



# Status of snow analysis in the COLOBOC priority project

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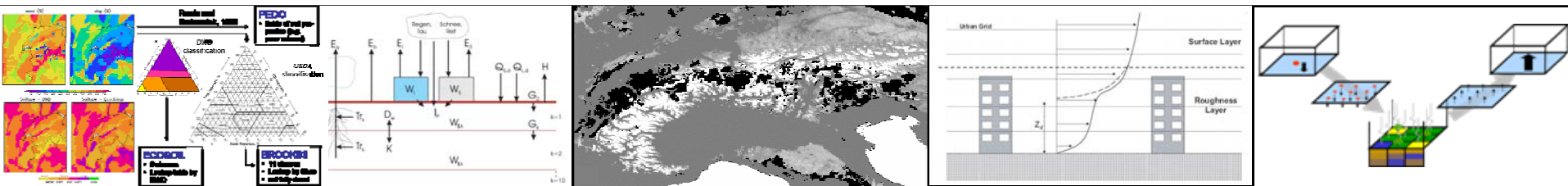
COSMO Seminar  
Langen, 9 March 2009



# 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.*





# Overview

- Goal of the project
- Set up of the snow analysis
- Available data for validations
- Validation results
- Results from the 2 layer snow model
- Conclusions and outlook



# Snow analysis

## Observations:

- Snow height, precipitation and weather type from SYNOP and regional networks.
- Meteosat Second Generation (**MSG**) Spinning Enhanced Visible and Infra-Red Imager (**SEVIRI**)  
6 channels with a time resolution of 15 minutes.

## Algorithm:

- Cressman interpolation of in-situ observations (cf. Buchhold, DWD).
- Model first-guess in data-poor regions.
- Correction to match MSG mask (cf. de Ruyter de Wildt).

## 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.



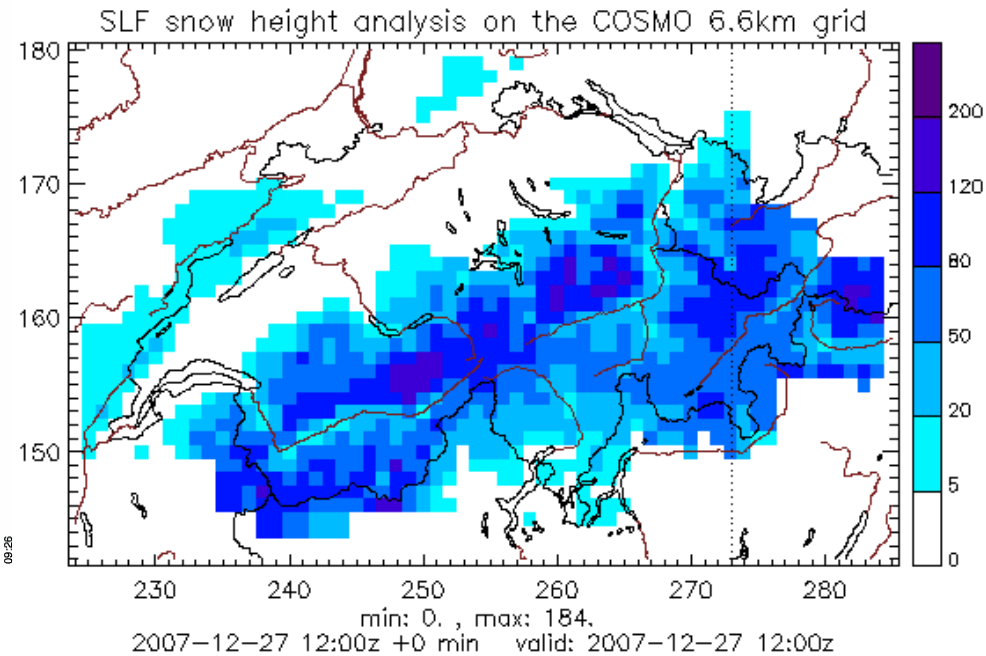
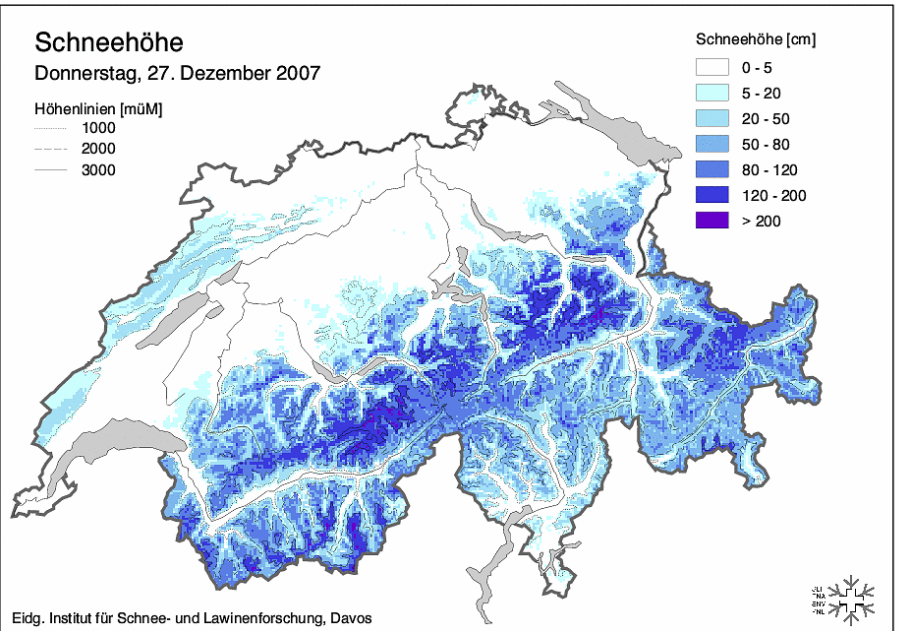
# Available data for validation (i)

