Francois Bouttier: EURRA

selected slides from a presentation
at ALADIN workshop
Sofia, 16-19 May 2006

What is EURRA ?

a plan for a European project - not yet defined nor funded, but with potentially big consequences on the future 'European Vision' organization

History:

- **1995-2002 : ECMWF reanalyses.** ERA-40 over 40 years is very much used in the climate & environment community.
- **2000-2004: EU** wants more 'public' mesoscale weather climatological data freely available. **ECMWF** suggests **EEA (European Environment Agency)** to fund a **European mesoscale reanalysis** called **EURRA.**
- **2005:** EEA & its partners outlines **user requirements for EURRA:**(i.e. many environmental agencies) **10-km resolution over at least 30 years.**
- **Now:** prepare a serious proposal so that ALADIN/HIRLAM can play a role in EURRA : needed by the environment community & will modernize our surface & diagnostic analysis tools.

EURRA scope

EEA needs:

- **low-level wind:** requires heavy 3D dynamical downscaling coupled to ERA-40 archive
- **coastal waves:** complex wave model coupled to ERA-40
- **T2m RH2m:** on Europe, requires SYNOP spatialization + NWP background
- **rr rr24:** need to merge radars + national raingauges
- **clouds, surface irradiance, SST:** need to blend satellite products
- **ground snow:** SYNOP + satellites + NWP background
- **soil humidity/temperature/runoff:** requires forced soil model (+ OI?)

EURRAsurf proposal: to cover all 'surface' fields, excluding 3D and ocean waves.

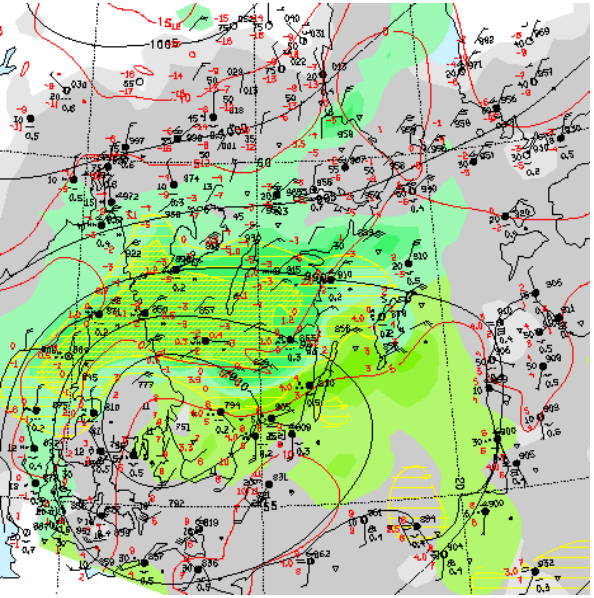
Why the ALADIN/HIRLAM interest in EURRA ?

- an opportunity to **modernize our surface analysis** & **product generation** software : higher resolution, using more data & NWP model features
- more resources by **joining forces** with the climate & nowcasting communities (and more if funded by EU)
- **important applications** for climate change studies
- better use of data (e.g. **SAF**) in NWP data assimilation
- generate **nowcasting products** from mesoscale NWP output
- a **strategic activity** in the future role of NWP institutes : relationship with EU, with the environment community, distribution of work & money among European NWP teams

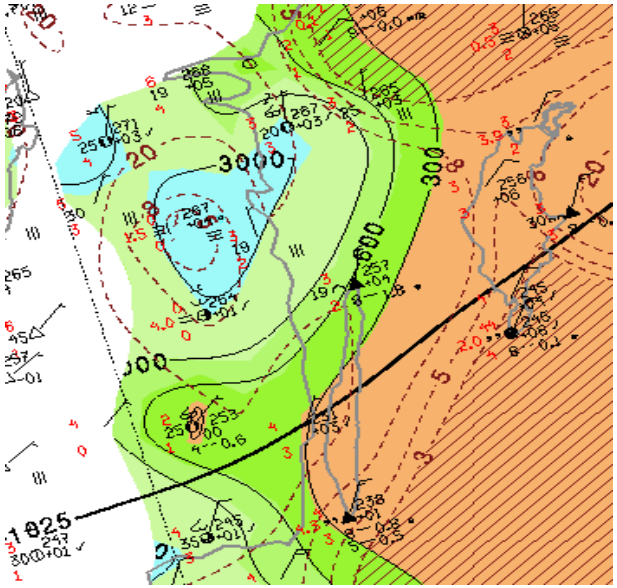
The MESAN system (courtesy of SMHI)

