DISTROMETRIC DROP SIZE DISTRIBUTION IN SOUTH BRAZIL: DERIVED Z-R RELATIONSHIP AND COMPARISONS WITH RADAR MEASUREMENTS

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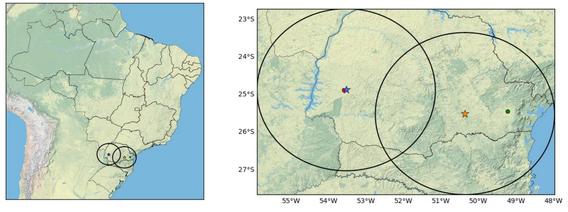
Objectives

General: Support to hydropower operations in Southern Brazil.

Specific: Distrometric based Z-R relations for the Teixeira Soares (TXS) and Cascavel (CAS) radar in the state of Paraná-Brazil; comparison of ZH from radar and distrometer.

Study Area



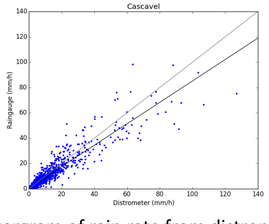
Radar, distrometer and raingage location. Red point indicates Cascavel distrometer and raingage and green point indicates Curitiba distrometer and raingage. Blue and orange stars indicate CAS (dual polarization) and TXS (single polarization) radar, respectively. Radar range is 240 km.

Data

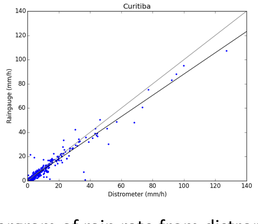
- **Distrometer:** DSD in the 0.3 – 0.5 mm diameter range, 60 sec time resolution. Cascavel period: 01/29/2014 to 03/10/2017. Curitiba period: 11/12/2013 to 07/15/2016.
- **Raingage:** 15 min time resolution. Period: same as distrometer.
- **CAS radar:** PPI at 1.5° elevation, every 7.5 min. Period: 01/05/2016 to 03/10/2017.
- **TXS radar:** PPI at 0.5° elevation, every 7.5 min. Period: 11/12/2013 to 07/15/2016.

Results

- **Comparison Distrometer-Raingage**

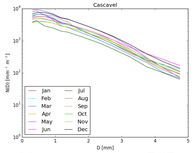


Scattergram of rain rate from distrometer and raingage at Cascavel, time resolution of 15 min.

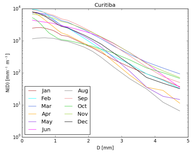


Scattergram of rain rate from distrometer and raingage at Curitiba, time resolution of 15 min.

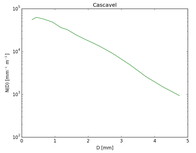
- **Drop Size Distribution**



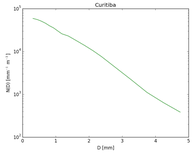
Monthly average DSD for Cascavel



Monthly average DSD for Curitiba. No data available for July.



DSD for the whole data period for Cascavel



DSD for the whole data period for Curitiba.

- **Z-R Relationships**

A and b coefficients for Cascavel for different relationships

General	288.5, 1.5					
Seasonal (1)	184.5, 1.6					
Seasonal (2)	422.0, 1.4					
Monthly	Jan	Feb	Mar	Apr	May	Jun
	237.0, 1.5	130.0, 1.7	209.0, 1.5	495.5, 1.3	292.5, 1.5	269.0, 1.5
	Jul	Aug	Sep	Oct	Nov	Dec
	387.5, 1.5	265.0, 1.7	378.5, 1.5	276.5, 1.6	382.5, 1.4	195.5, 1.6
Daily Interval (UTC)	10–14	14–17	17–22	22-10		
	164.0, 1.6	163.5, 1.6	152.6, 1.7	242.0, 1.5		

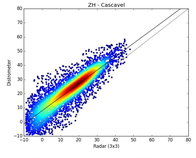
(1) Summer (December to February)
(2) Transition and Dry (March to November)

