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High resolution SRTM topography and Corine Land Cover in WRF

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Abstracts

We evaluate the impact of high resolution SRTM topography and Corine Land Cover (LC) data on the calculated 10m wind speeds, temperature at 2m (T2) and precipitation in WRF for the Lombardy region (Italy). We compare the results with the simulation using the standard 30-arc seconds USGS LC and with observations of the ARPA network for a winter and summer period in 2008. Our analysis shows that in general calculated average wind speeds are in general lower by WRF with the Corine LC, due to the larger fraction of the urban built-up category and agree better with the observations. Clear differences are found in calculated T2 outside the city of Milan. The probability of detection of rain and the Hansen-Kuipers score are somewhat higher by the simulation with Corine LC.

Objectives

NOVELTIS developed a system to implement high resolution topography (~90m) of the SRTM (Shuttle Radar Topography Mission) data base, together with the 100m (and 250m) resolution Corine Land Cover in the Weather Research Forecast (WRF) model. These novel implementations allows us to have a better representation of the topography (especially over mountainous regions) and land cover (urban, forest, water bodies) at high resolution meteorological modelling. These implementations will improve the meteorological modeling.

Method (1)

TOPOGRAPHY

We implemented and investigated the use of high topographic resolution SRTM 3 arc seconds (~90m) data in WRF and compared with WRF simulations using 10 arc minute (~20x20km), 2 arc minute (~4x4km) and topography resolutions (Fig. 1). We evaluated the impact of SRTM on wind speed and T2 calculations.

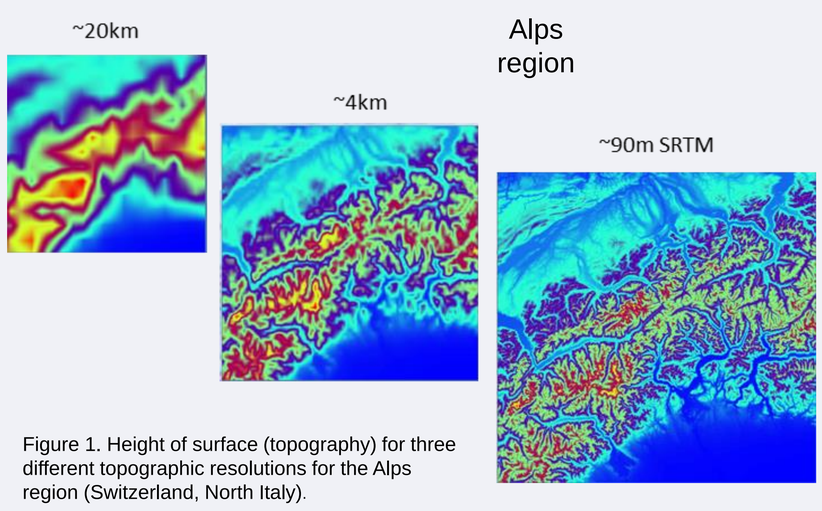

Figure 1. Height of surface (topography) for three different topographic resolutions for the Alps region (Switzerland, North Italy).

Results (1)

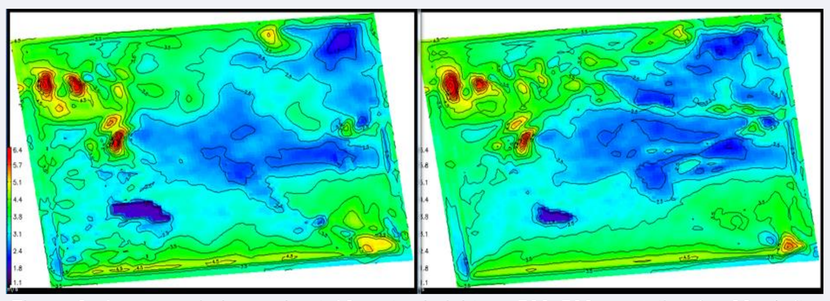

Figure 2. Average wind speeds at 10 meter height on 500x500 resolution for 30s (left panel) and 3s (right panel) topographic resolutions for a particular area.

