



## **Tropospheric Chemical Impact of Considering a Surrogate vs. an Explicit VSLBr Mechanism on the O<sub>3</sub> and HO<sub>x</sub> Distributions within the CAM-Chem model**

Rafael Pedro Fernandez (1,2), Javier Alejandro Barrera (2), Fernando Iglesias-Suarez (1), Carlos Alberto Cuevas (1), Douglass Kinnison (3), Jean-Francoise Lamarque (3), Simone Tilmes (3), Pamela Wales (4), Julie Nicely (5,6), Ross Salawitch (4,6), and Alfonso Saiz-Lopez (1)

(1) Department of Atmospheric Chemistry and Climate, Institute of Physical Chemistry Rocasolano, CSIC, Madrid, Spain, (2) National Research Council (CONICET), UTN-FRMendoza (GEAA) - IICB-FCEN-UNCuyo, Mendoza, Argentina, (3) National Center for Atmospheric Research, Boulder, CO, USA, (4) Department of Chemistry and Biochemistry, University of Maryland, College Park, MD, USA, (5) NASA Goddard Space Flight Center, Greenbelt, MD, USA, (6) Earth System Science Interdisciplinary Center, University of Maryland, College Park, MD

The contribution of very short-lived bromine (VSLBr) represent  $5 \pm 2$  ppt ( $\sim 25\%$ ) of total stratospheric bromine (WMO, 2018), which is still nowadays dominated by long-lived bromocarbons that do not impact on tropospheric chemistry. Due to their shorter lifetimes, the overall injection to the stratosphere of VSLBr compounds possesses two distinct pathways: i) Source Gas Injection (SGI), where the brominated species are injected as they were emitted at the surface; and ii) Product Gas Injection (PGI), where the photochemical processing of reactive species arising from SG degradation must be considered. Depending on the partitioning and distribution of SGI and PGI, the chemical impact of VSLBr on tropospheric and lowermost stratospheric ozone, HO<sub>x</sub> and other oxidizing species can be very different.

Many Chemistry Climate Models (CCMs) include a simplified treatment of tropospheric VSLBr sources by assuming a long-lived halocarbon (usually CH<sub>3</sub>Br) as a Surrogate for VSLBr. Even though these surrogate models possess a consistent evolution of the stratospheric bromine loading, CCMs including an explicit VSLBr representation compare better with organic and inorganic bromine observations in the lowermost stratosphere (Wales et al., 2018).

Here we used the halogenated version of the CAM-Chem model (Fernandez et al., 2014) to evaluate the chemical impact of considering an explicit treatment of VSLBr versus considering a simplified tropospheric treatment of long-lived CH<sub>3</sub>Br as surrogate of VSLBr. The explicit mechanism considers a full gas- and aerosol- phase chemical scheme (including sea-salt dehalogenation) as well as time-dependent and geographically-distributed VSLBr emissions inventory (Ordoñez et al., 2012), which replaces the typical lower-boundary surface conditions for long-lived compounds usually considered in CCMs. An additional baseline simulation neglecting the contribution of VSLBr is also considered. First we show the differences in the overall inorganic bromine (Bry) burden as a function of altitude, latitude and time of the year, and compare the model changes on SGI and PGI for each model configuration. Based on the vertical and latitudinal Bry distributions, we focus the analysis on determining the surrogate vs. explicit VSLBr impact on the tropospheric ozone burden, as well as the changes in HO<sub>x</sub> and NO<sub>x</sub> mixing ratios within different regions. In particular, seasonal variations in the Odd-Oxygen chemical loss channels during within the marine boundary layer (MBL), tropical tropopause layer (TTL) and mid-latitudes upper troposphere (UT) are evaluated. Our results indicate that the impact of VSLBr species is strongly underestimated when a simplified treatment of tropospheric VSLBr chemistry is considered, which might have strong climatic impacts.