Supplement of

The high-resolution version of TM5 for optimised satellite retrievals: Description and Validation

J. E. Williams *et al.*

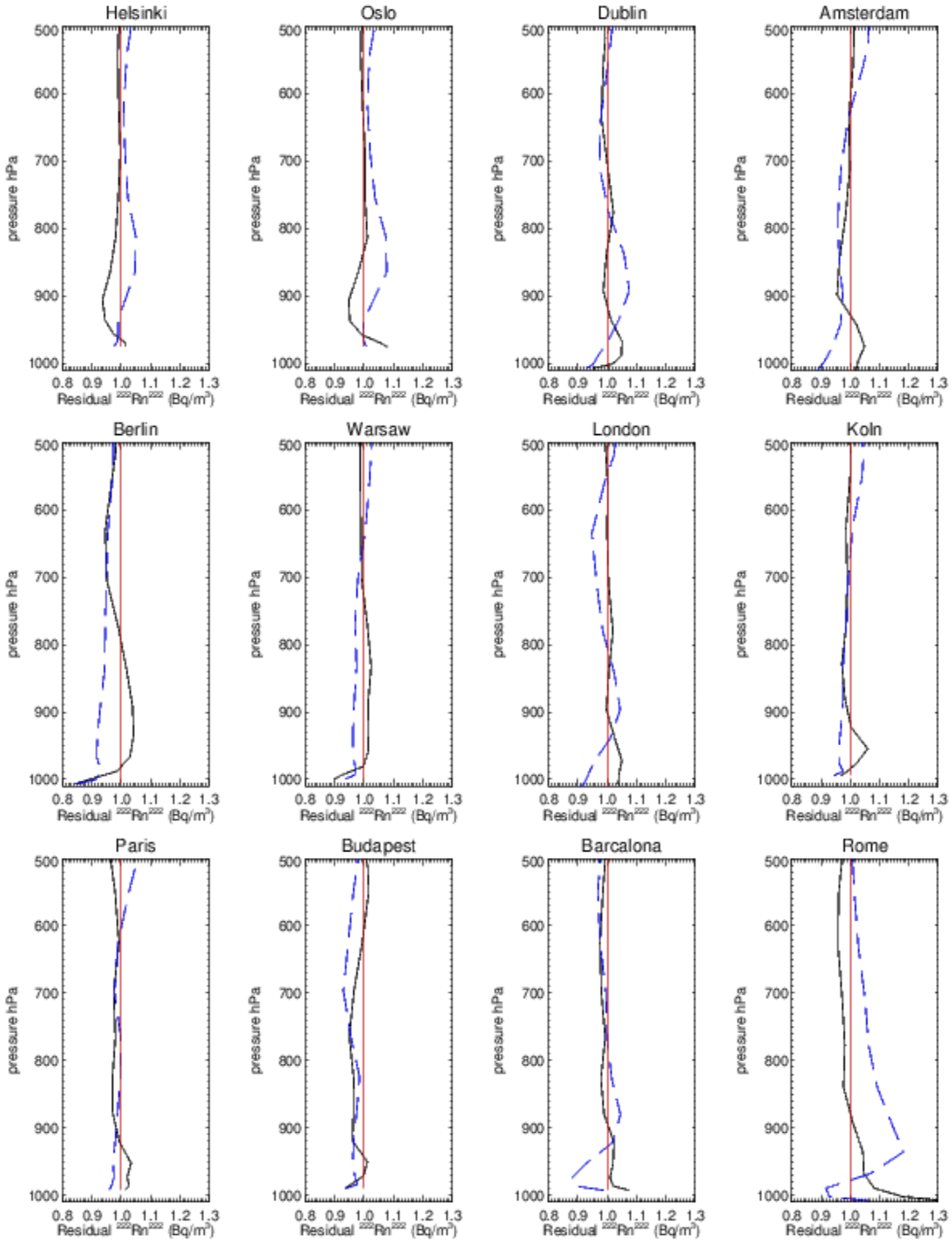

Figure S1: Differences in ratio of the vertical profiles of ^{222}Rn between 1º x1º /3º x 2º simulations above selected European cities for January (black) and July (Blue) during 2006. The red-line represents the ideal ratio of 1.0 throughout the column.

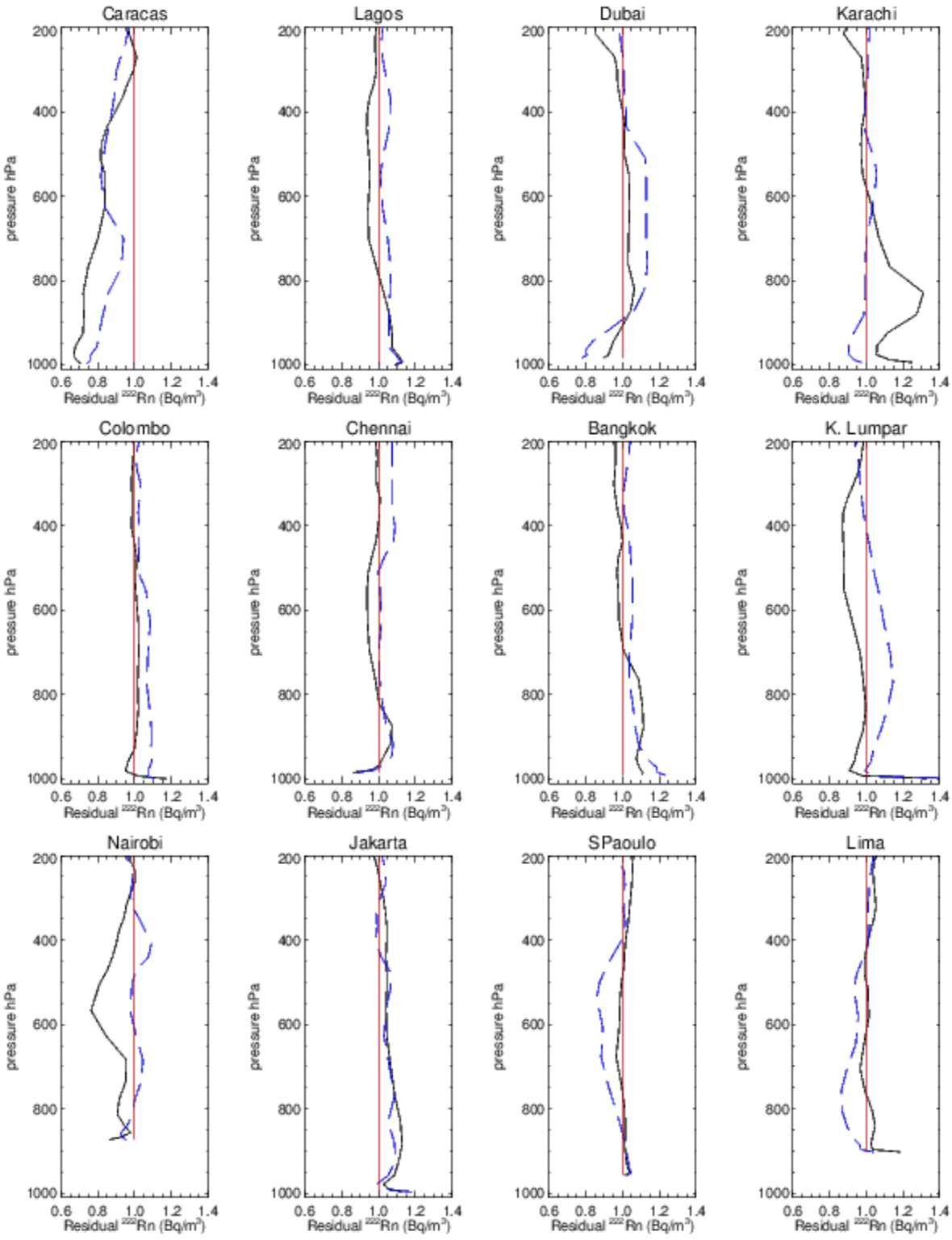

Figure S2: Differences in ratio of the vertical profiles of ^{222}Rn between 1º x1º /3º x 2º simulations above selected Tropical cities for January (black) and July (Blue) during 2006. The red-line represents the ideal ratio of 1.0 throughout the column.

