

In-situ measurements of cloud particles at Mt. Zeppelin

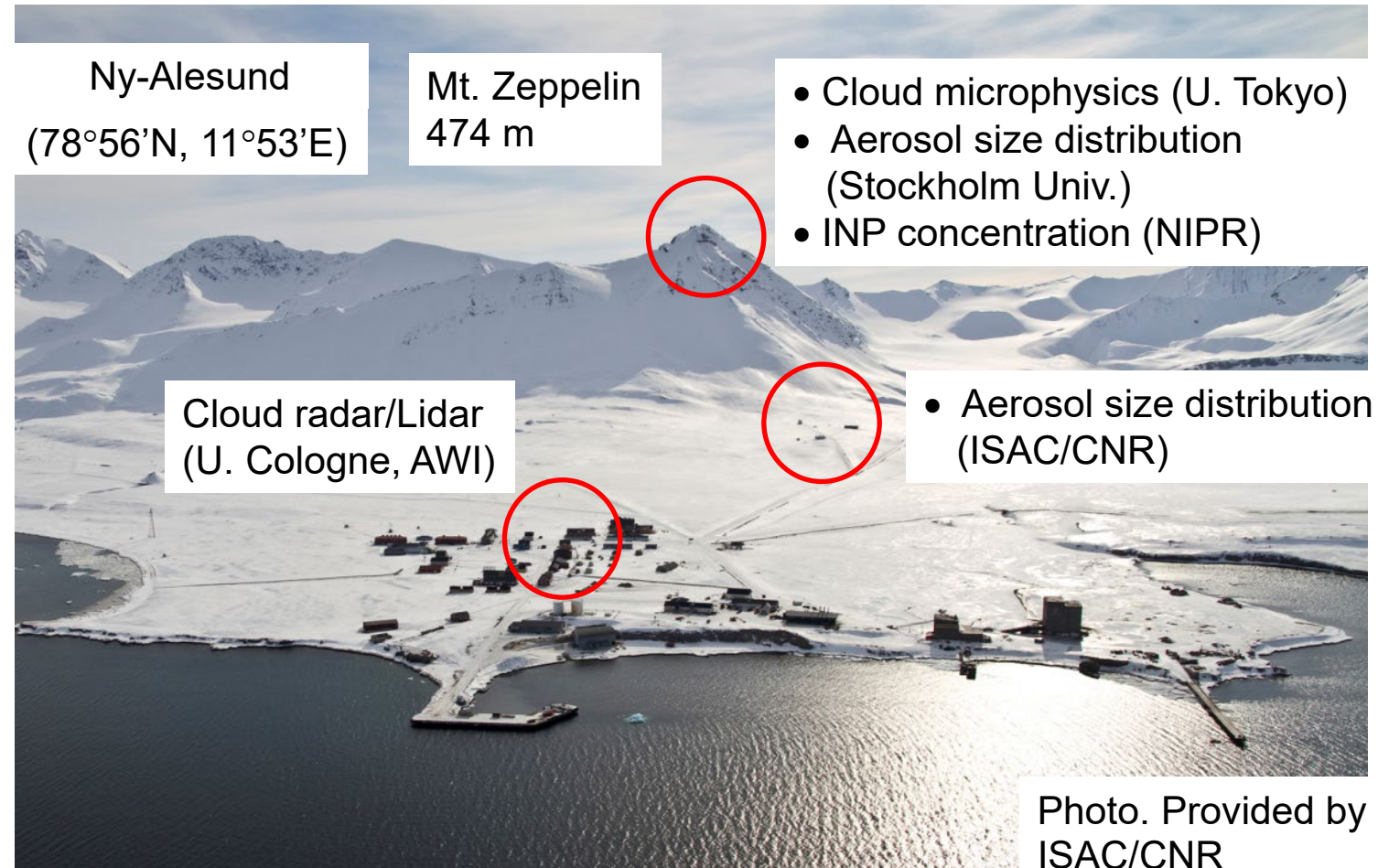
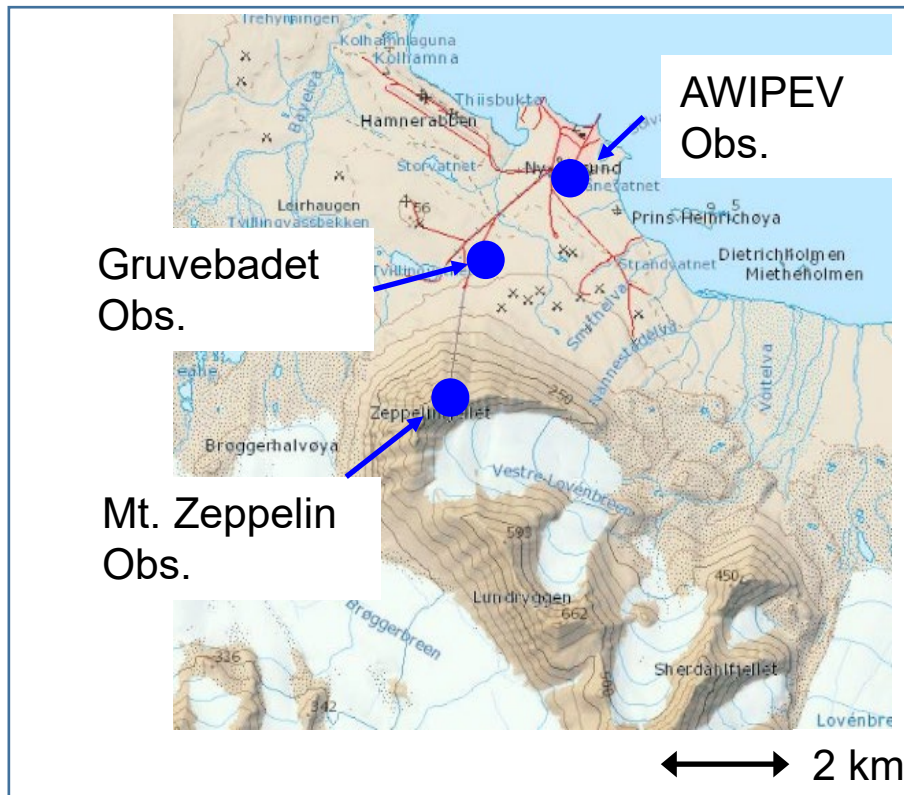
Makoto. Koike¹, Y. Tobo², K. Ebell³, K. Adachi⁴, and others

