HCR Vr and Z Data Quality

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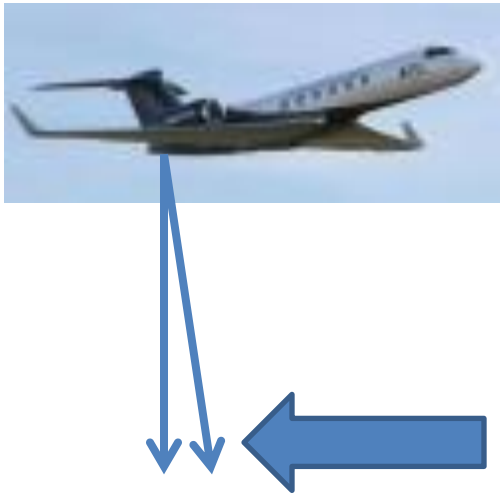
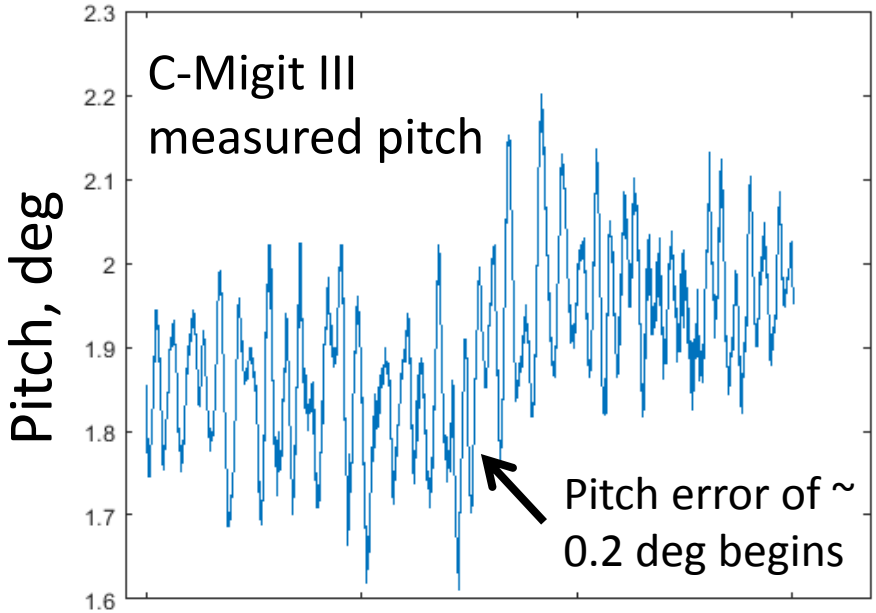
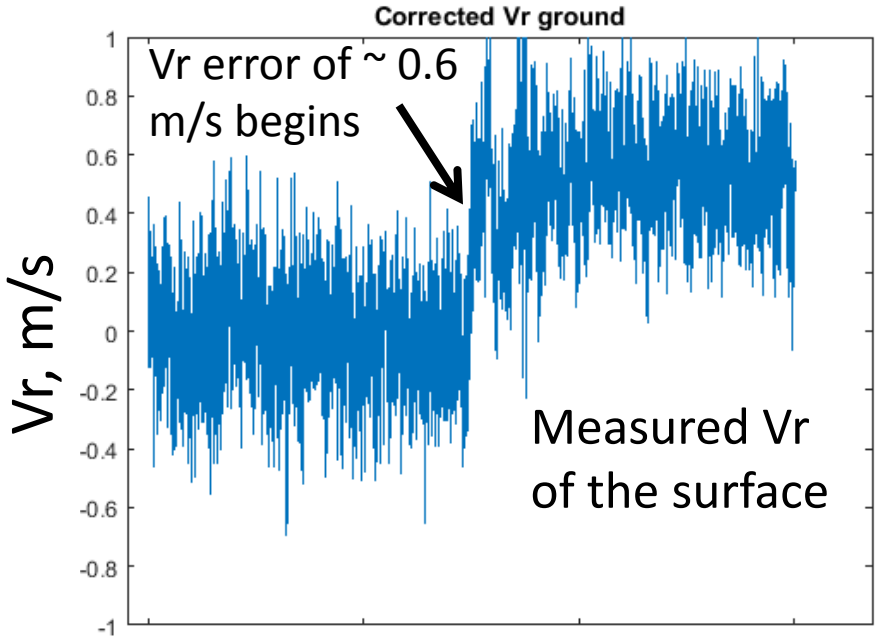
Navigation Correction

