Hampton University Science and Engineering Capabilities

William B. Moore

Hampton University

- One of the nation's premier HBCUs.

- Founded in 1868 as Hampton Normal School and Agricultural Institute

- 3200 Undergraduates, 500 Graduates, 3 STEM PhD programs.

Emancipation Oak
and University Chapel

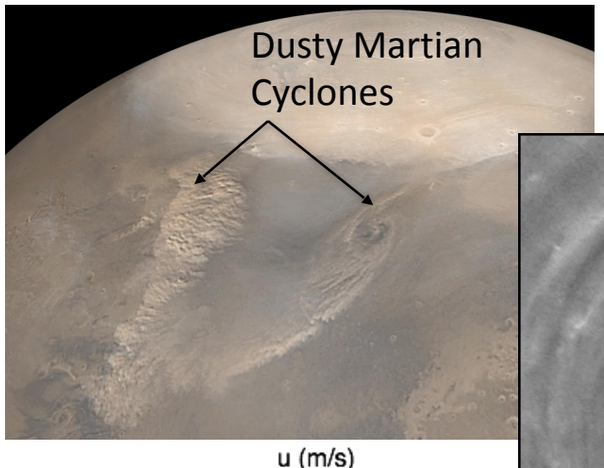
Hampton University

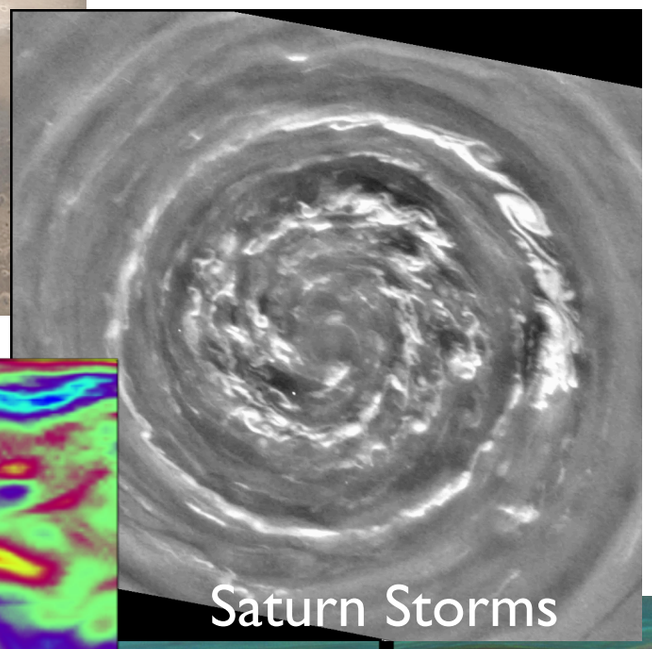
- School of Science:
  - Atmospheric & Planetary Science
  - Chemistry and Biochemistry
  - Computer Science
  - Marine & Environmental Science
  - Mathematics & Applied Mathematics
  - Physics
- School of Engineering and Technology:
  - Aviation
  - Chemical Engineering
  - Computer and Electrical Engineering

