Geophysical Research Abstracts
Vol. 17, EGU2015-14061, 2015
EGU General Assembly 2015

Non-local Second Order Closure Scheme for Boundary Layer Turbulence

Bettina Meyer (1) and Tapio Schneider (2)
(1) Switzerland, ETH Zurich, (bettina.meyer@erdw.ethz.ch), (2) Switzerland, ETH Zurich, (tapio@ethz.ch)

Turbulent fluxes of variables such as entropy and specific humidity in boundary layers and convection cannot be resolved explicitly in large-scale climate models but must be represented through parameterizations. Most current parameterizations use schemes that truncate the hierarchy of moment equations at first order and use second-order equations to estimate closure parameters, e.g., in local diffusive or non-local mass flux closures. However, truncations of moment equations at second order may lead to more accurate parameterizations. At the same time, they offer an opportunity to take spatially correlated structures (e.g., plumes) into account, which are known to be important for convective dynamics.

Here we demonstrate the viability of a spatially nonlocal second-order closure (CE2), obtained by truncating the hierarchy of cumulant equations at second order and neglecting cumulants of 3rd order and higher. To explore the applicability of the CE2 closure, we study characteristics of different turbulence regimes through LES, comparing fully nonlinear LES with quasi-linear LES in which interactions among turbulent eddies are suppressed but nonlinear eddy—mean flow interactions are retained, as they are in the CE2 closure. In physical terms, suppressing eddy—eddy interactions amounts to suppressing, e.g., interactions among plumes, while retaining interactions between plumes and the environment (e.g., entrainment and detrainment). That is, the CE2 closure explicitly resolves entrainment and detrainment, obviating the need to parameterize them.

A computational disadvantage is that solving the resulting equations for the second-order cumulants numerically in general is costly. We will be discussing ways in which additional assumptions (e.g., about horizontal correlation structures among turbulent fields) may lead to closures that are computationally efficient, yet more accurate than existing closures.