

CPEX 2017: Utilizing the Airborne Doppler Aerosol WiNd Lidar and Dropsondes for Convective Process Studies

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IOAS Observing Systems –PartII

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Overview

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

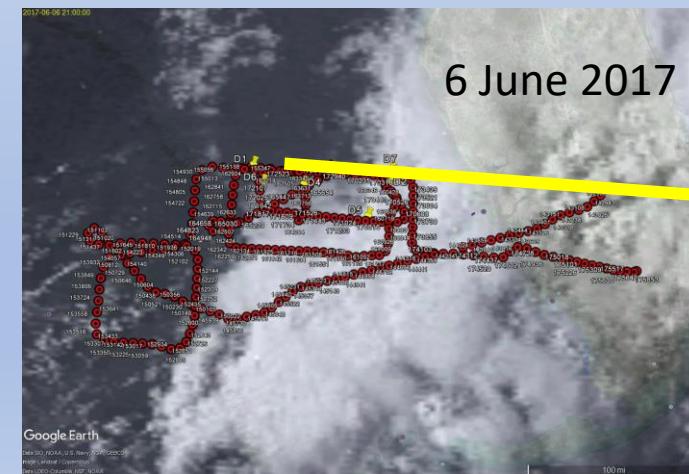
CPEX 2017: A Field Experiment to study Convective Processes in the Tropics

25 May – 24 June 2017

DC-8 based in Fort Lauderdale, Florida
DAWN, APR-2, HAMSR, MTHP, Dropsondes, MASC



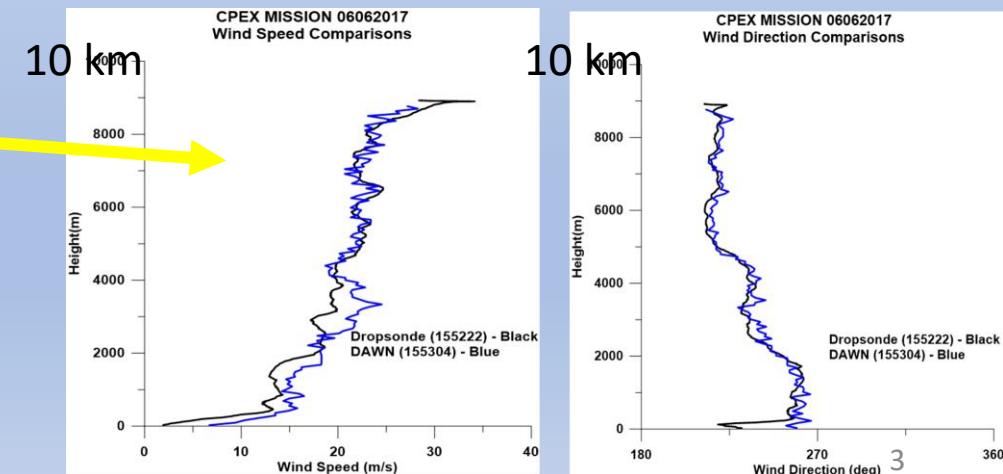
LaRC DAWN on NASA DC8



Each red circle is a DAWN sounding location

- 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)



Multi-scale Wind Variability Using DAWN in CPEX

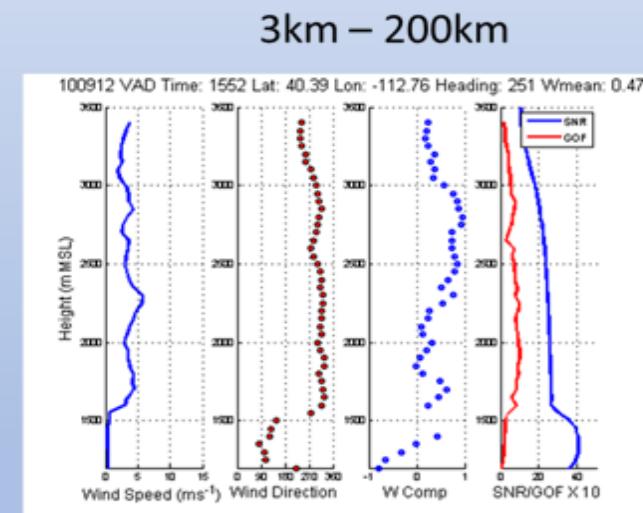
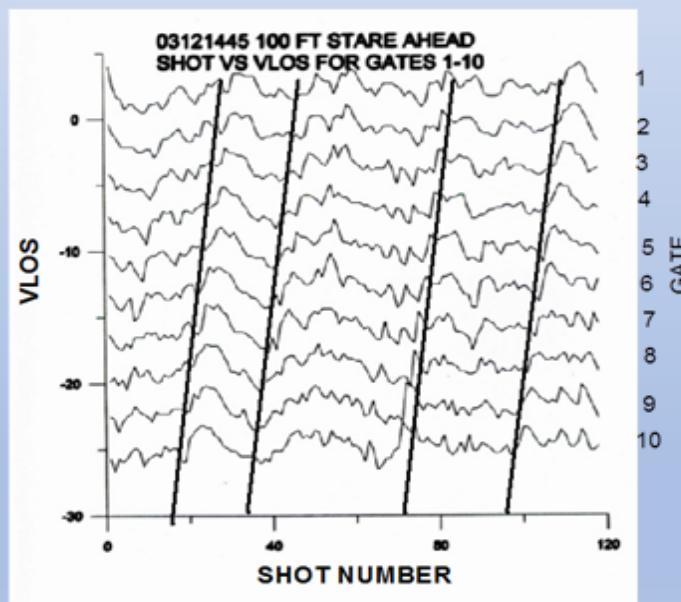
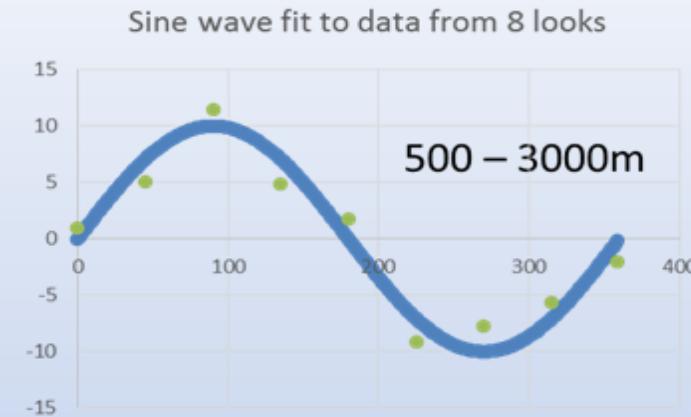
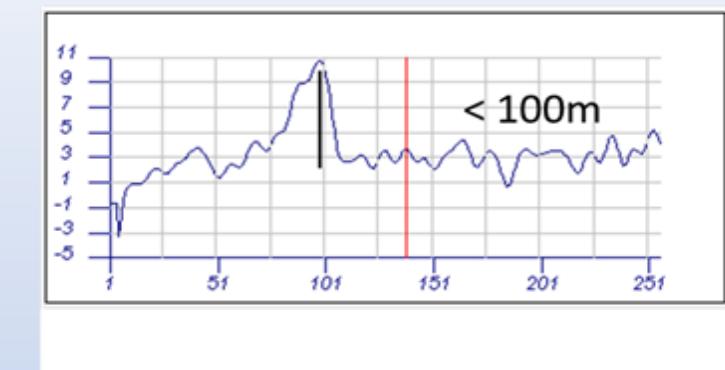
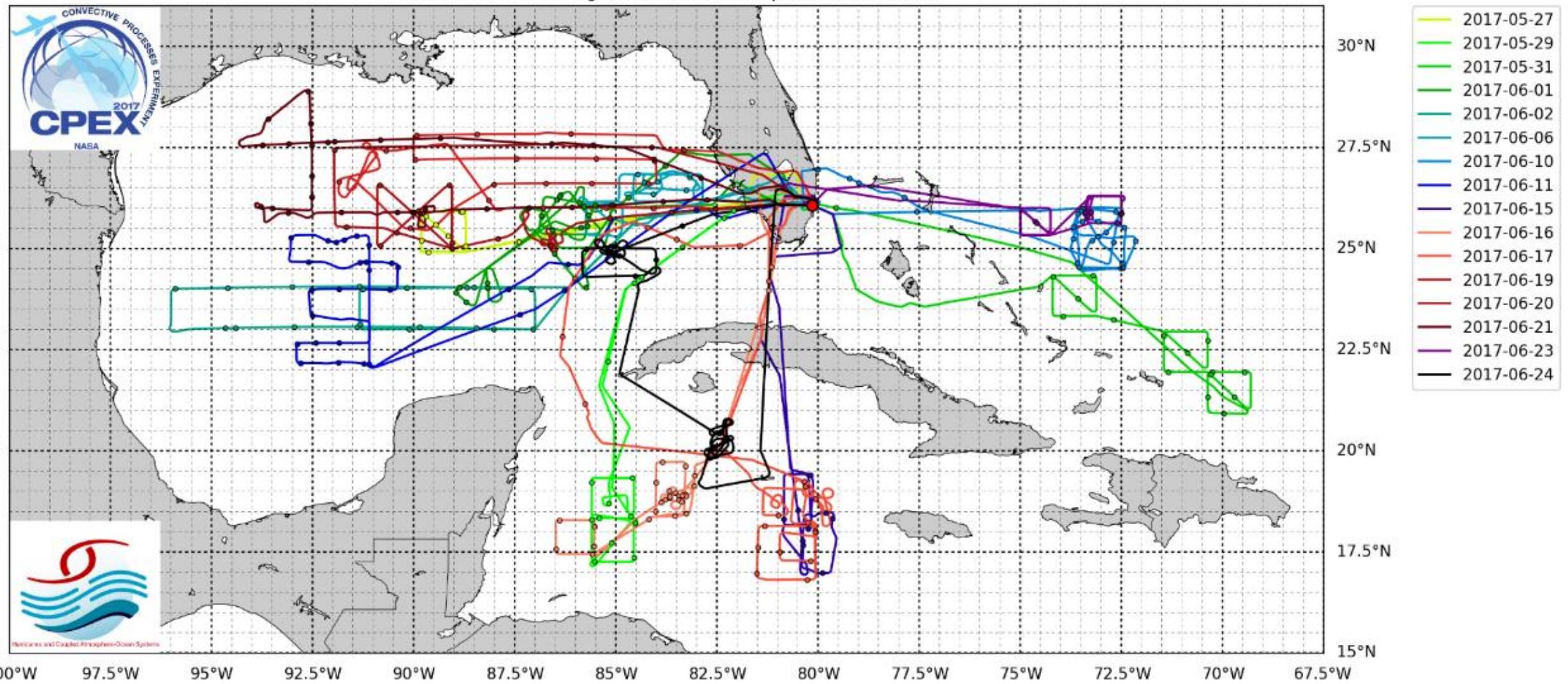
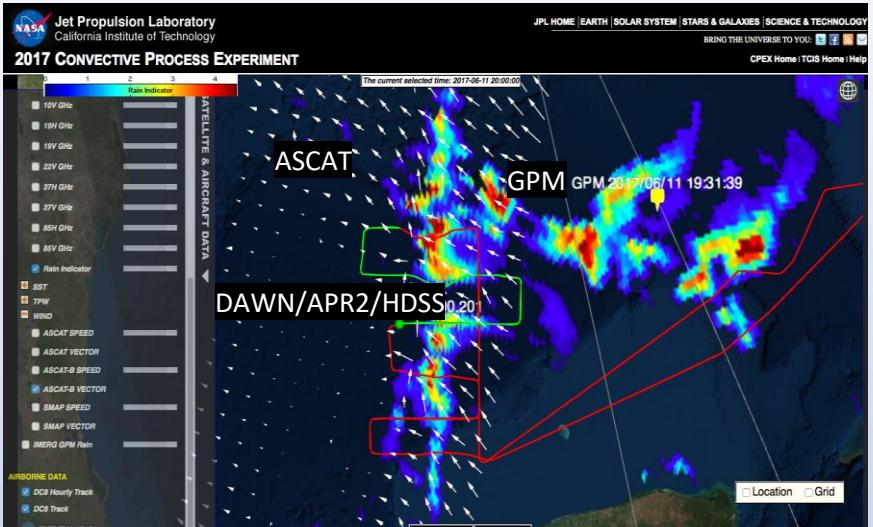


