Convective Cloud (Base) Updraft Measurements

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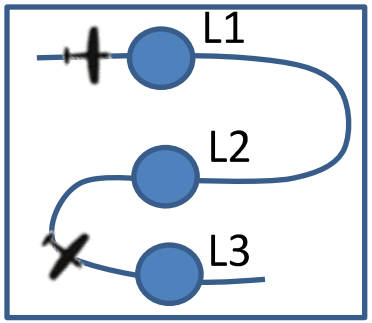
Importance of Airborne Wind Measurements

- Trace mechanism



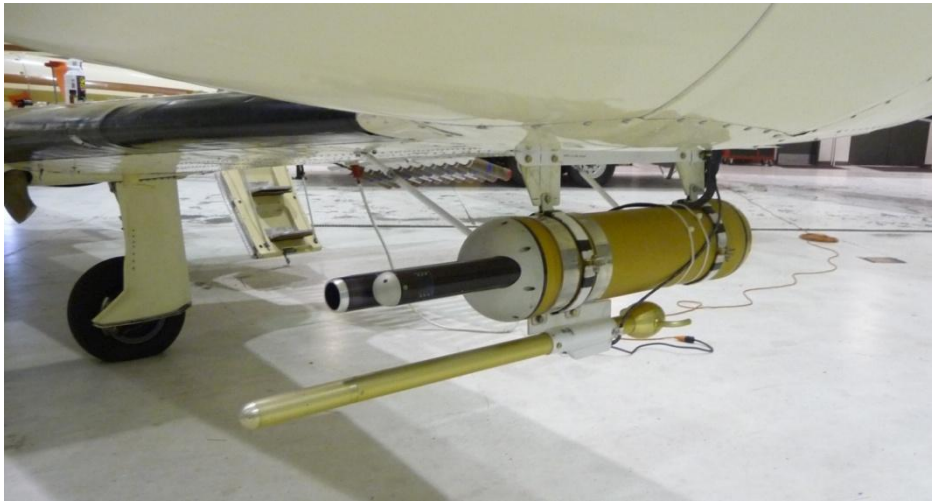
Conceptual model depicting an aircraft sampling measurements of a parcel shifting between three locations.

- Vertical Velocity (Updraft Velocity) helps determine near Cloud Base Maximum Supersaturation
  - Cloud Droplet Number Concentration

Updraft Measurement (Vertical Velocity)

- Pilot Estimates

- Gust Probes



Advantages & Disadvantages

Pilot Estimates

- Relatively Inexpensive
- Unaffected by Airflow Distortions
- Subjective
- Instrumentation Lag

Gust Probes

- Objective Measurements
- Fast Response
- Airflow distortions
- Aircraft modifications

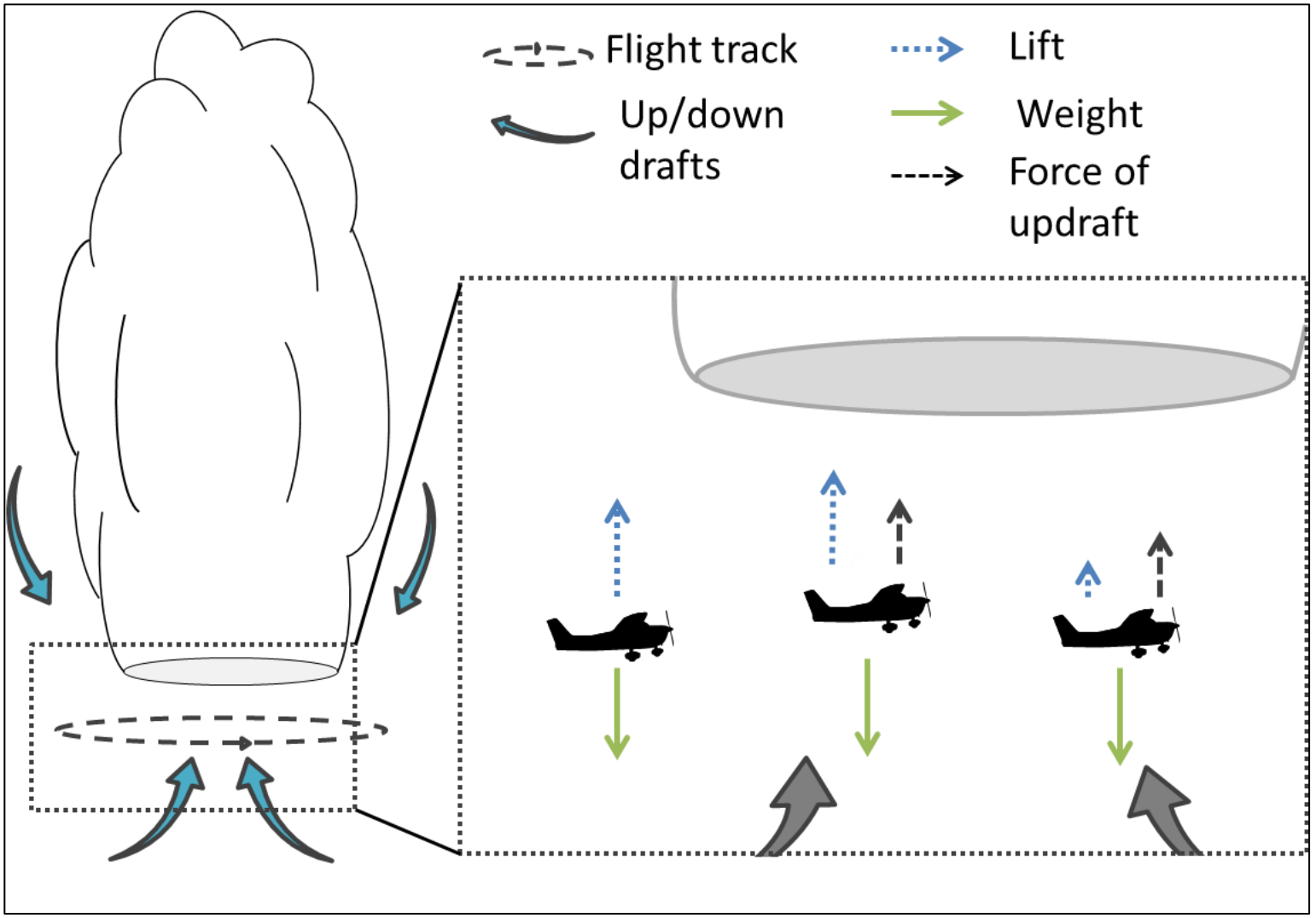
Objective

Evaluate pilot estimates to Aircraft Integrated Meteorological Measurement System (AIMMS) Updraft Measurements

Cloud Selection Criteria

Image taken from Cessna 340 flown during the Polarimetric Cloud Analysis and Seeding Test 2012 (POLCAST-2012) field project. POLCAST 2012 was conducted from 27 June – 3 August 2012 in North Dakota.

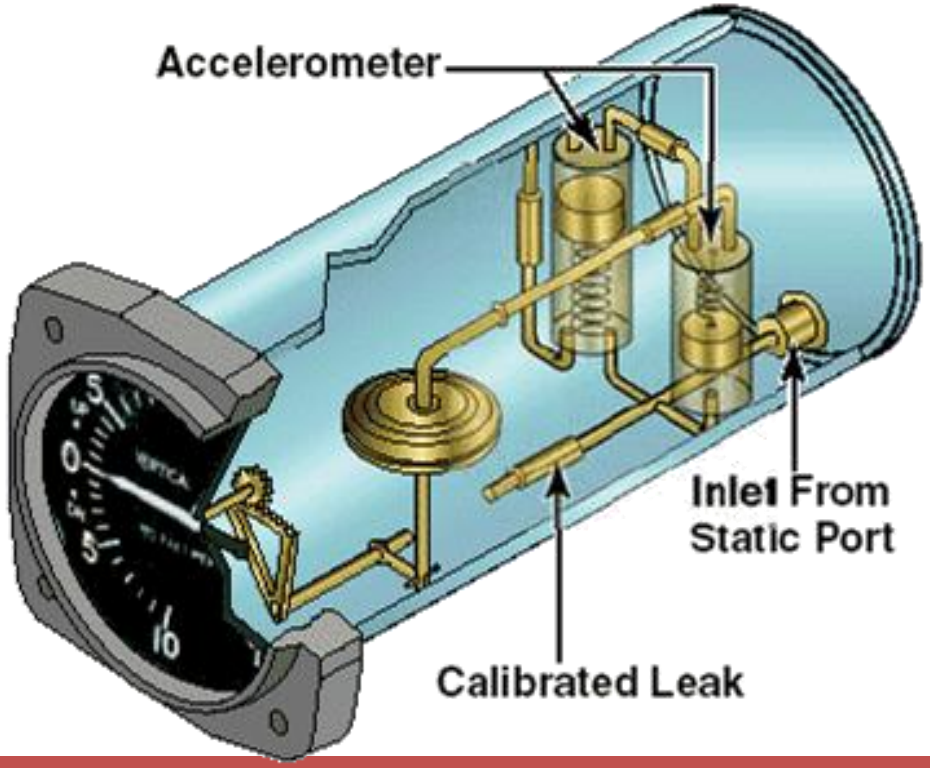
Attaining Pilot Estimates



Conceptual flight profile depicting aircraft encountering updrafts while sampling under developing cumulous clouds.

