On the use of SURFEX as a new surface scheme for ALADIN/ALARO

Hamdi R.

28th March 2013

Surfex working week 24-28 September 2012

ALADIN partners from Austria, Belgium, Morocco, Poland, Portugal, Tunisia, and Turkey participated to the SURFEX working week in Brussels 24-28 September 2012.

- **Group 1: Initialization with PREP/FullPos.**
- **Group 2: Testing of the local, national applications.**
- **Group 3: Consideration of the interface with the ALARO upper air physics.**

IRM

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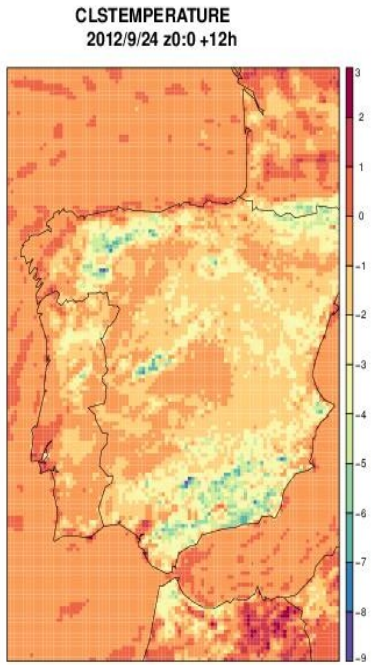
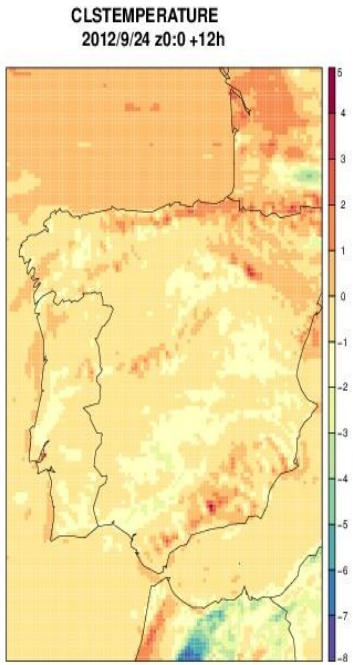
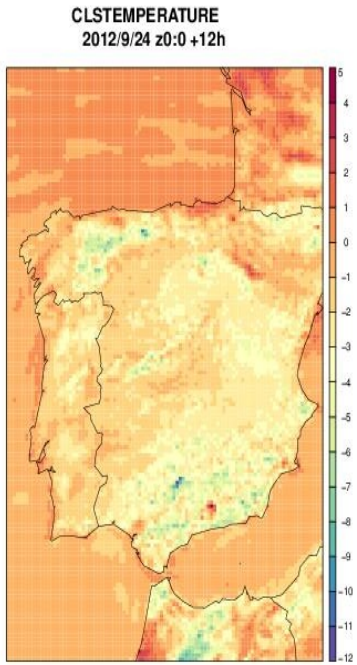
2m Temperature Portuguese domain







ALR – ALR.SFX

OPER – ALR

OPER – ALR.SFX

2m Temperature Moroccan domain: use of CANOPY

La première remarque est l'apport positif clair de SURFEX dans ALADIN pour la plupart des stations. Deuxième remarque concernant ALARO : remarquable surestimation de T2m et sous estimation de H2m pendant la période d'été pour les stations cotière avec un maximum de "difficulté" pour la station de layoune (cotière saharienne). c'est trops sec (manque d'apport d'humidité dans les basses couches).

NB : Reste à voir si SURFEX peut redresser la situation pour ALARO surtout pour les stations cotières. En effet, ALARO avec SURFEX plantait sur le calculateur à casa, l'application des modifications de Laslo (fournis par Rafiq) ont permis de résoudre le problème. Les expériences sont désormais tourné sur le calculateur à casa, il faut juste calculer les scores (difficulté dans le rapatriement des fichiers historiques).

Poland domain: use of TEB

To analyze influence of TEB parameterization on weather forecast over greatest urban areas of Poland: Industrial Region of Higher Silesia and Warsaw.

what is already done - for adopted configuration (grid 320x320x60, resolution 7.4km) clim files and pgd file are prepared/gathered, namelists and scripts are prepared and tested, computation of 36-hour forecasts for January and July 2012 are launched.

encountered problem - too strong winds for at least one case, detailed check necessary.

Surfex special issue Geophysical Model Development Journal

Integrating SURFEX in a wide range of national applications: performance within operational weather prediction models. Hamdi et al., GMD 2013, in preparation

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Working on the interface: SURFEX <-> ALARO + TOUCANS

- ALARO with very high resolution (~2km) requires new sophisticated turbulence/shallow convection scheme TOUCANS.
- TOUCANS calculates also third order moment terms (TOM), which interact strongly with surface fluxes (from SURFEX/ISBA), but since surface should stay externalised (Best et al.) → conflict
- Linking of the two schemes is needed without dramatic increase of complexity and numerical costs but keeping consistency

Working on the interface: SURFEX <-> ALARO + TOUCANS

- When increasing the horizontal resolution, it was found quite important to pay special attention to the way turbulence is triggered between the surface and lower model layer.
- Use tiling of the surface scheme in the turbulence scheme: some fraction of rough surfaces (urban areas) might start important turbulent behavior which would be escalated in the consecutive vertical developement.
- Either do multiple solving for each tile (expensive) or **to have an average lower boundary condition for a single solving**.

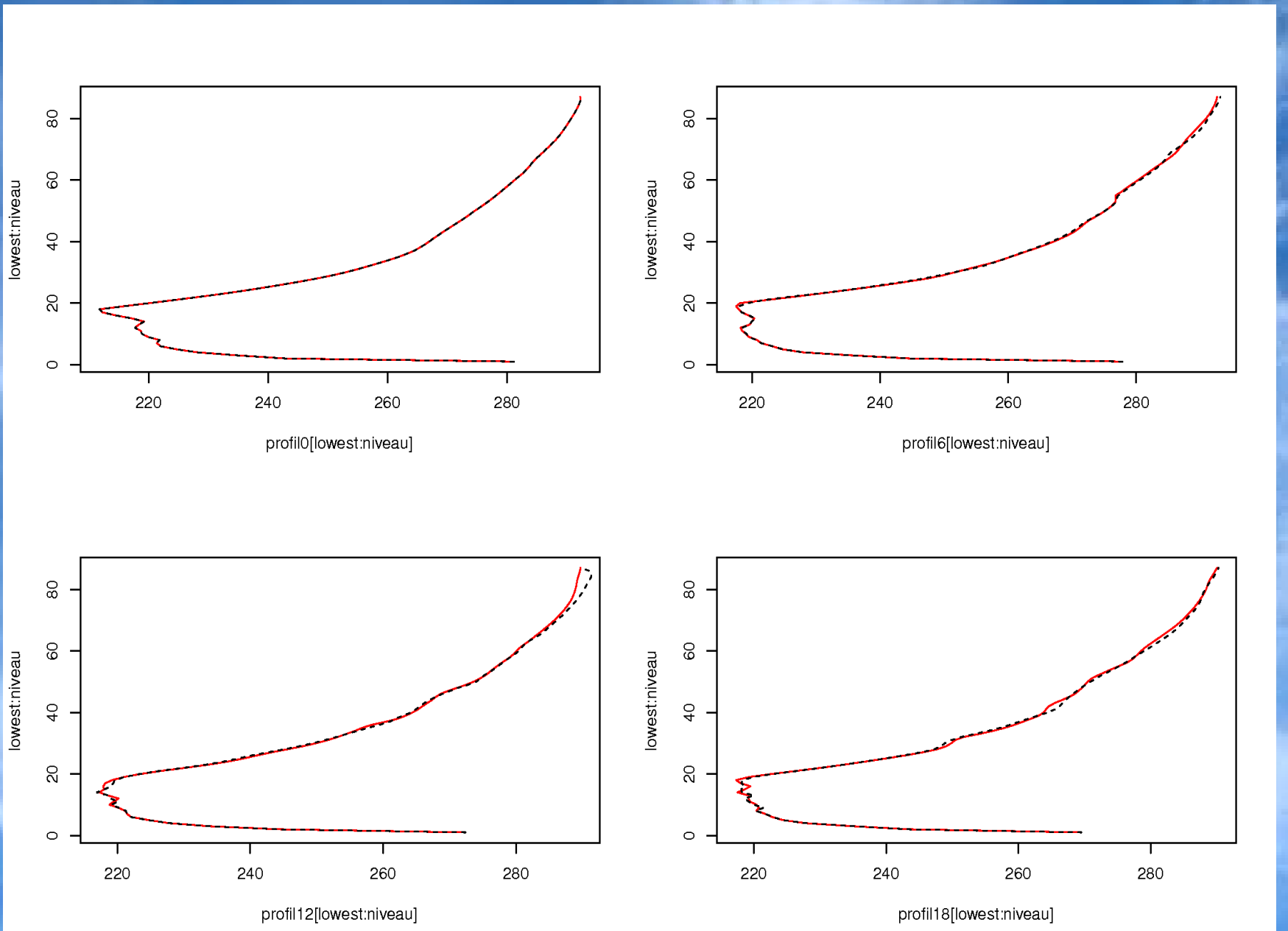
Working on the interface: SURFEX <-> ALARO + TOUCANS

