

# Appendix A4

## A4.1 Ozone – O<sub>3</sub>

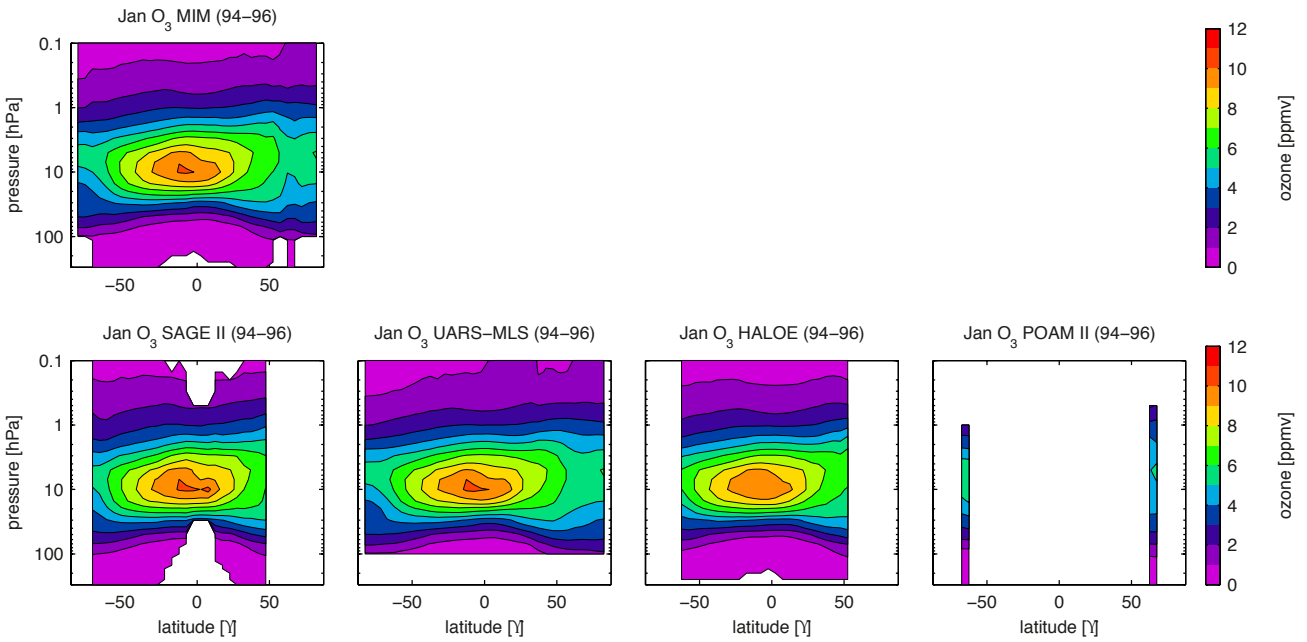


Figure A4.1.1: Monthly zonal mean O<sub>3</sub> for January 1994-1996 (MIM, SAGE II, UARS-MLS, HALOE, POAM II).

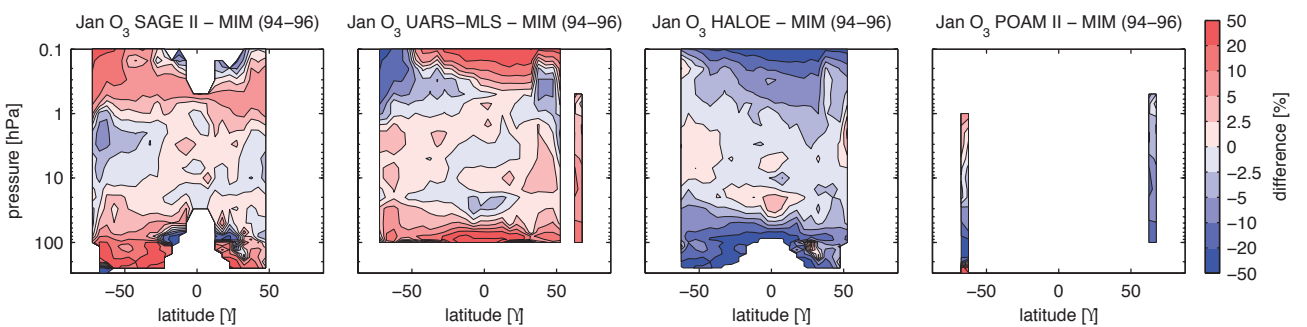
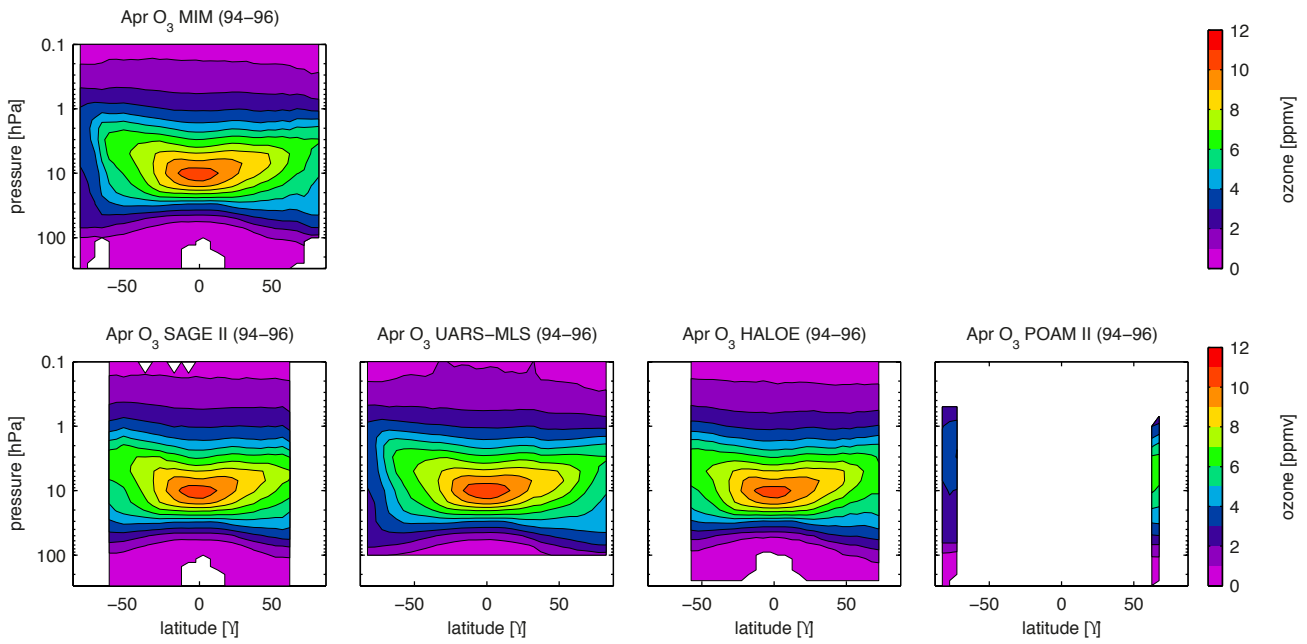
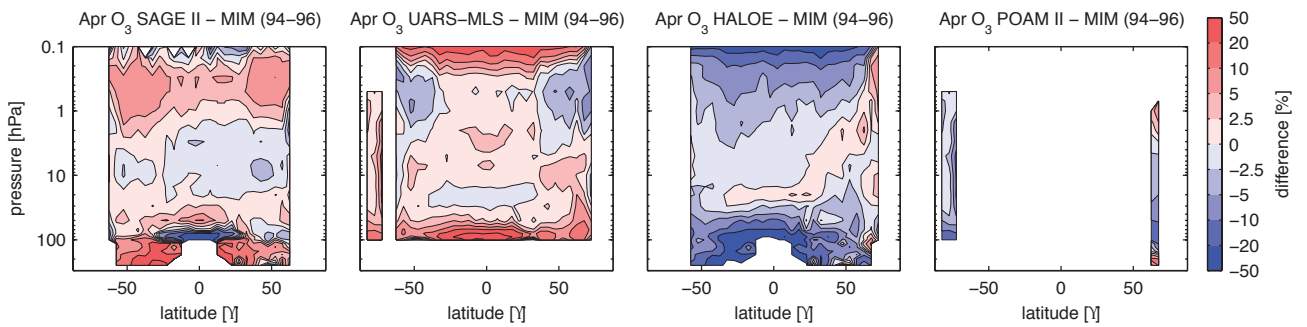


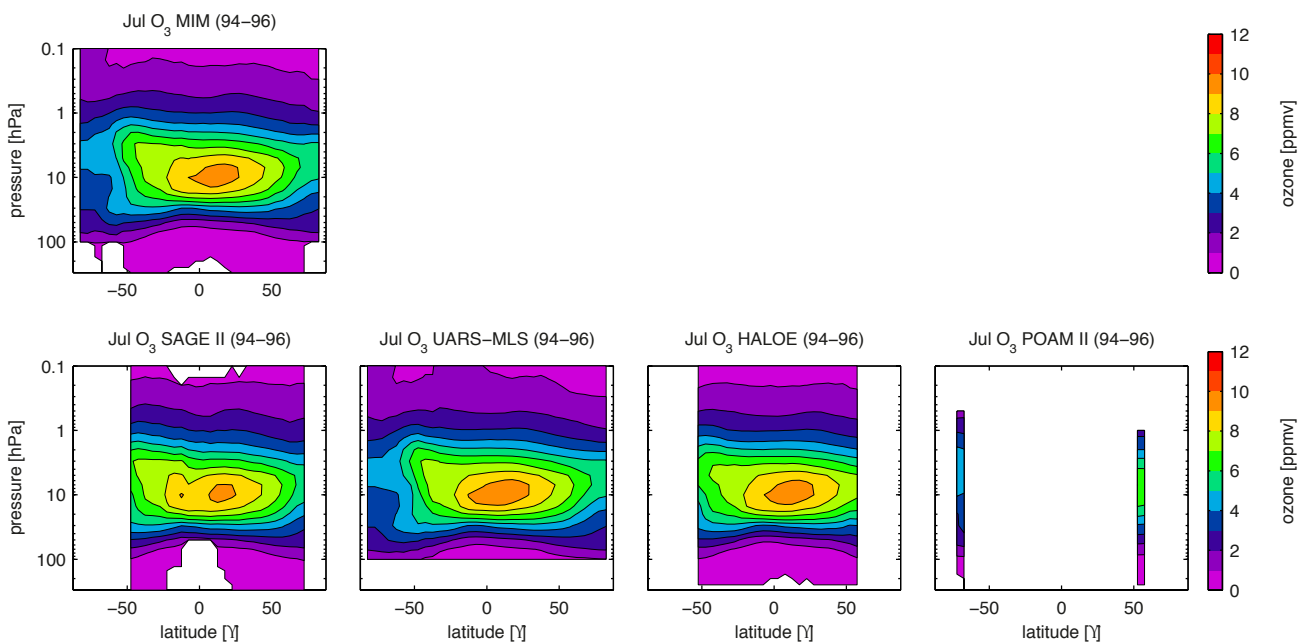
Figure A4.1.2: Monthly zonal mean O<sub>3</sub> differences for January 1994-1996. (Differences between the individual instruments and the MIM).



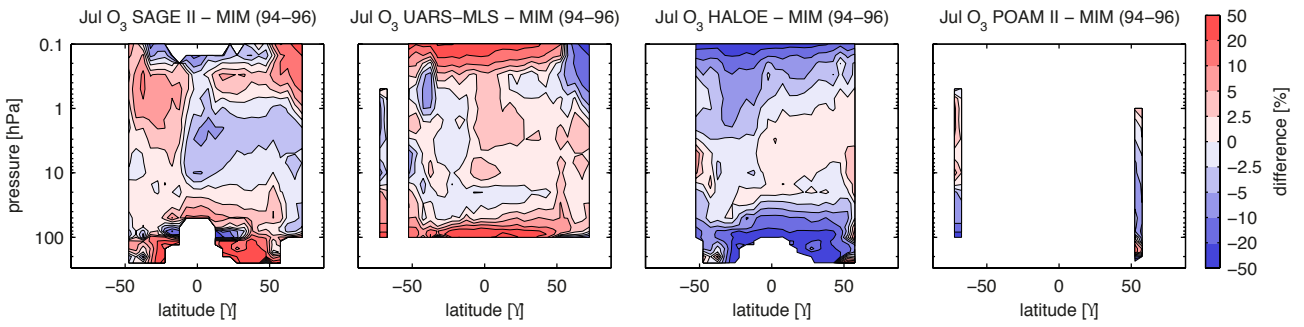
**Figure A4.1.3:** Monthly zonal mean  $O_3$  for April 1994-1996 (MIM, SAGE II, UARS-MLS, HALOE, POAM II).



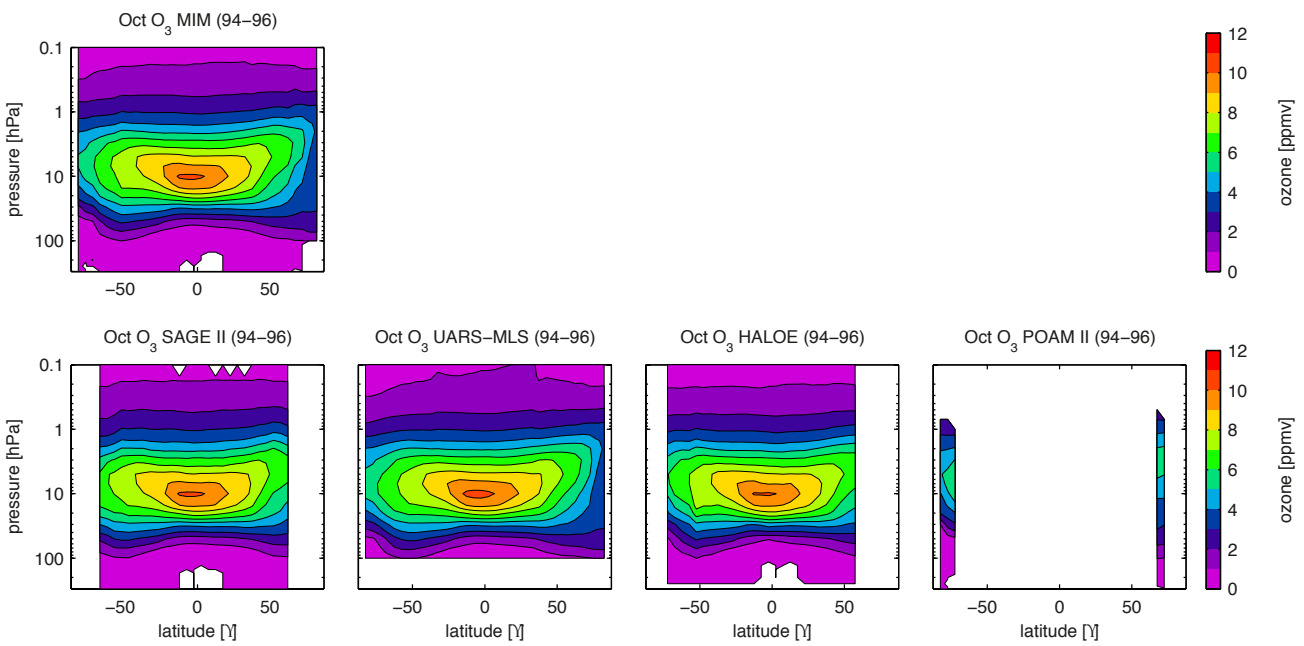
**Figure A4.1.4:** Monthly zonal mean  $O_3$  differences for April 1994-1996. (Differences between the individual instruments and the MIM).



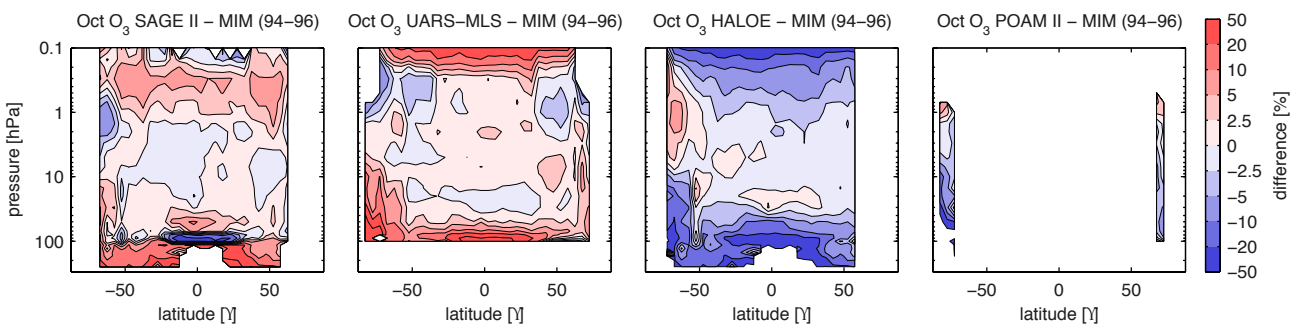
**Figure A4.1.5:** Monthly zonal mean  $O_3$  for July 1994-1996 (MIM, SAGE II, UARS-MLS, HALOE, POAM II).



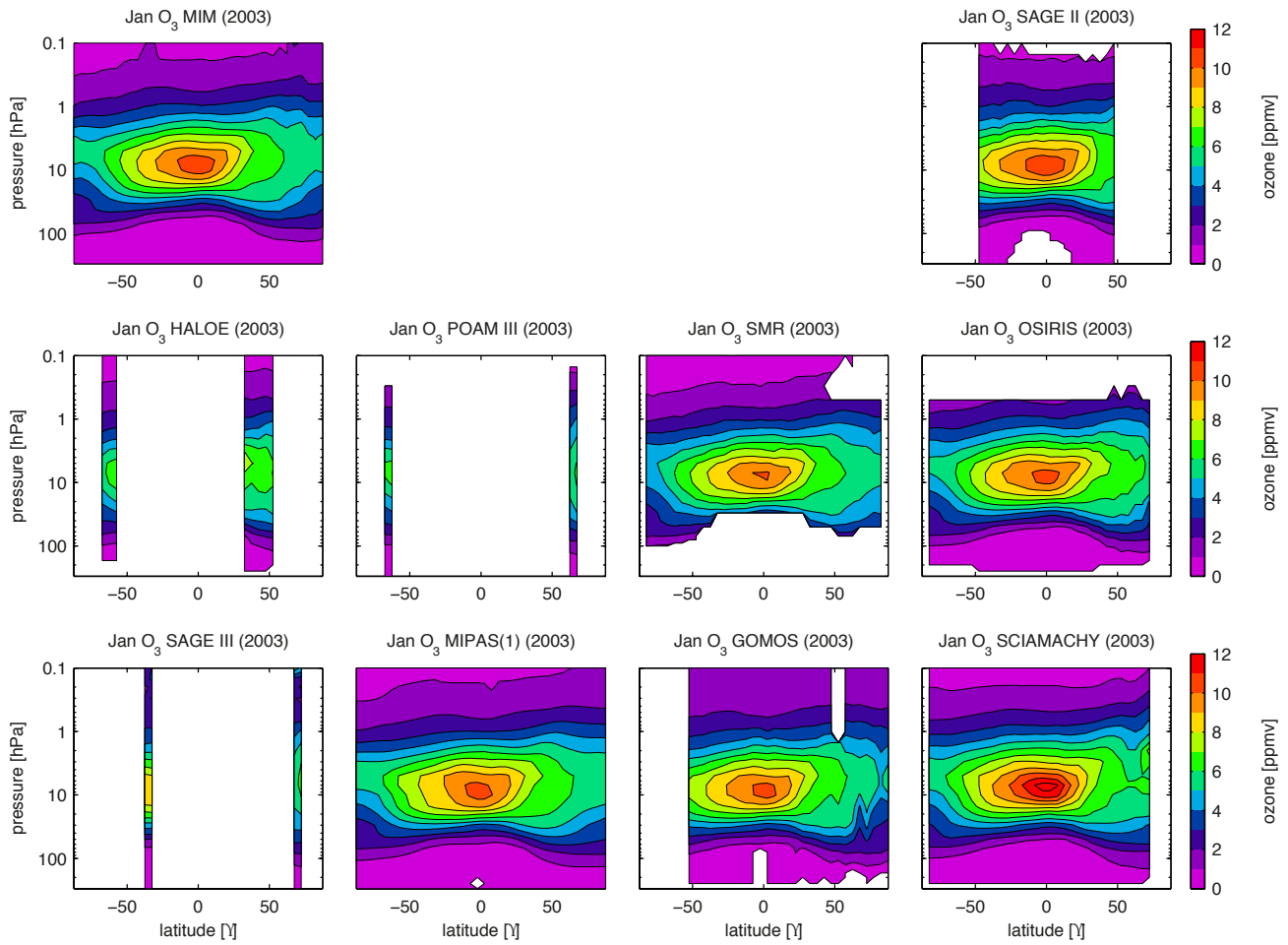
**Figure A4.1.6:** Monthly zonal mean  $O_3$  differences for July 1994-1996. (Differences between the individual instruments and the MIM).



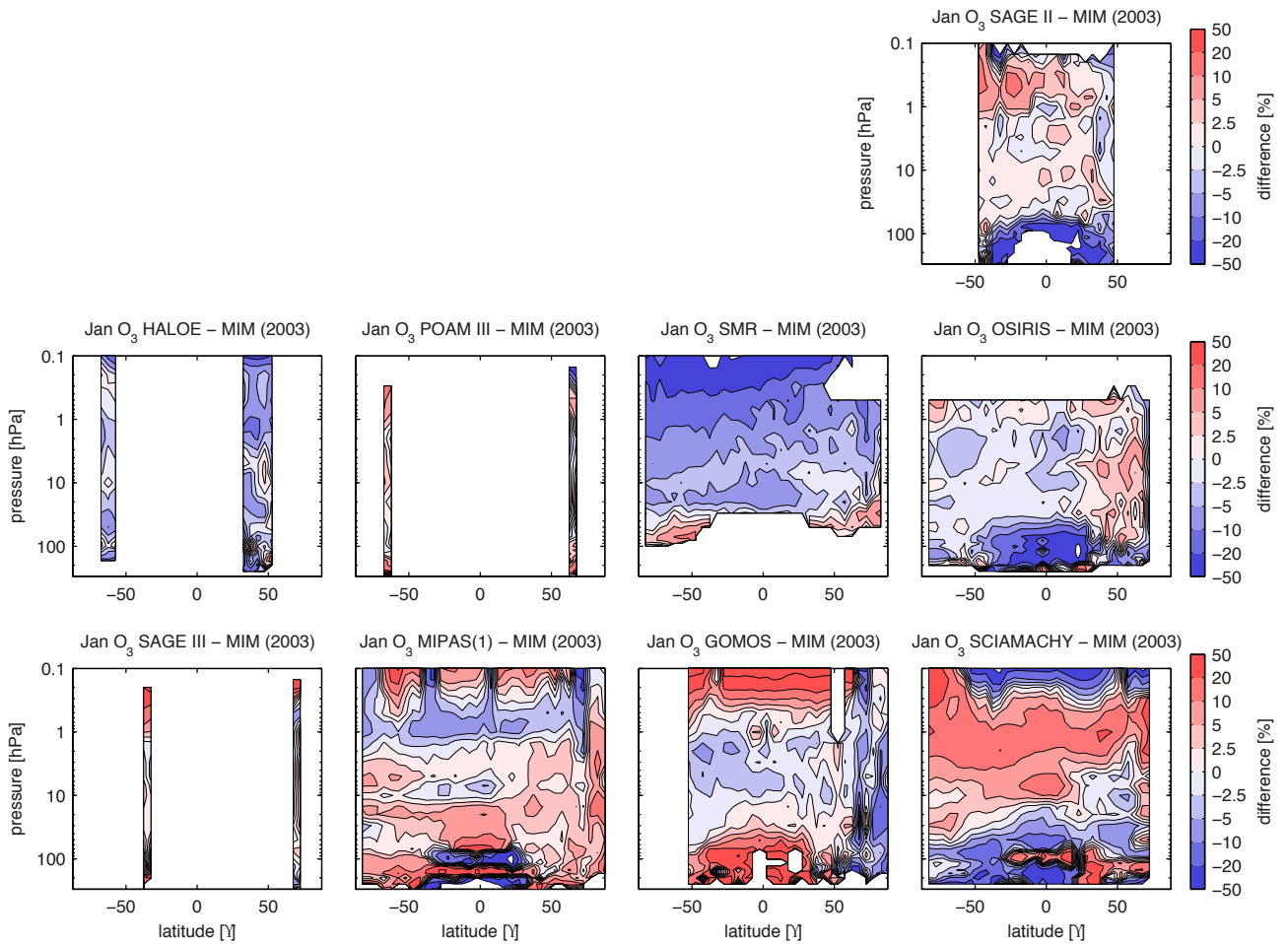
**Figure A4.1.7:** Monthly zonal mean  $O_3$  for October 1994-1996 (MIM, SAGE II, UARS-MLS, HALOE, POAM II).



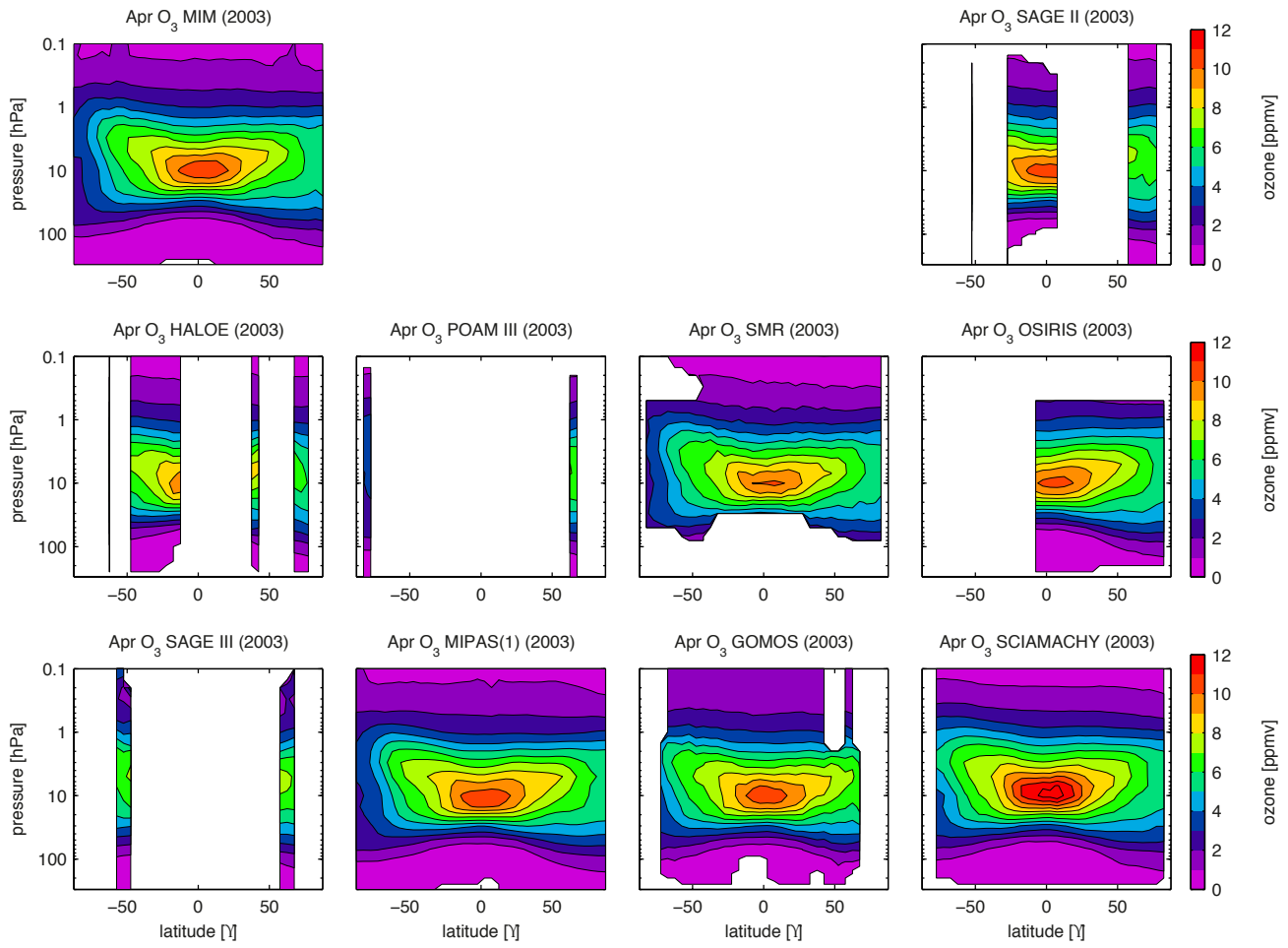
**Figure A4.1.8:** Monthly zonal mean  $O_3$  differences for October 1994-1996. (Differences between the individual instruments and the MIM).



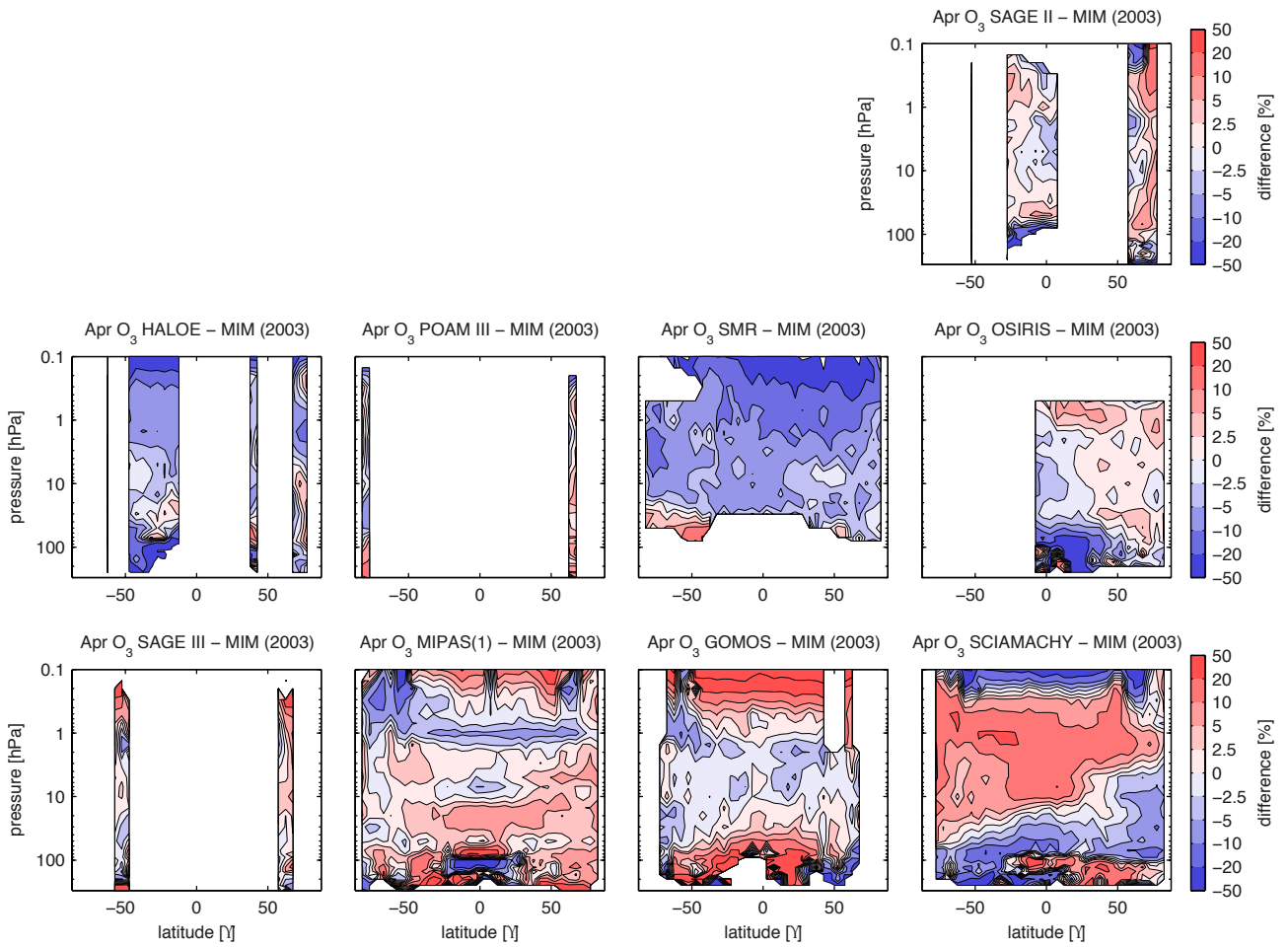
**Figure A4.1.9: Monthly zonal mean O<sub>3</sub> for January 2003 (MIM, SAGE II, HALOE, POAM III, SMR, OSIRIS, SAGE III, MIPAS(1), GOMOS, and SCIAMACHY).**



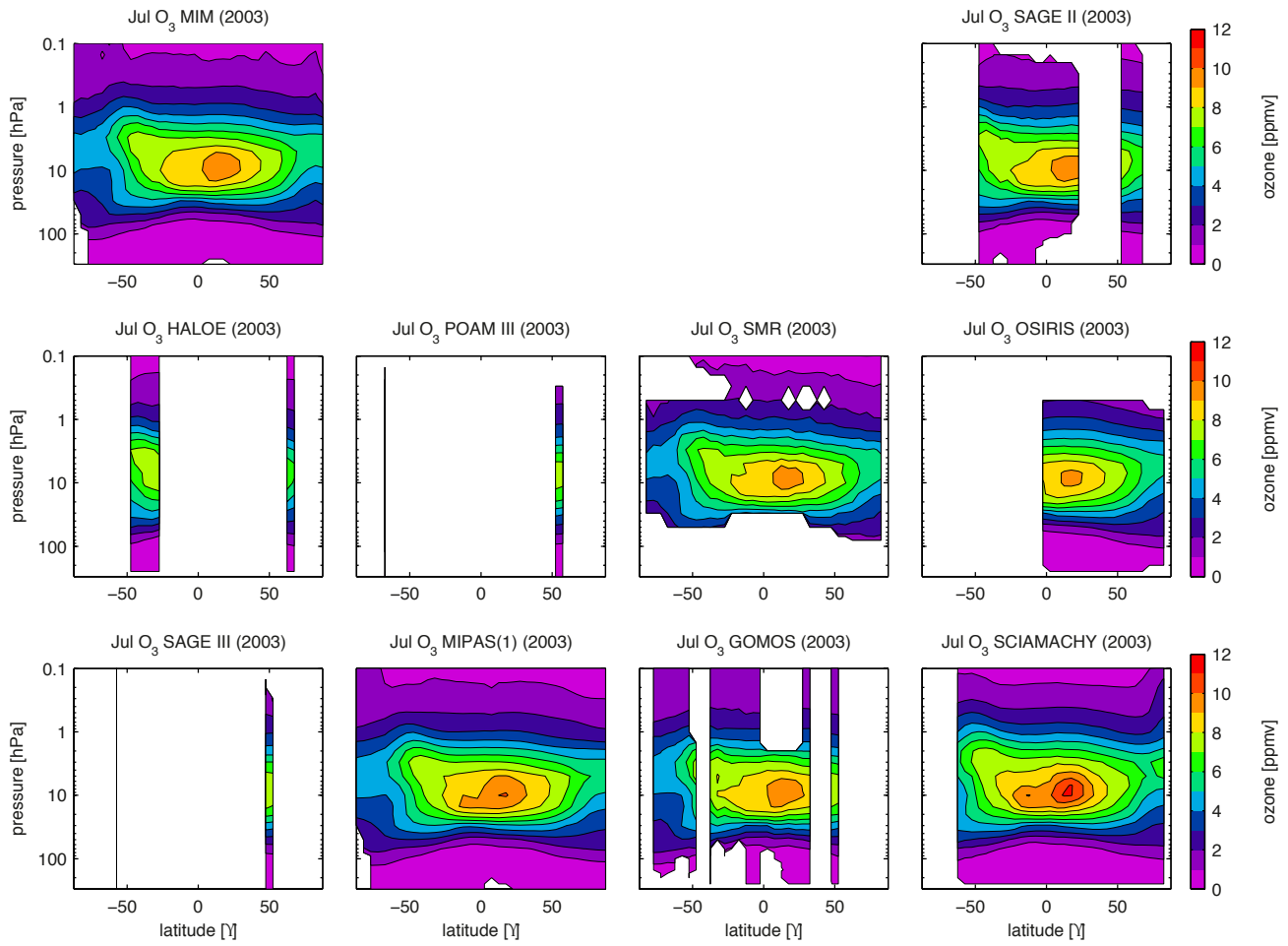
**Figure A4.1.10:** Monthly zonal mean  $O_3$  differences for January 2003. (Differences between the individual instruments and the MIM).



**Figure A4.1.11:** Monthly zonal mean  $O_3$  for April 2003 (MIM, SAGE II, HALOE, POAM III, SMR, OSIRIS, SAGE III, MIPAS(1), GOMOS, and SCIAMACHY).

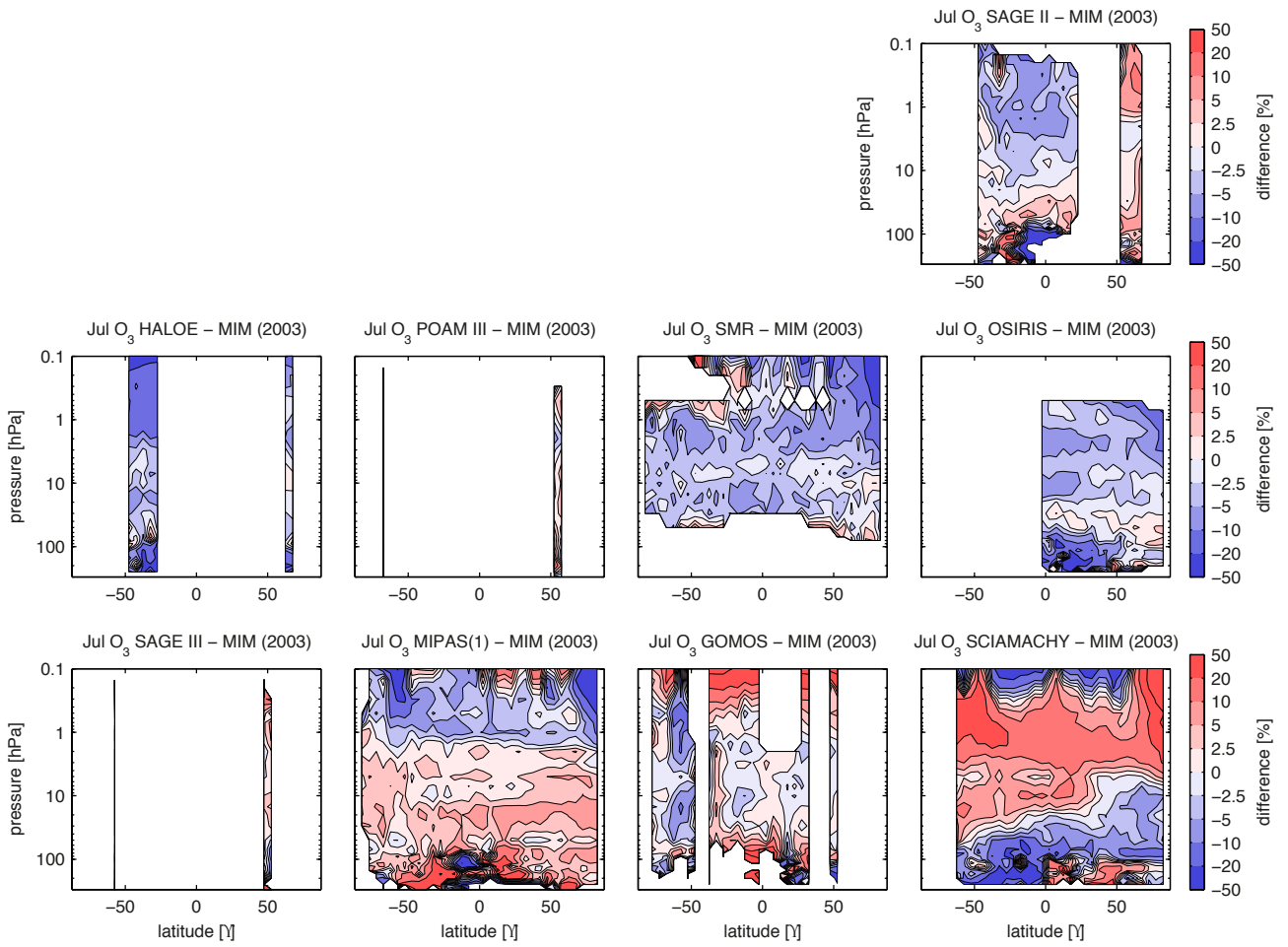


**Figure A4.12:** Monthly zonal mean  $O_3$  differences for April 2003. (Differences between the individual instruments and the MIM).

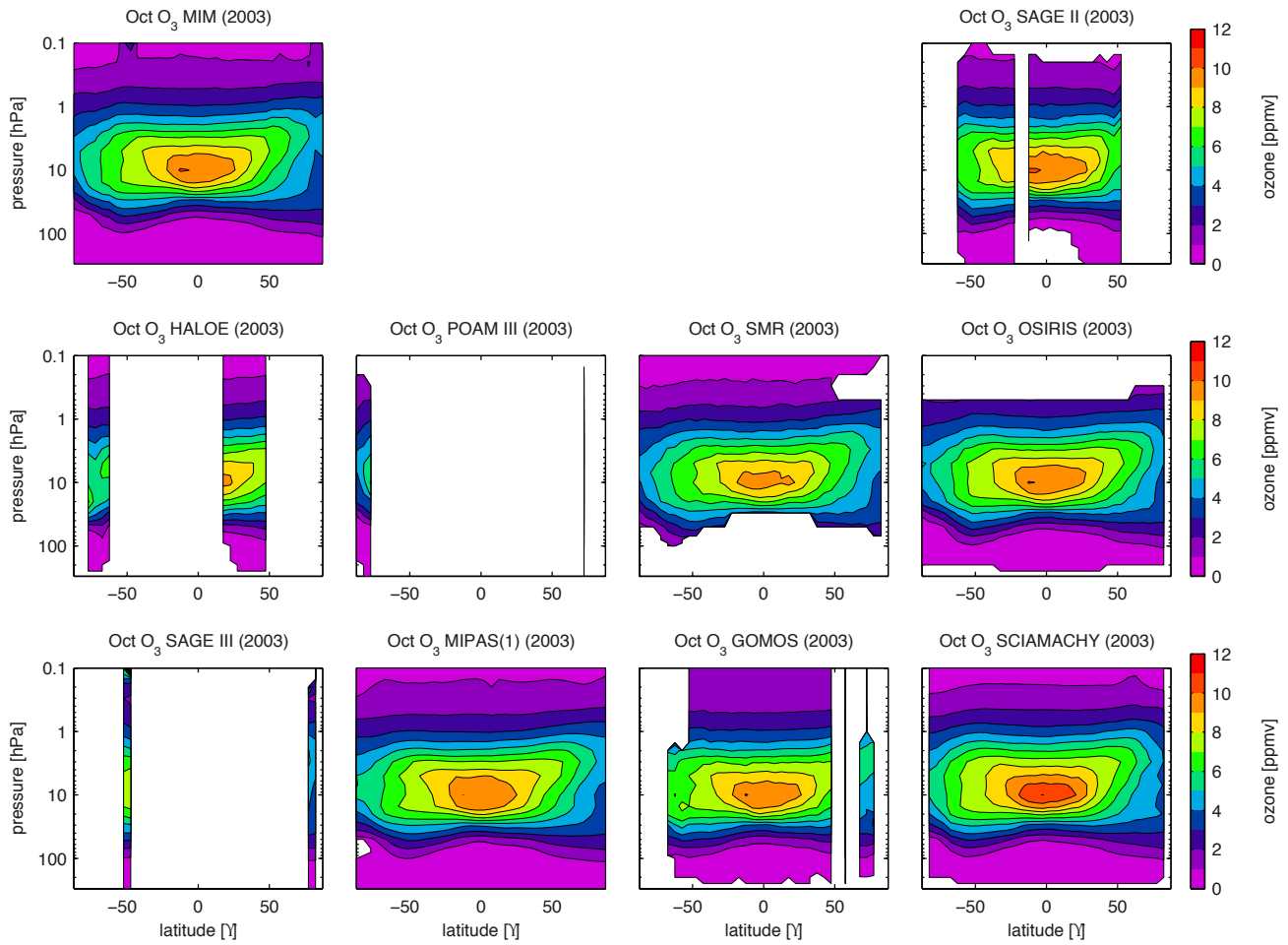


**Figure A4.1.13:** Monthly zonal mean O<sub>3</sub> for July 2003 (MIM, SAGE II, HALOE, POAM III, SMR, OSIRIS, SAGE III, MIPAS(1), GOMOS, and SCIAMACHY).