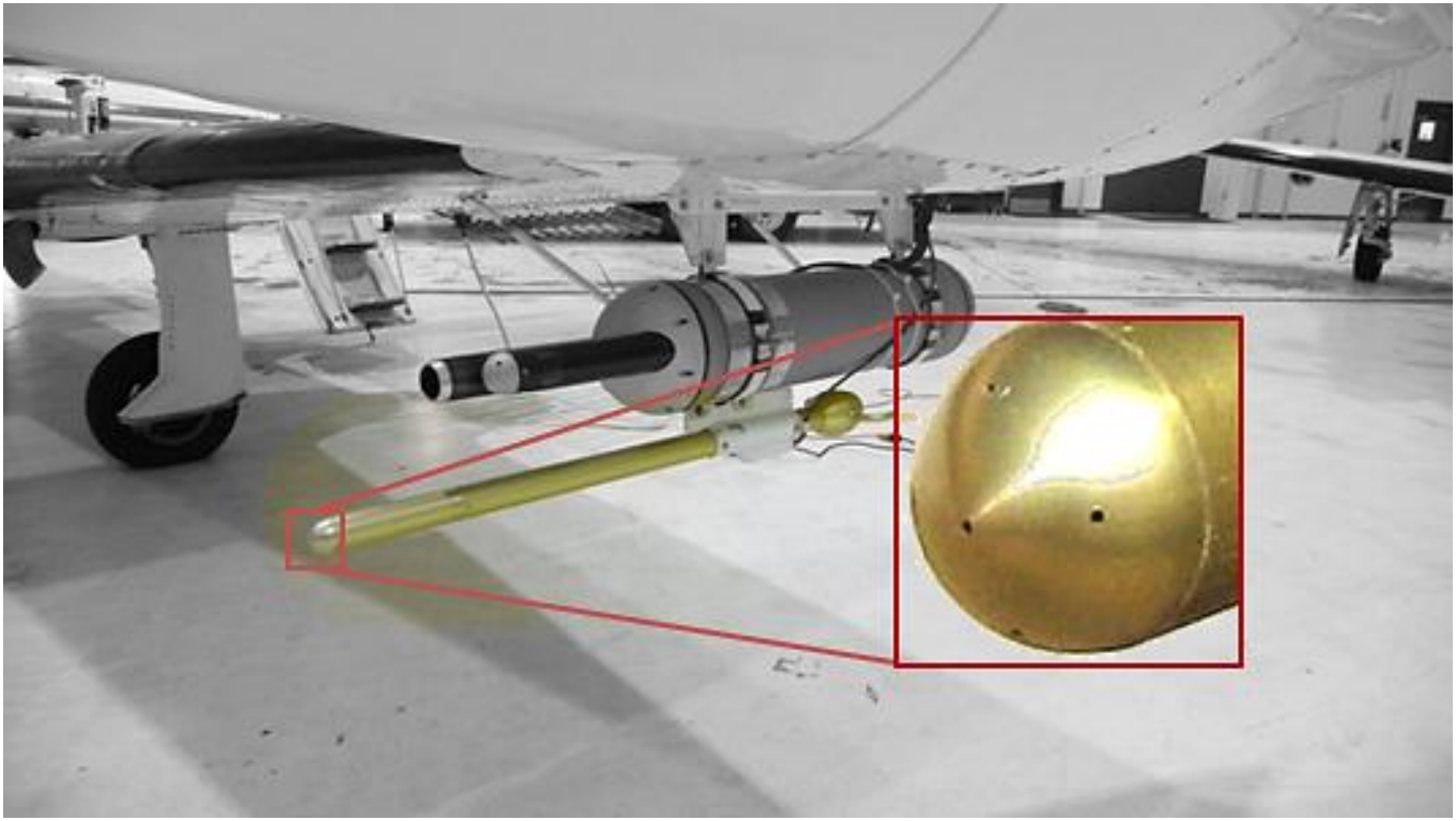
Attaining Pilot Estimates

Vertical Speed Indicator: indicates aircraft climb rate. Uses calibrated leak to create pressure difference that is directly related to vertical speed.



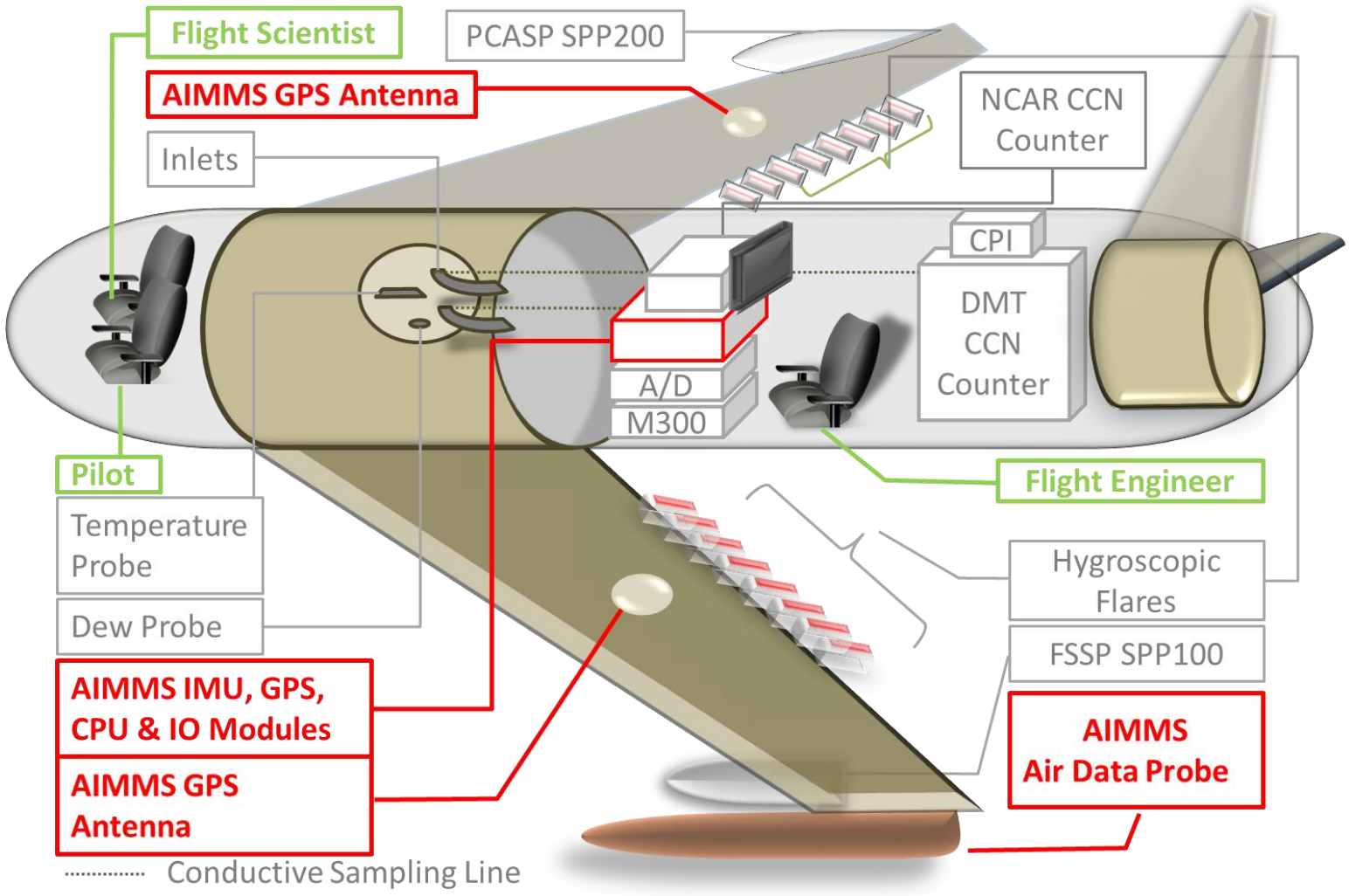
Airspeed Indicator, determines aircraft airspeed by measuring difference between ram air and static air pressure.

