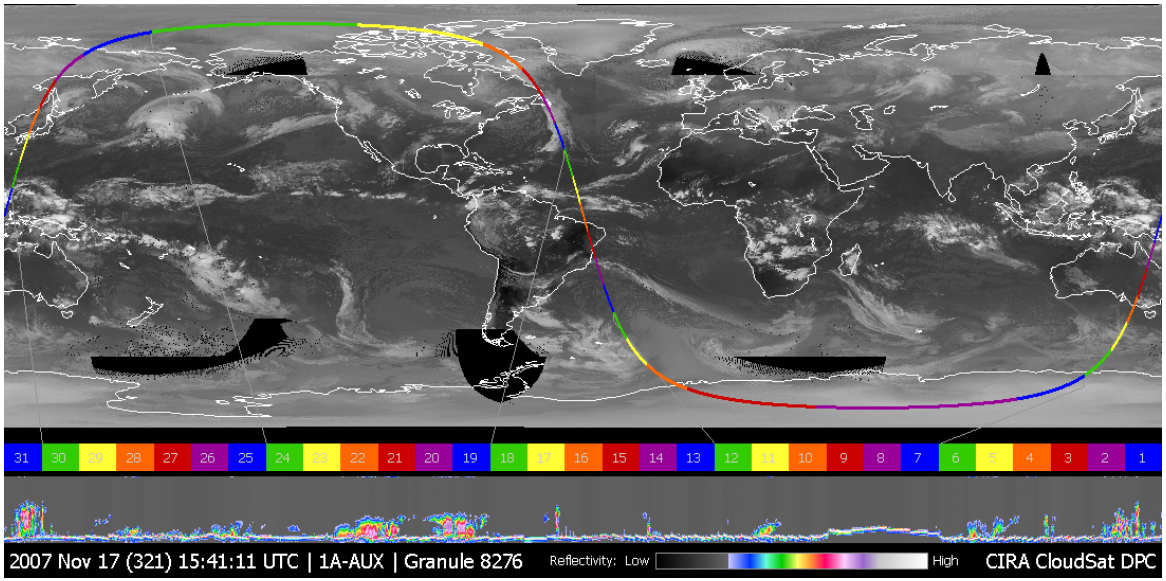
Satellite-Derived Analysis of Cloud and Precipitation Features over Southern Baffin Island

