

# GEOS-Chem Reference, Vol. 1: Makefiles

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# 1 Routine/Function Prologues

## 1.1 Module Interface Makefile (Main-level)

This is a "router" makefile. It calls the main GEOS-Chem Makefile (in the GeosCore sub-directory) to direct the Unix "make" utility how to build the GEOS-Chem source code.

### REMARKS:

To build the programs, call "make" with the following syntax:

```
make TARGET [ OPTIONAL-FLAGS ]
```

To display a complete list of options, type "make help".

Makefile uses the following variables:

Variable	Description
-----	-----
GEOSDIR	Specifies the directory where GEOS-Chem "core" routines are found
GEOSTOM	Specifies the directory where GEOS-Chem + TOMAS routines are found

### REVISION HISTORY:

```
16 Sep 2009 - R. Yantosca - Initial version
24 Nov 2009 - R. Yantosca - Now call libbpch and libcore targets in
                           the Makefile in the GeosCore sub-directory
11 Dec 2009 - R. Yantosca - Now get SHELL from Makefile_header.mk
25 Jan 2010 - R. Yantosca - Added Makefile targets for TOMAS microphysics
```

```
# Get the Unix shell definition
include ./Makefile_header.mk
```

```
# Define variables
GEOSDIR = GeosCore
GEOSTOM = GeosTomas
GTMM = GTMM
```

```
#=====
# Makefile targets: type "make help" for a complete list!
#=====
```

```
.PHONY: all lib libkpp libutil exe clean realclean doc docclean help
```

```
all:
@$(MAKE) -C $(GEOSDIR) all
```

```
lib:
@$(MAKE) -C $(GEOSDIR) lib
```

```
libcore:
@$(MAKE) -C $(GEOSDIR) libcore

libkpp:
@$(MAKE) -C $(GEOSDIR) libkpp

libutil:
@$(MAKE) -C $(GEOSDIR) libutil

exe:
@$(MAKE) -C $(GEOSDIR) exe

clean:
@$(MAKE) -C $(GEOSDIR) clean

realclean:
@$(MAKE) -C $(GEOSDIR) realclean

doc:
@$(MAKE) -C $(GEOSDIR) doc

docclean:
@$(MAKE) -C $(GEOSDIR) docclean

help:
@$(MAKE) -C $(GEOSDIR) help

#=====
# Targets for TOMAS aerosol microphysics code (win, bmy, 1/25/10)
#=====

.PHONY: tomas libtomas exetomas cleantomas

tomas:
@$(MAKE) -C $(GEOSTOM) TOMAS=yes all

libtomas:
@$(MAKE) -C $(GEOSTOM) TOMAS=yes lib

exetomas:
@$(MAKE) -C $(GEOSTOM) TOMAS=yes exe

cleantomas:
@$(MAKE) -C $(GEOSTOM) TOMAS=yes clean

#=====
# Targets for mercury simulation (ccc, 6/7/10)
```

```
#=====

.PHONY: hg

hg:
@$(MAKE) -C $(GEOSDIR) allhg
```

---

### 1.1.1 Makefile\_header.mk

This sub-makefile defines the variables which specify compilation options for the different supported compiler/platform combinations. Also, the default makefile compilation rules are specified here.

#### REMARKS:

To build the programs, call "make" with the following syntax:

```
make TARGET [ OPTIONAL-FLAGS ]
```

To display a complete list of options, type "make help".

The following variables are exported to the main-level Makefile:

Variable	Description
-----	-----
CC	Contains the default C compilation commands (for PGI only)
F90	Contains the Fortran compilation commands
FREEFORM	Contains the command to force F90 "free format" compilation
LD	Contains the command to link to libraries & make executable
LINK	Contains the commands to link to GEOS-Chem built libraries
R8	Contains the command to force REAL -> REAL*8
SHELL	Contains the default Unix shell to use when building code

FFLAGS is a local variable that is not returned to the "outside world", but is only used locally. COMPILER, HDF5, and OMP are all input via the command line or via environment variables.

```
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%          NOTE: The IBM/XLF compiler has not been validated yet.          %%
%%          Beta-testers welcome!                                           %%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%          NOTE: GEOS-Chem has not yet been ported to GNU Fortran.        %%
%%          Beta-testers welcome!                                           %%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
```

#### REVISION HISTORY:

16 Sep 2009 - R. Yantosca - Initial version  
 22 Sep 2009 - R. Yantosca - Bug fix, added -I\$(HDR) to F90 compilation lines  
 24 Sep 2009 - R. Yantosca - added NONUMA option for PGI compiler  
 07 Oct 2009 - R. Yantosca - Replaced .SUFFIXES section w/ pattern rules  
 19 Nov 2009 - R. Yantosca - Now use OMP variable to determine whether to  
 turn on OpenMP parallelization options  
 23 Nov 2009 - R. Yantosca - Now use -module \$(MOD) instead of -I\$(MOD) to  
 specify the directory for \*.mod files on both  
 IFORT and PGI compilers.  
 23 Nov 2009 - R. Yantosca - Now use -moddir=\$(MOD) and -M\$(MOD) instead of  
 -I\$(MOD) to specify the directory for \*.mod  
 files on the SunStudio compiler.  
 23 Nov 2009 - R. Yantosca - Change DEBUG to allow for new version of  
 Totalview which doesn't choke when debugging  
 parallel code (Totalview 8.6.1-1)  
 02 Dec 2009 - R. Yantosca - Added SUN32 switch for building 32-bit  
 executable on the SunStudio compiler  
 11 Dec 2009 - R. Yantosca - Now define SHELL here and export to other  
 Makefiles, so as to have a single place where  
 the Unix shell name is defined.  
 21 Dec 2009 - R. Yantosca - Add H5I and H5L variables to specify the  
 HDF5 library and include paths. Also set  
 the default to not link to the HDF5 libraries.  
 21 Dec 2009 - R. Yantosca - Now pass LINK back to the outside world, so  
 that the Makefile that builds the executable  
 can reference it.  
 19 Jan 2010 - R. Yantosca - Minor fix, add -m64 if SUN32 is not defined.  
 25 Jan 2010 - R. Yantosca - Now add -DTOMAS to FFLAGS if necessary  
 28 Jan 2010 - C. Carouge - Add -lisoropia to LINK, for ISORROPIA II

```

#=====
# Default settings for Makefile options
#=====

```

```

# IFORT is default compiler
ifndef COMPILER
COMPILER = ifort
endif

```

```

# OpenMP is turned on by default
ifndef OMP
OMP = yes
endif

```

```

# HDF5 output is turned off by default
ifndef HDF5
HDF5 = no

```

```

endif

# TOMAS runs on single processor (at least for now!)
ifeq ($(TOMAS),yes)
OMP = no
endif

#=====
# Default values for variables
#=====

# If your system uses "/bin/sh", then uncomment this line!
SHELL = /bin/sh

# If your system uses "/bin/bash", then uncomment this line!
#SHELL = /bin/bash

# If you have HDF5 installed on your system, then define both the include
# (H5I) and library paths (H5L) here! Otherwise leave these blank.
H5I = /home/bmy/NASA/basedir/x86_64-unknown-linux-gnu/ifort/Linux/include/hdf5
H5L = /home/bmy/NASA/basedir/x86_64-unknown-linux-gnu/ifort/Linux/lib

# Link to library files created from code in the various subdirs
# NOTE: -lGeosUtil should always be last!
LINK = -L$(LIB) -lKpp -lIsoropia -lGeosUtil
LHG = -L$(LIB) -lKpp -lIsoropia -lHg -lGeosUtil

# Add the HDF5 library link commands if necessary
ifeq ($(HDF5),yes)
LINK += -L$(H5L) -lhdf5_fortran -lhdf5_hl -lhdf5hl_fortran -lhdf5 -lsz -lz -lm
LHG += -L$(H5L) -lhdf5_fortran -lhdf5_hl -lhdf5hl_fortran -lhdf5 -lsz -lz -lm
endif

#=====
# IFORT compilation options (default)
#=====
ifeq ($(COMPILER),ifort)

# Turn on -traceback option by default for debugging runs
ifdef DEBUG
TRACEBACK=yes
endif

# Pick compiler options for debug run or regular run
ifdef DEBUG
FFLAGS = -cpp -w -O0 -auto -noalign -convert big_endian -g
else

```

```

FFLAGS    = -cpp -w -O2 -auto -noalign -convert big_endian -vec-report0
endif

# Turn on OpenMP parallelization
ifeq ($(OMP),yes)
FFLAGS    += -openmp -Dmultitask
endif

# Also add TOMAS aerosol microphysics option
ifeq ($(TOMAS),yes)
FFLAGS    += -DTOMAS
endif

# Add special IFORT optimization commands
ifndef IPO
FFLAGS    += -ipo -static
endif

# Add option for "array out of bounds" checking
ifndef BOUNDS
FFLAGS    += -CB
endif

# Also add traceback option
ifndef TRACEBACK
FFLAGS    += -traceback
endif

# Include options (i.e. for finding *.h, *.mod files)
INCLUDE   = -I$(HDR) -module $(MOD)

# Also append HDF5 include commands if necessary
ifeq ($(HDF5),yes)
INCLUDE   += -DUSE_HDF5 -I$(H5I)
endif

CC        =
F90       = ifort $(FFLAGS) $(INCLUDE)
LD        = ifort $(FFLAGS)
FREEFORM  = -free
R8        = -r8

endif

#=====
# Portland Group (PGI) compilation options
#=====
ifeq ($(COMPILER),pgi)

```

```

# Pick compiler options for debug run or regular run
ifdef DEBUG
FFLAGS    = -byteswapio -Mpreprocess -Bstatic -g -O0
else
FFLAGS    = -byteswapio -Mpreprocess -Bstatic -fast
endif

# Turn on OpenMP parallelization
ifeq ($(OMP),yes)
FFLAGS    += -mp -Mnosgimp -Dmultitask
endif

# Add option for suppressing PGI non-uniform memory access (numa) library
ifeq ($(NONUMA),yes)
FFLAGS    += -mp=nonuma
endif

# Also add TOMAS aerosol microphysics option
ifeq ($(TOMAS),yes)
FFLAGS    += -DTOMAS
endif

# Add option for "array out of bounds" checking
ifdef BOUNDS
FFLAGS    += -C
endif

# Include options (i.e. for finding *.h, *.mod files)
INCLUDE   = -I$(HDR) -module $(MOD)

# Also append HDF5 include commands if necessary
ifeq ($(HDF5),yes)
INCLUDE   += -DUSE_HDF5 -I$(H5I)
endif

CC        = gcc
F90       = pgf90 $(FFLAGS) $(INCLUDE)
LD        = pgf90 $(FFLAGS)
FREEFORM  = -Mfree
R8        = -Mextend -r8

endif

#=====
# SunStudio compilation options
#=====
ifeq ($(COMPILER),sun)

```



```

# Pick compiler options for debug run or regular run
# NOTE: -native builds in proper options for whichever chipset you have!
ifdef DEBUG
FFLAGS    = -fpp -g -O0 -stackvar -xfilebyteorder=big16:%all -native
else
FFLAGS    = -fpp -fast -stackvar -xfilebyteorder=big16:%all -native
endif

# Build Sun for 32-bit platform
ifdef SUN32
FFLAGS    += -m32
else
FFLAGS    += -m64
endif

# Turn on OpenMP parallelization
ifeq ($(OMP),yes)
FFLAGS    += -openmp=parallel -Dmultitask
endif

# Also add TOMAS aerosol microphysics option
ifeq ($(TOMAS),yes)
FFLAGS    += -DTOMAS
endif

# Add option for "array out of bounds" checking
ifdef BOUNDS
FFLAGS    += -C
endif

# Include options (i.e. for finding *.h, *.mod files)
INCLUDE   = -I$(HDR) -moddir=$(MOD) -M$(MOD)

# Also append HDF5 include commands if necessary
ifeq ($(HDF5),yes)
INCLUDE   += -DUSE_HDF5 -I$(H5I)
endif

CC        =
#-----
# If your compiler is under the name "f90", use these lines!
F90       = f90 $(FFLAGS) $(INCLUDE)
LD        = f90 $(FFLAGS)
#-----
# If your compiler is under the name "sunf90", use these lines!
#F90      = sunf90 $(FFLAGS) $(INCLUDE)
#LD       = sunf90 $(FFLAGS)

```

```

#-----
FREEFORM = -free
R8        = -xtypemap=real:64

endif

#=====
# IBM/XLF compilation options
# NOTE: someone who runs on IBM compiler should check this !!!
#=====
ifeq ($(COMPILER),xlf)

# Default compilation options
FFLAGS = -bmaxdata:0x80000000 -bmaxstack:0x80000000 -qfixed -qsuffix=cpp=f -q64

# Add optimization options
FFLAGS += -O3 -qarch=auto -qtune=auto -qcache=auto -qmaxmem=-1 -qstrict

# Turn on OpenMP parallelization
ifeq ($(OMP),yes)
FFLAGS += -qsmp=omp:opt -WF,-Dmultitask -qthreaded
endif

# Prior to 11/19/09:
## Add more options for parallel run
#ifndef DEBUG
#FFLAGS += -qsmp=omp:opt -WF,-Dmultitask -qthreaded
#endif

# Also add TOMAS aerosol microphysics option
ifeq ($(TOMAS),yes)
FFLAGS += -DTOMAS
endif

# Add option for "array out of bounds" checking
ifndef BOUNDS
FFLAGS += -C
endif

# Include options (i.e. for finding *.h, *.mod files)
INCLUDE = -I$(HDR) -I $(MOD)

# Also append HDF5 include commands if necessary
ifeq ($(HDF5),yes)
INCLUDE += -DUSE_HDF5 -I$(H5I)
endif

CC      =

