Visualization at ACEnet

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Ways to do Visualization

- Directly from code using libraries
  - VTK, NCAR
- As an external program
  - molden, ferret

External applications

- molden
  - Displays molecular density from ab-initio quantum chemistry packages
- ferret
  - Generalized imaging, used in places with large datasets, meteorology

How to use ferret

- Default usage involves interaction

  % ferret

  yes?

- Can be run in batch mode, running scripts to generate imagery

Core Concepts

- Variables – defined on a grid
- Grid – tells ferret how to locate data in space and time (or whatever the axes are)
- Data Set – a collection of variables stored together on disk
- Region – section of grid to use

Four Steps to use Ferret

1. Specify the data set
2. Specify the region
3. Define the desired variable or expression
4. Request the output

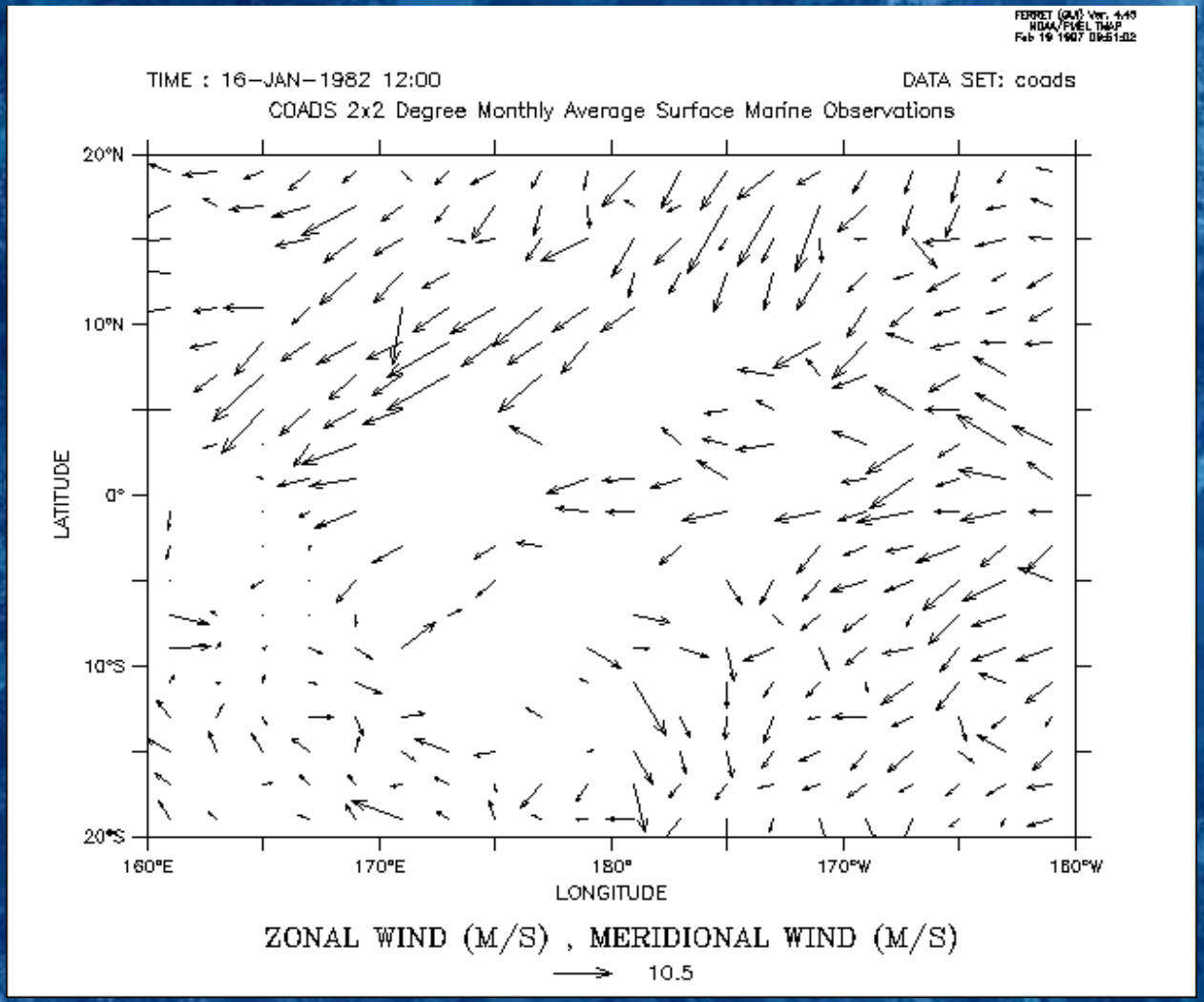
First example

yes? USE coads !global sea surface data

yes? SET REGION/Z=0/T="16-JAN-1982"/
X=160E:160W/Y=20S:20N

yes? VECTOR uwnd,vwnd !wind velocity
vector plot

First Example Output



Plottable Variables

- There are 3 types of plottable variables
  - File variables – read from disk files
  - User-defined variables – defined by the LET command
  - Pseudo-variables – regions (I,J,K,X,Y,...) used as variables
- All references to plottable variables must have a complete context

Grids

- All grids a 4-dimensional
- In most cases, these are 3 space and 1 time
- 3d, 2d, 1d, and 0d grids are special cases of the 4d grid where one or more axes are set to NORMAL

Grids 2

- Axes and grids may be defined by files (ending with '.grd')
- Can also be defined using DEFINE AXIS and DEFINE GRID

Context

- Context is made up of
  - A region or point is space and time
  - A data set(s)
- Ferret needs context to make sense of a reference to a plottable variable

Context - Region

- Region of space-time can be defined using subscripts or world coordinates
- Subscripts
  - I=,J=,K=,L= represent axes 1 through 4, respectively
- World coordinates
  - X=,Y=,Z=,T=
- The right hand side can be a single value or a range from min:max

Context – Data Set

- Data sets can be given by name or number
- Commands SET DATA, CANCEL DATA and D= all accept name or number
- Data sets are number in order that they are pointed to with SET DATA
- You can see this order with SHOW DATA

How do you tell ferret about context?

