CPEX 2017: Utilizing DAWN wind measurements for convective studies and mass budget calculations

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and

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Working Group on Space-based Lidar Winds

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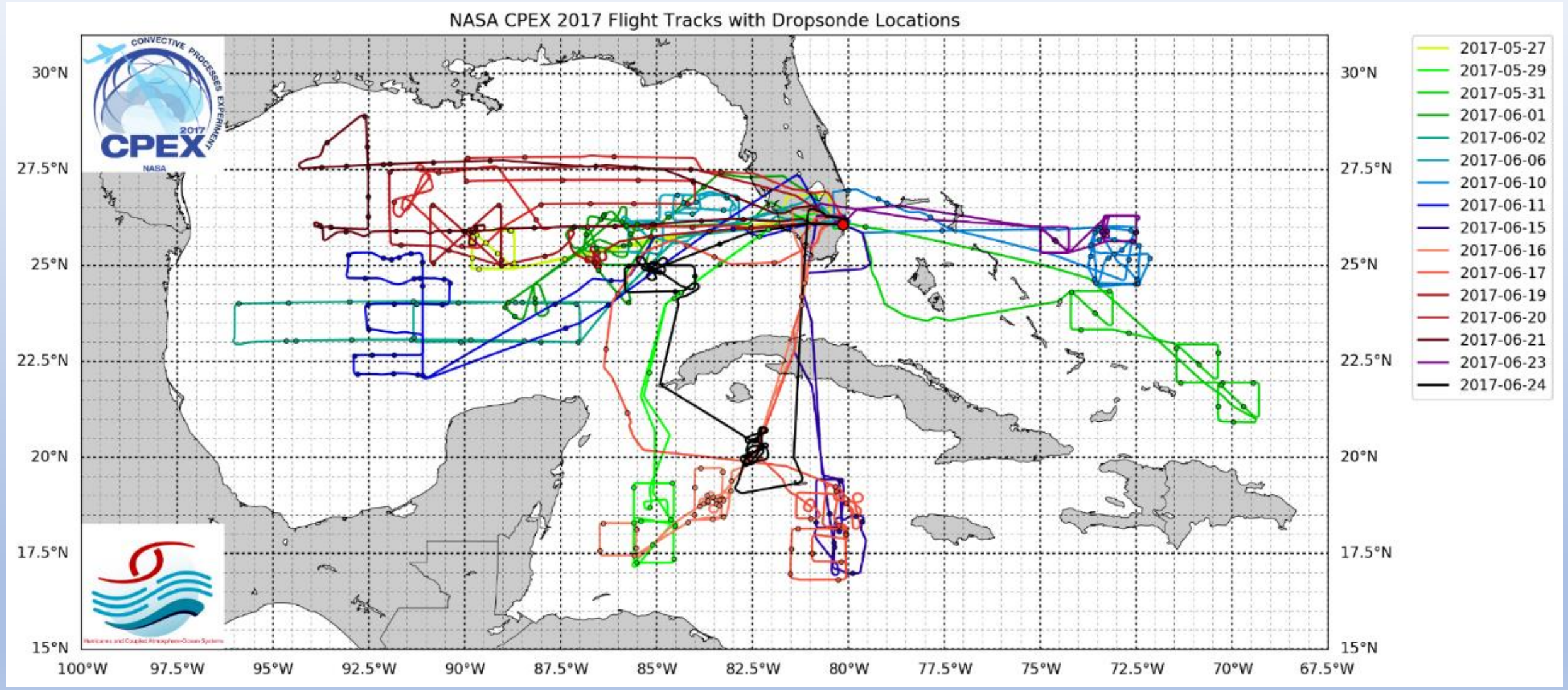
8 February, 2018

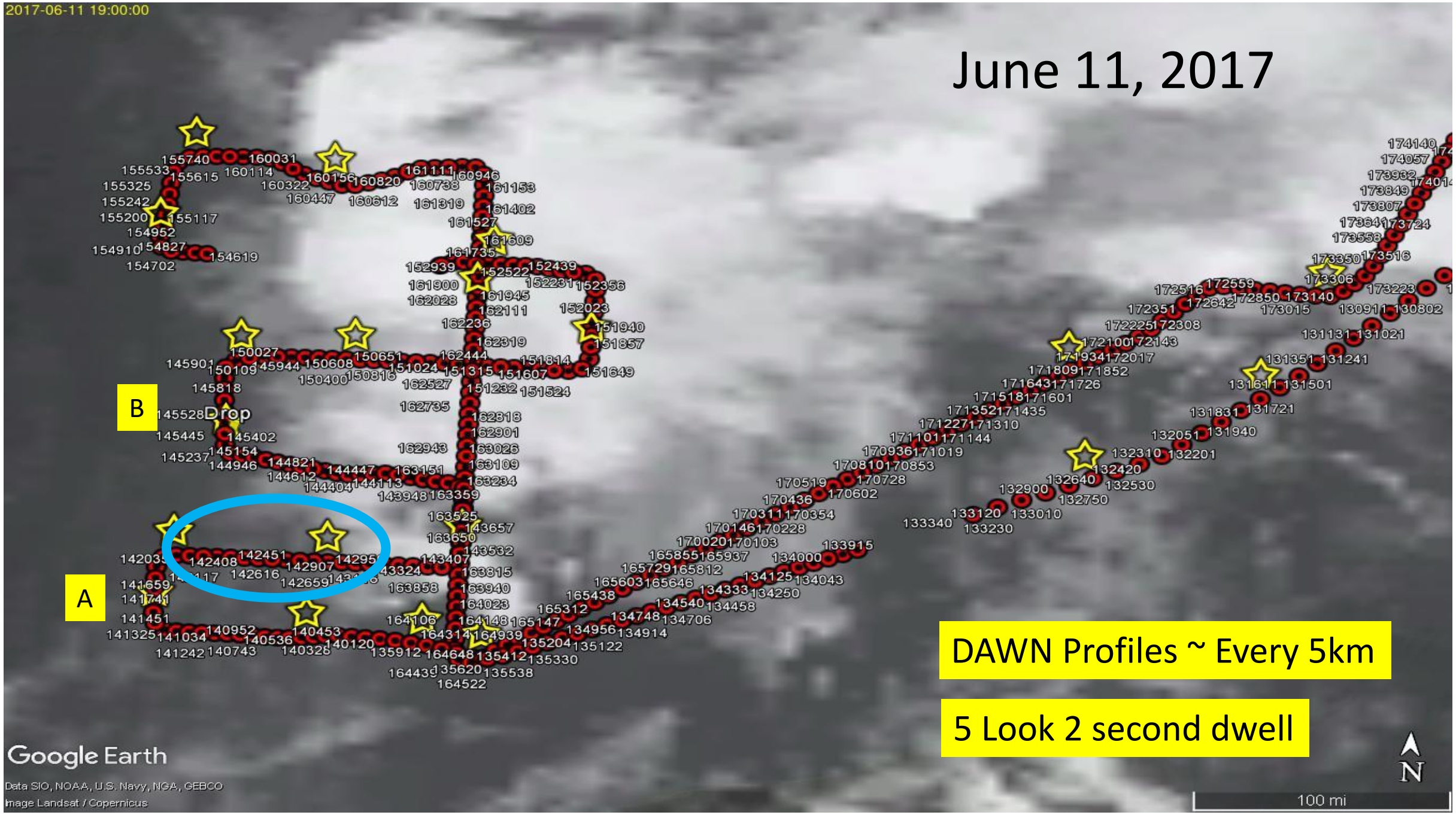
CPEX 2017: Convective Processes in the Tropics

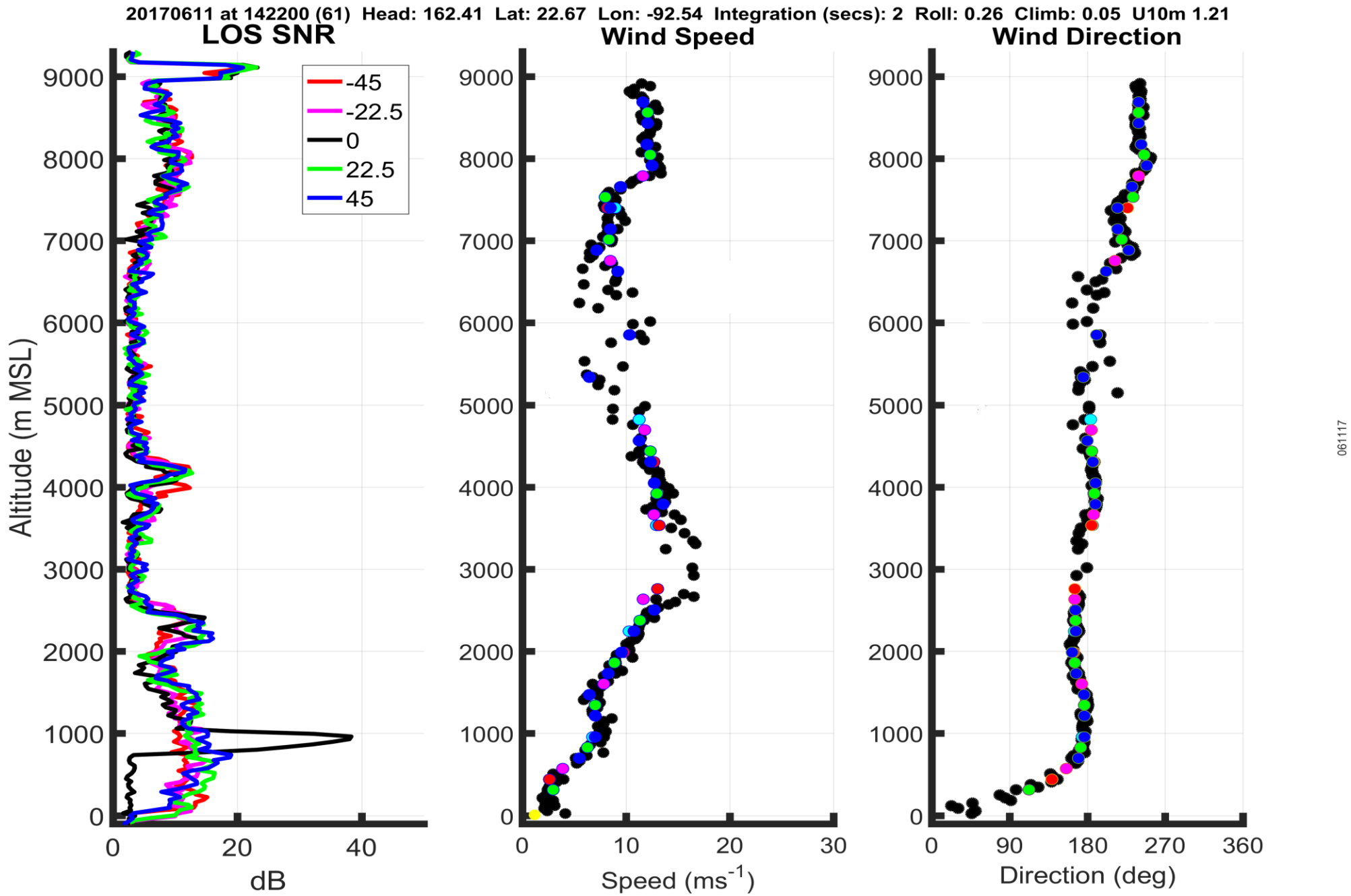
- The NASA funded CPEX (Convective Processes EXperiment) airborne campaign operated out of Ft Lauderdale, FL during May/June 2017 to investigate convective processes using the featured Doppler Aerosol WiNd Lidar (DAWN)
- Other instruments included APR-2, HAMSR, MTHP, Dropsondes
- The CPEX campaign flew 16 missions over the Atlantic Ocean, Caribbean Sea and the Gulf of Mexico and provided a unique set of **more than 5000 DAWN wind profiles** and **~ 300 dropsonde** wind, temperature and water vapor profiles.

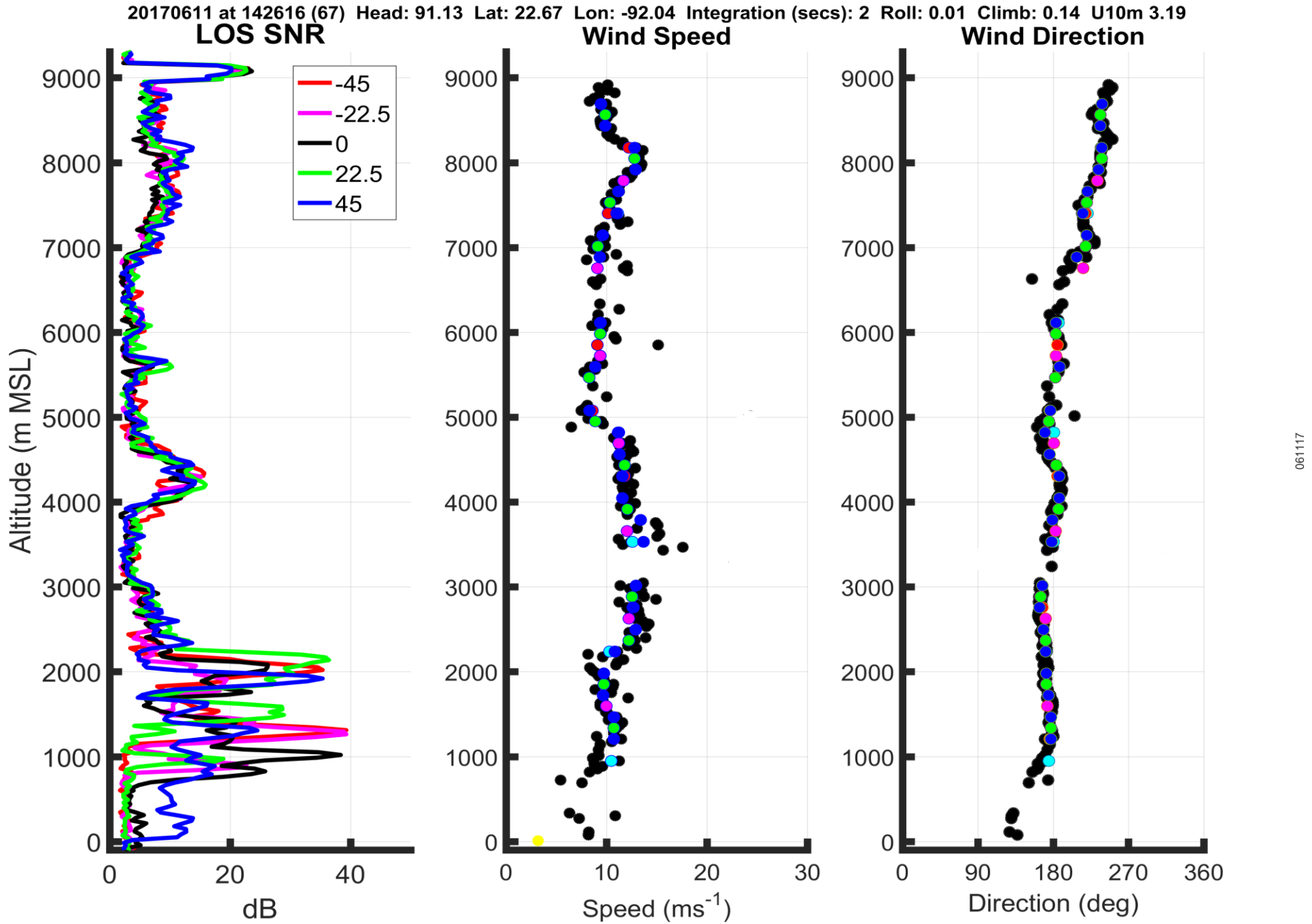
Original DAWN CPEX Science Objectives

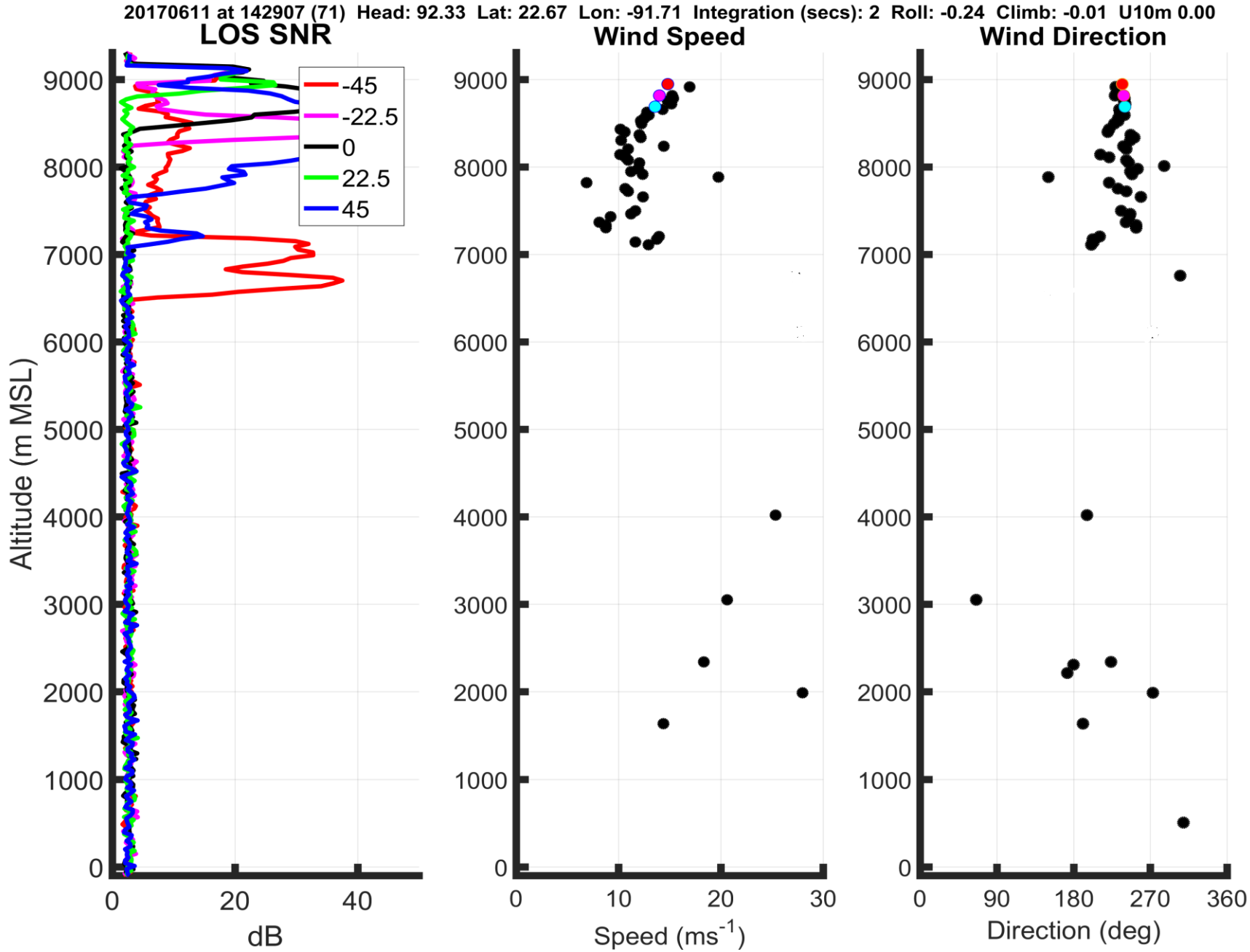
1) Utilize DAWN to study the dynamics of convective cloud initiation, maintenance, and decay, particularly over open tropical waters
2) **Study the dynamics of tropical convection by flying missions that allow us to compute mass budgets for 100 km x 100 km x 6-10 km volumes containing various degrees and life cycle of convection**
3) Provide cal/val for numerical models and other instruments
4) Improve model assimilation of lidar wind observations into numerical weather prediction models (Pu)


NASA CPEX 2017 Flight Tracks with Dropsonde Locations
CONVECTIVE PROCESSES EXPERIMENT
CPEX
2017
NASA
30°N
27.5°N
25°N
22.5°N
20°N
17.5°N
15°N
100°W
97.5°W
95°W
92.5°W
90°W
87.5°W
85°W
82.5°W
80°W
77.5°W
75°W
72.5°W
70°W
67.5°W
2017-05-27
2017-05-29
2017-05-31
2017-06-01
2017-06-02
2017-06-06
2017-06-10
2017-06-11
2017-06-15
2017-06-16
2017-06-17
2017-06-19
2017-06-20
2017-06-21
2017-06-23
2017-06-24