Aircraft Integrated Meteorological Measurement System



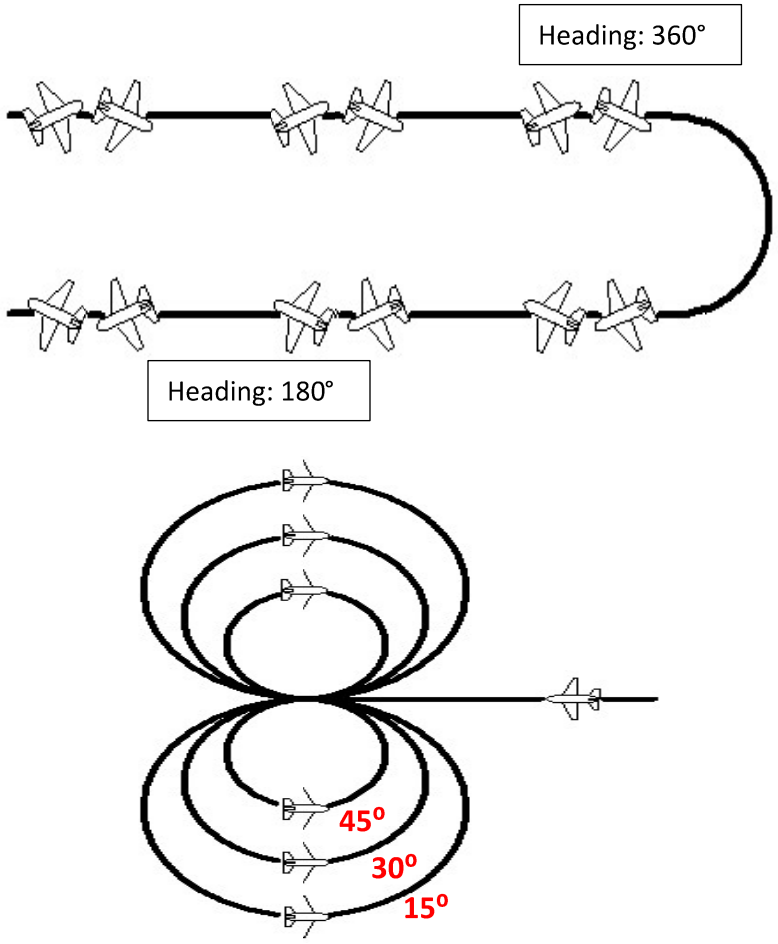
Aircraft Integrated Meteorological Measurement System (AIMMS) Air Data Probe mounted under the Forward Scattering Spectrometer Probe on the left wing of a Cessna 340.

Aircraft Integrated Meteorological Measurement System

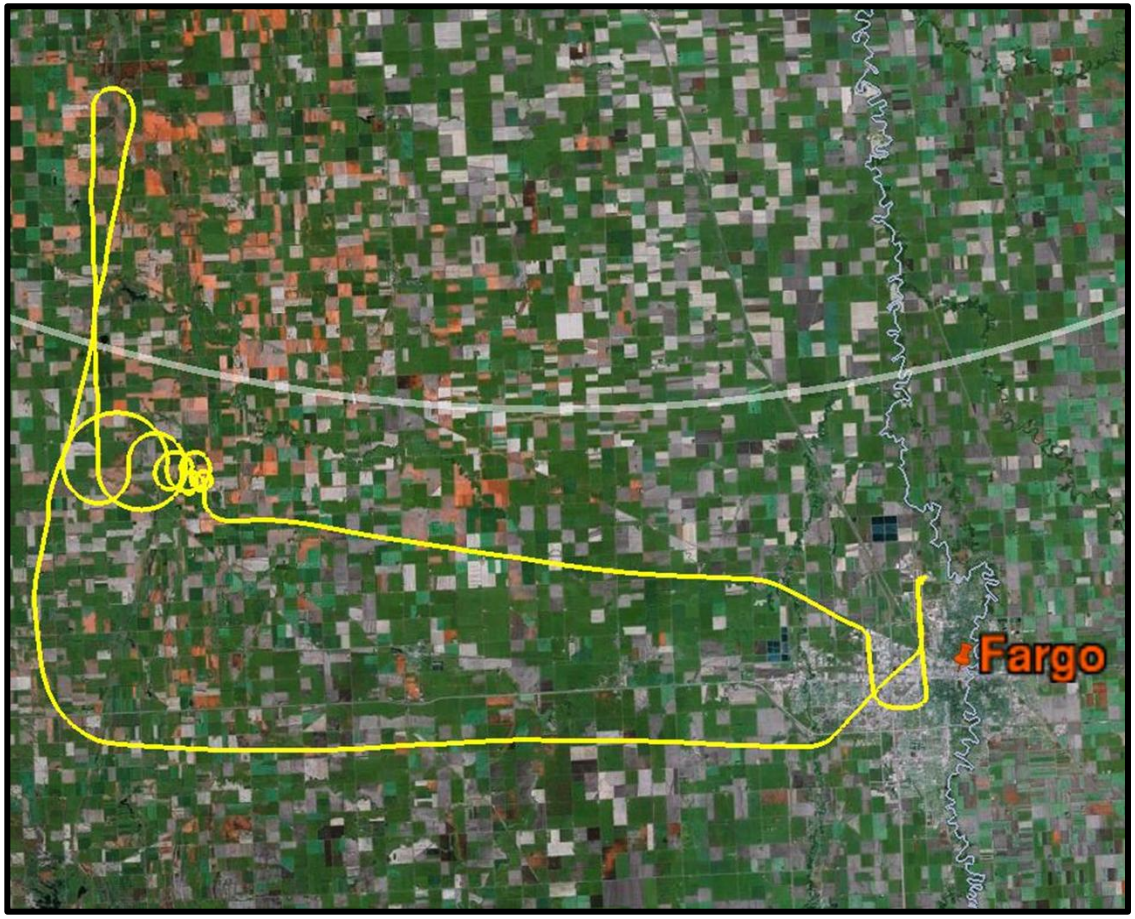


POLCAST 2012 Cessna 340 instrumentation layout. AIMMS components in red. Green denotes crew location. Grey denotes convective cloud research specific components.

20 July 2012 Calibration Flight

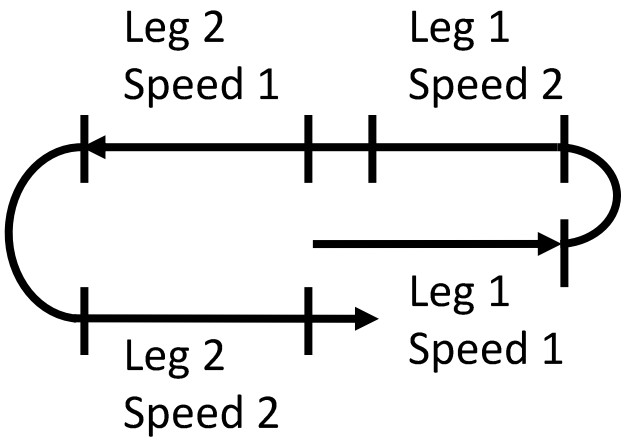


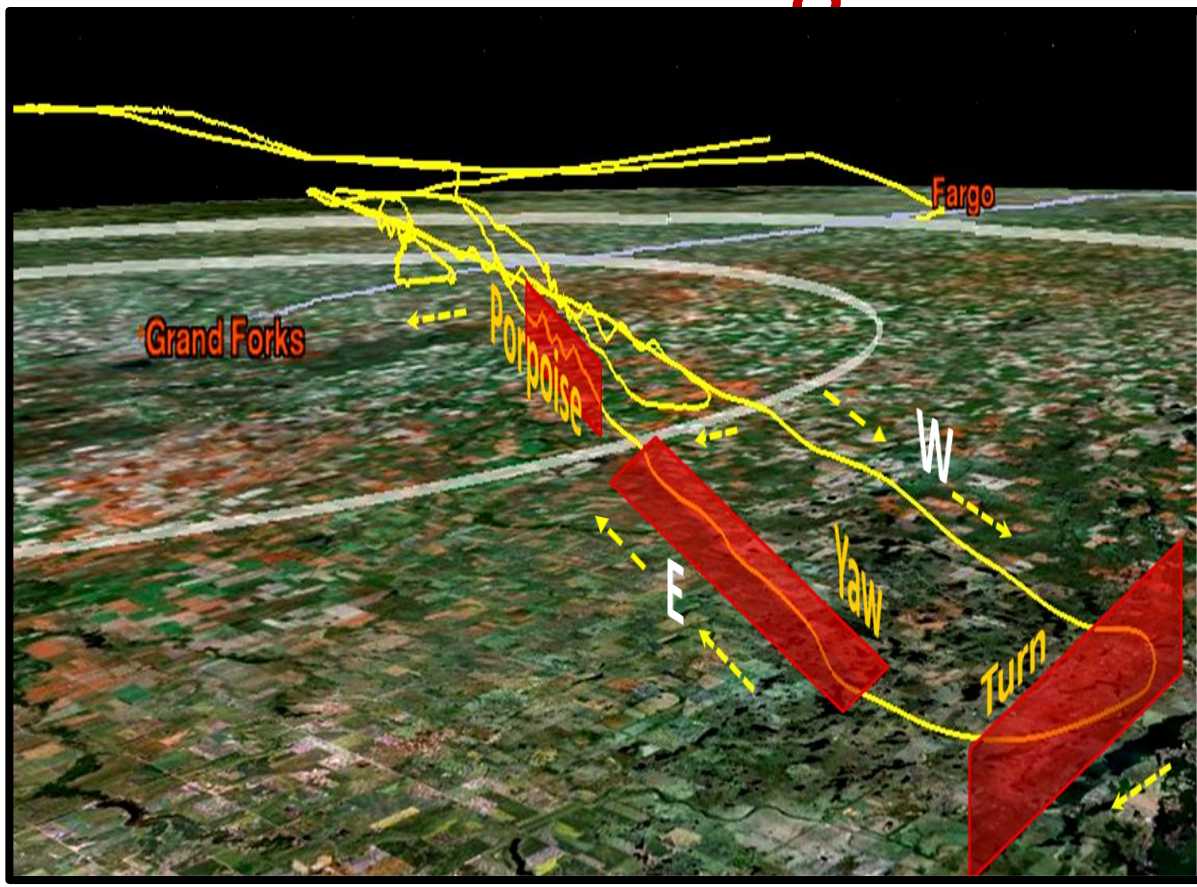
Calibration maneuvers conducted during the course of the July 20th flight.

