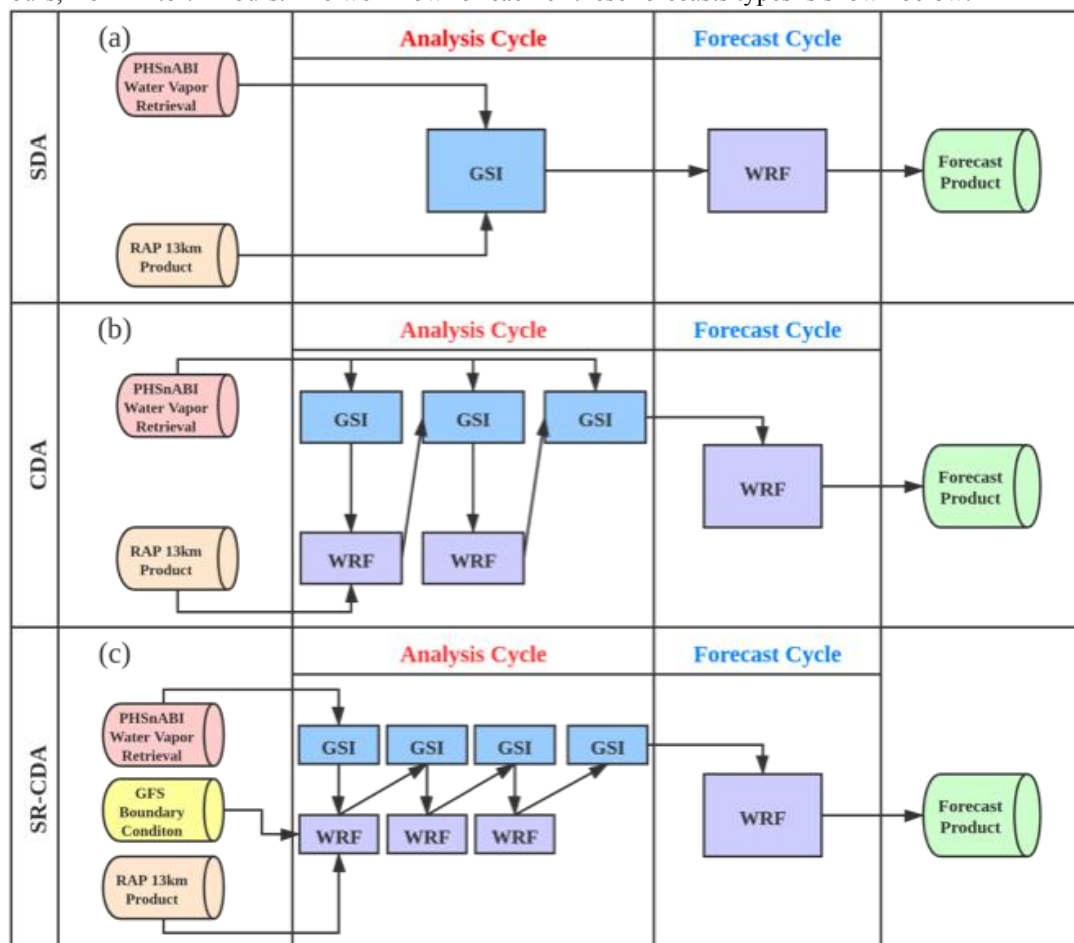


Introduction to the PHSnABI Forecast Website

William L. Smith Sr. and Qi Zhang

HU-SWRC/UW-SSEC Forecast Products

The City of Hampton Virginia and the NOAA JPSS Proving Ground and Risk Reduction (PGRR) Program provide support to the Hampton University Severe Weather Research Center (HU-SWRC) and the University of Wisconsin Space Science and Engineering Center (UW-SSEC), respectively, for a joint project to provide experimental forecast products based on the assimilation of high-resolution Direct Broadcast System (DBS) polar and geostationary satellite vertical profile data. The purpose of the web-site described here is to make these satellite data and forecast products available for their validation by the US National Weather Service (NWS) and the meteorological research community as needed before their production and use by the NWS on an operational basis for warning the US population of impending High Impact Weather (e.g., tornados, hail, flash floods, tropical storms, and hurricanes). Three different forecast systems are described here: (a) Single Data Assimilation (SDA) hourly initialization, which provides hourly interval forecasts from 1- to 12-hours, (b) Continuous Data Assimilation (CDA) of three, hourly interval satellite data sets, which provides hourly interval forecasts from 1- to 12-hours, and (c) Short Range - Continuous Data Assimilation (SR-CDA) assimilation of three, hourly interval, satellite data sets, which provides hourly interval forecasts, initialized every six hours, from 1- to 72-hours. The workflow for each of these forecasts types is shown below.



