UERRA - Uncertainties in Ensembles of Regional ReAnalyses

Per Undén: Coordinator UERRA (SMHI), Andrea Kaiser-Weiss (DWD), Manola Brunet (URV), Richard Renshaw (Met Office), Gé Verver, Else van den Besselaar, Albert Klein Tank (KMNI), Phil Jones (UEA) and UERRA partners

SEVENTH FRAMEWORK PROGRAMME

Preparing for the Operational Copernicus Climate Change Service

- Produce European regional meteorological reanalyses of **E**ssential **C**limate **V**ariables for several decades with data services and uncertainty estimation;
- At higher resolution than before and multimodel and ensemble data assimilation
- Provide observations for reanalyses
- User interaction and user driven archives and visualisation services

Building and running pre-operational pan-European multi-model ensemble reanalysis systems

Operational archiving and data services of Upper air model, pressure and height level parameters

Surface parameters and diagnostic parameters

REGIONAL REANALYSES

Domains & orography

METEO FRANCE

SMHI

MET OFFICE   COSMO UNI BONN
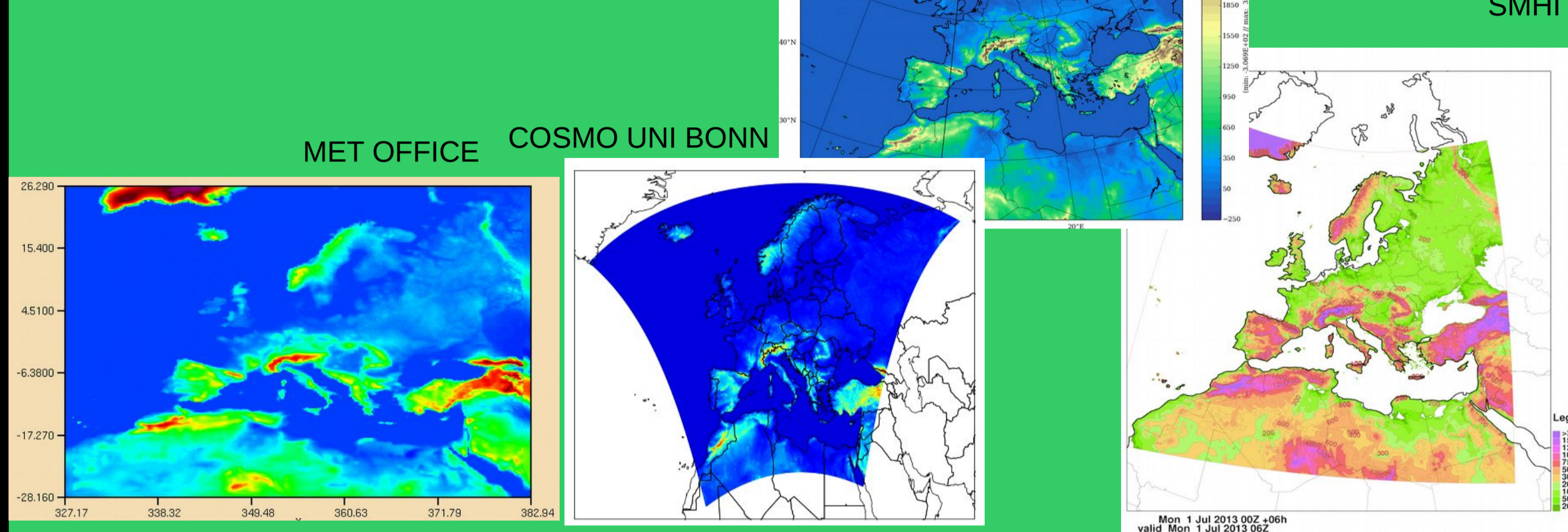
3D reanalyses covering the full atmosphere

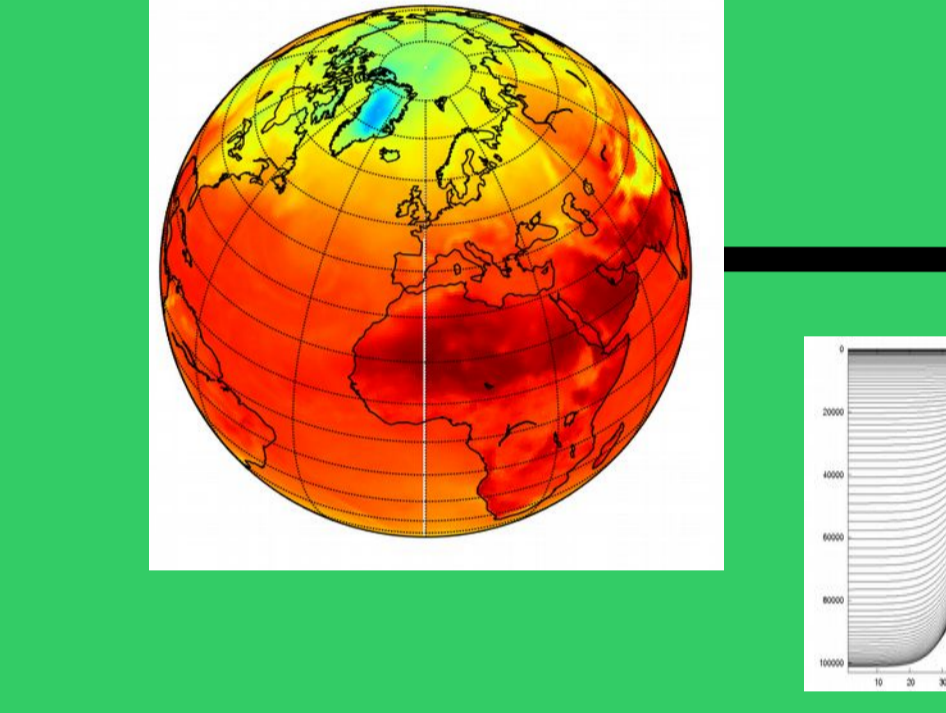| Met Office	SMHI/MF	HErZ-DWD
Hybrid 4D-Var, Ensemble of 4D-VARs	HARMONIE 3D-VAR	Ensemble Nudging (LETKF)
1 Control 12 km 70 levels 20 members 24 km ensemble	1 member 11 km 65 levels 2 members physics	1 Control 12 km 40 levels 20 members 12 km ensemble
ensemble ~1978 -2013	deterministic ~1961-2013 5 years ensemble	deterministic 2006-2010 ensemble 5 years
Conventional obs, satellite data, precip.	Conventional obs, Large scale constraint from ERA	Conventional obs

2D surface analyses driven by 3D

MF/SMHI MESCAN	SMHI MESAN
2D advanced statistical interpolation	2D advanced statistical interpolation
Downscaled ALADIN model background	Downscaled 3D HIRLAM climatological adaptation background
Surface and climate stations T, Td, precipitation	AVHRR, METEOSAT SEVIRI and MVIRI
5 km resolved T2m, Td, precipitation	5 km Cloud fraction
1961 - ~2013	~1982 - 2013

