Possible Influences of Aerosols on Mixed-Phase Clouds in the High Latitudes In the Northern and Southern Hemispheres

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Introduction

Several studies pointed out the importance of understanding aerosols' influence on the climate system in the Arctic (Jackson et al. 2012).
Aerosols influence clouds characteristics by acting as either ice nuclei (IN) (Lohmann 2001) or cloud condensation nuclei (CCN) (Twomey et al. 1959; Twomey 1977; Lohmann and Feichter 2005).

Objectives

(1) find the connection between aerosols and mixed-phase cloud microphysical properties
(2) find the differences in mixed-phase cloud microphysical properties between the Northern Hemisphere (NH) and Southern Hemisphere (SH)

Data and method

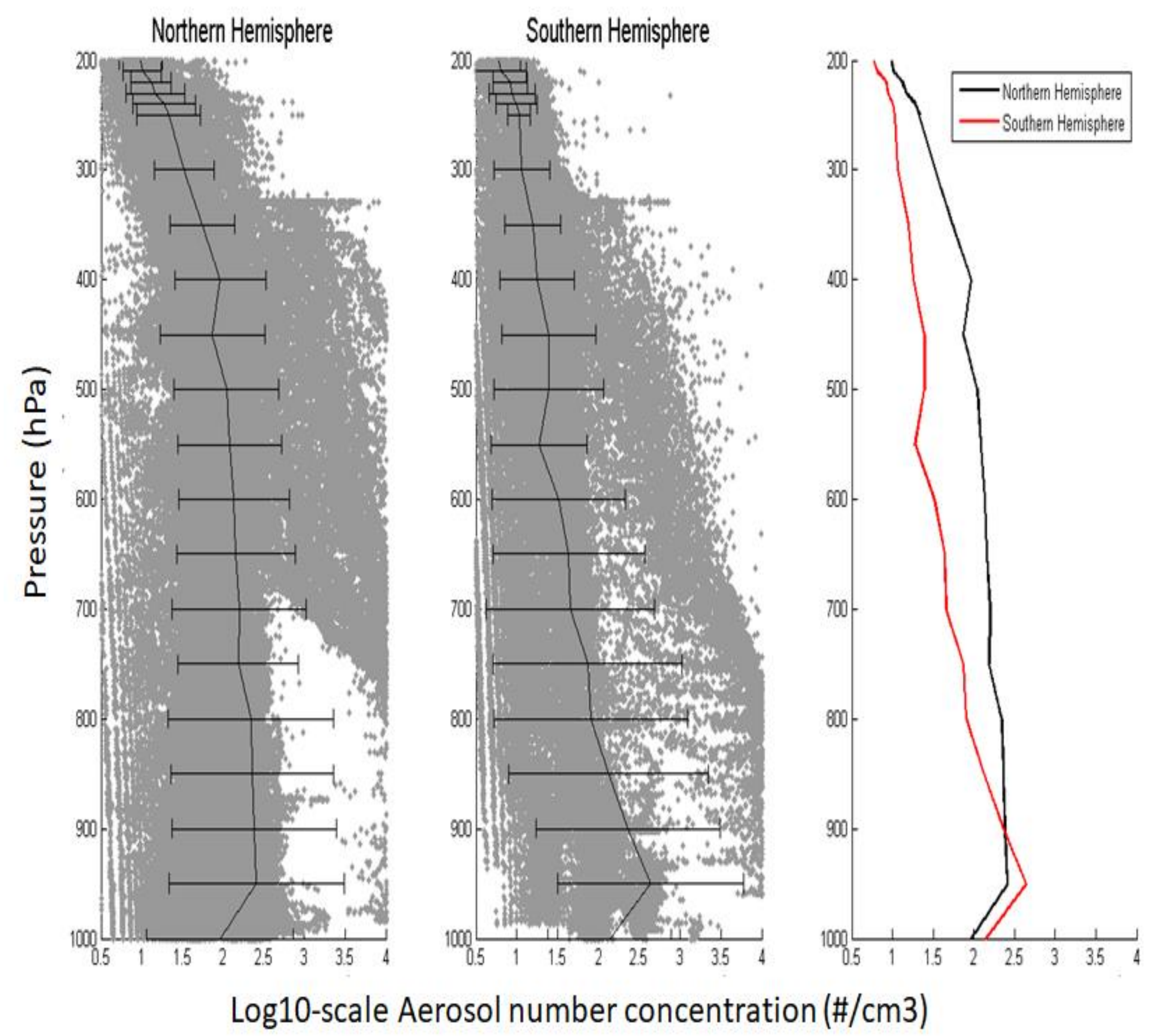
(1) In-situ aircraft data from the HIAPER Pole-to-Pole Observations (HIPPO) campaign
(2) It is has one of the longest flight duration currently available that sampled both NH and SH
(3) Aircraft programs sampled the atmosphere from the North Pole to the coastal waters of Antarctica.
(4) A relatively crude separation of ice and liquid is used, which assumes that in general, Cloud Droplet Probe measures liquid, and Fast-Two Dimensional Cloud probe measures ice particles.