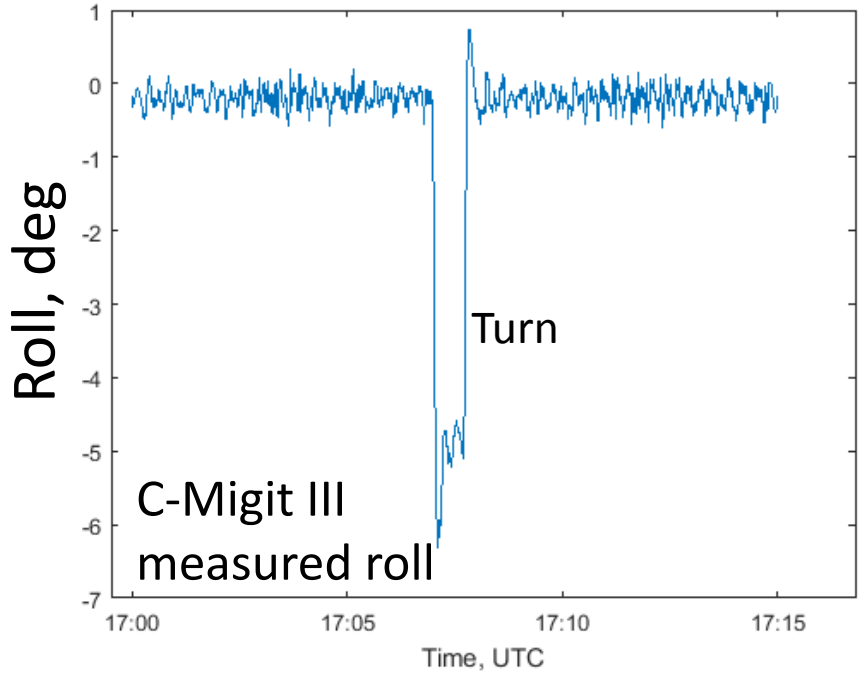
- Systron Donnor C-Migit INS/GPS system
  - Located at reflector for negligible moment arm
  - Size fits in the pod
  - Performance is quite good
    - 100 Hz data
    - Accurate to ~0.01 deg
- Real-time correction of pointing angle
  - Keeps antenna pointing in desired direction
  - Helps mitigate the cross wind errors

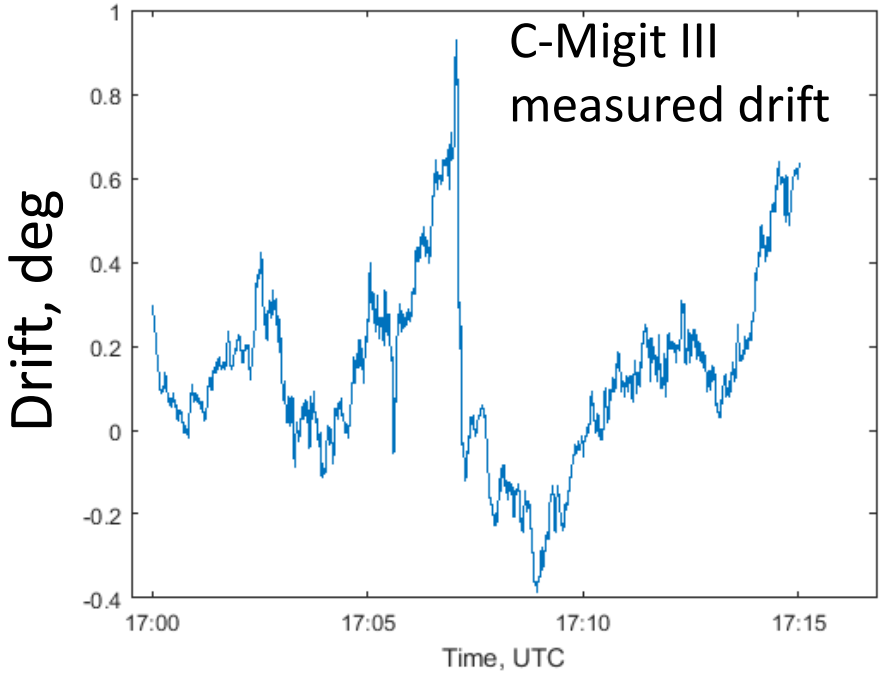


0.1 deg pitch error ~0.4 m/s error at 240 m/s GV speed


C-Migit III
measured pitch
Pitch error of ~
0.2 deg begins
Pitch, deg
2.3
2.2
2.1
2
1.9
1.8
1.7
1.6


Corrected Vr ground
Vr error of ~ 0.6
m/s begins
Measured Vr
of the surface
Vr, m/s
1
0.8
0.6
0.4
0.2
0
-0.2
-0.4
-0.6
-0.8
-1


Turn
C-Migit III
measured roll
Roll, deg
1
0
-1
-2
-3
-4
-5
-6
-7
17:00
17:05
17:10
17:15
Time, UTC

