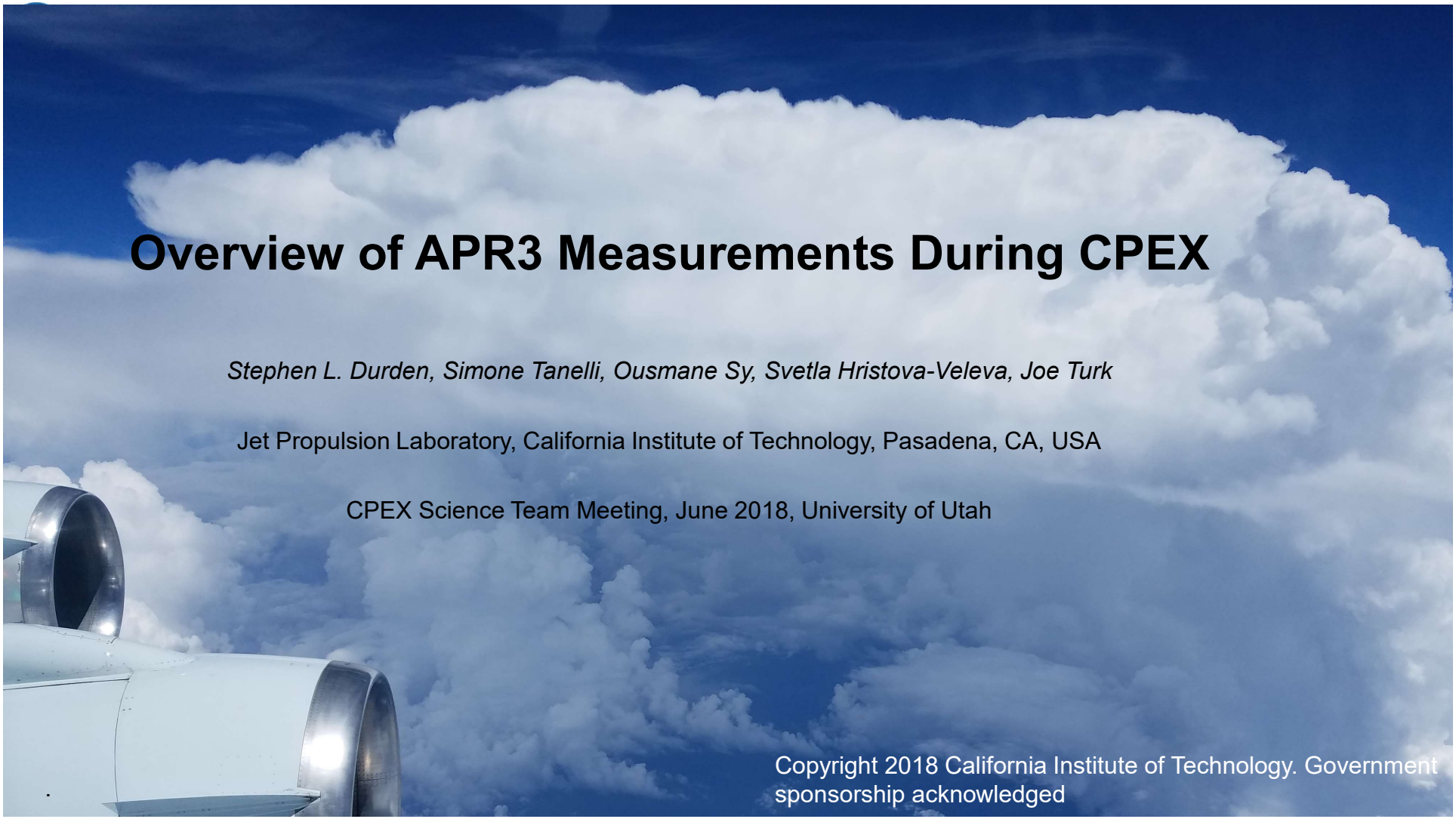

Overview of APR3 Measurements During CPEX

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CPEX Science Team Meeting, June 2018, University of Utah

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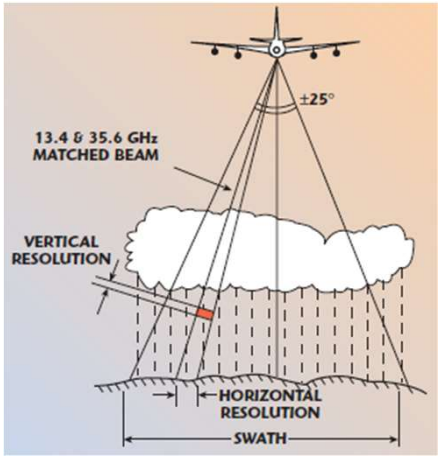
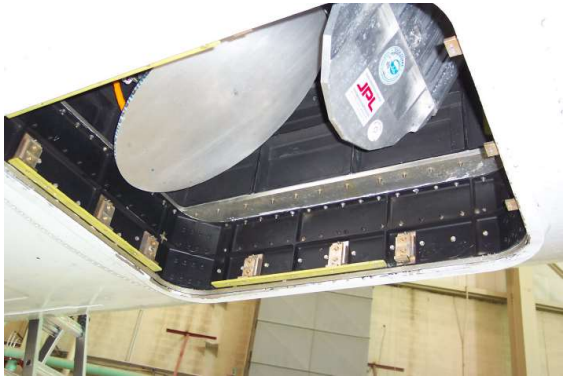
Airborne Precipitation Radar (APR-3) - Overview

