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Bundesamt für Meteorologie und Klimatologie MeteoSchweiz

Status of snow analysis in the COLOBOC priority project

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COSMO Seminar

Langen, 9 March 2009

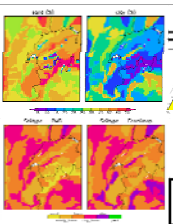
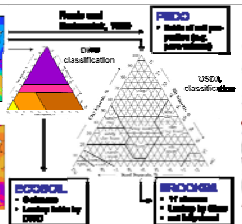
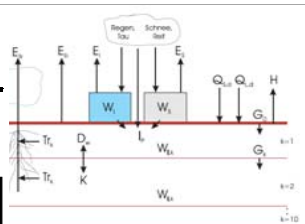
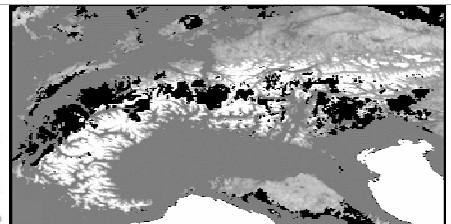
Overview

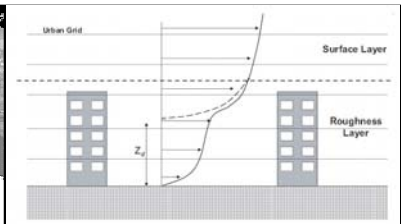
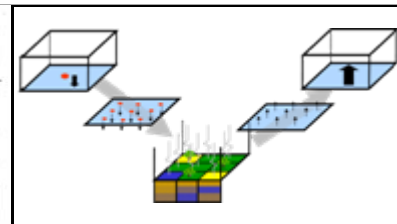
- Introduction to the project
- Set up of snow analysis
- Available data for validation
- Validation results
- Results from the 2 layer snow model
- Outlook

COLOBOC – Goal

Consolidation of Lower Boundary Conditions

It is the main goal of this project to incorporate all activities related to the lower boundary conditions which have already reached an advanced state, and to consolidate these developments into well tested and documented software packages readily usable by the COSMO community.

Snow analysis

Observations:

- Snow height, precipitation and weather type from SYNOP and regional networks (cf. Buchhold, DWD).
- Meteosat Second Generation (MSG) Spinning Enhanced Visible and Infra-red Imager (SEVIRI) 6 channels with 15 minutes time resolution (cf. de Ruyter de Wildt).

Algorithm:

- Cressman interpolation of in-situ observations
- Model first-guess in data-poor regions
- Correction to match MSG mask

Set-up:

- First-guess from full 3D model (production) or from TERRA stand-alone (experiments)
- TERRA stand-alone is the COSMO SVAT driven by hourly atmospheric analysis.

Available data for validation (i)

- **MSG** quality weighted snow mask on COSMO-7 and COSMO-2 grid:
  Information from composite snow mask weighted by associated quality flag and projected on model grid (snow, no snow, undef)

- IMIS measurement at ca. 90 Swiss stations between 1800 and 3000mAMSL from WSL Institute for Snow and Avalanche Research, SLF

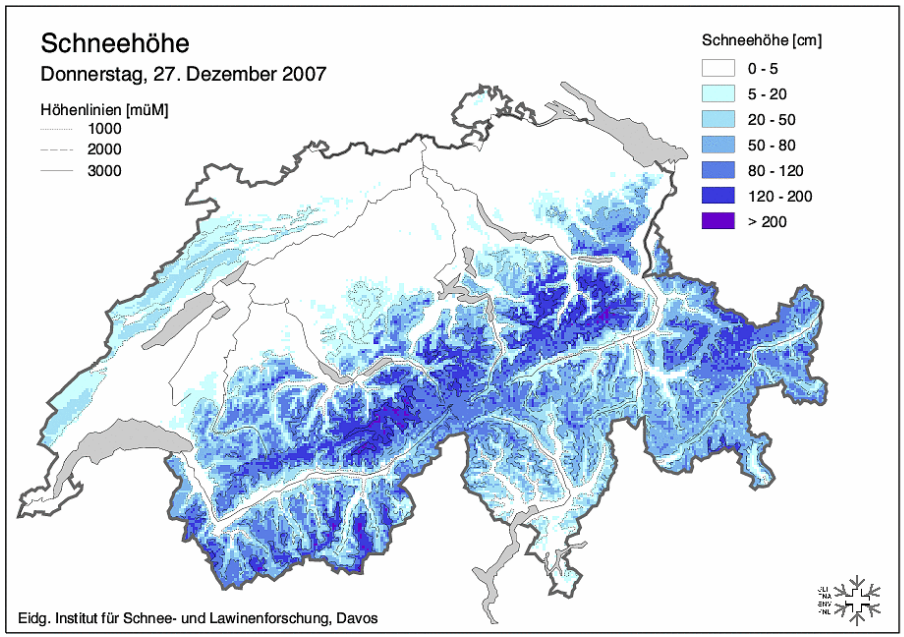
- **SLF** snow height analysis using all IMIS/ENET & NOAA data.

- Operational snow water equivalent analysis:
  COSMO-7, **COSMO-2** and
  COSMO-EU (this data is interpolated to the 6.6km Swiss grid).

