

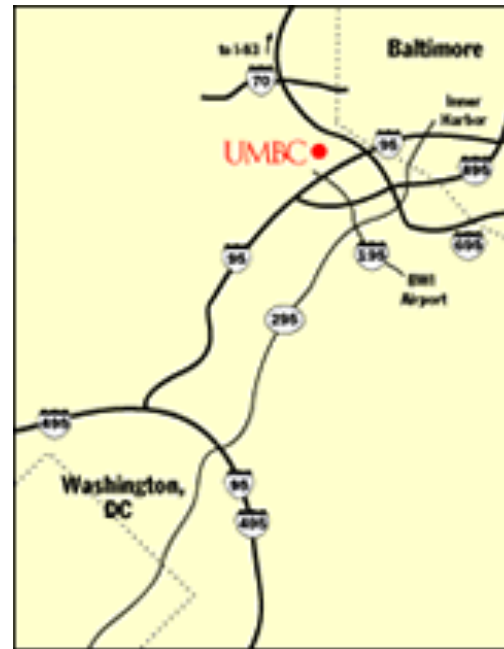
# Atmospheric Physics (ATPH) Graduate Program



# Overview of UMBC



- 14,000 Students
  - ~11,000 undergrad
  - ~3,000 grad
- 37 Academic Programs
  - 21 PhD programs

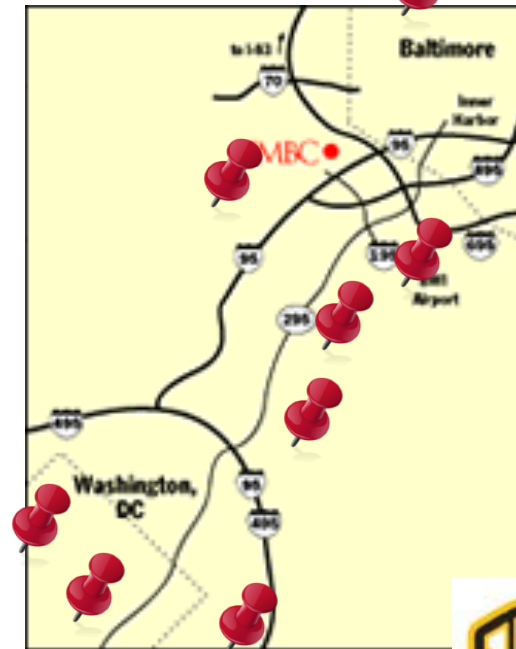


# UMBC

# Overview of UMBC



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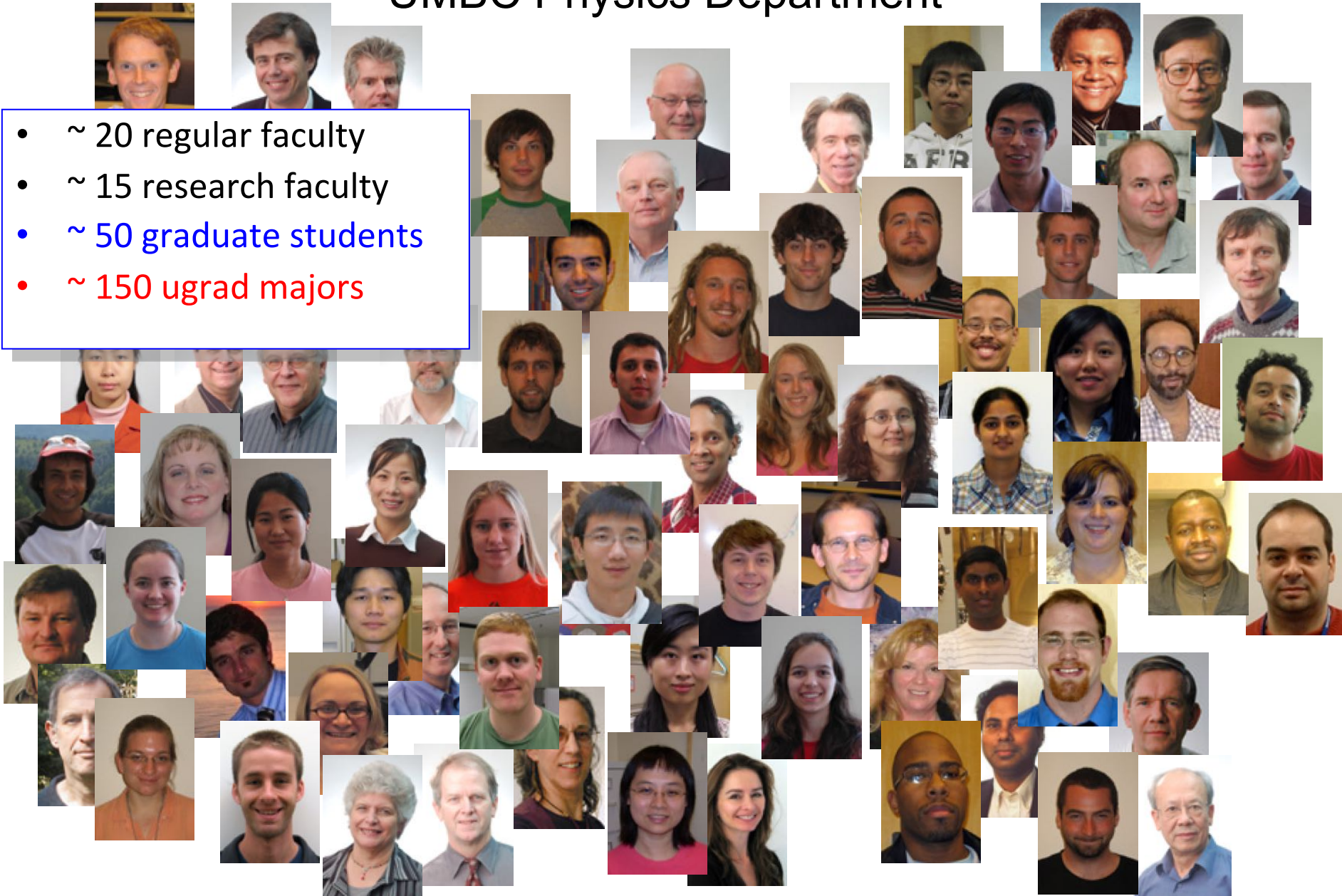
- ARL
- APL
- NRL
- NSA
- Northrop-Grumman
- NASA Goddard
- .....



