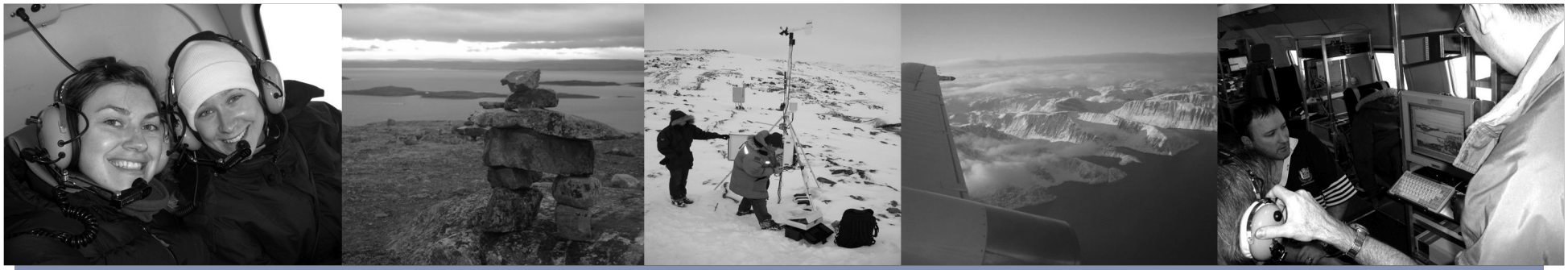


Characteristics of Upslope Precipitation in the Arctic during STAR

Shannon Fargey, John Hanesiak, Rebekah Martin

University of Manitoba

Walter Strapp

Cloud Physics and Severe Weather Research Section, Environment Canada

Mengistu Wolde

Flight Research Laboratory, National Research Council of Canada

UNIVERSITY OF MANITOBA

STAR Final Workshop – Winnipeg, MB June 14, 2010

Outline

- Motivation
- Research Methods
- Summary
  - orographic cloud & precipitation features
- Results from 2 case studies
  - clouds features
  - microphysical characteristics
  - upslope and upstream comparisons
- Concluding Remarks
- Future Research Plans

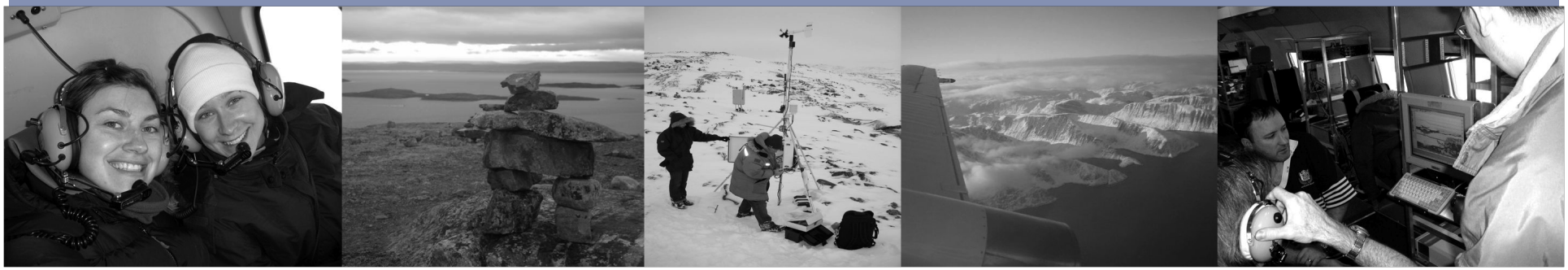
Motivation

- Forecasting the onset, duration and amount of precipitation associated with upslope flow in the Arctic is a continuing operational and modelling challenge

- The problem . . . acquiring high resolution data in to verify model output

- Aim – investigate orographic precipitation features in the Arctic and better understand the physical processes associated with them using high resolution data collected during STAR

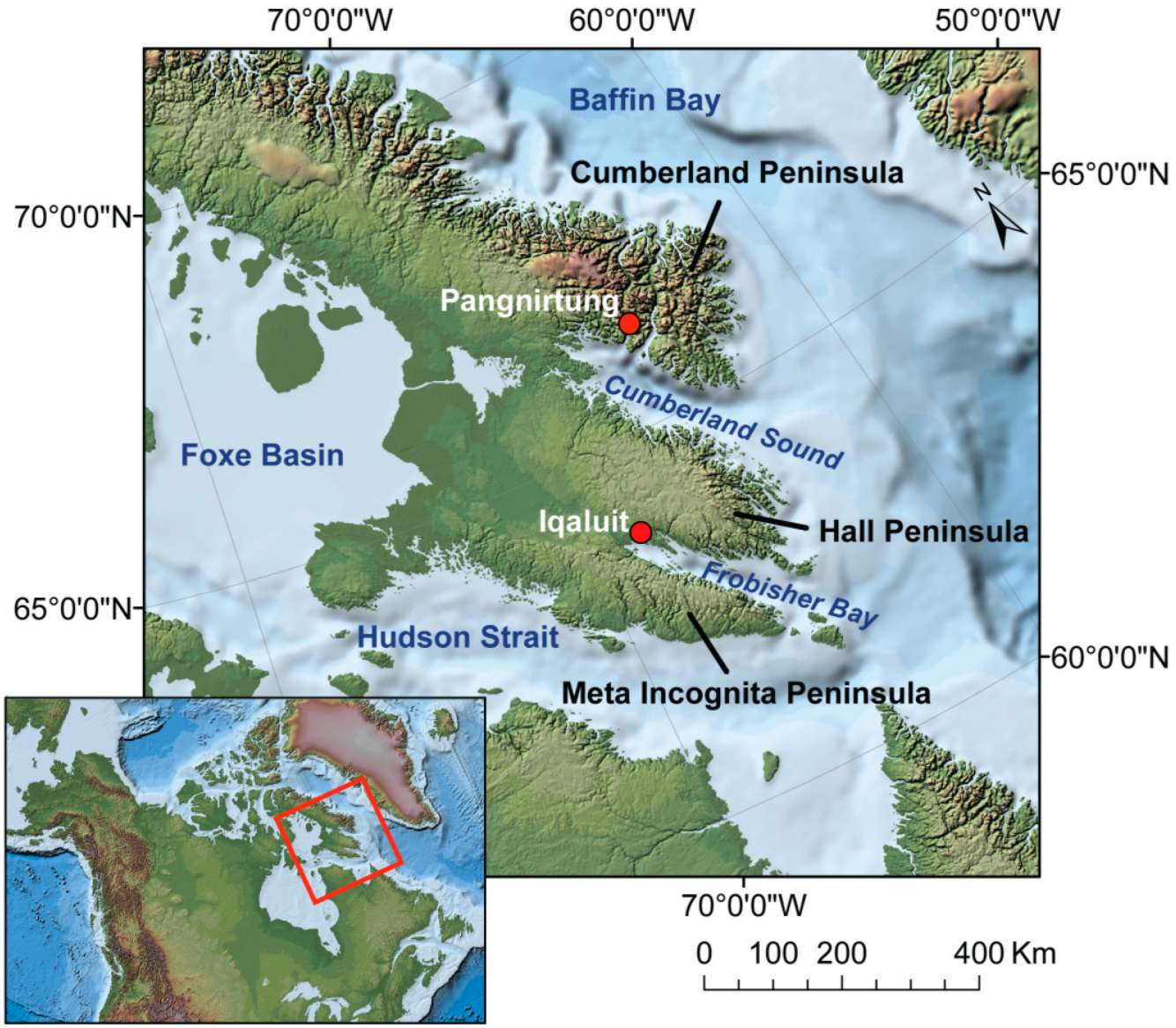
Methodology



- Storm Studies in the Arctic (STAR) research network
- Field Campaigns
  - Fall 2007 (Oct 1-Nov 30)
  - Winter 2008 (Feb)

"to better understand Arctic Storms and their associated hazards and lead to better prediction"

Methodology - Study Area



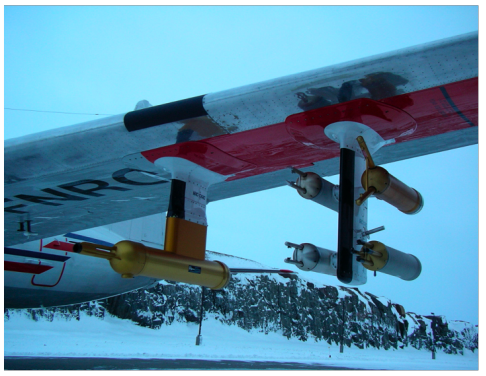
Field Data - NRC Convair-580 Research Aircraft

- Radar Measurements - NAWX System - Dual wavelength W-band (3.2 mm wavelength) and X-band (3.2 cm wavelength) polarimetric Doppler Radar

- Standard Meteorological measurements
  - Temp, RH . . .