- Solution 1: take the average neutral drag coefficient from SURFEX: PCDN (momentum) and then calculate the PCDNH (thermal) using the stability function of TOUCANS (different from the one used in SURFEX). The stability functions of TOUCANS are valid at the surface and in the boundary layer. TOUCANS is very sensitive to this!

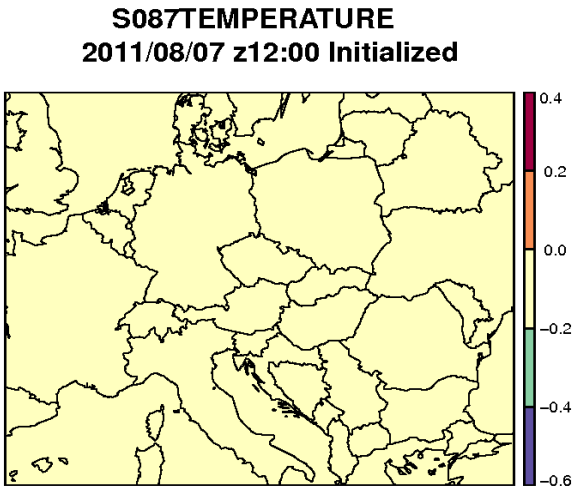
  Implemented and tested during my stay in Prague (10-21 dec. 2012) for SURFEX/ISBA but...

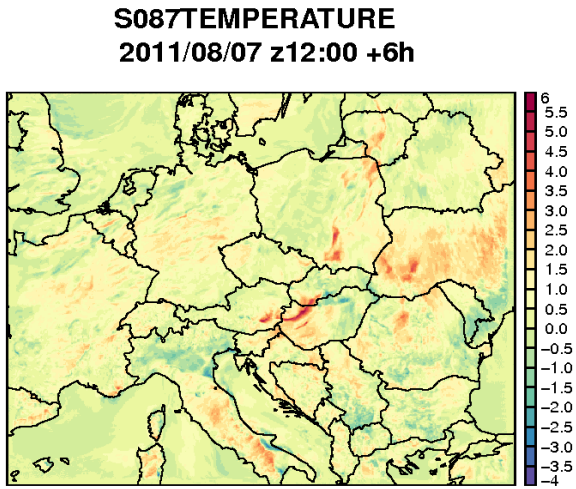
  What does mean an average neutral drag coefficient ?

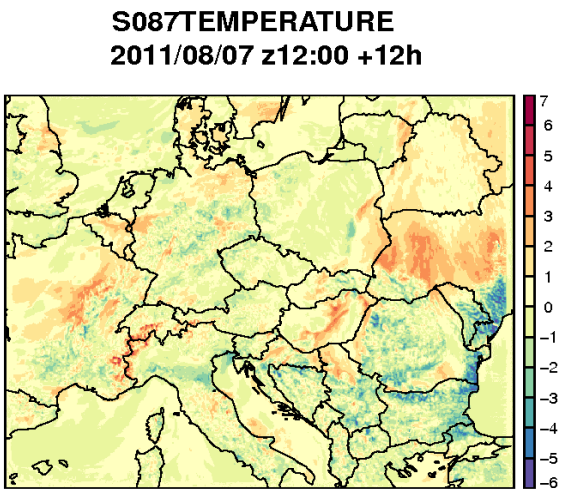
ALARO+TOUCANS+SURFEX: Prague 10–21 December 2012 Temperature profile

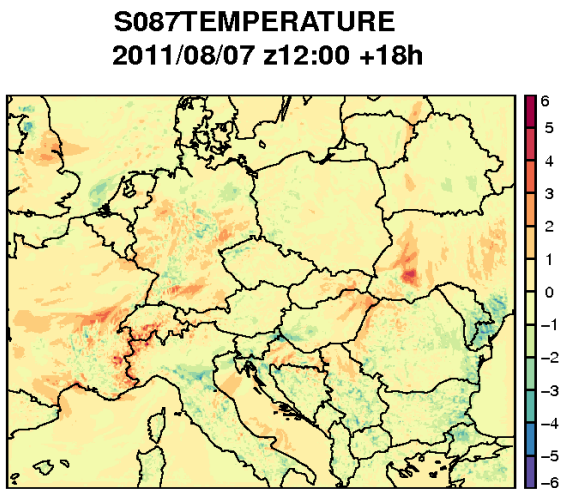


ALARO+TOUCANS+SURFEX:
Prague 10–21 December 2012
Temperature at the lowest alaro level









Working on the interface: SURFEX <-> ALARO + TOUCANS

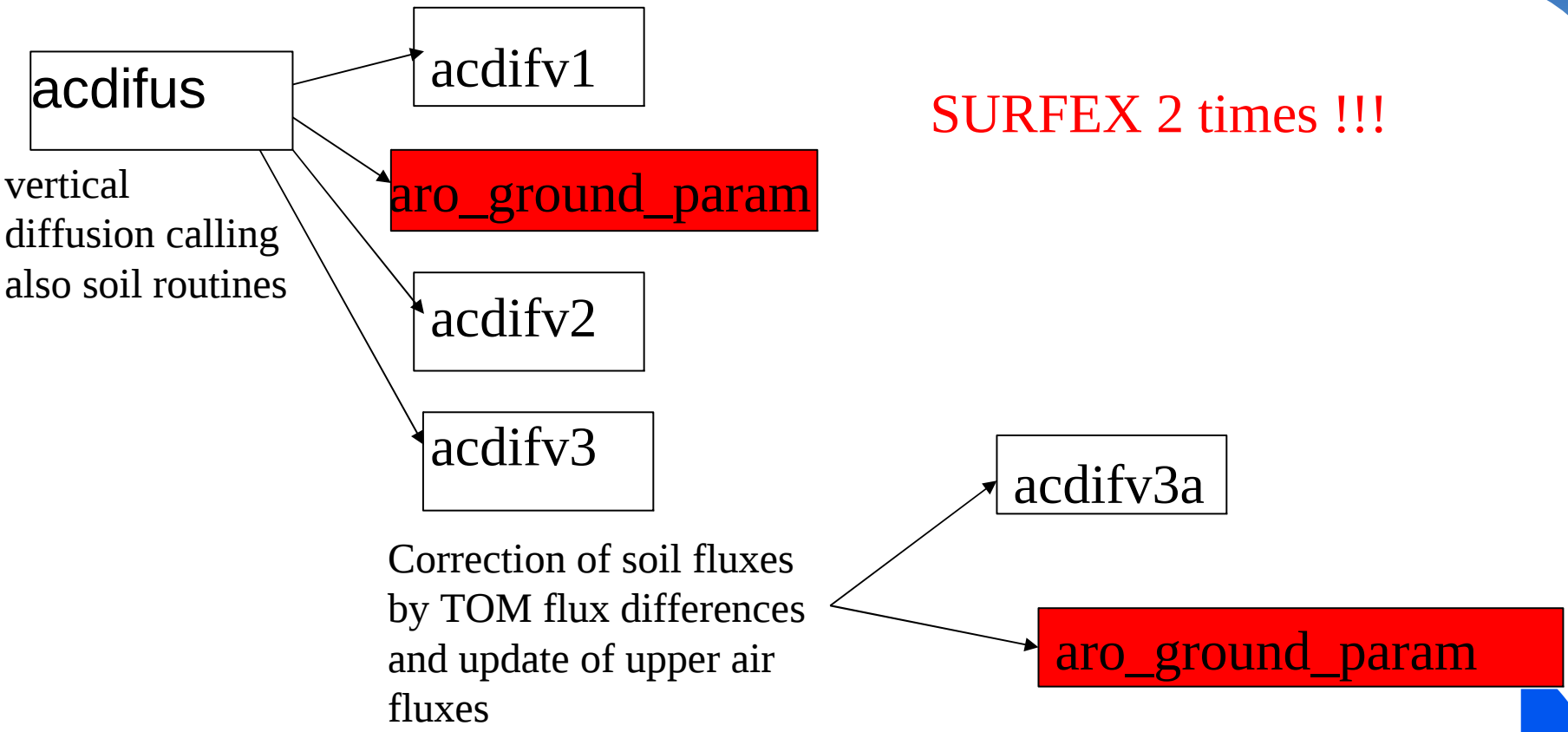
- Solution 2: Introduce the TOUCANS stability functions in SURFEX via the key LDRAG_COEF_ARP (drag.F90) and interface the averaged fluxes.