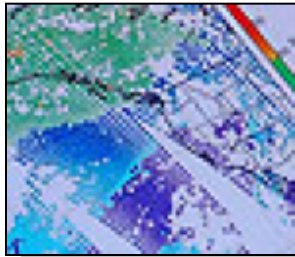
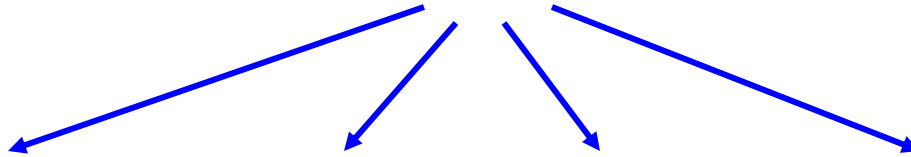


# UMBC Physics Department

- ~ 20 regular faculty
- ~ 15 research faculty
- ~ 50 graduate students
- ~ 150 ugrad majors



# 4 main research areas at UMBC



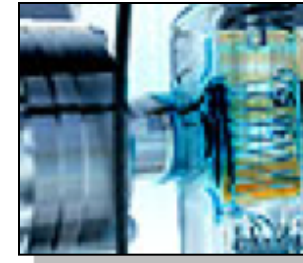
Atmospheric  
Physics



Astrophysics



Condensed  
Matter Physics



Quantum Optics  
& Information

Atmospheric Physics (ATPH)  
PhD program:

Physics PhD program

ATPH program accounts for  
 $\frac{1}{4}$  of faculty,  $\frac{1}{3}$  of graduate  
students

# We are #1 “Atmospheric Physics” Program



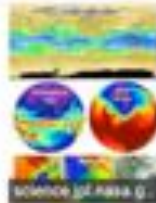
atmospheric physics



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About 96,400,000 results (0.69 seconds)

**Atmospheric physics** is a branch of meteorology and is related to climatology. **Atmospheric physicists** use mathematical and physical models to study and understand Earth's **atmosphere** and its weather systems. For example, they apply the theory of fluid dynamics to **atmospheric tides**.



[Atmospheric Physics - Study.com](https://study.com/directory/category/Physical.../Atmospheric_Physics.html)

[https://study.com/directory/category/Physical.../Atmospheric\\_Physics.html](https://study.com/directory/category/Physical.../Atmospheric_Physics.html)

About this result Feedback

[Atmospheric physics - Wikipedia](https://en.wikipedia.org/wiki/Atmospheric_physics)

[https://en.wikipedia.org/wiki/Atmospheric\\_physics](https://en.wikipedia.org/wiki/Atmospheric_physics)

Atmospheric physics is the application of physics to the study of the atmosphere. Atmospheric physicists attempt to model Earth's atmosphere and the ...

[Remote sensing](#) · [Cloud physics](#) · [Atmospheric electricity](#) · [Atmospheric tide](#)

[Atmospheric Physics - Department of Physics - UMBC](https://physics.umbc.edu/research/atmospheric/)



<https://physics.umbc.edu/research/atmospheric/>

Atmospheric Faculty, students, and scientists in the UMBC Atmospheric Physics (ATPH) graduate program perform research in a number of areas in ...

[Science - Atmospheric Physics And Weather \(329E\)](#)



Atmospheric physics

Field of study

Atmospheric physics is the application of physics to the study of the atmosphere. Atmospheric physicists attempt to model Earth's atmosphere and the atmospheres of the other planets using fluid flow equations, chemical models, radiation budget, and energy transfer processes in the atmosphere.

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### Faculty Members

Prof. Belay Demoz  
Prof. Lynn Sparling  
Prof. Zhibo Zhang

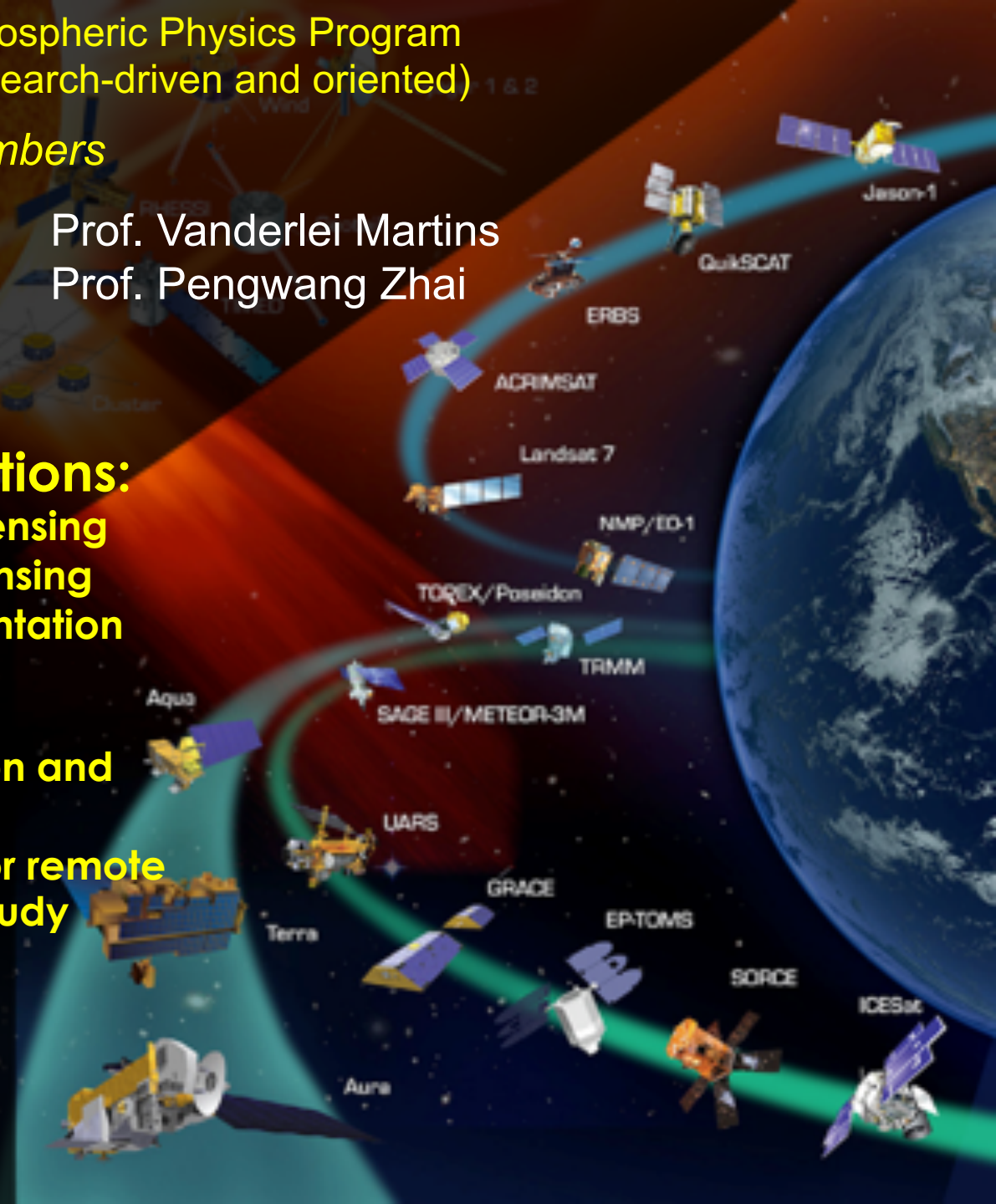
Prof. Vanderlei Martins  
Prof. Pengwang Zhai

