SURFEX/SODA activities at ZAMG

Stefan Schneider, Jasmin Vural

LACE data assimilation working days 2020

14.-16.9.2020

„Vienna“

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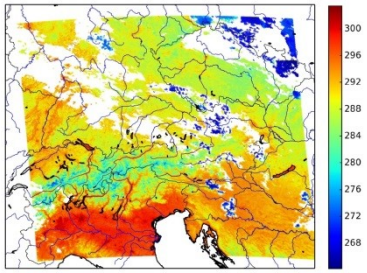
Surface assimilation setup

time

SODA (sEKF)



Observation to improve the analysis

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Surface assimilation setup

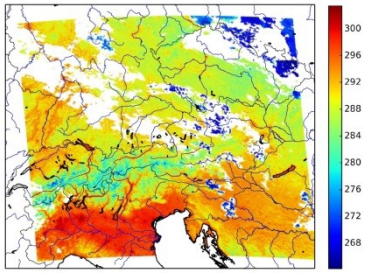
OFFLINE

1 reference

1 perturbed run for each control variable

Assimilation window depends on assimilated variable

SODA (sEKF)



Observation to improve the analysis

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Surface assimilation setup

OFFLINE needs atmospheric input data (e.g. from AROME):
T, RH, P, RR, SNOW, WIND, RADIATION, CO2

time

OFFLINE
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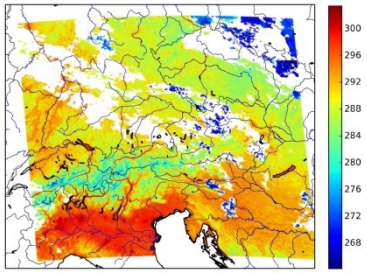

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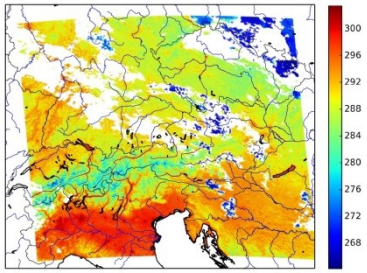

Observation to improve the analysis

STAND-ALONE version

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Surface assimilation setup

COUPLED version

OFFLINE needs atmospheric input data (e.g. from AROME):
T, RH, P, RR, SNOW, WIND, RADIATION, CO2

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OFFLINE

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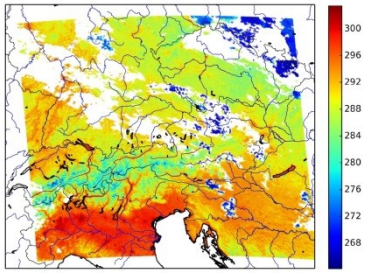
1 perturbed run for each control variable

Assimilation window depends on assimilated variable

SODA (sEKF)



Observation to improve the analysis

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Surface assimilation setup

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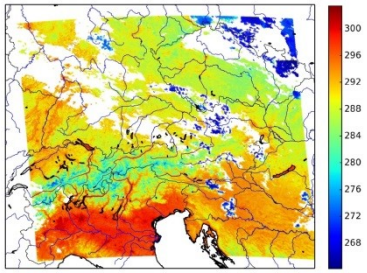

Observation to improve the analysis

AROME: CY40T1, including SURFEX 7.3

SODA, OFFLINE: SURFEX 8.1 with ZAMG improvements (more observations, control variables, observation error)

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Data assimilation experiments

- Land surface temperature: COUPLED
- Soil moisture: COUPLED
  STAND-ALONE
- T2M: STAND-ALONE
- LAI: COUPLED

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Land surface temperature assimilation

SURFEX: 8.1, sEKF assimilation
+ TS as OBS, TG3-8 as CTRL

atm. MODEL: AROME CY40T1 + SURFEX 7.3
2.5km grid, 90 layers

COUPLED version

DATA: combined LST measurements from Sentinel-3 and MSG
spatial resolution: 1km; temporal resolution: 15 minutes

Work has been funded to a large part by FFG-project ASTRID (project number 853992).

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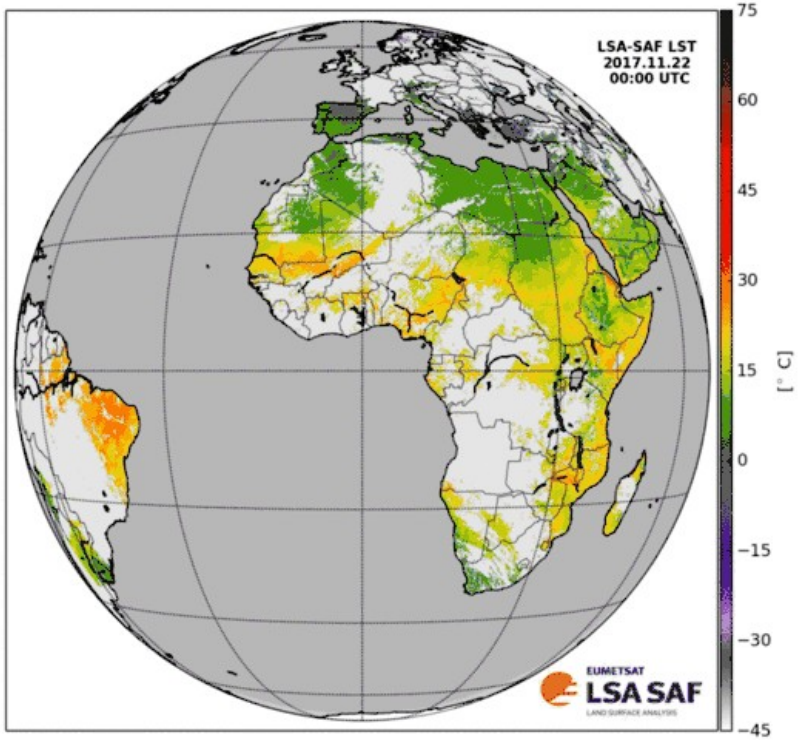
Land surface temperature assimilation – satellite data