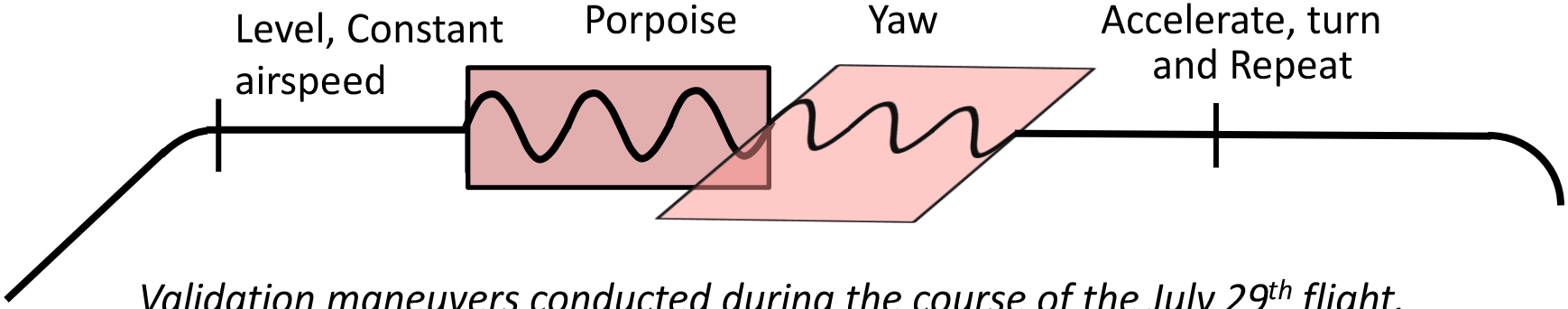


Flight track of calibration flight conducted west of Fargo.

July 29, 2012 Validation Flight

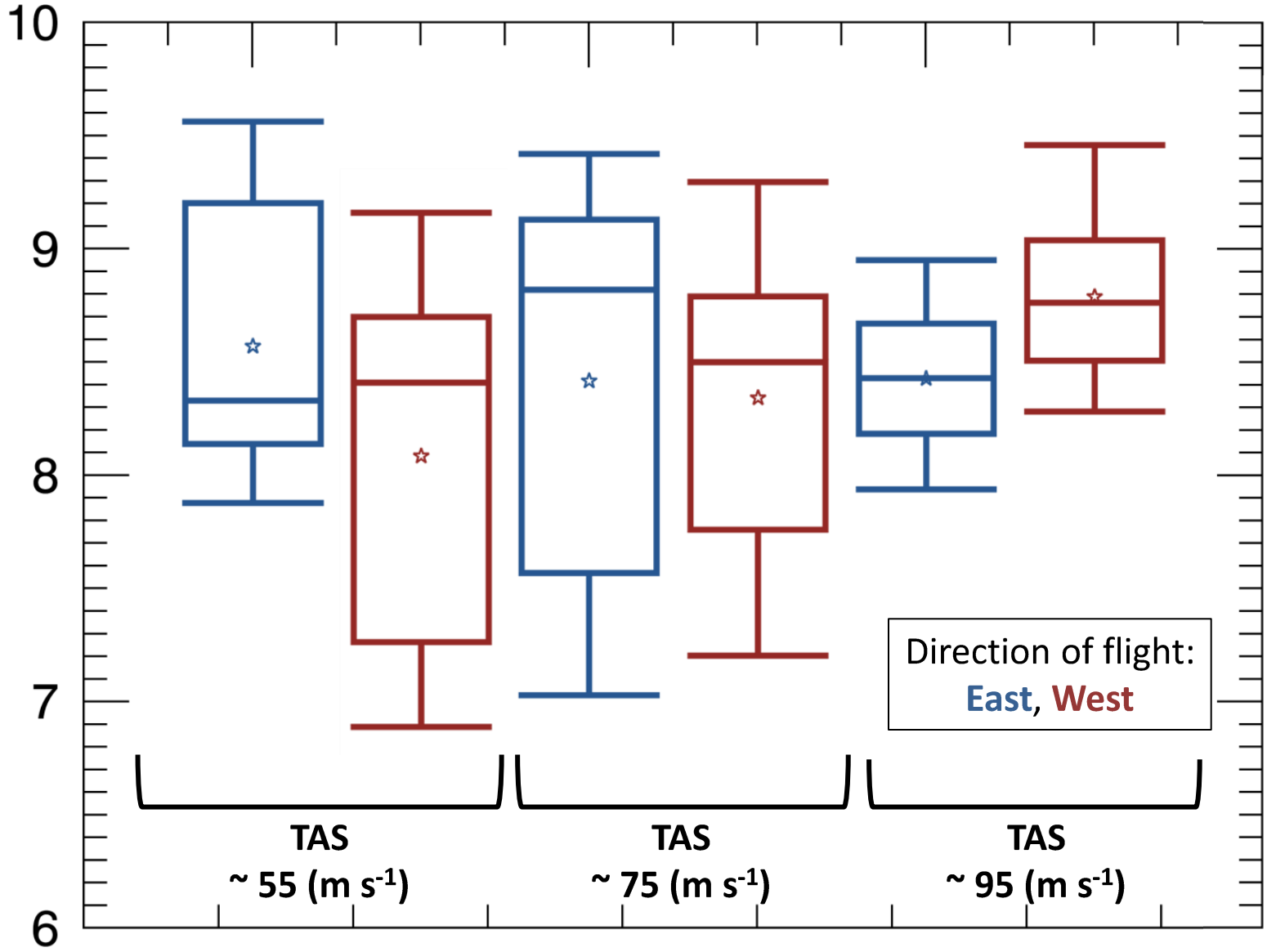






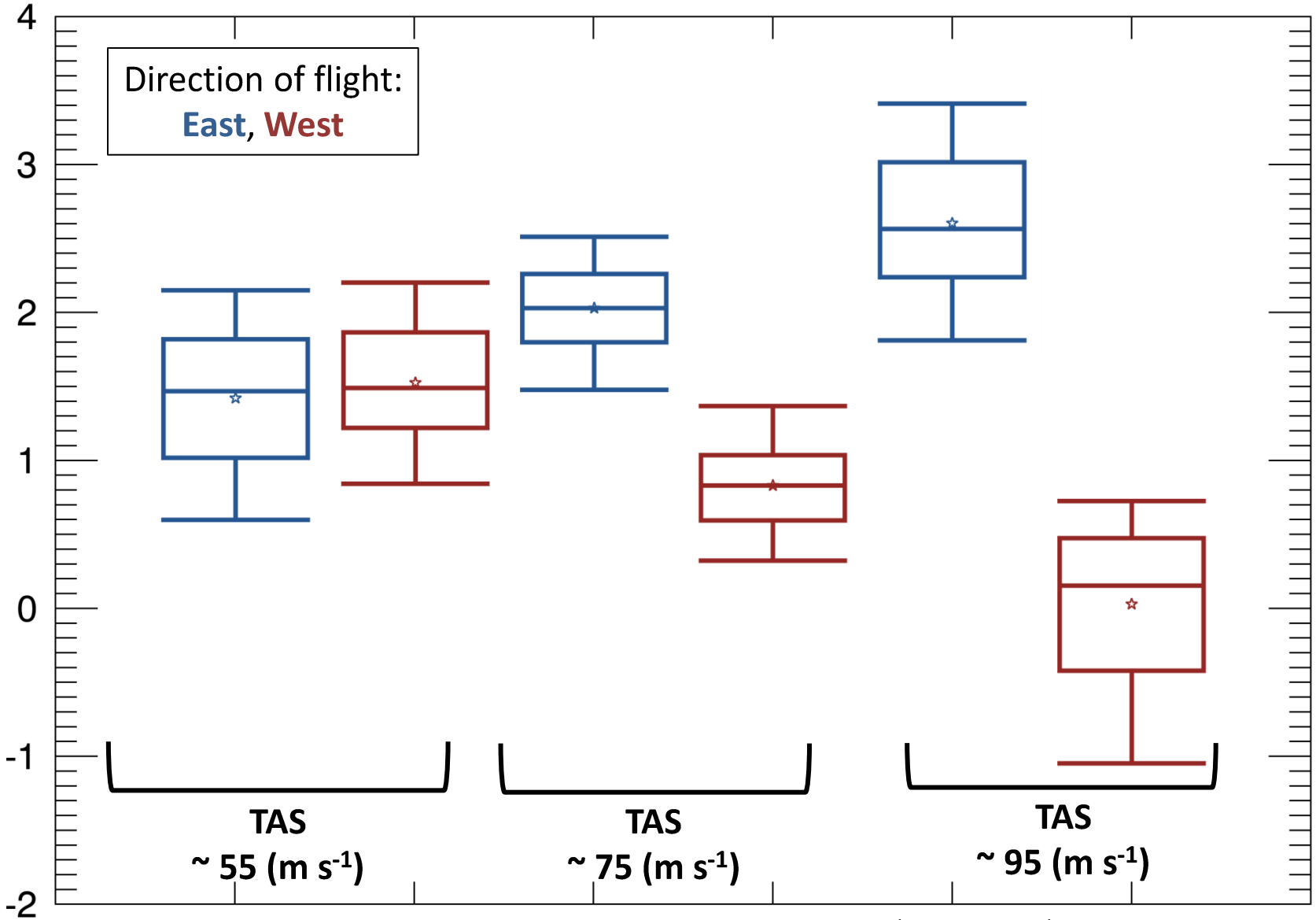
Validation maneuvers conducted during the course of the July 29th flight.