1) Univ. of Tokyo, 2) NIPR Japan, 3) Univ. of Cologne, 4) MRI Japan



Aerosol-cloud measurements in Ny-Alesund

Continuous **in situ measurements** of cloud and precipitating particles have been made at Mt. Zeppelin observatory in Ny-Alesund

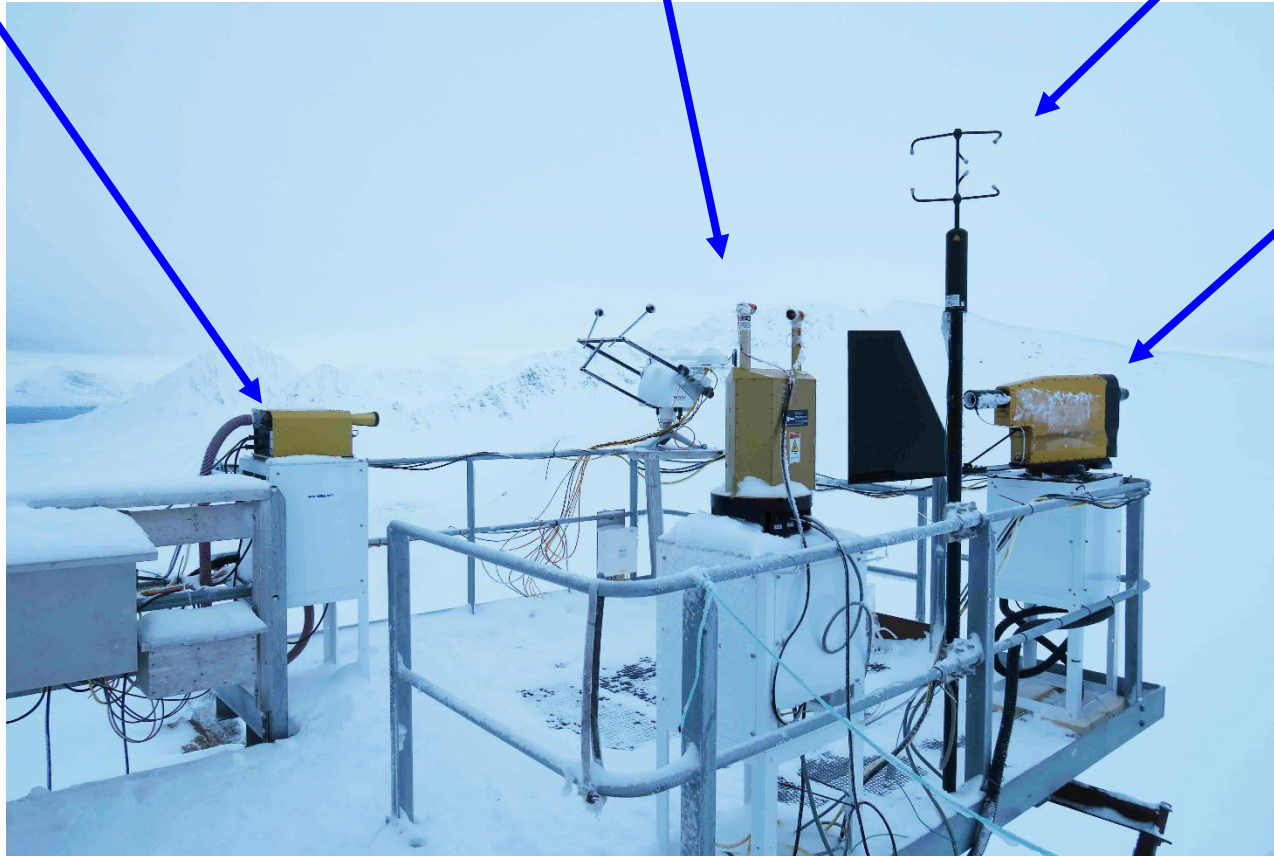


Instruments

DMT FM-120 (fog monitor)
Cloud particle size distribution
($D = 3 - 50 \mu\text{m}$)

DMT MPS
Precipitating particle size
