



Mister, Do you have the time?

Understanding Time in Geos-Chem and IDL

September 23, 2010

Different Time Bases



- **Tau (used by Geos-Chem)**
 - The elapsed hours between the current date/time and the beginning of an epoch (GEOS1 -> 1985/01/01, GISS_II -> 1980/01/01)
- **Astronomical Julian Day (JD)**
 - Interval of time in days and fractions of a day since 12:00:00.00 (Noon) January 1, 4713 BC Greenwich Mean Time
- **Calendar Time (Gregorian Date)**
 - Calendar used in most countries, including U.S.
- **Day of Year (DOY)**
 - number of days that have elapsed since the start of the year
- **Coordinated Universal Time (UTC)**
 - Mean solar time at the Royal Observatory in Greenwich, England
 - Used as a global time reference (standard time)
- **Greenwich Mean Time (GMT)**
 - Essentially the same as UTC
- **Local Time**
 - UTC adjusted by global time zone factor
 - Eastern Standard Time (EST) = UTC - 5 hours

Scale	July 20, 2009 2 pm GMT
Tau	215198.0
JD	2455033.1
Gregorian	7/20/2009 12 p.m.
DOY	201
UTC	20090720 14:00:00
GMT	20090720 14:00:00
Local	July 20, 2009 9:00:00 a.m.

Functions for Time



- GAMAP Functions

- ADD_DATE()
 - Compute YYYYMMDD date for a given time span from a given date
- DATE2YMD
 - Given a date in YYYYMMDD format, returns the year, month, and day in separate variables
- DAY_OF_YEAR ()
 - Computes the day number of a given date
- ISLEAP ()
 - Determines if given date is a leap year
- LOCALTIME()
 - Returns the local time for a given location
- NYMD2TAU ()
 - Calculate Tau from YYYYMMDD
- STRDATE ()
 - Generate a string value of date
- TAU2YYMMDD ()
 - Convert Tau to YYYYMMDD
- YMD2DATE ()
 - Convert Y, M, D to YYYYMMDD

- IDL Functions

- JULDAY ()
 - Calculate JD from month, day, year, hour, minute, second (opposite of CALDAT)
- LABEL_DATE()
 - Used to format JD values for plotting
 - Can also be used to print date to screen
print, label_date(0,0,JD, format='%M-%D-%Y')
=> Jul-20-2009
- TIMEGEN()
 - Creates an array of double-precision JD values
- CALDAT
 - Computes month, day, year, hour, minute, second from Julian Day value

Converting Time



- Tau to Julian Day
 - If Tau = 215198.0 hours since 1/1/1985, then use the IDL function `julday(month, day, year, hour, minute, second)` to calculate the number of days since 12 pm on January 1, 4713 BC

$$\text{JD} = 215198.0 \text{ hrs} \times \left(\frac{\text{days}}{24 \text{ hrs}} \right) + \text{julday}(1,1,1985,0,0,0)$$

$$\text{JD} = 2455033.1 \text{ days}$$

- This is important because ...

```
IDL> print, jdtype_center[iok], avg[iok]
      2455033.0      2455033.0      2455033.1      2455033.1      2455033.2      2455033.2
      16.121092     15.995333     15.932000     15.883333     15.013000     16.384667
```

... some atmospheric measurement data are saved as JD

ND48 & ND49 Time Series



```
-----+-----
*** ND48 MENU ***      :
Turn on ND48 stations  : T
Station Timeseries file : ./timeseries/rerun_aug2010/nd48/greenland.YYYYMMDD.1Jul2009_1Sep2009
Frequency [min]        : 60
Number of stations     : 11
Summit NOx             : 29 42 1 1
Summit Ox              : 29 42 1 2
Summit PAN             : 29 42 1 3
Summit CO              : 29 42 1 4
Summit HNO3           : 29 42 1 7
Summit BCPI           : 29 42 1 34
Summit OCPI           : 29 42 1 35
Summit BCPO           : 29 42 1 36
Summit OCPO           : 29 42 1 37
Summit NOy            : 29 42 1 19003
Summit Temp           : 29 42 1 99
-----+-----
```

```
*** ND49 MENU ***      :
Turn on ND49 diagnostic : F
Inst 3-D timeser. file  : ./timeseries/rerun_aug2010/nd49/ts_nd49.YYYYMMDD.bpch
Tracers to include      : 1 2 4 99
Frequency [min]        : 60
IMIN, IMAX of region   : 29 30
JMIN, JMAX of region   : 42 43
LMIN, LMAX of region   : 1 20
-----+-----
```

