METR 5303 Computer Problem #2

Assigned September 23, 2019, Due Tuesday, October 8, 2019

Using the same data set and grid you worked with in Computer Problem #1, perform the following four objective analysis:

1. $Z_{ij}^a = \dfrac{\sum_k w_k Z_k^o}{\sum_k w_k}, \quad w_k = 1, \ r_k \le R$

2. $Z_{ij}^a = \dfrac{\sum_k w_k Z_k^o}{\sum_k w_k}, \quad w_k = \dfrac{R^2 - r_k^2}{R^2 + r_k^2} \text{ for } r_k \le R$

3. $Z_{ij}^a = \sum_k w_k \left[Z_k^o + \left(\dfrac{\partial Z}{\partial x}\right)_k (x_{ij} - x_k) + \left(\dfrac{\partial Z}{\partial y}\right)_k (y_{ij} - y_k) \right] / \sum_k w_k$

$$= \sum_k w_k \left[Z_k^o + \frac{f}{mg}[u_k^o (y_k - y_{ij}) - v_k^o (x_k - x_{ij})] \right] / \sum_k w_k, \qquad w_k = 1 \text{ for } r_k \le R.$$

4. Same as 2, except that $w_k = \dfrac{R^2 - r_k^2}{R^2 + r_k^2}$.

In the above, (x_{ij}, y_{ij}) is the coordinate of a grid point, and (x_k, y_k) is the coordinate of an observation. Note: $w_k = 0, \ r_k > R$ and R = 648 km in all analysis, where r_k is distance between grid point (i, j) and k^{th} station.

Hand in a (28, 22) array of grid point values as well as a contour plot for each analysis. Please remember to label each contour plot.

Also, after completing each of the four analyses, determine Z_k^a , k =1, N, an estimate of the analysis at each of the N stations within the grid via bi-linear interpolation. For each analysis, print the following five columns of information:

k BLSTN Z_k^o Z_k^a $Z_k^a - Z_k^o$

Finally, compute the root mean square differences between the analysis and observations at the stations via the following for each of the analyses

$$RMSD = \left[\frac{1}{N} \sum_{k=1}^{N} (Z_k^a - Z_k^o)^2 \right]^{1/2}$$

where N is the number of stations within the grid.

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Additional Information: Computer Assignment #2

1. Use of winds: Assume the observed winds are geostrophic. Reorient the u and v components to your polar stereographic grid via

$$u_g = C\cos(\lambda - \alpha), \quad v_g = C\sin(\lambda - \alpha),$$

where λ = (reference longitude – station longitude), α = wind direction, and C = wind speed.

Since $u_g = -g/f \;\; dz/dy$ and $v_g = g/f \;\; dz/dx$,

or, rearranging, $\Delta z/(\Delta x)_e = f v_g/g$, where $(\Delta x)_e$ is earth distance and $(\Delta x)_{map} = m \; (\Delta x)_e$, where is the image scale factor, and m is the map scale factor.

Therefore, $\Delta z/(\Delta x)_{map} = f v_g/(mg)$, $\Delta z/(\Delta y)_{map} = -f u_g/(mg)$

Please note that the unit of distance you have been using is km. meter should be used in the formula.

2. Different ways for producing the contour plots. You are strongly encouraged to include map background in your contour plots.

Use of NCAR graphics package (available on most Linux/Unit computers. Commands are **boldface**)

To compile and link your code (an executable named "yourfile.exe" will be created):
ncargf90 –o yourfile.exe yourfile.f90 (assuming your program is in Fortran 90)

To run your code (a graphic file named "gmeta" will be created): **yourfile.exe**

To convert the gmeta file to a postscript file:
ctrans –d ps.mono gmeta > yourplot.ps

ps2pdf yourplot.ps yourplot.pdf

Your contour plot in in a PDF file.

Use NCL (NCAR Command Language) for contour plotting

The NCL graphics software package is installed on the SoM Linux machines. The web site for the NCL scripting language can be found at http://www.ncl.ucar.edu

Users will need to set the NCL root directory prior to using the software:

setenv NCARG_ROOT /usr/local/ncl

The documentation for NCL is located at:

http://www.ncl.ucar.edu/Document

There are some good examples and tutorials that users can run, including a section on drawing contours:

http://www.ncl.ucar.edu/Applications/

MATLAB

MATLAB is available on both the SoM Linux Lab and the Mac Lab machines. There are contouring commands available, but I am not sure if there are any mapping routines for map backgrounds that you will need.

Python

You can also try to do the plotting using Python.