distribution and images
($D = 25 - 1550 \mu\text{m}$)

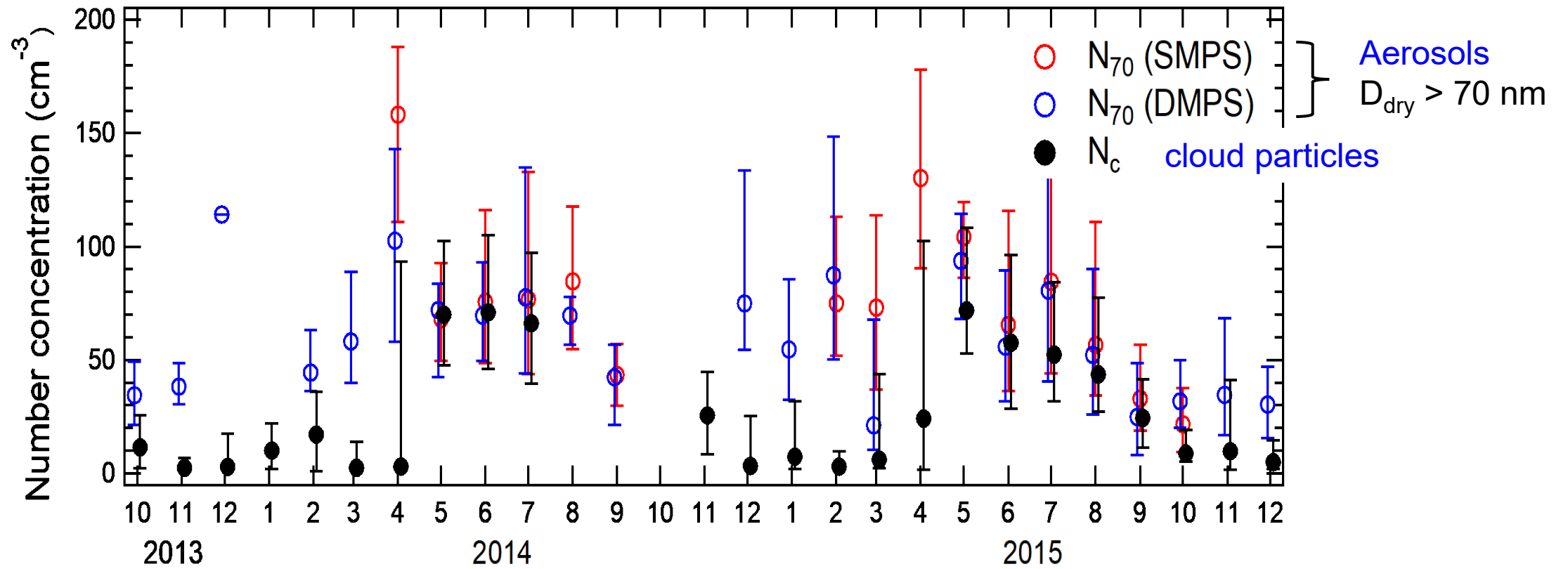
Metek Anemometer
Three-dimensional wind speed



SPEC (Hawkeye)

- FCDP
Cloud particle size distribution
($D = 1 - 50 \mu\text{m}$)
- 2D-S
Precipitating particle size
distribution and images
($D = 10 - 1280 \mu\text{m}$)
($D = 50 - 6400 \mu\text{m}$)
- CPI
Particle images
(pixel size = $2.3 \mu\text{m}$)

