

UERRA Regional reanalysis systems

Uncertainties in Ensembles of Regional ReAnalyses

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Grant Agreement 607193

FP7 SPACE 2013-1

Project Partners



Koninklijk Nederlands
Meteorologisch Instituut
Ministerie van Infrastructuur en Milieu



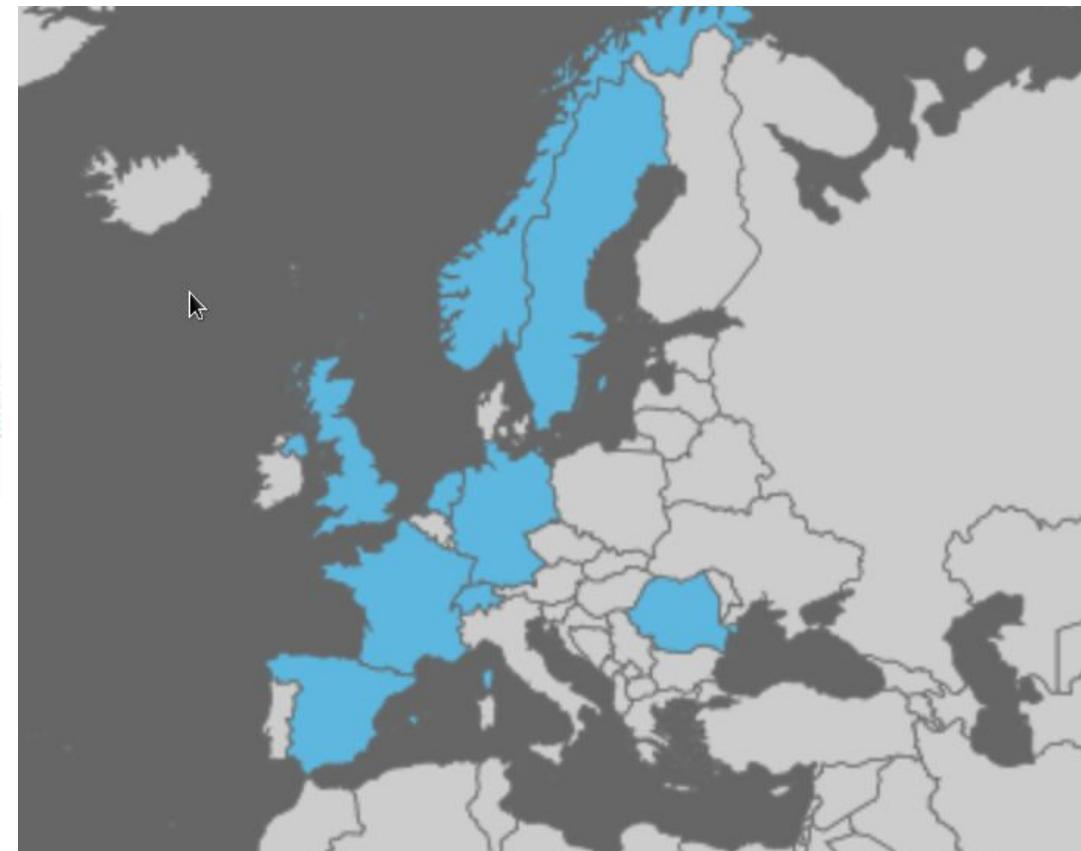
Met Office



Deutscher Wetterdienst
Wetter und Klima aus einer Hand



Meteorologisk
institutt



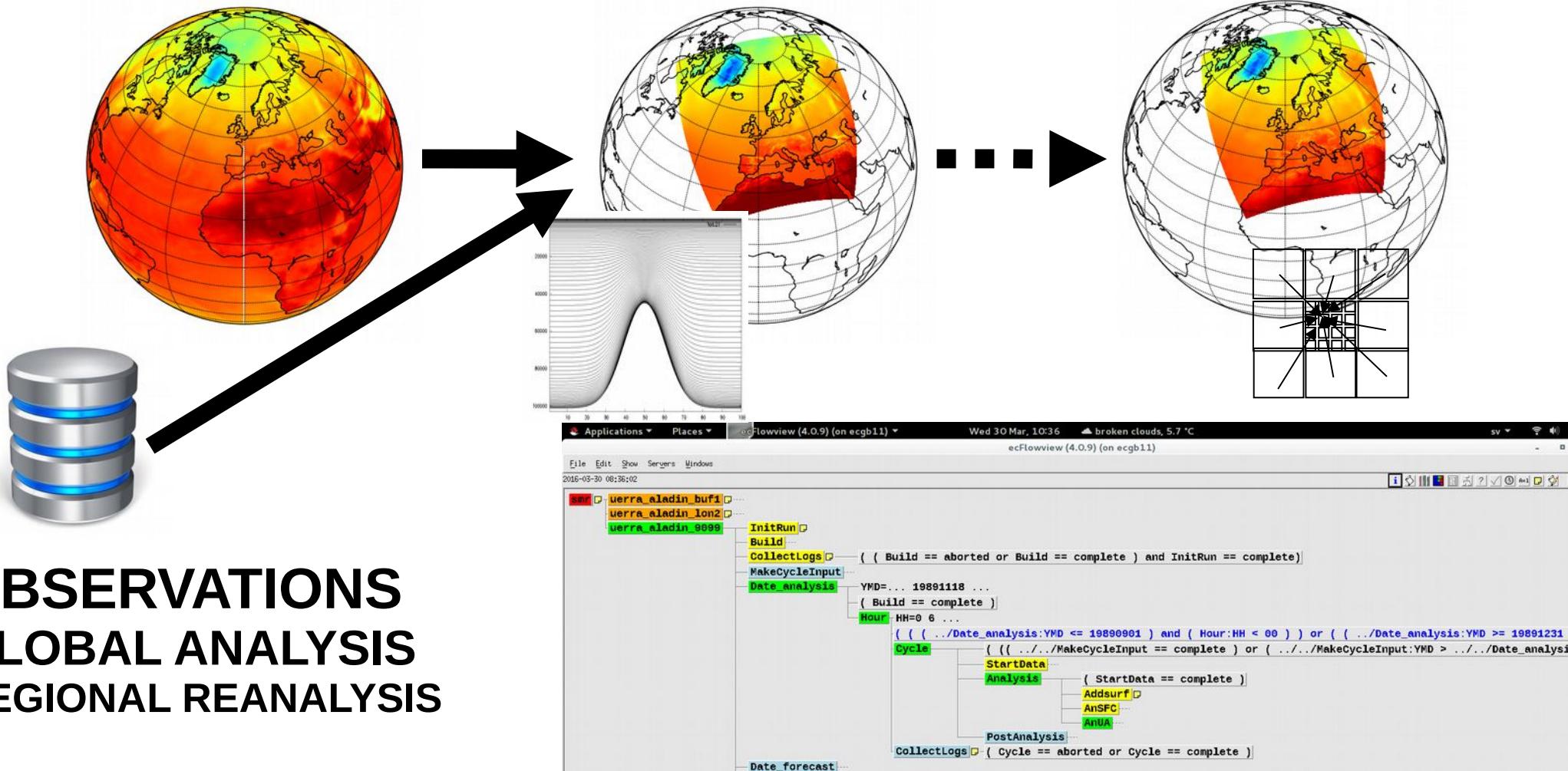
UNIVERSITAT
ROVIRA I VIRGILI



2-dim downscaling & reanalysis