- **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-gridded with “fieldextra”:



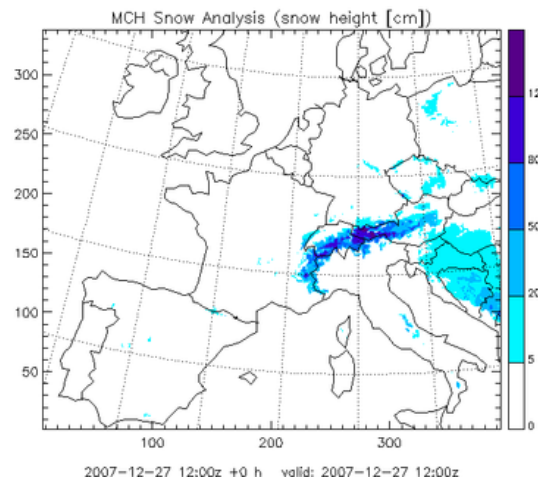
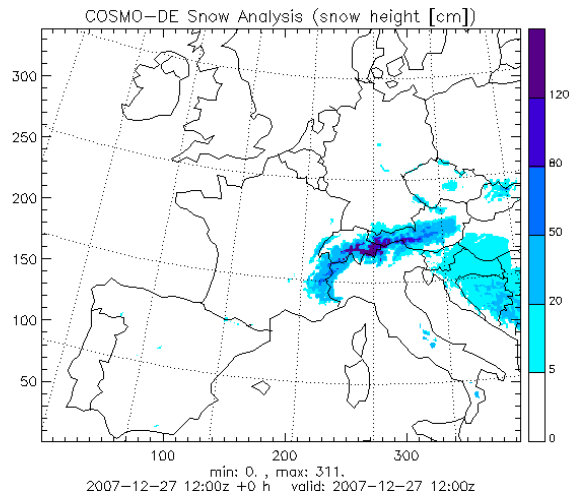


# Available data for validation (iii)

**COSMO-EU**

**COSMO-7**

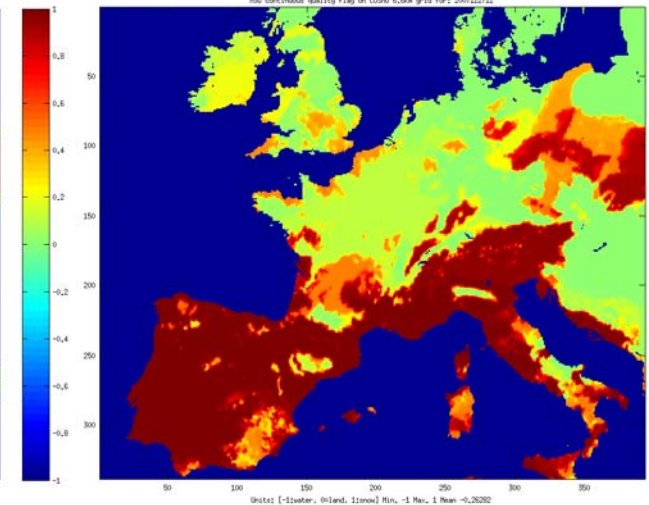
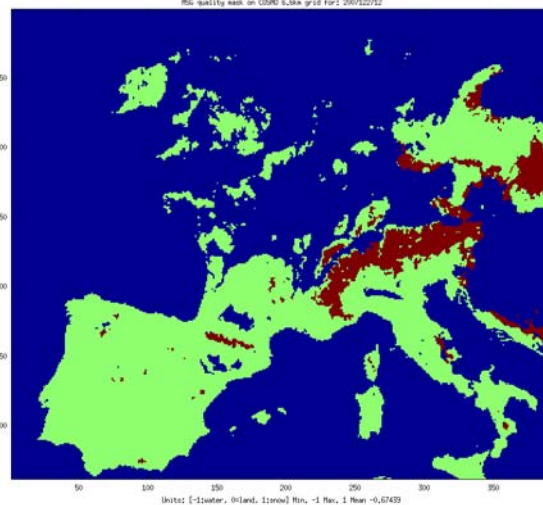
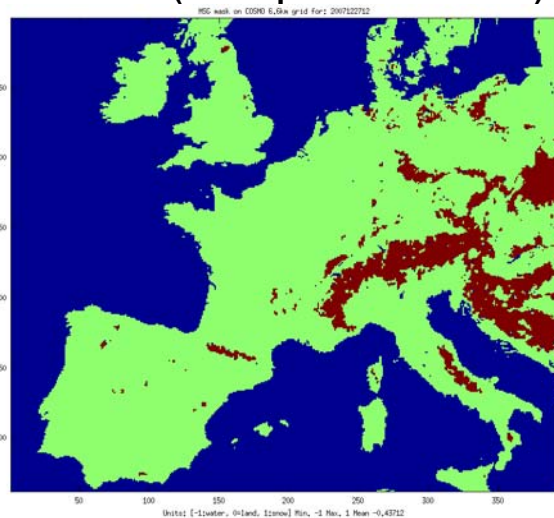
**SLF-stations**