Schematic showing the three types of forecasts being produced from the assimilation of PHSnABI sounding data: (a) Single Data Assimilation (SDA) hourly initialization, which provides hourly interval forecasts from 1- to 12-hours, (b) Continuous Data Assimilation (CDA) of three, hourly interval satellite data sets, which provides hourly interval forecasts from 1- to 12-hours, and (c) Short Range - Continuous Data Assimilation (SR-CDA) assimilation of three, hourly interval, satellite data sets, which provides hourly interval forecasts, initialized every six hours, from 1- to 72-hours.

(1) **Single Data Assimilation (SDA):** Products are based on assimilating combined Polar Hyper-spectral Sounding and Advanced Baseline Imager (PHSnABI) water vapor profiles into GSI-WRF based Numerical Weather Prediction (NWP) system at the initial time of the forecast cycle. A 12-hour lead time forecasts product with temporal resolution of 1 hour is generated (Figure 1a).

(2) **Continuous Data Assimilation (CDA):** Products are based on assimilating combined Polar Hyper-spectral Sounding and Advanced Baseline Imager (PHSnABI) water vapor retrieval into GSI-WRF based Numerical Weather Prediction (NWP) system in a continuous fashion by performing a 2-hour analysis cycle followed by the forecast cycle. The purpose of 2-hour analysis cycle is to spin-up the model dynamic and thermodynamic background variables (i.e., wind, temperature, and moisture by assimilating three 1-hour interval PHSnABI water vapor retrieval profile data sets over a 2-hour period for initializing the forecast cycle. This spin-up is intended to provide a more accurate initial condition for the 12-hour forecast than that used for the SDA 12-hour forecast. The forecast cycle for the CDA and SDA are the same (Figure 1b).

(3) **Short-range Continuous Data Assimilation (SR-CDA):** A Short-Range Continuous Data Assimilation (SR-CDA) system is produced by adding another data assimilation step in the CDA analysis cycle and replacing the RAP-derived lateral boundary condition with the GFS-based lateral boundary condition. The SR-CDA system is initialized at six-hour intervals (i.e., 00:00, 06:00, 12:00, 18:00 UTC) to provide atmospheric state forecasts out to 72-hours, at hourly intervals. This system provides forecasts of hurricane track, intensity, and landfall time and position for the U.S. Eastern and Gulf of Mexico coastal regions. (Figure 1c).

These forecasts are produced on a 24/7 basis from hourly interval vertical sounding data produced in near real-time for a large portion of the continental US, which is shown at: http://cas.hamptonu.edu/~adinorscia/ABInPHS_plots/TotalDomain-UW/. Tropical storm and hurricane forecasts are also produced for a region covering the South Central and Eastern USA and the tropical Gulf of Mexico as well as the Western Atlantic Ocean region, which is shown at: http://cas.hamptonu.edu/~adinorscia/ABInPHS_plots/TotalDomain-HU/. A separate user's guide will soon be provided for users of the tropical storm and hurricane domain forecasts.

Reference: Smith, W. L., Q. Zhang, M. Shao, and E. Weisz, 2020: Improved Severe Weather Forecasts Using LEO and GEO Satellite Sounding. J. Atmos. Oceanic Technol., doi: <https://doi.org/10.1175/JTECH-D-19-0158.1>.

Website Structure:

Main Page: <http://cas.hamptonu.edu/~qi.zhang/home/mainpage.html>

The main page contains a brief introduction of the Numerical Weather Prediction (NWP) system and the PHSnABI temperature and water vapor retrieval system, for the participants and funding agencies who are involved with this project.

