasonal forecasting of extreme events.

Original Extreme Forecast Index (EFI) [Lalaurette, 2003] was proposed for short/medium-range ensemble forecasts as a measure of the difference between a forecast probability distribution and a model climate distribution for a particular moment in the future. Simple properties of EFI:

- EFI takes values between -1 and +1;
- EFI is calculated in probability space rather than meteorological parameter space. Thanks to this EFI doesn’t keep information on original range of values of a particular meteorological parameter;
- For various meteorological parameters, seasons and regions EFI can be used uniformly without the problem with critical thresholds definition. This allows to compare EFI values for regions with very different climates and for different variables;
- For detecting severe weather conditions, we not only want to know if the EPS distribution deviates a lot from the climate, but also if it deviates in a direction that may be dangerous (to know that the wind will be unusually calm is very different from knowing that it will blow with unusual strength). EFI takes it into account.

For the purposes of long-range forecasting the original EFI was modified at the Hydrometcentre of Russia:

- All daily forecast data within a season for all ensemble members were used to build probability distribution functions (PDFs) of various derived statistics targeted at subseasonal extreme conditions;
- Similarly, seasonal model climate PDFs were derived from the corresponding daily hindcast data;
- To avoid the temporal inhomogeneity in the forecast and hindcast daily series (due to seasonal cycle) each model series was preliminary transformed into a standardized series of forecast/hindcast daily anomalies.

Besides of simple daily distributions various kinds of derived statistics targeted at particular types of extreme events can be embedded into this approach. The search of informative extreme statistics for LRF and assessment of their predictability is on the way. This work is supported by the Russian Foundation for Basic Research (grant № 09-05-00630).

Reference

Lalaurette, F. (2003): Early detection of abnormal weather conditions using a probabilistic extreme forecast index, - Q. J. Roy. Meteor. Soc. 129 (594), 3037-3057.

Status and priority needs of monitoring and predicting climate anomalies and extremes in Serbia

Goran Pejanović, Assistant Director

Republic Hydrometeorological Service of Serbia (RHMSS)

1. Meteorological observing system

Meteorological activity on the territory of the Republic of Serbia has a long and rich tradition. First systematic meteorological observations started in Belgrade, on 1 January 1848. Already in 1856, a network was established in Serbia with 20 meteorological stations and, in 1887, Belgrade Meteorological Observatory was founded at the University of Belgrade. For more than a half of the century, Belgrade Observatory was the center of National Meteorological Service. Republic Hydrometeorological Service of Serbia (RHMSS) was founded immediately after the II World War, in 1947.

Today RHMSS carries out the functions of National Hydrometeorological Service in the World Meteorological Organization. RHMSS is authorized for the establishment, development and operative functioning of national meteorological observation system which now comprises: a network of 32 surface synoptic/principal climatological stations, principal agrometeorological stations (Figure 1); 1 upper air synoptic (radiosounding) station; one meteorological radar center and 13 radar centers in the hail suppression system; a network of 97 ordinary climatological stations; a network of 35 ordinary agrometeorological stations, a network of 558 precipitation stations; a network of 52 phenological stations and a network of 26 air quality monitoring stations. Data are operatively collected each hour from the network of surface synoptic stations and all the stations are now included in international data exchange. These stations are an integral part of WMO RA VI Regional Basic Synoptic Networks of surface and upper-air stations. Four stations are included in WMO RA VI Regional Basic Climatological Network and one station in WMO GAW program. Automation of the network of surface synoptic stations has been carried out recently.

2. Climate monitoring

RHMSS is the host of South East European Virtual Climate Change Centre (SEEVCCC) which is included in WMO RA VI RCC Network. Thus, besides climate monitoring on national level, RHMSS provides support to SEEVCCC in carrying out operative functions of climate monitoring of the Southeastern Europe. On national level, for the needs of numerous domestic users, analysis is made of main climate elements (precipitation and temperature) and their anomalies (in relation to the reference period 1961-1990) for various time intervals. Data processing results are published as weekly, monthly and annual bulletins. Monthly products of the monitoring of temperature and precipitation quantity and their anomalies in the form of maps are regularly updated on the RHMSS site (www.hidmet.gov.rs). Within the framework of national climate monitoring bulletins, special attention is given to the occurrence of extreme events (floods, heat and cold waves, fires, droughts) and their impacts. RHMSS provides, via the web, maps of monthly means and anomalies (Figure 2) and text on significant weather events for European Climate System Monitoring (ECSM) coordinated by German Meteorological Service (DWD).

During the last few years, RHMSS developed and established operative national monitoring system of drought/moisture. Moisture condition-drought monitoring system is based on the operational application of 1-24 months Standardized Precipitation Index (SPI). It was found that two-month SPI index is in good correlation with the occurrence of agricultural drought, that is, floods on the territory of the Republic of Serbia. Monitoring of this index is significant for the work of agrometeorological service and hydrological forecasting service of RHMSS.

Besides the above mentioned, 27 climate indicators were processed in RHMSS on the basis of daily values of temperature and precipitation quantity in the period 1950-2009 as defined by the

ETCCDI (Expert Team on Climate Change Detection and Indices). These results were used in vulnerability assessment of economic sectors and population for the purpose of presenting climate variability and extreme climate events in the creation of National Communication for UN Framework Convention on Climate Change.

3. Long-term forecasts

RHMSS uses four methods for long-term weather forecast. For monthly forecasts, the method of analogies (for more than 25 years), while ECMWF products are used for seven-month forecast. Operative making of statistical forecasts based on CPT (Climate Predictability Tool) is under preparation. Newly added to national long-term weather forecast is seasonal ensemble forecast. For that purpose, coupled atmosphere-land-ocean model RCM- SEEVCCC for limited area is used which is also used for climate projections (scenarios).

Horizontal resolution of the atmospheric part of the model is 35km, and oceanic, 20km. For initial and lateral border conditions, RCM-SEEVCCC uses 41 members of seasonal ensemble forecasts of ECMWF. Available model products are the maps of mean ensemble values for air temperature (2m) and precipitation quantity as well as their anomalies in relation to CRU data (1961-1990). Besides, feasibility forecast is made for mean temperatures and monthly precipitation quantities given as diagrams. Statistical correction of model error is made on some products. Maps and diagrams are regularly updated on the site http://www.seevccc.rs/

4. Climate Watch System (CWS)

RHMSS climate warning system, i.e., climate watch system, is designated to provide advisories (climate watches) to inform the users, particularly those involved in natural hazards preparedness, mitigation and response on ongoing, pending or expected climate anomalies and their negative impacts.

For the purpose of establishing CWS, it is necessary to make the best link of climate monitoring to short-term and long-term (seasonal) forecast. Experimental work of RHMSS in this area is based on the connection of probabilistic long-term forecast of SPI from RCM-SEEVCCC model with observed SPI index. In case of overcoming of certain border index value, it is possible to issue appropriate warnings as a part of EARLY WARNING SYSTEM-a (Figure 3). Creation of climatological model is in progress as well as model verification pursuant to further improvement of the system. For the purpose of operative establishment of CWS, RHMSS should further strengthen its capacity and prepare to continuously monitor and assess the state of the subregional and local climate, evaluate available long range forecasts and, where conditions warrant, provide to the users concise and understandable climate early warning information at weekly, 10-day, monthly, and seasonal time scale.

Figure 1: National network of synoptic and principal climatological stations in the territory of Serbia

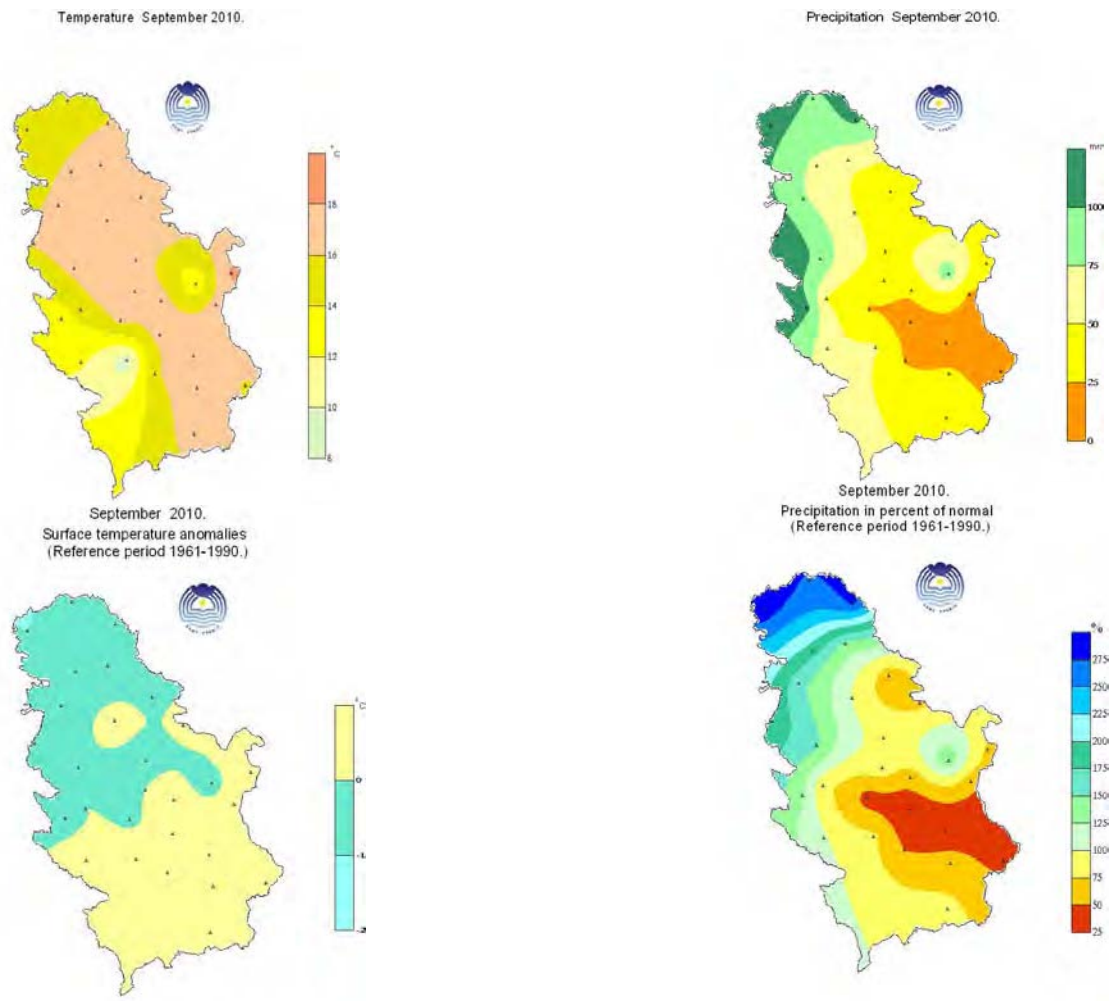


Figure 2: Monthly mean temperature and monthly precipitation amount as well as their anomalies

