Introduction to NCL Graphics

Vectors and Overlays

Part III in the series

November 10, 2014
Mary Haley
Notes

• Third in a series of five (?) intro lectures on NCL Graphics
• Two more webinars: panels & primitives – Nov 12
• Lectures loosely based ones used in NCL Workshops
• Geared towards new users of NCL. . .but with tips for advanced users
Goals for this series of lectures

• Get comfortable with creating NCL graphics
• Learn common things people do with NCL graphics
• Get tips for editing, debugging, creating publication-quality graphics
• Get questions answered
Assumptions

You have familiarity with:

- basic NCL language features
- NCL array syntax
- reading data off a NetCDF file using NCL
- basic structure of an NCL graphics script
- NCL/NetCDF data model
- UNIX
NCL Graphics topics for this lecture

- Gallery
  - Description of NCL vector plots
  - Line-by-line vector plot example
- Demo
  - Description of overlay plots
  - Line-by-line overlay plot example
- Demo
Vector types
1. Line
2. Curly
3. Wind barb
“masked” lambert conformal plot
Curly vectors colored by magnitude

Courtesy Dave Brown, NCAR/CISL
Overlay plots are plots that are drawn on top of other plots.
Streamlines over contours
Ufuk Turuncoglu, ITU
Turkey Climate Change Scenarios
Multiple overlays (contours and vectors)

Velocity Potential via Spherical Harmonics

Divergent Wind

Chi scaled by 1e6

m/s

90N

60N

30N

0

30S

60S

90S

180 150W 120W 90W 60W 30W 0 30E 60E 90E 120E 150E 180

-8 -7 -6 -5 -4 -3 -2 -1 0 1 2 3 4 5

Legend:
CCSM4 data
Six fields overlaid:
  Ice thickness
  (filled contours)
  Sea surface temperature
  (filled contours)
  Topo map
  (filled contours)
  Sea level pressure
  (line contours)
  UV winds
  Vertically-integrated clouds (partially transparent filled contours)

Gary Strand, NCAR/CGD
NCL Graphics topics for this lecture

• Gallery

• Description of NCL vector plots
  • Line-by-line vector plot example
  • Demo

• Description of NCL overlay plots
  • Line-by-line overlay plot example
  • Demo
Vector plots

- Requires U, V two-dimensional arrays of the same size
- Includes a “reference annotation” box
- Can be colored by magnitude or another field
- Line, curly, wind barbs available
- When you call `gsn_csm_xxxx_map`, this is an overlay plot
Vector types
1. Line
2. Curly
3. Wind barb
4. Colored by another field
Sample line vector over map plot

Reference annotation box
Sample of curly vectors colored by magnitude
NCL Graphics topics for this lecture

- Gallery
- Description of NCL vector plots
- Line-by-line vector plot example
- Demo
- Description of NCL overlay plots
- Line-by-line overlay plot example
- Demo
Example `vector1a.ncl`

- Generate dummy (10 x 10) U,V arrays
- No plot resources set
- `gsn_csm_vector`
- Scripts can be found at:

load "${NCARG_ROOT}/lib/ncarg/nclscripts/csm/gsn_code.ncl"
load "${NCARG_ROOT}/lib/ncarg/nclscripts/csm/gsn_csm.ncl"  
begin
    ;---Generate dummy u, v arrays
    npts = 10
    ii   = ispan(10,10*npts,10)
    u    = conform_dims((/npts,npts/),ii,0)
    v    = conform_dims((/npts,npts/),ii,1)

    ;---Open an X11 window
    wks = gsn_open_wks("x11","vector1a")

    ;---Call the plotting function
    vector = gsn_csm_vector(wks,u,v,False)
end
```plaintext
;---Generate dummy u, v arrays
n = 10
i = ispan(10,100,n)
u = conform_dims((/n,n/),i,0)
v = conform_dims((/n,n/),i,1)
```

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Arrows are centered on their locations (blue dot)

No coordinates provided, so 0 to n-1 are used (0 to 9)
Default vector reference length in this case is 0.06 in “NDC” units
NDC
“unit” square

0.10 NDC
0.06 NDC

(0.0,1.0)
(1.0,1.0)
(0.0,0.0)
(1.0,0.0)
Example `vector1b.ncl`

- Change the vector reference length with `vcRefLengthF`
load "${NCARG_ROOT}/lib/ncarg/nclscripts/csm/gsn_code.ncl"
load "${NCARG_ROOT}/lib/ncarg/nclscripts/csm/gsn_csm.ncl"

begin

;---Generate dummy u, v arrays
    npts = 10
    ii   = ispan(10,10*npts,10)
    u    = conform_dims((/npts,npts/),ii,0)
    v    = conform_dims((/npts,npts/),ii,1)

