Coarse Particle and Derived Ice Nuclei Concentrations in the Northern and Southern Subtropical Middle Troposphere

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Objectives -

1) Exercise the DeMott et al. (2010) and Niemand et al. (2012) IN parameterizations using middle tropospheric measurements of coarse mode aerosol

2) Show informative comparison (closure?) of parameterized IN with satellite-retrieved crystal concentration (MT layer clouds)

3) Examine parameterized IN sensitivity to temperature

4) Examine parameterized IN concentration variability

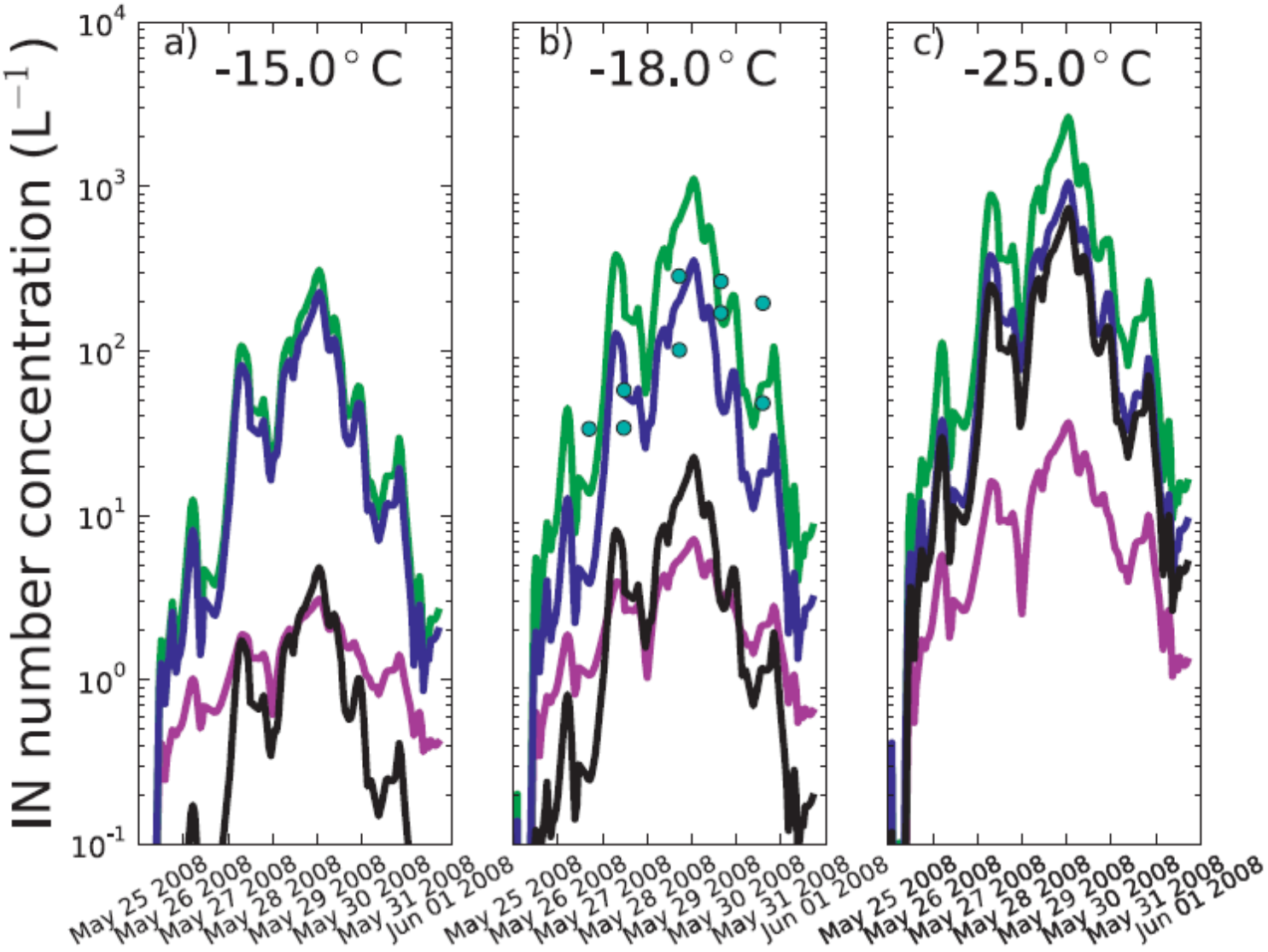


FIG. 14. Comparison of different parameterizations for the temperatures (a) −15°, (b) −18°, and (c) −25°C: DeMott et al. (2010) (purple), Hoose et al. (2010) (green), Phillips et al. (2008) (blue), and this study (black). In (b) the turquoise dots represent the measured IN with the background subtracted.

