WORLD METEOROLOGICAL ORGANIZATION

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JOINT MEETING

RA I DISSEMINATION EXPERT GROUP

RA I CLIMATE SERVICES AND ADAPTATION GROUP

GENEVA, SWITZERLAND

18-19 APRIL 2017

FINAL REPORT

Regulation 42

Recommendations of working groups shall have no status within the Organization until they have been approved by the responsible constituent body. In the case of joint working groups the recommendations must be concurred with by the presidents of the constituent bodies concerned before being submitted to the designated constituent body.

Regulation 43

In the case of a recommendation made by a working group between sessions of the responsible constituent body, either in a session of a working group or by correspondence, the president of the body may, as an exceptional measure, approve the recommendation of behalf of the constituent body when the matter is, in his opinion, urgent and does not appear to imply new obligations for Members. He may then submit this recommendation for adoption by the Executive Council or to the President of the Organization for action in accordance with Regulation 9(5).

EXECUTIVE SUMMARY

Access to high-quality hydro meteorological and climate data is fundamental for developing services to key economical sectors in Africa, like agriculture, water management, energy, transportation etc. Currently EUMETSAT is disseminating near real-time satellite data and products in Africa through EUMETCast-Africa, a multi-service dissemination system based on multicast technology (using Digital Video Broadcast, similar to satellite television). Already a significant amount of existing data and products disseminated through EUMETCast-Africa can serve the needs of users of climate sensitive sectors, however additional data and products could be made available through the same dissemination system, as well as through the internet and other means.

With the aim to identify which climate-services relevant data and products among those produced at the International Centers - gridded data such as those coming from ECMWF, Copernicus Services and EUMETSAT- can be used by the NMHSs in RA I to deliver national and regional climate services, WMO and EUMETSAT convened an experts meeting in WMO Headquarters on 18-19 April 2017. The participants of the meeting were the members of the RA I Dissemination Experts Group and members of the RA I Climate Services and Adaptation Working Groups. Both entities are serving WMO observations and climate programmes respectively and this event provided the opportunity to jointly meet for the first time.

Participants clearly identified datasets and products that could be useful for decision support across ten application areas (see table on pp 10-20). Moreover some of these datasets and products can be made accessible by the International Data Centers through existing delivery mechanisms. Some specific recommendations were put forward on additional and most appropriate data delivery mechanisms, as well as on the required infrastructure, training and other support that would enable the NHMSs to receive and process the data, and to deliver user-oriented climate information.

These main findings will be communicated to EUMETSAT Council for considering the inclusion of additional datasets in the EUMETCast-Africa broadcast, as well as will inform the Copernicus Climate Change Service (C3S) and the GFCS for guiding the implementation of climate services in RA I and potentially in other regions.

WMO and EUMETSAT, together, will explore potential opportunities for supporting the required infrastructure, software and capacity development in order to enhance the climate services delivery at regional and national level in Africa.

1. OPENING

E. Charpentier opened the meeting on behalf of the Director of the WMO Department for Observing and Information Systems, praised the group for pursuing very concrete objectives as the delivery of climate datasets in support of services responding to user requirements in RA-I. This responds to priorities of WMO and the recent drive towards deliverables and performance indicators.

M. Dilley, (Director of the Climate Prediction and Adaptation Branch of the WMO Climate and Water Department) stressed that there is a large amount of climate information with global coverage that can be very useful to deliver climate services including in RA-I. However there are a number of barriers, such as physical access to data, responding effectively to requirements, adding value to data depending on each country's needs. It is expected that the recommendations from the meeting will be considered by the EUMETSAT governing bodies, with a view to distribute climate datasets to Members in RA-I according to identified requirements and to potential donors with the aim to put in place specific activities to overcome the identified barriers.

V. Gabaglio (EUMETSAT) highlighted the value of RAIDEG for EUMETSAT as the interface discuss users needs in Africa. The EUMETCast-Africa baseline not only includes satellite data, but also model output from global NWP centres (e.g. UKMO, MeteoFrance, DWD, NCEP) and other data. Since 2010, RAIDEG has been the forum to identify requirements, as well as to show what is available and how to use it. Regarding climate services and in view of the mid-term review of GFCS, the value of RAIDEG should be leveraged to effectively deliver climate datasets to African users. EUMETSAT considers it valuable that RAIDEG and the RA-I CSA join forces to this end. Awareness and access to data are the first steps for delivering services in climate-sensitive sectors such as agriculture and water resource management, much like for weather and DRR applications. Several donors including in Europe are interested in supporting the delivery of climate services in RA-I.

WMO Secretary-General, Petteri Taalas, reminded participants that swift and tangible action is required to help GFCS implementation in Africa. He was pleased to find that the objectives of the meeting are addressing such an action. He expressed his appreciation with the long-standing EUMETSAT support to RA-I. He mentioned that WMO is contributing to an EU programme that will mobilize 100m€ in support of climate services in ACP countries. Other sources of funding for climate adaptation and mitigation can potentially be mobilized with the World Bank and the Green Climate Fund. Proposals have been put into all these mechanisms. The CREWS initiative will also contribute to support climate services in Africa as well as in other regions.
Key to climate services is data access and capacity to analyse the information generated by Copernicus Climate Change Service (C3S), U.S., China and other providers and tailor it to user requirements. The Regional Climate Centres will have a central role in supporting national priorities. He noted that many countries preferred receiving data and information directly from global sources, and not necessarily via a Regional Centre.

Participants introduced themselves in a tour-de-table, the list of participants is provided in Appendix I.

2. ADOPTION OF AGENDA

The Agenda (see Appendix II) was adopted with no modifications.

