BASCOE Reanalysis of Aura MLS, 2nd Release (BRAM-2)

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Experimental Setup

BRAM-2 has been produced by the Belgian Assimilation System for Chemical Observations (BASCOE).

Chemistry Transport Model (Errera et al., ACP, 2008):

- 58 stratospheric species advected by the Flux Form Semi Lagrangian (Lin and Rood, MWR, 1996).
- Around 200 chemical reactions (gas phase, photolysis and heterogeneous).
- PSC parameterization of their formation/evaporation, sedimentation and heterogeneous reaction rates on their surface (Huijnen et al., GMD, 2016).
- Spatial resolution: 2.5°lat x 3.75°lon x 37 levels between 0.1 hPa – surface.
- Time step: 30 minutes.
- Dynamical fields: ERA-Interim.

Data Assimilation (Skachko et al., GMD, 2014, 2016) :

- EnKF.
- Observational error tuned using Desroziers's method (Desroziers et al., QJRMS, 2005).

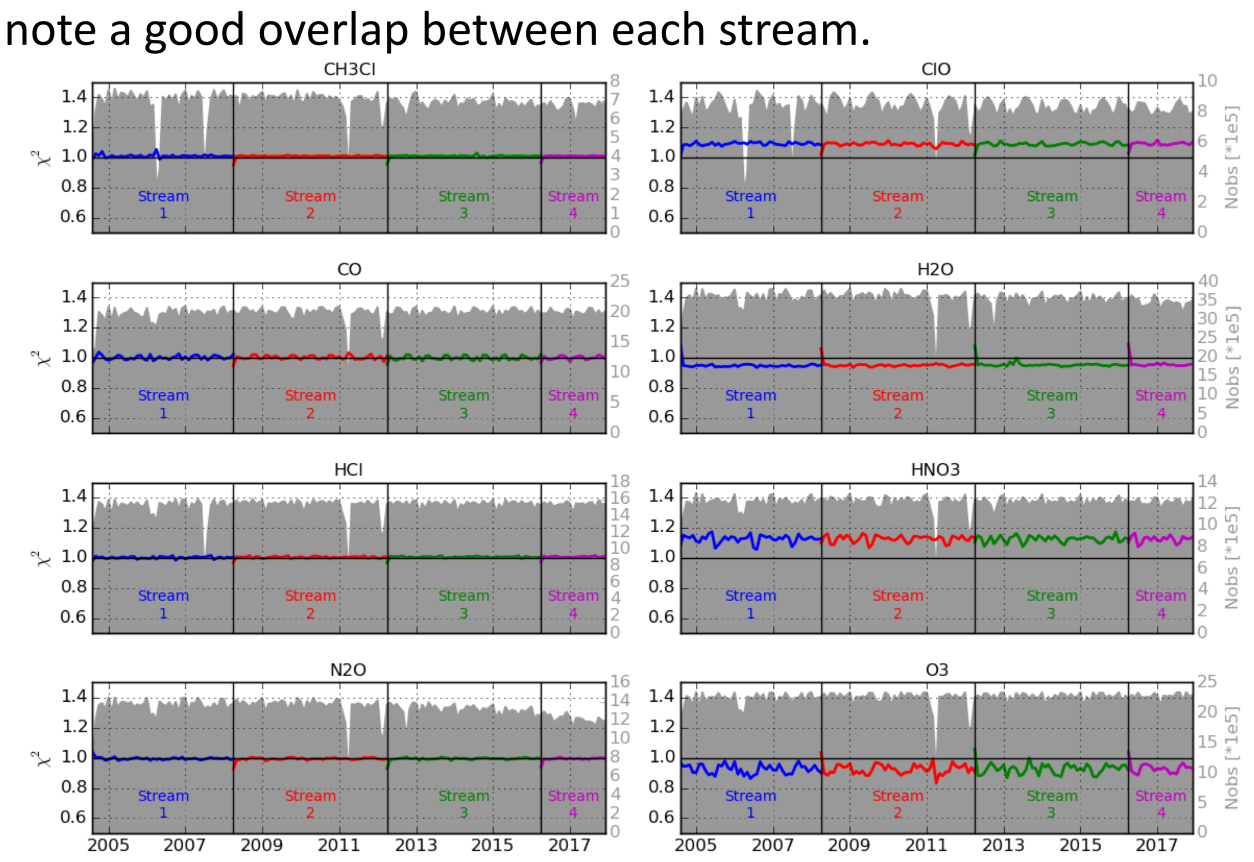
Observations:

- Aura MLS v4.2 profiles of O_3, H_2O, HNO_3, N_2O, HCl, ClO , CO and CH_3Cl according to the recommendations of the MLS Data Quality Document.
- Period: **Aug 2004-Dec 2017**.

