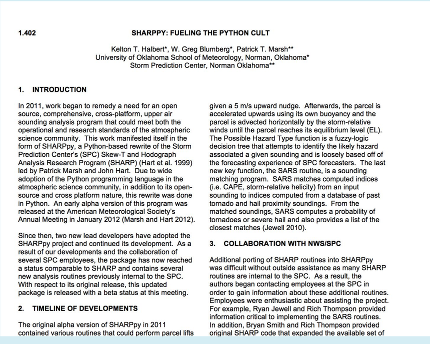
An Extension of the Python SHARPpy GUI to Display NASA AIRS Satellite Sounding Profiles and CAPE in Near-Real Time

Grace Przybyl, Callyn Bloch, Jessica Gartzke, Matthew Westphall, and Robert Knuteson
University of Wisconsin-Madison, Space Science and Engineering Center

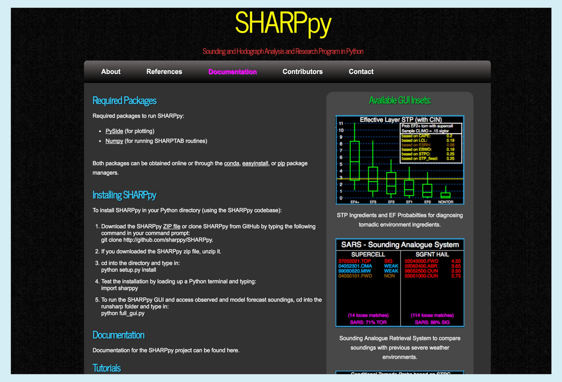
Abstract

SHARPpy is a collection of Python libraries created by Greg Blumberg and Kelton Halbert at the Uni. of Oklahoma that displays data in a sounding format used by the 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 display shows temperature and moisture vertical profiles as well as give a calculated value of CAPE (Convective Available Potential Energy) and other convective indices. The NASA AIRS (Atmospheric InfraRed Sounder) sensor operates on a polar orbiting satellite with sun-synchronous overpass at about 1:30 am and 1:30 pm. Retrievals of temperature and moisture from the AIRS data are produced in near-real time. The SHARPpy GUI (Graphical User Interface) plots points on a map using the latitudes and longitudes present in the locations file. The software extension to SHARPpy described here allows clicking on satellite field of view will bring up the AIRS sounding at that location. A further extension under development is the inclusion of ASOS station data in the locations list. The use of near-real time ASOS and AIRS data will help assist meteorologists in the nowcasting of severe weather with timely and accurate CAPE estimates.

Existing SHARPpy

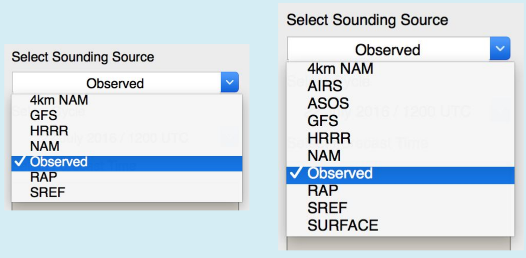


The current SHARPpy was created by Kelton Halbert and Greg Blumberg. It produces vertical temperature and moisture profiles as well as displays the calculated CAPE values from data in a sounding format that was created by NWS storm prediction center (SPC). The link for the SHARPpy GitHub page is here: https://github.com/sharppy/SHARPpy

