ECMWF and GHP

Products and experiments

Christel Prudhomme
with contributions from Gianpaolo Balsamo, Patricia
de Rosnay, Ervin Zsoter and colleagues from RD
and EFAS/GloFAS team

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CEH fellow

ECMWF

ECMWF products for natural hazards

10 days

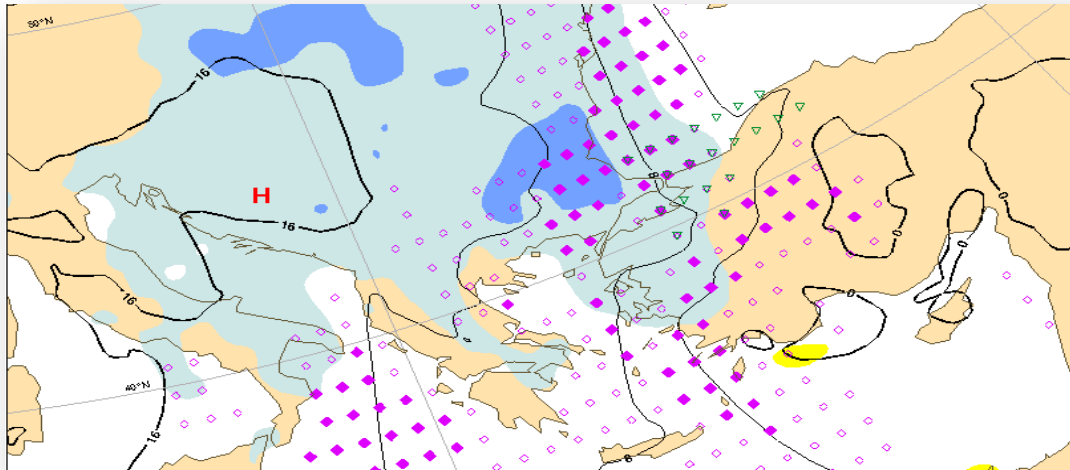| ECMWF product	Floods	Wildfire	Droughts	Malaria	Wind	Cyclone
High resolution	✓				✓	✓
Ensemble	✓	✓			✓	✓
Monthly			✓	✓		✓
Seasonal			✓	✓		
Re-Analysis	✓	✓	✓	✓		✓

6/12 Months
Climate

ECMWF Operational Forecasting System

High resolution deterministic forecast: twice per day
9 km 137-level, to 10 days ahead

Ensemble forecast: twice per day
51 members, 18 km 91-level, to 15 days ahead

Monthly forecast: twice a week (Mon/Thursdays)
51 members, 36 km 91 levels, to 46 days ahead

