ARCTIC PRECIPITATING SYSTEMS

Ronald Stewart
McGill University

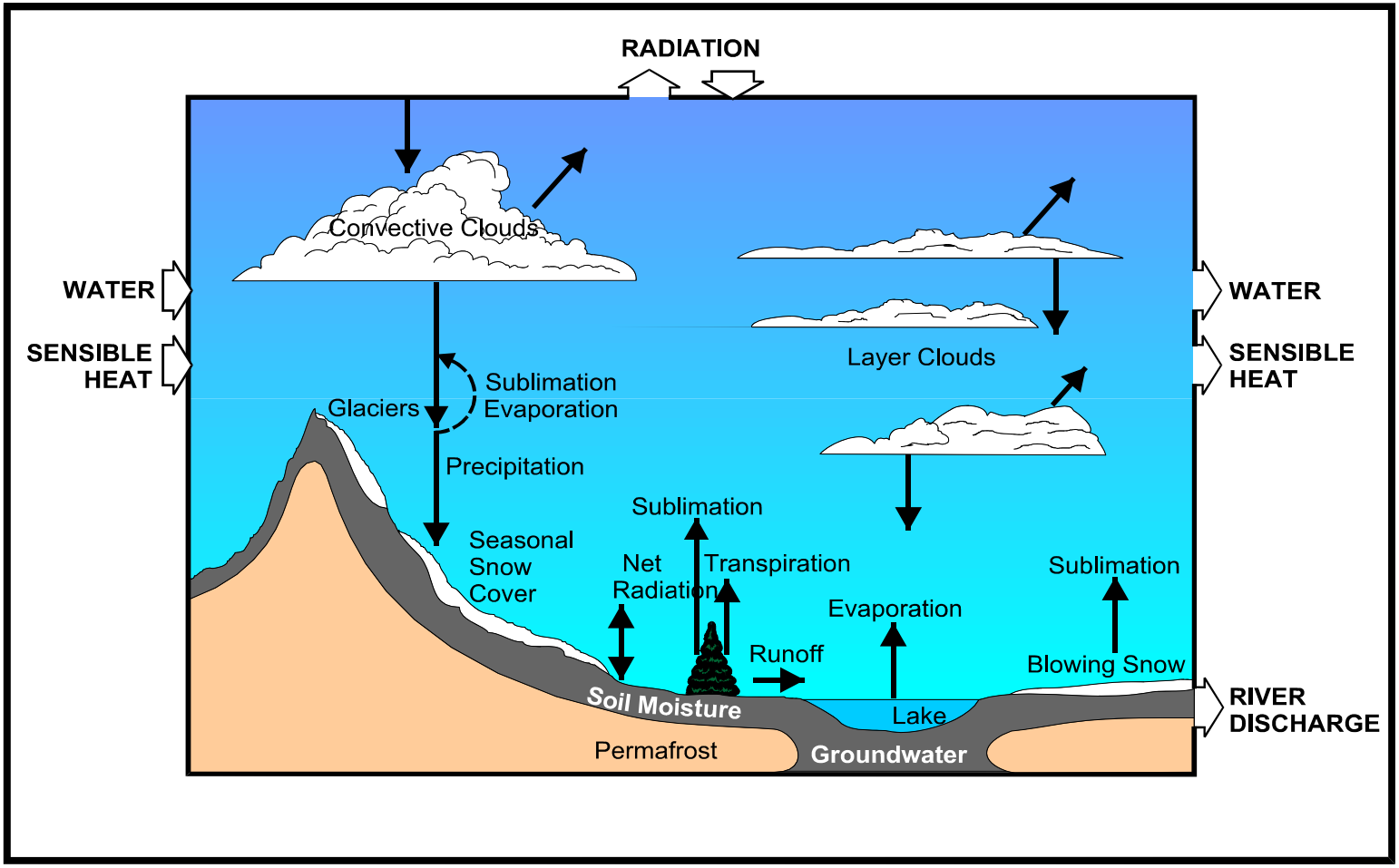
OBJECTIVE

For the Arctic, to give a general sense of:

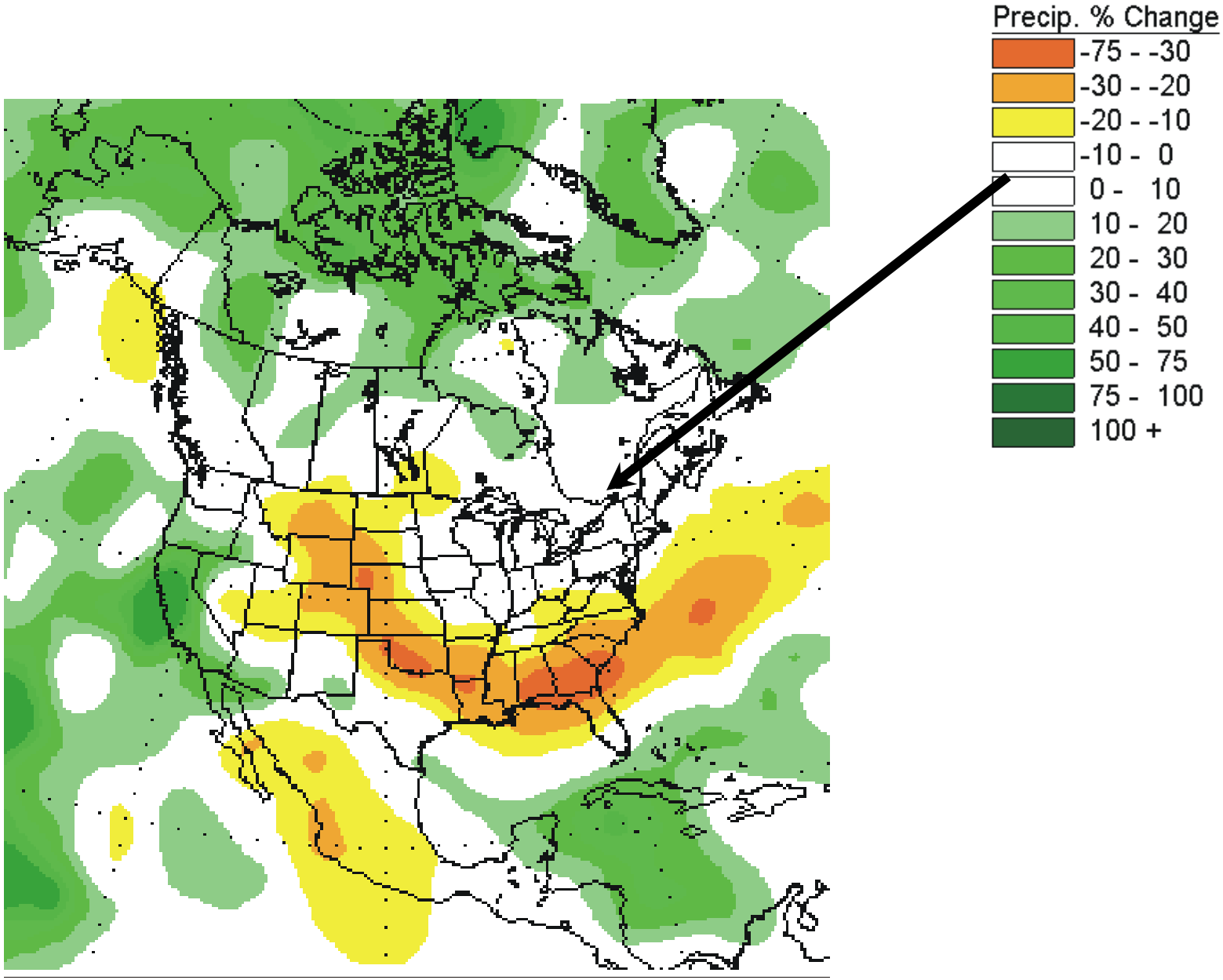
- Water cycle and its cold phase
- Storm tracks
- Light and heavy precipitation
- Relevant features of high latitudes
- Some important issues