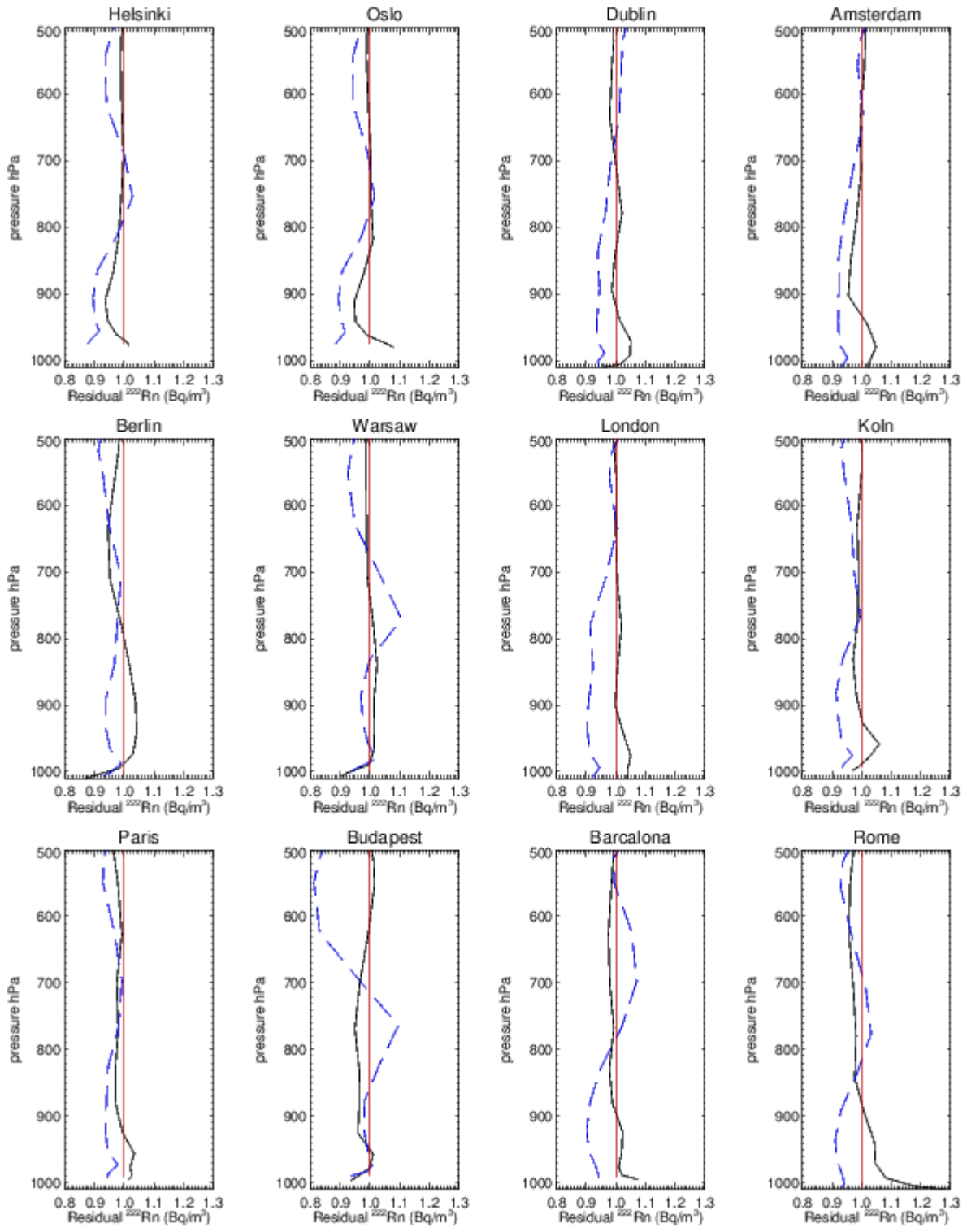

Figure S3: Differences in ratio of the vertical profiles of ^{222}Rn between 1º x1º /1º x 1º (Tiedke) simulations above selected European cities for January (black) and July (Blue) during 2006. The red-line represents the ideal ratio of 1.0 throughout the column.

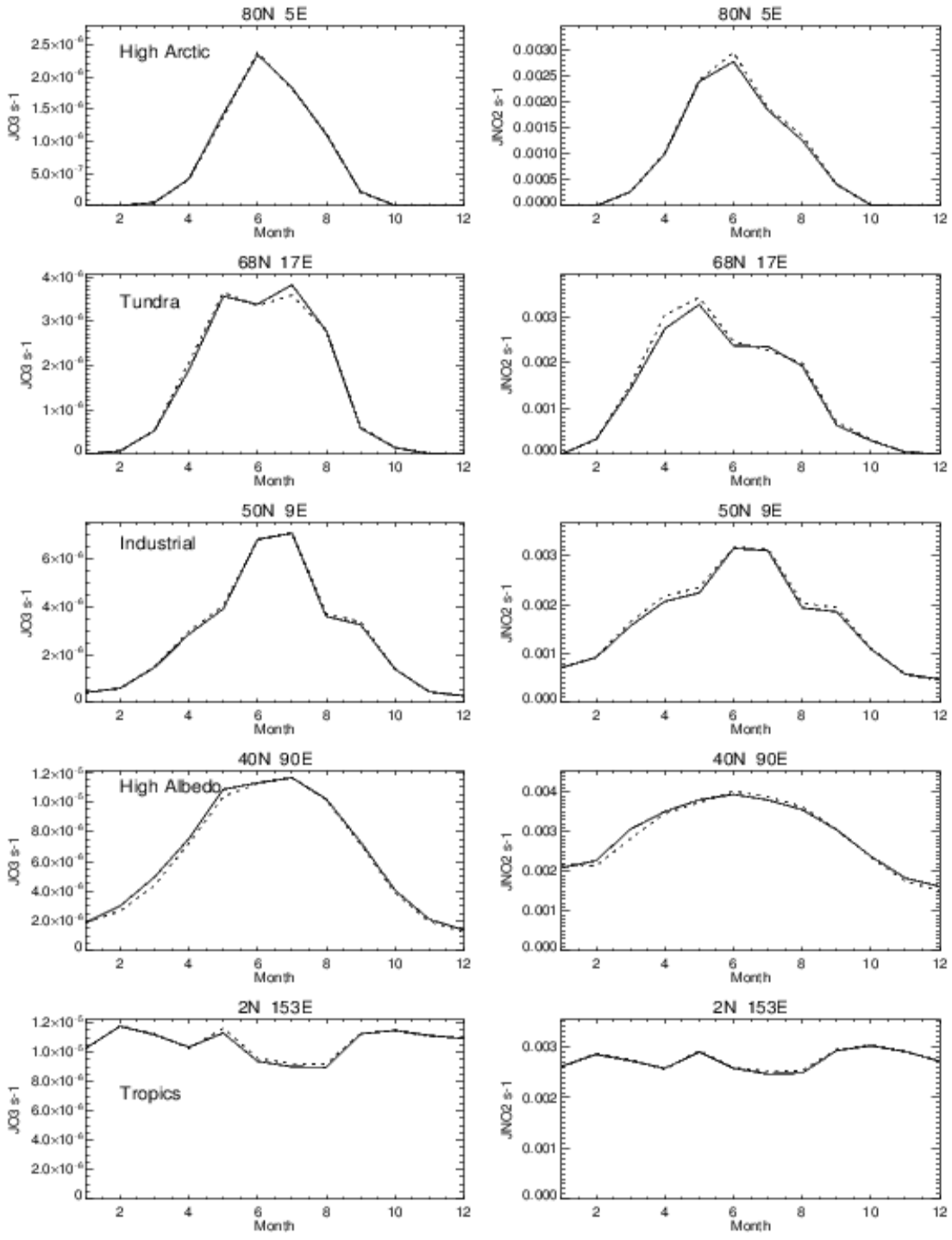

Figure S4: Monthly mean comparisons of JO3 (left) and JNO2 (right) at the surface between the 3º x 2º (solid line) and 1º x 1º (dashed line) simulations. The locations selected are identical to those shown in Williams et al. (2012), where the type of scenario is given in each panel to the left.

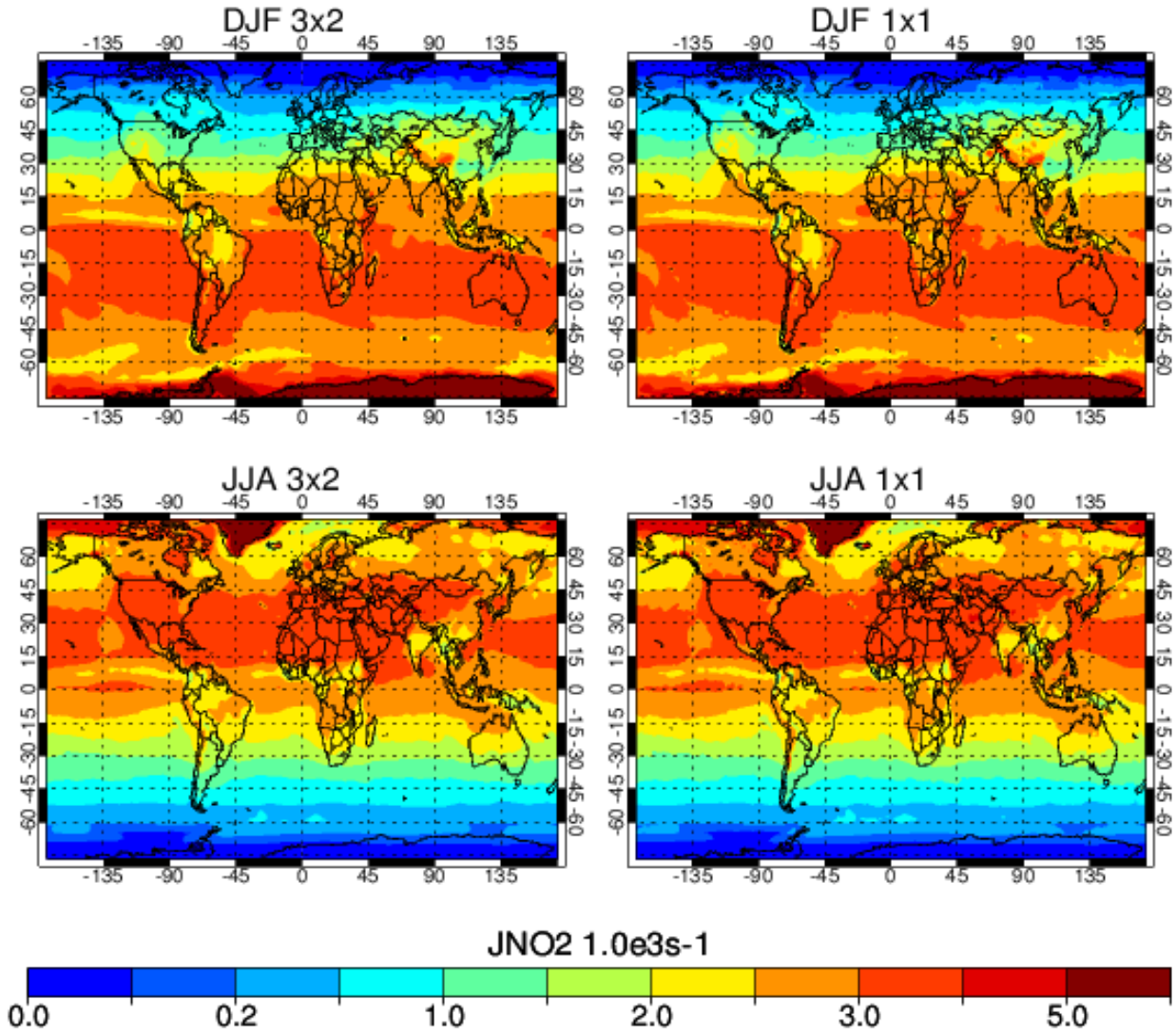

Figure S5: Comparisons of near-surface seasonal mean J_{NO2} values for (top) DJF and (bottom) JJA between the 3º x 2º (left) and 1º x 1º (right) simulations. The values shown are representative of the lowest km of the troposphere.