3-dim regional reanalysis

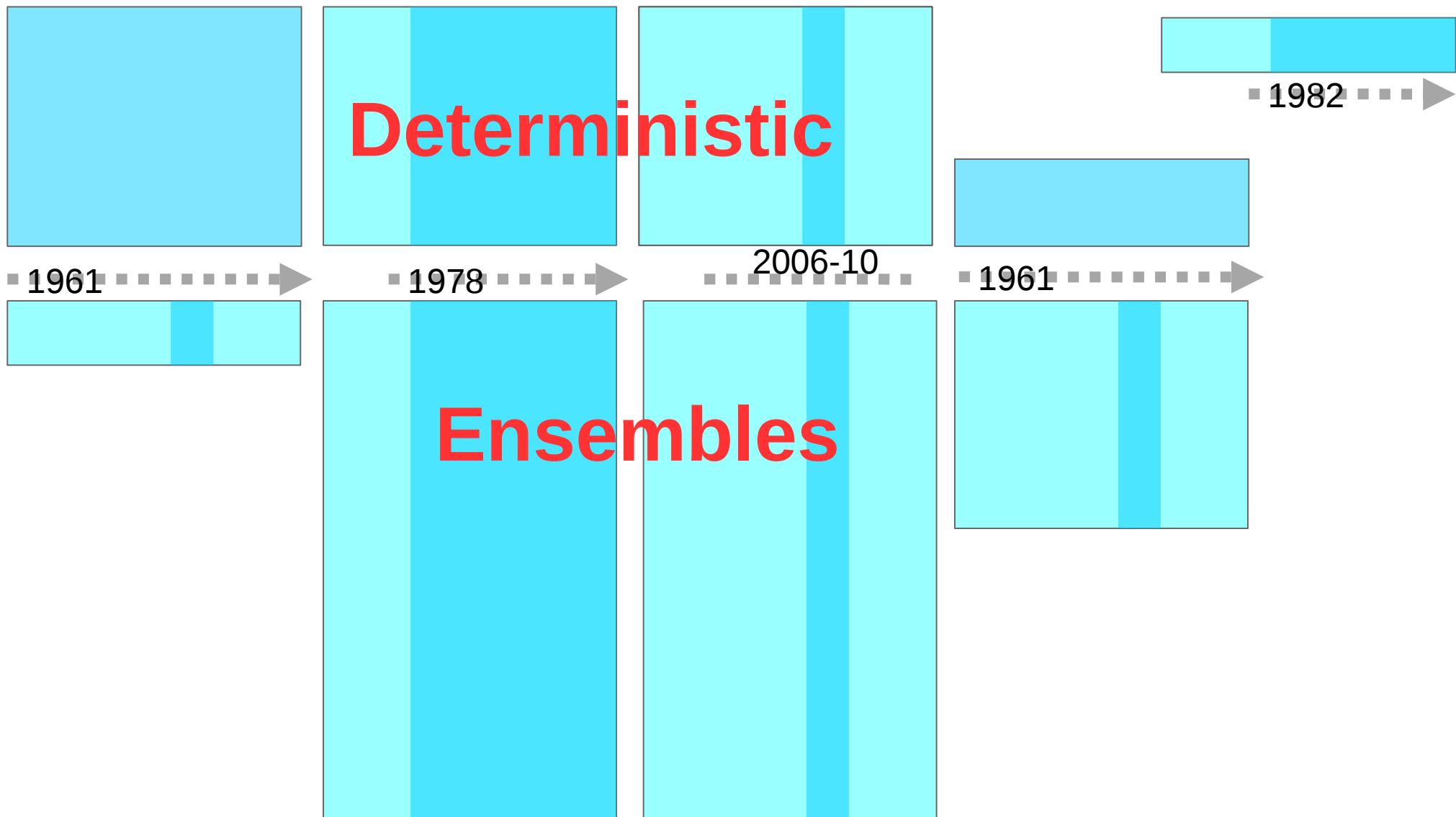
ERA-INTERIM reanalysis boundaries



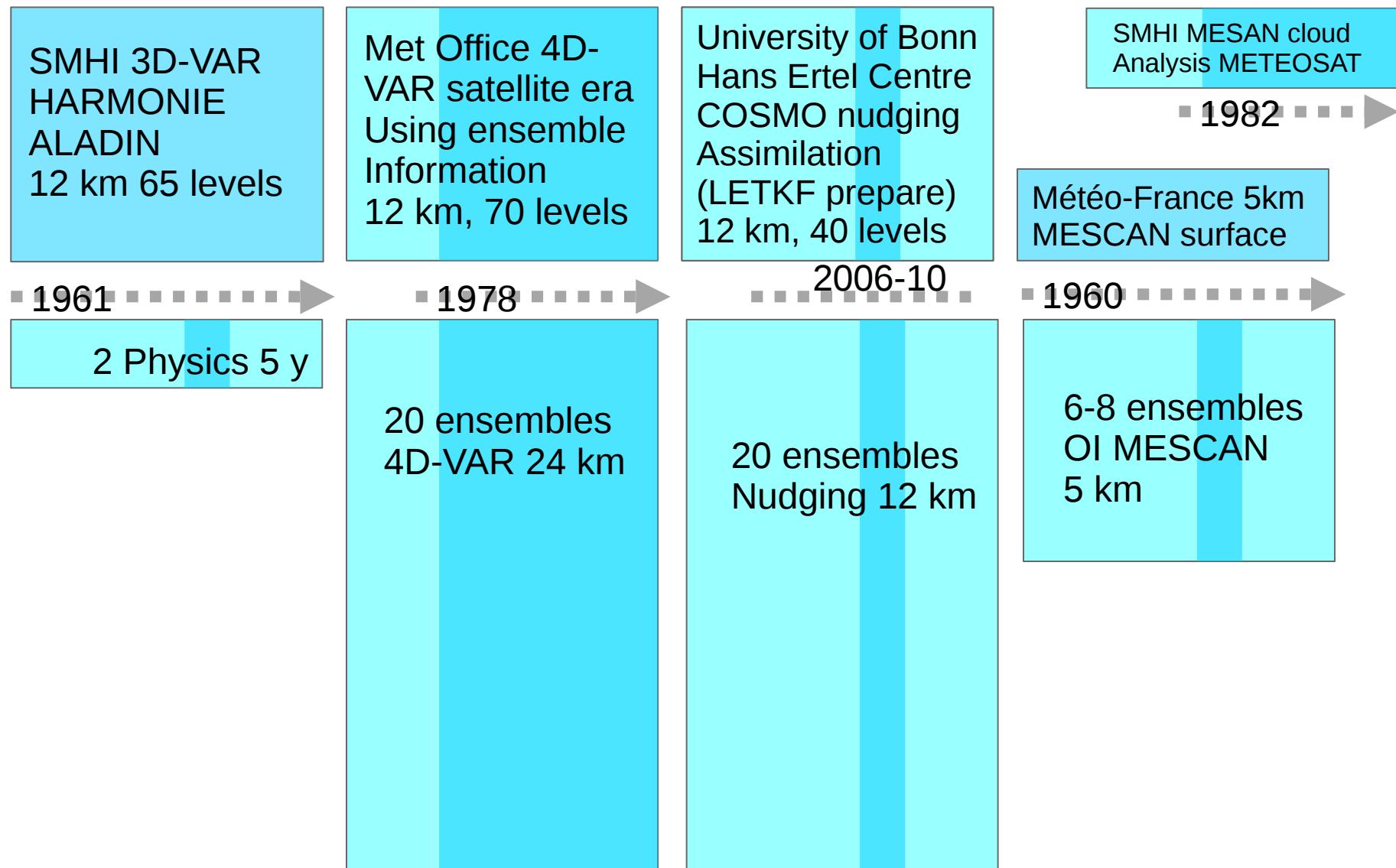
OBSERVATIONS GLOBAL ANALYSIS REGIONAL REANALYSIS

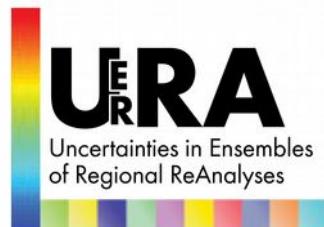
- + Regional reanalyses driven by global forcing and upper-air and surface observations using frozen systems
- + Multi-model and ensembles of reanalyses
- + Surface and upper-air parameters

European Area 11 | 5 km || Multi-model || 2, 6, 20 Ensembles || 55 | 35 | 30 | 5 y



