WMO Technical Conference

Moving from climate to impact forecasts
Delivering Climate Services for Decision Making

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and contribution from Euporias project
(thanks’ to Carlo, Pete and Ronald)
Introductory Remarks
Introductive Remarks

Climate Variability vs Climate Change

- Natural Climate & Climate Variability (CV) vs Anthropogenically forced Changes in Climate & Climate Variability (CC)
- From seasonal & Interannual up to multi decadal scales for the CV
- Slow evolutions on longer time scales for the CC

Needs of Adaptation to Climate Variability and Change

- From season up to interannual scales (mostly natural - CV)
- From decade up to longer time scales (natural + forced – CV + CC)
- Needs of terrain feedback to better adjust the proposed adaptation strategies
- Adaptation to the current climate variability as the first step of the adaptation to climate change
Introductive remarks

Seamless use of available Climate information

**DECADAL Forecasts & Projections**

Continuum of information on both space and time scales:
- ✓ Best compromise between users’ needs and possible products
- ✓ Consistency between use of information and information
- ✓ Needs of information on the use of the products (actions/decisions, decisional calendar, critical time scales …)

→ Provision of Climate Information should be an Action Driven Process

→ Strong Provider / User liaison needed
Use of already available Climate Forecasts

The **Seasonal forecast** is made for:

- Climate Risk Management related to the current climate variability
- Tactical decision for organisations or companies which are sensitive to/impacted by the current climate variability
- Crucial time window between the dissemination of the information and the potential users’ actions (Lead-Time)

- Decisions are always taken in an uncertainty environment
- The Forecasting information is only one among several elements which lead to the final decision
- The different decisional options are important to take on board, especially with respect of the forecast update process.
- A forecasting information which is not use for action and/or decision is helpless whatever the intrinsic quality of the forecast
Introductive Remarks

Uncertainties: projection & Forecast

Uncertainty sources

1. Radiative Forcing / Green House Gas Concentration Evolution
2. Climate Modeling
3. Internal Climate Variability
4. Initial conditions

• The uncertainty is inherent to the climate prediction and projection
• It is part of the climate information to be tailored and conveyed
• We have to cope with and to learn how to use it in the best possible way
Which Climate Service?

Definition of Climate Services (WMO)

- Generating and providing information on past, present and future climate, and on its impacts on natural and human systems
  - Climate monitoring
  - Climate watches
  - Monthly/Seasonal/Decadal climate predictions
  - Climate Change projections
  - Need for more information than climate

- Helping the user to choose the right product for decision making, and use it appropriately including aspects of uncertainty
  - Tailored information for Decision Making Processes (DMPs),
  - Impact of the use of the information onto the DMPs and associated evaluation,
  - Uncertainty and Decision Making,
  - Necessary shared knowledge,
Which Climate Service?

Schematic vision for a Climate Service within Euporias

- Impact Forecast Products
- Related Uncertainty
- Tailored Information to DMP
- Delivery Mechanism
- User Support (including CB & feedbacks)
- Climate Service provision

CSIS

UIP
Impact Forecasting Suites
**General Remarks**

- **Impact variables**
  - Directly related to Stakeholder activity
  - Relevant to describe Climate impact onto the user activity
  - Possibly mixing climate and non climate information

- **Impacts models**
  - Similar (in term of processes) to any climate model,
  - Needs of hindcast experience (skill, bias correction, ...)
  - Input related to climate and possibly non climate data,
  - Needs of initial conditions and forcing terms along the simulation,
  - Relative weight of climate variables onto the output,

- **Impact forecasting suites**
  - Downstream of the Climate forecasts,
  - Needs for downscaled climate information,
  - Process similar to Climate Forecasts (ensemble forecasts, multi-model issues, uncertainty assessment, probabilistic forecast, ...)
  - Output relevant for decision-making (possibly after some post-
Impact Forecasting suites

An example: from forecasting information to DMP

- The Manantali dam management (since 2005)

Atmospheric Forecast: beginning of August rain for SON

Post-processing/Dissemination: downscaling and tailoring the climate information in impact variable (river flow at a specific station).

Impact assessment: merging the impact information with management rules and dam data to provide information relevant to the DMP.

