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Forecasting the weather
- ensemble techniques
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An investigation on the vertical structure of the stable boundary layer from turbulence measurements at different heights

F. Tampieri (1), S. Viana (2), and C. Yagüe (3)

(1) CNR, ISAC, Bologna, Italy (f.tampieri@isac.cnr.it, +390516399658), (2) AEMET, Barcelona, Spain, (3) Universidad Complutense de Madrid, Facultad de CC. Físicas, Dpto. Geofísica y Meteorología, Madrid, Spain

SABLES98 data constitutes a quite comprehensive description of atmospheric stable boundary layer. Measurements taken at three different heights (5.8, 13.5 and 32 m a.g.l.) with sonic anemometers and mean wind and temperature at many heights up to 100 m cover a period from 10 to 28 September 1998. In this work we have used data form 7 consecutive nights forming the so called S-period characterised by weak to strong stability.

The multiscale analysis technique called MultiResolution Flux Decomposition (MRFD) has been applied to sonic data to evaluate the heat and momentum fluxes as well as temperature and velocity variances. MRFD allows to know what timescales contribute more to the covariance/variance of the temporal series and it has been used to locate the gap between turbulence and larger submesoscale motions, avoiding the 'contamination' from higher scale motions on the evaluation of turbulent fluxes or variances evaluated from eddy correlation technique with a fixed time window.

Based on the shape of the vertical profiles of variance of velocity components and of temperature, and of the momentum and sensible heat fluxes, the stable boundary layers can be broadly classified. Monotonically decreasing fluxes suggest the dominant influence of the surface effects, increasing fluxes are likely to be related to upper-level effects, like wind shear and/or gravity waves.

The applicability of the local scaling concept and of the literature formulations for the boundary layer height is investigated.

The height can be estimated by a fit of self-similar functions (Nieuwstadt, 1984; Zilitinkevich and Esau, 2007) on the data. It results that this height cannot be
expressed as a function of the surface fluxes only, at variance with the theoretical formulations.

The local scaling turns out to be broadly satisfied, in spite of the large data spread with increasing stability. Formulations in terms of the Richardson number and other stability parameters (like the more commonly used Obukhov length) are tested.

The results are used for a critical look to the current parameterisation of stable boundary layer description in numerical models of atmospheric dynamics and of air quality.