



HAL
open science

Ozone loss and detailed investigations on the chemistry in the core of FrIAC's (Frozen In Anticyclones) events occurring in 2007 and 2011

Nathalie Huret, Rémi Thiéblemont, Fabrice Jégou, A. Søvde, Y. J. Orsolini, M.-A. Drouin

► To cite this version:

Nathalie Huret, Rémi Thiéblemont, Fabrice Jégou, A. Søvde, Y. J. Orsolini, et al.. Ozone loss and detailed investigations on the chemistry in the core of FrIAC's (Frozen In Anticyclones) events occurring in 2007 and 2011. Quadrennial Ozone Symposium 2012, Aug 2012, Toronto, Canada. #6091, 2011. insu-01142882

HAL Id: insu-01142882

<https://insu.hal.science/insu-01142882>

Submitted on 16 Apr 2015

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.

Ozone loss and detailed investigations on the chemistry in the core of FrIAC's (Frozen In Anticyclones) events occurring in 2007 and 2011 (#6091).

N. Huret ⁽¹⁾, R. Thiéblemont ⁽¹⁾, F. Jegou ⁽¹⁾, A. Søvde ⁽²⁾, Y.J. Orsolini ⁽³⁾, and M.-A. Drouin ⁽¹⁾

⁽¹⁾ LPC2E/CNRS & Université d'Orléans, France, ⁽²⁾ Center for International Climate and Environmental Research – Oslo, Norway, ⁽³⁾ NILU, Norway

ABSTRACT :

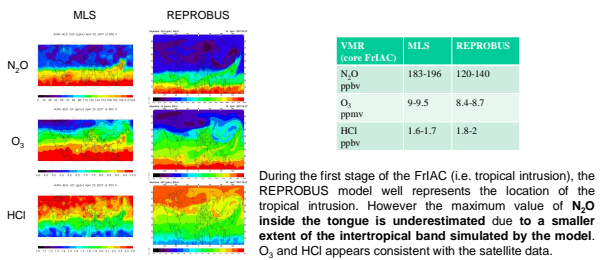
During springtime, after the final stratospheric warming, the breakdown of the polar vortex occurs and the summer circulation starts to develop. Air mass intrusions from the tropics can be trapped into the polar latitudes in an anticyclone which can persist until August, advected by summer easterlies. These structures, named "Frozen In Anticyclones" (FrIACs), have already been observed in 2003, 2005 and 2007 by MIPAS-ENVISAT and MLS-AURA instruments [Lahoz *et al.*, 2007, Manney *et al.*, 2006, Thiéblemont *et al.*, 2011]. These FrIACs lead to an irreversible ozone loss in the tropics. Here, we present a new case of FrIAC occurring in 2011. It is the major one in term of spatial extent since 1960 (see poster #6072). Using MIPAS, MLS tracer species and ozone measurements, we characterize in detail its duration and location in comparison with the previous FrIAC event in 2007. We compared simulations using several CTM models, and evaluated them against measurements. Then we examined the specific chemistry in the core of the FrIAC.

TOOLS :

The 2007 FrIAC event has been investigated using N₂O and O₃ measurements from Microwave Limb Sounder on Aura satellite platform whereas the 2011 FrIAC event has been investigated using a combination of MIPAS/ENVISAT and MLS/AURA satellite measurements, due to a lack of MLS data during the onset of the FrIAC. To characterize each event, we focus our study on the 850 K isentropic surface (i.e. ~10 hPa, ~30 km), where the FrIAC signal is the strongest [Thiéblemont *et al.*, 2011]. Measurements are compared with the results of two CTM models : REPROBUS [Lefèvre *et al.*, 1994] and the Oslo CTM [Søvde *et al.*, 2011], which have an horizontal resolution of 1°x1° and 2.7°x2.7°, respectively.

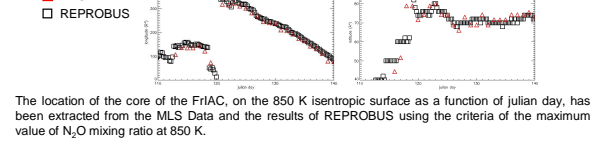
The 2007 FrIAC Event : Comparison MLS/REPROBUS

➤ On the 25 April 2007 : Intrusion



During the first stage of the FrIAC (i.e. tropical intrusion), the REPROBUS model well represents the location of the tropical intrusion. However the maximum value of N₂O inside the tongue is underestimated due to a smaller extent of the intertropical band simulated by the model. O₃ and HCl appears consistent with the satellite data.

