A Bimodal Particle Distribution Assumption in Cirrus: Comparison of retrieval results with in situ measurements

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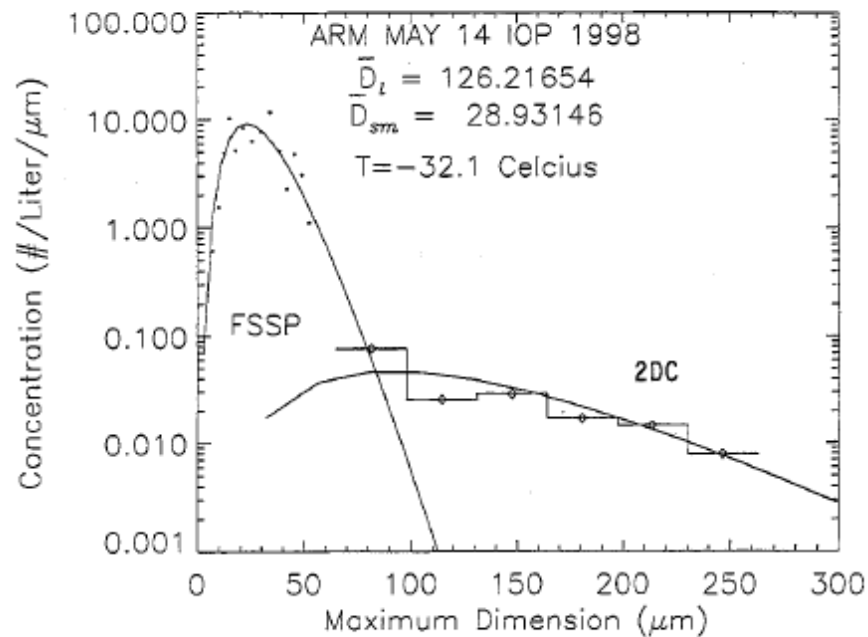Contributions from Min Deng, Jennifer Comstock

Motivation

Fig. 3. Example of FSSP and 2DC size spectra, their parameterized gamma fits, and how FSSP size spectra were extrapolated to larger sizes via a gamma fit to test for continuity with 2DC spectra.

- Particle spectra collected in situ consistently demonstrate bimodality with a small particle mode dominating the number concentration and extinction.

- Evidence for bimodality must be present in remote sensing measurements – if it exists at all (Mcfarquhar et al, 2007).
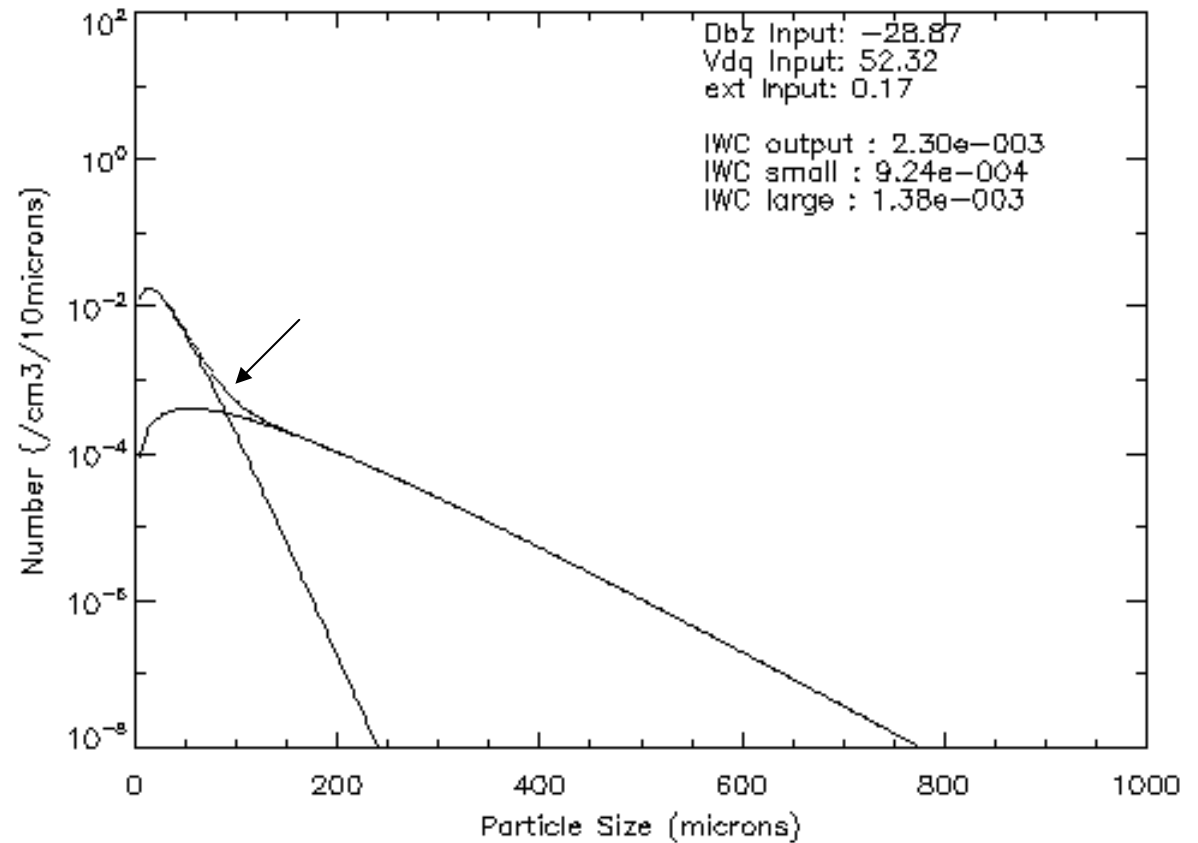
Particle Size Distribution Assumption

