Near-real time CAPE Combining Hyperspectral IR Satellite Sounding and Surface Met Stations

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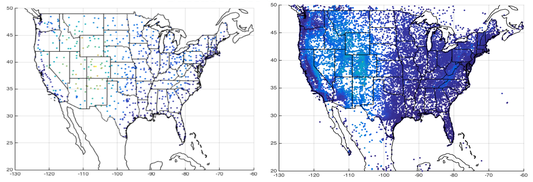
Introduction and Data

- Satellite data can provide spatial and temporal coverage between NWS radiosonde launch sites
- The Convective Available Potential Energy (CAPE): a measure of atmospheric instability, computed from vertical profiles of temperature and water vapor.
- Satellite estimates of the surface parcel introduce large uncertainties in satellite CAPE estimates (Gartzke et al. 2017)
- Satellite soundings struggle in the lower tropospheric region due to the increased opacity of the atmosphere.
  - Particularly true over land areas where uncertainties in surface emissivity penalize accuracy of temperature and dewpoint temperature retrieval
- Combined surface station data and satellite sounding product creates accurate near-real time estimate of SBCAPE.
  - Product will be compared to the operational NUCAPS-derived SBCAPE for validation
  - Will serve as a baseline for evaluation of future improvements in NUCAPS retrieval system to better serve real-time user applications over the CONUS region.

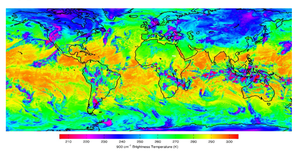
Surface Met Observations



ASOS Station Map **MADIS Station Map**

- ASOS (Automated Surface Observing System) station locations
  - Mostly located at U.S. airports.
- NOAA MADIS (Meteorological Assimilation Data Ingest System) station locations in right figure
  - Include ASOS stations as well as many others

Satellite Hyperspectral IR



- The Joint Polar Satellite System (JPSS) is the Nation's new generation polar-orbiting operational environmental satellite system.
- NUCAPS data from JPSS is used in this study.

CAPE Calculations using SHARPpy

- Satellite and Surface observations processed by the same method to allow them to be merged.
  - The spatial gradients are similar in the surface and satellite dewpoint fields.
- The CAPE calculations are made using the python libraries contained in the SHARPpy code distribution (Blumberg et al. 2017, BAMS).

References and Contact

- Gartzke, Jessica, et al. "Comparison of Satellite, Model, and radiosonde Derived convective Available Potential Energy (CAPE) in the southern great plains region." *Journal of Applied Meteorology and Climatology 2017* (2017).
- Nalli, N. R., A. Gambacorta, Q. Liu, C. D. Barnet, C. Tan, F. Iturbide-Sanchez, T. Reale, B. Sun, M. Wilson, L. Borg, and V. R. Morris, 2018: Validation of atmospheric profile retrievals from the SNPP NOAA-Unique Combined Atmospheric Processing System. Part 1: Temperature and moisture, IEEE Trans. Geosci. Remote Sens., 56(1), 180-190, doi:10.1109/TGRS.2017.2744558.
- Gambacorta, G., C. Barnet, and M. Goldberg, 2015: Status of the NOAA Unique CrIS/ATMS Processing System (NUCAPS): Algorithm development and lessons learned from recent field campaigns, in Proc. ITSC, Lake Geneva, WI, USA.
- Blumberg, W. G., Halbert, K. T., Supinie, T. A., Marsh, P. T., Thompson, R. L., & Hart, J. A. (2017). SHARPpy: an open source sounding analysis toolkit for the atmospheric sciences. *Bulletin of the American Meteorological Society*, (2017).

