



Observing the Arctic atmosphere: success stories from the A-Train constellation and implications for future ESA missions

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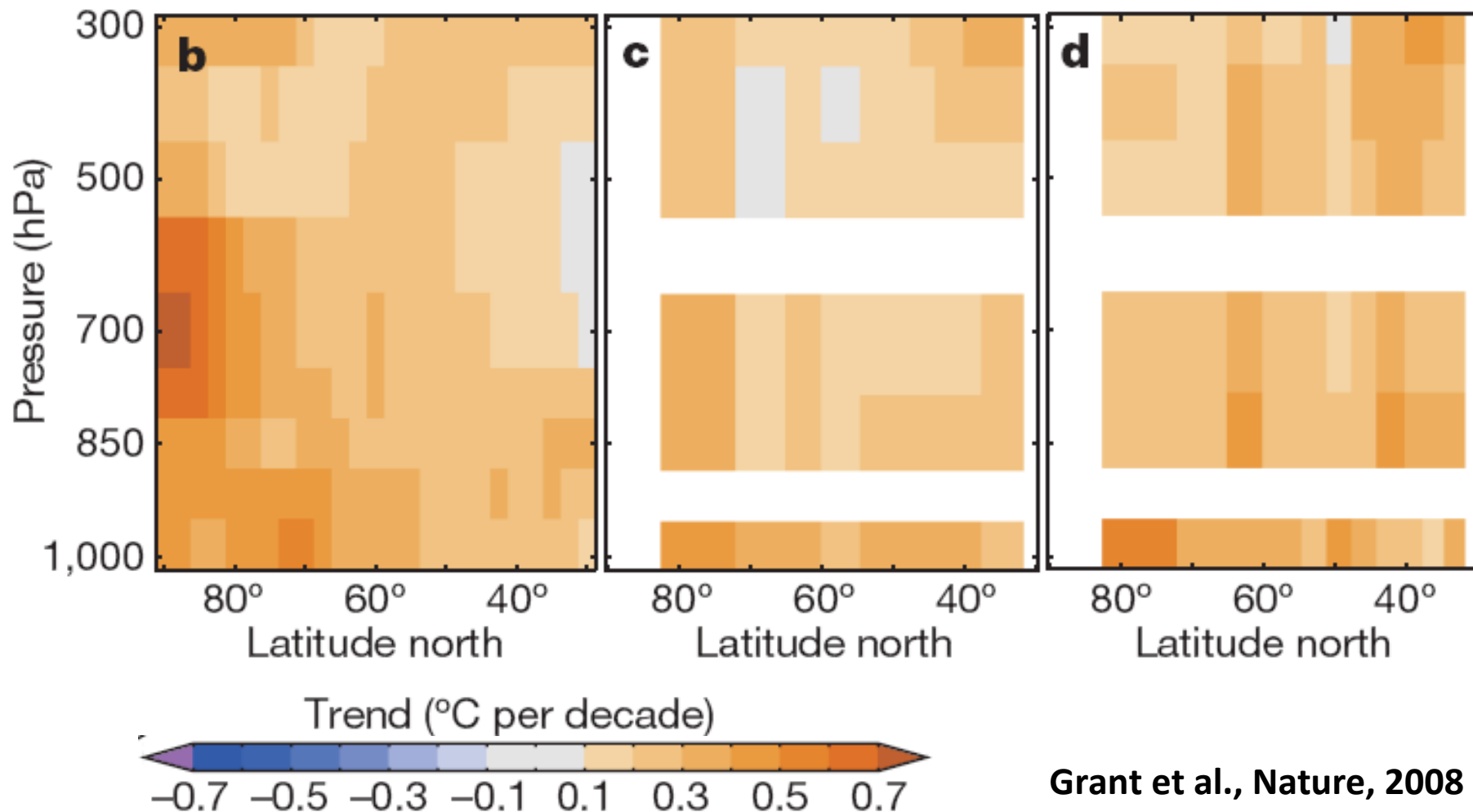
- **Dire need for accurate satellite observations**
- **NASA's A-Train constellation**
- **Some examples of atmospheric structure never before seen over the Arctic.**
- **Implications for future ESA missions**

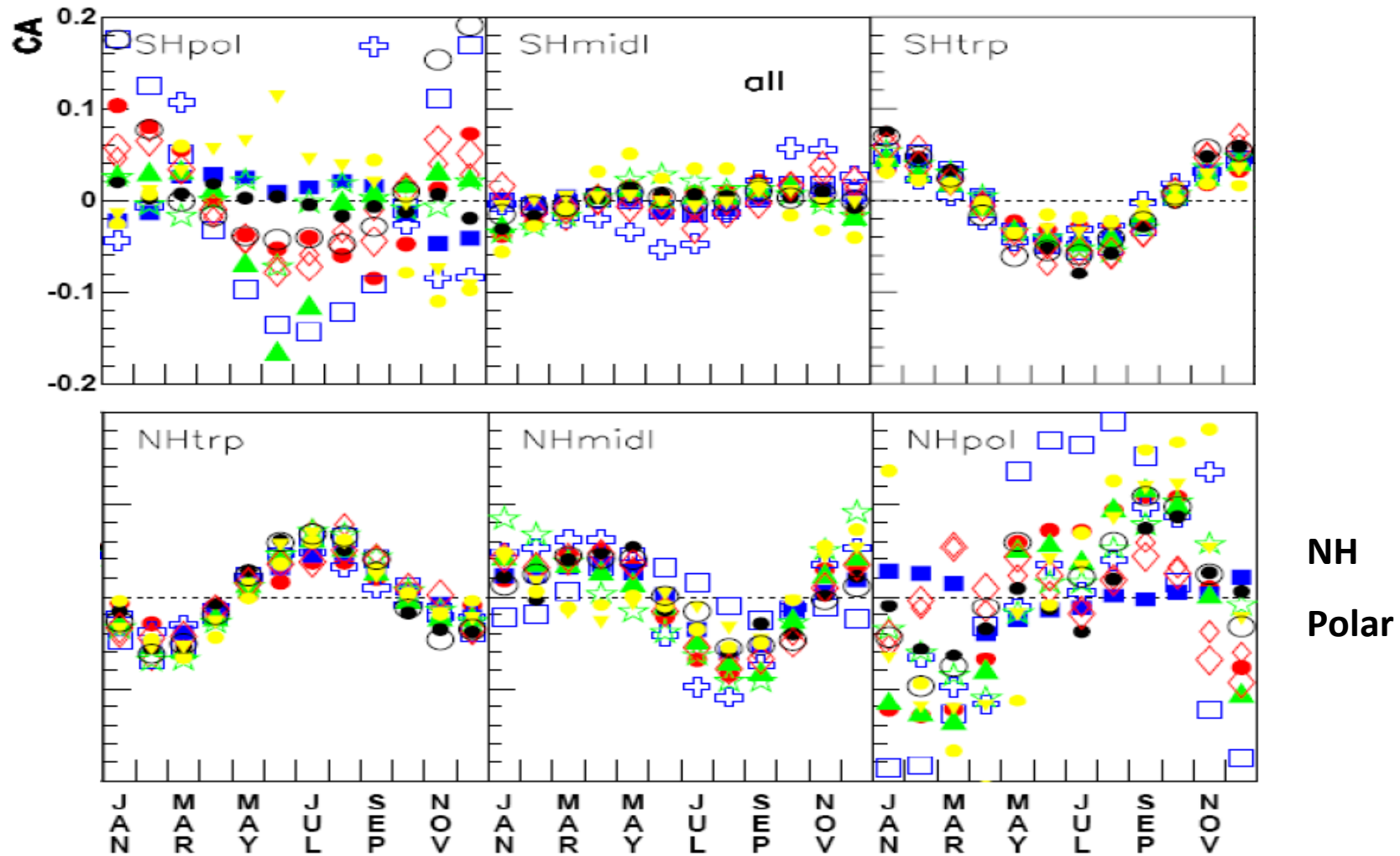
- **fragile and undergoing rapid changes in all measurable enviro-socio-economic dimensions.**
- **experiencing so-called “Arctic amplification”.**
- **a boiling pot of wide range of feedbacks occurring at various spatio-temporal scales.**
- **known to be highly unpredictable and estimates of its future scenarios have higher uncertainties.**

