Outline

• Motivation
• Cloud Probes
• Shattering Issues
• Quick-Look Products in Field
Motivation

1. μphysics data, together with other data/modeling studies, will identify & quantify instabilities & forcing mechanisms (frontogenesis, gravity waves) associated with bands & relate μphysical evolution of substructures to mesoscale dynamic forcing

2. SDs & bulk μphysics will be used to
   i. Input to mesoscale parameterization schemes
   ii. Knowledge about processes in continental winter cyclones
   iii. Info for characterizing m-Z relations
   iv. Data for placing μphysics in context of radar derived structure of bands (spatial structure & air motions)
   v. Determine how seeder/feeder process evolves within & outside bands
   vi. Determine role of supercooled water in generation of ice particles near cloud top & in subsequent growth as fall through trowal & warm frontal regions
Measurement Needs

- Need to measure SDs over complete range of particle sizes
- Need to measure bulk mass (liquid and ice) to ensure consistency with SDs through closure studies
  - Also required for Z-m relations
Cloud Probes

- FSSP-100 (3 to 45 \( \mu \)m), uncertain in ice
- CDP (3 to 45 \( \mu \)m), no inlet/shroud
- 2D-C (125 to 800 \( \mu \)m), shattering for D < 200-300 mm?
- 2D-P (200 to 6400 \( \mu \)m), good for large particles
- CPI (25 to 800 \( \mu \)m), particle images, SDs?
- CSI (measure of bulk water)
- PVM-100 liquid water probe
- PMS King liquid water probe
- TSI 3760 CN counter
- Rosemount icing detector
Shattering Effect: CAS vs CDP vs FSSP

Cloud and Aerosol Spectrometer
- Shroud
- Inlet

Forward Scattering Spectrometer Probe
- Surfaces for shattering

Cloud Droplet Probe
- No inlet or shroud

✓ The same working principle and look-up table
✓ Can we see evidence that shattering on FSSP or CAS amplifies small crystal concentrations?
FSSP > CDP for all ice clouds

CIP2:
- $N_{>100} = 0.0 \text{ L}^{-1}$
- $0.0 \text{ L}^{-1} < N_{>100} < 0.1 \text{ L}^{-1}$
- $0.1 \text{ L}^{-1} < N_{>100} < 1.0 \text{ L}^{-1}$
- $1.0 \text{ L}^{-1} < N_{>100}$

- April 4 - Flight 11
- April 5 - Flight 13
- April 13 - Flight 18
- April 19 - Flight 25
- April 25 - Flight 29
FSSP > CDP for all ice clouds irrespective of date

FSSP/CDP Ratio Increases

CIP2:
- $N_{>100}=0.0 \text{ L}^{-1}$
- $0.0 \text{ L}^{-1}<N_{>100}<0.1 \text{ L}^{-1}$
- $0.1 \text{ L}^{-1}<N_{>100}<1.0 \text{ L}^{-1}$
- $1.0 \text{ L}^{-1}<N_{>100}$

- April 4–Flight 11
- April 5–Flight 13
- April 13–Flight 18
- April 19–Flight 25
- April 25–Flight 29
Shattering Events

• There is now evidence that 2D-C for D < 200 to 300 μm also contaminated by shattering (Korolev)
  - Shattering events can be identified by interarrival times, # of particles in image and size of fragments

Lawson et al.
Shattered Particles are Included

Lawson et al.
Shattered Particles are Removed on SPEC FSSP & 2D-S

Lawson et al.
Correcting for Shattering

- We will use most sophisticated algorithms to remove shattered artifacts from data
  - BUT, there is some controversy as to whether software alone can do this
  - There are new probe tips (that can be easily exchanged) that can minimize impact of shattering
Modified OAP-2DC arms
Standard OAD-2DC arms

Modified OAD-2DC arms
Rejected and accepted OAP-2DC images

\[ \tau_{\text{rej}} = 1000 \text{ tics} \iff \Delta X = 2.5 \text{ cm} \]

Standard OAD-2DC arms

Modified OAD-2DC arms

- interarrival time
- aspect ratio
- partial images
- complete images

30 April 2008
No corrections on shattering

After corrections

GMT (hh:mm)
Field Products

• It is critically important that we examine the data after each flight and report any problems that we see with the probes
• We will be making quick look products available on a web site after each flight