**MSG (composite mask)**

**MSG (quality mask)**

**MSG (quality flag)**

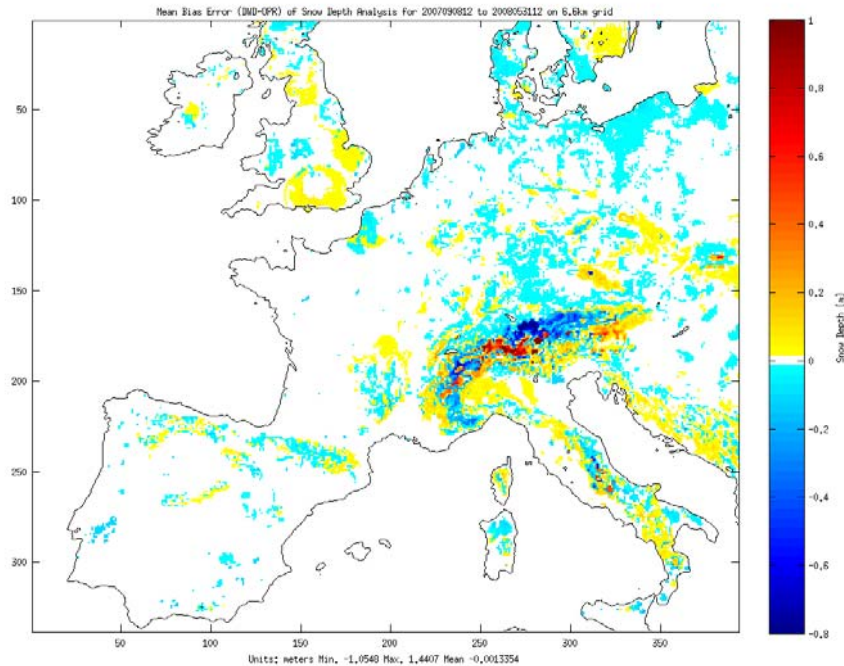




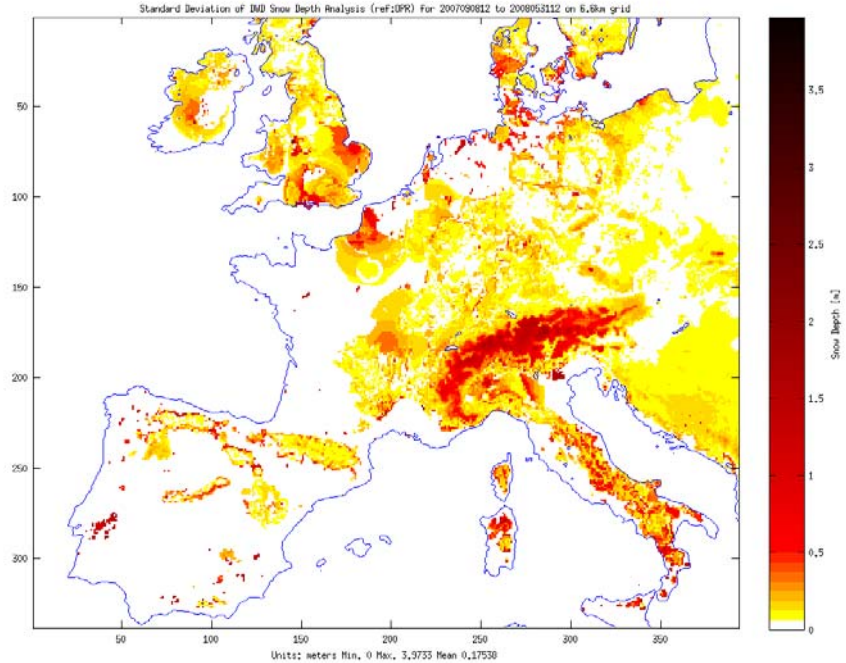


# Validation results at 6.6km

**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.

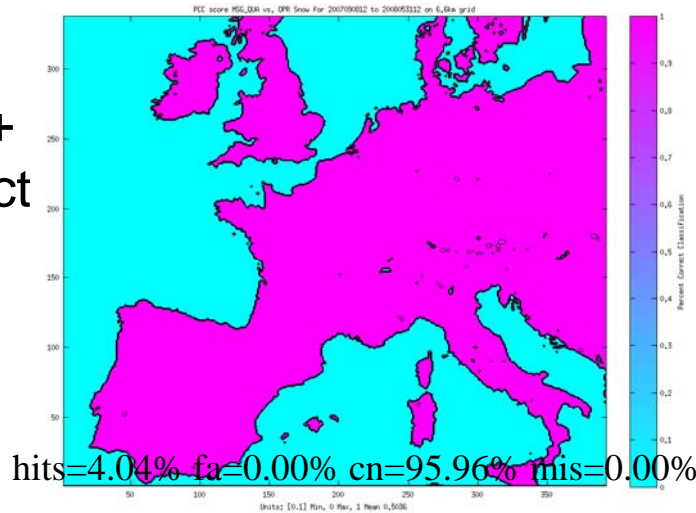




# Percent Correct Classification (MSG) 6.6km

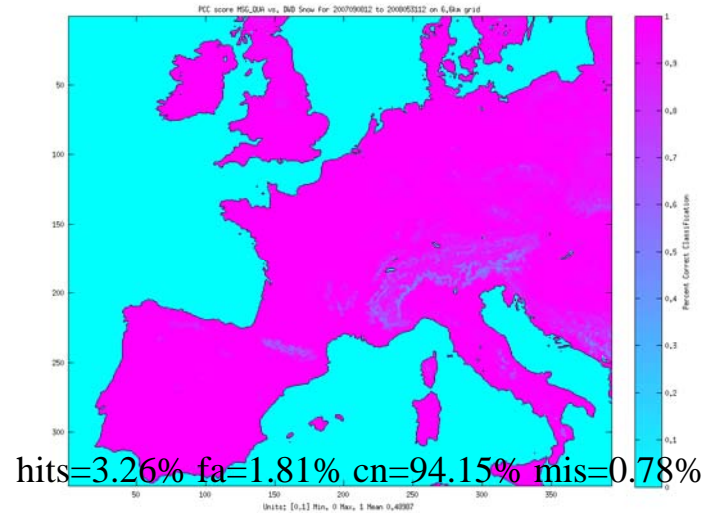
**PCC**  
(hits +  
correct  
neg.)

**C-7**



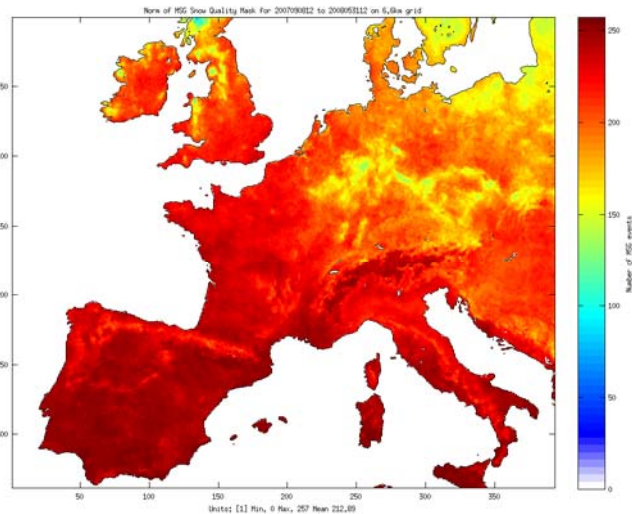
**PCC**  
(hits +  
correct  
neg.)