Alex Laplante (M.Sc), Ronald Stewart, William Henson

Department of Atmospheric & Oceanic Sciences
McGill University



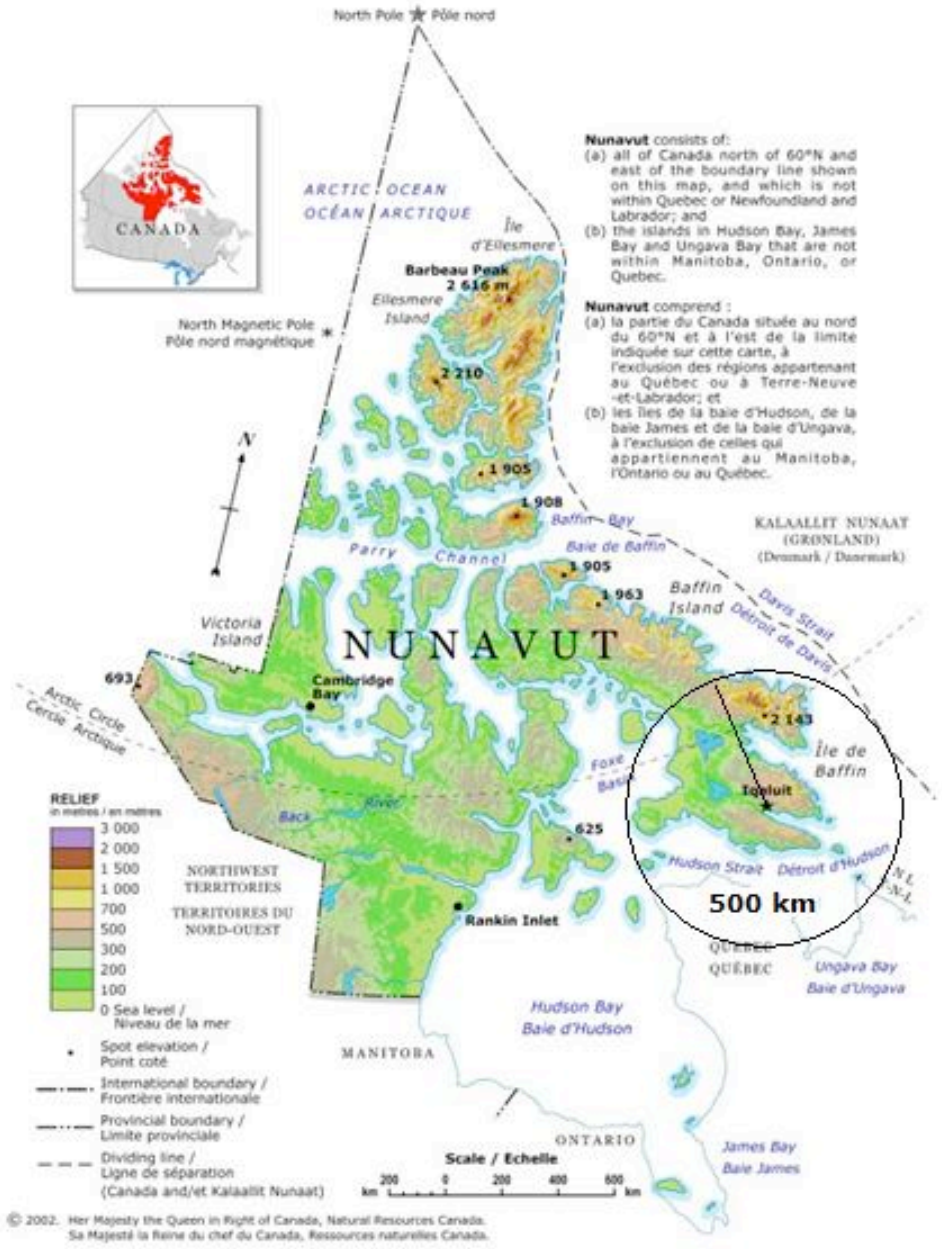
Motivation

- Because of a sparse and limited observational network in the polar regions, forecasting and modelling Polar storms are particularly difficult problems

- To resolve the issues in forecasting Arctic storms, the current study uses satellite data to improve our understanding of clouds and precipitation over southern Baffin Island

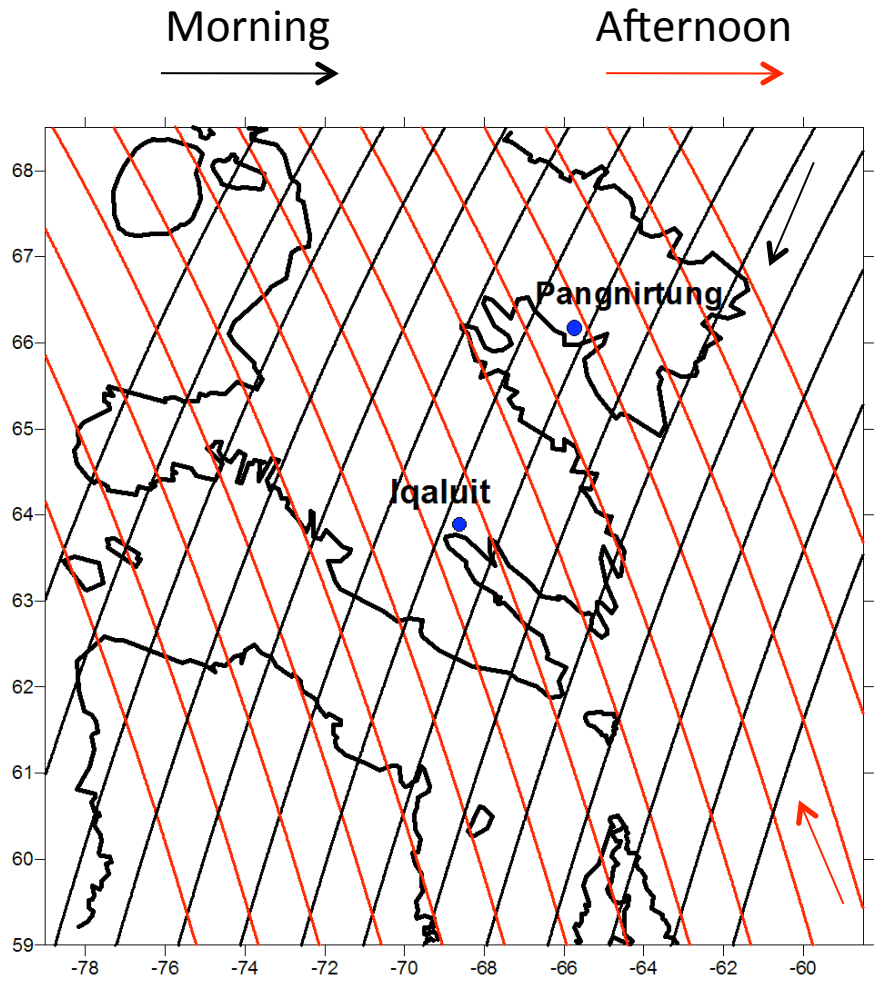
- **Objective**: to show initial results obtained in conjunction with the Fall STAR field campaign

- 500 km radius surrounding the community of Iqaluit
  - Area characterized with varied terrain and deep valleys
- Satellite data collected from October 1st through November 30th , 2007
  - CloudSat, MODIS, and Calipso data (A-Train constellation)