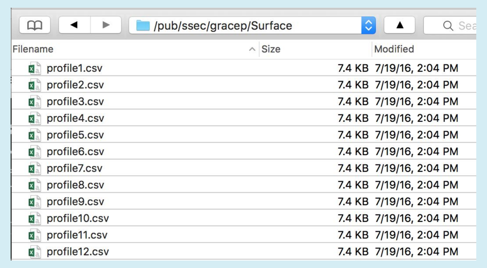


Extension of SHARPpy for use of Satellite and Surface Data

In order to display non-NWS data (e.g. AIRS satellite data) in SHARPpy, new .xml file and locations files were needed. The .xml file points SHARPpy to the locations file which gives the name, latitude, longitude, as well as the corresponding filename for each profile. Profiles are located on a remote FTP site. The .xml file points SHARPpy to the specific site URL. The .xml file was created by simply copying the standard.xml that comes with SHARPpy and modifying. The locations file was created using a python script that reads in all of the AIRS profiles, extracts the lat., lon. and name and creates a string for each profile. The strings are then printed to the locations file. Both the .xml and locations files must currently be placed in a hidden folder required by the SHARPpy software. SHARPpy reads these files and in the GUI, the drop down menu shows extended options for picking the AIRS satellite data alone, the ASOS surface data locations, and edited AIRS profiles that contain the surface temperature and dewpoint temperature from the nearest ASOS station in the first line of data.

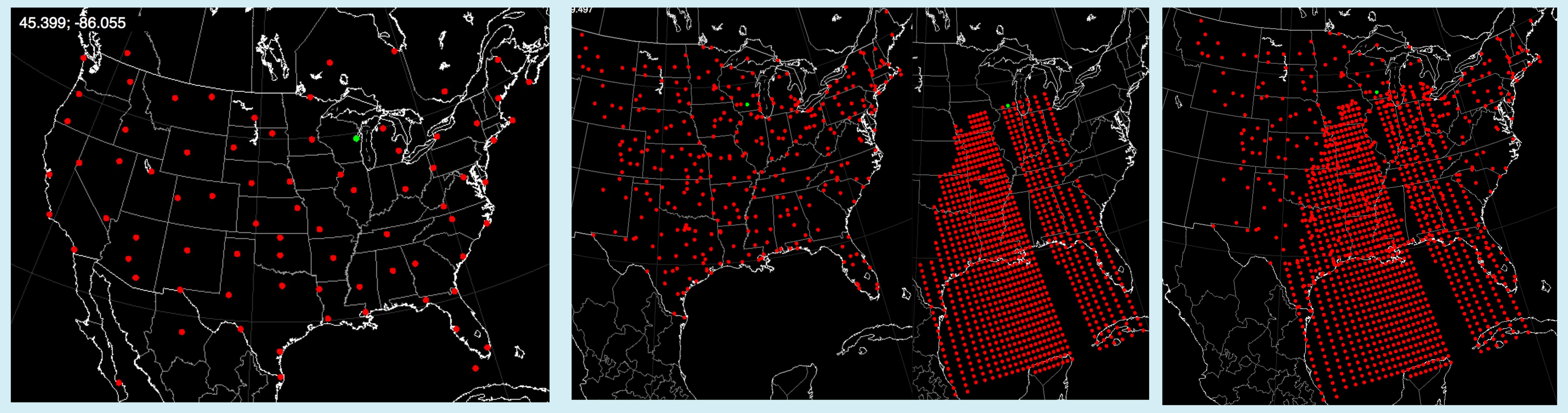


The original drop down menu (left) and the new drop down menu (right). The new selection options, AIRS, ASOS, and SURFACE display the AIRS satellite data, the locations of the ASOS surface stations and paired ASOS stations with the edited AIRS profiles, respectively.



An example of the AIRS profiles located on the remote server in the Surface folder.

The standard radiosonde launch locations under the SHARPpy Observed data source are shown in the left panel. The center panel shows the ASOS surface stations and an example AIRS satellite overpass. The right panel shows an overlay of the ASOS station locations and the coincident AIRS soundings.



