MICRE and MARCUS Activities and Plans

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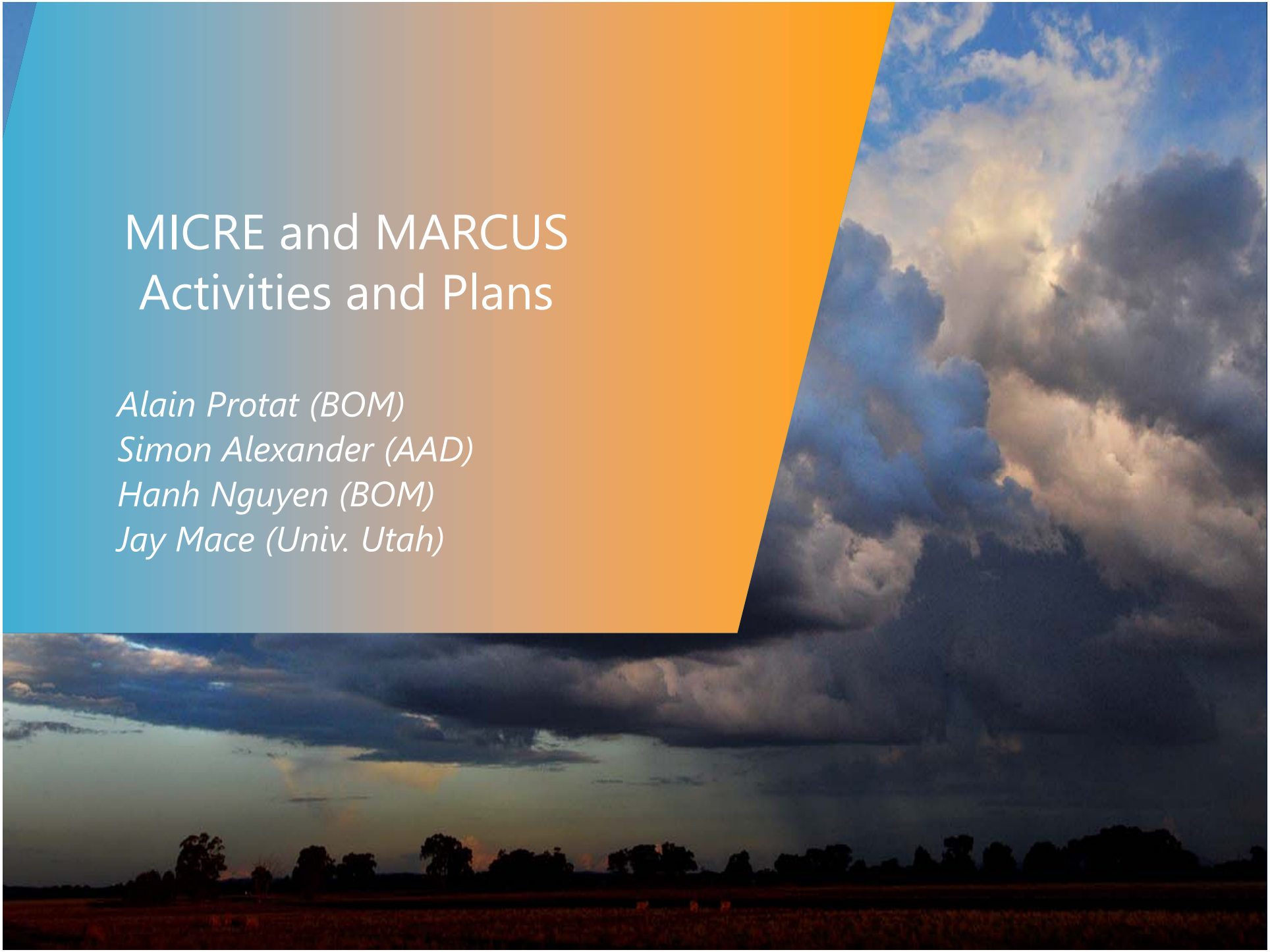

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Southern Ocean Strategy

- **2015 (trial), 2016: CAPRICORN-1** *RV Investigator* over the Southern Ocean. Clouds, aerosols, precipitation, surface energy fluxes, atmospheric composition. Process studies and statistical properties. *Lead A. Protat (BOM)*

