

Abstract

The SAFIRE-A Fourier transform Far-infrared spectrometer has been involved in field campaigns carried out with the M-55 Geophysica stratospheric aircraft in 2002-2003, with the aim of validating the level-2 products of the ENVISAT chemistry instruments. The limb sounding observations of volume mixing ratio vertical profiles of Ozone, Nitric Acid and Nitrous Oxide were especially focused on the validation of MIPAS data in the altitude range 10-20 km.

Three campaigns have been conducted with the Geophysica platform from Forlì, Italy (Lat. 44°N, Lon. 12°E) in July and October 2002 and from Kiruna, Sweden (Lat. 68°N, Lon. 20°E) in February-March 2003, as part of the ESABC (ENVISAT Stratospheric Aircraft and Balloon Campaigns) activities, with a total of 11 flights and 45 flight hours devoted to the validation of the ENVISAT chemistry payload.

Here, we report the results of measurements of O₃, HNO₃ and N₂O acquired by SAFIRE-A during the mid-latitude flight on the 10th of October 2002 and during the Arctic flight on the 2nd of March 2003.

The SAFIRE-A Instrument

SAFIRE-A (Spectroscopy of the Atmosphere using Far InfraRed Emission-Airborne) is a high resolution Fourier Transform spectrometer for limb sounding measurements of the atmospheric emission in the far-infrared. The instrument operates aboard the M-55 Geophysica aircraft and is capable of measuring the VMR vertical profiles of several atmospheric compounds from flight altitude (max. 20 km) down to the tropopause level.



Figure 1 - The SAFIRE-A spectrometer on-board the M-55 Geophysica aircraft during pre-flight operation

Instrument type	Polarising interferometer
Observation geometry	Limb sounding
Overall Dimensions	1800 x 880 x 650 mm
Total Weight	387 kg
Spectral Range	10 – 250 cm ⁻¹
Max. Spectral Resolution	0.004 cm ⁻¹
Number of detection channels	2
Filter bandwidth	Typically 2 cm ⁻¹
Field of view	0.57°
Vertical resolution	1.5 km
Interferogram acquisition time	12, 24, 48, 96 sec
Number of spectra in a sequence	11
Spectral Signal to Noise Ratio	> 500

Table 1 - SAFIRE-A: Main instrument characteristics

The mid-latitude validation flight on 24.10.2002

The flight on 24.10.2002 was planned in coincidence with the night-time ENVISAT overpass, aiming as a first priority at the validation of MIPAS observations along the orbit 3404 (scan 6 and scan 7).

In Fig. 2, the flight route is shown, along with the geo-location of MIPAS and SAFIRE-A tangent points. The same colour scale has been used to represent the flight altitude and the tangent heights. Black dots indicate the average location of the aircraft during the acquisition time of each SAFIRE-A sequence.

Due to the present unavailability of MIPAS level-2 products for orbit 3404, SAFIRE-A measurements of O₃, HNO₃ and N₂O profiles have been compared with MIPAS profiles from scan 2 and scan 3 of orbit 3418 (on 25th October 2002, ≈ h.20:50 UTC) recorded approximately at the same latitude, but ≈ 8° eastward in longitude.

In Fig. 3, results of this comparison are shown. A good agreement is generally observed between SAFIRE-A and MIPAS profiles of O₃ and HNO₃. Consistent values are also found for the vertical distribution of N₂O, even if, in this case, a systematic difference between MIPAS and SAFIRE-A profiles, with MIPAS values always 10 to 25% greater.