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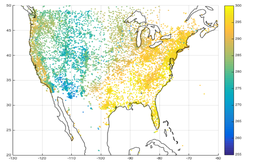
Methodology

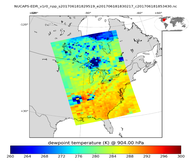
- Surface Met Observations are obtained hourly from the NOAA MADIS site https://madis.ncep.noaa.gov/.
- NUCAPS overpass retrieval files are copied from SSEC direct broadcast site ftp://ftp.ssec.wisc.edu/pub/eosdb/npp/cris/

Surface Met Observations

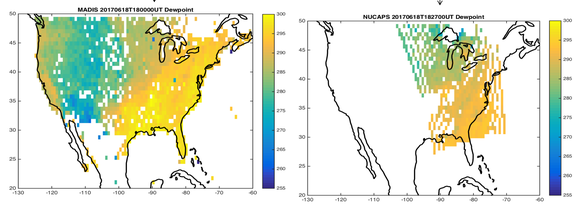


Extract hourly station averages

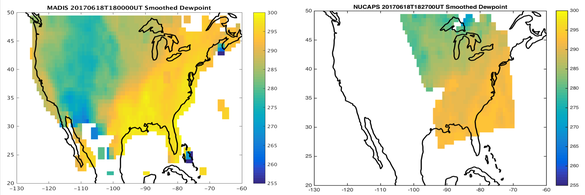
Satellite Surface Estimate



Extract near surface dewpoint

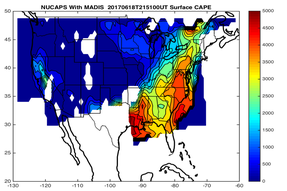


Both surface obs and satellite obs are averaged to a 0.7x0.7 degree grid. This is an example of the gridded dewpoint surface observations and satellite surface estimate for 18 June 2017.



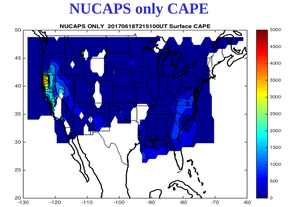
Both the surface met observations and satellite surface estimates are smoothed by a 2-dimensional 3x3 boxcar convolution. This is the same gridded data on 18 June 2017 after spatially smoothing.

MADIS CAPE with NUCAPS



SBCAPE using MADIS surface data combined with NUCAPS data for the daytime overpass on 18 June 2017

NUCAPS only CAPE



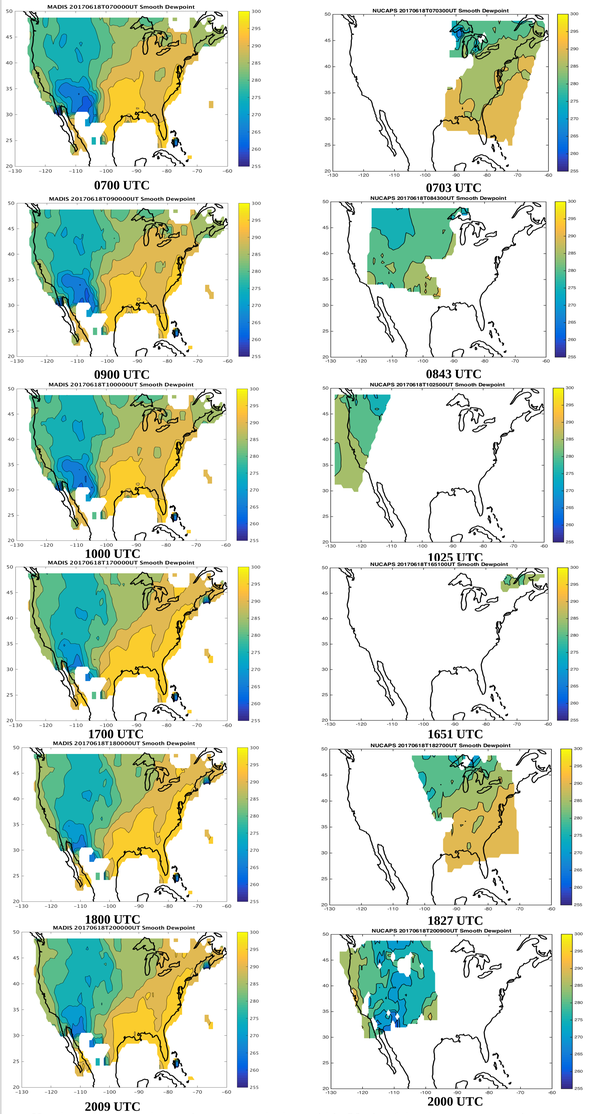
SBCAPE for NUCAPS only for daytime overpass on 18 June 2017.

