Microwave radiometry developments at University of Toronto

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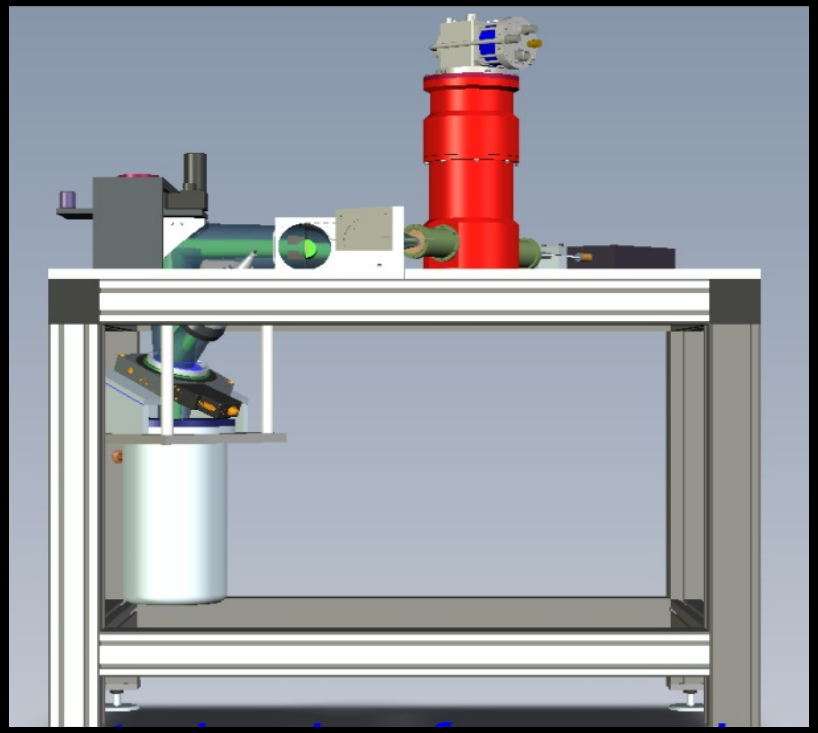
Outline

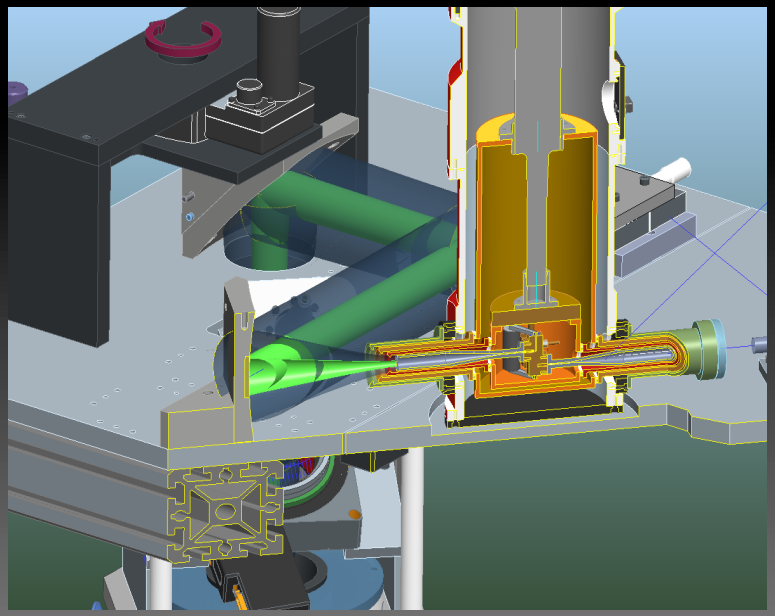
- Status of SPÉIR Instrument Development
- Testing of Retrieval Scheme with Kiruna Dataset

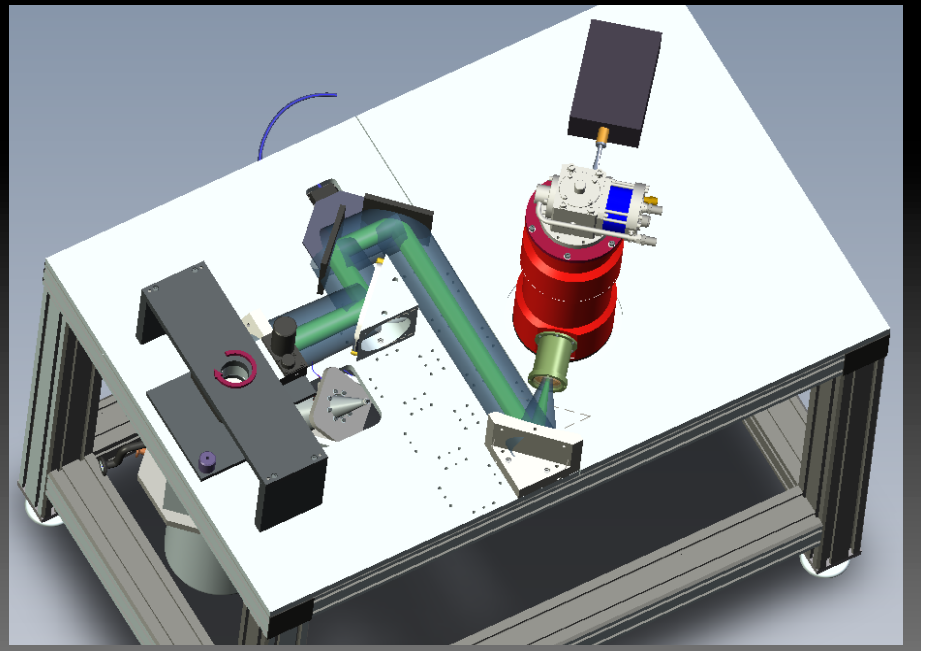
SPÉIR

- 260 – 280 GHz receiver (λ = 1 mm)
- Target species: O_3, ClO, HNO_3, N_2O
- Detector: SIS @ 4.2 K
- 1 GHz bandwidth / 1 MHz resolution (Fast Fourier Transform Spectrometer)
- Ultra-Gaussian horn antenna
- Calibration targets: Ambient and LN_2 cones
- New post detection sideband rejection enhancement (next gen. FFTS)