  Then calculate Cd=f(fluxes)

  Implemented but not yet tested...

- Incompatibility when switching on CANOPY ! Different turbulent scheme.

Working on the interface: SURFEX <-> ALARO + TOUCANS+TOM's correction



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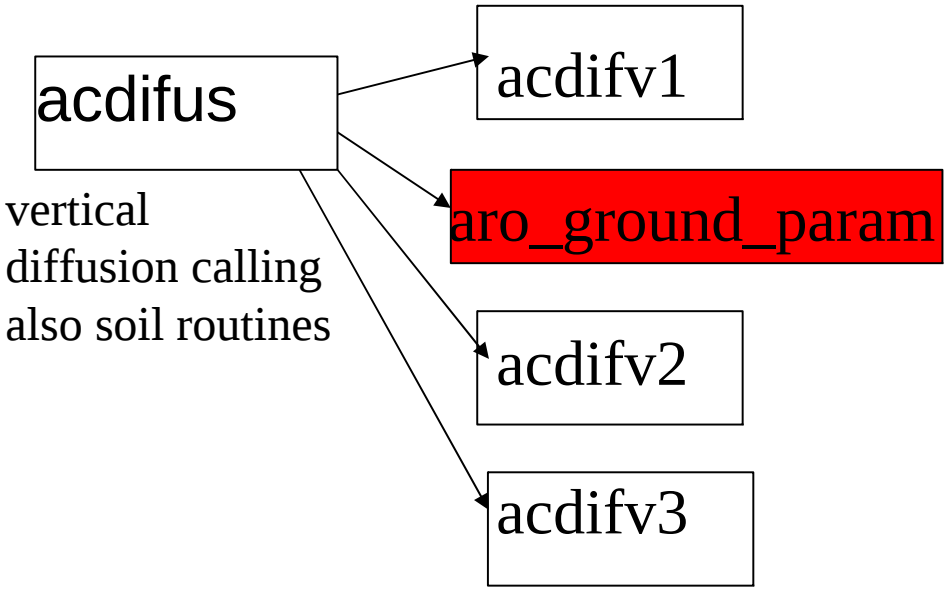
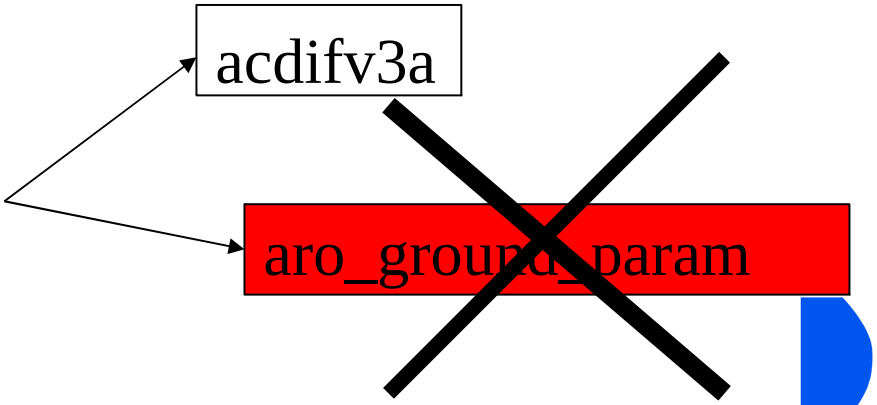


vertical diffusion calling also soil routines

SURFEX 1 time + storage of multiplicators for correction after TOMs

Correction of soil fluxes by TOM flux differences and update of upper air fluxes

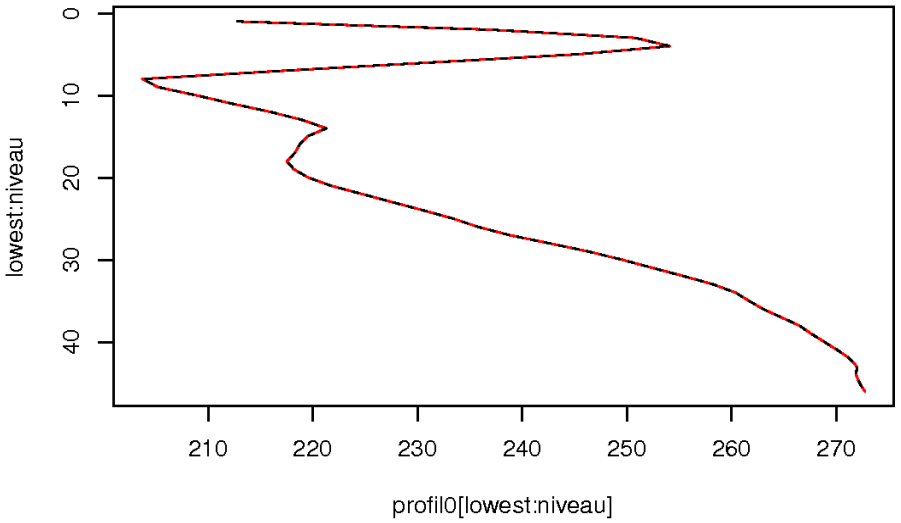


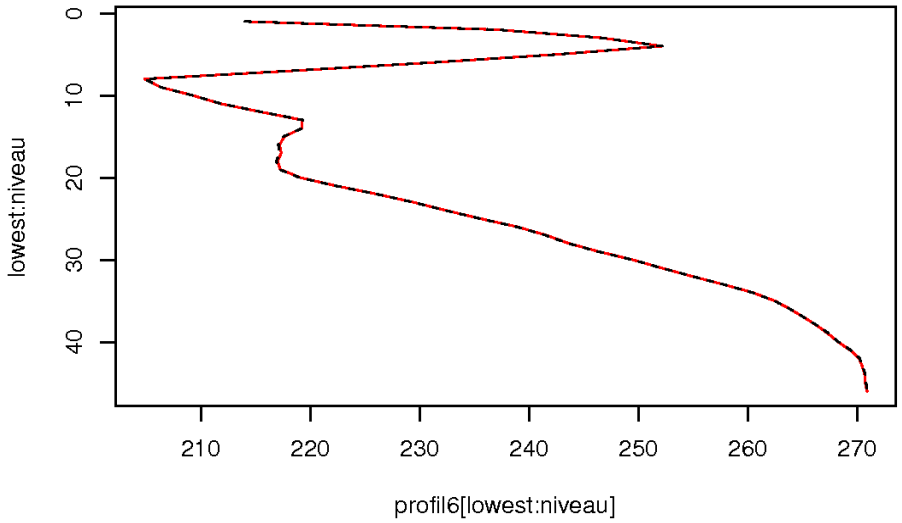
Working on the interface: SURFEX <-> ALARO + TOUCANS+TOM's