Horizontal Wind Measurements



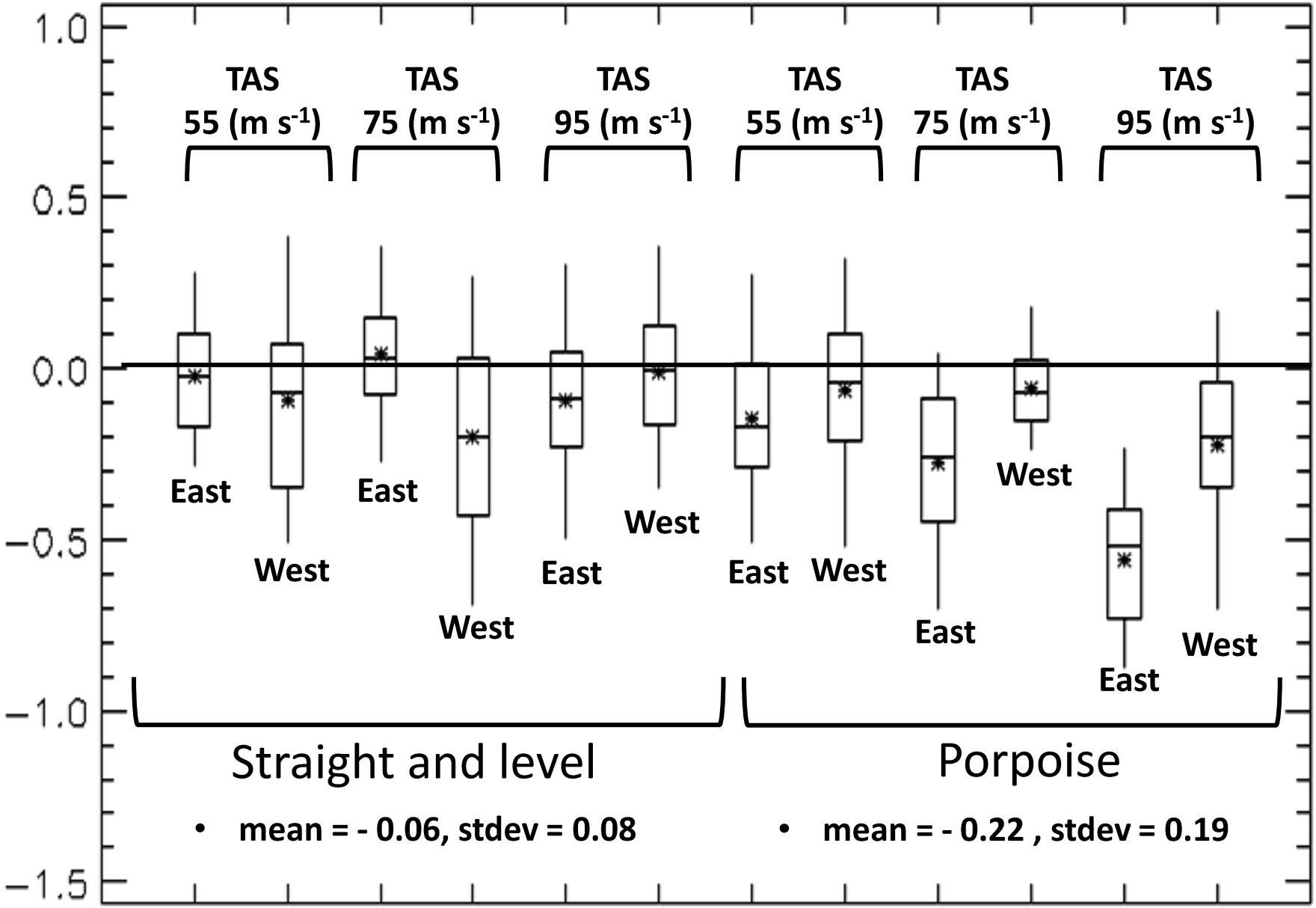
Box and whisker plot. Top and bottom bars are 25th and 95th percentile respectively. Top and bottom of box are 50th and 75th percentile values. Bar in box is the median value and star represents the mean measurement.

Horizontal Wind Measurements



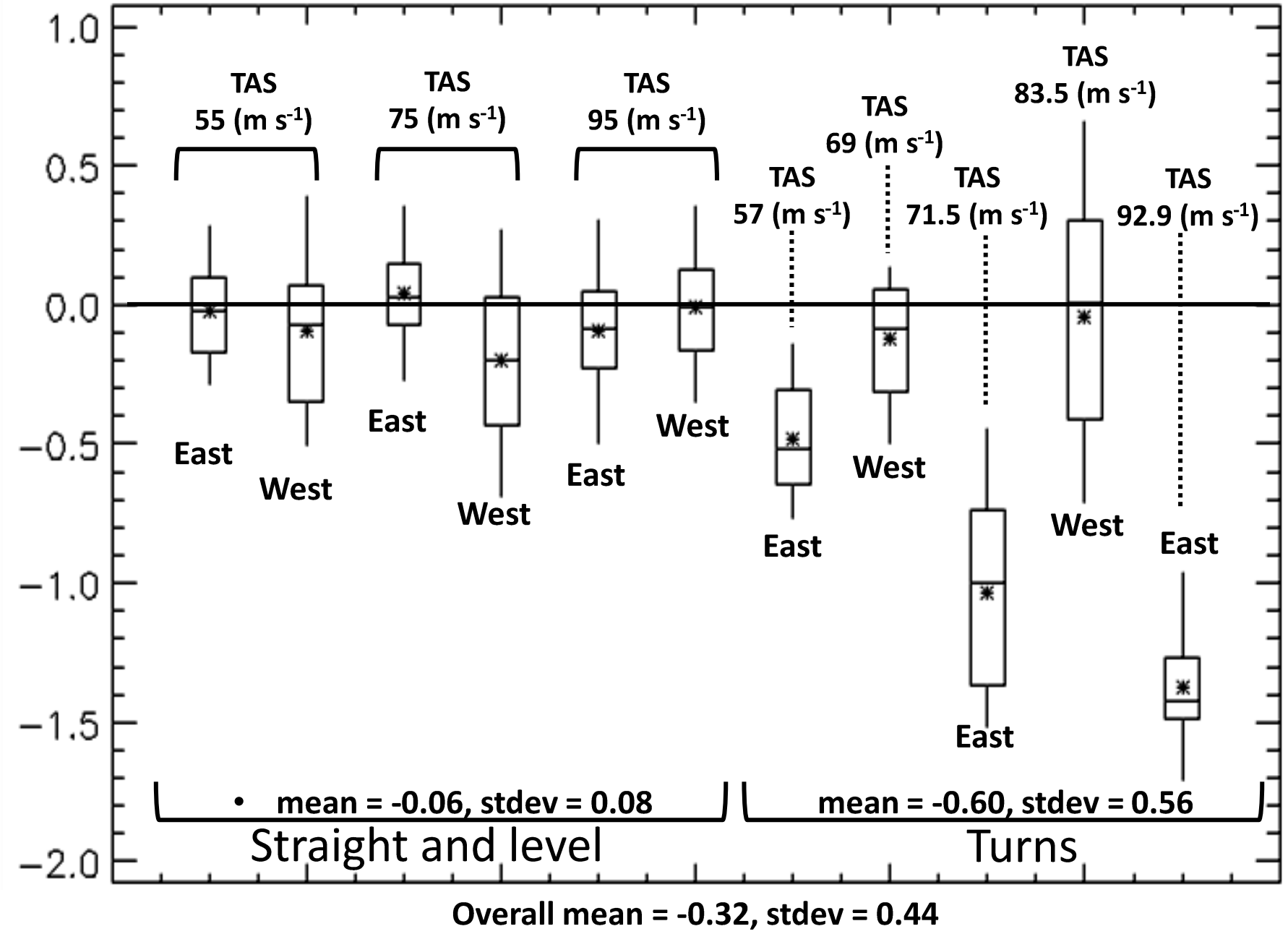
Box and whisker plot. Top and bottom bars are 25th and 95th percentile respectively. Top and bottom of the box are 50th and 75th percentile values. Bar in box is the median value and star represents the mean measurement.