Under the title of the main page, you will see a menu which contains 6 elements listed below:

1. Nowcast

Nowcast web page has the function of showing the Significant Tornado Parameter (STP), Most Unstable CAPE (MUCAPE), Lifted Index (LI) calculated from the initial condition, which is used by NWP system to generate the forecasts.

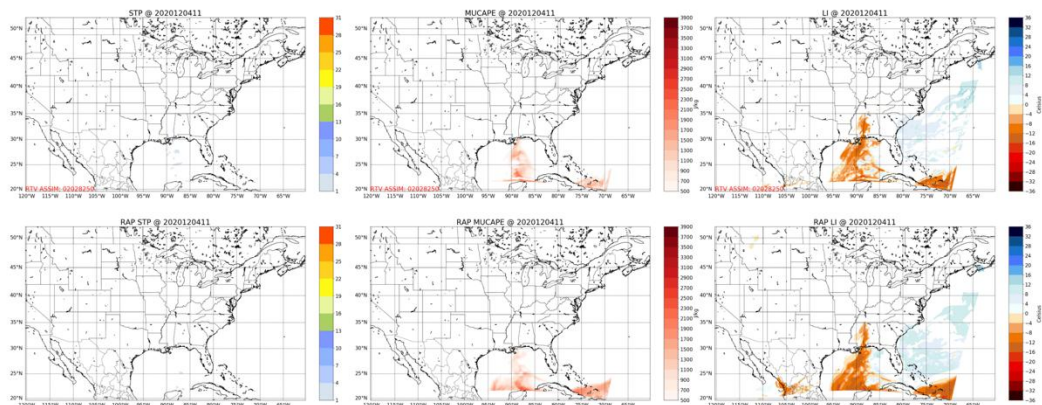
On the web page, you can see two selection panels: "System Type" (that has two choices: "Continuous Data Assimilation", "Single Data Assimilation") and "Forecast Initial Time" (that has six choices, varies from latest forecast initialization Coordinated Universal Time (UTC) to a 6-hour earlier UTC). With these two selection options, you can choose the time for the "Nowcast" (i.e., forecast initialization time), which you want to view. Note that you should always choose the "System Type" first and then choose the "Forecast Initial Time". After all the parameters are set up, the results on the website will like this:

System Type

Continuous Data Assimilation ▾

Forecast Initial Time

2020-12-04 11:00:00 UTC ▾

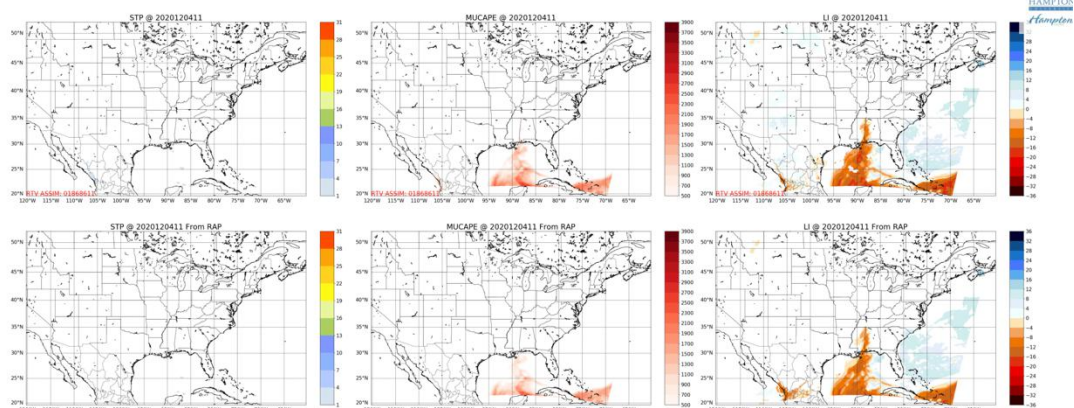


System Type

Single Data Assimilation ▾

Forecast Initial Time

2020-12-04 11:00:00 UTC ▾



NOTE: The results from the RAP are displayed, as well as the System Type (i.e., “Single Data Assimilation” or the “Continuous Data Assimilation”) results in the second row of each set of figures. If the result that you choose do not appear, you can choose an earlier “Forecast Initial Time”, since the data processing for the time chosen may not have been completed due to computational delays. If panels do not change, from one selection to another, your browser memory needs to be cleared before displaying these figures.