LandSAF LSA-001	ESA S-3 SLSTR LST



https://landsaf.ipma.pt/en/products/land-surface-temperature/lst/

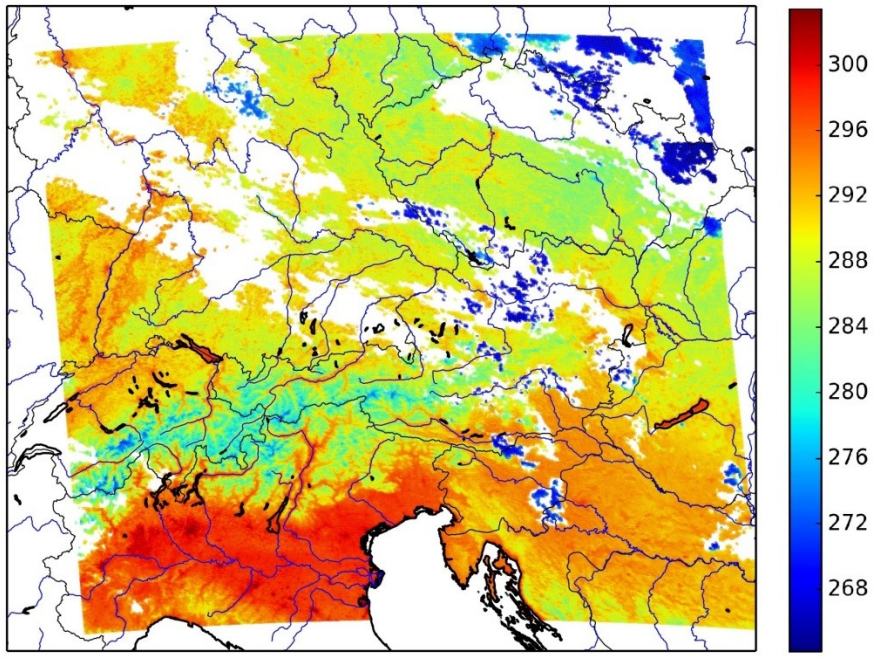


Fig. 1: Level-2 LST product for S3A on 20190705, 19.30UTC after applying quality flags. Obviously, some clouds are not masked completely, remaining as cold spots in the LST field.

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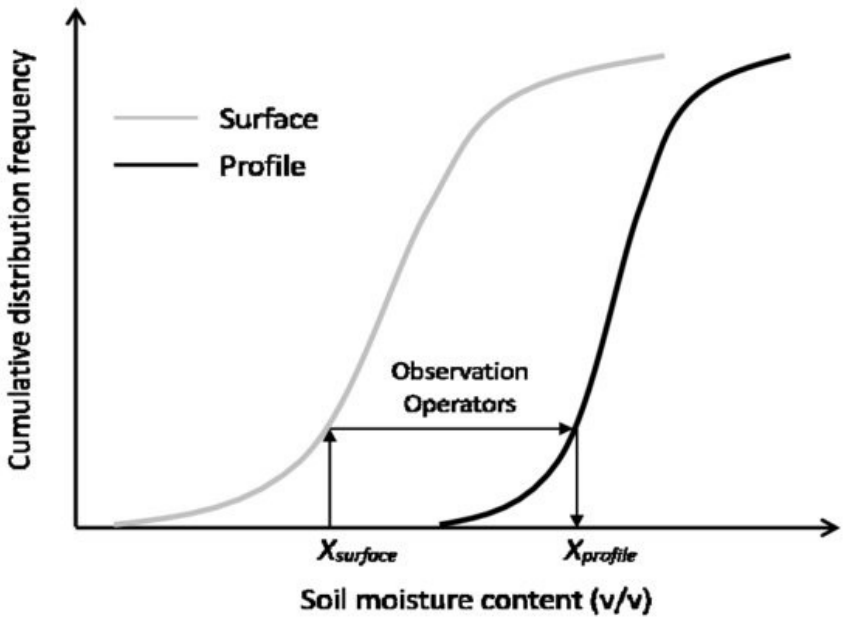
Land surface temperature assimilation – satellite data

