



# Analysis of new species retrieved from MIPAS

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## Introduction

The Michelson Interferometer for Passive Atmospheric Sounding (MIPAS) instrument, which operated on the Envisat satellite from 2002-2012 is a Fourier transform spectrometer for the measurement of high-resolution gaseous emission spectra at the Earth's limb. It operates in the near- to mid-infrared, where many of the main atmospheric trace gases have important emission features. The initial operational products were profiles of Temperature, H<sub>2</sub>O, O<sub>3</sub>, CH<sub>4</sub>, N<sub>2</sub>O, HNO<sub>3</sub>, and NO<sub>2</sub>, and this list was recently extended to include N<sub>2</sub>O<sub>5</sub>, ClONO<sub>2</sub>, CFC-11 and CFC-12. Here we present preliminary results of retrievals of the third set of species under consideration for inclusion in the operational processor: HCN, CFC-14 (CF<sub>4</sub>), HCFC-22, COF<sub>2</sub>, CCl<sub>4</sub>, SF<sub>6</sub>, OCS, HOCl and C<sub>2</sub>H<sub>6</sub>. Stratospheric fluorine has important effects on the atmosphere, especially fluorine in long-lived greenhouse gases. Atmospheric fluorine is mainly comes from man-made species, such as CFCs, HCFCs, SF<sub>6</sub>. Here we also study fluorine inventories measured by MIPAS.

## Data and Method

The Oxford L2 processor MORSE has been used to retrieve the Volume Mixing Ratio (VMR) of following new species: HCN, CFC-14 (CF<sub>4</sub>), HCFC-22, COF<sub>2</sub>, CCl<sub>4</sub>, SF<sub>6</sub>, OCS, HOCl and C<sub>2</sub>H<sub>6</sub>.

Here we analyzed these new retrieved species to establish their zonal mean for the period of 2010 March. For each gas, we eliminated those data which there are cloud-affected and a priori has a significant contribution, which is the measure random error greater than 50% of the retrieval. A global spike test for the whole month data, which is used to filter out profiles lie outside 5 standard deviation region. The standard deviation of profiles contributed to each point is also deduced in log space. and converted into fractional error in volume mixing ratio space in percentage unit. Figures of the fractional error for each species are shown in the Results and Discussion section.

