Airborne Gimballed Limb Observer for Radiance Imaging of the Atmosphere (GLORIA) data for Sentinel 5P validation

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Abstract. GLORIA is an imaging infrared limb and nadir sounder. The purpose of GLORIA is to measure temperature and composition in the upper troposphere/lower stratosphere at high spatial resolution. The instrument was designed to be deployed on board different research aircraft, namely the Russian high-altitude research aircraft M55 Geophysica and the German High Altitude and Long Range (HALO) research aircraft. GLORIA is able to measure infrared limb, nadir, and sub-zenith emissions between 780 and 1400 cm⁻¹ by means of a Michelson interferometer. The vertical resolution of the limb data is a few hundred meters. The application of tomographic reconstruction techniques to special limb observation modes allows for the derivation of 3-dimensional fields of atmospheric quantities with a resolution of up to 20 km x 20 km in both horizontal dimensions or a few hundred meters in one horizontal dimension.

In this paper, we present GLORIA ozone data obtained during two research flights in view of the geophysical validation of TROPOMI Level 1b and Level 2 products by this instrument.

GLORIA Volumetric Measurements

Diagnostics

GLORIA for Sentinel-5P Validation (GASVal)

This Sentinel-5P validation project aims to provide independent measurements of ozone, cloud top height and other constituent data to validate selected level-2 data products in the commissioning and operational phases of SSP. These data are obtained by the GLORIA instrument during two aircraft campaigns conducted in 2016 and 2017. These campaigns are funded in the framework of other projects. The conduction of further aircraft campaigns to validate operational SSP data products after 2017 is envisaged.

The aircraft campaign in Summer 2016 is conducted in the framework of the EU FP-7 STRATOCLIM project. It utilizes the Russian GEOPHYSICA aircraft (ceiling altitude ~20 km). The campaign base will be in the Indian region, the main scientific objective is the outflow of the Indian Monsoon. Measurements obtained during the transfer flights from Europe to Asia or local flights over Europe may also be used for SSP validation activities.

In Fall 2017, the WISE measurement campaign utilizing the German HALO aircraft (ceiling altitude ~15 km) will be conducted. The campaign base will be in Ireland, the main scientific objectives are planetary wave breaking and troposphere-stratosphere exchange. This campaign is led by Research Centre Jülich and funded by a consortium of German research centers and universities.

Both campaigns are supported by modeling activities to predict and analyze the mesoscale meteorological situation. This data can also be provided for SSP validation activities.

The datasets obtained by GLORIA have a significantly higher vertical resolution than SSP data, because they rely on limb-rather than nadir measurements. The horizontal resolution of GLORIA data depends on the measurement mode and can reach 20km x 20 km in both horizontal dimensions or a few hundred meters in one horizontal dimension. With this data, one can address several SSP validation tasks:

- validate ozone in the upper troposphere / lower stratosphere for all conditions
- validate tropospheric ozone for unpolluted conditions in the free troposphere
- verification of top-column ozone
- identify errors due to SSP-calibration- or radiative transfer issues
- validation of the optimal estimation part of the SSP retrieval by providing a-priori data at very high vertical resolution in the upper troposphere/lower stratosphere for the SSP retrieval
- estimate cloud fraction and thickness using infrared aerosol/cloud indices, as utilized, e.g., by MIPAS
- obtain the vertical and horizontal distribution of clouds at very high vertical and horizontal resolution
- obtain cloud top height

2nd half 2016: GEOPHYSICA Campaign STRATOCLIM

summer/fall 2017: HALO-Campaign WISE

GLORIA Measurements During the Commissioning Phase of Sentinel 5P