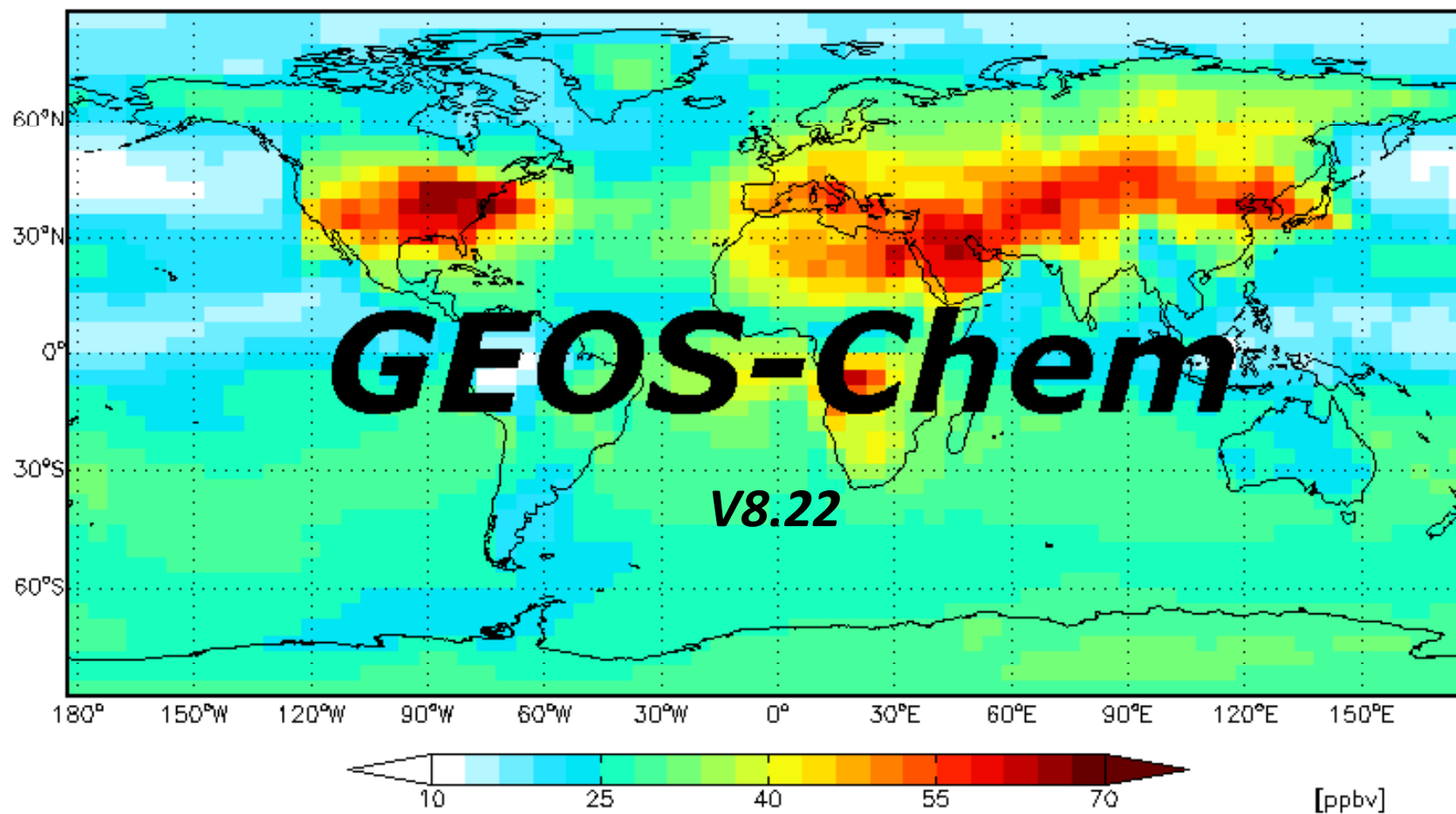
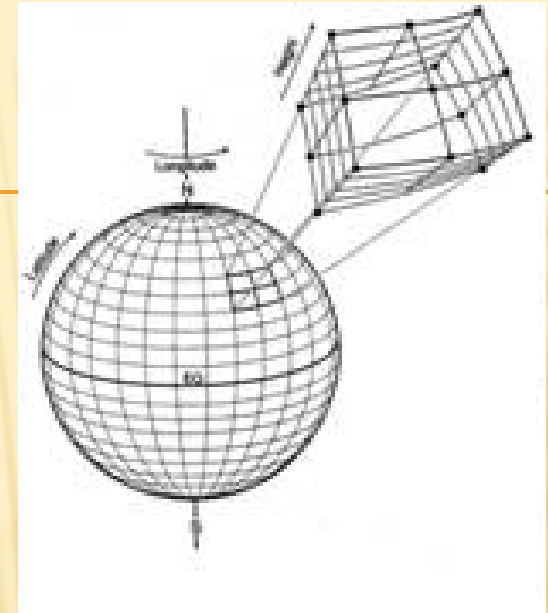


