M. Model Output Conventions

The NCAR CSM ocean model saves a variety of prognostic and diagnostic quantities to several history files during the course of an integration. In the initial release, the history files are written using Fortran unformatted IO. The choice of file content and format is largely historical, guided by the types of analysis undertaken with the model and by the characteristics of the NCAR Mass Storage System. To make the data more accessible through commonly available visualization and analysis tools, a set of filters have been developed to convert the model's native history files to netCDF files that conform to CSM conventions. This document briefly describes the content of the native history files, the filters and the resulting netCDF files.

Native History Files

The output from the model is stored in a series of history files. If instantaneous output has been generated, these files are named H1, H2, H3, etc. If time-averaged output has been generated, files containing time-averaged data are named H121, H122, H120, etc., as indicated in the table below. Variables are organized roughly into groups that would typically be used together in an analysis. The table below describes the organization of the files. Refer to the model documentation and source code for the definitions of variable names.

Inst. File	Avg. File	Record	Variables
H1	H121	1 - jmt	fitt, fj, ttsec, t(imt,km,nt)
H11	H122	1 - jmt	fitt, fj, ttsec, u(imt,km), v(imt,km), w(imt,kmt)
H2	H120	1	fitt, ttsec, dtuv, psi(imt,jmt)
		2	nconxy(imt,jmt,4)
		3	fitt, ttsec, c2dtuv, err(imt,jmt), dpdx(imt,jmt),dpdy(imt,jmt)
		4	fitt, ttsec, hblt(imt,jmt)
		5	fitt, ttsec, hbml(imt,jmt)
H3	H125	1	fitt, ttsec, ttn(8,jmt,nt), tmt(jmt,km)
		2	fitt, ttsec, ttn2(6:9,jmt,nt,0:nhreg), tmtiso(jmt,km)
H4	—	1	fitt, ttsec, buoy(0:km), plicin, plicex, ekt, engint(8), engext(8)
		2	psile(nisle), Tbarglb(km,nt), Tbarreg(nhreg,km,nt),pnorthpole
H5	H123	1 - jmt	fitt, fj, ttsec, uiso(imt,km), viso(imt,km),wiso(imt,km)
H7	H124	1 - jmt	fitt, fj, ttsec, smf(imt,2), stf(imt,nt), sswt(imt)

File Conversion Filters

While the native file organization provides efficient storage and access on the NCAR MSS, it can be awkward for model analysis purposes. Two filters that convert the data to netCDF format are provided to help ameliorate this problem. The first filter, "filtdiag", converts the model H3 (H125) and H4 file data, and the second, "filtprog", converts the data from the remaining model H-files. Both filters produce netCDF files that conform to CSM conventions for global and variable attributes. Our practice is to store data from multiple times (typically one year's worth) in the "diagnostic" files, and data from a single time in the prognostic files, though this easily configurable at run time. Due to the large number of land points carrying constant fill values in the model output, the files are efficiently (40% to 55%) compressed by standard Unix utilities like compress or gzip.

The output of the filters is minimally configurable at runtime through their input (via namelist IO) as indicated in Appendices A (filtdiag) and B (filtprog). The filters are written in ANSI standard Fortran 90 and have been tested in the NCAR Cray and IBM/RS6000 cluster environments. Example batch queue system scripts are also provided for each of these environments.

netCDF History Files

The netCDF file format is self describing. NCL descriptions of example ocean model netCDF files are included in Appendices C and D.

Appendix A. filtdiag input

group fileinfo
- ncfilenm – (character) – name of output netCDF file
- title – (character) – global attribute title string
- save_kmt – (logical) – save integer depth array in file
- save_rmask – (logical) – save integer basin index array in file

group expinfo
- modver – (character) – global attribute model version string
- case – (character) – global attribute case string
- daypyr – (real) – length of model calendar in days

