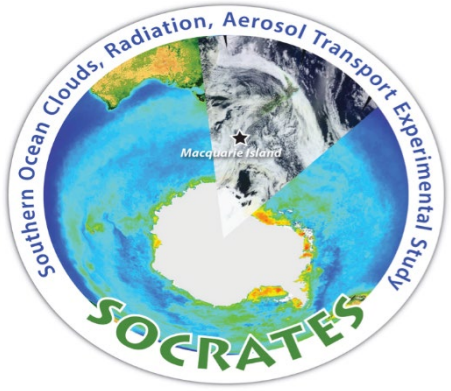
MARCUS-MICRE Update

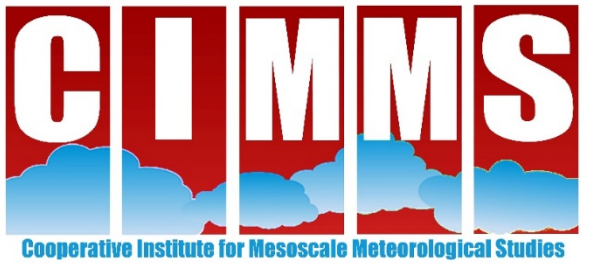
Greg McFarquhar[1] and Roj Marchand[2]

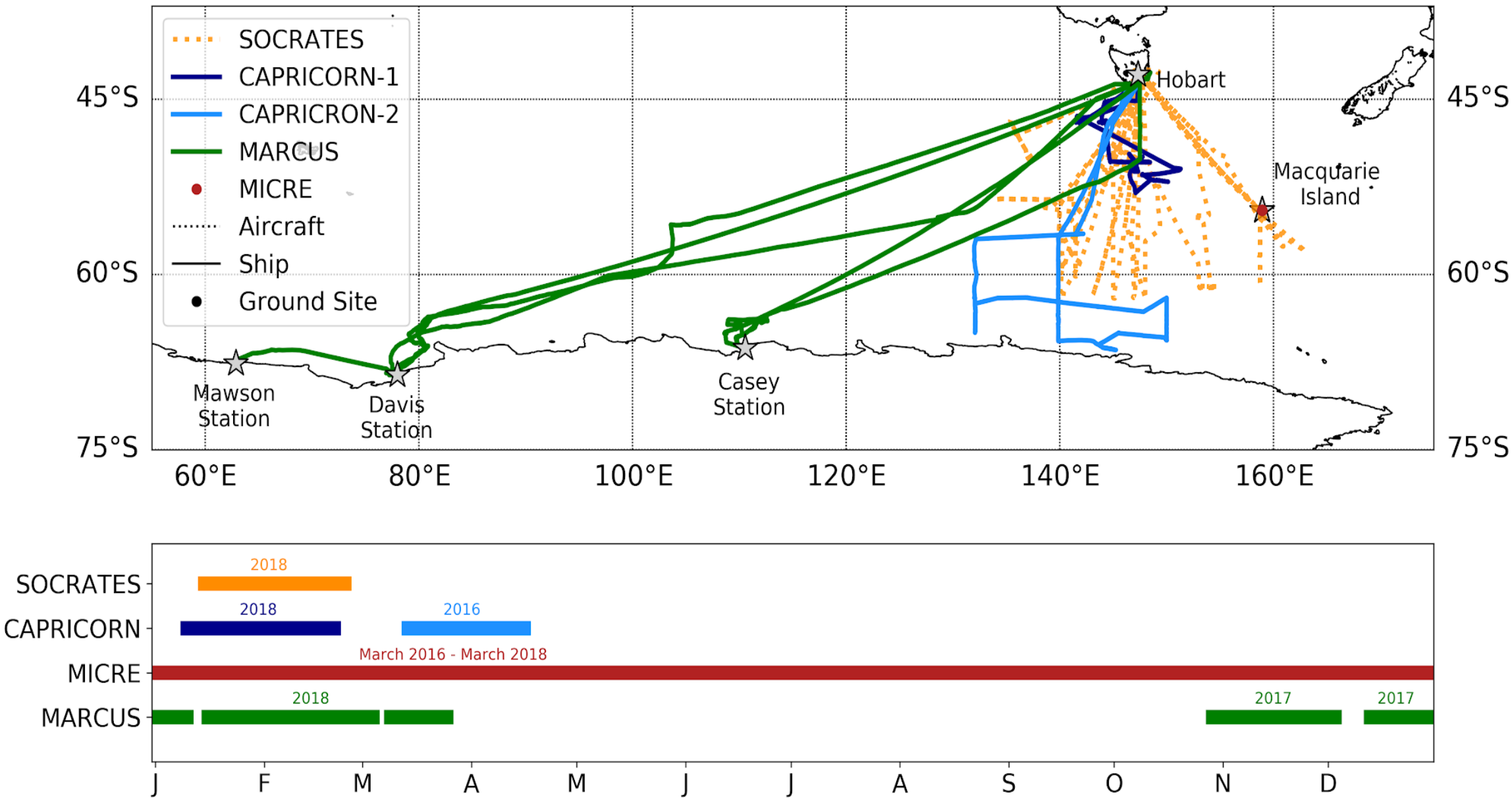
[1]Cooperative Institute for Mesoscale Meteorological Studies