χ^2-test

- BRAM-2 is based on four streams with an overlap of 1 month between each stream.
- Observational errors of O_3, H_2O, HCl, ClO, N_2O, CO and CH_3Cl are tuned using Desroziers's method which ensures $\chi^2 \approx 1$ (**Fig. 1**).
- Observational errors of HNO_3 are unchanged to get the system closer to MLS.
- All χ^2 time series are stable over the years while showing seasonal variations for some species. We also note a good overlap between each stream.

Figure 1: Time series of χ^2–tests for each assimilated species (colored lines, left y-axis) and the number of assimilated observations (gray area, right y-axis).



Evaluation of BRAM-2 in the UTLS

- Transport in the UTLS is particularly challenging in CTMs especially with the coarse resolution of BRAM-2
- Forecast-minus-Observations (FmO) statistics of BRAM2-MLS (**Fig. 2**) show that:
  - The mean of the FmO is within the MLS accuracy (i.e. the bias is not significant).
  - The standard deviations of the FmO are higher than the MLS precision and some averaging of BRAM-2 is necessary to reach the MLS uncertainty.
  - Mean(BRAM2-MLS) profile for O_3 displays vertical oscillations due to remaining oscillations in MLS v4.2x profiles, which are smoothed by BASCOE (**Fig 3 & 4**).
- FmO BRAM2-ACEFTS highlights the systematic differences between ACEFTS and MLS, in particular for CO
- Comparisons of BRAM-2 O_3 with MLS, MIPAS, WOUDC and ACEFTS highlight the differences between these instruments (**Fig. 4**).

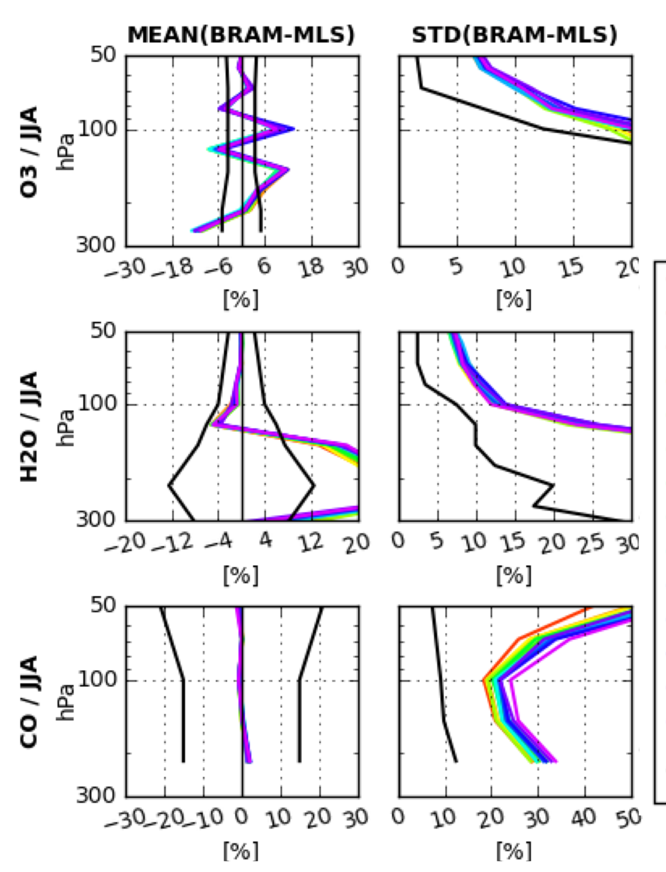
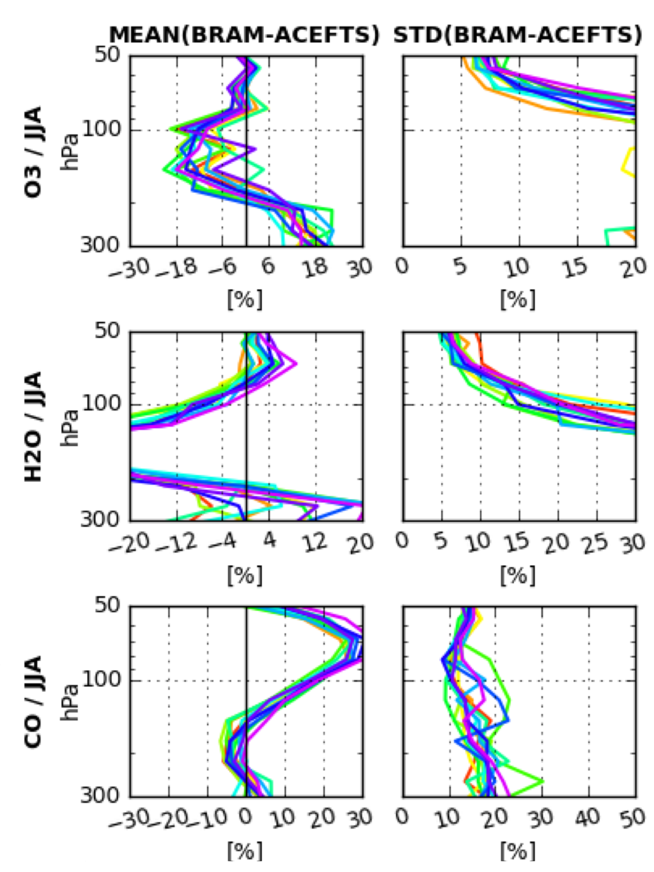