2. Hourly Forecast

The forecast web page enables forecast variables to be viewed at different NWP initialization times. On this web page, you can see two selection panels: “Forecast Variable” and “Forecast Initial Time”. The “Forecast Variable” menu has seven options: “Hourly Precipitation”, “Significant Tornado Parameter”, “Most Unstable CAPE”, “Lifted Index”, “850 hPa Basic Variables”, “700 hPa Basic Variables”, “500 hPa Basic Variables”. The “Forecast Initial Time” has seven choices, which varies from the latest forecast cycle initialized Coordinated Universal Time (UTC) time to 6-hours prior to the latest forecast cycle initialized UTC.

NOTE: The “Forecast Variable” must be selected before the “Forecast Initial Time” is selected

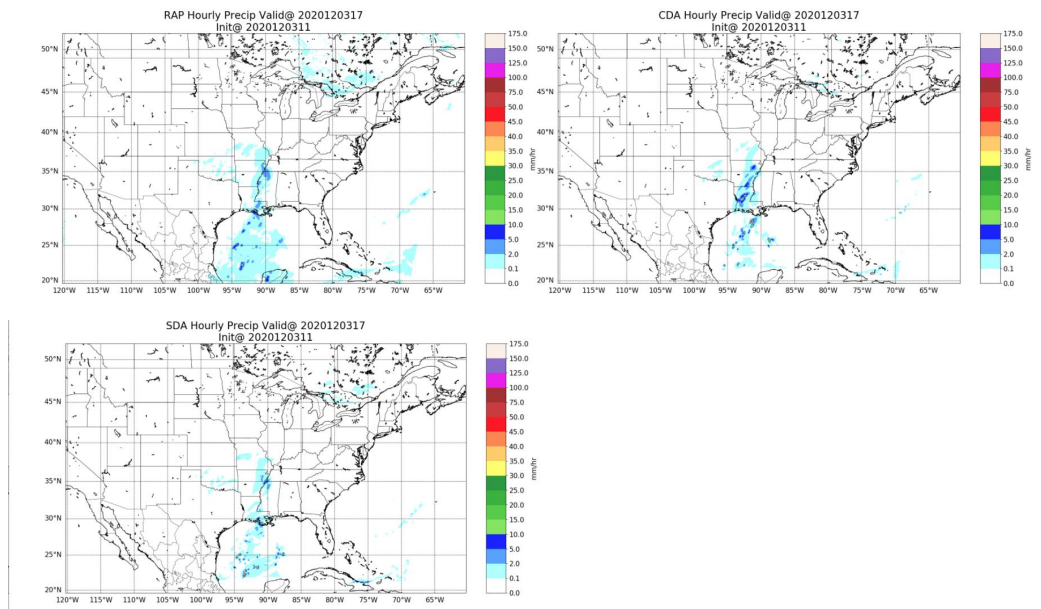
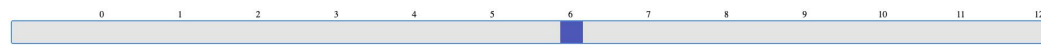
The dark blue box slide-bar, located under the “Forecast Lead Time (hours)” script, can be used to view the forecast time variation of the selected variable. The result shown has three subplots: RAP is shown by the upper left panel, Continuous Data Assimilation (CDA) is shown by the upper right panel, and Single Data Assimilation (SDA) is shown by the lower left panel. If you cannot see the results for the SDA, your web-browser scroll bar must be moved downward. Here is a screen shot.