- The MADIS data was substituted for the NUCAPS surface and then run through SHARPpy to complete the profile and calculate the different parameters including CAPE
- SBCAPE dramatically increased on the East Coast where storms were developing.

Direct Broadcast

NOAA Unique CrIS/ATMS Processing System (NUCAPS) EDR software for retrieval of atmospheric profiles from input Suomi-NPP CrIS and ATMS SDRs.

- Software to process the data is available from the Community Satellite Processing Package (CSPP) available from SSEC at http://cimss.ssec.wisc.edu/cspp



- Hourly surface met observations are matched up within 30min of the closest overpass time.
  - Example of ascending and descending orbits from S-NPP on 18 June 2017 and MADIS surface observations

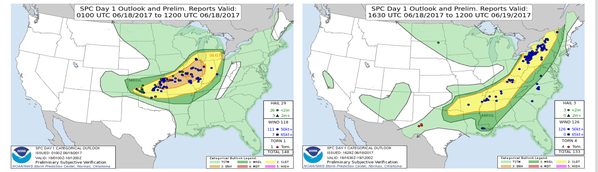
Near-Real Time CAPE

Merging Surface and IR Satellite Profile Data

With the combined surface met observations and the satellite profiles, the CAPE calculation is updated in near-real time to aid in severe weather prediction, similar to the convective outlook polygon maps produced by the Storm Prediction Center (SPC).

SPC Convective Outlook and Storm Reports 18 June 2017

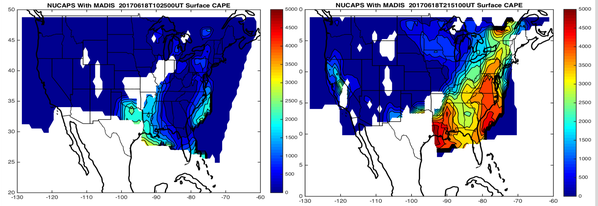
Nighttime Reports **Daytime Reports**



SPC Convective outlook for 18 June 2017 at 0100 UTC (Left) and at 1630 UTC (Right) including storm reports for the valid time.

Combined Surface and Satellite CAPE 18 June 2017

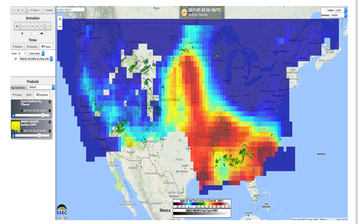
1:30AM Descending Orbit **1:30PM Ascending Orbit**



- The nighttime overpass occurred after the reported storms.
- The daytime overpass occured over the East Coast just before the storms began
  - Shows high values of CAPE in the area.
  - Area matches up well with the SPC convective outlook and storm reports for this time.

SSEC RealEarth™

- RealEarth™: currently being used to display the near-real time SBCAPE calculated product,
  - User friendly, easy to use.
- Example of the combined SBCAPE product that updates in near-real time after the satellite overpass
  - Available on the website and RealEarth™ app.
  - The NUCAPS-MADIS SBCAPE product is displayed under the 'JPSS - NUCAPS' tab https://realearth.ssec.wisc.edu/



Conclusions

- Accurate measurements of temperature and dewpoint at the surface are necessary for calculating an accurate SBCAPE value, which can help in forecasting of severe weather.
- The use of NUCAPS satellite profile data combined with NOAA MADIS surface observations improves the SBCAPE estimates and helps fill in temporal gaps in between radiosonde launches.
- Combined NUCAPS-MADIS SBCAPE product will help validate operational NUCAPS-derived SBCAPE and help evaluate future improvements in the NUCAPS retrieval system.