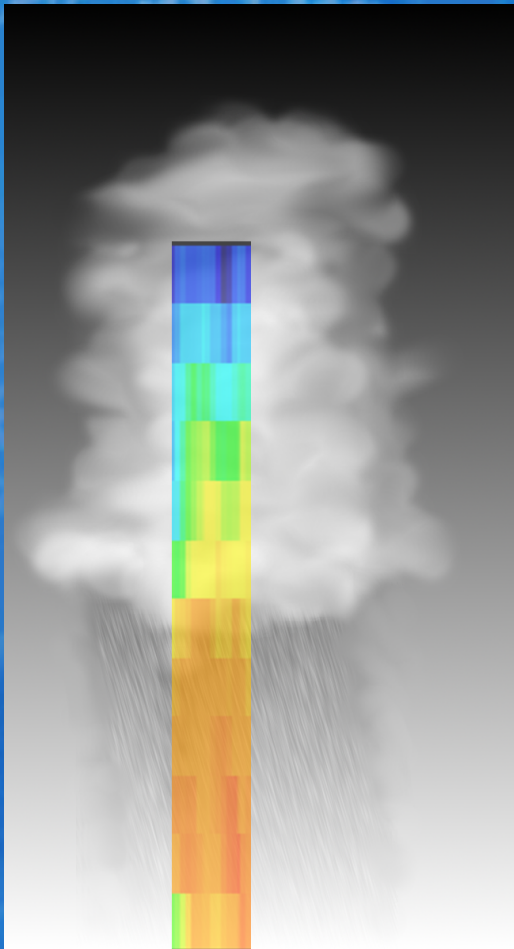


A Radar-based Snowfall Retrieval Product for NSA



This talk:

- ❑ Brief overview of retrieval
- ❑ Information-content based design decisions and retrieval advances

Additional details presented yesterday
in poster #173 (Cooper et al.)