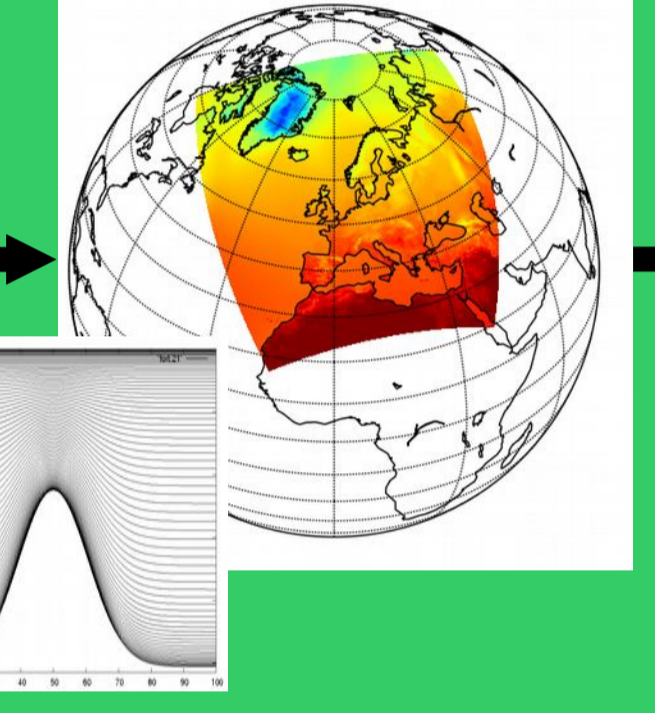boundary forcing from global ERA reanalyses (ERA-40, -Interim, coming –SAT or -5, incl. Ensembles)

OBSERVATIONS
GLOBAL ANALYSIS
REGIONAL REANALYSIS

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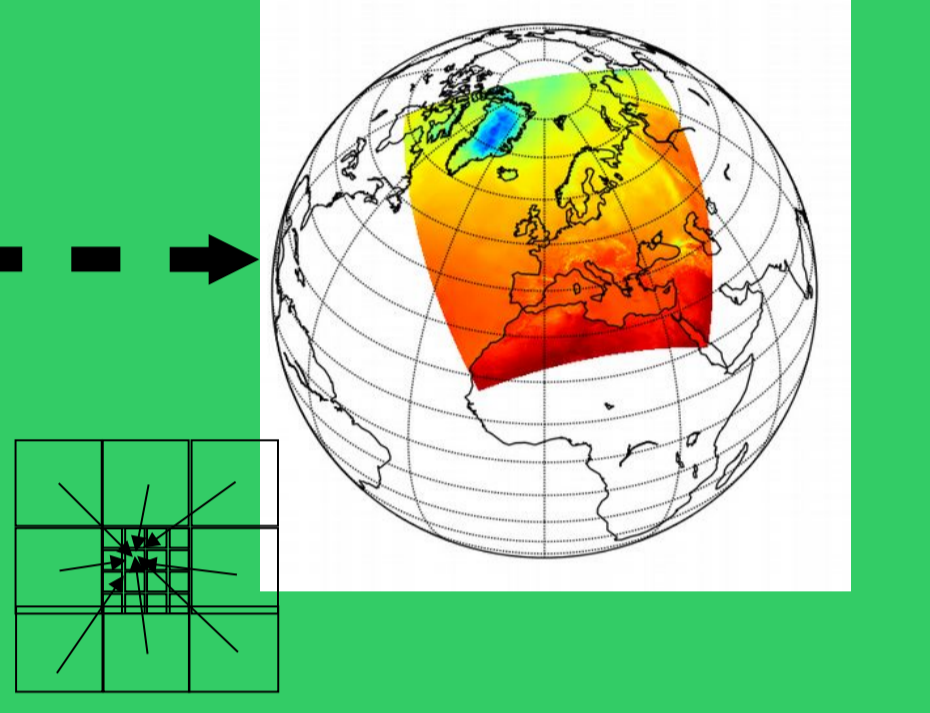- Surface and upper-air parameters