;---Open an X11 window
    wks = gsn_open_wks("x11","vector1b")

;---Set a vector resource
    res = True
    res@vcRefLengthF = 0.10 ; NCL chose 0.06

;---Call the plotting function
    vector = gsn_csm_vector(wks,u,v,res)
end
vector1a.ncl
vcRefLengthF = 0.06

vector1b.ncl
vcRefLengthF = 0.10
Example *vector1c.ncl*

- Change which vector magnitude (vcRefMagnitudeF) is rendered in length specified by vcRefLengthF

- Default is to render the longest vector (the one with maximum magnitude) in this reference length
load "\$NCARG_ROOT/lib/ncarg/nclscripts/csm/gsn_code.ncl"
load "\$NCARG_ROOT/lib/ncarg/nclscripts/csm/gsn_csm.ncl"

begin
    npts = 10
    ii   = ispan(10,10*npts,10)
    u    = conform_dims((/npts,npts/),ii,0)
    v    = conform_dims((/npts,npts/),ii,1)

    wks = gsn_open_wks("x11","vector1c")

    res               = True
    res@vcRefLengthF  = 0.10    ; NCL chose 0.06
    res@vcRefMagnitudeF = 100    ; max is 141.4

    vector = gsn_csm_vector(wks,u,v,res)
end
Example `vector1d.ncl`

- Increase size of U, V to create dense plot
- Thin the vectors with `vcMinDistanceF`
load "${NCARG_ROOT}/lib/ncarg/nclscripts/csm/gsn_code.ncl"
load "${NCARG_ROOT}/lib/ncarg/nclscripts/csm/gsn_csm.ncl"

begin

;---Generate larger (more dense) dummy u, v arrays

npts = 100
ii   = ispan(1,npts,1)
u    = conform_dims((/npts,npts/),ii,0)
v    = conform_dims((/npts,npts/),ii,1)

wks = gsn_open_wks("x11","vector1d")

res               = True
res@vcRefLengthF  = 0.10
res@vcMinDistanceF= 0.02  ; Thin the vectors

vector = gsn_csm_vector(wks,u,v,res)
end
No thinning of vectors

res@vcMinDistanceF = 0.02
Vector plot examples

NCL Home Page -> Examples -> Vectors
NCL Home Page -> Examples -> Vector effects

http://www.ncl.ucar.edu/Applications/vector.shtml
http://www.ncl.ucar.edu/Applications/veceff.shtml
NCL Graphics topics for this lecture

- Gallery
- Description of NCL vector plots
- Line-by-line vector plot example
- Demo
- Description of NCL overlay plots
- Line-by-line overlay plot example
- Demo
Demo

• Vectors over a map – `gsn_csm_vector_map`

• Will use “uv300.nc” data file

• Scripts (vector2x.ncl) and data file available from:

  NCL Home Page -> Support -> Webinars -> NCL Graphics

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- Gallery
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Overlays

• An “overlay plot” is a plot overlaid on top of a base plot

• Two types of overlays:
  1. “Transform” one plot into data space of another
  2. Simply “line up” two plots at their four corners

• Method #1 uses data space of plots’ axes

• Method #2 doesn’t do any transformation
“overlay” procedure

- **overlay** joins the “top” plot to “base” plot

  ```
  overlay(base_plot, top_plot)
  ```

- The two plots must either have:
  1. similar data spaces
  2. the “tfDoNDCOverlay” resource set to True

- The *top_plot* main title and tickmarks will not be part of *base_plot*
;---Create three curves
PI100 = 0.031415926535898
x1 = PI100*ispan(1,250,1)
x2 = PI100*ispan(1,300,1)
x3 = PI100*ispan(1,350,1)
y1 = sin(x1)
y2 = sin(3*sqrt(fabs(x2)))
y3 = sin(x3^2)
wks = gsn_open_wks("x11","xy")
res = True
res@vpWidthF = 0.70
res@vpHeightF = 0.25
res@xyLineThicknessF = 3

res@xyLineColor = "Purple"
res@trXMaxF = dimsizes(y1)
xy1 = gsn_csm_y(wks,y1,res)

res@xyLineColor = "Brown"
res@trXMaxF = dimsizes(y2)
xy2 = gsn_csm_y(wks,y2,res)

res@xyLineColor = "ForestGreen"
res@trXMaxF = dimsizes(y3)
xy3 = gsn_csm_y(wks,y3,res)

overlay(xy3,xy1); Overlay xy1 on xy3
overlay(xy3,xy2); Overlay xy2 on xy3
draw(xy3); Draws all three plots in one data space
frame(wks); Don’t forget to call this!
xy1 is purple, xy2 is brown, xy3 is green
wks = gsn_open_wks("x11","xy")
res = True
res@vpWidthF = 0.70
res@vpHeightF = 0.25
res@xyLineThicknessF = 3
res@tfDoNDCOverlay = True ; line up four corners of each plot