The bias will be towards the Canadian Arctic or sub-Arctic

WATER CYCLING

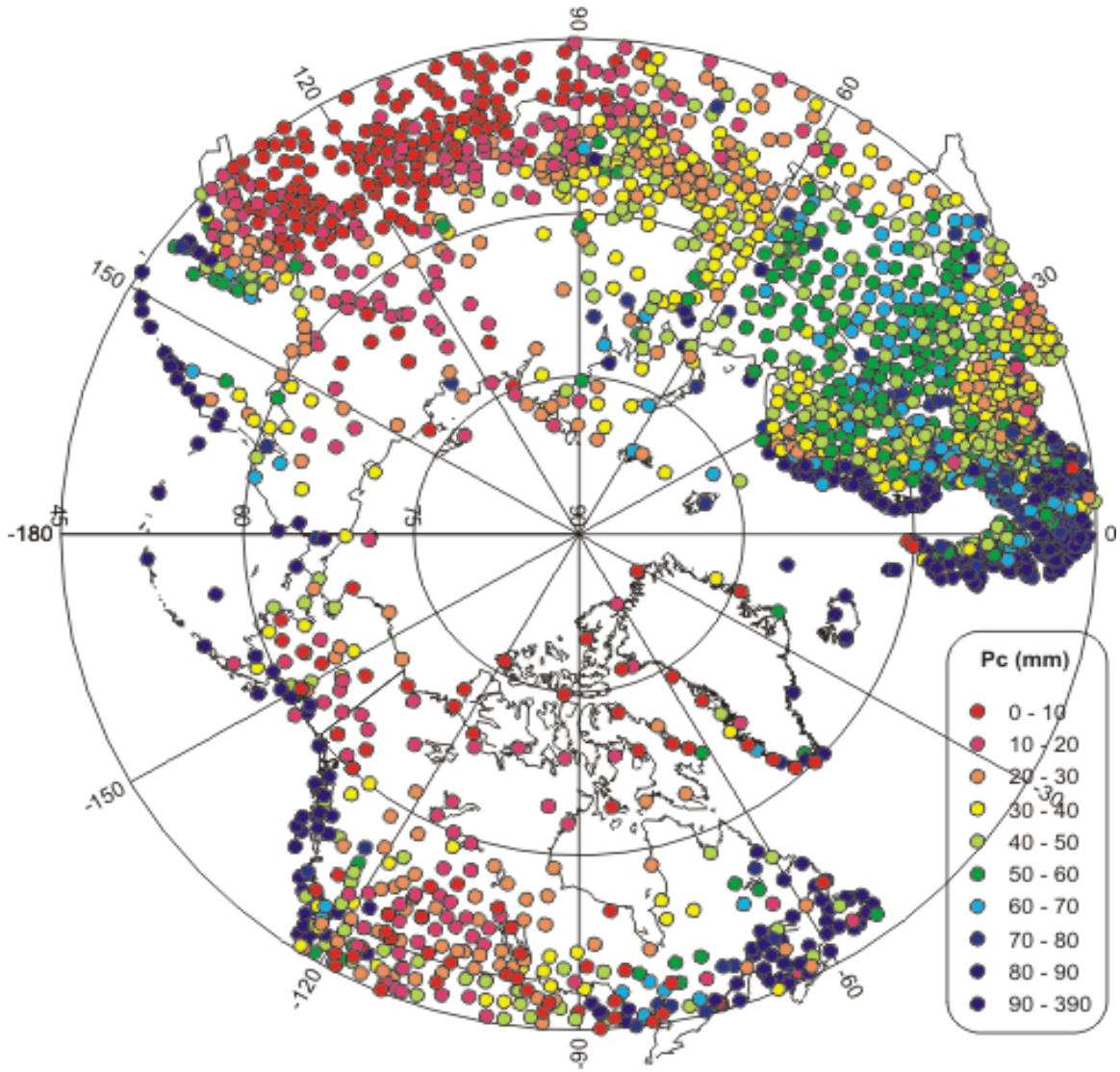


FUTURE PRECIPITATION



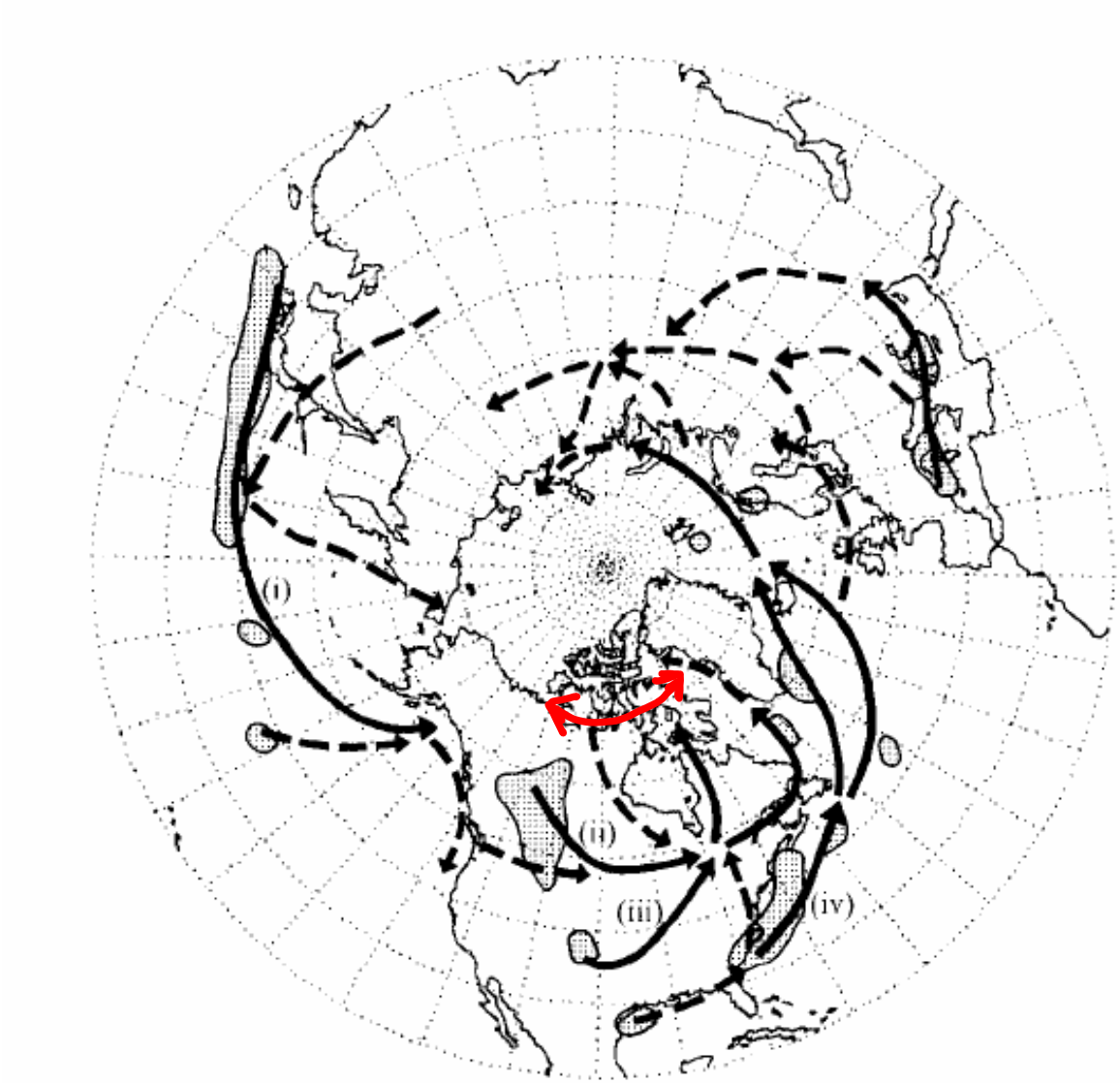

Ft. Simpson
Iqaluit

JANUARY PRECIPITATION

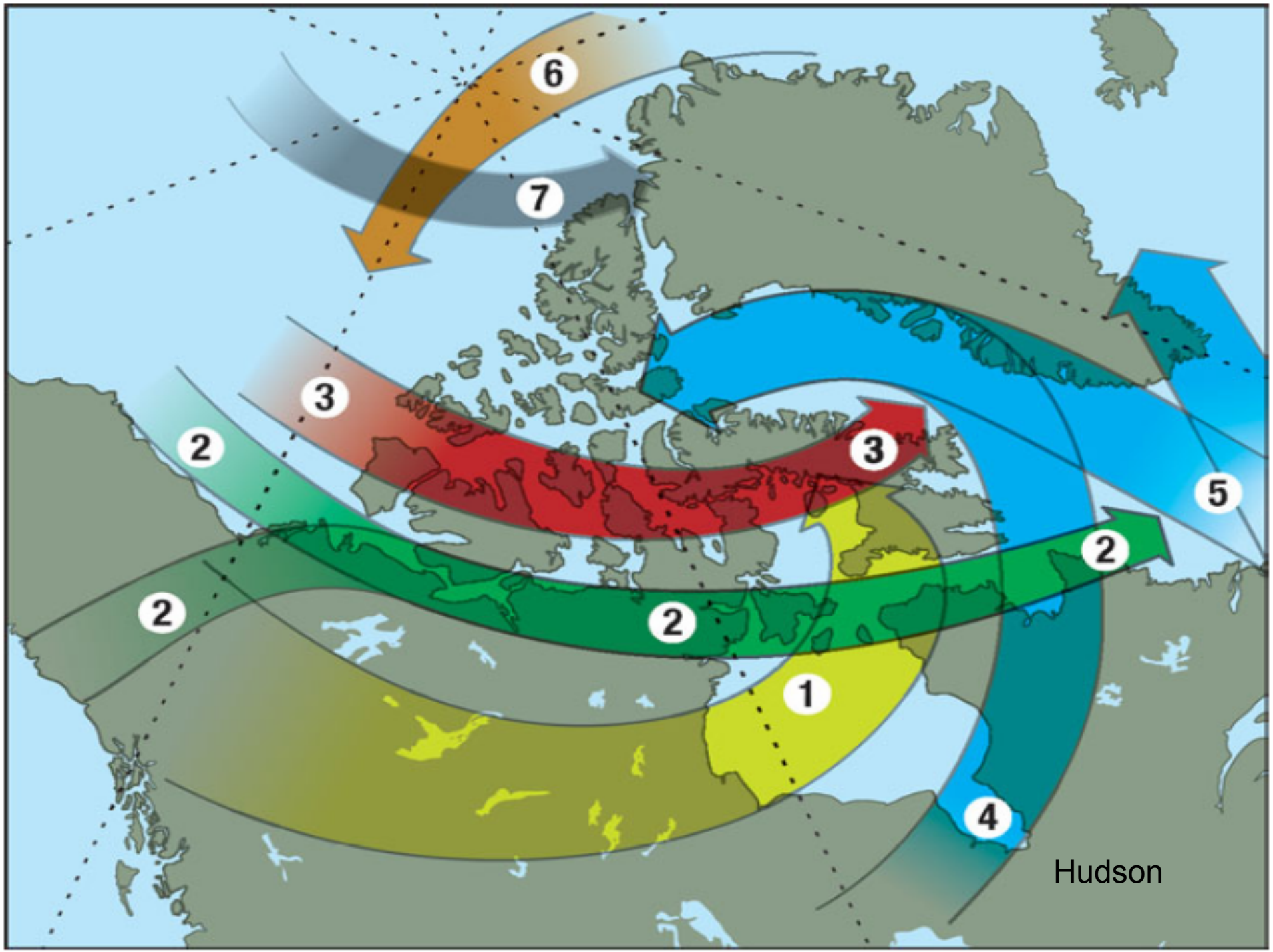


Yang et al.