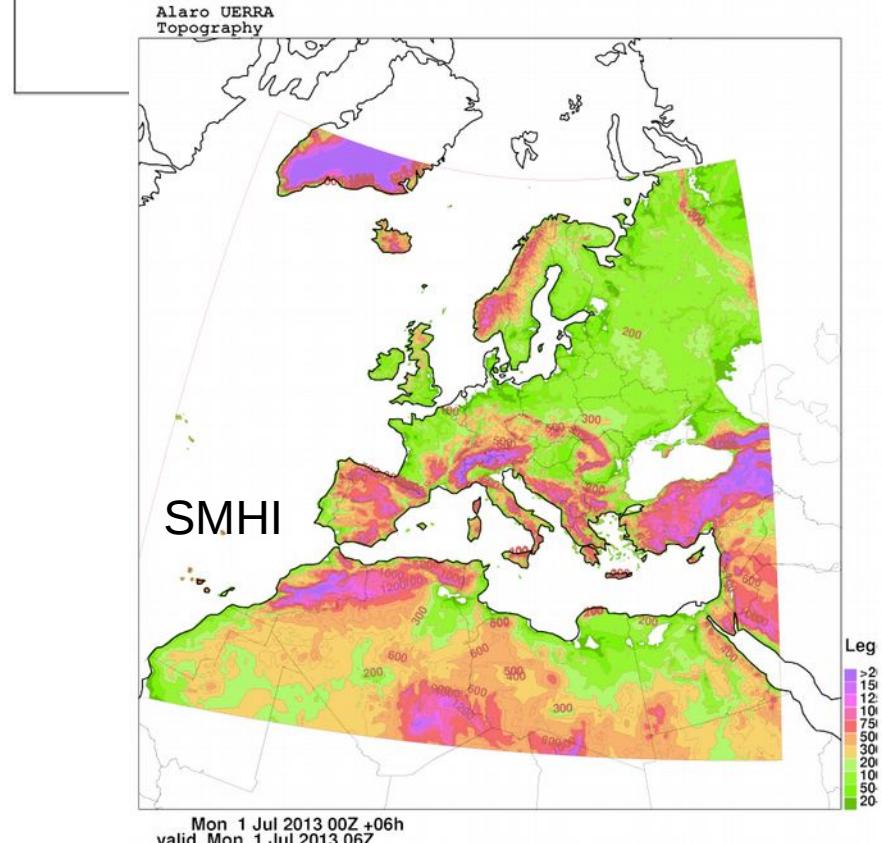
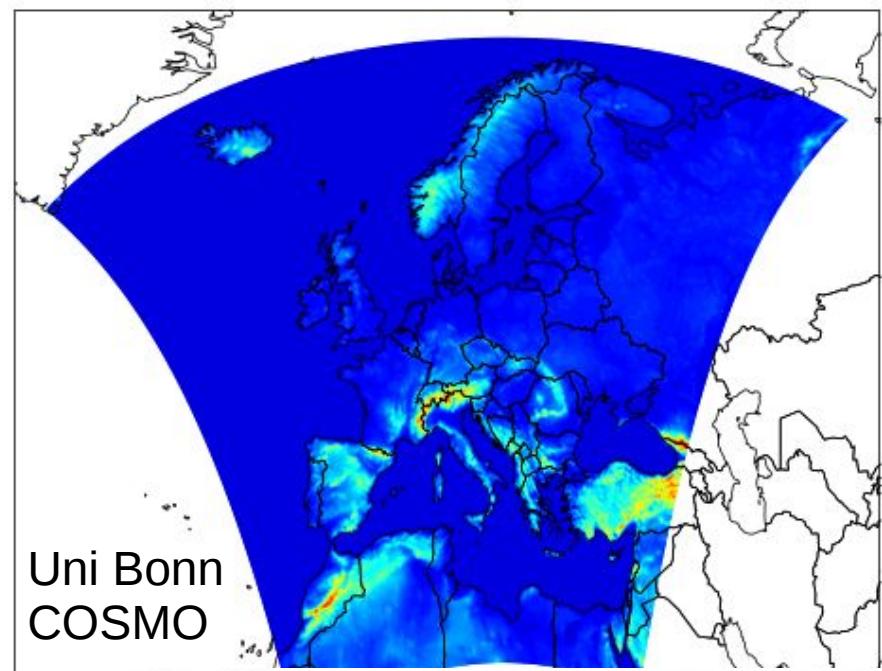
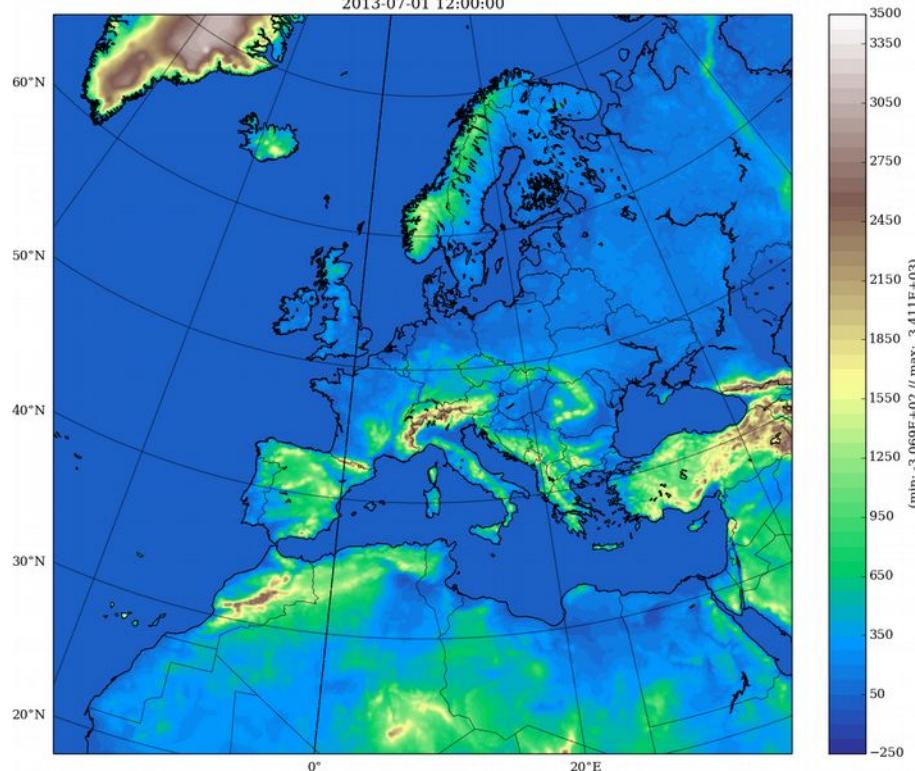
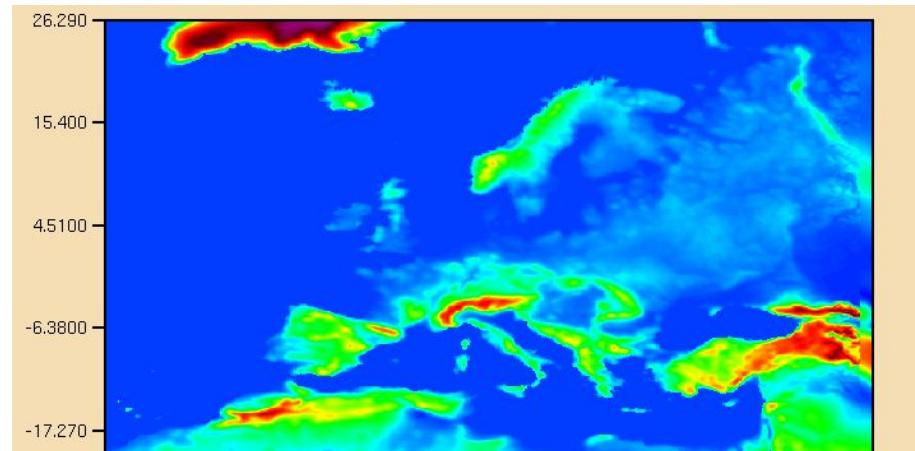
European Area 11 | 5 km || Multi-model || 2, 6, 20 Ensembles || 55 | 35 | 30 | 5 y





UERRA Domain & projections

Met Office
CORDEX
EU 11 km



SMHI - HARMONIE reanalysis data assimilation

HIRLAM and ALADIN consortia cooperate and develop a common
a km-scale operational NWP system.

HARMONIE - Hirlam Aladin Regional/Mesoscale Operational NWP In Europe

Variational 3D-VAR with a large scale constraint added

- Large scale forcing from ERA global reanalyses
- Information from satellites in ERA

Cost function:

$$J(x) = J_b + J_o + \underbrace{(x - x_{ls})^T V^{-1} (x - x_{ls})}_{J_k}$$

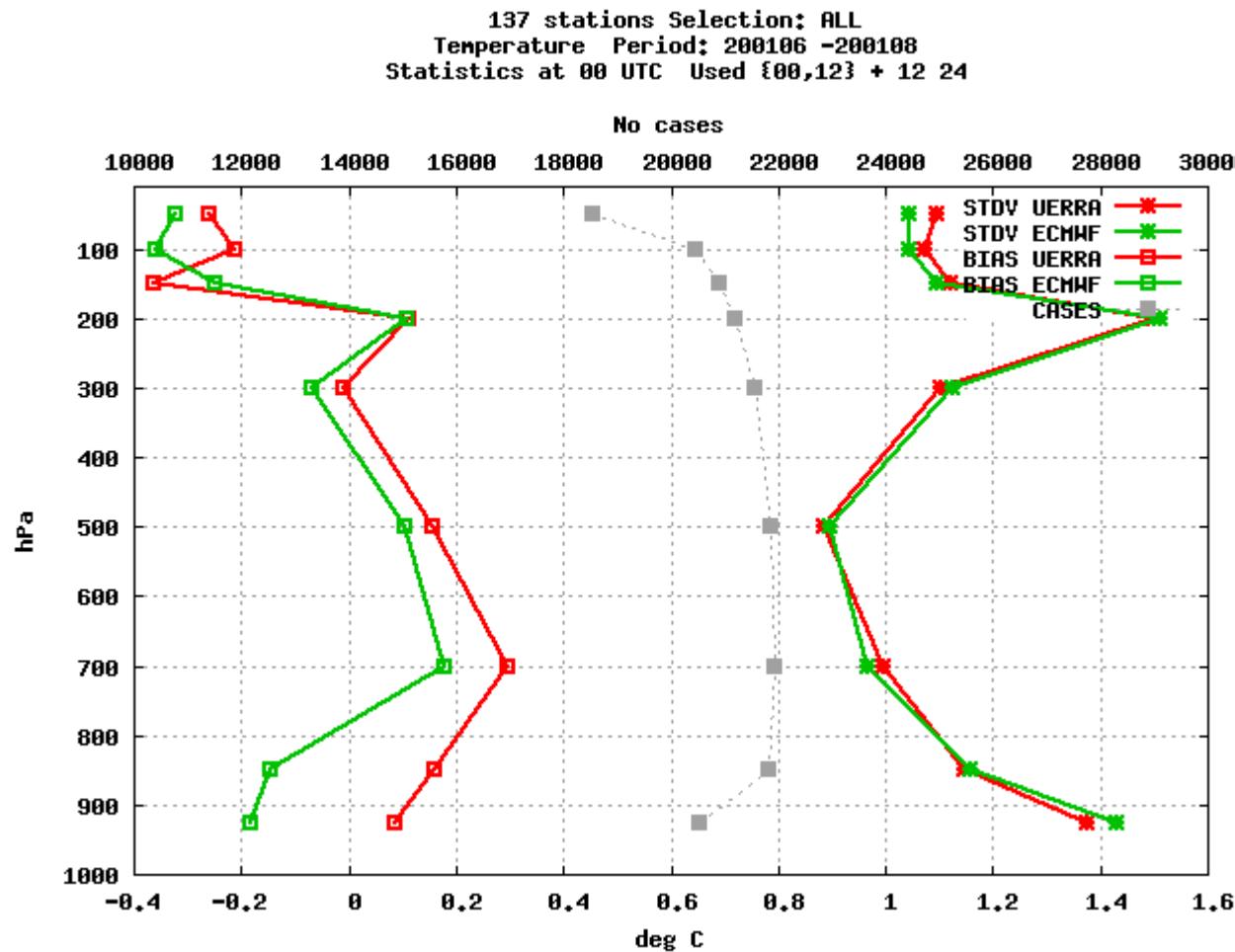
V = Error covariances of ERA-Interim in the HARMONIE geometry

