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-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%
- **C-EU**
  - hits=3.26% fa=1.81% cn=94.15% mis=0.78%

MSG Quality Mask
- Snow present
- C-7 and/or C-EU
- Snow present
Validation with SLF data at 6.6km

Bias \((\text{COSMO-7} - \text{SLF})\) [m]  

Bias \((\text{COSMO-EU} - \text{SLF})\) [m]

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%
- False alarm (fa) = 41.87%
- Correct rejection (cn) = 3.37%
- Missed detection (mis) = 0.02%

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

- Hits = 41.25%
- False alarm (fa) = 9.49%
- Correct rejection (cn) = 45.58%
- Missed detection (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]

COSMO-2 and COSMO-7 only 35 cases.
Results from TERRA stand-alone (TSA)

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

⇒ restart problem identified but not fixed!

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

Time series of domain mean [m] for TSA, COSMO-7 and COSMO-EU
Results with 2 layer snow model (2LSM)

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.