group trcinfo
- trcname – (character array) – tracer variable names
- trclname – (character array) – tracer long name variable attribute string
- trcunit – (character array) – tracer units variable attribute string
- trcscl – (real array) – tracer scale variable attribute
- trcoff – (real array) – tracer offset variable attribute
- ttnname – (character array) – northward tracer transport variable names
- ttnlname – (character array) – northward tracer transport long name variable attribute string
- ttnunit – (character array) – northward tracer transport units variable attribute string
- ttnscl – (real array) – northward tracer transport scale variable attribute
- ttnoff – (real array) – northward tracer transport offset variable attribute

group basinfo
- basin_nm – (character array) – names of basins in region mask

group auxinfo
- file_kmt – (character) – Unix file name for integer depth data
- file_rmask – (character) – Unix file name for integer region mask data

group inpinfo (repeatable)
- done – (logical) – no more input data to process
- file_h3 – (character) – Unix filename of H3 data
- file_h4 – (character) – Unix filename of H4 data

Appendix B. filtprog input

group fileinfo
- ncfilenm – (character) – name of output netCDF file
- title – (character) – global attribute title string
- save_kmt – (logical) – save integer depth array in file
- save_depth – (logical) – save real valued depth array in file
- save_rmask – (logical) – save integer basin index array in file
- save_ncon – (logical) – save convective adjustment counter data in file
- save_sswt – (logical) – save penetrative radiation flux data in file

group expinfo
- modver – (character) – global attribute model version string
- case – (character) – global attribute case string
- daypyr – (real) – length of model calendar in days
- is_average – (logical) – input history data is already averaged

group trcinfo
- trcname – (character array) – tracer variable names
- trclname – (character array) – tracer long name variable attribute string
- trcunit – (character array) – tracer units variable attribute string
- trcscl – (real array) – tracer scale variable attribute
- trcoff – (real array) – tracer offset variable attribute
- flxname – (character array) – surface tracer flux variable names
- flxlname – (character array) – surface tracer flux long name variable attribute string
- flxunit – (character array) – surface tracer flux units variable attribute string
- flxscl – (real array) – surface tracer flux scale variable attribute
- flxoff – (real array) – surface tracer flux offset variable attribute
- rfillval – (real) – value to use for missing real valued data
- ifillval – (integer) – value to use for missing integer valued data

group auxinfo
- file_kmt – (character) – Unix file name for integer depth data
- file_rmask – (character) – Unix file name for integer region mask data

group basinfo
- basin_nm – (character array) – names of basins in region mask

group inpinfo (repeatable)
- done – (logical) – no more input data to process
- file_h1t – (character) – Unix filename of H1 data
- file_h1u – (character) – Unix filename of H11 data
- file_h2 – (character) – Unix filename of H2 data
- file_h5 – (character) – Unix filename of H5 data
- file_75 – (character) – Unix filename of H7 data

