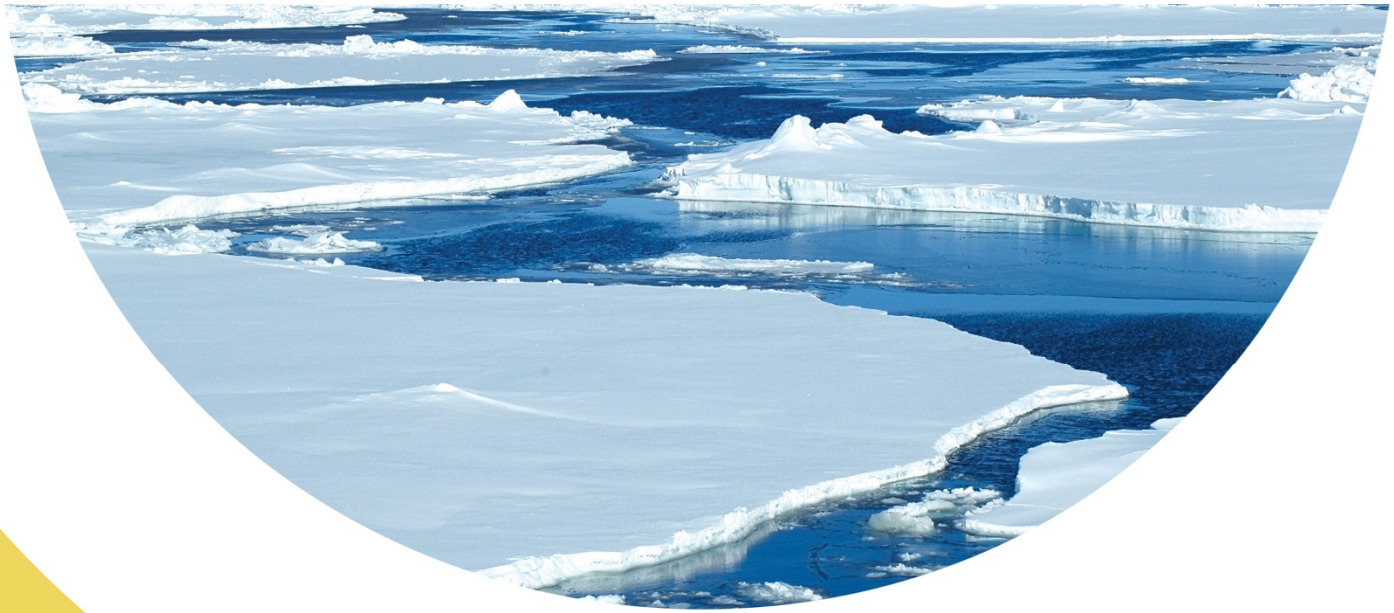

GMES Climate Service

Towards a European knowledge base in support of Mitigation and Adaptation

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European Commission
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GMES Climate Service expert group

- On 9th November 2010, the EU Regulation (911/2010) on the European Earth monitoring programme (GMES) and its Initial Operations (2011-2013) have come into force
- With this regulation GMES has become operational
- The service component of GMES shall comprise i.a:

Access to information for CC monitoring
in support of
mitigation and adaptation policies

- November 2010: GMES CC expert group
- April 2011: Consultation with major European (Climate-related Institutions)
- Report “GMES Climate Service” open for discussion

WMO-GFCS defines Climate Service as ‘Climate Information prepared and delivered to meet users needs’

Report prepared by the GMES Bureau based on contributions from:

GMES Climate Change expert group:

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- Adrian Broad (UK Met Office)
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- Martin Köchy (vTI, German Fed. Res. Inst. Rural Areas, Forestry, & Fisheries)
- Mikko Strahlendorff (Finnish Ministry for Transport)

§ Mark Doherty (ESA)
§ Jörg Schulz (EUMETSAT)
§ Adrian Simmons (ECMWF)
§ Arie Kattenberg, Steve Noyes (EUMETNET)
§ Tobias Fuchs (DWD)
§ André Jol, Markus Ehrhard (EEA)

§ European Commission DGs (JRC, ENTR, CLIMA, RTD, ECHO)

Key Points

The Service should describe the current and historical status of the Earth environment from national to global scales and from ECVs to (gridded) impact indicators.
The Service should provide tools to develop CC policies, and information on attribution of high impact events (heat-waves, flooding, etc).

