VALIDATION OF SCIAMACHY WATER VAPOR AND METHANE PROFILES BY BALLON-BORNE IN-SITU MEASUREMENTS WITH THE "CHILD" SPECTROMETER ONBOARD TRIPLE

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ABSTRACT

The lightweight near-infrared tunable diode laser spectrometer CHILD (**C**ompact **H**igh-altitude **I**n-situ **L**aser **D**iode spectrometer) was flown as an additional sensor on the TRIPLE gondola during two Envisat Validation Campaigns from Aire sour ´l Adour (France, fall 2002) and Kiruna (Sweden, spring 2003) to measure stratospheric CH_4 and H_2O profiles using in-situ TDL spectroscopy. In both cases, flight parameters were optimized to match ENVISAT overpasses during descent of the payload. Spectra were recorded from ground to float level (approx. 32.000 m). Another high-latitude campaign to take place in June 2003 from Esrange, Kiruna is currently being prepared.

1. GENERAL

With the ongoing progress in the processing and elaboration of level-2 (tracegas concentrations) data of the satellite spectrometer SCIAMACHY, *in situ* measurements of relevant atmospheric trace gases by aircraft or balloon missions are important for the validation of these data products. The CHILD spectrometer performed two flights within the framework of the ESABC (Envisat Stratospheric Aircraft and Balloon Campaigns) onboard the TRIPLE gondola, a third flight is currently (summer 2003) under preparation. The results show reliable and contamination-free *in situ* operation of the spectrometer. CHILD uses near-infrared tunable diode laser absorption spectroscopy (NIR-TDLAS), a proven and widely accepted method for trace gas measurements. Wavelengths used are 1393 nm for water vapour and 1648 nm for methane. The absorption features recorded by CHILD are the same that also can be used for the level-2 processing of SCIAMACHY data. Thus, uncertainty of spectroscopic line parameters can be completely removed from the validation results. After recording of the absorption features, calculation of the trace gas concentrations is straightforward using Beer´s law.

The laser beams are coupled into a multipass absorption cell (Herriott design) that offers 74 meters free-air absorption path for methane and 36 meters for water, respectively. The cell is open to the atmosphere in order to avoid contamination that can be produced by adsorption or condensation in closed inlet systems. The optical and electronical components of CHILD, before integration into the balloon gondola, can be seen in fig. 1. All signals are recorded onboard during flight, and at the same time a subset is transmitted to the ground control station for inflight inspection and preprocessing. Thus, trace gas profiles can be seen in realtime during the flight. The CHILD instrument is described in detail in [1]. Technical details and data analysis is also described in [2]. After a hard landing in the fall 2002 Aire sour ´L Adour campaign, where all instruments of the TRIPLE Gondola were damaged, a protective "birdcage" was put around the absorption cell. This approach proved to be very successful and even contributed to an increased stability of the optical signals during the flight. A summary of the technical data can be seen in table 1. The campaigns in which CHILD was taking part so far are listed in table 2.

