Convective Process Experiment (CPEX) 2017: Science Highlights

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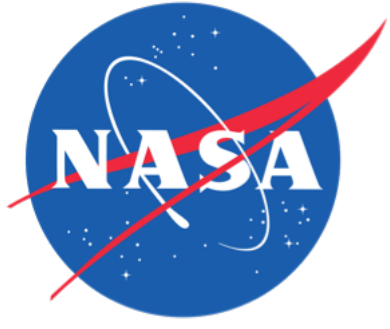


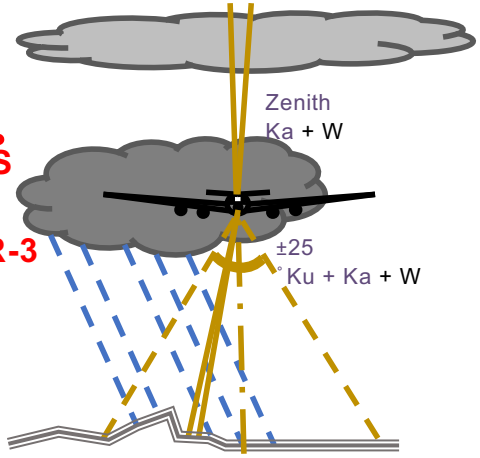
CPEX Science Meeting, Seattle, 16-18 July 2019

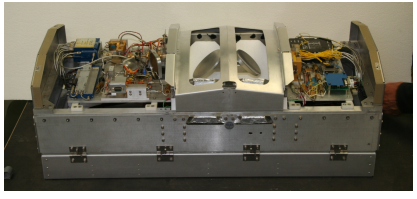
CPEX Science Objectives:

- **Better understanding of tropical convective processes including cloud dynamics, downdrafts, cold pools and thermodynamics during initiation, growth, and dissipation.**
- **Obtain a comprehensive set of simultaneous wind, temperature, and moisture profiles in vicinity of deep convection in all phases of convective life cycle.**
- **Improve model representation and prediction of convective and boundary layer processes.**

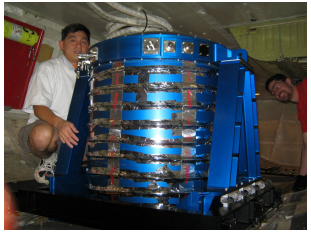
DC-8 Instrumentations

(NASA CPEX field campaign May-June 2017)

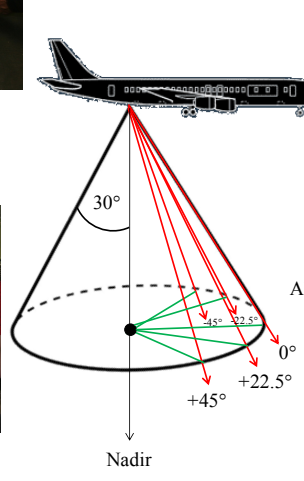




HAMSR



DAWN

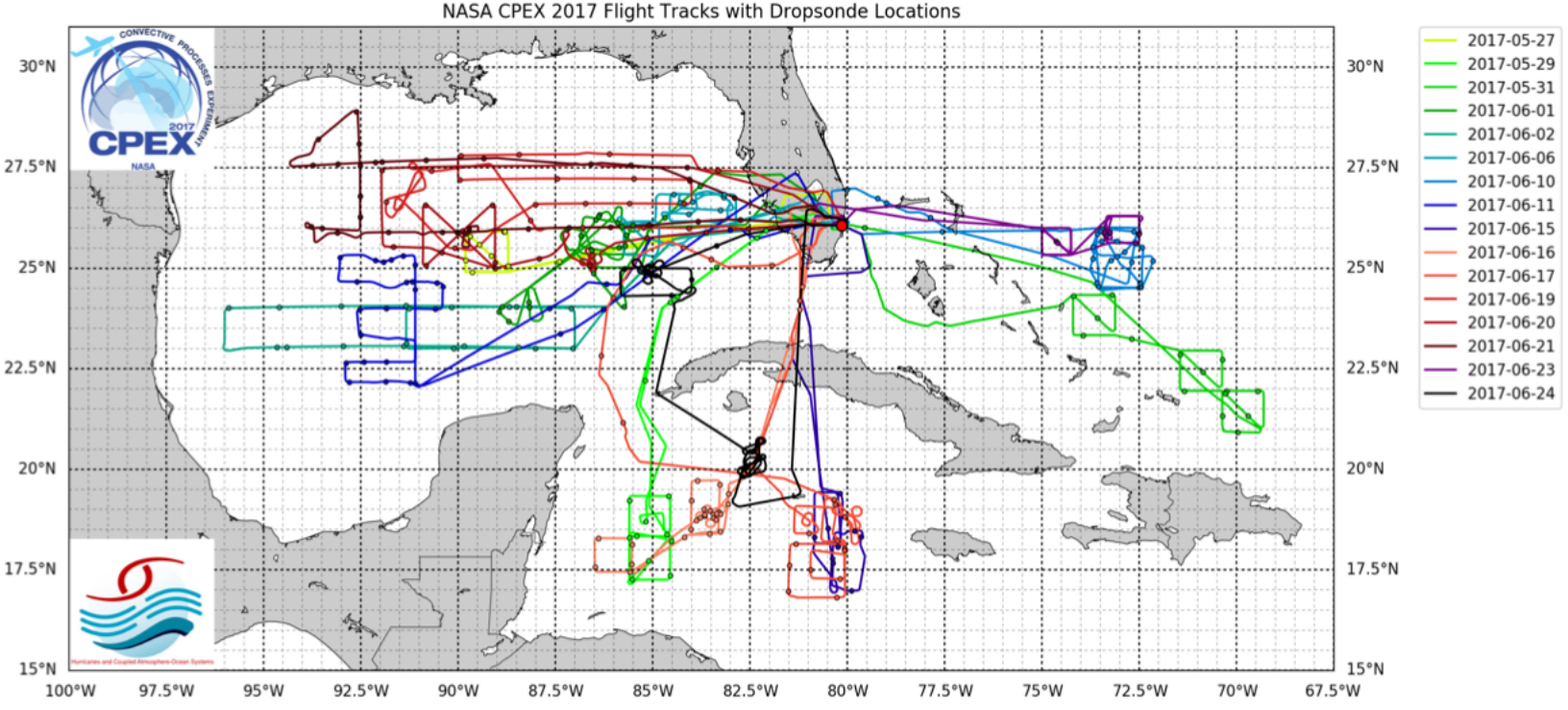


Example:
1 pattern = 22 s = 5.1 km
Along-Track & Temporal Resolution

Swath Width Depends on Flight Level
e.g., 6.5 km for 8 km FL

APR-3

DC-8 flight tracks during CPEX
(May-June 2017)



<u>16 missions</u>:

