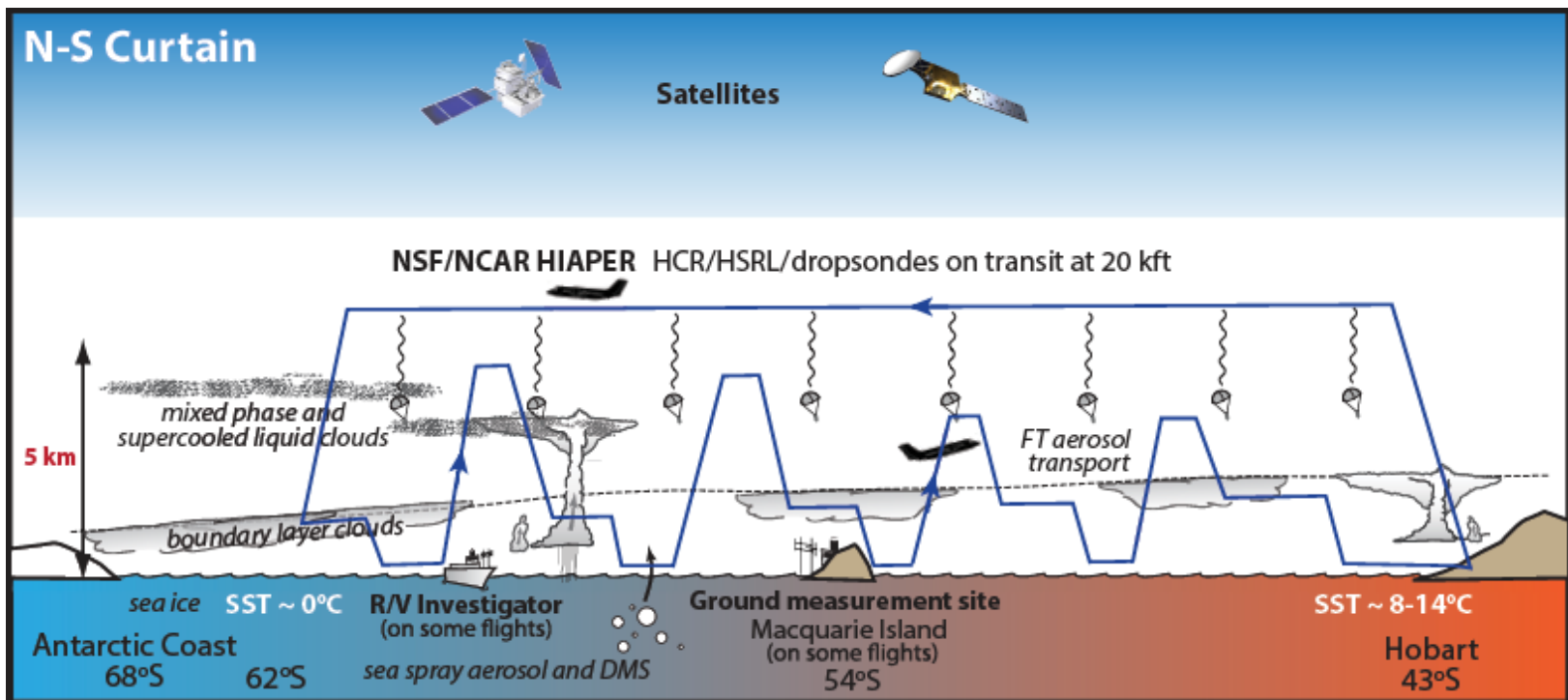




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Bureau of Meteorology

Australian Bureau of Meteorology supporting SOCRATES

Southern Ocean Cloud, Radiation and Atmospheric Transport Experimental Study
Jan-Feb, 2018



From: <https://www.eol.ucar.edu/content/socrates-project-overview>



Climate model bias in cold sectors of cyclones

Likely contributors to errors:

- (1) model deficiencies in **vertical turbulent transport** due to both cumulus and PBL parameterization,
- (2) interaction between parameterized cumulus convection and stratiform cloud processes, e.g., through processes such as **condensate detrainment**,
- (3) **microphysical deficiencies**, e.g., excessively rapid glaciation of supercooled liquid cloud or excessive precipitation from cumulus
- (4) errors in representing **sub-grid condensate** variability, and
- (5) inadequate **resolution of the circulation systems** in which the clouds evolve.

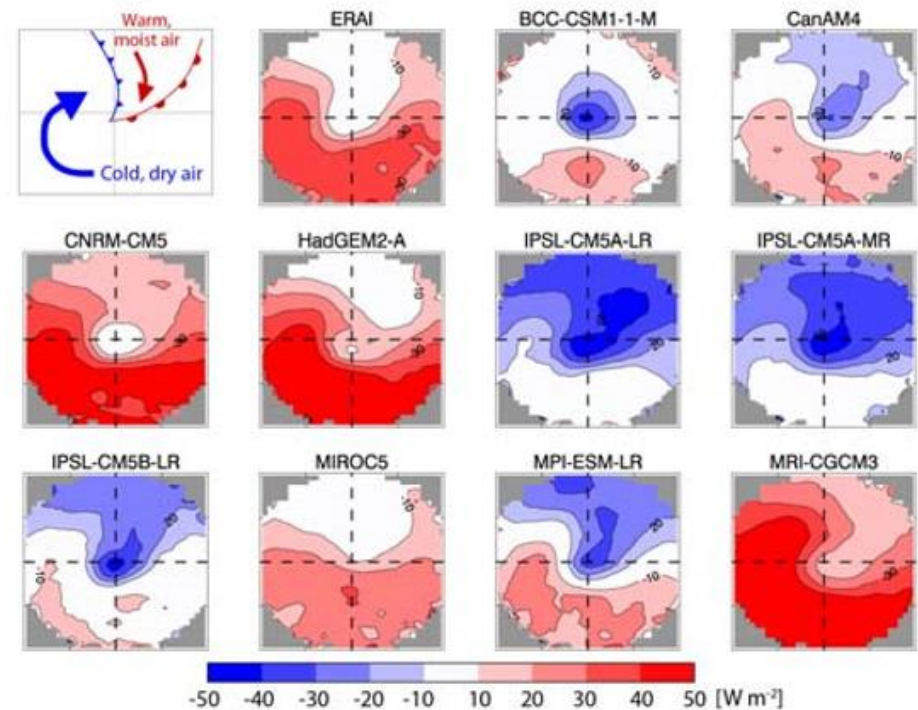
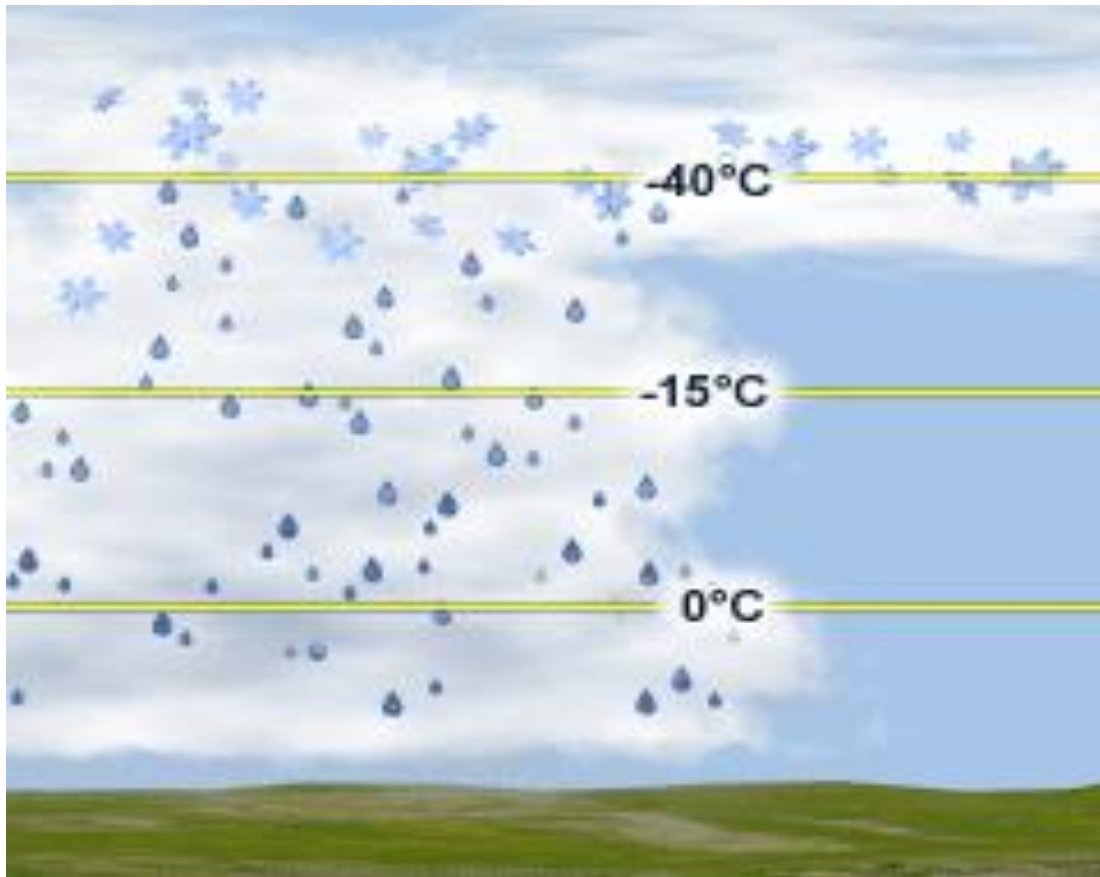


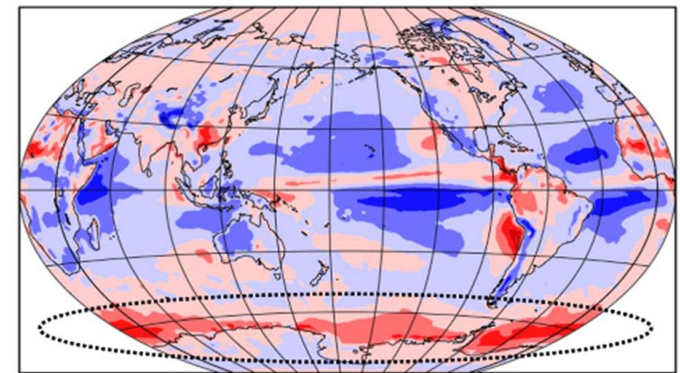
Figure 2: Cyclone compositing indicates consistent patterns of insufficient reflected shortwave in the cold, dry regions of the cyclones. Figure shows bias in absorbed shortwave radiation for AMIP models from Bodas-Salcedo et al. (2013).



Supercooled droplets



Absorbed Shortwave Radiation Mean Error - CMIP5



"The source of the image on the left is the COMET[®] Website at <http://meted.ucar.edu/> of the University Corporation for Atmospheric Research (UCAR), sponsored in part through cooperative agreement(s) with the National Oceanic and Atmospheric Administration (NOAA), U.S. Department of Commerce (DOC). ©1997-2017 University Corporation for Atmospheric Research. All Rights Reserved.



