# Olympic Mountain Experiment

# OLYMPEX-2015 Dropsonde Data Quality Report

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***The dropsonde data for this project were quality controlled and are maintained by the Earth Observing Laboratory at the National Center for Atmospheric Research (NCAR). NCAR is sponsored by the National Science Foundation (NSF). In the event that information or plots from this document are used for publication or presentation purposes, please provide appropriate acknowledgement to NSF and NCAR/EOL and make reference to Young K. and H. Vömel (2016): OLYMPEX 2015 Dropsonde Data Quality Report.***

***In the event that these datasets are used for research resulting in a publication, please include the following citations in your paper:***

***UCAR/NCAR - Earth Observing Laboratory. 2016. NASA QC OLYMPEX Dropsonde Data, Version 1.0. UCAR/NCAR - Earth Observing Laboratory. http://dx.doi.org/10.5065/D6QZ28BN. Accessed 01 July 2016***

# OLYMPEX 2015 Quality Controlled Dropsonde Dataset

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# OLYMPEX 2015 Dropsonde Data Quality Report

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# I. Dataset Overview

The Olympic Mountain Experiment (OLYMPEX) was a field campaign designed to collect atmospheric measurements, using a variety of instrumentation, to validate satellite measurements of precipitation from a constellation of satellites known as the Global Precipitation Measurement (GPM). The NASA DC-8 aircraft was deployed on 17 research flights, during which 53 standard research dropsondes were deployed between November 12 and December 19, 2015 (Table 1). A map of all dropsonde launch locations is provided in Figure 1. A frequency histogram of flight level altitudes, majority between 11.5 and 12.5 km, from the time of each dropsonde launch, is provided in Figure 2. This document contains information on the data file format, data parameters included in each of the files, and details regarding the quality control measures applied to the sounding data.

