SURFEX as a new land surface scheme for ALADIN partners

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1. Land surface modeling
2. Surface data assimilation

Strategy workshop, Toulouse, 26th April 2016

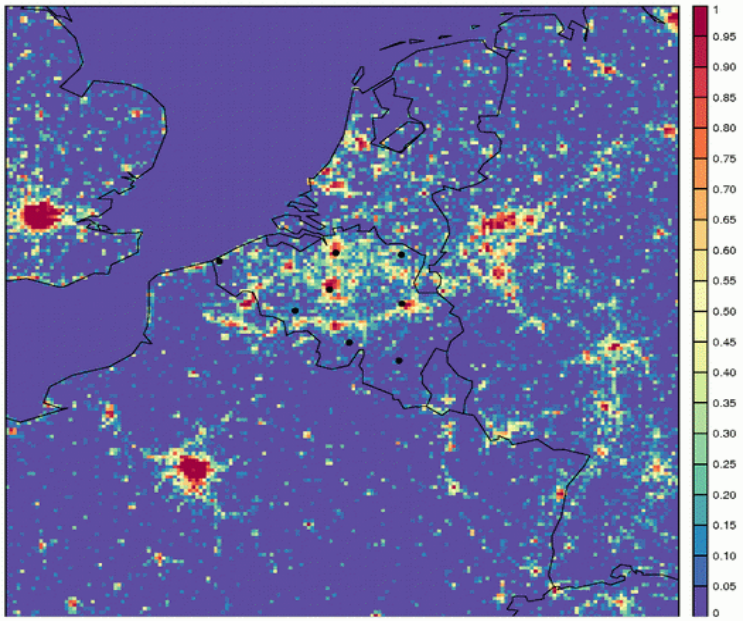
Kilometric resolution...what about the surface ?

- Increasing computational power allows operational NWP to be run at kilometric resolution using improved upper air parametrization (e.g. 3MT within the ALARO physics package).

- Example from the Belgian operational domain: A version of ALARO-0 at ~4km resolution has been in use operationally since 2009. However, this results in more grid that are 100 % urban.

This can not be computed by the old ISBA scheme of ALARO-0

----> Move to SURFEX/TEB



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

Coupling the Town Energy Balance (TEB) Scheme to an Operational Limited-Area NWP Model: Evaluation for a Highly Urbanized Area in Belgium

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ABSTRACT

The Town Energy Balance (TEB) single-layer scheme is implemented in a numerical weather prediction model running operationally at ~4-km resolution. The primary question addressed is the ability of TEB to function at this relatively coarse resolution and, thus, assessing its potential use in an operational configuration to improve sensible weather performance over Belgium. For this effort, simulations with and without TEB are first evaluated against 2-m observations and wind above the urban canopy for two months (January and July 2010). The results show that promising improvements are achieved by introducing TEB. The 2-m temperature and 2-m relative humidity improve compared to measurements in urban areas. The comparison of wind speed and wind direction above the urban canopy indicates that the structure of the flow in urban areas is better reproduced with TEB. It was found that the implementation of TEB results in an increase in winter precipitation over urban areas and downwind from urban areas, but during the summer TEB tended to cause rainfall to be locally concentrated and the total accumulated precipitation decreased obviously. Results from a 36-h case study during a high heat day with inland sea-breeze penetration (8 July 2010) indicate that the model satisfactorily captured the penetration of the sea breeze. In particular during the day, the TEB run shows a delay in the sea-breeze evolution compared to the operational run. During the night the results indicate that even at this coarse resolution, TEB is able to correctly reproduce the intensity of the observed urban heat island (UHI) of Brussels.

