CAIRT

The Changing-Atmosphere Infra-Red Tomography Explorer

A candidate for ESA‘s Earth Explorer 11

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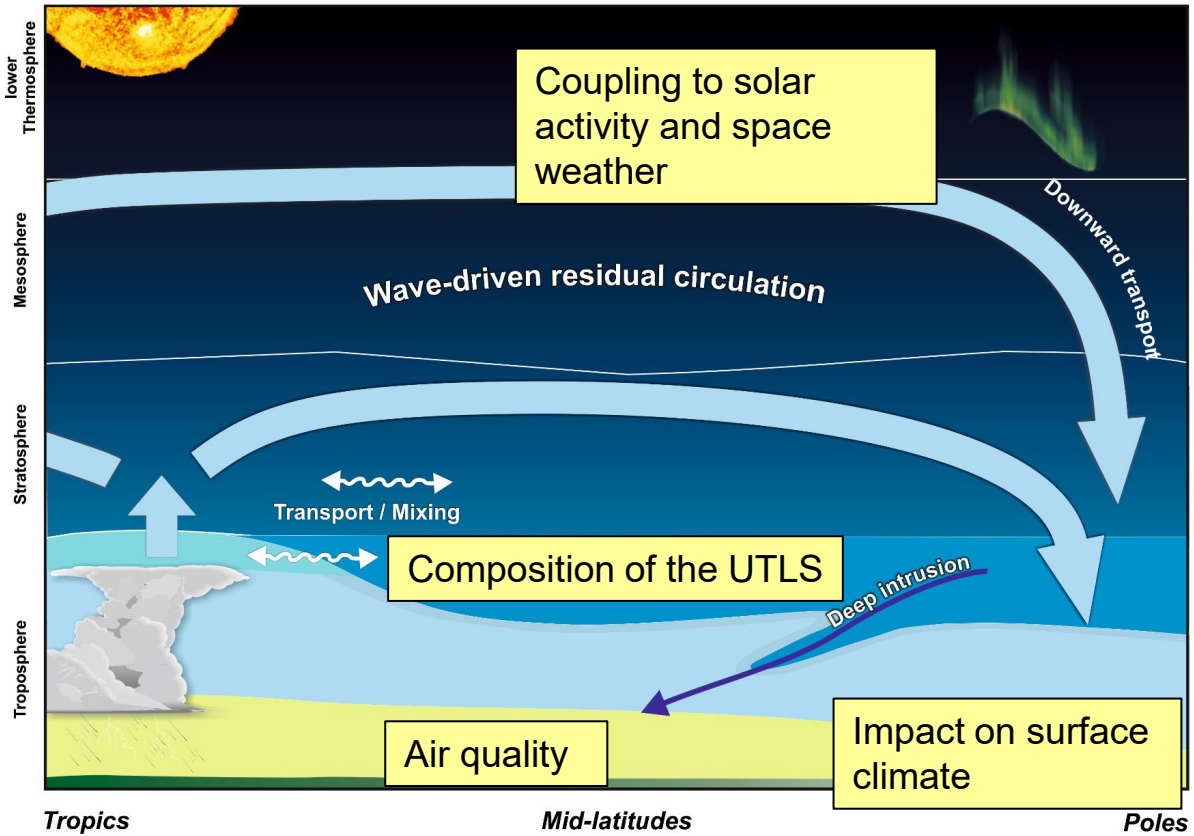
Circulation, composition and regional climate change CAIRT



Evidence for profound changes throughout the whole atmosphere:

- Atmospheric circulation
- Transport and mixing
- Impact on
  - UTLS composition and radiative forcing
  - air quality
  - coupling with solar activity / space weather
  - surface climate

ARTICLES
https://doi.org/10.1038/s41561-019-0456-x
nature geoscience

Australian hot and dry extremes induced by weakenings of the stratospheric polar vortex

Eun-Pa Lim[1*], Harry H. Hendon[1], Ghyslaine Boschat[2,3], Debra Hudson[1], David W. J. Thompson[4], Andrew J. Dowdy[1] and Julie M. Arblaster[2,3,5]

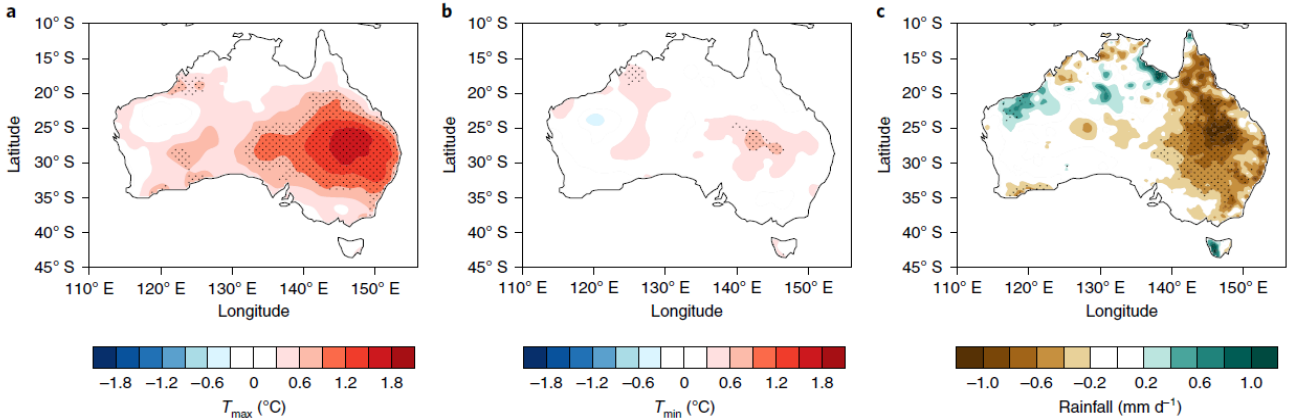


Photo: worldweatherattribution.org

The 2019/20 Australian wildfires generated a persistent smoke-charged vortex rising up to 35 km altitude