**So, how much do we know about
the Arctic atmosphere?**

**Let's examine few Essential Climate Variables (ECVs)
recognized by the Global Climate Observing System
(GCOS)...**

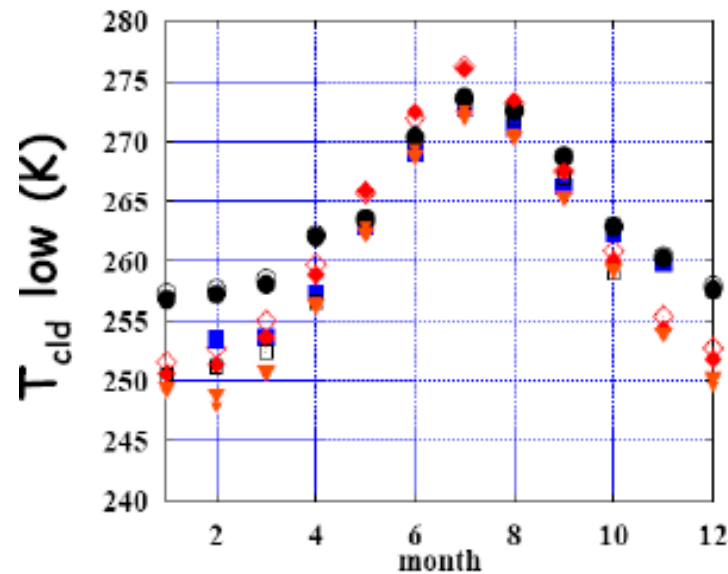
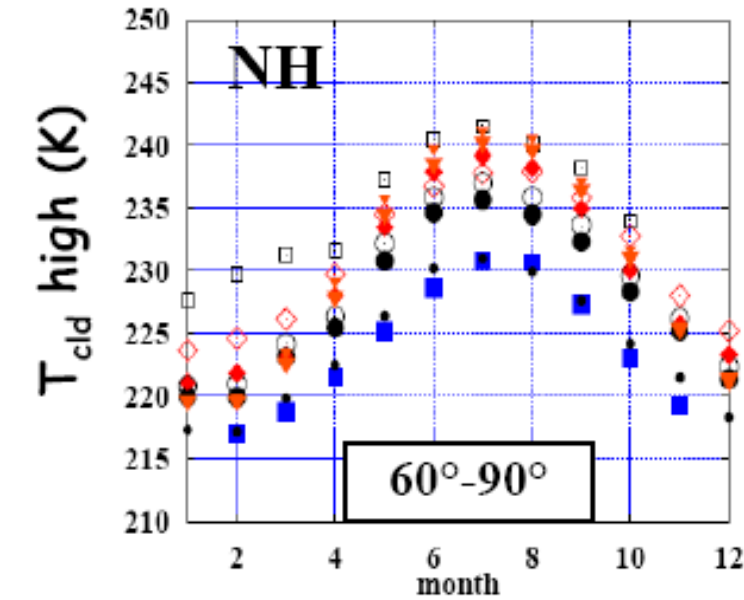
- Warming trends in the Arctic are data-set dependent.





Source: C. Stubenrauch's presentation from GEWEX CA, 2010

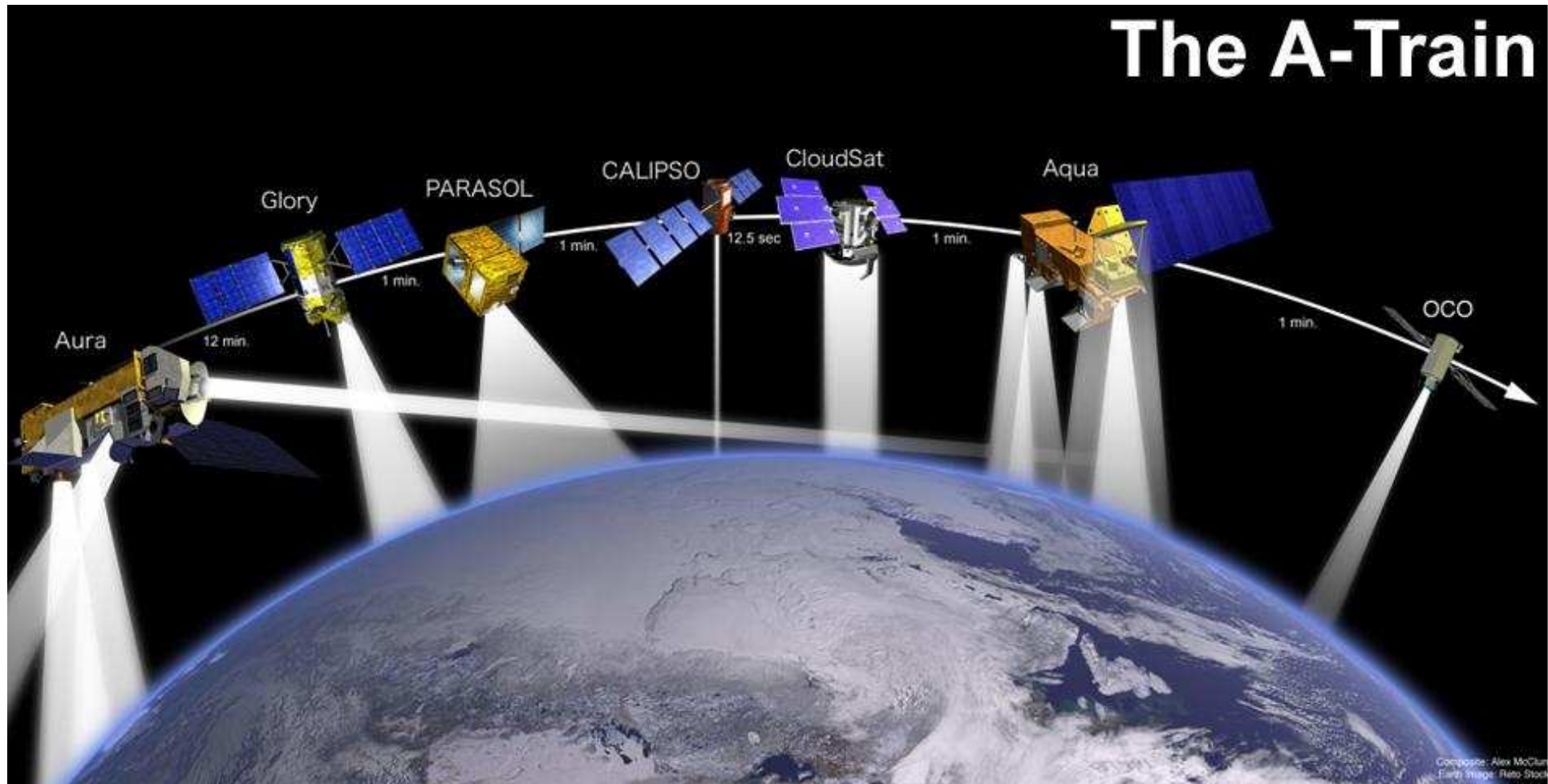
Cloud properties – cloud top temperature



What do observed differences in satellite data sets suggest?