ERA-INTERIM reanalysis boundaries → 3-dim regional reanalysis → 2-dim downscaling & reanalysis
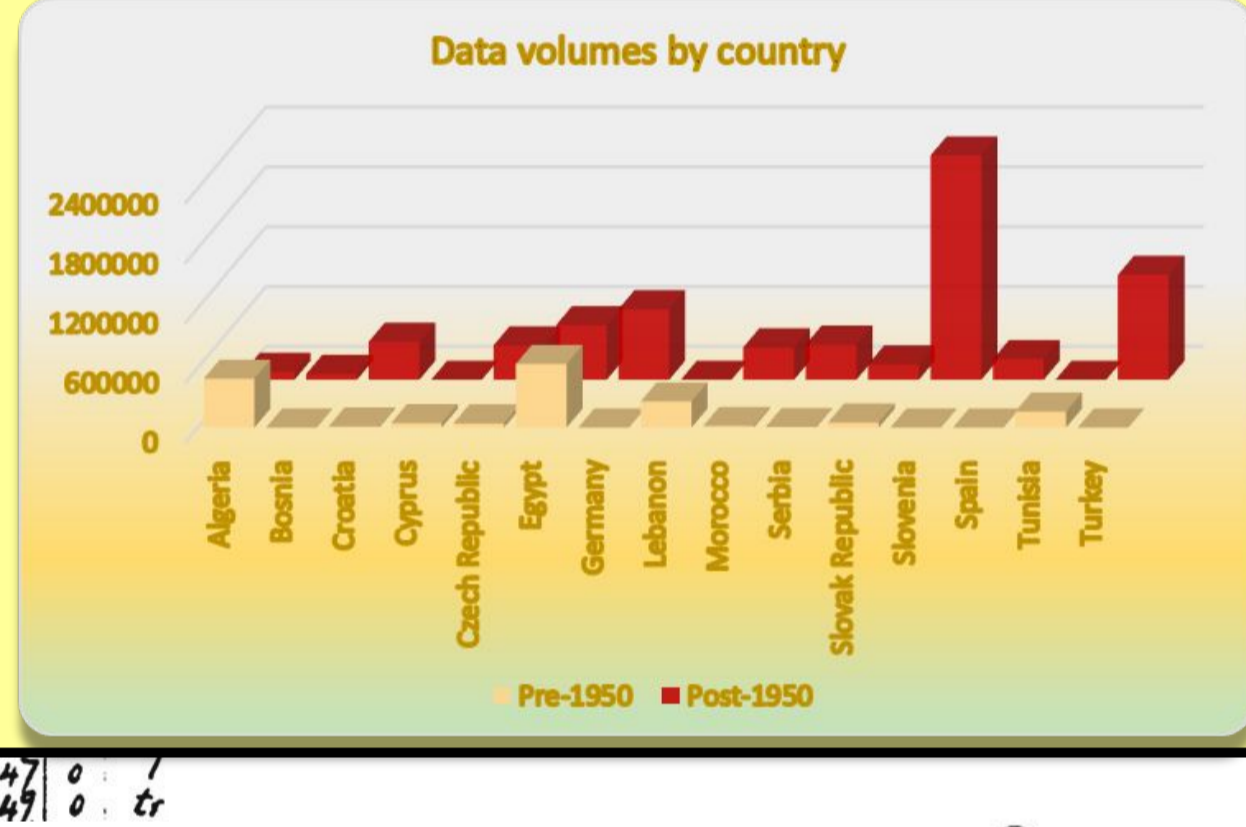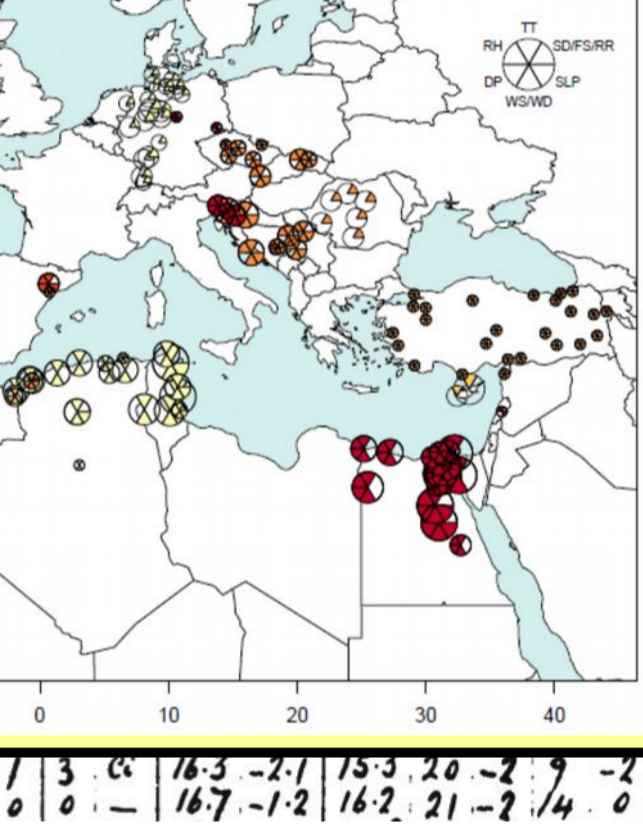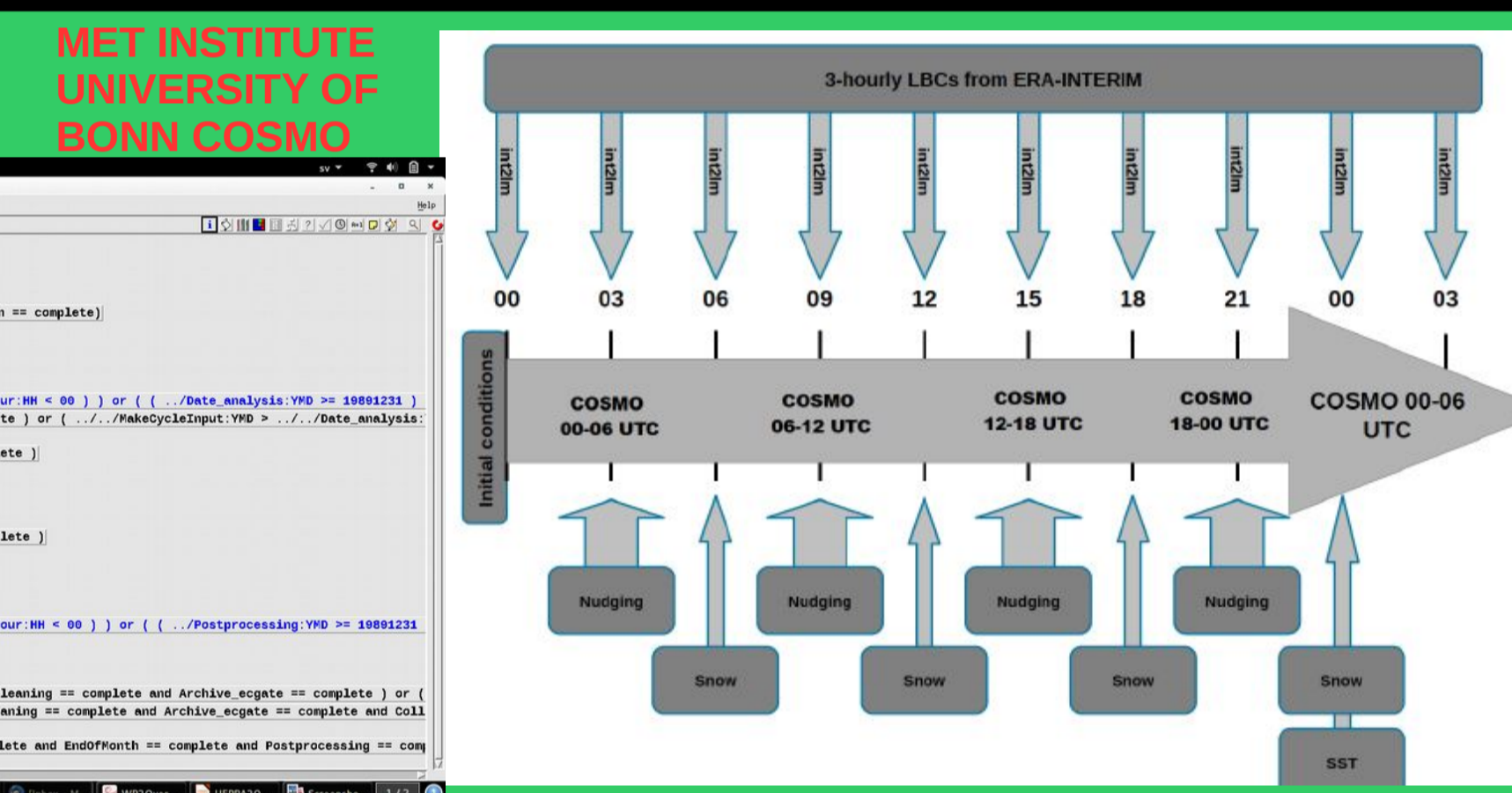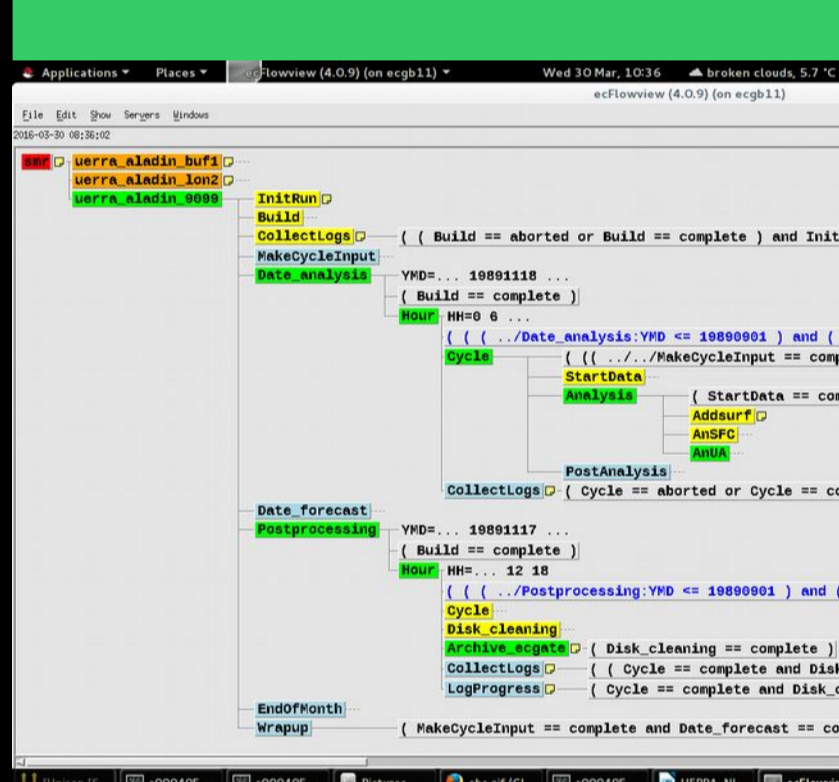
Data rescue of historical observations