COMMUNICATIONS EARTH&ENVIRONMENT

https://doi.org/10.1038/s43247-020-00022-5

Sergey Khaykin[1✉], Bernard Legras[2], Silvia Bucci[2], Pasquale Sellitto[3], Lars Isaksen[4], Florent Tencé[1], Slimane Bekki[1], Adam Bourassa[5], Landon Rieger[5], Daniel Zawada[5], Julien Jumelet[1] & Sophie Godin-Beekmann[1]

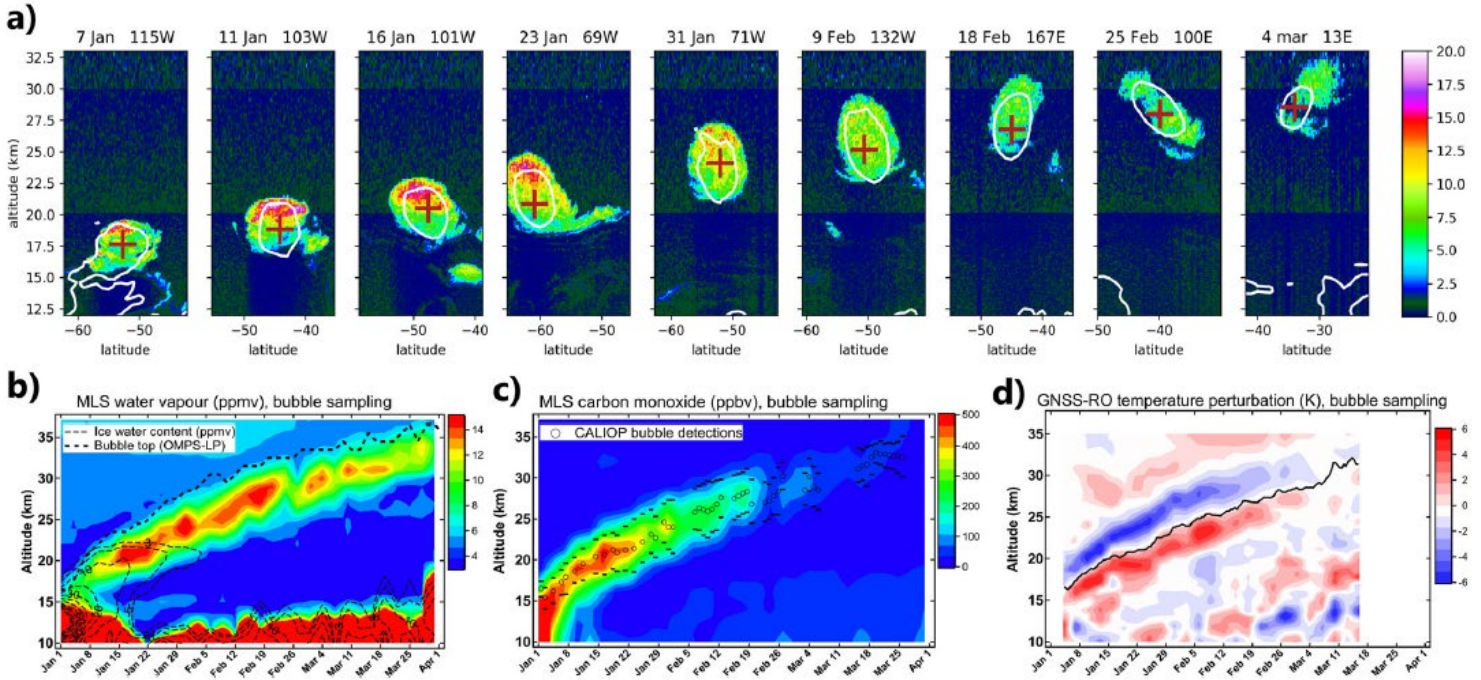
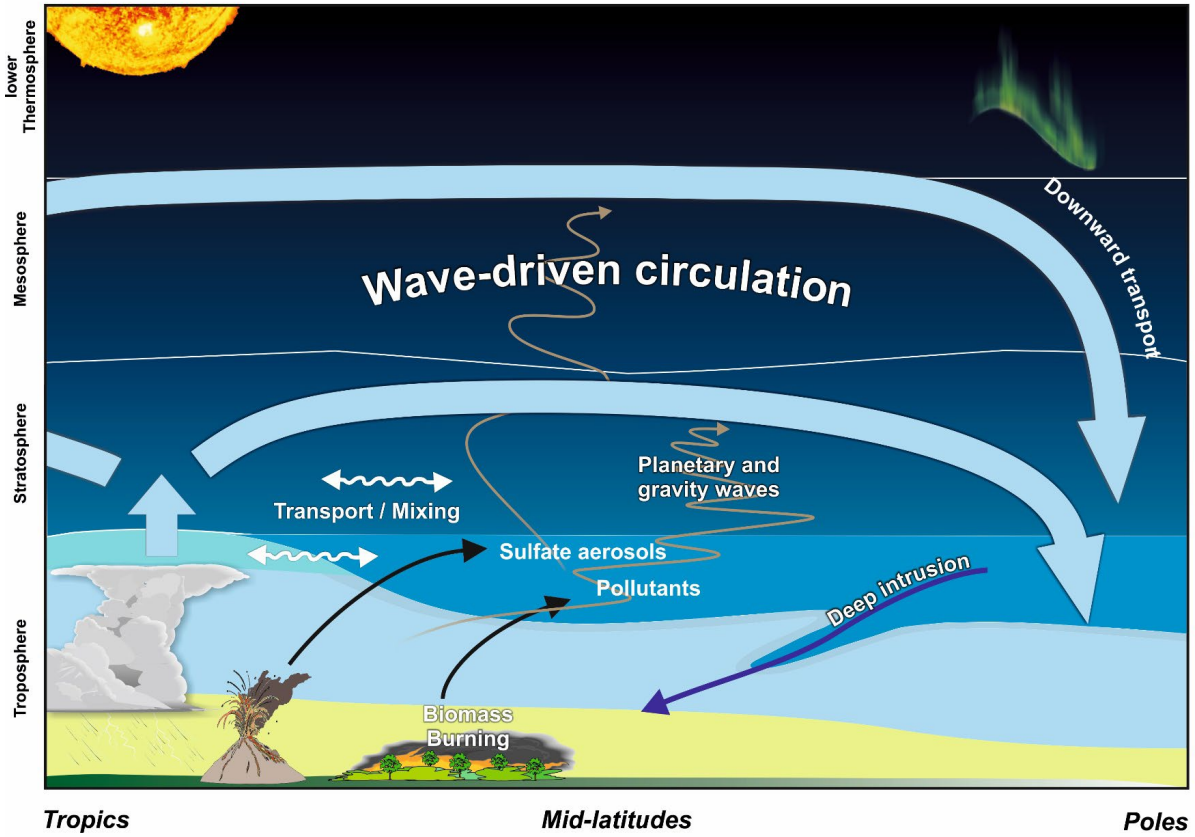