Porpoise: July 29, 2012

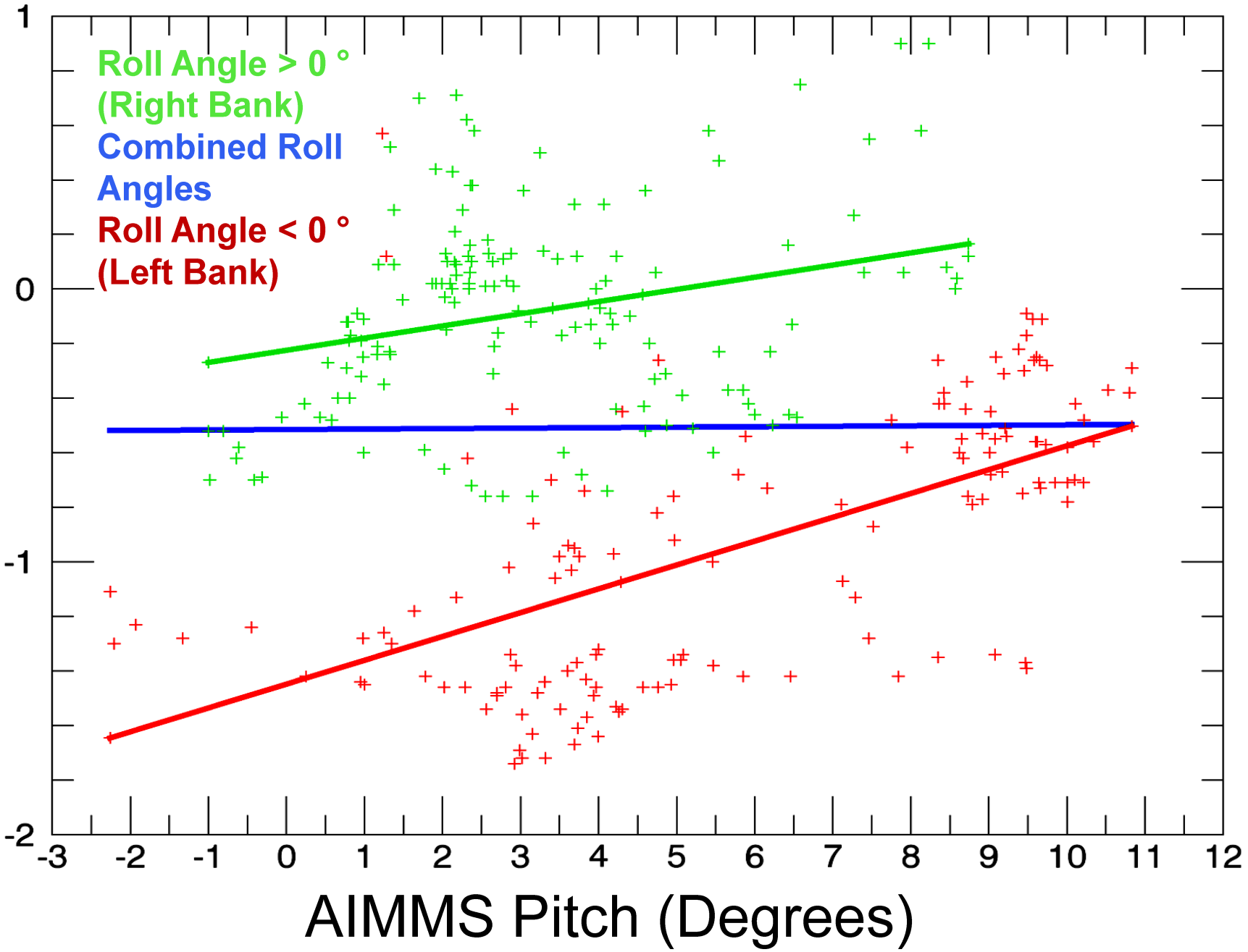


Overall mean = -0.14, stdev = 0.16

Turns: July 29, 2012

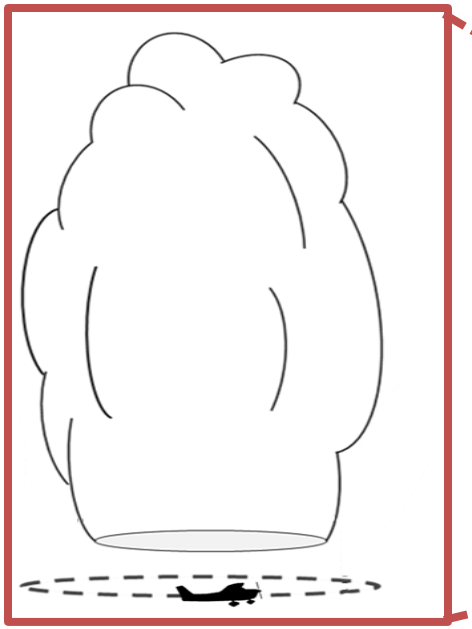


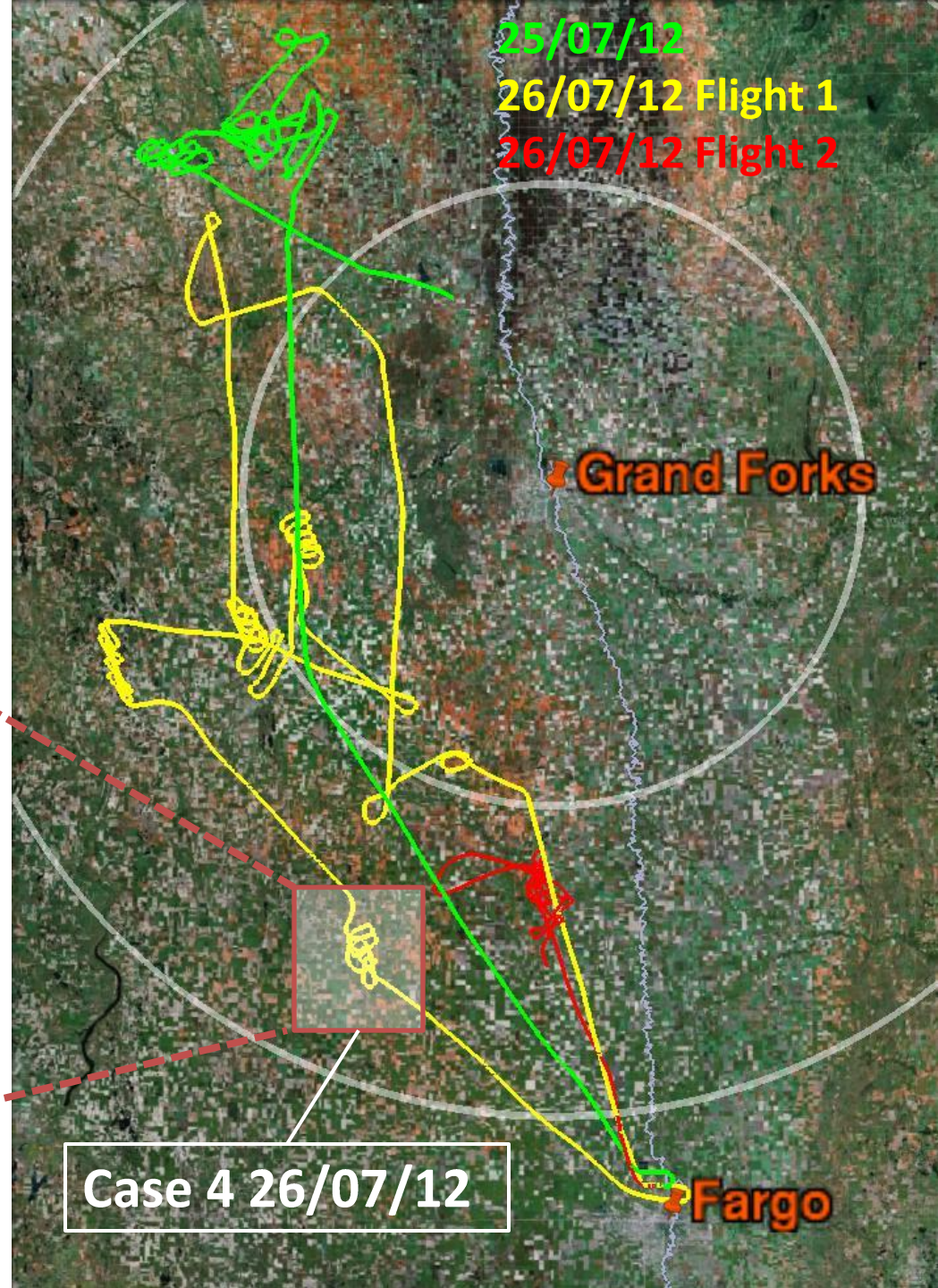
Turns Comparison: July 29, 2012