Forecast Variable

Hourly Precipitation

Forecast Initial Time

2020-12-03 11:00:00 UTC

Forecast Lead Time (hours) :

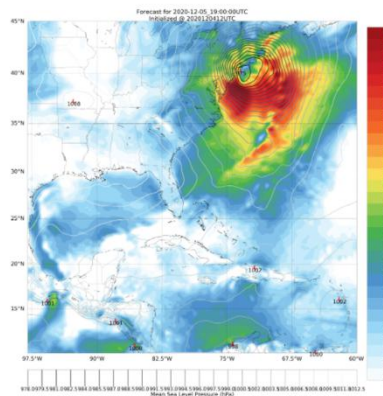
72hrs Forecast

The 72hrs forecast web page enables forecast variables to be viewed at different NWP initialization times. Because of computer limitations and the length of this forecast, the entire 72-hour forecast period is generally not available until one day after the initialization time, thereby providing 48 hours of forecasts beyond the time in which it is viewed. After typing in the forecast initialization time (YYYYMMDD), do not hit the return key, click on the ‘show’ box. Two graphics are displayed: (1) contours of Mean Sea Level Pressure (hPa) overlaying forecast 3-day surface (i.e., 10-meter AGL) wind speed (mps) and (2) 3-day accumulated precipitation (mm). The forecasts for every hour from the initialization time out to 72-hours can be seen by clicking on the ‘next’ tab to the right of the first display. A movie of the MSL pressure and surface wind speed forecasts can be seen by rapid clicking of the ‘next’ tab

Mean Sea Level Pressure and Maximum 10m AGL Wind Speed

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Previous



Next

3. Raob Evaluation

The “Raob Evaluation” web-page shows the difference between the 00 UTC and 12 UTC model forecast temperature, humidity, and vector wind velocity values and radiosonde observations at 00 and 12 UTC, respectively. The differences shown are computed as **Model Value – Radiosonde Observation**.

This “Raob Evaluation” web-page is similar to the Forecast web page. However, unlike the forecast web-page, which provides a “Forecast Initial Time” menu, the Raob Evaluation web page provides a “Raob Observation Time” menu. The “Variable and Level” selection menu includes nine choices: “850 hPa Relative Humidity”, “700h Pa Relative Humidity”, “500 hPa Relative Humidity”, “850hPa Air Temperature”, “700hPa Air Temperature”, “500hPa Air Temperature”, “850 hPa Vector Wind velocity”, “700h Pa Vector Wind velocity”, and “500 hPa Vector Wind velocity”.

Note: The “Variable and Level” selection must be made before the “Raob Observation Time” selection is made. The dark blue box slide-bar, located under the “Forecast Lead Time (hours)” script, is used to select the forecast lead-time for the comparison. The RAP/Radiosonde, SDA/Radiosonde, and CDA/Radiosondes differences are displayed. If no result is shown, choose an earlier radiosonde observation time.