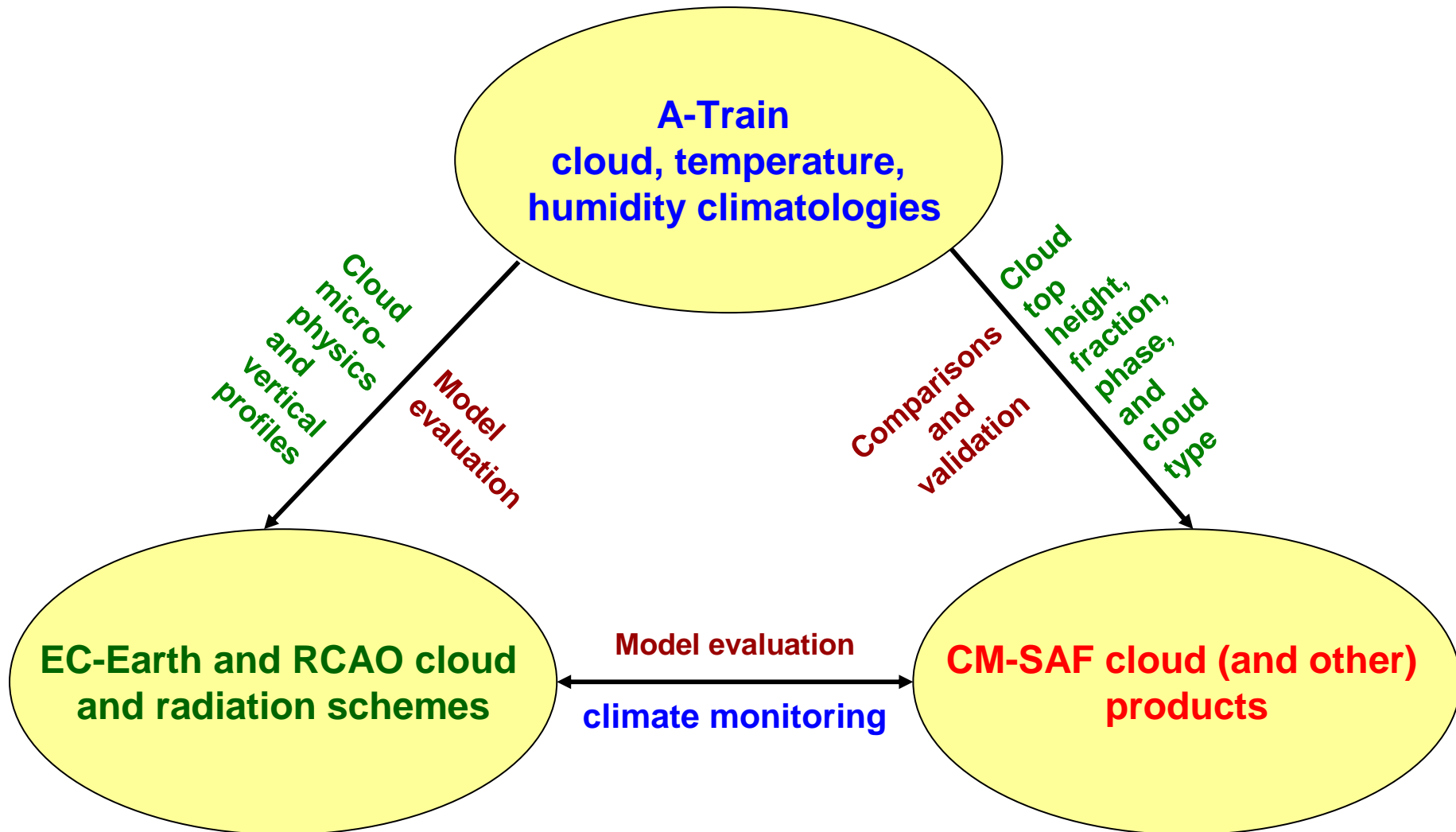
They, most likely, point out different sensitivities of instruments and the need for harmonization and synergy.

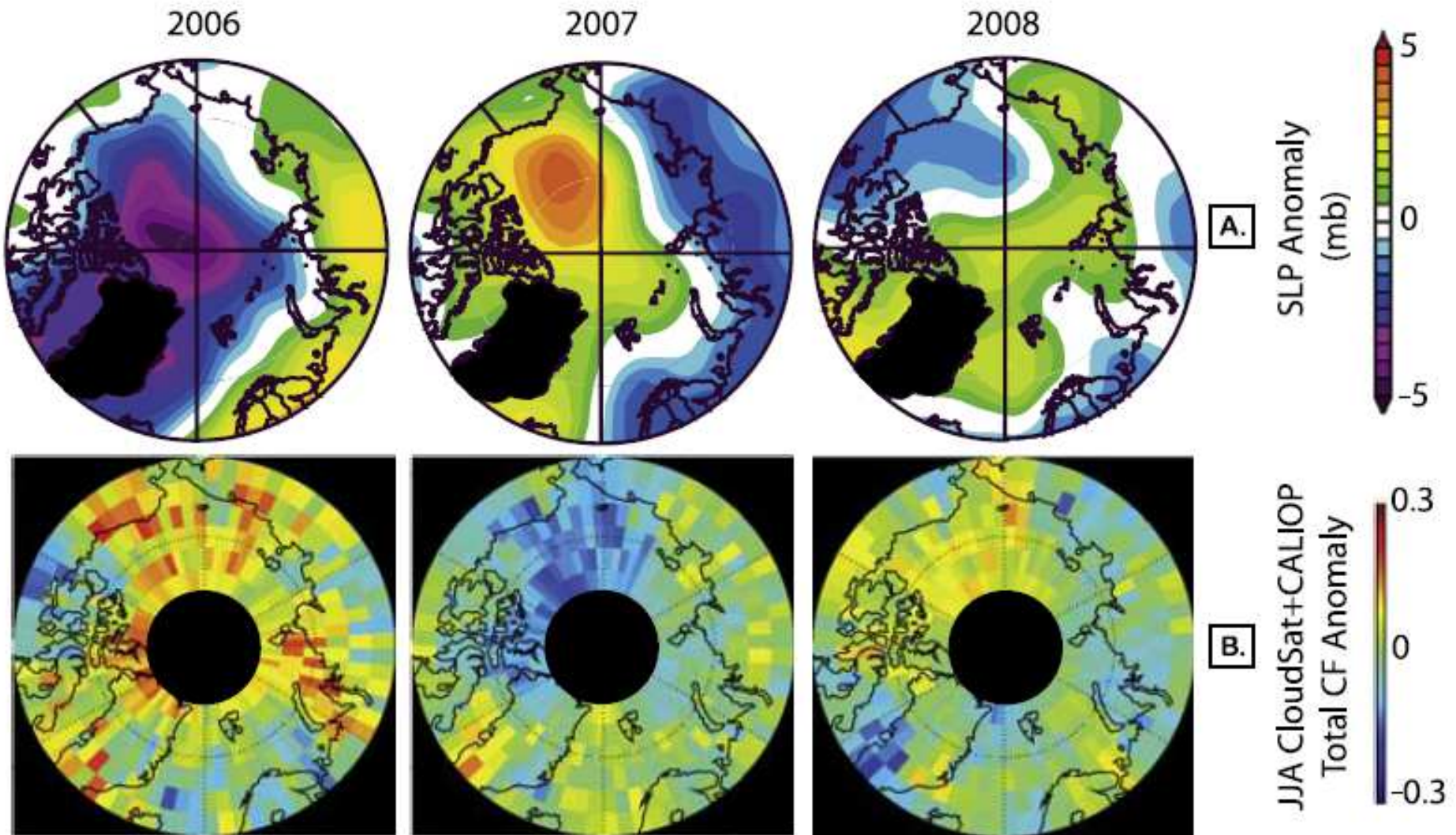
The sensors onboard A-Train constellation are proving pivotal in understanding these differences, improving climate models and our knowledge on the Arctic system in general.