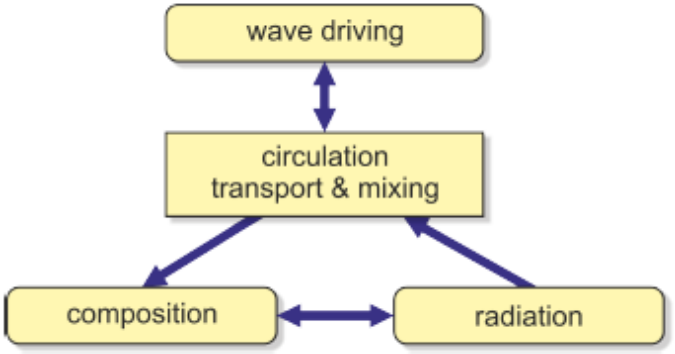
Photo: worldweatherattribution.org

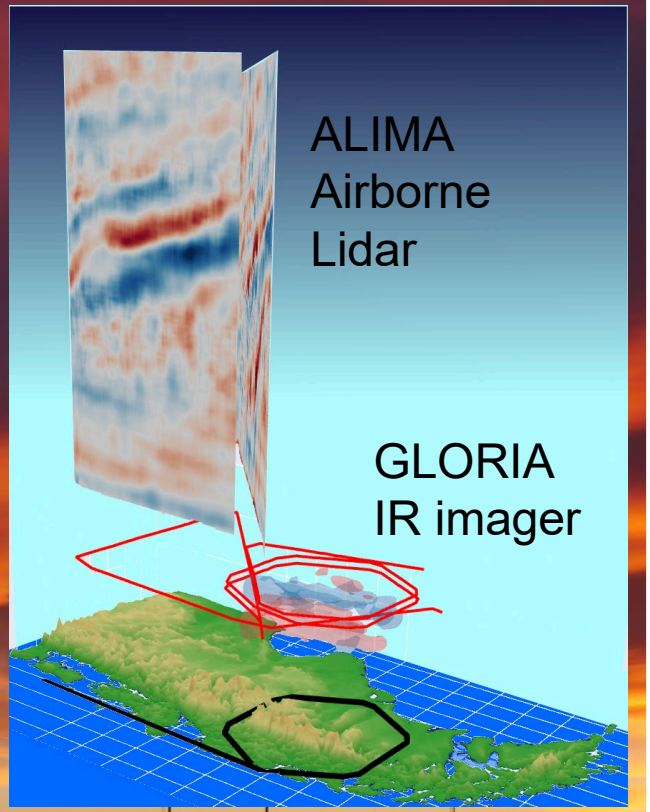
Circulation, composition and regional climate change CAIRT