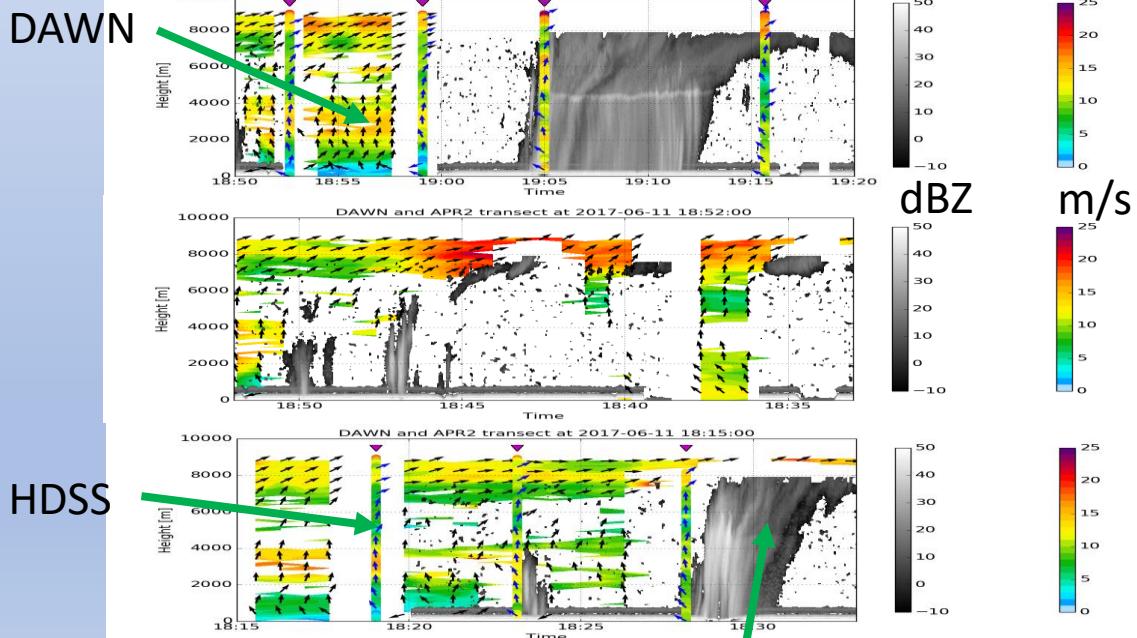
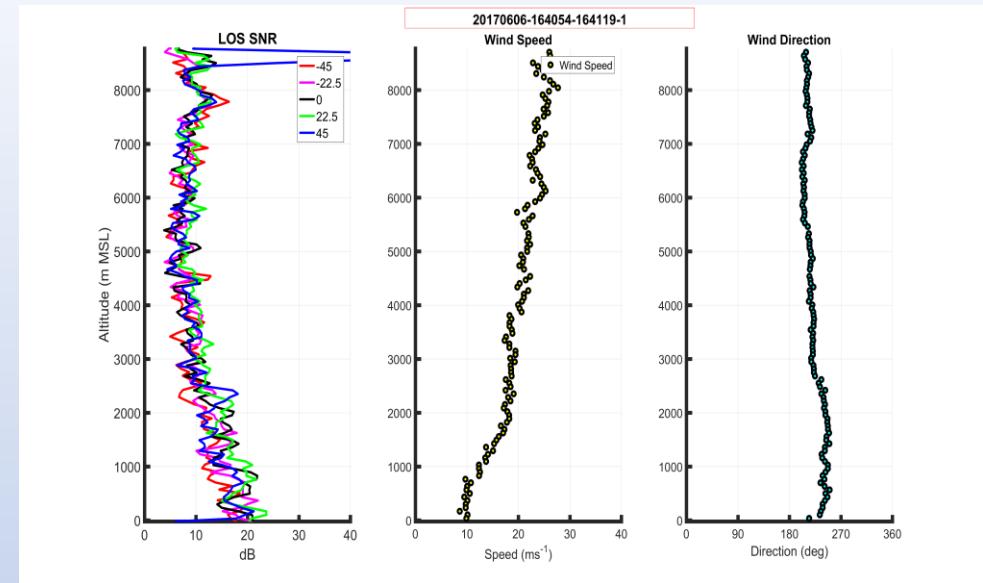
Illustration of the four scales of atmospheric dynamics observed with DAWN as explained in the text.

