Public-Private Sector Partnerships for Atmospheric Research: Progress and Prospects

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Some General Comments

Conference theme:

"Tropical Cyclone Operations and Research: Strength and Success through Partnerships and Alliances"

My Charge:

"provide insights on the role and importance of public-private partnerships in advancing the state of the science of tropical cyclone research and of atmospheric research, in general "

The talk has a personal bias toward my own experiences. This talk may induce boredom at this conference, since it includes hurricane as well as non-hurricane and OU examples of success. Due to time limitations, this talk covers only a few examples. Side effects may include frustration and disappointment over your favorite partnership being left out. If you experience these side effects, please make a comment at the end of this talk.

Acknowledgements

- NOAA (Frank Marks, James Franklin, Russ Schneider and Jack Hayes*)
- NASA (Scott Braun and Ramesh Kakar*)
- NSF (Brad Smull and Peter Milne)
- Private sector: Mike Eilts (WDT), Peter Neilly* (Weather Channel Companies) and Walt Dabberdt* (Vaisala)
- Academic and other: Berrien Moore (OU), Raj Pandya (NCAR), Terry Hock (NCAR), Jeff Lazo* (NCAR), Bob Palmer (OU), Jerry Lengoasa* (WMO) and numerous others

Motivation for a public-private partnerships

- **Opportunities from highly specialized expertise and resources**
- **Tremendous need for actionable weather information in the private sector**
  - The sensitivity of the US economy to day-to-day weather fluctuations is $485 billion (Lazo et al. 2011)
  - The hurricane oceanic and landfall impacts (Anderson and Burham 1973; Jarell and DiMaria 1999; Pielke and Carbone 2002; Considine et al. 2004; etc)
- **The private sector is part of the end-to-end flow of information for hurricanes and other hydrometeorological disasters**
- **The private sector is impacted by disasters and plays an important role in the response and the ability to develop community resiliency**
- **Significant opportunity for profi**t
  - Information economy (e.g., weather-related videos are the 3rd most popular topic; weather related apps have been the top money making application)
  - Profit opportunities in many sectors (e.g., energy - prediction of disruptions in the Gulf and refineries, early winter conditions and the price of heating fuels, fuel purchases for air lines, power estimates for alternative energy, water resource management etc)

Why should academics care: OU examples

- School of Meteorology: 6 endowed chairs ($1M per) and 2 professorships ($0.5 M per) as a result of corporate and personal generosity (e.g., Chesapeake Energy (2), Williams Energy, American Airlines, WeatherNews, Mark and Kandi McCasland, Tommy C. Craighead and Robert E. Lowry. These endowments are primarily aimed at research excellence[1]

- Numerous smaller corporate gifts for everything from scholarships, office remodels, sponsorship of student activities, and the OU party at the AMS.

- Greater movement toward corporate partnerships on computing and modeling

- Our radar enterprise is built upon partnerships with the private sector and with NOAA

[1]Research excellence except for the speaker's endowed chair

OKLAHOMA'S EDGE
ECONOMIC DEVELOPMENT GENERATING EXCELLENCE

Development and Manufacture of Low-Cost X-Band Radars in Oklahoma

- Joint $1.8M grant between OU/ARRC and Enterprise Electronics Corporation

- Goal is the development of a low-cost, light-weight X-band polarimetric radar
  - 180 kg total weight
  - No radome necessary
  - Low-power consumption
  - Solid-State Transmitter (100 W H/V)
  - Pulse Compression
  - 2-deg beamwidth
  - Polarimetric Flexibility (sim H/V, alt H/V)

ENTERPRISE ELECTRONICS CORPORATION
EEC

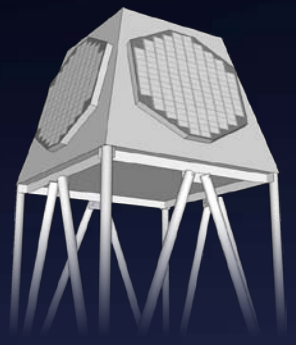
ATMOSPHERIC RADAR RESEARCH CENTER
ARRC
The UNIVERSITY of OKLAHOMA