1. Introduction

Nowadays, increasing computational power allows operational numerical weather prediction (NWP) to be run at higher spatial resolution. The inner nests of these models are generally run with a typical horizontal resolution of 2–10 km, enabling them to capture and simulate many of the mesoscale atmospheric systems of interest such as sea breezes, valley flow effects, and even deep convective systems. This leads to 2.5-km resolution simulations from the Application of Research to Operations at Mesoscale convective-scale operational model (AROME-France; Seity et al. 2011), which are similar to the results produced by other European projects such as the German version of the Consortium for Small-Scale Modeling model (COSMO-DE) at 2-8 km resolution (Seifert et al. 2008) and the Met Office's Unified Model at 4-km resolution (Davies et al. 2005). At the Royal Meteorological Institute of Belgium (RMIB), our framework, ALARO-0 (Gerard et al. 2009), is a version of the Action de Recherche Petite Echelle Grande Echelle–Aire Limitée Adaptation Dynamique Développement International (ARPEGE–ALADIN) operational limited area model (e.g., Horányi et al. 2006) with a revised and modular structure of the physical parameterizations. A specific approach is adopted, with an integrated sequential treatment of resolved condensation, deep convection, and microphysics together with the use of prognostic variables. This new version currently allows for the production of consistent and realistic results at resolutions ranging from a few tens of kilometers down to less than 4 km. A version at ~4-km resolution has been in use operationally at RMIB since 2009.

However, running NWP models at this high resolution results in more grid points than are needed to represent 100% of urban areas. Parameterizations that take into

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Geoscientific Model Development
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Evaluating the performance of SURFEXv5 as a new land surface scheme for the ALADINcy36 and ALARO-0 models

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Abstract. The newly developed land surface scheme SURFEX (SURFace EXternalisée) is implemented into a limited-area numerical weather prediction model running operationally in a number of countries of the ALADIN and HIRLAM consortia. The primary question addressed is the ability of SURFEX to be used as a new land surface scheme and thus assessing its potential use in an operational configuration instead of the original ISBA (Interactions between Soil, Biosphere, and Atmosphere) scheme. The results show that the introduction of SURFEX either shows improvement for or has a neutral impact on the 2 m temperature, 2 m relative humidity and 10 m wind. However, it seems that SURFEX has a tendency to produce higher maximum temperatures at high-elevation stations during winter daytime, which degrades the 2 m temperature scores. In addition, surface radiative and energy fluxes improve compared to observations from the Cabauw tower. The results also show that promising improvements with a demonstrated positive impact on the forecast performance are achieved by introducing the town energy balance (TEB) scheme. It was found that the use of SURFEX has a neutral impact on the precipitation scores. However, the implementation of TEB within SURFEX for a high-resolution run tends to cause rainfall to be locally concentrated, and the total accumulated precipitation obviously decreases during the summer. One of the novel features developed in SURFEX is the availability of a more advanced surface data assimilation using the extended Kalman filter. The results over Belgium show that the forecast scores are similar between the extended Kalman filter and the classical optimal interpolation scheme. Finally, concerning the vertical scores, the introduction of SURFEX either shows improvement for or has a neutral impact in the free atmosphere.

1 Introduction

Numerical weather prediction models need parameterizations of the surface processes to estimate the fluxes for physical budgets such as sensible heat, latent heat, momentum and radiation between the atmosphere and the surface features

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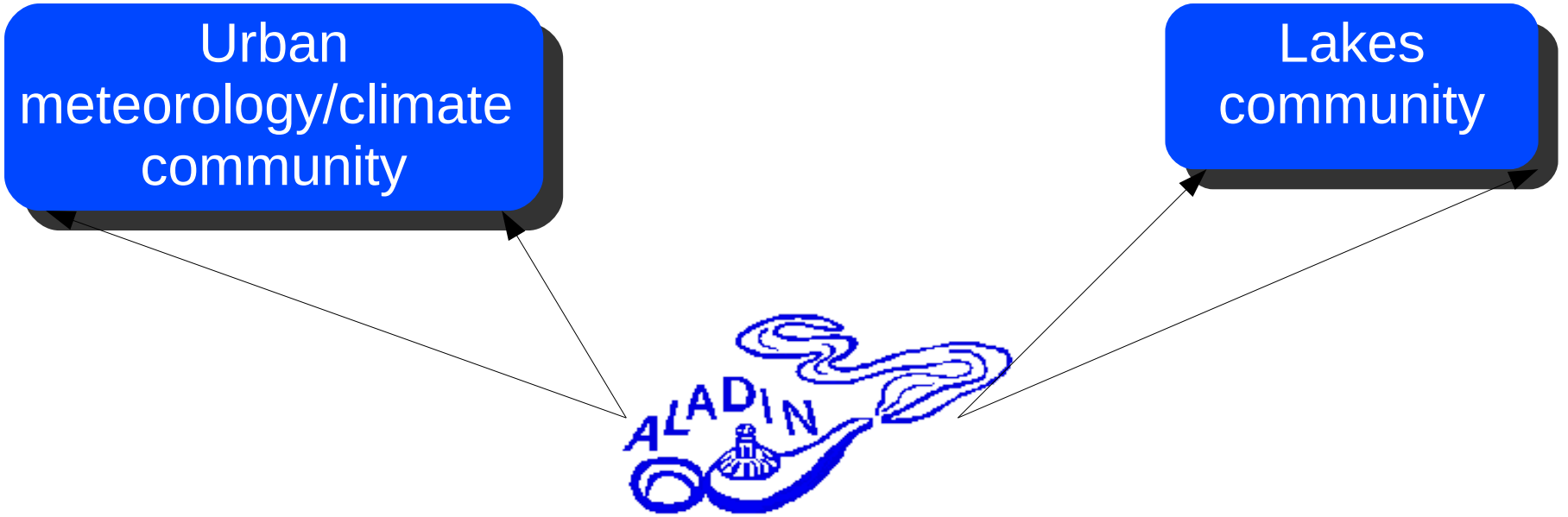
The use of SURFEX within the ALADIN partners...