Norman Wood, University of Wisconsin - Madison
Tristan L'Ecuyer, University of Wisconsin - Madison
Steve Cooper, University of Utah



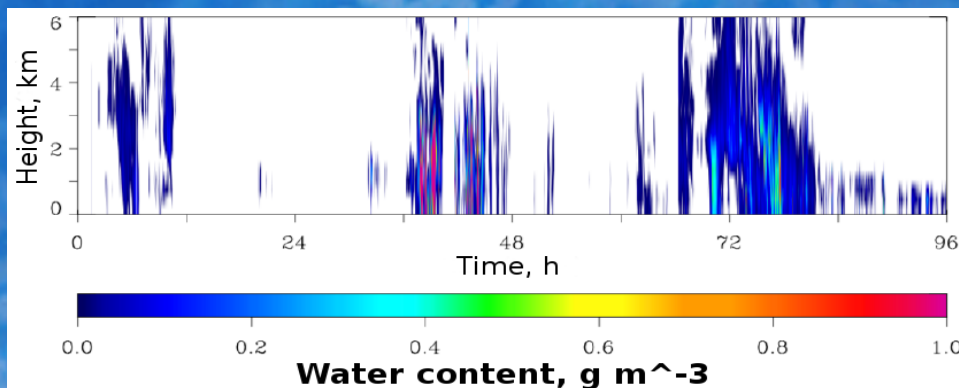
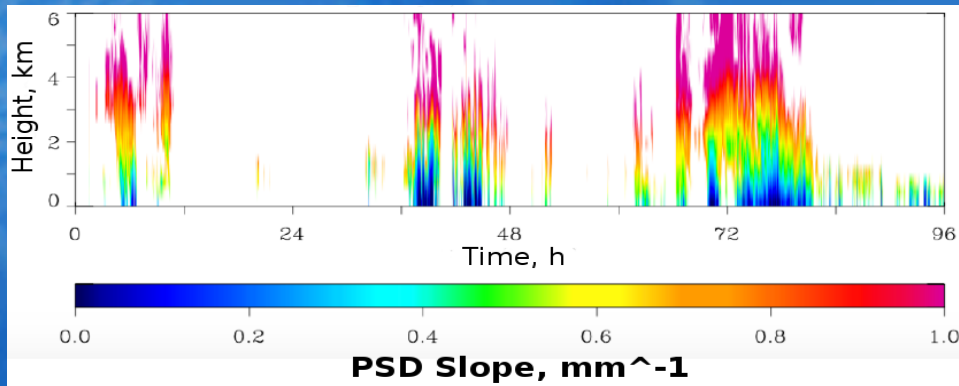
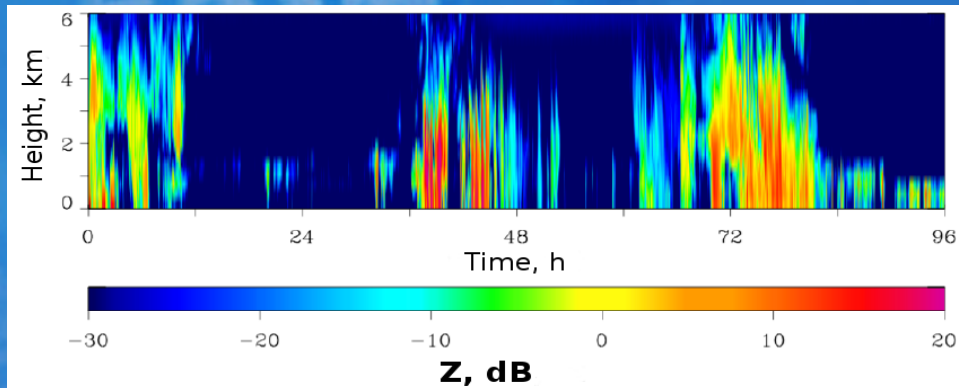
U.S. DEPARTMENT OF
ENERGY

