Quick start for SPEEDY Version 41.5

by

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1 Installation and running code

The tar file:

speedy_ver41.5.tar

contains all files needed to run the SPEEDY AGCM at T30L8 resolution.

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

Molteni F (2003) Atmospheric simulations using a GCM with simplified physical parametrizations. I. Model climatology and variability in multi-decadal experiments. Clim Dyn 20: 175-191

Results from an earlier 8-level configuration, (version 40) are presented in the paper:

Kucharski F, Molteni F, and Bracco A (2006) Decadal interactions between the western tropical Pacific and the North Atlantic Oscillation. Clim Dyn 26: 79-91

Results from an earlier 8-level configuration, (version 41) are presented in the paper:

Kucharski, F, Molteni F, King, M P, Farneti, R, Kang, I-S, and Feudale, L (2013) On the need of intermediate complexity general circulation models: a 'SPEEDY' example.
BAMS 94: 25-30, DOI: 10.1175/BAMS-D-11-00238.1

Papers relevant to the models dynamical core are Held and Suarez (1994), Bourke (1974), as well as Amezcua et al. (2011).

A full documentation and verification web-page can be accessed at:
http://users.ictp.it/~kucharsk/speedy-net.html

To run the model, please follow the following steps.

1. untar the file: tar -xvf speedy_ver41.tar

2. cd speedy_ver41

   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 ver41.5.input/

   The 'source' directory contains the version-41.5 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 101 0

   The three input parameters have the following meaning:

   t30 : horizontal resolution

101 : 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 'ver41.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 ver41.5

ver41.input : 6 files setting model constants, time-stepping parameters and input files

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 'ver41.input' and 'update' will replace the original versions contained in source. Also, the script creates a subdirectory named e.g. 'exp_101' 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_101' at the end of the integration.

5. Check your 'input' and 'output/exp_101 directories, and compare the files for your exp (101) with the examples given from a test experiment (100) 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. 101; 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: no. of (complete) months

NDAYSL = No. of additional days in the last month of int.

NSTEPS = No. of time steps in one day

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

NSTPPR = Frequency (no. of steps) of post-processing

NSTOUT = Frequency of time-mean output:

< 0 : monthly means, > 0 : no. of steps

IDOUT = daily output flag:

0 = no, 1 = basic (mslp, temp0, gh500, prec),

2 = as 1 + U/V/Q_850 and U/V_200 hPa,

3 = as 2 + evap, ustr, vstr, olr, lshf, sshf

NMONRS = Frequency (no. of months) of 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 = Frequency (no. of steps) of shortwave radiation comp.

NSTRDF = Duration of random diabatic forcing (0 : no forcing,

> 0 : no. of initial steps, < 0 : whole integration)

INDRDF = Initialization index for random diabatic forcing

ICLAND = coupling flag for land-surface temp. (0=no, 1=land-model)

ICSEA = coupling flag for sea-surface temp.

0 = precribed SST, no coupling

1 = precribed SST, ocean model forced by atm.

2 = full (uncorrected) SST from coupled ocean model

3 = SST anomaly from coupled ocean model + obs. SST clim.

4 = as 3 with prescribed SST anomaly in ElNino region

ICICE = coupling flag for sea-ice temp. (0=no, 1=ice-model)

ISSTAN = SST anomaly flag: 0 = no (clim. SST), 1 = observed anomaly

(active if ICSEA = 0, 1; set to 1 if ICSEA = 4)

ISSTY0 = initial year of observed SST anomaly file

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

month (computed from ISSTY0 or reset by user)

LPPRES = Flag to post-process upper-air fields

on pressure levels (.false. for model level p.p.)

LCO2 = Flag to include exponential CO2 absorbtivity increase

(.false.= no CO2 increase,

.true.= exponential CO2 absorbtivity increase)

1.3 Input files

Delivered in the speedy package are the input file (boundary conditions) necessary to run speedy. These are derived from the ECMWF re-analysis (ERA Interim, see Dee et al., 2011), and 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 t30 or t47.

The following input files (Grads format) are needed ('hres' refers again either to t30 or t47):

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

1. orog_lsm_alb.'hres'.grd : Orography, land-sea mask and Albedo definitions.
2. sst_7908clim.'hres'.sea.grd : Climatological sea surface temperatures (averaged from 1979 to 2008).
3. seaice_7908clim.'hres'.sea.grd : Sea-ice distribution.
4. surfv_st3_7908clim.'hres'.land: Land temperature distribution.
5. sndep_7908clim.'hres'.land.grd : Snow depth.
6. veget.'hres'.land.grd : vegetation cover.
7. soilw_7908clim.'hres'.land.grd : Soil wetness.