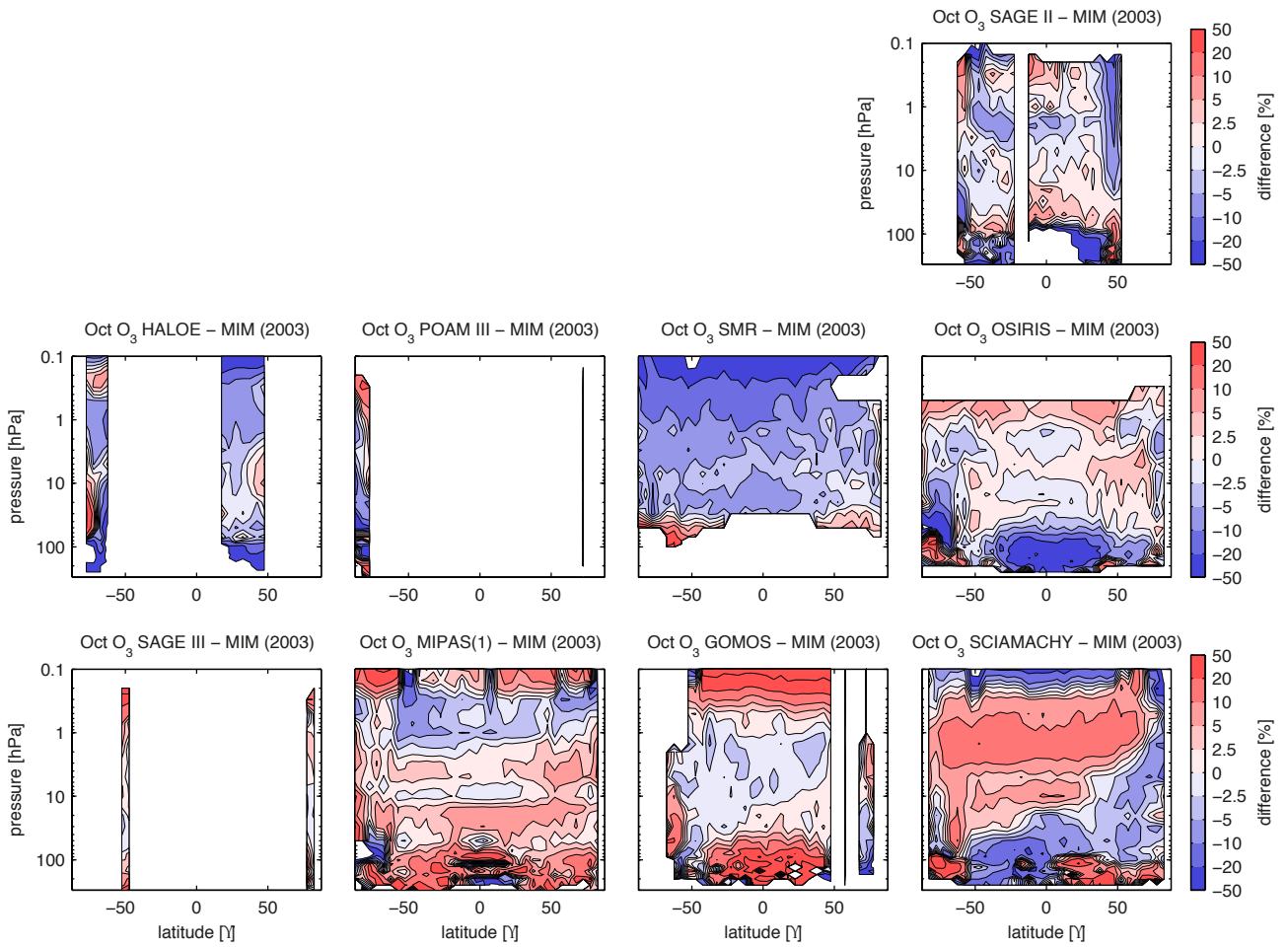




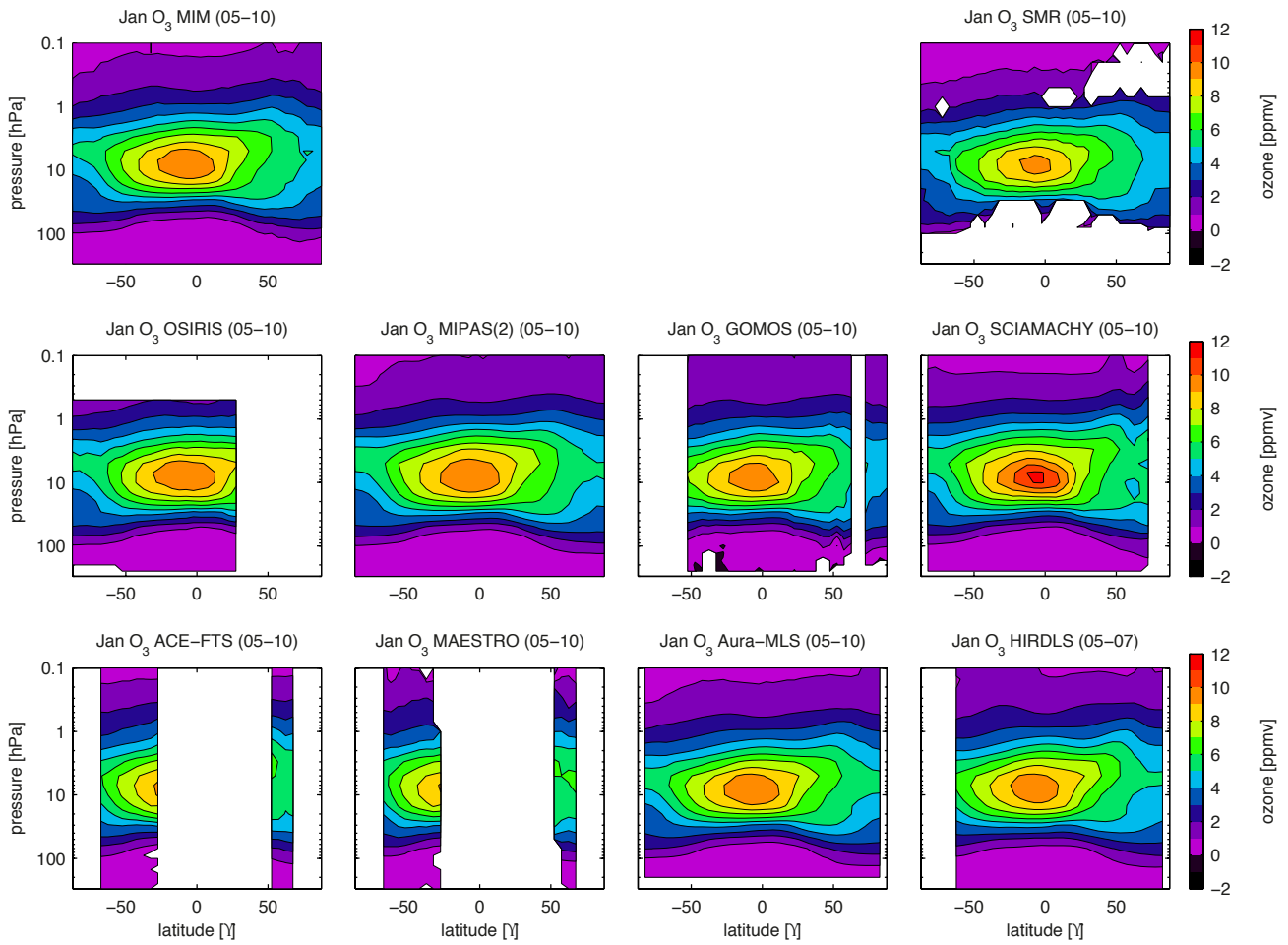
**Figure A4.1.14:** Monthly zonal mean O<sub>3</sub> differences for July 2003. (Differences between the individual instruments and the MIM).



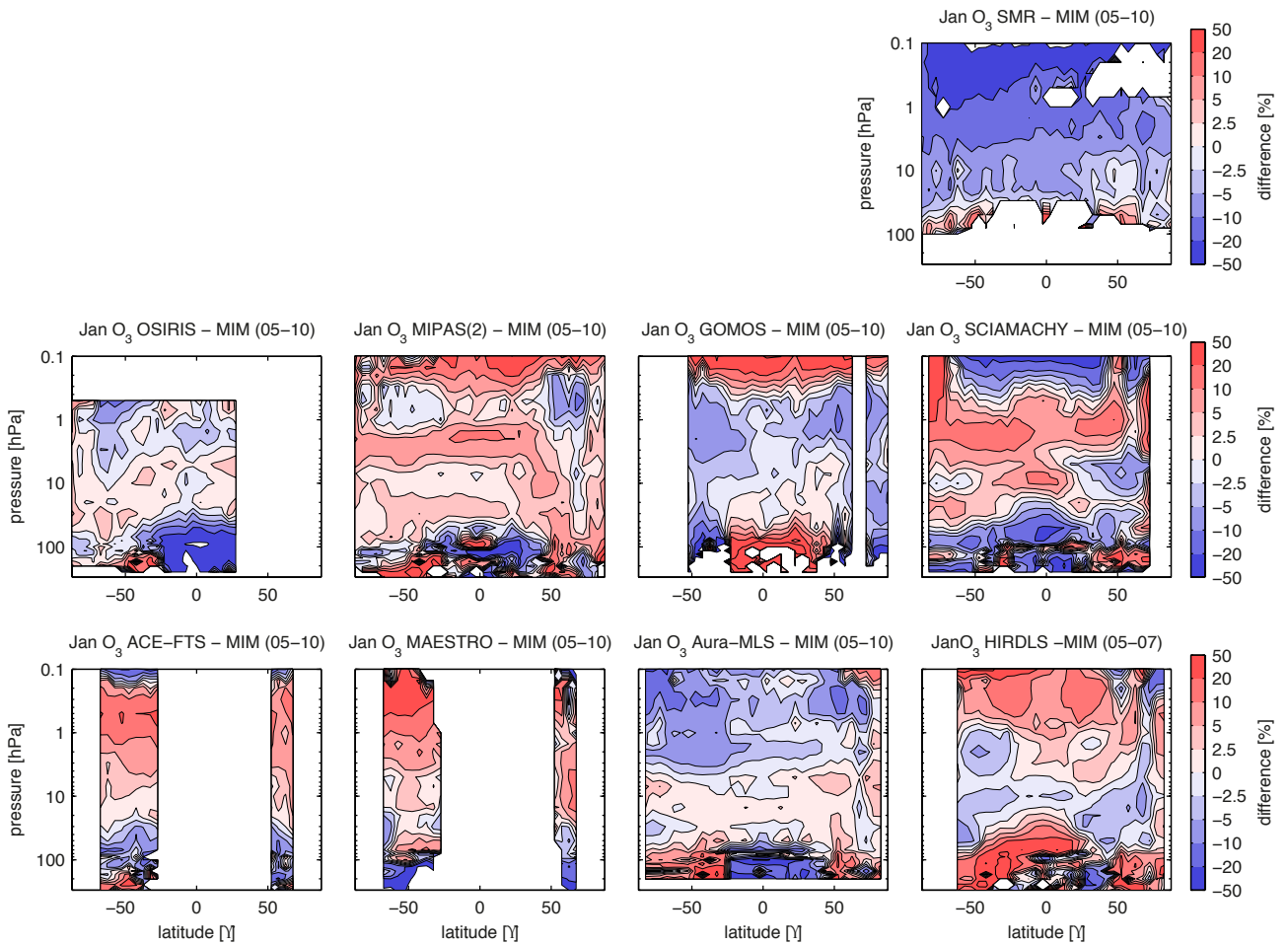
**Figure A4.1.15:** Monthly zonal mean  $O_3$  for October 2003 (MIM, SAGE II, HALOE, POAM III, SMR, OSIRIS, SAGE III, MIPAS(1), GOMOS, and SCIAMACHY).



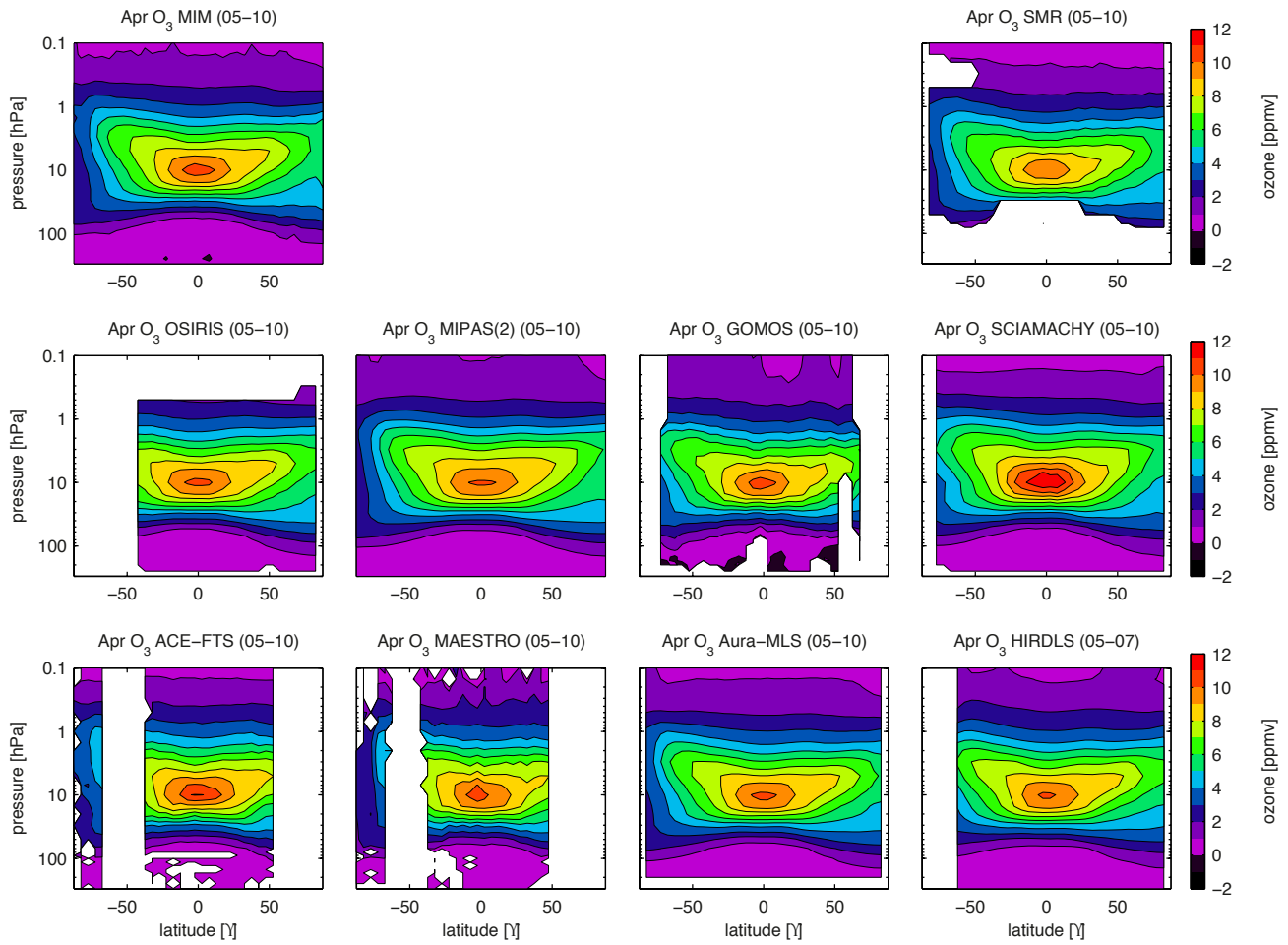
**Figure A4.16:** Monthly zonal mean  $O_3$  differences for October 2003. (Differences between the individual instruments and the MIM).



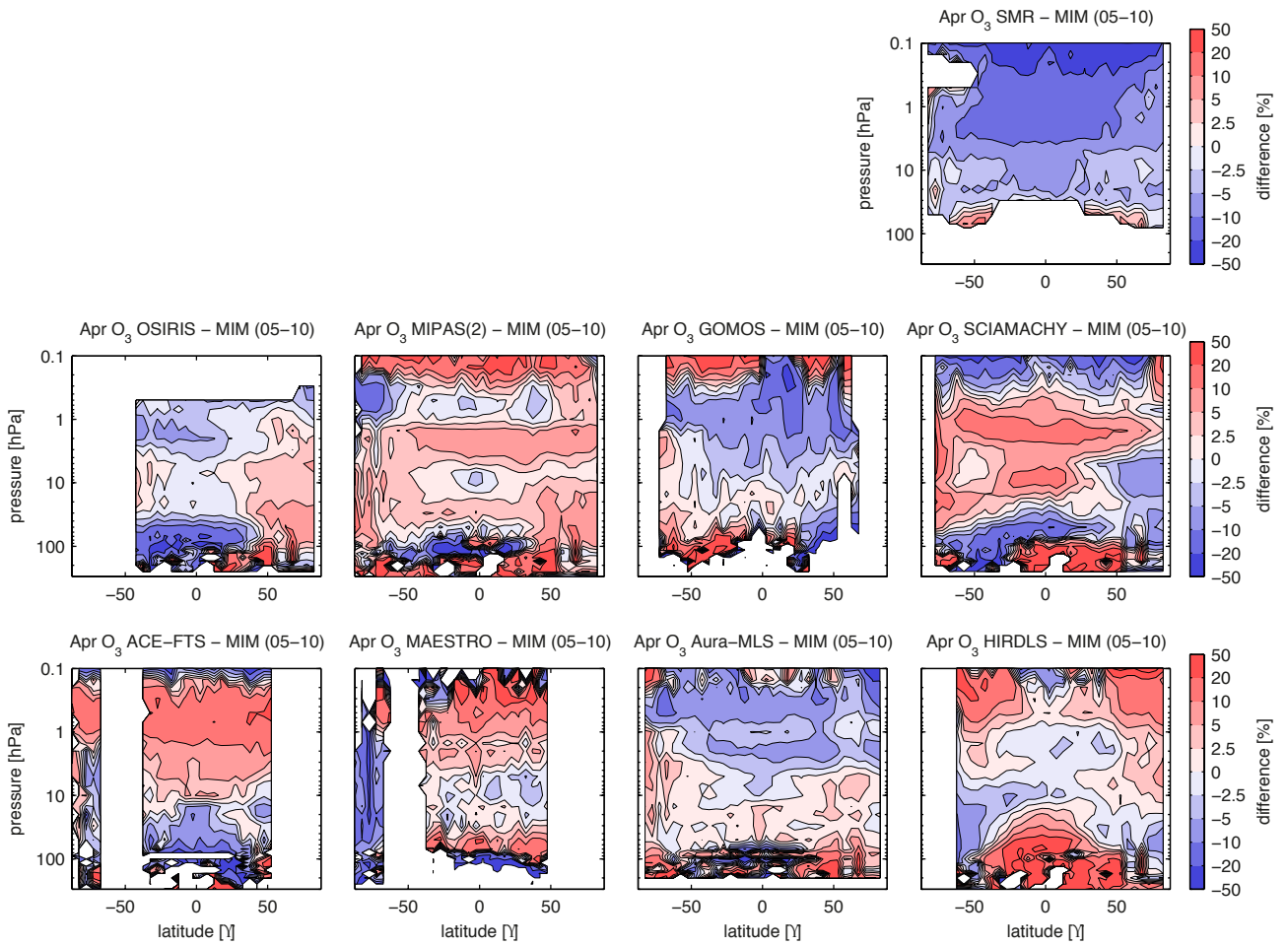
**Figure A4.1.17: Monthly zonal mean  $O_3$  for January 2005-2010 (MIM, SMR, OSIRIS, MIPAS(2), GOMOS, SCIAMACHY, ACE-FTS, ACE- MAESTRO, Aura-MLS and HIRDLS).**



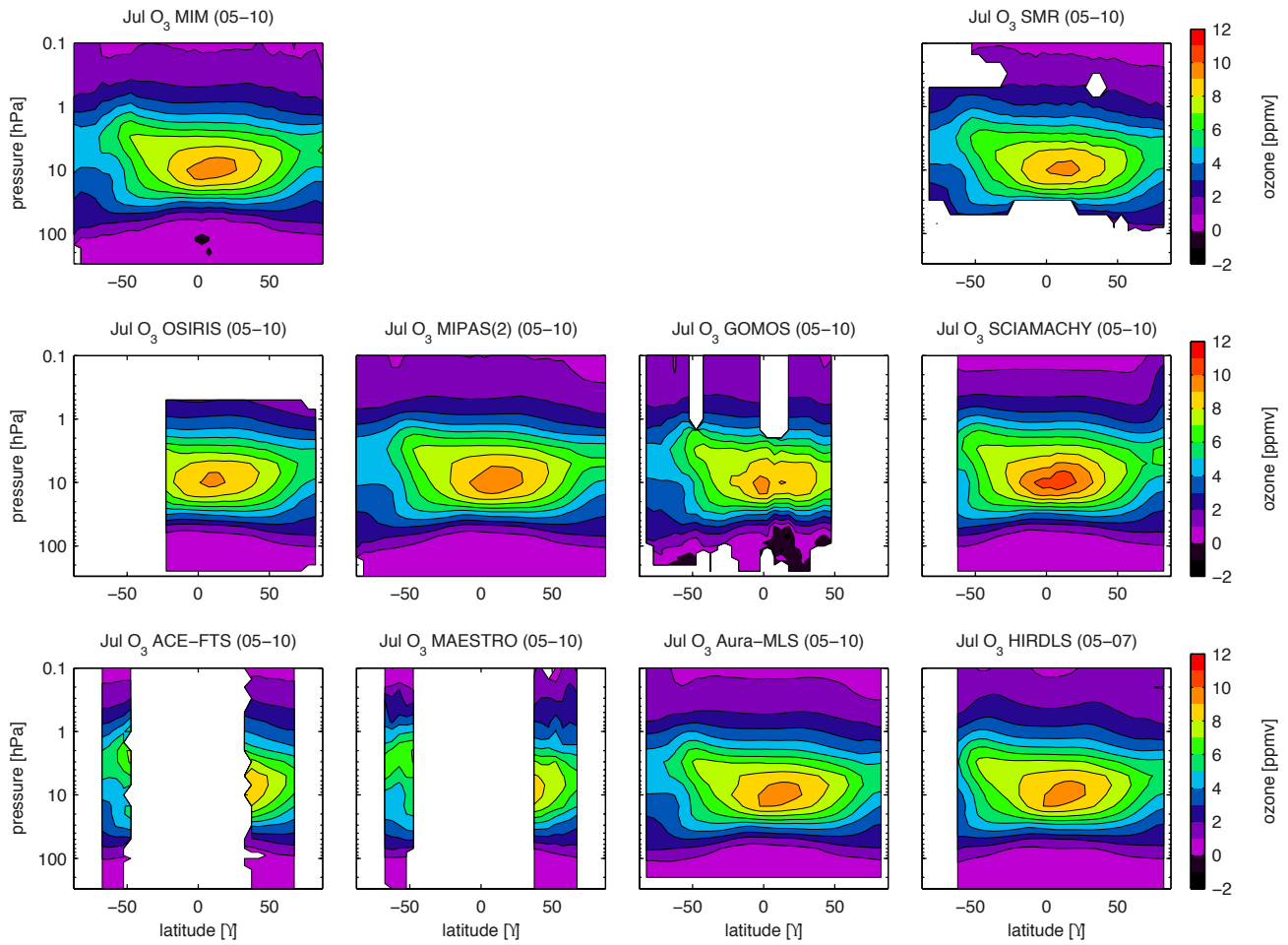
**Figure A4.1.18:** Monthly zonal mean  $O_3$  differences for January 2005-2010. (Differences between the individual instruments and the MIM).



**Figure A4.1.19:** Monthly zonal mean  $O_3$  for April 2005-2010 (MIM, SMR, OSIRIS, MIPAS(2), GOMOS, SCIAMACHY, ACE-FTS, ACE- MAESTRO, Aura-MLS and HIRDLS).

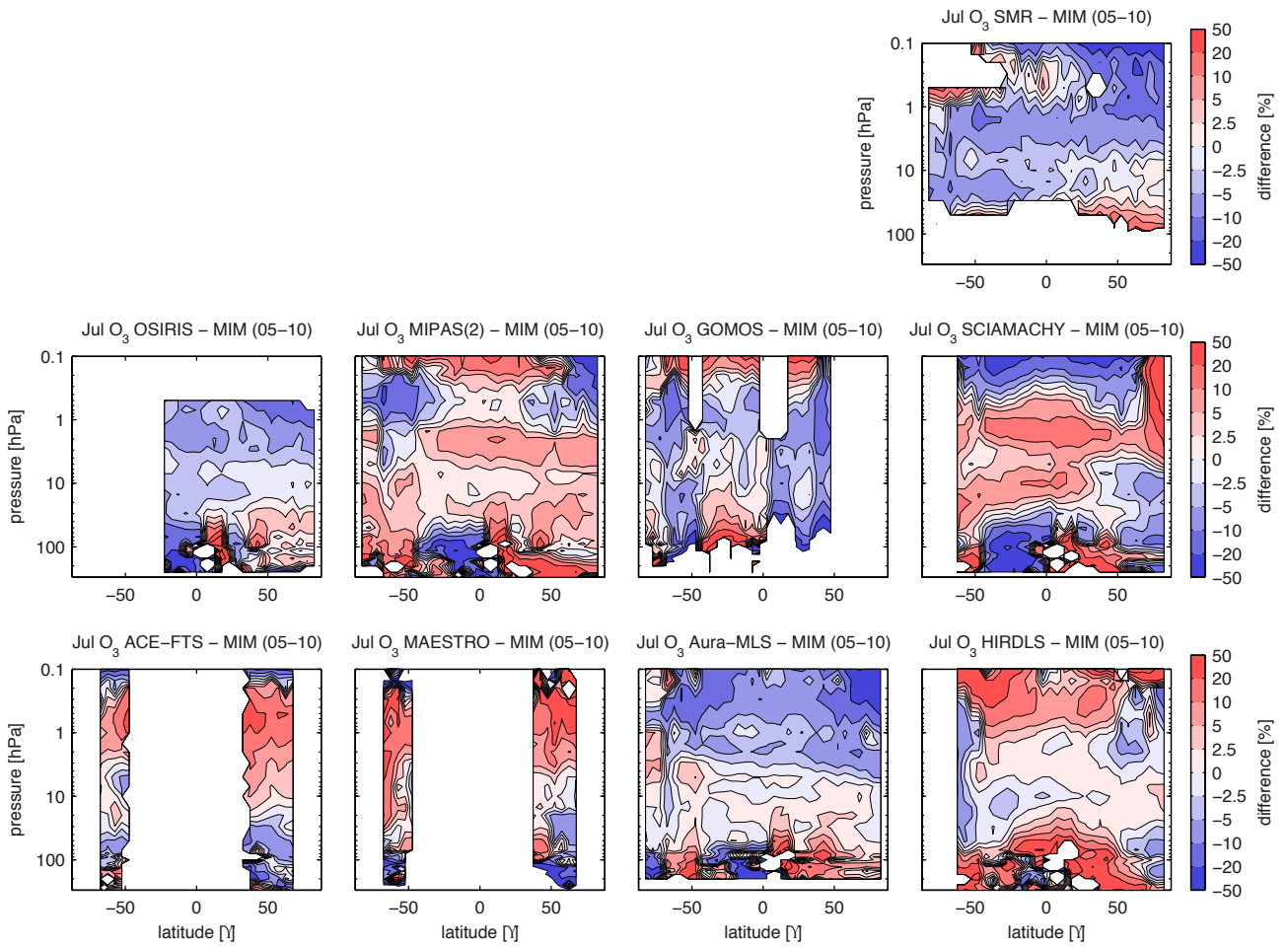


**Figure A4.1.20:** Monthly zonal mean O<sub>3</sub> differences for April 2005-2010. (Differences between the individual instruments and the MIM).

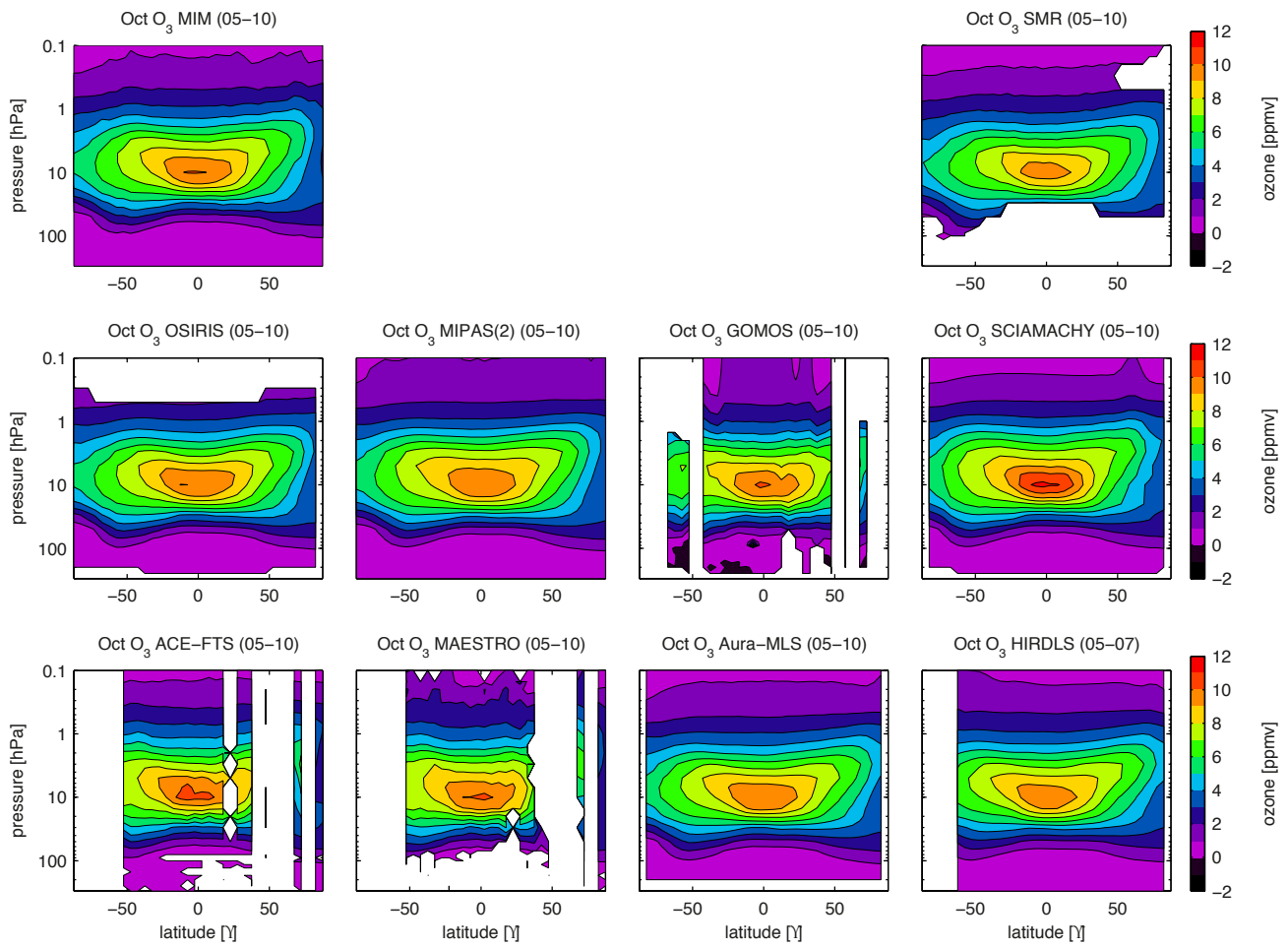


**Figure A4.1.21: Monthly zonal mean O<sub>3</sub> for July 2005-2010 (MIM, SMR, OSIRIS, MIPAS(2), GOMOS, SCIAMACHY, ACE-FTS, ACE- MAESTRO, Aura-MLS and HIRDLS).**

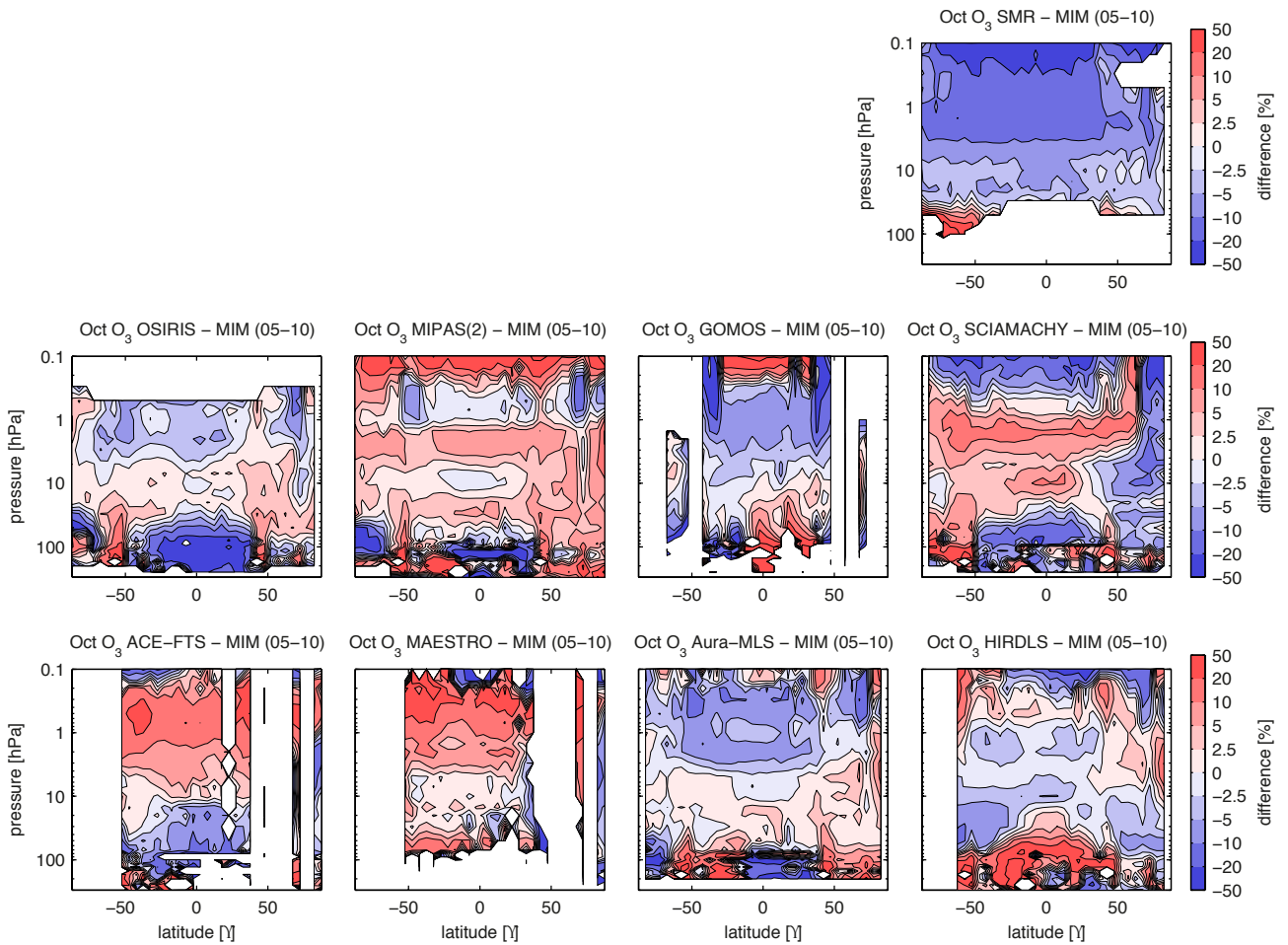




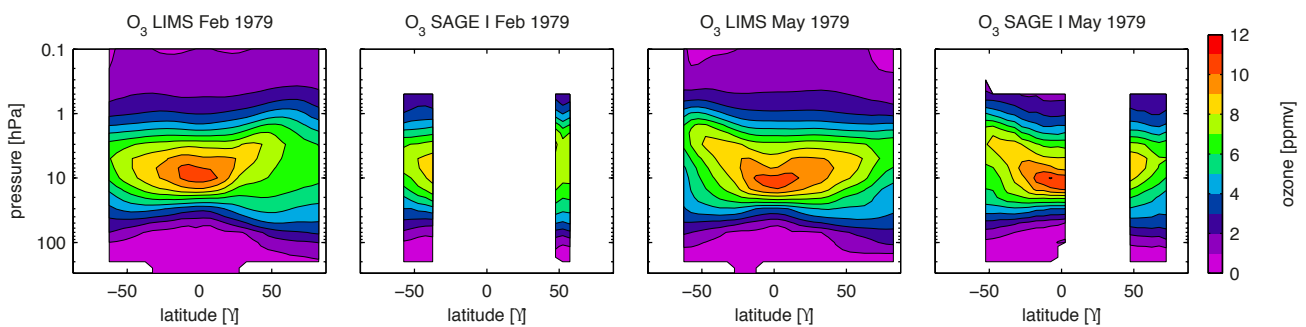
**Figure A4.1.22:** Monthly zonal mean  $O_3$  differences for July 2005-2010. (Differences between the individual instruments and the MIM).



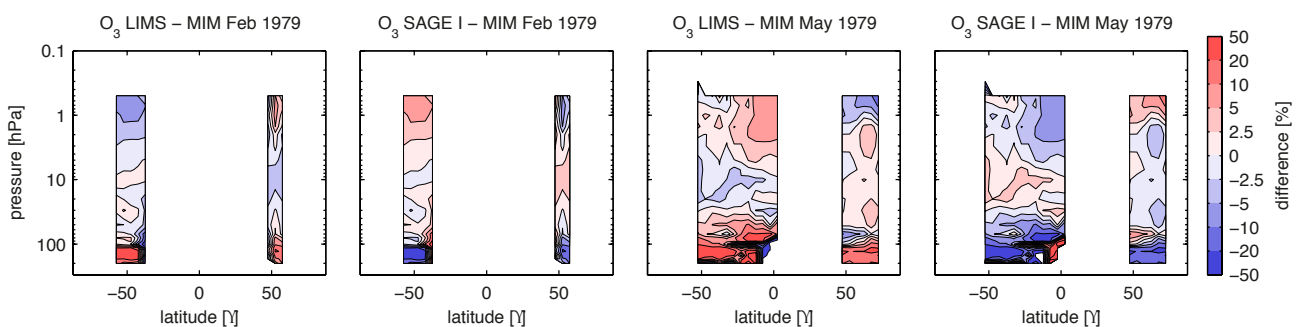
**Figure A4.1.23: Monthly zonal mean O<sub>3</sub> for October 2005-2010 (MIM, SMR, OSIRIS, MIPAS(2), GOMOS, SCIAMACHY, ACE-FTS, ACE- MAESTRO, Aura-MLS and HIRDLS).**



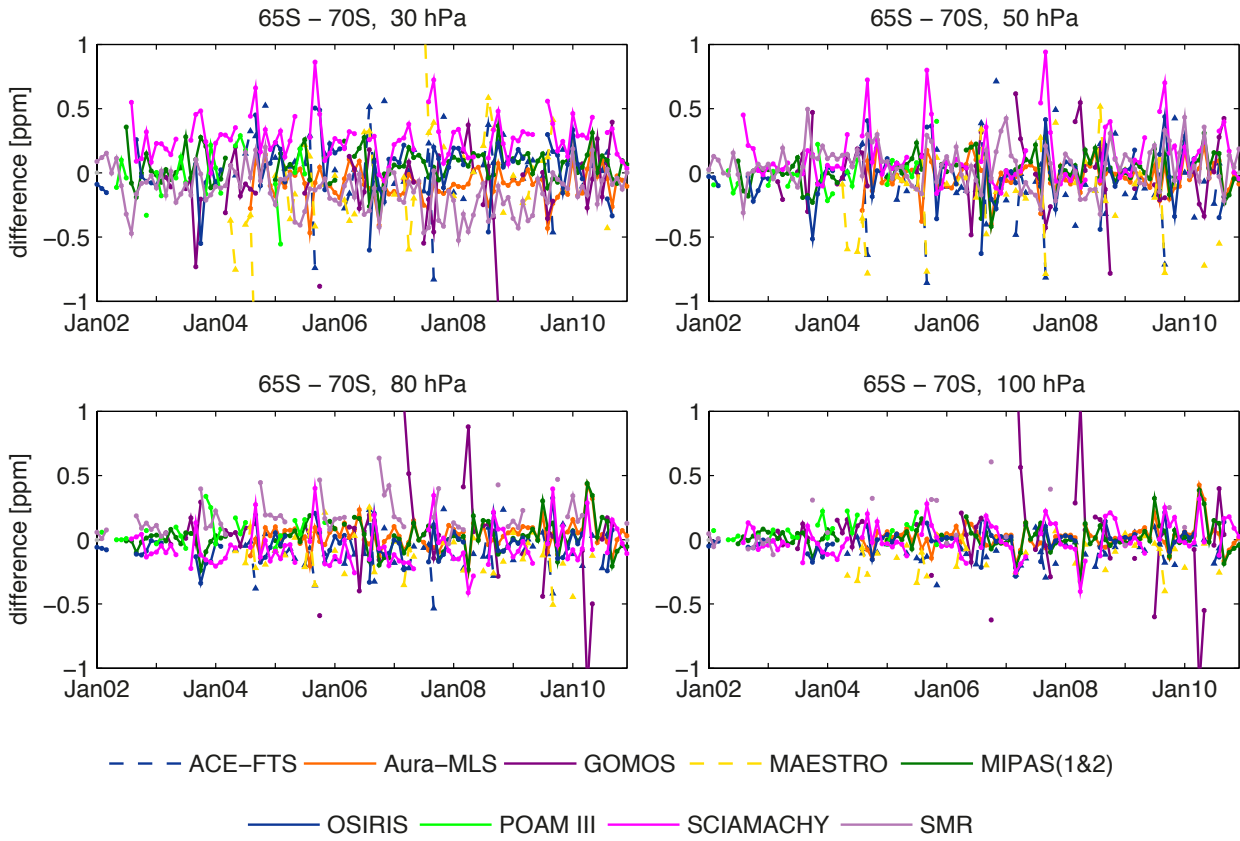
**Figure A4.1.24:** Monthly zonal mean  $O_3$  differences for October 2005-2010. (Differences between the individual instruments and the MIM).



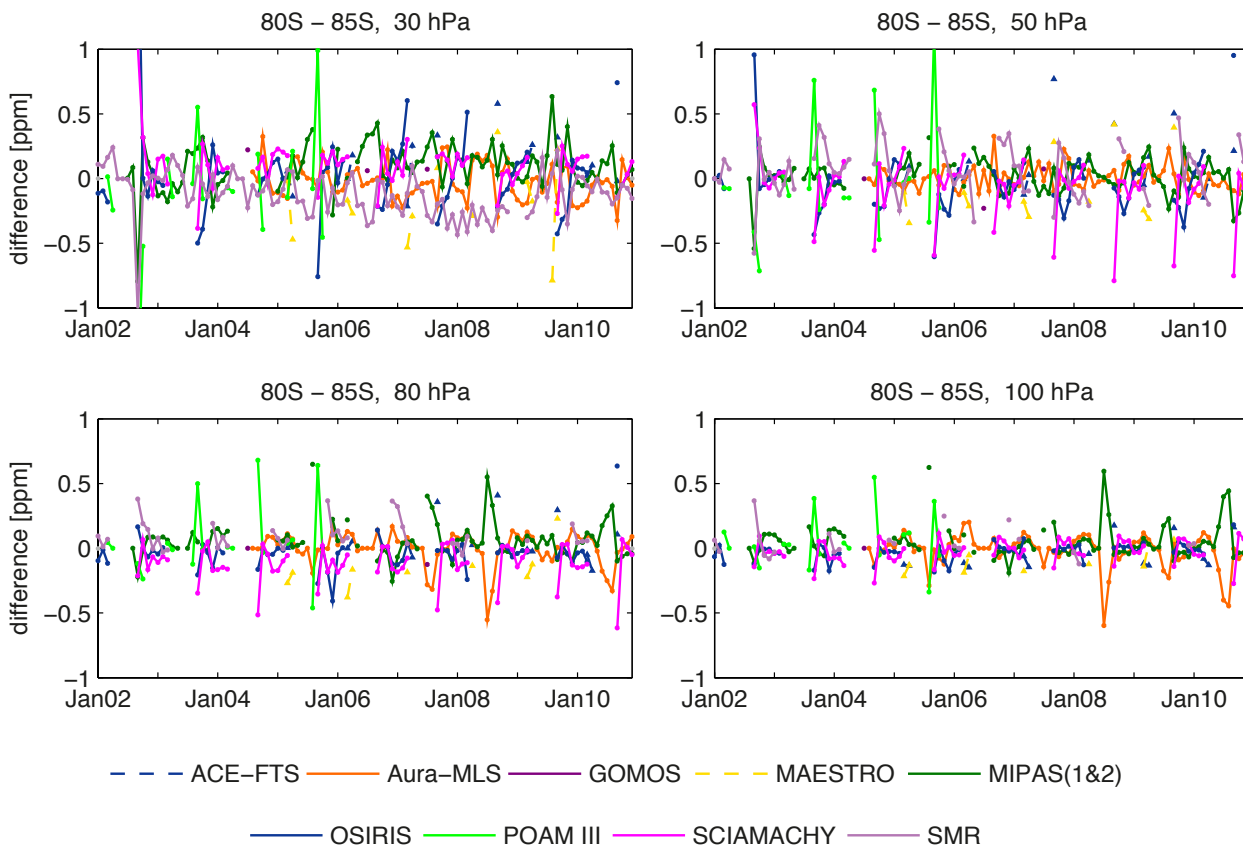
**Figure A4.1.25:** Monthly zonal mean  $O_3$  for February and May 1979 (LIMS and SAGE I).



**Figure A4.1.26:** Monthly zonal mean  $O_3$  differences for February and May 1979. (Differences between the individual instruments and the MIM).



**Figure A4.1.27:** Absolute  $O_3$  differences at 65°S–70°S. (Differences between the individual instruments and the MIM at 30, 50, 80 and 100 hPa).



**Figure A4.1.28:** Absolute  $O_3$  differences at 80°S–85°S. (Differences between the individual instruments and the MIM at 30, 50, 80 and 100 hPa).

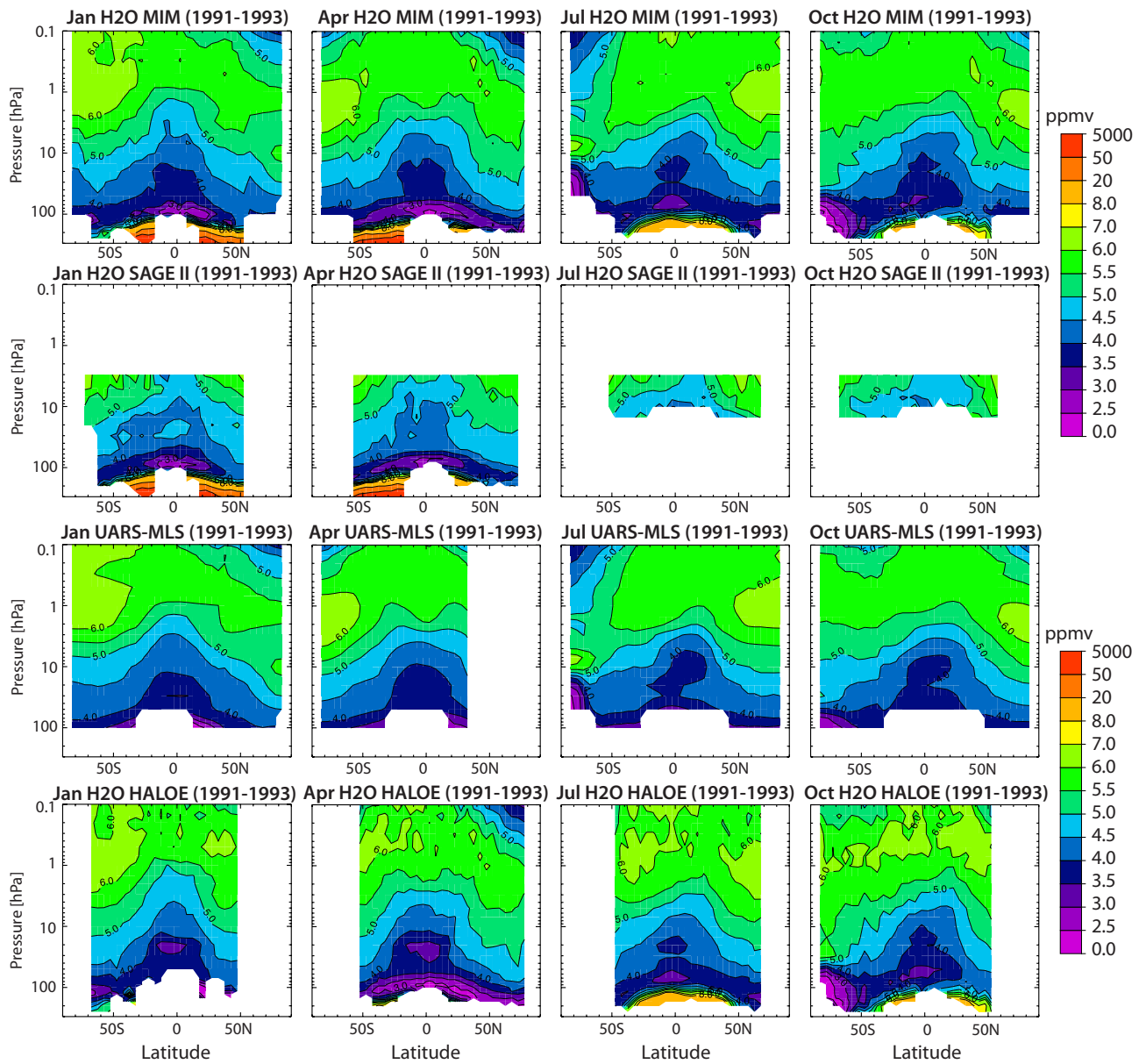
A4.2 Water vapour – H<sub>2</sub>O

Figure A4.2.1a: Monthly zonal mean H<sub>2</sub>O 1991-1993 (MIM, SAGE II, UARS-MLS, and HALOE).