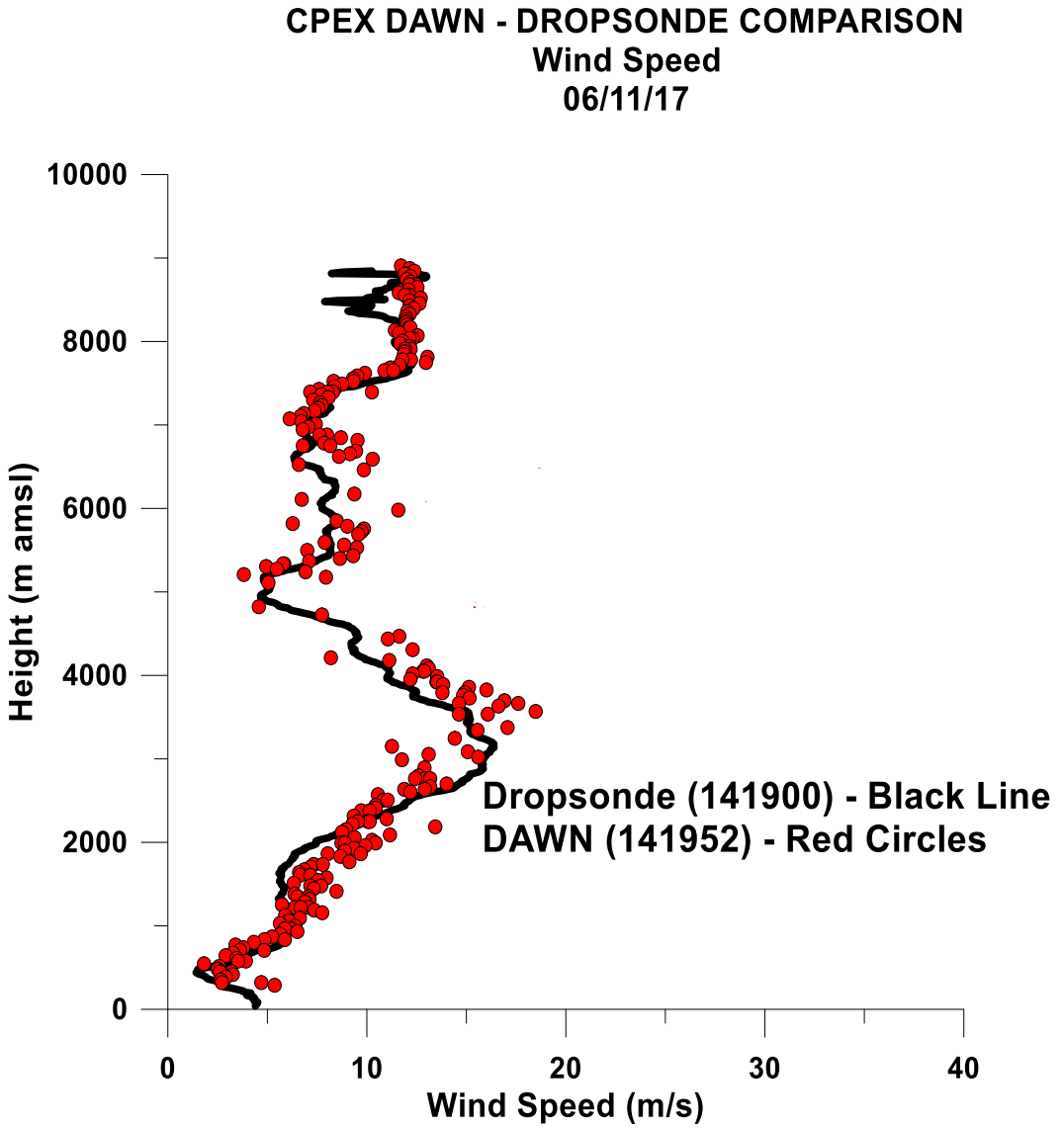

2017-06-11 19:00:00
June 11, 2017
B
Drop
A
DAWN Profiles ~ Every 5km
5 Look 2 second dwell
Google Earth
Data SIO, NOAA, U.S. Navy, NGA, GEBCO
Image Landsat / Copernicus
N
100 mi

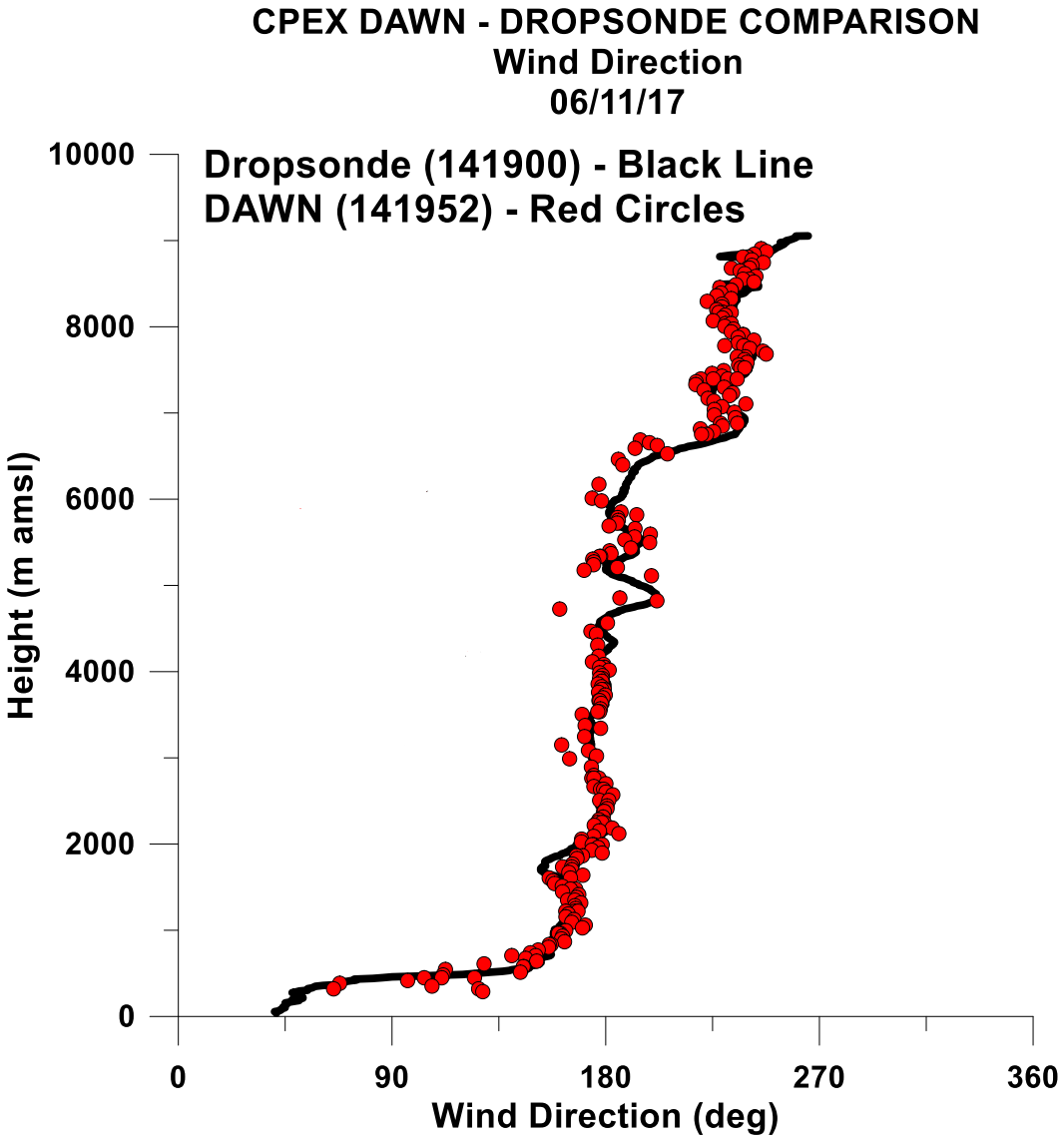

20170611 at 142200 (61) Head: 162.41 Lat: 22.67 Lon: -92.54 Integration (secs): 2 Roll: 0.26 Climb: 0.05 U10m 1.21
LOS SNR
Wind Speed
Wind Direction
-45
-22.5
0
22.5
45
Altitude (m MSL)
dB
Speed (ms-1)
Direction (deg)
061117


20170611 at 142616 (67) Head: 91.13 Lat: 22.67 Lon: -92.04 Integration (secs): 2 Roll: 0.01 Climb: 0.14 U10m 3.19
LOS SNR
Wind Speed
Wind Direction
-45
-22.5
0
22.5
45
Altitude (m MSL)
dB
Speed (ms-1)
Direction (deg)
061117

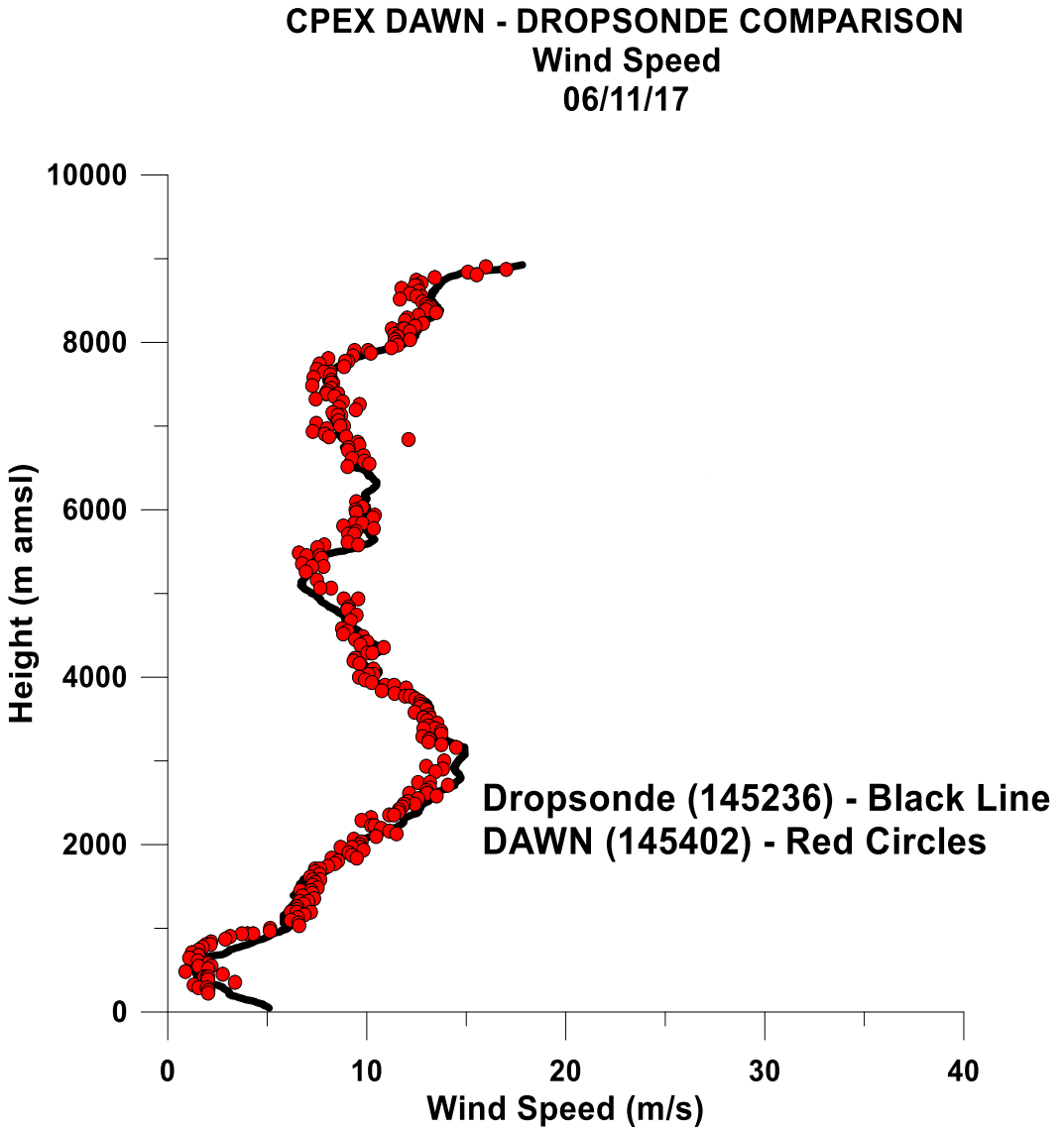

20170611 at 142907 (71) Head: 92.33 Lat: 22.67 Lon: -91.71 Integration (secs): 2 Roll: -0.24 Climb: -0.01 U10m 0.00
LOS SNR
Wind Speed
Wind Direction
-45
-22.5
0
22.5
45
Altitude (m MSL)
dB
Speed (ms-1)
Direction (deg)
061117

