Observations of Clouds, Aerosols and Water Vapour using the CANDAC RMR Lidar

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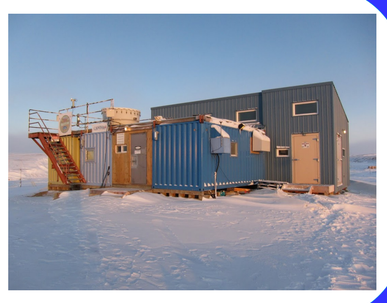


Overview

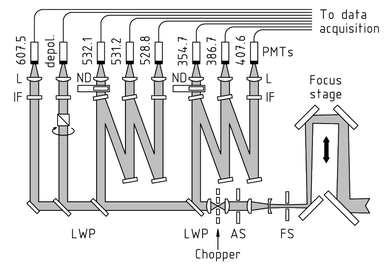
The CANDAC Rayleigh-Mie-Raman lidar (CRL) is located in Eureka, Nunavut (80N, 86W) at the Zero Point Altitude Laboratory (0PAL). During the 2011 winter measurement campaign, analogue counting channels were implemented allowing for a larger dynamic range of signal which helped to provide higher resolution aerosol backscatter coefficient measurements. A case extending from March 3 to 15 is shown below including aerosol and water vapour lidar measurements along with Microwave Humidity Sounder (MHS) measurements and FLEXPART trajectories.

CANDAC RMR Lidar

A) Transmitter
- 532 nm and 355 nm

B) Receiver
- eight wavelength dependent channels

C) Variable Aperture and Field Stops



March 3 - 15, 2011

Aerosols and Clouds:

During the first half of the measurement thick precipitating ice clouds are seen which encompass the entire Troposphere in the aerosol measurement. Before the clouds there was high aerosol loading at the same altitudes indicating the aerosols could have acted as cloud condensation nuclei. There is also highly stratified aerosol after the clouds exit.

Water Vapour:

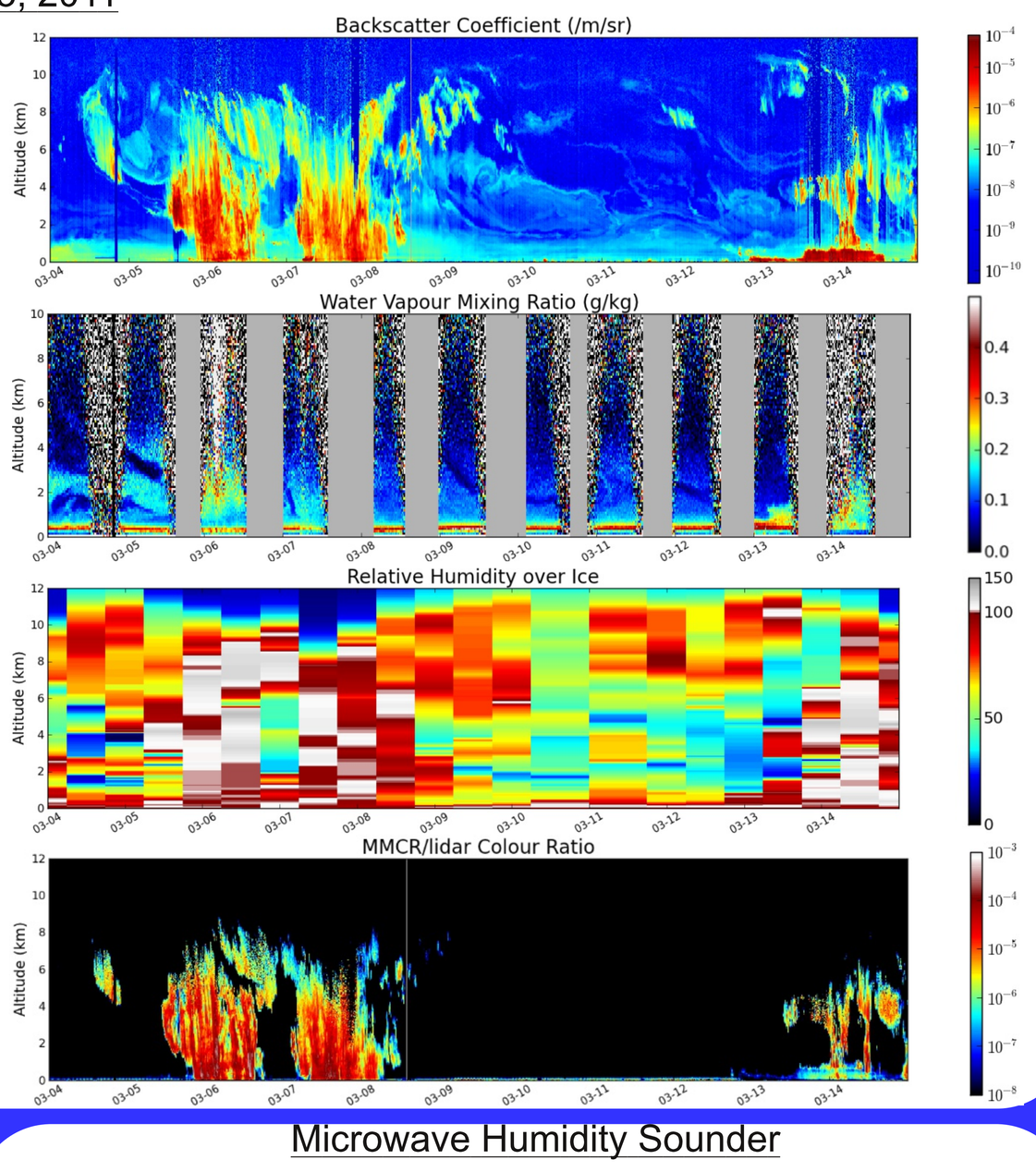
Water vapour measurements show a correlation between enhanced aerosol backscatter coefficient and water vapour mixing ratio before and after the cloud enters the measurement. In particular it can be seen that there is a small layer where the atmosphere is void of aerosol and water vapour which starts at 5 km before the cloud enters the measurement and down to 2 km afterwards.

