

# Assimilation of LandSAF albedo product in a limited area NWP model

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# 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> ->

4th Land SAF user conference, Toulouse, 15-17 Nov, 2010

**LAND SURFACE ANALYSIS  
SATELLITE APPLICATIONS FACILITY**

Description

**Surface Albedo**

AL - BB - BH 2005/08/15 - 00:00 UTC

0.1 0.2 0.3 0.4 0.5

**Product Documentation**  
This product is pre-operational status. Its documentation are the product user manual document (PUM) and the product output format document (POF). The validation documentation for this product is available in the (VR) document.

**Introduction**  
Land surface albedo is a key variable for characterising the energy balance in the coupled soil-vegetation-atmosphere system. The albedo quantifies the part of the energy that is absorbed and transformed into heat and latent fluxes. Owing to strong feedback effects the knowledge of albedo is important for determining weather conditions at the atmospheric boundary layer. Climate sensitivity studies with Global Circulation Models have confirmed the unsteady nature of the energy balance with respect to small changes in surface albedo. Other domains of applications are in hydro-meteorology, agro-meteorology and environment-related studies.

**Product Description**  
The Albedo product is generated each day at the full spatial resolution of the MSG/SEVIRI instrument. An iterative scheme allows the composition of the information with a characteristic time scale of five days. The product is based on the three short-wave channels (VIS 0.6µm, NIR 0.8µm, SWIR 1.6µm). In addition to the corresponding narrowband estimates, broadband albedo is derived for the visible, near-infrared and total short-wave wavelength ranges. Information on cloud cover is obtained from the output of the Nowcasting and Very Short Range Forecasting Satellite Application Facility (NVC SAF) software. Dynamic information on the atmospheric pressure and water vapour content comes from the ECMWF numerical weather prediction model. Climatologic values are currently used for ozone concentration and aerosol optical thickness.

**Product Time Line Versions**

Year: 2009  
Date: Today  
Vers: 6.2

[Detailed](#)

ASSIMILATION OF LANDSAF ALBEDO PRODUCT IN A LIMITED AREA NWP MODEL

# ALADIN NWP model

- Local counterpart of ARPEGE, French global model, dynamical core same as in IFS (ECMWF)
- Used operationally 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:  $x_i^a = [a_{veg}^a, a_{bs}^a]^T$

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

$$x_i^a = x_i^b + K_i [y_i - Hx_i^b] \quad K_i = A_i^b H^T [HA_i^b H^T + R_i]^{-1}$$

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

$$x_{i+1}^b = Mx_i^a + w_i$$

$$M = I, \bar{w} = 0$$

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

obs. operator:

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

obs. error:

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

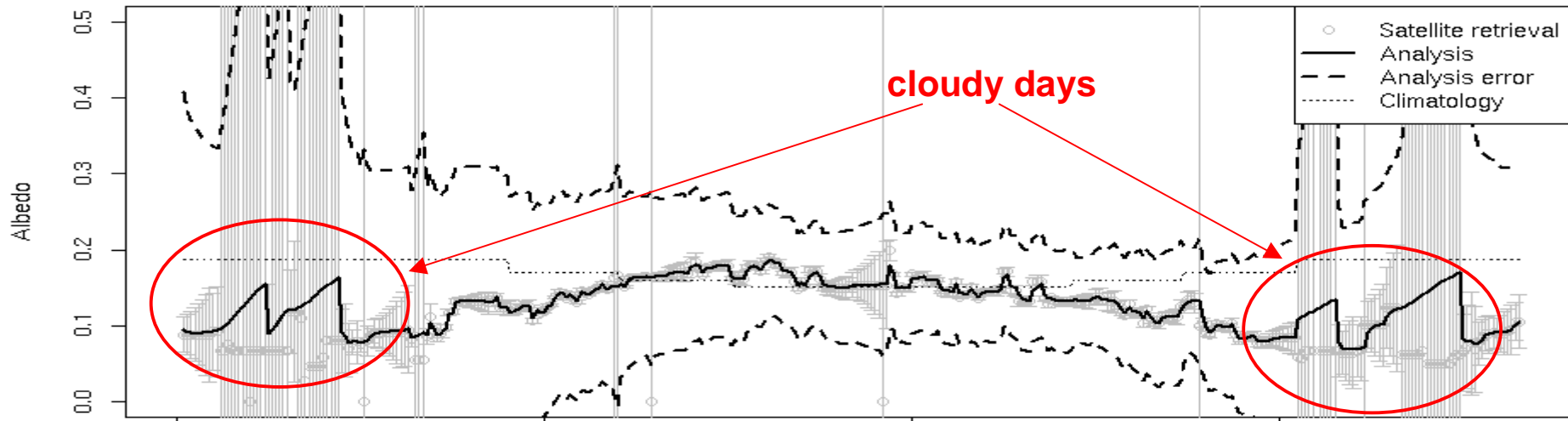
model. error (Q) is such that:

