Model Description

Scientist:

Roel Neggers
ECMWF
Shinfield Park, Reading, RG2 9AX, England
Roel.Neggers@ecmwf.int
+44 118 9869450

Model Name and History:

- Long name: *Single column model (SCM) of the European Centre for Medium-range Weather Forecasts (ECMWF) - Cycle 30r1 including the new dual mass flux scheme for PBL convection.*
- Acronym: *ECMWF_dualM*
- Short name: *ECMWF dual mass flux scheme*
- Generic predecessor or relative: *ECMWF_cy30r1 (does take part in this study)*

Model Type: 1D

Numerical Domain:

- Domain size in x-direction: -
- Domain size in y-direction: -
- Domain size in z-direction: *from 1000 to .01 mbar*
- Number of grid points in x-direction: *1*
- Number of grid points in y-direction: *1*
- Number of grid points in z-direction: *91*
- Grid size in x-direction: -
- Grid size in y-direction: -
- Grid size in z-direction: *Varying with height (about 17 layers in lowest 2km)*
- Time step: *300s*

Numerical Technique:

- Numerical method (finite-difference, spectral, etc.): *AsGP*
- Advection scheme and its order of accuracy: *AsGP*
- Time scheme and its order of accuracy: *AsGP*
- Dynamical equations (elastic, anelastic, etc.): *AsGP*
- Numerical diffusion (type, order, magnitude of coefficient): *AsGP*
- Lateral boundary conditions: *AsGP*
- Upper boundary condition (Sponge layer, specification, ...): *AsGP*
- Translation velocity of the reference frame: *AsGP*

Physical Parameterizations:

- Surface flux parameterization for heat, moisture, momentum: *AsGP*
- Longwave radiation parameterization: *AsGP*
- Shortwave radiation parameterization: *AsGP*
- How were radiative fluxes above the computational domain handled? *AsGP*

- Cloud/convective (1D model) parameterization:

  Cloud fraction and total condensate: *AsGP, except that a new statistical cloud scheme is used for the PBL. The potentially skewed PDF is reconstructed in $\{\theta_l, q_t\}$- space by using multiple independent PDFs, following the bimodal approach of Lewellen and Yoh (1993). One PDF is associated with updraft cloudiness, the other with more passive cloudiness. Condensate is then obtained through integration of over-saturation in the reconstructed PDF, acknowledging the sub-grid variation of saturation specific humidity with temperature.*

  Mixed phase fraction: *AsGP: Only one prognostic variable for condensate water species is used. The distinction between the water and ice phase is a diagnostic function of temperature within a specified range.*

  Precipitation: *AsGP: For pure ice-clouds, two separate classes of ice-particles are modelled (smaller and larger than 100μm). Small ice particle content is modelled using the parameterization of McFarquhar and Heymsfield (1997), using a small terminal fall speed of 0.15 m/s. For the (variable) large ice particle fall speed the parameterization of Heymsfield and Donner (1990) is used. For precipitation in mixed-phase and pure water clouds, the Sundqvist (1978) scheme is used. Evaporation of precipitation follows the parameterization of Kessler (1969), below a threshold relative humidity.*

- Turbulence closure scheme:

  Turbulent transport: *AsGP: Modeled using the Eddy Diffusivity Mass flux (EDMF) framework (Siebesma et al., submitted to JAS, 2006). In this scheme K-diffusion and advective mass flux transport are applied simultaneously. New in this version: multiple transporting updrafts are explicitly resolved. A new mass flux closure is applied, involving parameterization of the area fraction of each updraft group, assumed to be flexible as a function of model state.*

  Variables predicted and diagnosed by the turbulence closure: *turbulent fluxes of thermodynamics and momentum, the associated tendencies, profiles of multiple updrafts, turbulent variances, eddy-diffusivity coefficients.*

  Closure for eddy diffusivity coefficients: *AsGP: bulk profile method using multiple independent modes with predefined vertical structures and depth ranges.*

Closure for mixing across interfaces: *New: at *both* mixed layer top and cumulus PBL top, the vertical mixing is explicitly modeled using entrainment-efficiency formulations (e.g. Wyant et al., 1997), dependent on bulk Richardson numbers of the associated layers and inversions.*

Documentation:

- Present model: Neggers, Roel A. J., M. Köhler, and A. Beljaars: A dual mass flux scheme for boundary layer convection. Part I: Formulation. *In preparation for JAS, August 2006.*
- Predecessor or relative: IFS Documentation Cycle 28r1, Part IV: Physical processes. Available at *http://www.ecmwf.int/research/ifsdocs/*

Remarks on the supplied data:

The vertical profile data of quantities 7 and 8 (the rain and snow mixing ratios) is not available in our 1D model, because any precipitation is removed from the column immediately. Instead, these quantities are given as precipitation fluxes [mm/day].

I assumed the radiative fluxes in time-series group 2 (quantities 2-8) are by convention positive in the direction asked for.