### Major Research Directions:

- Aerosol/cloud remote sensing
- Ocean color remote sensing
- Remote sensing instrumentation
  - Air pollution
  - Extreme weather
- Climate model evaluation and improvement
- Machine-learning and AI for remote sensing and climate study

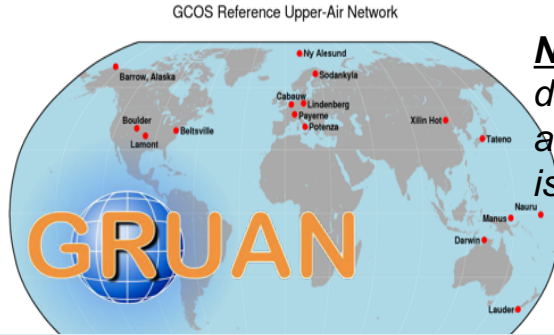
more info:

[Zhibo.Zhang@umbc.edu](mailto:Zhibo.Zhang@umbc.edu)  
(410)-455-6315



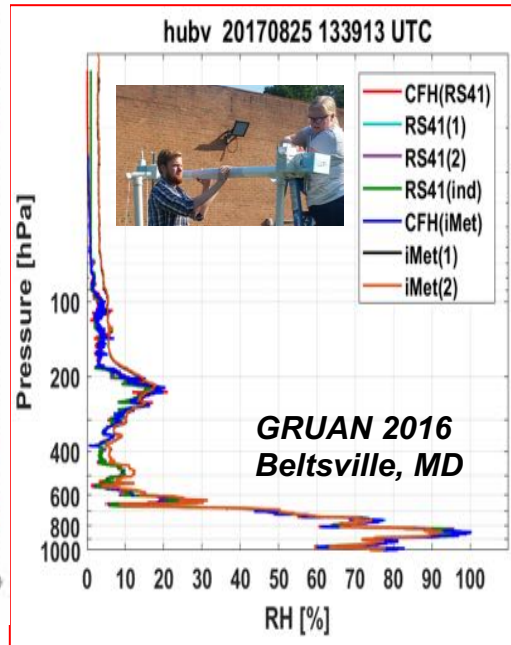
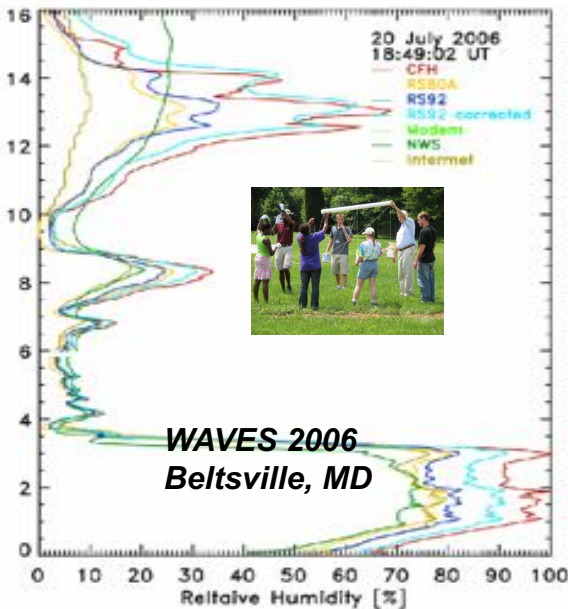
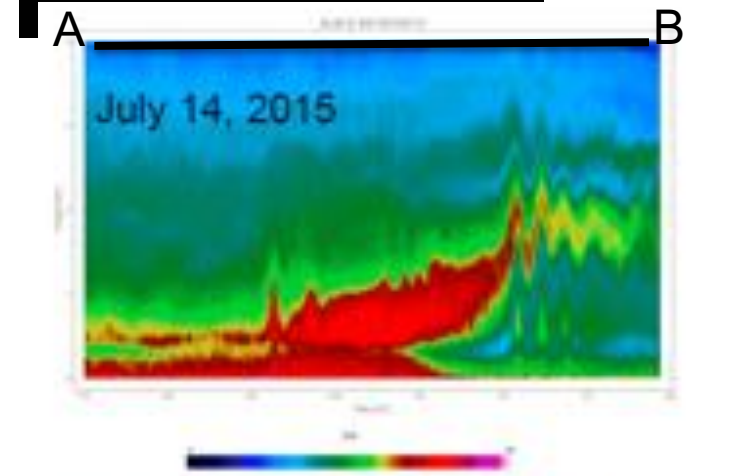
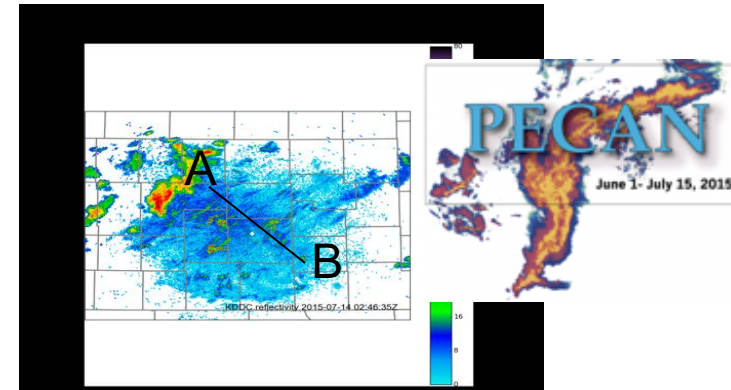
**Dr. Belay B. Demoz**  
UMBC-Physics/JCET

Questions: What physics *controls* the weather?  
How do we measure the *these processes*?  
What type of instruments and *what quality*?



**Networks:** linking observation from different sites – to solve a climate and weather problem. Example here is from a climate network GRUAN.

**Instrumentation:** physics, network capability, What and how can we improve on multi-instrumentation networks? How should they be deployed.



