****
Description of ECHAM5-HAM, version used for MPACE model intercomparison
Corinna Hoose, ETH Zurich, Institute for Atmospheric and Climate Science
August 2006
****

Scientist:
- Name
Corinna Hoose
- Affiliation
ETH Zurich, Institute for Atmospheric and Climate Science
- Address
Universitatsstrasse 16, CH-8092 Zurich, Switzerland
- Email address
corinna.hoose@env.ethz.ch
- Fax number
+41 44 633 1058

Model Name and History:
- Long name [model/variant]
echam5301_HAM_E5301_1.51_CDNC_0.12_ICNC
- Acronym (to be used in graphics & data files naming)
ECHAM5-HAM
- Short/conversational name (other than acronym, if any)
ECHAM5
- Generic predecessor or relative (name/variant, and acronym, whether or not it also takes part in this study)
ECHAM4

Model Type:
1D (single column version of the general circulation model with the same physics)
Numerical Domain:
- Domain size in x-direction:
1.875 degrees (T63)
1.125 degrees (T106) (sensitivity study 3)
- Domain size in y-direction:
1.875 degrees (T63)
1.125 degrees (T106) (sensitivity study 3)
- Domain size in z-direction:
surface to 10 hPa
- Number of grid points in x-direction:
1
- Number of grid points in y-direction:
1
- Number of grid points in z-direction:
31
98 (sensitivity study 3)
- Grid size in x-direction:
1.875 degrees (T63)
1.125 degrees (T106) (sensitivity study 3)
- Grid size in y-direction:
1.875 degrees (T63)
1.125 degrees (T106) (sensitivity study 3)
- Grid size in z-direction (if stretched please specify):
hybrid sigma-levels
- Time step
900s
360s (sensitivity study 3)

Numerical Technique:
- Numerical method (finite-difference, spectral, etc.):
vertical: finite-difference, horizontal (in the GCM): spectral
- Advection scheme and its order of accuracy:
flux form semi-Lagrangian scheme (Lin & Rood, 1996)
- Time scheme and its order of accuracy:
semi-implicit based on Robert et al. (1972)
- Dynamical equations (elastic, anelastic, etc.):
anelastic
- Numerical diffusion (type, order, magnitude of coefficient)
- Lateral boundary conditions:
- Upper boundary condition (Sponge layer, specification, ...):
- Translation velocity of the reference frame
- Other information

Physical Parameterizations:
- Surface flux parameterization for heat, moisture, momentum:
similar to Louis (1979)
- Longwave radiation parameterization:
RRTM scheme (Mlawer et al., 1997)
- Shortwave radiation parameterization:
Fouquart & Bonnel (1980)
- How were radiative fluxes above the computational domain handled?
- Microphysical (2D/3D models) or cloud/convective (1D model)
parameterization: type, number
of hydrometeor classes, ...
Prognositc equations for cloud liquid water, cloud ice, cloud droplet
number concen and
ice crystal number concentration.

Aerosol activation:
Lin & Leaitch (1997)

Autoconversion:
Khairoutdinov & Kogan (2000)

Ice nucleation:
Contact freezing after Levkov et al. (1992) with a
temperature-dependent number of contact IN after Young (1974).
Immersion freezing after Lohmann & Diehl (2006) with the maximum
number of IN (parameter Bhi) prescribed from the MPACE intercomparison
document, multiplied by the surface fraction of BC.

Cloud cover: diagnostic with a statistical-dynamical approach (Tompkins,
2002)

- Turbulence closure scheme (turbulence closure type, variables
predicted and diagnosed by - -
the turbulence closure, closure for turbulent length scale, ...)
Eddy diffusivity model (K-model) with a TKE-1.5-closure, prognostic
equation for the TKE

- Other information
Aerosol specifications:
Accumulation and coarse mode aerosol prescribed as detailed in the
MPACE intercomparison document. Mass components: 70% sulfate, 30%
black carbon.

Documentation:
Please provide references that more fully describe your model.
- Documentation (present model), if available.
Detailed model description: Roeckner et al. (2003)

Diehl, K. & S. Wurzler (2004), Heterogeneous drop freezing in the immersion mode: Model calculations considering soluble and insoluble particles in the drops, Journal of the Atmospheric Sciences 61, 2063-2072

Khairoutdinov, M. & Y. Kogan (2000), A new cloud physics parameterization in a large-eddy simulation model of marine stratocumulus, Monthly Weather Review 128, 229-243

Levkov, L. B. Rockel, H. Kapitzka, and E. Raschke (1992): 3D mesoscale numerical studies of cirrus and stratus clouds by their time and space evolution, Beitr. Phys. Atm. 65, 35-58

Lin, H. & R. Leaitch (1997), Development of an in-cloud aerosol activation parameterization for climate modelling, Proceedings from the WMO Workshop on Measurements of Cloud Properties for Forecasts of Weather and Climate, Mexico City.

Lohmann, U. & K. Diehl (2006), Sensitivity studies of the importance of dust ice nuclei for the indirect aerosol effect on stratiform mixed-phase clouds, Journal of the Atmospheric Sciences 63(3), 968-982

Lohmann, U. (2002), Possible aerosol effects on ice clouds via contact nucleation, Journal of the Atmospheric Sciences 59, 647-656

Lohmann, U., J. Feichter, C. C. Chuang & J. E. Penner (1999), Prediction of the number of cloud droplets in the ECHAM GCM, Journal of Geophysical Research 104(D8), 9169-9198

Roeckner, E., Baeuml, G., Bonventura, L., Brokopf, R., Esch,M., Giorgetta, M., Hagemann, S., Kirchner, I., Kornblueh,L., Manzini, E., Rhodin, A., Schlese, U., Schulzweida, U. and Tompkins, A. (2003), The atmospheric general circulation model ECHAM5. PART I: Model description, Report 349, Max Planck Institute for Meteorology, Hamburg, Germany, available from http://www.mpimet.mpg.de

Stier, P., J. Feichter, S. Kinne, S. Kloster, E. Vignati, J. Wilson, L. Ganzeveld, I. Tegen, M. Werner, Y. Balkanski, M. Schulz & O. Boucher (2005), The aerosol-climate model ECHAM5-HAM, Atmospheric Chemistry and Physics 5, 1125-1156

Young, K. C. (1974): A numerical simulation of wintertime, orographic precipitation. Part I: Description of model microphysics and numerical technique. Journal of the Atmospheric Sciences 31, 1735-1748

Other remarks:
Both periods: The SCM version of ECHAM5 does not allow nudging, so the horizontal winds are prescribed instead of nudged.
Ozone was used from the model-climatology and not from the arctic profile, but the values are very similar.
Surface sensible & latent heat fluxes are diagnosed varibales in ECHAM5 and cannot be directly prescribed. We have found a fix for this by prescribing the turbulent heat and moisture tendency in the lowest

layer in dependency of the surface fluxes from the analysis.
This way the diagnosed fluxes match pretty well the analysis data.