3. SUMMARY OF ACTIVITIES IN COUNTRIES / SUB-REGIONS AND INFORMATION REQUIREMENTS

The members of the RA I Climate Services and Adaptation Working Group were asked to collect information from the NMHSs in Africa and present a summary of the key climate services that are already provided and those that have been already identified as needed at national and regional level. Each of the five members presented a summary of the African subregion that he/she represents. By following the schema of the Climate Services Information System (CSIS) in figure 1, the presenters reviewed the current status of the climate services provision and identified those services that are likely/desirable to be delivered in the future. Subsequently the presenters listed the data required to maintain/improve the current service delivery and those needed to be available for the enhanced climate services. Figure 2 schematically represents the information cascade from users needs to data and products delivery.
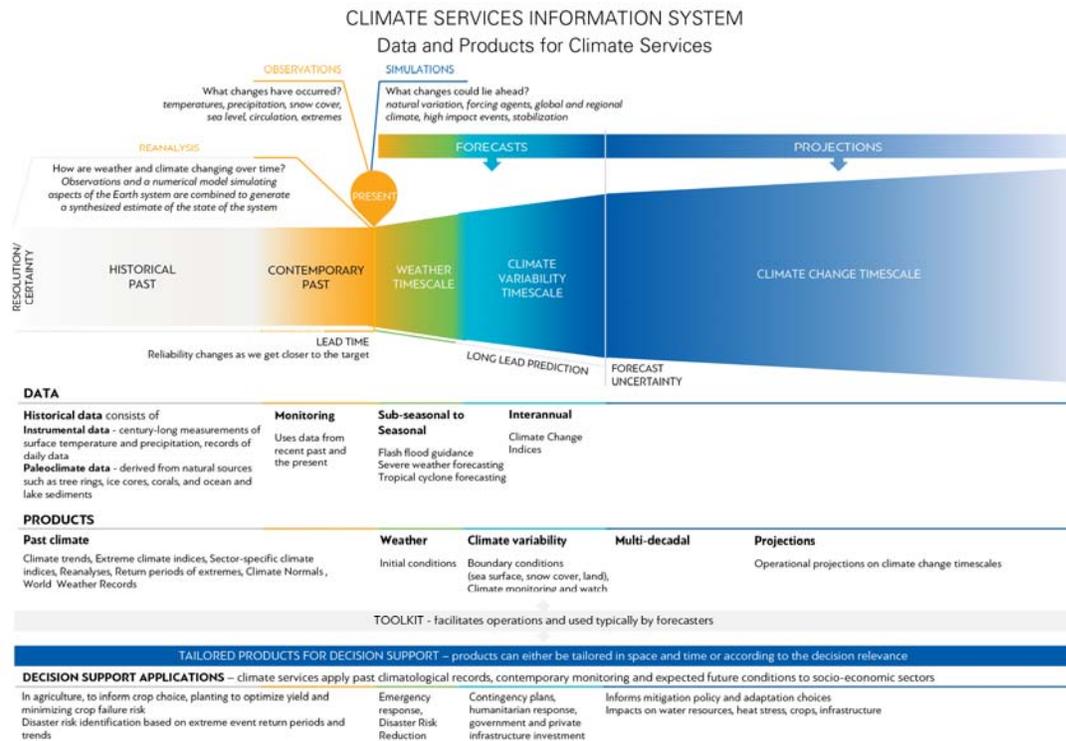
CLIMATE SERVICES INFORMATION SYSTEM
Data and Products for Climate Services

OBSERVATIONS
What changes have occurred?
temperatures, precipitation, snow cover, sea level, circulation, extremes

SIMULATIONS
What changes could lie ahead?
natural variation, forcing agents, global and regional climate, high impact events, stabilization

REANALYSIS
How are weather and climate changing over time?
Observations and a numerical model simulating aspects of the Earth system are combined to generate a synthesized estimate of the state of the system

PRESENT

FORECASTS

PROJECTIONS

RESOLUTION/CERTAINTY

| HISTORICAL PAST | CONTEMPORARY PAST | WEATHER TIMESCALE | CLIMATE VARIABILITY TIMESCALE | CLIMATE CHANGE TIMESCALE |

LEAD TIME
Reliability changes as we get closer to the target

LONG LEAD PREDICTION

FORECAST UNCERTAINTY

DATA

Historical data consists of
Instrumental data - century-long measurements of surface temperature and precipitation, records of daily data
Paleoclimate data - derived from natural sources such as tree rings, ice cores, corals, and ocean and lake sediments

Monitoring
Uses data from recent past and the present

Sub-seasonal to Seasonal
Flash flood guidance
Severe weather forecasting
Tropical cyclone forecasting

Interannual
Climate Change Indices

PRODUCTS

Past climate
Climate trends, Extreme climate indices, Sector-specific climate indices, Reanalyses, Return periods of extremes, Climate Normals, World Weather Records

Weather
Initial conditions

Climate variability
Boundary conditions (sea surface, snow cover, land), Climate monitoring and watch

Multi-decadal

Projections
Operational projections on climate change timescales

TOOLKIT - facilitates operations and used typically by forecasters

TAILORED PRODUCTS FOR DECISION SUPPORT – products can either be tailored in space and time or according to the decision relevance

DECISION SUPPORT APPLICATIONS – climate services apply past climatological records, contemporary monitoring and expected future conditions to socio-economic sectors

In agriculture, to inform crop choice, planting to optimize yield and minimizing crop failure risk
Disaster risk identification based on extreme event return periods and trends

Emergency response, Disaster Risk Reduction

Contingency plans, humanitarian response, government and private infrastructure investment

Informs mitigation policy and adaptation choices
Impacts on water resources, heat stress, crops, infrastructure

Figure 1: Schematic representation of the types of climate data and products required for climate services

User Requirements Related to Climate Services
Users needs in terms of:
- New data and products
- Dissemination requirements

Users feedback

Processing chain
- Reception
- Curating
- Processing / merging
- Modelling / statistics
- Producing products
- Visualising
- Disseminate

RCC

Processing chain
- Reception
- Curating
- Processing / merging
- Modelling / statistics
- Producing products
- Visualising
- Disseminate

National service

Regularly updated data and Products: [1]
- Continuation of time series (point, area, volume)
  - Analyses
  - Satellite / remote
  - In-situ observations
- Social data

Background / baseline data and Products: [2]
- Climatologies / Atlases
- Long time series (point, area, volume)
  - Reanalyses
  - Satellite / remote
  - In-situ observations
- Social data

Data Delivery

Regional User
Government / Business

User
Government / Business

Society

Training Activities:
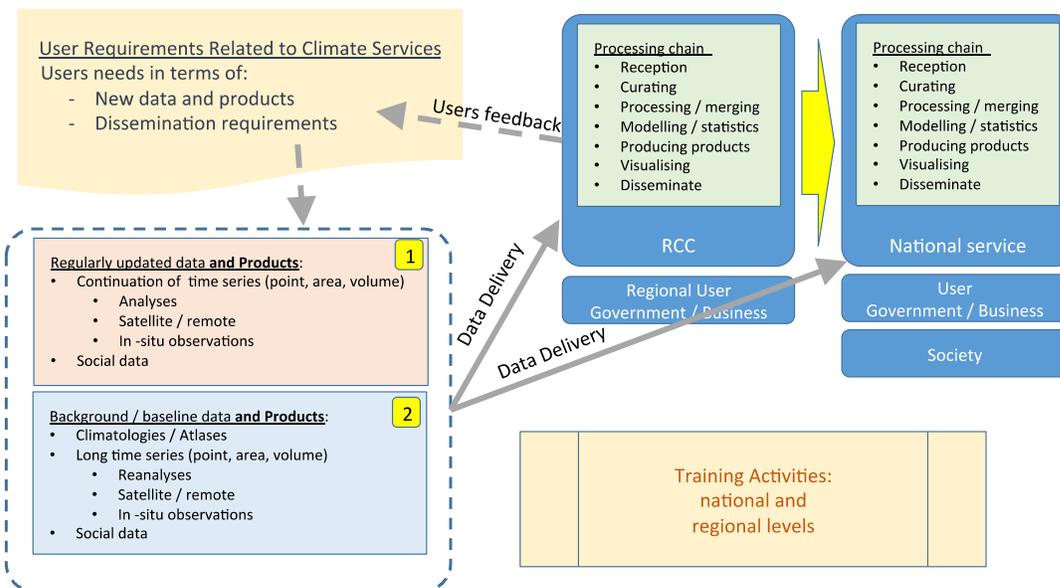national and
regional levels

Figure 2: Schematic cycle of data/products generation, dissemination, uptake for climate services

3.1 Eastern Africa – Tsegaye Ketema (Ethiopian Met Service) presented results only for Ethiopia because the other countries in the sub-region did not send their responses in time for the meeting. At present NMA of Ethiopia provides agromet, hydromet and biomet services for different socio-economic sectors. Monitoring and forecasting of agricultural products, including livestock, was identified as a need not yet delivered. NMA is currently updating the GeonetCast infrastructure for monitoring different environmental conditions. The 1kmx1km

Digital NDVI data is being processed every ten days and disseminated to insurance companies for premium payouts on crop insurance.