**Diagnosing Model physics:** Use the observation to constrain, validate, improve models. .

**Making sense of what is measured:** An example of cold front generated bore and associated role undulations during PECAN

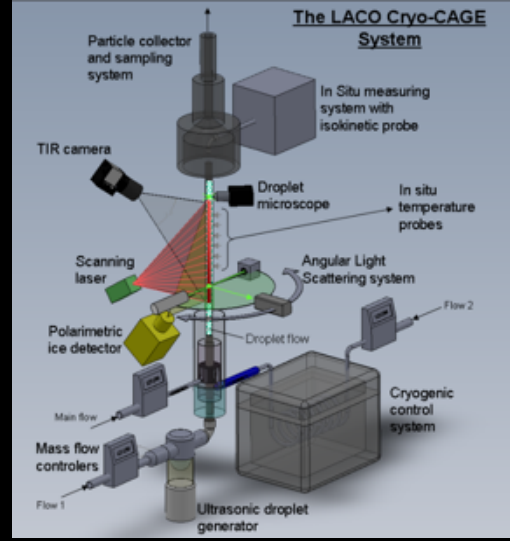
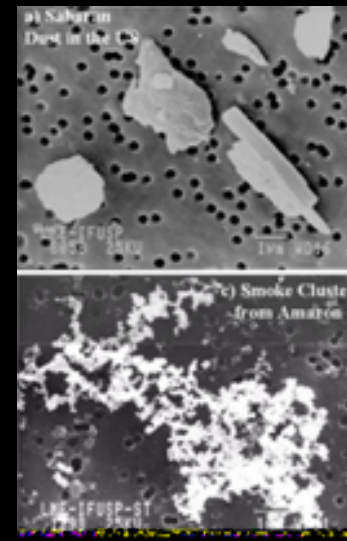




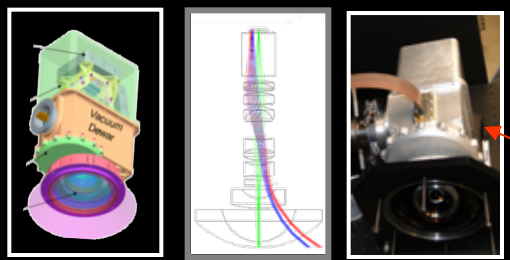
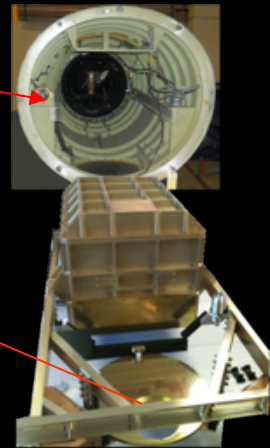
## Laboratory for Aerosols, Clouds and Optics

New Remote Sensing Instruments and Algorithms

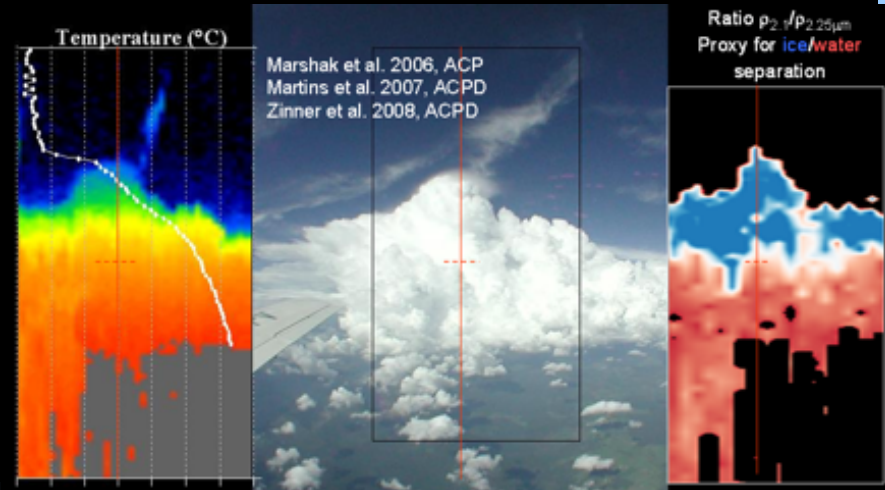
Laboratory Simulations and Measurements



Instrument Development



Field and Aircraft Measurements



# First UMBC Satellite Underway...

# HARP

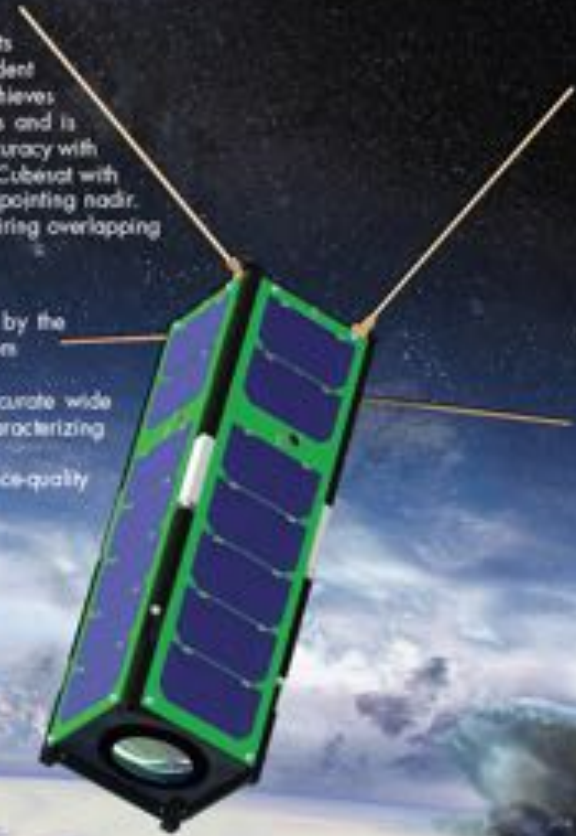
## Hyper-Angular Rainbow Polarimeter

In-Space Validation of Earth Science Technologies (InVEST)

The HARP payload is a wide FOV imager that splits three spatially identical images into three independent polarizers and detector arrays. This technique achieves simultaneous imagery of three polarization states and is the key innovation to achieve high polarimetric accuracy with no moving parts. The spacecraft consists of a 3U CubeSat with 3-axis stabilization designed to keep the imager pointing nadir. The hyper-angular capability is achieved by acquiring overlapping images at very fast speeds.

