

DAWN performance during CPEX 2017, comparison with dropsondes, and future applications

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8 February, 2018

Overview

- CPEX general objectives
- DAWN as the “featured” instrument
 - Precision and bias expectations
 - Issues related to airborne DWLs (A/C motion accounting, sampling along flight path, etc.)
- DAWN comparisons with dropsondes
 - Sampling issues
- Summary

CPEX Science Objectives

1. **Improve understanding of convective processes** including cloud dynamics, downdrafts, cold pools and thermodynamics during initiation, growth, and dissipation
2. **Obtain a comprehensive set of observations, especially from DAWN**, in the vicinity of scattered and organized deep convection in all phases of the convective life cycle
3. **Improve model representation of convective and boundary layer processes** over the tropical oceans using a cloud-resolving, fully coupled atmosphere-ocean model
4. **Improve model assimilation of the wind, temperature and humidity profiles** from the wind lidar and dropsondes into numerical weather prediction models

CPEX 2017: A Field Experiment to study Convective Processes in the Tropics

25 May – 24 June 2017

DC-8 based in Fort Lauderdale, Florida

DAWN, APR-2, HAMSRS, MTHP, Dropsondes, MASC

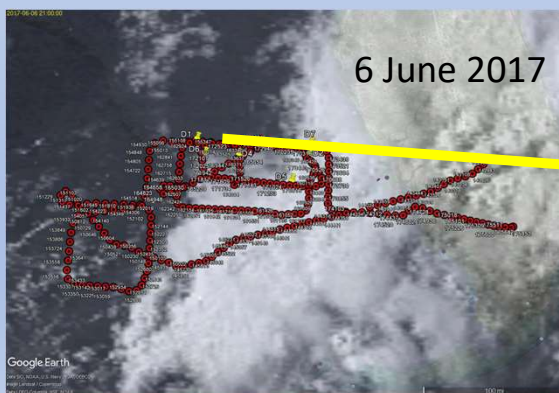


LaRC DAWN on NASA DC8

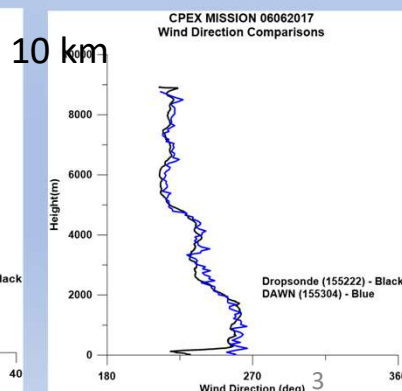
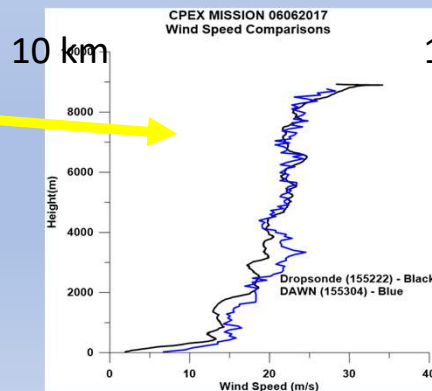


- DAWN is NASA's most capable airborne wind-profiling lidar
- Previously participated in NASA GRIP (2010) and Polar Winds (2014-15) airborne campaigns
- Laser pulses at 2-micron wavelength and 10 Hz are eyesafe at any range; daytime observations not compromised by solar background
- Data may be post flight processed multiple times with various number of shots accumulated (horizontal resolutions), vertical resolutions, and wind search bandwidths for maximum information extraction
- CPEX science flights indicate excellent vertical coverage and agreement with dropsonde winds (e.g. from 9.5km in plots below)

DAWN (blue) vs Dropsonde (black)



Each red circle is a DAWN sounding location



DAWN: the instrument

- Developed at NASA/LaRC and flown on NASA King Air and NASA DC-8 in GRIP(2011), PolarWinds(2014 and 2105) and CPEX (2017).
- Coherent 2 um Doppler lidar
- 100mJ, 10Hz, 15cm (designed for 250mJ)
- 2 second LOS nominal integrations (range from 1 second to 20 second integrations depending upon clouds and aerosols)
- 50-500m LOS with adaptive integration
- 5 angle stares (-45, -22.5, 0, 22.5, 45) at 30 degrees off nadir
 - 1,2,5,8 and 12 angle stares were options

Multi-scale Wind Variability Using DAWN in CPEX



50 – 400m

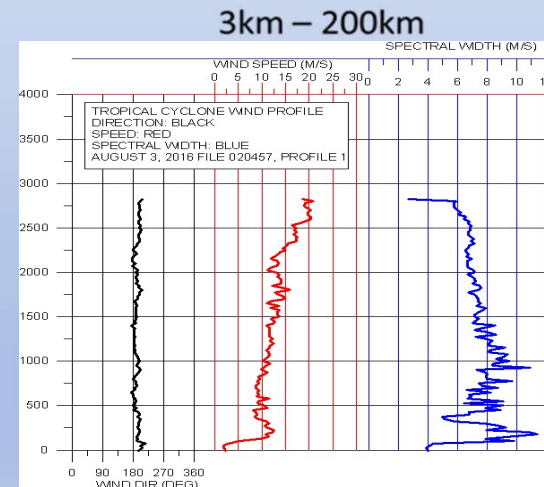
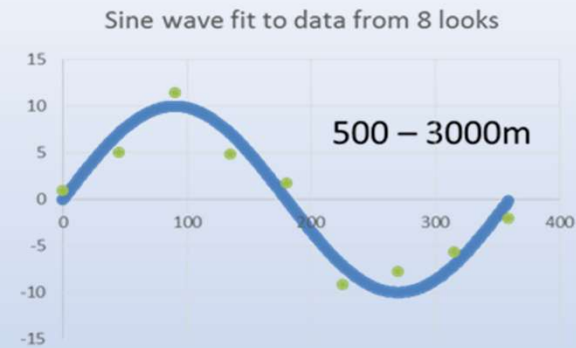
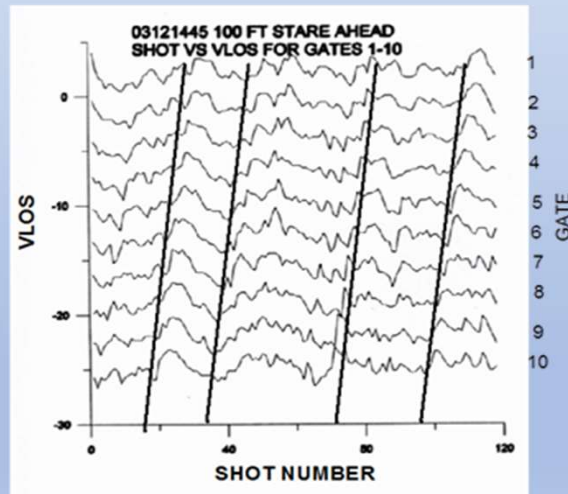
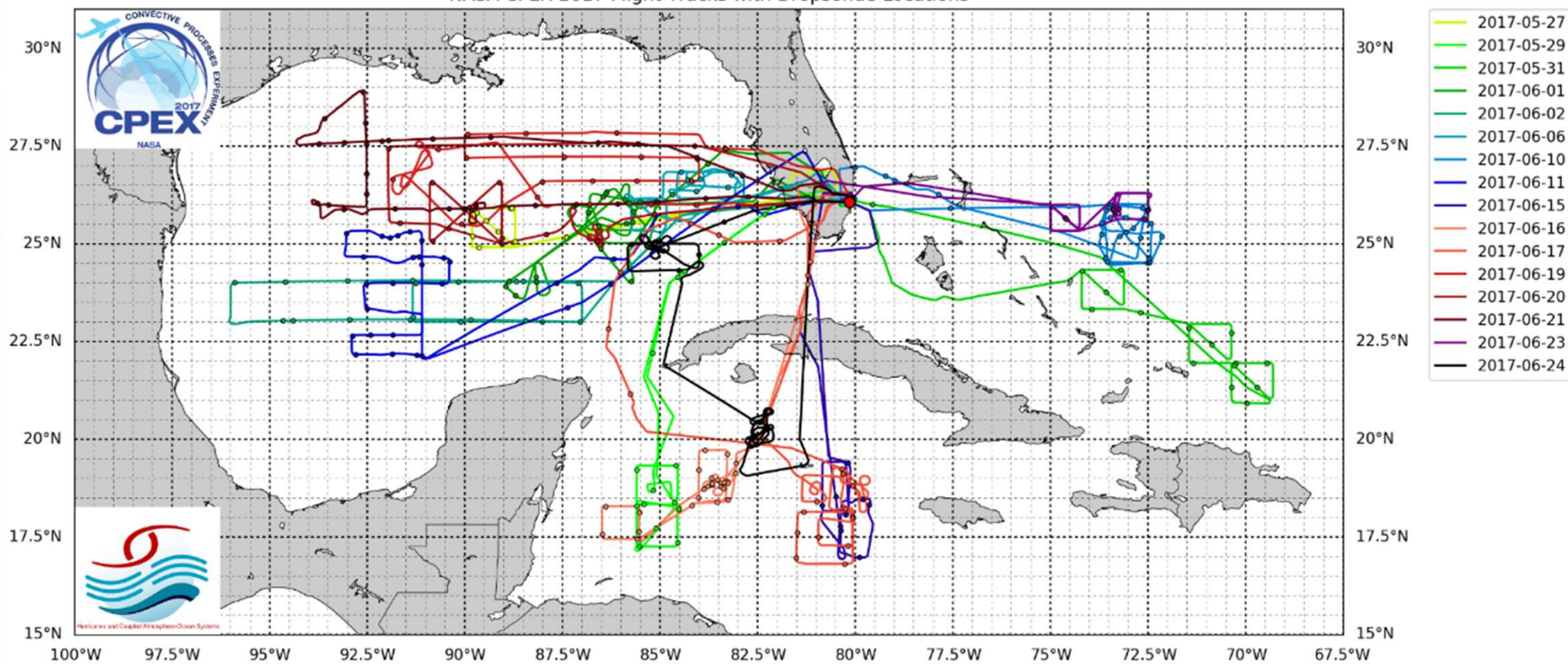
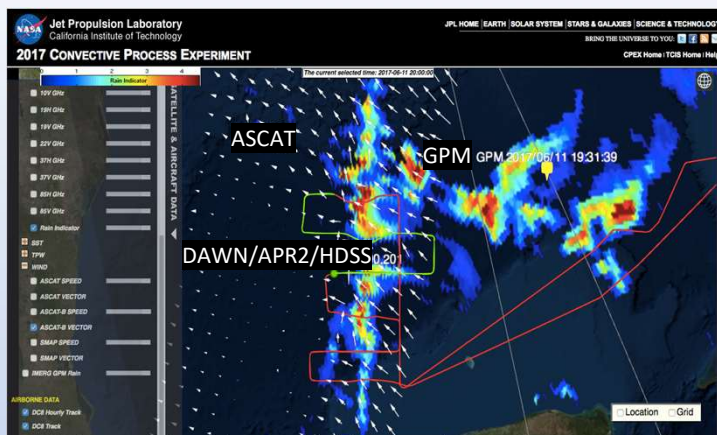


