

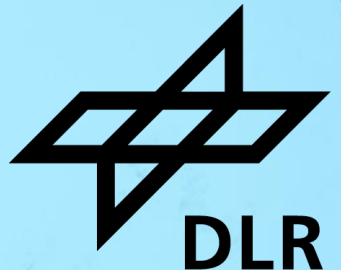
# OSAS-B – THE OXYGEN SPECTROMETER FOR ATMOSPHERIC SCIENCE ON A BALLOON

**H.-W. Hübers<sup>1,2</sup>, P. Dern<sup>1</sup>, E. Dietz<sup>1</sup>, S. Frohmann<sup>1</sup>, B. Klein<sup>2</sup>, A. Semenov<sup>1</sup>, M. Wienold<sup>1</sup>**

<sup>1</sup>Deutsches Zentrum für Luft- und Raumfahrt (DLR), Institute of Optical Sensor Systems, Berlin

<sup>2</sup>Humboldt-Universität zu Berlin, Department of Physics

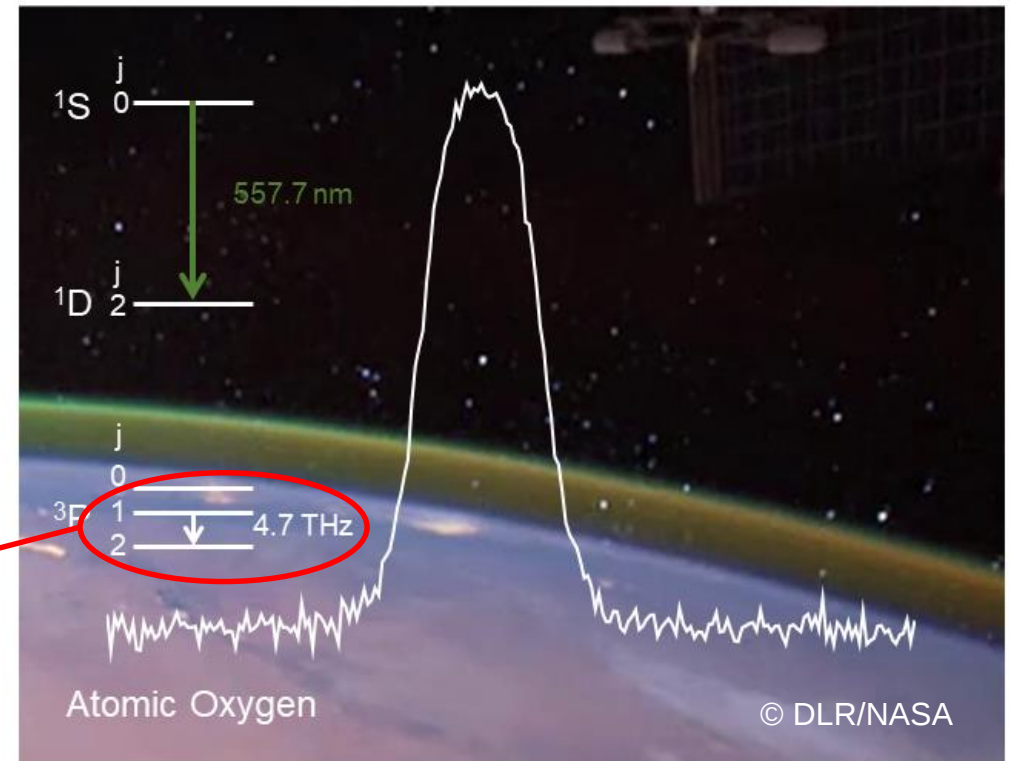
<sup>3</sup>Max-Planck Institut für Radioastronomie, Bonn