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MetArea 10

Australian EEZ

Melbourne FIR

Australian
Antarctic Territory



photos courtesy of AAD



Australian Government

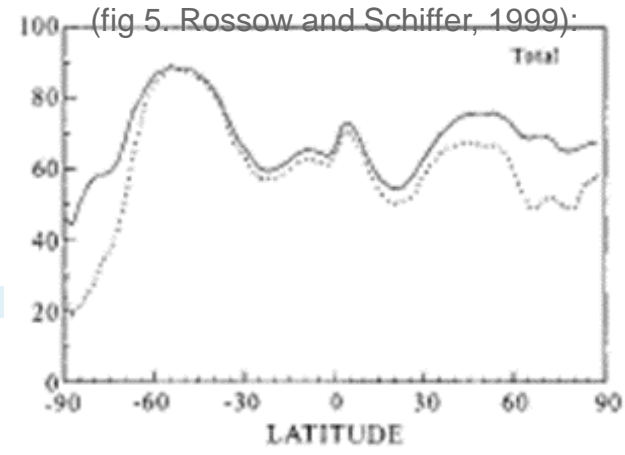
Bureau of Meteorology

Talk about:

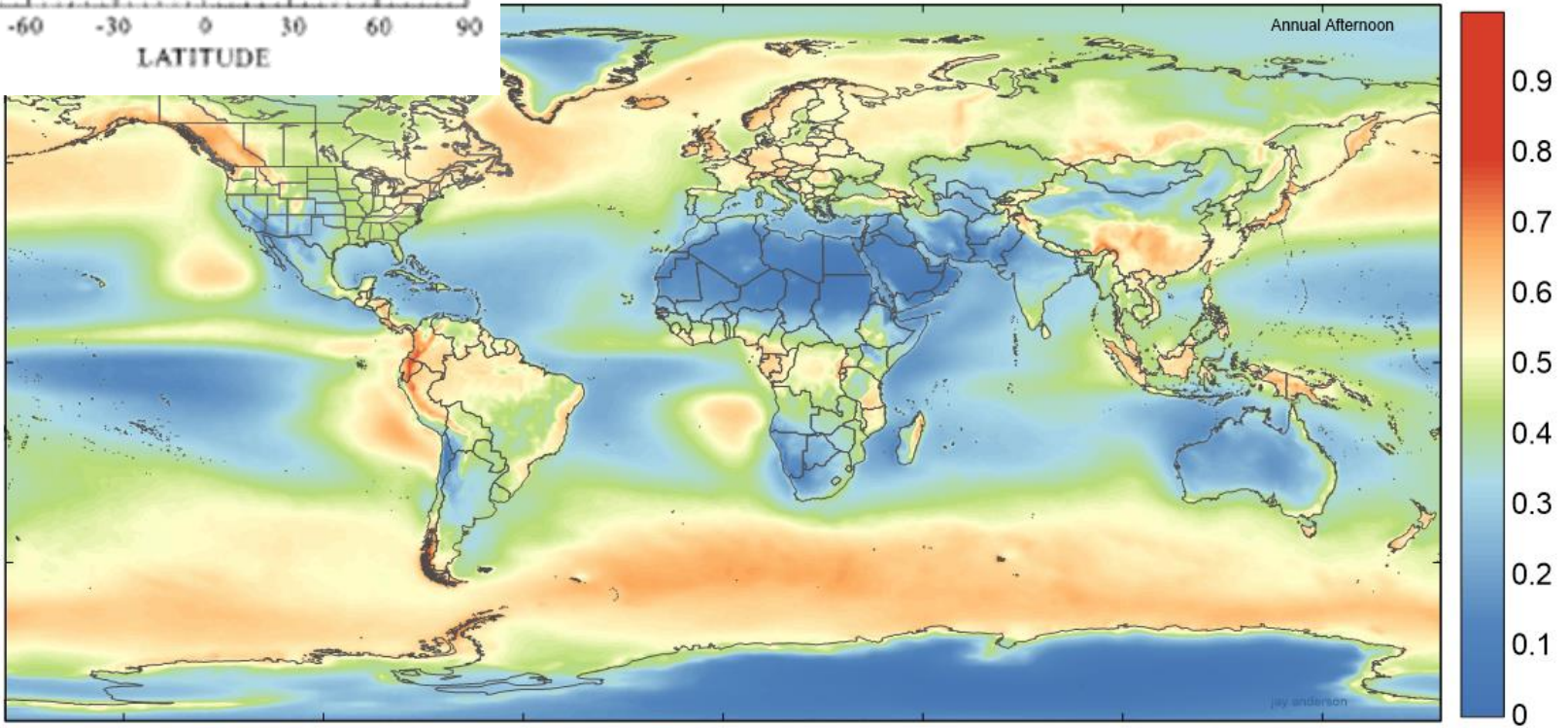
1. SO clouds (10 Mins):
 - i. Quick overview
 - ii. Operational considerations

2. A field campaign to improve understanding (10 Mins):
 - i. SOCRATES
 - ii. Flight planning support
 - iii. Things learned (preliminary)

Zonally Averaged Total cloud cover all seasons



Southern Ocean Clouds



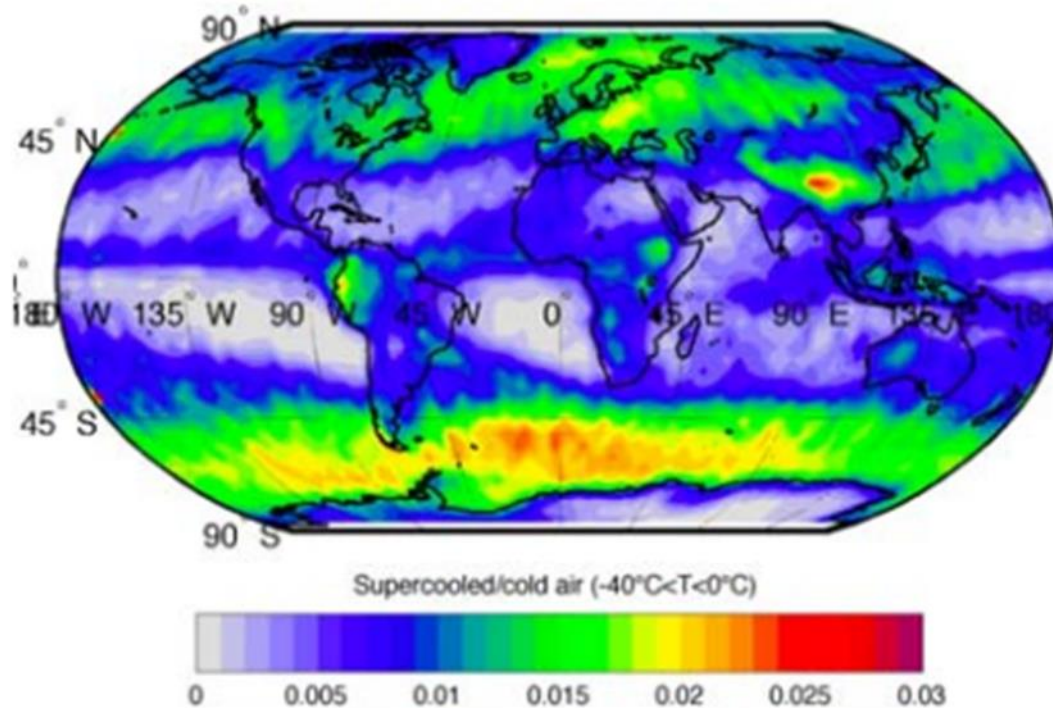
Map of global annual afternoon cloudiness derived from observations from the Aqua satellite 2002-2015. Data: NASA



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Probability of Cloud Containing supercooled Liquid Water between -40 and 0C



Retrieved using CALIPSO depolarisation measurements from DARDAR algorithm of Delanoe and Hogan (2008)



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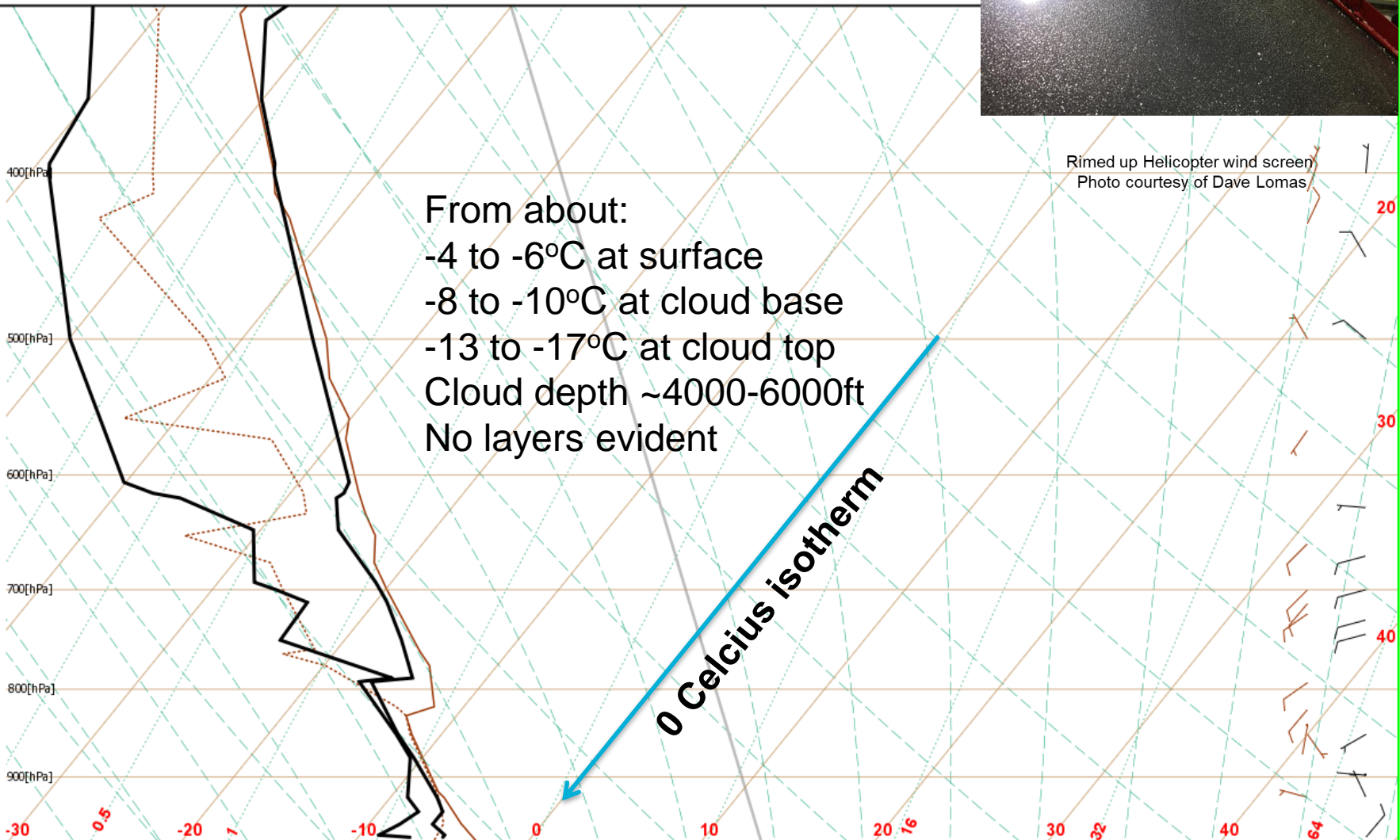
Freezing Rain at Davis

Radiosonde Observations

10 hours prior (brown) and 2 hours after (black)



Model Information for: DAVIS - 89571, valid Thu 23 Feb 12:00 UTC



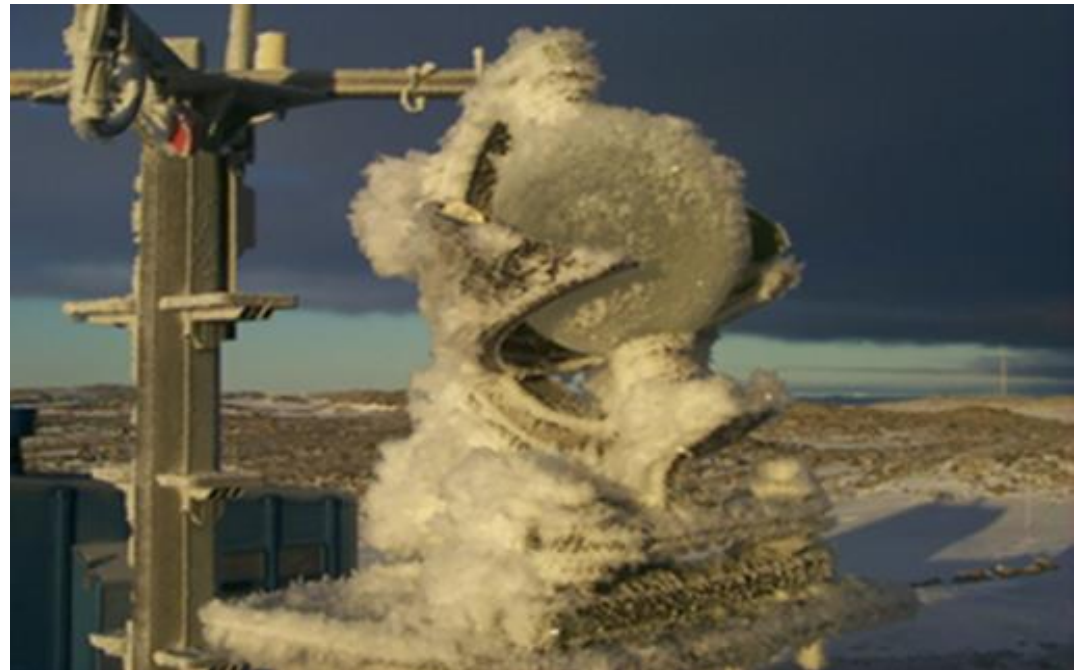
Note: If viewing observations, click 'Update Layers' button (in the Ascent Navigator) to obtain latest sonde traces



