Methods for Filtering Parsivel² Data from Different Rain Regimes

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ARM now deploys 9 Parsivel² disdrometers and will likely increase this number this year. Disdrometers contribute significant observations of the drop size distribution of rainfall and they help to improve our understanding of precipitation processes.

The Parsivel² devices have proven to:

1) be very reliable - lots of data to work with

2) produce better small drop counts than the Joss-Waldvogel disdrometers

3) be relatively inexpensive

The data from the Parsivel2 disdrometer have some documented issues (Tokay et al., 2014)

1) the number of large drops for diameters greater than 5 mm tend to be overestimated

2) observed fall velocities for drops with diameters less than 1.09 mm tend to be too low

3) observed fall velocities for drops with diameter greater than 3.35 mm tend to be too high

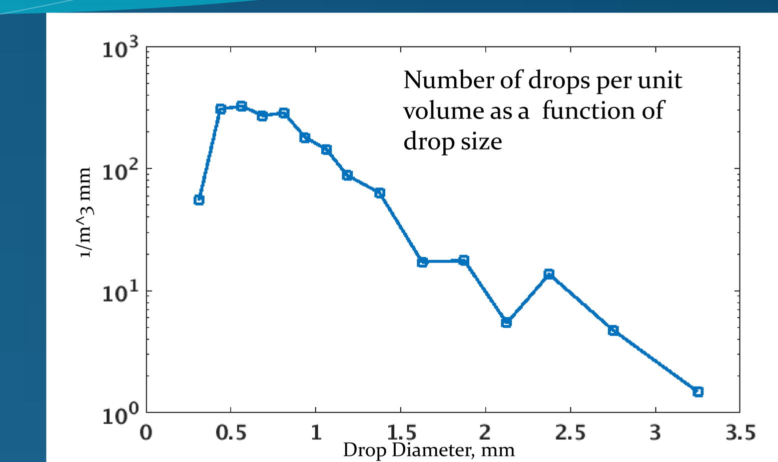
Hence the observations need filtering ***note example below***

Parsivel² in Antarctica

Image courtesy of Greg Stone

Precipitation that falls in the measurement area between the two electronics housings is counted and measured. Drop diameter accumulations and their mean fall velocity is recorded over a one minute window.

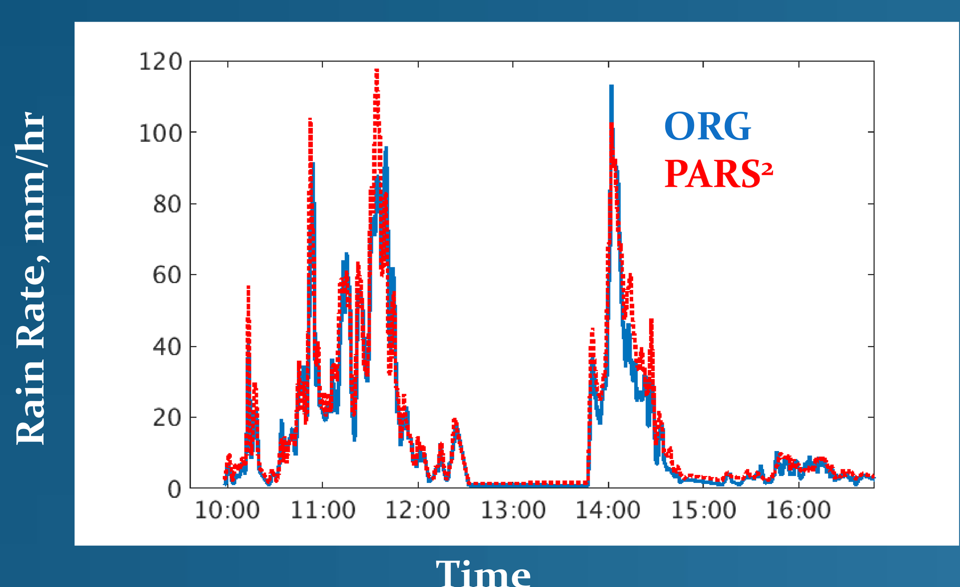
Parsivel² Primary Measurement drop size distribution



Concluding Remarks

- Filtering to remove outlier data can improve the quality of Parsivel² drop spectra. It will also decrease the number of drops in the spectra and will require longer accumulation times to obtain the best results.
- Filtering the Parsivel² data will be of particular importance in using equivalent radar reflectivity factor calculated from Parsivel² data to calibrate nearby radars.

