Wind forecast quality – impact of surface roughness

LACE stay report

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1. Introduction

The general motivation for this work are the observations and comments made by some forecasters that the wind fields in the model output (be it ALARO at 5km or AROME at 2.5km) “seem unreal”. To be more elaborate: in general, the wind in the model is according to them too weak in the valleys and too strong over the ridges, which is according to their findings not true for some comparable models (in particular COSMO).

The vague description from the previous paragraph covers a broad spectrum of possible subjects and points for investigation. It was therefore decided that the two weeks stay would be limited to analysis of the difference in physiography fields and seeing possible effect of changing those on the forecast. The inspiration for this was a talk by Martina Tudor on ALADIN/HIRLAM workshop in Lisbon in April 2016.

Furthermore, time permitting, the implementation of DADA (dynamical adaptation for wind) as it is operationalized in Ljubljana would be performed and tested at ZAMG.

2. Roughness length fields comparison

Following Martina Tudor´s example with roughness length on a domain with 8km resolution (shown in her talk at Lisbon workshop), the same was plotted for 5km Austrian ALARO domain, the operational Austrian AROME at 2.5km, the 1.2km RUC domain and also for the old Austrian ALADIN 10 km domain – see Figure 1. The chequered flag pattern shown by Martina is visible particularly on images for resolutions of 5km and 2.5 km, whilst the 10km field seems much more physical. At 1.2km resolution, however, the field seems completely unrealistic. A chickenpox pattern emerges – the field becomes very sharp and uneven with steep gradients. This leads us to believe that this is likely a sampling problem.

On the other hand, the SURFEX roughness length fields seem more meaningful and physical (see Figure 2), except that it is in general lower. It was therefore more or less logical to try to replace the roughness length in FA climate files with the ones coming from the SURFEX world and see what happens. Of course this is particularly important for ALARO since it is not using SURFEX and hence is more prone to the unrealistic representation shown in Figure 1.