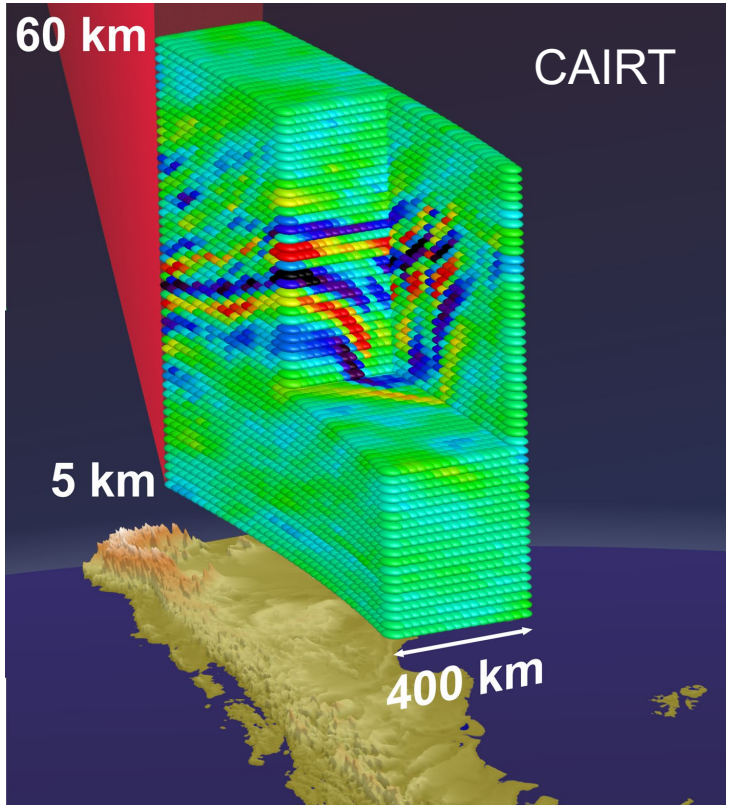


Evidence for profound changes throughout the whole atmosphere:

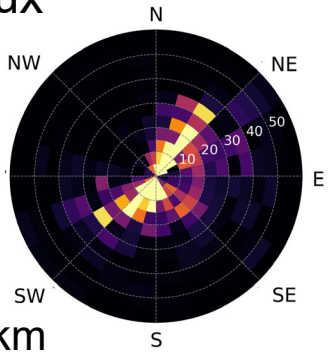
- The role of small scale processes and gravity waves



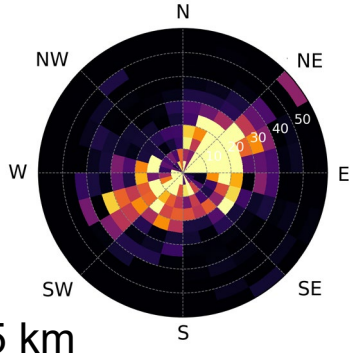




Gravity wave momentum flux



35 km



25 km

Preusse et al., Friday 14:45, Nairobi

Objective A: Quantify the middle-atmosphere circulation from the upper troposphere to the lower thermosphere (age-of-air, temperature, long-lived trace gases)

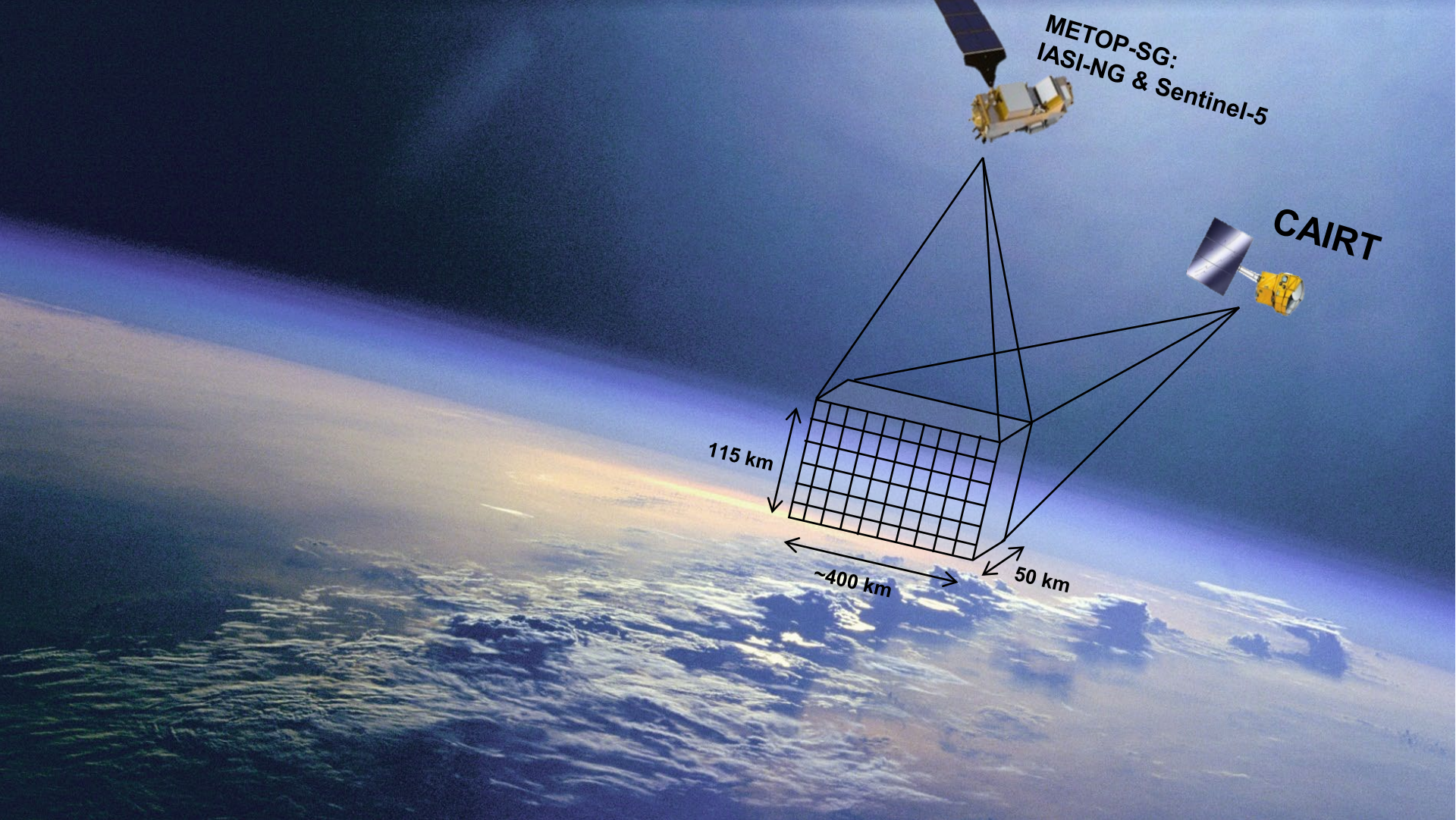
Objective B: Quantify the atmospheric gravity wave momentum flux and wave driving

