UERRA - Uncertainties in Ensembles of Regional ReAnalyses

SMHI

METEO FRANCE
Toujours un temps d'avance

Koninklijk Nederlands Meteorologisch Instituut
Ministerie van Infrastructuur en Milieu

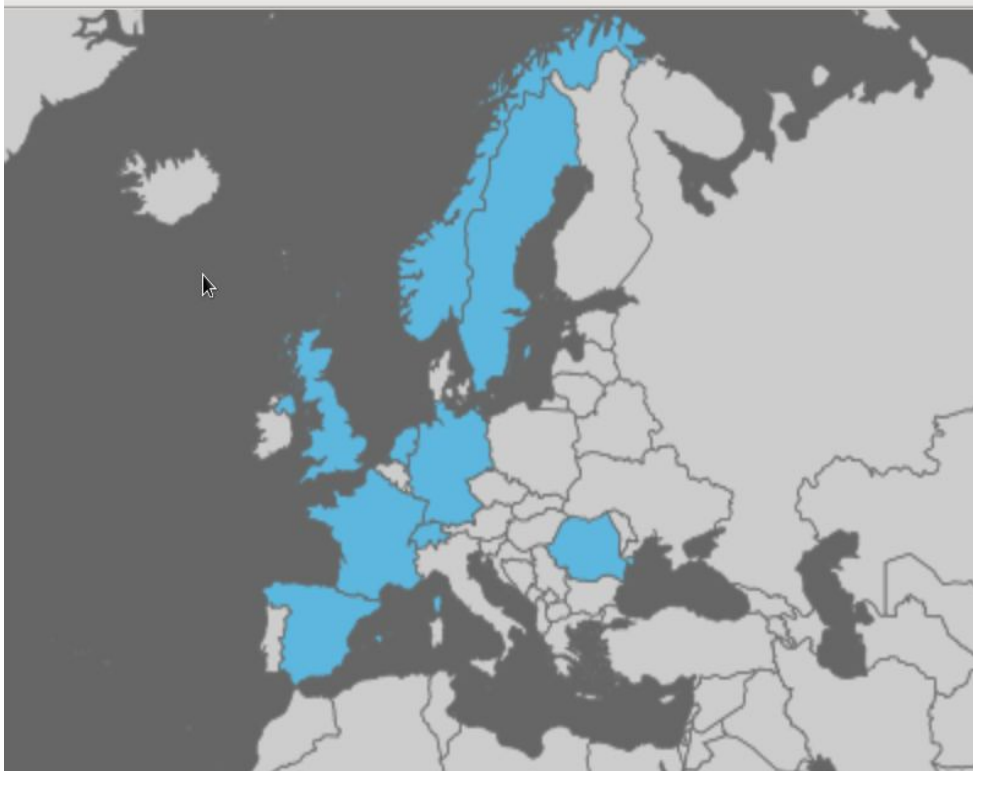
UEA
University of East Anglia

Met Office

ECMWF

Deutscher Wetterdienst
Wetter und Klima aus einer Hand

DWD



Meteorologisk institutt

UNIVERSITAT ROVIRA I VIRGILI

METEO ROMANIA

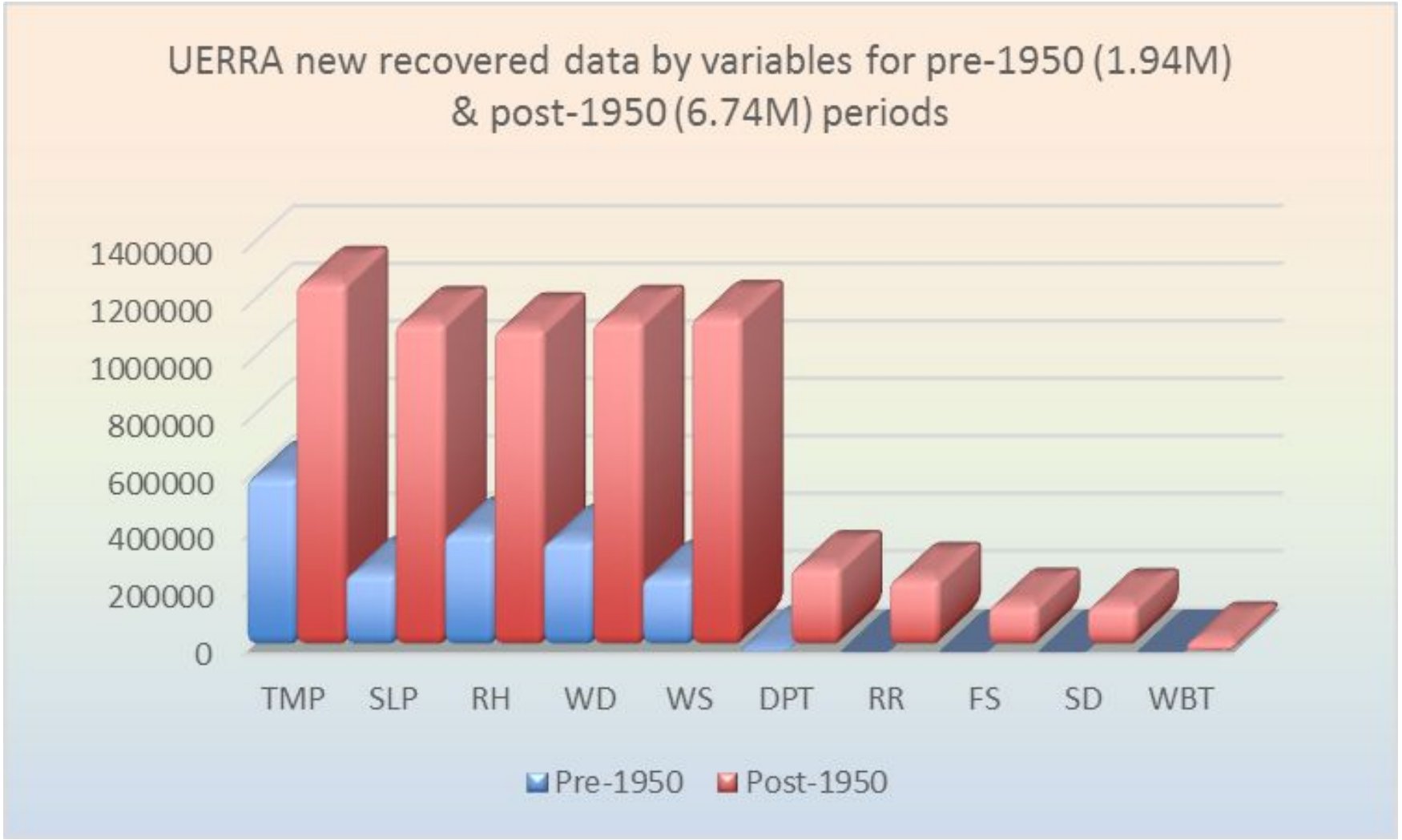
universitätbonn
Rheinische Friedrich-Wilhelms-Universität Bonn