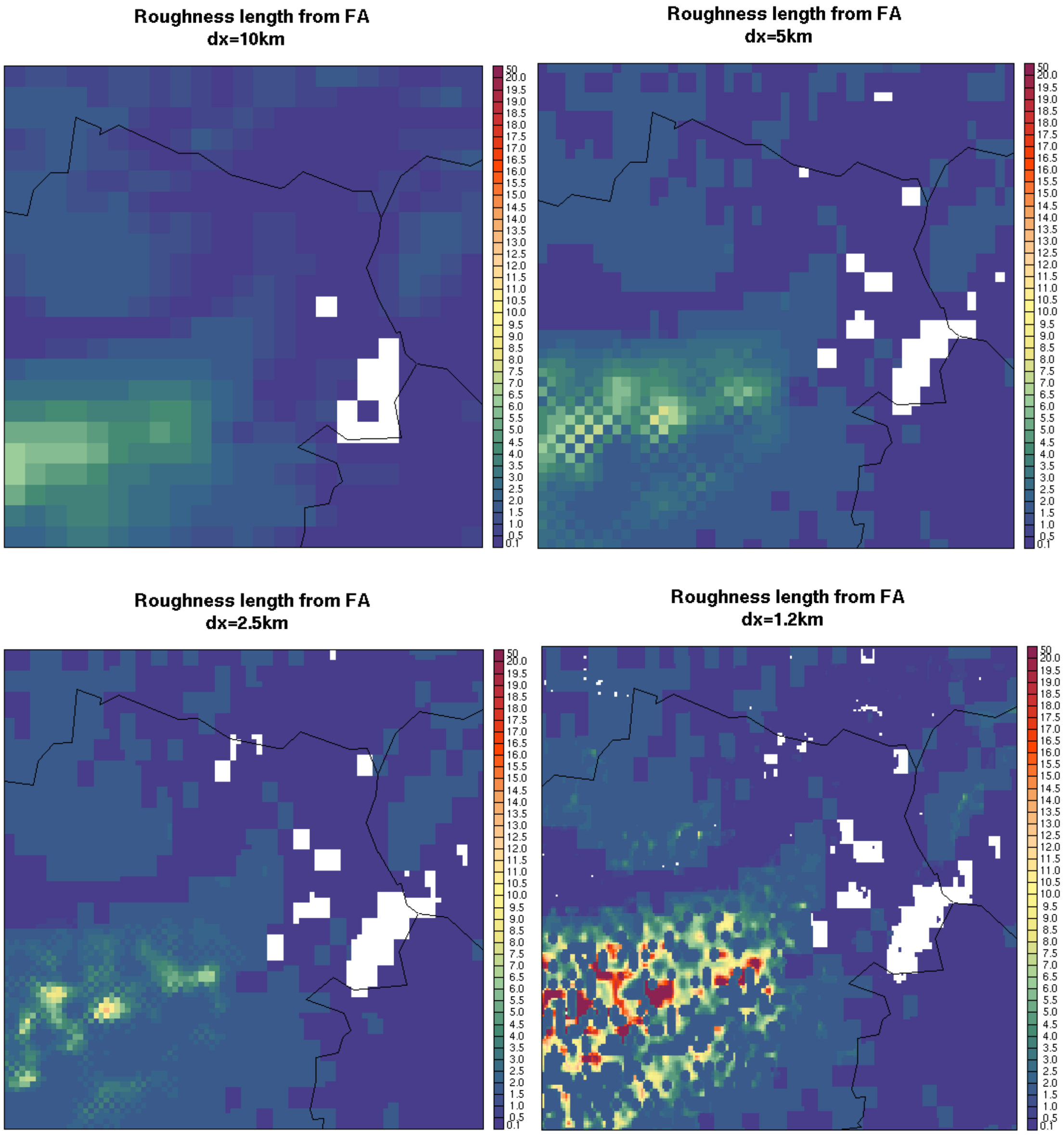

Figure 1: Roughness length from FA climate files at various resolutions. The zoomed in section is NE part of Austria – the white spot to the right in each image is the Neusiedler See. Note that the color scheme is the same for all four images.

