Uncertainties in precipitation estimates from space-borne radar observations

Mircea Grecu

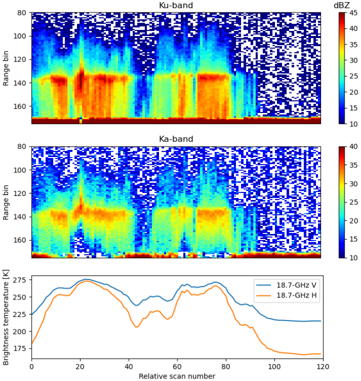
NASA Goddard Space Flight Center and Morgan State University

March 2nd,2023

Sources of uncertainties

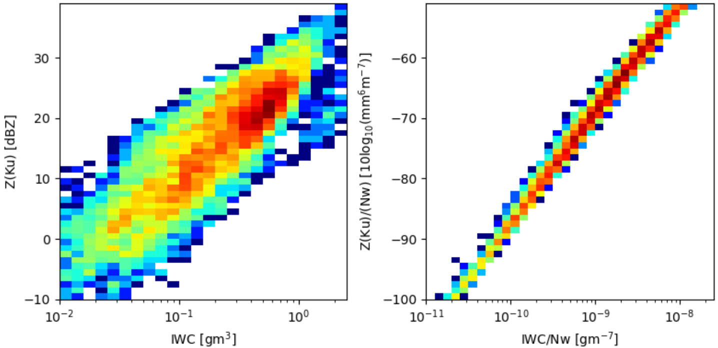
Major sources of uncertainty include:

- Variability in the Z-R relationships
- Attenuation in the observed radar reflectivity
- Variability in the radar beam footprint
- Ground clutter



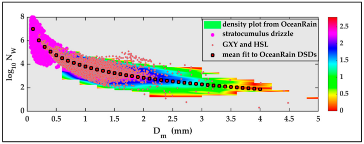
Variability in the Z-Precipitation Rate relationships

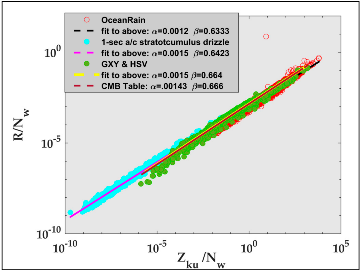
- At least 2 parameters are required to describe Particle size distributions (PSDs).
- Consequently, the Z-Precipitation Rate relationships require at least 2 parameters. The generalized PSD intercept, $N_w = \frac{4^4}{\pi \rho_w} \frac{PWC}{D_m^4}$, greatly simplify Z-Rate relationships.



The N_w problem. General considerations

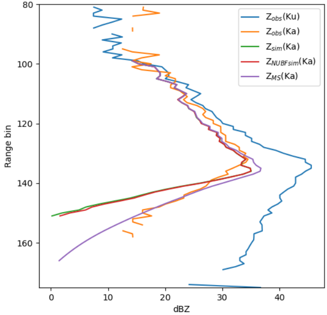
- The N_w parameter greatly simplifies the formulation, but not the problem.
- It does not solve it though, as N_w still needs to estimated independently of the radar observations.
- Ground observations may be used to impose constraints on N_w.
- However, such constraints are not very effective for PSD characterized by large mean particle sizes D_m.





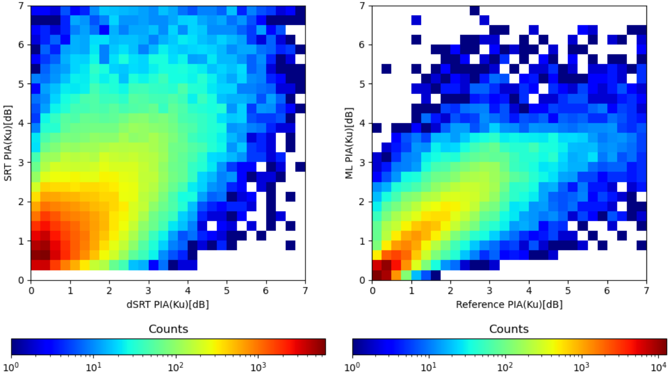
The N_w problem. Radar profiling considerations

- Additional constraints can be imposed by using radar by considering N_w in the radar profiling context.
- That is, the attenuation correction process needs to be consistent with the N_w parameter. $Z(r) = Z_m(r)/PIA$ $PIA = (1 - \epsilon(N_w)q \int_0^r Z_m^{\beta}(s)ds)^{1/\beta}$
- The analytical PIA needs to be consistent with the SRT PIA estimate and Ka-band reflectivity observations when available.



The N_w problem. Further considerations

- Surface Reference Technique (SRT) PIA is a useful piece of information when reliable.
- Dual SRT PIA is more reliable than single SRT PIA, except for heavy convection.
- Over oceans SRT PIA estimates are significantly more reliable than over land.
- For snow and light rain, SRT PIA estimates are not reliable.



Snow estimation issues

- The variability of N_w is still a problem, but there is very little attenuation in snow to use the PIA as a constraint.
- When dual frequency observations are available, D_m and hence N_w may be estimated from the dual frequency reflectivity ratio (DFR).
- However, the DFR may be very noisy.
- More robust methods, i.e. Machine-Learning based, may be used to derive to incorporate "in-situ" information and provide more accurate estimates.