UERRA : Grant Agreement 607193 EU FP7 SPACE 2013-1

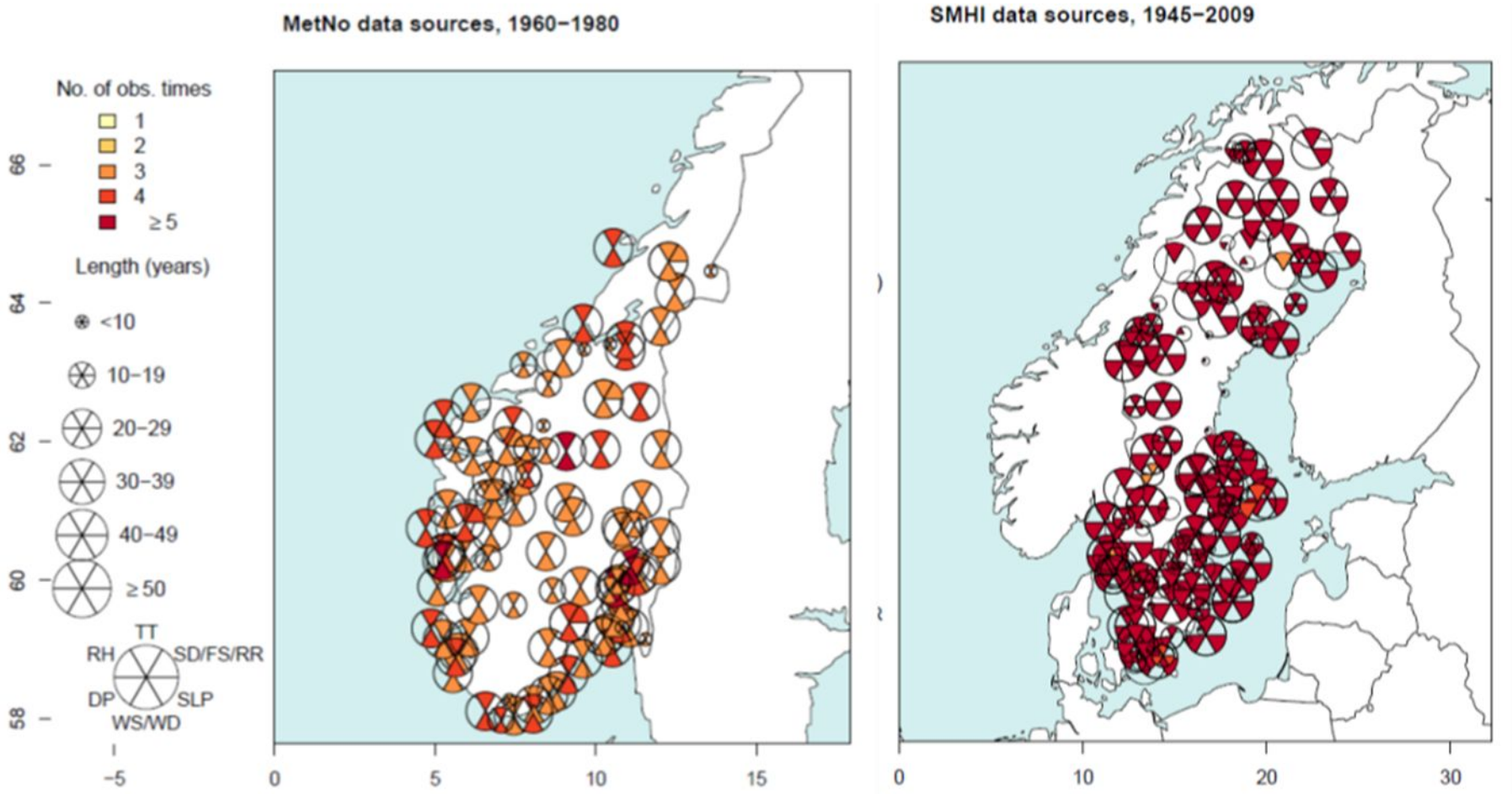
One of 5 pre-operational Copernicus Projects

ERA-CLIM2	European Reanalysis of the Global Climate System
UERRA	Uncertainties in Ensembles of Regional ReAnalyses
QA4ECV	Quality Assurance for Essential Climate Variables
CLIPC	A Climate Information Portal for Copernicus
EUCLEIA	European Climate and weather events: interpretation and attribution

Distribution of the 8.7 M rescued observation data from URV. NMA-Romania has rescued additionally 300 k precipitation observations. Catalonia, Norway and Sweden have provided some 170 M data from their already digitised open data which have not been available before.
The data are undergoing automatic and manual quality control flags and some 9 % are flagged of which half can be corrected.