NASA CPEX 2017 Flight Tracks with Dropsonde Locations



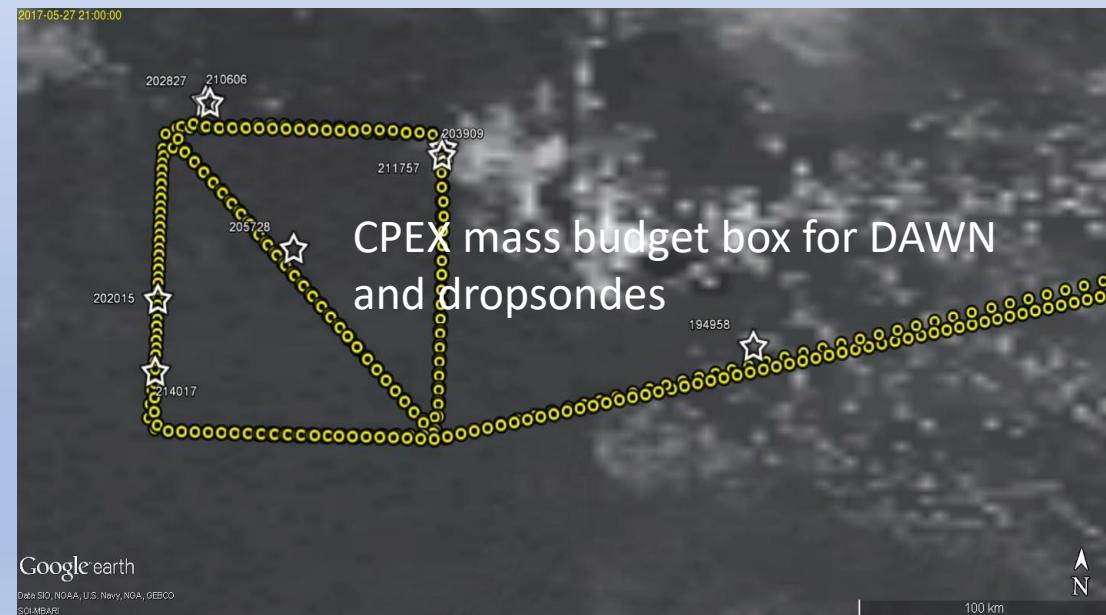


DAWN
wind profile
from 30000'
around CPEX
mass budget
box



Provided by Shuyi Chen

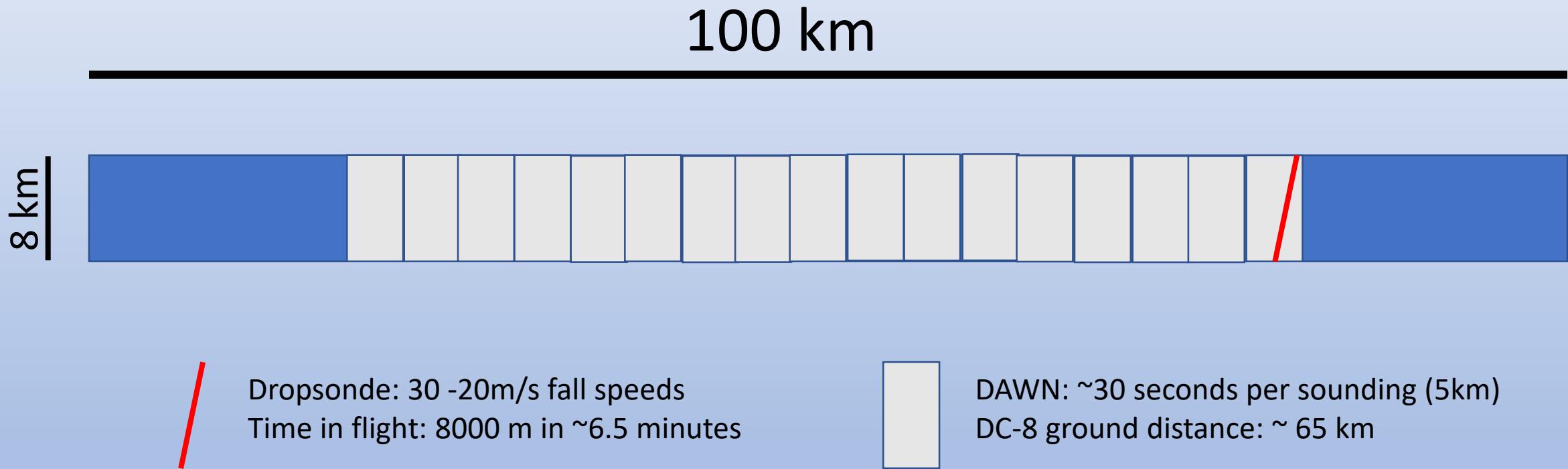
APR2



DAWN: the instrument

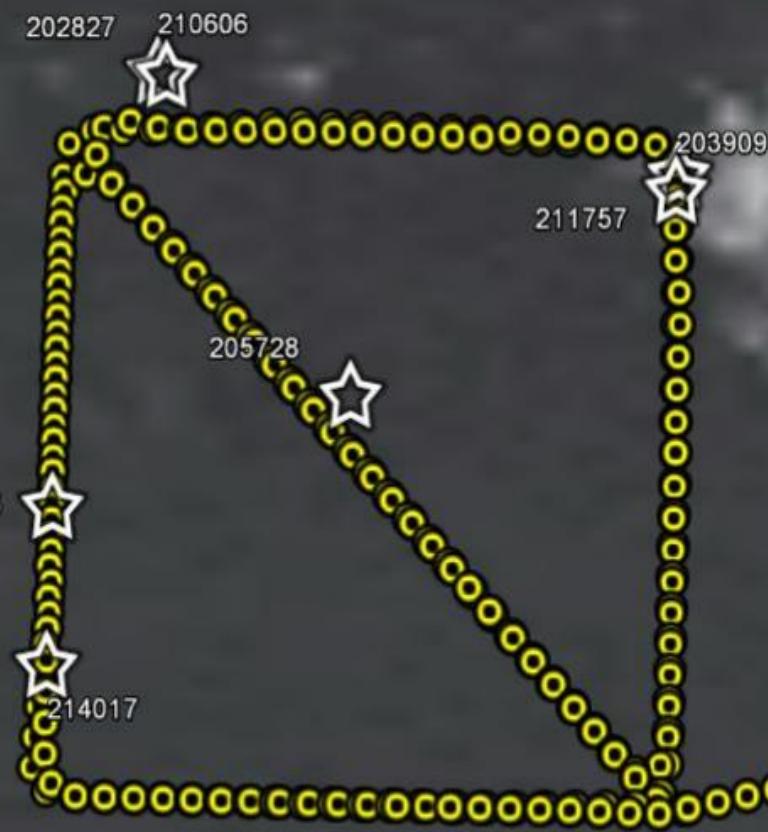
- Developed at NASA/LaRC and flown on NASA King Air and NASA DC-8 in GRIP(2011), PolarWinds(2014 and 2105) and CPEX (2017).
- Coherent 2 um Doppler lidar
- 100mJ, 10Hz, 15cm
- 2 second LOS nominal integrations (range from 1 second to 20 second integrations depending upon clouds and aerosols)
- 50-500m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

DAWN vs dropsonde sampling comparisons



2017-05-27 21:00:00

100 km



Google earth

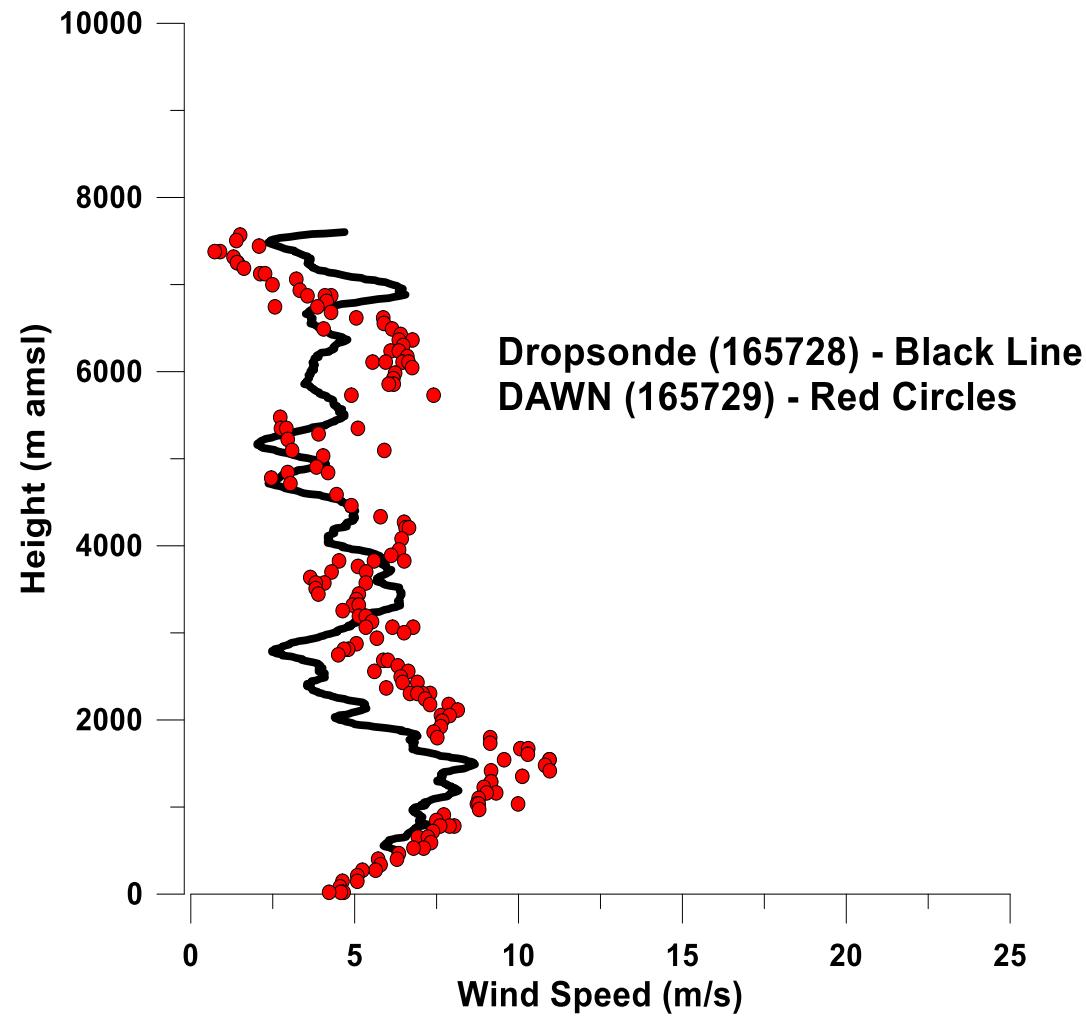
Data SIO, NOAA, U.S. Navy, NGA, GEBCO
SOI-MBARI