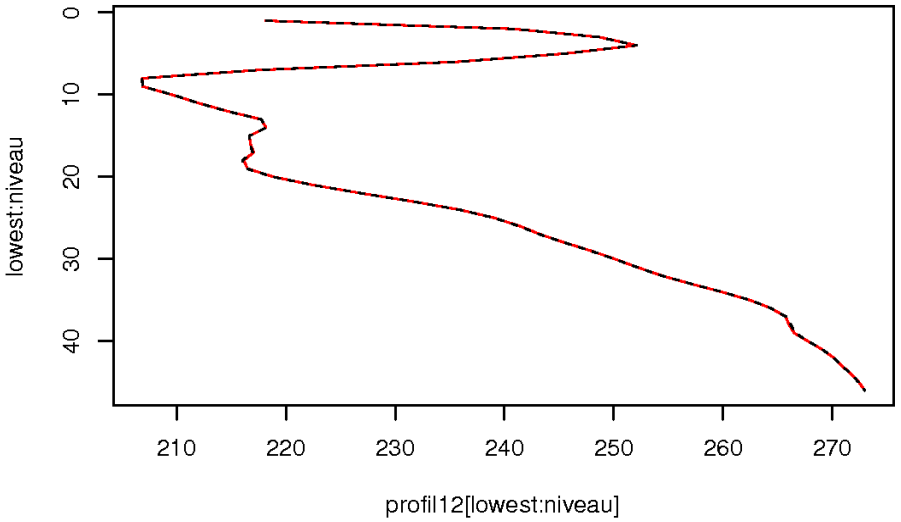
•Solution: Three argument are added to the routine **ARO_GROUND_DIAG.F90**: ZPCDN (neutral drag coefficient), ZPSNG (snow fraction at the ground), ZPFROZEN1 (fraction of frozen soil from isba only! For TEB, sea and water this is considered as 0.).

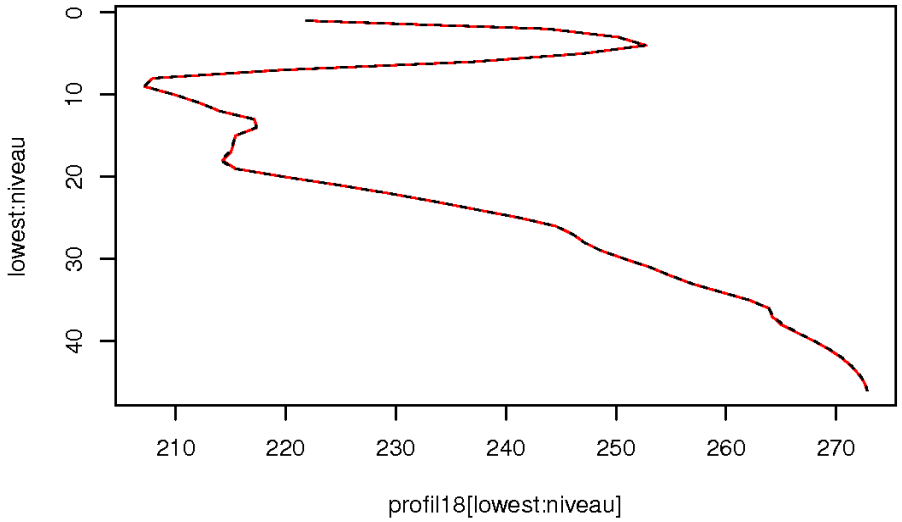
• The TOM's correction are added just after the call of ARO_GROUND_DIAG inside APLPAR.F90.

ALARO+TOUCANS+SURFEX: Prague 10–21 December 2012 Temperature Profile









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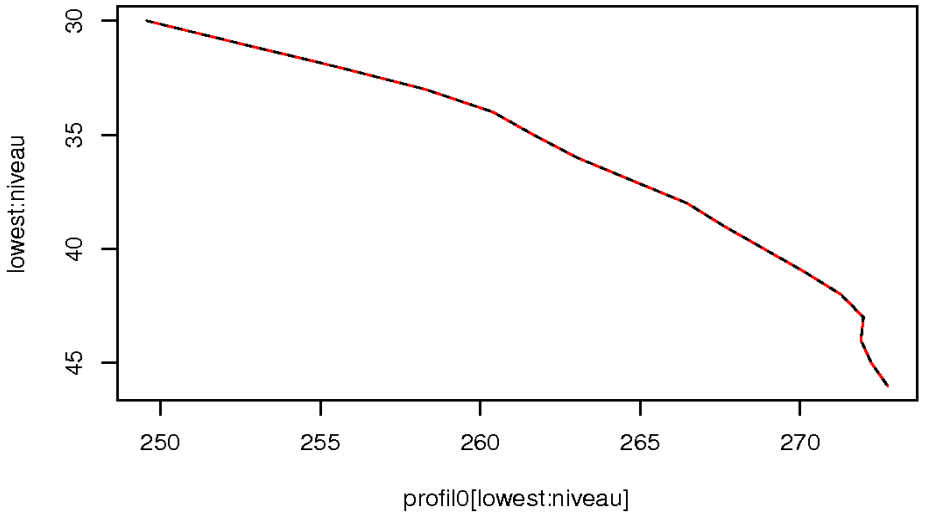

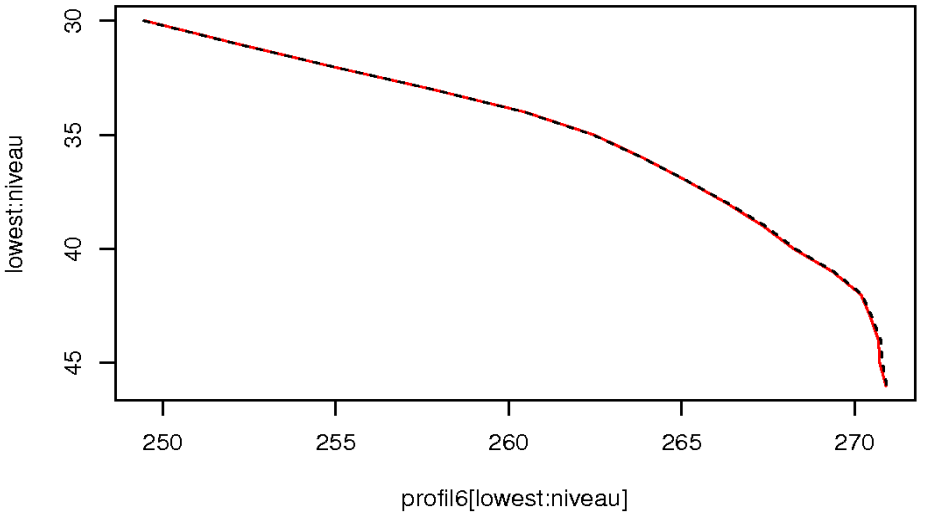

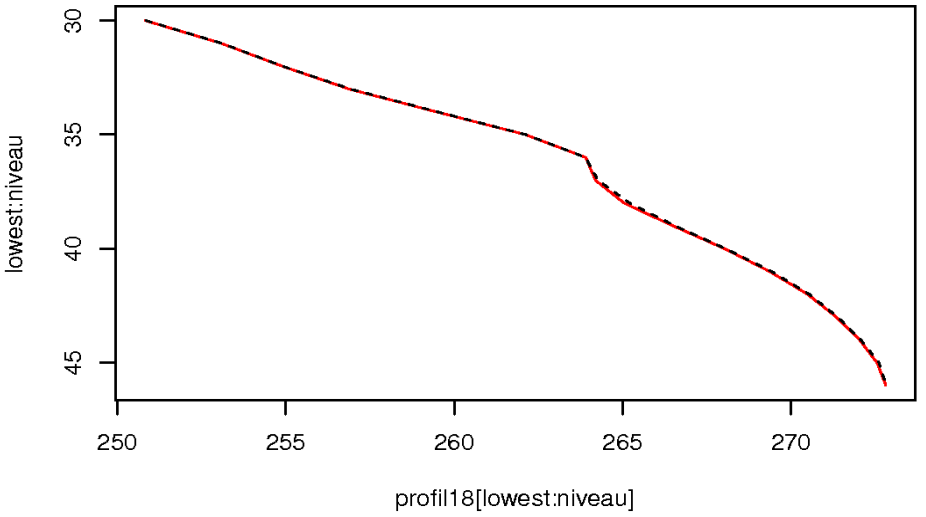

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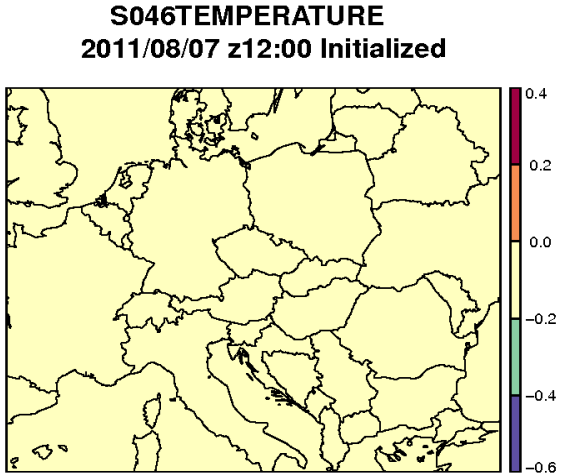