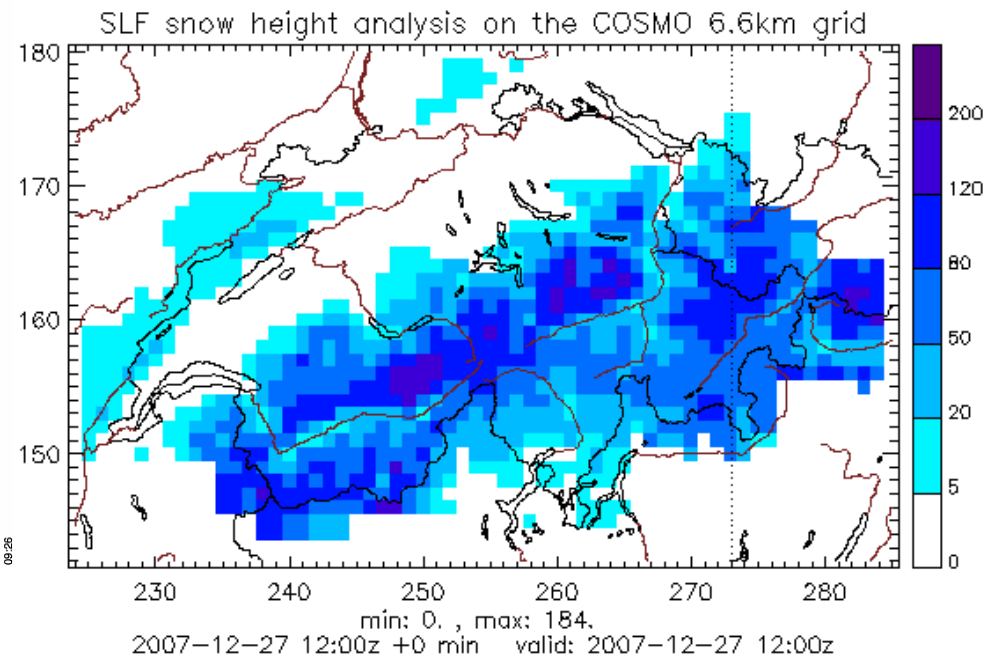
- SNOWPACK finite element model of layered snow structures (including phase change, water transport and snow drifting) at 8 Swiss stations.

Available data for validation (ii)

SLF analysis: original 1km resolution

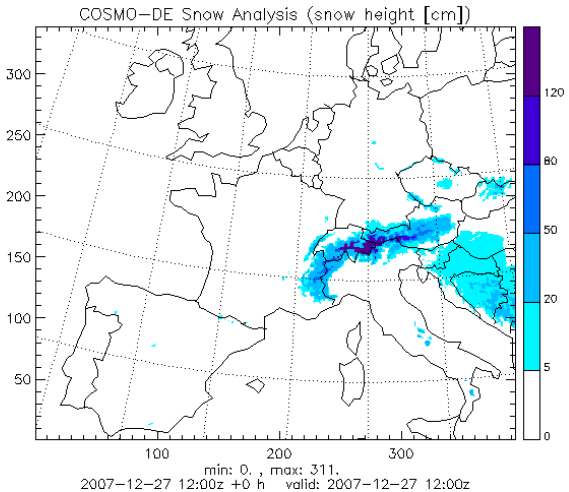


Re-grided with “fieldextra”:

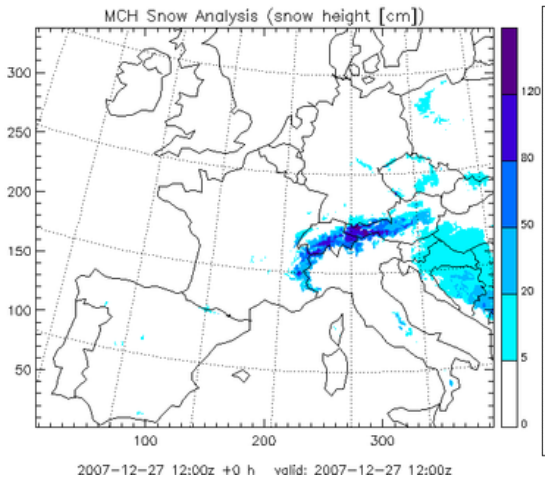


Available data for validation (iii)