- A **synop/metar spatialization tool** (OI with **nonisotropic** structures functions) for nowcasting, used around 30km resol. Recently extended to process **radar & satellite data**

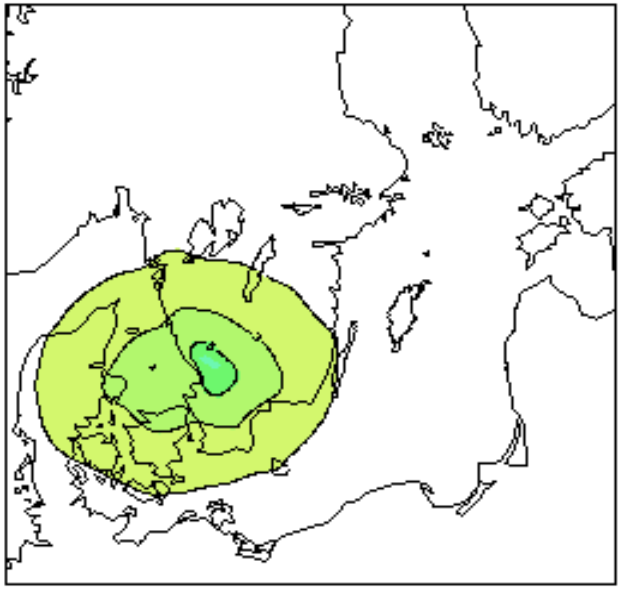
ref: Häggmark L., K.-I. Ivarsson, S. Gollvik and P.-O. Olofsson, 2000: Mesan, an operational mesoscale analysis system. *Tellus,* **52A,** 2-20.



cloud cover (grey) & precip (green)



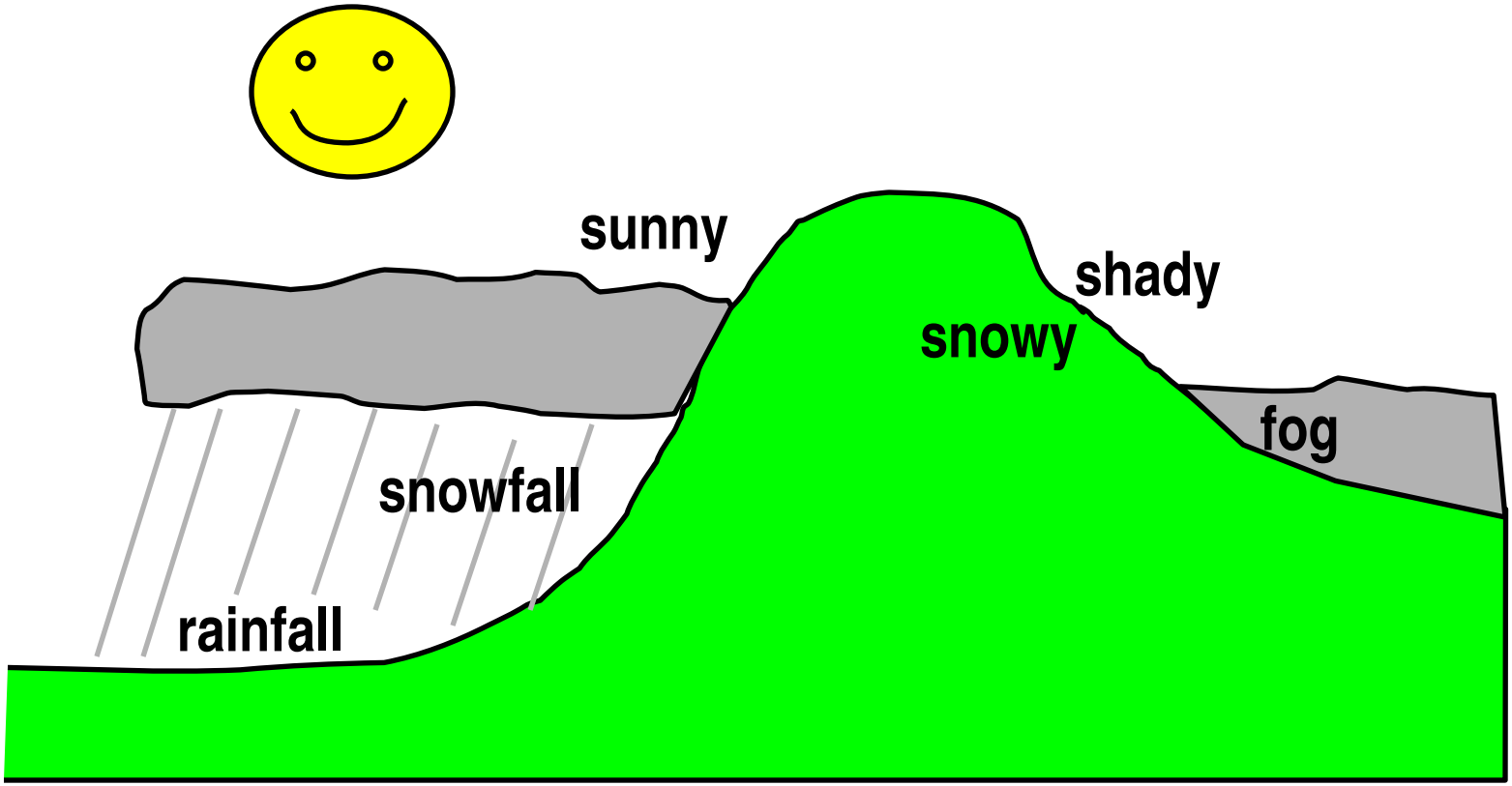
cloud base (colours) & visibility (grey)



