Ice Retrievals from IMPACTS airborne radar observations

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Abstract

Ice retrievals from airborne radar observations from IMPACTS are investigated. Retrievals are derived using a non-parametric methodology (Grecu et al. 2018) that matches radar observations to synthetic reflectivities simulated from observed particle size distributions. A benefit of non-parametric procedure is that it provides uncertainty estimates for all the retrieved parameters, i.e. ice water content (IWC), mass mean diameter (Dm) and particle size distribution (PSD) generalized intercept (Nw). The retrieved parameters are compared to "in-situ" observations for three flight legs on 25 January and 5 February 2020. The retrieved IWC is highly correlated with estimates from the NCAR probes. The agreement is best when a variable mass-diameter relationship, derived by minimizing the differences between reflectivity simulated from the probe particle size distribution (PSD) and airborne radar observations, is used. The agreement between retrieved and in-situ Dm and Nw is not always good, but temporal and spatial sampling differences may impact the comparison.

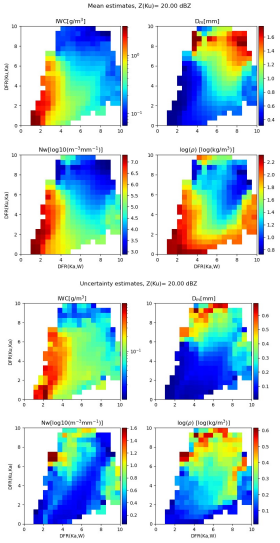
Objectives and Methodology

Objectives

- Derive IWC, Dm and Nw estimates from Ku,Ka, and W-band radar observations.
- Quantify uncertainties in the radar retrievals.
- Compare with in-situ estimates and quantify uncertainties in the NCAR probe estimates.

Methodology

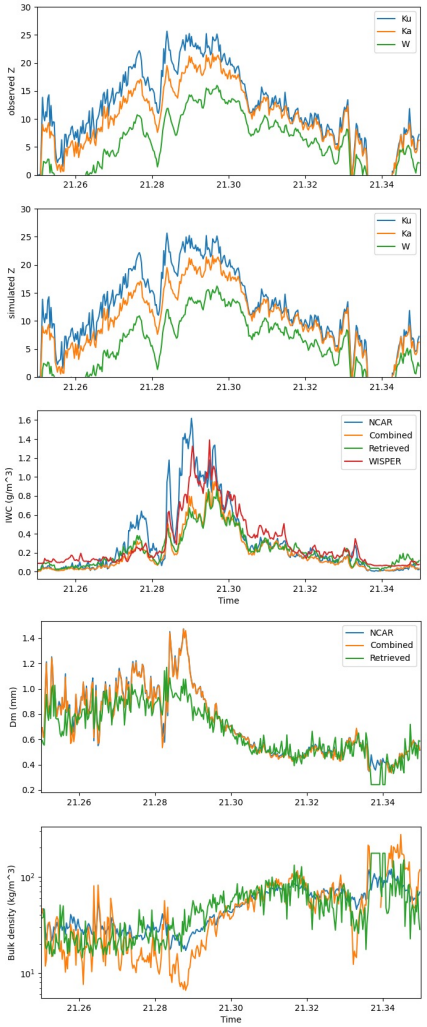
- Use sorting to construct scattering lookup tables that exhibit multiple mass-diameter relationships.
- Simulate Ku-, Ka-, and W-band reflectivities and specific attenuation from NCAR probe PSD observations and all existing scattering lookup tables.