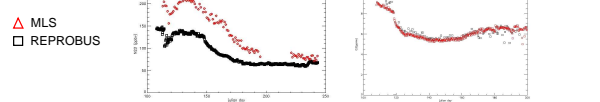
➤ Location of the core of the FrIAC : MLS/REPROBUS



The location of the core of the FrIAC, on the 850 K isentropic surface as a function of Julian day, has been extracted from the MLS Data and the results of REPROBUS using the criteria of the maximum value of N₂O mixing ratio at 850 K.

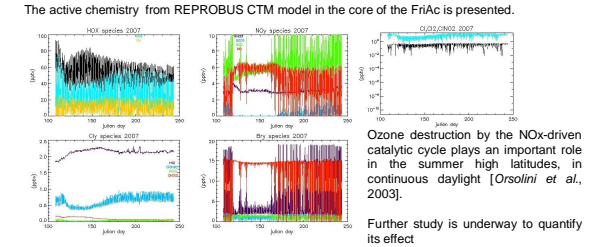
The model well represents the evolution of the location (latitude and longitude) of the FrIAC core.

➤ N₂O and Ozone evolution in the core of the FrIAC :



The time evolution of N₂O in the core of the FrIAC obtained by the CTM model is quantitatively different from the MLS measurements. However the shape is similar with a first step associated with constant high value of N₂O (typical of the tropics) during 40 days and then a decrease during 20 days to typical polar content. The ozone mixing ratio rapidly decreases in the core of the FrIAC during the first 20 days. Model results and MLS data are consistent regarding the ozone evolution.

➤ Active chemistry in the core of the FrIAC : REPROBUS



The active chemistry from REPROBUS CTM model in the core of the FrIAC is presented.

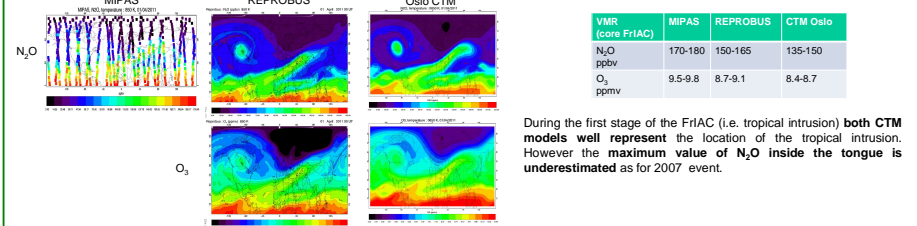
The 2007 FrIAC event appears to be well represented by the REPROBUS CTM simulation. The N₂O signal is qualitatively in agreement with the shape of the N₂O evolution from MLS data, but the abundance of N₂O in the initial tropical intrusion is smaller in the model. O₃ mixing ratio evolution are very similar. In 15 days, a loss of ozone is observed in the core of the FrIAC. Such loss is being examined by investigating the chemical processes. For the 2011 event, simulations have been made by two different CTM model, and in both cases, there are not able to represent the dynamical signature : N₂O high tropical values in the core of the FrIAC disappear too quickly (only 50 days). O₃ evolution in the core of the 2011 FrIAC is, as for the 2007 event, in agreement with the measurements. Additional work , has to be made, in particular with higher resolution simulations, to better understand why the CTMs are not able to represent the 2011 event. Allen *et al.* [2011] has encountered the same type of differences on the 2005 FrIAC event.

Acknowledgments

This study has been conducted within the framework of the STRAPOLETE and ENRICHED project supported by the "Agence Nationale de la Recherche ANR (STRAPOLETE project ANR 08 BLAN 0300), the "Institut Polaire Paul Emile Victor" (IPEV) and the "Centre National d'Etudes Spatiales (CNES)". We thanks ETHER CNES/INSU data base. For their support, the EOS-MLS instrument science team, and MIPAS-IMK science team for the satellite data and the European Centre for Medium-Range Weather Forecasts for providing the ERA-Interim data.

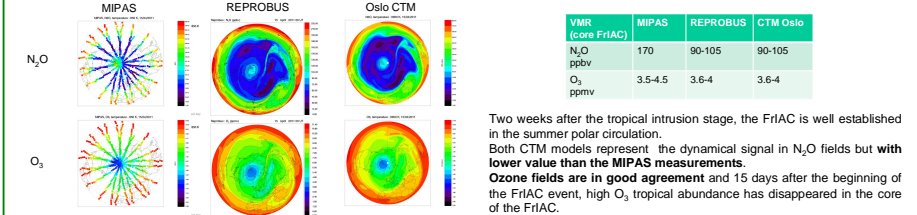
The 2011 FrIAC Event : Comparison MIPAS/REPROBUS/Oslo CTM

➤ On the 01 April 2011 : Intrusion



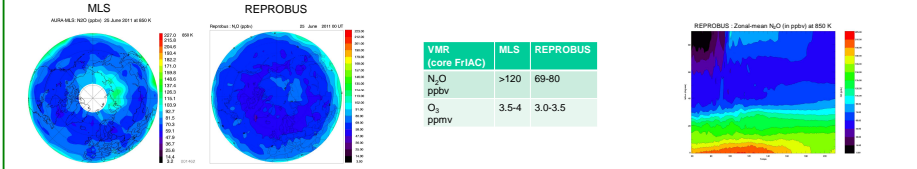
During the first stage of the FrIAC (i.e. tropical intrusion) both CTM models well represent the location of the tropical intrusion. However the maximum value of N₂O inside the tongue is underestimated as for 2007 event.

