AOSC 470/600 – Fall 2016
Case Study/Research Project

Research Project Overview:
The expectations for the written and oral portions of the term project are available in supplementary documents.

Downloaded Data:
I have retrieved data for all of your case studies already, either in the form of CFSR, NARR, or GFS analysis data. I have files in both grib and netcdf format. From halo or metsrv8, your data can be found in the following directories:

/data/studentdata/dkleist/casedat

There are sub directories for each case named YYYY_Stormname, where YYYY is the four digit year and "Stormname" is a string used to identify something about the event. If you have trouble locating your data, please email me.

Hand Analysis:
You have two options:

1. Send in a request with area of interest, variables, and time for something you wish to analyze (2d map on some level or perhaps vertical profile/skew-T). I can create a pdf with plotted station data for you.
2. Find and use a free resource on the web to plot observational data for you to analyze.
3.

If you choose option (2), please make sure you are plotting observational data (not gridded model or reanalysis data).

Data Sources:
If you wish to find other/more data, there is lots of free data available for use in putting together your required figures. For the self-generated diagnostic, I recommend using reanalysis data (CFSR or NARR). Reanalysis data sets are nice since they are continuous, gridded (3D) fields that can be used to analyze. Grib files from two reanalysis data sets and other data sets are readily available from:

- NCDC NOMADS: http://nomads.ncdc.noaa.gov/data.php
    - CFSR: This is the most recent global reanalysis dataset from NOAA/NCEP. Simply click on CFSR, 6-hourly files, 3D pressure level data. From there, the various grib files are sorted by date (first YYYY, then YYYYMM, then YYYYMMDD). These are version 2 grib files that you can download to a local machine (AOSC, your personal desktop), or load the URL into the Integrated Data Viewer data specification. The first bullet is for data between 1979 and 2011, the second link is for real time data from 2011 to the present….analysis files are available in 6 hour increment (if you needs something with higher temporal frequency, you can fill in the gaps using forecast data):
        - http://nomads.ncdc.noaa.gov/modeldata/cmd_pgbh/
            - If using this dataset, look for files named pgbh00*, these are 00 hour "forecast files", which are good enough to use as analysis fields for this purpose (technically, they are actually model output after the first model timestep). The date within the subdirectories and the date in the file

name is for the analysis/initialization time. The files named pgbhNN, where NN is a non-zero integer, are model forecasts from the initialization time (i.e. pgbh04.gdas.1998090612.grb2 is a 4 hour forecast from September 6th, 1998 at 12 UTC). Feel free to use these forecast files if you want to show fields with higher temporal frequency.

- http://nomads.ncdc.noaa.gov/modeldata/cfsv2_analysis_pgbh/
  - If using these data set (2011 to present), look for files of the naming convention cdas1.tHHz.pgrbh00.grb2. These are identical to the aforementioned pgbh00* files. Note that the date is not in the file name. However, the date is specified by the directory from which you retrieved the file and is also encoded into the grib files themselves. The HHz references the initialization cycle (either 00, 06, 12, or 18). The same holds true as before for the cdas1.tHHz.pgrbhNN.grb2, where NN represents a model forecast hour.

- NARR: This was a regional reanalysis that was run by NCEP some time ago. It is a bit older, courser resolution, and run only over a limited area domain.

- ESRL RAOB: http://www.esrl.noaa.gov/raobs/
  - This is a handy website for retrieving old radiosonde data in either ascii (text) or netcdf format.

- UCAR Research Data Archive: http://rda.ucar.edu/
  - This data access location requires (free) registration and is an amazing resource that has access to lots and lots of data, including observations (upper air and surface), reanalysis data, model forecast data, etc. If there is something you think you need but require assistance, please contact me.

If you download grib data and wish to convert to netcdf, please contact me.

Where should I put data and how can I get it?