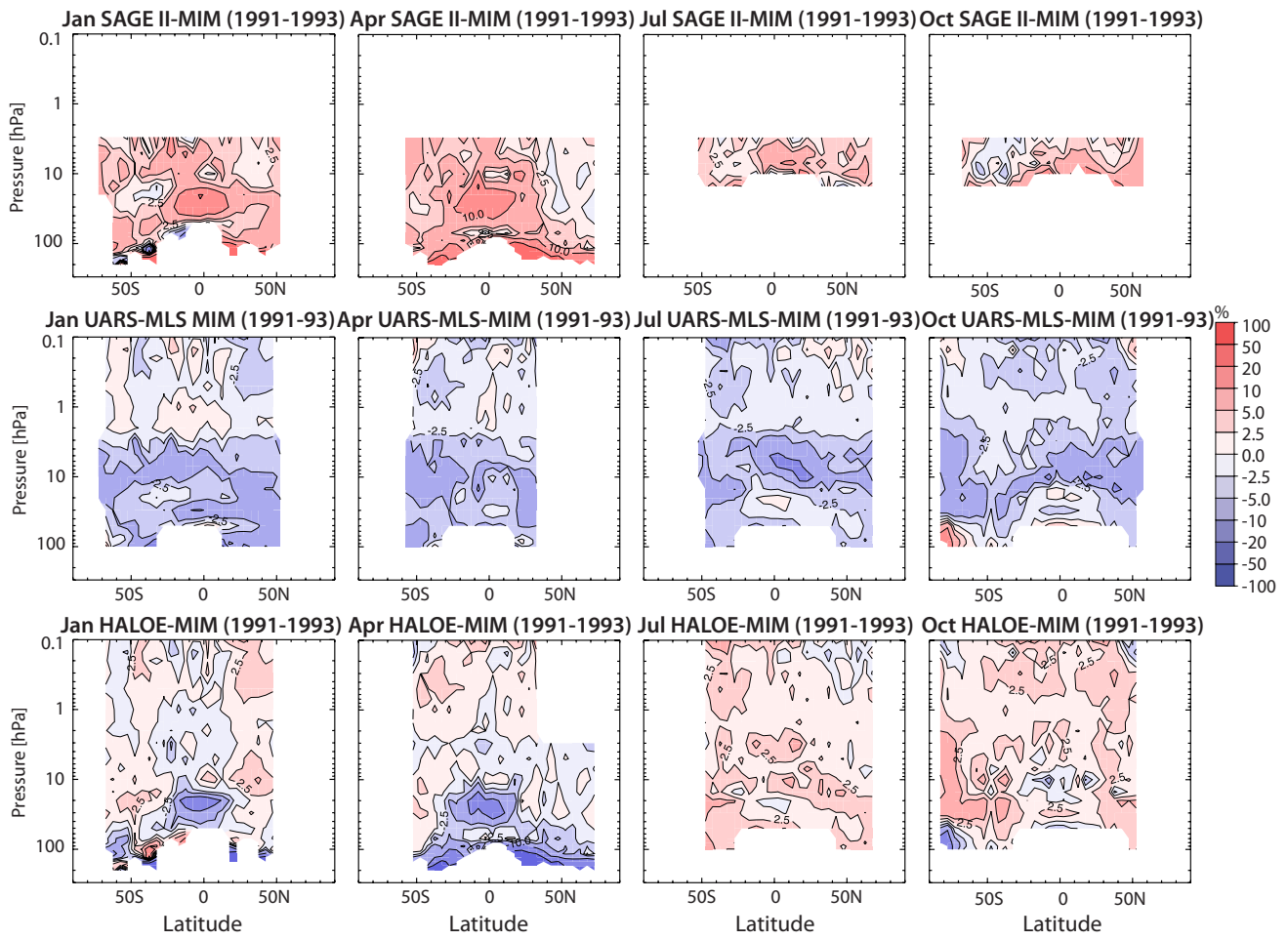


Figure A4.2.1b: Monthly zonal mean  $H_2O$  differences 1991-1993 (SAGE II, UARS-MLS, and HALOE).

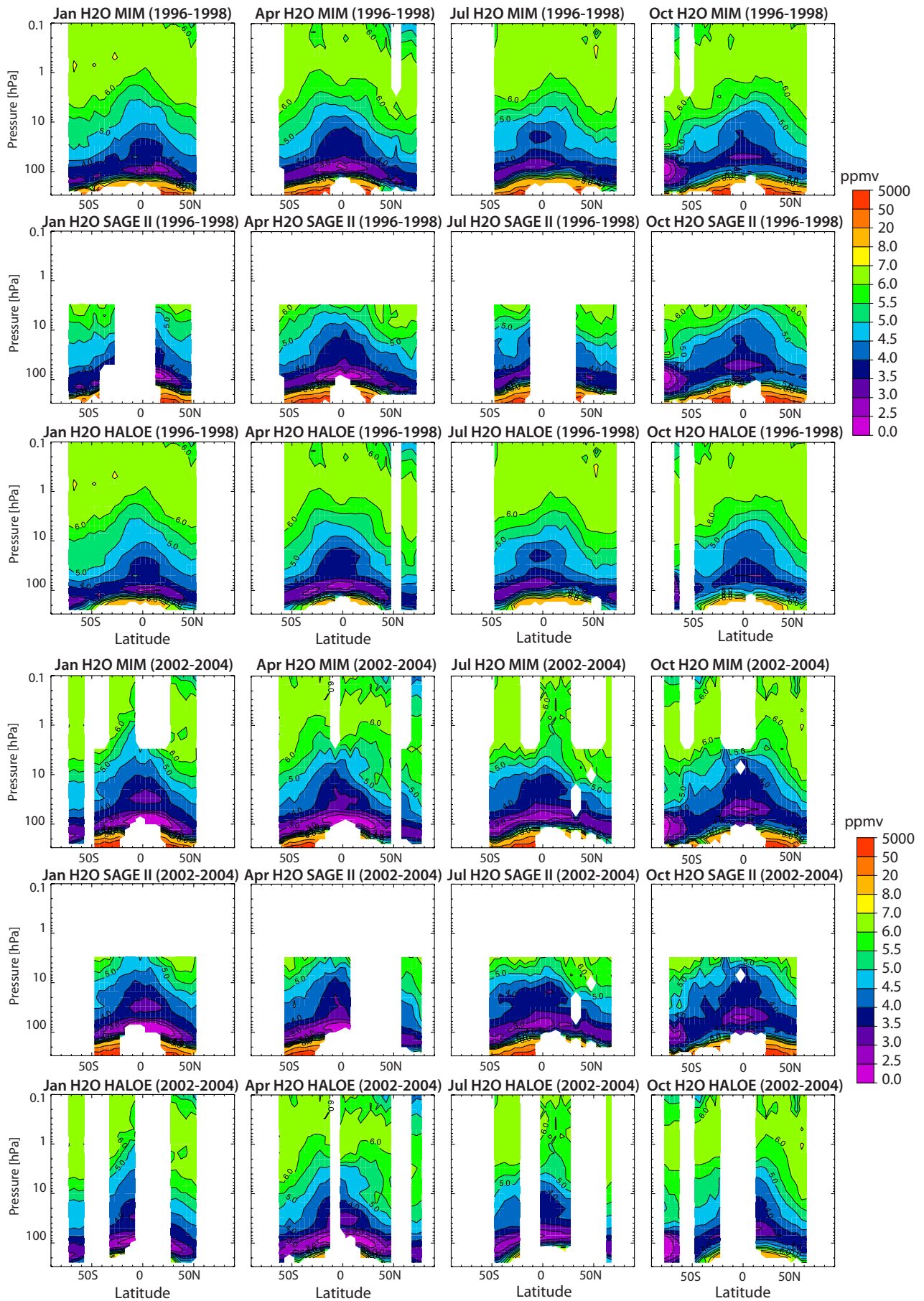


Figure A4.2a: Monthly zonal mean H<sub>2</sub>O 1994-1996 and 2002-2004 (MIM, SAGE II, and HALOE).

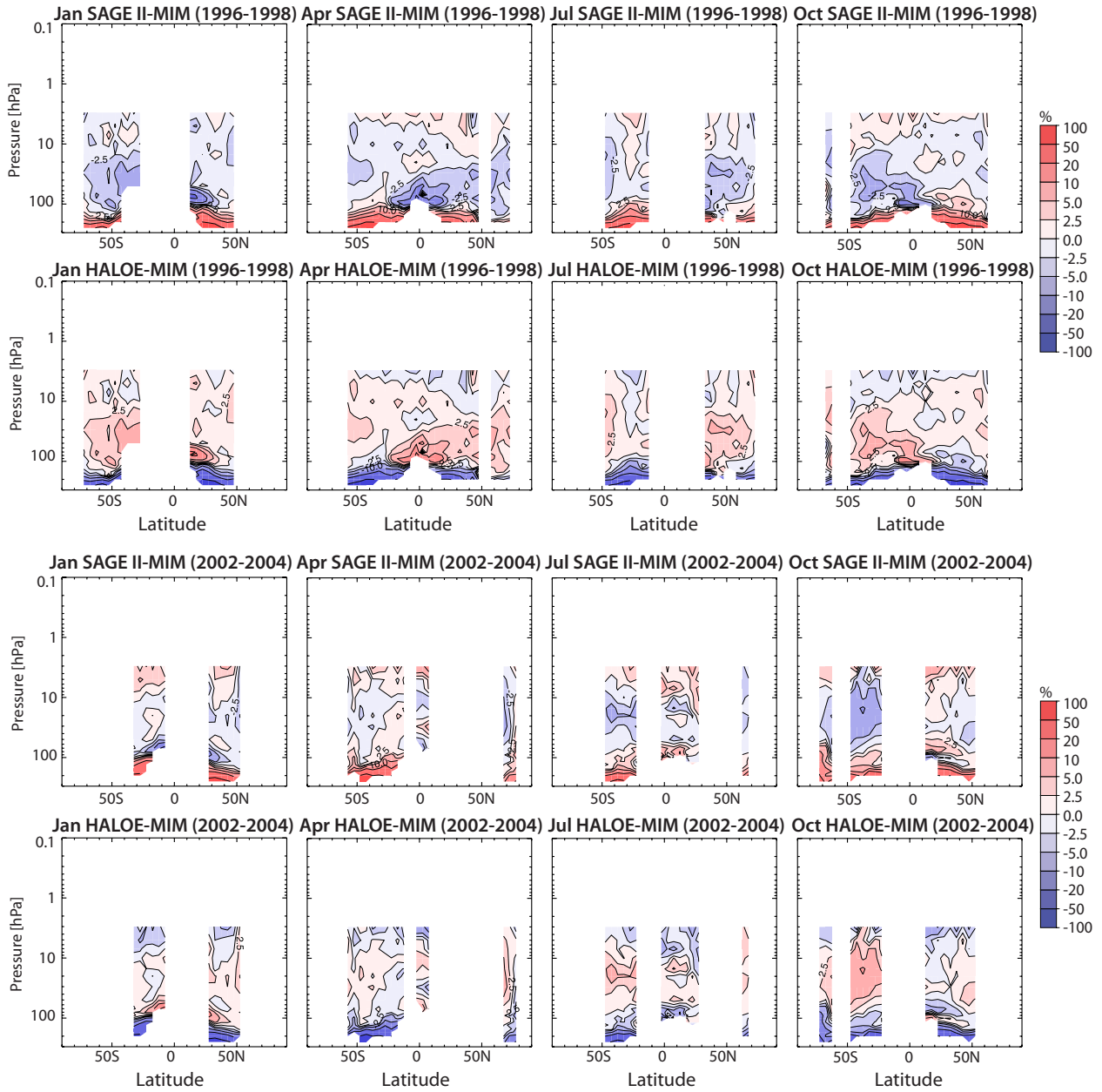
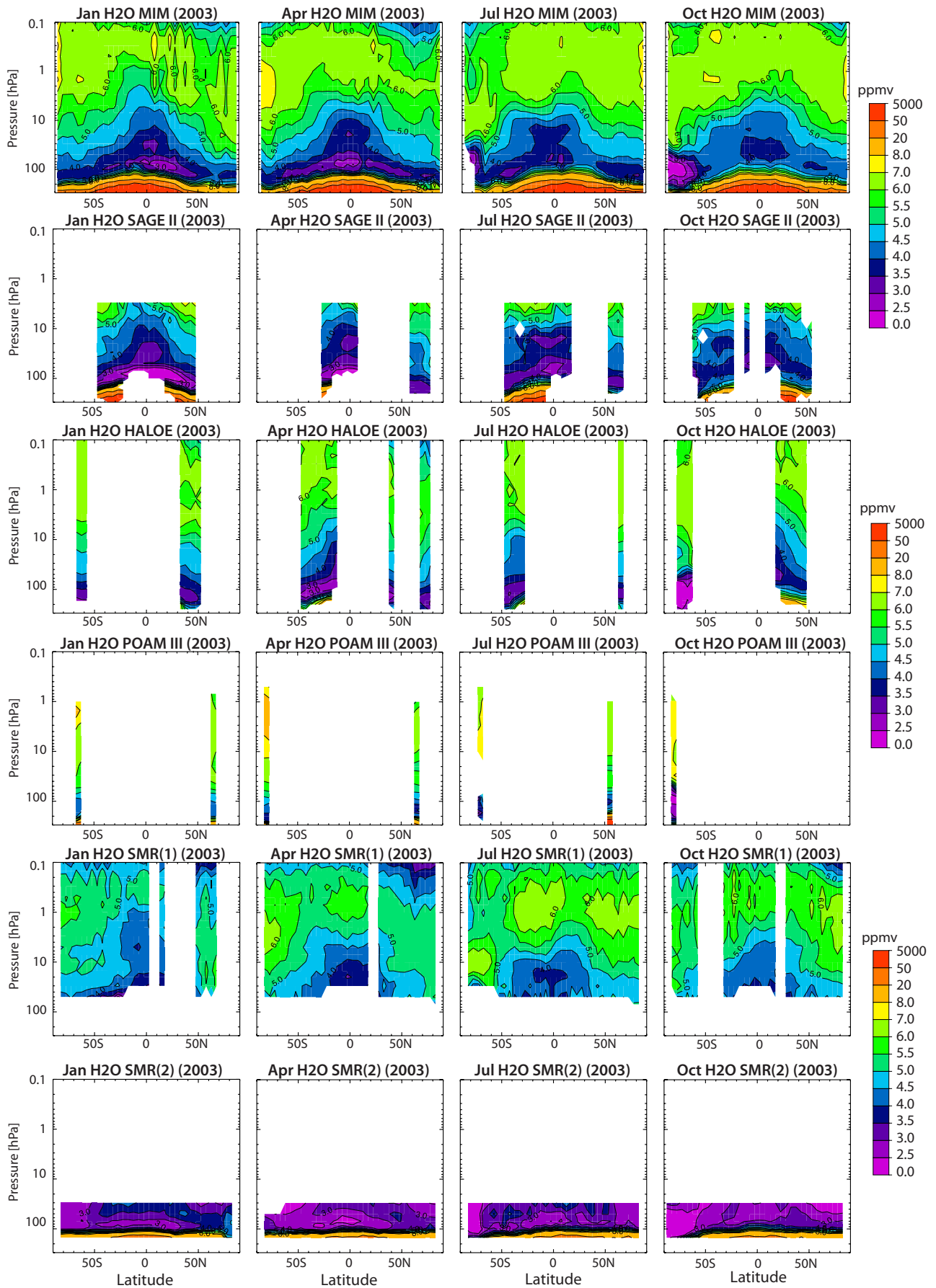


Figure A4.2.2b: Monthly zonal mean  $H_2O$  differences 1994-1996 and 2002-2004 (SAGE II and HALOE).





**Figure A4.2.3a:** Monthly zonal mean  $H_2O$  2003 (MIM, SAGE II, HALOE, POAM III, and SMR(1 and 2)), SMR(2) is not included in the MIM.

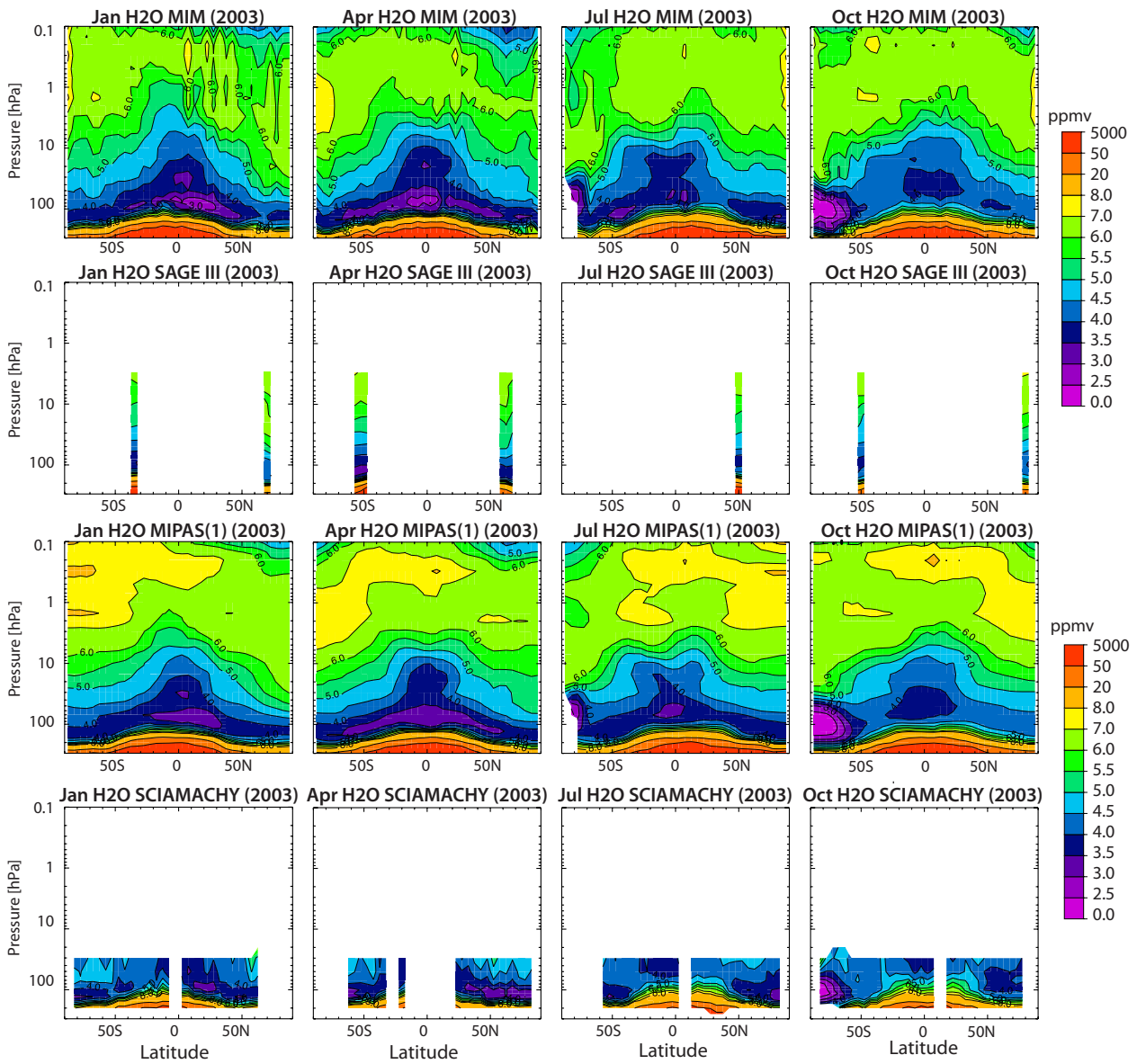


Figure A4.2.3a continued: (SAGE III, MIPAS(1) and SCIAMACHY).

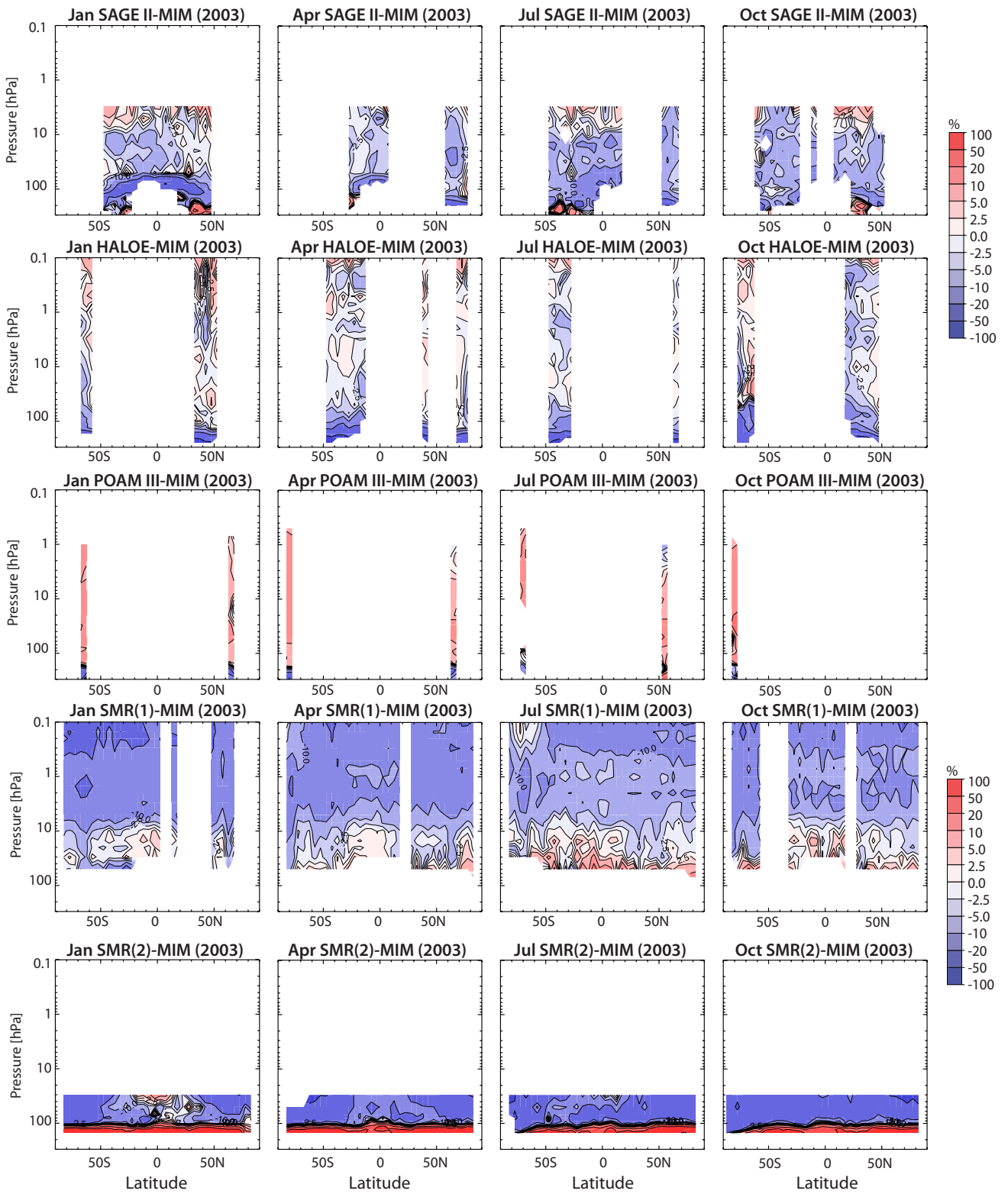


Figure A4.2.3b: Monthly zonal mean H<sub>2</sub>O differences 2003 (SAGE II, HALOE, POAM III, SMR(1 and 2)).

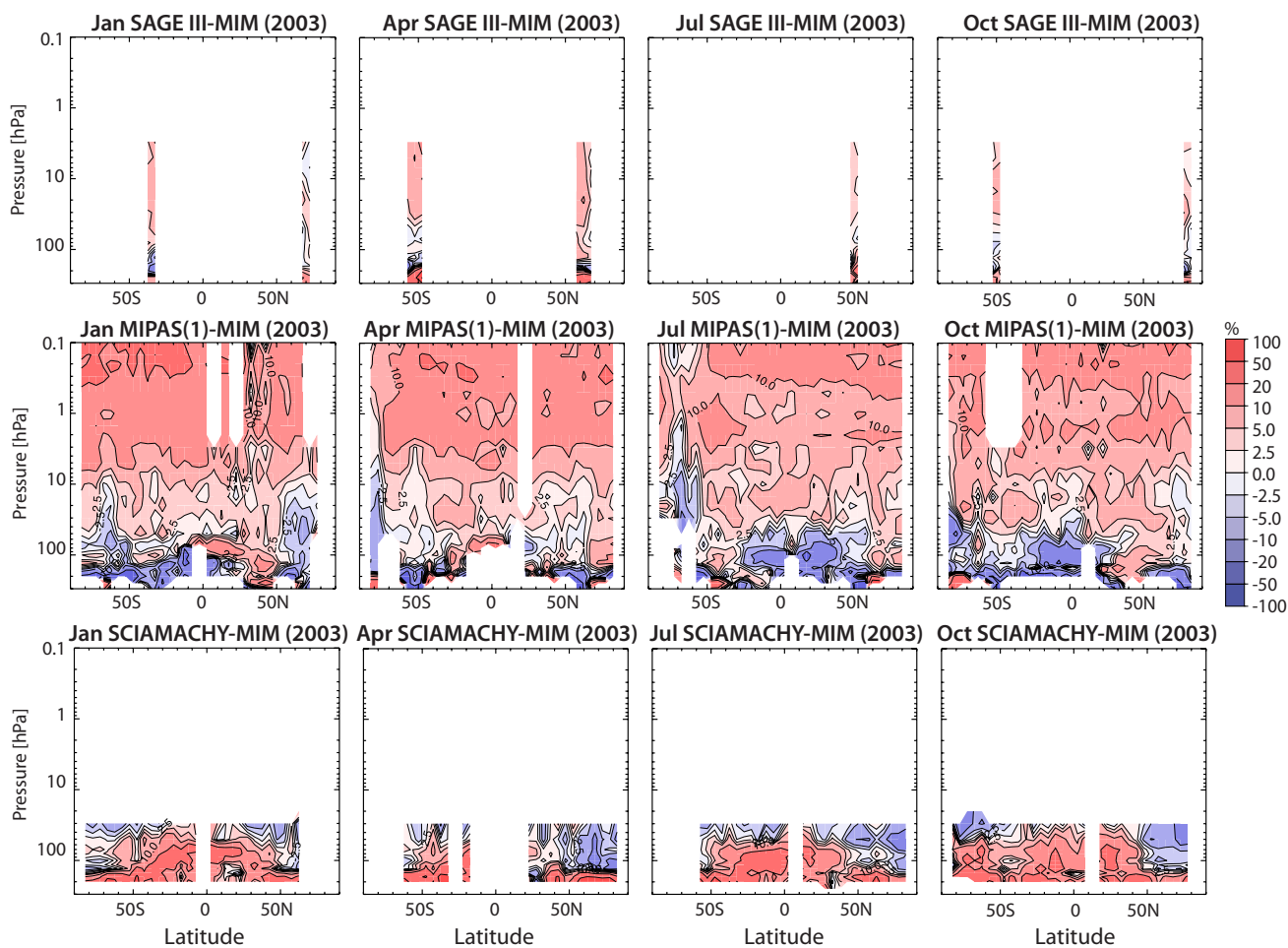
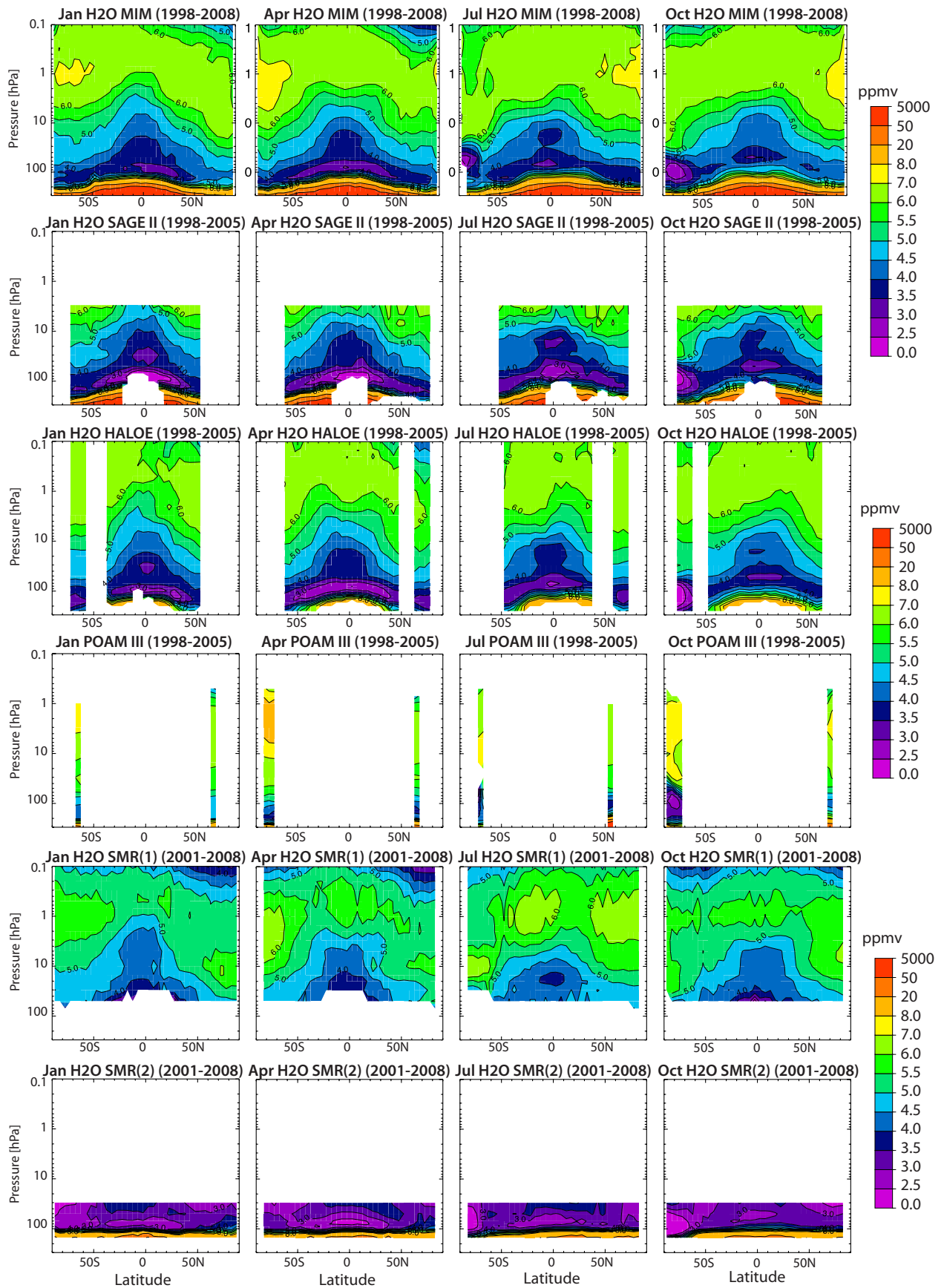


Figure A4.2.3b continued: (SAGE III, MIPAS(1), and SCIAMACHY).



**Figure A4.2.4a:** Monthly zonal mean  $H_2O$  1998-2008 (MIM, SAGE II, HALOE, POAM III, and SMR(1 and 2)), SMR(2) is not included in the MIM. Note, the various instruments are averaged over different time periods within 1998-2008.

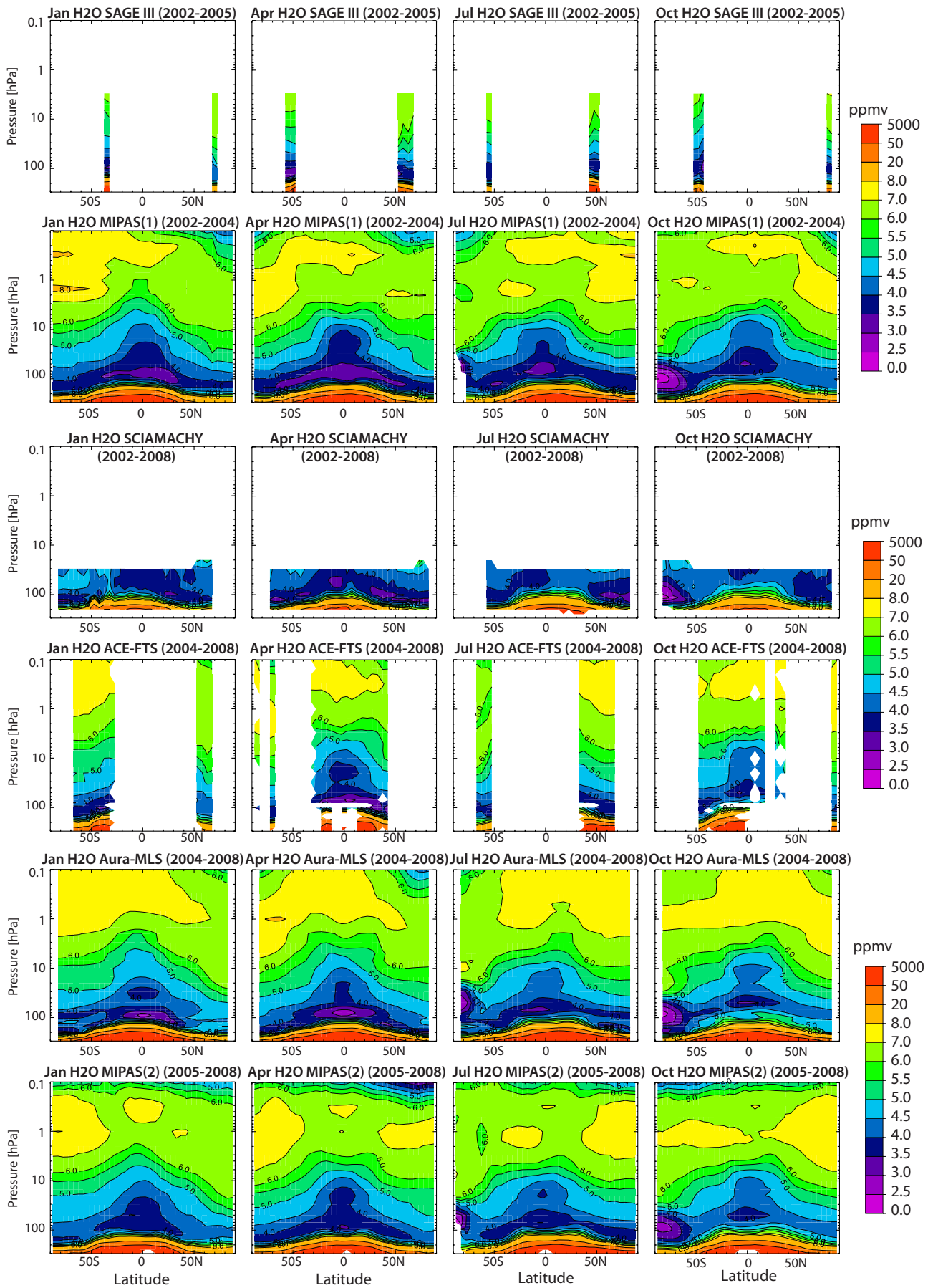


Figure A4.2.4a continued: (SAGE III, MIPAS(1), SCIAMACHY, ACE-FTS, Aura-MLS, and MIPAS(2)).

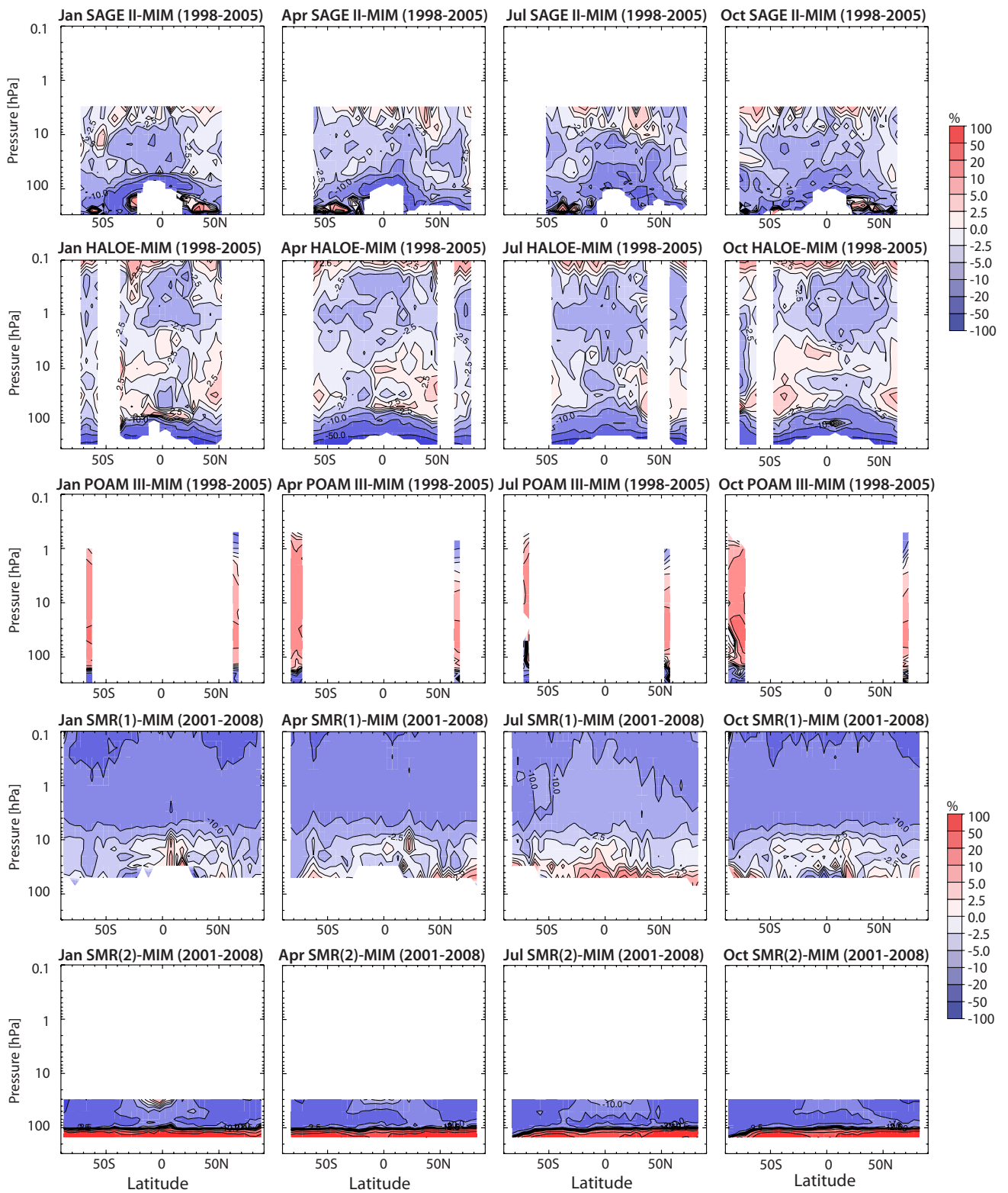


Figure A4.2.4b: Monthly zonal mean H<sub>2</sub>O differences 1998-2008 (SAGE II, HALOE, POAM III, SMR(1 and 2)).

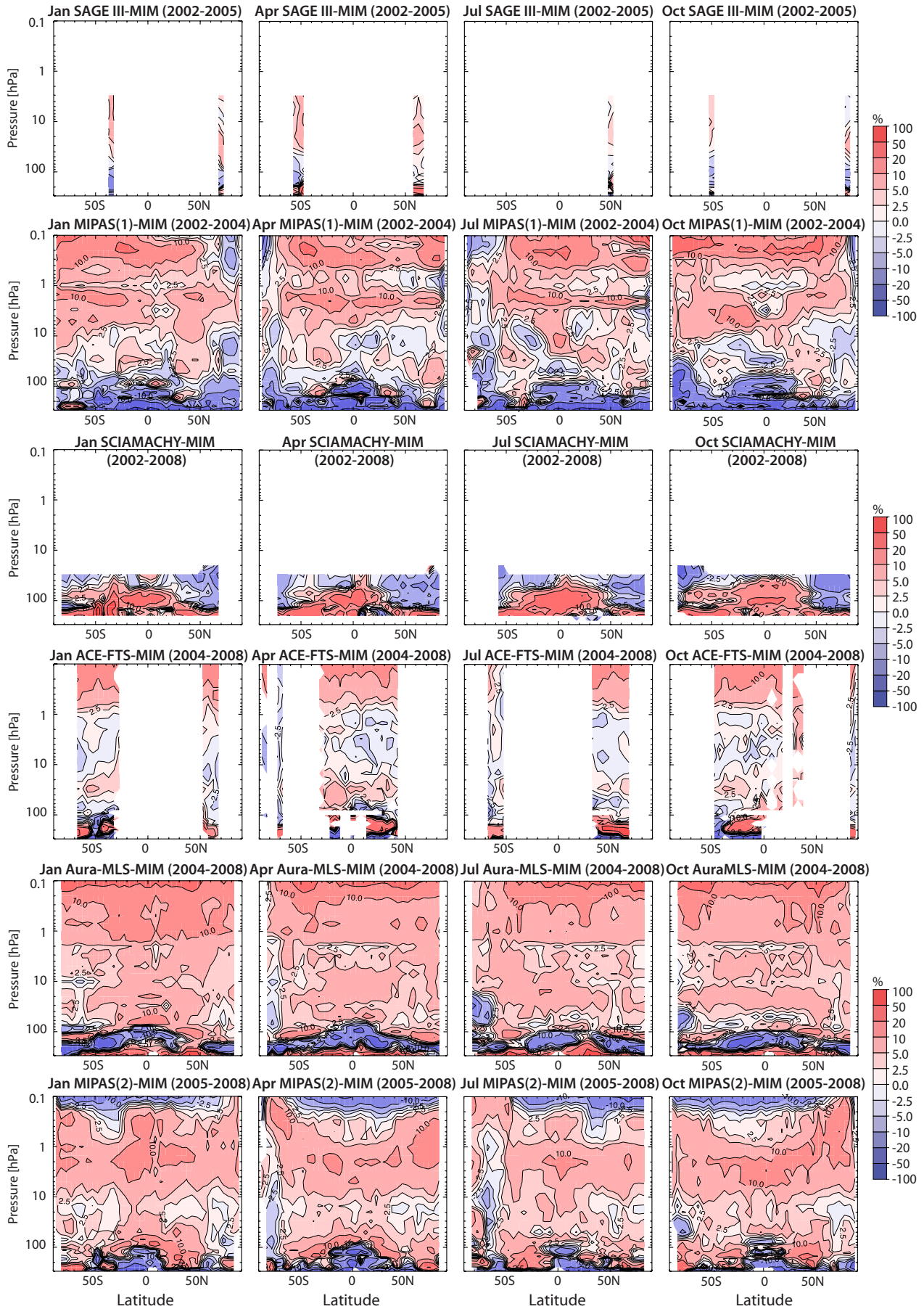
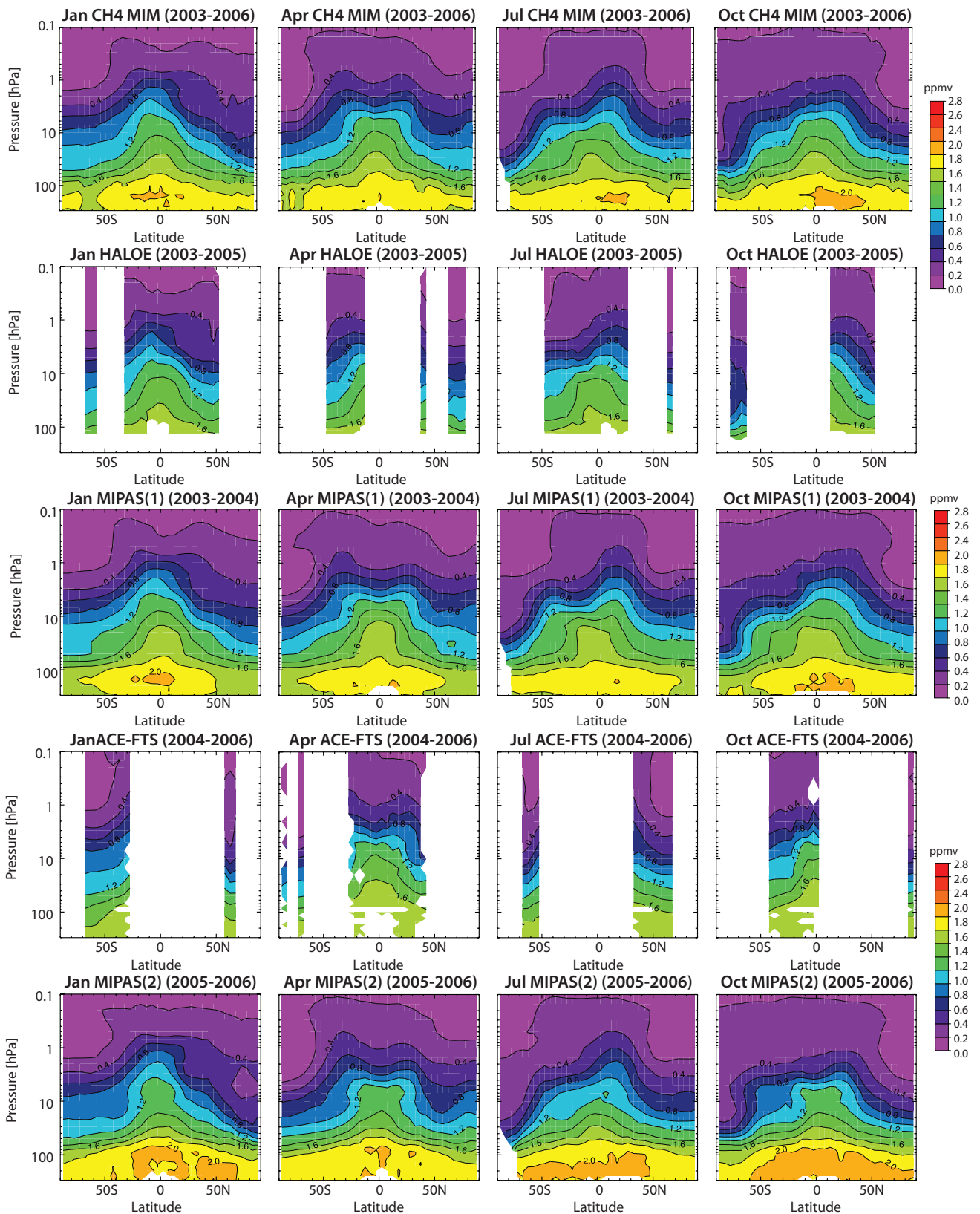
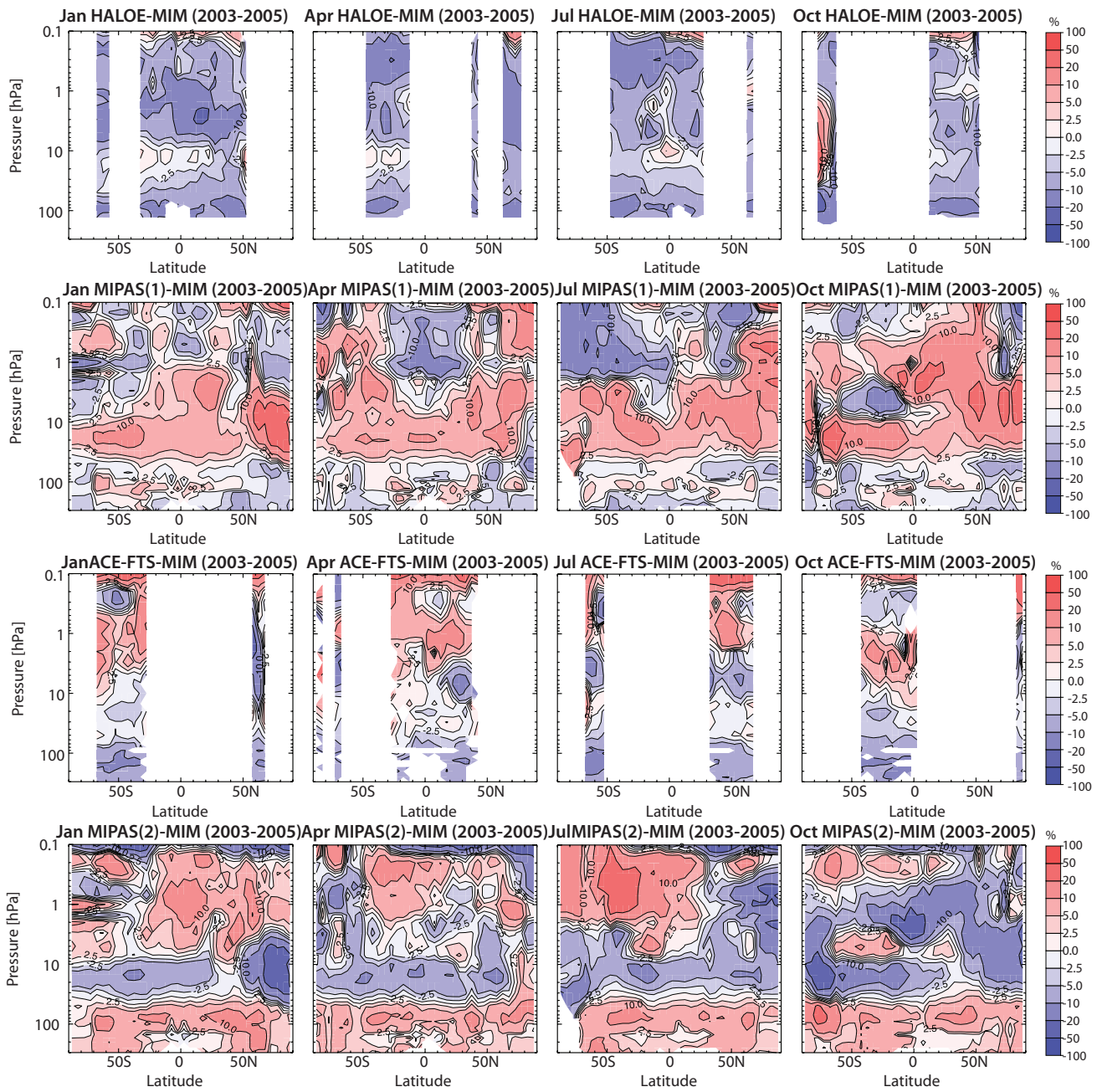


Figure A4.2.4b continued: (SAGE III, MIPAS(1), SCIAMACHY, ACE-FTS, Aura-MLS, and MIPAS(2)).