COSMO-EU

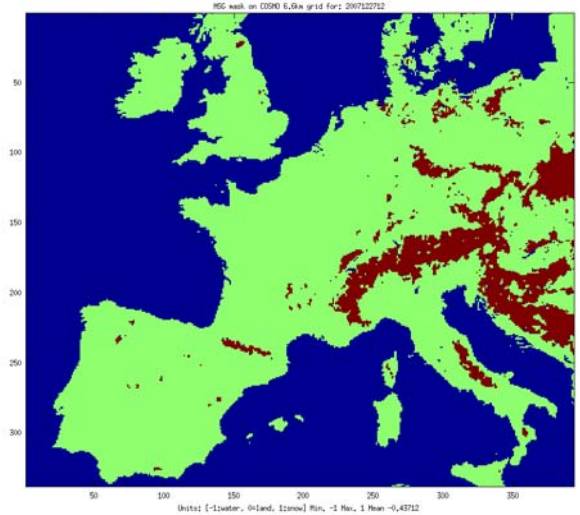


COSMO-7

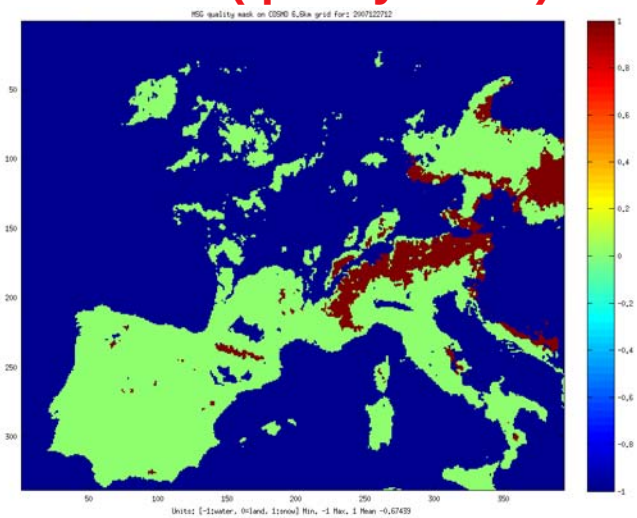


SLF-stations

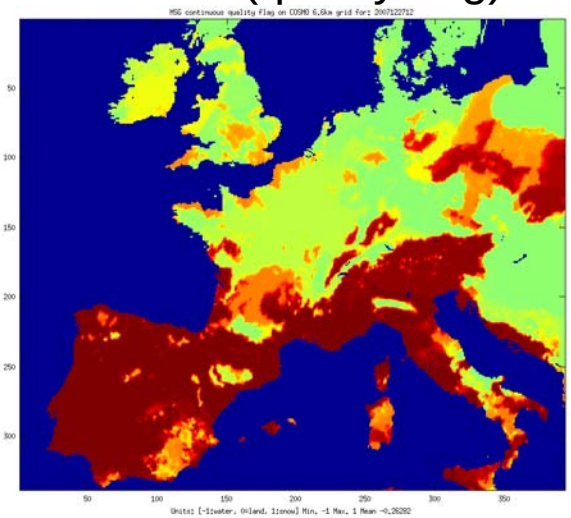
MSG (composite mask)



MSG (quality mask)

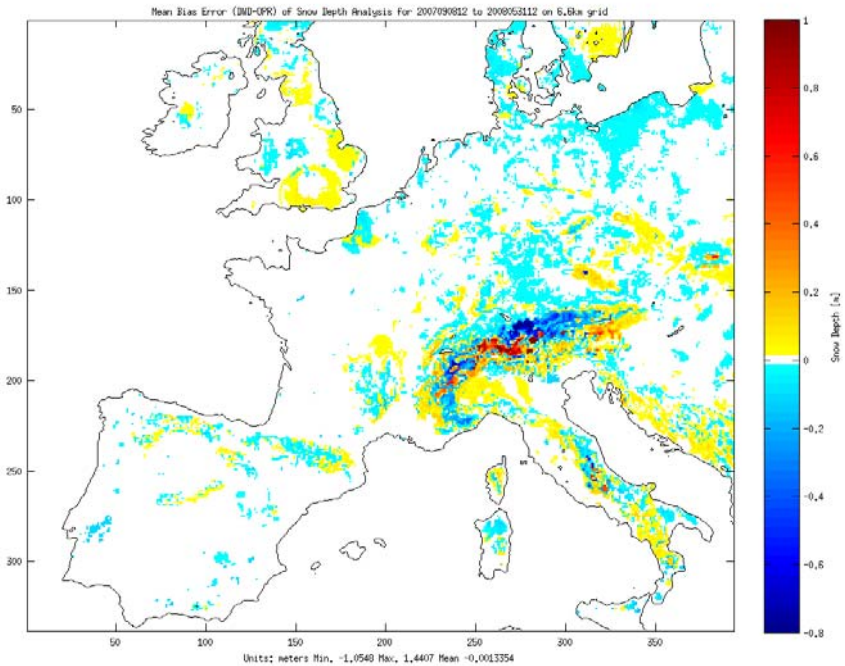


MSG (quality flag)

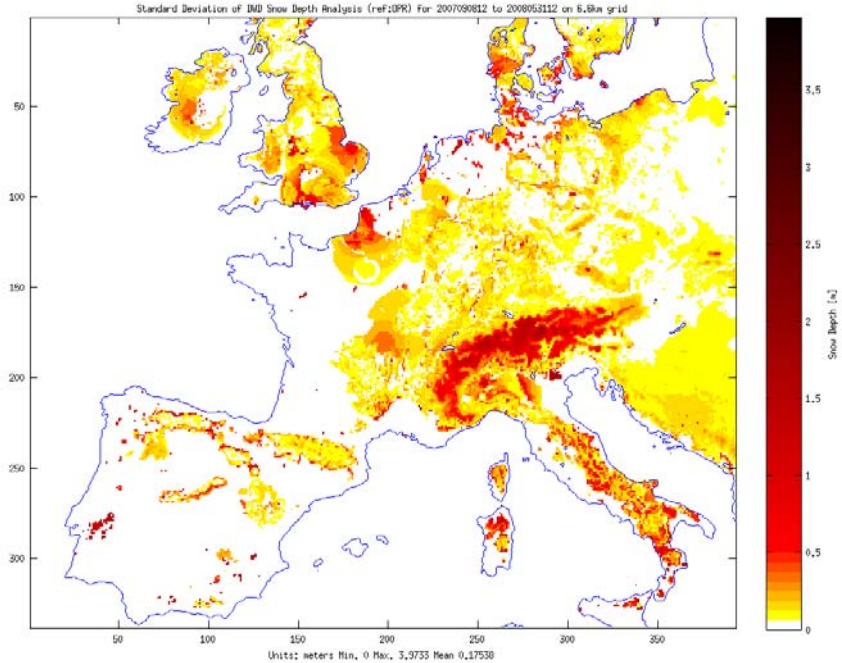


Validation results at 6.6km

Bias (COSMO-EU **-** COSMO-7) [m]



Standard Deviation [m]



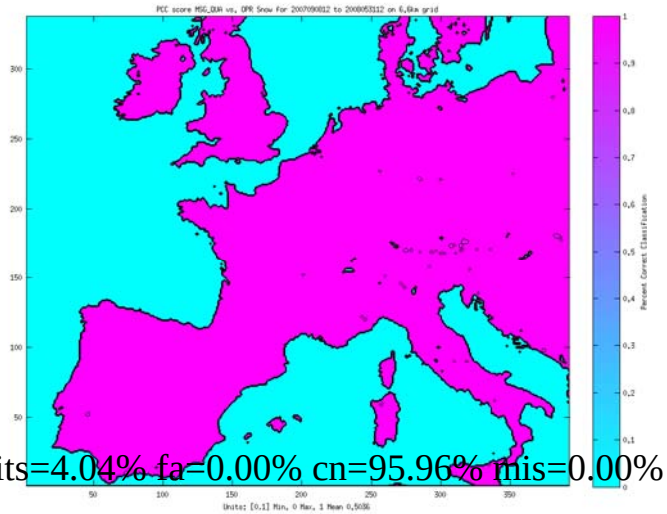
Period: September 8, 2007 to May 31, 2008 = 257 cases

All interpolated to the COSMO-7 (6.6km) grid.