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

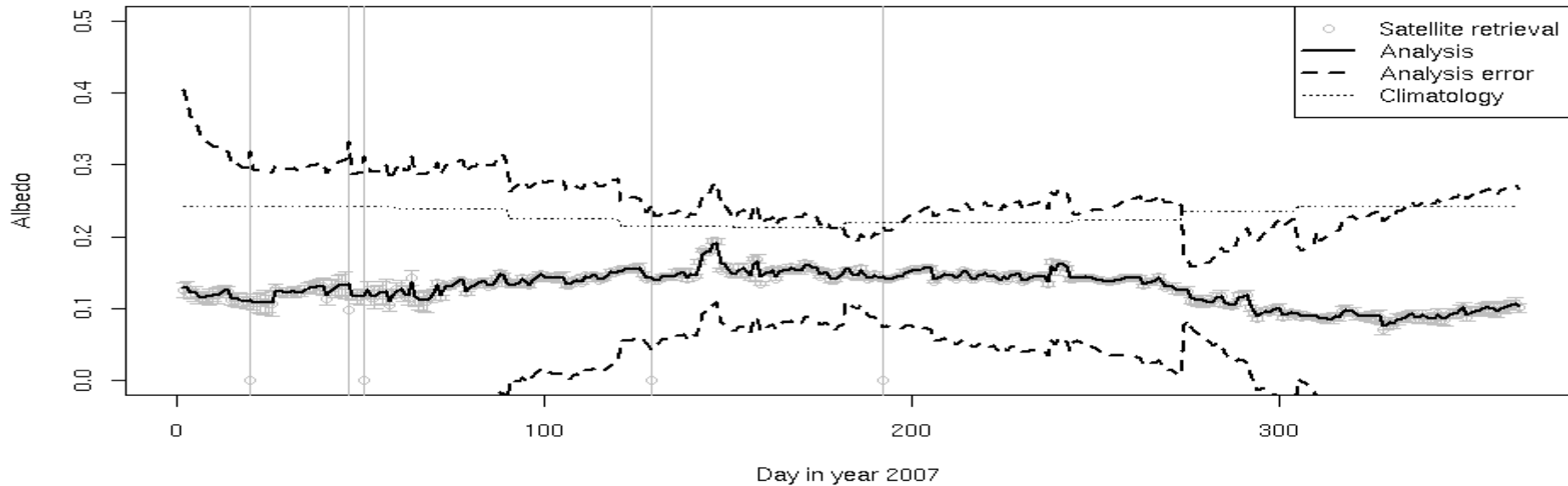
forecast step

# Analysed albedo timeseries

Evolution of albedo for lon=7.05, lat=48.67  
(Hesse)



Evolution of albedo for lon=3.85, lat=43.74  
(Puechabon)

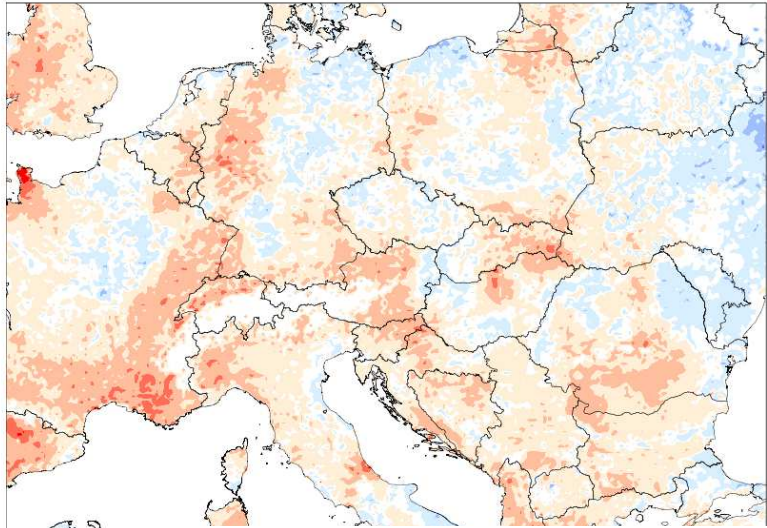


# Experiment set-up

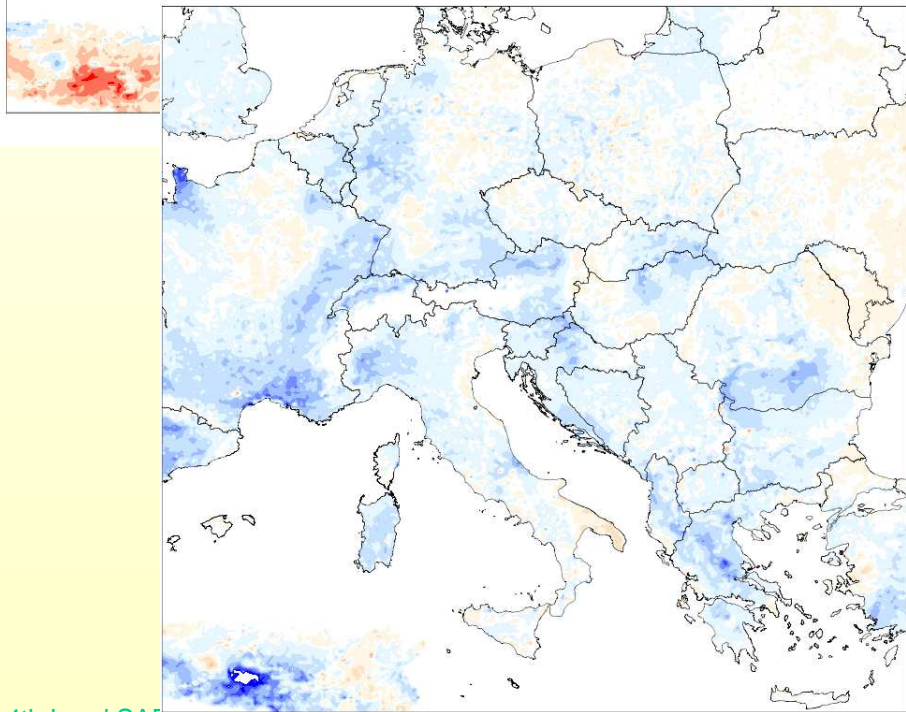
- ALADIN cycle 32, with a set-up similar to Meteo France operational one of 2007
- only dynamic adaptation (IC and LBCs from Arpège – no data assimilation)
- computational domain covering central Europe and part of Mediterranean (~9.5 km, 250x270)
- 01/02/2007 -> 31/12/2007, forecast length +54h
- initialization at 00UTC (use previous day albedo retrieval)
- albedo assimilation performed 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