CDF matching

time series of measurements from S3A and MSG for 09/2017-12/2019



Gao et al., 2017; DOI: 10.5194/hess-2017-292

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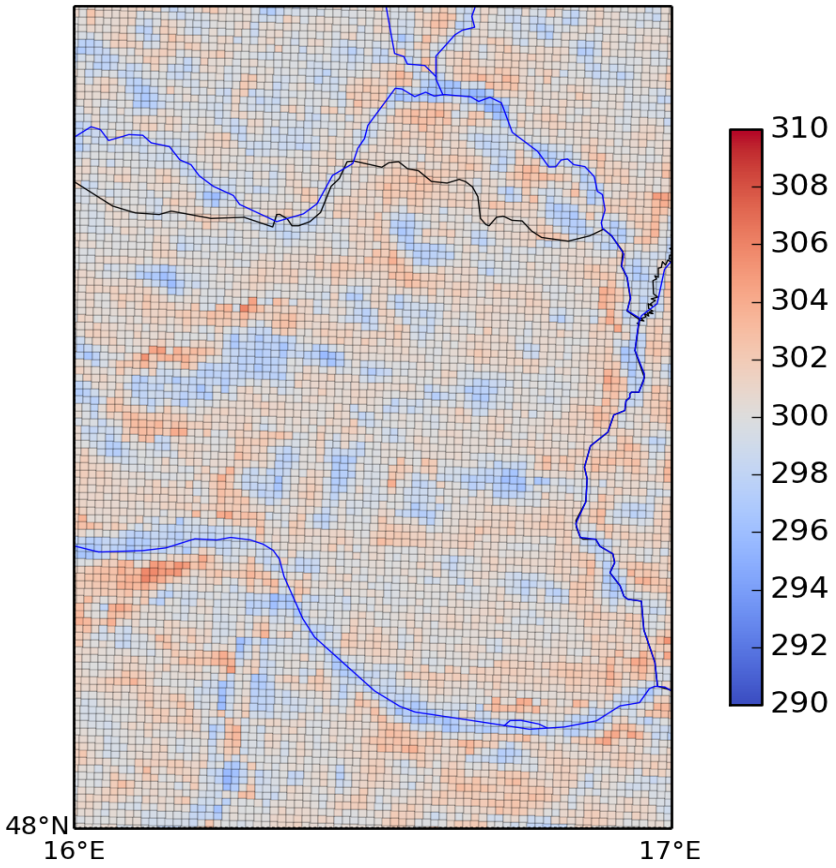
Land surface temperature assimilation – satellite data

An academic example: MSG is „measuring“ 300K everywhere and the downscaling algorithm is applied. The ouput is plotted on the left side.



Results from ASTRID, FFG No. 853992

Fig. 6: Weinviertel, Vienna and Wienerwald after the correction (left) and land cover as seen by Google Earth (right).

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Land surface temperature assimilation – satellite data

Validation of MSG-S3A-product against S3B

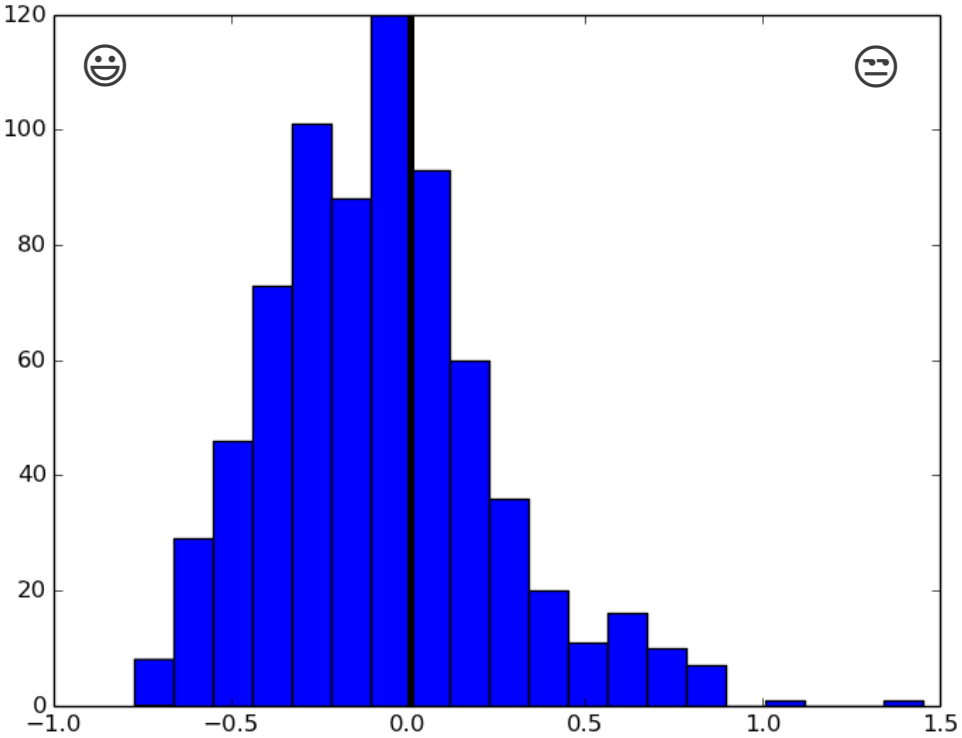

Fig. 14: Histogram for the 720 cases that have been investigating. The x-axis shows the improvement of MS3 vs. MSG compared to S3B in the unit Kelvin. Negative values (mean value over all grid cells) indicate that MS3 is closer to S3B as MSG.

For the hottest 100 cases, MSG+S3A is significantly better than MSG in 80 cases.

