Automated Parsivel Unit (APU) data processing during Olympic Mountain Experiment (OLYMPEx)

During OLYMPEx, thirteen APU were operated. In addition, a single Parsivel^2 unit was operated at Hurricane Ridge (hrd). The Environment Canada also operated a single Parsivel^2 unit in Albert Head (ahd), British Columbia. The coordinates and elevation (meters) of each site is given below (courtesy of Joe Zagrodnik of University of Washington). The OLYMPEx APU data processing period extends from beginning of November 2015 to the end of January 2016 even though the experiment ended on January 15, 2016. A number of sites dismounted at the end of the experiment, while three APU sites (apu10, apu13 and apu30), hrd and ahd sites continued operation through Spring 2016. A number of APU sites (apu01, apu02, apu03, apu06, apu07, apu08, apu10, apu11, apu30) and hrd and snp sites were installed late Summer and Autumn 2015. The early installation and late dismounting was partly due to the continuous record of size distribution observations and partly due to logistic reasons. The rain algorithm is applied to APU dataset and please note that mixed and frozen precipitation occurred at high elevation sites.

Site name	latitude	longitude	elevation	Unit ID
Wallace Cabin	47°12'9.12"	-124°12'8.43"	15	apu01
Seed Orchard	47°15'59.91"	-124° 7'5.04"	260	apu02
Fish Hatchery	47°21'35.80"	-123°59'35.04"	170	apu03
Neilton Point	47°23'23.42"	-123°52'1.34"	2155	apu04
Amanda Park (S6)	47°27'34.41"	-123°53'23.11"	210	apu05
Prairie Creek	47°30'42.12"	-123°55'59.52"	1780	apu06
Norwood	47°29'35.90"	-123°48'34.11"	213	apu07
Bishop CRN	47°30'48.75"	-123°48'42.82"	285	apu08
Bunch Field	47°32'14.68"	-123°40'52.95"	380	apu09
Wynoochee Trailer	47°29'48.80"	-123°34'51.20"	3340	apu10
Graves Creek	47°34'19.45"	-123°34'57.16"	593	apu11
Kalaloch	47°36'11.67"	-124°22'10.02"	39	apu13
Upper East Fork Quinault	47°40'47.47"	-123°23'2.86"	2100	apu30
Albert Head, British Columbia	48°23'13.62"	-123°28'40.95"		ahd
Hurricane Ridge	47°58'13.29"	-123°29'55.56"	5260	hrd
Snoqualmie Pass	47°25'29.01"	-121°24'50.48"	3020	snp

The APU data has been collected at 10 seconds intervals. The raw output is the 32 x 32 diameter versus velocity matrix. In addition to the raw output at 10-second intervals, the following files are considered as input files for the data processing.

Input files:

1.1 parsivel_diameter.txt,

The files has four columns: The drop shape corrected mid bin size diameters in mm, corresponding bin width in mm, corresponding terminal fall speed in m/sec following Beard (1976, Journal of Atmospheric Sciences, volume 33, 851-864), and corrected mid bin fall velocities in m/sec. It should be noted that terminal fall velocities above 6.0 mm in diameter (bin 22 through bin 32) are subject to the error since Beard (1976) do not extend to for the drops larger than 6.0 mm. A linear interpretation has been performed for the drops larger than 6.0 mm in diameter.

1.2 parsivel_matrix.txt,

The file is a 32 x 32 matrix that corresponds to the drop size and fall velocities of the manufacturer output. The file screens the drops following ±50% terminal fall speed limit. If the drop fall is outside the ±50% of its terminal fall speed, it is regarded as secondary drop and eliminated from the processing. The matrix consists of "1" for accepted and "0" for rejected drops.

As part of the data processing, the 10-second observations are integrated to 1-minute. However, the time stamp of the 10-second observations has been documented in a file to distinguish the non-rainy periods from non-data collection periods. It should be noted that the thresholds of 10 drops and 0.01 mm h^{-1} has been applied to 1-minute observations to eliminate noise from rainy minutes.

Output files:

2.1 apuXX_data.olympex

XX: APU unit number from 01-11, 13 and 30.

The file provides the existing database. It consists of 5 to 10 columns: year, day of the year, hour, minute, and seconds (6 column maximum from 0 to 50).

2.2 apuXX_dropcounts_min. olympex

The file provides the total number drops at each bin size at 1-minute integration. The file consists of 36 columns: year, day of the year, hour, minute, and 32 size bin drop counts.

2.3 apuXX_rainparameter_min. olympex

The file is designed to present the integral rain parameters based on *measured* fall velocities at 1-minute integration. The file consists of 11 columns: year, day of the year, hour, minute, total number of drops, total concentration (drops m^{-3} of air), liquid water content (g m^{-3}), rain rate (mm h^{-1}), reflectivity in Rayleigh regime (dBZ), mass-weighted

drop diameter (mm), maximum drop diameter (mm). It should be noted that four of these rain parameters, total concentration, liquid water content, reflectivity in Rayleigh regime, and mass-weighted drop diameter requires fall speed information in their formulations. More information on the disdrometer-based calculation of integral rain parameters can be found in Tokay et al. (2001, Journal of Applied Meteorology, 40, 2083-2097).

2.4 apuXX_rainparameter_min_ter. olympex

The file provides the integral rain parameters based on *terminal* fall velocities at 1-minute integration. The file consists of 11 columns: year, day of the year, hour, minute, total number of drops, total concentration (drops m^{-3} of air), liquid water content (g m^{-3}), rain rate (mm h^{-1}), reflectivity in Rayleigh regime (dBZ), mass-weighted drop diameter (mm), maximum drop diameter (mm).

2.5 apuXX_raindsd_min. olympex

The file provides the raindrop size distribution based on *measured* fall velocities at 1-minute integration. The file consists of 36 columns: year, day of the day, hour, minute, and 32-bin rain drop size distribution (drops m^{-3} mm^{-1}).

2.6 apuXX_raindsd_min_ter. olympex

The file provides the raindrop size distribution based on *terminal* fall velocities at 1-minute integration. The file consists of 36 columns: year, day of the day, hour, minute, and 32-bin rain drop size distribution (drops m^{-3} mm^{-1}).

2.7 apuXX_rainevent. olympex

The file provides the rain event summaries. The events are separated by 1-hour or more rain-free periods in rain rate time series that can be extracted from 2.3 or 2.4. The events that are less than 3 minute or rain total less than 0.1 mm are not included. The file has 8 columns: year, event start day of the year, event start hour and minute, event end day of the year, event end hour and minute, event rainy minutes, event maximum rain rate (mm h^{-1}), event rain total (mm), event maximum drop diameter (mm).