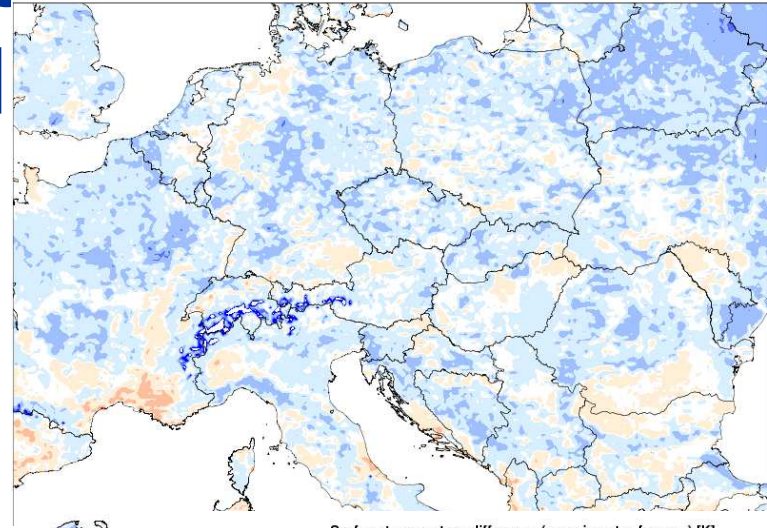


Surface temperature difference (experiment-reference) [K]  
for March 15, 2007 at 12 UTC, after 12 hours of integration

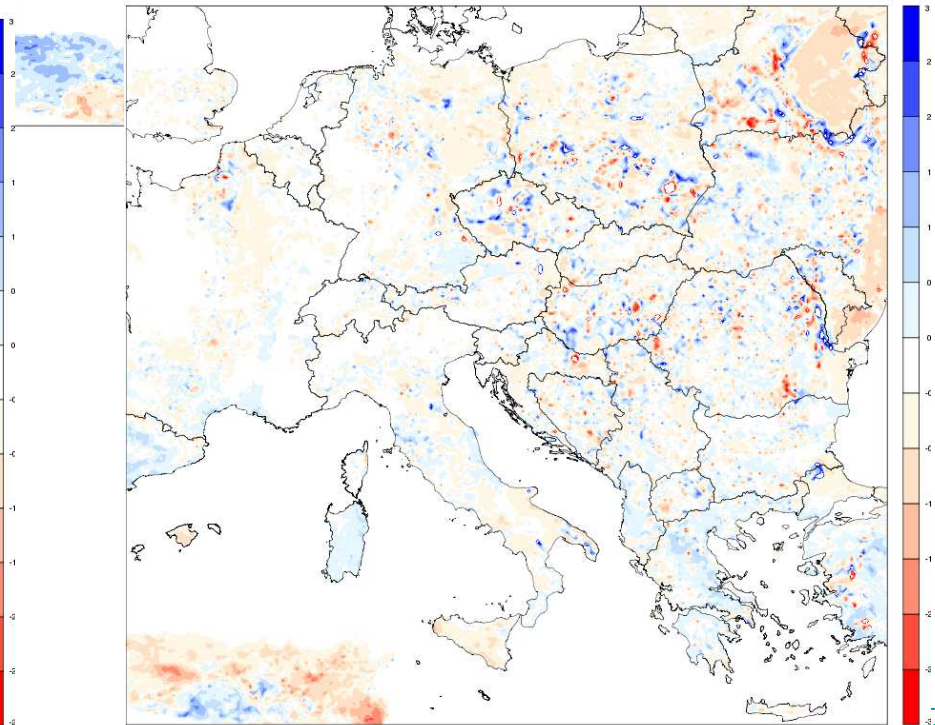


4th Land SAF

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



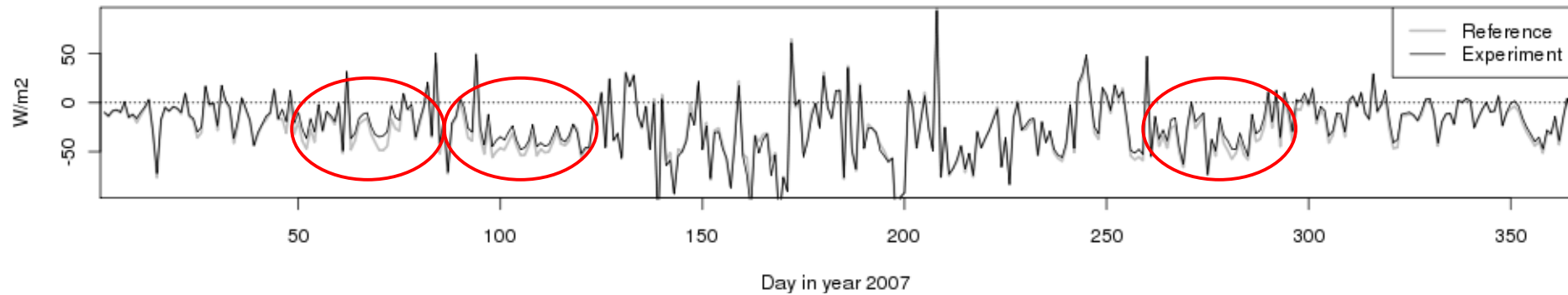
Surface temperature difference (experiment-reference) [K]  
for June 15, 2007 at 12 UTC, after 12 hours of integration



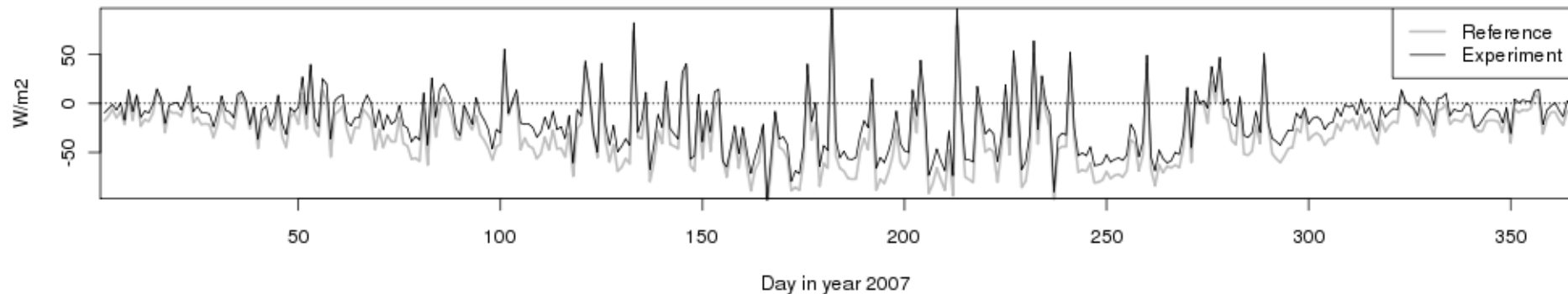
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# Net radiation validation

