Surface issues for SRNWP

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Thanks to J.-M. Bettems, D. Mironov, P. Pellerin, J.-L. Roujean, D. Carrer, Y. Seity, J.-C. Calvet, J. Cedilnik

Outline

- Specificities of surface aspects for SRNWP
- Coupling strategies
- Modelling aspects
- Physiographic data bases
- Data assimilation aspects
- Validation studies

Purpose of surface schemes

- Realistic description of momentum, energy and mass (water, CO_2, aerosols, …) exchanges between the Earth's surface and the atmospheric turbulent boundary layer.
- Framework of SRNWP :
  - Temporal scales : < ~ few days
  - Spatial scales : few kms

Main surface types

Bare soil

Vegetation

Snow

Oceans

Ice caps

Sea ice

Main surface types

Bare soil

Vegetation

Snow

Oceans

Ice caps

Sea ice

Towns

Lakes

How to characterize surfaces ?

- Fast evolving components (< 1 day) : **modelling** (evolution of prognostic variables)
- Slow evolving components (~ 1 week) : **data assimilation** and surface analyses
- Static components (> 1 month) : specification though **physiographic data bases**

- Land surface temperature, interception reservoir
- Root zone soil moisture – snow cover - SST
- Soil texture, land cover

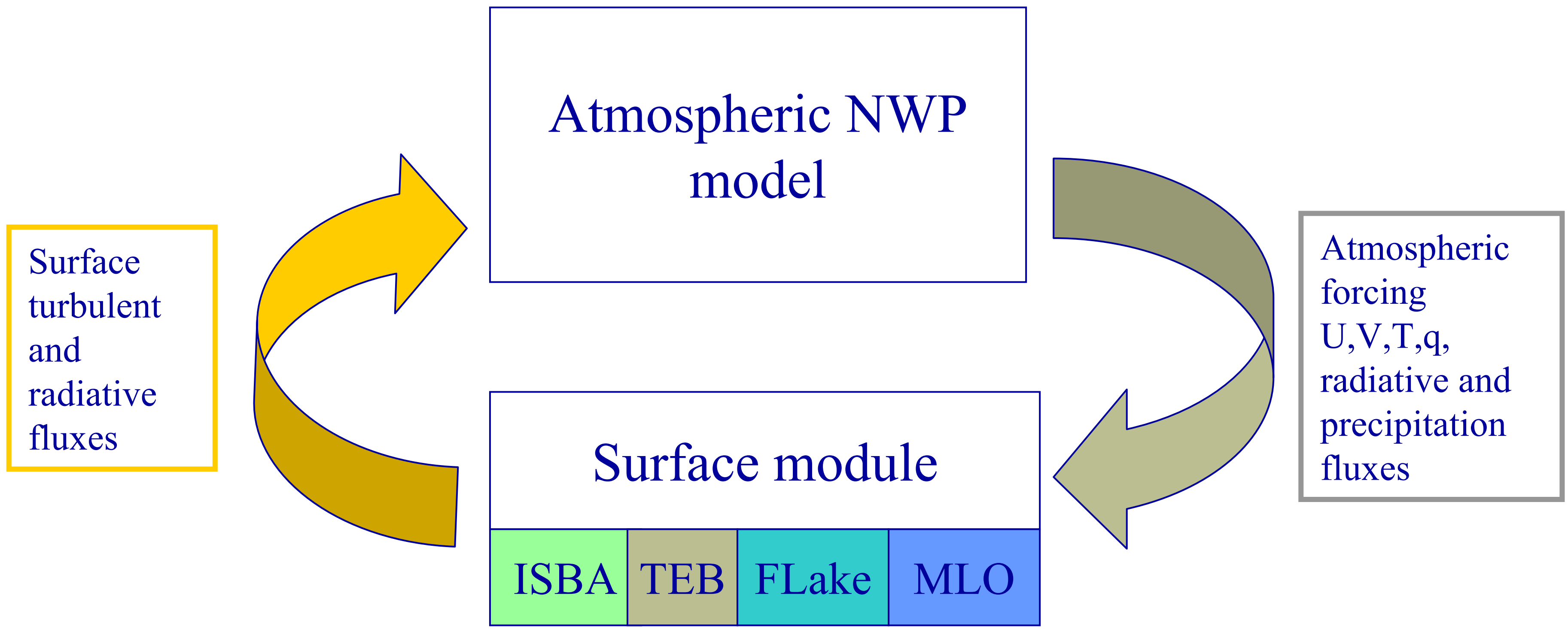
Motivations for collaborations

- Common interest on some aspects – Share common experience
- Complexity of surface processes => Benefit from complementary expertise
- Take advantage of European initiatives (e.g. EUMETSAT SAF – EUMETNET OPERA)
- Share national validation data bases

Coupling strategies

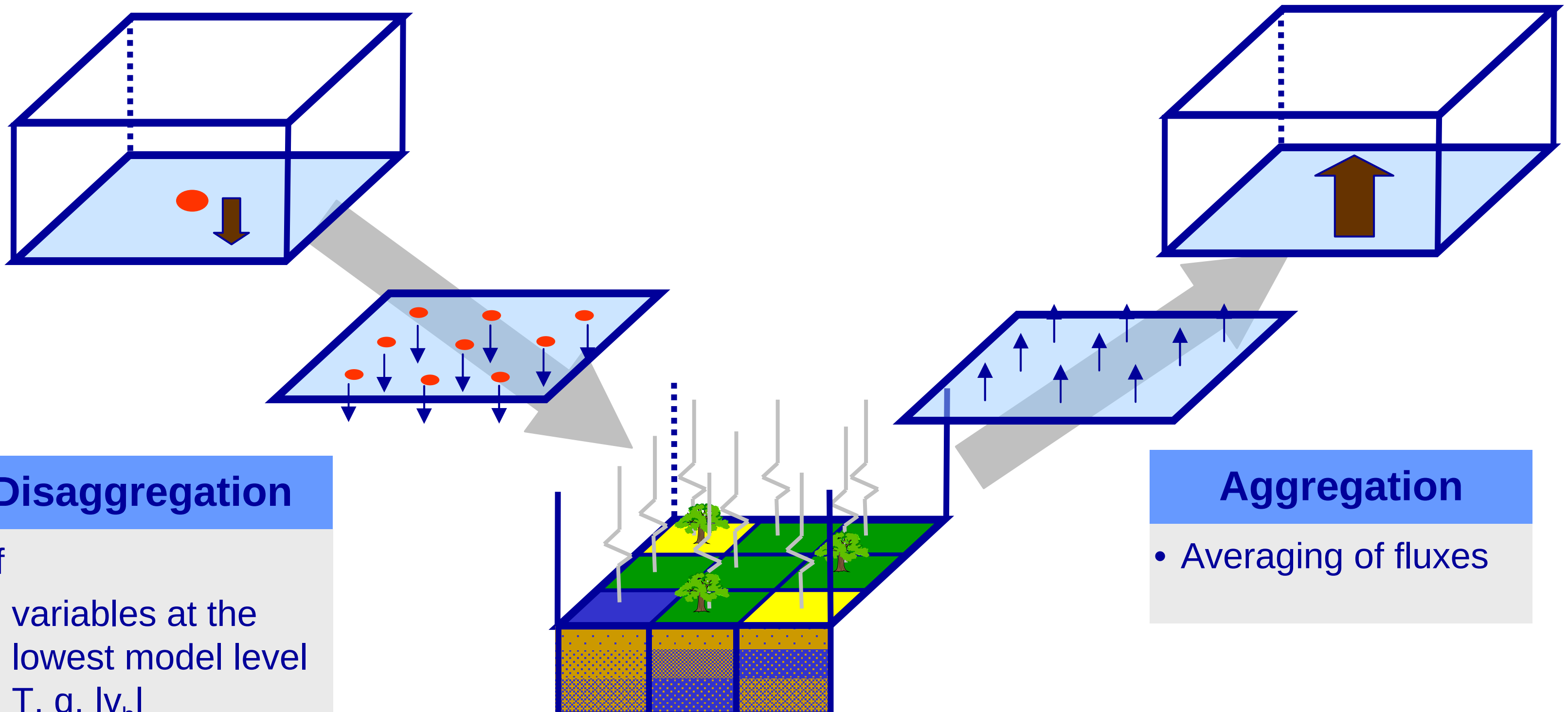
- Surface externalised from the atmospheric model : to be used by various models (NWP, mesoscale research, climate, hydrology), offline validations and data assimilation
- Existing platforms : SURFEX and JULES
- How is consistency achieved between modules (e.g. subgrid heterogeneities, orography, continuity between SBL and ABL ?)
- How can modularity be achieved (external vs internal coupler) ?

