Documentation of SPEEDY Version 32

by

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1 Installation and running code

The tar file:

speedy_zagreb.tar

contains all files needed to run the SPEEDY AGCM at T30L7 resolution.

Results from a earlier, 5-level configuration, (version 23) are presented in the paper:

'Atmospheric simulations using a GCM with simplified physical parametrizations. I: Model climatology and variability in multi-decadal experiments', by F. Molteni, Climate Dynamics (2003).

Papers relevant to the models dynamical core are Held and Suarez (1994) as well as Bourke (1974).

To run the model, please follow the following steps.

1. untar the file: tar -xvf speedy_zagreb.tar
2. cd speedy_zagreb

   After that, the command 'ls -l' will return the following:

   drwxr-xr-x data/

   drwxr-xr-x hflux/

   drwxr-xr-x input/

   drwxr-xr-x output/

   drwxr-xr-x run/

   drwxr-xr-x source/

drwxr-xr-x tools/

drwxr-xr-x tmp/

drwxr-xr-x update/

drwxr-xr-x ver32.input/

The 'source' directory contains the version-32 code and the boundary input data is stored in the 'data' directory. Unlike other subdirectories, it may be moved outside the working directory

3. In the 'run' directory, the script 'run_exp.s' prepares and runs an experiment as abackground job.

4. Now you may try to run your first experiment running the run_exp.s script as follows:

   run_exp.s t30 002 0

   The three input parameters have the following meaning:

   t30 : horizontal resolution

   002 : experiment no.

   0 : no. of previous exp. for restart (0 means you start from an atmosphere at rest and no restart file is needed)

   The script first allows you to update the files contained in directory 'ver32.input' using the emacs editor, which also shows you the content of a documentation file (don't change anything as a first test!); then the script copies into the dir. tmp the content of the following directories:

source : SPEEDY master source for ver.32

ver32.input : 4 files setting model constants and time-stepping parameters

update : copies of any piece of model code which you wish to modify

Initially, 'update' contains the model 'makefile' which you have to modify appropriately.

In doing so, any file in 'ver32.input' and 'update' will replace the original versions contained in source. Also, the script creates a subdirectory named e.g. 'exp_002' in dir. 'input' containing all your input/update files, and a 'run_setup' text file with the 4 input parameters. In this way, all data needed to rerun an experiment are saved.

After copying files, the fortran code is compiled interactively in dir. 'tmp', an executable is created, links to the boundary-condition files are set up and the model is run. The model output is temporarily kept in dir. 'tmp' and moved to dir. 'output/exp_002' at the end of the integration.

5. Check your 'input' and 'output/exp_002 directories, and compare the files for your exp (002) with the examples given from a test experiment (001) run at ICTP with the same code and parameters. Obviously, you will not get exactly identical binary files, but results should be comparable.

1.1 Output files

In the following all output files per experiment are listed, where 'nnn' is a 3 digit experiment id (e.g. 002; to be defined when running the run-script) and 'yyyy' are 4 digit years, starting from that year given in 'cls_instep.h' as 'IYEAR0'.

atgcm'nnn'.lis : a printed list with check messages and figures;

atgcm'nnn'.lst : a restart file, with one (in this case) or multiple restart datasets;

attm'nnn'.ctl : GRADS control file for time-mean fields

attm'nnn'_'yyyy'.grd : GRADS data file (one for each year) for time-mean fields

atva'nnn'.ctl : GRADS control file for variance/covariance fields

atva'nnn'_'yyyy'.grd : GRADS data file (one for each year) for var./cov. fields

atdf'nnn'.ctl : GRADS control file for diabatic heating fields

atdf'nnn'_'yyyy'.grd : GRADS data file (one for each year) for heating fields

daytm'nnn'.ctl : GRADS control file for daily output

daytm'nnn'_'yyyy'.grd GRADS data file (one for each year) for daily output

Please note that, while the time-mean and variance/cov. fields are on pressure levels (as in .ctl file), the diabatic heating fields are on model (sigma) levels.