N

100 km

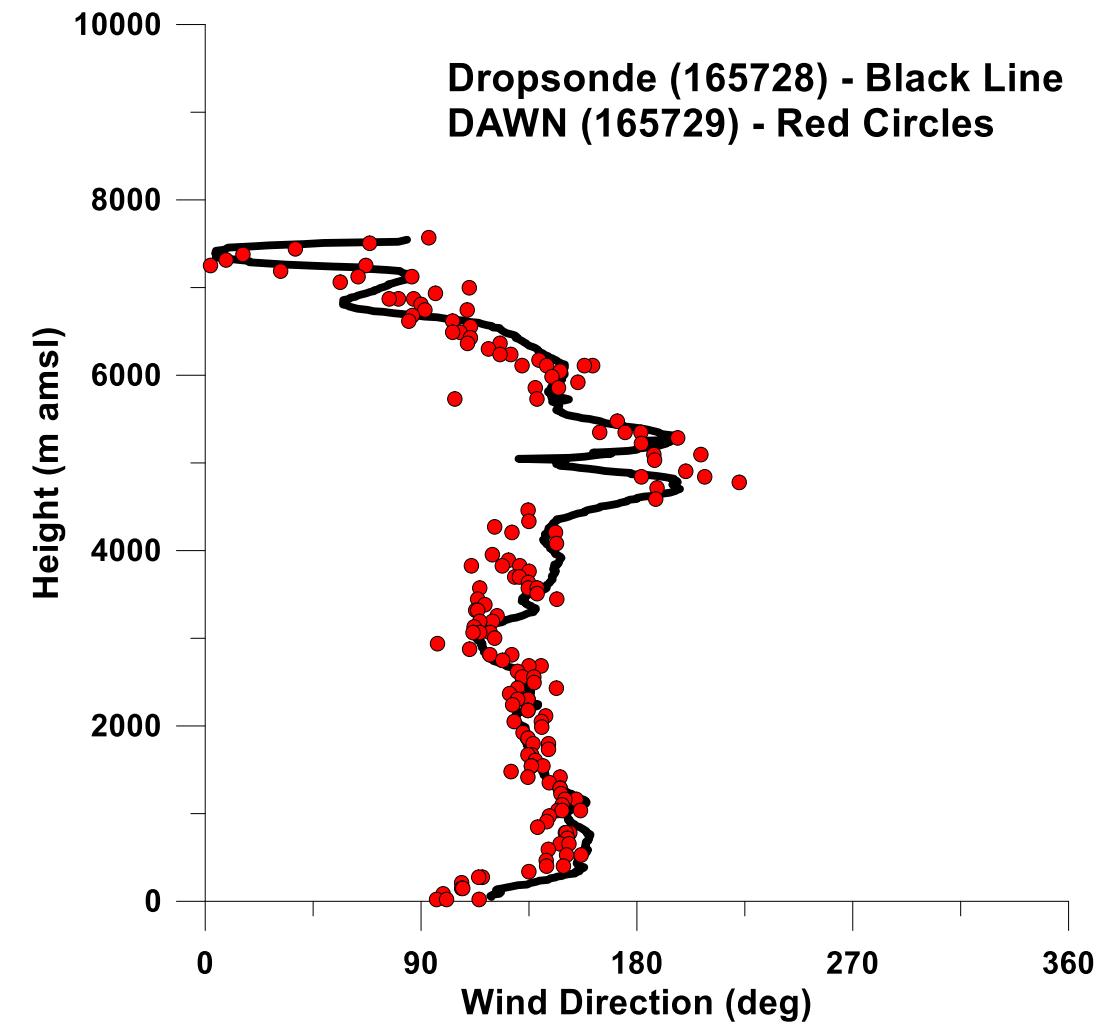
CPEX DAWN - DROPSONDE COMPARISON

Wind Speed
05/27/17

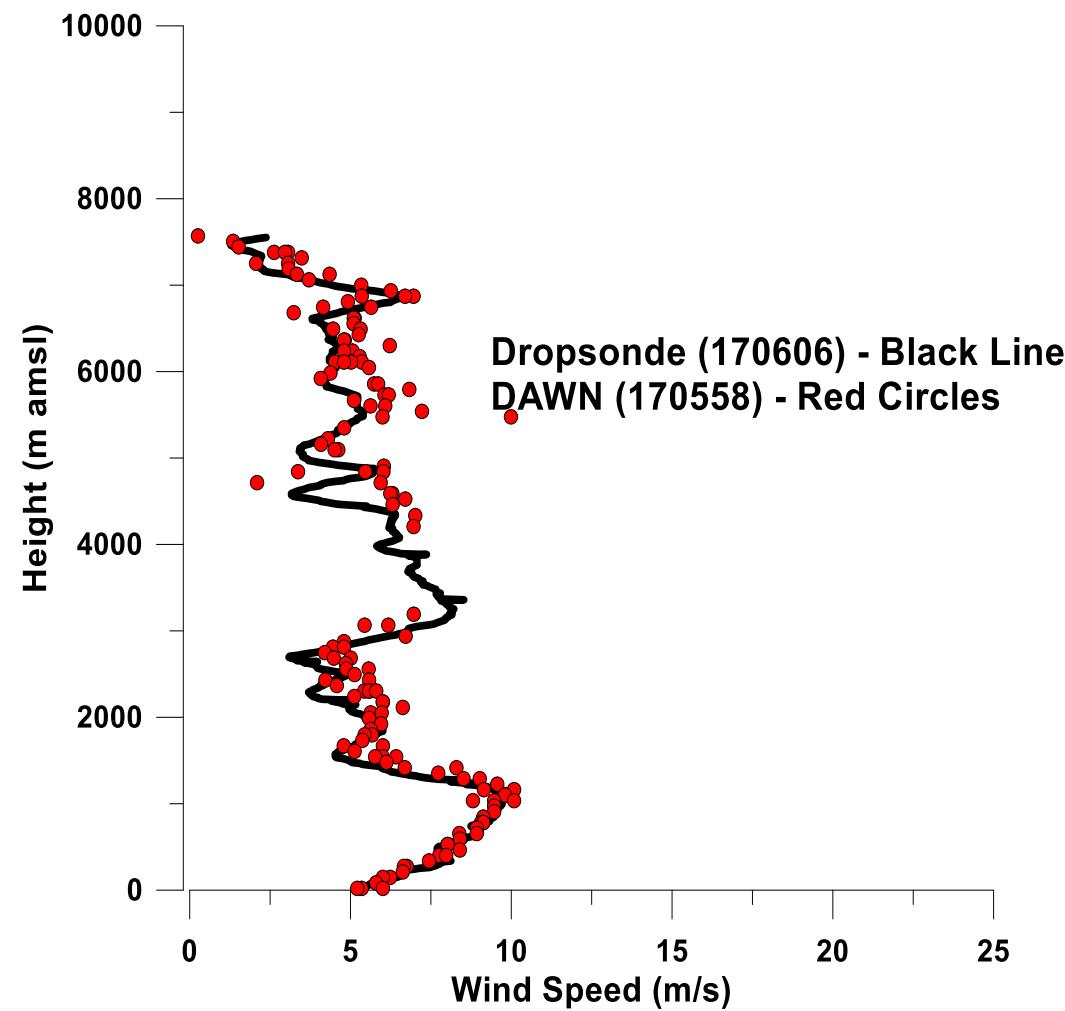


CPEX DAWN - DROPSONDE COMPARISON

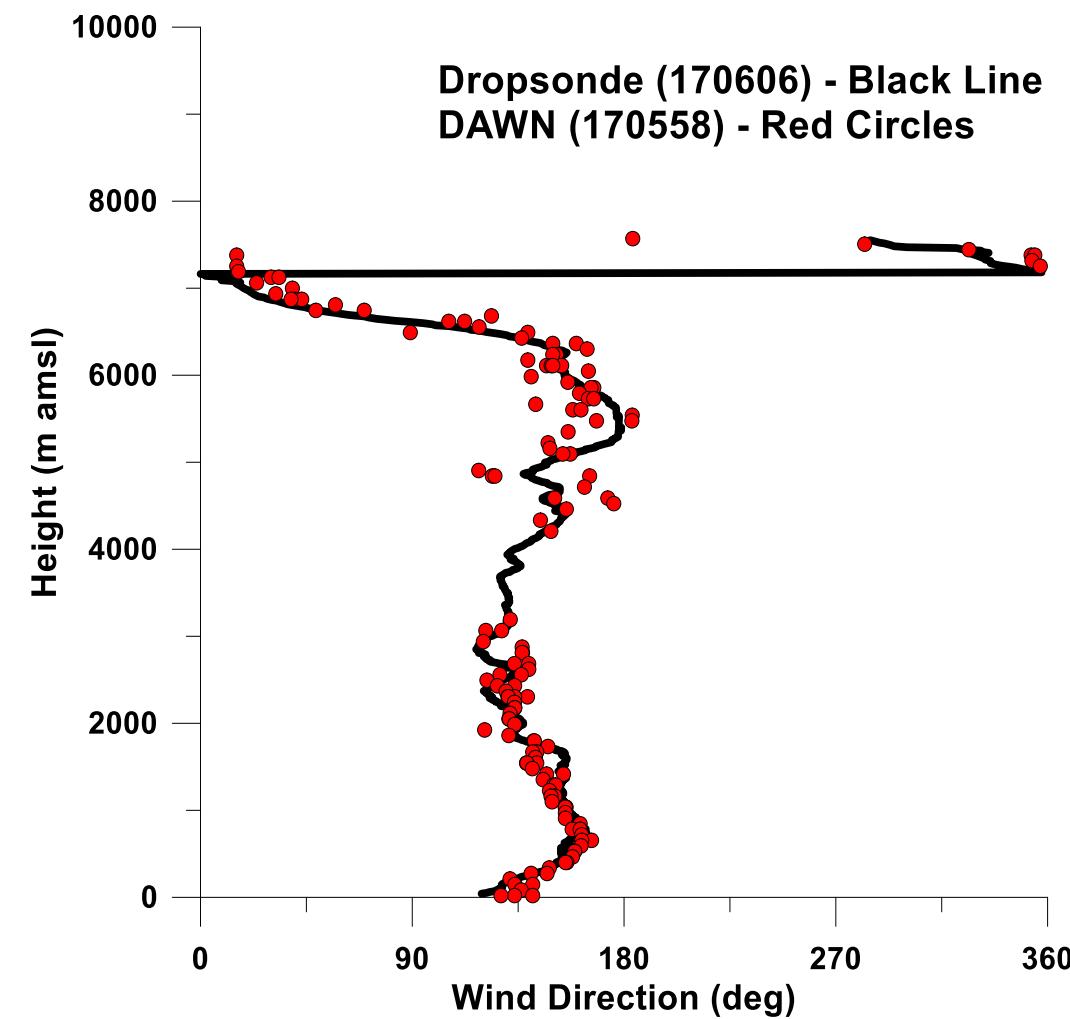
Wind Direction
05/27/17



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



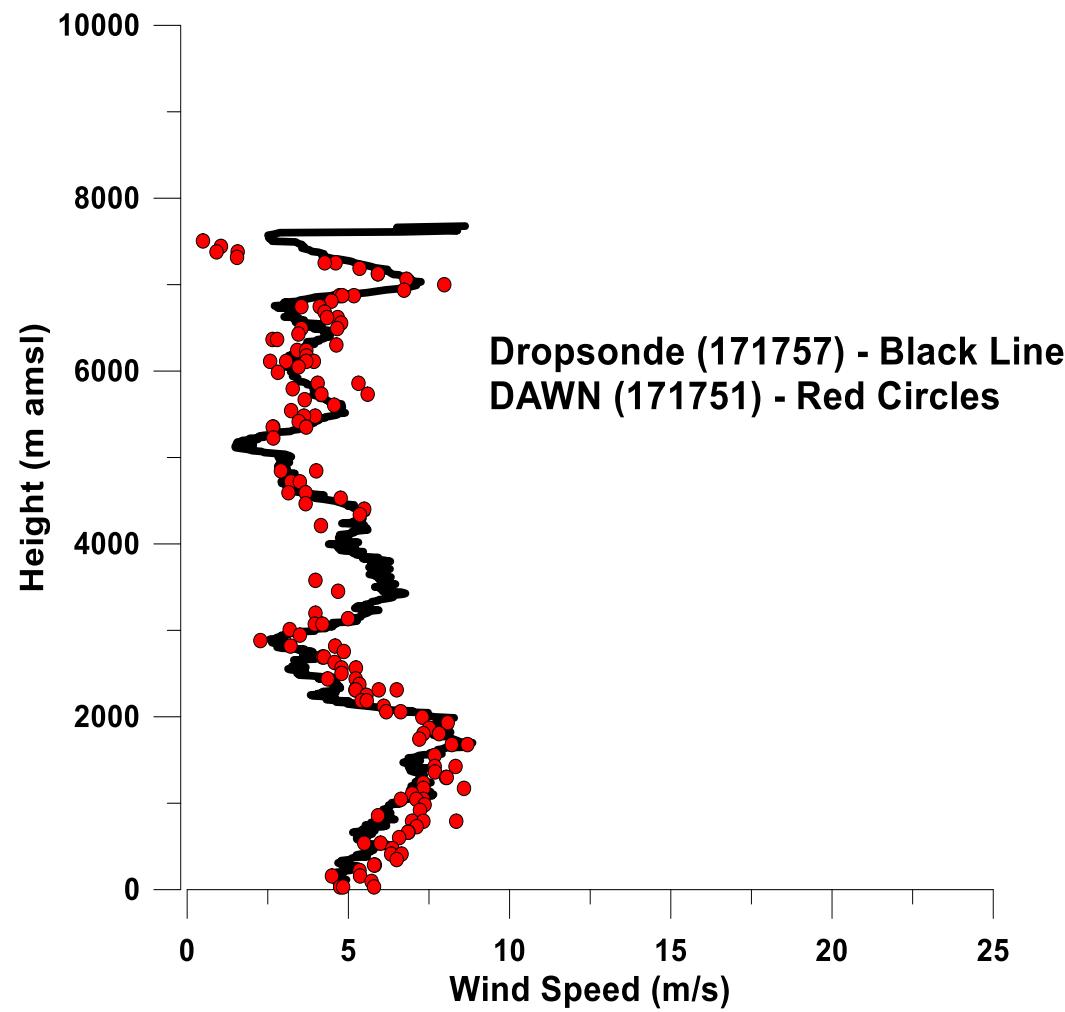
CPEX DAWN - DROPSONDE COMPARISON
Wind Direction
05/27/17



