A European Regional Reanalysis (EURRA)

Elements of a possible project

Results from a Workshop, 21-22 November 2005, ECMWF

Adrian Simmons

Participants

- **European Environment Agency**
  - Philippe Crouzet

- **ECMWF Member States**
  - **Austria** (Helfried Scheifinger)
  - **Denmark** (Eigil Kaas, Leif Laursen)
  - **Finland** (Carl Fortelius, Sylvain Joffre)
  - **France** (Pierre Bessemoulin, François Bouttier)
  - **Germany** (Franz Berger, Jörg Schulz)
  - **Netherlands** (Jeanette Onvlee)
  - **Norway** (Øyvind Saetra, Ole Einar Tveito)
  - **Portugal** (Pedro Viterbo)
  - **Spain** (Jana Sánchez Arriola)
  - **Sweden** (Bengt Dahlström, Anna Jansson, Per Kållberg)
  - **Switzerland** (Mark Liniger)
  - **United Kingdom** (Richard Jones, Andrew Lorenc)

- **Invited Expert**
  - Fedor Mesinger (NCEP & University of Maryland)

- **ECMWF**
  - Dick Dee, Sakari Uppala, Adrian Simmons
  - Dominique Marbouty, Philippe Bougeault, Walter Zwieflhofer, Tony Hollingsworth

Why ?

Clear requirement for processed data expressed by the European Environment Agency (EEA):

- – Primary interest is in data over land for assessing primary water resources, water composition, status and potential of ecosystems, air quality and climate-change issues

- – Interest in ocean data for coastal erosion and sediment transport

- – Partner bodies have other interests, e.g. JRC's activities in flood- and crop-forecasting

- – Coverage back to 1975/76 is required; coverage to the late 1940s is desirable if product quality is sufficient

- – Resolution should be 10km or finer if feasible

- – Hindcast and forecast/simulation data are also required

Other envisaged requirements include those of offshore-energy and insurance industries

How ?

Various approaches are possible:

- **Downscaling of ERA-40 and successor global reanalyses using regional models and lower-boundary values**

- **Separate approaches for particular types of fields, such as:**
  - Specialised analyses of two-metre temperature, precipitation, snow cover, …

  - Surface analyses from Land Data Assimilation Systems

  - Analyses of atmospheric constituents from regional air-quality models

- **Full European-domain reanalyses using regional data assimilation systems**

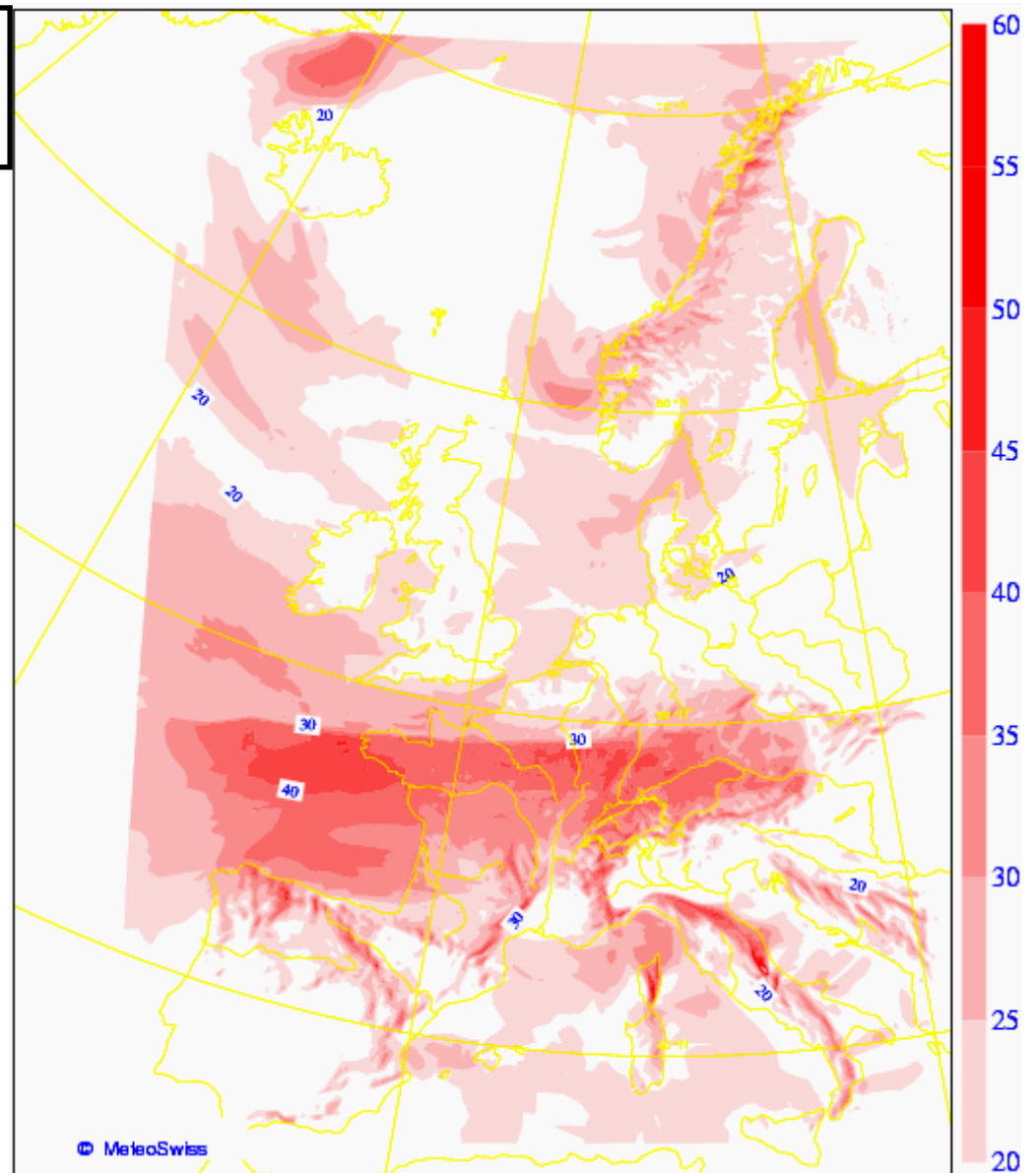# Downscaling by MeteoSwiss, in collaboration with industry

