Injection of unprecedented amounts of water vapor into the stratosphere by the eruption of Hunga Tonga-Hunga Ha'apai

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29 November 2022, GRUAN ICM-14

This material is based upon work supported by the National Center for Atmospheric Research, which is a major facility sponsored by the National Science Foundation under Cooperative Agreement No. 1852977.

Hunga Tonga-Hunga Ha’apai eruption sequence

Before 15 January 2022

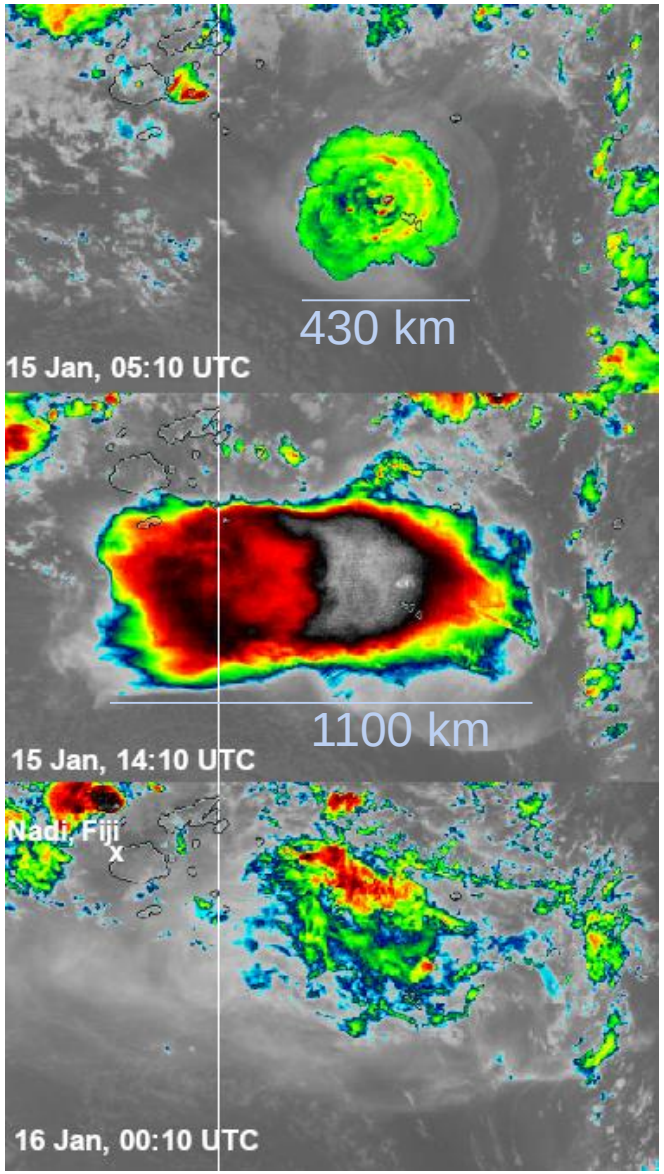
After 15 January 2022

Hunga Tonga-Hunga Ha’apai eruption sequence

05:10 UTC, 15 Jan
one hour after start
of eruption

14:10 UTC, 15 Jan
ten hours after start
of eruption

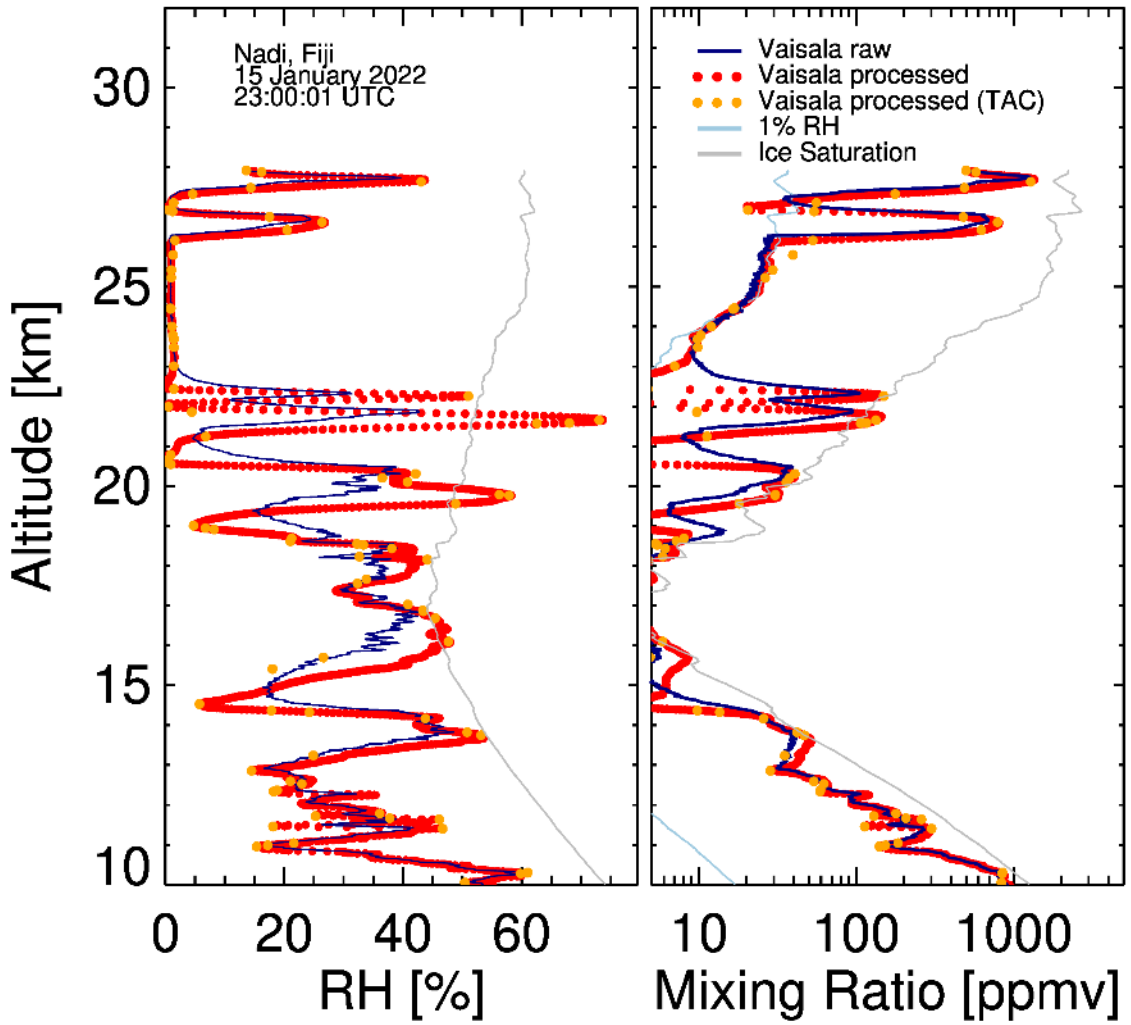
00:10 UTC, 16 Jan
19 hours after start
of eruption