# Atomic oxygen in the mesosphere and lower thermosphere (MLT) of Earth

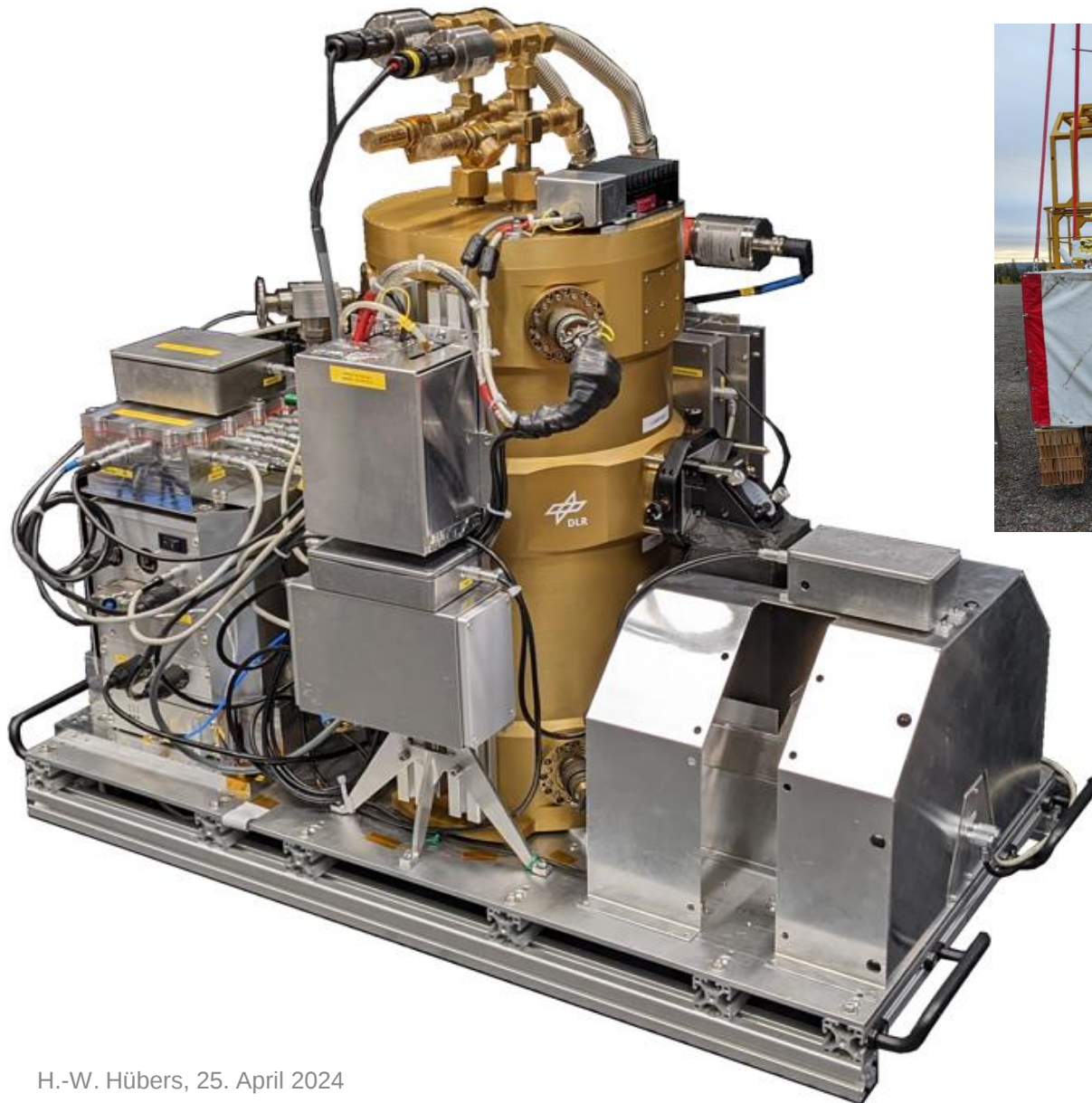
## Atomic oxygen in the MLT (quick facts)

- is the main component of the Earth's mesosphere and lower thermosphere (MLT),
- extends from about 80 km to above 400 km,
- governs photochemistry and energy balance
- is a tracer for dynamical motions in the MLT
- decelerates satellites in Low-Earth-Orbit (LEO)
- causes corrosion of satellites in LEO