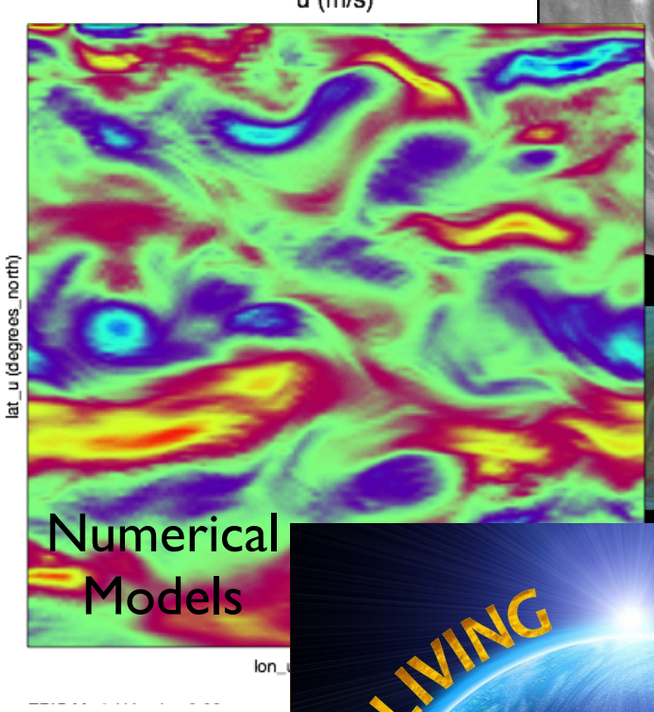
Planetary Science at Hampton University

Moore and Sayanagi

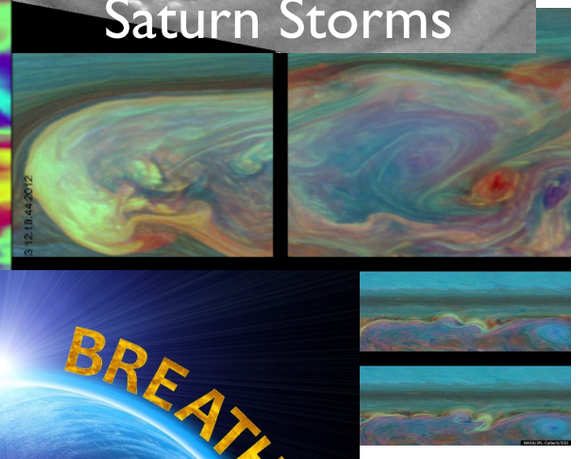
Atmospheres



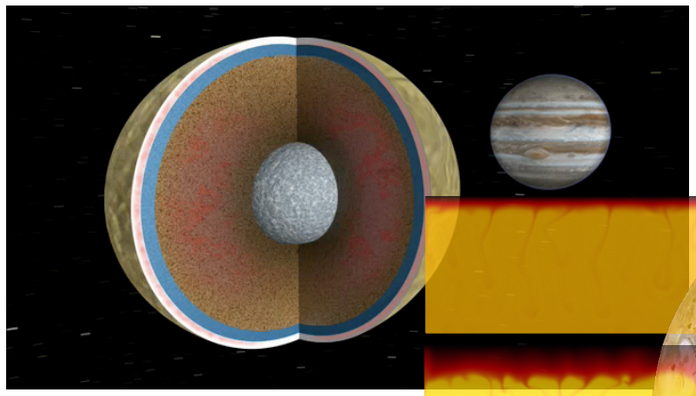


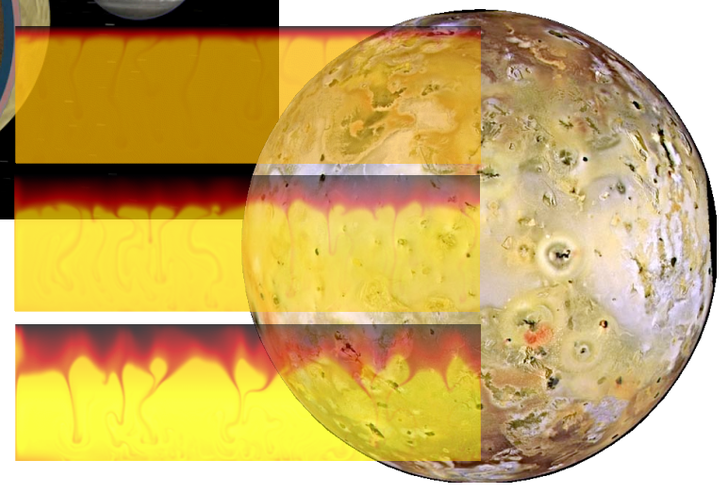


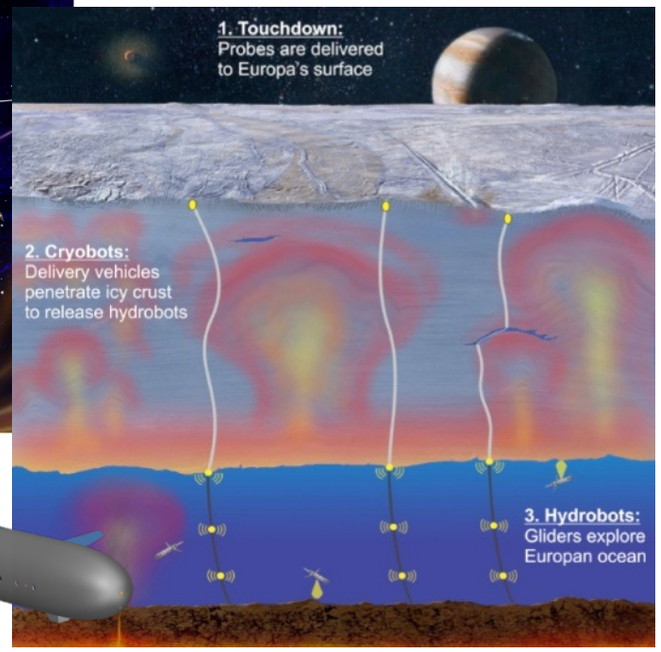
Numerical Models

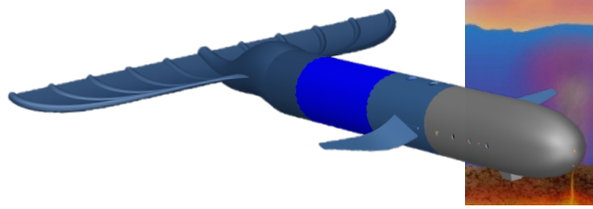


Interiors and Dynamics









Exploration

NASA Planetary Missions

- **Sayanagi**: *Cassini*, Europa Clipper, concept studies.

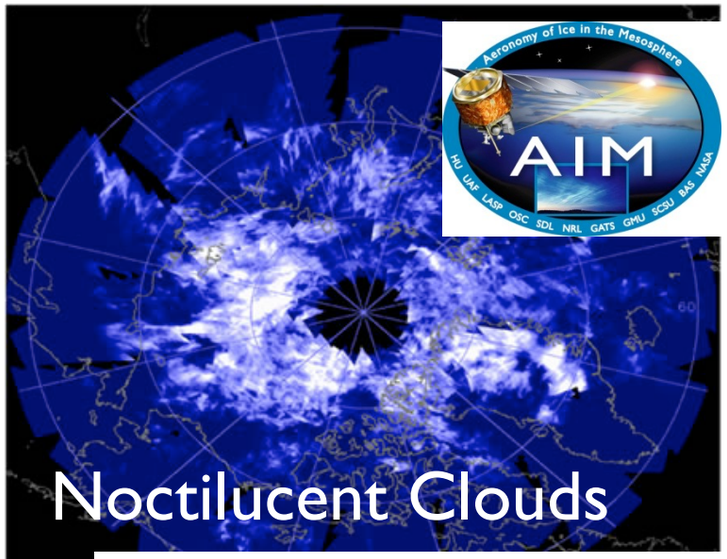
- **Moore**: *Magellan, Galileo*, JUICE (ESA), instrument development (PICASSO).

Atmospheric Science at Hampton University

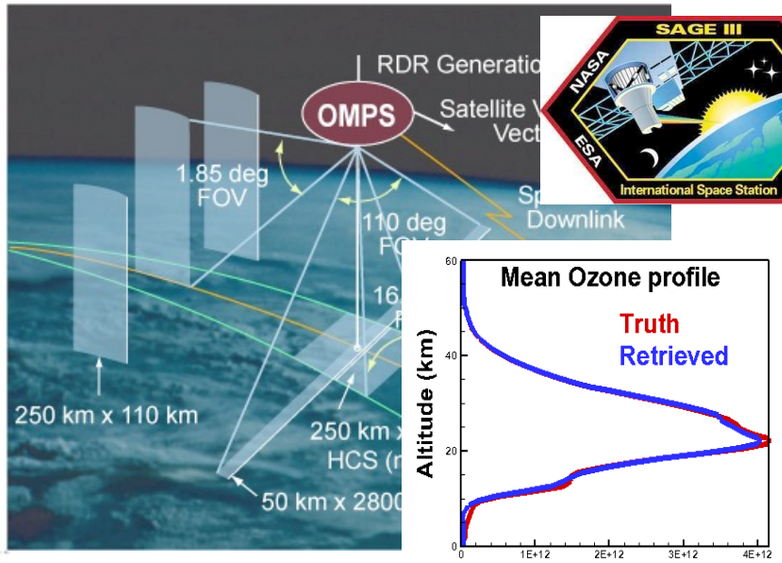
McCormick, Russell, Loughman, Smith (Sr.), Anderson, McNabb, Yue