10.4 μm IR images
HIMAWARI
Geostationary satellite

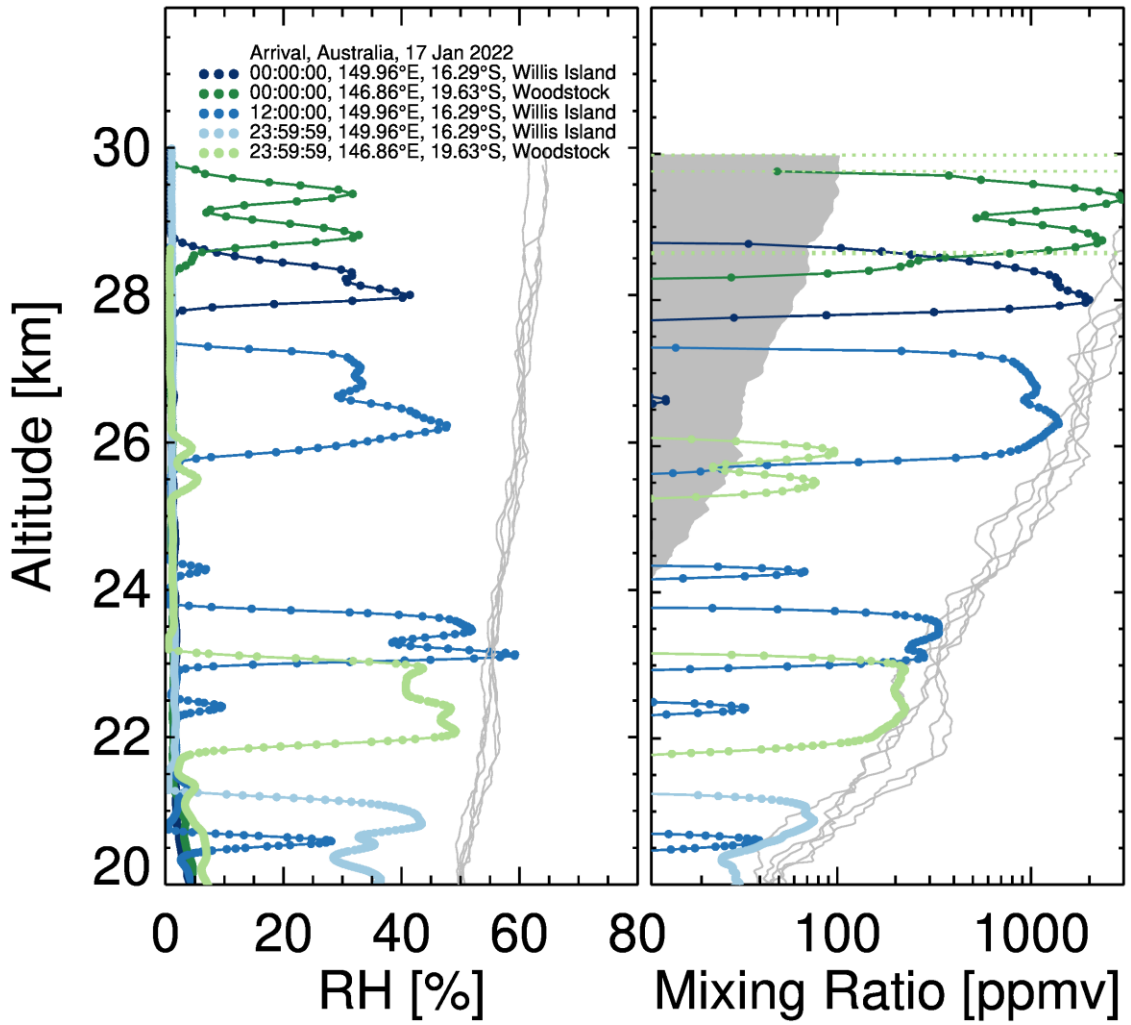
First radiosounding
at Fiji

Vaisala RS41 sounding, Nadi, Fiji, 16 Jan 00:00 UTC



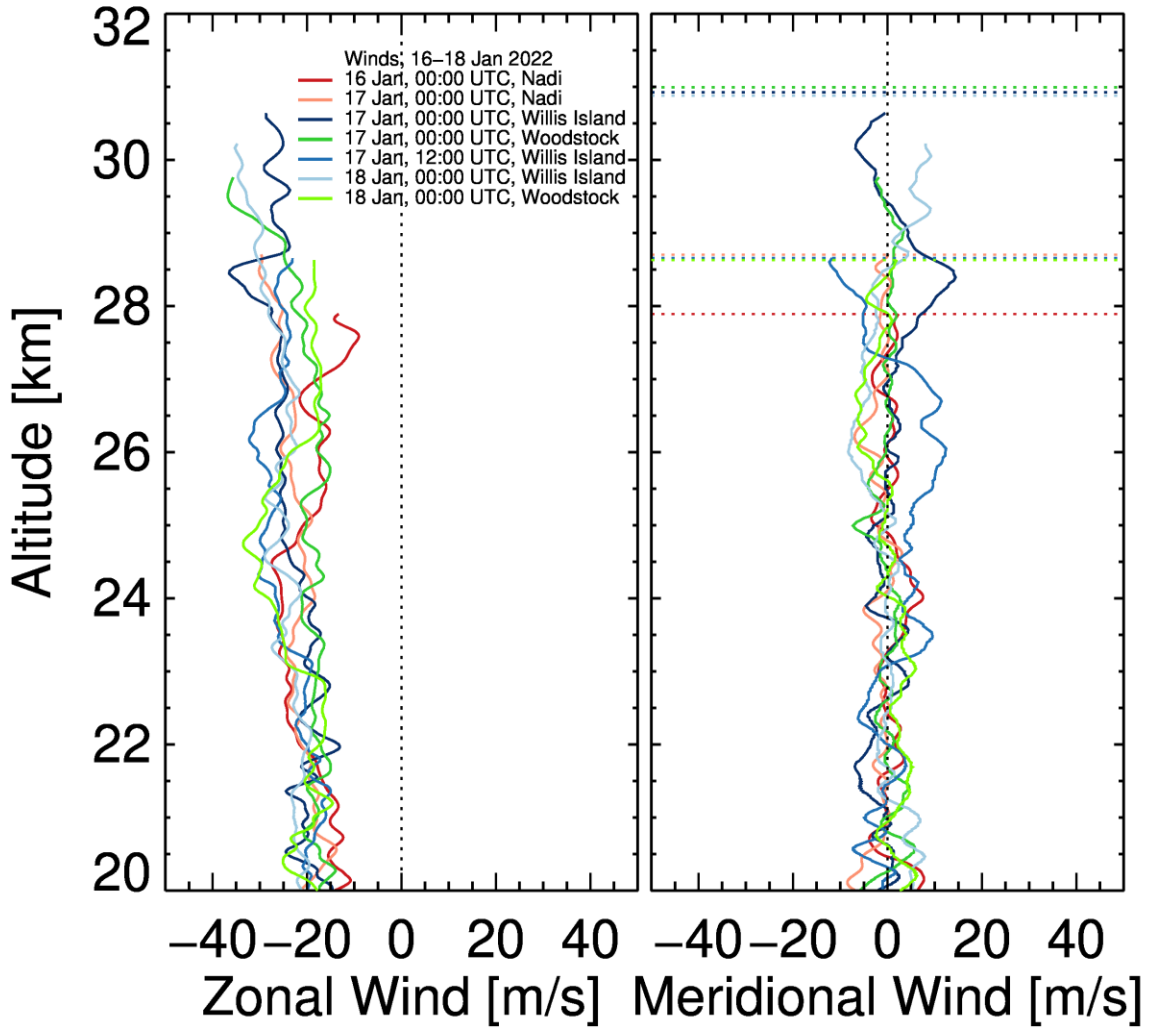
High resolution data thanks to Fiji Meteorological Service