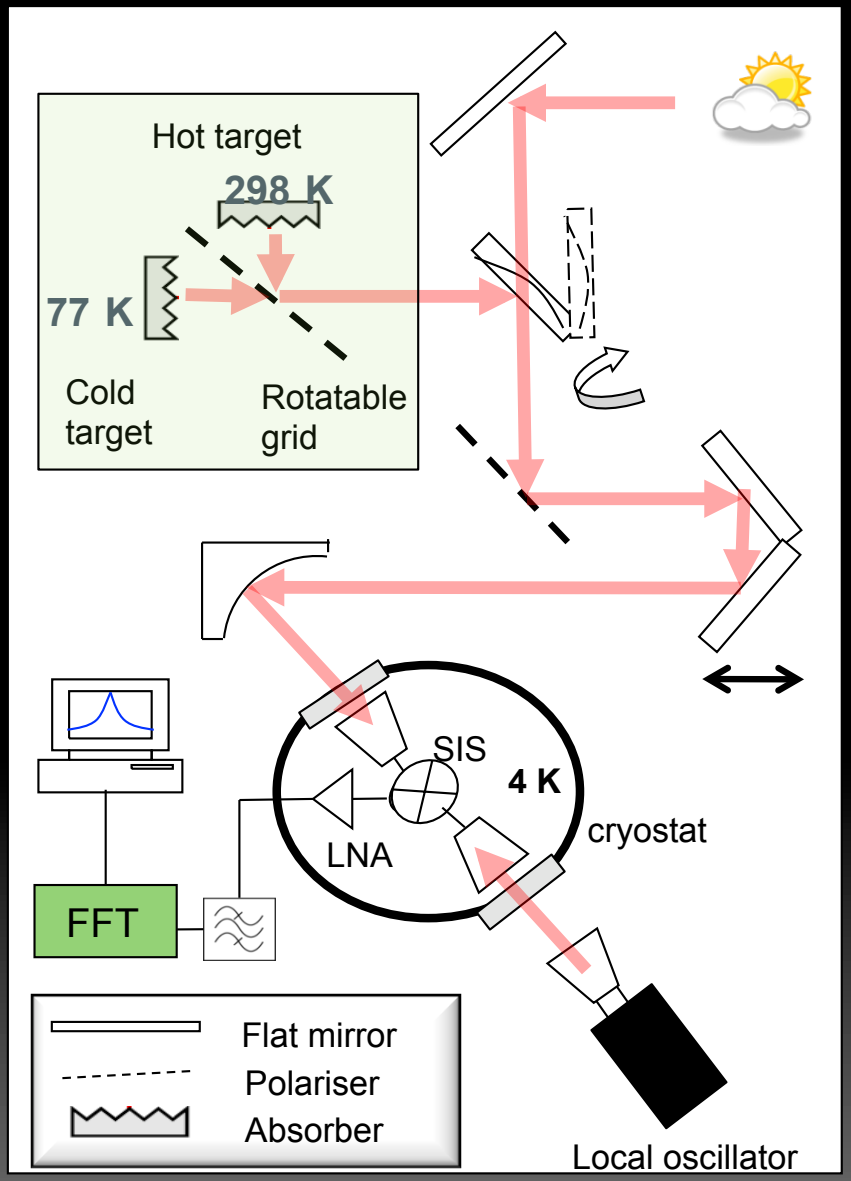


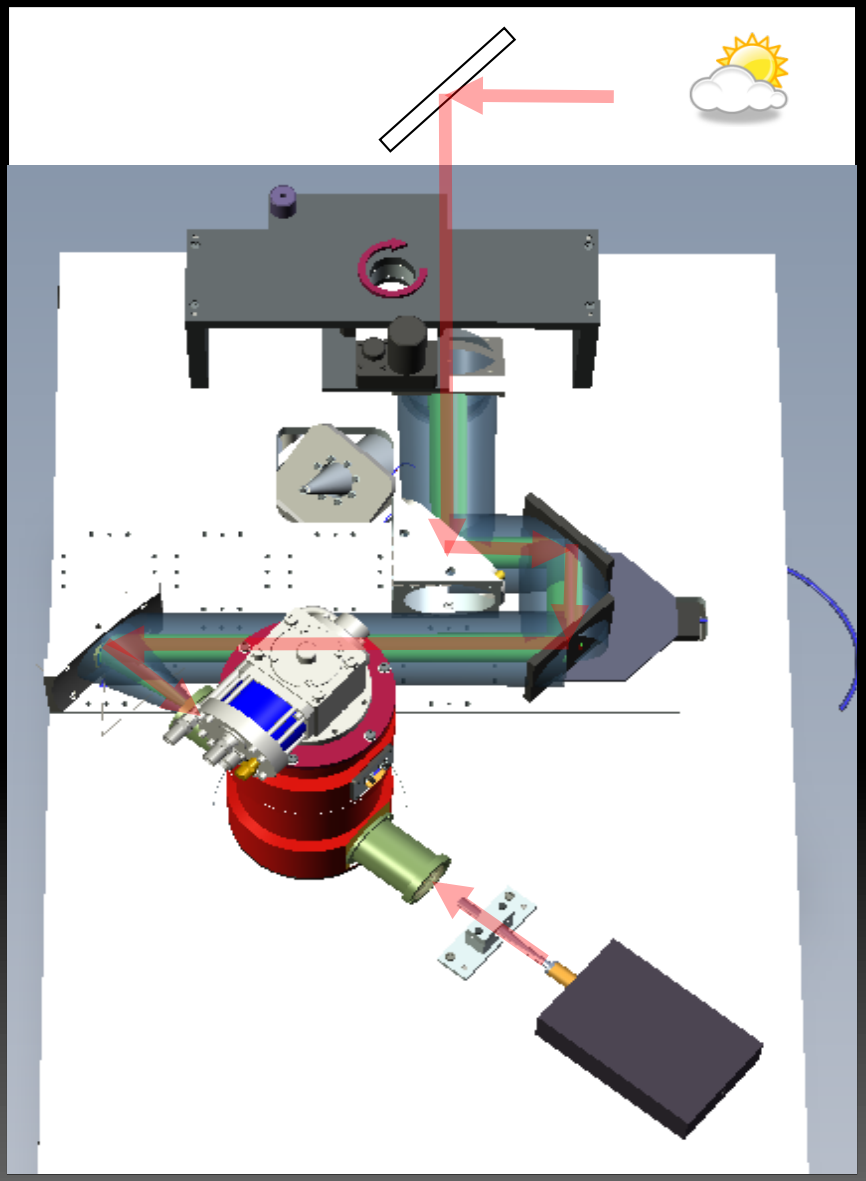
Goal: make the first continuous measurements of ClO in Canada





SPÉIR

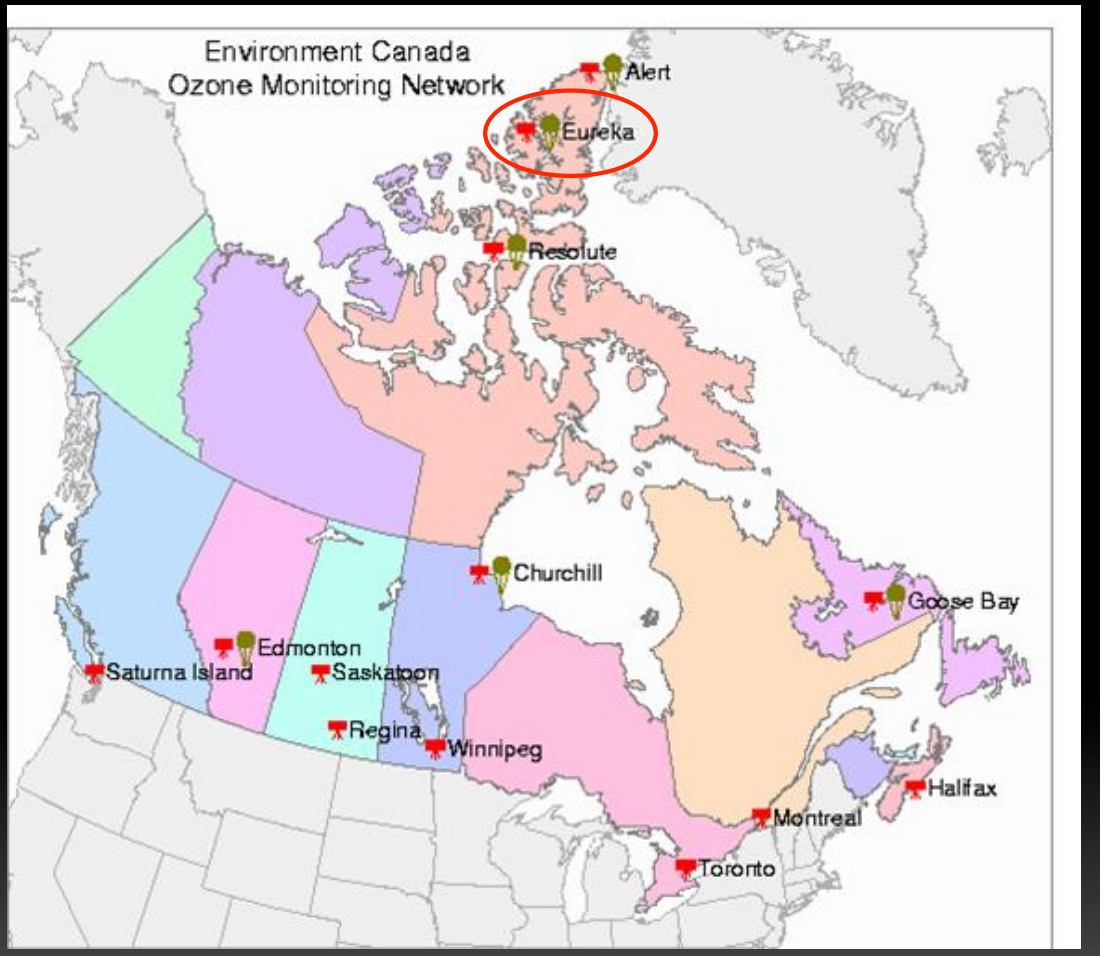

Hot target
298 K
77 K
Cold target
Rotatable grid
SIS
4 K
cryostat
LNA
FFT
Flat mirror
Polariser
Absorber
Local oscillator



PEARL at Eureka

Polar Environment Atmospheric Research Laboratory (PEARL)

- Formerly Environment Canada's Arctic Stratospheric Ozone (AStrO) Observatory
- Operated by the Canadian Network for Detection of Atmospheric Change (CANDAC) since Aug. 2005
- ~25 experiments at 3 facilities to characterize the atmosphere from 0-100 km



- On Ellesmere Island, Nunavut (80ºN, 86ºW)
  - 15 km from Env. Canada's Eureka Weather Station
  - 1100 km from North Pole

Ridge Laboratory - one of three PEARL sites in Eureka, Nunavut

Photos courtesy of Pierre Fogal.

Status of Project

- Design work completed with Uni. Bern and Thomas Keating Instruments in spring 2013
- Programming development undertaken at U. Toronto over past two years

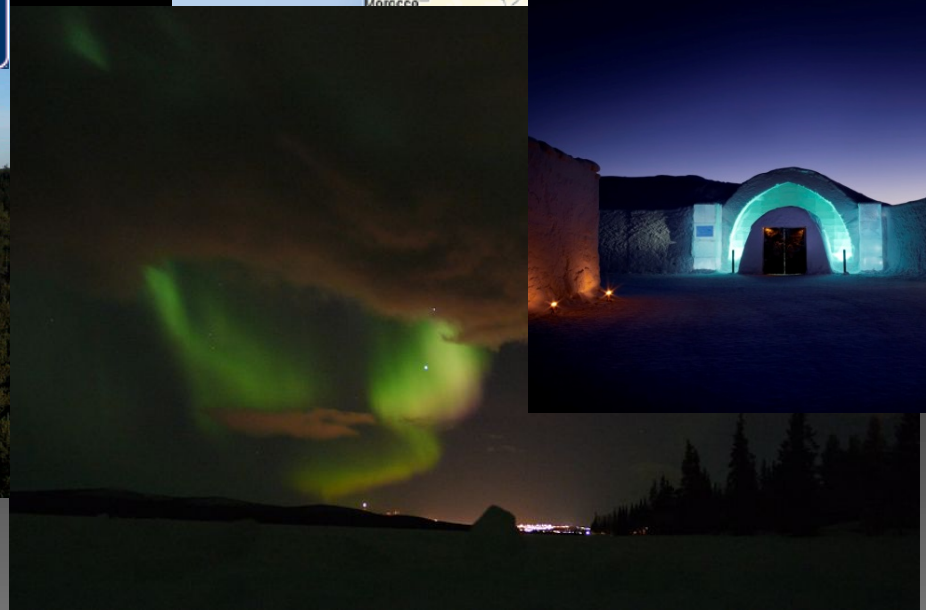
Project on hold at present:

- Agreed with funding agency to terminate current grant at end of design phase
- Working on new opportunities to fund instrument

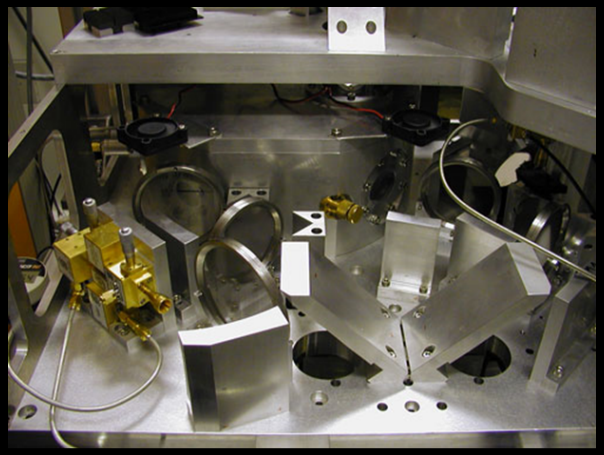
Kiruna and the Swedish Institute of Space Physics (IRF)