The current data requirements for the services delivery is:

- ECMWF high-resolution model for short-range forecasting
- Landsat 7/8, Sentinel 1 for surface water
- SMOS, ASCAT, CCI real-time, Sentinel 1, SMAP for topsoil moisture
- MODIS, Sentinel 1/2, existing land-cover maps for vegetation mapping
- Sentinel 2/3, SPOT-vegetation, GEOV1, PROBA-V, Fluorescence for vegetation state

Additional data required are:

- Evapotranspiration (ET) and vegetation state data for vegetation water stress
- TAMSAT, RFI, ERC, CHIPS, IMERG for rainfall
- MOD16, GLEAM, MTE, ECMWF, Landsat for ET products
- Rangeland mapping and livestock mapping

3.2 Central Africa – Wilfrid Serge Likeba (Congo-Brazzaville) gave an overview of national-level needs for the central Africa sub-region. Currently the NMHSs deliver hydromet information derived from Weather and seasonal Forecasts, short-term Agromet forecast (10 days), climate monitoring, historic climate data for the following services:

- Forecasting of lowest water level for navigation on Oubangui river
- Date of beginning and end of rainfall seasons
- Monitoring of temperature related to seasonal diseases (meningitis, hypertension, …)

New needs have been identified at national level that will be addressed in the immediate future :

- Malaria alerts
- CLIMSOFT data management
- Forecast schedule of sowing dates
- Vegetation cover
- Bush fire
- Forecast of water heights for river navigation

Data requirements for maintaining the current service delivery is:

- Climate observations data
- Riverflow and water depth data
- El-Nino outlook
- Sea surface temperature

Improvements in forecast skill as well as the modernization of the observational network will provide a better service in the next four years. In this time horizon the NMHSs aspire to increase their services to the communities and be able to deliver:

- Agromet forecasts, from short-term to seasonal, including climatic monitoring
- Seasonal forecast for health
- Climate monitoring, seasonal forecast, and vigilance maps for DRR
- Urbanization and urban expansion.

At regional level ACMAD issues a seasonal forecast bulletin for the whole Africa continent and manages the regional climate data network. For the next few years a regular PRESAC (seasonal forecast for central Africa) is desirable by each of the countries covered, as well as climatological atlases and long-term climate projections (2030, 2050). Data required for future developments are the same data as at national level plus impact data for DRR, economic impact data, water resources data.

3.3 Western Africa – Pascal Yaka (Burkina Faso) summarized the input received from 13 countries in the sub-region. Key climate products that are currently provided by the NMHSs or responsible organization include:

- Daily temperature and rainfall charts
- Seasonal temperature and rainfall
- Monthly outlook of climatology bulletin
- 10-days agro-hydro-meteorological bulletin for crops fields management
- Onset- mid- and end crops yield assessment bulletin
- Marine forecast for fisheries
- Daily technical assistance to end users for climate sensitive sectors
- Climate data for research and education
- Climate information for media
- Solar radiation, potential ET and dry spell periods
- Early warnings (alert) of extreme weather events

New products that are needed now but not yet available:
- Rainfall estimation
- Cloudiness
- Short- and long-wave radiation
- ET and water balance
- Vegetation status (NDVI, SAVAT)
- Forest fire risk indexes
- Soil moisture
- Cloud mask
- Land use
- Heat waves and impacts on health
- Air pollution level
- Water for pastures and livestock
- Environmental management and protection
- Climatological atlases
- Climate projections
- Climate index for insurance

New capabilities that could be available over the next four years:
- Downscaling weather and climate products at subnational scale
- Sector-specific forecast for: energy, health, DRR, water and agriculture/fisheries
- Modernization of observing system (AWS)
- Improvement of technical and human capacity
- Commercialization and marketing of climate services
- Climate projections

Data requirements:
- Lightning
- Fog and haze
- Wind velocity and direction
- Rainfall intensity and frequency
- Humidity and temperature
- Solar radiation
- Air pollution
- Extreme weather forecasts.

3.4 Regional Africa – Pascal Yaka (Burkina Faso) explained that the RCCs provide products based on the operational long-range forecasts (LRF) generated at the Global Producing Centers

(GPC). Seasonal climate outlook and consensus statements on regional and subregional forecast are a few of the RCC products and services. Moreover, RCCs provide operational support for climate monitoring and data archiving. RCCs offer training for using their products and services. Several areas for improvements have been identified for providing better services both at short- and long-term:

- training on gridding station data and blending in situ and satellite obs
- Data sharing and accessibility
- Platform for climate information dissemination
- Data rescue
- Development of Climate Data Management System (CDMS)
- High-resolution regional climate change projections
- Strengthening the capacity of NMHSs in downscaling and climate services
- Strong collaboration with GPCs to improve forecast skill in Africa
- Implementation of IGAD strategy
- Engaging users at RCOFs
- Producing prototype climate services (PCSs)
- Generation of climate change scenarios.

Data needs:

- Dataset of insitu precipitation, temperature and wind
- Gridded dataset from satellites
- Climate scenarios
- Crop and cropping area data
- Soil and ET data
- Temperature and rainfall at 25km resolution
- Bias corrected precipitation forecast at 3hr time resolution and 10 days lead time

3.5 Land Agriculture specific example from AGRYMET (Jose Camacho)

The METAGRI OPS (Operational) project was launched by WMO in 2012 with the objectives to improve the performance of the Roving Seminars and to develop new components like training, development of communication, feedback and evaluation tools, and institutional strengthening. Especially for the development of operational and training tools METAGRI has planned several training activities with AGRHYMET:

- New version of SARRA-H model for agricultural campaign monitoring
- INSTAT+ software for the computation of onset and cessation dazes of rainy season, duration of dry spells
- QGIS software
- Installation and training of CLIMSOFT database management software
- Methods of forecasting the agroclimatic characteristics of the rainy season
- Training in remote sensing products for agrometeorology, vegetation indices, rainfall estimation, PET, solar radiation.

Several activities will be carried out for improving the performance and reliability of the agromet tools and services, especially in the area of optimally integrating datasets, validation and evaluation of datasets, regional atlases of agricultural parameters.

3.6 Discussion

Members of the audience made some general comments on the subregional presentations:

- More collaboration is needed among the countries in Central Africa given that there is no functional RCC in this subregion
- Roles and relationship between regional and national levels need to be better understood
- Energy sector demands need to be better represented in data requirements
- Research on data analysis and integration for generation of skillful products is a key requirement
- Need for guidelines and standardized methodologies for using the global datasets should be addressed in order to avoid fragmentation of efforts
- Communication and awareness raising campaigns should be integrated in the climate services activities.