Research Outcomes

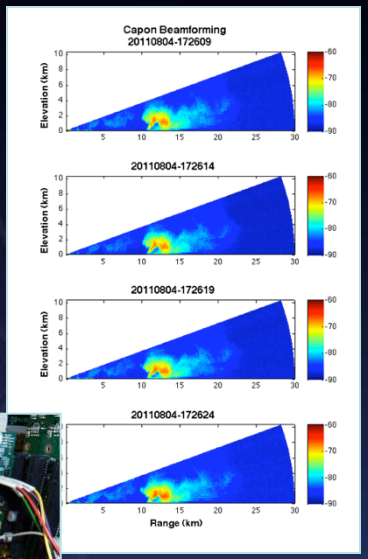
•Innovative pulse compression waveforms (non-linear FM, no tapering) with less than -50 dB range sidelobes

•Unique solid-state transmitter design with reduced power consumption

•Advanced signal processing algorithms for quality control



Multi-mission Phased Array Radar - MPAR



- OU/ARRC is working very closely with NSSL and Lockheed Martin Corporation
- Overall goal is to investigate advantages and challenges of phased array technology for weather observations

Research Outcomes

- Knowledge-based adaptive sensing
- Pulse compression for improved sensitivity
- Multi-mission including clear-air sensing
- Phased array polarimetry
- Digital array radar
- Cylindrical polarimetric PAR demonstrator
- MPAR resource allocation for QPE
- Efficient digital receiver design

NATIONAL SEVERE STORMS LABORATORY
U.S. DEPARTMENT of COMMERCE
NATIONAL OCEANIC and ATMOSPHERIC ADMINISTRATION

ATMOSPHERIC RADAR RESEARCH CENTER
ARRC
The UNIVERSITY of OKLAHOMA

LOCKHEED MARTIN

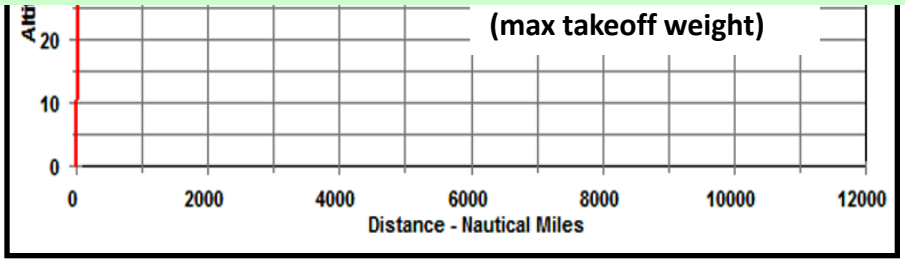
Partnerships

- Advanced capability in the private sector
  - NASA Hurricane research
  - Phased array and other advanced radar technology
  - Cloud physics instrumentation for NSF research
- Advanced capability developed outside the private sector
  - Dropsonde for hurricane research
  - Modeling including the FSU super ensemble
- Development partnerships
  - The large enterprise associated with remote sensing from space
  - Doppler on Wheels: NSF facility for research including for hurricane landfall
  - Stratospheric ballooning and driftsonde for Antarctic

NASA's Global Hawk Unmanned Airborne System

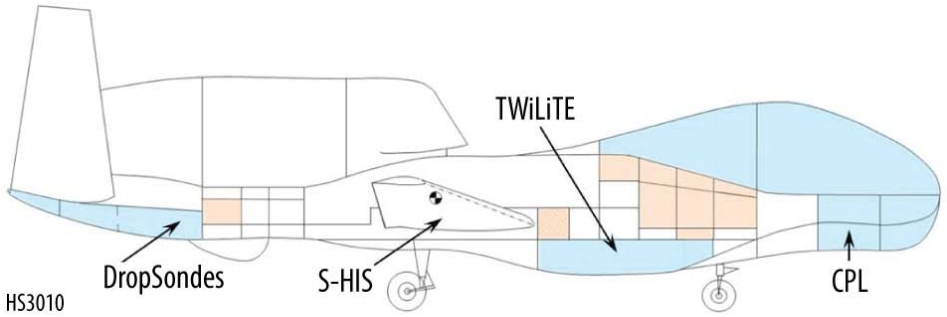
NASA and Northrop Grumman are returning NASA's two Global Hawk aircraft to flight this year under a Space Act Agreement signed in May 2008. NASA plans to use the aircraft for missions to support its Science Mission Directorate and the Earth science community that require high-altitude, long-distance airborne capability.

