TOUCANS
- internal architecture of turbulence part
- 'users guide'

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This document explains changes (with respect to the CY35t1 cycle) in the code, that were done by:

- introduction of turbulence scheme eTKE,
- preparations of the code for inclusion of TOMs terms in to the code and
- addition of computation for shallow convection cloudiness.

For more details see the presentation about turbulence part of TOUCANS scheme.

1 Exercise

We have prepared an exercise which should help you to find orientation in the changes in the new code.

Subroutines which are modified (APLPAR, ACMIXELEN, ACPTKE, SUPHY0), new subroutines (ACMRIPP, ACTKEHMT, ACTKECOEFK) and the original subroutines (ACHMT, ACCOEFK, ACMIXLENZ) are contained in the same directory as this document.

All new changes which were done in the code are commented and marked with "!AL1WD", so you can easily find them. Only exception in this is the subroutine ACMRIPP, which whole code is 'new'. Along the code are several comments, that should help you in understanding the code.

In the exercise you should find and identify the changes in the code and invent switches for the new turbulent scheme so, that a clean transition between old code (Louis scheme or pTKE scheme) and the new code (eTKE scheme) is possible.

2 Changes

List of changes(cycle CY35t1):

1. New subroutines ACTKEHMT and ACTKECOEFK for eTKE scheme (equivalent with full TKE scheme) have been added to the code. They are counterparts of ACHMT and ACCOEFK subroutines (Louis scheme).

   ACTKEHMT computes primary drag coefficients PCD(C_M) and PCH(C_H) and ACTKEHMT computes primary exchange coefficients PKUROV(K_m), PKTROV(K_h) and PKNROV(K_N).

   The difference between ACHMT and ACCOEFK and in ACTKEHMT and ACTKECOEFK is in the computation of stability functions - ZFMTKE(F_m), ZFTTKE(F_h) and in different computation of parameters for 'dry' antifibrillation scheme : ZAU(α_u), ZAT(α_θ) according to new stability functions $F_{m/h}$.

   Stability functions $F_{m/h}$ are computed from stability functions $\chi_3(Ri)$, $\phi_3(Ri)$, which can be from modified CCH02 scheme or from fitted QNSE scheme. This two options are controlled by the switch LCOEFK_QNSE (TRUE=QNSE).

   Form of stability functions $\chi_3(Ri)$, $\phi_3(Ri)$ is dependent on the values of parameters: C3TKEFREE (C_3), ETKE_RIFC(Ri_{fc}), ETKE_R (R) , ETKE_3LAM0($3\lambda_0$),ETKE_Q(Q) and NUPTKE(ν). There are only 3 degrees of freedom in this system of parameters. We have chosen ν, R, Ri_{fc} to be inputs for the turbulent scheme. All other parameters are computed in subroutine SUPHY0.

   ACTKECOEFK doesn't compute Richardson number (Ri) - ZRITKE directly, but gets it as input PMRIPP (Ri''). PMRIPP is computed in subroutine ACMRIPP.

   Correction for moist gustiness is no longer applied in ACTKECOEFK. It is shifted into subroutine ACMIXELEN.

2. New subroutine ACMRIPP has been added to the code. It's purpose is to compute Richardson number, which embraces shallow convection modification with it's antifibrillation correction, PMRIPP - Ri''.

   ACMRIPP also computes shallow convection cloudiness PNEBCVPP, correction for moist gustiness PRRCOR=$\sqrt{\gamma^{PRC}}$ and Brunt–Väisälä frequency - PNBVNO=$\left(\frac{N}{\rho g}\right)^2$, which corresponds to Ri''. All these arrays are on half levels.

   Turbulent scheme (modified CCH02 or fitted QNSE) is again given by the switch LCOEFK_QNSE.

3. Subroutine ACPTKE (TKE solver) has been modified. Computation of parameters K_E - ZKERV and $\frac{\Delta t}{\tau_\epsilon}$=ZTAUITKE is influenced by

   PSTAB_ZKERV=$\frac{\chi_3(Ri)^{\frac{3}{2}}}{f(Ri)^{\frac{3}{4}}}$ (function of Richardson number), which is computed for eTKE scheme in ACTKEHMT and ACTKEECOEFK or is set to 1.0 for pTKE scheme.

4. Subroutine ACMIXELEN (computation of TKE mixing lengths) has been modified. Conversion between Prandtl-type mixing length PLMU and TKE mixing length PLML is now influenced by function of Richardson number: ZRXTERM=$\frac{f(Ri)^{\frac{1}{4}}}{\chi_3(Ri)^{\frac{1}{2}}}$.

   ZRXTERM is computed from 'dry' Richardson number (without shallow convection) or from Richardson number with 'moist' AF scheme - Ri'' - PMRIPP(new input). The choice is controlled by new input switch LLCOEFK_RIPP(TRUE=Ri"). This choice is needed, because ACMIXELEN is called twice - before ACMRIPP and after ACMRIPP.

   Additionally a correction for moist gustiness with PRRCOR(new input) is applied on outgoing mixing lengths.