60th INTERDEPARTMENTAL HURRICANE CONFERENCE

Tropical Cyclone Reconnaissance and Observations Systems Wrap-up

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Why Wrap-up?

• Action item from 59th IHC:
  – Develop interagency strategy for future airborne / spaced-based tropical cyclone recon / observation
    • Addresses full range of observing technologies (e.g., manned, unmanned, space-based, SFMR upgrades, next generation dropwindsondes, etc.)

• Expected outcome from the 60th IHC:
  – A list of current and promising tropical cyclone observation capabilities
    • Serve as initial framework for development of future tropical cyclone airborne / space-based tropical cyclone observation needs and requirements
Strategy

- Used information from:
  - Session 2: *Observing the Tropical Cyclone and its Environment from Genesis to Post Storm: Current Capabilities to Future Requirements*
  - Poster session
  - Other sessions
    - Session 3: *Tropical Cyclone Modeling and Prediction*
    - Session 4: *JHT—Transitioning Research to Operations*
New airborne technology **trifecta**
- Stepped Frequency Microwave Radiometer (SFMR)
  - C-band, nadir viewing radiometer
- Airborne tail doppler radar
- GPS dropsonde
- Instrument **trifecta** is essential for real-time interpretation of rapidly changing events, especially near landfall

Airborne ocean profilers (AXBT, AXCTD): ocean heat content

**Operational Scanning Radar Altimeter (SRA)**
- Airborne measurement of directional wave spectra
- NASA system flown last mission; potential replacement funded by NOAA Phase I Small Business Innovative Research (SBIR) contract

**Imaging Wind and Rain Airborne Profiler (IWRAP)**
- Dual band (C and Ku), dual-polarized pencil-beam airborne radar
- Obtain ocean surface wind field and vertical profiles of the atmospheric boundary layer (ABL) winds
Aircraft

• Future
  – NOAA SRA
  – SFMRs on AF WC-130s
    • Nov 06: Testing complete
    • ’07 season: ~ 4 SFMR systems
    • ’08 season: all WC-130s
  – Advanced Wind and Rain Airborne Profiler (AWRAP)
    • High resolution measurements of ABL winds, precipitation, and ocean surface winds
    • Much improved sensitivity; advanced algorithms applied to IWRAP raw data
      – Improved ABL obs (w/i 50 m of sfc) compared to IWRAP
Aircraft

- Future
  - Hurricane Imaging Radiometer (HIRad)
    - Follow-on to SFMRs
    - Compatible with airborne platforms, including unmanned aircraft systems (UAS), and payload for space-based platforms
  - Global Environmental Micro Sensors (GEMS) (??)
    - Lagrangian drifters
    - Operational Issues
      - Deployment scenarios (cost, practicality, etc.)
      - Aviation hazards
      - Robustness to harsh conditions in tropical cyclones (e.g. rain out)
Aircraft - Hurricane Research

- NOAA P-3s, NCAR ELDORA, NRL P-3
  - Vital instrumentation: key to advancing hurricane science
- NASA ER-2

TCSP ER-2 Instrument Payload

- High Altitude MMIC Sounding Radiometer (HAMSR)
- Microwave Temp. Profiler (MTP)
- ER-2 Doppler Radar (EDOP)
- Cloud Radar System (CRS)
- MODIS Airborne Simulator (MAS)
- Advanced Microwave Precipitation Radiometer (AMPR) Lightning package (LIP) REVEAL

- Hurricane Dennis, Tropical Storms Eugene & Gert, Hurricane Emily (night overflight!)
UAS - Hurricane Research

- Unmanned Aircraft Systems (UAS)
- Ms. Sara Summers (NOAA/ESRL)
An aircraft like the Global Hawk could fly above the hurricane at 60 to 65 K, staying with the storm for extended periods.

It could use remote sensors (radar and Stepped Frequency Microwave) to continuously monitor hurricane surface winds.

It could drop sondes to continuously monitor storm central pressure, and oceanic sondes to determine sea temperatures.

It could carry repeaters so that it could maintain cell phone communications in the affected areas as the storm makes landfall.
UAS - Hurricane Research

Potential Use of Low Level UAS

- Low level hurricane environment too dangerous for manned planes
- Location of environment where the ocean's warm water energy is directly transferred to the atmosphere just above it
- Low-level in situ measurements will potentially enhance existing observational capabilities within the tropical cyclone environment
Key participants:
NOAA: Ed Rappaport and Naomi Surgi
NASA: Ramesh Kakar and Robbie Hood
Air Force: Col Mark Weadon

Question: How can we collaborate on hurricane monitoring + research?
• Our Agencies have different mission objectives, but our end goals are the same
• First step in our pathway forward: National mission / experiment involving UAS
• Develop a plan for Near Term

#1 NOAA Priority identified by modeling and forecasting community: very low altitude operations & research, i.e. <300M
• Conduct a low level UAS Hurricane demonstration in 2006 (Joe Cione)
UAS - Hurricane Workshop

Key Questions

• Will UAS platforms / instruments provide data that will IMPROVE THE FORECAST?

• Will the data improve the models and provide a better analysis for forecasters, particularly in the short-term?

• What will the data provide above what we are already getting from satellites and manned planes?

• Where are the current data gaps, and what combination of UAS(s) and sensors would serve to fill those gaps?

• Could the UAS test platform(s) be used to develop and test new instruments?
Satellite

- **Continuing to exploit current satellite data**
  - Positive impact of satellite data for SHIPS
  - Data assimilation into NWP
  - Identification of signals of secondary eyewall formation
    - Precursor of eyewall replacement cycles
      - WindSat
      - Advanced Dvorak Technique (ADT)
      - Satellite-based Tropical Cyclone Current Intensity Consensus (SATCON)
- **Future**
  - Prepare to exploit data from future satellites: COSMIC, GPM, NPOESS, GOES-R+
Summary / Next Step

• Have developed framework of future tropical cyclone airborne / space-based tropical cyclone observation needs and requirements

• As required, form Joint Action Group to review / refine
  – Develop interagency plan for future airborne / spaced-based tropical cyclone recon / observation