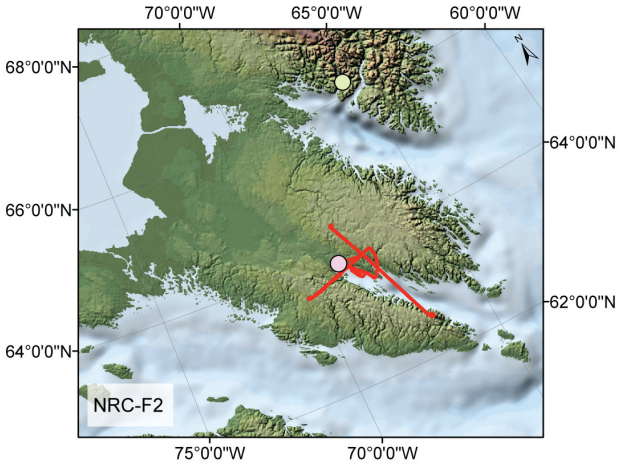
- Microphysics -
  - TWC and LWC
    - CVI, King, Rosemount Ice Detector
  - 2-D particle measuring systems
    - 2-D Spectra 2DC/2DP imaging probes

- Dropsondes – vertical profiles of atmosphere

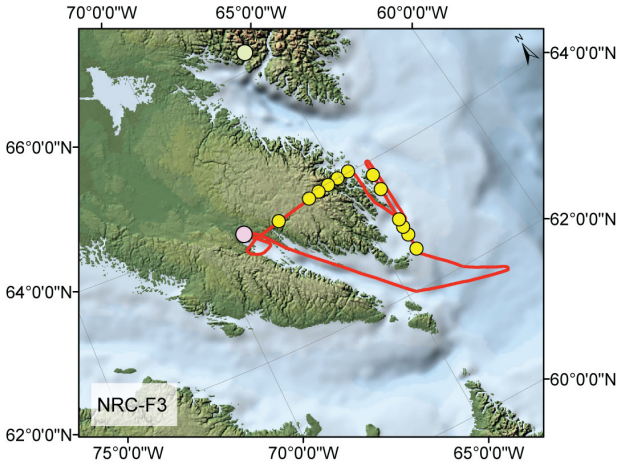


Data - Event Summary

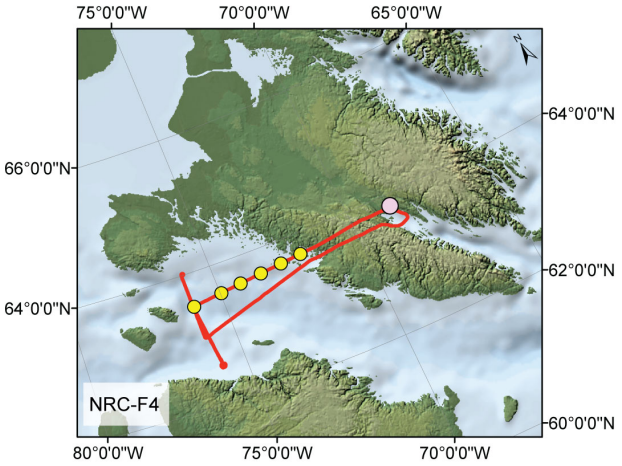
F2 - Nov 6 16:53-19:38



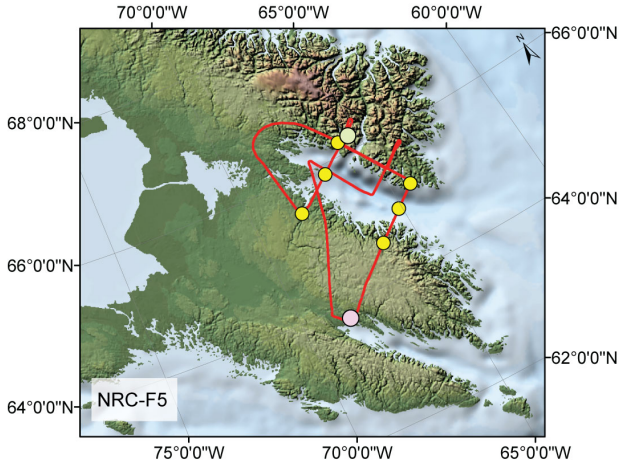
F3 - Nov 8 02:35-06:22



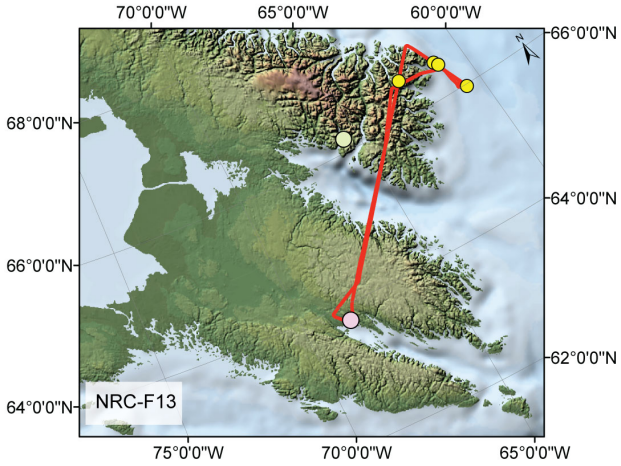
F4 - Nov 9-10 21:29-01:25

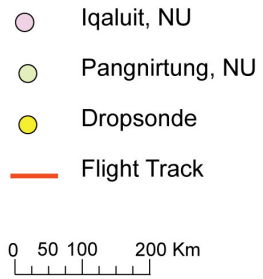


F5 - Nov 12 11:45-16:11



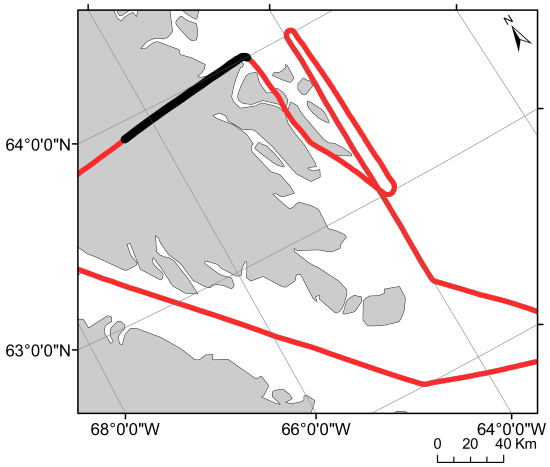
F13 - Nov 28 15:00-18:53





Orographic Cloud Characteristics

- 10 flight sections traversing topography
  - Max elevation crossed (600 m – 1700 m)



- Cloud tops:
  - ranged from 1200 m - 7000 m
  - Median = 3350 m, Mode = 2000 m

- Structure:
  - Precipitation at the surface common with upslope flow (max reflectivity generally on windward slopes)
  - Precipitation aloft with areas of sublimation/evaporation were common

Orographic Cloud Microphysical Characteristics Summary

ID	Particle type	Riming	Sample Height (m)
F2	IR, C, P	Y	1500
	D,CBB,PD	Y	1600
	Drizzle, C		1500
F3	IR, C, D	Y	4500
F5	IR, D, P	Y (heavy)	1500-2300
F13	IR, C	Y	2200

Particle type reference:

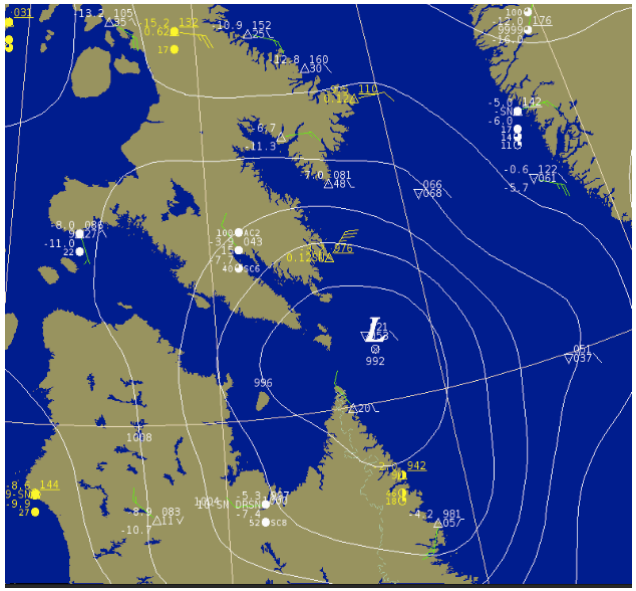
IR (irregular ice crystal)
D (dendrites)
C (circular ice crystal)
P (plates)
CBB (crystal with broad branches)
PD (plates with dendrite extensions)

