Assimilation of LandSAF albedo product in a limited area NWP model

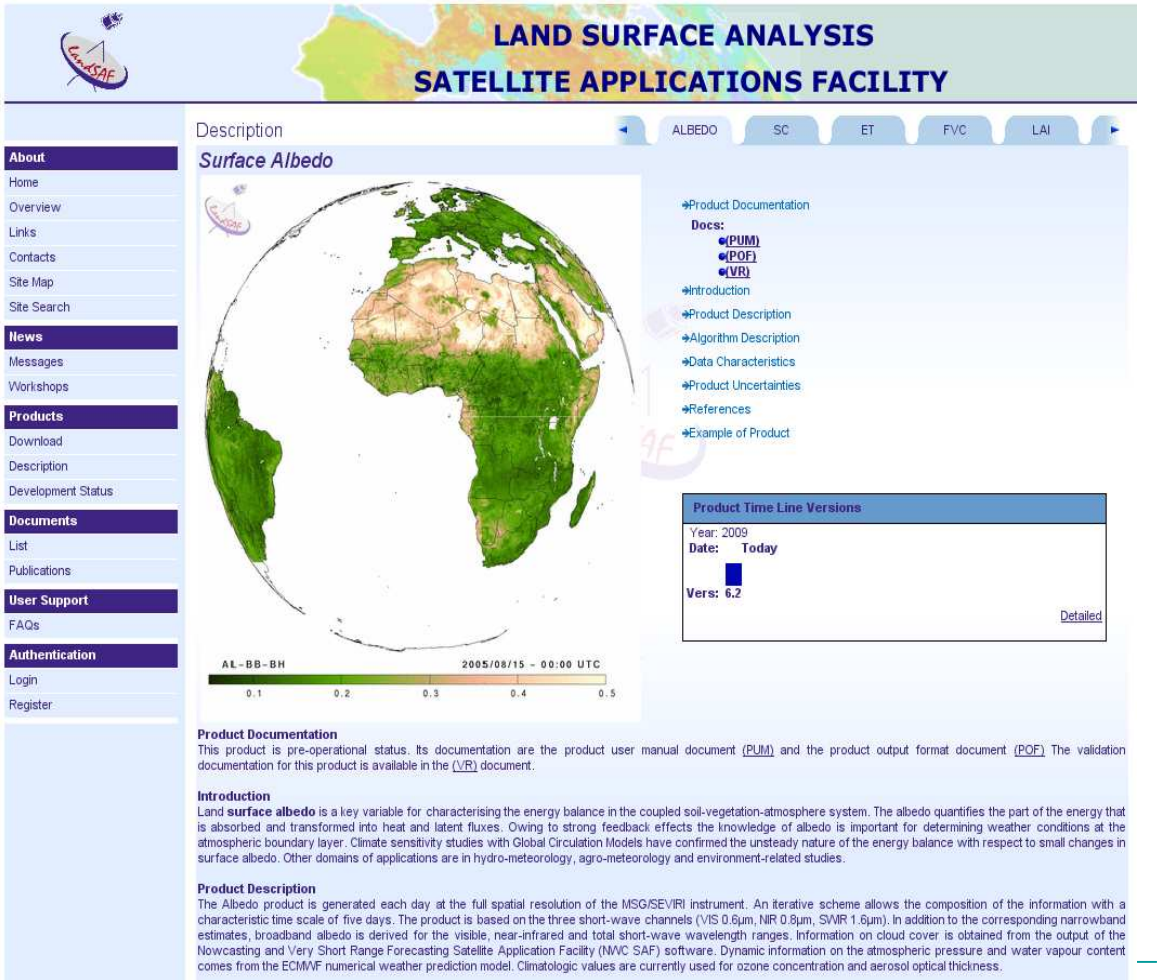
Jure Cedilnik
Environmental Agency of Slovenia / RC-LACE

Dominique Carrer
Jean-François Mahfouf
Jean-Louis Roujean
Météo France

LandSAF Albedo Product

- In preoperational phase, routinely produced since 2005
- Daily product
  - BB BH albedo,
  - Obs error
  - Quality flag
  - Age of pixel
- SEVIRI resolution

http://landsaf.meteo.pt ->



ALADIN NWP model

- Local counterpart of ARPEGE, French global model, dynamical core same as in IFS (ECMWF)
- Used operationaly at many European met. services
- ISBA [Noilhan and Planton 1989, Mahfouf 1995] used as surface scheme – (a switch to SURFEX and ECOCLIMAP is planned in near future)
- pre-Ecoclimap albedo dataset [Webb 1991, Champeaux 1999]
- radiation scheme uses only one short wave band

Kalman Filter Based Albedo Analysis

by Dominique Carrer

- LSAF provides total broadband albedo and its uncertainty,
- model uses vegetation and bare soil albedo

analysis step

state vector: $x_i^a = \left[a_{veg}^a, a_{bs}^a\right]^T$

obs. vector: $y_i = \left[a_{veg}^{clim}, a_{bs}^{clim}, a_{tot}^{saf}\right]^T$

$$x_i^a = x_i^b + K_i\left[y_i - Hx_i^b\right]$$

$$K_i = A_i^b H^T \left[HA_i^b H^T + R_i\right]^{-1}$$

$$A_i^a = (1 - K_i H) A_i^b$$

obs. operator:

$$H = \begin{bmatrix} 1 & 0 \\ 0 & 1 \\ veg & 1-veg \end{bmatrix}$$

obs. error:

$$R_i = \begin{bmatrix} \left(\sigma_{veg}^{clim}\right)^2 & 0 & 0 \\ 0 & \left(\sigma_{bs}^{clim}\right)^2 & 0 \\ 0 & 0 & \left(\sigma_{tot}^{saf}\right)^2 \end{bmatrix}$$