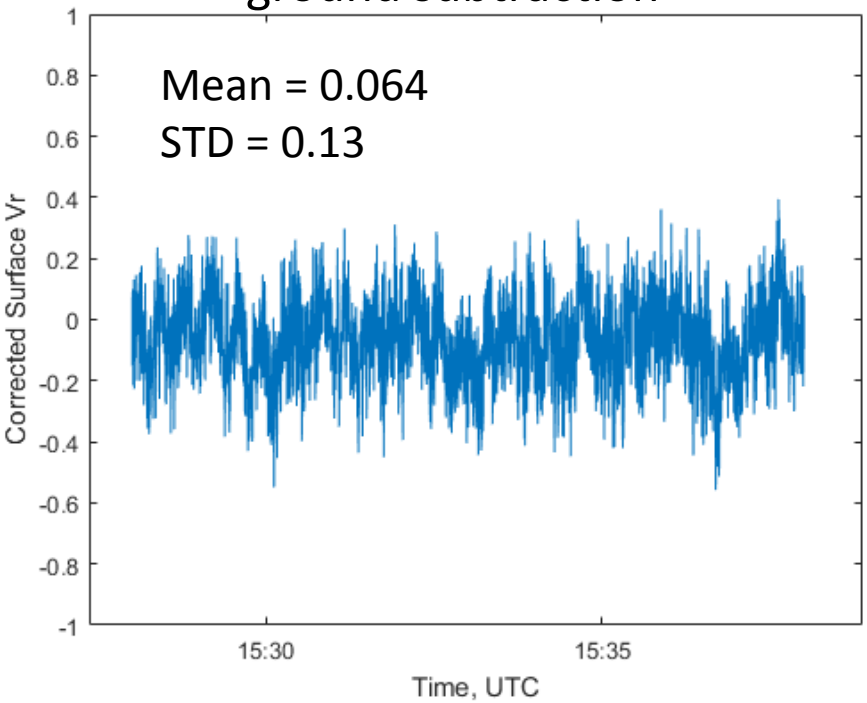

C-Migit III
measured drift
Drift, deg
1
0.8
0.6
0.4
0.2
0
-0.2
-0.4
17:00
17:05
17:10
17:15
Time, UTC

Correcting HCR Vr Measurements for Platform Motion

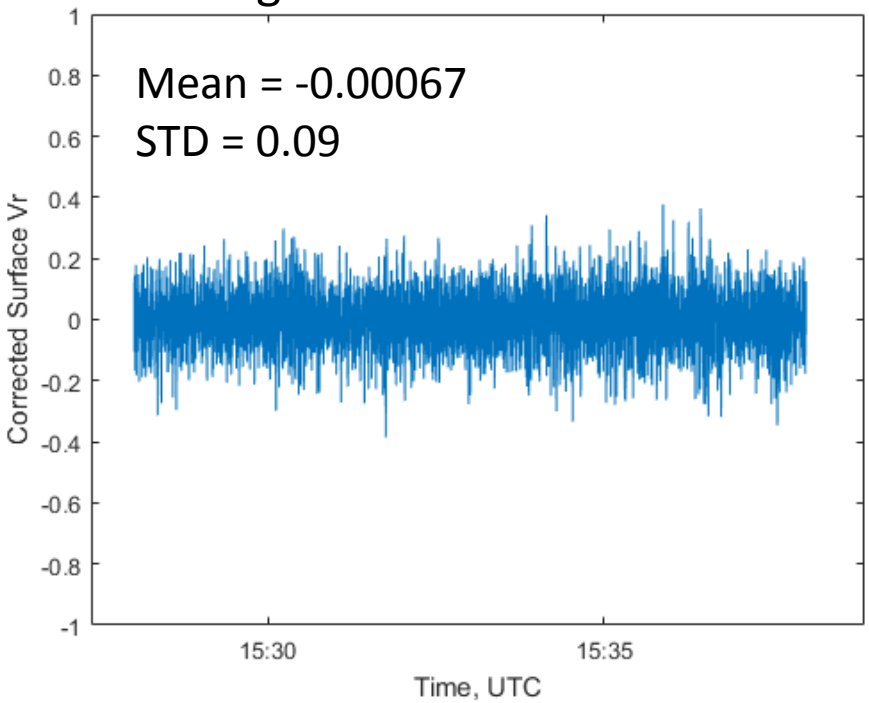
- Therefore we need an alternative correction
- For nadir-pointing data it is possible to use the measured Vr at the surface for correction
  - Filter noise from surface Vr
  - Subtract filtered surface Vr from Vr field
  - Developed and tested prior to CSET
  - Overall Vr within +/- 0.1 m/s
- For zenith-pointing data this is not possible
- The Vr errors will be larger for zenith pointing data

Nadir Looking

Corrected Vr before ground subtraction



Corrected Vr after ground subtraction



Even when C-MIGIT III does not contain errors, ground calibration improves Vr!

Correcting Vr – Zenith Looking

- No reference for Vr correction
- For version QC1 release of data the zenith-looking data uses C-MIGIT III INS/GPS data for Vr correction
  - Will lead to errors up to about 0.5 m/s in some cases
- Using GV INS/GPS system
  - Calibrated for use with HCR
  - Preliminary results show improvements possible
  - The pointing angle of the wingpod relative to the fuselage varies with flight conditions
    - Wing flex at different speeds/altitudes
    - Temperature (thermal expansion)
    - Angle of attack
    - Etc.
  - EOL researching these factors to develop improved Vr correction using GV