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Wilkins Ice Runway

7 FZFG events in 90 day period
(Dec-Feb 2016-17)

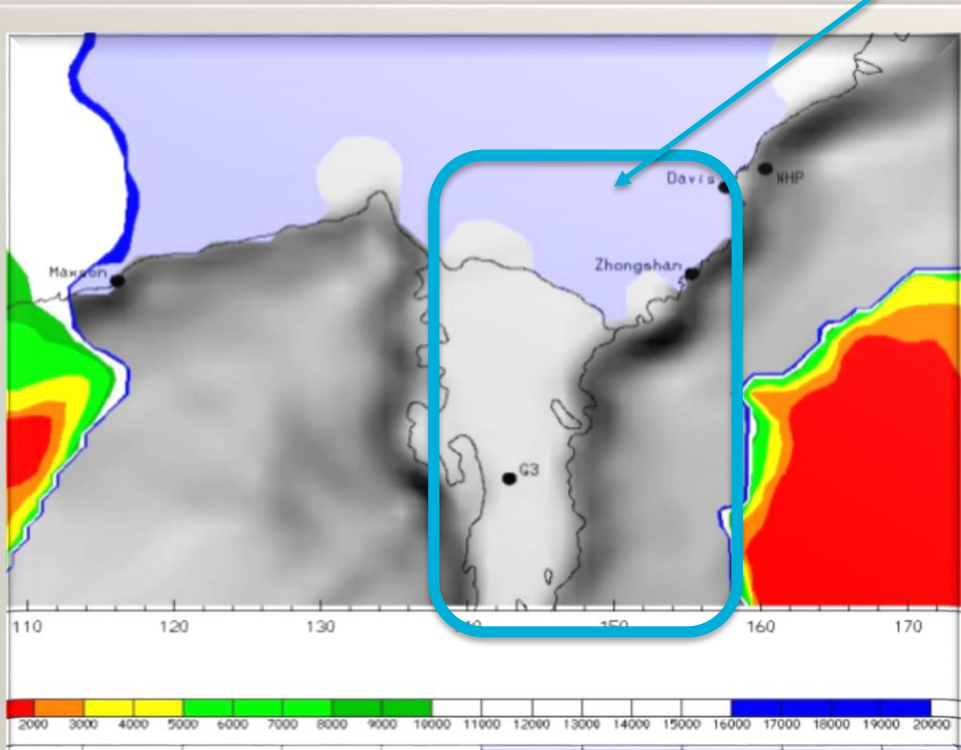




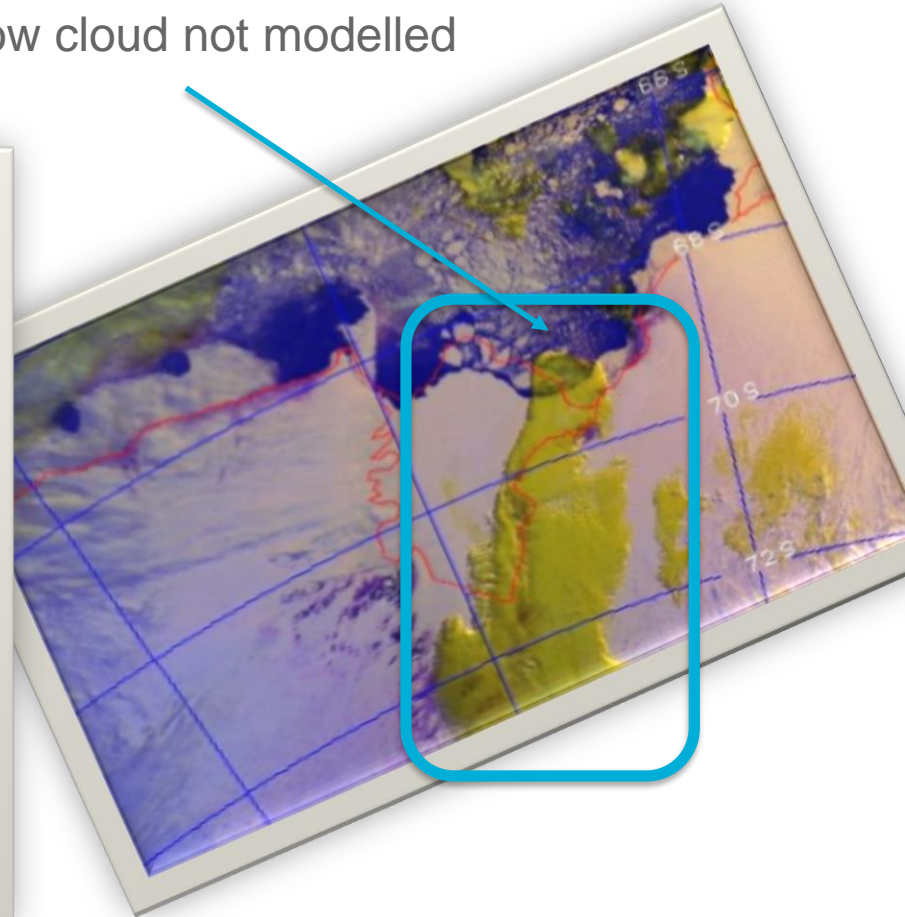
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Model vs Sat Pic

~500km of low cloud not modelled



AMPS WRF - cloud base height



Terra false colour



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Talk about:

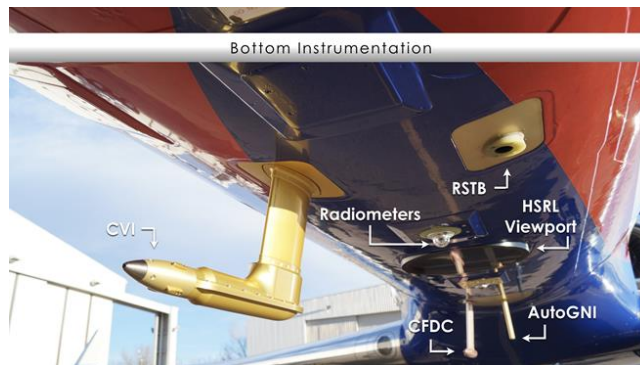
1. SO clouds (10 Mins):
 - i. Unique characteristics
 - ii. NWP and GCM errors

2. **A field campaign to improve understanding:**
 - i. **SOCRATES (10 Mins)**
 - ii. **Flight planning support**



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NSF/NCAR Gulfstream-V High-performance Instrumented Airborne Platform for Environmental Research (GV HIAPER)



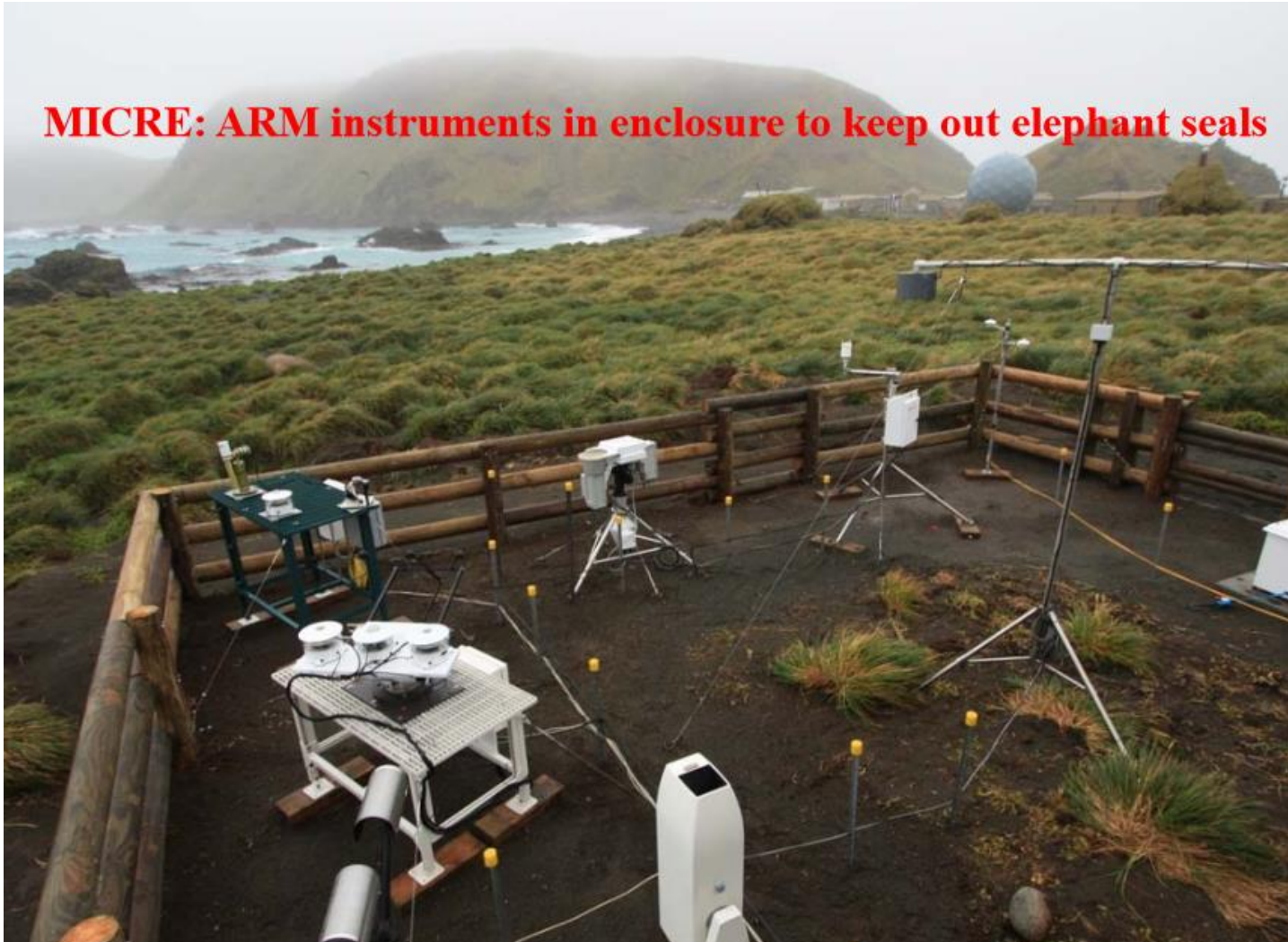


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Macquarie Island Clouds and Radiation Experiment 'MICRE'

MICRE: ARM instruments in enclosure to keep out elephant seals





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RSV Aurora Australis

MARCUS

Measurements of Aerosols, Radiation, and Clouds over the Southern Ocean



Top/bottom
Images courtesy
of Doug Thost



Image Scott Carpentier



Image courtesy of Doug Thost

OceanRAIN Disdrometer (Univ. Hamburg)

Surface Energy Flux Package

(MNF/Melb. Uni)



2-channel MWR

(Univ. Utah)