**C-EU**



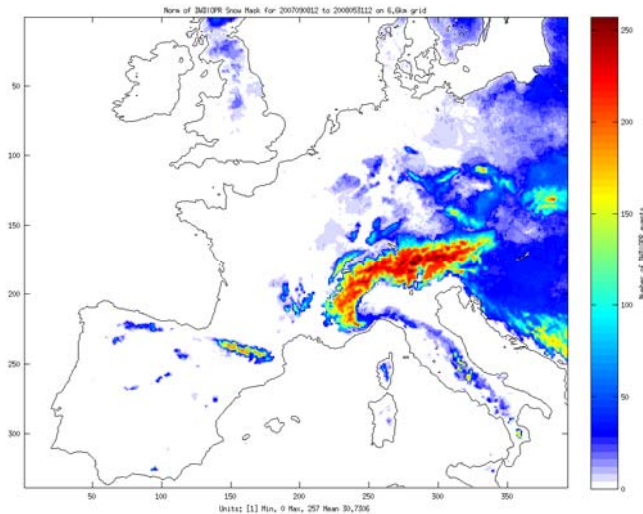
**MSG**  
Quality  
Mask

**SNOW**  
present



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

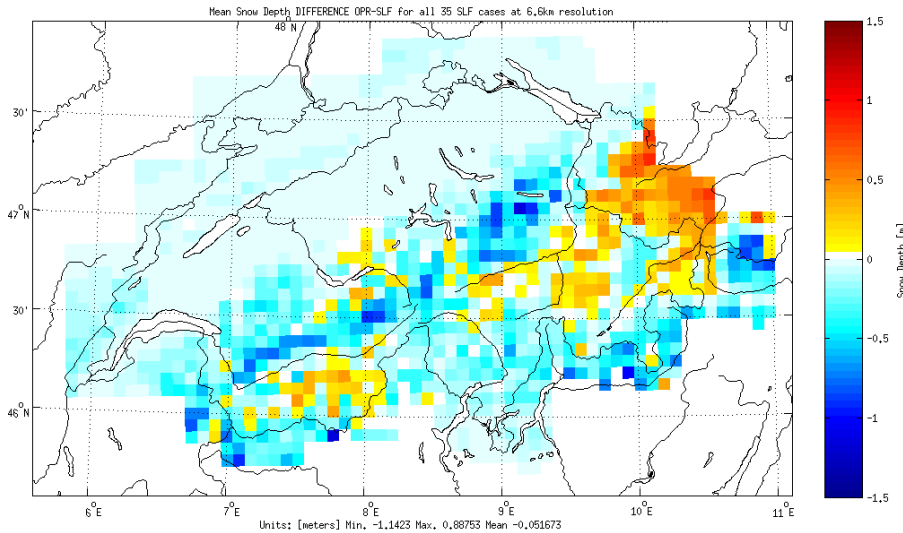
**SNOW**  
present



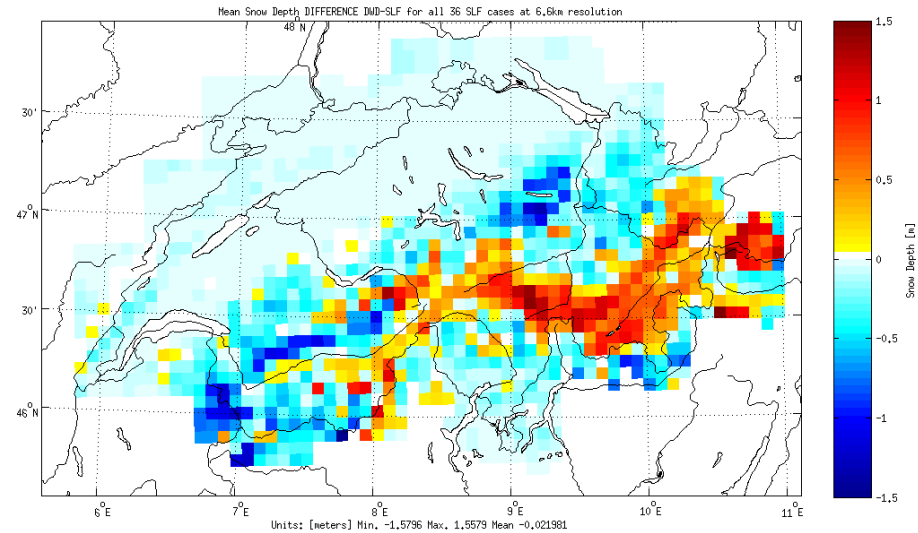


# Validation with SLF data at 6.6km

**Bias** (COSMO-7 – SLF) [m]



**Bias** (COSMO-EU – SLF) [m]



**Period:** September 8, 2007 