EFFECT OF THE TERRAIN FEATURES ON THE ACCURACY OF CALMET. A COMPLEX TERRAIN CASE STUDY

A. Hernandez-Garces[2], J.A. Gonzalez[1], J.J. Casares[1]

[1]Dept. of Chemical Engineering, Universidade de Santiago de Compostela, 15782 Santiago de Compostela, Spain
(ja.souto@usc.es)
[2]Centro de Estudios de Ingeniería de Procesos (CIPRO), Facultad de Ingeniería Química, Instituto Superior Politécnico José Antonio Echeverría (CUJAE), Havana, Cuba

ABSTRACT

Accurate and high resolution meteorological fields are critical to obtain good air quality modelling results, a common tool in air quality management. CALMET diagnostic model is a good solution to obtain high resolution meteorological fields, but its setup includes a wide number of schemes and parameters which should be selected on the specific environment where the model is applied. Particularly, TERRAD parameter takes into account the influence of the terrain features in the CALMET model results. In this work, CALMET outputs using different TERRAD values were tested over a complex terrain and coastal environment at the NW of the Iberian Peninsula. Surface wind and temperature CALMET results were compared to hourly observations from eleven surface stations. As a result, the lowest wind speed RMSE (2.51m·s^{-1}) was achieved using a TERRAD value of 6 km. No significant differences in surface temperature results were found.