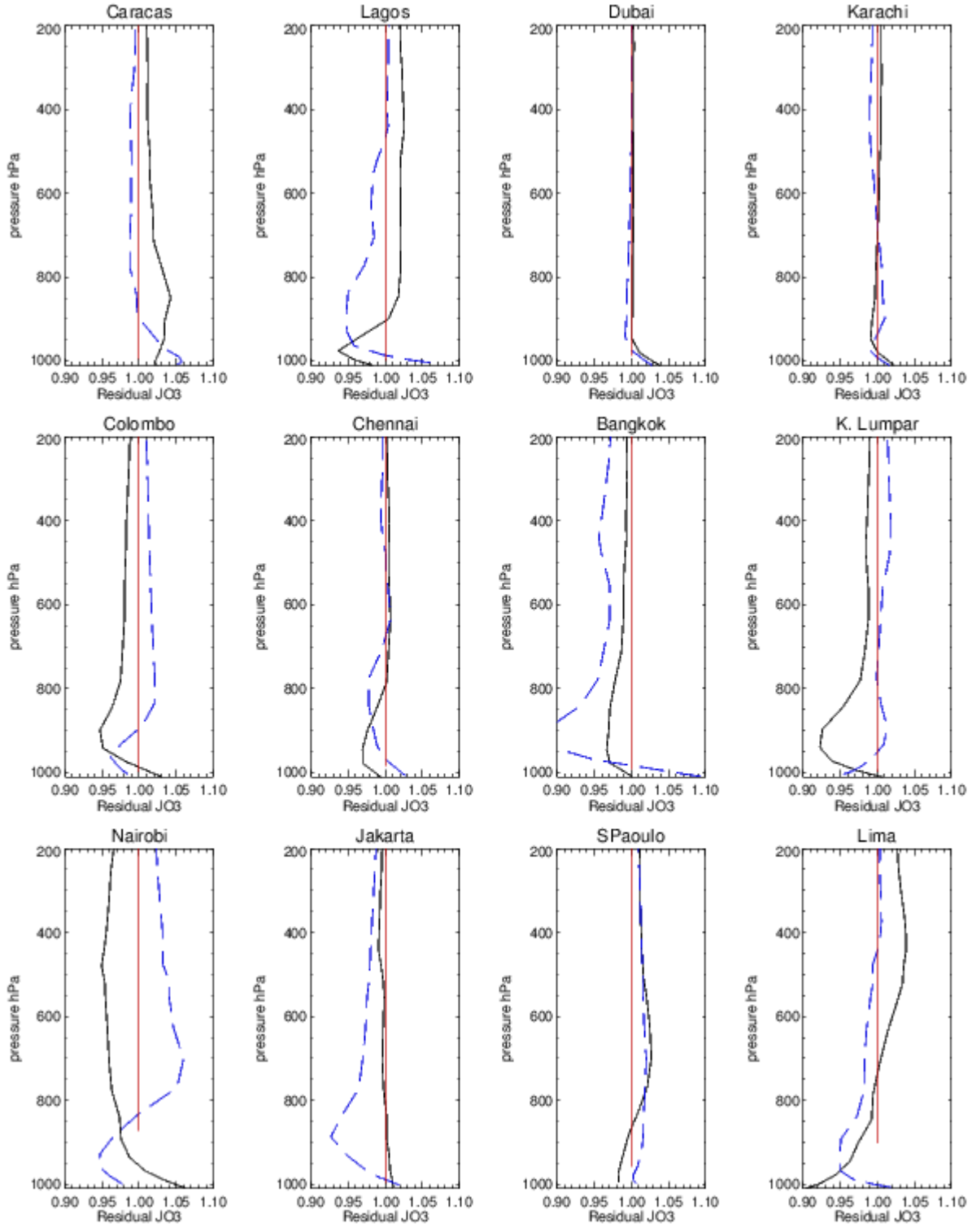

Figure S6a: Comparisons of J_{O3} profiles above selected tropical cities for January (black) and July (Blue) during 2006.

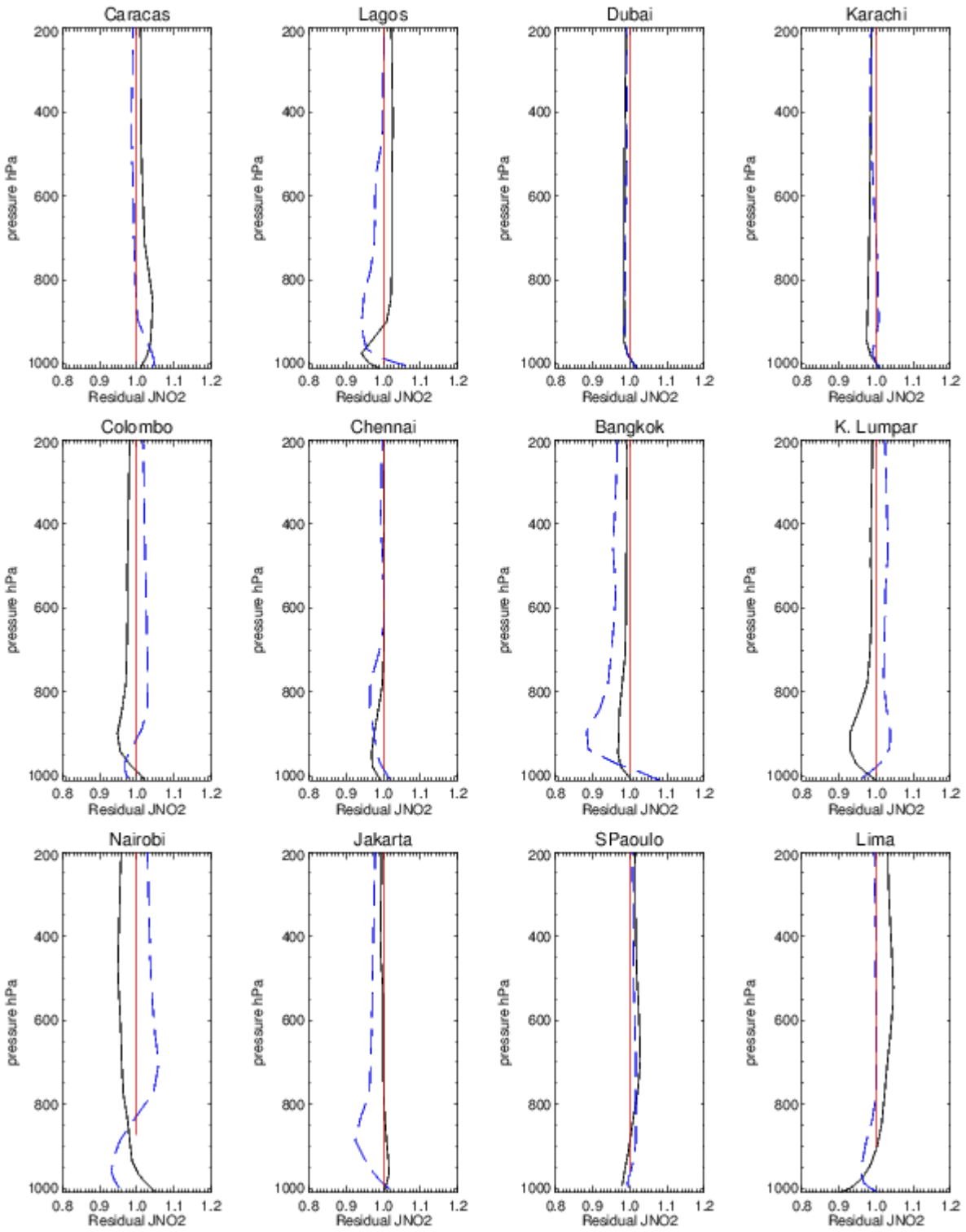

Figure S6b: Comparisons of J_{NO2} profiles above selected tropical cities for January (black) and July (Blue) during 2006.