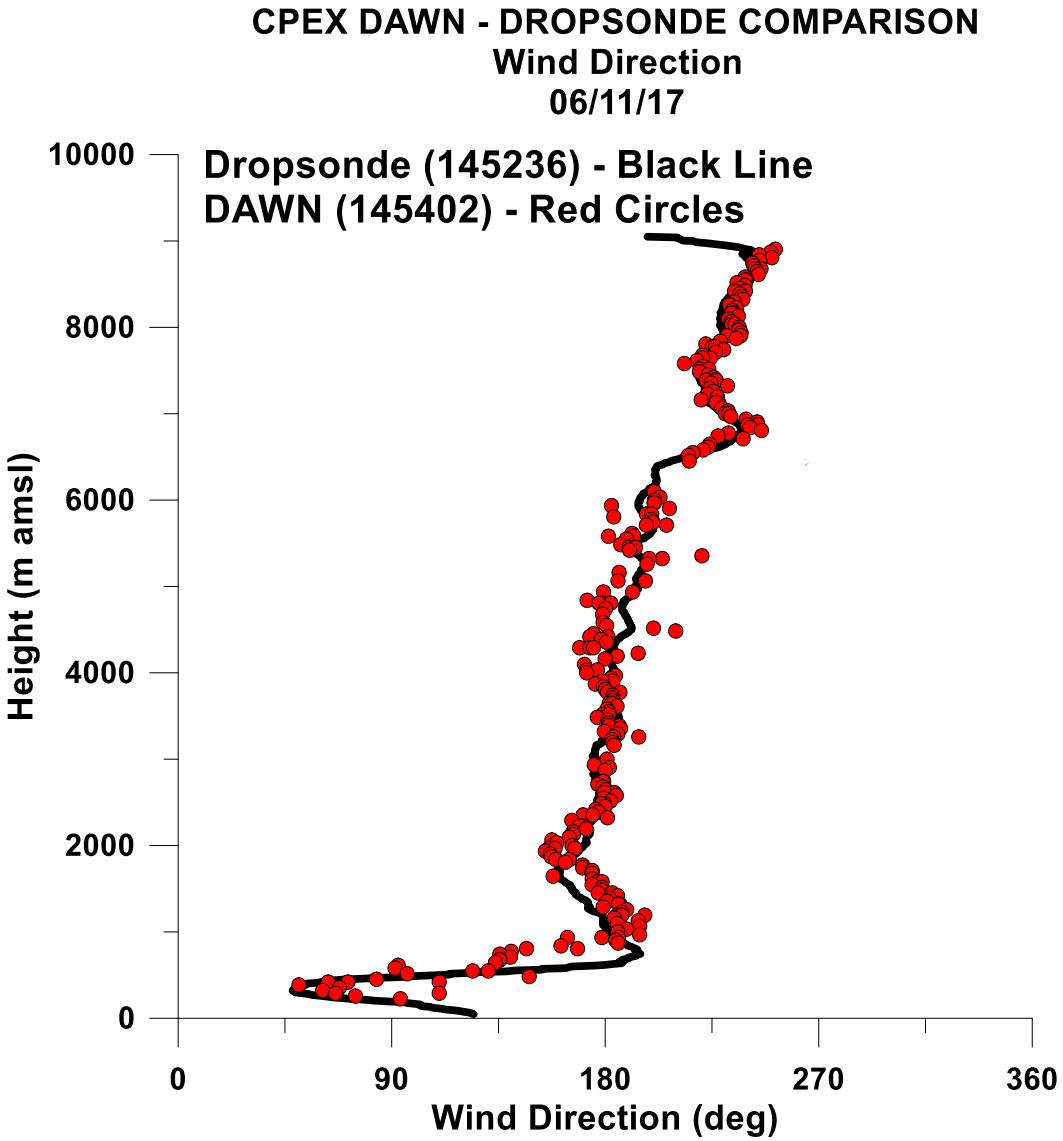
Western S-N Leg A





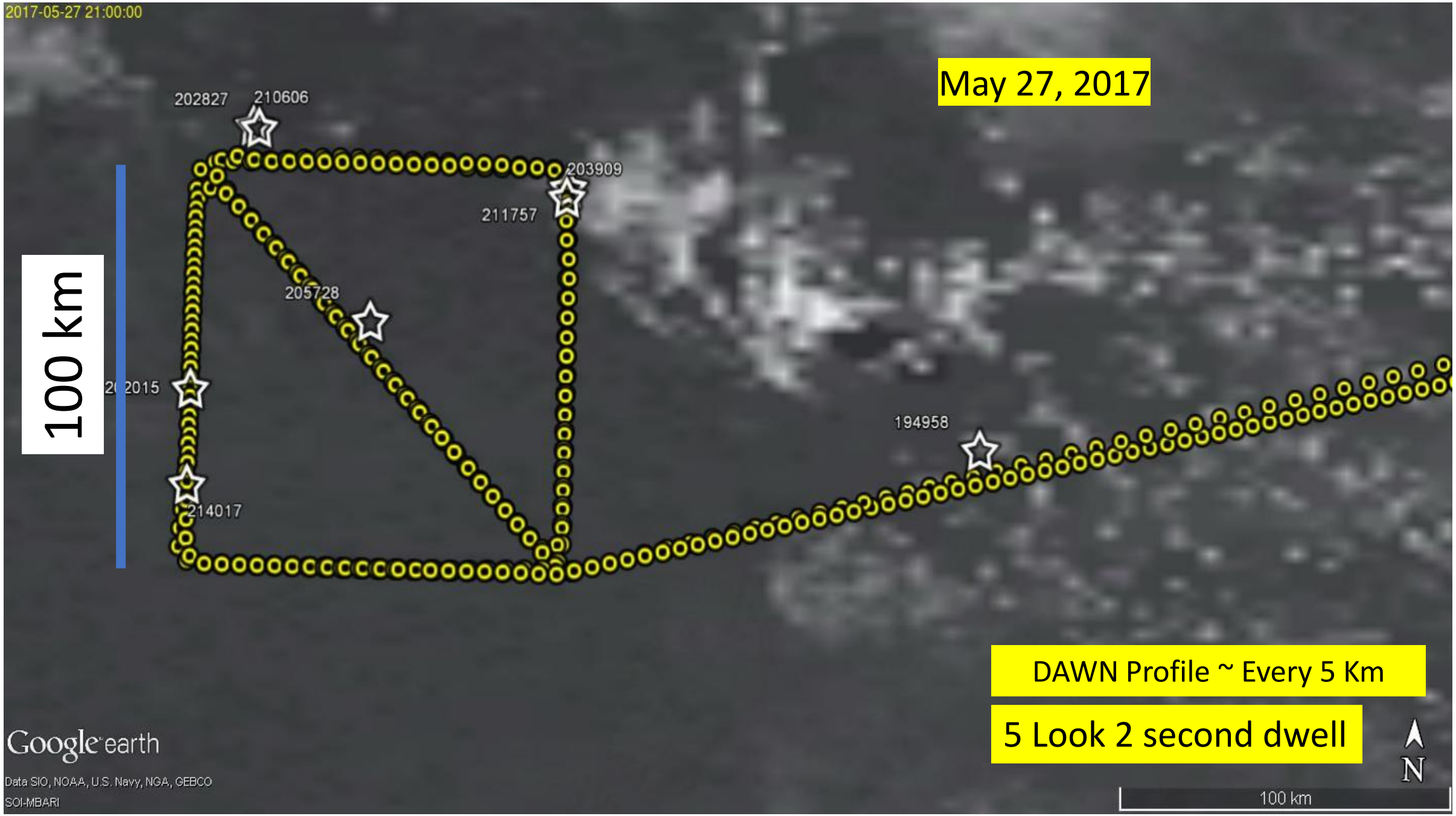
Western S-N Leg B



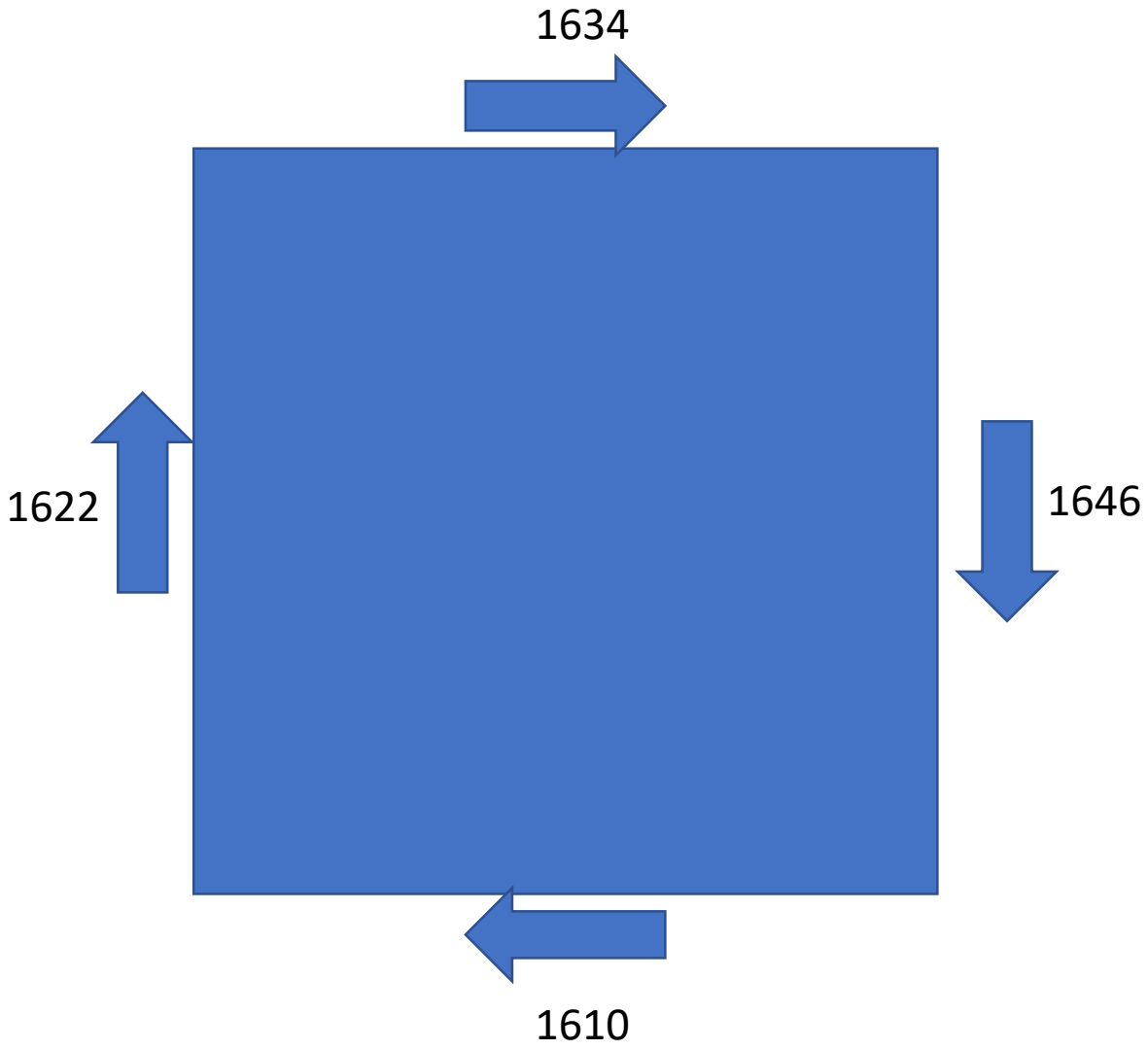


CPEX Mass Budget Science

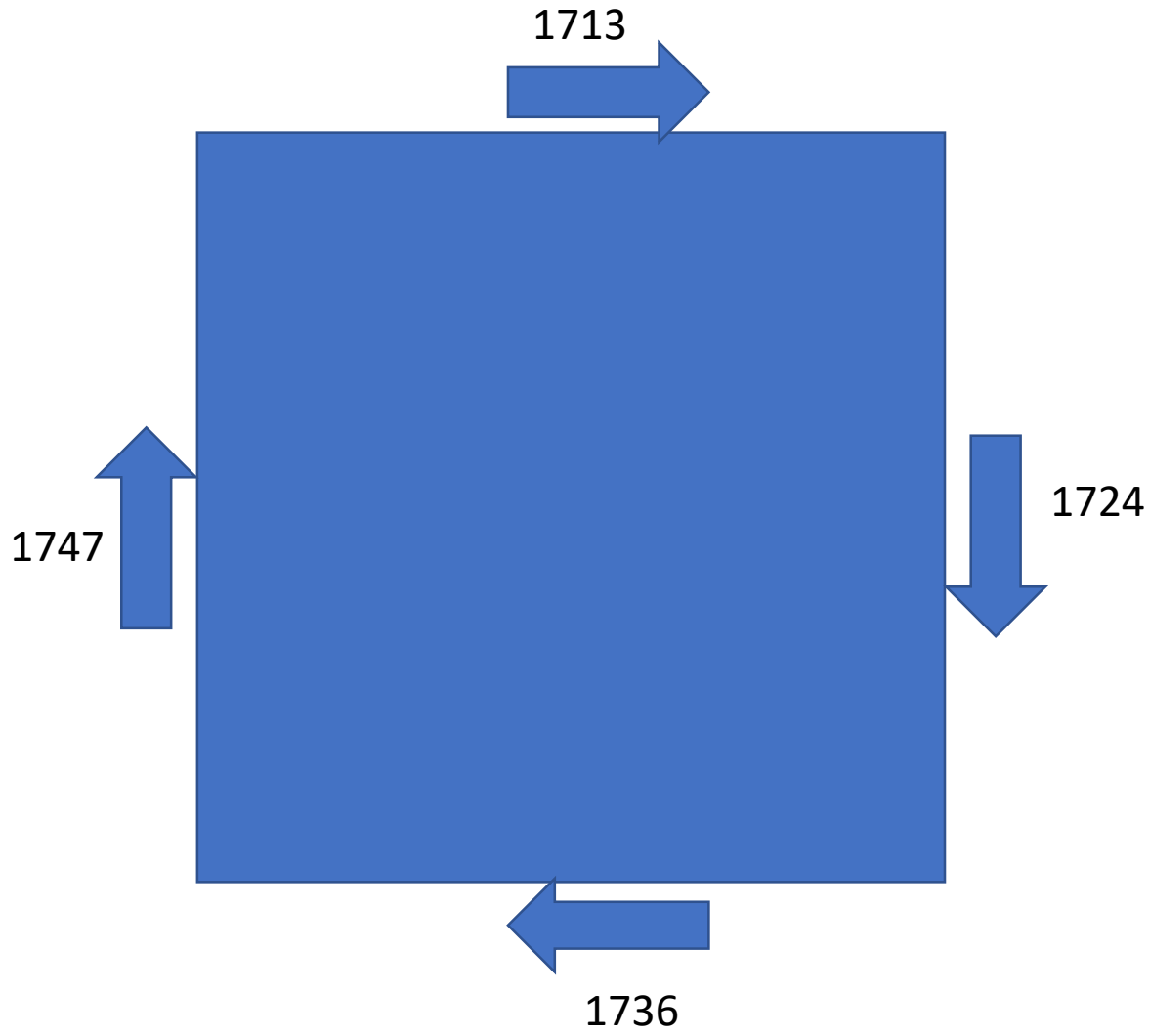
- Objective
  - Compute mass budgets and divergence for 100 km x 100 km x 6-10 km volumes containing various degrees of cloud coverage to help us describe the dynamics of the atmosphere over the tropical ocean
- CPEX Boxes
  - **Over 20 ~ 100 km x 100 km boxes were flown during CPEX 2017 which included:**
    1) Undisturbed conditions
    2) Disorganized or scattered/broken convection
    3) Decaying convection
    4) Organized (line/area) convective system


2017-05-27 21:00:00
May 27, 2017
202827
210606
203909
211757
205728
2015
214017
194958
100 km
DAWN Profile ~ Every 5 Km
5 Look 2 second dwell
Google earth
Data SIO, NOAA, U.S. Navy, NGA, GEBCO
SOI-MBARI
N
100 km

