United Nations
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Climate Research for Development in Africa

CGIAR

RESEARCH PROGRAM ON
Climate Change, Agriculture and Food Security

CCAFS

NCAR COMMAND LANGUAGE (NCL)

Objective Climate Forecasts for Agriculture and Food Security Sector in Eastern and Southern Africa Training of Trainers Workshop

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Victoria Falls, Zimbabwe

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INTRODUTION

- NCL (NCAR Command Language) is an interpreted language designed for access, analysis and visualization of data.

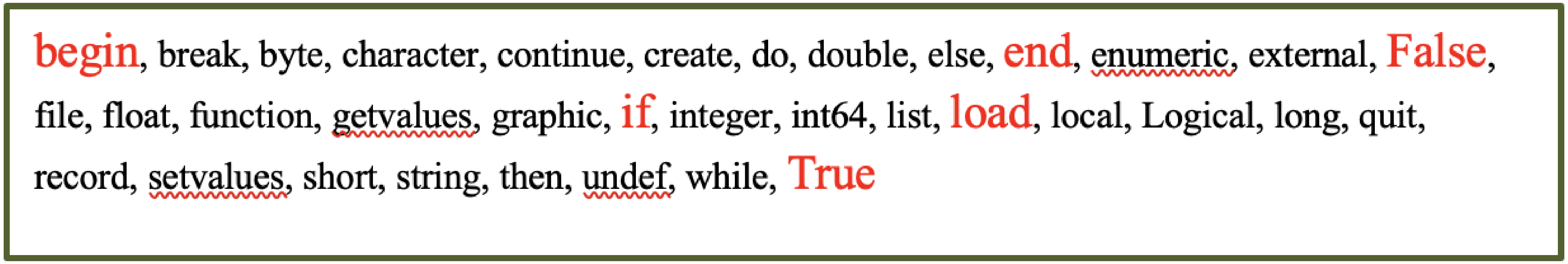
- The software is **open source** and was developed with emphasis on Atmospheric Science data.

- A number of input files are supported by NCL these include **NetCDF,** GRIB1, GRIB2, HDF4, HDF5, Binary, **Shapefiles** and **Ascii.**

- NCL can be run in both interactive mode (command prompt) and batch process using scripts.

RESERVED KEY WORDS

- NCL has several-reserved keywords, if you try to use these key words for your variables you will likely get errors. In addition to the keywords all build in functions and procedure names are reserved.



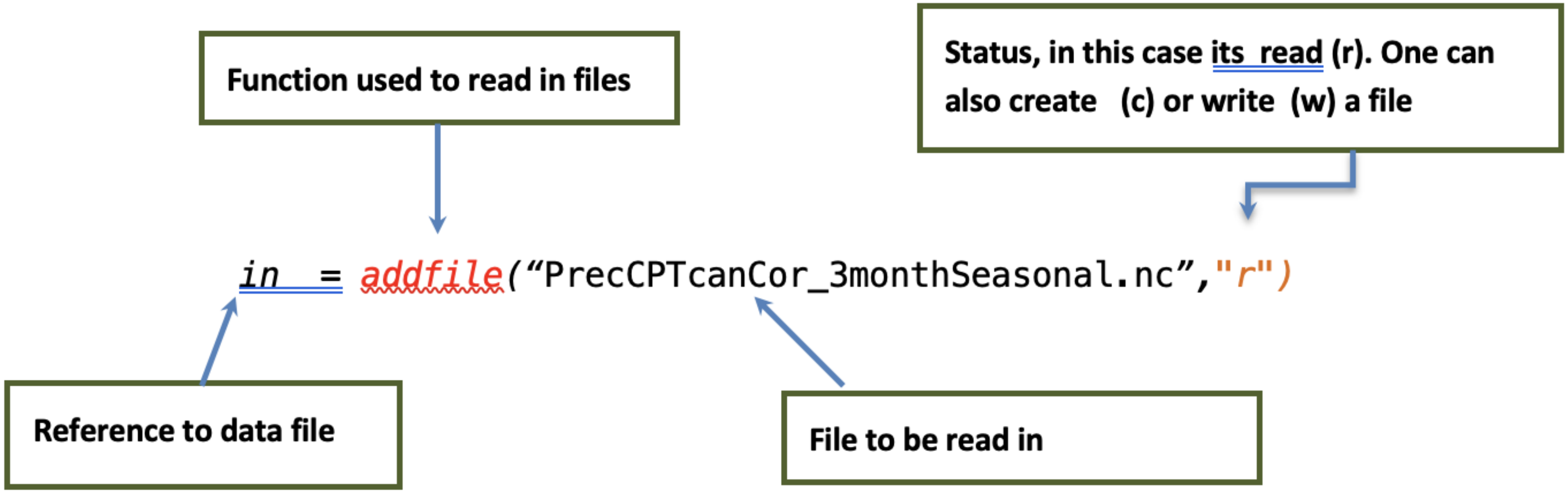
begin, break, byte, character, continue, create, do, double, else, end, enumeric, external, False, file, float, function, getvalues, graphic, if, integer, int64, list, load, local, Logical, long, quit, record, setvalues, short, string, then, undef, while, True