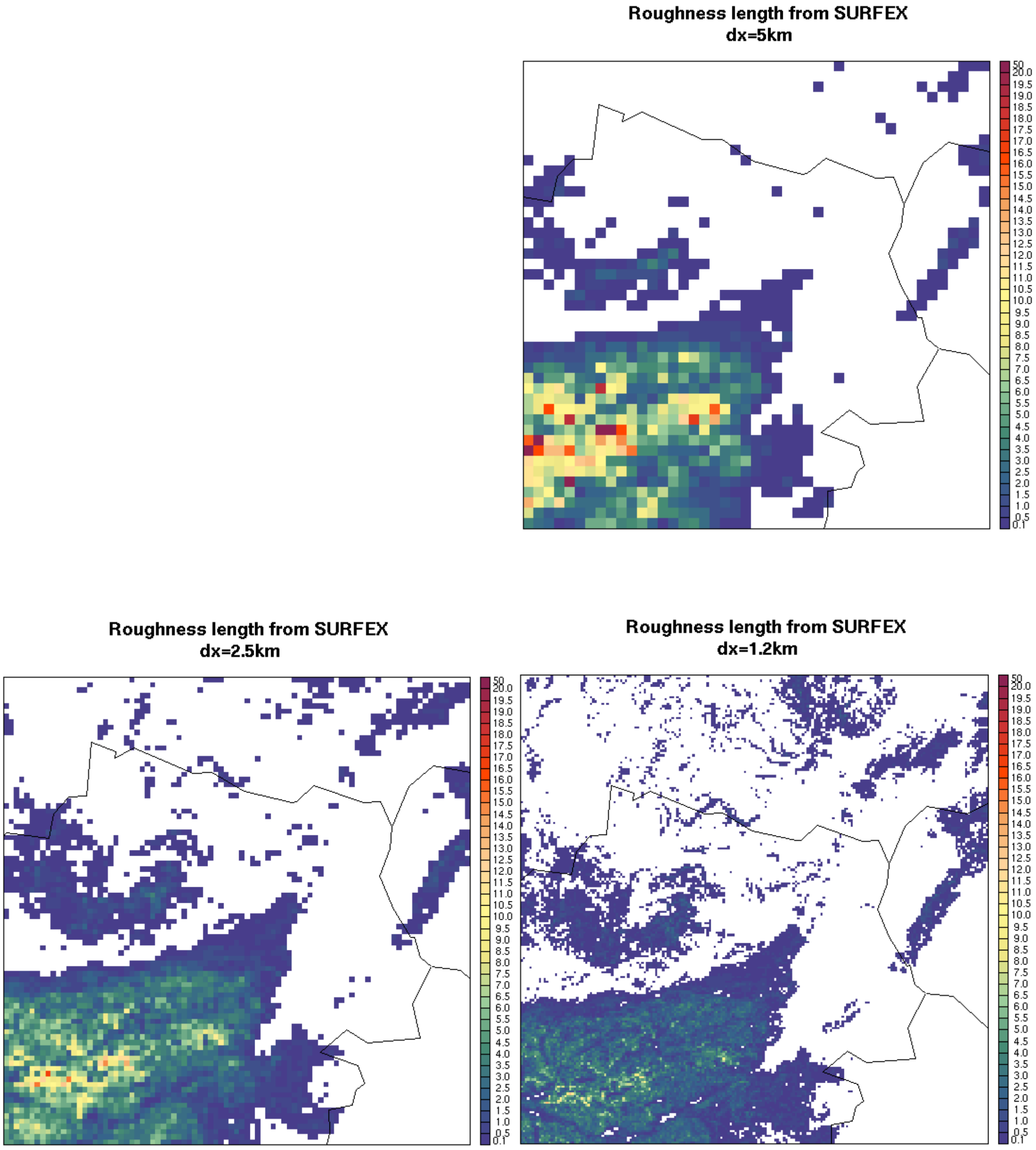

Figure 2: Same as in Figure 1, except that the source of data is the SURFEX file. Note that the color scheme is the same for all three images (top left (at 10 km) is skipped in this case) and is identical to the one in Figure 1. Note also that there is no lack of division/multiplication by g, as might be intuitive from comparison to Figure 1.

3. Implementation of SURFEX roughness length in ALARO at 5km

Initial tests with simple modification of roughness length in the ALARO suite didn´t yield any success. The roughness length coming from the SURFEX file was multiplied by g, for its representation to be equal to its FA counterpart (SURFZ0.FOIS.G field). Note at this point, that in SURFEX file there are three fields to be merged together in one (Z0REL, Z0WATER, Z0SEA) and that undefined values are represented by 10^20. Such values have to be avoided before encoding the field in the FA file (e.g. the extension zone should be treated specifically).

Nevertheless, the system crashes when run with such modifications. The DFI is working for the backward integration, but blows in the first step of the forward one. Most probably the reason for this crash is the fact that in general the roughness length coming from the SURFEX world is usually much lower than the one from FA climate files and the wind accelerates too much.

4. Implementation of DADA wind downscaling

DADA is downscaling of wind by integrating the dynamic part of the model with constant LBCs and a short time step at higher resolution. It can be regarded as a sort of post processing of the model output. Usually within some ten of timesteps, the wind field would converge to one adapted to the new model orography at higher resolution.

The DADA suite successfully implemented at ZAMG in the frame of this stay is very similar to the one in Ljubljana using cycle 38t1. The only difference was the domains used – the coupling domain was the Austrian operational ALARO5 and the target domain was the one of AROME RUC with the resolution of 1.2 km (even though in this case the model run at this resolution was in fact ALADIN with no physics and not AROME).

Leaving the roughness length field of the target domain intact (in the FA climate file), the suite finishes with success, but the quality of results can probably be questionable, due to the issues in previous sections of this report. See Figure 3 for some test results.

However, when the roughness is replaced with the one from SURFEX, the model would mostly crash. First experience shows that usually the model crash is more likely during daytime. However, this assumption needs to be investigated further.

At least three things remain to be solved:

a) The correct switches for NH dynamics need to be sought, also to migrate to cycle 40t1 – this was unsuccessfully tried also during this stay with the help of a document written by Petra Smolikova and published on LACE web page, but without success. There was no time for a deeper look into this problem and for correspondence with Petra on the matter.

b) The second issue is similar to the one under section 3. The proper equivalent for the roughness length should be sought – the simple replacement from the SURFEX file causes the model to (usually) blow. Again, the most probable reason is the same as in section 3: that on the average the roughness length coming from SURFEX is smaller than the one from ALADIN climate files, probably causing the wind to increase. One easy option would be to simply rescale roughness length from SURFEX by a certain factor.

c) Extensive testing and tuning should be carried out to find the most appropriate length of time-step, length of integration etc, and possibly also different (higher) spatial resolution for the target domain.