to May 31, 2008

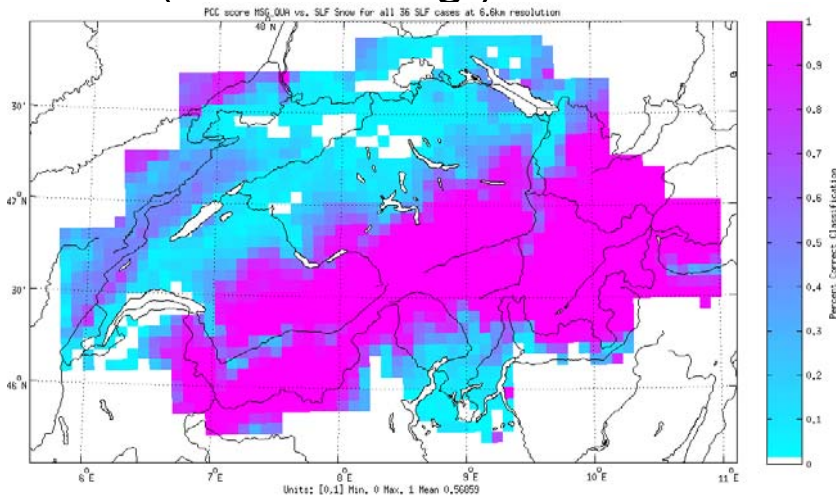
COSMO-7 only **35 cases.**

COSMO-EU only **36 cases.**

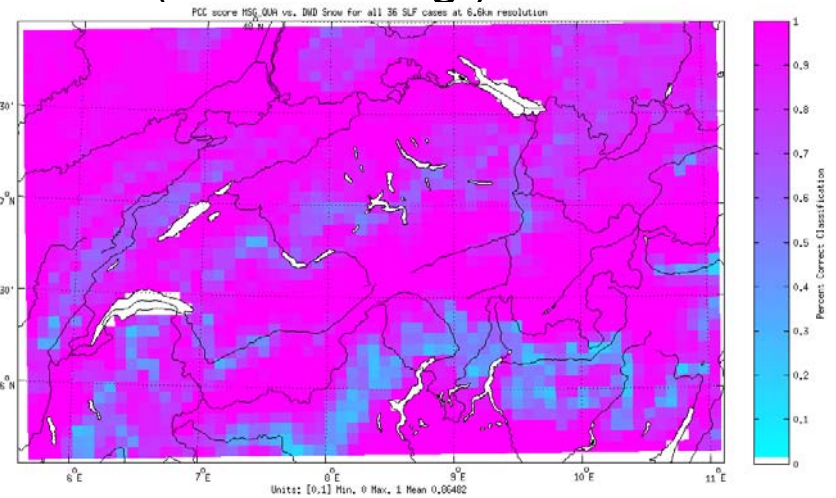


# Compare with SLF and MSG data at 6.6km

**PCC** (hits+cor.neg.) SLF



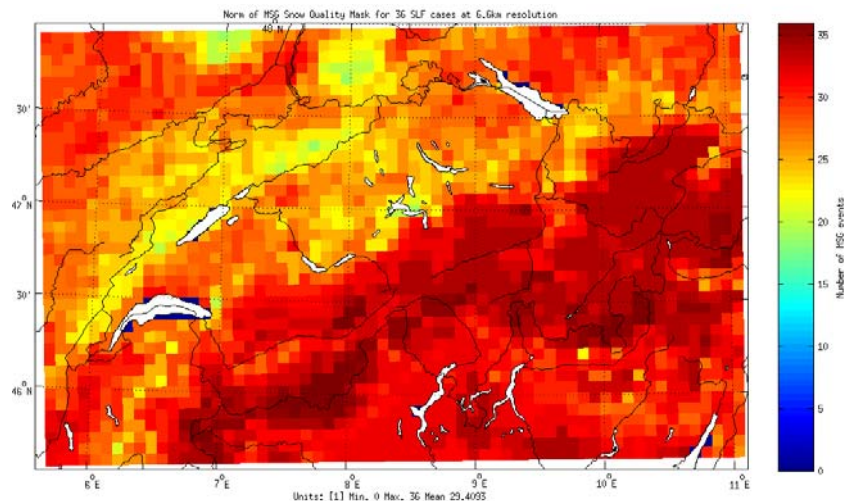
**PCC** (hits+cor.neg.) COSMO-EU



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