CASE STUDY: Northwestern of Iberian Peninsula

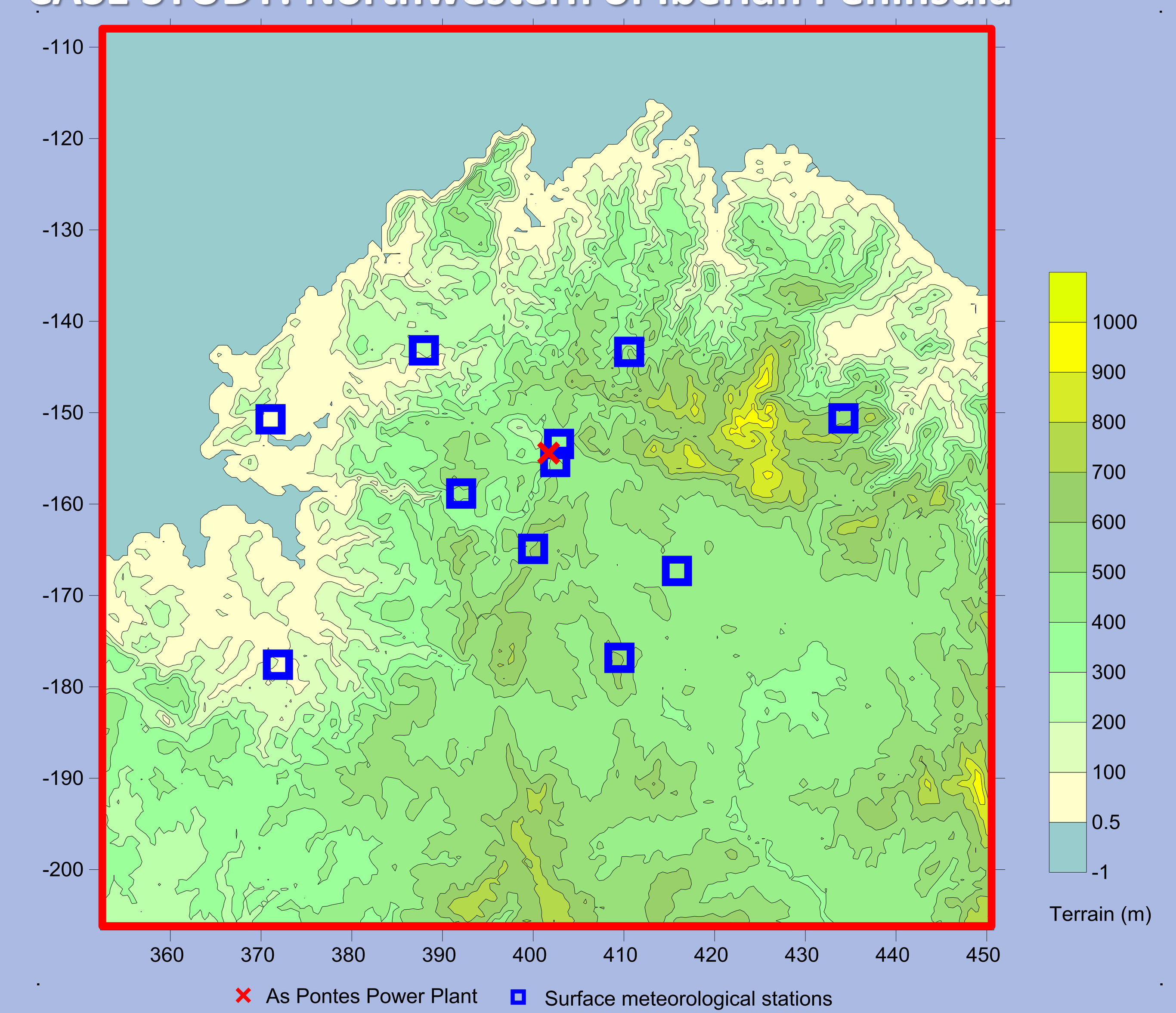

Figure 1. Location (UTM coordinates) and digital elevation model (asl-m) of the CALMET simulation domain inside the D3 domain, with the location of meteorological surface sites for model assessment. Terrain values [-1,0.5] correspond to sea level.

In order to compare to previously CALMET simulations over the same environment (Gonzalez et al., 2015) the following testing period was considered: June 1st, 2006 – June 3rd, 2006. This period corresponds to anticyclonic and stable conditions, which are typical in this region during the synoptic pattern High Pressure over Atlantic and Europe .