Seasonal variation of N_c and N_{70}



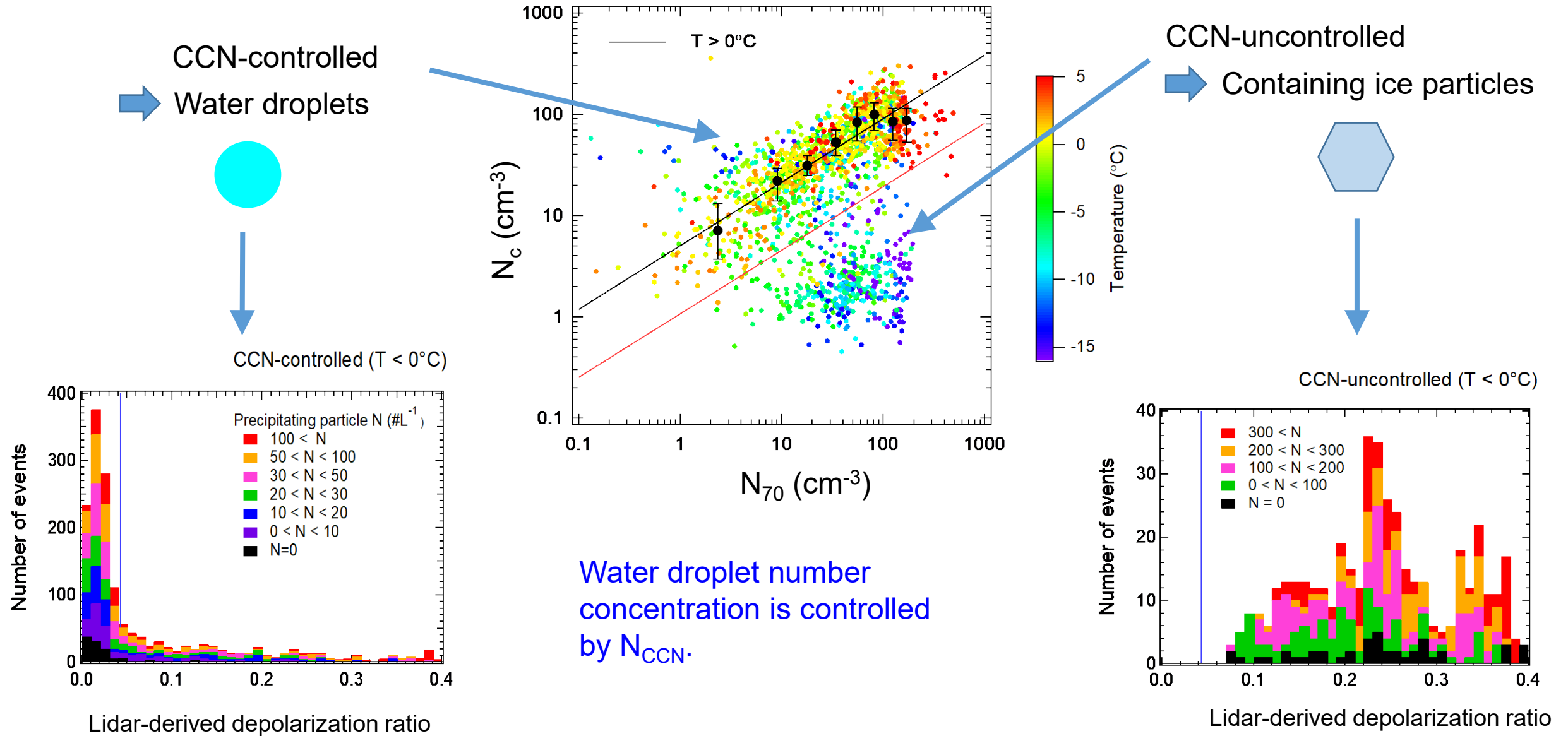
Max. in summer ($65 \pm 8 \text{ cm}^{-3}$)

$N_c \approx N_{70}$

Min. in winter ($8 \pm 78 \text{ cm}^{-3}$)