Mark Liniger

PartnerRe

Storm: Lothar

Maximum wind gusts (ms⁻¹) shown for period 00 to 18UTC, 26 December 1999

Downscaled from ERA-40 using 28km and 7km versions of the Lokal-Modell

One of more than 100 winter storms processed

SMHI mesoscale analysis

Anna Jansson and Per Kållberg

Resolution:
- 11 km
- 6 hourly

Analysed parameters:
- 2 m temperature
- 12 and 24 h acc. precipitation
- 10 m u- and v-wind

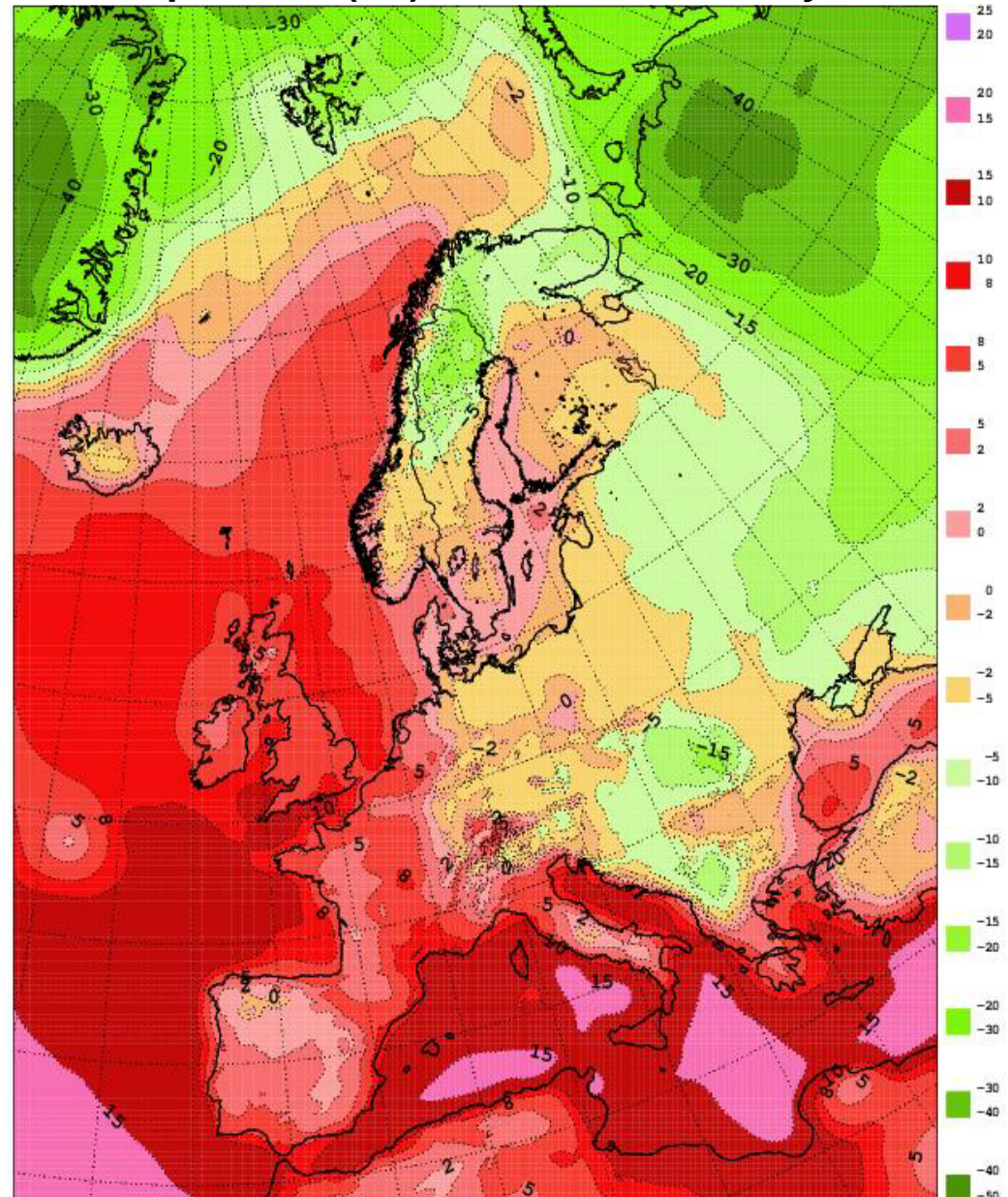**Analysed method:**
- Optimal Interpolation