forecast step

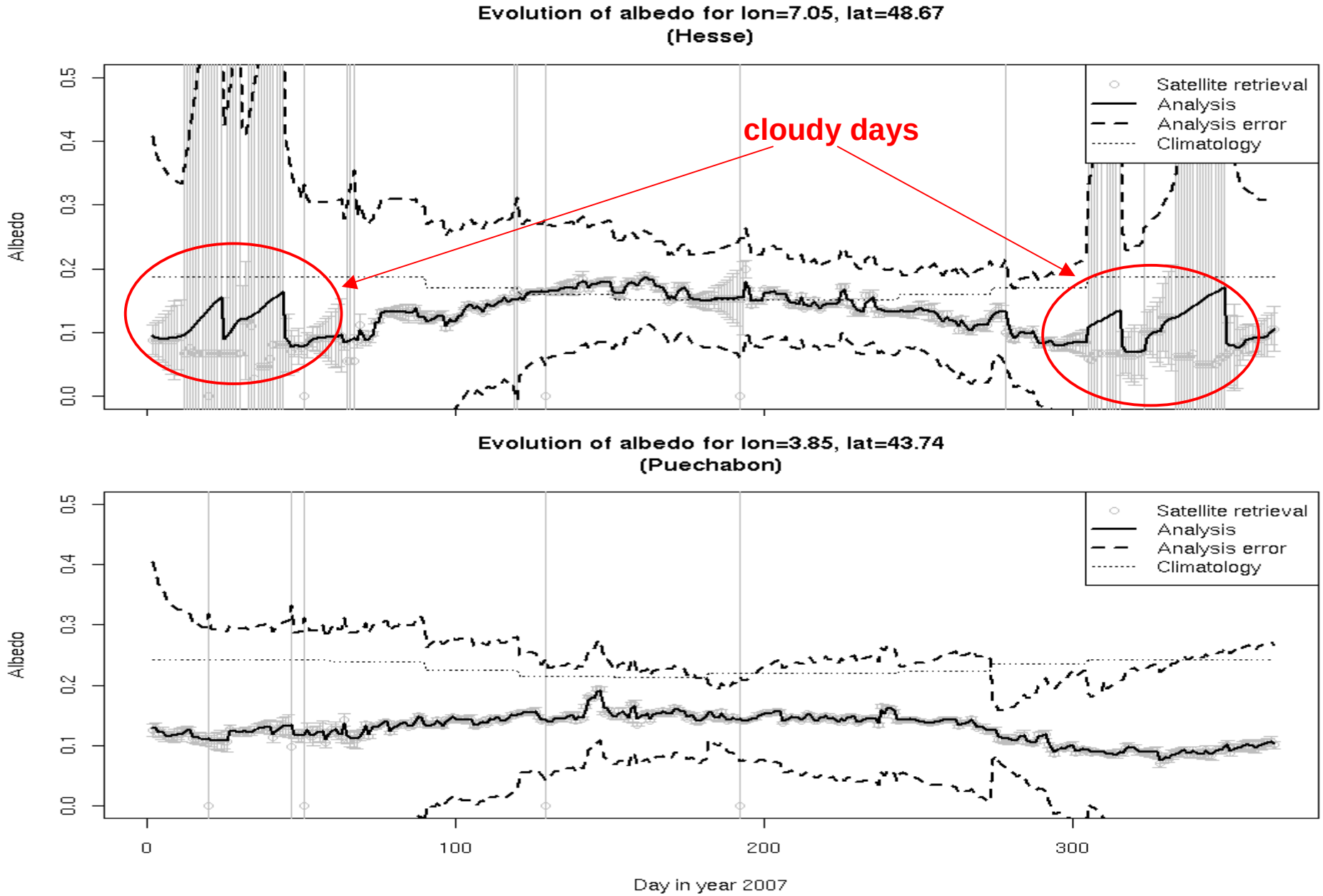
$$x_{i+1}^b = Mx_i^a + w_i \qquad M = I \ , \overline{w} = 0$$

$$A_{i+1}^b = MA_i^a M^T + Q_i$$

model. error (Q) is such that:

$$A_{i+1}^b = \begin{bmatrix} \left(2^{2/(1-veg)}\right)^{t_{i+1}-t_i} & 0 \\ 0 & \left(2^{2/veg}\right)^{t_{i+1}-t_i} \end{bmatrix} A_i^a$$