GEOS5 47L  $O_x$  for Jul 2005 L=1 (0.3 km)



# WHAT IS GEOS-CHEM?

*The GEOS–Chem model is a global three-dimensional model of tropospheric chemistry driven by assimilated meteorological observations from the Goddard Earth Observing System (GEOS) of the NASA Global Modeling Assimilation Office (GMAO).*



## INPUT

- GMAO Meteorology Data
- Detailed Emissions Data
  - Fossil Fuel
  - Biomass Burning
  - Biofuel Burning
  - Biogenic
  - Aerosol

## CALCULATION

- Detailed Timestep Models
  - Transport
  - Convection
  - Chemistry
  - Photolysis

## OUTPUT

- Binary Data Files
  - Tracer Data
  - Diagnostic Info
  - Time Series
  - Met Data
- Restart Files

**POSTPROCESSING**



# HOW DOES IT WORK?

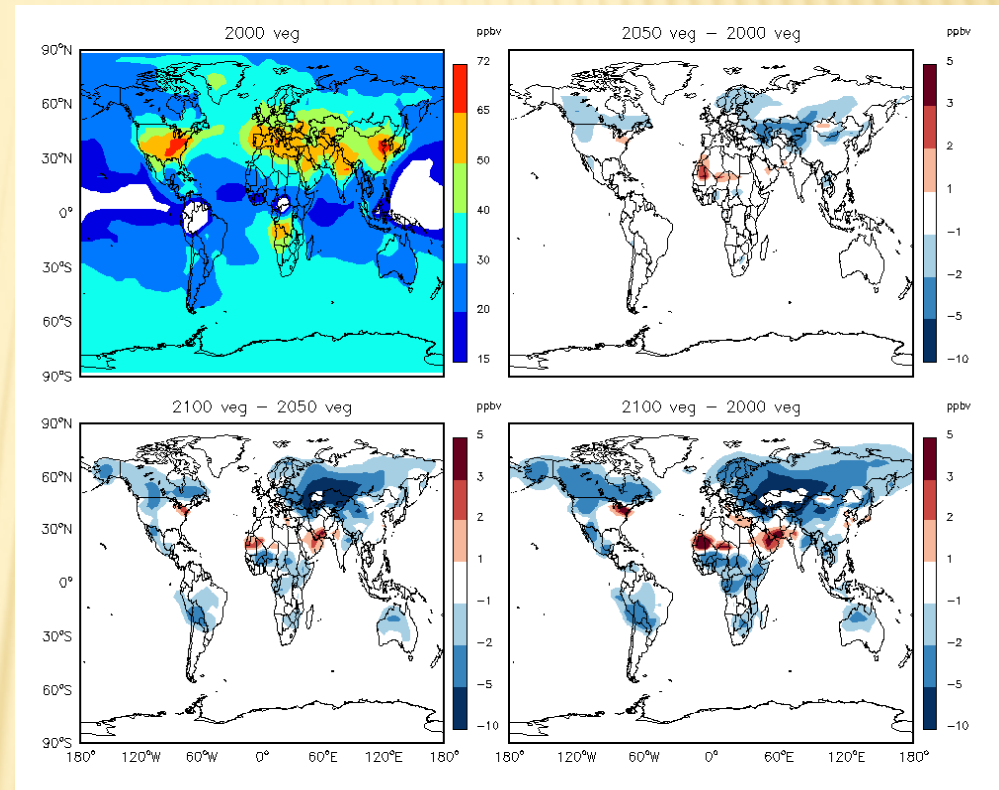