Rain Rate from early fall during GoAmazon (20150506)



Differences can be observed in rainfall
- intensity
- timing

For all of the analysis presented here the optical rain gauge observations are deemed to be ground truth.

Filtering Techniques

The standard method for filtering Parsivel² data relies upon

- Identifying outliers as those points with observed drop fall velocities widely different from Gunn and Kinzer (1949, GK49) or similarly published drop fall velocities

This analysis goes further and evaluates the use of a

- maximum drop diameter threshold in conjunction with drop fall velocity to identify outlier observations

The hours long rainfall events of 20150506 in Brazil (MAO) and 20160115 from Graciosa Island (ENA) provided many Parsivel² observations with rain rates greater than 3 mm/hr and with 500 or more drops counted. Each event offered good contrast beginning with heavy rainfall and ending with weak rainfall.

Each observed drop size spectrum was varied by

1) Incrementally limiting the **maximum drop size** (0.062 mm to 24 mm)
2) Restricting the **acceptable range in fall velocity** (+- 10% of GK49 to +- 50% of GK49)
3) Limiting **both** maximum drop size and fall velocity range simultaneously

SKILL

Skill in filtering is determined by the correlation coefficient between rain rate as observed by the optical rain gauge and rain rate as calculated from filtered drop size distribution. For any given drop distribution rain rate is calculated as follows