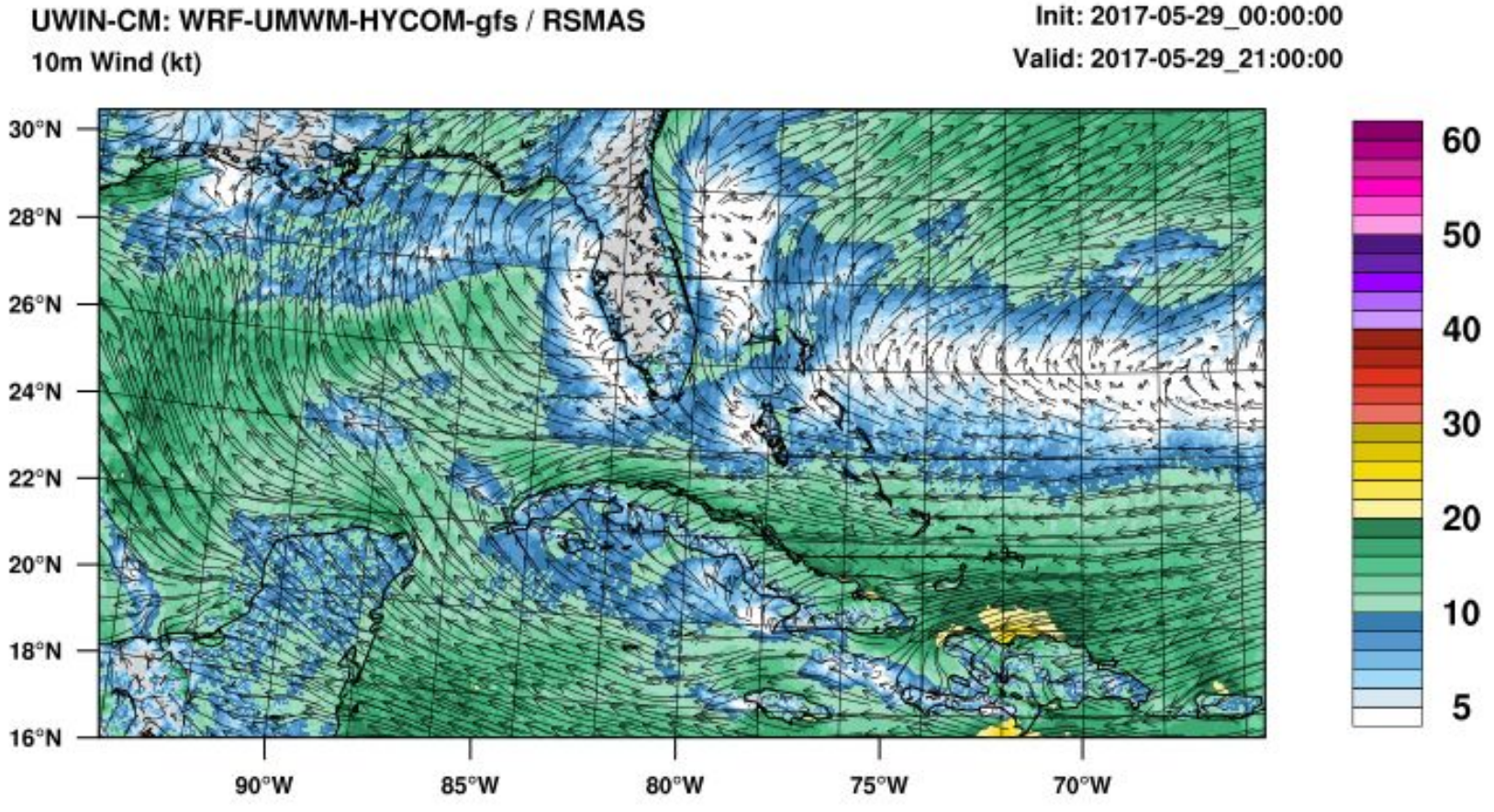
4 non-convective, 3 isolated convection, 2 cloudy, 3 MCSs, 2 pre-TC, 2 Tropical Storm Cindy

CPEX Website

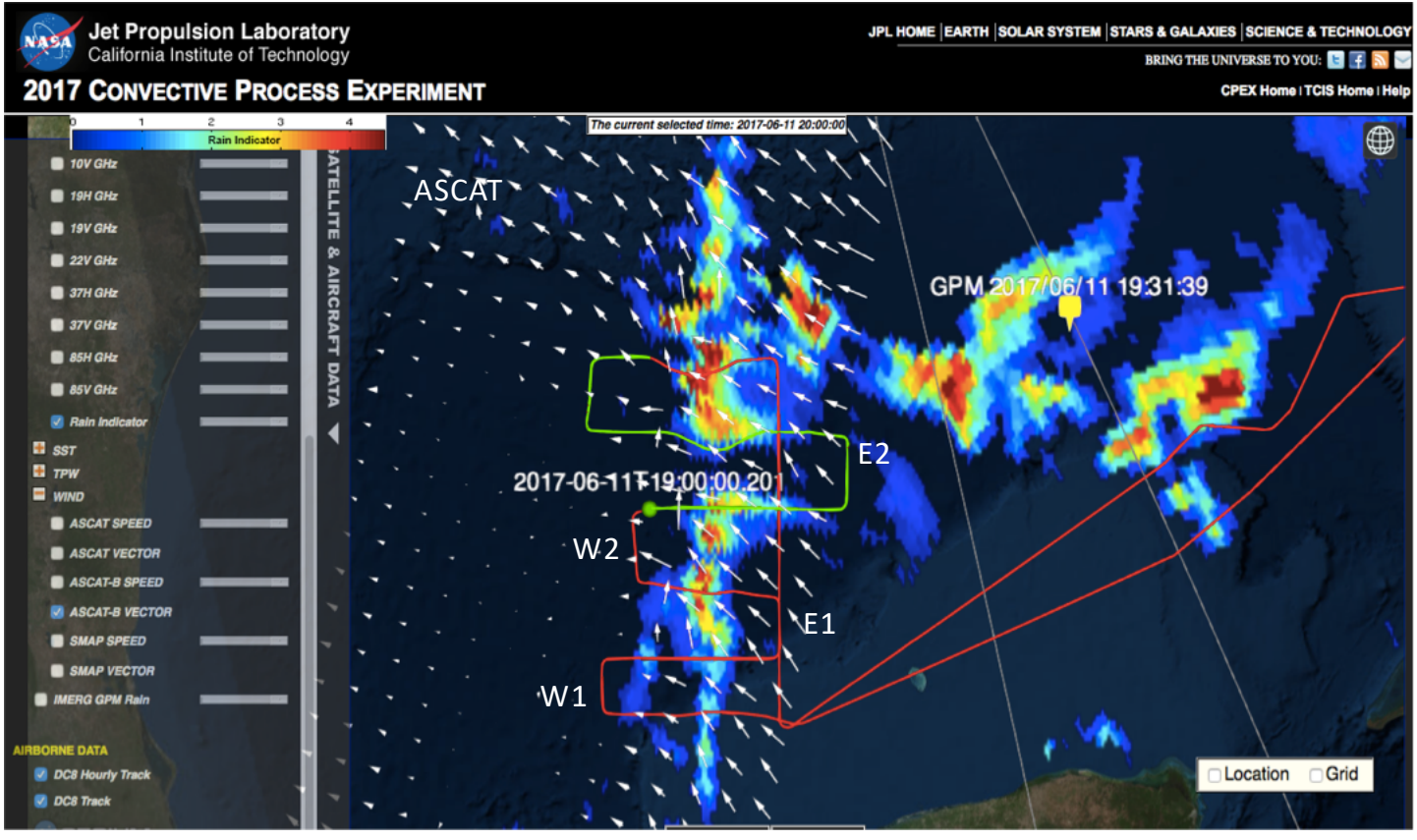
https://cpex.jpl.nasa.gov

- **Served as the official project website, offering the following resources:**
  - Event Calendar
  - Flight and Science Summaries
  - Daily Forecast Reports
  - Quicklook Images
  - Information about aircraft and instruments
  - Team contact information and campaign image gallery
  - **Gateway to related data resources –**
    - **Data Portal (https://cpexportal.jpl.nasa.gov)**
    - **FTP server for all observed data and GFS**
    - **Model Forecast pages, etc.**