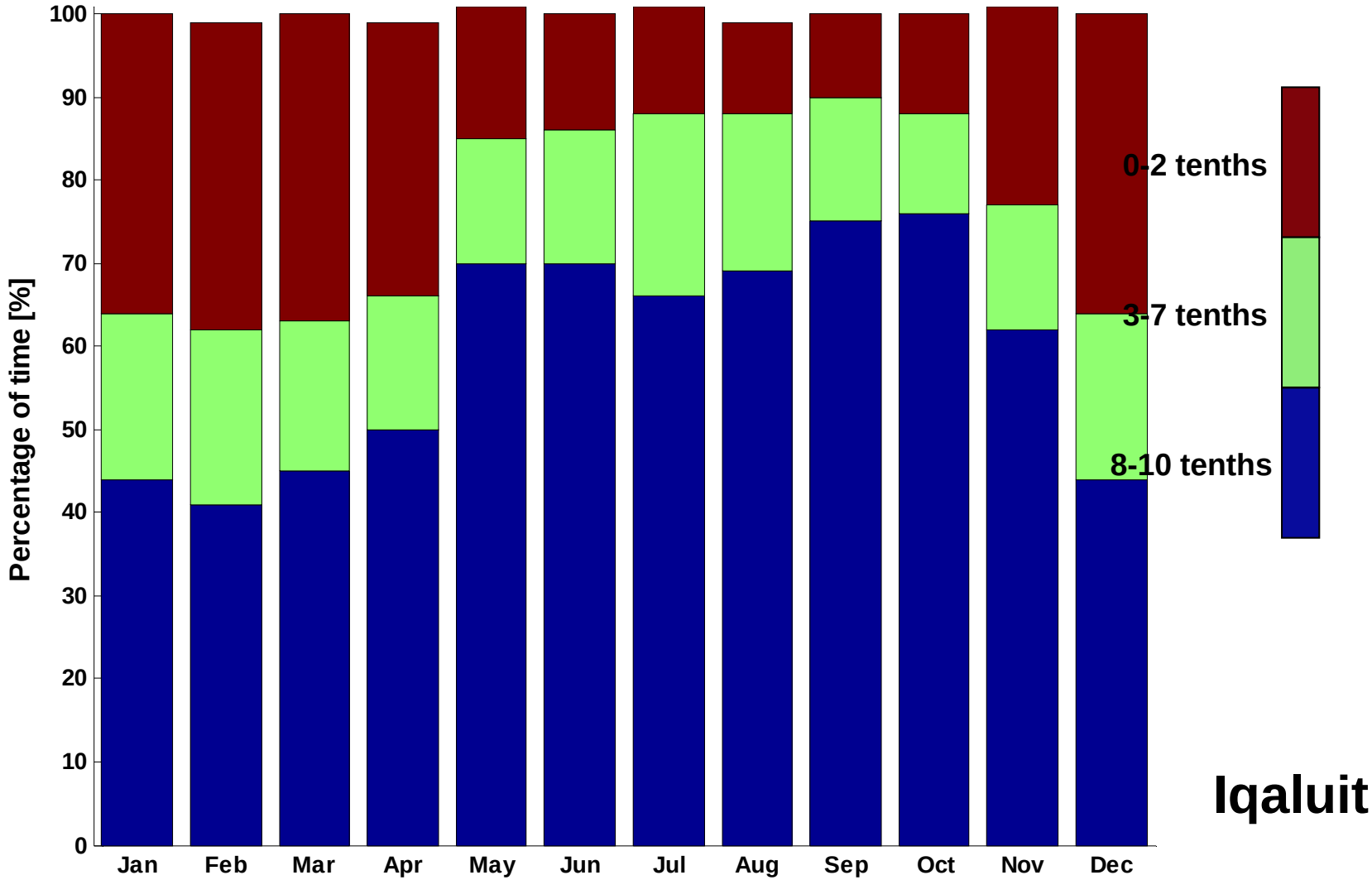
STORM TRACKS



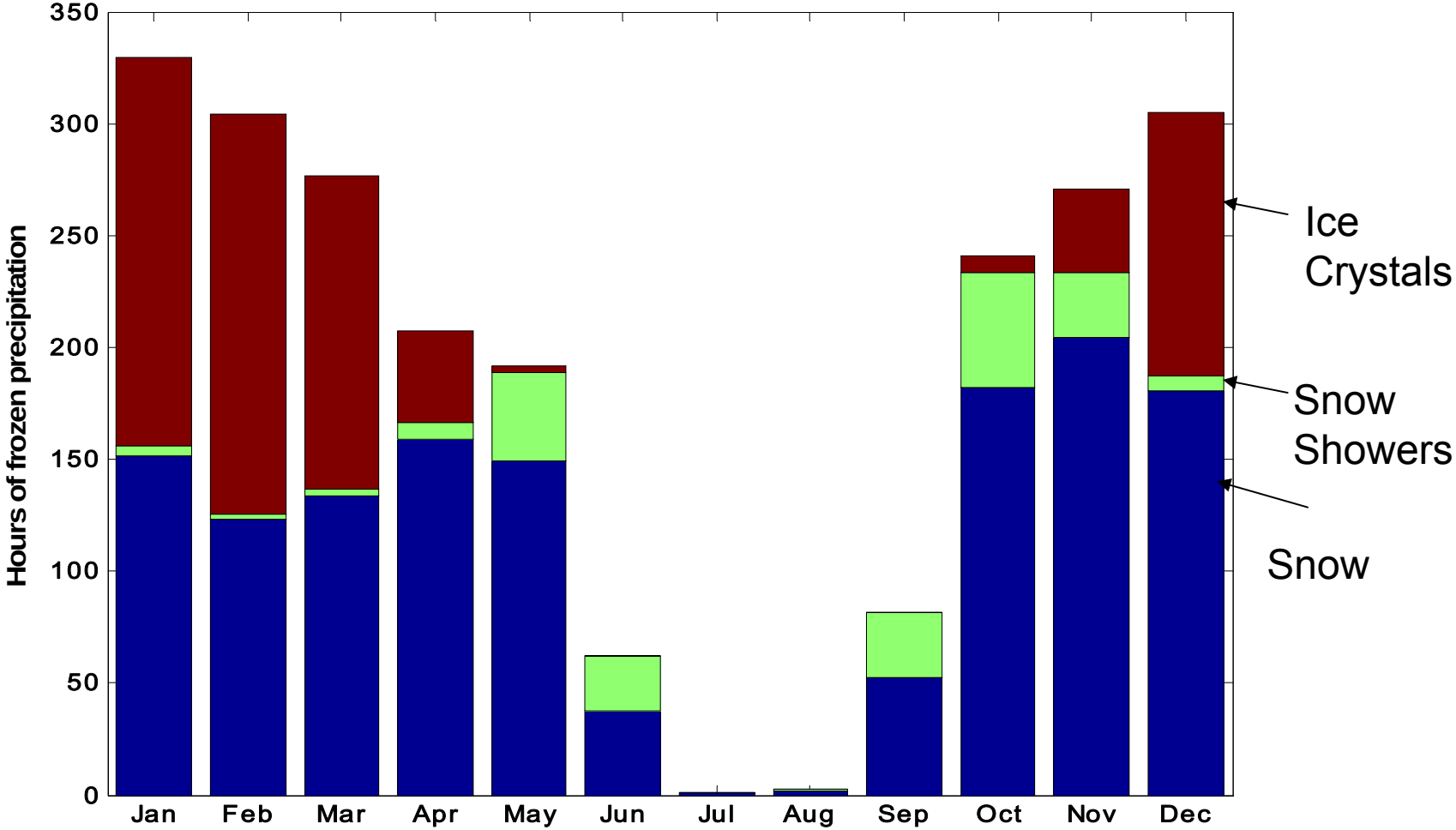
Whittaker and Horn (1984)