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

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



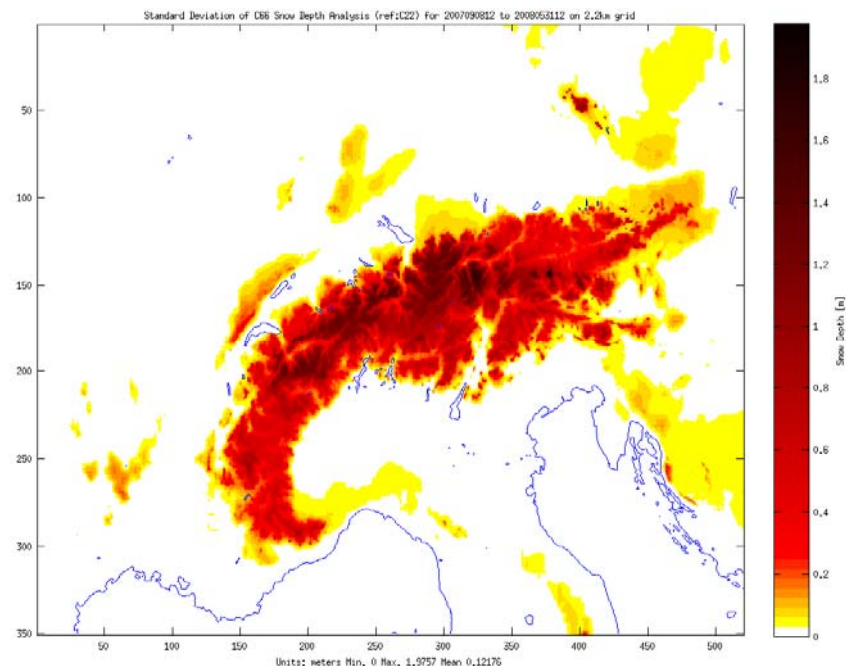
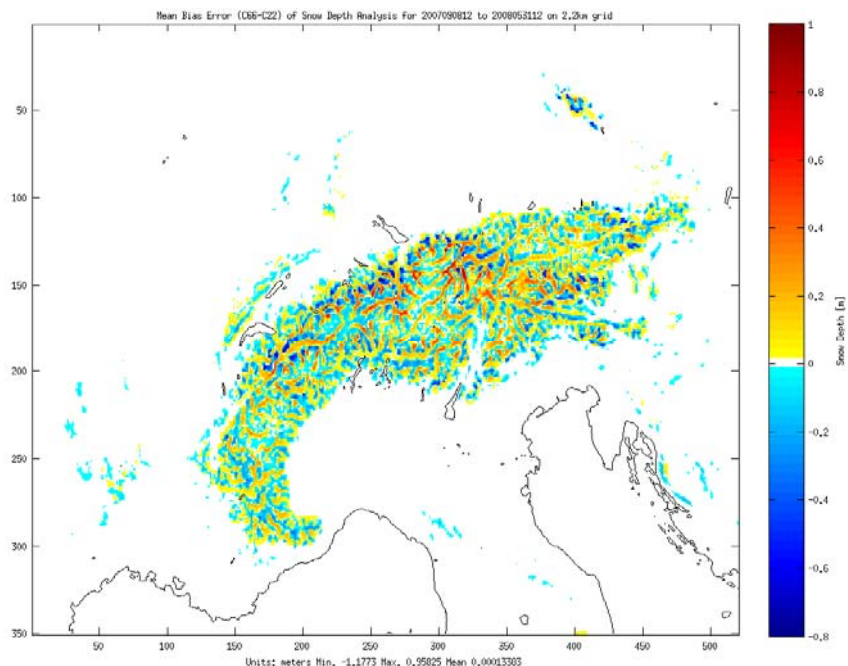




# Validation results at 2.2km

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

**Standard Deviation** [m]



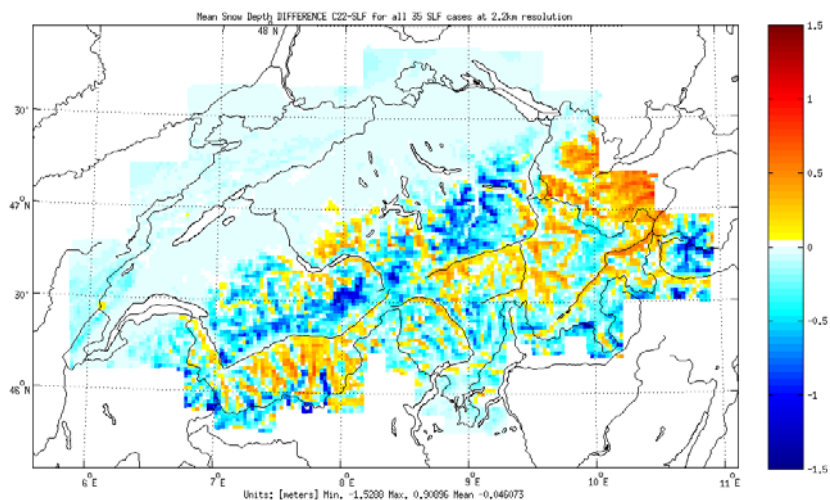
**Period:** September 8, 2007 to May 31, 2008 = **255 cases**