```

```

F90      = xlf90_r $(FFLAGS) $(INCLUDE)
LD        = xlf90_r $(FFLAGS)
FREEFORM = -qrealsize=8
R8        = -r8

endif

#=====
# Specify pattern rules for compilation
# (i.e. tell "make" how to compile different types of source code files)
#=====
%.o : %.f
$(F90) -c $<
%.o : %.F
$(F90) -c $<
%.o : %.f90
$(F90) -c $(FREEFORM) $<
%.o : %.F90
$(F90) -c $(FREEFORM) $<
%.o : %.c
$(CC) -c $*.c

#=====
# Export global variables so that the main Makefile will see these
#=====
export CC
export F90
export FREEFORM
export LD
export LINK
export R8
export SHELL

```

---

## 1.2 Module Interface Makefile (in the GeosUtil subdirectory)

This makefile compiles the various GEOS-Chem utility modules, which provide basic functionality for:

- Collapsing vertical levels in the stratosphere
- Date and time computations
- Defining data directories
- Defining the GEOS-Chem horizontal grid

- Defining the GEOS-Chem pressure coordinate grid
- Defining the logical units for GEOS-Chem file I/O
- Defining various Unix commands
- Platform-specific error handling
- Manipulating string variables
- Regridding data (horizontally) from fine to coarse resolution

## REMARKS:

To build the programs, call "make" with the following syntax:

```
make TARGET [ OPTIONAL-FLAGS ]
```

To display a complete list of options, type "make help".

```

%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%% NOTE: Normally you will not have to call this Makefile directly,
%% it will be called automatically from the Makefile in the directory
%% just above this one!
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%

```

Makefile uses the following variables:

Variable	Description
-----	-----
SHELL	Specifies the shell for "make" to use (usually SHELL=/bin/sh)
ROOTDIR	Specifies the root-level directory of the GEOS-Chem code
HDR	Specifies the directory where GEOS-Chem include files are found
LIB	Specifies the directory where library files (*.a) are stored
MOD	Specifies the directory where module files (*.mod) are stored
AR	Sys var w/ name of library creator program (i.e., "ar", "ranlib")
MAKE	Sys var w/ name of Make command (i.e, "make" or "gmake")

## REVISION HISTORY:

```

19 Nov 2009 - R. Yantosca - Initial version
23 Nov 2009 - R. Yantosca - Now don't copy module files; they will be
                           automatically written to the mod directory
11 Dec 2009 - R. Yantosca - Now get SHELL from Makefile_header.mk
21 Dec 2009 - R. Yantosca - If HDF5=yes, then look for hdf5.mod in the
                           HDF5 include path $(HDF5_INC).

```

```

# Define variables
ROOTDIR = ..
HDR      = $(ROOTDIR)/Headers

```

```

HELP    = $(ROOTDIR)/help
LIB      = $(ROOTDIR)/lib
MOD      = $(ROOTDIR)/mod

# Include header file.  This returns CC, F90, FREEFORM, LD, R8, SHELL,
# as well as the default Makefile compilation rules for source code files.
include $(ROOTDIR)/Makefile_header.mk

#=====
# List of files to compile.  Here the order is not important,
# as we will explicitly define the dependencies listing below.
#=====

# List of source files
SRC = $(wildcard *.f) $(wildcard *.f90)

# Replace .f and .f90 extensions with *.o
TMP = $(SRC:.f=.o)
OBJ = $(TMP:.f90=.o)

# Special files just for IFORT
ifeq ($(COMPILER),ifort)
OBJ += ifort_errmsg.o
endif

# Special files just for PGI
ifeq ($(COMPILER),pgi)
OBJ += linux_err.o
endif

#=====
# Makefile targets: type "make help" for a complete listing!
#=====

.PHONY: clean help

lib: $(OBJ)
$(AR) crs libGeosUtil.a $(OBJ)
mv libGeosUtil.a $(LIB)

clean:
rm -f *.o *.mod

help:
@$(MAKE) -C $(HELP)

#=====
# Dependencies listing (grep "USE " to get the list of module references!)
#=====

```

```

#
# From this list of dependencies, the "make" utility will figure out the
# correct order of compilation (so we don't have to do that ourselves).
# This also allows us to compile on multiple processors with "make -j".
#
# NOTES:
# (1) Only specify object-file dependencies that are within this directory.
#      Object files in other directories will be referenced at link-time.
# (2) For "make -j" to work, all files in this directory must have a
#      listed dependency.
#=====

bpch2_mod.o      : bpch2_mod.f      error_mod.o      file_mod.o      julday_mod.o
charpak_mod.o    : charpak_mod.f
directory_mod.o  : directory_mod.f
error_mod.o      : error_mod.f
file_mod.o       : file_mod.f      error_mod.o
grid_mod.o       : grid_mod.f      error_mod.o
ifort_errmsg.o   : ifort_errmsg.f
julday_mod.o     : julday_mod.f
linux_err.o      : linux_err.c
pressure_mod.o   : pressure_mod.f  error_mod.o
regrid_1x1_mod.o : regrid_1x1_mod.f charpak_mod.o error_mod.o grid_mod.o
time_mod.o       : time_mod.f      charpak_mod.o error_mod.o grid_mod.o \
                                     julday_mod.o
transfer_mod.o   : transfer_mod.f  error_mod.o
unix_cmds_mod.o  : unix_cmds_mod.f

# NOTE: if HDF5=yes then we need to also look for the hdf5.mod
# in the HDF5 include path (bmy, 12/21/09)
hdf_mod.o        : hdf_mod.f      error_mod.o      grid_mod.o
ifeq ($(HDF5),yes)
$(F90) -DUSE_HDF5 -I$(HDF_INC) -c $<
endif

```

---

### 1.3 Module Interface Makefile (in the ISOROPIA/ subdirectory)

This makefile compiles the ISOROPIA code. Object files (\*.o) are bundled into the libIsoropia.a library (located in the LIB directory). Module files (\*.mod) are copied to the MOD directory.

#### REMARKS:

To build the programs, call "make" with the following syntax:

```
make TARGET [ OPTIONAL-FLAGS ]
```

To display a complete list of options, type "make help".

```
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%% NOTE: Normally you will not have to call this Makefile directly,  %%
%% it will be called automatically from the Makefile in the directory %%
%% just above this one!                                             %%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
```

Makefile uses the following variables:

Variable	Description
-----	-----
SHELL	Specifies the shell for "make" to use (usually SHELL=/bin/sh)
ROOTDIR	Specifies the root-level directory of the GEOS-Chem code
HDR	Specifies the directory where GEOS-Chem include files are found
LIB	Specifies the directory where library files (*.a) are stored
MOD	Specifies the directory where module files (*.mod) are stored
AR	Sys var w/ name of library creator program (i.e., "ar", "ranlib")
MAKE	Sys var w/ name of Make command (i.e, "make" or "gmake")
R8	Specifies the c

## REVISION HISTORY:

21 Dec 2009 - C. Carouge - Initial version

```
# Define variables
```

```
SHELL = /bin/sh
```

```
ROOTDIR = ..
```

```
HDR = $(ROOTDIR)/Headers
```

```
HELP = $(ROOTDIR)/help
```

```
LIB = $(ROOTDIR)/lib
```

```
MOD = $(ROOTDIR)/mod
```

```
# Include header file. This returns variables CC, F90, FREEFORM, LD, R8,
# as well as the default Makefile compilation rules for source code files.
include $(ROOTDIR)/Makefile_header.mk
```

```
=====
# List of files to compile (the order is important!). We specify these as
# a list of object files (*.o). For each object file, the "make" utility
# will find the corresponding source code file (*.f) and compile it.
=====
```

```
# List of source files
```

```
SRC = $(wildcard *.f) $(wildcard *.f90)
```

```

# Replace .f and .f90 extensions with *.o
TMP = $(SRC:.f=.o)
OBJ = $(TMP:.f90=.o)

#=====
# Makefile targets: type "make help" for a complete listing!
#=====

.PHONY: clean help

lib: $(OBJ)
$(AR) crs libIsoropia.a $(OBJ)
mv libIsoropia.a $(LIB)

clean:
rm -f *.o *.mod

help:
@$(MAKE) -C $(HELP)

#=====
# Dependencies listing (grep "USE " to get the list of module references!)
#
# From this list of dependencies, the "make" utility will figure out the
# correct order of compilation (so we don't have to do that ourselves!)
#=====

isoropiaIcode.o: isoropiaIcode.f isrpia.inc
$(F90) $(R8) -c $<

```

---

#### 1.4 Module Interface Makefile (in the KPP subdirectory)

This is main "router" makefile for the KPP solver. It compiles the KPP code for one of the following types of GEOS-Chem simulations:

1. GEOS-Chem "standard" simulation (43 tracers)
2. GEOS-Chem "secondary organic aerosol" simulation (54 tracers)

The KPP code will be compiled using one of the following numerical solvers:

1. rosenbrock (This is the default option.)
2. lsodes
3. radau5
4. runge\_kutta



**REMARKS:**

To build the programs, call "make" with the following syntax:

```
make TARGET [ OPTIONAL-FLAGS ]
```

To display a complete list of options, type "make help".

```
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%% NOTE: Normally you will not have to call this Makefile directly,  %%
%% it will be called automatically from the main GEOS-Chem Makefile in  %%
%% GeosCore directory!                                              %%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
```

Makefile uses the following variables:

Variable	Description
-----	-----
SHELL	Specifies the shell for "make" to use (usually SHELL=/bin/sh)
ROOTDIR	Specifies the root-level directory of the GEOS-Chem code
DOC	Specifies the directory where GEOS-Chem documentation is found
HDR	Specifies the directory where GEOS-Chem include files are found
LIB	Specifies the directory where library files (*.a) are stored
MOD	Specifies the directory where module files (*.mod) are stored
AR	Sys var w/ name of library creator program (i.e., "ar", "ranlib")
MAKE	Sys var w/ name of Make command (i.e., "make" or "gmake")
NTRAC	Cmd line argument; specifies either 43 or 54 tracer simulation
KPPSOLVER	Cmd line argument; specifies the type of integrator to use

**REVISION HISTORY:**

```
16 Sep 2009 - R. Yantosca - Initial version
18 Sep 2009 - P. Le Sager - Added kppintegrator target & commented
                        "make -C int" calls
20 Nov 2009 - P. Le Sager - Added CHEM option
23 Nov 2009 - R. Yantosca - Added realclean target
11 Dec 2009 - R. Yantosca - Now get SHELL from Makefile_header.mk
```

```
# Define variables
```

```
ROOTDIR = ..
DOC      = $(ROOTDIR)/doc
HDR      = $(ROOTDIR)/Headers
HELP     = $(ROOTDIR)/help
LIB      = $(ROOTDIR)/lib
MOD      = $(ROOTDIR)/mod
```

```
# Include header file. This returns CC, F90, FREEFORM, LD, R8, SHELL,
# as well as the default Makefile compilation rules for source code files.
```

```

include $(ROOTDIR)/Makefile_header.mk

# Make the standard 43-tracer simulation the default
ifndef CHEM
CHEM = standard
endif

# Check if NTRAC option is used
ifdef NTRAC

ifeq ($(NTRAC),43)
CHEM = standard
endif

ifeq ($(NTRAC),54)
CHEM = SOA
endif

endif

# Make rosenbrock the default solver
ifndef KPPSOLVER
KPPSOLVER = rosenbrock
endif

# solver (S=Source, T=Target)
SOLVER_SFILE=./int/gckpp_Integrator_$(KPPSOLVER).f90
SOLVER_TFILE=./$(CHEM)/gckpp_Integrator.f90

#=====
# Makefile targets: type "make help" for a complete listing!
#=====

.PHONY: all lib kppintegrator clean realclean doc help

all: lib

lib: kppintegrator
    @$(MAKE) -C $(CHEM)

kppintegrator:
    @diff $(SOLVER_SFILE) $(SOLVER_TFILE) ;\
    if [ $$? == 1 ] ; then \
    echo " copy $(SOLVER_SFILE) --> $(SOLVER_TFILE)";\
    cp $(SOLVER_SFILE) $(SOLVER_TFILE) ; \
    fi

```

```

clean:
@$(MAKE) -C $(CHEM) clean

realclean:
@$(MAKE) -C standard clean
@$(MAKE) -C SOA clean
@$(MAKE) -C isoprene clean

help:
@$(MAKE) -C $(HELP)

```

---

## 1.5 Module Interface Makefile (in the KPP/43t subdirectory)

This makefile compiles the KPP solver code for the GEOS-Chem 43 tracer simulation (i.e. without secondary organic aerosol tracers). Object files (\*.o) are bundled into the libKpp.a library (located in the LIB directory). Module files (\*.mod) are copied to the MOD directory.