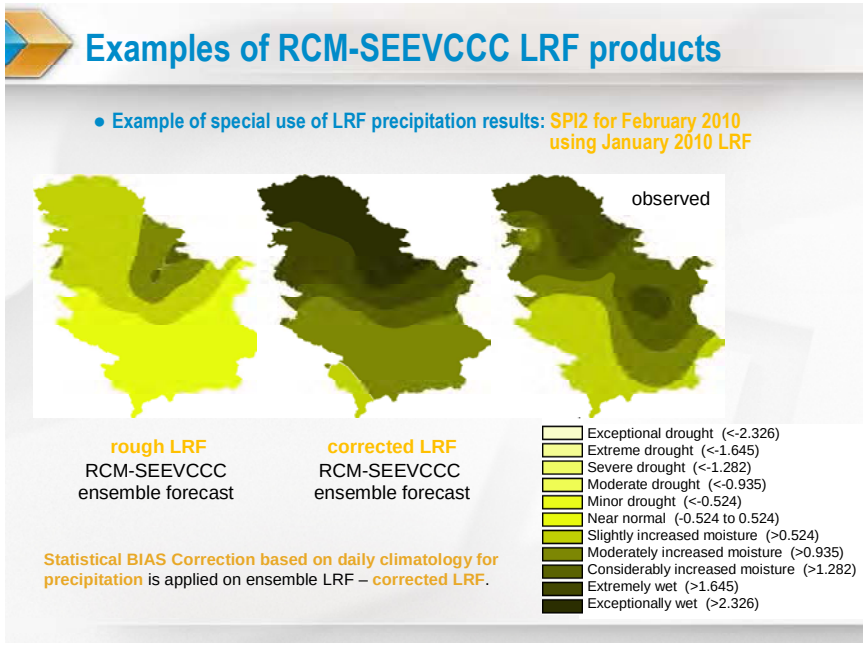


Figure 3: Example: Extremely wet SPI2 for February 2010 – LRF forecast start: January 1st 2010

Climate monitoring in Spain

Antonio Mestre

State Meteorological Agency of Spain (AEMET)

AEMET activities with regard to Climate Services are mainly focused on climate monitoring and generation of regionalized climate change scenarios. AEMET also provides services related with observational and modelling data for different types of users. With respect to climate monitoring, the operational activities of AEMET include the issue of a set of climate bulletins describing the behaviour of the climatic elements from a certain period of time.

These products are being produced at different time scales: Daily scale information (climate records of the previous day), weekly bulletin (based on pluviometric information and data to be sent to the Ministry of Environment), ten days- bulletin (Hidryc Balance), monthly Climate reports at both national and regional scale, seasonal climate reports and annual climate report. An example of these climate monitoring products is presented in figure 1.

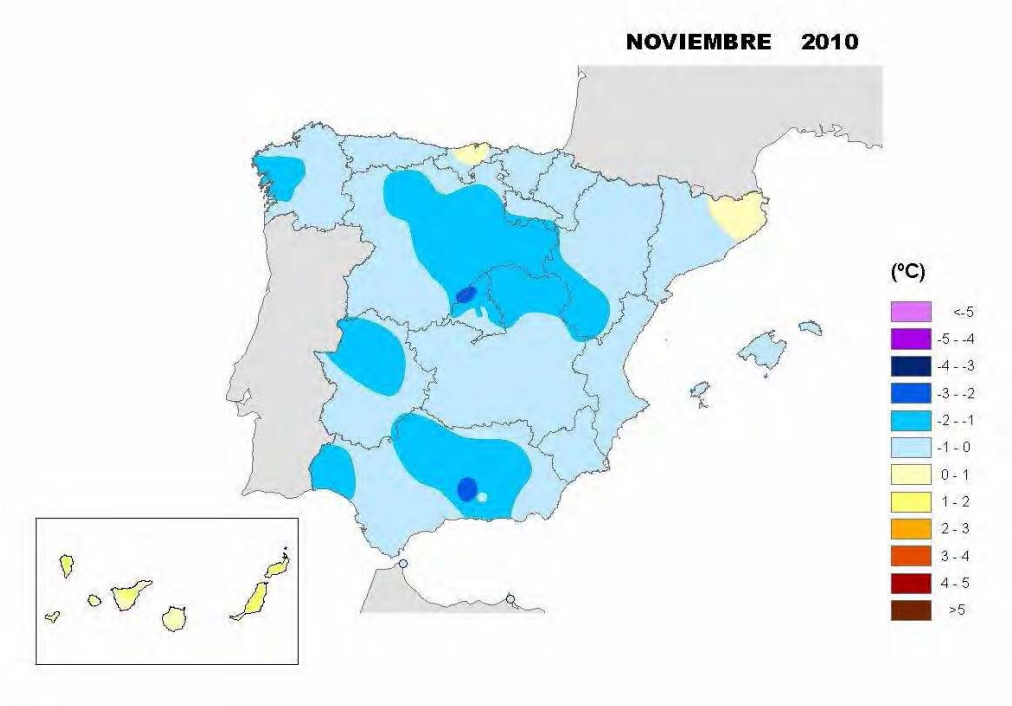


Figure 1:
Example of climate monitoring product: Temperature anomalies in November 2010

Due to the importance of soil moisture estimation for decision-making in different sectors, particularly for farmers (irrigation needs evaluation, soil workability, drought assessment and early warning), forestry services (forest fires risk assessment and controlled burning authorisation) and hydrology, AEMET has developed a gridded national water balance to monitor soil moisture conditions. The water balance model inputs are: 10-m wind, 2m-temperature and surface pressure from the analysis of HIRLAM 0,2º plus synoptic data in real time of sunshine duration and precipitation as well as physiographical and edaphological information. The water balance outputs are a set of variables like soil moisture content, soil moisture percentage with respect to the field capacity, reference and actual evapotranspiration and precipitation, as well as the anomalies of these parameters as compared with their normal values (reference period in this case is 1996-2005). All these outputs are issued in a grid of 0,2º resolution. A hydrological cycle monitoring

product (with information on precipitation, evapotranspiration, soil water status and reservoirs storage) is issued every 10 days based on this information (see an example of Water Balance output in figure 2).

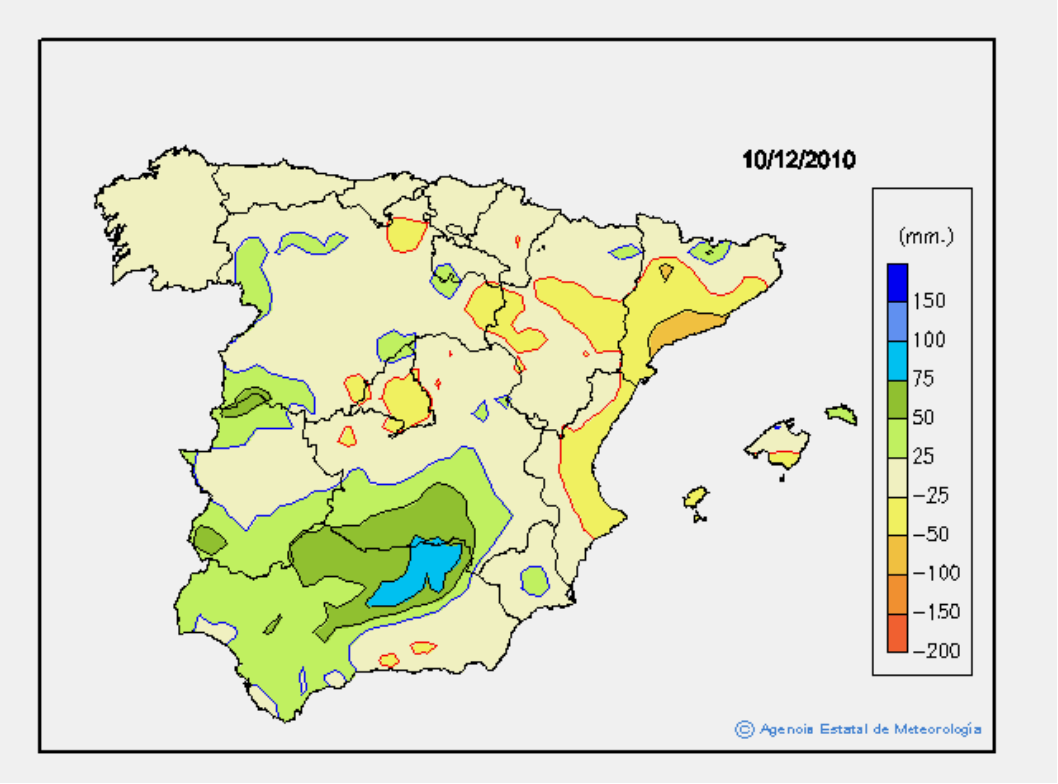


Figure 2:
Example of water balance output: map of soil water content anomaly

Concerning the monitoring of extreme events, drought is the most recurrent climate hazard that affects the territory of Spain and precipitation deficits occur in cycles of highly variable duration, spatial distribution and extension. Because of this, a monitoring program to watch and to evaluate drought is being operationally carried out at AEMET on a national level. Information based on the SPI estimation and use is monthly renewed (Mestre and Moreno, 2008). The program to calculate SPI makes use of climatic data from the National Climatic Data Base, as well as of daily rainfall data obtained in quasi real time from the synoptical stations network. The resulting product are SPI tables and graphics representing sites and basins over several accumulation periods ranging from one month to one year, with the aim of evaluating drought at different time scales (see an example in figure 3). The drought module has been developed as an independent module in the framework of the above mentioned National Water Balance. Climate data as well as daily precipitation data entering in quasi-real time are its input data. The SPI, developed by Mckee in 1993 is the drought index currently used.

