

netCDF / NCL Relationship

- netCDF is a **file format** ; NCL is a **language**. What is the connection?

- NCL **variable model** is based on the netCDF variable model

- NCL makes GRIB, HDF, HDF-EOS files 'look like' netCDF files

- This **consistent view** of variables and file contents from disparate file formats is a very powerful feature of NCL.

netCDF Conventions

Convention: set of **rules** for file contents

- makes data comparison easier
- facilitates development of viewing (eg: **ncview**) & processing tools (netCDF Operators; Climate Data Op.)

COARDS (1995; frozen)

- **C**ooperative **O**cean/**A**tmosphere **R**esearch **D**ata **S**ervice
- created for **rectilinear** grids
- http://ferret.wrc.noaa.gov/noaa_coop/coop_cdf_profile.html

CF (2005/2006; continues to evolve)

- **C**limate and **F**orecast Metadata Convention (1.0 -> 1.6)
- generalizes and extends the **COARDS** convention
- much more complex; **curvilinear** and **unstructured** grids
- **calendar** attributes (eg: no_leap, 360_day, 365_day,..)
- <http://cf-pcmdi.llnl.gov/>

Most climate related data archives use netCDF and adhere to these conventions: eg: **CMIP5**, **CMIP3**, **CESM**, **IPCC**. etc

Parts of netCDF file

`ncdump -h foo.nc` (or `ncl_filedump foo.nc`)

Global Attributes

global attributes:
title = "Temp: 1999"
source = "NCAR"
Conventions = "CF-1.0"

time=**UNLIMITED** (90 currently)

Dimension Names & Dimension Sizes

dimensions:

lat = 64
lon = 128
time = 90

exercise:

`ncl_filedump FOO.nc | less`
`ncl_filedump FOO.grb | less`

VARIABLES:

Names , Types, Attributes,

variables:

float lat(lat)

lat:long_name = "latitude"

lat:units = "degrees_north"

float lon(lon)

lon:long_name = "longitude"

lon:units = "degrees_east"

double time(time)

time:long_name = "time"

time:units = "hours since ..."

float T(time, lat, lon)

T:long_name = "Temperature"

T:units = "degC"

T:missing_value = 1.e+20f

T:**_FillValue** = 1.e+20f

netCDF/NCL: Coordinate Variable (CV)

- **CV**: **C**oordinate **V**ariable definition
 - **one dimensional variable**
 - **dimension name** is the same as the **variable** name
 - **must be numeric** (integer, float, double)
 - **must be monotonic** (increasing or decreasing)
- **CV** examples
 - **lat**(lat), **longitude**(longitude), **plevel**(plevel), **time**(time)
- **CV** allow ‘natural’ coordinates via **{...}** syntax
 - **Q**(time,plevel,lat,longitude)
 - CV: **Q**(:, {925:400}, {-20:60}, {130:280})
 - Index: **Q**(:, 3:10, 24:40, 42:75)

netCDF/NCL variable

- **array** is basic element [length 1 (**scalar**)]
- may have additional information: **not required**

x

4.35	4.39	0.27	-3.35	-6.90
4.36	4.66	3.77	-1.66	4.06
9.73	-5.84	0.89	8.46	10.39
17.01	3.68	5.08	0.14	-5.63
-0.63	-4.12	-2.51	1.76	-1.43
-4.29	0.07	5.85	0.87	-99.99

name: x
type: float [real]
shape: 2-dimensions
size: 6 (rows) x 5 (columns) [**row major**; C, Matlab]
values: x(**2,3**) = **8.46** [**0-based indexing**; C, IDL]

long_name: "Temperature"
units: "degC"
_FillValue: **-99.99**
named dimensions: x(**time, lat**)
lat: (/ -60, -30 ,0, 30, 60 /)
time: (/2000, 2003, 2004, 2005, 2010 /)

Meta data

Detailed Look netCDF Variable (NCL)

```
ncl <return> ; interactive mode
ncl 0 > f = addfile ("UV300.nc", "r") ; read nc, grb, hdf, hdfEOS)
ncl 1 > u = f->U ; import variable ( STRUCTURE )
ncl 2 > printVarSummary (u) ; variable overview
```

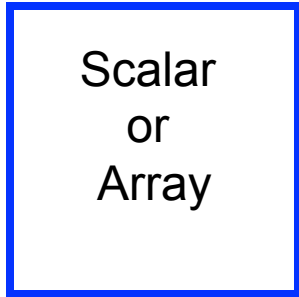
Variable: **u**
Type: **float**
Total Size: 65536 bytes
16384 values
Number of Dimensions: **3**
Dimensions and Sizes: [**time**|2] x [**lat** | 64] x [**lon** | 128]
Coordinates:
time: [1 .. 7]
lat: [-87.8638 .. 87.8638]
lon: [0 .. 357.185]
Number of Attributes: 5
_FillValue : 1e36 [CF]
units : m/s [COORDS, CF]
long_name : Zonal Wind [COORDS, CF]
short_name : U
missing_value : 1e36 [COORDS; CF-1.6]