### REMARKS:

To build the programs, call "make" with the following syntax:

```
make TARGET [ OPTIONAL-FLAGS ]
```

To display a complete list of options, type "make help".

```

%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%% NOTE: Normally you will not have to call this Makefile directly,  %%
%% it will be called automatically from the Makefile in the directory  %%
%% just above this one!                                             %%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%

```

Makefile uses the following variables:

Variable	Description
-----	-----
SHELL	Specifies the shell for "make" to use (usually SHELL=/bin/sh)
ROOTDIR	Specifies the root-level directory of the GEOS-Chem code
HDR	Specifies the directory where GEOS-Chem include files are found
LIB	Specifies the directory where library files (*.a) are stored
MOD	Specifies the directory where module files (*.mod) are stored
AR	Sys var w/ name of library creator program (i.e., "ar", "ranlib")
MAKE	Sys var w/ name of Make command (i.e, "make" or "gmake")

### REVISION HISTORY:

```

16 Sep 2009 - R. Yantosca - Initial version
21 Sep 2009 - R. Yantosca - Now call Makefile in help directory to
                             display the help screen options
23 Nov 2009 - R. Yantosca - Now don't copy module files; they will be
                             automatically written to the mod directory
11 Dec 2009 - R. Yantosca - Now get SHELL from Makefile_header.mk

# Define variables
ROOTDIR = ../..
HDR      = $(ROOTDIR)/Headers
HELP     = $(ROOTDIR)/help
LIB      = $(ROOTDIR)/lib
MOD      = $(ROOTDIR)/mod

# Include header file.  This returns CC, F90, FREEFORM, LD, R8, SHELL,
# as well as the default Makefile compilation rules for source code files.
include $(ROOTDIR)/Makefile_header.mk

#=====
# List of files to compile.  Here the order is not important,
# as we will explicitly define the dependencies listing below.
#=====

# Source code files
SRC = $(wildcard gckpp*.f90)

# Object files
OBJ = $(SRC:.f90=.o)

#=====
# Makefile targets: type "make help" for a complete listing!
#=====

.PHONY: clean help

lib: $(OBJ)
$(AR) crs libKpp.a $(OBJ)
mv libKpp.a $(LIB)

clean:
rm -f *.o *.mod geos

help:
@$(MAKE) -C $(HELP)

#=====
# Dependencies listing (grep "USE " to get the list of module references!)

```

```

#
# From this list of dependencies, the "make" utility will figure out the
# correct order of compilation (so we don't have to do that ourselves!)
#=====

gckpp_Function.o      : gckpp_Parameters.o

gckpp_Global.o        : gckpp_Parameters.o

gckpp_Hessian.o       : gckpp_Parameters.o      \
                       gckpp_HessianSP.o

gckpp_Initialize.o    : gckpp_Parameters.o      \
                       gckpp_Global.o           \
                       gckpp_Util.o             \
                       gckpp_Monitor.o

gckpp_Integrator.o    : gckpp_Parameters.o      \
                       gckpp_Global.o           \
                       gckpp_Function.o         \
                       gckpp_Rates.o            \
                       gckpp_Jacobian.o         \
                       gckpp_LinearAlgebra.o

gckpp_Jacobian.o      : gckpp_Parameters.o      \
                       gckpp_JacobianSP.o

gckpp_LinearAlgebra.o : gckpp_Parameters.o      \
                       gckpp_JacobianSP.o

gckpp_Model.o         : gckpp_Precision.o       \
                       gckpp_Parameters.o       \
                       gckpp_Global.o           \
                       gckpp_Function.o         \
                       gckpp_Integrator.o       \
                       gckpp_Rates.o            \
                       gckpp_Jacobian.o         \
                       gckpp_Hessian.o          \
                       gckpp_Stoichiom.o        \
                       gckpp_Monitor.o          \
                       gckpp_Util.o             \
                       gckpp_LinearAlgebra.o

gckpp_Parameters.o    : gckpp_Precision.o

#gckpp_Rates.o        : gckpp_Parameters.o      \
#                       gckpp_Global.o           \
#                       gckpp_Monitor.o          \

```

```

#                                gckpp_comode_mod.o

gckpp_Rates.o                   : gckpp_Parameters.o      \
                                gckpp_Global.o            \
                                gckpp_Monitor.o
gckpp_Stoichiom.o               : gckpp_Parameters.o      \
                                gckpp_StoichiomSP.o
gckpp_Util.o                    : gckpp_Parameters.o      \
                                gckpp_Global.o            \
                                gckpp_Monitor.o

```

---

## 1.6 Module Interface Makefile (in the KPP/SOA subdirectory)

This makefile compiles the KPP solver code for the GEOS-Chem SOA simulation (with aromatic formation of secondary organic aerosol tracers). Object files (\*.o) are bundled into the libKpp.a library (located in the LIB directory). Module files (\*.mod) are copied to the MOD directory.

### REMARKS:

To build the programs, call "make" with the following syntax:

```
make TARGET [ OPTIONAL-FLAGS ]
```

To display a complete list of options, type "make help".

```

%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%% NOTE: Normally you will not have to call this Makefile directly, %%
%% it will be called automatically from the Makefile in the directory %%
%% just above this one! %%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%

```

Makefile uses the following variables:

Variable	Description
-----	-----
SHELL	Specifies the shell for "make" to use (usually SHELL=/bin/sh)
ROOTDIR	Specifies the root-level directory of the GEOS-Chem code
HDR	Specifies the directory where GEOS-Chem include files are found
LIB	Specifies the directory where library files (*.a) are stored
MOD	Specifies the directory where module files (*.mod) are stored
AR	Sys var w/ name of library creator program (i.e., "ar", "ranlib")
MAKE	Sys var w/ name of Make command (i.e., "make" or "gmake")

**REVISION HISTORY:**

16 Sep 2009 - R. Yantosca - Initial version  
 21 Sep 2009 - R. Yantosca - Now call Makefile in help directory to  
                   display the help screen options  
 23 Nov 2009 - R. Yantosca - Now don't copy module files; they will be  
                   automatically written to the mod directory  
 11 Dec 2009 - R. Yantosca - Now get SHELL from Makefile\_header.mk

# Define variables

ROOTDIR = ../..

HDR      = \$(ROOTDIR)/Headers

HELP     = \$(ROOTDIR)/help

LIB      = \$(ROOTDIR)/lib

MOD      = \$(ROOTDIR)/mod

# Include header file. This returns CC, F90, FREEFORM, LD, R8, SHELL,  
 # as well as the default Makefile compilation rules for source code files.  
 include \$(ROOTDIR)/Makefile\_header.mk

#=====

# List of files to compile. Here the order is not important,  
 # as we will explicitly define the dependencies listing below.  
 #=====

# Source code files

SRC      = \$(wildcard gckpp\*.f90)

# Object files

OBJ      = \$(SRC:.f90=.o)

#=====

# Makefile targets: type "make help" for a complete listing!  
 #=====

.PHONY: clean help

lib: \$(OBJ)

\$(AR) crs libKpp.a \$(OBJ)

mv libKpp.a \$(LIB)

clean:

rm -f \*.o \*.mod geos

help:

@\$(MAKE) -C \$(HELP)

#=====

```

# Dependencies listing (grep "USE " to get the list of module references!)
#
# From this list of dependencies, the "make" utility will figure out the
# correct order of compilation (so we don't have to do that ourselves!)
#=====

gckpp_Function.o      : gckpp_Parameters.o

gckpp_Global.o        : gckpp_Parameters.o

gckpp_Hessian.o       : gckpp_Parameters.o      \
                      gckpp_HessianSP.o

gckpp_Initialize.o    : gckpp_Parameters.o      \
                      gckpp_Global.o           \
                      gckpp_Util.o             \
                      gckpp_Monitor.o

gckpp_Integrator.o    : gckpp_Parameters.o      \
                      gckpp_Global.o           \
                      gckpp_Function.o         \
                      gckpp_Rates.o            \
                      gckpp_Jacobian.o         \
                      gckpp_LinearAlgebra.o

gckpp_Jacobian.o      : gckpp_Parameters.o      \
                      gckpp_JacobianSP.o

gckpp_LinearAlgebra.o : gckpp_Parameters.o      \
                      gckpp_JacobianSP.o

gckpp_Model.o         : gckpp_Precision.o      \
                      gckpp_Parameters.o       \
                      gckpp_Global.o           \
                      gckpp_Function.o         \
                      gckpp_Integrator.o       \
                      gckpp_Rates.o            \
                      gckpp_Jacobian.o         \
                      gckpp_Hessian.o          \
                      gckpp_Stoichiom.o        \
                      gckpp_Monitor.o          \
                      gckpp_Util.o             \
                      gckpp_LinearAlgebra.o

gckpp_Parameters.o    : gckpp_Precision.o

gckpp_Rates.o         : gckpp_Parameters.o      \
                      gckpp_Global.o           \

```



```

                                gckpp_Monitor.o

gckpp_Stoichiom.o      : gckpp_Parameters.o      \
                        gckpp_StoichiomSP.o

gckpp_Util.o          : gckpp_Parameters.o      \
                        gckpp_Global.o          \
                        gckpp_Monitor.o

```

---

## 1.7 Module Interface Makefile (in the GeosTomas subdirectory)

This is the main makefile for GEOS-Chem + TOMAS aerosol microphysics. It compiles the GEOS-Chem core source code files and into object files (\*.o). Module files (\*.mod) are copied to the MOD directory.

### REMARKS:

To build the programs, call "make" with the following syntax:

```
make TARGET [ OPTIONAL-FLAGS ]
```

To display a complete list of options, type "make help".

```

%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%% NOTE: Most of the time this Makefile will be called automatically    %%
%% from the router Makefile in the top-level directory. However, if      %%
%% you are in the ./GeosCore directory, then you can call this Makefile  %%
%% to build the GEOS-Chem source code, libraries, and executables.      %%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%

```

Makefile uses the following variables:

Variable	Description
-----	-----
SHELL	Specifies the shell for "make" to use (usually SHELL=/bin/sh)
ROOTDIR	Specifies the root directory for the GEOS-Chem code
BIN	Specifies the directory where executable files are stored
BPCH	Specifies the directory where the G-C bpch routines are stored
DOC	Specifies the directory for generating documentation w/ ProTeX
EXE	Specifies the name of the executable file
HDR	Specifies the directory where include files are found
LIB	Specifies the directory where library files (*.a) are stored
LINK	Specifies the link commands to the GEOS-Chem library files
KPP	Specifies the directory where th KPP solver files reside
MOD	Specifies the directory where module files (*.mod) are stored

OBJ Specifies the list of object files (\*.o) to be created.  
 UTIL Specifies the directory where the G-C utility modules are found  
 AR Sys var w/ name of library creator program (i.e., "ar", "ranlib")  
 MAKE Sys var w/ name of Make command (i.e, "make" or "gmake")  
 NTRAC Cmd line argument; specifies either 43 or 54 tracer simulation  
 KPPSOLVER Cmd line argument; specifies the type of integrator to use

NOTE: CC, F90, FREEFORM, LD, R8 are included from "Makefile\_header.mk".

%%%  
 %% You can compile GEOS-Chem in parallel using the "make -jN" option! %%  
 %%  
 %% N = number of proceses that you want to run simultaneously (i.e. %%  
 %% (when one file is finished compiling, "make" will immediately start %%  
 %% on the next one). Usually N is the # of processors on your system. %%  
 %%%

## REVISION HISTORY:

25 Jan 2010 - R. Yantosca - Initial version for TOMAS microphysics  
 28 Jan 2010 - C. Carouge - Modifications for ISORROPIA II  
 10 May 2010 - R. Yantosca - Add dependency for RD\_AOD.f  
 26 Aug 2010 - R. Yantosca - Modifications for MERRA met fields  
 23 Sep 2010 - R. Yantosca - Removed "tropopause.f" from compile list  
 23 Sep 2010 - R. Yantosca - Updated dependencies for v9-01-01

# Define variables

ROOTDIR = ..

BIN = \$(ROOTDIR)/bin

BPCH = \$(ROOTDIR)/GeosBpch

CORE = \$(ROOTDIR)/GeosCore

DOC = \$(ROOTDIR)/doc

EXE = geostomas

HDR = \$(ROOTDIR)/Headers

HELP = \$(ROOTDIR)/help

ISO = \$(ROOTDIR)/ISORROPIA

LIB = \$(ROOTDIR)/lib

KPP = \$(ROOTDIR)/KPP

MOD = \$(ROOTDIR)/mod

UTIL = \$(ROOTDIR)/GeosUtil

GTMM = \$(ROOTDIR)/GTMM

# This directory only contains files that are different for the TOMAS  
 # aerosol microphysics. For files that are the same as for the regular  
 # GEOS-Chem code, look in the GeosCore directory.  
 VPATH = ../GeosCore

# Include header file. This returns CC, F90, FREEFORM, LD, R8, SHELL,

```
# as well as the default Makefile compilation rules for source code files.
include $(ROOTDIR)/Makefile_header.mk
```

```
#####
# List of files to compile. We need to manually list all object files, since
# some of these will be referenced from the ../GeosCore directory.
#
# Parallel make may not work with TOMAS. Investigate later... (bmy, 1/25/10)
#####
```

```
OBJ =
BLKSLV.o          drydep_mod.o          partition.o       \
CLDSRF.o          dust_dead_mod.o       pbl_mix_mod.o    \
CO_strat_pl.o     dust_mod.o            pderiv.o         \
EFOLD.o           edgar_mod.o           photoj.o         \
FLINT.o           emep_mod.o            physproc.o       \
GAUSSP.o          emf_scale.o           pjc_pfix_geos5_window_mod.o \
GEN.o            emfossil.o            pjc_pfix_mod.o   \
JRATET.o          emisop.o             planeflight_mod.o \
JVALUE.o          emisop_grass.o         precipfrac.o     \
LEGND0.o          emisop_mb.o           pulsing.o        \
MATIN4.o          emissdr.o            rd_js.o          \
MIESCT.o          emissions_mod.o       rd_prof.o        \
NOABS.o           emmonot.o            rdisopt.o       \
OPMIE.o           epa_nei_mod.o         rdlai.o         \
RD_TJPL.o         fast_j.o             rdland.o        \
RnPbBe_mod.o      fertadd.o            rdlight.o       \
SPHERE.o          findmon.o            rdmonot.o       \
XSEC1D.o          fjfunc.o             rdsoil.o        \
XSEC02.o          fjx_acet_mod.o        readchem.o      \
XSEC03.o          future_emissions_mod.o reader.o         \
a3_read_mod.o     fvdas_convect_mod.o         readlai.o       \
a6_read_mod.o     fyhoro.o             restart_mod.o    \
acetone_mod.o     fyrno3.o             rpmares_mod.o   \
aerosol_mod.o     gamap_mod.o            ruralbox.o      \
aircraft_nox_mod.o gasconc.o          scale_anthro_mod.o \
airmas.o          gc_biomass_mod.o       schem.o         \
anthroems.o       gcap_convect_mod.o         seasalt_mod.o   \
arctas_ship_emiss_mod.o gcap_read_mod.o   set_aer.o       \
arsl1k.o          geia_mod.o            set_prof.o      \
backsub.o         get_global_ch4.o          setbase.o       \
benchmark_mod.o   getifsun.o         setemdep.o      \
biofit.o          gfed2_biomass_mod.o        setemis.o       \
biofuel_mod.o     global_ch4_mod.o       setmodel.o      \
biomass_mod.o     global_hno3_mod.o      sfcwindsqr.o   \
boxvl.o           global_no3_mod.o       smvgear.o       \
bravo_mod.o       global_nox_mod.o       soaprod_mod.o  \
c2h6_mod.o        global_old_mod.o       soilbase.o      \
```