---

- ✗ Written in Fortran-90
  - + Compiled on Intel Professional Fortran
- ✗ Runs on Dell PowerEdge remote server
  - + Red Hat Enterprise Linux
  - + Two quad-core 64bit processors 3.33 GHz
  - + 16GB memory, 2TB drive space
- ✗ Access server through X-windows from PC
  - + Xming client, PuTTY terminal
  - + WinXP, Win7, Vista??
- ✗ Configure model via text input files
- ✗ Process output with IDL programs

# WHAT IS IT USED FOR?

Wide Applications...

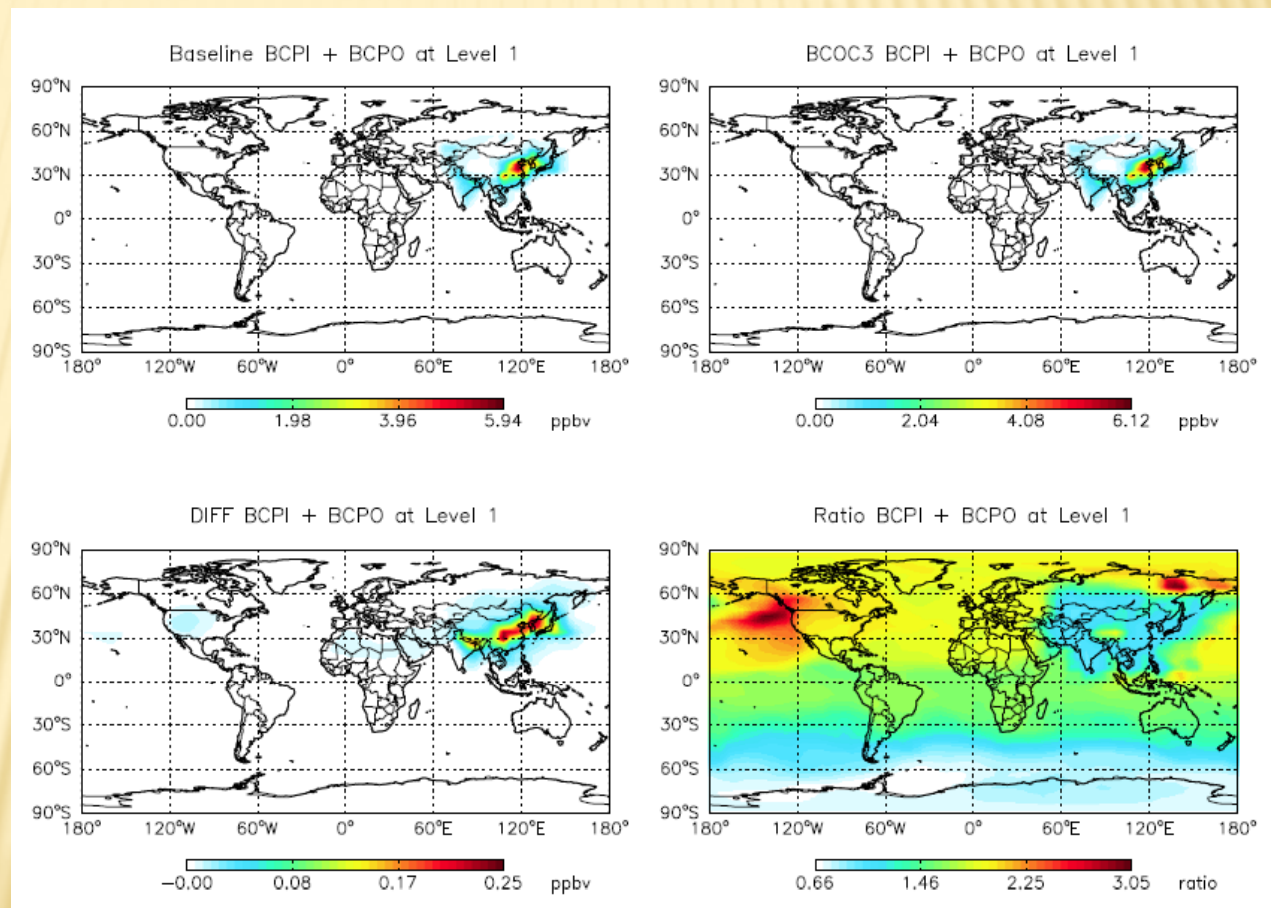
- ✘ Chemical Transport
- ✘ Chemical Budgets
- ✘ Flux Inversions
- ✘ Climate Forcing
- ✘ Air Quality
- ✘ Ecosystem Exchange
- ✘ Satellite Retrievals
- ✘ Diagnostic Studies