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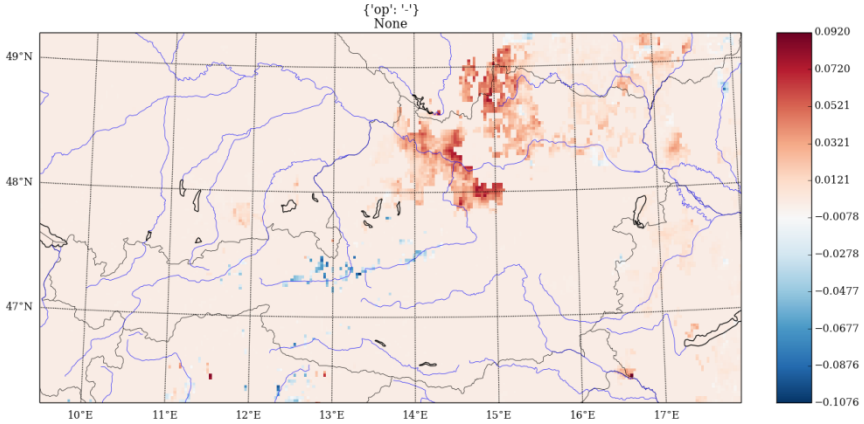
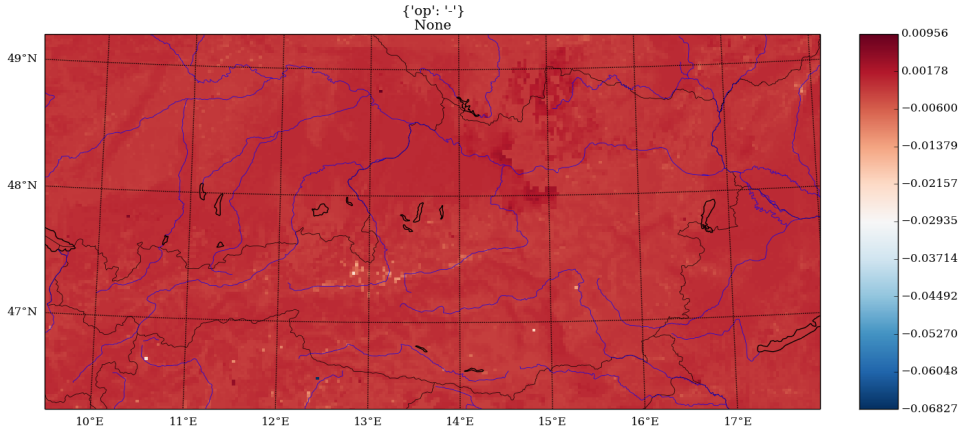
Setup of assimilation cycle

AROME provides atmospheric forcing for OFFLINE
SODA provides improved soil analysis for AROME

For OBS=TS and CTRL=TG1, the impact is really small



Analysis +0.09 to -0.11K



+1h forecast +0.01K to -0.07K

Results from ASTRID, FFG No. 853992

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Setup of assimilation cycle

=> Hourly assimilation cycle

COBS_M=TS (MSG+S3A)
XERROBS_M=0.01
CVAR_M=TG1,TG2,TG3,TG4,TG5,TG6,TG7,TG8
XSIGMA_M=0.6,0.5,0.4,0.4,0.4,0.4,0.4,0.4
XTPRT_M=0.0001

How to initialise TG in PREP for ISBA_DF properly?

Results from ASTRID, FFG No. 853992

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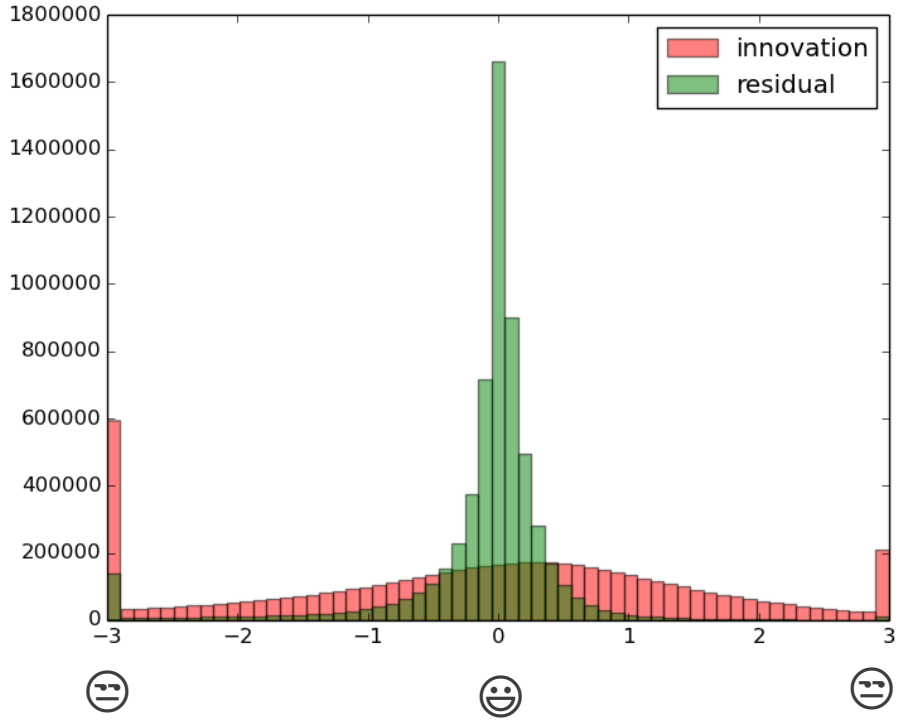
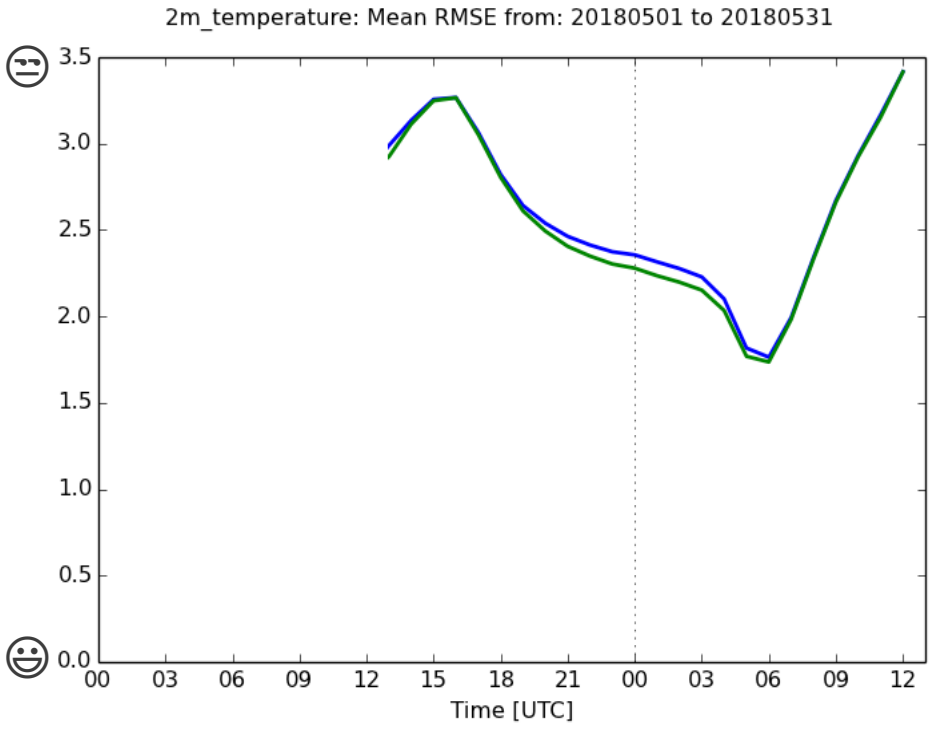
Results