cac_anthro_mod.o	global_o3_mod.o	soilcrf.o	\
calcrate.o	global_oh_mod.o	soilnoxems.o	\
carbon_mod.o	gwet_read_mod.o	soiltemp.o	\
ch3i_mod.o	h2_hd_mod.o	soiltype.o	\
chemdr.o	hcn_ch3cn_mod.o	streets_anthro_mod.o	\
chemistry_mod.o	i6_read_mod.o	subfun.o	\
cleanup.o	icoads_ship_mod.o	sulfate_mod.o	\
co2_mod.o	initialize.o	sunparam.o	\
comode_mod.o	inphot.o	tagged_co_mod.o	\
convection_mod.o	input_mod.o	tagged_ox_mod.o	\
dao_mod.o	isoropiaII_mod.o	tcorr.o	\
decomp.o	jsparse.o	toms_mod.o	\
diag03_mod.o	jv_index.o	tpcore_bc_mod.o	\
diag04_mod.o	ksparse.o	tpcore_fvdas_mod.o	\
diag1.o	lai_mod.o	tpcore_geos5_window_mod.o	\
diag3.o	lightning_nox_mod.o	tpcore_mod.o	\
diag41_mod.o	linoz_mod.o	tpcore_window_mod.o	\
diag42_mod.o	logical_mod.o	tracer_mod.o	\
diag48_mod.o	lump.o	tracerid_mod.o	\
diag49_mod.o	main.o	transport_mod.o	\
diag50_mod.o	megan_mod.o		\
diag51_mod.o	meganut_mod.o	tropopause_mod.o	\
diag51b_mod.o	mercury_mod.o	upbdflex_mod.o	\
diag56_mod.o	mmran_16.o	update.o	\
diag_2pm.o	ndxx_setup.o	uvalbedo_mod.o	\
diag_mod.o	nei2005_anthro_mod.o	vdifff_mod.o	\
diag_oh_mod.o	ocean_mercury_mod.o	vdifff_pre_mod.o	\
diag_pl_mod.o	ohsave.o	vistas_anthro_mod.o	\
diagoh.o	optdepth_mod.o	wetscav_mod.o	\
xtra_read_mod.o	aero_drydep.o	tomas_mod.o	\
tomas_tpcore_mod.o	RD_AOD.o	depo_mercury_mod.o	\
land_mercury_mod.o	global_br_mod.o	merra_a1_mod.o	\
merra_a3_mod.o	merra_cn_mod.o	merra_i6_mod.o	\

```
#=====
# Makefile targets: type "make help" for a complete listing!
#=====
```

```
.PHONY: clean realclean doc docclean help
```

```
all:
```

```
  @$(MAKE) TOMAS=yes lib
```

```
  @$(MAKE) TOMAS=yes exe
```

```
lib: libkpp libutil libiso libtomas
```

```
libtomas: $(OBJ)
```

```

libiso:
@$(MAKE) -C $(ISO)

libkpp:
@$(MAKE) -C $(KPP)

libutil:
@$(MAKE) -C $(UTIL)

exe:
$(LD) $(OBJ) $(LINK) -o $(EXE)
cp -f $(EXE) $(BIN)

clean:
rm -f *.o *.mod geos geostomas

realclean:
@$(MAKE) clean
@$(MAKE) -C $(ISO) clean
@$(MAKE) -C $(KPP) realclean
@$(MAKE) -C $(UTIL) clean
@$(MAKE) -C $(CORE) clean
@$(MAKE) -C $(GTMM) clean
@$(MAKE) docclean
rm -f $(LIB)/*.a
rm -f $(MOD)/*.mod
rm -f $(BIN)/geos*

doc:
@$(MAKE) -C $(DOC) all

docclean:
@$(MAKE) -C $(DOC) clean

help:
@$(MAKE) -C $(HELP)

#=====
# Dependencies listing (grep "USE " to get the list of module references!)
#
# From this list of dependencies, the "make" utility will figure out the
# correct order of compilation (so we don't have to do that ourselves).
# This also allows us to compile on multiple processors with "make -j".
#
# NOTES:
# (1) Only specify object-file dependencies that are within this directory.
#     Object files in other directories will be referenced at link-time.
# (2) For "make -j" to work, all files in this directory must have a

```

# listed dependency.

#=====

```

a3_read_mod.o      : a3_read_mod.f      dao_mod.o      \
                    diag_mod.o          logical_mod.o

a6_read_mod.o      : a6_read_mod.f      dao_mod.o      \
                    diag_mod.o          logical_mod.o

acetone_mod.o      : acetone_mod.f      dao_mod.o      \
                    diag_mod.o

aerosol_mod.o      : aerosol_mod.f      comode_mod.o   \
                    dao_mod.o          diag_mod.o     \
                    logical_mod.o      tracerid_mod.o \
                    tracer_mod.o       tropopause_mod.o

aircraft_nox_mod.o : aircraft_nox_mod.f                      \
                    dao_mod.o          diag_mod.o

airmas.o           : airmas.f

anthroems.o        : anthroems.f                      \
                    future_emissions_mod.o edgar_mod.o   \
                    geia_mod.o          logical_mod.o   \
                    scale_anthro_mod.o  tracer_mod.o    \
                    tracerid_mod.o

arctas_ship_emiss_mod.o : arctas_ship_emiss_mod.f          \
                    logical_mod.o      scale_anthro_mod.o \
                    tracerid_mod.o     tracer_mod.o

arsl1k.o           : arsl1k.f

backsub.o          : backsub.f

benchmark_mod.o    : benchmark_mod.f                      \
                    tracerid_mod.o     tracer_mod.o

biofuel_mod.o      : biofuel_mod.f                      \
                    dao_mod.o          diag_mod.o       \
                    epa_nei_mod.o      future_emissions_mod.o \
                    logical_mod.o      streets_anthro_mod.o \
                    tracerid_mod.o     tracer_mod.o

biofit.o           : biofit.f

biomass_mod.o      : biomass_mod.f                      \

```

	diag_mod.o	gc_biomass_mod.o	\
	gfed2_biomass_mod.o	logical_mod.o	\
	tracerid_mod.o	tracer_mod.o	
BLKSLV.o	: BLKSLV.f		
boxvl.o	: boxvl.f	dao_mod.o	
bravo_mod.o	: bravo_mod.f		\
	future_emissions_mod.o	logical_mod.o	\
	scale_anthro_mod.o	tracerid_mod.o	
c2h6_mod.o	: c2h6_mod.f		\
	biofuel_mod.o	biomass_mod.o	\
	dao_mod.o	diag_mod.o	\
	geia_mod.o	global_oh_mod.o	\
	logical_mod.o	tracerid_mod.o	\
	tracer_mod.o		
cac_anthro_mod.o	: cac_anthro_mod.f		\
	future_emissions_mod.o	logical_mod.o	\
	scale_anthro_mod.o	tracerid_mod.o	\
	tracer_mod.o		
calcrate.o	: calcrate.f		\
	comode_mod.o	dao_mod.o	\
	diag_mod.o	drydep_mod.o	\
	logical_mod.o	pbl_mix_mod.o	\
	planeflight_mod.o	tracerid_mod.o	
carbon_mod.o	: carbon_mod.f		\
	biomass_mod.o	comode_mod.o	\
	dao_mod.o	diag_mod.o	\
	drydep_mod.o	future_emissions_mod.o	\
	gfed2_biomass_mod.o	global_no3_mod.o	\
	global_o3_mod.o	global_oh_mod.o	\
	logical_mod.o	megan_mod.o	\
	pbl_mix_mod.o	tracerid_mod.o	\
	tracer_mod.o	tropopause_mod.o	\
	vdiff_pre_mod.o	meganut_mod.o	\
	tomas_mod.o		
ch3i_mod.o	: ch3i_mod.f		\
	biofuel_mod.o	biomass_mod.o	\
	dao_mod.o	diag_mod.o	\
	diag_pl_mod.o	logical_mod.o	\
	tracerid_mod.o	tracer_mod.o	\
	uvalbedo_mod.o		

```

chemdr.o          : chemdr.f                                \
                   aerosol_mod.o      comode_mod.o          \
                   dao_mod.o          diag_oh_mod.o         \
                   diag_pl_mod.o      future_emissions_mod.o \
                   dust_mod.o         logical_mod.o         \
                   planeflight_mod.o  restart_mod.o         \
                   tracer_mod.o       tracerid_mod.o        \
                   tropopause_mod.o   uvalbedo_mod.o

chemistry_mod.o   : chemistry_mod.f                        \
                   acetone_mod.o      aerosol_mod.o         \
                   c2h6_mod.o         carbon_mod.o         \
                   ch3i_mod.o         comode_mod.o         \
                   dao_mod.o         drydep_mod.o          \
                   dust_mod.o         global_ch4_mod.o      \
                   h2_hd_mod.o        hcn_ch3cn_mod.o      \
                   isoropiaII_mod.o   logical_mod.o        \
                   mercury_mod.o      optdepth_mod.o       \
                   rpmares_mod.o      RnPbBe_mod.o         \
                   seasalt_mod.o      sulfate_mod.o        \
                   tagged_co_mod.o    tagged_ox_mod.o       \
                   tracerid_mod.o     tracer_mod.o         \
                   tomas_mod.o

cleanup.o         : cleanup.f                                \
                   acetone_mod.o      aerosol_mod.o         \
                   arctas_ship_emiss_mod.o aircraft_nox_mod.o \
                   biomass_mod.o      biofuel_mod.o        \
                   bravo_mod.o        c2h6_mod.o           \
                   cac_anthro_mod.o   carbon_mod.o         \
                   co2_mod.o          comode_mod.o         \
                   dao_mod.o          depo_mercury_mod.o    \
                   diag_mod.o         diag03_mod.o         \
                   diag04_mod.o       diag41_mod.o         \
                   diag50_mod.o       diag51_mod.o         \
                   diag51b_mod.o      diag_oh_mod.o        \
                   diag_pl_mod.o      drydep_mod.o         \
                   dust_mod.o         dust_dead_mod.o      \
                   edgar_mod.o        emep_mod.o          \
                   epa_nei_mod.o      gc_biomass_mod.o     \
                   isoropiaII_mod.o   gfed2_biomass_mod.o  \
                   global_ch4_mod.o   global_hno3_mod.o   \
                   global_no3_mod.o   global_nox_mod.o    \
                   global_o1d_mod.o   global_oh_mod.o     \
                   h2_hd_mod.o        hcn_ch3cn_mod.o      \
                   lai_mod.o          land_mercury_mod.o   \
                   lightning_nox_mod.o linoz_mod.o         \