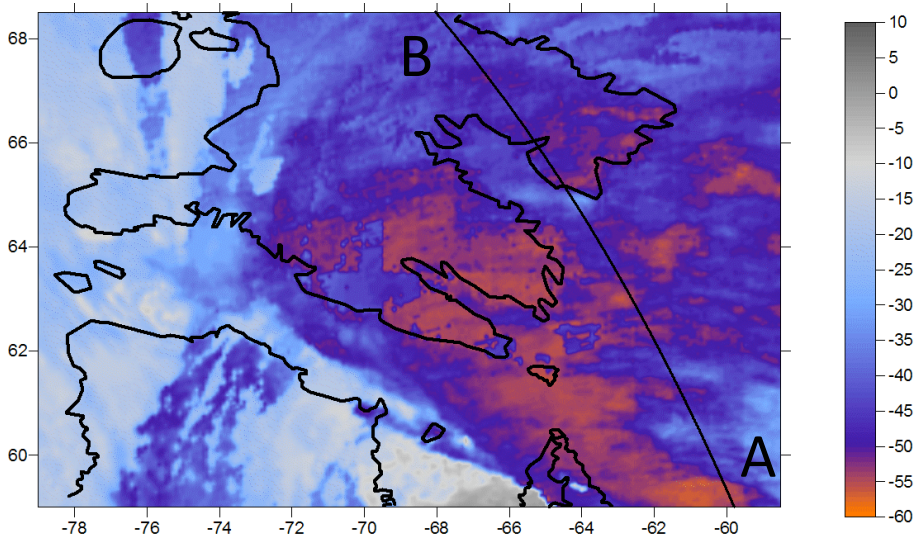
Satellite Coverage

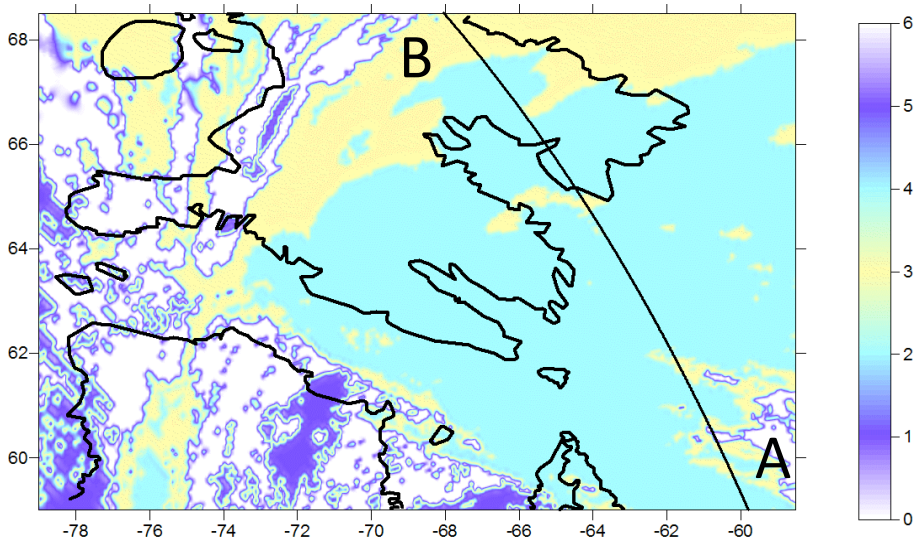
- 26 non-repeating orbital segments for a total of 105 passes
  - Two orbital passes per day (morning and afternoon)
- Satellite data covers a wide array of variables, including:
  - cloud top height
  - radar reflectivity
  - cloud top temperature



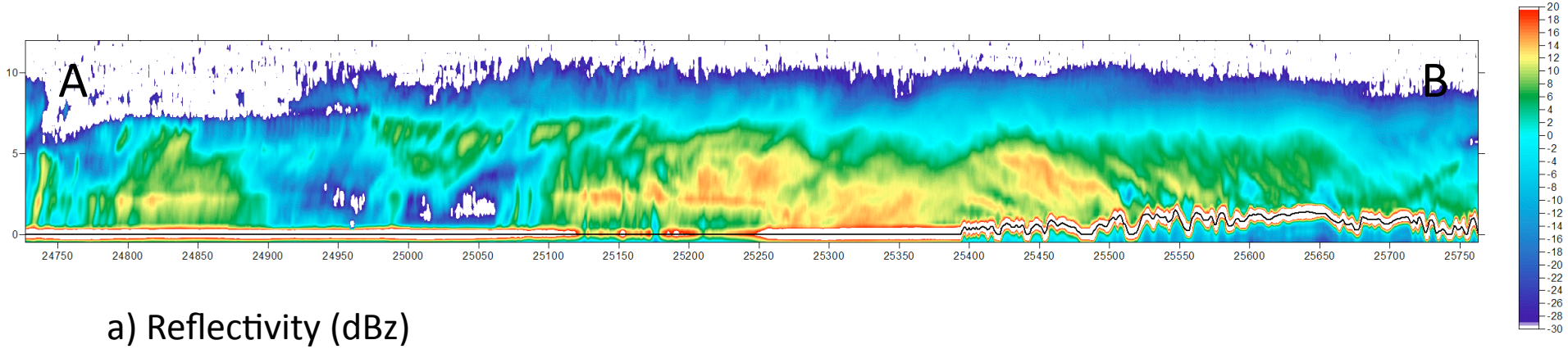
- Major low pressure system passing through Iqaluit on November 17th, 2007 at 1650 UTC
  - cold cloud tops (<-60°C)
  - low cloud top pressure (<200 mb)
  - vertical extents of >10 km.