- **2016 – 2018: ACRE / MICRE** long-term ground-based observations at Macquarie Island and Davis to get high-res. high-quality measurements (but at a single point). Intraseasonal and interannual variability. *Leads Roj Marchand (U. Washington), S. Alexander (AAD), A. Protat.*

- **Sept 2017 – April 2018: MARCUS** Aurora Australis resupply voyages with ARM Mobile Facility 2 containers (funded US DoE ARM project). Add to ACRE and CAPRICORN statistics, extend statistics further South. *Lead G. Mc Farquhar (Univ. Illinois)*

- **2018 (Jan – March, 45 days): SOCRATES** experiment with NCAR G-V aircraft (US NSF ~ funded) coordinated with the 2018 **CAPRICORN-2** *RV Investigator* voyage (MNF granted). Aircraft in-situ and remote sensing measurements of cloud – aerosol interactions on transects. *Leads G. Mc Farquhar (Univ. Illinois), R. Wood, C. Bretherton, Aussies etc …*

- **2018 – 2020 PLATO** Adding precipitation measurements in CAPRICORN-2, MARCUS, and Antarctica. *Lead S. Alexander (AAD)*

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Scientific Objectives

The main objective is to collect and analyze a comprehensive database about all relevant components of the Southern Ocean troposphere in order to :

Characterize the properties of clouds (macrophysics, microphysics, radiative effect) , aerosols (size distribution, microphysics, chemistry), precipitation (size distribution, rain rate), and boundary layer structure of SO cloud systems + variability with latitude + variability as a function of the large-scale forcing (using cloud regimes);

Evaluate A-Train cloud macrophysics, microphysics, CALIPSO-derived ocean products, aerosol / cloud discrimination, CloudSat / GPM rainfall properties, and surface flux products;

Evaluate the current skill of the suite of ACCESS models at different scales to reproduce these properties of the Southern Ocean cloud systems (NESP-ESCC hub project 2.5). Collaborate to improve the partitioning of ice and liquid in mixed-phase SO clouds in the model (UK Met Office, CSU).