Time series of daily average net radiation (modeled - observed)  
for lon=7.05, lat=48.67 (Hesse)

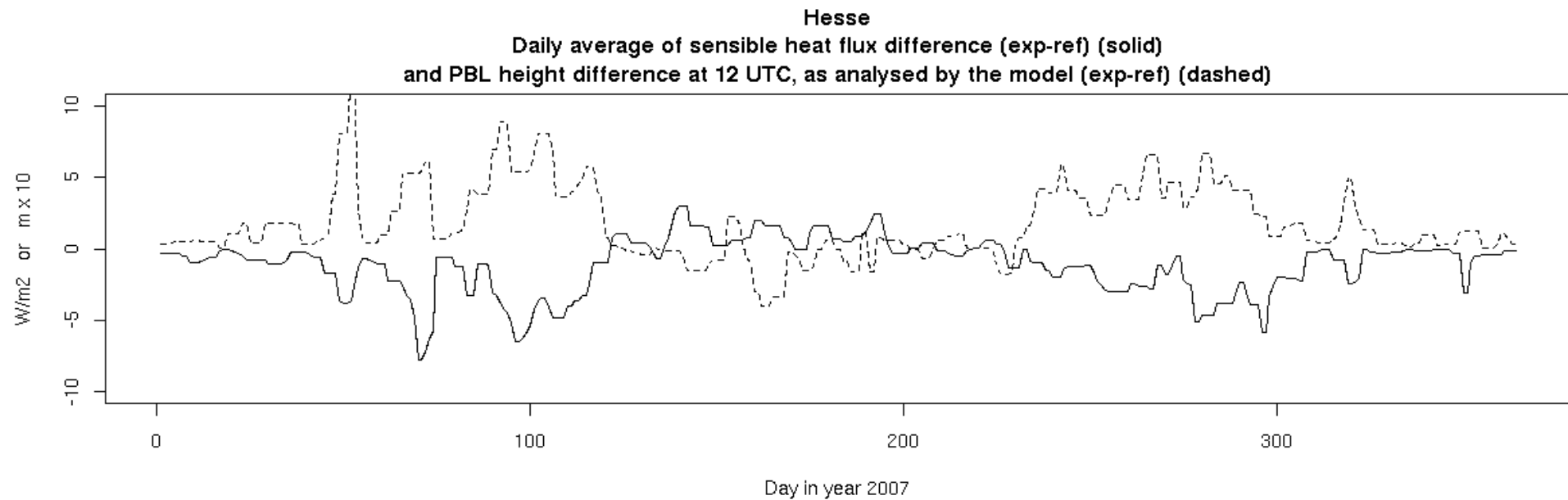


Time series of daily average net radiation (modeled - observed)  
for lon=3.85, lat=43.74 (Puechabon)