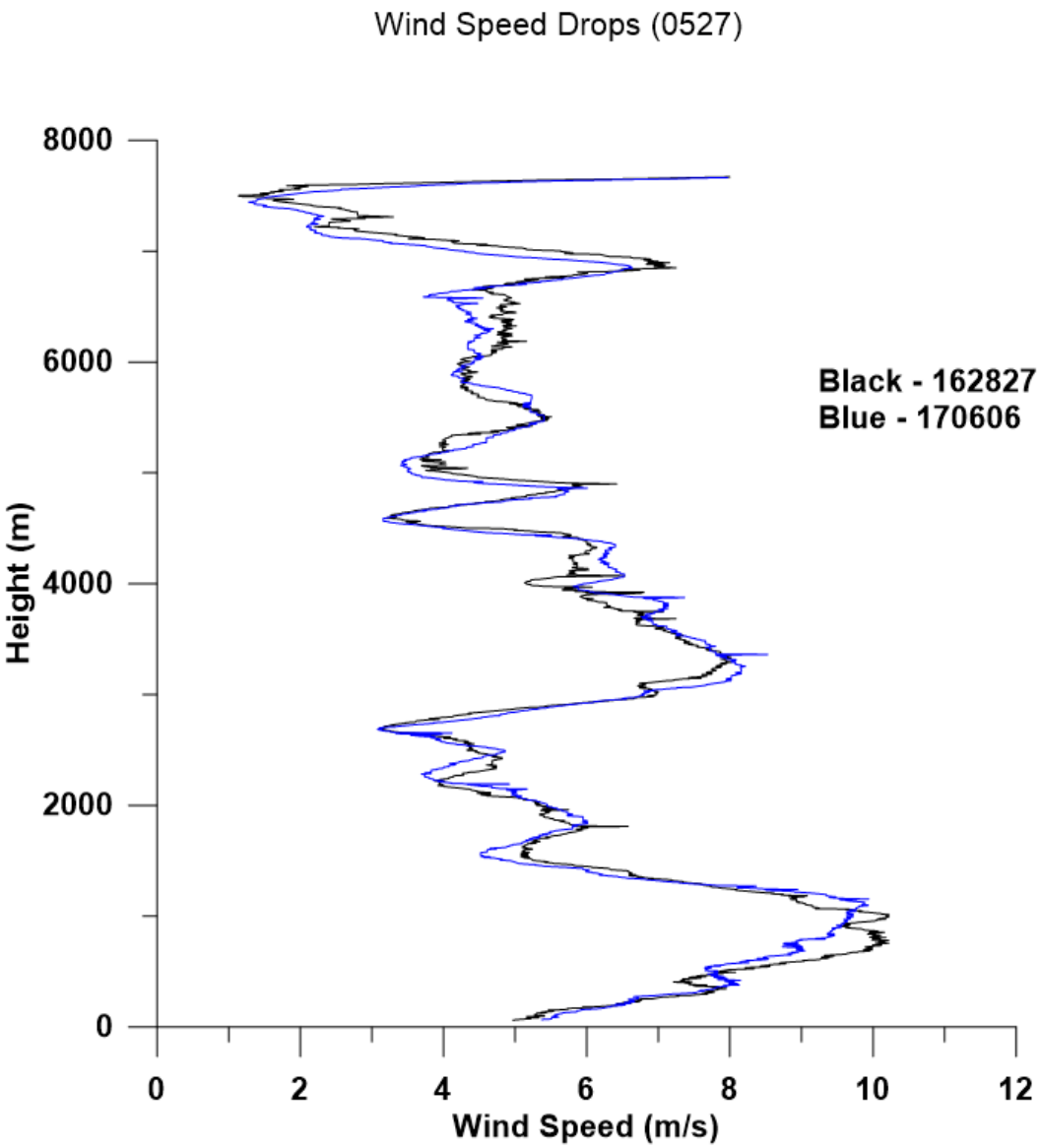
BOX A

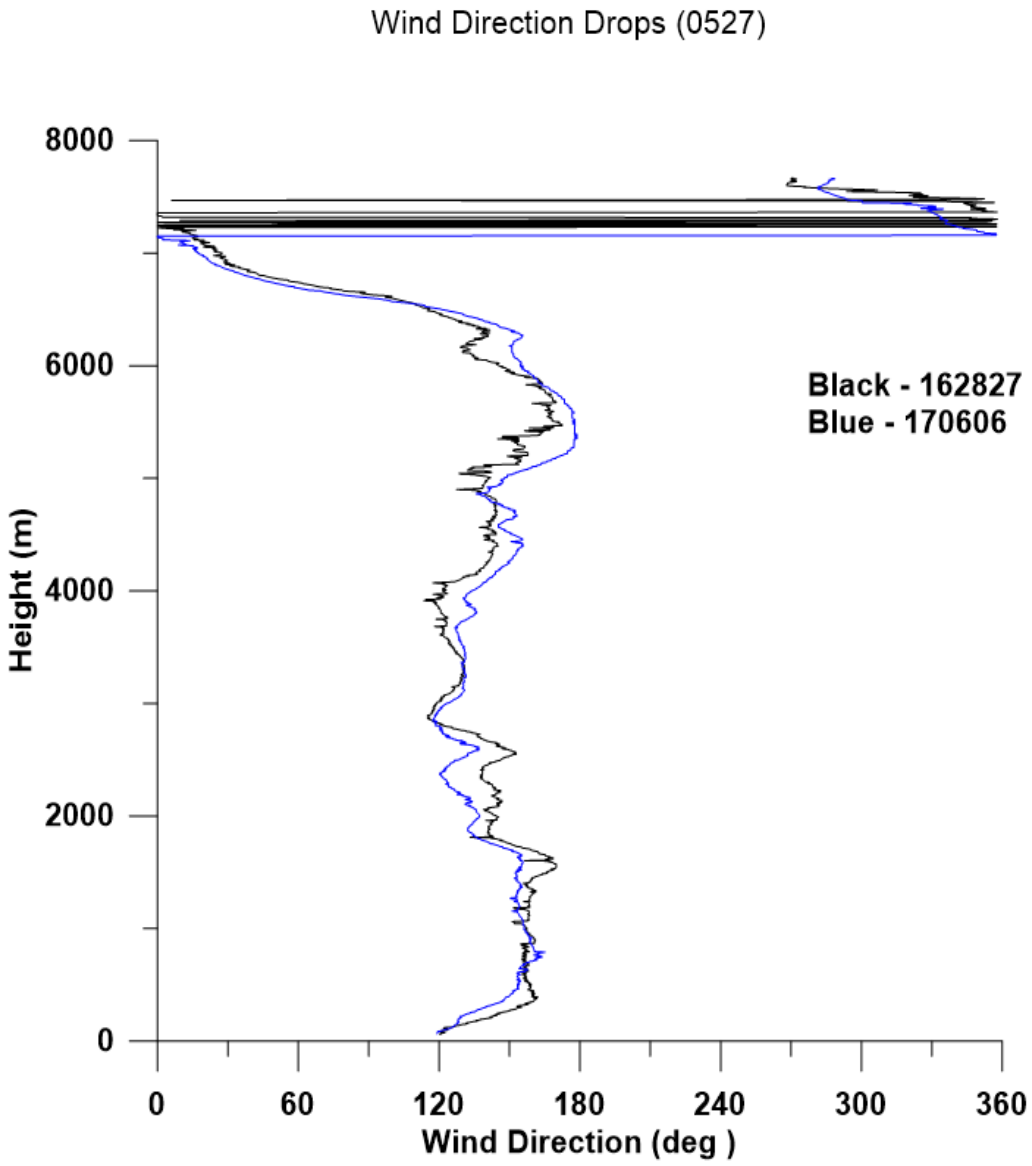


BOX B

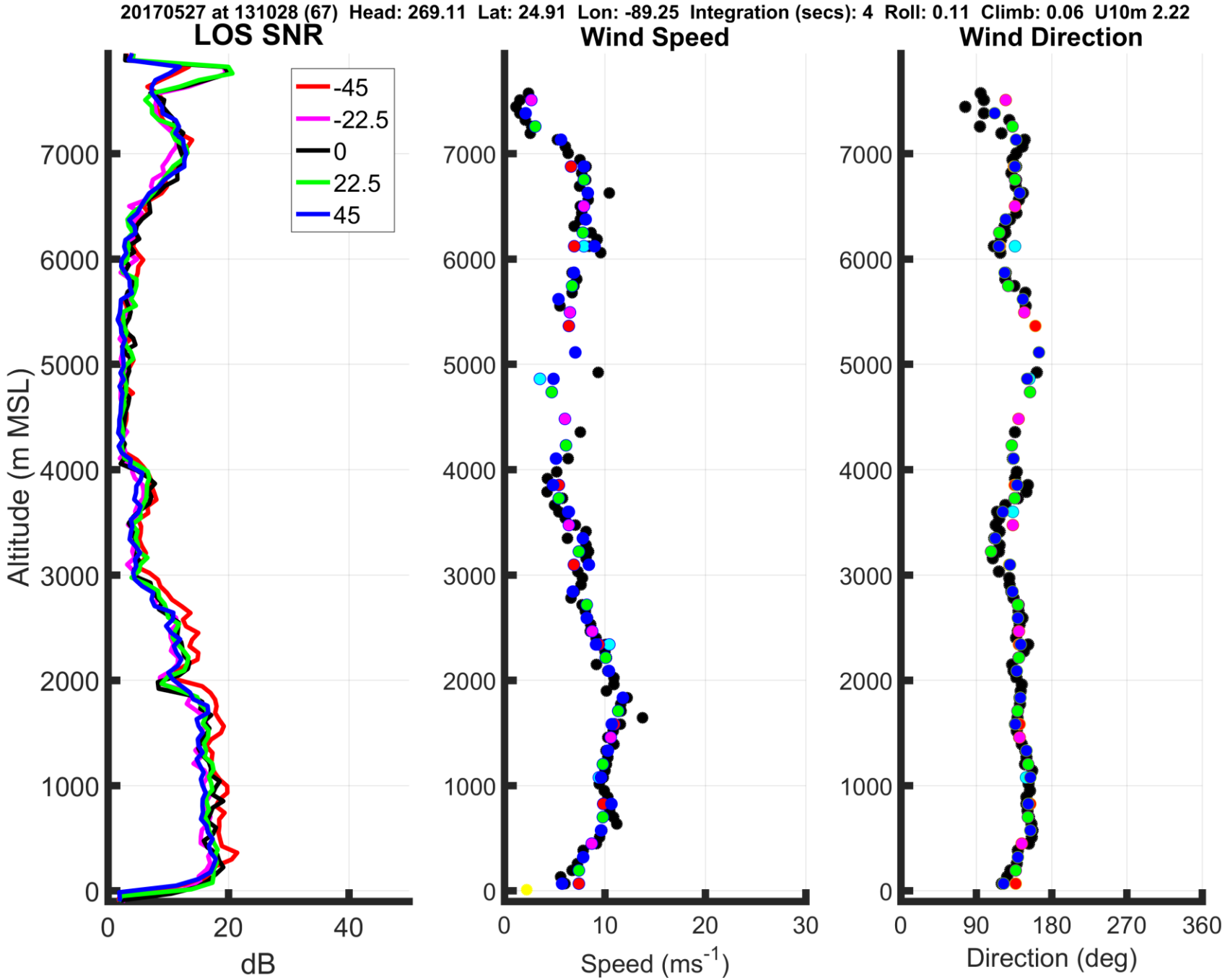


Start of Northern W-E Leg

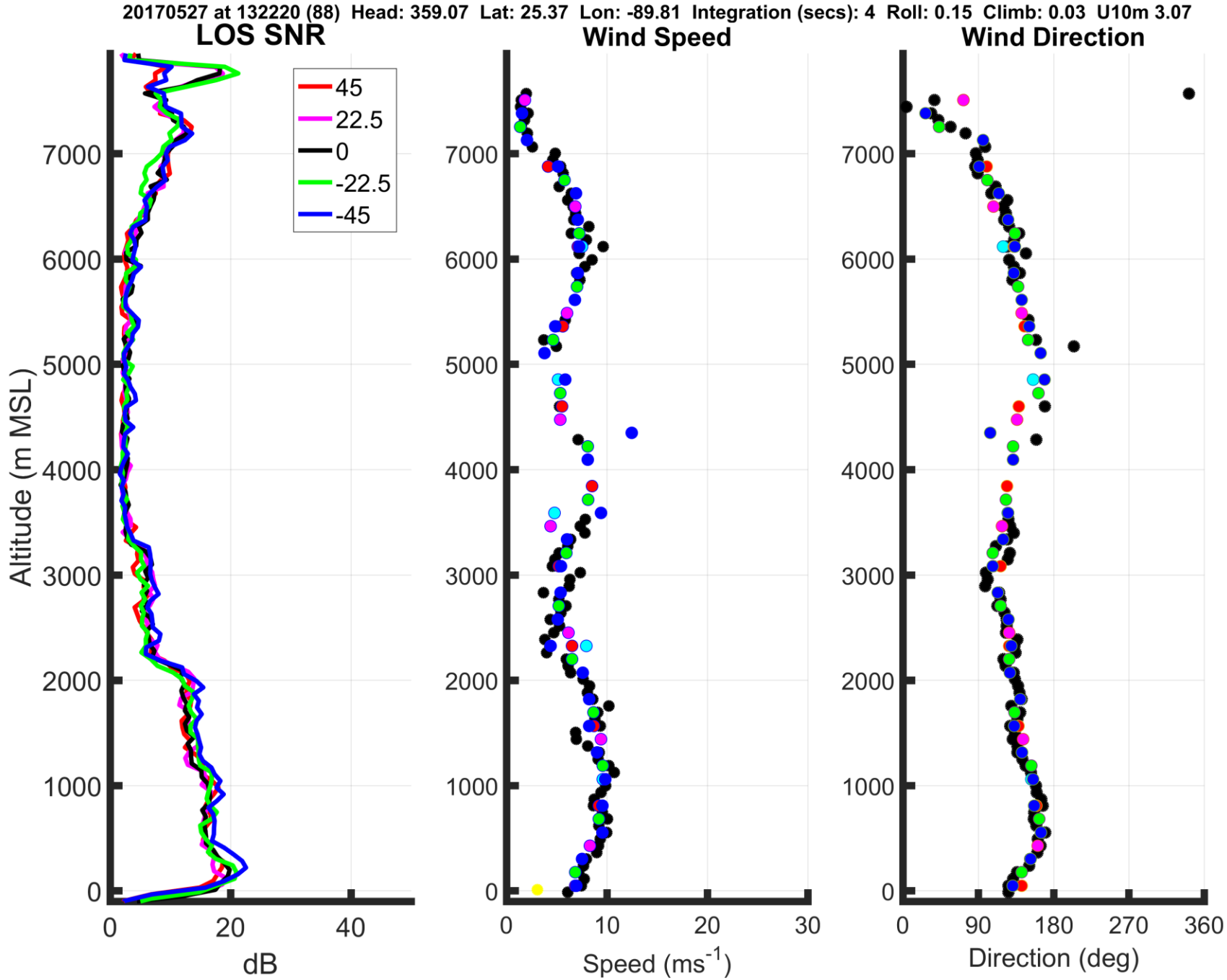




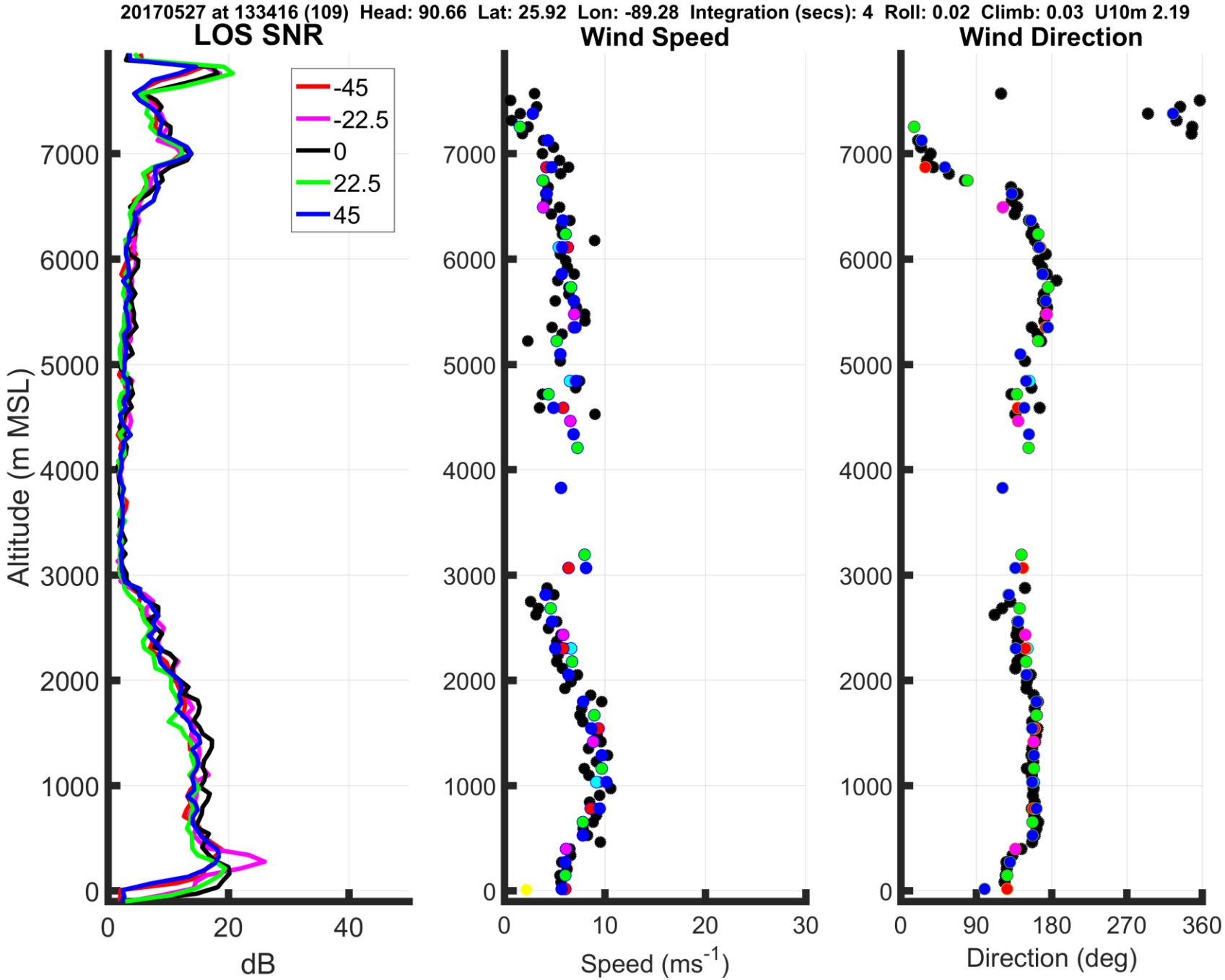
Mid Point Box A
Southern Leg



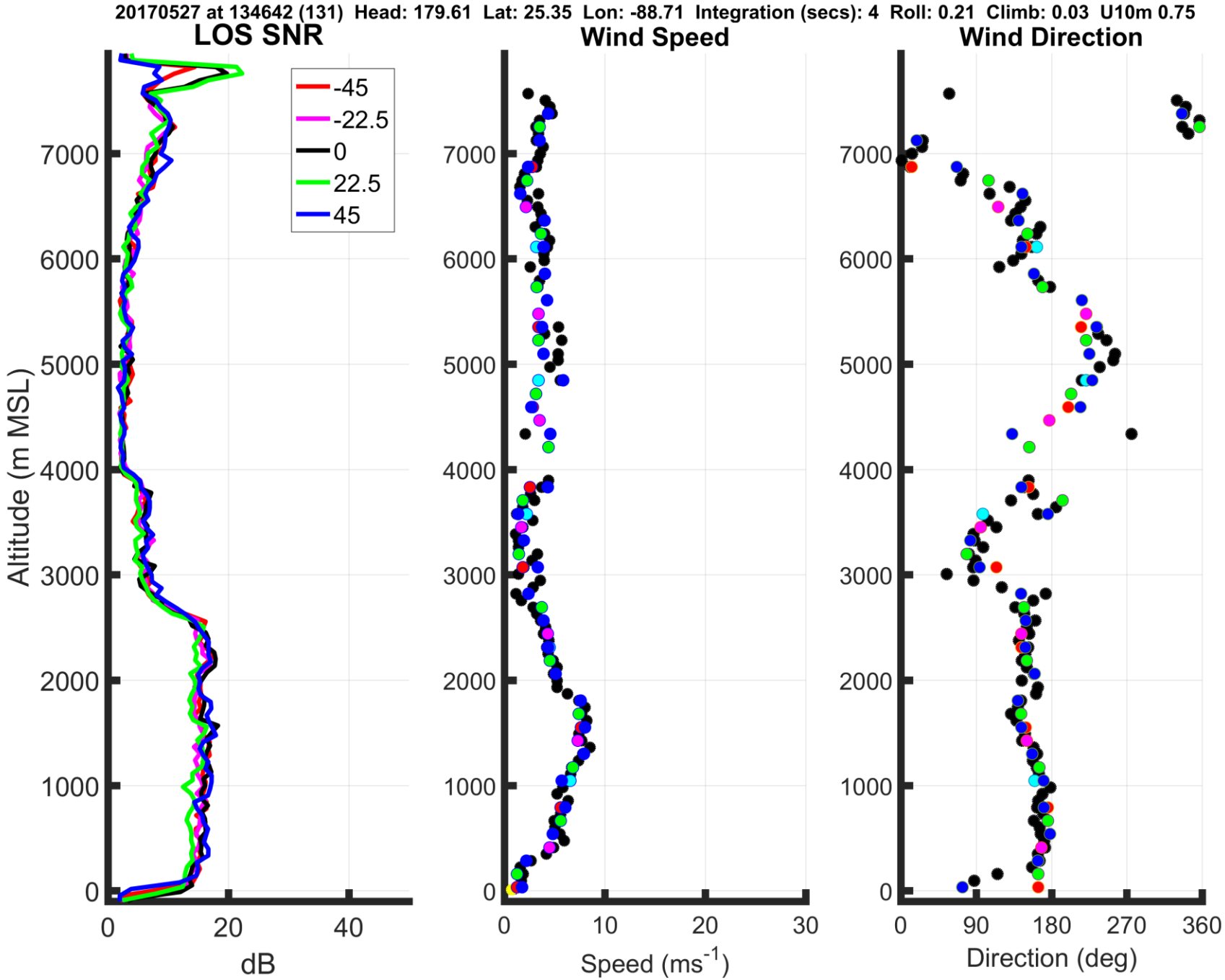
Mid Point Box A
Western Leg



Mid Point Box A
Northern Leg

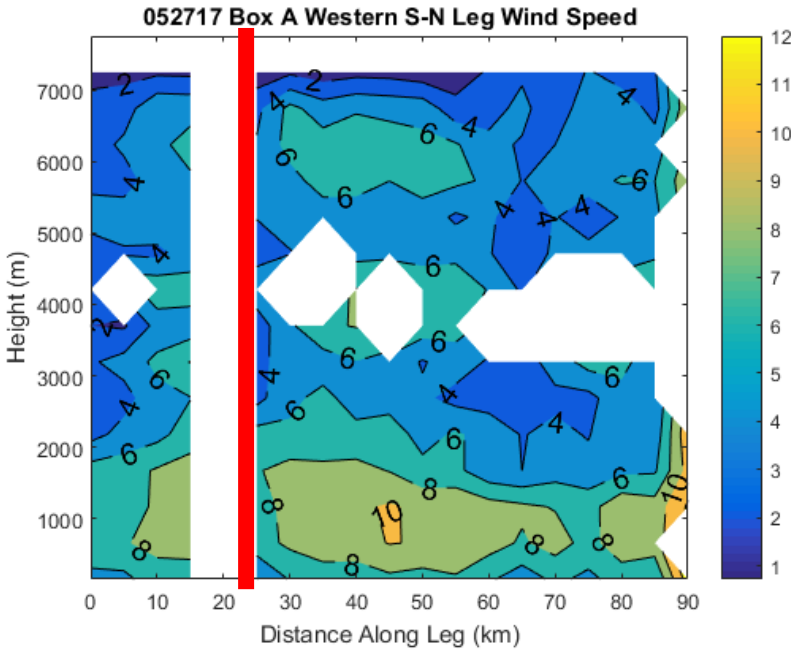


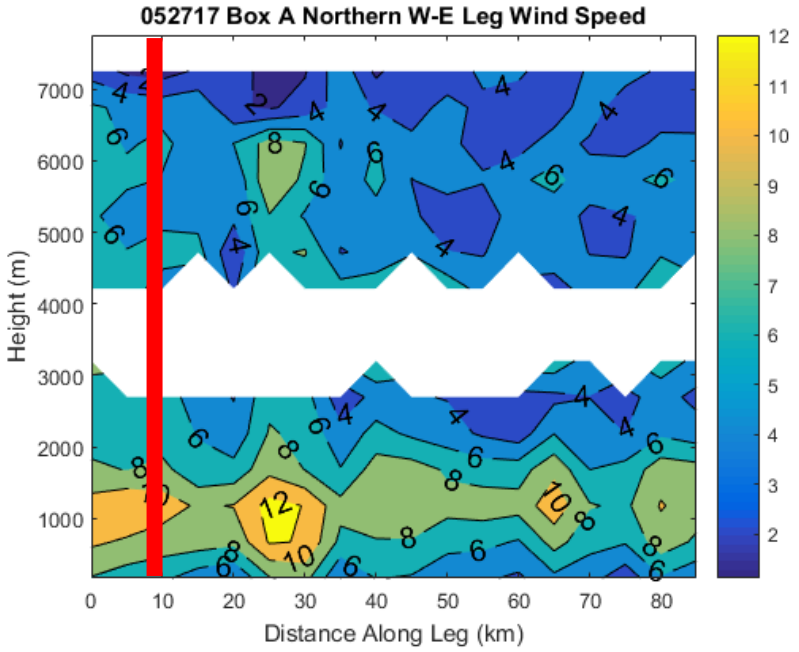
Mid Point Box A
Eastern Leg

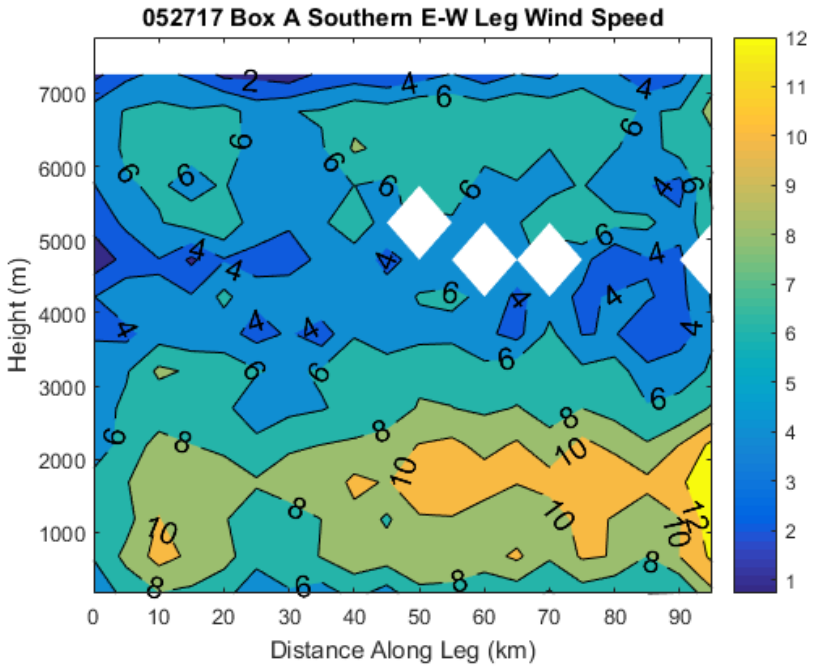


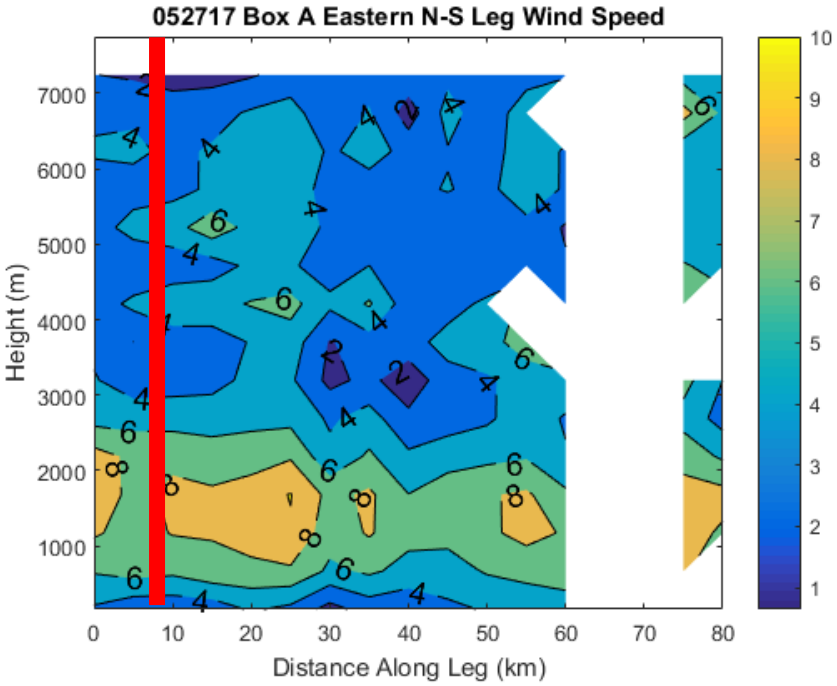
052717

BOX A



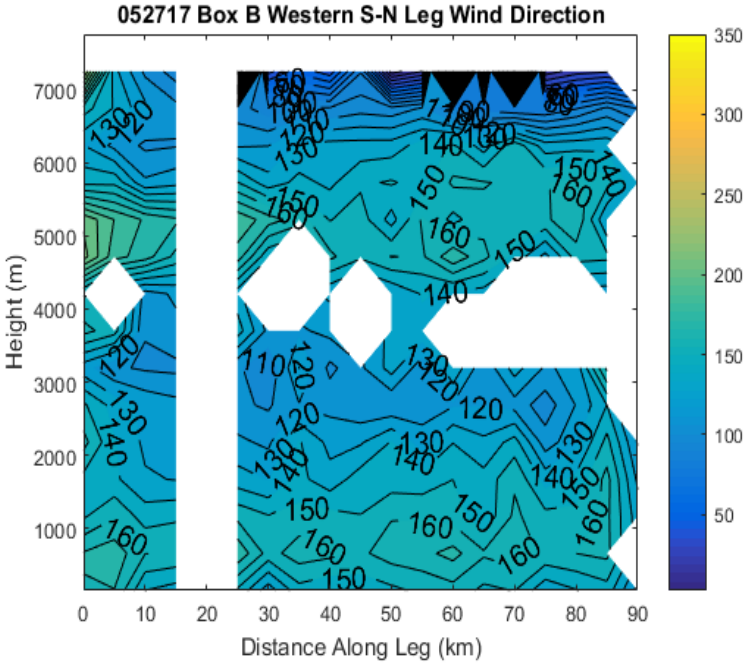


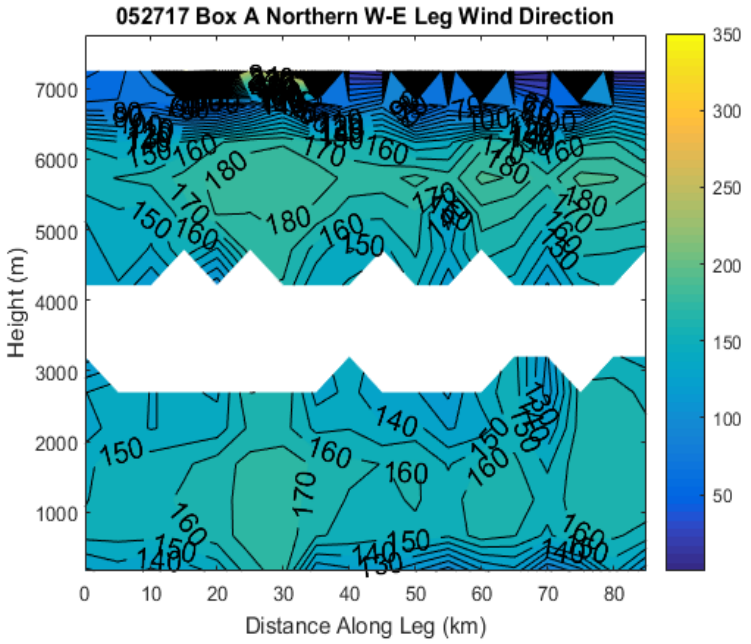


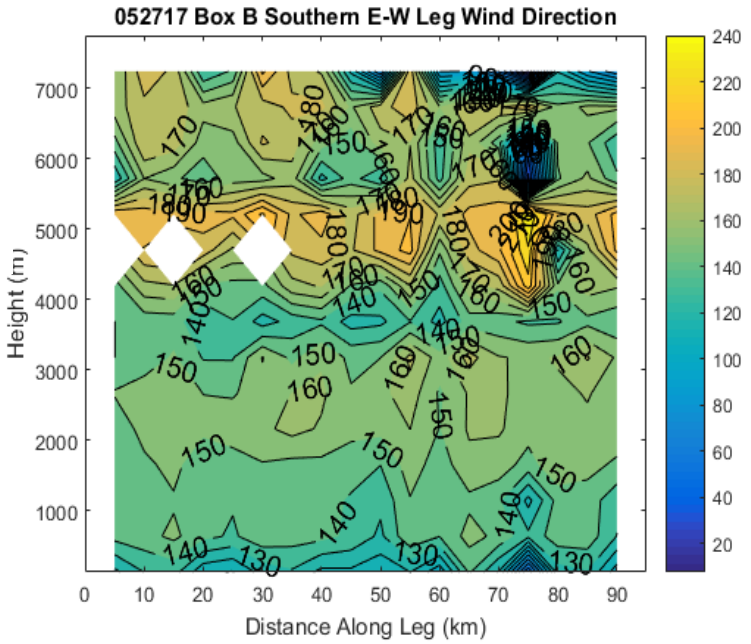


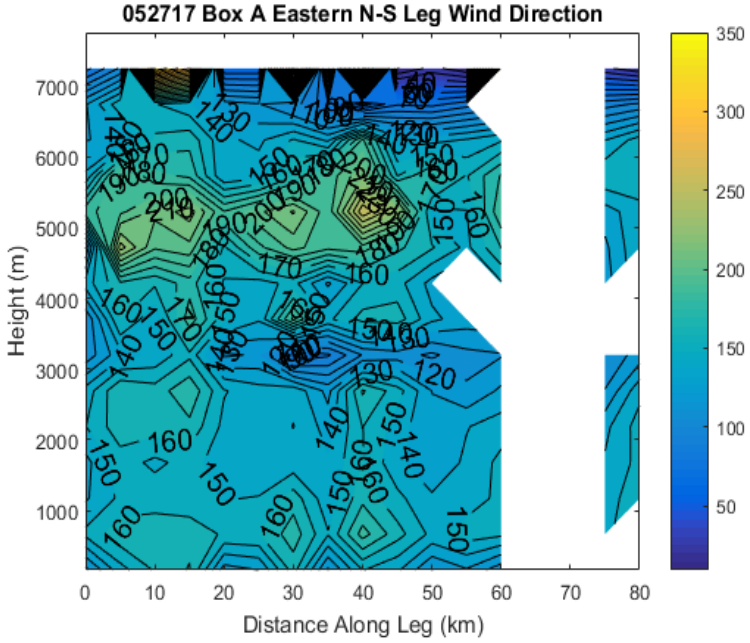
Wind Speed

BOX A



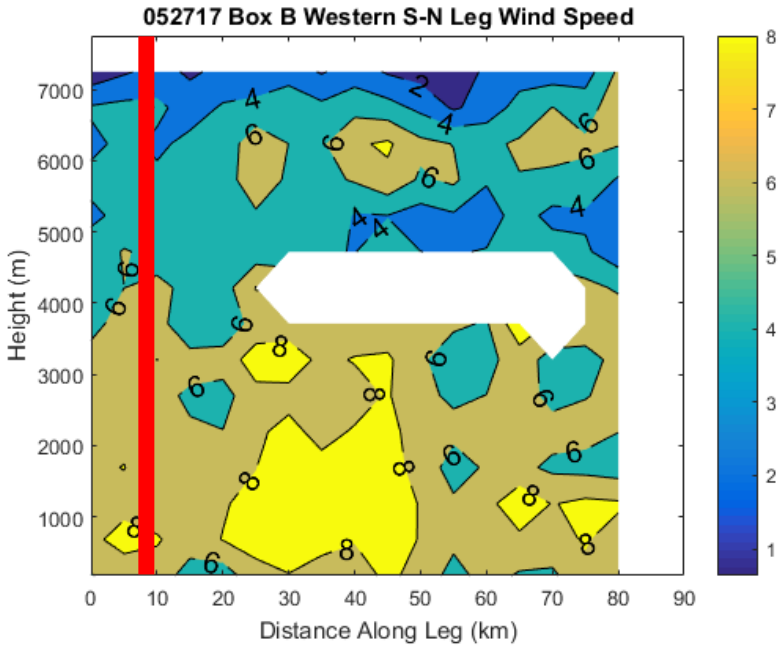


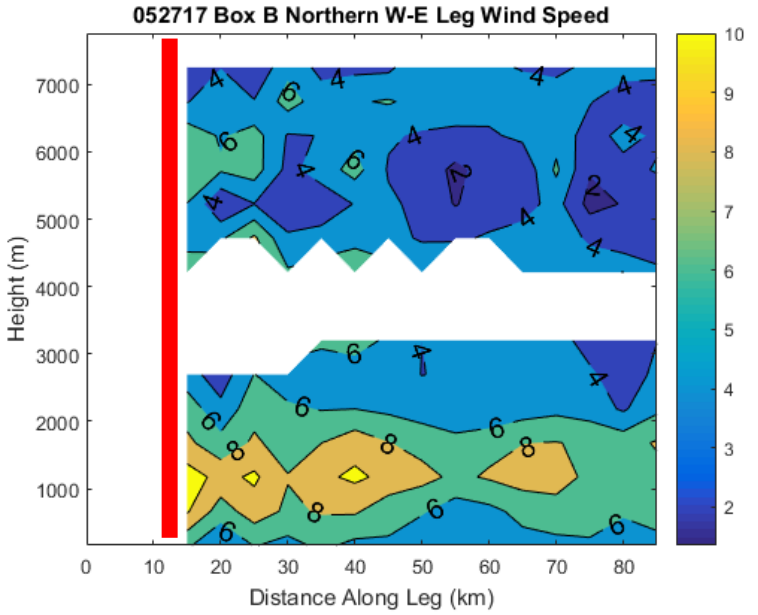