### OBJECTIVES

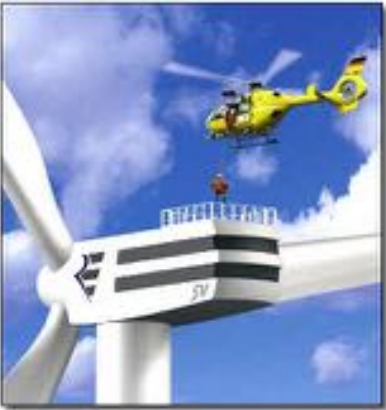
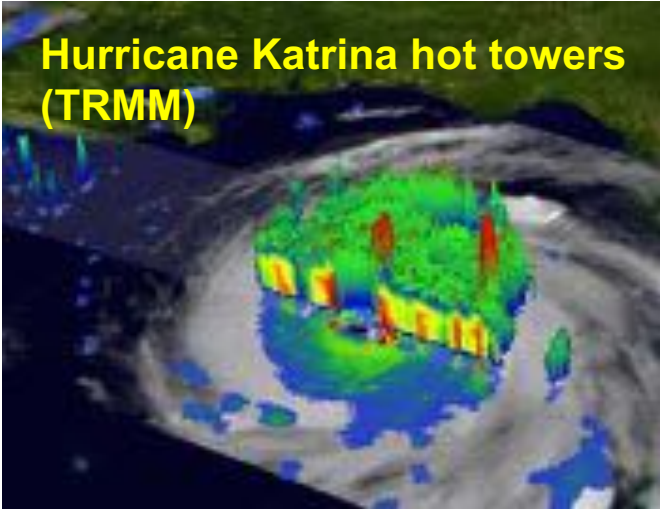
- Space validation of new technology required by the NASA Decadal Survey Aerosol-Cloud-Ecosystems (ACE) mission
- Prove the on-flight capabilities of a highly accurate wide FOV hyper-angle imaging polarimeter for characterizing aerosol and cloud properties
- Prove that cubesat technology can provide science-quality Earth Sciences data





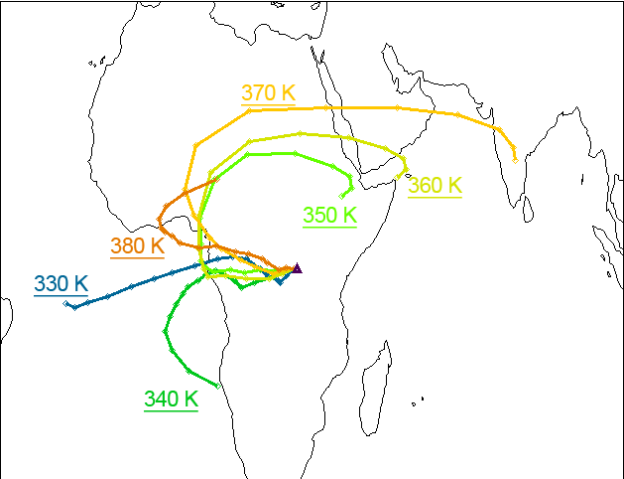
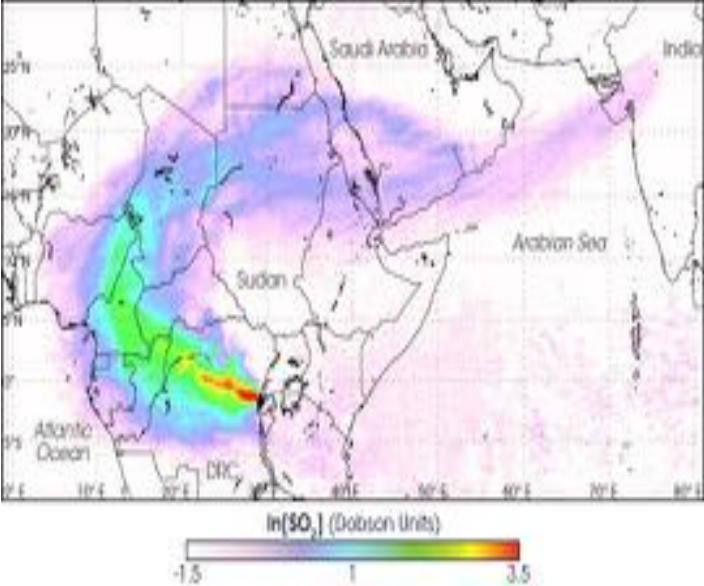
# Lynn Sparling Research areas:

**Hurricanes:** Small scale processes in the eye and eyewall and links to intensity change



**Low level winds:** Energy generation and boundary layer dynamics.

**Long-range transport:** Tracking SO2 emissions from volcanoes.







# Aerosol, Cloud, Radiation-Observation and Simulation (ACROS) Group led by

Dr. Zhibo Zhang

Supported by

NASA

Department of Energy (DOE)

National Science Foundation (NSF)

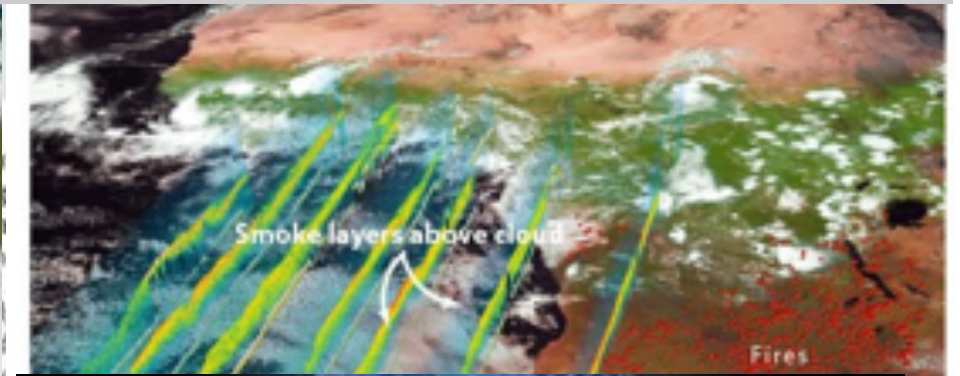
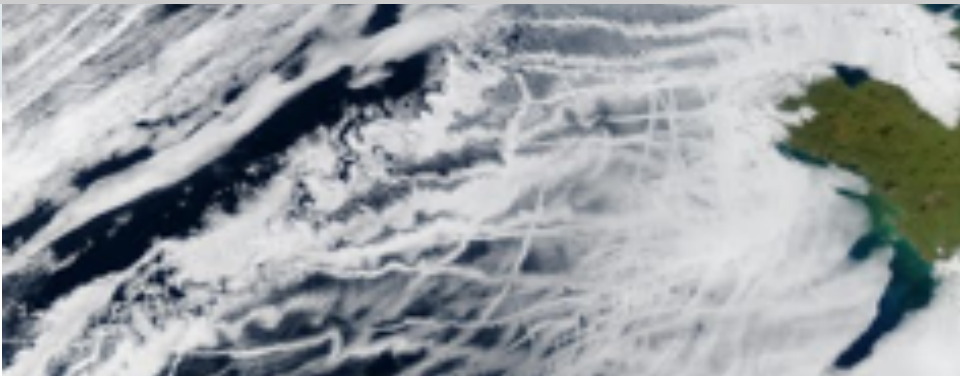