CREST @ HU
Cooperative Remote Sensing Science & Technology Center

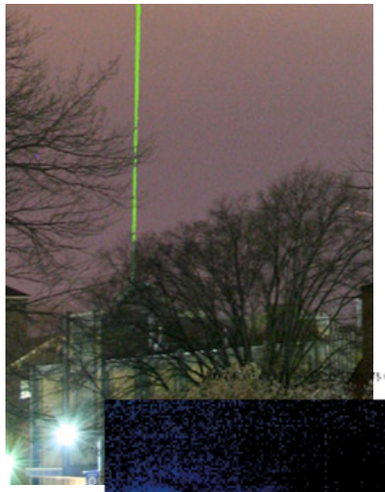
Noctilucent Clouds



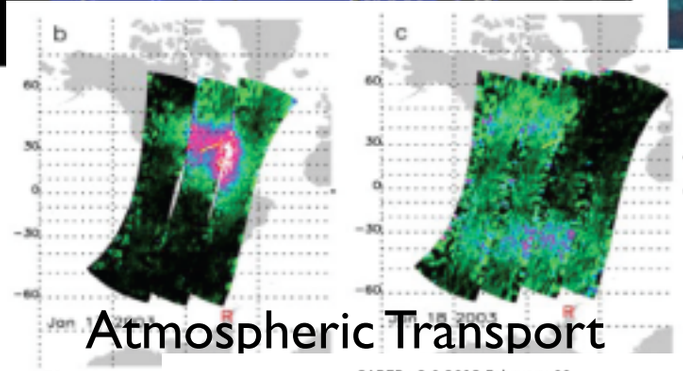
Ozone Profiling

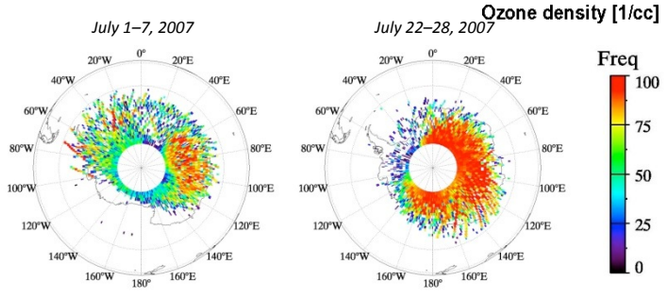


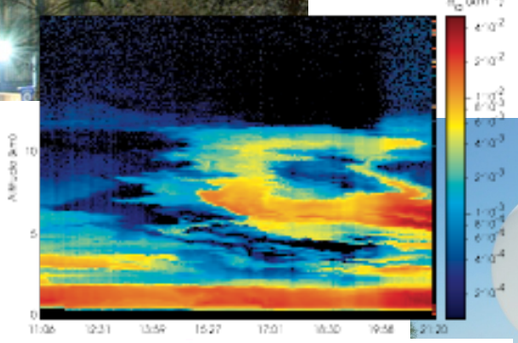
HU LIDAR system



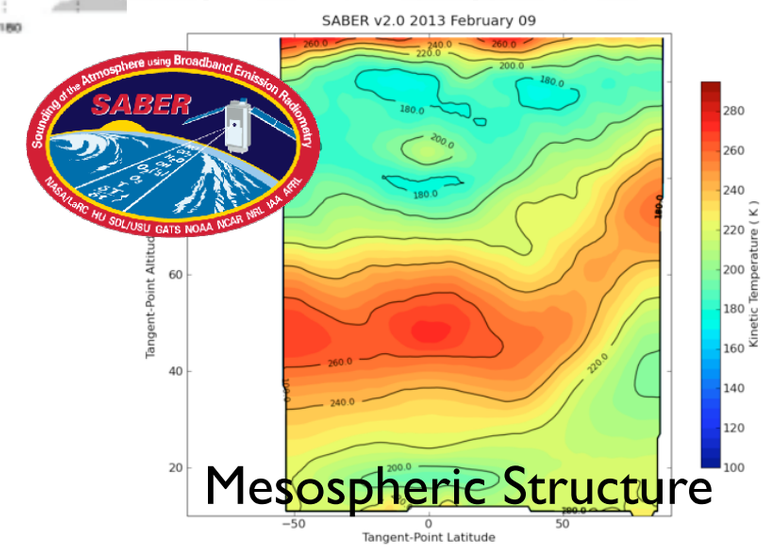
Atmospheric Transport



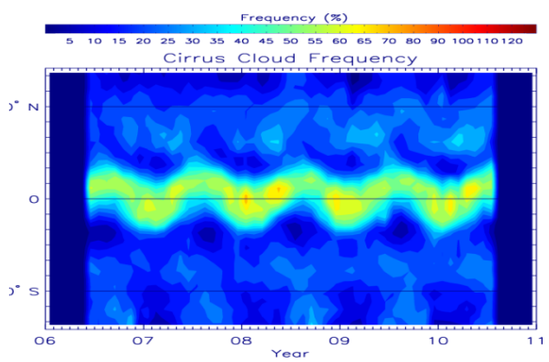




Mesospheric Structure

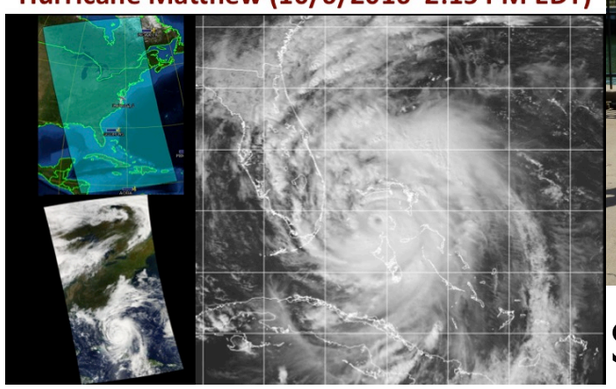


Cloud Climatology



Severe Storms

HU Direct Broadcast MODIS Images
Hurricane Matthew (10/6/2016 2:15 PM EDT)

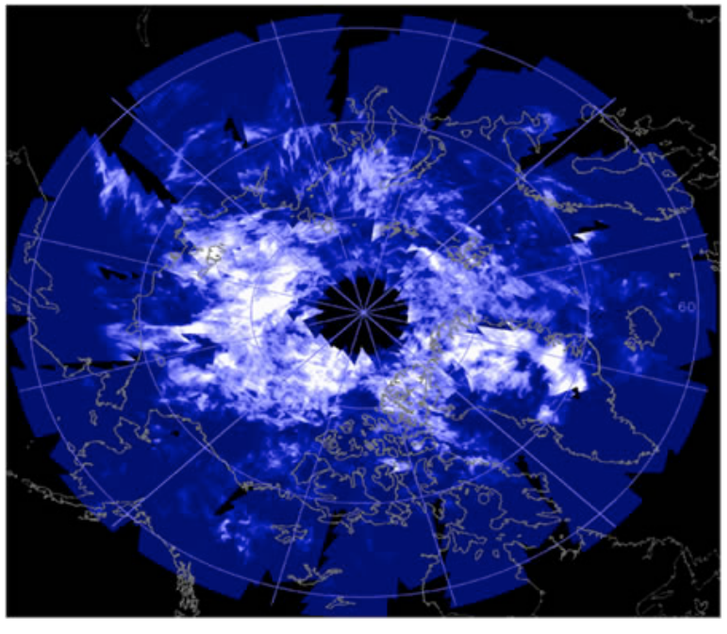


Atmospheric Research

- AIM Satellite Operations
- Direct Broadcast Satellite Applications
- Severe Weather Research Center
- Ground-Based Instrumentation Cluster
- UAS applications

AIM Satellite Mission

- PI-led Heliophysics SMEX mission.
- On-station for 15 years this month.
- Mapping mesospheric ice clouds.
- Mission operations have been extended many times with excellent contract performance.