"Today marks the debut of NASA's newest airborne science capability," said Kevin L. Petersen, director of Dryden. "These Global Hawks represent the first non-military use of this remarkable robotic aircraft system. NASA's partnership with Northrop Grumman has made this possible."

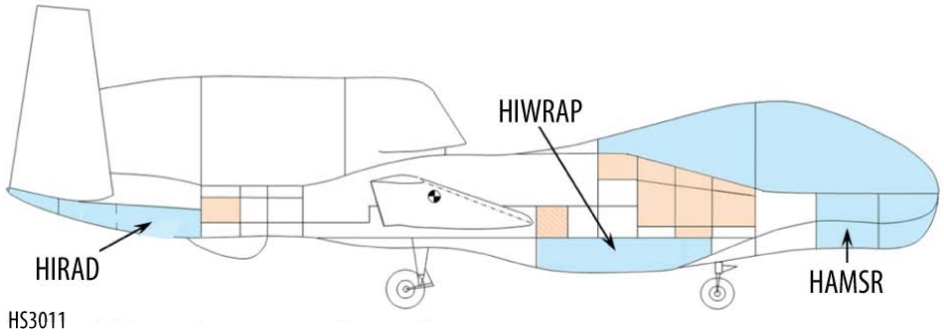


HS3 Measurements

Environmental Measurement Configuration



Over-Storm Measurement Configuration



HS3 will utilize two NASA Global Hawks:

- One equipped to sample the storm environment
- One equipped to sample the storm inner core

Hurricane and Severe Storm Sentinel (HS3)

Application of the Global Hawk for Hurricane Studies

PI: Scott A. Braun (GSFC)

Science Goal:

To understand hurricane genesis and intensification.

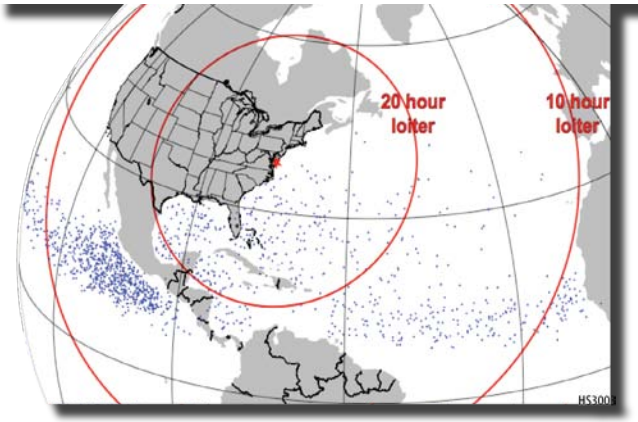
Key Science Questions:

- How do hurricanes form?
- What causes rapid intensity changes?
- What is the role of deep convective cores in intensification?
- What's the role of the Saharan Air Layer?

Deployment Details:

- Deployments during hurricane seasons of 2012, 2013, and 2014
- Based at NASA's Wallops Flight Facility in Virginia
- 275 science flight hours (~10-11 26-hour flights) per deployment

Genesis Locations and Loiter Times



Two Global Hawk (GH) aircraft

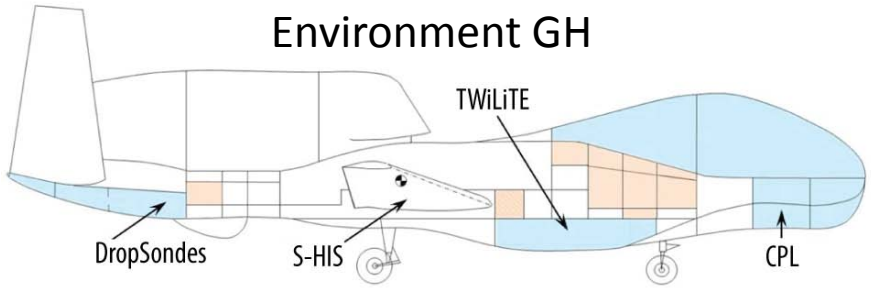
Environment GH instrumentation

- TWiLiTE (direct detection wind lidar)
- CPL (cloud & aerosol lidar)
- Scanning HIS (T, RH)
- Dropsondes (wind, T, RH)