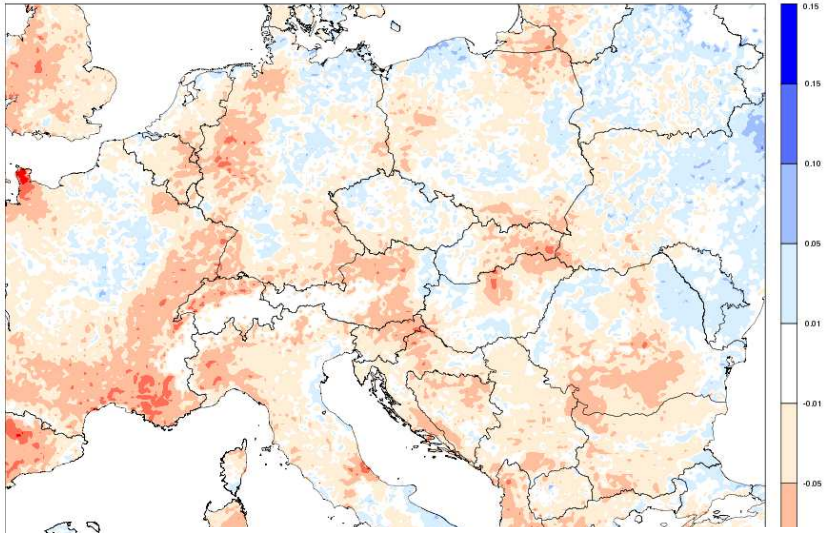
Analysed albedo timeseries



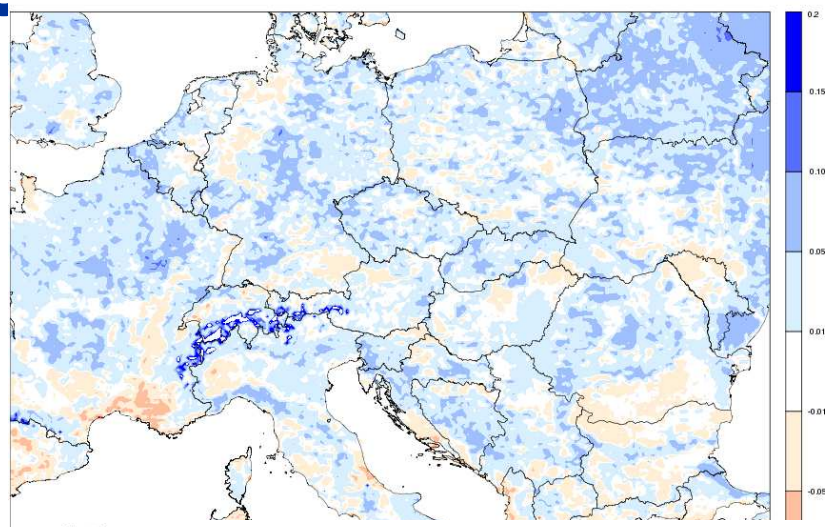
Experiment set-up

- ALADIN cycle 32, with a set-up similar to Meteo France operational one of 2007
- only dynamic adaptation (IC and LBCs from Arpège – no data assimilation)
- computational domain covering central Europe and part of Mediterranean (~9.5 km, 250x270)
- 01/02/2007 -> 31/12/2007, forecast length +54h
- initialization at 00UTC (use previous day albedo retrieval)
- albedo assimilation perfomed offline – new albedo information is injected in the initial file
- albedo is analyzed in model space – one interpolation of LSAF data from SEVIRI to model LCC grid (nearest neighbour)
- only gridpoints with no snow were modified

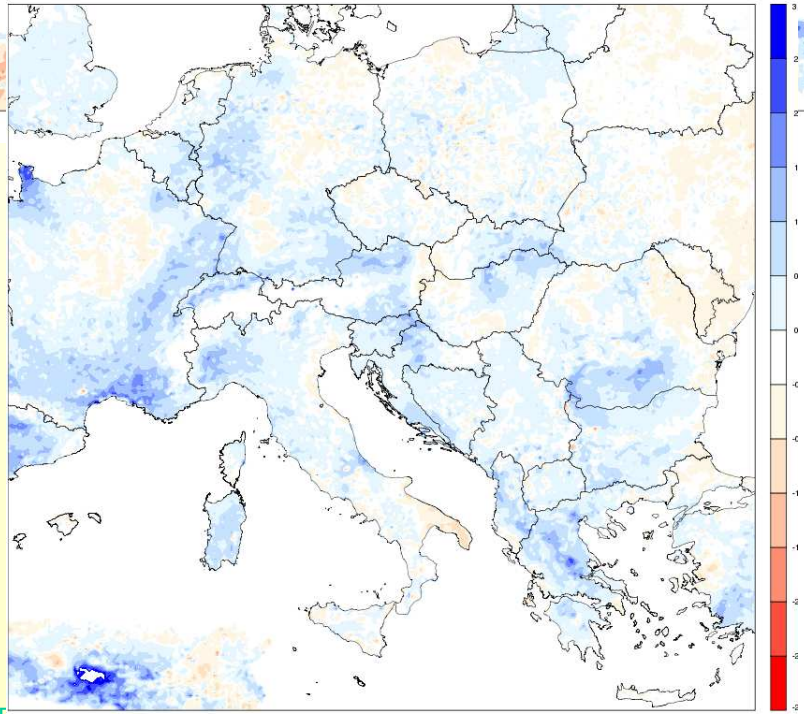
Surface albedo difference (experiment-reference)
for March 15, 2007



Surface albedo difference (experiment-reference)
for June 15, 2007



Surface temperature difference (experiment-reference) [K]
for March 15, 2007 at 12 UTC, after 12 hours of integration