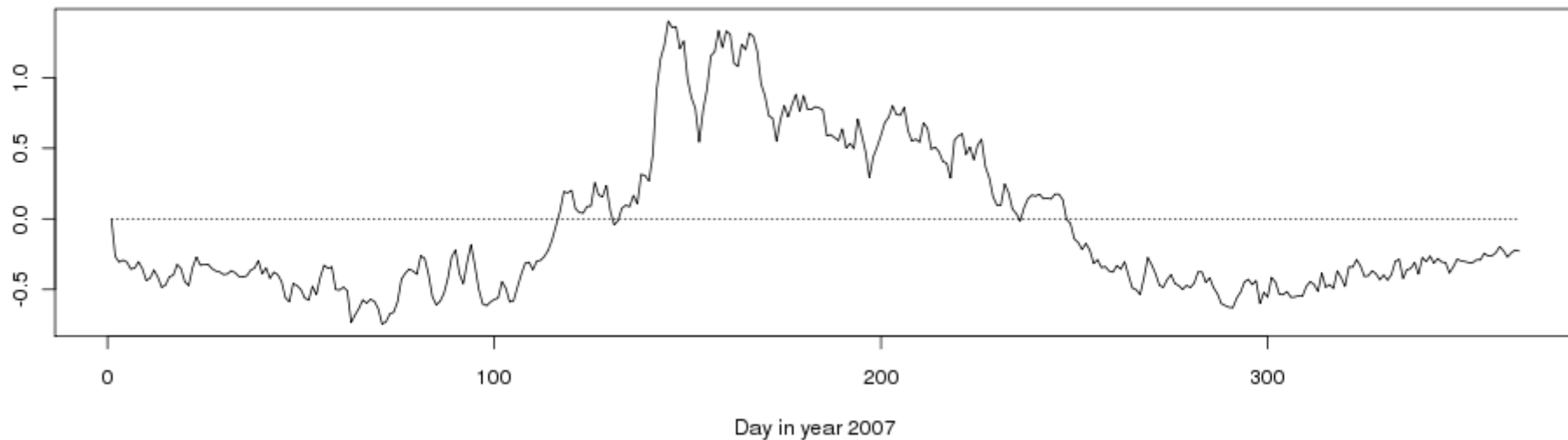


# Sensible heat flux and PBL height timeseries



# Evolution of average latent heat flux

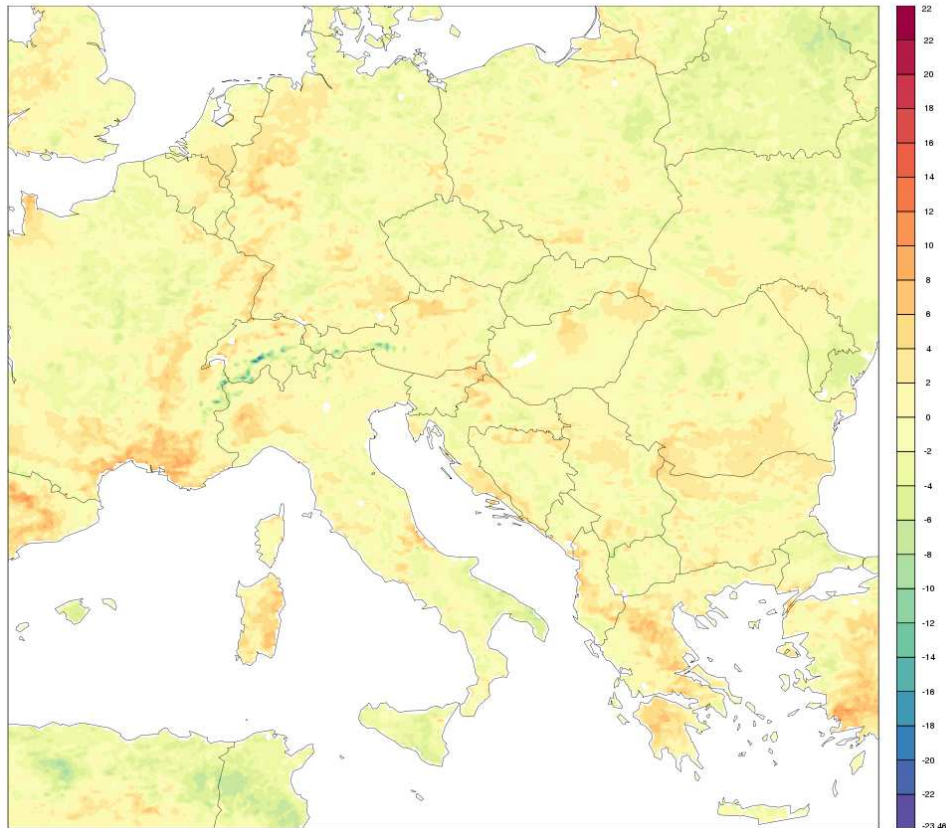
Difference for daily surface latent heat flux domain average (evaporation and sublimation) experiment (LSAF albedo assimilation) compared to reference (use of climatology) [W/m<sup>2</sup>]



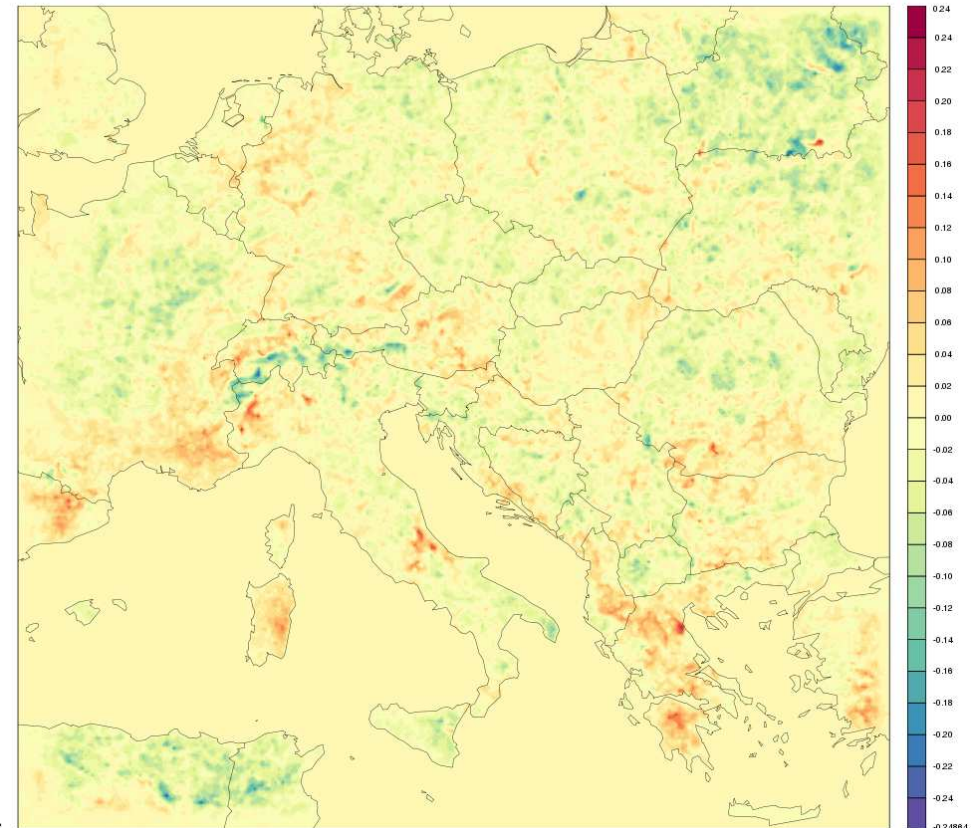
- always negative, but less negative in experiment
  - less precipitation in experiment compared to reference
- > convection

# Impact on precipitation and latent heat flux

Relative difference in average daily latent heat flux for months April through October [%]  
experiment(LSAF) - reference