Case Studies

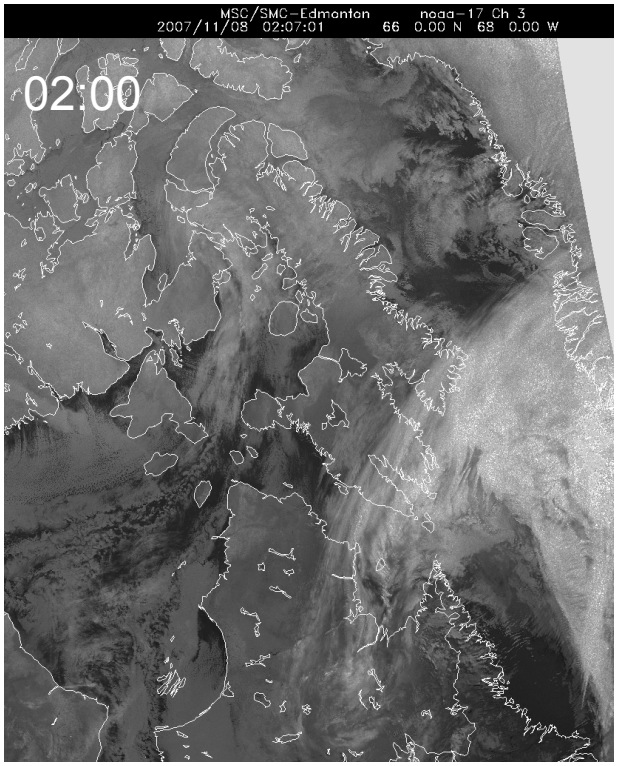
F3

Nov 8, 2007
02:35-06:22

05:00



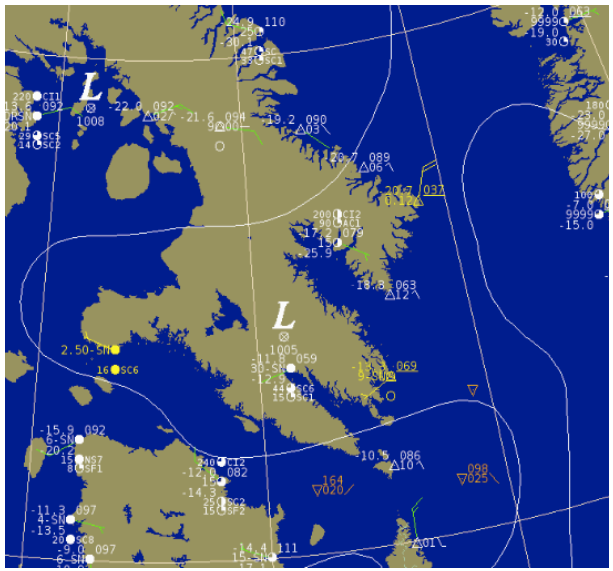
02:00



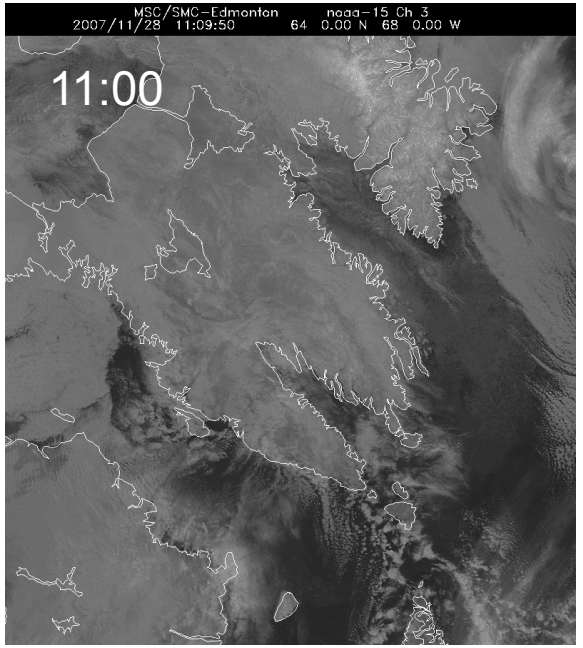
F13

Nov 28, 2007
15:00-18:53

16:00

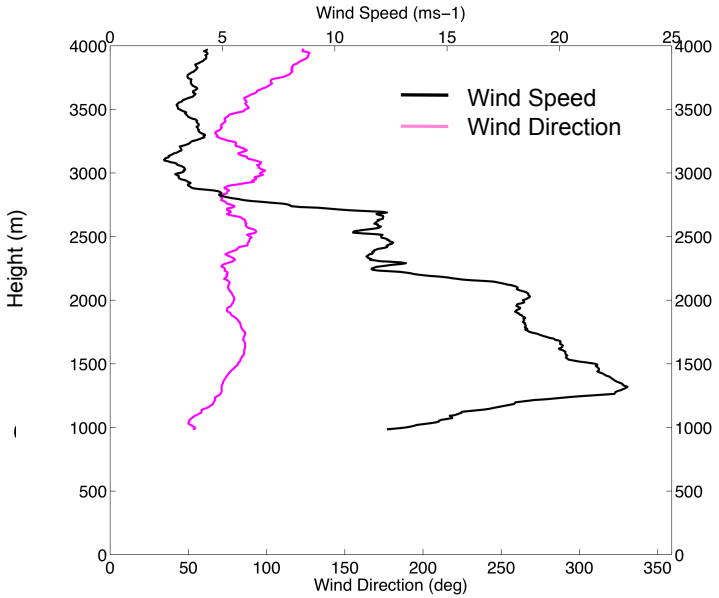


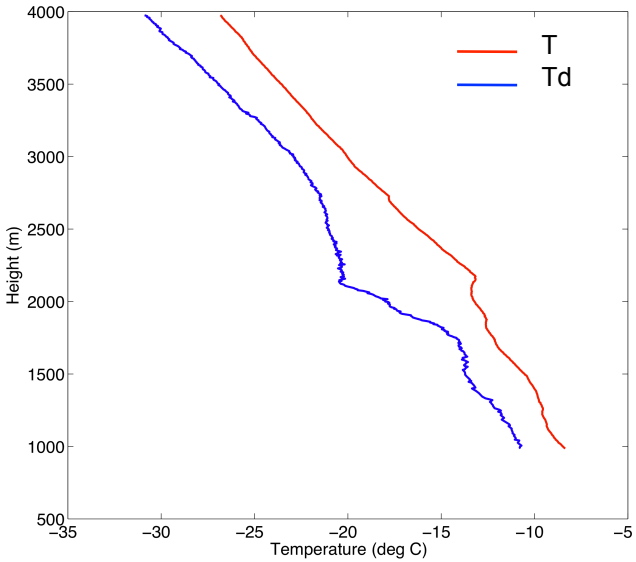
11:00



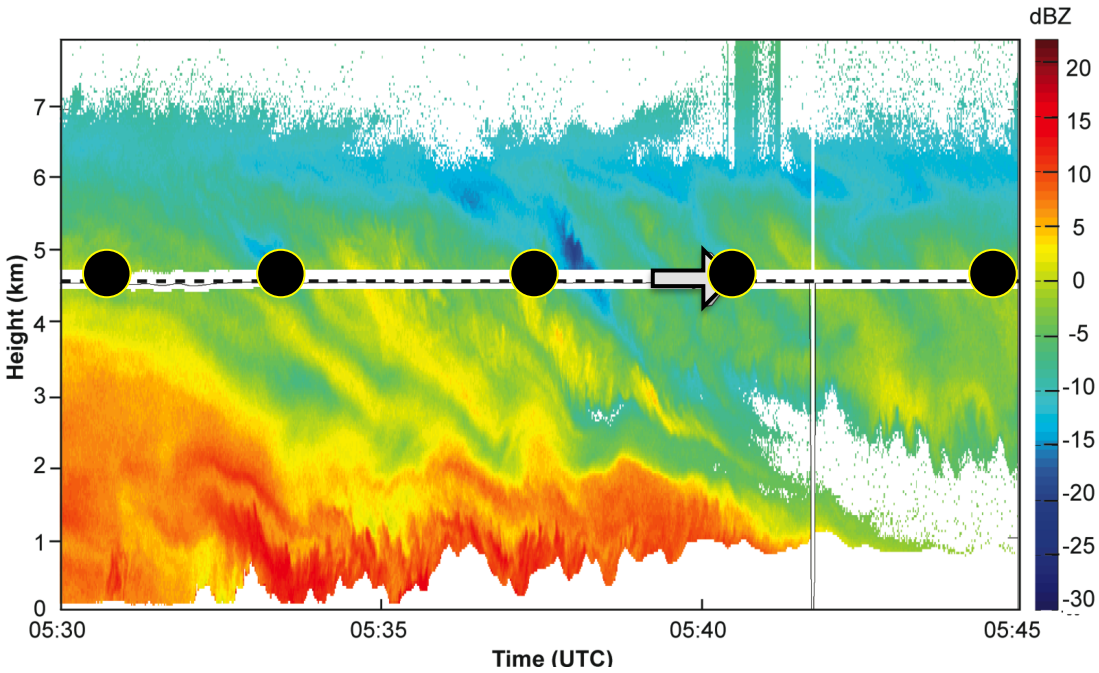
F3 Cloud Characteristics

Dropsonde

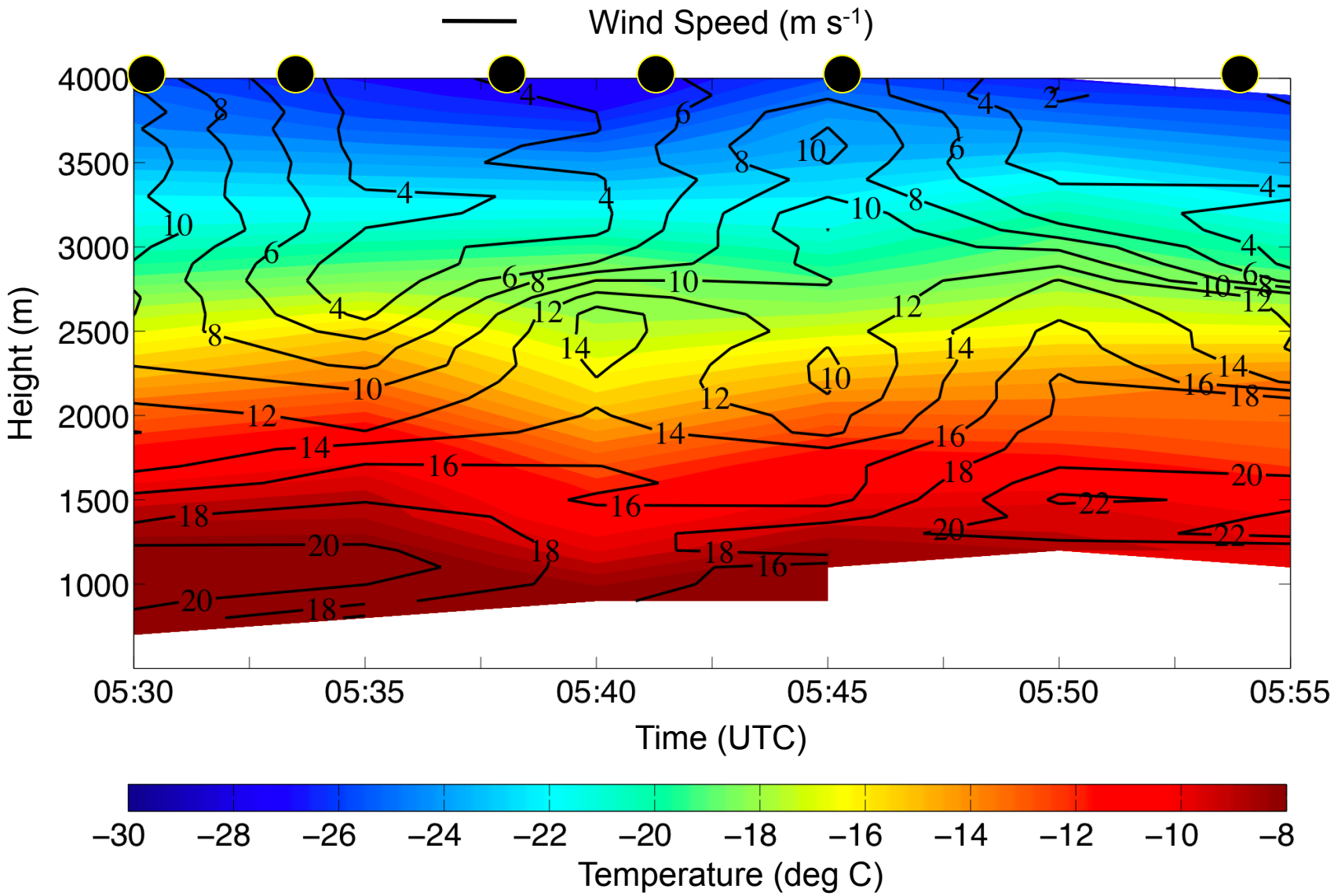




W-band Radar Reflectivity Profile



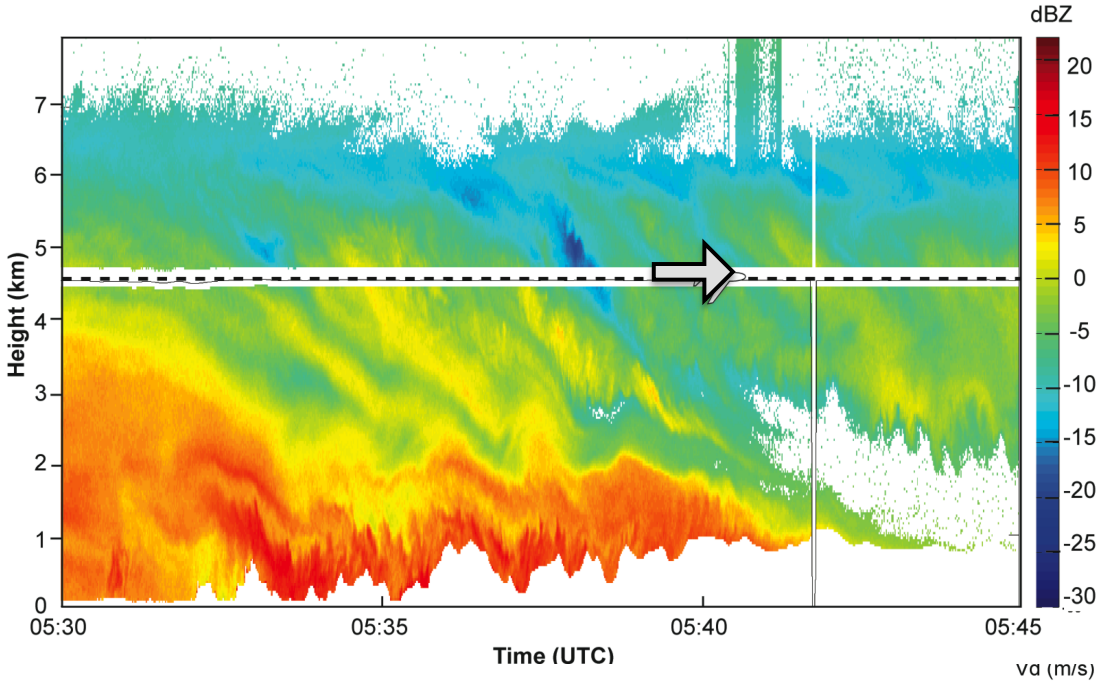
F3 Dropsonde Crosssection



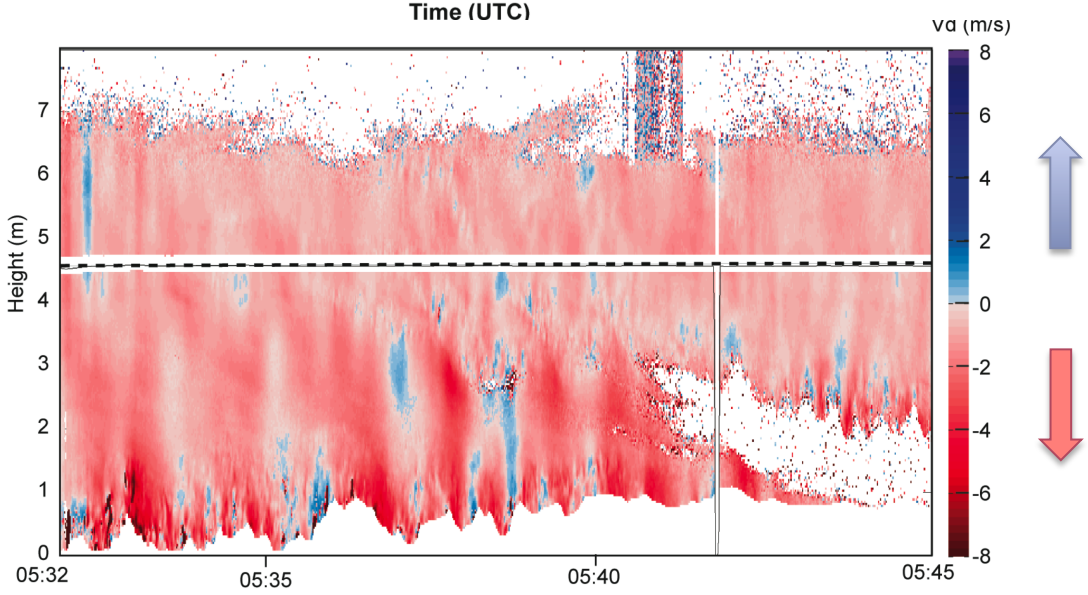
F3 Cloud Characteristics

W-band Radar

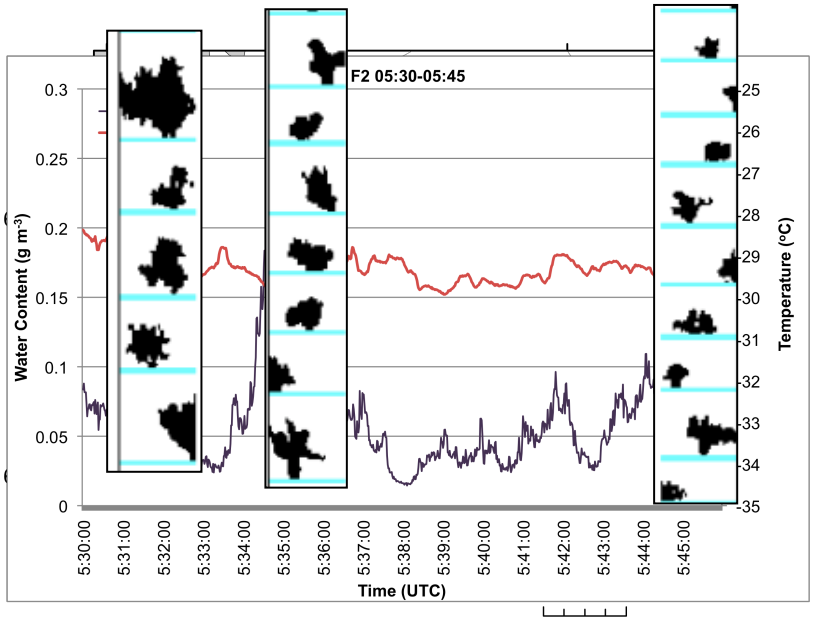
Reflectivity Profile

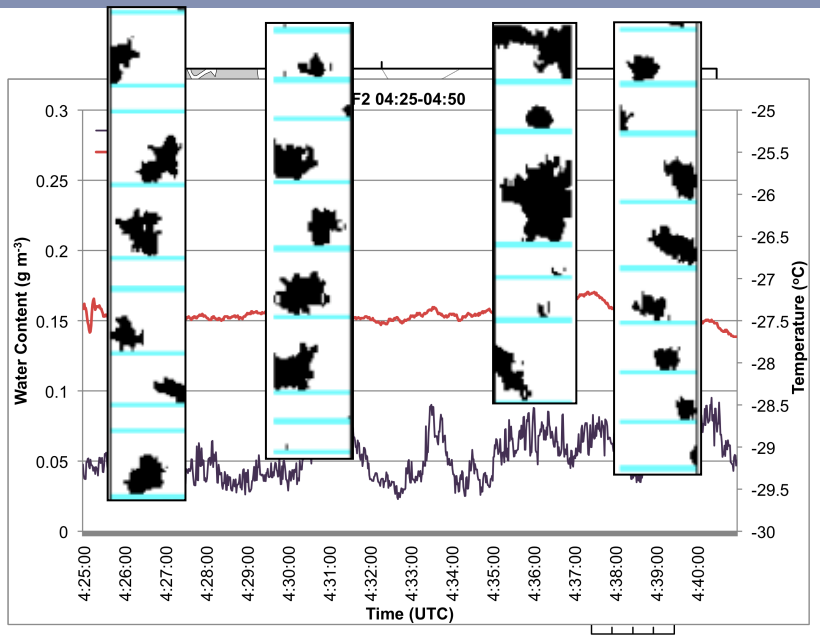