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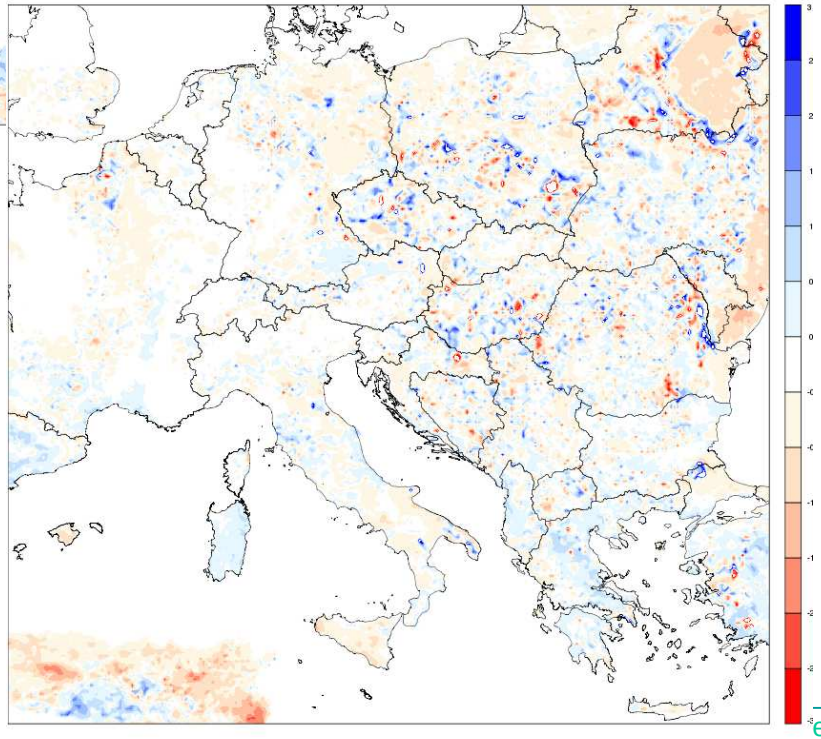
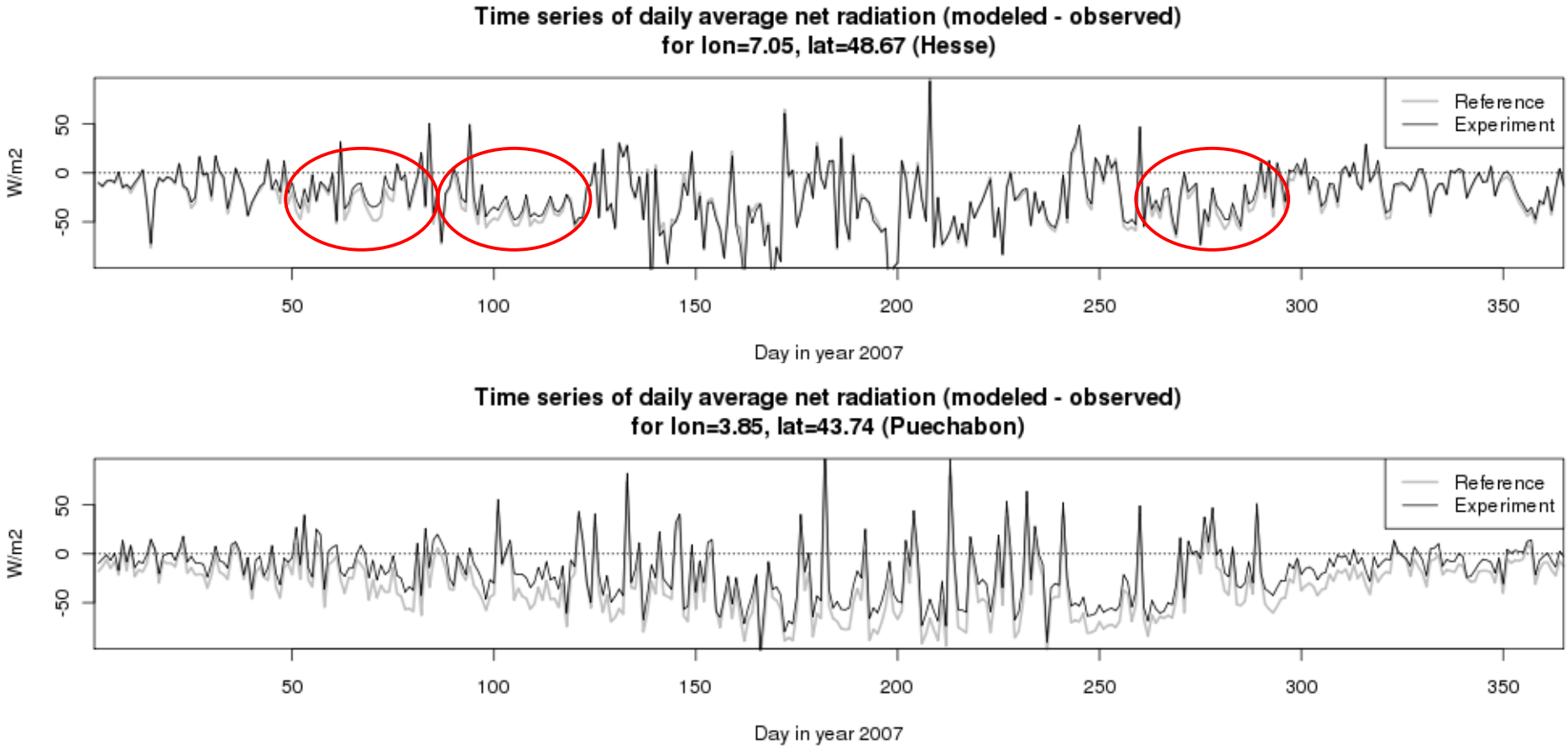
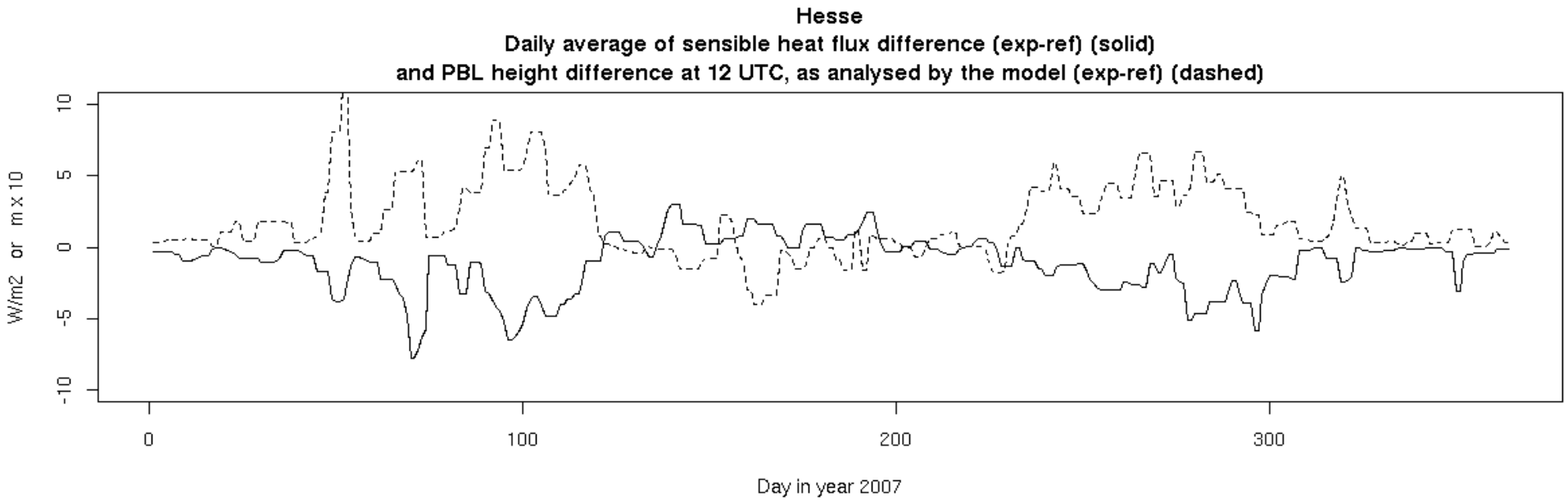