Kiruna: 67.84 N, 20.41 E

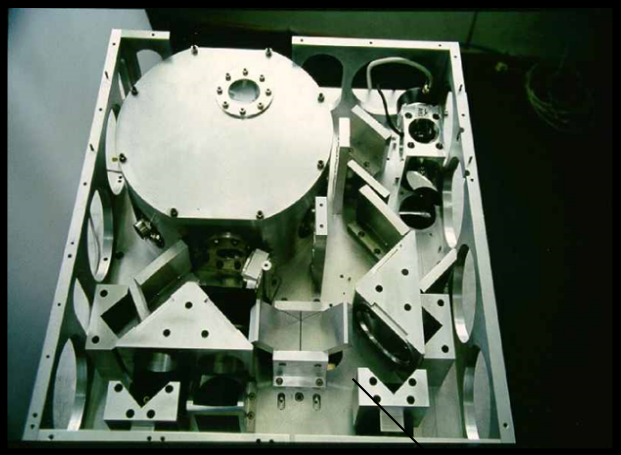
Founded: 1900
Population: 18,148
Size:16.53 km^2
Province: Lapland



KIMRA and MIRA 2 ground-based millimetre wave radiometers



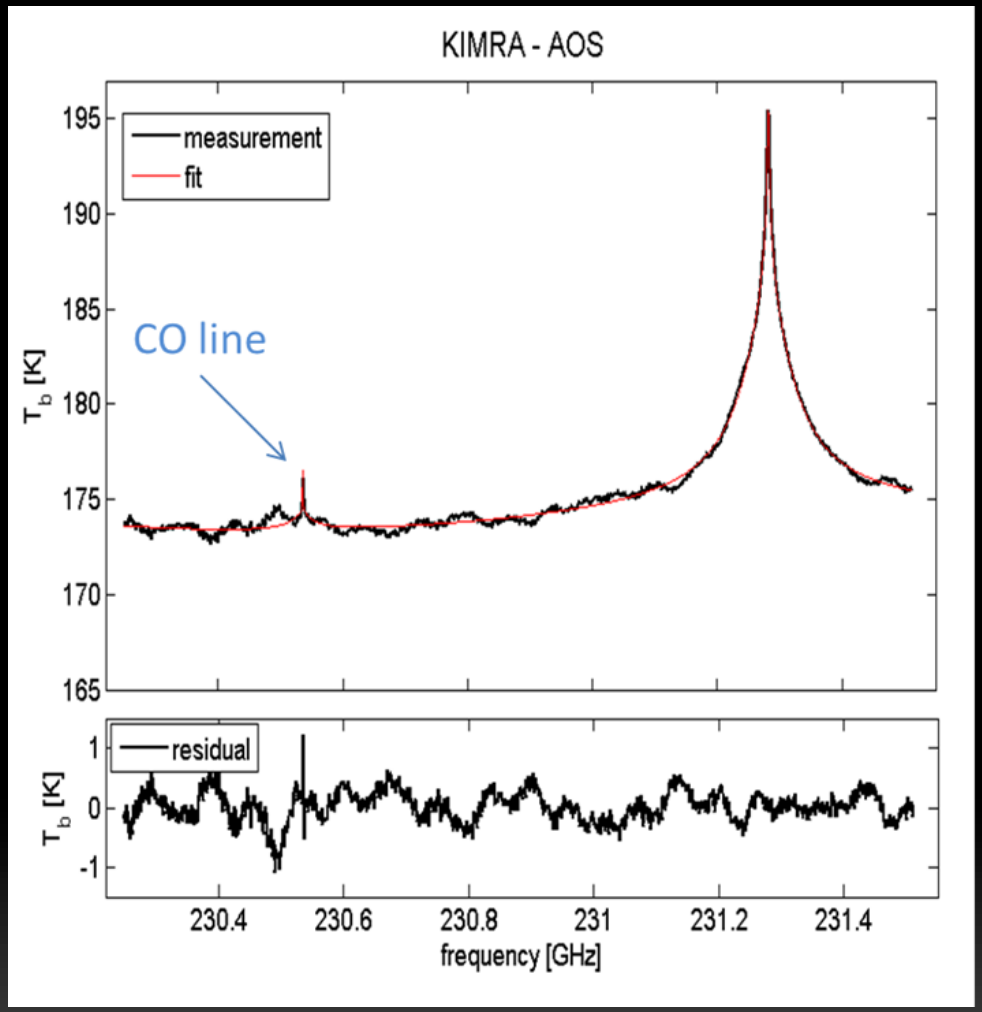
KIMRA

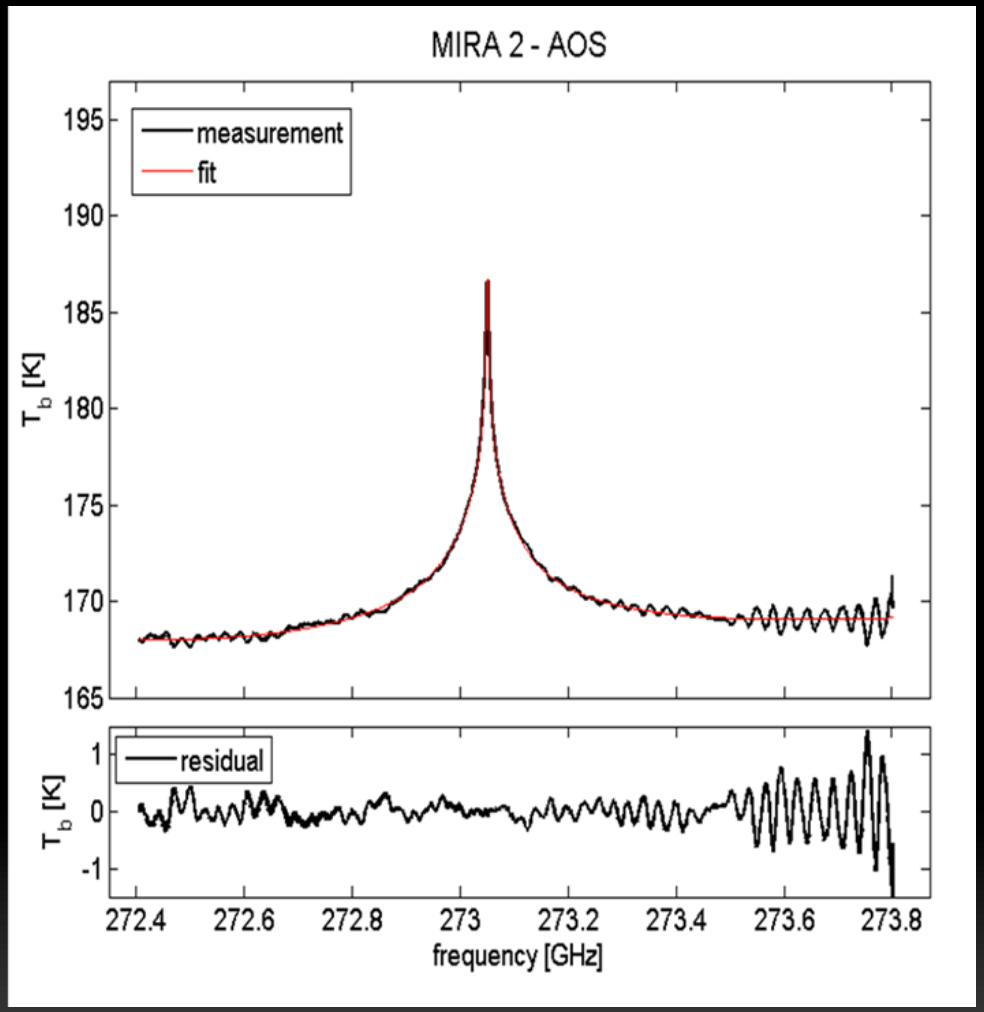


MIRA 2

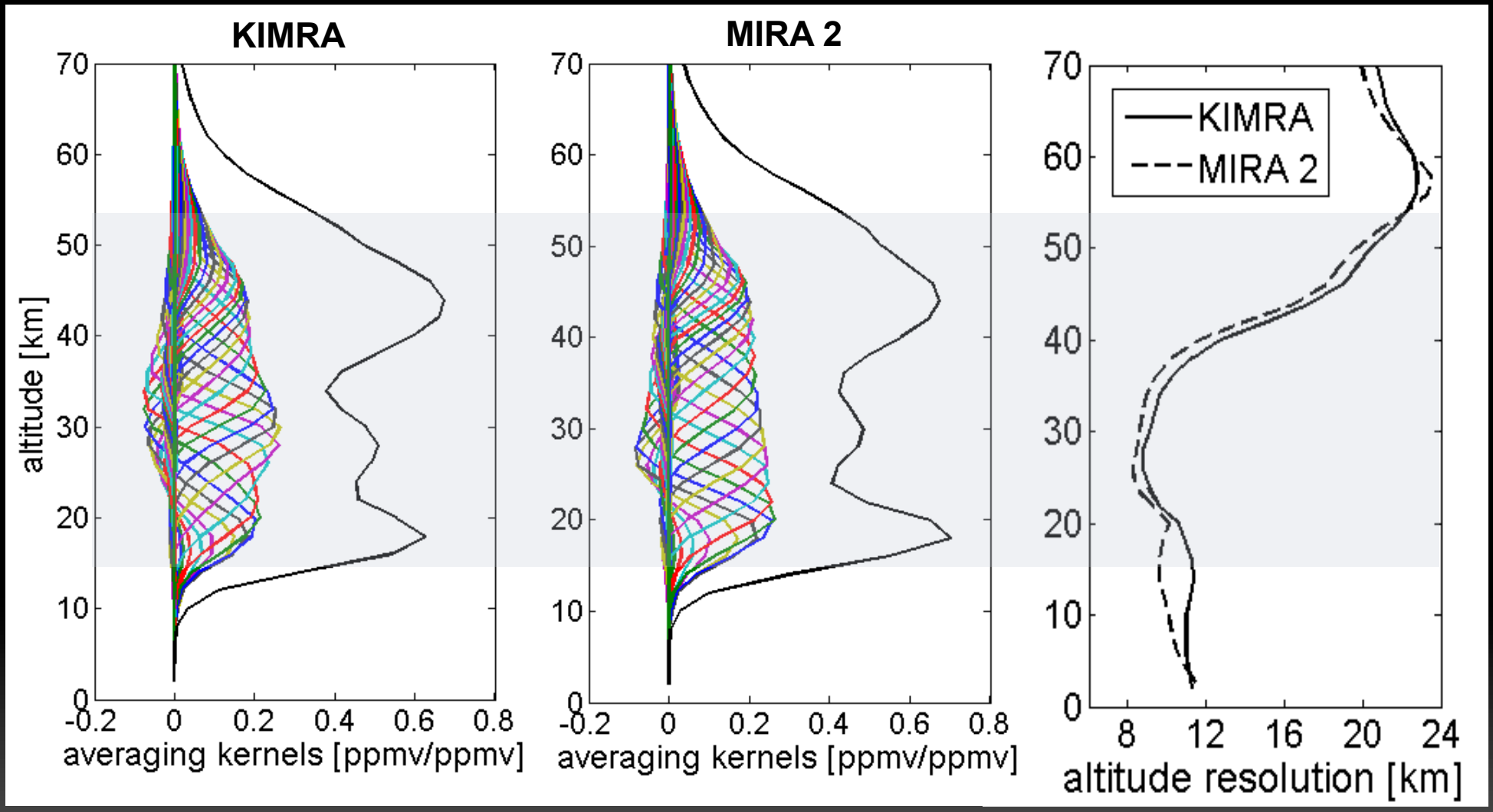
KIMRA		MIRA 2
231 GHz	operation frequency	273 GHz
cooled (35 K) Schottky diode	detector	cooled (35 K) Shottky diode
1800 K	noise temperature	750 K
Martin Pupplett	sideband filter	Martin Pupplett
AOS bandwidth: 1.27 GHz resolution: 0.7 MHz	spectrometer	AOS bandwidth: 1.4 GHz Resolution: 0.7 MHz