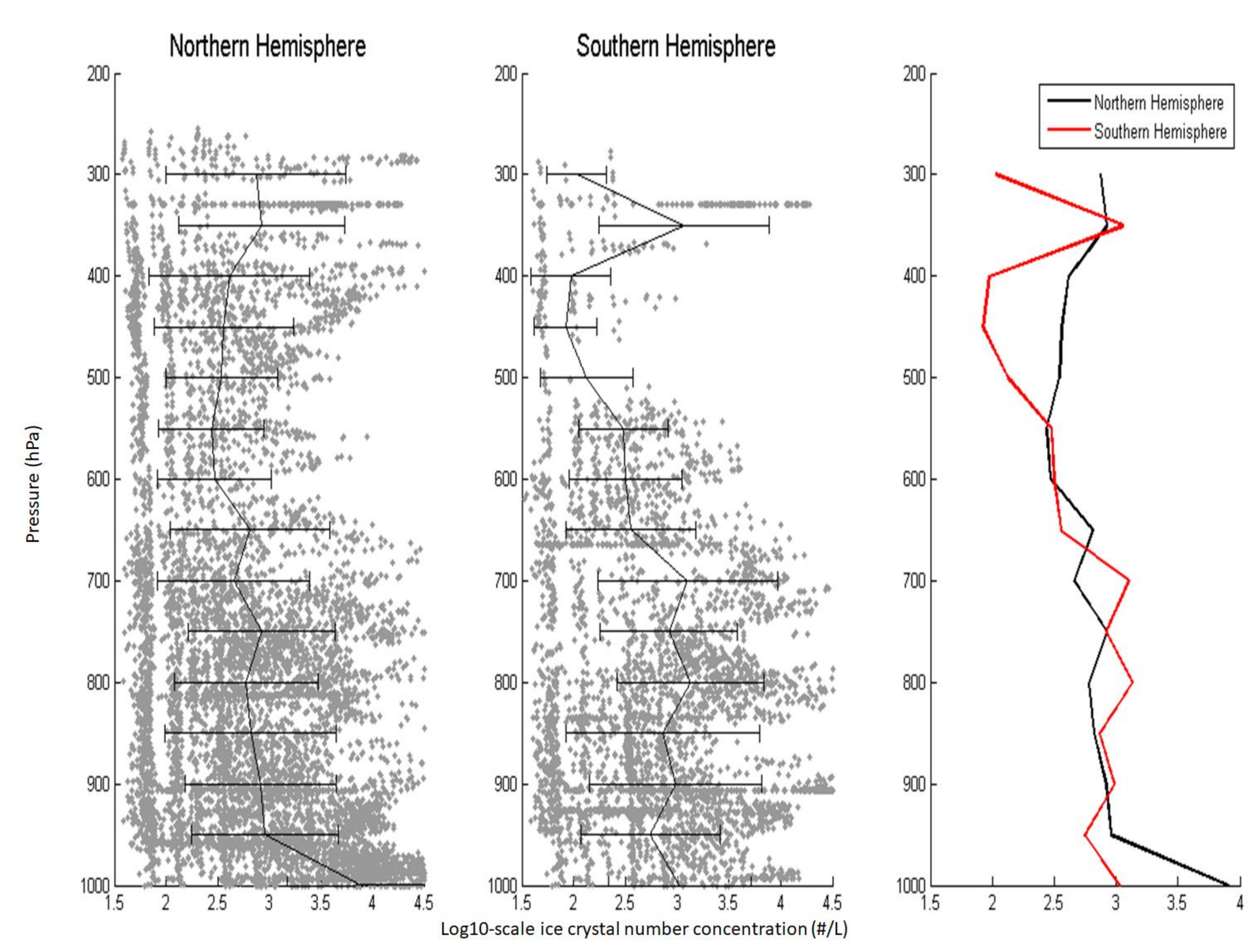
Results

Is the aerosol number concentration higher in the NH than the SH?