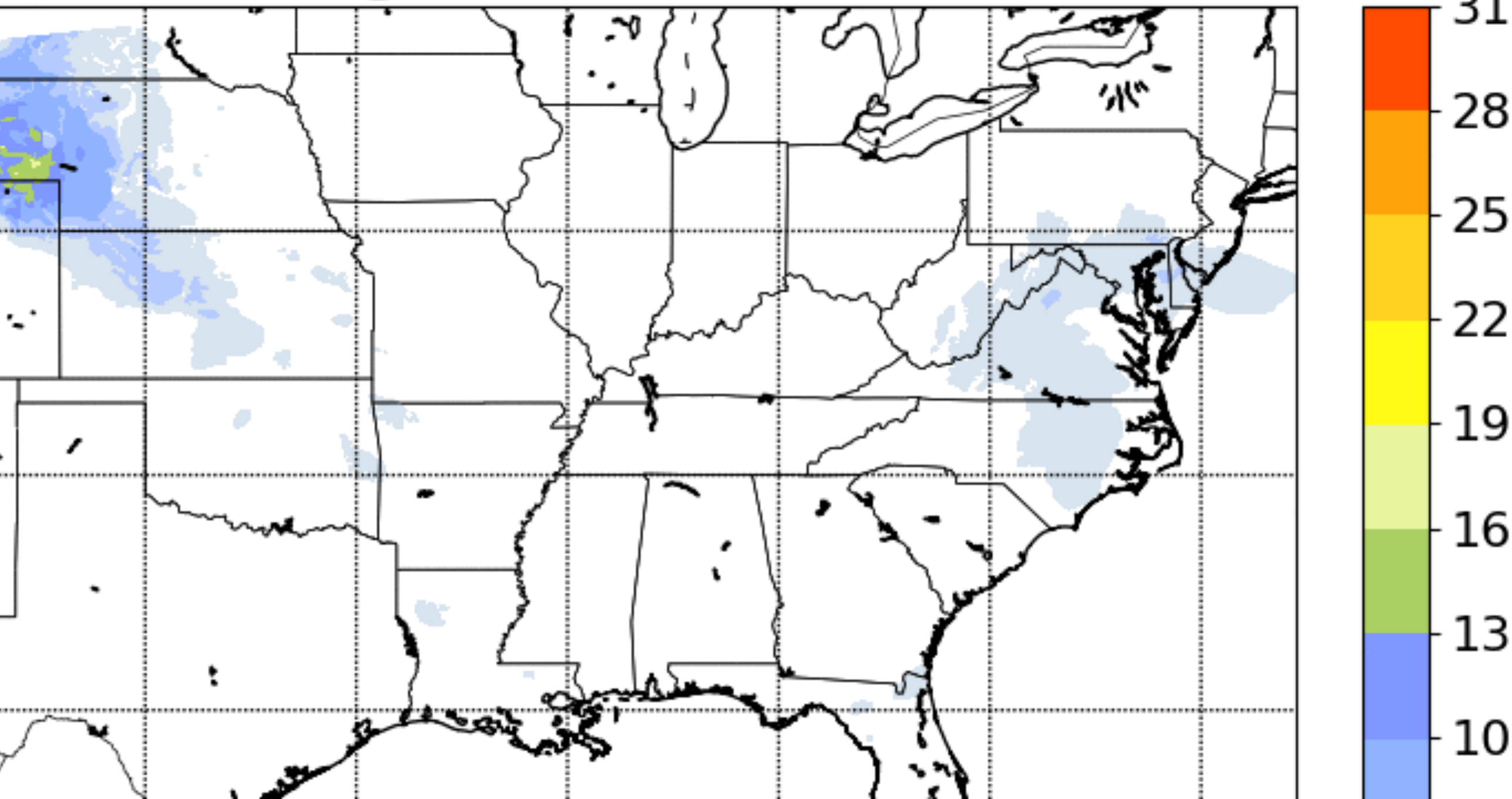
Real-Time DBS Applications

- The Hampton University DBS tracks over a dozen satellites downlinking real-time data and processing it to level 2 using the Wisconsin CSPP stack.
- The main advantage of direct reception of the satellite signals is a 90 - 120 minute lead time over its arrival online.
- Rapidly evolving processes such as convective storms and flooding need rapidly updated data.
- Applications include: Emergency management, airspace operations (piloted and UAS), weather alerts, wind power and utility operations.