Time period:
- 1990 – 2004

Input data:
- ERA-40/ECMWF-OPS as first guess
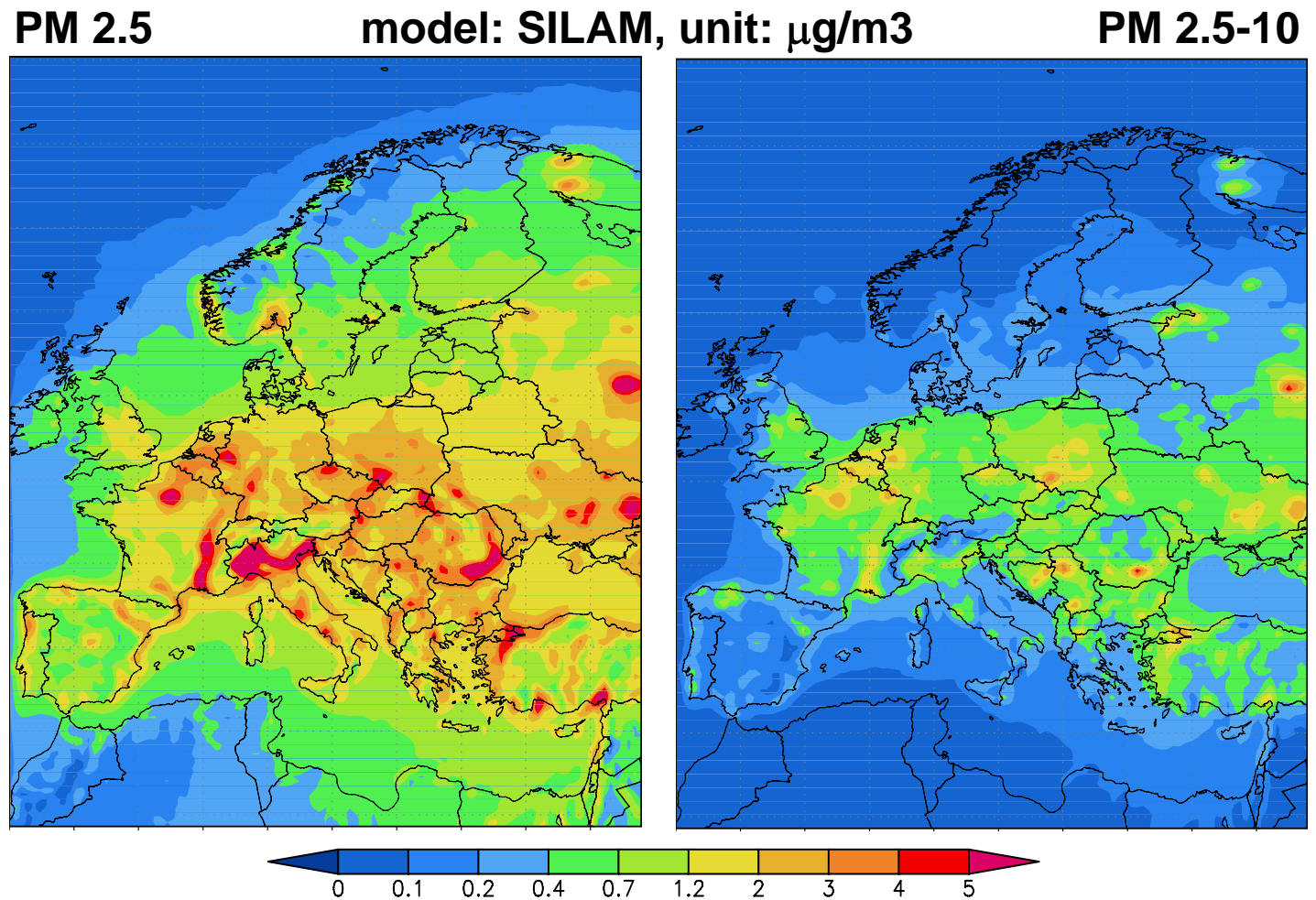- Observations from SMHI's archive