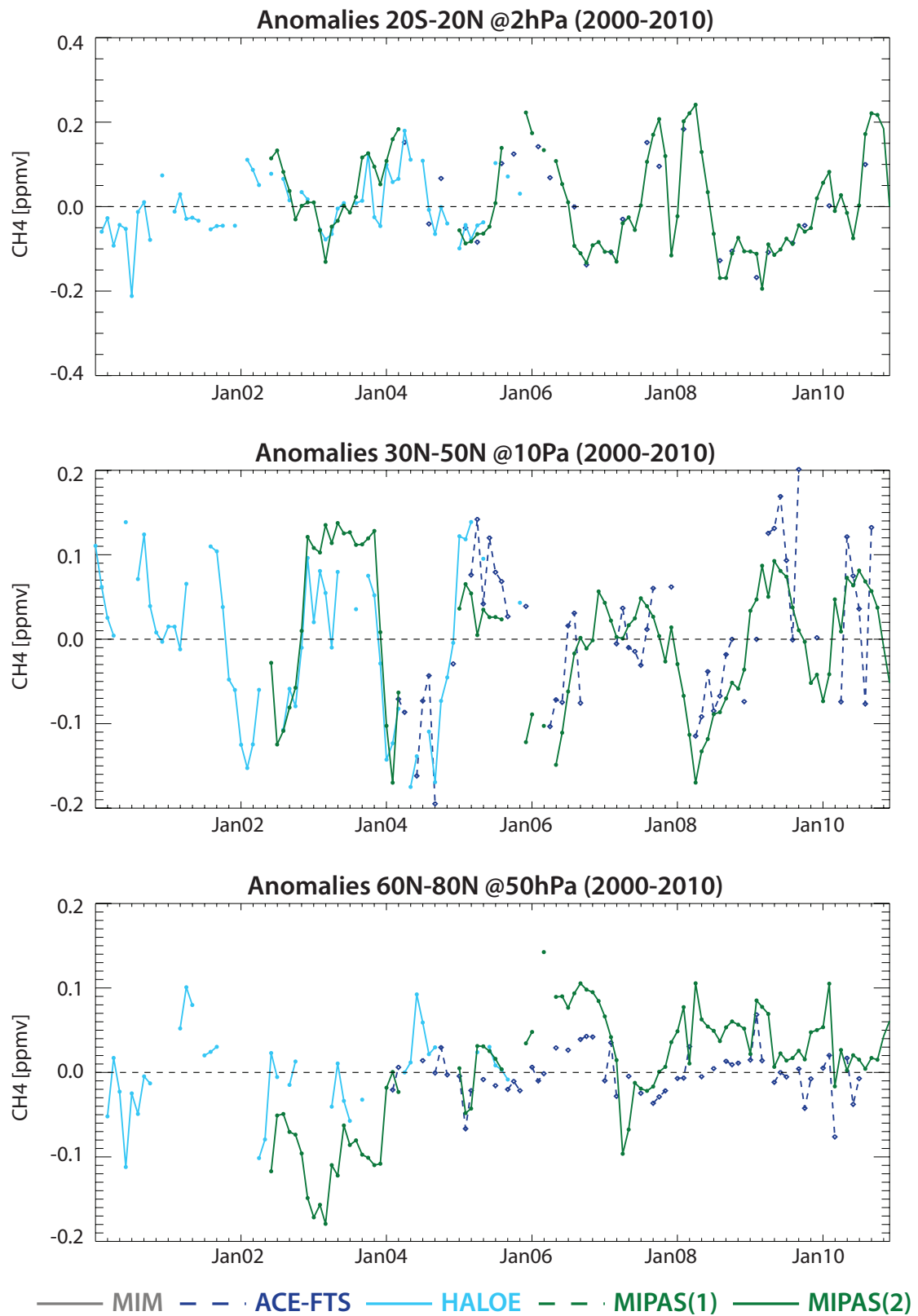


A4.3 Methane – CH<sub>4</sub>

**Figure A4.3.1a:** Monthly zonal mean CH<sub>4</sub> 2003-2006 (MIM, HALOE, MIPAS(1), ACE-FTS, and MIPAS(2)). Note, the various instruments are averaged over different time periods within 2003-2006.



**Figure A4.3.1b:** Monthly zonal mean  $CH_4$  differences 2003-2006 (HALOE, MIPAS(1), ACE-FTS, and MIPAS(2)). Note, the various instruments are averaged over different time periods within 2003-2006.



**Figure A4.3.2:** Interannual variability in  $\text{CH}_4$  2000-2010. Deseasonalized anomalies are shown for 20S-20N at 2, 10, and 50 hPa (top to bottom).

A4.4 Nitrous Oxide – N<sub>2</sub>O

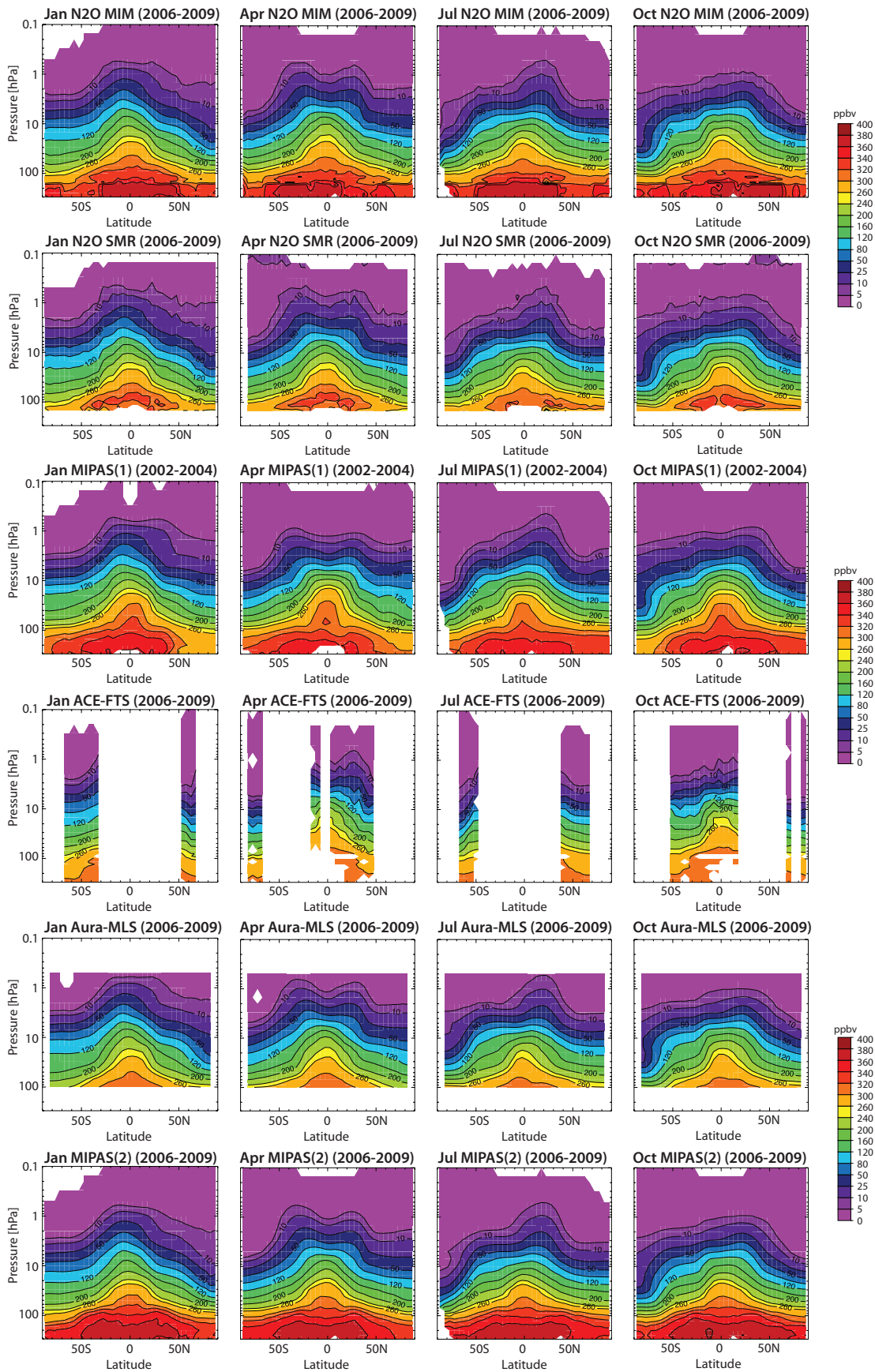


Figure A4.4.1a: Monthly zonal mean N<sub>2</sub>O 2006-2009 (MIM, SMR, MIPAS(1), ACE-FTS, Aura-MLS, and MIPAS(2)). Note, MIPAS(1) is averaged over 2002-2004.

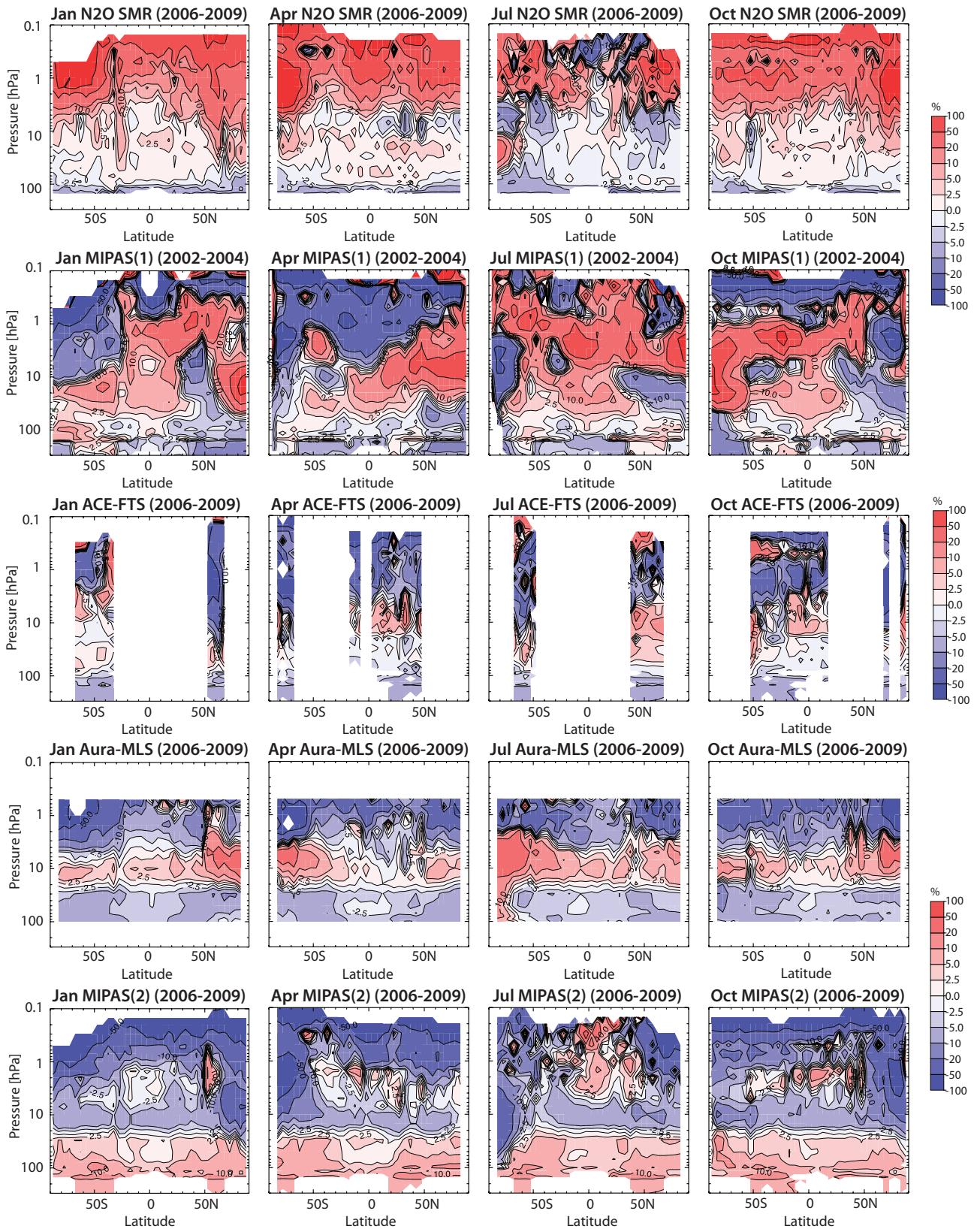
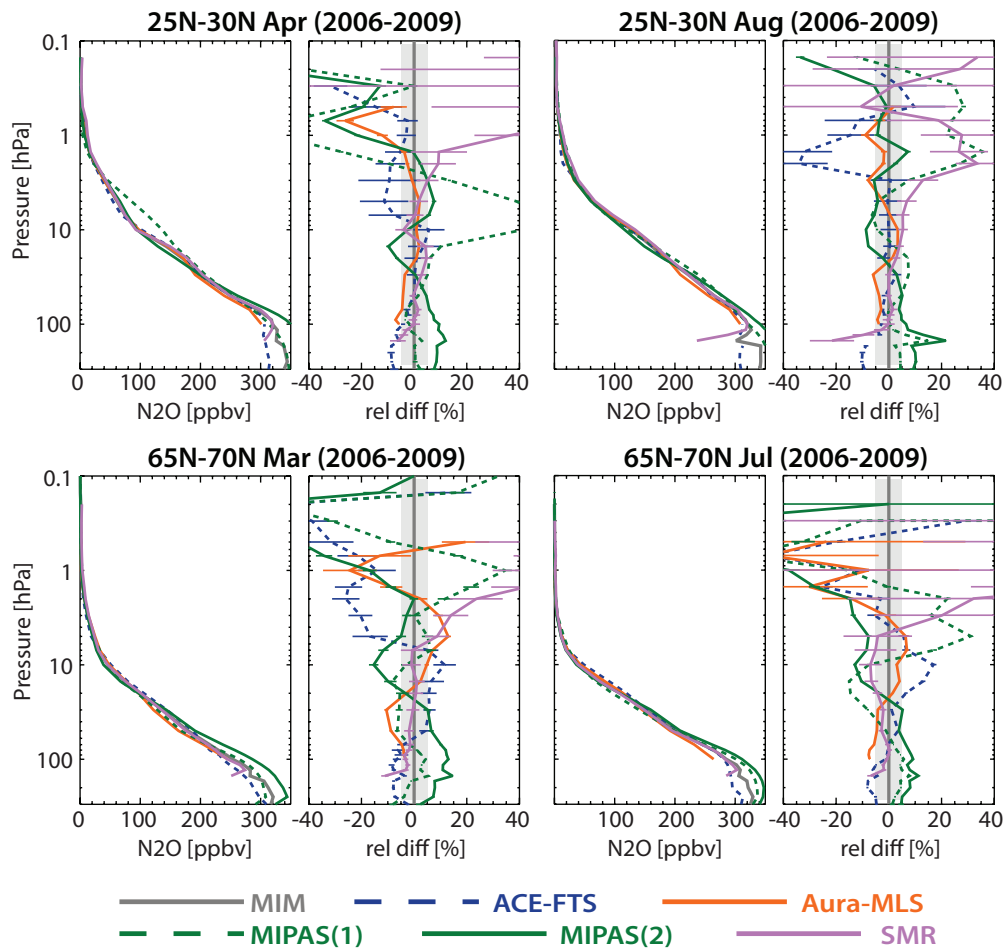
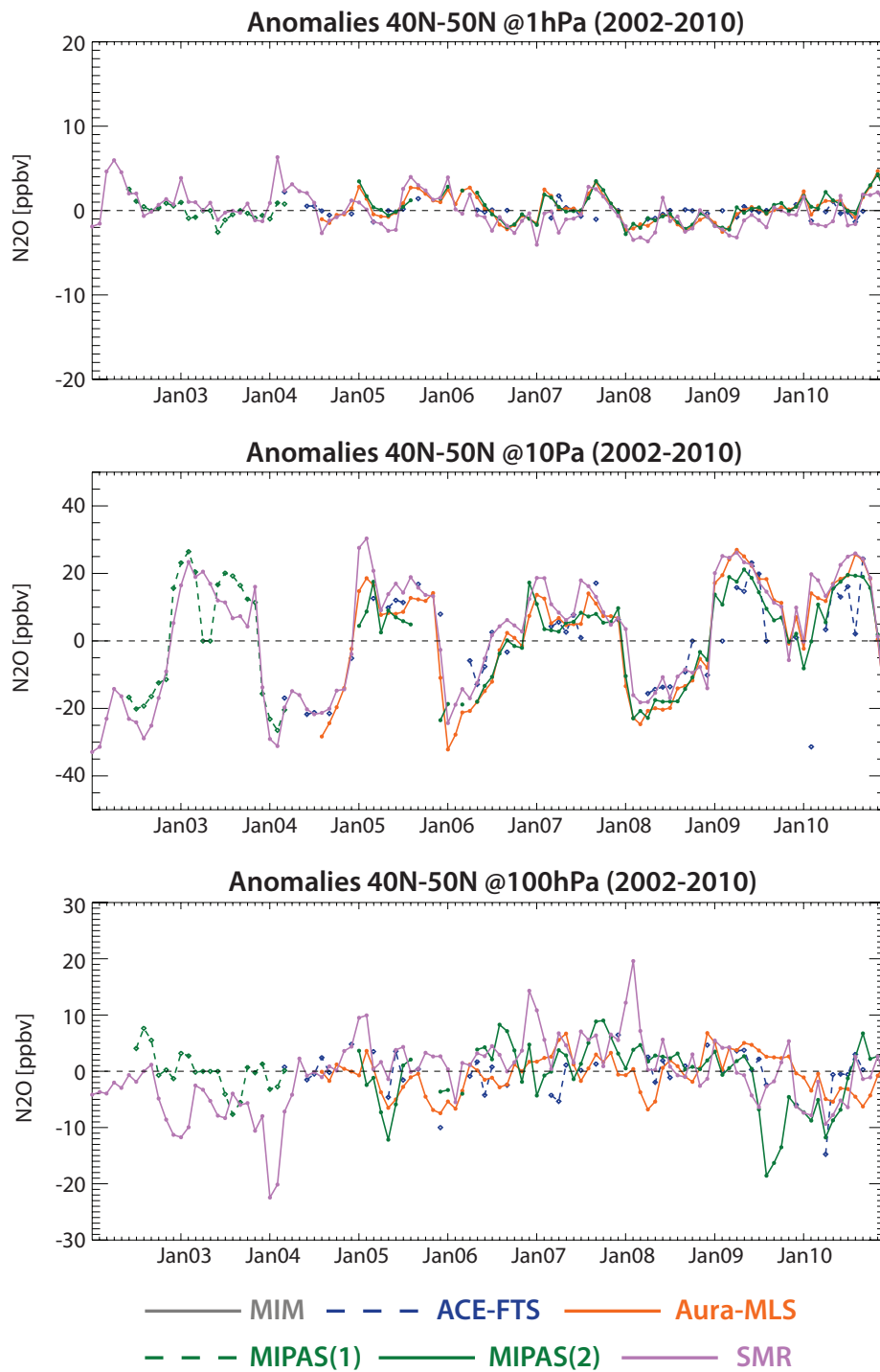


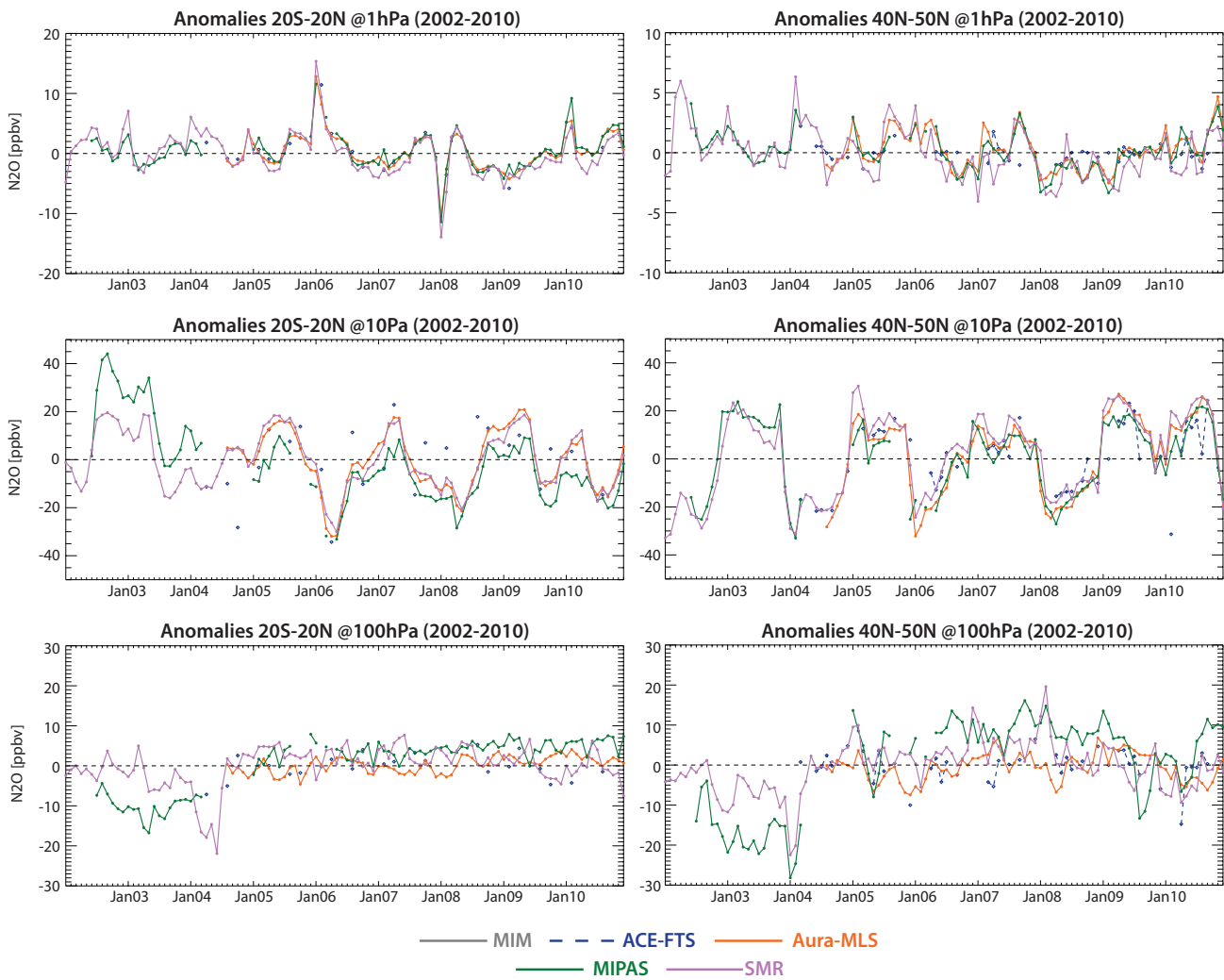
Figure A4.4.1b: Monthly zonal mean  $N_2O$  differences 2006-2009 (SMR, MIPAS(1), ACE-FTS, Aura-MLS, and MIPAS(2)).



**Figure A4.4.2:** Vertical profiles of zonal mean  $N_2O$  and differences 2006-2009 (MIM, SMR, MIPAS(1), ACE-FTS, Aura-MLS, and MIPAS(2)). The profiles are shown for 25N-30N April and August (upper panels), and for 65N-70N March and July (lower panels). Note MIPAS(1) is averaged over 2002-2004.

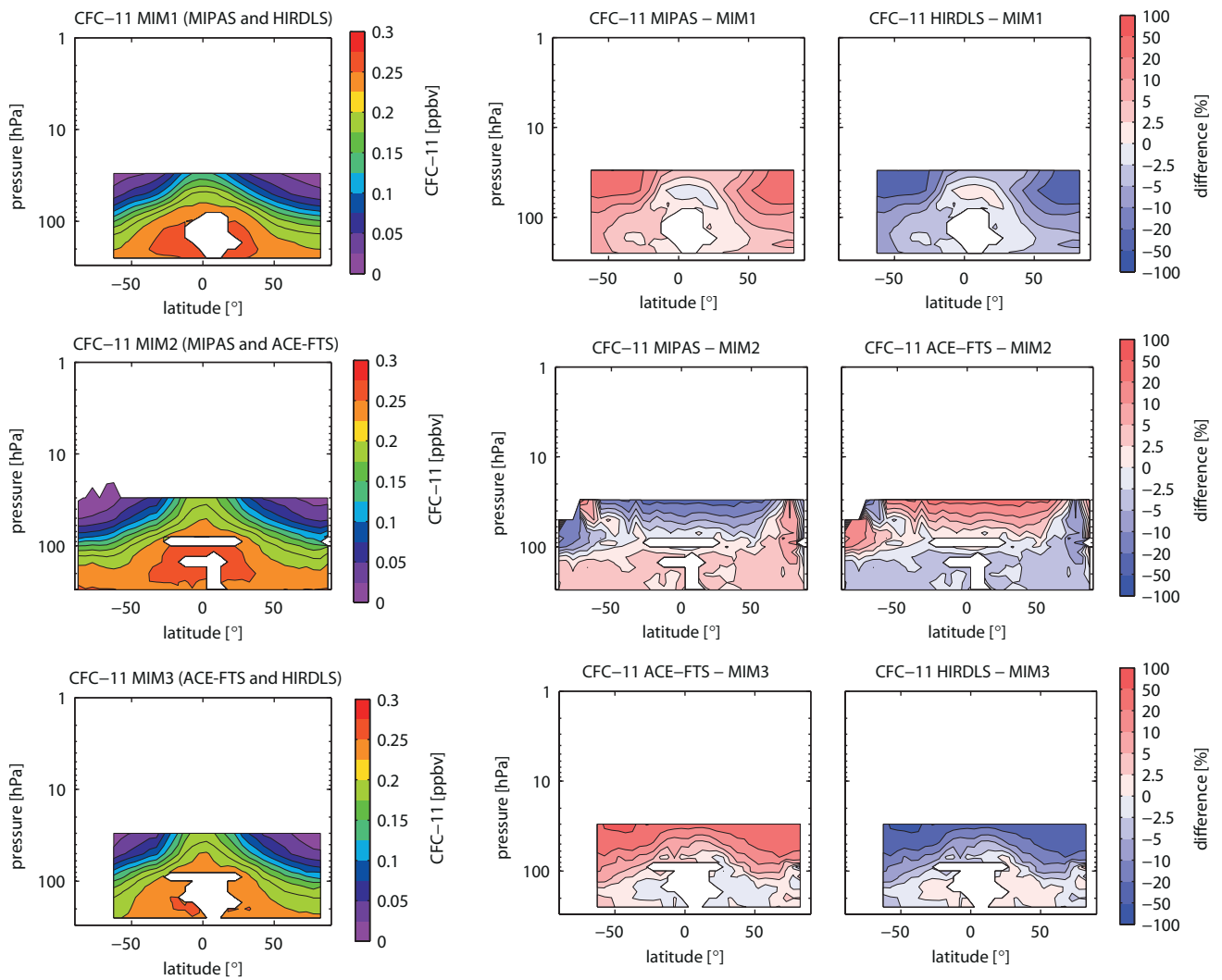


**Figure A4.4.3:** Interannual variability in  $N_2O$  2002-2010. Deseasonalized anomalies are shown for 40N–50N at 1, 10 and 100 hPa (top to bottom).

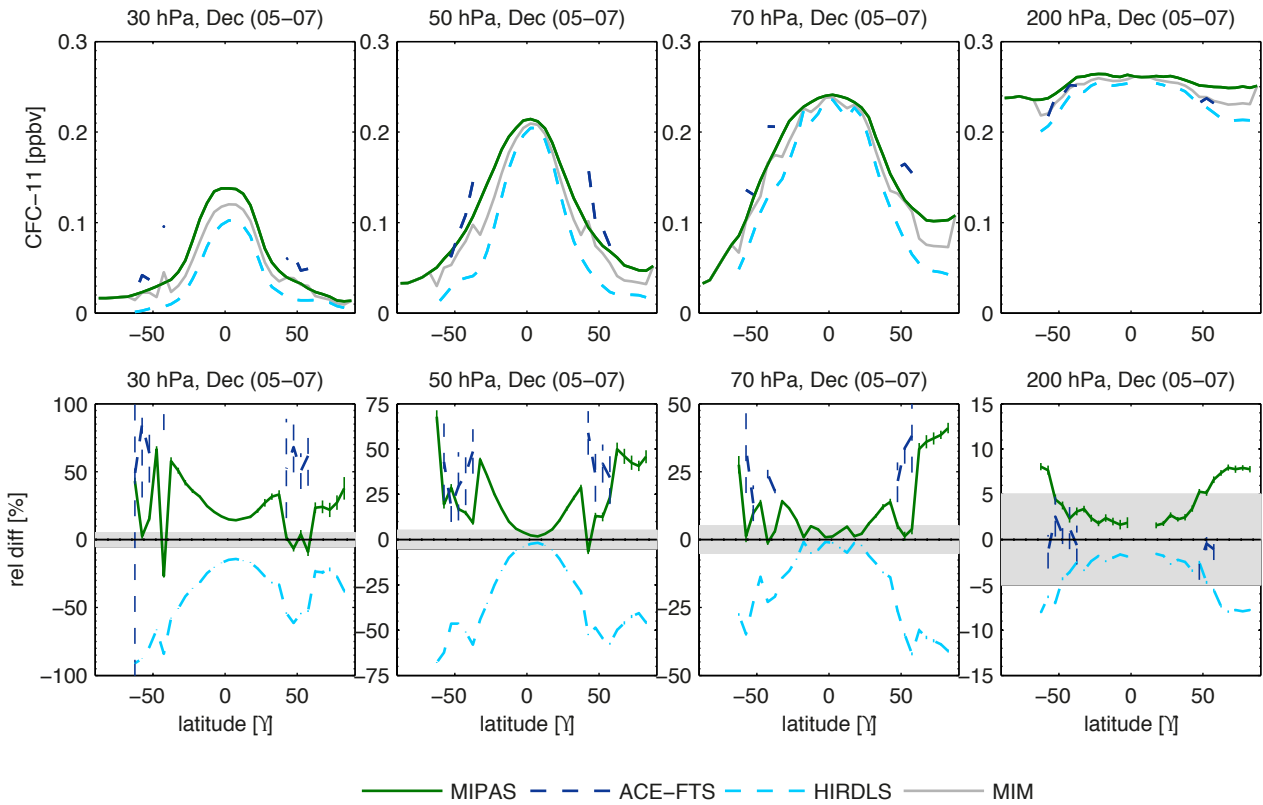


**Figure A4.4.4: Interannual variability in  $N_2O$  2002-2010.** Deseasonalized anomalies are shown for 20S-20N (left) and 40N-50N (right) at 1, 10 and 100 hPa (top to bottom). Note that MIPAS(1) and MIPAS(2) are treated as one instrument in this evaluation, revealing an inconsistency between the earlier and later timeseries at lower altitudes in the tropics and extra-tropics when compared to Figure A4.4.3.

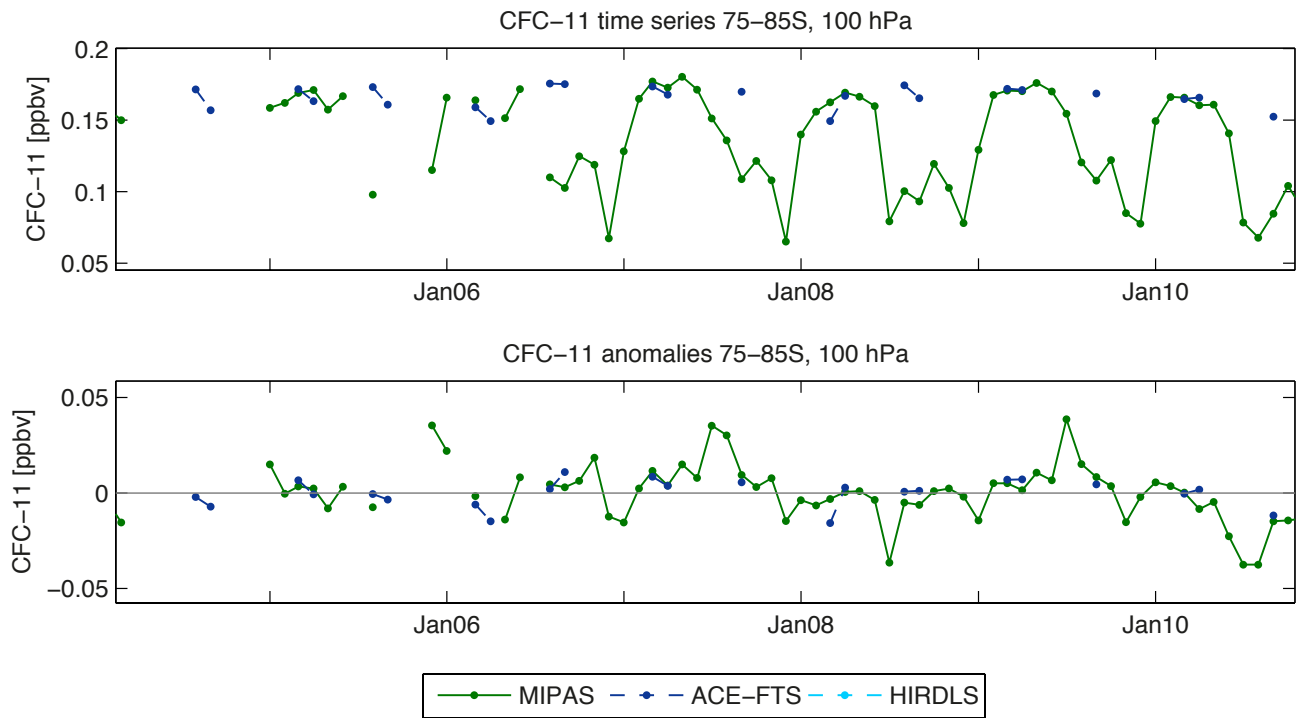


A4.5 Trichlorofluoromethane – CCl<sub>3</sub>F (CFC-11)

**Figure A4.5.1:** Annual zonal mean CFC-11 for 2005-2007 (Left panels: MIM of MIPAS and HIRDLS (upper row), MIPAS and ACE-FTS (middle row), ACE-FTS and HIRDLS (lower row). Right panels: differences of the two instruments and their respective MIM.)

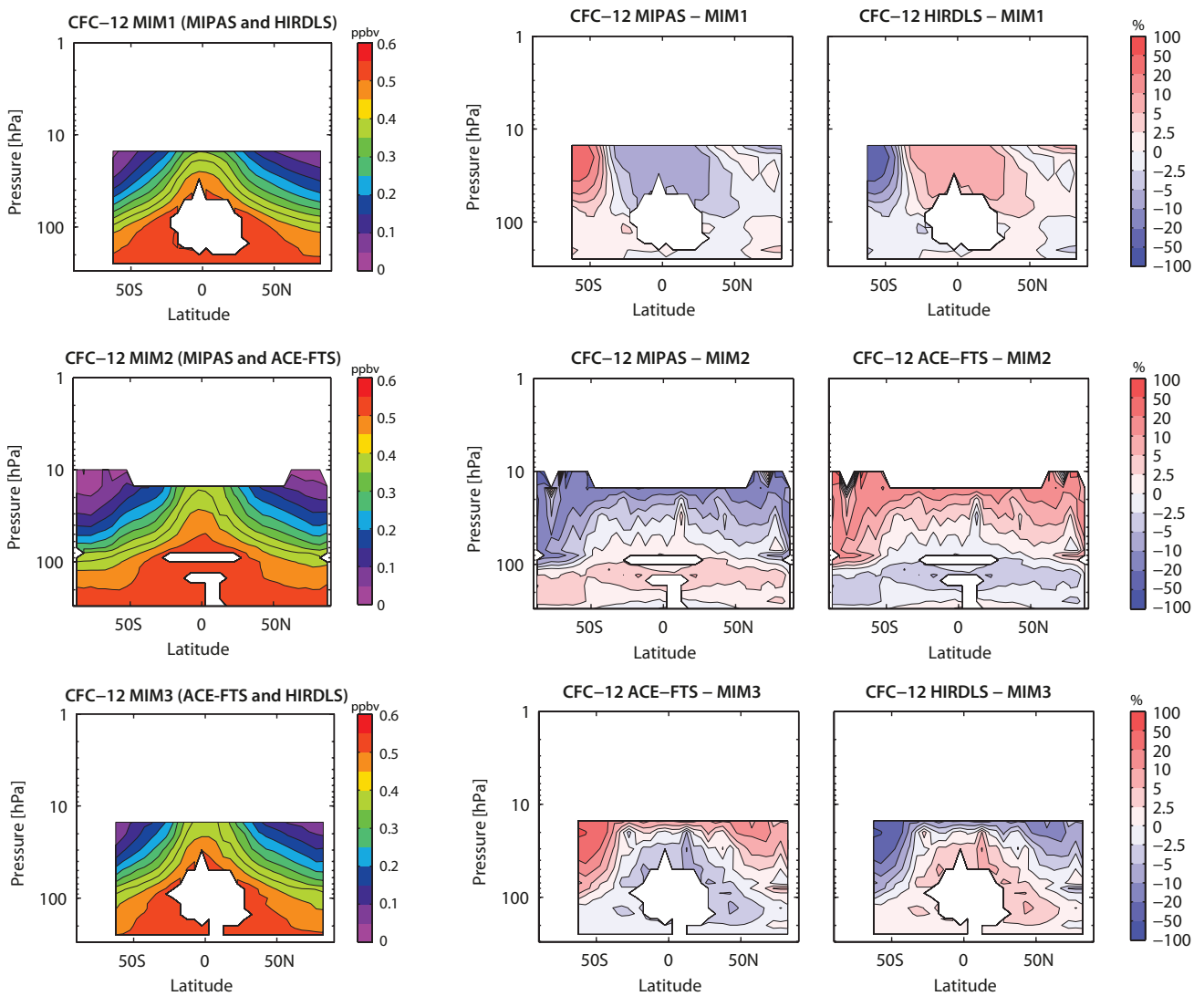


**Figure A4.5.2:** Meridional profiles of zonal mean CFC-11 for 2005-2007 (Upper row: Profiles at 30, 50, 70, and 200 hPa for December. Lower row: differences between the individual instruments and the MIM. Bars indicate the uncertainties in the relative differences.)

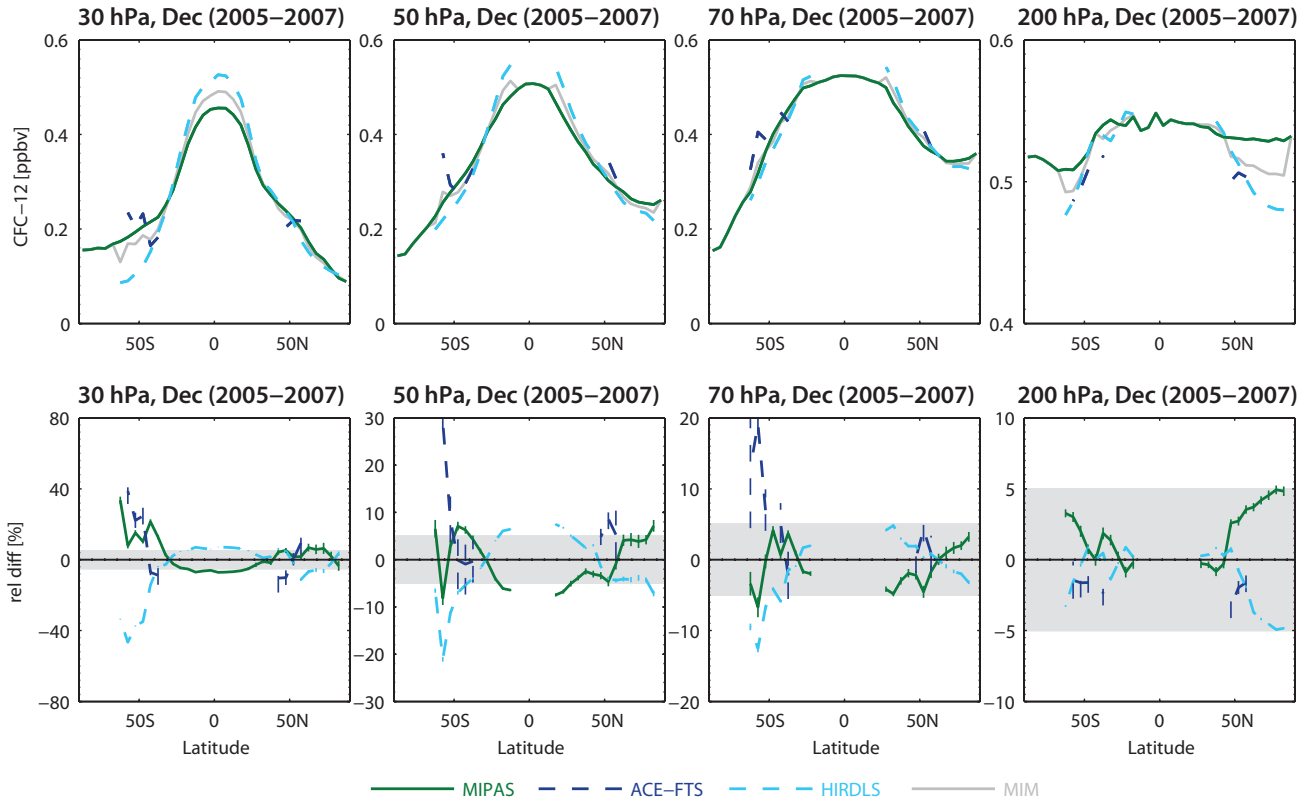


**Figure A4.5.3:** Time series of CFC-11 at 75°S – 85°S. (Monthly mean values (upper panel) and deseasonalized anomalies (lower panel) at 100 hPa.)

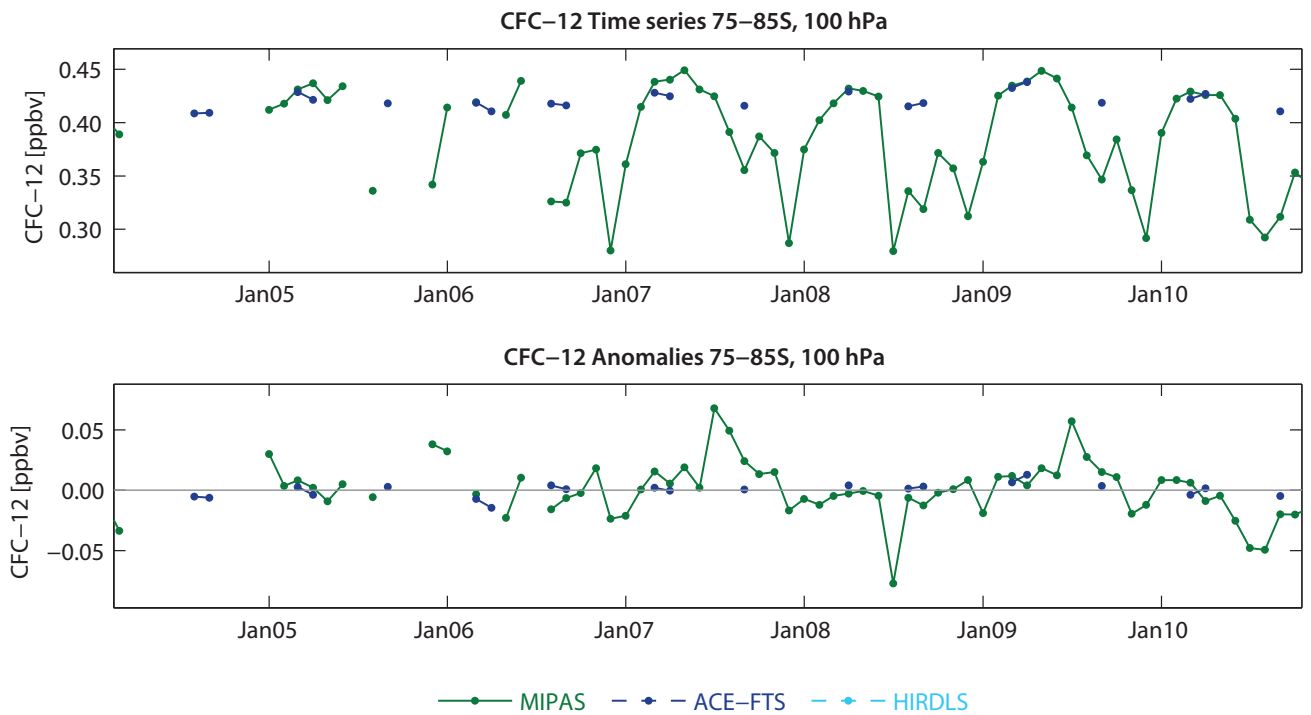
### A4.6 Dichlorodifluoromethane – CCl<sub>2</sub>F<sub>2</sub> (CFC-12)



**Figure A4.6.1:** Annual zonal mean CFC-12 for 2005-2007 (Left panels: MIM of MIPAS and HIRDLS (upper row), MIPAS and ACE-FTS (middle row), ACE-FTS and HIRDLS (lower row). Right panels: differences of the two instruments and their respective MIM.)