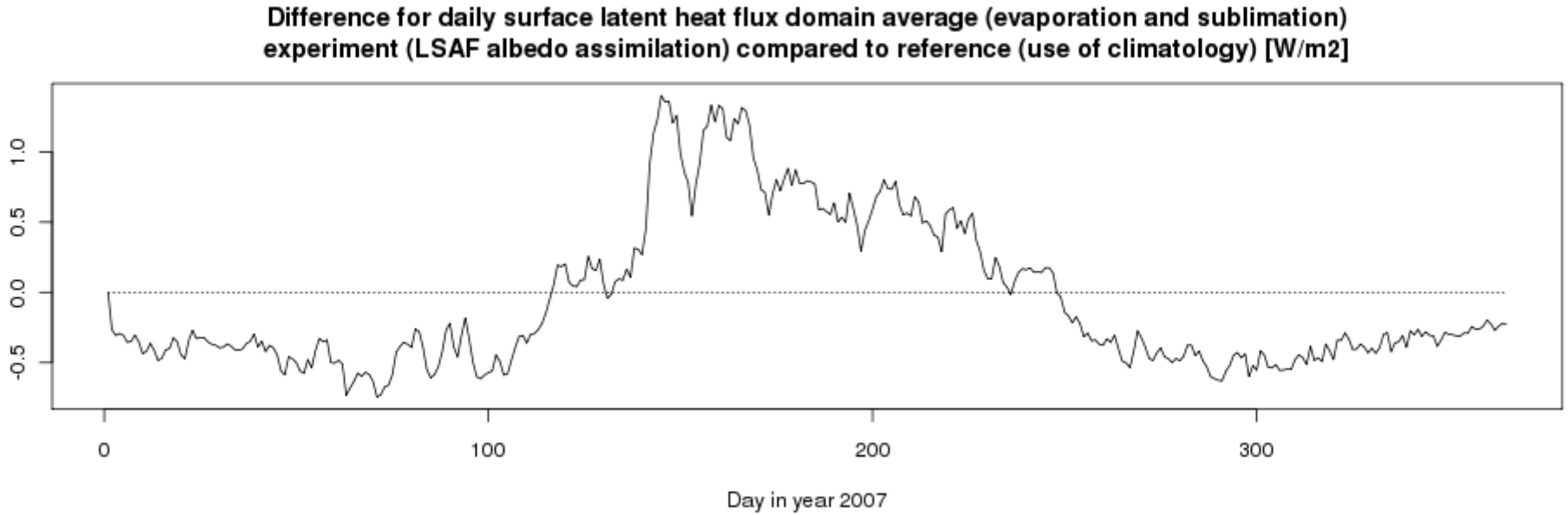
Net radiation validation



Sensible heat flux and PBL height timeseries



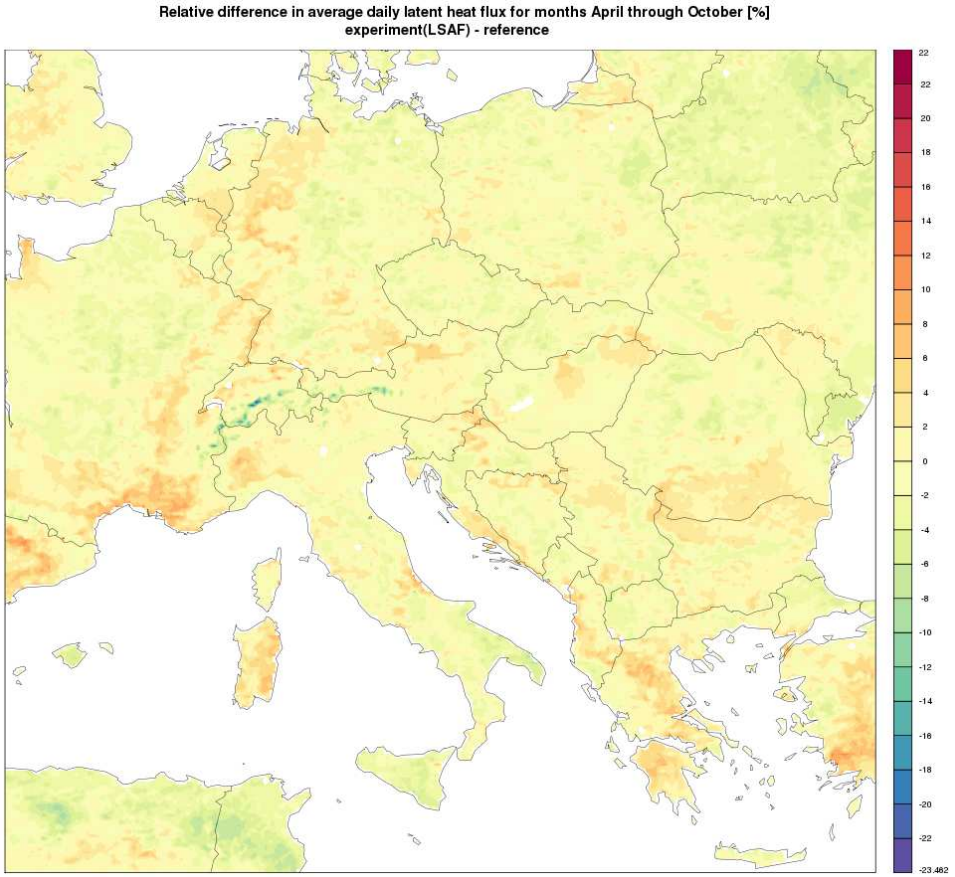
Evolution of average latent heat flux

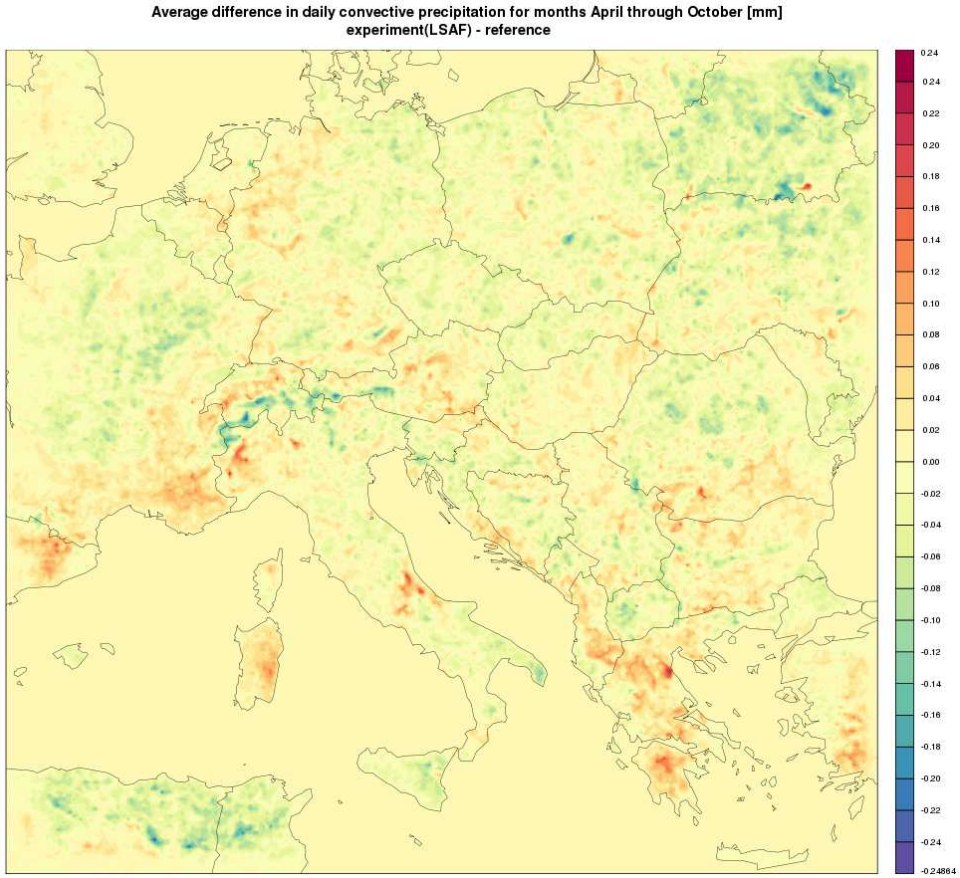


- always negative, but less negative in experiment
- less precipitation in experiment compared to reference