$N_c \ll N_{70}$

Relationship between N_c and N_{70}



Sensitivity on CCN

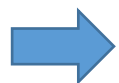
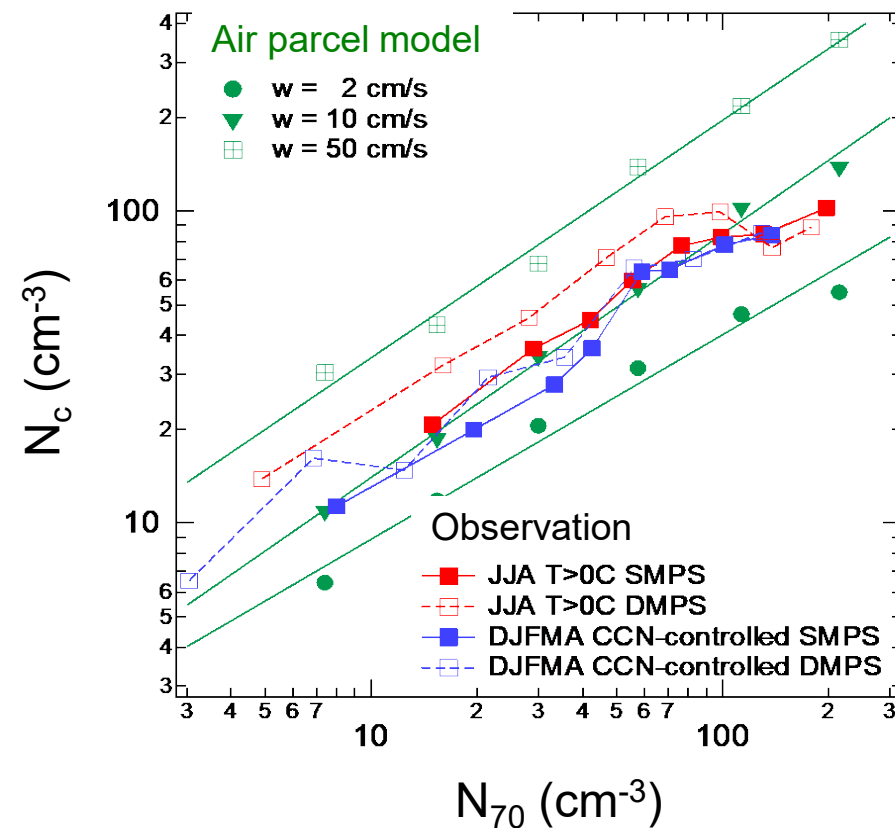
The slope indicates the sensitivity of N_c to N_{CCN} (ACI-index). They are similar between summer and winter.

Summer (new particle formation season)
 0.66 ± 0.09

Winter – spring (the Arctic haze season)
 0.75 ± 0.06

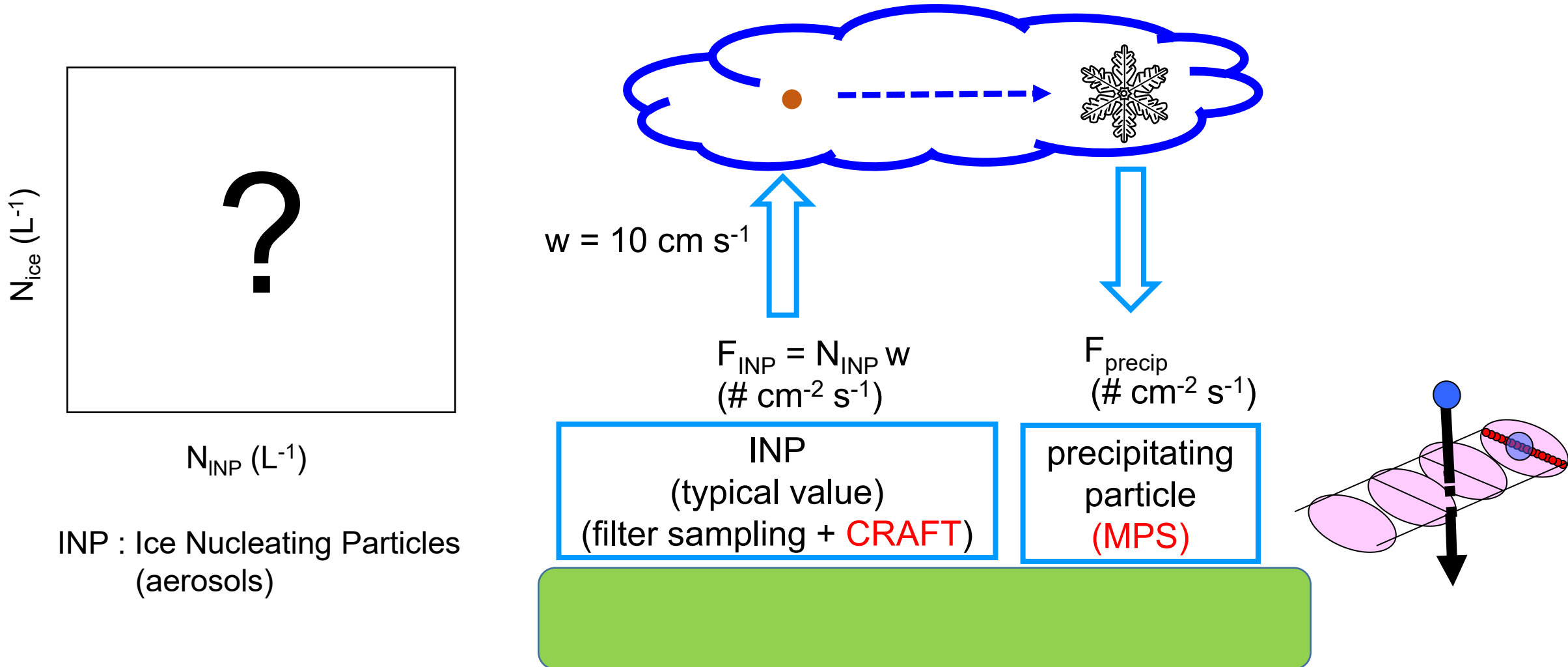
Even if N_{CCN} doubles, N_c increases less than twice as much.
(buffered-system)

Air parcel model calculations using observed aerosol size distributions can reproduce the observed sensitivities.