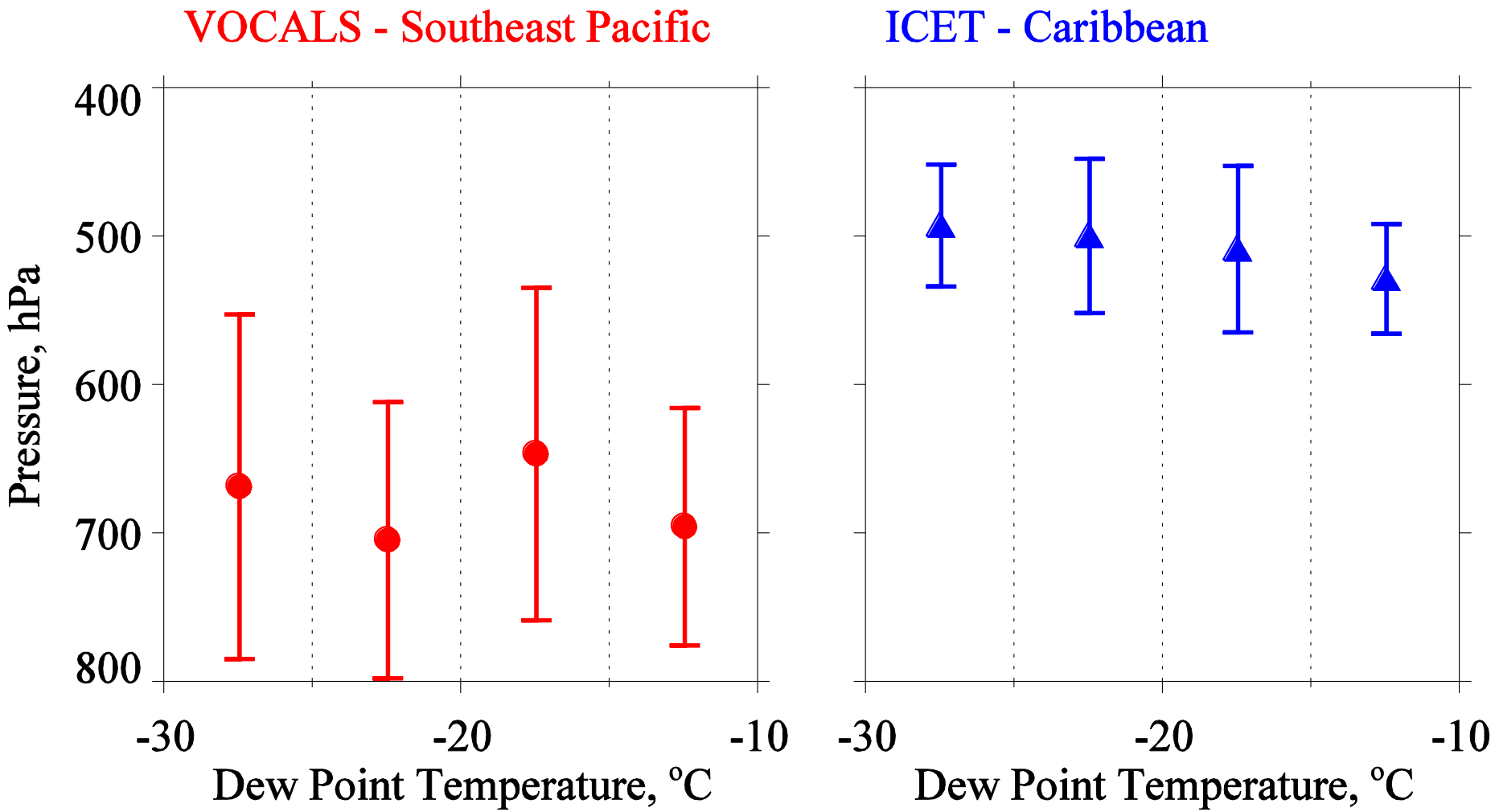
Wing-mounted Coarse Aerosol Instruments - VOCALS and ICET