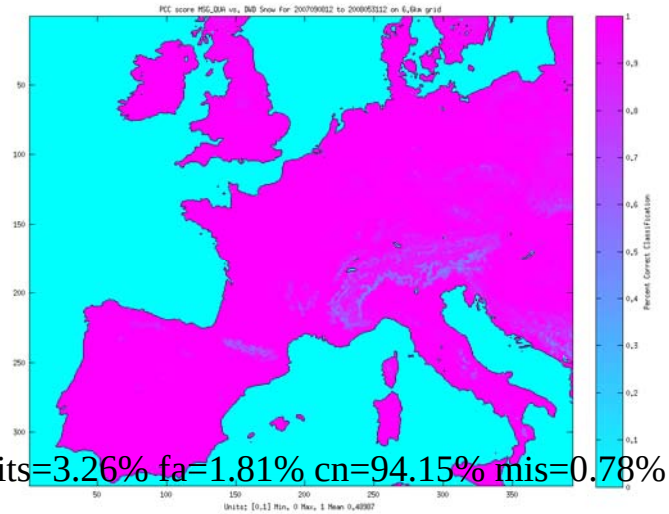
Percent Correct Classification (MSG) 6.6km

PCC (hits + correct neg.)

C-7



hits=4.04% fa=0.00% cn=95.96% mis=0.00%



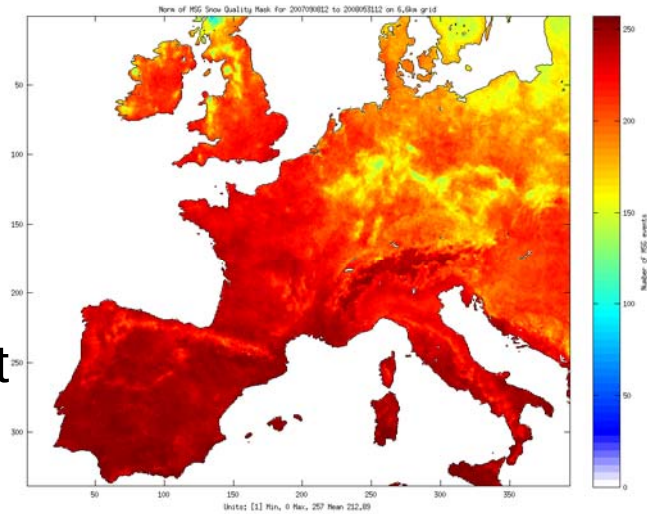
hits=3.26% fa=1.81% cn=94.15% mis=0.78%

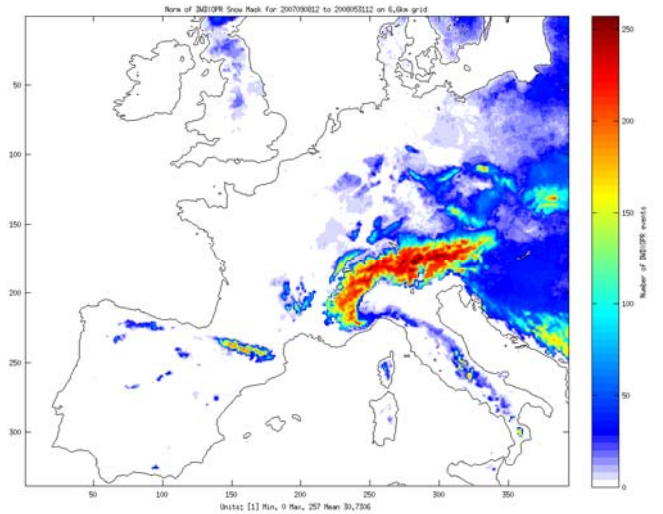
PCC (hits + correct neg.)

