Turbulence Parameterization in the B-RAMS using Taylor's Approach

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Abstract

The atmosphere is not a homogeneous air mass around the Earth. It presents stratification. The first layer in the atmosphere is the Planetary Boundary Layer (PBL), a thin layer in direct contact with the ground, where the turbulent and viscosity effects must be considered. The evolution of the PBL is controled by turbulent mixing induced by temperature difference between the atmosphere and the ground (thermal production), and by the winds in the lower levels (mechanical production). In a convective boundary layer (CBL) the turbulence is generated by heat flux from the Earth to the atmosphere, and by wind field shear. The stable boundary layer (SBL) appears in the nocturnal period or, under special conditions, in cloudy days. In the neutral layer the turbulence is predominantly mechanical, that is, small heat flux and intensity of wind field relatively high.

Many approaches in turbulence start assuming Reynolds' hypothesis, where the turbulence is described as a sum of a mean stream plus a ?uctuation term (with zero mean). The turbulence contribution in momentum, energy, and mass equations is constituted by the product between ?uctuations. These terms represent new unknowns in the equations. The system of equations can be closed using the *K*-theory, where the turbulent ?uxes are represented by the gradient of the mean stream multiplied by an eddy diffusivity. This model of turbulence can be applied for many physical systems, such as combustion, solar physics, pollutant diffusion, and geophysical ?uid dynamics.

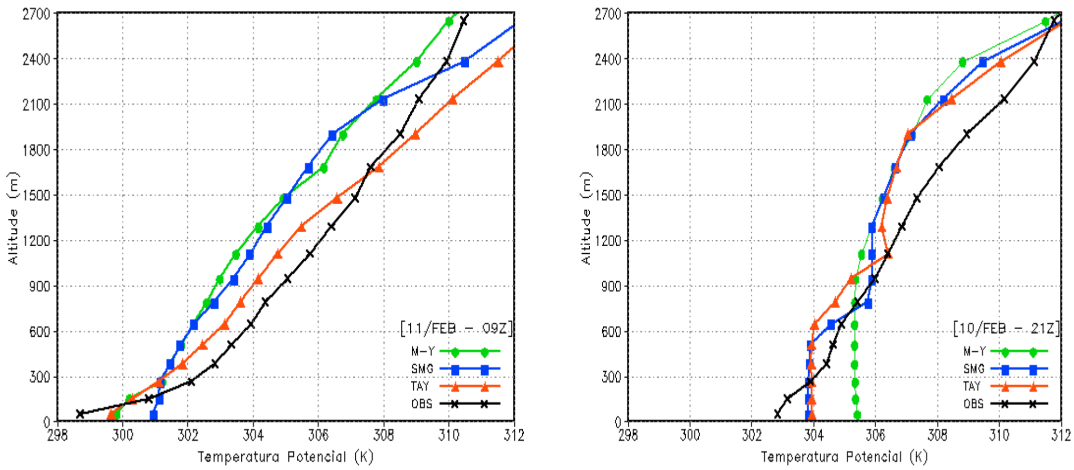
In this paper, formulations for the turbulence based on the Taylor's statistical theory of turbulence (Taylor, 1921) and by an analytical model for the energy spectra (Degrazia et al., 2000) are employed into a mesoscale meteorological model: B-RAMS. These new parameterizations are appropriate for the most important atmospheric stability regimes.

In this paper we show and discuss model results and perform comparisons with another 2 standard parameterizations, already included in B-RAMS: Smagorinsky (1963), and Mellor-Yamada (1982). Observational data collected on LBA/ABRACOS and LBA/Rebio_Jarú sites are employed to perform a comparison amoung the turbulence models.

Observational data related to the sites from WETAMC campaing were considered. A selection

was done over those data, where the criterion used was a *good* evolution of the CBL. After such data analysis, a 48 h period was adopted, starting at 10/Fev/1999 00:00 UTC up to 12/Fev/1999 00:00 UTC. For this period, the B-RAMS carried out data assimilation, performing a weighted average with 99% of true for the radiosonde data in the site places. The ProVeg is a iniciative to improve the ground vegetation covering in the forecasting and climate prediction models, from the adaptation of a more detailed database representing a more accurate the soil physical properties and the vegentation types of the Brazilian territory forma mais acurada as propriedades físicas dos solos e os tipos de vegetação do território brasileiro (PROVEG, 2005).

Figure 1a shows the simulation results to the Rebio Jarú site at 15Z, and Figure 1b are results for the ABRACOS site at 21Z day 10 de fevereiro de 1999 ABRACOS site, both at the day 10-february-1999. All models present good representation for the diurnal cycle, however the Taylor's approach has a much lower computational effort.



(a) (b)

Figure 1: Intercoparison amoung rasdiosonder and turbulence models: (a) ABRACOS site, (b) Rebio Jarú site.

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