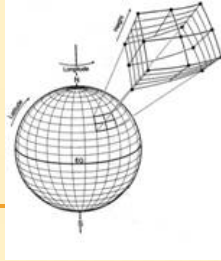
Ox Concentrations in 2050 and 2100

# CARBON HALF-LIFE STUDY

- ✘ Baseline – Model unchanged
- ✘ BC3 – Black carbon half-life changed to 3x
- ✘ Created mask to isolate carbon emissions to China



# MODEL DETAILS



- ✘ Global Horizontal & Vertical Grid
- ✘ GEOS-5  $4^\circ \times 5^\circ$  Reduced Vertical
  - + 45 Latitude, 72 Longitude, 47 Layers
  - + 152,280 cubes

## Available Grids

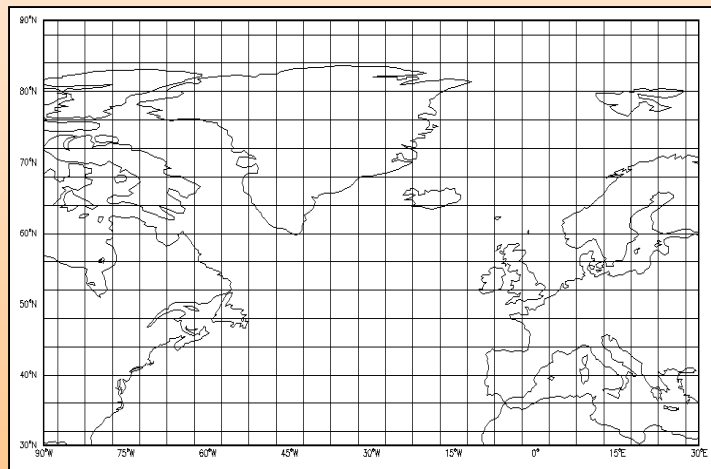
$4^\circ \times 5^\circ - 45 \times 72 \times 47 = 152,280$   
 $2^\circ \times 2.5^\circ - 90 \times 144 \times 47 = 609,120$   
 $1^\circ \times 1.25^\circ - 180 \times 288 \times 47 = 2,436,480$   
 $1^\circ \times 1^\circ - 180 \times 360 \times 47 = 3,045,600$   
 $0.5^\circ \times 0.667^\circ - 360 \times 540 \times 47 = 9,136,800$

## Run Times

$4^\circ \times 5^\circ - 1$  month simulation = 45 min  
 $2^\circ \times 2.5^\circ - 1$  month simulation = 10 hrs