```



megan_mod.o	mercury_mod.o	\
ocean_mercury_mod.o	pbl_mix_mod.o	\
pjc_pfix_mod.o	planeflight_mod.o	\
seasalt_mod.o	sulfate_mod.o	\
tagged_co_mod.o	toms_mod.o	\
tracer_mod.o	transport_mod.o	\
tropopause_mod.o	uvalbedo_mod.o	\
vistas_anthro_mod.o	wetscav_mod.o	\
icoads_ship_mod.o	tpcore_fvdas_mod.o	\
tpcore_geos5_window_mod.o	tomas_mod.o	
CLDSRF.o	: CLDSRF.f	
co2_mod.o	: co2_mod.f	biomass_mod.o \
	diag04_mod.o	tracer_mod.o \
tracerid_mod.o		
CO_strat_pl.o	: CO_strat_pl.f	\
	dao_mod.o	tracer_mod.o \
	tracerid_mod.o	tropopause_mod.o
comode_mod.o	: comode_mod.f	tracer_mod.o
convection_mod.o	: convection_mod.f	\
	dao_mod.o	diag_mod.o \
	depo_mercury_mod.o	fvdas_convect_mod.o \
	gcap_convect_mod.o	logical_mod.o \
	mercury_mod.o	tracer_mod.o \
	tracerid_mod.o	wetscav_mod.o
dao_mod.o	: dao_mod.f	\
	logical_mod.o	tracer_mod.o
decomp.o	: decomp.f	
depo_mercury_mod.o	: depo_mercury_mod.f	\
	dao_mod.o	diag_mod.o \
	logical_mod.o	tracerid_mod.o
diag03_mod.o	: diag03_mod.f	tracerid_mod.o
diag04_mod.o	: diag04_mod.f	
diag1.o	: diag1.f	\
	dao_mod.o	diag_mod.o \
	tracer_mod.o	tracerid_mod.o \
	tropopause_mod.o	

```

diag3.o                : diag3.f                                \
                        biofuel_mod.o                          biomass_mod.o      \
                        diag_mod.o                             diag03_mod.o       \
                        diag04_mod.o                           diag41_mod.o       \
                        diag42_mod.o                           diag56_mod.o       \
                        diag_pl_mod.o                          depo_mercury_mod.o  \
                        drydep_mod.o                           logical_mod.o      \
                        tracer_mod.o                           tracerid_mod.o     \
                        wetscav_mod.o                          tomas_mod.o

diag41_mod.o           : diag41_mod.f                          pbl_mix_mod.o

diag42_mod.o           : diag42_mod.f                                \
                        dao_mod.o                             logical_mod.o      \
                        tracerid_mod.o                         tracer_mod.o

diag48_mod.o           : diag48_mod.f                                \
                        dao_mod.o                             pbl_mix_mod.o      \
                        tracerid_mod.o                         tracer_mod.o

diag49_mod.o           : diag49_mod.f                                \
                        dao_mod.o                             lai_mod.o          \
                        pbl_mix_mod.o                         tracerid_mod.o     \
                        tracer_mod.o

diag50_mod.o           : diag50_mod.f                                \
                        comode_mod.o                          dao_mod.o          \
                        logical_mod.o                         pbl_mix_mod.o      \
                        tracerid_mod.o                         tracer_mod.o      \
                        tropopause_mod.o

diag51_mod.o           : diag51_mod.f                                \
                        dao_mod.o                             lai_mod.o          \
                        logical_mod.o                         pbl_mix_mod.o      \
                        tracerid_mod.o                         tracer_mod.o      \
                        tropopause_mod.o

diag51b_mod.o          : diag51b_mod.f                             \
                        dao_mod.o                             lai_mod.o          \
                        logical_mod.o                         pbl_mix_mod.o      \
                        tracerid_mod.o                         tracer_mod.o      \
                        tropopause_mod.o

diag56_mod.o           : diag56_mod.f

diag_2pm.o             : diag_2pm.f                                \
                        diag_mod.o                             tropopause_mod.o

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```

diag_mod.o          : diag_mod.f

diag_oh_mod.o       : diag_oh_mod.f          \
                    comode_mod.o            logical_mod.o      \
                    tracerid_mod.o          tracer_mod.o

diag_pl_mod.o       : diag_pl_mod.f          \
                    comode_mod.o            logical_mod.o      \
                    tracerid_mod.o          tracer_mod.o

drydep_mod.o        : drydep_mod.f           comode_mod.o        \
                    dao_mod.o              diag_mod.o         \
                    logical_mod.o          pbl_mix_mod.o       \
                    tracerid_mod.o         tracer_mod.o        \
                    meganut_mod.o          tomas_mod.o

diagoh.o            : diagoh.f               diag_mod.o

dust_dead_mod.o     : dust_dead_mod.f        dao_mod.o

dust_mod.o          : dust_mod.f             \
                    comode_mod.o           dao_mod.o          \
                    diag_mod.o             drydep_mod.o       \
                    dust_dead_mod.o        logical_mod.o       \
                    tracerid_mod.o         tracer_mod.o

edgar_mod.o         : edgar_mod.f            \
                    future_emissions_mod.o logical_mod.o      \
                    scale_anthro_mod.o

EFOLD.o            : EFOLD.f

emep_mod.o          : emep_mod.f             \
                    future_emissions_mod.o logical_mod.o      \
                    scale_anthro_mod.o     tracerid_mod.o      \
                    tracer_mod.o

emf_scale.o         : emf_scale.f            tracerid_mod.o

emfossil.o          : emfossil.f             \
                    bravo_mod.o            cac_anthro_mod.o     \
                    dao_mod.o             diag_mod.o          \
                    edgar_mod.o           emep_mod.o          \
                    epa_nei_mod.o         icoads_ship_mod.o    \
                    logical_mod.o         nei2005_anthro_mod.o  \
                    streets_anthro_mod.o  tracer_mod.o        \
                    tracerid_mod.o        vistas_anthro_mod.o

```

```

emisop.o          : emisop.f          dao_mod.o          \
                   meganut_mod.o

emisop_grass.o    : emisop_grass.f    dao_mod.o

emisop_mb.o       : emisop_mb.f        dao_mod.o

emissdr.o         : emissdr.f          \
                   acetone_mod.o      aircraft_nox_mod.o \
                   biofuel_mod.o      dao_mod.o          \
                   diag_mod.o         emissions_mod.o   \
lightning_nox_mod.o logical_mod.o    \
                   megan_mod.o        tracer_mod.o       \
                   tracerid_mod.o     meganut_mod.o

emissions_mod.o   : emissions_mod.f    \
                   arctas_ship_emiss_mod.o biomass_mod.o  \
                   bravo_mod.o        c2h6_mod.o          \
                   cac_anthro_mod.o    carbon_mod.o       \
                   ch3i_mod.o          co2_mod.o           \
                   dust_mod.o          edgar_mod.o         \
                   emep_mod.o          epa_nei_mod.o       \
                   global_ch4_mod.o    h2_hd_mod.o         \
                   hcn_ch3cn_mod.o     icoads_ship_mod.o  \
                   logical_mod.o       mercury_mod.o      \
                   nei2005_anthro_mod.o RnPbBe_mod.o      \
                   seasalt_mod.o       streets_anthro_mod.o \
                   sulfate_mod.o       tagged_co_mod.o    \
                   tracer_mod.o        vistas_anthro_mod.o

emmonot.o         : emmonot.f

epa_nei_mod.o     : epa_nei_mod.f      \
                   future_emissions_mod.o logical_mod.o   \
                   scale_anthro_mod.o  tracerid_mod.o    \
                   tracer_mod.o

fast_j.o          : fast_j.f           \
                   dao_mod.o           toms_mod.o

fertadd.o         : fertadd.f          logical_mod.o

findmon.o         : findmon.f

fjfunc.o          : fjfunc.f

fjx_acet_mod.o    : fjx_acet_mod.f

```

```

future_emissions_mod.o      : future_emissions_mod.f

fvdas_convect_mod.o         : fvdas_convect_mod.f          \
                             dao_mod.o                     \
                             depo_mercury_mod.o             \
                             tracerid_mod.o                 \
                             tracer_mod.o

fyhoro.o                    : fyhoro.f

fyrno3.o                    : fyrno3.f

gamap_mod.o                 : gamap_mod.f                  \
                             diag03_mod.o                   \
                             diag41_mod.o                   \
                             diag48_mod.o                   \
                             diag50_mod.o                   \
                             diag51b_mod.o                  \
                             diag56_mod.o                   \
                             diag_pl_mod.o                  \
                             drydep_mod.o                   \
                             logical_mod.o                   \
                             tracerid_mod.o                  \
                             tracer_mod.o                    \
                             tomas_mod.o                     \
                             wetscav_mod.o                  \

ifeq ($(COMPILER),sun)
$(F90) -O0 -c $<
endif

gasconc.o                   : gasconc.f                    \
                             comode_mod.o                   \
                             dao_mod.o                       \
                             drydep_mod.o                    \
                             tropopause_mod.o                \
                             logical_mod.o

GAUSSP.o                    : GAUSSP.f

gc_biomass_mod.o            : gc_biomass_mod.f              \
                             future_emissions_mod.o         \
                             tracerid_mod.o                  \
                             tracer_mod.o

gcap_convect_mod.o          : gcap_convect_mod.f            \
                             dao_mod.o                       \
                             diag_mod.o

gcap_read_mod.o             : gcap_read_mod.f               \
                             dao_mod.o                       \
                             diag_mod.o                       \
                             logical_mod.o

geia_mod.o                  : geia_mod.f

GEN.o                       : GEN.f

get_global_ch4.o            : get_global_ch4.f              \

```

	future_emissions_mod.o	logical_mod.o	
getifsun.o	: getifsun.f	comode_mod.o	
gfed2_biomass_mod.o	: gfed2_biomass_mod.f		\
	future_emissions_mod.o	logical_mod.o	\
	tracer_mod.o	tracerid_mod.o	
global_br_mod.o	: global_br_mod.f	tropopause_mod.o	
global_ch4_mod.o	: global_ch4_mod.f		\
	dao_mod.o	diag_mod.o	\
	diag_oh_mod.o	diag_pl_mod.o	\
	global_oh_mod.o	logical_mod.o	\
	tracer_mod.o	vdiff_pre_mod.o	
global_hno3_mod.o	: global_hno3_mod.f		\
	dao_mod.o	tracer_mod.o	
global_no3_mod.o	: global_no3_mod.f		
global_nox_mod.o	: global_nox_mod.f		
global_o1d_mod.o	: global_o1d_mod.f		
global_o3_mod.o	: global_o3_mod.f		
global_oh_mod.o	: global_oh_mod.f		
gwet_read_mod.o	: gwet_read_mod.f		\
	dao_mod.o	diag_mod.o	\
	logical_mod.o		
h2_hd_mod.o	: h2_hd_mod.f		\
	biofuel_mod.o	biomass_mod.o	\
	dao_mod.o	diag_mod.o	\
	drydep_mod.o	geia_mod.o	\
	global_nox_mod.o	global_o1d_mod.o	\
	global_oh_mod.o	logical_mod.o	\
	scale_anthro_mod.o	tagged_co_mod.o	\
	tracerid_mod.o	tracer_mod.o	\
	tropopause_mod.o	meganut_mod.o	
hcn_ch3cn_mod.o	: hcn_ch3cn_mod.f		\
	biomass_mod.o	dao_mod.o	\
	diag_mod.o	geia_mod.o	\
	global_oh_mod.o	logical_mod.o	\
	pbl_mix_mod.o	tracerid_mod.o	

```

i6_read_mod.o          : i6_read_mod.f          \
                        dao_mod.o                diag_mod.o          \
                        logical_mod.o

icoads_ship_mod.o      : icoads_ship_mod.f          \
                        future_emissions_mod.o    logical_mod.o      \
                        scale_anthro_mod.o        tracerid_mod.o     \
                        tracer_mod.o

initialize.o           : initialize.f              \
                        diag_mod.o                diag03_mod.o         \
                        diag04_mod.o              diag41_mod.o         \
                        diag42_mod.o              diag56_mod.o         \
                        diag_pl_mod.o             logical_mod.o

inphot.o               : inphot.f

input_mod.o            : input_mod.f              \
                        benchmark_mod.o           biofuel_mod.o      \
                        depo_mercury_mod.o        diag03_mod.o          \
                        diag04_mod.o              diag41_mod.o          \
                        diag42_mod.o              diag48_mod.o          \
                        diag49_mod.o              diag50_mod.o          \
                        diag51_mod.o              diag51b_mod.o         \
                        diag56_mod.o              diag_oh_mod.o         \
                        diag_pl_mod.o             drydep_mod.o         \
                        emissions_mod.o           future_emissions_mod.o \
                        gamap_mod.o              land_mercury_mod.o     \
                        logical_mod.o            mercury_mod.o         \
                        ocean_mercury_mod.o       planeflight_mod.o      \
                        restart_mod.o            tpcore_bc_mod.o        \
                        tracerid_mod.o            tracer_mod.o          \
                        transport_mod.o          upbdflex_mod.o         \
                        wetscav_mod.o            tomas_mod.o

isoropiaII_mod.o       : isoropiaII_mod.f          \
                        dao_mod.o                global_hno3_mod.o      \
                        logical_mod.o            tracerid_mod.o       \
                        tracer_mod.o            tropopause_mod.o

jsparse.o              : jsparse.f                comode_mod.o

JRATET.o               : JRATET.f                fjx_acet_mod.o

JVALUE.o               : JVALUE.f

jv_index.o             : jv_index.f

```

```

ksparse.o          : ksparse.f

lai_mod.o          : lai_mod.f          logical_mod.o

land_mercury_mod.o : land_mercury_mod.f          \
                    biomass_mod.o          dao_mod.o          \
                    depo_mercury_mod.o      lai_mod.o          \
                    logical_mod.o          tracerid_mod.o      \

LEGND0.o           : LEGND0.f

lightning_nox_mod.o : lightning_nox_mod.f          \
                    dao_mod.o          diag56_mod.o          \
                    diag_mod.o          logical_mod.o

linoz_mod.o        : linoz_mod.f          \
                    dao_mod.o          tracerid_mod.o          \
                    tracer_mod.o      tropopause_mod.o

logical_mod.o      : logical_mod.f

lump.o             : lump.f          \
                    comode_mod.o      tracerid_mod.o

main.o             : main.f          \
                    a3_read_mod.o      a6_read_mod.o          \
                    benchmark_mod.o     chemistry_mod.o       \
                    convection_mod.o     comode_mod.o          \
                    diag_mod.o           diag41_mod.o          \
                    diag42_mod.o         diag48_mod.o          \
                    diag49_mod.o         diag50_mod.o          \
                    diag51_mod.o         diag51b_mod.o         \
                    diag_oh_mod.o        dao_mod.o            \
                    depo_mercury_mod.o   drydep_mod.o          \
                    emissions_mod.o      global_ch4_mod.o      \
                    gcap_read_mod.o      gwet_read_mod.o       \
                    i6_read_mod.o        input_mod.o           \
                    lai_mod.o            lightning_nox_mod.o    \
                    linoz_mod.o          logical_mod.o         \
                    megan_mod.o          pbl_mix_mod.o          \
                    ocean_mercury_mod.o  planeflight_mod.o    \
                    soaproduct_mod.o     tpcore_bc_mod.o      \
                    tracer_mod.o         transport_mod.o       \
                    tropopause_mod.o     restart_mod.o        \
                    upbdflex_mod.o       uvalbedo_mod.o       \
                    vdiff_mod.o          wetscav_mod.o         \
                    xtra_read_mod.o      merra_cn_mod.o        \