ACROS: Aerosol, Cloud, Radiation-Observation and Simulation group at UMBC

<https://sites.google.com/umbc.edu/acros/home>

Satellite-based Cloud/Aerosol Remote Sensing

Aerosol-cloud-radiation interactions



Radiative effects of aerosols

Climate modeling and evaluation



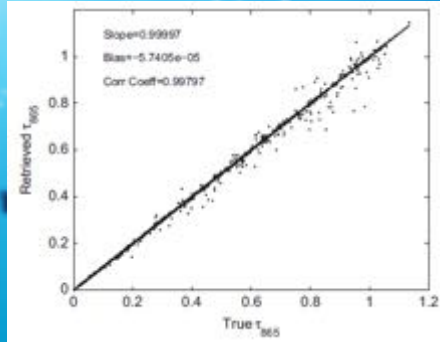
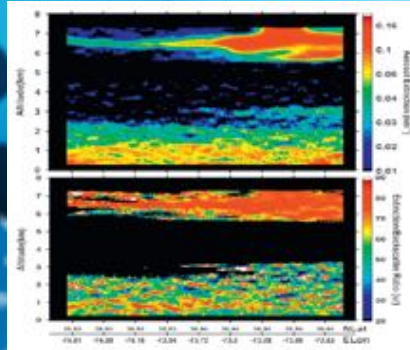


**Dr. Pengwang Zhai**  
**Physics Department, UMBC**

Quest: To develop new optical remote sensing methods for ocean water and aerosols.



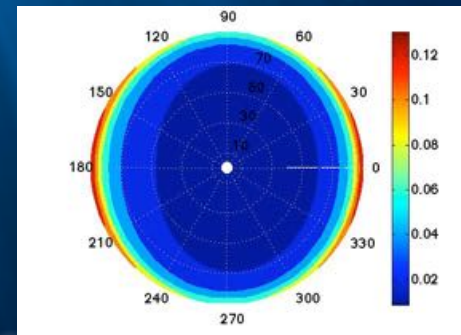
# Optical Remote Sensing



Light Scattering



Radiative Transfer

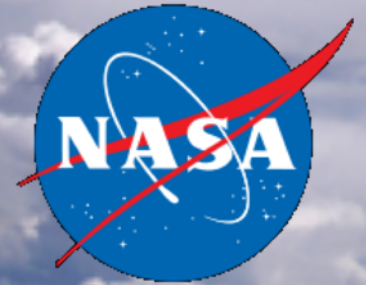




UMBC



**JCET**  
The Joint Center for  
Earth Systems Technology  
<http://jcet.umbc.edu/>



## Earth Science Joint Center with NASA Goddard

7/1/95 – 6/30/98 — *(H. Melfi)*

7/1/98 – 12/31/05 - *(Melfi/Hoff)*

10/1/05 – 9/30/10 - *(Hoff)*

10/1/10 – 9/30/15 – *(Hoff/ Eichenlaub)*

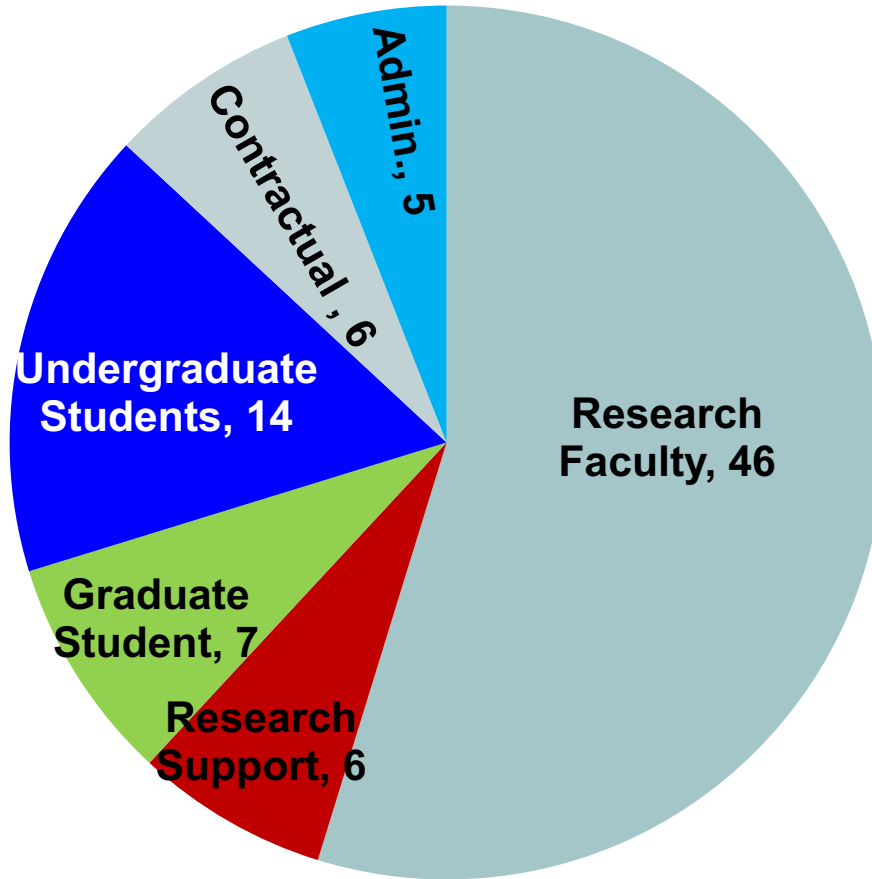
10/1/15 – 9/30/20 – *(Demoz)*

### **Beyond the numbers:**

- 2011-2017: ~ 800 journal papers
- 2006-2018: ~ 138 graduate students
- Hundreds of undergrads