Office of
Science



Retrieval

Surface snowfall rate with vertical profiles of size distributions and water contents



Bayesian **optimal estimation** (OE) uses KaZR Z_e profiles with *a priori* information (Gaussian PDFs) about particle properties and size distributions “background” values and about temperature.

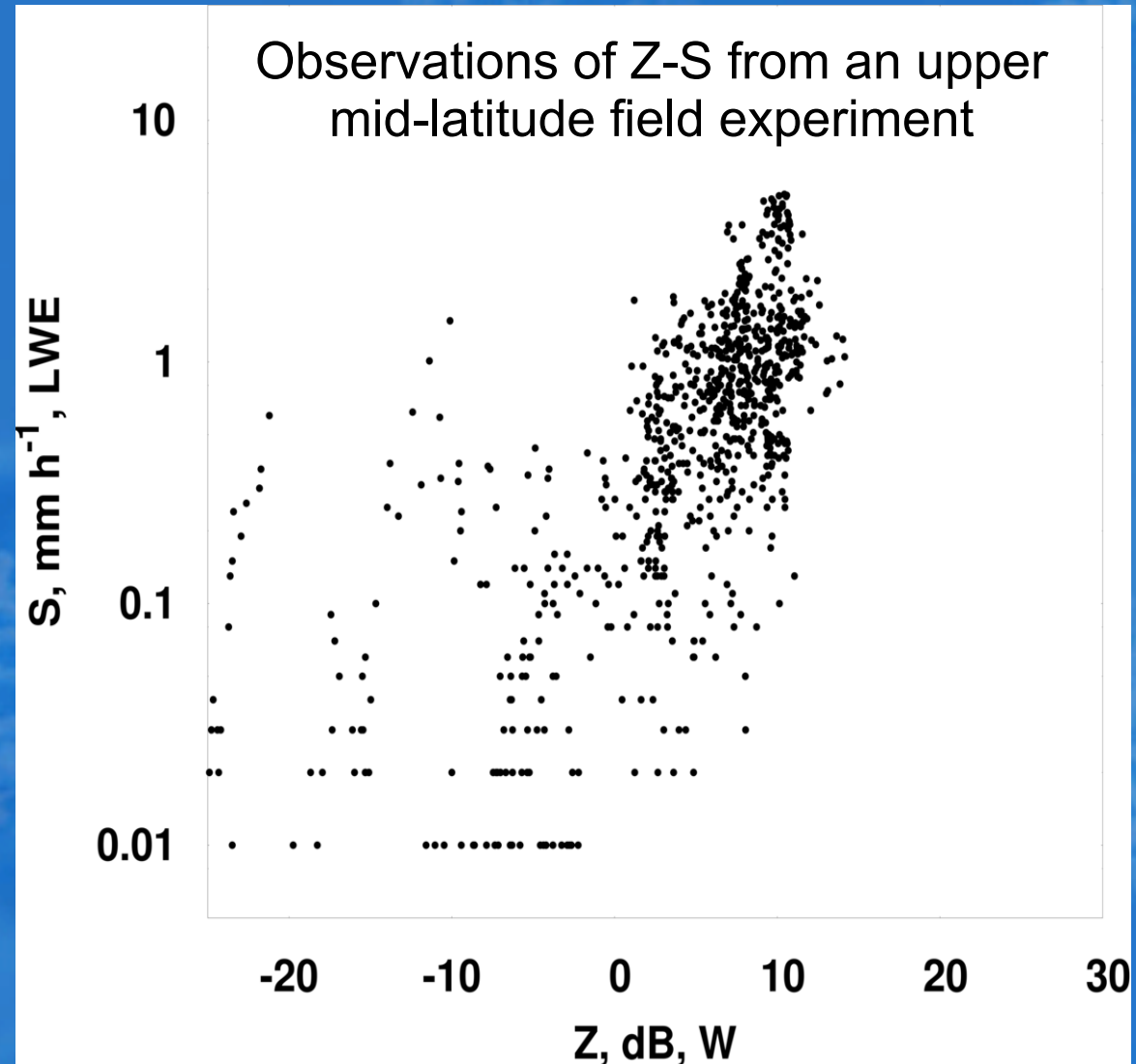
The retrieval improves the estimates of exponential size distribution PDFs based on the observed reflectivity profiles.

The retrieval applies *a priori* particle properties to retrieve size distribution PDFs, from which **water content profiles** and **surface snowfall rates** (with **uncertainties**) are derived.