- Dual-frequency operation with Ku-band (13.4 GHz) and Ka-band (35.6 GHz)
- W-band nadir and scanning capability but not used in CPEX



- Measures reflectivity at co- and cross-polarizations, and Doppler
- Range resolution is ~ 50 m
- Range sampling 30 m
- Horizontal resolution at surface (from 11 km altitude) is ~ 1 km
- Maximum unambiguous velocity of ±27.5 m/s Ku-band and ±10.5 m/s Ka-band



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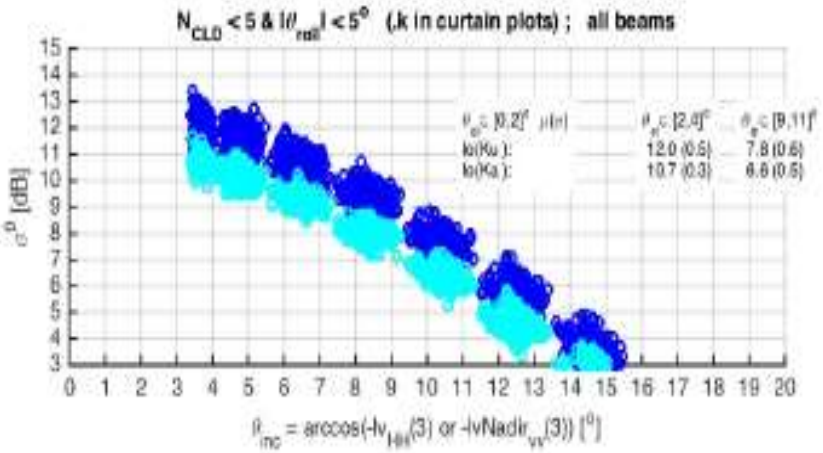
Data Quality

- Reflectivity calibration is likely 1-2 dB
  - Based on 10-degree incidence sigma0 at Ku-band
  - Based on Mie scattering calculations in light rain at Ka-band
  - GPM DPR reflectivity ~1.5 dB higher
- LDR measurements are OK to near -20 dB; LDR lower than this is likely contaminated by system cross-polarization isolation
- Velocity is motion-corrected total Doppler, including particle fall speed
  - Used surface Doppler to estimate aircraft motion
  - Simple de-aliasing algorithm applied but some aliasing may be left over



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Contents of APR3-L2ZV_DC8_20170610203143_R2_KUsKAs.h5

All files are KUsKAs
"APR2 mode", W-band is not available

No "hires" structure

- d = struct with fields:

  lores: [1×1 struct]
  params_KUKA: [1×1 struct]
  postEng_cal: [1×1 struct] – not needed by users

- d.params_KUKA = struct with fields:

  AntRetraceTime_s: 0.6000
  AntScanLeft_deg: -25
  AntScanRight_deg: 25
  AntScanTime_s: 1.2000
  CalVersion: 99
  Fixed_Ka_Pt: 0
  Ka_Port: 0
  Nbeams: 24
  Nbeams_data: 23
  Nbeams_noise: 1
  Nbin_per_ray: 550
  Npuls_avge: 250
  Nscan: 621
  PRF_Hz: 5000
  Range_Size_m: 30
  Rx_Atten: 10
  Tx_Atten: 20
  pulselen_us: 10
  range0_m: -810.0000

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Contents of APR3-L2ZV_DC8_20170610203143_R2_KUsKAs.h5 (II)

d.lores →

alt3D: [621×24×550 double]
alt_nav: [621×24 double]
beamnum: [621×24 double]
drift: [621×24 double]
gsp_mps: [621×24 double]
isurf: [621×24 double]
lat: [621×24 double]
lat3D: [621×24×550 double]
ldr14: [621×24×550 double]
ldr35: [621×24×550 double]
lon: [621×24 double]
lon3D: [621×24×550 double]
look_vector: [621×24×3 double]
look_vector_radar: [621×24×3 double]
path_vals: [621×24×15 double]
pitch: [621×24 double]
roll: [621×24 double]
scantime: [621×24 double]
sequence: [621×24 double]
surf_vals: [621×24×8 double]
surface_index: [621×24 double]
v_surf: [621×24 double]
v_surfdc8: [621×24 double]
vel14: [621×24×550 double]
vel14c: [621×24×550 double]
vel35: [621×24×550 double]
vel35c: [621×24×550 double]
zhh14: [621×24×550 double]
zhh35: [621×24×550 double]

