Effects of sea spray in large-eddy simulation of the hurricane boundary layer

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The use of large-eddy simulation (LES) facilitates investigation of the role of sea spray and spume in the atmospheric boundary layer under hurricanes. In particular LES allows exploration of the effects of spray on enthalpy and momentum fluxes between the ocean and air. We implement a generation function for spray and spume based on the work of Andreas (1998), giving a generation rate which depends on wind speed and droplet diameter and which may vary in the horizontal according to estimated whitecap coverages. The resultant flux of spray from ocean to air and associated sensible heat transfer (due to spray injection and subsequent fallout) are then calculated locally.

The spray also affects the turbulent atmosphere through evaporation, which is treated using various prognostic schemes. The modeled thermodynamic air-spray interaction

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is two-way, allowing both condensation and evaporation. We have tested the efficacy of several 'conserved' temperature variables in representing the spray-air interaction, a nontrivial and relevant issue in conditions having large liquid-water mixing ratios. The modeled spray has a size-dependent slip velocity, and hence exchanges momentum with the air (causes drag in both horizontal and vertical) and also can fall out of the computational domain back into the ocean.

Through high-resolution LES we explore both the dynamic and thermodynamic effects of spray on the hurricane boundary layer. The LES results permit assessment and comparison of existing one-dimensional models of spray-mediated fluxes used in full-scale hurricane simulations. In particular, the results of LES offer insight into the thermodynamic feedbacks which the existing models attempt to parameterize, and facilitate the improvement of such models.

References

Andreas, E.: 1998, A new sea spray generation function for wind speeds up to 32 ms^{-1}. *J. Phys. Oceanogr.*, **28**, 2175–2184.