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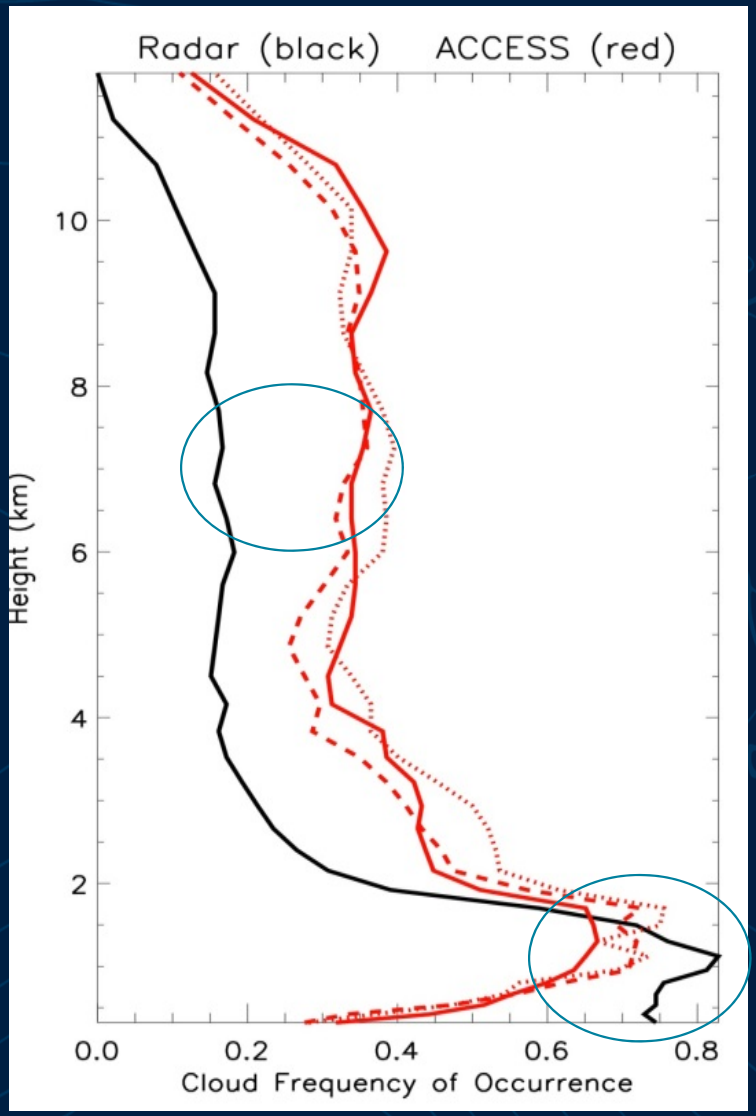
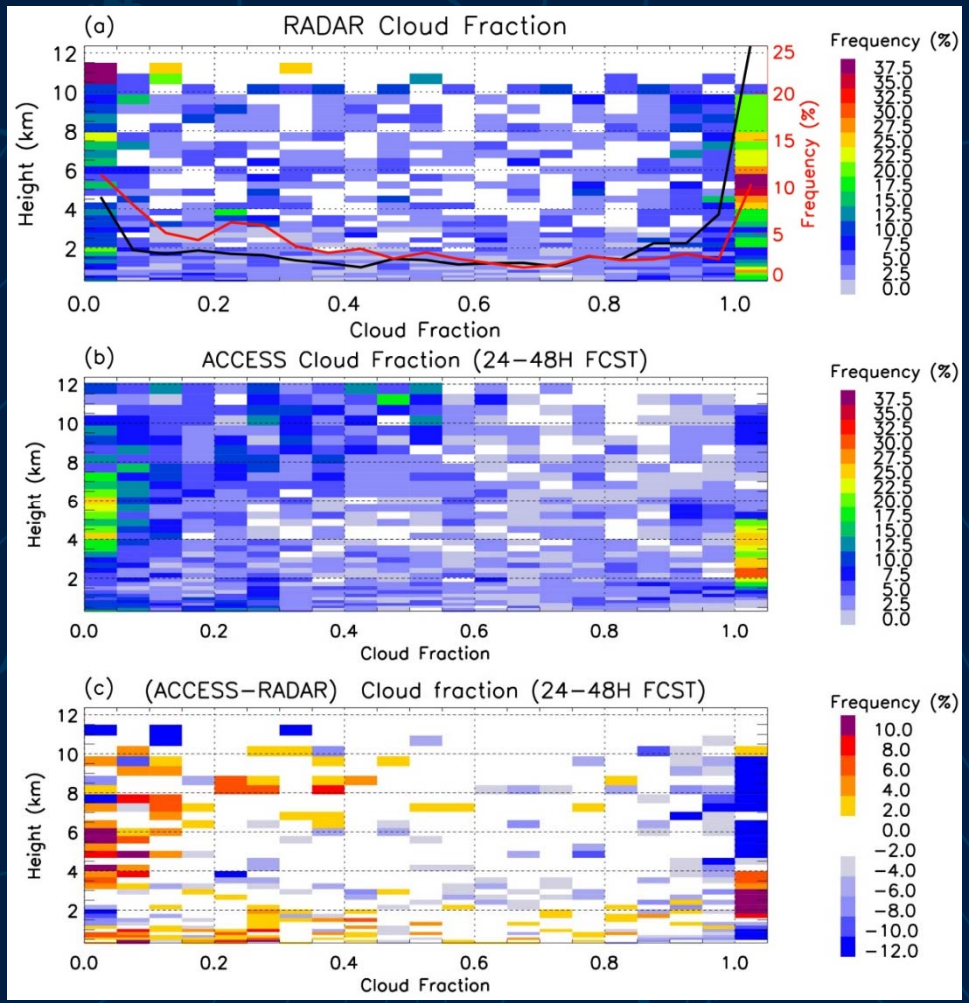
CAPRICORN-1 2015 Trial Voyage Results



Protat et al. 2017, JGR



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CAPRICORN-1 2015 Trial Voyage Results

Underestimation of low-level clouds and overestimation of mid-level / high clouds : what does that do to the surface radiation budget ?

