**Project #1**

This project will entail making atmospheric observations and analyzing the data. Each team will be broken into three sub-teams 1) Data and analysis, 2) Theory, and 3) Project management. It will be the responsibility of the data team to collect the data and perform other analysis. The theory team provides context for these types of observations and the management team makes sure everything is completed and presented to the Program Directors (Tim and Hannah).

Science is a collaborative process and good scientists work with a variety of people to push the research forward. Experimentalists make the observations which tell us about the atmosphere itself while the theoreticians try to tell us what this means by using computer simulations and analysis techniques. The goal of this project is to give you a sense of how science is actually performed. It can be frustrating and it’s often at these times when you learn the most about what you’re studying.

**Rawinsonde Launch Instructions**

**Project Description**

Each group will be launching a weather balloon to collect meteorological data at multiple altitudes. The sensor packages that we will be working with are inexpensive rawinsondes designed for educational and scientific use (Sparv Embedded: Windsond S1H2). The sensor packages measure the following variables:

* Time (local time)
* Altitude (m)
* Pressure (Pa)
* Speed (m/s)
* Rise speed (m/s)
* Heading (°)
* Temperature (°C)
* Relative Humidity (%)
* Latitude (°)
* Longitude (°)

**Launching the Rawinsonde**

*Inflating the Balloon and Preparing the Sensor Package*

1. Inflate the balloon to 18-20 inches in diameter
2. Insert battery into rawinsonde package (wait to turn on the sonde package)
3. Tie rawinsonde to balloon → BE VERY CAREFUL AS TO NOT BREAK THE WIRE CONNECTING THE STRING TO THE RAWINSONDE CIRCUIT BOARD

*Preparing the Software*

1. Set radio frequency to a value between 420 Hz and 430 Hz
2. Turn on the rawinsonde package
3. Click “Pair with sonde”
   1. A new screen will pop up which is where all the functionality of the sonde will be shown
   2. The software will automatically begin collecting data in “/Documents/Windsond files/”
      1. You will find files with names corresponding to the date and time of the launch
         1. KML file (for plotting in Google Earth)
         2. *“date/time*.raw\_history” (an Excel File with all the data from the launch)
         3. *“date/time*.raw” (an Excel file with data from just the flight)
4. **Go to “Sonde status” tab and set the “Cut-down altitude” to “9999”**
5. Wait until GPS fix
   1. You will hear the rawinsonde package make a distinct *happy* beeping noise which means that the rawinsonde has received GPS fix
6. Switch over to the “Weather” tab and you are ready to Launch!
7. After the flight, the software will create data files. The “csv” file (comma separated variable) can be opened in Excel. The “kml” file can be opened in Google Earth

**Back Trajectory Analysis**

When you make observations, you need to understand what the data mean. One way to do this is to learn about where the air came from. Using meteorological data, you can calculate “back trajectories” which are basically the path the air you sampled took before it reached the balloon. The Hybrid Single Particle Lagrangian Integrated Trajectory Model (HYSPLIT) model was developed by the National Oceanographic and Atmospheric Administration’s Air Resources Laboratory (NOAA ARL) to help with this process. Fortunately, there is an online version of HYSPLIT that’s fairly straightforward to use. Go to the following website:

<https://www.ready.noaa.gov/HYSPLIT_traj.php>

1. Click on the link to “compute *archive* trajectories”
2. Select “1” trajectory using a “normal” type then click “Next”
3. For meteorology: select HRRR 3km
4. Input the latitude and longitude that you want to run the trajectory from. You’ll input the altitude in a later step. Click “Next”
5. Scroll through the list of meteorology files and select the one that is closest in time to your balloon launch, that includes the time of the observation. Your observations are in “local time” (the time in College Park) while the meteorological data are in “universal time” (the time in Greenwich, England). You’ll need to convert local time into universal time to determine which file to use. It will most likely be the 18Z file. Click “Next”
6. Choose “backward” trajectory and “model vertical velocity”
7. Input the appropriate time of the observation in UTC
8. Choose a run time of 120 hours
9. Add the appropriate height of the observation
10. Leave everything else at the default setting
11. Dump ambient temperature, rainfall, and relative humidity
12. Click “Request Trajectory”
13. Be patient
14. Once the program is finished, you should see a map of the trajectory.
15. Download the pdf plot as well as the Google Earth KMZ file
16. Click on and download the “trajectory endpoints file”. This is a text file. The last three columns of data should be the air temperature, rainfall, and relative humidity.
17. Try plotting the air temperature, rainfall, and relative humidity in a similar fashion as altitude is plotted in the pdf file. How do the data in the trajectory endpoints file compare to the data from the balloon?
18. Create back trajectories for at least 4 points along the balloon flight track

**Plotting in Google Earth**

Go to Google Earth. If you want to, you can download this to your computer but it can take up a lot of memory.

1. Click “Launch Google Earth”
2. Go to “settings” (this may take some searching) and make sure the “Enable KML file import” is enabled
3. No go to “My Places”. In the left hand bar this symbol is about half down and looks like flag
4. Click on import kml file and select the kml file from your balloon flight
5. Once the flight is plotted, click save
6. Now follow the same procedure to plot your back trajectories (kmz files will work in Google Earth).
7. Practice zooming in and out to create different views of the data and trajectories. If you select the “3D” button in the lower right and play around with the compass you can create 3D visualizations of the data and trajectories.
8. To create figures, you can use your computer to take a screen capture (crop out parts of the picture that show your desktop, etc.)

Once you’ve followed these steps, use the figures you’ve made to create a story board and work with the theory team and the project managers to “tell a story”.

**Theory**

The job of the theory team is to provide background and history of balloon observations as well as what the actual observations from your balloon flight mean. Some questions to consider answering: How are weather balloon data used today? Are there other uses for balloon observations? When did balloon observations begin and for what purpose? What types of observations compliment balloon data? What do the specific observations made on the day of your balloon flight and the back trajectories tell us about the air that the balloon flew through. This report should be at least two pages, 12 pt font, 1 inch margins, single spaced, properly cited, with a bibliography.

**Final Written Report and Presentation**

The final written report should be a clear and concise combination of the information provided by the data and theory teams. On September 26th, the project managers from the groups will make a 6-7 minute presentation using whatever visual aids, such as powerpoint, are most appropriate. Like the written report, this will summarize the information from the data and theory teams. Be prepared to answer questions from the Program Managers.

**Sample Annotated Bibliography in MLA Format**

Aristotle. *Poetics*. Trans. S. H. Butcher. *The Internet Classics Archive*. Web Atomic and Massachusetts Institute of Technology, 13 Sept. 2007. Web. 4 Nov. 2008. ‹http://classics.mit.edu/›.

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