Copernicus Climate Change Service (C3S)

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Most of the slides are from the European Commission

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NAGIS Workshop, Budapest, 7-8 November, 2016
Table of content

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★ The Copernicus and C3S projects in general

★ The details of the C3S projects, particularly
  ★ Climate Data Store (CDS) as the heart of the system
  ★ Sectoral Information System (SIS) as the main climate impact/adaptation projects

★ Lesson learnt and Questions & Answers
BACKGROUND
(NaTéR – NAGIS)
Background: my past and present

★ I have been working at the Hungarian Meteorological Service from 1990 to 2011 (then I joined the European Centre for Medium-Range Weather Forecasts, ECMWF)

★ Now I work at the reanalysis team of the C3S project

★ My main area of expertise:
  ★ Short range numerical weather prediction (regional modelling)
  ★ Regional climate modelling

★ 2003: Design of a (regional) climate modelling project in Hungary

★ 2005-2007: National Climate Dynamics Project

⇒ the NAGIS (NaTéR) idea was born
  (against the “head wind” of the VAHAVA project)
Some background: NaTeR (NAGIS) idea

24 November, 2005: Presentation at the Hungarian Academy of Sciences in the Meteorological Scientific Days

2010: A brochure about our climate dynamics work and the application areas (include uncertainty information)

→ Create a database, which would serve the climate adaptation community with relevant climate information including uncertainty information (it was planned to host it by the Hungarian Meteorological Service)
6 services use Earth Observation data to deliver ... added-value products

Contributing missions

Sentinels

GMES Services

Coordinated Data Access System

GMES Space Component

in-situ

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Continuity until 2030
Monitoring the State of the Earth System Environment ...

Copernicus: 6 operational services

... cross-cutting Thematic Services

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From the Copernicus regulation (EU) 377/2014:

"the Climate Change service shall provide information to increase the knowledge base to support adaptation and mitigation policies. It shall in particular contribute to the provision of Essential Climate Variables (ECVs), climate analyses, projections and indicators at temporal and spatial scales relevant to adaptation and mitigation strategies for various Union's sectoral and societal benefit areas."
COPERNICUS CLIMATE CHANGE SERVICE (C3S)

Implemented by COPERNICUS CLIMATE CHANGE SERVICE (C3S)
C3S vision

- To be an **authoritative source** of climate information for Europe
  (⇒ build Copernicus/C3S brand!)

- To build upon national investments and **complement** national climate service providers
  (⇒ not exclusive!)

- To **support** the market for **climate services** in Europe
  (⇒ user and mitigation/adaptation focus!)
**C3S objectives**

How is the climate changing?

*Observations & Re-analysis*

What are the societal impacts?

*Climate indicators & Sectoral information*

How will climate change in the future?

*Predictions & Projections*

http://climate.copernicus.eu/
Stage 0/I - Proof of Concept (PoC)/Pre-operational
Stage II - Operational ~20 ECVs, ~5-6 Sectors
Stage III - Operational ~30 ECVs, ~10 Sectors
C3S components

- Climate Data Store (CDS)
  - ECVs past, present and future
  - Observed, reanalysed and simulated
  - Derived climate indicators
  - Tools to support adaptation and mitigation at global and European level

- Sectoral Information System (SIS)

- Evaluation and Quality Control (EQC)
  - Monitors quality of C3S products and services
  - Ensures C3S delivers state-of-the-art climate information to end-users
  - Identifies gaps in service provision
  - Bridges Copernicus with the research agenda in Europe (e.g. H2020, national research projects)

- Outreach and Dissemination
  - Web content
  - Public outreach
  - Coordination with national outreach
  - Liaison with public authorities
  - Conferences, seminars
  - Training and education

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**Technical challenges:**

- Diversity of users
- Diversity of data sets
- Very large data volumes
- Data residing at different locations
- Interoperability, efficiency
- User-defined workflows
- Variety of presentation methods
- Need for interactivity
- Access via API
- User management
- Performance monitoring
CDS architecture

Data repositories (distributed)
- Located at different data providers, seamlessly available via CDS
- May implement basic tools to perform analytics on local data

Web portal (centralised)
- Content Management System (articles, news, events)
- Browsing/searching CDS product catalogue, tools catalogue, ...
- Manages users’ data retrieval and computation requests

Broker/Scheduler
- Dispatches data retrieval and computation requests to the relevant data repositories (including from other services)
- Implements quality of service

- CDS development has started 1 July 2016 (alpha version available in January 2017)
- CDS toolbox development has started 1 September 2016
Global reanalysis:

ERA5 is now in production (3 streams)

- 32km global resolution
- Uncertainty estimates
- Improved use of observations
- Newly reprocessed satellite data
- Hourly data from 1979-NRT
- Access to all input observations

EUMETSAT reprocessing activity

C3S: global reanalysis

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Aim: to generate multi-model seasonal forecast products based on the best information available, to an operational schedule, and make them publicly available.

