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An Extension of the Python SHARPpy GUI to Display Combined Satellite Soundings and ASOS Surface Data in Near-Real Time

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1. INTRODUCTION/OVERVIEW

SHARPpy is a program created by Greg Bloomberg and Kelton Halbert that displays data in a sounding format created by NWS storm prediction center (SPC). Currently SHARPpy supports operational radiosonde upper air soundings of temperature and water vapor as well as selected NWP model fields. The soundings show temperature and moisture vertical profiles as well as give a calculated value of Convective Available Potential Energy (CAPE). The NASA Atmospheric InfraRed Sounder (AIRS) sensor operates on a polar orbiting satellite with sun-synchronous overpass at 1:30a.m. and 1:30p.m.. Retrievals of temperature and moisture from the AIRS data are produced in near-real time. The Automated Surface Observing System (ASOS) is used to measure surface temperature and dewpoint at airports across the U.S.. The SHARPpy GUI (Graphical User Interface) plots points on a map using the latitudes and longitudes present in the locations file (figure 1). Clicking on an ASOS surface station location will bring up the sounding (figure 2) for the closest AIRS sounding profile with the surface temperature and dewpoint from the ASOS observation data. The extension includes a satellite decoder module which allows for remote access to the sounding locations as well as the profile data. This would allow for users to have access to data in near-real time from satellite overpasses. The use of near-real time satellite and surface observations may help assist meteorologists in the nowcasting of severe weather. This will allow for faster, more accurate predictions that could help with issued watches and warnings.

2. WHY COMBINE SATELLITE AND SURFACE DATA?

Satellites are used constantly in weather prediction and observation. However, errors and inaccuracies are commonly overlooked. Satellites orbit the Earth nearly 440 miles from the surface, and though many sensors, like the AIRS sensor on the Aqua satellite, record surface data, the data at the surface is not as accurate as the data gathered higher up in the atmosphere. This can cause errors in calculations, such as the surface Convective Available Potential Energy (CAPE) used in this project. These errors can lead to delays in detecting storms, however, they can be avoided by combining satellite and surface data. As shown in figure 3, the AIRS profile by itself had an initial surface CAPE value of 0 J/Kg (weak instability) while the AIRS profile with the ASOS surface station data (figure 4) had a surface CAPE value of 2707 J/kg (strong instability). This change in calculated surface CAPE could make the difference in detecting severe weather. Satellite data alone doesn’t have the accuracy at the surface level that is needed for a true representation of the instability. Only once the surface parcel begins moving upward in the atmosphere, does the AIRS sensor begin detecting accurately the temperature and dewpoint temperature for each level.

3. SURFACE DATA COVERAGE/MADIS

The ASOS surface data used in this project, shown in figure 5, is part of a large-scale system that gathers and distributes surface data from around the world called the Meteorological Assimilation Data Ingest System (MADIS). This system encompasses surface data from airports, highways, military observations, NOAA research facilities, and more. With the coverage that MADIS provides, there is potential for satellite and surface data around the world to be combined for more accurate predictions and observations. Figures 6, 7 and 8 show that while the United States and a large portion of Europe have ample surface coverage, many other countries and continents have very few surface stations where combining satellite data would be possible. These areas must rely solely on the satellite data they receive for their storm prediction, data that could be inaccurate. Satellite data can only be improved in areas where there is surface data coverage.

4. COMBINING AND DISTRIBUTING THE DATA

The original SHARPpy requires the locations file for each datasource to be present in the hidden .sharppy folder on each user's computer. This limits the usability of SHARPpy based on a user's access to the files and their ability to place them properly. A change to the .xml file (figure 9) was made to point the program to a locations file that is in the same FTP site location as the data profiles. This allows for any user with the AIRS or another custom datasource has access to new profiles and updated locations as soon as they select the source without replacing any files on their computer. Though the .xml still must be placed in the hidden .sharppy folder, it is a one-time placement as opposed to the constant replacement of the locations files. A change to the SHARPpy code is being worked on now so that new datasources appear with the installation of SHARPpy instead of manual placement of the .xml file as is currently done. In combination with the remote locations files, this will make viewing outside datasources easier for users in the future. All they will need to do is download the adapted version from the GitHub page.