4. CURRENT DATA DISSEMINATION AND ARCHITECTURE

4.1 Copernicus Climate Change Services (C3S) Climate Data Store (CDS) (Mark Higgins)

The European Copernicus Climate Change Service (C3S) climate data store is still in its development phase. It will be a platform enabling unified and consistent access to climate data:
- Global estimates of ECVs from satellite and insitu observations
- Reprocessed climate data records, reference observations
- Data rescue and climate data collection
- Climate reanalysis
- Multi-model seasonal forecast products
- Access to CMIP data and products (both global and regional)

The C3S is also creating a User Requirement Data Base for collecting feedbacks from users. A mechanism to capture RA-I user requirements and feedback vis-a-vis C3S will be important for data delivery improvement.

4.2 Current EUMETCast-Africa baseline (Mark Higgins and Christine Träger-Chatterjee)

A typical EUMETCast reception station comprises a standard PC, a DVB reception device (internal or external), and a satellite off-set antenna fitted with a digital universal V/H LNB for Ku-band, or fitted with a circular polarisation feedhorn, bandpass filter and special LNB for C-band. To decode and decrypt the EUMETCast data stream, the EUMETCast client software and the EUMETCast key unit is required. For data processing and visualization, software applications are available commercially. The system is designed for near real-time access to data that requires frequent updates, the full list of all products available on EUMETCast can be found at: navigator.eumetsat.int

RAIDEG is acting as the advisory group for EUMETCast Africa and should be the mechanism for the RA-I to set priorities about what could be added in EUMETCast-Africa system (2.7Mbit/s bandwidth). When it comes to climate data, RCCs can have a role in assessing the fitness-for-purpose of the disseminated products and thus RCC representative and RAIDEG members should work hand-in-hand (ACMAD is representing RA-I RCC in RAIDEG).
The Atmospheric, Marine and Land products currently available in EUMETCast-Africa are listed in Appendix III.

During the previous RAIDEG meeting, the inclusion of EUMETSAT Climate Monitoring SAF products on EUMETCast Africa was discussed, and two products (out of 4 requested) have already been added to the dissemination baseline.

Satellite-based estimates of river level are available in research mode from http://www.legos.obs-mip.fr/soa/hydrologie/hydroweb/Page_2.html. This prodcuts will be soon available as operational products as part of Copernicus (Land or Marine service).

5. BREAK-OUT GROUPS AND RESULTS

Breakout groups were formed in order to define a comprehensive list of users of climate information and subsequently to identify the data needed in support of their decision processes. The first exercise focused in grouping the climate users and data needs in each African subregion – building on the morning presentations. The second exercise focused on the high-priority climate sensitive sectors, with the aim to consolidate a refined list of user-oriented climate data and products. In the second exercise the groups were asked to further identify areas in need of implementation support (barriers in data access, need of processing, visualization tools, increase of capacity etc..). Access to PUMA/MESA infrastructure and training on standardize tools for analysis and products, such as the GeoNetCast toolbox[1], was recognized as needed for every climate service in the list. The results of the work of the breakout groups is summarized in the table immediately below. A synthesis of the types of data and products needed across all sectors, drawn from the table, is provided in Appendix VI

User	Decision	Data	Areas in need of implementation support[2]
Energy			
electrical utility - public or private company	energy sources management planning and operation of energy production and consumption avoiding power shortage	Short-term (hours / days) to seasonal forecast (temperature, wind, solar, precipitation) both for demand and supply at 5km resolution. Extreme forecast index (EFI) at kilometric scale (ECMWF) Nowcasting for hourly scale Extreme indices	Capacity Building Training the producers Training of product users Communication for operalization Downscaling any of the parameters from regional models to local scale
Energy generators managers: Hydro power,	normal operations risk management	Streamflow prediction (short term and seasonal) Rainfall-runoff relationship	

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[1] https://www.itc.nl/Pub/WRS/WRS-GEONETCast/GEONETCast-toolbox.html
[2] e.g.: gaps in data access, processing, visualization, tools, capacity (human, technical), sub-regional or country-level, national awareness

User	Decision	Data	Areas in need of implementation support[2]
Solar and wind power plants (local off grid or large scale)	Maintenance Investment planning	(dam levels), RFE for catchment extreme event occurrence and intensity solar radiation, wind speed and direction, cloud coverage seasonal temperature and precipitation forecast 50m, 100m wind speeds& direction, solar potential climatologies, for renewable resources assessment	
Ministry of Energy. Government	Energy and climate mitigation strategies assessment of renewable energy potentials Energy reliability, pricing and policy	climate projections / scenarios climatologies of temperature, precipitation, solar radiation and wind speed and direction short-term (hours / days) to seasonal forecast (temperature, wind, solar, precipitation) both for demand and supply	
Water			
Governments	Planning of water storage, restrictions Policies and regulations Sensibilization campaign	Seasonal 3-months forecast in (sub)catchment area at (ideally) 5km resolution (rainfall, temperature, ET, wind) updated every month. 10-days monitoring (precipitation, 10m wind, 2m temperature)	Capacity building ; integrating forecast from global centres with local/regional data and experience Request for monthly forecasts

User	Decision	Data	Areas in need of implementation support[2]
		at (ideally) 5 km resolution	
Water distribution / provision managers	shortage management, restrictions and maintenance	10-day monitoring and Short-term forecast (2m temperature) Rolling seasonal forecasts, updated monthly at (ideally) 5km Drought indices (Standardize Precipitation Index, SPI) at (ideally) 1km resolution every 1,3,6 and 12 months Climatology of river discharge and regular monitoring (10-days) aggregated water level in the reservoirs	Capacity building - Processing and visualization tools - Communication skills - Mechanism to ensure the use of available products Climatology of river discharge and regular monitoring (10-days)
river basin authority	prioritization of water resources usage	streamflow prediction, seasonal and short-term forecasting (rainfall, temperature, ET, soil moisture) Extreme event (flooding)	
sanitation infrastructure (Designing and Maintenance)	operation and maintenance of sanitation infrastructure Management of sanitation planning	Extreme event forecast and climatology (2 m temperature, rainfall, 10m wind) Short-term forecast, daily forecast (2m Temperature, rainfall, 10m wind) Digital Elevation Model	
Agriculture			
Farmer	Sowing dates, seed	Seasonal forecast	downscaled forecasts (high

User	Decision	Data	Areas in need of implementation support[2]
	choice, fertilization planning, irrigation, pest control	forecast of the start of the rainy season, intra-season dry/wet spell forecasts, 10-day rainfall monitoring, monthly monitoring (all variables), ET forecast, forecast of soil temperature, soil moisture monitoring and forecasts Vegetation monitoring and forecast Extremes events forecast Forecast of pests distribution (wind, for desert locusts) Harvest time Crop yield Climatology Onset / cessation of rainfall season (Temporal and spatial coverage) Extreme values in temperature (min/max)	spatial resolution for specific agro-ecological zones) onset/cessation forecasts Intra- seasonal dry/wet spell forecasts soil moisture observing equipment; monitoring and forecasting ENACTS running locally with TAMSAT feed and integration of local rainfall observations Crop models (weather, climate and NDVI) Bulletins/text messages to communicate data/advice to farmers through extension, development agents and community radios
Crop estimation group/Groupe de Travail Pluri-Disciplinaire	provide analysis to ministries on season and its progress	meteorological data, crop data, land use data, Reanalysis on temp, rainfall, winds, ET Rolling seasonal forecasts (3-months), updated monthly	Downscaling products Assistance in interpreting locally downscaled model outputs and other outputs