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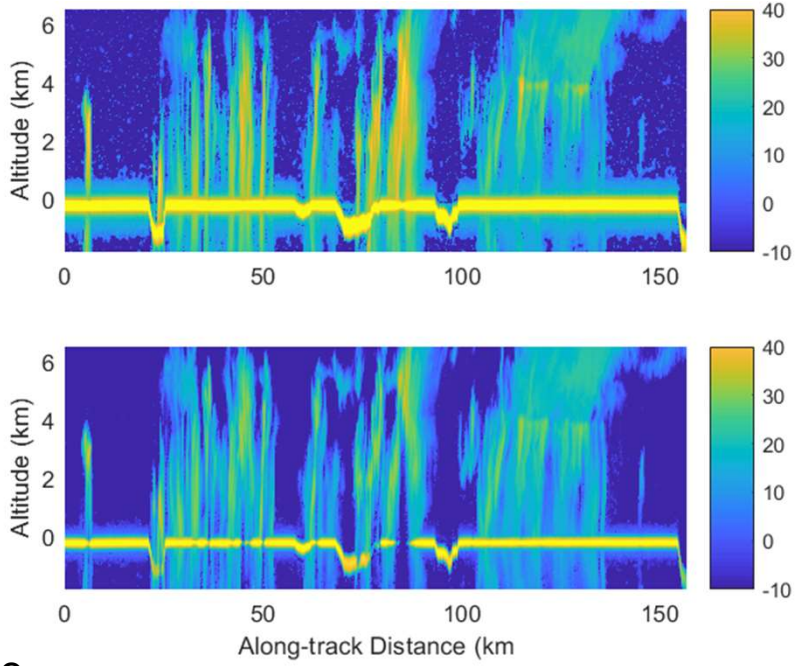
Accessing Reflectivity

Get reflectivity from
    d.lores.zhh14(:,1:23,:)
    d.lores.zhh35(:,1:23,:)

Make images:
    pcolor(x,y,squeeze(z14(:,beam,:))')
    pcolor(x,y,squeeze(z35(:,beam,:))')

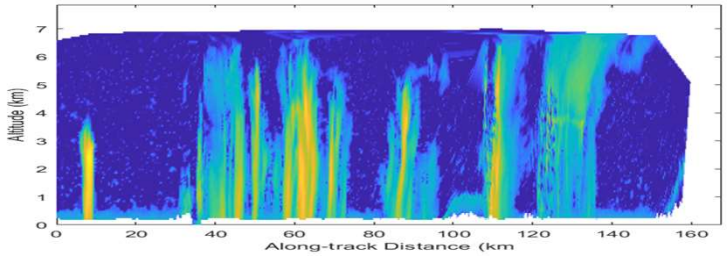
Using same beam in all scans causes surface to move due to aircraft turns

- Can resample to Cartesian
- Slices have constant surface range



Ku

Ka



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APR3 Data Collection During CPEX

#	Date	Observation
1	2017, May 27	First local science flight; box pattern in central Gulf; clear air only
2	2017, May 29	Sampling of scattered convection in NW Caribbean; cells 1813, 1942-2000
3	2017, May 31	Multiple boxes over Atlantic, near Bahamas and north of Hispaniola; mostly clear but cells at 1936, 2120
4	2017, June 1	Convective system over eastern Gulf; multiple passes over convection; 25 minute data loss at Ka-band due to TWT amplifier breaker trip
5	2017, June 2	Extended E-W box over western and central Gulf; clear areas and some convective cells, e.g., 1750, 1928; decaying convection 1830-1900, 2100-2110
6	2017, June 6	Convection over eastern Gulf, especially near1858, 1955-2115, 2105, 2140
7	2017, June 10	Boxes east of the Bahamas; stratiform with some convection on ascent 1840-1850, small cells in box 1925, 2004, 2035-2045, 2118, 2140, 2210-2216
8	2017, June 11	East west legs over convective system in central Gulf; isolated cells 1801, 1830, 1850; extensive precip on lines starting 1900, 1920, and N to S line starting 2005
9	2017, June 15	Caribbean, east of Yucatan, convection at times near 1920, 1940, 1953, 2011

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APR3 Data Collection During CPEX (II)

#	Date	Observation
10	2017, June 16	Caribbean, boxes east of Yucatan; convection near times 1830-1940, 2050-2140
11	2017, June 17	Caribbean, boxes east of Yucatan; convective cells 1745, 1800-1815, 2044-2054, 2223; sampled convective system with box pattern between 1900 and 2030
12	2017, June 19	East west legs over north central and northeast Gulf, Tropical Storm Cindy; extensive precipitation 1700-1820, 1840-2005; numerous isolated cells to 2130, then more extensive areas to 2224
13	2017, June 20	Bow tie pattern in central Gulf; convective system 1742-1754, cells 1815-1820, very shallow convection 1923, extensive precip 2110-2150
14	2017, June 21	East west flight across Gulf; isolated cell 1842, 1942, 2028, 2107, 2124, 2158, 2240; stratiform/transitional 1925-1937
15	2017, June 23	Box pattern to east of Bahamas crossed isolated cells 1832, 1859, 1910, 1917; multiple lines over area with isolated cells 1912-1939
16	2017, June 24	Over and around Cuba; convection 1744, box pattern cells near 1829, isolated cells 1843-1944; mature cell near 2106, more cells 2112-2143