2m temperature (^{O}C) for 6UTC, 1 January 1999

FMI analysis of atmospheric composition

Sylvain Joffre

Particulate matter concentrations, 2000

PM 2.5   model: SILAM, unit: μg/m3   PM 2.5-10

0   0.1   0.2   0.4   0.7   1.2   2   3   4   5
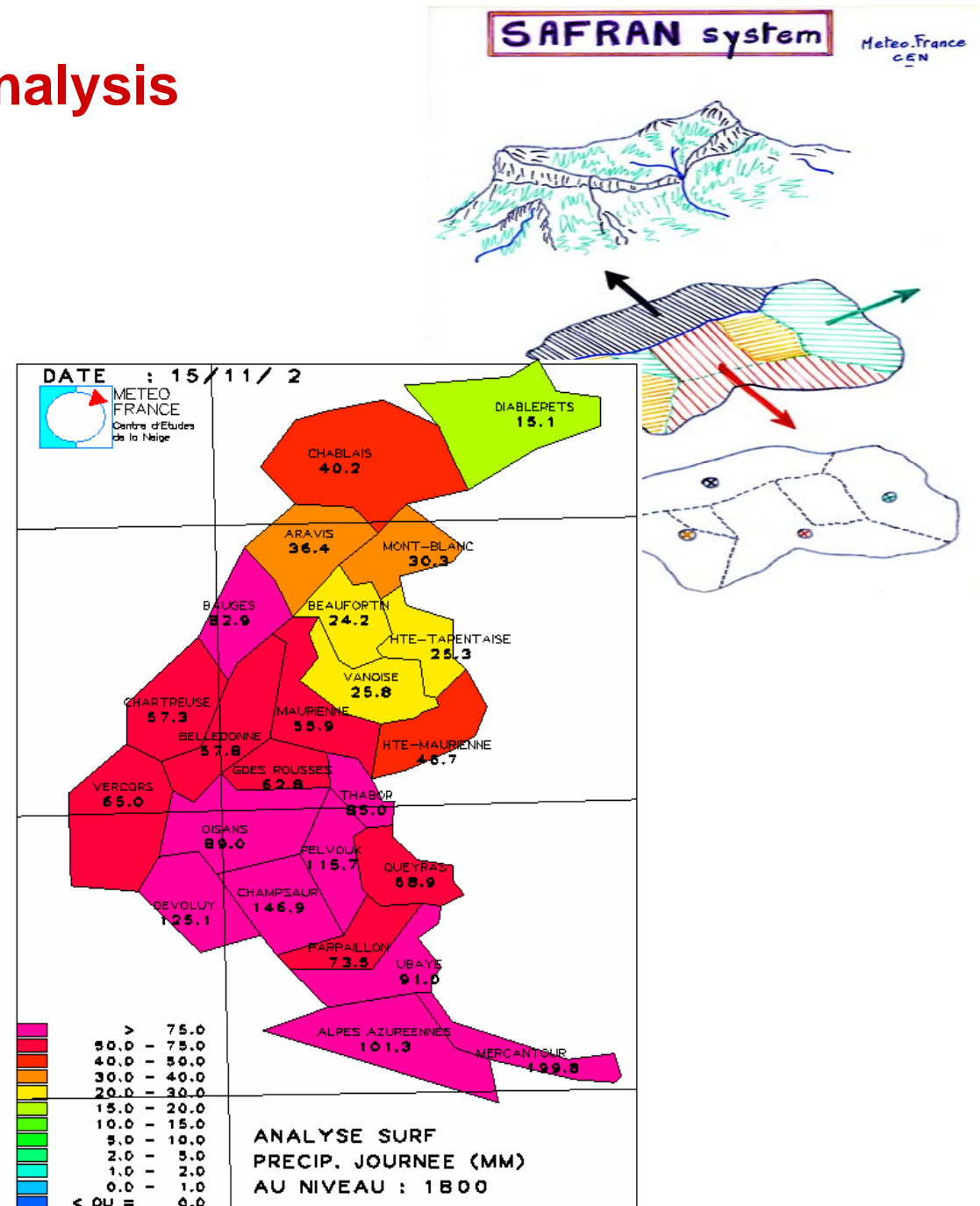
Météo-France SAFRAN analysis

François Bouttier

OI surface analysis and localisation for mountainous regions

Originally for avalanche risk, now for mountain environment and hydrology
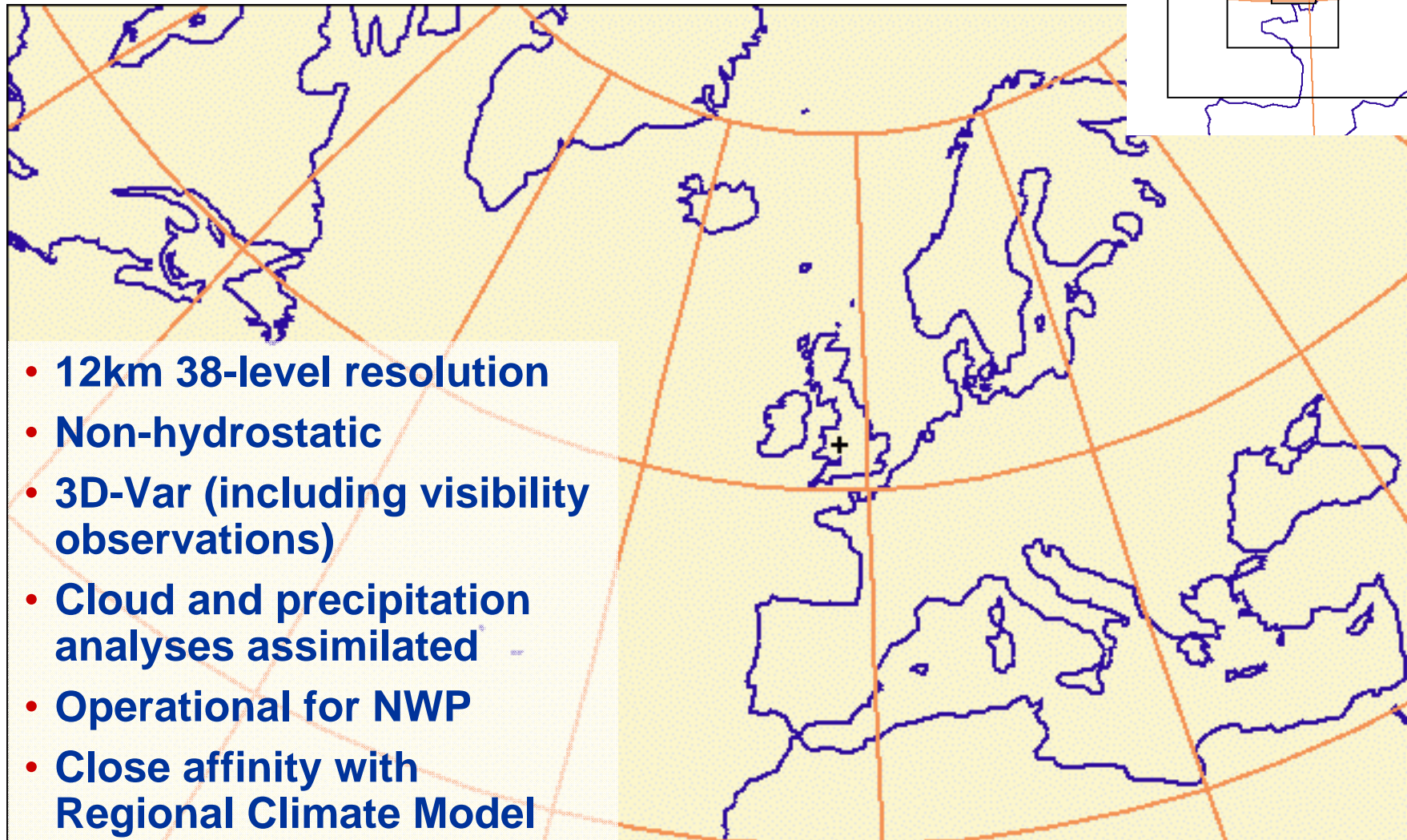
Accounts for sub-grid altitude and slope exposure