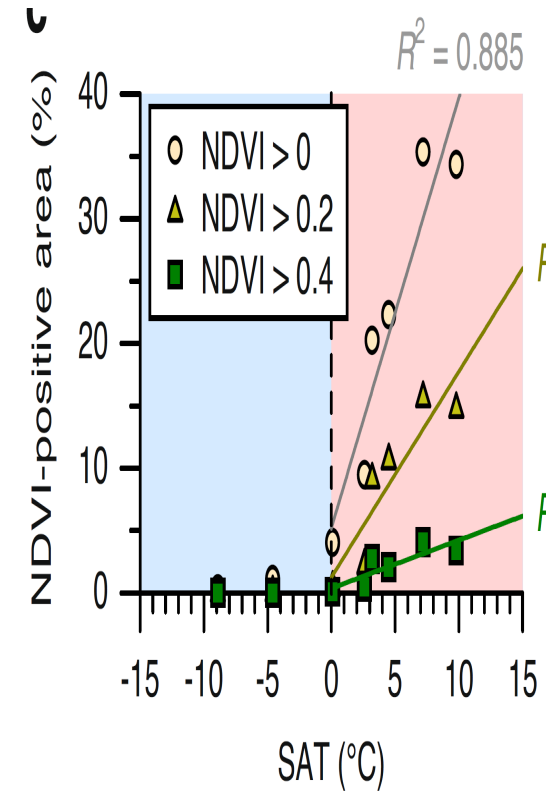
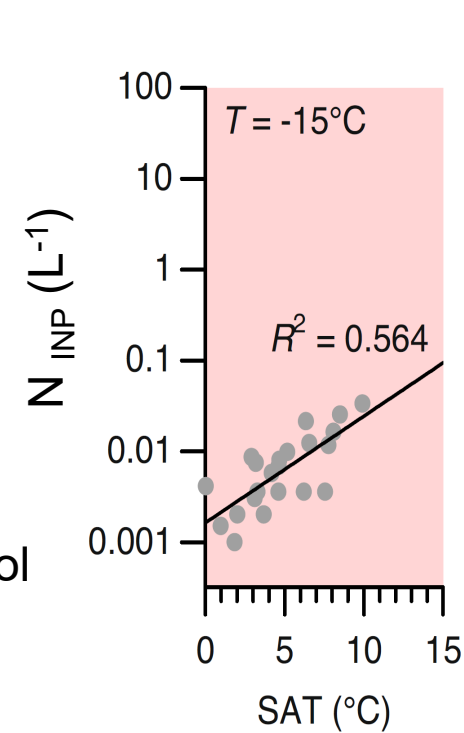
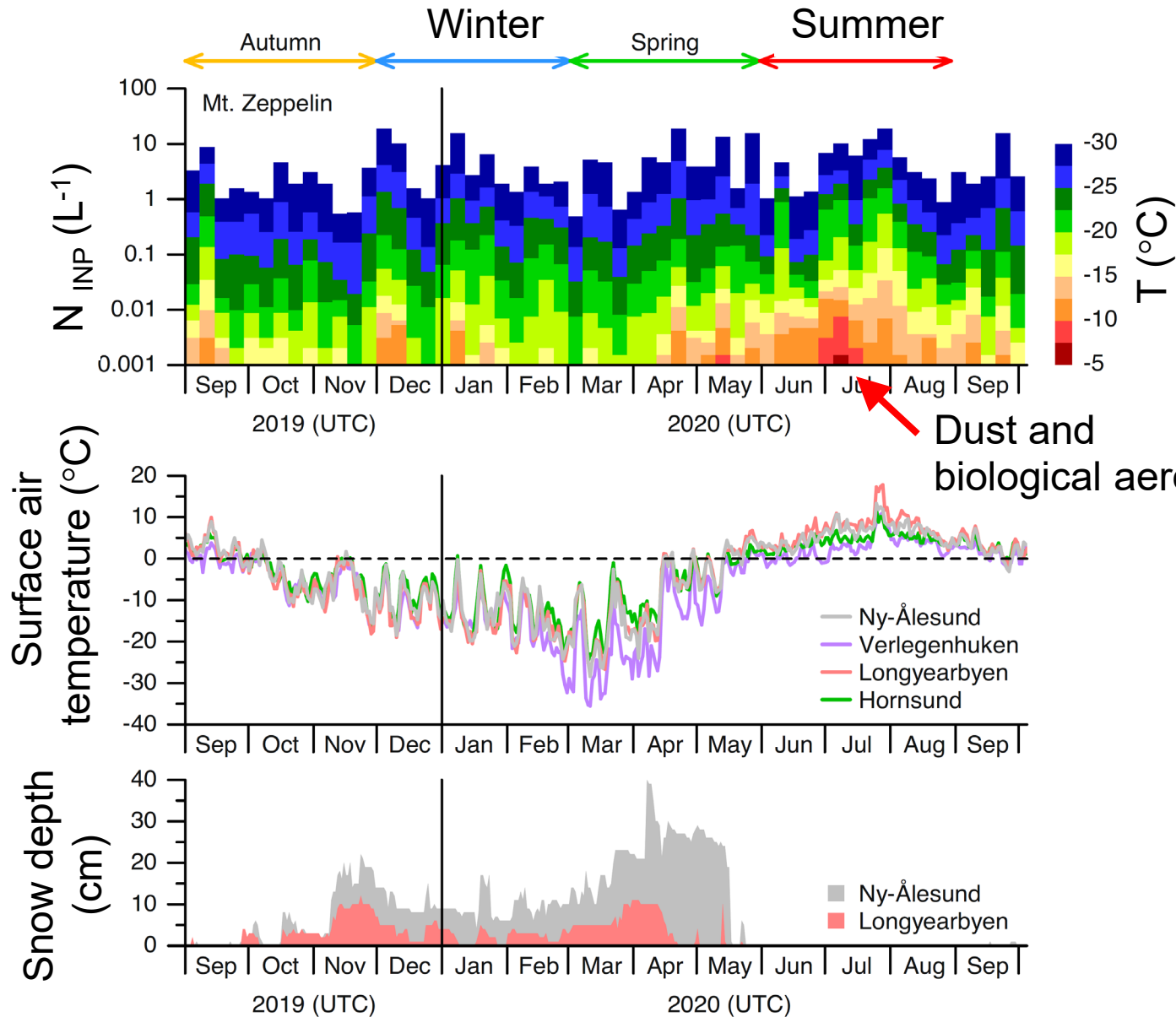