KIMRA and MIRA 2: example spectrum and fit using OEM (ARTS and Qpack)



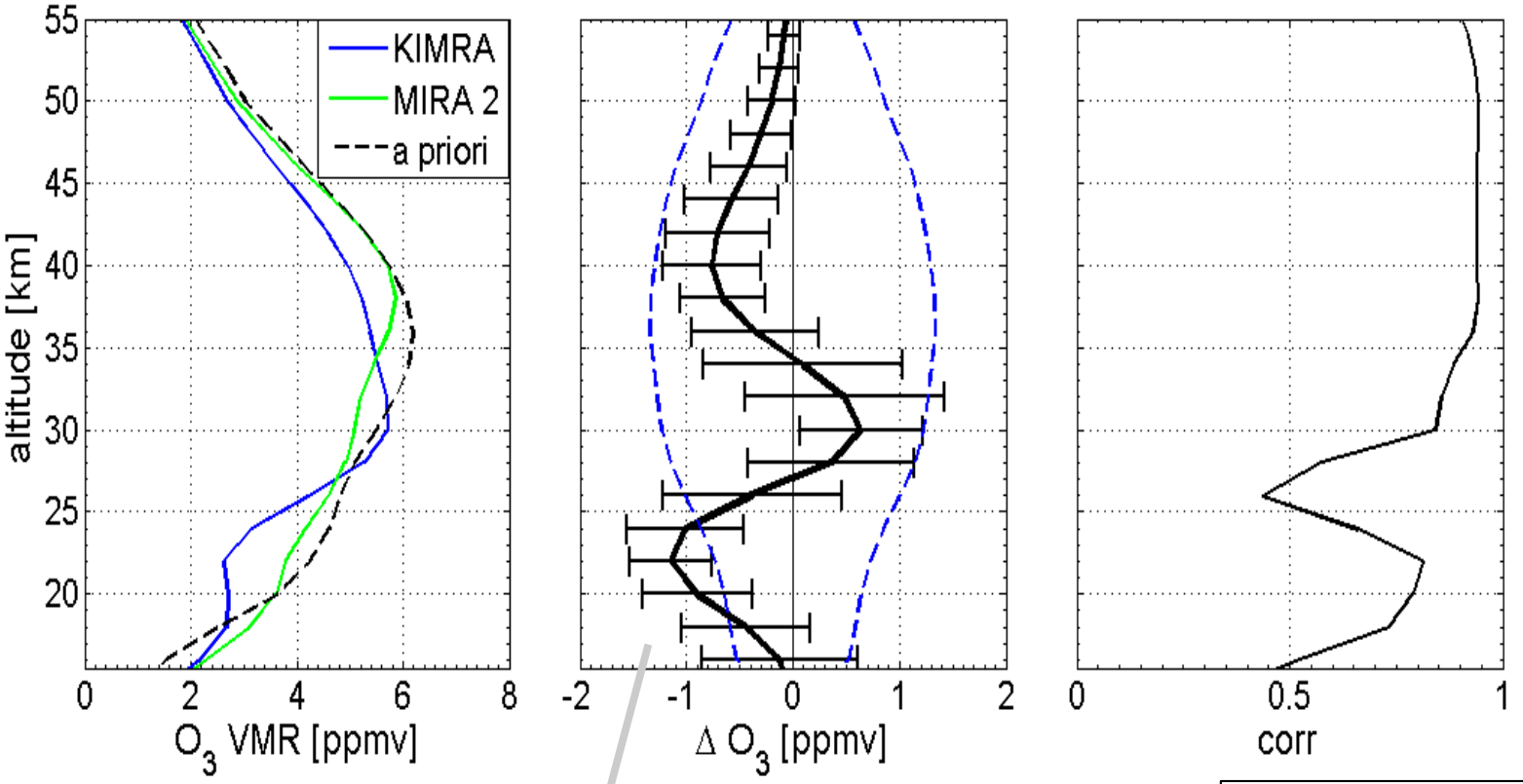


KIMRA and MIRA 2: averaging kernels and altitude resolution (FWHM)



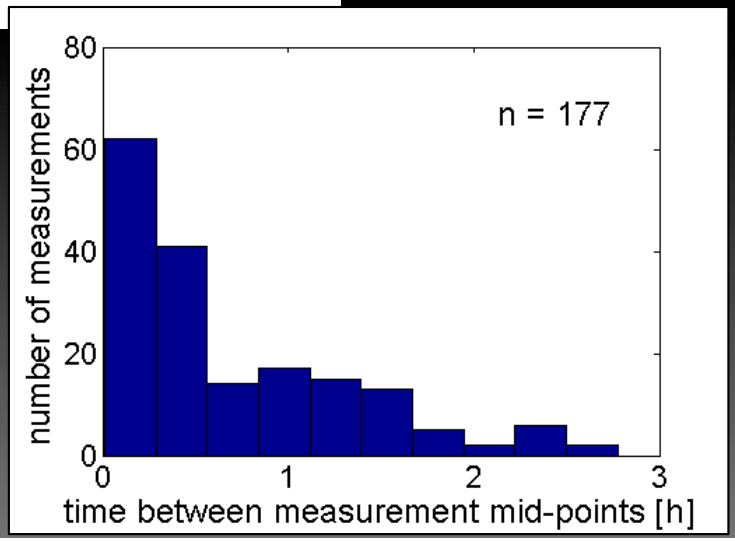
Black line in averaging kernels plots is (measurement response)/2