Internal coupling strategy (SURFEX)



ALMA coupling norm (Polcher et al., 1998; Best et al., 2004)

Mosaic approach in COSMO



Disaggregation

of

- variables at the lowest model level T, q, $|v_h|$ (homogenous)
- precipitation RR (homogenous)
- downwelling radiation (homogenous)

Local Calculations

- soil physics
- transfer coefficients
- surface fluxes

Aggregation

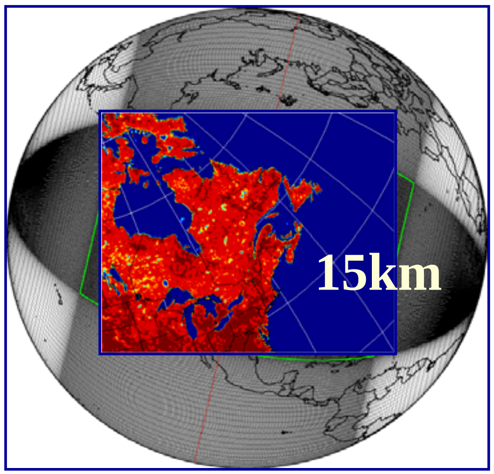
- Averaging of fluxes

From J.-M. Bettems (Meteo Swiss)

External coupling strategy

Canadian environmental modelling system

Computer 1



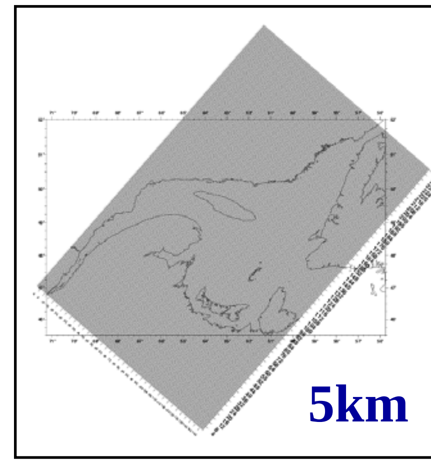
Atmospheric model

$\Delta t = 550$ s

OASIS

External
Coupler
Interpolation
Aggregation

Computer 2



Regional Ocean model

$\Delta t = 250$ s

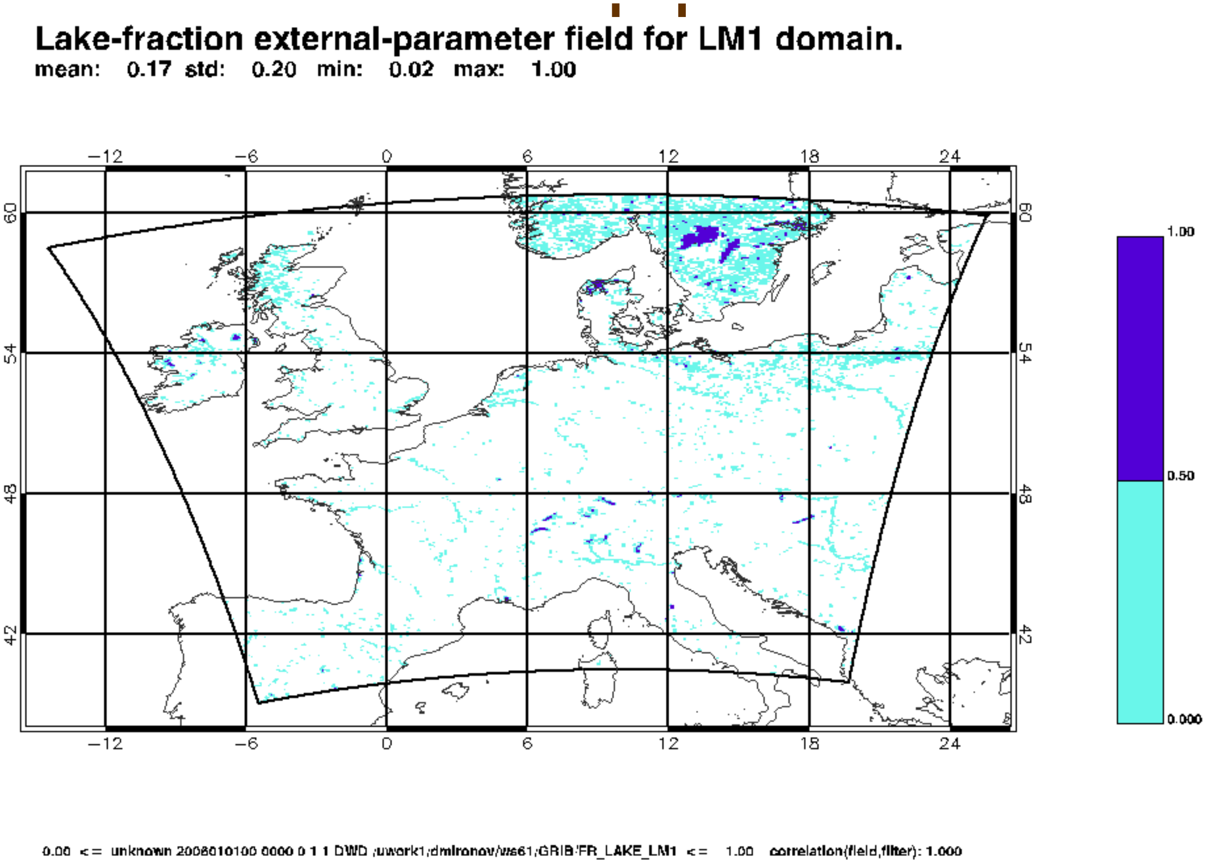
From P. Pellerin (MSC)

[*also hydrological models*]

Current modelling developments

- Description of missing processes in SURFEX (ALADIN/LACE) already available in HIRLAM : snow/forest interactions (workshop in Toulouse), prognostic sea-ice
- New (common) area of development : use of FLake
- Common interest in stable surface boundary layers : CANOPY in SURFEX, QNSE theory in HIRLAM
- What else is relevant for SRNWP (available in SURFEX) : towns, ocean, interactive vegetation, aerosol transport, … ?