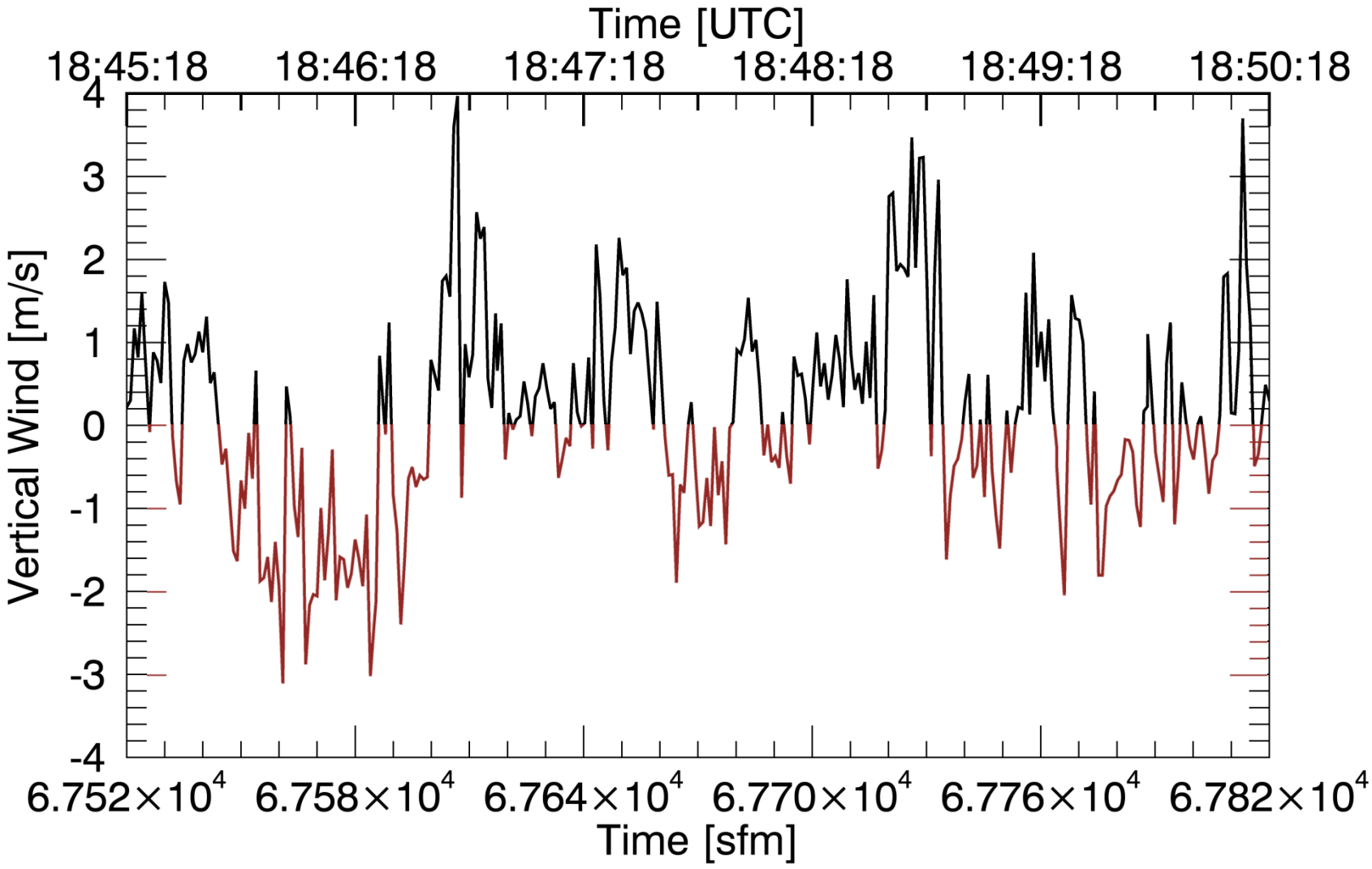


Data Flights

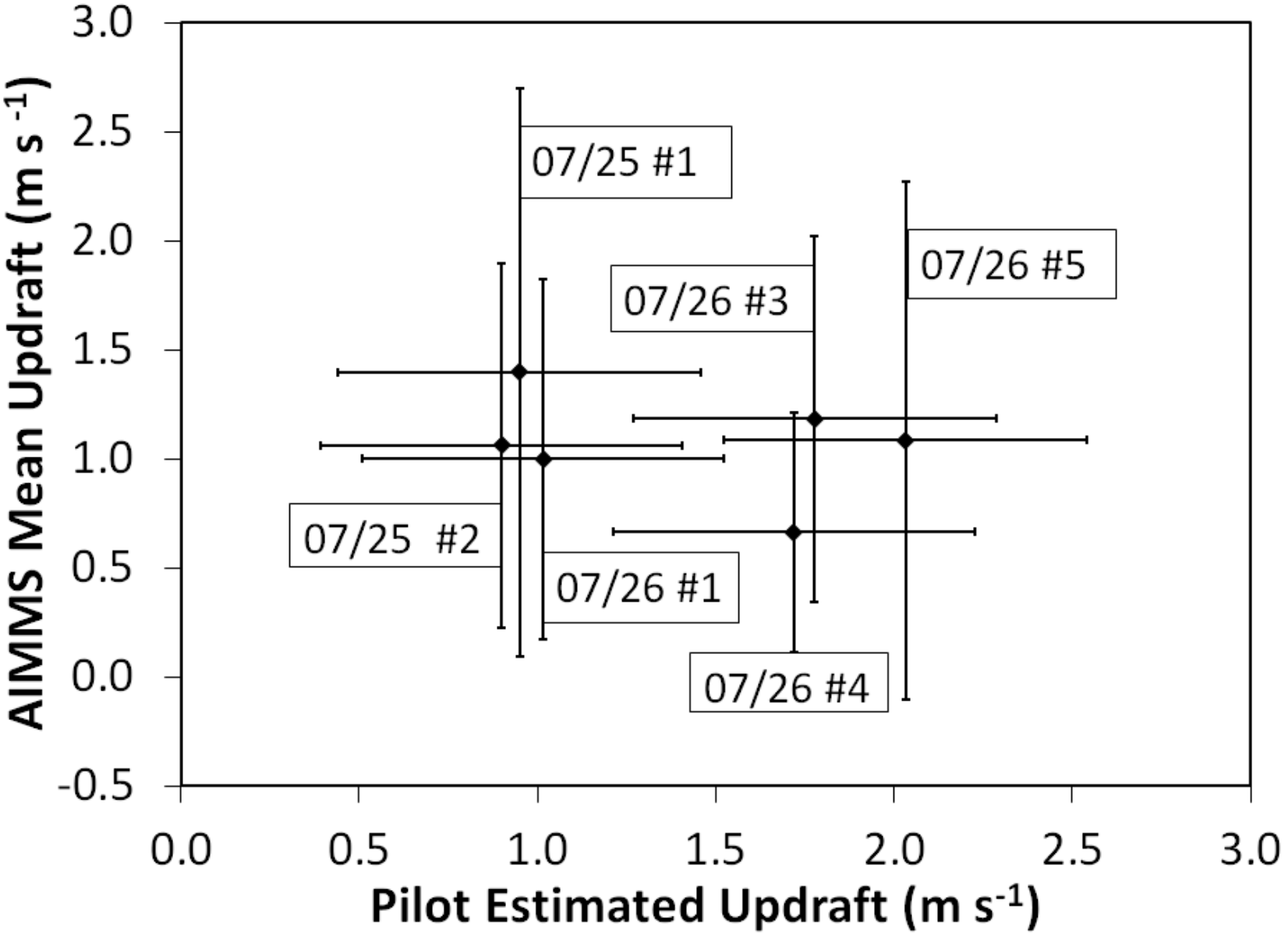
Measurements were collected on three flights. Highlighted in the box below is one case where measurements were made below a convective cloud.