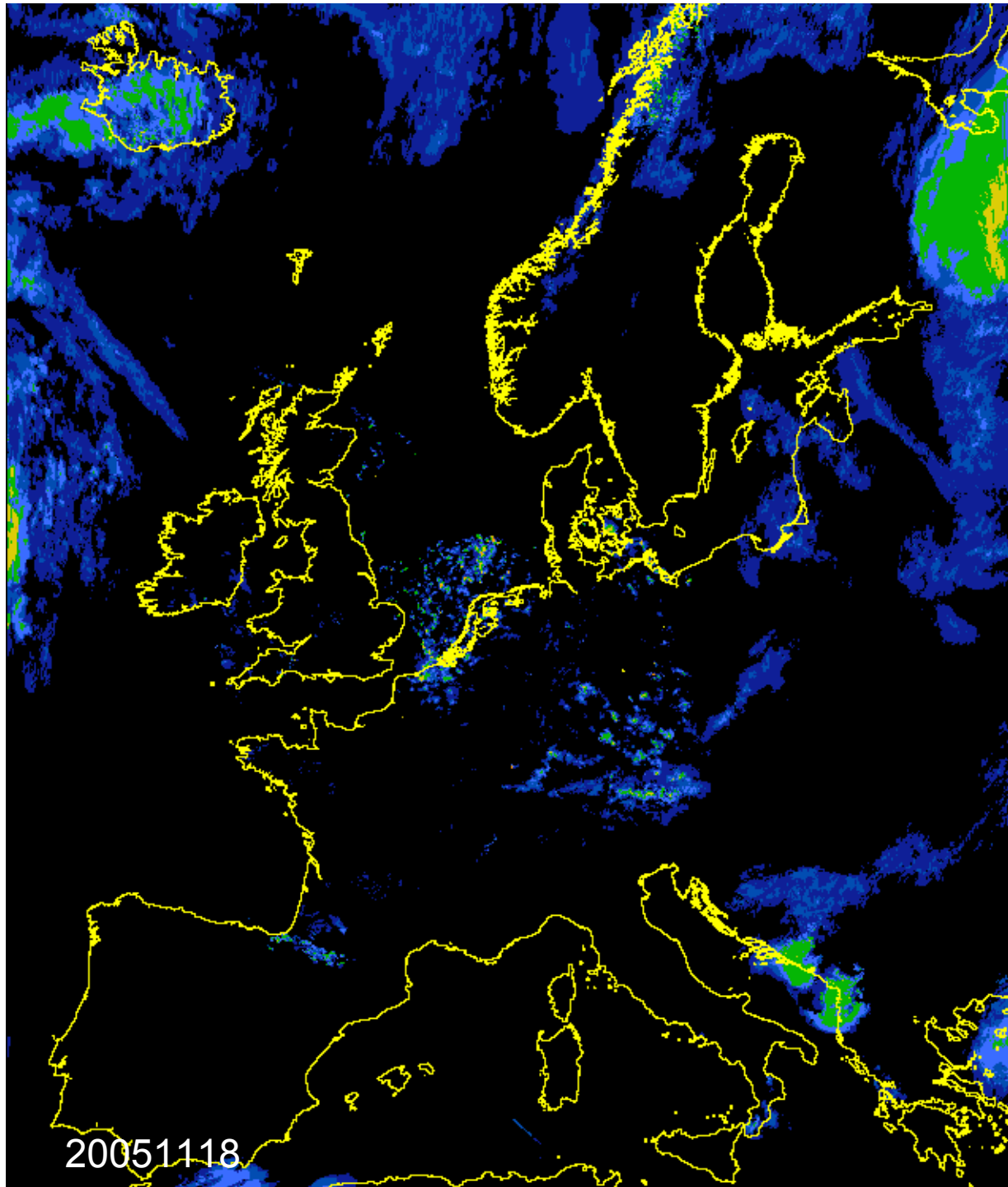**Uses rain-gauge and satellite data, 1D-column physics for localisation**

Met Office North Atlantic Europe model

Andrew Lorenc, Richard Jones

- **12km 38-level resolution**
- **Non-hydrostatic**
- **3D-Var (including visibility observations)**
- **Cloud and precipitation analyses assimilated**
- **Operational for NWP**
- **Close affinity with Regional Climate Model**

Analysis:
radar composite +
precipitation rates
derived from satellite
and synoptic reports
where radar data were
unavailable.
Archived since 2002.

COLOUR KEY [mm/hr]