Water Permanent Commission
20 August

POGR

Decision Making Process: Choice of the best strategy with respect of concurrent use of water and the characteristics of the climate (dry season occurring end of October and forecast of the end of the rainy season)

Tailored Information

- Use of the River Flow forecast clearly related to the DMP and management rules
- Transformation of the impact forecast in risk assessment
- Model simulation of water stock evolution into the dam
- Critical threshold into the DMP
- Critical date for Decision (by mid-august)
Euporias Project and Impact Forecasts
Aim and Main Objectives

- To develop and deliver a reliable and trusted impact prediction system
  - for five semi-operational prototypes.
  - working examples of 'end-to-end' climate-to-impacts-to-decision-making services
  - operating on the Seasonal and Decadal (S2D) time scales (mostly season to year).
- To assess and document key knowledge gaps and vulnerabilities
  - for important sectors (e.g. Water, Energy, Transport, Food security, Health, etc.)
  - along with the needs of specific users within these sectors,
  - through close collaboration with project stakeholders.
- To develop a set of standard tools and techniques
  - tailored to the needs and actions of stakeholders
  - for calibrating, downscaling, and modelling sector-specific impacts on S2D timescales.
- To develop a knowledge-sharing protocol
  - necessary to promote the use of these tools and information.
  - To assess and document the current marketability of climate services in Europe.
- To demonstrate that climate information can be made more actionable by directly addressing users’ needs and actions in both the development and delivery of climate services.
Euporias Project

Selected prototypes and associated Impact forecasts

Resilience

Objective: To provide monthly to seasonal probabilistic climate forecasts for safe and efficient energy management.

Stakeholders:
Energy producers (e.g., EDF, www.edf.com), grid operators (e.g., REE, www.ree.ee), renewable energy operators (e.g., EDP, www.edp.com), energy investors (e.g., Iberdrola, www.iberdrola.com), energy insurers (e.g., Munich RE, www.munichre.com).

Energy

- Energy management at the European Scale (IC3),
- Energy demand and supply (via Temperature and Wind forecasts),

Transport

- Impact of winter conditions on transport (UK),
- Air, Rail, ... transport impacts (via forecasted Climate Conditions)

Winter conditions for UK Transport

Objective: to assess the potential skill for transport impacts forecasts using GloSea5 and UK transport data.

Stakeholder: UK Dept for Transport
(https://www.gov.uk/government/organisations/department-for-transport)

As recent years have demonstrated, wintry conditions have a significant impact on most forms of transport in the UK and Northern Europe. Airport closures, road accidents and delays/cancellations of train services are just some examples of the possible consequences of widespread snowfall over the British Isles. Recently it has been discovered that skilful predictions can be made of the likelihood of occurrence of cold air outbreaks in winter, at least times of weeks to months. The Met Office engaged with a transport...
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Selected prototypes and associated Impact forecasts

Land management tool

Objective: Enable land managers to make more weather-resilient decisions.

Stakeholder: Clinton Devon Estates  www.clintondevon.com

LEAP- Ethiopia’s National Food Security Early Warning System

Objectives: The prototype will enable the integration of seasonal weather forecasts into Ethiopia’s existing national food security early warning system, known as LEAP (Livelihoods, Early Assessment and Protection), to enable earlier and more accurate estimates of the people in need of food assistance in the coming months.

Stakeholders: World Food Programme (WFP)
http://www.wfp.org/disaster-risk-reduction/leap

Agriculture

- Land Management (UK)
- Winter Crop Cover planting (via forecasted Climate Conditions, especially Rain)

Health

- Livelihood Early Assessment and Protection (Ethiopia)
- Crops (via especially Rain and Drought monitoring and forecasting)

Clinton Devon Estates (CDE) is a major regional land owner in the South-West UK, with responsibility for 25,000 acres of land. Its areas of business cover farming, sustainable forestry, conservation management, deer management, commercial and residential property and businesses including the region’s premier equestrian venue. CDE’s decision making depends critically on-land and weather conditions, covering timescales from hours to decades.
Euporias Project

Selected prototypes and associated Impact forecasts

River Flow forecasts for water resource management in France

Objective: to provide relevant and tailored information leading to an effective decision for the water stock management for both the refilling and low-flow periods.

Stakeholder: EPTB Seine Grands Lacs : www.seinegrandslacs.fr
DREAL Midi-Pyrénées : www.midi-pyrenees.developpement-durable.gouv.fr

Downscaled near surface temperature and precipitation coming from the Météo France operational system for seasonal forecasting will feed the SIM suit (a refined SVAT model at an 8-km resolution coupled with a river flow routing module) to produce probabilistic forecast of river flows with different lead-times and for specific stations along the rivers. River flow forecasts are tailored to fit critical thresholds, for crucial seasons for which decision making processes are established.

Water Resource

- Low-Flow and Reservoir Refilling period management (MF)
- River-Flow and Soil Wetness Index forecasts (via Temperature and Rainfall forecasts)

Seasonal discharge multi-model forecast system

Objective: The objective of this prototype is to provide the hydropower industry with high quality discharge forecasts at the seasonal scale of to assist them in decision making and planning of operations.