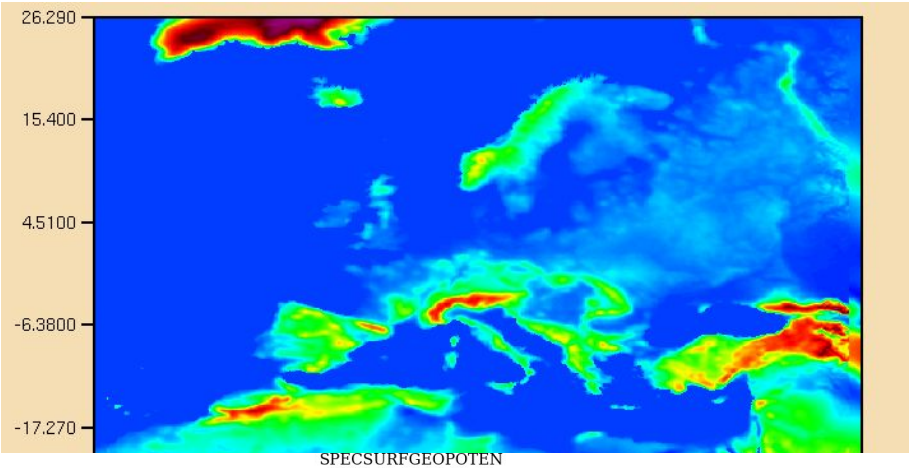


Norwegian and Swedish open data extracted and forwarded

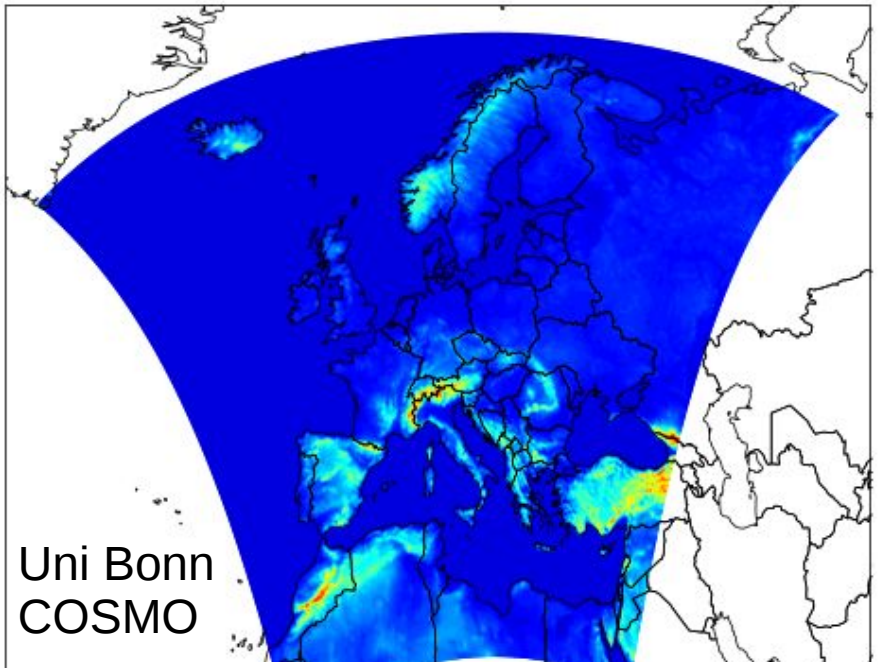


UERRA Domain & projections

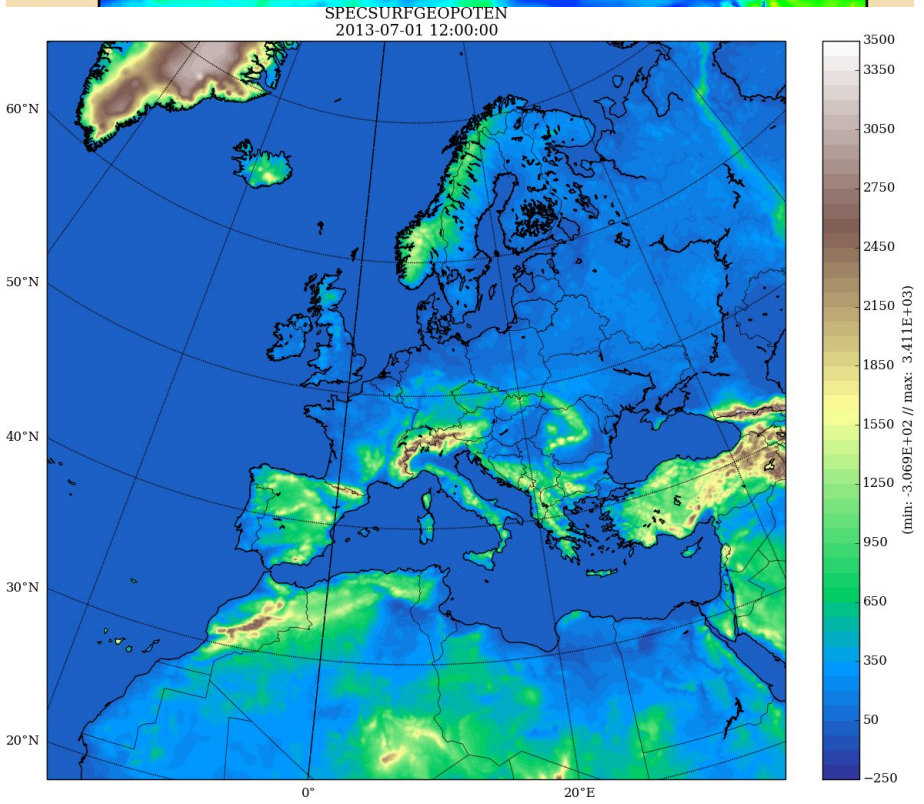
Met Office CORDEX EU 11 km



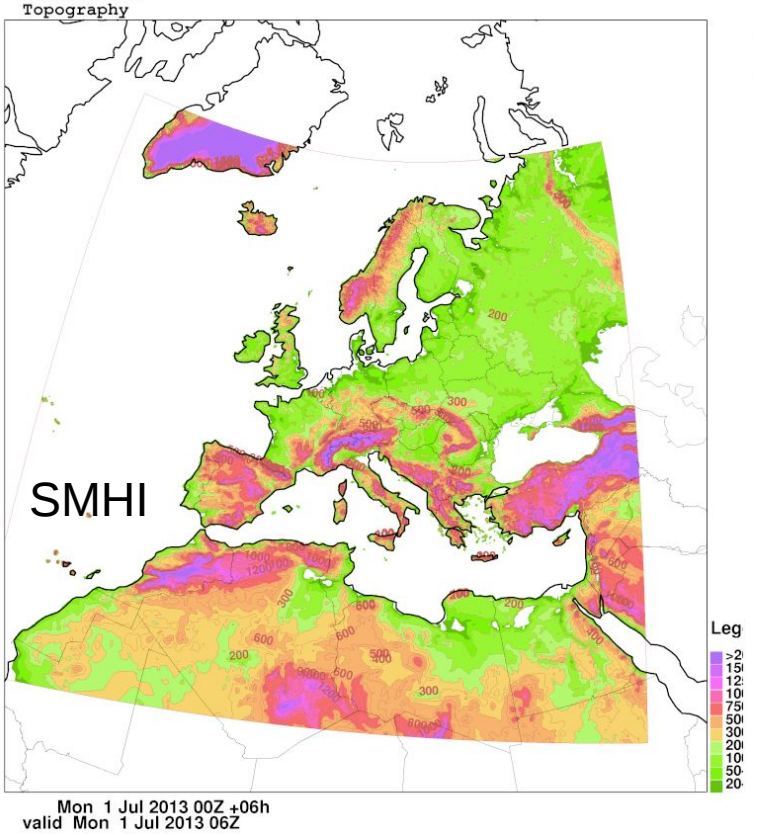
Uni Bonn COSMO



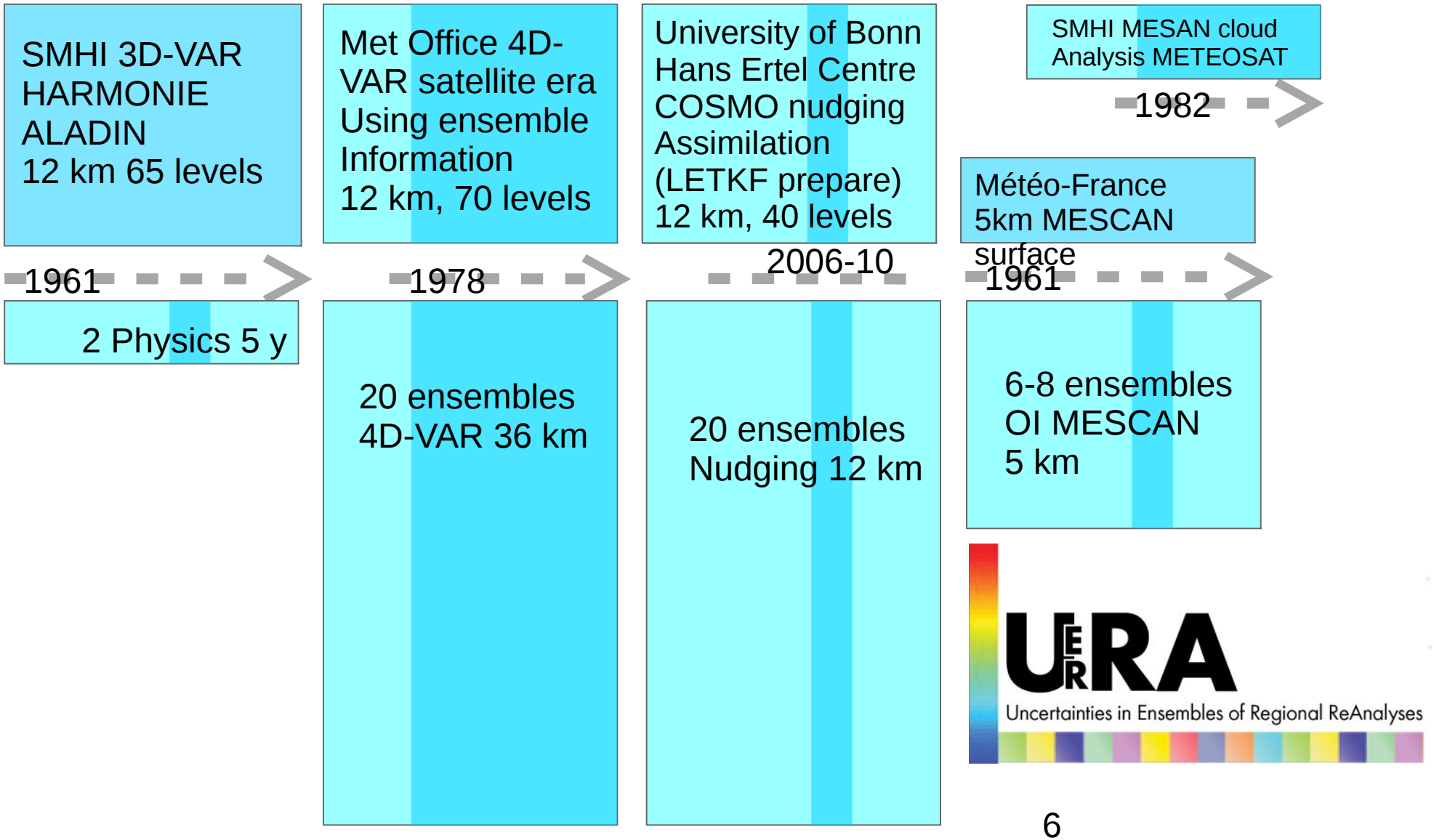
MF



SMHI



European domain, Multi-model, Deterministic and Ensembles (2,20,20, 6-8 members), over 35-55 years (5 and 20 years UB/MESAN)



UERRA
Uncertainties in Ensembles of Regional ReAnalyses

SMHI - HARMONIE ALADIN reanalys:
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:

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

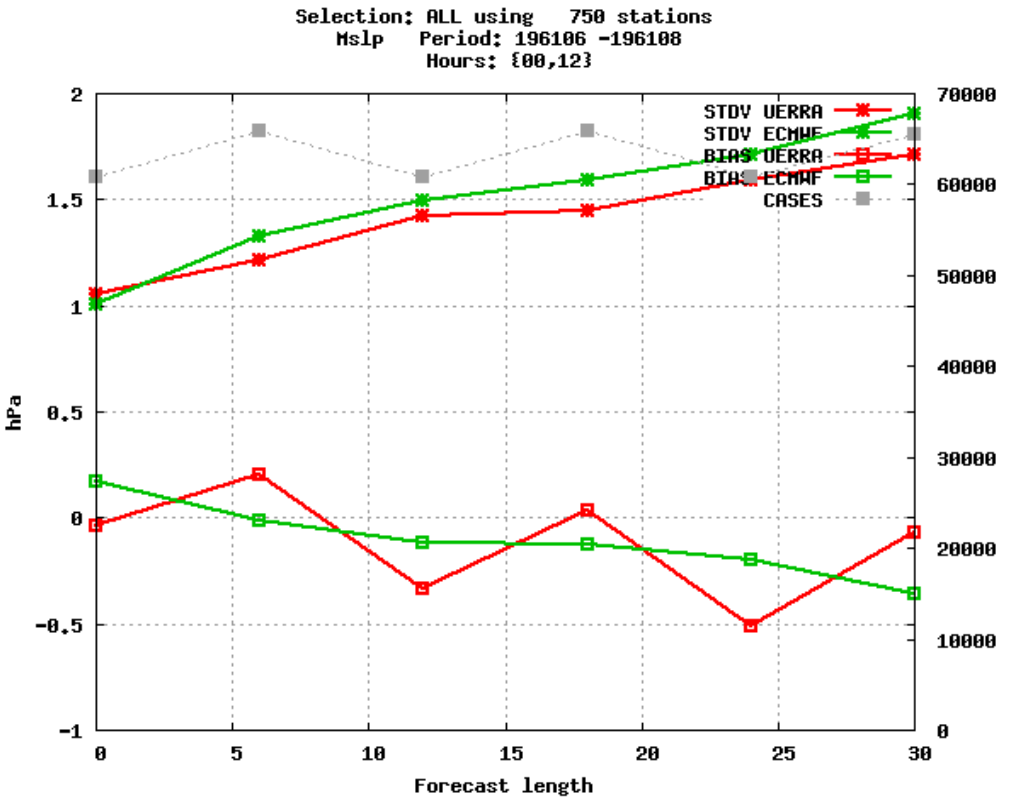
V = Error covariances of ERA-Interim in the HARMONIE geometry

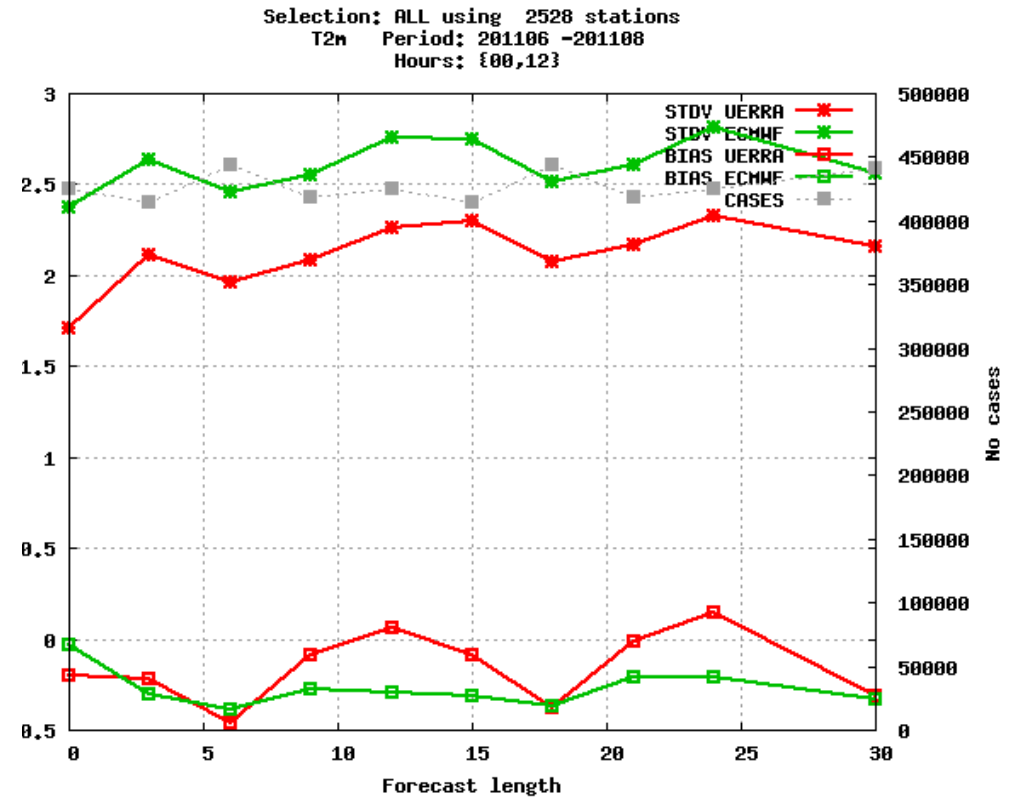
Need some ensemble statistics to determine **V**

Model setup

	Aladin	Alaro
Dynamics	2TL Semi-implicit semi-lagrangian discretisation, hydrostatic	
Vertical	Hybrid pressure terrain-following coordinate	
Horizontal diffusion	Spectral diffusion	Traditional SLHD
Surface	SURFEX (Le Moigne 2012)	
Turbulence	TKE (Cuxart et al 2000) (prognostic equation)	pTKE (Geleyn et al 2006)
Mixing length	Bougeault Lacarrere (1989) Modified by the shallow cloud thickness and deep convection	Prandtl-type mixing length (Geleyn)
Shallow convection	KFB (Bechtold et al 2001) (Mass flux scheme)	Modified Ri (Geleyn 1987)
Deep convection	Moisture convergence (Bougeault 1985)	3MT (Gerard & Piriou 2007)
Clouds (PDF)	Smith (1990)	Xu & Randall (1996)
GWD	Catry et al. 2008	
Microphysics	Ql,Qi,Qr,Qs Lopez(2002) Bouteloup et al (2005)	Ql,Qi,Qr,Qs,Qg(diag)
Radiation	RRTM for LW (Mlawer et al. 1997), SW (Morcrette et al. 2001)	Modified old version of acraneb

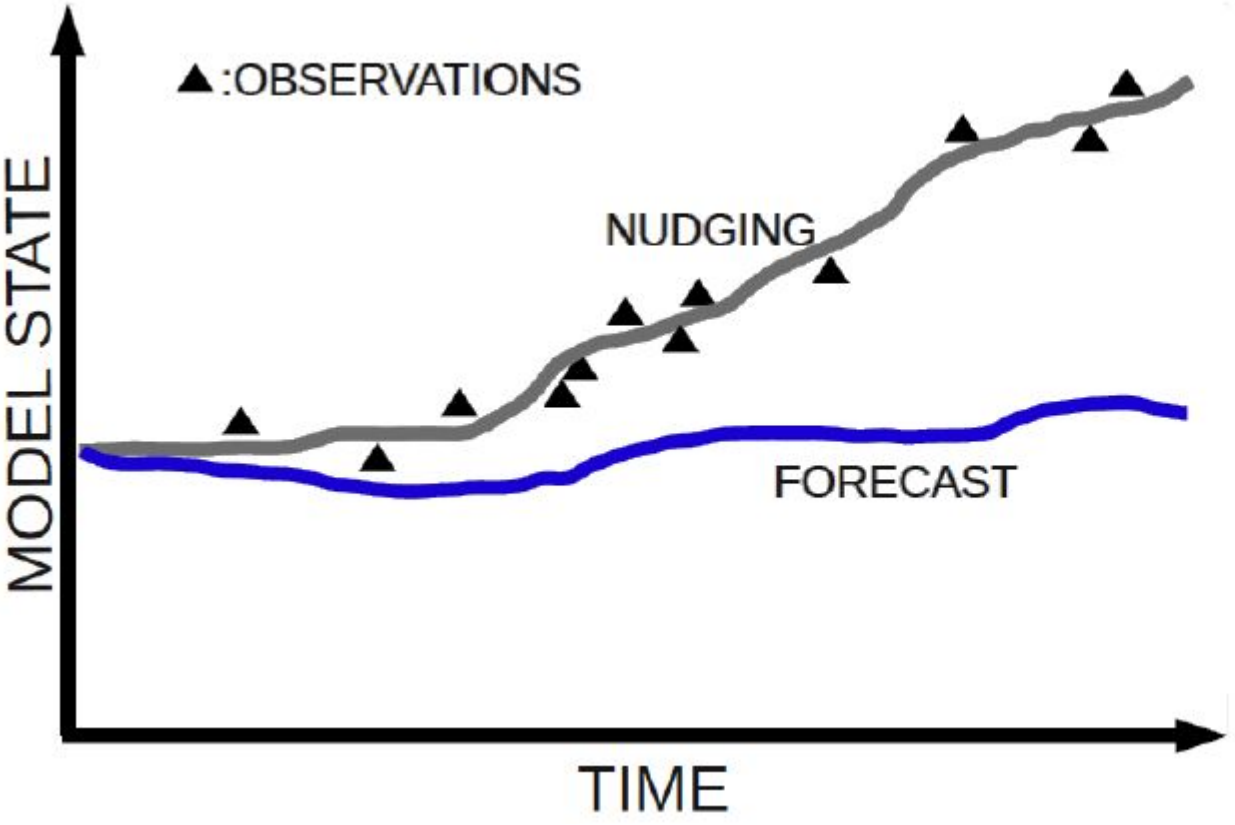
Standard deviation and bias between SMHI UERRA and SYNOP pressures and ERA-Interim June-August 1961 and to the right for T2m