Ocean backscatter: Model computations and measurements

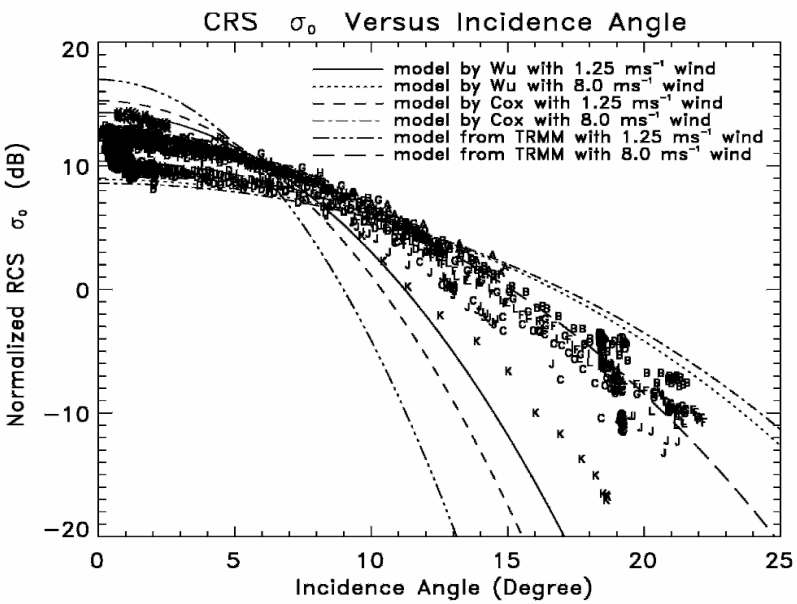
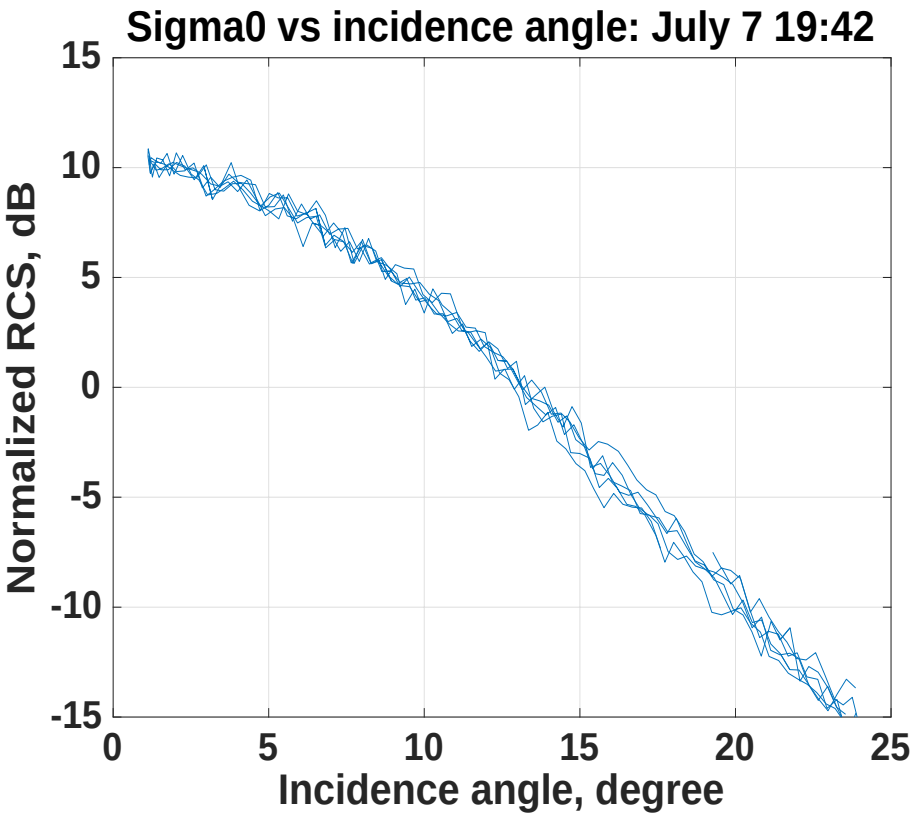


FIG. 9. The σ_o measured by the CRS vs incidence angle from different turns made in different days. A total of 12 turns from clear weather is shown.