C-EU

MSG Quality Mask

SNOW present



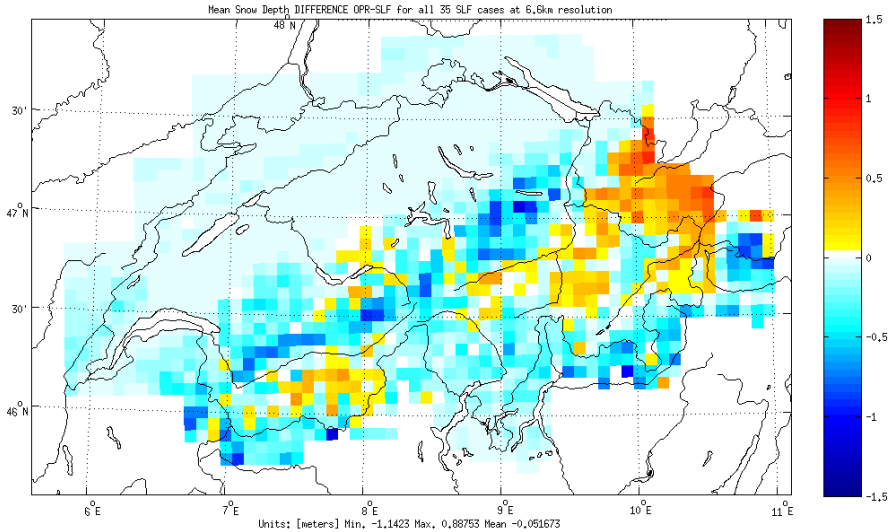


C-7 and/or **C-EU**

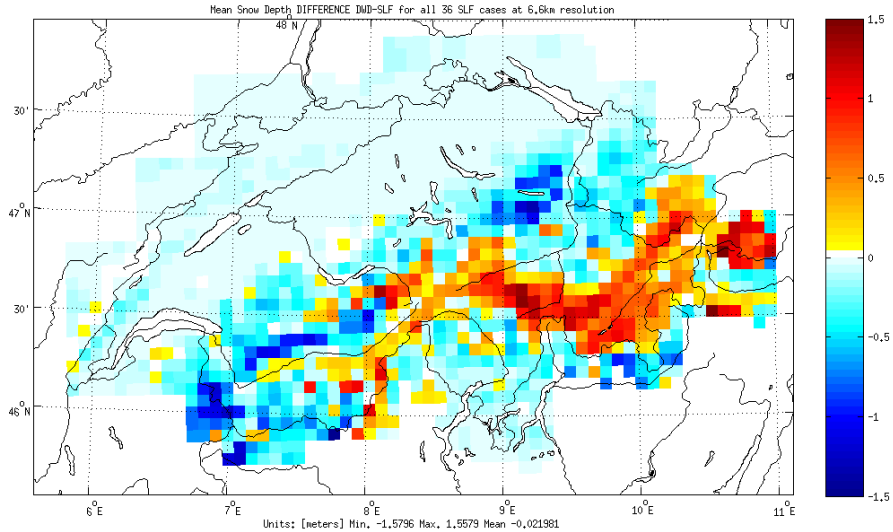
SNOW present

Validation with SLF data at 6.6km

Bias (COSMO-7 **–** SLF) [m]



Bias (COSMO-EU **–** SLF) [m]



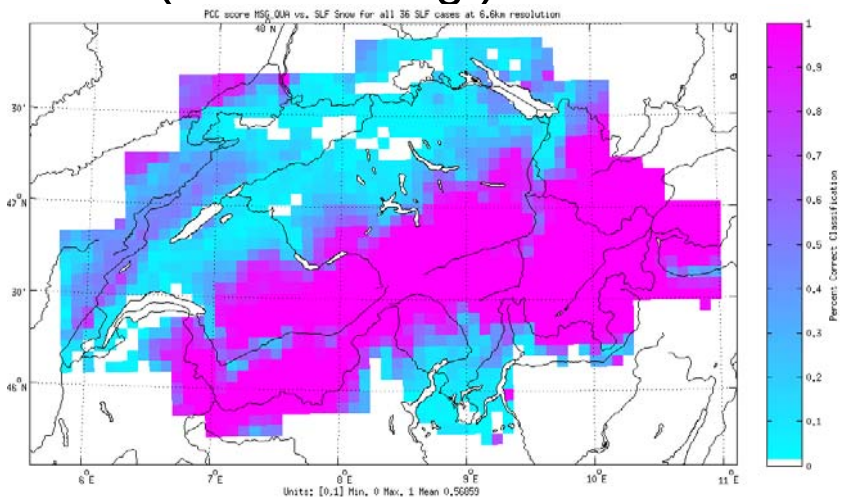
Period: September 8, 2007 to May 31, 2008

COSMO-7 only 35 cases.

COSMO-EU only 36 cases.

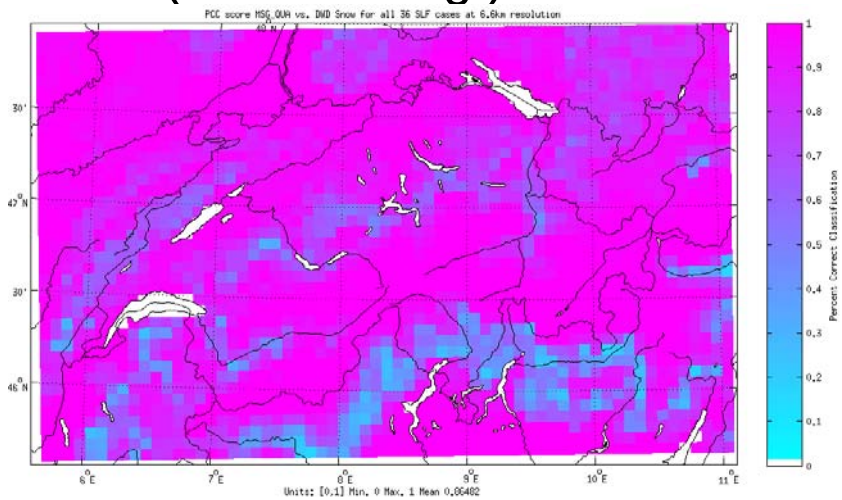
Compare with SLF and MSG data at 6.6km

PCC (hits+cor.neg.) SLF



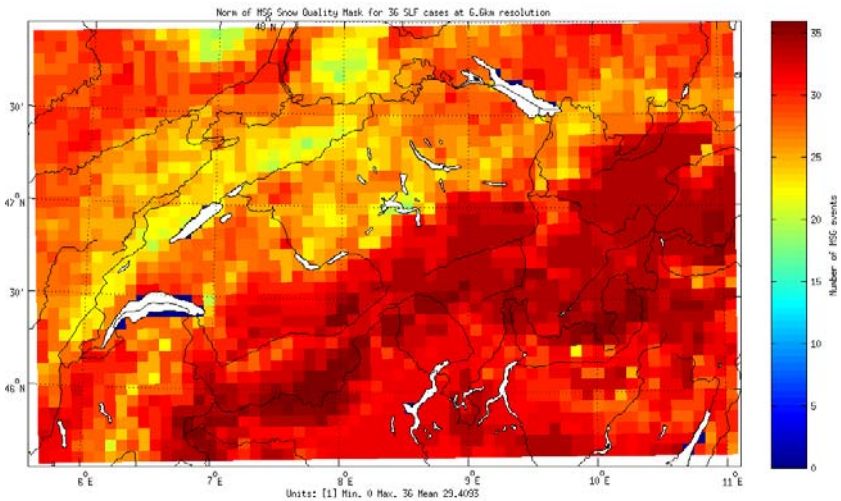
hits=54.74% fa=41.87% cn=3.37% mis=0.02%