Frequency of occurrence of cloud type and layers (%)

CFO (%)	Low	Mid/high	Multi-layer	Precip	Clear-sky
Obs	57.3	3.4	19.5	12.0	7.8
Model	29.4	0.5	43.2	23.2	3.7

It is actually multi-layer situations (trickier for radiation calculations)

Associated Surface Radiation & Model Errors

All Clouds

CRE (Wm^{-2})	SW	LW	NET
Obs	-71	+49	-22
Model	-90	+54	-36
Model-Obs	-19	+5	-14

SW errors of opposite sign as climate model errors

Low Clouds

CRE (Wm^{-2})	SW	LW	NET
Obs	-80	+53	-27
Model	-55	+48	-7
Model-Obs	+25	-5	+20

SW errors of same sign as climate model errors in low cloud situations

Multi-Layer

CRE (Wm^{-2})	SW	LW	NET
Obs	-77	+53	-24
Model	-121	+57	-64
Model-Obs	-44	+4	-40

Multi-layer situations cause large radiation errors of opposite sign In ACCESS-R

Protat et al. 2017, JGR

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Cloud population during CAPRICORN-1

Mace and Protat, 2018ab, JAMC, in revision

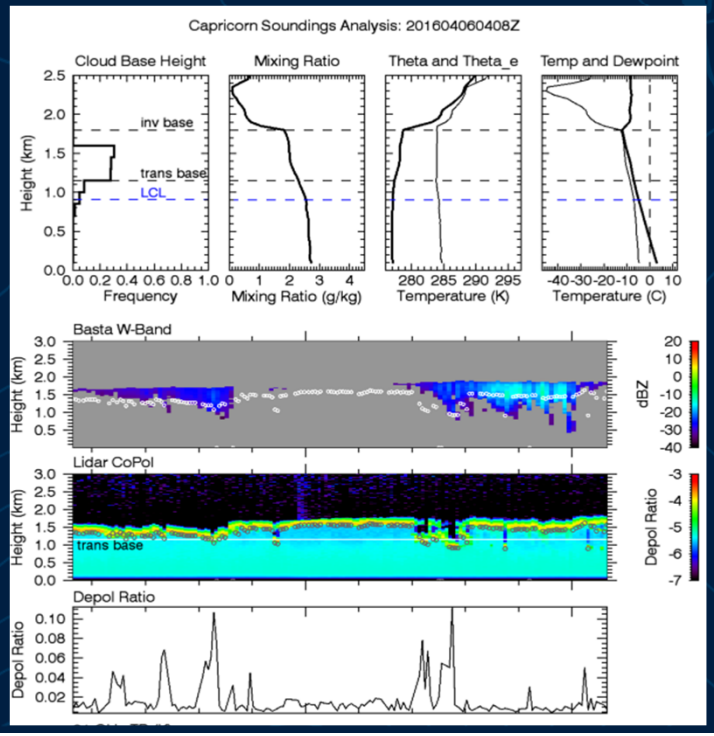
MBL clouds dominating cloud fraction occur in decoupled BLs.

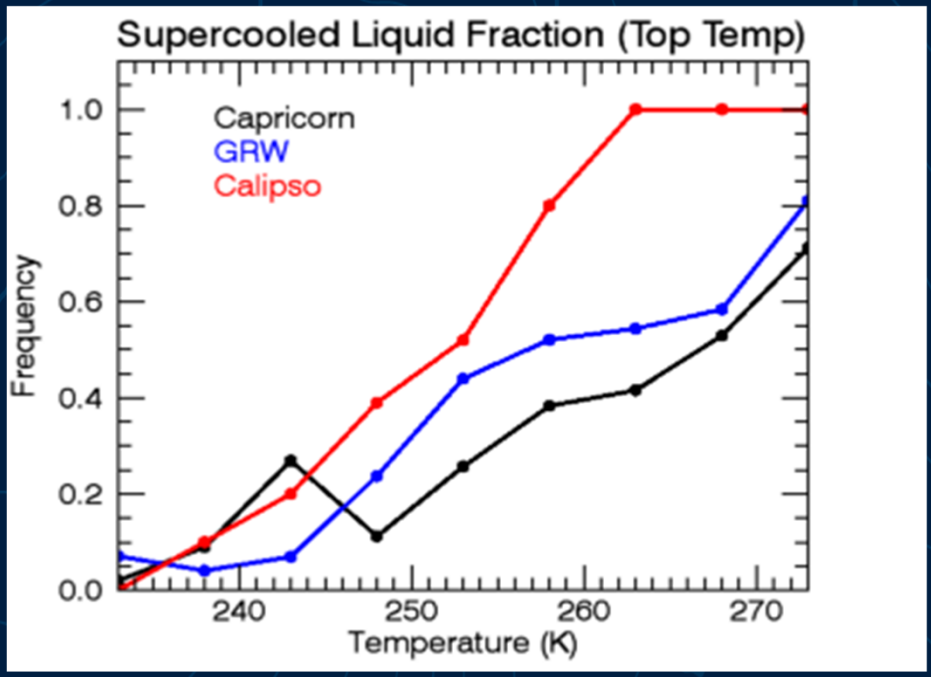
Main difference with NH is that they are often supercooled, rare presence of ice