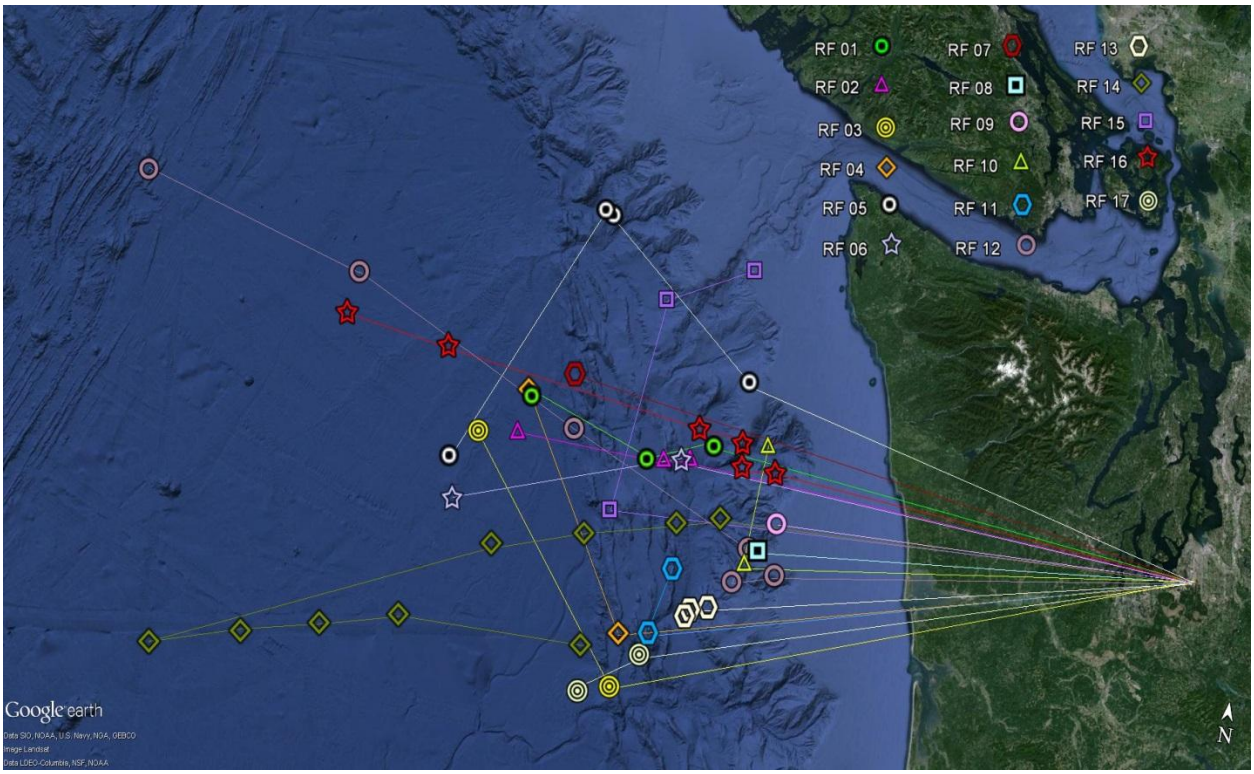


**Figure 1** Map of all DC8 flight tracks and dropsonde launch locations.

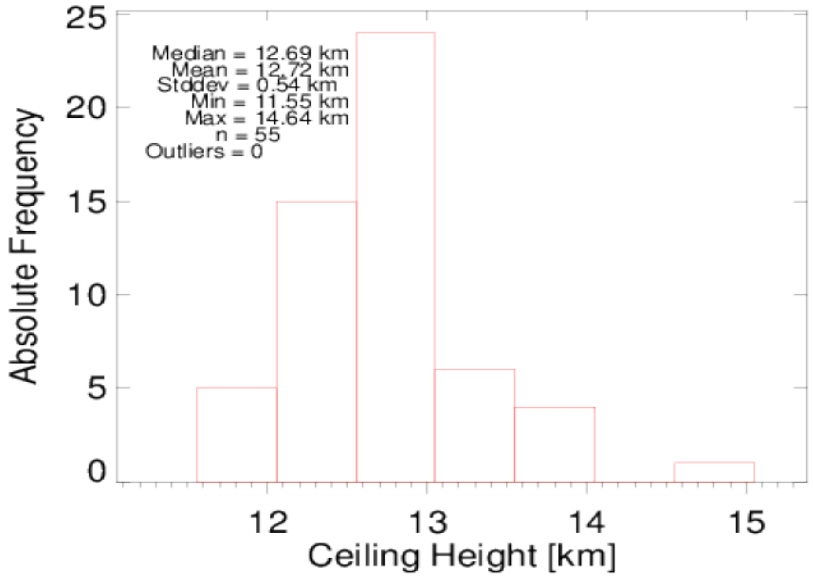


**Figure 2** Frequency histogram of flight level altitudes at dropsonde launch times.

### Table 1. Dropsonde Counts for each OLYMPEX Research Flight

| Research Flight | Dates | Sondes deployed |
|---|---|---|
| RF01 | Nov 12 | 3 |
| RF02 | Nov 13 | 3 |
| RF03 | Nov 14 | 2 |
| RF04 | Nov 18 | 2 |
| RF05 | Nov 23 | 5 |
| RF06 | Nov 24 | 2 |
| RF07 | Nov 25 | 1 |
| RF08 | Dec 01 | 1 |
| RF09 | Dec 03 | 1 |
| RF10 | Dec 04 | 2 |
| RF11 | Dec 05 | 2 |
| RF12 | Dec 08 | 6 |
| RF13 | Dec 10 | 3 |
| RF14 | Dec 12 | 9 |
| RF15 | Dec 13 | 3 |
| RF16 | Dec 18 | 6 |
| RF17 | Dec 19 | 2 |
| **Total** | | **53** |

For more information on the OLYMPEX project please visit:
https://www.eol.ucar.edu/field_projects/OLYMPEX

## EOL Sounding File Format and Data Specifics

The EOL format is an ASCII text format that includes a header (Table 2), with detailed project/ sounding information, and seventeen columns of high resolution data (Table 3). The "QC.eol" files are quarter-second resolution data files with appropriate corrections and quality control measures applied. Note that the thermodynamic data (pressure, temperature and humidity (PTU)) are only available at half-second resolution, while wind data is available at quarter-second resolution. The naming convention for these files is "D", followed by "yyyymmdd_hhmmss_P.QCeol" where yyyy = year, mm = month, hh = hour of the day GMT, mm = minute of the hour, ss = second of the hour (which refer to the launch time of the sonde),and "QC.eol" refers to the EOL file format type.