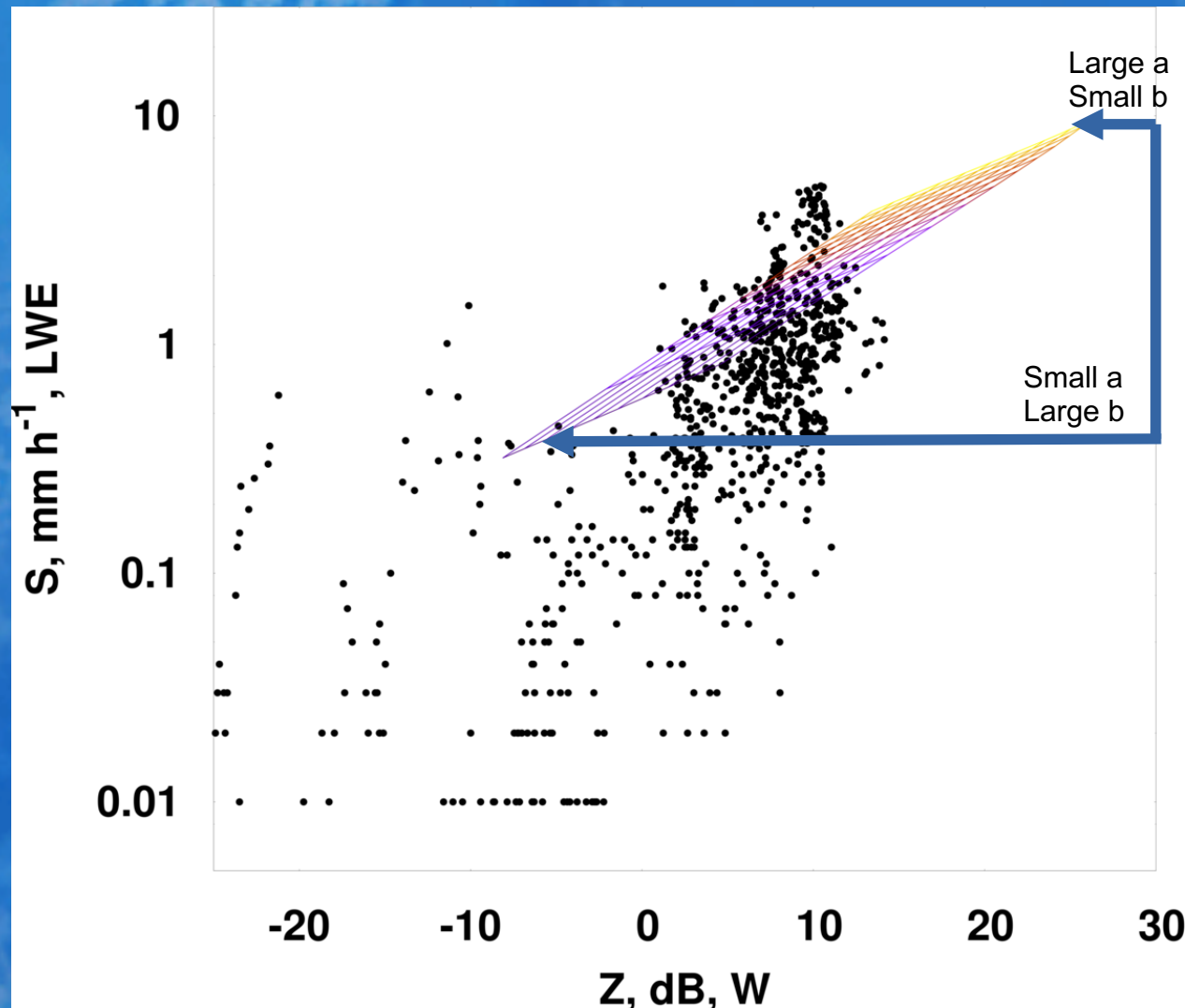
What drives Z-S variability?

- PSD
- Particle properties:
 - mass
 - shape
 - mass and shape together control:
 - backscatter cross-section
 - fallspeed

Which are most significant?