Impacts of CCN on water cloud droplets can be explained by simple cloud microphysics and ready be implemented into numerical models.

Relationship between N_{ice} and N_{INP} ?



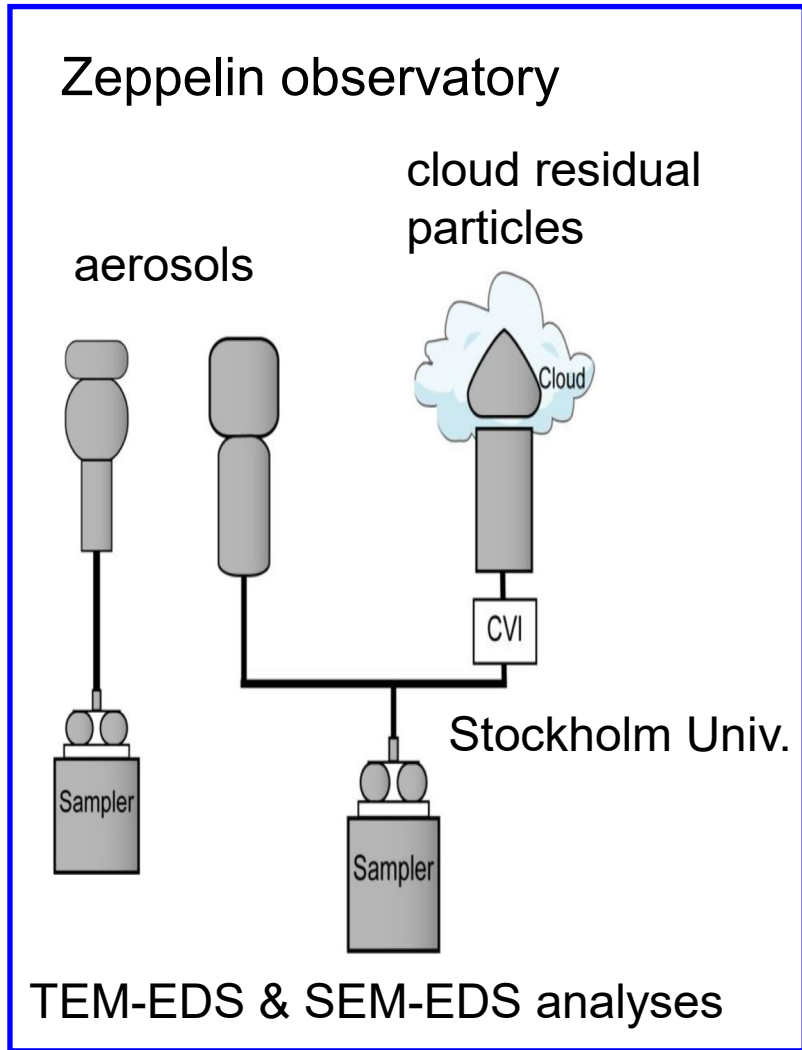
Seasonal variation in INP (Yutaka Tobo)