6
7
3
2
3
5
2
2
2
1
4
Hudson

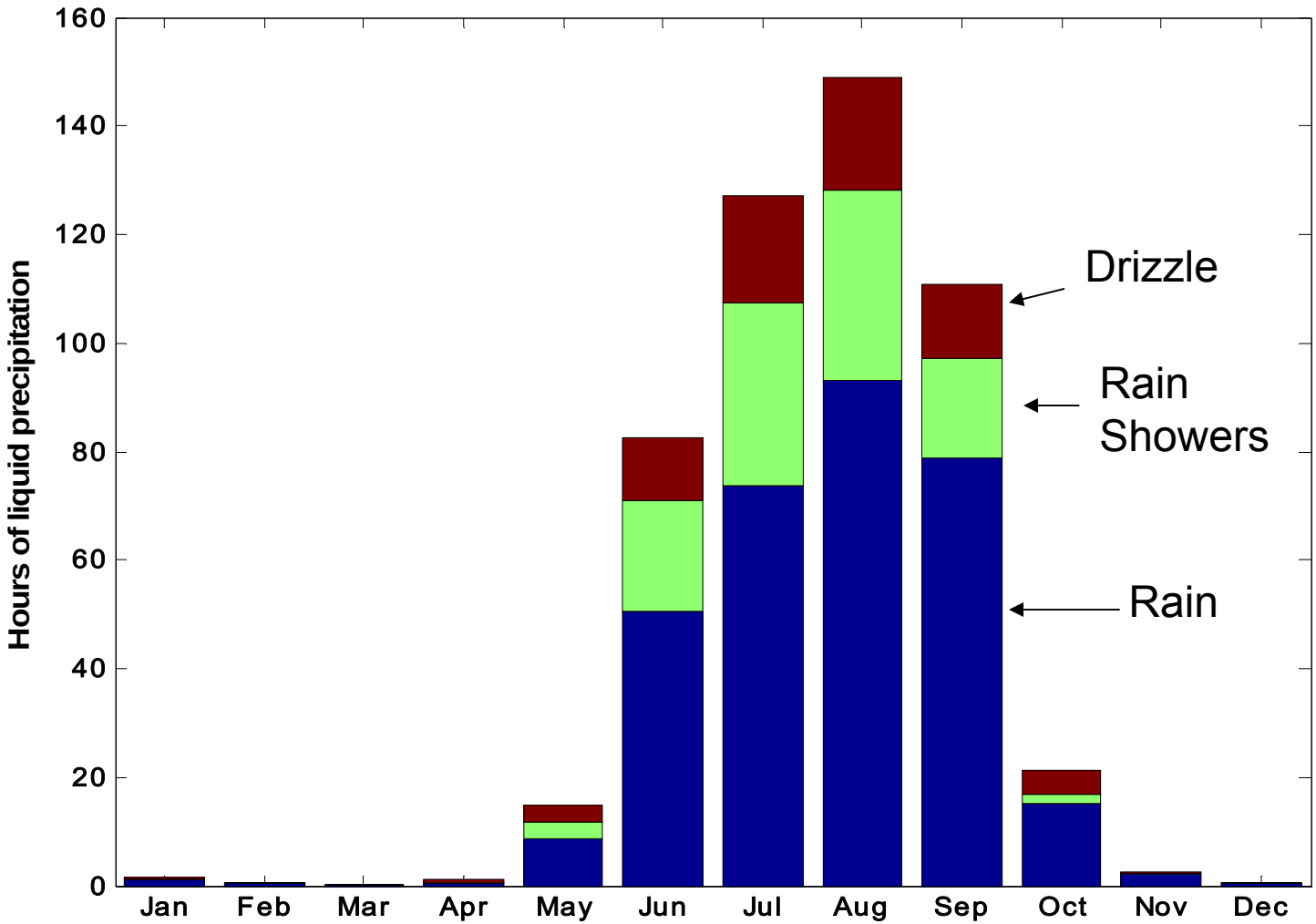
CLOUD FRACTION



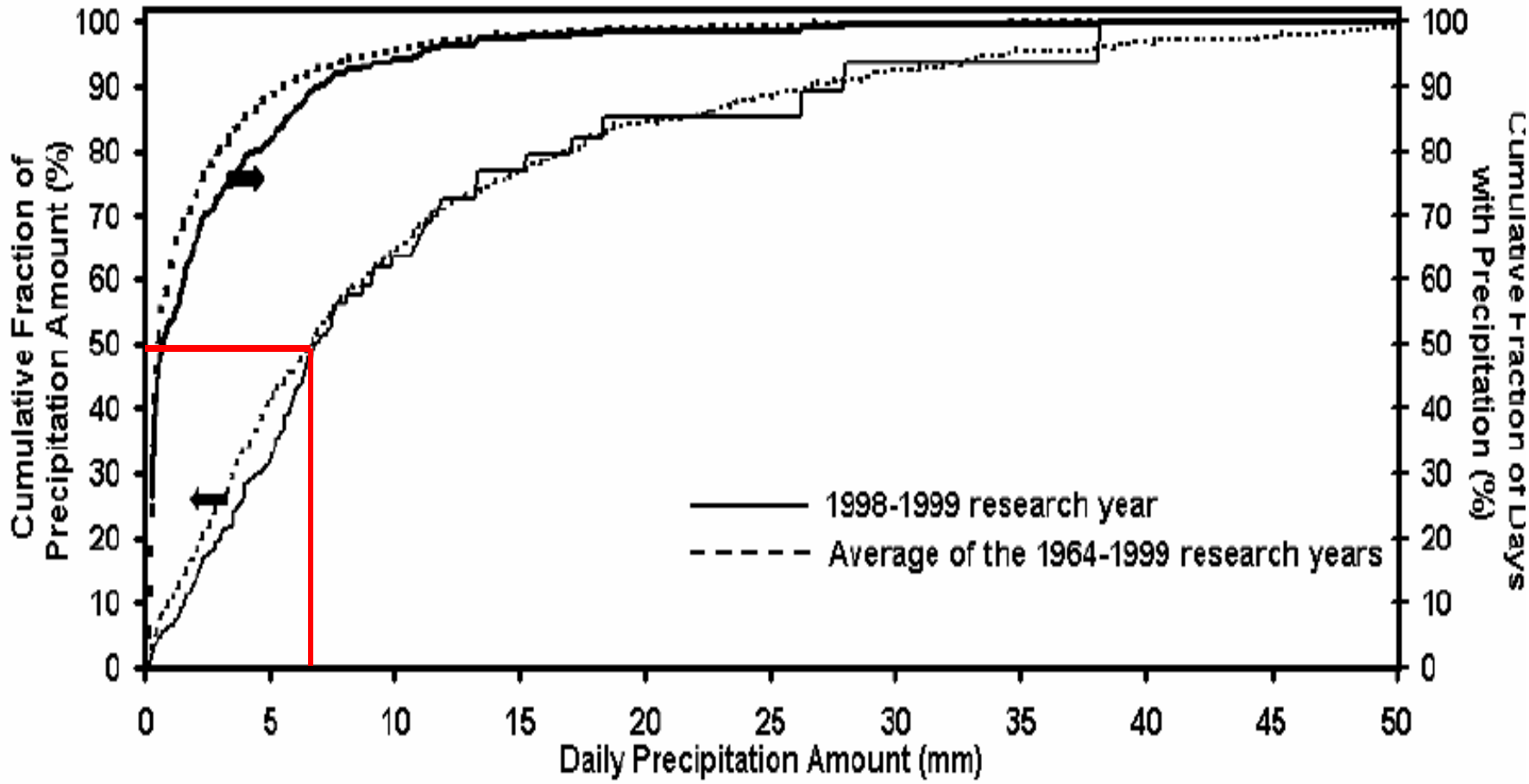
SOLID PRECIPITATION



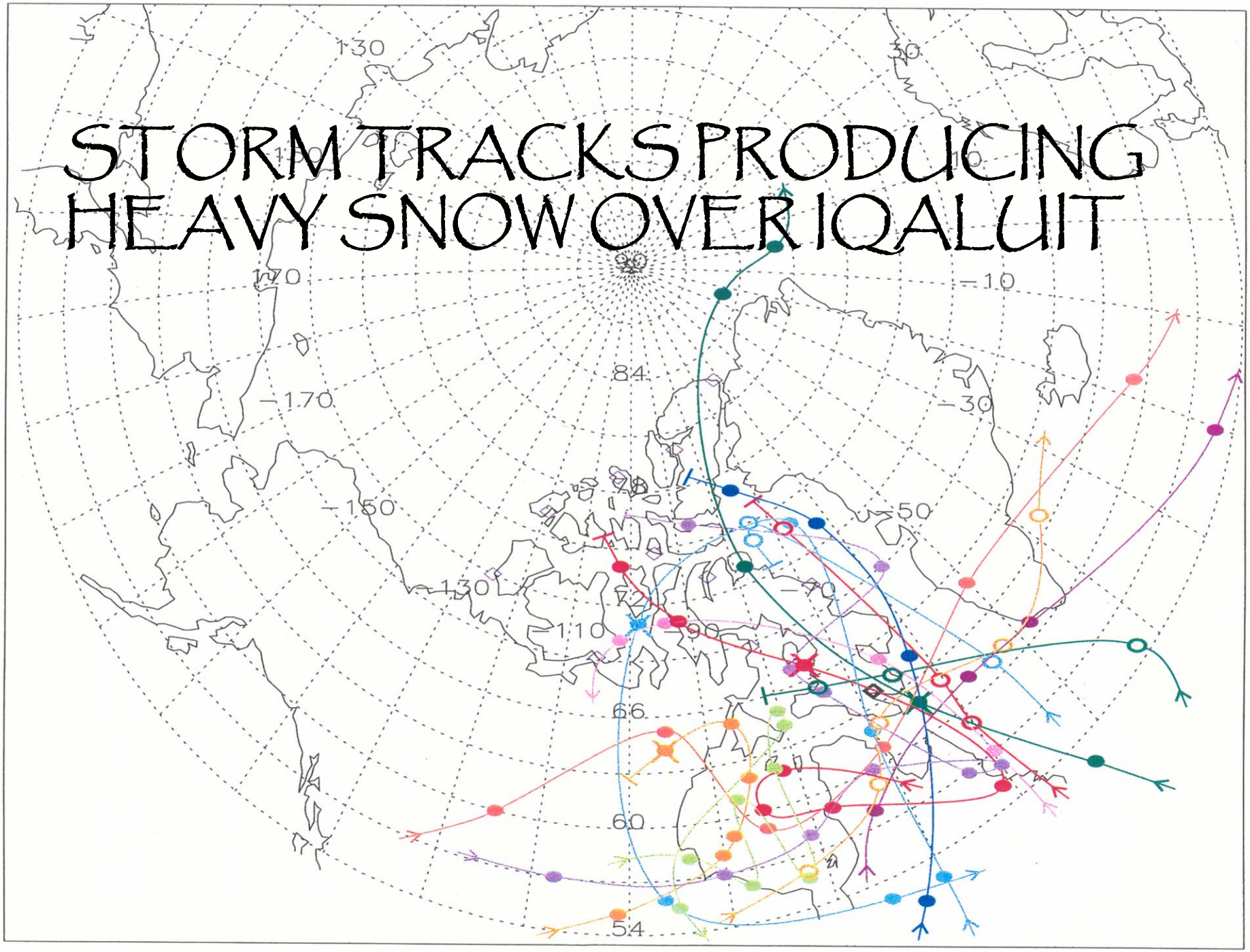
LIQUID PRECIPITATION



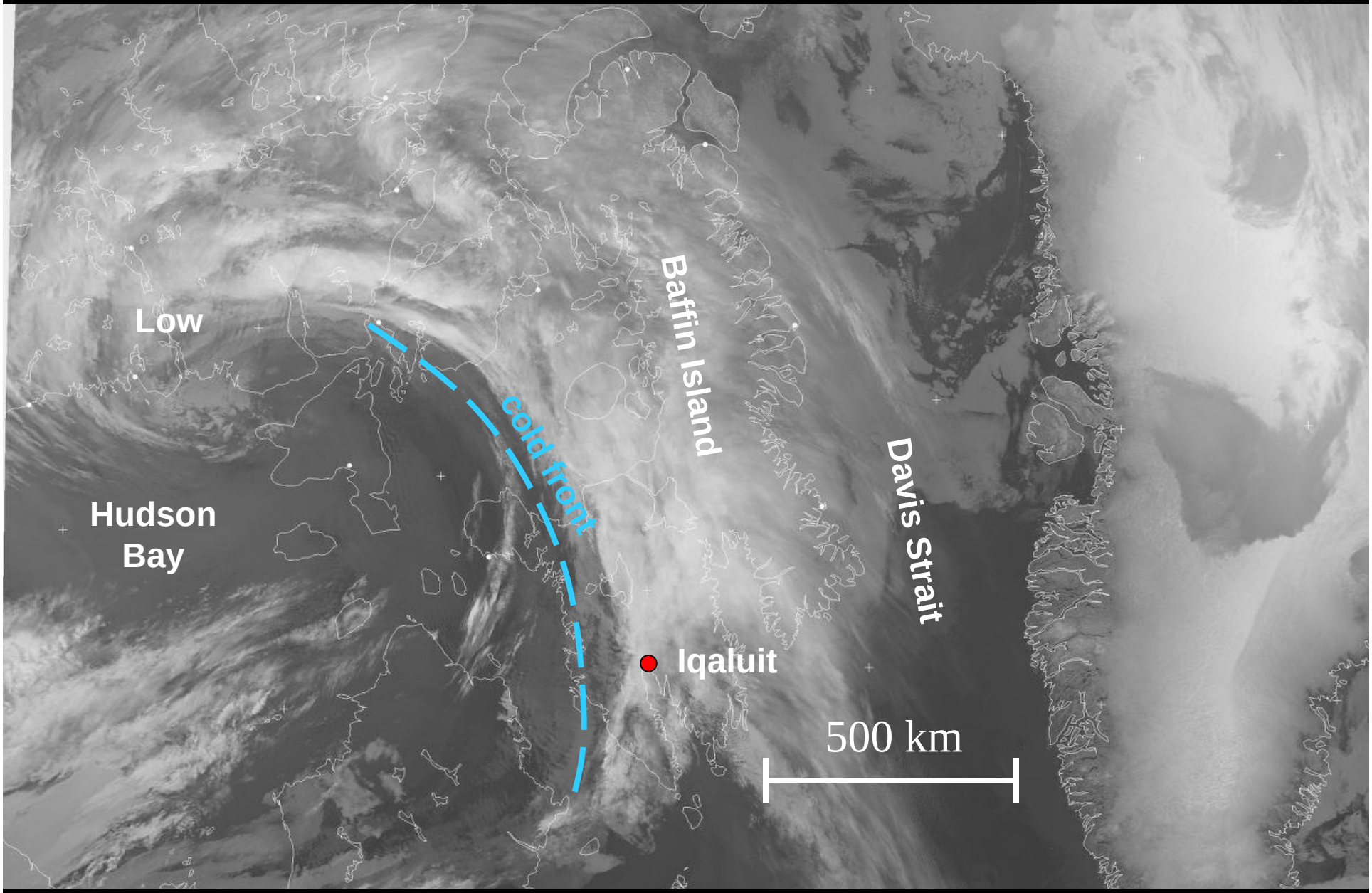
PRECIPITATION AMOUNTS