Effects of Mass, PSD, and Fallspeed

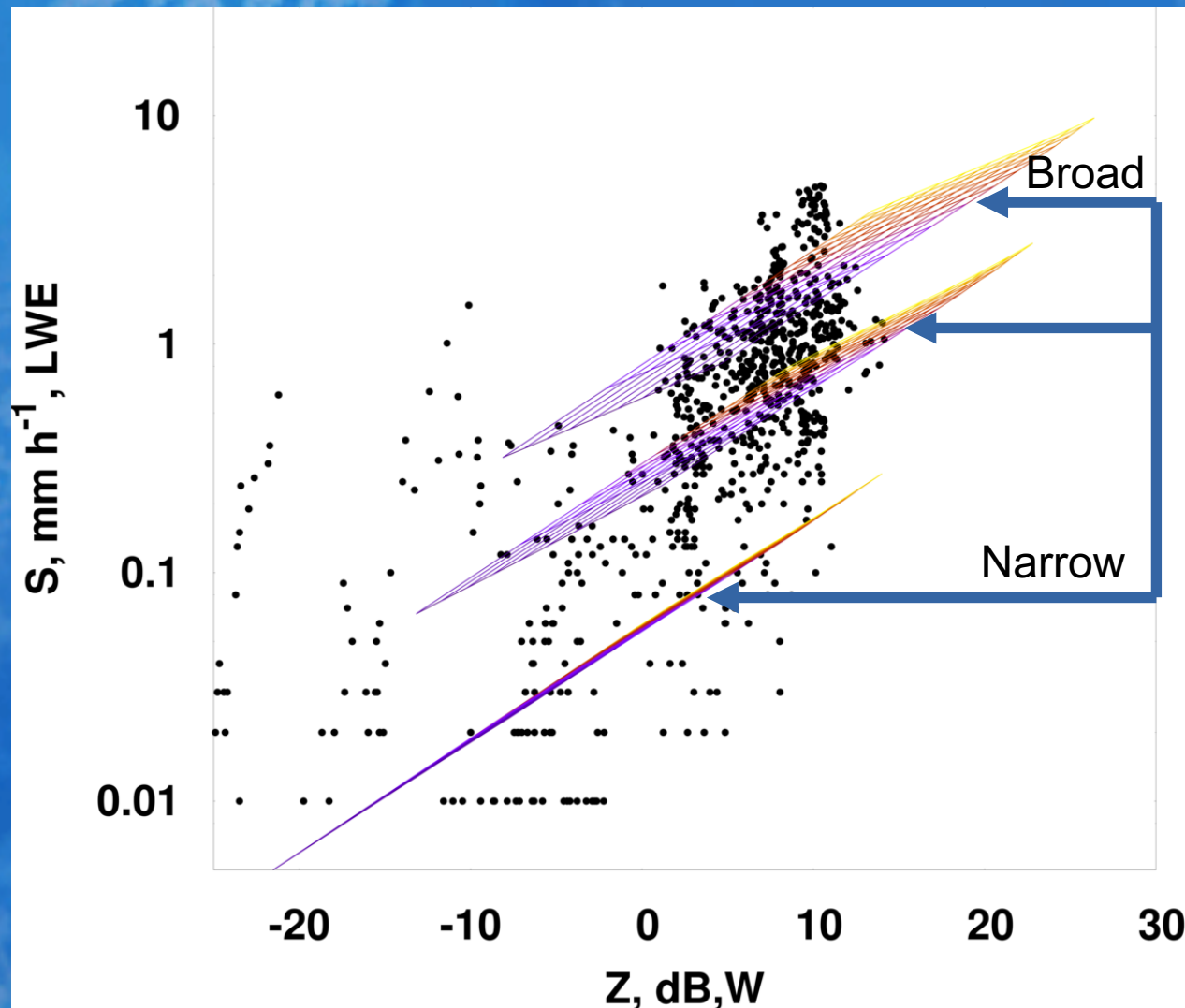


Variations in $m(D)$ for fixed PSD (broad), fallspeed (~ 1 m/s), and shape (spheroidal)