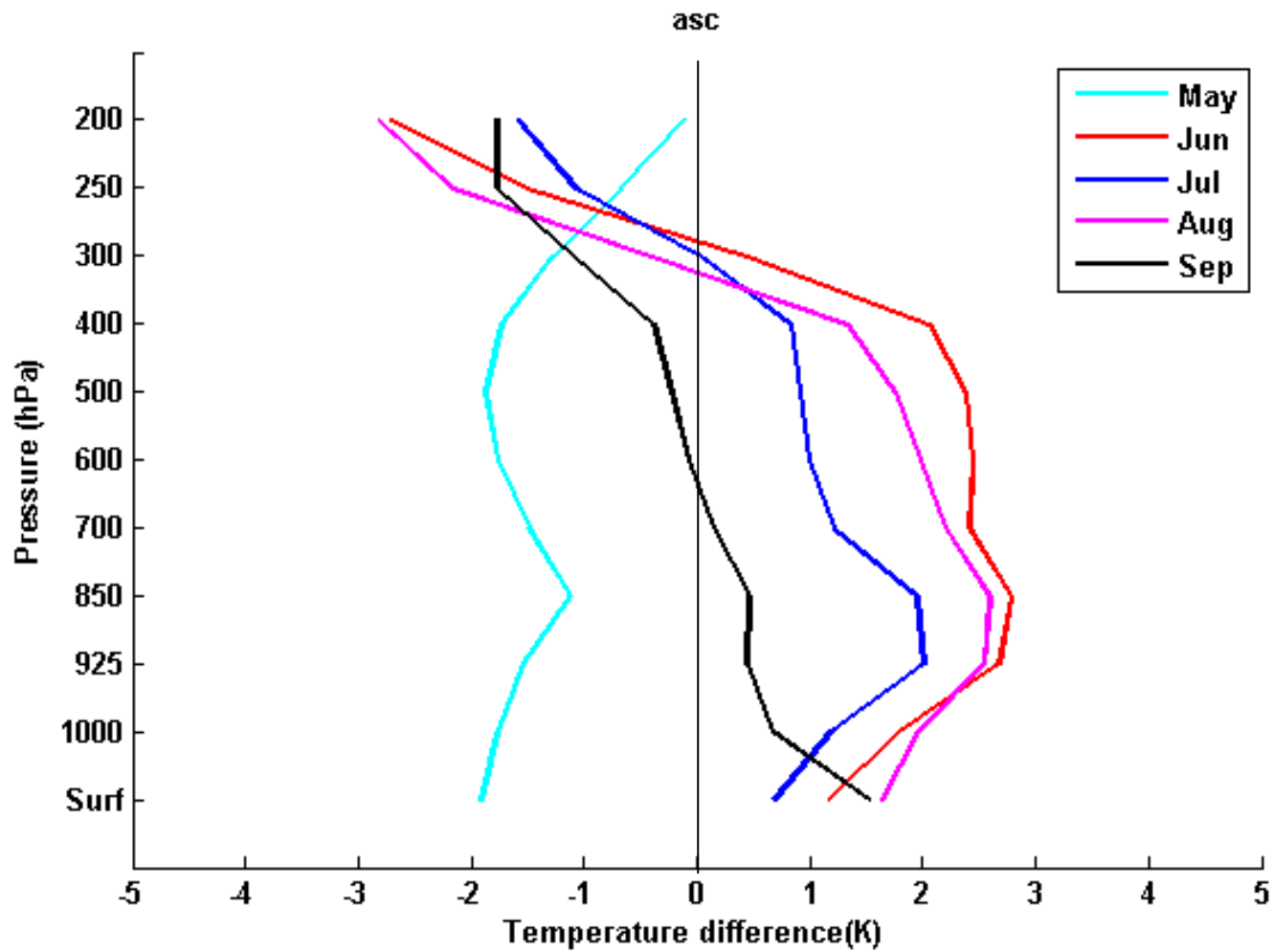
Exploiting A-Train observations for Arctic studies