Model analysis before/after data assimilation
vs.
satellite observations



Forecast quality with/without data assimilation, based on station data



Results from ASTRID, FFG No. 853992

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Soil moisture assimilation

SURFEX: 8.1, sEKF assimilation

+ WG3-6 as observation, WG3-8 as CTRL

+ local observations error

atm. MODEL: AROME CY40T1 + SURFEX 7.3

2.5km grid, 90 layers

COUPLED version

DATA: combined superficial soil moisture data from Sentinel-1 and ASCAT

spatial resolution: 1km; temporal resolution: 1 day

Work has been funded to a large part by EUMETSAT

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Soil moisture assimilation

Local observation error brings no significant improvement so far

Vural et al. 202(0/1) “Assimilation of the SCATSAR-SWI with SURFEX: Impact of local observation errors in Austria”, accepted with revisions in MWR

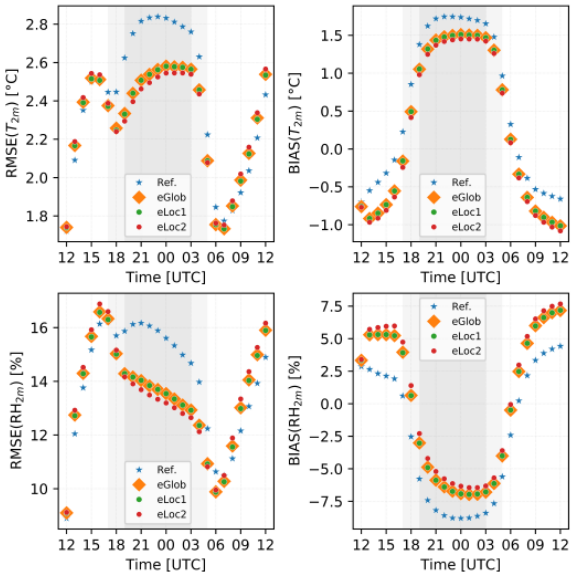

FIG. 6. RMSE (*left*) and bias (*right*) of 2 m temperature (*top*) and 2 m relative humidity (*bottom*) for the reference run (blue stars), *eGlob* (orange squares), *eLoc1* (green dots), and *eLoc2* (red dots). The grey shaded areas indicate the approximate duration of the shortest and longest night in Austria in the investigated period. The graphs represent the average over all weather stations below 600 m.

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Soil moisture assimilation

SURFEX: 8.1, sEKF assimilation

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+ local observations error

atm. MODEL: AROME CY40T1 + SURFEX 7.3

2.5km grid, 90 layers

STAND-ALONE version

DATA: combined superficial soil moisture data from Sentinel-1 and ASCAT

spatial resolution: 1km; temporal resolution: 1 day

Work has been funded to a large part by FFG-project BMon (project number 872408)