1.2 Input parameters

The input parameters defined in file 'cls_instep.h' that are edited when running the model are as follows

NMONTS = Integration length in months

NDAYSL = No. of days in the last month of int. (max=30)

NSTEPS = No. of time steps in one day

NSTDIA = Period (no. of steps) for diagnostic print-out

NSTPPR = Period (no. of steps) for post-processing

NSTOUT = Period (no. of steps) for time-mean output

IDOUT = daily output flag (0=no, 1=basic (Z500,PREC,MSLP,TEMP0), 2=full)

NMONRS = Period (no. of months) for restart file update

ISEASC = Seasonal cycle flag (0=no, 1=yes)

IYEAR0 = Year of initial date (4-digit, eg 1900)

IMONT0 = Month of initial date (1 to 12)

NSTRAD = Period (no. of steps) for shortwave radiation

NSTRDF = Duration of random diabatic forcing (0 : no forcing, $\geq$: no. of initial steps, ≤ 0 : whole integration)

INDRDF = Initialization index for random diabatic forcing

IALST = anomaly flag for land-surface temp. (0=no, 1=slab-model)

IASST = anomaly flag for sea-surface temp. (0=no, 1=prescribed, 2=slab-model, 3=prescr.+slab-model)

IAICE = anomaly flag for sea-ice temp. (0=no, 1=slab-model)

ISST0 = record in SST anomaly file corr. to the initial month

LPPRES = Flag to post-process upper-air fields on pressure levels (.false. for model level p.p.)

1.3 Input files

Delivered in the speedy package are the input file (boundary conditions) necessary to run speedy. These are linked to the 'tmp' directory by the inpfiles.s script that is optionally edited when running the run scripts. The input files are stored in 'data/bc/'hres'/clim' 'data/bc/'hres'/anom', where the horizontal spectral resolution 'hres' is t21 or t30.

The following input files (Grads format) are needed ('hres' refers again either to t21 or t30):

Necessary climatological files in 'data/bc/'hres'/clim'

1. orog_lsm_alb.'hres'.grd : Orography, land-sea mask and Albedo definitions.

2. sst_8190clim.'hres'.sea.grd : Climatological sea surface temperatures (averaged from 1981 to 1990).

3. seaice_8190clim.'hres'.sea.grd : Sea-ice distribution.

4. skt_8190clim.'hres'.land.grd : Land skin temperature distribution.

5. sndep_8190clim.'hres'.land.grd : Snow depth.

6. veget.'hres'.land.grd : vegetation cover.

7. soilw_8190clim.'hres'.land.grd : Soil wetness.

Optional anomaly files in 'data/bc/'hres'/anom', needed if in 'cls_instep.h' IASST = 1.

1. sst_anom_7990.'hres'.grd : sea surface temperature anomalies from 1979 to 1990 with respect to the period 1981 to 1990.

2 Structure of the program

Generally names of the files containing subroutines are as follows:

'purpose'_'subroutine'.f,

where 'purpose' stands for 'ini' (related to initialization), 'dyn' (dynamics), 'phy' (physics), 'spe' (spectral transformation) and 'ppo' (post-processing). It follows the name of the main subroutine of the file.

2.1 Calling tree

The calling tree has to be read from top to bottom (subroutine call tree) and from left to right (sequence of subroutine calls from one program or subroutine). Therefore, first go as far to the bottom as possible, then in the deepest layer as far to the right as possible and back up to the next layer, to the right as far as possible. And so on and so forth....

Keep in mind that not every subroutine call is present in the calling tree. We focussed rather on main subroutine calls (those who determine the names of subroutine files as discusses above).