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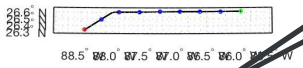
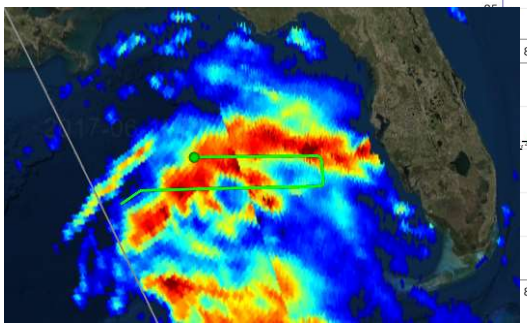
Example Case 1: June 19 TS Cindy

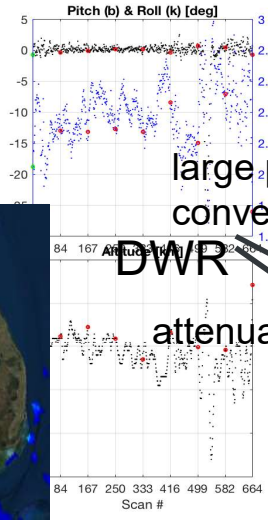


High reflectivity at Ku-band

Strong attenuation at Ka-band

DC8 19Z-20Z