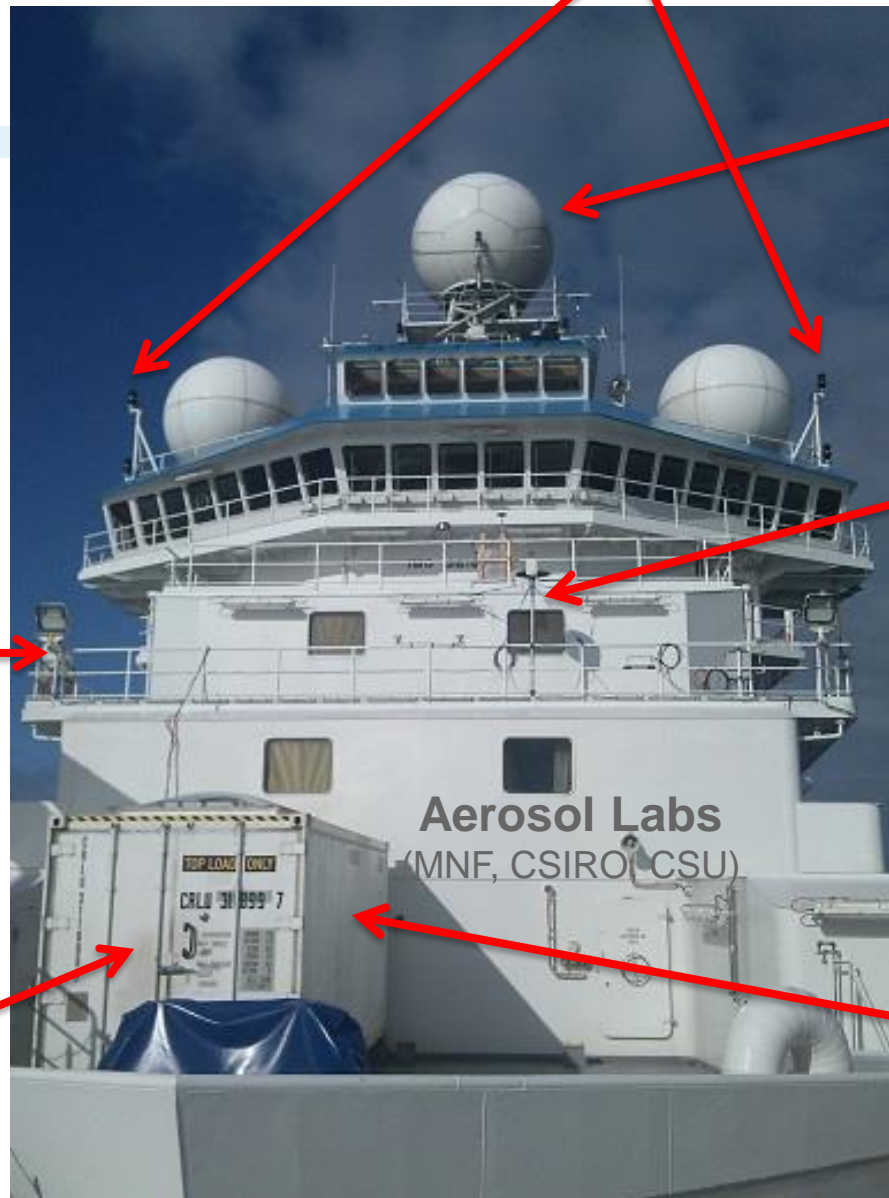


Cloud radar



Downwelling Radiation

(MNF)

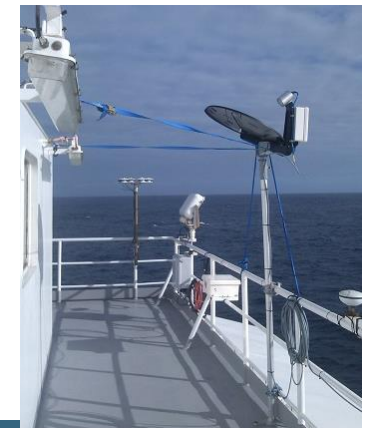


**Dual-Pol C-band
Doppler radar**

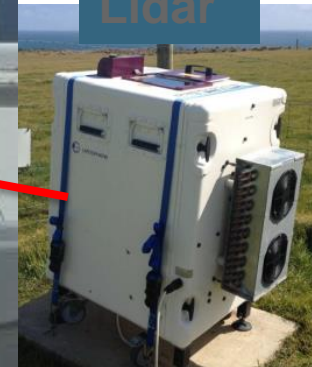
(MNF)

Micro rain radar

(Duke Uni. / NASA)



Lidar



Aerosol Labs

(MNF, CSIRO, CSU)



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Talk about:

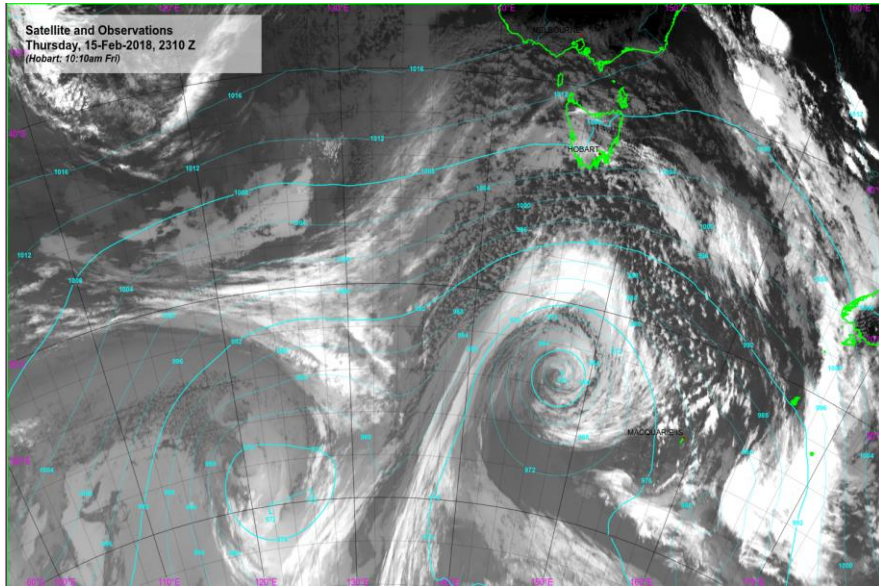
1. SH clouds at high latitudes (10 Mins):
 - i. Unique characteristics
 - ii. NWP and GCM errors

2. A field campaign to improve understanding (10 Mins)
 - i. SOCRATES
 - ii. **Flight planning support**

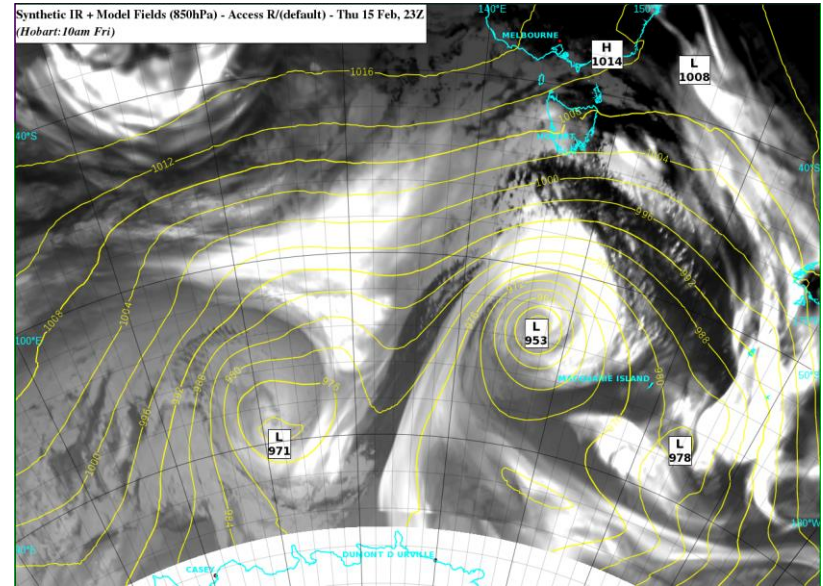


Flight Planning

Particular focus on cold sectors of cyclones



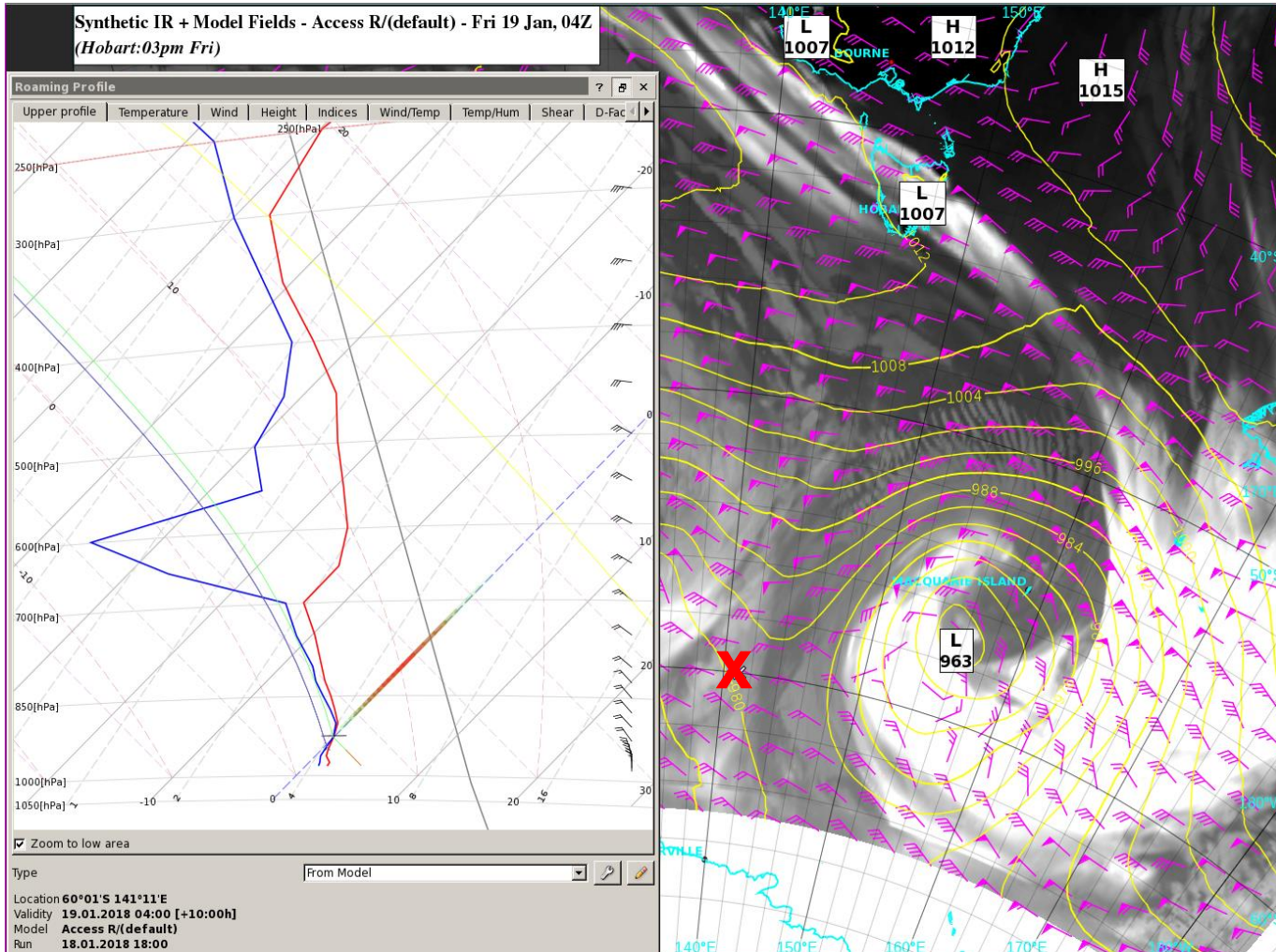
Himarawi IR
15 Feb 2018 2310UTC



Access R Synthetic Cloud IR
15 Feb 2018 2300UTC (12UTC, 15 Feb run)