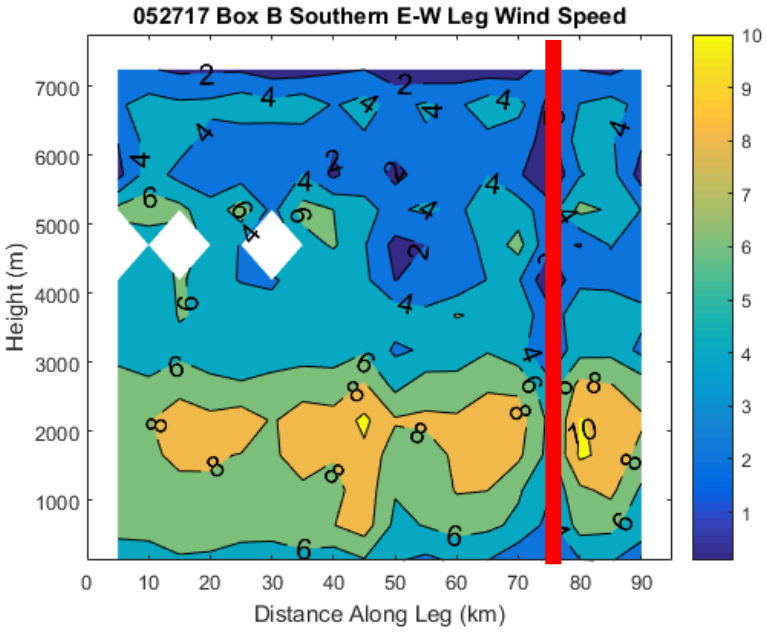


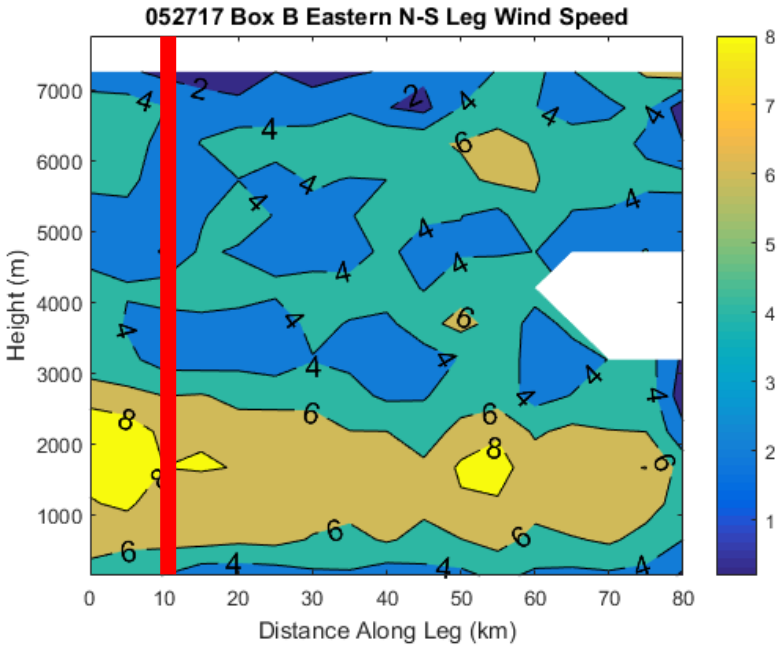
Wind Direction

BOX B



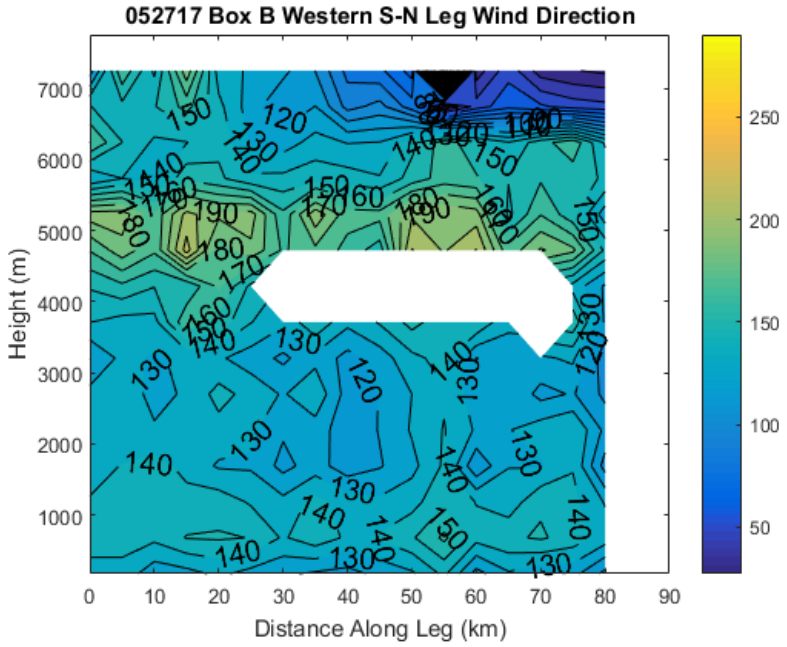


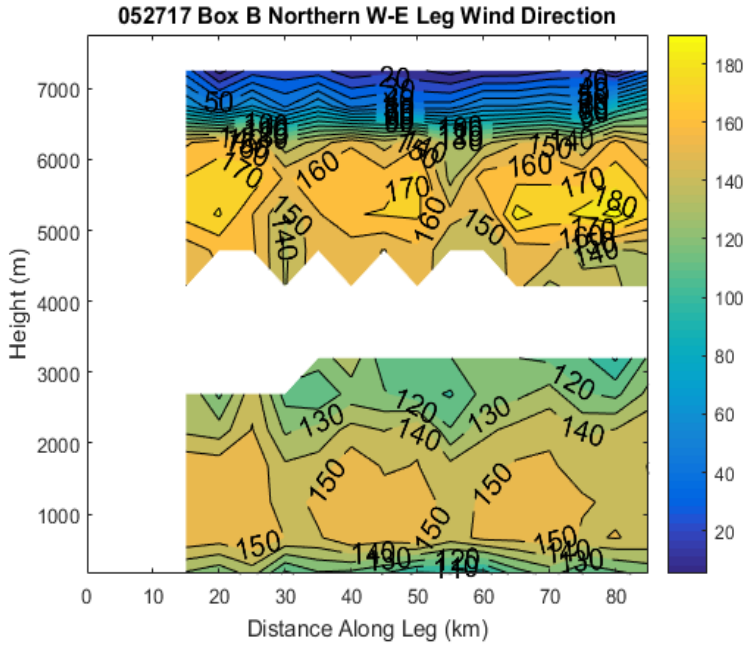


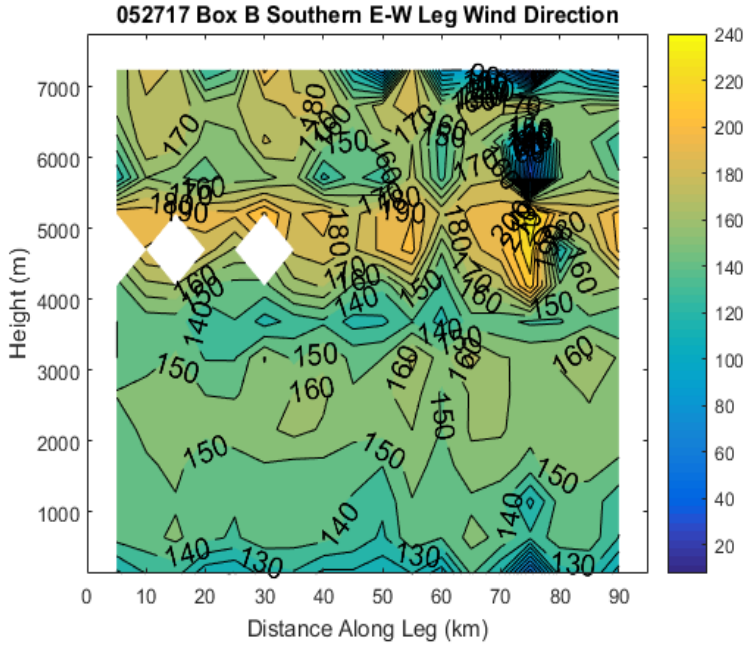


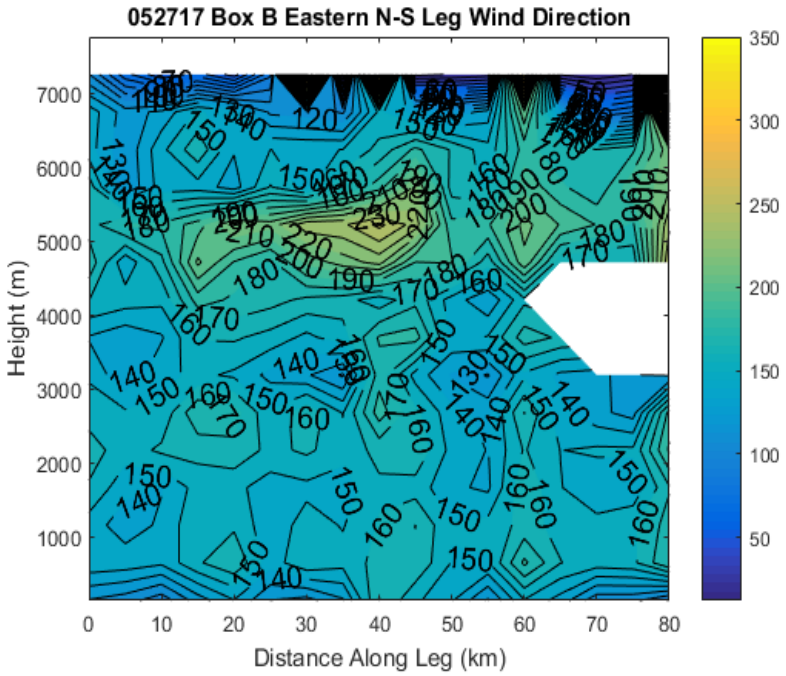
Wind Speed

BOX B



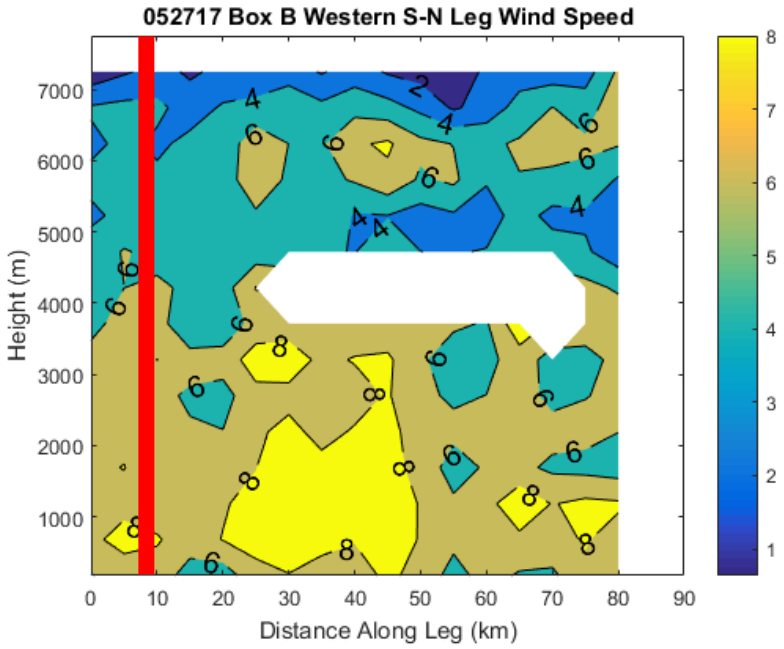


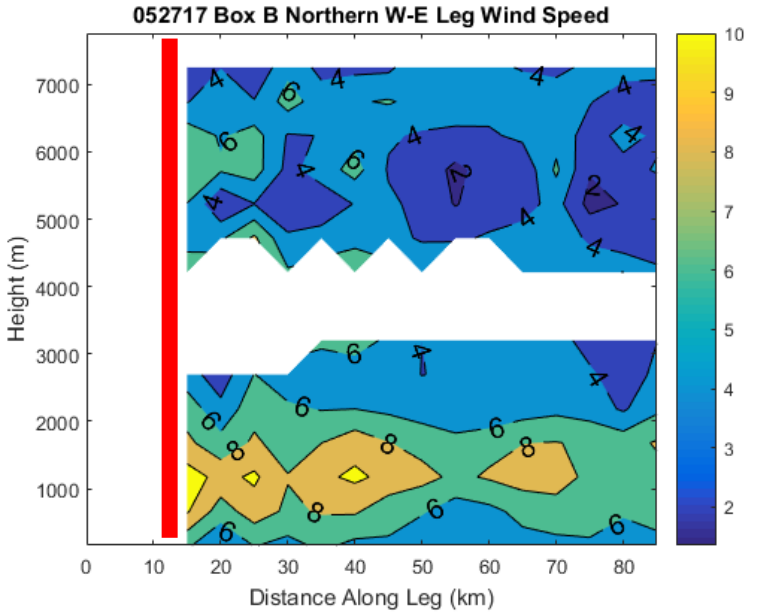


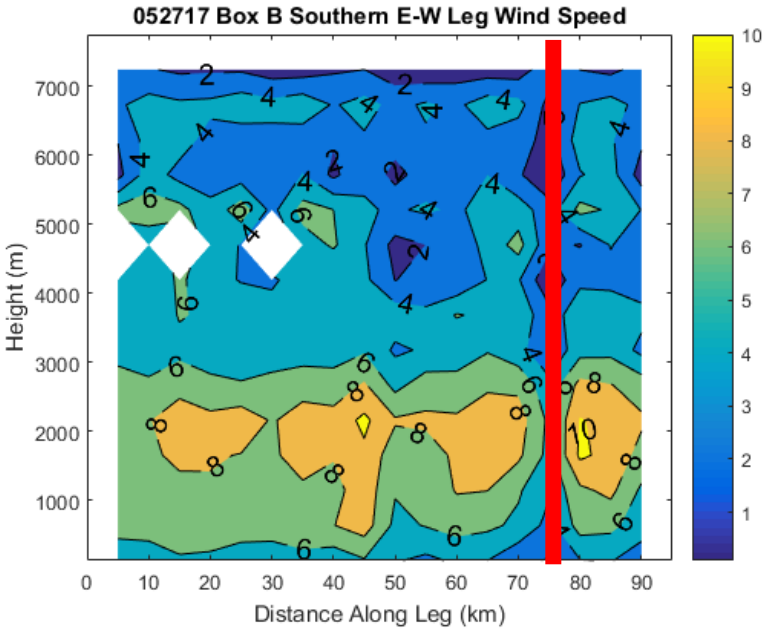


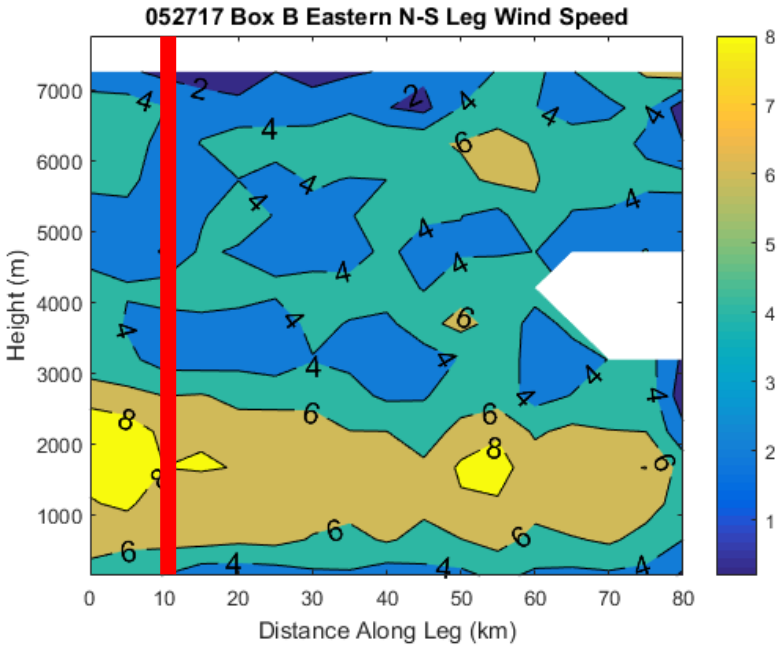
Wind Direction

BOX B

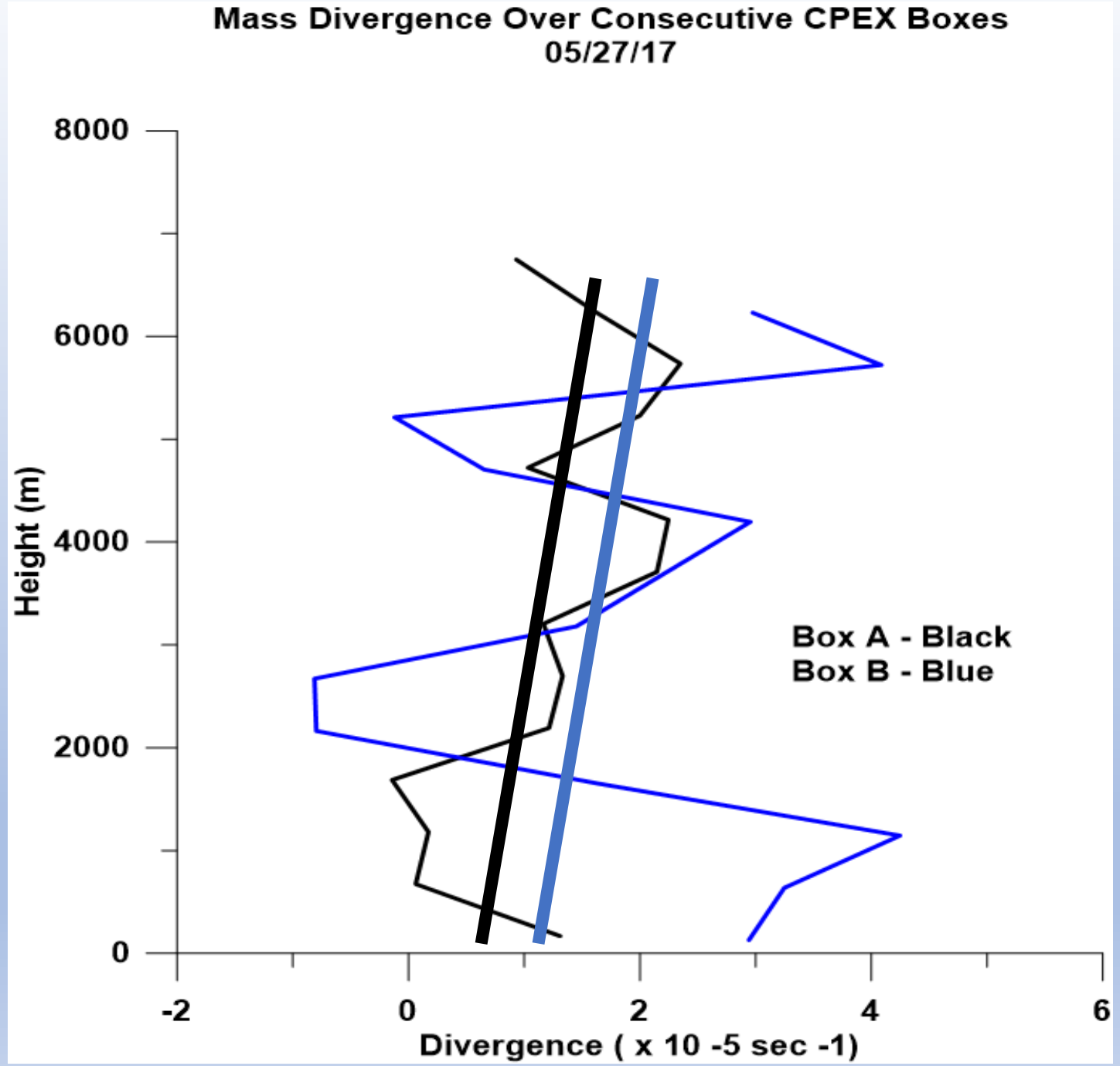


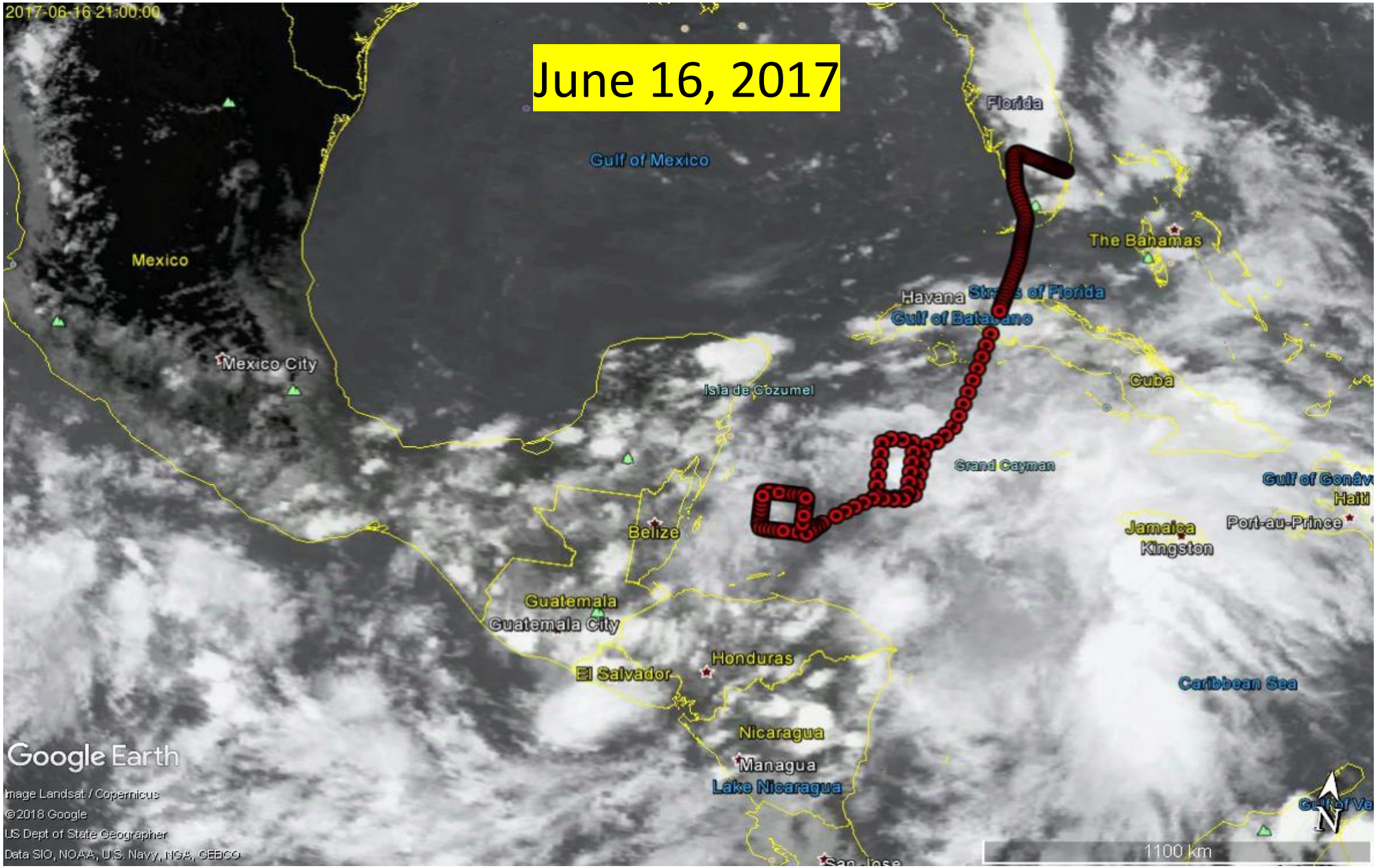


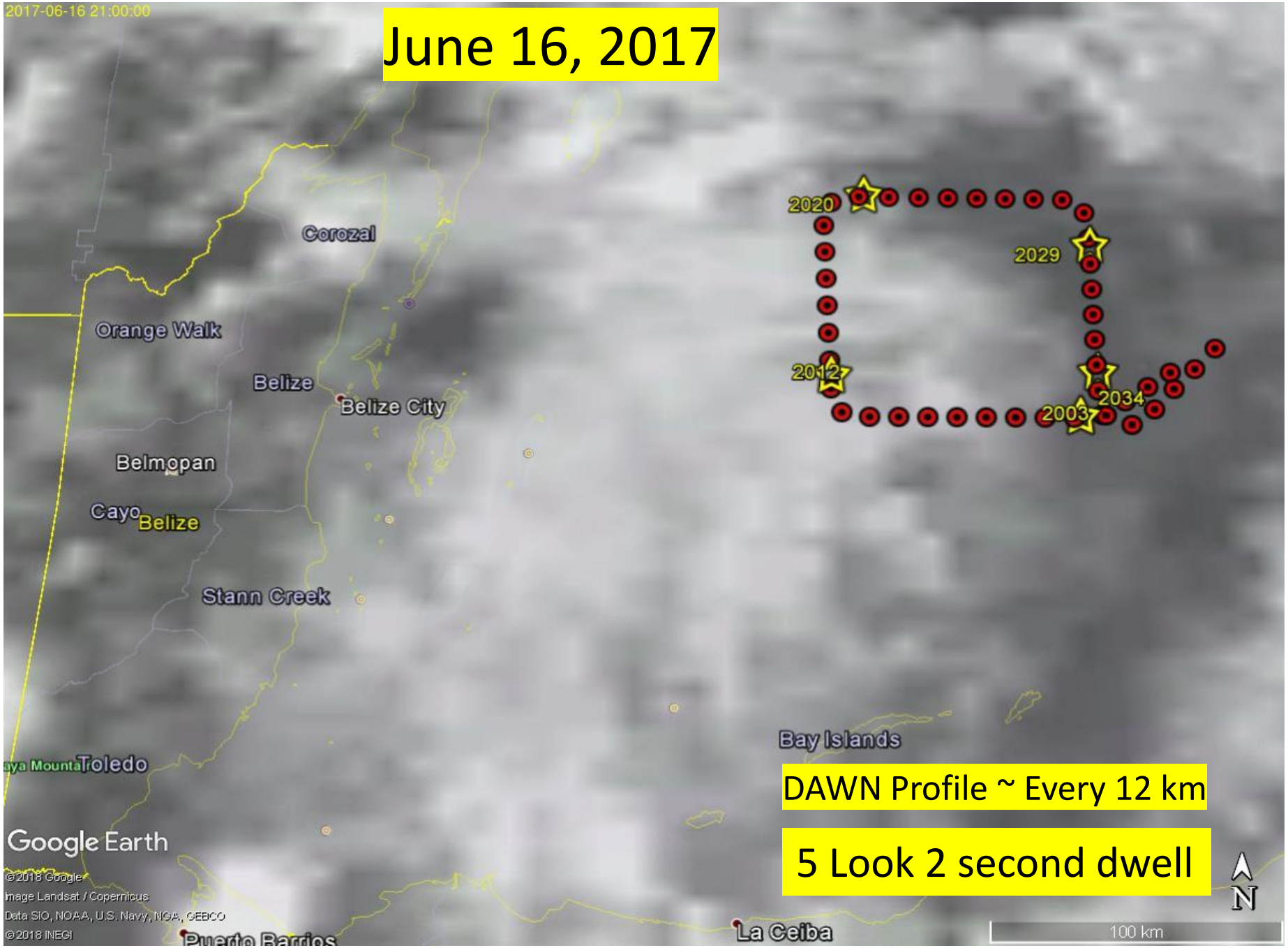


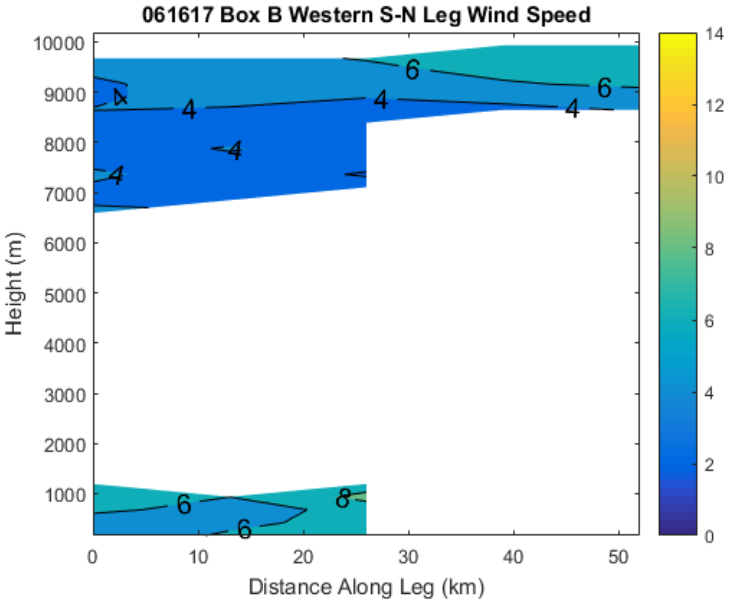


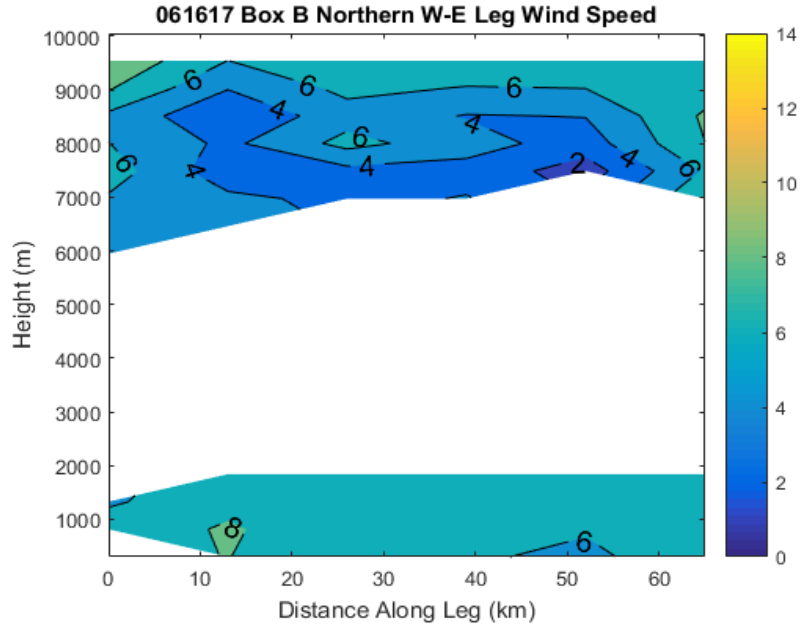
Wind Speed

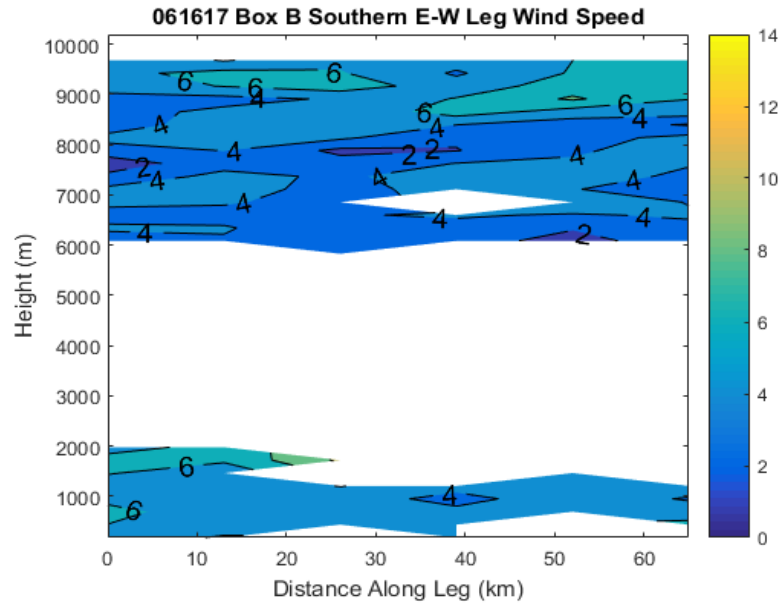

Mass Divergence Over Consecutive CPEX Boxes
05/27/17
8000
6000
4000
2000
0
Height (m)
-2
0
2
4
6