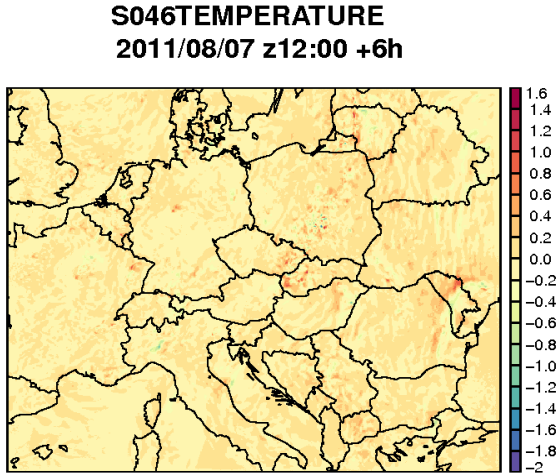

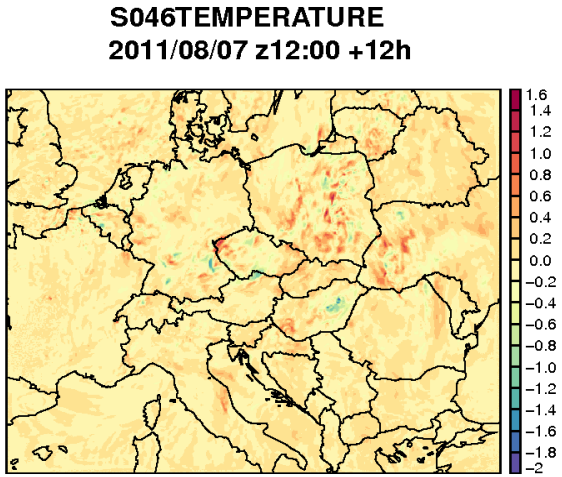

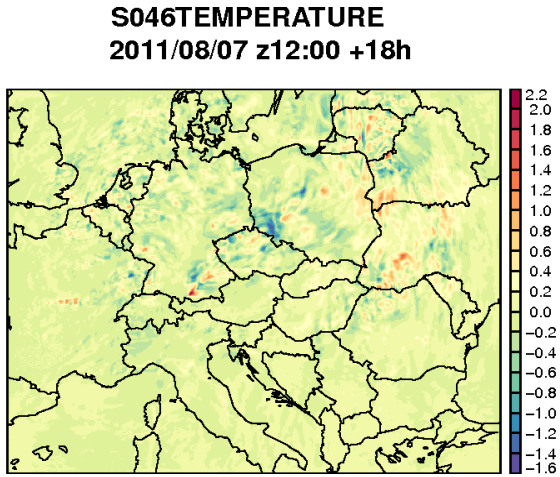

Replace Optimal Interpolation by the Extended Kalman Filter for the soil analysis

1. Development of a SURFEX EKF for ALARO and comparison of the offline and coupled version with the OI analysis.

2. Preliminary results on combining SURFEX EKF with 3dVar atmospheric assimilation.

3. A feasibility study of using a Short Time Augmented Extended Kalman Filter (STAEKF) for Soil Analysis.

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Replace Optimal Interpolation by the Extended Kalman Filter for the soil analysis

- Implementation of offline and coupled SURFEX EKF for ALADIN
- Comparison between offline and coupled EKF: jacobians, gain, increments
- Comparison of forecast scores of EKF, OI and runs without assimilation

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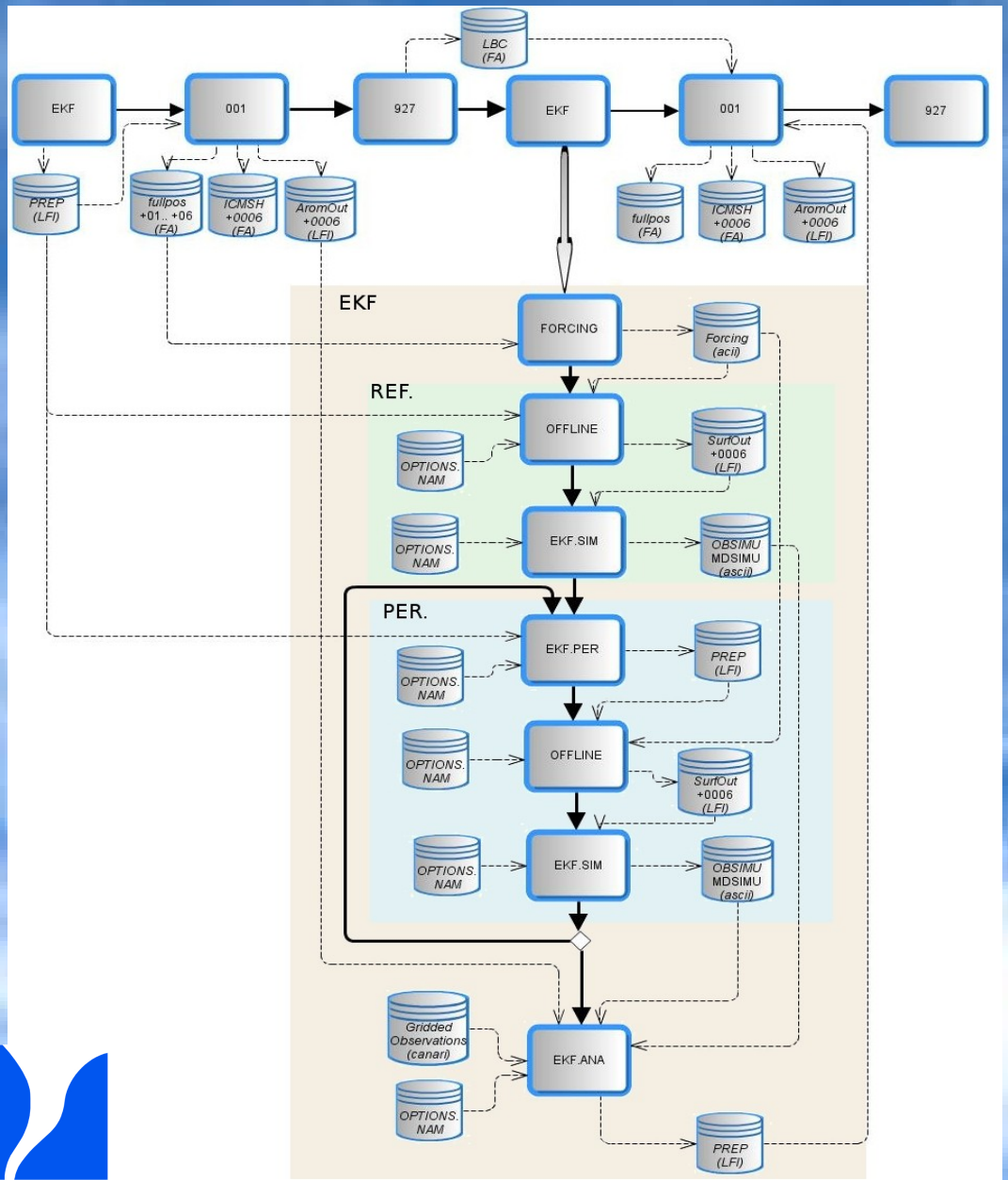