Flight Planning model Skew T/Log P

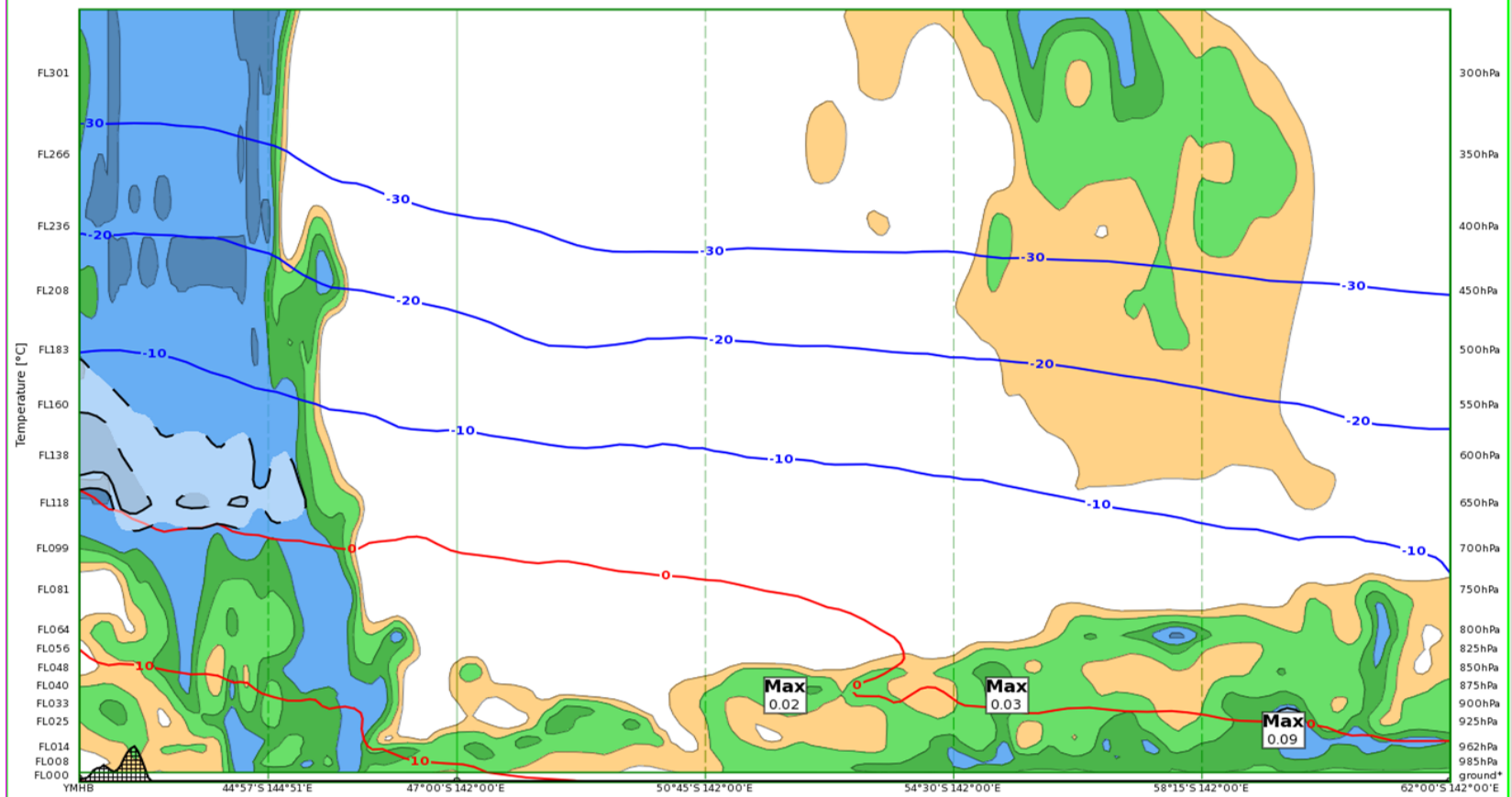




Model output Rel-Hum, T and LWC

Icing Probability Cross-Section

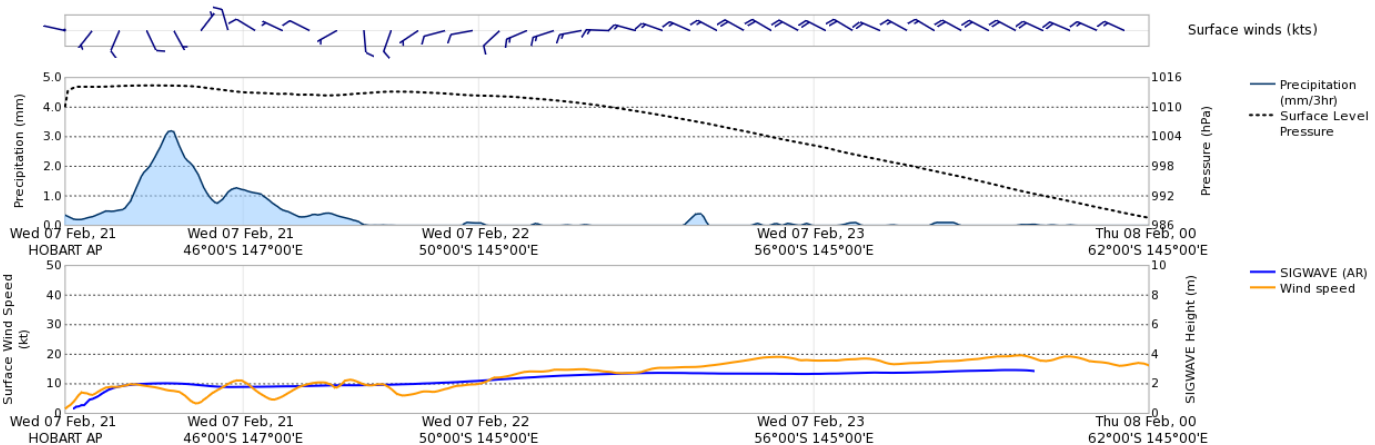
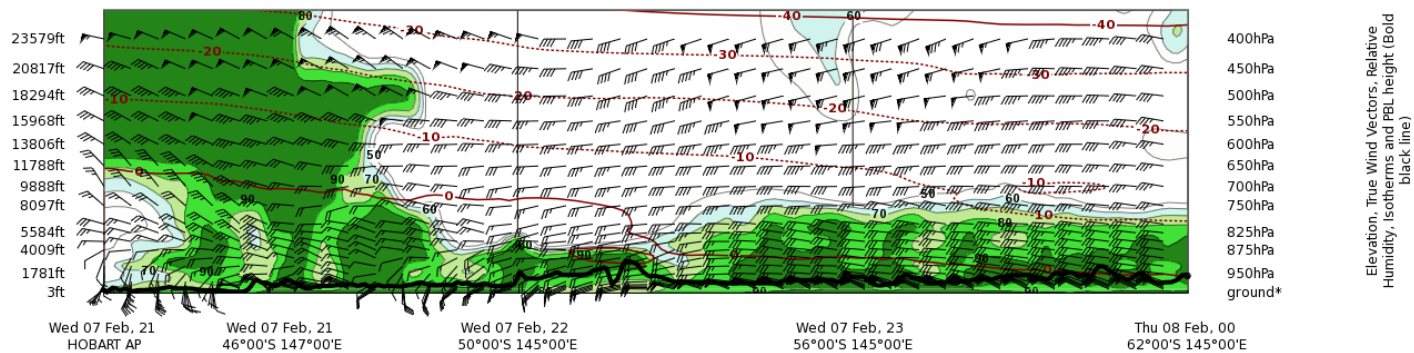
Flight Route: HOBART AP - 62°00'S 142°00'E
Validity: 08.02.2018 03:00





Model output: route x-sections wind, rel-Hum, SLP, precip, waves

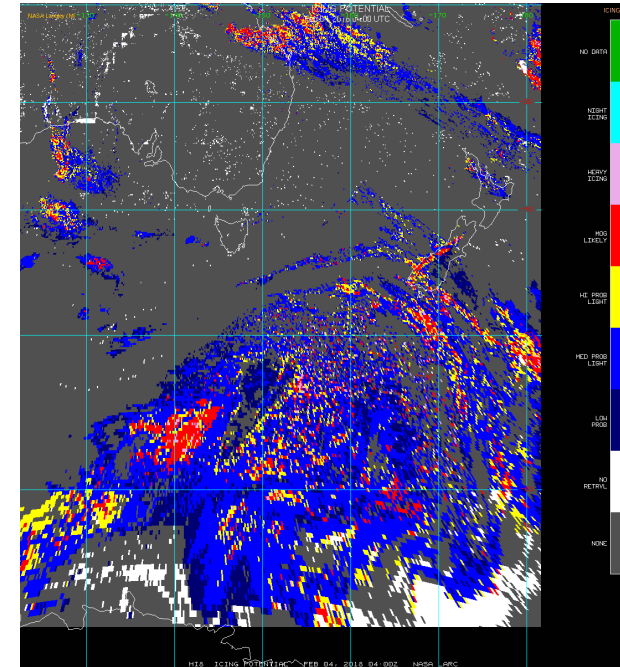
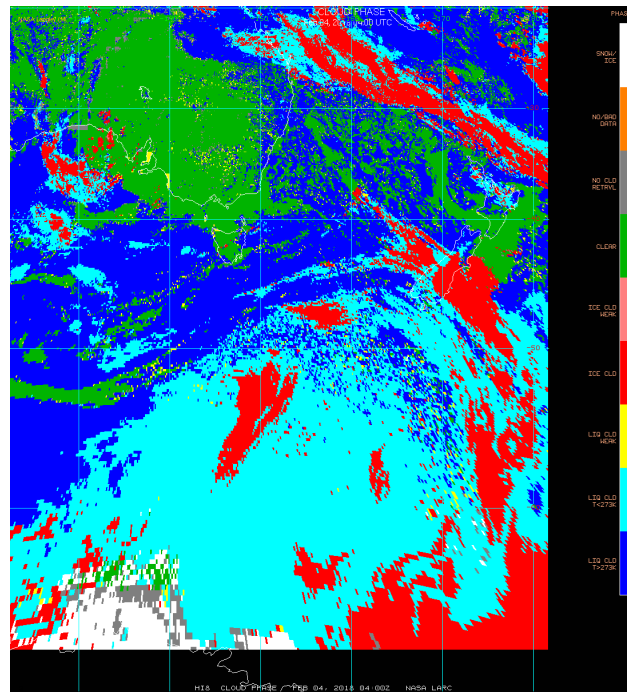
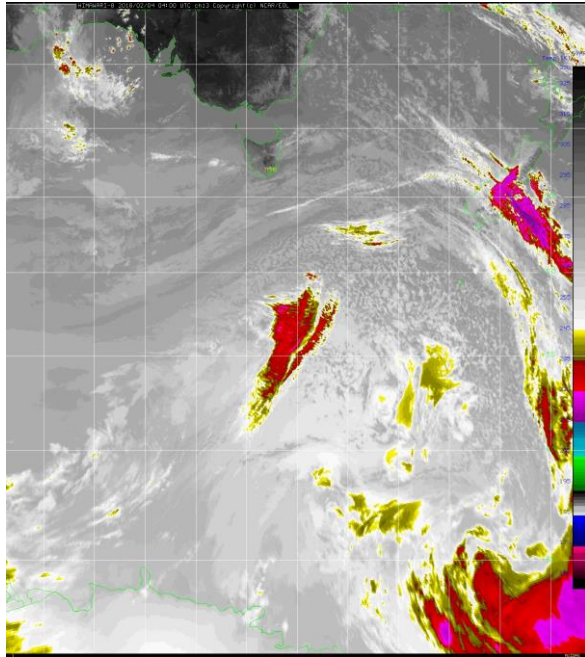
HOBART AP - 62°00'S 145°00'E Flight Forecast
Model: Access R/(default)
Validity: Wednesday 07 February 2100UTC - Thursday 08 February 0000UTC





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Bureau and NASA LaRC Himawari 8 Products