KIMRA and MIRA 2: retrieved profile comparison

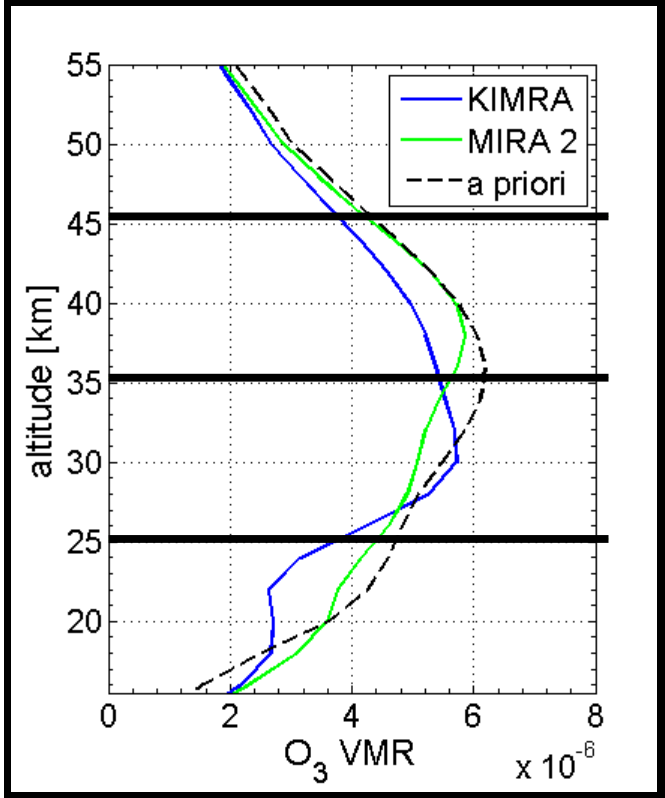


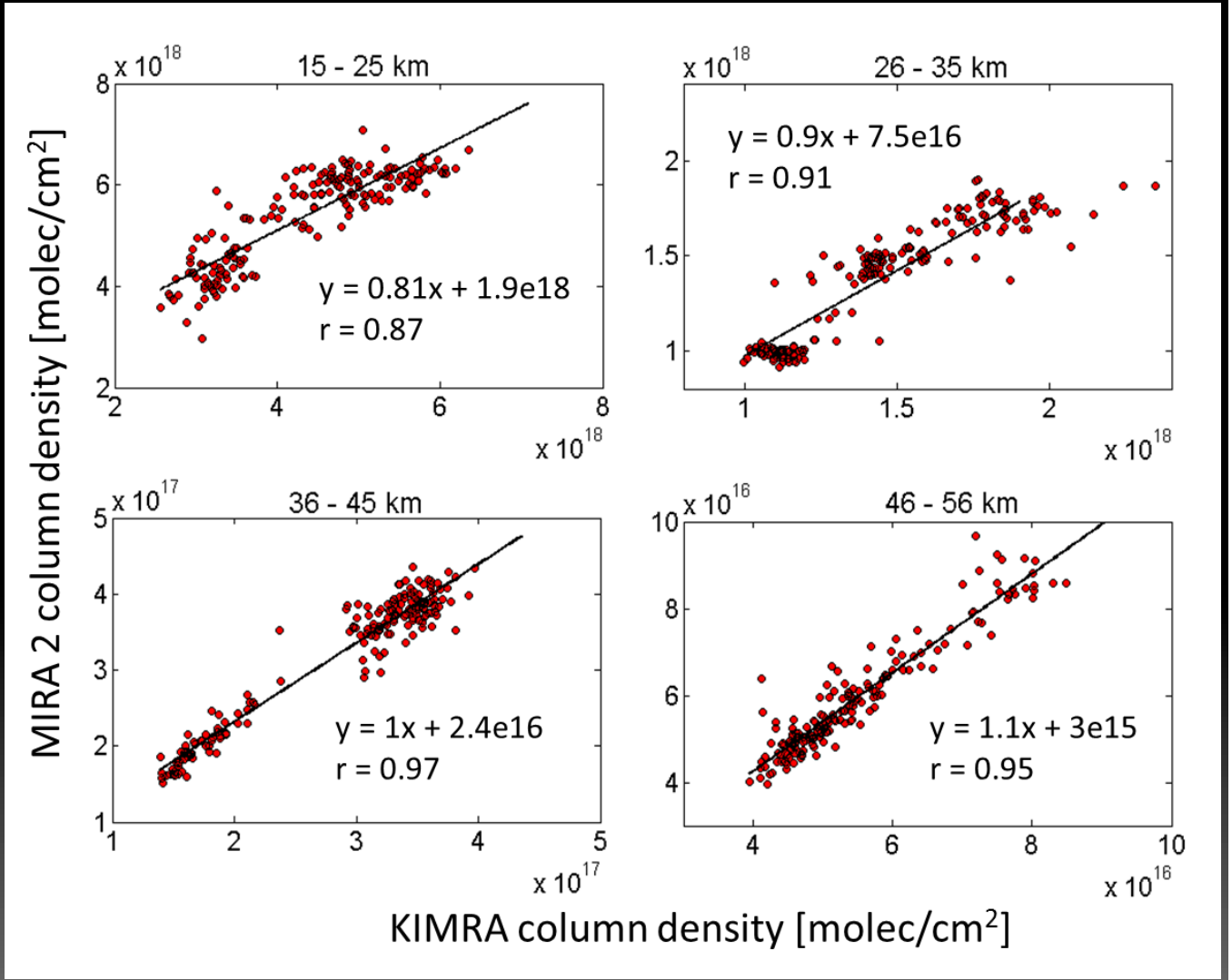
mean with standard deviation as error bar
KIMRA meas. error + MIRA 2 meas. error

Measurements overlap in time.
All north-facing

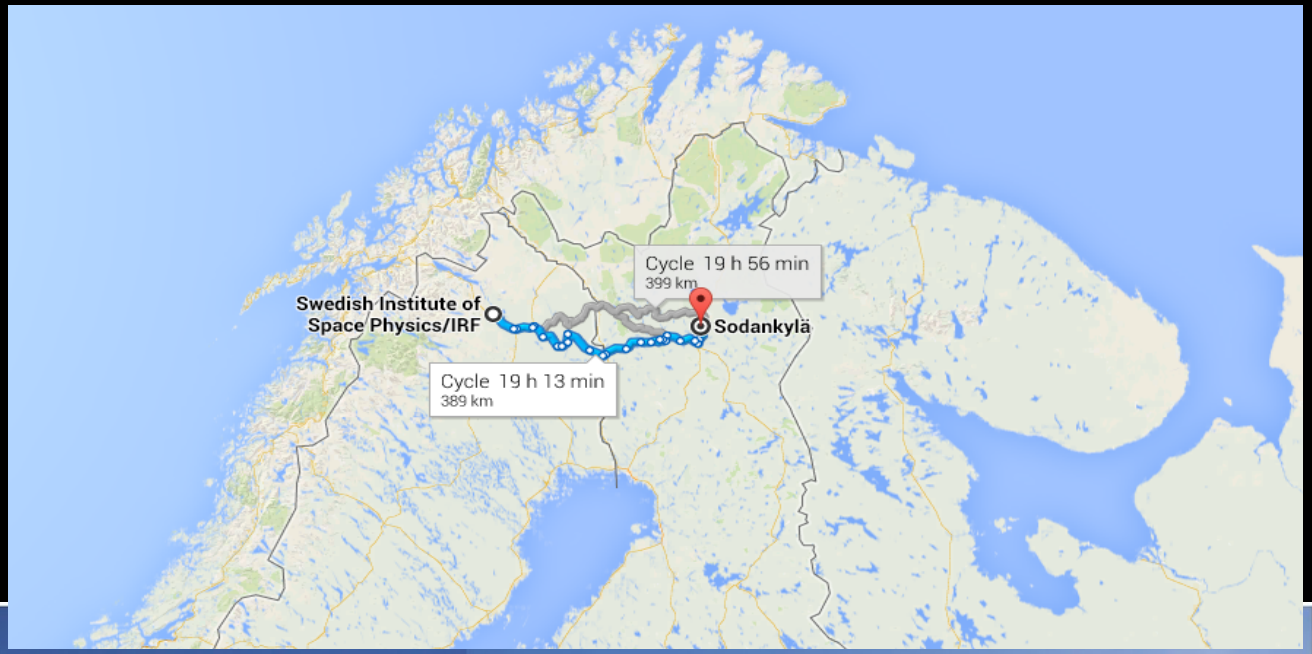


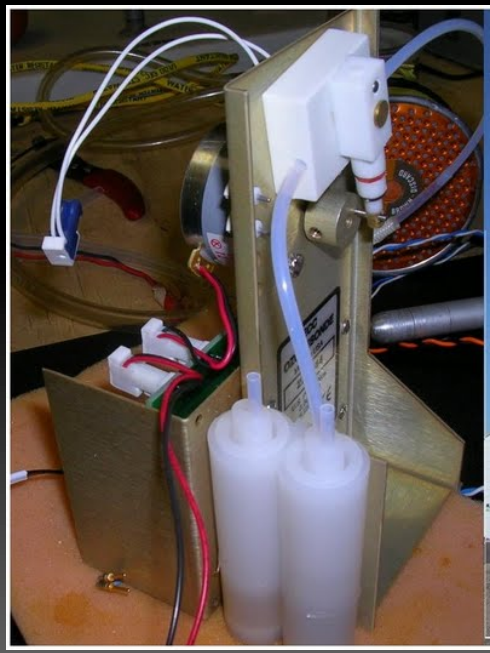
KIMRA and MIRA 2: partial column comparison





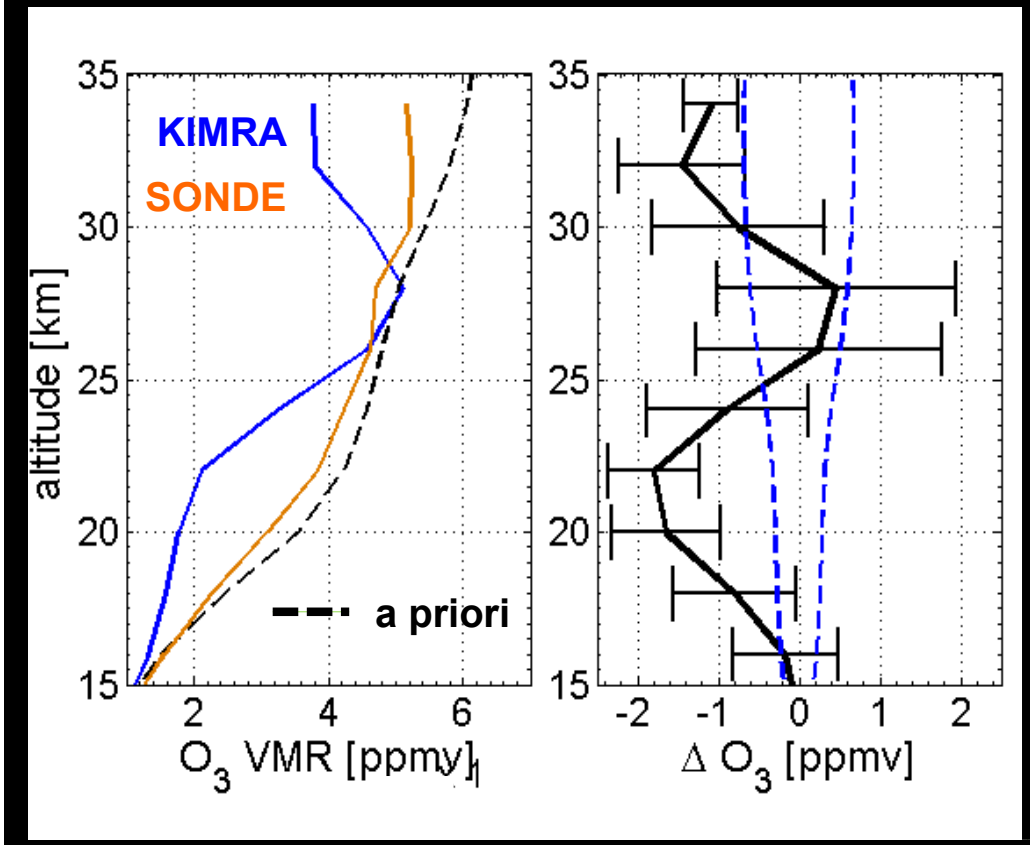
Comparison with ozonesondes launched from Sodankylä