Classic netCDF
Variable Model

NCL
syntax/funcs
query
use
modify
add
any aspect of
variable

NCL Variable model

X



attributes

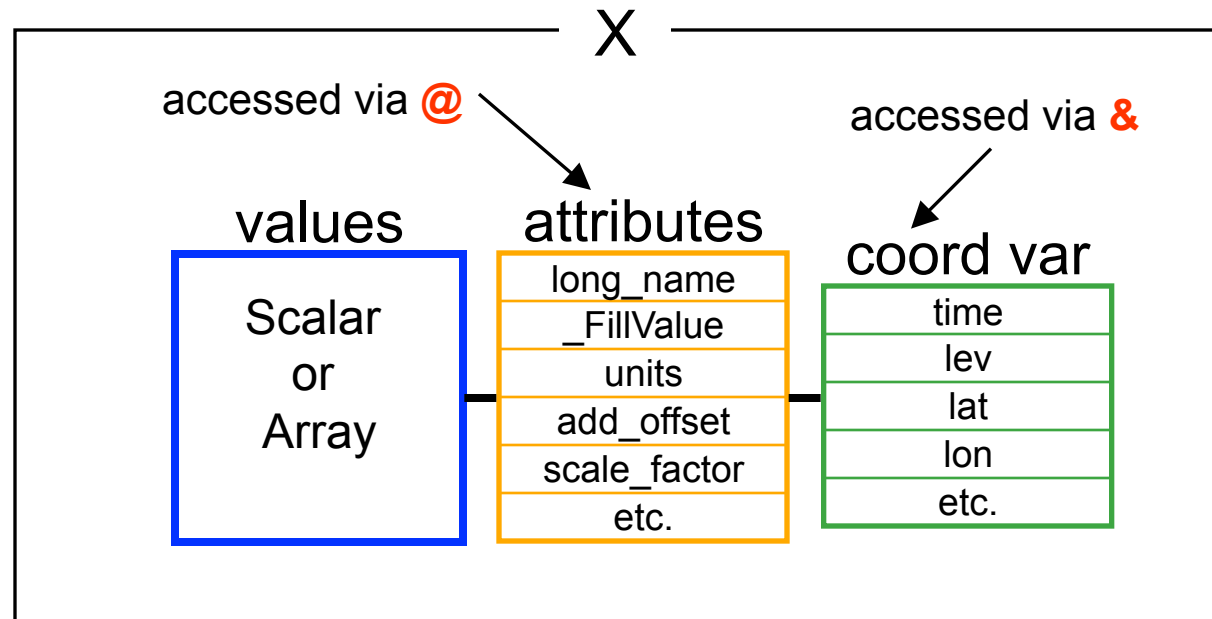
long_name
_FillValue
units
add_offset
scale_factor
etc.

coordinates

time
lev
lat
lon
etc.

```
f = addfile("foo.nc", "r") ; grb/hdf  
x = f->X
```

**NCL reads scalar/array variable,
attributes, and coordinate
variables as one object (structure)**



```
load "$NCARG_ROOT/lib/ncarg/nclscripts/csm/gsn_code.ncl"
load "$NCARG_ROOT/lib/ncarg/nclscripts/csm/gsn_csm.ncl"
```

Graphic libraries

```
f = addfile("erai_1989-2009.mon.msl_psl.nc","r") ; open file [hdf,grib]
p = f->SLP ; (time,lat,lon)
; ( 252,121,240)
```

```
printVarSummary(p) ; variable overview
```

```
wks = gsn_open_wks("ps","sample") ; open a PS file
plot = gsn_csm_contour_map(wks,p(0,:::),False) ; default plot
; uses attributes, coordinates
```