- *Already more than 8M data recovered*
- *Emphasis on sub-daily scale → observation stream for reanalyses*
- *Comprehensive quality control and data development (correction, homogenisation)*
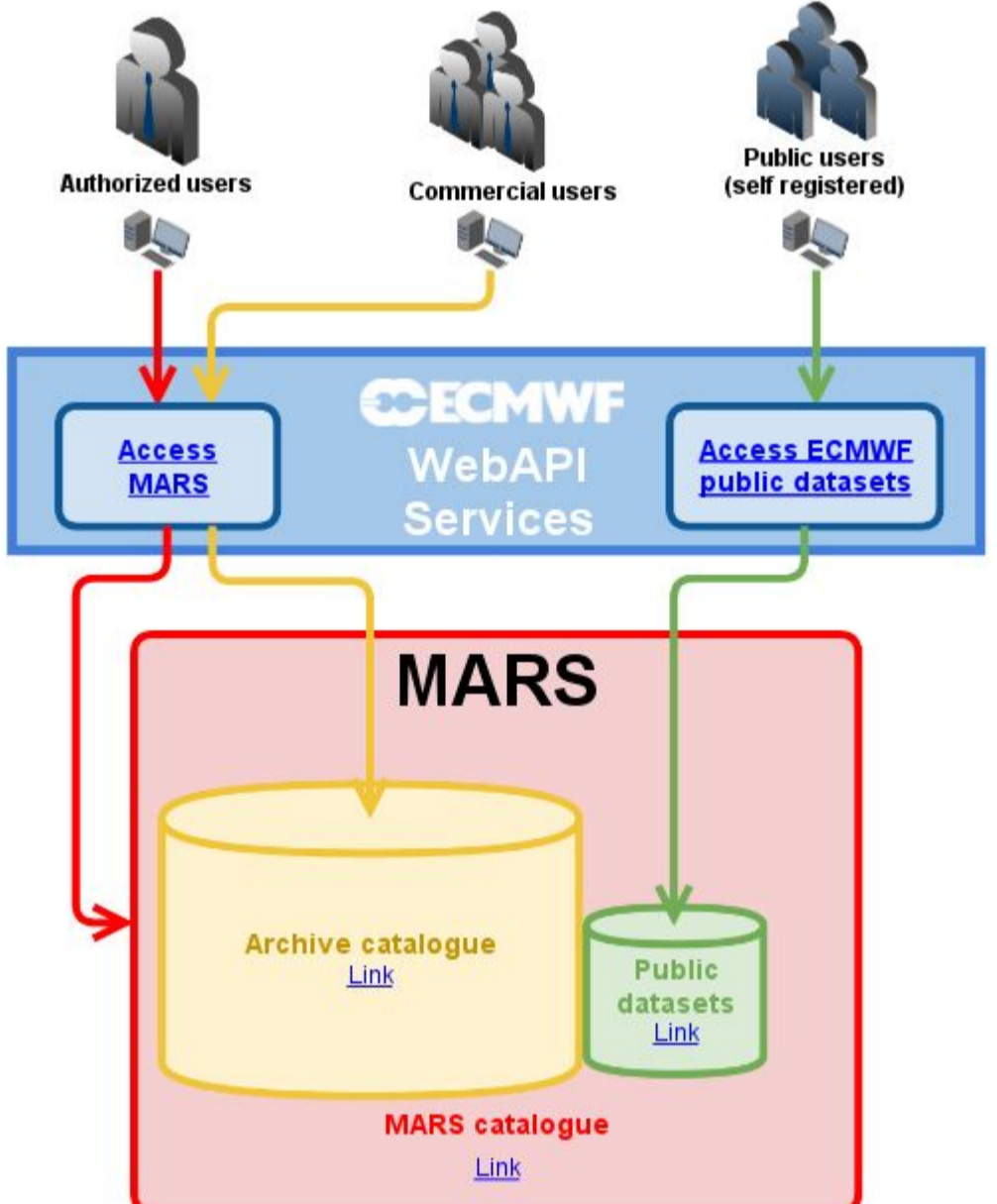
UERRA data sources 1879–2012

Data volumes by country

DATA ASSIMILATION
MET INSTITUTE UNIVERSITY OF BONN COSMO

3-hourly LBCs from ERA-INTERIM

COSMO 00-06 UTC / COSMO 06-12 UTC / COSMO 12-18 UTC / COSMO 18-00 UTC / COSMO 00-06 UTC

Ensembles: Standard Deviation of ALADIN-ALARO Physics differences

SMHI HARMONIE

Temperature, aladin-alaro, month 01, 12 UTC   Temperature, aladin-alaro, month 01, 00 UTC

MET OFFICE UM

Forecast (cloud fraction) 2009 07 01 20 UTC "super-obs" MESAN

HIRLAM EURO4M 20090701_18=003 analysis

Cloud analysis 2D VAR MESAN SMHI

Ensemble of 4D-VARs Followed by Hybrid 4D-VAR

ARCHIVING IN MARS

Authorized users   Commercial users   Public users (self registered)

- *The common UERRA archive is MARS at ECMWF*
- *Data services from MARS and ESGF interface*
- *Web Map Servers*
- *Visualisation through Metview and WMS*