- Bimodal PSD: two modified gamma

$$N_s(D) = A_s \left(\frac{D}{Dg_s} \right)^{\alpha_s} \exp\left(-\frac{D - Dg_s}{Dg_s}\right)$$
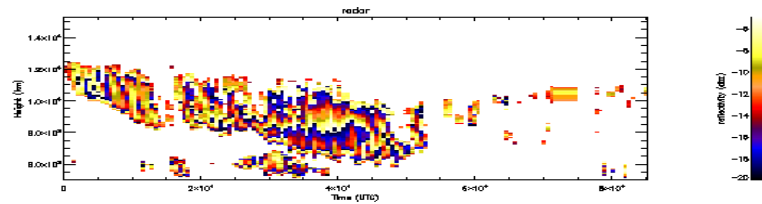
$$N_l(D) = A_l \left(\frac{D}{Dg_l} \right)^{\alpha_l} \exp\left(-\frac{D - Dg_l}{Dg_l}\right)$$
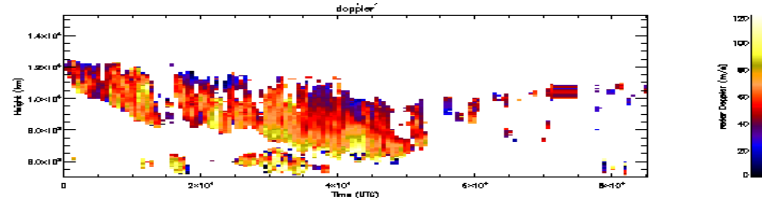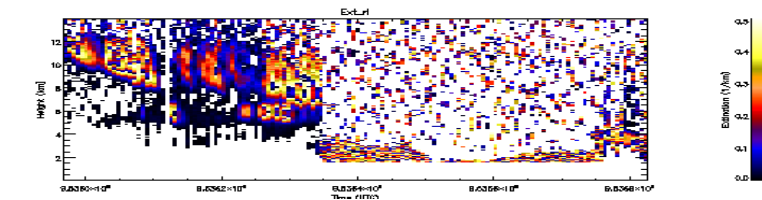
$$N(D) = N_s(D) + N_l(D)$$

Measurements

Ze

Vd

ext

Problem: Three measurements (extinction, Z, Vd)

Solution: Assume the particle size at which the functions agree and iterate on this quantity searching for best agreement with data.