The surface.xml file (bottom) points to AIRS_Surface_locations.txt (top) in order for SHARPpy to plot the points in the GUI as seen to the left. The corresponding filenames SHARPpy looks for on the remote server are at the end of each row.

```
icao,iata,synop,name,state,country,lat,lon,elev,priority,srcid
AIRS_1,AIRS,,AIRS,,US,19.5149, -96.4443,229,3,profile1
AIRS_10,AIRS,,AIRS,,US,23.7762, -97.7166,229,3,profile10
AIRS_100,AIRS,,AIRS,,US,24.1523, -95.8424,229,3,profile100
AIRS_101,AIRS,,AIRS,,US,24.6277, -95.9842,229,3,profile101
AIRS_102,AIRS,,AIRS,,US,25.1028, -96.1272,229,3,profile102
AIRS_103,AIRS,,AIRS,,US,25.5779, -96.2715,229,3,profile103
AIRS_104,AIRS,,AIRS,,US,26.0528, -96.4172,229,3,profile104
AIRS_105,AIRS,,AIRS,,US,26.5273, -96.5642,229,3,profile105
AIRS_1055,AIRS,,AIRS,,US,30.6156, -86.8405,229,3,profile1055
AIRS_1055_S,AIRS,,AIRS,,US,30.6156, -86.9405,229,3,profile1055_S
AIRS_1056,AIRS,,AIRS,,US,31.0979, -86.9501,229,3,profile1056
AIRS_1057,AIRS,,AIRS,,US,31.5805, -87.0570,229,3,profile1057
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AIRS_1059,AIRS,,AIRS,,US,32.5454, -87.2723,229,3,profile1059