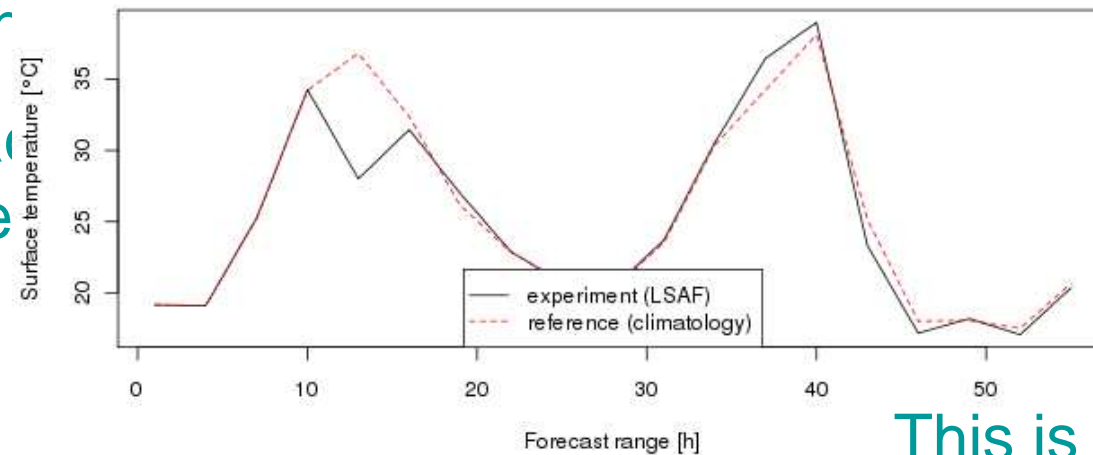


Average difference in daily convective precipitation for months April through October [mm]  
experiment(LSAF) - reference



# Positive correlation of albedo and surface temperature

- found when analysing the greatest impact of the albedo analysis  $\sim 10^{\circ}\text{C}$
- on a grid-poir
- experiment at daytime temperature

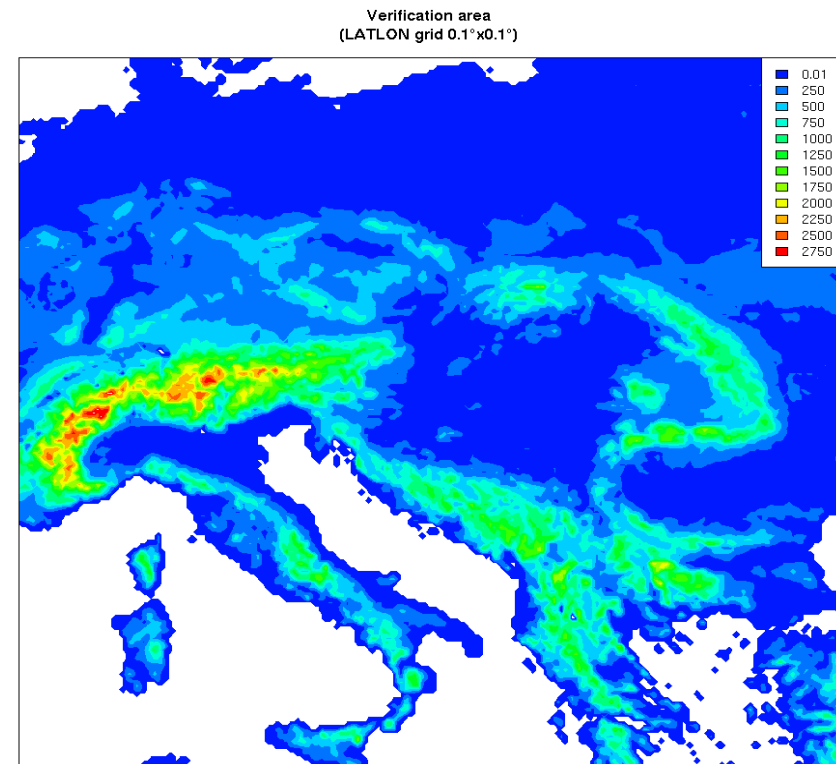


This is a 3D model!



# Objective verification

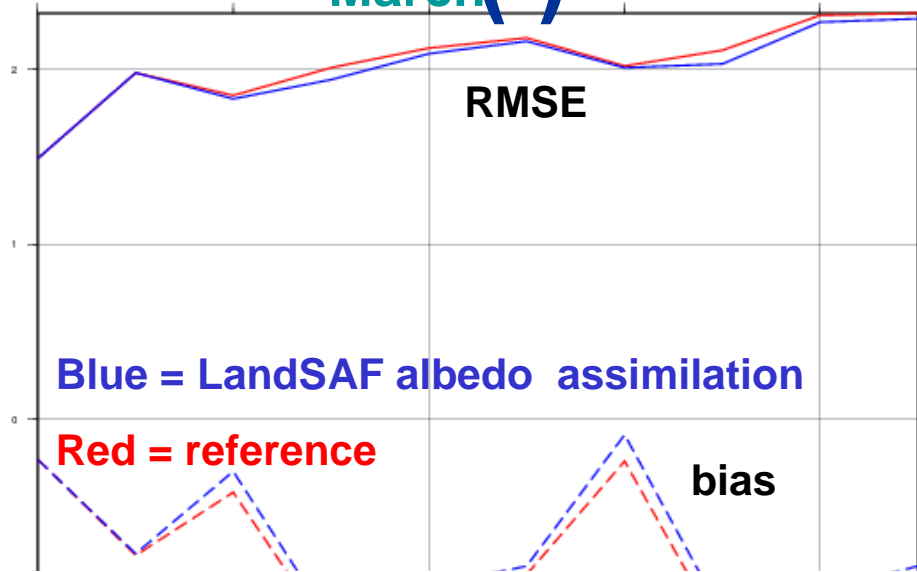
- Objective verification against SYNOP data over Europe (roughly 80 observations)
- Using reliable COMPASS software (MeteoFrance verification department)
- Greatest impact on temperature scores (2m), almost no signal on other variables (except correlation with moisture) and no signal for temps