Divergence (x 10 -5 sec -1)
Box A - Black
Box B - Blue

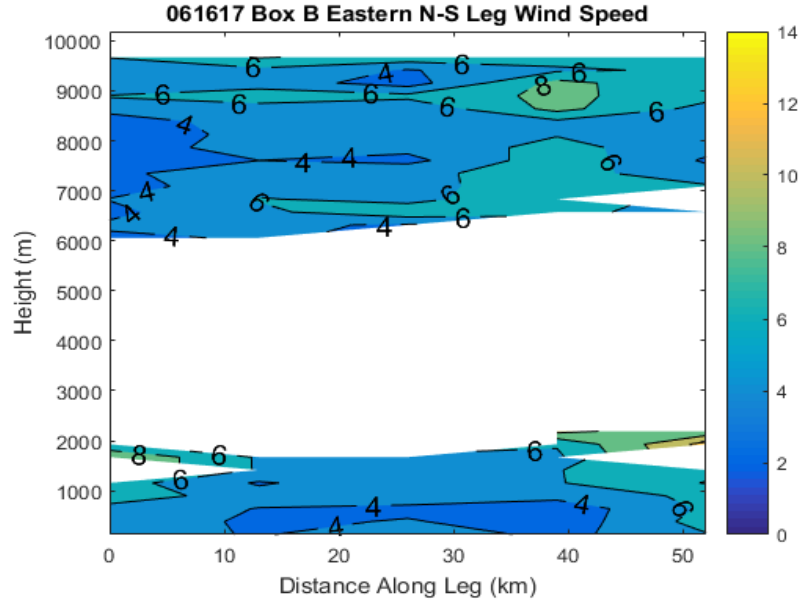

2017-06-16 21:00:00
June 16, 2017
Florida
Gulf of Mexico
Mexico
The Bahamas
Havana
Gulf of Batabano
Mexico City
Isla de Cozumel
Cuba
Grand Cayman
Belize
Haiti
Port-au-Prince
Jamaica
Kingston
Guatemala
Guatemala City
Honduras
El Salvador
Caribbean Sea
Nicaragua
Managua
Lake Nicaragua
Google Earth
Image Landsat / Copernicus
©2018 Google
US Dept of State Geographer
Data SIO, NOAA, U.S. Navy, NGA, GEBCO
1100 km
N

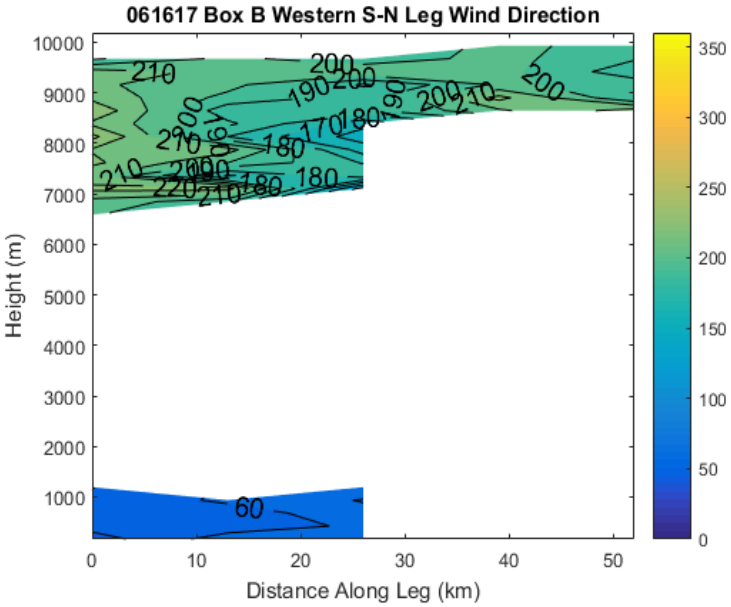

2017-06-16 21:00:00
June 16, 2017
Corozal
Orange Walk
Belize
Belize City
Belmopan
Cayo
Belize
Stann Creek
Toledo
Bay Islands
La Ceiba
2020
2029
2012
2034
2003
DAWN Profile ~ Every 12 km
5 Look 2 second dwell
N
100 km
Google Earth
©2018 Google
Image Landsat / Copernicus
Data SIO, NOAA, U.S. Navy, NGA, GEBCO
©2018 INEGI