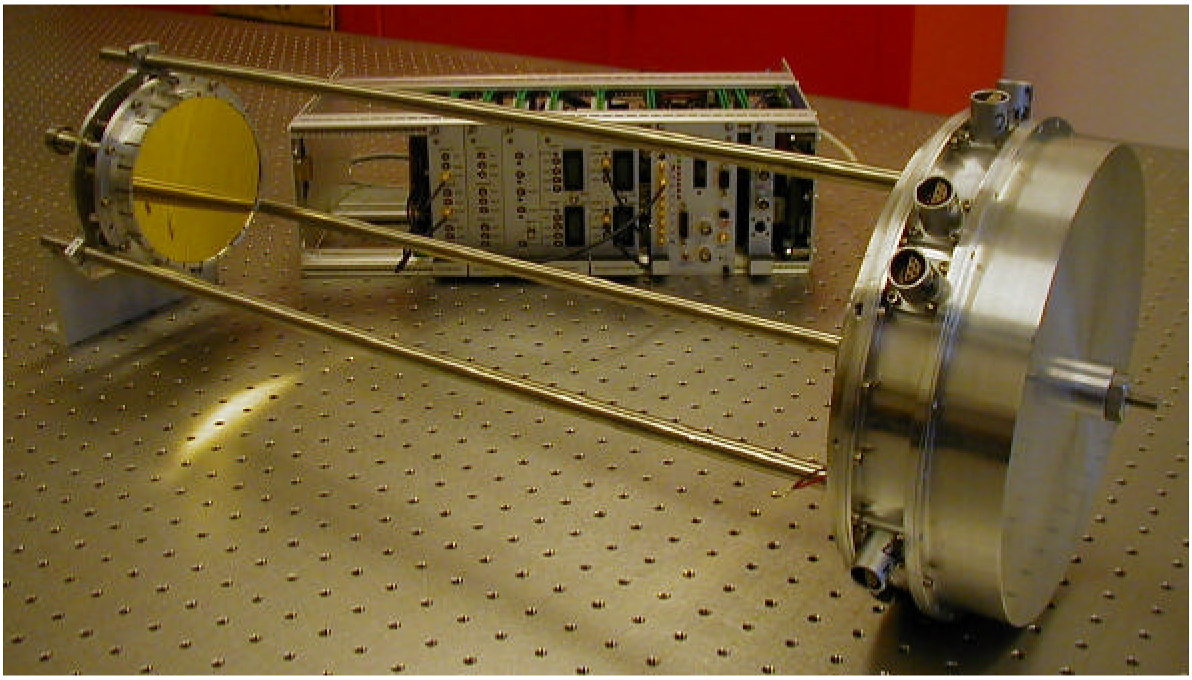


Fig. 1: Multireflection absorption cell and electronic unit of the CHILD TDL spectrometer

Table 1: Characteristics of the TDL Spectrometer CHILD

GENERAL		
Total mass	Approx. 25 kg	
Dimension	25 dia x 80 length (optics) 50 x 15 x 32 cm (electronics)	
Power Consumption	40 Watts	
SPECTROSCOPIC		
	CH_4	H_2O
Wavelength used	1648.2 nm	1392.53 nm
Absorption Path Length	74.0 m	35.9 m
Scan Range	17 GHz	15 GHz
Minimum detectable Absorption (MDA) in practical Operation	4 – 8 x 10E-5 (limited by noise in absorption signal)	4 x 10E-4 (limited by possible local contaminations from Balloon)
Time Resolution	1 sec. (tropopause) 50 sec. (stratospheric float)	1 sec. (tropopause) 50 sec. (stratospheric float)

Table 2: Campaigns with CHILD onboard the TRIPLE Gondola

Aire sour ´L Adour Fall 2001 (France, mid-Latitude)	Technical test
Aire sour ´L Adour Fall 2002 (France, mid-Latitude)	Envisat Validation
Kiruna Spring 2003 (Sweden, High-Latitude)	Envisat Validation
Kiruna Summer 2003 (Sweden, High-Latitude)	Envisat Validation

2. FLIGHT RESULTS

The trajectories of the recent CHILD flights with TRIPLE on 24 September 2002 (France) and 06 March 2003 (Sweden) are shown in fig.3 and 4 . On both flights, launch was scheduled for early morning to match satellite overpasses at 10:30 and 10:04 UT, respectively. Measurements were taken during all phases of the flight from launch, ascent and float to descent (fig. 5 and 6). Especially for the water vapor, best (contamination free) in-situ measurements can be expected on descent, after outgassing of the large balloon envelope during stratospheric float. Therefore, the descent phase of the flights was timed for the closest possible satellite match around 30 hPa pressure level. During float, which took approximately 15 minutes, stratospheric balloons with control valve like the one used here tend to perform vertical oscillations on the order of a few hundreds of meters altitude. During these oscillations, water vapour from the balloon´s own boundary layer can contaminate the in-situ measurements. These effects were seen in our data (and also in the data of other in-situ instrumentation onboard TRIPLE) as isolated spikes. An intercomparison of CHILD measurements with other TRIPLE instrumentation is shown in [3].