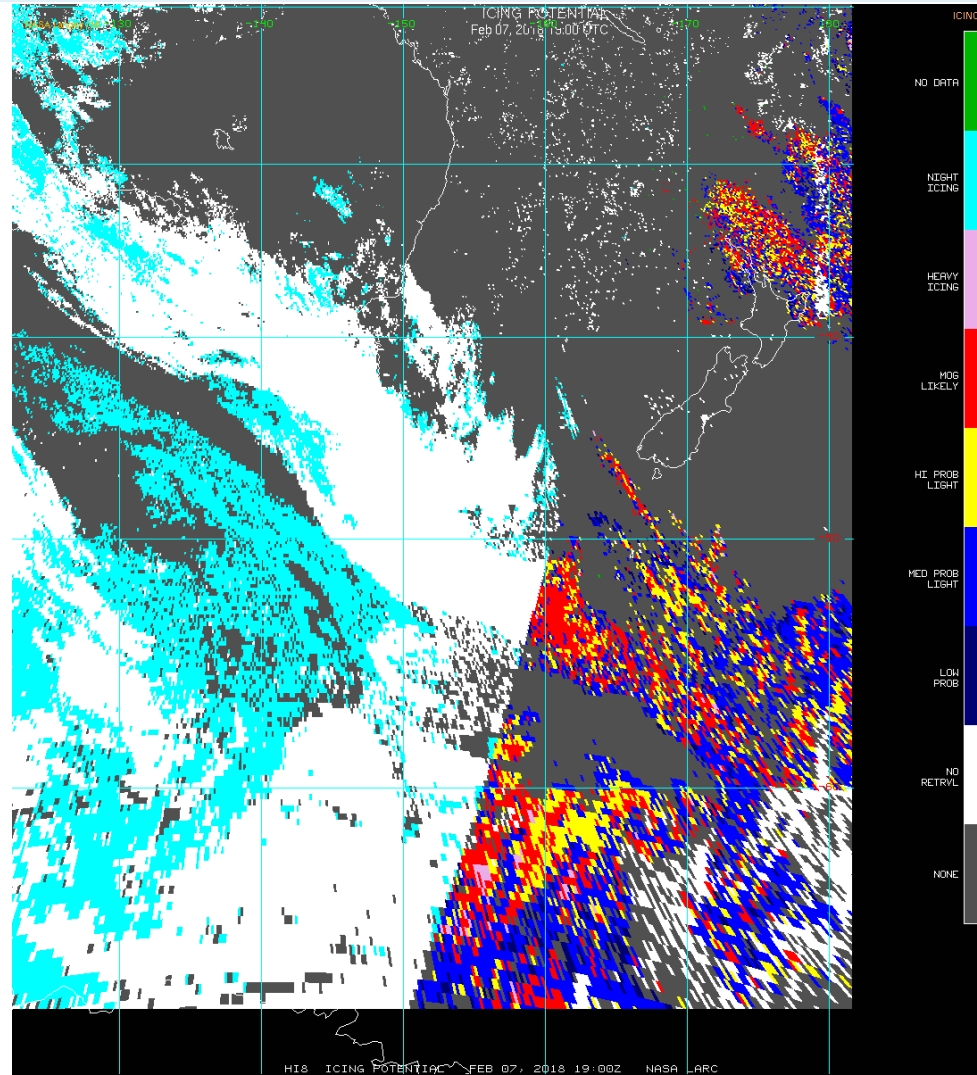




Australian Government

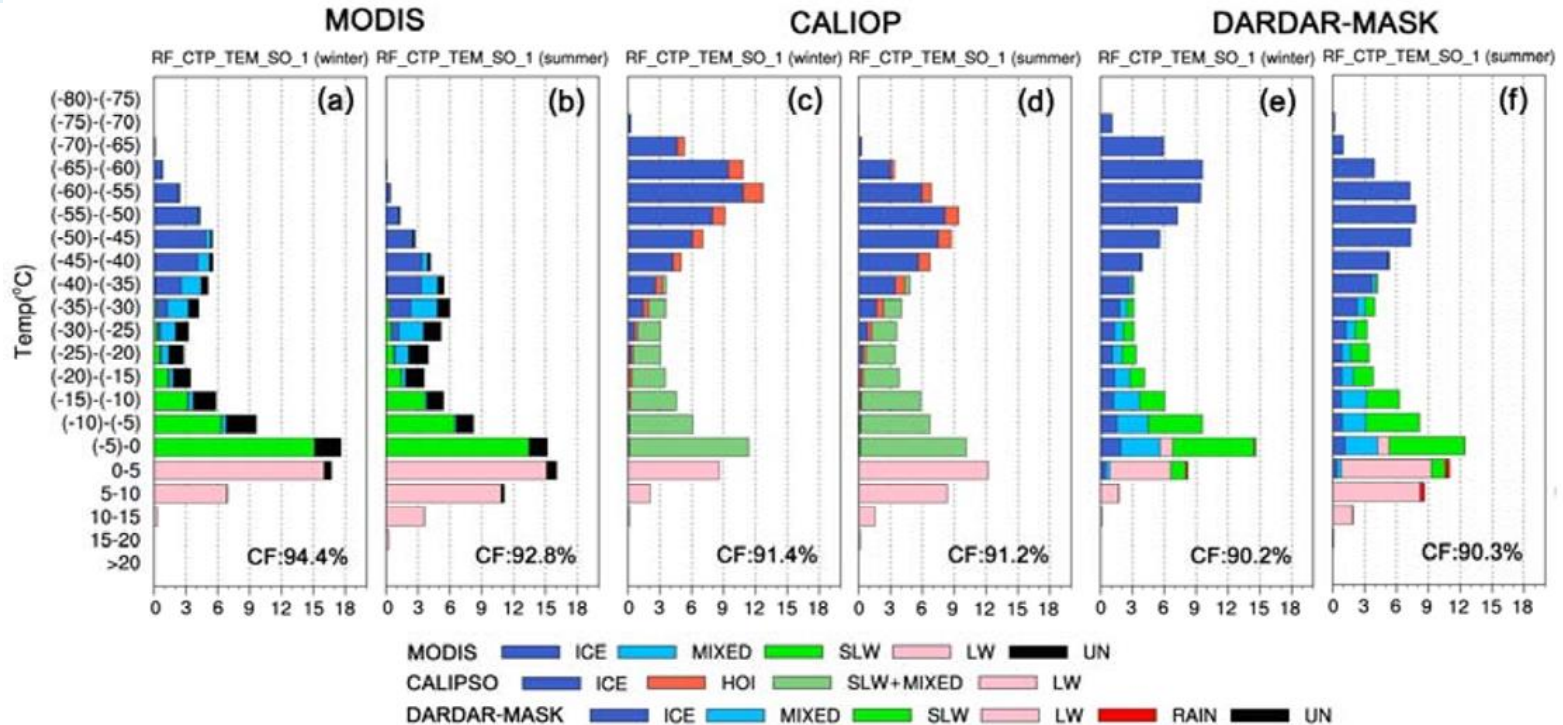
Bureau of Meteorology

Limitations of diagnostics





Limitations of Satellite products



- Vertical distribution of cloud top phase retrieved from MODIS operations product (Platnick et al. 2003), CALIOP (Hu et al. 2010) and DARDAR algorithm (Delanoë and Hogan 2010). The operational MODIS retrieval shows less high cloud and a warm bias (expected) with much less SLW below -20°C and a lot of “uncertain”. CALIPSO does not distinguish between SLW and Mixed Phase, while DARDAR records considerable glaciation (ice-only) at cloud-top between 0 and -30 °C, which is not reported by either CALIPSO or MODIS. From Huang et al (2014b).



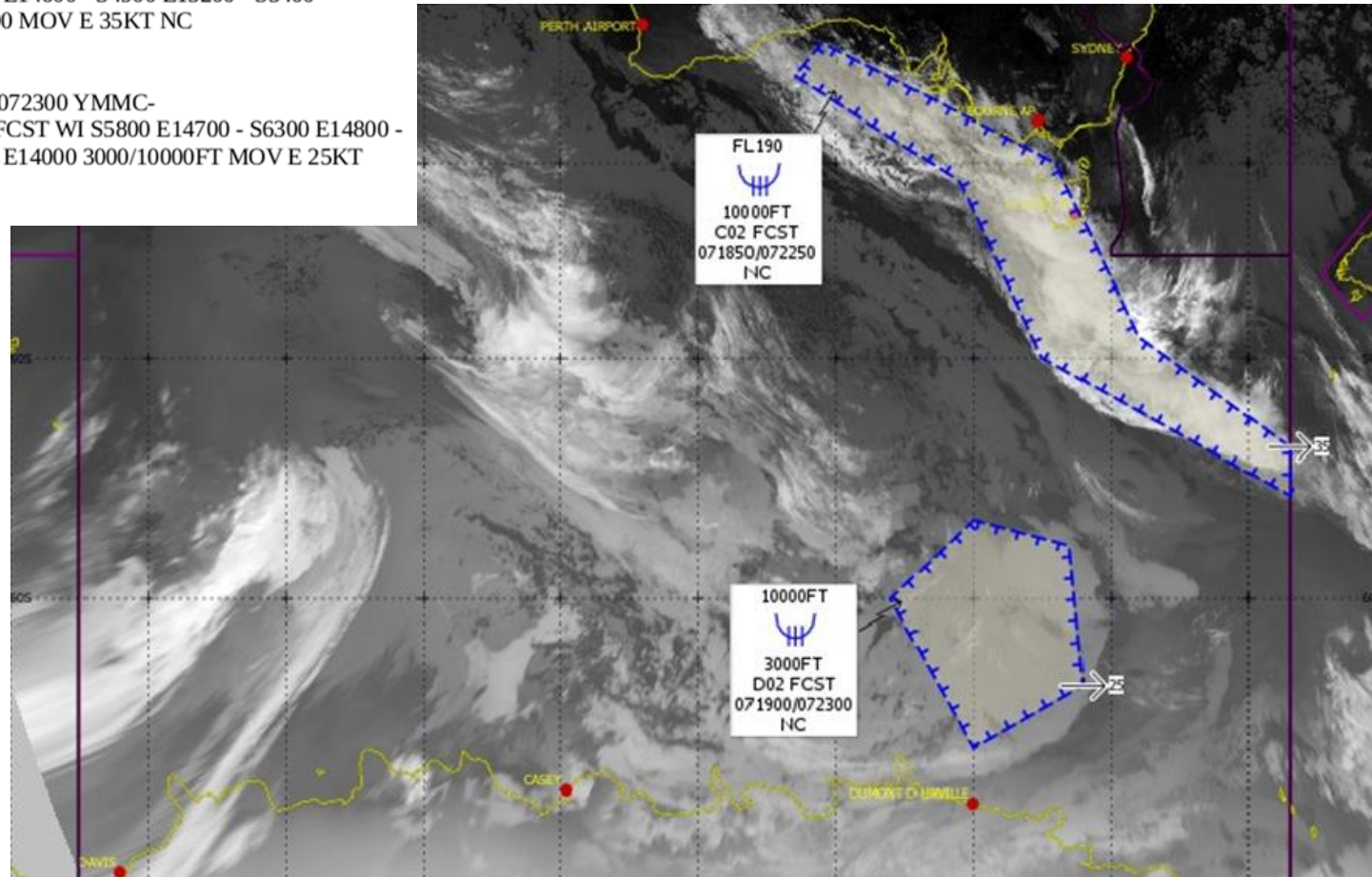
Australian Government

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SIGMET

YMMM SIGMET C02 VALID 071850/072250 YMMC-
YMMM MELBOURNE FIR SEV ICE FCST WI S5000 E14500 - S4100 E13900 -
S3500 E12700 - S3300 E12900 - S4000 E14600 - S4900 E15200 - S5400
E16300 - S5600 E16300 10000FT/FL190 MOV E 35KT NC
RMK: MM=

YMMM SIGMET D02 VALID 071900/072300 YMMC-
YMMM MELBOURNE FIR SEV ICE FCST WI S5800 E14700 - S6300 E14800 -
S6500 E14000 - S6000 E13400 - S5700 E14000 3000/10000FT MOV E 25KT
NC
RMK: ME=