ND48 & ND49 Time Series



- Time series data are stored by Geos-Chem in 3-dimensional data blocks
- While these files can be used directly, performance is hampered by large file sizes or number of files
- It is preferable to combine the raw time series files into a combined series using `gc_combine_nd48` or `gc_combine_nd49` → 4-dimensional data blocks (i,j,k,t)

ND48 Time Series

- All time series data stored in one large file
- Must be combined before processing
- Time array is NOT carried into combined file
- Stores data for one grid box only
- Practical limit of 10 tracers
- Can store data from multiple levels but must start at Level 1

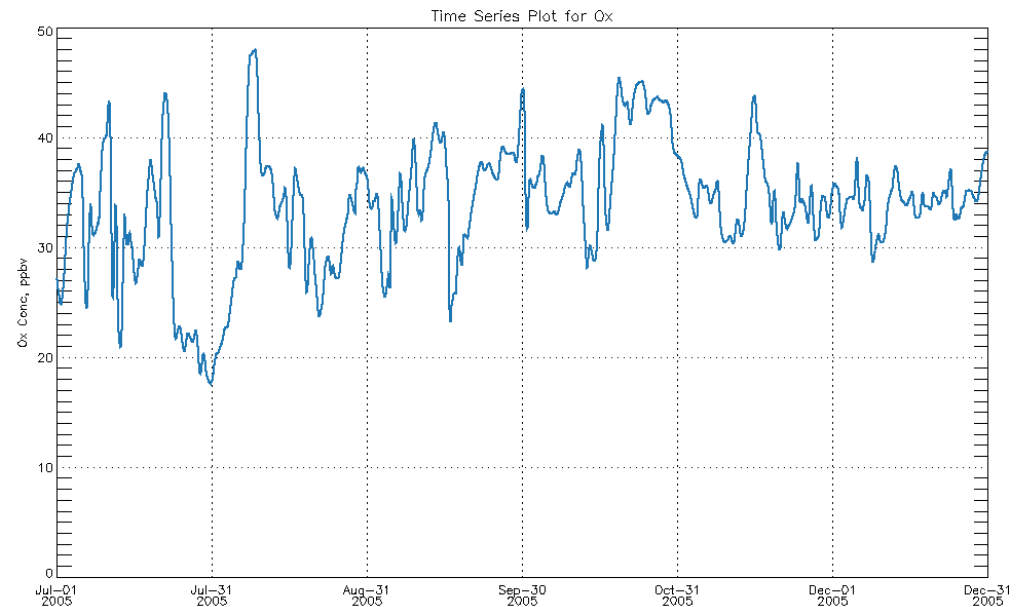
ND49 Time Series

- Time series data stored in a file for each day
- Can be combined during processing, thereby preserving time
- Stores data for multiple contiguous grid boxes
- No limit to number of tracers
- Can store data from multiple contiguous levels

An Example for ND49...



- Plot ozone 1-hour time series for Summit Station
- Functions used
 - gc_combine_nd49
 - open_device, close_device
 - keyword_set()
 - map_set
 - ctm_tracer_info
 - plot
 - help
 - label_date()
 - tau2yymmdd()
 - dialog_message()
 - Custom external function



Additional References



- GAMAP Online Manual
 - [http://wiki.seas.harvard.edu/geoschem/index.php/Date and time computations with GAMAP](http://wiki.seas.harvard.edu/geoschem/index.php/Date_and_time_computations_with_GAMAP)
- ISO-8601 - *Data elements and interchange formats -Information interchange - Representation of dates and times*
 - [http://www.geo.mtu.edu/geoschem/docs/ISO_8601-2004 E.pdf](http://www.geo.mtu.edu/geoschem/docs/ISO_8601-2004_E.pdf)