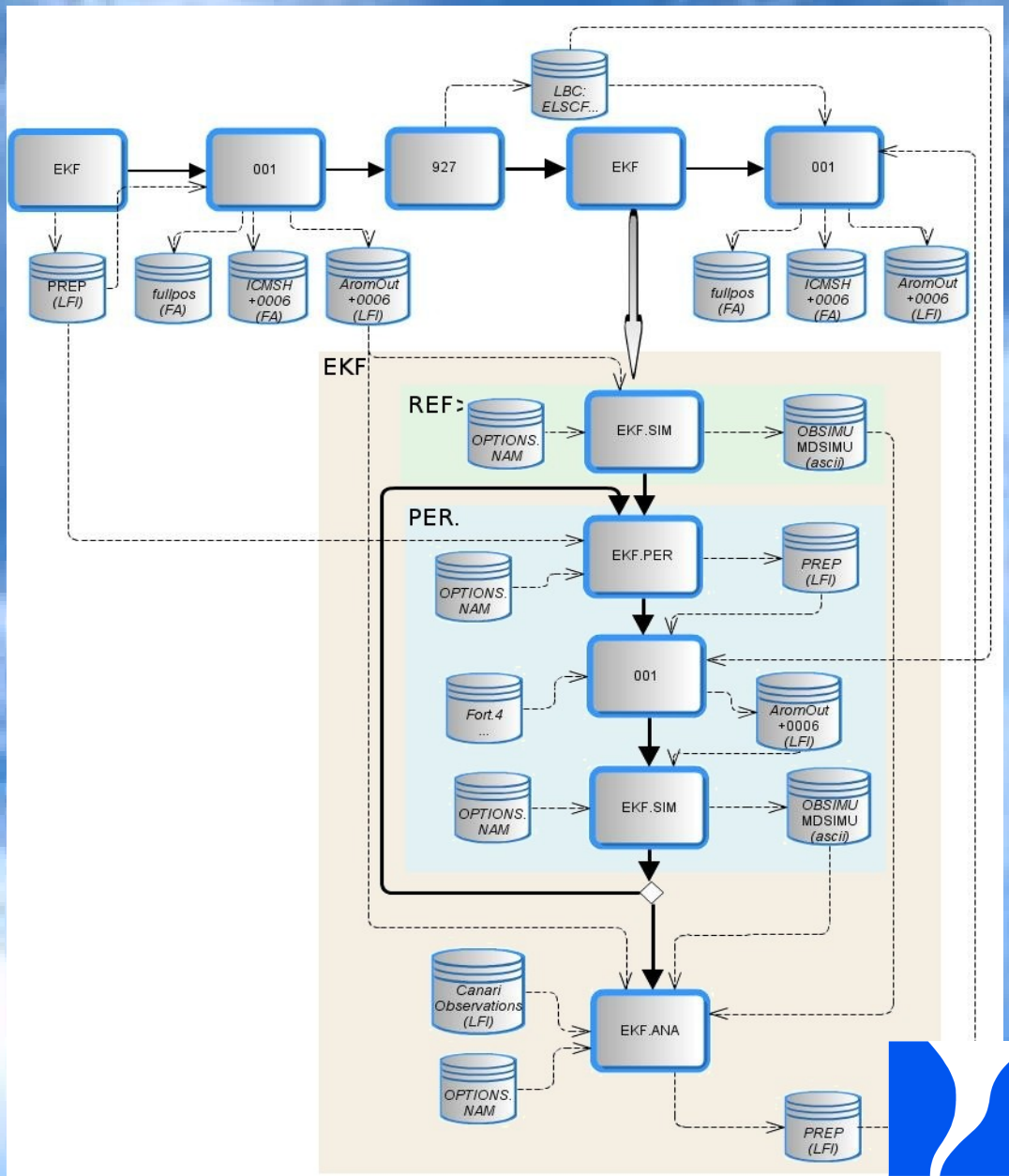

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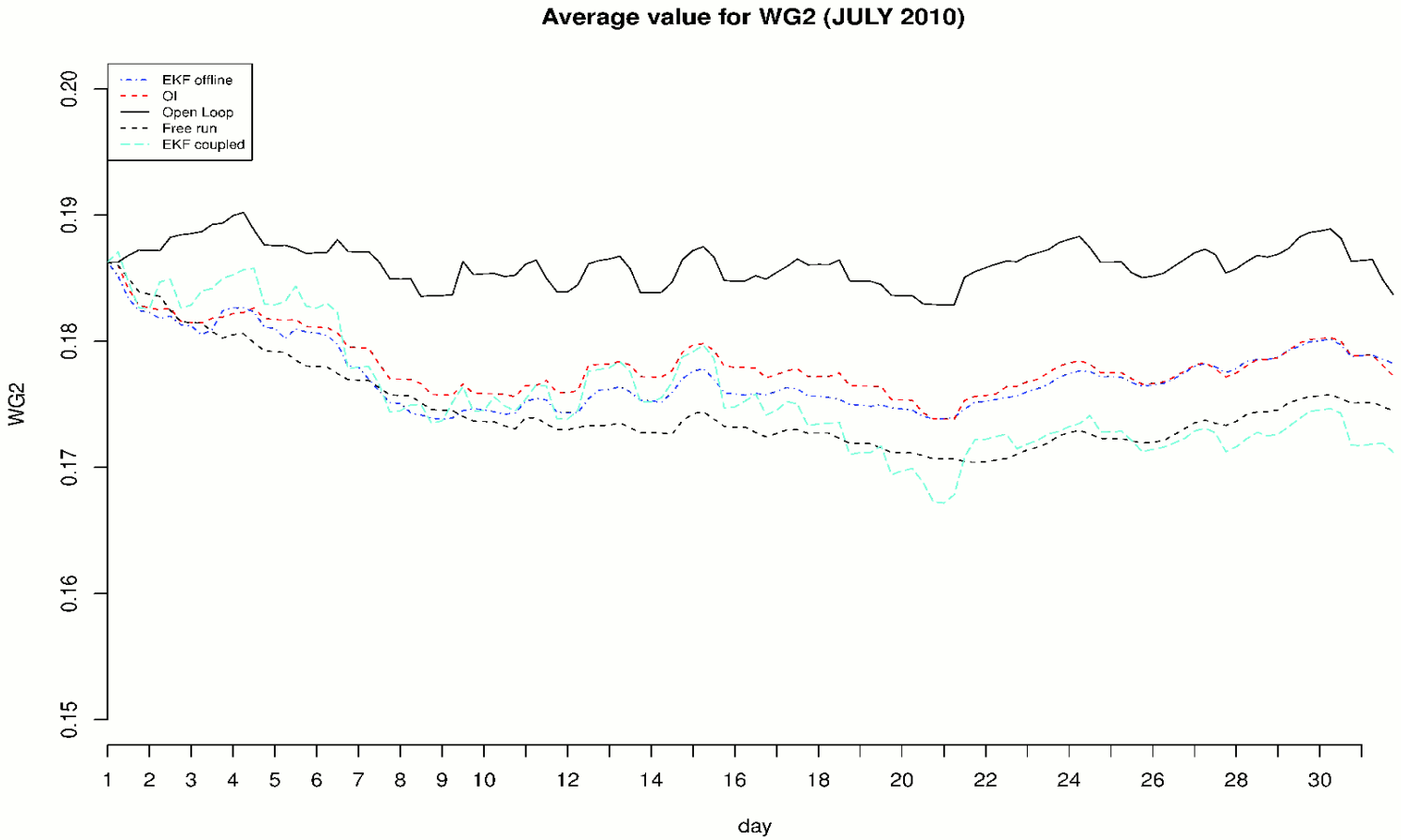