Vaisala RS41 soundings, East Coast, Australia, 17 Jan 00:00 - 24:00 UTC



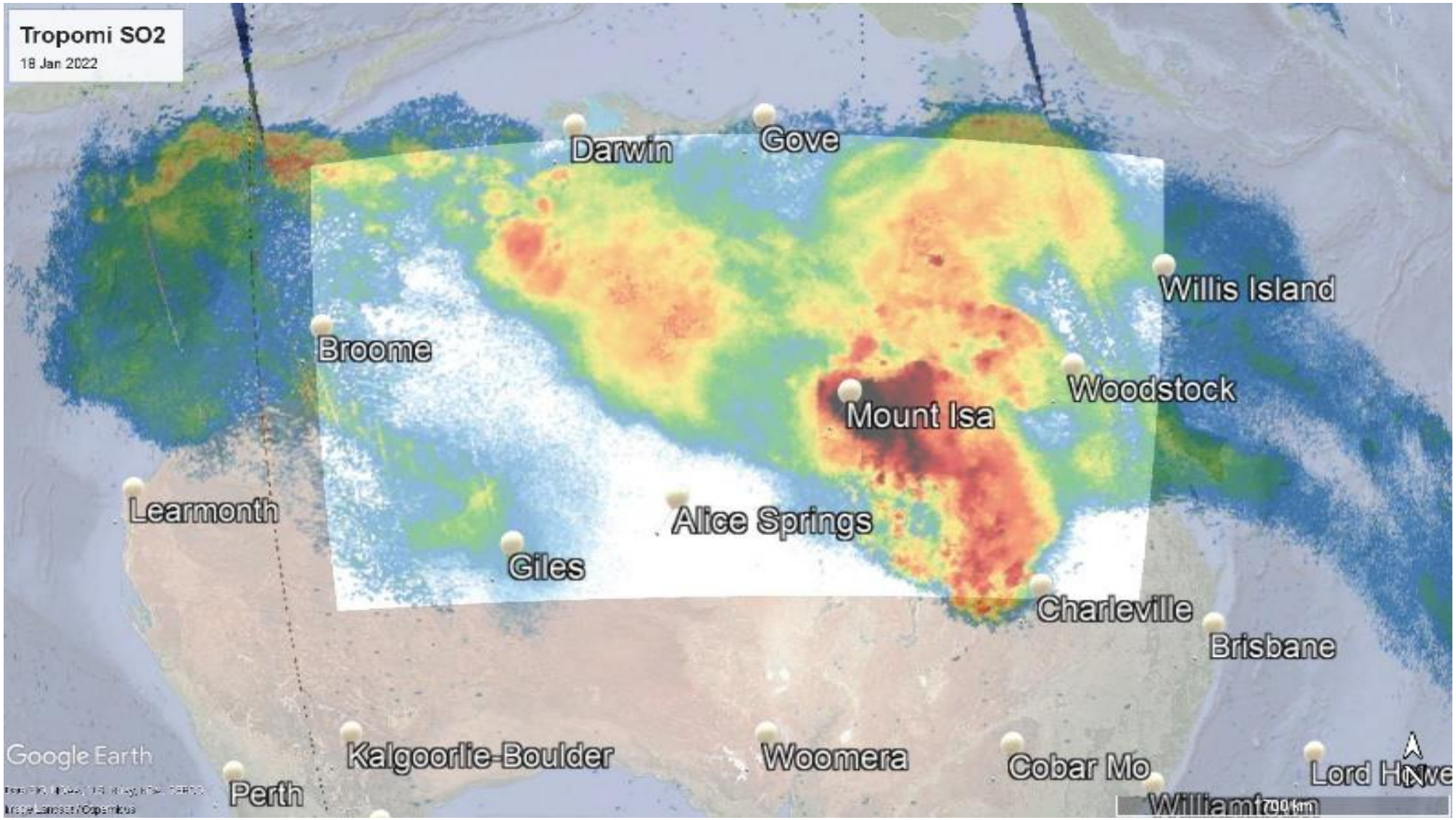
Wind shear

Wind shear of
30 m/s at 30 km
20 m/s at 20 km