Raman Data Provided by Jennifer Comstock

Retrieval Algorithm

- Forward model:

$$Z_e = \int\limits_{.}^{\infty} a_z N(D) D^{b_z+6} dD$$

$$V_{dq} = V_d - W_m = \frac{1}{Z_e} \int\limits_{0}^{\infty} V(D) a_z N(D) D^{b_z+6} dD$$

$$\beta_{ext} = 2\int\limits_{0}^{\infty} a_a D^{b_a} N(D) dD$$

$$R = \frac{N_l(D_q)}{N_s(D_q)} = 1$$

- One mode or two modes:

    Compare calculated extinction with total extinction
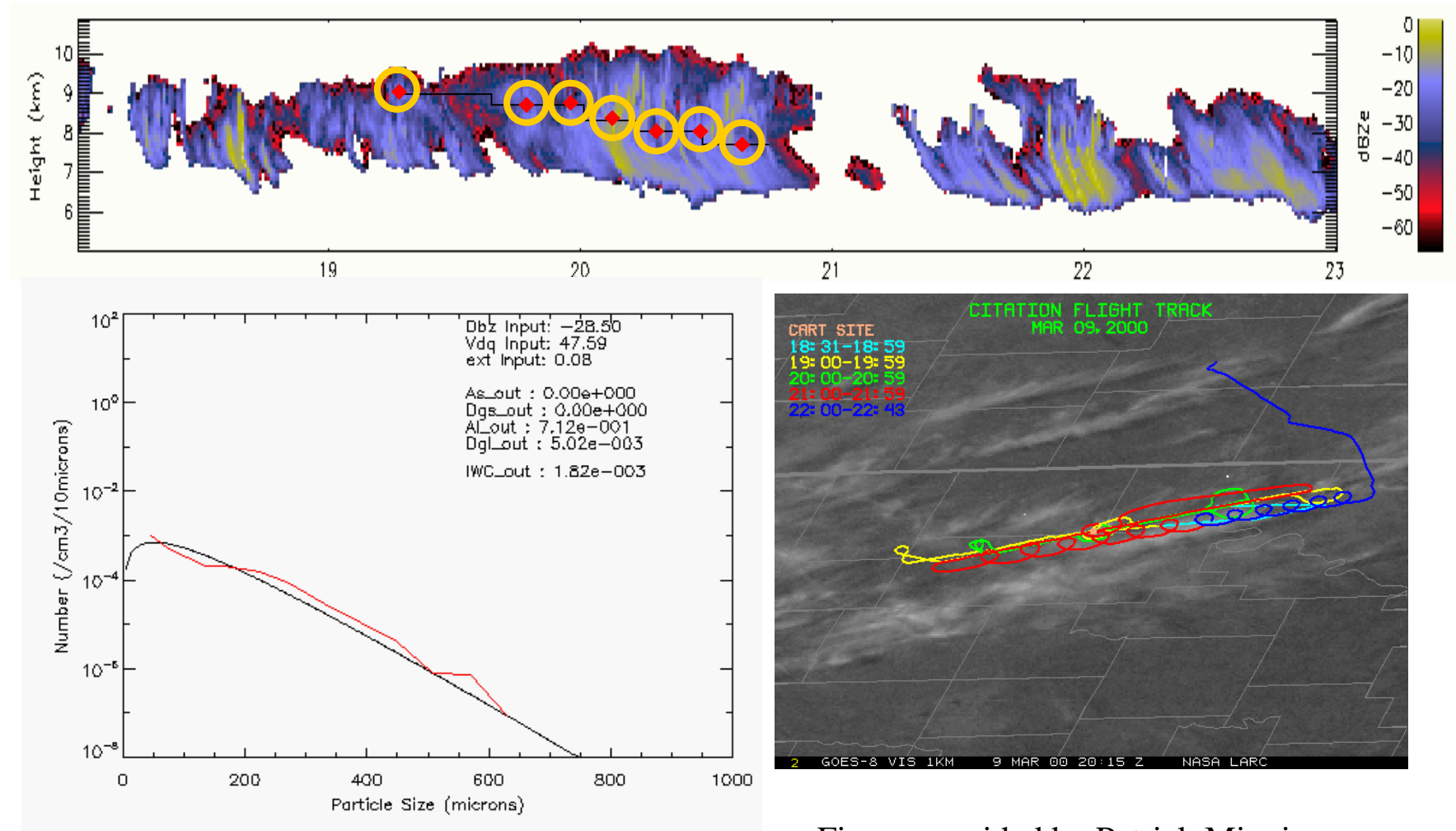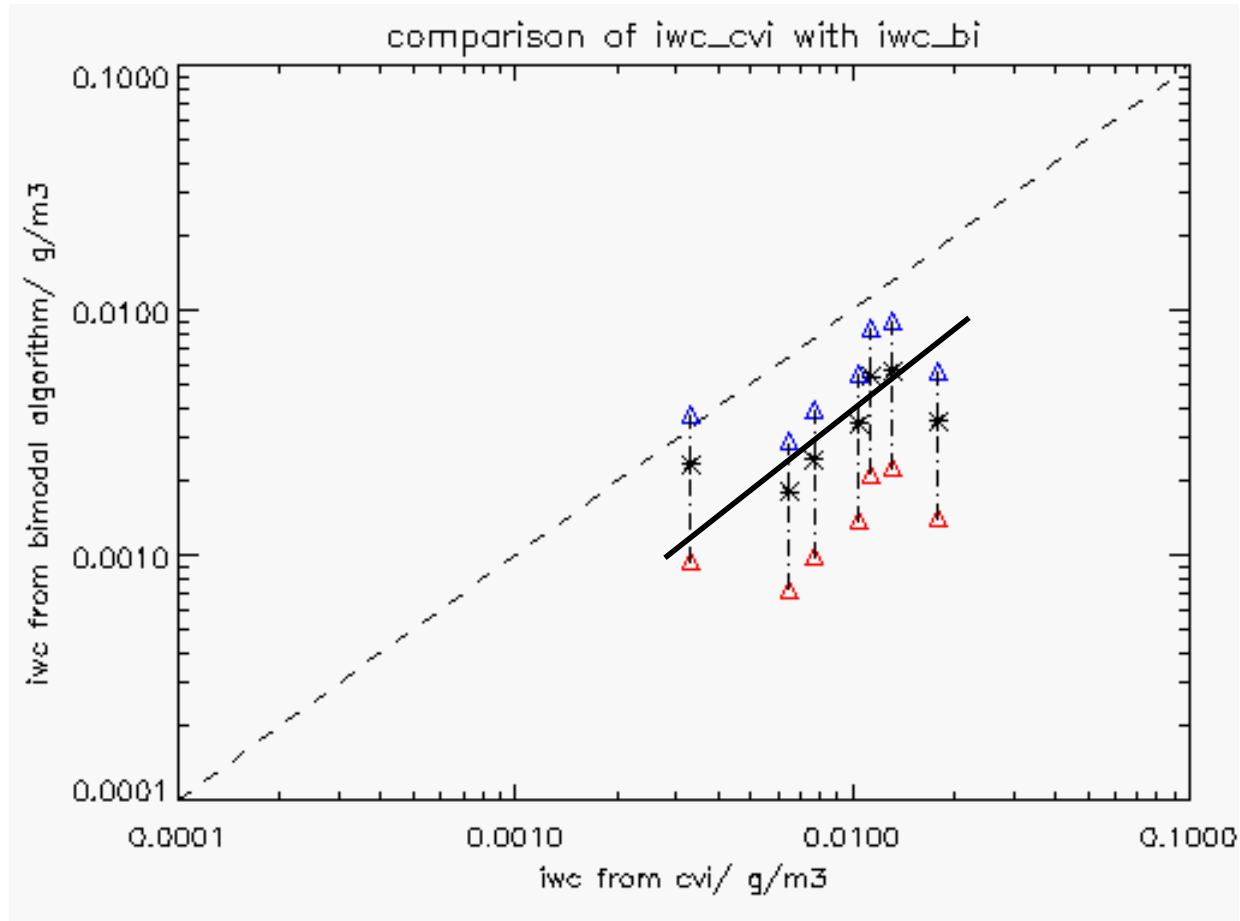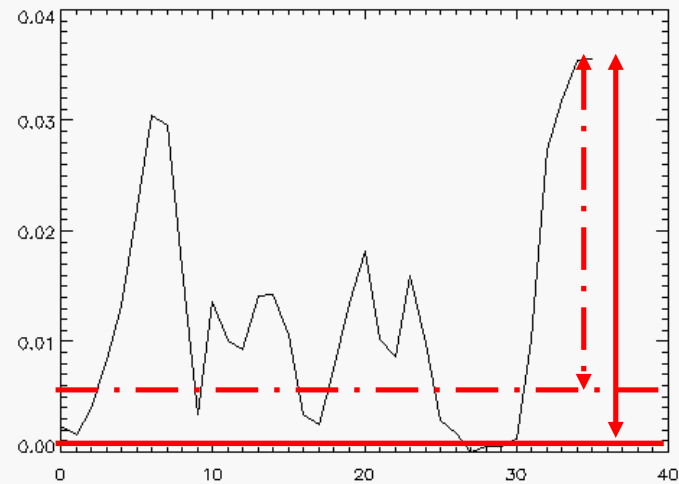