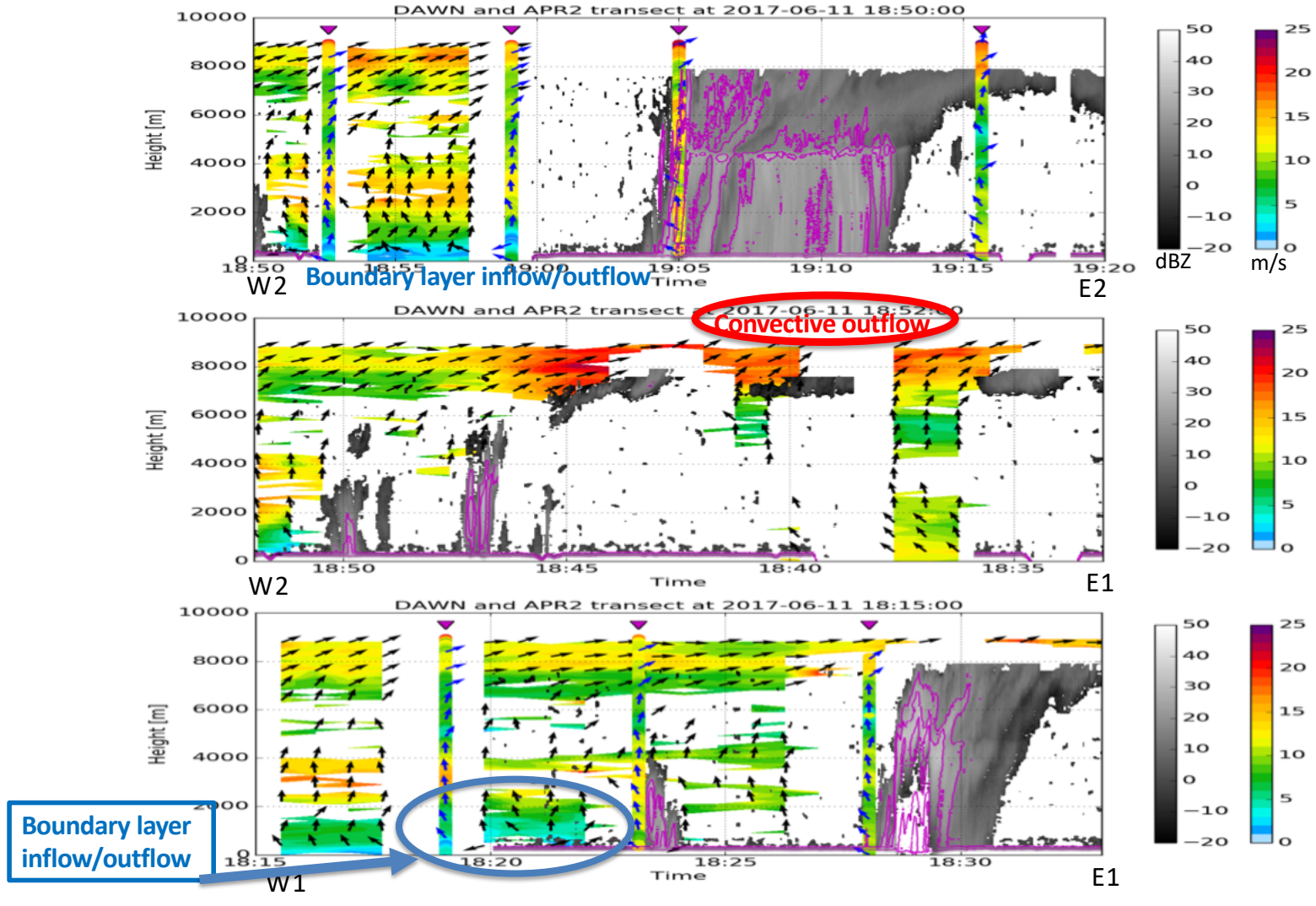
CEPX Daily Weather Forecast (UWIN-CM, coupled atmosphere-wave-ocean model)

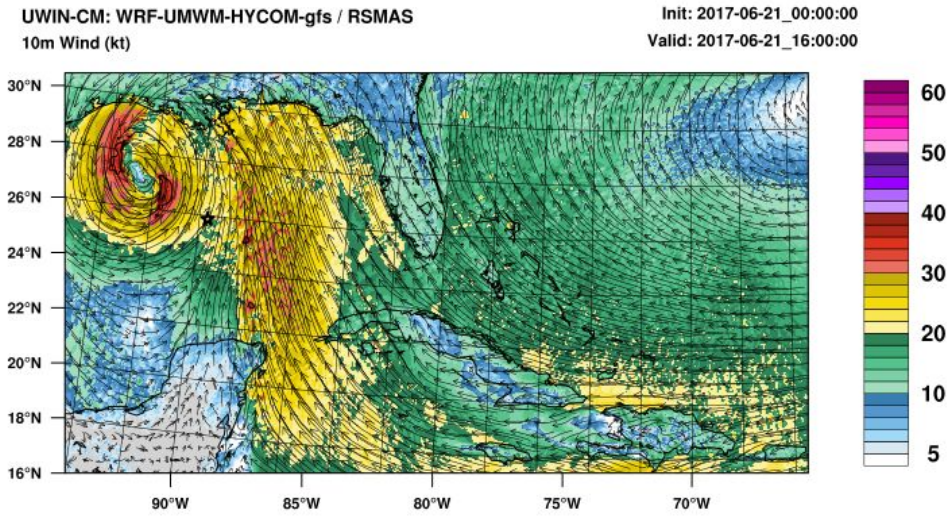


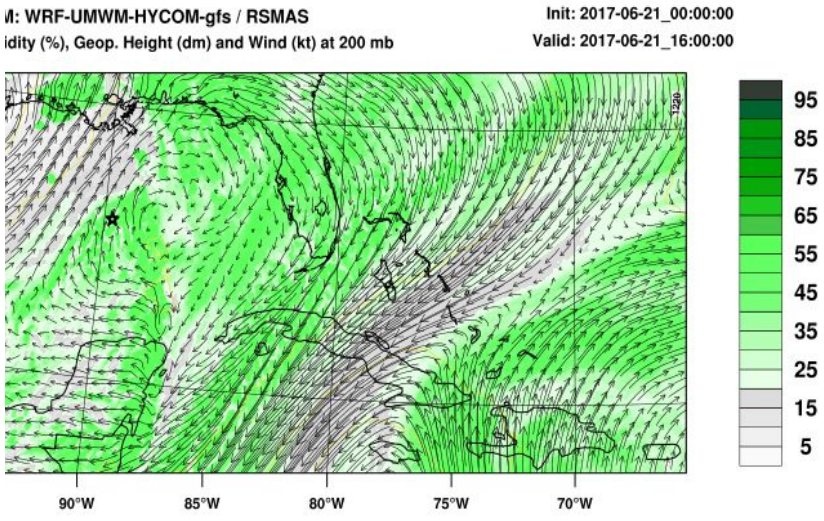
11 June 2017: Convective systems (APR2) and environment (DAWN)



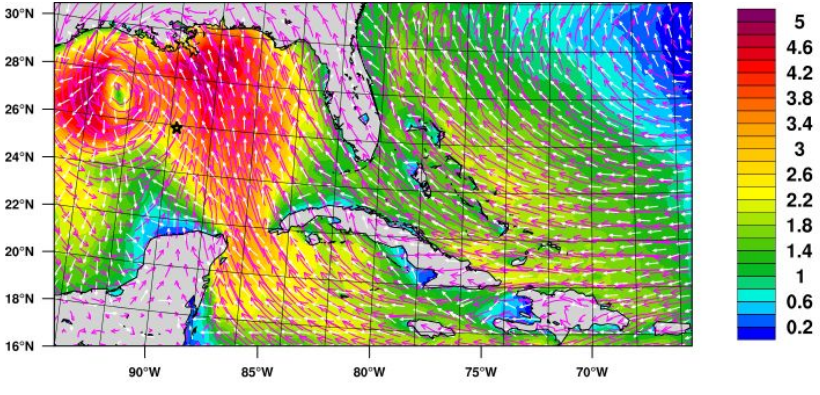
NASA DC-8 flight tracks (red and green) overlaid with GPM and ASCAT overpasses


DAWN and APR2 transect at 2017-06-11 18:50:00
Height [m]
Time
dBZ
m/s
W2
Boundary layer inflow/outflow
E2
DAWN and APR2 transect at 2017-06-11 18:52:00
Convective outflow
W2
E1
DAWN and APR2 transect at 2017-06-11 18:15:00
Boundary layer inflow/outflow
W1
E1