Greater occurrence of ice phase in sub-freezing low clouds than reported by CALIPSO

Microphysics : LWP ~ 15-25 gm^{-2}, Reff ~ 8 μm, N_T ~ only 20 cm^{-3}, tau ~ 3-4

Addressing the SW bias will require understanding and better simulating the formation, microphysics, and maintenance of those thin supercooled MBL clouds





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MICRE Cloud radar – Lidar product

- MICRE BASTA Cloud radar has four modes : 12.5, 25, 100, 200m (12s)
- MICRE AAD Lidar: 15m and variable temporal resolution (~90s)
- We need to combine those datasets in a common grid:
  - Easier to use for non-specialists
  - Combined cloud mask product
  - Combined cloud phase product
  - Radar-lidar cloud microphysical retrievals
- Merged cloud radar – lidar product is 25m, 60s resolution.
- Tested on CAPRICORN (2016) dataset
- Will be available for MICRE dataset ~ May 2018 *(contact me if interested)*
- Who's doing this for MARCUS ?

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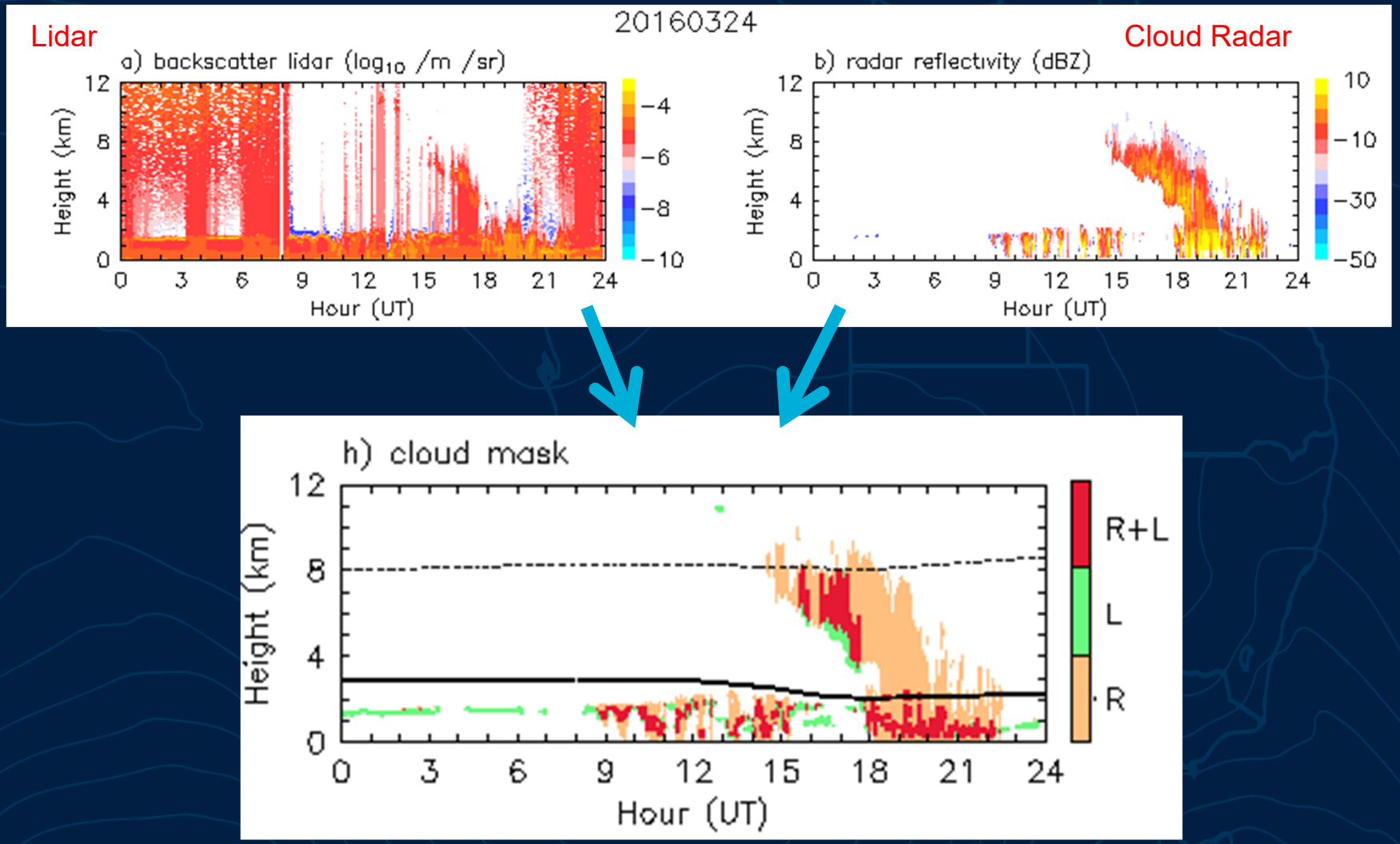
Merged cloud mask