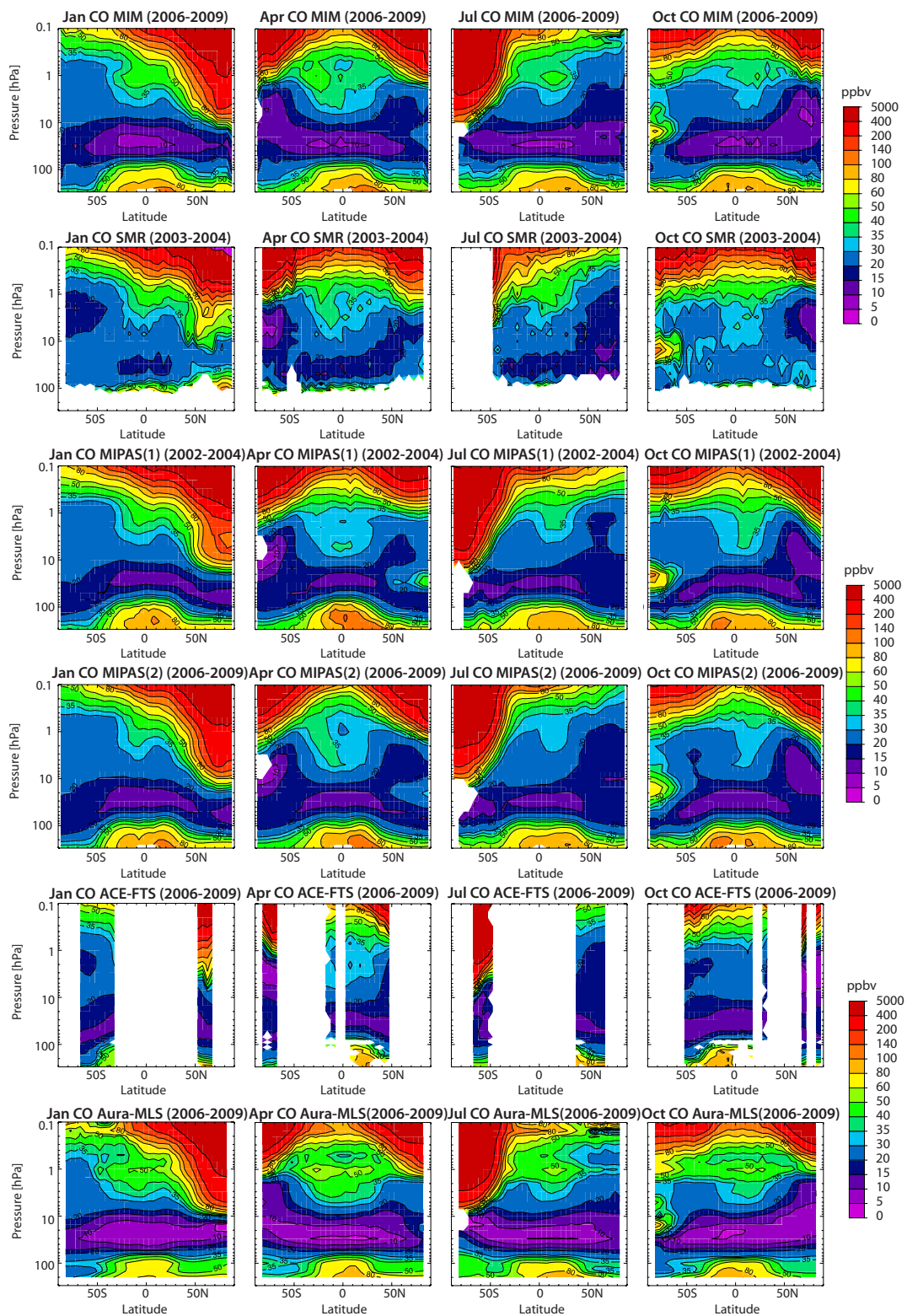


**Figure A4.6.2:** Meridional profiles of zonal mean CFC-12 for 2005-2007 (Upper row: Profiles at 30, 50, 70, and 200 hPa for December. Lower row: differences between the individual instruments and the MIM. Bars indicate the uncertainties in the relative differences.)



**Figure A4.6.3:** Time series of CFC-12 at 75°S – 85°S. (Monthly mean values (upper panel) and deseasonalized anomalies (lower panel) at 100 hPa.)

## A4.7 Carbon monoxide – CO



**Figure A4.7.1a:** Monthly zonal mean CO 2006-2009 (MIM, SMR, MIPAS(1), MIPAS(2), ACE-FTS, and Aura-MLS). Note, SMR and MIPAS(1) data are averaged over different time periods and hence not included in the MIM.

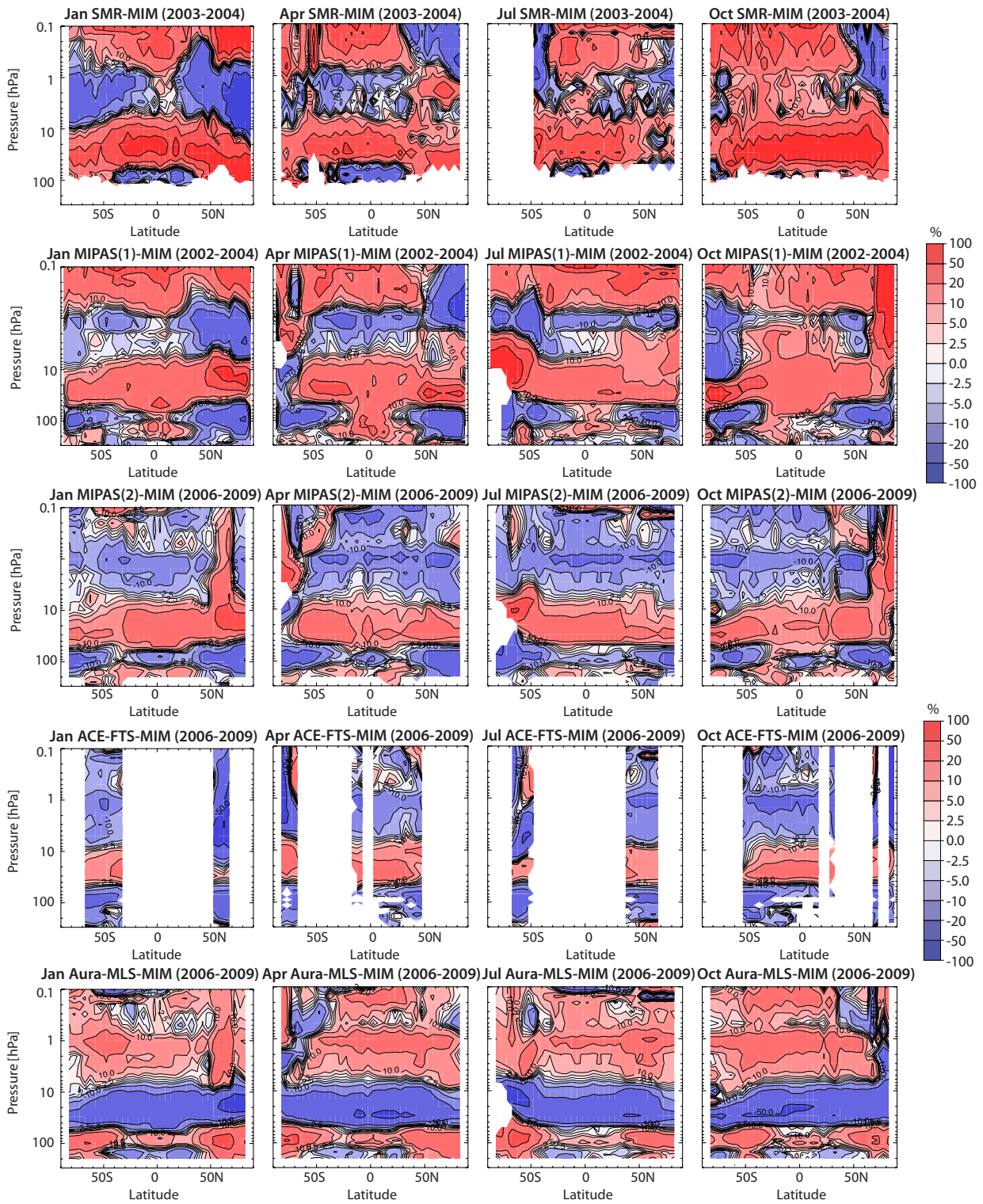


Figure A4.7.1b: Monthly zonal mean CO differences 2006-2009 (SMR, MIPAS(1), MIPAS(2), ACE-FTS, and Aura-MLS).

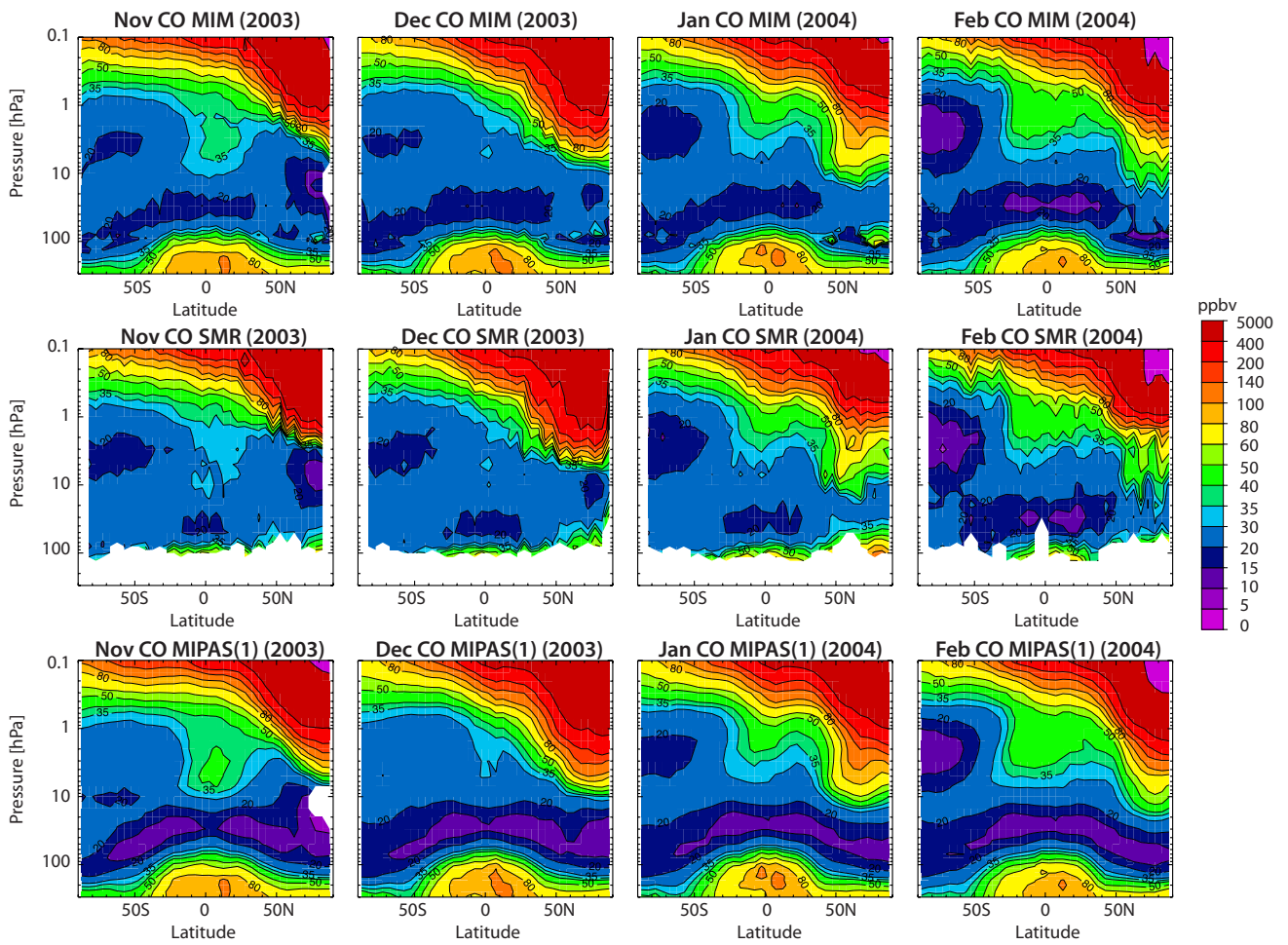


Figure A4.7.2a: Monthly zonal mean CO Nov 2003 to Feb 2004 (MIM, SMR, and MIPAS(1)).

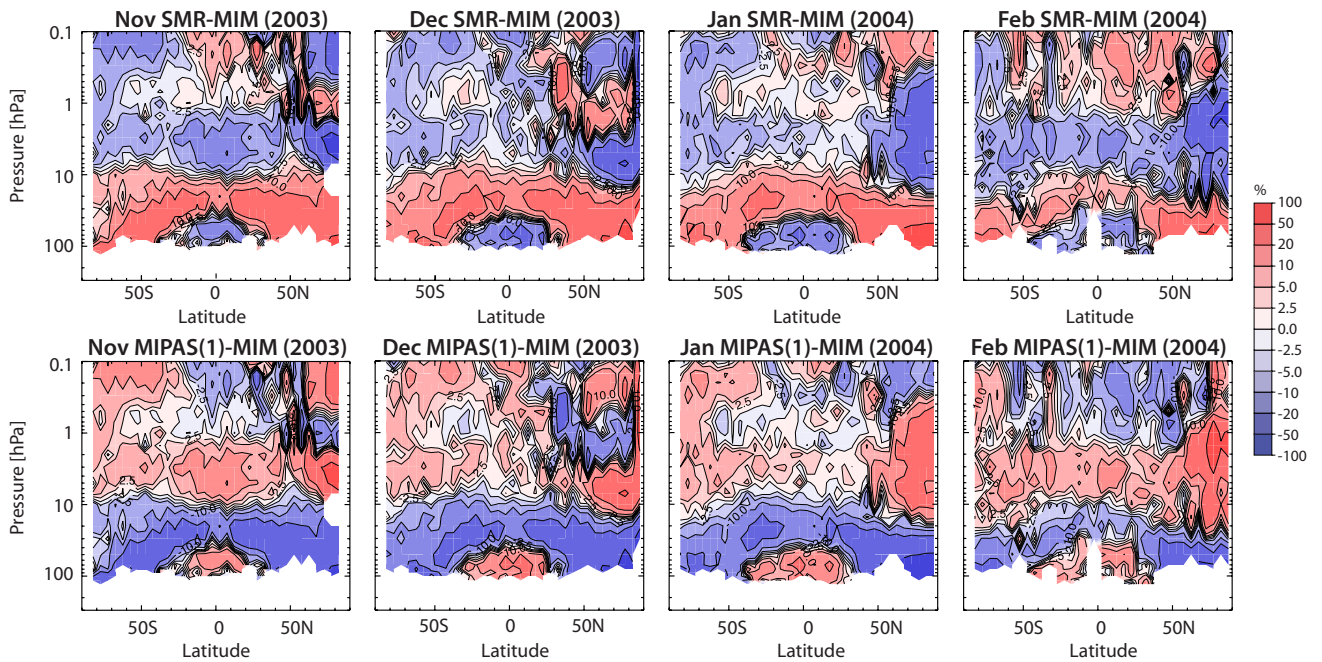
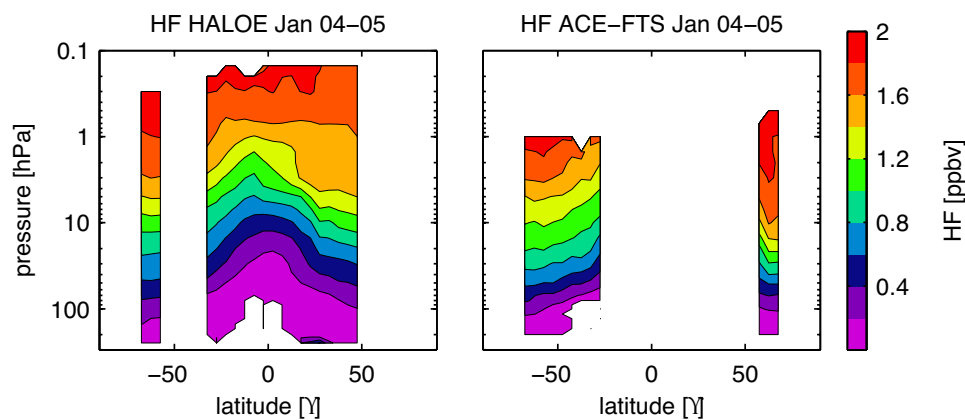
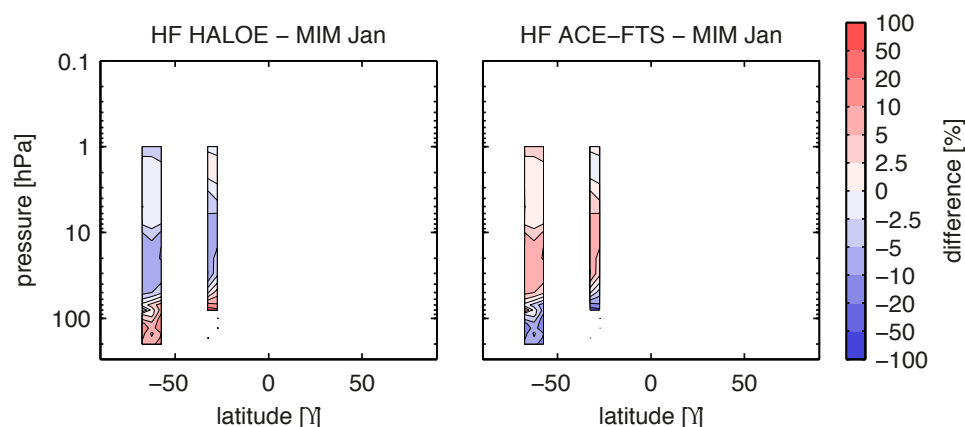


Figure A4.7.2b: Monthly zonal mean CO differences Nov 2003 to Feb 2004 (SMR and MIPAS(1)).

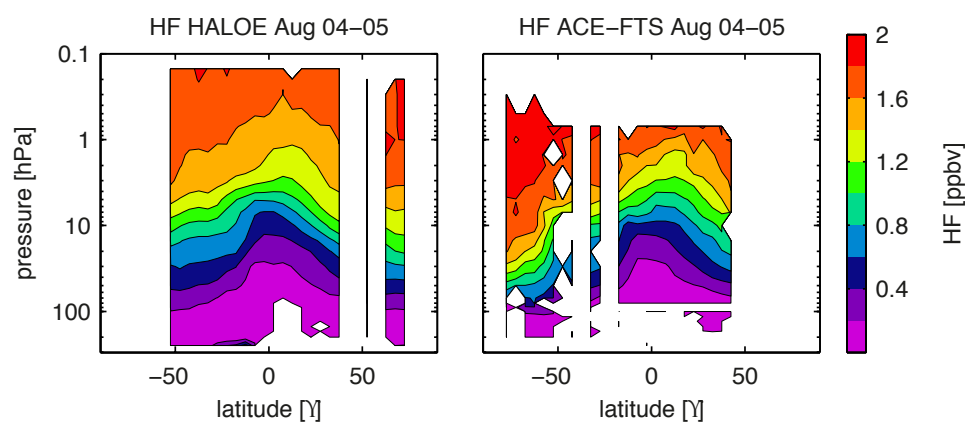
## A4.8 Hydrogen fluoride – HF



**Figure A4.8.1:** Cross sections of monthly zonal mean HF for January 2004-2005. Monthly zonal mean HF cross sections for January 2004-2005 are shown for HALOE and ACE-FTS.

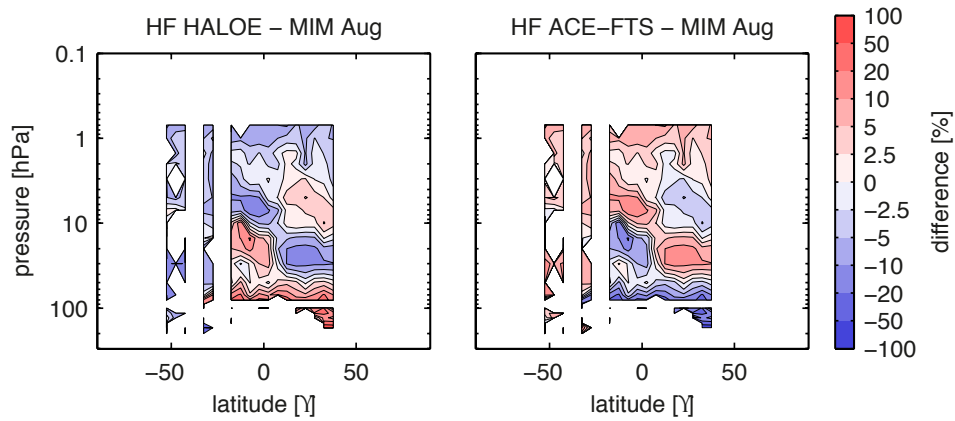


**Figure A4.8.2:** Cross sections of monthly zonal mean HF differences for January 2004-2005. Monthly zonal mean HF differences for January 2004-2005 between the individual instruments (HALOE and ACE-FTS) and the MIM are shown.

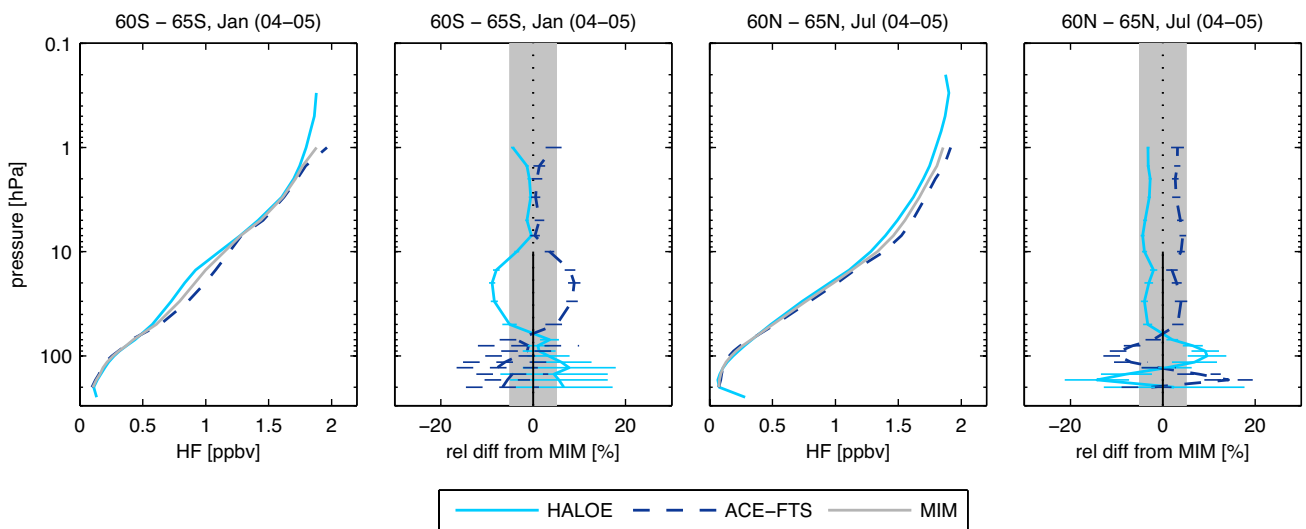


**Figure A4.8.3:** Cross sections of monthly zonal mean HF for August 2004-2005. As Figure A4.8.1 for August.

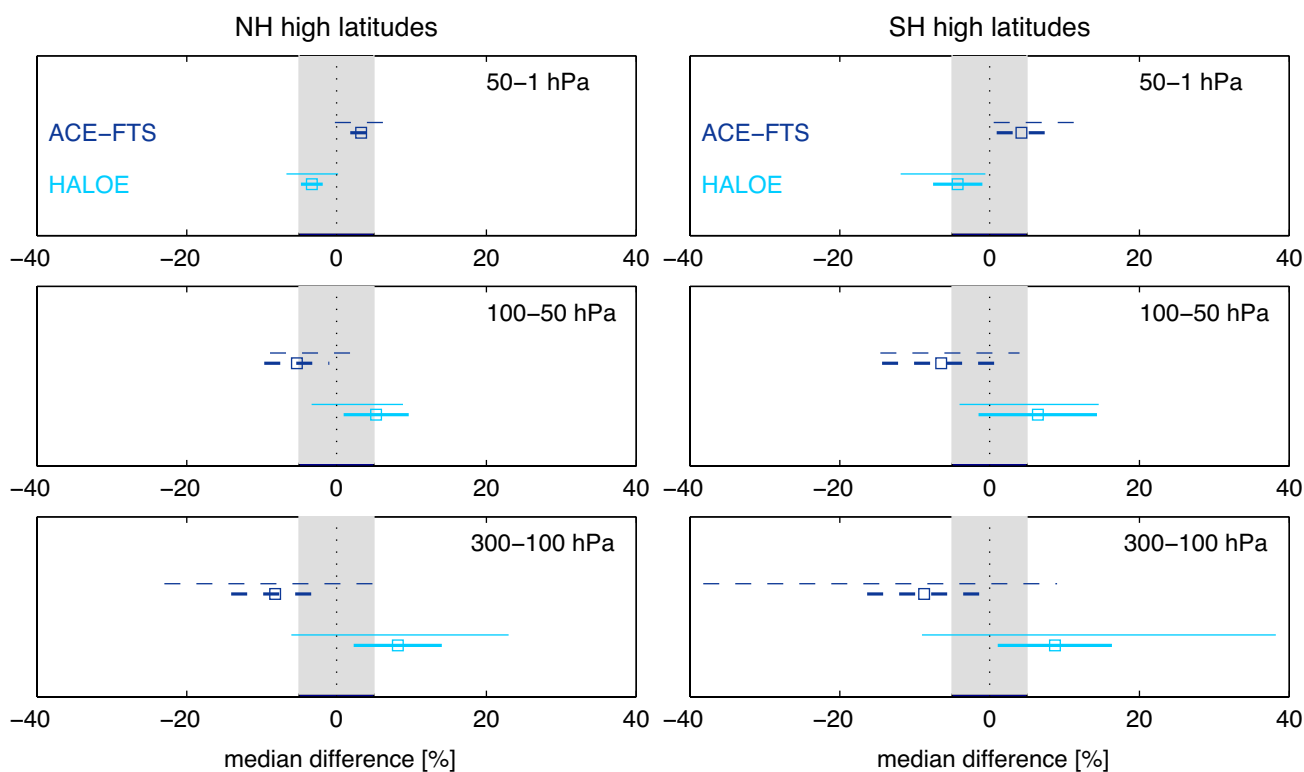




**Figure A4.8.4:** Cross sections of monthly zonal mean HF differences for August 2004-2005. As Figure A4.8.2 for August.

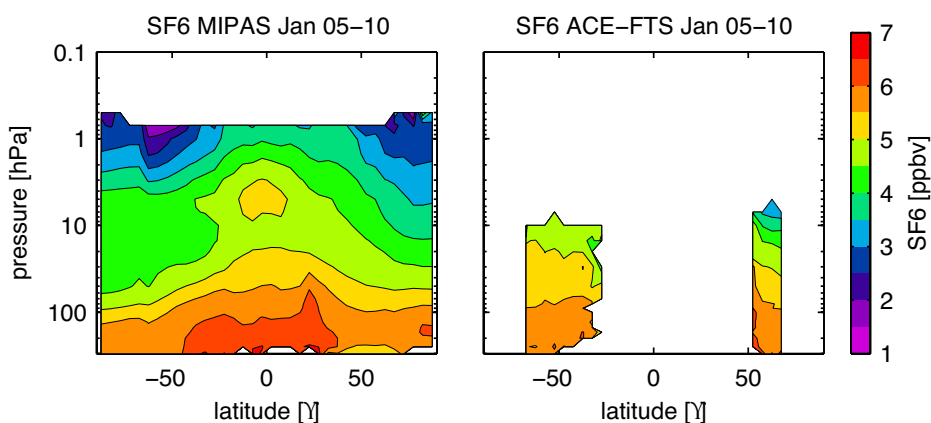


**Figure A4.8.5:** Profiles of monthly zonal mean HF for 2004-2005. Zonal mean HF profiles for 60°S-65°S, January (left panels) and 60°N-65°N, July (right panels) are shown together with their differences from the MIM. The grey shading indicates the +/-5% difference range. Bars indicate the uncertainties in the relative differences.

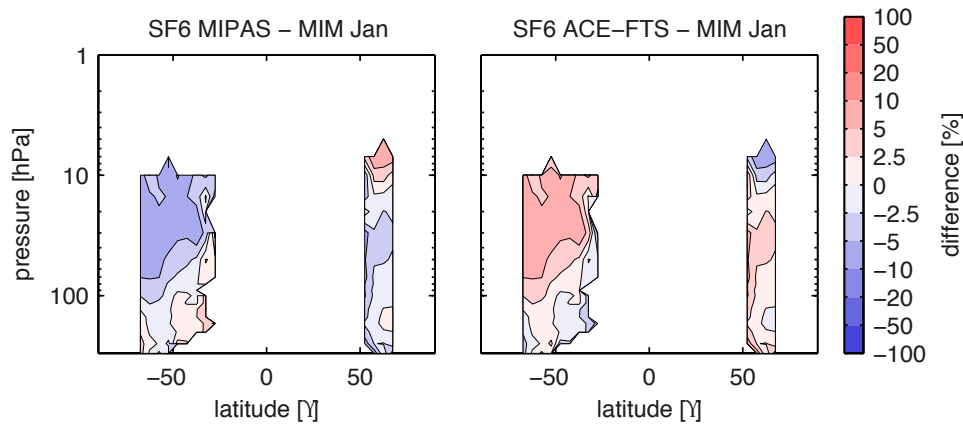


**Figure A4.8.6: Summary HF differences at high latitudes for 2004-2005.** Over a given latitude and altitude region the median (squares), median absolute deviation (MAD, thick lines), and the standard deviation (thin lines) of the monthly mean relative differences between an individual instrument-climatology and the MIM are calculated. Results are shown for the SH (60°S-90°S) and NH (60°N-90°N) high latitudes and for 3 different altitude regions from the UT up to the MS between 300 and 1 hPa for the reference period 2004-2005.

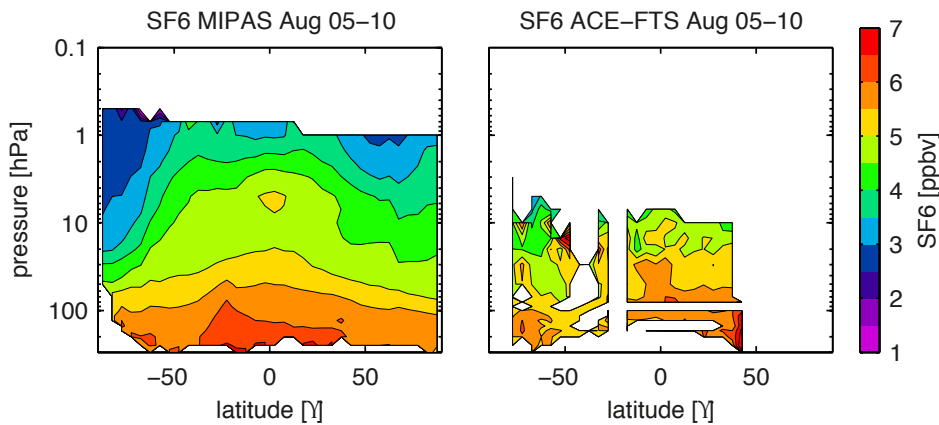
#### A4.9 Sulfur hexafluoride – SF<sub>6</sub>



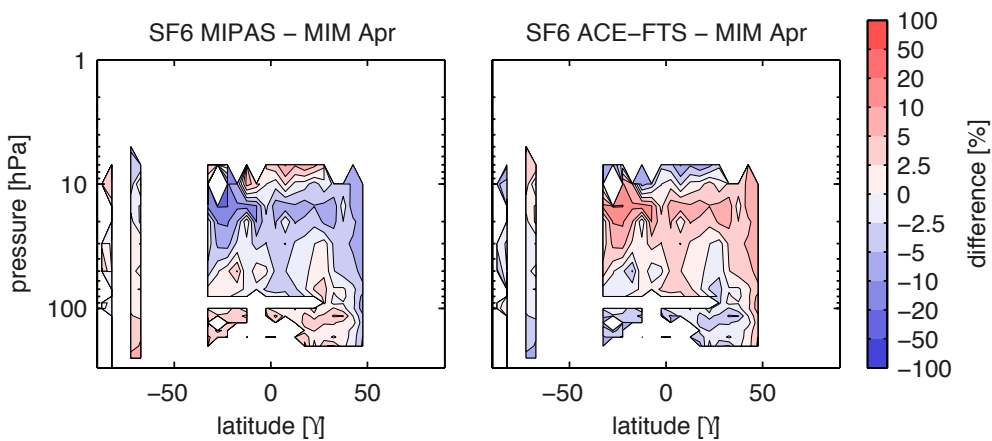
**Figure A4.9.1: Cross sections of monthly zonal mean SF<sub>6</sub> for January 2005-2010.** Monthly zonal mean SF<sub>6</sub> cross sections for January 2005-2010 are shown for MIPAS and ACE-FTS.



**Figure A4.9.2:** Cross sections of monthly zonal mean  $SF_6$  differences for January 2005-2010. Monthly zonal mean  $SF_6$  differences for January 2005-2010 between the individual instruments (MIPAS and ACE-FTS) and the MIM are shown.



**Figure A4.9.3:** Cross sections of monthly zonal mean  $SF_6$  for April 2005-2010. As Figure A4.9.1 for April.



**Figure A4.9.4:** Cross sections of monthly zonal mean  $SF_6$  differences for April 2005-2010. As Figure A4.9.2 for April.

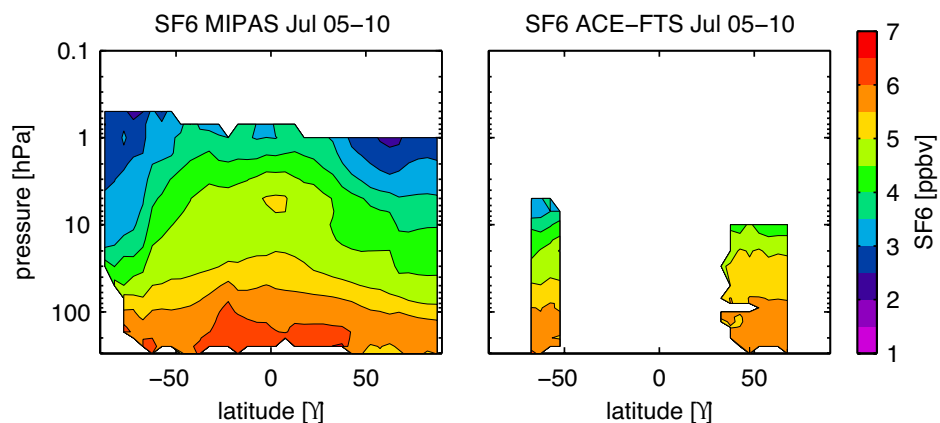


Figure A4.9.5: Cross sections of monthly zonal mean SF<sub>6</sub> for July 2005-2010. As Figure A4.9.1 for July.

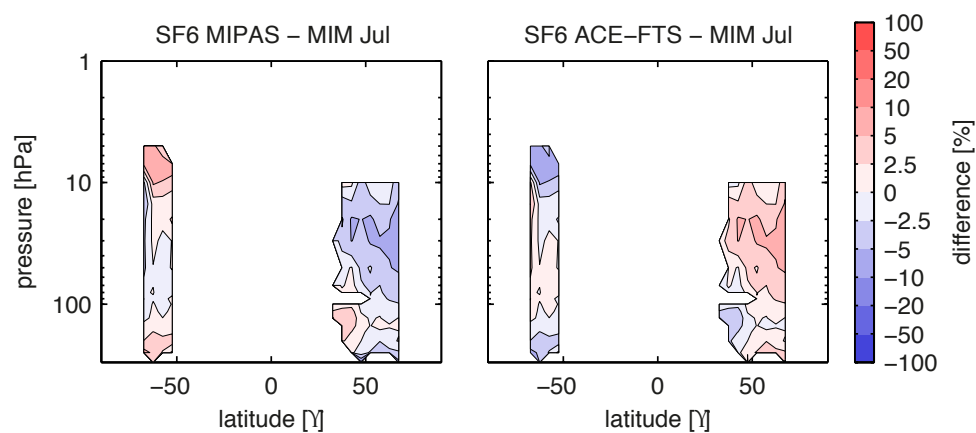


Figure A4.9.6: Cross sections of monthly zonal mean SF<sub>6</sub> differences for July 2005-2010. As Figure A4.9.2 for July.

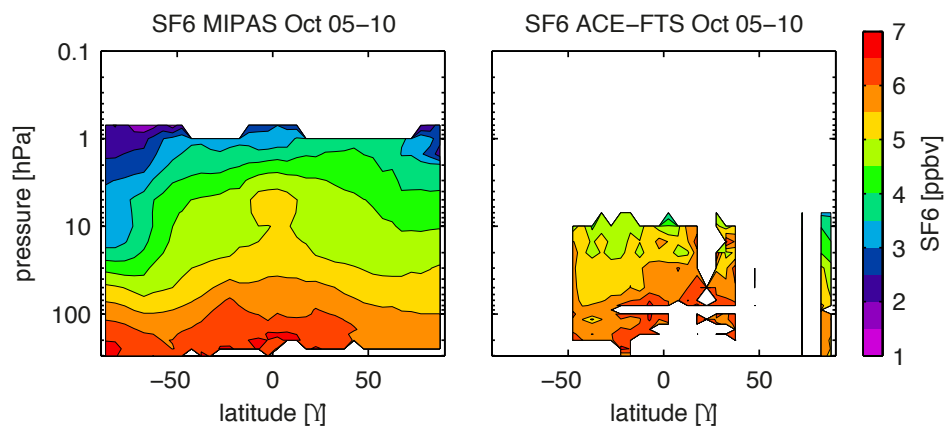
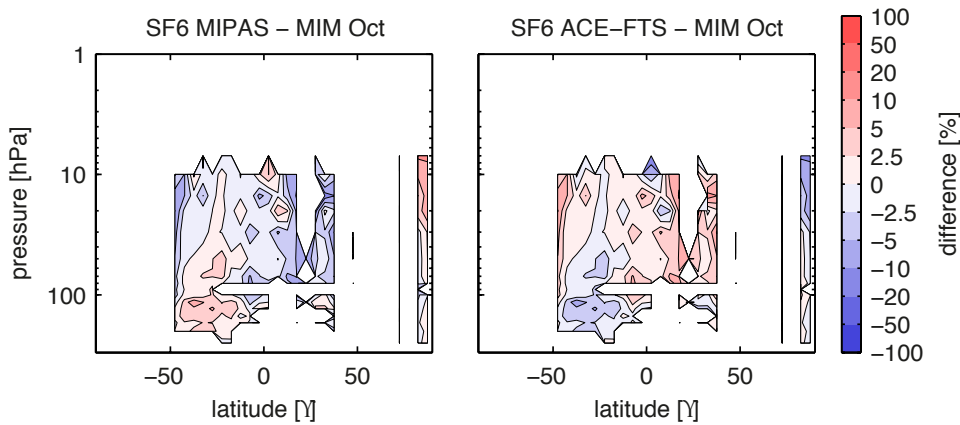
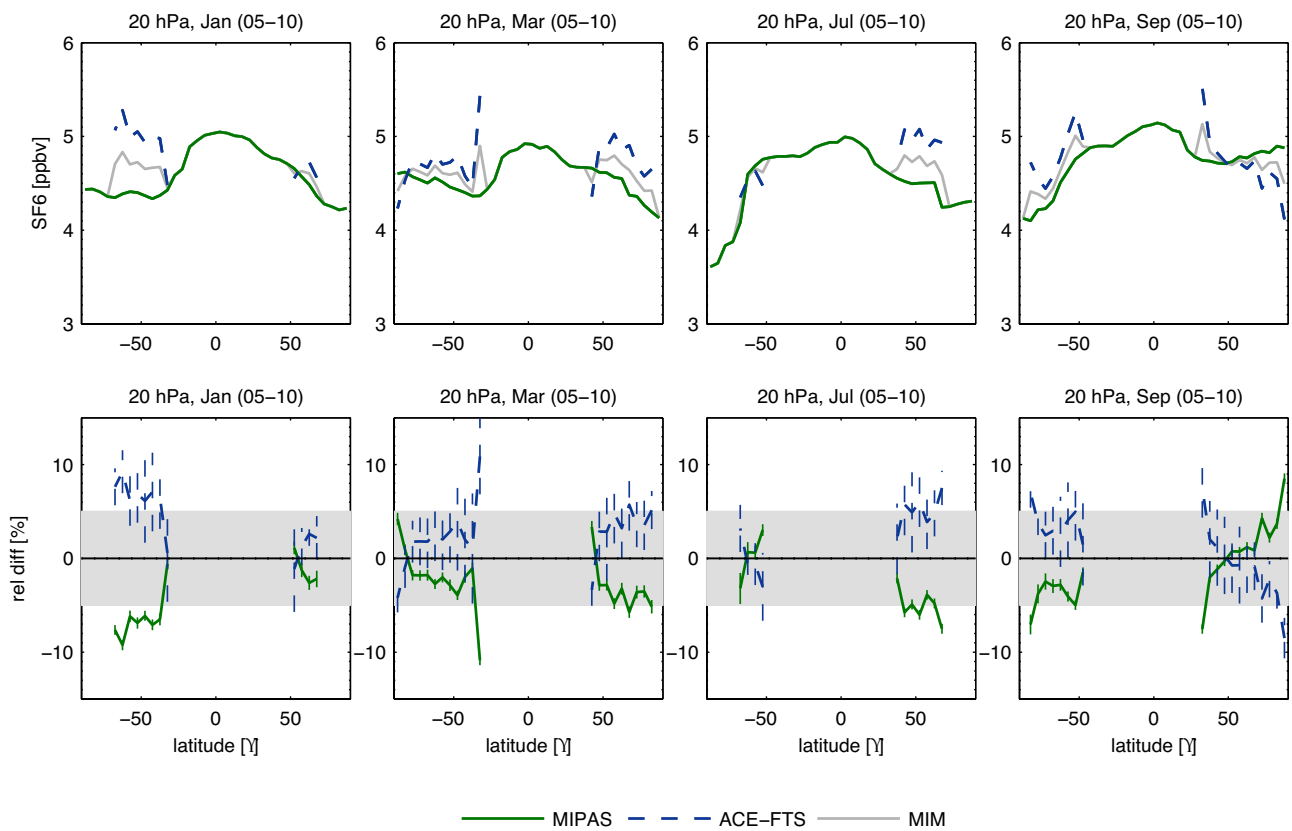


Figure A4.9.7: Cross sections of monthly zonal mean SF<sub>6</sub> for October 2005-2010. As Figure A4.9.1 for October.

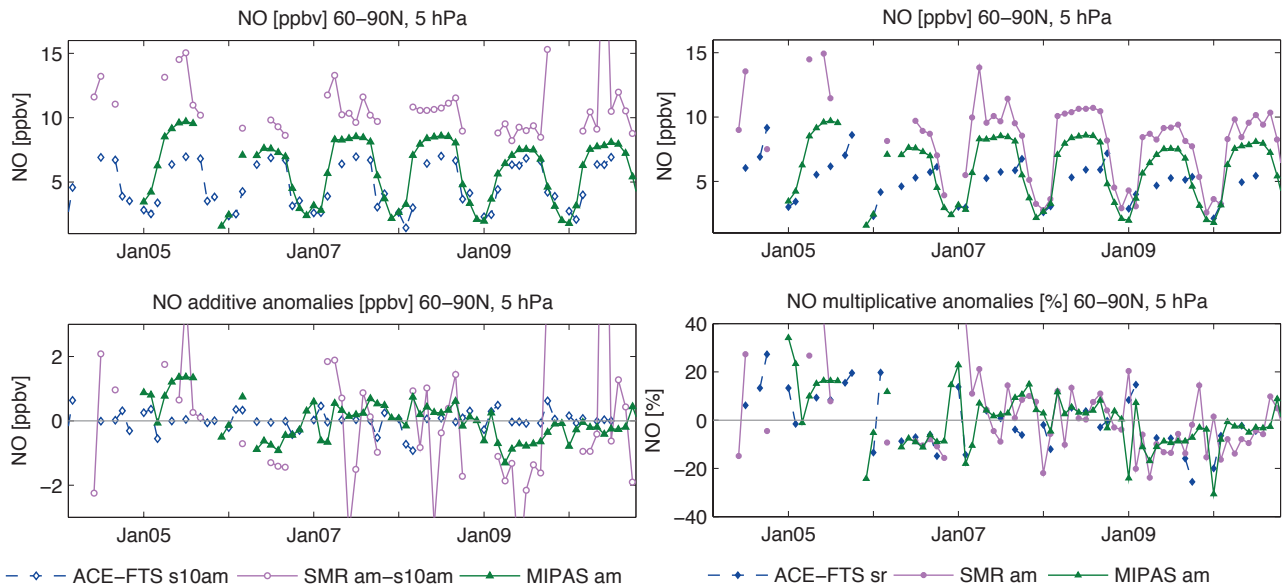


**Figure A4.9.8:** Cross sections of monthly zonal mean SF<sub>6</sub> differences for October 2005-2010. As Figure A4.9.2 for October.

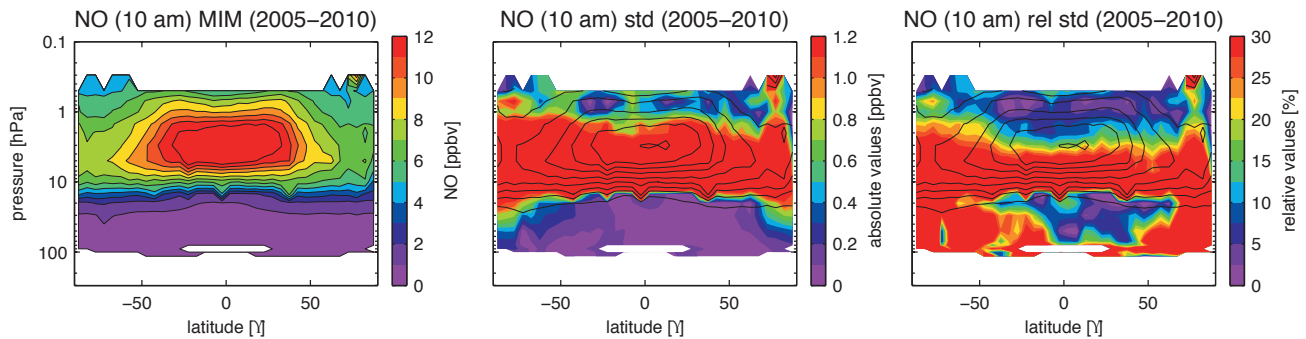


**Figure A4.9.9:** Meridional profiles of monthly zonal mean SF<sub>6</sub> for 2005-2010. Meridional monthly zonal mean SF<sub>6</sub> profiles at 20 hPa for January, March, July and September are shown in the upper row. Differences of the individual instruments (MIPAS and ACE-FTS) to the MIM are shown in the lower row. The grey shading indicates the +/-5% difference range. Bars indicate the uncertainties in the relative differences.

**A4.10 Nitrogen oxide – NO**



**Figure A4.10.1: NO Time series for 2005-2010.** Monthly mean values (upper panels) and deseasonalized anomalies (lower panels) of NO between 60°N – 90°N at 5 hPa. The 10 am climatologies (left panel) correspond directly to 10 am LST (filled symbols) or are scaled to 10 am LST (open symbols). The daytime climatologies (right panel) correspond to a variety of LSTs as described in Section 4.10.1.



**Figure A4.10.2: Summary of NO annual zonal mean state for 2005-2010.** Annual zonal mean cross section of the NO MIM for 10 am based on MIPAS at 10 am and SMR and ACE-FTS scaled to 10 am with a chemical box model is shown in the left panel. Additionally, the standard deviation over all respective instruments (middle panel) and the relative standard deviation (calculated by dividing the absolute standard deviation by the MIM, right panel) are presented. Black contour lines give the MIM distribution.

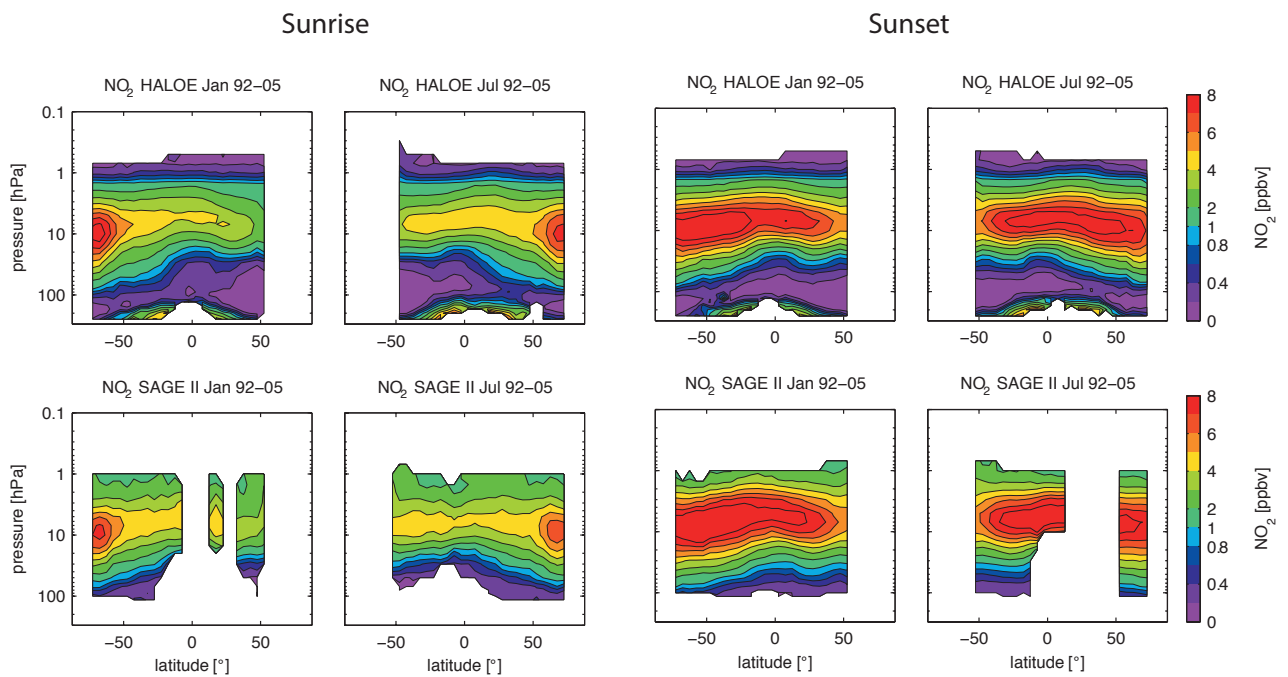
A4.11 Nitrogen dioxide – NO<sub>2</sub>

Figure A4.11.1: Monthly zonal mean NO<sub>2</sub> for 1992-2005. Sunrise (column 1 and 2) and sunset (column 3 and 4) NO<sub>2</sub> cross sections for January, and July are shown for HALOE and SAGE II.