Appendix C. Example Prognostic Data File NCL (2 × 2 model)

```
netcdf ocnprog_y0007.d000.00
dimensions:
    time = UNLIMITED ; // (1 currently)
    lon_t = 152 ;
    lon_u = 152 ;
    lat_t = 111 ;
    lat_u = 111 ;
    z_t = 45 ;
    z_w = 46 ;
    nchar = 132 ;
    basins = 8 ;
```

```
variables:
    double time(time) ;
        time:long_name = “time” ;
    float lon_t(lon_t) ;
        lon_t:long_name = “Longitude (T grid)” ;
    float lon_u(lon_u) ;
        lon_u:long_name = “Longitude (U grid)” ;
    float lat_t(lat_t) ;
        lat_t:long_name = “Latitude (T grid)” ;
    float lat_u(lat_u) ;
        lat_u:long_name = “Latitude (U grid)” ;
    float z_t(z_t) ;
        z_t:long_name = “Depth (T grid)” ;
    float z_w(z_w) ;
        z_w:long_name = “Depth (W grid)” ;
    char basins_label(basins, nchar) ;
        basins_label:long_name = “Ocean Basins” ;
    float daypyr ;
        daypyr:long_name = “Calendar Length” ;
    long itt(time) ;
        itt:long_name = “Time Step Number” ;
    float dz(z_t) ;
        dz:long_name = “Vertical Grid Cell Thickness” ;
    float dzz(z_w) ;
        dzz:long_name = “Vertical Grid Cell Spacing” ;
    float dxt(lon_t) ;
        dxt:long_name = “Zonal T Grid Cell Width” ;
    float dxu(lon_u) ;
        dxu:long_name = “Zonal U Grid Cell Width” ;
    float dyt(0lat_t) ;
        dyt:long_name = “Meridional T Grid Cell Width” ;
    float dyu(lat_u) ;
        dyu:long_name = “Meridional U Grid Cell Width” ;
    long kmt(lat_t, lon_t) ;
        kmt:long_name = “Depth of Ocean in Model Levels” ;
    long rmask(lat_t, lon_t) ;
        rmask:long_name = “Basin Index” ;
    long H(lat_t, lon_t) ;
        H:long_name = “Ocean Depth” ;
    float T(time, lat_t, z_t, lon_t) ;
        T:long_name = “Potential Temperature” ;
    float S(time, lat_t, z_t, lon_t) ;
        S:long_name = “Salinity” ;
    float U(time, lat_u, z_t, lon_u) ;
        U:long_name = “Eulerian Velocity East Component” ;
    float V(time, lat_u, z_t, lon_u) ;
        V:long_name = “Eulerian Velocity North Component” ;
    float W(time, lat_t, z_w, lon_t) ;
        W:long_name = “Eulerian Velocity Vertical Component” ;
    float Uiso(time, lat_u, z_t, lon_u) ;
        Uiso:long_name = “Eddy Induced Transport Velocity East Component” ;
    float Viso(time, lat_u, z_t, lon_u) ;
        Viso:long_name = “Eddy Induced Transport Velocity North Component” ;
```

```
    float Wiso(time, lat_t, z_w, lon_t) ;
        Wiso:long_name = "Eddy Induced Transport Velocity Vertical Component" ;
    float psi(time, lat_t, lon_t) ;
        psi:long_name = "Barotropic Transport Streamfunction" ;
    float dpdx(time, lat_u, lon_u) ;
        dpdx:long_name = "Surface Pressure Gradient East Component" ;
    float dpdy(time, lat_u, lon_u) ;
        dpdy:long_name = "Surface Pressure Gradient North Component" ;
    float hblt(time, lat_t, lon_t) ;
        hblt:long_name = "Boundary Layer Depth" ;
    float hbml(time, lat_t, lon_t) ;
        hbml:long_name = "Mixed Layer Depth" ;
    float smfx(time, lat_u, lon_u) ;
        smfx:long_name = "Surface Momentum Flux East Component" ;
    float smfy(time, lat_u, lon_u) ;
        smfy:long_name = "Surface Momentum Flux North Component" ;
    float Tflx(time, lat_t, lon_t) ;
        Tflx:long_name = "Surface Heat Flux" ;
    float Sflx(time, lat_t, lon_t) ;
        Sflx:long_name = "Surface Salt Flux" ;

// global attributes:
    :conventions = "CSM NetCDF Conventions Version 0.0" ;
    :filename = "ocnprog_y0007.d000.00.nc" ;
    :platform = "Model: CSM Ocean Component" ;
    :model_ver = "D02L45T2" ;
    :case = "b001.02" ;
    :title = "Field Variables" ;
    :time_rep = "n",
```