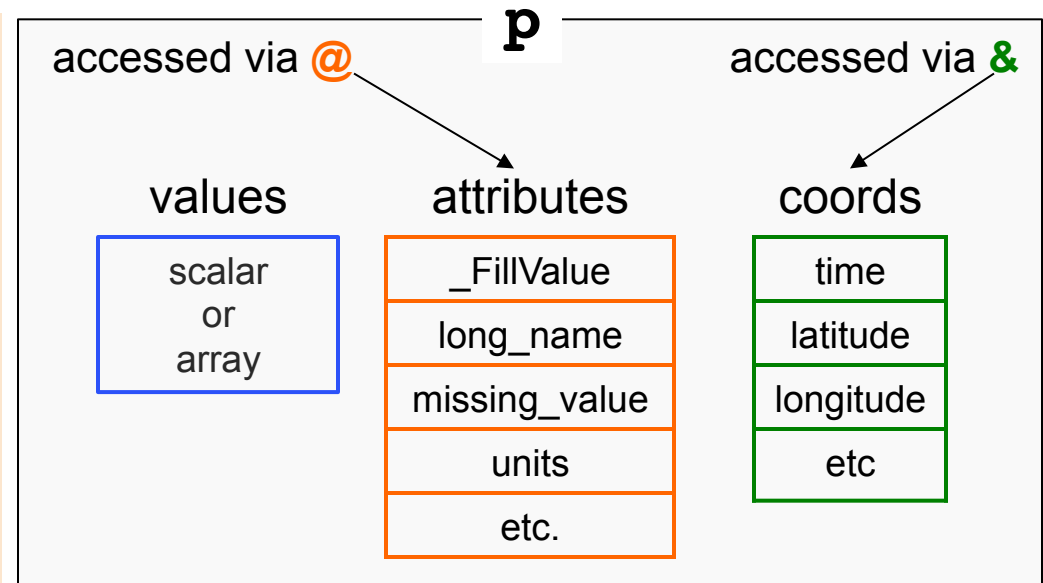
NetCDF [NCL] Variable model

```
p = f->SLP
```

NCL reads

- *data values (scalar or array)*
- *attributes @*
- *coordinate variables &*

as a **single** data structure.



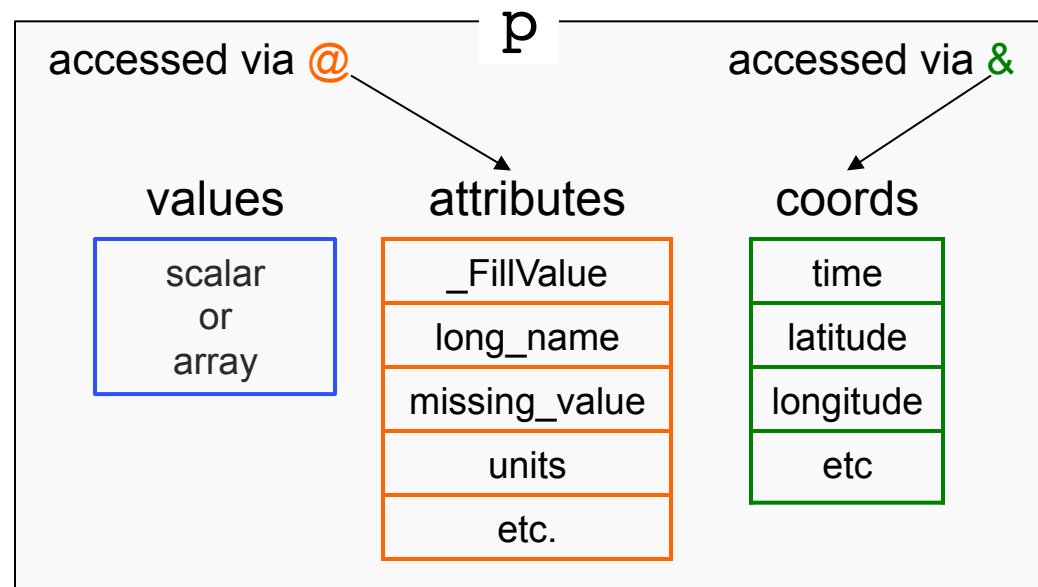
NetCDF [NCL] Variable model

`p = f->SLP`

NCL reads

- *data values*
- *attributes*
- *coordinate arrays*

as a **single** data object.



```
Variable: p
Type: float
Total Size: 29272320 bytes
           7318080 values
Number of Dimensions: 3
Dimensions and sizes: [time | 252] x [latitude | 121] x [longitude | 240]
Coordinates:
    time: [780168..963504]
    latitude: [90..-90]
    longitude: [ 0..358.5]
Number Of Attributes: 4
  _FillValue : 1e+20
  units      : hPa
  long_name  : Mean sea level pressure
  missing_value : 1e+20
```

“`printVarSummary(p)`” output

```
load "$NCARG_ROOT/lib/ncarg/nclscripts/csm/gsn_code.ncl"
```

```
load "$NCARG_ROOT/lib/ncarg/nclscripts/csm/gsn_csm.ncl"
```

```
f = addfile("erai_1989-2009.mon.msl_psl.nc","r") ; open file [hdf,grib]
```

```
p = f->SLP ; (time,lat,lon)
```

```
; ( 252,121,240)
```

```
printVarSummary(p) ; netCDF variable model
```

```
wks = gsn_open_wks("ps","sample") ; open a PS file (sample.ps)
```

```
plot = gsn_csm_contour_map(wks,p(0,:::),False) ; B&W plot
```