AIRS_106,AIRS,,AIRS,,US,27.0016, -96.7127,229,3,profile106
AIRS_1060,AIRS,,AIRS,,US,33.0279, -87.3807,229,3,profile1060
AIRS_1061,AIRS,,AIRS,,US,33.5101, -87.4896,229,3,profile1061
AIRS_1062,AIRS,,AIRS,,US,33.9925, -87.5990,229,3,profile1062
AIRS_1063,AIRS,,AIRS,,US,34.4747, -87.7090,229,3,profile1063
AIRS_1063_S,AIRS,,AIRS,,US,34.4747, -87.8090,229,3,profile1063_S
251.0-5.5-4.5-KASX,ASOS,,ASOS,,US,43.2,-90.7,251,3,ASOS
202.0-24.7-14.9-KOVS,ASOS,,ASOS,,US,44.9,-91.5,202,3,ASOS
276.0-20.0-12.7-KEAU,ASOS,,ASOS,,US,43.8,-88.5,276,3,ASOS
240.0-22.8-14.3-KFLD,ASOS,,ASOS,,US,42.6,-87.9,240,3,ASOS
219.0-26.0-13.6-KENW,ASOS,,ASOS,,US,43.9,-91.3,219,3,ASOS
199.0-22.3-15.2-KLSE,ASOS,,ASOS,,US,43.2,-90.2,199,3,ASOS
217.0-21.4-16.5-KLNR,ASOS,,ASOS,,US,43.1,-89.4,217,3,ASOS
261.0-21.8-14.9-KMSN,ASOS,,ASOS,,US,44.6,-90.2,261,3,ASOS
```
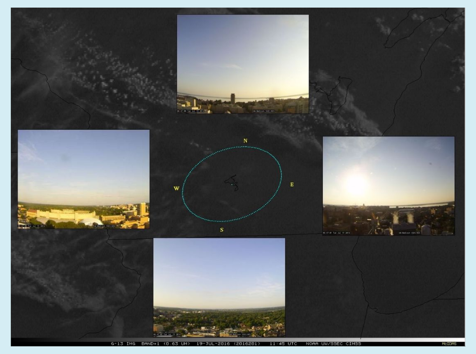
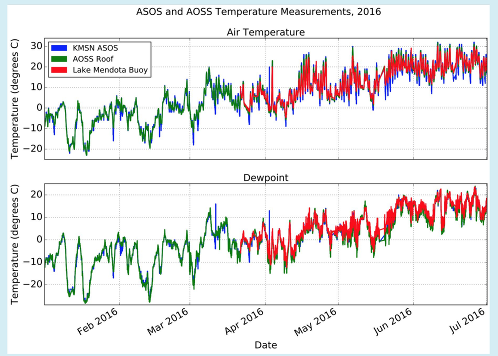
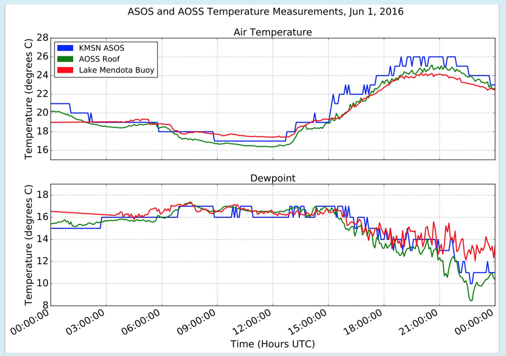

```xml
<?xml version="1.0" encoding="UTF-8" standalone="no" ?>
<sourcelist>
    <datasource name="SURFACE" ensemble="true" observed="false">
    <outlet name="SURFACE" url="ftp://ftp.ssec.wisc.edu/pub/ssec/gracep/test/{srcid}.csv" format="spc" >