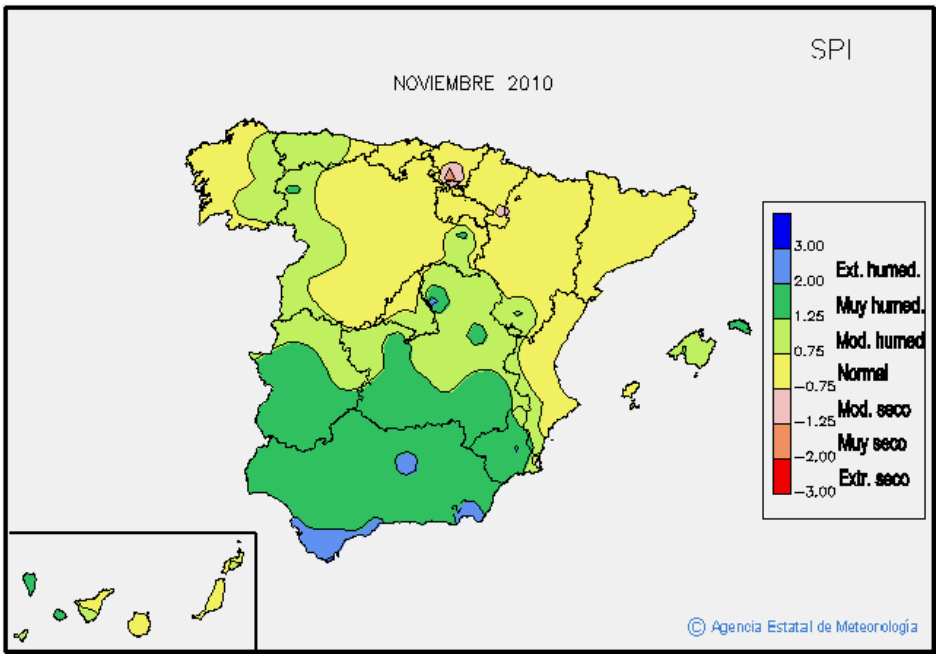


Figure 3:
Example of SPI 12 map using local data from 90 stations (AEMET network)

Concerning long range forecasts, in Spain there is a strong demand of seasonal forecasting products for decision making by institutional and socio-economic sectors. But due to the low predictability at mid latitudes, up to now it only seems viable in some “windows of opportunity”. Currently seasonal forecasts (based on ECMWF, EUROSIP and IRI outputs) are produced in AEMET every month, but they are only delivered to a small number of governmental authorities. An outlook (text) for the next three weeks is also issued every Friday and delivered to a certain number of Official Institutions based on the ECMWF monthly forecast outputs.

At this time there is no Climate Watch System implemented in AEMET. There is a Severe Weather Warning System operationally running (Meteoalerta) that provides the information needed to alert to the possible occurrence of severe weather up to three days in advance. It uses a 4 level-color-system; the criteria for threshold are based on climatology and the risk associated to different phenomena.

Out from this framework, a new Early Warning System of Forest Fire Risk has been recently developed in AEMET. The Fire Danger Rating System (FDRS) is based on the production of gridded analysis and short-term predictions of the Canadian Fire Weather Index. The analysis is produced through the combined use of the 0,05º resolution HIRLAM model outputs and data from the Automatic Weather Station Network of AEMET. The FWI was calibrated making use of daily data of forest fires occurrence and total burned area for each zone, in order to obtain the threshold values for a total of five danger classes.

Status of the monitoring and forecasting of climate anomalies and extremes in the United Kingdom

John Prior

National Climate Information Centre, Met Office, Exeter, UK

1. Monitoring

In order to support climate research and services it is essential that long, high quality, complete and homogeneous series of climate data are available. These are needed on national, European and global scales, with appropriate spatial and temporal resolutions.

1.1 United Kingdom

The National Climate Information Centre (NCIC) is responsible for:

- Developing and maintaining information about the UK (land) climate, e.g. averages, extremes and time series
- Preparing monthly / seasonal / annual summaries of national / regional weather
- Placing into context any noteworthy weather in the UK, e.g. floods, heat waves
- Monitoring changes in the UK climate, e.g. trends maps, time series

Most of these activities rely upon the gridding of climate data, enabling real time-series and colour-shaded maps to be prepared. The Met Office web site is the main method used to disseminate this information, http://www.metoffice.gov.uk/weather/uk/climate.html.

NCIC also provides data to other UK government organisations (e.g. the Centre for Ecology and Hydrology), that are then combined with other data (e.g. groundwater levels) to produce information tailored to specific applications (e.g. flood risk and water resource assessments).

In support of the UK Climate Projections project (UKCP09), a report “The climate of the UK and recent trends” was prepared, including maps of 30-year averages and trends. An observed data download facility was also provided for climate change research, with numerous 5 km and 25 km gridded data sets on timescales from daily to annual (http://ukclimateprojections.defra.gov.uk/).

1.2 European and Global

Land and marine data sets covering a broad range of climate variables and indices have been assembled by the Met Office Hadley Centre, often in collaboration with other national weather services and / or research bodies such as the University of East Anglia. Many of these are made available via http://www.metoffice.gov.uk/hadobs.

The data sets include:

HadCRUT3, monthly land surface air temperatures and sea surface temperatures on a global 5° latitude - longitude grid, expressed as differences from the 1961-90 normals and covering the period 1850 to present (Figure 1).

HadISST, monthly sea surface temperature and sea-ice concentration on a global 1° latitude - longitude grid from 1870 to 2 months before the current month.

HadSLP2, monthly land and marine mean sea - level pressure on a global 5° latitude - longitude grid from 1850 to 2004, with a reanalysis - based update thereafter.

HadCRUH, monthly land and marine surface specific humidity and relative humidity anomalies on a global 5° latitude - longitude grid, covering the period 1973 to 2003.

HadEX, a global land-based extremes data set produced through the joint WMO - CCl / CLIVAR / JCOMM Expert Team on Climate Change Detection, Monitoring and Indices, comprising 27 indices of air temperature and precipitation on a 2.5° x 3. 75° grid. These represent seasonal and / or annual values from 1951 to 2003.

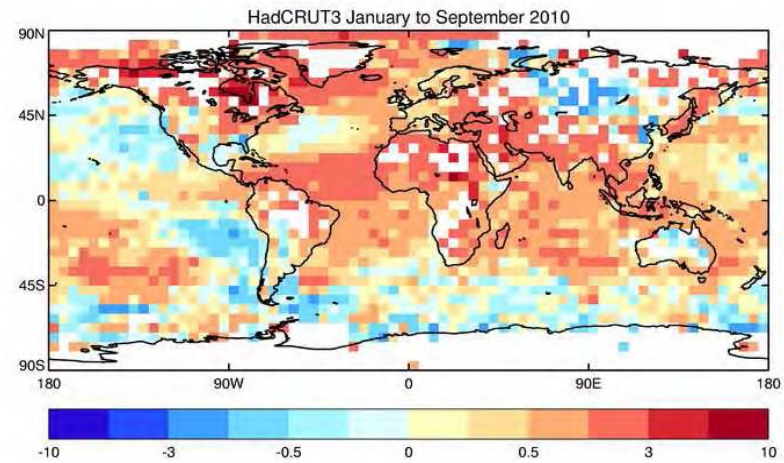


Figure 1: Temperature anomalies (1961-90) for January to September 2010 in deg C

Following endorsement by WMO - CCl, a project has begun recently to assemble a single comprehensive international databank of surface air temperature observations taken globally at monthly, daily and sub-daily resolutions (http://www.surfacetemperatures.org/).

Activities at 1.1 and 1.2 contribute to the:

- WMO Annual Statement on the Status of the Global Climate
- Annual Bulletin on the Climate in WMO Region VI
- Annual 'State of the Climate' special supplement to the Bulletin of the AMS

2. Forecasting

Monthly, seasonal and decadal forecasts are produced, as well as climate projections for the 21st century.

2.1 Seasonal forecasting

The ensemble prediction system GloSea4 uses a coupled ocean-atmosphere model to generate probabilistic forecasts of temperature and rainfall up to six months ahead on global and regional scales. Figure 2 is an example of the rolling 3-month temperature and rainfall anomaly forecasts made for northern Europe. The Met Office is a WMO Global Producing Centre for long-range forecasts.

Long-range predictions often consider large-scale phenomena (such as ENSO and NAO) or other regional patterns. Guidance is provided for overseas services and agencies, e.g. on Sahel rainfall in the wet season (July to September), tropical storm activity in the North Atlantic from July to November and rainfall in north-east Brazil in the wet season (February to May) (http://www.metoffice.gov.uk/science/specialist/long-range/).