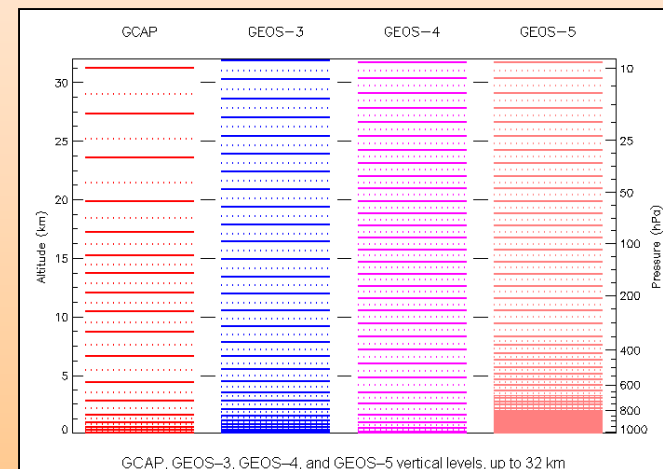
## Global Resolution

$4^\circ$  Latitudinal x  $5^\circ$  Longitudinal



## GEOS-5 Vertical Layers

47 Layers (Reduced Layer Model)



# BASIC LINUX COMMANDS

- × cd – change directory
  - × cd /ctm\_homes/ctm\_tools
  - × cd ../../
- × pwd – show present working directory
  - × pwd
- × mkdir – make directory
  - × mkdir gc\_model\_dir
- × ls – file list
  - × ls – basic listing
  - × ls -l – long listing
  - × ls -la – long listing, show hidden files
- × cat, more, head, tail – show contents of text files
  - × tail ./logs/gc\_model.log
- × cp – copy file
  - × cp <source> <destination>
- × mv – rename file
  - × mv <old name> <new name>
- × rm – remove (delete) file
  - × rm <file name>
- × rmdir – remove (delete) directory
  - × rmdir <dir name>
- × exit – close terminal window
  - × exit
- × nano, vi, vim – Linux text editors
  - × nano input.geos

## More Information

<http://www.tuxfiles.org/linuxhelp/linuxcommands.html>

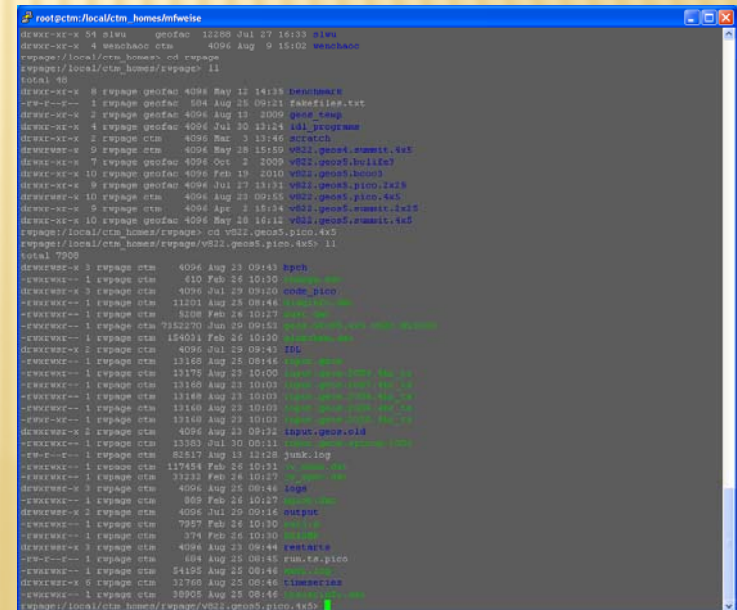
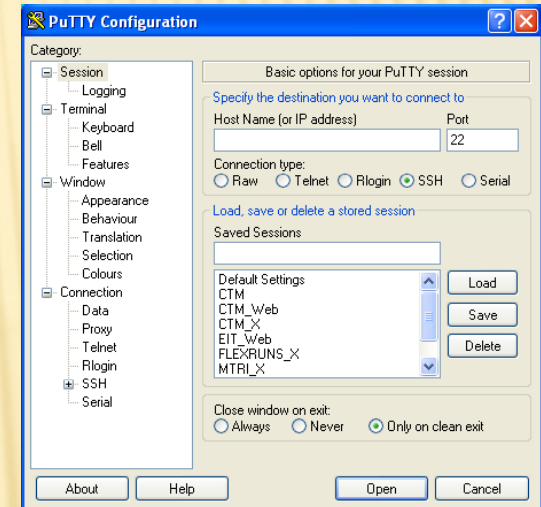
<http://www.reallylinux.com/docs/basic.shtml>