School of Meteorology, University of Oklahoma, Norman, OK

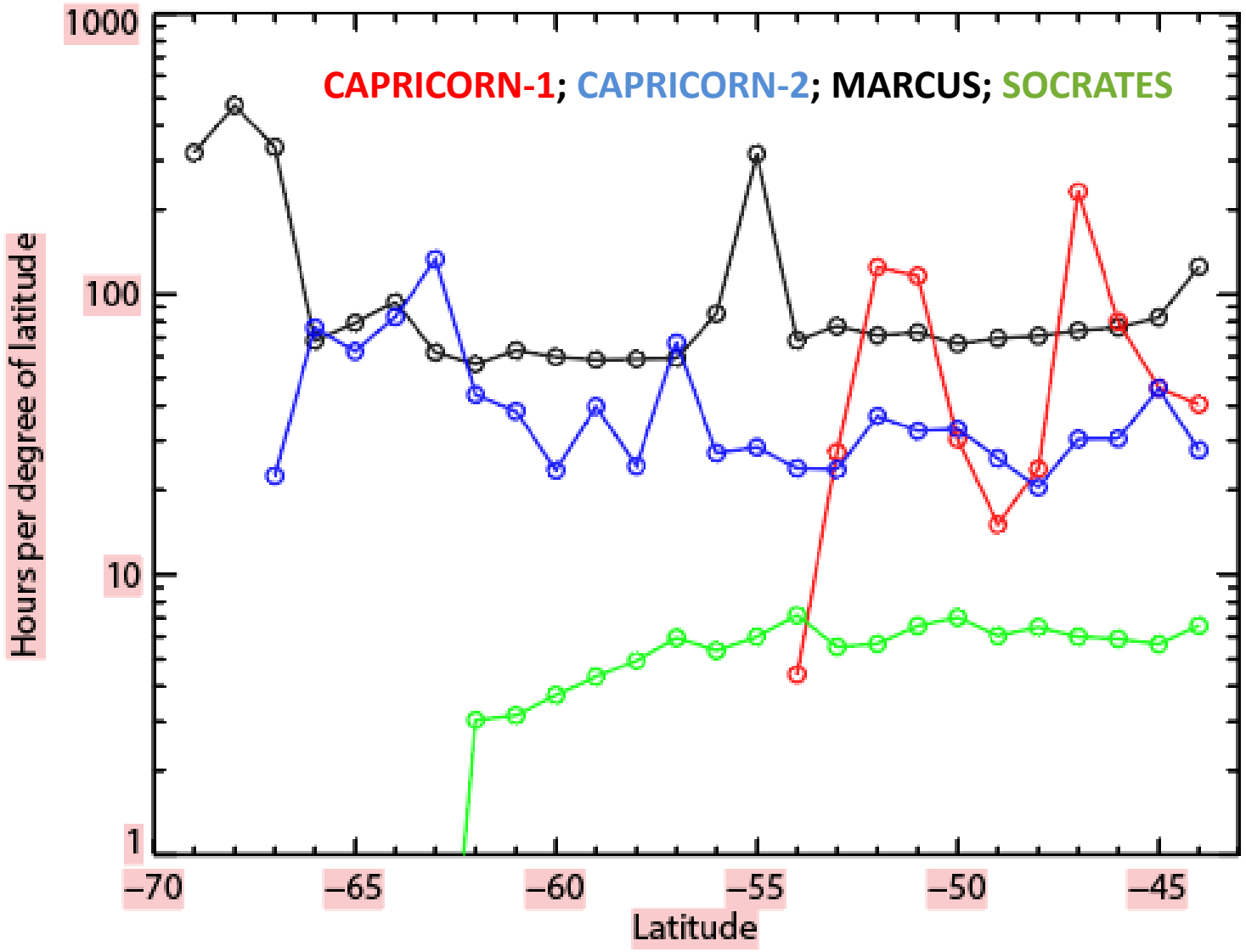
[2]Department of Atmospheric Science, University of Washington, Seattle, WA