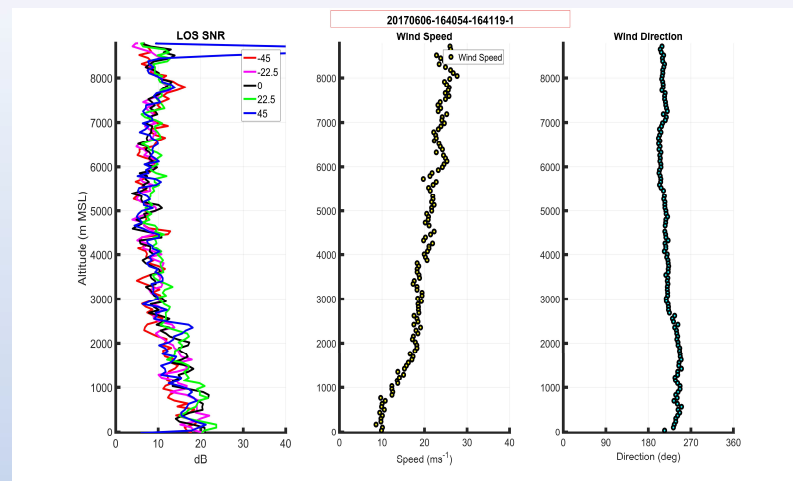
Illustration of the four scales of atmospheric dynamics observed with DAWN as explained in the text.