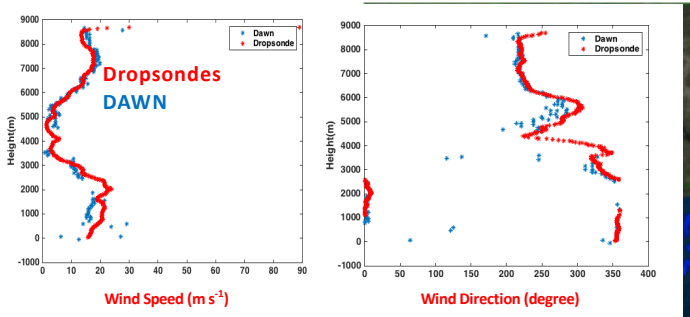


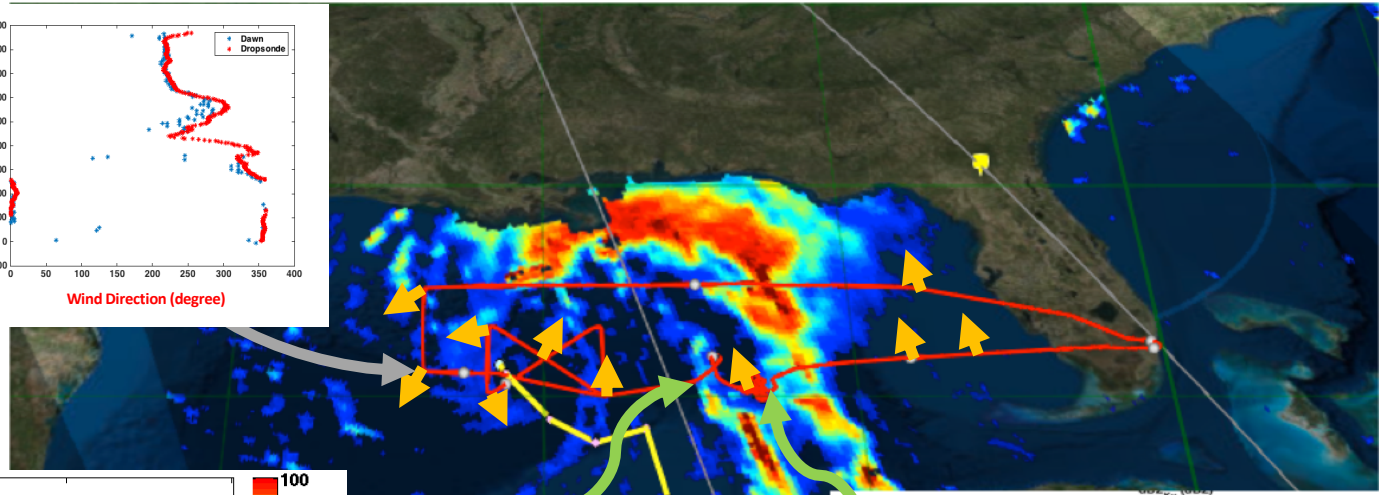
Significant Wave Height (m)

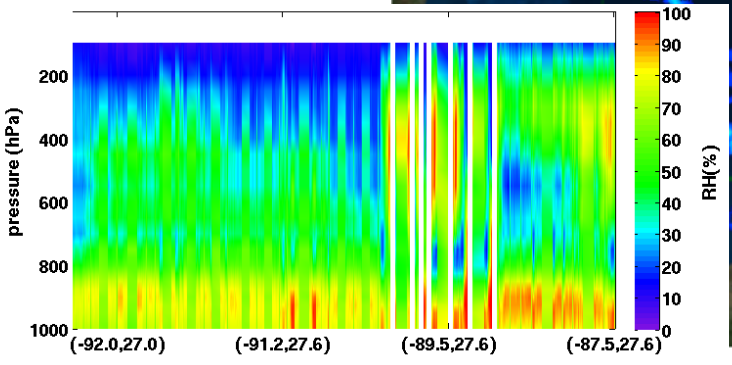


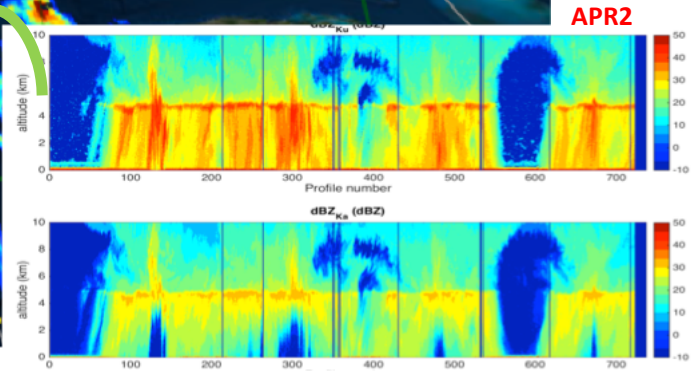
UWIN-CM Forecast of Tropical Storm Cindy

20 June 2017: Mutli-instruments observations of Tropical Storm Cindy





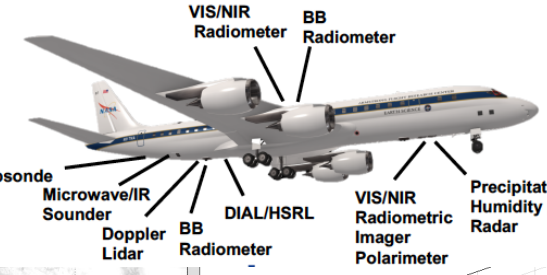


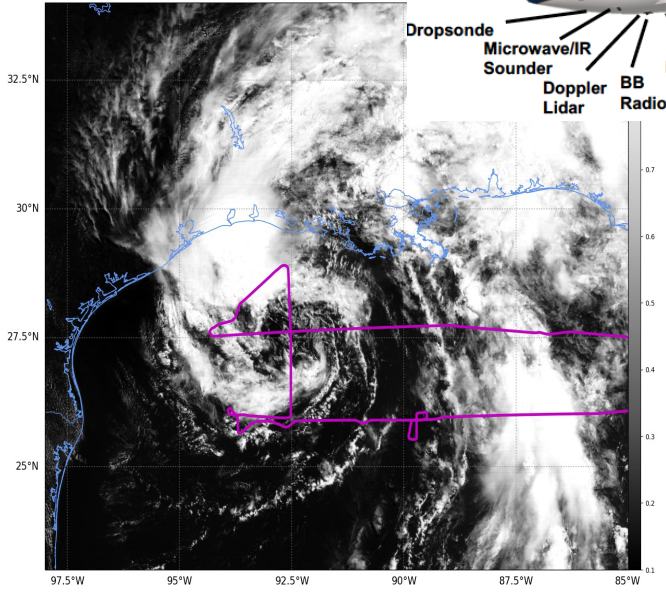


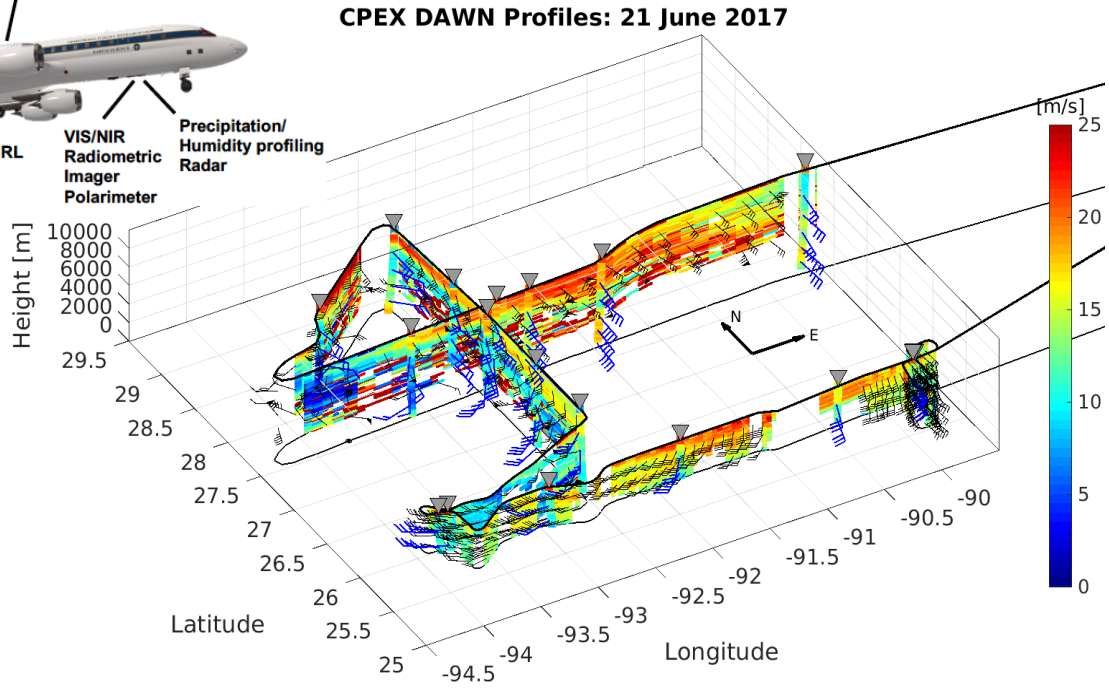
Red curves mark the DC-8 flight path and the color shading is the Rain Index derived from AMSR-2 microwave radiance. The HAMSR relative humidity and APR2 radar reflectivity curtain plots are along the southern segment of the flight path. Gray lines are GPM overpasses. Orange arrows are DAWN wind vectors at 850 hPa. The agreement between DAWN and dropsondes winds (insets) is very good.