Access MARS   ECMWF WebAPI Services   Access ECMWF public datasets

MARS

Archive catalogue Link   Public datasets Link

MARS catalogue Link

ECMWF

ESGF Earth System Grid Federation

USERS

- *Climate information*
- *Bulletins for public*
- *Information for policy makers*
- *User interaction and evaluation*
- *Downscaling*
- *Model validation, climate*
- *Energy wind and solar*
- *Information and training*
- *Agriculture and forestry season*
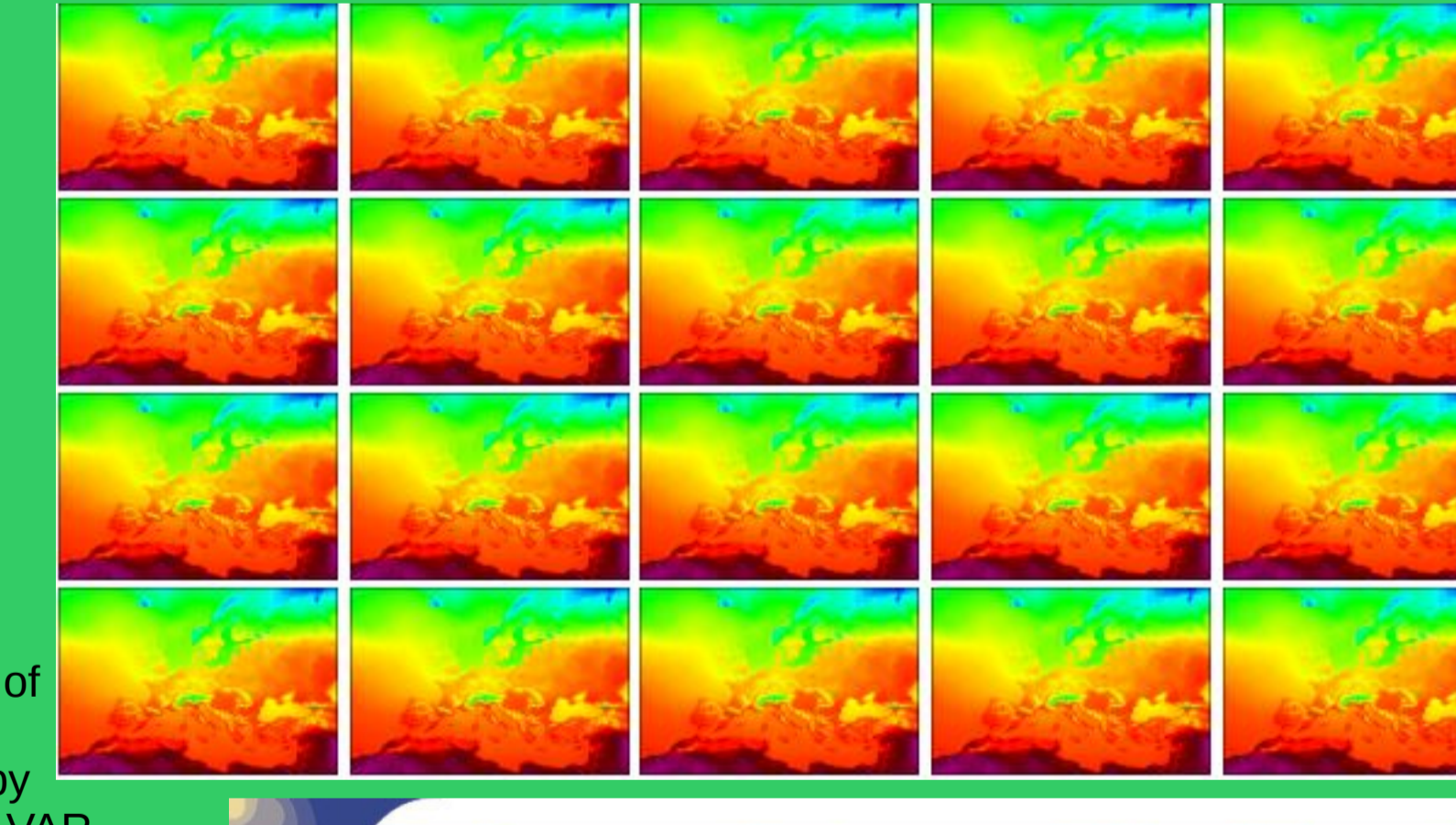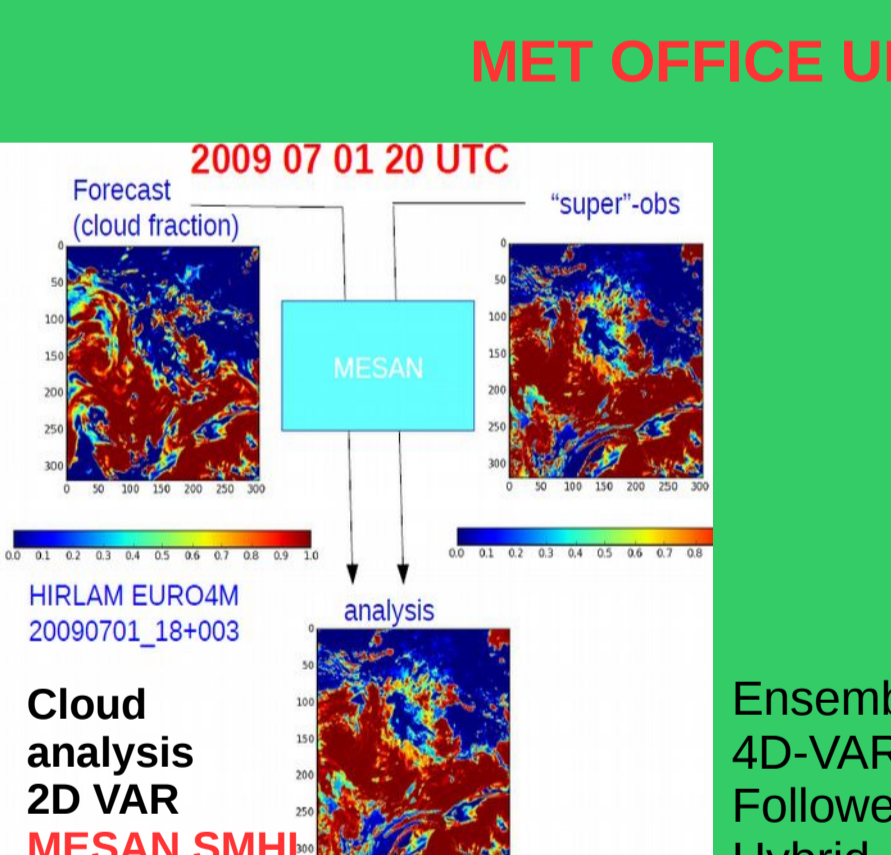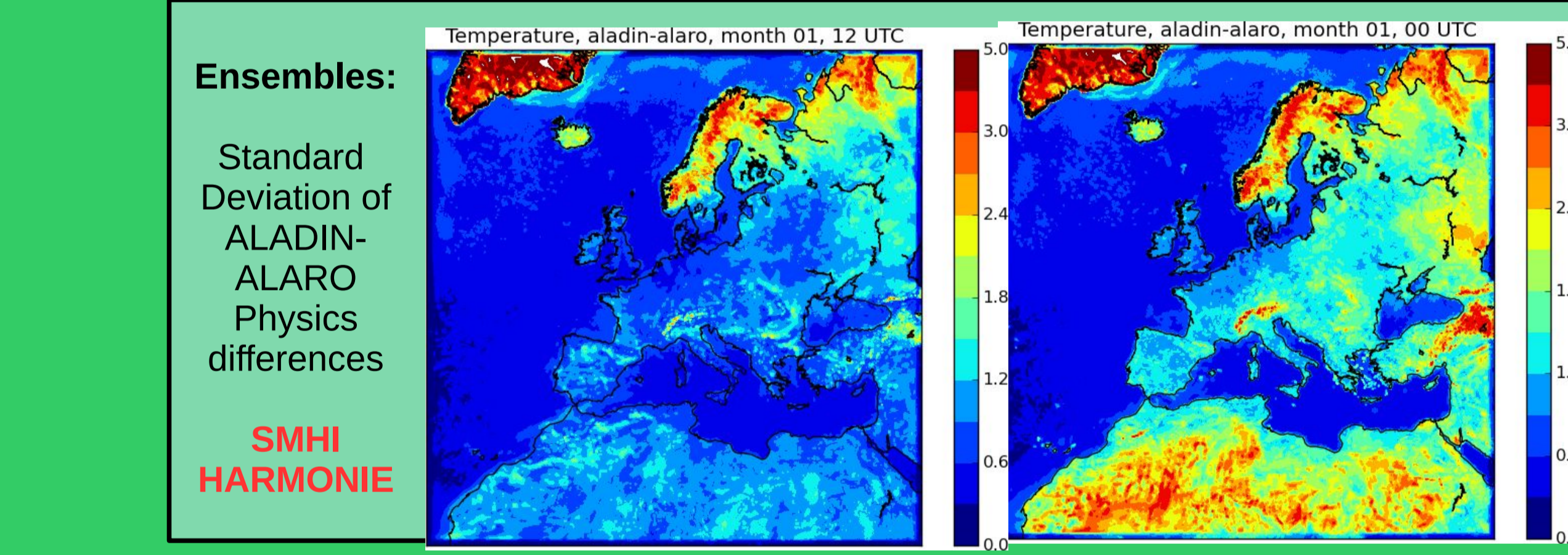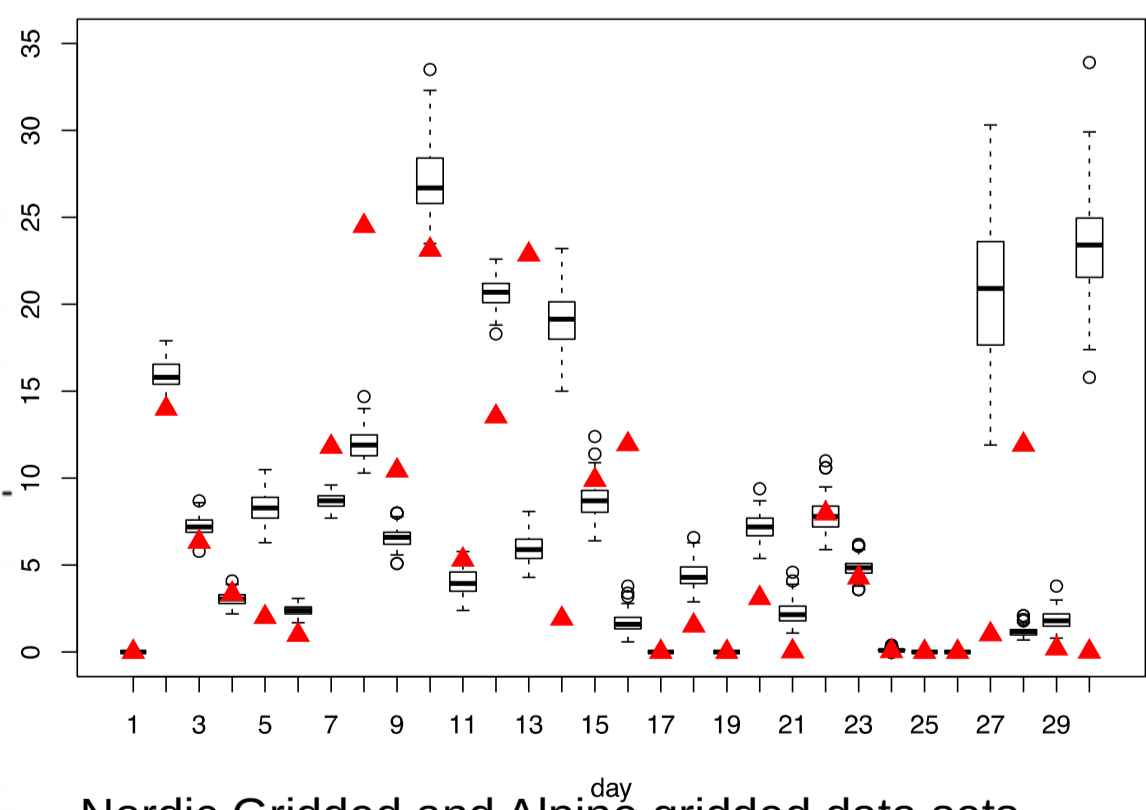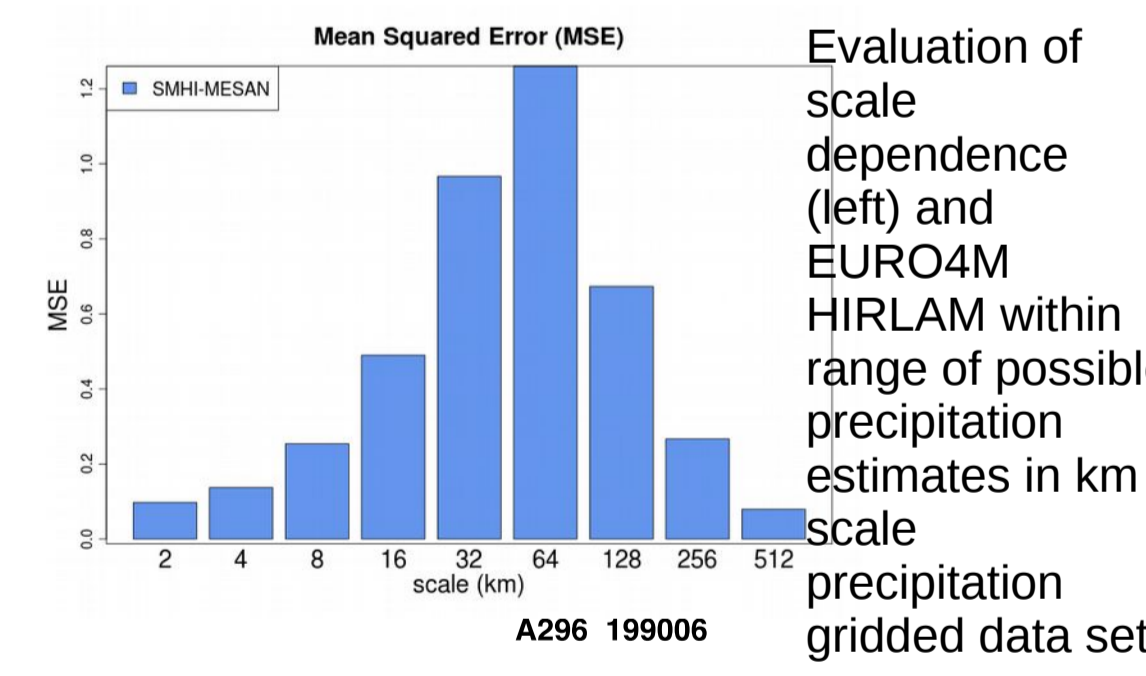- *Severe weather statistics*