Need some ensemble statistics to determine V

Observation comparison between UERRA and ERA-INTERIM

SMHI HARMONIE ALADIN 3D-VAR 11 km reanalysis summer 2001

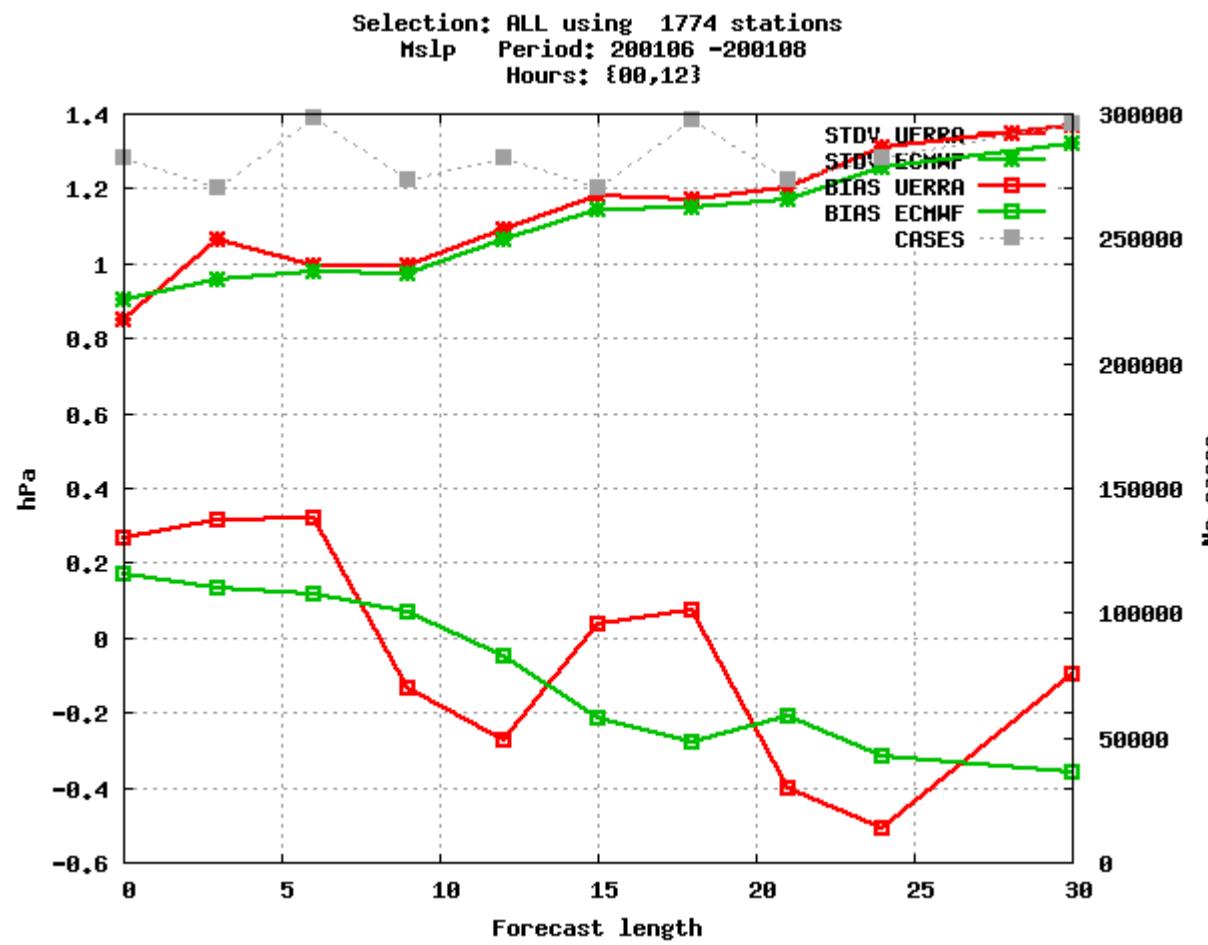
Radiosondes bias and standard deviations