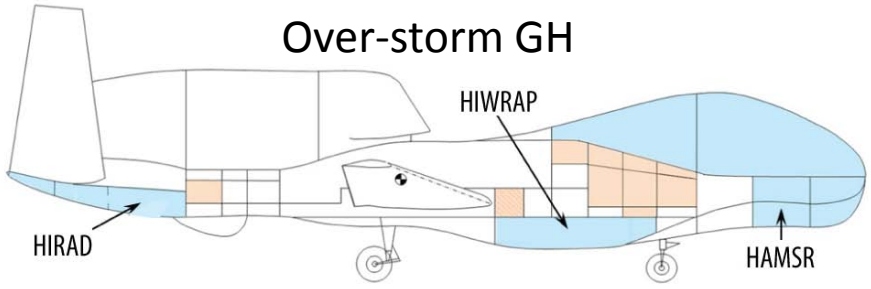
Over-storm GH instrumentation

- HIWRAP (3-D preip. + 3D winds + sfc winds)
- HIRAD (sfc winds and rain)
- HAMSR (T, RH, hydrometeor profiles)

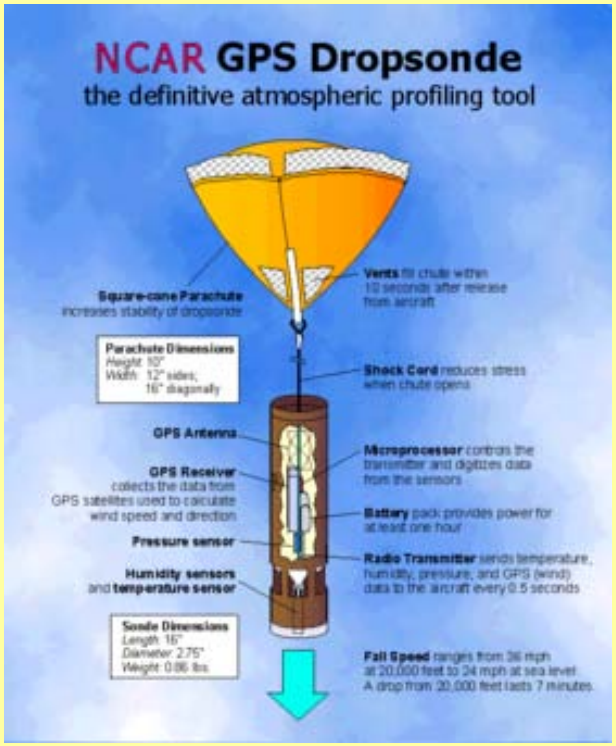
Environment GH



Over-storm GH



Dropsonde



- First developed by NCAR in the 1970s
- Licensed to and long-term relationship with Vaisala; NSF facility and also used by NASA and NOAA
- Extensive use for operations and for hurricane research (e.g., targeting and data assimilation studies, treatment of boundary layer physics in numerical models, tropical cyclone dynamics, etc)
- In 2011, NCAR was awarded the Governor's Award for High-Impact Research for its work with dropsondes
- Partnership with NASA on Global Hawk dropsonde system

Corporate and Individual Generosity

- Google.org, in 2008 the philanthropic arm of Google (NASDAQ: GOOG), has announced grants of more than $14 million to support partners working in Southeast Asia and Africa to prevent the next pandemic.

  - Columbia University International Research Institute for Climate and Society (IRI) – $0.9 M multi-year grant to improve the use of forecasts, rainfall data and other climate information in East Africa, and link weather and climate experts to health specialists so they can better predict outbreaks of infectious diseases.