The header contains information including data type, project name, site location, actual release time, and other specialized information, shown in Table 2. The first seven header lines contain information identifying the sounding. The release location is given as: lon (deg min), lon (dec. deg), lat (deg min), lat (dec. deg), GPS altitude (meters). Longitude in deg min is in the format: ddd mm.mm'W where ddd is the number of degrees from True North (with leading zeros if necessary), mm.mm is the decimal number of minutes, and W represents W or E for west or east longitude, respectively. Latitude has the same format as longitude, except there are only two digits for degrees and N or S for north/south latitude. The following three header lines contain information about the data system, auxiliary information and comments about the sounding. The last 3 header lines contain header information for the data columns. Line 12 holds the field names, line 13 the field units, and line 14 contains dashes (--- characters) signifying the end of the header. Data fields are listed below in Table 3. The last line of the header contains information about the current version of ASPEN and its configuration used for the final data QC. It also contains a flag, 'TDDryBiasCorrApplied', indicating the files have been corrected for a temperature dependent dry bias in the relative humidity measurements (for more information, please see 'Data Quality Control Process' in Section II)

The variables pressure, temperature, and relative humidity are calibrated values from measurements made by the dropsonde. The AVAPS software applies a .4 mb dynamic correction to the pressure measurements, in real time. The dew point is calculated from the relative humidity and temperature using the vapor pressure equation (Bolton, 1980). The geopotential altitude is calculated from the hydrostatic equation, typically from the ocean's surface upward. For dropsondes that failed to transmit useful data to the surface, geopotential altitude is integrated from flight level down. The descent rate of the sonde is computed using the time-differentiated hydrostatic equation. The position (lat, lon) and wind data come directly from the dropsonde GPS receiver. The uncertainty of the GPS altitude is estimated to be less 20 m. Investigators should follow meteorological convention and use geopotential altitude.

### Table 2 - EOL Sounding File Format (dropsonde and radiosonde)

```
Data Type/Direction:                    AVAPS SOUNDING DATA, Channel 1/Descending
File Format/Version:                    EOL Sounding Format/1.1
Project Name/Platform:                  OLYMPEX, 11/23/2015/RF05/NASA - McDonnell Douglas DC-8, N817NA
Launch Site:
Launch Location (lon,lat,alt):          126 23.04'W -126.383972, 47 42.07'N 47.701092, 11791.00
UTC Launch Time (y,m,d,h,m,s):          2015, 11, 23, 16:58:32
Sonde Id/Sonde Type:                    141235023/Vaisala RS904
Reference Launch Data Source/Time:      IWGADTS Format (IWG1)/17:26:41
System Operator/Comments:               Clayton/We lost power after about 2-3 min. after launch. Launched a second sonde,
```

```
Post Processing Comments:                Aspen V3.3-236; Created on 30 Jun 2016 19:49 UTC; Configuration research-dropsonde;
TDDryBiasCorrApplied
/
  Time    -- UTC  --    Press    Temp    Dewpt     RH     Uwind    Vwind    Wspd     Dir      dZ     GeoPoAlt     Lon          Lat       GPSAlt
   sec    hh mm   ss      mb       C       C        %      m/s      m/s      m/s     deg      m/s       m         deg          deg         m
-------- -- -- ----- -------- ------- ------- ------- -------- -------- -------- -------- -------- --------- ------------ ------------ ---------
```

**Table 3 - Lists data fields provided in the EOL format ASCII soundings**

| Field No. | Parameter | Units | Measured/Calculated |
|---|---|---|---|
| 1 | Time | Seconds | ---------- |
| 2 | UTC Hour | Hours | ---------- |
| 3 | UTC Minute | Minutes | ---------- |
| 4 | UTC Second | Seconds | ---------- |
| 5 | Pressure | Millibars | Measured |
| 6 | Air Temp | Degrees C | Measured |
| 7 | Dewpoint Temp | Degrees C | Calculated |
| 8 | Relative Humidity | Percent | Measured |
| 9 | U Wind Component | Meters/Second | Calculated |
| 10 | V Wind Component | Meters/Second | Calculated |
| 11 | Wind Speed | Meters/Second | Measured |
| 12 | Wind Direction | Degrees | Measured |
| 13 | Descent Rate | Meters/Second | Calculated |
| 14 | Geopotential Altitude | Meters | Calculated |
| 15 | Longitude | Degrees | Measured |
| 16 | Latitude | Degrees | Measured |
| 17 | GPS Altitude | Meters | Measured |