Objective C: Attribute changes in stratospheric ozone due to circulation and chemistry

Objective D: Quantify the flux of reactive nitrogen species from the upper atmosphere into the stratosphere

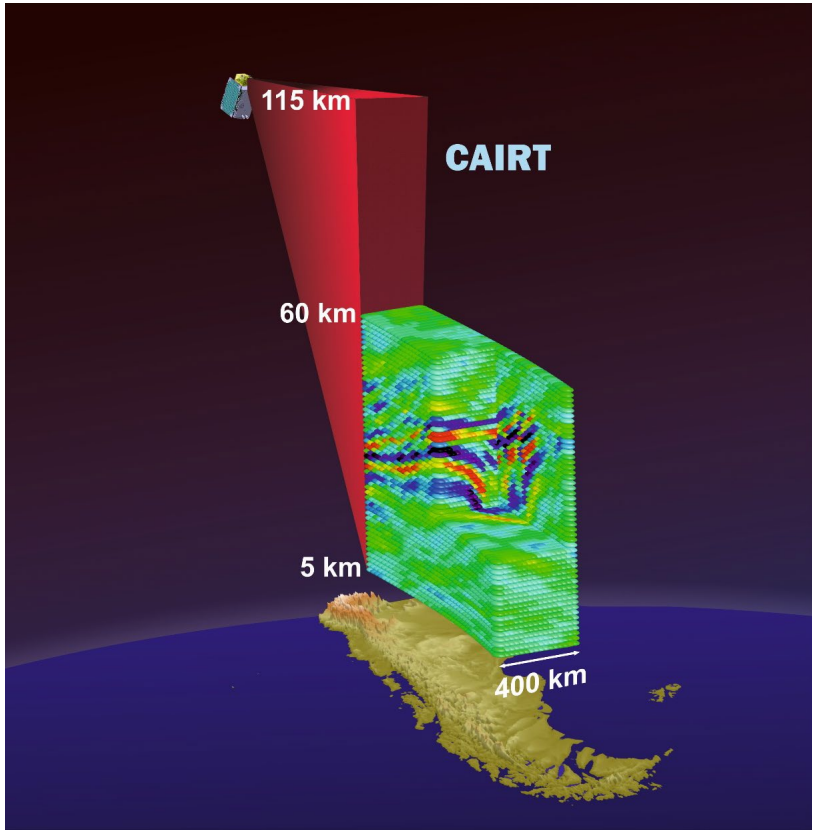
Objective E: Quantify the upper troposphere and lower stratosphere (UTLS) aerosol composition and precursor gases

Objective F: Quantify UTLS variability, stratosphere-troposphere exchange and its impact on tropospheric composition and air quality


METOP-SG:
IASI-NG & Sentinel-5
CAIRT
115 km
~400 km
50 km

Tomography by Infra-Red Limb Imaging

CAIRT



Mission characteristics

- Infrared limb imager
  - Nominal sampling 50 x 50 x 1 km
  - 5 – 115 km vertical coverage
  - 3D tomographic retrievals
- Spectral coverage
  - 710 cm^{-1} to 2200 cm^{-1} (4.5 µm to 14 µm) @ 0.1 cm^{-1} sampling
- Sun-synchronous orbit, 835 km
  - Loose formation with MetOp-SG (IASI-NG, Sentinel-5)