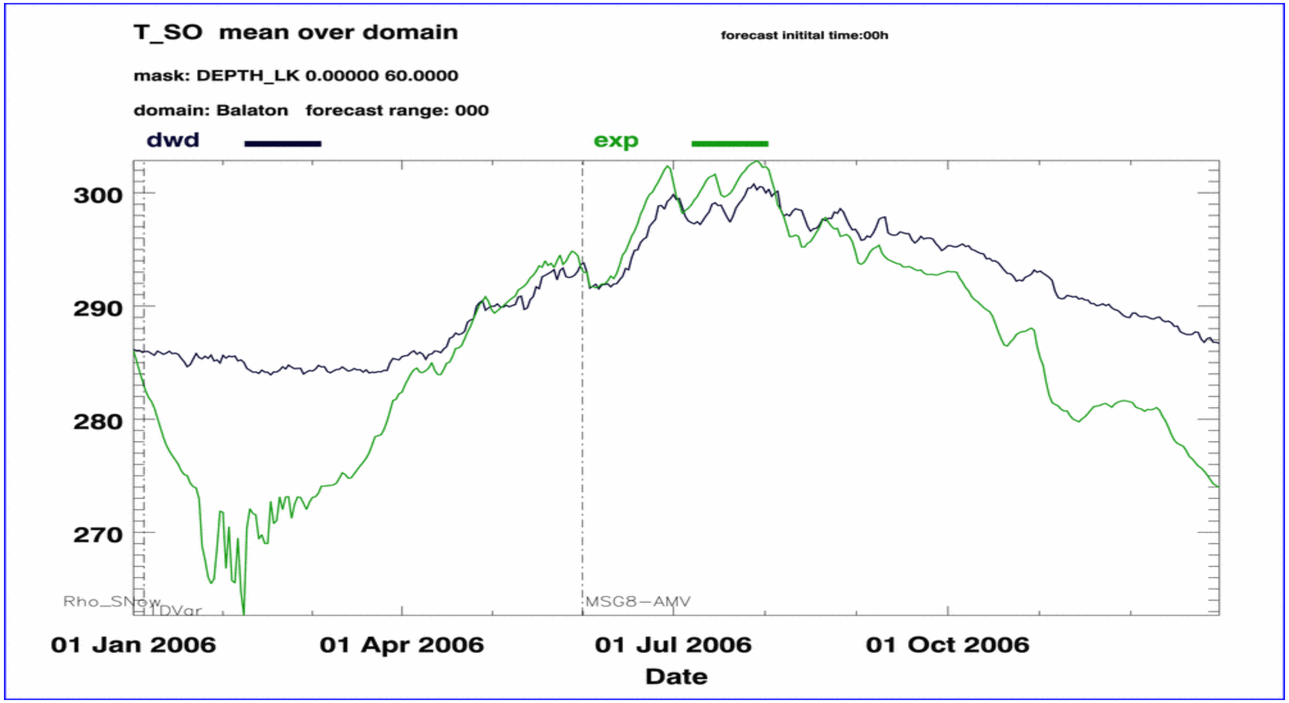
Lake Fraction in COSMO LM1



Lake-fraction external-parameter field for the LM1 numerical domain (DWD) of the NWP model COSMO based on the GLCC data set (http://edcsns17.cr.usgs.gov/glcc/) with 30 arc sec resolution, that is ca. 1 km at the equator.

From D. Minonov (DWD)

FLake in COSMO: Results from Parallel Experiment 5632
1 January – 31 December 2006

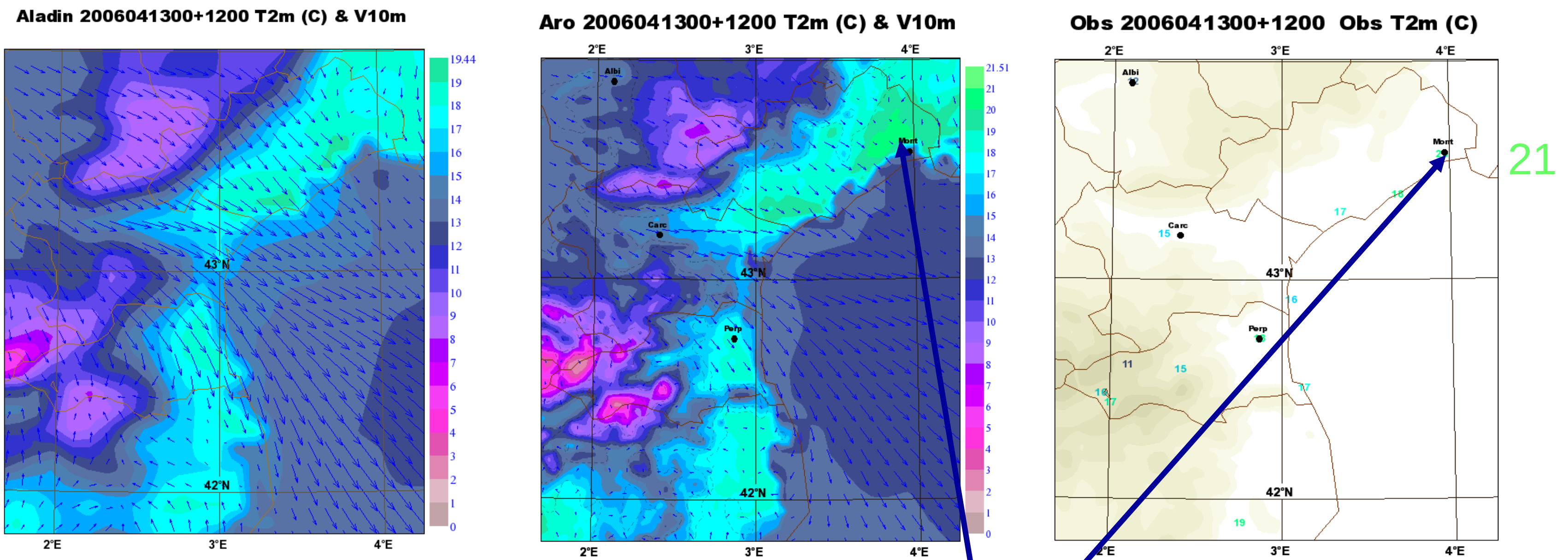


Lake Balaton, Hungary (mean depth = 3.3 m)

- Black – lake surface temperature from the COSMO-LM SST analysis
- Green – lake surface temperature computed with FLake

From D. Minonov (DWD)

