Characterizing the spatial variability of ice water content in and below mixed-phase clouds.

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B08

1. Motivation

- Mixed-phase clouds (MPC) play important role in Arctic climate system
- Processes determining spatial variability of ice water content (IWC) in MPCs not sufficiently understood
- Observing MPC processes directly is challenging
- Radar observations of IWC not very accurate

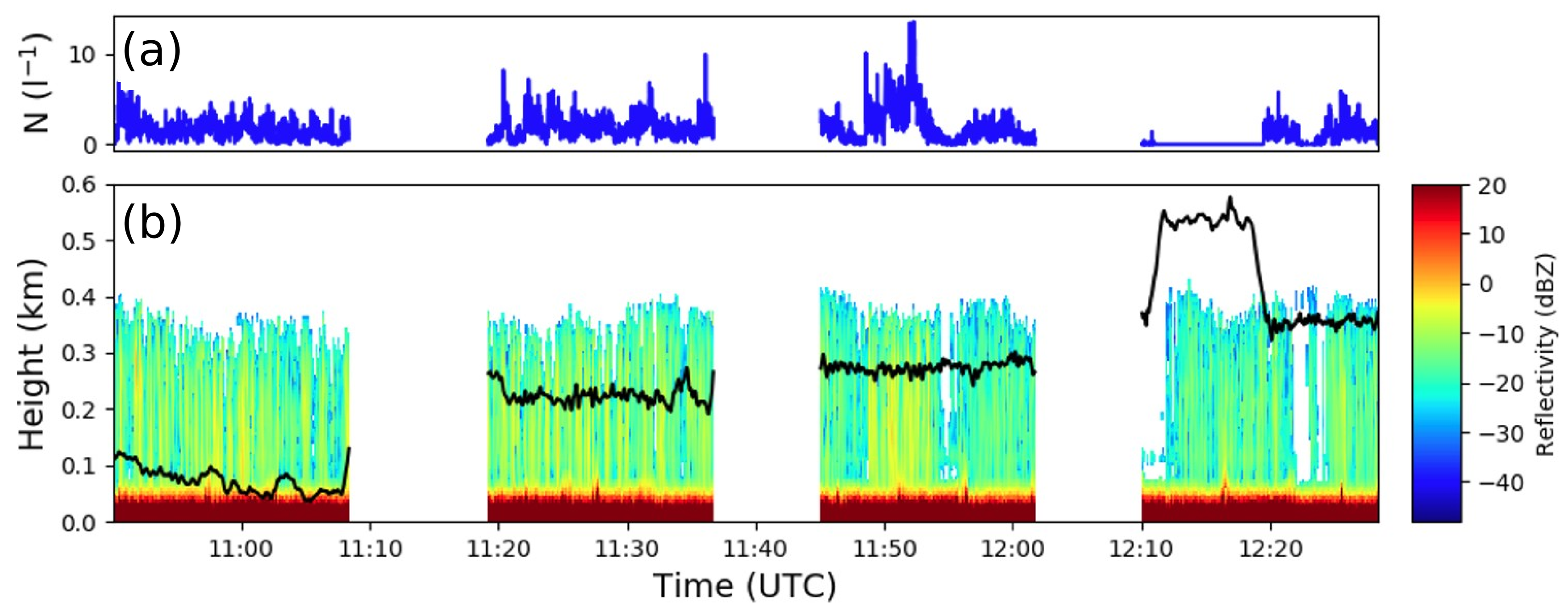

Fig. 1: *(**a**): in-situ number concentration, (**b**): radar reflectivity and flight altitude of in-situ aircraft, ACLOUD, Ehrlich et a. 2019*

Research Objectives

1) Improve **understanding of processes influencing spatial variability** of Arctic MPCs

2) Develop **seamless inverse retrieval for complete cloud 'curtain'** to combine the information content of in-situ and aircraft measurements