            <time range="0" delta="0" offset="0" delay="1"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

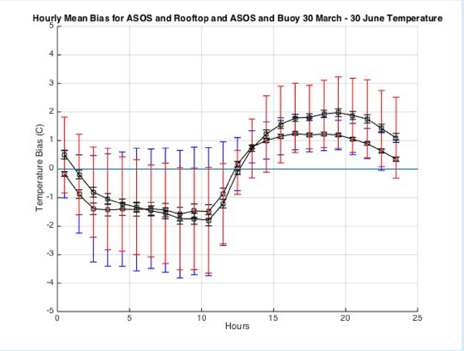
Madison Airport ASOS Station (KMSN) Validation Using SSEC Rooftop and Lake Mendota Buoy

The temperature and dewpoint measurements from the ASOS station at the Dane County Airport were compared to the SSEC rooftop measurements and the Lake Mendota Buoy measurements for 2016 to test the accuracy of ASOS data. The hourly Mean Bias and Standard deviation for the differences in the temperature and the dewpoint were calculated for the ASOS station and Rooftop (Blue) and the ASOS station and the Buoy (Red) between March 30, 2016 and June 30, 2016. On average, during the day, the ASOS temperatures get slightly warmer than both the buoy temperatures and rooftop temperatures most likely due to daytime heating, but at night, ASOS temperatures are slightly cooler than the other two locations.



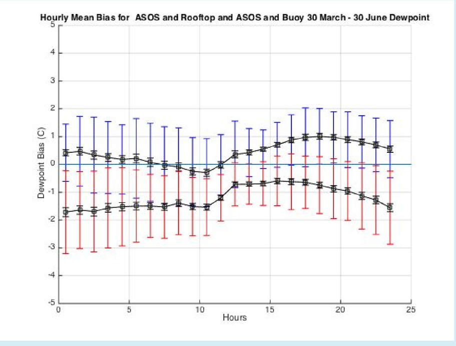






ASOS minus Rooftop

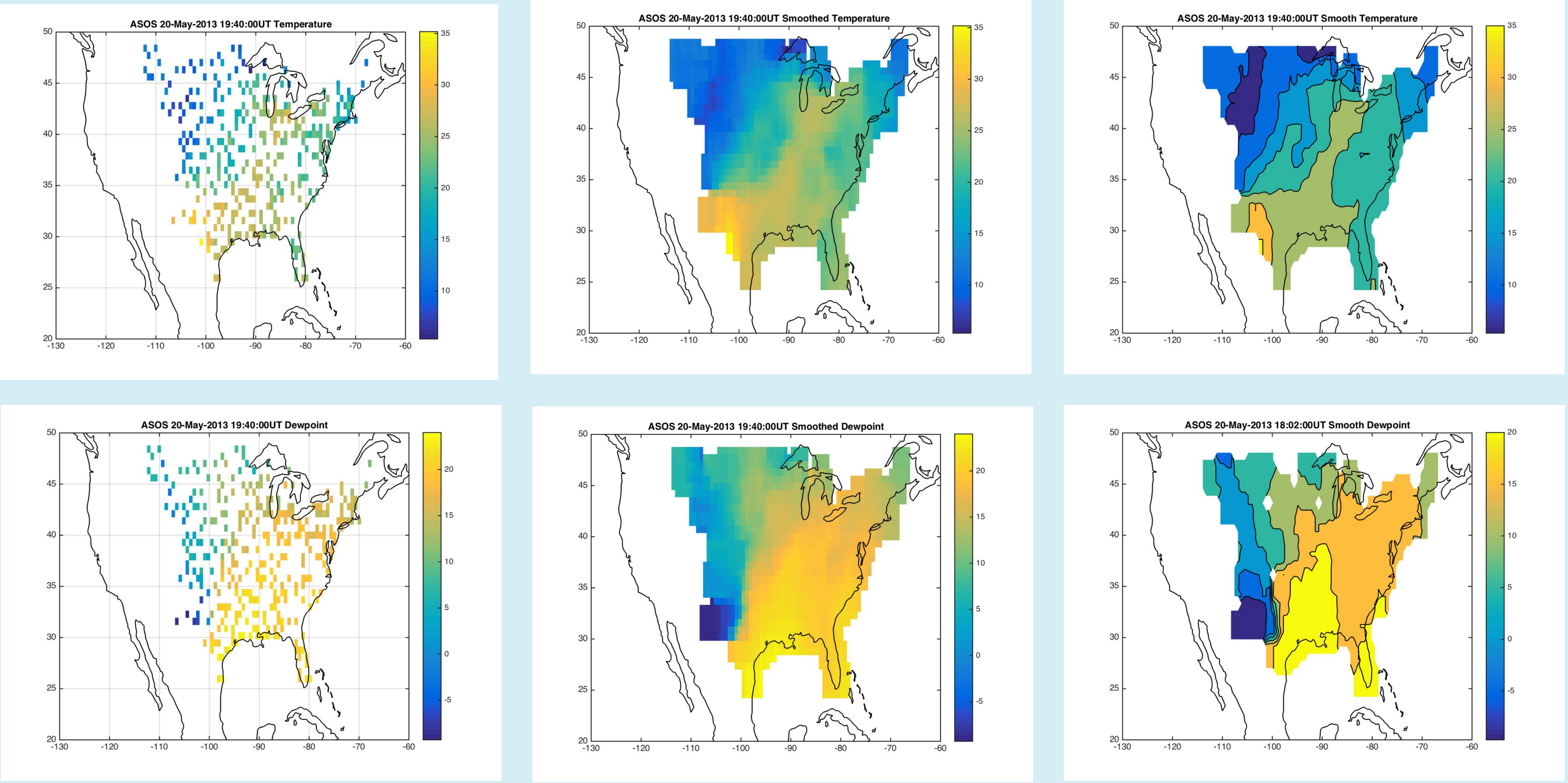
ASOS minus Buoy



Automated Surface Observing Systems (ASOS) Case Study: May 20, 2013 19:40 UT