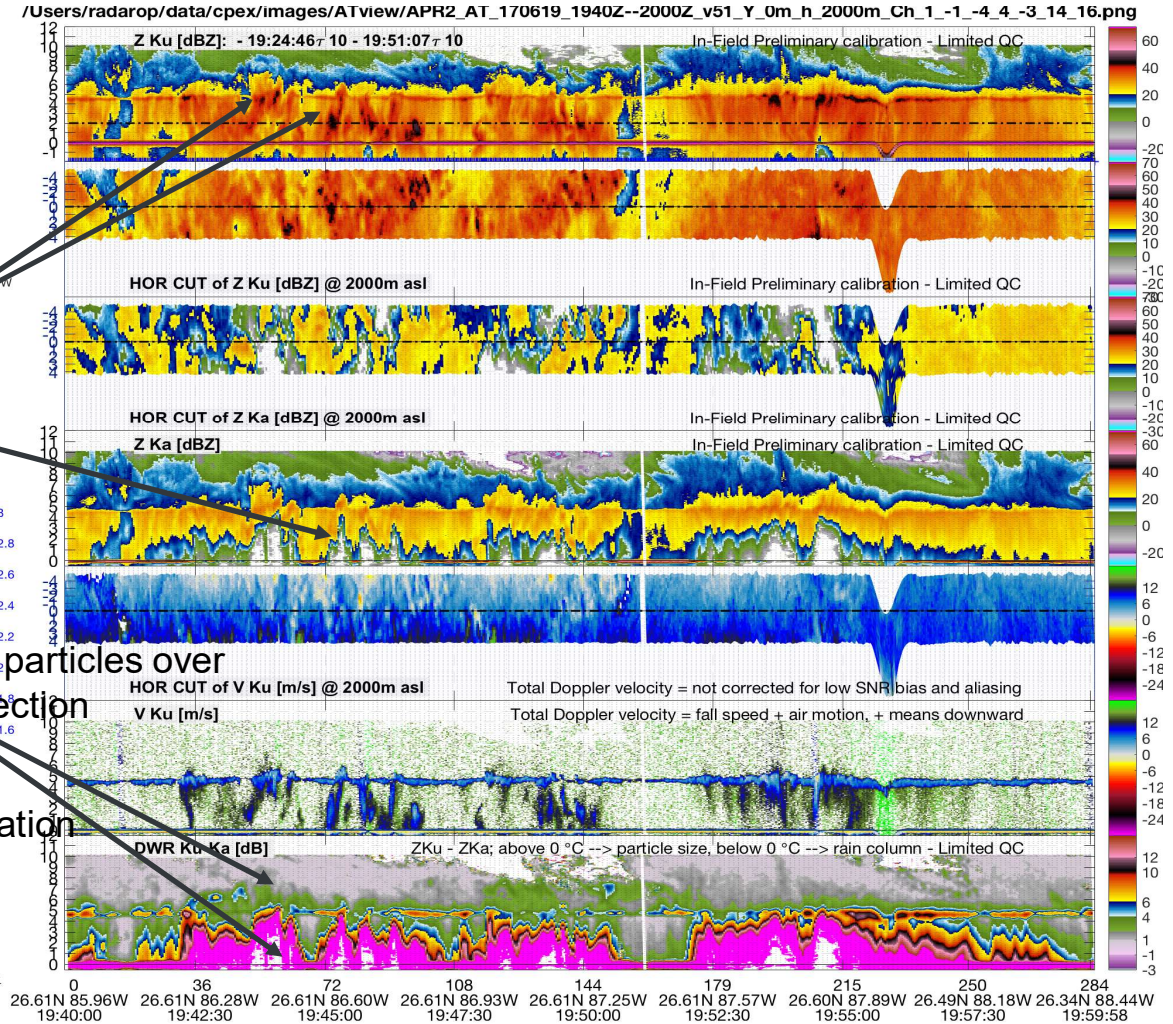




large particles over convection

DWR

attenuation



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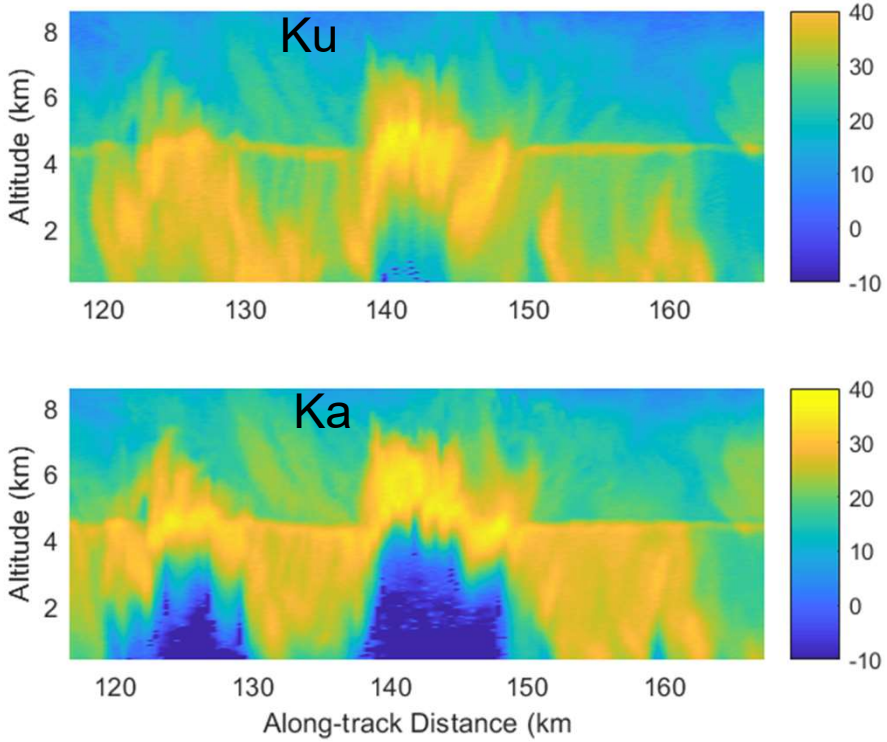
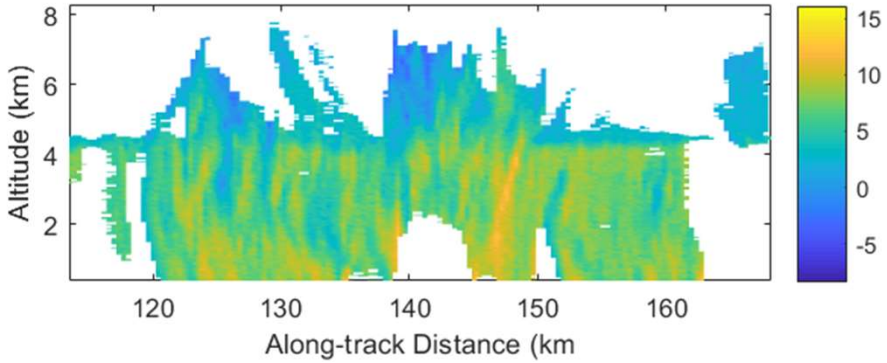
Example Case 1: June 19 TS Cindy (II)
Zoom in on Convection Near 1945