Level 1 data: IR limb images with high spectral resolution

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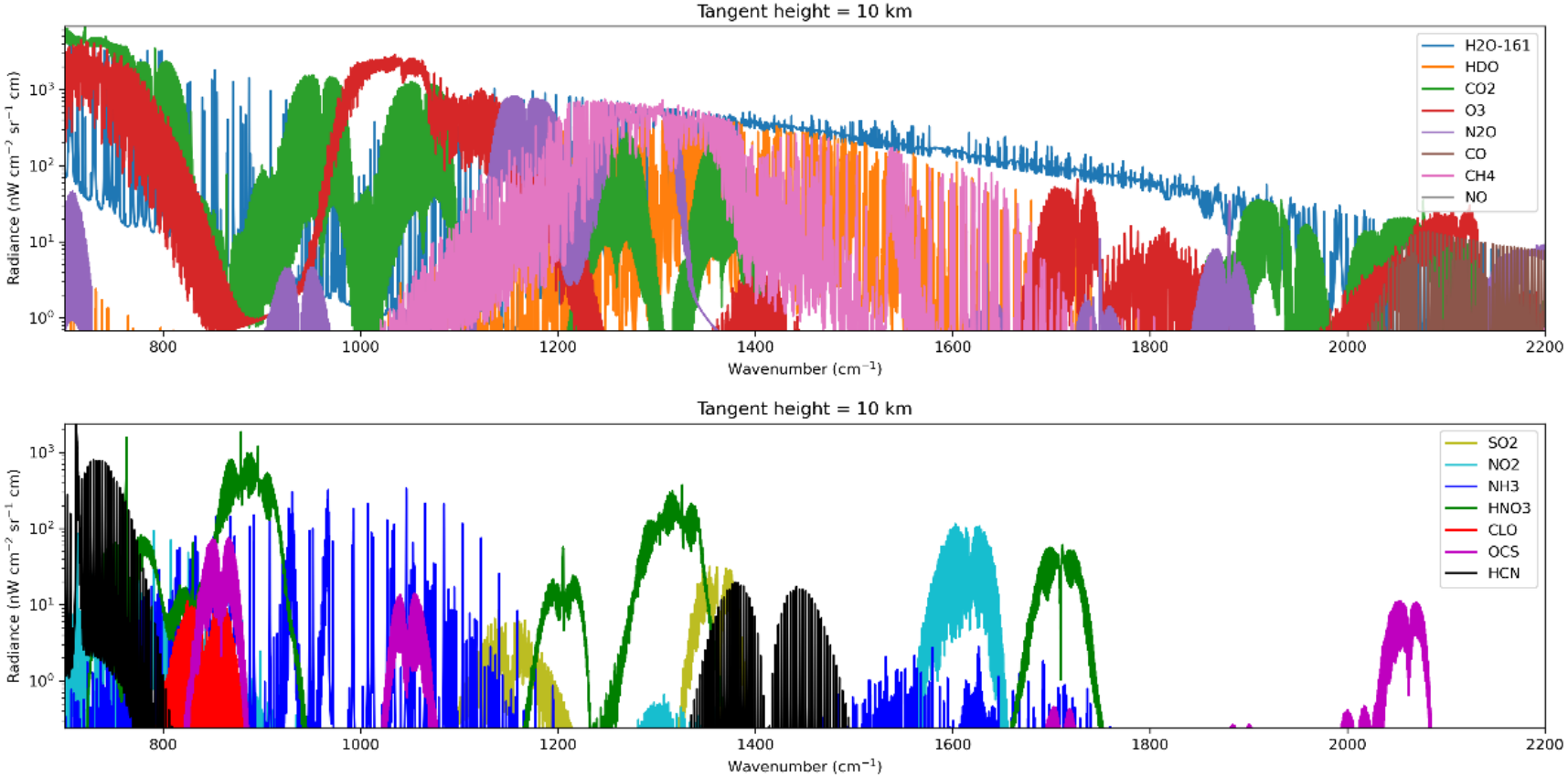