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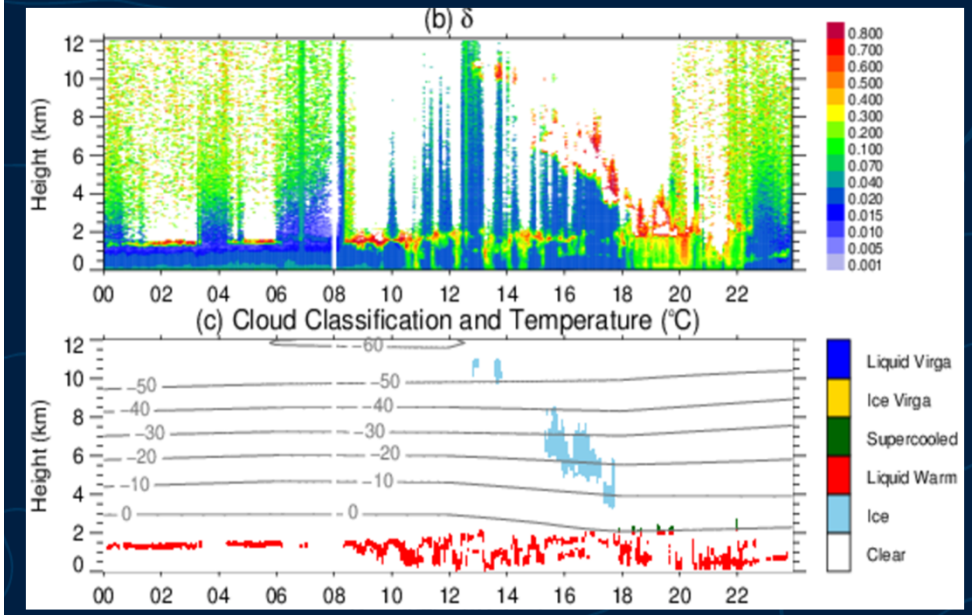
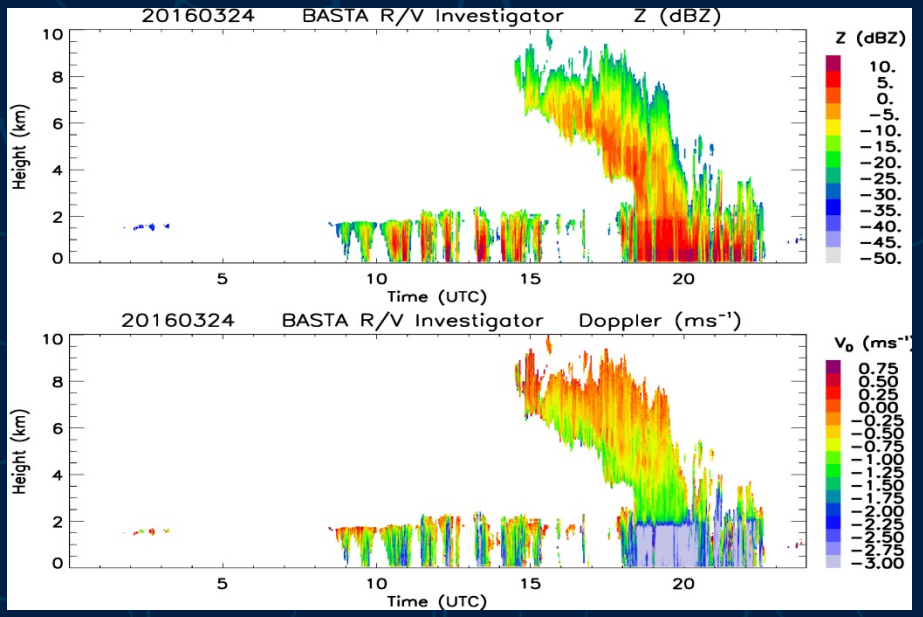
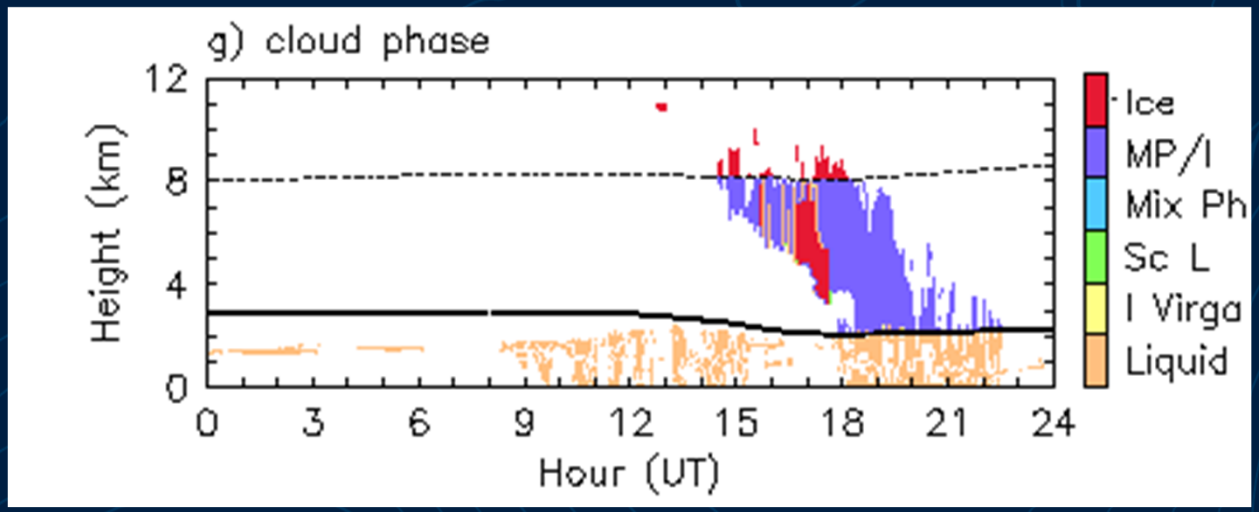
Merged cloud phase







