The dependence of arctic stratus microphysical properties on aerosol characteristics: results from ISDAC.

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1. Motivation

Aerosols affect cloud microphysical properties, which affect radiative budget and surface mass balance. Three indirect effects have been proposed for arctic mixed-phase clouds:

- ***glaciation indirect effect*** **- ice nuclei (IN) increase → ice crystal concentration (Ni) increase**
- ***riming indirect effect*** **- Cloud condensation nuclei (CCN) increase → drop size decrease → less ice crystal growth by riming → ice water content (IWC) decrease**
- ***cold 2nd indirect effect*** **- CCN increase → drop concentration (NI) increase → drop size decreases → less ice crystal formation → decreased Ni**

2. Methodology

Data from 20 bulk & size-resolved cloud instruments on Convair-580 combined & compared to give value added product of microphysical properties (IWC, Ni, NI, LWC, N(D), …)

PCASP probe gives best estimate of aerosol concentration & median volume diameter (D_{vm})

Flights above/below & throughout cloud allow comparison of cloud/aerosol profiles

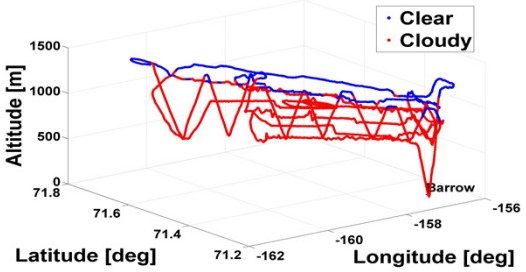

Figure 1. Flight profile on April 8 2008 sampling cloud deck

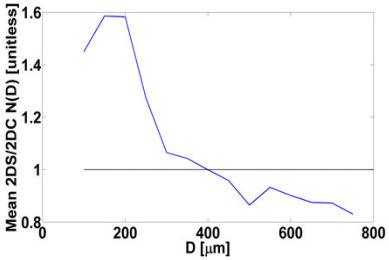

Figure 2. 2DS N(D) / 2DC/N(D) for all ISDAC ice cases; 2DS detects particles missed by 2DC for D < 300 μm and thus used to represent N(D) in this range.

Figure 3. Probes used for measuring liquid and ice crystal size distributions during ISDAC; Combined and compared with data from bulk water probes to define cloud microphysical properties.

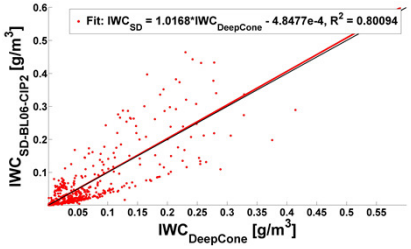

Figure 4. IWC derived from N(D) using Baker and Lawson [2006] technique against bulk IWC measured by deep cone Nevzorov probe; many such diagrams analyzed to determine optimum combination of probes & technique for calculating mass to define cloud properties

3. Statistical Analysis

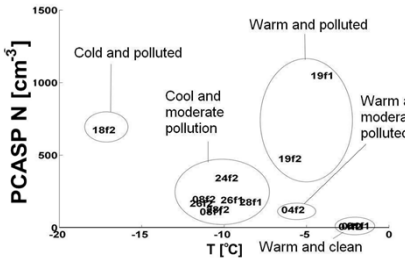

Figure 5. Mean N_{PCASP} & temperature for each flight showing variety of regimes sampled.

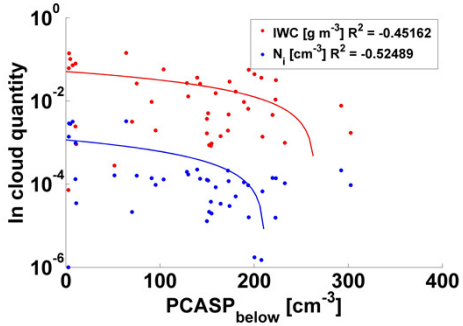

Figure 8 Cloud mean Ni & IWC vs. N_{PCASP} below cloud shows negative correlations; no strong dependence on D_{vm} below cloud (not shown).

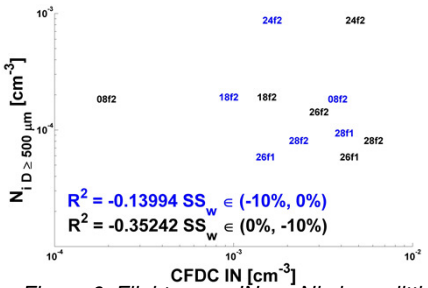

Figure 6. Flight mean IN vs. Ni shows little evidence for glaciation indirect effect.

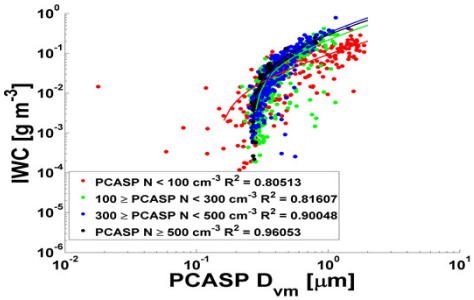

Figure 9 IWC below cloud well correlated with D_{vm} below cloud; correlation with PCASP concentration weaker (~ -0.38)

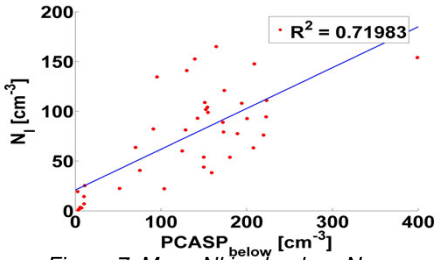

Figure 7. Mean NI in cloud vs. N_{PCASP} below cloud strongly correlated. Does cold second or riming indirect effect

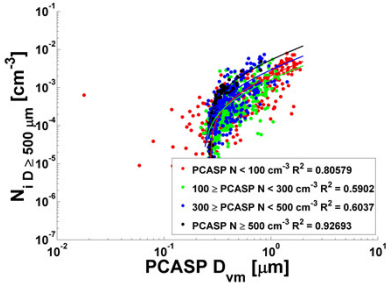

Figure 10. Ni below cloud well correlated with D_{vm} below cloud; correlation with PCASP concentration weaker (~ -0.37)

4. Conclusions

- **Little evidence for glaciation indirect effect**
- **IWC & Ni below cloud more correlated with below cloud D_{vm} than N_{PCASP}**
- **In cloud IWC &Ni some correlation with N_{PCASP}**

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