Relative Humidity:

During the period where there are clouds extending through the troposphere the relative humidity over ice is over 100% for the column indicating there could be separate air masses feeding water vapour to the cloud at different altitudes.

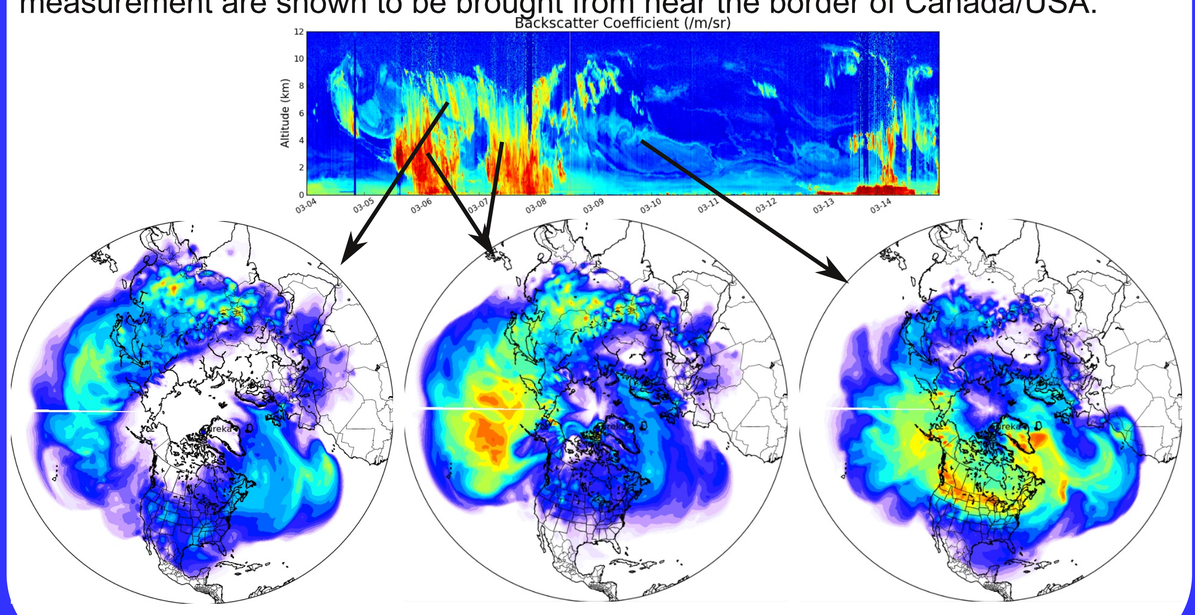
Cloud Particle Effective Radius:

Using the ratio of the Millimeter Cloud Rader (MMCR) and CRL 532 nm backscatter coefficients it is possible to find a quantity called the colour ratio which is a proxy for the size of the particles measured. The colour ratio shows the precipitation is predominantely the same size vertically indicating that the ice crystals are not evaporating with decreasing altitude. This gives more evidence that there could be multiple water vapour sources.



