Improving the surface roughness over shallow waters

Pedro A. Jiménez¹ and Jimy Dudhia²

¹ Research Applications Laboratory, National Center for Atmospheric Research, Boulder, CO, USA (jimenez@ucar.edu)
² Mesoscale and Microscale Meteorology Division, National Center for Atmospheric Research, Boulder, CO, USA

Shallow water effects on surface winds
Over the open ocean, a modified version of the Charnock relationship provides a good representation of the feedback between the wind speed and the surface roughness (Edson et al. 2013). However, data from field campaigns have revealed that over shallow waters the roughness of the surface is higher than the corresponding values over the open ocean (DeCosmo et al. 1996). In spite of this differentiated behavior, our atmospheric models apply the same wind stress formulation regardless of the depth of the waters. The influence of introducing an alternative formulation consistent with data recorded over shallow waters is investigated.

Research strategy
The atmospheric evolution is simulated (WRF3.5.1) over a coastal region during a complete year wherein observations of the wind speed were available at a total of eight levels within the first 100 m of the atmosphere (Fig. 1). Realizing the importance that the closure assumptions associated with the representation of the turbulent mixing within the planetary boundary layer (PBL) may exert on the results, we used a total of 4 different PBL parameterizations.

Observed VS simulated wind speed distribution
The frequency of high wind speeds is overestimated by the standard WRF formulation. A wind stress formulation valid for the open ocean (Edson et al 2013) provides similar results.

Main Research Finding
Increasing the surface drag is necessary to reconcile model results with observations of the wind profile within the first 100 m of the atmosphere. The alternative formulation consists of a linear relationship between the wind and the logarithm of the aerodynamic roughness length. This increased drag is consistent with observations acquired over shallow waters during the Humidity Exchange Over the Sea (HEXOS) program (DeCosmo et al. 1996, Janssen 1997).

References