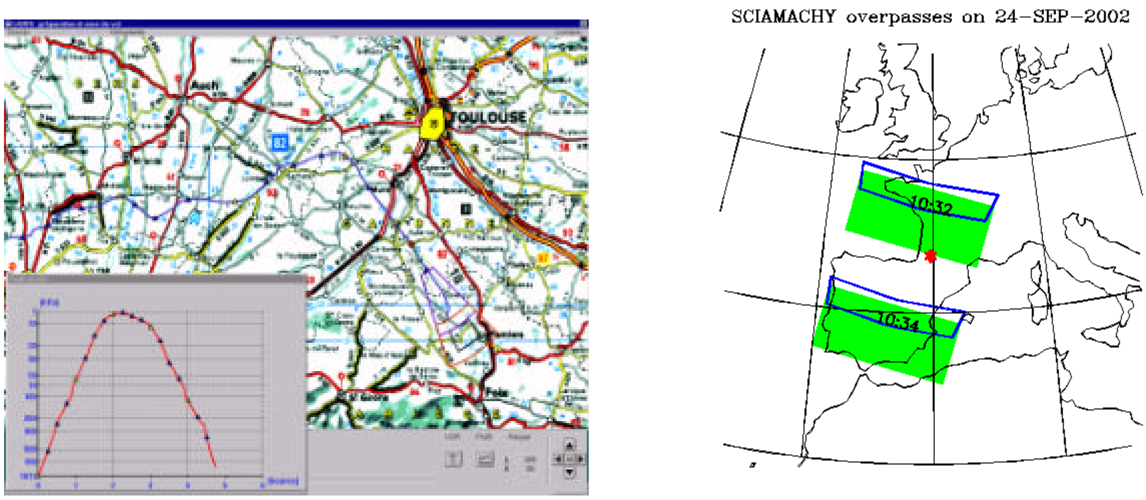
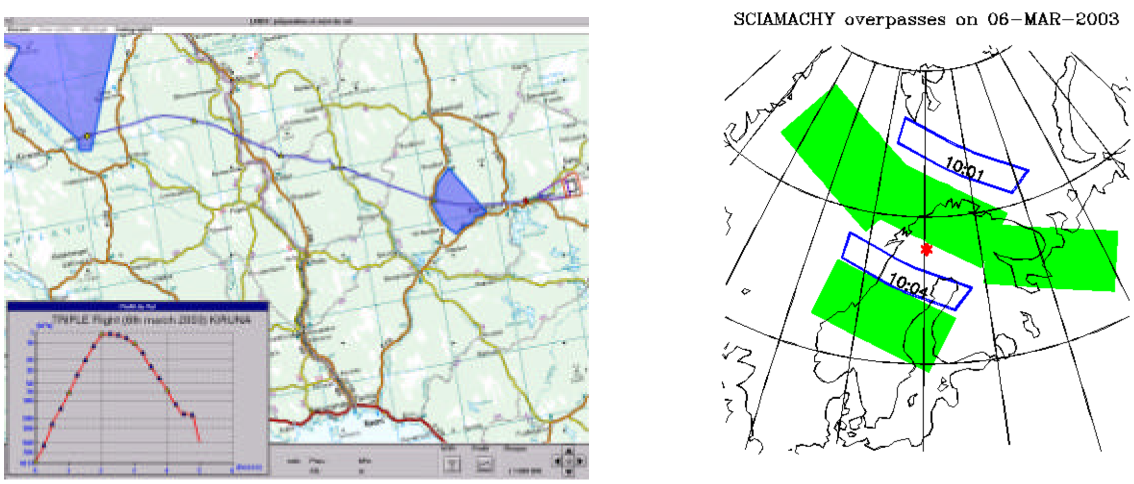
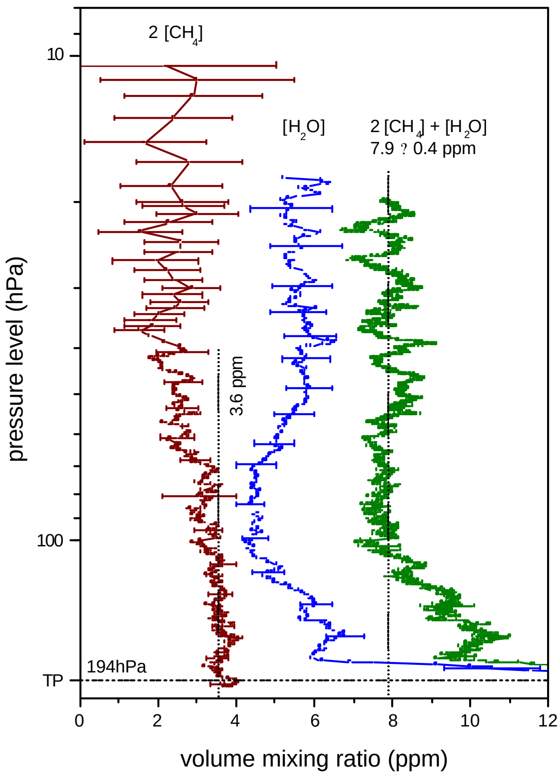
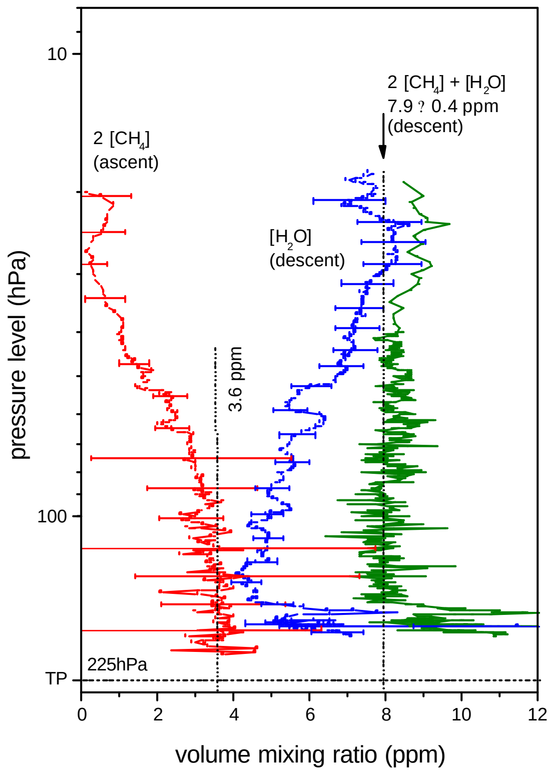