PCC (hits+cor.neg.) COSMO-EU



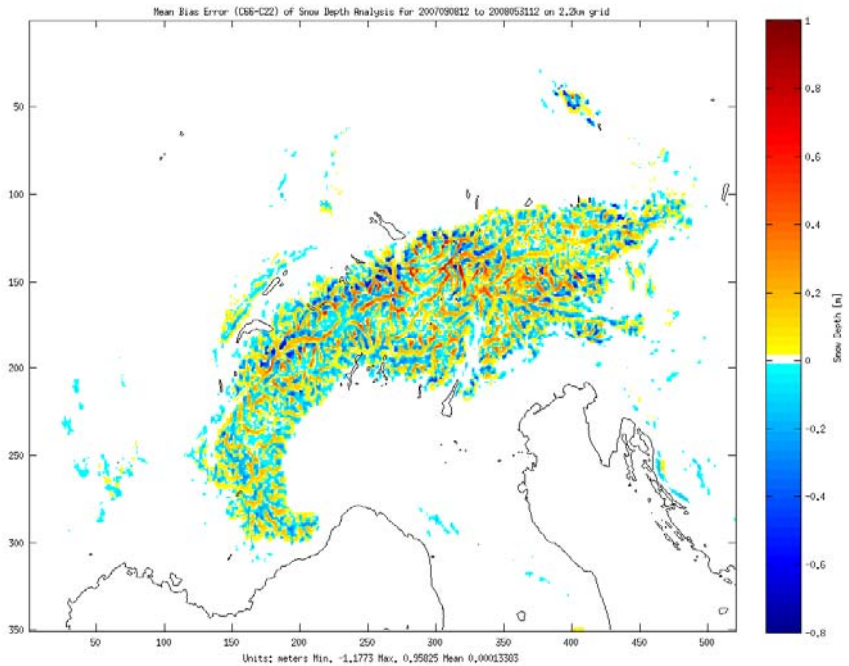
hits=41.25% fa=9.49% cn=45.58% mis=3.68%

MSG Quality Mask
SNOW present
36 cases (mean: 29)

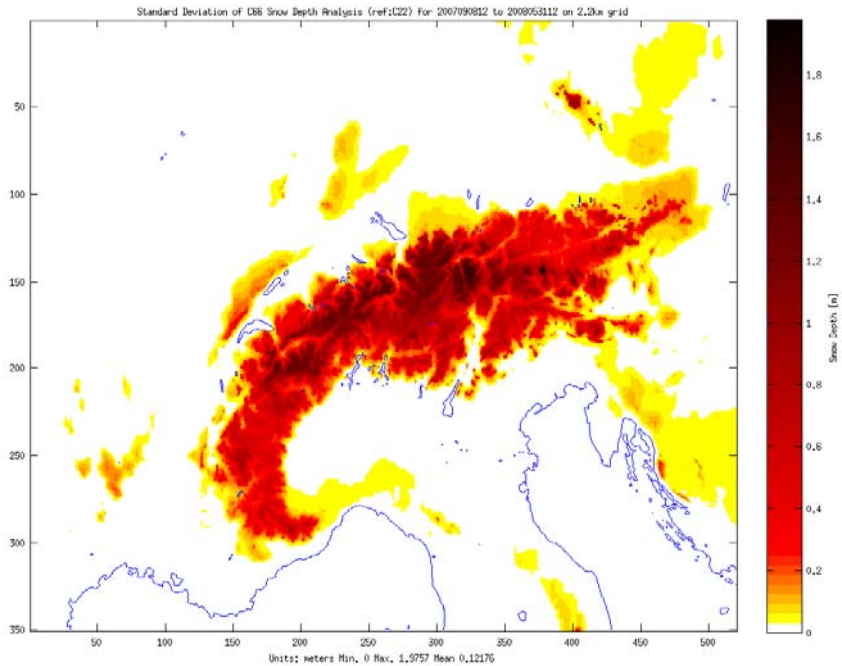


Validation results at 2.2km

Bias = COSMO-7 **-** COSMO-2 [m]



Standard Deviation [m]