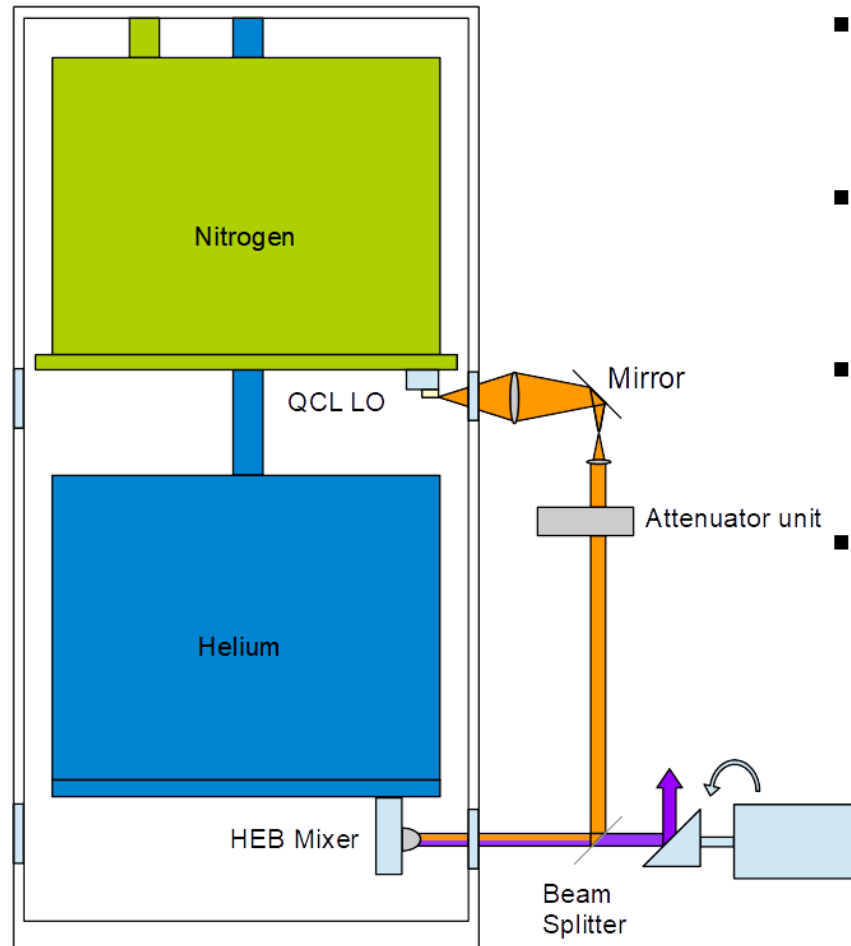
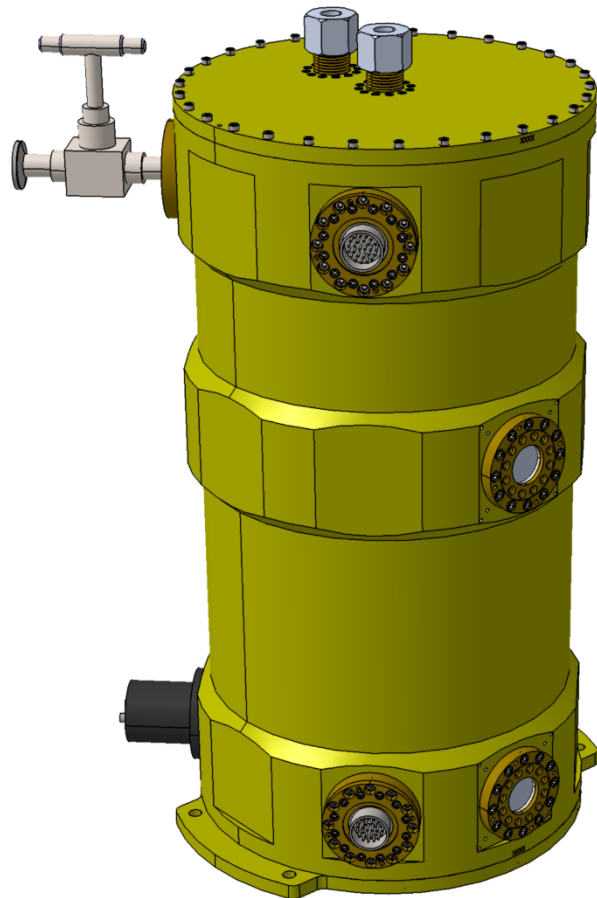
(energy levels not to scale)