12 Hour Warning

Tornado Parameter Valid @ 2021090112

Init @ 2021090112 UTC



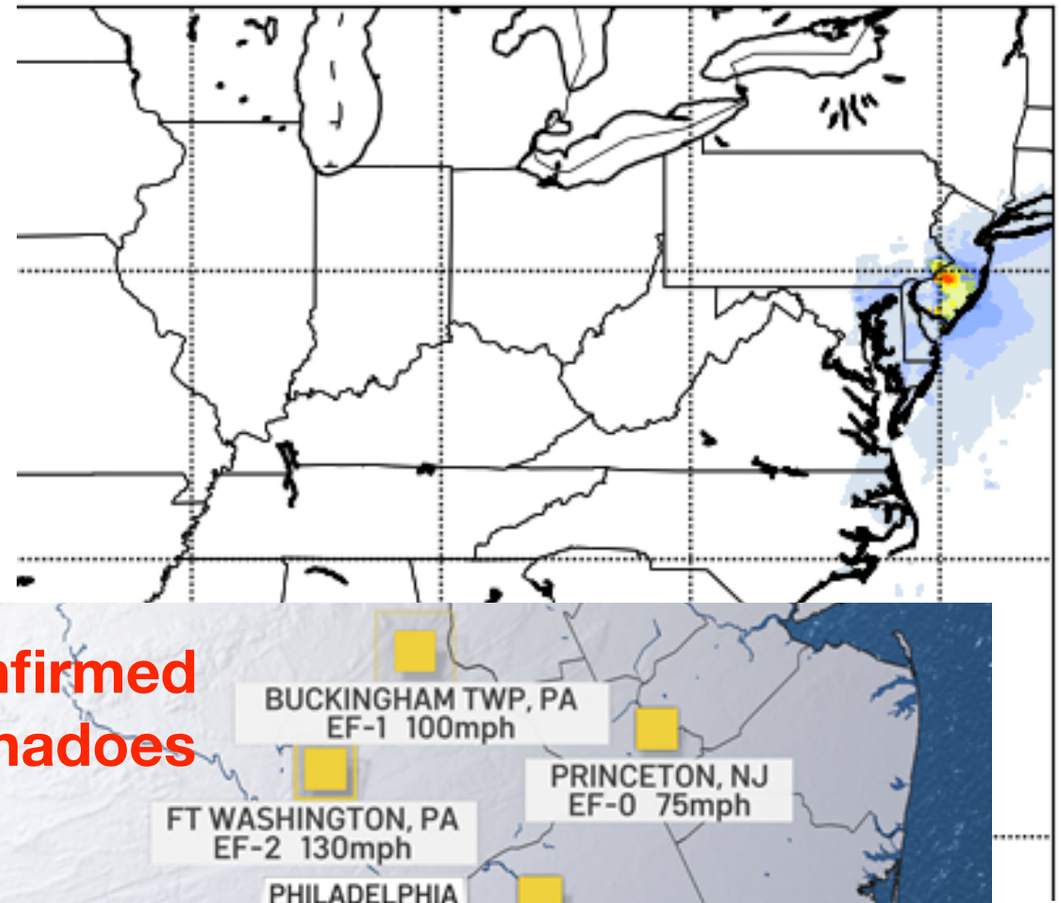
Severe Weather Research

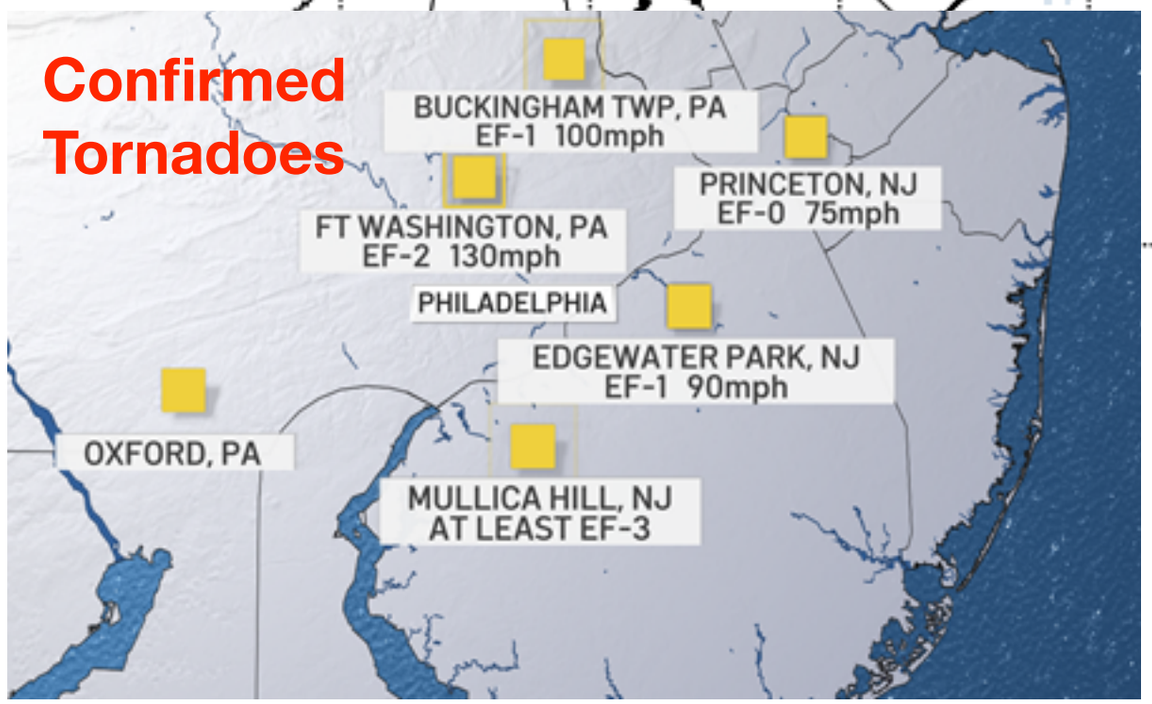
- Pioneering innovative uses of real-time satellite data to improve forecasts of rapidly developing weather systems.

- Improving wind, rain, hail, hurricane, and tornadic storm forecasts.

- Partnership with University of Wisconsin, Madison, NASA, and NOAA.