SOCRATES
CAPRICORN-1
CAPRICRON-2
MARCUS
MICRE
Aircraft
Ship
Ground Site
45°S
60°S
75°S
60°E
80°E
100°E
120°E
140°E
160°E
Hobart
Macquarie Island
Mawson Station
Davis Station
Casey Station
SOCRATES
CAPRICORN
MICRE
MARCUS
2018
2018
2016
March 2016 - March 2018
2018
2017
2017
J
F
M
A
M
J
J
A
S
O
N
D

Synergy between Southern Ocean projects



Campaign Advantages

MICRE: Long seasonal sample

CAPRICORN: More detailed oceanographic, aerosols & surface flux measurements

MARCUS: Seasonal cycles poleward of 60˚S

SOCRATES: Process studies and remote sensing evaluation

MICRE: Macquarie Island Cloud Radiation Experiment

MICRE Instrumentation	Notes / Quantities Measured
SKYRAD, GRDRAD	Up & downwelling surface BB SW & LW fluxes.
Ceilometer	Cloud base heights and backscatter
Microwave Radiometer (MWR)	Brightness temperatures for retrieving vapor & LWP
Multi-Filter Rotating Shadow-band Radiometer (MFRSR)	Direct and diffuse radiances at visible, shortwave & IR frequencies Retrieval of aerosols and cloud optical depth.
Disdrometer (Parsivel)	Drop size distribution, precipitation rate, type, and amount.
CIMEL sun photometer	NFOV Radiances at visible and SW IR Retrievals of aerosol τ & angstrom exponent).
Cloud Radar	CAWCR W-band Doppler radar (03/16 to 03/17)
Polarization Lidar	AAD 532nm polarization capable lidar
Ceilometer	University of Canterbury
Aerosol Filter Samples	CSU, Analysis of INPs (04/17 – 03/18).
CPC and CCNC	CSIRO
BOM station - twice daily sondes - surface met	P, T, q. BoM records go back to 1949. Have recently added sky camera and radiometers

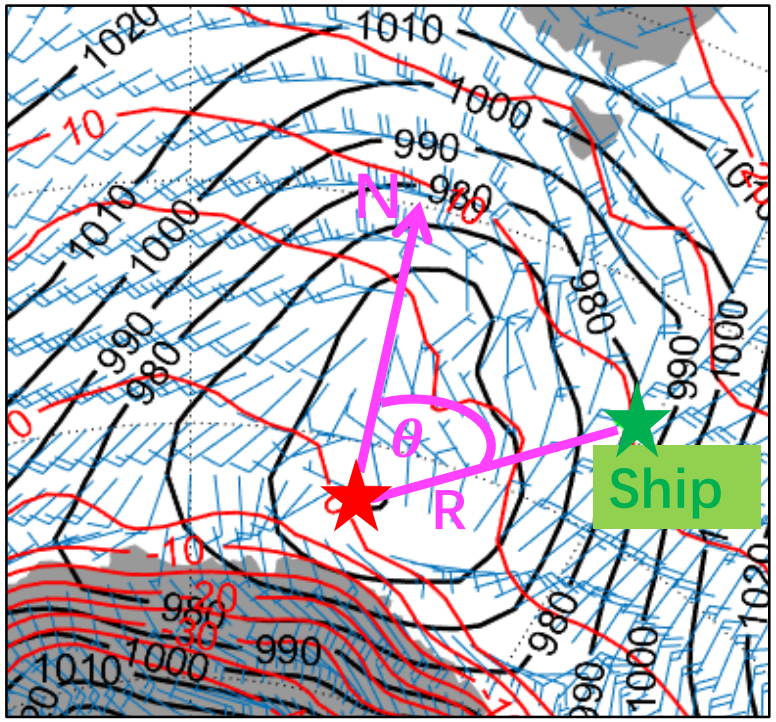
Clouds: Ship- and Ground-based Remote Sensing

- **Ding/McFarquhar VAP segregate data by environmental, geographic & meteorological conditions observed during MARCUS to identify controls of SLW**