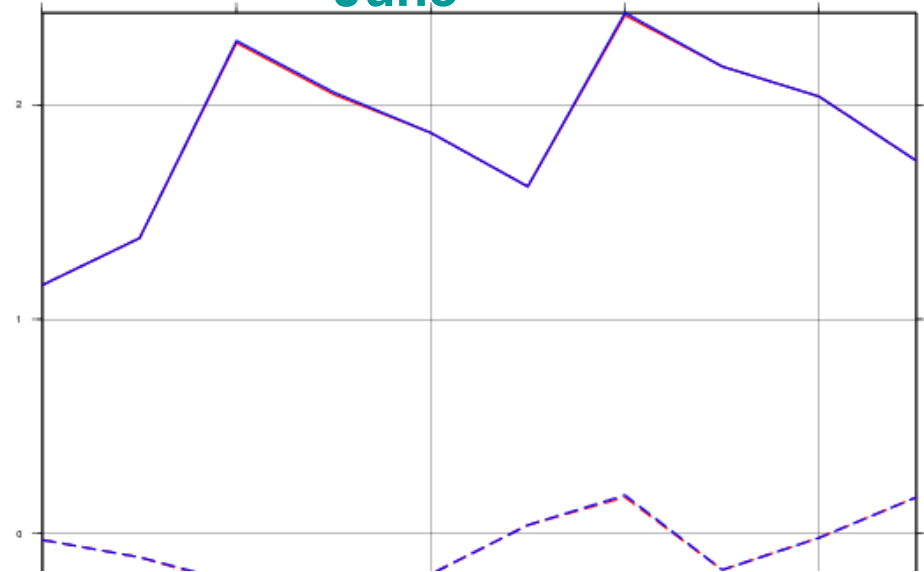


# SCORES FOR Z10 TEMPERATURE

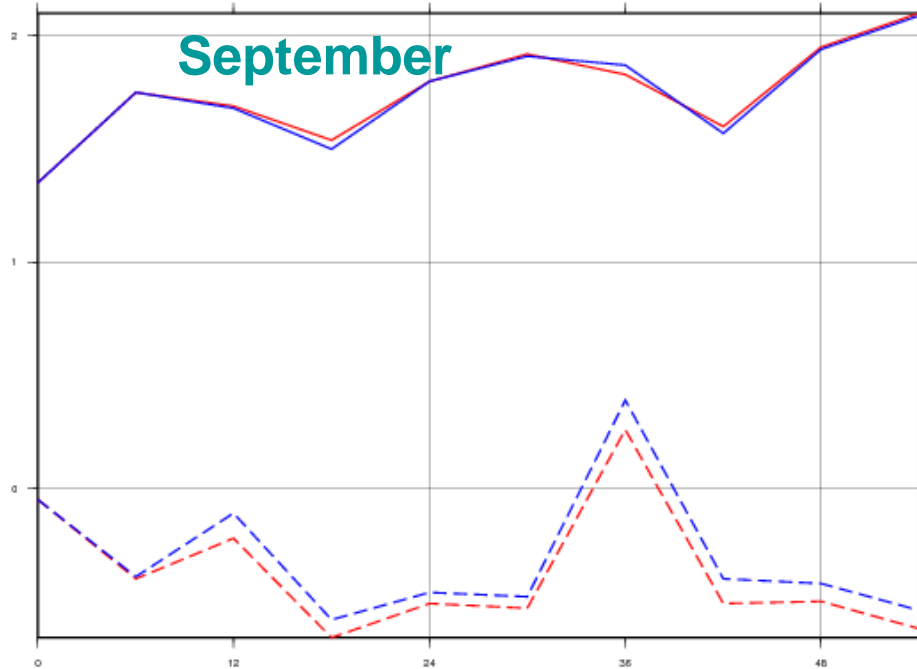
March (I)