12 Hour Advance Forecast



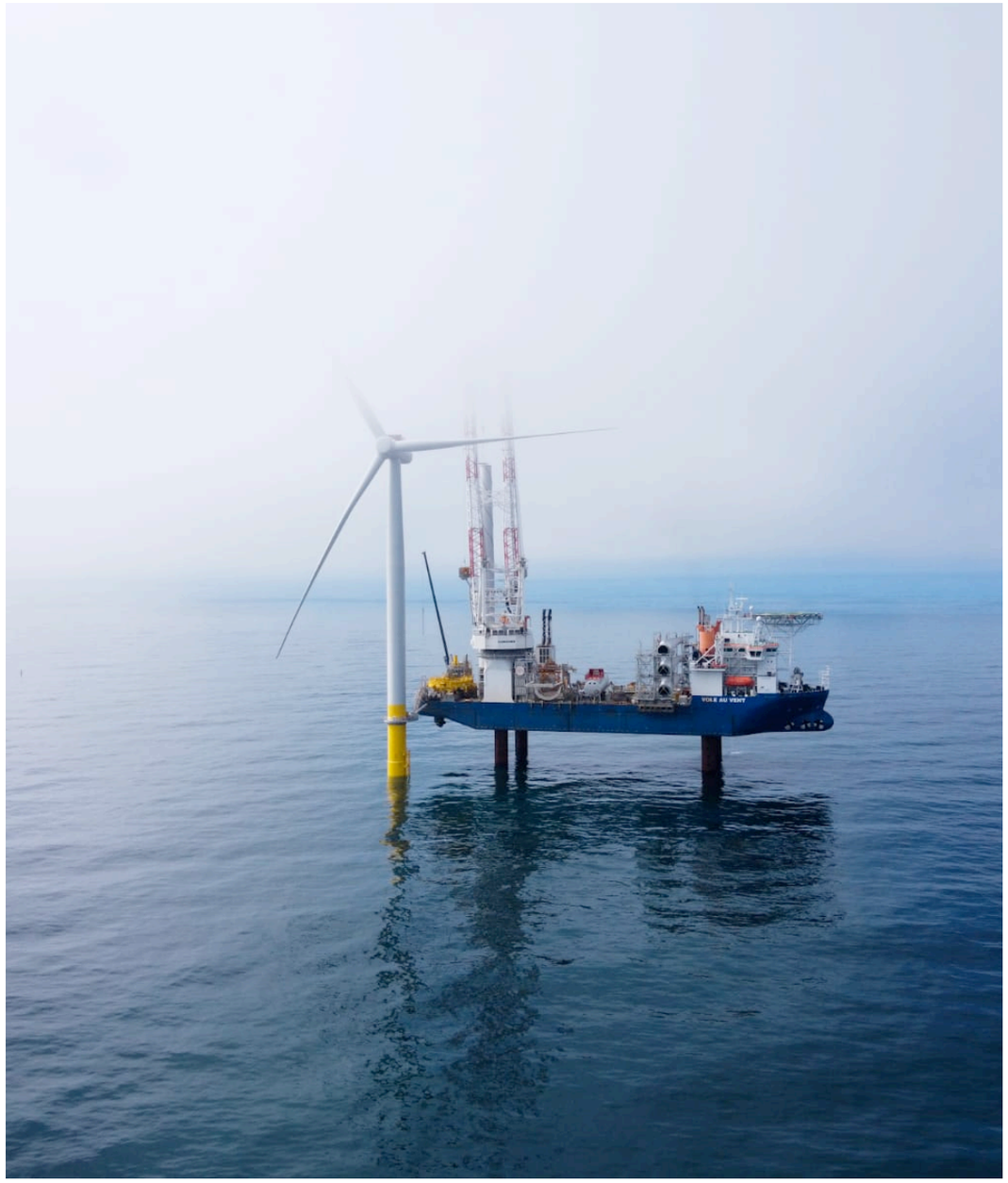


Wind Power Research

- Improved forecasts for both severe and routine weather are vital to the safe operations of wind farms.

- Hampton University is developing improved forecasts of wind speed and direction in the lower atmosphere.

- We are in discussions with Dominion Energy, who are putting ~250 turbines off the coast of VA in the coming decade.

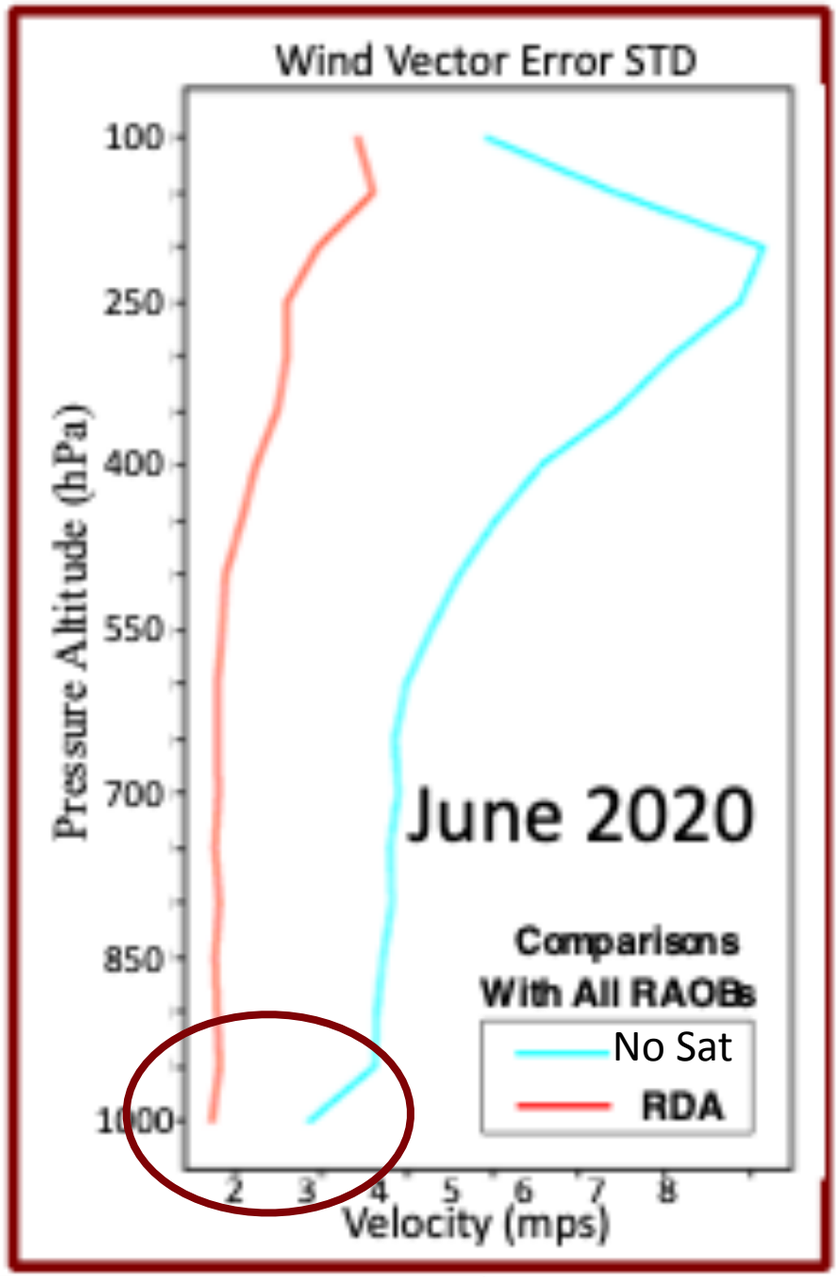


Installation of one of two test turbines currently off the coast of Virginia.

Direct Broadcast Satellite (DBS) Data Contributions to the VA Offshore Wind Energy Project

Winds Via NWP Model Temperature and Humidity Data Assimilation:

- High-resolution (2-km) combined polar orbiting satellite hyperspectral temperature and humidity profiles and geostationary satellite multispectral humidity profiles are continuously assimilated (1-hour time frequency) into 1-3-km resolution NWP forecast models on an hourly basis.
- Assimilating these data for a period of three hours produces model grid point wind profiles dynamically consistent with the spatial and time variations observed with the satellite thermodynamic sounding data over the 3-hr period. The model diagnosed winds are called Satellite Profile Retrieval Data Assimilated (RDA) winds.