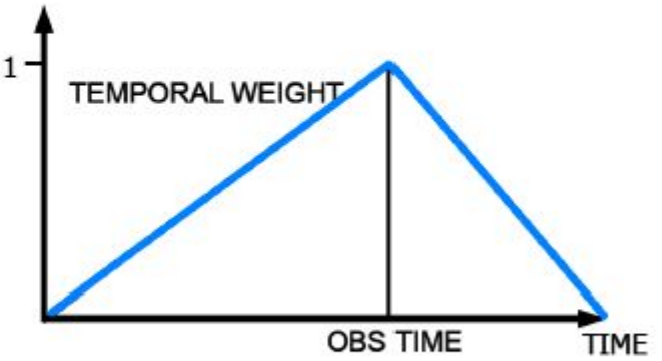




COSMO University Bonn / DWD
Ensemble nudging

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

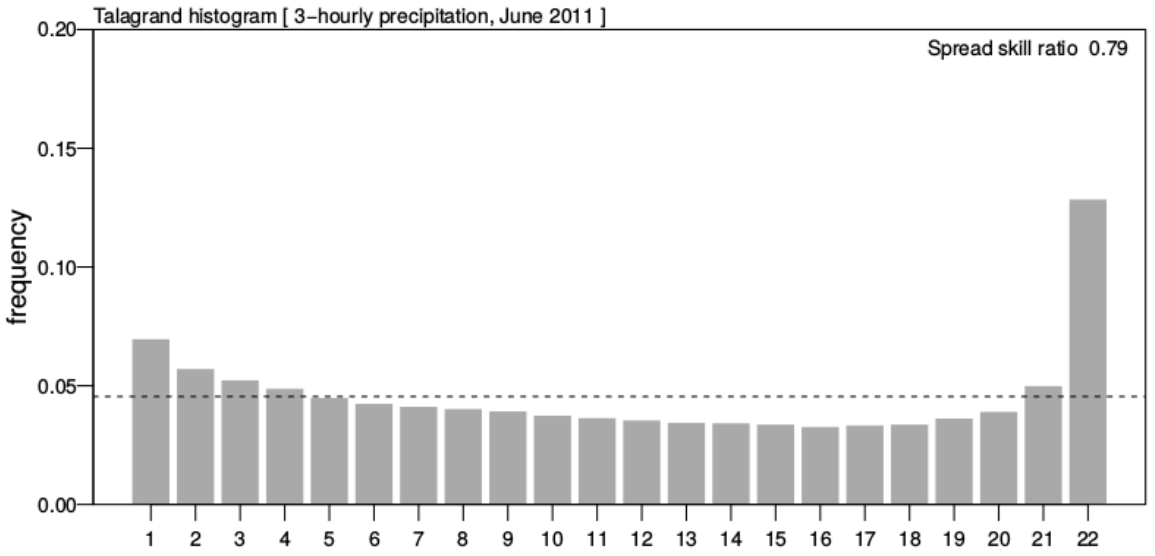




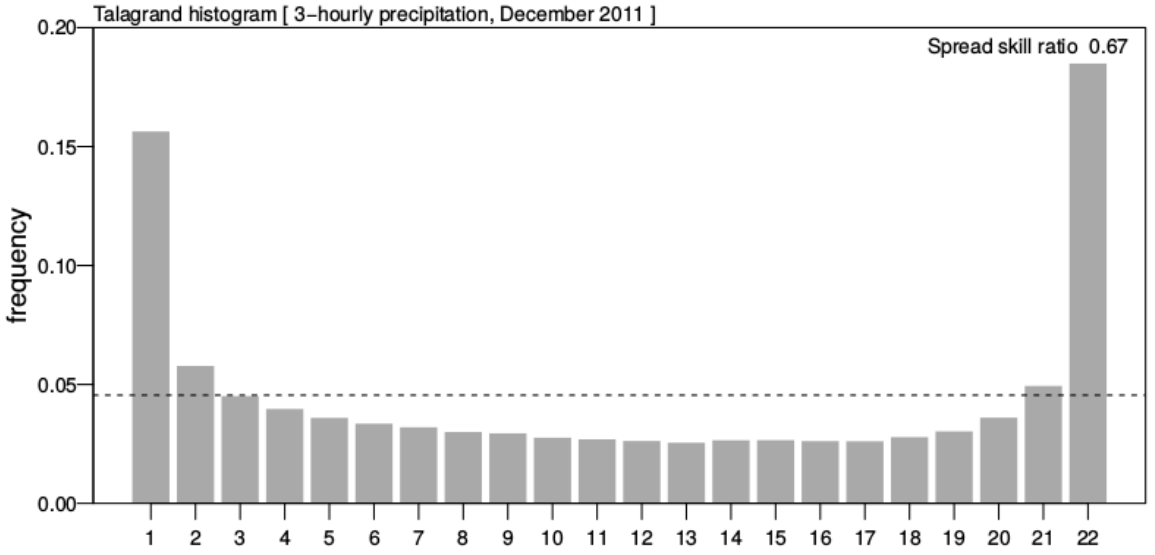
(1) Schraff, 1997

Analysis rank histogram - validating ensemble quality

June