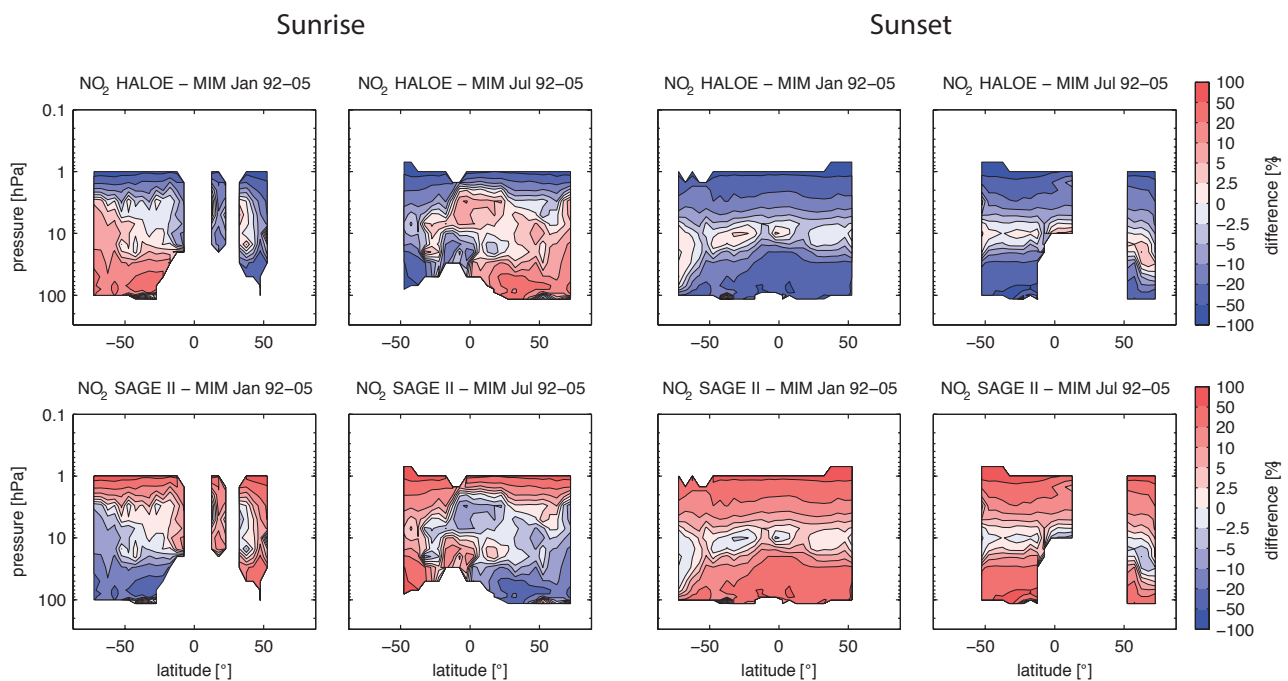
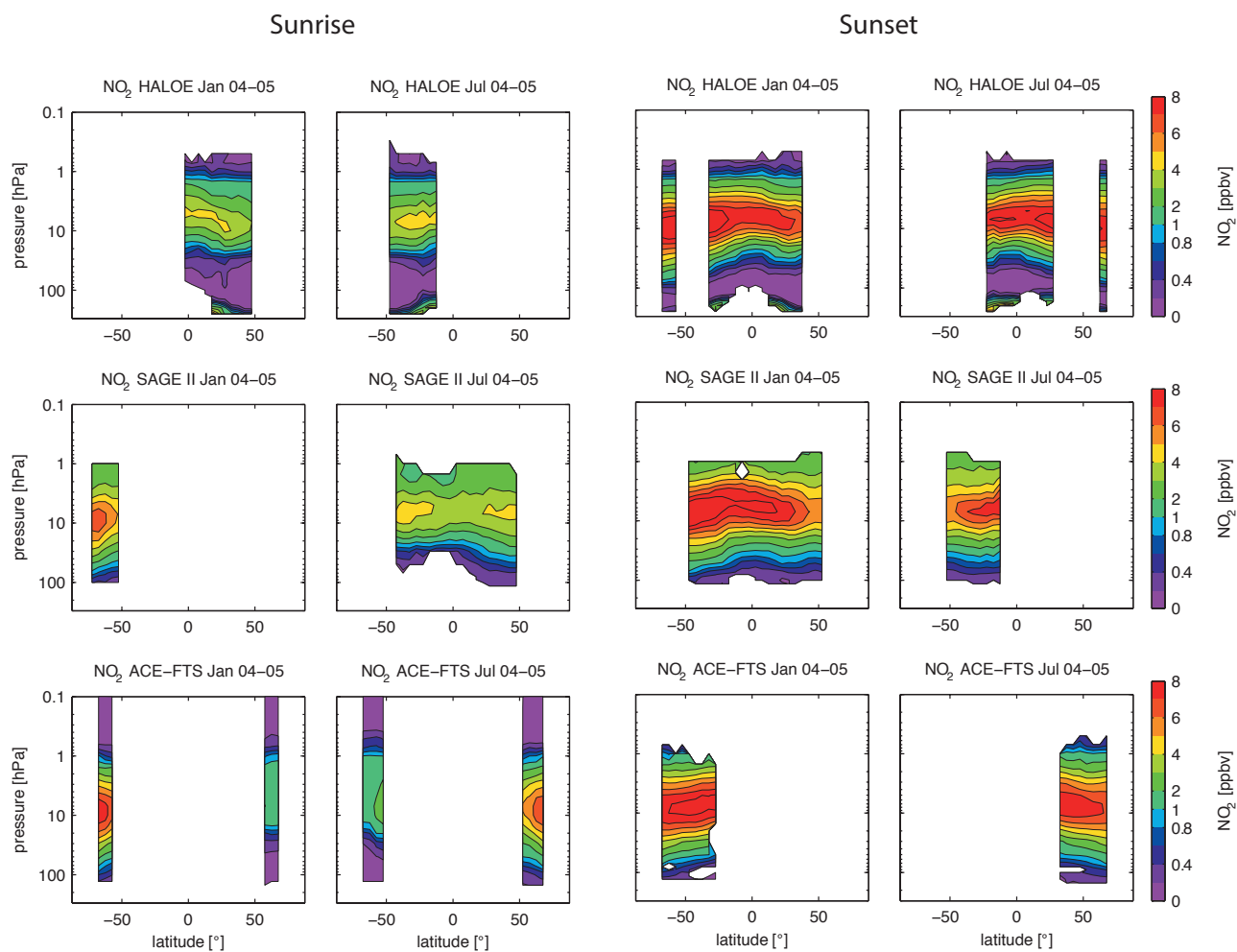
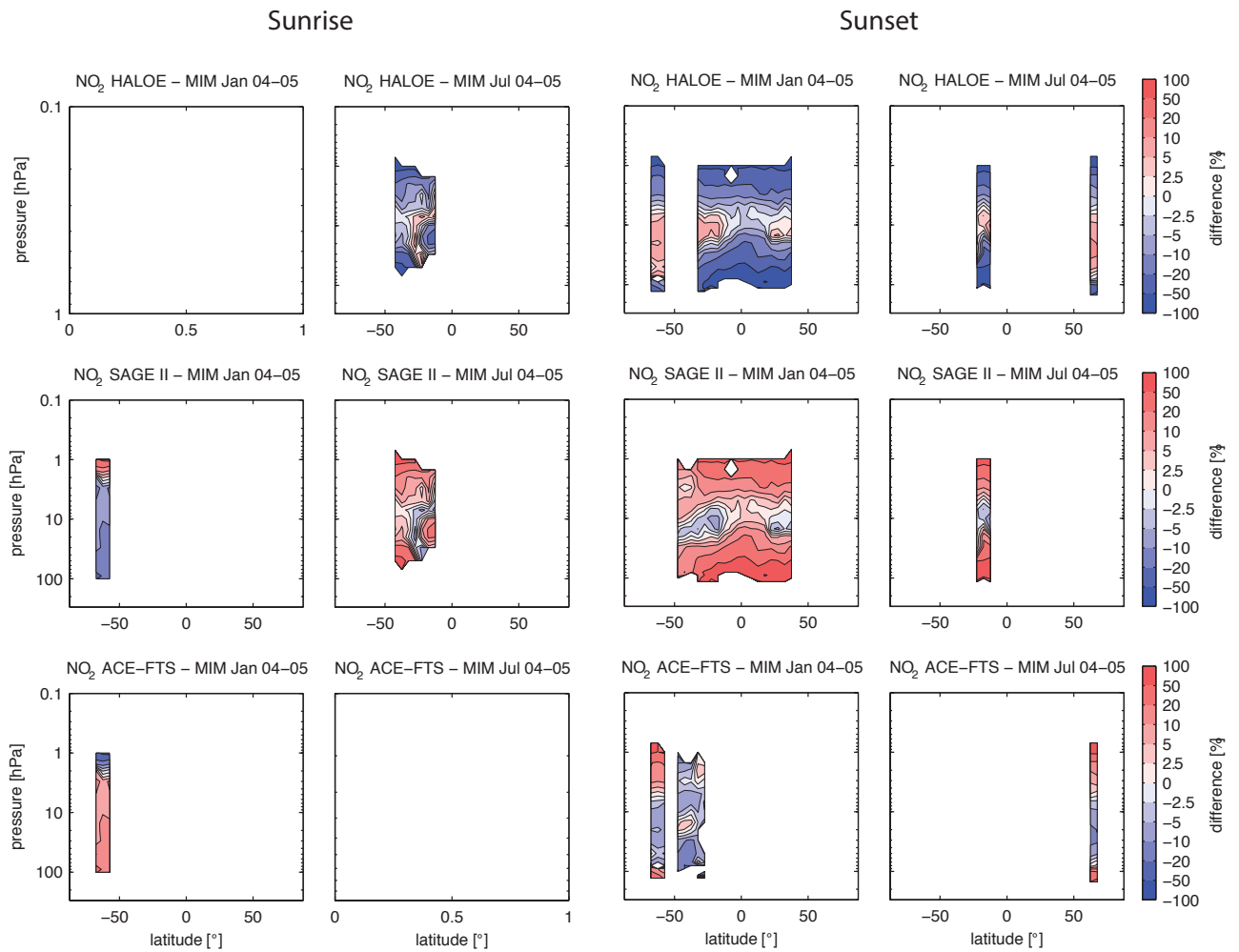


Figure A4.11.2: Monthly zonal mean NO<sub>2</sub> differences for 1992-2005. Sunrise (column 1 and 2) and sunset (column 3 and 4) NO<sub>2</sub> differences for January, and July between the individual instruments and their MIM are shown.



**Figure A4.11.3: Monthly zonal mean  $\text{NO}_2$  for 2004-2005.** Sunrise (column 1 and 2) and sunset (column 3 and 4)  $\text{NO}_2$  cross sections for January, and July are shown for the HALOE, SAGE II, and ACE-FTS.





**Figure A4.11.4: Monthly zonal mean  $\text{NO}_2$  differences for 2004-2005.** Sunrise (column 1 and 2) and sunset (column 3 and 4)  $\text{NO}_2$  differences for January, and July between the individual instruments (HALOE, SAGE II, ACE-FTS) and their MIM are shown.

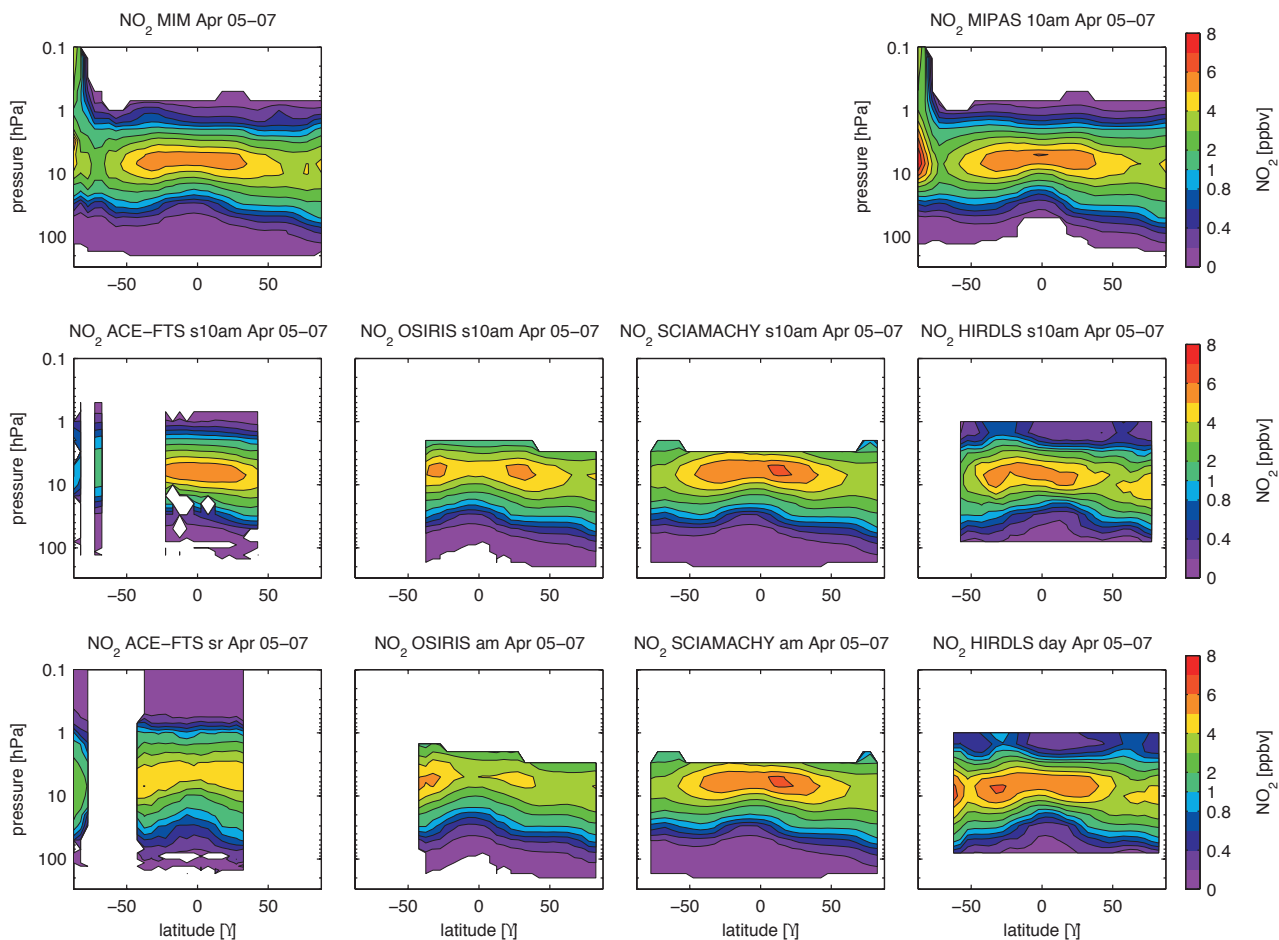
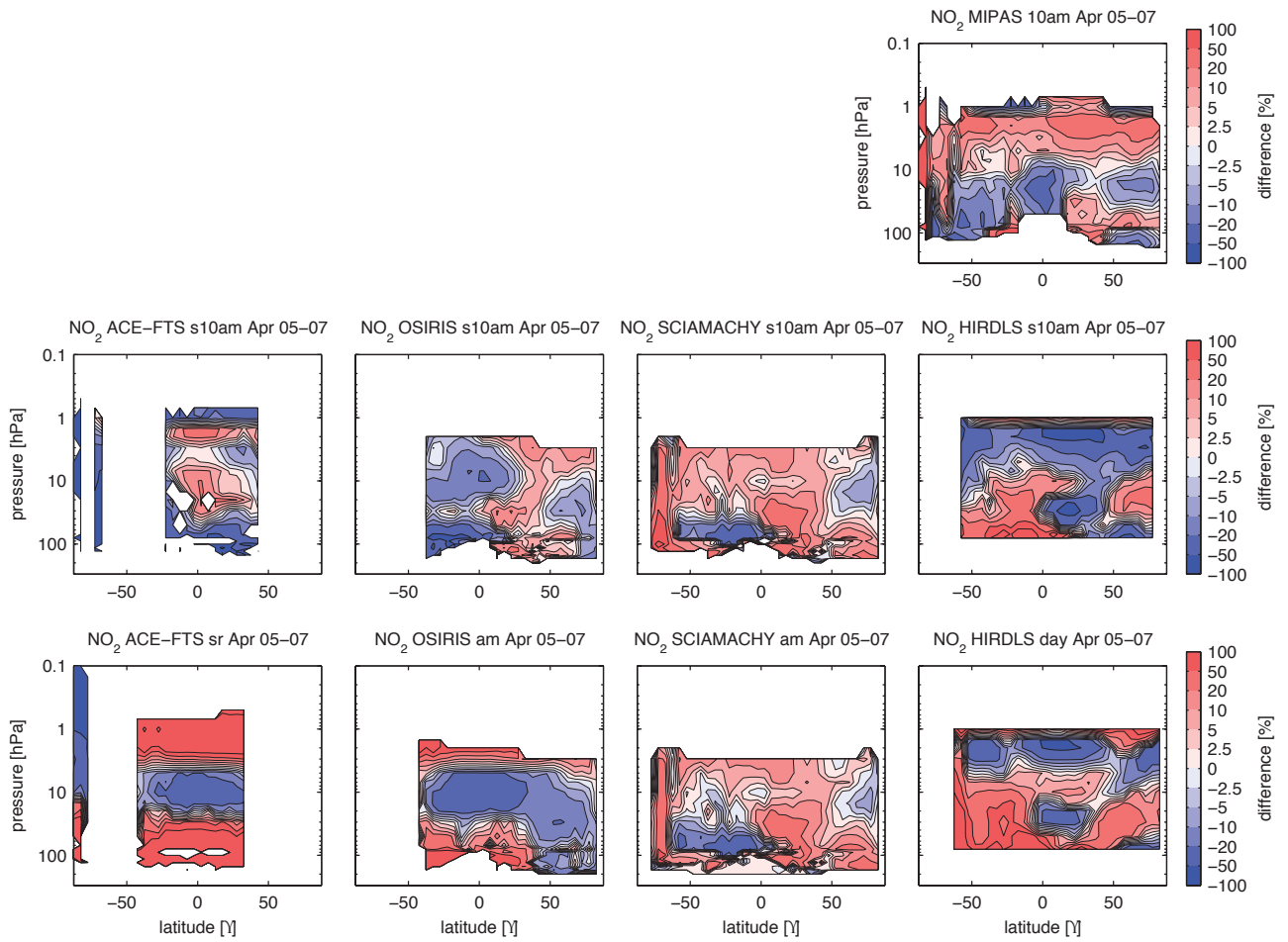
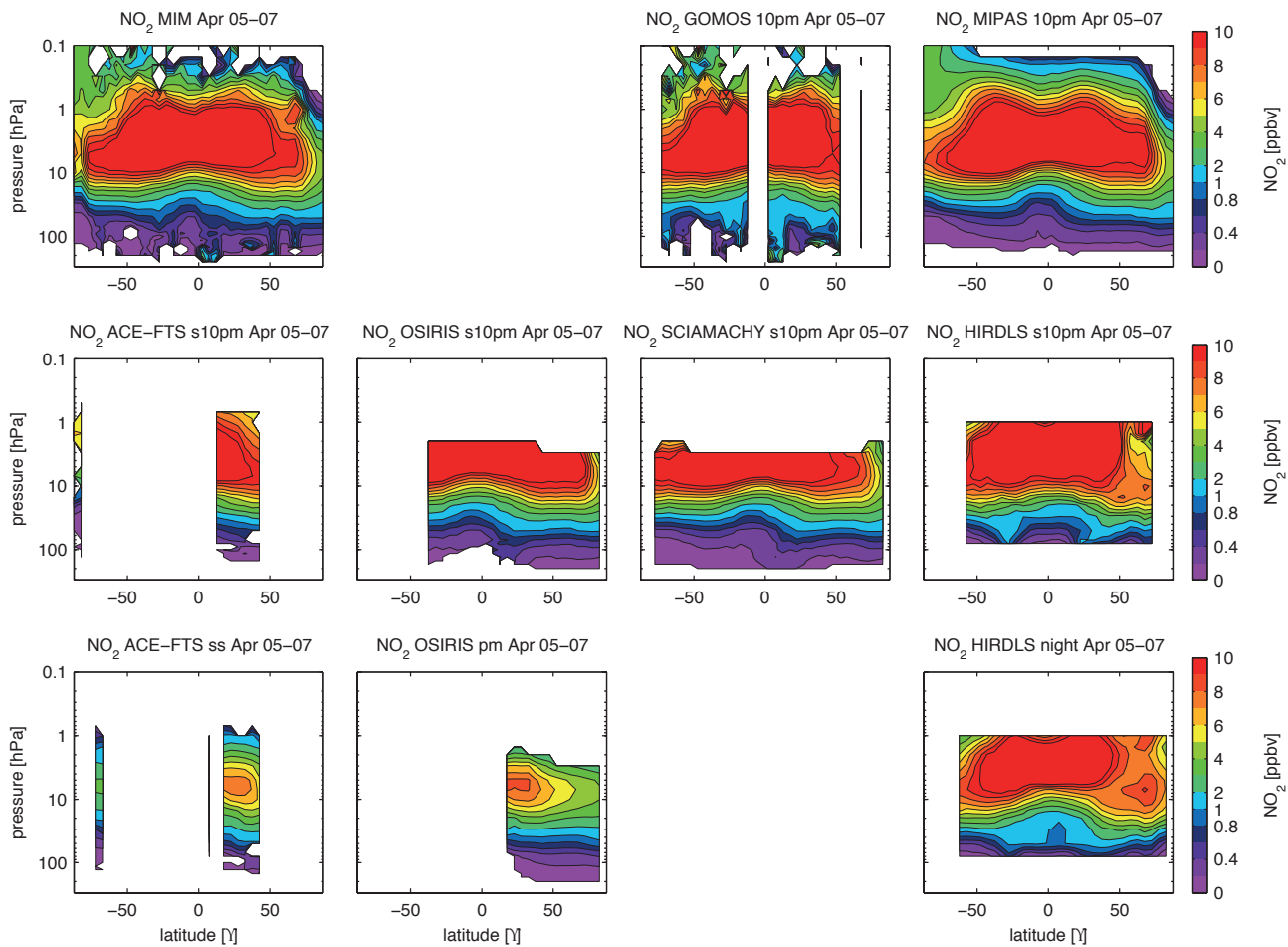


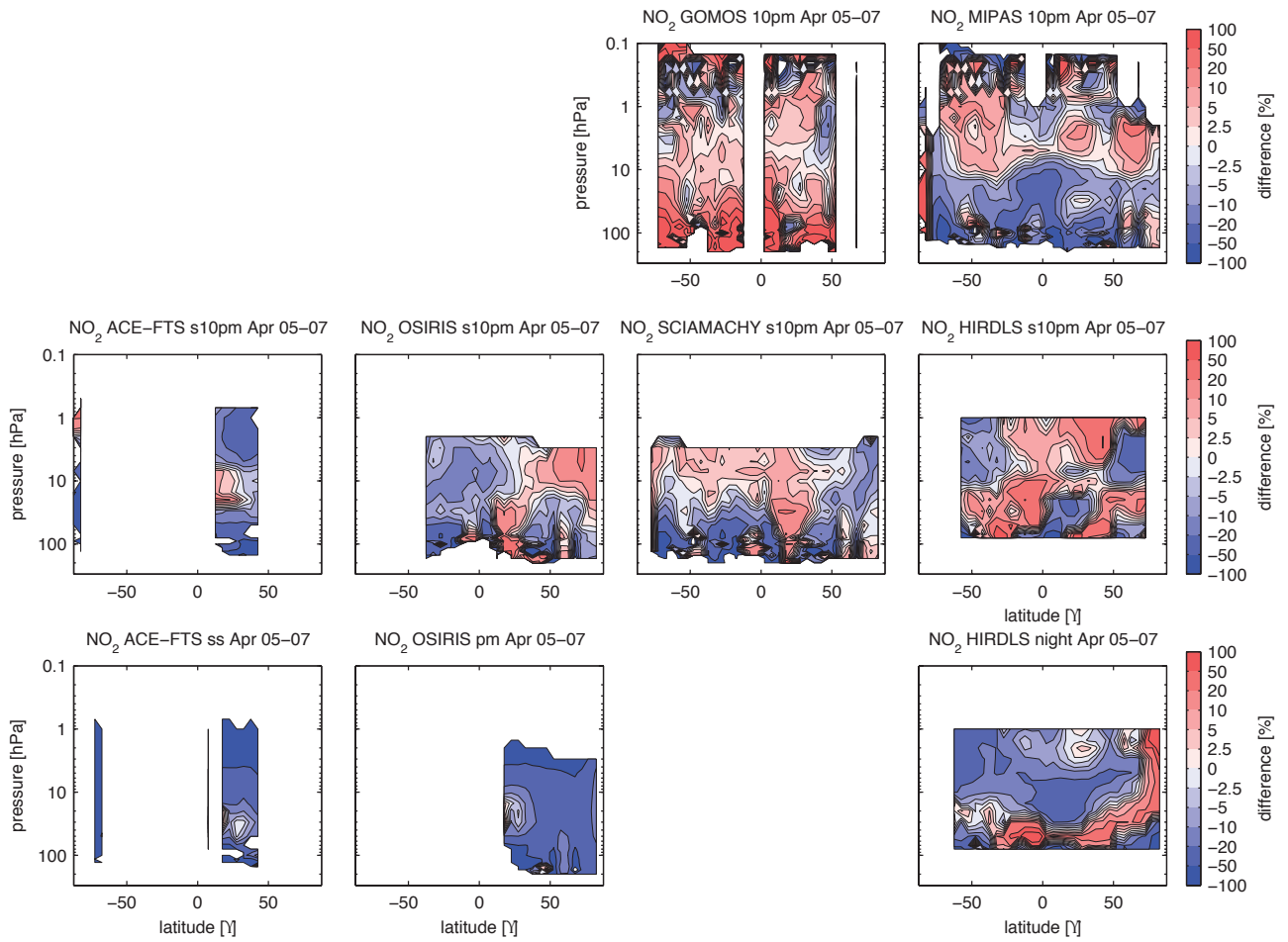
Figure A4.11.5: Monthly zonal mean, daytime  $\text{NO}_2$  for April 2005-2007. Measurements correspond to 10am (MIPAS) or are scaled to 10am. In addition, unscaled data from ACE-FTS, OSIRIS, SCIAMACHY, and HIRDLS are shown.



**Figure A4.11.6: Monthly zonal mean, daytime  $\text{NO}_2$  differences for April 2005-2007. Measurements correspond to 10am (MIPAS) or are scaled to 10am. In addition, unscaled data from ACE-FTS, OSIRIS, SCIAMACHY, and HIRDLS are shown.**



**Figure A4.11.7: Monthly zonal mean, nighttime  $\text{NO}_2$  for April 2005-2007. Measurements correspond to 10pm (MIPAS, and GOMOS) or are scaled to 10pm. In addition, unscaled data from ACE-FTS, OSIRIS, and HIRDLS are shown.**



**Figure A4.11.8: Monthly zonal mean, nighttime NO<sub>2</sub> differences for April 2005-2007. Measurements correspond to 10pm (MIPAS, and GOMOS) or are scaled to 10pm. In addition, unscaled data from ACE-FTS, OSIRIS, and HIRDLS are shown.**

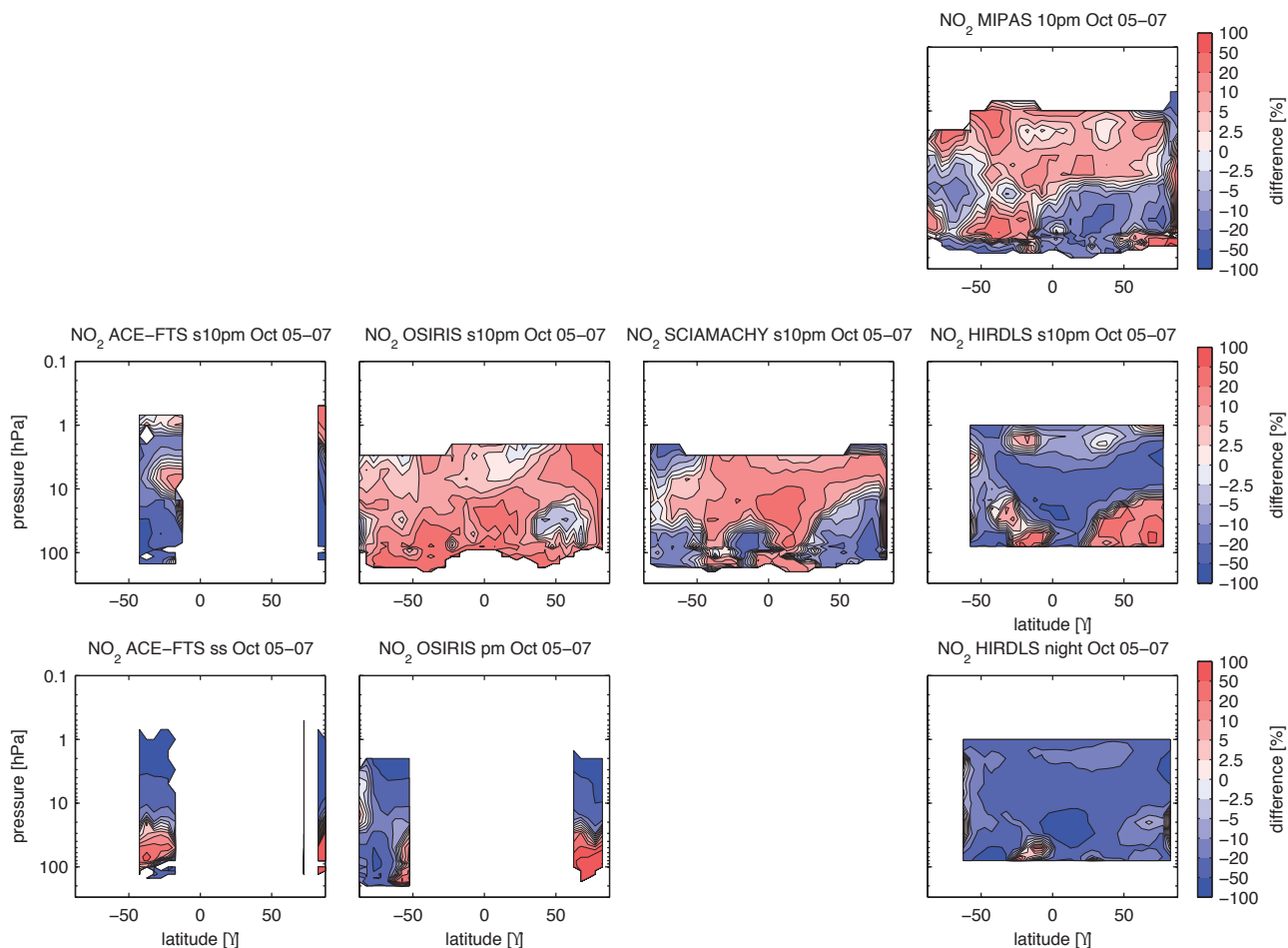


Figure A4.11.9: Monthly zonal mean, nighttime NO<sub>2</sub> differences for October 2005-2007. As Figure A4.11.8 but for October and without GOMOS.

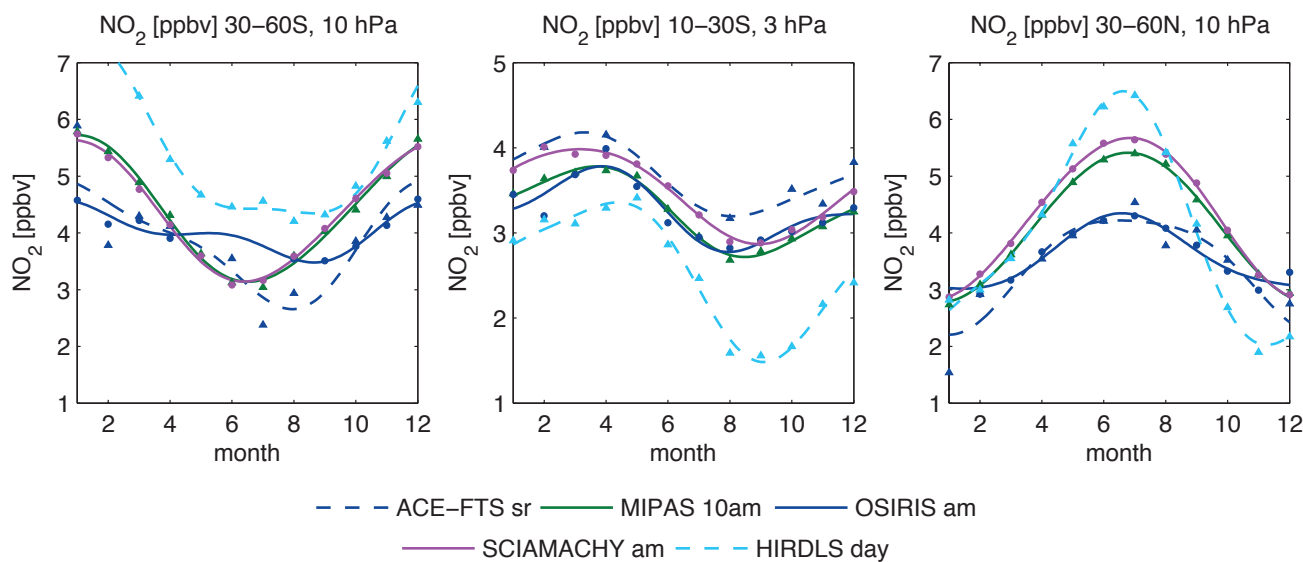
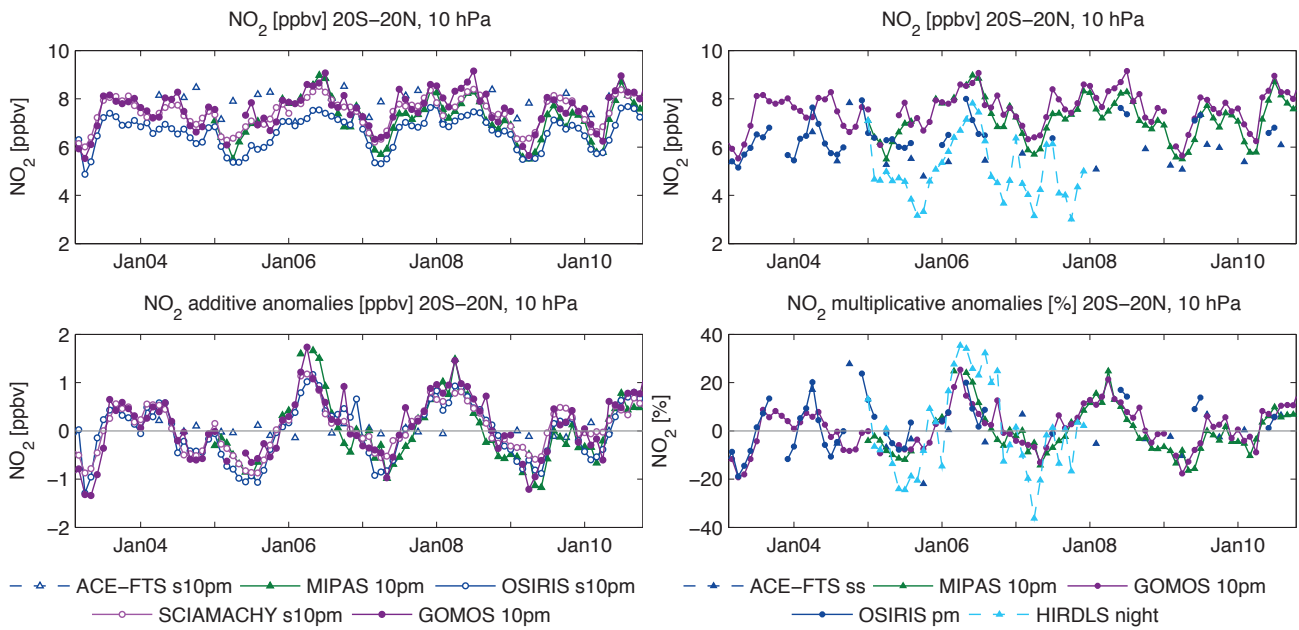
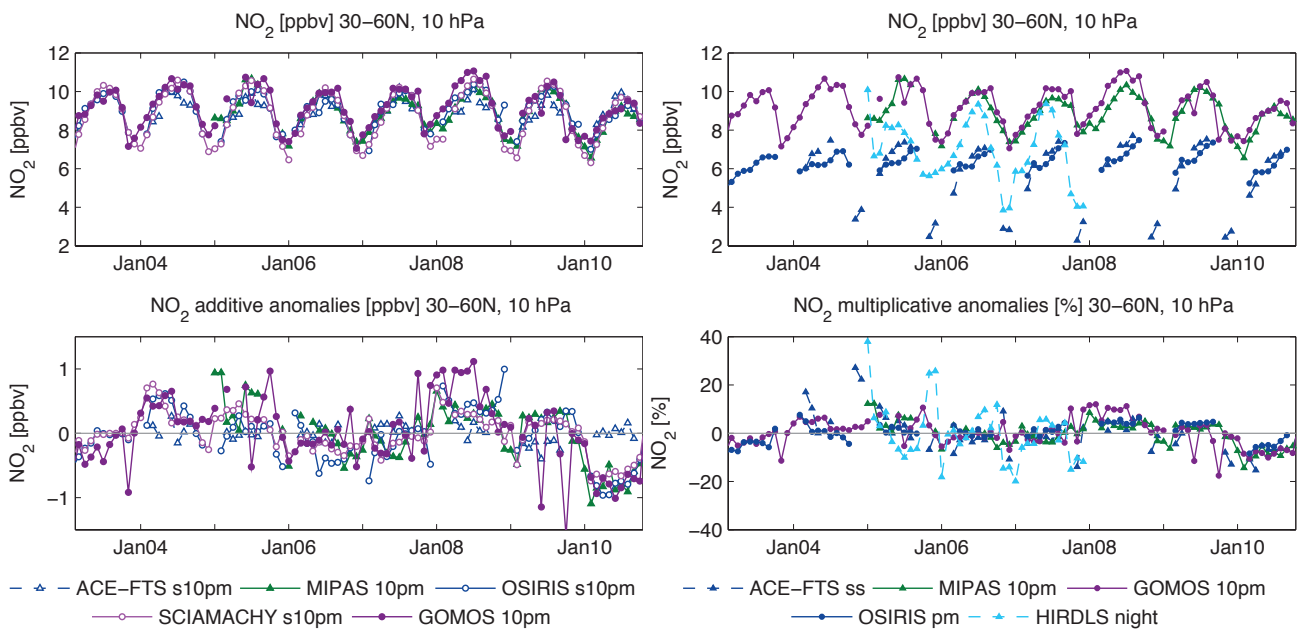


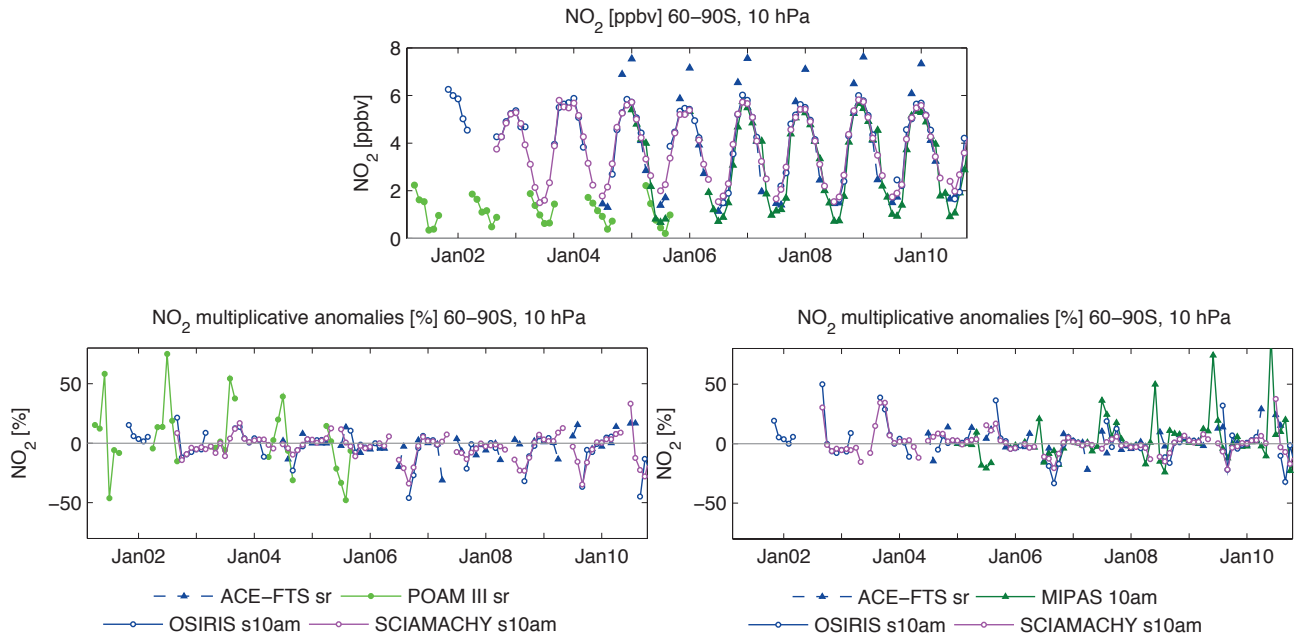
Figure A4.11.10: Seasonal cycle of daytime NO<sub>2</sub> for 2005-2007. NO<sub>2</sub> seasonal cycle for 30°S-60°S at 10 hPa (left column), 10°S-30°S at 3 hPa (middle column) and 30°N-60°N at 10 hPa (right column). Measurements correspond to a variety of LSTs.



**Figure A4.11.11: Time series of nighttime  $\text{NO}_2$  for 2003-2010.** Monthly mean values (upper panels) and deseasonalized anomalies (lower panels) of  $\text{NO}_2$  between  $20^\circ\text{S} - 20^\circ\text{N}$  at 10 hPa. Data sets correspond to 10pm (left panels) or to a variety of LSTs (right panels) with scaled date given by open symbols.

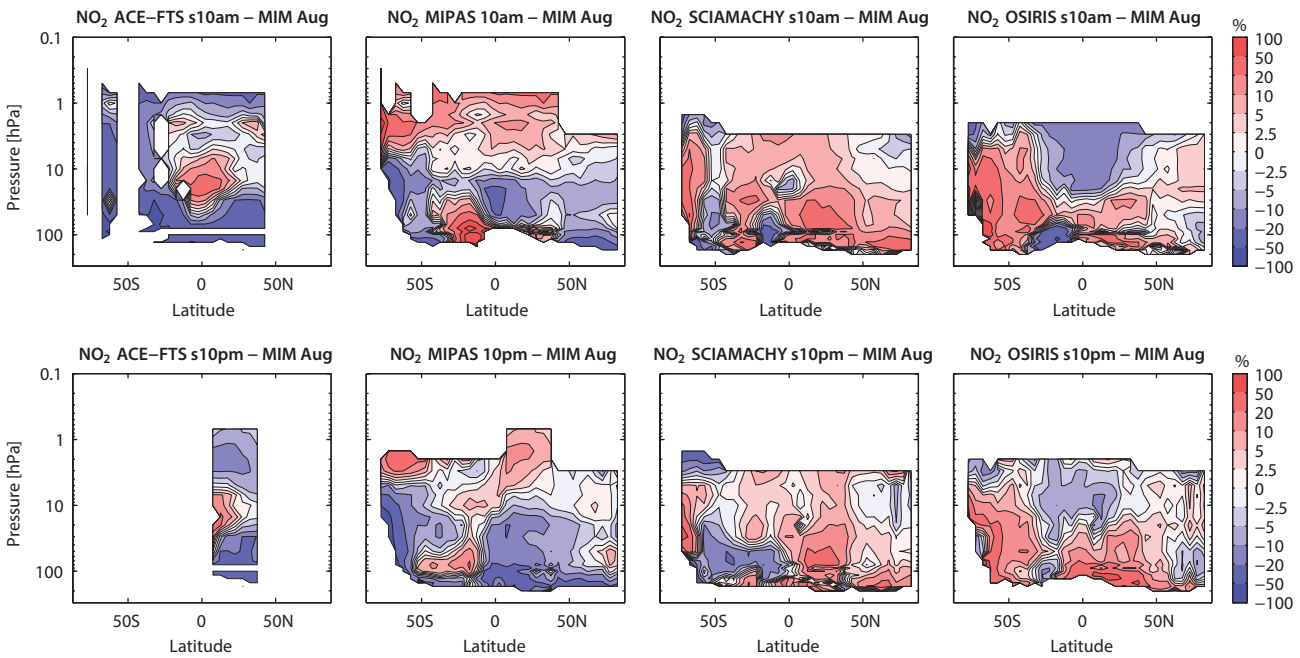


**Figure A4.11.12: Time series of nighttime  $\text{NO}_2$  for 2003-2010.** Monthly mean values (upper panels) and deseasonalized anomalies (lower panels) of  $\text{NO}_2$  between  $30^\circ\text{N} - 60^\circ\text{N}$  at 10 hPa. Data sets correspond to 10pm (left panels) or to a variety of LSTs (right panels) with scaled date given by open symbols.



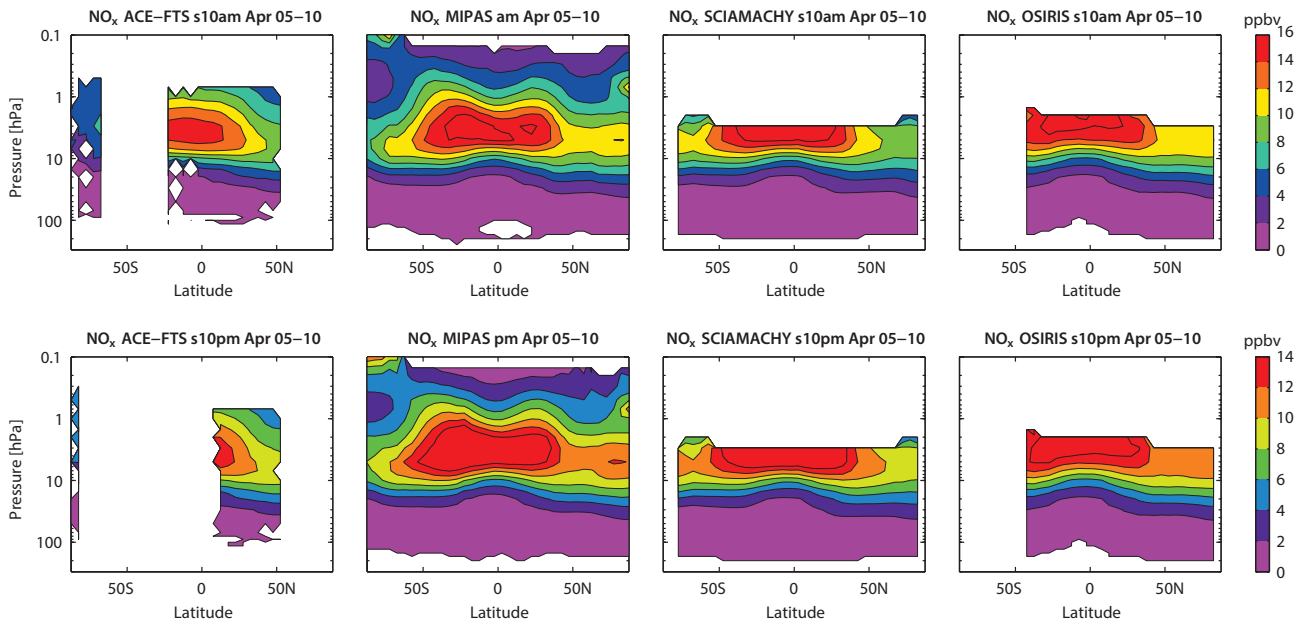
**Figure A4.11.13:** Time series of daytime  $\text{NO}_2$  for 2001-2010. Monthly mean values (upper panel) and deseasonalized anomalies (lower panels) of  $\text{NO}_2$  between  $60^\circ\text{S} - 90^\circ\text{S}$  at 10 hPa. Climatologies have been normalized with respect to 2003-2005 (lower left panel) or with respect to 2005-2007 (lower right panel) with scaled date given by open symbols.