NASA CPEX 2017 Flight Tracks with Dropsonde Locations



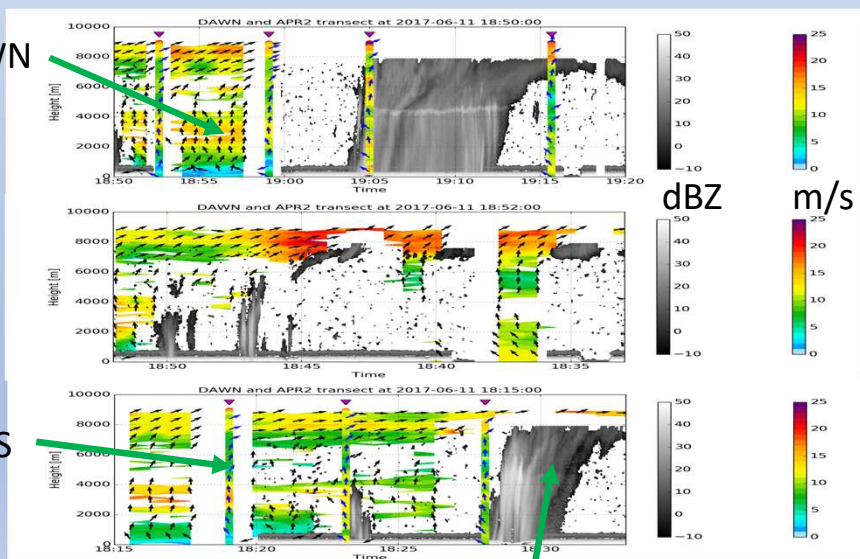


DAWN
wind profile
from 30000'
around CPEX
mass budget
box



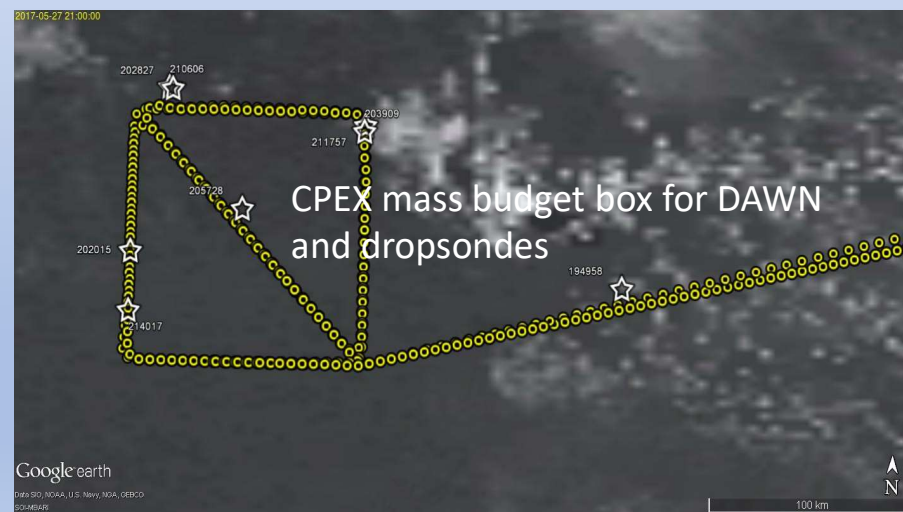
DAWN

HDSS

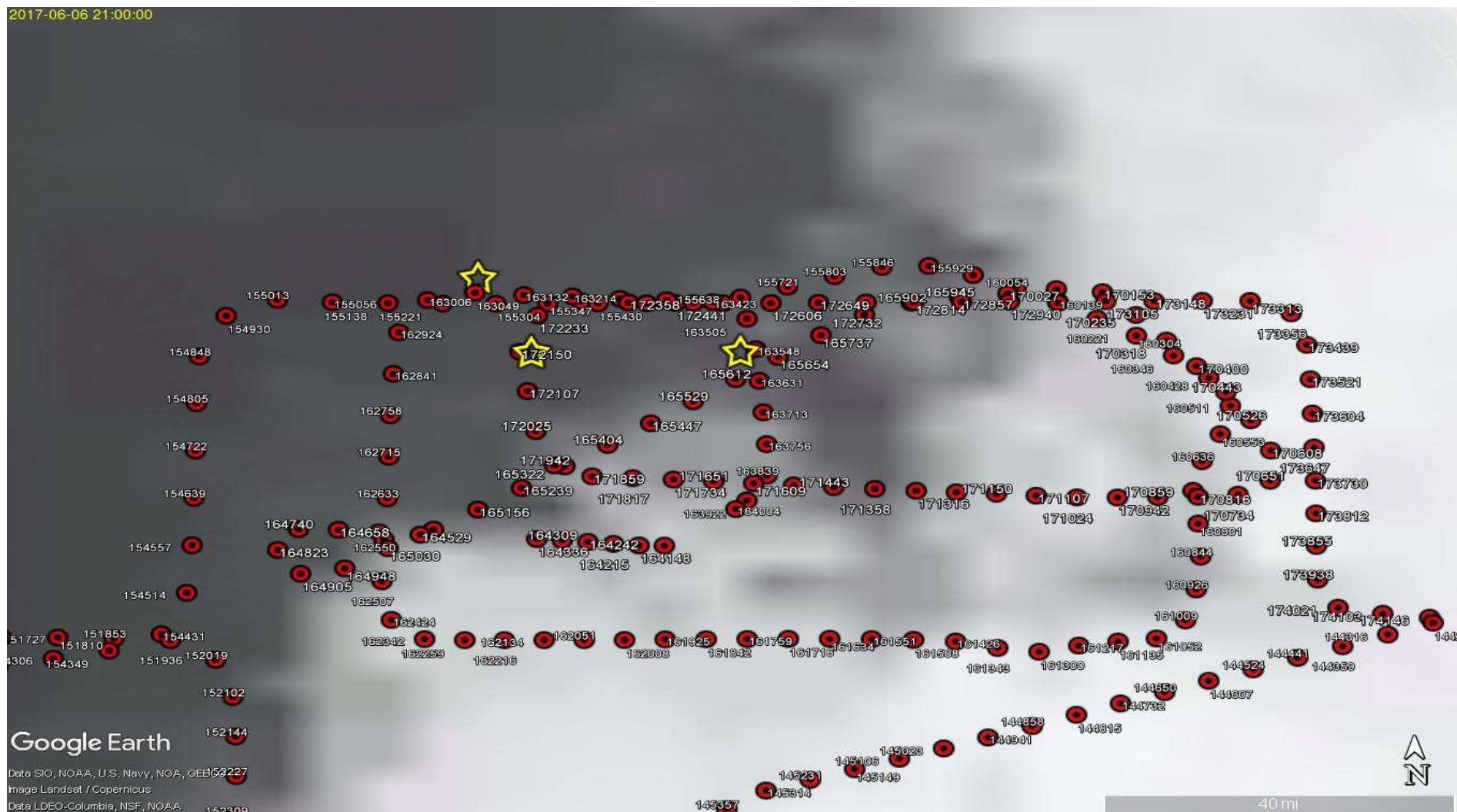


Provided by Shuyi Chen

APR2



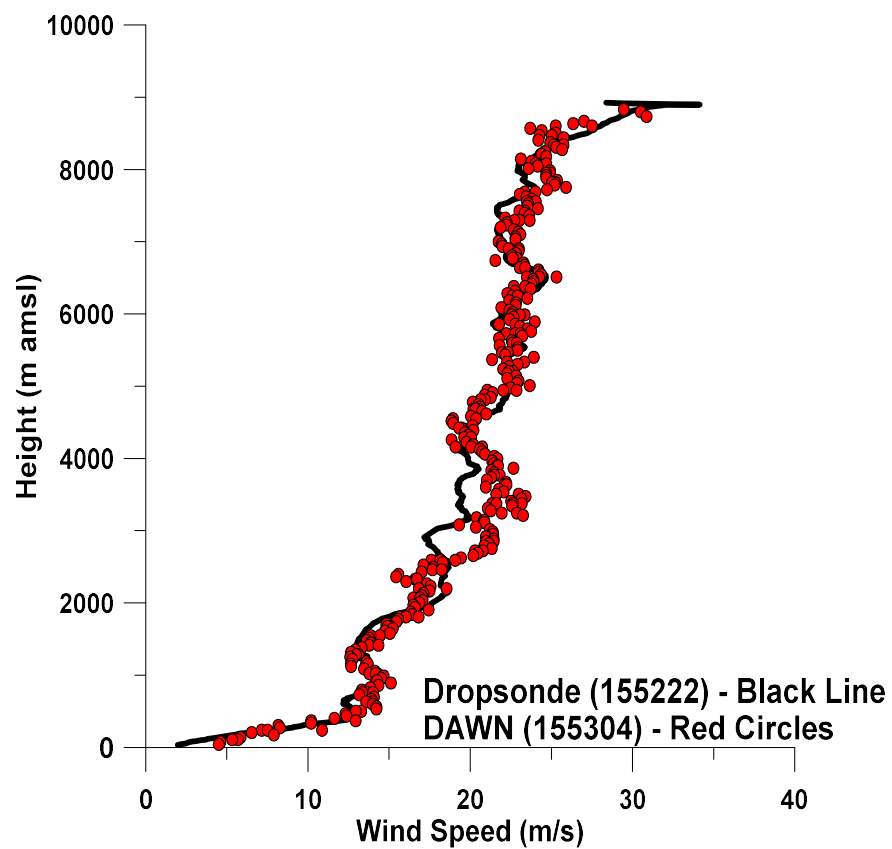
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CPEX DAWN - DROPSONDE COMPARISON

Wind Speed

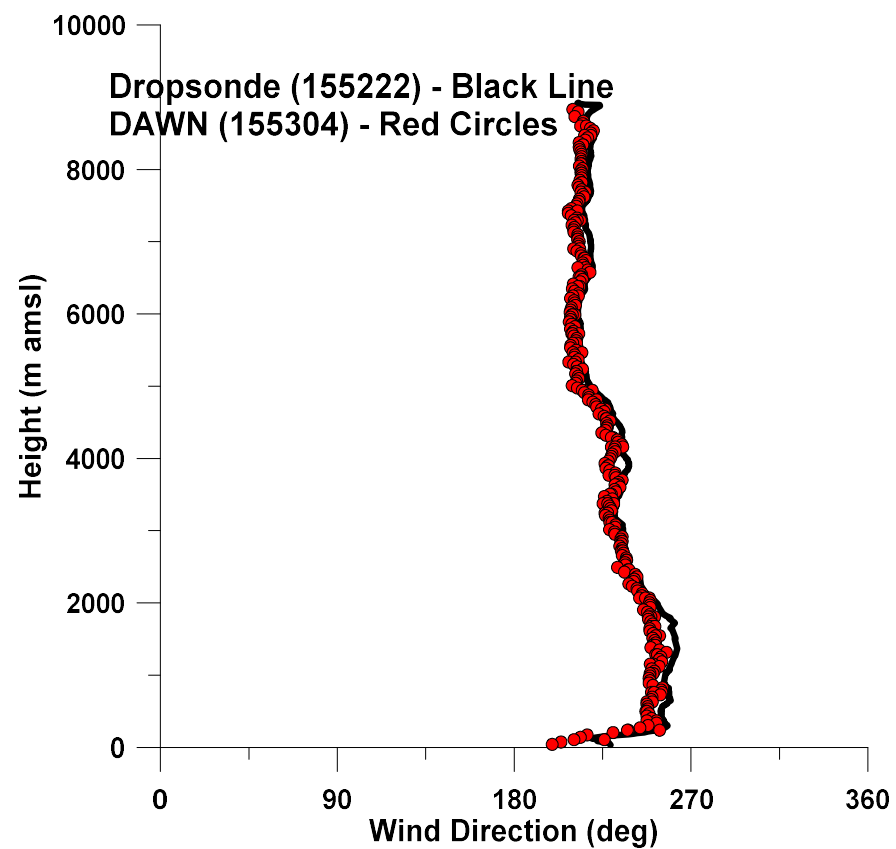
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CPEX DAWN - DROPSONDE COMPARISON