SYNTAX CHARACTERS

=	Assignment syntax
;	Starts a comment
->	For inputting/outputting supported data formats
(/…../)	Array constructor
{……}	Subscript array using coordinate values
\	Continuation character for wrapping long lines
@	create or reference an attribute
|	separator for named dimensions
&	create or reference a coordinate variable
::	Separator when calling external codes
$ $	Enclose strings when importing or exporting variables
!	Create or reference a named dimension

READING IN FILES

- Two main functions are available for reading in files (NetCDF (.nc), Grib1(.grb), Grib2 (.grb2), HDF4(.hdf), HDF5(.hdf), and Shapefiles(.shp)) **addfile** and **addfiles.** The function addfile can also be used to create and write files.


Function used to read in files
Status, in this case its read (r). One can also create (c) or write (w) a file
Reference to data file
File to be read in

```
in  = addfile(“PrecCPTcanCor_3monthSeasonal.nc”,"r")
```

VARIABLES IN A FILE

- A variable is an element in a file, which can change. The variables are **case sensitive** thus *RAIN* and *rain* are different variables.

- Variable names must begin with an alphabetic character and can contain numeric characters.

- In most cases when the variable is read it also contains its metadata.

- To have an idea of the variables that are in a file, there are 2 functions that can be utilized using **ncdump** or **ncl_filedump**.

READ IN A VARIABLE

- To read a variable from any supported file format with all metadata information included:

```
fin = addfile("PrecCPTcanCor_3monthSeasonal.nc", "r")
 t = fin->corr
```

- To strip off the metadata, enclose the file variable reference with ‘*(/…/)*’. Only, the special _FillValue attribute will be carried over.

```
fin = addfile("PrecCPTcanCor_3monthSeasonal.nc", "r")
t = (/ fin->corr /)
```

READ IN FILES: ADDFILES

- There are cases when one might want to access multiple data files. In this case the function addfiles is utilized in conjunction with ***systemfunc***. The function systemfunc execute a shell command and returns the output.

```
files  =systemfunc(“ls wrfdaily*.nc”)
 in=addfiles(files, “r”)
```

files: list of reference to the multiple data files

READ IN FILES: ADDFILES

- Two options are available for importing a variable into memory, the ***cat*** and ***join***. These can be achieved using the ***ListSetType*** command. The default option is cat.

```
T2Mean=in[:]->T2MEAN
```

- Since cat is the default option, to use the join option one needs to specify this through using ListSetType

```
ListSetType(in, “join”)
T2Mean=in[:]->T2MEAN
```

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ARRAYS

- Array operations require that all arrays conform to each other. This means that the arrays must have the same size and shape.

- NCL also automatically handles missing values.

- There are three types of subscripting:
  - Standard
  - Named
  - Coordinate
- Remember, the subscription of an array or dimension starts, like in C, with the index 0.

  e.g. a = (/ 4, 2, 1, 3 /) 4 elements; index 0-3

ARRAYS: STANDARD SUBSCRIPTING

- The subscripts used in standard subscripting are integers.

- The most general form of a standard subscript is ***x:y:i*** which indicates the range x to y in strides of i.

Consider the array a defined by

- a= (/5,6,7,8,9, 10,1, 2,4,2)
- b=a(0:4:2) subset the first 5 and time-steps of 2: this should give an array containing (/5,7,9/)
- c= a(:4) subset first 4 with time-step of 1
- d= a(::-1) flips the order

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ARRAYS: NAMED SUBSCRIPTING

- Named subscripting allows you to reorder arrays, but is only allowed when all dimensions of the array are named dimensions.

- Let us use a variable precip that has two dimensions named "lon" and "lat". The dimension "lat" is of size 61 and the dimension "lon" is of size 56:

Re-order the dimensions:

```
p_reord1 = precip(lon|:, lat|:)
p_reord2 = precip(lon|19:39, lat|0:9)
```

ARRAYS: COORDINATE SUBSCRIPTING

- For coordinate subscripting, all of the rules for the standard subscripting apply except for curly **brackets { },** which are used to distinguish coordinate subscripts from standard subscripts.