**JCET 2020: Celebrating 25 years of  
collaborative research and education**

# JCET: By the numbers



## 2017-2018 JCET Composition

<i>Research Analysts</i>	5
<i>Faculty Research Assistants</i>	2
<i>Associate Research Engineer</i>	1
<i>Assistant Research Engineer</i>	1
<i>Research Assistant Professors</i>	6
<i>Assistant Research Scientists</i>	4
<i>Associate Research Scientists</i>	4
<i>Research Associate Professors</i>	10
<i>Senior Research Scientists</i>	6
<i>Research Professor</i>	6
<i>Post-Doc Research Associates</i>	6
<i>Program Coordinator</i>	1
<i>Administrative Staff</i>	5
<i>Contractual</i>	6
<i>Undergraduate Students</i>	14
<i>Graduate Students</i>	7
<b>Total</b>	<b>84</b>

# JCET: Teaching Contribution

## PHYSICS

PHYS 621: Intro to Atmospheric Science

PHYS 622: Clouds, Aerosol and Radiation

PHYS 640/440: Computational Physics

PHYS 721: Atmospheric Radiation

PHYS 741: Inverse Methods

PHYS 335: Physics & Chemistry of the Atmosphere

PHYS 112: Basic Physics II

**JCET Seminars – Professional Development for graduate students:**

PHYS 650: Precipitation Science (Spring 2018)

## CSEE

CSMC 626: Computer Security

*Honors College:*

*Climate Change & Public Policy*

*Proposed:*

*Interdisciplinary Climate Change  
(undergraduate)*

## GES

GES 302: Arctic Geography

GES 311: Weather and Climate

GES 381: Remote Sensing

GES 400x: Earth's Cryosphere

GES 415: Climate Change

GES 481/681: Remote Sensing and Image  
Processing for Environmental Applications



# Mixing Layer Height or “Boundary Layer Height”

- Diagnostic variable atmospheric transport and dispersion forecasting models.
- Without realistic PBL heights models have large errors that result in inadequate public protection against unhealthy air quality.
- National Research Council has recommended a “network of networks”<sup>1</sup>
  - After 60 years of remote sensing research, it is astounding that the PBL is not measured regularly throughout its diurnal cycle

1- NRC. 2009. *Observing Weather and Climate from the Ground Up: A Nationwide Network of Networks*. Washington, DC: National Academy Press.

# Observations Lead The Way

NRC

R. Hoff

Observing Weather and Climate  
from the Ground Up: A Nationwide  
Network of Networks (2009)

NSF

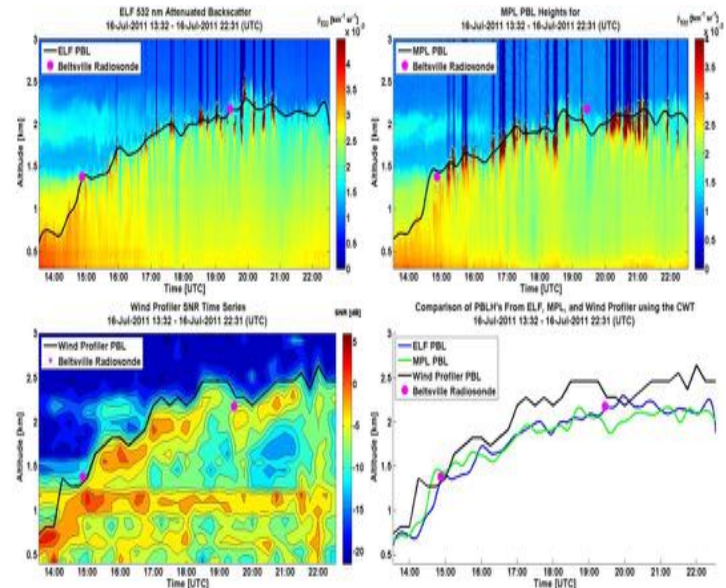
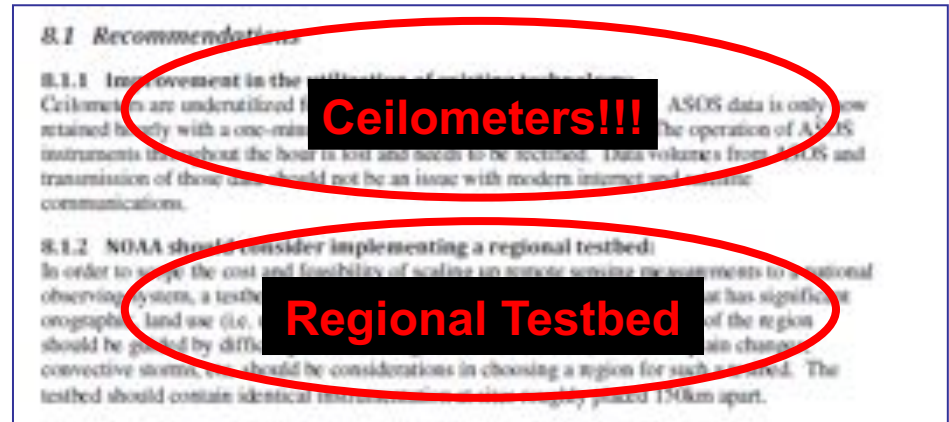
B. Demoz

Thermodynamic Profiling  
Technology Workshop (2011)

NASEM

R. Delgado

The Future of Atmospheric Boundary  
Layer Observing, Understanding, and  
Modeling (2018)

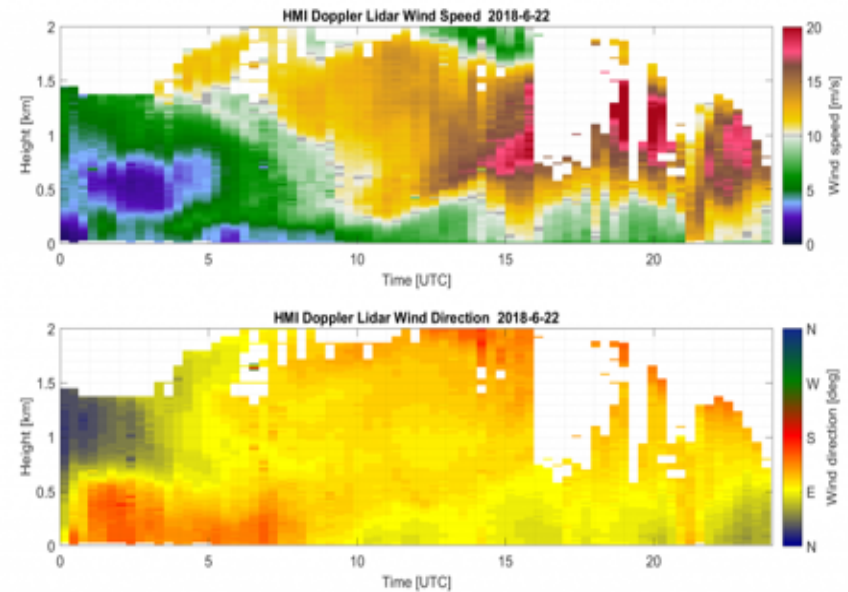


\***Compton** et al. (2013), J. Atmos. Ocean. Tech., doi:10.1175/JTECHD-12-00116.1

# Air Quality:

[www.lidar.umbc.edu](http://www.lidar.umbc.edu) or Search for “smogblog”

Land-water differences in  $O_3$  within the boundary layer and correlation of diurnal evolution of dynamics and chemistry.