Doppler Ku-band; positive down
Terminal velocity not removed



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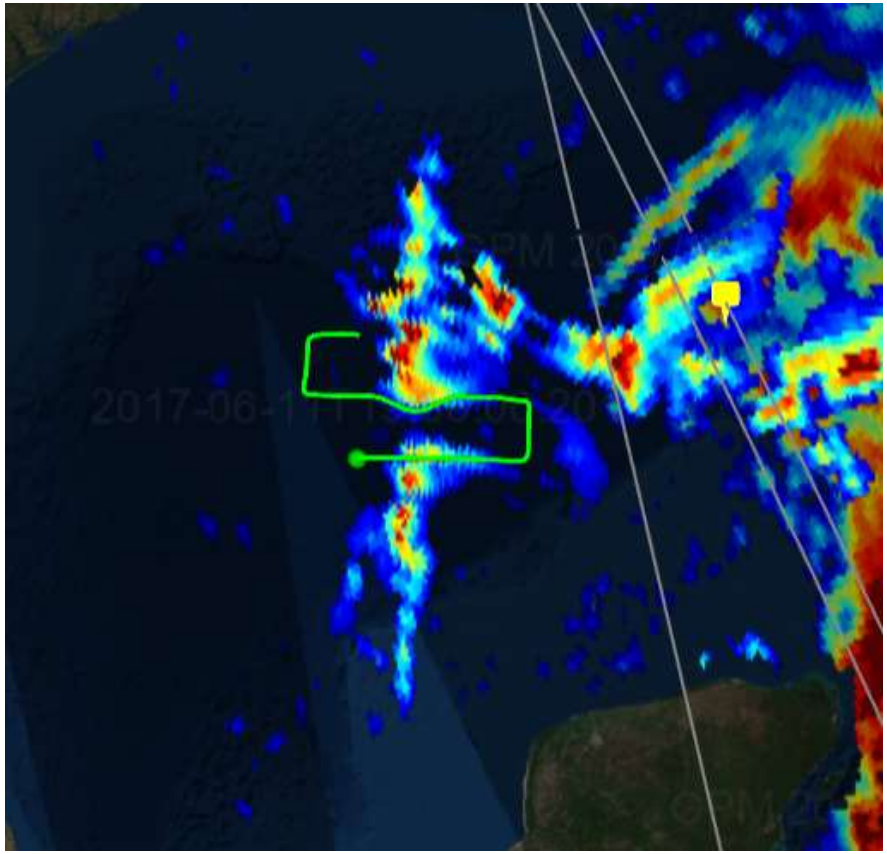
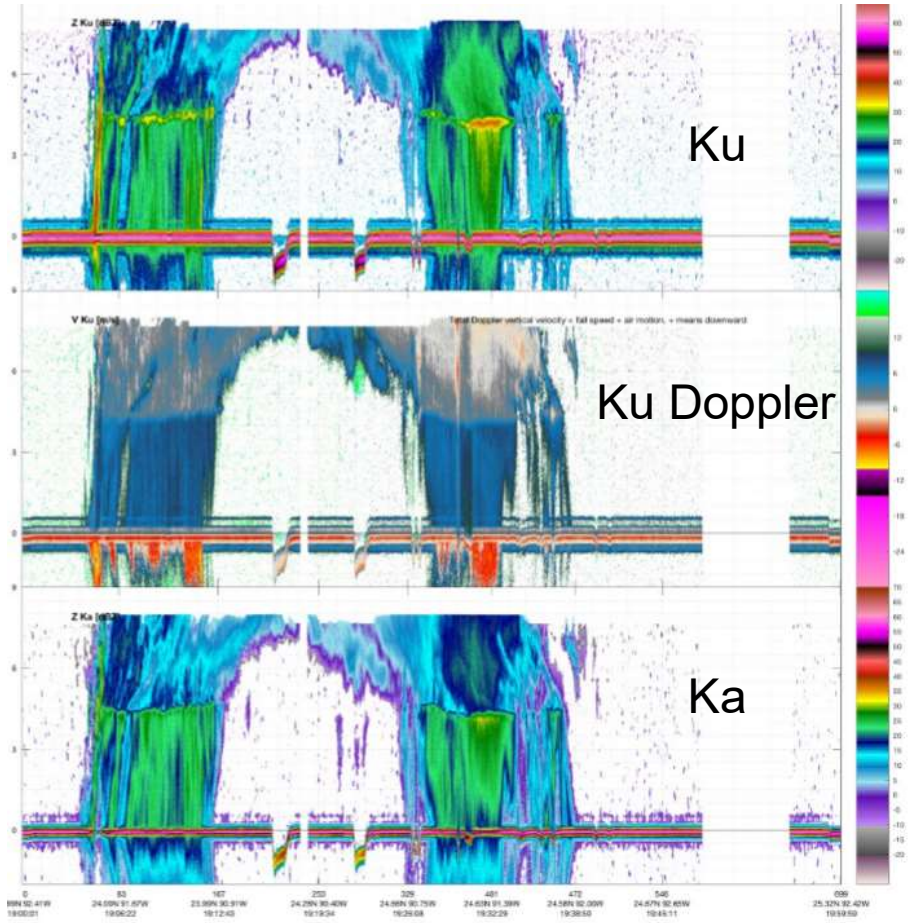
Example Case 2: June 11