rain rate = $\prod/6 * 0.0036 * 1/(F * t) * \sum n_i * D_i^3$

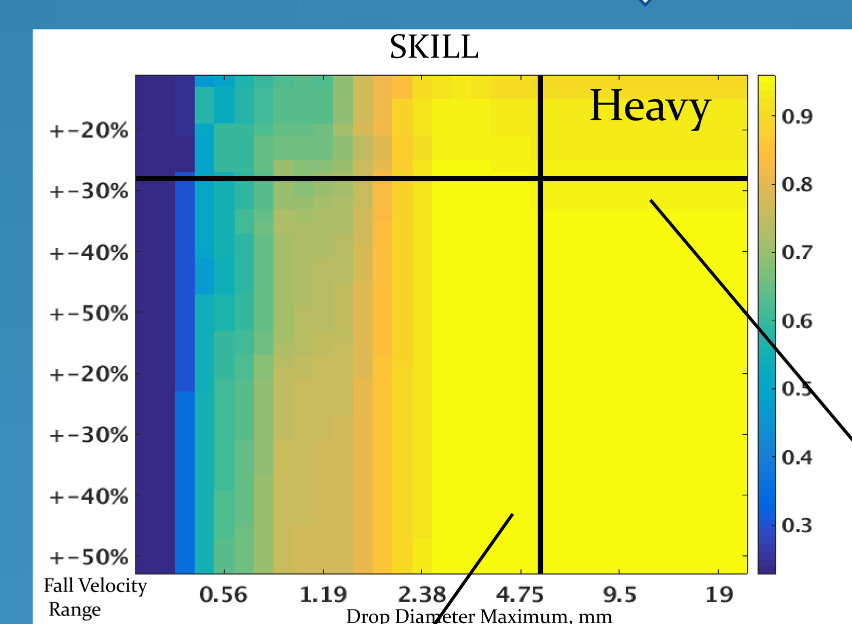
F = measurement area

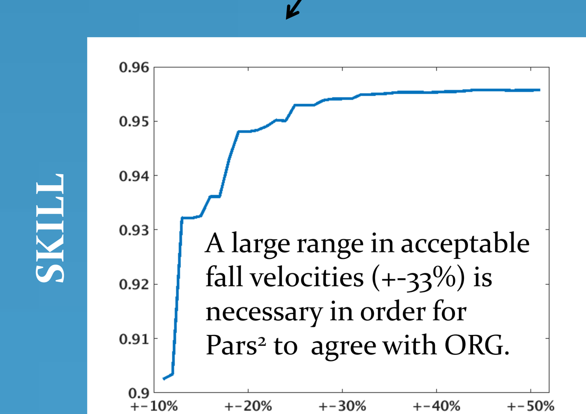
t = accumulation time

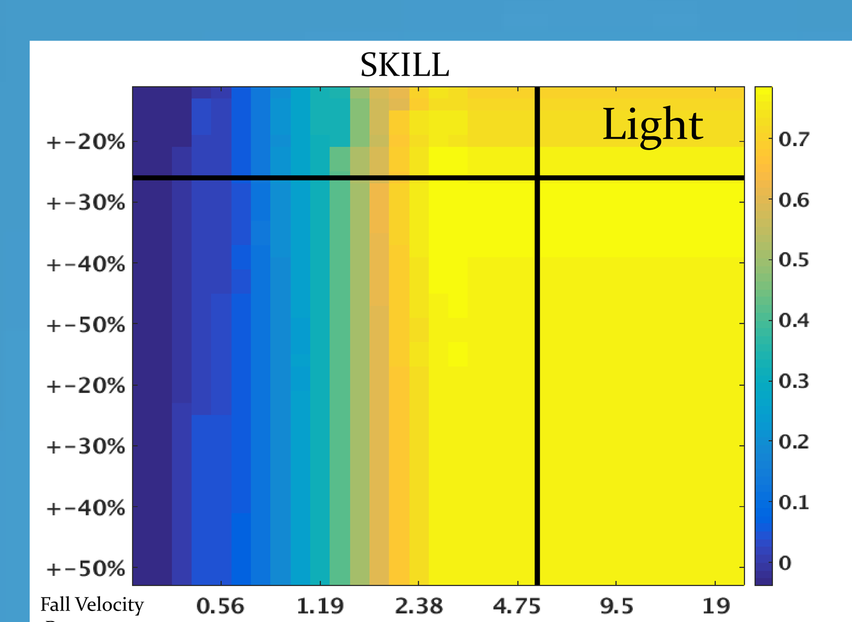
n_i = number of drops in diameter bin i

D_i = the diameter of drops at center of bin i

MAO Results

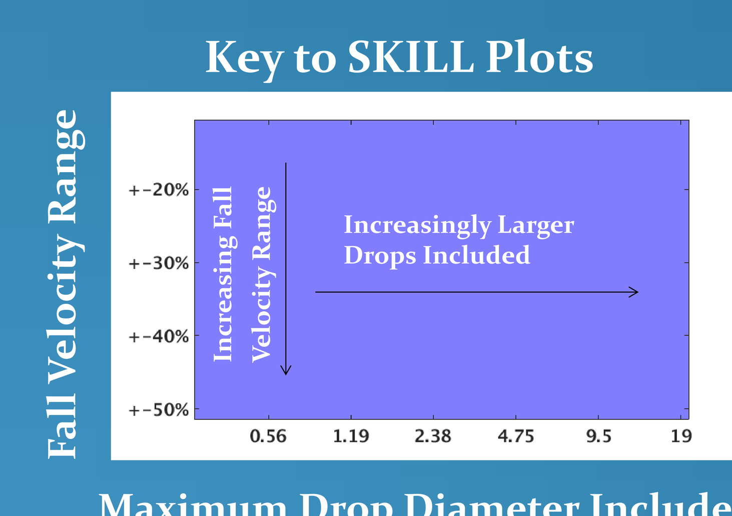


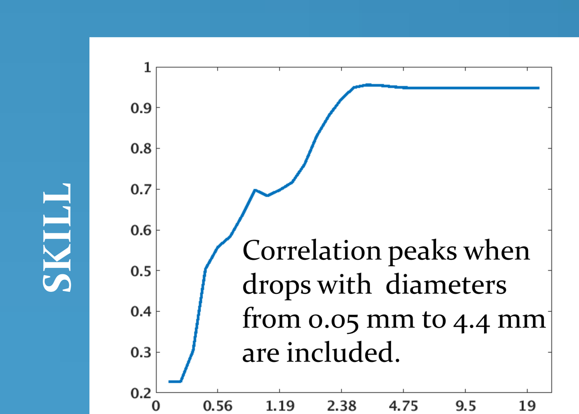




Heavy Rain Intensity > 6 mm/hr

Light Rain Intensity 3 mm/hr to 6 mm/hr



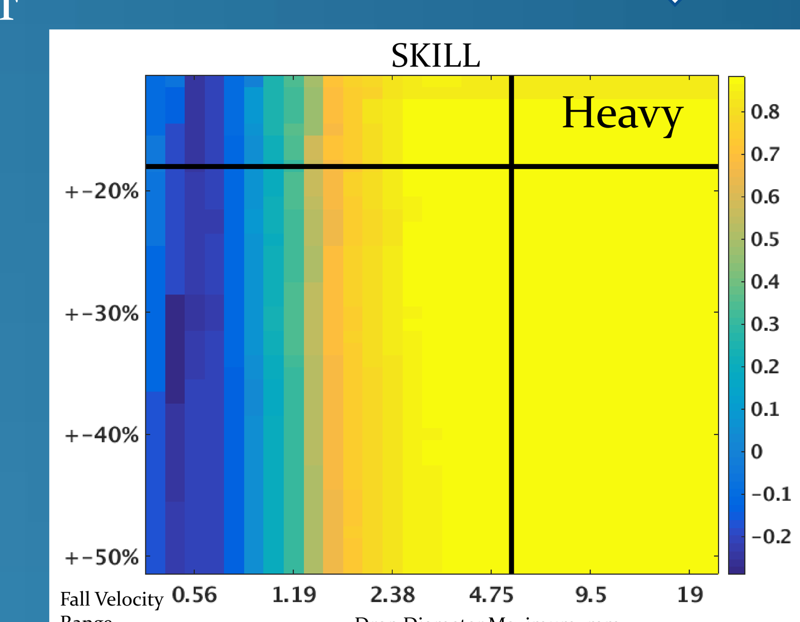


Notes

1) ORG/Pars² correlations for light rain at ENA roughly half that for MAO for same rain rate regimes.