Impact of urban tiles



ALADIN
Δx=9.5 km

AROME –TEB
Δx=2.5 km

Montpellier

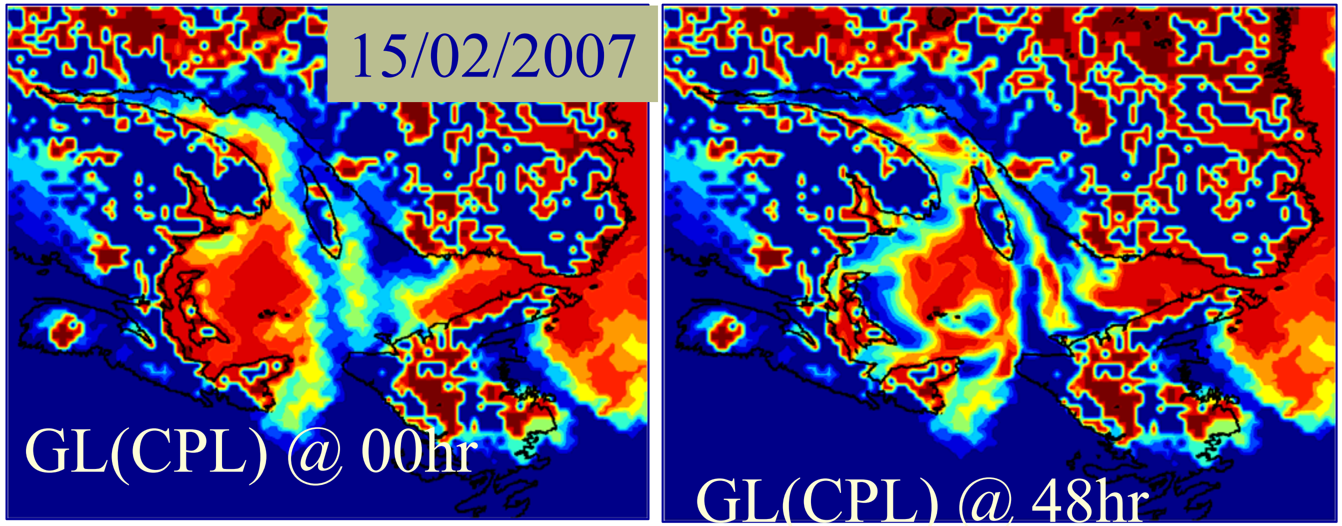
SYNOP
observations

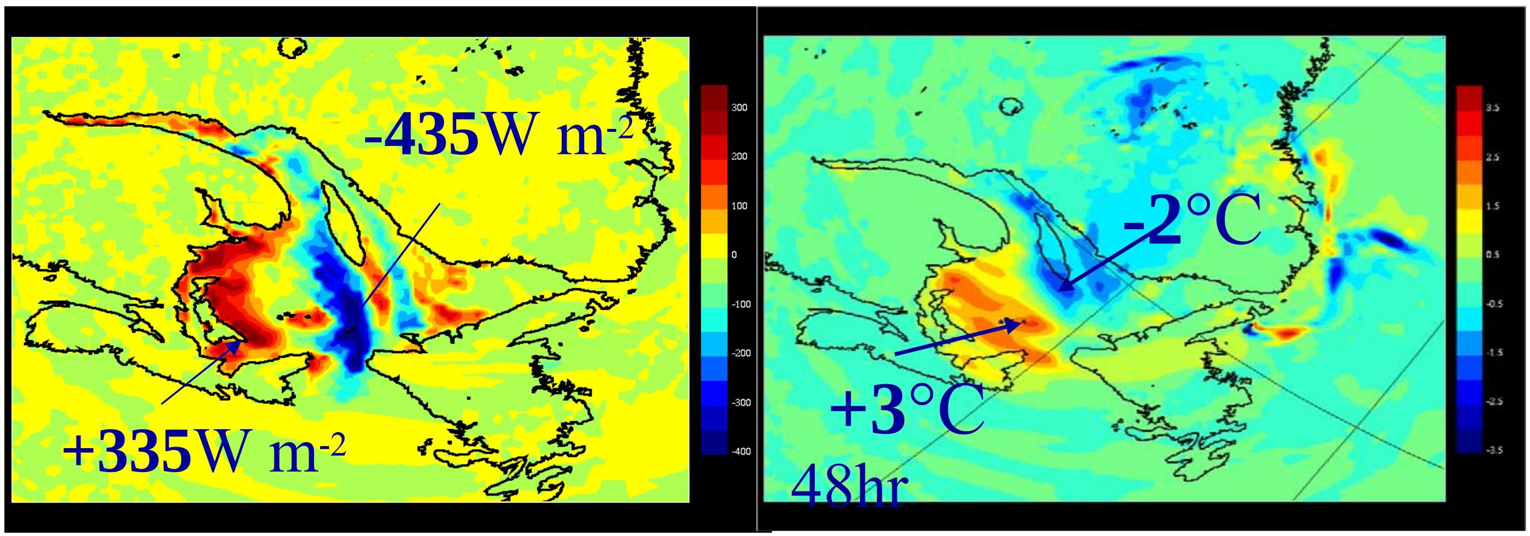
12-h forecast of screen-level temperature

METEO FRANCE

From Y. Seity (MF)

Sea-ice thickness





Sensible heat flux (W/m2)

Temperature (°C)

From P. Pellerin (MSC)

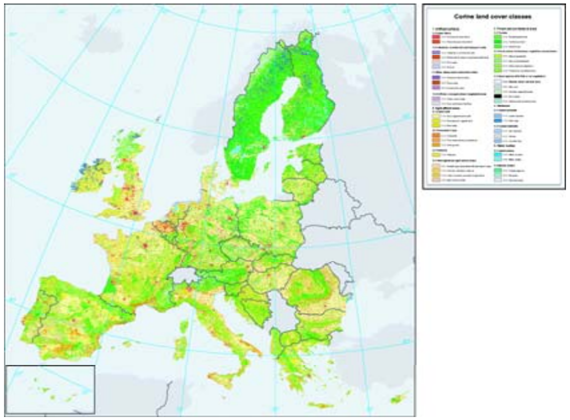
Physiographic databases

- Resolution issues : soil texture global products (FAO) at 10 km
- Availability of high resolution land cover maps over Europe : CORINE2000 (100 m)
- Interest for regional data sets vs global data sets (LAM outside Europe) ?
- Land cover maps = climatologies => use of real-time satellite products
- Databases for new surface types : towns, lakes ?

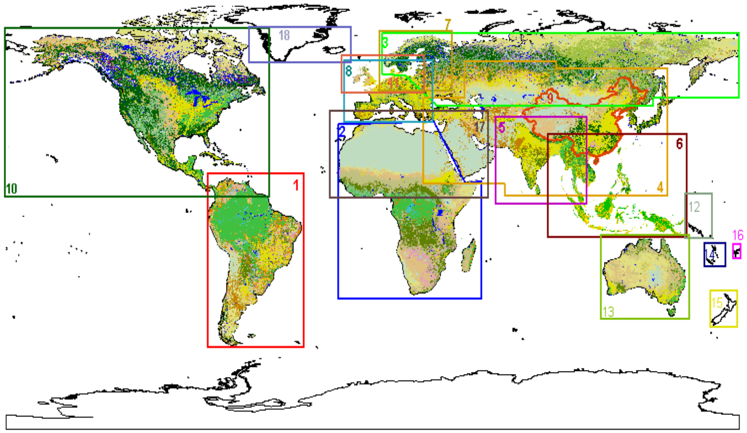
ECOCLIMAP 2

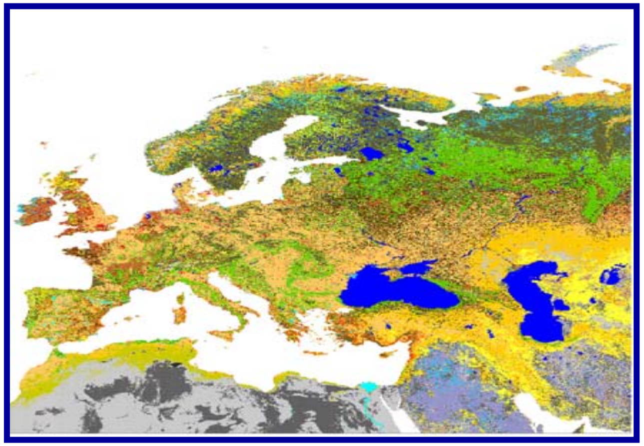
- Revised land cover climatology at Météo-France
- Higher resolution and improved quality of land cover maps
- Multi-year data availability
- Improved method for ecosystem classification

CORINE2000 – 100m



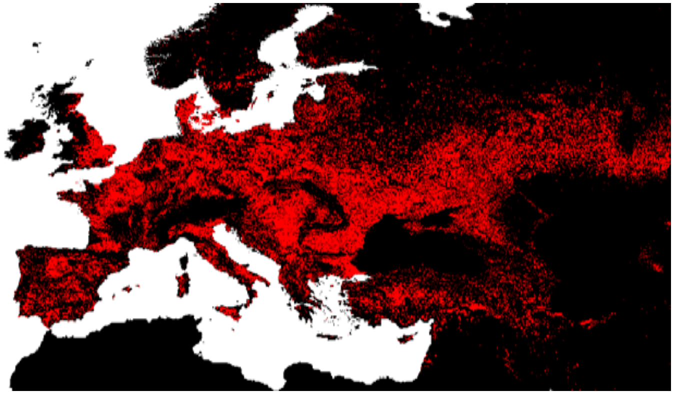
GLC2000 – 1 km

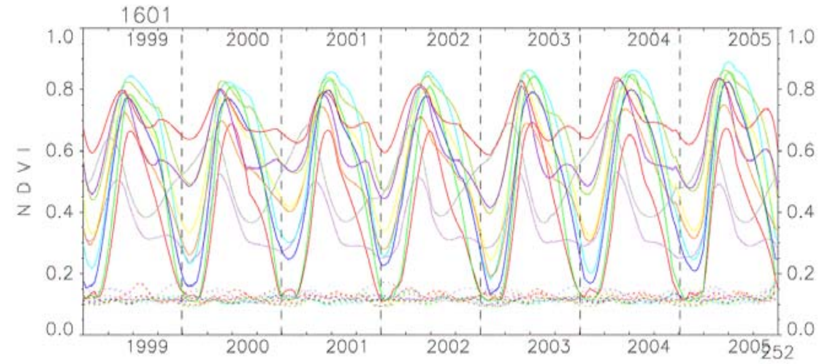




1-km merged land cover map

From J.L. Roujean (MF)