<http://www.tuxfiles.org/linuxhelp/cli.html>

<http://www.redhat.com/docs/manuals/linux/RHL-6.2-Manual/getting-started-guide/ch-doslinux.html>

# CONNECTING TO THE SERVER

- ✗ Connect to the network/internet
- ✗ Start Xming client 
- ✗ Start PuTTY & configure
  - + Host name: ctm.geo.mtu.edu
  - + Data
    - ✗ Auto-login username: your userid
  - + Connection>SSH>X11
    - ✗ Check Enable X11 forwarding
    - ✗ X display location: localhost:0.0
  - + Session
    - ✗ Enter Saved Session Name: CTM
    - ✗ Click Save button to save configuration
  - + Click Open button to start connection
- ✗ Enter password when prompted





# SETTING UP A MODEL

- ✗ Create directory for new model & copy model files
- ✗ The file input.geos controls all user-specified model parameters

- + Start & End Time
- + Time Steps
- + File Names
- + Output File Frequency
- + Emissions
- + Tracers
- + Diagnostics Details
- + Time Series Details

## Suggested Directory Structure

```
drwxr-sr-x 2 rwpag ctm 4096 Aug 25 15:34 bpch
-rwxr-xr-x 1 rwpag ctm 610 Aug 25 15:16 chemga.dat
-rwxr-xr-x 1 rwpag ctm 11201 Aug 25 15:37 diaginfo.dat
-rwxr-xr-x 1 rwpag ctm 7016057 Aug 25 15:16 geos.GEOSS_4x5.v822
-rwxr-xr-x 1 rwpag ctm 154031 Aug 25 15:16 globchem.dat
drwxr-sr-x 2 rwpag ctm 4096 Aug 25 15:30 IDL
-rwxr-xr-x 1 rwpag ctm 13177 Aug 25 15:37 input.geos
-rwxr-xr-x 1 rwpag ctm 117454 Aug 25 15:16 jv_atms.dat
-rwxr-xr-x 1 rwpag ctm 33232 Aug 25 15:16 jv_spec.dat
drwxrwsr-x 2 rwpag ctm 4096 Aug 25 15:34 logs
-rwxr-xr-x 1 rwpag ctm 889 Aug 25 15:16 mglsh.dat
drwxr-sr-x 2 rwpag ctm 4096 Aug 25 15:33 output
-rwxr-xr-x 1 rwpag ctm 623020 Aug 25 15:16 Ox.mass.final
-rwxr-xr-x 1 rwpag ctm 623020 Aug 25 15:37 Ox.mass.initial
-rwxr-xr-x 1 rwpag ctm 7175 Aug 25 15:16 ratj.d
drwxr-sr-x 2 rwpag ctm 4096 Aug 25 15:36 restarts
-rwxr-xr-x 1 rwpag ctm 54195 Aug 25 15:37 smw2.log
-rwxr-xr-x 1 rwpag ctm 36346 Aug 25 15:37 tracerinfo.dat
rwpag:/local/ctm_homes/rwpag/practice>
```

# RUNNING A MODEL

- ✘ `geos > ./logs/log_file_name.log &`

```
-rwxrwxr-- 1 rwpage ctm 54195 Aug 25 08:46 saw2.log
drwxrwsr-x 6 rwpage ctm 32768 Aug 25 08:46 timeseries
-rwxrwxr-- 1 rwpage ctm 38905 Aug 25 08:46 tracerinfo.dat
rwpage:/local/ctm_homes/rwpage/v822.geos5.pico.4x5> geos > ./logs/log_file_name.log &
```