Wind Direction

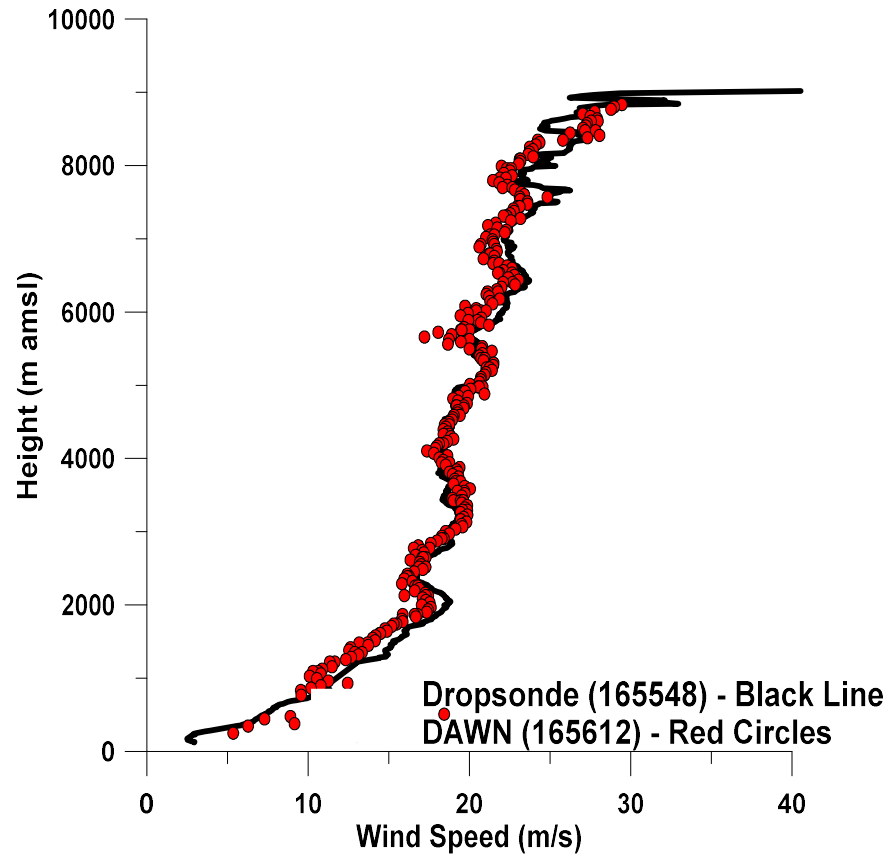
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CPEX DAWN - DROPSONDE COMPARISON

Wind Speed

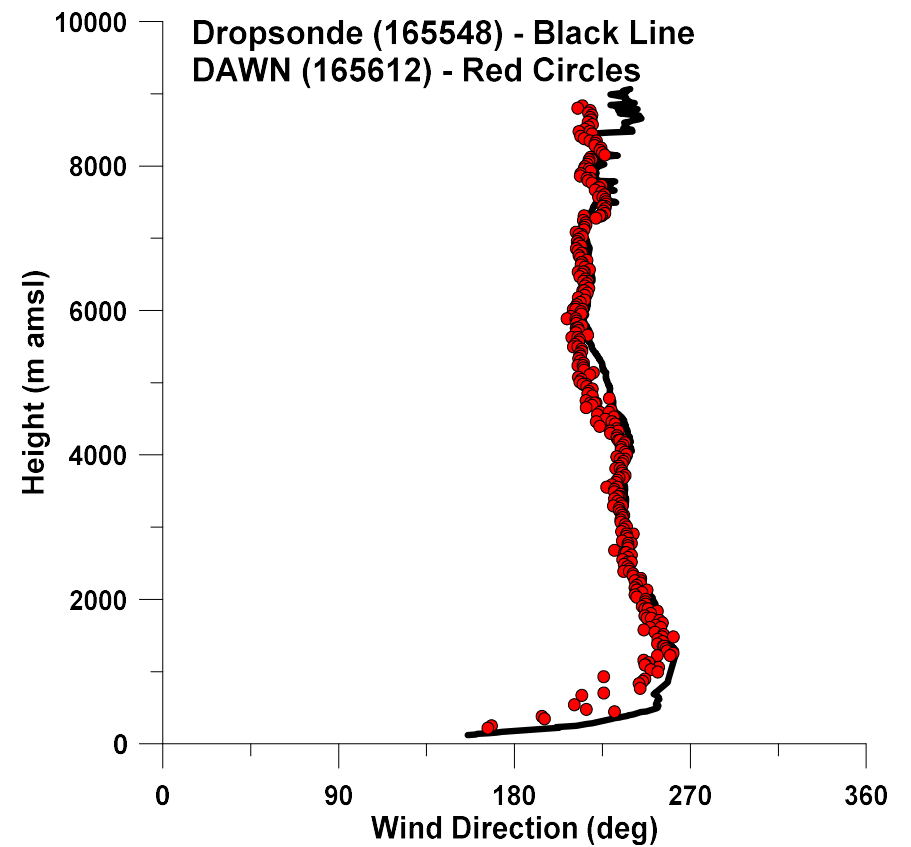
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CPEX DAWN - DROPSONDE COMPARISON

Wind Direction

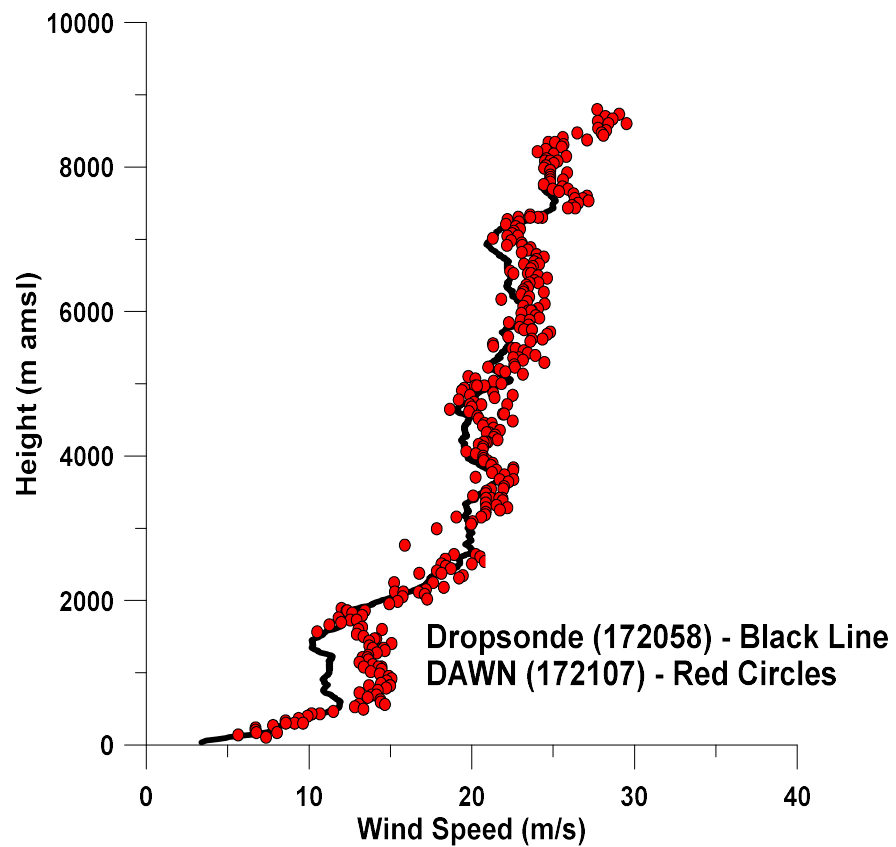
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CPEX DAWN - DROPSONDE COMPARISON