## II. Data Quality Control Process

1) Time series plots of quality controlled temperature, RH, wind speed, and fall rate, are used to examine the consistency of soundings launched during each flight, and to show the variability of soundings from different missions. These plots are also used to determine if the sounding did not transmit data to the surface, or if there was a "fast fall" caused by failure of the parachute to properly deploy, or malfunctioning of any of the dropsonde sensors.

2) Profiles of pressure, temperature, RH, wind speed and descent rate from the raw D-files are examined to identify features that may warrant further investigation. Corrections are applied where appropriate.

3) All dropsonde GPS altitude measurements have been improved by removing any existing real-time geoid correction and replacing it with a more accurate geoid height from the Earth Gravitational Model 1996 (EMG96). On average the difference between the two is approximately 1.6 m, but the scatter is quite significant, making this correction necessary.

4) Filtering of GPS latitude, longitude and altitude is performed to remove spikes.

5) The raw sounding D-files with the corrected pressure offset, updated flight level data and filtered GPS data are then processed through the Batch Atmospheric Sounding Processing ENvironment (ASPEN) software which:

    i) Applies a correction algorithm to address a dry bias in the RD94 and mini-dropsonde (NRD94) relative humidity measurements, which was discovered in data collected from 2010 to present. For more information on this issues please see #7 below.

    ii) Performs smoothing, sensor time response corrections, and removes suspect data points.

    The ASPEN software version and configuration file used for this program are included in the header of each "QC.eol" sounding file. For more information on ASPEN or to download the software please visit: http://www.eol.ucar.edu/software/aspen

6) A dry bias in the relative humidity measurements was discovered, in the Spring of 2016, in all RD94dropsondes from 2010 to present and all mini-dropsondes (NRD94) collected. This dry bias is strongly temperature dependent and most significant at cold temperatures. It is considered small at warm temperatures. All sounding files undergoing post-processing have been corrected for this error and contain the flag, 'TDDryBiasCorrApplied', in the last line of the header to confirm that this correction has been applied. For more information on the dry bias, please access the technical note, linked below, which contains information on the origin, magnitude and impact of the dry bias.

    NCAR/EOL Technical Note: Dropsonde Dry Bias

    https://www.eol.ucar.edu/system/files/software/Aspen/Windows/W7/documents/Tech%20Note%20Dropsonde_Dry_Bias_20160527_v1.3.pdf

7) Profiles of quality controlled temperature, RH, wind speed and wind direction versus geopotential altitude are examined. These enable us to visually evaluate the final data product for outliers, or any other obvious problems that may have previously gone undetected.

## III. Overview of issues

Performing the quality control procedures outlined above allows us to identify and, in many cases, resolve issues that could potentially impact research performed using these data sets.
The following issues, noted in Table 4, were found. Where necessary, corrections have been applied. Following the table are more detailed descriptions of the data quality issues discovered and information on how they were addressed.

### Table 4 – Summary of Data Quality Issues Found with the OLYMPEX Dropsonde Data

| Data Quality Issue | # of soundings |
|---|---|
| Fast Falls | 1 |
| Soundings Not to Surface | 2 |

1. **Fast Falls –** One dropsonde, D20151212_163657, was classified as "fast fall" (Figure 4), meaning the parachute failed to properly deploy resulting in the dropsonde falling at an accelerated rate. When a fast fall occurs, GPS wind measurements can be unreliable (due to irregular motion of the dropsonde) and a lag in the response of the T/RH and sensors may occur. We caution data users about the increased uncertainty of wind speed, wind direction, U/V winds, Temperature and RH data contained in these data files.