19Z-20Z





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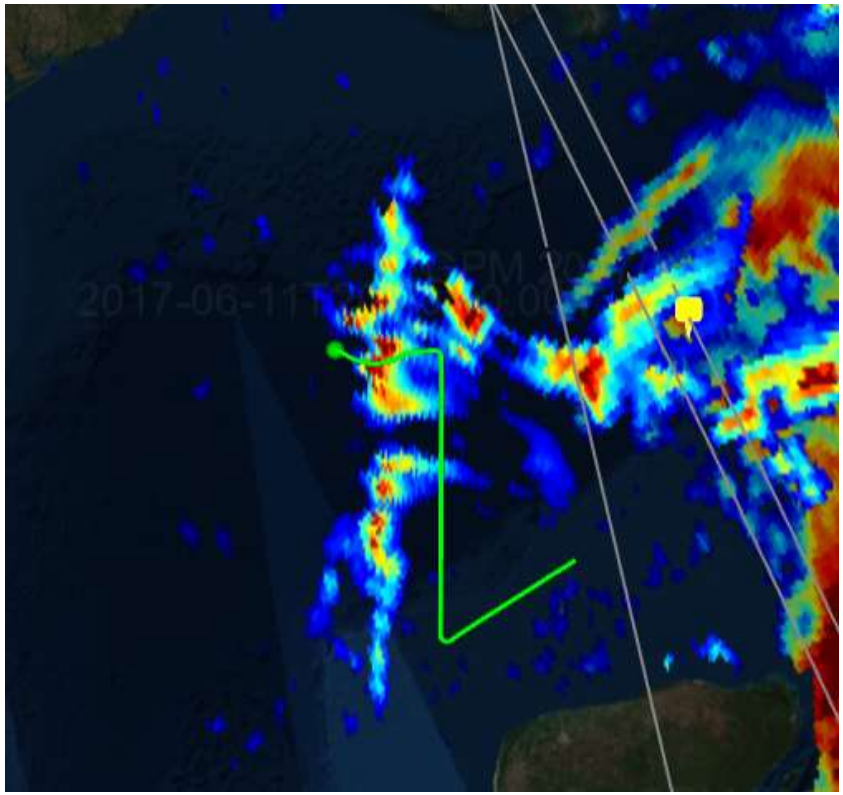
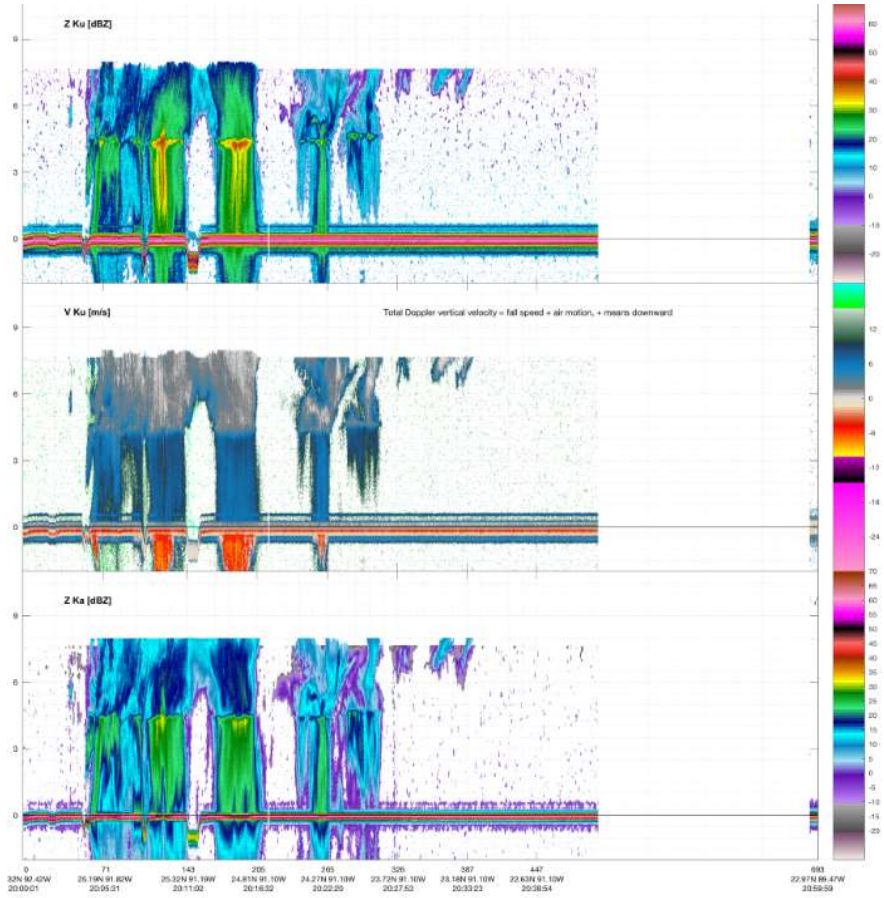
Example Case 2: June 11 (II) 20Z-21Z