User	Decision	Data	Areas in need of implementation support[2]
		Updates every 10-days in case of dry spells

Prediction of vegetation state / Normalized Differential Vegetation Index (NDVI); Dry-matter index, Crop pest and disease

Crop yield forecasts

Drought and Water stress indices | |
| Ministries (Agriculture, Industry, Economy, Power) | To warn or not, import or not, mitigate food shortage

Agricultural planning | Same as farmers (see above) seasonal forecast, crop estimation forecasts, season monitoring relative to crops and livestock lifecycle, alerts | Same as farmers

Briefing materials (for visualization) |
| Extension services (people who provide advice) | Provide good advice to producers | Same as farmers (see above) Climatologies of agro-ecological zones (moisture, precip, radiation, 2m temp, humidity)

seed and fertilizer availability, market information | |
Commercial (Seed/fertilizer producers/importers)	What cultivars to sell and what price	Seasonal forecast and season progression of market conditions	
Public	Make economic choices at household level, livelihood choices	Forecasts at all timescales and season progression	
Pest forecasting / control / mitigation			Existing WMO - FAO publication
Livestock			
pastoralists	Types and	seasonal forecast of	downscaled forecast

User	Decision	Data	Areas in need of implementation support[2]
livestocks technicians and planners	numbers (of animals to breed	temperature, humidity and rainfall	
pastoralists livestocks technicians and planners	areas to graze and decision for nomadism Protection of livestock from diseases	small water bodies monitoring and forecast vegetation and rainfall monitoring and forecast, ET monitoring and forecasting if available extreme weather forecast	Rangeland mapping small water bodies visualisation (particularly outside eastern Africa)
government	livelihood in some arid region (e.g. Sahel)	5-10 years prediction of rainfall pattern	downscaled forecasts awareness/sensitisation of decision makers
Fisheries			
Fisheries local committees and fishermen	Guidance to fishermen Managing of fishing grounds	Potentially improvements of existing Sea Surface Temperature (SST) and ocean colour products Algal bloom marine forecasting and early warning (wave height, swells, winds, visibility) phytoplankton and chlorophyll, coastal SST and forecasts, sea salinity, marine currents (upwelling)	Training NMHS technicians on interpretation of products, marine modeling and forecasting Training staff from the ministry of fisheries about interpretation of information provided SMS/voice alerts Lake level forecasts to protect property
Ministry for fisheries	protect resources planning	All of the above seasonal SST monitoring and forecast	Training NMHS technicians on interpretation of products, marine modeling and forecasting Training staff from the ministry of fisheries about interpretation of information provided downscaled SST forecast
Health			
Health	sensibilisation	Seasonal forecast	**Gaps :**

User	Decision	Data	Areas in need of implementation support[2]
authorities / Ministry of public health	(public campaign), health planning (para-)medicine stock management)	(rainfall, humidity, temperature Seasonal forecast (3 months - 8 months) **Frequency**: Monthly **Spatial Resolution**: 25-50 km (currently produced spatial resolution) heat wave forecast (or cold spell), UV index short to medium term Temperature forecast Humidity forecast Cloud Cover Forecast ET Frequency: 2 x day Spatial Res: < 16 Km Lead time: 2-3 days Consider ACMAD Monthly Bulletin Cloud Climatology - Useful for research purposes	1. National Awareness of specific products on EUMETCast and WMO GPC-web a). NDVI, Rel Humidity.and other parameters. b)Training on the interpretation of seasonal forecasts (probabilistic forecasts). 2.West and Central Africa -Lack of relevant products such as specific forecasts for short and medium range (2-10 days.) 3. Lack of heat wave bulletins in Central & Western Africa. 4. Health impact models and training in biometeorology **1.1.1.1.1 General Challenges:** 1. National level -Access to gridded data 2. Station data coverage 3. Extended Range forecasts (11-30 days) will be relevant to health sector (area of continuing research)
Malaria: Warning forecasting team **Meningitis:** Warning authority (national civil contingencies or health) Vector borne diseases, water borne disease and air borne diseases warning authority Animal	Bring together data (weather and socio-economic) and generate a forecast To warn or not What information to cascade to hospitals / health workers, public, private enterprise ...and national actions (spraying, distribution of mosquito nets)	Malaria risk mapping, seasonal monitoring and forecasting and environmental monitoring (eg. ENACTS product), modelling and forecasting (agriculture, soil moisture) malaria case history **1.Risk Map Products:** Based on Meteorological parameters (Checklist) -to include	Gaps in ENACTS product for Mozambique, Zimbabwe, Botswana, Malawi, Somalia; Gaps for Central and West Africa Existing ENACTS products used in Ethiopia, Kenya, these require additional data on relative humidity; and other data such as socioeconomic records from hospitals Source of Verification of health related monitoring and forecasts. 1. Lack of awareness that NMS can provide forecast on malaria related parameters. 2. Lack of interpretation and integration of data to

User	Decision	Data	Areas in need of implementation support[2]
diseases (rift valley fever, east coast fever, anthrax, foot and mouth etc..) warning authority Health Ministry / Authorities		humidity forecast in combination with rainfall , temperature. Dust, haze, intensity of solar radiation, surface wind and humidity, monitoring and forecast **Frequency:** Daily **Spatial resolution:** < 16 km Ideally 1-10 km **Lead time:** 3 - 10 day ahead Seasonal forecast (Rainfall, Temperature, Humidity) Forecast from forecasting /warning team Warning, malaria and meningitis prevalence, prevalence are affected, impact forecast Their action plans (which get developed in partnership with the warning team or some each base). Requirements to reports	produce a "Malaria Warning Index" - no such product available 3. Lack of interpretation and integration of data to produce a "Meningitis Warning Index" - no such product available Lack of action plans and integration of institutions affected **Solution:** Training end users Existing FAO publication
(Air quality, Dust events) Ministry of Environment, Ministry of Health	Monitoring air pollution and issue warnings related to hazards for human health and livelihoods (respiratory diseases) Mitigation action (emission control and reduction, traffic regulation,	Particulate matter, ash from biomass burning, aerosol optical depth near surface; near-ground concentration of ozone, SO2, NO2, VOCs, UV index Emission sources and sinks, emission inventory data Air Quality Forecasts Frequency: Daily	Access to gridded dust monitoring and forecasting product from SDS-WAS Barcelona (not just png) (ACMAD) Lack of awareness of monitoring capacity on air pollution and dust Air quality and dispersion modelling Monitoring product on smoke