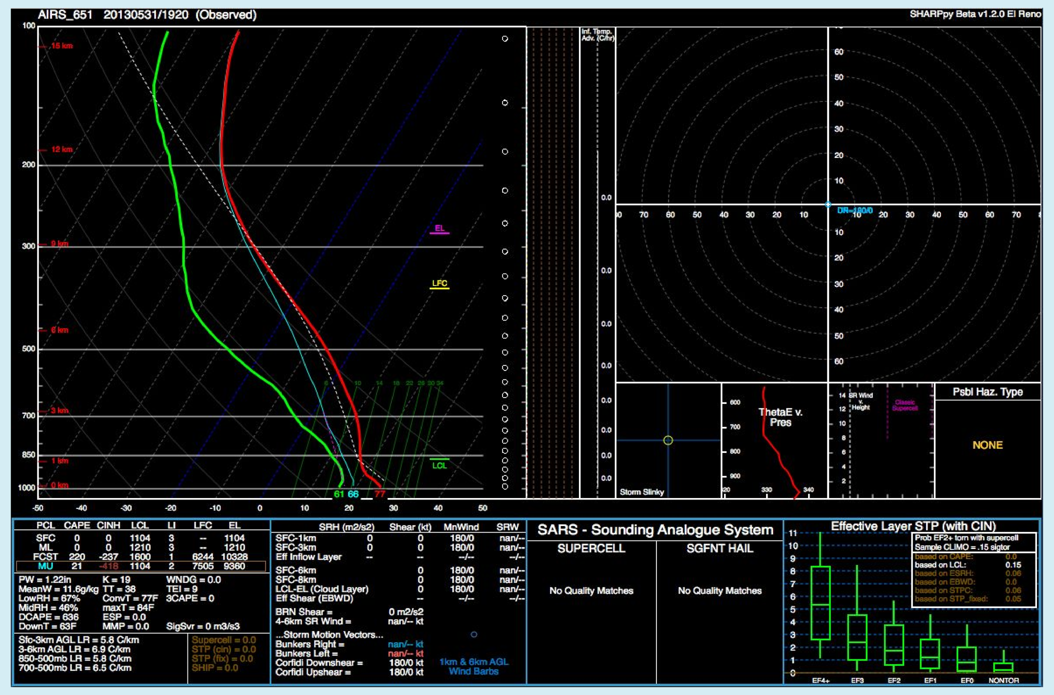
Temperature:
-Station Locations
-Lat/Lon Smoothed
-Contour Map

Dewpoint:
-Station Locations
-Lat/Lon Smoothed
-Contour Map

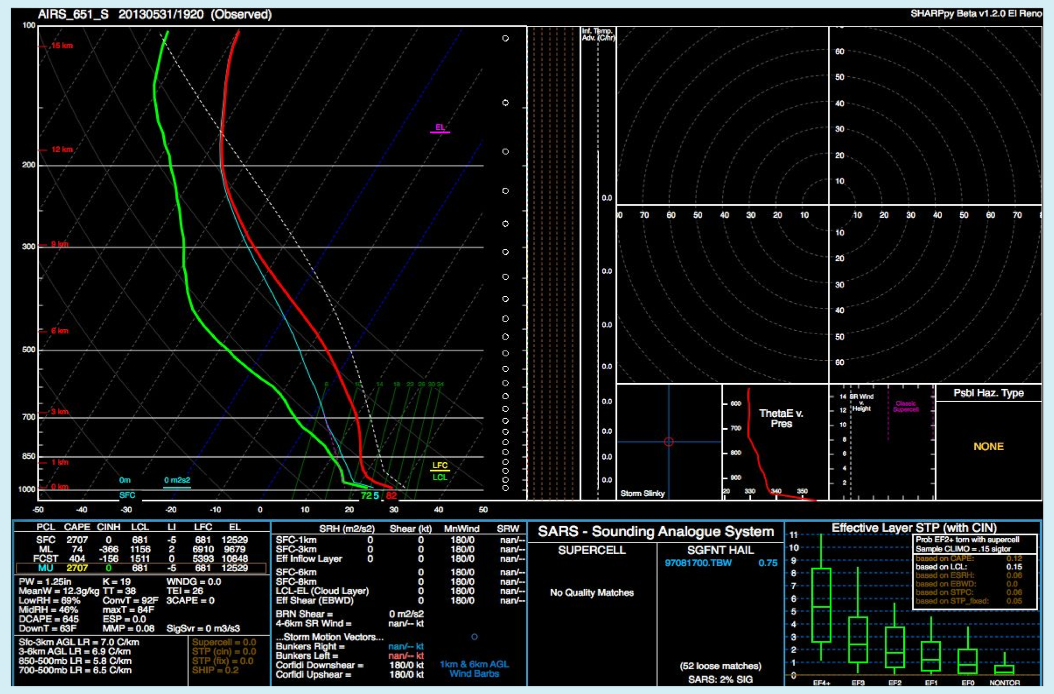


Results

Replacing the temperature and dewpoint in the first line of data in AIRS profiles closest to ASOS surface stations with the temperature and dewpoint from those stations yielded changes in the look of the profiles produced by the SHARPpy GUI as well as in the calculated CAPE (Convective Available Potential Energy) as shown below. The surface CAPE value in the case below increased from 0 J/Kg to 2707 J/Kg. The surface CAPE value in the case stated increased from 0 J/Kg to 2707 J/Kg. That is a change from weak instability (0 to 1000 J/Kg) to strong instability (2500 to 4000 J/Kg). This indicates that while the AIRS satellite gathers accurate data higher up in the atmosphere, it's estimate of the surface temperature and dewpoint is not completely accurate and is benefitted by the implementation of the ASOS surface station data.

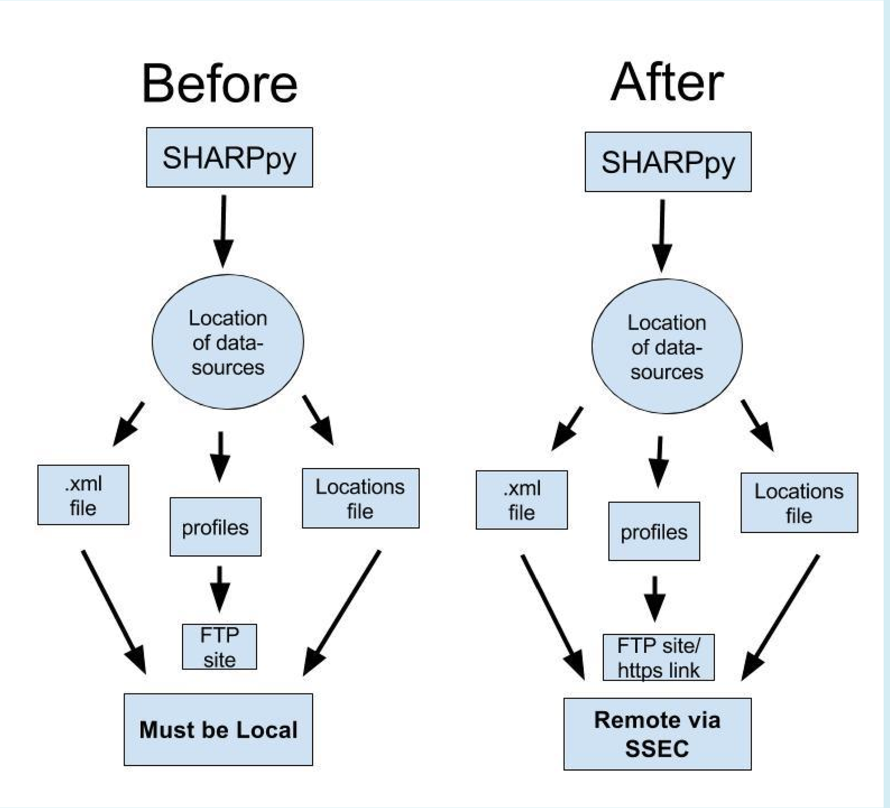


The original AIRS profile 651 (left), and the edited AIRS profile 651 (right). The temperature and dewpoint in the edited profile were taken from ASOS station KBTR, located in the southeastern portion of Louisiana.



Conclusions and Future work

- Currently, the .xml file and locations files must be placed into a hidden folder on the user's computer. This puts a limit on how effective SHARPpy is for displaying satellite data in near-real time due to the need for the user to download and replace the existing locations file each time they want new data. Continued work will allow for all necessary components be accessible remotely via SSEC. This will allow for SHARPpy to be utilized more for displaying satellite data.
- By creating a new .xml file and locations file, satellite data can be easily displayed in the SHARPpy GUI. This could be automated in the future to provide near-real time data to the user. See diagram (right).
- The NASA AIRS satellite data can be improved upon by using ASOS surface station temperature and dewpoint. The ASOS data allows for more accurate calculations of CAPE and temperature and moisture profiles.



Acknowledgements

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