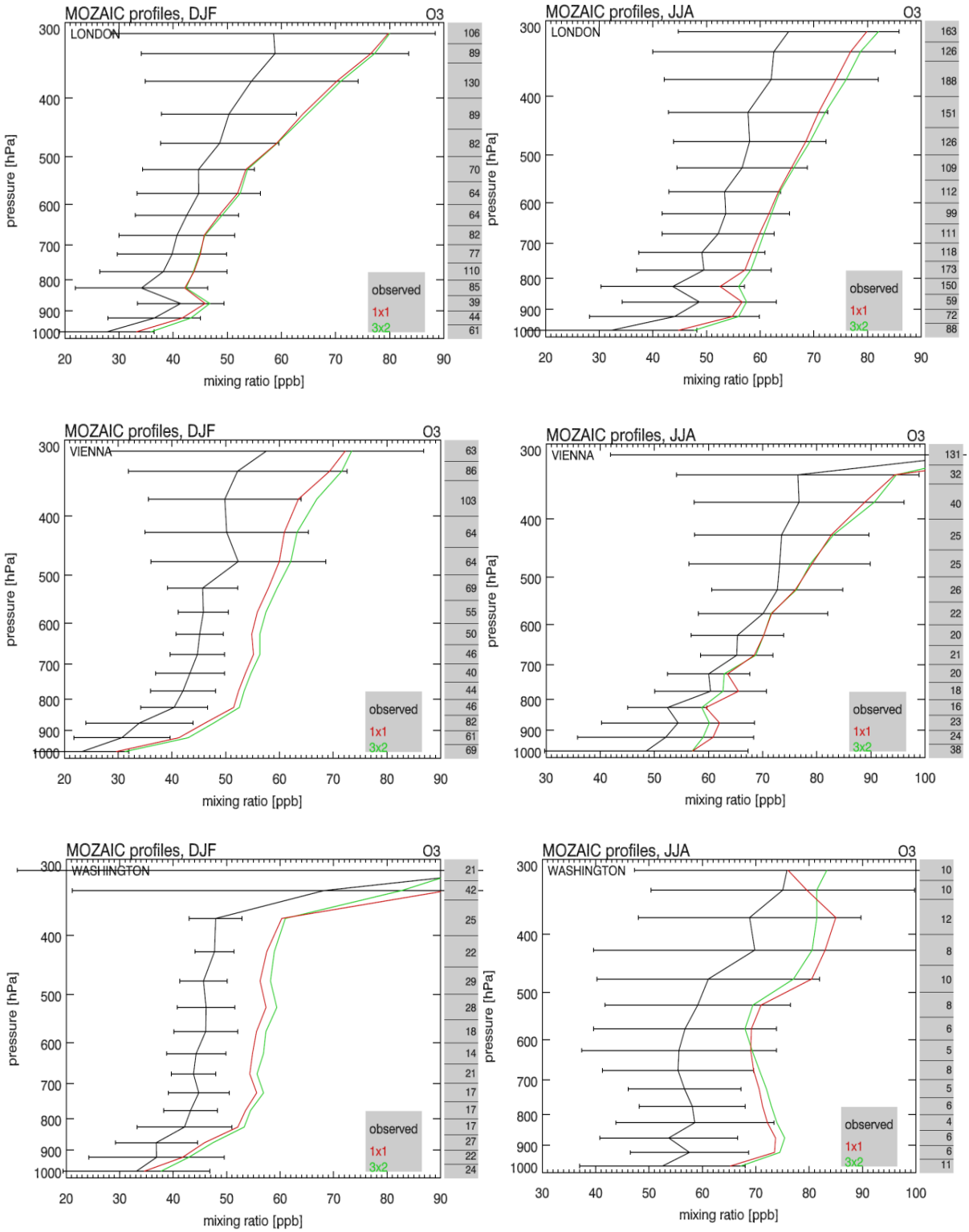

Figure S7a: Seasonal comparisons of tropospheric O_3 profiles taken as part of the MOZIAC flight program for (left) DJF and (right) JJA for (top) London, (middle) Vienna and (bottom) Washington. Comparisons are shown for volume mixing ratios.

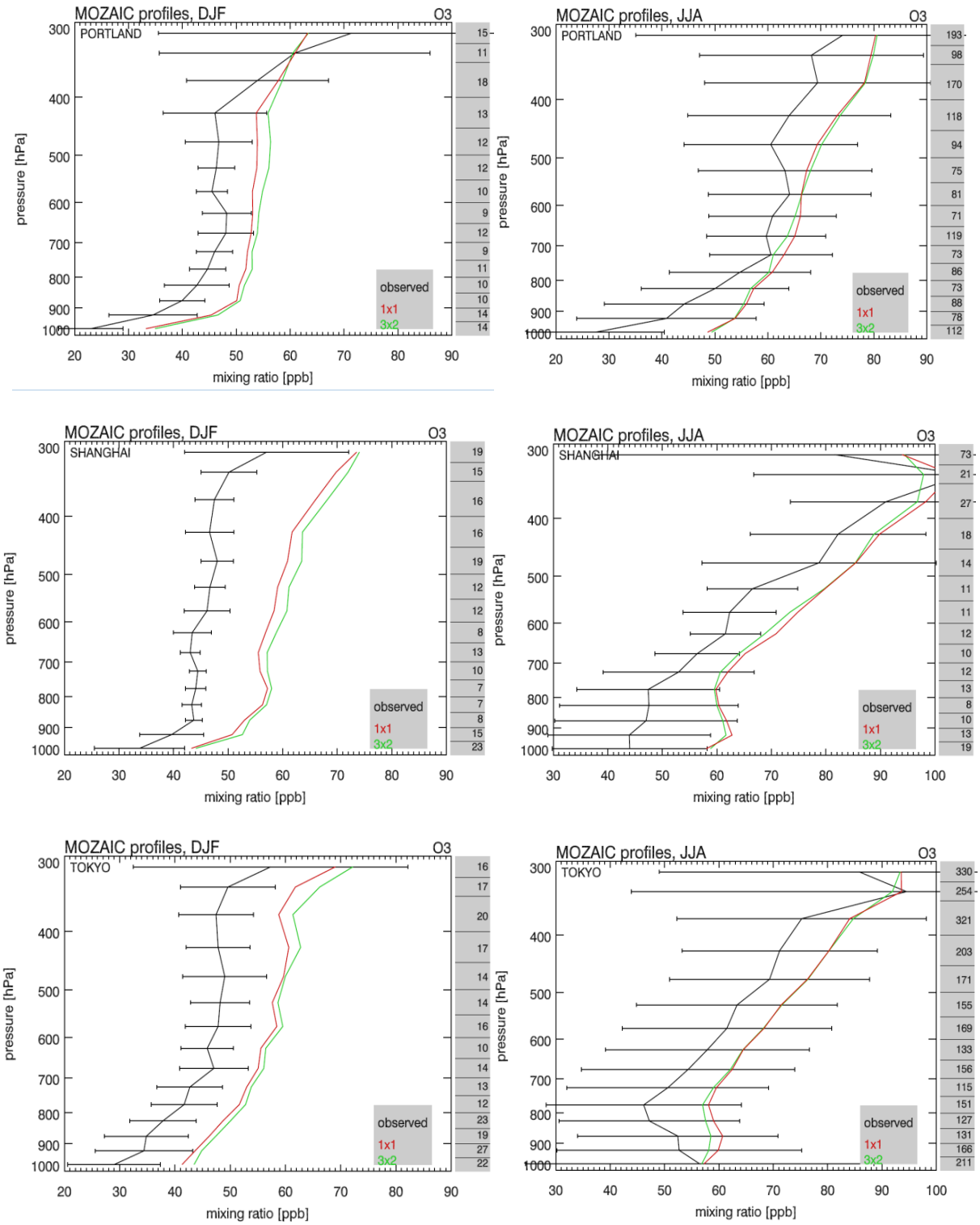

Figure S7b: As for Fig. S7a except for Portland (top), Shanghai (middle) and Tokyo (bottom). Comparisons are shown for volume mixing ratios.