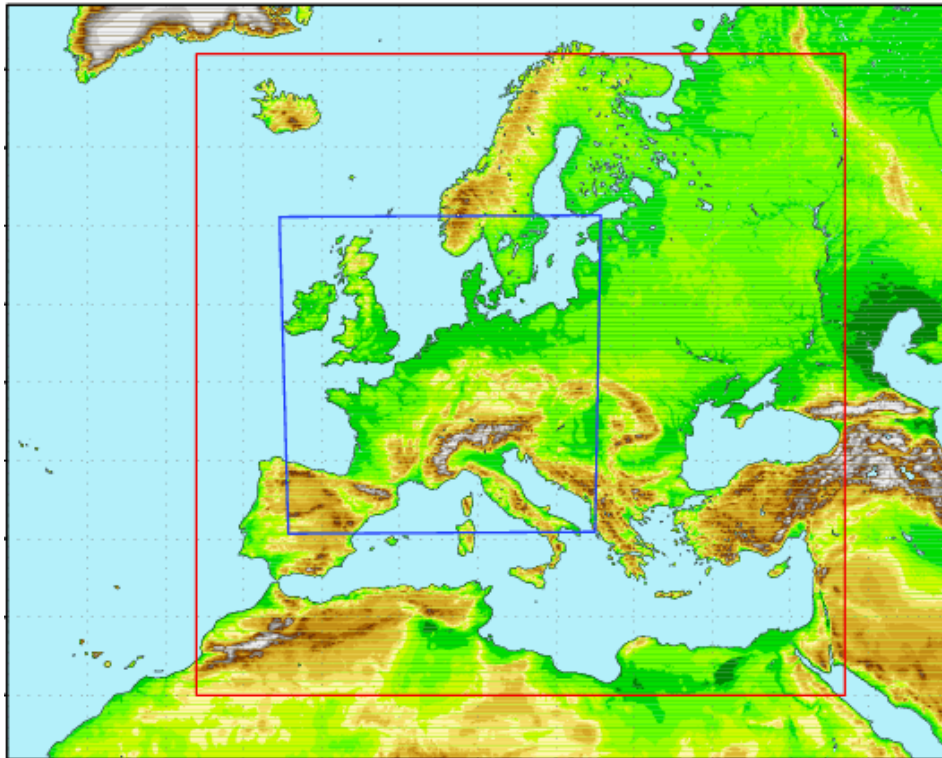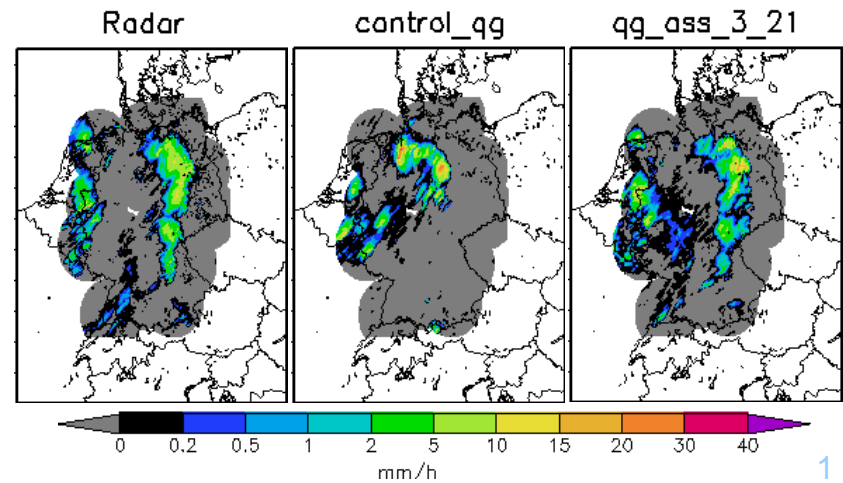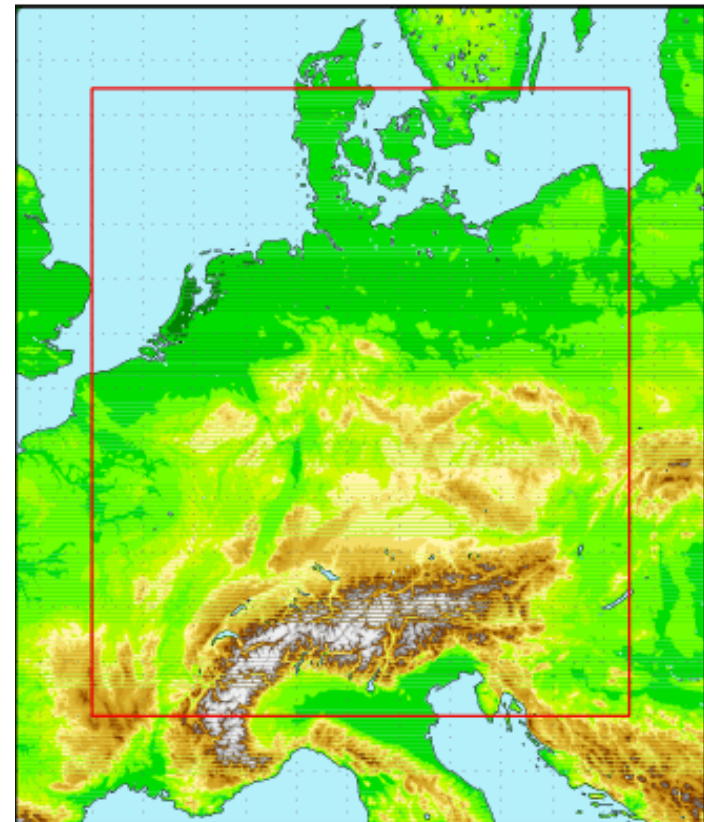|	
	0.0 : 0.25
	0.25 : 0.5
	0.5 : 1.0
	1 : 2
	2 : 4
	4 : 8
	8 : 16
	16 : 32
	>32

20051118

DWD local and mesoscale models

Jörg Schulz, Franz Berger

Lokal-Modell Europa   **7km resolution**

Lokal-Modell Kürzestfrist   **2.8km resolution**

Radar   control_qg   qg_ass_3_21

0   0.2   0.5   1   2   5   10   15   20   30   40

mm/h

North American Regional Reanalysis

Fedor Mesinger

Resolution:
- 32 km
- 3 hourly

Analysis:
- 3D-Var
- Assimilation of analysed precip

Lateral BCs:
- NCEP-DOE Reanalysis 2

Time period:
- 1979 – …

ETA model

RMS fit to sonde temperature (K)