- Example array

  m = (/ -5.0, 10.0, 15.0, 20.0, 25.0, 30.0 /)

  m!0 = "lat" –name the dimension
  m&lat = m – associate the array
  mw = m({ -5.0 : 25.0 : 2}) contains the values – 5.0,15.0,25.0

GRAPHICS

- In this section we learn how to plot the data. NCL can write the following graphics: ps, eps, pdf, png, and X11.

- X11 is good when the script is being tested and is only able to display the plots but does not save the output.
- There are 5 major parts that are required for plotting
  - Load the functions or procedures
  - Open data file
  - Define the variable
  - Define the plot resources
  - Plot

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SIMPLE PLOTTING EXAMPLE

1. Load functions

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

2 and 3 Data file and variable

```
begin
 y = cos(0.2*ispan(0,50,1)) ; 51 points   ;
```

4. Set up plot resources

```
wks = gsn_open_wks("ps","test") ; ‘test.ps’
 res = True ; plot options
 res@xyLineColor = "Blue" ; line color
 res@tiMainString = "Practise plot"
 res@gsnMaximize = True
```

5. Plot

```
plot = gsn_csm_y(wks,y,res) ; no X values ;
     end
```

SHAPEFILES

- A shapefile is geospatial vector data format for GIS system software. Mostly used to mask data to a specified region. Shapefiles can have three different types of data
  - Point (locations of cities or places or interest, election data)
  - Polyline (non-closed boundaries like rivers and roads)
  - Polygon (closed geographic boundaries like countries)

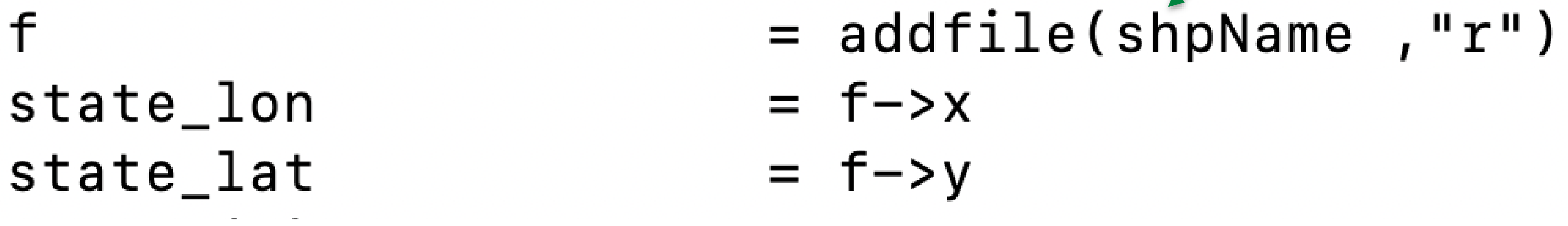
- Only one data type per shapefile.

- ***NB: Shapefiles are read in the same way with other files that is use addfile however you need the .shp, .shx and .dbf in the same directory.***

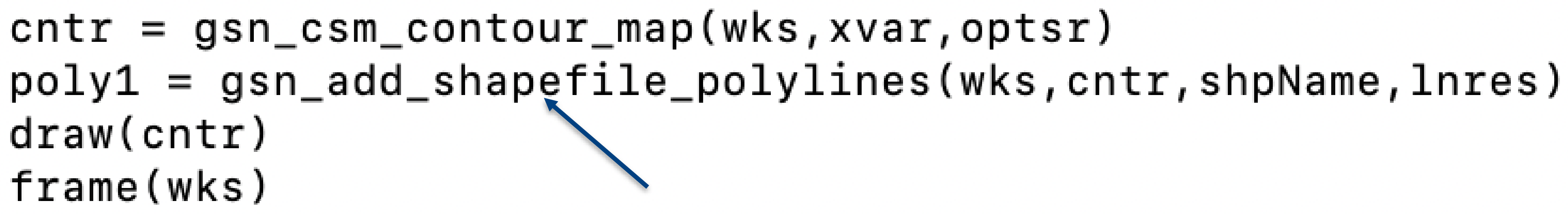
USING SHAPEFILES WHEN PLOTTING

Extract from plotting script

Read in the shapefile



```
f                          = addfile(shpName ,"r")
state_lon                  = f->x
state_lat                  = f->y
```



```
cntr = gsn_csm_contour_map(wks,xvar,optsr)
poly1 = gsn_add_shapefile_polylines(wks,cntr,shpName,lnres)
draw(cntr)
frame(wks)
```

