GRILLE SPECTROMETER EXPERIMENT ONBOARD THE NASA ATLAS-1 MISSION

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This project is a part of the BISA Project 'Tropospheric and stratospheric composition measurements by spectroscopy methods'.

The Grille spectrometer is an infrared absorption spectrometer that has been developed in the early seventies for the study of the vertical distribution of atmospheric minority constituents in the atmosphere, in particular NO_x species in the stratosphere, by solar occultation absorption spectroscopy in the 2.5 to 10 micron spectral range.

Grille spectrometer instruments have been flown onboard stratospheric balloons, leading to early observations of NO and NO_2 and of HCl, as well as onboard airplanes, among which Concorde. A spaceborne version of the instrument has participated in the Spacelab-1 mission in December 1983 : this 9-days flight has allowed to determine vertical concentration profiles within the lower stratosphere up to the lower thermosphere ($<$130 km altitude) of the following constituents : NO, NO_2 and N_2O, HCl and HF, CO and CO_2, H_2O, CH_4 and O_3. Therefore the actual presence of the same instrument onboard the NASA Space Shuttle during the ATLAS-1 mission is very important for extending this series of observations up to the present times.

The ATLAS (Atmospheric Laboratory for Applications and Science) missions will investigate how Earth's atmosphere and climate are affected by the Sun and by the products of industrial complexes and agricultural activities ; the first 9days mission was launched on March 24, 1992 and included in its payload 13 instruments for the study of the Earth atmosphere, solar and space plasma physics and astronomy. As such, it was able to examine the linkages that exist between all main parts of the atmosphere through dynamical and chemical couplings, and its relationships with the solar radiation, in particular in the ultraviolet region of the solar spectrum, as called for in the core programme of IGBP. Thanks to the mission design and the participants' training, part of the observations planning was adapted to the occurrence of sporadic events, e.g., solar proton events and auroras. Additional information

will be retrieved from the observations that were performed in overlap with other satellite measurements, in particular from UARS (Upper Atmosphere Research Satellite), giving access to more dynamical and atmospheric (photo)-chemistry data.

The Grille spectrometer design allows the simultaneous observation in two different spectral windows, thus enabling the study of some of the close couplings between chemically active species that exist in the atmosphere through physical and (photo)chemical interactions. Onboard ATLAS1, absorption measurements have been performed successfully during 65 solar occultations, covering a latitude belt from 55° South to 30° North ; the lower altitude limit of the measurements was limited to about 30 km due to the presence of the Pinatubo aerosols, the higher altitude limit depends on the target species. The NO_x species have been observed up to more than 100 km altitude, paying special attention to their mutual couplings and to the exchange between thermosphere and stratosphere. Reactions between NO_x and the chlorine compounds strongly influence the role of the latter in the ozone destruction cycle ; therefore simultaneous measurements of HF and HCl have also been performed. The NO_x play a crucial role in the questions of the ozone hole and of the greenhouse warming and should be subject to biogenic and anthropogenic changes since the earlier 1983 measurements. The same holds true for the CO_x and for CH_4 and H_2O, that were measured simultaneously. We will try to retrieve O_3 up to the lower mesosphere : in particular its coupling with CO was aimed at.

In conclusion, the flight of the Grille spectrometer onboard ATLAS-1 provides an extension of the series of regular observations of the Earth atmospheric composition that has been made in the past by the same instrument, permitting the detection of possible trends as has already been demonstrated for the growth of the HCl compound over the last decade. In particular via its integration on a mission that is entirely dedicated to aeronomic studies, it will contribute to the understanding of the global middle atmospheric processes.

References

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