January

NCEP-DOE Reanalysis 2

NARR

hPa

Input precipitation analysis   Jan 1998   NARR precipitation

0 2 4 6 8 10 12 14 16 inches
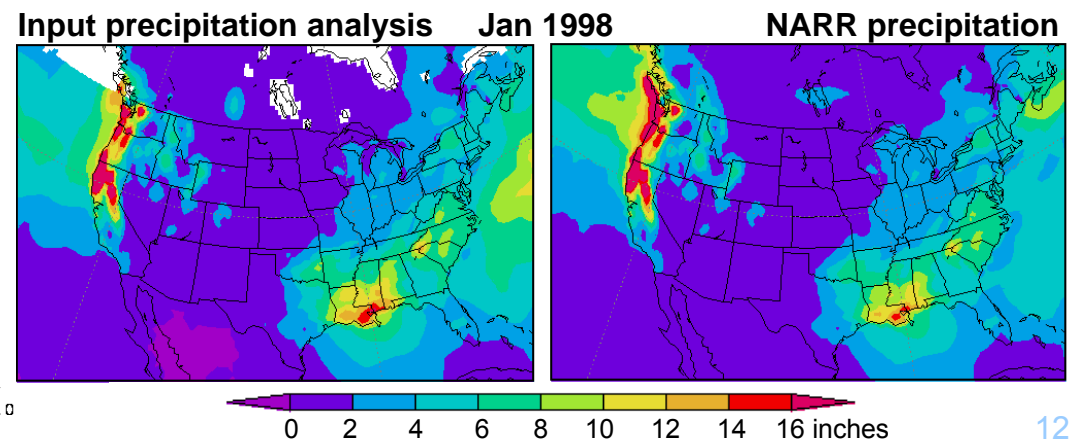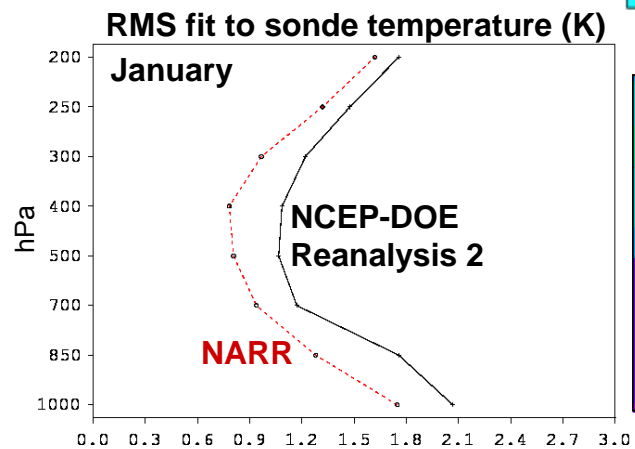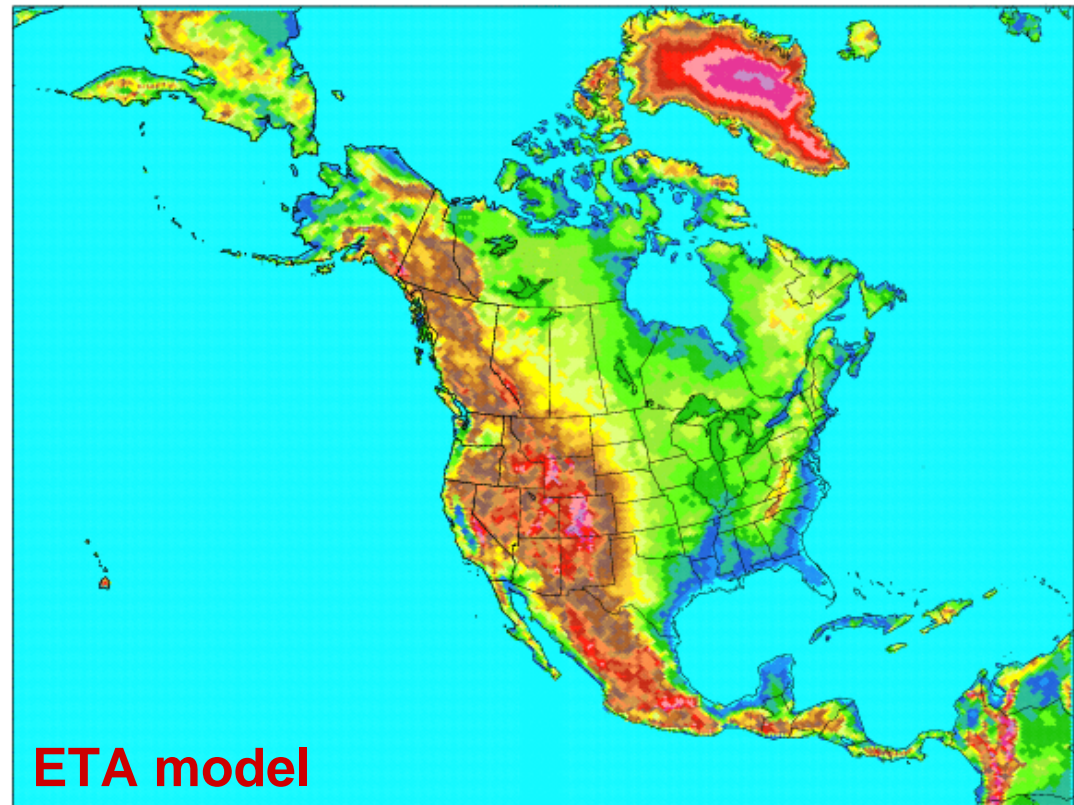
EUROGRID Showcase