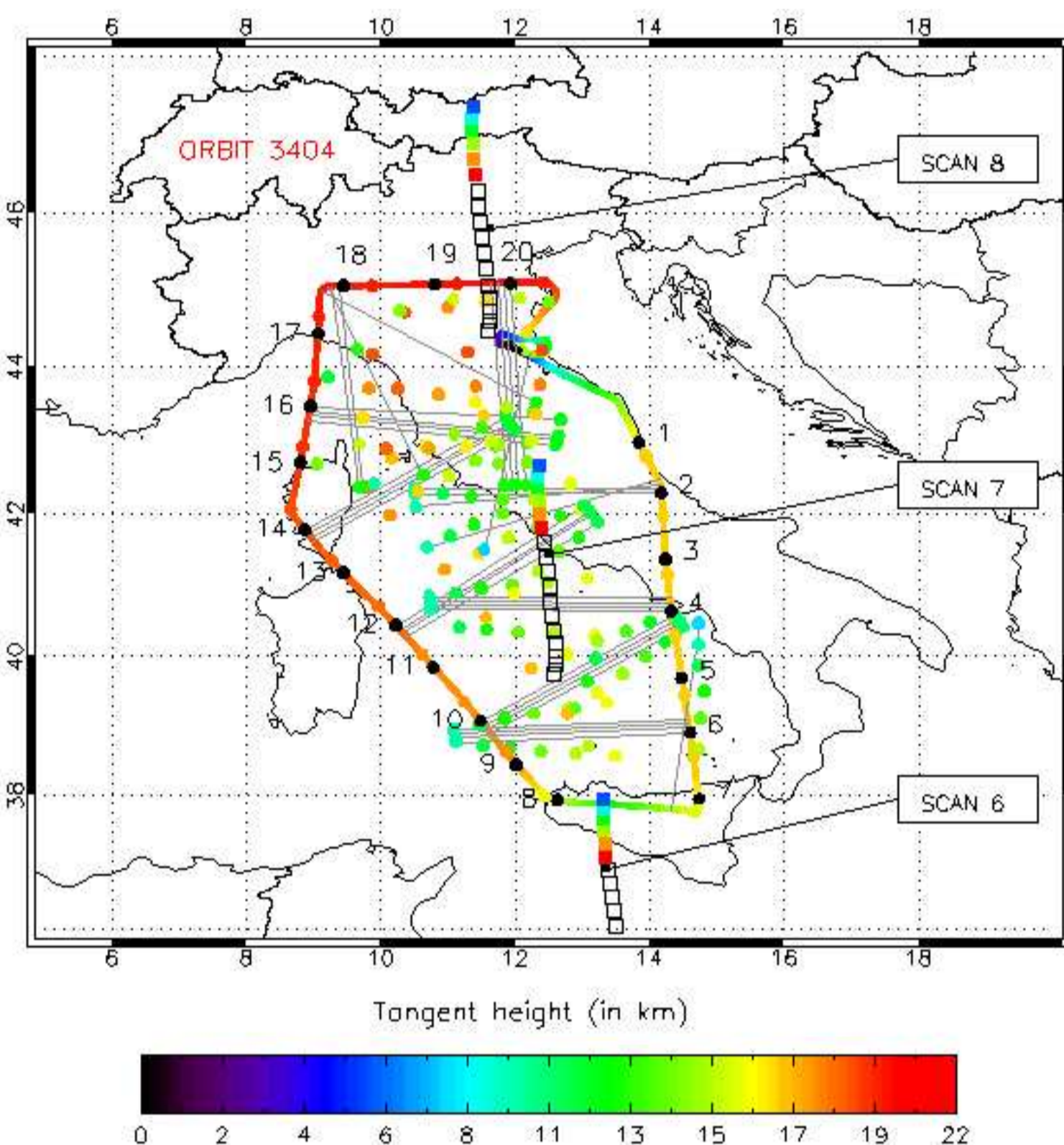


Figure 2 – Map of the 24.10.2002 flight

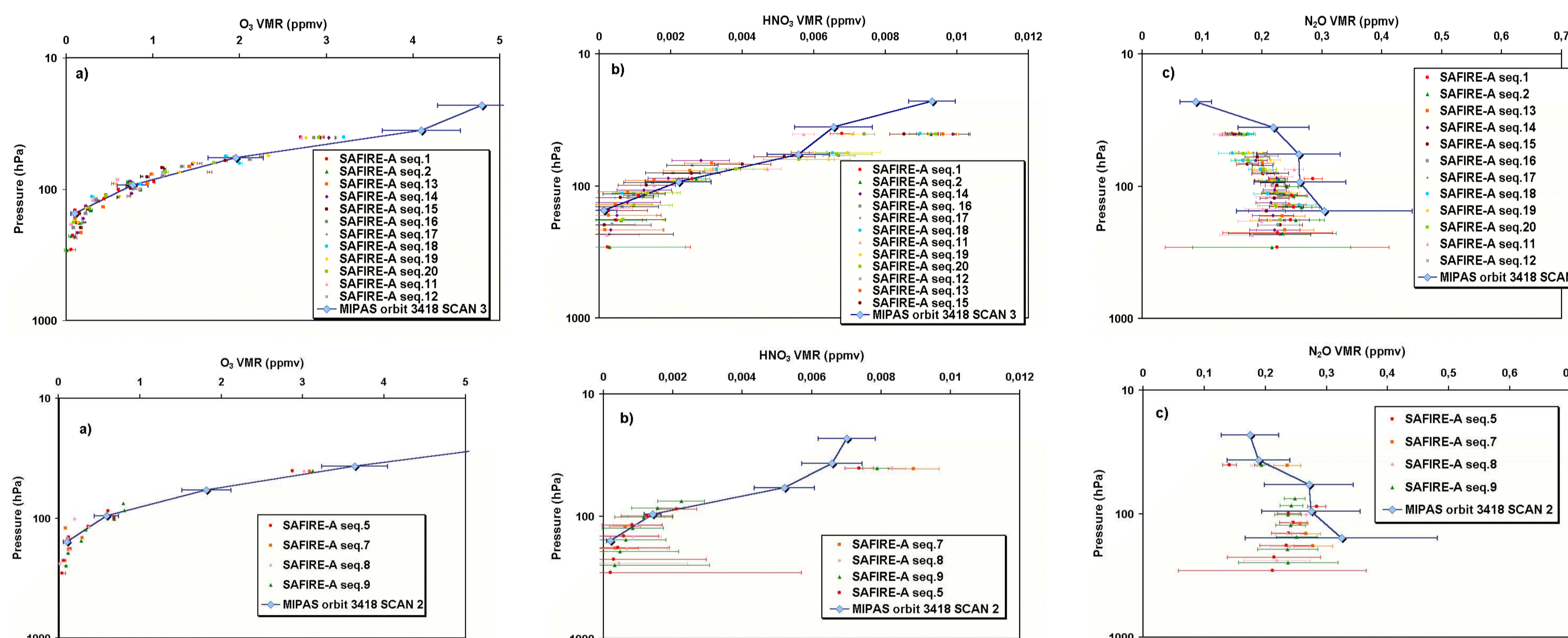


Figure 3 – Comparison between O₃, HNO₃ and N₂O profiles measured by SAFIRE-A (24.10.2002) and MIPAS (25.10.2002)

The Arctic validation flight on 02.03.2003

The flights performed from Kiruna in February - March 2003 aimed at validating level-2 products of the ENVISAT chemistry instruments in presence of strong horizontal and vertical gradients. On 2nd of March 2003, the SAFIRE-A limb sequences were planned to sound the same air masses explored by MIPAS scans 11, 12 and 13 on the orbit 5250, whilst the aircraft was flying across the border of the polar vortex, as shown in Fig. 4 and 5.

An excellent spatial and temporal overlapping was obtained between MIPAS scan 8 and SAFIRE-A sequence 19.