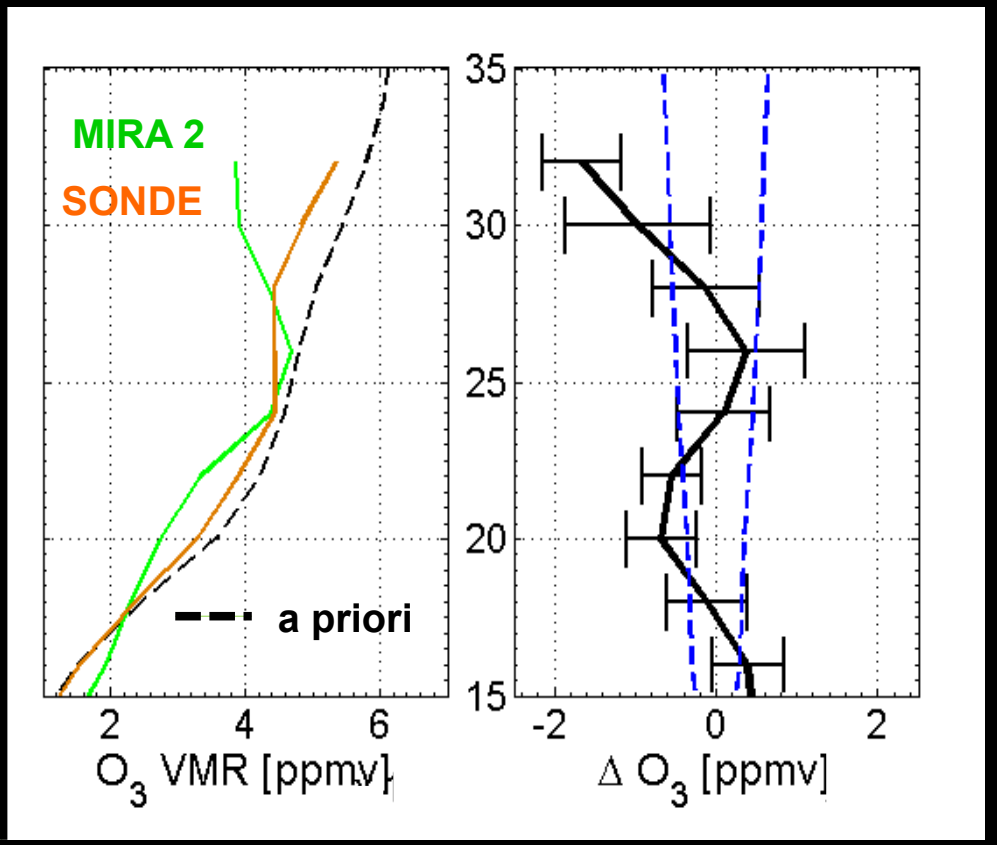




http://nerc-bortas.blogspot.ca/2011/05/ozone-sonde-launches.html

KIMRA and MIRA 2: retrieved profile comparison with ozonesondes

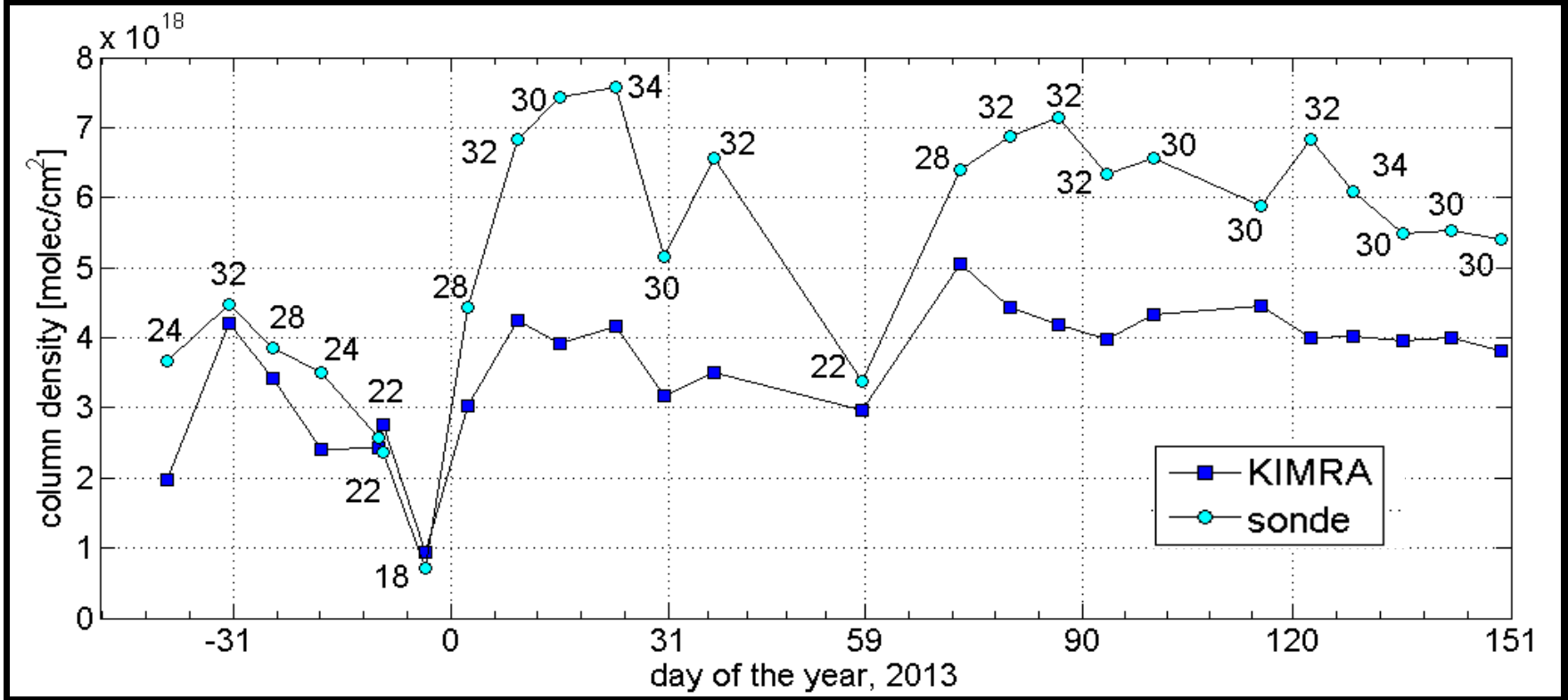




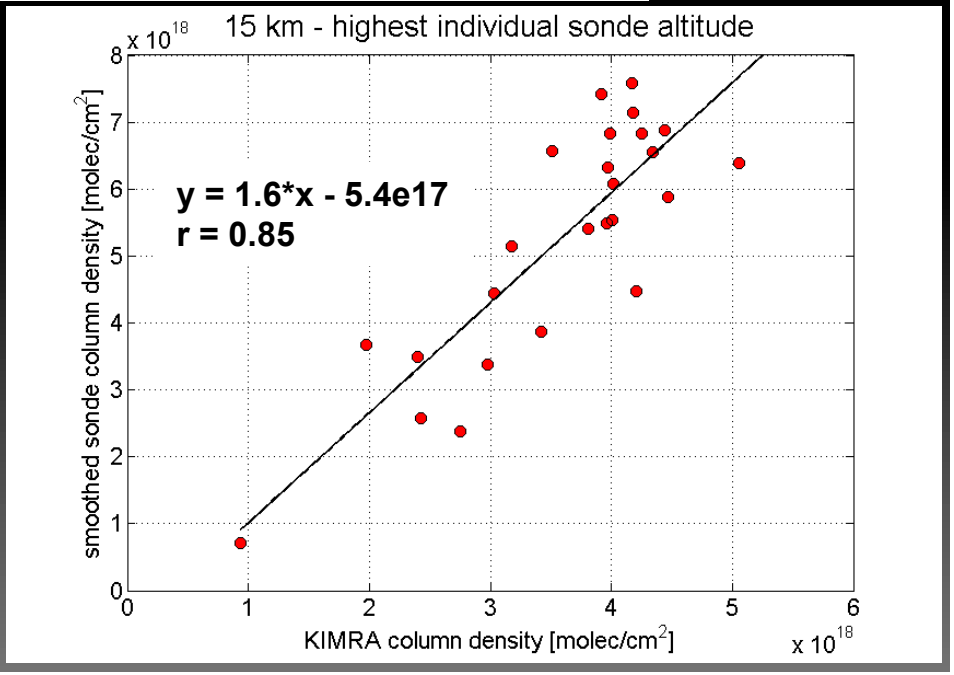
mean with standard deviation as error bar
KIMRA meas. error or MIRA 2 meas. error

Measurements within 24hrs of each other.
KIMRA has the only 2 measurements with coincidence above 6 hours.
Altitude points have different numbers of values in the mean, because of different max height of sondes

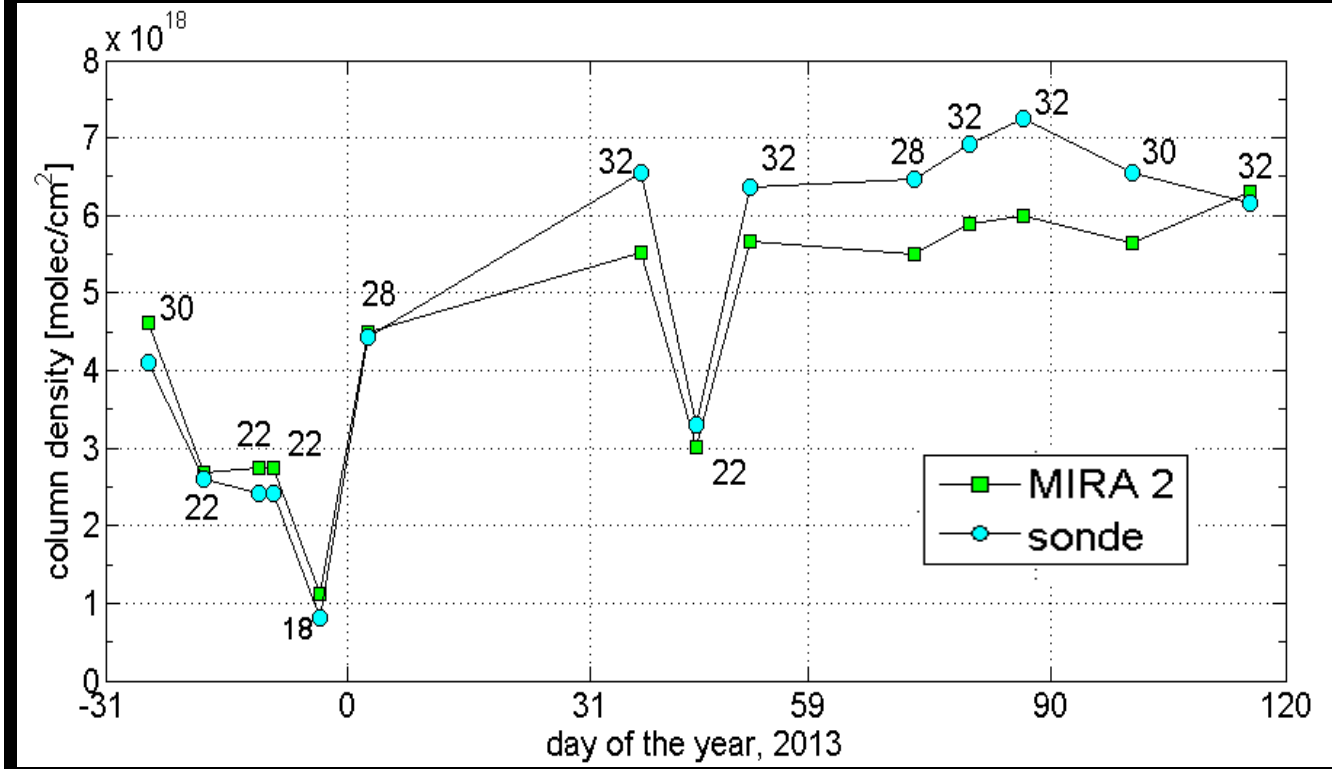
KIMRA and MIRA 2: column comparisons with ozonesondes