UERRA

ERA-Interim

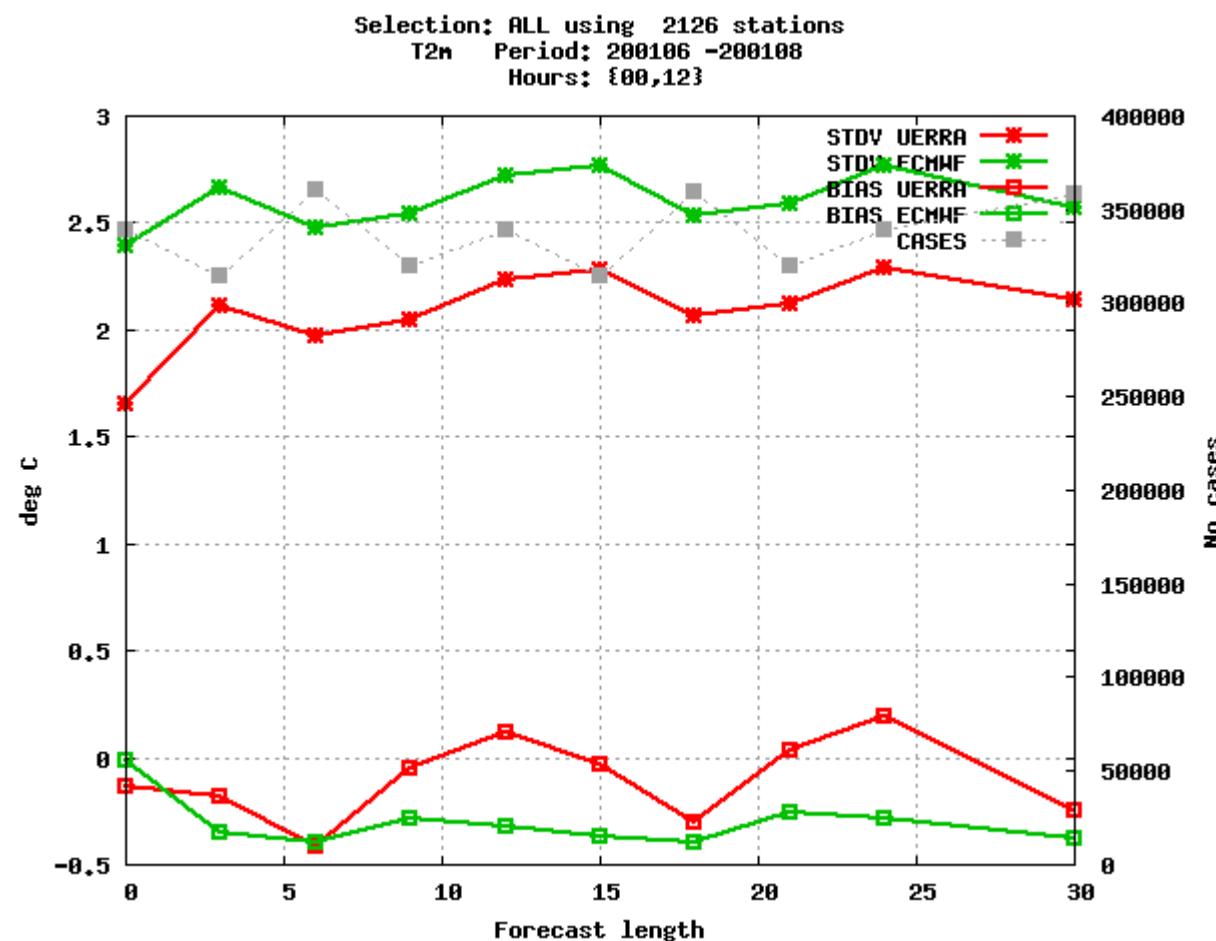
MSL pressure



UERRA

ERA-Interim

T2m

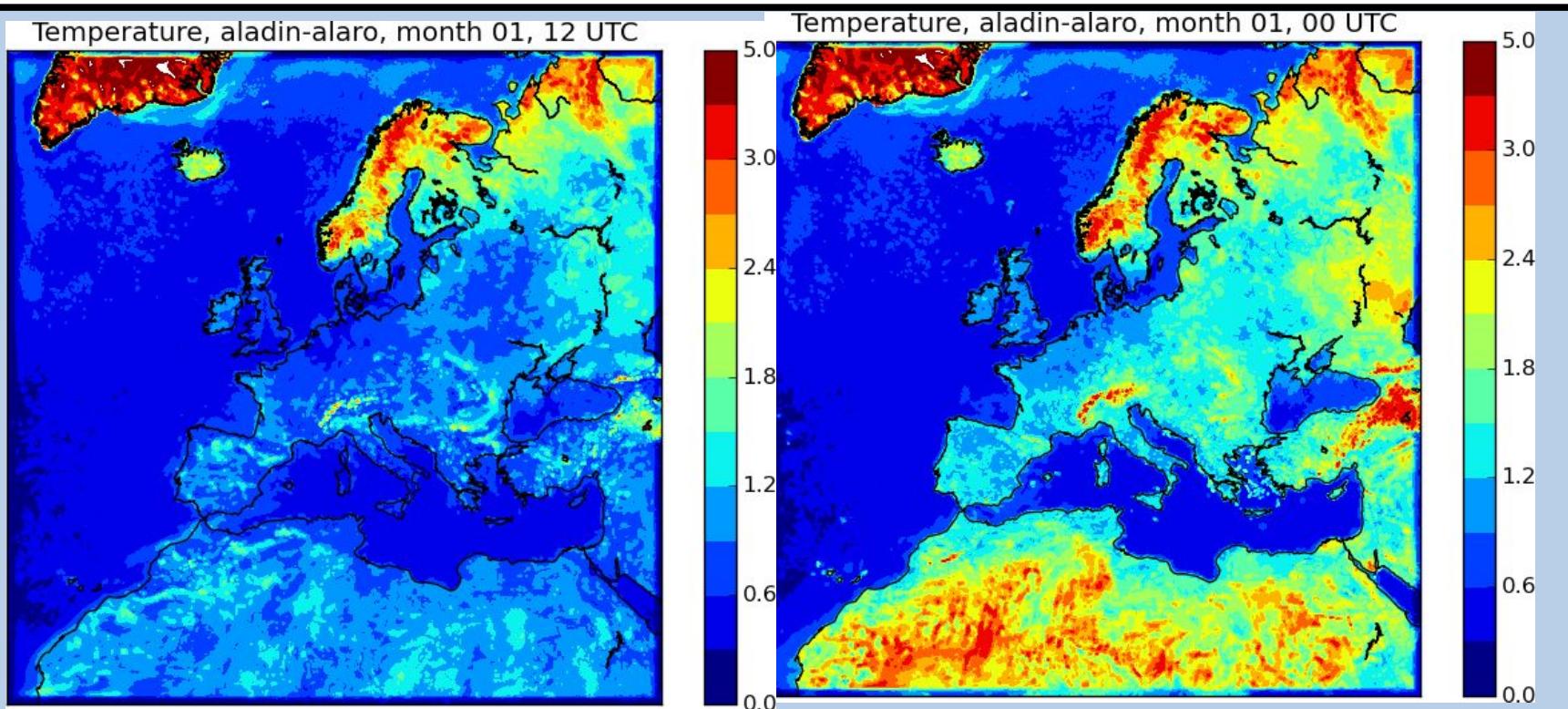


UERRA

ERA-Interim

Differences due to 2 physics schemes

Ensembles :
Standard Deviation of ALADIN-ALARO Physics differences

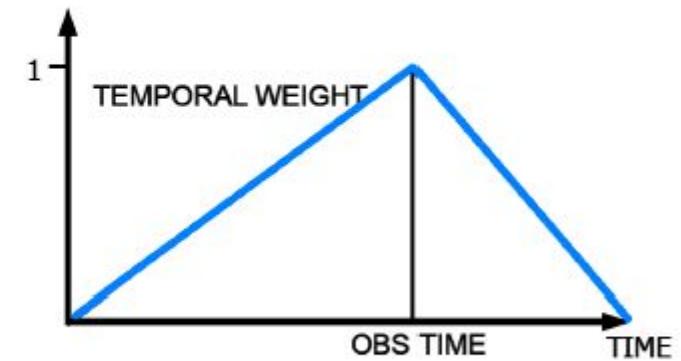
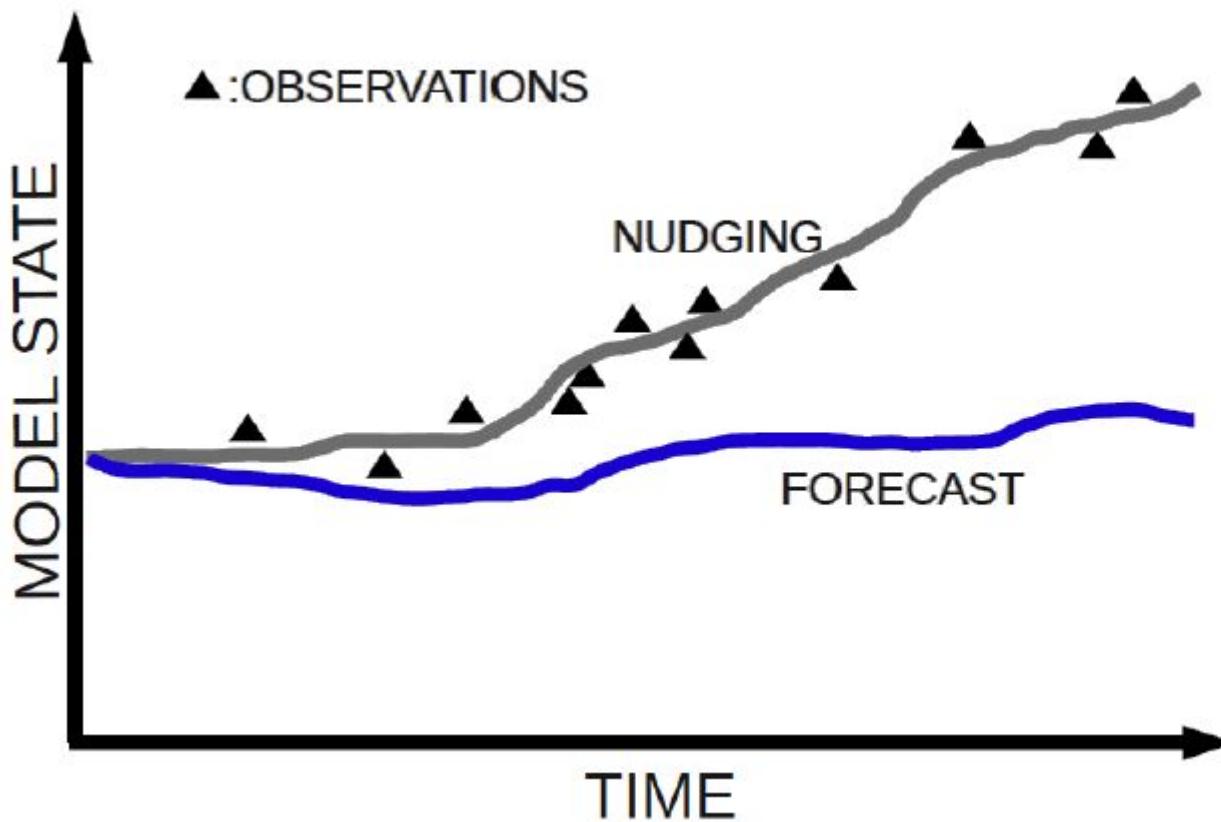