MODELS AND METHODS

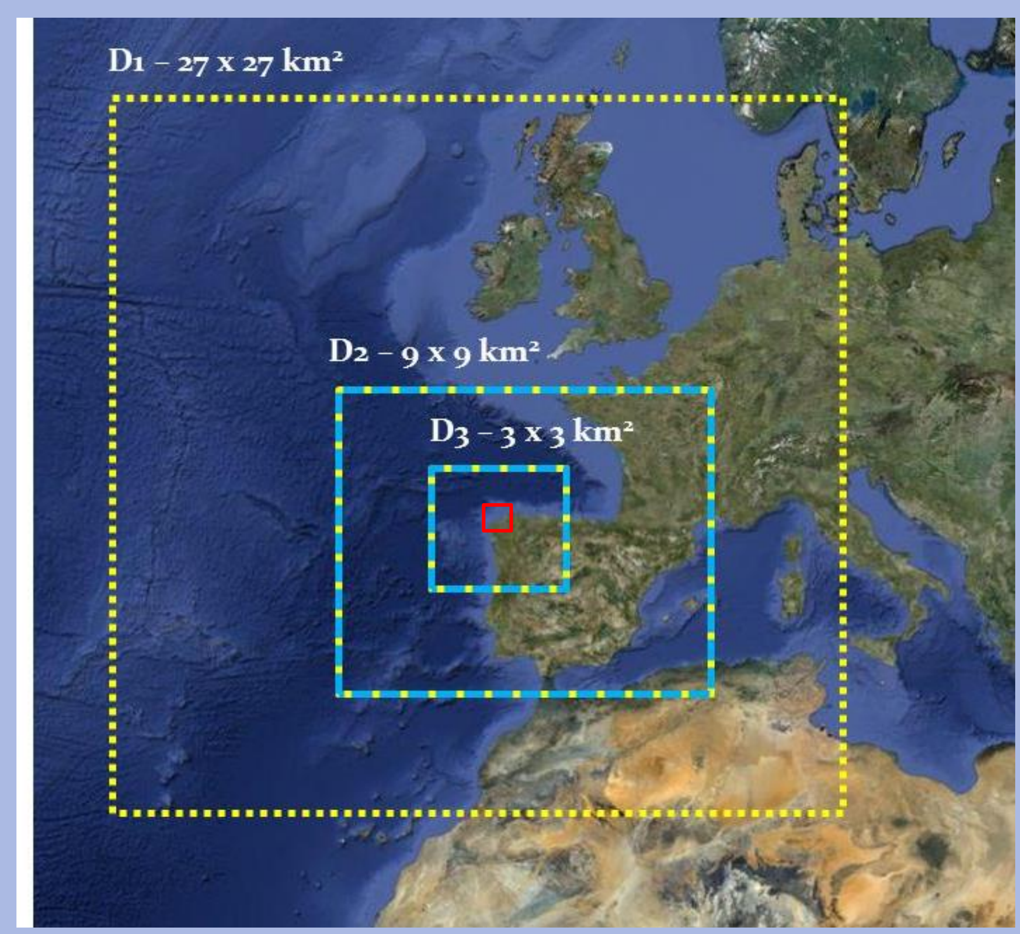

Figure 2. Nested WRF simulation domains (resolution: D1: 27x27 km²; D2: 9x9 km²; D3: 3x3 km²), to provide meteorological inputs to CALMET model domain (☐; 0.5x0.5 km² resolution).

METEOROLOGICAL MODELS SETUP

WRF MODEL	CALMET MODEL
•Three domains (Fig. 3) one-way nesting •Microphysics: WMS-5, WRF Single-Moment 5-class •Cumulus: Grell-Devenyi ensemble •Short wave radiation: D1: RRTMG; D2 & D3: Dudhia •Long wave radiation: D1: RRTMG; D2 & D3: RRTM •Surface layer: MM5 similarity •Land surface: 5-layer thermal diffusion •PBL: Yong Sei University (YSU) •Input: GFS 1º analysis	•Horizontal resolution: 0.5x0.5 km² •14 vertical layers: (top-face, agl-m): 20, 40, 80, 160, 320, 640, 1200, 2000, 3000, and 4000. •TERRAD: (km) 0.5, 1, 3, 5, 6, 7, 9, 15, 20, 30 • Default CALMET interpolation and parameterization options

