Addendum to "Extension of the Reference atmospheres and Vibrational Temperatures": The IG2 Climatology

Support to MIPAS Level 2 product validation (MIPAS_L2).

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Abstract

We report here on the description of the extension above 80 km of the abundances (vmr) of the IG2 climatology (SLIMCAT) (4 months $\times$ 6 latitudes bands $\times$ 2 diurnal conditions (day/night)) and on the vibrational temperatures calculated for this climatology.

1 Introduction

In this addenda we report on the description of the extension above 80 km of the abundances (vmr) of the IG2 climatology (SLIMCAT) and on the vibrational temperatures calculated for this climatology.

2 The Extension of the Reference Atmospheres of the IG2 climatology (48 reference atmospheres)

We have extended (up to 200 km) and/or modified the IG2 reference atmospheres supplied by UL (output of SLIMCAT model with data up to about 80 km) for months January, April, July, and October; latitudes -75, -45, -10, +10, +45, and +75; and DAY and NIGHT.

The sources/corrections applied to the input reference atmospheres are listed in Table 1.

The extension from the uppermost model altitude (80 km) to 200 km was done by using a log-interpolation of arbitrary (but reasonable) values at 140 and 200 km.

The photodissociation coefficients, J's, were calculated in the IAA box model with TUV model (Madronich and Flocke, 1998), except for J_{NO} that was taken from the Minschwaner and Siskind (1993) parameterization. Calculated J's are written out in the *npar.DAT files (see below).

Model calculations (IAA box model, MSIS, Garcia & Solomon, NOEM) were performed for particular reference days (see Table 2) within the corresponding season (i.e. March-May for April) at 10 am/pm local time. These reference days were chosen such that SZA at 10 am/pm reflects the average SZA of all MIPAS observations in the corresponding latitudinal and seasonal band at day (SZA$<$90) and night (SZA$>$90) conditions. The mean SZA's for daytime conditions, which have been used for calculating the vibrational temperatures (see next section), are also listed in Table 2.

For each of the 48 reference atmospheres we supplied 3 different files:

1. `<month><lat><day/ngt>_PT.DAT` includes pressure and temperatures profiles. Below 70 km they have been taken from the IG database version V4 (Remedios et al., 2006) and MSIS above that altitude.

2. `<month><lat><day/ngt>.DAT` includes the vmr profiles for the following gases: H_2O, CO_2, O_3, N_2O, CO, CH_4, NO, NO_2, HNO_3, OH, ClO, HO_2, O, O(^1D), N, H, N_2, O_2, and HCN.

3. `<month><lat><day/ngt>_npar.DAT` includes NLTE-relevant parameters. In particular the photodissociation rates of O_2, J_{O2}, as requested by UL. This is the last entry in the files.

The files can be found at `http://www.iaa.es/~puertas/qwg/ig2.html`.

We have plotted the vmr of all species for all conditions which can be found at the same web site in file `atm_figures.zip`. The species have been grouped in two sets, set 1: (H_2O, O_3, N_2O, CO, CH_4 and CO_2); and set 2: (NO, NO_2, HNO_3, OH, O, O(^1D), N and H). There are 4 files for the 2 sets of species and day/night (`atm_<s1/s2>_<day>/<ngt>.pdf`).

The compiled vmrs have been compared against the original SLIMCAT vmr profiles. For these figures the species have been grouped in three sets: set 1: (H_2O, N_2O, CO, CH_4); set 2: (O_3, O

Table 1: Summary of the changes introduced in the IG2 reference atmospheres.

Gas	Data source
N_2	MSIS (up to 200 km)
O_2	MSIS (up to 200 km)
CO_2	IG database (V4) below 50 km. WACCM between 50 to 140 km. Extrapolated above up to vmr=2 ppmv at 200 km.
H_2O	SLIMCAT below 65 km. Garcia & Solomon above up to 110 km. Extrapolated above to vmr=10^{-4} ppmv at 200 km.
CO	SLIMCAT below 35 km. Garcia & Solomon above up to 110 km. Extrapolated above to vmr=1 ppmv at 200 km.
HCN	IG database (V4) up to 120 km. Extrapolated above to vmr=4.5×10^{-5} ppmv at 200 km.
OH	Garcia & Solomon up to 90 km. In photochemical equilibrium with H above 110 km (using IAA box model).
H	Garcia & Solomon up to 90 km. MSIS above up to 200 km. Low cut-off of 10^{-14} ppmv. Smoothing applied†.
HO_2	SLIMCAT below 75 km. Extrapolated above with vmr=10^{-6}, 10^{-9}, and 10^{-10} at 100, 140 and 200 km. Smoothing applied†.
O_3	SLIMCAT below 60 km. Garcia & Solomon above (up to 110 km) with diurnal correction for MIPAS am and pm times (IAA box model) between 67-82 km. Extrapolated above with vmr=10^{-6} and 10^{-8} at 140 and 200 km. Smoothing applied† above 75 km.
O	IAA box model below 80 km (consistent with O_3). MSIS above up to 200 km. Low cut-off of 10^{-15} ppmv. Smoothing applied†.
O(^1D)	IAA box model.
NO_2‡	SLIMCAT below 20 km. Garcia & Solomon above up to 110 km, diurnal correction applied taken the NOx from Garcia & Solomon and NO_2/NO partitioning from the IAA box model. Above 110 km calculated with IAA box model. Smoothing applied† below 30 km and above 75 km.
NO‡	IAA box model (consistent with NO_2 as explained above) below 85 km. NOEM model above up to 200 km. Low cut-off of 10^{-8} ppmv and smoothing applied† for computational stability in T_v's.
N	IAA box model (consistent with NO) below 85 km, MSIS above (up to 200 km)
HNO_3	SLIMCAT up to 75 km. Extrapolated above with vmr=10^{-9}, 10^{-12}, and 10^{-15} at 100, 140 and 200 km. Smoothing applied† above 45 km.
ClO	SLIMCAT up to 75 km. Extrapolated above with vmr=10^{-7}, 10^{-14}, and 10^{-16} at 100, 140 and 200 km. Smoothing applied† at all altitudes.