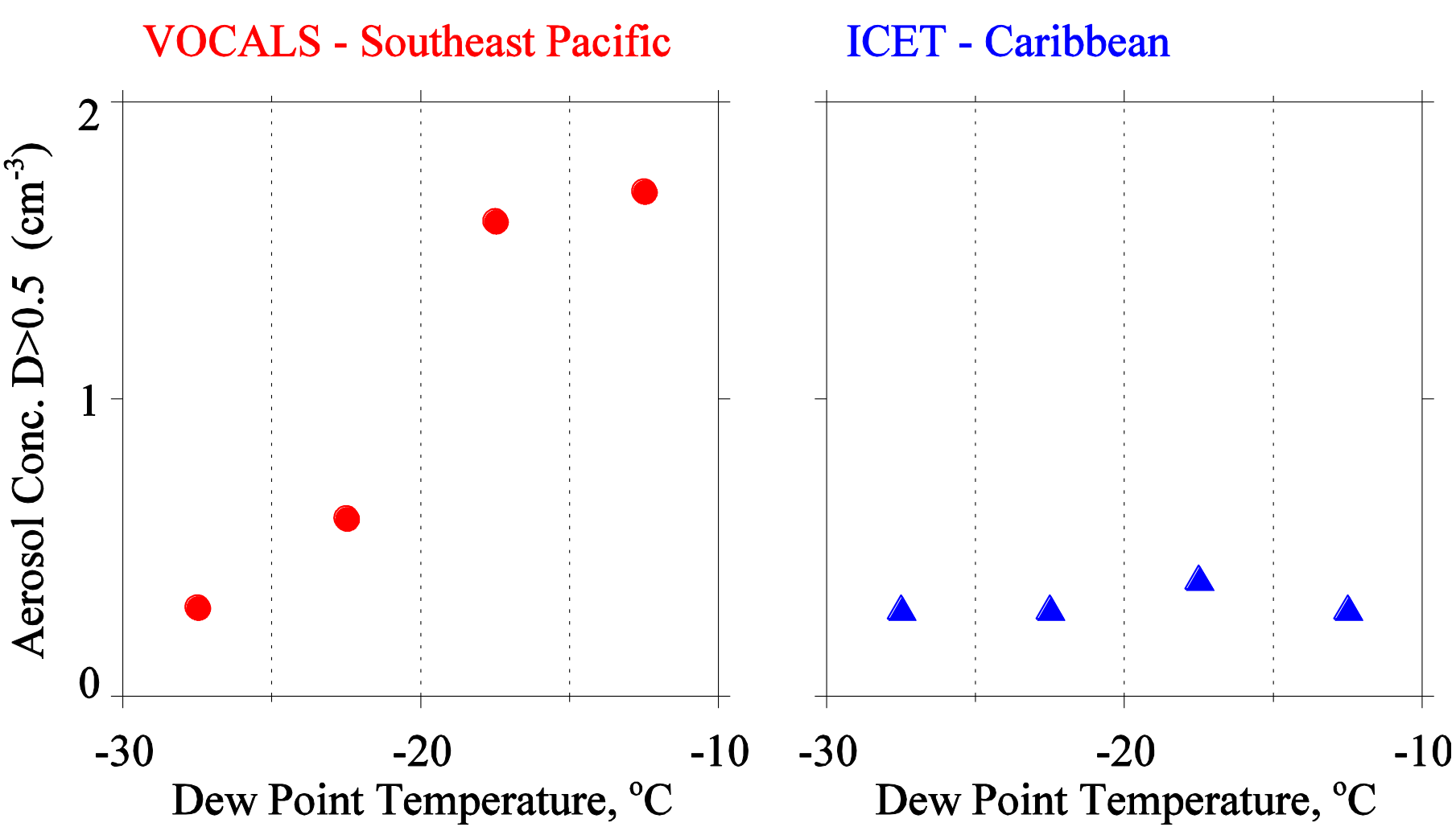
DeMott et al., PNAS, 2010

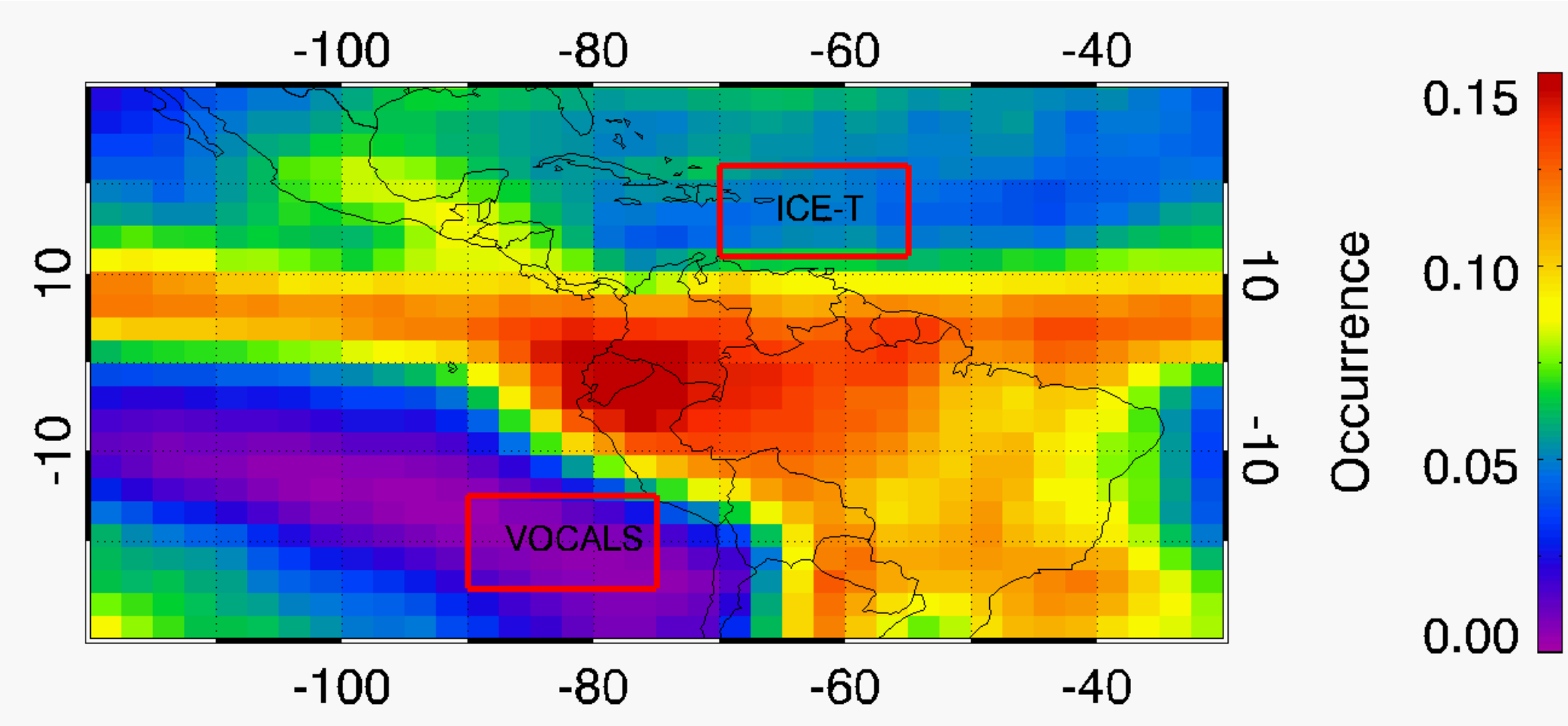
$$N_{IN} = N^{a \cdot T_s + b} \cdot c \cdot T_s{}^{d}$$