CPEX DAWN - DROPSONDE COMPARISON

Wind Speed

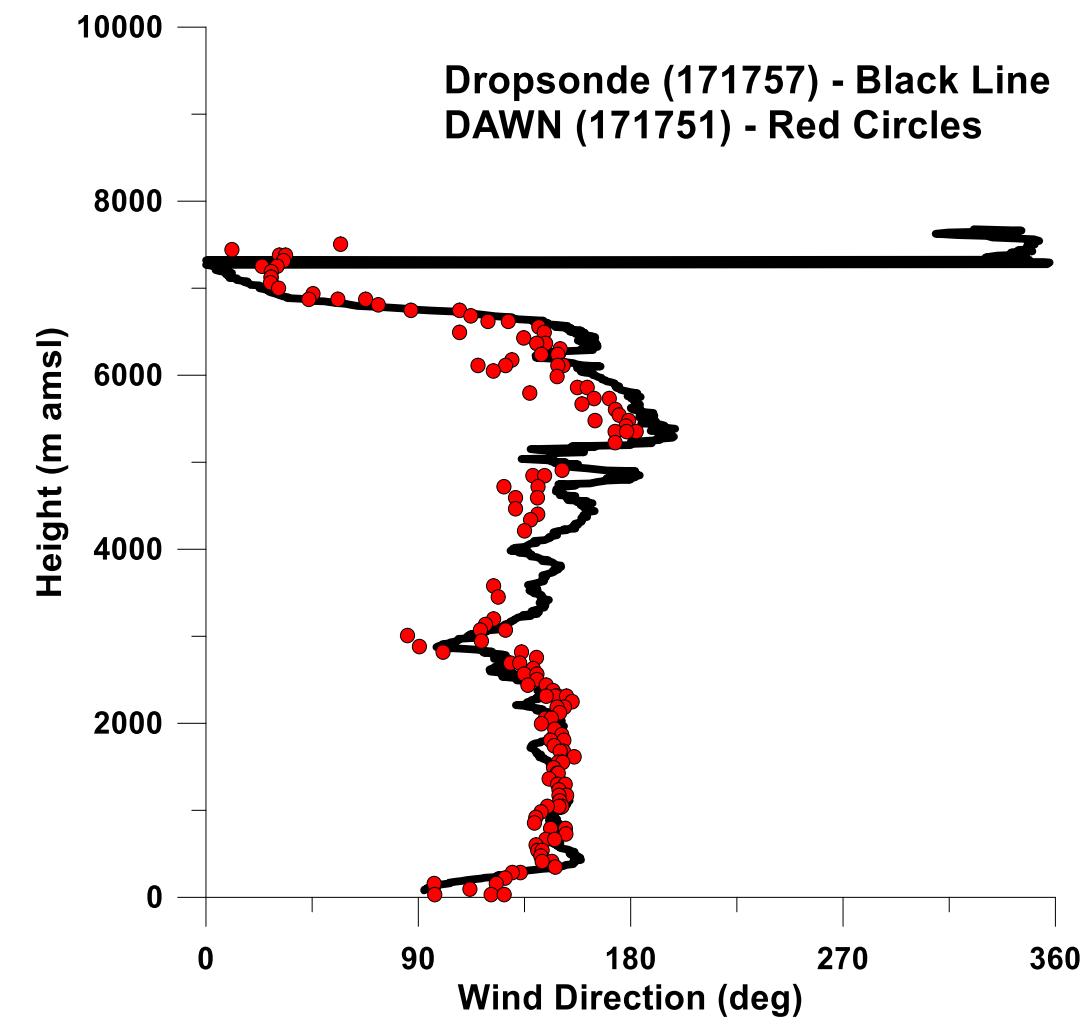
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CPEX DAWN - DROPSONDE COMPARISON

Wind Direction

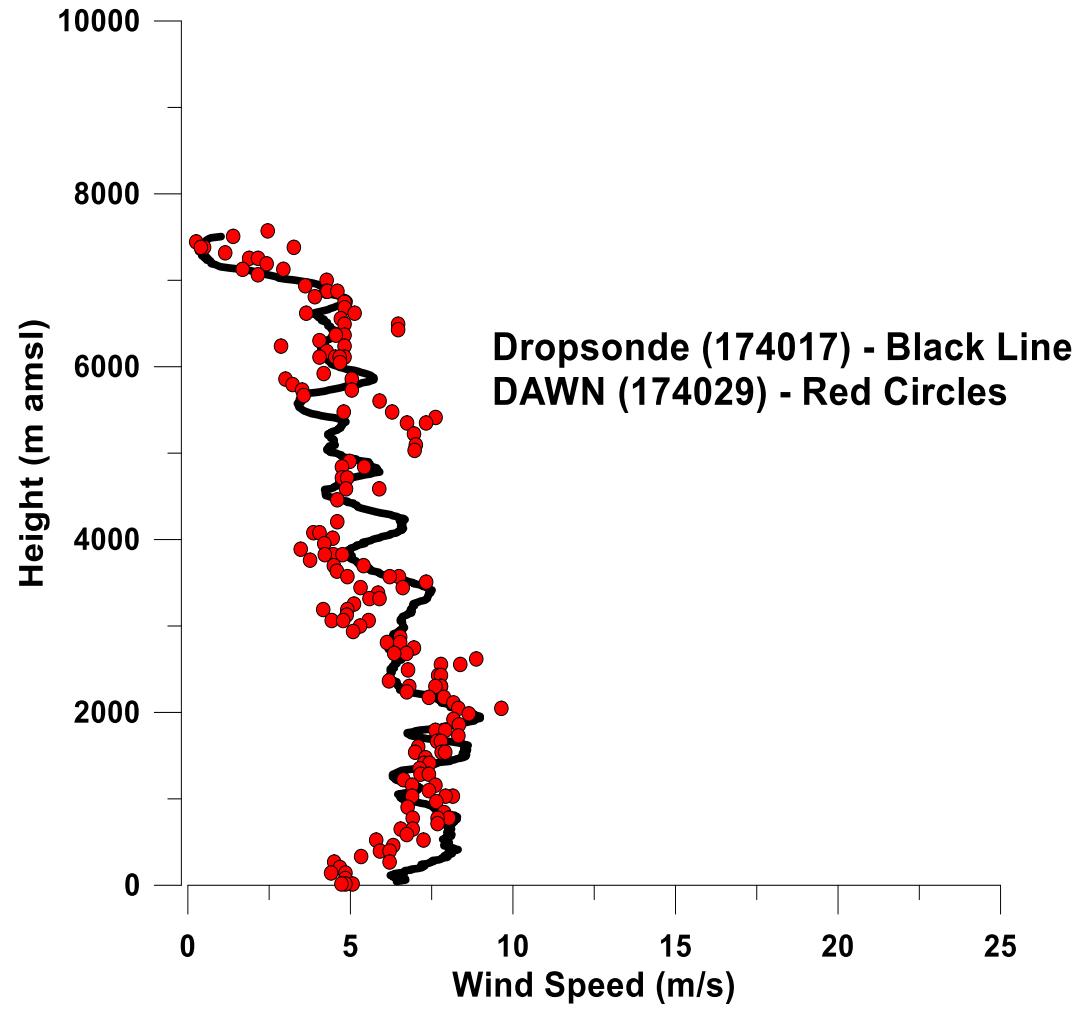
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CPEX DAWN - DROPSONDE COMPARISON

Wind Speed

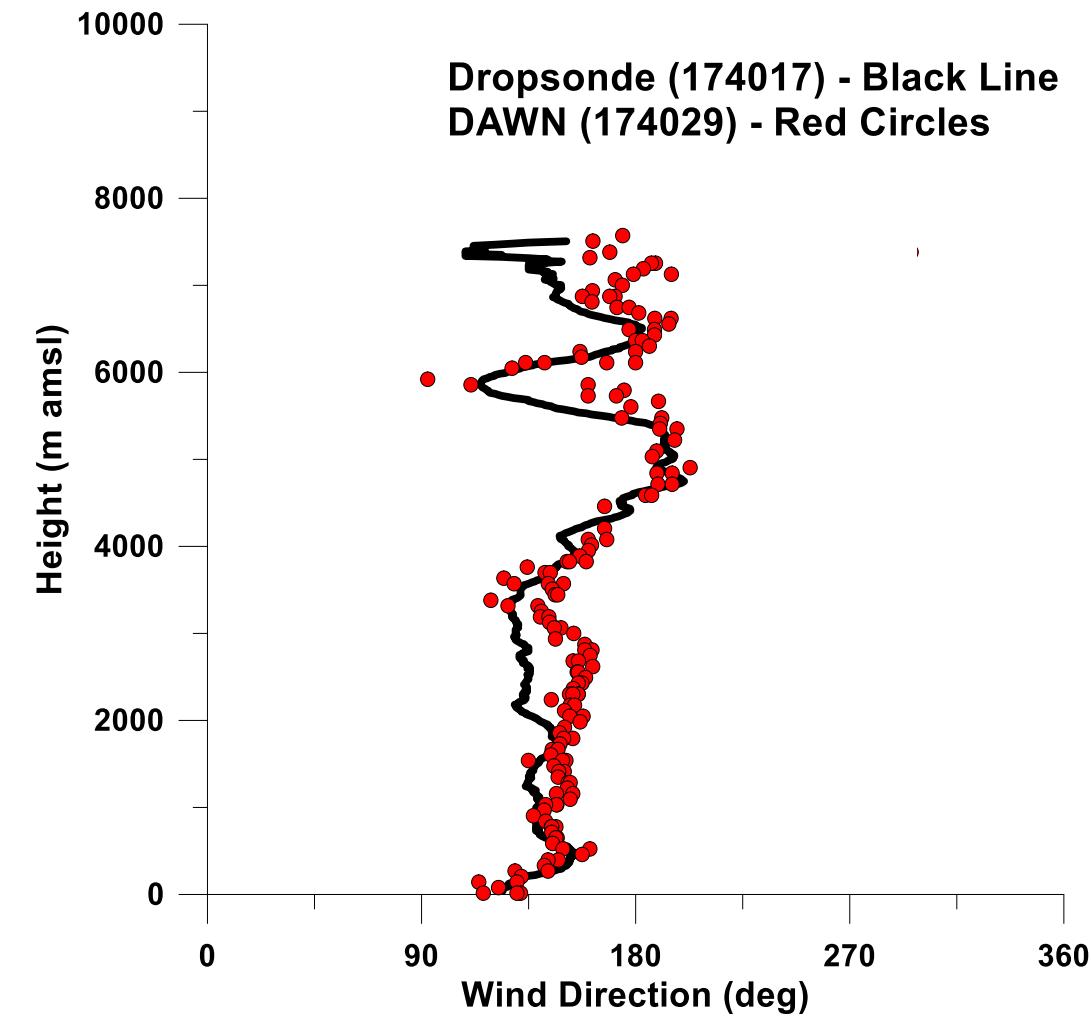
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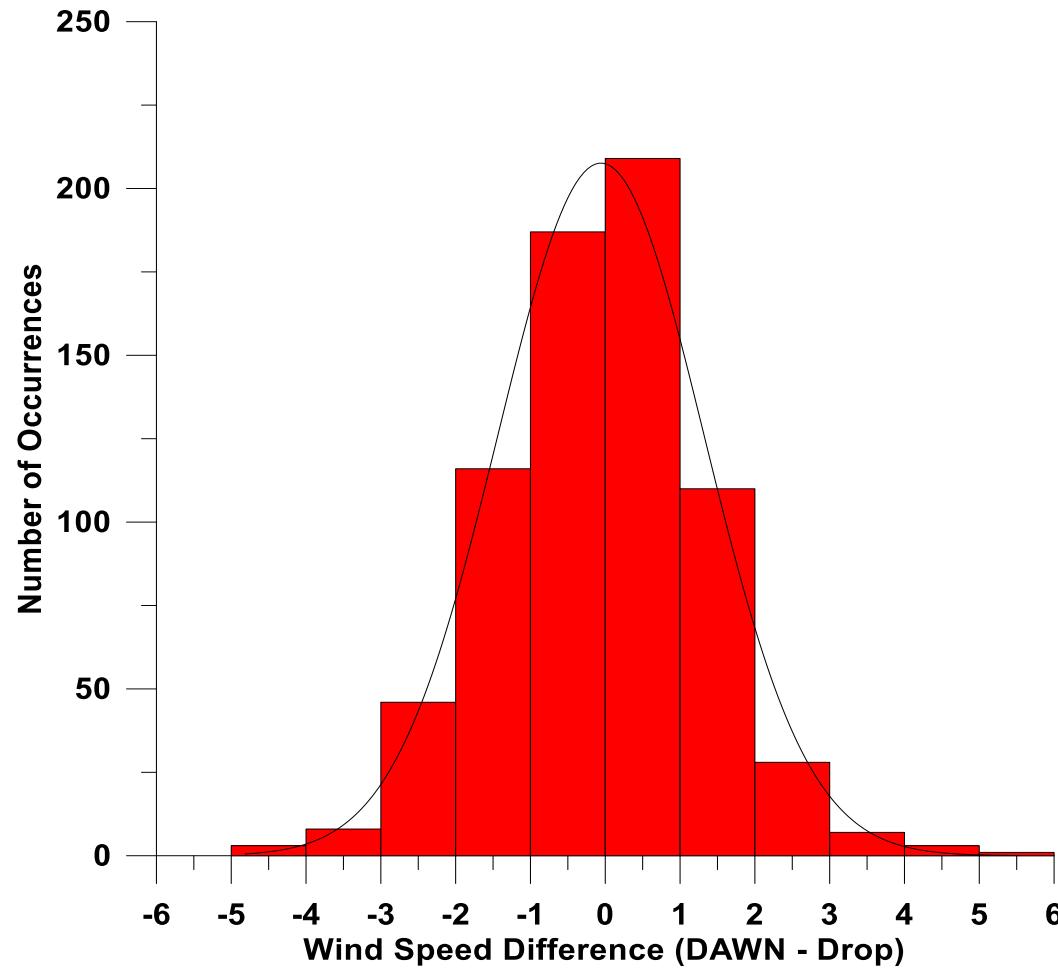
CPEX DAWN - DROPSONDE COMPARISON