In Fig. 6 the O₃, HNO₃ and N₂O vertical distribution retrieved by SAFIRE-A are compared with the corresponding VMR profiles measured by MIPAS approximately at the same time. Additional profiles from SAFIRE-A sequences 2, 3 and 4 (acquired at the same latitude a couple of hours earlier) are also plotted to get an indication of the atmospheric variability within the time of the flight. Once again a good agreement is obtained for O₃ and HNO₃ profiles, whilst for N₂O MIPAS still provides slightly higher values than SAFIRE-A, with differences that are significantly larger than the errors at altitudes around 100 hPa (approx. 16 km).

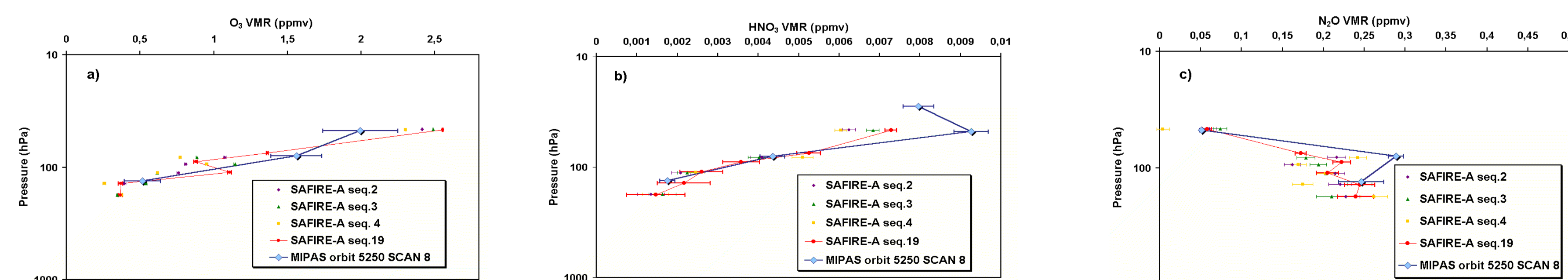


Figure 6
Comparison between O₃, HNO₃ and N₂O profiles measured on 02.03.2003 by SAFIRE-A (h ≈ 21:30 UTC for seq. 19) and MIPAS (h ≈ 20:35 UTC)

