Preliminary results from SPIRALE balloon-borne *in situ* stratospheric measurements during 2009 polar summer

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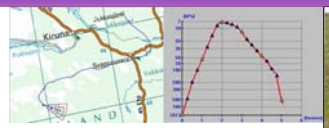
The SPIRALE (French acronym for infrared absorption spectroscopy by tunable laser diodes) balloon-borne instrument has been launched twice within 17 days in the polar region (Kiruna, Sweden, 67.9°N – 21.1°E) during summer, at the beginning and at the end of august 2009. In situ measurements of the trace gases O_3, CH_4, CO, OCS, N_2O, HNO_3, NO_2 and HCl have been performed between 10 and 34 km height, with very high vertical resolution (~5 m). The stratospheric profiles of these species present specific structures associated with tropical intrusion in the low levels. Both flight results are compared between each other in order to evaluate the impact of the turn-around occurring during this season on the chemical composition of the stratosphere.

The SPIRALE instrument: Infrared absorption spectroscopy of tunable laser diodes

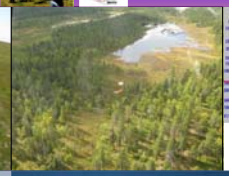
- ✓ ***In situ*** **measurements of several tracers and chemically active species.**
- ✓ **Laser absorption takes place in an open air Herriott cell with 6 diodes as light sources in the domain 1250 - 3000 cm^{-1}.**
- ✓ **Very long absorption path (434 m here) between 2 mirrors due to a deployable mast 3.5 m.**

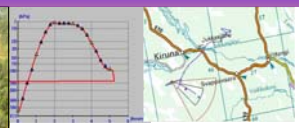
- ✓ **Fast measurements (every 1.1 s) permit a vertical resolution of 5 m.**
- ✓ **Detection limits of few 10 pptv with uncertainties of 3% - 30% depending on the abundance of the species.**

SPIRALE 1st flight: 07 Aug 2009: DAYTIME
Measurements from 01:45 to 06:00 UT (3h45-8h local)



Trajectory and Profile

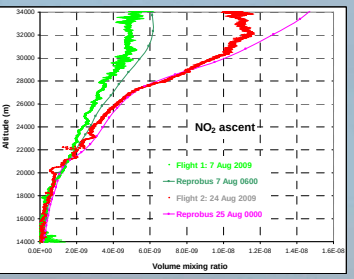




Trajectory and Profile

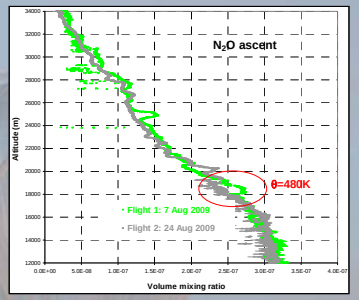
SPIRALE 2nd flight: 24 Aug 2009: NIGHTTIME
Measurements from 20:49 to 01:38 UT (22h29 – 3h38 local)

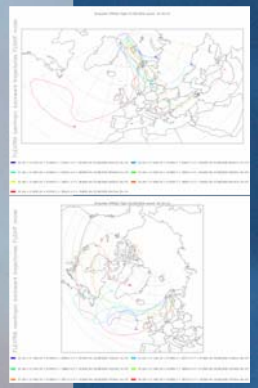
♦NO_2



- Diurnal effect on NO_2 correctly reproduced by Reprobus 3D-CTM (Lefèvre et al., 1994)
- As expected, diminution of the concentration in the stratosphere: N_2O principal natural source of NO_x in the stratosphere → Anti-correlation between N_2O and NO_2.
- At 18-20 km (θ=480K), higher N_2O mixing ratio for Flight 1 than for Flight 2, anti-correlated to HNO_3 and HCl lower mixing ratios, corresponding to northern latitudes backward trajectories (Flextra model: Stohl et al., 1995).

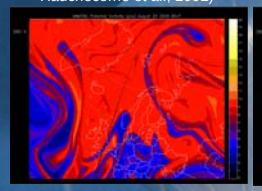
♦N_2O

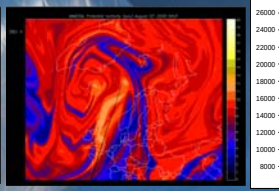


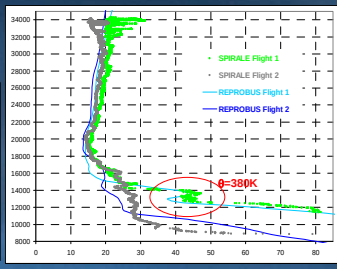


♦CO

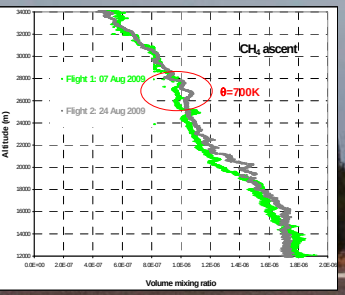
- At 12-14 km (θ=380K), great difference in CO and O_3 mixing ratios between Flight 1 and Flight 2
- → tropical intrusion shown on PV maps below (Mimosa model: Hauchecorne et al., 2002)



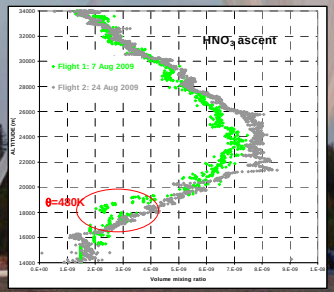




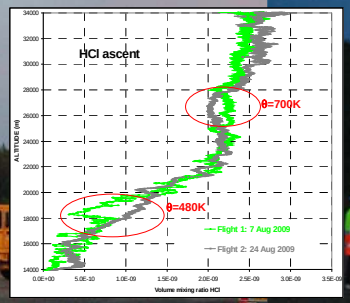
♦CH_4



♦HNO_3

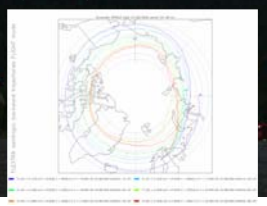


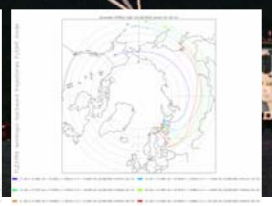
♦HCl

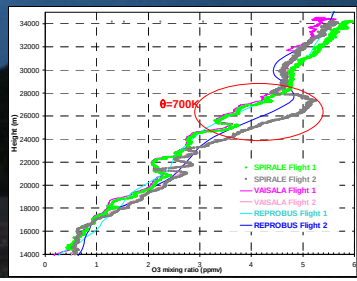


♦O_3

- O_3 confirmed by Vaisala probe.
- Notable increase of O_3 at 26-28 km (θ=700K) for Flight 2 / Flight 1, correlated to CH_4 and anti-correlated to HCl, corresponding to more southern backward trajectories (Flextra model: Stohl et al., 1995).







SPIRALE BALLOON DATA: a tool for dynamics studies, a reference for satellite data, a basis for global and small scales modelling processus studies → better understanding of the summer polar stratosphere

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