Seasonal forecast: once a month (coupled to ocean model)
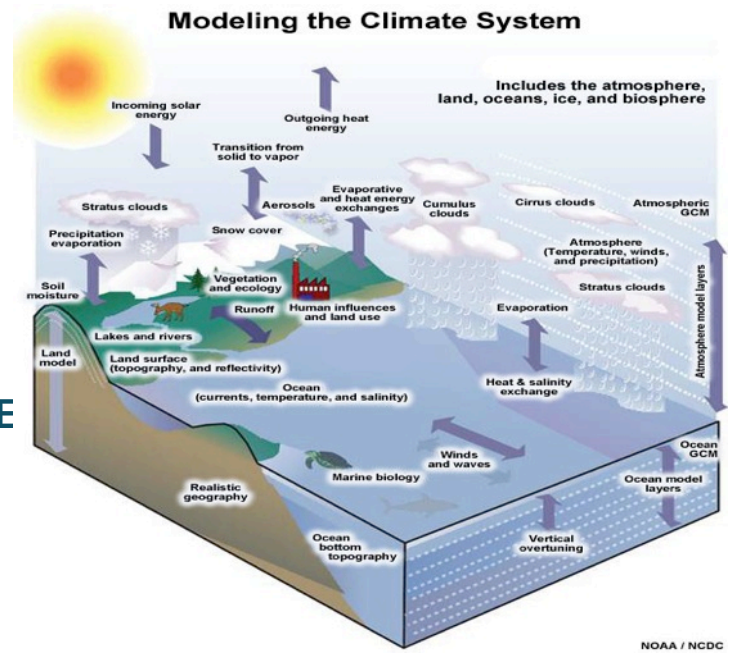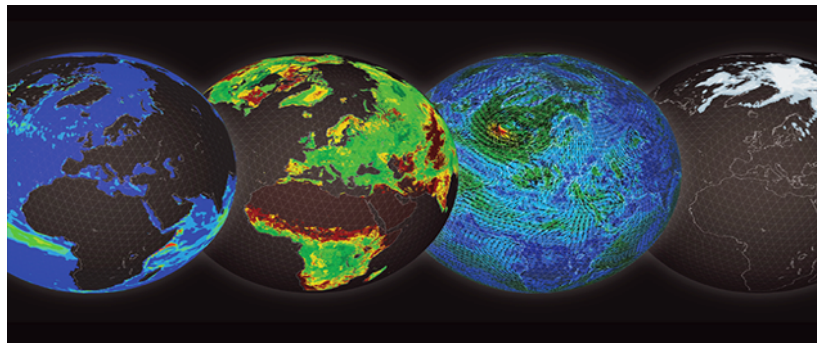51 members, ~80 km, 91 levels, to 7 months ahead