2. Data

(AC)³ aircraft campaigns: ACLOUD & HALO (AC)³

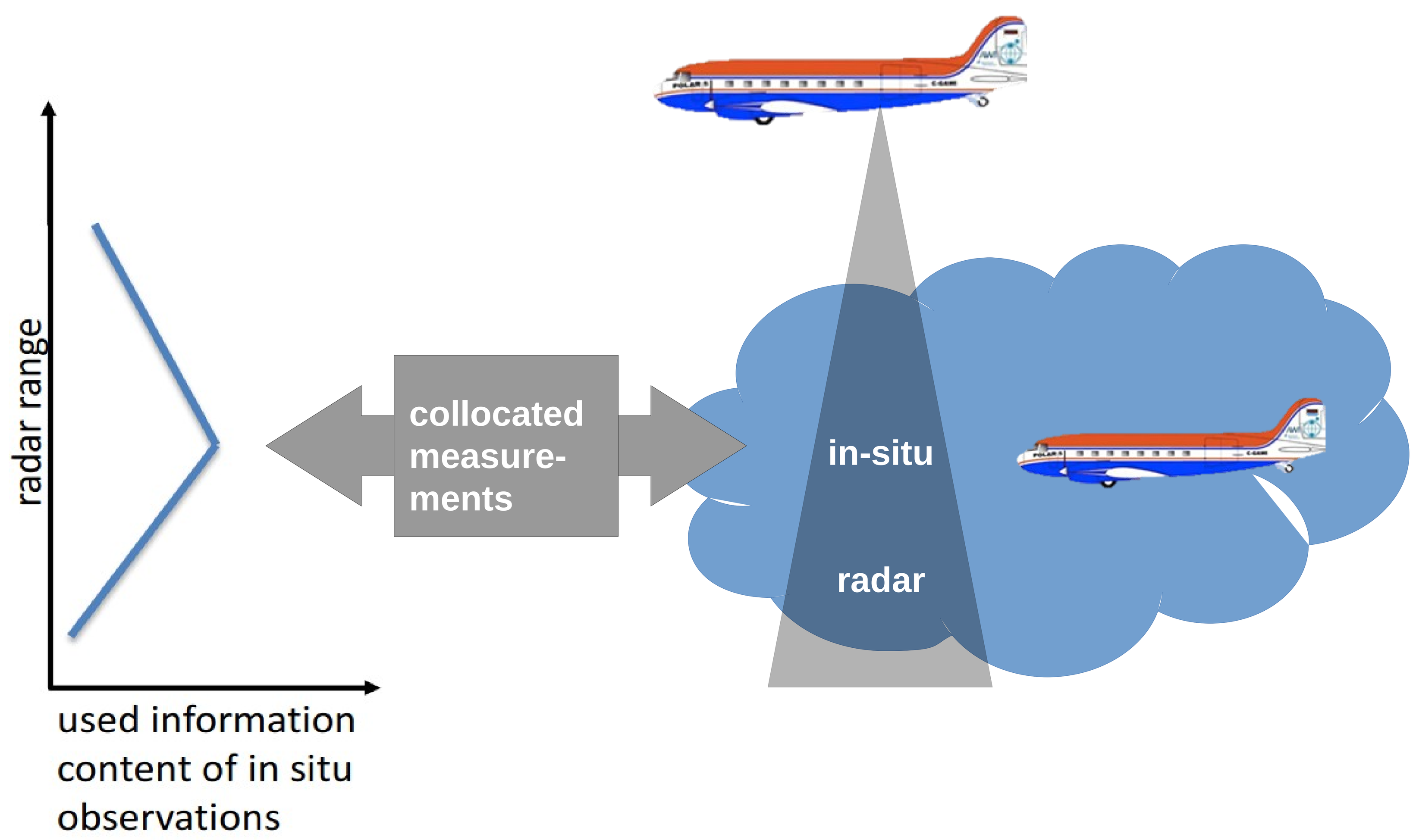

Fig. 2: *Collocated radar and in-situ measurements*

4. Preliminary results & Outlook

- PhD (Nina Maherndl) started July 2021
- Work in progress: closure of in-situ and radar measurements during ACLOUD, see Fig. 4 for case study of flight 11

Hypothesis

Spatial variability of IWC in and below MPCs is regulated by:
- spatial variability of **surface properties**
- and **cloud top thermodynamic phase**
- **macrophysical properties** (cloud type, liquid water path, cloud depth, ...)

Correlating these properties to IWC variability will allow to identify the dominating processes.

