# CICCI 2015 Flight Data

The data were collected with the instrument payload. Most of each flight was devoted to a single vertical spiral ascent, with the plane rising at a rate of 30 meters per minute while flying in a 1.8 km diameter circle. For each of the 8 NOAA-PMEL Manta aerosol flights during CICCI - STADS 2015 the following data plots are available:

- The flight track (map).
- A time series of altitude.
- A vertical profile plot from the steady vertical ascent. This plot contains profiles of air temperature, RH, wind speed, wind direction, aerosol light absorption coefficient (Bap) at red, green and blue wavelengths, and aerosol light scattering coefficient (Bsp) at the same three wavelengths.
- For the flights that were close in time to a radiosonde launched a few kilometers away in Ny-Ålesund, there is a radiosonde inter-comparison of air temperature, RH, wind speed and wind direction.

The data used to generate these plots can be obtained from james.e.johnson@noaa.gov.

note: all times are UTC

| Flight | Date | Launch | Land | Flight Track | Altitude Timeseries | Vertical Profile | RadioSonde intercompare |
|---|---|---|---|---|---|---|---|
| 15-010 | 2015-04-21 | 07:53 | 10:22 | track_15_010.png | altitude_flight_15_010.png | profile5_a_flight_15_010.png | RS_compare_010.png |
| 15-013 | 2015-04-21 | 16:34 | 18:21 | track_15_013.png | altitude_flight_15_013.png | profile5_a_flight_15_013.png | |
| 15-014 | 2015-04-22 | 09:01 | 11:30 | track_15_014.png | altitude_flight_15_014.png | profile5_a_flight_15_014.png | RS_compare_014.png |
| 15-018 | 2015-04-25 | 10:55 | 13:07 | track_15_018.png | altitude_flight_15_018.png | profile5_a_flight_15_018.png | RS_compare_018.png |
| 15-021 | 2015-04-27 | 17:14 | 19:18 | track_15_021.png | altitude_flight_15_021.png | profile5_a_flight_15_021.png | RS_compare_021.png |
| 15-023 | 2015-04-28 | 11:54 | 13:17 | track_15_023.png | altitude_flight_15_023.png | profile5_a_flight_15_023.png | |
| 15-027 | 2015-04-29 | 16:01 | 15:51 | track_15_027.png | altitude_flight_15_027.png | profile5_a_flight_15_027.png | |
| 15-029 | 2015-05-01 | 13:16 | 15:51 | track_15_029.png | altitude_flight_15_029.png | profile5_a_flight_15_029.png | RS_compare_029.png |

## Data Reduction:

Temperature, RH, winds and Circle Averaging Algorithm:

A flight profile of a spiral vertical ascent was used for each of these flights. The autopilot of the UAS was commanded to fly in a small, 1.8 km diameter circle at a constant ascent rate of 30 meters per minute. The position of the circle was fixed to the ground, and the UAS autopilot was programed to keep within a narrow range of airspeeds. As there was generally a horizontal wind this meant that in the frame of reference of the moving air the plane was not flying in circles but in ovals. This also meant that the pitch and especially the roll of the plane was not steady, but oscillated with one oscillation per circle flown. We found that there was an oscillation of about 0.7 degrees C in our air temperature data that was correlated with the direction the UAS was pointed and there was one temperature oscillation per circle flown. There was a corresponding oscillation in the RH record as well. In order to remove this oscillation from the data record a circle averaging algorithm was developed. From one-half circle from the bottom to one-half circle of the top of the spiral ascent each one second value (the $i^{th}$ value) was replaced with an average of the value of all points in that circle, from where the UAS was last pointed 180 degrees away from the $i^{th}$ value to where it was next pointed 180 degrees away. In other words each point in the profile was replaced with the average of all points from one-half circle below it to one-half circle above it and was the average was over exactly one circle. As the airspeed of the plane was typically 55 knots (28 m/s) this meant that each point is the center of a moving average of about 200 seconds.

The UAS autopilot measures the wind speed by comparing the velocity vector the UAS is flying through the air (from it's heading and airspeed) to its GPS velocity vector. The difference between the two vectors is a one directional component of the real wind. The UAS autopilot data record provided the north and east wind components, but as they could only be calculated on one direction at a time it was expected that an oscillation of the wind components would be present that would the oscillation would correlate with each circle in the vertical spiral. This was in fact seen, and the above circle averaging algorithm was used to eliminate this oscillation in the wind components. After this averaging the wind components were then combined to calculate the wind speed and direction for each second in the vertical spiral.

Aerosol Measurements:

Mixing Condensation Particle Counter (MCPC):

The MCPC provided a data record of one point per second. The MCPC instrument measures the volumetric flow of air and keeps it to a constant volumetric rate. The only correction was to convert the data provided in particles per actual (volumetric) cm^3 to particles per STP cm^3, assuming a standard pressure of 1013 mb and a standard temperature of 0 degrees C. In some of the profiles there were spikes of a few seconds. We assume that these spikes came from the UAS on the downwind side of a circle sampling its own exhaust that it emitted on the upwind side. The number of such spikes were generally three or less per flight and they were manually removed in the data record before the plots were made.

Aerosol Light Absorption:

The aerosol absorption photometer draws in air at 1600 ml/min through a spot in a sample filter with an area of about 20 mm^2 where all of the particles are deposited. The air flow is then directed through a second, identical reference filter. An single LED light source alternately shines red, green and blue (624, 525, and 450 nm) light through both the filters and a photodiode under under each filter records the amount of light passing through the filter which is stored as arbitrary counts for each color in each second. In the data processing the sample counts are divided by the reference counts to get the transmission ratio, Tr, for each color at each second. The rate at which Tr declines is proportional to the amount aerosol light absorption.

The time series of the one second Tr from the absorption photometer generally had a smooth decline, but there were a few very sharp one to five second excursions. An algorithm was used that examined the one second data and if the relative change in the sequential Tr values exceeded a settable limit, generally 10^-4 to 10^-5, then those data were thrown out and replaced with smooth interpolated line. Ten second intervals of the Tr slope were used along with the recorded flow rate and the formula of Bond et al., 1999 to calculate a 10 second moving average of the aerosol absorption coefficient at each second, for each of the three wavelengths. For this caculation the flow rate through the instrument was reduced to standard temperature and pressure, so that the resulting Bap is not affected by changes in pressure with altitude. There were a few large spikes in the resulting time series of aerosol light absorption and these were removed by hand. The cleaned 10 second data was then smoothed with a 40 second moving average. This data was seen to have some periodic oscillations that were correlated spiral path of the UAS so the above circle averaging algorithm was used to create the circle averaged absorption. As each circle took a little over 3 minutes to complete, each point in the was moving average of about 180 to 200 seconds and contained exactly one circle.

Filter based measurements of aerosol light absorption are subject to overestimating absorption due to light scattering by particles on the filter medium. The aerosol light scattering was estimated from the POPS data and the A. Vikkula, 2010 formulas were used to subtract this correction. This correction generally lowered the reported aerosol absorption values by about 10%.

Bond, T. C., Anderson, T. L., and Campbell, D. (1999). Calibration and Intercomparison of Filter-Based Measurements of Visible Light Absorption by Aerosols. *Aerosol Sci. Technol.*, 30:582–600.

A. Virkkula (2010), Correction of the Calibration of the 3-wavelength Particle Soot Absorption Photometer (3 lambda PSAP), *Aerosol Sci. Technol.,* 44:706–712.