# OSAS-B: Launch from Esrange/Kiruna (Sept. 7, 2022)

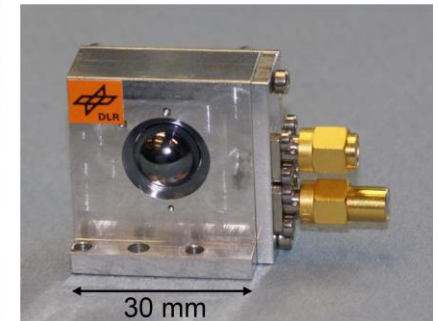
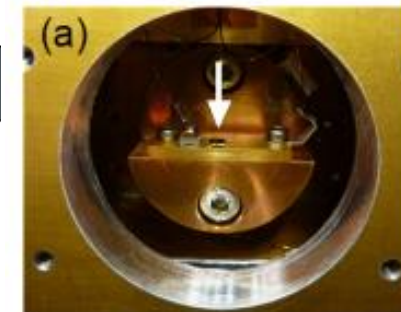


OSAS-B: Compact (70 kg, 100 W) 4.7-THz heterodyne spectrometer for a stratospheric balloon (35 km altitude)

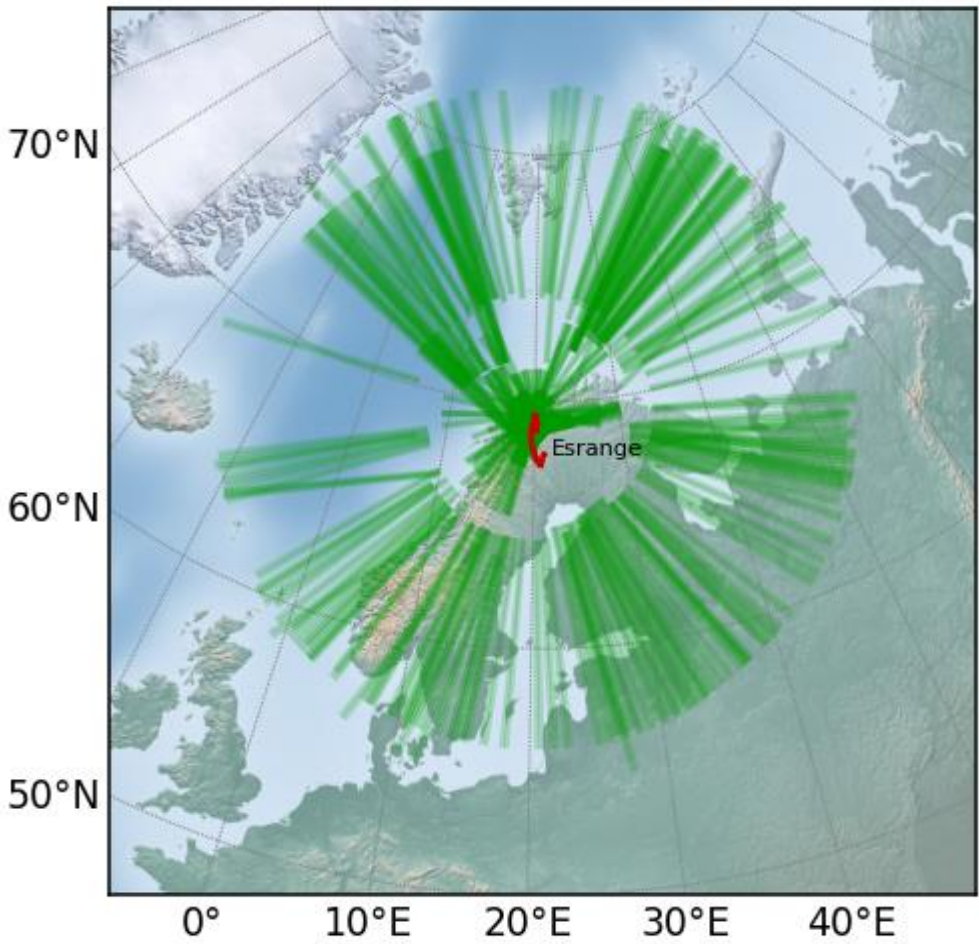
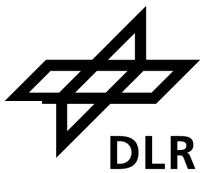
# OSAS-B: Receiver frontend design