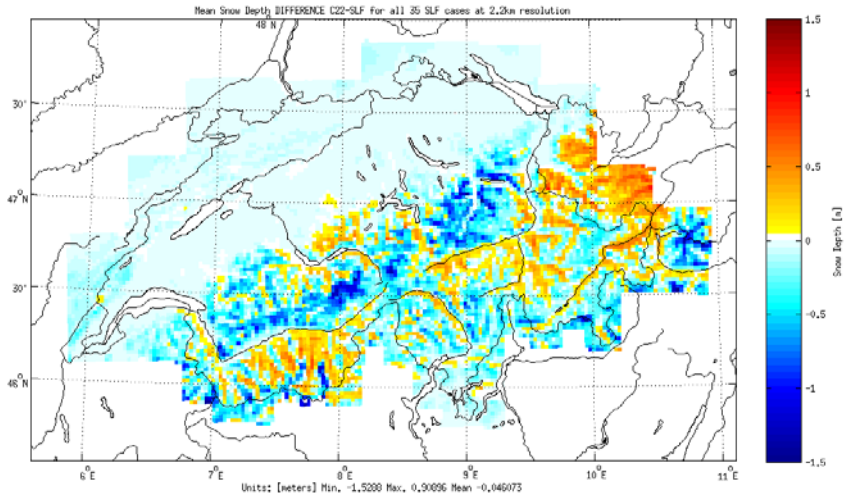


Period: September 8, 2007 to May 31, 2008 = 255 cases

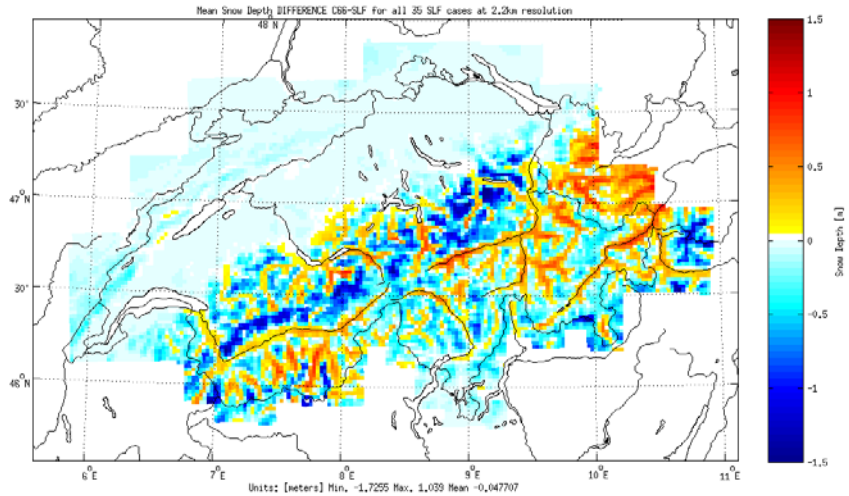
All interpolated to the COSMO-2 (2.2km) grid.

Validation with SLF data at 2.2km

Bias (COSMO-2 **–** SLF) [m]

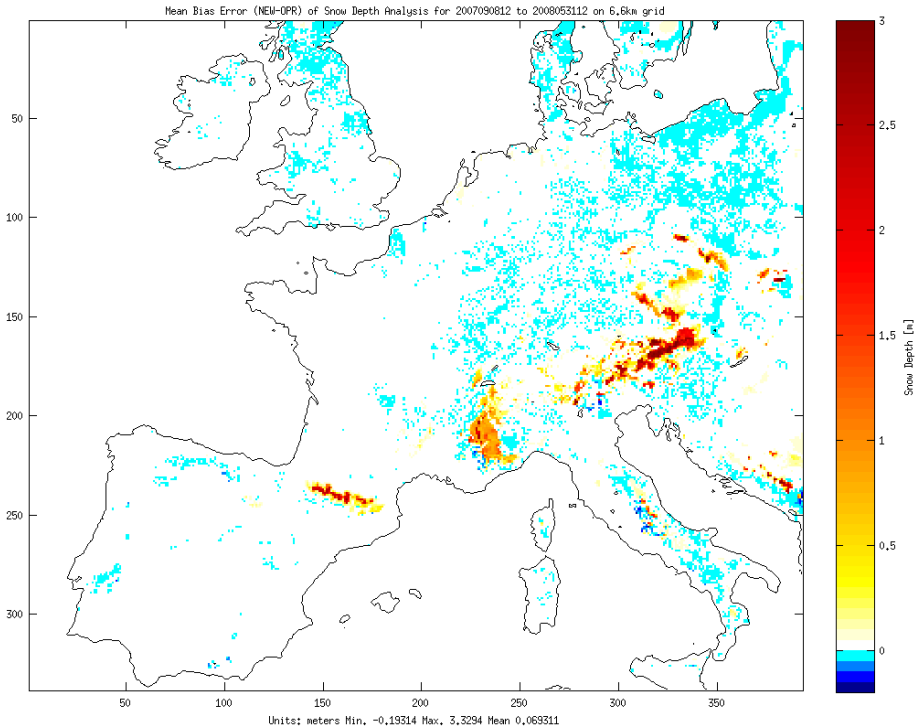


Bias (COSMO-7 **–** SLF) [m]



Period: September 8, 2007 to May 31, 2008
COSMO-2 and COSMO-7 only 35 cases.

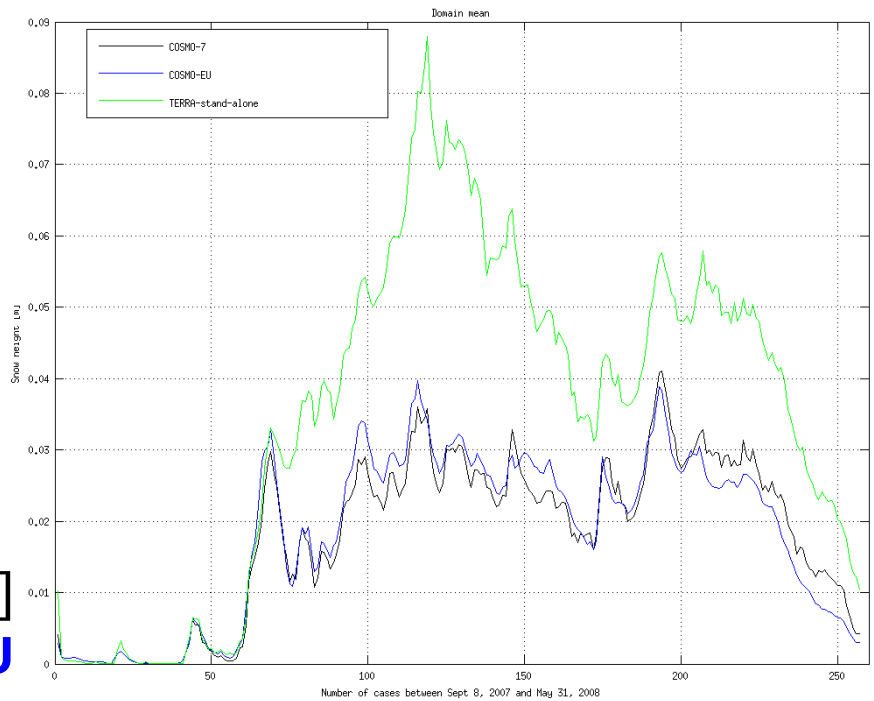
Results from TERRA stand-alone (TSA)



Bias = **TSA** - **COSMO-7** [m]
(max. > 3m)

TSA restarts every day (12utc) after snow analysis step.