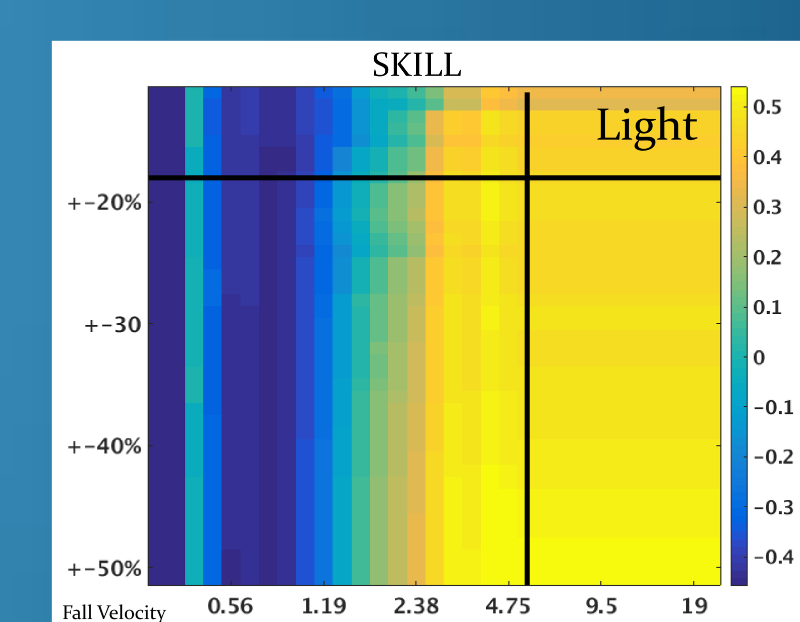
2) MAO ORG/Pars² correlations for heavy rain vs light rain are considerably higher.

ENA Results



Note

The ENA ORG/Pars2 correlation peaks for heavy rainfall peaks for drop diameter range 0.02 mm to 2.26 mm as opposed to 4.4 mm for MAO



ARM CLIMATE RESEARCH FACILITY

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Gunn, R. and G.D. Kinzer, 1949. The terminal velocity of fall for water droplets in stagnant air. J. Meteor, 6, 243-248.

Tokay, A., D.B. Wolff, and W.A. Petersen, 2014. Evaluation of the new version of the laser-optical disdrometer, OTT Parsivel2. J. Atmos. Oceanic Techno, 31, 1276-1288. DOI: 10.1175/JTECH-D-13-00174.1.