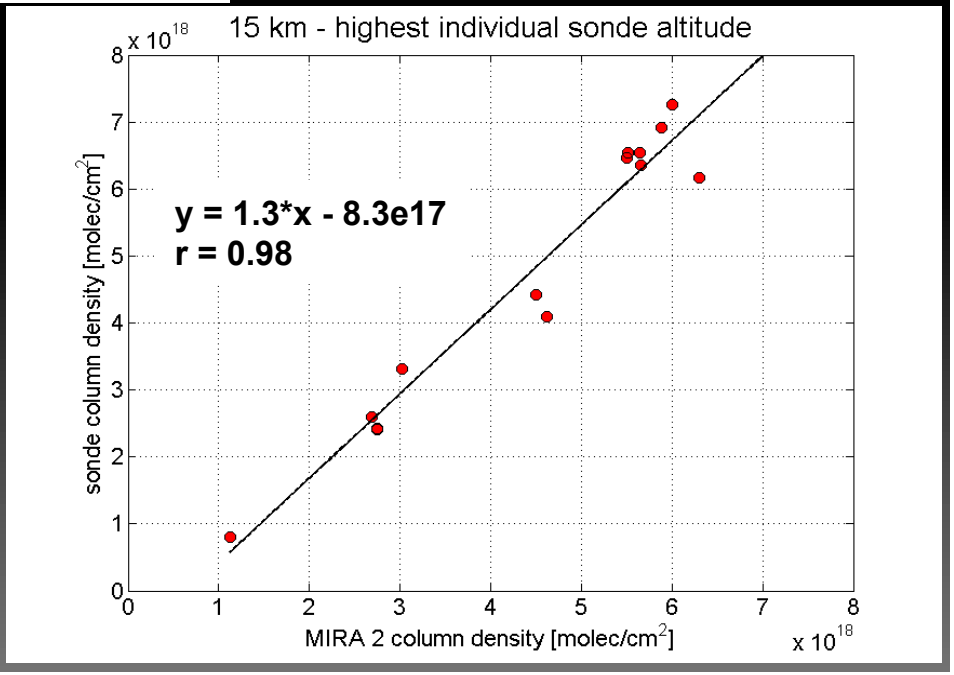
Numbers beside points show the max height of the ozonesonde (and KIMRA profile)

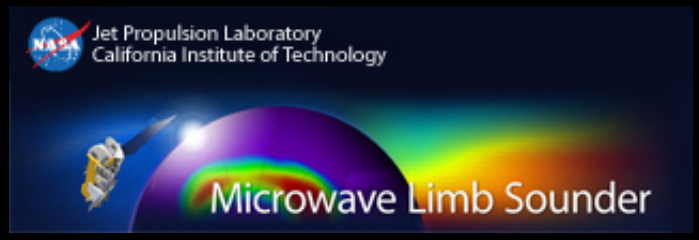


KIMRA and MIRA 2: column comparisons with ozonesondes



Numbers beside points show the max height of the ozonesonde (and MIRA 2 profile)



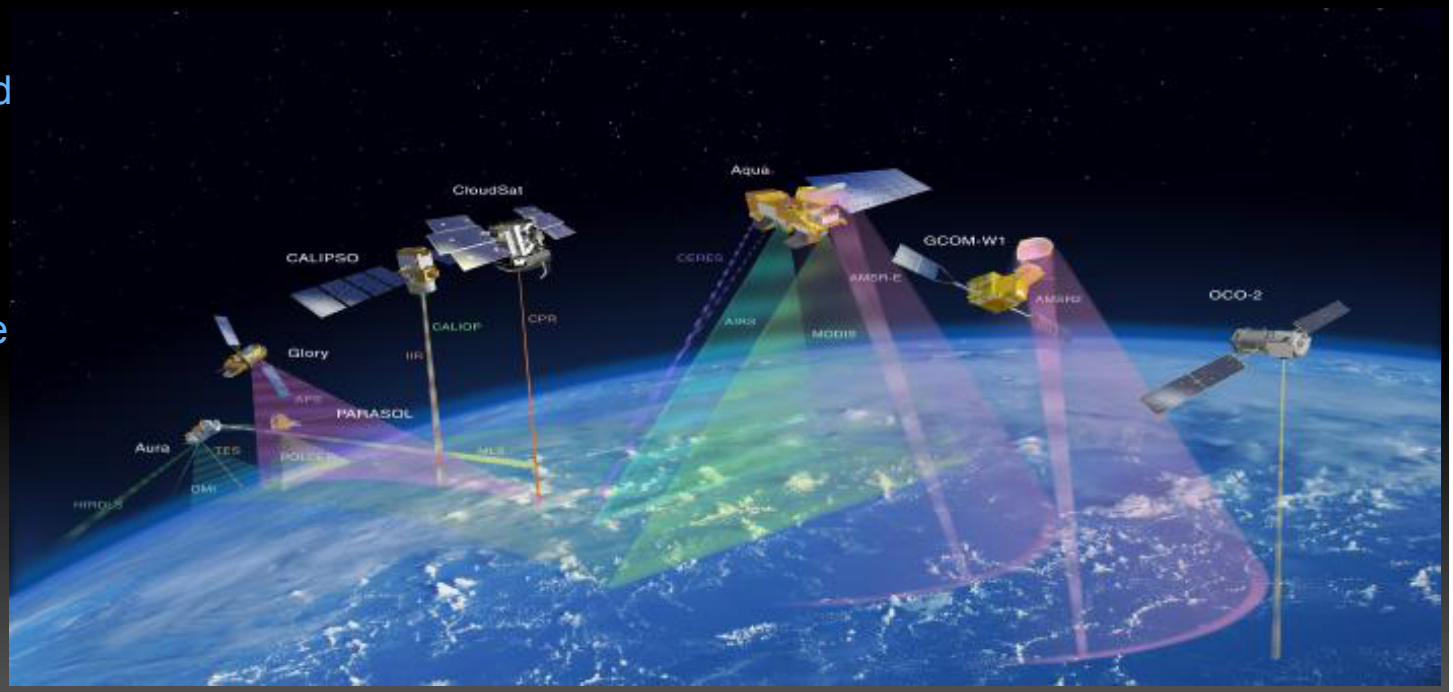


MLS measures thermal emission from broad spectral bands centered near 118, 190, **240**, 640 and 2500 GHz are measured continuously (24 hours per day) by 7 microwave receivers (2 each at 118 and 2500 GHz)

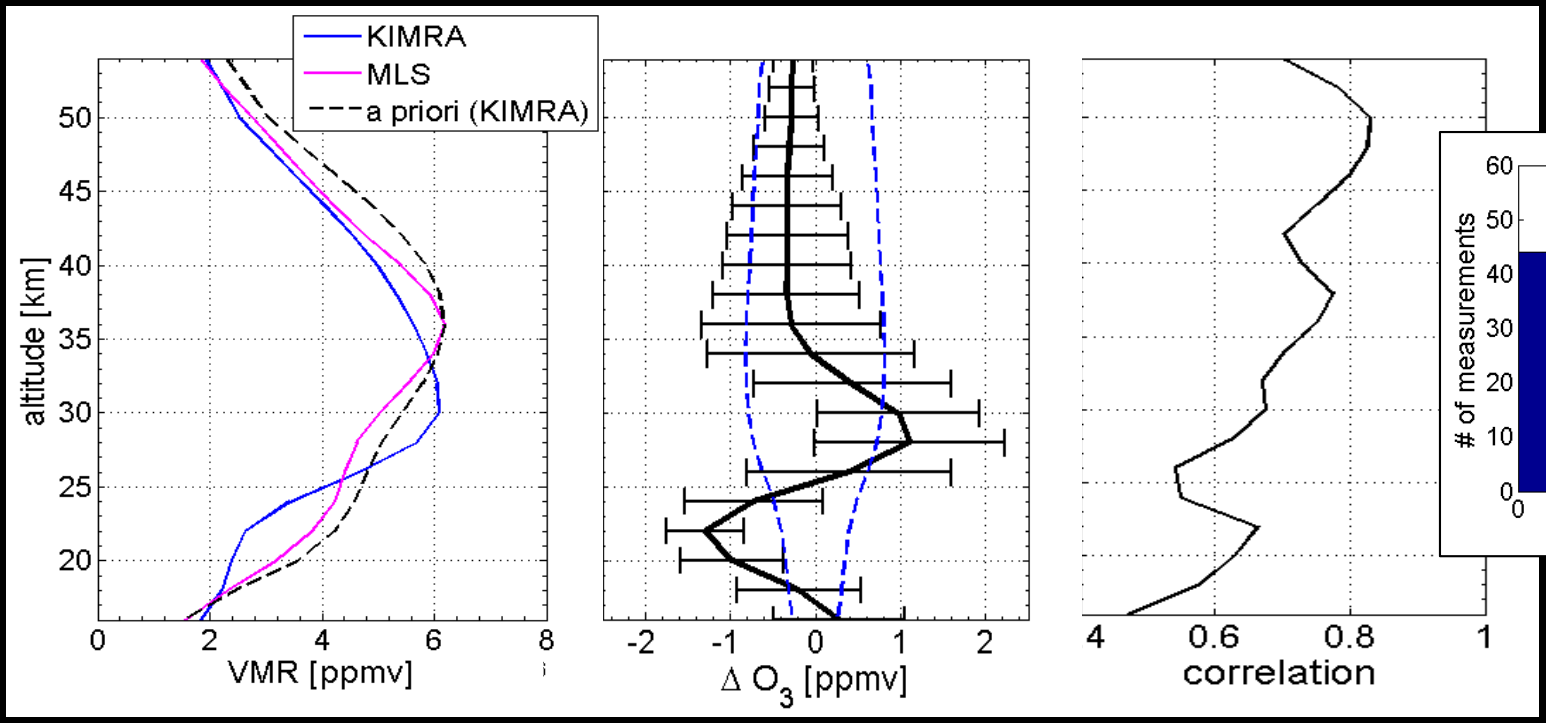
Comparison with MLS (microwave limb sounder)