ECMWF strategy

ECMWF STRATEGY 2016-2025

EARTH SYSTEM APPROACH

ENSEMBLE MODELLING AND ASSIMILATION. GOAL: 5KM

SCALABILITY ACROSS WHOLE NWP CHAIN

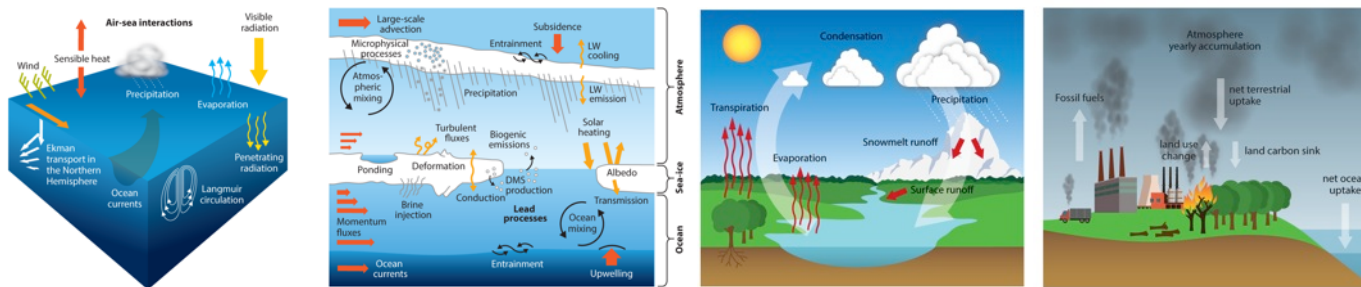Modeling the Climate System

Representing the coupled surface processes

An Earth System Ensemble approach for more seamless prediction & involving coupling of processes (Weather, Environment, Climate, Human-influence) Requires the representation of surface processes.
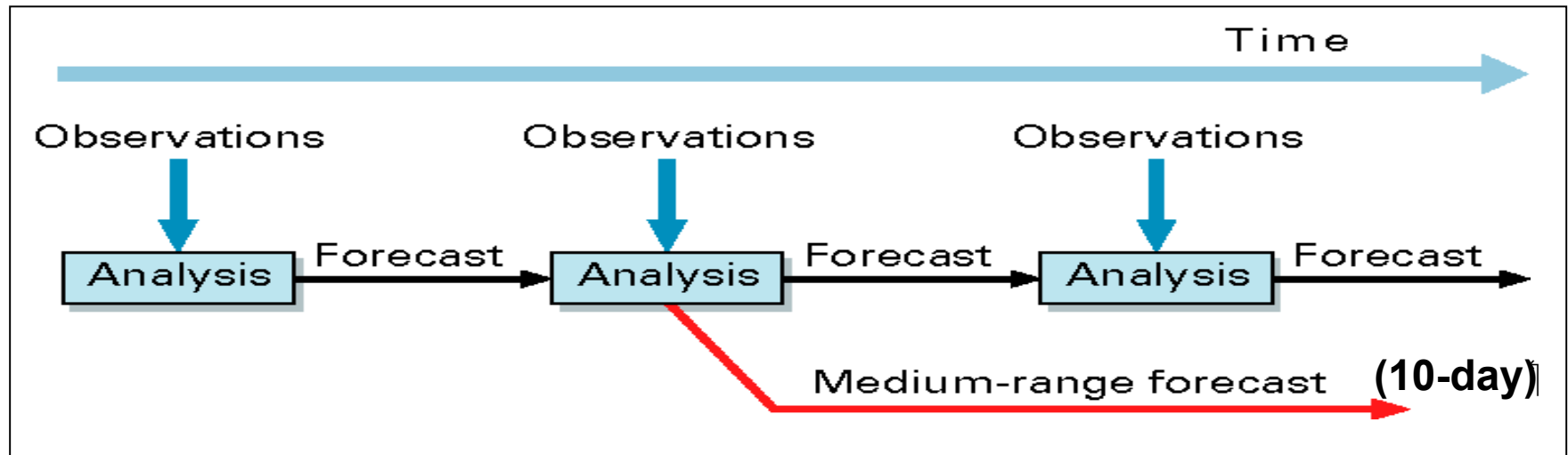
Research topics

J.-R. Bidlot, S. Keeley, K. Mogensen, P. Janssen, M. Choulga, G. Arduini, S. Boussetta, G. Balsamo
ECMWF coupled processes team in 2017
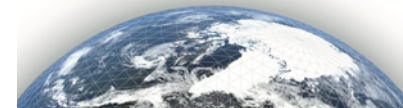
ECMWF Integrated Forecasting System IFS

> **Forecast Model** → **GCM including the H-TESSEL land surface model (coupled)**

> **Data Assimilation** → **initial conditions of the forecast model prognostic variables**

> - **4D-Var for atmosphere ; 3D-Var for ocean (for ensemble and seasonal)**
> - **Land Data Assimilation System (LDAS)**

> **Different LDAS for different ECMWF systems and products**

Thanks to P. de Rosnay

Copernicus Emergency Management Service
GloFAS – Global Hydrological Forecasting System

IFS runoff outputs routed offline

Meteorological forecasts
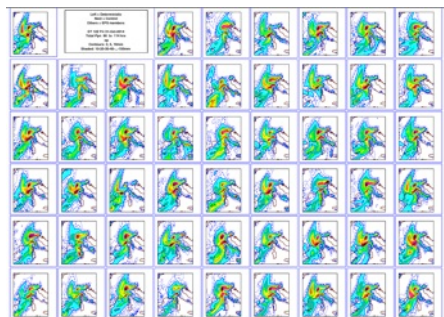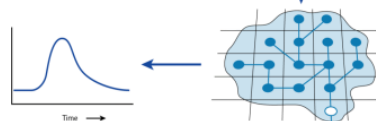
Hydrological model