Three pillars of the ArcticClim project

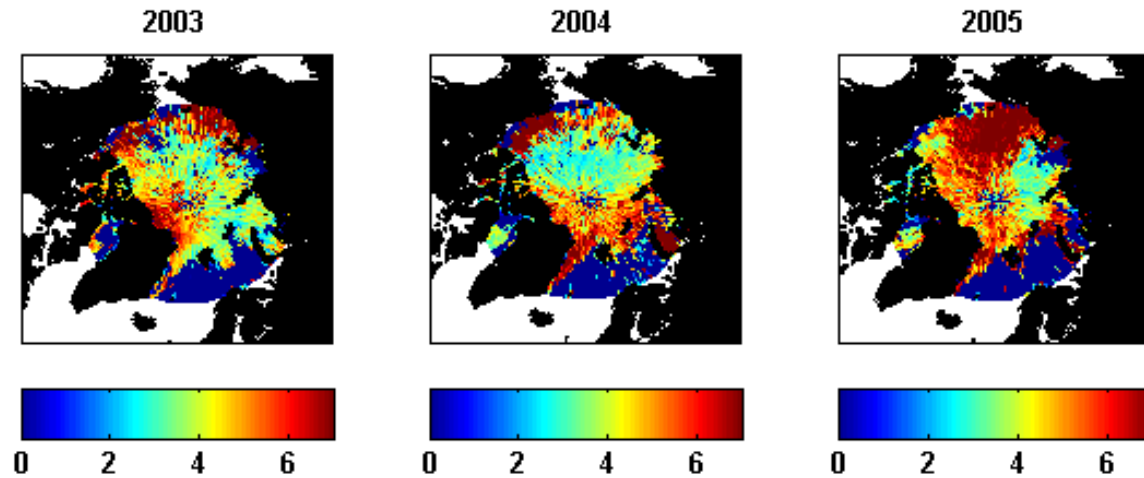




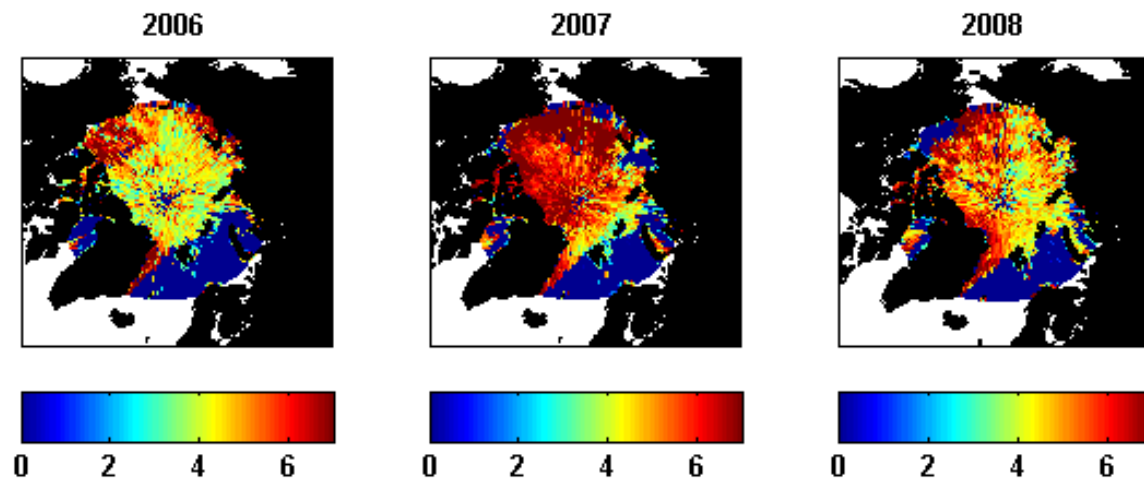
Strong warming in the troposphere during summer 2007



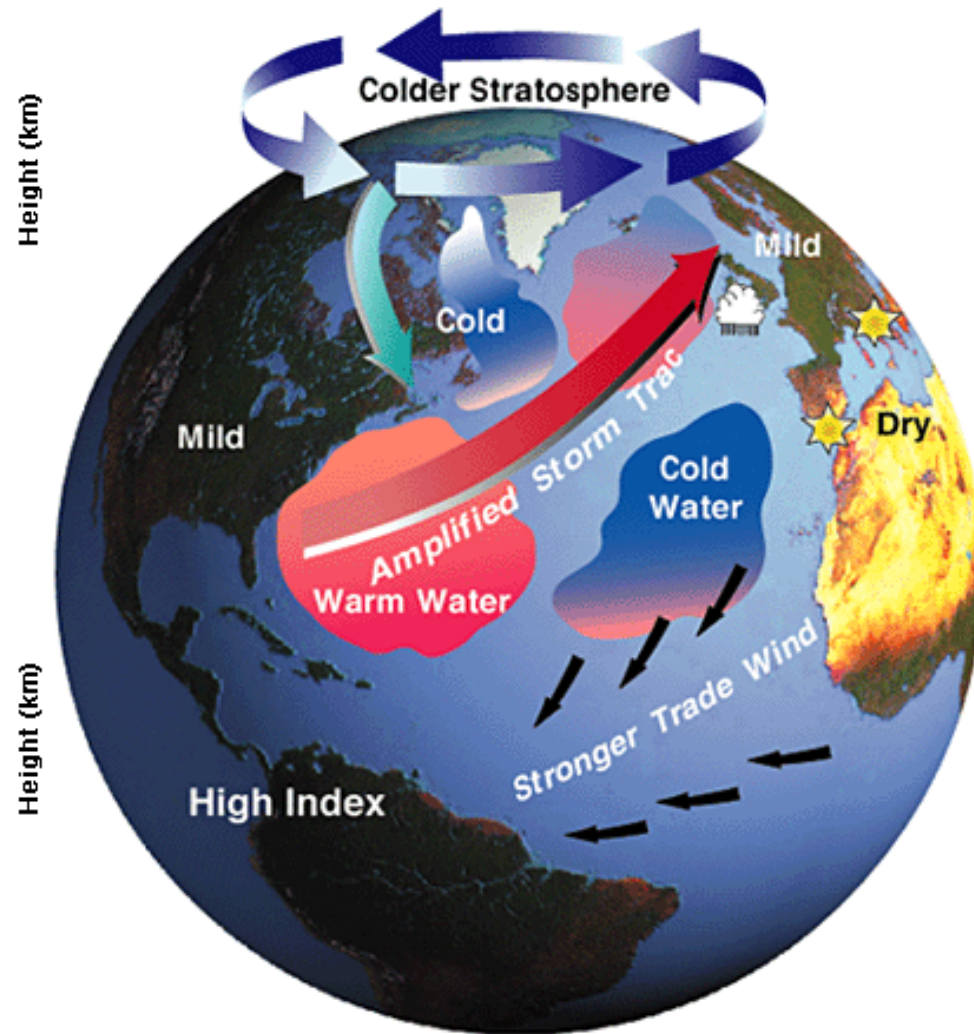
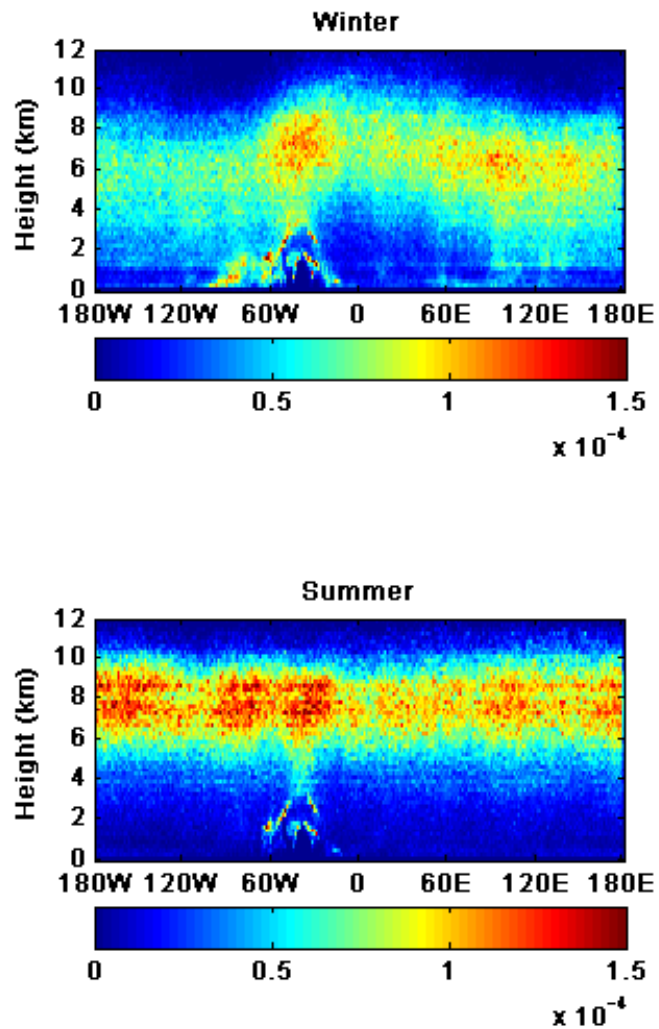
Strong temperature inversions during summer 2007