Niemand et al., JAS, 2012

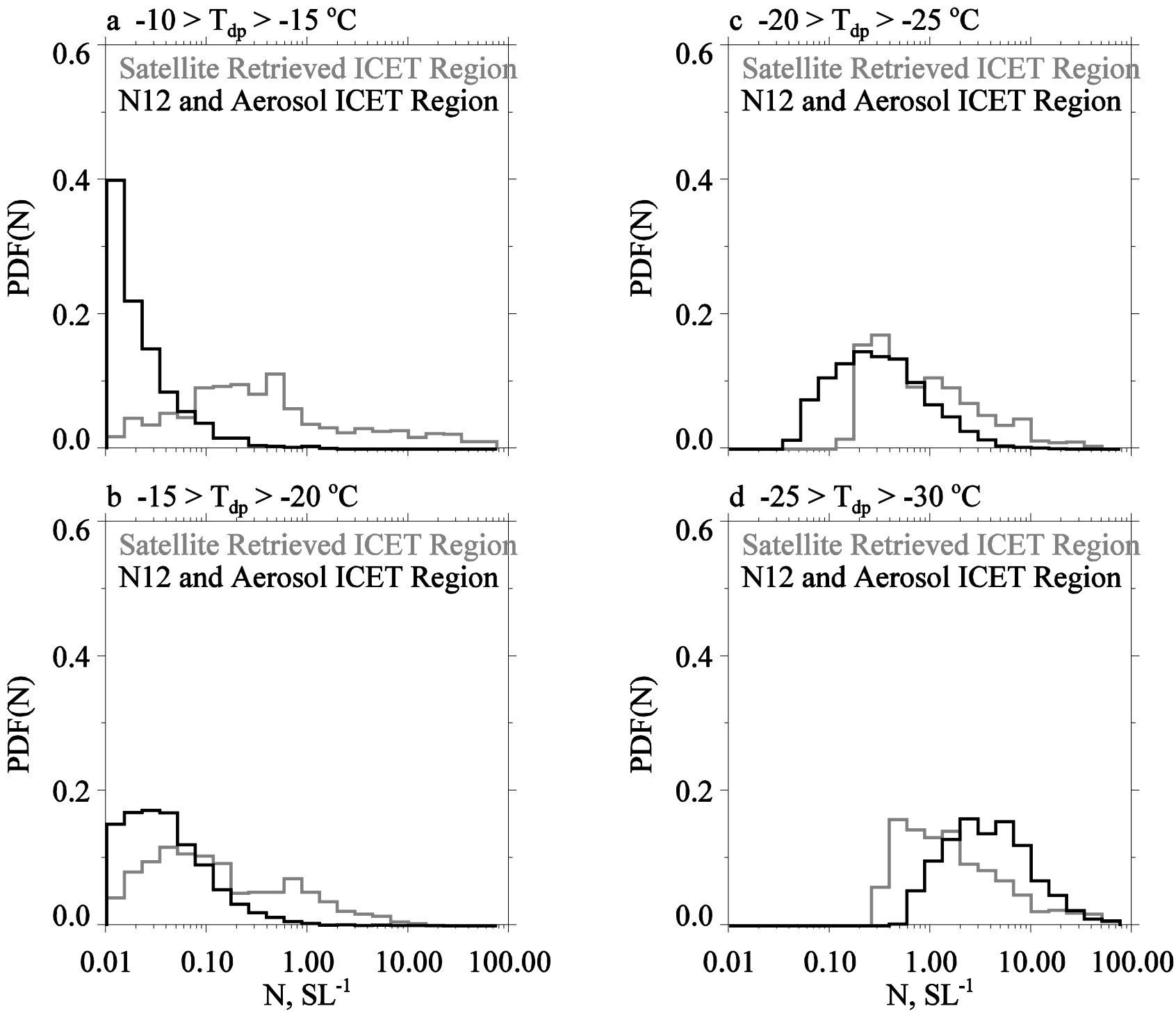
$$N_{IN} = SA \cdot a \cdot \exp(b \cdot T_s)$$