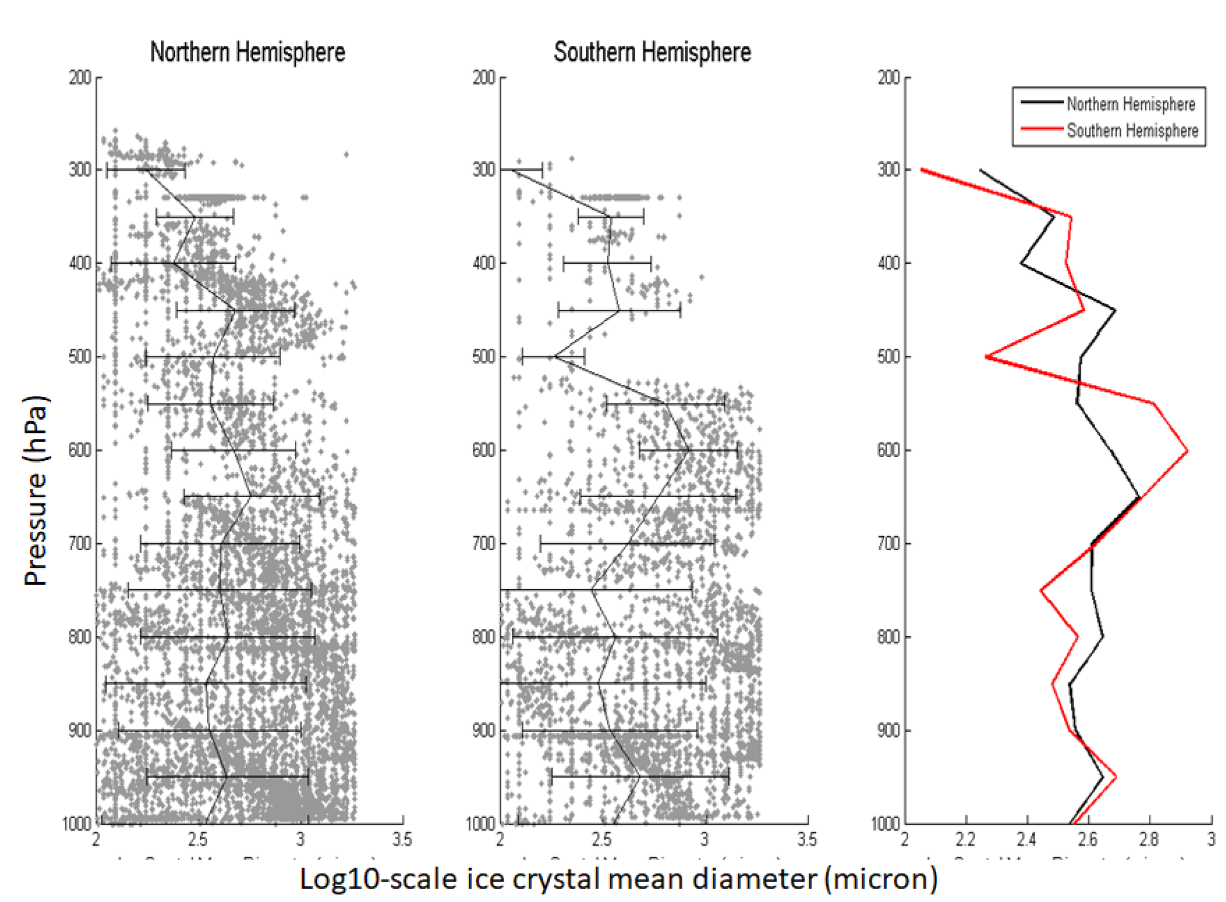
As soon as pressure starts to decrease to lower than 950 hPa, aerosol concentration in the NH becomes higher than that in the SH.

Near the surface, the SH contains slightly higher aerosol concentrations.