Wind Speed

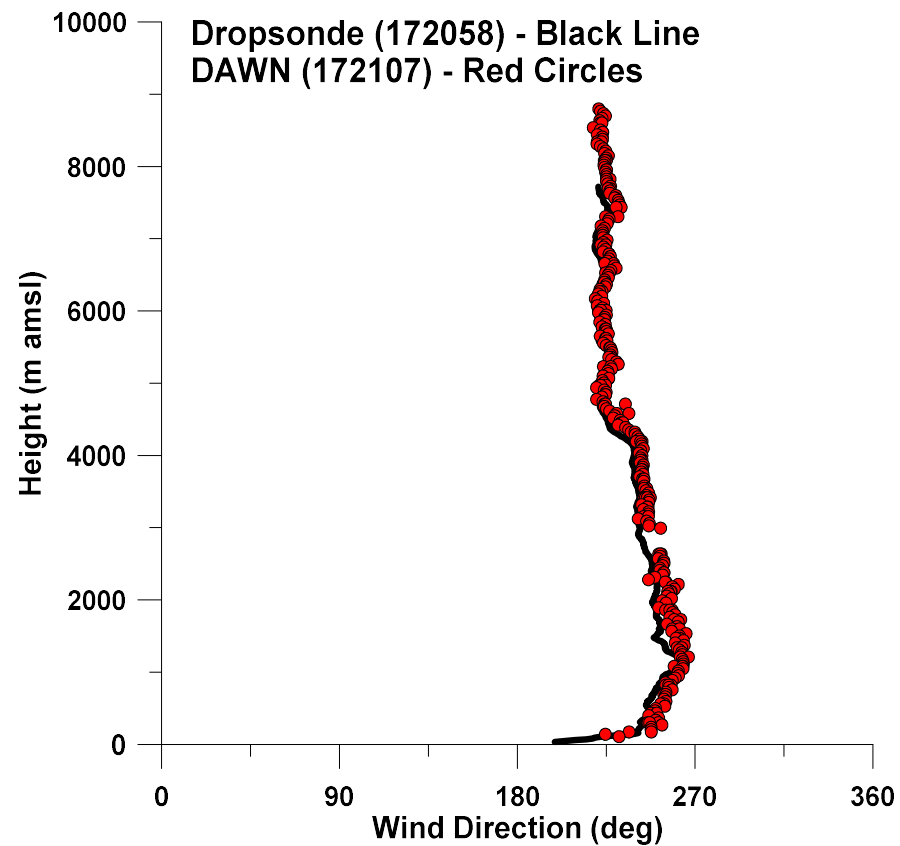
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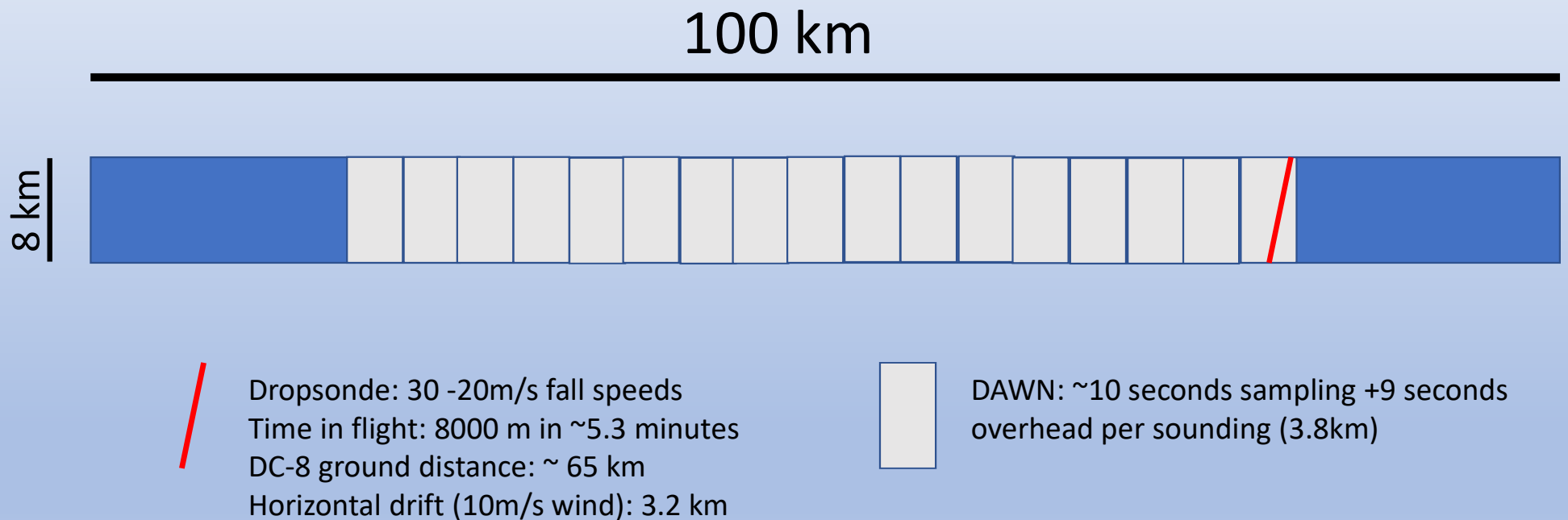
CPEX DAWN - DROPSONDE COMPARISON

Wind Direction

06/06/17



DAWN vs dropsonde sampling comparisons



2017-05-27 21:00:00

100 km

21 2015

202827 210606

203909 211757

205728

194958

214017

Google earth

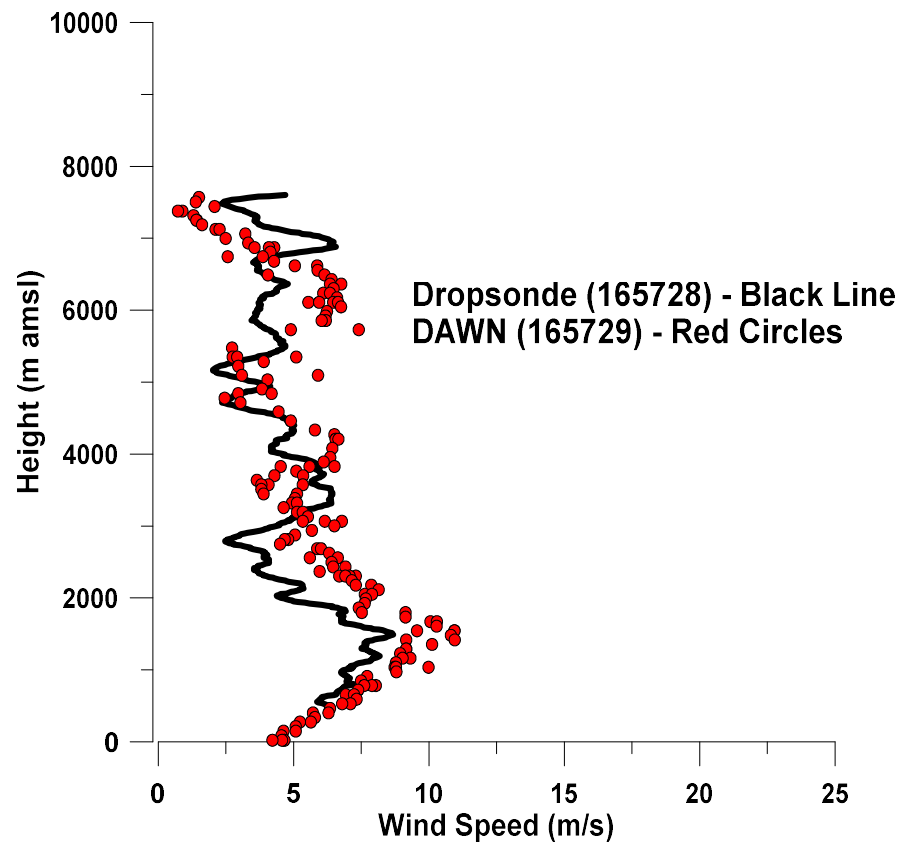
Data SIO, NOAA, U.S. Navy, NGA, GEBCO
SIO/MBARI