  - > convection

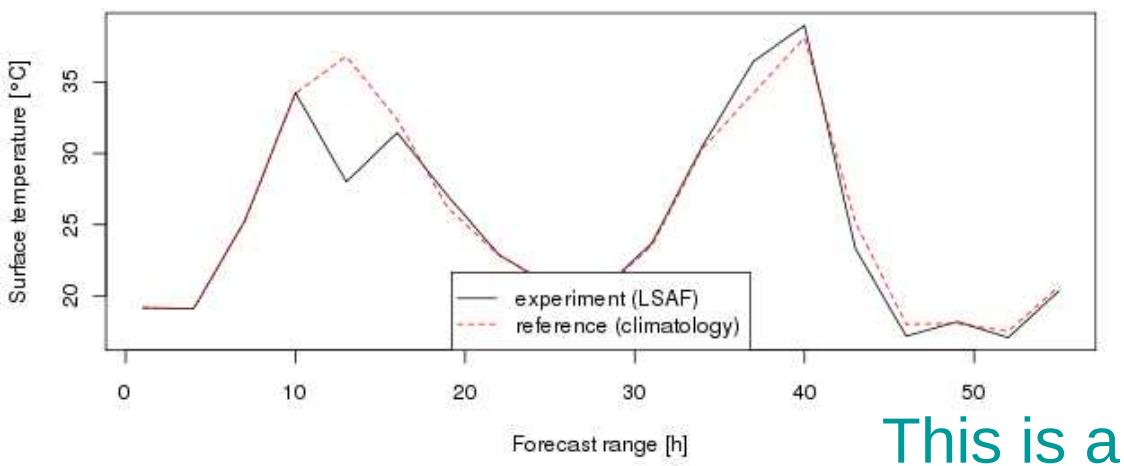
Impact on precipitation and latent heat flux



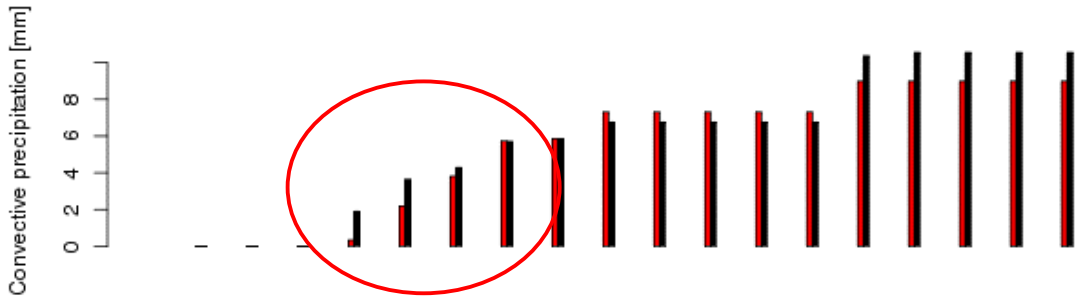


Positive correlation of albedo and surface temperature

- found when analysing the greatest impact of the albedo analysis ~ 10℃
- on a grid-poir
- experiment a daytime tempe