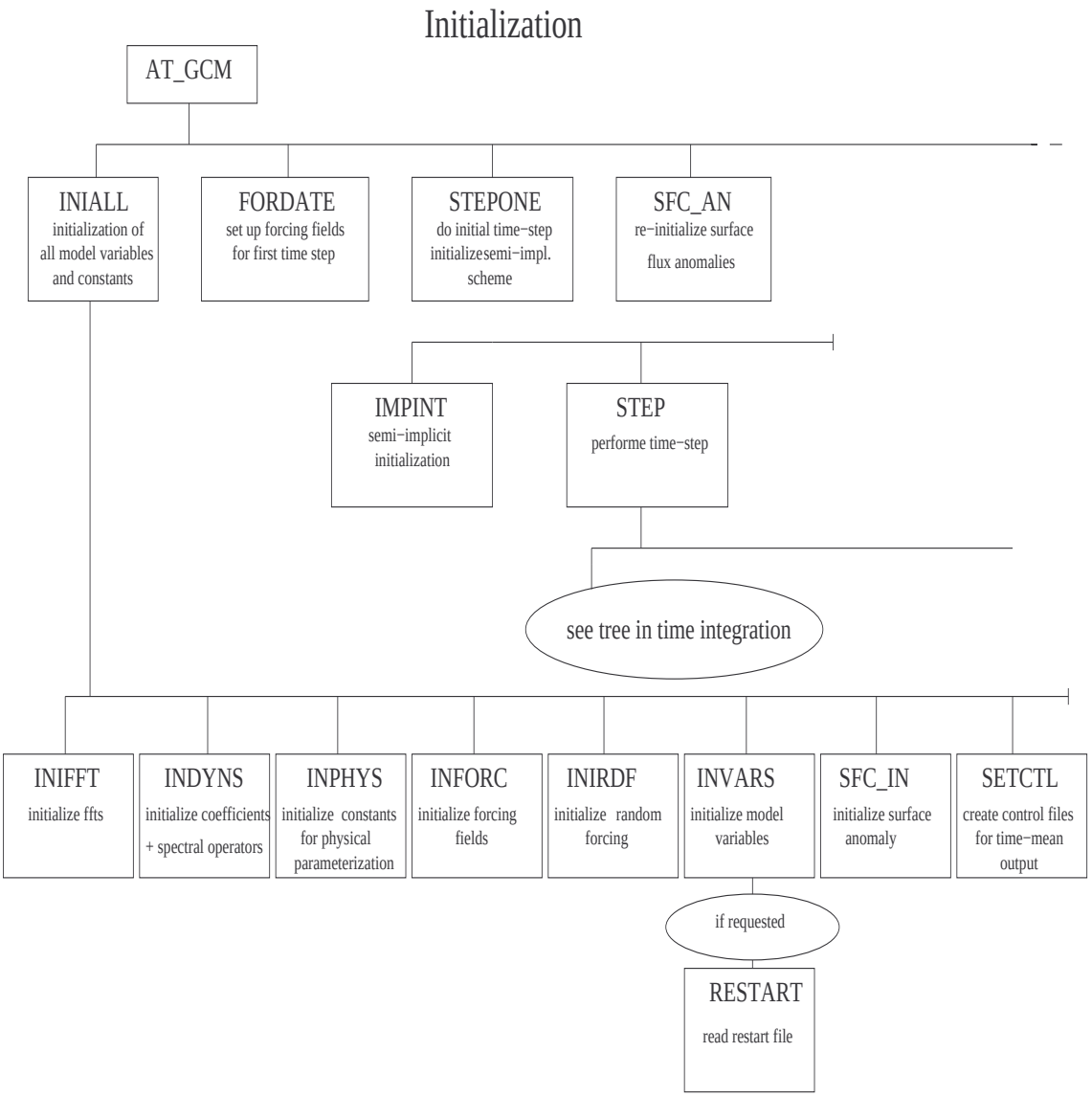

Figure 1: Call Tree of speedy: Initialization phase.