- Ice, liquid, and mixed phase cloud tops are all observed
  - discontinuous
  - cloud tops with T<-40°C are largely ice

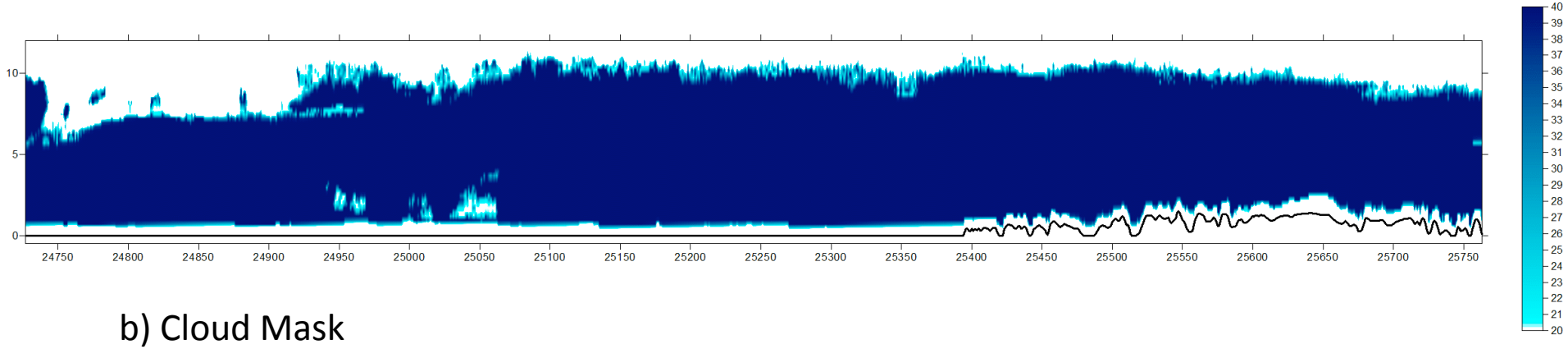




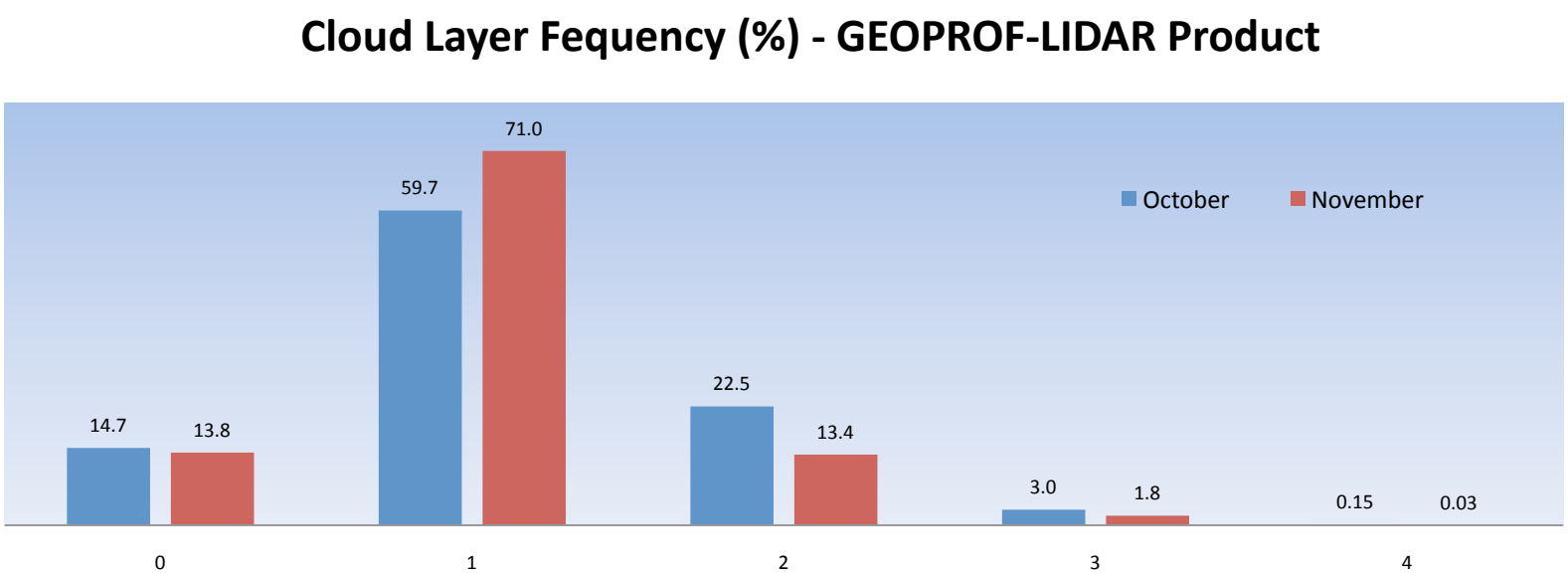
CloudSat (2B-GEOPROF)



a) Reflectivity (dBz)