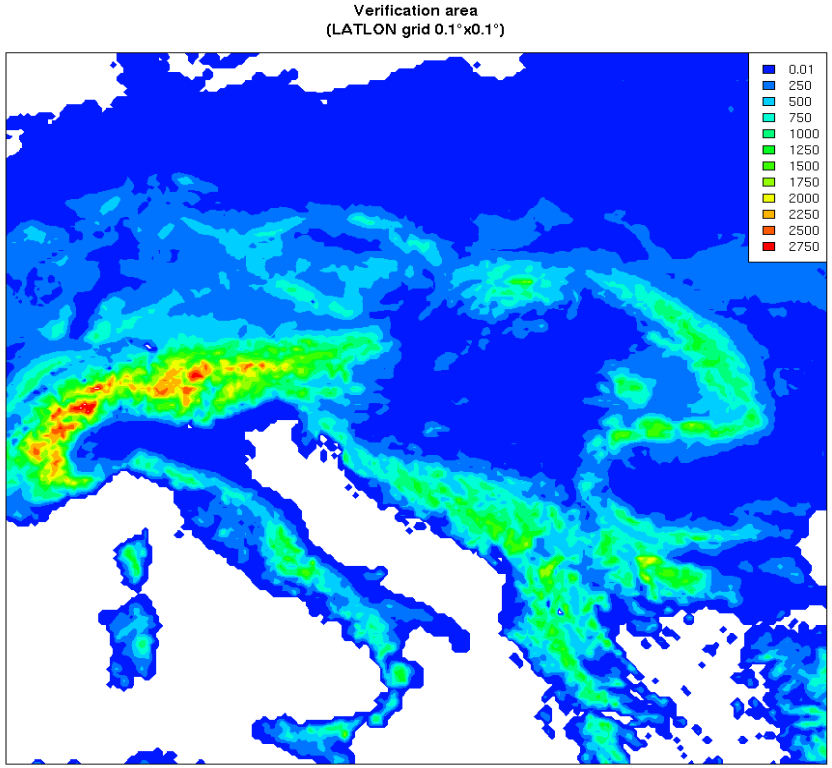


This is a 3D model!

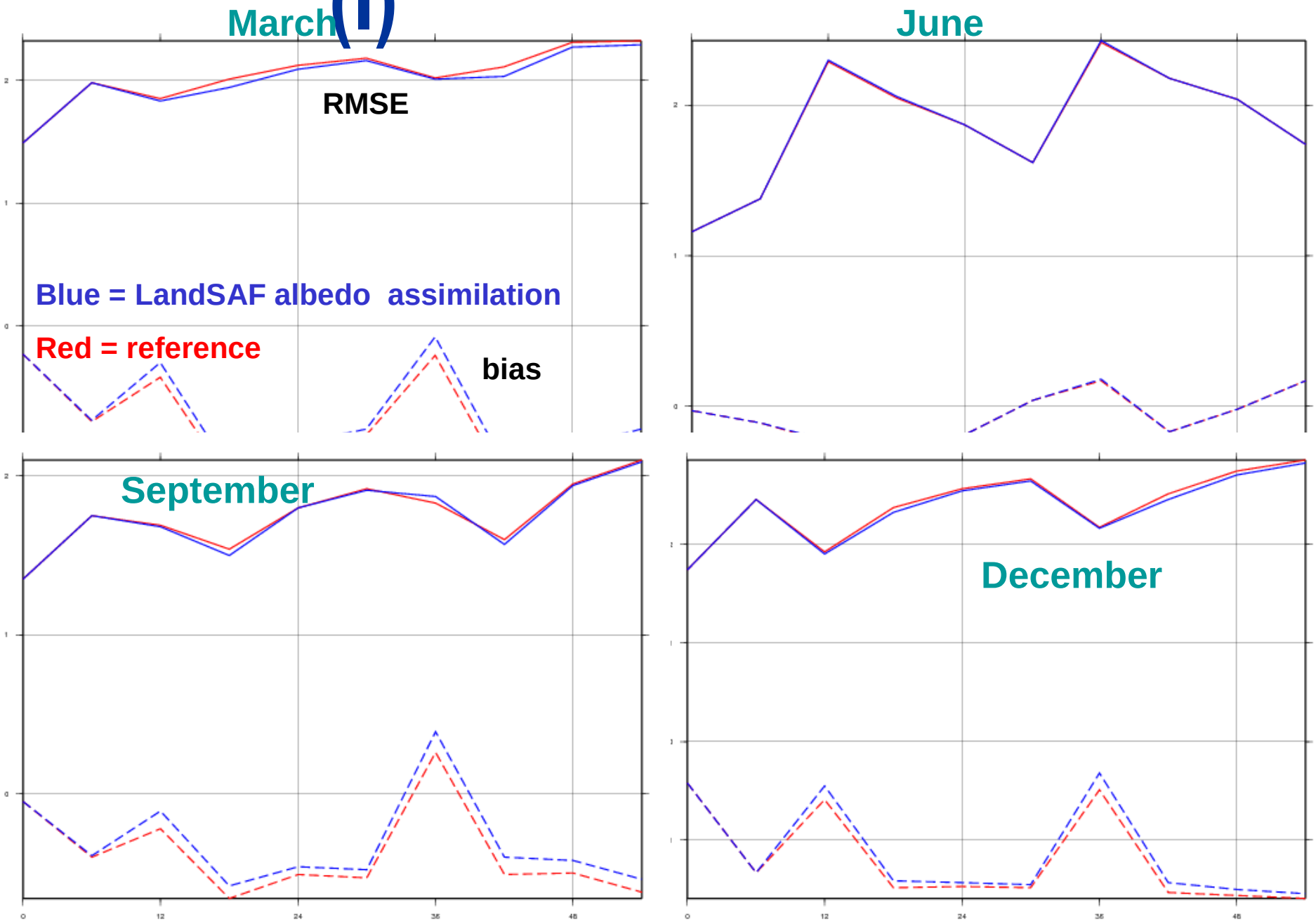


Objective verification

- Objective verification agains SYNOP data over Europe (roughly 80 observations)
- Using reliable COMPASS software (MeteoFrance verification department)
- Greatest impact on temperature scores (2m), almost no signal on other variables (except correlation with moisture) and no signal for temps