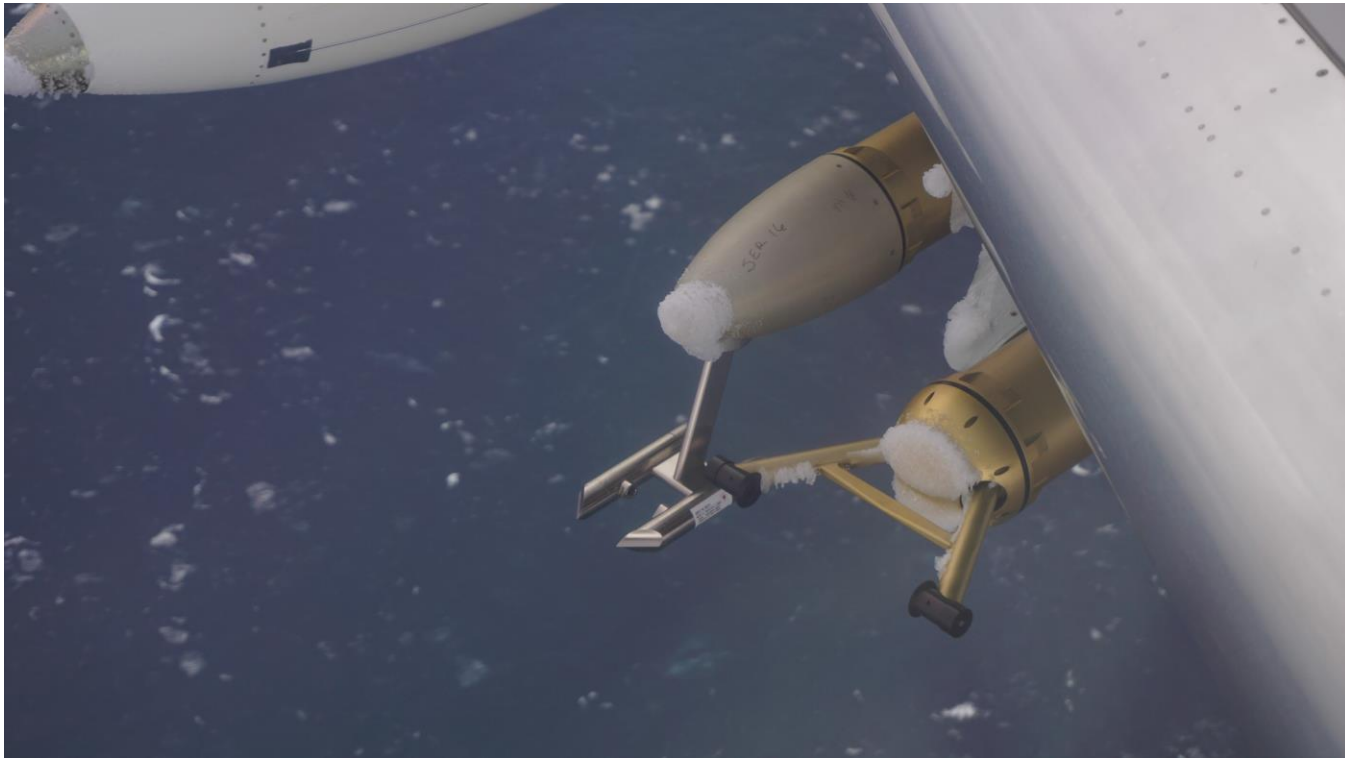




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Some significant icing encountered in Strato-Cumulus



Icing on the instruments

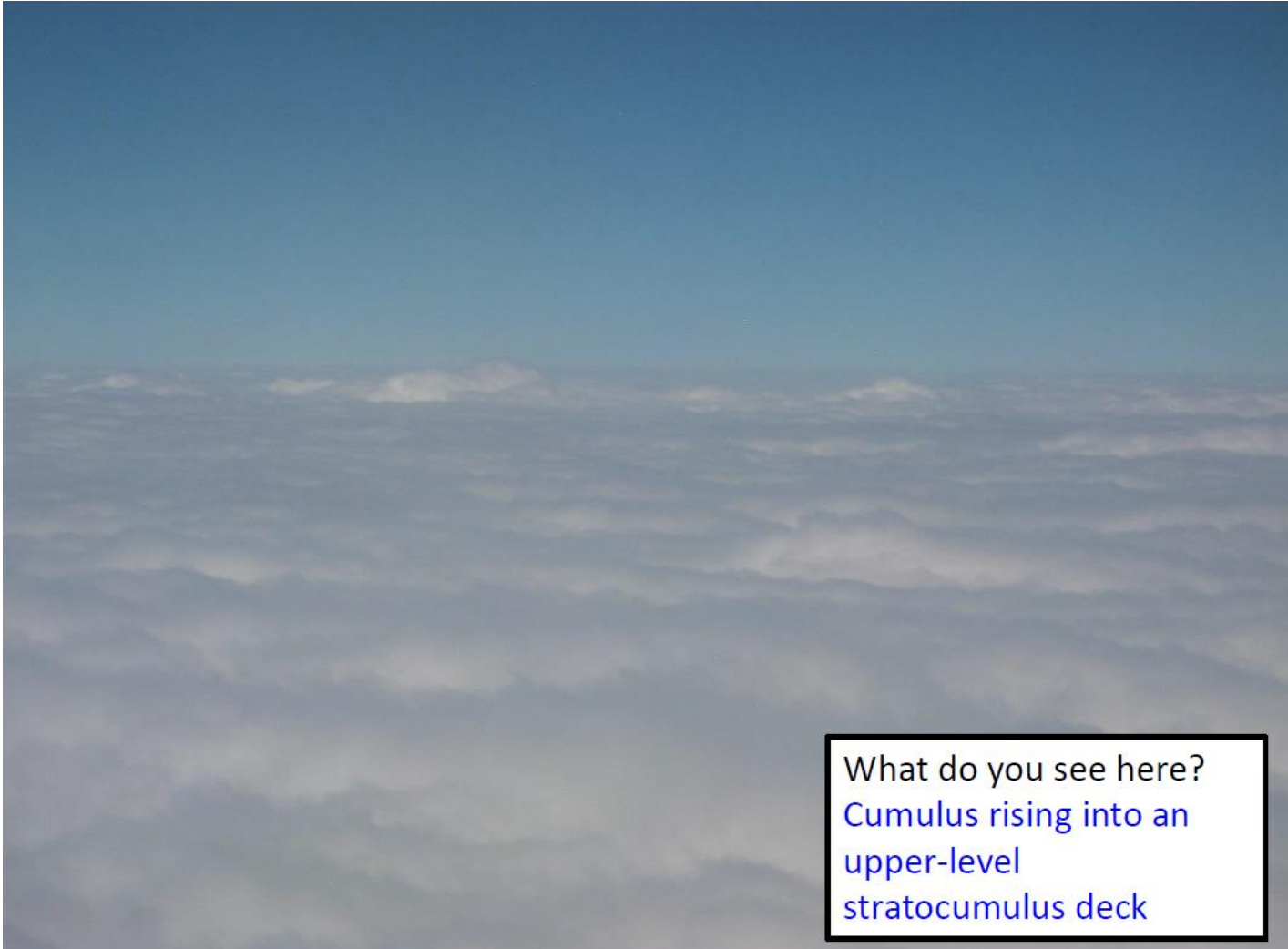
Looking out the right side of the GV at 0419 UTC, minutes after aborting a 10-min in-cloud leg and descending to lower altitude.



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RF09 – Digital Camera



What do you see here?
Cumulus rising into an
upper-level
stratocumulus deck



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Bureau of Meteorology

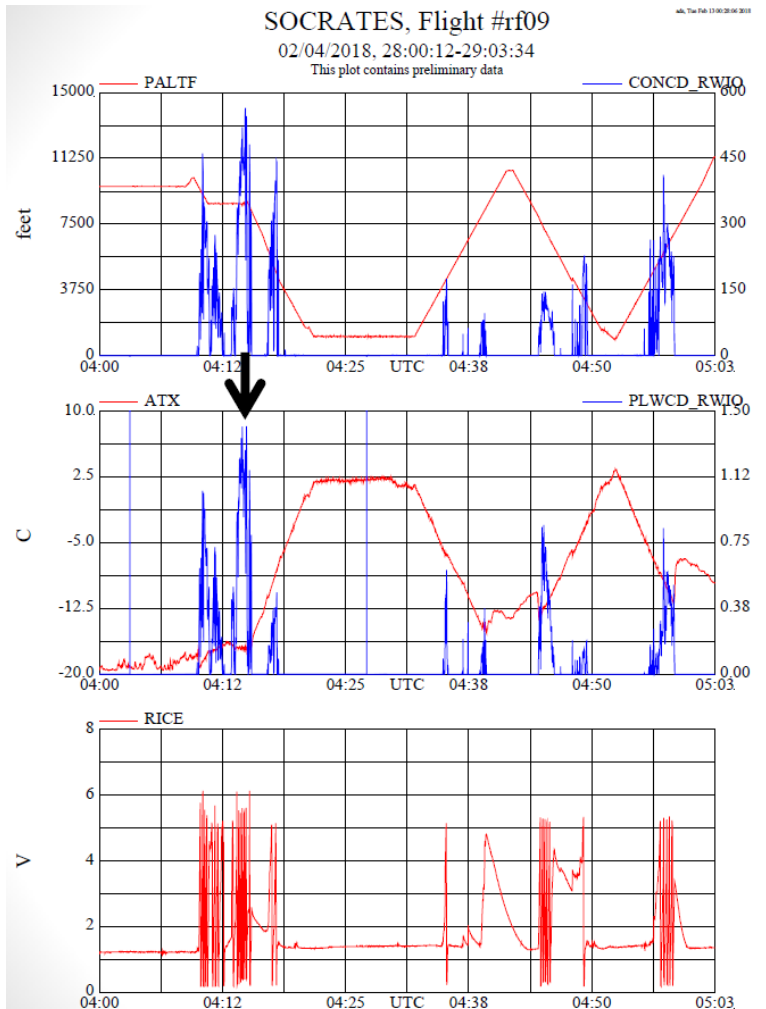
Convection feeding moisture



Cumulus rising into an upper-level stratocumulus deck



RF09- Aircraft Observations



2. BoM SIGMETs for icing during SOCRATES

RF09, 4 Feb.:
No icing SIGMET.

Deeper (below 10000 ft)
cold-air outbreak Cu rising
into SrCu.

-18C cloud top temperature.

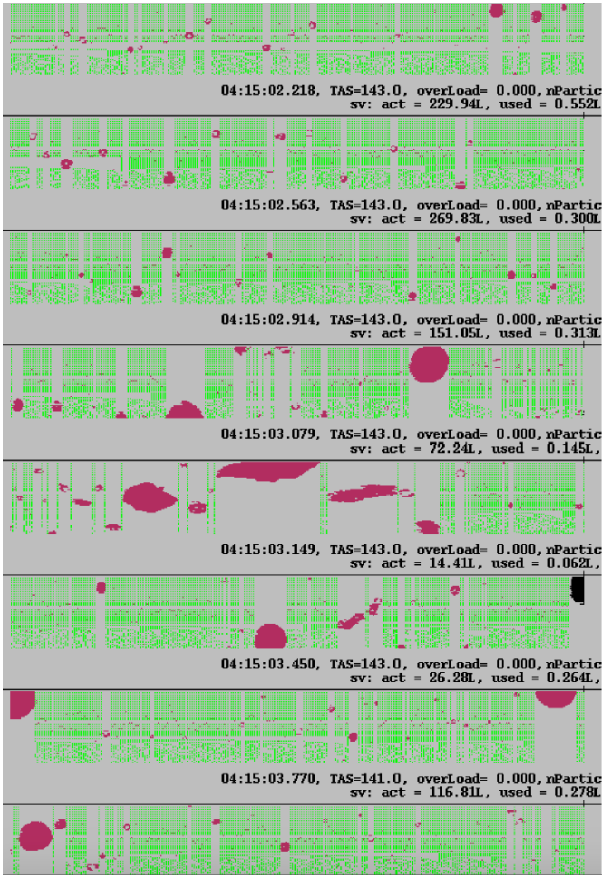
Sustained higher LWC (~1.0
g/m³).

RICE triggers repeatedly.

Some ice buildup on aircraft
instrumentation.



RF09 – Droplet sizes



Scale:
1.6 mm

RF09, 4 Feb.:
No icing SIGMET.

Deeper (below 10000 ft)
cold-air outbreak Cu rising
into SrCu.

-18C cloud top temperature.

Sustained higher LWC (~1.0
g/m³) for about a minute.

RICE triggers repeatedly.

Some ice buildup on aircraft
instrumentation.