Li et al. (2005), JTEC

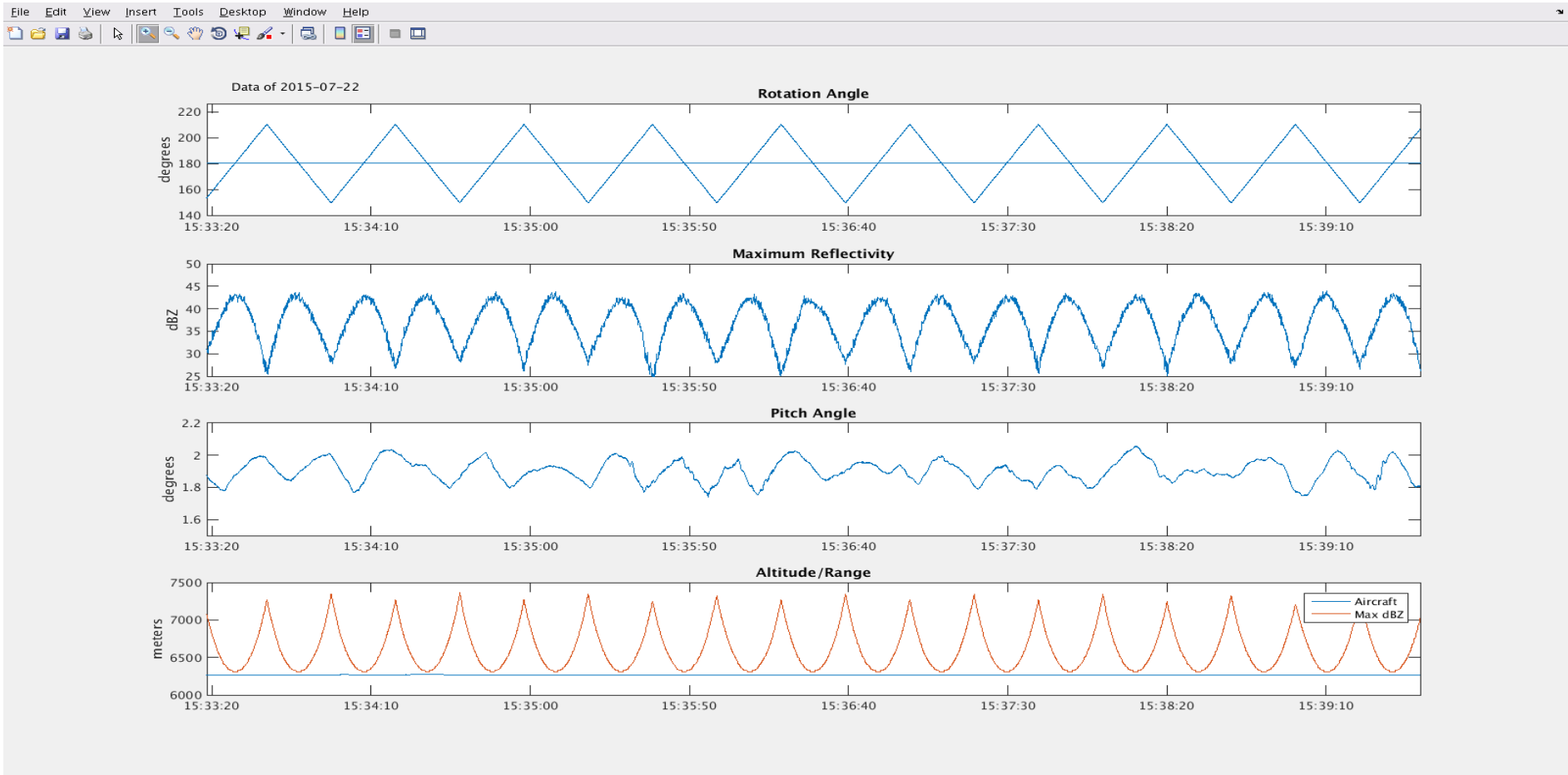


Next Step

- Seek inputs from the PI team on potential future improvements to CSET data
- Please let us know your needs!
- Please point out any problems with data!