structure function for precip

SAFRAN system (Météo-France)

optimized for mountain weather



step 1: spatialize T2m RH2m rr cloudiness

step 2: estimate vertical profiles using sounding, physics, NWP output

step 3: **desaggregation** wrt. altitude, slope, exposure on mountains groups with **homogeneous climate**

(step 4: force physical models of snow/avalanche, or ISBA+hydrology)

Other scientific aspects

Fine-scale analysis of sensitive ecosystems:

- lakes
- small islands
- coasts
- ponds & flooded areas

EURRAsurf algorithmics

On data-rich areas, the best products are interpolated obs.

Imagery products are great for coverage and pattern identification, but often need **cross-tuning** with in-situ obs.

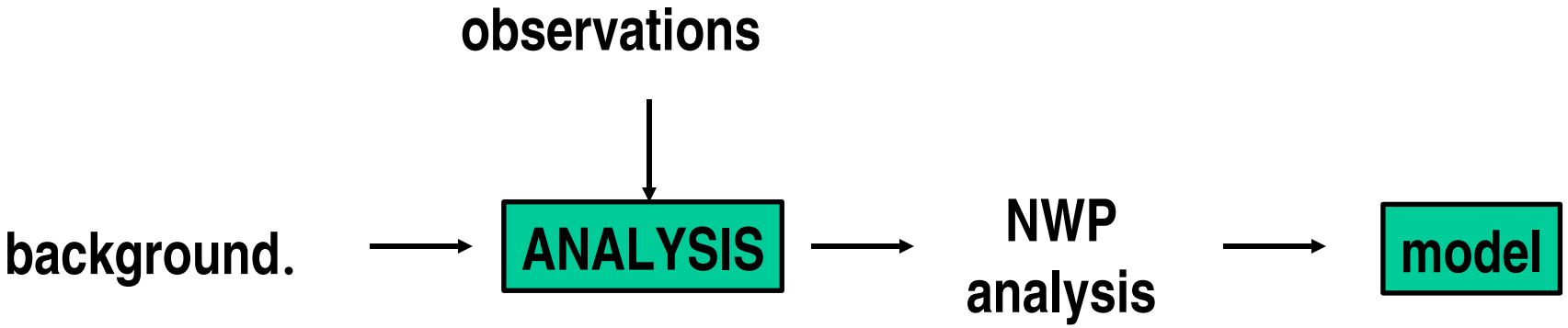
On data-poor areas, **NWP output** needs to help the obs.