A GMES Climate Service should comprise the following initial services elements:

- Data integration and climate monitoring
- Climate modelling (prediction/projections)
- Earth system re-analysis (with interactions between Atmosphere, Ocean, Land, etc)
- Gridded climate impact indicators
- Attribution information products
- Gridded GHG emission inventories

User needs and Climate Quality (1)

- GMES Climate service should support (Climate policy) users at European and National level
  - European level: EC DG-CLIMA => White paper (2009): The Clearing House Mechanism will rely on GMES information concerning climate change impact, vulnerability and best practices on adaptation.

    Both Observations and Model results
  - National level: Public Institutions, like National Meteorological Services
- GMES Climate service will have to complement and interact with existing services and activities

User needs and Climate Quality (2)

- The ambition of the GMES Climate Service must be to provide information products meeting the three GCOS goals:
  - Monitoring the climate system
  - Detecting and attributing climate change
  - Assessing impacts of, and supporting adaptation to, climate variability and change
- This will be achieved through the 50 GCOS Essential Climate Variables (ECVs) as endorsed by WMO, CEOS, COP, UNFCCC, and
  - All ECVs are required to support the work of the UNFCCC and the IPCC
  - All ECVs are technically and economically feasible for systematic observation
  - International exchange of these variables is required for both current and historical observations

Essential Climate Variables (ECVs)

- **ATMOSPHERE** (over Land, Sea, and Ice)
  - Surface: Pressure, Air Temperature, Precipitation, Surface Radiation Budget, Water Vapour, Wind Speed and Direction
  - Upper-air: Cloud Properties, Earth Radiation Budget, Temperature, Water Vapour, Wind Speed and Direction
  - Composition:Aerosols properties, Carbon Dioxide, Methane and other Long-Lived Green House Gases (N2O, CFCs), Ozone, Ozone and Aerosol Precursors (NO2, SO2, HCHO, CO)
- **OCEANIC**
  - Surface: Carbon Diozide Partial Pressure, Current, Ocean Acidity, Ocean Colour, Phytoplankton, Sea Ice, Sea Level, Sea State, Sea Surface Salinity (SSS), Sea Surface Temperature (SST)
  - Sub-Surface: Carbon, Current, Nutrients, Ocean Acidity, Ogygen, Salinity, Temperature, Tracers, Global Ocean Heat Content (?)
- **TERRESTRIAL**
  - River Discharge, Water Use, Ground Water, Lakes, Snow Cover, Glacier and Ice Caps, Permafrost, Albedo, Land Cover, Fraction of Absorbed Photosynthetically Active Radiation, Leaf Area Index, Above Ground Biomass, Fire Disturbance, Soil Moisture, Soil Carbon, Ice Sheets

Products and tools for monitoring policies

- Climate monitoring and data integration
  - Focus on GCOS ECVs
  - Recovery, logging, digitally archiving, homogenization
- Earth system re-analysis
  - Including interactions between Atmosphere – Ocean – Land -Ice/Snow - Hydrological Cycle – Dynamical vegetation
  - Data assimilation with integrated observational data
- Portal for climate impact indicators
  - Improve historical records of impact indicators
  - Conversion into gridded data sets covering sparse regions
- Delivering of consistent data sets of observational data
  - For climate model initialisation for seasonal and decadal predictions
  - For re-analysis and attribution
- Attribution service
  - Natural climate variability versus human-induced effects
  - Linking Desaster Risk Reduction to CC
  - Relies on climate modelling capabilities

Required Actions (1)

- Actions on ECVs
  - Strong collaboration is necessary with ESA-CCI, EUMETSAT, other archives to fill gaps, to ensure continuity, further development and quality control of ECVs (Atmosphere/Marine/Land)
  - Link space and in-situ components of the observing system to increase accuracy of the products
  - Follow the GCOS climate monitoring principles and the recommendations of the JRC-2010 report
  - What will be delivered by the other GMES services (Atmosphere/Marine/Land)

Required Actions (2)

- Actions on Re-analysis
  - Modelling – Computing power - Data analysis – New data
  - Long-term objective of a GMES Climate service: Coupled Atmosphere – Ocean – Land – Ice/Snow – Hydrological Cycle – Dynamical Vegetation model
  - Make best use of existing capabilities, e.g. ECMWF, ERA-Interim, ERA-Clim, EURO4M
- Actions on Impact Indicators
  - Evolved from simple ECV statistics to more complex ones based on reanalysis output
  - Demand for more accurate extreme statistics and higher resolution, i.e. a need for an efficient and user-friendly statistics tool