HU SWRC DBS Data Greatly Improves Near Surface Wind Accuracy

Ground-Based Instrumentation at HU

	HU Instrument										
Product	Met Sonde (0-30km)	O3 Sonde (0-30km)	Cimel Photometer (Column, 9 λ s)	48" Mie-Raman OPO DIAL (0-30km)	48"Mie-Raman lidar (0-30km)	Doppler lidar (0-5km) Periodically on loan from ARL	Scanning lidar (0-5km)	Pandora Spectro-photometer (Column O3, NO2, …..)	Luftt CHM15k Ceilometer	Atmospheric Sounder Spectrometer by Infrared Spectral Technology (ASSIST)	SKYLER X-Band Radar
PBL Height	X	X		X	X	X	X		X	X	X
Aerosol Optical Depth			X	X	X						
O3 Profile		X		X						X	
Aerosol Profile				X	X		X		X		
Cloud Heights and Properties				X	X		X		X		X
H_2O Profile/RH	X	X		X	X		X			X	
Temperature Profile	X	X		X	X					X	
Winds Profile	X	X				X					X
Column Gases (O3, NO2, …					X			X			
Precipitable Water			X					X	X		X
Various Gases (SO_2, NO_2, CH_4, etc., λ= 190 nm-2.2 µm				X							

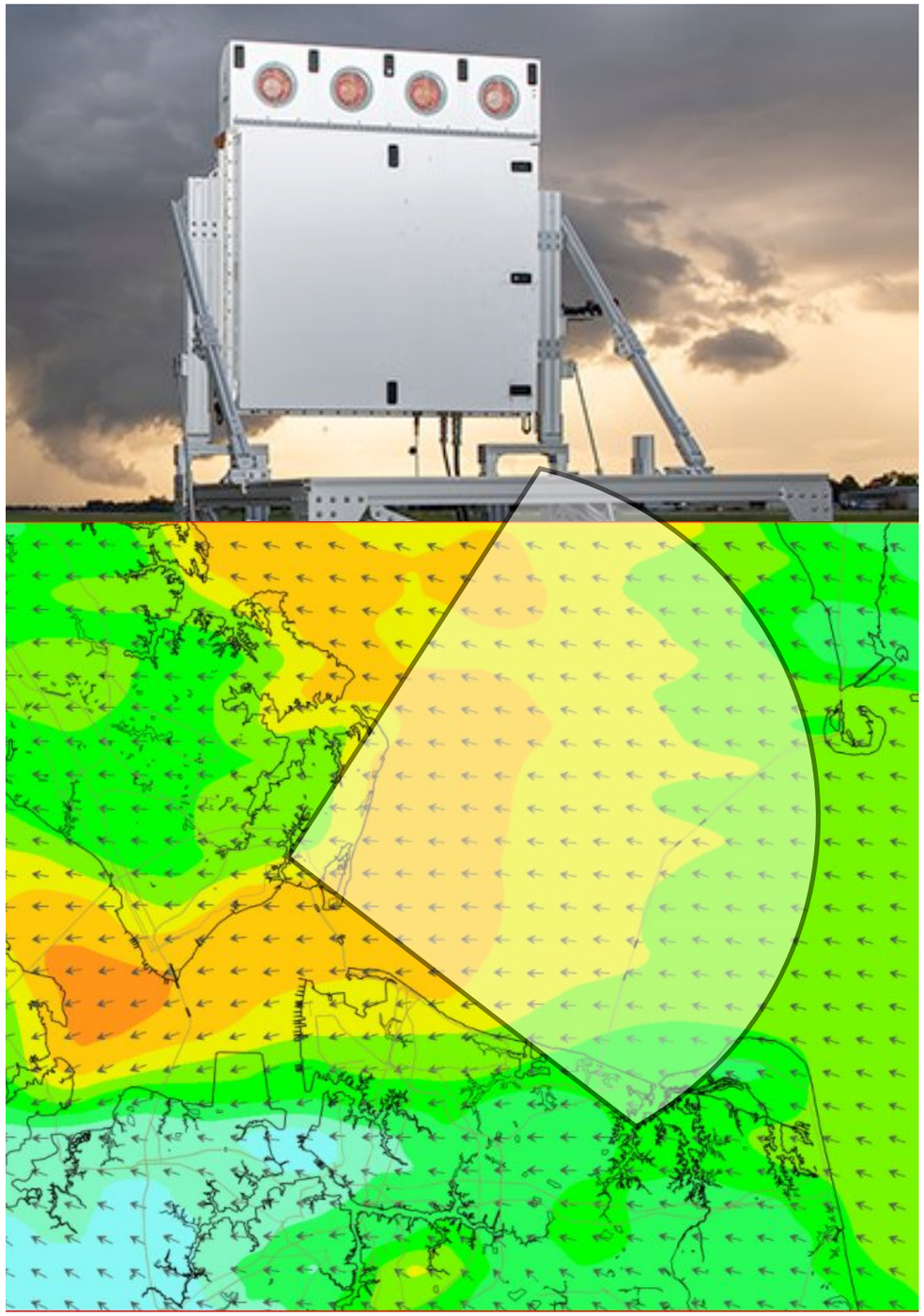
Radar Applications to Severe Weather Research

- In addition to the DBS, Hampton University has recently acquired a SKYLER X-band radar system from Raytheon.

- This dual-polarization, phased array radar has a range of 30km, high vertical and horizontal resolution (20m), Doppler wind capability, and is electronically steerable over 90^{o}.

- We will be researching how to integrate the SKYLER data into our forecast system as well as utilize it for UAS tracking and route planning.

- Multiple SKYLERs would enable 3-D wind vectors and a larger coverage area.



Calibration/Validation Hub

- Hampton University has assembled a unique array of atmospheric measurement techniques.

- Satellite and ground instrument calibration and validation can be done in one stop, with HU providing a wide range of measurements.

- Instrument performance monitoring can be done regularly, ensuring consistently reliable data.

- The recent ASSIST and SKYLER acquisitions will make this a truly unrivaled facility.