Fig. 3: Flight trajectory (left) and SCIAMACHY overpass (right) for TRIPLE flight on 24.09.02 from Aire sour ´L Adour (France), and on 06.03.03 from Kiruna (Sweden). Flight parameters were optimized for satellite overpass on balloon descent, were best contamination-free measurements can be made.





Aire sour L´Adour, 24 September 2002



Kiruna, 06 March 2003

Fig. 3 (left): Profiles of water vapour and methane recorded with the CHILD spectrometer on board TRIPLE during ENVISAT validation flights on 24 September 2002, and (right) on 06 March 2003

The comparison of our flight results with “inofficial” SCIAMACHY data products is currently underway. These data products are processed off-line at the Institute of Environmental Physics, University of Bremen, depending on availability of the relevant orbits (level-1 data), and will be used for a first validation until the official level 2 data from ESA become available.

3. CONCLUSION

The lightweigt CHILD spectrometer was flown piggy-back as an additional sensor on the TRIPLE during two ENVISAT validation flights. A third flight is under preparation. Profiles of water vapor and methane were obtained by *in-situ* measurements. Flight parameters were chosen as to get a close match with an ENVISAT overpass for the validation of SCIAMACHY. The instrument operated nominal during all phases of the flight and recorded complete profiles of the two trace gases, that are now available to validate the corresponding measurements of SCIAMACHY at the time when they will be available.

4. ACKNOWLEDGEMENT

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5. REFERENCES

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