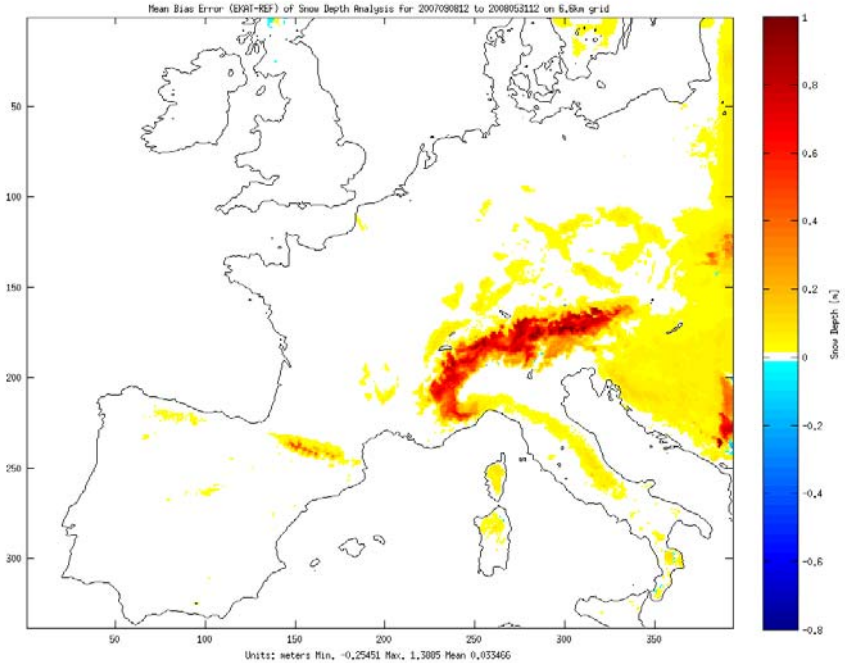
⇒ **restart** problem identified but not fixed!



Time series of domain mean [m] for **TSA**, **COSMO-7** and **COSMO-EU**

Results with 2 layer snow model (2LSM)

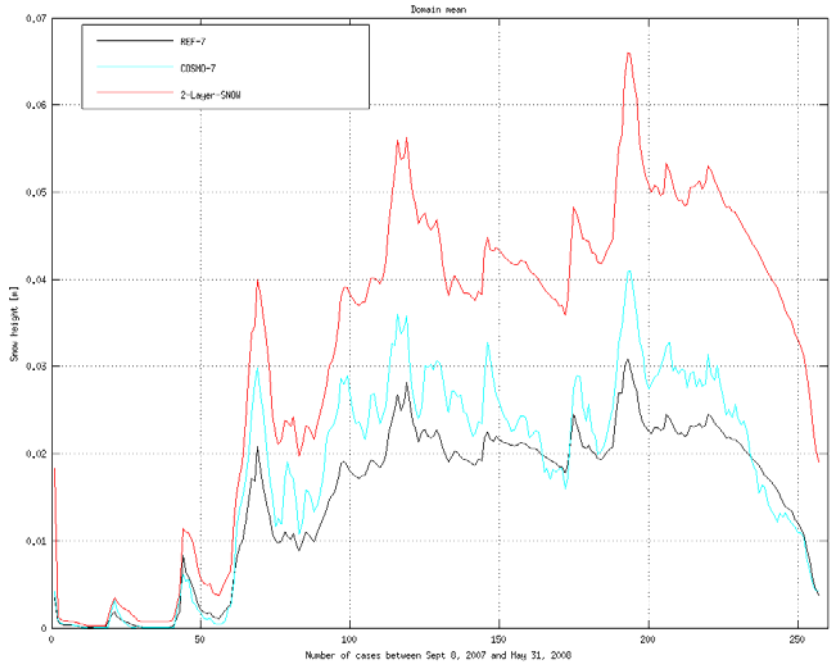
Courtesy of E. Machulskaya



Bias = **2LSM** - **REF** [m]

REF is TERRA stand-alone **without** snow analysis.

Time series of domain mean [m] for **TSA**, **COSMO-7** and **REF**



Comparison COSMO-EU vs. COSMO-7

Differences in algorithms:

- **tuned** Cressman-scheme in **C-7**
- different observations in AU, FR, IT
- **C-7** uses MSG snow mask and **C-EU** uses NOAA

Findings:

⇒ Main differences between 2 analysis over topography, in some places very significant

⇒ Improved snow/no snow on the edge of topography (compared against MSG mask)

⇒ C-7 in the Alps is better than C-EU, as seen from independent SLF analysis

⇒ Artificial ring structures from structure functions

Comparison COSMO-2 vs. COSMO-7

Differences in algorithms:

- **C-2** uses **high resolution** visible channel of MSG (1.5-2km) in addition to the other MSG information

Findings:

⇒ **better** representation of valleys and mountains by **C-2**

⇒ **larger** extreme values in **C-2**

Foreseen:

altitudinal interpolation of in-situ observations (cf. R. Orth, IACETH) should particularly be beneficial for higher resolution models (C-2).