December

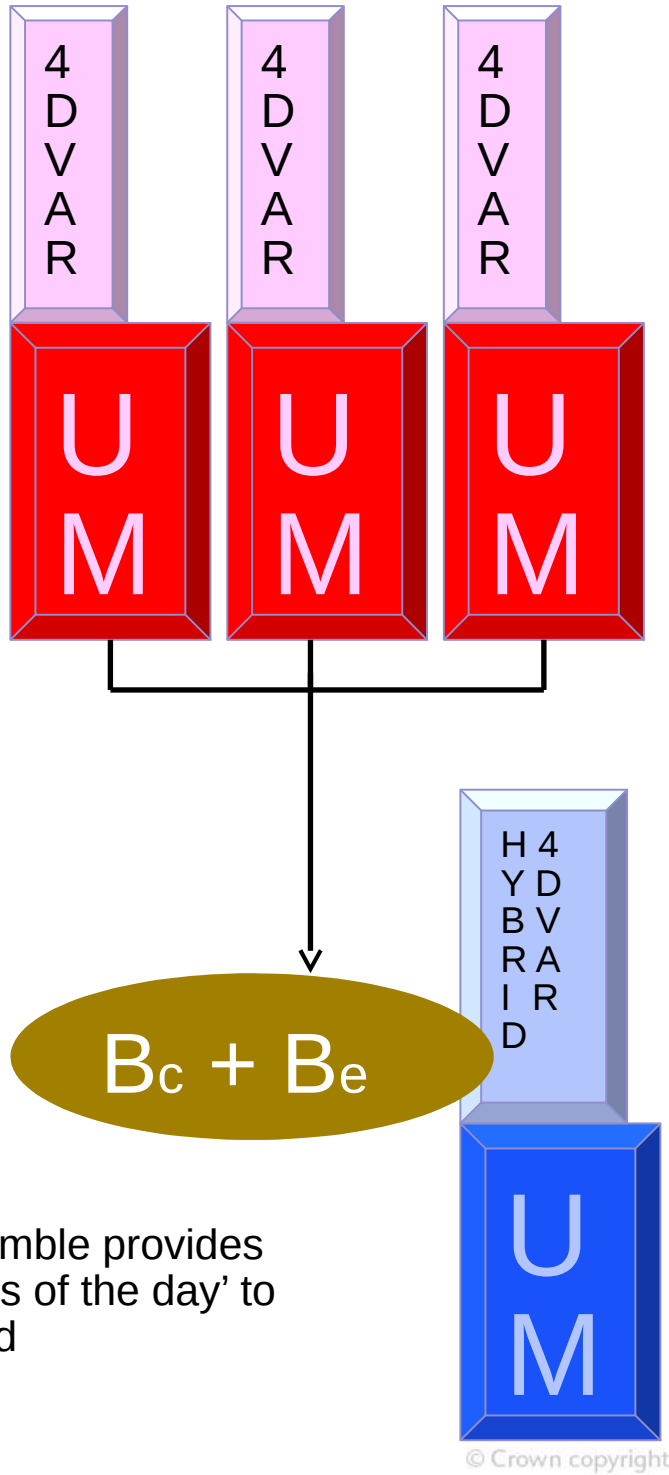


UERRA – Met Office

- Satellite Era Reanalyses

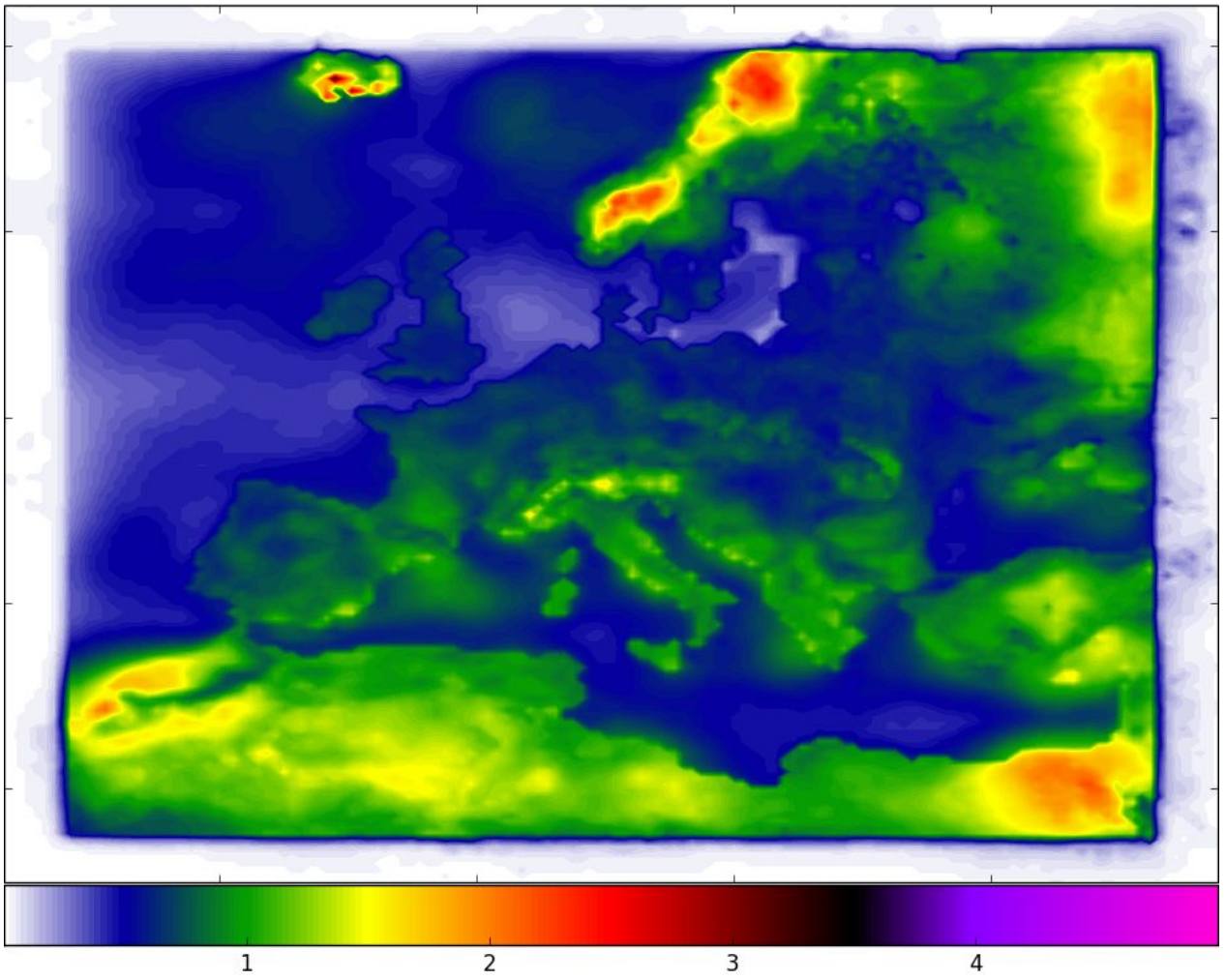
- **Size 20 Ensemble of static 4DVAR**
- Provides lower resolution fields with uncertainty estimation
- i.e. mean & spread at 24km
- **Production start: Dec 2015**