SMHI HARMONIE

COSMO University Bonn / DWD

Ensemble nudging

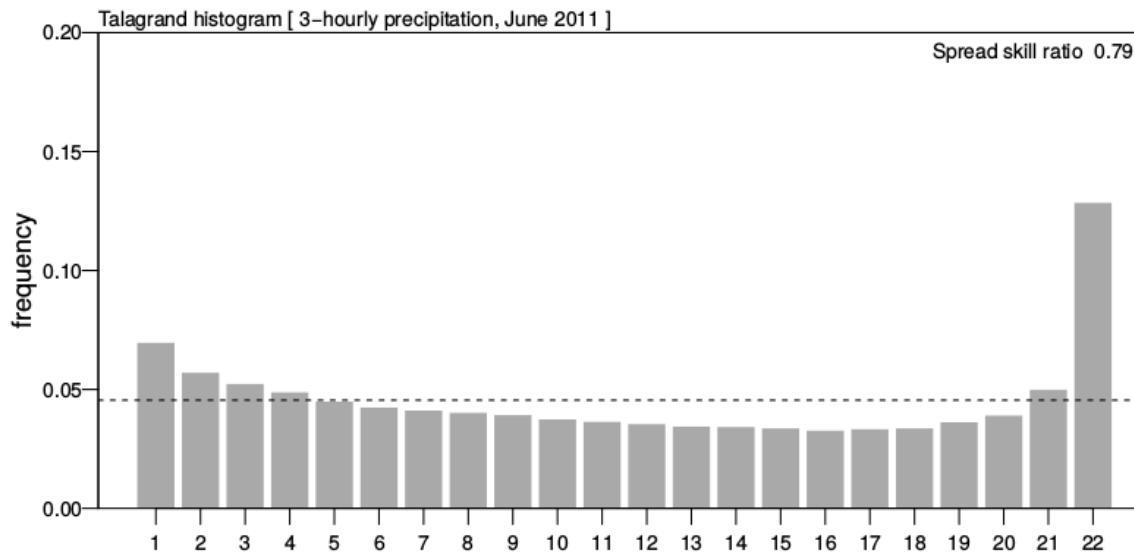
$$\frac{\partial}{\partial t} \psi(\mathbf{x}, t) = F(\psi, \mathbf{x}, t) + G_\psi \cdot \sum_{k(obs)} W_k(\mathbf{x}, t) \cdot [\psi_k^{obs} - \psi(\mathbf{x}_k, t)]$$



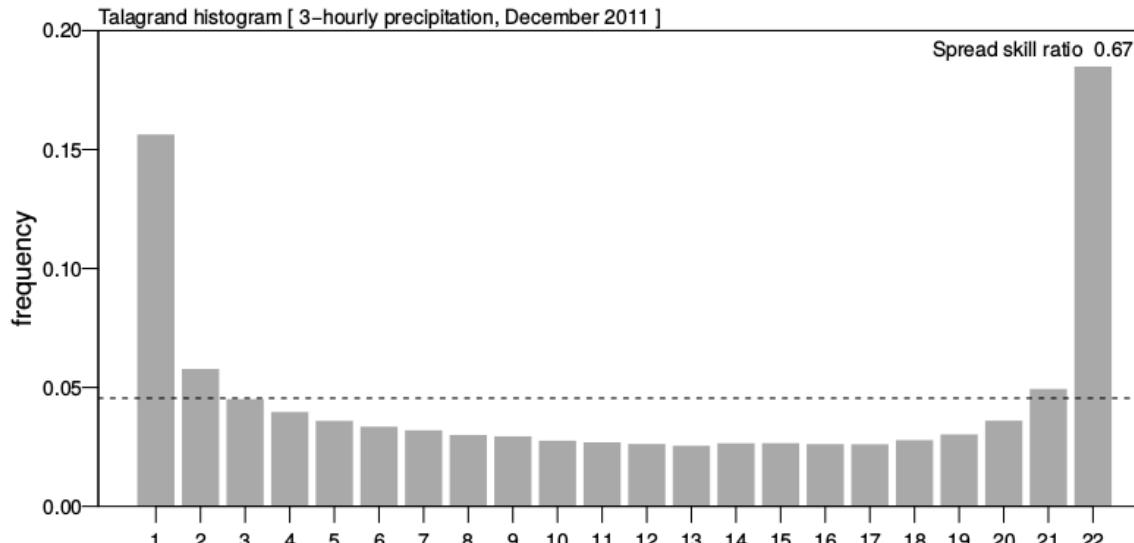
(1) Schraff, 1997

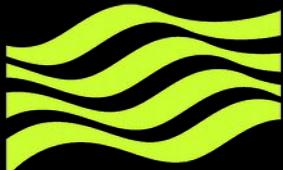
Analysis rank histogram - validating ensemble quality

June



December





Met Office

UERRA – Met Office

- Satellite Era Reanalyses

- Size 20 Ensemble of static 4DVAR
- Provides lower resolution fields with uncertainty estimation
- i.e. mean & spread at 24km
- **Production start: Sept 2016**

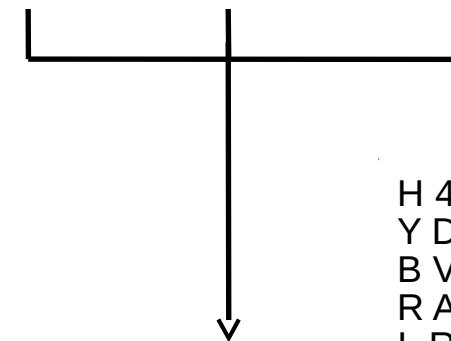
- Deterministic reanalysis using hybrid 4DVAR
- Uses ensemble reanalysis uncertainty to improve assimilation (B)
- Provides higher resolution deterministic fields at 12km
- **Production start: late 2016**

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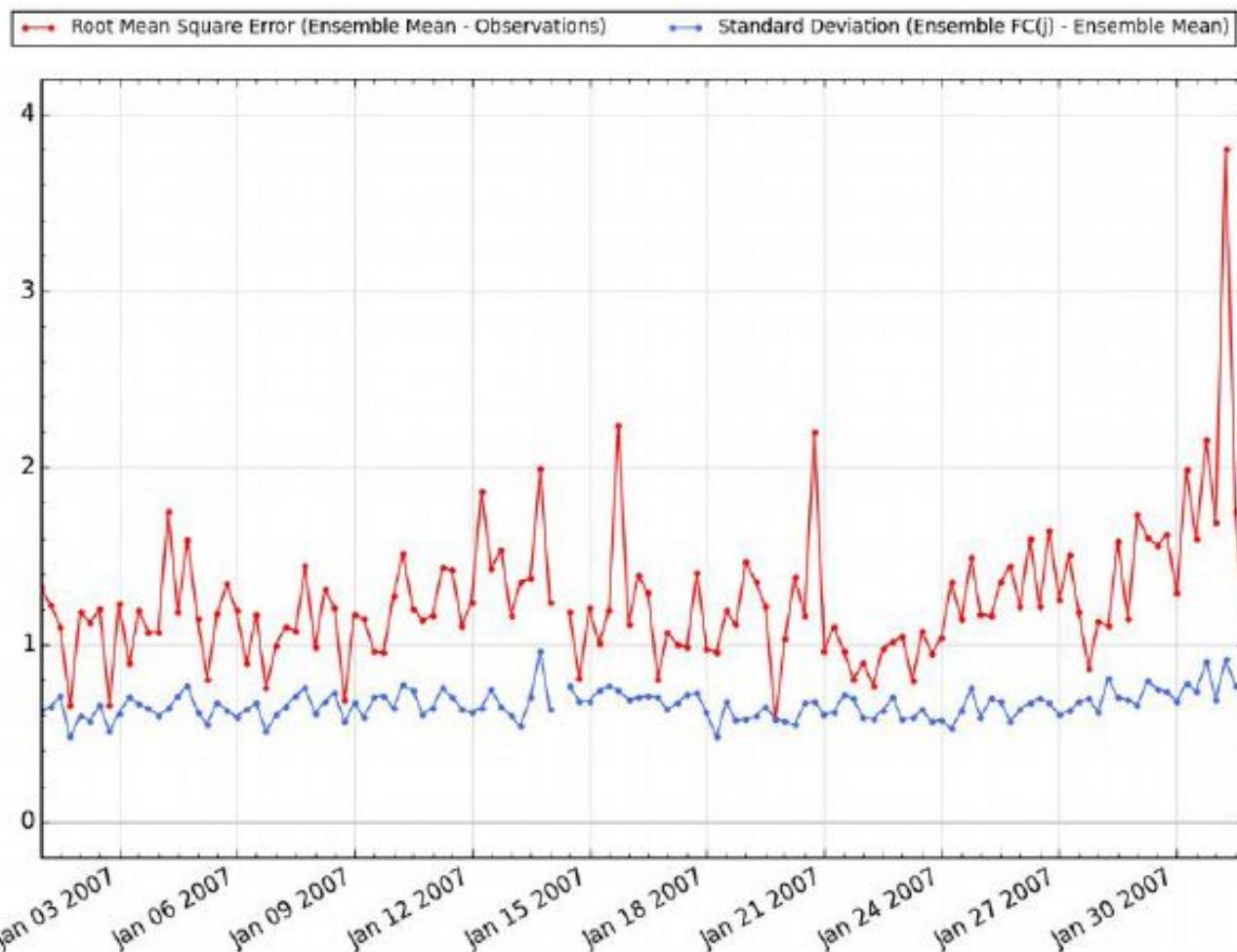


- Ensemble provides ‘errors of the day’ to hybrid

U
M

Met Office spread and errors

Figure 5: January 2007, RMS Error (red) in ensemble mean 850hPa temperature



(K) verified against radiosondes, and ensemble spread (blue)