Wind Direction

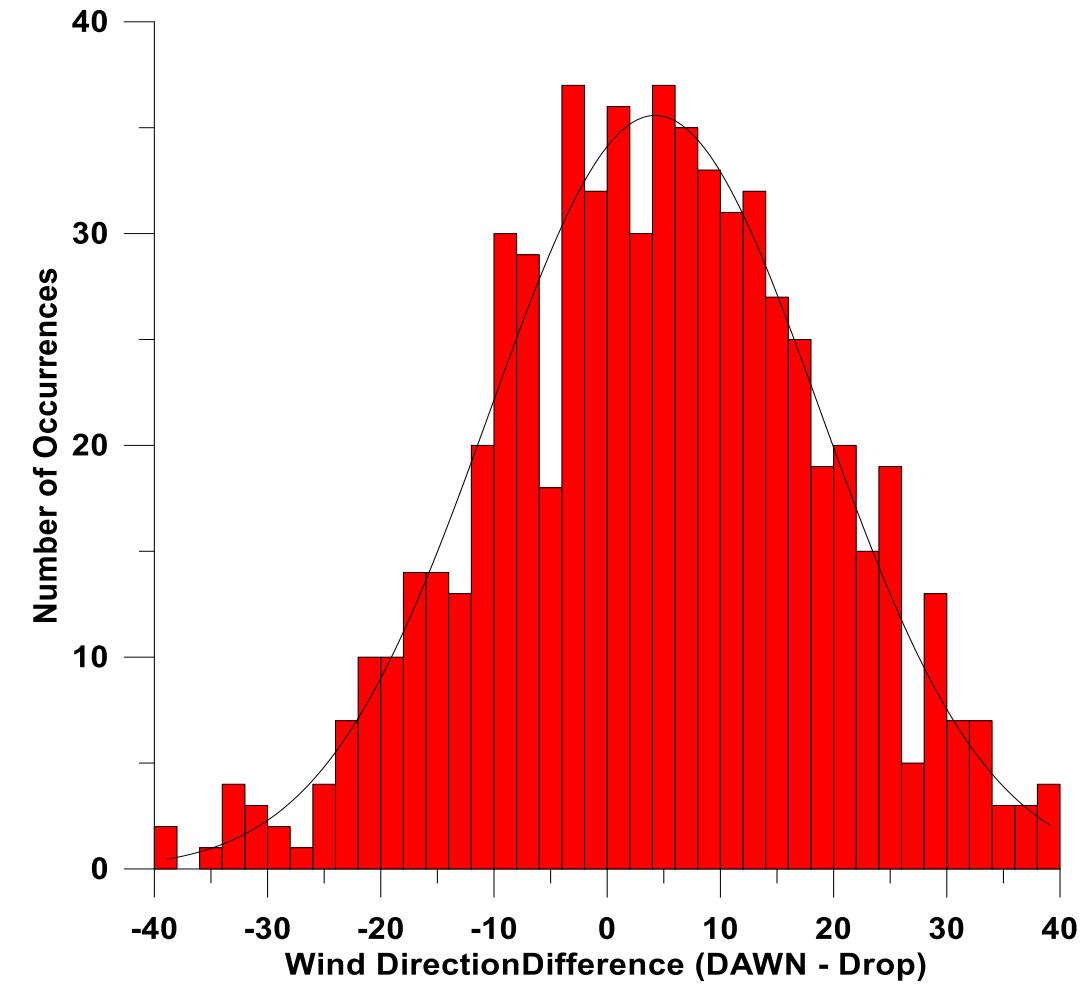
05/27/17



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 residual aircraft motion accounting due to drift in heading during flight