Results (1)

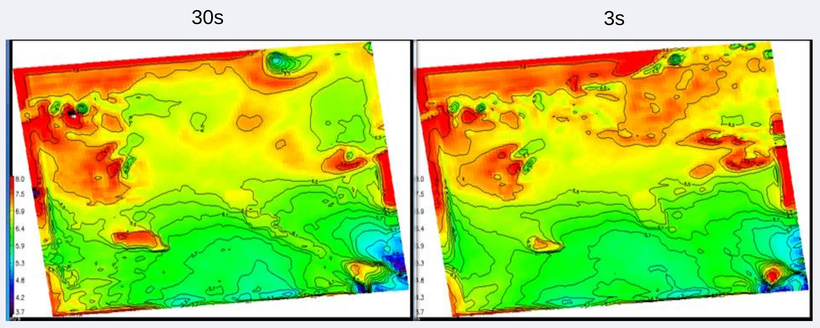

Figure 3. Average T2 on 500x500m resolution for 30s (right panel) and 3s (left panel) topographic resolutions for a particular area.

The average 10m wind speeds by 3s on 500x500m resolution show more detail than the 30s resolution, especially over the elevated regions (Fig. 2). Similar differences are observed between 30s and SRTM (3s) for T2 (Fig. 3). These differences in wind speed and T2 corroborates the differences in the topography on 500x500m between 30s and 3s. The higher SRTM topographic resolution shows a more significant impact on calculated wind speed and T2 calculated values, when the horizontal model resolution is lower than 1x1km, i.e. 500x500m.

Method (2)

LANDUSE

We implemented and investigated the use of high resolution of the Corine LC data base (100x100m) on wind and temperature calculations in WRF by comparing with 30 arc second resolution (~1km). Land use fraction contains the fraction of each land category at each point. Fig. 4 shows large differences are observed in the Land Use Index between the different resolutions. In Fig. 5 the shape of the city Milan and the urban built up area is clearly visible and better represented by the Corine LC than in the 30s USGS.

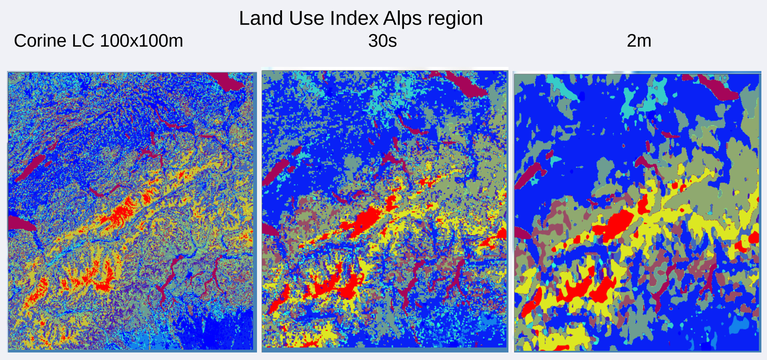

Figure 4. Land Use Index by the Corine LC (left panel) on 100x100m spatial resolution, together with the Land Use Index by the USGS Land Cover on 30s (middle) and 2 arc minutes resolution (right panel) for the Alps region are shown. The 30s and 2 arc minutes are given as standard input by WRF.

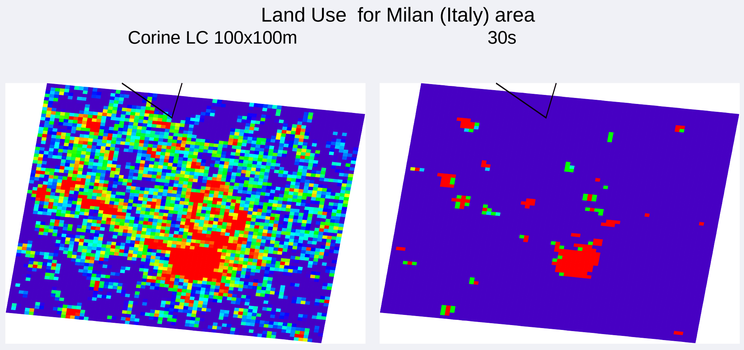

Figure 5. The Land Use by the Corine LC (left panel the USGS Land Cover on 30 arc seconds resolution (right panel) for the Milan city region (Italy) are shown.