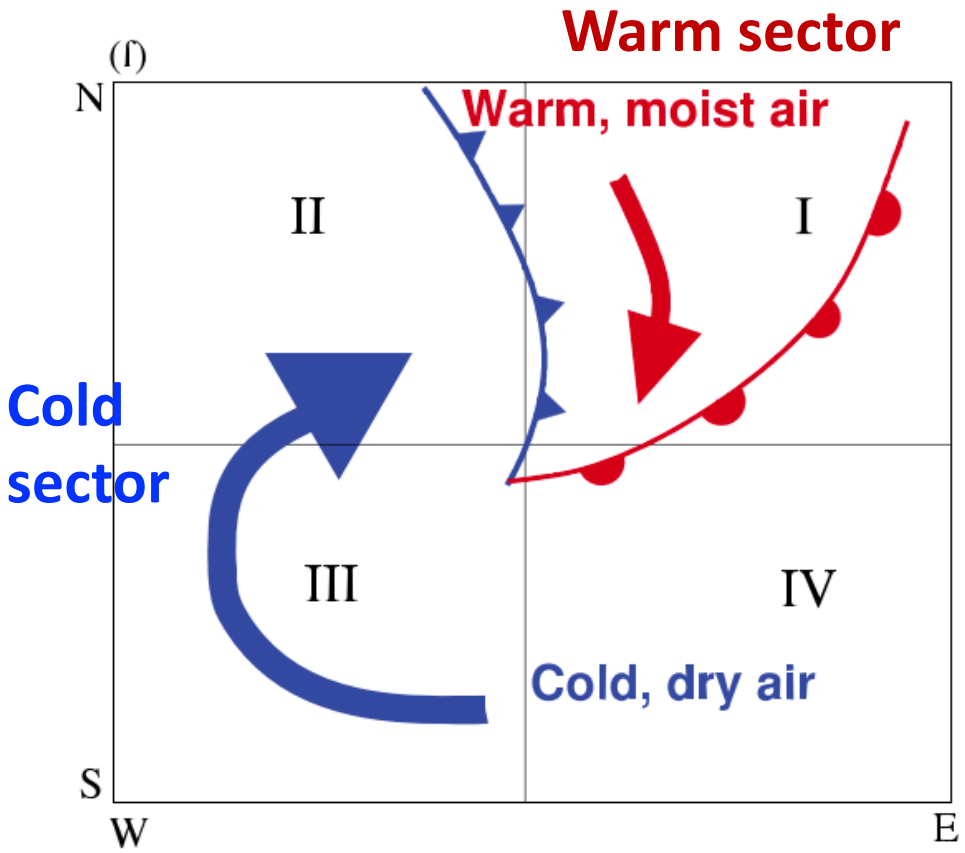
Variable	Source
Sea surface temperature (SST)	Infrared Thermometer
Cloud base temperature (CBT)	Cloud base height (CBH) from Ceilometer merged with T profiles from 6hourly sounding
Precipitating /non-precipitating clouds (PC/NPC)	Maximum column radar reflectivity dBZ_{max}>-15 dBZ is PC, -30<dBZ_{max} <-15dBZ is NPC (Huang et al., 2016)
Coupled /decoupled	$\triangle c_b$ = CBH – LCL, $\triangle c_b$ >300m is decoupled & $\triangle c_b$ <300m is coupled (Comstock et al., 2005)
North/ South of the ocean polar front (NPF/SPF)	Daily SST from AVHRR (Dong et al., 2006)
Air mass origin westerly/ easterly (W/E)	48hrs HYSPLIT back trajectory simulation
Location relative to cyclone	Sea level pressure (SLP)

4. Relative location in cyclone system

Conceptual models:

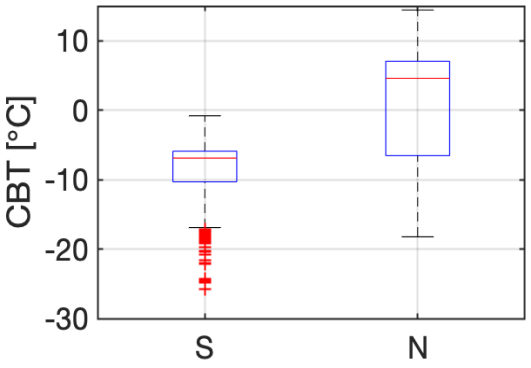


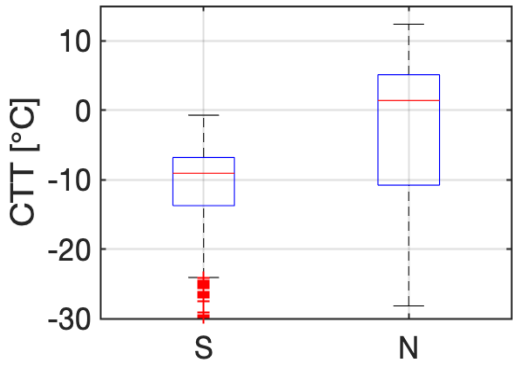
Ding et al. 2020

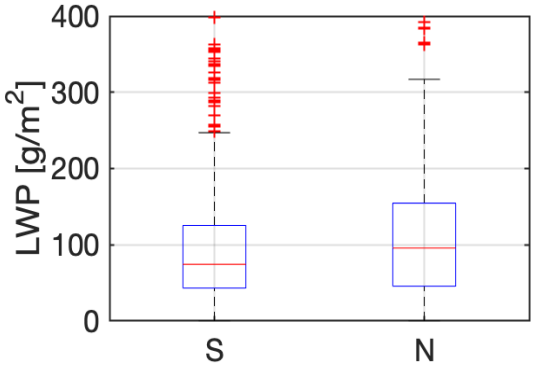


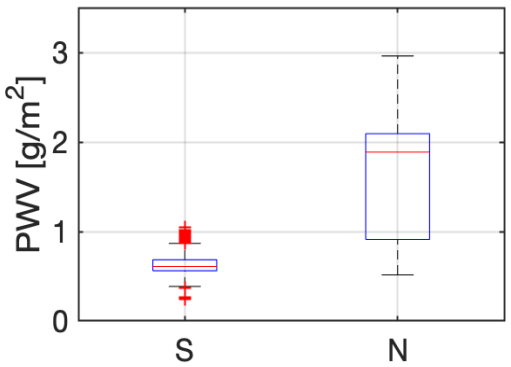
Bodas-Salcedo et al. (2016)
Lang et al. (2018)

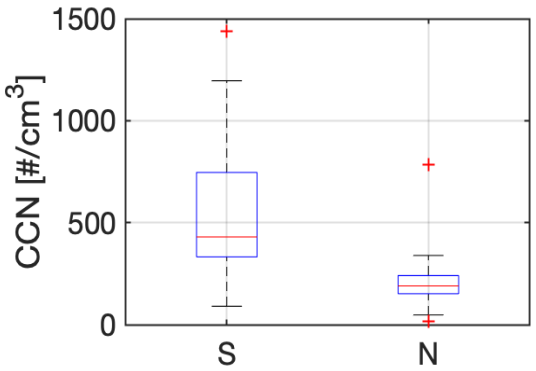
Clouds: Ship- and Ground-based Remote Sensing







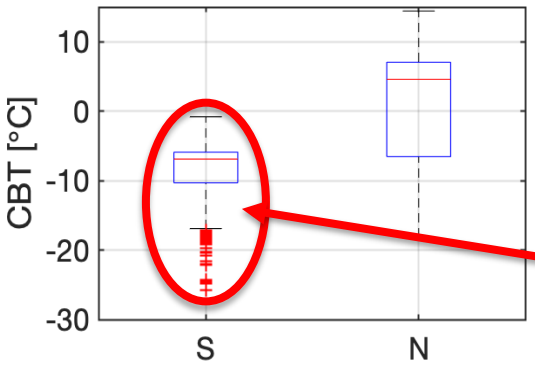


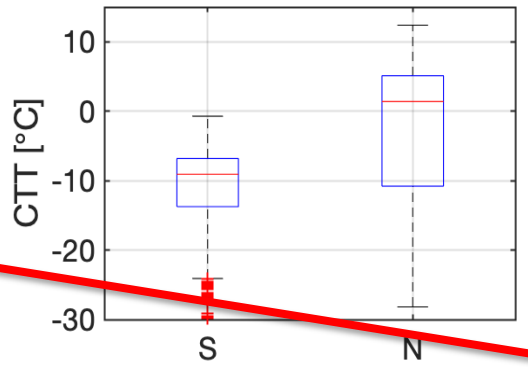


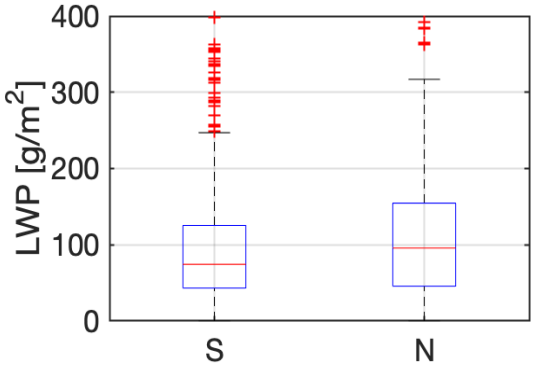
- How properties of single-layer, non-precipitating clouds with z_b < 3 km & > 500 km from nearest cyclone center varied whether north or south of 60˚S.