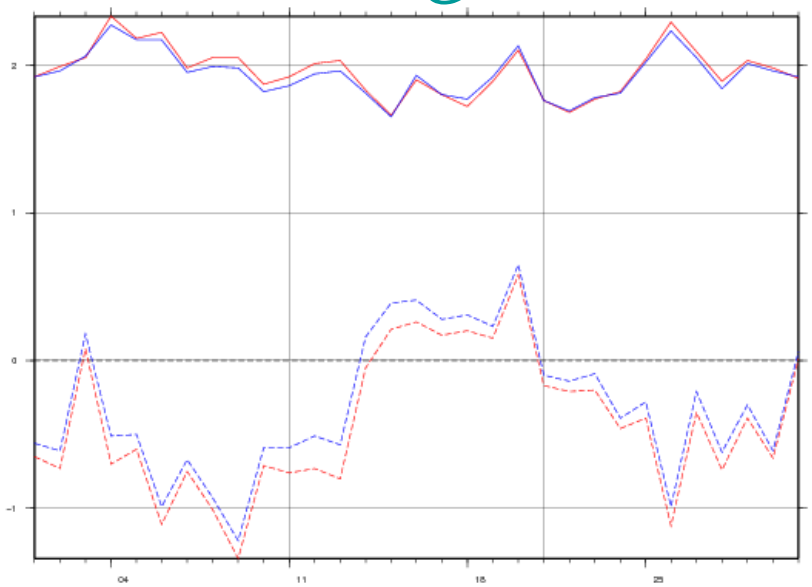


Scores for 2m temperature (I)

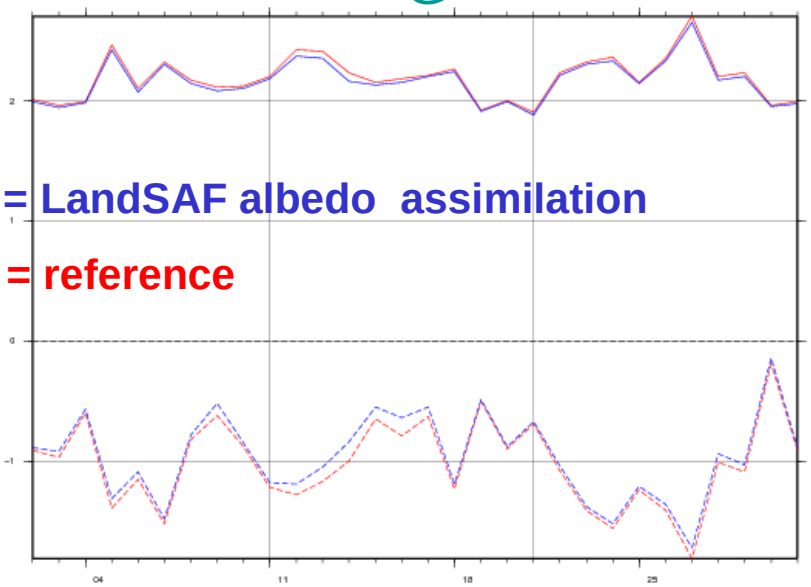


Scores for 2m temperature (II)

March @+12h



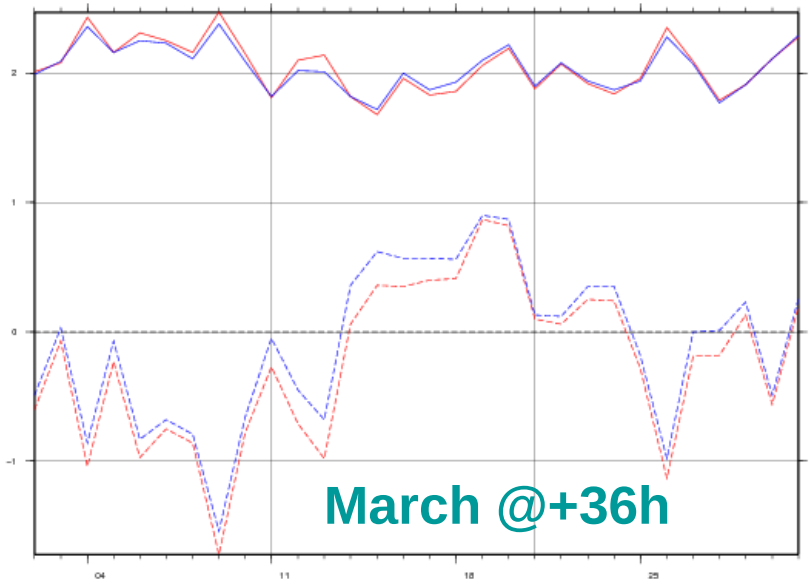
March @+24h



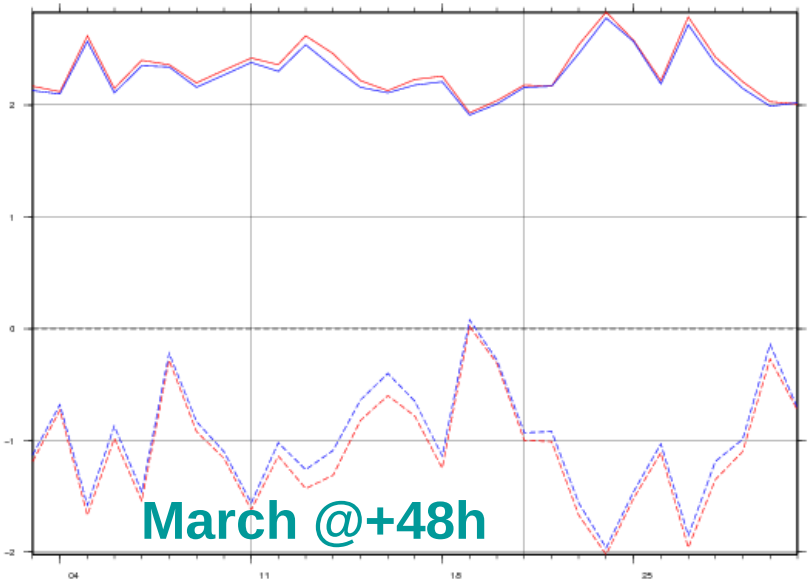
Blue = LandSAF albedo assimilation

Red = reference

day in March 2007 ->



March @+36h



March @+48h

Conclusions

- relatively large impact of Land SAF albedo assimilation
- larger impact than purely improved climatology (e.g. ECOCLIMAP)
- acts as a sort of a systematic bias correction – reducing cold bias for T2m
- sometimes too pronounced (introducing additional warm bias)
- least of impact is in late spring and summer months (April - July)

  -> probably connected to stability and activation of turbulence and convection schemes