- Program context: use SET REGION and SET DATA (you can see what is there with SHOW REGION and SHOW DATA)
- Command context: Use command qualifiers I,J,K,L,X,Y,Z,T,D with commands PLOT, CONTOUR, SHADE, LIST and VECTOR

How do you tell ferret about context?

- Variable context: use the same qualifiers from the command context to modify plottable variables
  - LET U200 = U[Z=200,D=U_DATA]
  - LIST U[1:100:5]

Transformations

- Transformations can be applied to plottable variables along their axes
- Can only be defined in variable context
- Examples:
  - PLOT U[Z=0:100@AVE] - the variable U averaged between Z=0 and Z=100
  - LIST/L=1:200 U[L=@SBX:5] – U with a boxcar smoother of width 5 points along L

Transformations

- Other examples:
  - @FAV fill data holes with averages
  - @DIN definite integral
  - @IIN indefinite integral
  - @DDC centered derivative
  - @SHF shift data a number of points along an axis
  - @MIN minimum value along an axis
- See HELP TRANSFORMATIONS for more

How to load data

- Data can be loaded from ASCII and binary files, NetCDF and TMAP files
- SET DATA data_file – tries to load the file named 'data_file' from the data directory
- File extension determines file type (.cdf for NetCDF)
- SHOW DATA lists all data sets, the last loaded is the current default data set

Loading ASCII Data

- Two options:
  - SET DATA/EZ file_name.dat
  - FILE file_name.dat
- Possible qualifiers:
  - /VARIABLES names the variables in the file
  - /TITLE associates a title with the data set
  - /GRID indicates multi-dimensional data and units
  - /COLUMNS tells how many data values are in each record
  - /FORMAT specifies the format of the records
  - /SKIP skip initial records of the file
  - /ORDER specifies order of axes

Example 1

- Loading a file with a single column of data values and plotting the results

  yes? FILE/VAR=height plant.dat

  yes? PLOT height

- This loads the values of plant heights over time stored in the file *plant.dat*

Example 2

- By default, ferret only assign memory for 20480 points
- If you have more data than this, you need to define an axis and grid

```
yes? DEFINE AXIS/X/X=1:50000:1 longax
yes? DEFINE GRID/X=longax biggrid
yes? FILE/VAR=height/GRID=biggrid
    plant.dat
yes? PLOT height
```

Example 3

- Say you have the height of a plant and the amount of water, over time?

  Yes? FILE/VAR=”height,water”
  plant_wat.dat

  yes? PLOT height,water

Example 4

- The past examples have looked at one or two variables (height and water) over one dimension (time)
- What if you have one variable (height) over two dimensions (row and column in a greenhouse)
- We need to define axes and a grid

Example 4 – con't

Yes? DEFINE AXIS/X=1:4:1 xplants

yes? DEFINE AXIS/Y=1:3:1 yplants

yes? DEFINE GRID/X=xplants/Y=yplants gplants

yes? FILE/VAR=height/GRID=gplants greenhouse.dat

yes? CONTOUR

- This gives us a contour plot of the plants in the greenhouse

Making Hardcopies

- By default, ferret displys plots immediately
- The most direct method is

  SET MODE METAFILE

  CANCEL MODE METAFILE
- All plots generated between these two commands will also output a graphic metafile (ANSI/ISO GKSM format)
- gksm2ps translates to PostScript

Outputting GIF files

- GIF files can be written out using the FRAME command.
- Default output is HDF, but ferret will change based on file extension
- FRAME follows a plotting command

```
SET DATA/FILE my_data.dat
PLOT
FRAME/FILE=my_plot.gif
```

Making Movies

- Movies are simply groups of images, one for each frame of the movie
- Use the REPEAT command to generate a movie

```
yes? SET DATA coads_climatology

yes? REPEAT/L=1:12/ANIMATE/LOOP=5 (SHADE sst; GO fland)
```

- Default format is HDF, but can use GIF also

Saving Movies

- You need to use the FRAME qualifier

```
SET DATA coads_climatology
REPEAT/L=1:12 (FILL sst_anom; FRAME/FILE=my_movie.mgm)
```

- NCSA (National Center for Supercomputing Applications)have tools to convert .mgm files to mpeg

  ftp://ftp.hdfgroup.org/HDF/contrib/NCSA/H

Creating GIF Movies

REPEAT/J=1:36 (GO scriptfile 'j'; FRAME/FILE=whirl-'j'.gif)

- Scriptfile is a script to do the actual plot, using j to determine the plot characteristics
- This creates the files whirl-1.gif, whirl-2.gif, etc
- Can use a third-party program (like whirlgif) to combine these into a single gif movie