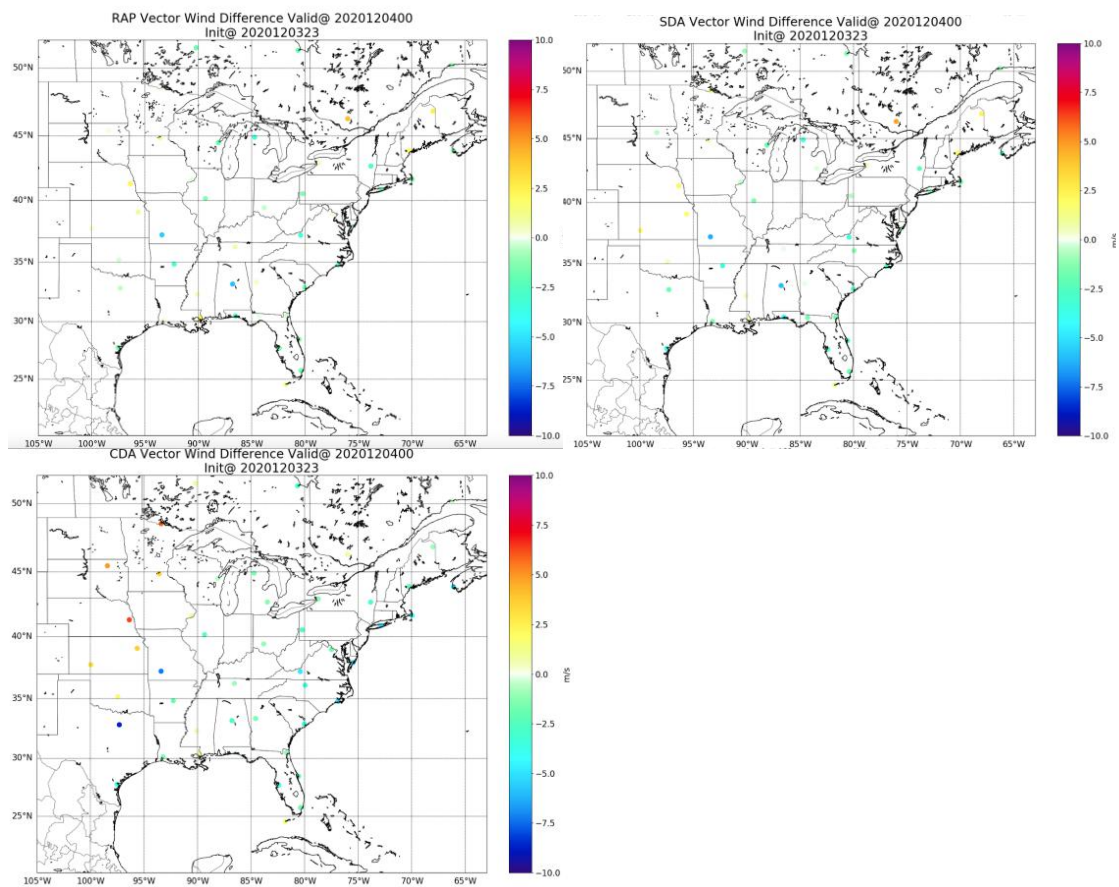
Variable and Level

700hPa Vector Wind

Raob Observation Time

2020-12-04 00:00:00 UTC

Forecast Lead Time (hours):



4. Precipitation Evaluation

The “Hourly Precipitation Evaluation” web-page shows comparison between the “Critical Success Index (CSI)” for the CDA and SDA 1- to 12-hour forecasts. The CSI is a verification measure of categorical forecast performance equal to the total number of correct event forecasts (hits) divided by the total number of storm forecasts plus the number of misses (hits + false alarms + misses). The NOAA Stage-IV hourly accumulated rainfall defined from rain gage and Radar measurements is used as “truth” for the computation of this index. The availability of this validation product is generally lagging 1-day behind real-time. After typing in the forecast initialization time (YYYYMMDD) desired, do not hit the return key, click on the ‘show’ box. Three CSI graphic panels are displayed for the 12-hr forecast cycle: (1) Hourly Accumulated Light Precipitation (1- to 2- mm/hr.), (2) Hourly Accumulated Moderate Precipitation (2- to 5- mm/hr.), and (3) Hourly Accumulated Heavy Precipitation(>5mm/hr.).

Hourly Precipitation Evaluation Based on NCEP StageIV Data

!!! Do Not Punch the Carriage Return Button After Entering the Forecast Initail Time Variable !!!

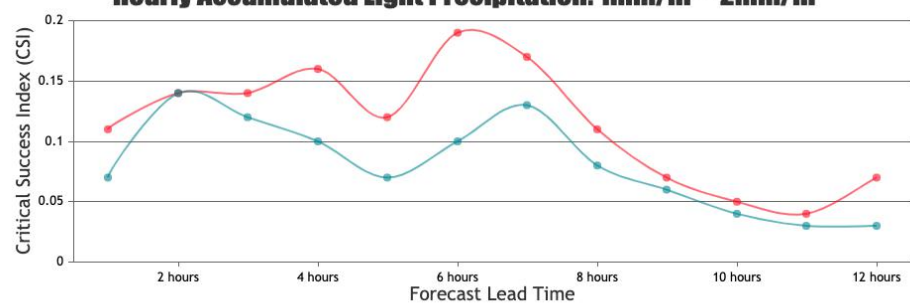
!!! Just Click the "Show" Button nicely !!!