Outputs
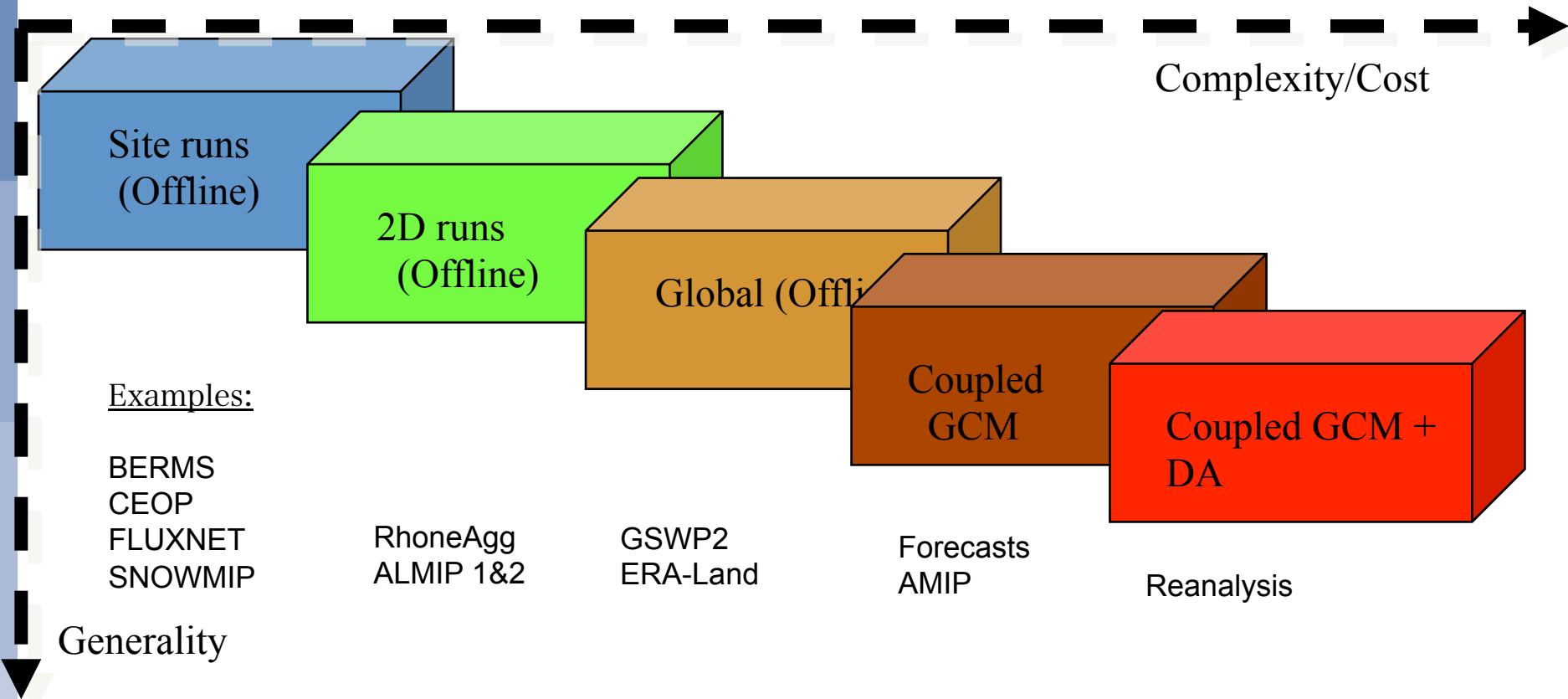
Spatial resolution 0.1 degree
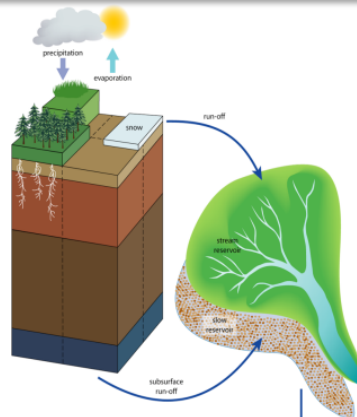
Global ensemble forecasts (ECMWF) ~18km