3. Methods

Obtain **closure** between **forward modeled in-situ data** and **observed radar reflectivity** values to asses forward operator performance
Joint in-situ & radar ice water content retrieval based on **Optimal Estimation**
Use in-situ observations as a priori information for the retrieval scale uncertainty with physical distance between radar and in-situ measurements

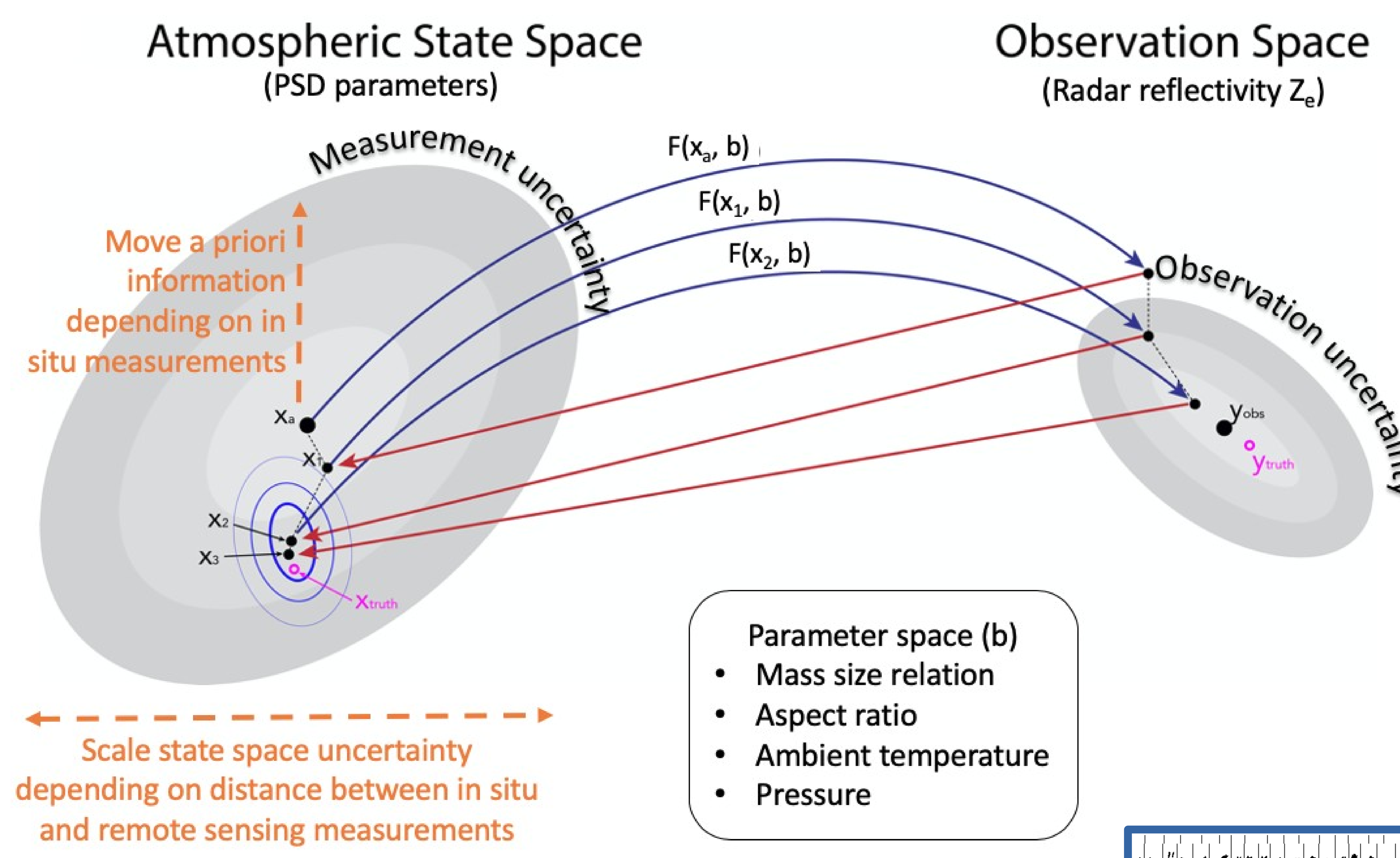

Fig. 3: *Optimal estimation, modified after Maahn et al. 2020*