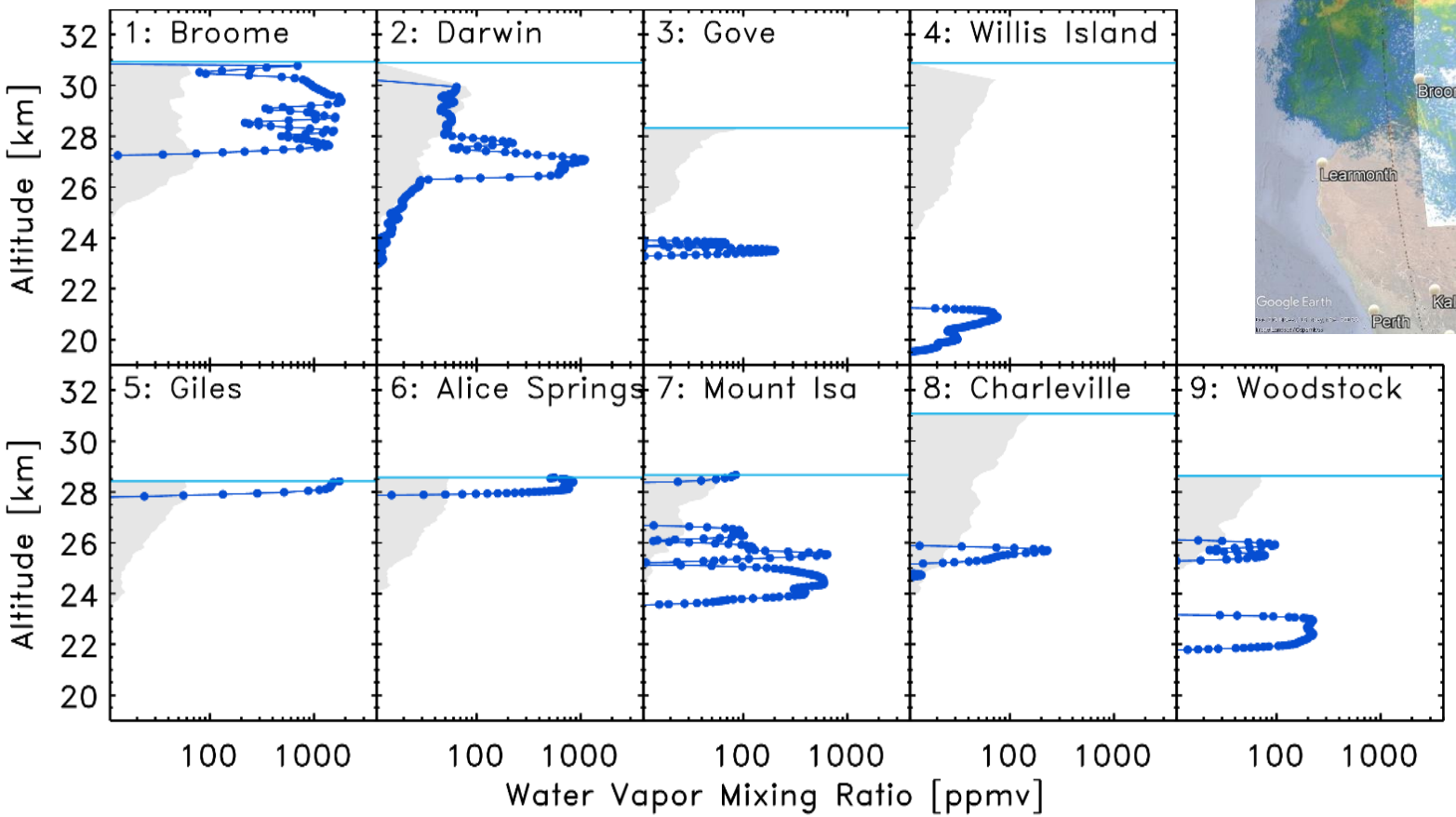


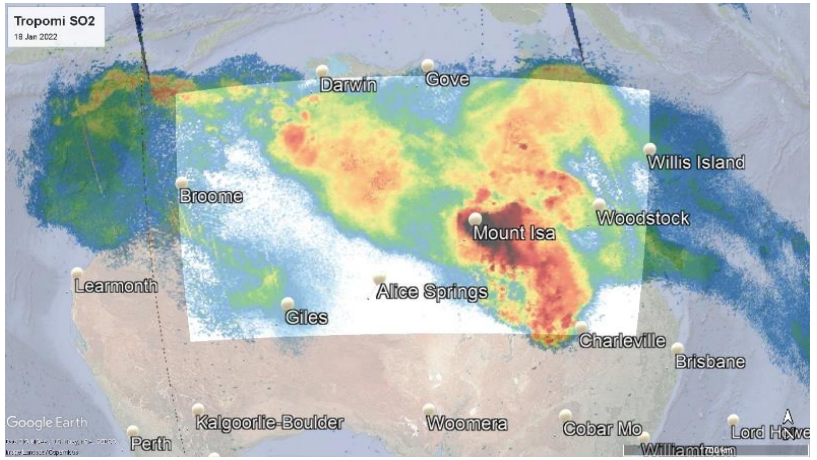
Vaisala RS41 soundings, Australia, 18 Jan 00:00 UTC

SO2 distribution from TropOMI



Vaisala RS41 soundings, Australia, 18 Jan 00:00 UTC