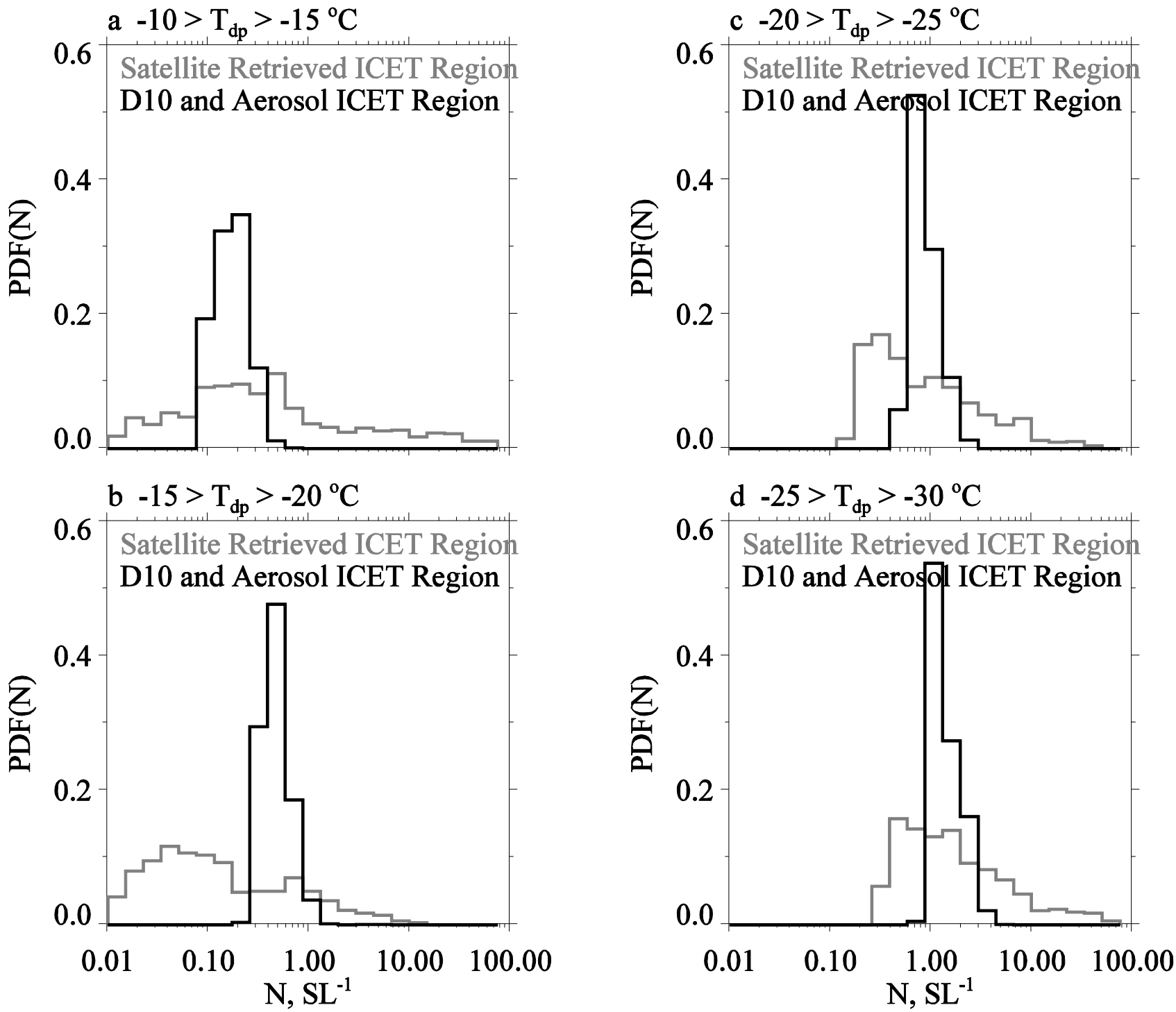

VOCALS - Southeast Pacific
ICET - Caribbean
Pressure, hPa
400
500
600
700
800
-30
-20
-10
Dew Point Temperature, °C
-30
-20
-10
Dew Point Temperature, °C