CPEX Mission on 21 June 2017: TS Cindy

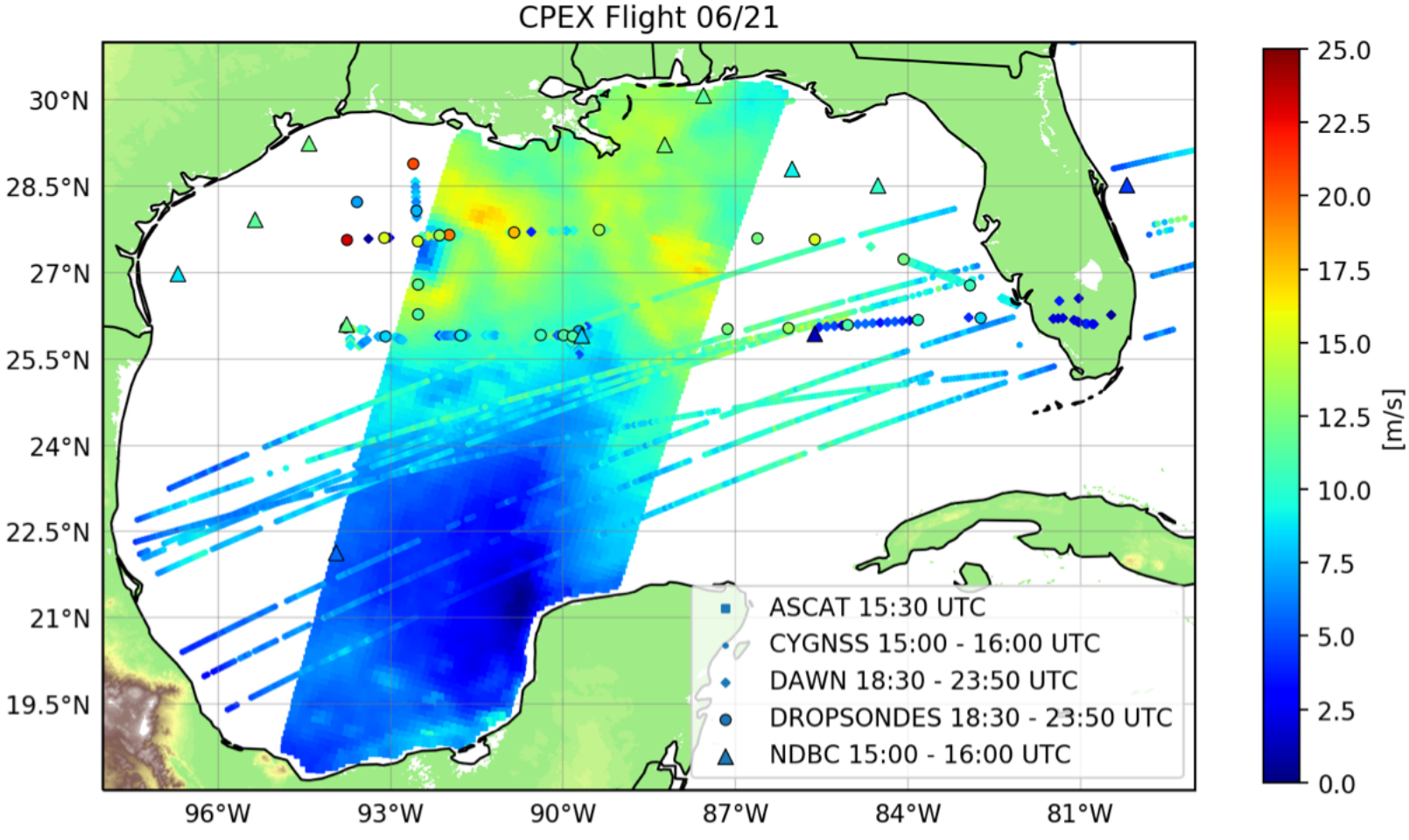
- 1st of its kind observations with DAWN and dropsondes that captured 3D winds and shear in a TC (in Tropical Storm Cindy).