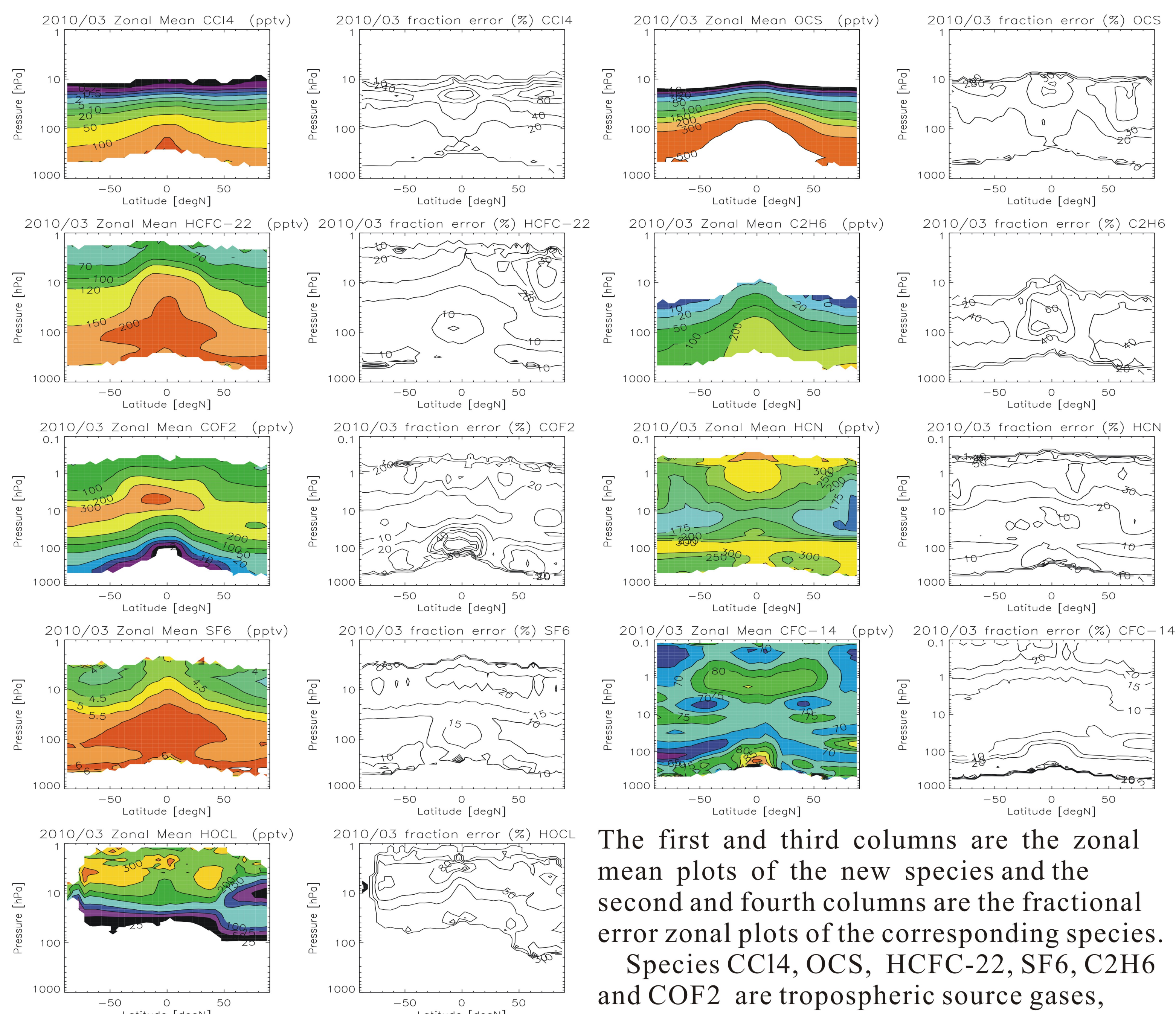
The fluorine species measured by MIPAS are COF<sub>2</sub>, CFC-11, CFC-12, CFC-14, CFC-22 and SF<sub>6</sub>. We produce their global vertical profiles and the total fluorine volume mixing ratio,  $[F] = 2[COF_2] + [CFC-11] + 2[CFC-12] + 4[CFC-14] + 2[CFC-22] + 6[SF_6]$ , (see figure 19). From E. Mahieu et. al. (2008), most of the stratospheric fluorine species eventually form Hydrogen Fluoride (HF), which is not measured by MIPAS. Figure 20 is the expected HF zonal mean for 2010 March, which is produced by subtracting the total fluorine zonal mean measured by MIPAS from the maximum value of VMR (F).

## Future work

The preliminary results of these new species retrievals will be further compared with the ACE – FTS results, model results and other MIPAS L2 processors.

Also the fluorine inventories will be further analyzed and compared with the ACE HF budget.

## Results and Discussions

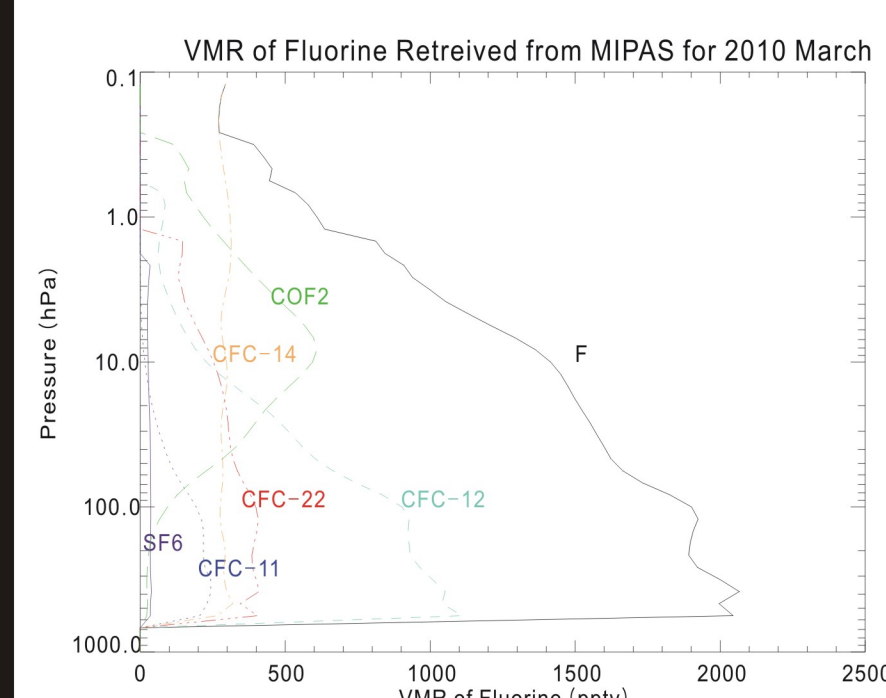


The first and third columns are the zonal mean plots of the new species and the second and fourth columns are the fractional error zonal plots of the corresponding species.