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

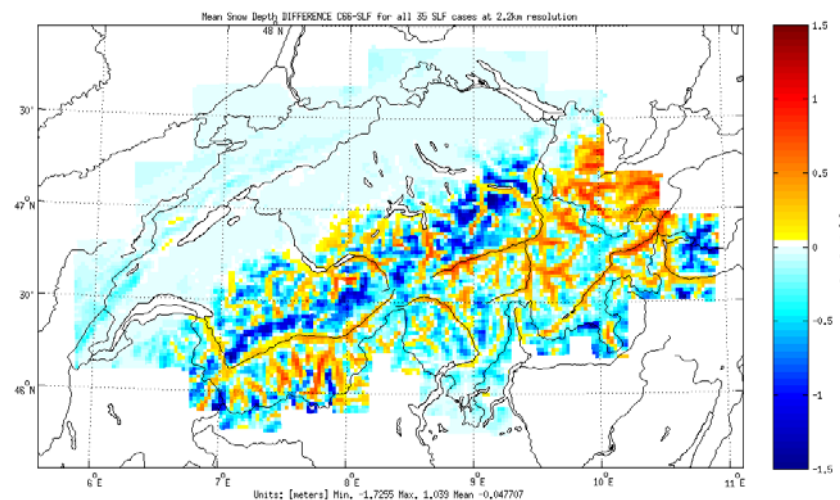


# Validation with SLF data at 2.2km

**Bias** (COSMO-2 – SLF) [m]



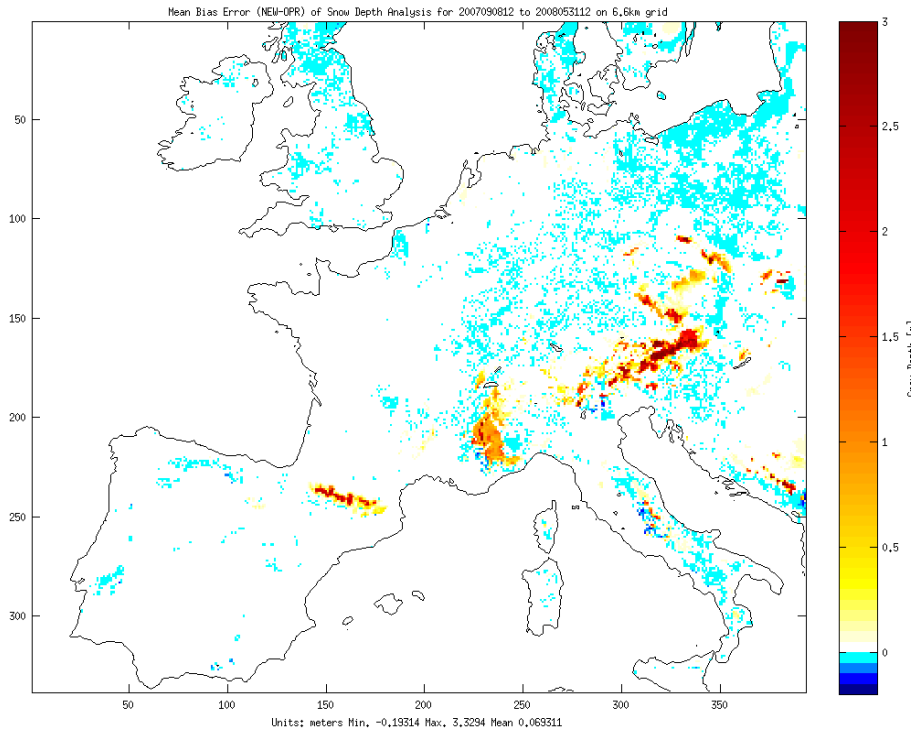
**Bias** (COSMO-7 – SLF) [m]