2-D surface fields analyses driven by 3D reanalyses

MF/SMHI
MESCAN

2D advanced
Statistical
Interpolation

Downscaled
ALADIN model
background

Surface and climate
stations
T, Td,
precipitation

5 km Europe
T2m, RH, 24 h
precipitation

1961 - ~2016

SMHI
MESAN

2D advanced
Statistical
interpolation

Downscaled
3D HIRLAM model
Climatological
adaptation background

AVHRR, METEOSAT
SEVIRI and
MVIRI

5 km Europe
Cloud fraction
hourly

~1982 - 2013

SMHI
HYPE

Hydrological
physical
model

ERA, EURO4M and
UERRA reanalyses
Precipitation and
temperature forcing

No input observations
Validation against
discharge data

River discharge
35000 catchments
Europe, median
215 km²

~1979 - 2010

MF SURFEX
and TRIP

Surface flux model
Hydrological physical
model

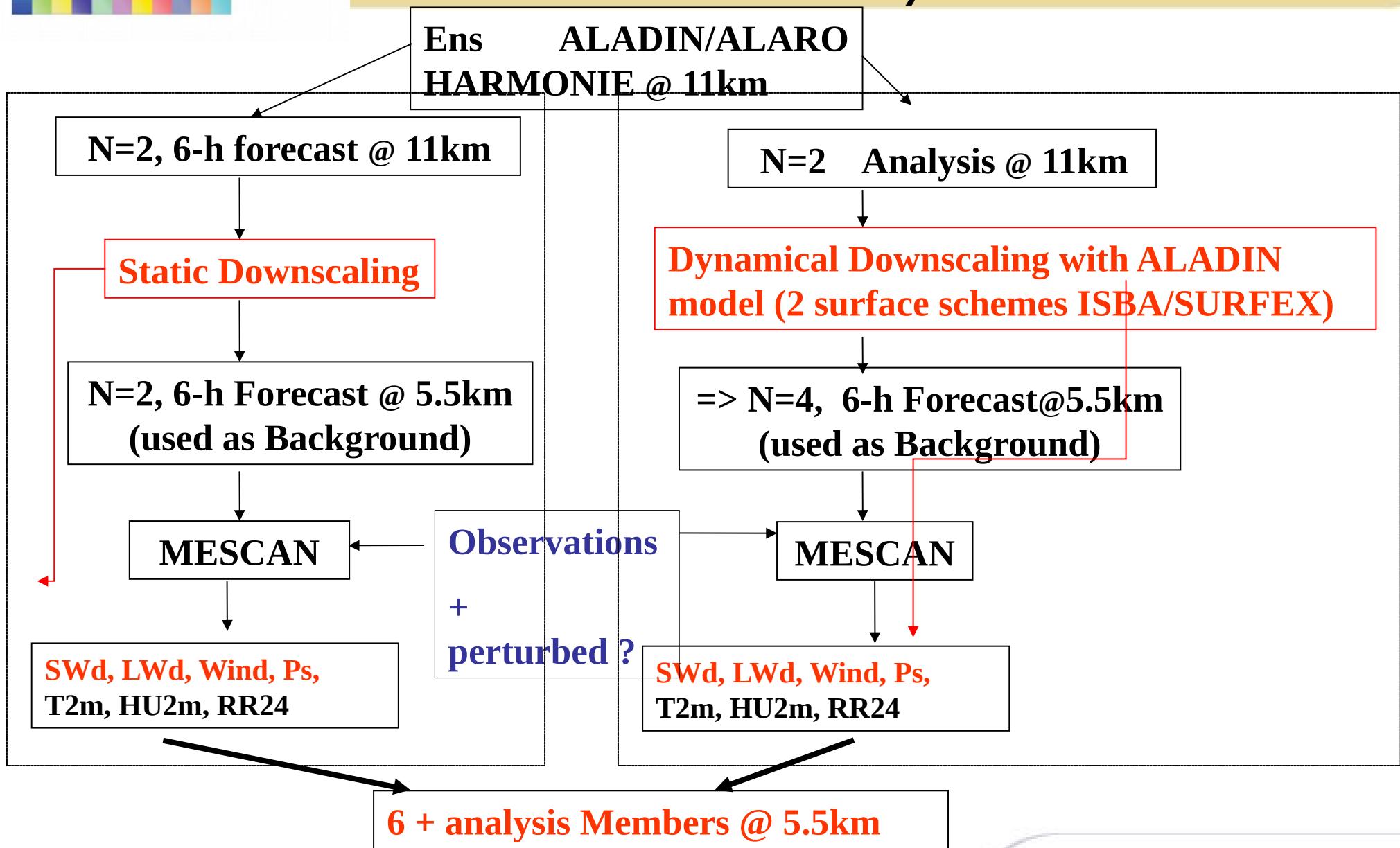
MESCAN
atmospheric
variables and
precipitation

No input observations
Validation against
discharge data

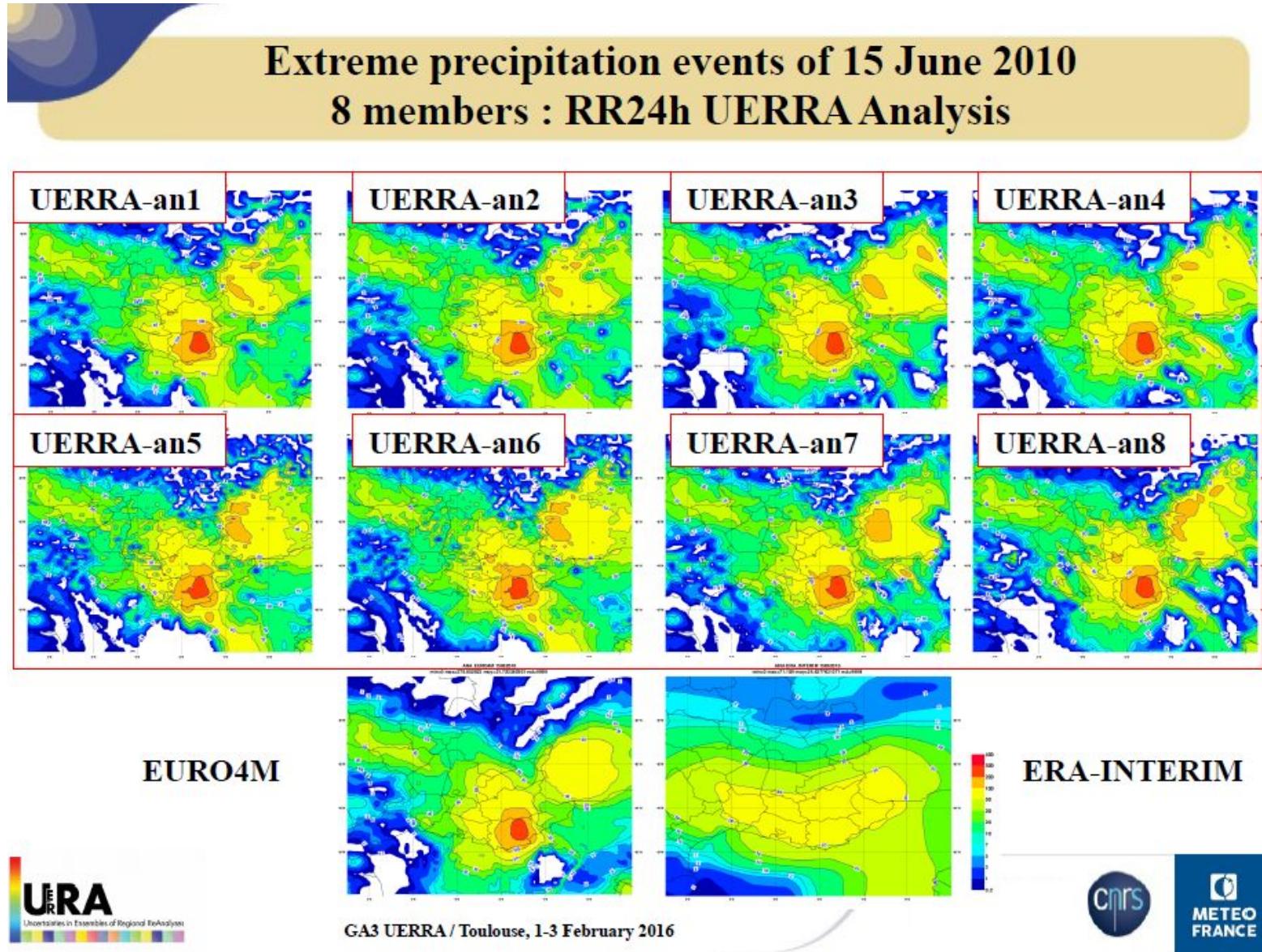
River discharge
25 km -> rivers

~1981 - 2010

Ensemble of Surface analyses 2006-2010 (Test-bed)