**A4.12 Nitrogen oxides –  $\text{NO}_x$**

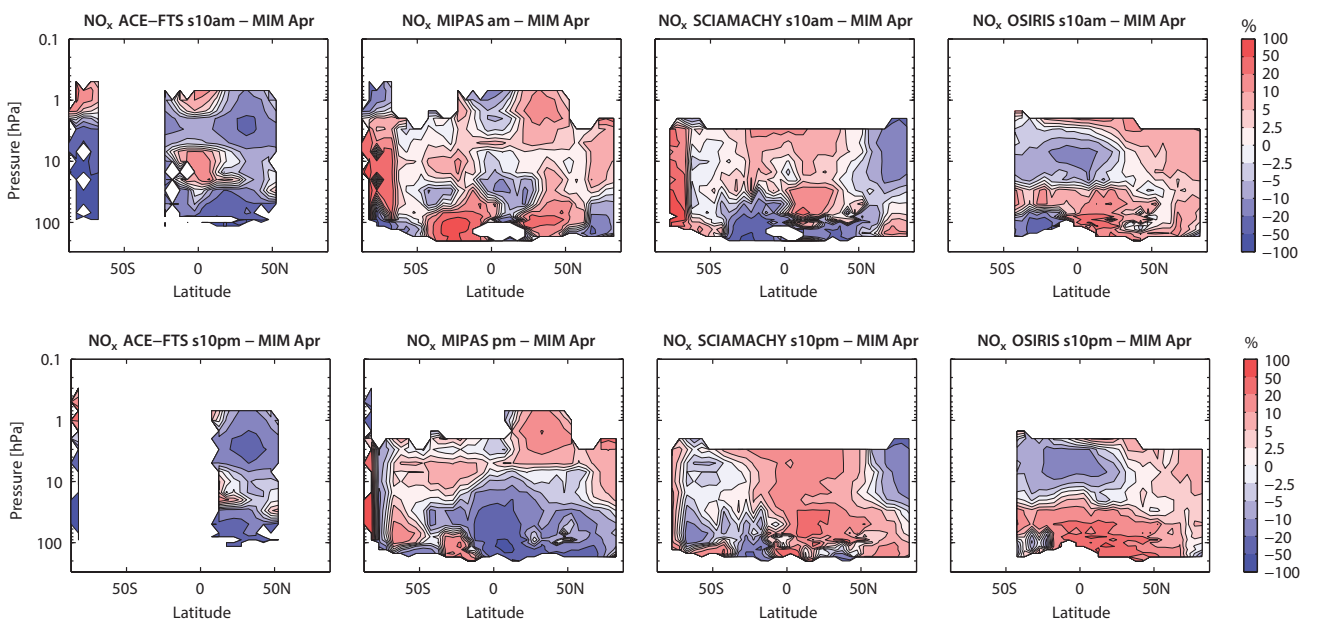


**Figure A4.12.1:** Monthly zonal mean  $\text{NO}_2$  differences for August 2005-2010.  $\text{NO}_2$  differences to the MIM of the 10am (upper panels) and the 10pm (lower panels) climatologies are shown.

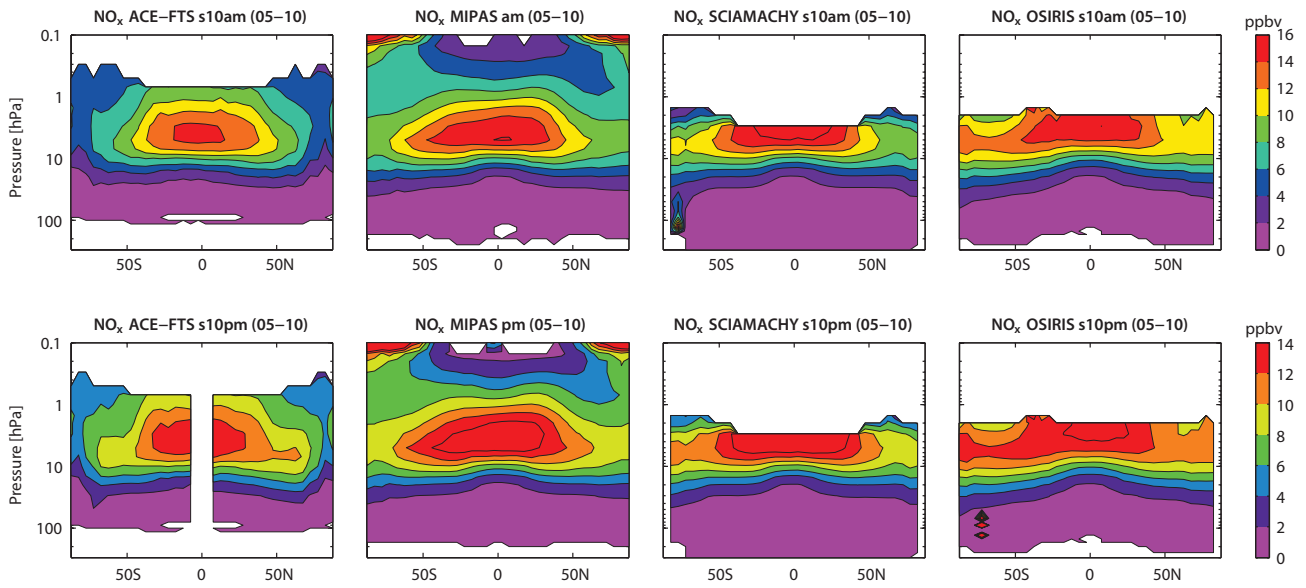




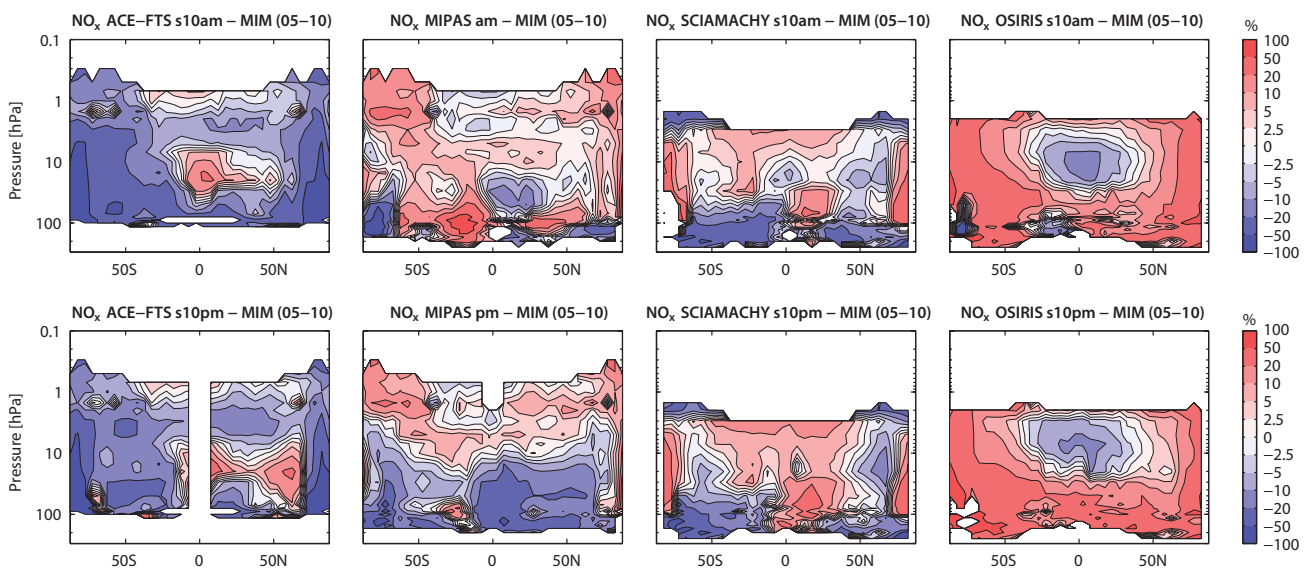
**Figure A4.12.2:** Monthly zonal mean  $\text{NO}_x$  for April 2005-2010.  $\text{NO}_x$  cross sections of 10am (upper panels) and 10pm (lower panels) climatologies are shown.



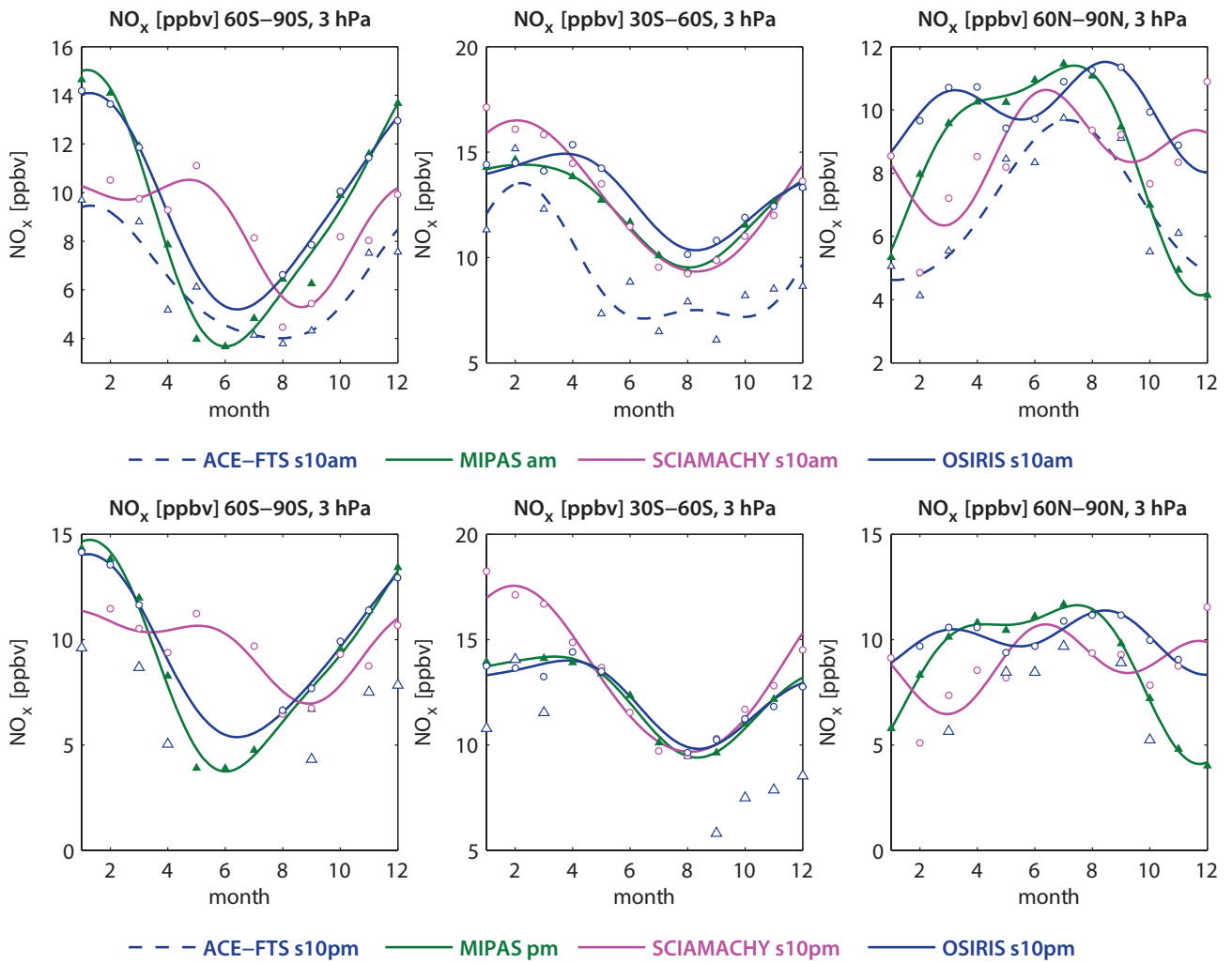
**Figure A4.12.3:** Monthly zonal mean  $\text{NO}_x$  differences for April 2005-2010.  $\text{NO}_x$  differences to the MIM of the 10am (upper panels) and the 10pm (lower panels) climatologies are shown.



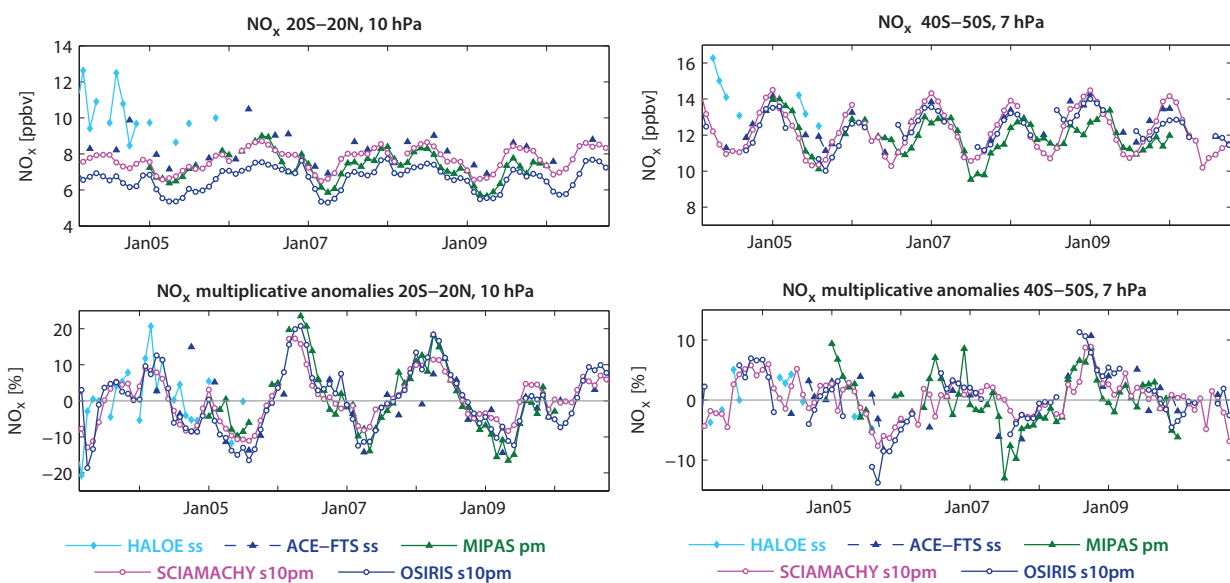
**Figure A4.12.4:** Annual zonal mean  $\text{NO}_x$  for 2005-2010.  $\text{NO}_x$  cross sections of 10am (upper panels) and 10pm (lower panels) climatologies are shown.



**Figure A4.12.5:** Annual zonal mean  $\text{NO}_x$  differences for 2005-2010.  $\text{NO}_x$  differences to the MIM of the 10am (upper panels) and the 10pm (lower panels) climatologies are shown.

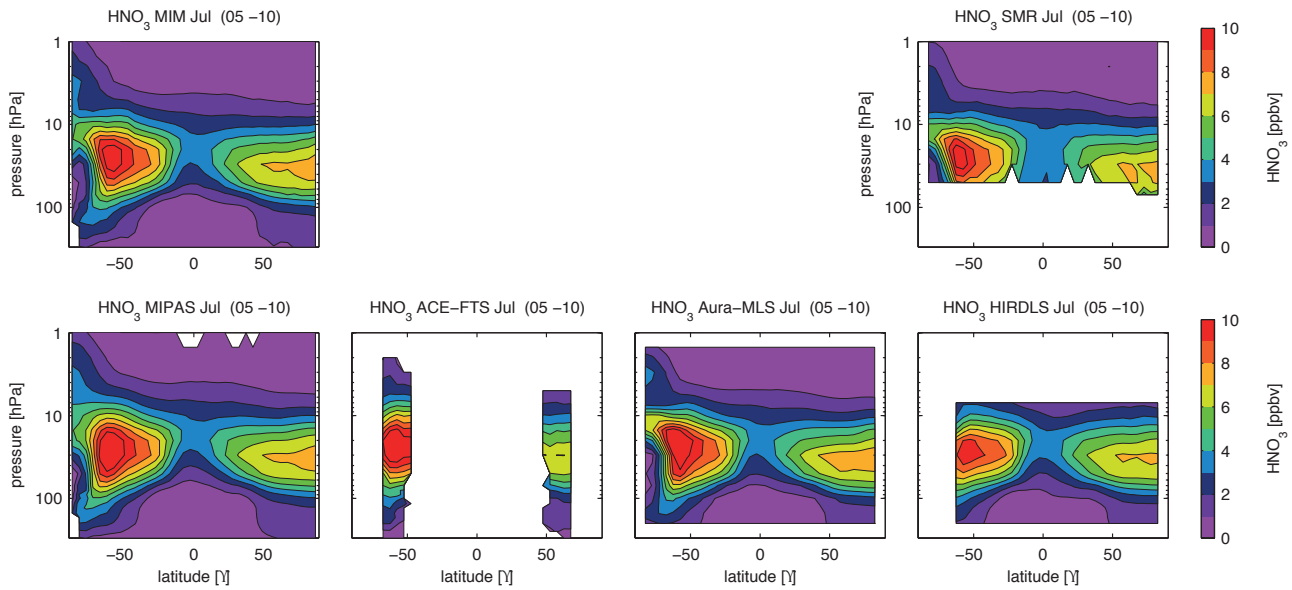


**Figure A4.12.6:** *NO<sub>x</sub> seasonal cycle for 2005-2010. Monthly zonal mean NO<sub>x</sub> at 3 hPa for 60°S-90°S (left column), 30°S-60°S (middle column) and 60°N-90°N (right column) for 10am (upper row) and 10pm (lower row) climatologies. Measurements correspond directly to 10am/10pm (filled symbols) or are scaled to 10am/10pm (open symbols).*

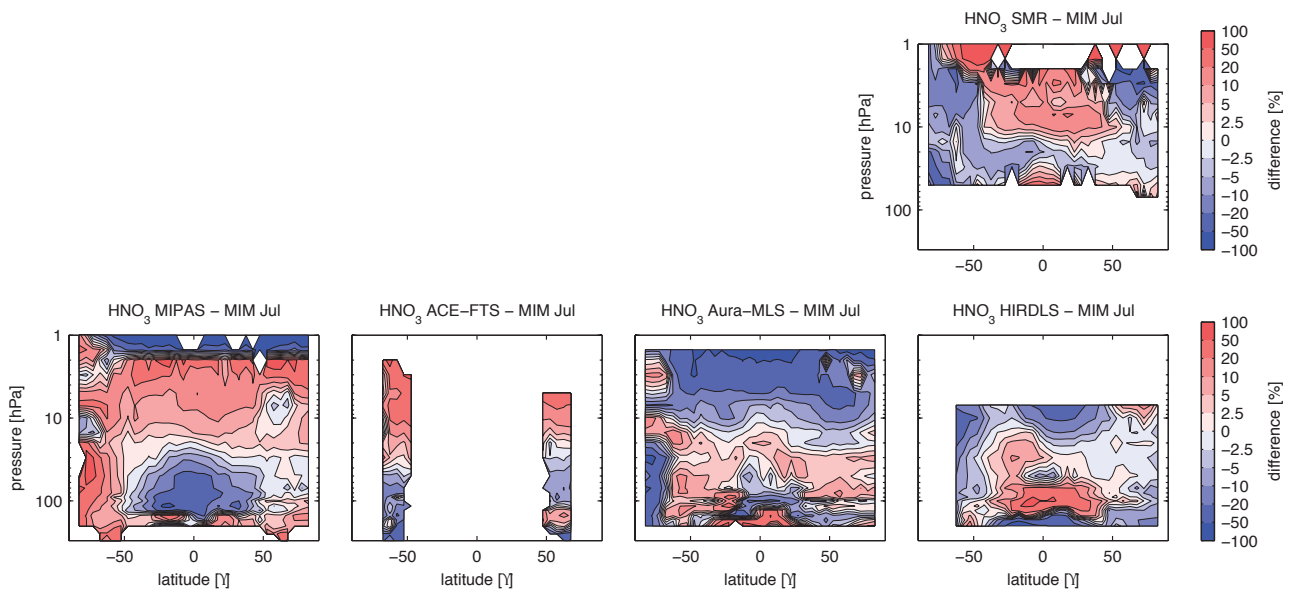


**Figure A4.12.7:** *NO<sub>x</sub> time series for 2003-2010. Monthly mean values (left panels) and deseasonalized anomalies (right panels) of NO<sub>x</sub> at 10 hPa for 20°S – 20°N and at 7 hPa for 40°S-50°S, respectively. Measurements correspond to local sunset conditions (ss) or 10pm LST (filled symbols) or are scaled to 10pm LST (open symbols).*

**A4.13 Nitric acid – HNO<sub>3</sub>**



**Figure A4.13.1:** Monthly zonal mean HNO<sub>3</sub> for July 2005-2010. (MIM, SMR, MIPAS, ACE-FTS, Aura-MLS, and HIRDLS.)



**Figure A4.13.2:** Monthly zonal mean HNO<sub>3</sub> differences for July 2005-2010. (Differences between the individual instruments and the MIM.)

**A4.14 Peroxynitric acid – HNO<sub>4</sub>**

No Appendix for this section.

**A4.15 Dinitrogen pentoxide – N<sub>2</sub>O<sub>5</sub>**

No Appendix for this section.

### A4.16 Chlorine nitrate – $\text{ClONO}_2$

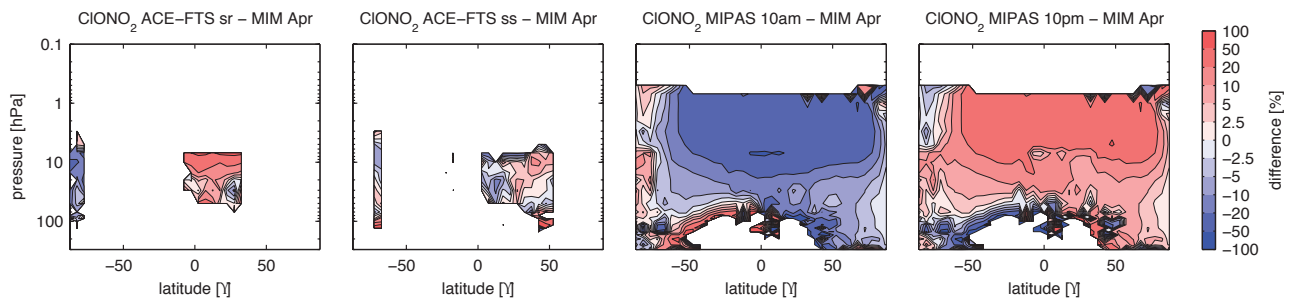


Figure A4.16.1: Monthly zonal mean  $\text{ClONO}_2$  differences to the MIM for April 2005-2010.

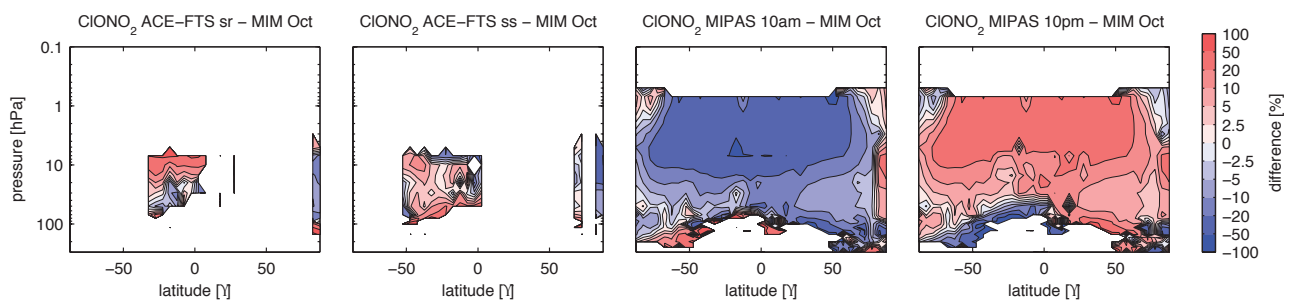


Figure A4.16.2: Monthly zonal mean  $\text{ClONO}_2$  differences to the MIM for October 2005-2010.

### A4.17 Total reactive nitrogen – $\text{NO}_y$

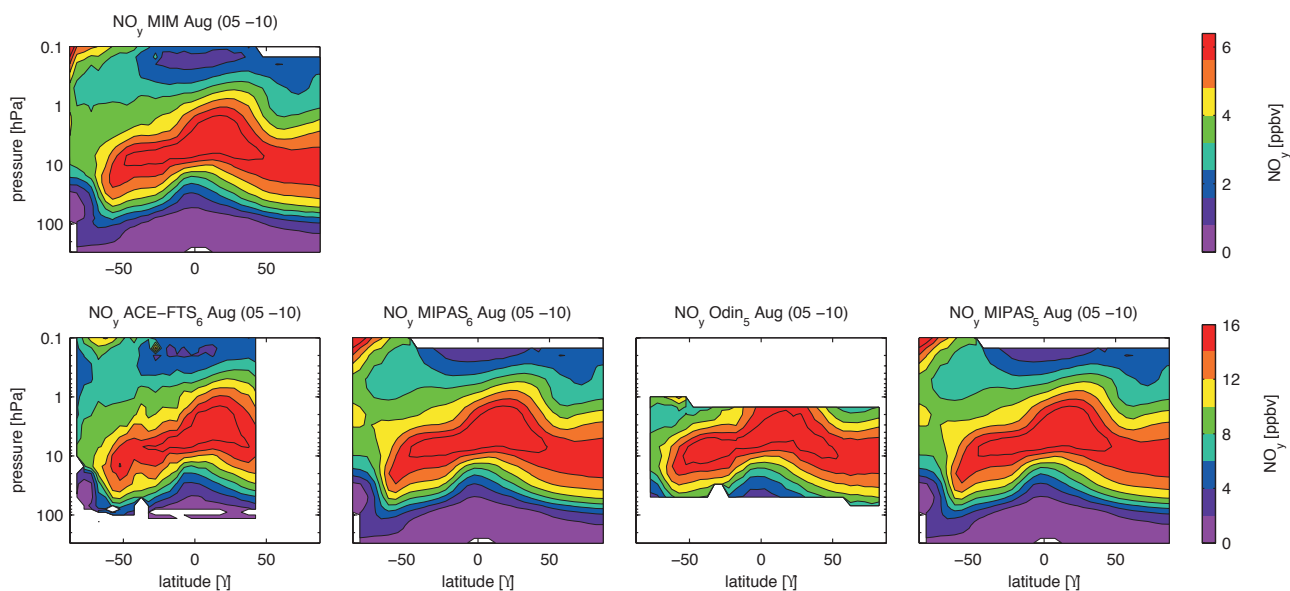
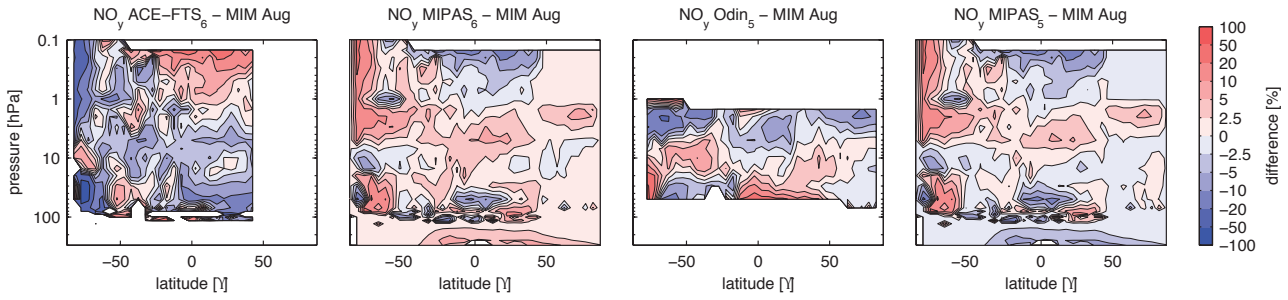
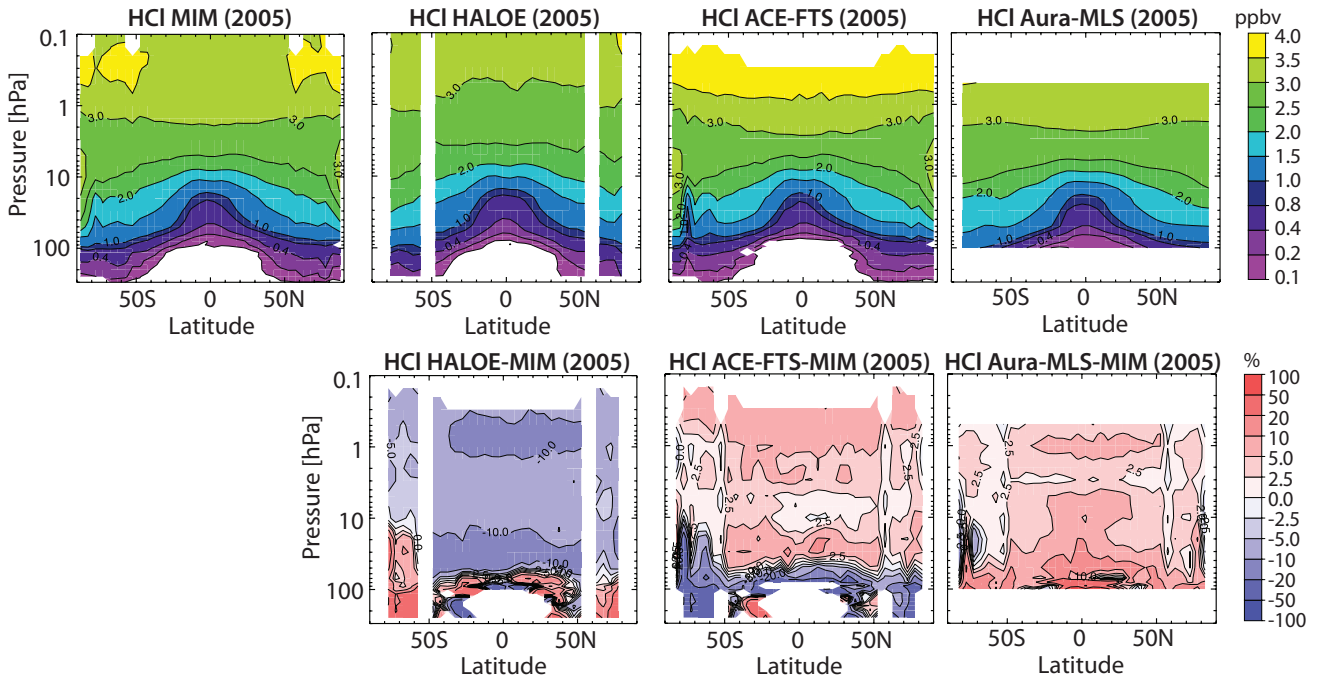


Figure A4.17.1: Cross sections of monthly zonal mean  $\text{NO}_y$  for 2005-2010. Monthly zonal mean  $\text{NO}_y$  cross sections for August 2005-2010 are shown for the MIM in the upper panel and for ACE-FTS<sub>6</sub>, MIPAS<sub>6</sub>, Odin<sub>5</sub> and MIPAS<sub>5</sub> in the lower panels. Note that MIPAS<sub>5</sub> is not included in the MIM.

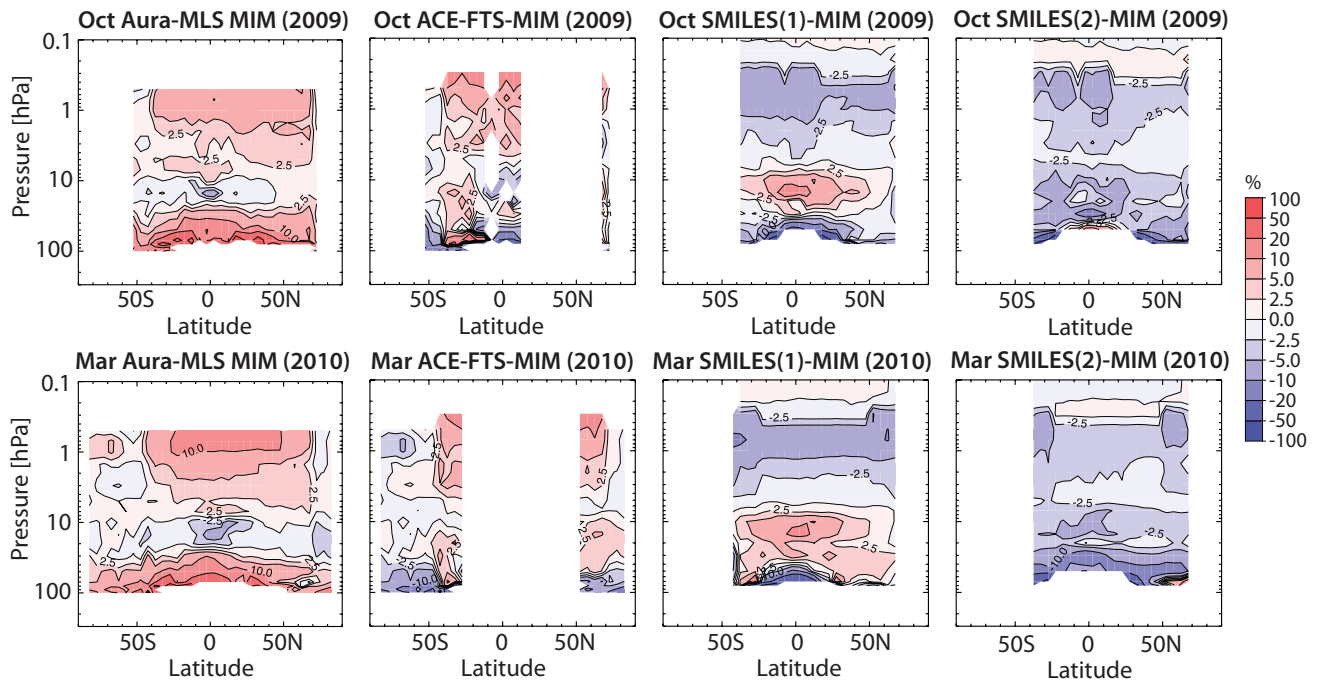


**Figure A4.17.2:** Cross sections of monthly zonal mean  $NO_y$  differences for 2005-2010. Monthly zonal mean  $NO_y$  differences for August 2005-2010 between the individual instruments and the MIM are shown.

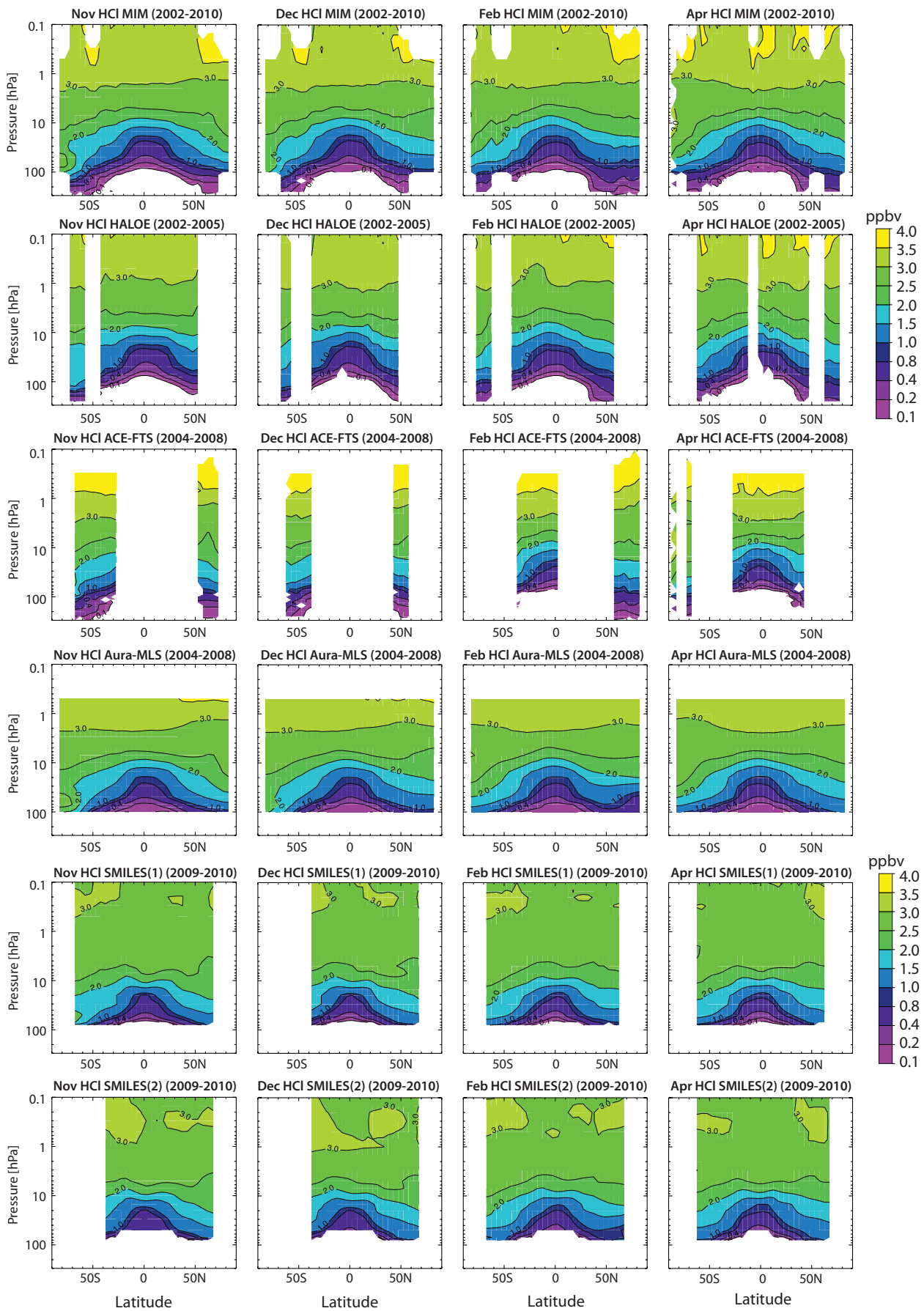
**A4.18 Hydrogen chloride – HCl**



**Figure A4.18.1:** Annual zonal mean HCl and differences 2005 (MIM, HALOE, ACE-FTS, and Aura-MLS).



**Figure A4.18.2:** Monthly zonal mean HCl differences Oct 2009 and Mar 2010 (ACE-FTS, Aura-MLS, SMILES(1), and SMILES(2)).



**Figure A4.18.3a:** Monthly zonal mean HCl 2002-2010 (MIM, HALOE, ACE-FTS, Aura-MLS, SMILES(1), and SMILES(2)). Note, the various instruments are averaged over different time periods within 2002-2010.



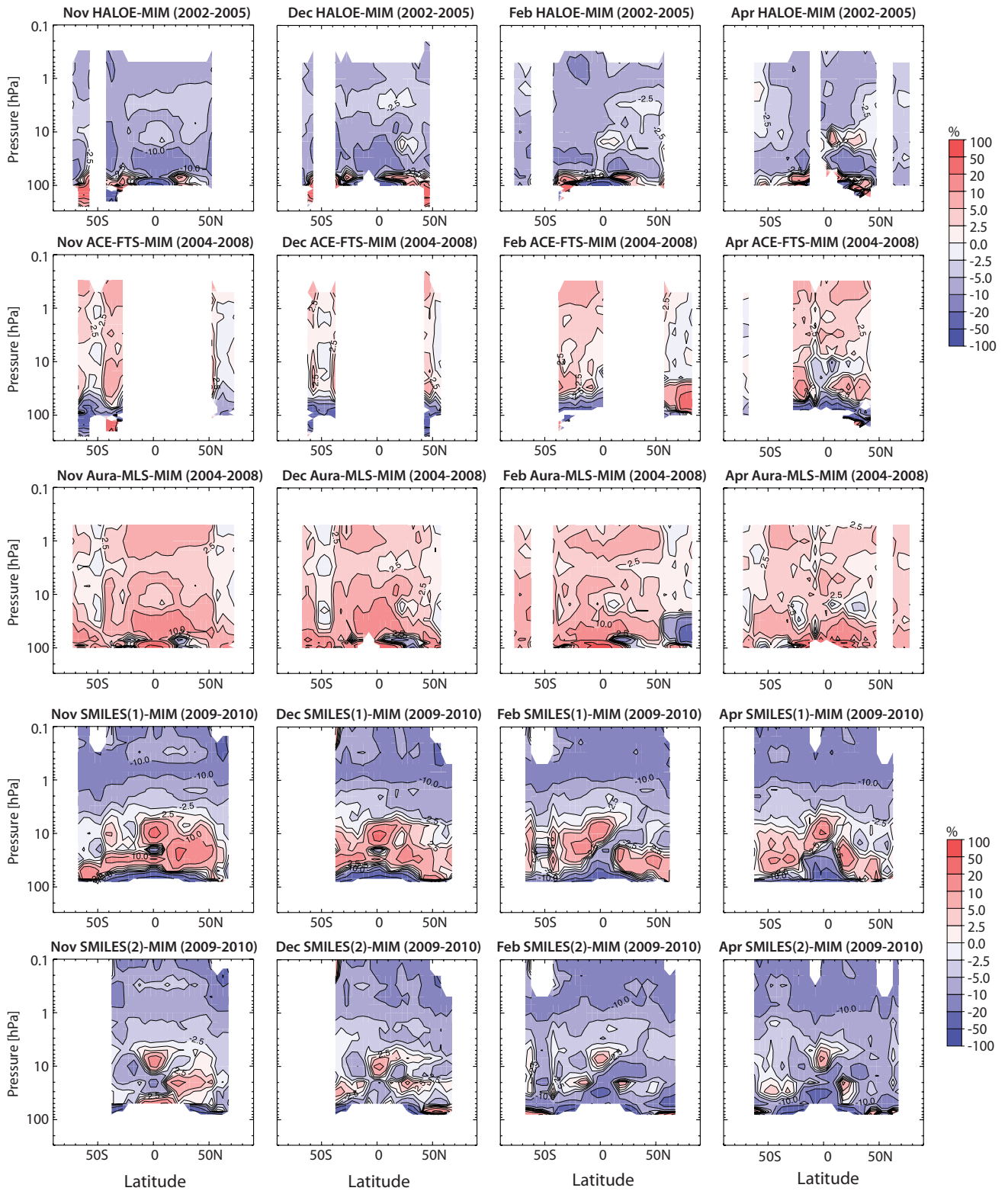


Figure A4.18.3b: Monthly zonal mean HCl differences 2002-2008 (HALOE, ACE-FTS, Aura-MLS, SMILES(1), and SMILES(2)).

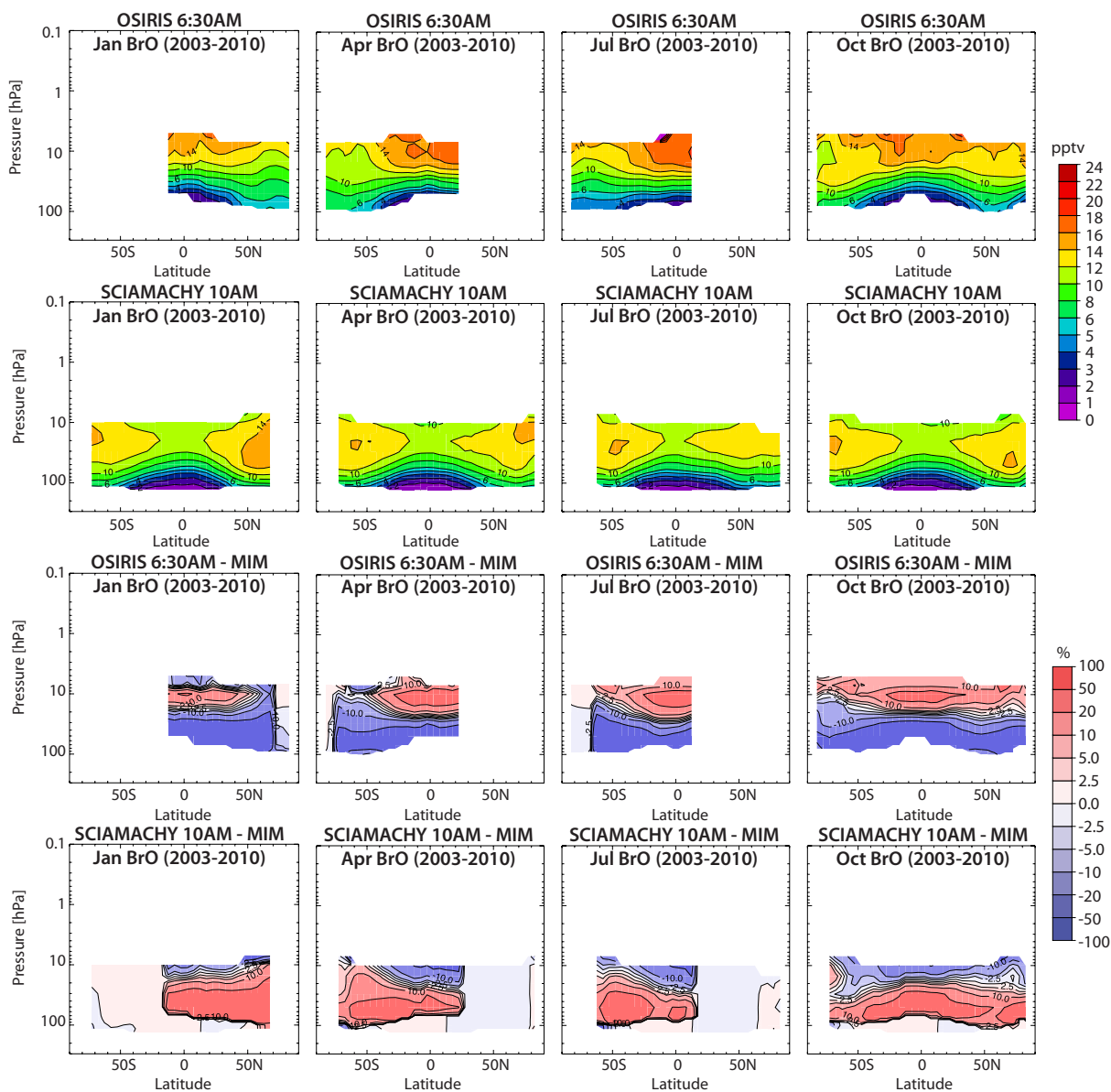
**A4.19 Chlorine oxide – ClO**

No Appendix for this section.

**A4.20 Hypochlorous acid – HOCl**

No Appendix for this section.