100 km

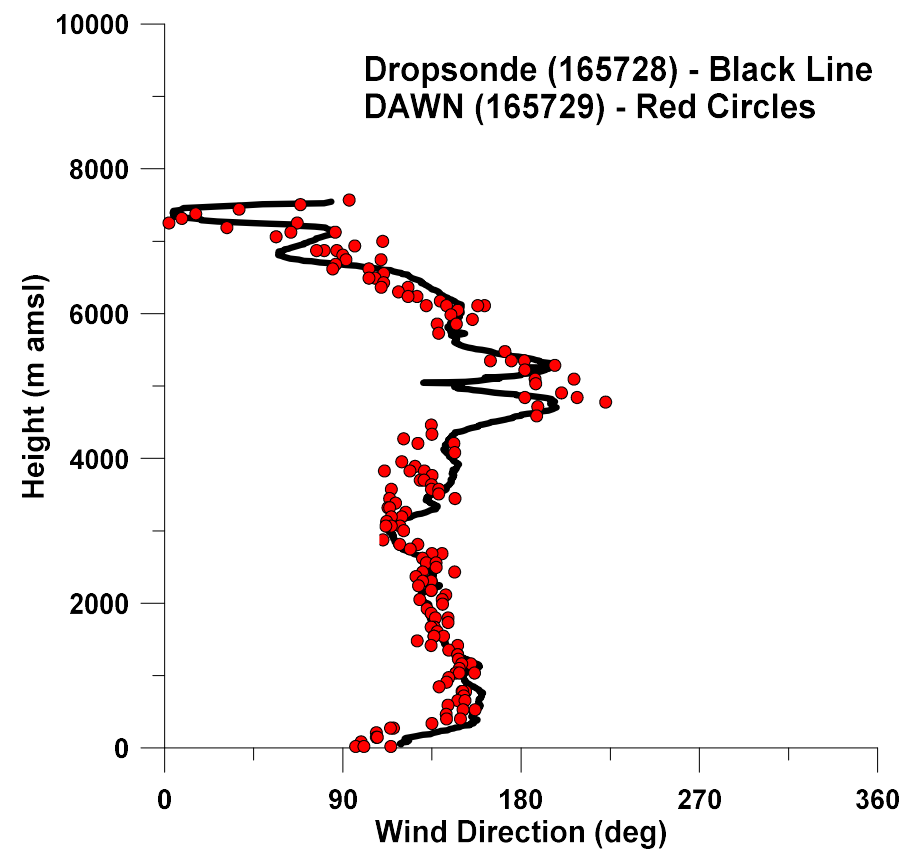
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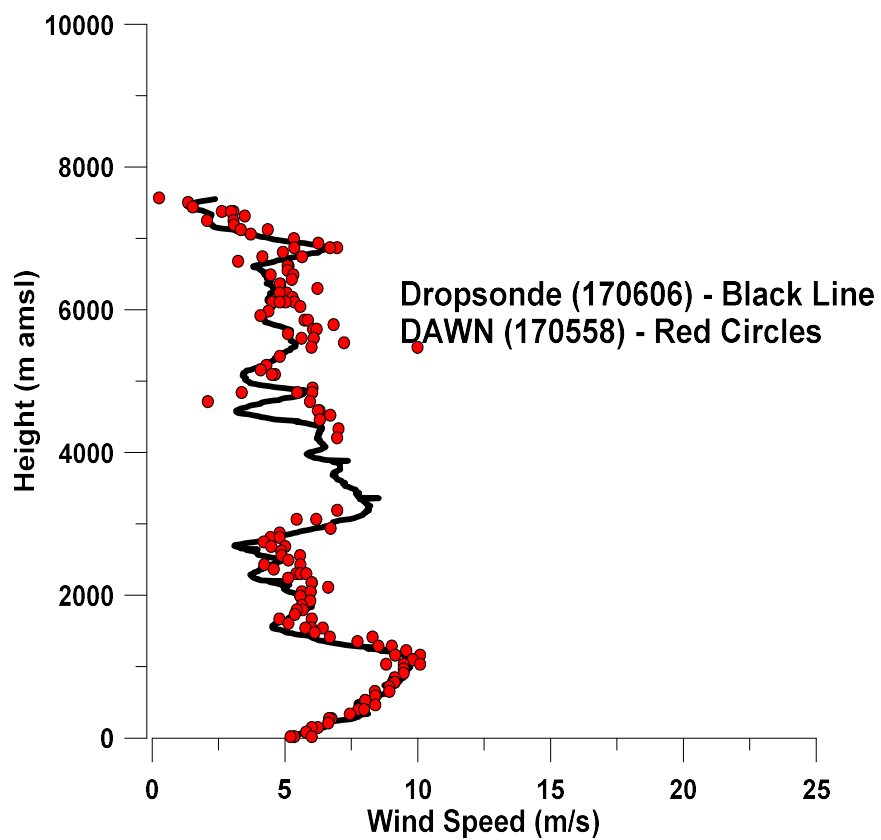
CPEX DAWN - DROPSONDE COMPARISON
Wind Speed
05/27/17



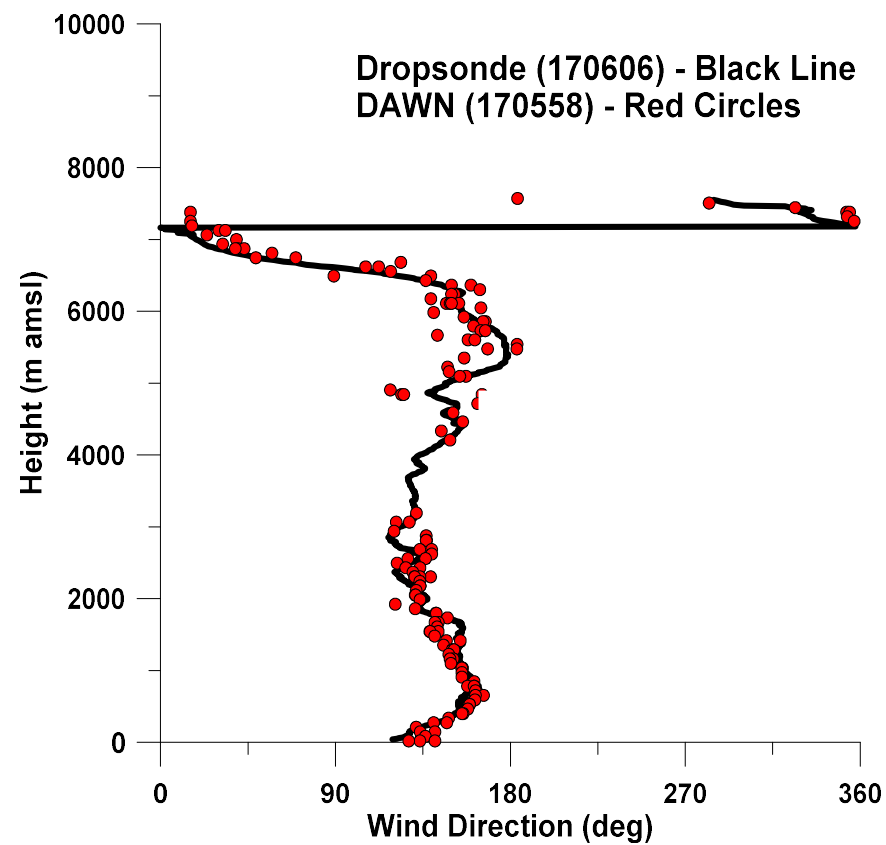
CPEX DAWN - DROPSONDE COMPARISON
Wind Direction
05/27/17



