

## PECAN FP2 Flux Tripod Measurements

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### 1. Data Set Overview

During PECAN, the Naval Postgraduate School conducted flux measurements on a 5.66 m tripod at FP2 in Greenburg Business Park in an open grassy field. The flux tripod measurements were made from June 6, 2015 to July 14, 2015. It was comprised of two flux packages located at the top (5.66 m) and middle (2.83 m) of the tripod.

### 2. Instrument Description

Two flux packages were instrumented on the tripod. The first level had a Campbell Scientific CSAT3 and a LI-COR 7500 Open Path Infrared Gas Analyzer to measure high-rate 3-D winds and water vapor and CO<sub>2</sub> concentrations. The second level had a Campbell Scientific IRGASON that is an integrated sonic anemometer and infrared gas analyzer with both sampling volumes collocated. Both levels had Rotronic HC2-S3 probes to measure mean air temperature and relative humidity. Barometric pressures at each level were measured with internal IRGASON and LI-7500 barometers. Data were collected at 50 Hz with a Campbell Scientific CR3000 micrologger and time synchronized with a Garmin GPS16X-HVS GPS receiver. Below are the manufacturer specifications for each sensor:

#### Level 01 Instruments:

2.83 m, AGL

*Campbell Scientific CSAT3 3-D Sonic Anemometer*

Range

U<sub>x</sub>, U<sub>y</sub>, U<sub>z</sub>: +/- 65.535 m/s

c (speed of sound): 300 – 366 m/s (-50 to +60 degC)

Accuracy

U<sub>x</sub>, U<sub>y</sub> (horizontal velocities): +/- 8.0 cm/sec

U<sub>z</sub> (vertical velocity): +/- 4.0 cm/sec

Precision

U<sub>x</sub>, U<sub>y</sub> (horizontal): 1 mm/sec rms

U<sub>z</sub> (vertical): +/- 1 mm/sec rms

c (speed of sound): 15 mm/sec ~ 0.025 degC rms

*LI-COR 7500 Open Path Infrared Gas Analyzer (CO<sub>2</sub>/H<sub>2</sub>O)*

Range

CO<sub>2</sub>: 0 – 5148 mg/m<sup>3</sup>

H<sub>2</sub>O: 0 – 42 g/m<sup>3</sup>

RMS Noise

CO<sub>2</sub>: 0.27 mg/m<sup>3</sup> at 20 Hz

H<sub>2</sub>O: 0.0047 g/m<sup>3</sup> at 20 Hz

Zero Drift with temperature (per degC)

CO<sub>2</sub>: +/- 0.5 mg/m<sup>3</sup>

H<sub>2</sub>O: +/- 0.04 g/m<sup>3</sup>

*Rotronic HC2-S3 Temperature/RH Probe*

Range:

Air Temperature: -40 to +60 degC

Relative Humidity: 0 – 100 %

Accuracy:

Air Temperature +/- 0.1 degC

Relative Humidity +/- 0.8 %RH at 23 degC

**Level 02 Instruments:**

5.66 m, AGL

*Campbell Scientific IRGASON (3-D Sonic & Infrared Gas Analyzer)*

Range

Ux, Uy, Uz: +/- 65.535 m/s

c (speed of sound): 300 – 366 m/s (-50 to +60 degC)

Accuracy

Ux, Uy (horizontal velocities): +/- 8.0 cm/sec

Uz (vertical velocity): +/- 4.0 cm/sec

CO2: 1% of full scale

H2O: 2% of full scale

Precision

Ux, Uy (horizontal velocities): 1 mm/sec rms

Uz (vertical velocity): +/- 0.5 mm/sec rms

c (speed of sound): 15 mm/sec ~ 0.025 degC rms

CO2: 0.2 mg/m<sup>3</sup>

H2O: 0.004 g/m<sup>3</sup>

*Rotronic HC2-S3 Temperature/RH Probe (same as above)*

*Vaisala PTB110 Barometer*

Accuracy

+/- 0.15 kPa (-30 to +50 degC)

**3. Data Collection and Processing**

Spurious data removal

'Bad' data are replaced with 'NaN' (not-a-number). These data are identified for being clearly erroneous (out of reasonable range), having 'bad' instrument diagnostic values, or having no data because of sensor failure or power outage. Section 5 (daily log) gives the time period when no data are available.

Flux calculation

Turbulent fluxes of momentum, sensible, and latent heat are calculated with non-overlapping 30-minute averaging using eddy correlation method. Sections of bad data identified in 3.1 were filled with 'NaN'. Sensible heat flux was calculated using the sonic temperature. The temperature, humidity, wind, and pressure are all 30-minute averages corresponding to the time of the fluxes.