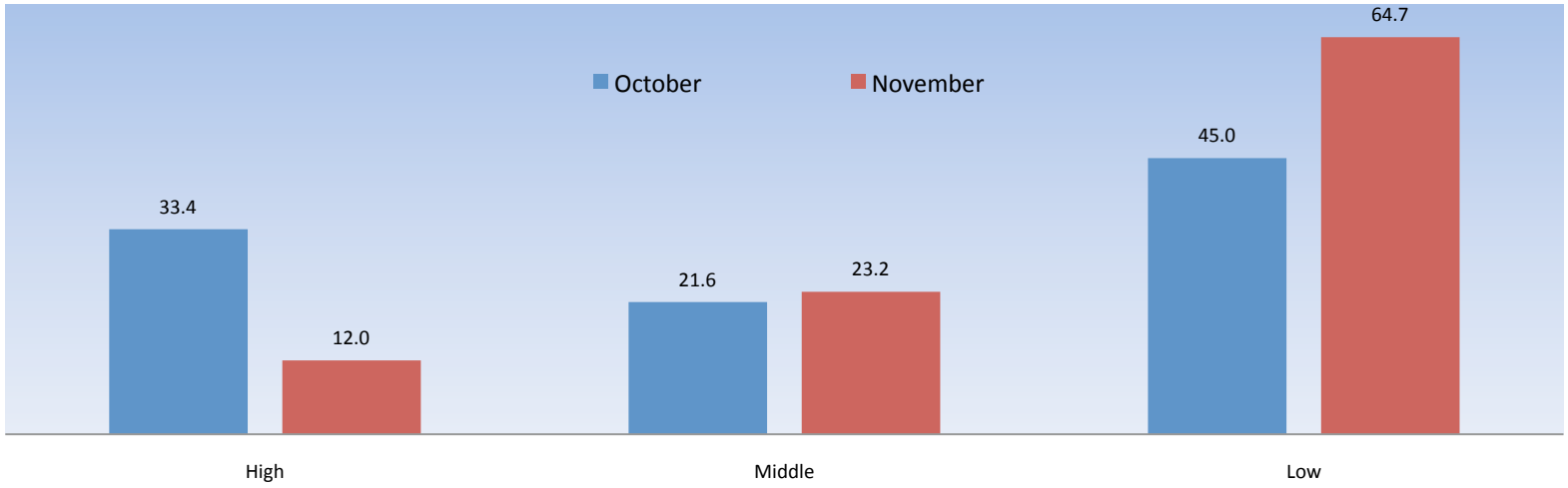


b) Cloud Mask

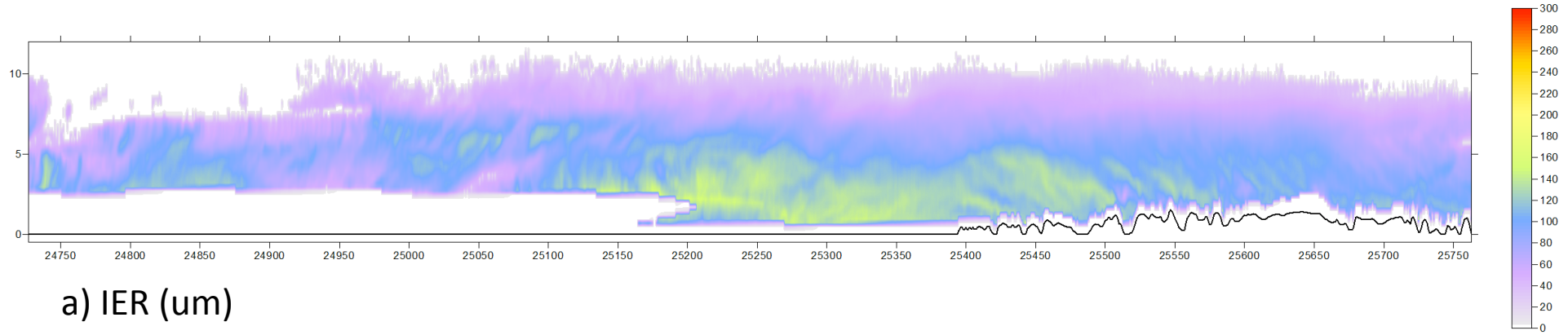


- High occurrence of clouds over the region
  - clouds were observed 86% of the time with the remaining 14% being cloud-free regions
- Single layer clouds are the most prominent (~65%)
  - Multi-layered clouds occur with relatively high frequencies
  - Month-to-month decrease in frequency for multi-layered clouds

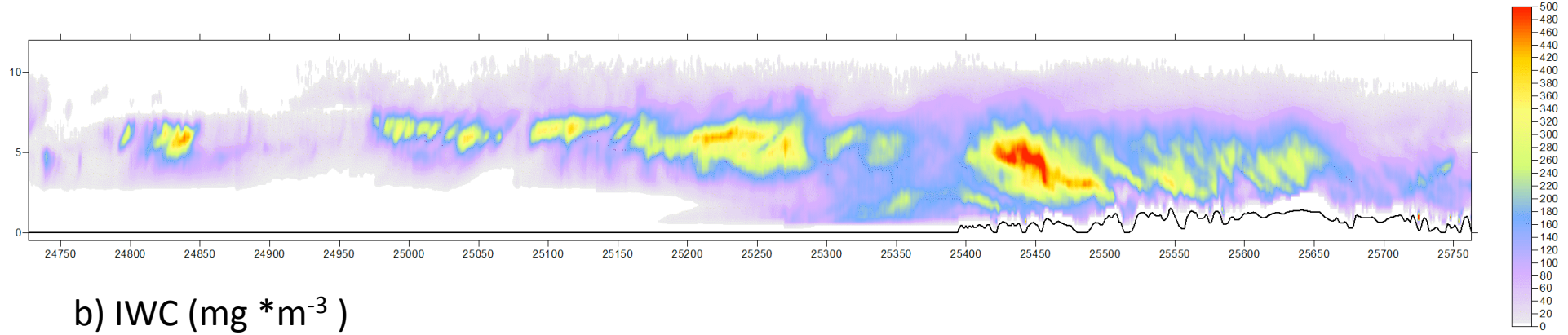
Cloud Top Height Occurrence (%) - GEOPROF-LIDAR Product