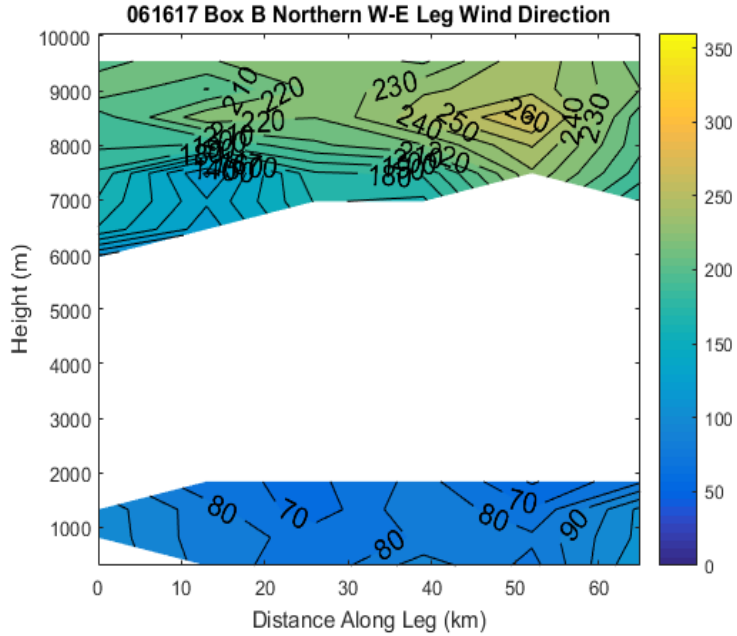

061617 Box B Western S-N Leg Wind Speed
Height (m)
Distance Along Leg (km)

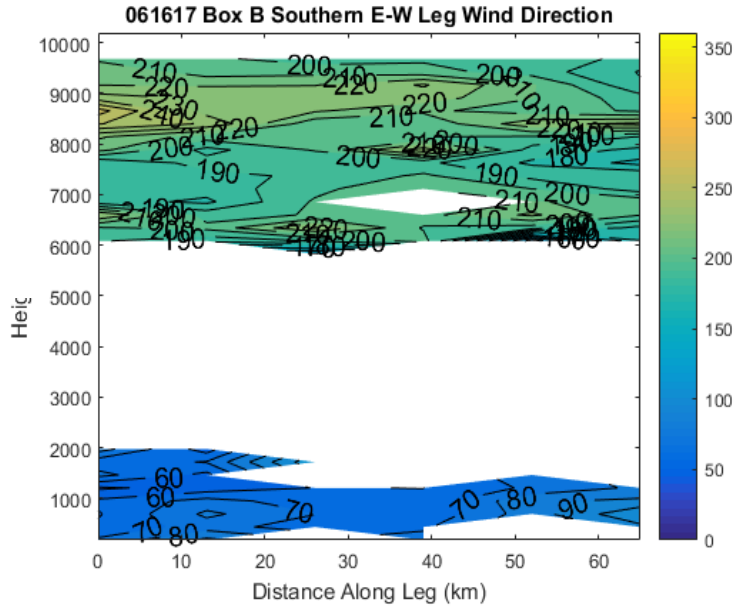

061617 Box B Northern W-E Leg Wind Speed
Height (m)
Distance Along Leg (km)

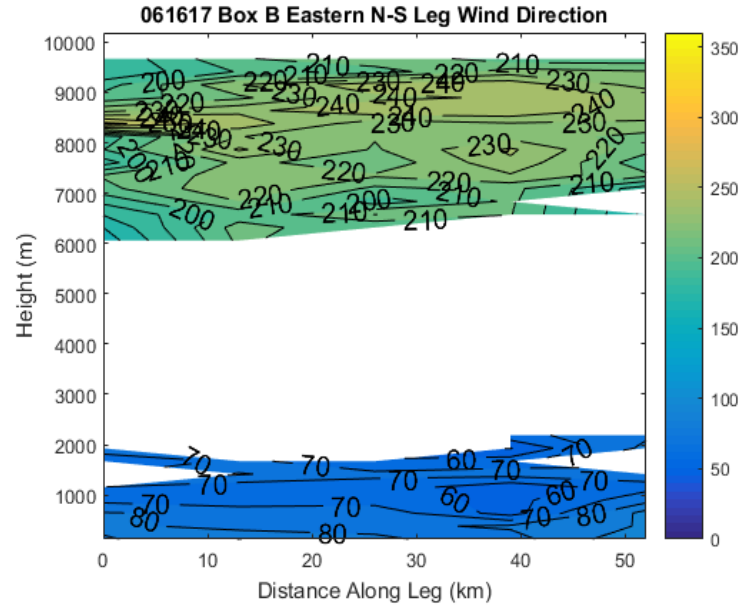

061617 Box B Southern E-W Leg Wind Speed
Height (m)
Distance Along Leg (km)

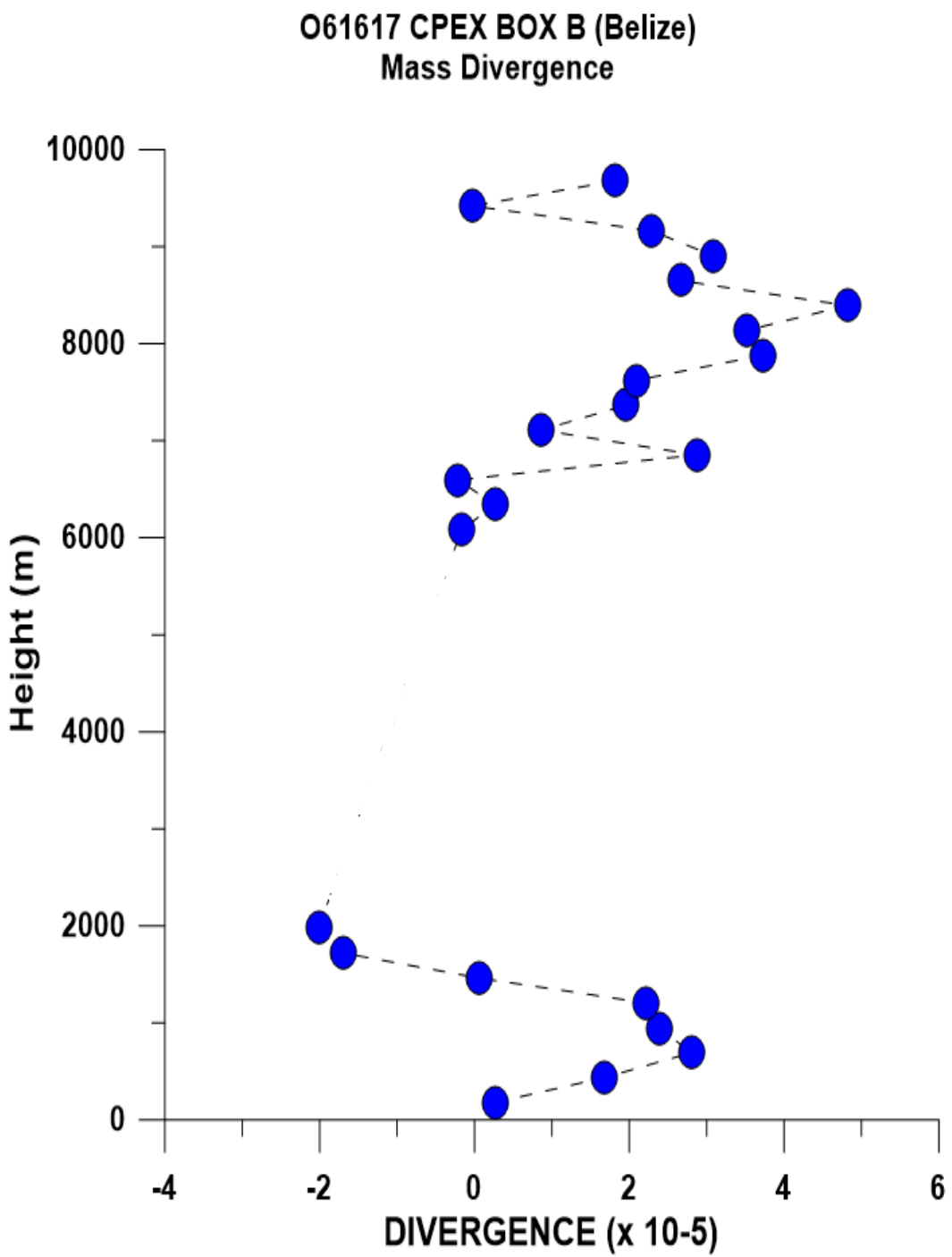

061617 Box B Eastern N-S Leg Wind Speed
Height (m)
Distance Along Leg (km)


061617 Box B Western S-N Leg Wind Direction
Height (m)
Distance Along Leg (km)


061617 Box B Northern W-E Leg Wind Direction
Height (m)
Distance Along Leg (km)


061617 Box B Southern E-W Leg Wind Direction
Distance Along Leg (km)

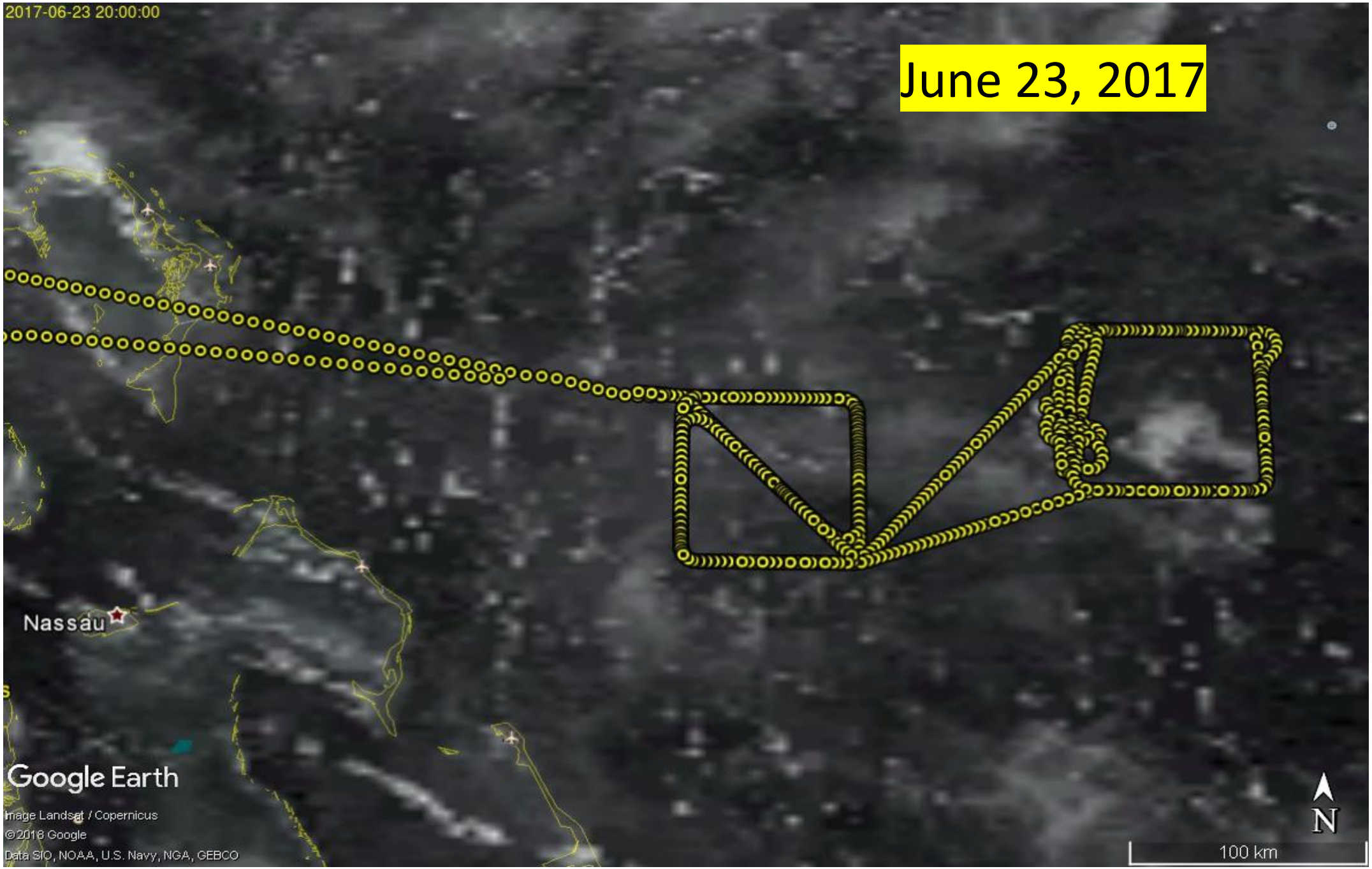

061617 Box B Eastern N-S Leg Wind Direction
Height (m)
Distance Along Leg (km)

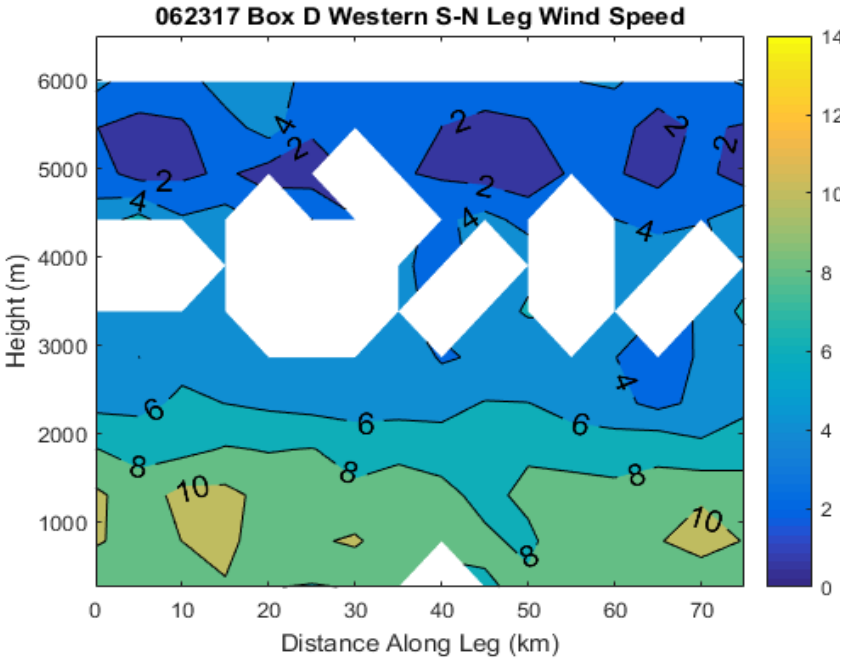

O61617 CPEX BOX B (Belize)
Mass Divergence
10000
8000
6000
4000
2000
0
Height (m)
-4
-2
0
2
4
6
DIVERGENCE (x 10-5)

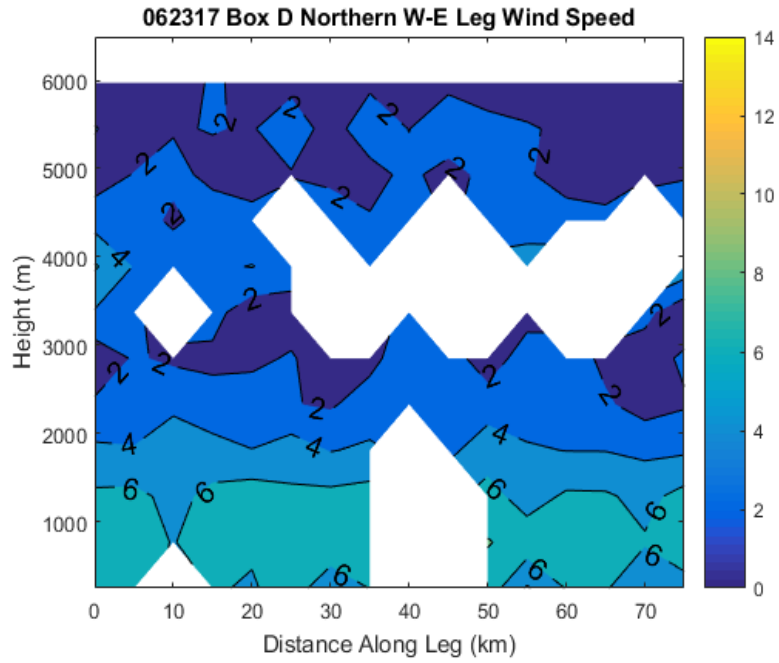
Summary

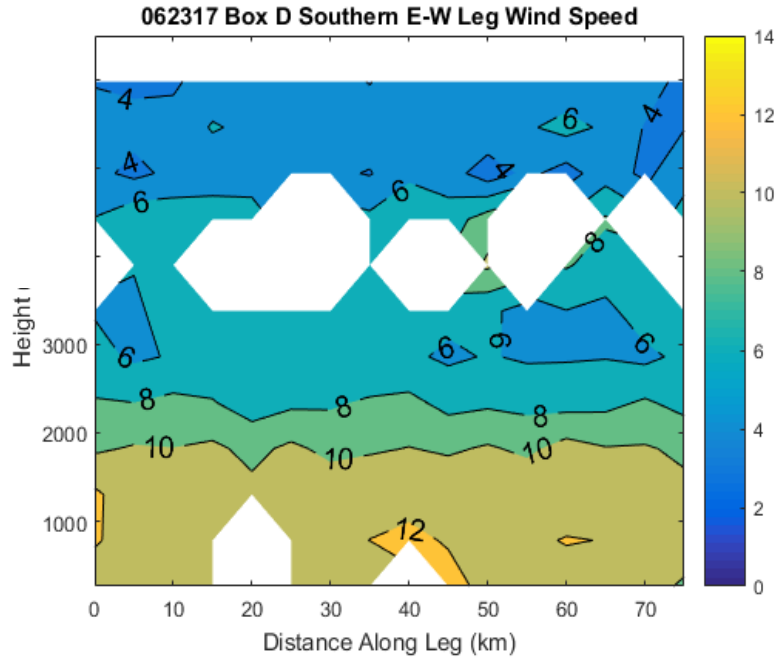
- The CPEX campaign has provided a unique set of more than 5000 DAWN wind profiles and ~ 300 dropsonde wind, temperature and water vapor profiles during all stages of the convective life cycle
- The DAWN airborne instrument can provide the velocity fields in the vicinity of scattered and organized deep convection
- CPEX science flights indicate good vertical coverage and good agreement with dropsonde winds
- The DAWN data have been used to compute mass budgets and divergence for 100 km x 100 km x 8-10 km volumes containing various degrees of cloud coverage ranging from cloud free to broken and scattered convection.
- Future work will continue on the investigation of the dynamics in more active and growing convection.

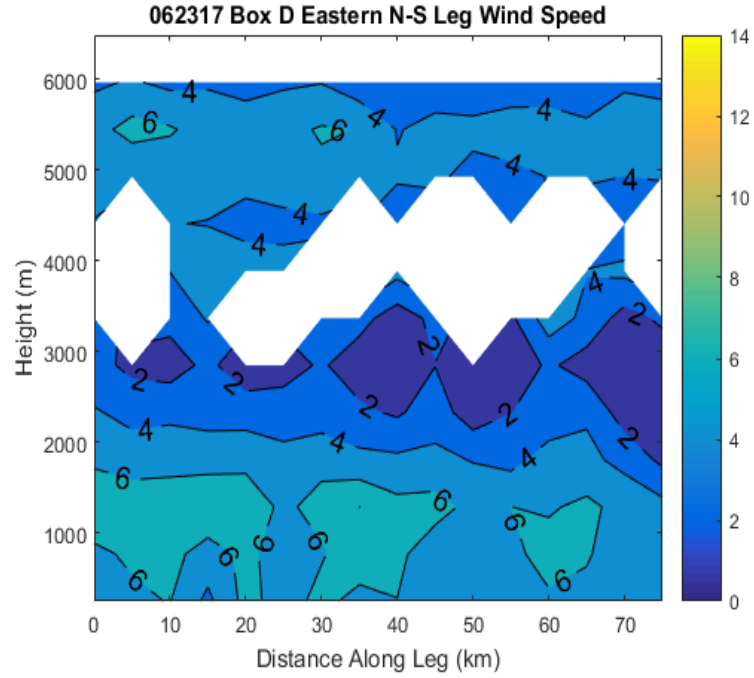
EXTRAS

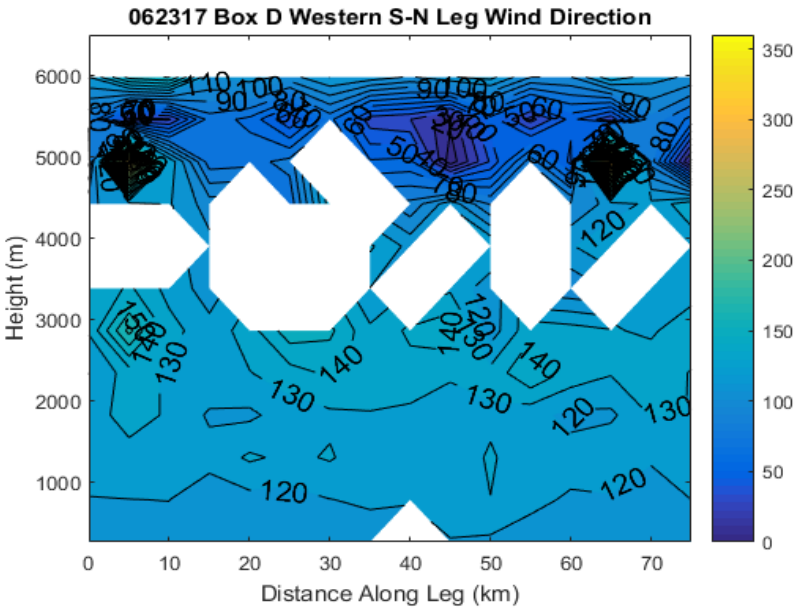

2017-06-23 20:00:00
June 23, 2017
Nassau
Google Earth
Image Landsat / Copernicus
©2018 Google
Data SIO, NOAA, U.S. Navy, NGA, GEBCO
N
100 km