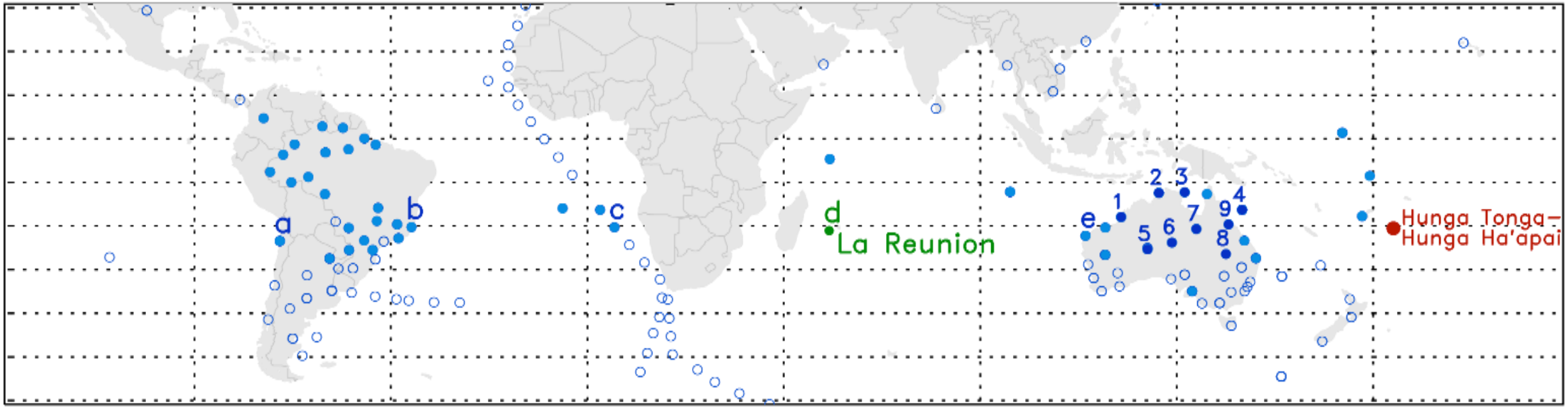


SO2 distribution from TropOMI

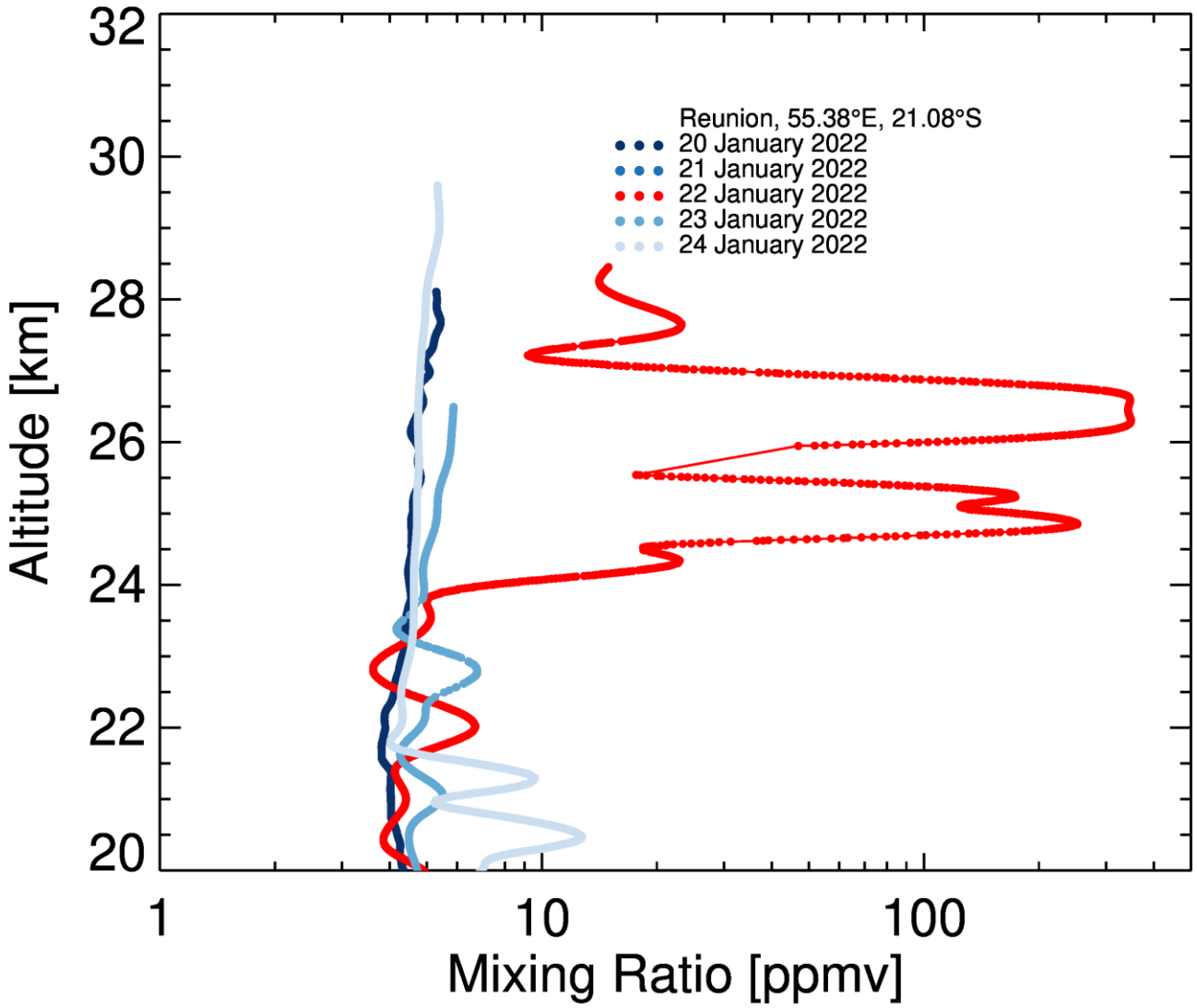
Amount of injected water vapor > 50 Tg (maybe up to 100 Tg)