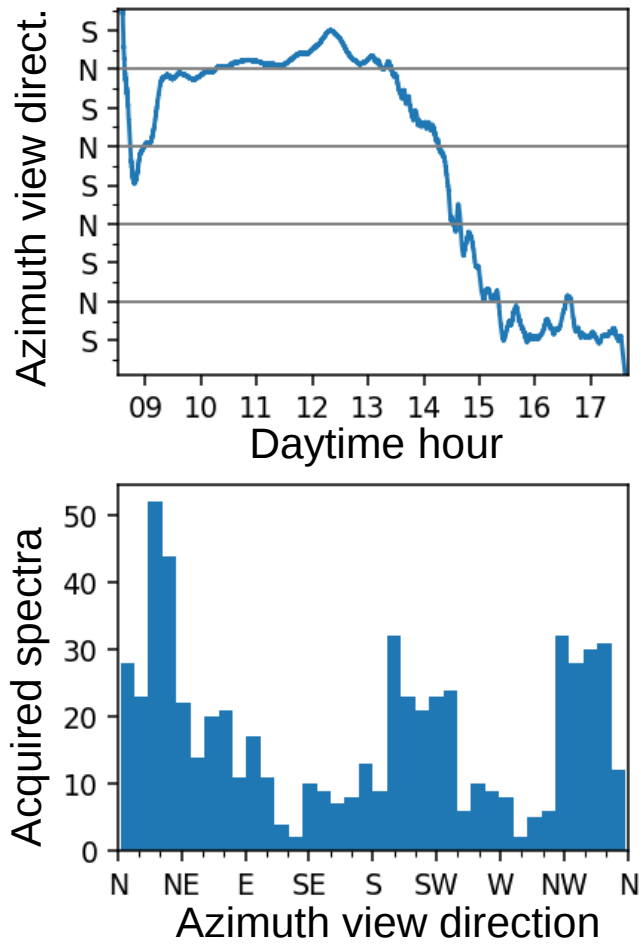
- Dewar: Solid Nitrogen / liquid Helium (60K/4K) with active pressure control
- Local oscillator: 4.7 THz quantum-cascade laser operated at 60 K
- Mixer: Quasi-optical superconducting hot-electron bolometer operated at 4K
- Backend spectrometer: Digital fast Fourier transform spectrometer (MPI Bonn)