User	Decision	Data	Areas in need of implementation support[2]
	policies on car imports, ...) Meningitis warnings	Spatial Resolution: Same as NWP models Dust events and transport (daily) Dust products from EUMETCast (CAMS) Copernicus Atmospheric Monitoring System	and ash due to biomass burning (Southern and Central Africa) Lack of ground-based equipment to monitor atmospheric composition and air quality Mobile air pollution detectors
Disaster Risk Reduction			
(hydro meteorological hazards) Civil protection Ministry of interior Ministry of planification	preparation, response, recovery and mitigation planning, prevention, early warning systems	extreme events forecast (wind, rainfall, thunderstorm/flash flood, drought, lightning, temperature, sand & dust storms, swells) early warning/ seasonal forecast (preparation) Nowcasting & Very Short Range Forecasts: (0-12 hours) Climate forecast up to 5 years: flooded areas mapping (for mitigation) **Frequency**: 1 x per annum **Spatial Resolution:** Climate model (200km) mapping of flood-prone areas (for adaptation) requiring soil type, soil moisture, terrain model, rainfall patterns, runoff response (daily	**GAP:** SWFDP products for West Africa. - already implemented in Southern and East Africa. -Lack of weather radars NOTE: 1.Area of Research RDT product from Nowcasting - SAF. **General Gaps:** 2. Communication structures of warning messages- whether it reaches the intended end user. 3. Coordination with Disaster Risk Reduction structures. Lack of multimodel forecast analysis (Ensemble Predictions). Solution - Training . **NOTE:** Annual and Inter Annual models -still an area of research Lack of weather radar systems in Africa for monitoring extreme events

User	Decision	Data	Areas in need of implementation support[2]
		forecast) Pre-flood research to be conducted: **Product:** Climate Data Soil moisture data :daily-weekly, monthly	
(Fire management) Ministry of forestry Technicians of environmental management	Early preparedness (fire hazard warnings), bushfire management	extreme temperature and extreme low humidity monitoring (10 days) and forecast (daily to seasonal), lightning (ATDNet). **1.Product : Fire Danger Index (FDI)** Parameters required: Temp, etc. + NDVI. Temporal Frequency : Daily Product Spatial Resolution: <4 km **2. Active Fire Monitoring :** EUMETCast Fire Product Real-time product (every 15 minutes): MESA- AFIS Fire Product	**Gaps:** 1.Training on utilising product. 2. Monitoring tools at areas of decision making
Infrastructure			
Urban and rural planning authorities, Construction and engineering sector Ministries, government	type of buildings and infrastructure (bridges, roads, railways) Where and when to build, infrastructure management Planning (resilience, etc)	Wind speed and direction, temperature, precipitation climatologies **Climatological data:** Parameters: Temp, Rainfall, Wind, etc. Temporal scale: 30 year dataset	GAPS: Lack of awareness of user community what NMS can provide Training on elaboration of data and its impact on structures. Data gaps in areas of construction: Reanalysis could help; training on interpretation of

User	Decision	Data	Areas in need of implementation support[2]
		Return periods of extreme events Decadal (10 years, even 5 years) climate predictions	reanalysis needed Downscaled projections at local scale and capacity building
Transport			
Transport (land, air, water) authorities, Ship operators, Logistics companies	River-based navigation and related transport of goods and passengers Maritime navigation Terrestrial transport	Daily monitoring and forecasting of streamflow, river runoff, precipitation, and anomalies Nowcasting, short to medium term forecasting Extreme events forecast Aviation Forecasts Marine Forecast Products (Satellite based river level measurement see for example http://www.legos.obs-mip.fr/soa/hydrologie/hydroweb/Page_2.html)	1.Lack of river runoff time series 2.Lack of connection to hydrological models 3.Training on the use of river runoff data and hydrological models Capacity building in nowcasting and marine forecasting
Climate Change (Mitigation and Adaptation)			
Government and local communities	adaptation	forecasting at all timescales decadal downscaled climate projections	Downscaling at local level
Ministry of Environment	Report on national contribution to Paris Agreement Monitor progress against Intended Nationally Determined Contributions (INDCs	GHG sources and sink monitoring Emission inventories **Data:** Climate Data (Meteorological Parameters) Ozone - SAF	**Gap**: 1.Lack of coordination between institutions monitoring GHG and sources of GHG emissions (power companies). 2. Lack of policies regulating the provision of such data. (transparency). 3. Lack of GHG monitoring stations. 4. Access to high resolution GHG datasets.

Several common issues were highlighted in the open discussion that followed the work of the groups:

- Research, assessment and improvement of products (fitness-for-purpose, utility, feedbacks) should be integrated in the implementation
- Communication of uncertainty of products, adapted to user's needs and level of understanding is a key element
- Resolution of forecasting models is currently not adequate to address needs of small islands. Downscaling of model output is another requirement currently not addressed.
- Bandwidth and storage capacity for monitoring and nowcasting products from weather radar, lightning sensors, is often insufficient in Member countries.
- Near-Real Time (NRT) and delayed-mode requirements for data should be addressed separately when discussing dissemination
- Develop smart ways to make climate data (e.g. ECVs) accessible in inventories and archives (e.g., by building upon existing ones such as in Europe, U.S., etc... since national resources are often too limited)
- Integration of national data at national level requires data sharing
- Analysis and visualization tools are very important to make data valuable.
- Training on impact-based forecasting in the various sectors is needed
- Platforms for integrating various data sources are necessary (e.g., to combine meteorological and other environmental data).

6. SYNTHESIS AND ACTIONS

Looking more closely at what needs to be done to develop services, the following themes emerged from a first analysis of the data (shown in Appendix IV)

1. Some data can be used for several different services, e,g, solar data can be used for: solar energy potential: radiation for crop forecasting in agriculture and for UV monitoring for health

2. Most applications require multiple data sources that need to be worked with in an integrated manner

3. Many climate applications require comparing a climatology with a current observation. This requires a climatology and compatible observation. These may have different dissemination mechanisms (e.g. by postmail and EUMETCast).

4. Consistent/ standard tools would be helpful, as they will help exchange/sharing of experience, cross-support between users (Focus group), maintenance, evolution, etc.

5. There is a wide range of data required and a wide range of data available, a rigorous matching exercise or process would be helpful (it does not all need to be done at once). This might/must be an ongoing process, as new requirements and products will come up / will be developed. This would also require that users are kept aware and informed about available data and how to access them.

6. How services engage with users came up often. NMHSs can do a better job of designing and delivering products that are more useful to users. This is part of the user interface platform in GFCS. There is a systemic requirement for information and training to do this well.

- ○ Included in this is an element of communicating and working with users. Particularly when the users may act, and the event does not always happen

6.1 Examples of easy-to-implement activities

Target solar energy planning: solar energy atlas and monthly updated anomalies in similar formats to the ENACTS maproom

Data and tool inputs:
1. The EUMETSAT CM SAF provides high quality data for solar radiation
2. CM SAF also provide an R-tool box to analyze and visualize CM SAF data.
3. The monthly mean solar radiation products available on EUMETCast. This is compatible with the dataset and can be used to compute anomalies.

Training and information inputs:
1. Case studies that shows the use of the data
2. Information on how to access and use data and tool boxes
3. Training of the data scientist to process the data
4. Training of the customer advisor (could be same person) to use the product
5. Training of the service manager in how to work with the customer

Service development needs:
1. Service provider and service user need to work together to define the service level and delivery processes.