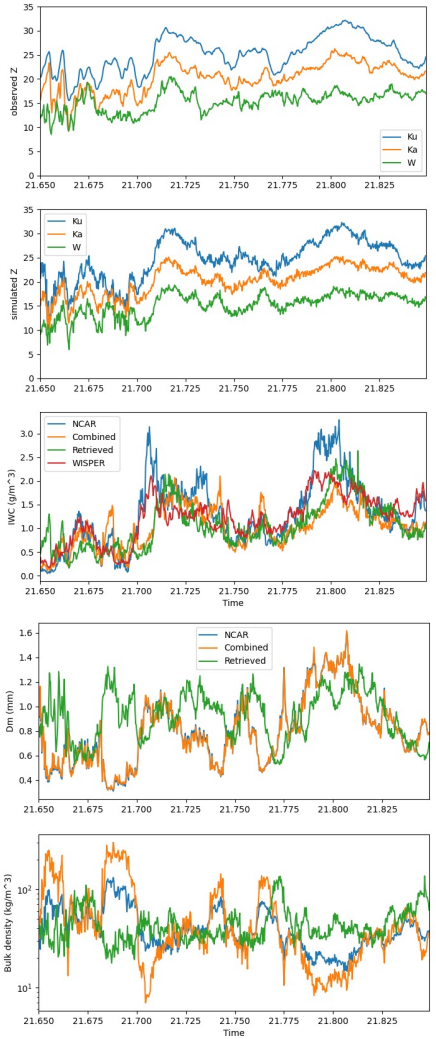
- Use range search procedure to derive mean estimates and uncertainties for every possible (Ku,Ka,W) reflectivity combination (an example for Z(Ku)=20dBZ is shown in the plot above).
- Derive retrievals for flight legs with good in-situ observations.
- Derive in-situ optimal estimates by minimizing the errors between reflectivity observations simulated from observed PSD and actual radar observations. This is achievable by choosing the scattering lookup tables that minimizes the differences between simulations and observations.
- Analyze and interpret results.

RESULTS (5 February 2020)

- Three flight legs (one on 5 February 2020, and the others on 25 January 2020) are investigated.
- The agreement between IWC retrievals and in-situ estimates is good for all three cases
- Dm and Nw retrievals agree best with the in-situ observations for the 5 February case. For the other two cases, the agreement is rather poor, but the patterns in Dm are suggestive of temporal-spatial mismatches.



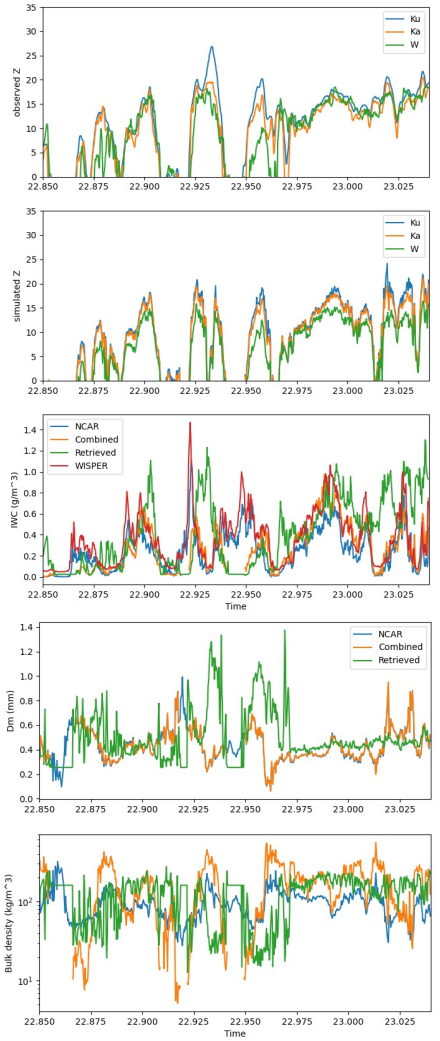
RESULTS (25 January 2020)



Conclusions

- Retrieved IWCs agree well with the in-situ estimates for all cases.
- The agreement between retrieved and in-situ Dm varies from case to case (temporal and spatial mismatches may impact the agreement).
- Reflectivities simulated from in-situ PSD agree well with radar observations, which suggests that variability in the mass diameter relations is a major source of uncertainty in both radar retrievals and in-situ estimates.

RESULTS (25 January 2020; ctd)



Future Work

- Additional cases.
- Explicit error bars on all variables.