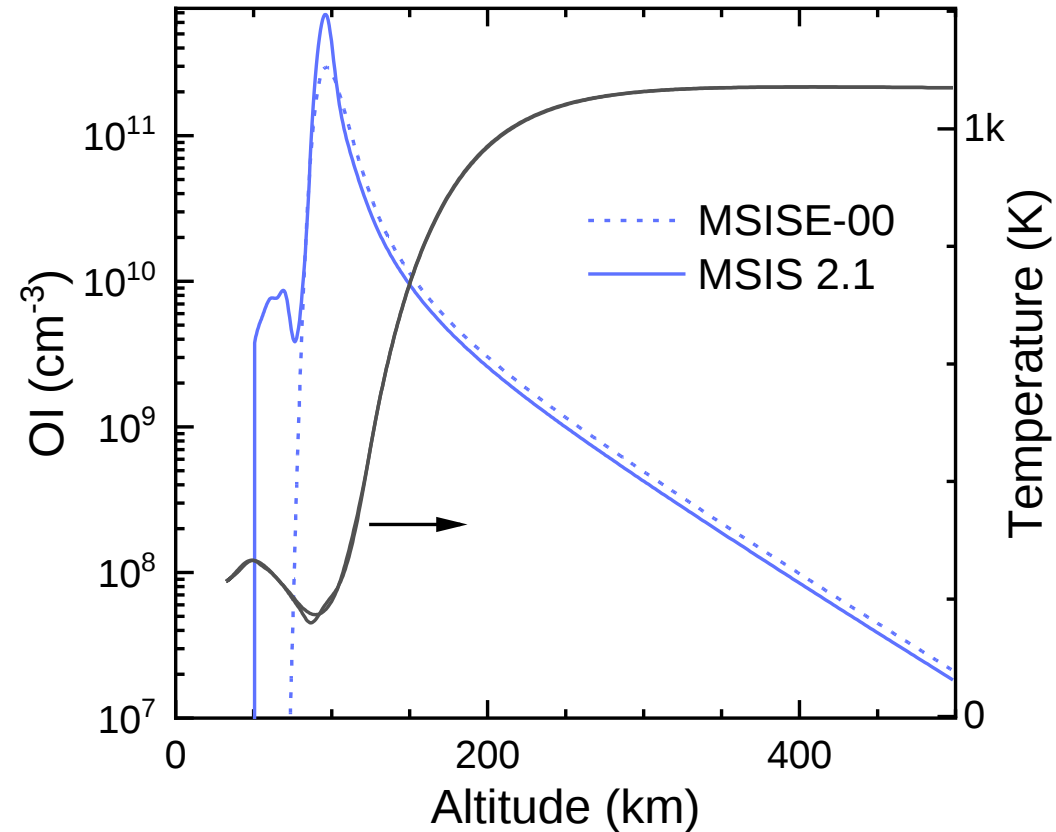
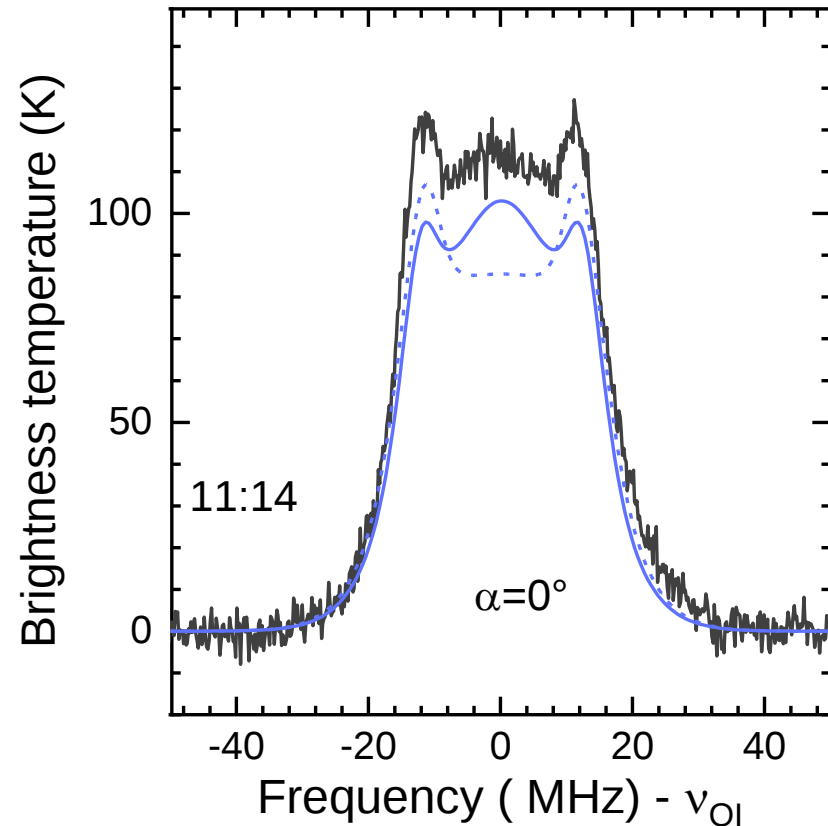
# Balloon trajectory and pointing directions