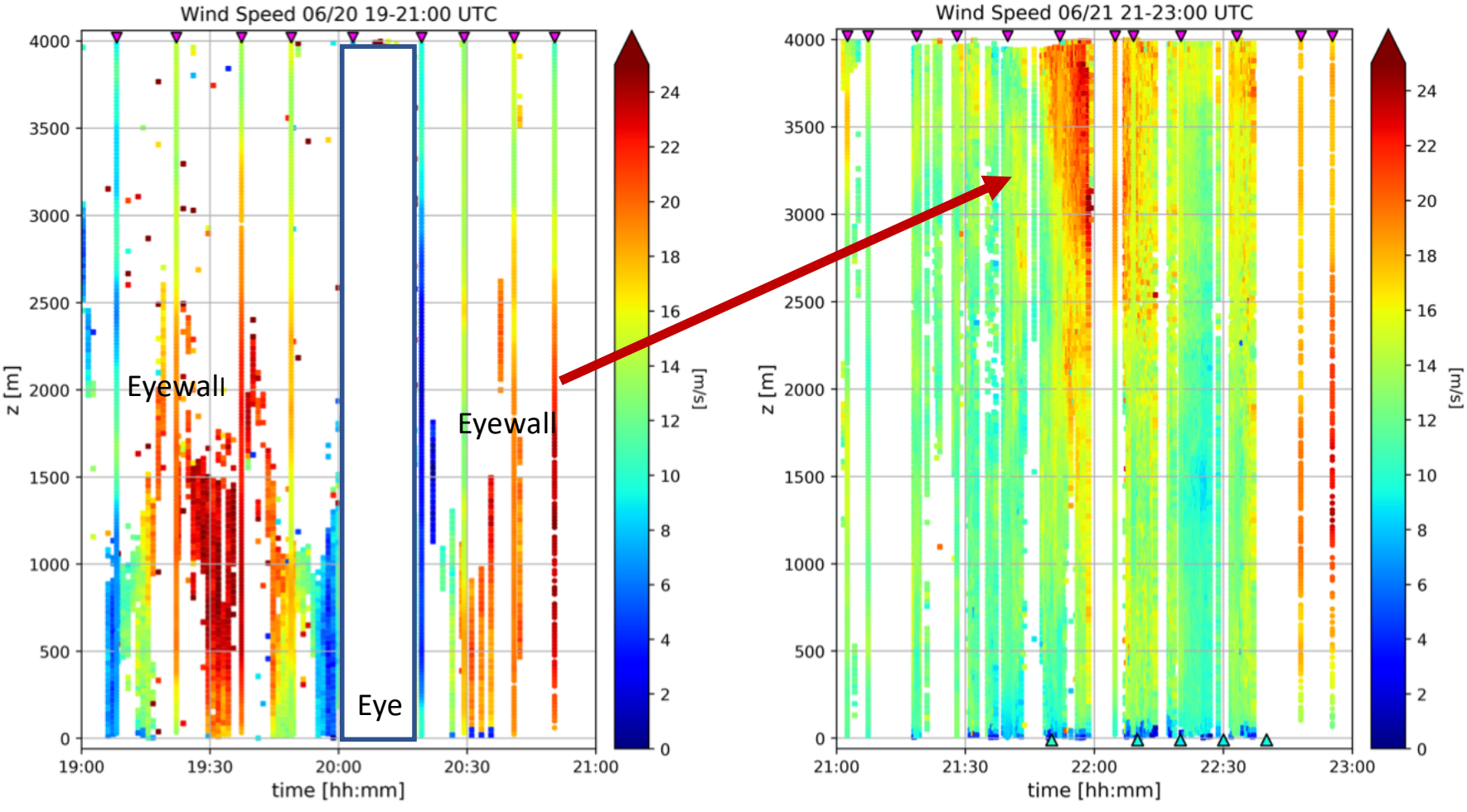


Surface Winds: ASCAT, CYGNSS, dropsondes and moorings

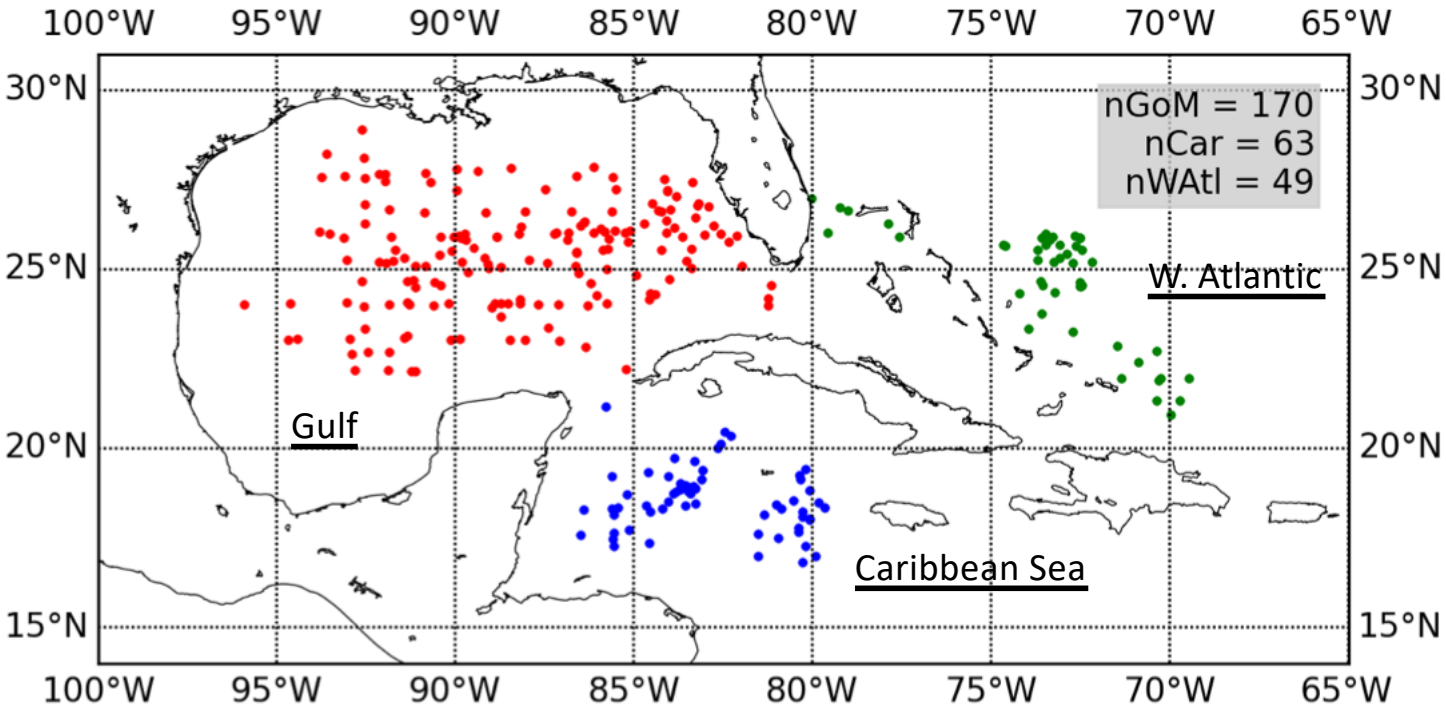


Formation/Intensification: TS center

TS outer region

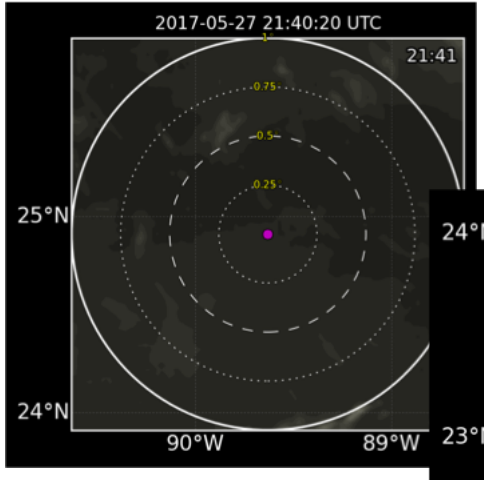


Dropsondes deployed by regions during CPEX

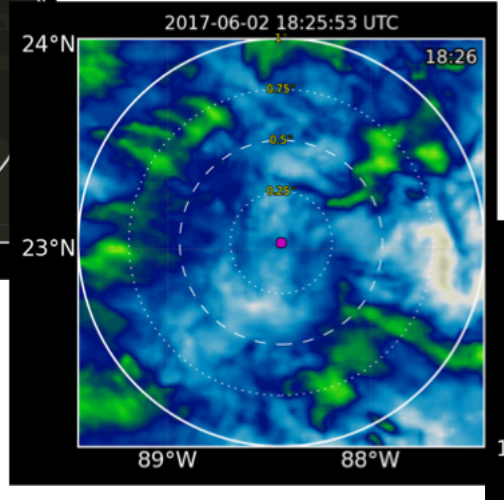


Classification of weather conditions:

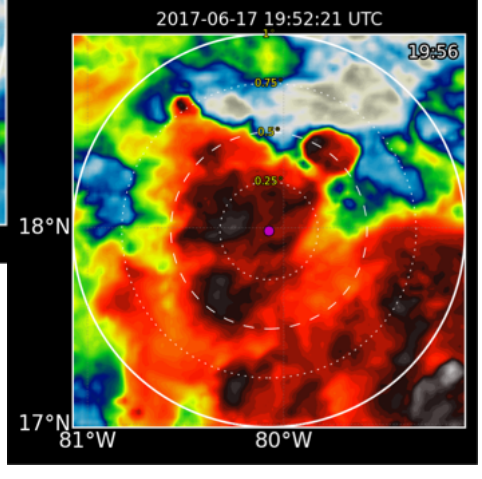
Clear/Undisturbed

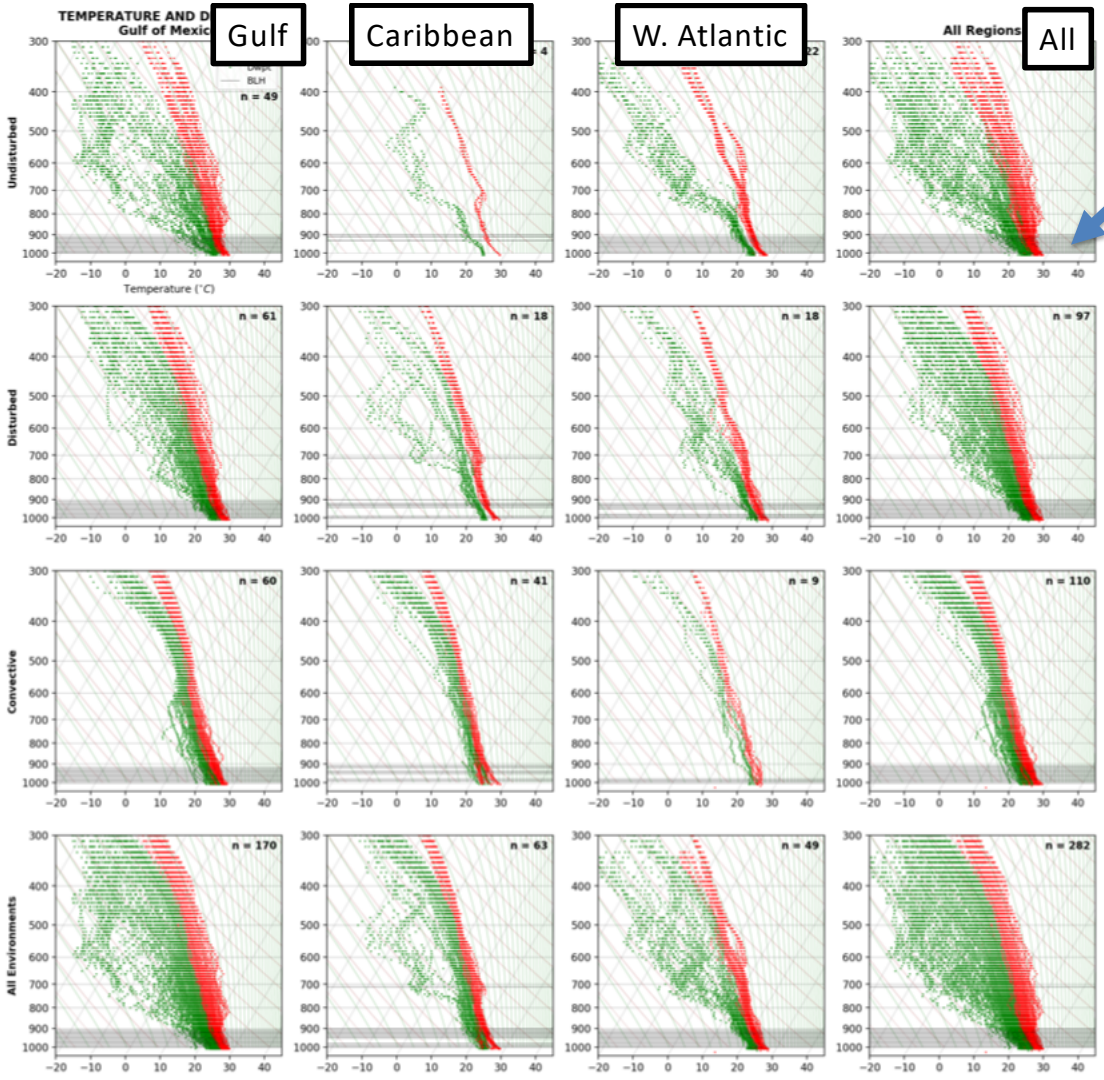


Disturbed



Convective





Undisturbed /Clear

Disturbed/ Near -storm

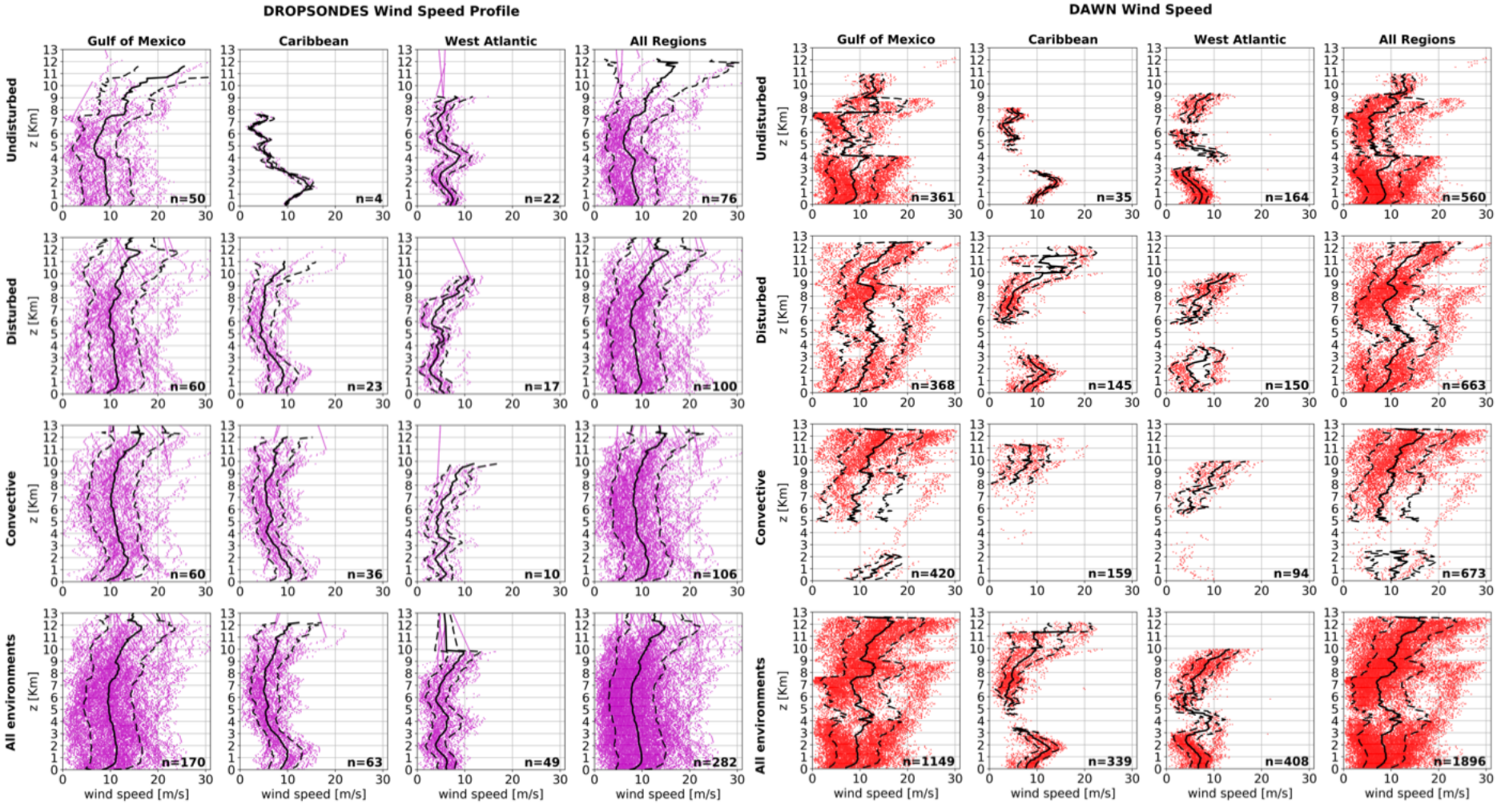
Convective

All

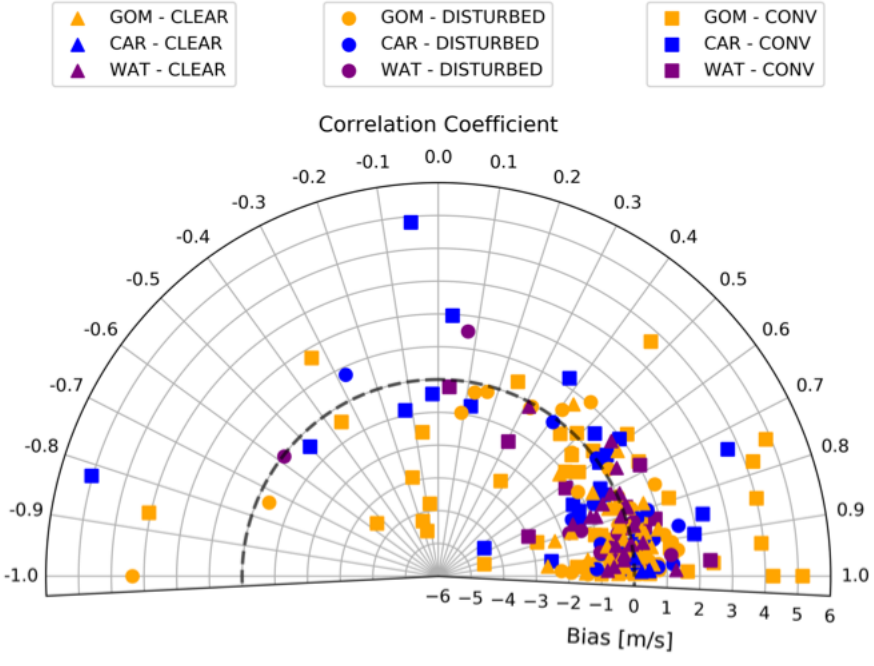
Boundary Layer Height (vary from 100-1000m, avg. = 560 m)

Highly variable!

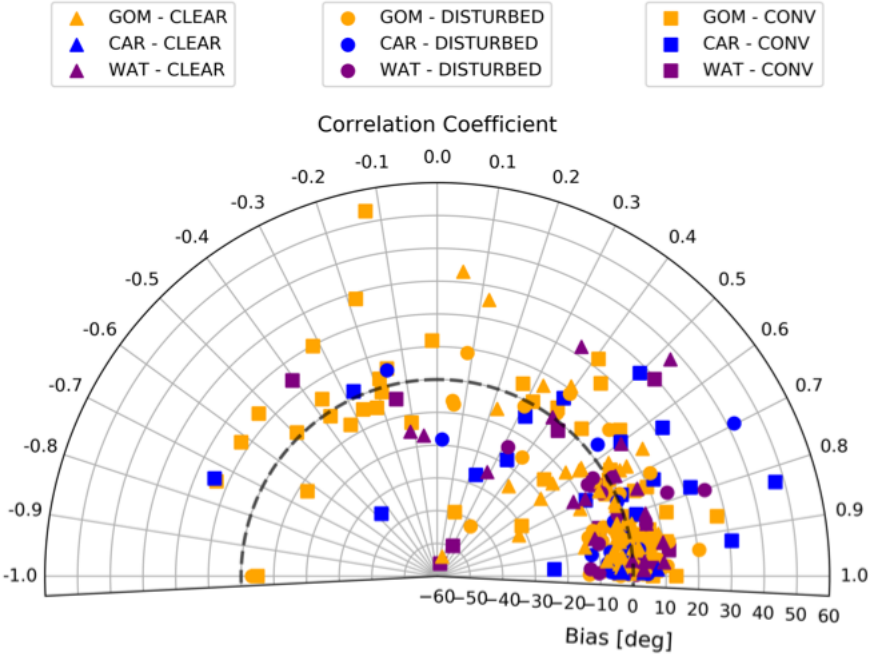
How do compare winds from dropsondes and DAWN?

