Research Opportunities for Operational Airborne Fleet in 2030

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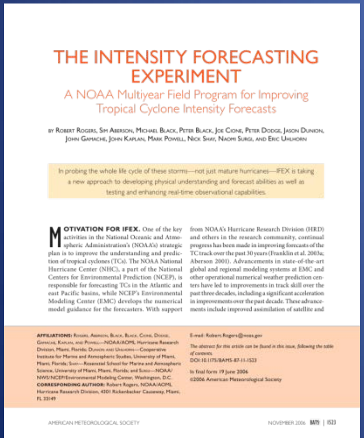
Research challenges with tropical cyclones (TCs)

- Rapid intensity changes, including genesis
- Structure changes (e.g., shear interactions, SEF/ERCs, wind field expansion)
- Track deviations
- Rainfall
- Storm surge

Addressing these issues requires a multiscale approach

- Environmental - O(1000 km) - troughs, shear, dry air, SST/OHC distributions
- Vortex - O(1-100 km) - symmetric/asymmetric dynamics, VRWs, M distributions
- Convective - O(1 km) - convective bursts, vortical hot towers
- Turbulent/PBL - O(1-100 m) - surface fluxes, PBL mixing, entrainment
- Microscale - O(1mm) - hydrometeor production, latent heating

Intensity Forecasting Experiment (IFEX): Three objectives



THE INTENSITY FORECASTING EXPERIMENT

A NOAA Multiyear Field Program for Improving Tropical Cyclone Intensity Forecasts

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In probing the whole life cycle of these storms—not just mature hurricanes—IFEX is taking a new approach to developing physical understanding and forecast abilities as well as testing and enhancing real-time observational capabilities.

MOTIVATION FOR IFEX. One of the key activities in the National Oceanic and Atmospheric Administration's (NOAA's) strategic plan is to improve the understanding and prediction of tropical cyclones (TCs). The NOAA National Hurricane Center (NHC), a part of the National Centers for Environmental Prediction (NCEP), is responsible for forecasting TCs in the Atlantic and east Pacific basins, while NCEP's Environmental Modeling Center (EMC) develops the numerical model guidance for the forecasters. With support from NOAA's Hurricane Research Division (HRD) and others in the research community, continual progress has been made in improving forecasts of the TC track over the past 30 years (Franklin et al. 2003a; Aberson 2001). Advancements in state-of-the-art global and regional modeling systems at EMC and other operational numerical weather prediction centers have led to improvements in track skill over the past three decades, including a significant acceleration in improvements over the past decade. These advancements include improved assimilation of satellite and

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Rogers et al., BAMS, 2006, 2013

1) Sampling throughout TC lifecycle for model DA, evaluation
2) New measurement technologies
3) Physical process research