What source groups and locations do policy makers need to focus on to reduce ozone over the Chesapeake Bay?

- Power Plants and Poultry/Agriculture Industry Impacting Air Quality in the Chesapeake Bay



# Interdisciplinary Research Undergraduate and Graduate Students

Atmospheric Physics

Biology

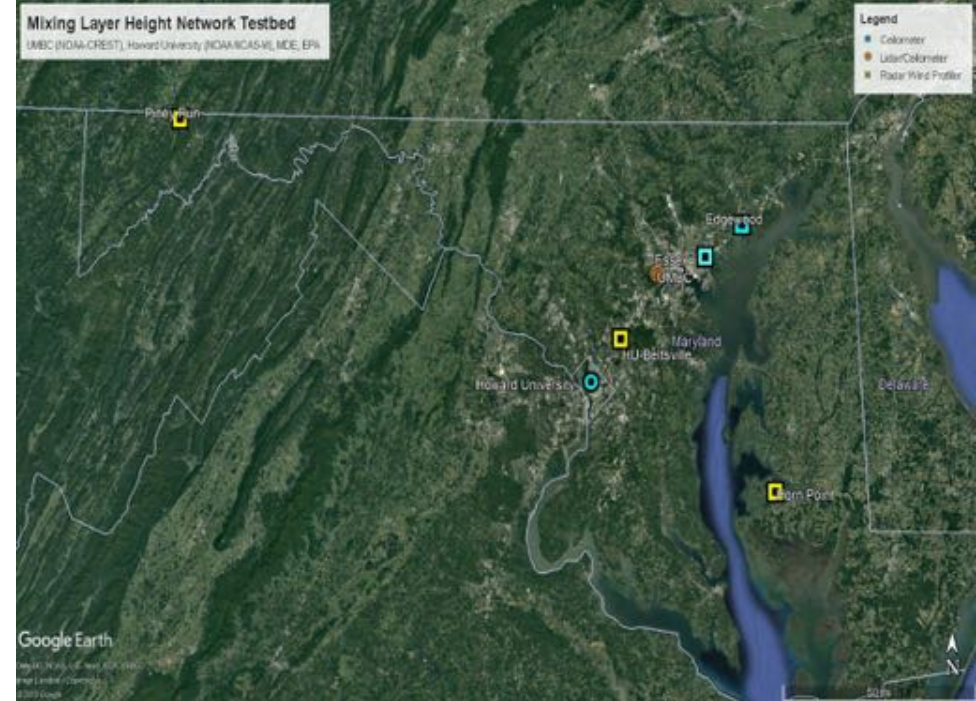
Computer Science and Electrical  
Engineering

Geography and Environmental Systems

Math and Statistics

Mechanical Engineering

Physics



## Mixing Layer Height Network Testbed

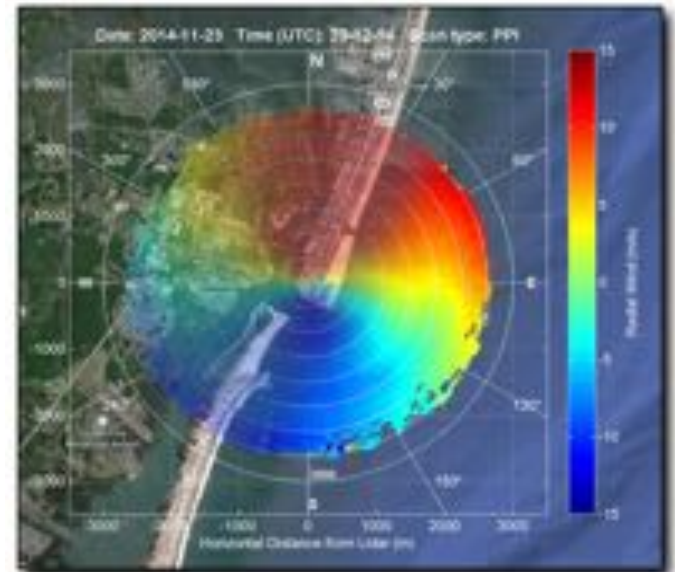
State and Federal Stakeholders  
MDE, EPA, NOAA, NASA

# “Lidar Compound Eye” View of the World Carbon Management

**All wind capacity is not created equal: untangling uncertainties in offshore wind energy development.**

## **Coastal Doppler Wind Lidar Measurements**

- Focuses on building bridges between atmospheric science and public policy to help reduce economic uncertainties in the offshore wind energy industry



# UMBC's newest research center: the Earth and Space Institute (ESI).

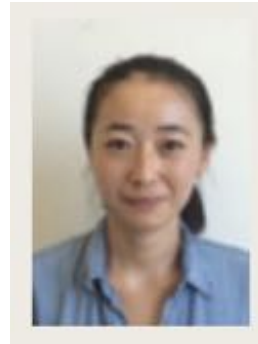




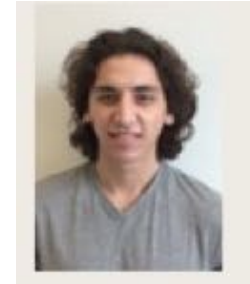
# Multiple opportunities available for graduate students

- GAANN Fellowship
- JCET research fellowship
- Research assistantship
- Teaching assistantship
- NASA/NSF fellowship

JCET Fellowship



GAANN Fellowship



Recent NASA NESSF fellowship



Recent graduates



NASA postdoc program (working for NASA!)

# Contact information

## Important Links

- UMBC Physics department
  - <http://physics.umbc.edu/>
- UMBC ATPH program
  - <http://physics.umbc.edu/research/atmospheric/>
- UMBC graduate school
  - <http://gradschool.umbc.edu/>
- UMBC Joint Center for Earth Systems Technology (JCET)
  - <http://jcet.umbc.edu/>

## Contact Information

Zhibo Zhang: ATPH program director

[Zhibo.Zhang@umbc.edu](mailto:Zhibo.Zhang@umbc.edu)

(410) 455-6315

**Apply for *ATPH* program today**