Geophysical Research Abstracts
Vol. 14, EGU2012-1127, 2012
EGU General Assembly 2012

The structure of the stable boundary layer as from radiosounding profiles and eddy correlation measurements

L. Caporaso (1,2), A. Riccio (3), F. Di Giuseppe (4,2), and F. Tampieri (5)

(1) Dept. of Physics, Univerisity of Bologna, IT, (2) ARPA-SIMC, Bologna, IT, (3) Department of Applied Science, University of Naples 'Parthenope', IT, (4) ECMWF, Reading, UK, (5) CNR-ISAC, Bologna, IT

The planetary boundary layer (BL) can be thought as the region where air masses are strongly influenced by the surface processes and which interacts through exchange processes with air masses originating from above. Being strongly coupled to the ground, this layer evolution is controlled by turbulence, produced through shear and heat flux, which leads to rapid fluctuations in quantities such as flow velocity,temperature, moisture and to intense vertical mixing.

At the resolution of atmospheric models employed in operational weather forecast, turbulent processes are not explicitly resolved and the Monin-Obukhov similarity theory (MOST) commonly provides the framework for their parametrization. Accordingly to MOST, temperature and wind profiles below the first model level (in the surface layer) can be diagnosed by scaling prescribed functions with surface turbulent fluxes of heat and momentum. The relationship which holds between mean vertical profiles and surface fluxes is therefore the key element to determine the lower boundary condition for vertical transport in these models.

Using an extensive set of measurements and a multivariate nonlinear regression algorithm it will be shown that in the limit of very stable conditions the Monin-Obukhov similarity theory looses validity. For high atmospheric stability, while it is possible to find values for surface fluxes of momentum and heat to scale the similarity temperature and wind profiles so to match observations, these values are not in agreement with the equivalent measured quantities. In other words surface fluxes are found not to be adequate scaling variables for the mean profiles as they are not sufficient to completely describe the stable boundary layer structure. Discrepancies with the MOST theory become more evident in very stable conditions when the bulk Richardson number (R_b) is larger than $\mathcal{O}(2)$.

The correct characterization of very stable boundary layer is of considerable practical importance. The absence of significant mixing allows buildup of high concentrations of contaminants which can be diagnosed directly by the boundary layer height, h. One of the practical consequences of the outlined finding is therefore that formulations of h, which mainly relay on surface turbulent fluxes are inaccurate in very stable conditions. It is then shown as an example that the expression for h suggested by Zilitinkevich et al which is a function of surface fluxes and atmospheric stability leads to h estimates in disagreement with the ones obtained by inspecting the mean profiles