† A log-smoothing with a vertical length of 5 km has been applied to remove unphysical oscillations in the original profiles.

‡ The NO_2 and NO from the SLIMCAT model were modified below 80 km in order to account for the NOx descent in the polar regions. Outside the polar regions the SLIMCAT model and the Garcia & Solomon and IAA box models give very similar values.

Table 2: Solar zenith angles and day of the year used in compilations of the species profiles. The SZA at daytime listed here were also used for the calculations of the T_v for the IG2 climatology.

		DAY		NIGHT	
Month	Latitude(°)	SZA (°)	Day	SZA (°)	Day
January	-75	58.7	20090126	94.2	20090228
January	-45	35.6	20090116	107.8	20090116
January	-10	31.4	20081218	135.2	20090101
January	10	44.8	20090101	148.5	20081220
January	45	72.2	20090116	144.4	20090116
January	75	85.8	20090228	122.0	20090123
April	-75	78.4	20090326	112.2	20090415
April	-45	60.1	20090416	134.8	20090410
April	-10	34.2	20090416	148.8	20090324
April	10	31.2	20090324	145.8	20090416
April	45	44.5	20090412	120.9	20090413
April	75	67.5	20090416	101.9	20090325
July	-75	85.3	20080831	121.0	20080729
July	-45	72.4	20090716	144.7	20090716
July	-10	44.8	20090702	148.7	20090618
July	10	31.5	20090620	135.2	20090702
July	45	35.3	20090716	107.6	20090716
July	75	58.1	20090725	94.7	20080831
October	-75	67.6	20081015	101.0	20080926
October	-45	44.6	20081011	119.8	20081016
October	-10	31.0	20080923	145.8	20081016
October	10	34.2	20081016	149.2	20080924
October	45	59.6	20081014	136.1	20081013
October	75	78.3	20080924	113.1	20081017

OH, O(^1D), and H); and set 3: (NO, NO_2, HNO_3, N, and O_3 which was also included for easy reference). There are 6 files for the 3 sets of species and day/night (`datm_<s1/s2/s3>_<day>/<ngt>.pdf`).

3 Vibrational temperatures for the IG2 climatology (48 ref. atm.)

Vibrational temperatures have been calculated for the 48 reference atmospheres, for the same species and vibrational levels than for the 5 reference atmospheres described in the `http://www.iaa.es/~puertas/qwg/5_atm/TN_IGext_VTs.pdf` technical note. The same non-LTE models have been applied here. For daytime, the vibrational temperatures were calculated for the corresponding SZA's listed in Table 2.

The vibrational temperatures are given at 1 km grid from 0 to 200 km and have been written in

the KOPRA format. The files can be found at
http://www.iaa.es/~puertas/qwg/ig2.html(vts.zip) and the figures of the vibrational temperatures for the different atmospheres, gases and vibrational levels are available in vt_figures.zip in the same web site. There is a folder of type <month><lat><day/ngt> for each of the 48 reference atmospheres. The files inside each folder are named as vt_mm.kop, where mm is the molecule (H_2O, CO_2, ...).

For the major features of the vibrational temperatures we refer to the
http://www.iaa.es/~puertas/qwg/5_atm/TN_IGext_VTs.pdf technical note.

The vibrational temperatures have been plotted for all species, vibrational levels, and for all conditions. The figures can be found at the same web site in file vt_figures.zip. There are 13 species $\times$ 2 (day/night) = 26 files (vt_<gas>_<day>/<ngt>.pdf). In each file are plotted the T_v's for all vibrational levels of the gas in question for the 4 months and 6 latitude bands.