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



# Results from TERRA stand-alone (TSA)

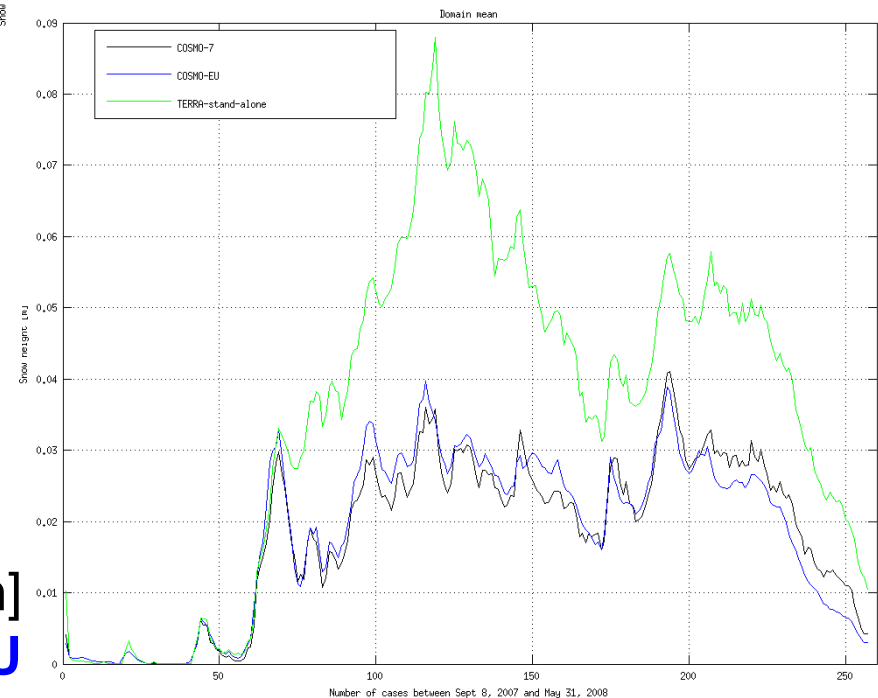


**Bias = TSA - COSMO-7 [m]**  
(max. > 3m)

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

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

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

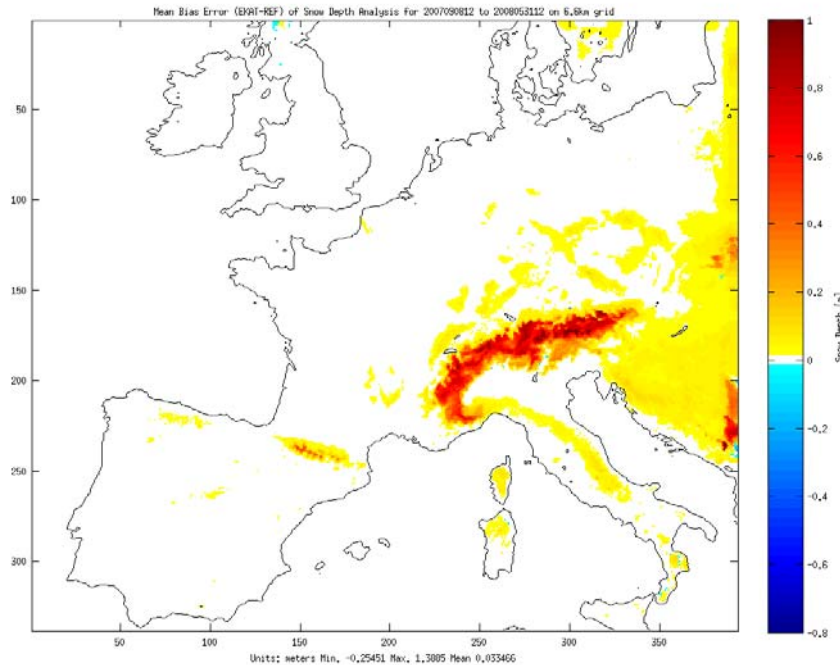






# Results with 2 layer snow model (2LSM)

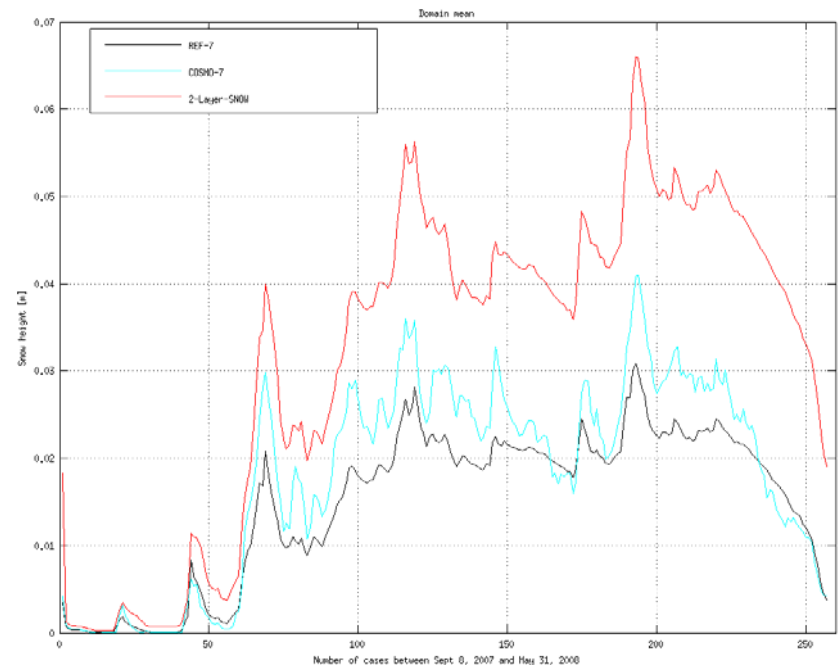
Courtesy of E. Machulskaya



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).



# Outlook

## **Snow analysis:**

- Implement altitudinal interpolation and bug fixes from DWD.
- Check impact of these changes.

## **TERRA stand alone:**

- Find remedy for the restart problem.

## **Snow model:**

- Finalize results and define standard configuration of the 2 layer snow model.

## **Finally:**

- Produce deliverable package for the COSMO users.