red: balloon trajectory, green: lines of sight



# Measurements vs. atomic oxygen models for the MLT



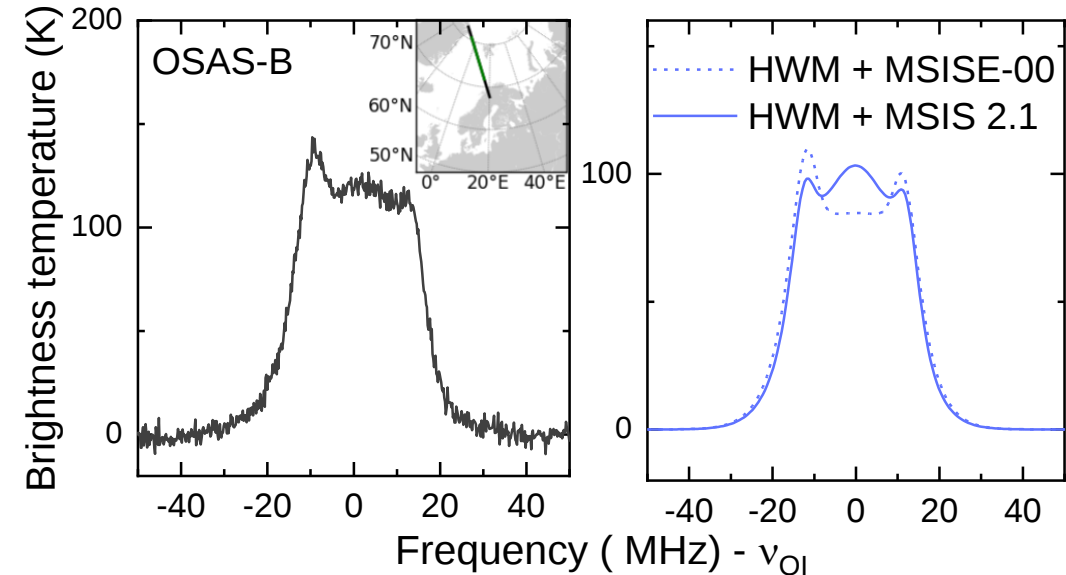
Horizontal pointing: peak structure sensitive to low-altitude atomic oxygen.

Calculated lineshapes based on MSIS 2.1 model agree very well with the observed spectra.

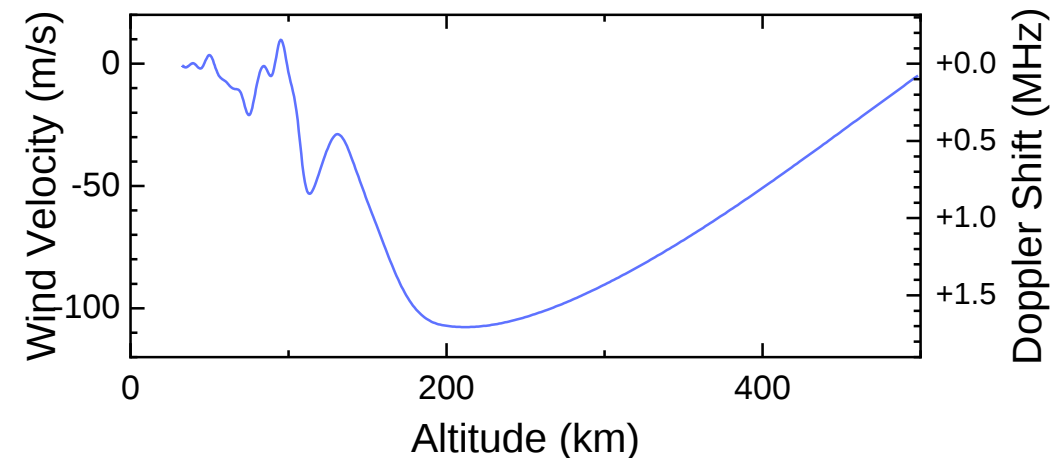
# Sensitivity to winds in the MLT

- Shear winds cause an asymmetric lineshape due to a relative Doppler-shift of spectral contributions
- Observed with OSAS-B for certain lines of sight during the day
- Horizontal winds in the MLT are predicted by the Horizontal-Wind Model (HWM-2014, Drob et al., Earth Space Sci. 2, 301, 2015; Python module: pyhwm2014)

Horizontal pointing toward NNW after sunrise



Wind along line of sight according to HWM-2014 model



# Summary

- New measurements of atomic oxygen in the MLT
- OSAS-B is the first 4.7-THz heterodyne spectrometer on a stratospheric balloon
- Future improvement: addition of 2 THz frequency channel for  $^3P_0 \rightarrow ^3P_1$  transition
- Dedicated spaceborne mission (“Keystone”) devoted to atomic oxygen in the MLT has been selected by ESA for a Phase 0 study

Thank you for your attention!