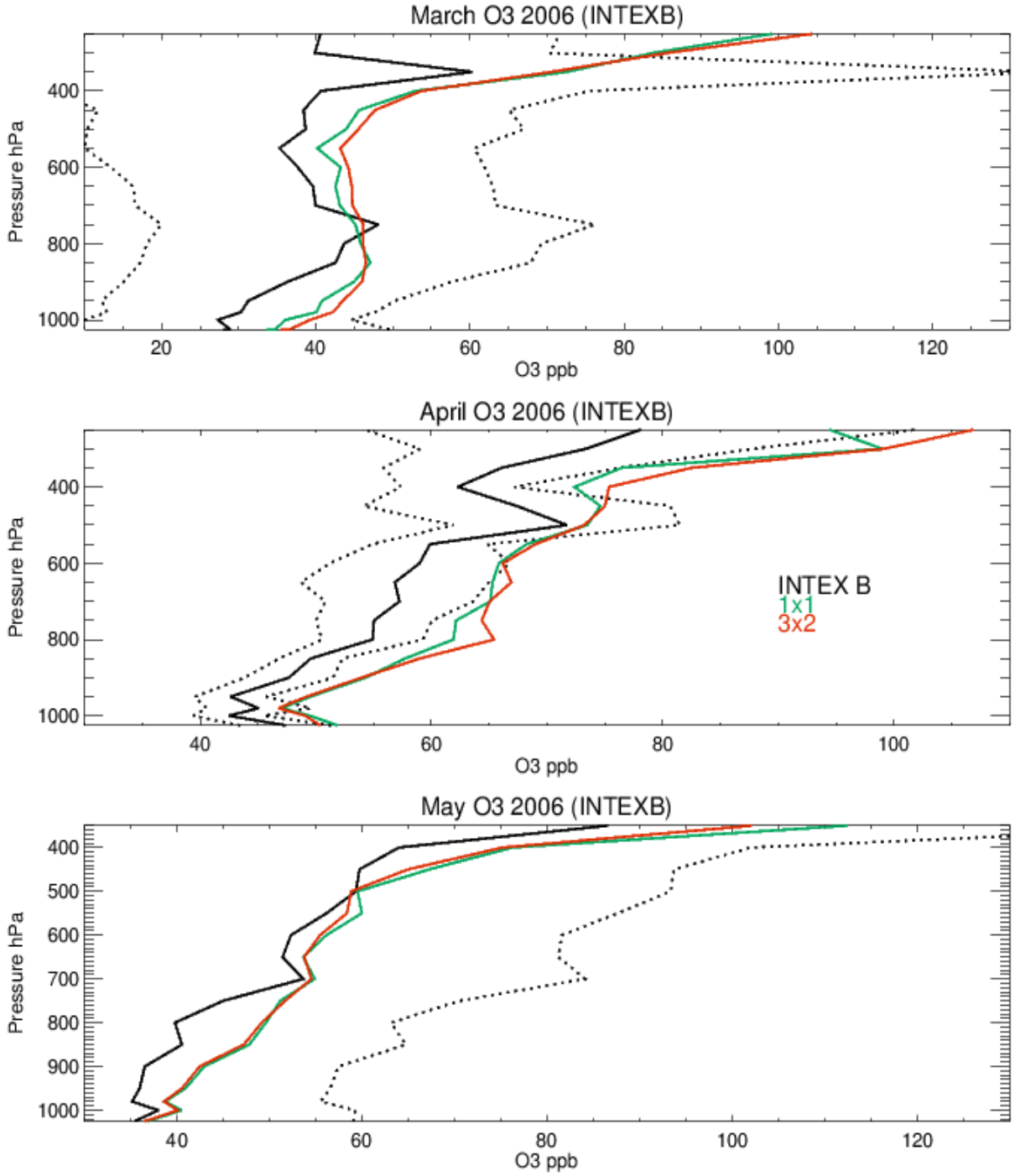

Figure S8: Comparisons of monthly composites of tropospheric O_3 profiles against measurements taken during the INTEX-B campaign between March and May 2006 for both 3º x 2º and 1º x 1º simulations. The dotted line represents the 1-σ variability associated with the measurements.

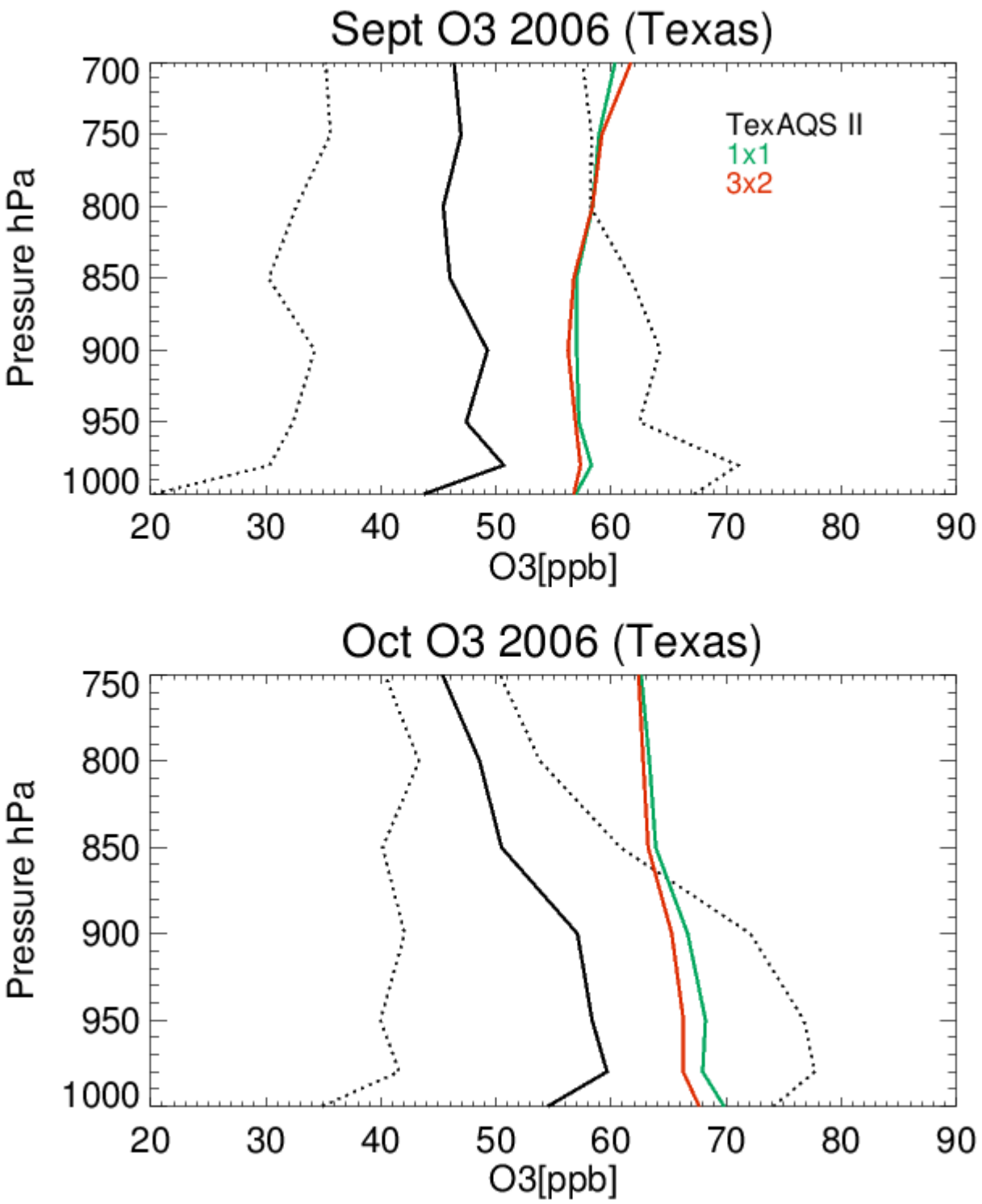

Figure S9: Comparisons of monthly tropospheric O_3 profiles assembled from data taken during September and October 2006 as part of the Texas-AQS measurement campaign. The 1-σ deviation from the measurements is shown as the dotted line for each of the days. For details of the flight paths the reader is referred to the details given in Parrish et al. (2009).

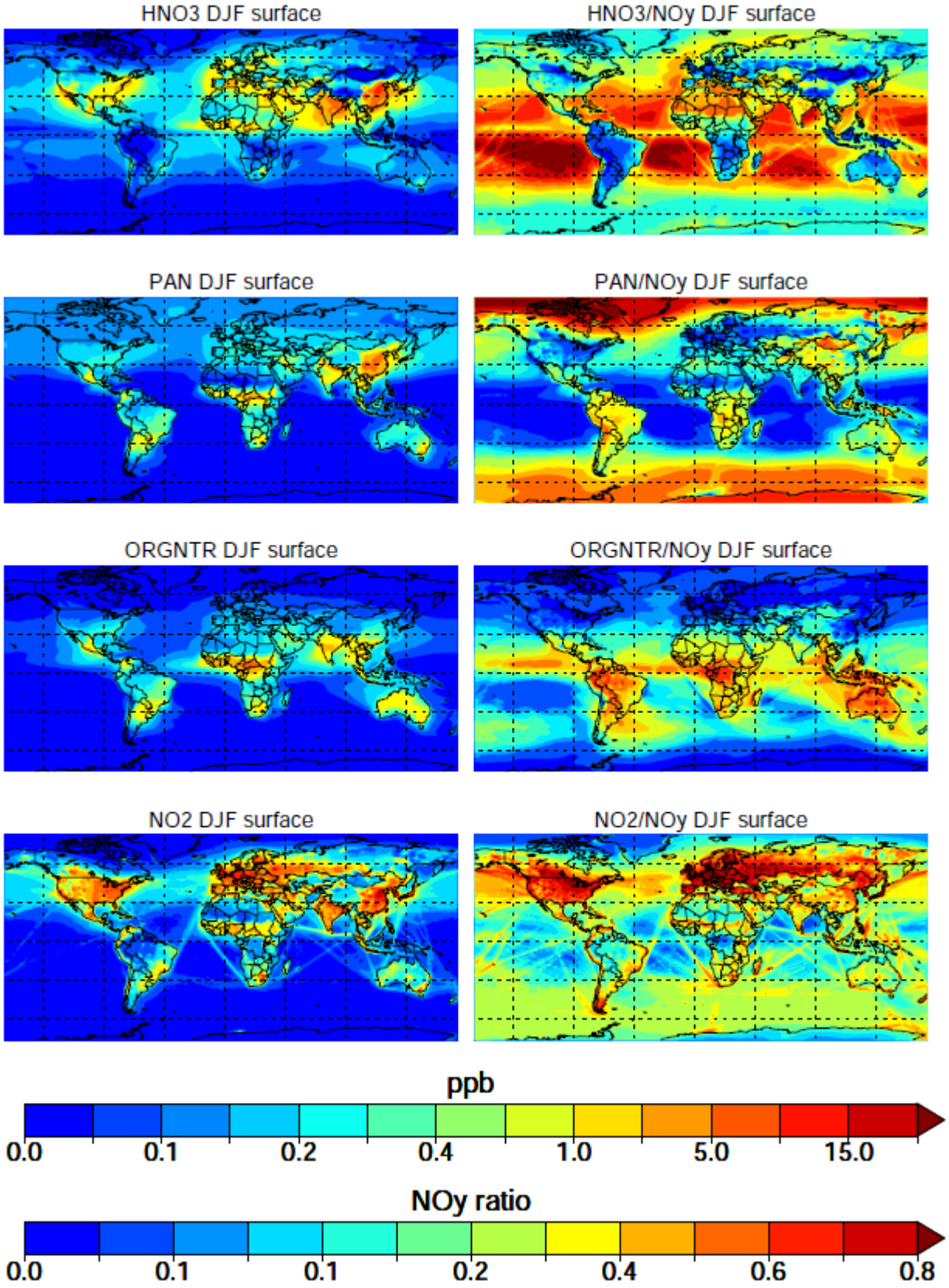

Figure S10: The horizontal mean distribution of (top to bottom) HNO_3, PAN, ORGNTR and NO_2 in the 1° x 1° simulation for DJF, along with the corresponding NO_y ratios.