```



	merra_a1_mod.o	merra_a3_mod.o	\
	merra_i6_mod.o		
MATIN4.o	: MATIN4.f		
megan_mod.o	: megan_mod.f	a3_read_mod.o	\
	lai_mod.o	logical_mod.o	\
	meganut_mod.o	merra_a1_mod.o	
meganut_mod.o	: meganut_mod.f	dao_mod.o	
mercury_mod.o	: mercury_mod.f		\
	dao_mod.o	depo_mercury_mod.o	\
	diag03_mod.o	diag_mod.o	\
	drydep_mod.o	global_br_mod.o	\
	global_o3_mod.o	global_oh_mod.o	\
	land_mercury_mod.o	lai_mod.o	\
	logical_mod.o	ocean_mercury_mod.o	\
	pbl_mix_mod.o	RnPbBe_mod.o	\
	tracerid_mod.o	tracer_mod.o	\
	tropopause_mod.o	vdiff_pre_mod.o	
merra_a1_mod.o	: merra_a1_mod.f		\
	logical_mod.o	dao_mod.o	
merra_a3_mod.o	: merra_a3_mod.f		\
	logical_mod.o	dao_mod.o	
merra_cn_mod.o	: merra_cn_mod.f		\
	logical_mod.o	dao_mod.o	
merra_i6_mod.o	: merra_i6_mod.f		\
	logical_mod.o	dao_mod.o	
MIESCT.o	: MIESCT.f		
ndxx_setup.o	: ndxx_setup.f		\
	biofuel_mod.o	diag_mod.o	\
	diag_oh_mod.o	drydep_mod.o	\
	logical_mod.o	planeflight_mod.o	\
	tracer_mod.o	tracerid_mod.o	\
	wetscav_mod.o	tomas_mod.o	
nei2005_anthro_mod.o	: nei2005_anthro_mod.f		\
	future_emissions_mod.o	logical_mod.o	\
	scale_anthro_mod.o	tracerid_mod.o	\
	tracer_mod.o		

```

NOABS.o                : NOABS.f

ocean_mercury_mod.o    : ocean_mercury_mod.f          \
                        dao_mod.o                      \
                        diag03_mod.o                    \
                        tracerid_mod.o                  \
                        depo_mercury_mod.o              \
                        logical_mod.o                   \
                        tracer_mod.o

ohsave.o               : ohsave.f                      \
                        diag_mod.o                      \
                        comode_mod.o                    \
                        tracerid_mod.o

optdepth_mod.o         : optdepth_mod.f                \
                        diag_mod.o

OPMIE.o                : OPMIE.f

partition.o            : partition.f                   \
                        comode_mod.o                    \
                        tracerid_mod.o

pbl_mix_mod.o          : pbl_mix_mod.f                  \
                        dao_mod.o                      \
                        diag_mod.o                      \
                        logical_mod.o                   \
                        tracer_mod.o

pderiv.o               : pderiv.f

photoj.o               : photoj.f

physproc.o             : physproc.f                    \
                        comode_mod.o                    \
                        chemistry_mod.o                 \
                        logical_mod.o                   \

pjc_pfix_geos5_window_mod.o : pjc_pfix_geos5_window_mod.f

pjc_pfix_mod.o         : pjc_pfix_mod.f

planeflight_mod.o      : planeflight_mod.f             \
                        comode_mod.o                    \
                        dao_mod.o                      \
                        tracer_mod.o                    \
                        tropopause_mod.o

precipfrac.o           : precipfrac.f                  \
                        dao_mod.o

pulsing.o              : pulsing.f

RD_AOD.o               : RD_AOD.f

rd_js.o                : rd_js.f

rd_prof.o              : rd_prof.f

rdisopt.o              : rdisopt.f

```

rdlai.o	: rdlai.f		
rdland.o	: rdland.f	logical_mod.o	
rdlight.o	: rdlight.f		
rdmonot.o	: rdmonot.f		
rdsoil.o	: rdsoil.f		
RD_TJPL.o	: RD_TJPL.f		
readchem.o	: readchem.f		\
	diag_pl_mod.o	drydep_mod.o	\
	logical_mod.o		
reader.o	: reader.f		
readlai.o	: readlai.f	logical_mod.o	
restart_mod.o	: restart_mod.f		\
	comode_mod.o	dao_mod.o	\
	logical_mod.o	tracer_mod.o	
RnPbBe_mod.o	: RnPbBe_mod.f		\
	dao_mod.o	diag_mod.o	\
	logical_mod.o	tracer_mod.o	\
	tropopause_mod.o		
rpmares_mod.o	: rpmares_mod.f		\
	dao_mod.o	global_hno3_mod.o	\
	tracerid_mod.o	tracer_mod.o	\
	tropopause_mod.o		
ruralbox.o	: ruralbox.f		\
	comode_mod.o	tropopause_mod.o	
scale_anthro_mod.o	: scale_anthro_mod.f		
schem.o	: schem.f	dao_mod.o	\
	tracerid_mod.o	tracer_mod.o	\
	tropopause_mod.o		
seasalt_mod.o	: seasalt_mod.f		\
	dao_mod.o	diag_mod.o	\
	drydep_mod.o	logical_mod.o	\
	pbl_mix_mod.o	tracerid_mod.o	\

	tracer_mod.o	vdiff_pre_mod.o	\
	tomas_mod.o		
set_aer.o	: set_aer.f		
set_prof.o	: set_prof.f		\
	dao_mod.o	toms_mod.o	
setbase.o	: setbase.f		
setemdep.o	: setemdep.f	drydep_mod.o	\
	tracer_mod.o	tracerid_mod.o	
setemis.o	: setemis.f		\
	aircraft_nox_mod.o	biofuel_mod.o	\
	biomass_mod.o	comode_mod.o	\
	diag_mod.o	emissions_mod.o	\
	lightning_nox_mod.o	logical_mod.o	\
	pbl_mix_mod.o	tracerid_mod.o	\
	tropopause_mod.o		
setmodel.o	: setmodel.f		
sfcwindsqr.o	: sfcwindsqr.f	dao_mod.o	
smvgear.o	: smvgear.f	comode_mod.o	
soaprod_mod.o	: soaprod_mod.f		\
	carbon_mod.o	dao_mod.o	\
	logical_mod.o	tracer_mod.o	
soilbase.o	: soilbase.f		
soilcrf.o	: soilcrf.f		
soilnoxems.o	: soilnoxems.f		\
	dao_mod.o	diag_mod.o	\
	future_emissions_mod.o	logical_mod.o	\
	meganut_mod.o		
soiltemp.o	: soiltemp.f		
soiltype.o	: soiltype.f		
SPHERE.o	: SPHERE.f		
streets_anthro_mod.o	: streets_anthro_mod.f		\
	future_emissions_mod.o	logical_mod.o	\

```

        scale_anthro_mod.o      tracerid_mod.o      \
        tracer_mod.o

subfun.o      : subfun.f

sulfate_mod.o      : sulfate_mod.f      \
        arctas_ship_emiss_mod.o biomass_mod.o      \
        bravo_mod.o      cac_anthro_mod.o      \
        comode_mod.o      dao_mod.o      \
        diag_mod.o      drydep_mod.o      \
        edgar_mod.o      emep_mod.o      \
        epa_nei_mod.o      future_emissions_mod.o \
        gfed2_biomass_mod.o global_hno3_mod.o      \
        global_no3_mod.o      global_oh_mod.o      \
        icoads_ship_mod.o      tomas_mod.o      \
        logical_mod.o      nei2005_anthro_mod.o      \
        pbl_mix_mod.o      scale_anthro_mod.o      \
        seasalt_mod.o      streets_anthro_mod.o      \
        tracerid_mod.o      tracer_mod.o      \
        tropopause_mod.o      uvalbedo_mod.o      \
        vdiff_pre_mod.o      wetscav_mod.o

sunparam.o      : sunparam.f

tagged_co_mod.o      : tagged_co_mod.f      \
        biofuel_mod.o      biomass_mod.o      \
        dao_mod.o      diag_mod.o      \
        diag_pl_mod.o      global_nox_mod.o      \
        global_oh_mod.o      logical_mod.o      \
        megan_mod.o      meganut_mod.o      \
        pbl_mix_mod.o      tracerid_mod.o      \
        tracer_mod.o      tropopause_mod.o

tagged_ox_mod.o      : tagged_ox_mod.f      \
        dao_mod.o      diag_mod.o      \
        diag_pl_mod.o      drydep_mod.o      \
        logical_mod.o      pbl_mix_mod.o      \
        tracerid_mod.o      tracer_mod.o      \
        tropopause_mod.o      meganut_mod.o

tcorr.o      : tcorr.f

toms_mod.o      : toms_mod.f

tpcore_bc_mod.o      : tpcore_bc_mod.f      \
        logical_mod.o      tracer_mod.o

tpcore_geos5_window_mod.o : tpcore_geos5_window_mod.f90

```

```
$(F90) -c $(FREEFORM) $(R8) $<
```

```
tpcore_mod.o      : tpcore_mod.f      dao_mod.o      \
                   diag_mod.o         global_ch4_mod.o \
                   tracer_mod.o       tomas_tpcore_mod.o
```

```
$(F90) -c $(R8) $<
```

```
tpcore_window_mod.o : tpcore_window_mod.f  dao_mod.o      \
                      diag_mod.o         global_ch4_mod.o \
                      tracer_mod.o       tomas_mod.o
```

```
$(F90) -c $(R8) $<
```

```
tracer_mod.o      : tracer_mod.f
```

```
tracerid_mod.o    : tracerid_mod.f      \
                   logical_mod.o        tracer_mod.o
```

```
transport_mod.o   : transport_mod.f      \
                   dao_mod.o             diag_mod.o      \
                   logical_mod.o         pjc_pfix_mod.o    \
                   tpcore_mod.o          tpcore_bc_mod.o   \
                   tpcore_fvdas_mod.o    tpcore_window_mod.o \
                   tracer_mod.o          \
                   tpcore_geos5_window_mod.o \
                   pjc_pfix_geos5_window_mod.o
```

```
tropopause.o      : tropopause.f      \
                   dao_mod.o          diag_mod.o      \
                   logical_mod.o      tropopause_mod.o
```

```
tropopause_mod.o  : tropopause_mod.f    \
                   comode_mod.o        dao_mod.o      \
                   diag_mod.o          logical_mod.o
```

```
upbdflex_mod.o    : upbdflex_mod.f      \
                   dao_mod.o          linoz_mod.o      \
                   logical_mod.o      tagged_ox_mod.o   \
                   tracerid_mod.o     tracer_mod.o      \
                   tropopause_mod.o
```

```
update.o          : update.f
```

```
vdifff_pre_mod.o  : vdifff_pre_mod.f    tracer_mod.o
```

```
ifeq ($(COMPILER),sun)
```

```
$(F90) -O3 -c $<
```

```
endif
```

```

vdiff_mod.o          : vdiff_mod.f90                      \
                      comode_mod.o      dao_mod.o          \
                      depo_mercury_mod.o diag_mod.o         \
                      drydep_mod.o      logical_mod.o       \
                      ocean_mercury_mod.o pbl_mix_mod.o      \
                      tracer_mod.o      tracerid_mod.o       \
                      vdiff_pre_mod.o
vistas_anthro_mod.o  : vistas_anthro_mod.f                \
                      future_emissions_mod.o epa_nei_mod.o  \
                      logical_mod.o      scale_anthro_mod.o \
                      tracerid_mod.o     tracer_mod.o
wetscav_mod.o        : wetscav_mod.f                      \
                      dao_mod.o          diag_mod.o         \
                      depo_mercury_mod.o logical_mod.o       \
                      mercury_mod.o      ocean_mercury_mod.o \
                      tracerid_mod.o     tracer_mod.o        \
                      tomas_mod.o
XSEC1D.o             : XSEC1D.f
XSEC02.o             : XSEC02.f
XSEC03.o             : XSEC03.f
xtra_read_mod.o      : xtra_read_mod.f      dao_mod.o      \
                      diag_mod.o          logical_mod.o     \
                      tomas_mod.o
#-----
# Dependencies of files specific to TOMAS microphysics (bmy, 1/25/10)
#-----
tomas_mod.o          : tomas_mod.f                      \
                      dao_mod.o      diag_mod.o          \
                      diag_pl_mod.o  logical_mod.o       \
                      tropopause_mod.o tracer_mod.o      \
                      tracerid_mod.o
tomas_tpcore_mod.o   : tomas_tpcore_mod.f90              \
                      tomas_mod.o      tracerid_mod.o
aero_drydep.o        : aero_drydep.f                    \
                      dao_mod.o          diag_mod.o         \
                      drydep_mod.o      dust_mod.o         \
                      logical_mod.o     pbl_mix_mod.o       \

```

```

tracer_mod.o          tracerid_mod.o      \
tropopause_mod.o      tomas_mod.o

```

## 1.8 Module Interface Makefile (in the GTMM subdirectory)

This is main "router" makefile for the GTMM model. It compiles the GTMM code for GEOS-Chem mercury simulations. **REMARKS:**

To build the programs, call "make" with the following syntax:

```
make TARGET [ OPTIONAL-FLAGS ]
```

To display a complete list of options, type "make help".

```

%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%% NOTE: Normally you will not have to call this Makefile directly,  %%
%% it will be called automatically from the main GEOS-Chem Makefile in %%
%% GeosCore directory!                                              %%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%

```

Makefile uses the following variables:

Variable	Description
SHELL	Specifies the shell for "make" to use (usually SHELL=/bin/sh)
ROOTDIR	Specifies the root-level directory of the GEOS-Chem code
DOC	Specifies the directory where GEOS-Chem documentation is found
HDR	Specifies the directory where GEOS-Chem include files are found
LIB	Specifies the directory where library files (*.a) are stored
MOD	Specifies the directory where module files (*.mod) are stored
AR	Sys var w/ name of library creator program (i.e., "ar", "ranlib")
MAKE	Sys var w/ name of Make command (i.e, "make" or "gmake")

## REVISION HISTORY:

```

16 Sep 2009 - R. Yantosca - Initial version
18 Sep 2009 - P. Le Sager - Added kppintegrator target & commented
                        "make -C int" calls
21 Sep 2009 - C. Carouge  - Adapted to use with GTMM model.