STORM TRACKS PRODUCING HEAVY SNOW OVER IQALUIT

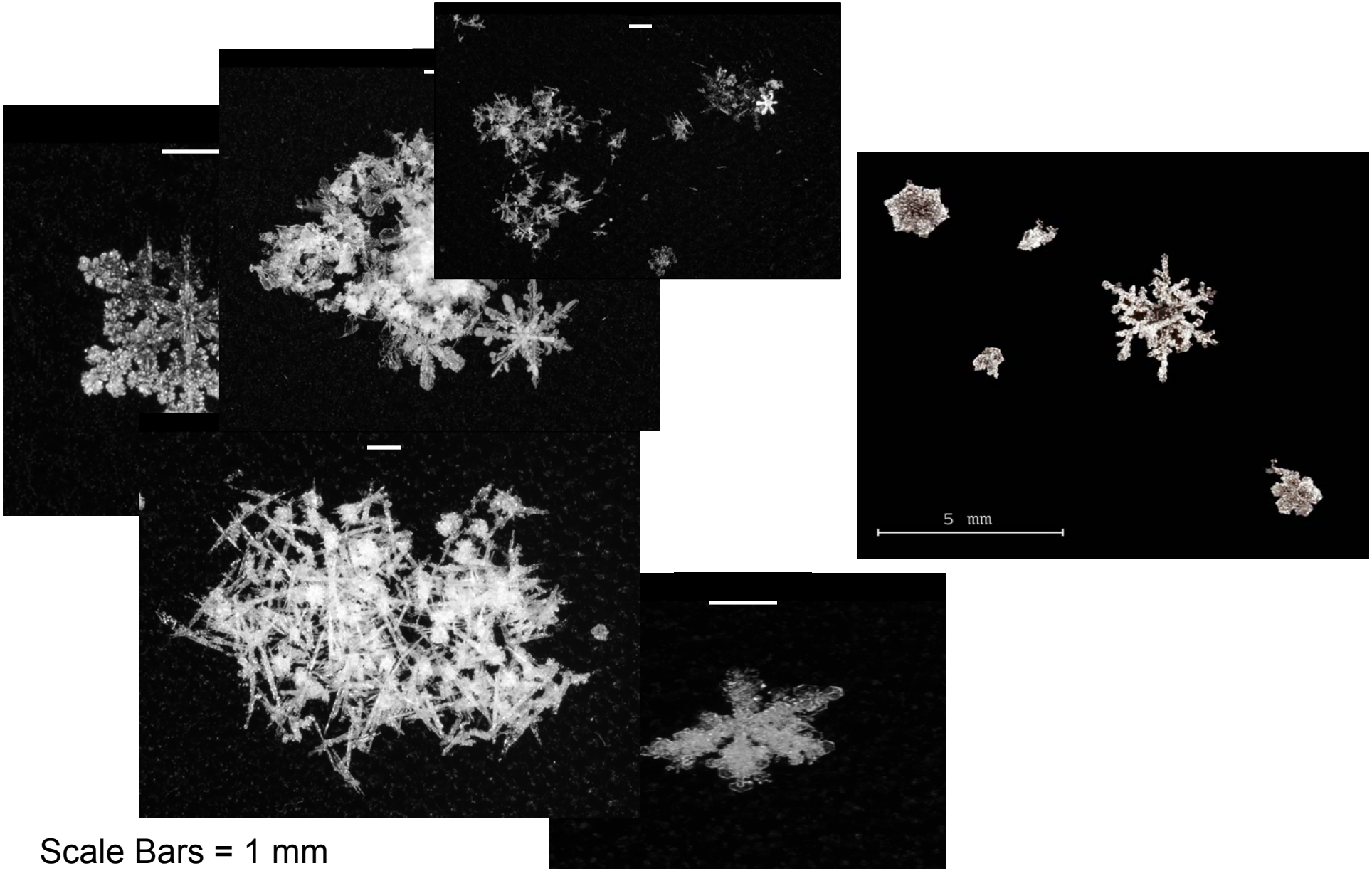


Severe Snowstorm, 20:33 EST on 24 October 2004



Heavy snow and strong winds at Iqaluit

IQALUIT



Scale Bars = 1 mm

LIGHT PRECIPITATION

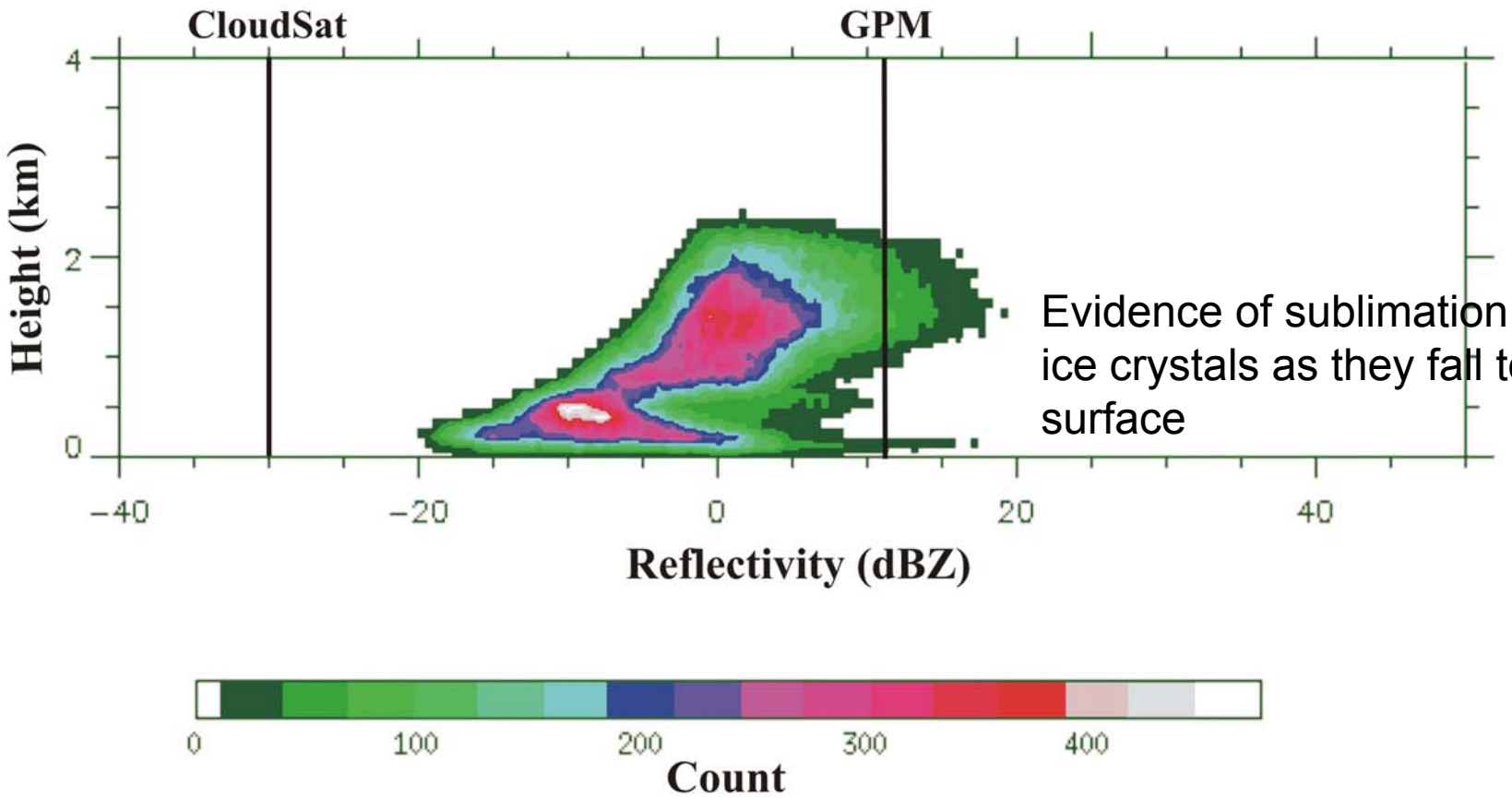
- **Light snowfall (< 2.5 mm/h) commonly occurs at Fort Simpson:**

