The CCSM
Climatological Data Ocean Model (docn5)

Version 5.0.1

Combined

User's Guide,
Source Code Reference,
and **Scientific Description**

Mariana Vertenstein and Brian Kauffman

September 2002

Community Climate System Model
National Center for Atmospheric Research, Boulder, CO
http://www.ccsm.ucar.edu/models

CVS Revision `$Revision: 1.7 $` Build date: August 29, 2002

Contents

1 Introduction

The Climatological Data Ocean Model (docn5) functions as the ocean component in a CCSM configuration. Recall that a *configuration* consists of various independent *component models* (e.g. atmosphere, land, ocean, sea-ice), each connected to a *coupler*. The data ocean component interacts with the coupler just like any ocean model would, but it is not an active model. Rather, it takes SST data from an input data file and sends it to the coupler, ignoring any forcing data received from the coupler. The input data file may contain either climatological SST data (e.g. from Shea, Trenberth, & Reynolds) or a time series of multi-year data. Such a "data model" is useful for coupling active atmosphere and land models with climatological or multi-year SST forcing data.

Important note: When assembling a CCSM configuration, the user must carefully consider the limitations and requirements of all components and make sure that the complete set of component models will interact in a meaningful way. In particular, the user must verify that the data provided by this model is adequate for their specific application.

2 Input Datasets

The data ocean model requires two input netCDF datasets: a domain dataset specifying the model grid domain and an SST dataset. The SST dataset contains either yearly climatological or multiyear SST data along with the SST domain grid.

To obtain input datasets, the data ocean model first checks in the current working directory for the required file. If the file is not there, the directory specified by the namelist variable **DATA_DIR** (see below) is examined. If that search is also unsuccessful, the full pathname on disk is finally checked.

2.1 Domain data

On startup, docn5 reads in model domain data from a netCDF file. Data exchanged with the coupler will be on this model domain. The model domain dataset contains values for the longitude grid cell centers, latitude grid cell centers, longitude grid cell vertices, latitude grid cell vertices, grid cell areas and domain mask. Memory is dynamically allocated at startup for variables dependent on the model domain grid.

The 2d domain mask identifies land points. A mask value of 0 indicates land points (i.e. not in the model's domain) and negative values indicate land-locked regions (e.g. the Caspian Sea).

Two domain datasets are currently provided with the distribution:

- **domain.gx1v3_010723.nc**
- **domain.gx3_010202.nc**

Both of these datasets correspond to non-rectilinear grids.

2.2 SST data

On startup, the data ocean model reads in SST data from a netCDF file specified by the namelist variable **DATA_FILE** (see section 3). This file contains either annual or multiyear SST data (in degrees Celsius) along with corresponding SST domain grid information.

An annual SST dataset contains 12 months of climatological SST data (presumably monthly mean fields). A multiyear dataset may contain monthly data spanning more than one year. Annual SST data is cycled, whereas multiyear SST data is not. If the requested model date lies outside the time range for the multiyear SST data, the model will exit with an error statement.

If the SST domain grid is in rectilinear coordinates, docn5 will interpolate the input SST data from the SST domain grid to the model domain grid. SST grids that are in rectilinear coordinates will contain one dimensional x and y coordinate arrays.

If the SST domain grid is in non-rectilinear coordinates, the SST domain grid **MUST** be identical to the model domain grid since docn5 currently does not perform interpolations from one non-rectilinear coordinate grid to another. Non-rectilinear SST domain grids will contain two dimensional x and y coordinate arrays.

An annual SST climatological dataset, **sst.str_970911.nc**, is provided with the distribution. This dataset is in rectilinear coordinates and therefore can be used with any domain dataset provided. If using this dataset, the namelist variable **DATA_FORM**, specifying whether the input dataset contains annual or multiyear data, must be set to 'annual'. Furthermore, the namelist variable, **DATA_SSTNAME**, which specifies the netCDF variable name for the SST data, must be set to 'T'.

Two multiyear SST datasets are also provided with the distribution:

- **AMIP_bcgx1v3_1976-1996_010817.nc**
- **AMIP_bcgx3_1976-1996_011030.nc**

It is important to note that these datasets can only be used only with the corresponding domain datasets, **domain.gx1v3_010723.nc** and **domain.gx3_010202.nc**. If these multiyear SST datasets are used, then **DATA_FORM** must be set to 'multiyear' and **DATA_SSTNAME** must be set to 'SST_cpl'. Furthermore, the namelist variables **DATA_LONNAME** and **DATA_LATNAME** must be set to **'xc'** and **''yc'**, respectfully. They **SHOULD NOT** be set to **nlat** and **nlon**.

2.3 Namelist

On startup, the data ocean model reads an input namelist parameter file from **stdin.ocn**.

3 Namelist

Following is a list and description of available namelist input parameters.