Results (2)

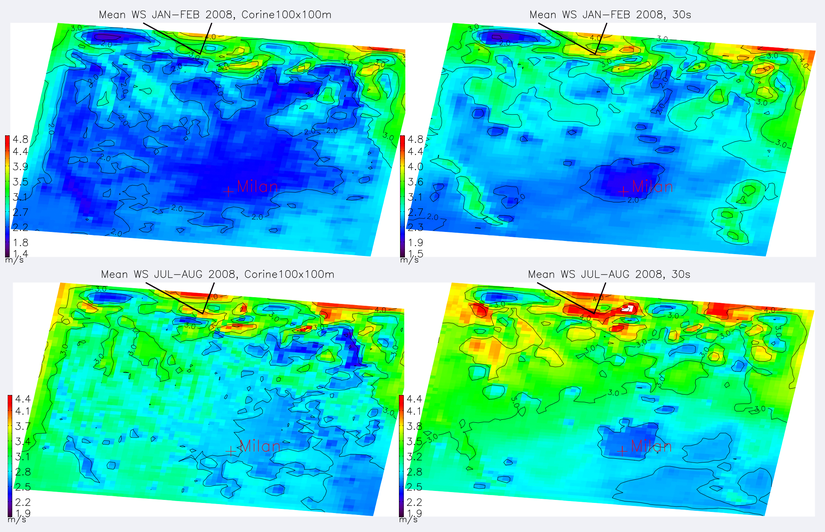

Figure 6. Average wind speed (m/s) calculated by WRF with Corine LC (top left) and 30s (top right) for the period January – February 2008 and for the period July – August 2008 with Corine LC (bottom left) and 30s (bottom right).

We clearly see the impact of changing the land cover resolution on calculated wind speed profiles for the Milan region for the both periods (Fig. 6). The simulation with Corine LC shows lower wind speeds in the urban environments than the simulation with the 30s resolution, due to more friction/resistance by the buildings (see also Fig. 5). The simulation with Corine LC shows higher temperatures in the city than 30s during both winter time and summer time (Fig. 7).

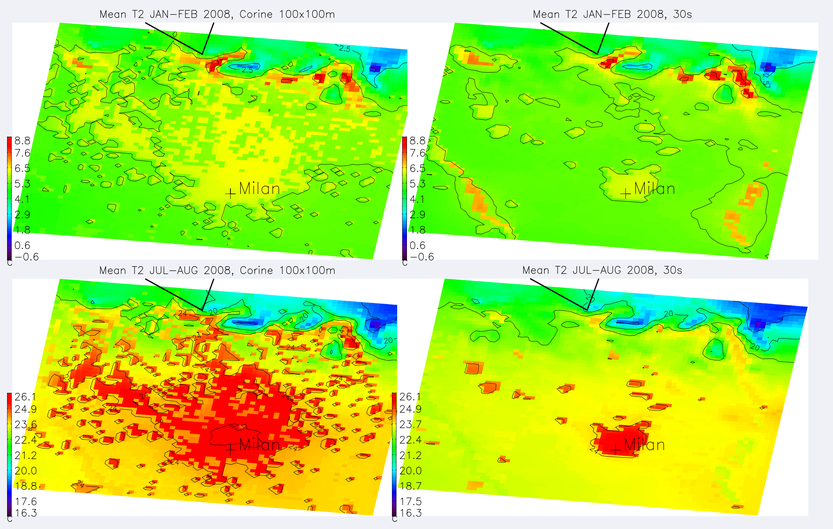

Figure 7. Average T2 (°C) calculated by WRF with Corine LC (top left) and 30s (top right) for the period January – February 2008 and for the period July – August 2008 with Corine LC (bottom left) and 30s (bottom right). The city centre of Milan is highlighted.

Conclusions

- ❑ We successfully implemented the Corine LC (100x100m resolution) in the WPS processing chain.
- ❑ The processed Corine LC data set in the WPS processing chain shows higher details of the Land Use, LU Index and water bodies than the standard 30arc seconds provided by WRF.
- ❑ The simulation with the Corine LC data set shows higher temperatures in highly populated regions than the simulation with 30arc seconds.
- ❑ The simulation with the Corine LC data set shows lower wind speeds in highly populated regions than the simulation with 30arc seconds.