Level 2 products

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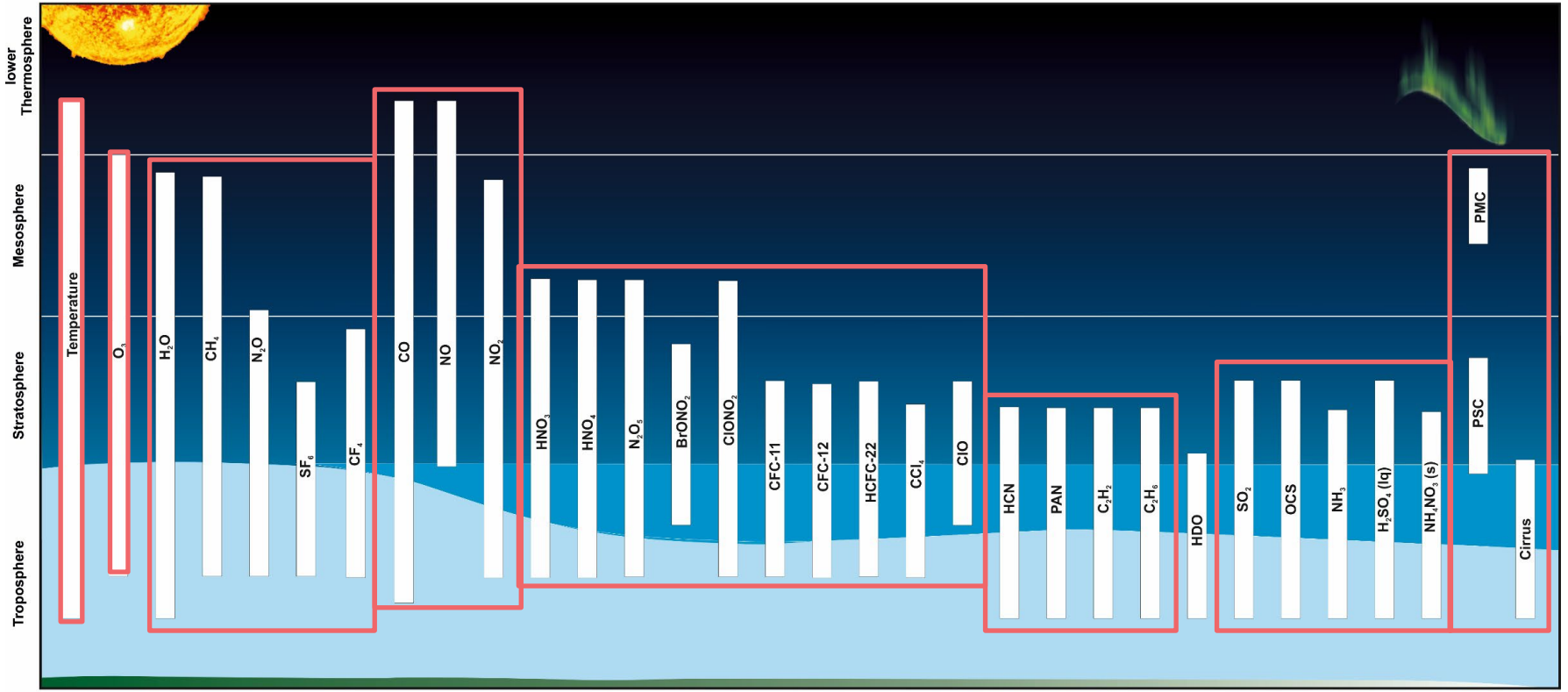
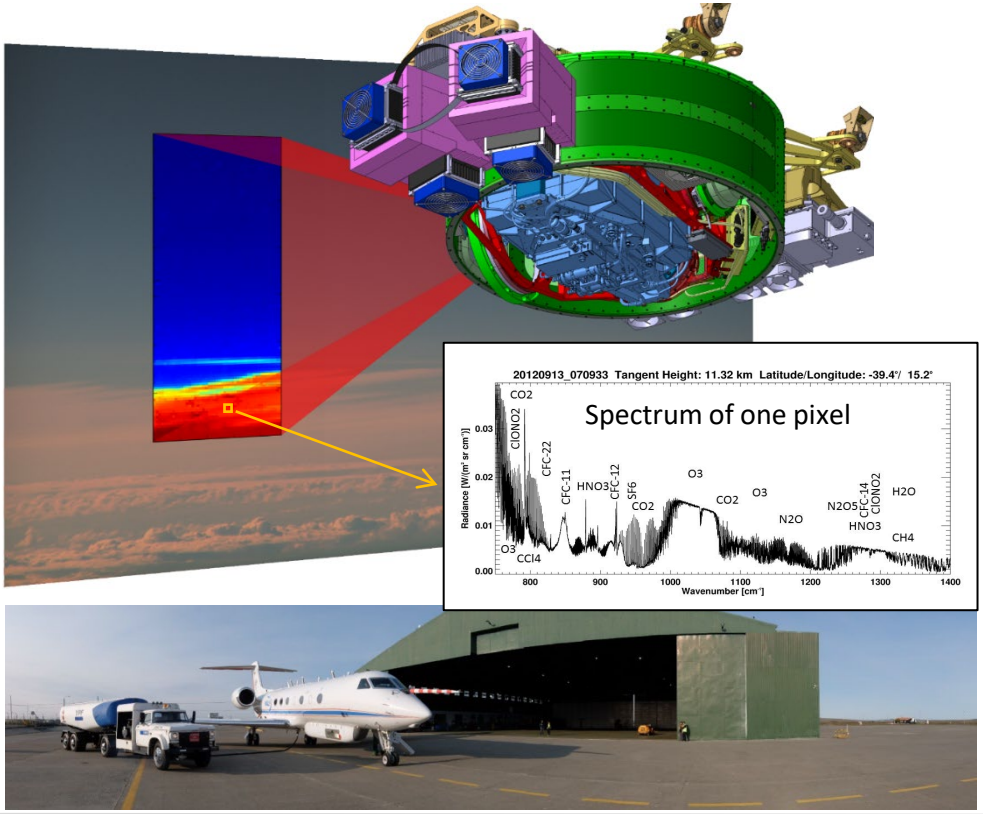
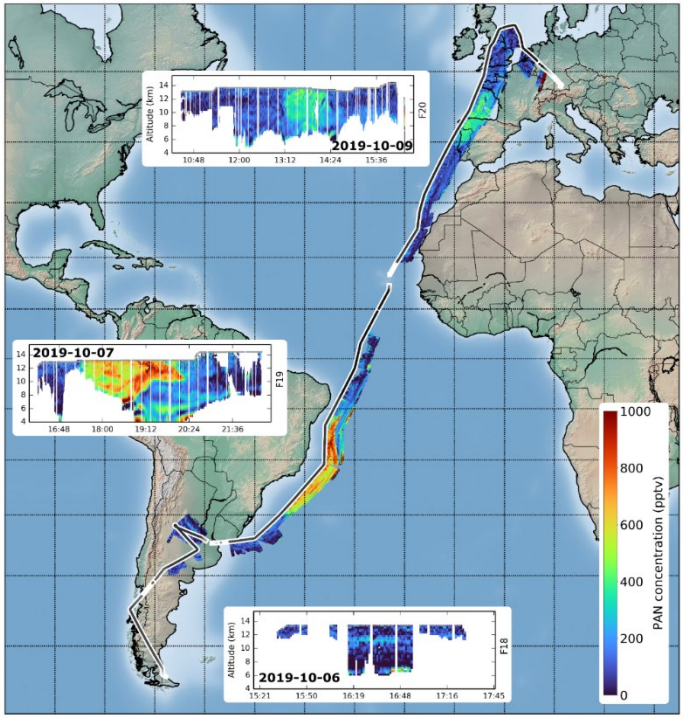