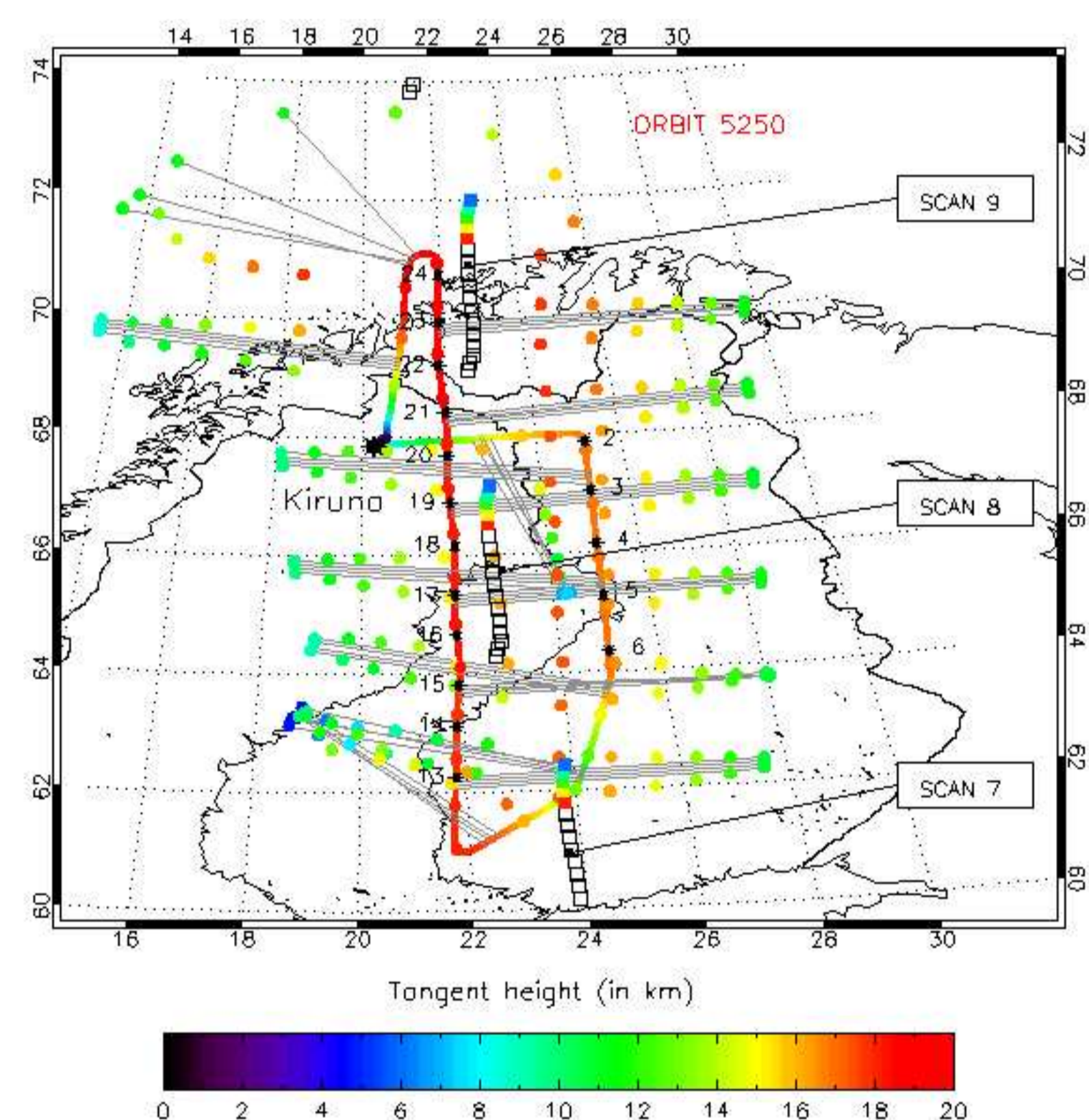


Figure 4
Map of the 02.03.2003 flight

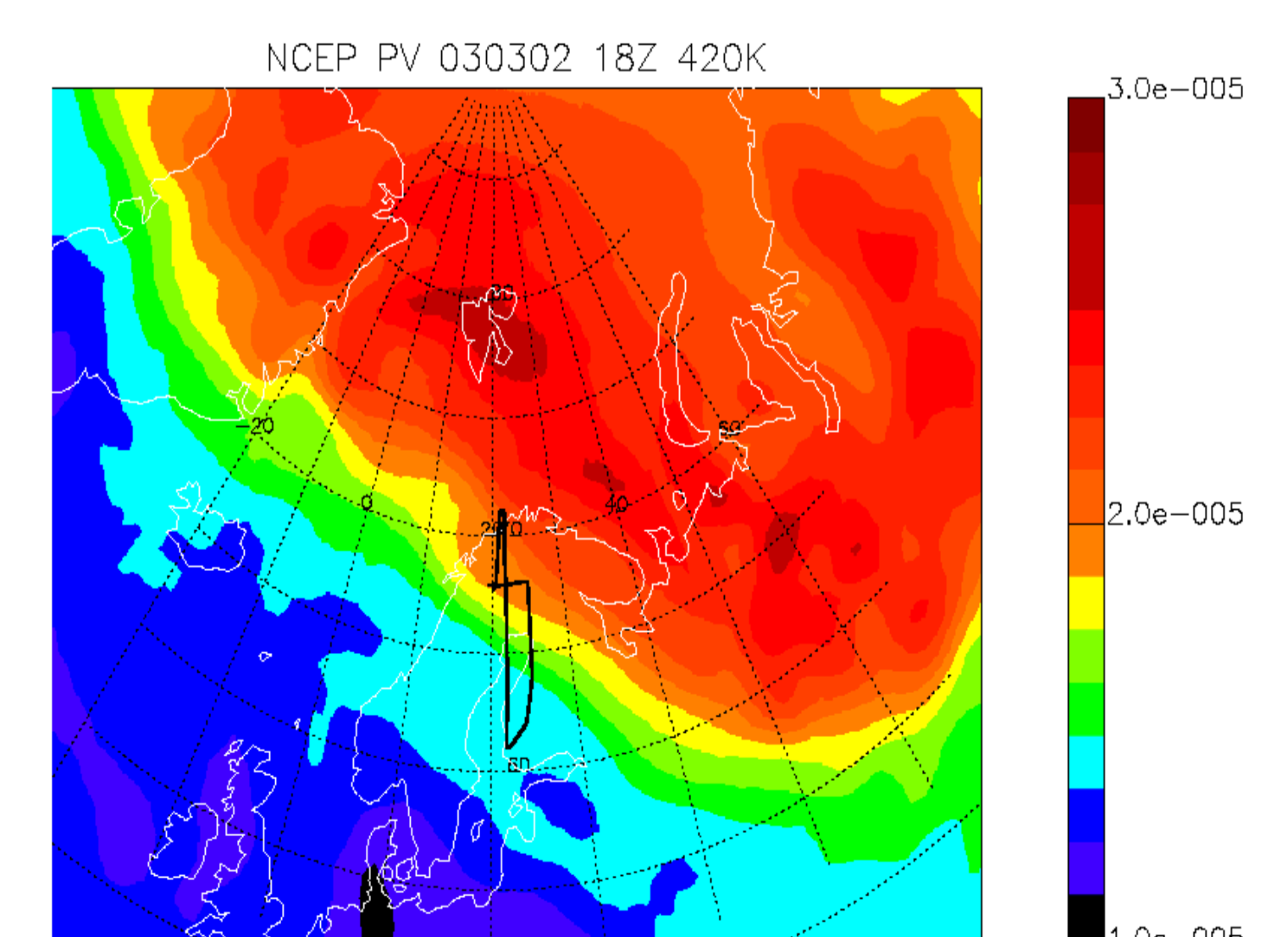


Figure 5
False colour map of potential vorticity for the 420 K isoentropic surface (NCEP, 18:00Z) and M-55 Geophysica flight route .