UNCERTAINTY ESTIMATION

- *Use standardized uncertainty measures for all data sets*
- *Exploring different methods*
- *Investigate spatio-temporal scales and trends*
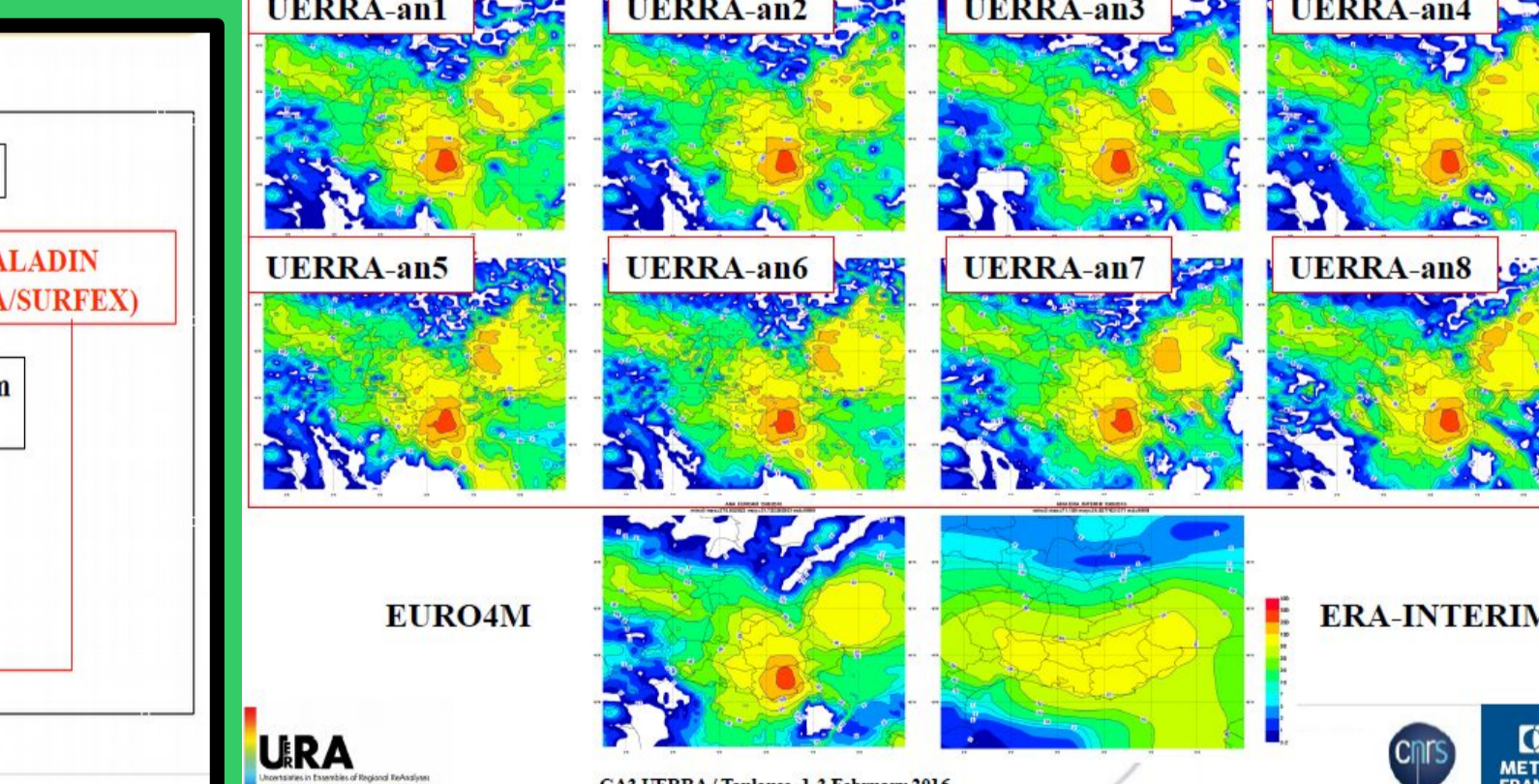- *Emphasis on the user's perspective*
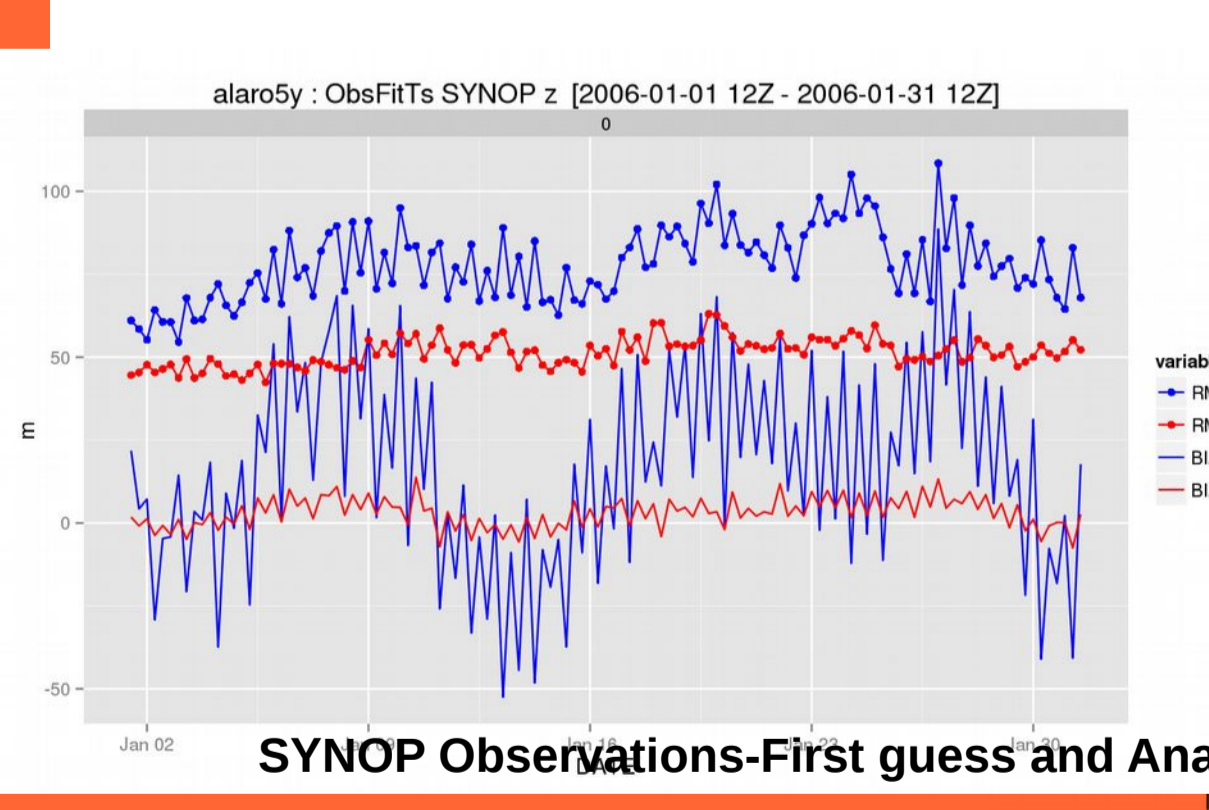
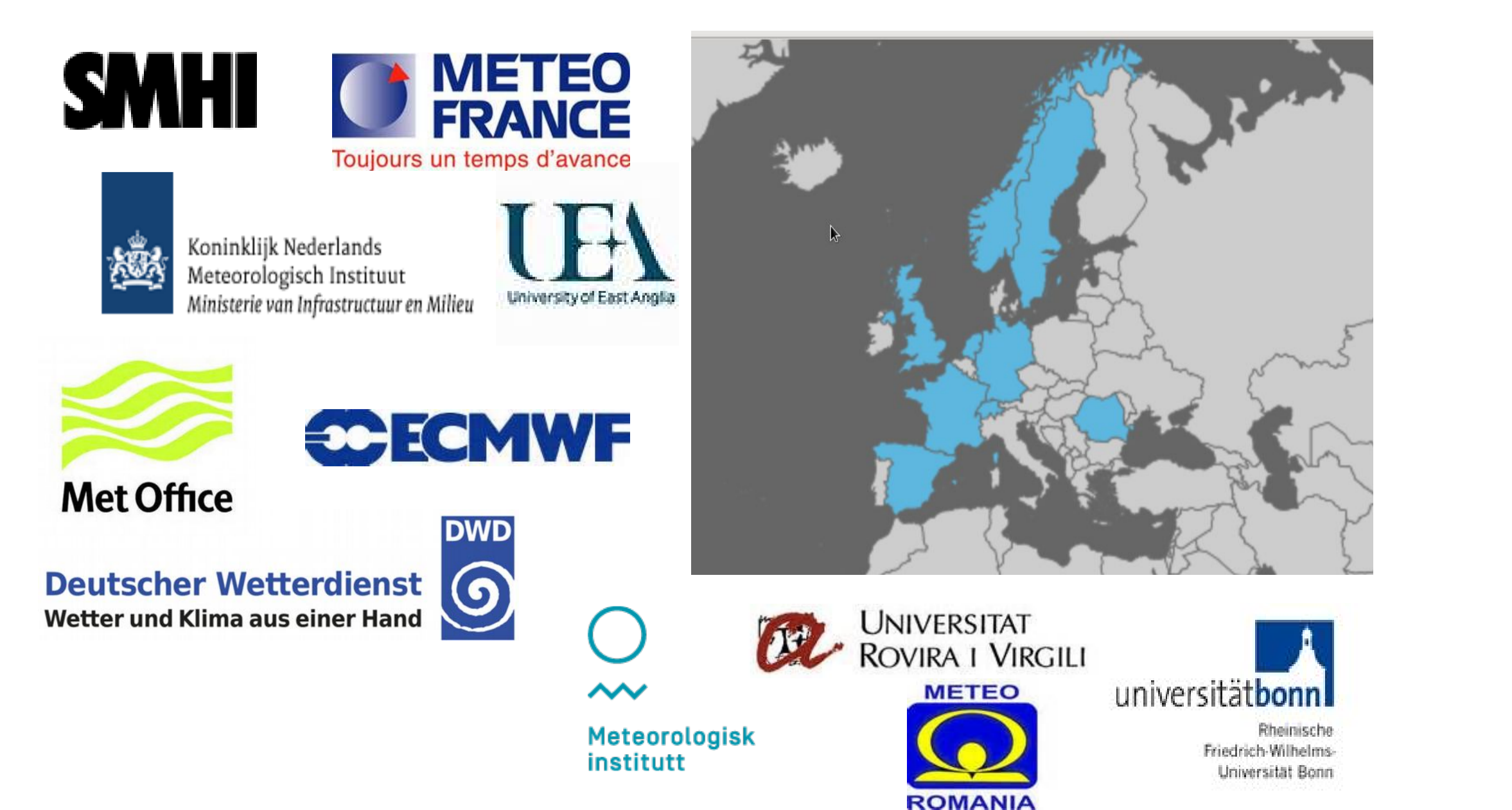**Task 3.1 Coordinated uncertainty evaluation**
- D 3.2 Common evaluation procedures (-> data source):
  - A: feedback statistics
    - Data source: radiosonde soundings
    - Parameters: T,Vs, RH
  - B: point measurements
    - Data source: station data
    - Parameters: Ws, Tmin, Tmax, number of days of threshold exceedance of T and RR
  - C: gridded measurements
    - Data source: gridded data
    - Parameters: RR, Tmin, Tmax
  - D: satellite data products
    - Data source: CM-SAF and CCI
    - Parameters: global radiation, total cloud cover, swe
  - E: ensemble based comparison
    - Data source: WP1 ensemble of gridded data
    - Parameters: RR, Tmin, Tmax
  - F: user related models