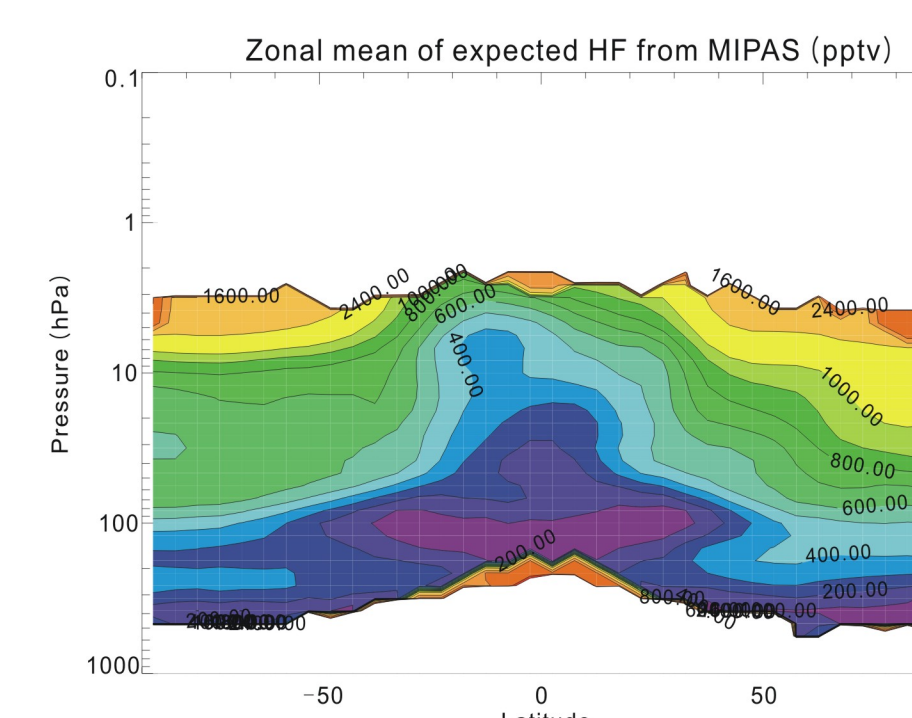
Species CCl<sub>4</sub>, OCS, HCFC-22, SF<sub>6</sub>, C<sub>2</sub>H<sub>6</sub> and COF<sub>2</sub> are tropospheric source gases, which are shown in their zonal mean plots.

There is an increase in VMR for COF<sub>2</sub> in the high stratosphere which is because COF<sub>2</sub> is an intermediate product in the degradation of CFCs in the stratosphere, also because COF<sub>2</sub> is destroyed by photolysis and reaction with O(1D) in the upper stratosphere, which results in a decrease of VMR. The observed structures of the gases CCl<sub>4</sub>, OCS, HCFC-22, SF<sub>6</sub>, C<sub>2</sub>H<sub>6</sub> and COF<sub>2</sub> are as expected. And for gases CFC-14, HOCl and HCN there are some unexplained features in their zonal mean plots. For example, the maximum VMR of HCN in high altitude is larger than that over the equator.

Figures in the second and fourth columns are the zonal plots of fractional error at each point corresponding to figures in the first and third columns. For example, 20% of the fractional error represents that the retrieval at this point has 20% error, and the VMR,  $v$ , lies in the range



This figure is the vertical profile of all the fluorine species measured by MIPAS, and F is the total fluorine defined before. In the lower stratosphere and upper troposphere, the fluorine mainly contributed by CFC-12. COF<sub>2</sub> contributes nearly half of the fluorine VMR at 10hPa pressure level, while CFC-14 dominates in the upper stratosphere. The total [F] is decreasing as the altitude increases, they are eventually formed into HF



This figure is the expected HF zonal mean from MIPAS as defined in the data and method section.