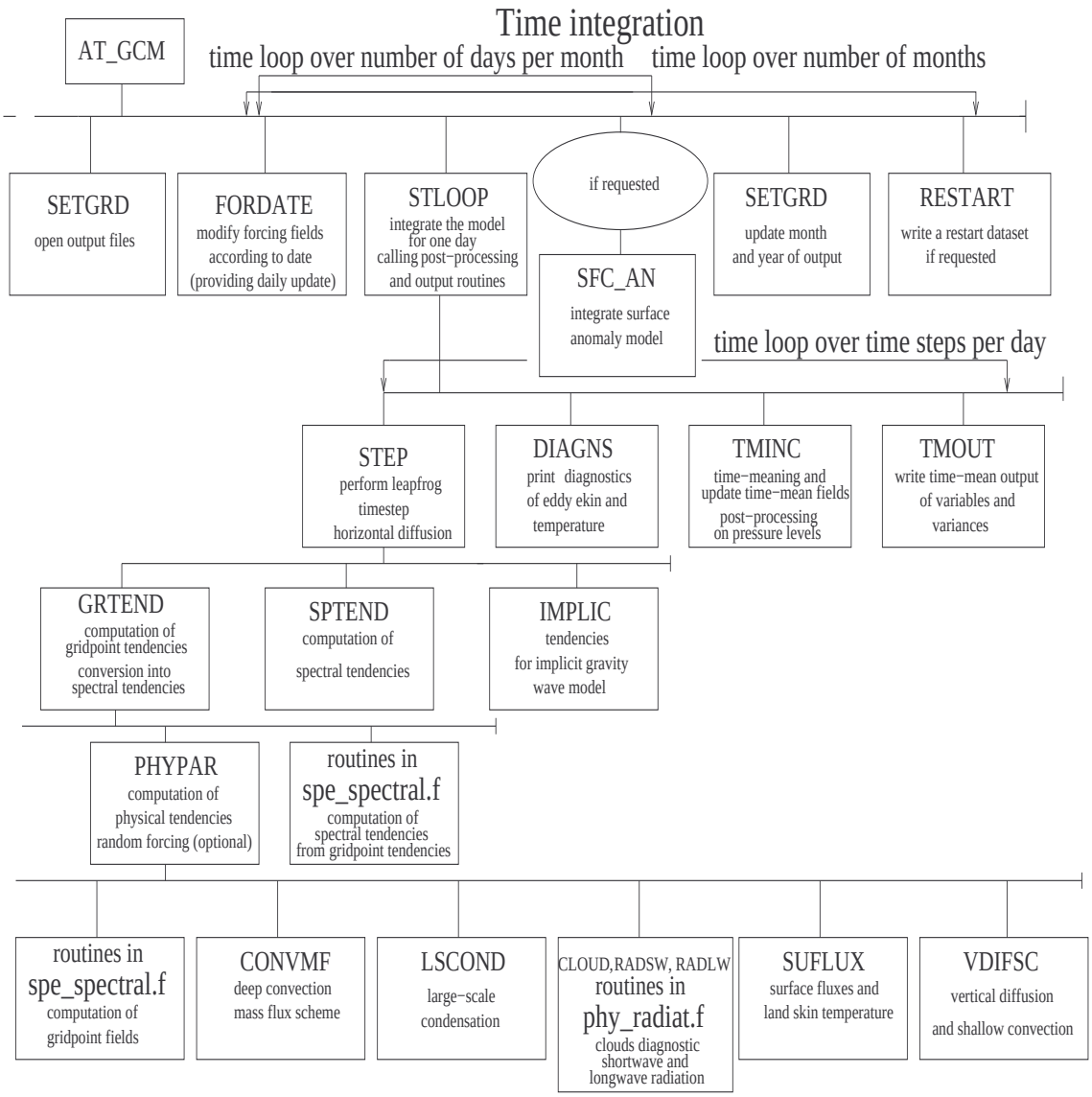

Figure 2: Call Tree of speedy: Time integration phase.

3 Running speedy with surface anomaly model

For the surface anomaly model, 3 options are available:

1. IALST = 1: for land-surface anomaly
2. IASST = 2: uses a slab-ocean model
3. IAICE = 1: for ice-temperature anomaly model

These 3 options can obviously be combined to run the land-surface anomaly, slab-ocean model and the ice-temperature anomaly model simultaneously, or one

can, for example, just run the land-surface model by setting IALST = 1, IASST = 0, IAICE = 0.

For the standard configuration delivered the file 'hflux/clim_hflux_573.grd', derived from a 10-year control run with climatological sst. This file can be used to drive the surface anomaly models as long as no parameters in 'cls_indyns.h' or 'cls_inphys.h' are changed.

3.1 Creating new heatflux climatology

If something is changed in the models physical or dynamical parameter settings, a new heatflux climatology has to be created. The procedure to create such a file is to time-average and write to a separate file the variable SSHF and LSHF listed in the attm'nnn'.ctl file of an experiment output (preferably at at least run for 50 years), which was run with climatological sst and the modifications to the dynamics or physics. The averaging has to be performed for every month a the year separately. The file has to be a direct access file. An example GRADS and unix script to perform the averaging is stored in the directory 'tools': 'calc_hflux_clim.s' calls 'calc_hflux_clim.gs'.

4 References

Bourke, W., 1974: A multi-level spectral model. I. Formulation and Hemispheric integrations, *Mon. Wea.r Rev.*, **102**, 687-701

Held, I. M. and Suarez, M. J., 1994: A proposal for the intercomparison of the dynamical cores of atmospheric general circulation models, *Bull. Amer. Meteor. Soc.*, **75**, 1825-1830

Molteni, F., 2003: Atmospheric simulations using a GCM with simplified physical parameterizations. I. Model climatology and variability in multi-decadal experiments, *Climate Dynamics*, **20**, 175-191