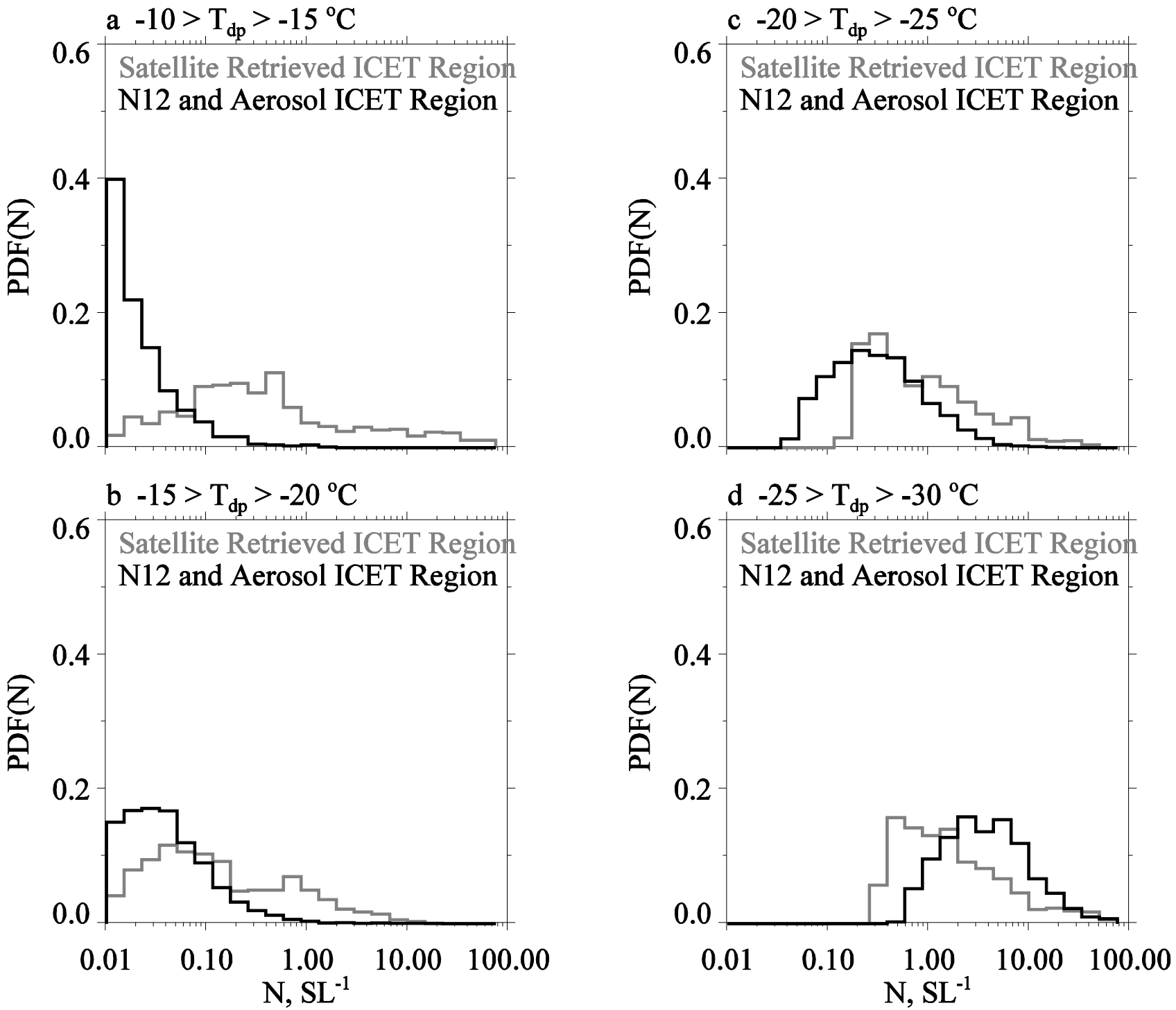

VOCALS - Southeast Pacific
ICET - Caribbean
Aerosol Conc. D>0.5 (cm-3)
2
1
0
-30
-20
-10
Dew Point Temperature, °C
-30
-20
-10
Dew Point Temperature, °C



Occurrence of mid-level liquid-layer-topped stratiform clouds
October, November, December (VOCALS)
June, July, August (ICET)
2006, 2007, 2008, 2009, 2010 CloudSat/CALIPSO measurements


a -10 > T_dp > -15 °C
b -15 > T_dp > -20 °C
c -20 > T_dp > -25 °C
d -25 > T_dp > -30 °C
Satellite Retrieved ICET Region
N12 and Aerosol ICET Region
PDF(N)
0.0
0.2
0.4
0.6
0.01
0.10
1.00
10.00