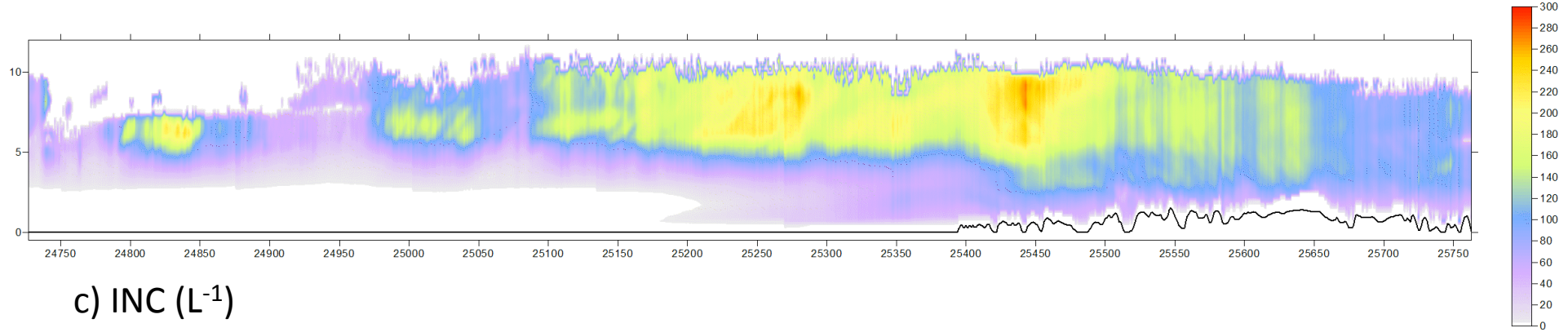
- High cloud top heights (>7 km ASL) are a relatively common feature of clouds over southern Baffin Island
  - 33% of clouds are high clouds in October
  - Cloud top heights seen to surpass 12 km in few cases
  - Low level clouds (1000 – 3000 m) become more dominant in November with high cloud top heights greatly diminishing in frequency



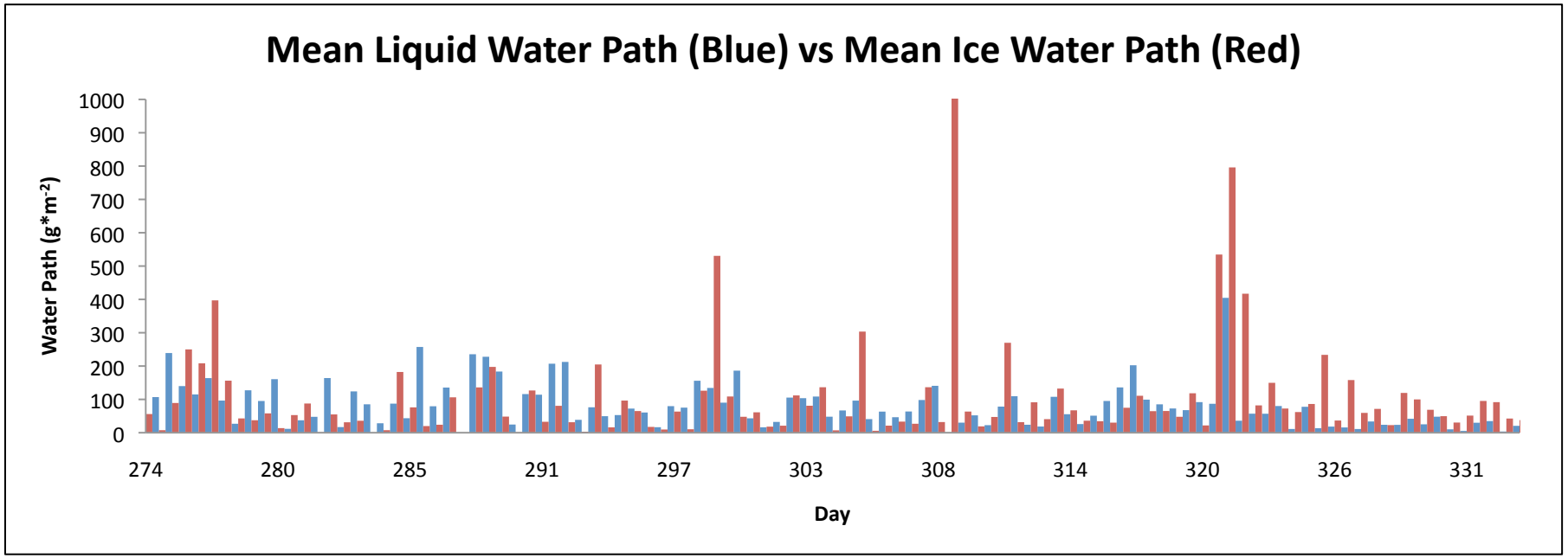
a) IER (um)