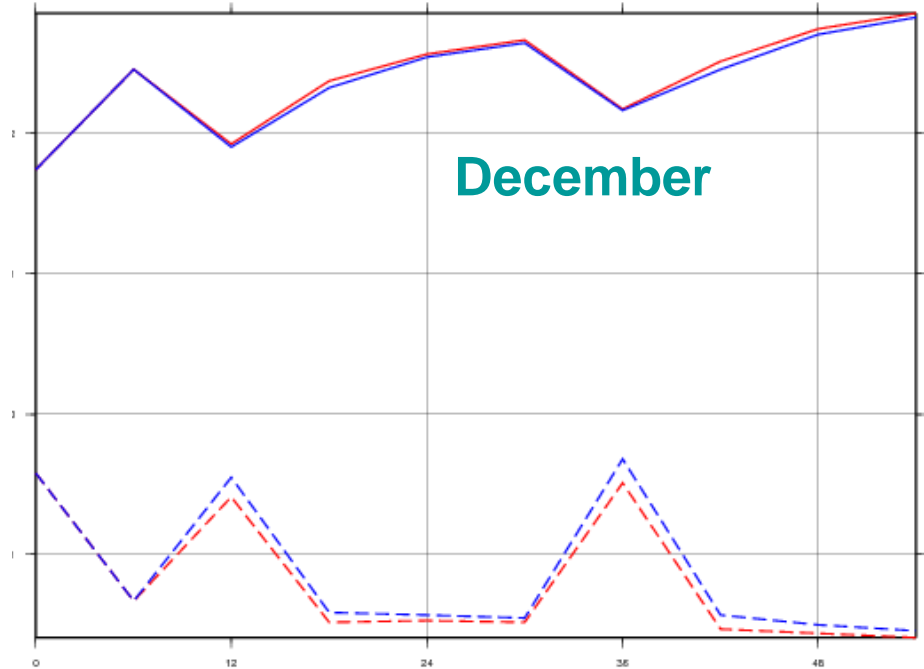
June



September

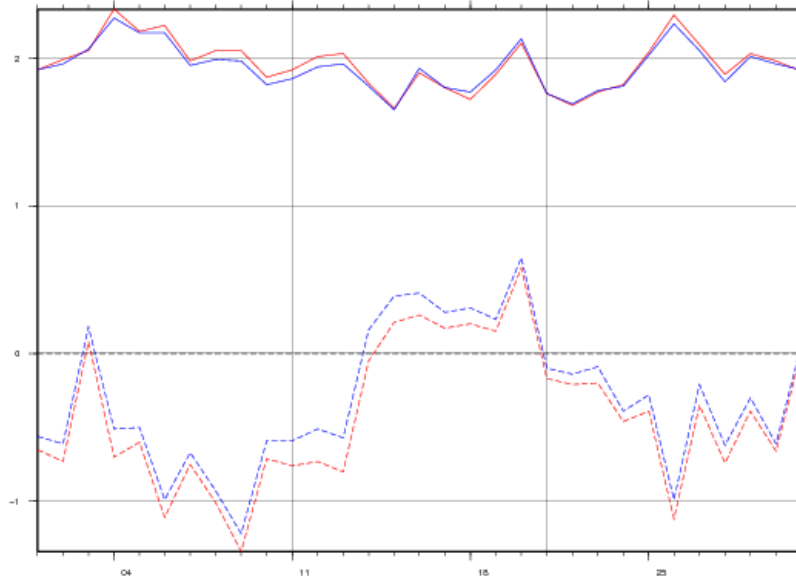


December

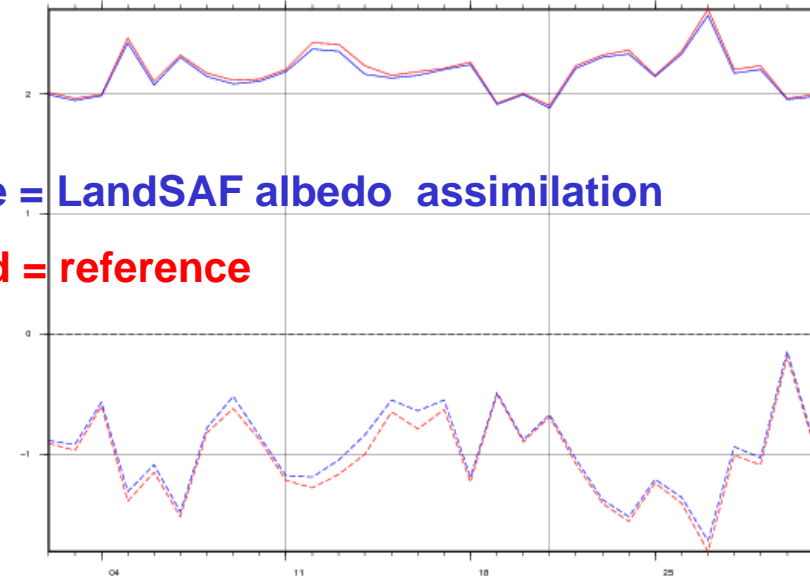


# Scores for 2m temperature (II)

March @+12h



March @+24h

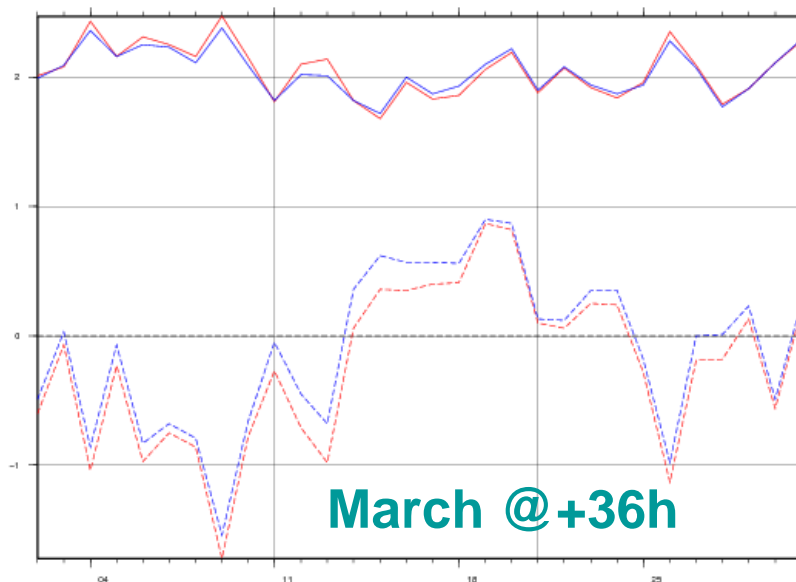


Blue = LandSAF albedo assimilation

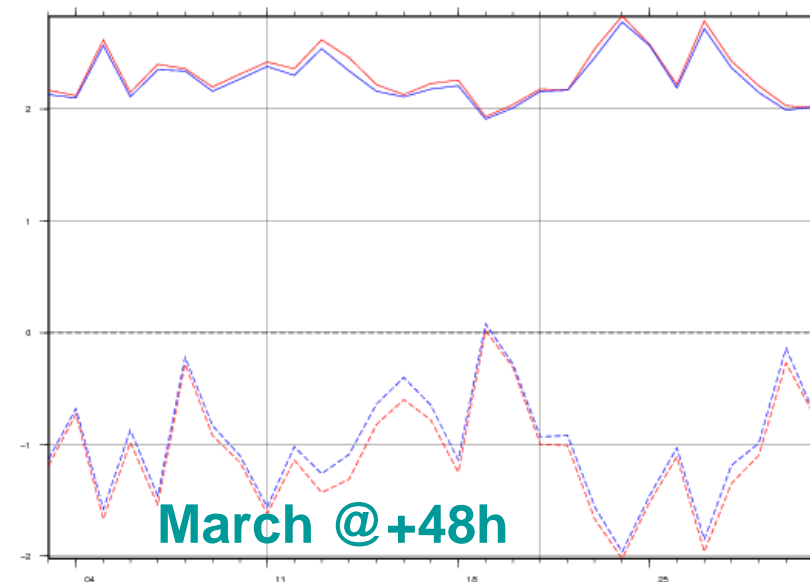
Red = reference

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