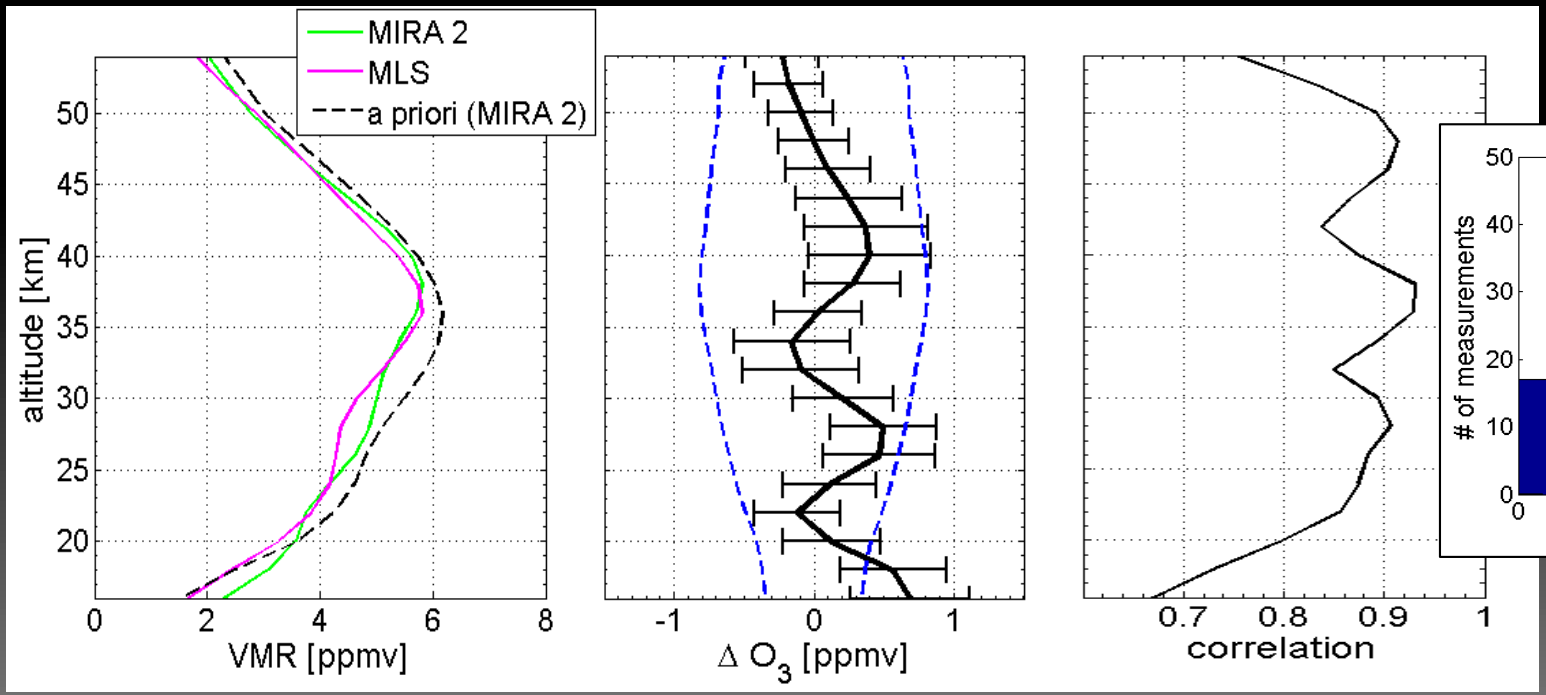
Views forward along the Aura spacecraft flight direction, scanning its view from the ground to ~90 km every ~25 seconds.

Near-polar 705 km altitude orbit. Orbit stays fixed relative to the sun; to give daily global coverage with ~13 orbits per day.

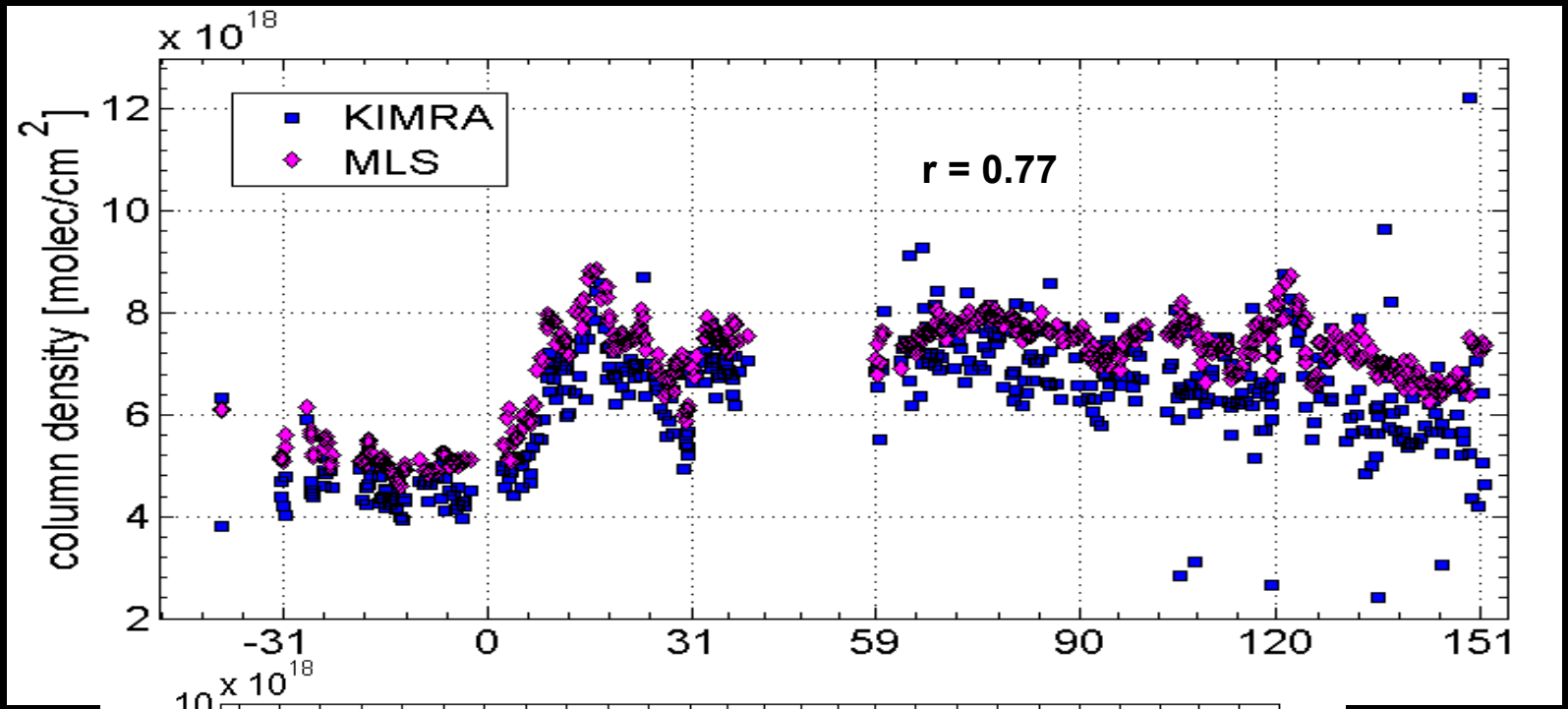


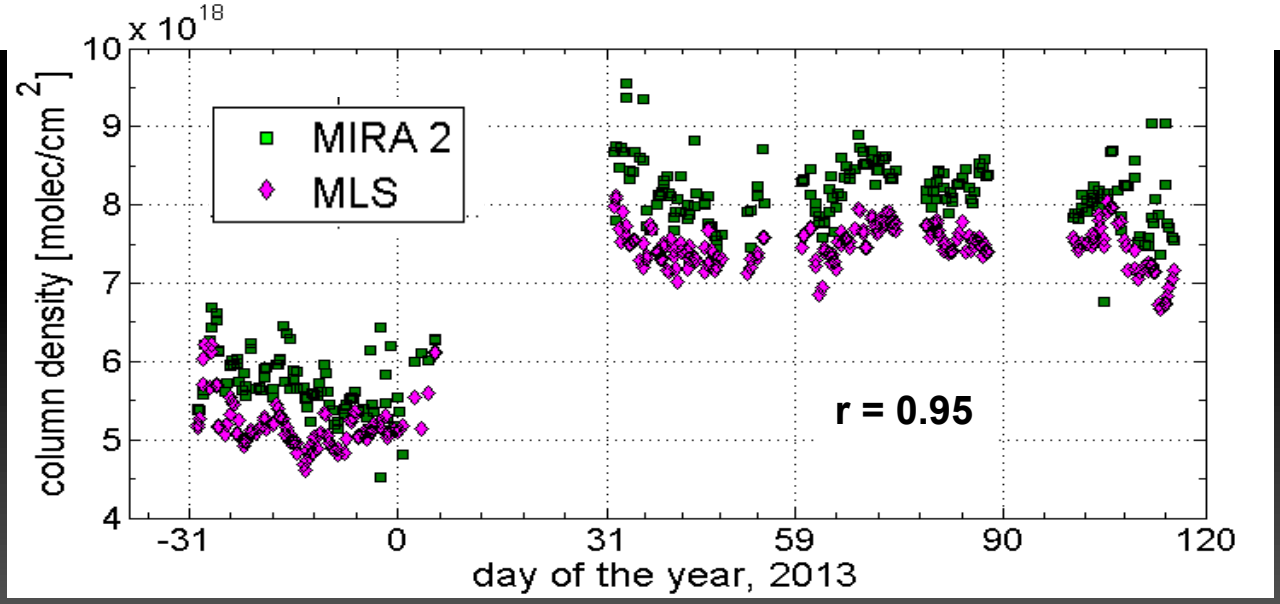
KIMRA and MIRA 2: profile comparison with Aura MLS





KIMRA and MIRA 2: column comparison with Aura MLS





Acknowledgements

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- CFI (Canada Foundation for Innovation)
- Onatrio Research Foundation
- NSERC (Natural Sciences and Engineering Research Council Canada)

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- Finnish Meteorological Institute
- The Aura MLS team