A Research Hub

Calibration/Validation

Lidar

Pandora

AERONET

Satellites

GEO

DBS

UAS Sensors

ASSIST

SWRC

Server

Cluster

UAS Research

Ceilometer

Ground Stations

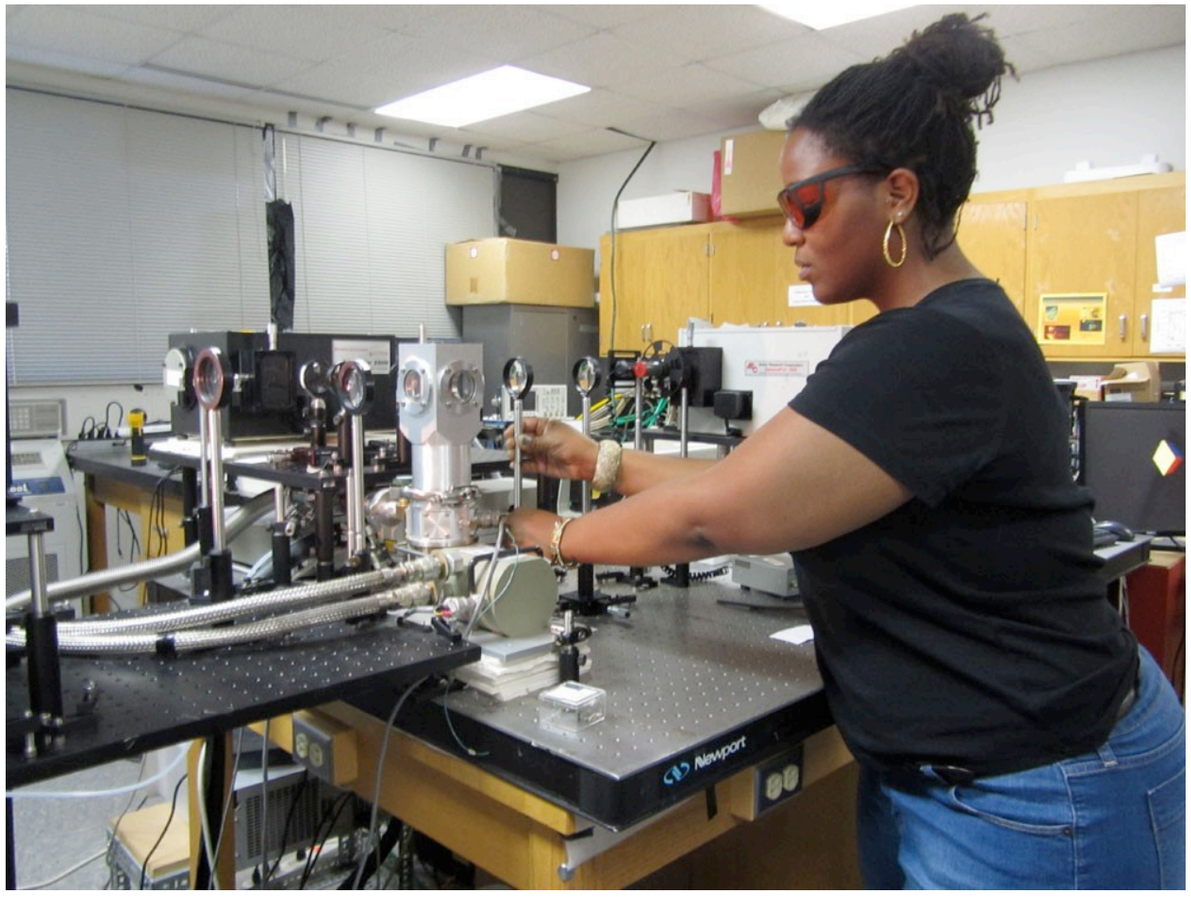
Balloon Sondes

SKYLER

Weather Forecast

Physics

- Particle Physics (w/JLab)
- Medical Radiation Physics (HUPTI)
- Laser Physics
- Nano-photonics



Electrical and Computer Engineering

- Integrated Photonics
- Communications
- Micro/nano-electronic Devices
- Information Fusion and Signal Processing
- Machine Learning
- Quantum Information Systems
- Cyber-physical Systems
- Robotics & UAS

Industry and Federal Partnerships

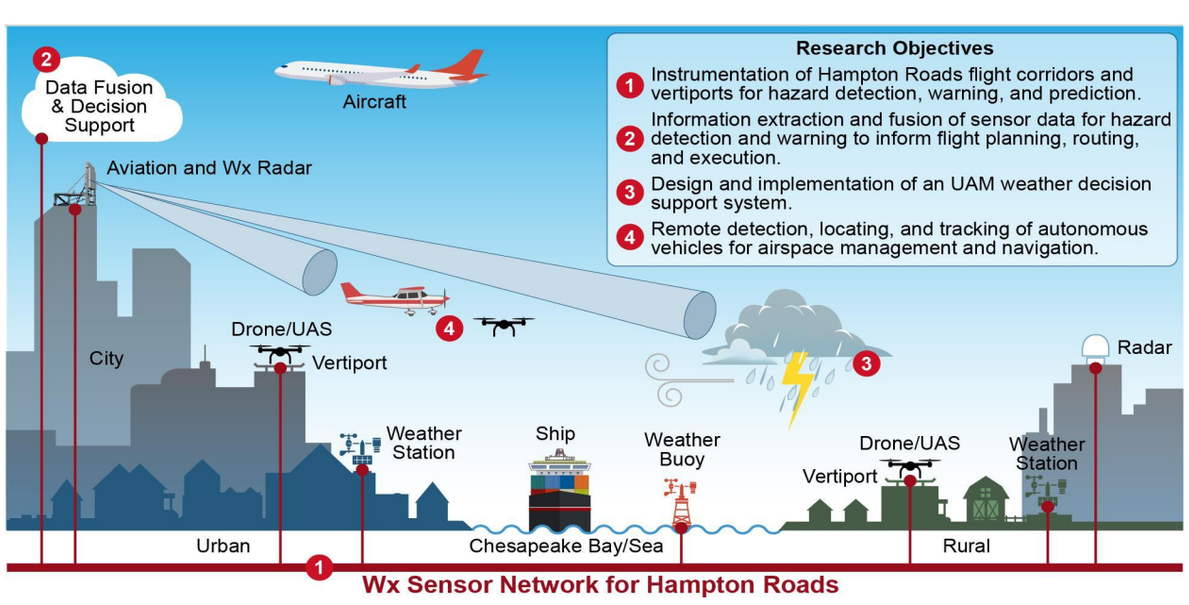
Aviation

Aviation Department History

- Department of Aviation was officially established in 1985.
- The program can be traced back to 1940s, as one of only 6 HBCUs that participated in Civilian Pilot Training Program.
- Several Tuskegee Airmen attended and graduated from Hampton for initial pilot training before heading off to Tuskegee.

Aviation Programs

- Aviation Management: Airport Administration
- Aviation Management: Air Traffic Control (ATC)
- Flight Education
- Aviation Management: Airport Administration – Online
- UAS Management (FAA UAS-CTI)



UAS/Wx Sensors for Autonomous Infrastructure

HU Partnerships

- Hampton University works with multiple state, local, and federal agencies as a trusted partner.
- World-class research capabilities.
- Top-flight students.
- Scientific leadership.
- Let’s work together.