Required Actions (3)

- Actions on access to climate prediction data
  - A GMES Climate service should incorporate climate information at all time scales from history to a few decades into the future
  - Beneficial for the down-stream services
  - Link to WMO-GFCS for which climate prediction is a key ingredient, and the IPCC Coupled Model Intercomparison project

Required Actions (4)

- Actions on Attribution
  - Establishing the most likely cause for a detected change with some level of confidence
  - For instance, Anthropogenic external forcing factors, increase in GHG, changes in aerosol concentrations OR natural climate variability
  - Attribution products are developed using climate models to determine the expected response to a particular climate forcing
  - Relies heavily on model capabilities
  - Provides a useful tool for evidence-based climate change adaptation policies

Infrastructures (1)

- Satellite observations
  - Monitoring capacity analyzed in JRC-2010 report
  - To cover all ECVs, several components need to be better sustained in future
  - Recommend a highly complementary system consisting of GMES space infra-structure, operational meteorological missions and specific research missions to achieve consistent product quality over long periods of time
  - Regular reanalysis and production of ECVs are integral parts in improving the exploitation of satellite data
  - GMES services have to impose their requirements into the multipurpose Sentinel missions. EUMETSAT is arranging this for Atmosphere and Ocean – Climate should be added

Infrastructures (2)

- In-situ observations
  - The Climate service needs to rely on WMO for global exchange of national observations, and on EUMETNET coordinated programmes for the European exchange of national observations
  - It needs to support collection and digitization programmes in Europe and worldwide, to combine data from different networks and to achieve optimal coverage
  - To support the Global Reference Upper Air Network (GRUAN) for benchmarking for comparison with satellite data
  - Infrastructure projects like ICOS (carbon observation), IAGOS (aircraft observation), ARGO and EuroARGO (oceanographic observations), and EuroSITES (deep ocean network) need to be supported

Infrastructures (3)

- Supercomputing, Data Portal, Clearing House
  - Reanalysis activities: Processing power needed for assimilation of observations into Earth system modelling (cf with EURO4M and ERA-Clim)
  - Data mining (Knowledge Discovery in Data) and visualization tools
  - Various database concepts (such as the EUMETNET showcase EUROGRID and European Virtual Observatory) should be explored to manage the astronomical climate data holdings spread out in several institutes now.
  - Together with ESA-CCI, WMO-GFCS, FP7/Climate and other sources, the Climate Service should provide input to the DG CLIMA funded activity to develop an EU Clearing House Mechanism on Adaptation

Long-term Research Requirements

- Modelling and re-analysis of the entire coupled Earth system including: Atmosphere-Ocean-land-Snow/Ice-HydrologicalCycle-DynamicalVegetation should be the long-term target.
- A strong research component has to be included to increase product quality – has to evolve with technological and scientific developments. The Climate service will benefit from operational numerical weather prediction activities
- Service set up and future development depend on user feedback
- Need to provide guidance and expertise, and to train people in the use of climate information and its associated uncertainties
- Specific research needs will be discussed in the next Session

Governance and International Collaboration

- GMES Climate has to follow the GCOS requirements and their governance process as these are acknowledged by both GEO and WMO. The ultimate customer is UNFCCC.
- Sufficient flexibility is needed to be able to adapt to the evolution of user needs over time

The evolution of GMES Climate Service needs to be based on the GMES User Forum which contributes to:

- Scientific analysis of the evolving needs of the service users and the capabilities of the current service providers to meet these needs
- Liaison with and co-ordination of the pan-European actors among the service providers (ESA-CCI, EUMETSAT-SAFs, ECMWF, EUMETNET, …)
- Formulation of calls for the provision of GMES Climate services
- Evaluation of the performance of service products in meeting the users needs for the services