Extra slides

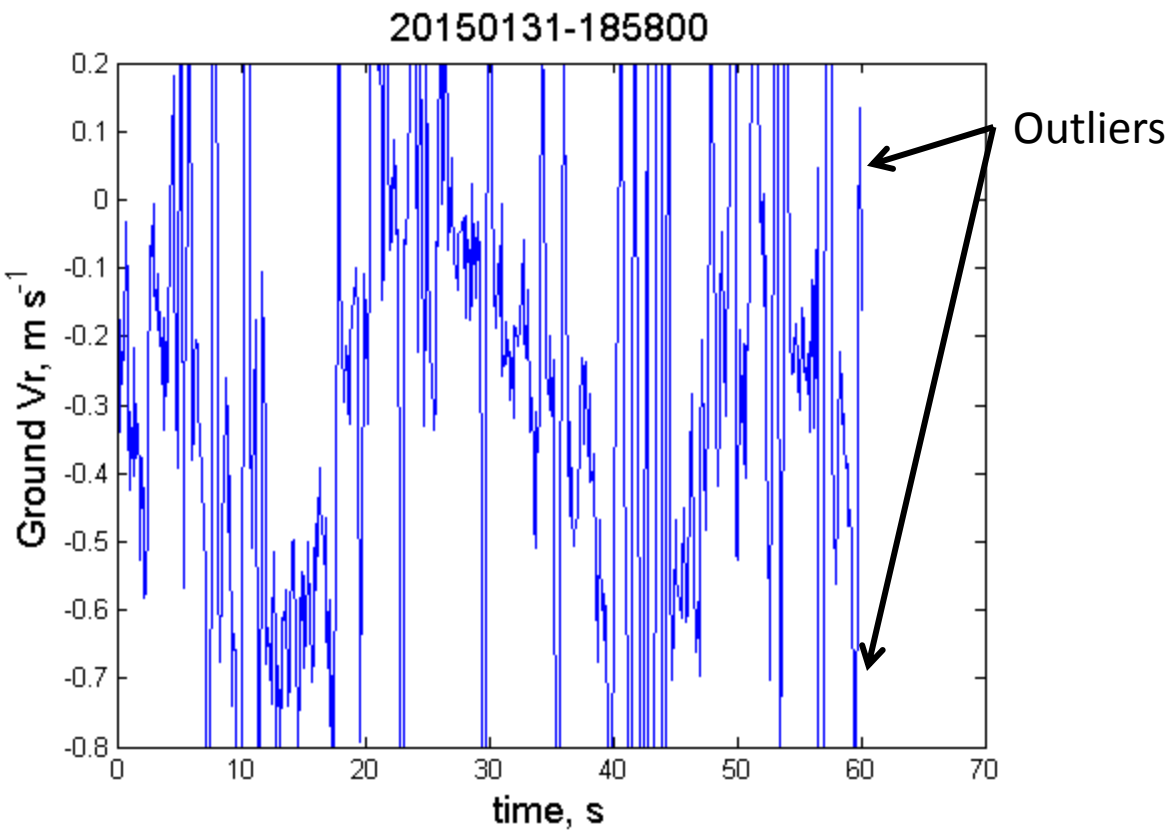
Sea surface backscatter



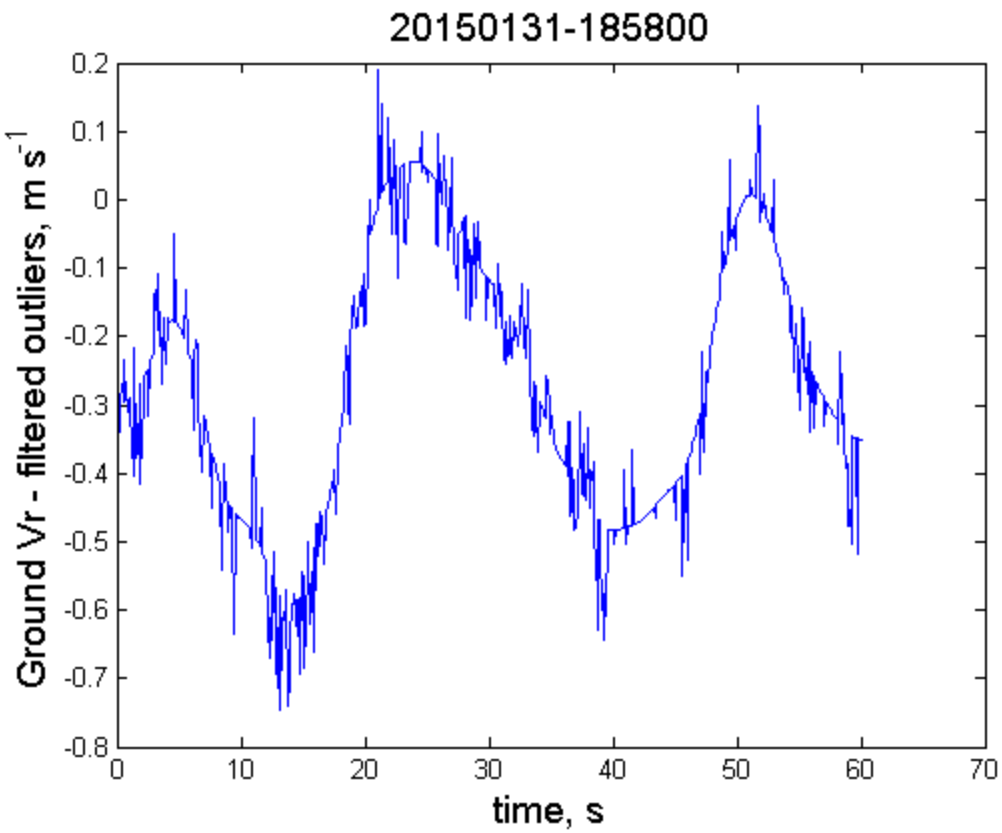
Correcting Vr – Nadir Looking

- Use surface velocity to correct Vr
  - Developed and tested on Nor'easter data
- First: must find surface Vr
  - Maximum reflectivity at ranges near surface
  - Found to be reliable
- Apply low pass filters on the measured ground velocity to remove noise
  - Mean and Median filters excluding outliers pretty good
  - FIR filter removes noise and follows trends better
- Applied to 10 Hz data
- Two different FIR filters applied
- First remove outliers
  - Outliers defined as points in which the data differs from the filtered data (1 iteration) by more than 0.11 m/s (2σ)
  - Remove outliers in data by substituting FIR filtered data into time series
- Apply FIR filter to data with outliers removed
- Subtract final estimated ground Vr from Vr field
- Vr within +/- 0.1 m/s