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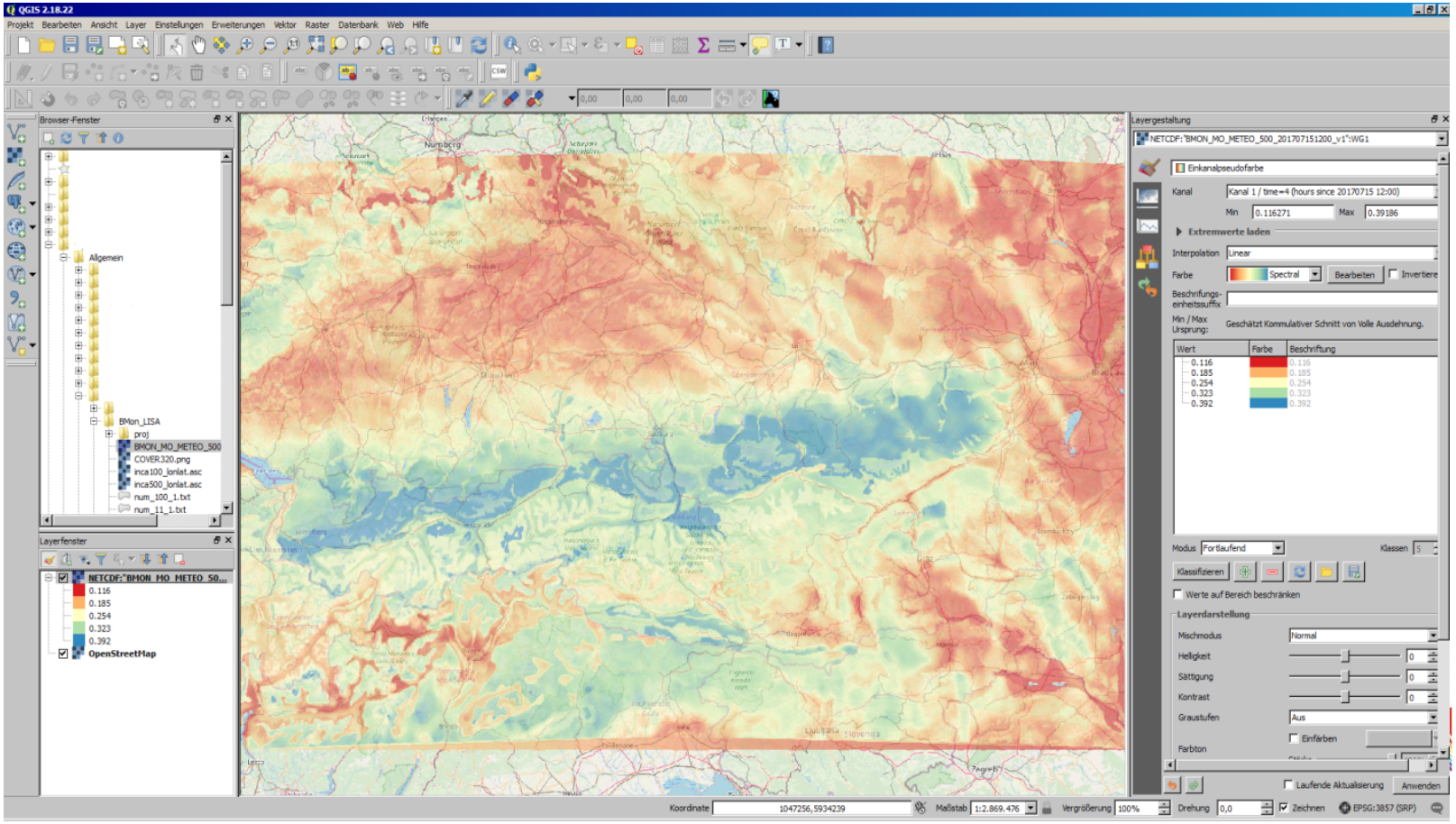
Soil moisture assimilation

Basic idea: soil model can run with high spatial sampling (500m grid for Austria) as input for hydrological monitoring system

AROME forcing interpolated to 500m grid



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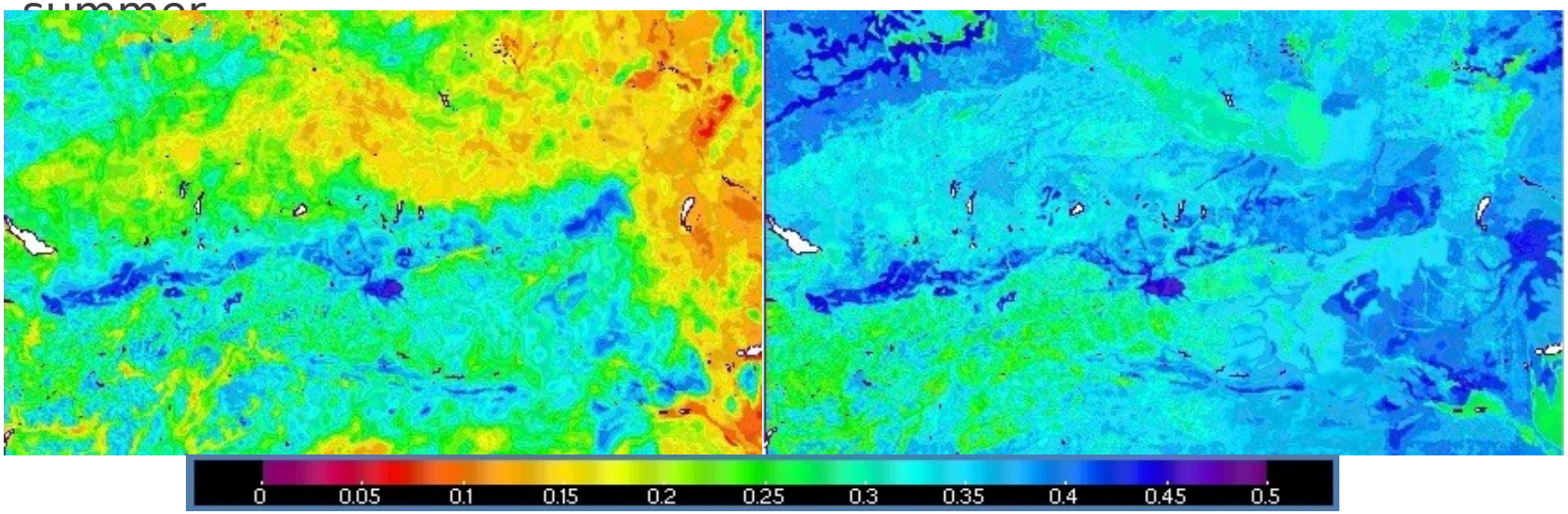
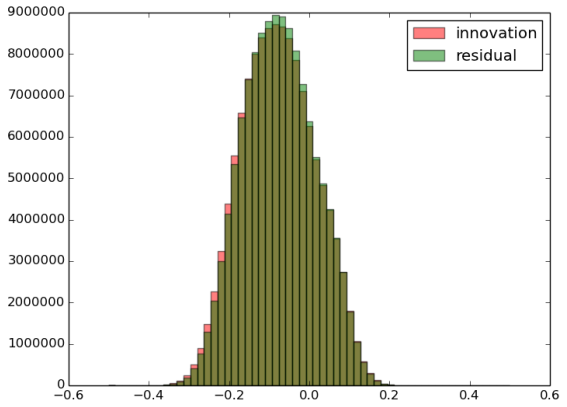
Soil moisture assimilation