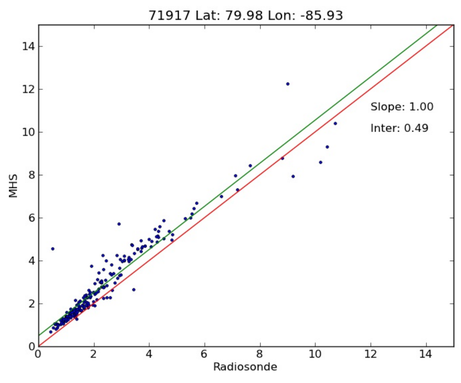
FLEXPART

FLEXPART is a Lagrangian backward/forward dispersion model that uses wind fields from ECMWF data. Back trajectories were modeled for different altitudes in the clouds and aerosols during the measurement. The plots shown are footprints which only show the locations that the parcel was near the surface. The top of the clouds predominately show two possible origins for the water vapour being the Pacific and Atlantic Oceans. It also shows a possible origin for aerosols in Eastern Eurasia which could be acting as CCN in the cloud. The footprints before the clouds (not shown) match the Eastern Eurasia trajectories. The lower altitudes within the cloud show water vapour being picked up predominately in the Pacific Ocean. The aerosols after the the clouds in the measurement are shown to be brought from near the border of Canada/USA.

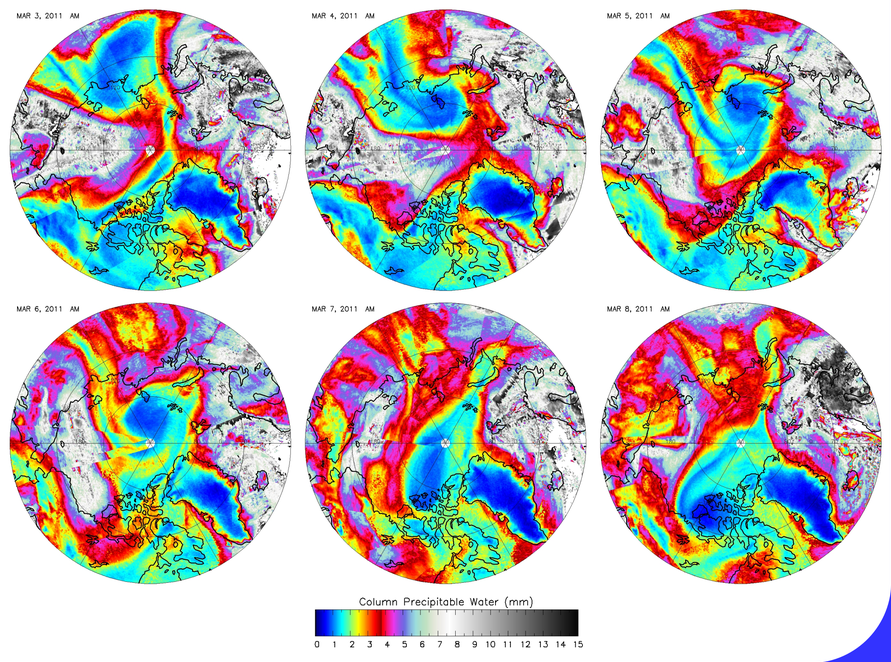


Microwave Humidity Sounder

The Microwave Humidity Sounder (MHS) is a satellite based instrument measuring the temperature at five different frequencies which can be applied to retrieve column water vapour. The technique used was derived from an AMSU-B retrieval for dry regions[1] which did not need assumptions of surface emissivity and is accurate for values up to 7 mm. The figure on the right compares radiosonde and MHS column water vapour at Eureka, Nunavut and shows fairly good correlation for the calibration used with the MHS data.



MHS retrievals from March 3 to March 8 show a water vapour intrusion over Eureka which corresponds to the same time the clouds are overtop. The water vapour appears to come from the Pacific Ocean which matches the FLEXPART results.



Future Work

-Look at infrared flux tower measurements to see the effects of the clouds and water vapour on the downward radiation

-Use Aerosol Mass Spectrometer measurements to find out the type of aerosols

-Look at vertical wind fields within the cloud to see if there is uplift

References

1) C. Melsheimer and G. Heygster, Improved Retrieval of Total Water Vapor Over Polar Regions From AMUS-B Microwave Radiometer Data, IEEE Transactions on Geoscience and Remote Sensing, Vol. 40, No. 8, 2008

Acknowledgements

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