Forecast Initial Time: 2020120600

Show

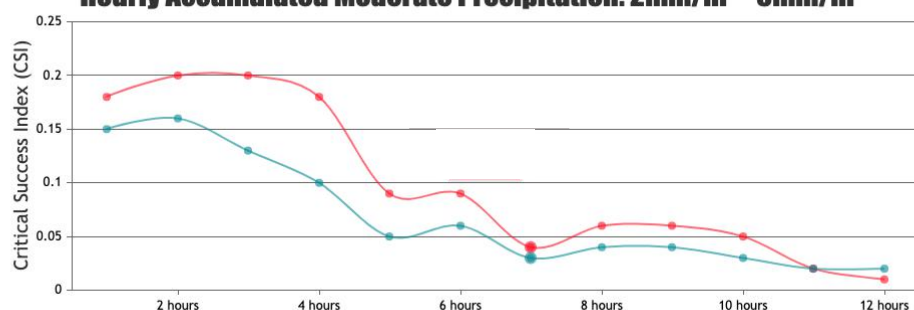
Forecast Init@ 2020120600

Hourly Accumulated Light Precipitation: 1mm/hr ~ 2mm/hr



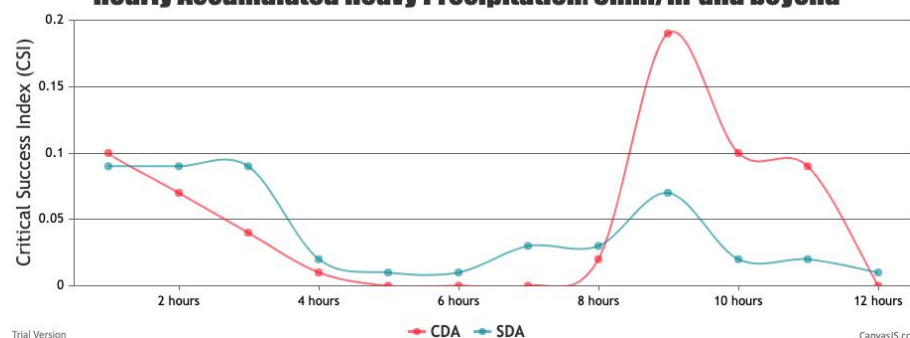
trial version

Hourly Accumulated Moderate Precipitation: 2mm/hr ~ 5mm/hr



Trial Version

Hourly Accumulated Heavy Precipitation: 5mm/hr and beyond



Trial Version

Canva5.com

4. Model Output

Quick links to the Grib2 format forecast products are provided at:

http://cas.hamptonu.edu/~qi.zhang/home_2.0/ForecastGrib2.html

4.1 CDA Nowcast

Initial condition used by CDA NWP system, interpolated to pressure level

4.2 SDA Nowcast

Initial condition used by SDA NWP system, interpolated to pressure level

4.3 CDA Forecast

Forecast results generated by CDA NWP system, interpolated to pressure level

4.4 SDA Forecast

Forecast results generated by CDA NWP system, interpolated to pressure level

5. PHSnABI

Quick links to the PHSnABI retrieval products, which are assimilated into the SDA and CDA NWP system are provided at:

http://cas.hamptonu.edu/~qi.zhang/home_2.0/PHSnABISource.html

5.1 PHSnABI in UW

PHSnABI products generated at the University Wisconsin-Madison.

5.2 PHSnABI in HU

PHSnABI products generated at the Hampton University.

6. Web-sites:

6.1 Introduction Document:

http://cas.hamptonu.edu/~qi.zhang/home_2.0/Introduction.pdf

6.2 Grib2 Variables File Document:

http://cas.hamptonu.edu/~qi.zhang/home_2.0/VariableExplanationForHU.pdf

7. Help personnel and other useful links:

Forecast Products:

QI.ZHANG@HAMPTONU.EDU

Satellite Input Data (Polar and Geostationary):

bill.l.smithsr@gmail.com (For both UW and HU products)

eriko@ssec.wisc.edu (UW data products)

anthonyedinorscia@gmail.com (HU data products)

scott.lindstrom@noaa.gov (Forecast Evaluation Results)

john.mcnaabb@hamptonu.edu (DBS Polar Data)

Satellite Sounding Data Products:

<http://dbps.cas.hamptonu.edu/development/>

Satellite Sounding Data User's Guide:

<http://dbps.cas.hamptonu.edu/development/WebsiteUsersGuide.pdf>