Problem: the assimilation run is getting far too moist during summer



Soil moisture in kg/kg for the upper layer (WG1) on June 1st, 2018 for the reference run v1 (left) and the assimilation run v3 (right), both with AROME forcing.



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LAI assimilation

SURFEX: 8.1, sEKF assimilation
+ local observation error

atm. MODEL: AROME CY43T2 + SURFEX 8.0
2.5km grid, 90 layers

COUPLED version

DATA: Sentinel-2 based LAI for Austria (provided by BOKU)
spatial resolution: 10m; temporal resolution: ~5 days

Work is funded to a large part by FFG-project LAETITIA (project number 878882)

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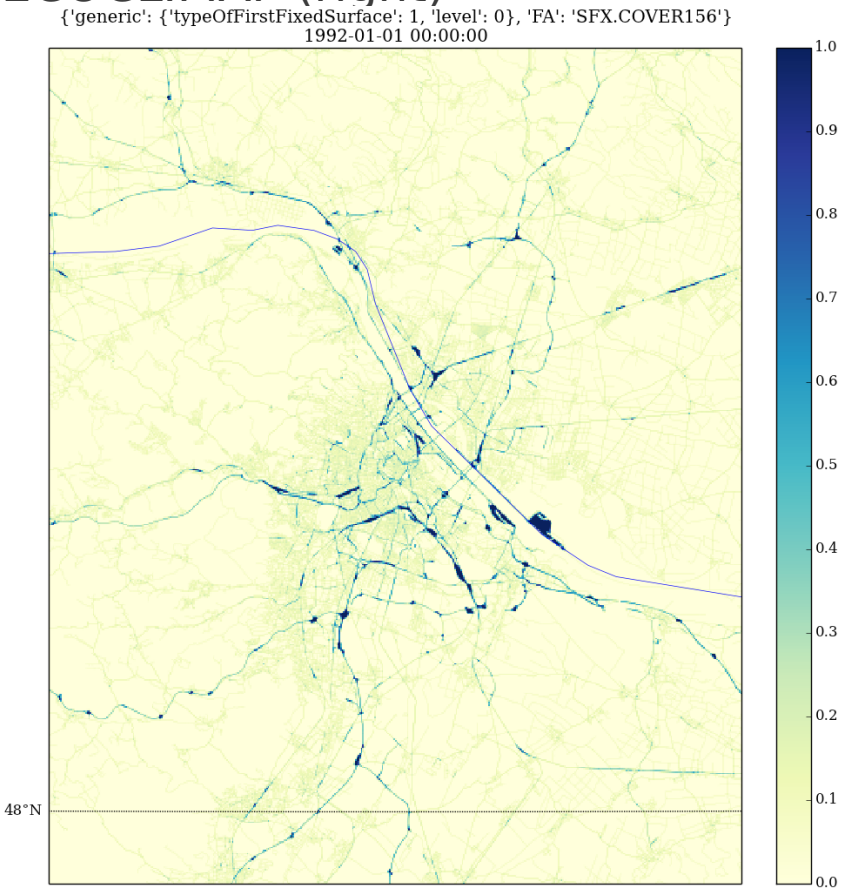
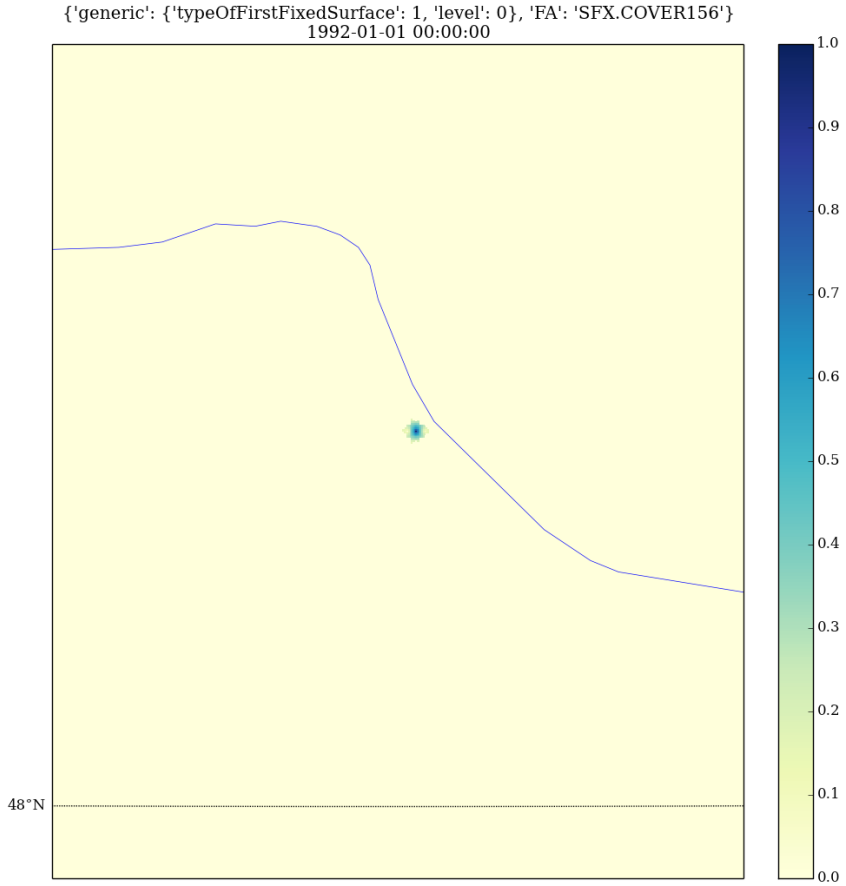
LAI assimilation