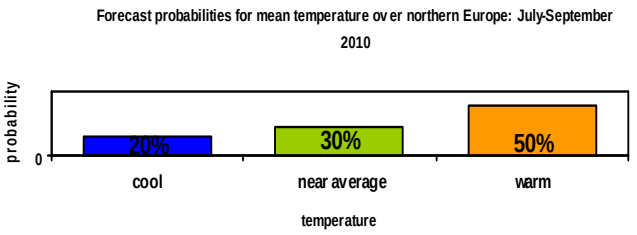


Figure 2: Forecast of air temperature for July - September 2010 over northern Europe

2.2 Decadal forecasting

Over the next decade, changes in climate are expected to be caused by a combination of anthropogenic changes in atmospheric greenhouse-gas and aerosol concentrations, natural variations in volcanic eruptions reaching into the stratosphere and in solar activity and natural, unforced climate variability. These effects must be considered in order to predict regional changes of temperature on this timescale.

The Decadal Prediction System (DePreSys) achieves this by starting with observed atmospheric and oceanic conditions and including projected emissions of greenhouse gases and variations in solar activity. The Hadley Centre Coupled Model version 3 (HadCM3) is used. Forecasts are experimental and skill levels vary from place to place. (http://www.metoffice.gov.uk/research/modelling-systems/unified-model/climate-models/depresys)

2.3 Climate projections

Projections to 2099 have been produced for the UK for 3 greenhouse gas emissions scenarios (low, medium and high), various probabilities (10, 33, 50, 67 and 90%) and 30-year periods (representing the 2020s, 2050s and 2080s). The outputs are for 25 km grid squares and various UK administrative and river basin regions. (http://ukclimateprojections.defra.gov.uk/)

3. Strategic aspects

For the provision of these climate services, general considerations include:

- *Research and development* – including station data digitisation, series quality control and homogenisation, data interpretation and analysis techniques (e.g. gridding); estimation of uncertainties; improving model initialisation and atmosphere / ocean representation; forecast verification

- *Collaboration* – with organisations that have complementary data / skills / knowledge to 'add value' and create user-orientated services

- *Satisfying user requirements* – including data delivery timeframe / method, language, data units, data accuracy and relevant weather thresholds; allowing user flexibility (e.g. through interactive visualisation of map-based information); seeking and acting upon user feedback

- *Communication* – what should be communicated, and how; unambiguous language; representation of data uncertainties and forecast confidence measures

- *Data policy* – international data exchange; access to data (e.g. through download facilities) for research applications

© Crown copyright 2010

Session 4 - Climate watch implementation in RA VI
(Parallel working group sessions)

- Group 1: Format, content and dissemination of (national) climate advisories
- Group 2: User aspects of (national) climate advisories
- Group 3: Basic infrastructure requirements and needs for (national) climate watch implementation, incl. role of the RA VI Pilot RCC-Network and the SEECOFs mechanisms
- Group 4: Research and development aspects including capacity building

WMO Workshop on climate monitoring
including the implementation of Climate Watch Systems in RA VI

Draft guidelines for break-out groups

Karsten Friedrich, Deutscher Wetterdienst (DWD), Offenbach, Germany

Goal of the break-out group discussions

Whilst the overall goal of the workshop is to facilitate the implementation of a climate watch system in RA VI, the task of the break-out groups is to address the following aspects in more detail:

Break-out group 1: Format, content and dissemination of (national) climate advisories

Break-out group 2: User aspects of (national) climate advisories

Break-out group 3: Basic infrastructure requirements and needs for (national) climate watch implementation, incl. role of the RA VI (Pilot) RCC-Network and the SEECOF mechanism

Break-out group 4: Research and development aspects including capacity building

The break-out groups are expected to help specifying, how different components of a RA-VI Climate Watch System should look like and identify necessary steps towards its implementation.

The annexes suggest some seeding questions for discussions.

The break-out groups are expected to report back to the plenary immediately after the lunch break. The plenary will review and discuss the outcome of the break-out groups and, within session 4, agree on an overall concept for climate watch implementation in RA-VI, taking into account regional, national and user aspects. Related actions to be tackled will be identified, which build the basis for a RA-VI climate watch implementation action plan to be compiled and adopted in session 5.

Organisation of the break-out group discussions

Break-out groups shall finish their considerations by 12:45 (-> lunch break; afternoon session starts at 14:15 in room BLUE). Break-out groups should agree on a coffee/tea break (-> cafeteria; pls show badges at the cash desk)				
Break-out group	Chair	Rapporteur	Background assistance	Room
1	R. Ruuhela, Finland	J. Prior, UK	O. Baddour, WMO	BLUE
2	D. Spasova, Serbia	S. Pashiardis, Cyprus	N. Berghi, WMO	E0.B.21
3	A. Hovsepyan, Armenia	K. Friedrich, Germany	P. Hechler, WMO	YELLOW
4	K. Pandzic, Croatia	D. Kiktev, Russian Federation	S. Rösner, Germany	GREEN

Role of the chair:

- Moderate and stimulate discussions according to the key points provided
- Streamline discussions within the framework of the key points
- Provide summaries of discussions and recommendations
- Manage the time
- Present the discussion outcomes to the plenary in the beginning of the afternoon session

Role of the rapporteur:

- Record discussion outcomes
- Assist the Chair in summarising discussions
- Structure notes, so that they can be presented in the afternoon session
- Provide a written summary of the discussion outcomes to the WMO representative who will be co-ordinating the final report (-> Omar Baddour)

Some seeding questions for break-out group 1:
Format, content and dissemination of (national) climate advisories

1. Is the Australian example of a climate watch advisory as given in the WMO brochure 'Climate Watch System: Early Warning against Anomalies and Extremes' sufficient for RA VI purposes?
2. *(brochure see http://www.wmo.int/pages/publications/showcase/documents/CWS_EN_v1.pdf; hardcopies of the Australian example will be provided!)*

3. Which issues are relevant to the format, content, dissemination and verification of (national) climate watches in RA VI?

4. How to define criteria for issuing, updating and ending a climate watch advisory?

5. How to verify climate watch advisories and how to monitor and improve the system?

Some seeding questions for break-out group 2:
User aspects of (national) climate advisories

1. Who are potential user groups for national climate watch advisories in RA VI?

2. How to compile and update relevant user requirements for national climate watch advisories?

3. How to liaise with (potential) users of national climate watch advisories?

4. How to access and handle socio-economic data to understand impacts of climate watch advisories on user decision processes?

5. Is there a need for regional climate watch advisories?

6. How to best communicate and disseminate climate watches to the users?

Some seeding questions for break-out group 3:
Basic infrastructure requirements and needs for (national) climate watch implementation, incl. role of the RA VI (Pilot) RCC-Network and the SEECOF mechanism

1. Why do we need a climate watch system in RA VI and what are the system requirements?

2. Which sources of climate data and climate information (including monitoring and prediction methodologies, tools and products) are available to enable NMHSs to issue national climate watch advisories?

3. Which guidance products (including timing) and tools are needed from global and regional institutions and mechanisms, such as GPCs, RCCs, RCOFs etc., to enable NMHSs in RA VI to issue national climate watch advisories?

4. How to make best use of existing capabilities at national and regional level, including GPCs, RA VI RCC-Network, SEECOF etc.?

5. Which are the specific requirements for NMHSs to implement climate watch systems at national level?

Some seeding questions for break-out group 4:
Research and development aspects including capacity building

1. Which research and development aspects need to be tackled and resolved in order to provide ideal climate watch advisories in RA VI?

2. Whom to address with such research and development aspects?

3. What kind of capacity building requirements are involved in the implementation of a climate watch system in RA VI (focus on national level, such as infrastructure/equipment, staff resources, training etc.)?

4. How to mobilise resources and how to attract sponsors to assist in capacity building for fully implementing a climate watch system in RA VI?

5. How to facilitate the information exchange amongst NMHSs on climate watch practices and experiences?

Summary report of the working group – 1: Session on

FORMAT, CONTENT AND DISSEMINATION OF CLIMATE WATCHES (ADVISORIES)

Chair: Reija Ruuhela
Rapporteur: John Prior

1. General considerations

This summary describes the achieved consensus of the discussions in this particular working group session. Therefore all the conclusions are only preliminary until they have been discussed more widely at the national level in RA VI countries. Possible Climate Watch pilots will give valuable experience for improvement of the Climate Watch concept later on. The most profound questions are if the feasibility of the long range forecasts is sufficient and what the timescale of these climate outlooks is. Also the name "Climate Watch" may be difficult to translate or is already in use in several national languages in RA VI countries and needs further discussion.

(i) Timescales – definition of a Climate Watch (CW)
Weather Warnings (WW) are used for up to 3-5 days. Climate Watches are longer term than Weather Warnings, involving climate monitoring and LRF for up to several months ahead according to predictability. The objective is seamless prediction, with CWs and WWs complementing each other, according to national requirements. For example, a CW because of a LRF of a warmer than average summer season could be followed by a heat wave WW, issued a few days ahead.

(ii) Two types of CWs
Two types of CWs would be issued: one for the General public and another one for specialised user groups such as safety authorities and sectoral decision makers. The CW for the public would contain only general level information about the predicted climate anomalies and impacts. The CW for specialised user groups would include more detailed description of climate anomalies e.g. use of various indices. Potential impacts of the extreme climate event would be assessed. Uncertainties regarding the LRF and potential impacts are essential parts of the CW for specialised user groups. There is a need to ensure that the CW is issued only to relevant users – often just the specialised ones (with consultation and input from partner organisations).

(iii) Responsibilities
Regional Climate Centers (RCCs) issue general guidance and monitoring information on a regional scale. The NMHSs prepare CWs according to national criteria, agreed with users. It should be recognised that sometimes the responsibility for issuing a CW (or equivalent) lies with another organisation. This may be because it is based upon expert interpretation of weather information by a partner, or because another government department has an agreed responsibility. An example is the issue of a water situation alert by a national hydrological agency, based upon rainfall monitoring and/or a LRF provided by the NMHS.