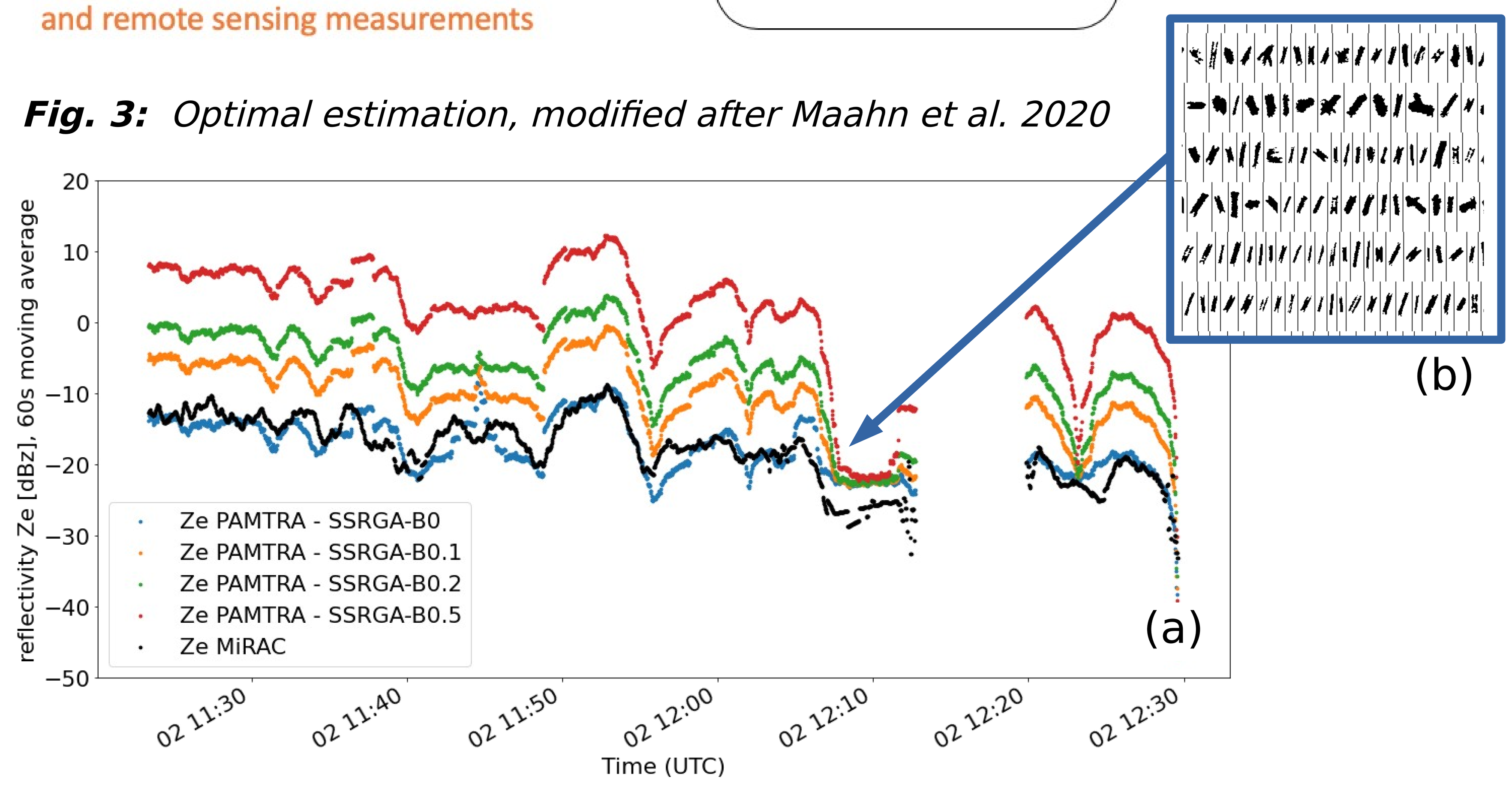

Fig. 4: (a) *PAMTRA simulated radar reflectivities using Self Similar Rayleigh Gans Approximation (SSRGA) and different mass-size relationships derived by Leinonen and Szyrmer (2015) for increasingly rimed aggregates compared to MiRAC measured radar reflectivity. **(b)** Example CIP images of particles larger 500 microns provided by Regis Dupuy.*

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