Summary

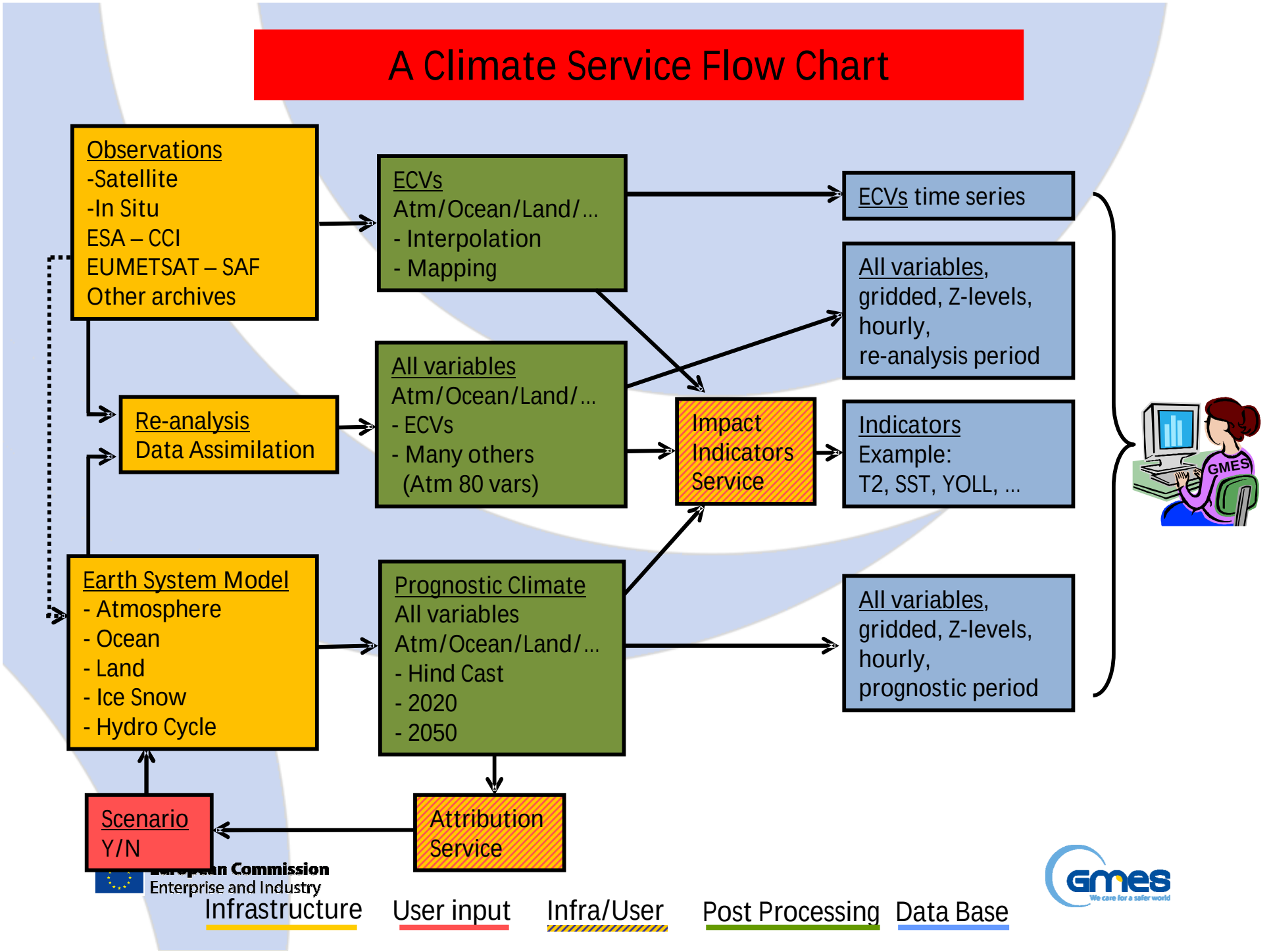
The Service must describe the current and historical status of the Earth environment from national to global scales and from ECVs to (gridded) impact indicators.
The Service must provide tools to develop CC policies, and information on attribution of high impact events (heat-waves, flooding, etc).

A GMES Climate Service should comprise the following initial services elements:

- Data integration and climate monitoring
- Climate modelling (prediction/projections)
- Earth system re-analysis (with interactions between Atmosphere, Ocean, Land, etc)
- Gridded climate impact indicators
- Attribution information products
- Gridded GHG emission inventories

Schematically this can be put into the following (simplified) flow chart

A Climate Service Flow Chart



The Helsinki Questions

- How to integrate research needs in the evolving service and which are priorities – FP7/8?
- Where to invest in supercomputing and how to integrate existing capacities?
- How to support Climate prediction/projection/scenario – facilitate access to existing activities?
- Will it be possible to address the huge challenge of an attribution service and how to interface with user?
- Impact indicator service – direct generation and/or supporting tools?
- How to implement links between GMES Climate Service and GFCS?
- Expectations regarding data policy?
- Roadmap for GMES Climate Service?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