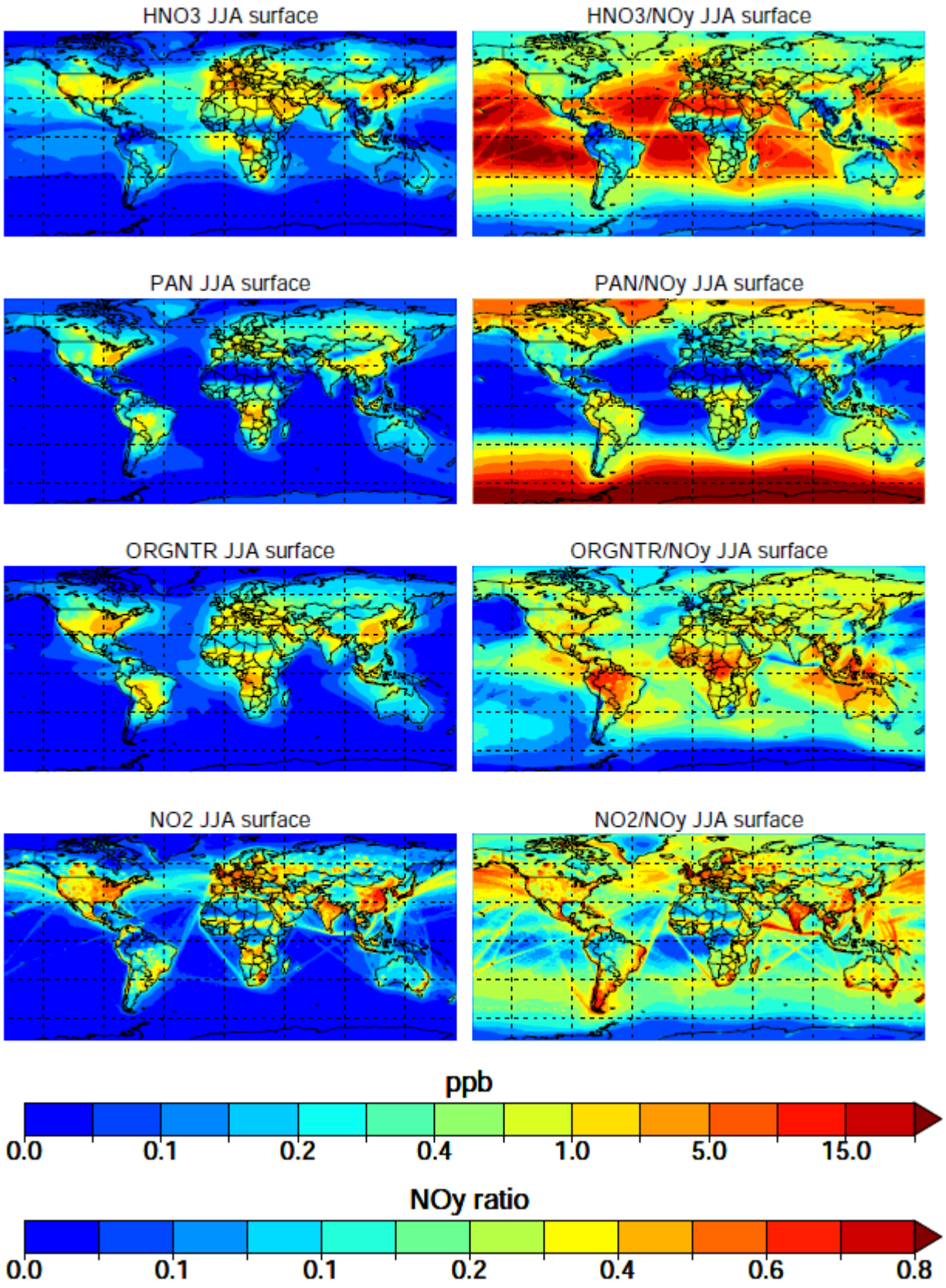

Figure S11: As for Fig S10 except for season JJA.

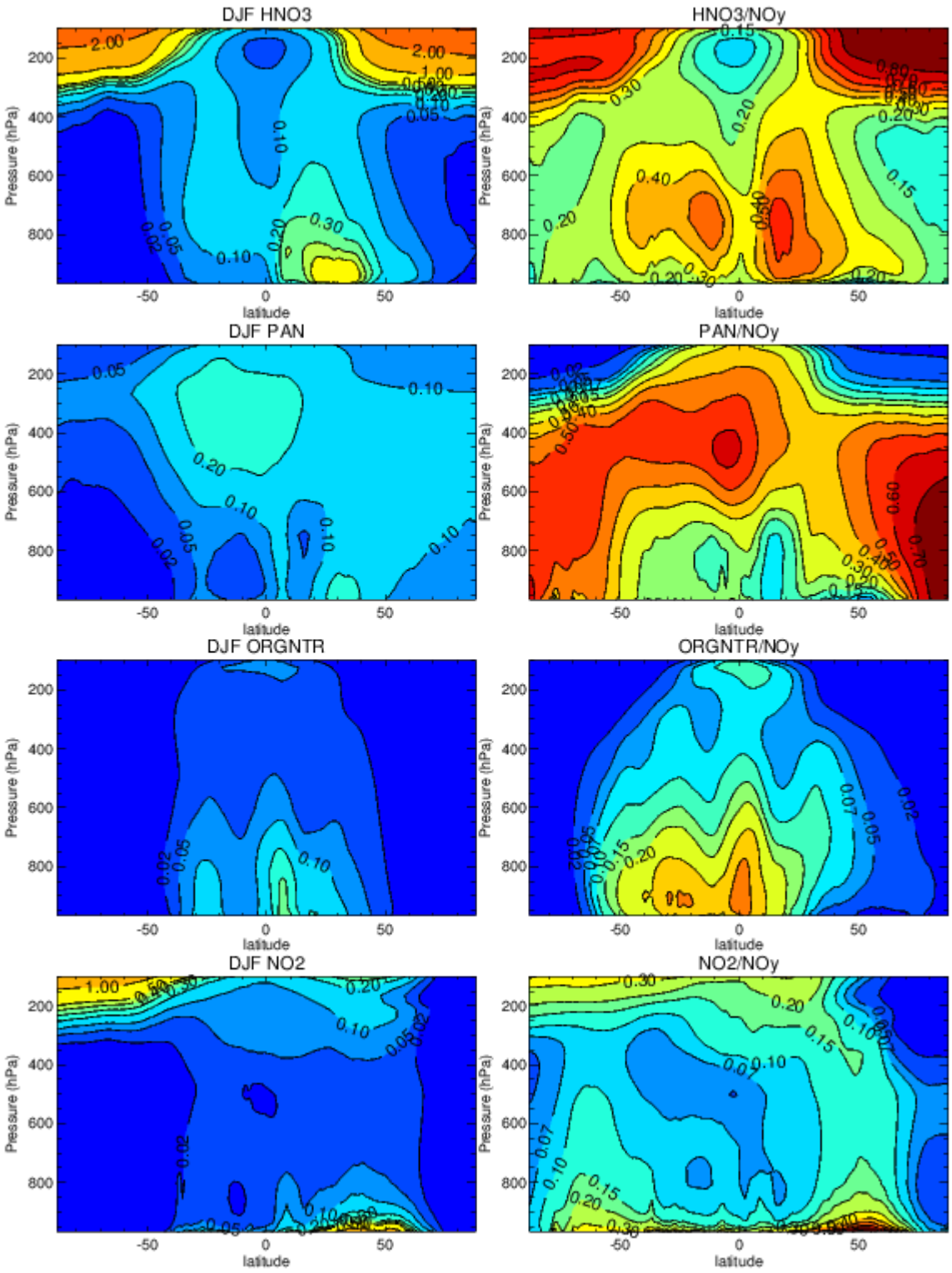

Figure S12: The seasonal zonal mean distribution of (top to bottom) in the 1° x 1° simulation for HNO_3, PAN, ORGNTR and NO_2 for DJF with the corresponding NO_y ratios.