Highly active INP could be released from Arctic natural sources in response to surface warming.

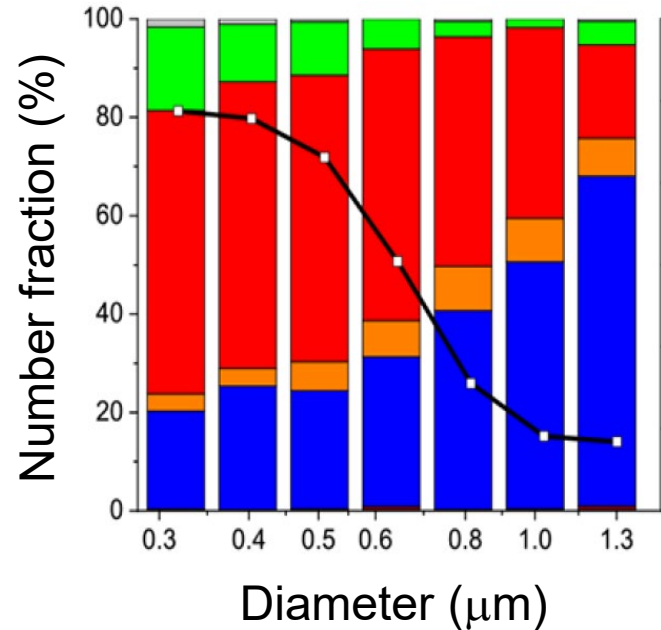
Tobo, Hermansen, et al., Comm. Earth & Env. 2024

Cloud residual particles (Kouji Adachi)

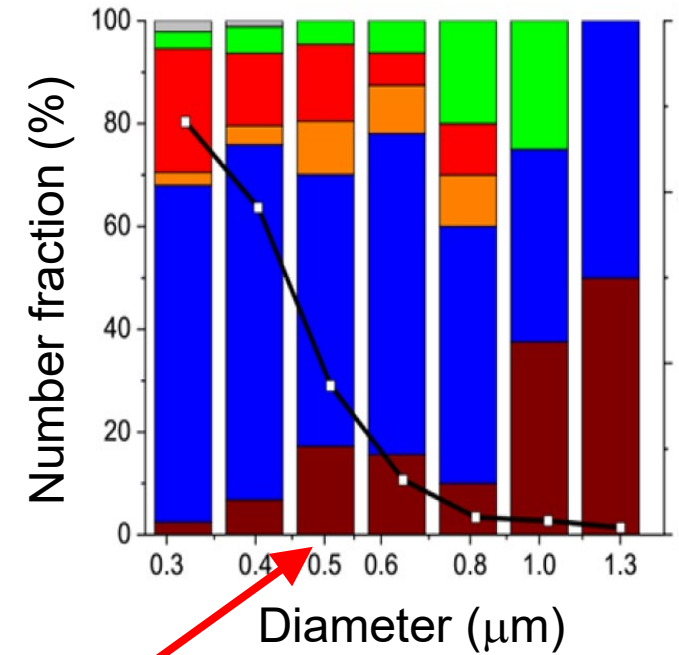


Winter (Dec-Jan)

Aerosol



Cloud residual particles



Below 0°C, the number ratio of cloud residue particles including **mineral dust increased**, suggesting that mineral dust may act as INP.

Summary

Year-round in situ measurements of cloud and precipitating particles have been made at Mt. Zeppelin observatory.

Water clouds

1. N_{water} is generally controlled by N_{CCN} .
2. The sensitivity (slope) of N_{water} on N_{CCN} does not show a clear seasonal variation.
This sensitivity can be explained by simple cloud microphysics.

Mixed-phase clouds

1. At temperatures below -20°C , F_{precip} appears to be directly controlled by F_{INP} .
2. At temperatures above -15°C , F_{precip} is much higher than F_{INP} . By measuring the shape of precipitation particles, we are investigating the reasons for this.

Next step

- Investigating the relationship between cloud microphysics and dynamically changing INP
- Investigating the relationship between cloud microphysics and macroscopic structures of clouds such as the vertical structure of clouds