RESULTS

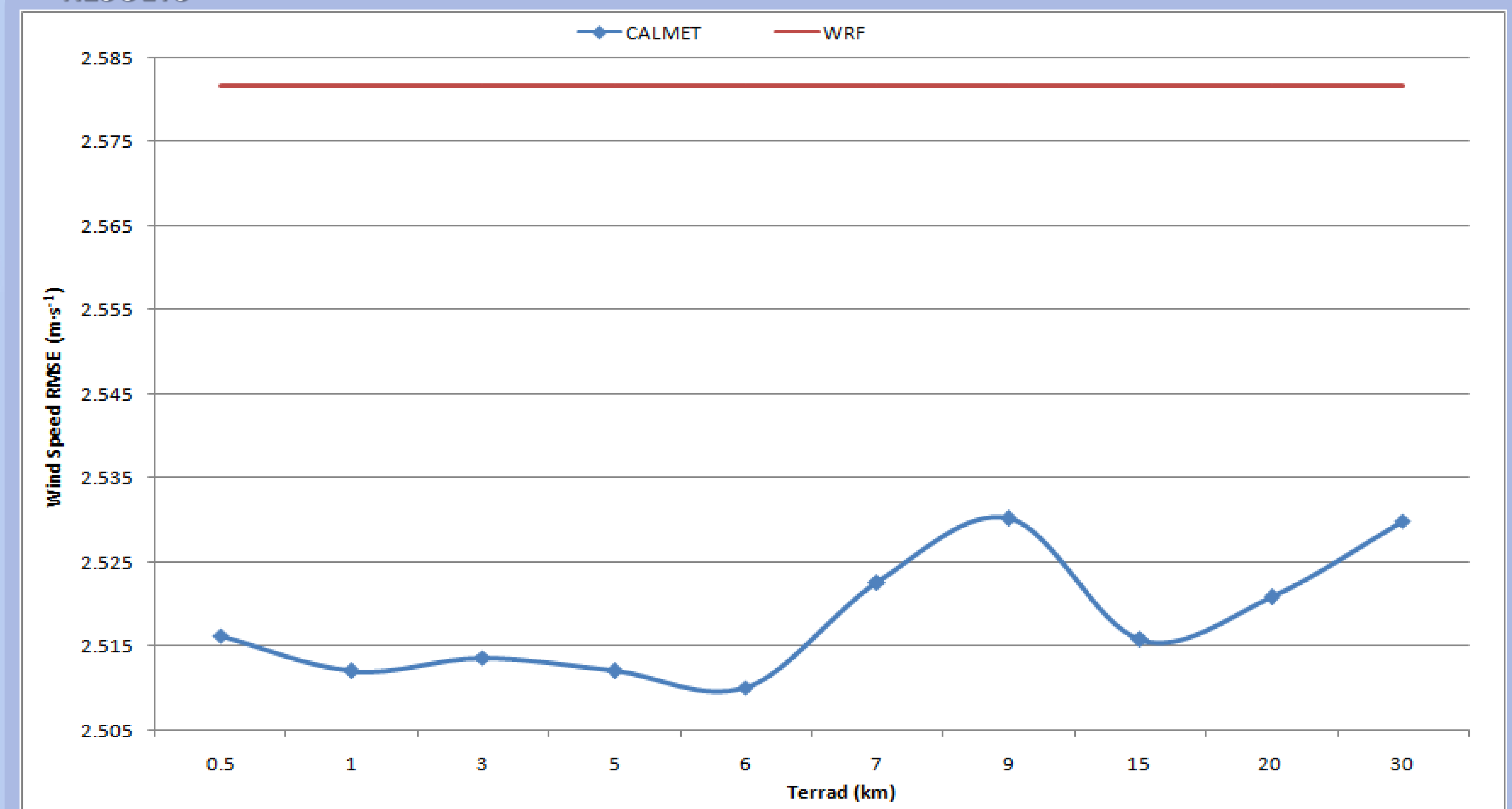

Figure 3. Wind speed RMSE variation from WRF simulation (3x3 km² resolution) and CALMET simulations with different TERRAD values.

SURFACE TEMPERTURE STATISTICS

Simulation	Temperature RMSE (°C)
TERRAD (km)	
0.5	2.2941
1	2.2939
3	2.2931
6	2.2928
9	2.2927
15	2.2926
20	2.2926
30	2.2925

CONCLUSIONS

The influence of complex terrain features in CALMET requires the calibration of different parameters and model options. In this work, TERRAD empirical parameter shows its influence over surface wind speed results in a complex terrain and coastal environment. Absolute differences in surface wind speed performance (RMSE, against surface measurements) obtained by using different TERRAD values simulations are small, because of the higher influence of the same WRF output applied as CALMET input. However, a minimum RMSE is obtained with TERRAD=6 km, which is a bit higher than the maximum TERRAD recommended value (5 km). This can be related to the complex terrain features, as higher complexity can require higher TERRAD values, in order to consider the influence of further topographic features over the wind flow. On the other hand, no influence of TERRAD value is observed in surface temperature performance, as temperature has low sensitivity to the topographic features..

Acknowledgements

Anel Hernandez's research stages at the University of Santiago de Compostela were supported by USC-Banco de Santander PhD Programme for Latinoamerican university teachers.

References

Chang, J.C. and Hanna, S.R., 2004: Air quality model performance evaluation. Meteorology and Atmospheric Physics, 87, 167-196.
Lakes Environmental, 2011: CALPUFF Air Dispersion Modeling Workshop, Course Slides. Barcelona - Oct 19-21, 2011.
Scire, J. S., Robe, F.R., Fernau, M.E. and Yamartino, R.J. 2000. A User's Guide for the CALMET Meteorological Model. Earth Tech, USA.
Willmott, C.J., 1981: On the validation of models. Physical Geography, 2(2), 184–194.