Higher-resolution models like AROME and HARMONIE can bring more useful info than older models:

- **NWP data assimilation** provides safe fields, but much information is smoothed out.
- Assimilated NWP precip & clouds provide poor patterns, but (usually) good **description of the 3D environment**.(e.g. lapse rate)

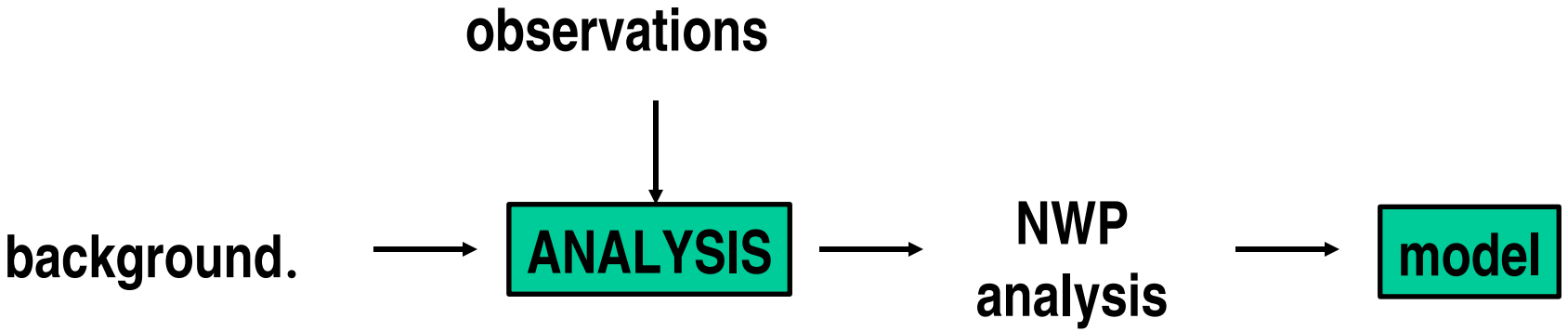
EURRAsurf algorithmics

The NWP way: data analysis for model initialization.