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



- Ensemble provides 'errors of the day' to hybrid

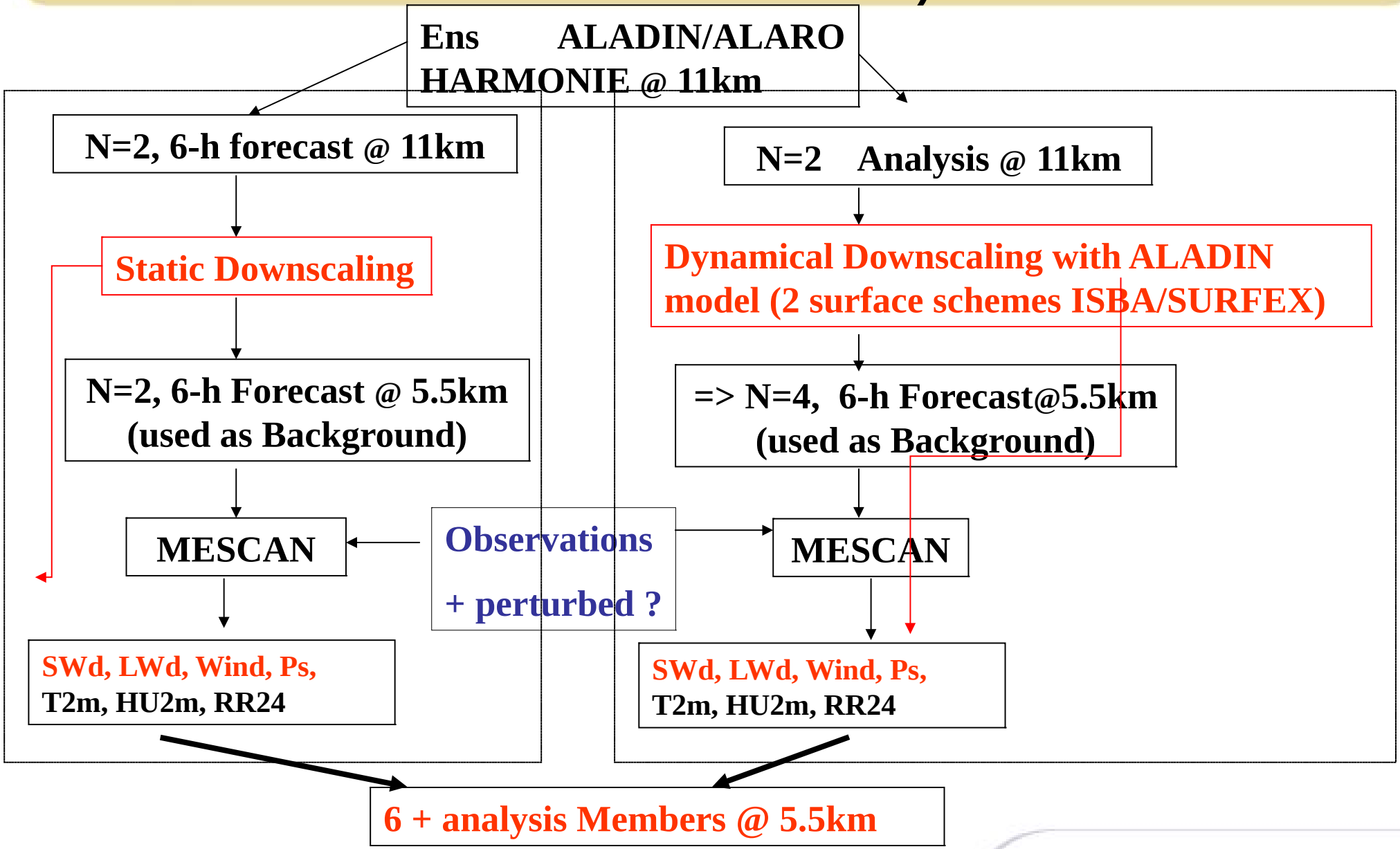
Spread of 2m temperature for March 1979 from the Met Office system Ensemble 4D-VAR reanalysis

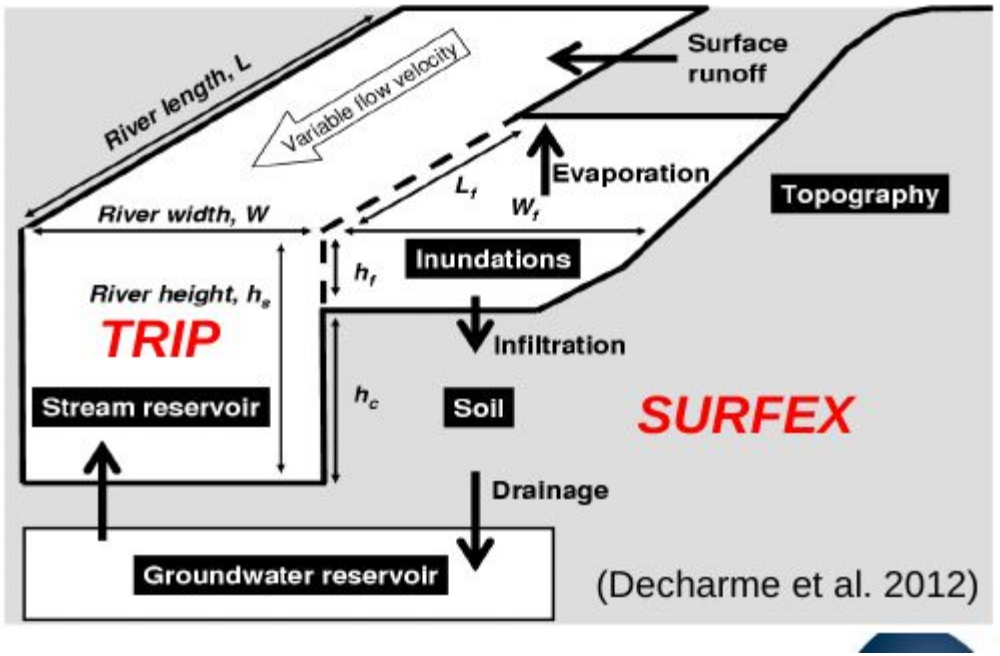


2-D surface fields analyses driven by 3D reanalyses

MF/SMHI MESCAN	SMHI MESAN	SMHI HYPE	MF SURFEX and TRIP
2D advanced Statistical Interpolation	2D advanced Statistical interpolation	Hydrological physical model	Surface flux model Hydrological physical model
Downscaled ALADIN model background	Downscaled 3D HIRLAM model Climatological adaptation background	ERA, EURO4M and UERRA reanalyses Precipitation and temperature forcing	MESCAN atmospheric variables and precipitation
Surface and climate stations T, Td, precipitation	AVHRR, METEOSAT SEVIRI and MVIRI	No input observations Validation against discharge data	No input observations Validation against discharge data
5 km Europe T2m, RH, 24 h precipitation	5 km Europe Cloud fraction hourly	River discharge 35000 catchments Europe, median 215 km^2	River discharge 25 km -> rivers
1961 - ~2016	~(1982)2004 - 2013	~1979 - 2010	~1981 - 2010

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





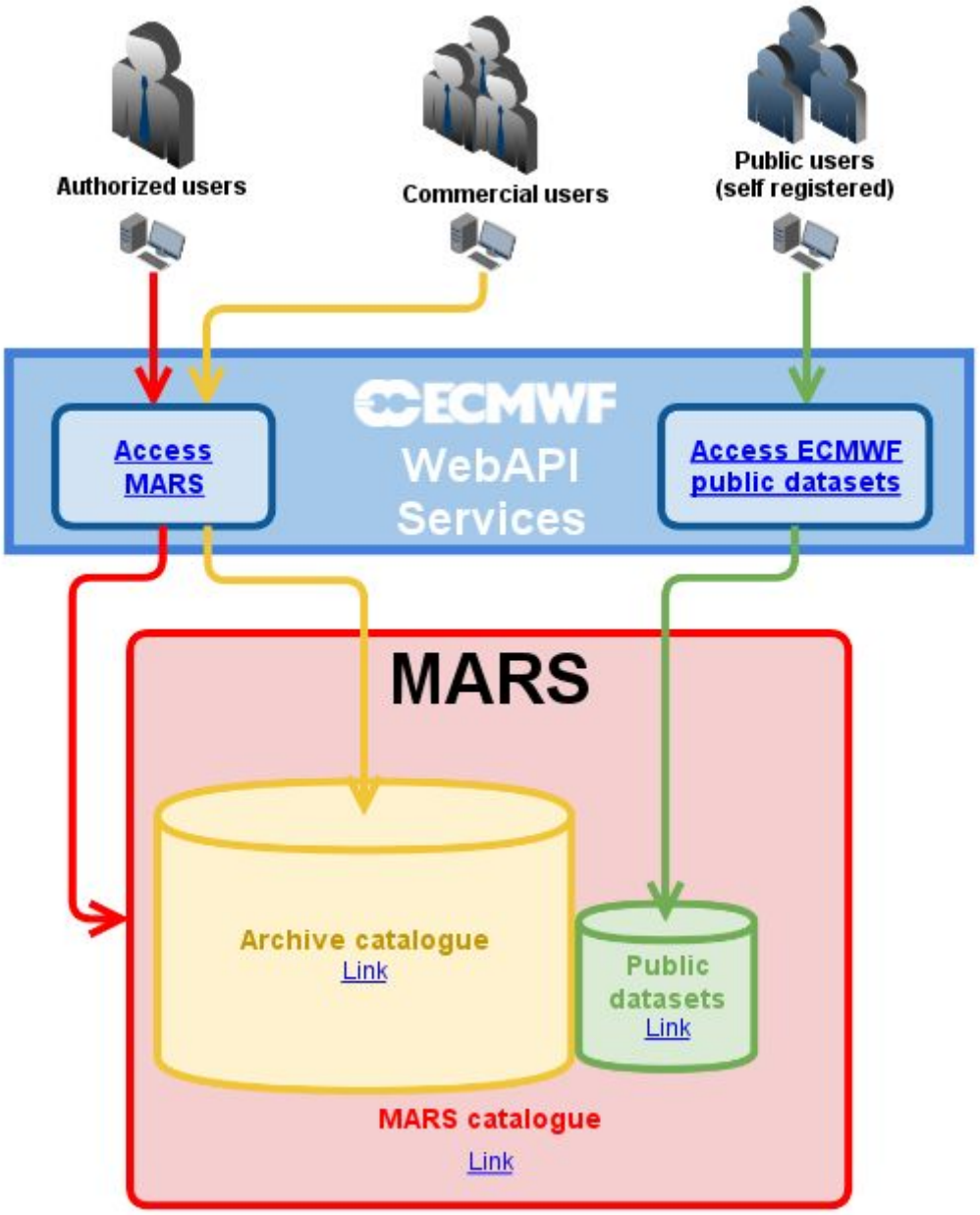
daily
Surface runoff
Drainage
every time step
Evapotranspiration
Canopy evaporation
Soil ice sublimation
Snow sublimation
Snow melting
Surface runoff
Drainage
TRIP
SURFEX
(Decharme et al.2012)