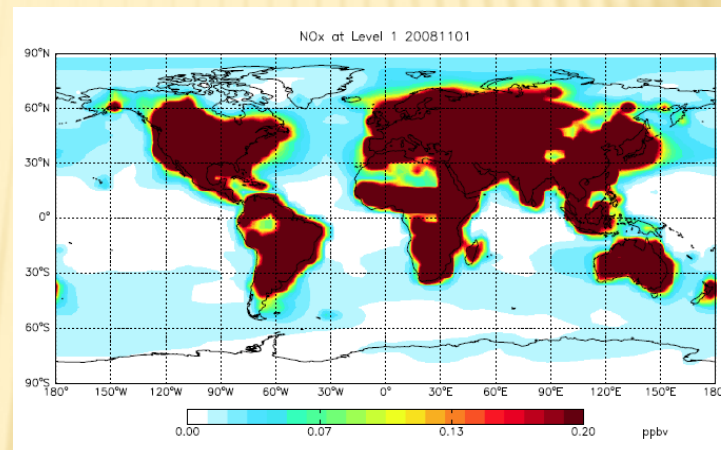
- ✘ The ‘&’ causes the program to run in the background, releasing control of terminal window to the user
- ✘ Use ‘`tail ./logs/log_file_name.log`’ to examine the log file and monitor progress of the model

```
- SCHEM: Strat chemistry at 2008/06/30 09:00
---> DATE: 2008/06/30 GMT: 09:30 X-HRS: 4353.500
---> DATE: 2008/06/30 GMT: 10:00 X-HRS: 4354.000
- PHYSPROC: Trop chemistry at 2008/06/30 10:00
- SCHEM: Strat chemistry at 2008/06/30 10:00
---> DATE: 2008/06/30 GMT: 10:30 X-HRS: 4354.500
---> DATE: 2008/06/30 GMT: 11:00 X-HRS: 4355.000
- PHYSPROC: Trop chemistry at 2008/06/30 11:00
rwpage:/local/ctm_homes/rwpage/v822.geos5.pico.4x5>
```

# PROCESSING OUTPUT

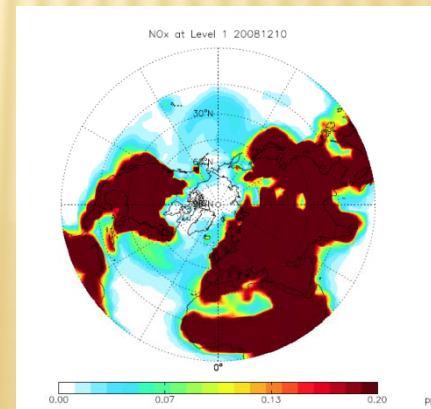
## ✘ Quick (but somewhat limited) – GAMAP

- + Read BPCH file
- + Find Tracer Data
- + Calculate Averages
- + Generate Plots
- + Save to GIF and/or PS



## ✘ Detailed (but more difficult) – IDL program

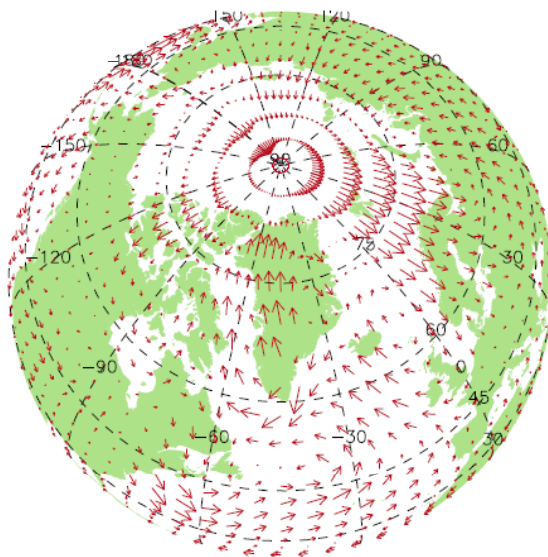
- + Graphics
- + Calculations
- + Extracted Data
- + Anything is Possible...