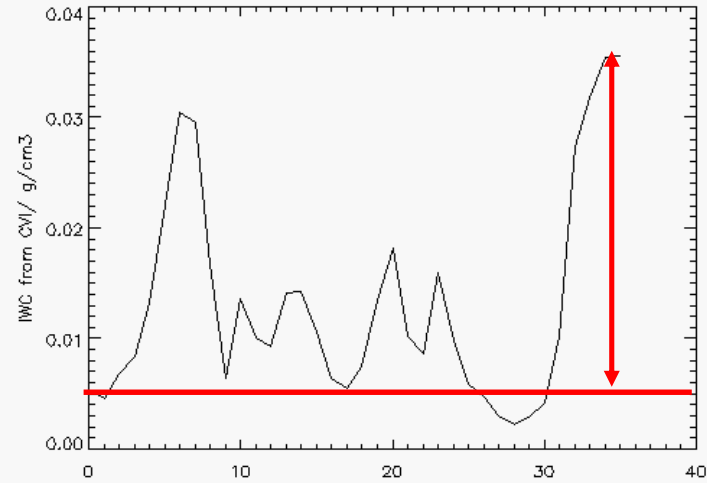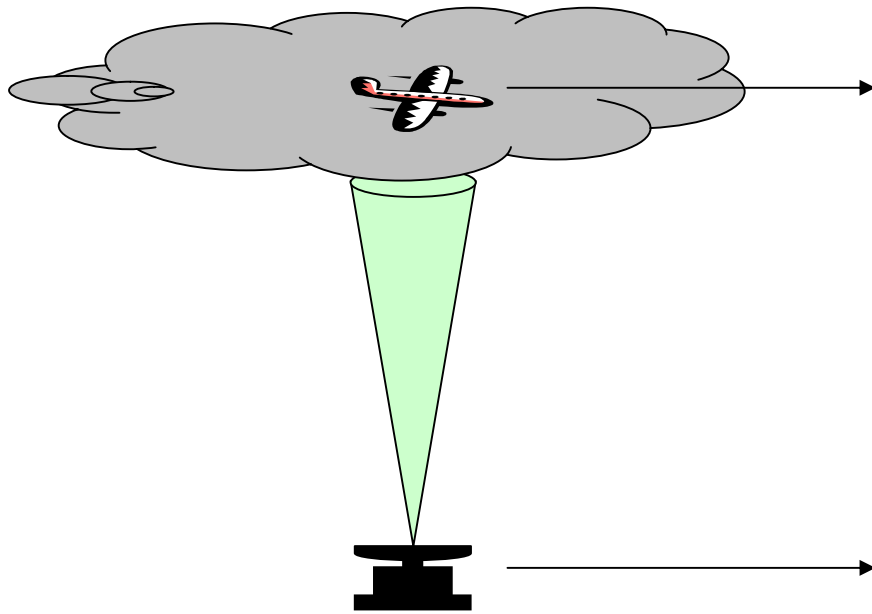
In situ Measurements
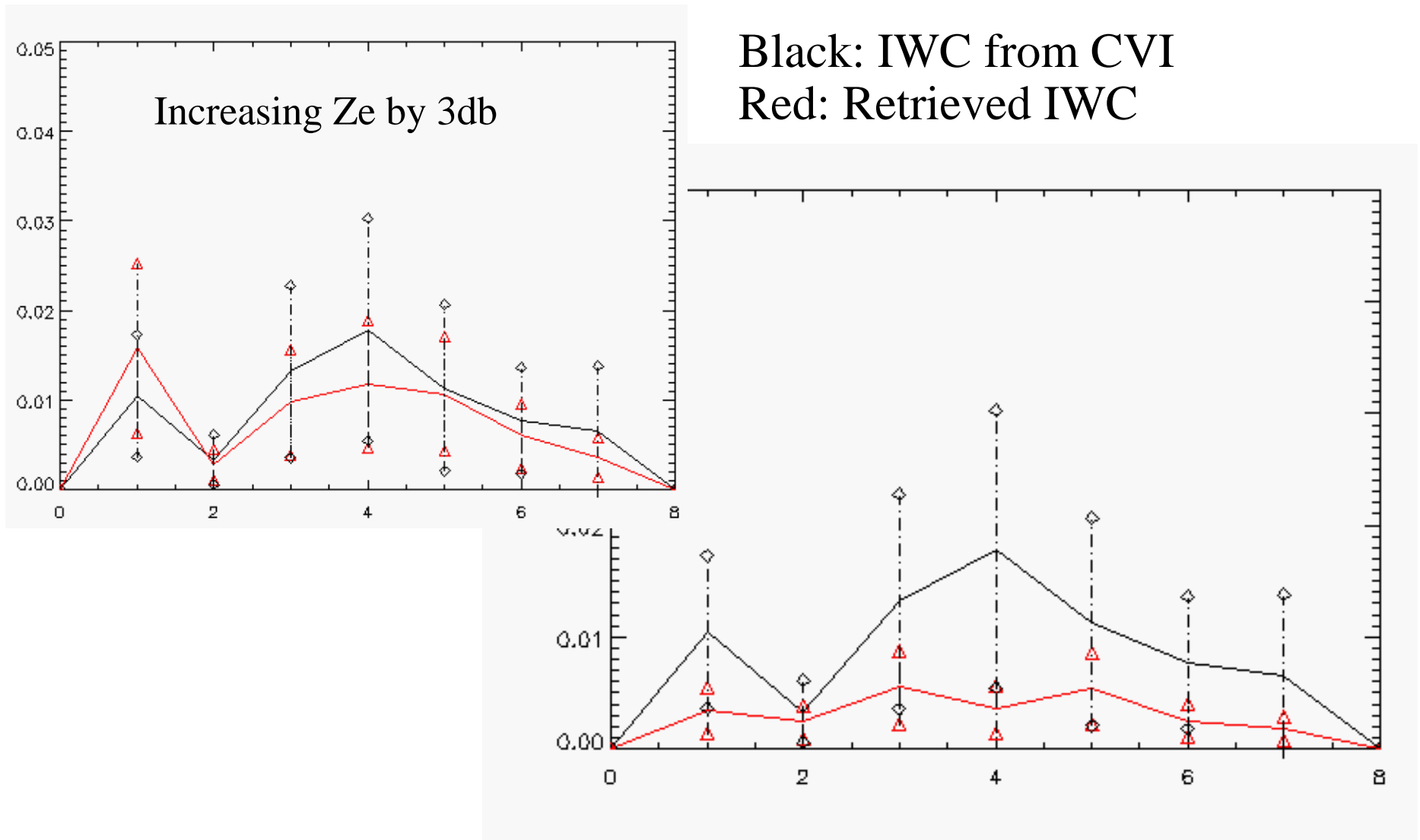

Figure provided by Patrick Minnis

Comparison of IWC

CVI data provided by Cynthia Twohy

Due to CVI not Measuring small IWC

Due to Instruments Calibration?

Increasing Ze by 3db

Black: IWC from CVI
Red: Retrieved IWC

Future Work

- Take into account the effect of small IWC that CVI cannot measure

- Calibration of radar measurements

- Compare FSSP size distributions