HTESSEL (ECMWF) + LISFLOOD (JRC) ~10km

River discharge up to 30 days on 0.1 degree Probabilistic forecasts

Daily forecasts open data

Thanks to E. Zsoter

Copernicus
Europe's eyes on Earth

A stepwise approach to model complexity

Complexity/Cost

Site runs (Offline)

2D runs (Offline)

Global (Offline)

Coupled GCM

Coupled GCM + DA

Examples:

BERMS
CEOP
FLUXNET
SNOWMIP

RhoneAgg
ALMIP 1&2

GSWP2
ERA-Land

Forecasts
AMIP

Reanalysis

Generality

ECMWF
EUROPEAN CENTRE FOR MEDIUM-RANGE WEATHER FORECASTS
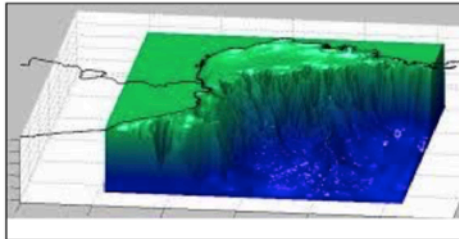
Thanks to P. de Rosnay

Earth System Modelling Components

NEMO3.4

NEMO3.4 (Nucleus for European Modelling of the Ocean)

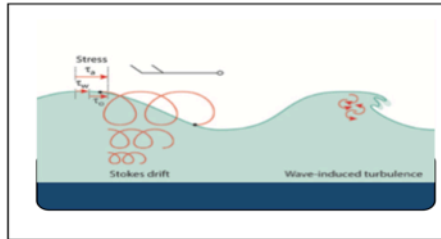Madec et al. (2008)

Mogensen et al. (2012)

ORCA1_Z42: 1.0° x 1.0°
ORCA025_Z75 : 0.25° x 0.25°

EC-WAM

ECMWF Wave Model

Janssen, (2004)

Janssen et al. (2013)

ENS-WAM : 0.25° x 0.25°
HRES-WAM: 0.125° x 0.125°

LIM2

The Louvain-la-Neuve Sea Ice Model

Fichefet and Morales Maqueda (1997)

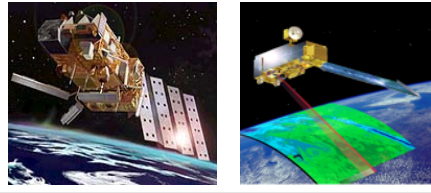Bouillon et al. (2009)

Vancoppenolle et al. (2009)

ORCA025_Z75 : 0.25° x 0.25°

Ocean 3D-Model Surface Waves and currents, Sea-ice.

Remote

NOAA/NESDIS
H-SAF
ASCAT
SMOS
SMAP

In Situ

Soil moisture

Snow

Land Data Assimilation Snow depth, soil moisture, soil/snow temp …

Hydrology-TESSEL

Balsamo et al. (2009)
van den Hurk and Viterbo (2003)

Global Soil Texture (FAO)

New hydraulic properties

Variable Infiltration capacity & surface runoff revision

NEW SNOW

Dutra et al. (2010)

Revised snow density

Liquid water reservoir

Revision of Albedo and sub-grid snow cover

NEW LAI

Boussetta et al. (2013)

New satellite-based Leaf-Area-Index

SOIL Evaporation

Balsamo et al. (2011),
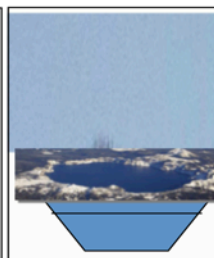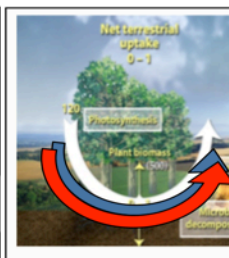
Albergel et al. (2012)