# MORE COMPLEX PLOTS

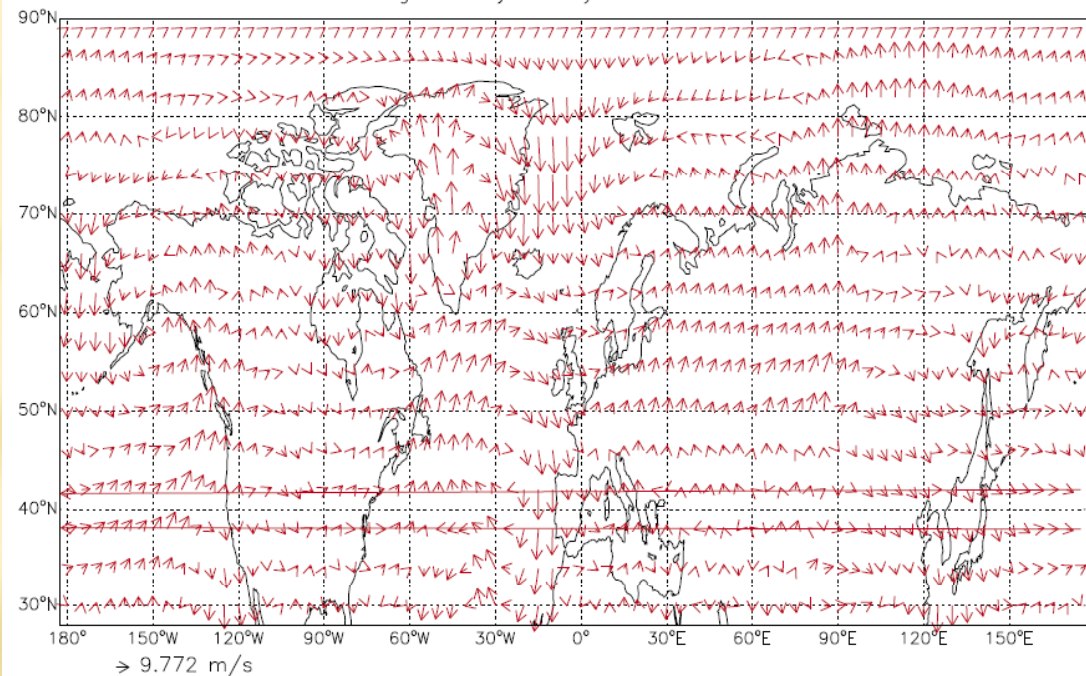
## Velocity Fields on Satellite Plot

Velocity Field for 20090101



## Velocity Fields over North Atlantic

Average Monthly Velocity Field for 20081101



# FURTHER READING

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- × Geos-Chem Online Manual
  - + <http://acmg.seas.harvard.edu/geos/doc/man/>
- × GAMAP Online Manual
  - + <http://acmg.seas.harvard.edu/gamap/doc/index.html>
- × Wiki Help with Search, Add'l References
  - + <http://wiki.seas.harvard.edu/geos-chem>
- × IDL Manuals
  - + [http://www.geo.mtu.edu/geoschem/IDL\\_Manuals/](http://www.geo.mtu.edu/geoschem/IDL_Manuals/)
- × This presentation
  - + [http://www.geo.mtu.edu/geoschem/docs/2010-08-25\\_Geos-Chem\\_Seminar.pdf](http://www.geo.mtu.edu/geoschem/docs/2010-08-25_Geos-Chem_Seminar.pdf)

# NEED HELP??

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  - + Office Dow 626
    - ✘ Mon-Fri, 8 am to 4 pm
  - + [rwpage@mtu.edu](mailto:rwpage@mtu.edu)
  - + 487-1067