Mean Squared Error (MSE)

Evaluation of scale dependence (left) and EURO4M HIRLAM within range of possible precipitation estimates in km scale precipitation gridded data sets

alaro5y : ObsFitTs SYNOP z [2006-01-01 12Z - 2006-01-31 12Z]

SYNOP Observations-First guess and Analysis

Analysis rank histogram

Nordic Gridded and Alpine gridded data sets

METEO FRANCE ALADIN – ALARO - > MESCAN

Ens HARMONIE @ 11km

N=2, 6-h forecast @ 11km   N=2 Analysis @ 11km

Static Downscaling   Dynamical Downscaling with ALADIN model (2 surface schemes ISBA/SURFEX)

N=2, 6-h Forecast @ 5.5km (used as Background)   => N=4, 6-h Forecast@5.5km (used as Background)

MESCAN   MESCAN

Perturbed Obs ??

SWd, LWd, Wind, Ps, T2m, HU2m, RR24   SWd, LWd, Wind, Ps, T2m, HU2m, RR24

6+ ? analysis Members @ 5.5km

Extreme precipitation events of 15 June 2010 8 members : RR24h UERRA Analysis

UERRA-an1   UERRA-an2   UERRA-an3   UERRA-an4
UERRA-an5   UERRA-an6   UERRA-an7   UERRA-an8

EURO4M   ERA-INTERIM

Project partners

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
Meteorologisk institutt
UNIVERSITAT ROVIRA I VIRGILI
METEO ROMANIA
universität bonn — Rheinische Friedrich-Wilhelms-Universität Bonn

5 precursor FP7 projects

Among 5 pre-operational Copernicus Projects (SPACE 9.1 call)

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

ERA-CLIM2   QA4ECV   URA   CLIPC Climate Information Portal   Eucleia