American Aviation categorisation
for Icing threat

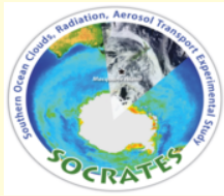
- Freezing Drizzle (FZDZ) with Dmax 100-500 µm
- Freezing Rain (FZRA) with Dmax > 500 µm



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Campaign Datasets at

http://data.eol.ucar.edu/master_list/?project=SOCRATES



DATA BY CATEGORY

- Accompanying Archives
- Aerosols
- Aircraft
- Chemistry
- GIS
- Land Based
- Model
- Oceanography
- Photography
- Radar
- Radiation
- Satellite
- Ship Based
- Upper Air

[Back to SOCRATES](#)

Email comments & questions to
eol-datahelp@ucar.edu

Photography	
Forward-Looking_Digital_Camera_Imagery.[(NCAR/EOL)]	New 2018-03-09
Left-Looking_Digital_Camera_Imagery.[(NCAR/EOL)]	New 2018-03-09
MARCUS RSV Aurora Australis Total Sky Imager Data	New 2018-03-12
R/V Investigator ISS Sky Camera Data [(NCAR/EOL)]	
Right-Looking_Digital_Camera_Imagery.[(NCAR/EOL)]	New 2018-03-09
Radar	
MARCUS RSV Aurora Australis Marine W-Band (95 GHz) ARM Cloud Radar Data	New 2018-03-12
Preliminary_GV-HIAPER Cloud Radar (HCR) moments data, 10Hz in cfradial format [(NCAR/EOL)]	Preliminary New 2018-04-12
Preliminary_GV-HIAPER Cloud Radar (HCR) time series data [(NCAR/EOL)]	Preliminary New 2018-04-12
R/V Investigator 95 GHz Cloud Radar Data [(BoM)]	
R/V Investigator Dual-pol C-band Doppler Radar Data [(MNF/BoM)]	
R/V Investigator Micro rain radar data	
Radiation	
MICRE GRDRAD (Ground Radiometers) Data	
MICRE Multifilter Rotating Shadowband Radiometer (MFRSR) Data	



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Can I use this data?

"... EOL commits to the following:

- ...Timely release of quality-controlled EOL data and associated metadata and documentation.*
- Full and open data sharing of all EOL data with the scientific community and public."*

Refer: <https://www.eol.ucar.edu/content/eol-data-policy>



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acknowledgments

The operational, technical and scientific support provided by NCAR's Earth Observing Laboratory, sponsored by the National Science Foundation.

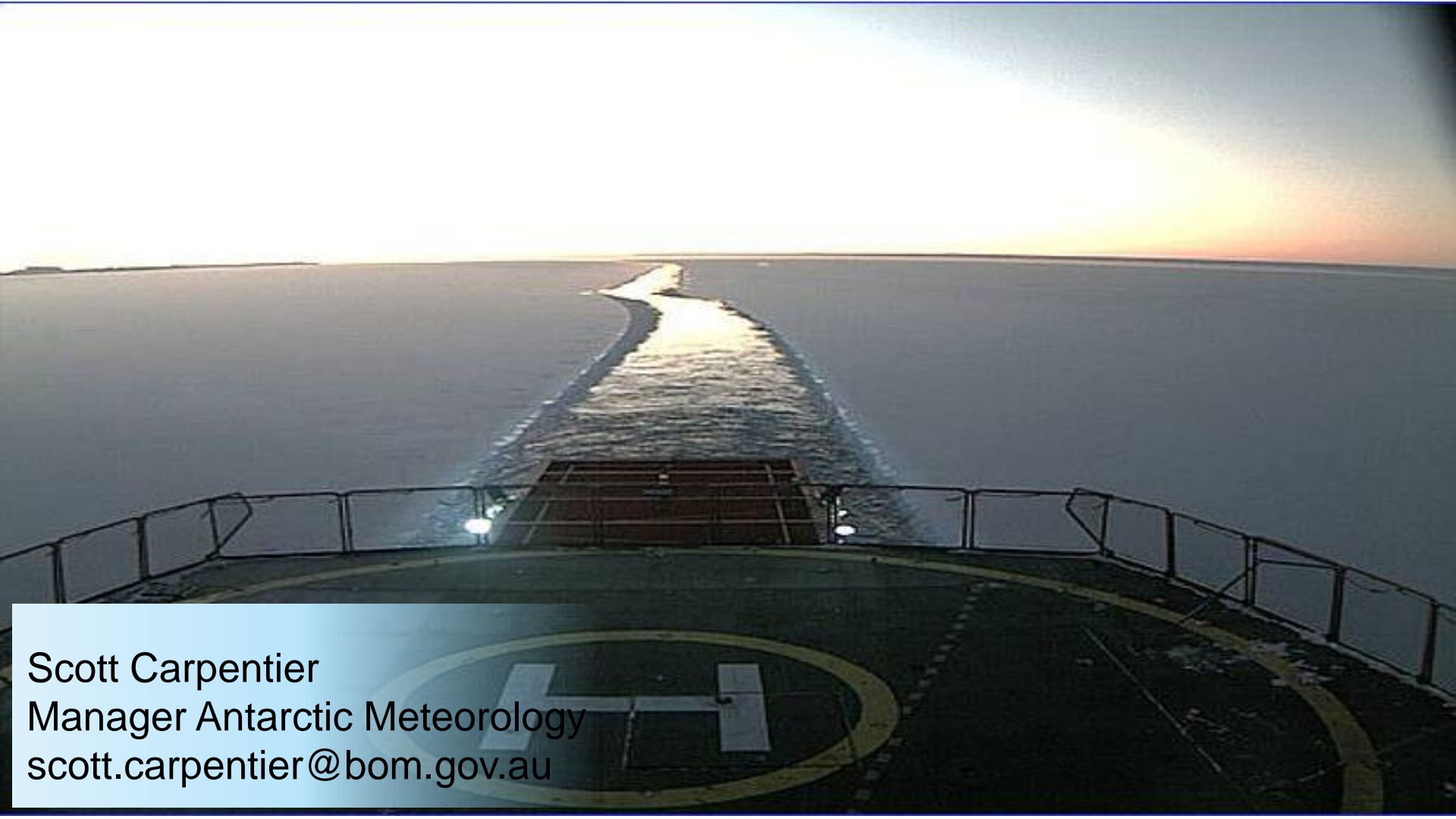
- The **CAPRICORN** project (2015-2018): *R/V Investigator* over the Southern Ocean. Clouds, aerosols, precipitation, surface energy fluxes, atmospheric composition. Process studies and statistical properties. Lead A. Protat (BOM)
- The AAD **ACRE** and US ARM **MICRE** projects (2016-2018): Two years of continuous ground-based observations at Macquarie Island (54S). High-quality measurements at a single point. Focus is intraseasonal and interannual variability. Leads Roj Marchand (U. Washington), S. Alexander (AAD), A. Protat (BOM).
- The ARM **MARCUS** project (2017-2018): AAD Aurora Australis resupply voyages with ARM Mobile Facility (2 containers). Add to ACRE and CAPRICORN statistics, extend statistics further South. Lead G. Mc Farquhar (Univ. Illinois) with Australian contributions from BOM and AAD.
- The **SOCRATES** international experiment (Jan- Feb 2018): NCAR G-V aircraft (US NSF funded) coordinated with the 2018 CAPRICORN RV Investigator voyage (MNF granted). Aircraft in-situ and remote sensing measurements of cloud – aerosol interactions on transects. Leads G. Mc Farquhar (NCAR G-V), A. Protat (CAPRICORN)



Australian Government

Bureau of Meteorology

Thank You



Scott Carpentier
Manager Antarctic Meteorology
scott.carpentier@bom.gov.au



Australian Government
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NSF/NCAR Gulfstream-V High-performance Instrumented Airborne Platform for Environmental Research (GV HIAPER)



Instrument Acronym	Instrument Name	Measurement
2DS	Two-Dimensional Stereo probe	Two-dimensional images of cloud and precipitation particles from 10-1280 μm
Ballast	--	A non-operational pod that mirrors the weight and aerodynamics properties of the opposite side wing store
Gust Pod	All Weather Wind Gust Pod	3-D wind in all conditions and provides aircraft position, attitude, ground speed, aircraft attack angle (AKRD), Solid State Recording Device (SSRD), and aircraft true air speed (TASX)
King Probe	King (CSIRO) Liquid Water Sensor	Cloud liquid water content
PHIPS	Particle Habit Imager and Polar Nephelometer	Simultaneously images a cloud particle and measures its angular scattering phase function
UHSAS	Ultra-High Sensitivity Aerosol Spectrometer	Concentration and size distribution of aerosol particles having diameters from 0.060 --1.0 μm



Left Wing Instruments



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NSF/NCAR Gulfstream-V High-performance Instrumented Airborne Platform for Environmental Research (GV HIAPER)



Instrument Acronym	Instrument Name	Measurement
2DC-25	Two-Dimensional Optical Array Cloud Probe	Two-dimensional images of hydrometeors from 25-1560 μm
CDP	Cloud Droplet Probe	Cloud droplet size distribution and various measurements derived from that size distribution from 1-50 μm
CLH-2	University of Colorado Closed-path Laser Hygrometer, v2	“Total water”, the sum of water vapor and particulate water, water vapor resulting from the evaporation of cloud particles
Forward Camera	Forward Camera	Provides imagery of the scene ahead of aircraft. Image resolution is 1024x768, with a 62° (horizontal) x 48° (vertical) field of view
HCR	HIAPER Cloud Radar	Radar W-band reflectivity factor and radial velocity of hydrometeors
PIP	Precipitation Imaging Probe	Quantity and images of precipitation sized particles from 100 microns to 6.4 mm in size
RICE	Rosemount Icing Detector	Presence of supercooled water; also a rough measurement of the quantity



Right Wing Instruments



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Bureau of Meteorology

NSF/NCAR Gulfstream-V High-performance Instrumented Airborne Platform for Environmental Research (GV HIAPER)



Instrument Acronym	Instrument Name	Measurement
<u>CCN</u>	Cloud Condensation Nuclei Counter	Spectrum of cloud condensation nuclei concentration
<u>CN</u>	Condensation Nucleus Counter	Total ambient concentration of aerosol particles larger than the threshold size for the instrument, typically about 11 nm diameter (6 nm for the water-based counter); dependent on flight conditions
<u>IR radiometer</u>	Infrared radiometer	Infrared radiation
<u>VCSEL</u>	Vertical Cavity Surface-Emitting Laser Hygrometer	Water vapor concentration and related derived values (mixing ratio, dew point, etc.)



Top Instrumentation

Top Instruments

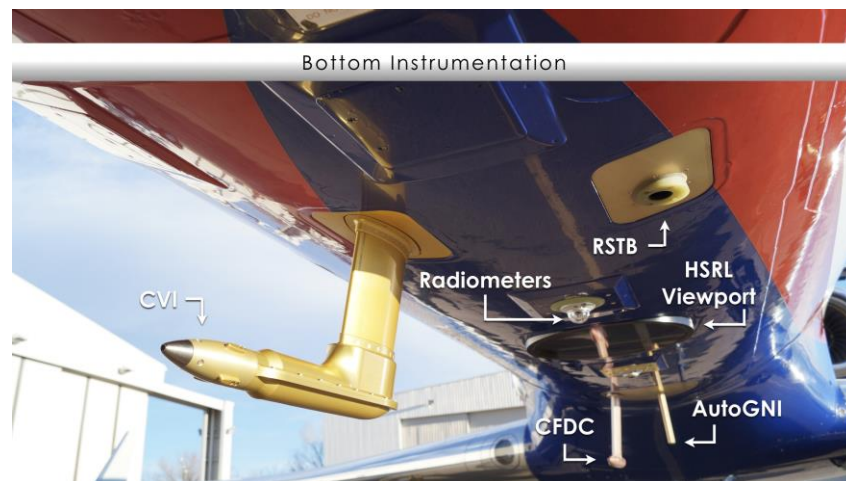


Australian Government
Bureau of Meteorology

NSF/NCAR Gulfstream-V High-performance Instrumented Airborne Platform for Environmental Research (GV HIAPER)



Instrument Acronym	Instrument Name	Measurement
<u>CFDC</u>	Continuous Flow Diffusion Chambers	Particle size distribution
<u>CVI</u>	Counterflow Virtual Impactor	Cloud particle concentration, condensate mass, water vapor (for isotopic analysis) and aerosol particle residuals
<u>AutoGNI</u>	Giant Nuclei Impactor	Giant aerosol particles
<u>HSRL</u> (Viewport)	High Spectral Resolution Lidar	Back scatter cross section, extinction and depolarization properties of atmospheric aerosols and clouds
<u>Radiometers</u>	Broadband Radiometers	Infrared (IR) and Visible spectrum
<u>RSTB</u>	Radiometric Surface Temperature	Terrestrial radiation
<u>AVAPS</u> (Dropsonde System)	Airborne Vertical Atmospheric Profiling System	High resolution vertical profiles of ambient temperature, pressure, humidity, wind speed and wind direction; dropsondes are ejected out of the back right side of the aircraft through a small pressurized port



Bottom Instruments