```

```

# Define variables
SHELL   = /bin/sh
ROOTDIR = ..
HDR      = $(ROOTDIR)/Headers
HELP    = $(ROOTDIR)/help

```



```
LIB      = $(ROOTDIR)/lib
MOD      = $(ROOTDIR)/mod
LGTMM    = -L$(LIB) -lHg
```

```
# Include header file.  This returns variables CC, F90, FREEFORM, LD, R8,
# as well as the default Makefile compilation rules for source code files.
include $(ROOTDIR)/Makefile_header.mk
```

```
#####
# List of files to compile.  Here the order is not important,
# as we will explicitly define the dependencies listing below.
#####
```

```
# Source code files
SRC = $(wildcard *.f90)
```

```
# Object files
OBJ = $(SRC:.f90=.o)
```

```
#####
# Makefile targets: type "make help" for a complete listing!
#####
```

```
.PHONY: clean help gtmm
```

```
lib: $(OBJ)
$(AR) crs libHg.a $(OBJ)
mv libHg.a $(LIB)
```

```
gtmm:
@$(MAKE) lib
@$(MAKE) exe
```

```
exe:
$(LD) $(OBJ) $(LGTMM) -o gtmm
```

```
clean:
rm -f *.o *.mod gtmm
```

```
help:
@$(MAKE) -C $(HELP)
```

```
#####
# Dependencies listing (grep "USE " to get the list of module references!)
#
# From this list of dependencies, the "make" utility will figure out the
# correct order of compilation (so we don't have to do that ourselves!)
```

```

#=====

CleanupCASAarrays.o      : CleanupCASAarrays.f90 defineConstants.o \
                          loadCASAinput.o      defineArrays.o

GTMM.o                   : GTMM.f90              defineConstants.o \
                          loadCASAinput.o      defineArrays.o      \
                          dorestart_mod.o      input_gtmm_mod.o

GTMM_coupled.o           : GTMM_coupled.f90      defineConstants.o \
                          defineArrays.o        dorestart_mod.o      \
                          loadCASAinput.o       input_gtmm_mod.o

HgOutForGEOS.o           : HgOutForGEOS.f90      defineConstants.o \
                          loadCASAinput.o      defineArrays.o      \
                          CasaRegridModule.o

assignAgeClassToRunningPool.o : assignAgeClassToRunningPool.f90 \
                          defineConstants.o     loadCASAinput.o      \
                          defineArrays.o

assignRanPoolToAgeClass.o : assignRanPoolToAgeClass.f90 \
                          defineConstants.o     loadCASAinput.o      \
                          defineArrays.o

defineArrays.o           : defineArrays.f90      defineConstants.o

doFPARandLAI.o           : doFPARandLAI.f90      defineConstants.o \
                          loadCASAinput.o      defineArrays.o

doHerbCarbon.o           : doHerbCarbon.f90      defineConstants.o \
                          loadCASAinput.o      defineArrays.o
# $(F90) -O0 -c $(FREEFORM) doHerbCarbon.f90

doHerbCarbonHg.o         : doHerbCarbonHg.f90    defineConstants.o \
                          loadCASAinput.o      defineArrays.o
# $(F90) -O0 -c $(FREEFORM) doHerbCarbonHg.f90

doHerbivory.o            : doHerbivory.f90       defineConstants.o \
                          loadCASAinput.o      defineArrays.o

doHgDeposition.o         : doHgDeposition.f90    defineConstants.o \
                          loadCASAinput.o      defineArrays.o

doLatitude.o             : doLatitude.f90        defineConstants.o \
                          loadCASAinput.o      defineArrays.o

doLeafRootShedding.o     : doLeafRootShedding.f90 defineConstants.o \

```

	loadCASAinput.o	defineArrays.o	
doMaxHg.o	: doMaxHg.f90 loadCASAinput.o	defineConstants.o defineArrays.o	\
doNPP.o	: doNPP.f90 loadCASAinput.o	defineConstants.o defineArrays.o	\
doOptimumTemperature.o	: doOptimumTemperature.f90 loadCASAinput.o	defineConstants.o defineArrays.o	\
doPET.o	: doPET.f90 loadCASAinput.o	defineConstants.o defineArrays.o	\
doSoilMoisture.o	: doSoilMoisture.f90 loadCASAinput.o	defineConstants.o defineArrays.o	\
doTreeCarbon.o	: doTreeCarbon.f90 loadCASAinput.o	defineConstants.o defineArrays.o	\
# \$(F90) -O0 -c \$(FREEFORM) doTreeCarbon.f90			
doTreeCarbonHg.o	: doTreeCarbonHg.f90 loadCASAinput.o	defineConstants.o defineArrays.o	\
# \$(F90) -O0 -c \$(FREEFORM) doTreeCarbonHg.f90			
getAgeClassBF.o	: getAgeClassBF.f90 loadCASAinput.o	defineConstants.o defineArrays.o	\
getFireParams.o	: getFireParams.f90 loadCASAinput.o	defineConstants.o defineArrays.o	\
getFuelWood.o	: getFuelWood.f90 loadCASAinput.o	defineConstants.o defineArrays.o	\
getSoilMoistParams.o	: getSoilMoistParams.f90 loadCASAinput.o	defineConstants.o defineArrays.o	\
getSoilParams.o	: getSoilParams.f90 loadCASAinput.o	defineConstants.o defineArrays.o	\
input_gtmm_mod.o	: input_gtmm_mod.f90 defineArrays.o	defineConstants.o	\
load_GC_data.o	: load_GC_data.f90 loadCASAinput.o	defineConstants.o CasaRegridModule.o	\
loadCASAinput.o	: loadCASAinput.f90 defineArrays.o	defineConstants.o CasaRegridModule.o	\

```

loadHgDeposition.o          : loadHgDeposition.f90  defineConstants.o  \
                             loadCASAinput.o        defineArrays.o    \
                             CasaRegridModule.o
organizeAgeClasses.o        : organizeAgeClasses.f90 defineConstants.o  \
                             loadCASAinput.o        defineArrays.o
processData.o               : processData.f90        defineConstants.o  \
                             loadCASAinput.o        defineArrays.o
# $(F90) -O0 -c $(FREEFORM) processData.f90
sort_pick_veg.o             : sort_pick_veg.f90      defineConstants.o
dorestart_mod.o             : dorestart_mod.f90      defineConstants.o  \
                             defineArrays.o

```

---

## 1.9 Module Interface Makefile (in doc subdirectory)

Makefile for building the documentation (in PDF and PostScript formats) for the GEOS-Chem model source code, makefiles, and related scripts.

### REMARKS:

To build the documentation, call "make" with the following syntax:

```
make TARGET [ OPTIONAL-FLAGS ]
```

To display a complete list of options, type "make help".

You must have the LaTeX utilities (latex, dvips, dvi2pdf) installed on your system in order to build the documentation.

### REVISION HISTORY:

```

16 Sep 2009 - R. Yantosca - Initial version
21 Sep 2009 - R. Yantosca - Now call Makefile in help directory to
                             display the help screen options
19 Nov 2009 - R. Yantosca - Now build documentation for Makefiles in the
                             GeosUtil and GeosCore subdirectories
11 Dec 2009 - R. Yantosca - Now get SHELL from Makefile_header.mk
28 Jan 2010 - R. Yantosca - Now add the Makefiles in the GeosTomas and
                             ISOROPIA subdirs to the documentation
27 Aug 2010 - R. Yantosca - Brought up to date for newly documented code
31 Aug 2010 - R. Yantosca - Add documentation for GTMM routines
14 Sep 2010 - R. Yantosca - Now split make commands into include files

```

```
#=====
```

```

# Initialization
#=====

# Define variables
ROOTDIR := ..
BIN      := $(ROOTDIR)/bin
BPCH     := $(ROOTDIR)/GeosBpch
CORE     := $(ROOTDIR)/GeosCore
DOC      := $(ROOTDIR)/doc
GTMM     := $(ROOTDIR)/GTMM
HDR      := $(ROOTDIR)/Headers
HELP     := $(ROOTDIR)/help
ISO      := $(ROOTDIR)/ISOROPIA
KPP      := $(ROOTDIR)/KPP
TOM      := $(ROOTDIR)/GeosTomas
UTIL     := $(ROOTDIR)/GeosUtil

# Get the Unix shell in SHELL from the Makefile_header.mk
include $(ROOTDIR)/Makefile_header.mk

#=====
# Makefile targets
#=====

.PHONY: all docclean help

all: srcdoc utildoc gtmm doc makedoc

clean:
rm -f *.tex *.ps *.pdf

help:
@$(MAKE) -C $(HELPPDIR)

#=====
# Build the GEOS-Chem documentation
#=====

# Commands to build the source code documentation
include ./Makefile_SrcDoc.mk

# Commands to build the utility module documentation
include ./Makefile_UtilDoc.mk

# Commands to build the makefile documentation
include ./Makefile_MakeDoc.mk

# Commands to build the GTMM documentation

```

```
include ./Makefile_GtmmDoc.mk
```

---

### 1.9.1 Makefile\_SrcDoc.mk (in doc subdirectory)

This Makefile fragment contains commands to build the documentation for the GEOS-Chem Source Code. It is inlined into the Makefile (in the doc subdirectory) by an "include" command.

#### REMARKS:

To build the documentation, call "make" with the following syntax:

```
make TARGET [ OPTIONAL-FLAGS ]
```

To display a complete list of options, type "make help".

You must have the LaTeX utilities (latex, dvips, dvipdf) installed on your system in order to build the documentation.

#### REVISION HISTORY:

```
14 Sep 2010 - R. Yantosca - Initial version, split off from Makefile
14 Sep 2010 - R. Yantosca - Added optdepth_mod.f to list
15 Sep 2010 - R. Yantosca - Added diag_2pm, diag_56, diagoh, ohsave
16 Sep 2010 - R. Yantosca - Added diag_pl_mod
04 Nov 2010 - R. Yantosca - Added acetone_mod
10 Nov 2010 - R. Yantosca - Added lightning_nox_mod
19 Nov 2010 - R. Yantosca - Added anthroems, RnPbBe_mod, tagged_ox_mod
19 Nov 2010 - R. Yantosca - Added tcorr, emfossil, emf_scale
01 Dec 2010 - R. Yantosca - Added global_br_mod, global_no3_mod
01 Dec 2010 - R. Yantosca - Added global_nox_mod, global_old_mod
01 Dec 2010 - R. Yantosca - Added global_oh_mod, toms_mod
02 Dec 2010 - R. Yantosca - Added upbdflex_mod, diag41_mod, diag42_mod
02 Dec 2010 - R. Yantosca - Added diag03_mod, diag49_mod, diag50_mod
02 Dec 2010 - R. Yantosca - Added diag51_mod, diag51b_mod, boxvl, rdmonot
02 Dec 2010 - R. Yantosca - Added rdlight, rdland, rdsoil, emmonot
16 Dec 2010 - R. Yantosca - Renamed output files to "GC_Ref_Vol_3.*"\
21 Dec 2010 - R. Yantosca - Added comode_mod
```

# List of source code files (order is important)

```
SRC1 := \
./intro.geos-chem \
./headers.geos-chem \
$(HDR)/define.h \
$(HDR)/CMN_SIZE \
$(HDR)/CMN_DIAG \
$(CORE)/acetone_mod.f \
```

```
$(CORE)/arctas_ship_emiss_mod.f      \  
$(CORE)/bravo_mod.f                  \  
$(CORE)/cac_anthro_mod.f             \  
$(CORE)/chemistry_mod.f              \  
$(CORE)/co2_mod.f                    \  
$(CORE)/comode_mod.f                 \  
$(CORE)/convection_mod.f             \  
$(CORE)/dao_mod.f                    \  
$(CORE)/depo_mercury_mod.f           \  
$(CORE)/diag03_mod.f                 \  
$(CORE)/diag04_mod.f                 \  
$(CORE)/diag41_mod.f                 \  
$(CORE)/diag42_mod.f                 \  
$(CORE)/diag49_mod.f                 \  
$(CORE)/diag50_mod.f                 \  
$(CORE)/diag51b_mod.f                \  
$(CORE)/diag56_mod.f                 \  
$(CORE)/diag_pl_mod.f                 \  
$(CORE)/diag_oh_mod.f                 \  
$(CORE)/diag_mod.f                   \  
$(CORE)/dust_mod.f                   \  
$(CORE)/emep_mod.f                   \  
$(CORE)/emissions_mod.f              \  
$(CORE)/fjx_acet_mod.f               \  
$(CORE)/gamap_mod.f                  \  
$(CORE)/global_br_mod.f              \  
$(CORE)/global_no3_mod.f              \  
$(CORE)/global_nox_mod.f              \  
$(CORE)/global_o1d_mod.f              \  
$(CORE)/global_o3_mod.f              \  
$(CORE)/global_oh_mod.f              \  
$(CORE)/h2_hd_mod.f                  \  
$(CORE)/icoads_ship_mod.f            \  
$(CORE)/input_mod.f                  \  
$(CORE)/isoropiaII_mod.f             \  
$(CORE)/land_mercury_mod.f           \  
$(CORE)/lightning_nox_mod.f          \  
$(CORE)/linoz_mod.f                  \  
$(CORE)/logical_mod.f                \  
$(CORE)/megan_mod.f                  \  
$(CORE)/meganut_mod.f                \  
$(CORE)/merra_a1_mod.f               \  
$(CORE)/merra_a3_mod.f               \  
$(CORE)/merra_cn_mod.f               \  
$(CORE)/merra_i6_mod.f               \  
$(CORE)/nei2005_anthro_mod.f         \  
$(CORE)/optdepth_mod.f               \  
$(CORE)/pjc_pfix_mod.f               \  