**Components of the seasonal service:**

- **Forecast data:** a list of atmosphere (and ocean) variables, on 1x1 degree grid, at daily or sub-daily resolution, from 6-month forecasts
- **Graphical products** (e.g. time series for indices, maps, climagrams)
- **Processed data** (e.g. indices, probabilities, inputs for SIS)
- **First set of products** will be available starting Q4 2016
**Global Climate Projections:**

- Provision of support to one Earth System Grid Federation (ESGF) node in Europe
- Multi-model product generation
- Roadmap toward a reference set of climate projections for Europe (EUCP)

**Regional Climate Projections:**

- Provide access to existing CORDEX simulations for European domains and to boundary conditions derived from GCM simulation through the CDS.
- Definition and generation of a “3-D matrix” (RCM/GCM/RCP) of RCM projections.
SECTORAL INFORMATION SYSTEM (SIS)
C3S: Sectoral Information System (SIS)

Proof of concept development of sectoral applications

Copernicus Climate Change Service
Sectoral Information System: schematic example of the idea

1. Water Manager has climate issue
2. Water Manager consults Purveyor
3. Purveyor understands issue and goes to C3S
4. Purveyor consults Data provider/ CDS

5. Data provider search and extracts data to Purveyor
6. Purveyor tailors, downscales, merges, repurposes datasets
7. Purveyor extracts, explains, visualises relevant information to water manager
8. Water manager makes decision and business improves!

9. Purveyor reports on needed climate indicators to data provider
10. Data Provider produces new pan-EU climate indicators
11. New climate indicators are readily available in C3S and CDS
12. Purveyor can extend business with more clients!!

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http://swicca.eu
SWICCA: Service for Water Indicators in Climate Change adaptation

- Lead Swedish Meteorological and Hydrological Institute (SMHI; Sweden)
- Partners: 13 partners from 9 countries (Austria, Germany, Greece, Italy, the Netherlands, Slovakia, Spain, Sweden, USA)
- Pan-European coverage, but also case studies
- Have a look on their website: swicca.climate.copernicus.eu (lot of useful material: maps, graphics, demonstrators, tutorials, descriptions etc.)
**SIS: SWICCA project**

**SWICCA data:** ≈900 datasets (Sept. 2016)

**Model ensemble**

- **Emission Scenario**
- **Global climate model**
- **Regional climate model**
- **Bias correction**
- **Hydrological model**

**User requests**

- **SWICCA variables**
  - 36 CII:s
  - 3 temperature
  - 7 precipitation
  - 10 water
  - 12 water quality
  - 2 air
  - 2 socio-economic
  - 4 ECV:s
  - Temperature
  - Precipitation
  - River flow
  - Unregulated river flow

- **Visualization and Downloads**
  - **Spatial resolution**
    - 0.5 degree grid (50 km)
    - 0.1 degree grid (12 km)
    - 5 km grid
    - Catchments (mean: 215 km²)
  - **Time slices**
    - Reference period (1971-2000)
    - Early century (2011-2040)
    - Mid-century (2041-2070)
    - End-century (2071-21000)
  - **Transient time-series (ECVs)**
  - **RCPs:** 2.6; 4.5; 8.5

**Users in water management**

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SIS proof-of-concept projects: water management (2)

- EDgE: End-to-End demonstrator for improved decision making in the water sector in Europe
  - Lead: Natural Environment Research Council’s for Ecology & Hydrology (NERC-CEH; UK)
  - Partners: 6 partners from 5 countries (Germany, Norway, Spain, UK, USA)
  - Norway, Spain and UK case studies planned
  - Web: edge.climate.copernicus.eu (less results so far)
SIS proof-of-concept projects: energy (1)

- CLIM4ENERGY: Climate for Energy
  - Lead: Alternative Energies and Atomic Energy Commission (CEA; France)
  - 7 partners from 6 countries (Finland, France, Germany, Spain, Sweden, UK)
  - Web: clim4energy.climate.copernicus.eu
FIRST PRODUCT: TAILORED HIGH-RESOLUTION (12km, 3-hourly) CLIMATE PROJECTION ENSEMBLE (10 MODELS) WITH BIAS CORRECTION AND MODEL SELECTION METHODOLOGY (Version 1)

