Convective Process Experiment (CPEX) 2017: Science Highlights

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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)

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

Nadir
+45°
+22.5°
0°
30°

Zenith
Ka + W
±25
Ku + Ka + W

Dropsondes
HAMSRS

DAWN
2 s
460 m

22 s
5.1 km

HAMSRS

DAWN

APR-3

APR*

MMS
16 missions:
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://cpxexportal.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

Boundary layer inflow/outflow

Convective outflow

W1 E1
W2 E2

Height [m]

Time

dBZ
m/s

W1 E1

Boundary layer inflow/outflow

W2 E1
UWIN-CM Forecast of Tropical Storm Cindy
20 June 2017: Multi-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).
Formation/Intensification: TS center

Wind Speed 06/20 19-21:00 UTC

Eye
Eyewall
Eyewall
Eye

TS outer region

Wind Speed 06/21 21-23:00 UTC
Dropsondes deployed by regions during CPEX

- nGoM = 170
- nCar = 63
- nWAtl = 49
Classification of weather conditions:

- Clear/Undisturbed
- Disturbed
- Convective
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)
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
1st DC-8 flight over Cuba

Inside of TS Cindy

CPEX Weather Forecast Team