Bengt Dahlström

- **A project now adopted by the EUMETNET Council**

- **EUROGRID was conceived as:**
  - creating a database of gridded meteorological values covering Europe (now viewed as coming from EURRA)
  - providing a product-generation system based on this database
  - providing a system for dissemination of information to users

- **EUROGRID Showcase is a demonstrator, providing:**
  - a sample database of gridded values
  - a package for the creation of climatological products
  - an assessment of present estimation methods for temperature, precipitation, wind and humidity
  - a report on experience from the Showcase

- **Implications for data services for EURRA will need to be assessed with EUMETNET and the EEA**

Examples of possible national contributions of digitised data for assimilation/validation

Netherlands	• **Radar and other ground-based remote sensing data** • **Cabauw validation data** • **Atmospheric composition data**
Norway	• **Historical sea-ice data – weekly since 1960s** • **Gridded 1km resolution temperature, precipitation and snow-water-equivalent over Norway**
Portugal	• **Data rescue would be focussed on EURRA** • **Additonal precipitation data** • **Navy buoys**
Spain	• **All available GTS and climatological-network data** • **Pluviometric data are already in digitised form, but early radiosonde, pilot and synop data need digitisation**

Elements of a EURRA project

1) **Design and organisation**

2) **Development of database of observations**

3) **Provision of input data fields and other 2D analyses**

4) **R&D in data assimilation for regional reanalysis**

5) **Production of reanalyses**
   - Pre-production testing
   - Production itself
   - Post-processing

6) **Validation**

7) **Dissemination**

EURRA element 1: Design and organisation

- **Timetable and scope of project**
  - What balance should be struck between 3D/4D data assimilation activities and specialised 2-D analysis activities?
  - Should project include future ERA-65/75 global reanalysis?
  - What are possible production phases? Over what domain?

- **User requirements and involvement**
  - Needed for detailed design and implementation

- **Overall organisation of project**
  - Leadership
  - Choice of regional data assimilation system(s)
  - Distribution of other tasks
  - Cost estimates
  - Funding possibilities

- **Management structure**

Possible EURRA timetable and production phases

Phase	Resolution and Period	Name and nature	Production period
1	10km regional 1957-2009	**EURRA-1** Downscaled from ERA-40 and ERA-Interim	2008-2010
2	10km regional 1989-2009	**EURRA-2** Reanalysis using ERA-Interim lateral BCs	2009-2010
3a	10km regional 1938/48-2012	**EURRA-3** Reanalysis using ERA-65/75 lateral BCs	2011-2013
3b	2km regional 1938/48-2012	**EURRA-4** Downscaled from EURRA-3	2011-2013
4	2km regional 1989-2012	**EURRA-5** Reanalysis using lateral BCs from ERA-65/75 and/or EURRA3	2014-2015

EURRA element 2: Development of database of observations

- **Should be linked with other activities and initiatives**
  - ECSN, JRA, NCAR, NCDC, …

- **National European efforts to prepare additional datasets**

- **EURRA development and production requires:**
  - Gathering data from various sources
  - Creating optimal merged input datasets
  - Pre-assimilation formatting and quality control

- **Database will be an internal deliverable of EURRA in its own right**
  - Data policy issues need consideration

- **Applicable for global as well as regional reanalysis**

EURRA element 3: Provision of input data fields and other 2D analyses

- **Regional assimilation system(s) will require a number of data fields to be specified, depending on design of system**

- **Fields (mostly time-varying) may include:**
    - Sea-surface temperature and ice distributions
    - Lake temperatures and ice state
    - Land-surface and soil characteristics
    - Precipitation and snow analyses
    - Atmospheric composition
    - …………

- **Fields will be external deliverables of EURRA in their own right**

- **Will be complemented by 2D (model-free or specialised model-based) analyses of certain observations, as alternatives to reanalysis products. These should be linked to other activities (CM, OSI and other SAFs, …)**

EURRA element 4: R&D in data assimilation for regional reanalysis

- **Refinement of regional data assimilation systems for application in reanalysis, including:**

    - Specification of background and observation error covariances

    - Bias handling (model as well as observational)

    - Choice of domain

    - Development of monitoring tools and quality measures

    - Implementation of run-time diagnostics in assimilating model

- **Use of radar data, and other aspects of use of precip data**

- **Use of early satellite data**

- **Coastal ocean assimilation**

- **….**

EURRA element 5: Production of reanalyses

- **Pre-production testing**
  - Time for this should not be underestimated

- **Production**
  - Monitoring is key activity
  - Extent of requirement for on-the-fly data-use and bias-correction decisions will depend on extent of pre-data screening and use of adaptive bias-correction systems

- **Post-processing**
  - Formation of additional datasets: monthly means, climatologies, subsets for specialised users, …
  - Revision of archive streams (time series, feedback information, output grids, …)
  - Blends into validation and dissemination elements

EURRA element 6: Validation

- **Linked to primary user requirements**

- **Activated for pre-production testing**

- **Done in part by the primary production team, with the remainder distributed among other stakeholders**

- **Validation should be a "near-real-time" activity as production proceeds**
  - Forms a component of production monitoring

EURRA element 7: Dissemination

- **Documentation**

- **Data services**

- **User support**

- **Workshops**

- **Training**

EURRA: Next steps

- **Workshop report and presentations have been published (now without restriction) on ECMWF website**

- **Conclusions have been presented to the ECMWF and EUMETNET Councils**

- **The EEA has discussed the idea of the project with its Member States and received a favourable initial response**

- **The EEA will announce a vacancy for a Consultant to help develop the project**

- **It is envisaged that the Consultant will work with representatives of ECMWF and the European regional NWP consortia to develop a detailed proposal for the project**