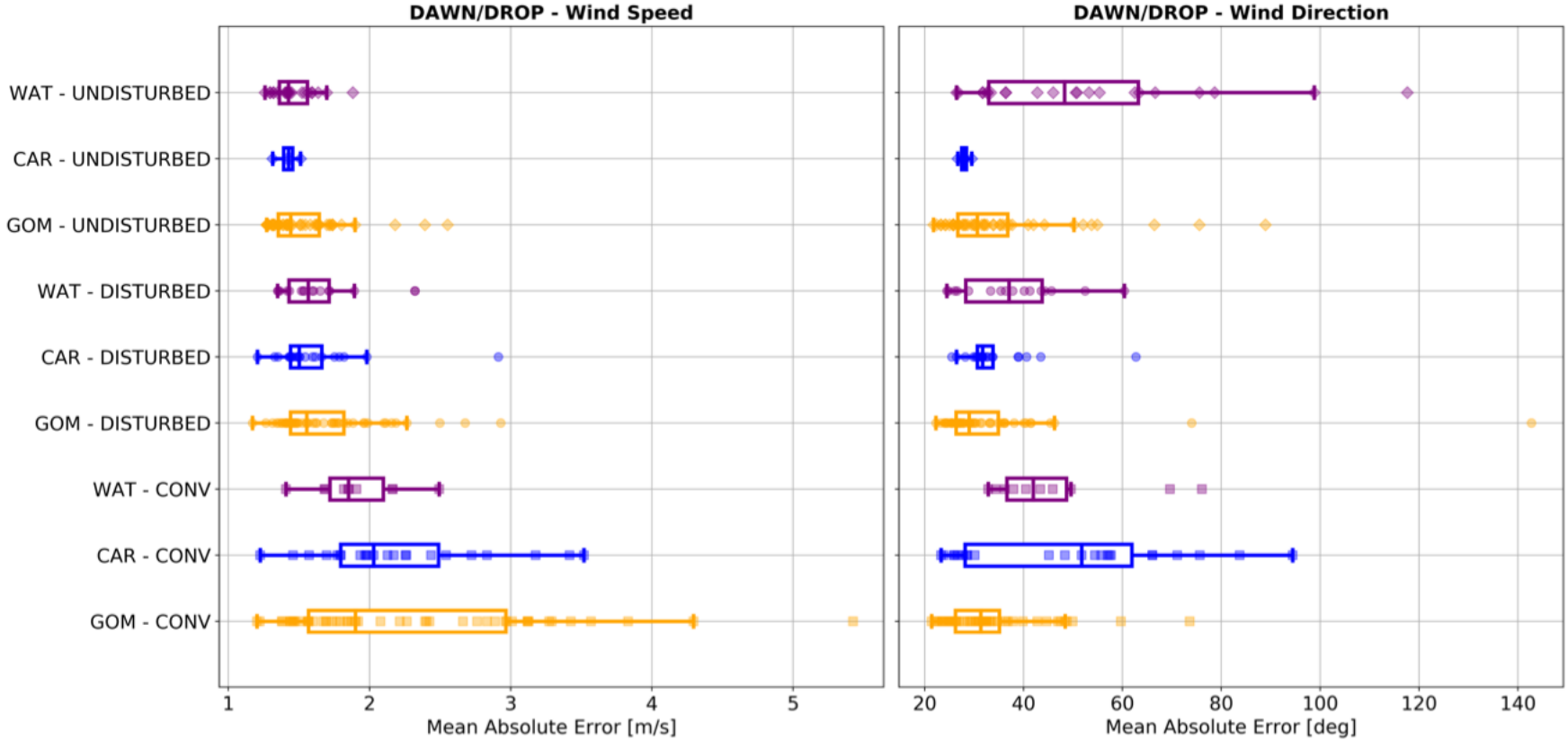


Wind Speed: Bias vs Correlation
(mean bias = -0.5 m/s; mean correlation = 0.71)



Wind Direction: Bias vs Correlation
(mean bias = 0.2 deg; mean correlation = 0.62)



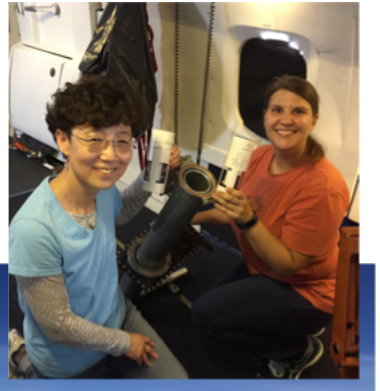

DAWN/DROP - Wind Speed
DAWN/DROP - Wind Direction
WAT - UNDISTURBED
CAR - UNDISTURBED
GOM - UNDISTURBED
WAT - DISTURBED
CAR - DISTURBED
GOM - DISTURBED
WAT - CONV
CAR - CONV
GOM - CONV
1
2
3
4
5
Mean Absolute Error [m/s]
20
40
60
80
100
120
140
Mean Absolute Error [deg]

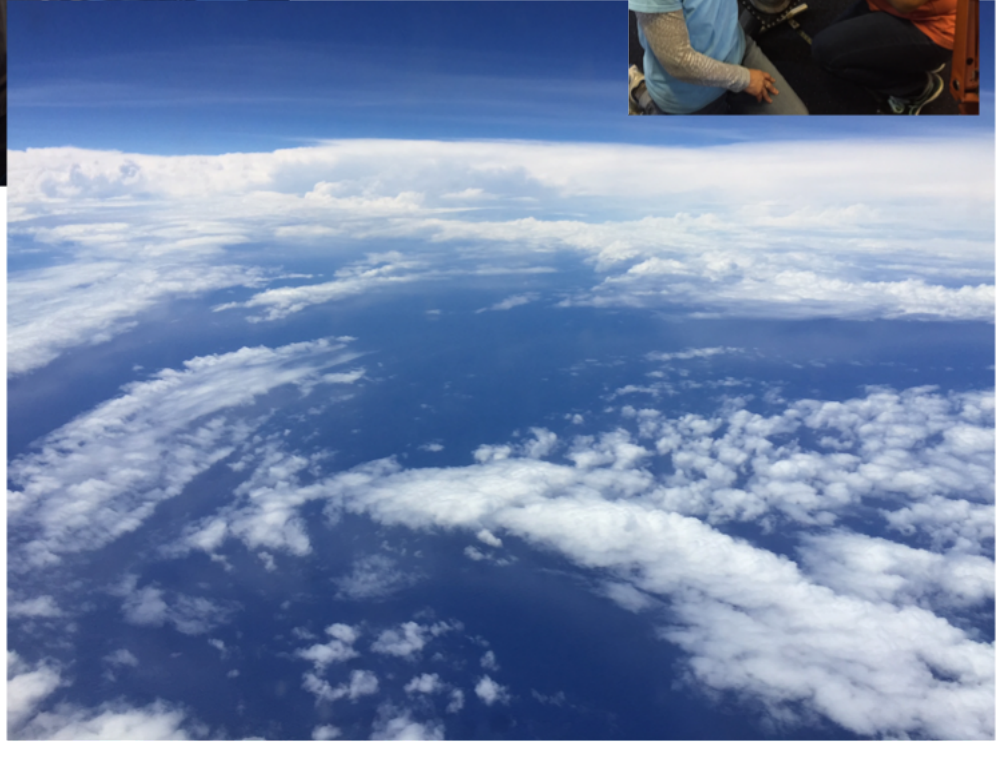
Summary:

- For the first time, wind lidar (DAWN) and dual-frequency precipitation radar (APR2) measurements captured convective structure and near-storm winds including convective in/out flow in the boundary layer and above the convection on June 11th.
- First of its kind observations of a tropical storm development from pre-tropical disturbance in the Caribbean Sea, to tropical depression, and formation of Tropical Storm Cindy in the Gulf of Mexico from June 15-21.
- Sixteen DC-8 aircraft missions from 27 May-24 June covered a wide range of weather conditions, which provide observations in convection, near-storm/disturbed, and undisturbed conditions. Cold pools, boundary layer profiles, winds in environment, in/out flow near convection.
- A great data set for assessing model bias, data assimilation and NWP impact studies


ARMSTRONG FLIGHT RESEARCH CENTER
EARTH SCIENCE

Inside of TS Cindy





CPEX Weather Forecast Team