  90% of the time during precipitation

- **Associated cloud tops vary greatly in height:**

  approximately 50% are > 5 km

REFLECTIVITY PROFILES
(a light snow event over Ft. Simpson)



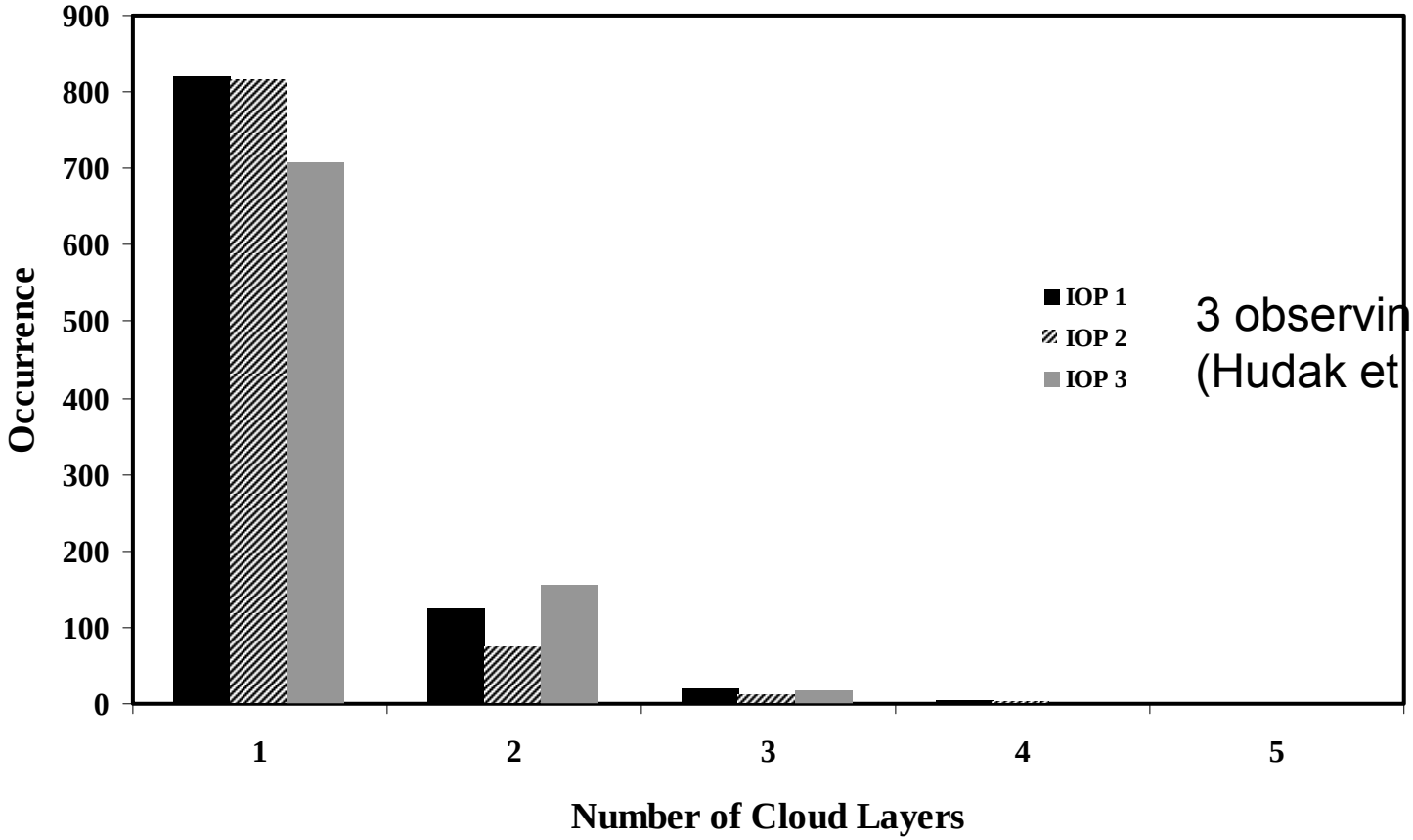
Evidence of sublimation of ice crystals as they fall to the surface