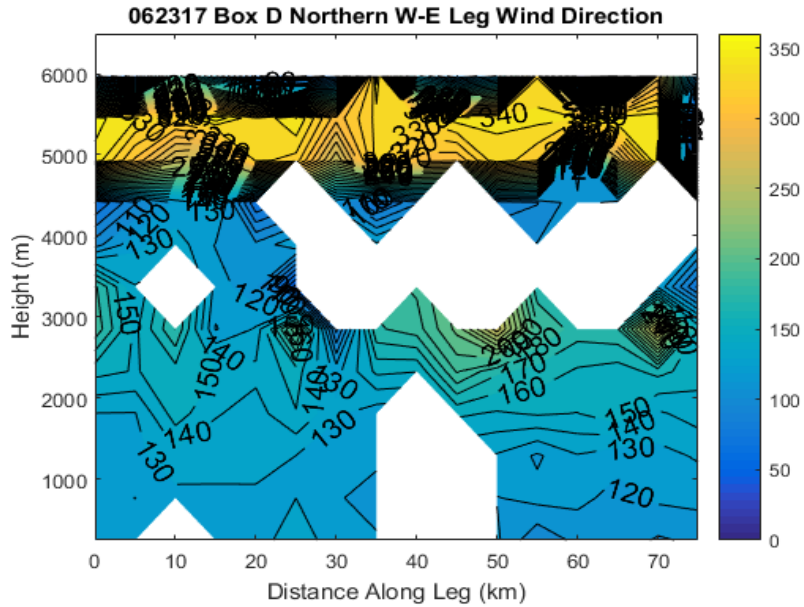

062317 Box D Western S-N Leg Wind Speed
Height (m)
Distance Along Leg (km)

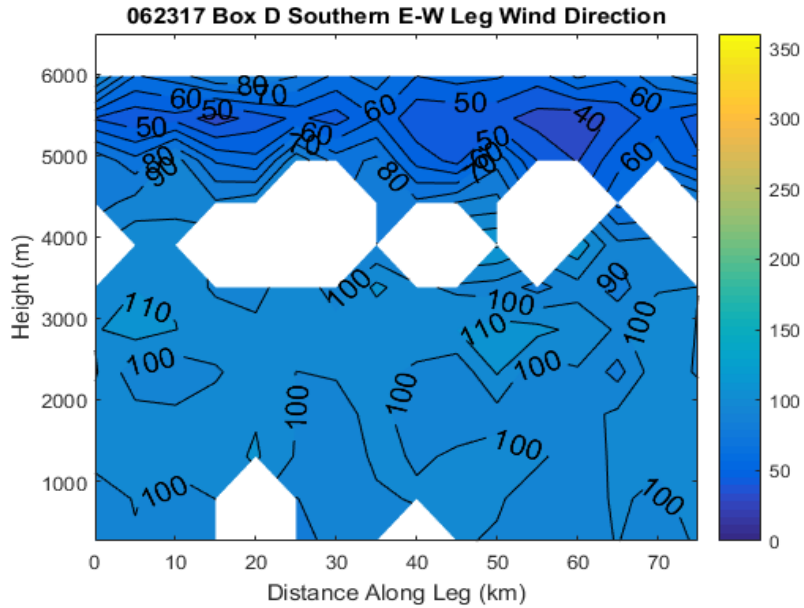

062317 Box D Northern W-E Leg Wind Speed
Height (m)
Distance Along Leg (km)

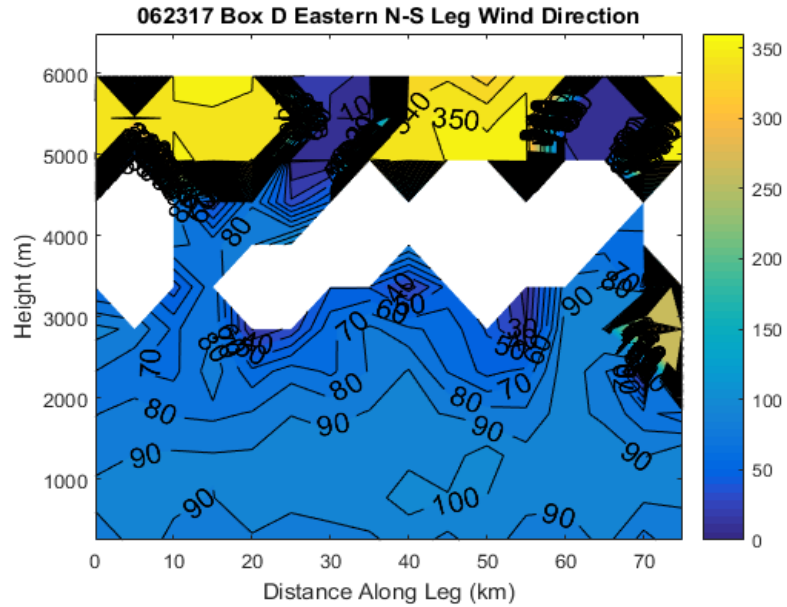

062317 Box D Southern E-W Leg Wind Speed
Height
Distance Along Leg (km)

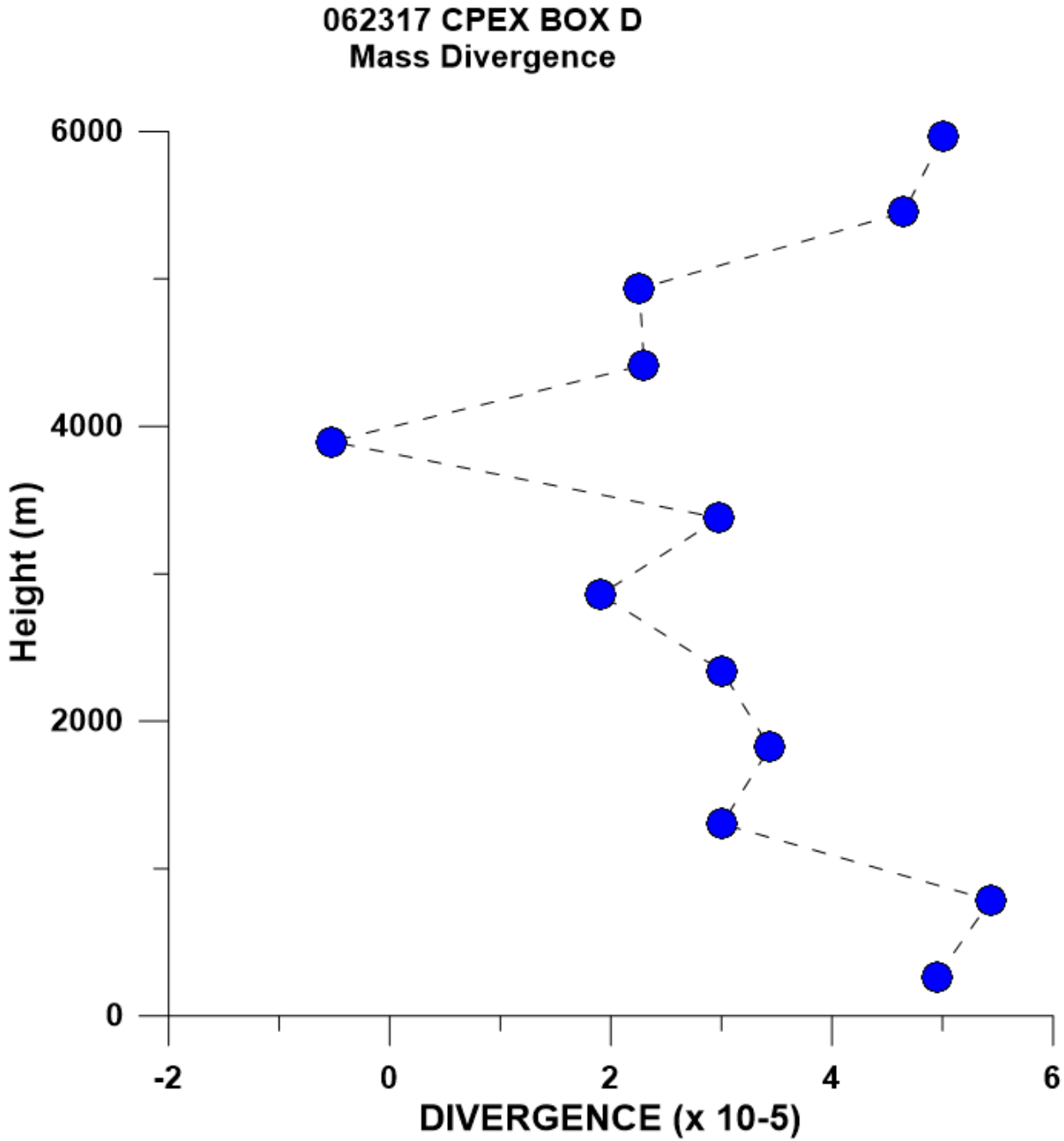

062317 Box D Eastern N-S Leg Wind Speed
Height (m)
Distance Along Leg (km)

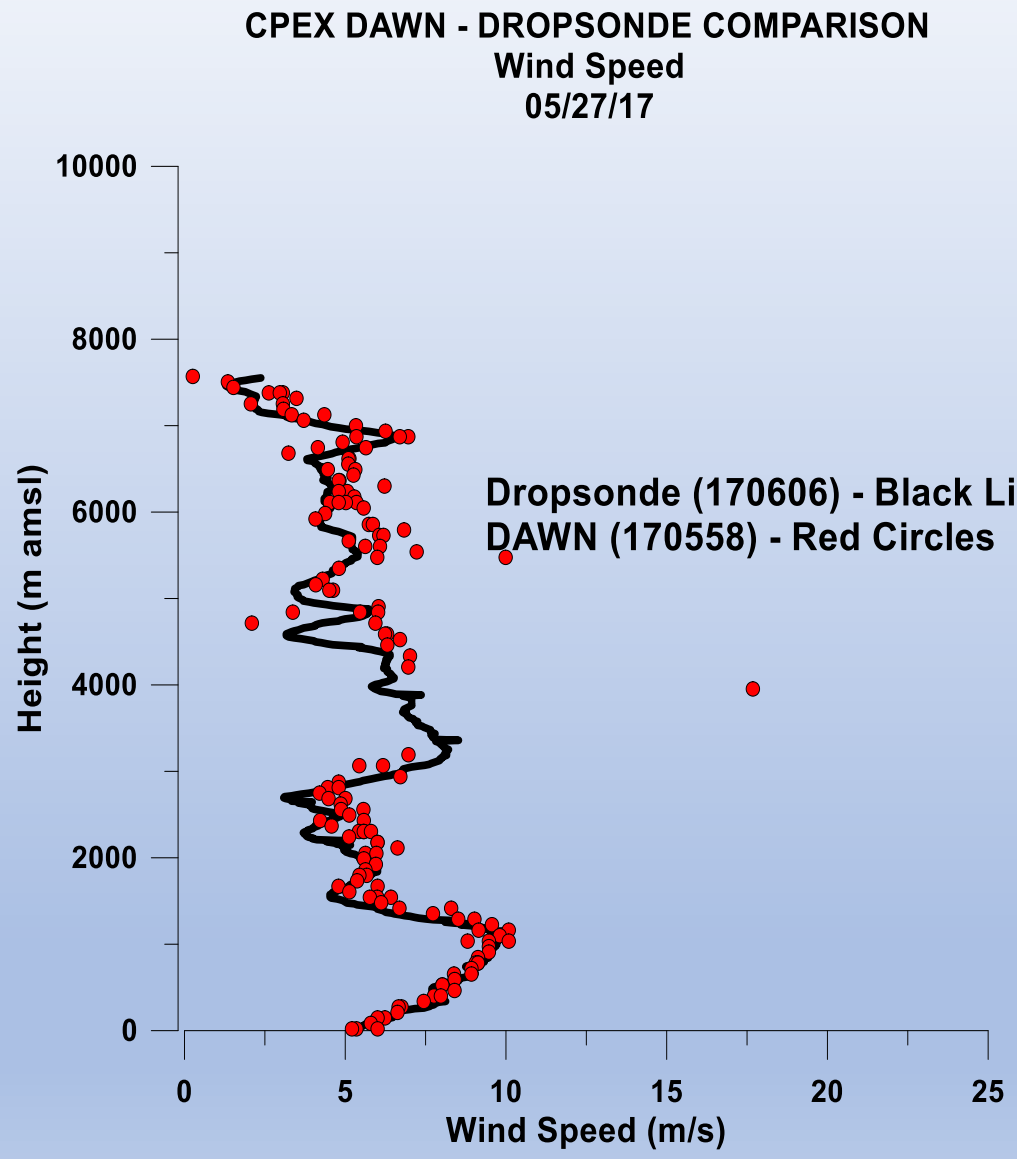

062317 Box D Western S-N Leg Wind Direction
Height (m)
Distance Along Leg (km)

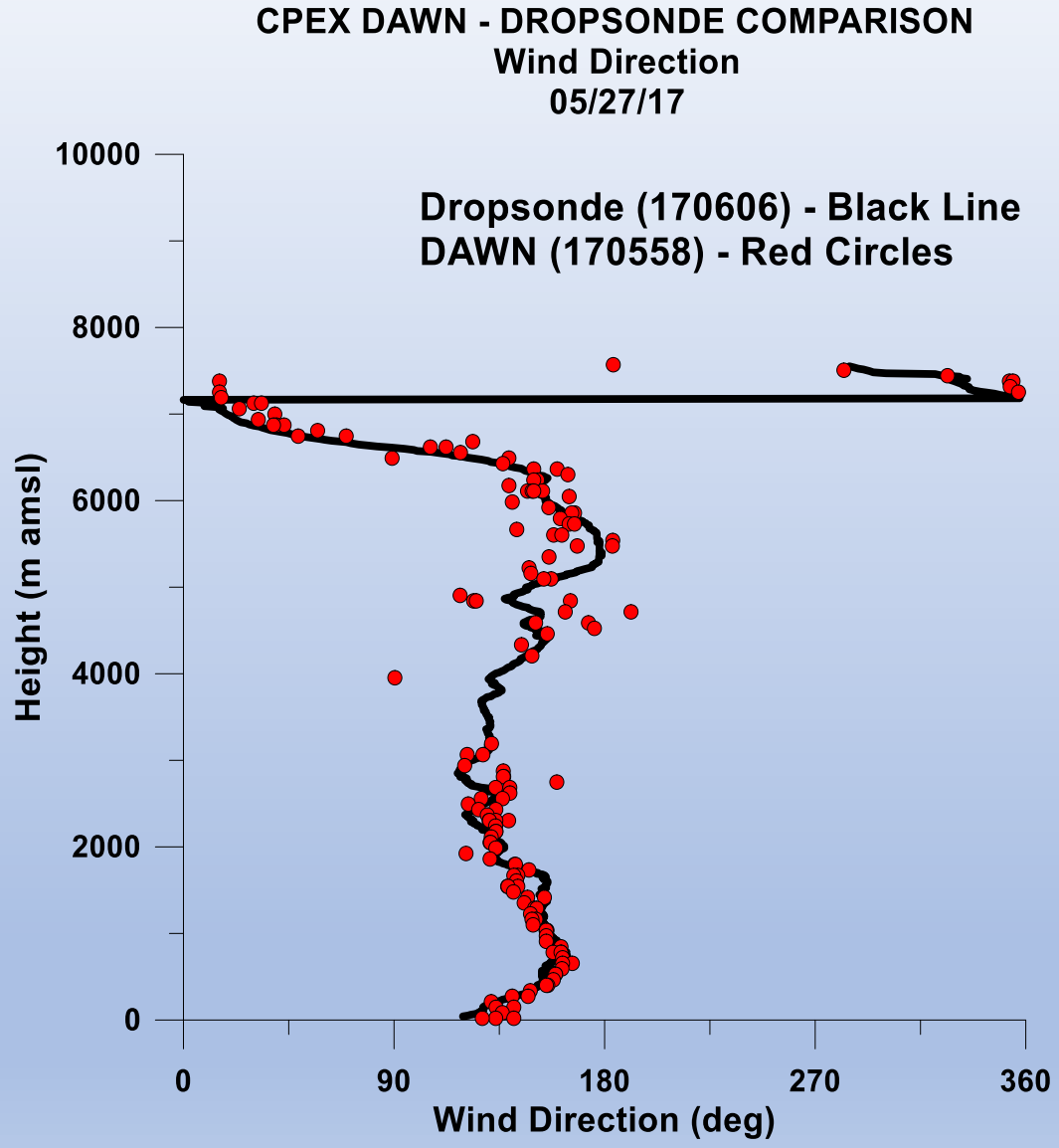

062317 Box D Northern W-E Leg Wind Direction
Height (m)
Distance Along Leg (km)

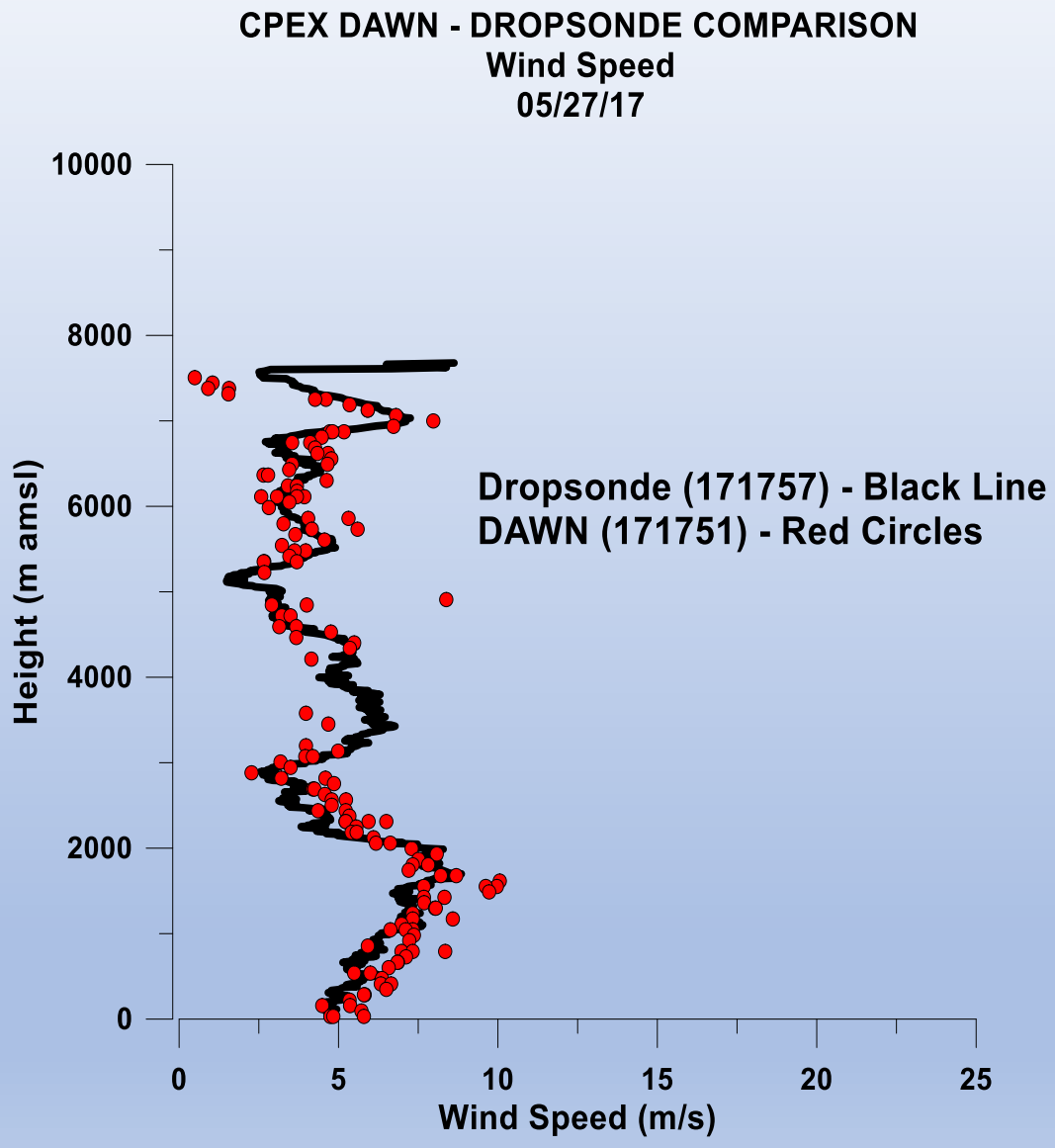

062317 Box D Southern E-W Leg Wind Direction
Height (m)
Distance Along Leg (km)

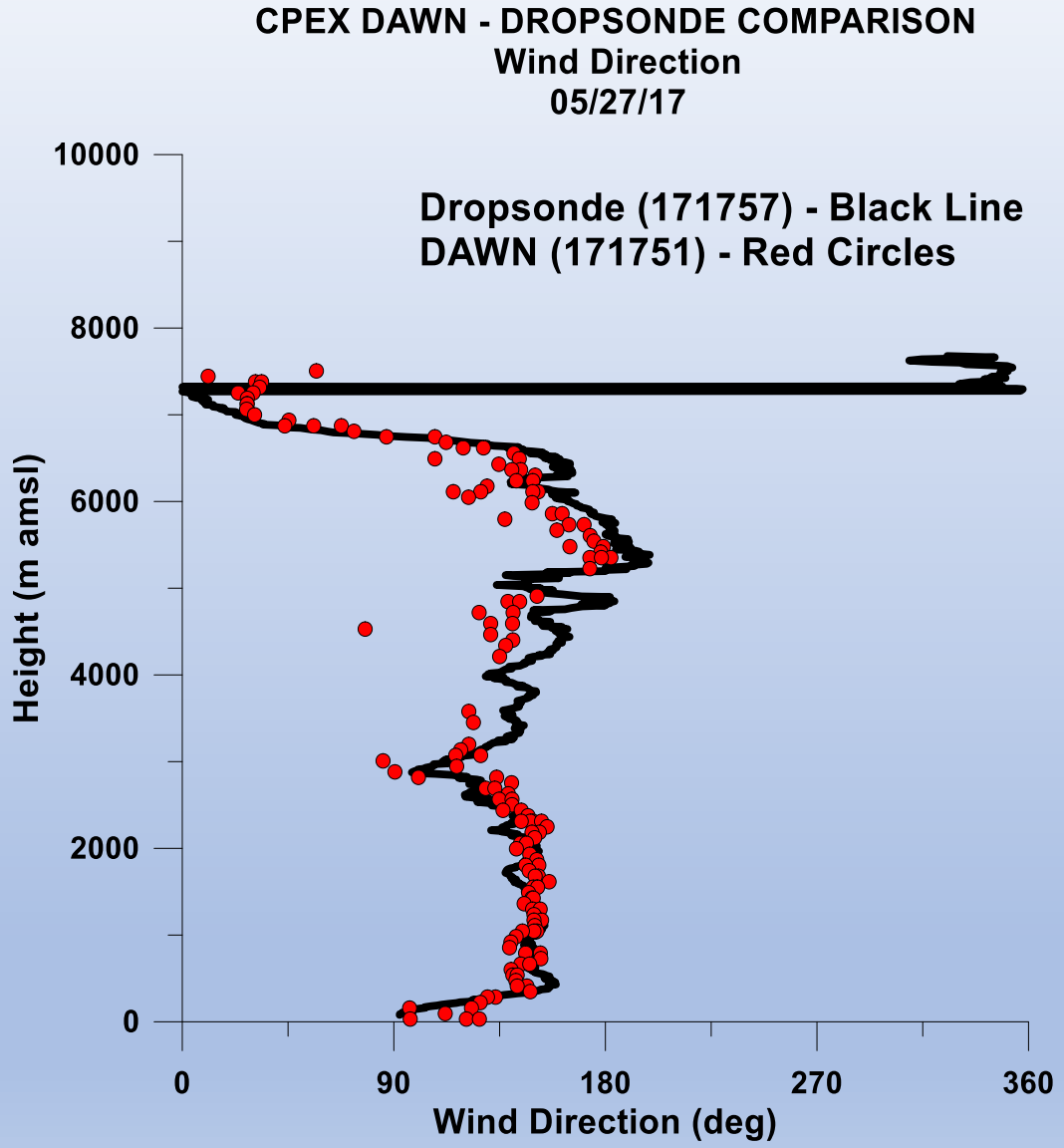

062317 Box D Eastern N-S Leg Wind Direction
Height (m)
Distance Along Leg (km)


062317 CPEX BOX D
Mass Divergence
6000
4000
2000
0
Height (m)
-2
0
2
4
6
DIVERGENCE (x 10-5)


CPEX DAWN - DROPSONDE COMPARISON
Wind Speed
05/27/17
Dropsonde (170606) - Black Line
DAWN (170558) - Red Circles
Height (m amsl)
10000
8000
6000
4000
2000
0
0
5
10
15
20
25
Wind Speed (m/s)


CPEX DAWN - DROPSONDE COMPARISON
Wind Direction
05/27/17
Dropsonde (170606) - Black Line
DAWN (170558) - Red Circles
Height (m amsl)
10000
8000
6000
4000
2000
0
0
90
180
270
360
Wind Direction (deg)


CPEX DAWN - DROPSONDE COMPARISON
Wind Speed
05/27/17
Dropsonde (171757) - Black Line
DAWN (171751) - Red Circles
Height (m amsl)
10000
8000
6000
4000
2000
0
0
5
10
15
20
25
Wind Speed (m/s)


CPEX DAWN - DROPSONDE COMPARISON
Wind Direction
05/27/17
Dropsonde (171757) - Black Line
DAWN (171751) - Red Circles
Height (m amsl)
10000
8000
6000
4000
2000
0
0
90
180
270
360
Wind Direction (deg)