4. CONCLUSIONS/FUTURE WORK

As expressed above, this project has shown that while satellite data is very useful for forecasting, it can be deceiving at the surface. However, through the addition of surface data into the satellite profiles, it is possible to correct the inaccuracies at the surface layer. Utilizing the MADIS surface data has the potential to extend the coverage of surface data to most of the United States and much of western Europe, as well as other areas shown in the MADIS coverage figure.

With SHARPpy, the adaptation with the .xml file for remote locations files allows for more ease of use with the current program. However, the proposed plan of making the .xml file remote as well will take the project one step further.

Both continuations have the potential to improve upon the adaptations made in this project to make the results as well as the methods more accurate and accessible for its users. We hope that they can be utilized in the upcoming 2017 storm season.

Acknowledgements:

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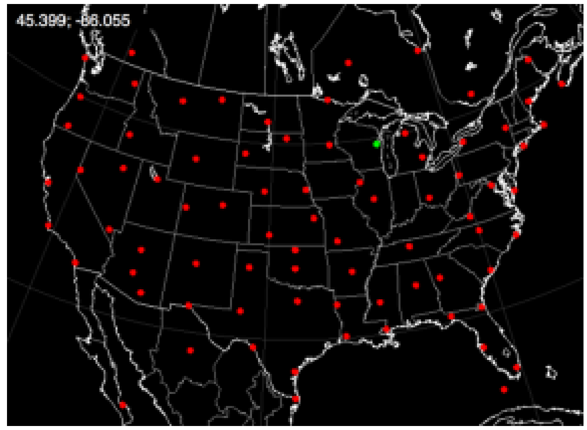
References:

Halbert, K. T., W. G. Blumberg, and P. T. Marsh, 2015: "SHARPpy: Fueling the Python Cult"

Jessica Gartzke, B.A.; Robert Knuteson; Grace Przybyl; Steve Ackerman; Henry Revercomb: "COMPARISON OF SATELLITE, MODEL, AND RADIOSONDE DERIVED CONVECTIVE AVAILABLE CONVECTIVE ENERGY (CAPE) IN THE SOUTHERN GREAT PLAINS REGION" has been submitted to Journal of Applied Meteorology and Climatology.

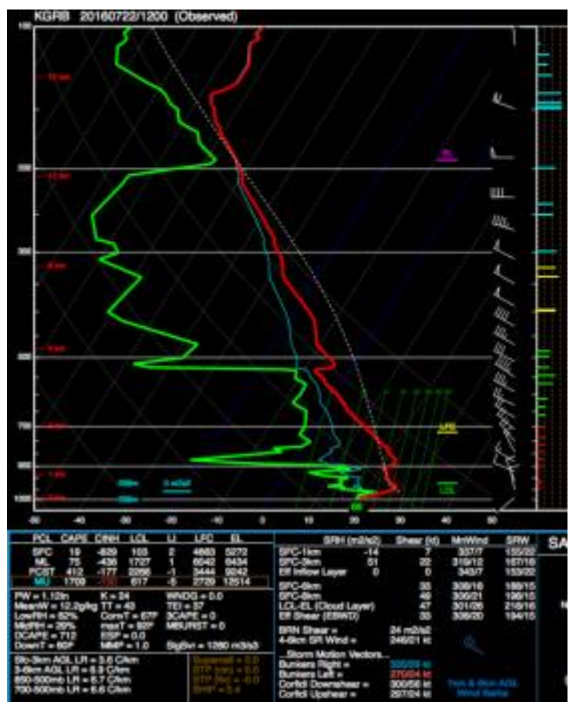
Figures:

Figure 1



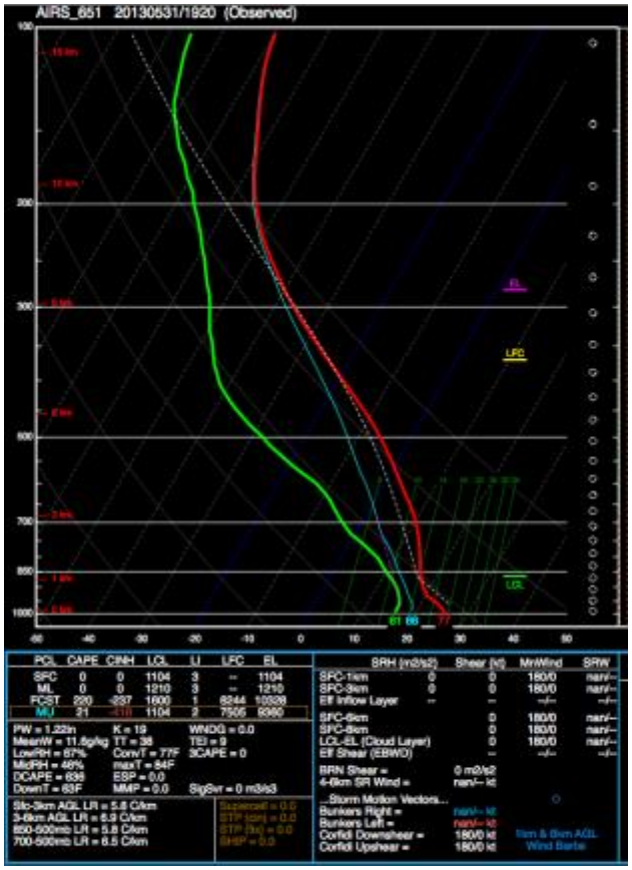
This figure shows the SHARPpy Observed datasource. The red dots are the plotted points that represent a sounding.

Figure 2



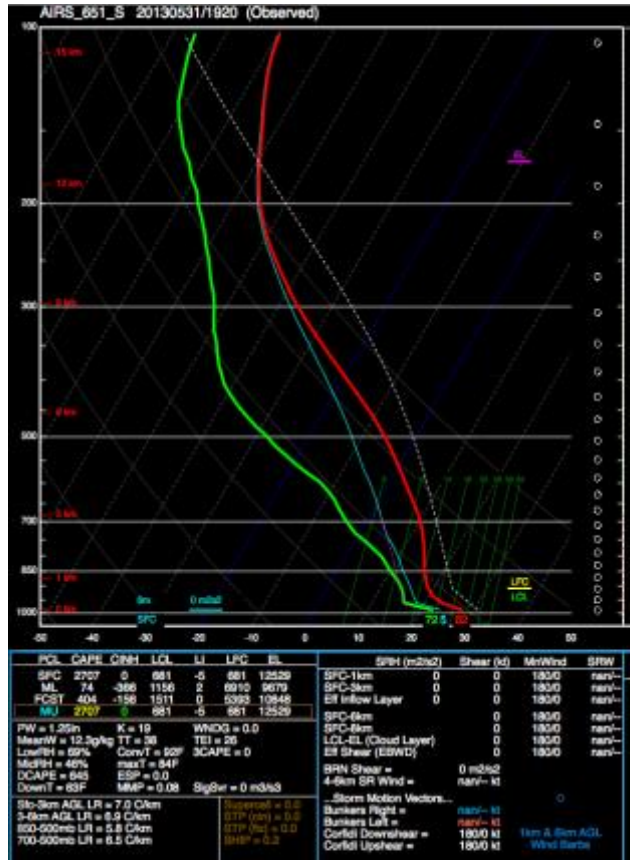
This figure shows a sounding from May 22, 2016 that was observed from the station KGRB. This is the type of temperature/moisture profile that the SHARPpy GUI creates when a profile is selected.