```

```
$(CORE)/RnPbBe_mod.f          \  
$(CORE)/scale_anthro_mod.f    \  
$(CORE)/tagged_ox_mod.f       \  
$(CORE)/toms_mod.f            \  
$(CORE)/tropopause_mod.f      \  
$(CORE)/tpcore_fvdas_mod.f90  \  
$(CORE)/tpcore_geos5_window_mod.f90 \  
$(CORE)/transport_mod.f       \  
$(CORE)/upbdflex_mod.f        \  
$(CORE)/vdiff_mod.f90        \  
$(CORE)/vdiff_pre_mod.f       \  
$(CORE)/vistas_anthro_mod.f    \  
./subs.geos-chem              \  
$(CORE)/anthroems.f           \  
$(CORE)/boxv1.f               \  
$(CORE)/diag1.f               \  
$(CORE)/diag3.f               \  
$(CORE)/diag_2pm.f            \  
$(CORE)/diagoh.f              \  
$(CORE)/emfossil.f            \  
$(CORE)/emf_scale.f           \  
$(CORE)/emmonot.f             \  
$(CORE)/fast_j.f              \  
$(CORE)/findmon.f             \  
$(CORE)/initialize.f          \  
$(CORE)/ndxx_setup.f          \  
$(CORE)/ohsave.f              \  
$(CORE)/rdlai.f               \  
$(CORE)/rdland.f              \  
$(CORE)/rdsoil.f              \  
$(CORE)/rdlight.f             \  
$(CORE)/rdmonot.f             \  
$(CORE)/readlai.f             \  
$(CORE)/ruralbox.f            \  
$(CORE)/setemis.f             \  
$(CORE)/sfcwindsqr.f          \  
$(CORE)/tcorr.f
```

# Output file names

TEX1 := GC\_Ref\_Vol\_3.tex

DVI1 := GC\_Ref\_Vol\_3.dvi

PDF1 := GC\_Ref\_Vol\_3.pdf

PS1 := GC\_Ref\_Vol\_3.ps

# Make commands

srcdoc:



```
rm -f $(TEX1)
protex -sf $(SRC1) > $(TEX1)
latex $(TEX1)
latex $(TEX1)
latex $(TEX1)
dvi2pdf $(DVI1) $(PDF1)
dvips $(DVI1) -o $(PS1)
rm -f *.aux *.dvi *.log *.toc
```

---

### 1.9.2 Makefile\_UtilDoc.mk (in doc subdirectory)

This Makefile fragment contains commands to build the documentation for the GEOS-Chem utility modules. It is inlined into the Makefile (in the doc subdirectory) by an "include" command.

#### REMARKS:

To build the documentation, call "make" with the following syntax:

```
make TARGET [ OPTIONAL-FLAGS ]
```

To display a complete list of options, type "make help".

You must have the LaTeX utilities (latex, dvips, dvi2pdf) installed on your system in order to build the documentation.

#### REVISION HISTORY:

14 Sep 2010 - R. Yantosca - Initial version, split off from Makefile

16 Dec 2010 - R. Yantosca - Renamed output files to "GC\_Ref\_Vol\_2.\*"

# List of source code files

```
SRC3 := ./intro.util $(wildcard $(UTIL)/*.f)
```

# Output file names

```
TEX3 := GC_Ref_Vol_2.tex
```

```
DVI3 := GC_Ref_Vol_2.dvi
```

```
PDF3 := GC_Ref_Vol_2.pdf
```

```
PS3  := GC_Ref_Vol_2.ps
```

# Make commands

```
utildoc:
```

```
rm -f $(TEX3)
```

```
protex -sf $(SRC3) > $(TEX3)
```

```
latex $(TEX3)
```

```
latex $(TEX3)
```

```

latex $(TEX3)
dvi2pdf $(DVI3) $(PDF3)
dvips $(DVI3) -o $(PS3)
rm -f *.aux *.dvi *.log *.toc

```

---

### 1.9.3 Makefile\_GtmmDoc.mk (in doc subdirectory)

This Makefile fragment contains commands to build the documentation for the Global Terrestrial Mercury Model (GTMM). It is inlined into the Makefile (in the doc subdirectory) by an "include" command.

#### REMARKS:

To build the documentation, call "make" with the following syntax:

```
make TARGET [ OPTIONAL-FLAGS ]
```

To display a complete list of options, type "make help".

You must have the LaTeX utilities (latex, dvips, dvi2pdf) installed on your system in order to build the documentation.

#### REVISION HISTORY:

14 Sep 2010 - R. Yantosca - Initial version, split off from Makefile

16 Dec 2010 - R. Yantosca - Renamed output files to "GC\_Ref\_Vol\_4.\*"

# List of source code files (order is important)

```

SRC4 := \
./intro.gtmm \
$(GTMM)/GTMM.f90 \
$(GTMM)/CasaRegridModule.f90 \
$(GTMM)/defineArrays.f90 \
$(GTMM)/defineConstants.f90 \
$(GTMM)/dorestart_mod.f90 \
$(GTMM)/input_gtmm_mod.f90 \
$(GTMM)/loadCASAinput.f90 \
./subs.gtmm \
$(GTMM)/CleanupCASAarrays.f90 \
$(GTMM)/GTMM_coupled.f90 \
$(GTMM)/HgOutForGEOS.f90 \
$(GTMM)/assignAgeClassToRunningPool.f90 \
$(GTMM)/assignRanPoolToAgeClass.f90 \
$(GTMM)/doFPARandLAI.f90 \
$(GTMM)/doHerbCarbon.f90 \
$(GTMM)/doHerbCarbonHg.f90 \
$(GTMM)/doHerbivory.f90 \
$(GTMM)/doHgDeposition.f90 \

```

```

$(GTMM)/doLatitude.f90          \
$(GTMM)/doLeafRootShedding.f90  \
$(GTMM)/doMaxHg.f90            \
$(GTMM)/doNPP.f90              \
$(GTMM)/doOptimumTemperature.f90 \
$(GTMM)/doPET.f90              \
$(GTMM)/doSoilMoisture.f90      \
$(GTMM)/doTreeCarbon.f90       \
$(GTMM)/doTreeCarbonHg.f90     \
$(GTMM)/getAgeClassBF.f90      \
$(GTMM)/getFireParams.f90      \
$(GTMM)/getFuelWood.f90        \
$(GTMM)/getSoilMoistParams.f90  \
$(GTMM)/getSoilParams.f90      \
$(GTMM)/loadHgDeposition.f90    \
$(GTMM)/load_GC_data.f90       \
$(GTMM)/organizeAgeClasses.f90  \
$(GTMM)/processData.f90        \
$(GTMM)/sort_pick_veg.f90

```

```
# Output file names
```

```
TEX4 := GC_Ref_Vol_4.tex
```

```
DVI4 := GC_Ref_Vol_4.dvi
```

```
PDF4 := GC_Ref_Vol_4.pdf
```

```
PS4  := GC_Ref_Vol_4.ps
```

```
# Make commands
```

```
gtmmdoc:
```

```
rm -f $(TEX4)
```

```
protex -sf $(SRC4) > $(TEX4)
```

```
latex $(TEX4)
```

```
latex $(TEX4)
```

```
latex $(TEX4)
```

```
dvipdf $(DVI4) $(PDF4)
```

```
dvips $(DVI4) -o $(PS4)
```

```
rm -f *.aux *.dvi *.log *.toc
```

#### 1.9.4 Makefile\_MakeDoc.mk (in doc subdirectory)

This Makefile fragment contains commands to build the documentation for the GEOS-Chem Makefiles. It is inlined into the Makefile (in the doc subdirectory) by an "include" command.

**REMARKS:**

To build the documentation, call "make" with the following syntax:

```
make TARGET [ OPTIONAL-FLAGS ]
```

To display a complete list of options, type "make help".

You must have the LaTeX utilities (latex, dvips, dvi2pdf) installed on your system in order to build the documentation.

**REVISION HISTORY:**

14 Sep 2010 - R. Yantosca - Initial version, split off from Makefile

16 Dec 2010 - R. Yantosca - Renamed output files to "GC\_Ref\_Vol\_1.\*"

```
# List of source code files (order is important)
```

```
SRC2 := \
./intro.make \
$(ROOTDIR)/Makefile \
$(ROOTDIR)/Makefile_header.mk \
$(UTIL)/Makefile \
$(ISO)/Makefile \
$(CODE)/Makefile \
$(KPP)/Makefile \
$(KPP)/standard/Makefile \
$(KPP)/SOA/Makefile \
$(TOM)/Makefile \
$(GTMM)/Makefile \
$(DOC)/Makefile \
$(DOC)/Makefile_SrcDoc.mk \
$(DOC)/Makefile_UtilDoc.mk \
$(DOC)/Makefile_GtmmDoc.mk \
$(DOC)/Makefile_MakeDoc.mk \
$(HELP)/Makefile
```

```
# Output file names
```

```
TEX2 := GC_Ref_Vol_1.tex
DVI2 := GC_Ref_Vol_1.dvi
PDF2 := GC_Ref_Vol_1.pdf
PS2  := GC_Ref_Vol_1.ps
```

```
# Make command
```

```
makedoc:
```

```
rm -f $(TEX2)
```

```
protex -fS $(SRC2) > $(TEX2)
```

```
latex $(TEX2)
```

```
latex $(TEX2)
```

```
latex $(TEX2)
dvipdf $(DVI2) $(PDF2)
dvips $(DVI2) -o $(PS2)
rm -f *.aux *.dvi *.log *.toc
```

Displays the makefile help screen for GEOS-Chem.

**REMARKS:**

To build the programs, call "make" with the following syntax:

`make TARGET [ OPTIONAL-FLAGS ]`

To display a complete list of options, type "make help".

Makefile uses the following variables:

Variable	Description
----------	-------------

\_\_\_\_\_

**SHELL** Specifies the shell for "make" to use (usually SHELL=/bin/sh)

**REVISION HISTORY:**

```
21 Sep 2009 - R. Yantosca - Initial version
24 Sep 2009 - R. Yantosca - Added info about NONUMA option for PGI
24 Sep 2009 - R. Yantosca - Now list rosenbrock as default solver
19 Nov 2009 - R. Yantosca - Updated comments
23 Nov 2009 - R. Yantosca - Updated comments
11 Dec 2009 - R. Yantosca - Now get SHELL from Makefile_header.mk
21 Dec 2009 - R. Yantosca - Added info about HDF5 option
25 Jan 2010 - R. Yantosca - Added info about TOMAS option
10 Mar 2010 - C. Carouge - Remove info about TOMAS option. Keep info
                        about tomas target.
```

```
# Get the Unix shell (in SHELL variable) from Makefile_header.mk
```

ROOTDIR = ..

```
include $(ROOTDIR)/Makefile_header.mk
```

help:

```
@echo %%%%;
```

```
@echo '%%%'      GEOS-Chem Help Screen      '%%%'
```

```
@echo ,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,
```

```
@echo
```

```

@echo 'Usage: make TARGET [ OPTIONAL-FLAGS ]'
@echo ''
@echo 'TARGET may be one of the following:'
@echo 'all           Default target (synonym for "lib exe")'
@echo 'lib           Builds all GEOS-Chem source code (synonym for "libkpp libutil libcore")'
@echo 'libcore       Only builds GEOS-Chem objects & libraries in GeosCore subdir'
@echo 'libutil       Only builds GEOS-Chem objects & libraries in GeosUtil subdir'
@echo 'libkpp        Only builds GEOS-Chem objects & libraries in KPP subdir'
@echo 'exe           Build GEOS-Chem executable'
@echo 'clean         Removes *.o, *.mod files in source code subdirs only'
@echo 'realclean     Removes all *.o, *.mod, *.lib *.a, *.tex, *.ps, *.pdf files everywhere'
@echo 'doc           Builds GEOS-Chem documentation (*.ps, *.pdf) with ProTeX in doc subdir'
@echo 'docclean      Removes *.tex, *.pdf, *.ps from the doc subdir'
@echo 'help          Displays this help screen'
@echo ''
@echo 'Special targets for TOMAS aerosol microphysics:'
@echo 'tomas         Build GEOS-Chem + TOMAS code (synonym for "libtomas exetomas")'
@echo 'libtomas      Only builds GEOS-Chem + TOMAS objects & libraries'
@echo 'exetomas      Only builds GEOS-Chem + TOMAS executable'
@echo 'cleantomas    Removes *.o *.mod files in GeosTomas directory only'
@echo ''
@echo 'Special target for mercury simulation:'
@echo 'hg            Build GEOS-Chem + GTMM for mercury simulation'
@echo ''
@echo 'OPTIONAL-FLAGS may be:'
@echo 'COMPILER=___  Options: ifort pgi sun xlf (default is ifort)'
@echo 'HDF5=yes      Enables writing diagnostic timeseries output to HDF5 files'
@echo 'DEBUG=yes     Compiles GEOS-Chem for use w/ a debugger'
@echo 'BOUNDS=yes    Turns on subscript-array checking (for debugging purposes)'
@echo 'OMP=[yes|no]  Turns OpenMP parallelization on/off (default is yes)'
@echo 'IPO=yes       Turns on optimization options -ipo -static (ifort only)'
@echo 'TRACEBACK=yes Turns on -traceback option (ifort only)'
@echo 'NONUMA=yes    Turns on -mp=nonuma option (pgi only)'
@echo 'CHEM=___      Specifies which simulation is done. Options: standard SOA'
@echo 'NTRAC=[43|54] Specifies # of tracers for KPP chemical solver. Should use CHEM flag ins
@echo 'KPPSOLVER=___ Specifies the integrator used w/ KPP:'
@echo '              Options: lsodes radau5 rosenbrock runge_kutta (default is rosenbrock)'
@echo '              (NOTE: This is set by default if you use "make tomas")

```