➤ On the 15 April 2011



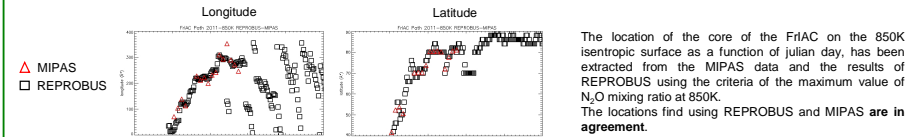
Two weeks after the tropical intrusion stage, the FrIAC is well established in the summer polar circulation. Both CTM models represent the dynamical signal in N₂O fields but with lower value than the MIPAS measurements. Ozone fields are in good agreement and 15 days after the beginning of the FrIAC event, high O₃ tropical abundance has disappeared in the core of the FrIAC.

➤ On the 25 June 2011



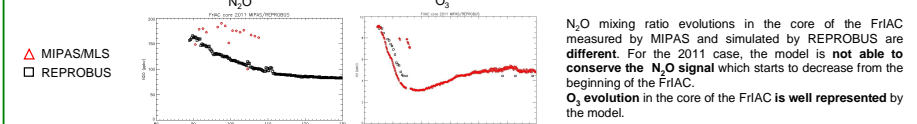
The N₂O signal of the FrIAC has disappeared in the REPROBUS simulation on the 25 June, whereas this signal still exists in MLS data. The 2011 FrIAC event is centered on the North Pole ⇔ difficulties to follow the evolution of this event with MLS data. The zonal mean of N₂O fields shows that the FrIAC signal persists 50 days (more than 3 months) in REPROBUS (in MLS data).

➤ Location of the core of the FrIAC : MIPAS/REPROBUS



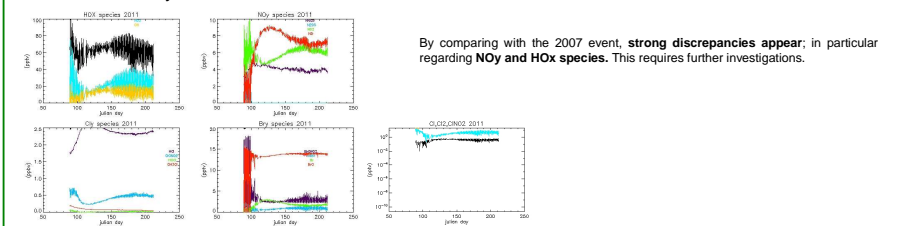
The location of the core of the FrIAC on the 850K isentropic surface as a function of Julian day, has been extracted from the MIPAS data and the results of REPROBUS using the criteria of the maximum value of N₂O mixing ratio at 850K. The locations find using REPROBUS and MIPAS are in agreement.

➤ N₂O and Ozone evolution in the core of the FrIAC : MIPAS & MLS/ REPROBUS



N₂O mixing ratio evolutions in the core of the FrIAC measured by MIPAS and simulated by REPROBUS are different. For the 2011 case, the model is not able to conserve the N₂O signal which starts to decrease from the beginning of the FrIAC. O₃ evolution in the core of the FrIAC is well represented by the model.

➤ Active chemistry in the core of the FrIAC : REPROBUS



By comparing with the 2007 event, strong discrepancies appear, in particular regarding NOy and HOx species. This requires further investigations.

References

R. Thiéblemont, N. Huret, Y.J. Orsolini, A. Hauchecorne and M.-A. Drouin (2011), JGR, 116, D20110, doi:10.1029/2011JD016042.
 Manney *et al.* (2006), GRL, 33, L06810, doi:10.1029/2005GL025418.
 Orsolini *et al.* (2003), QJRM, 129, 595, 3265-3275, doi:10.1256/qj.02.211.
 Lefèvre *et al.* (1994), JGR, 99, 8183-8195, doi:10.1029/93JD03476.
 Allen *et al.* (2011), ACP, 11, 4557-4576, doi:10.5194/acp-11-4557-2011.
 W. Lahoz, A.J. Geer and Y.J. Orsolini (2007), QJRM, 133, 197-211.
 Søvde *et al.* (2011), QJRM, 137, 654, 118-128.