2. Format of a Climate Watch for specialised users

The group agreed with the guidance given in the WMO brochure "Climate Watch System" (reference http://www.wmo.int/pages/publications/showcase/documents/CWS_EN_v1.pdf) and accepted the Australian template given in the brochure, but recommend an RA VI example needs to be also prepared, including the following supplementary information:

- Title "Climate Watch" and a serial number related to the event (in addition to "…for Rainfall Deficiency" in the given template);
- The region of the country that is/will be affected;
- CW can contain information about several climate anomalies which may affect several sectors and must be relevant to RAVI (see Annex);
- Severity measures according to the potential impacts;

- Reference to the frequently updated Weather Warnings that may also be issued later or are valid in a case if the CW is triggered based on climate monitoring;
- RA VI–specific climate situation e.g. NAO, seasonal indicator such as snow cover;
- Contact point within the NMHS, responsible for the issue / updating of the CW

3. Content of a Climate Watch

In addition to a brief description of the climate anomalies for which the watch is delivered, the group found that indications be given with respect to the following information:

- Severity scale, similar to the European Meteo-alarm approach with 4 colours (http://www.meteoalarm.eu/) ;
- Measure for observed extremes e.g. given as return periods;
- Suitable climate indices e.g. SPI, forest fire risk;
- Uncertainty information (confidence measures);
- Possible impacts, tailored to general public or specialised users;
- Relevant RA VI climate indicators

4. Dissemination of a Climate Watch

The group emphasized that the dissemination should be based on the user requirements e.g. web, email alerts. Basically the dissemination would use the already established methods used by NMHSs to reach its user organisations; additional emphasis was made as follows:

- Specialised sectors would use CW based on monitoring and LRF, as well as weather warnings;
- Liaison with the specialised user about the wording and possible impacts is recommended;
- For the general public, CWs would be disseminated using the same media used for Weather Warnings when and where appropriate

5. Criteria for managing a Climate Watch

There are three set of criteria in managing a climate watch system at three stages:

- Initiation of a Climate Watch

The initiation of a CW should be based on climate information derived from climate monitoring (ongoing) and information derived whenever possible from a forecast e.g. LRF. The initiation of a CW should be based according to agreed user criteria (NMHS to establish these)

- Updating a CW

It is essential that a climate watch be updated as frequently as warrant according to the user expectations e.g., weekly but at least within 1 month frequency. The update should make clear the status and the time validity of the CW.

- Formal notification of the end of a CW

When the conditions for issuing climate watch end, it is essential to issue a formal notification about the end of the watch.

6. Evaluation of a Climate Watch System

In order to improve an established Climate Watch System, it is necessary to measure its performance and deficiencies. The evaluation of the system helps NMHSs to improve it and to describe the robustness of the system which is essential information that users needs for their decision making. The group emphasized that it is particularly important:

- To consider within the feasibility study for the implementation of a CWS a mechanism to allow regular user feedback;

- To establish an impact data base (knowledge base) at NMHS and RCC;
- To monitor the performance of CWS regularly against the criteria used for issuing the related advisories

7. Other recommendations

- CCl to progress the work on (i) the definitions of extremes (heat waves, wind storms etc) and (ii) the national climate monitoring products**;**
- RCC to provide an alternative example of a CW, tailored to the Region**;**
- RCC to coordinate work on defining levels of severity, taking into account the national users' needs**;**
- Establish more RCOFs e.g. SW Europe, Polar region**;**
- RCC to collect experiences of pilot Climate Watches, e.g. from SEECOF, and recommend best practice**;**
- Encourage NMHSs to have dialogue with stakeholders to define relevant criteria**;**
- RCC to coordinate standard reference period for CWs and a template for a data / knowledge base on extreme events and impacts.

Annex: The main weather hazards in RA VI member countries

In general the possible weather hazards triggering CWs vary from country to country in RA VI. The low predictability and variable skill of LRF limits the possibilities to issue CWs based on the forecasts of extreme climate events and would be more on the time scale of Weather Warnings. On the other hand, the possibility of issuing CWs based on climate monitoring widens the set of triggering climate factors. The Group identified the following examples of events that might be reasons for CWs and/or WWs:

Flooding (including those caused by coastal flooding, snowmelt, fluvial (river) flooding, pluvial (flash) floods), heatwaves, cold spells, droughts, (risk of) forest fires, snowfalls (including avalanches), icing, windstorms, hail, lightning strikes, wave height.

Summary report of the working group - 2 Session on:

USER ASPECTS OF CLIMATE WATCHES

Chair: Spasova Danica
Rapporteur: Pashiardis Stelios as a Rapporteur.

Participants from: Austria, Bosnia and Herzegovina, Cyprus, Finland, Germany, Italy, FYR of Macedonia, Montenegro, Serbia

Users of climate information are individuals or organizations whose interests are affected by climate anomalies and who consider climate information when making decisions. The team identified four potential groups of users based on their activities, as shown in the following list:

1st group of users:

Government organisations responsible for climate hazard risk management

- Civil Protection Services
- Fire Alarm
- Health

2nd group of users:

Economical sectors like:

- Agriculture
- Tourism & Sport
- Transport
- Water management agency
- Energy
- Insurance
- Forestry
- Construction industry
- Environmental
- Land use & planning

3rd group of users:

- General public
- Media

4th group of users:

- Neighbouring countries
- International organisations
- Food security organisations

The definition of user requirements for national climate watches can be compiled through specialised leaflets, meeting with users or by online communication. The definition of the climate indicators must be developed with participation of end users in a way that they must be easily understood. Ongoing interaction between NMHSs and the user community is important. It is important that the end users understand the skill associated with the forecast system, any weakness in the observing system and the terminology associated with the Climate Watch. It is also important to regularly evaluate whether the Climate Watch System is addressing the user's needs.

To handle socio-economic data and understand the impacts of climate watch advisories on user decision processes, NMHSs need to have good cooperation with the relevant institutions, access to statistical data and relevant feasibility studies. It is essential to establish Risk Management Databases to combine climate hazards with the relevant damages.

There are various ways to communicate and disseminate climate watches to the users using the existing technology: Email, Fax, Mobile, Website, TV, Newspaper or using the existing infrastructure established for the Early Warning System. The webpage will be associated with frequently asked questions (FAQ) to explain to the users the method or give explanatory notes on the outputs.

Climate Watches are to be issued in a timely manner to allow end users sufficient time to incorporate them into their decision-making process. Regular updates of the Climate Watches in different time intervals depending on the climate hazard are essential. Finally, verification and uncertainty could be also documented. Furthermore, there is a need fro regional climate watch advisories but these could take place on a sub regional level, taking into account trans boundary effects of climate hazards (e.g. multinational river basin management).

The following recommendations were provided by the group:

- Promotion of climate watch system through awareness campaign;
- To ensure that climate watch advisory is part of the communication strategy of NMHSs;
- To prepare relevant inventory for each hazard following best practises from region, including examples from other regions;
- To prepare inventory for available parameters and indicators for specific climate hazards and specific group of users;
- Develop in cooperation with user agencies such as civil protection authority and relevant end users best practices for managing the aspects of false alarms.

Summary report of the working group – 3: Session on

BASIC INFRASTRUCTURE REQUIREMENTS AND NEEDS FOR NATIONAL CLIMATE WATCH IMPLEMENTATION, INCLUDING THE ROLE OF THE RA-VI PILOT RCC-NETWORK AND THE SEECOF MECHANISM

Chair: Anahit Hovsepyan
Rapporteur: K. Friedrich

The working group conducted its work based by addressing 5 stimulating questions and proposing recommendations for the issues raised

1. Why do we need a Climate Watch System in RA-VI and what are the system requirements?

The working group noted that the time scale for climate watch advisories should cover the period of 2 weeks to 3 months. It emphasized that there are many sectors in RA-VI as potential users for climate watches energy sector (to mange the resources) including for example agriculture, water, tourism and health. The group suggested that implementing climate watch system in RA-VI would require the following elements:

- Vulnerability assessments to identify climate risks which CWS should primarily target
- Coordinate cross-departmental work at NMHSs (separated responsibilities for different issues relevant to Climate Watches)
- Ensure that observations follow WMO standard practices

Hazard	Timescale	Requirements	Comments
Heat wave	From days to weeks to month	Best available temperature forecast	Number of days which exceeds or undercuts a certain threshold (threshold has to define for the different countries)
Cold wave and frost	From days to weeks to month	Best available temperature forecast	Number of days which exceeds or undercuts a certain threshold (threshold has to define for the different countries)
Drought	Weeks to month or season	SPI, Soil moisture product (not necessary for dry regions of low rainfall and irrigation) Temperature, precipitation forecast and circulation forecast	Soil moisture forecast is not implemented in LRF-Model
Flood (floods caused by storm or by rain)	Hours to month	Soil moisture product, snow accumulation, current status of reservoirs in national scale, SAF products regarding to e.g. snow cover	
Sand storm	Hours to days	Soil moisture, visibility, optical depth, wind maps	In present difficulties to identify by LRF
Forest fire	Weeks to month	Relative humidity, wind, temperature	

Wind storm	Hours to days	Wind, pressure, circulation regime, number of storm events, tracks	In present difficulties to identify by LRF depends on the forcing, it is different for each year but the likelihood can identified within discussion of experts (website)
Snow fall accumulation of snow cover	Days to weeks to month	Satellite data, snow density, snow depth, extent of snow cover	
Fog	Days to week	Relative humidity, visibility, wind, number of days with fog	

Combination of different hazards (e.g. thick snow cover following by a heat wave, sand storms following a heat wave)

2. What are the sources of climate data and climate information to enable NMHSs to issue national climate watch advisories?