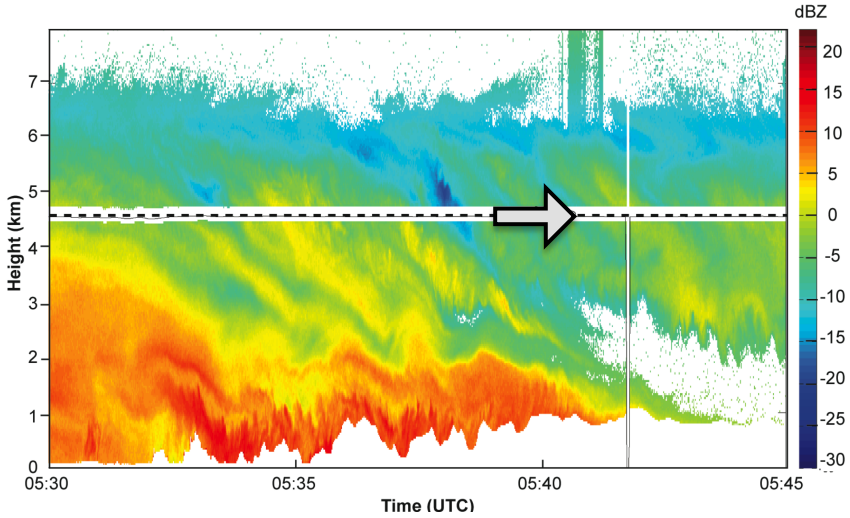
Doppler Velocity

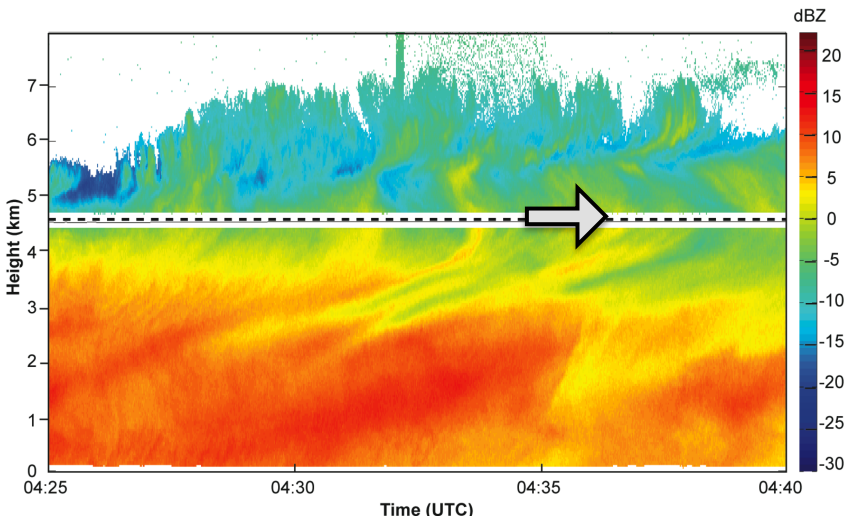


F3 Microphysical Characteristics

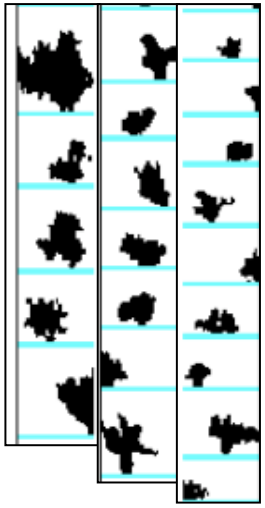




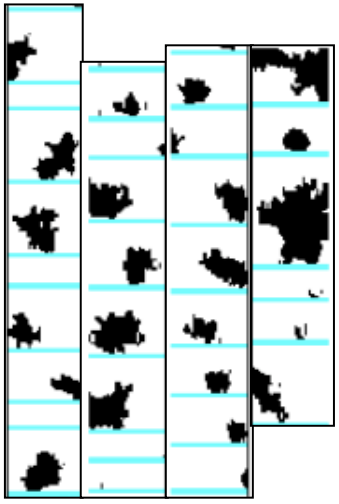


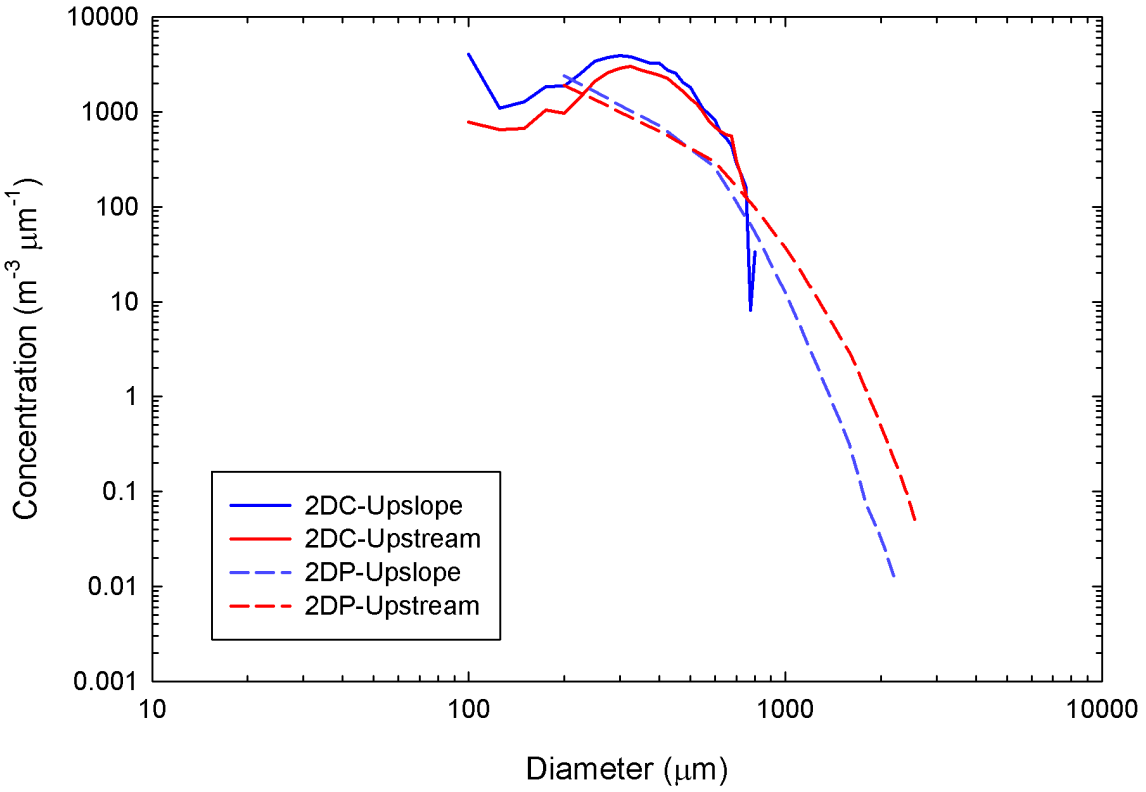


F3 Microphysical Characteristics



Upslope 05:30-05:45
Upstream 04:25-04:40

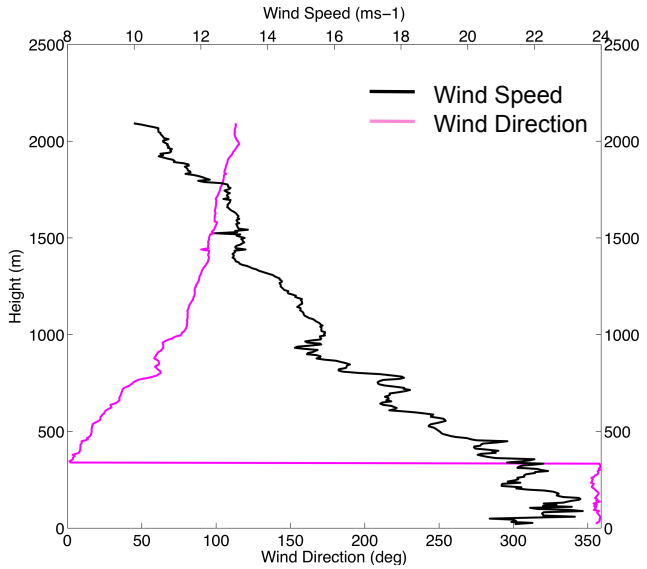


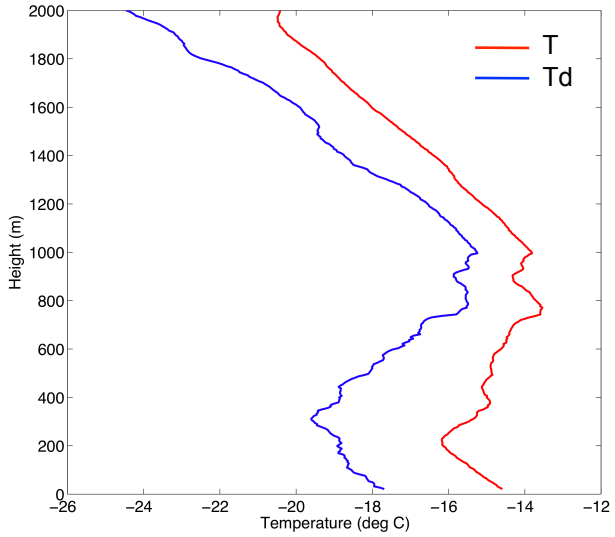


2DC 100-800 μm
2DP 200-6400 μm

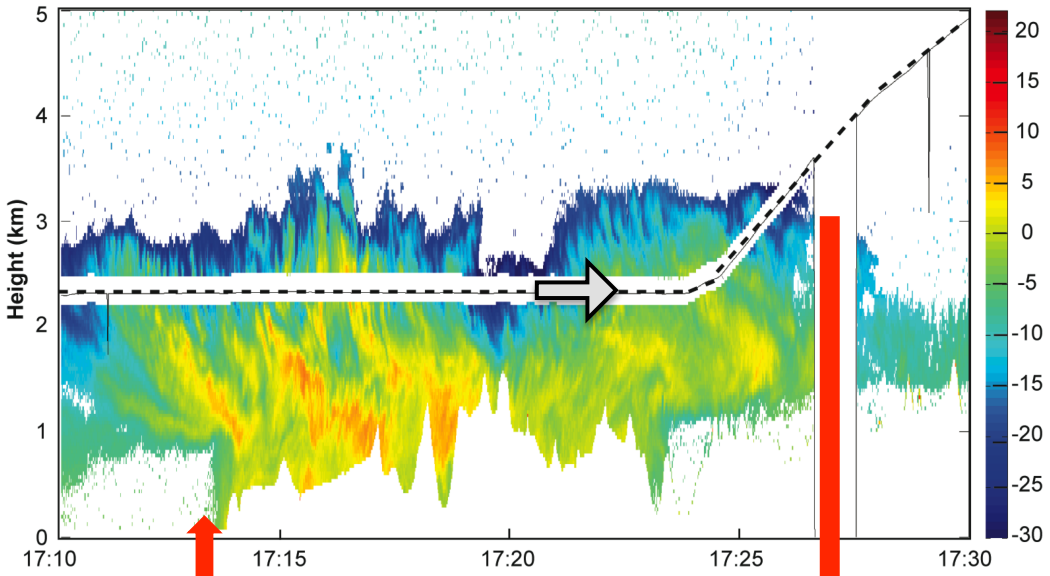
F13 Cloud Characteristics

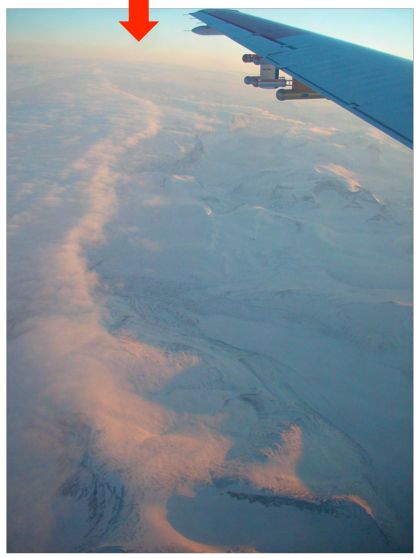
Dropsonde



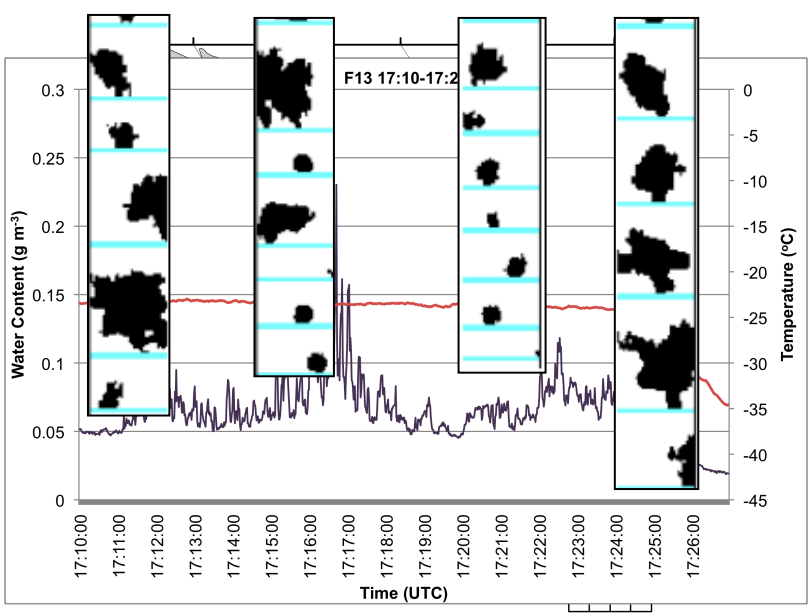


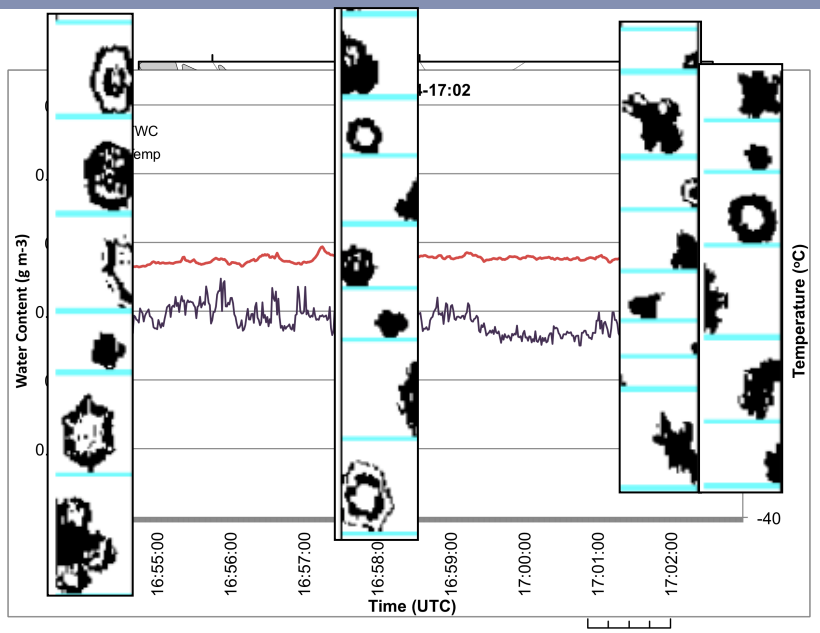
W-band Radar Reflectivity Profile