Stakeholder: ELFORSK (www.elforsk.se)

This prototype is a multi-model seasonal forecast system for making ensemble stream flow predictions. The system will be implemented for the Angerman River in northern Sweden. The basin is Sweden's third largest by area, 31864 km², and the second largest by hydropower production with an average annual production of 6900 GWh.

Water Resource

- Hydro-Power (SMHI)
- River Discharge (via temperature and rainfall forecasts)
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Other case studies and associated Impact forecasts

Water Resources

- **Water management (Spain)**
  - Domestic water demand, Water resource, Dam management and Water supply
  - River Discharge (via Temperature, Rainfall and SSTs)

- **Inland Water Way network (Germany)**
  - Transport related and Drought early warning system
  - River Discharge and Water Level (via Temperature and Rainfall)

Agriculture

- **Vineyard production (Iberian Peninsula)**
  - Vineyard development, Biotic and Abiotic risks, Wine production and quality
  - Grapevine phenological cycle, Bioclimatic indices (mostly via Temperature, Rainfall)

Health

- **Human mortality (Europe)**
  - Climate related mortality
  - Mostly via Temperature and Humidity

Tourism

- **Winter Tourism management (French Alpin area)**
  - Ski resort activity
  - Snow falls and Snow level (via Temperature and Rainfall)
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Schematic representation of the MF Water resource prototype

- Tailoring the climate information to the needs of the DMPs of our stakeholders - critical thresholds and related risk assessment for decisions
- Conveying the probabilistic information up to the Decision Making Processes
- Running the DMPs in a retrospective mode (over the hindcast period) with 2 set of forecasts as proposed in the Placebo protocol
- Assessing the added value of the seasonal forecast, the impact of the use of the information onto the DMPs and the relative weight of the Climate Information within the DMPs (thanks to the Placebo protocol)

- Building the Climate Service prototype first tailored to our specific stakeholders and their DMPs
- Providing the Climate Service in operational mode using web based services and existing web plateforms (to be likely adapted) at Météo-France
- Extending the Climate Services across France, application domains (e.g. Energy, Agriculture) and potentially across Europe
Some Challenges
Some Challenges

Evaluation of Impact Forecasts

Evaluation of the impact probabilistic forecast

- Reference data (impact variables, …)
- Reference strategy (climatology, random atmospheric forcing, …)

Evaluation of the impact of the use of the information

- Demonstration of the impact of the use of the information onto the DMP: based on Placebo concept
  - Extension of the Placebo concept to the evaluation of the quality of the decisions made using DMPs: provision of 2 set of forecasts
  - Set 1: impact forecast using Atmospheric Seasonal Forecast forcing
  - Set 2: impact forecast using Random Atmospheric Forcing ("Placebo" like set of climate information) presented in the same fashion than the one used for impact seasonal forecast

- Stakeholders “replaying” (if possible) 30 years of decisions (blind method),
- Issuing a comprehensive analysis of the Decision made,
Some Challenges

Initialisation of impact models

Model Specific Requirements

- **Observed data**
  - Temperature, Precipitation, Snow, ...
  - Vegetation, River Discharge ...

- **Model data**
  - Soil Wetness, River Discharge ...
  - Energy Demand, ...

- **Climatology (from both observation or models)**
  - Spin up issues ...

Sector specific requirements

- **Agriculture**: crop development stage, carbon pools,
- **Water resource**: water stock (lakes, reservoirs, snow, ...)
Some Challenges

- Probabilistic forecasts / Multi-model ensemble
  - Using several atmospheric models
  - Using several downscaling methods
  - Using several impact models
    - Consistency of the different models
    - Impact model issues
    - Dual coupling (e.g. vegetation, …)
Some Challenges

- Downscaling needs and bias correction
  - Sensitivity of impact models to atmospheric forcing
    - Type of parameters to be downscaled
    - Impact of downscaled parameters onto model output
  - Bias correction
    - Atmospheric Seasonal Forecasts
    - Impact variables
Pathway Ahead
As a tentative conclusion

Provision of Climate Services tailored for Decision Making

- The products and associated uncertainty must be tailored to the targeted DMP
  - Relevant impact information (without forgetting vulnerability and exposure)
  - Critical decisional thresholds
  - Risk assessment

- The nature of the CS should depend on the capabilities of the stakeholder
  - Advanced vs basic stakeholders
  - Location of the information with respect of the DMP

- The provision of a support to stakeholders is crucial for the best possible use of tailored information
  - Organisation of the user support and associated technical resources
  - Capacity Building (dual/twin CB) and shared knowledge
  - Advanced vs basic stakeholders
As a tentative conclusion

A pathway toward Climate Service prototypes

Mutual Awareness/Education about the prototypes
- Presentation/discussion with the Stakeholders and corresponding Decision Bodies
- Understanding of the DMPs and their environment for decisions

Learning phase
- Run of the DMPs over a limited set of years (all the actors)
- Identification of potential limits and problems and possible corrections
- Feedback to the tailoring section

Development of the CS prototypes
- Addressing the delivery mechanism
- Tailoring the information
- Setting up the user support
- Designing the interface
- Preparing/planning the CB activities to build the necessary shared knowledge

Evaluation of the Added value in Decision Made (demonstration of the usefulness and value of CS)
Thank you for attending!

