AOSC 652: Analysis Methods in AOSC Assignment #3

Due: Monday, 19 September 2016 (start of class)

100 points total, plus max 10 points extra credit **Name:** _____

Late penalty: 10 pts per day

This assignment provides exposure to the analysis of satellite data. We will be looking at measurements of ***total ozone column*** obtained by the OMI (Ozone Monitoring Instrument) instrument on the NASA Aura spacecraft. OMI is a collaborative effort of scientists at the Royal Netherlands Meteorological Institute and NASA Goddard Space Flight Center.

Part 1. Data Processing (50 points): Here, we will be processing data archived in ASCII (text) files using the FORTRAN code we have discussed in class.

First, download a month's worth of OMI ozone data from the jwocky.gsfc.nasa.gov site using the ftp command, as described in class. Pick your favorite month in a recent year (i.e., 2015 or 2016) for which a complete month of data files are available.

Next, modify the code from Wednesday to complete **subroutine bilinear**. Please consult the Press et al. reading! Also, add appropriate comments to **subroutine bilinear**.

Once subroutine bilinear is working correctly, use the code to produce a time series of total for the latitude and longitude of ***some place of your choosing*** (please *do not* pick London in March 2013, since this was the example shown in class). Please use a precise latitude/longitude for the chosen site and please indicate, in the header of the file, the latitude/longitude you have used. The total ozone time series should be an ASCII data file conforming to the format described in class, with day of month in the first column, date (YYMMDD or YYYYMMDD format) in the second column, and total column ozone (Dobson Units or DU, which is the unit of measure in the NASA files) in the third column.

Finally, produce a plot of total column ozone at the selected location versus day of month, for the month you have selected. You may use either the hppltd program described in class or *any other Linux based graphical display software*.

Please turn in hardcopies of:

1. the FORTRAN code used to conduct the bilinear interpolation
2. the ASCII data file containing the values of total ozone for the entire month
3. the plot of total ozone versus time

   For the code and ASCII data file, please print using the enscript command and also please ***include the full path in the filename*** (for grading, it helps us immensely if you let us know where these files reside).

Extra Credit, part 1 (maximum 5 points): add comments throughout the FORTRAN code, indicating how various parts function.

Part 2. The Ozone Movie (50 points). This part of the assignment provides exposure to the ***power of data visualization*** and provides exposure to linux Open Office, which is similar to PowerPoint. You are welcome to complete this part of the exercise using PowerPoint rather than Open Office, should you so desire.

The "virtual animation" you will make is described below. Here, we ask you to provide the full pathname of the Open Office (*.odp) or PowerPoint (*.pptx) file that contains your animation:

Please follow the steps below to complete the animation:

A. For every day of the month you have chosen, download images of total column from either ftp://toms.gsfc.nasa.gov/pub/omi/images/global, ftp://toms.gsfc.nasa.gov/pub/omi/images/npole, or ftp://toms.gsfc.nasa.gov/pub/omi/images/spole. Please use either global (directory global) or polar for NH (directory npole) or SH (directory spole); i.e., select the most appropriate projection style. These files will be in the Portable Network Graphics (PNG) format.

> PNG files http://en.wikipedia.org/wiki/Portable_Network_Graphics provide a compact representation of images using an open source (i.e., free) format that is especially amenable for screen presentations using Powerpoint or Impress. PNG files can be directly imported into either program. While images rendered in PNG format provide a fantastic compromise between quality and file size for the transfer of information over the world wide web, most scientific journals in Atmospheric & Oceanic Science do not accept for publication images prepared in PNG format ☹

B. Prepare a series of plots that show the progression of total column ozone, for your selected month, over your selected location: i.e., the first plot will show the time series for day 1; the second plot will show the time series for days 1 and 2; the last plot will show time series for the entire month. You will have a series of either 28, 30, or 31 plots, depending on the number of days in the month you have chosen. If you use the code hppltd to prepare these plots, the files will be in encapsulated postscript (EPS) format.

> EPS files http://en.wikipedia.org/wiki/Encapsulated_PostScript and the closely related postscript (PS) file format http://en.wikipedia.org/wiki/PostScript provides precise control over laser printer format to allow finely detailed objects to be printed from a graphically enabled vector representation of the final image. The process of converting vector graphics to a bit mapped image is called rasterization. Many scientists prefer to use EPS or PS for analysis and for the EPS format is preferred by many scientific journals (EPS builds upon PS by the use of a "bounding box", which makes it easier to blend text with an image for publication purposes). Since EPS and PS are based on vector graphics, and since Powerpoint and Impress do not provide tools for optimal rasterization of EPS or PS images, it is typically better to convert an EPS or PS file to another file format, which will then be imported into Powerpoint or Impress.

C. If you have prepared the line plots using hppltd, convert the EPS files to the PNG format using the linux "convert" command: i.e.:

> convert –density 200 tmp101.eps tmp101.png

produces file tmp101.png (output) from tmp101.eps (input).

See command:

/homes/metofac/rjs/aosc652/week_03/animation/.convert

for a shortcut on carrying out the conversion for a full complement of tmp*eps files.

If you have prepared the plots using some other software, and the file format does not look good within OpenOffice, either output or convert the files to png format.

D. Here is the tedious part of this exercise ☹ :

i) Using either OpenOffice Impress (Linux equivalent of PowerPoint) or using PowerPoint, create an ODP or a PPTX file that contains a series of slides, such that:

The top half of each slide shows the ***global image (or polar projection)*** of the total ozone (PNG file) obtained from ftp sites noted above

The bottom half of each slide shows the ***time series*** of total ozone (plot you created), with the line stopping *at the date that corresponds to the date of the global image*

The ODP or PPTX file should contain either 28, 30, or 31 slides, depending on which month you choose. On Friday, Ross will go over a convenient way to enter the information into Open Office Impress, so that the layout of each image is identical.

ii) Save the OpenOffice Impress (*.odp) or PowerPoint (*.pptx) file, place in a location accessible to the instructors, and provide the full path of this file (i.e., writte the fullpath of the filename above)

Extra Credit, part 2 (maximum 5 points): Compare the values of total ozone you have found for your chosen location to the values given at the following NASA website:

http://ozoneaq.gsfc.nasa.gov/tools/ozonemap

and comment on the level of agreement, or lack thereof, between the two values of total ozone.

To use the NASA website, first select the date from the box on the right hand side of the page using the calendar, then enter your latitude & longitude into the box just to the right of the date (you have to over write the lat / lon in the box), then for the comparison use the NASA value from OMI. You should then be able to click through the calendar to get values of OMI Ozone at your location, for the entire month.

How does the interpolation provided by the OMI website differ from the interpolation you have conducted? Why do the values differ and which do you think are more accurate?

Note: a picture is worth a thousand words! We produce animations using methods similar to those used in this exercise ***all the time***. We post them regularly on links accessible from the UMd Atmos. Chem webpage, such as:

http://www.atmos.umd.edu/~rjs/aq/aq_animated_100920.gif