Appendix D. Example Diagnostic Data File NCL (2 × 2 model)

```
netcdf ocndiag_y0005
dimensions:
    time = UNLIMITED ; // (12 currently)
    lon_t = 152 ;
    lon_u = 152 ;
    lat_t = 111 ;
    lat_u = 111 ;
    z_t = 45 ;
    z_w = 46 ;
    nchar = 132 ;
    islands = 8 ;
    basins = 8 ;
    engterm = 9 ;
    ttnterm1 = 8 ;
    ttnterm2 = 4 ;
```

```
variables:
    double time(time) ;
        time:long_name = “time” ;
    float lon_t(lon_t) ;
        lon_t:long_name = “Longitude (T grid)” ;
    float lon_u(lon_u) ;
        lon_u:long_name = “Longitude (U grid)” ;
    float lat_t(lat_t) ;
        lat_t:long_name = “Latitude (T grid)” ;
    float lat_u(lat_u) ;
        lat_u:long_name = “Latitude (U grid)” ;
    float z_t(z_t) ;
        z_t:long_name = “Depth (T grid)” ;
    float z_w(z_w) ;
        z_w:long_name = “Depth (W grid)” ;
    char islands_label(islands, nchar) ;
        islands_label:long_name = “Islands” ;
    char basins_label(basins, nchar) ;
        basins_label:long_name = “Ocean Basins” ;
    char engterm_label(engterm, nchar) ;
        engterm_label:long_name = “Energy Diagnostic Terms” ;
    char ttnterm1_label(ttnterm1, nchar) ;
        ttnterm1_label:long_name = “Meridional Tracer Transport Terms” ;
    char ttnterm2_label(ttnterm2, nchar) ;
        ttnterm2_label:long_name = “Meridional Tracer Transport Terms” ;
    float daypyr ;
        daypyr:long_name = “Calendar Length” ;
    long itt(time) ;
        itt:long_name = “Time Step Number” ;
    float dz(z_t) ;
        dz:long_name = “Vertical Grid Cell Thickness” ;
    float dzz(z_w) ;
        dzz:long_name = “Vertical Grid Cell Spacing” ;
    float dxt(lon_t) ;
        dxt:long_name = “Zonal T Grid Cell Width” ;
    float dxu(lon_u) ;
        dxu:long_name = “Zonal U Grid Cell Width” ;
    float dyt(lat_t) ;
        dyt:long_name = “Meridional T Grid Cell Width” ;
    float dyu(lat_u) ;
        dyu:long_name = “Meridional U Grid Cell Width” ;
    long kmt(lat_t, lon_t) ;
        kmt:long_name = “Depth of Ocean in Model Levels” ;
    long rmask(lat_t, lon_t) ;
        rmask:long_name = “Basin Index” ;
    float tmt(time, z_w, lat_u) ;
        tmt:long_name = “Eulerian Meridional Transport Streamfunction” ;
    float tmtiso(time, z_w, lat_u) ;
        tmtiso:long_name = “Eddy Induced Meridional Transport Streamfunction” ;
    float Tttn_terms(time, lat_u, ttnterm1) ;
        Tttn_terms:long_name = “Meridional Heat Transport” ;
    float Sttn_terms(time, lat_u, ttnterm1) ;
        Sttn_terms:long_name = “Meridional Salt Transport” ;
```

```
float Tttn_basins(time, basins, lat_u, ttnterm2) ;
    Tttn_basins:long_name = "Meridional Heat Transport" ;
float Sttn_basins(time, basins, lat_u, ttnterm2) ;
    Sttn_basins:long_name = "Meridional Salt Transport" ;
float ekt(time) ;
    ekt:long_name = "Global Average Kinetic Energy Density" ;
float buoylev(time, z_w) ;
    buoylev:long_name = "Level Integrated Buoyancy Work" ;
float buoyglb(time) ;
    buoyglb:long_name = "Global Average Buoyancy Work" ;
float engext(time, engterm) ;
    Pengext:long_name = "Global Average External Mode Energy Budget" ;
float engint(time, engterm) ;
    engint:long_name = "Global Average Internal Mode Energy Budget" ;
float T_horz(time, basins, z_t) ;
    T_horz:long_name = "Horizontal Average Potential Temperature" ;
float S_horz(time, basins, z_t) ;
    S_horz:long_name = "Horizontal Average Salinity" ;
float pisle(time, islands) ;
    pisle:long_name = "Island Streamfunction" ;
float pnp(time) ;
    pnp:long_name = "Barotropic Transport Streamfunction at North Pole" ;

// global attributes:
    :conventions = "CSM NetCDF Conventions Version 0.0" ;
    :filename = "ocndiag_y0005.nc" ;
    :platform = "Model: CSM Ocean Component" ;
    :model_ver = "D02L45T2" ;
    :case = "b001.02" ;
    :title = "Diagnostic Variables" ;
    :time_rep = "n",
```