Assumptions:

Radar does not detect Sc liquid
Basis for Mixed-phase vs Sc liquid

ERA-Interim T perfect

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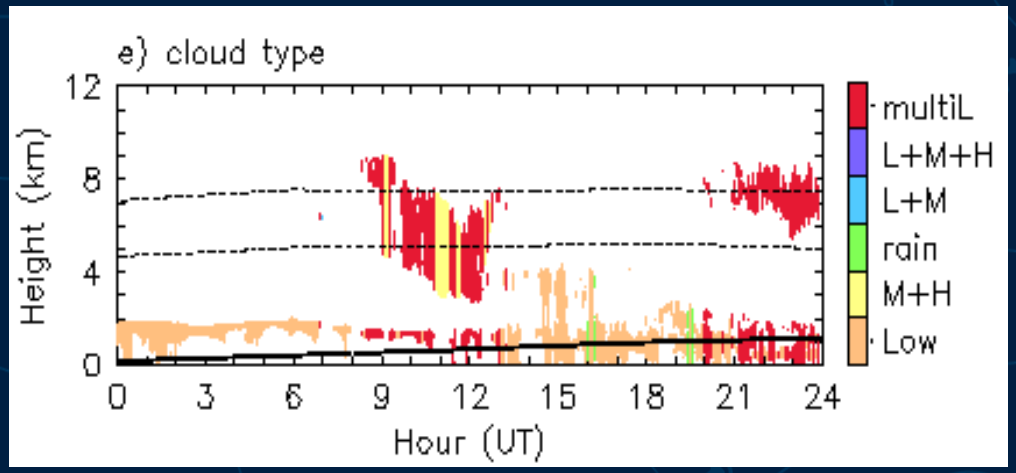
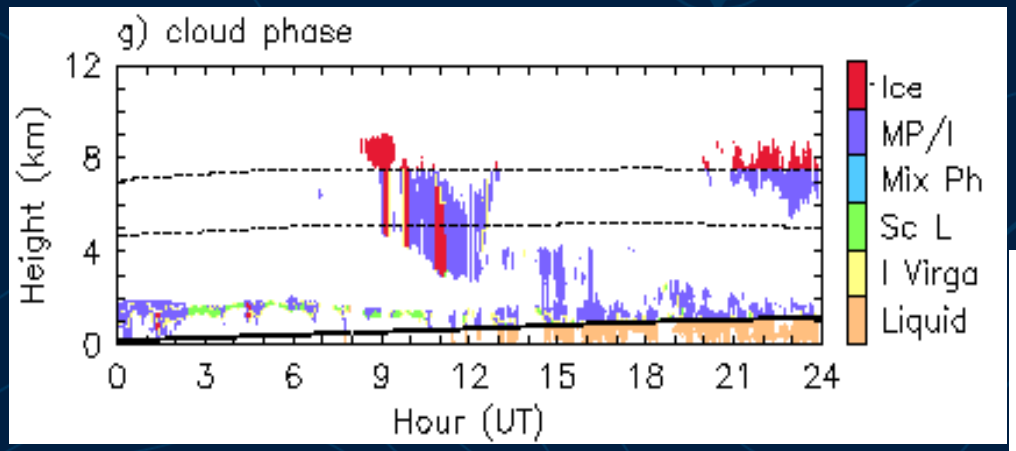
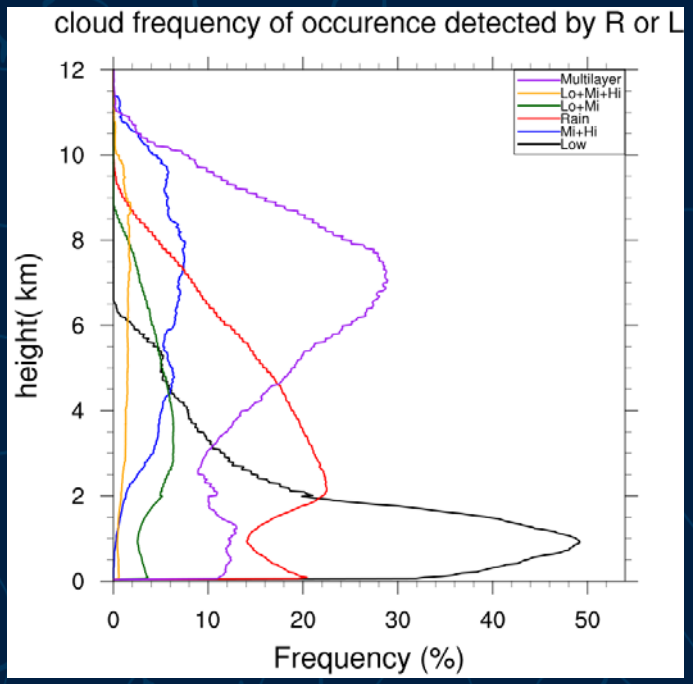
Merged Cloud Cover Type







	Low	Mi+Hi	Lo+Mi	Lo+Mi+H	Multilayer	Rain	All
SW	-65.00	-21.79	-40.52	-51.47	-79.76	-136.90	-65.91
LW	46.52	20.94	58.28	41.35	51.34	62.39	46.80
NET	-18.47	-0.84	17.76	-10.12	-28.42	-74.51	-19.10

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Modelling activities

- Unified Model Partnership members (UK Met Office, NIWA, BOM) will produce simulations with the 1.5 km model and the climate model (T-AMIP)
- Sensitivity tests will focus on mixed-phase partitioning, the role of ice nuclei, and improvements in GLOMAP (aerosol chemistry) and CASIM.
- ECMWF will extract global simulations over the MICRE, MARCUS and CAPRICORN periods for model evaluation
- ASR modellers interested in joining ?