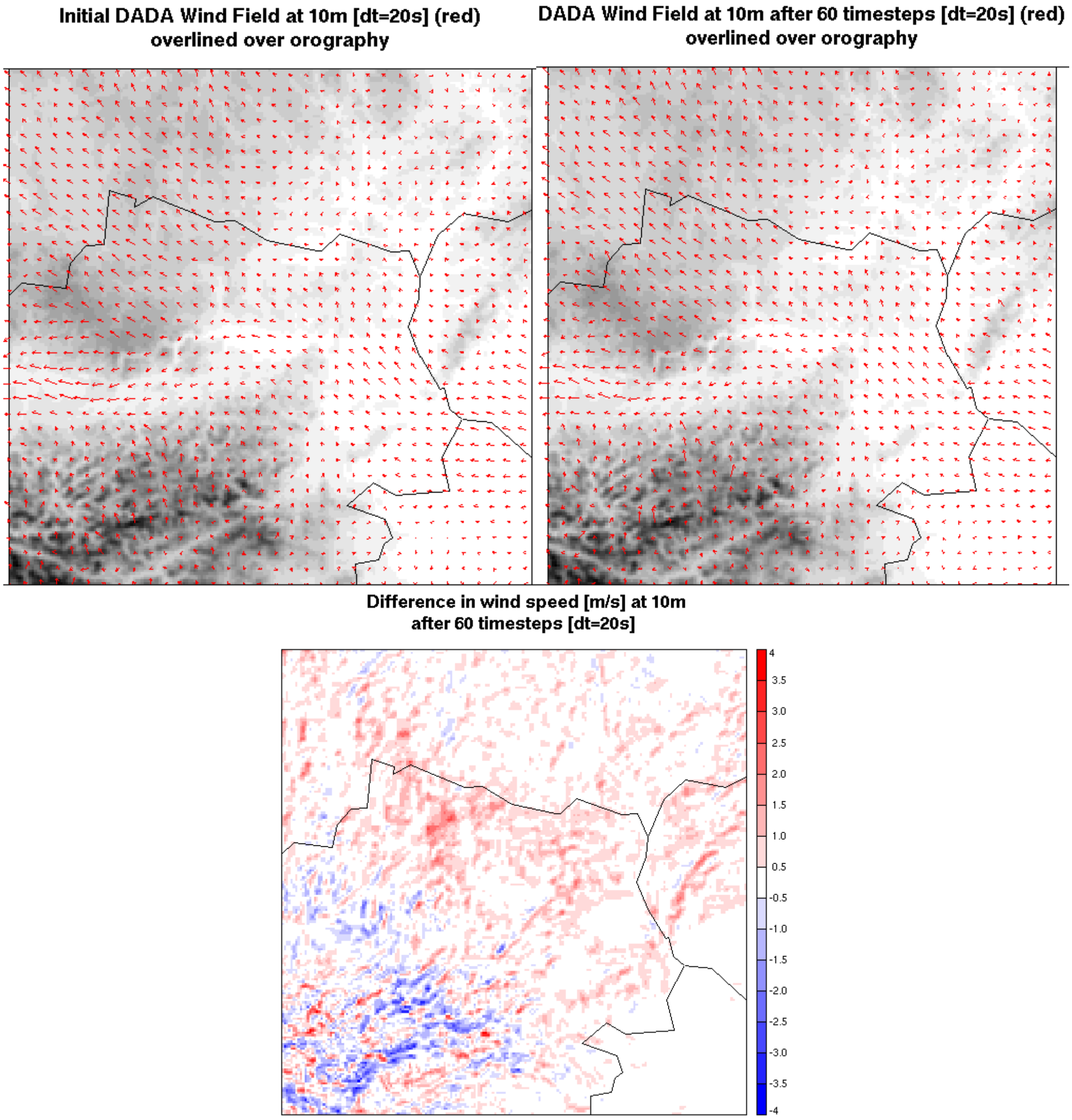

Figure 3: Wind field at 10m ovelined over orography: initial field (top left), after 60 timesteps of integration - dynamics only, dt=20s (top right) and the difference in wind speed at 10m for the two.