Data Ocean namelist	
REST_TYPE	
Description	restart type (either 'initial' or 'continue')
Type	char*16
Default	'continue'
Required	No
DOMAIN_FILE	
Description	full pathname or filename of domain dataset
Type	char*256
Default	'null'
Required	Yes
DATA_FILE	
Description	full pathname or filename of SST dataset
Type	char*256
Default	'null'
Required	Yes
DATA_FORM	
Description	type of SST data (either "annual" or "multiyear")
Type	char*16
Default	'annual'
Required	No
DATA_SSTNAME	

Description	netCDF variable name of SST field
Type	char*16
Default	'T'
Required	No
DATA_LONNAME	
Description	netCDF variable name of longitude coordinate can be 1d or 2d (for non-rectilinear)
Type	char*16
Default	'xc'
Required	No
DATA_LATNAME	
Description	netCDF variable name of latitude coordinate can be 1d or 2d (for non-rectilinear)
Type	char*16
Default	'yc'
Required	No
DATA_DIR	
Description	full pathname of directory containing input files
Type	char*256
Default	'null'
Required	No
NCPL	
Description	The number of times per day the model exchanges data with the coupler
Type	integer
Default	1
Required	No (assuming the default is appropriate)
INFO_DBUG	
Description	Debugging formation (level:0,1,2,or 3) level 0 => write out least amount of debug info level 1 => write out small amount of debug info level 2 => write out medium amount of debug info level 3 => write out large amount of debug info
Type	integer
Default	1
Required	No
CASE_NAME	
Description	case name
Type	char*16
Default	' '
Required	No
CASE_DESC	
Description	case descriptor
Type	char*64
Default	' '
Required	No

4 Output Datasets

4.1 History Files

The data ocean model does not create history files. The only data associated with this model is the data that is already contained in the input SST dataset.

4.2 Restart Files

The data ocean model does not need or create restart files.

4.3 Runtime Diagnostics

The data ocean model generates diagnostic messages which are written to stdout. This output consists mostly of brief messages that indicate how the simulation is progressing and whether any error conditions have been detected. Stdout also contains a record of the values of all model input parameters.

5 Coupler Data Exchange

This model sends the following fields to the coupler (via message passing):

- SST: surface temperature (Kelvin)
- u: zonal velocity (m/s)
- v: meridional velocity (m/s)
- dh/dx: zonal surface slope (m/m)
- dh/dy: meridional surface slope (m/m)
- Q: heat of fusion (Q>0) or melting potential (Q<0)

The SST data is obtained from the input SST dataset and linearly interpolated in time (and possibly spatially interpolated to the model domain grid). SST data is converted from degrees Celsius to degrees Kelvin before being sent to the coupler. Currently, the remaining fields are set to zero. The data ocean model must send these fields to the coupler due to the coupler/ocean interface requirement. The fields are set to zero because we must assume they might be used by the coupler (or perhaps another component model) and it would seem that zero values are reasonable in this context. The coupler has no way of knowing whether the components it is connected to are active models or data models.

6 Running the Data Model

6.1 Overview

The docn5 cannot run by itself, it can only execute in the context of running the complete CCSM system – a framework that requires atmosphere, ice, land, and ocean components, as well as a coupler component. The scripts that build and run the CCSM system are described in detail in the CCSM2.0.1 User's Guide, a holistic guide to running the complete system. This Guide includes a line-by-line explanation of the master run script and data model "setup scripts". A brief description of the CCSM run scripts is below. See the CCSM User's Guide for complete information.

We briefly note that the docn5 setup script supports the use of either the distributed climatological or multiyear SST datasets depending on the settings of the environment variable **MULTIYEAR_SST** and the ocean grid.

6.2 Master Run Script and Component Setup Scripts

Two levels of c-shell scripts are used to build and run the CCSM system. A master "run script" coordinates the building and running the complete system while the component model "setup scripts" are responsible for configuring each individual CCSM component (including docn5). Each CCSM component setup script is run in its own, separate subdirectory, where its executable resides and in which all of its input and output files are kept. The CCSM execution is controlled by the master script, referred to as "the run script".

The run script has the following tasks:

a. Set batch system options

b. Define common build and run environment variables

c. Select multi-processing and resolution specs

d. Run the setup script for each component

e. Run the CCSM Integration.

f. Archive/harvest/resubmit when this run is finished

The common build and run environment variable defined in the run script are automatically propagated to each of the component model setup scripts. These variables define such things as the machine architecture, the number of CPUs to run on, common experiment and file naming conventions.

Once the master run script has defined the common environment, each of the component models (cpl, atm, ice, lnd, and ocn) are configured using individual component setup scripts (e.g. docn.setup.csh) which:

a. Parse the environment variables sent from the master run script. These are, in effect, input variables that might be required by a setup script or otherwise might alter the behavior of the setup script.

b. Position or create any input data files, as necessary, including input namelist data files and climatological data files.

c. Build the component model executable.

Finally, when all of the component model setup scripts have successfully completed, the run script executes all CCSM components simultaneously. The CCSM component models run simultaneously as a multi-program/multi-data (MPMD) message passing system, using MPI to exchange data.

7 Source Code Maintenance

The code data ocean is written almost entirely using standard Fortran 90. The code does not need to compiled with a particular model resolution in mind. Memory for the particular model resolution is allocated at run time based on data in the SST and domain input files. This code was developed using the CVS revision control system, but only one "tagged" version of the code is available within any one distribution. Each source code file contains detailed revision control information.