EMS Annual Meeting Abstracts
Vol. 11, EMS2014-416, 2014
14th EMS / 10th ECAC

Extension of turbulent scheme with prognostic TKE towards higher order solutions - prognostic TPE and parametrisation of TOMs

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Classical parameterisation of turbulence in NWP is based on local down-gradient turbulent transport, i.e. turbulent mixing that decreases local gradients of diffused variables. This approach accounts for the majority of turbulent mixing impacts.

However in very stable stratification the down-gradient approach fails to model counter-gradient heat transport maintained by velocity shear. This problem can be solved by introducing a prognostic treatment of Turbulent Potential Energy (TPE), following for instance Zilitinkevich et al. 2013.

In unstable stratification the local transport is unable to account for distant turbulent transport caused by presence of semi-organised large eddies. The simplest solution to this problem is the parameterisation of Third Order Moments (TOMs). The most compact solution for this problem can currently be found in Canuto et al. 2007.

The aim of our presentation is to explain the generalisation of a scheme with prognostic TKE, consistently integrating both above extensions in case of dry air turbulence. The used baseline is characterised by a framework of stability dependency functions valid for the whole range of Ri with consideration of anisotropy and absence of critical Richardson number Ri_{cr}. Introduction of both TOMs and prognostic TPE via usually neglected terms in the heat flux equation is thus consistently valid for the whole range of Ri.

Both prognostic TPE and TOMs parameterisations can be generalised when considering influence of moisture - expansion and latent heat release. Several problems must however be specifically addressed, owing to interactions between diffusion of heat and of moisture, for distinguishing between entropic and buoyancy consideration, and because of the non-linear influence of partial cloud cover.