100.00
N, SL-1


a -10 > T_dp > -15 °C
b -15 > T_dp > -20 °C
c -20 > T_dp > -25 °C
d -25 > T_dp > -30 °C
Satellite Retrieved ICET Region
D10 and Aerosol ICET Region
PDF(N)
0.0
0.2
0.4
0.6
0.01
0.10
1.00
10.00
100.00
N, SL-1


a -10 > T_dp > -15 °C
b -15 > T_dp > -20 °C
c -20 > T_dp > -25 °C
d -25 > T_dp > -30 °C
Satellite Retrieved ICET Region
N12 and Aerosol ICET Region
PDF(N)
0.0
0.2
0.4
0.6
0.01
0.10
1.00
10.00
100.00
N, SL-1

Conclusions:

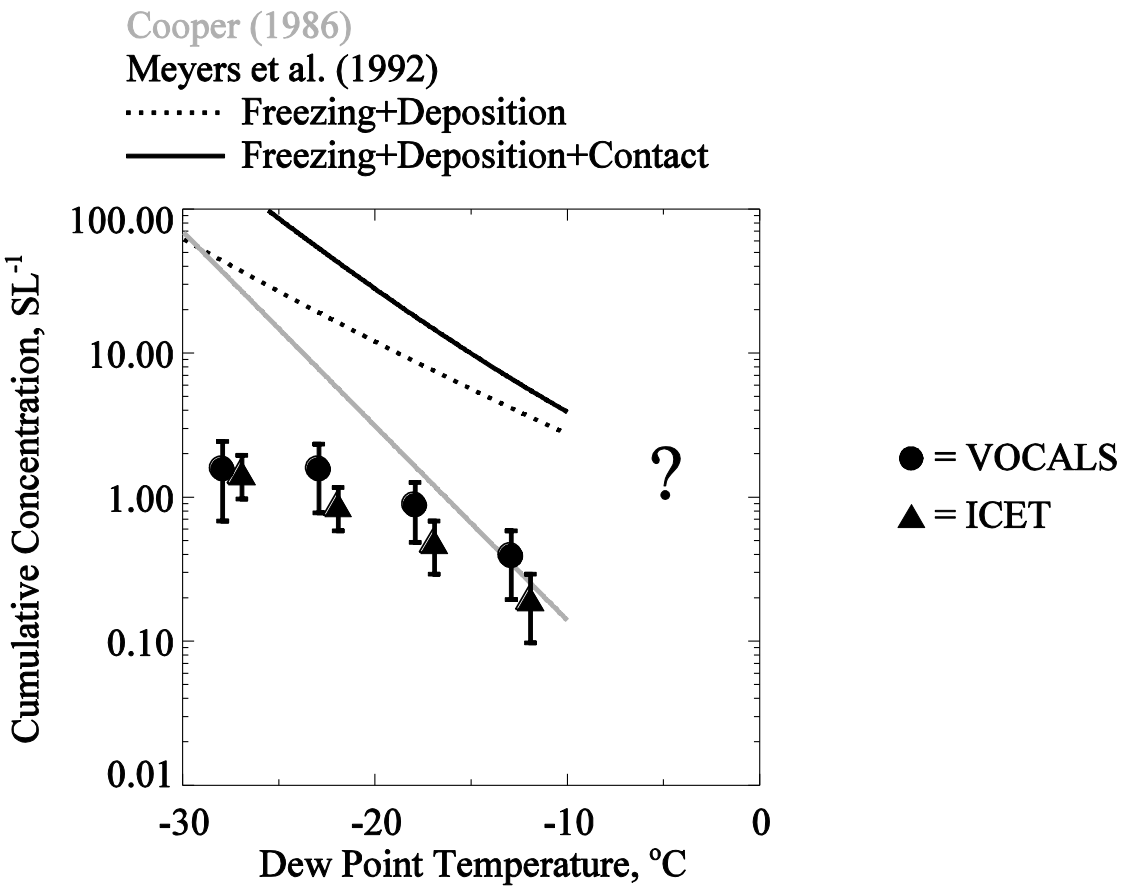
1) Comparison of parameterized IN and satellite-retrieved cloud ice concentration