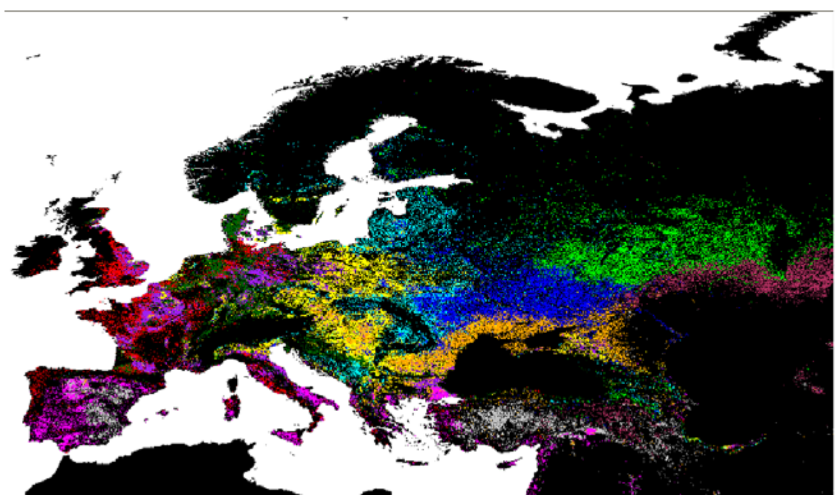




Crop cover

NDVI SPOT/VGT

Automatic classification

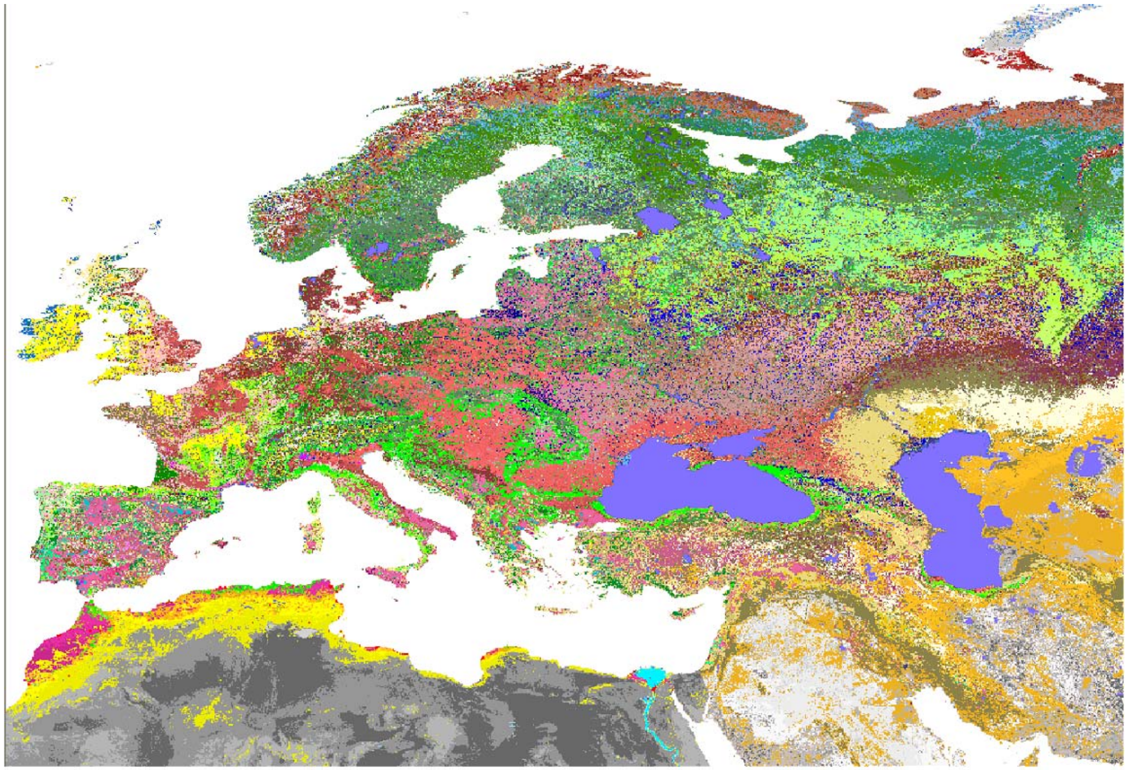


Crop ecosystems

From
J.-L. Roujean (MF)

ECOCLIMAP II

Resulting land cover map: 305 ecosystems



Look-up tables for internal model parameters

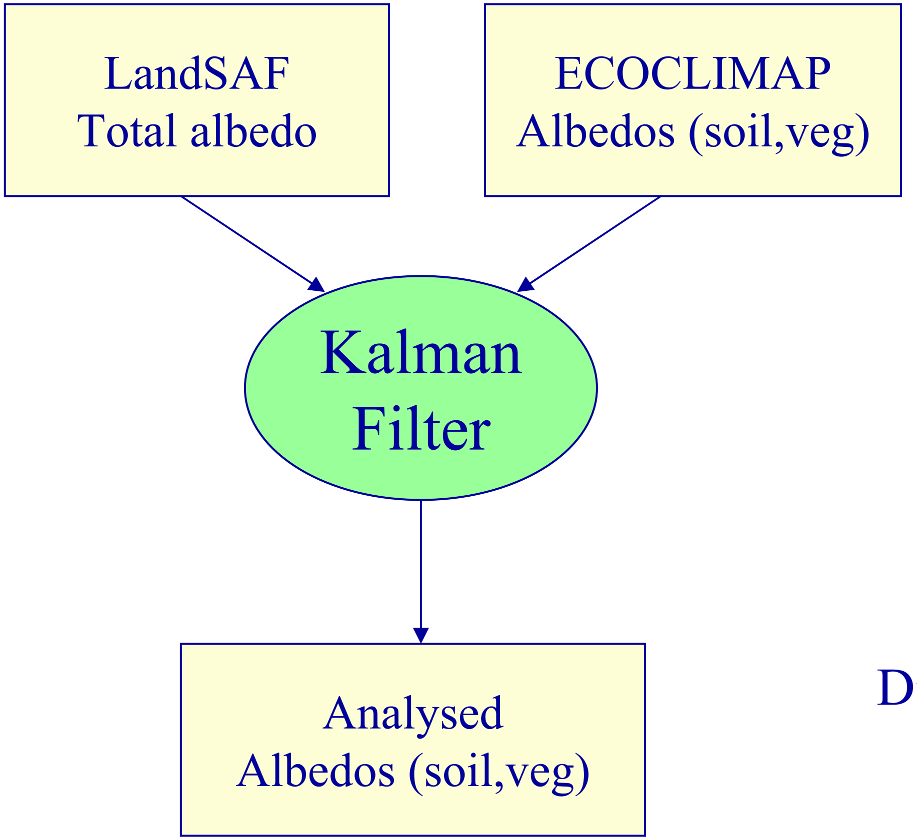
Data assimilation aspects (1)

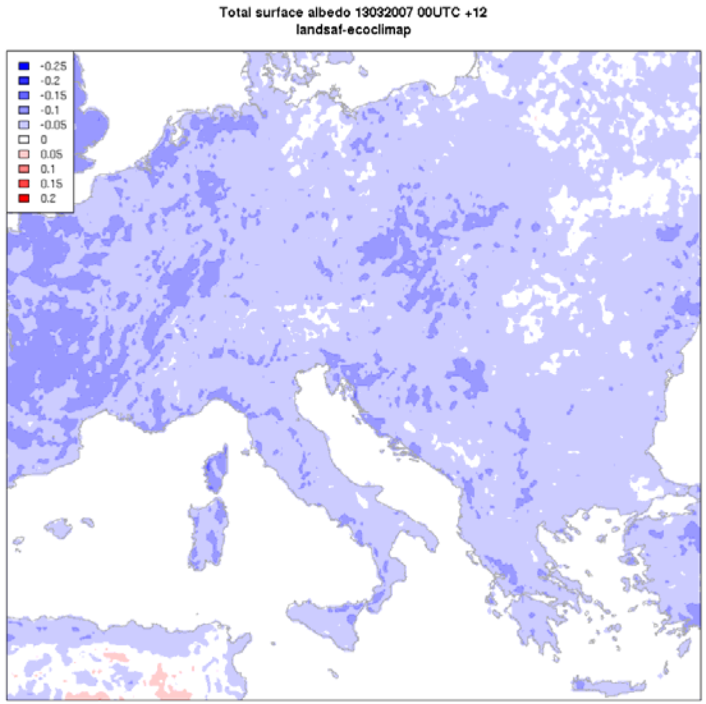
- Better usage of remote-sensing data (available over Europe)
- SST and Sea-ice : OSI-SAF – MERSEA - OSTIA
- Snow analysis : snow cover / snow water equivalent (LandSAF, MODIS)
- Soil moisture analysis : satellite derived products (ASCAT, AMSR-E, SMOS)
- Vegetation properties : albedo – LAI (LandSAF, MODIS)
- Radiative forcing : downward fluxes (LandSAF)
- Precipitation forcing : radar networks (OPERA)

Data assimilation aspects (2)

- Improved land data assimilation systems :
  - EKF : SURFEX, MSC, ECMWF
  - EnKF : NILU (Met.No), US community
- Improve 2D analysis systems (SST, snow cover, screen-level variables) : OI accounting for anisotropy effects (e.g. wavelet structure functions)