> ~ 5% of global stratospheric water vapor mass

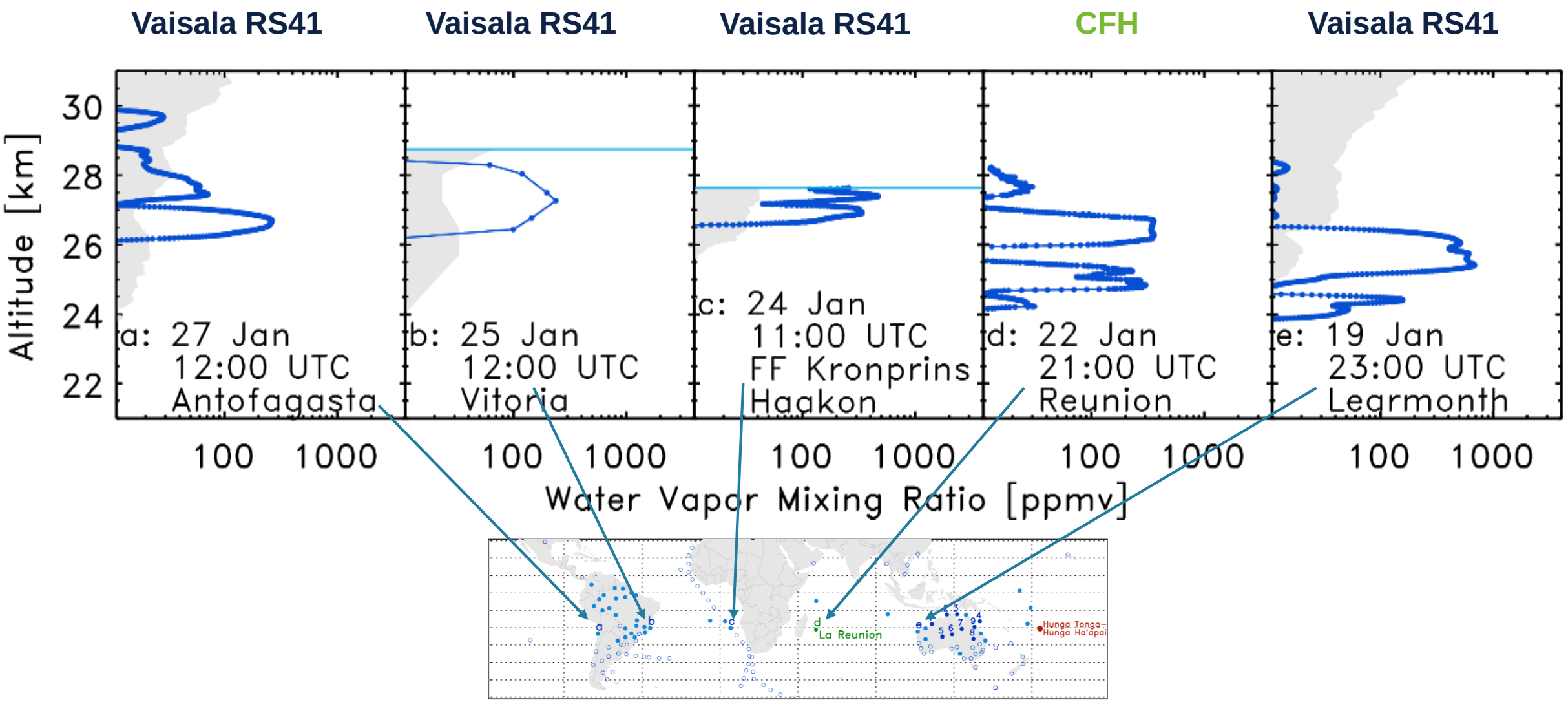
Map of all soundings



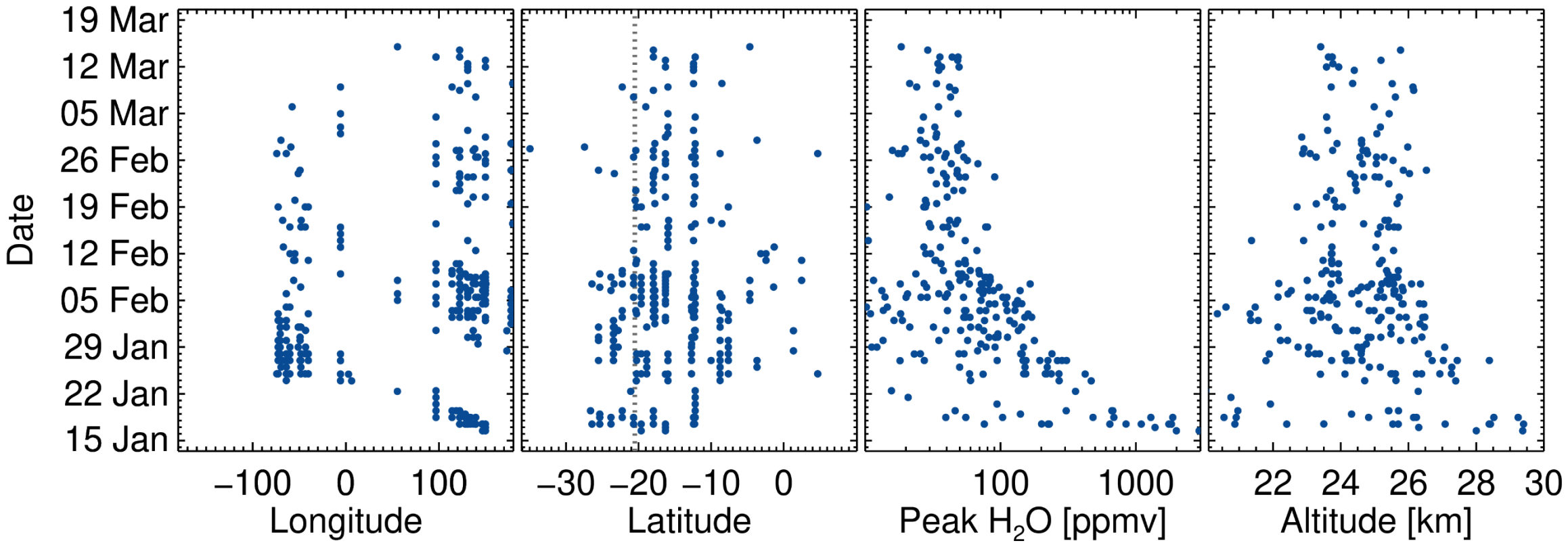
CFH Profiles at Reunion



Sequence of first detection along 20°S, 19-27 Jan 2022

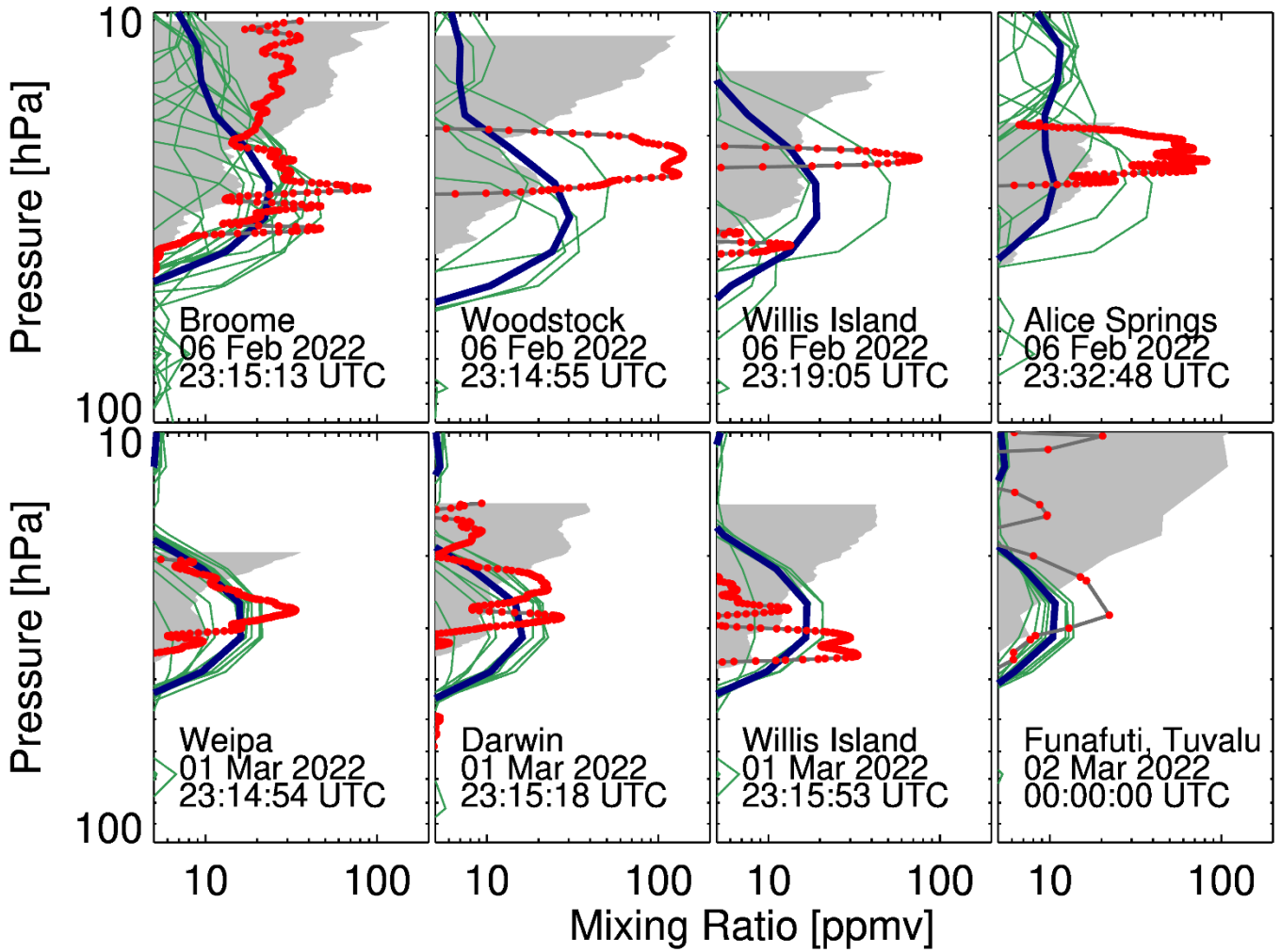


Tracking the plume

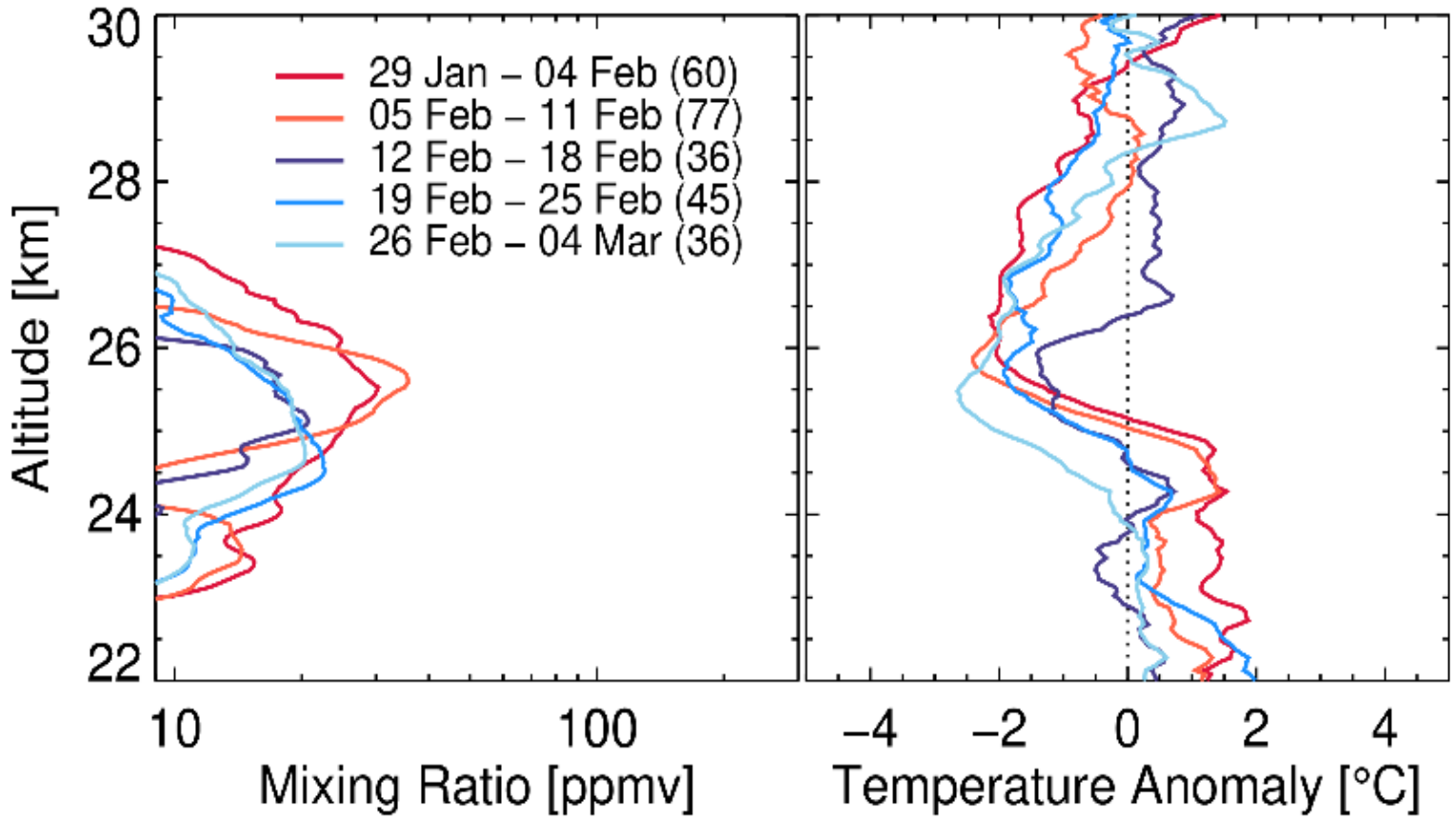


Each data point is one Vaisala RS41 sounding

What does MLS see



Radiative impact



Summary

- Operational Vaisala RS41 radiosondes provide in situ observations of the eruption
- Injection of more than 50 Tg (maybe up to 100 Tg) water vapor into the stratosphere
- Initial concentrations of water vapor in excess of 2000 ppmv
- Initial mixing ratio profiles limited by the ice saturation
- Wind shear caused slanting of the plume, i.e. earlier arrival at higher altitude
- Center of water vapor layer at around 25 km (mid February through late March)
- Mixing ratio peak in the plume in the range 30 ppmv and decreasing
  (Status end of March based on Vaisala RS41 radiosondes)
- Evidence of radiative cooling within the water vapor layer.

Reference:

Vömel H., S. Evan, and M. Tully (2022): Water vapor injection into the stratosphere by Hunga Tonga-Hunga Ha'apai, Science, 377, 1444-1447, doi.org/10.1126/science.abq2299.

Data available at: https://doi.org/10.5065/p328-z959