Other proposed studies:
- Rainfall: what data are available to generate climatologies in Africa (surface, satellite and reanalysis), what are the limitations on use, what are the mechanisms to access the data, what corresponding data is available for monitoring and computing anomalies
- Wind at 10m, 50m, 100m for energy generation: what data are available to generate climatologies in Africa (surface, satellite and reanalysis), what are the limitations on use, what are the mechanisms to access the data,
- Temperature at land surface, 2m: what data are available to generate climatologies in Africa (surface, satellite and reanalysis), what are the limitations on use, what are the mechanisms to access the data

New data for Near-Term
- Request to ECMWF to have Extreme Forecast Index (EFI), and training on its use in climate services
- WMO SDS-WAS data rather than images on EUMETCast Autumn EUM DBs
- 11-30 day data from ECMWF ... research data or available operationally? Rainfall T, Humidity, ...

New data for Long-Term
- Access to the Copernicus Climate Change Service (C3S); advice from C3S on data selection and training on data application will be useful in the future phases of C3S. This is probably true for all the Copernicus services / data providers. (Request to be made via ACMAD on behalf of RA I)
- SWFDP products for West Africa.
- ENACTS extension to other countries is recommended.

Improved Data Access
- ECMWF / EUM web available to people in health / agriculture - all data in one page, with appropriate user control
- Requirement need to make discovery easier

6.2 Actions and Recommendations:

ACTION 1: WMO / EUMETSAT to write a letter to EC (DG GROW / DEVCO) regarding the priority data and support needs of African climate services within GFCS, to be taken into account by the Copernicus programme and C3S in particular.

ACTION 2: RAIDEG together with RA I CSA to validate the list of data gaps identified, between now and the next RAIDEG meeting. EUMETSAT to identify what is not on EUMETCast already.

ACTION 3: RAIDEG request EUMETSAT (for the next baseline update) to investigate the inclusion of:
- WMO SDS WAS data
- CMSAF cloudiness / cloud cover monthly mean

ACTION 4: EUMETSAT and services in Senegal & Mauritius to investigate how to distribute the radiation dataset, including EUMETCast dissemination.

ACTION 5: WMO/EUMETSAT to inform the GFCS-ACP project development process about the outcome of this meeting.

ACTION 6: The CSA/RAIDEG Chairs to provide a report on the outcome of this meeting to the GFCS-ACP meeting in Dakar (Senegal) in the week of 29 April 2017. (Vincent Gabaglio to facilitate)

ACTION 7: WMO Space Programme to ask IPWG for a plain language document on the usefulness of various datasets (in situ, satellite, reanalysis data) for developing climatologies and seasonal monitoring products in sub-saharan Africa at 200 km and 5 km.
RECOMMENDATION that this open question be considered at national, regional (including RCCs) and international (IPWG, ENACTS) levels, noting Resolution 60 and the national policy in many countries to protect the rainfall data and the need for countries to get somethign back for thier data.

Note the importance of providing information about data and training on the data and RECOMMEND to the international centres to consider the information and training requirements that go with data provision.

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APPENDIX II: AGENDA

Day 1: Tuesday 18 April

9:00-9:30	Welcome from WMO

Session 1: Climate Information from the service-user perspectives.
Focus on GFCS priority areas Energy, Agriculture, Water, DRR, Health

9:30 – 10:30	Summary of activities in the countries/sub regions and information requirements (chair: Pascal Yaka) • Ethiopia – Eastern Africa (Tsegaye Ketema) • Central Africa (Wilfrid Serge Likeba) • Western Africa (Pascal Yaka) • RA I RCCs (Pascal Yaka)
10:30-11:00	Coffee Break
11:00-11:10	Land agriculture specific example from AGRYMET (Jose Camacho)
11:10-12:30	Discussion
12:30-14:00	Lunch

Session 2: Current dissemination and architecture (chair: Mariane Diop Kane)

14:00-14:10	The current situation EUMETCast and C3S Climate Data Store (Mark Higgings)
14:10-14:20	Current EUMETCast-Africa data dissemination for GFCS (Christine Trager-Chatterjee)

Session 3: Breakout groups per sub regions

14:20-15:30	Members of the two working groups are grouped per sub regions to identify the climate service-related data, products, infrastructure and capacity gaps at regional scale. Group 1: Eastern Africa Group 2: North/Western Africa Group 3: Central/Southern Africa Each group is composed by members from the regions + WMO and EUMETSAT facilitators. Each group will decide its own chair and rapporteur
15:30-16:00	Coffee Break
16:00-17:00	Presentations from the breakout groups
17:00-18:00	Discussion on the outcomes of the breakout groups

Day 2: Wednesday 19 April

Session 4: How would the climate service evolve at regional and national level across the 5 GFCS areas; which data and products are needed; what kind of infrastructure system and tools are needed

9:00-10:00	Breakout groups per GFCS priority areas. Depending on the outcomes of Session 1, the groups should be formed considering the main emerging needs of climate services, indicatively Group 1: Agriculture and Food Security Group 2: Water and Energy Group 3: Disaster Risk Reduction & Health
10:00 – 10:30	Presentations form the breakout groups
10:30-11:00	Coffee Break
11:00-11:30	Presentations form the breakout groups…. continued
11:30-12:30	Discussion on the outcomes of the breakout groups
12:30-14:00	Lunch
	Parallel meeting with a small group to summarize the outcomes of the two breakout exercises and draft a unified synthesis and set of recommendations

Session 5: Discussion and Finalization of recommendations and key messages for stakeholders (chairs Mariane Diop Kane and Pascal Yaka)

14:00-14:30	Presentation of draft synthesis and recommendations
14:30-15:30	Discussions and comments from the participants on the draft
15:30-16:00	Coffee Break
16:00-18:00	Finalization of the meeting outcomes

APPENDIX III: LIST OF PRODUCTS IN EUMETCAST AFRICA RELEVANT TO GFCS

ATMOPSHERE
- **Dust** forecast products for Africa (from Barcelona Forecast Dust Centre)
- map of **air temperature** (observations); anomaly, max and min temperature for Southern Africa (from Botswana Department of Meteorological Services, MESA SADC) (1 image every 10 days)
- **Surface temperature** from **GOES-E and MSG**
- **Daily downward longwave** irradiance from **GOES-E and MSG**
- map of cumulative ground **rainfall**; anomaly, max and min for Southern Africa (from Botswana Department of Meteorological Services, MESA SADC) (1 image every 10 days)
- Monthly Mean **Surface Solar irradiance** from CM SAF (1 image per month)
- **Surface Solar irradiance** from **Feng Yun 2E and 2G** (1 per day)
- **Daily Surface solar irradiance** from **GOES-E and MSG**
- Monthly Mean **Fractional cloud cover** from CM SAF (1 image per month)
- CMA **precipitation estimates** from Feng Yun 2E (1 or 4 per day) (may be of interest for the Indian ocean countries)
- **precipitable water** and **other** products from **Feng Yun 2E and 2G** (1 per day)
- **Lightning detection** data from ground based ATDNET (UKMet Office)

