EGU2020-16999, updated on 21 Apr 2021
https://doi.org/10.5194/egusphere-egu2020-16999
EGU General Assembly 2020
© Author(s) 2021. This work is distributed under
the Creative Commons Attribution 4.0 License.

Impacts of stratospheric dynamical variability on total inorganic fluorine from observations and models constrained by state-of-the-art reanalyses

Maxime Prignon[1], Peter F. Bernath[2,3], Simon Chabrillat[4], Martyn P. Chipperfield[5], Sandip S. Dhomse[5], Wuhu Feng[5], Daniele Minganti[4], Christian Servais[1], Dan Smale[6], and Emmanuel Mahieu[1]
[1]University of Liège, Department of Astrophysics, Geophysics and Oceanography, Liège, Belgium
(maxime.prignon@uliege.be)
[2]Old Dominion University, Norfolk, VA
[3]University of Waterloo, ON
[4]BIRA-IASB, Brussels
[5]University of Leeds, UK
[6]NIWA, Lauder, NZ

Man-made halogenated compounds emitted from the Earth's surface ultimately reach the stratosphere where they undergo photolysis, leading to three main fluorine reservoirs: hydrogen fluoride (HF), carbonyl fluoride (COF_2) and carbonyl chloride fluoride (COClF). This process is directly influenced by the strength of the mean meridional circulation of the stratosphere, the Brewer-Dobson Circulation (BDC). The BDC is projected to speed-up with the greenhouse gases induced global warming. However, studies have highlighted a multiyear variability in the strength of the BDC resulting in hemispheric asymmetries in observed and modelled trends of age of air and long-lived tracers.

Total inorganic fluorine (F_y, the fluorine weighted sum of HF, COF_2 and COClF) is used here as a tracer of the stratospheric circulation changes. We perform an analysis and interpretation of Fourier transform infrared (FTIR) multidecadal time-series of HF and COF_2 from the Jungfraujoch (Switzerland, 46.55°N) and Lauder (New-Zealand, 45.03°S) stations and from the space-borne Atmospheric Chemistry Experiment - Fourier Transform Spectrometer (ACE-FTS). Indeed, the summation of HF and COF_2 is a very good proxy of F_y as we determine, from ACE-FTS and the chemical-transport model (CTM) TOMCAT, that COClF is only accounting for less than 5% of the total F_y budget.

The kinematic CTM BASCOE (Belgian assimilation system for chemical observations) is used here to assess the representation of the investigated circulation changes in four state-of-the-art meteorological reanalyses, i.e., ERA-Interim, JRA-55, MERRA and MERRA-2. We also investigate if WACCM4 (Whole Atmosphere Community Climate Model version 4) is able to reproduce these changes through a free-running simulation.

The ground-based and satellite FTIR time-series of COF_2 show contrasting results over their

common time period (2004-2019), with a positive total column trend above the Jungfraujoch, and a non-significant (ground-based) or decreasing trend (ACE-FTS) above Lauder. We find large discrepancies between the BASCOE-CTM simulations, with MERRA-2 inducing overly large simulated F_y total columns which could confirm the weaker tropical upwelling highlighted in previous age of air studies.