Figure 32: Evolution of the WG2 values averaged over the domain for July 2010

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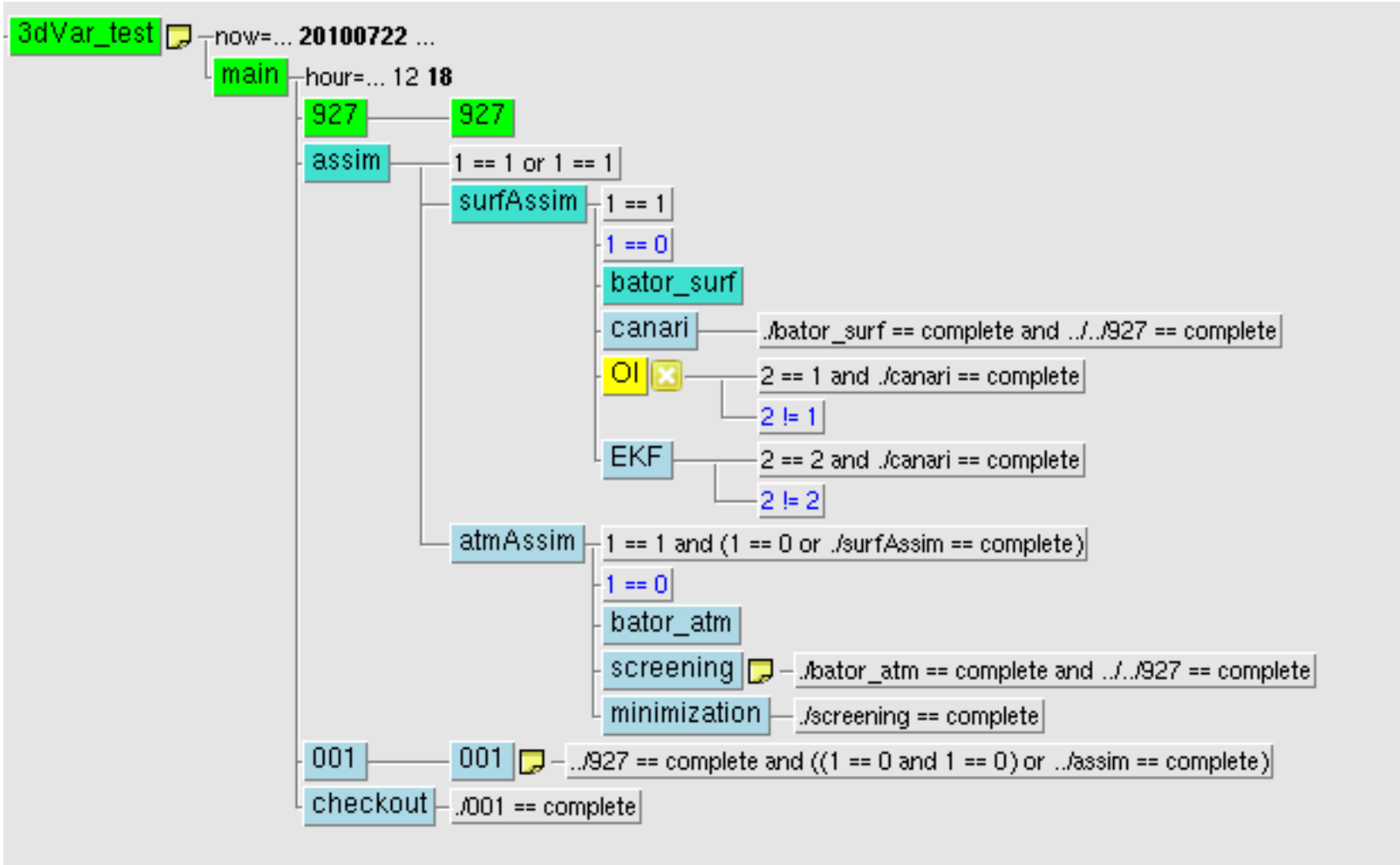

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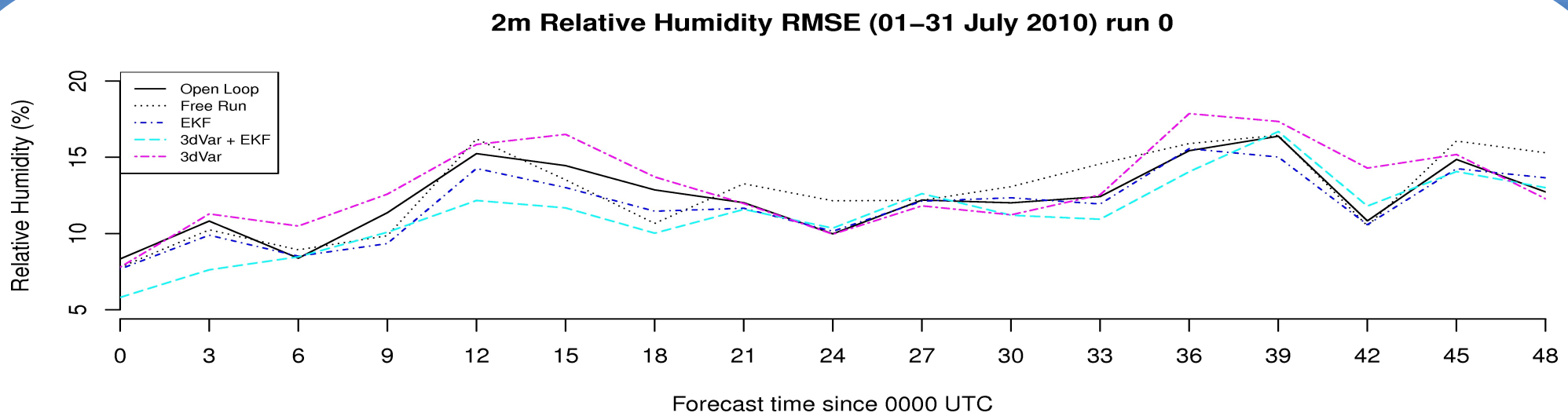

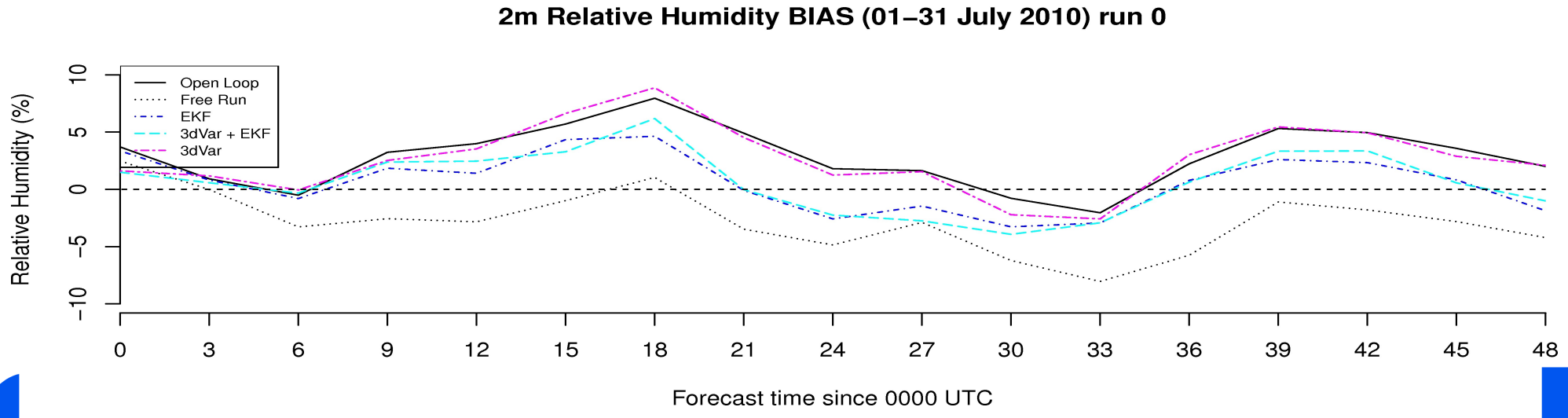

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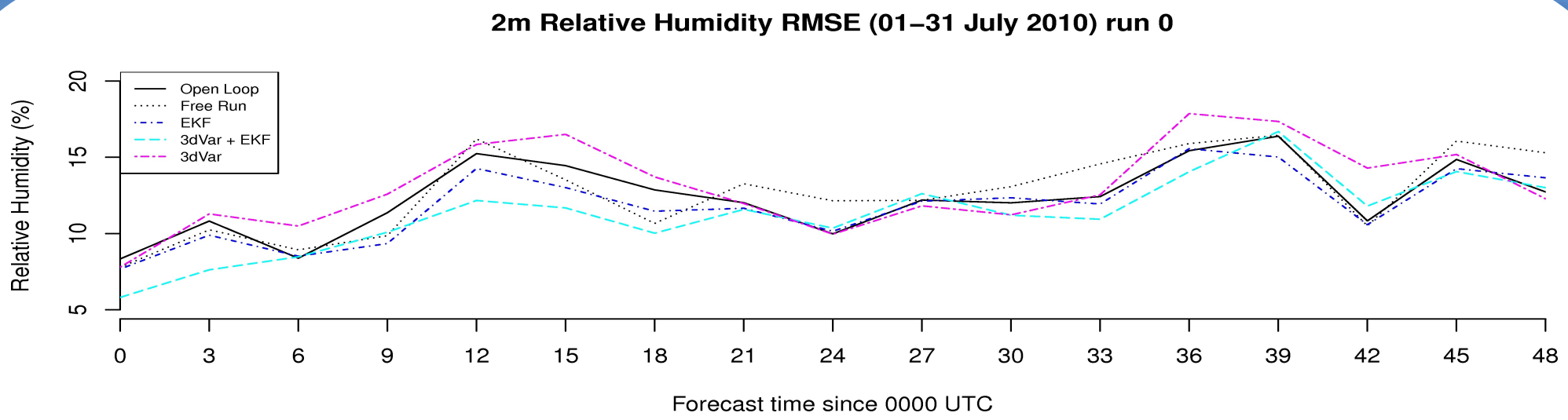