Land albedo analysis

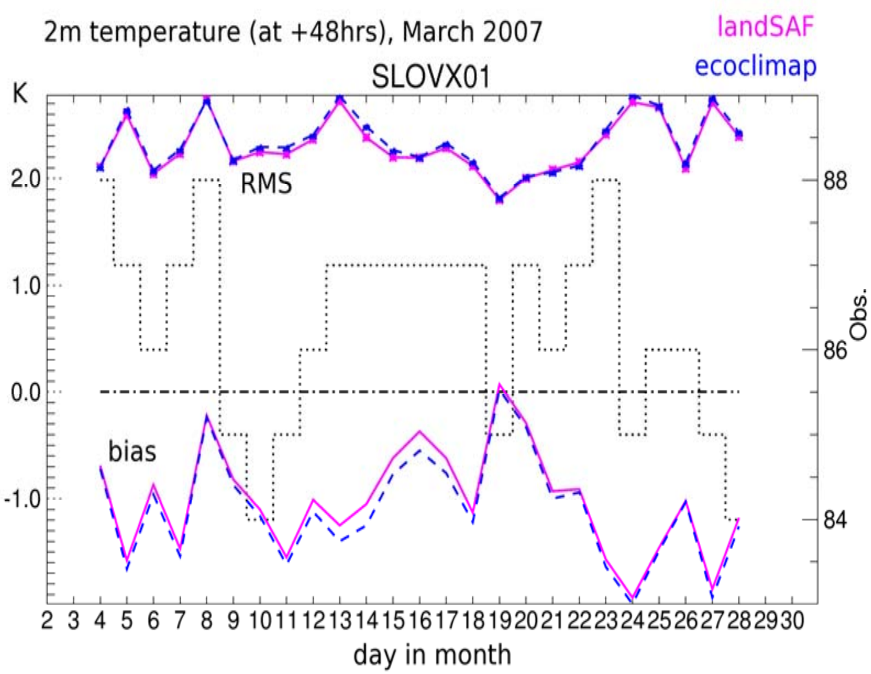




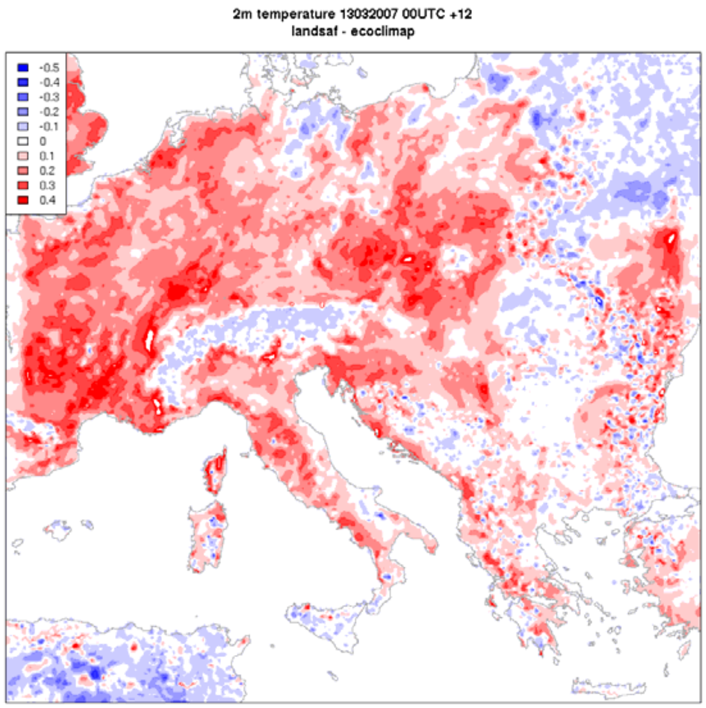
Difference (ANA – ECO) – 13/03/2007

J. Cedilnik

Impact on forecasts



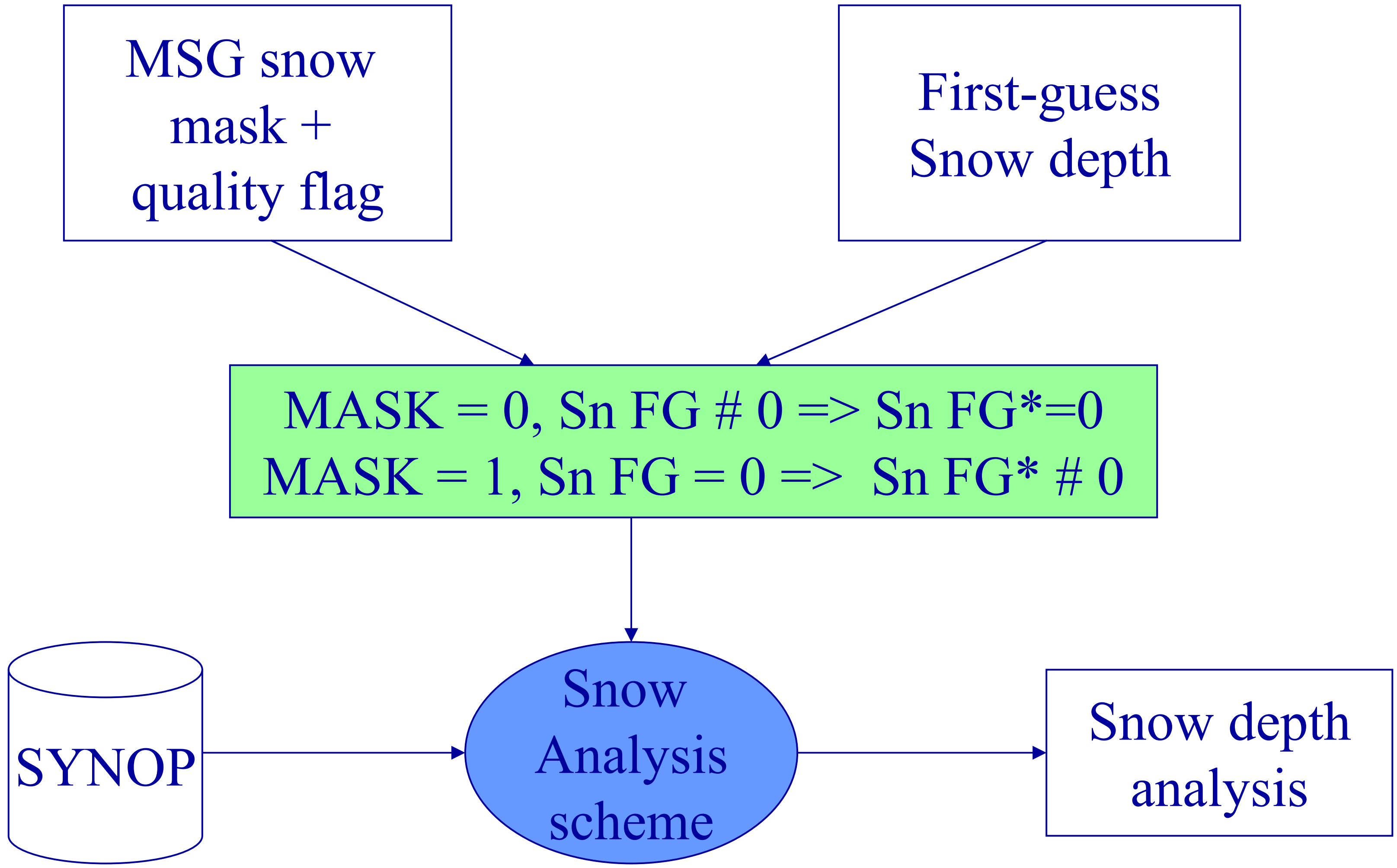
T2m forecast scores in March 2007



Differences in T2m FC+12
13 March 2007

J. Cedilnik LACE

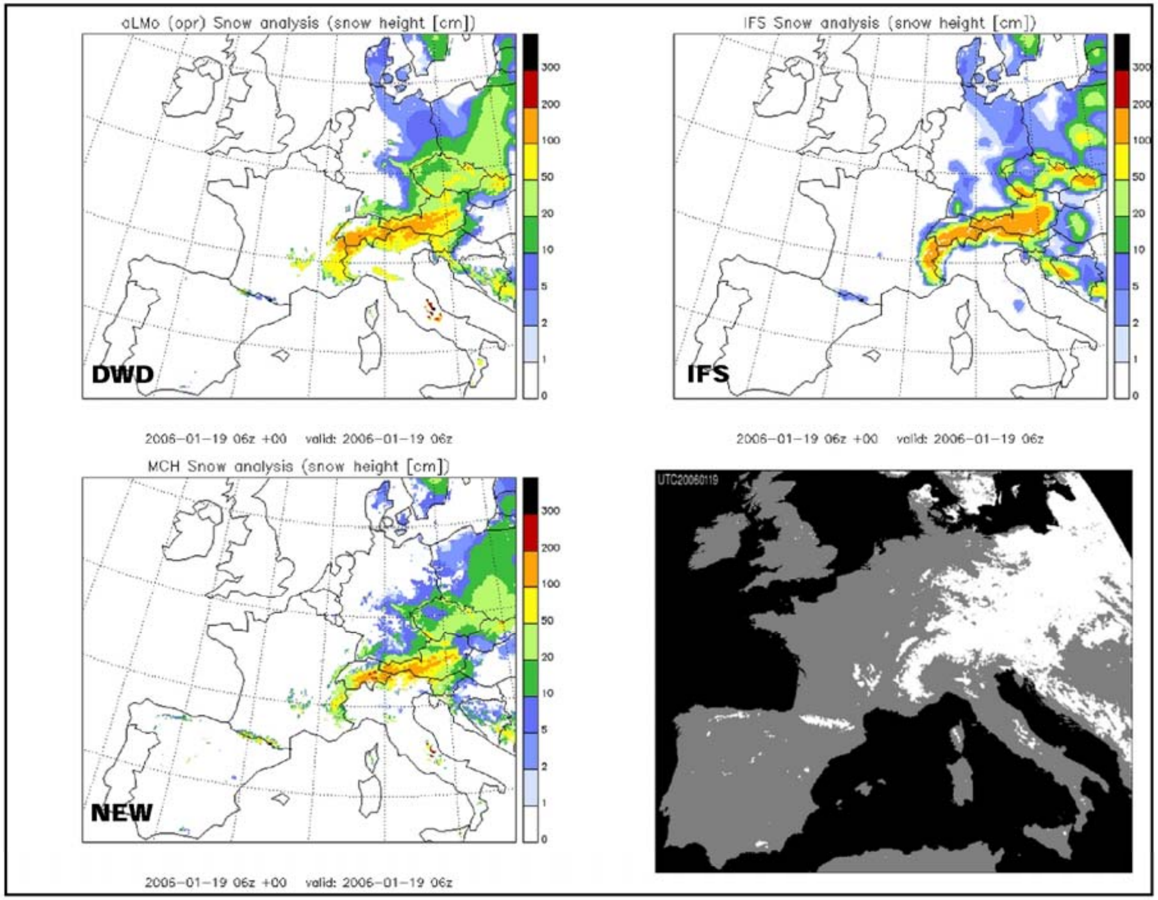
Snow analysis with satellite obs



Example from COSMO – 19/01/2006

COSMO OLD

IFS



COSMO NEW

MSG snow mask

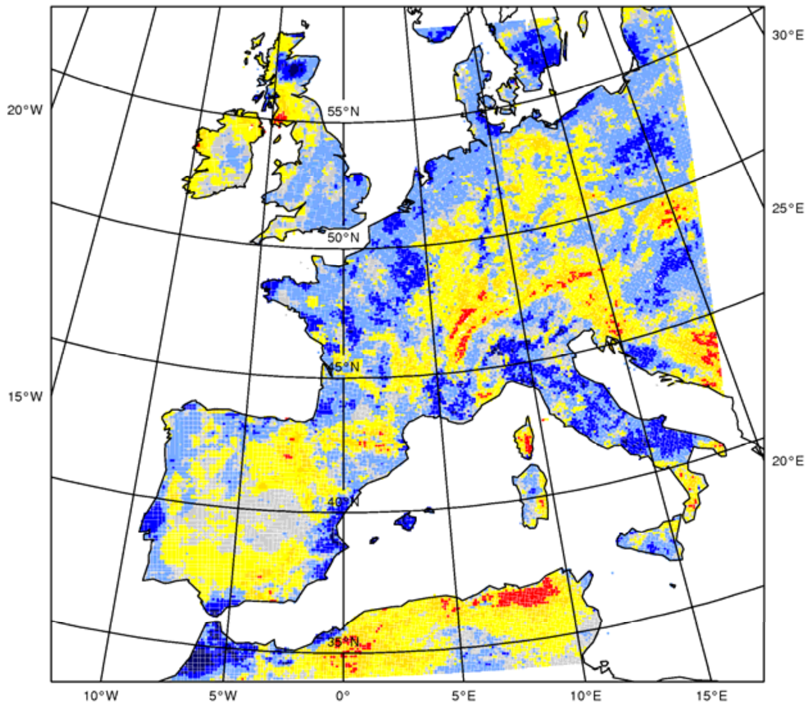
