

## IMPROVEMENTS TO THE RETRIEVAL OF NO<sub>2</sub> COLUMN FOR THE GOME-2 INSTRUMENT

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### ABSTRACT:

NO<sub>2</sub> is an important trace gas in both the stratosphere and troposphere. Since January 2007, the nadir-looking GOME-2 satellite instrument has been providing NO<sub>2</sub> data on a global scale which is of great interest for climate research and atmospheric chemistry studies. In this contribution, we report on an improved algorithm for the retrieval of total and tropospheric NO<sub>2</sub> columns from the GOME-2 instrument.

### 1. INTRODUCTION

In the stratosphere, nitrogen dioxide (NO<sub>2</sub>) participates in the ozone cycle. In the troposphere, NO<sub>2</sub> is a key air pollutant related to ozone formation, photochemical smog production, and eutrophication. Tropospheric NO<sub>2</sub> is produced by both natural and anthropogenic processes, such as fossil fuel combustion, biomass burning, lightning and bacterial activities.

In the last decades, many in-situ, airborne, and satellite techniques have been applied to measure NO<sub>2</sub> in the troposphere and stratosphere. The Global Ozone Monitoring Experiment-2 (GOME-2) satellite instrument has been providing a unique global NO<sub>2</sub> dataset started from the year 2007. Currently there are two GOME-2 instruments operating in tandem on board EUMETSAT's Meteorological Operational satellites MetOp-A and MetOp-B, launched in October 2006 and September 2012 respectively. GOME-2 is an optical spectrometer sensing the solar irradiance and backscattered Earthshine radiance in the UV and visible spectral range. GOME-2 provides morning measurements at 9:30 local time with a spatial resolution of 80×40 km<sup>2</sup>.

The operational GOME-2 near-real-time, off-line and reprocessed NO<sub>2</sub> products are generated with the GOME Data Processor algorithm at the German Aerospace Center (DLR). This contribution focuses on the algorithm development for the retrieval of NO<sub>2</sub> columns for the GOME-2 satellite instrument.

### 2. NO<sub>2</sub> RETRIEVAL

The retrieval algorithm of total and tropospheric NO<sub>2</sub> column for GOME-2 consists of several steps (Valks et al., 2011). (1) The differential optical absorption spectroscopy (DOAS) method (Platt and Stutz, 2008) is applied to determine the NO<sub>2</sub> slant columns from GOME-2 in the visible wavelength region. NO<sub>2</sub> slant columns are converted to initial total NO<sub>2</sub> vertical columns by dividing a stratospheric air mass factor (AMF). The AMF is determined using a radiative transfer model based on

the vertical NO<sub>2</sub> profile and a set of forward model parameters, including the GOME-2 viewing geometry, surface albedo, clouds and aerosols. (2) Stratospheric NO<sub>2</sub> columns are estimated and removed using NO<sub>2</sub> measurements over clean regions based on the assumption of longitudinal homogeneity. (3) Tropospheric NO<sub>2</sub> columns are derived by a tropospheric AMF based on tropospheric vertical NO<sub>2</sub> profiles from chemistry transport model. The calculation of tropospheric AMF requires the same input parameters (i.e. viewing geometry, surface and cloud properties) as for the stratospheric AMF, but its dependency on these parameters is much stronger.

Three important parts of the total and tropospheric NO<sub>2</sub> column retrieval for GOME-2 has been improved. (1) The retrieval of the NO<sub>2</sub> slant column is performed with the DOAS method in an extended wavelength region (425-497 nm, Richter et al., 2011) with updated reference spectra. The GOME-2 slit function variations over time and along orbit are taken into account. The new version 6.1 of the GOME-2 level-1b data is applied. (2) The NO<sub>2</sub> stratospheric column density is determined with the STRatospheric Estimation Algorithm from Mainz (STREAM, Beirle et al., 2016). (3) The tropospheric AMF is calculated using a new surface albedo climatology based on GOME-2 observations (Tilstra et al., 2017) and a priori vertical NO<sub>2</sub> profiles are obtained from the chemical transport model TM5-MP (Williams et al., 2017).

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