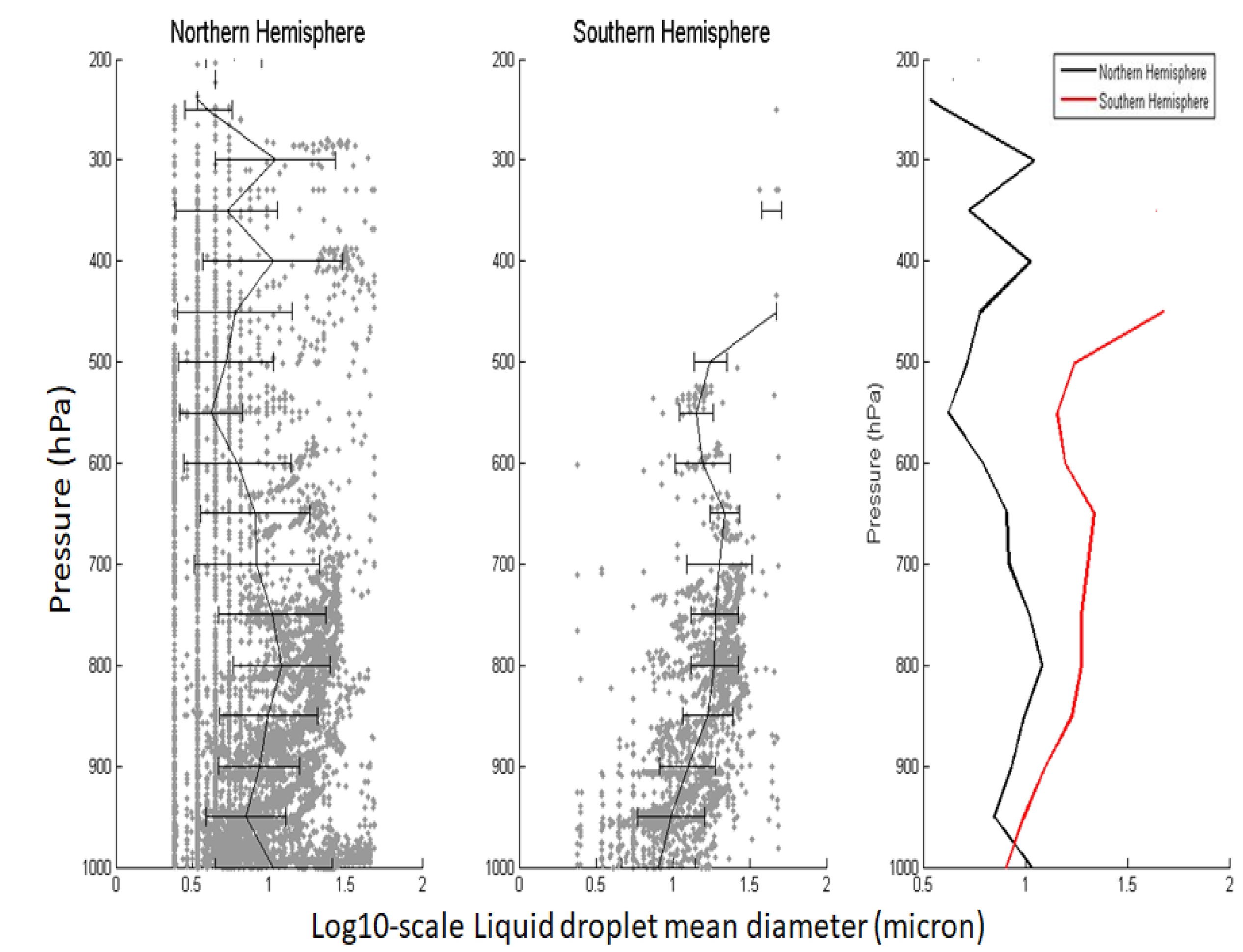




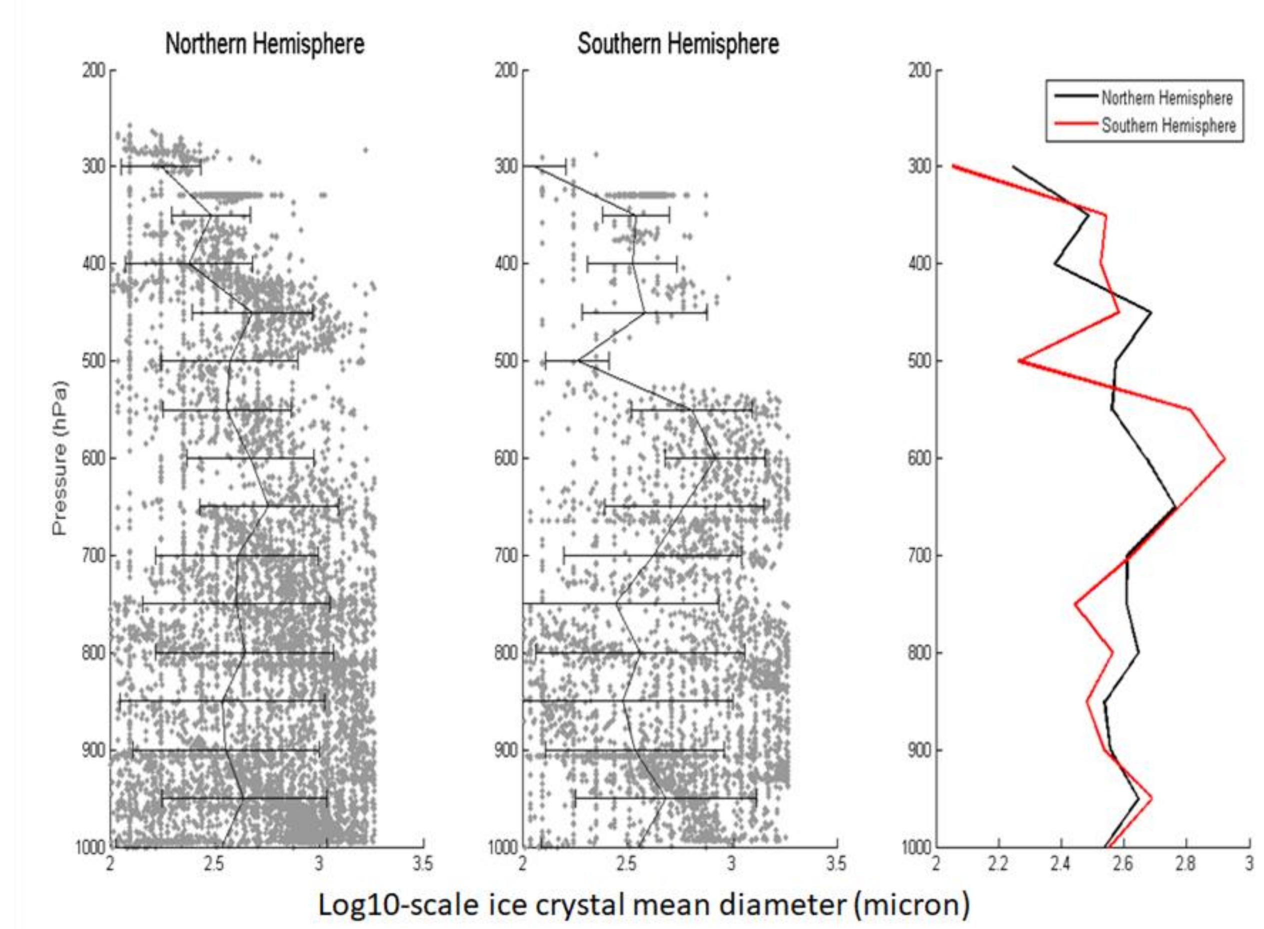
- Higher ice crystal concentrations (Nice) are seen at the upper level in the NH, likely due to the glaciation effect
- At mid-troposphere, both hemispheres have similar Nice, likely due to the competing effects of glaciation and thermodynamic aerosol indirect effects



- The SH has the smallest and largest ice mean diameters (Dice).
- The SH has larger Dice than NH in the mid-troposphere, possibly due to more efficient riming (i.e., riming indirect effect).



- Lower liquid droplet number concentrations (Nliq) in the NH.
- likely due to the effect of ice crystals via the Wegner-Bergeron-Findeisen (WBF) process



- Liquid droplet mean diameter (Dliq) is higher in the SH than the NH.
- possibly due to less riming effect and/or less effective WBF process in the SH, which allows liquid droplets to grow larger.

Summary

•From the analysis, there are possible correlations between mixed-phase clouds and aerosols, likely due to the three effects: glaciation, riming, thermodynamic indirect effects
•The competitions of these three effects are dependent upon the vertical levels and temperature. The analysis shows that more samples in other geographical locations are need to be considered to study cloud-aerosol interaction.

Future work

•WRF model simulations
•Account for other dynamical influences
•Use a comprehensive method to separate ice and liquid

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