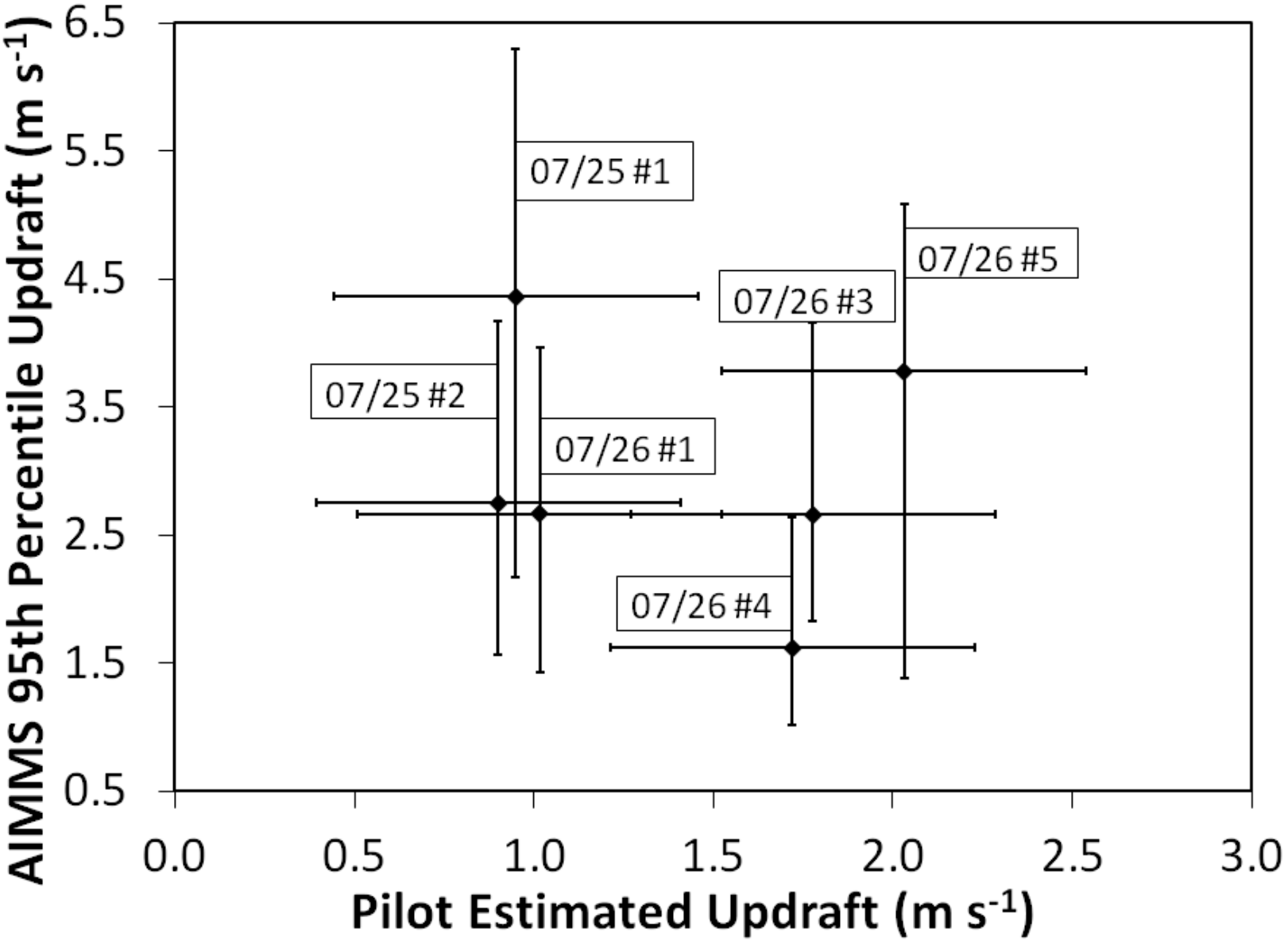




Vertical wind velocity measured at a frequency of 1.0 Hz by the Aircraft Integrated Meteorological Measurement System (AIMMS) during the first flight on 26 July 2012. Time period is the first five minutes (67,518-67,818 seconds from midnight (sfm)) of sampling for target case 1.



AIMMS mean distribution updraft measurements (y-axis) versus pilot updraft estimates (x-axis). Horizontal bars show ±0.50 m s $^{-1}$ range of pilot estimates. Vertical bars show one standard deviation for 1.0 Hz AIMMS measurements.



AIMMS 95th percentile updraft measurements (y-axis) versus pilot updraft estimates (x-axis). Horizontal bars show ±0.50 m s $^{-1}$ range of pilot estimates. Vertical bars show range between maximum value (top) and 75th percentile (bottom) of 1.0 Hz AIMMS measurements.

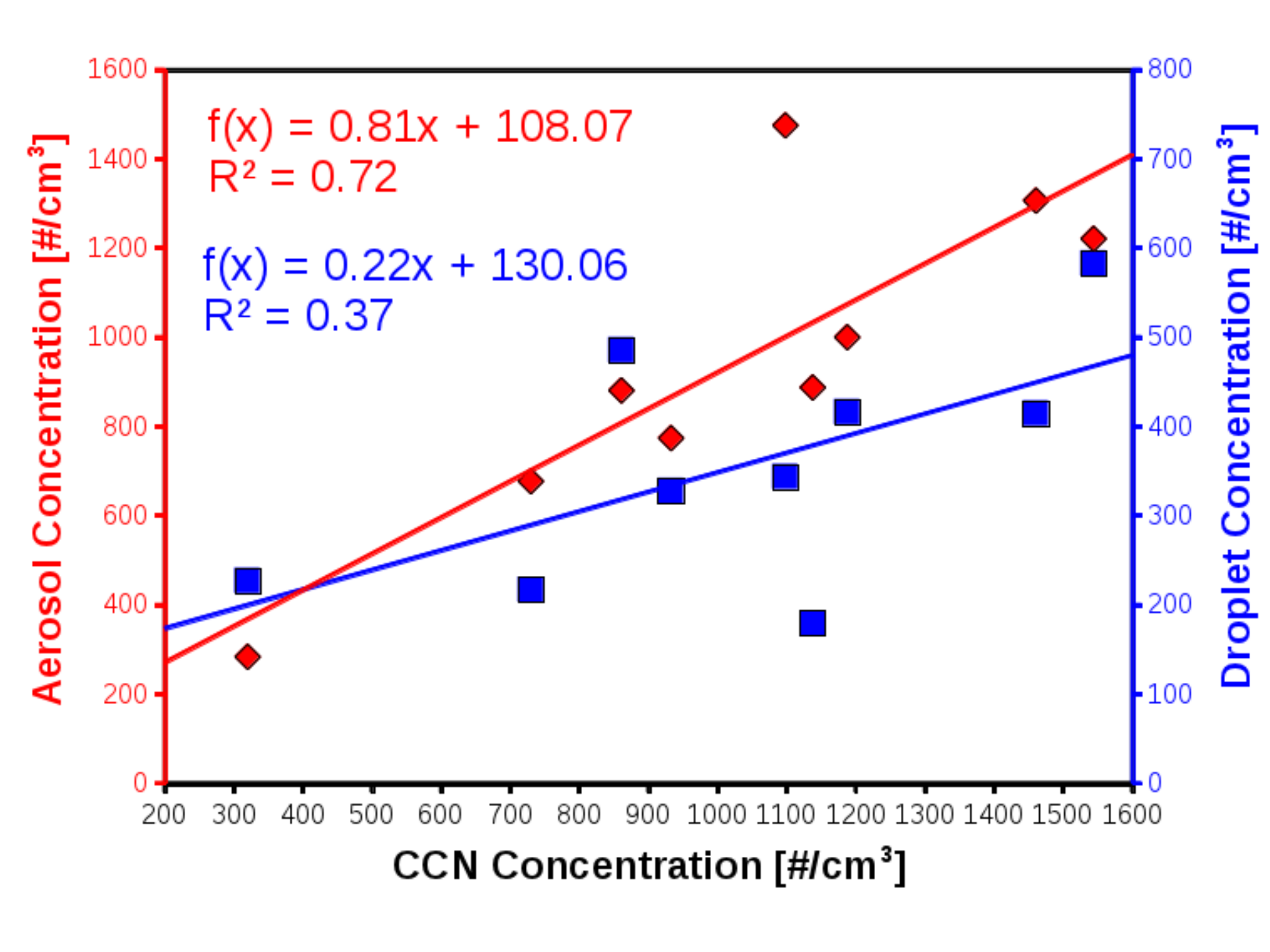
Results

- Validation flight indicates AIMMS probe was well calibrated; however, left and right turns provide different vertical wind bias.
- Agreement between pilot estimates and AIMMS mean updraftes (approximately 1.0 m s^{-1}).
- Five out of six of the 95th percentile AIMMS measurements are above pilot estimates.
- Both Pilot and AIMMS gust probe have difficulty in discerning difference between 1.0 and 2.0 m s^{-1} mean updrafts.

Future Work

- Integrate North Dakota validation results with Saudi Arabia results.
- Publish “Evaluation of Two Calibration Methods for the Aventech AIMMS20AQ Aircraft Wind System” paper.

Questions


f(x) = 0.81x + 108.07
R² = 0.72
f(x) = 0.22x + 130.06
R² = 0.37
Aerosol Concentration [#/cm³]
Droplet Concentration [#/cm³]
CCN Concentration [#/cm³]
0
200
400
600
800
1000
1200
1400
1600
100
300
500
700
900
1100
1300
1500