Figure 2 (left): FmO statistics BRAM2-MLS in the tropical UTLS

Figure 3 (right): FmO statistics BRAM2-ACEFTS in the tropical UTLS



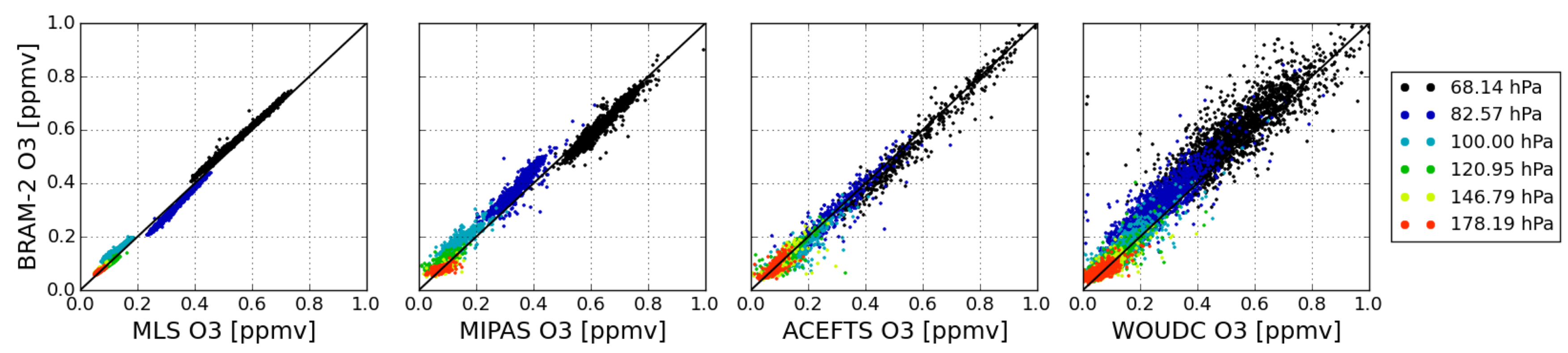


Figure 4: BRAM-2 O_3 vs MLS, MIPAS, ACEFTS and Ozonesondes (from left to right) in the tropical UTLS. Each dot represents a daily mean in the 30°S-30°N band for each MLS pressure layer.