**A4.21 Bromine oxide – BrO**



**Figure A4.21.1: Monthly zonal mean BrO (unscaled) and differences 2003-2010 (OSIRIS and SCIAMACHY). The MIM is taken from Figure 4.21.3a in Section 4.21.**

**A4.22 Hydroxyl radical – OH**

*No Appendix for this section.*

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**A4.23 Hydroperoxy radical – HO<sub>2</sub>**

*No Appendix for this section.*

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**A4.24 Formaldehyde – CH<sub>2</sub>O**

*No Appendix for this section.*

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**A4.25 Acetonitrile - CH<sub>3</sub>CN**

*No Appendix for this section.*

A4.26 Aerosols

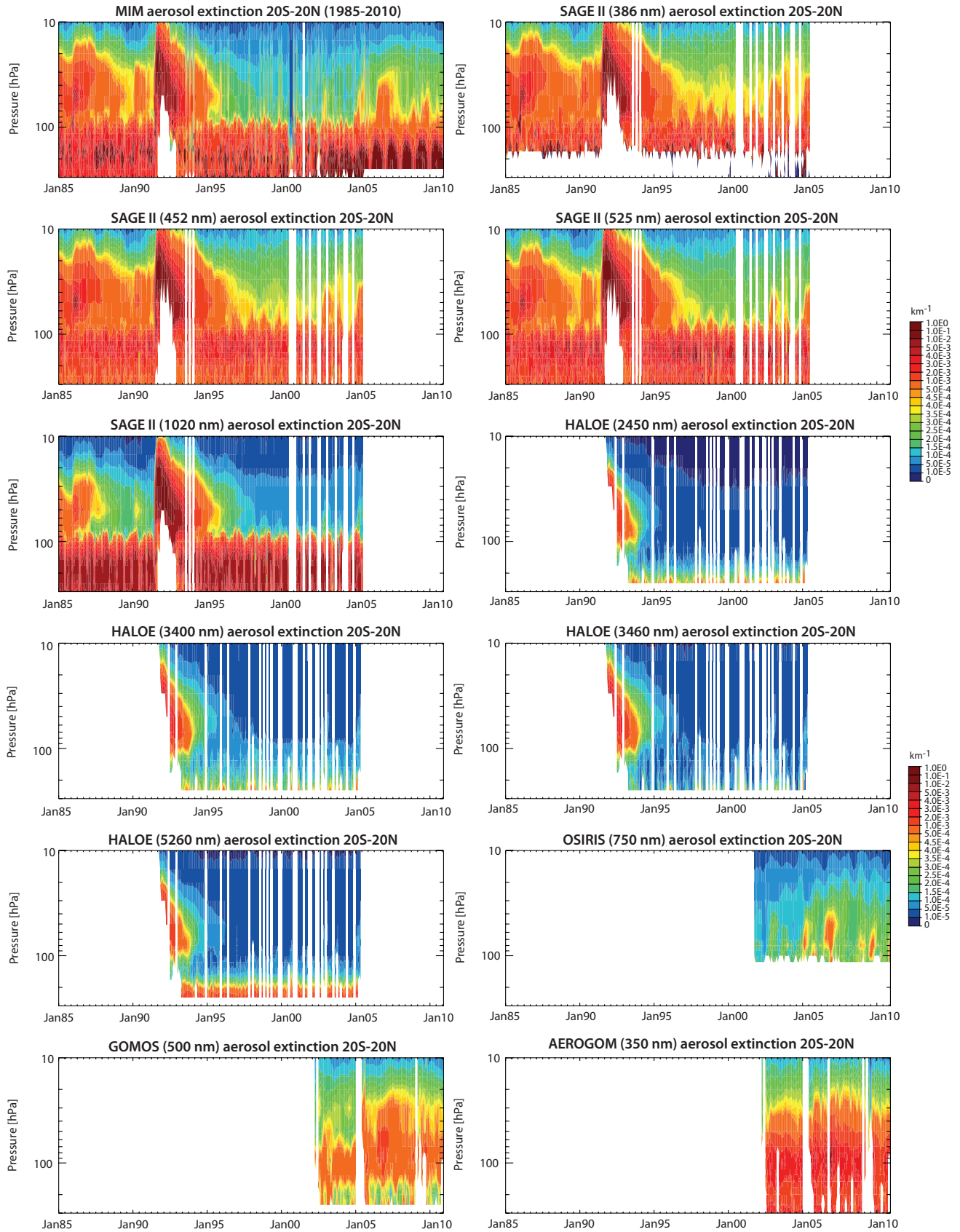


Figure A4.26.1: Time-altitude evolution of aerosol 1985-2010 (for 20S-20N; MIM and all available wavelength products of each instrument).

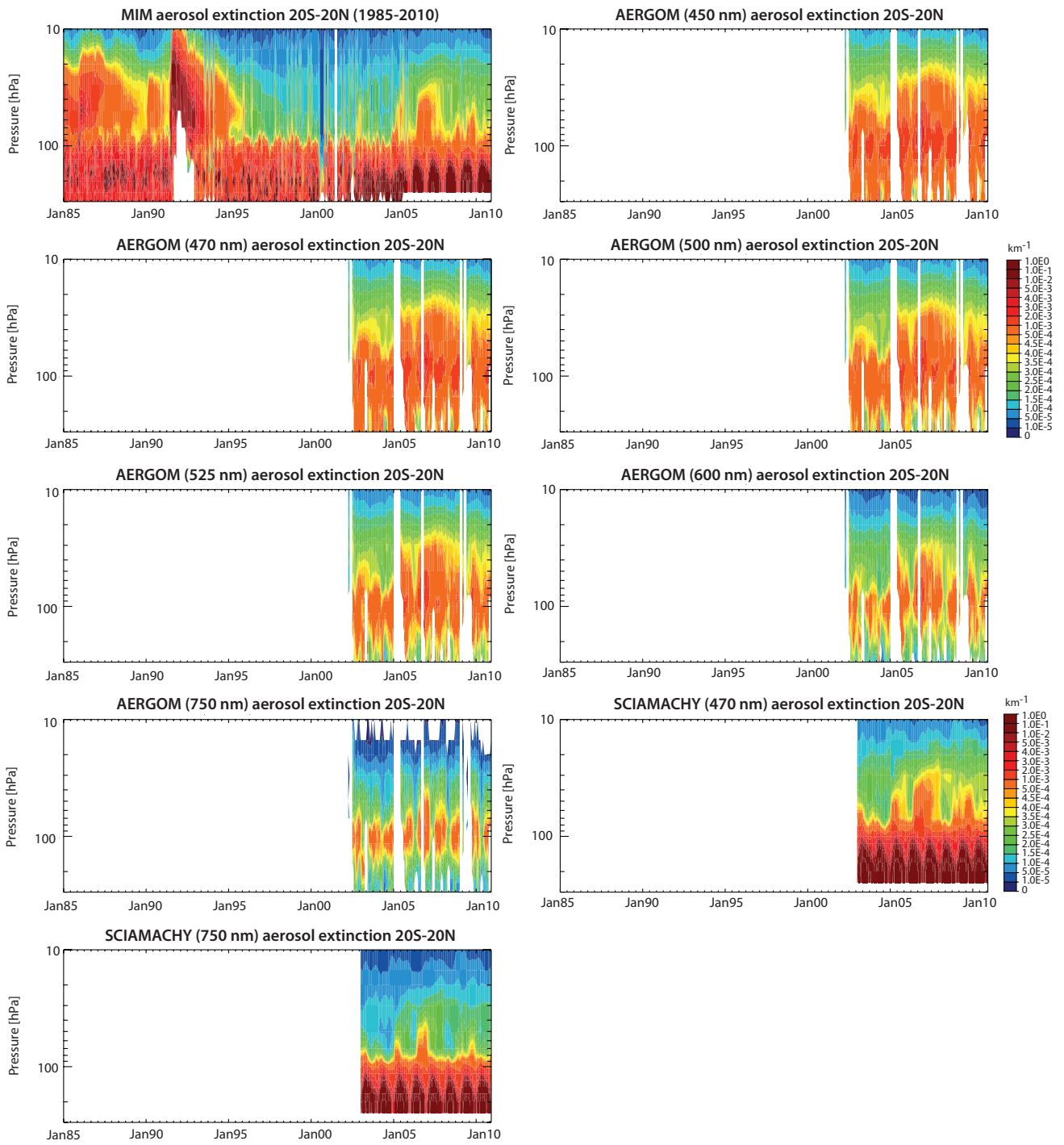
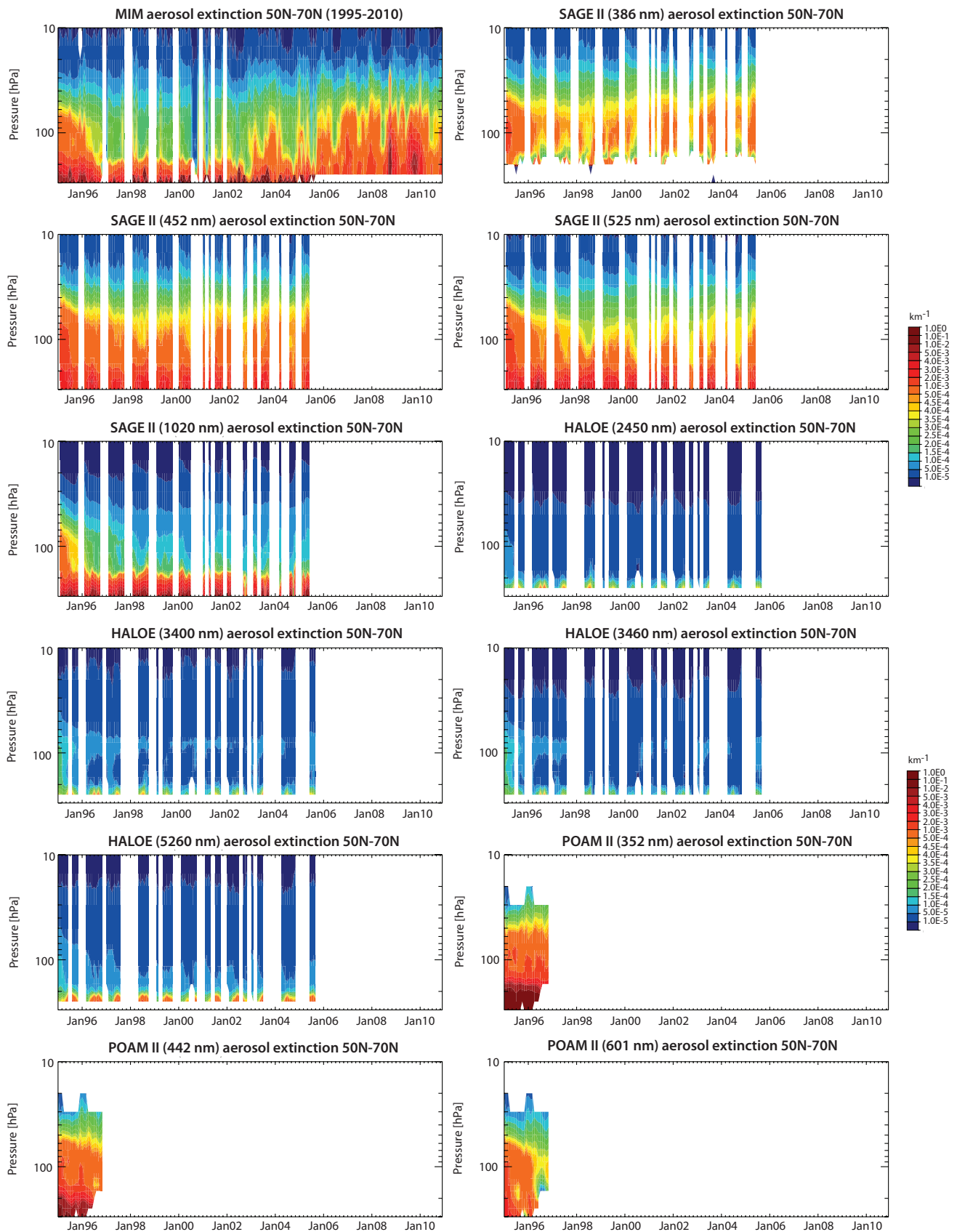


Figure A4.26.1 continued.



**Figure A4.26.2:** Time-altitude evolution of aerosol 1985-2010 (for 50N-70N; MIM and all available wavelength products of each instrument).

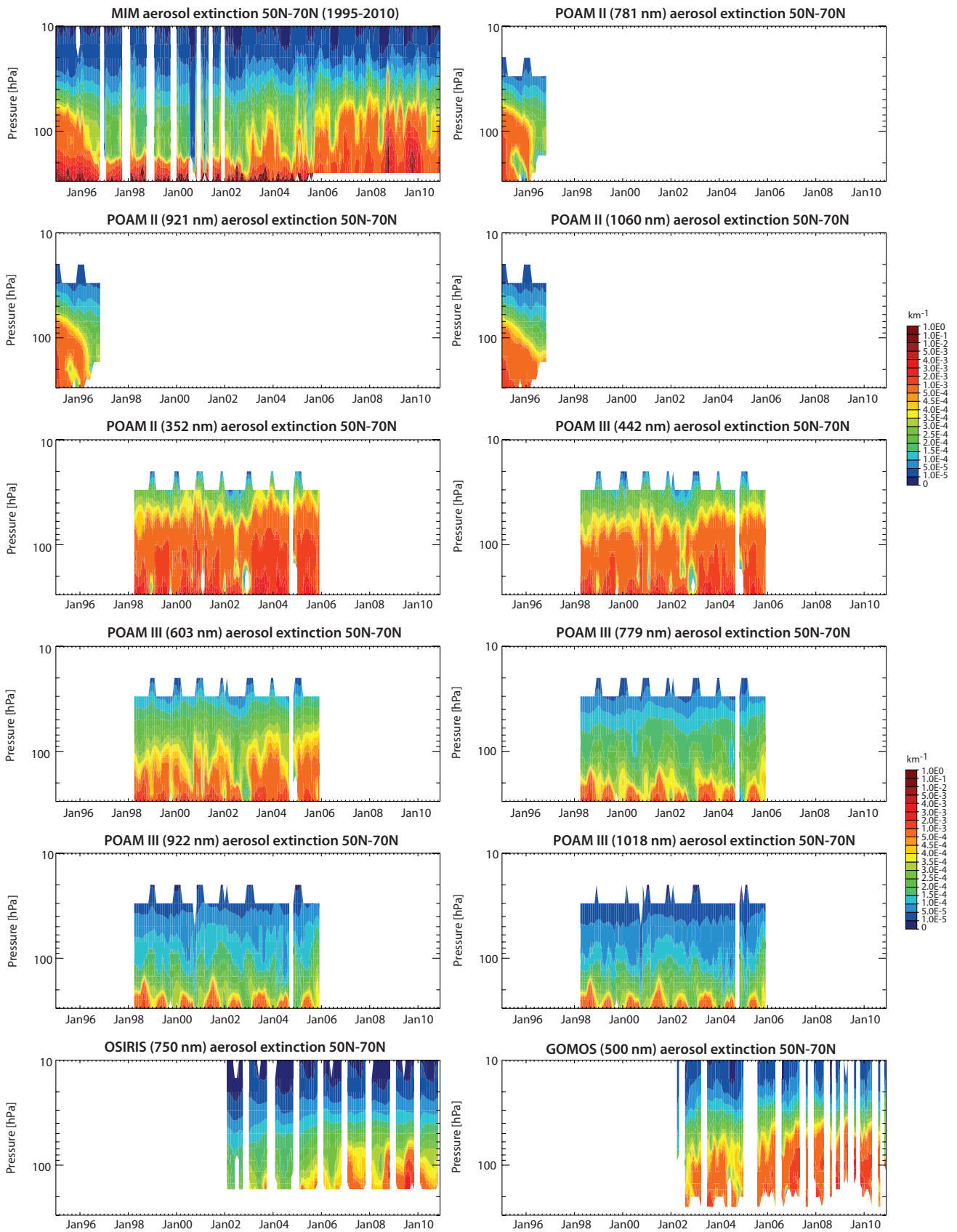


Figure A4.26.2 continued.

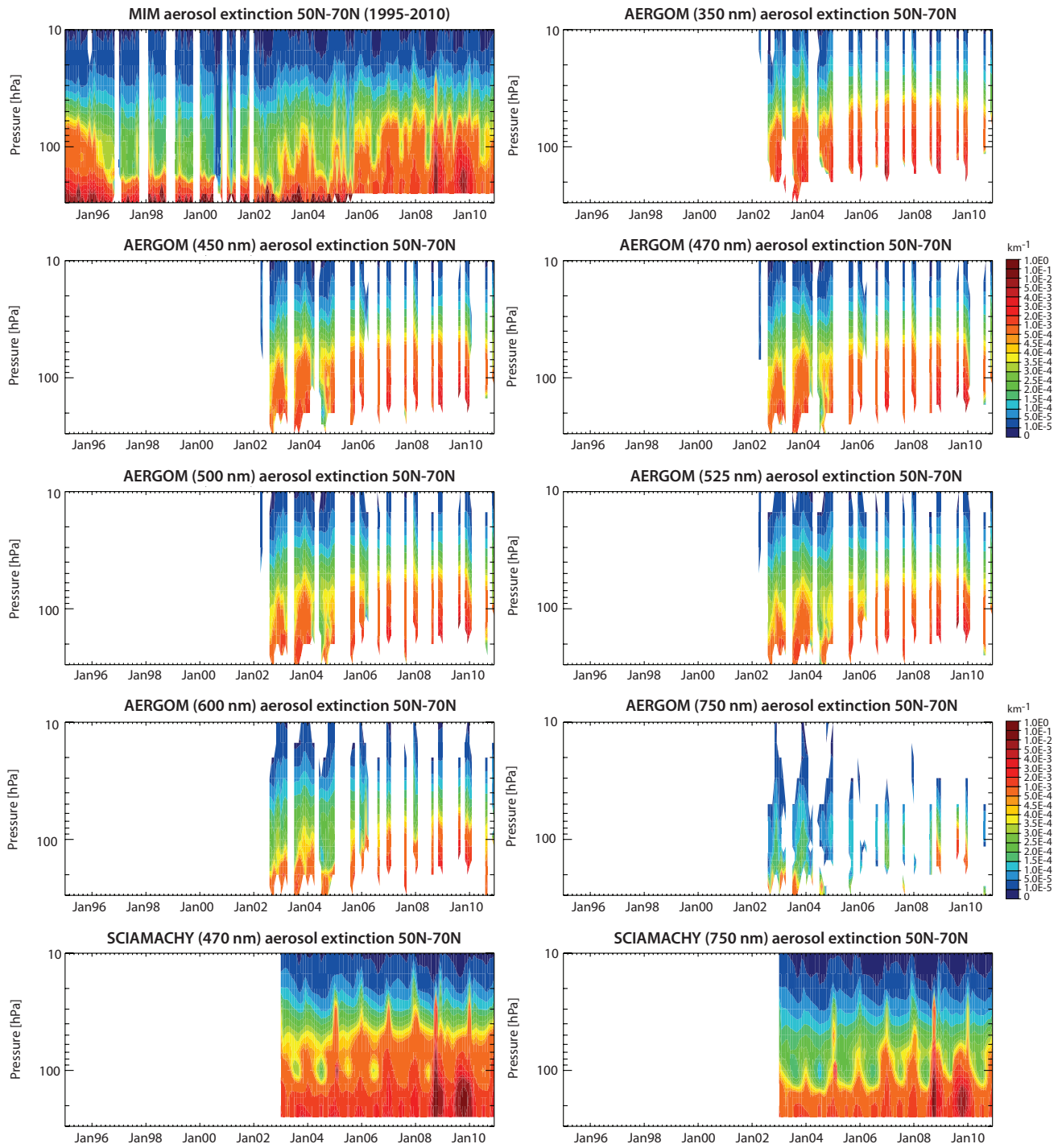
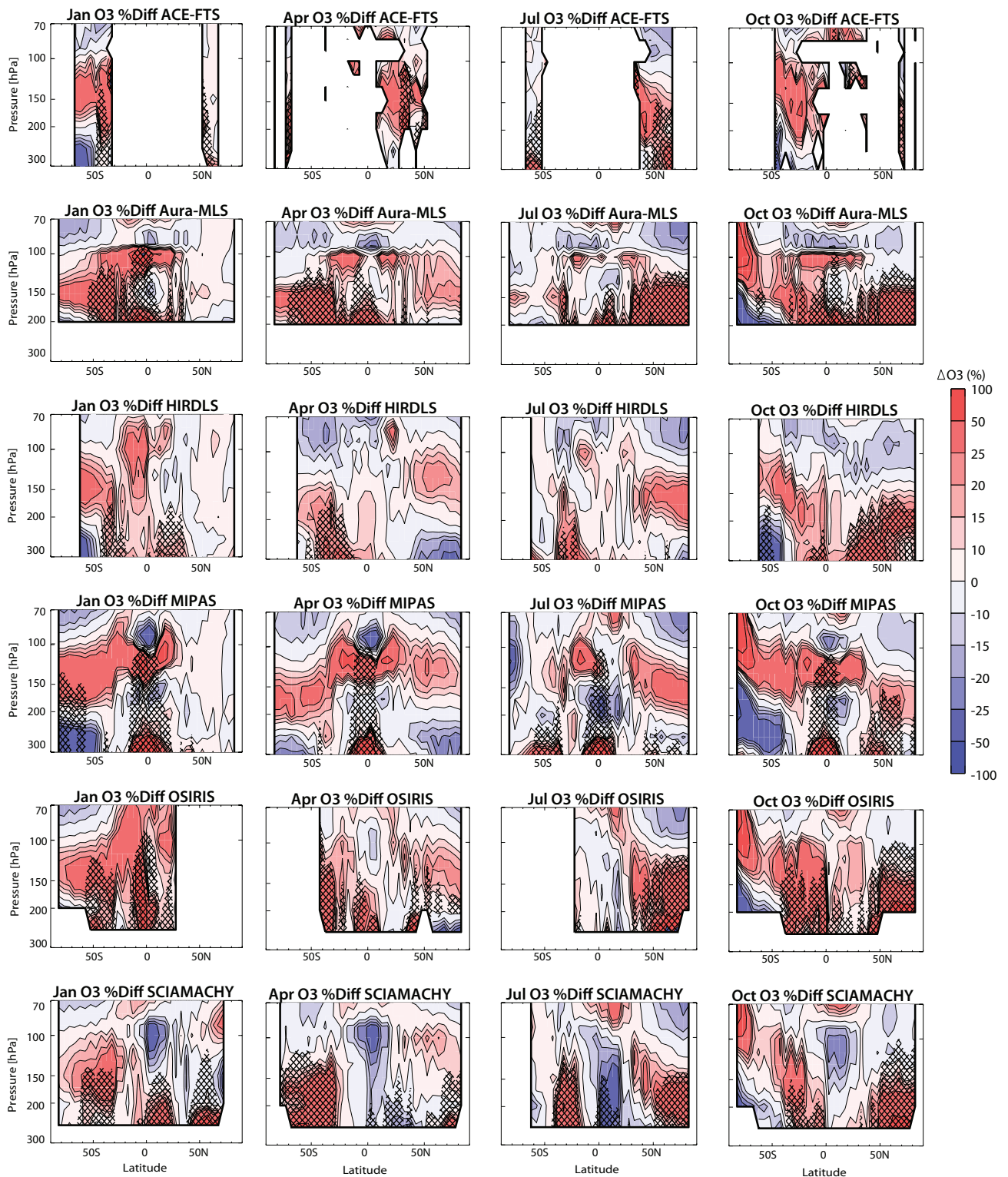


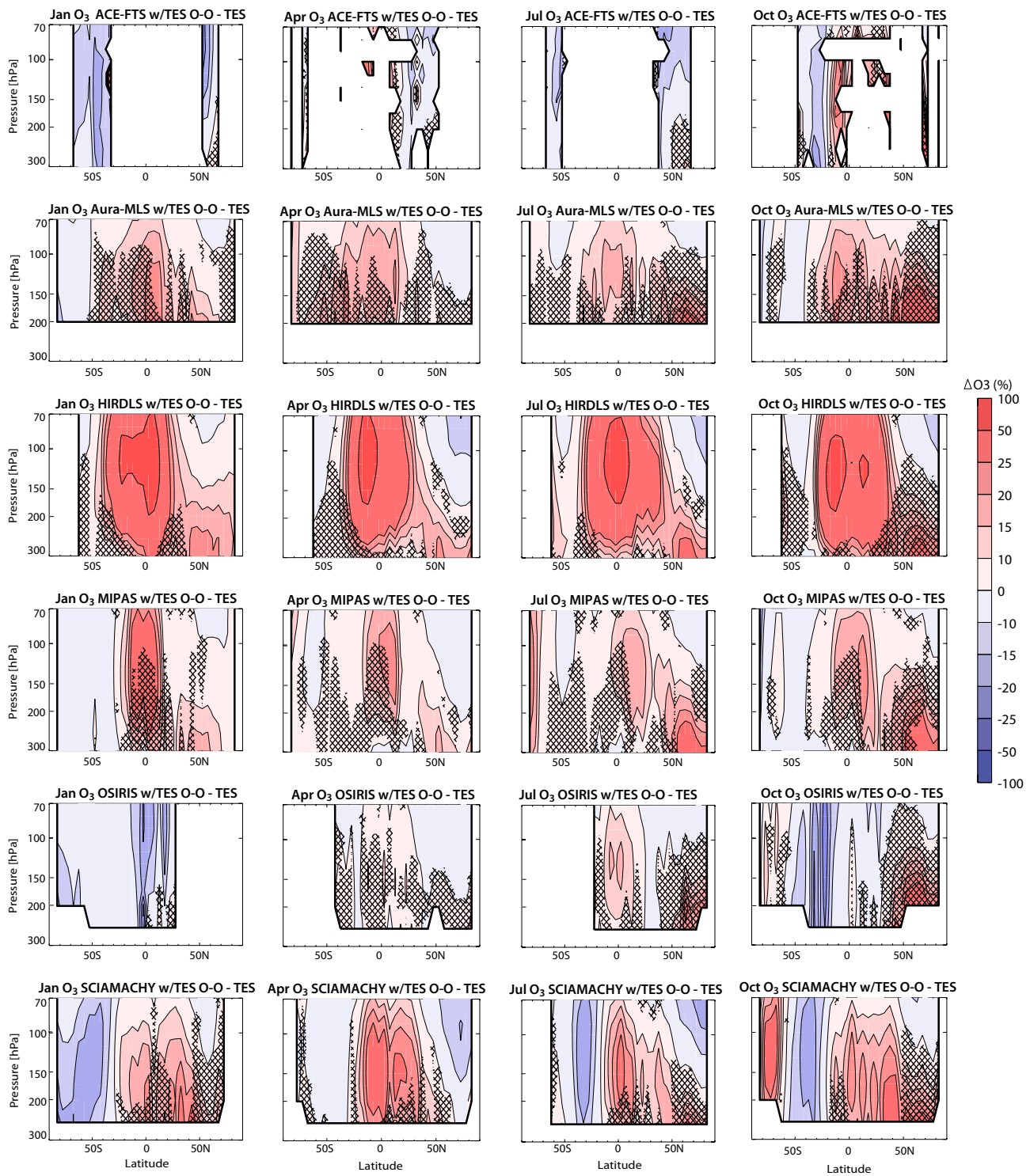
Figure A4.26.2 continued.



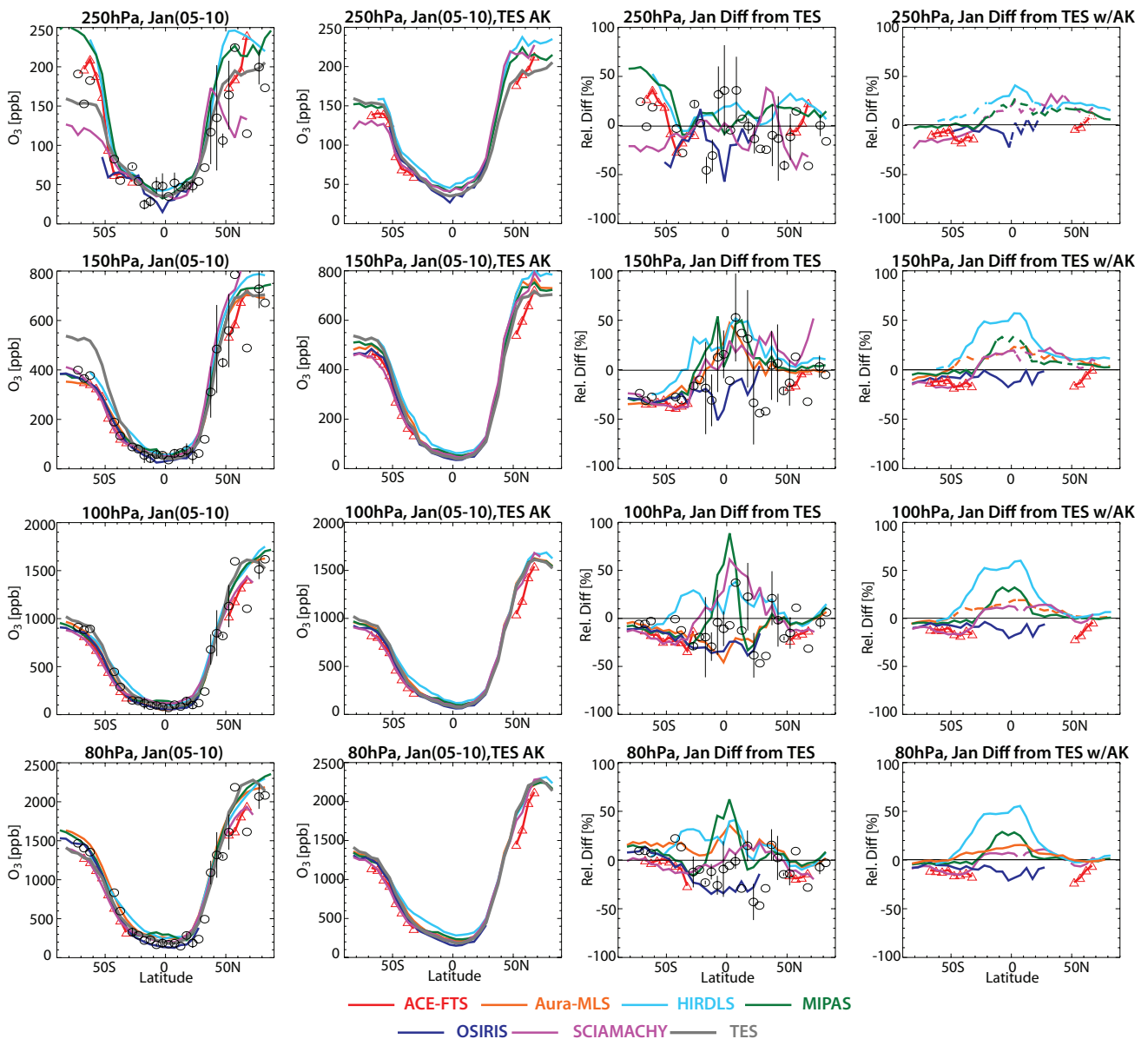
## A4.27 UTLS ozone evaluations based on TES averaging kernels



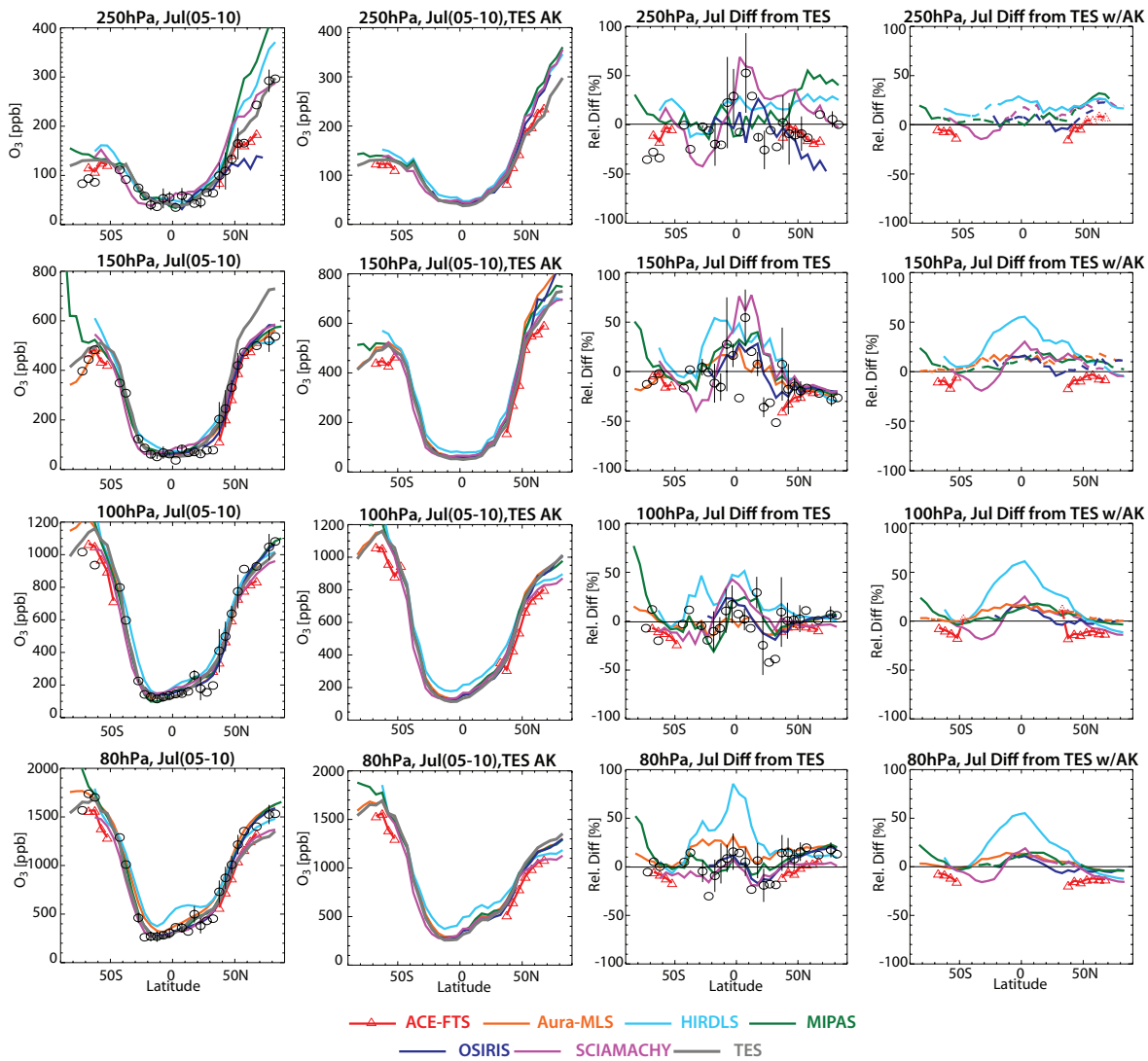
**Figure A4.27.1:** Percent change in zonal mean ozone introduced by the TES observational operator. (January, April, July, October). Hatched regions indicate where the difference between the virtual retrievals using the TES a priori as the fill profile and those using the scaled a priori as the fill profile exceeds 10%.



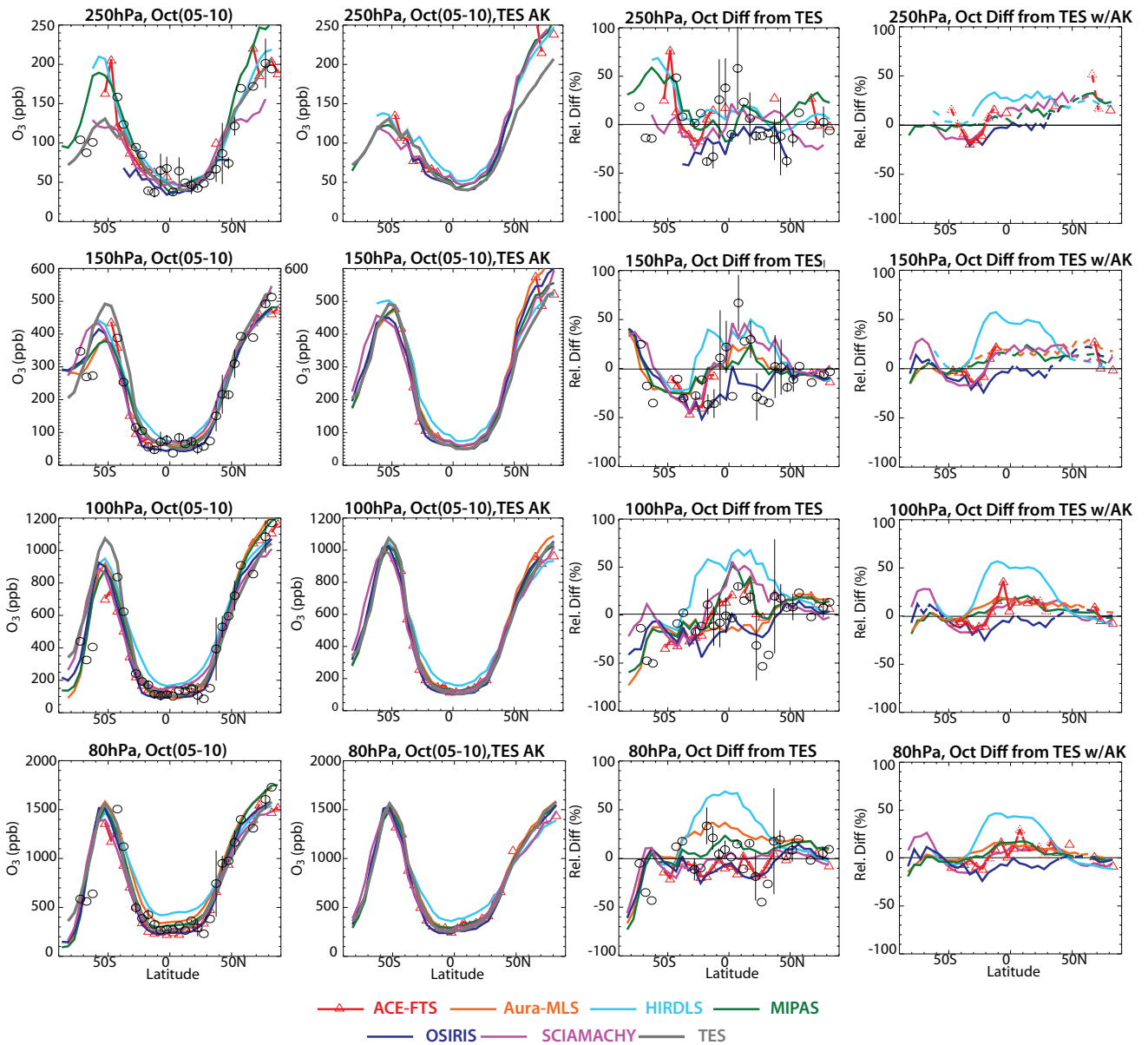
**Figure A4.27.2:** Zonal mean ozone percent differences between virtual retrievals and TES. (January, April, July, and October). Hatched regions indicate where the difference in the virtual retrieval using the two different fill profiles exceeds 50% of the difference between the virtual retrieval and TES.



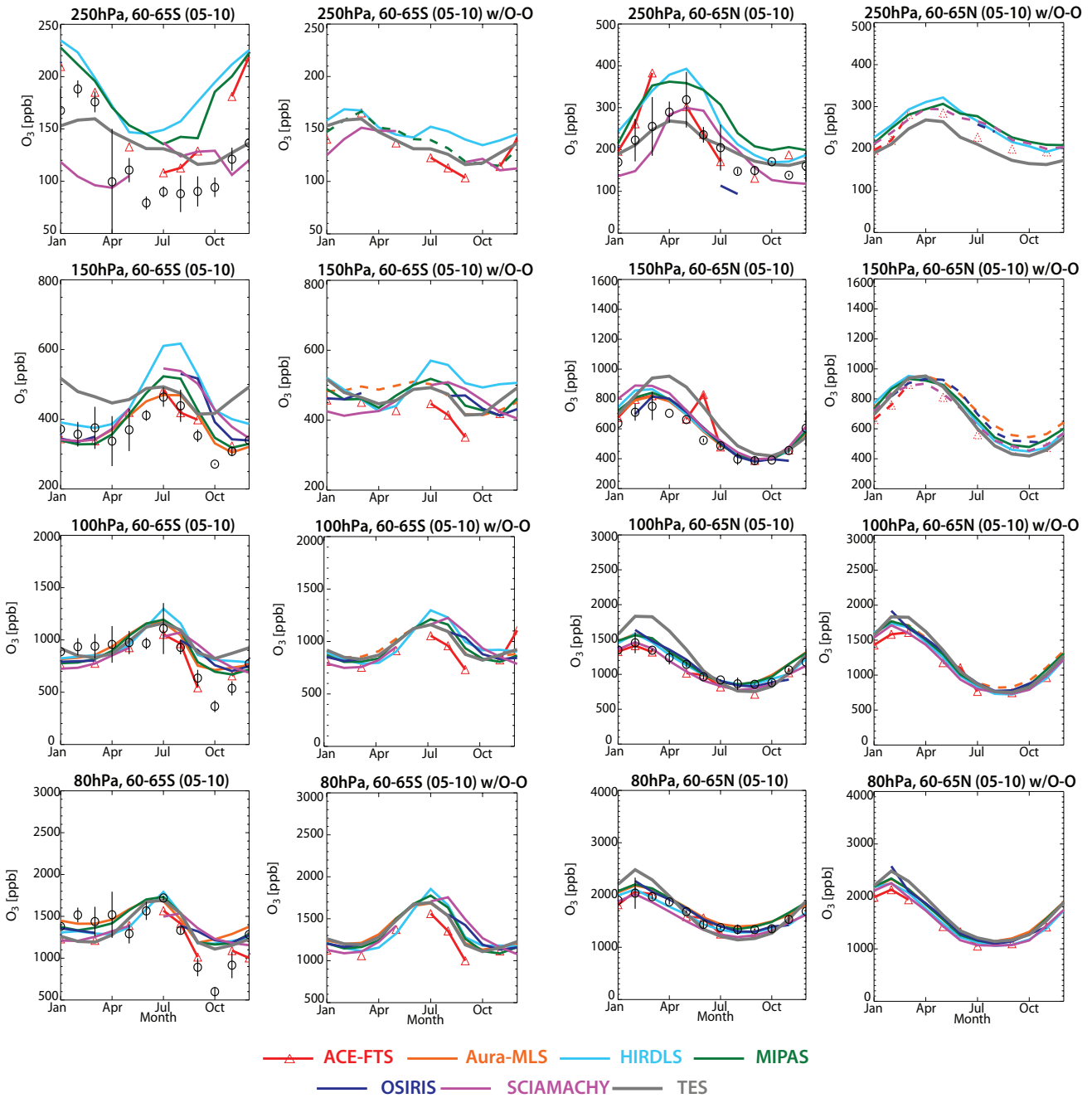
**Figure A4.27.3:** Meridional profiles of monthly mean zonal mean ozone for January 2005-2010. First column: Original climatologies (250 hPa, 150 hPa, 100 hPa, 80 hPa). Black circles: ozonesonde climatology; vertical bars: standard deviation for latitude bands with more than one station. Second column: Virtual TES retrievals. Third column: Percent difference between original climatologies and TES. Black circles and vertical bars as above. Fourth column: Same as third column, but for virtual TES retrievals. Dashed lines: difference in the virtual retrieval using the two different fill profiles exceeds 50% of the difference between the virtual retrieval and TES.



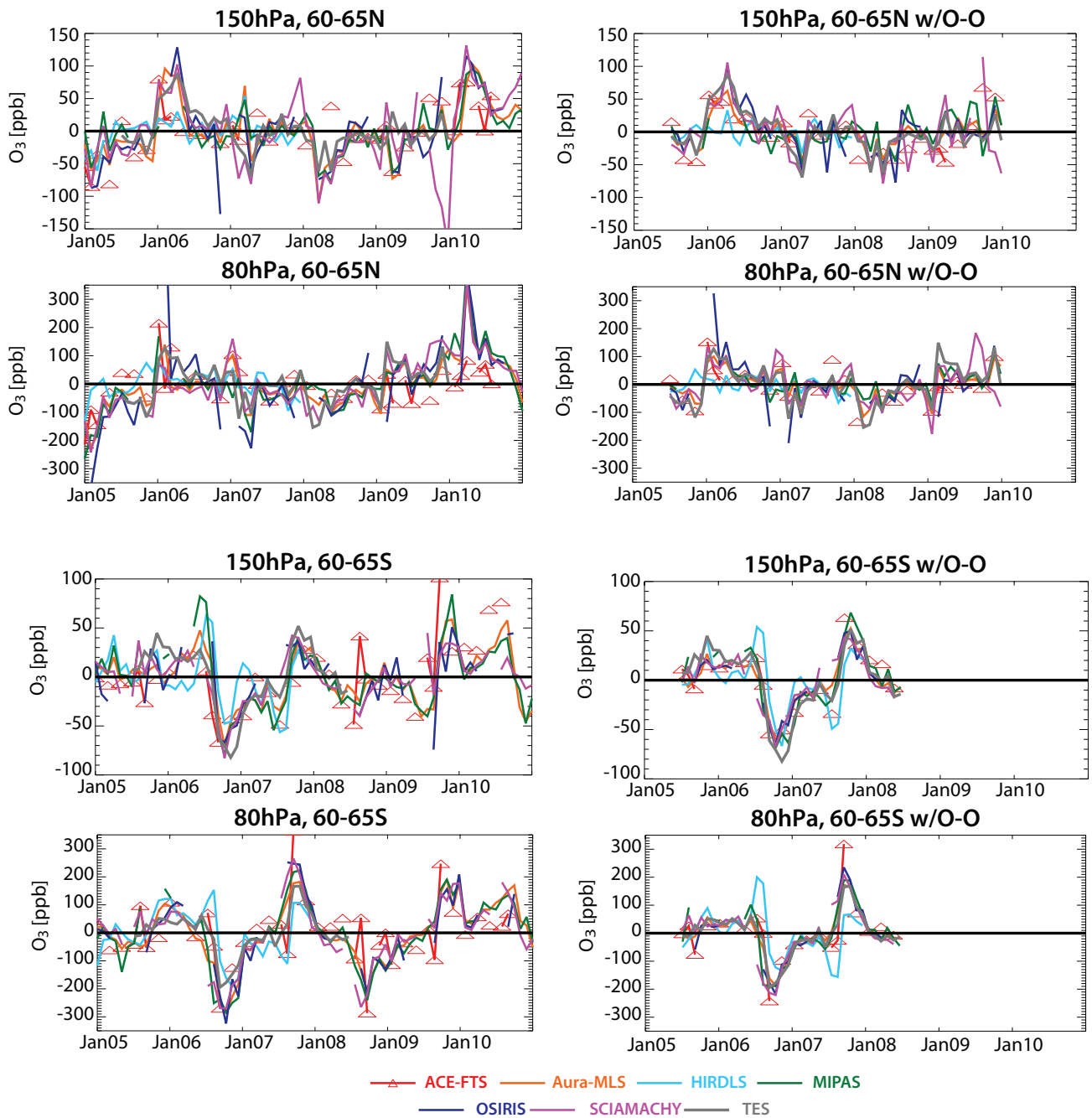
**Figure A4.27.4:** Meridional profiles of monthly mean zonal mean ozone for July 2005-2010. Same as Figure A4.27.3 but for July.



**Figure A4.27.5:** Meridional profiles of monthly mean zonal mean ozone for October 2005-2010. Same as Figure A4.27.3 but for October.



**Figure A4.27.6:** Seasonal cycle of high latitude ozone in the UTLS for 2005-2010. Left two columns: 60-65S; right two columns: 60-65N (250 hPa, 150 hPa, 100 hPa, 80 hPa). Left column in each grouping: original climatologies; right: virtual retrievals. Dashed lines: difference in the virtual retrieval using the two different fill profiles exceeds 50% of the difference between the virtual retrieval and TES in the annual mean. Black circles: ozonesonde climatology; vertical bars: standard deviation for latitude bands with more than one station.



**Figure A4.27.7:** Interannual variability of high latitude ozone in the UTLS for 2005-2010. Deseasonalized ozone anomalies (150 hPa, 80 hPa) for 60-65N (top 4 panels) and 60-65S (bottom 4 panels). Left column: original climatologies; right column: virtual retrievals. Dashed lines: portions of the virtual retrieval where the difference in the virtual retrieval using the two different fill profiles exceeds 50% of the difference between the virtual retrieval and TES in the annual mean.