The group identified several sources of climate information available to serve for feeding any climate watch system at national level, *e.g*. RCC-Network, SEECOF, ECMWF, EUMETSAT etc. *Nevertheless the group stressed the need to make available some fundamental tools to develop CWS products including for downscaling information (LRF) at national scale. The group made the following suggestions under this topic:*

- Consider consistent reference periods amongst national and regional climate monitoring products and LRF products as well as amongst monitoring and LRF products;

- Regarding reference periods consider decline of observations, e.g. in observation in the 1990s year for former Soviet Union and the Balkan countries due to war;

- Consider monitoring in real time availability of data;

- Establishment of statistical basis for indices for national and regional reference periods, such as return period analyses etc.;

- Consider assessment of capacities of RA VI NMHSs relevant to climate watches, such as observational, monitoring, predictive and modelling capacities;

3. Which guidance products (including timing) and tools are needed from global and regional institutions and mechanisms, such as GPCs, RCCs, RCOFs etc., to enable NMHSs in RA-VI to issue national climate watch advisories?

The group considered a three step approach for climate watches: Analyse of global -> regional -> national level of climate system and integrate information accordingly (Cf. table 1 above). The group stressed the need to consider the varying capacities and user requirements in the region. In general there are essential common issues w.r.t to methodologies and infrastructure in the region which need to be considered to help in implementing such as:

- Consider monitoring thresholds of temperature and other parameters (taking into account differing threshold requirements for different regions/countries);
- Consider challenges of differing availability and quality of observations and data for product generation;
- RCCs to consider using reanalysis data (ERA-interim);
- Consider extending RCC products beyond RA VI borders to enable Members on the border to get sufficient information on the spatial distribution of the parameters/information (-> use reanalysis data and/or exchange related data with neighbouring RCCs);

- Consider an appropriate flow of information from global through the regional to the national level and vice versa!
- RCCs to consider providing (gridded) data jointly with their products;
- Consider appropriate timeliness of input information to climate watch advisories including consideration of input data quality levels (e.g. use of SYNOP data);
- Consider use of satellite data, including EUMETSAT SAF products;
- RCCs to consider weekly updates of monthly products;
- Consider national knowledge of climate system

4. How to make best use of existing capabilities at national and regional level, including GPCs, RA VI RCC-Network, SEECOF etc.?

Considerable climate information is already available within RA-VI which can be best used for implementing CWS in the region. In this regards RCCs are requested to provide information (catalogue) on their products as well as products available from other sources, such as the EUMETSAT SAF Network, entities providing information on general circulation indices (CPC) including guidance on how best to use such products. The group identified additional aspects which need also to be considered for the implementation including:

- Need appropriate internet connection for accessing large amount of data and products. This requires high speed and large internet bandwidth as well as capacity to handle related formats, such as GRIB for GPC digital products
- Need for appropriate exchange of experiences amongst NMHSs
- Need for training on downscaling techniques

5. Which are the specific requirements for NMHSs to implement Climate Watch Systems at national level?

- Upgrading the existing infrastructure to accommodate CWS requirements
- Manpower requirement where it is insufficient
- Establish close cooperation with relevant organisations/institutes on national level
- Develop capacity building and training
- Technology transfer (RCM, downscaling tools etc.)

Summary report of the working group – 4: Session on

RESEARCH AND DEVELOPMENT ASPECTS INCLUDING CAPACITY BUILDING

Chair : K. Pandzic
Rapporteur: D.Kiktev

The working group conducted its work based by addressing 5 stimulating questions and proposing recommendations for the issues raised

1. What is the scientific basis for Climate Watch?

Input for Climate Watch is provided by climate monitoring and LRF. Today's skill of LRFs is at best modest even for seasonal means. However, goals of Climate Watch imply forecasting of more complex statistics compared to simple means on the basis of LRF model output.
Dynamical LR-Forecasting is based on the hypothesis that slowly varying external forcing (SSTs, soil moisture, sea ice, snow cover etc.) have a substantial influence on the atmospheric statistical characteristics. Assuming that this hypothesis (hypothesis about so-called «second kind of predictability») is correct we can expect that influence of slowly varying external forcing on the atmosphere will affect statistics of extreme events beyond the interval of deterministic predictability of individual synoptic structures (Some examples of such kind of products are already available, e.g. seasonal forecasts of tropical cyclones activity).

2. Which research and development aspects need to be tackled and resolved in order to provide ideal climate watch advisories in RA-VI?

- Predictability aspects:
  - Identification of predictable phenomena on time scales beyond the period of deterministic forecasts,
  - Predictability of various derived statistics/events/indices (some of them might be predictable better than others),
  - Regional predictability;
  - Conditional predictability of extremes (predictability linked with particular circulation patterns)
- Climatology of extremes;
- Calibration of forecasts for rear events;
- Verification of rear events

3. Whom to address with such research and development aspects?

- WMO Regional Climate Centres (RCCs);
- WMO Global Producing Centres (GPCs);
- University Community;
- The Joint CCl/Clivar/JCOMM Expert Team on Climate Change Detection and Indices;
- The CBS Expert Team on Extended Long Range Forecast;
- Research projects on climate extremes, e.g. under WCRP;
- The CCl-Task Team on definition of weather and climate extreme events

4. What kind of capacity building requirements are involved in the implementation of a climate watch system in RA-VI (focus on national level, such as infrastructure/equipment, staff resources, training etc.)?

Addressing CB in CWSs in RA-VI should include essentially training on Climate Watch taking into consideration that this activity is at an early stage of development. In this regards, the group identified potential areas for training as follow:

- Interaction and contacts with media;
- Development of user-oriented language;
- Development of standardized answers/expressions on limitation and possibilities of model data,
- Calculation and usage of various indices etc.

5. How to mobilise resources and how to attract sponsors to assist in capacity building for fully implementing a climate watch system in RA VI?

- The group suggested to seek for potential sponsors for Climate Watch activity including
- At sub-regional level: interested agencies;
- At regional and global levels: European Commission, WMO, UNDP, WB.

In supporting resource mobilisation the group suggested to organize regional round tables with local authorities to explain possibilities for and needs of Climate Watch. Climate Watch activity should be integrated into regional adaptation strategies.

6. How to facilitate the information exchange amongst NMHSs on Climate Watch practices and experiences?

- Benefit from the organisation of Regional Climate Outlook Forums (RCOFs) and other events such as focused workshops which might be relevant for exchange of experience and information on recent advances;
- In the long run Climate Watch activity should be integrated into WMO Information System;
- Vision of future Climate Watch products form should build on the experience of the European Meteo Alarm; http://www.meteoalarm.eu/

Potential contributors for RA-VI region:

RA-VI Regional Climate Centre Nodes on Monitoring, LRF and Data; ECMWF (reanalysis and forecasts) and other GPCs from worldwide, EUMETSAT, EuroGRID etc.

Role of RCC LRF-node:

Statistical processing of LRF-output to identify extreme conditions, regional integrated multi-model products

Period for update of Climate Watch information:

From months to days (to near real-time) => Data exchange have to be improved (infrastructure issue)

Data needs for Climate Watch

There is a need in daily model data (both for forecasts and hindcasts) from GPCs for calculation of derived indices. This issue to be addresses to CBS ETELRF and GPCs.
Correspondingly, long-term time observational station series and gridded climate data sets are needed for validation.

7. Recommendations:

Research agenda:

- Develop further predictability aspects on:
  - Identification of phenomena predictable on time scales beyond the period of deterministic forecasts;
  - Predictability of various derived statistics/events/indices;
- Research on climatology of extremes with links to particular circulation patterns
- Verification including verifications of rear events on the basis of hindcasts

Data needs for Climate Watch to data providers

There is a need in daily model data (both for forecasts and hindcasts) from GPCs for calculation of derived indices. This issue should be addresses to CBS ETELRF and GPCs.
Correspondingly, long-term time observational station series and gridded climate data sets are needed for validation.

Training with the following aspects:

Contacts with media, user-oriented language, standardized answers/expressions on limitation and possibilities of model data on calculation and usage of various indices etc.

Annex

- Annex A: Opening remarks of the President of the WMO Regional Association RA VI
- Annex B: Agenda
- Annex C: List of participants
- Annex D: Group photo

Annex A

Opening remarks of the President of the WMO Regional Association RA VI

Dear colleagues, representatives of DWD, WMO, RA VI NMHSs, University of Berlin, dear friends

It is my great privilege and pleasure to welcome you on the behalf of the WMO Regional Association VI (Europe) and to express my truly delight witnessing performance of this WMO Workshop on Climate Monitoring what includes the implementation of climate watch systems in RA VI. I would like to express my appreciation to the DWD on the proactive role in hosting and supporting of this important RA VI event and even more: the leadership on the establishment of the Global Framework of Climate Services including RA VI Regional Climate Centre Network. I would also like to remind you on the vital contribution of the DWD in pioneering the training on the use of satellite data for the climate monitoring under the frame of GCOS project in Southeastern Europe as a joint activity with EUMETSAT, WMO, ICEED and the Croatian National Meteorological Service - DHMZ.

This Workshop is actively rewarding demands of the Association to the RA VI Management group and President to fulfil the RA VI Action plan related to the climate monitoring, particularly in bridging differences in RA VI and building up holistic approach on overall benefit at the national scale. For this reason, I am delighted to witness representatives of 30 RA VI NMHSs, including four at Caucasus region and two in the Middle East. I am very much sure that this activity actively contributes to re-design of the regional basic observational network commencing by the WIGOS Demonstration Project. Evidently, this Workshop is actively supporting the process of the capacity building and development of the RA VI RCC network structure and its tree nodes related to climate data, climate monitoring and long-range forecasting. We all expect comprehensible benefit of such framework in accomplishment of development needs related to proper respond to global and regional climate changes and related challenges and guidance on the suitable act in response to a changing climate.