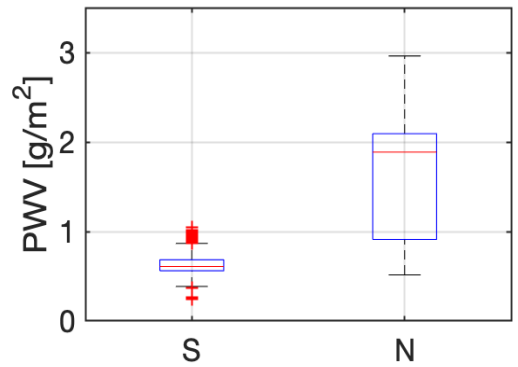
Ding et al. 2020

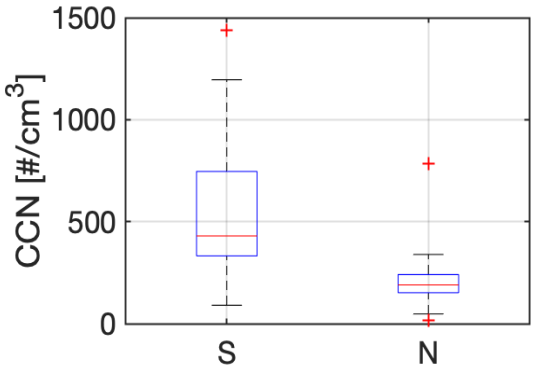
Clouds: Ship- and Ground-based Remote Sensing







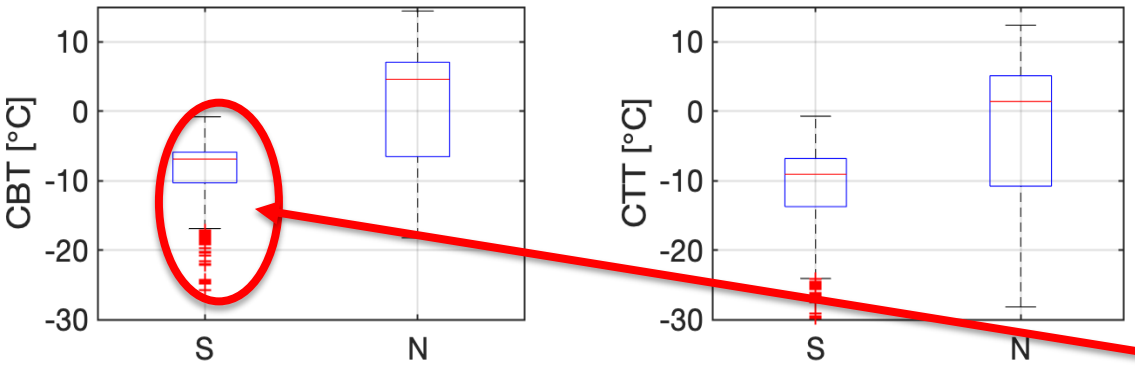


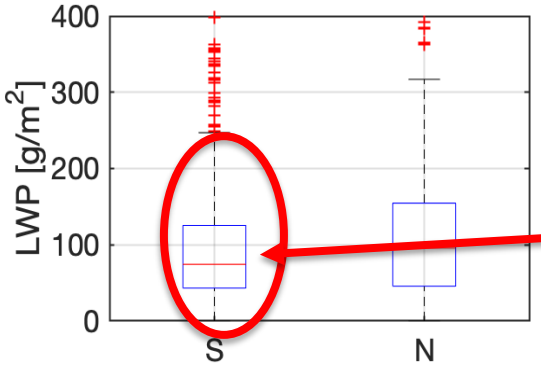


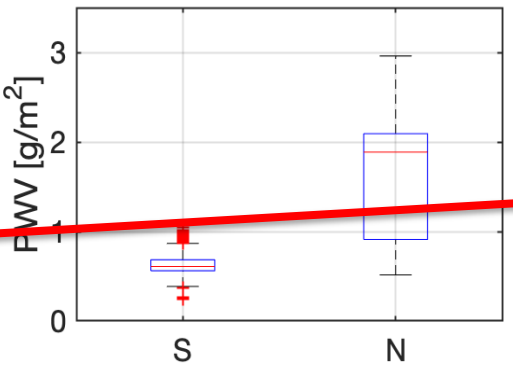
- How properties of single-layer, non-precipitating clouds with z_b < 3 km & > 500 km from nearest cyclone center varied whether north or south of 60˚S.
- Average cloud base T ~ -10˚C S of 60˚S