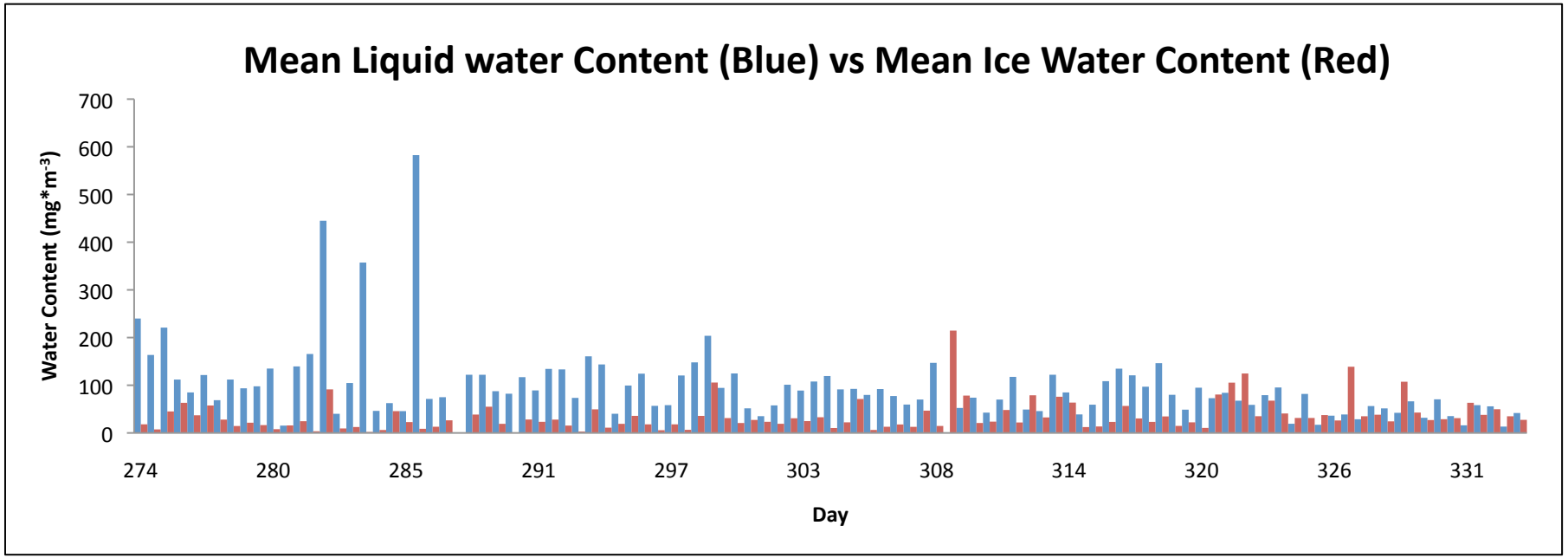


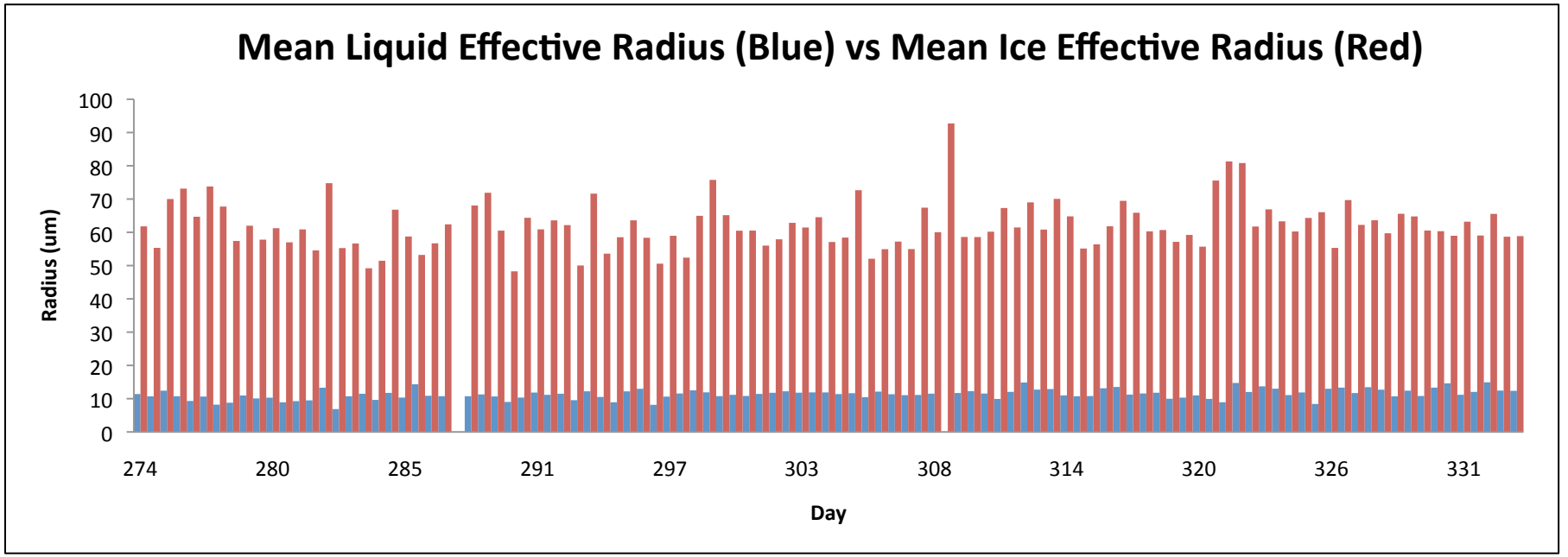
b) IWC (mg *m^{-3})