Improve PGD.fa with land cover data from Urban Atlas (left) instead of ECOCLIMAP (right)





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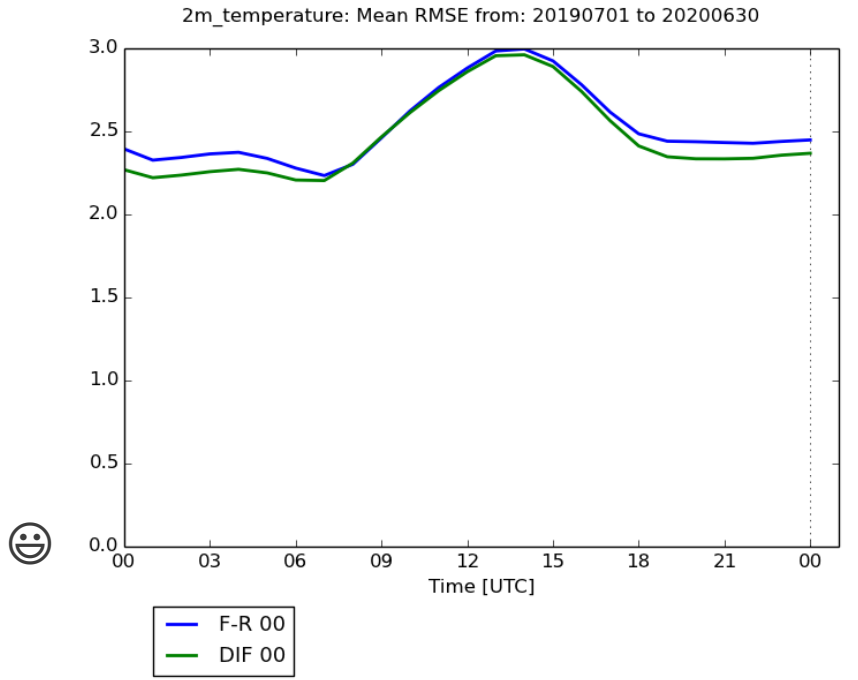
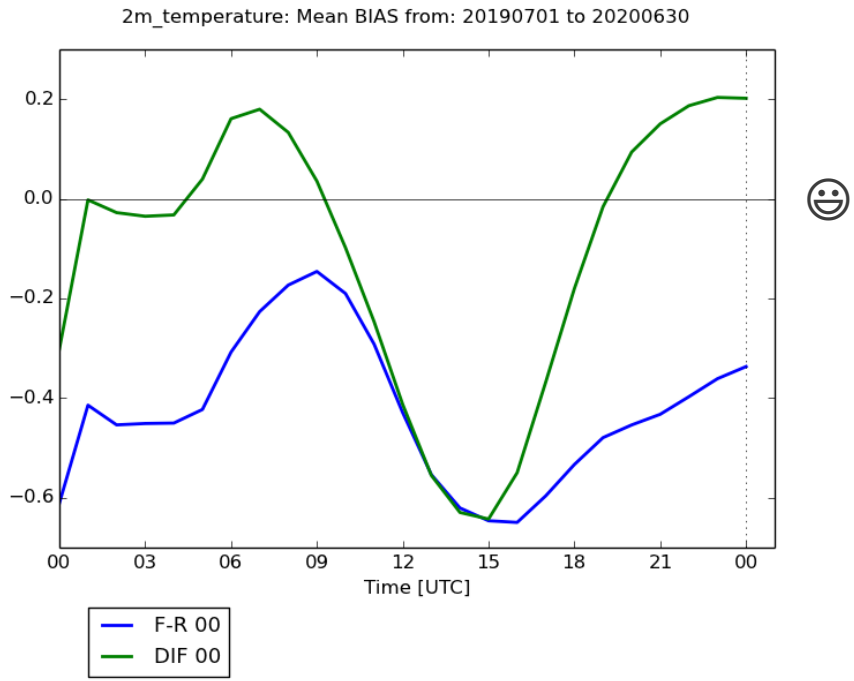
Further topics

Comparison of force-restore and diffusion soil scheme in CY43T2:

Needed to implement sEKF in operational mode

- No data assimilation at all, just basic AROME for 07/2018 – 06/2020
- validated against Austrian TAWES stations
- 3-L snow scheme is problematic





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The End

Thank you for your attention!

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