res@xyLineColor = "Purple"
res@trXMaxF = dimsizes(y1)
xy1 = gsn_csm_y(wks,y1,res)
res@xyLineColor = "Brown"
res@trXMaxF = dimsizes(y2)
xy2 = gsn_csm_y(wks,y2,res)
res@xyLineColor = "ForestGreen"
res@trXMaxF = dimsizes(y3)
xy3 = gsn_csm_y(wks,y3,res)

overlay(xy3,xy1) ;---Overlay xy1 on xy3
overlay(xy3,xy2) ;---Overlay xy2 on xy3
draw(xy3) ;---Draws all three plots
frame(wks)
xy1 is purple, xy2 is brown, xy3 is green
Method 1: overlay plots in data space of base plot

Method 2: line up plots by their four corners
;;;---Generate dummy u, v, w arrays

N = 20
PI = 3.14159
I = ispan(0,N-1,1)
u = 10. * cos(conform_dims((/N,N/),(2.0 * PI / N) * I, 0))
v = 10. * cos(conform_dims((/N,N/),(2.0 * PI / N) * I, 1))
w = u^2+v^2

wks = gsn_open_wks("x11","overlay1a")

vcres = True ; vector resources
vcres@vcLineArrowColor = "Brown"
vcrestiMainString = "Vector plot"
vector = gsn_csm_vector(wks,u,v,vcrest)

cnres = True ; contour resources
cnres@cnLineColor = "NavyBlue"
cnres@tiMainString = "Contour plot"
contour = gsn_csm_contour(wks,w,cnres)

overlay(vector,contour) ; overlay contour plot on vector plot

draw(vector) ; This will draw both vector and contour plot
frame(wks)
;---Generate dummy u, v, w arrays
N  = 20
PI = 3.14159
I  = ispan(0,N-1,1)
u  = 10. * cos(conform_dims((/N,N/),(2.0 * PI / N) * I, 0))
v  = 10. * cos(conform_dims((/N,N/),(2.0 * PI / N) * I, 1))
w  = u^2+v^2

wks = gsn_open_wks("x11","overlay1b")
vcres                           = True       ; vector resources
vcres@vcLineArrowColor          = "Brown"
vcres@tiMainString             = "Vector plot"
vector  = gsn_csm_vector(wks,u,v,vcres)

cnres                           = True       ; contour resources
cnres@cnLineColor              = "NavyBlue"
 cnres@tiMainString             = "Contour plot"
 contour = gsn_csm_contour(wks,w,cnres)

overlay(contour,vector)        ; overlay vector plot on contour plot
draw(contour)  ; This will draw both contour and vector plot
frame(wks)
What's the difference?

`overlay(vector,contour)`

Vector plot

`overlay(contour,vector)`

Contour plot
;---Generate dummy u, v, w arrays
N = 20
PI = 3.14159
I = ispan(0,N-1,1)
u = 10. * cos(conform_dims((/N,N/),(2.0 * PI / N) * I, 0))
v = 10. * cos(conform_dims((/N,N/),(2.0 * PI / N) * I, 1))
w = u^2+v^2

wks = gsn_open_wks("x11","overlay1c")

vcres = True ; vector resources
vcres@vcLineArrowThicknessF = 3.0 ; 3x as thick
vcres@tiMainString = "Vector plot"
vector = gsn_csm_vector(wks,u,v,vcres)

cnres = True ; contour resources
cnres@cnFillOn = True ; turn on color fill
cnres@lbOrientation = "Vertical" ; make labelbar vertical
cnres@tiMainString = "Contour plot"
contour = gsn_csm_contour(wks,w,cnres)

overlay(contour,vector) ; overlay vector plot on contour plot
draw(contour) ; This will draw both contour and vector plot
frame(wks)
Overlay examples

NCL Home Page -> Examples -> overlay
http://www.ncl.ucar.edu/Applications/overlay.shtml

Can also go to the “functions” link on Examples page and search for “overlay”.

Lots of examples use this procedure.
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- Gallery
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- Demo
- Description of NCL overlay plots
- Line-by-line overlay plot example
- Demo
Demo

• Overlays

• Will use “era40.pl.t85.tuvo.200001.nc”

• Scripts (overlay3x.ncl) and data file available from:

NCL Home Page -> Support -> Webinars -> NCL Graphics
http://www.ncl.ucar.edu/Training/Webinars/NCL_Graphics/VectorOverlayDemo
Questions?

ncl-talk@ucar.edu

http://mailman.ucar.edu/mailman/listinfo/ncl-talk