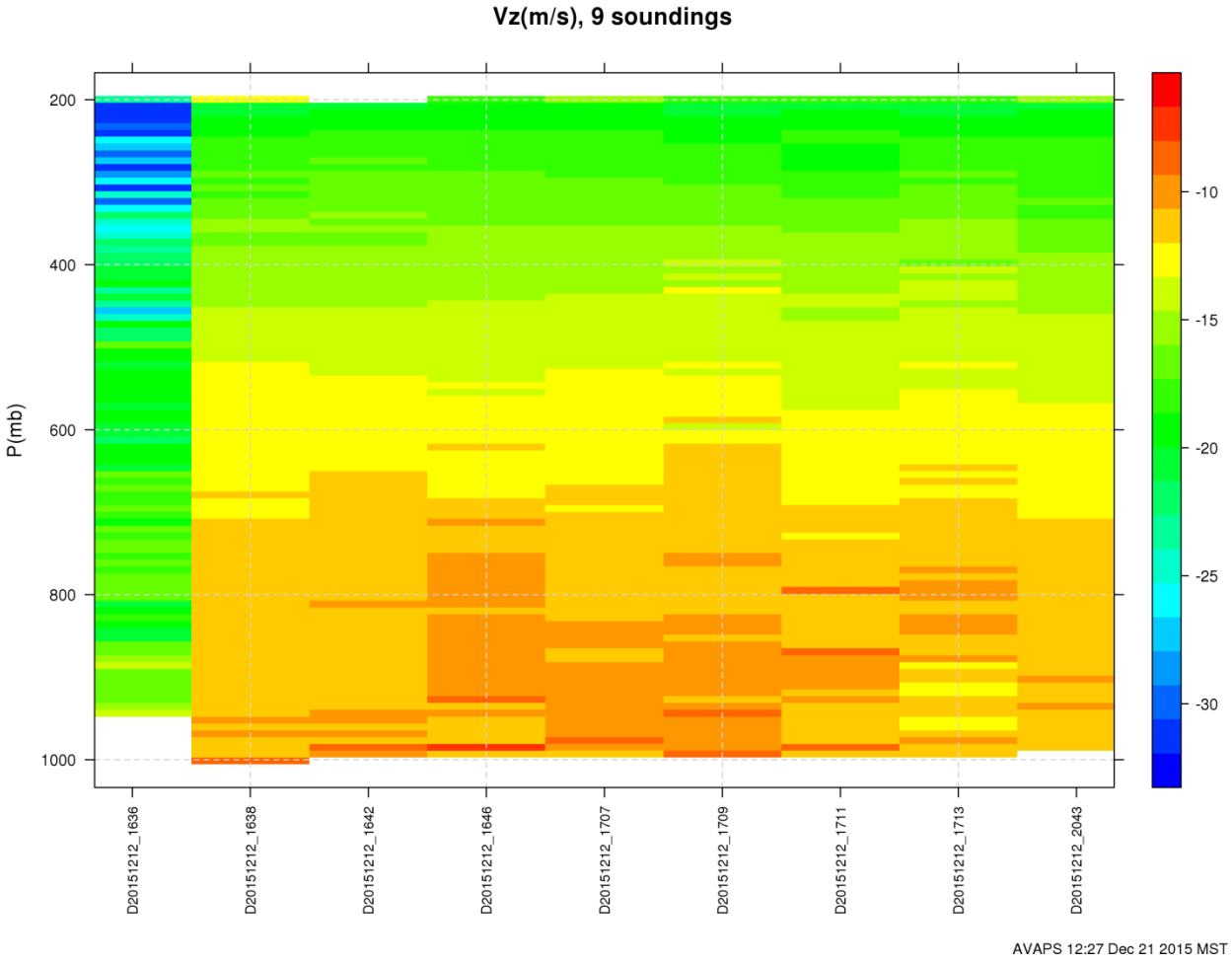


**Figure 3** GPS descent rates of dropsonde launched from Research Flight 14. Sounding file D20151212_163657 was a "fast fall sounding", with an accelerated fall speed caused by failure of the parachute to properly deploy.

2. **Data Not to Surface** – Two dropsondes, D20151123_165332 and failed to transmit useful data to surface. Data from these dropsondes ended prematurely. The first, D20161123_165332 ended after just 2 minutes into flight, when power to the station was inadvertently turned off. The second dropsonde D20151212_163657, had a weak telemetry signal and was lost just prior to splash.