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The role of the turbulence in the topographic scheme of the WRF model to improve the surface wind speed over the Iberian Peninsula

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The Weather Research and Forecasting (WRF) model includes a parameterization to resolve the topographic effects developed by Jimenez et Dudhia (2012). The improvements that this scheme exerts over the surface wind speed were assessed over the Iberian Peninsula using 400 stations at 2 m during 2005. The analysis showed that the drag generated by the topography reduces the wind bias under stable conditions (during nighttime), but it decelerates the wind speed too much under unstable conditions (during daytime), especially the windiest months. This suggests that the wind speed is not only influenced by friction mechanisms, but also turbulent processes seem to play a key role when orographic features are considered. Bearing this in mind, the aim of this work is to modulate the friction as function of the turbulence.

For this task, the turbulent kinetic energy (TKE) is derived from the Yonsei University (YSU) paramaterization of the planetary boundary layer (PBL) using a diagnostic equation. This equation is based on the Mellor-Yamada closure turbulent model using the 1.5-order assumption and the vertical turbulent fluxes of YSU scheme. On the other hand, this TKE allows one to compute the PBL height with a hybrid diagnostic equation. The hybrid PBL height is obtained using the virtual potential temperature for unstable conditions and TKE for stable conditions. With the TKE and the hybrid PBL height from the YSU scheme and the convective velocity, the friction has been modulate to reduce the wind speed bias.

The results show that the TKE underestimates the magnitude and the height of turbulence in comparison with the TKE from other PBL parameterizations of WRF. Beside these limitations, the TKE can be used to improve the modeled wind speed. To consider the TKE or convective velocity in the modulation of the friction significantly improves the representation of the diurnal cycle of wind speed, except during the evening transition when the wind speed is still underestimated. The negative wind speed bias during these conflicting hours can be alleviated by considering the hybrid PBL height.

Jiménez, P. A., & Dudhia, J. (2012). Improving the Representation of Resolved and Unresolved Topographic Effects on Surface Wind in the WRF Model. Journal of Applied Meteorology & Climatology, 51(2).