Evaluation of BRAM-2 During Southern Polar Winters

- PSC schemes implemented in atmospheric models are generally subject to large uncertainties (much larger than in normal conditions). Chemical assimilation in PSC conditions is thus challenging.
- Qualitatively, BRAM-2 is able to reproduce the evolution of the chemical state of the southern polar stratosphere as measured by MLS (**Fig. 5**). Compared to a control run (no assimilation, CTRL), BRAM-2 corrects most of the model deficiencies.
- Forecast-minus-Observations (FmO) statistics of BRAM2-MLS (**Fig. 6**) show that:
  - The mean of the FmO is within the MLS accuracy (i.e. the bias is not significant).
  - The standard deviations of the FmO are higher than the MLS precision and some averaging of BRAM-2 is necessary to reach the MLS uncertainty. This may be due to the relatively low horizontal resolution of BRAM-2.
- Comparisons of BRAM-2 vs MLS are very stable over the years (**Fig. 6**) thanks to the stability of MLS and the tuning of the observational error in BASCOE.
- The FmO BRAM-2 vs ACEFTS (**Fig. 7**) highlights the differences between MLS and ACEFTS, especially for O_3 and H_2O for which BRAM-2 can be considered as a proxy of MLS. The annual variability of the FmO is attributed to variability of the sampling of ACEFTS.