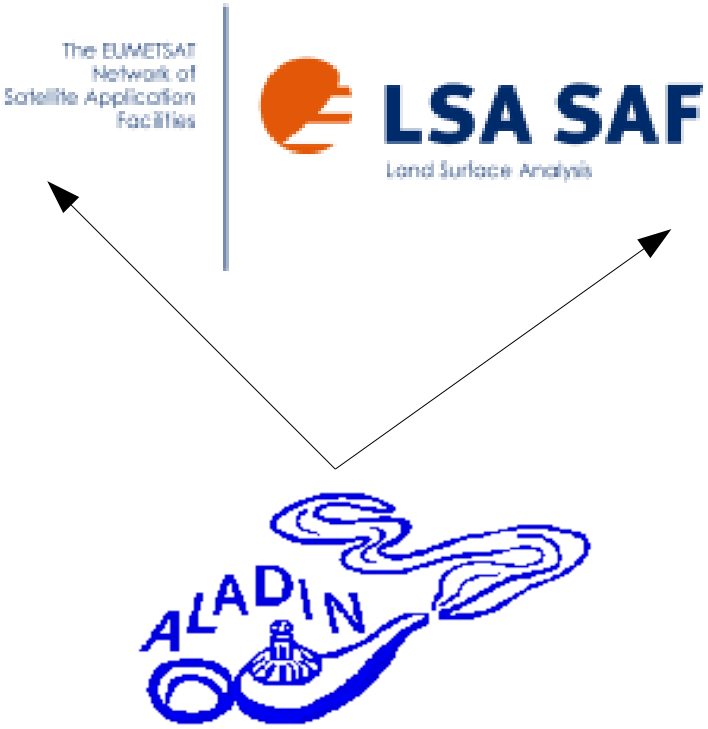


ECOCLIMAP 1km horizontal resolution but this could be improved using local higher resolution dataset from ALADIN partners

A new high resolution soil data will be available for Belgium (MASC, Belspo project)---> improve the ECOCLIMAP database

---> Another good opportunity to work together on the terrain and physiography database

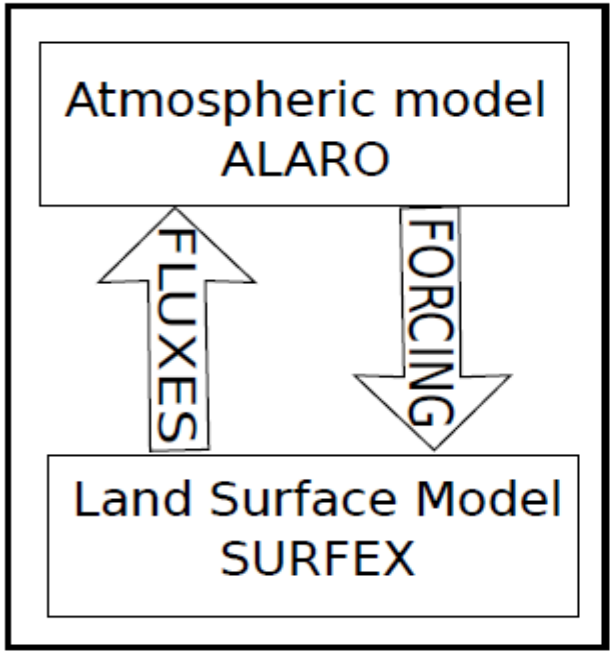
The use of SURFEX within the ALADIN partners...