Sub-ensemble election procedure

Filter 1
Identification and exclusion of outliers based on performance criteria

Filter 2
Selection of sub-ensemble possibilities based on climate sensitivity spread criteria

Filter 3
Selection of sub-ensemble possibilities based on variable response spread criteria

Filter 4
Selection of sub-ensemble possibilities based on performance score sorting
CLIM4ENERGY: (industrial) partners and indicators

Nine indicators
- Wind power
- Hydropower (2)
- Grid balance (2)
- Freezing rain
- Soil practicability
- Sea level
- Waves
**SIS proof-of-concept projects: energy (2)**

- **ECEM: European Climatic Energy Mixes**
  - Lead: University of East Anglia (UEA; UK)
  - 4 partners from 3 countries (France, Italy, UK)
  - Web: [ecem.climate.copernicus.eu](http://ecem.climate.copernicus.eu)
From climate variables to energy systems

Calibrated Climate Variables
- Temperature
- Rainfall
- Wind Speed
- Cloud Cover
- Solar Radiation
- Others

Calibrated Climate Variables + Ancillary
- Rainfall
- Cloud Cover
- Others?

Define models & transfer functions
Select / Gather relevant datasets

Energy Variables
- Hydro Power
- Solar Power
- Demand
- Wind Power
- Thermal Power

Energy Variables Impacts
- Sub-Country Scale
- Historical Period
- Seas. Fcst

+ Extreme Events Case Studies
- Skill & Reliability
- Assessment of Seasonal Forecasts of Energy Variables

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**Agriculture and forestry:**
- **AgriCLASS:** Agriculture Climate Advisory Services
- Lead: Telespazio Vega (UK)
**SIS proof-of-concept projects: others (2)**

- **Insurance:**
  - WISC: Windstorm Information Service
  - Lead: CGI (UK)
  - 7 partners from 3 countries (the Netherlands, Switzerland, UK)
  - Web: [wisc.climate.copernicus.eu](http://wisc.climate.copernicus.eu) (see „explore” for demonstrator)
**SIS proof-of-concept projects: others (2)**

- **Infrastructure and health:**
  - URBAN-SIS
  - Lead: Swedish Meteorological and Hydrological Institute (SMHI, Sweden)
  - 6 partners from 3 countries (Italy, Sweden, UK)
  - Target: major European cities
  - Pilot demonstrations: Bologna, Stockholm, Amsterdam-Rotterdam
  - Web: [urbansis.climate.copernicus.eu](http://urbansis.climate.copernicus.eu) (not too many things there, so far)
Essential Climate Variables (ECV) form basis for impact indicators:
- precipitation (and snow), water vapour
- temperature, wind speed and direction
- surface radiation budget
- urban background air quality (NO2, O3, PM10, PM2.5)
- soil moisture and river discharge

Hourly 1x1 km² gridded information for 5-10 year windows for historical and present/future conditions.

Impact indicators tailored for urban infrastructure and health
Takeaway messages

★ Copernicus includes a satellite (space) component and 6 operational services built around them
★ Copernicus provides free access to its data
★ C3S aims to
  ★ build a brand and have an authoritative source of climate information
★ Complement national activities
★ Support the climate services market in Europe
★ The heart of C3S is the Climate Data Store (CDS)
★ The Sectoral Information System (SIS) will provide impact/adaptation advice
★ Please consult regularly with the climate.copernicus.eu website!
Some NAGIS-related suggestions, discussion points

- It makes sense to follow the C3S project, since lots of things are happening there
- It would be nice to be involved more in Copernicus (see coming tenders; Central and Eastern Europe is under-represented)
- CDS and SIS projects
  - Uncertainty estimation: How to address uncertainties in a unique way for all the sectoral projects? Is it at all possible to have the same strategy for all the projects?
  - Bias correction: What about bias correction for the projections (based on past statistics)? Is it needed? Is it sector specific?
  - C3S vs. national projects: How C3S (SIS) and NAGIS can complement each other in an optimal way?
The Copernicus Climate Change Service (C3S) will combine observations of the climate system with the latest science to develop authoritative, quality-assured information about the past, current and future states of the climate in Europe and worldwide.

climate.copernicus.eu