Airborne Limb-Imaging Demonstrator GLORIA



Example: Biomass burning



(Poster by Johansson et al., Day 1)

Results from CAIRT balloon campaign

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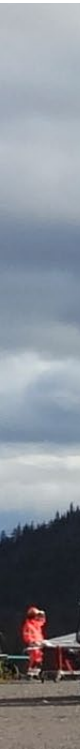

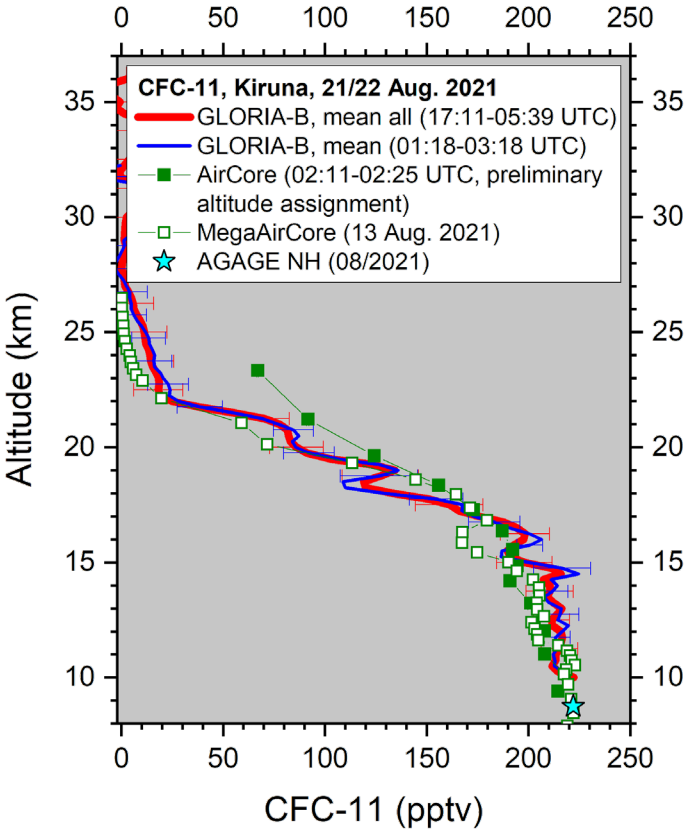

Poster by Wetzel et al., Day 2

First results from CAIRT Phase 0 Science Study

CAIRT

- **Errera et al.,** EE11 candidate CAIRT mission: objectives for **trace species** in the stratosphere and mesosphere, Poster day 2
- **Raspollini et al.,** Study of the lower stratosphere and troposphere exploiting the **synergy of limb and nadir** measurements: expected contribution of Earth Explorer 11 candidate mission CAIRT, Poster day 2
- **Höpfner et al., Aerosols** and their source gases in the upper troposphere and stratosphere from infrared limb-emission spectroscopy: a perspective on the EE11 mission candidate CAIRT from its precursors, Poster day 5
- **Funke et al.,** Towards a quantitative understanding of **space weather impacts** on stratospheric ozone and natural climate variability: expected contributions of Earth Explorer 11 candidate mission CAIRT, Poster day 5
- **Preusse et al.,** The CAIRT EE11 mission: A way towards global **gravity wave** momentum budgets, Oral on day 5 at 14:45

Summary

CAIRT

- There is a pressing need for **observations to resolve the ongoing changes** throughout the whole depth of the atmosphere
- **CAIRT** will provide the needed **global 3D tomographic measurements** of critical processes from troposphere to lower thermosphere at ~ 50 x 50 x 1 km resolution
- **First imaging IR limb sounder** in space
- High-resolution measurements of temperature will provide **momentum flux**, phase speed and direction of **atmospheric gravity waves**
- Long-lived tracers will provide information on **age-of-air, transport, mixing and circulation changes**
- A **3D picture of climate relevant trace gases and aerosols**
- Flying in formation with Metop-SG will provide **synergies with IASI-NG and Sentinel-5** for measuring tropospheric composition