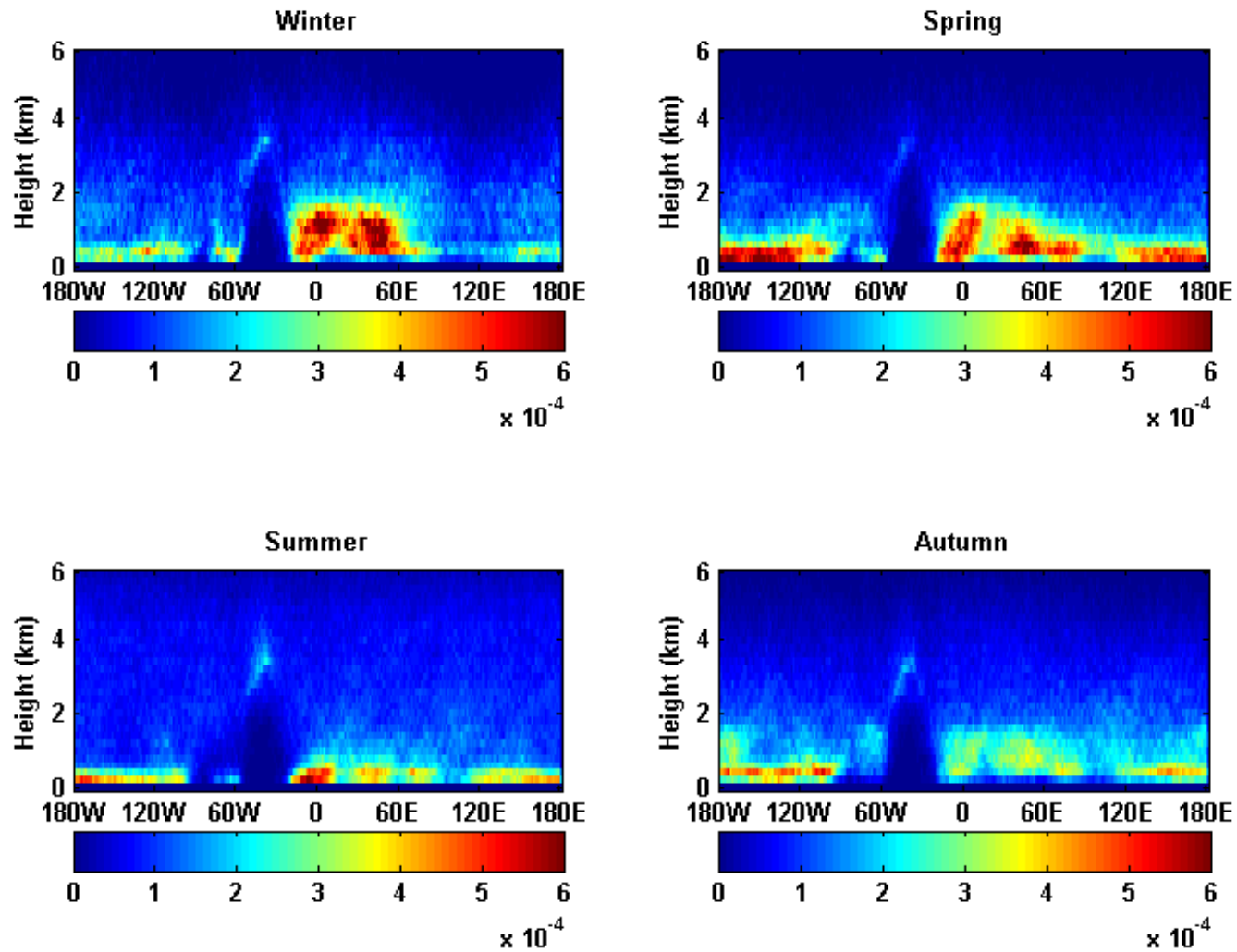
Devasthale et al., ACP, 2010

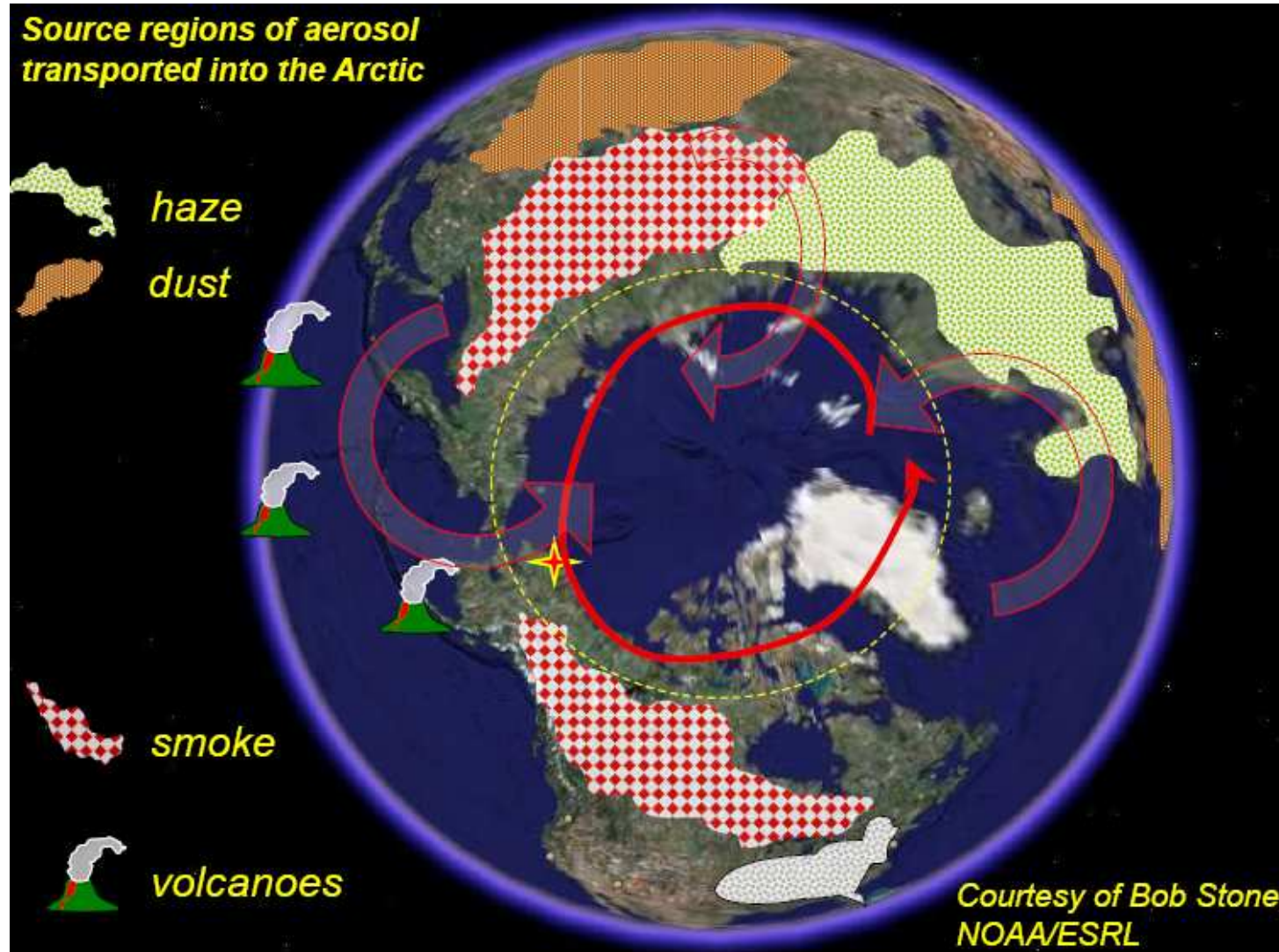


CALIOP reveals footprints of tropospheric dynamics in ice clouds (NAO+storms+waves)

