K. <u>How to Run the Model</u>

The NCAR CSM Ocean Model Job Script

Two job scripts are provided by the NCAR CSM ocean model developers: one which compiles the ocean model and creates a binary to be used in the coupled model system, and another which compiles and executes the stand-alone ocean model. Both scripts are intended to be self explanatory and are designed to reduce the possibility of set-up errors, but because there are certain features which may need some additional explanation, this section provides supplementary documentation.

Starting and Restarting the NCAR CSM Stand-Alone Ocean Model

There are several procedures for starting and restarting the NCAR CSM ocean model, depending on the options chosen by the user. Originally, the CSM model had only one method for starting the model and one for restarting it, but the subsequent addition of an automatic restart option and an option to create a new run based on restart files from another case increased the number of start/restart procedures to five.

The MOM 1.1 produced a single restart file, containing all the necessary time levels of information. A major disadvantage of a single restart file is that the file size gets unmanageably large as the model resolution becomes finer. Consequently, the NCAR CSM ocean model produces three restart files. The R2 restart file contains the time information, barotropic streamfunction variables, and the accumulated ice formation (when *sflxiceflx* is defined). The required two time levels of the potential temperature, salinity, and horizontal velocity fields are stored in two of the R3, R4, or R5 restart files. The empty restart file is determined automatically by the code itself based on the number of time levels stored internally.

The autorestart feature was added for the user's convenience: it allows the same job script to be submitted for multiple continuation runs, completely unaltered. The user need not provide restart file names in the script; rather, this information is read from a "pointer" file and the ocean model, during execution, then reads the most recent restart files from the NCAR mass-storage system. The autorestart option is selected by setting the script-control variable *autorestart* = yes, which in turn adds *autorestart* to the list of all preprocessor options.

Whether or not the autorestart feature is selected, the standard method of starting an initial CSM ocean model run is to set the following script variables: *initial_run* = yes, *nb*=0, *restart_flag* = false, and then to provide initial conditions for the starting date of the model integration. Typically, mean January Levitus values have been used. The length of the model integration is controlled by setting *numsteps*, the total number of timesteps for the run. The job script then sets the model variable, *nlast*, to *numsteps*.

Because there are situations in which modelers want to start a new model run from initial conditions provided from a prior run, but want to reset the starting time, a variant start-up option is available: set *initial_run* = yes and *nb*=0, but set *restart_flag* = true, and provide the names of the R2, R3, R4, and/or R5 restart files. This is one manner in which the ocean model may be initialized in coupled model runs, and it is valid regardless of the *autorestart* setting.

The method used to continue a model run depends on whether or not the *autorestart* option was chosen in the initial run. If *autorestart* was not in effect, the model run is continued by setting *initial_run* = no, *nb* = *itt*, the timestep number from the last restart file, *restart_flag* = true, *autorestart* = no, and by providing the names of the restart files, i.e., the R2, R3, R4, and/or R5 files in the appropriate part of the job script. For each subsequent continuation run, the user must set *nb* = *itt*, and provide the most recent restart-file names. The script will automatically set the value of *nlast* to *nb* + *numsteps*.

If continuing an *autorestart* run, however, the user needs only to set *initial_run* = no and *autorestart* = yes. The user may decide to reset the value of *numsteps* during subsequent continuation runs, but if not, then all continuation runs may be initiated by submitting and resubmitting this continuation script entirely unaltered. The user should note that the script sets *nlast* to *numsteps* in this case; however, the autorestart preprocessor option activates code which sets *nlast* to the last timestep of the previous run, *itt* + *nlast*, thus effectively setting the total integration length to *numsteps*.

Timing and Memory Requirements

Because the model time requirements depend on the particular options chosen, it is impractical to provide precise model timing and memory information for all configurations. However, such information from the 2×2 and 3×3 models with the options presented in this document will provide a useful starting estimate for users who select other model options or run on other computers.

Memory requirements for the ocean model increase with the number of processors selected. Commonly, we run the models at NCAR on Cray YMPs or J90s, with either 8 or 16 processors. The 2×2 model requires 32Mw of memory on a 16-processor machine and 23Mw of memory on an 8-processor machine. The figures for the 3×3 model are 11Mw and 8Mw, respectively. When the preprocessor option *time_average* is chosen, then the model memory requirements increase. The 2×2 model requires 38Mw of memory on a 16-processor machine and 29Mw of memory on an 8-processor machine.