H_2O / E / CO_2

Integration of

Carbon/Energy/Water

Boussetta et al. 2013

Agusti-Panareda et al. 2015

Lake & Coastal area

Mironov et al (2010),

Dutra et al. (2010),

Balsamo et al. (2012, 2010)

Extra tile (9) to for sub-grid lakes and ice

LW tiling (Dutra)

Enhance ML

Snow ML5

Soil ML9

Dutra et al. (2012, 2016)

Balsamo et al. (2016)
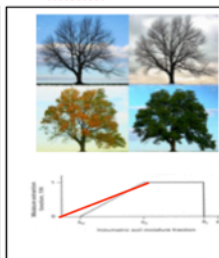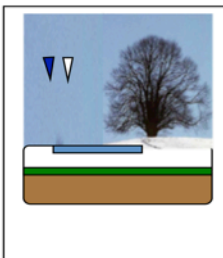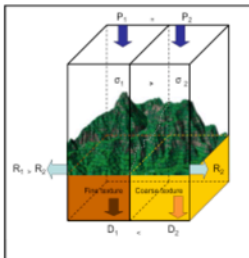
Land surface 1D-model soil, snow, vegetation, lakes and coastal water (thermodynamics only).

Thanks to G. Balsamo

Climate Change

- **Complete**: combines vast amounts of observations into global fields

- **Consistent**: uses the same physical model and DA system throughout

- **State-of-the-art**: uses best available observations and model at highest feasible resolution

- **ERA5** a large number of essential climate variables within the **C3S Climate Data Store**

Q2 2017: public release 2010 – 2016
Access: first via Web-API (similar to Era-Interim)
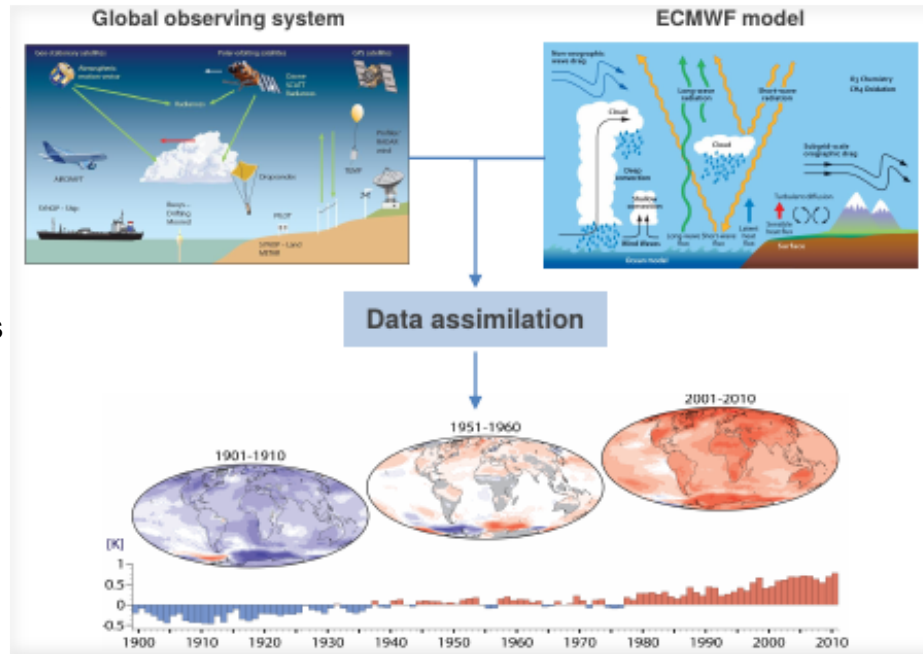   Feb 2018: via the **C3S Climate Data Store**

Q4 2017: 2017 – timely updates
- ERA5: Updates with about 2-months delay (final product)
- ERA5T: Updates with short delay (<1 week, preliminary product)

Q1-3 2018: Release 1979 – 2009:
- Continue ERA5 timely updates
- Continue ERA-Interim for another 6 months