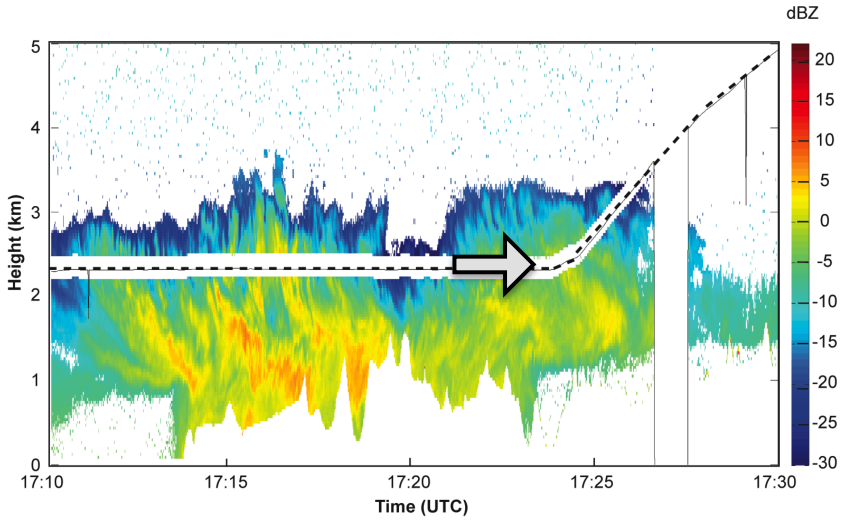


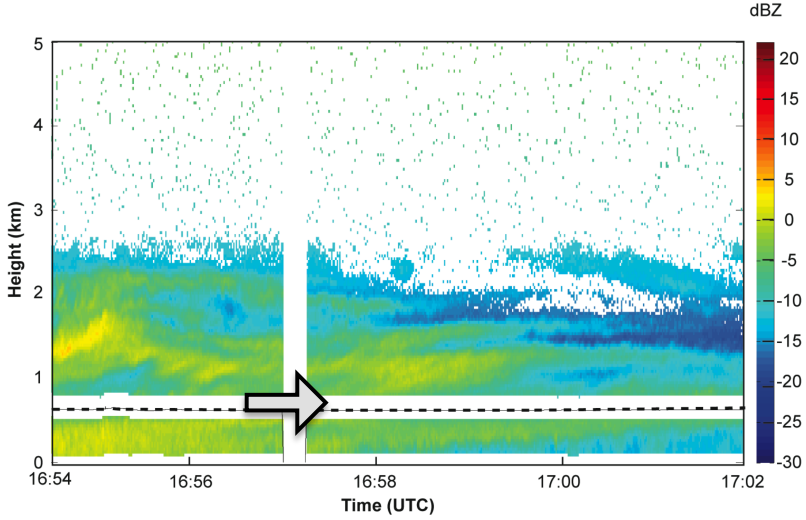


F13 Microphysical Characteristics

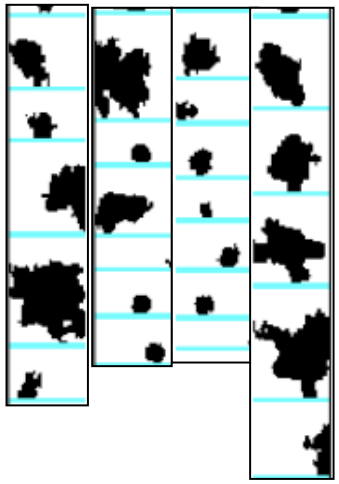




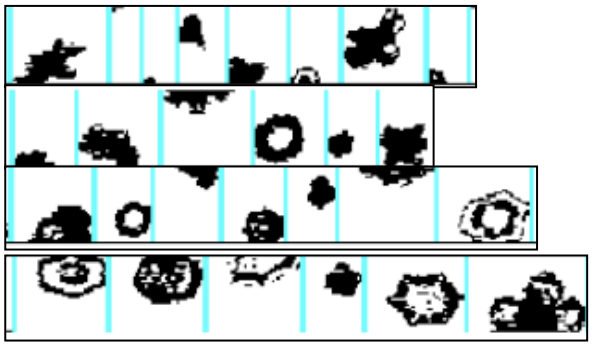


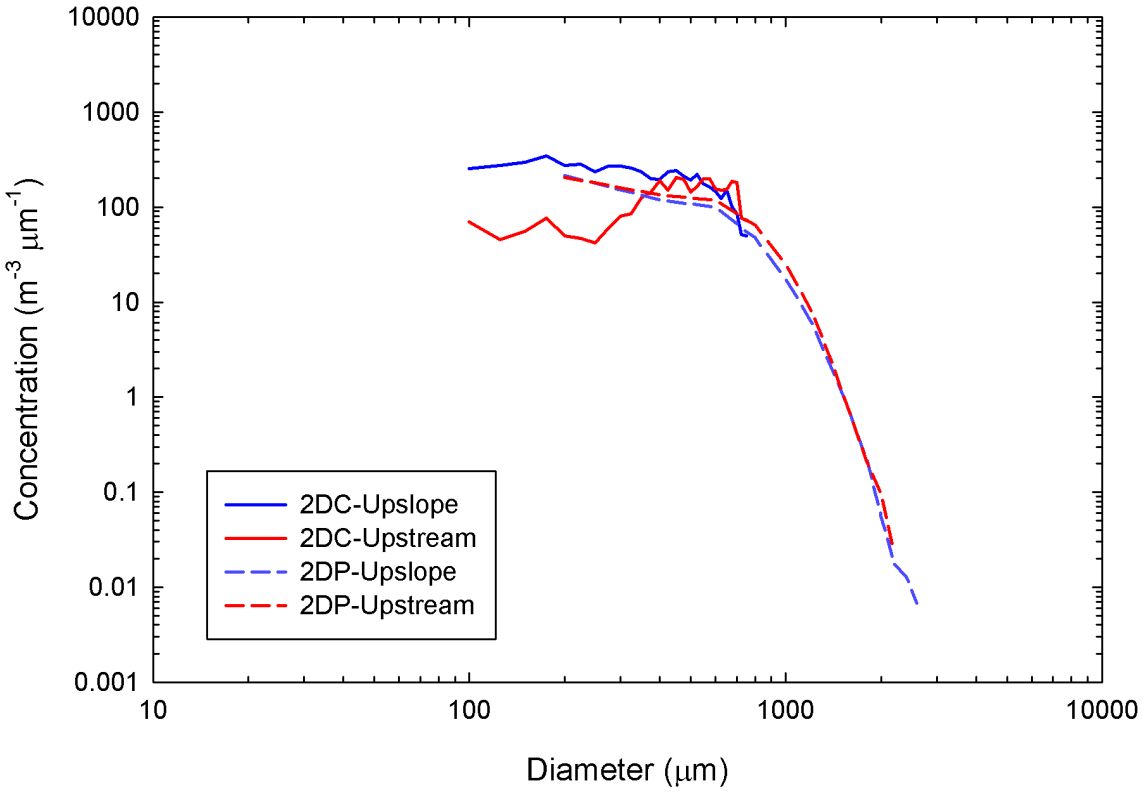


F13 Microphysical Characteristics



Upslope 17:12-17:20
Upstream 16:54-17:02





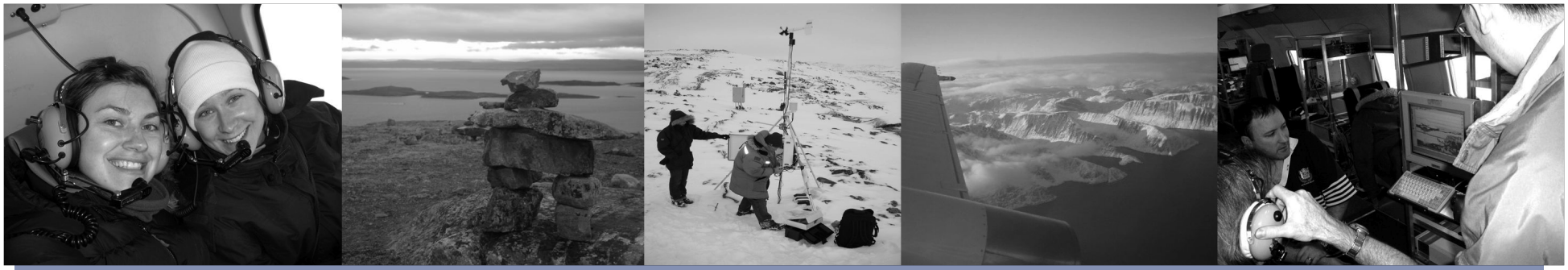
2DC 100-800 μm
2DP 200-6400 μm

Conclusions

- Cloud structure showed similarities and differences:
  - Precipitation at the surface common with upslope flow
  - Regions of sublimation and precipitation aloft can be identified in most cases
  - Cloud top height variable, generally between 2000 m – 3000 m
- TWC was low in all cases (avg. less than 0.1 g m^{-3})
- Dominant particle types in orographic cloud was irregularly shaped ice crystals
  - Growth by riming and aggregation appear to be common
- Total Ice Crystal Concentration greater over topography then over ocean prior to lifting
  - In all cases due to higher concentration of smaller particles

Future Work

- What are the synoptic and mesoscale characteristics associated with terrain induced/enhanced precipitation events?
- What are the cloud (including structure and dynamics) and microphysical characteristics associated with this type of precipitation event?
- How do the thermodynamic properties of the cloud differ upstream to when lifting occurs?
- How do representations of orographic cloud and precipitation from the aircraft measurements compare to the current operational model (GEM and GEM-LAM)?
- By conducting a sensitivity study of one or two cases during STAR, a) can more details on processes involved in these events be revealed, and b) can we identify areas where improvements can be made to the models physics parameterizations?



Thank you

Canadian Foundation for Climate and Atmospheric Sciences (CFCAS)
Fondation canadienne pour les sciences du climat et de l'atmosphère (FCSCA)

University of Manitoba

CEOS

Storm Studies in the Arctic
STAR
Nunavut, Canada
Etudes des Tempêtes dans l'Arctique

The Department of Environment and Geography

NSERC CRSNG