Timing figures are closely linked to the options selected. For our configuration, the 2×2 model uses approximately 19 cpu seconds per timestep on a Cray J90, and approximately 9 cpu seconds per timestep on a Cray YMP. The comparable figures for the 3×3 model are 5 and 2.4 cpu seconds, respectively.

Preprocessor Options

This is a list of preprocessor options in effect for standard CSM ocean runs.

	2×2 stand-alone ocean	2×2 coupled ocean/atmosphere	3×3 stand-alone ocean
Numerical options	congrad5pt islands fourfil northpole taperhrzvd upwind3	congrad5pt islands fourfil northpole taperhrzvd upwind3	congrad5pt islands fourfil northpole taperhrzvd
Model resolution	(default)	(default)	model3x3
Vertical sub-grid-scale mixing	implicitvmix kmix	implicitvmix kmix	implicitvmix kmix
Horizontal and isopycnal sub-grid-scale mixing	consthmix isopycmix isopycmixspatialvar	consthmix isopycmix isopycmixspatialvar	consthmix isopycmix isopycmixspatialvar
Surface forcing options	sflxcombo sflxcomboavan sflxiceflx sflxsw restormed	sflxpvm sflxpvmicetilt sflxiceflx sflxsw	sflxcombo sflxcomboavan sflxiceflx sflxsw
Boundary conditions	cyclic	cyclic	cyclic
Input/Output	diskless	diskless	diskless
Model performance and monitoring	multitasking readchunk timing	multitasking readchunk timing	multitasking timing
Conveniences	autorestart readrmsk	autorestart readrmsk time_average	autorestart readrmsk

Forcing files for the 2x2 model

Grid and forcing input files are stored on the NCAR Mass Storage System. These files are read from the MSS in the job shell script as follows:

msread fort.61 /NJN01/CSM/2DEG45L/AUX/tauu_x2_mmid.85-88

msread fort.62 /NJN01/CSM/2DEG45L/AUX/tauv_x2_mmid.85-88

msread fort.71 /NJN01/CSM/2DEG45L/AUX/sst_x2_mid.str

msread fort.72 /NJN01/CSM/2DEG45L/AUX/lev_sss_x2_mm.ieee

msread fort.73 /NJN01/CSM/2DEG45L/AUX/t_x2_mmid.85-88

msread fort.74 /NJN01/CSM/2DEG45L/AUX/q_x2_mmid.85-88

msread fort.75 /NJN01/CSM/2DEG45L/AUX/aqcl_x2_mid.85-88

msread fort.76 /NJN01/CSM/2DEG45L/AUX/afrc_x2_mid.85-88

msread fort.77 /NJN01/CSM/2DEG45L/AUX/pmsu_x2_mid.85-88

msread fort.78 /NJN01/CSM/2DEG45L/AUX/s_x2_mmid.85-88

msread fort.80 /MORZEL/CSM/2DEG45L/AUX/topo.smth5.2xcoar.msea

Forcing files for the 3x3 model:

msread fort.61 /MORZEL/CSM/3DEG25L/AUX/tauux3mmid.85-88

msread fort.62 /MORZEL/CSM/3DEG25L/AUX/tauvx3mmid.85-88

msread fort.71 /MORZEL/CSM/3DEG25L/AUX/sstx3mid.str

msread fort.72 /MORZEL/CSM/3DEG25L/AUX/lev_sss_x3_mm.ieee

msread fort.73 /MORZEL/CSM/3DEG25L/AUX/tx3mmid.85-88

msread fort.74 /MORZEL/CSM/3DEG25L/AUX/qx3mmid.85-88

msread fort.75 /MORZEL/CSM/3DEG25L/AUX/aqclx3mid.85-88

msread fort.76 /MORZEL/CSM/3DEG25L/AUX/afrcx3mid.85-88

msread fort.77 /MORZEL/CSM/3DEG25L/AUX/pmsux3mid.85-88

msread fort.78 /MORZEL/CSM/3DEG25L/AUX/sx3mmid.85-88

msread fort.80 /MORZEL/CSM/3DEG25L/AUX/topo.3x.smth5.iceland

When the model is run in coupled mode, the topography file must be accessed, but no forcing files are needed. All the forcing files, but not the topography files, are in IEEE format, and an ASSIGN statement is needed for each file. See the shell script for details.