Function to addshapefile to a plot

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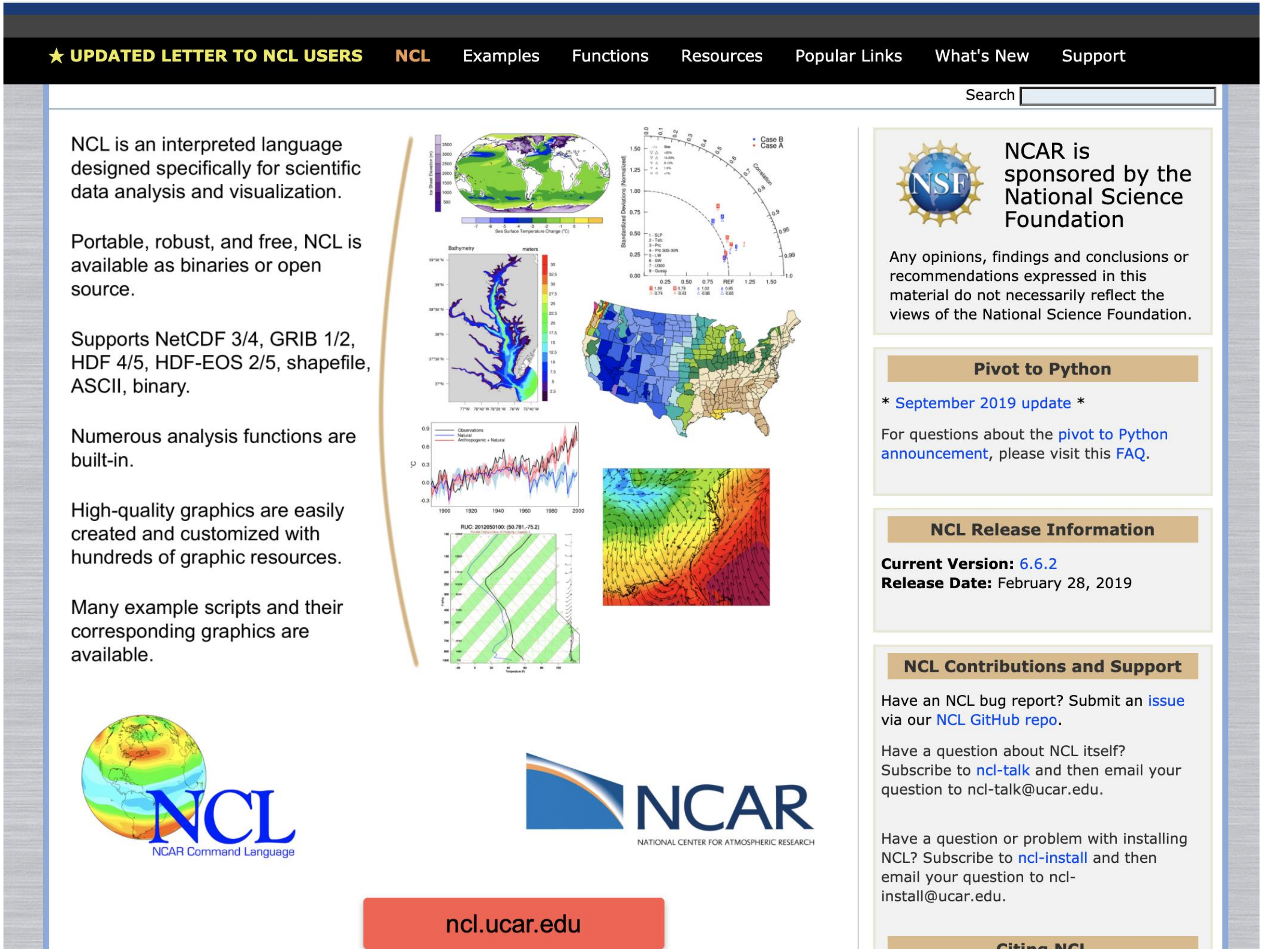
WHERE CAN I LEARN MORE?



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NCL is an interpreted language designed specifically for scientific data analysis and visualization.

Portable, robust, and free, NCL is available as binaries or open source.

Supports NetCDF 3/4, GRIB 1/2, HDF 4/5, HDF-EOS 2/5, shapefile, ASCII, binary.

Numerous analysis functions are built-in.

High-quality graphics are easily created and customized with hundreds of graphic resources.

Many example scripts and their corresponding graphics are available.

NCL
NCAR Command Language

NCAR
NATIONAL CENTER FOR ATMOSPHERIC RESEARCH

ncl.ucar.edu

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Pivot to Python

* September 2019 update *

For questions about the pivot to Python announcement, please visit this FAQ.

NCL Release Information

Current Version: 6.6.2
Release Date: February 28, 2019

NCL Contributions and Support

Have an NCL bug report? Submit an issue via our NCL GitHub repo.

Have a question about NCL itself? Subscribe to ncl-talk and then email your question to ncl-talk@ucar.edu.

Have a question or problem with installing NCL? Subscribe to ncl-install and then email your question to ncl-install@ucar.edu.

Citing NCL

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THANK YOU

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