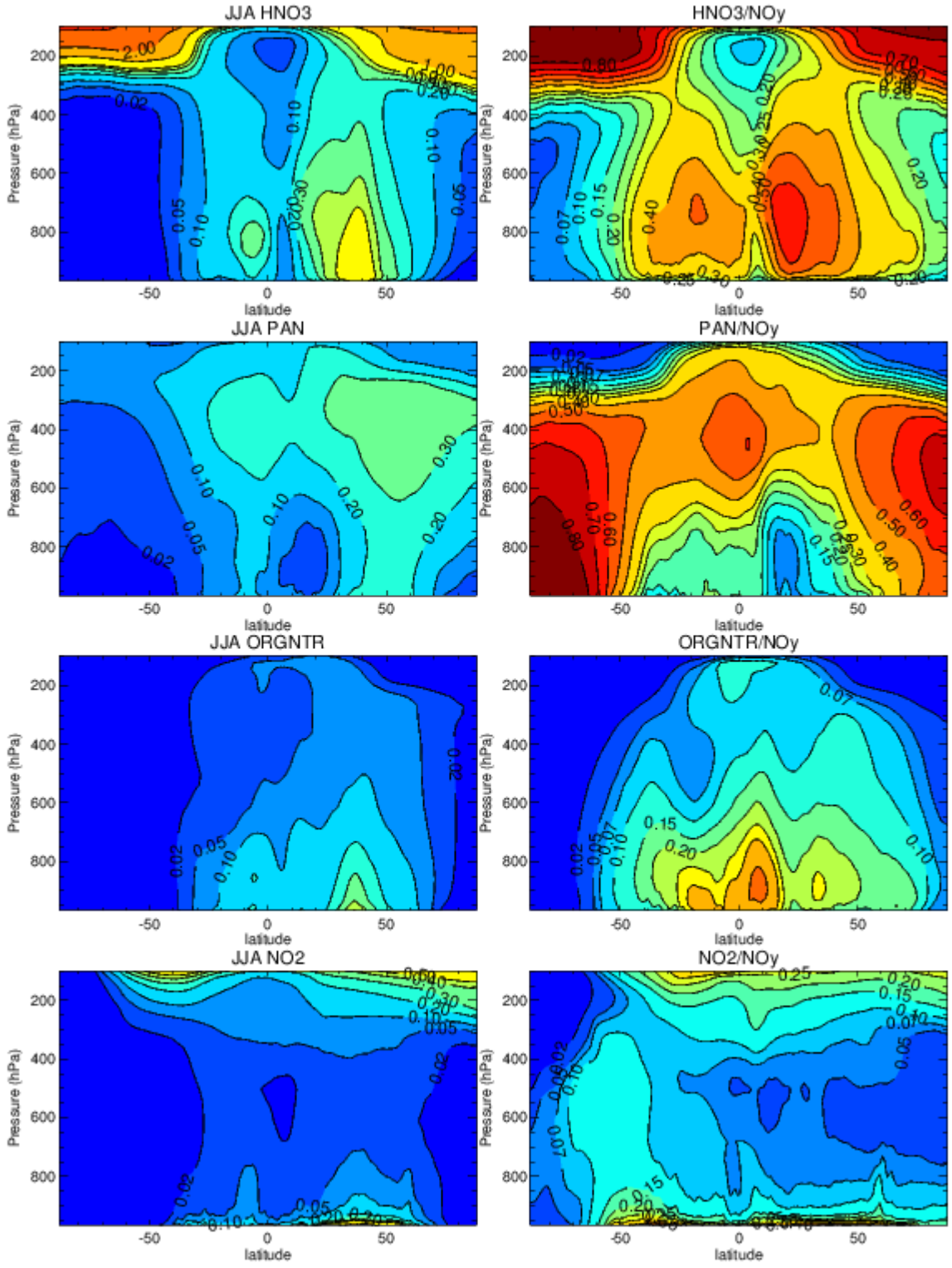

Figure S13: As for Fig. S12 except for season JJA.

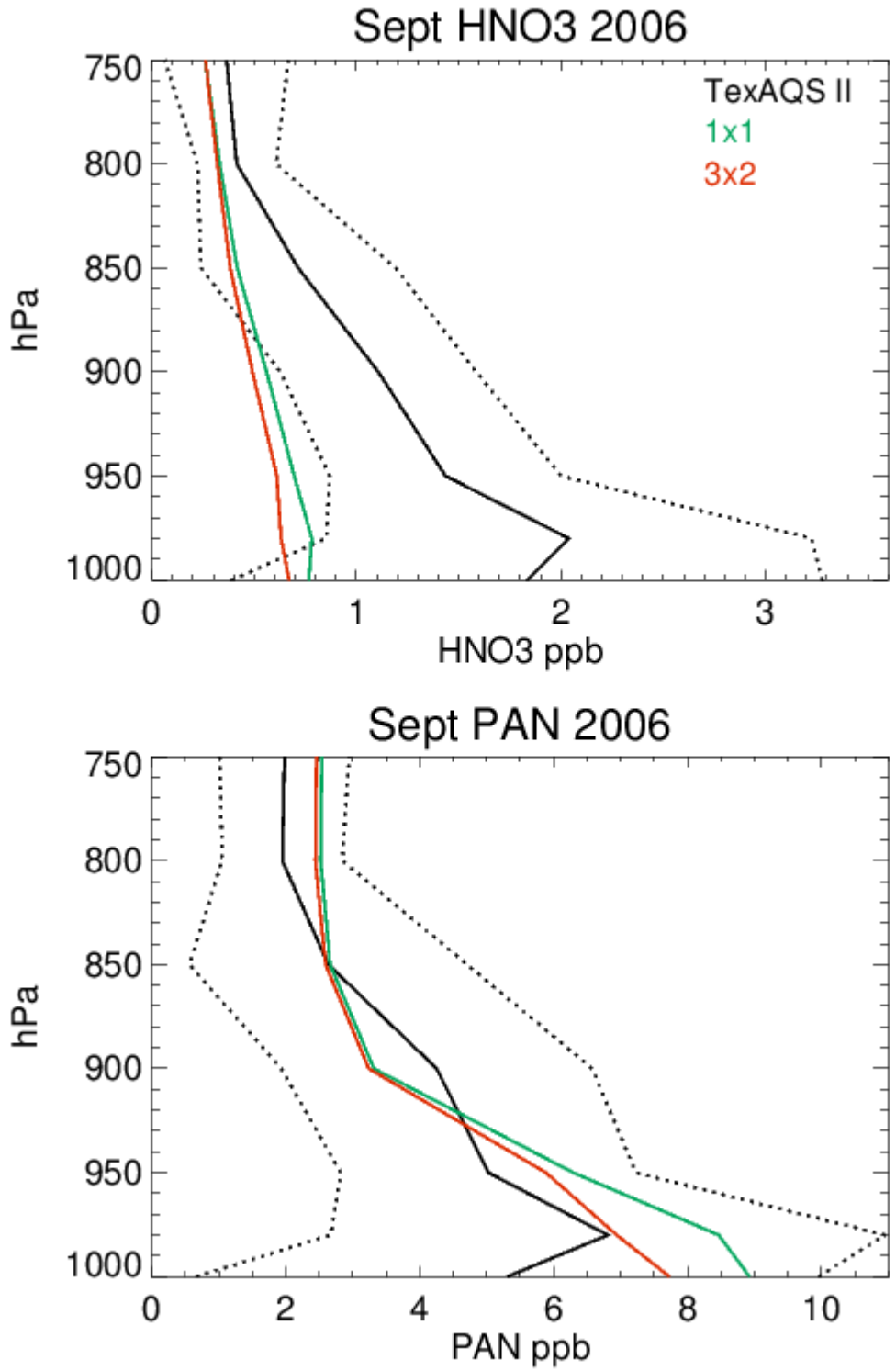

Figure S14: Comparisons of monthly tropospheric HNO_3 (top) and PAN (bottom) profiles during September 2006 above Texas. The 1-σ deviation from the measurements is shown as the dotted line for each species. For details of the flight paths the reader is referred to the details given in Parrish et al. (2009).