A and b coefficients for Curitiba for different relationships

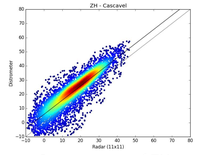
General	236, 1.5					
Seasonal (1)	229.5, 1.5					
Seasonal (2)	238.5, 1.5					
Monthly	Jan	Feb	Mar	Apr	May	Jun
	221.5, 1.5	138.5, 1.8	326.5, 1.4	352.0, 1.3	118.5, 1.8	157.5, 1.6
	Jul	Aug	Sep	Oct	Nov	Dec
	–	263.5, 1.6	164.0, 1.7	489.0, 1.3	352.0, 1.4	285.5, 1.4
Daily Interval (UTC)	10–14	14–17	17–22	22-10		
	152.0, 1.5	257.5, 1.5	422.5, 1.4	275.5, 1.3		

(1) Summer (December to February)
(2) Transition and Dry (March to November)

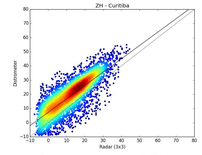
- **Scattergrams of ZH from Radar and Distrometer**



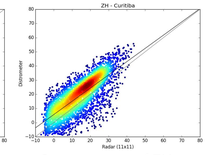
Scattergram of ZH radar vs ZH distrometer. Radar data are averages over 3x3 cells.



Scattergram of ZH radar vs ZH distrometer. Radar data are averages over 11x11 cells.

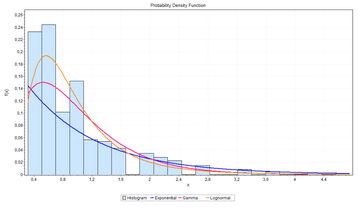


Scattergram of ZH radar vs ZH distrometer. Radar data are averages over 3x3 cells.

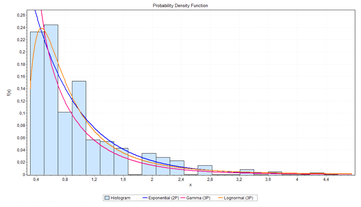


Scattergram of ZH radar vs ZH distrometer. Radar data are averages over 11x11 cells.

- **Standard Distribution Fitting for Cascavel Distrometer**



Probability density functions curves for Exponential (1P), Gamma (2P) and Lognormal (2P).



Probability density functions curves for Exponential (2P), Gamma (3P) and Lognormal (3P).

Comments and Conclusions

- Distrometric Z-R relationships were derived, which were stratified by season and by daily interval. The relations apply to most relevant radar covered areas in South Brazil with outstanding agro-industrial activities and hydropower generation. The Summer tuned (December-February) relationship is undergoing tests in the context of radar rainfall input to hydrological models.
- Reflectivities both from radar and distrometer were compared for two different radar cell areas. Scatterplots show slopes above 0.93 and a shift from the 1.1 curve; approximate bias range was 5-to-7 dBZ. Verification of this shift includes a thorough radar calibration procedure.
- DSD for the distrometer at CAS remain, in general, between the curves for July (dry season) and December (wet season); those two curves run approximately in parallel (ratio of droplet concentration about constant). Curves feature peak concentrations at the lowest diameter range, which are not much pronounced. For the Curitiba distrometer the curves run, in general, between those for March and August. Only the curves for December and January feature peak concentration; peaks are quite smooth.
- Exponential, Gamma and Lognormal standard distributions were fitted to the Cascavel distrometer data. The order of ranking (best-to-worst) through the K-S Goodness of fit Test was: lognormal, lognormal (3P), exponential (2P), gamma, gamma (3P) and exponential.

References

Baltas, E., Panagos, D., Mimikou, M., 2016: Statistical Analysis of the Raindrop Size Distribution Using Disdrometer Data. *Hydrology* , *3*(1), 9 .

Kalina, E. A., K. Friedrich, S. M. Ellis, D. W. Burgess, 2014: Comparison of Disdrometer and X-Band mobile radar observations in convective precipitation. *Monthly Weather Review*, 142, 2414-2435.