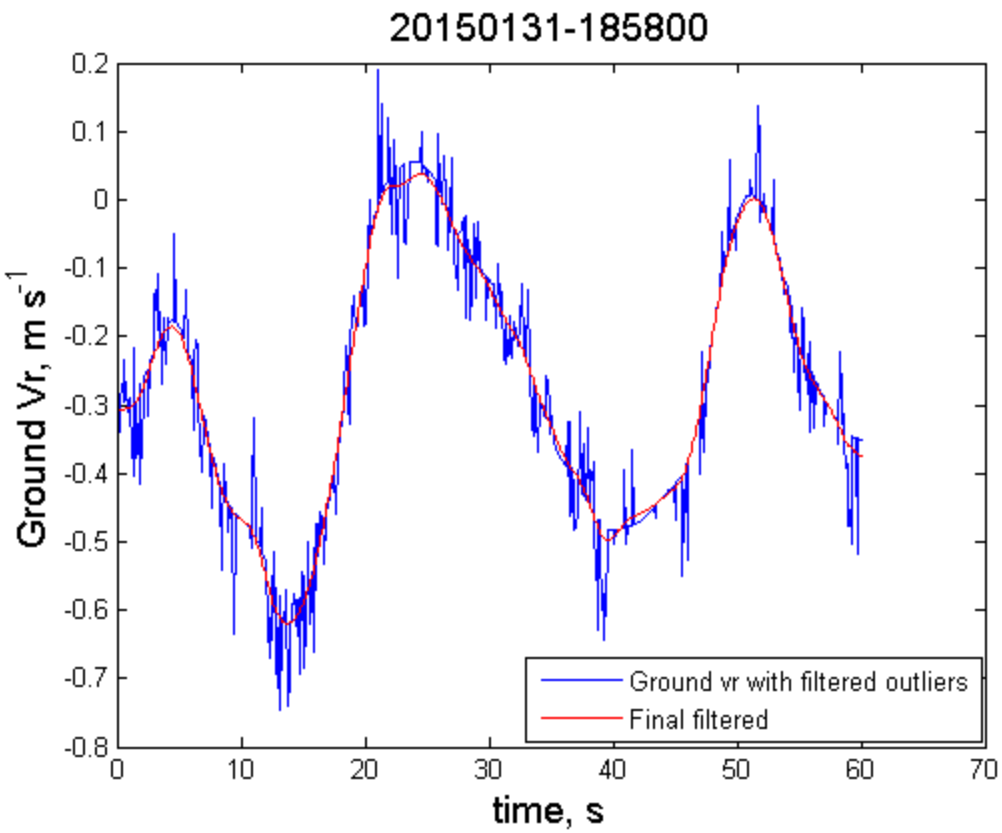
Measured VEL (Nor'easter)



Outliers removed with first FIR filter



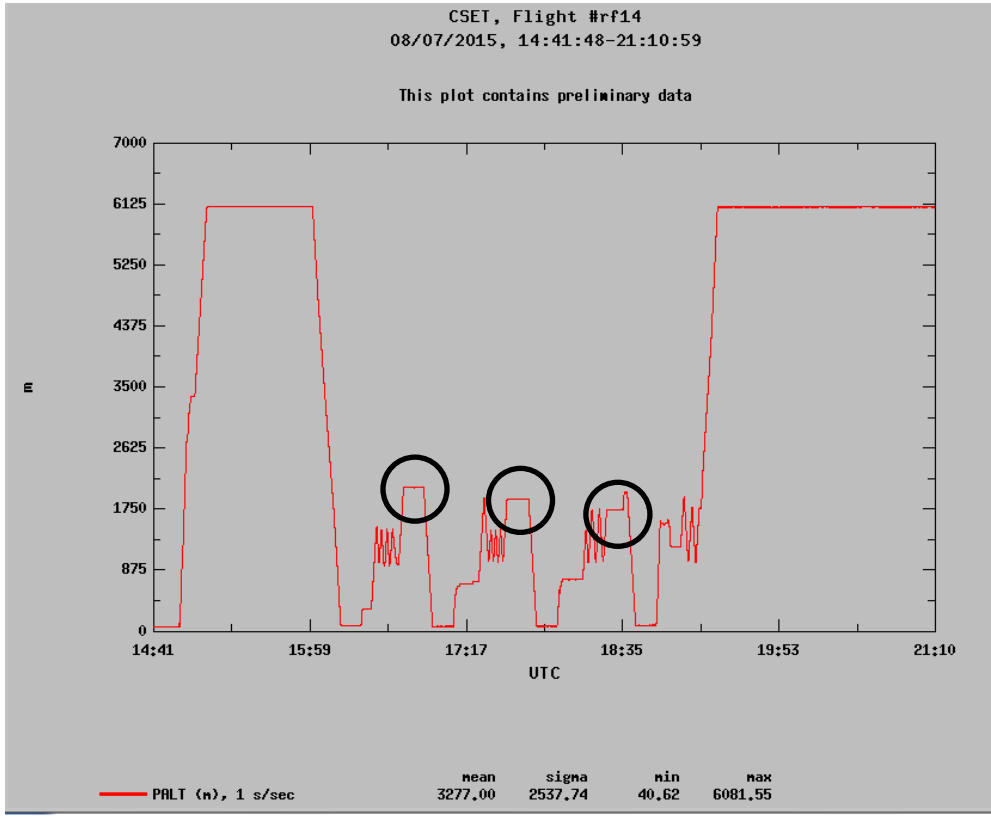
Final fit



Subtract the final filtered surface Vr from Vr field to correct for platform motion