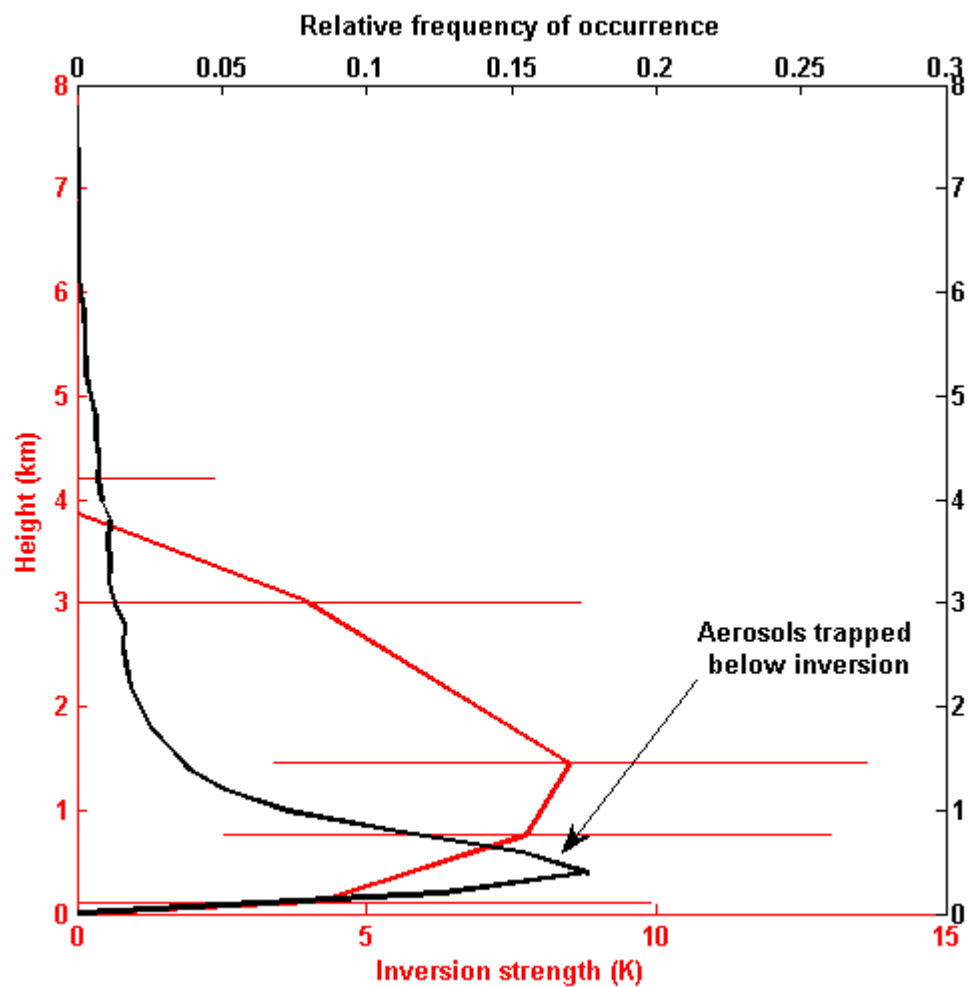


Zonal distribution of liquid phase clouds

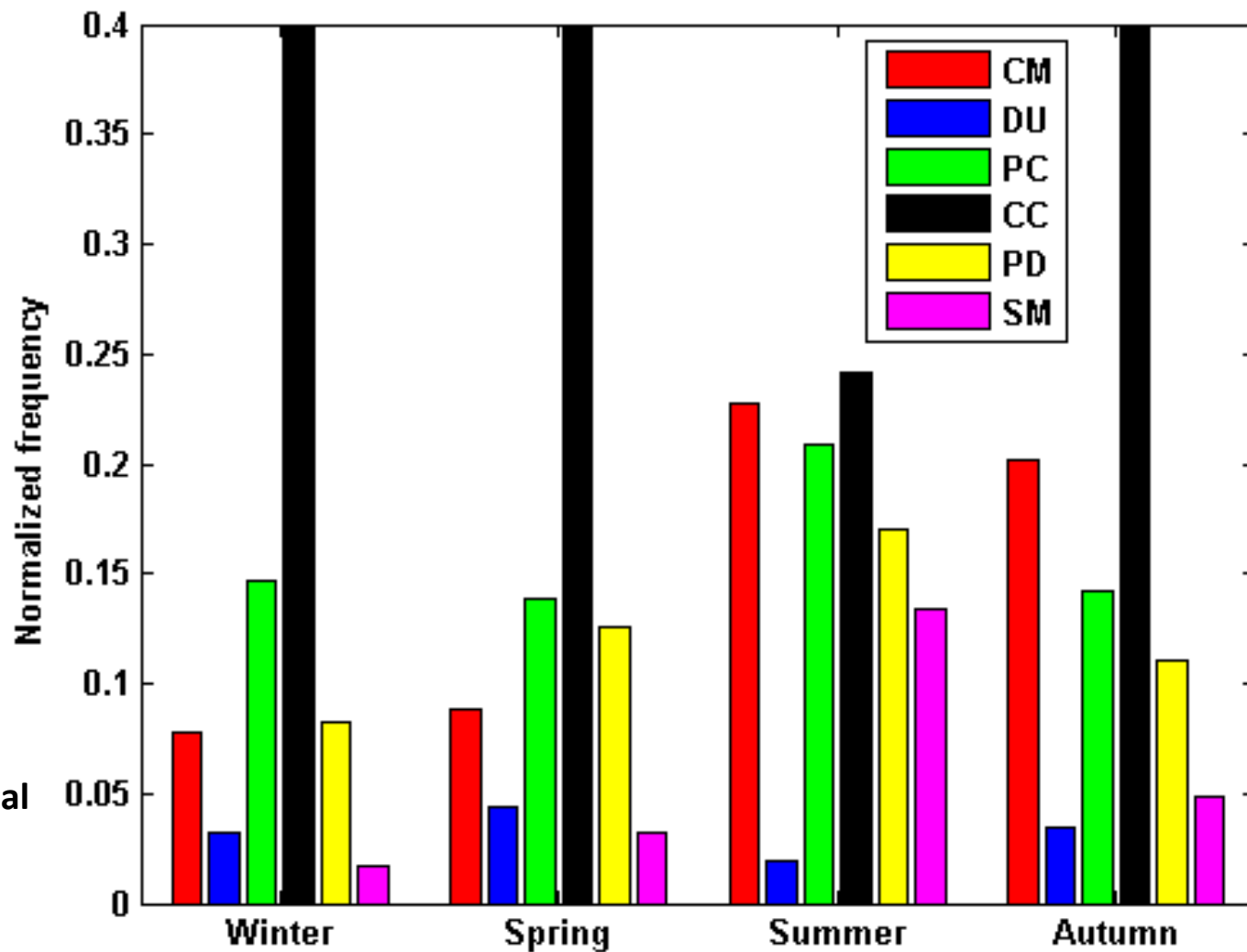




Aerosols trapped below strong inversion during winter



Relative contribution of different aerosol types

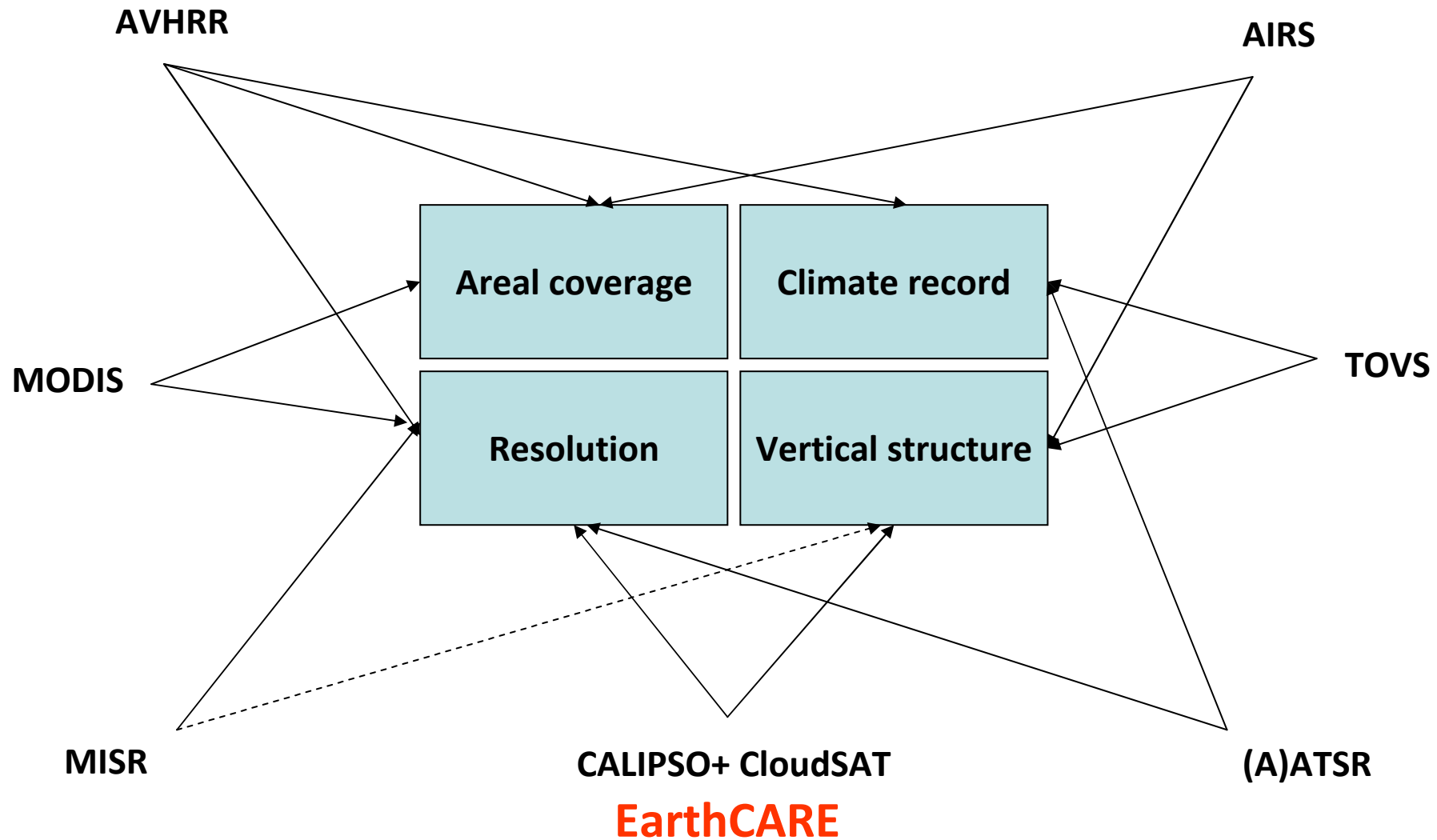


CM – clean marine
 DU – dust
 PC – polluted continental
 CC – clean continental
 PD – polluted dust
 SM – smoke.

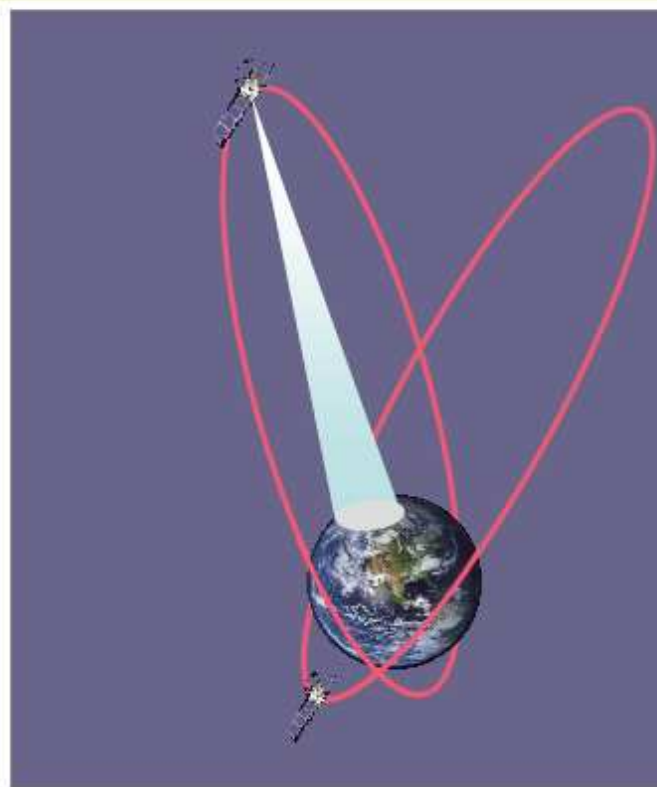
Implications for the future ESA missions (esp. EarthCARE)

- **provides invaluable experience towards planning, engineering and monitoring of research and operational missions focusing on the Arctic.**
- **justifies the importance of vertical information in the context of EarthCARE.**
- **is an exemplary demonstration of advantages of synergistic analyses.**

Combining strengths of different sun-synchronous sensors



2-sat constellation in Molniya Orbit =
continuous views over one pole



2 satellites to provide
continuous GEO-like
imagery 50-90 N
15 min refresh

0.5-1 km VIS
2 km IR

12-h period
63.4 deg. inclination

Apogee: ~39,500 km
Perigee: ~600 km

2-way, 24/7 high data
Rate communications
(up to 12 Mb/sec)
Ka-band **Canada**



Environment
Canada

Environnement
Canada

Polar Communications and Weather Mission - Objectives

1. Reliable communications and navigation services in the high latitudes (North of 70°) to ensure:

- Security
- Sustainable Development
- Support to Northern Communities
- Safety of the Air and Marine Navigation
- Arctic Science

2. High temporal/spatial resolution meteorological data above 50° N in support of:

- Numerical Weather Prediction (short to medium range)
- Environmental monitoring, emergency response
- Climate monitoring

3. Space Weather Monitoring

- **Canadian-led mission with international partnerships**
 - Canadian contribution to WMO space-based observing system
 - data policy consistent with Resolution 40 (free access)



- **Operational meteorology/Nowcasting**
 - Operational payloads (Envisat, MetOp, MTG)
 - Sentinel family
 - contribution to the PCW Mission

- **Climate research**
 - EarthCARE

Experience shows that both go hand-in-hand.

- **Large discrepancies still exist in the estimates of key atmospheric ECVs over the Arctic.**
- **The A-Train has helped (and continues to help) to constrain uncertainties in those ECVs and to improve historical datasets.**
- **The rationale for synergistic exploitation of information from different sensors has become convincing.....and ever more so for the region like the Arctic.**



Thank you for your attention.

Acknowledgements:

Swedish National Space Board

And

The entire A-Train team