- $m(D) = aD^b$
- The colored grid shows variations in a and b

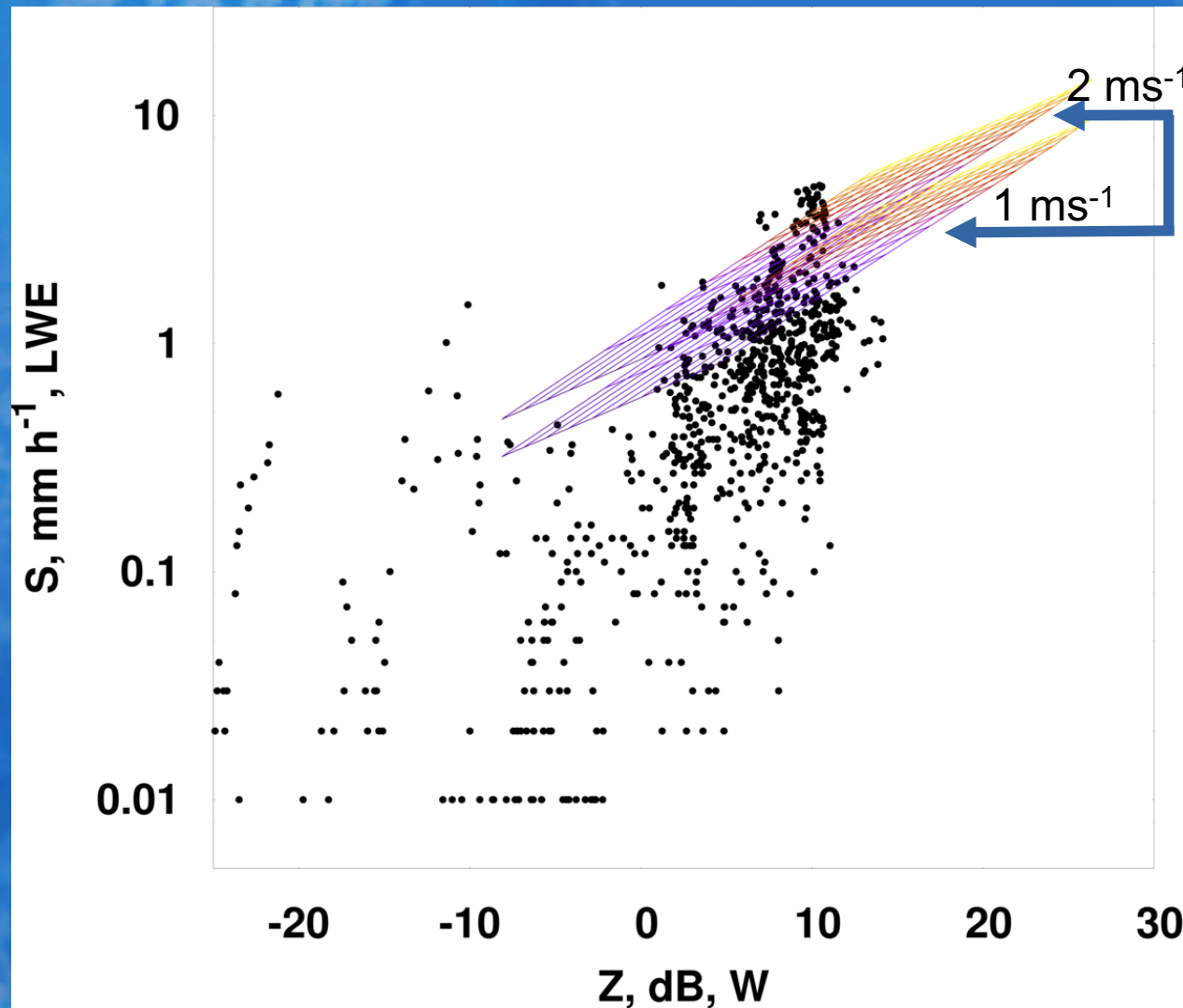
Note: Combinations of a and b used for these T-matrix simulations extended beyond observed values