Figure 3



AIRS profile 651, located in southeastern Louisiana, displayed in SHARPpy as a temperature and moisture profile with calculated convective indices. Surface CAPE is 0 J/Kg.

Figure 4



AIRS profile 651 with surface temperature and dewpoint substituted from surface station KBTR of ASOS. Also in a temperature and moisture profile with calculated convective indices. Surface CAPE is 2707 J/Kg, an increase from weak instability to strong instability from figure 6.

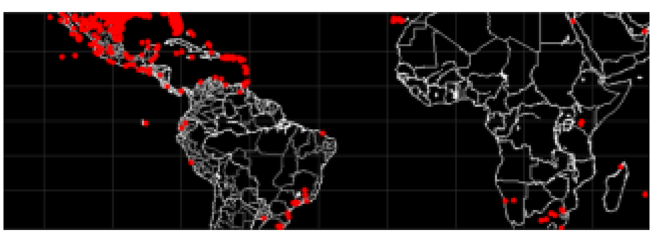
Figure 5

This figure is the ASOS coverage over the United States east of the Rocky Mountains.

Figure 6

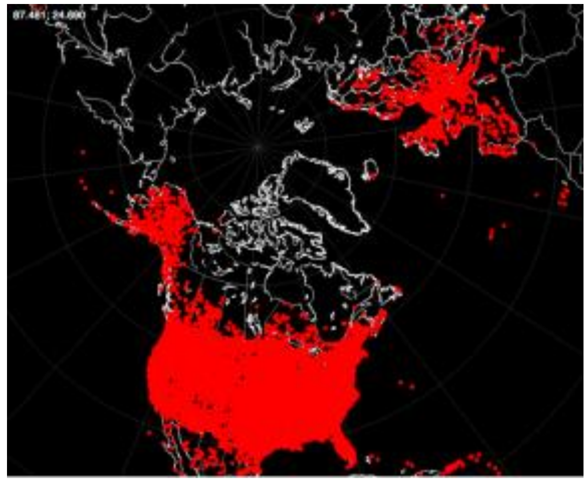
This figure shows MADIS coverage over the United states and into Canada and Mexico.

Figure 7



This figure shows MADIS coverage over the tropics, focused mainly on Latin American, South America and parts of Africa.

Figure 8



This figure shows MADIS coverage in western Europe and Alaska.

Figure 9

```
<?xml version="1.0" encoding="UTF-8" standalone="no" ?>
<sourcelist>
    <datasource name="AIRS" ensemble="false" observed="true">
        <outlet name="AIRS" url="ftp://ftp.ssec.wisc.edu/pub/ssec/graceg/AIRS/{srcid}.csv" format="spc" >
            <time range="0" delta="0" offset="0" delay="1" cycle="1" archive="24"/>
            <points csv="AIRS_locations.txt" />
        </outlet>
    </datasource>
</sourcelist>
```

```
<?xml version="1.0" encoding="UTF-8" standalone="no" ?>
<sourcelist>
    <datasource name="SURFACE" ensemble="false" observed="true">
    <outlet name="SURFACE" url="ftp://ftp.ssec.wisc.edu/pub/ssec/graceg/MADIS/{srcid}.csv" format="spc" >
            <time range="0" delta="0" offset="0" delay="1" cycle="24" archive="24"/>
            <points url="ftp://ftp.ssec.wisc.edu/pub/ssec/graceg/MADIS/MADIS_locations.txt" />
        </outlet>
    </datasource>
</sourcelist>
```

The top figure is the original .xml file for the AIRS datasource. Note the <points csv="AIRS_locations.txt"> line which indicates the locations file that is in the hidden .sharppy file on each user's computer.

The bottom figure is the revised .xml file that was used to display the AIRS with ASOS data (datasource called SURFACE). It points to the FTP site where the profiles are located instead of a folder on the user's computer.