In addressing such priority tasks, the RA VI Management group has significantly enhanced its structure and performance by establishing the tree Working Groups that are directly managing the new Task Teams with clearly defined deliverables. The crucial one for climate monitoring is the RA VI Working Group on Climate and Hydrology with its related Expert Groups and Task Teams that are actively involved in performance and outcomes of this workshop.

I am very pleased to let you know that the Working Group on Climate and Hydrology, particularly the Expert Group on Climate, has started the process of establishing sustainable Regional Climate Outlook Forums in RA VI as the part of the forthcoming Global Framework of Climate Services. It has successfully completed the third Regional Climate Outlook Forum – for Southeastern Europe, so called SEECOF, and initialized the SEECOF Focal Point Network.

Dear colleagues, finally, it is my pleasure to rely with confidence on the host, organizers and facilitators of the Workshop. I wish to all of us a fruitful time and the full success of the Workshop on the benefit of our NMHSs, our countries and consequently our RA VI (Europe) and WMO community.

Thank you

Annex B

Agenda

25.10.2010	**08:30 - 09:00**	**Registration**
	09:00 - 12:35	**Session1: Key lectures on rising awareness** *Chair: K.-J. Schreiber (DEU)*
	09:00 - 09:20	Welcome addresses *K.-J. Schreiber (DEU),* *I. Cacic (RA VI),* *O. Baddour (WMO)* Arrangements for the meeting *S. Rösner (DEU)*
	09:20 - 10:05	Climate variability and change and related extreme events: global and regional perspective *Prof. U. Ulbrich (University of Berlin, DEU)*
	10:05 - 10:35	**Coffee break**
	10:35 - 11:05	The need and requirements for an efficient climate early warning system - agrometeorological perspectives *Dr. Dr. habil K.-C. Kersebaum (ZALF, DEU)*
	11:05 - 11:35	The need and requirements for an efficient climate early warning system - hydrological perspectives *M. Puupponen (FIN)*
	11:35 - 12:05	WMO climate related activities and programmes *O. Baddour (WMO***)**
	12:05 - 12:35	The Climate Services Information System components of the GFCS: WMO's contributions *P. Hechler (WMO)*
	12:35 - 14:05	**Lunch**
	14:05 - 17:40	**Session 2: International and regional projects and activities relevant to Climate Watch Systems** *Chair: P. Hechler (WMO)*
	14:05 - 14:50	WMO climate watch concept and related systems *O. Baddour (WMO)*
	14:50 - 15:15	Seasonal forecasts of ECMWF for RA VI and predictive skills *P. Poli (ECMWF)*
	15:15 - 15:15	(moved to 27 October, afternoon session)
	15:15 - 15:40	The RA VI Pilot RCC-Network node on Climate Monitoring: products and services *P. Bissolli (DEU)*
	15:40 - 16:25	**Coffee break and group photo**
	16:25 - 16:50	The RA VI Pilot RCC-Network node on long-range forecasts: products and services *J.-P. Céron (FRA) & D. Kiktev (RUS)*
	16:50 - 17:15	The SEECOF mechanism *A. Hovsepyan (ARM)*
	17:15 - 17:40	The SEE-VCCC initiative *M. Dacic (SRB)*
	17:40	**Adjourn of day 1**
	18:00 - 19:00	**Ice breaker**

26.10.2010	**09:00 - 13:06**	**Session 3: Country presentations on the status and priority needs of monitoring and predicting climate anomalies and extremes** *Chair: O. Baddour (WMO)*	
	09:00 - 09:12	Armenia	*A. Hovsepyan*
	09:12 - 09:24	Austria	*G. Hohenwarter*
	09:24 - 09:36	Azerbaijan	*S. Khalilov*
	09:36 - 09:48	Belgium	*L. Debontridder*
	09:48 - 10:00	Bosnia and Herzegovina	*Z. Majstorovic*
	10:00 - 10:12	Bulgaria	*V. Alexandrov*
	10:12 - 10:24	Croatia	*K. Pandzic*
	10:24 - 10:36	Cyprus	*S. Pashiardis*
	10:36 - 10:48	Finland	*R. Ruuhela*
	10:48 - 11:18	**Coffee break**	
	11:18 - 11:30	France	*J.-P. Céron*
	11:30 - 11:42	Georgia	*L. Kartveishvili*
	11:42 - 11:54	Germany	*T. Fuchs*
	11:54 - 12:06	Hungary	*Z. Bihari*
	12:06 - 12:18	Italy	*F. Mainmone*
	12:18 - 12:30	Jordan	*M. Semawi*
	12:30 - 12:42	Kazakhstan	*A. Abenova*
	12:42 - 12:54	Lithuania	*D. Valiukas*
	12:54 - 13:06	Luxembourg	*T. Eiffener*
	13:06 - 14:30	**Lunch**	
	14:30 - 17:12	**Session 3 (continued)** *Chair: M. Puupponen (FIN)*	
	14:30 - 14:42	Moldova	*T. Linih*
	14:42 - 14:54	Montenegro	*S. Pavicevic*
	14:54 - 15:06	Norway	*K. Iden*
	15:06 - 15:18	Portugal	*V. Pires*
	15:18 - 15:30	Russian Federation	*D. Kiktev*
	15:30 - 15:42	Serbia	*G. Pejanovic*
	15:42 - 15:54	Spain	*A. Mestre*
	15:54 - 16:24	**Coffee break**	
	16:24 - 16:36	Sweden	*P. Harsmar*
	16:36 - 16:48	The former Yugoslav Republic of Macedonia	*N. Aleksovska*
	16:48 - 17:00	Turkey	*M. Demircan*
	17:00 - 17:12	United Kingdom of Great Britain & Northern Ireland	*J. Prior*
	17:12	**Adjourn of day 2**	
	19:00 - 22:00	**Social Event**	
27.10.2010	**09:00 - 12:45**	**Session 4: Climate Watch implementation in RA VI (Parallel working group sessions)** *Stefan Rösner (DEU)*	
	09:00 - 09:15	Briefing on parallel working group sessions *P. Hechler (WMO)*	
	09:15 - 12:45	**Group 1: Format, content and dissemination of (national) climate advisories** *Chair: R. Ruuhela(FIN)* *Rapp.: J. Prior (GBR)*	
	09:15 - 12:45	**Group 2: User aspects of (national) climate advisories**	

		Chair: D. Spasova (SRB) *Rapp.: St. Pashiardis (CYP)*
	09:15 - 12:45	**Group 3: Basic infrastructure requirements and needs for (national) climate watch implementation, incl. role of the RA VI Pilot RCC-Network and the SEECOFs mechanisms** *Chair: A. Hovsepyan (ARM)* *Rapp.: K. Friedrich (DEU)*
	09:15 - 12:45	**Group 4: Research and development aspects including capacity building** *Chair: K. Pandzic (HRV)* *Rapp.: D. Kiktev (RUS)*
	12:45 - 14:15	**Lunch**
	14:15 - 14:40	The RA VI Pilot RCC-Network node on Climate Data: products and services *G. Verver (NLD)*
	14:40 - 15:40	**Presentation of the working group's conclusions and plenary discussion including drafting of an action plan** *WG chairs & rapporteurs*
	15:40 - 16:10	**Coffee break**
	16:10 - 18:10	**Continued presentation of the working group's conclusions and plenary discussion including drafting of an action plan** *WG chairs & rapporteurs*
	18:10	**Adjourn of day 3**
28.10.2010	**09:00 - 09:45**	**Host presentation** *K.-J. Schreiber / (DEU)*
	09:45 - 10:45	**Session 5: The way forward and adoption of the action plan (including a summary discussion on implications on the RA VI Pilot RCC-Network)** *Chair: M. Dacic (SRB)*
	10:45 - 11:15	**Coffee break**
	11:15 - 12:45	**Continued session 5**
	12:45 - 13:00	**Closure of workshop** *O. Baddour (WMO), S. Rösner (DEU)*

Annex C

List of participants

Name	First name	Institute	Address	Country	Phone	Fax	Email
Abenova	Ainur	Kazhydromet	Orynbor st. 11/1 010000 Astana	Kazakhstan	+7 7172 798335	+7 7172 798344	intercoop@kazhydromet.kz; aina_8383@mail.ru
Aleksovska	Nina	Hydrometeorological Service, Macedonia	Skupi BB, 1000 Skopje	The former Yugoslav Republic of Macedonia	+389 2 3097 004	+389 2 3097 118	naleksovska@meteo.gov.mk
Alexandrov	Vesselin	National Institute of Meteorology and Hydrology	66 Tzarigradsko shose, BG-1784 Sofia	Bulgaria	+359 2 462 4215	+359 2 9884494	vesselin.alexandrov@meteo.bg
Baddour	Omar	World Meteorological Organization (WMO)	7 bis, avenue de la Paix CH-1211 Geneve 2	-			obaddour@wmo.int
Becker	Dr. Andreas	Deutscher Wetterdienst	Global Precipitation Climatology Centre Frankfurter Strasse 135 63067 Offenbach	Germany	+49 (0)69 8062 2900	+49 (0)69 806212900	andreas.becker@dwd.de
Berghi	Natalia	World Meteorological Organization (WMO)	7 bis, avenue de la Paix CH-1211 Geneve 2	-	+41 22 730 8298	+41 22 730 8534/8047	nberghi@wmo.int
Bihari	Zita	Hungarian Meteorological Service	H-1024 Budapest, Kitaibel P. u. 1	Hungary	+3613464727	+3613464687	bihari.z@met.hu
Bissolli	Dr. Peter	Deutscher Wetterdienst	Regional Climate Monitoring Frankfurter Strasse 135 63067 Offenbach	Germany	+49 (0)69 8062 2936	+49 (0)69 800863 115	Peter.Bissolli@dwd.de
Cacic	Ivan	Meteorological and Hydrological Service	Gric 3, HR-10000 Zagreb	Croatia	+385 91 4564 675	+385 1 4851 901	cacic@cirus.dhz.hr
Céron	Jean-Pierre	Météo France	42 avenue G. Corriolis F-31057 Toulouse Cédex 1	France	+33 (5) 61 07 83 10	+33 (5) 61 07 83 09	Jean-Pierre.Ceron@meteo.fr