ARCHIVING IN MARS

+ The common UERRA archive is MARS at ECMWF
+ Data services from MARS and ESGF node at KNMI for E-OBS data and sub-set of reanalyses
+ Web Map Servers
+ Visualisation through Metview and WMS

ECMWF

ESGF
Earth System Grid Federation



Analysis: six hourly
at 00 UTC, 06 UTC, 12 UTC, 18 UTC (hourly for COSMO)
Forecasts : T+1,2,3,4,5,6,9,12,15, 18,21,24,27,30 started at 00 UTC and 12 UTC
T+1,2,3,4,5,6 started at 06 UTC and 18 UTC

Model levels

Store analysis output every six hours at 00UTC, 06UTC, 12UTC, 18UTC for all models.

Height levels

15
30
50
75
100
150
200
250
300
400
500

Pressure levels

1000
975
950
925
900
875
850
825
800
750
700
600
500
400
300
250
200
150
100
70
50
30
20
10

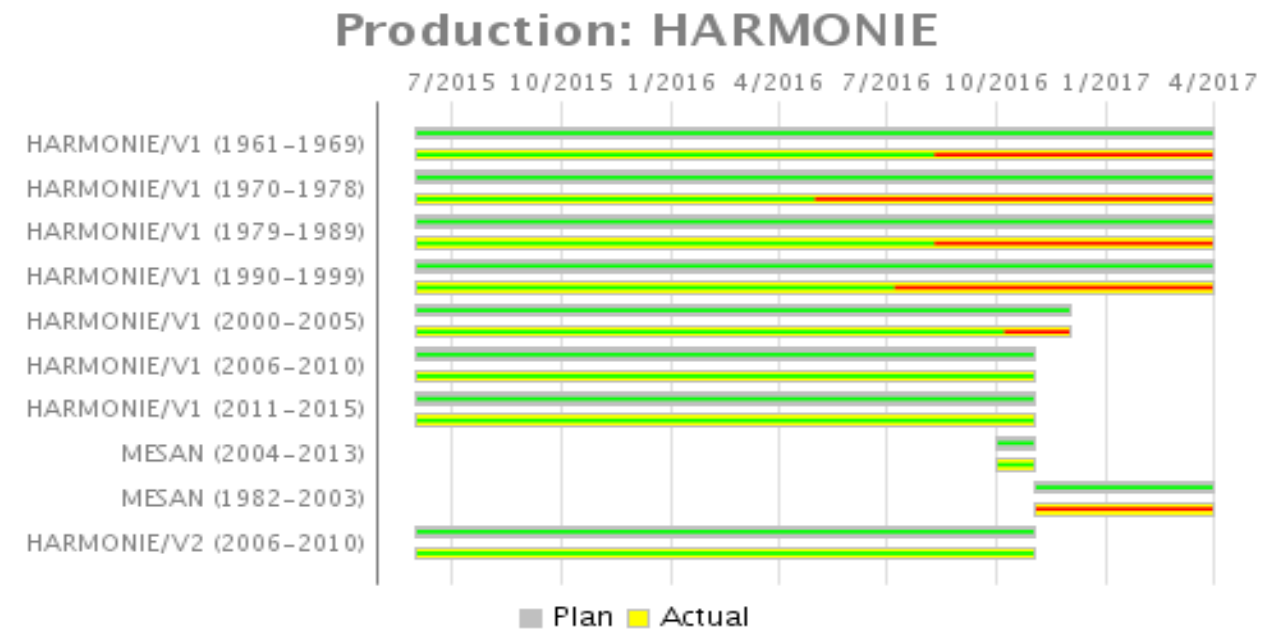
Surface levels:

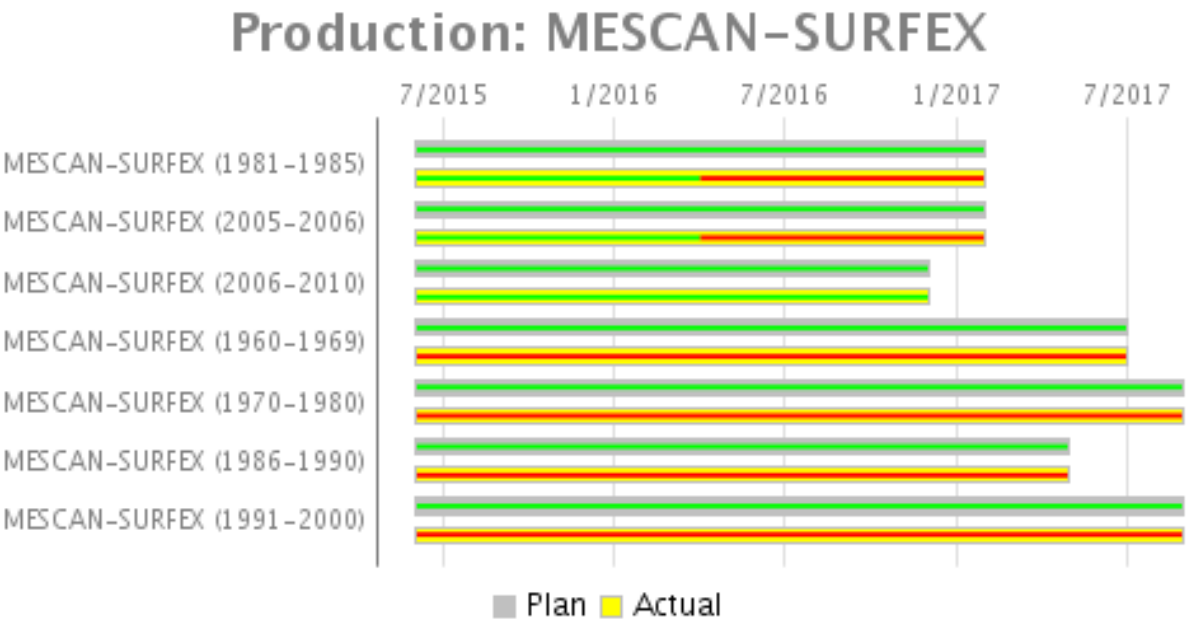
Temperature, wind, clouds, fluxes of sensible and latent heat, radiation fluxes, snow, rainfall

Soil levels

Temperature and soil wetness

Ongoing reanalysis production and archiving





Production and MARS archiving at ECMWF

SMHI HARMONIE (ALADIN)

1961-69 Done

1970-78 spring 78, half a year left

1979-89 summer 89, half a year left

1990-99 summer 98, 1 ½ year left

2000-15 Done

2006-10 2nd physics (ALARO) done

Mars archived1980-1987, 1990 and 2000-2011

Météo-France MESCAN -

1981-85 Done and in Mars test

2005-10 Done and in Mars test

SMHI MESAN cloud analysis 2006-2014 done

Met Office UM 4D-VAREnsemble 4D-VARs

1978-79

2008-

Uni Bonn COSMO Ensemble 5 years

2008