The following constants were used to convert from the kinematic flux to fluxes:  
Heat capacity under constant pressure  $c_p = 1.005 \times 10^3 \text{ J kg}^{-1} \text{ K}^{-1}$ . Latent heat is  $L = 2.6 \times 10^6 \text{ J kg}^{-1}$ . Air Density was calculated for each data point based on pressure and temperature measurements.

#### 4. Data Format

30 minute averaged data for the duration of PECAN from the Flux Tripod compiled into a single netCDF file named FluxTripod\_NPS\_FP2.nc and its variable names, desc. The variable name suffix (i.e. 01 and 02) represent the level from which the measurement was made.

Variable Name	Units	Instrument	Description
UTC_matlab_time	Day		UTC fractional day from Jan 0, 0000
YEAR	YEAR		Year (UTC)
MONTH	MONTH		Month (UTC)
DAY	DAY		Day (UTC)
HOUR	HOUR		Hour (UTC)
MINUTE	MINUTE		Minute (UTC)
T01	Kelvin	HC2-S3	Air temperature at level 01
T02	Kelvin	HC2-S3	Air temperature at level 02
RH01	%	HC2-S3	Relative humidity at level 01
RH02	%	HC2-S3	Relative humidity at level 02
Ps01	hPa	LI7500	Relative humidity at level 01
Ps02	hPa	PTB 110	Barometric pressure at level 02
Ux01	$\text{m s}^{-1}$	CSAT3	East-West component of wind at level 01
Ux02	$\text{m s}^{-1}$	IRGASON	East-West component of wind at level 02
Uy01	$\text{m s}^{-1}$	CSAT3	North-South component of wind at level 01
Uy02	$\text{m s}^{-1}$	IRGASON	North-South component of wind at level 02
tau_01	$\text{N m}^{-2}$	CSAT3	Wind stress level 01
tau_02	$\text{N m}^{-2}$	IRGASON	Wind stress level 02
SHF_01	$\text{W m}^{-2}$	CSAT3	Sensible heat flux level 01
SHF_02	$\text{W m}^{-2}$	IRGASON	Sensible heat flux level 02
LHF_01	$\text{W m}^{-2}$	CSAT3/LI7500	Latent heat flux level 01
LHF_02	$\text{W m}^{-2}$	IRGASON	Latent heat flux level 02

## 5. Data Remarks

Below is a daily log (zulu time) for the NPS Flux Tripod.

2015 JUN 06	Began data collection at 0400Z. Stopped data collection to optimize datalogger code, 2130 and resumed 2530 (next day 0130)
2015 JUN 07	Nothing to report
2015 JUN 08	Nothing to report
2015 JUN 09	Nothing to report
2015 JUN 10	Data outage due to flux amperage load is beyond the battery charger current rating. Battery charger issues remedied and power restored. Data outage from 0900 to 2030.
2015 JUN 11	Thunderstorm event with max wind speed ~30 m/s, ~0.55 inches of rain within 10 minutes. Winds blew open datalogger enclosures and rain flooded the power distribution boxes, however did not interrupt data collection. Level 1: Data outage from 0300 to 2400 Level 2: No data outage, IRGASON's wind and water vapor sensors seem to be more robust in these extreme conditions.
2015 JUN 12	Nothing to report
2015 JUN 13	Nothing to report
2015 JUN 14	Level 1: Data outage 0100 to 1130, sonic anemometer diagnostic throwing bad diagnostic codes. Level 2: Nothing to report
2015 JUN 15	Level 1: Data outage 0930 to 1430 Level 2: Nothing to report
2015 JUN 16	Nothing to report
2015 JUN 17	Nothing to report
2015 JUN 18	Nothing to report
2015 JUN 19	Data outage from 0930 to 1430 (both levels).
2015 JUN 20	Nothing to report
2015 JUN 21	Nothing to report
2015 JUN 22	Nothing to report
2015 JUN 23	Nothing to report
2015 JUN 24	Nothing to report
2015 JUN 25	Nothing to report
2015 JUN 26	Nothing to report
2015 JUN 27	Nothing to report
2015 JUN 28	Nothing to report
2015 JUN 29	Nothing to report
2015 JUN 30	Nothing to report
2015 JUL 01	Nothing to report
2015 JUL 02	Nothing to report
2015 JUL 03	Nothing to report

2015 JUL 04	Nothing to report
2015 JUL 05	Nothing to report
2015 JUL 06	Nothing to report
2015 JUL 07	Nothing to report
2015 JUL 08	Nothing to report
2015 JUL 09	Nothing to report
2015 JUL 10	Level 2: Data outage from 0730 to 1130. Level 1: Data outage from 0600 to 1500.
2015 JUL 11	Nothing to report
2015 JUL 12	Nothing to report
2015 JUL 13	Nothing to report
2015 JUL 14	End data collection at 1800

**Example Data:** Below are plots from NPS Flux Tripod dataset. The blue lines are data from level 1 and orange line are data from level 2.