MARINE
- **sea level anomalies** (CNES)
- **sea surface salinity** (1/day) (ECOWAS)
- **potential fishing zones** (1/day) (ECOWAS)
- **SST** (ECOWAS)
- **Sea surface currents** (ECOWAS)
- **Chlorophyll α** (NASA)
- OSI SAF products

LAND
- **crop and fire products** (**NDVI** etc) (BDMS MESA SADC-thema)
- **evapotranspiration, fire, LAI** etc (LSA SAF)
- **rainfall** (TAMSAT)

APPENDIX IV: SUMMARY OF CLIMATE DATA AND PRODUCTS RELEVANT TO GFCS FROM ACROSS SECTORS

Joint meeting RA I DEG/CSA, 18-19 April 2017				
Data and products requirements for climate (Summary)				
Type of data/product	**Variable / Phenomenon of Interest**	**Repeat cycle**	**Spatial resolution**	**Service Area**
Monitoring	lightning (ATDNet, others)			fire mgt
Monitoring	active fires (e.g., EUMETCast Fire Product (MESA- AFIS Fire Product))	15 min		fire mgt
Monitoring	fire danger index (FDI); parameters required: surface temperature, etc. + normalized differential vegetation	daily	< 4 km	fire mgt
Monitoring	heat/cold wave, UV index, temperature, humidity, cloud cover, ETP, soil moisture, vegetation	daily	1-10 km	health
Monitoring	particulate matter, ash from biomass burning, aerosol optical depth near surface; near-ground concentration of ozone, SO2, NO2, VOCs, UV index			health
Monitoring	streamflow, river runoff, precipitation, and their anomalies	daily		transport
Monitoring	crop yields			agriculture
Monitoring	small water bodies			livestock
Monitoring	coastal SST, ocean colour, salinity, currents (upwelling), phytoplankton and chlorophyll, algal blooms			fishing
Monitoring	GHG emissions, ozone			climate change
Monitoring	fog, haze			transport
Monitoring	water level in reservoirs			water
Monitoring	dust events, haze, solar irradiance, surface winds and humidity	daily		health
10-day monitoring	dry spells, rainfall, temperature, evapotranspiration, soil temperature, soil moisture, vegetation	10 days		agriculture
10-day monitoring	precipitation, 10m wind, 2m temperature, river discharge		5 km	water
10-day monitoring	river discharge			water
10-day monitoring	extreme temperature and extreme low humidity			fire mgt
Daily, weekly, monthly monitoring	soil moisture			DRR
Monthly monitoring	rainfall, temperature, evapotranspiration, soil temperature, soil moisture, vegetation			agriculture
Seasonal monitoring	crops, livestock, alerts			agriculture
Nowcasting	solar irradiance (short and long-wave radiation), cloud cover, wind speed and direction	hourly		energy
Nowcasting & Very Short Range Forecasts: (0-12 hours)				DRR
Aviation Forecasts				transport
Marine Forecasts				transport
Marine Forecasts				agriculture / fisheries
Forecast of pests distribution	e.g. wind, for desert locusts			agriculture
Forecast	crop yields			agriculture
Forecast	small water bodies			livestock
Forecast	sand and dust storms			DRR
Short term forecast	streamflow			energy
Short term forecasts (hours/days)	temperature, wind, solar, precipitation		5 km	energy
Short term forecast	rainfall		catchment area	energy
Short term forecast	2m temperature, evapotranspiration		5 km	water
Short term forecasts (hours/days)	wave height, swells, winds, visibility			fishing (agriculture)
Dust events and transport		daily		health
Air Quality Forecasts		daily	same as NWP models	health
Daily forecast	extreme temperature (min/max) and extreme low humidity			fire mgt
Daily forecast	extreme events			DRR

Data and products requirements for climate (Summary)

Type of data/product	Variable / Phenomenon of interest	Repeat cycle	Spatial resolution	Service Area
2-3 day forecasts	heat/cold wave, UV index, temperature, humidity, cloud cover	2 x daily	< 16 km	health
3-10 day forecasts	rainfall, humidity, temperature, vegetation	daily	1-10 km	health
10-day forecast	rainfall	3-hourly		agriculture
10-day forecast	extreme temperature and extreme low humidity			fire mgt
10-day forecast	dust events, haze, solar irradiance, surface wind and humidity	daily		health
Intra-season dry/wet spell forecasts	rainfall			agriculture
Onset / cessation of rainfall season (Temporal and spatial coverage)				agriculture
Monthly forecast	temperature, rainfall	10 days		water
Forecasts (nowcasting to seasonal)	streamflow, river runoff, precipitation, and anomalies	daily		transport
Seasonal forecast	streamflow			energy
Seasonal forecast	rainfall, temperature, evapotranspiration, soil temperature, soil moisture, vegetation	updated monthly		agriculture
Seasonal forecast	coastal SST			
Seasonal forecast	rainfall, humidity, temperature, vegetation	updated monthly	25-50 km	health
Seasonal forecast	extreme temperature and extreme low humidity			fire mgt
Seasonal forecast	temperature, precipitation, humidity, evapotranspiration, vegetation			livestock
Seasonal forecasts	rainfall, temperature, evapotranspiration, and wind	updated monthly	5 km	water
Seasonal forecasts	temperature, wind, solar, precipitation		5 km	energy
Seasonal forecasts				DRR
Annual - inter annual forecasts (up to 5 years)		annual	200 km	DRR
Climate forecast up to 5 years				DRR
5-10 years prediction	rainfall			livestock
Decadal (10 years, even 5 years) climate prediction	rainfall, temperature, streamflow, wind speed and direction, sea level			infrastructure
climate projections / scenarios				energy
Climatologies	temperature, precipitation, solar radiation, wind speed and direction at 50m and 100m above ground			energy
Climatologies	rainfall, 2m temperature, ETP, soil temperature, soil moisture, vegetation, radiation, humidity	agro-ecological zones		agriculture
Climatologies (30 years)	Wind speed and direction, temperature, precipitation			infrastructure
Climatology	river discharge			water
Climatology	clouds			health
GHG sources and sink monitoring				climate change
F dust				climate change
Emission sources and sinks, emission inventory data				health
Drought indices	Standardized Precipitation Index	1,3,6 and 12 months	1 km	water
Drought/water stress indices				agriculture
Extreme event occurrence and intensity				energy
Extreme events	flooding			water
Extremes events	including min/max temperature			agriculture
Extreme events forecast				transport
Extreme events forecast				livestock
Extreme events forecasts	wind, rainfall, thunderstorm/flash flood, drought, lightning, temperature			DRR
Extreme forecast Index (EFI) at kilometric scale			1 km	energy
Return periods of extreme events				infrastructure
Rainfall-runoff relationship (dam levels)				energy
Reanalysis	temperature, rainfall, winds, evapotranspiration			agriculture, others
Digital elevation model	elevation			DRR
Mapping	flooded areas, surface water			DRR
Mapping	flood-prone areas requiring soil type, soil moisture, digital terrain model, rainfall patterns, runoff			DRR
Mapping	land cover (including urban areas), evapotranspiration, vegetation (to assess water stress), fluorescence for vegetation state			
Malaria risk mask				health
Malaria case history				health
Seed and fertilizer availability				agriculture
Market information				agriculture