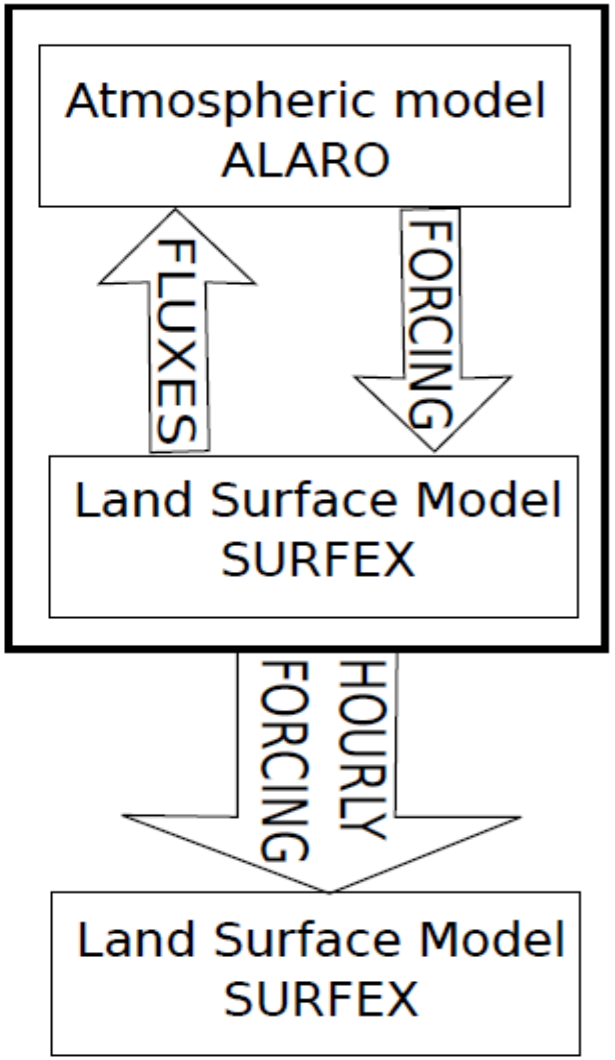
Replace the monthly value of ALBEDO, LAI,..etc with real or near-real-time product from SAF-LAD

Slevenia:
Cedilnik et al. Impact Assessment of Daily Satellite-Derived Surface Albedo in a Limited-Area NWP Model, JAMC, 2012

2. Surface offline data assimilation SODA



Coupled



Offline

- Replace the old OI by more sophisticated assimilation methods...

Extended Kalman Filter: EKF
- Mahfouf et al. (2009) first feasibility study over France
- PhD thesis of Annelies Duerinckx(2015) over Belgian operational domain
- Test over Austrian & Hungarian domain

Short Time Augmented Kalman Filter: STAEKF
- Carrasi et al. (2012) first feasability study
- Duerinckx (2015) 0-D test in Cabauw with very encouraging results

Ensemble Kalman Filter: EnKF
- see presentation of Patrick Samuelsson

- Use of more observations

Precipitations observations (rain gauges, radars) :

+ direct link with the variations of soil water content

Satellite observations:

+ global coverage

+ infrared: clear sky, low vegetation, geostationary satellites : high temporal and spatial resolutions (energy budget), strong sensitivity to low level wind, surface roughness

+ microwave: active and passive instruments measure directly the soil moisture in the first few centimeters (scatterometer (ERS,ASCAT), passive or active radiometers (SMOS, AMSR): resolution ~20/40km, frequency ~0.3/1 per day

- Land SAF product as forcing for SURFEX offline runs...

From the last ALADIN-HIRLAM meeting in Lisbon...

1. Establish a surface community

2. Start collaboration with the offline surface community...
   hydrological applications,
   roads conditions applications,
   Urban applications

3. Start regular meeting either side meeting or dedicated meeting