If you will be using GrADS, python, or other software on AOSC servers, I suggest copying data to your space on the aosc machines. Getting data from the internet is easy to do using "wget" if you know the full path. For example, from halo (or metosrv8), I would first cd to the directory that I want to save data (here, I will show an example of putting data in a directory off of my home directory, in subdirectory aosc600/tmp):

```
cd ~/aosc600/tmp
```

The "~" references my home directory, so the full path for the above is as follows (use the pwd command to figure out what directory you are in):

```
pwd
```

which then tells me that I am in:

```
/homes/metofac/dkleist/aosc600/tmp
```

Then, I simply execute a series of wget commands (or write a script to do so):

```
wget
http://nomads.ncdc.noaa.gov/modeldata/cfsv2_analysis_pgbh/2013/201310/20131010/cdas1.t00z.pgrbh00.grib2
```

This will download the data from the above URL to my local directory. However, I strongly recommend renaming all files so that they have the full data (YYYYMMDDHH) associated with them. This makes

using the template feature of grads control files much easier. So for the above file, I may rename it to something like:

mv cdas1.t00z.pgrbh00.grib2 pgrbh00.cdas1.2013101000

You are also free to create and use space in /data/op.

What is grib data?

Grib stands for "gridded binary" and is the WMO-established format for gridded meteorological data. There is lots of software out there that can easily manipulate and visualize data from grib files (including but not limited to grads, IDV, etc.). There are two versions for grib data (version 1/grib1, and version 2/grib2). You can use the utility wgrib or wgrib2 (format dependent) to query the contents of a file. For a more verbose description, simply use "wgrib –v" or "wgrib2 –v".

What is bufr data?

BUFR stands for binary universal form, and is another established standard for meteorological data. This format is typically used to exchange non-gridded data, i.e. observations. Since this type of data is not regular (i.e. it is not on a regular grid), it is much more difficult to manipulate and visualize. I have software available for converting upper air bufr data to grads binary files if desired.

What is netcdf?

NetCDF stands for network common data form, and has a machine independent, self-describing file formatting. Some of the data from the UCAR site and the ESRL site will come in netcdf format. Netcdf can be easily visualized using grads, **python**, or other software.

What if I am unfamiliar with UNIX/LINUX?

If you are uncomfortable with using grads, python, or other visualization software, I suggest using the Unidata "Integrated Data Viewer" to produce your "self generated diagnostic" figure. The software is described and readily available here:
http://www.unidata.ucar.edu/software/idv/

In fact, you can run IDV without installing the software locally on your computer if you have Java WebStart already installed. IDV is nice in that it uses a GUI and is fairly easy to use. You will still need to make sure you download the relevant data and/or point IDV to the right URL.

How should I do my hand/manual analysis?

The requirement for this component is that you have to do a hand drawn analysis/contouring of some quantity from observations. You have a few options, including but not limited to:

- Use the Plymouth State website to plot some observations, and then manually contour yourself. Use the "data plot" option from the following URL
  - http://vortex.plymouth.edu/surface-u.html
- Retrieve observations from the NCDC, ESRL, or UCAR website. Once done, plot the observational quantity that you want to manually analyze and perform your hand contouring. Observations will typically come in ascii, netcdf, or bufr format. I recommend trying to use the netcdf format as it is easiest to work with.

Make sure that the quantity you analyze is relevant to the case study and narrative being presented.

What is a conceptual model?
From Wikipedia: "A **conceptual model** is a **model** made of the composition of **concepts**, which are used to help people know, understand, or simulate a subject the **model** represents. Some **models** are physical objects; for example, a toy **model** which may be assembled, and may be made to work like the object it represents."

Some examples were provided as part of Lecture 21. There are lots of examples on the web. The graphic can be hand drawn, put together using something like Adobe Illustrator or Paint, or can be something as simple as a flow-chart made using MS Office. The conceptual model should help illustrate your main point/hypothesis/theme in a single figure.

Final comments/suggestions

- Try to apply concepts from class to your case
- If you cannot plot forcing terms directly, plot their components and describe qualitatively. For example:
    - If you wanted to talk about forcing for vertical motion from the "thermal advection term" in the QG-omega equation, plot temperature and winds, and describe qualitatively where you expect local max (recall the forcing term is the Laplacian of thermal advection) or local min, which are related to vertical motion forcing.
    - Plot upper level heights and isotachs. Describe qualitatively where you expect upper vertical motion associate with divergence/convergence based on concepts covered in class.
- If something is unclear, come to office hours or send an email. However, do not procrastinate.
- If you have trouble with data, I am happy to assist in retrieving data, creating control files for GrADS, or making other suggestions. All you have to do is make an appointment or ask for help! Please feel free to use the python scripts from earlier this semester.
- Be sure to cite any and all figures, text, and other material that is not your own.