Effects of Mass, PSD, and Fallspeed



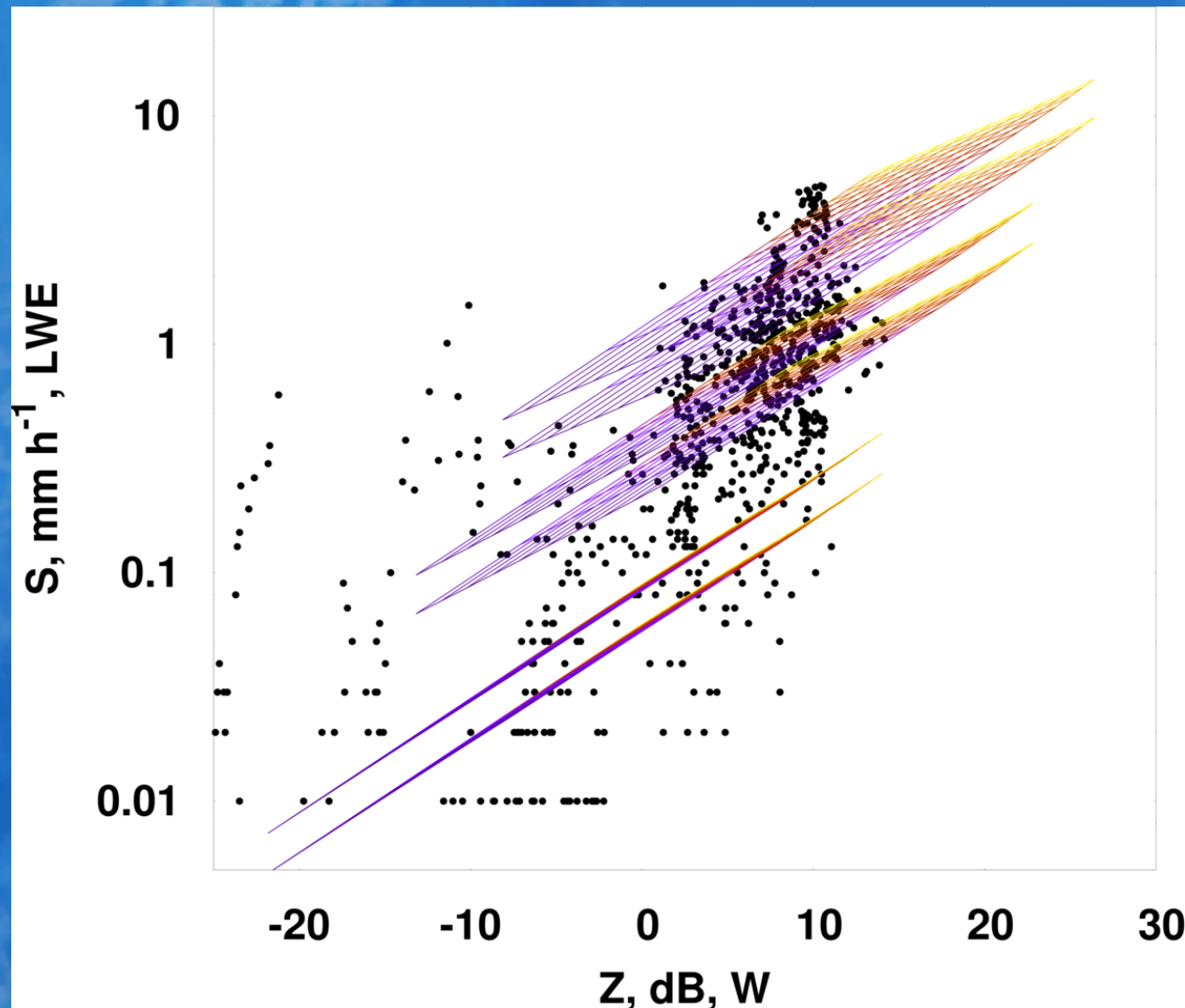
Variations in PSD (broad to narrow) with fixed fallspeed (~ 1 m/s), and shape