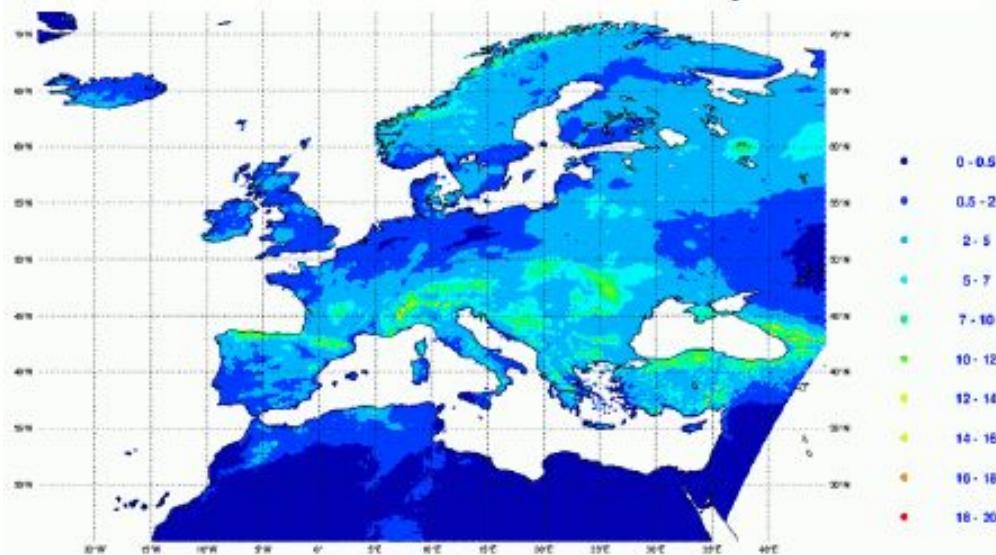


Ensemble members due to different model backgrounds

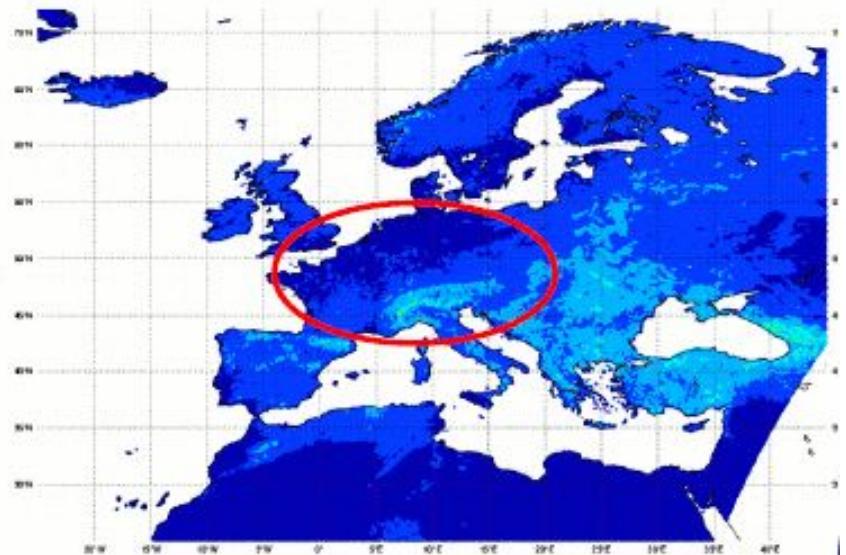


Statistics and uncertainty from ensemble

Ensemble Mean of Analyses

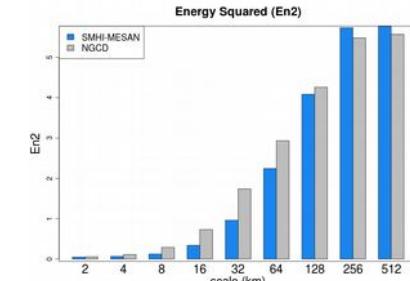
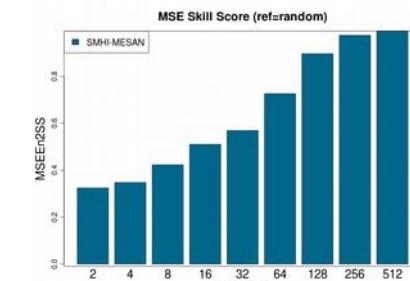
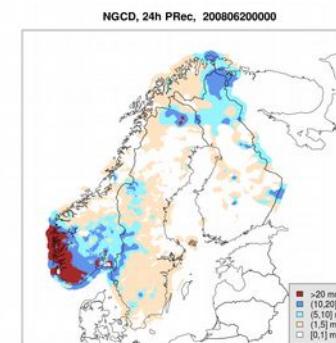
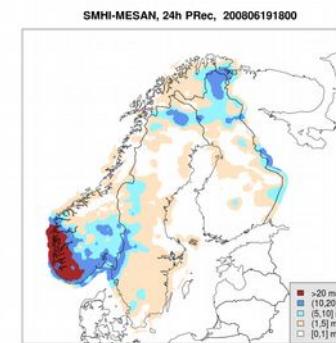
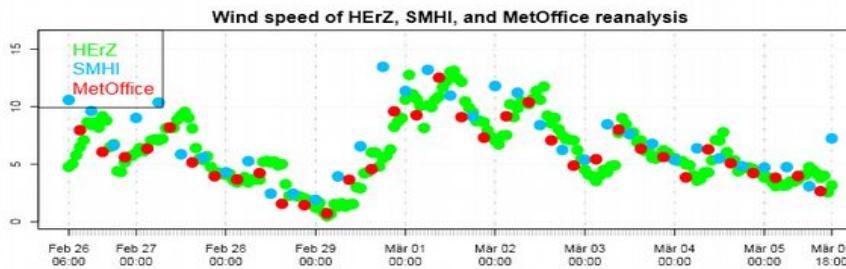
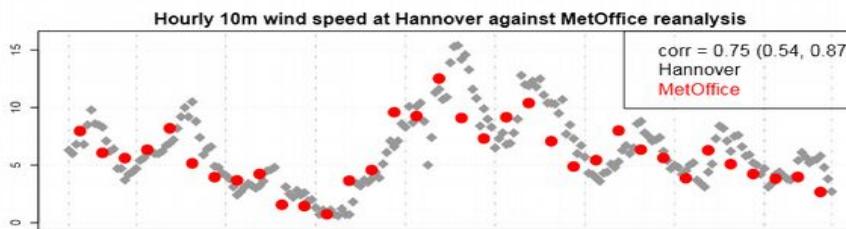
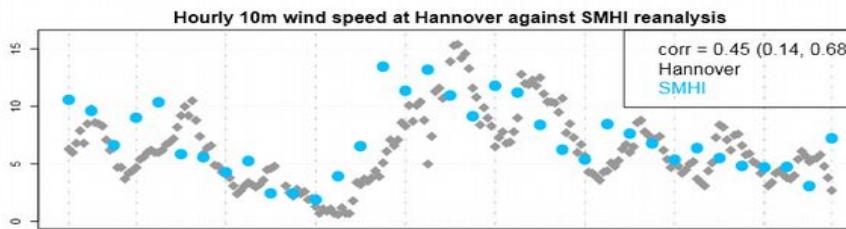
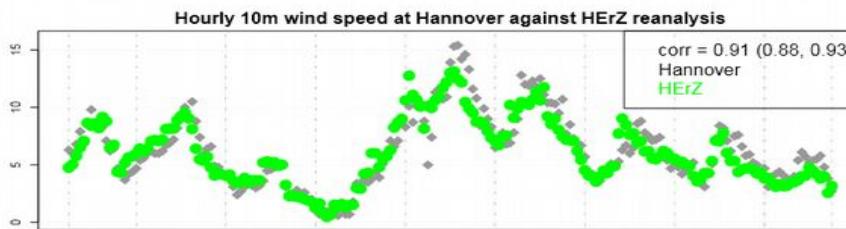


Ensemble Mean SD of Analyses



Evaluation

Nordic Gridded Climate Dataset as one reference



Evaluation R-library for spatial verification PDF based
20

Timeline

2015 – HARMONIE 5 years 2 physics

- HARMONIE
- MF MESCAN (5 year 6 member ensemble)
- UM Ensemble 4D-VAR start test only
- MESAN cloud analysis 0 years test

2016 – HARMONIE another 20 y -> 25-30 y 5 streams @ 4-5 years

- MESCAN -> 5 + 25 years
- MESAN cloud analysis 25 years
- UM Ensemble 4D-VARs 20-30 years
- UBO COSMO Ensemble 5 years

2017 – HARMONIE 25 years -> 55 years

- MESCAN 25 years -> 55 years
- UM Ensemble 4DVAR -> 36 years, Hybrid 4D-VAR 36 years
- UBO COSMO diagnostics

End

Showcase Workshop afternoon 23/11 -24/11
ECMWF, Shinfield Park, Reading

Read more on www.uerra.eu

www.uerra.eu