2) Using D10 the IN temperature sensitivity is ~ 10-fold over -10 ^{o}C to -30 ^{o}C temperature interval

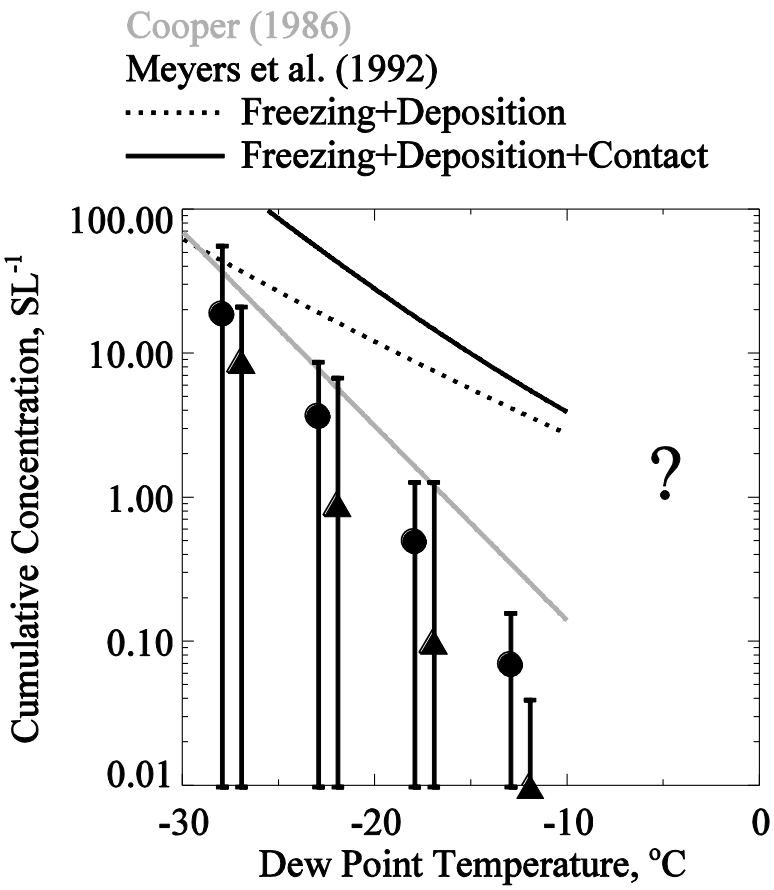
3) Using N12 the IN temperature sensitivity is ~ 300-fold over the -10 ^{o}C to -30 ^{o}C temperature interval

4) With D10, IN variability is smaller, implying less variability of crystal concentration, in models, and in comparisons to retrievals

DeMott et al., 2010



Niemand et al., 2012



Publications that do (will) acknowledge ICET work:

Cai, Y., J.R.Snider and P. Wechsler, Calibration of the passive cavity aerosol spectrometer probe for airborne determination of the size distribution, Atmos. Meas. Tech., 6, 2349-2358, doi:10.5194/amt-6-2349-2013, 2013

J.R.Snider, D.Leon, Z.Wang and D.Zhang, Coarse Particle and Derived Ice Nuclei Concentrations in the Northern and Southern Subtropical Middle Troposphere, in preparation