Fgure 2: Snow analysis on 19.01.2006. Clockwise form upper left panel: DWD product, ECMWF product, MSG derived snow mask for that day (composite map), and new product discussed in this paper. Note the large snow patch over North-Eastern Germany not present in the new product; the snow map shows bare soil over this region (in grey), but the corresponding satellite information is old due to overcast situation (not shown).

From J.M. Bettems (Meteo Swiss)

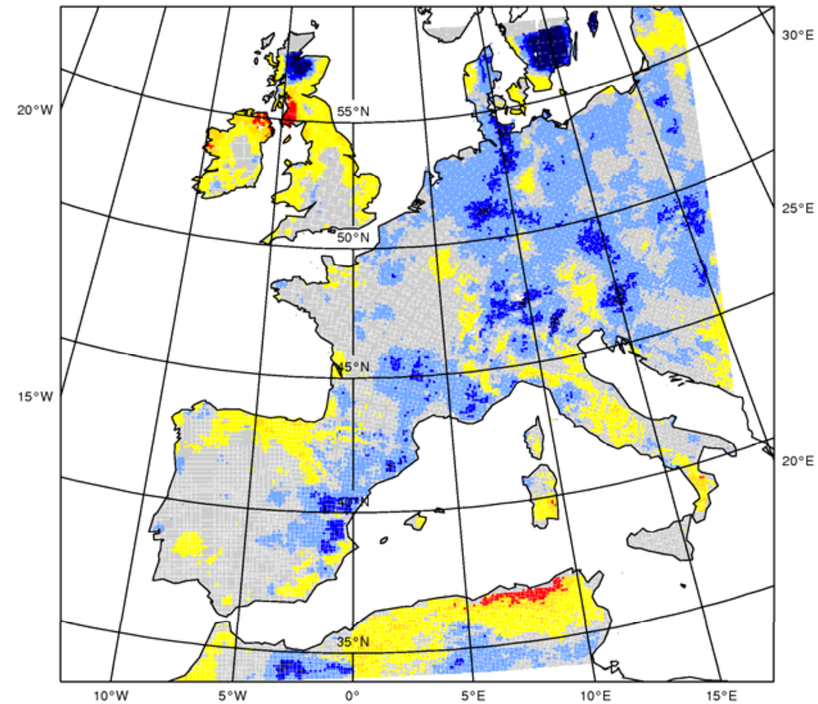
Soil moisture analysis

SURFEX EKF (accumulated increments in root zone)

SYNOP (T2m,HU2m) –ERS (SM)



ERS (SM)