VIRGA

November 2005, Iqaluit

Sublimating
ice crystals below
cloud are common
in the Arctic

CLOUD LAYERING DURING PRECIPITATION

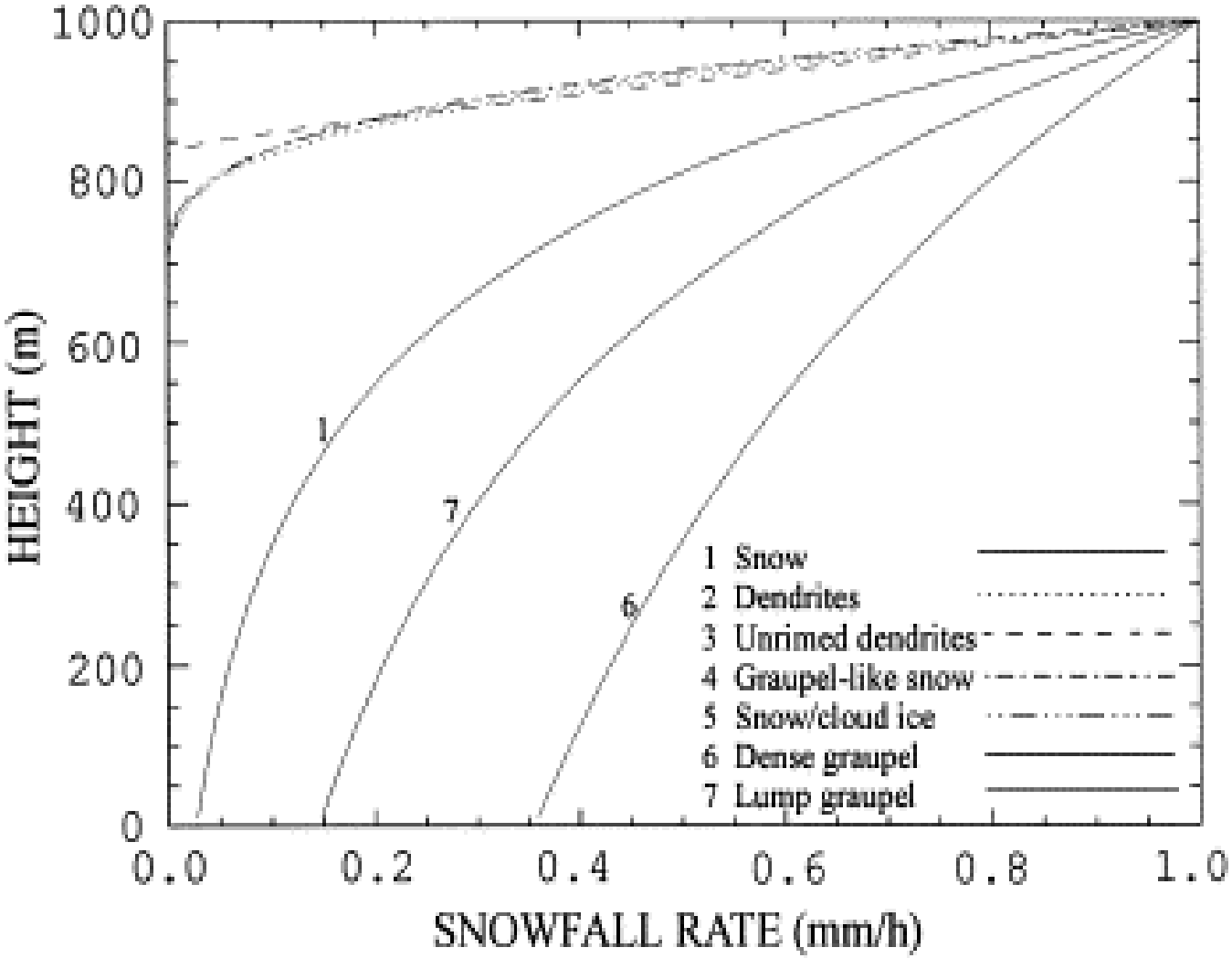


3 observing periods
(Hudak et al., 2004)

Ft. Simpson, North West Territories

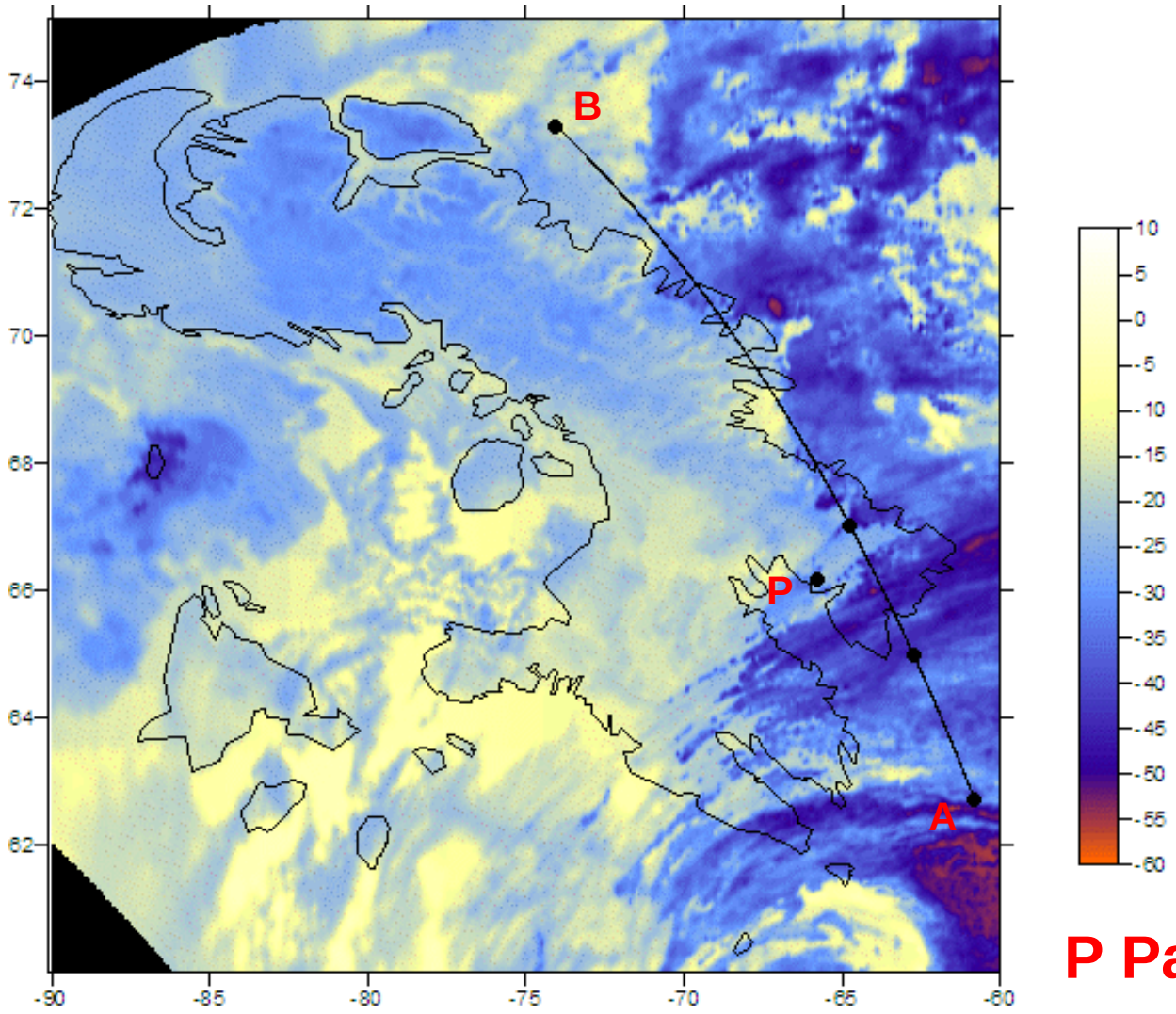
SNOWFALL RATE AND PARTICLE TYPES

for T=0°C and RH=60%



CLOUDSAT OVER BAFFIN ISLAND

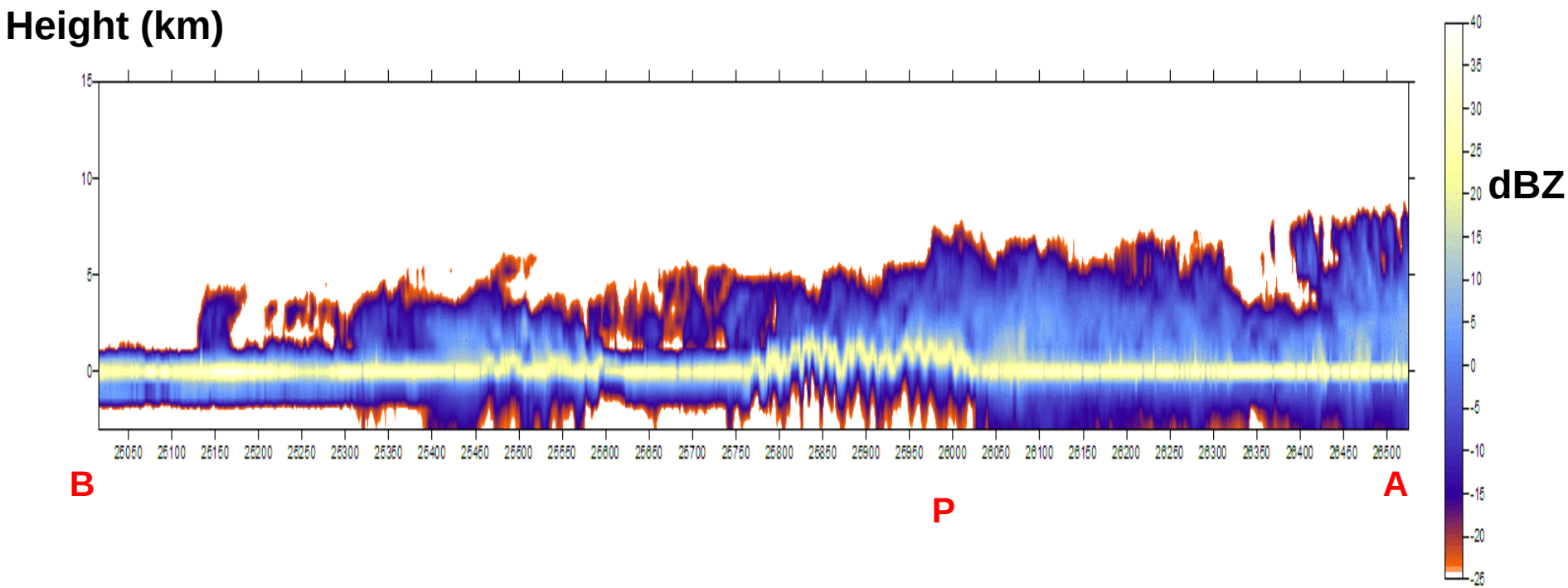
November 7, 2006



MODIS CTT (°C)