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

2017-05-27 21:00:00

100 km



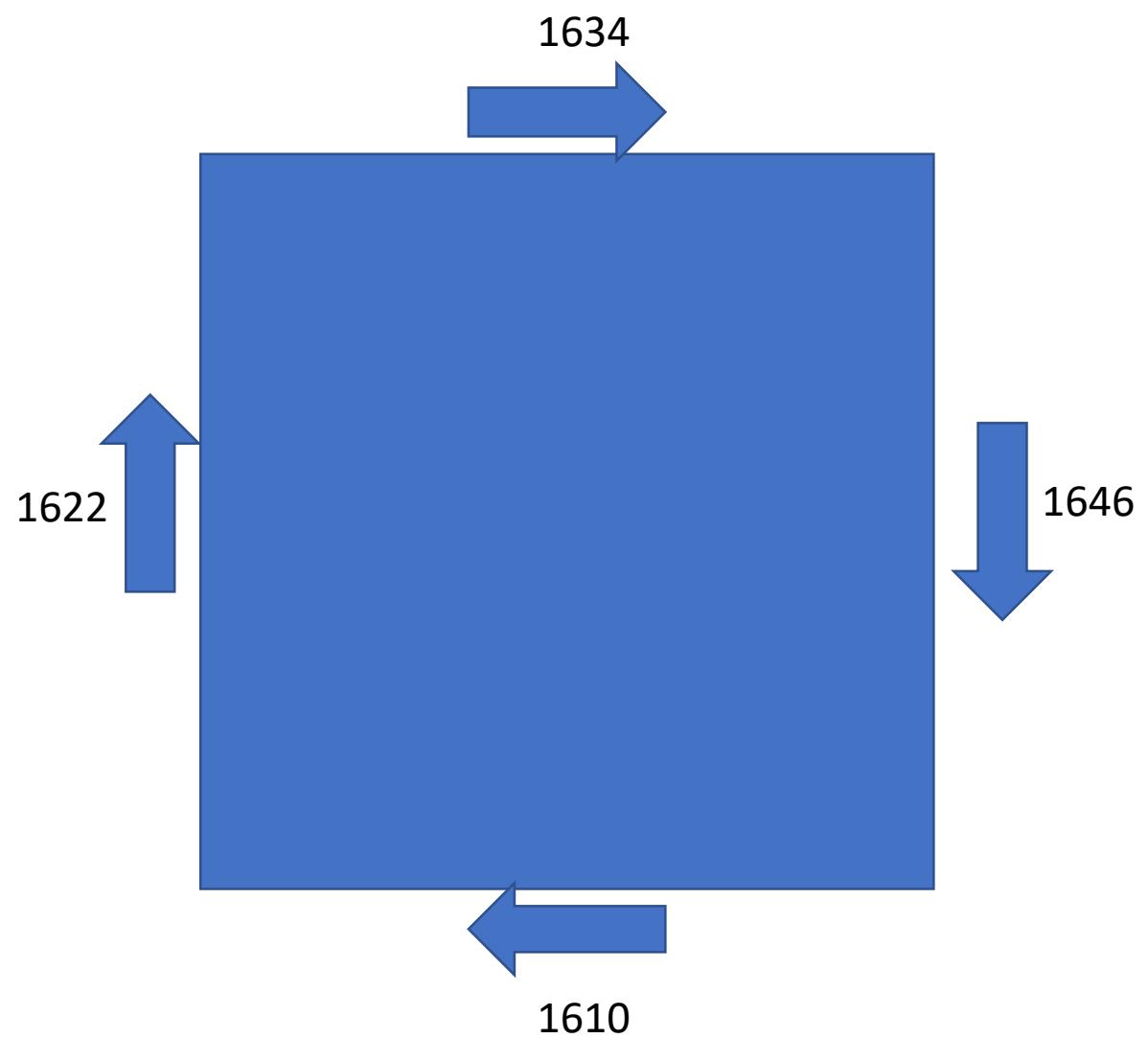
Google earth

Data SIO, NOAA, U.S. Navy, NGA, GEBCO
SOI-MBARI

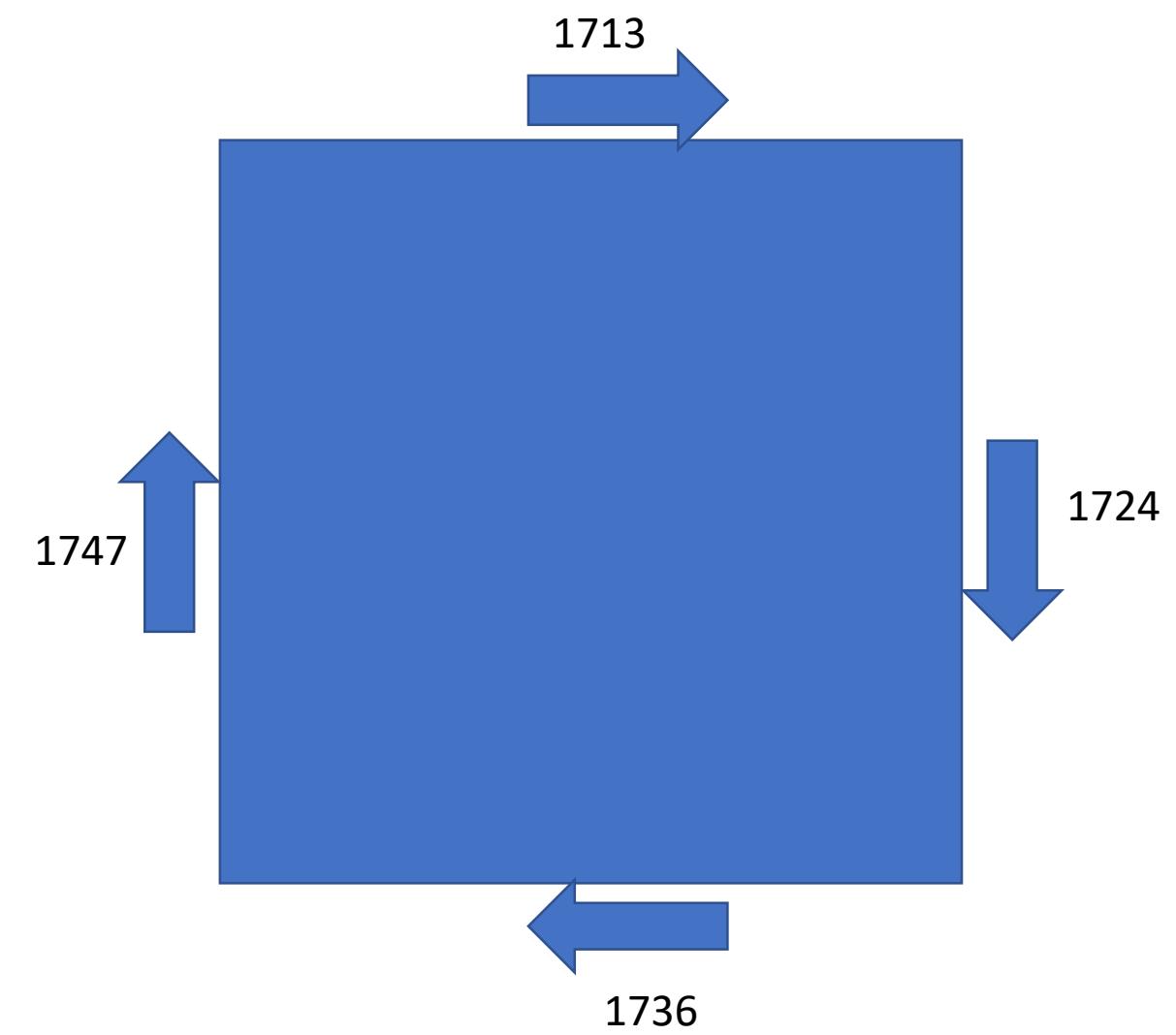
N

100 km

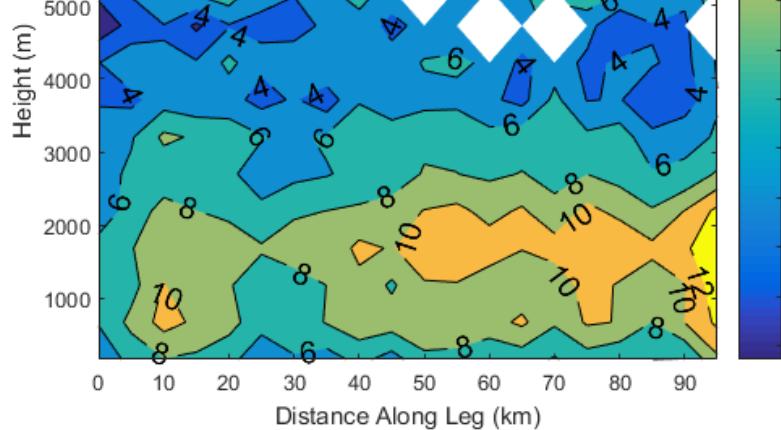
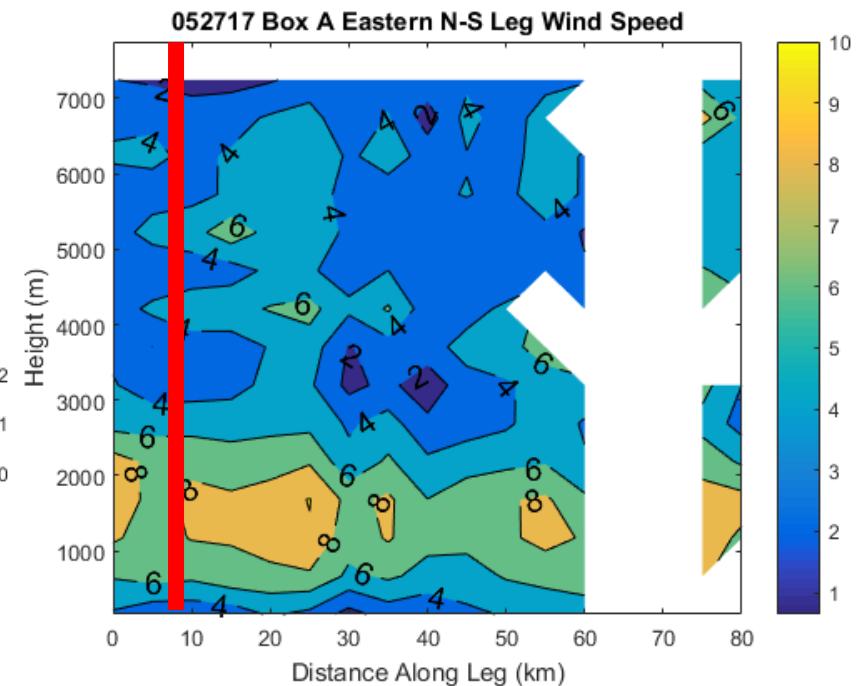
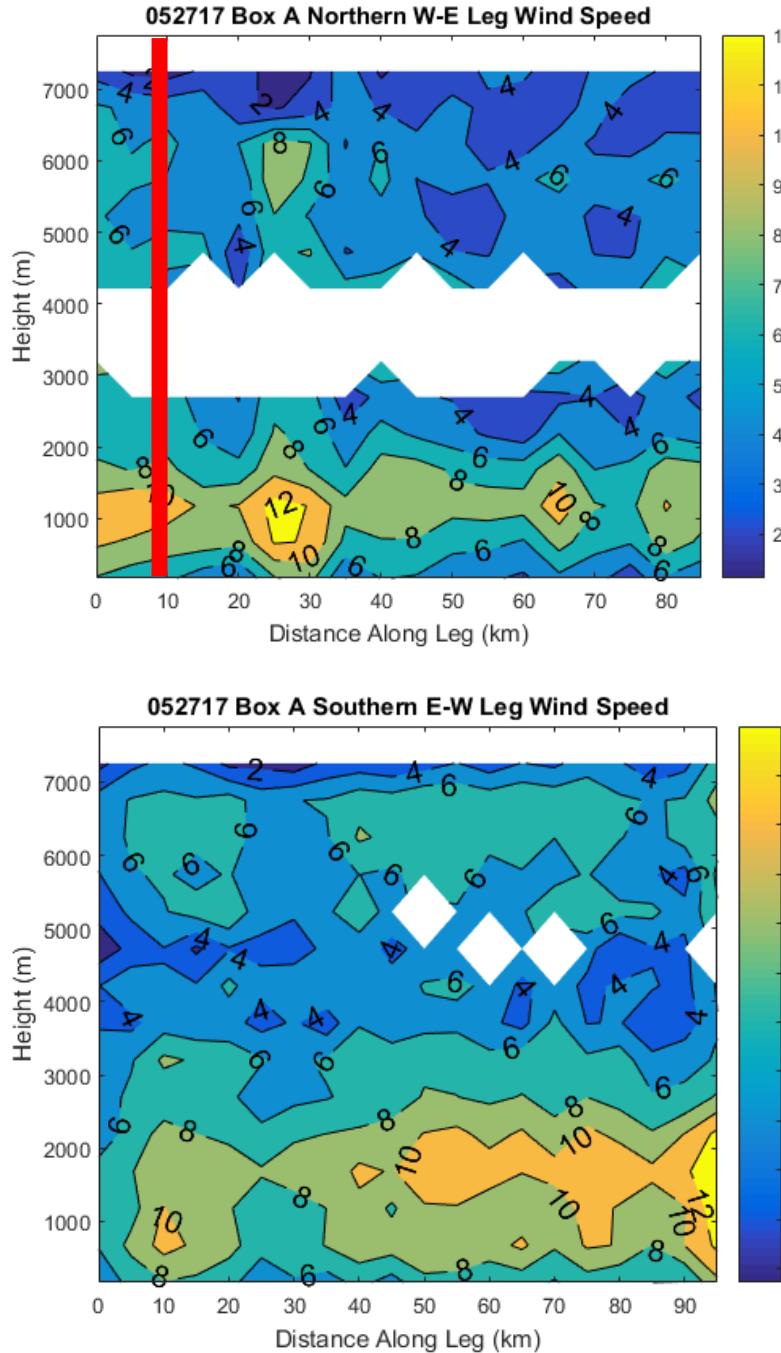
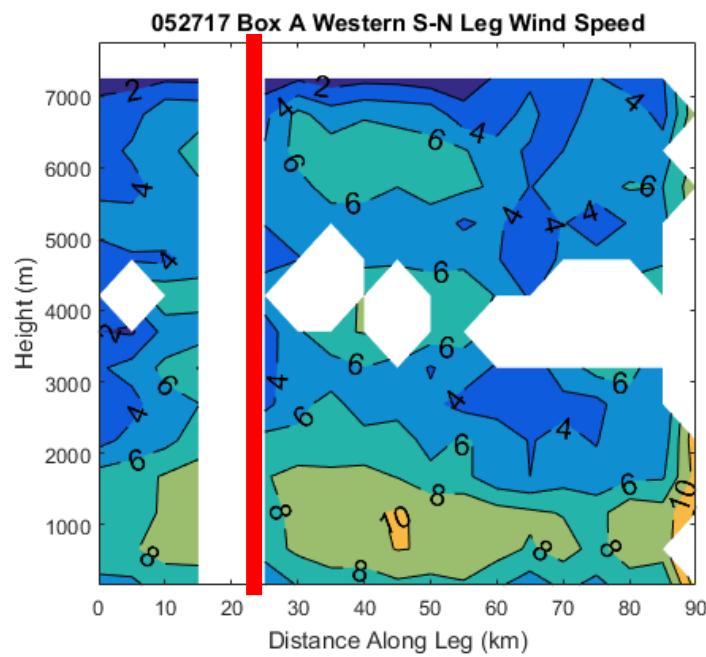
BOX A