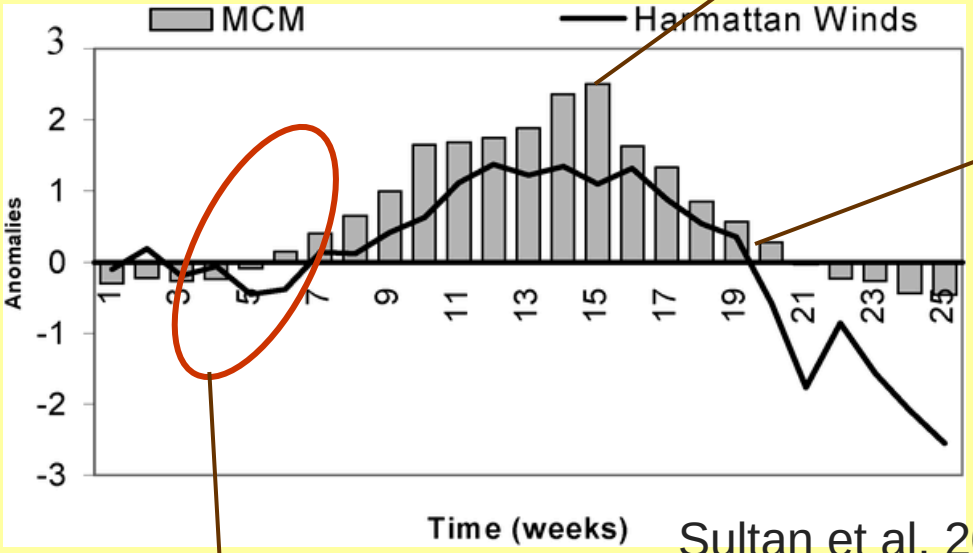
  - University Corporation for Atmospheric Research – $0.9 M multi-year grant to build and implement a system that will use weather projections to inform and target response to disease threats in West Africa.

SDS Impacts on Respiratory Health: Africa

- Acute respiratory infections among children are one of the major causes of mortality in developing countries, especially in Africa (Black et al., 2003; Romieu et al., 2002; Smith et al., 1999).
- Bacterial meningitis can affect 100,000 people in Africa each year with 10,000 fatalities and ¼ of people with some permanent disability.

Predictability & Early Warning of Bacterial Meningitis?

Do environmental factors control amplitude?



Sultan et al. 2005, IRD

Can we predict the return to humid conditions and the end of the epidemic?

Can we predict the onset -- vegetative index, wind, dust, and dryness?

Corporate and Individual Generosity

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  - While a long-term partnership did not result for these weather efforts, this philanthropy was seed funding that jump started initiatives in weather-health in the US, a meningitis forecast system in Africa, and a dust forecast and research center for N. African in Spain and supported by the Spanish government

Challenges to overcome

- The gap from development to commercialization is large vs. developers initially have more knowledge about the product
- Difference in goals (e.g., profits, mission oriented research, scientific knowledge, education) can impede collaboration
- Private-public partnerships are relatively sensitive (e.g., change in business priorities, impacted by new partners, change in personnel, one inept graduate student, etc.)
- Partnerships often take time to develop
- Intellectual property is looked upon differently by researchers, administrators and the private sector (e.g., why pay twice)