CPEX DAWN - DROPSONDE COMPARISON
Wind Speed
05/27/17



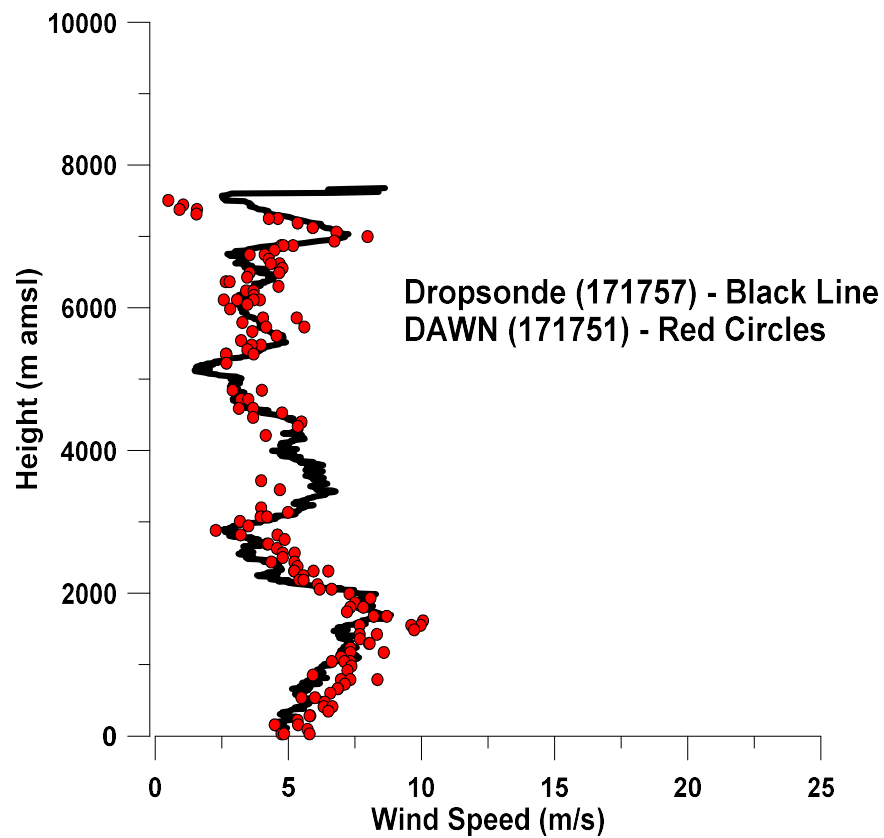
CPEX DAWN - DROPSONDE COMPARISON
Wind Direction
05/27/17



CPEX DAWN - DROPSONDE COMPARISON

Wind Speed

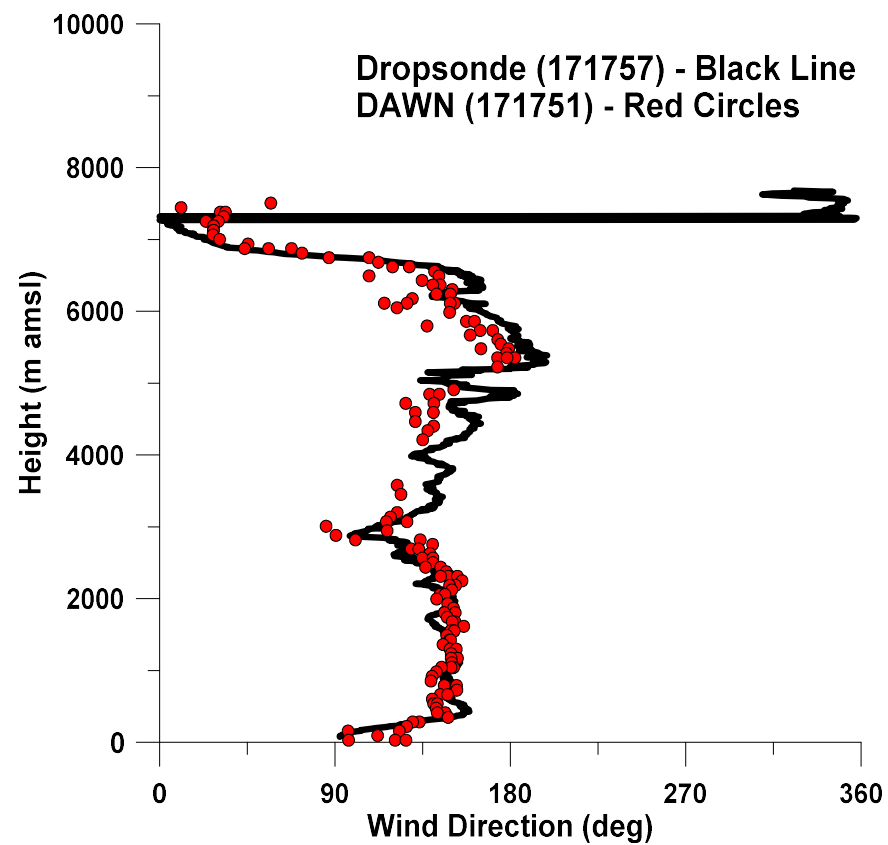
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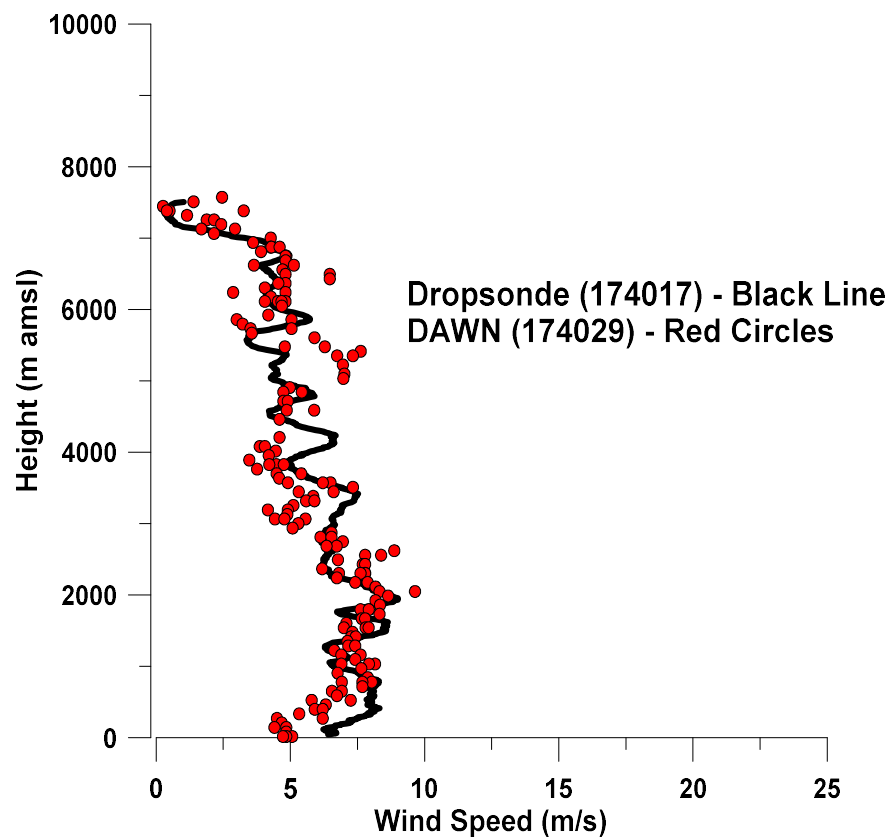
CPEX DAWN - DROPSONDE COMPARISON