2018: integration of ERA5 segment from 1950

Thanks to H. Hersbach

Climate Change

|	ERA-Interim	ERA5
Period	1979 – present	Initially 1979 – present, later addition 1950-1978
Streams	1979-1989, 1989-present	Parallel streams, one per decade
Assimilation system	2006, 4D-Var	2016 ECMWF model cycle (41r2), 4D-Var
Model input (radiation and surface)	As in operations, *(inconsistent sea surface temperature)*	*Appropriate for climate*, e.g., evolution greenhouse gases, volcanic eruptions, sea surface temperature and sea ice
Spatial resolution	79 km globally 60 levels to 10 Pa	*31 km globally* 137 levels to 1 Pa
Uncertainty estimate		Based on a 10-member *4D-Var ensemble* at 62 km
Land Component	79km	ERA5L, 9km (separate, forced by ERA5)
Output frequency	6-hourly Analysis fields	*Hourly* (three-hourly for the ensemble), *Extended list of parameters* *~ 9 Peta Byte (1950 - timely updates)*
Extra Observations	Mostly ERA-40, GTS	Various *reprocessed CDRs*, *latest instruments*
Variational Bias correction	Satellite radiances	Also ozone, aircraft, surface pressure

Thanks to H. Hersbach

Copernicus Europe's eyes on Earth | European Commission | **ECMWF**

- **To contain**:
    - Information for consistent and harmonised climate change analysis
    - ECVs & climate indicators on
  past, present and future evolution
  of coupled climate system
    - Includes seasonal forecasts
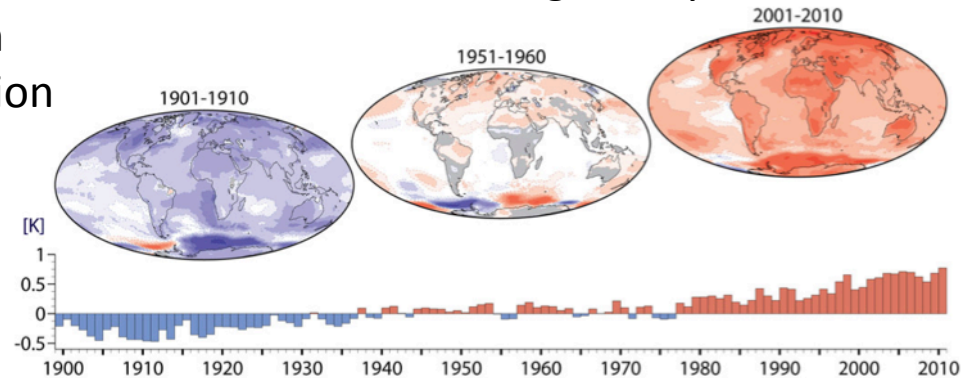
- **State-of-the-art data dissemination and visualisation tools**
    - Data resources
    - Computing facilities to develop improved seasonal forecasts

- Customized products disseminated via **Climate-ADAPT platform**

- **Sector-specific climate impact indicators** from additional external datasets and partnerships

Thanks to H. Hersbach

Possible contributions to GEWEX HP/ TPE?

- **ERA5 re-analysis; Coupling/ LDAS experiments**

  - Prediction precipitation

  - Water and energy cycles and processes

  - Melting ice and global consequences

  - Weather and climate extremes

  - Water for food basket of the world

  - (Near-term climate prediction)

  - (Carbon feedback in climate system)

- **C3S Climate Data Store**

  - Global water resources systems

  - Changes in extremes

  - Melting ice and global consequences

  - Weather and climate extremes

  - Regional sea level change and coastal impact

  - Water for food basket of the world

- **GloFAS experiments**

  - Global water resources systems

  - Water for food basket of the world

ECMWF

EUROPEAN CENTRE FOR MEDIUM-RANGE WEATHER FORECASTS

Thank you

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