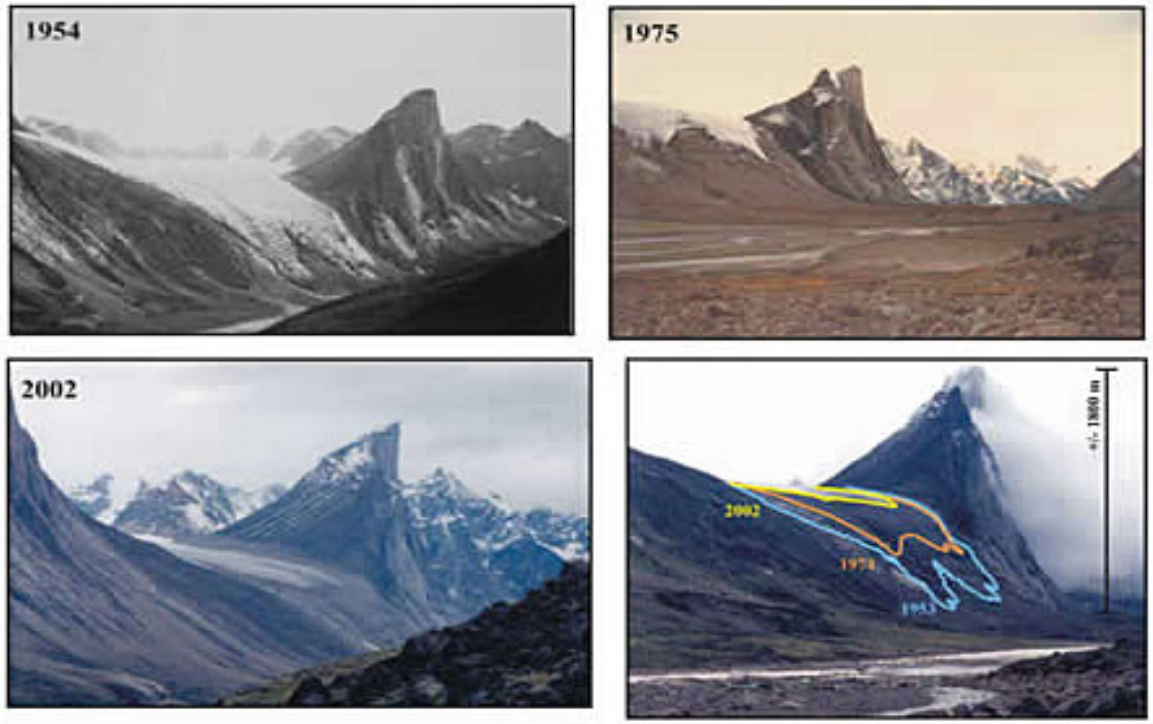
P Pangnirtung

CLOUDSAT INFORMATION

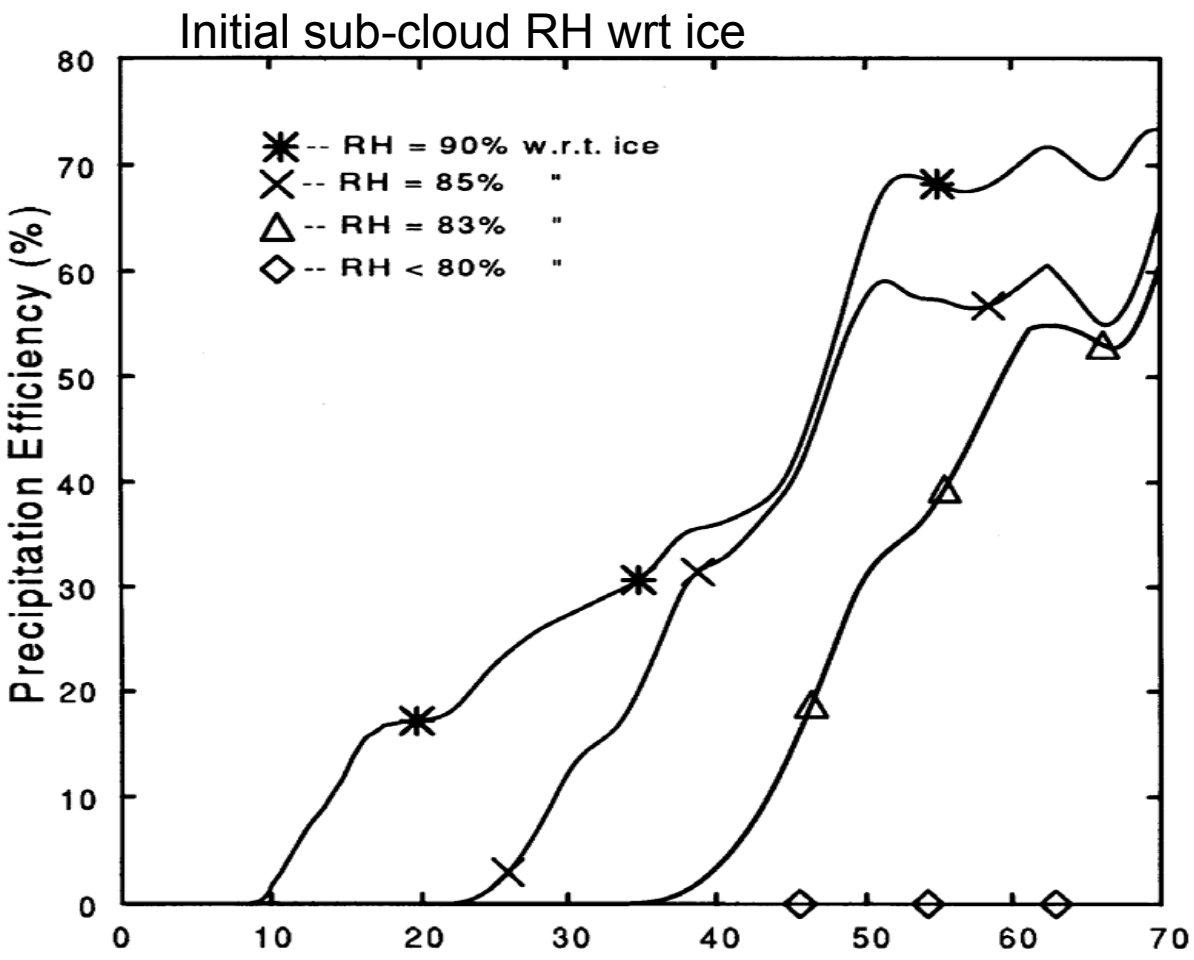


PENNY ICE CAP

- The birth place of the Last Ice Age is shrinking



PRECIPITATION EFFICIENCY



Time after initiation of cloud model (h)

HIGH LATITUDE 'DISTINCT' FEATURES

Some 'distinct' features of the Arctic include:

- Persistent coldness
- Strong atmospheric stability
- High Coriolis parameter
- Vast flat regions interspersed with topography
- (often) Limited local moisture sources
- (often) 'Clean' air
- …

ISSUES RELATED TO PRECIPITATING SYSTEMS

A few issues include …

Within the current climate system:

- **What precisely is the role of these systems within the cycling of water in the Arctic?**
- **What is the means through which precipitation is produced within these systems and what bottlenecks are there?**
- **To what extent do surface features (open water, topography, snowcover …) influence the production of their precipitation?**
- **How do precipitating systems affect the evolution of, for example, ice caps, glaciers and sea ice?**

And, how will these systems 'interact' with a changing climate?

CONCLUDING REMARKS

A few key comments include:

- **Precipitating systems are part of the overall climate system**
- **Precipitating systems that influence the Arctic follow a number of different tracks and typically pass over a varying surface**
- **The Arctic has several 'distinct' features that may directly or indirectly affect precipitation production**
- **Over the long cold season, these systems produce light as well as heavy precipitation**
- **The detailed nature of the actual snow particles is important**

And:

- **We have a great opportunity to collectively address these and many other important issues associated with the Arctic hydrological cycle**


Thank you for your attention