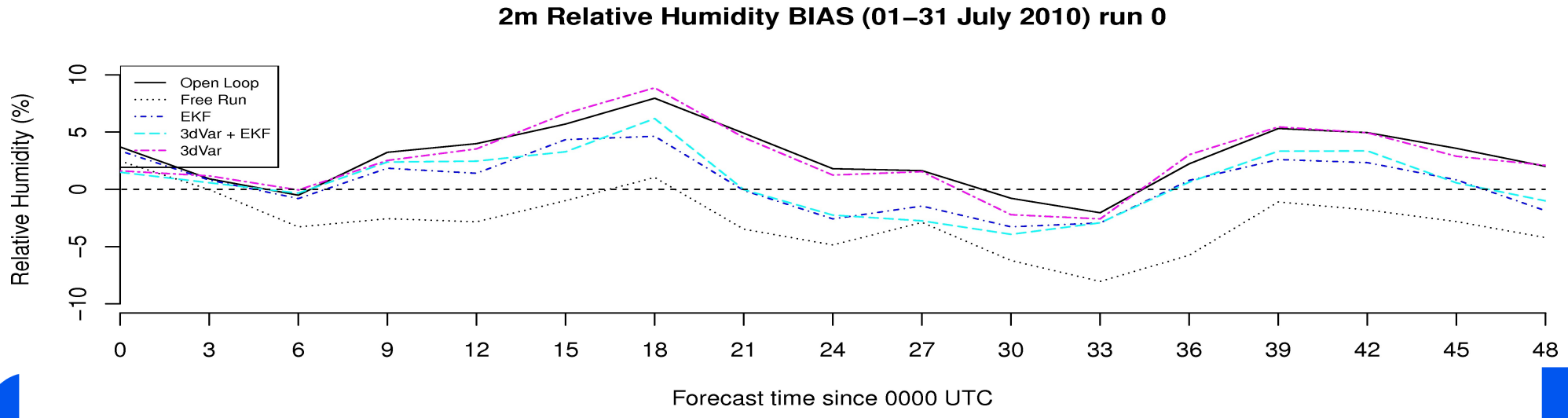

Test of the STAEKF for the soil analysis

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Test of the STAEKF for the soil analysis

- **Recently, Carrassi and Vannitsem (2011, QJRMS) introduced an alternative formulation of the EKF where the uncertain model parameters are estimated along with the system state variables.**

- **The algorithm, Short Time Augmented Extended Kalman Filter (STAEKF), uses a deterministic formulation for the model error dynamics (Nicolis, 2003, JAS).**

- **The same formulation has been used for the treatement of the error arising from the unresolved scales (Carrassi and Vannitsem, 2011, IJBC) and in the context of variational assimilation (Carrassi and Vannitsem, 2010, MWR).**

- **We undertake here a set of numerical twin experiments designed to test the STAEKF in estimating three land surface parameters: LAI, the albedo, and the minimum stomatal resistance RSmin.**

- **Assimilation of 2m temperature and relative humidity using an offline version of ISBA.**

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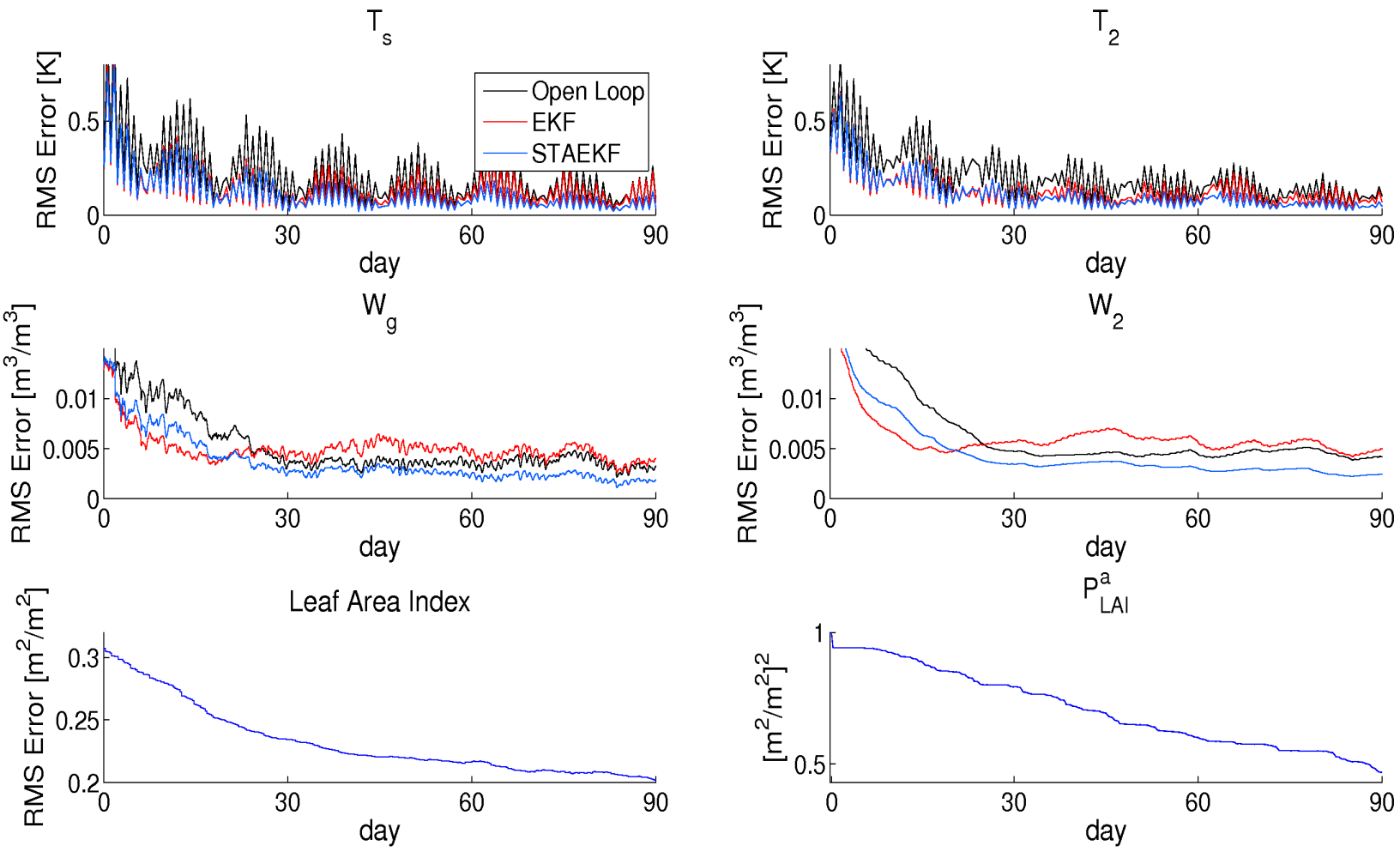

- **Integrating SURFEX in a wide range of national applications: performance within operational weather prediction models. Hamdi et al., GMD 2013, in preparation**

- **Continue the work of the interface with TOUCANS: a stay is planned in Prague this year.**

- **Continuing the evaluation of the STAEKF with data from the Cabauw tower.**

- **Introducing the STAEKF within the SODA system and test it with 3-D VAR ALARO.**

- **A scientific paper about the coupling 3DVAR + EKF for ALADIN is in preparation (PhD of Annelies).**