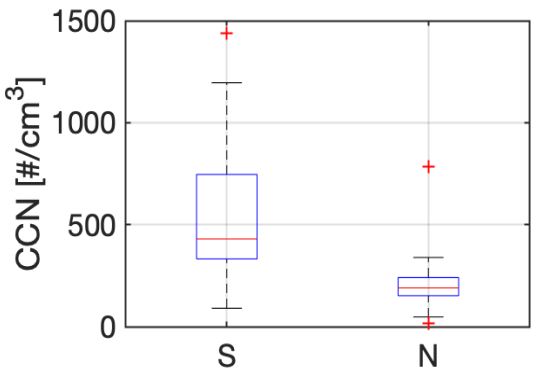
Ding et al. 2020

Clouds: Ship- and Ground-based Remote Sensing





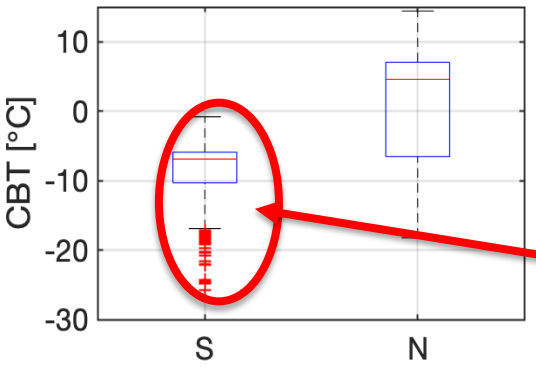


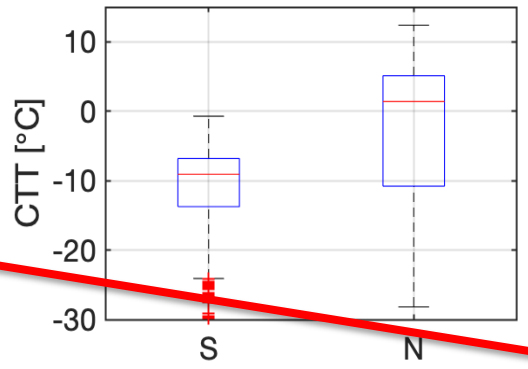


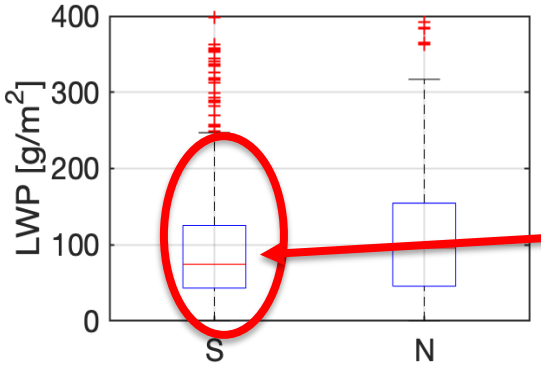
- How properties of single-layer, non-precipitating clouds with z_b < 3 km & > 500 km from nearest cyclone center varied whether north or south of 60˚S.
- Average cloud base T ~ -10˚C S of 60˚S → SLW extensive south of polar front

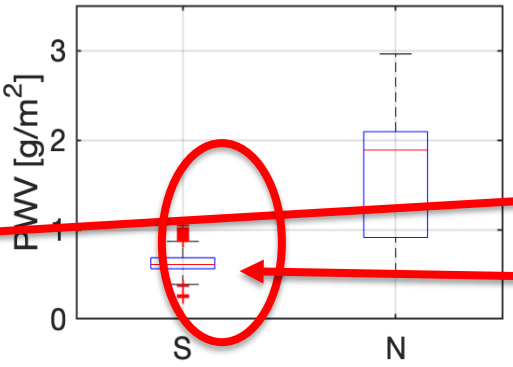
Ding et al. 2020

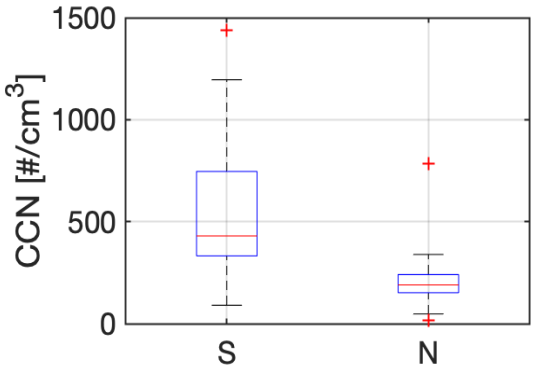
Clouds: Ship- and Ground-based Remote Sensing