WMO Technical Conference on Climate Services – Building on CLIPS Legacy

World Meteorological Organization
Weather · Climate · Water

WCRP
World Climate Research Programme

DWD

METEO FRANCE
Toujours un temps d’avance
Placebo Protocol

**Method proposed to stakeholders**
- Provision of 2 set of hindcasts (set 1 and set 2),
- Set 1 and set 2 indistinguishable, used in blinded-like mode
- Years not in chronological order,
- Stakeholders “replaying” (if possible) 30 years of decisions,
- Issuing a comprehensive analysis of the Decision made,
  - Set 1, Set 2 and Past decisions
  - Note the need to define what is a “good” decision, a ”bad” decision and likely an “acceptable” decision

**Expected results**
- To assess the added value of the impact forecasts (vs random atmospheric forcing),
- To assess the impact of using impact forecasts on decision made,
- To assess to some extent the relative weight of CI into DMPs,
- To provide (if relevant) recipes usable to demonstrate the interest and the value of the provided Climate impact forecasts and beyond of the provided Climate Services.
Some Challenges

Reference Strategy

- Random Atmospheric Forcing - **Additional forecast**

- **9 Random IC**
  - SAFRAN
  - T and RR

- **SAFRAN Climatology** (cf. periods) for Wind, Humidity, Pressure, Radiation (IR + Global)

- **9 runs**

**ATMOSPHERIC FORCINGS**

- Period from 1958 to 2005 (ENSEMBLES) – 9 members
- Period from 1979 to 20012 (System3) – 9 or 11 members
Some Challenges

Comparison of skills between Hydro-SF (April IC) and RAF for River Flow forecasts

- **Spring**
  - Regions where Hydro-SF is significantly better than RAF
  - Regions where Hydro-SF is equivalent to RAF
  - Regions where RAF is significantly better than Hydro-SF

- **Summer**
  - Skills can significantly better for River Flow and SWI than for Temperature and Rainfall

(Ref: Singla et al. 2012)
Euporias Project

Selection of prototypes

- Application form documenting each prototype
  - Expected skill and implication in terms of the overall value to the stakeholder
  - Evidence of commitment, engagement and enthusiasm on the stakeholder side,
  - Evidence of how the prototype can inform stakeholder decision-making process
  - Understanding of the connection between climate driver and impacts,
  - Strategy for assessing the impact of the prototype on the decision made,
  - Proposal addressing sector, region or timescale otherwise underrepresented
  - How other prototypes can be generated on the back of the proposed one,
  - Promotion of wide coordination/collaboration across partners in the project,
  - Exportability to other regions and sectors,
  - Sustainability after the end of the project
Météo-France Prototype

Management of the Reservoirs

Flood control

## Météo-France Prototype

### Management of the Low Flow period

**Bilan hydrologique sur la période 2001-2012 (efficacité du soutien d’étiage)**

<table>
<thead>
<tr>
<th>Location</th>
<th>Annee satisfait</th>
<th>Année non satisfait</th>
</tr>
</thead>
<tbody>
<tr>
<td>À Portet-sur-Garonne</td>
<td></td>
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<tr>
<td>À Lamagistère</td>
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<tr>
<td>À Tonneins</td>
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**Bilan hydrologique 2012, avec et sans soutien d’étiage, à Portet-sur-Garonne**

<table>
<thead>
<tr>
<th>Period</th>
<th>Debit measured</th>
<th>Debit without support</th>
<th>Support benefit</th>
<th>Q Alert reinforced</th>
<th>DCR</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>q1 m/s</td>
<td>q2 m/s</td>
<td>q3 m/s</td>
<td>q4 m/s</td>
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**Débits à Portet-sur-Garonne du 1er juin au 31 octobre 2012**

- Values habituelles pour la période
- Total 29 m³/s

**Source:** Smeay 2010 "Soutien d’étiage"
Some issues for Adaptation

- Downscaling challenge: from 2°5 to 8 km

Interpolation on SYMPOSIUM zones

Interpolation 1/r² Distance

Vertical Gradient (Simulation 1)
T: -0.65 °K/100m
Rain: +0.7 à 2 mm/year/1m

Cumulated rain in mm over March-April-May 1998

Interpolation on ISBA mesh - 8km