Dacic	Milan	Director and PR of Serbia with the WMO Republic Hydrometeorological Service of Serbia	Kneza Viseslava 66 11000 Belgrade	Serbia	+381 11 3050923	+381 11 3050847	milan.dacic@hidmet.gov.rs
Debontridder	Luc	RMIB	Ringlaan 3 1180 Brussels	Belgium	+32 2 3730521	+32 2 3730528	Luc.Debontridder@oma.be
Eiffener	Tessy	Service Météorologique du Luxembourg, Lux.-Findel-Airport	B.P. 273 L-2012 Luxemburg	Luxembourg	+352 4798 2028	+352 4798 2849	ter@airport.etat.lu
Friedrich	Karsten	Deutscher Wetterdienst	Frankfurter Strasse 135 63067 Offenbach	Germany	+49 (0)69 8062 2961	+49 (0)69 800863 115	Karsten.Friedrich@dwd.de
Fuchs	Tobias	Deutscher Wetterdienst	Frankfurter Strasse 135 63067 Offenbach	Germany	+49 (0)69 8062 2872	+49 (0)69 8062 3987	tobias.fuchs@dwd.de
Harsmar	Per-Olof	Swedish Meteorological and Hydrological Institute	60176 Norrkoping	Sweden	+46 11 4958192	+46 11 4958001	per-olof.harsmar@smhi.se
Hayrapetyan	Kamo	Armstatehydromet	54 Leo Street, Yerevan, 0002	Armenia	+37410 533616	+37410 532952	armstate@meteo.am
Hechler	Peer	World Meteorological Organization (WMO)	7 bis, avenue de la Paix CH-1211 Geneve 2	-			phechler@wmo.int
Hohenwarter	Gerhard	ZAMG	Hohe Warte 38 A-1190 Wien	Austria	+43 1 36026 2212	+43 1 36026 72	g.hohenwarter@zamg.ac.at
Hovsepyan	Anahit	Armstatehydromet	54 Leo Street, Yerevan, 0002	Armenia	+37410 533616	+37410 532952	anahit_hovs@yahoo.com
Iden	Knut Arne	The Norwegian Meteorological Institute	P.O. Box 43 Blindern NO-0313 Oslo	Norway	+47 22 963259	+47 22 963050	knut.iden@met.no
Kartveishvili	Liana	Hydrometeorological Department of National Enviromental Agency of Georgia	S-601 76 Norrköping	Georgia	+995 32 439528	+995 32 439550	lianakarteliskvili@yahoo.com

Kersebaum	PD Dr. Dr. habil K. Christian	Inst. of Landscape Systems Analysis (ZALF)	Leibniz-Centre for Agricultural Landscape Research Eberswalder Str. 84 D - 15374 Müncheberg	Germany	+49 (0)33432 82 394	+49 (0)33432 82 334	ckersebaum@ZALF.de
Khalilov	Sahib	Azerbaijan NMHs Deputy Director	50 Heydar Aliyer Av. AZ-1154 Baku	Azerbaijan	+99412 567 8806	+99412 495 1578	s_khalilov@yahoo.com
Kiktev	Dmitry	Hydrometcentre of Russia	11-13 Bolshoy Predtechensky st. Moscow	Russian Federation	+7 499 2551354	+7 499 1551582	kiktev@mecom.ru
Komuscu	Ali Umran	Turkish State Meteorological Service	Sensing Department Kalaba 06120 Ankara	Turkey	+90 312 3022624	+90 312 3606276	aukomuscu@dmi.gov.tr
Koppe-Schaller	Dr. Christina	Deutscher Wetterdienst	Regional Bureau of Climate and Environment Consultancy Stefan-Meier-Straße 4 79104 Freiburg	Germany	+49 (761) 2820273	+49 (761) 2820277	christina.koppe@dwd.de
Kutaladze	Nato	Hydrometeorological Department of National Enviromental Agency of Georgia	150 David Agmashenebeli, 0112 Tbilisi	Georgia	+995 32 439528	+995 32 439550	cwlam08@gmail.com
Kuusisto	Esko	Finland's environmental administration	Mechelininkatu 34 A PL 140 00251 Helsinki	Finland	+358 20 490 123	+358 20 490 2590	esko.kuusisto@ymparisto.fi
Linih	Tatiana	State Hydrometeorological Service	134, Grenoble Str MD-2072 Chisinau	Moldova	+373 22 773529	+372 22 773529 +372 22 773636	climat@meteo.md; intern@meteo.md
Mainmone	Filippo	CMMA - Italian Air Force Met Service	via die Pratica di Mare 00040 Pomezia (Rome) Aeroporto "De Bernardi"	Italy	+39 069129 3895	+39 069129 3254	maimone@meteoam.it
Majstorovic	Zeljko	Federal Hydrometeorological Institute Bosnia and Herzegovina	str. Bardakčije 12, 71000 Sarajevo	Bosnia and Herzegovina	+387 3327 6708	+387 3344 2435	zemajstorovic@yahoo.com

Mestre	Antonio	Aemet	Leonardo Prieto Castro 8, 28040 Madrid	Spain	+349158197 05	+34915819 767	amestreb@aemet.es
Nitsche	Helga	Deutscher Wetterdienst	Regional Climate Monitoring Frankfurter Strasse 135 63067 Offenbach	Germany	+49 (0)69 8062 2931	+49 (0)69 800863 115	Helga.Nitsche@dwd.de
Pandzic	Kreso	Meteorological and Hydrological Service	Gric 3, HR-10000 Zagreb	Croatia	+385 91 4564 684	+385 1 4851 901	pandzic@cirus.dhz.hr
Pashiardis	Stelios	Cyprus Meteorological Service	1418 Nicosia	Cyprus	+357 22 802911	+357 22 305500	spashiardis@ms.moa.gov.cy
Pavicevic	Sanja	Hydrometeorological Institute of Montenegro	IV Proleterske 19, Podgorica	Montenegro	+ 382 (0)20 655 431	+ 382 (0)20 655 197	sanja.pavicevic@meteo.co.me
Pejanovic	Goran	Republic Hydrometeorological Service of Serbia	Kneza Viseslava 66 11000 Belgrade	Serbia	+381 11 3050923	+381 11 3050847	goran.pejanovic@hidmet.gov.rs
Pires	Vanda	Instituto de Meteorologia	Rua C do Aeroporto	Portugal	+351 21 8447114	+351 21 8402370	vanda.cabrinha@meteo.pt
Poli	Paul	European Centre for Medium Range Weather Forecast	Shinfield Park Reading RG2 9AX	United Kingdom of Great Britain and Northern Ireland	NN	NN	
Prior	John	National Climate Information Centre, Met Office Hadley Centre	FitzRoy Road, Exeter Devon EX1 3PB	United Kingdom of Great Britain and Northern Ireland	+44 1392 886206	+44 1392 885681	john.prior@metoffice.gov.uk
Puupponen	Markku	D.Sc. (Tech.), Leading Hydrologist Finnish Environment Institute Freshwater Centre		Finland			markku.puupponen@ymparisto.fi
Rapp	Jörg	Deutscher Wetterdienst	Frankfurter Strasse 135 63067 Offenbach	Germany	+49 69 8062 2799		joerg.rapp@dwd.de

Rösner	Stefan	Deutscher Wetterdienst	Regional Climate Monitoring Frankfurter Strasse 135 63067 Offenbach	Germany	+49 (0)69 8062 4306	+49 (0)69 800863 115	Stefan.Roesner@dwd.de
Ruuhela	Reija	Finnish Meteorological Institute	P.O. Box 503 FI-00101 Helsinki	Finland	+358 500 424533	+358 9 19293146	reija.ruuhela@fmi.fi
Schreiber	Klaus-Jürgen	Deutscher Wetterdienst	Frankfurter Strasse 135 63067 Offenbach	Germany	+49 (0)69 8062 2758	+49 (0)69 8062 3759	Klaus-Juergen.Schreiber@dwd.de
Semawi	Mohammad	Jordan Meteorological Department	Amman, 11134 P.O. Box 341011	Jordan	+962 6 4892408	+962 6 4894409	msemawi@yahoo.com; admin@jometeo.gov.jo
Spasova	Danica	Republic Hydrometeorological Service of Serbia	Kneza Viseslava 66 11000 Belgrade	Serbia	+381 11 3050923	+381 11 3050847	danica.spasova@hidmet.gov.rs
Ulbrich	Prof. Dr. Uwe	Freie Universität Berlin Institut für Meteorologie	Carl-Heinrich-Becker-Weg 6-10 D-12165 Berlin	Germany	+49 30 838 71186		ulbrich@met.fu-berlin.de
Valiukas	Donatas (Mr.)	Lithuanian Hydrometeorological Service	Rudnios str. 6 LT-09300 Vilnius	Lithuania	+370 5 275 0418	+370 5 272 8874	d.valiukas@meteo.lt
Verver	Dr. Gé H.L.	Royal Netherlands Meteorological Institute (KNMI)	Climate Research and Seismology Department P.O. Box 201, 3730 AE De Bilt	Netherlands (the)	+31 30 2206 444		ge.verver@knmi.nl

Annex D

Group photo

For more information, please contact:

World Meteorological Organization

Observing and Information Systems Department

Tel.: +41 (0) 22 730 82 68 – Fax: +41 (0) 22 730 80 21

E-mail: wcdmp@wmo.int

7 bis, avenue de la Paix – P.O. Box 2300 – CH 1211 Geneva 2 – Switzerland

www.wmo.int