Looking ahead to 2030

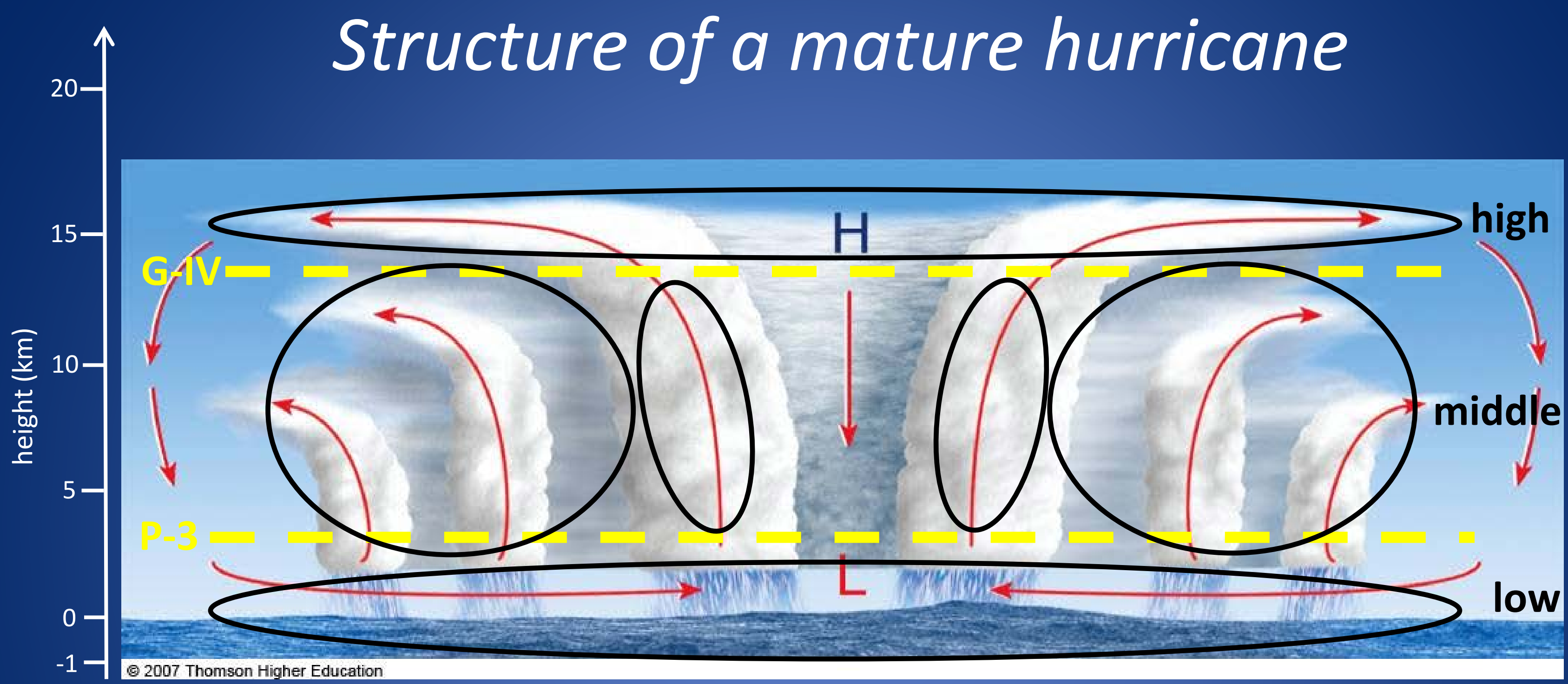
Technology will advance

- Modeling & DA capabilities
  - resolution increases
  - sophistication of data assimilation
  - complexity of physical parameterizations
- Observing platforms and instruments
  - mixed fleet of manned and unmanned aircraft
  - miniaturization of sensors

Scientific needs will remain

- Observations will be needed to address them
- P-3's will likely be at or near the end of their service life
- New observing techniques should consider
  - necessary fields
  - spatial coverage
  - temporal continuity
  - geographic range

Gaps in our airborne observing systems



- Low: air-sea fluxes; surface-layer temperature, moisture, wind field; subsurface current structure
- Middle: microphysical structure, especially above melting level; three-dimensional winds, temperature, moisture in clear air
- High: outflow kinematic structure; radiative field

Current aircraft incapable of optimally sampling these areas

Requirements for new airborne platforms and instrumentation

Low: primarily unmanned platforms

- measure temperature, moisture, winds in lowest 1-2 km and at surface
  - in situ unmanned (e.g., Coyote, Aeroclipper)
  - remote sensing from manned or unmanned (e.g., HIRAD)
- measure SST, subsurface structure
  - expendables from manned or unmanned (e.g., IR sondes, airborne-deployed AUVs)

Requirements for new airborne platforms and instrumentation

Middle: combination manned/unmanned

- microphysics above melting level
  - manned (e.g., airborne dual-Pol, A-10)
  - unmanned (e.g., Global Hawk with dual-Pol, GH deploy Coyote)
- winds, temperature, moisture in clear air
  - manned (e.g., lidar)
  - unmanned (e.g., HAMSR)
- finer-scale convective structure
  - manned (e.g., phased-array)
  - unmanned (e.g., HIWRAP on GH)

Requirements for new airborne platforms and instrumentation

Upper: unmanned platforms

- winds in outflow layer
  - unmanned: dropsondes from high-altitude, long endurance (e.g., Global Hawk)
  - unmanned: tracers deployed from balloons