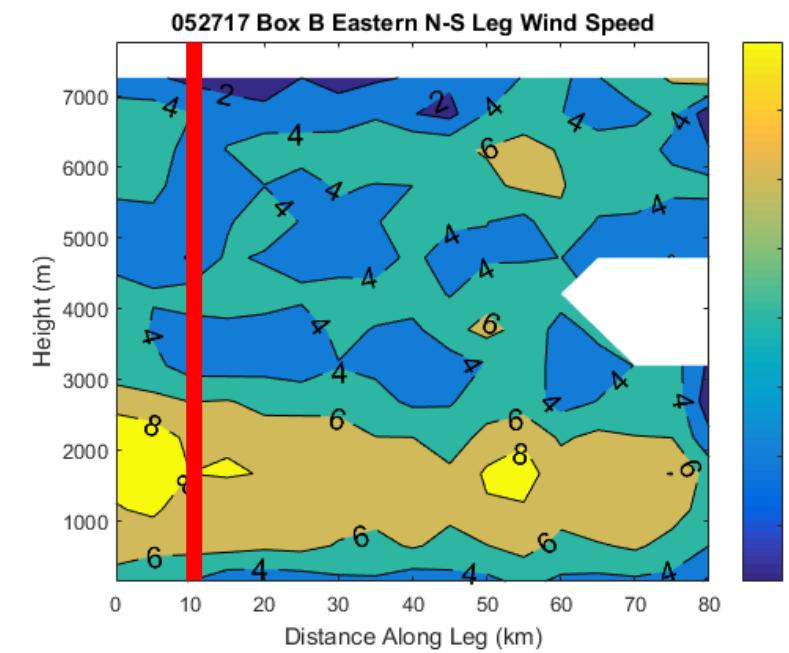
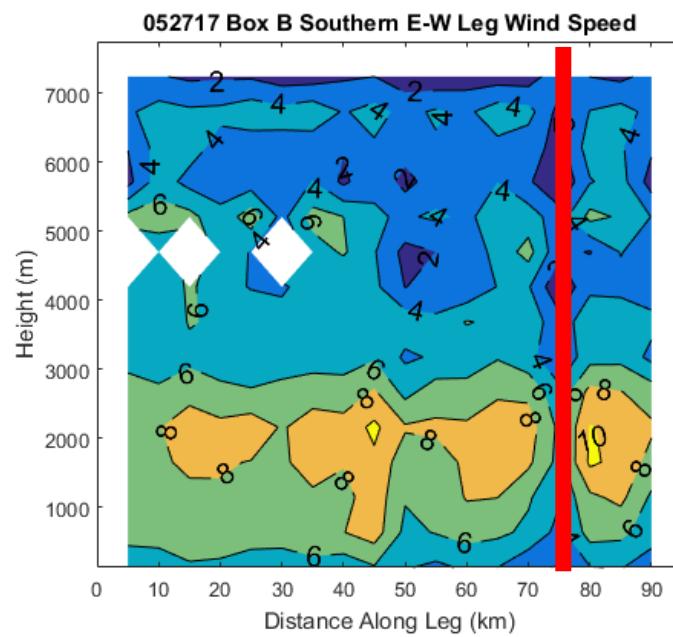
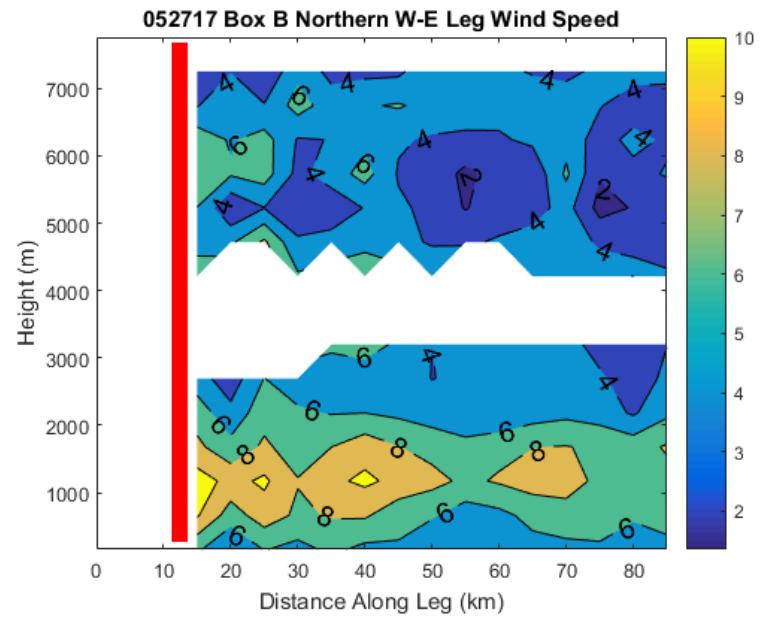
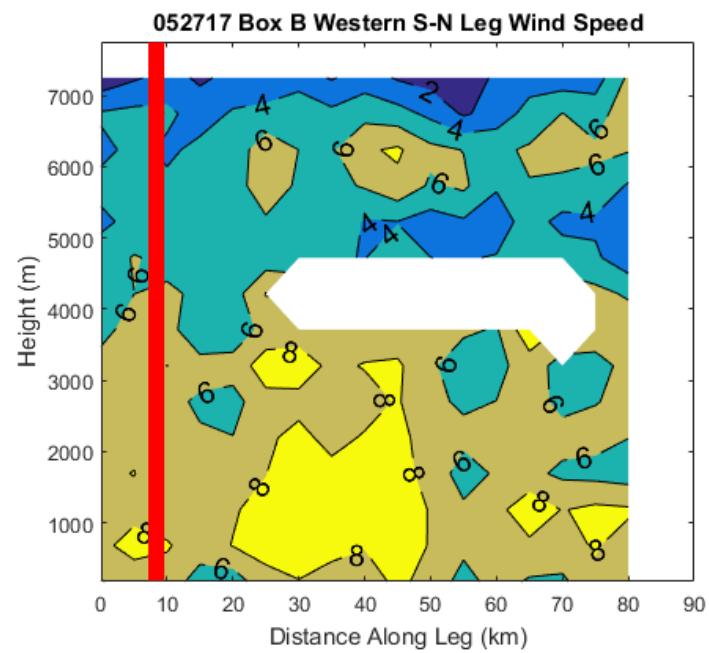
BOX B



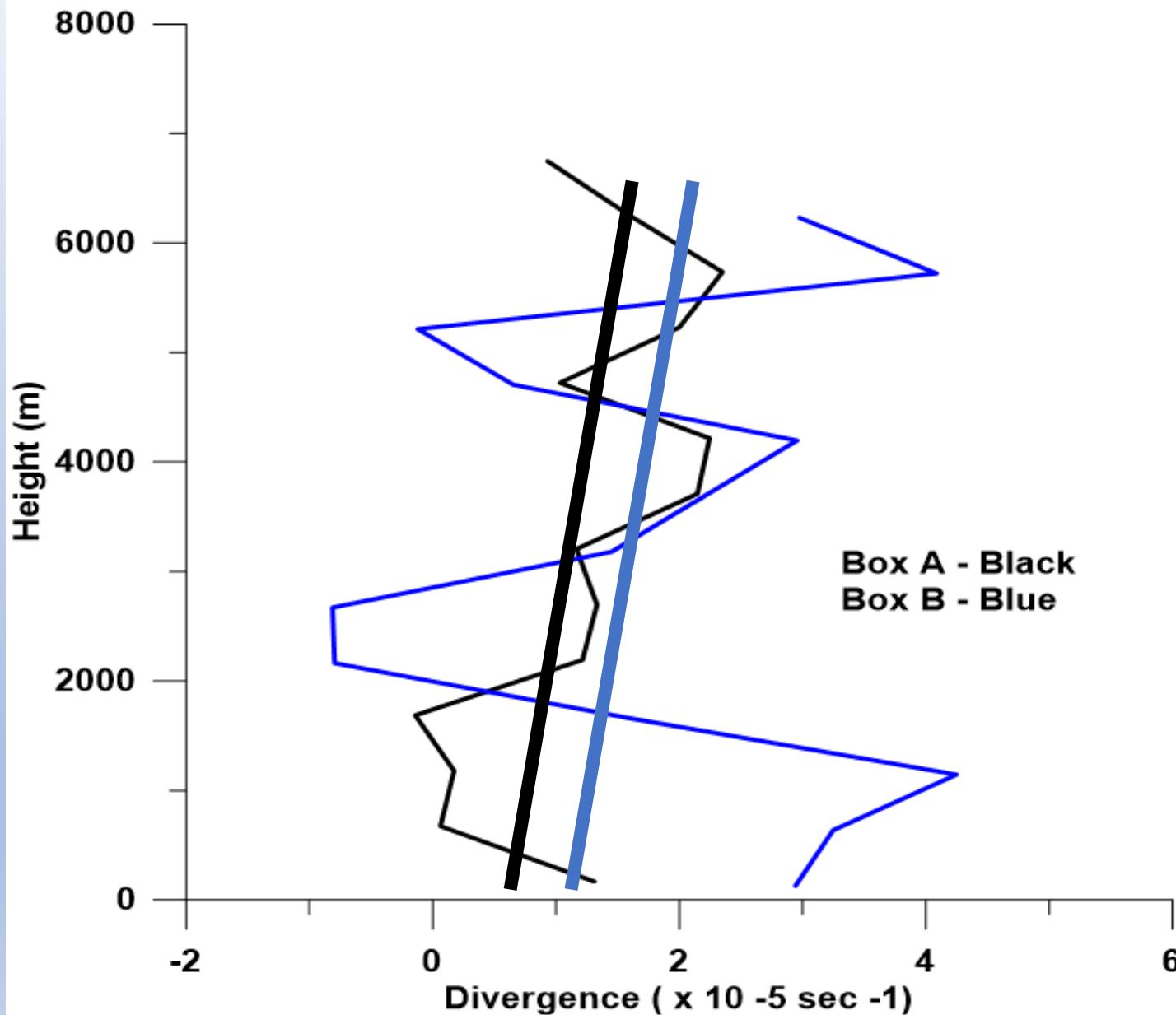
BOX A



BOX B



Mass Divergence Over Consecutive CPEX Boxes
05/27/17



Summary

- 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.
- 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 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.