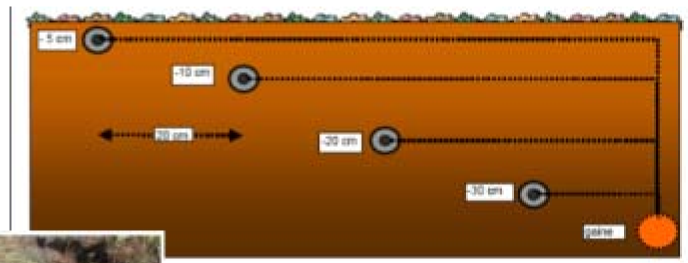
July 2006

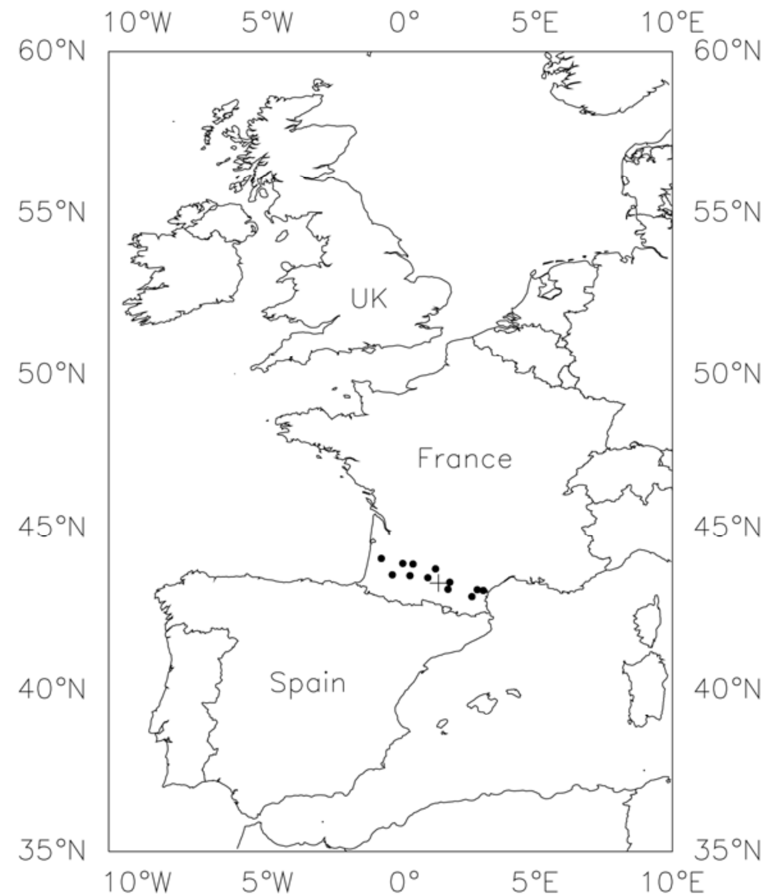
Validation studies

- Complement SYNOP data (screen-level parameters and precipitation)
- Share data from instrumented sites (over long periods of time – limited interest of data from field campaigns) – fluxes + soil variables :
  - SMOSREX, SMOSMANIA (Météo-France)
  - Lindenberg, Payerne, Cabauw

SMOSMANIA

- Soil Moisture Observing System – Meteorological Automatic Network Integrated Application
  - 12 stations at already existing AWS locations
  - Real-time soil moisture measurements –5cm –10cm –20cm –30cm
  - 1 measurement every 12 minutes

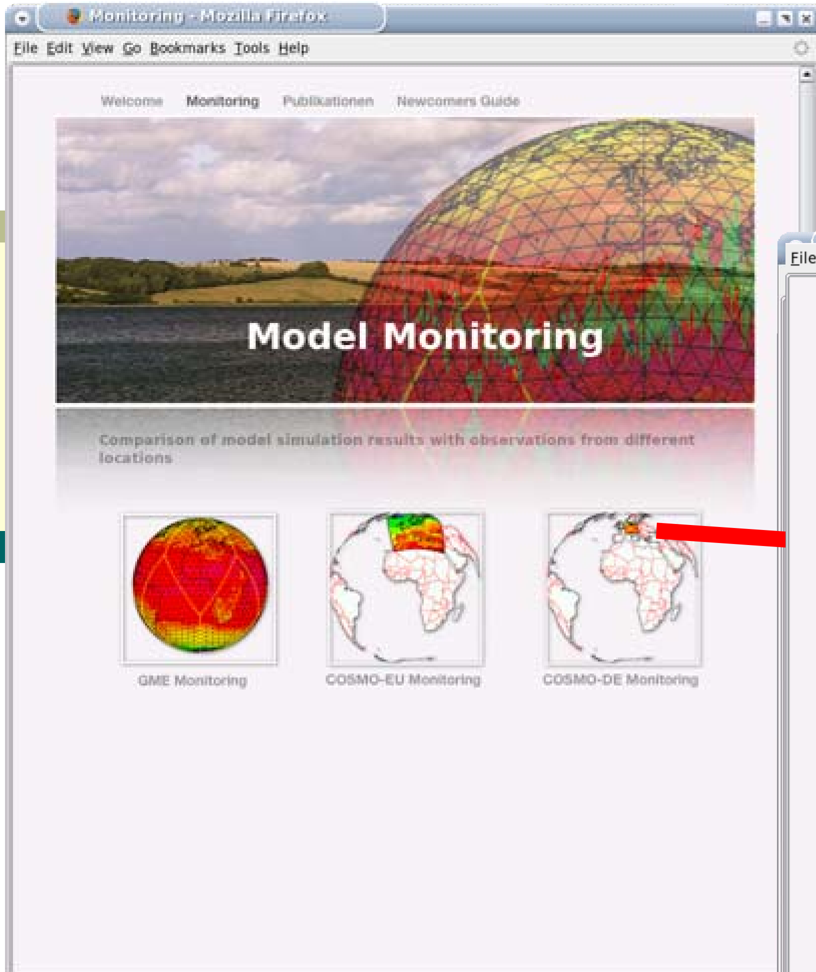


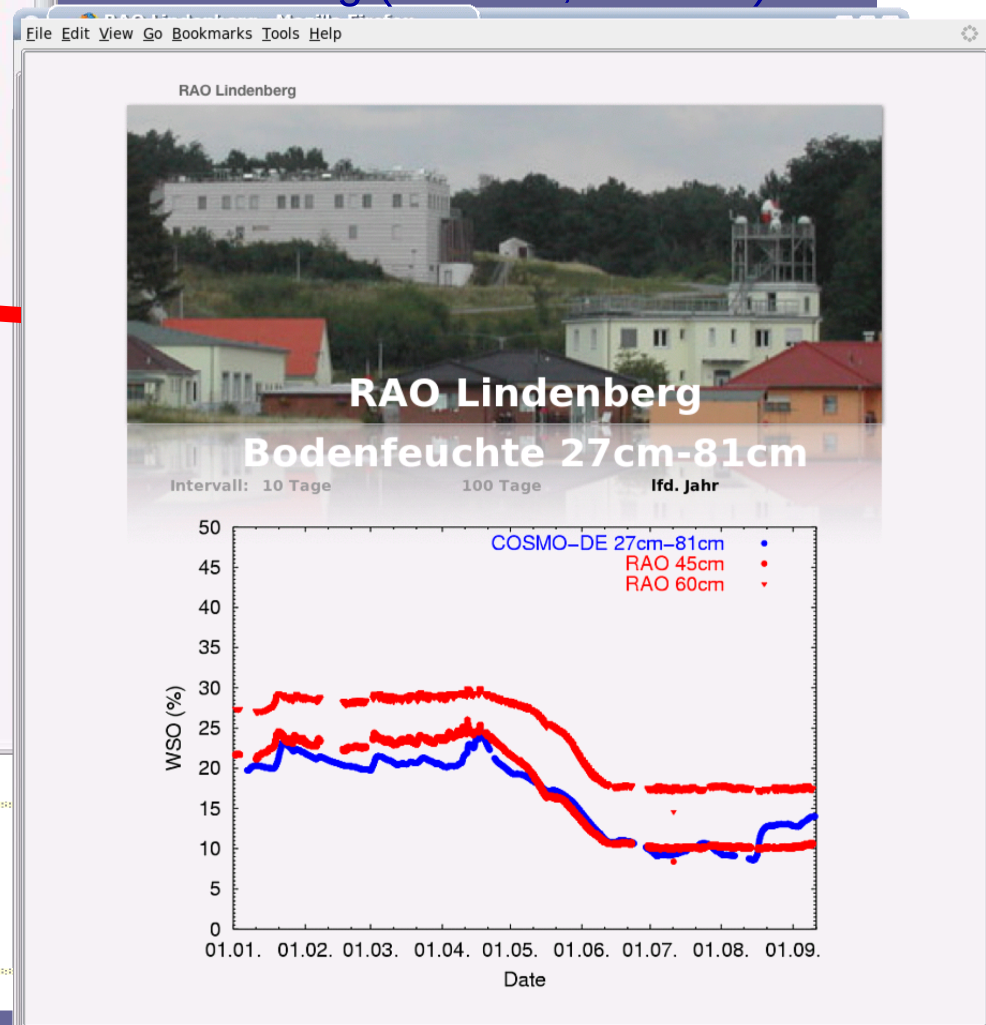


From J.C. Calvet (MF)

Model Monitoring in COSMO

Monitoring of model near-surface and soil variables against observations
Richard-Assmann Observatory (RAO) Lindenberg (52.15 N, 14.11 E)





Observation

Model