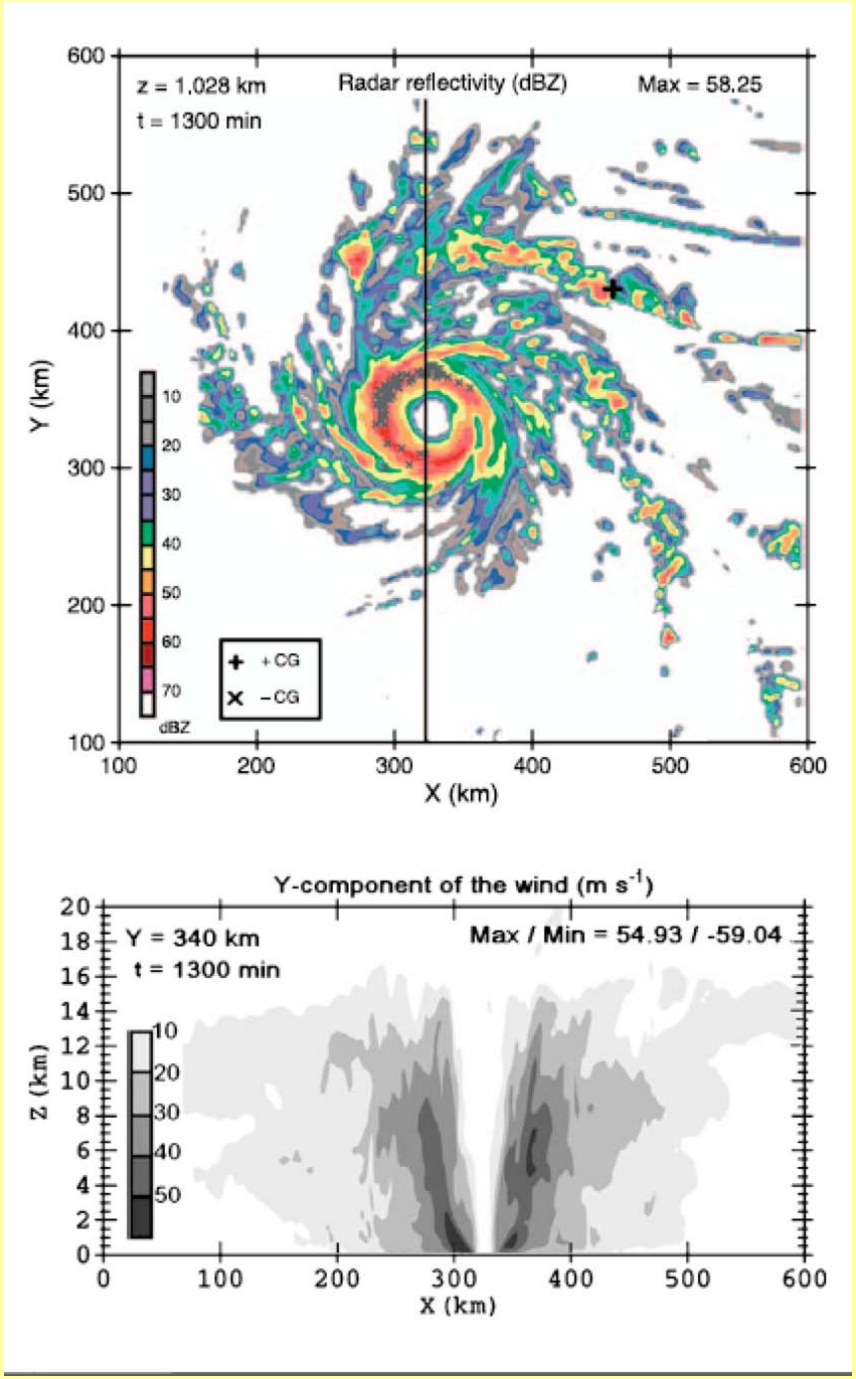
Future

- Hurricane community (to me) has a high degree of cooperation between partners (e.g., PREDICT, HS3 and NSF instruments on the NASA Global Hawks, private sector rep in HFIPS, research and operational collaboration NOAA-NASA, NOAA-NSF researchers, etc).

- Continue and expand partnerships on advanced instrumentation and use all tools available (from PI driven NSF MRIs (and SBIRs?) to NASA high level agreements). Requires continued communication on trends in technology, research and operations

- Weather Ready Nation requires greater cooperation between physical and social science research. The public-private sector needs overlap for hurricane forecasts (e.g., how to communicate information, response to information). Corporate sponsorship of this type of social science research should be explored.

- Development of partnerships in modeling due to technical trends in computing and research frontiers in convection permitting (1 km) ensembles and convective resolving (10 m grid) models



US-French CONCORDIASI

Sounding coverage from driftsonde