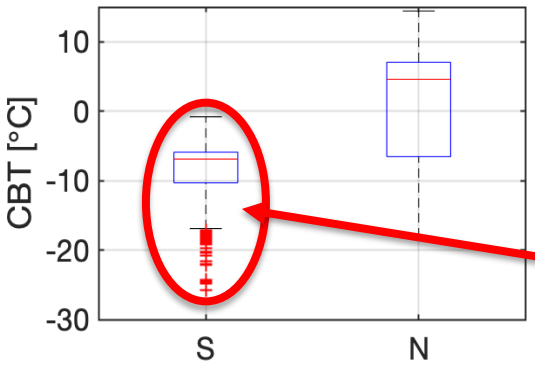


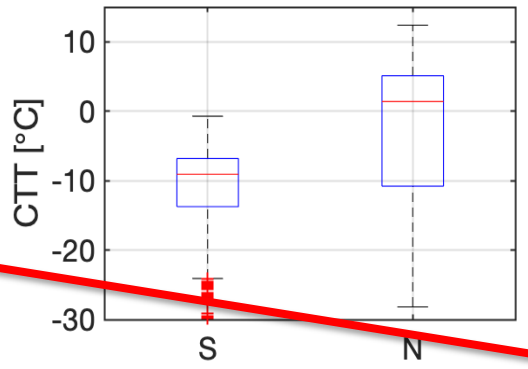


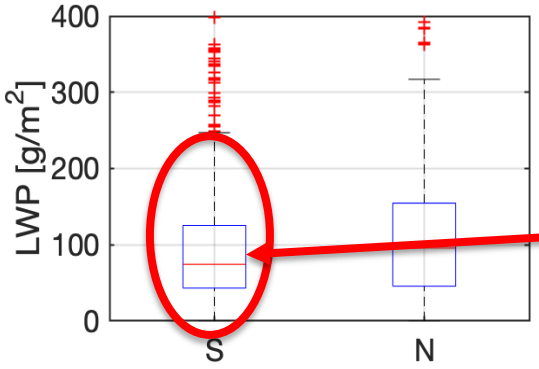
- How properties of single-layer, non-precipitating clouds with z_b < 3 km & > 500 km from nearest cyclone center varied whether north or south of 60˚S.
- Average cloud base T ~ -10˚C S of 60˚S → SLW extensive south of polar front even though less precipitable water

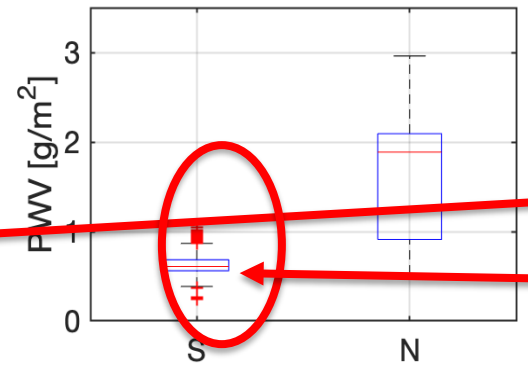
Ding et al. 2020

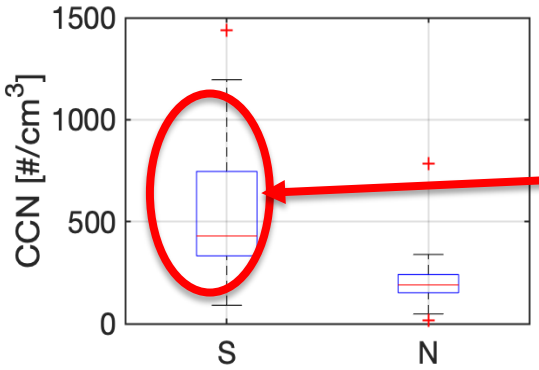
Clouds: Ship- and Ground-based Remote Sensing











- How properties of single-layer, non-precipitating clouds with z_b < 3 km & > 500 km from nearest cyclone center varied whether north or south of 60˚S.
- Average cloud base T ~ -10˚C S of 60˚S → SLW extensive south of polar front even though less precipitable water
- CCN and retrieved N_c peaked in December and appear less south of 60˚S

Ding et al. 2020