Air-Sea Fluxes

The surface turbulent fluxes of momentum, heat, and moisture at the interface between the atmosphere and the oceans represent an exchange of energy between the two. In the oceans, momentum flux drives ocean currents and surface mixing while fluxes of heat and freshwater affect sea surface temperature (SST) which in turn drives some climate processes (Zeng et al. 1998). In the atmosphere, the evaporation of water from the ocean helps to drive the water cycle.

In climate or global circulation models (GCMs) and numerical weather prediction (NWP) models, these fluxes, which are boundary conditions to both atmospheric and oceanic GCMs, are calculated based upon the difference between the bulk values of the model-generated wind speed, temperature, and humidity at some height in the surface layer and of the ocean current speed, temperature, and humidity at the surface. This method is also generally used to generate data sets of surface fluxes from bulk values of these parameters derived surface observations or from data that were remotely sensed from satellites.

Each group that develops a model or data set designs their own method or algorithm to calculate sea surface turbulent fluxes. While all of these algorithms commonly calculate the fluxes from the bulk variables stated above, they differ slightly because of what effects they may or may not include, what parameters they use, and what conditions they are most appropriate for (Zeng et al. 1998, Brunke et al. 2002).

n order to understand which effects are most important and which parameters produce the most accurate fluxes, we endeavored to compare the algorithms used in several climate and NWP models and several used to generate data sets along with the in-house algorithm and another algorithm developed from field data from an experiment in the western tropical Pacific commonly used by the scientific community (Zeng et al. 1998; Brunke et al. 2002, 2003) and to evaluate which of these algorithms are the least and most problematic (Brunke et al. 2003). We also analyzed how much of an effect the accuracy of the derived bulk values has on the values of the resultant fluxes in two data sets (Brunke et al. 2002).

Recently, we have extended this work to investigate how much these algorithm uncertainties contribute to fluxes in 11 flux products (reanalyses, satellite-derived, and combined) in comparison to uncertainties in the state variables which are inputted into the bulk algorithms. It turns out that bulk variable uncertainties dominate many products' sensible heat (thermal) and momentum (wind stress) flux biases, because the biases of some of these products' state variables can be quite high.

For more information on this research, check out:

Brunke, M. A., X. Zeng, and S. Anderson, 2002: Uncertainties in sea surface turbulent flux algorithms and data sets. *Journal of Geophysical Research*, **102**, doi:10.1029/2001JC000992.

Brunke, M. A., C. W. Fairall, X. Zeng, L. Eymard, and J. A. Curry, 2003: Which bulk aerodynamic algorithms are least problematic in computing ocean surface turbulent fluxes? *Journal of Climate*, **16**, 619-635.