Wind Direction

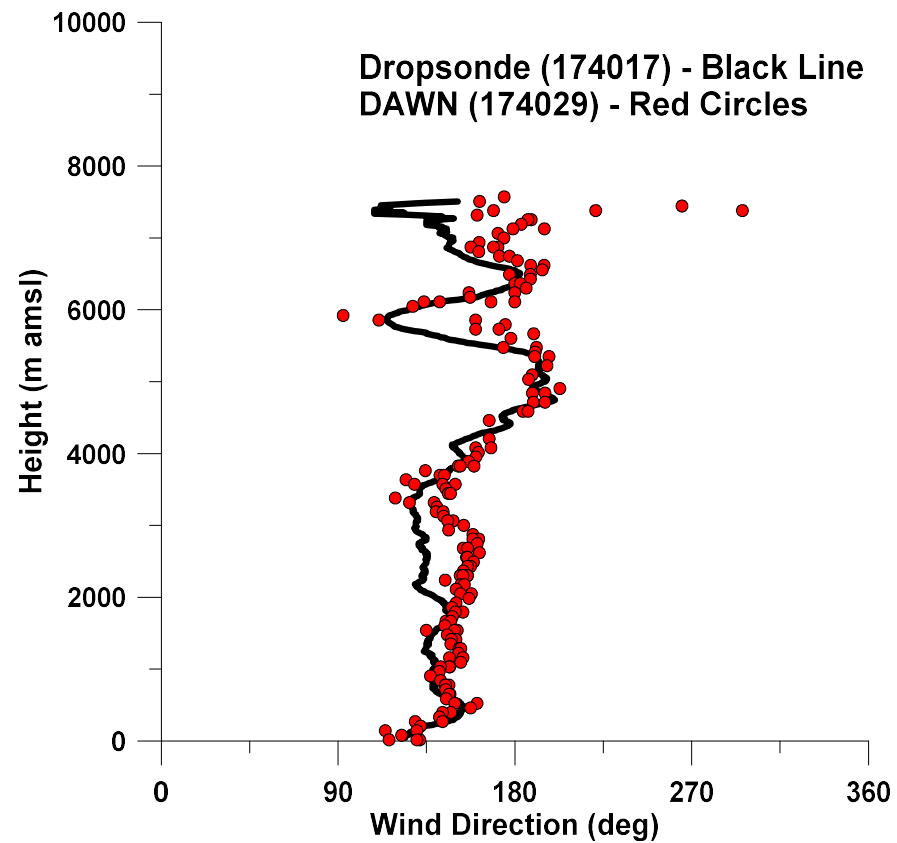
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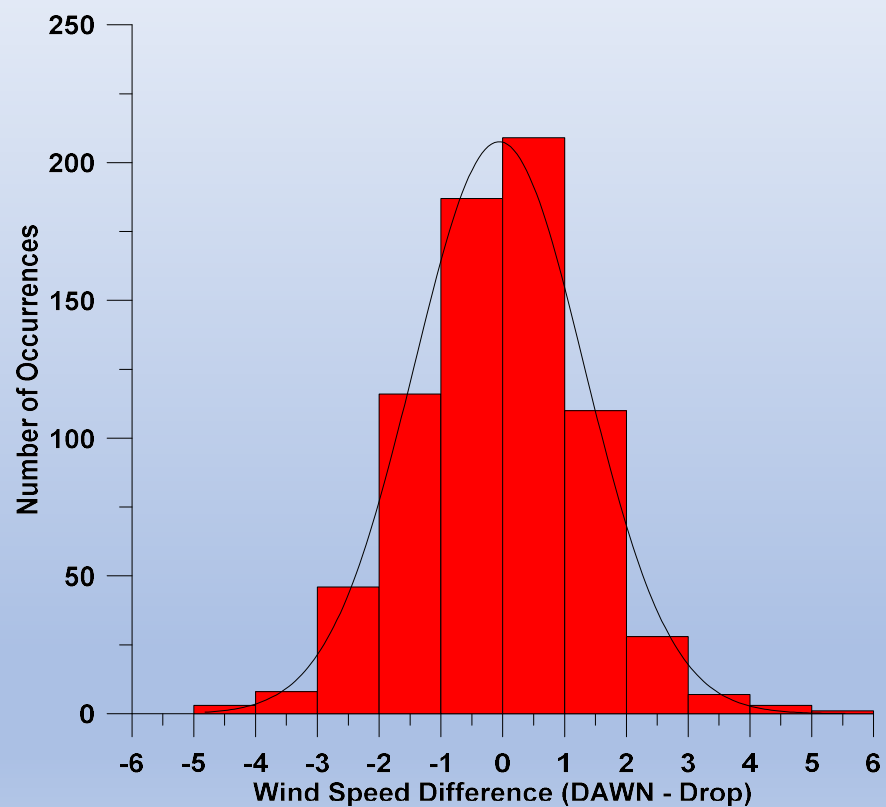
CPEX DAWN - DROPSONDE COMPARISON
Wind Speed
05/27/17



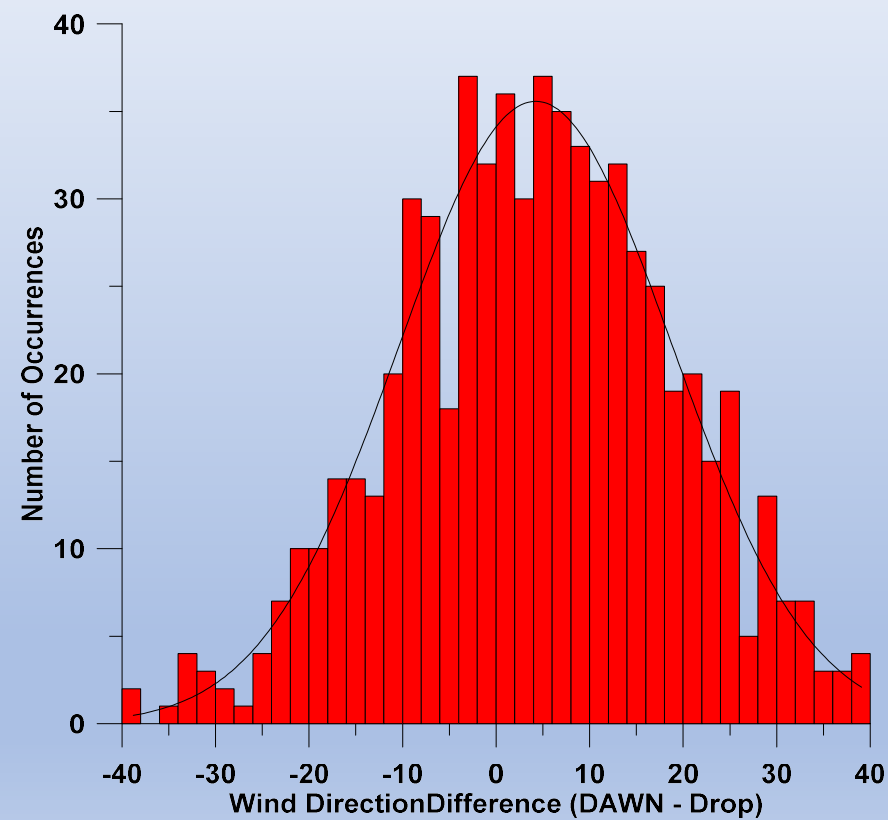
CPEX DAWN - DROPSONDE COMPARISON
Wind Direction
05/27/17



DAWN - Dropsonde Wind Speed Comparisons
CPEX - May 27, 2017 (All Drops) - BASE



DAWN - Dropsonde Wind Direction Comparisons
CPEX - May 27, 2017 (All Drops) - BASE



Comparison biases and random differences

Date	# Comparisons	WS bias (m/s)	WS RMSD (m/s)	WD bias (deg)	WD RMSD (deg)
5/27/17	702	.008	1.12	+6.57	15.54
5/31/17 & 6/11/17	2174	.68	1.83	+2.11	13.9

Note 1: Primary cause of bias is due to drift in reported heading from the true heading
Example: .1 degree heading error on DC-8 introduces .34 m/s error in computed wind speed

Note 2: Primary reason for RMSD (root mean square differences) is spatial and temporal separation of dropsonde and DAWN samples

Ongoing CPEX DAWN research

- Shuyi Chen paper for AMS Bulletin
- SWA/LaRC papers on instrument performance
- Preparation for ADM Cal/Val
- Direction comparison vs. wind speed.
- Decimation experiments to simulate space based sampling

Summary (1)

- CPEX was a NASA funded airborne campaign operated out of Ft Lauderdale, FL to investigate convective processes using the featured Doppler Wind Lidar , DAWN.
- The CPEX campaign in May/June 2017 has provided a unique set of more than 5000 DAWN wind profiles and ~ 300 dropsonde wind, temperature and water vapor profiles.
- The DAWN and dropsonde data are being used to compute mass budgets for 100 km x 100 km x 8-10 km volumes containing various degrees of cloud coverage ranging from cloud free to organized deep convection. Paper by Greco et al coming up later this afternoon.

Summary (2)

- The first pass of DAWN vs. dropsonde comparisons support the following:
 - Airborne DWL soundings and dropsonde soundings should never be expected to be identical and thus should never be used as a “calibration” of ADWL with the exception of bias estimates based upon 1000’s of comparisons under
 - Coherent DWL soundings limited to a few km (~ 2-5km) in the vicinity of a dropsonde sampling volumes approach “about as good as is possible” comparison for expressing differences of wind speed and wind direction on the scale of a few 100ms.
 - Sampling related differences (not measurement errors) dominate the statistics of ADWL vs dropsonde comparisons. Thus airborne coherent DWLs provide low bias information content with more representativeness and on smaller horizontal space scales compared to dropsondes.
- The CPEX science team is currently conducting research that, besides the DAWN and dropsonde, includes data from numerical models, the JPL precipitation radar, temperature and/or moisture sounders such as HAMSR, MTHP, and MASC.