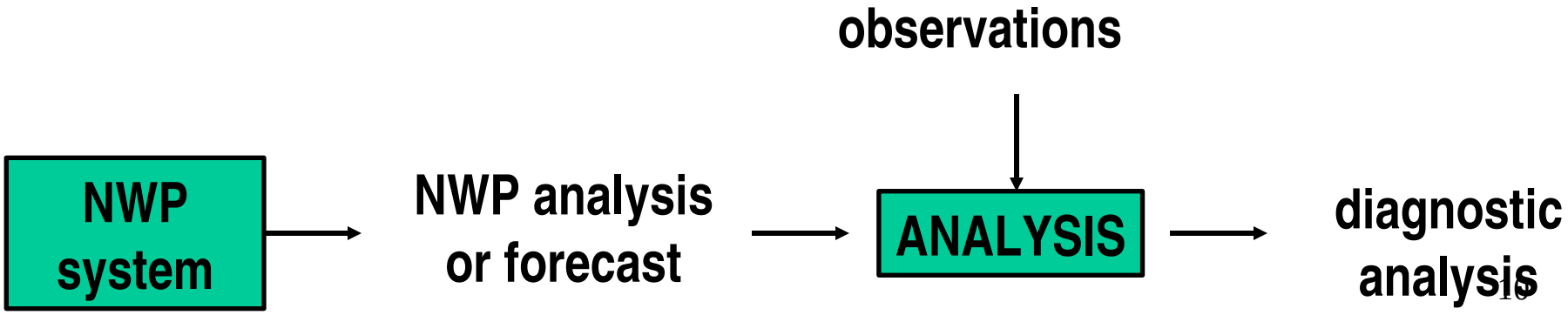


EURRAsurf algorithmics: obs vs model

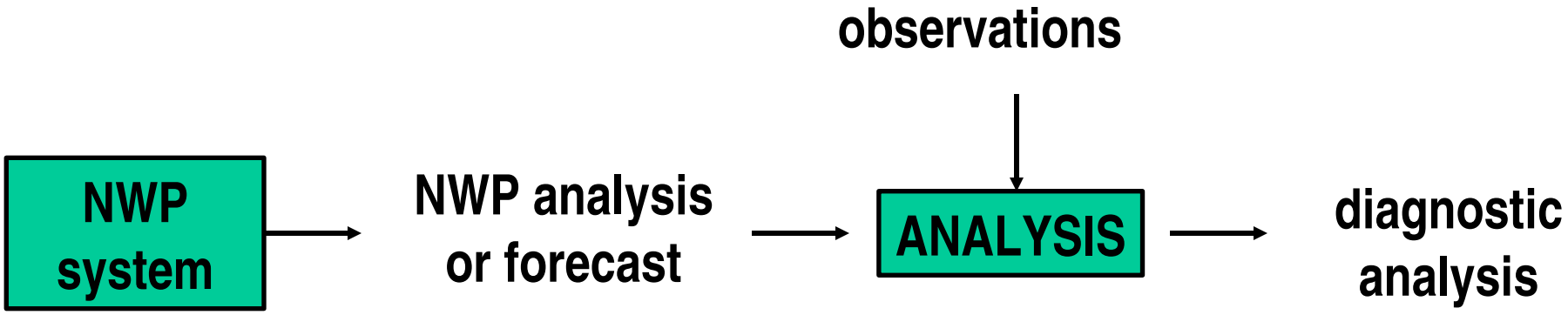
The NWP way: data analysis for model initialization.



The diagnostic way: data analysis for obs spatialization

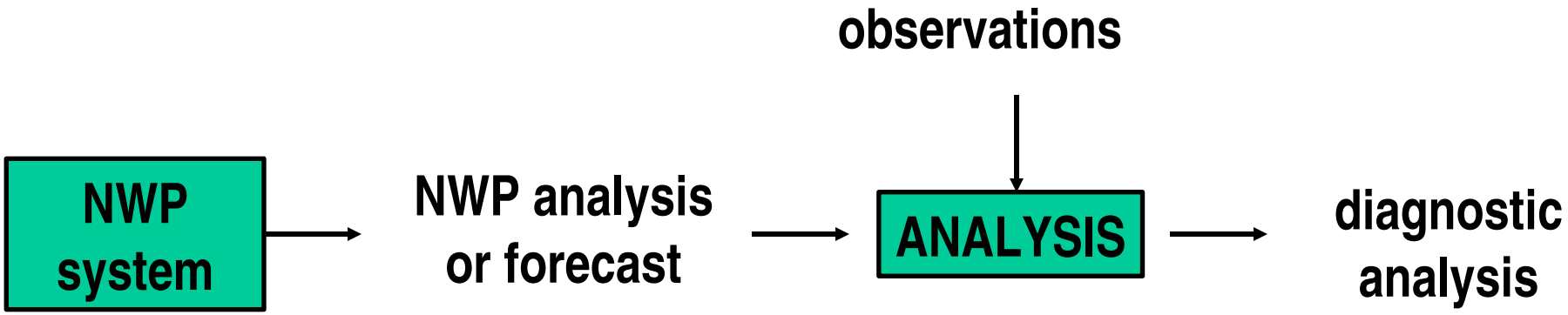


EURRAsurf algorithmics: obs vs model



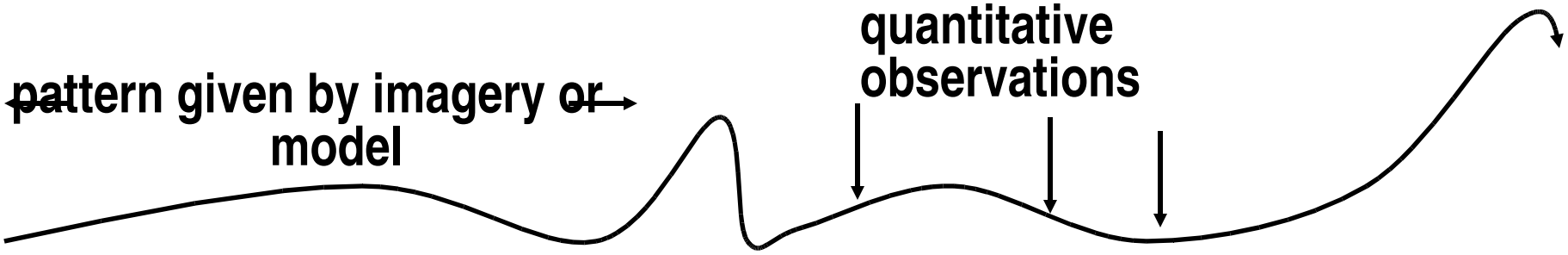
- **fit observations** more tightly than in NWP analysis
- no need to worry for **data thinning** or forecast quality (except as sanity check)
- problem: unclear theoretical foundations e.g. for QC or Jb
- more freedom to **use fancy structure functions** (Mesan)
- i.e. need to invent ad hoc measures of analysis quality, e.g.
  - aesthetics,
  - **cross-validation** vs independent data
  - **scores of applicative models**