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

1. hadisst_anom_1_1_1870_2016_mean1979_2008.'hres'.grd: sea surface temperature anomalies from 1870 to 2016 with respect to the period 1979 to 2008 derived from the Hadley Centre Sea Ice and Sea Surface Temperature data set (HadISST; Rayner et al., 2003).

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), 'cpl' (coupling to land and sea) 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).

The anatomy of SPEEDY:

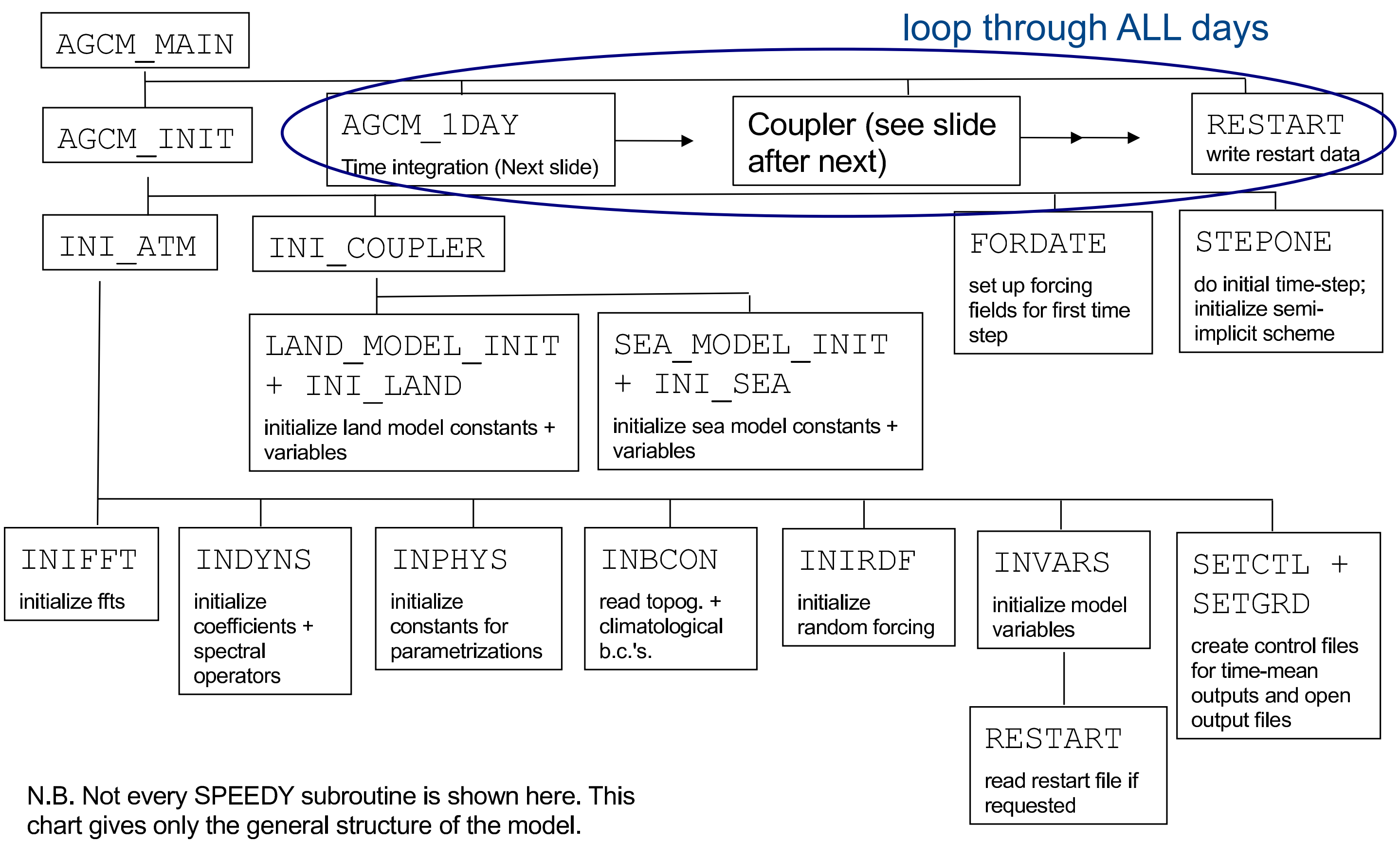

Figure 1: Call Tree of speedy

The anatomy of SPEEDY:

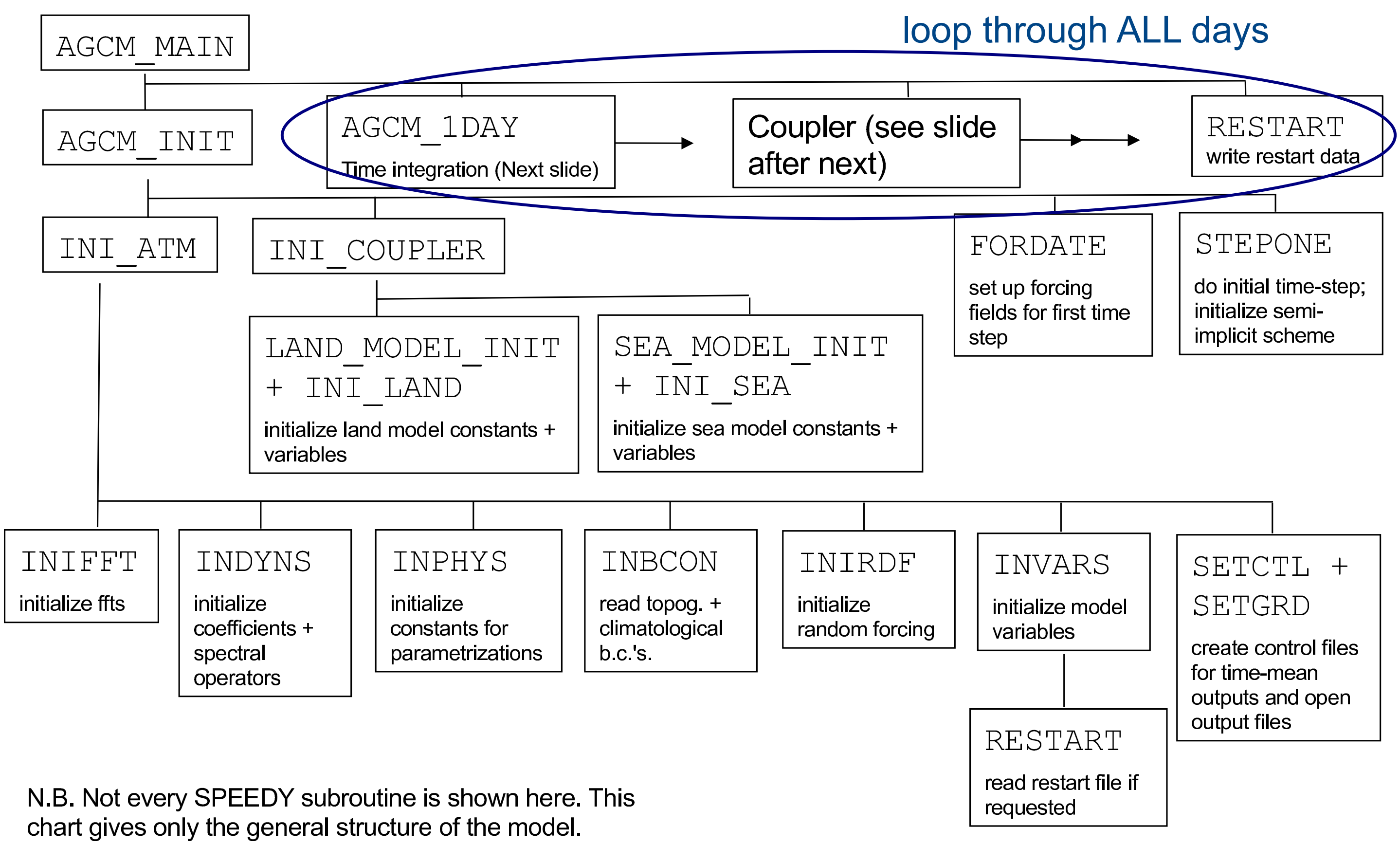

Figure 2: Call Tree of speedy: Continued

3 Running speedy with modeled surface temperature anomalies

For the surface anomaly model (slab model), 3 options are available:

1. ICLAND = 1: uses land-surface temp. anomalies
2. ICSEA = 2: uses a slab-ocean model
3. ICICE = 1: uses ice-temp. anomalies

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 ICLAND = 1, ICSEA = 0, ICICE = 0. The default configuration is

1. ICLAND = 1
2. ICSEA = 0
3. ICICE = 1

This runs a surface temperature anomaly model over land and ice, whereas over the ocean SST-anomalies (ISSTAN=1) or climatological SSTs can be prescribed (ISSTAN=0).

For running the ocean mixed layer model, a heat-flux climatology has to be prescribed. For the standard configuration delivered the file 'hflux/hflux_speedy_ver41.5_1979_2008_clim.grd', derived from a 30-year control ensemble run with observed sst. This file can be used to drive the ocean mixed layer model as long as no parameters in 'cls_indyns.h' or 'cls_inphys.h' are changed. It must be included in the 'inpfiles.s' file.

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 for running the ocean mixed layer. 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

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