Effects of Mass, PSD, and Fallspeed



Variations in fallspeed with fixed PSD and shape

Effects of Mass, PSD, and Fallspeed

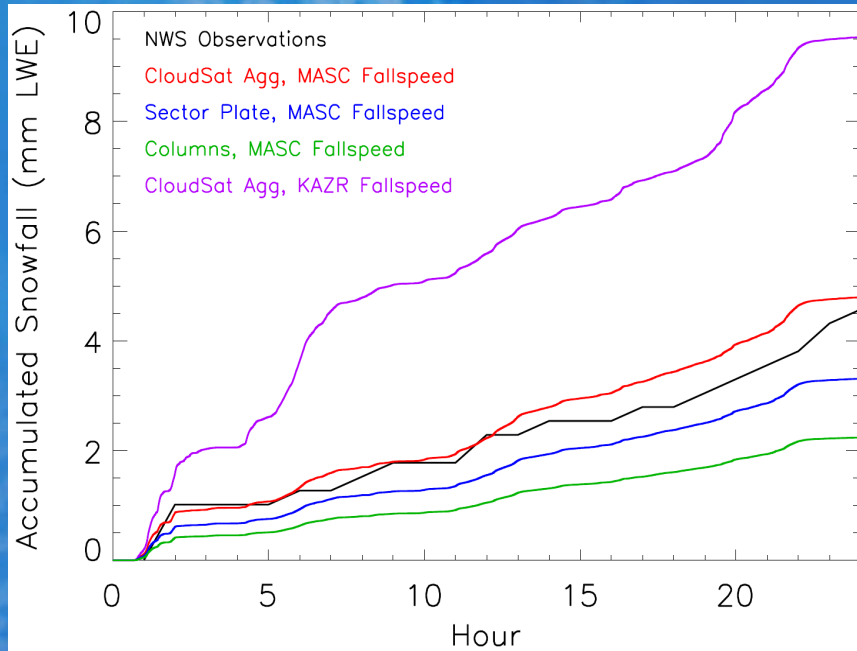


Sources of Z-S variation

- PSD is primary
- Mass, i.e. $m(D)$, is secondary
- Fallspeed is tertiary

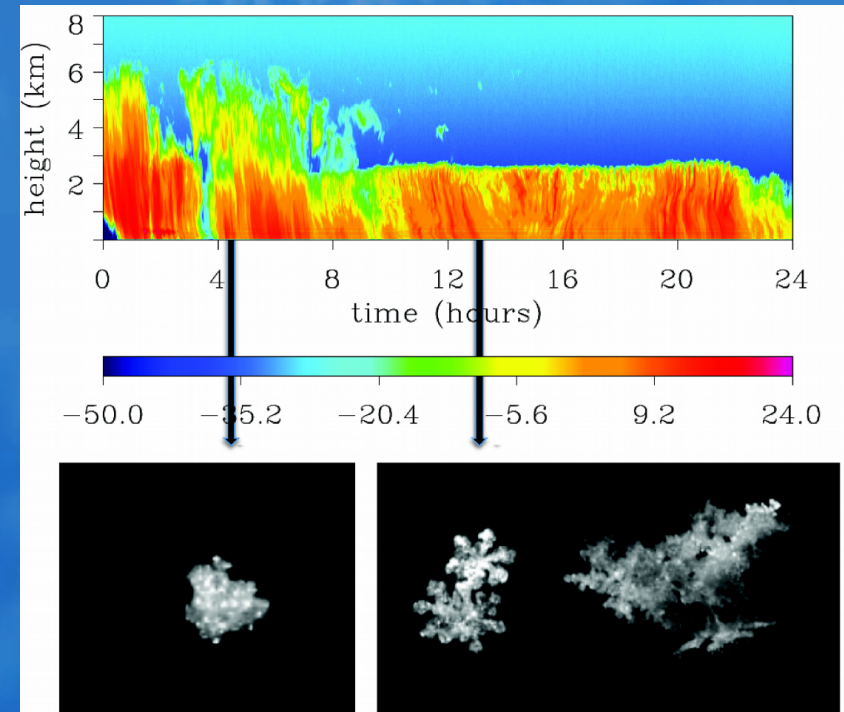
What about shape?

Shape Effects



Different shapes, same $m(D)$ and $V(D)$: Pure shape variations (independent of mass) affect retrieval results non-negligibly, but have less effect on Z-S than PSD and mass.

Particle imagery data (illustrated here from the Multi-Angle Snowflake Camera, but also from the Particle Imaging Package, PIP) are being investigated in conjunction with other relevant observations for constraining *a priori* particle properties (e.g., $m(D)$, $V(D)$)



Conclusions

- Z-S is controlled primarily by PSD. Associated uncertainties may be reduced by using regime-specific observed PSDs.
- $m(D)$ followed by $V(D)$ are also significant uncertainty source, but can be constrained using coincident particle imagery.
- We are working to ready the new snowfall data product for distribution later this summer.