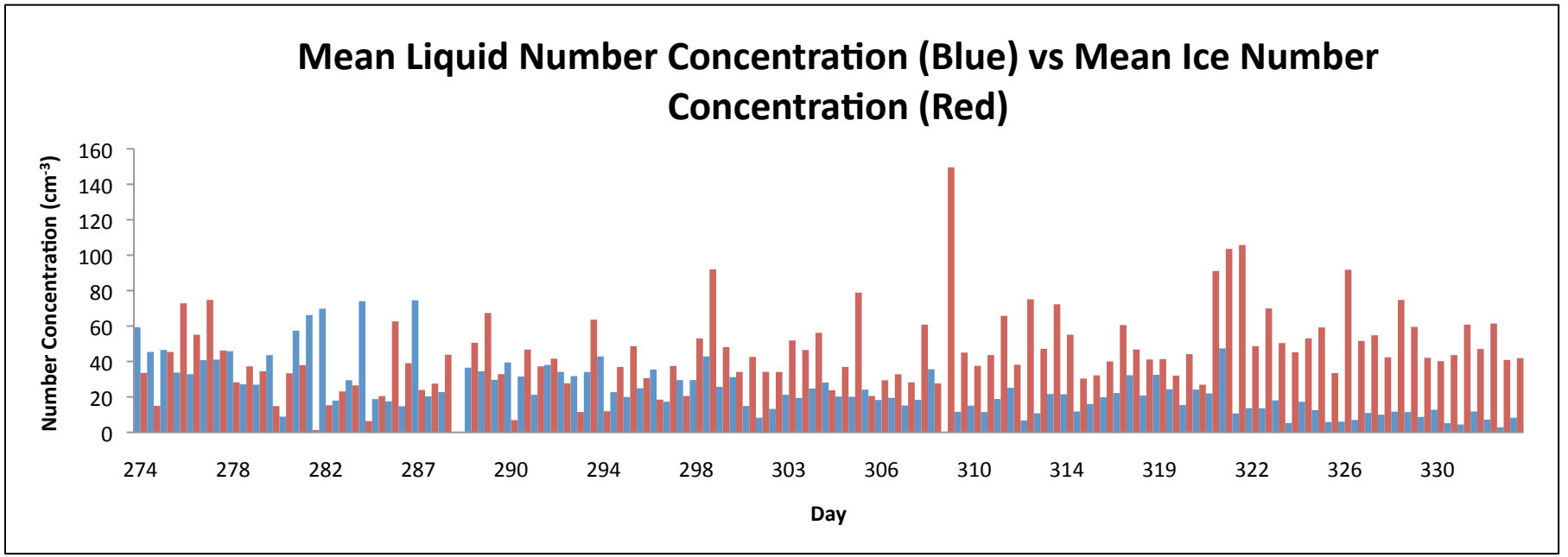


c) INC (L^{-1})


Mean Liquid Water Path (Blue) vs Mean Ice Water Path (Red)
Water Path (g*m-2)
1000
900
800
700
600
500
400
300
200
100
0
274
280
285
291
297
303
308
314
320
326
331
Day


Mean Liquid water Content (Blue) vs Mean Ice Water Content (Red)
Water Content (mg*m-3)
700
600
500
400
300
200
100
0
274
280
285
291
297
303
308
314
320
326
331
Day


Mean Liquid Effective Radius (Blue) vs Mean Ice Effective Radius (Red)
Radius (um)
100
90
80
70
60
50
40
30
20
10
0
274
280
285
291
297
303
308
314
320
326
331
Day


Mean Liquid Number Concentration (Blue) vs Mean Ice Number Concentration (Red)
Number Concentration (cm-3)
160
140
120
100
80
60
40
20
0
274
278
282
287
290
294
298
303
306
310
314
319
322
326
330
Day

- Ice and water characteristics of clouds changed from October to November
  - LWC, LNC, and LWP decreased between 40 – 50 %
  - INC and IWP increased by approximately 40% with IWC increasing nearly 80%
  - Ice and liquid radii remained unchanged

- at cloud top, larger concentration of smaller particles
- at cloud base, low concentration of larger particles

- For the deep low of November 17th at 1650 UTC,
  - LWC: 84 mg*m^{-3} IWC: 105 mg *m^{-3}
  - LER: 9 um IER: 81 um
  - LNC: 47 cm^{-3} INC: 104 cm^{-3}
  - LWP: 405 mg*m^{-2} IWP: 796 mg*m^{-2}

- Summary
  - Arctic clouds have been observed with great detail
    - Deep, single-layer clouds are common in major storm systems originating from mid-latitudes
    - Reflectivity ranges from -30 dBz – 20 dBz
    - high occurrence of high clouds
    - ice properties become dominant from October to November

- Future work
  - compare CloudSat data (radar & microphysics) with ground and NRC research aircraft data
  - Model products

Questions?