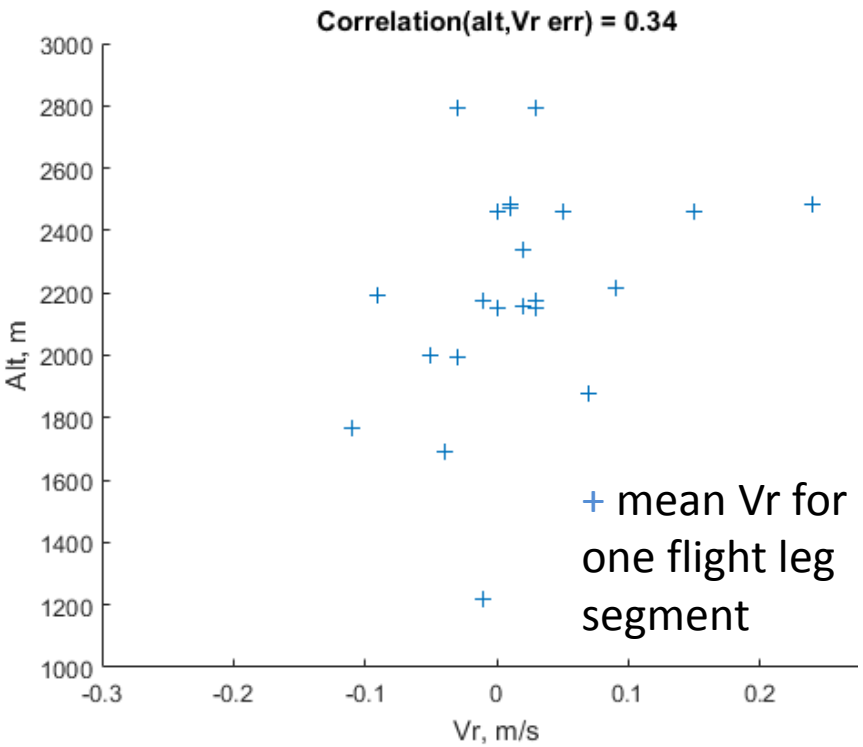
GV INS Analysis

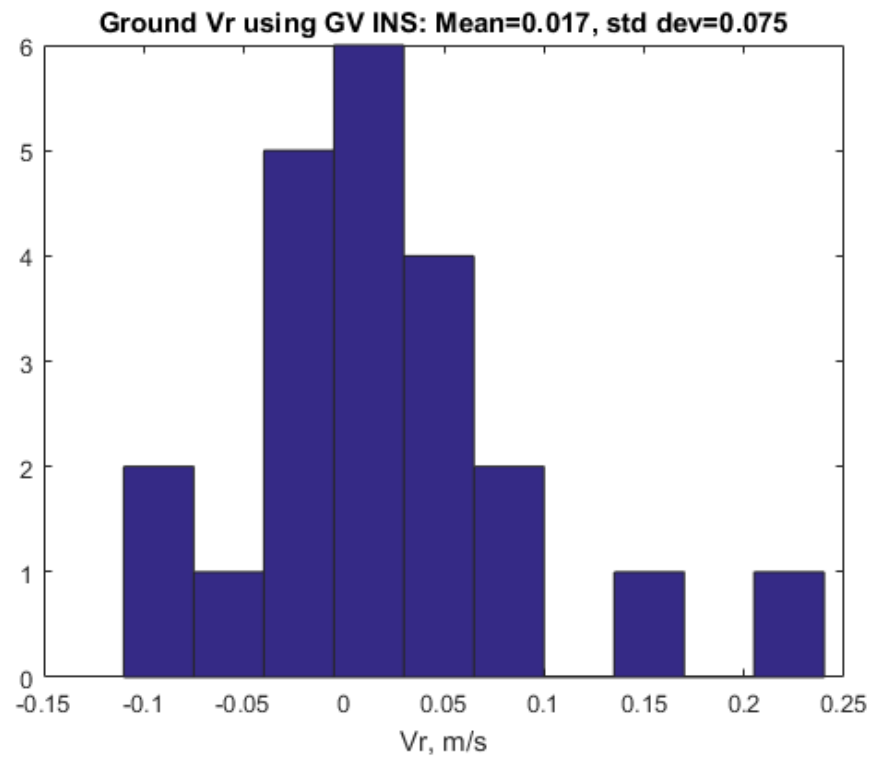
- To test using GV for zenith legs we used nadir pointing legs because we had the surface ref
- Analyzed nadir pointing legs with GV altitude about 2000 m (lowest nadir legs)
  - Surface Vr was truth
- Interpolate GV INS data to HCR time grid
- Estimated pitch, drift and roll offsets for GV INS using several legs with different drift values
- Estimated mean and standard deviation of surface Vr using GV INS using RF3 through RF16
  - RF1 and RF2 did not contain suitable data
  - 22 legs total used



Results

- Altitude < 2800 m
- Ground speed about 140 m/s
- Mean Vr using GV INS = 0.017 m/s
- Std dev Vr using GV INS = 0.075 m/s





Correcting HCR Vr Measurements for Platform Motion

- Vr correction depends on accurate pointing data AND accurate INS navigation data
- The HCR INS/GPS system (C-MIGITS III) experienced stability issues during CSET
- Sudden onset of navigation errors
- Slow drift of navigation errors
- Example in next slide
  - Pitch angle error of ~ 0.2 deg starts with aircraft turn
  - Vr error of about 0.6 m/s results (seen in ground vr)
  - The 0.6 m/s error is completely accountable by the 0.2 deg pitch error and the ground speed
  - Drift too small to be a factor