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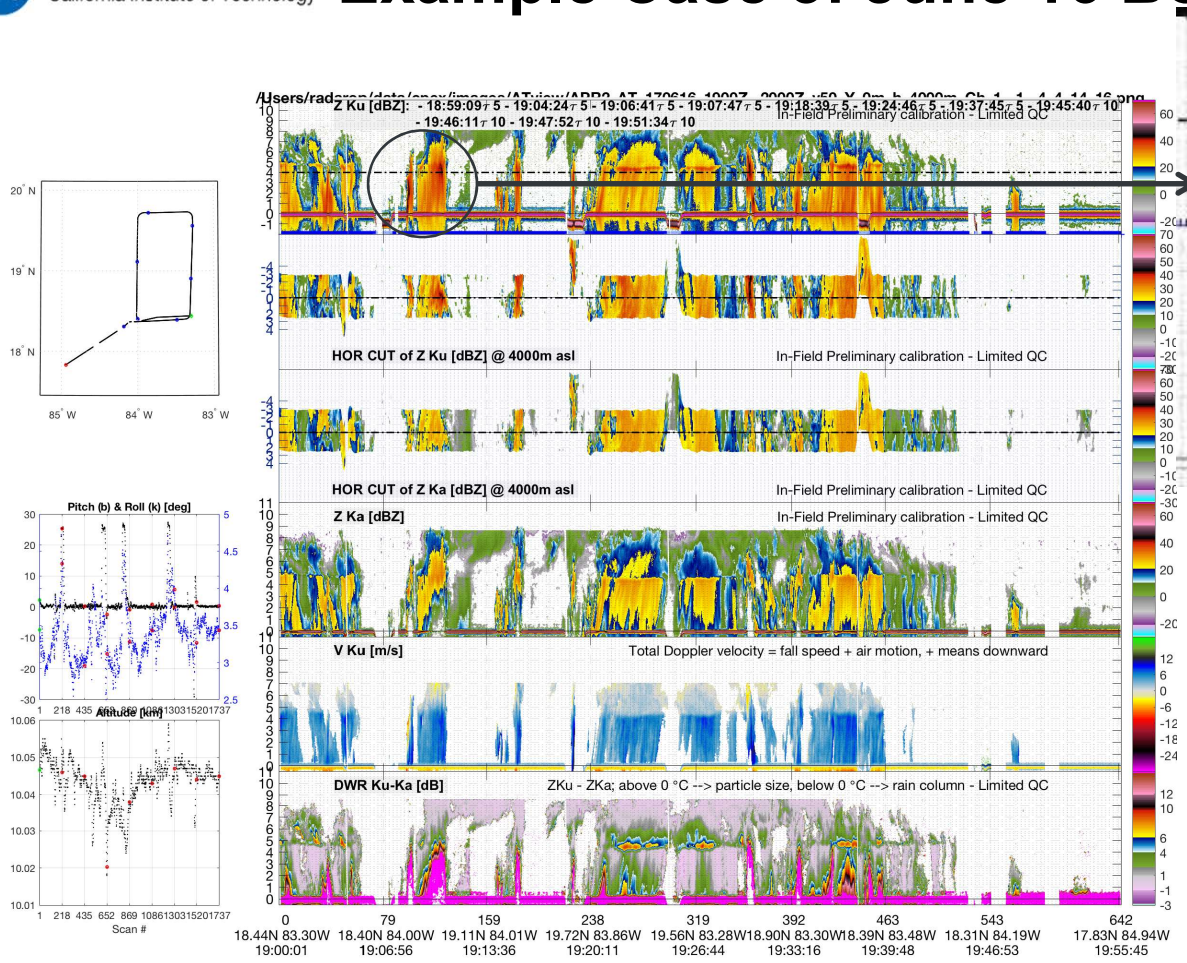
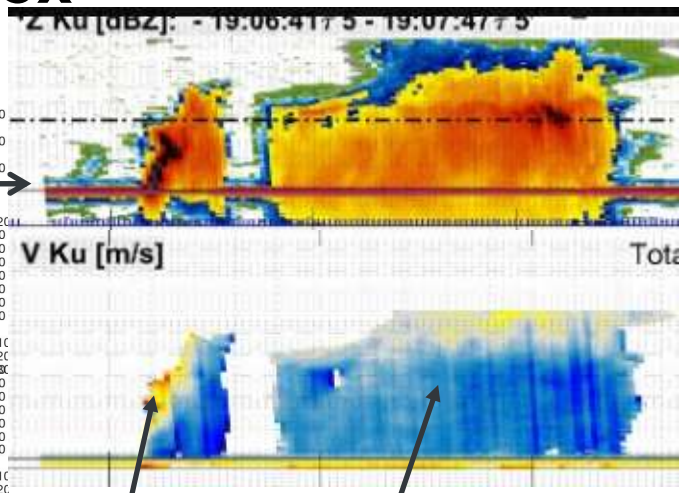
Example Case 3: June 16 Box





updraft

Stratiform or decaying convection?

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Summary

- No serious instrument problems over experiment
- Release version calibration appears consistent with previous APR3 Ku/Ka data
- Data format is HDF5, new starting with 2016 ORACLES data
- Release version has been through standard QC but may have some as yet undetected issues – please contact us with questions
- Numerous cases of good data in convection
  - We would like to identify cases with APR3 data in precipitation and DAWN winds in nearby clear areas
  - Example: June 16 box?