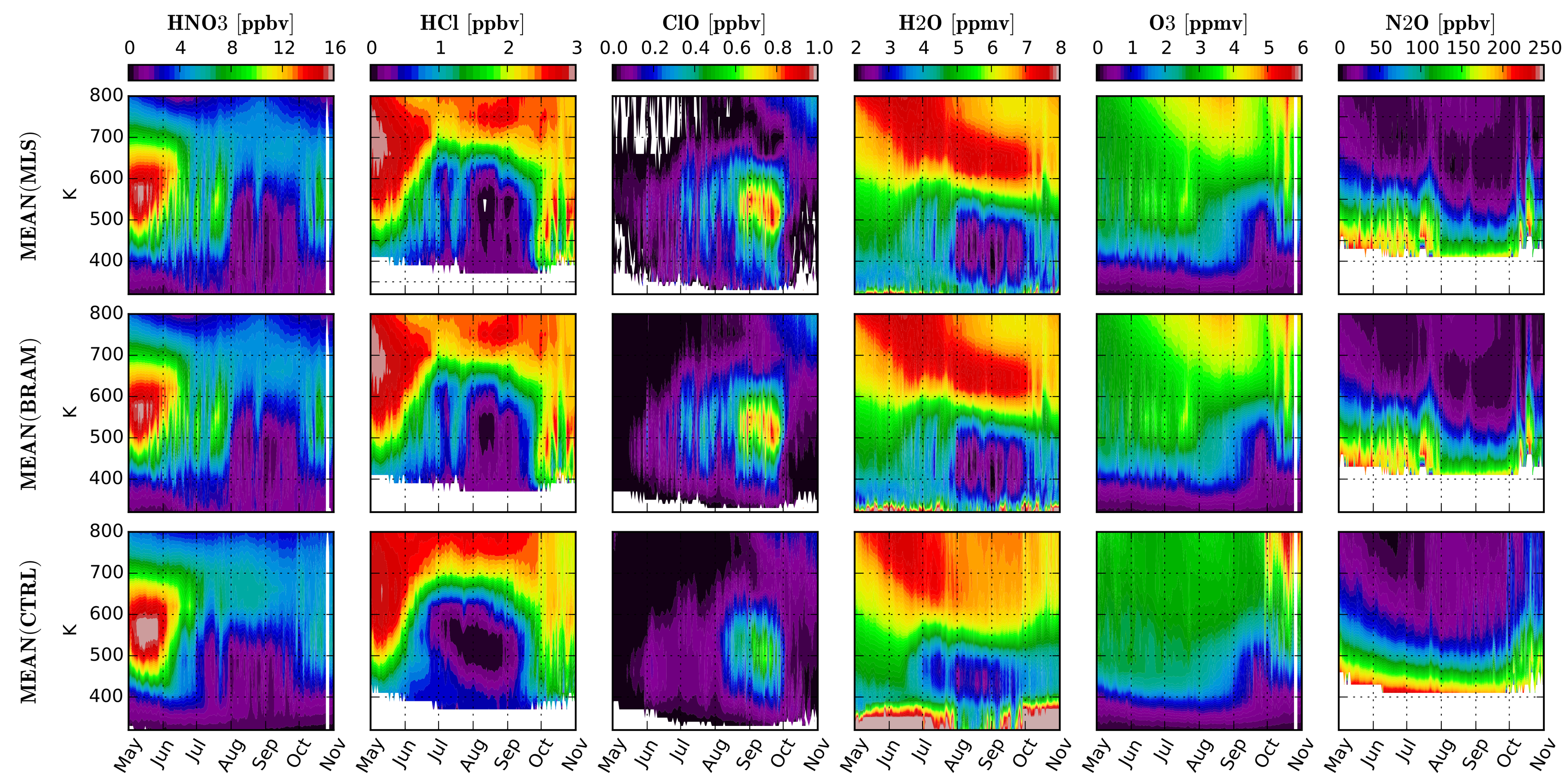


Figure 5: Time series of daily averaged inner vortex volume mixing ratio of MLS (top), BRAM-2 (middle), and the control run (CTRL, bottom) for Antarctic winter 2009 between 90°S-75°S of equivalent latitude and for (from left to right) HNO_3, HCl, ClO, H_2O, O_3 and N_2O.

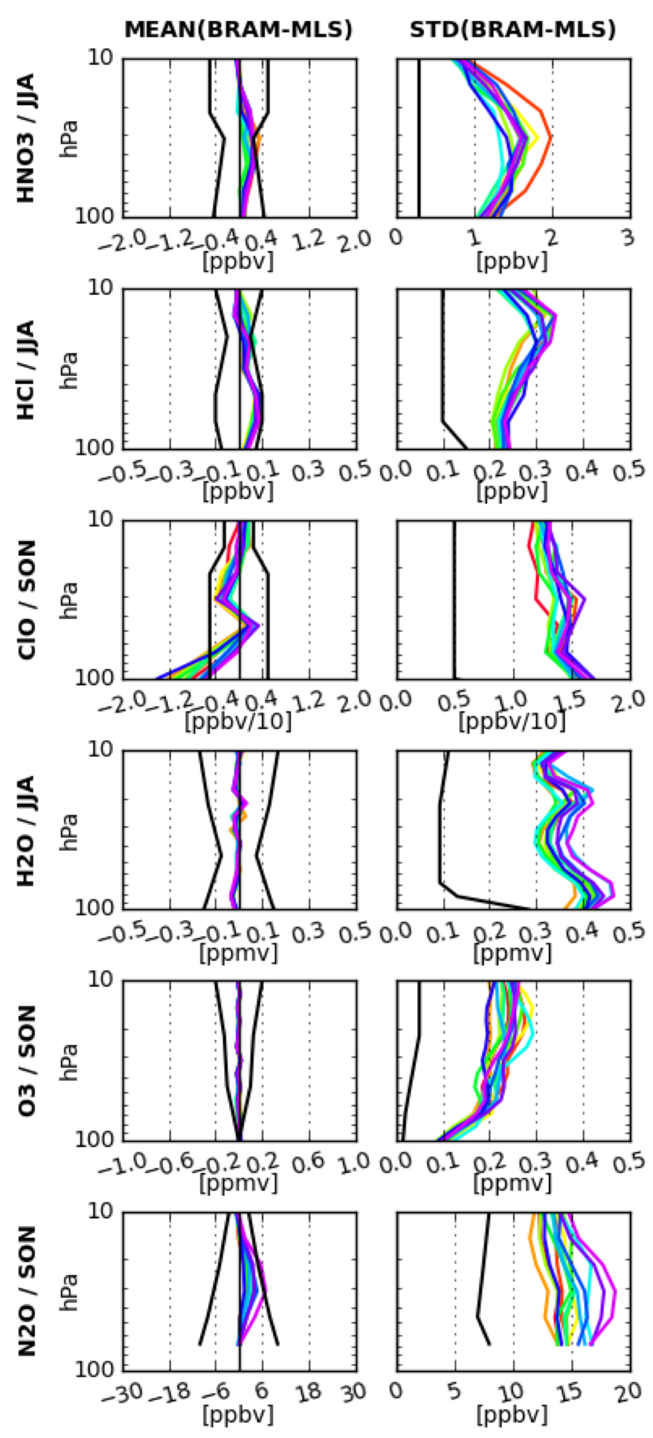
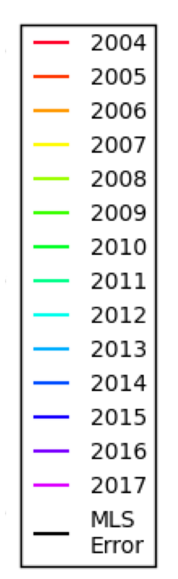
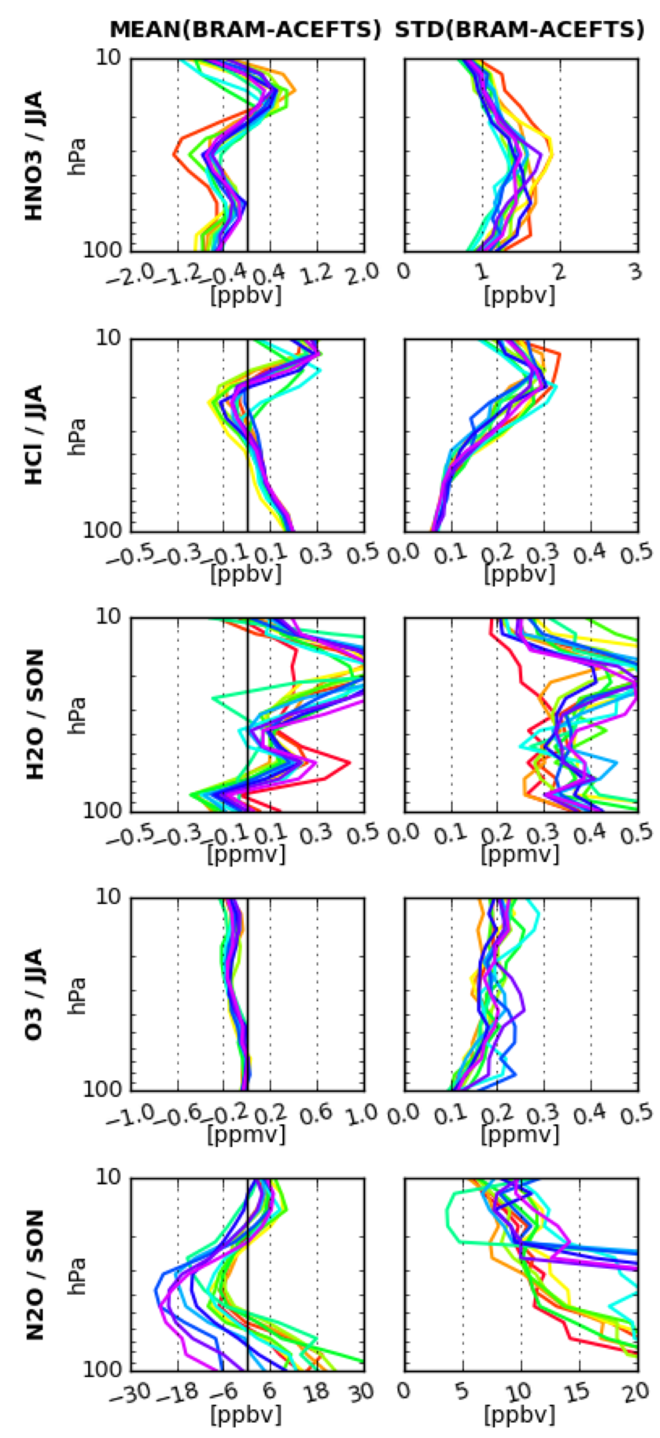


Figure 6 (left): FmO statistics BRAM2-MLS between 90°S-60°S for JJA (HNO_3, HCl and H_2O) or SON (O_3, N_2O and ClO).

Figure 7 (right): as in Fig. 7 but for BRAM2-ACEFTS





How to obtain BRAM-2

- 6-hourly analyses of the 8 assimilated species plus Cl_2O_2 are freely available.
- Std dev of ensemble also provided for the 8 assimilated species (not for Cl_2O_2).
- Each species and ERA-I temperature are delivered in yearly NetCDF-CF files.
- Size per files: 2.9 Gb ; total size: 345 Gb.
- To download the dataset, ask login/password to quentin@aeronomie.be.
- See also information on the BASCOE webpage: strato.aeronomie.be->Datasets->BRAM

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Poster presented during the SPARC General Assembly 2018, October 1-5, Kyoto, Japan
This poster can be downloaded here: strato.aeronomie.be -> Presentations