using model guess in practice



- **T2m, RH2m, etc:** use model local gradients wrt orography (height & slope exposure, a la SAFRAN), coastlines, cloud cover
- **soil moisture:** use model radiation ? and model precip in data-poor areas
- **radiation and cloudiness:** use model vertical profile for better analysis of cloud base & top
- **precipitation:** model in data-poor areas
- **surface snow:** use radiation & precip analysis for time evolution
- **SST, ice, fog:** use model forcing when obs are unavailable

blending different observations



- method to **blend different kinds of point obs** is rather well known (use OI weights)
- less obvious: mix poorly calibrated **imagery patterns** with sparse, more precise observations ?
- related problem: **stitch** together several gridded products (e.g. satellite snow or SST products with holes in them)
- <u>ideas:</u>
  - **use in situ obs to calibrate** imagery bias correction (e.g. radar rr)
  - **relax imagery towards good obs** in their neighborhood (must set influence radius, handle **time & representativeness mismatches**)
  - **textural info** tells whether imagery or obs smoothing is better (idea of ANTILOPE raingauge/radar blending tool)
  - switching rules among several options, with **smoothing in space & time**

Enforcing product consistency

- essential because users are likely to recombine several parameters to "cook" their own products
- basic requirement: use **common physiographies**, physical constants and laws in all computations.
- need to **define consistency rules** and design a workable chain of dependencies:
  - precipitation implies cloudy skies
  - snow implies negative temperature (more or less)
  - fog implies RH close to 100%
  - waves imply open non-frozen sea
  - positive SST implies non-frozen sea
  - increasing snow depth implies snowfall
  - radiation is sensitive to cloudiness & fog
  - T and evaporation are sensitive to radiation
  - 2D fields must be reasonably consistent with 3D fields
  - etc...

Basic EURRAsurf specifications (1)

- must be able to cover the entire **Europe & Mediterranean area at resolutions between 10km and 1km**
- must be able to run **since 1970 and** make good use of **modern observations** over recent years
- able to use basic, public observations **and** make good use of extra national datasets (e.g. ENSEMBLE archive, radars)
- strong interface with ERA-40 archive of obs & fields
- **reanalysis mode speed:** about 20 days per day i.e. 30 years in 18 months of production, in computing centre
- **nowcasting mode speed:** 5 minutes per analysis over one country, on local cluster

Basic EURRAsurf specifications (2)

- always select the best data source for each product. Avoid attachement to any particular technique (users are sensitive to the worst features, not the best ones). **3 - 4 data sources for each parameter** sound good.
- all products must come with accurate **quality measures**, varying in space and time (if only to allow subsequent re-merging with extra data sources)
- a **minimum, reasonable quality** must be enforced everywhere, at any time (fallback on e.g. ERA-40 products)
- special attention to be paid to **long-term trends** in the system, because EURRA will primarily be used for climate monitoring: beware of nonphysical drifts & time inconsistencies e.g. because of evolving obs networks = artifacts to be actively monitored and fought

From idea to reality

The good news: fairly distinct subprojects, easy to distribute, there is ample prior expertise in ALADIN & HIRLAM centres.

The bad news: extra work is required to deliver

- enormous grids (Europe at 2km)
- international data acquisition of high-resolution obs archives
- reprocessing of huge ERA-40 archive
- core staffing for project (at least 2 people for 2 years)

- physically consistent products
- geographical stitching if we have subdomains
- evolution of physiographies over 30 years
- documented products database accessible to users

First dependency analysis