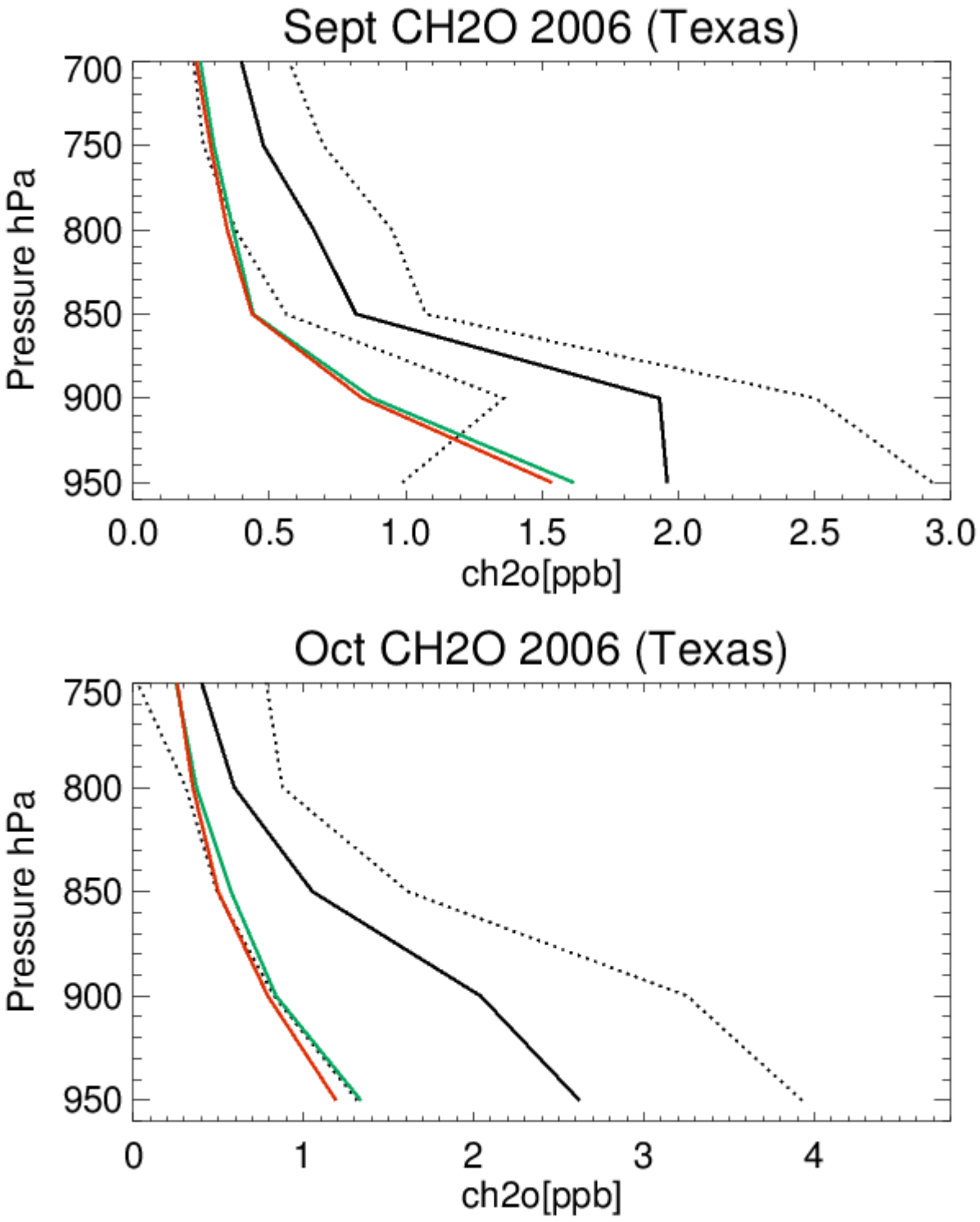

Figure S15: Comparisons of monthly tropospheric CH_2O profiles assembled from data taken during September 2006 as part of the Texas-AQS measurement campaign. The 1-σ deviation from the measurements is shown as the dotted line. For details of the flight paths the reader is referred to the details given in Parrish et al. (2009).

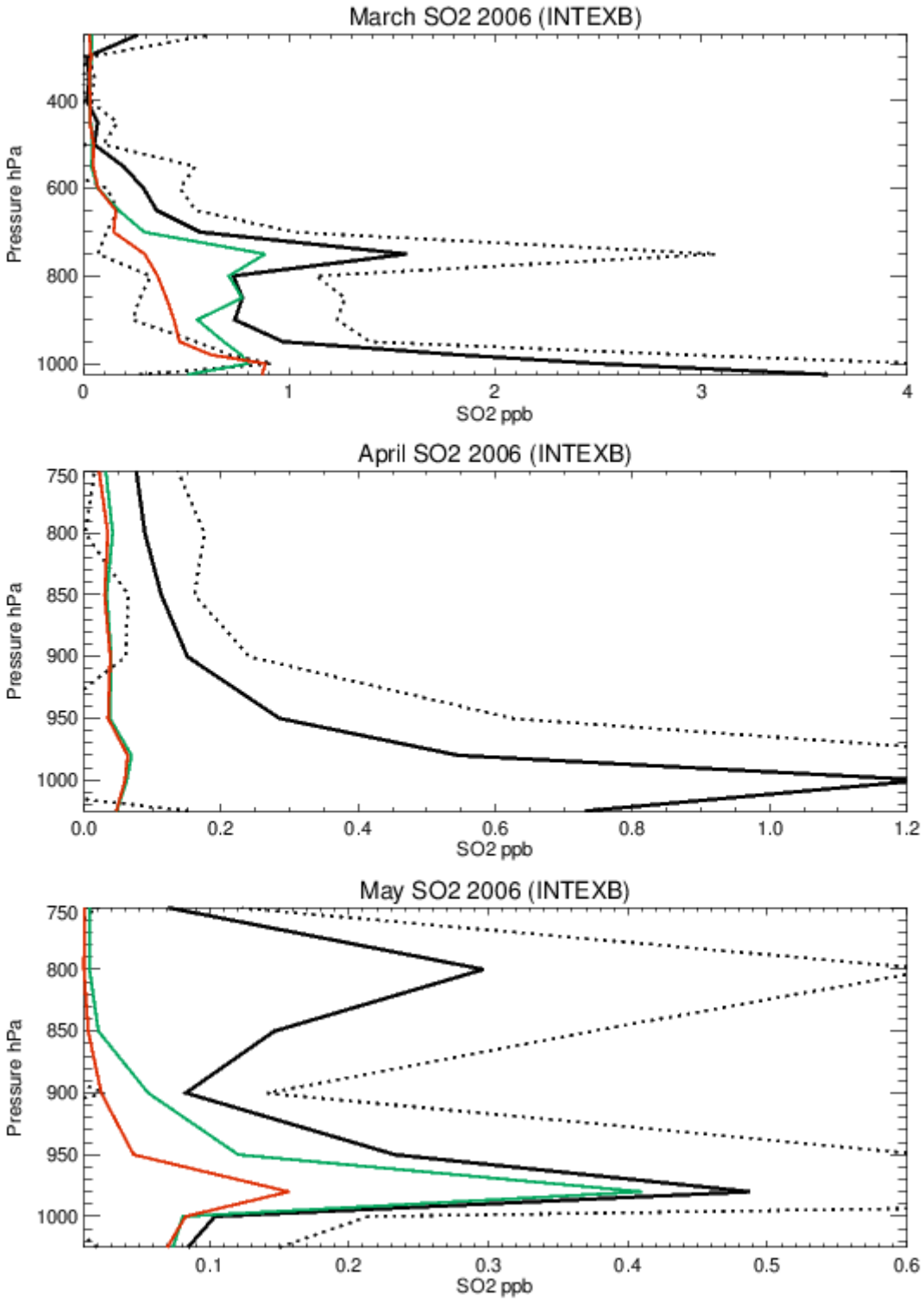

Figure S16: Comparisons of the vertical distribution of SO_2 from both 3°x2° and 1°x1° simulations against measurements made as part of the INTEX B campaign during 2006. The 1-σ deviation from the measurements is shown as the dotted line for each species. For details on the exact location of the flights the reader is referred to Parrish et al. (2009).

Table S1: The tropospheric chemical budget terms for the chemical production (CP), chemical destruction (CD) and accumulated deposition for HNO_3, PAN and ORGNTR given in Tg N yr^{-1} for the 1º x 1º simulation during 2006. Loss of HNO_3 into NO_3^- accounts for the missing HNO_3 loss term. The chemical troposphere is defined according to Stevenson et al. (2006) and fixed across simulations. Percentage differences are given in the parenthesis when compared against the corresponding budget terms from the 3º x 2º simulation (1º x1º/3º x2º). The SH, Tropics and NH are defined as 30-90ºS, 30ºS-30ºN and 30-90ºN, respectively.

Budget Term (Tg/N)	Global	SH	Tropics	NH
Strat. Nudge	0.3 ()	0.1 ()	0.1 ()	0.1 ()
HNO_3 CP	44.0 (0.3)	1.9 (1.0)	22.8 (-1.0)	19.3 (1.7)
HNO_3 CD	6.7 (-4.8)	0.5 (4.7)	3.9 (-2.5)	2.3 (6.7)
HNO_3 Dep.	35.9 (1.5)	2.0 (-0.5)	18.2 (1.6)	15.6 (1.7)
PAN CP	199.1 (-2.4)	7.6 (-3.0)	150.8 (-2.7)	40.7 (-1.1)
PAN CD	197.5 (-2.4)	7.7 (-3.0)	150.2 (-2.7)	39.7 (-1.1)
PAN Dep.	1.6 (2.5)	0.1 (1.0)	0.7 (-0.5)	0.8 (-4.6)
ORGNTR CP	9.8 (-4.8)	0.3 (-3.0)	6.9 (-5.5)	2.6 (-3.4)
ORGNTR CD	4.2 (-4.6)	0.2 (-5.0)	2.9 (-3.4)	1.3 (-0.8)
ORGNTR Dep.	5.7 (-3.6)	0.5 (-2.0)	3.5 (-4.4)	1.8 (-2.8)

Table S2: The tropospheric chemical budget terms for the short-lived N-species HONO, HNO_4 and N_2O_5 (Tg N yr^{-1}) during 2006 for the 1º x 1º simulation. Both HNO_4 and N_2O_5 exist in chemical equilibrium with their respective chemical precursors which accounts for the dominant loss terms (not given), where only oxidation by OH and heterogeneous conversion terms are provided. The chemical troposphere is defined according to Stevenson et al. (2006) and fixed across simulations. Percentage differences are given in the parenthesis when compared against the corresponding budget terms from the 3º x 2º simulation (1º x1º/3º x2º). The SH, Tropics and NH are defined as 30-90ºS, 30ºS-30ºN and 30-90ºN, respectively.

Budget Term (Tg N yr^{-1})	Global	SH	Tropics	NH
HO + NO	22.9 (-3.0)	1.3 (-0.8)	16.4 (-6.4)	5.2 (9.0)
OH + HONO	2.6 (-1.9)	0.1 (-)	1.8 (-5.2)	0.7 (6.3)
HNO_4 CP	168.7 (-1.4)	7.5 (-0.4)	106.4 (-1.2)	54.7 (-1.7)
OH + HNO_4	13.5 (-1.2)	1.1 (0.9)	8.4 (-2.0)	4.0 (-)
N_2O_5 CP	628.4 (12.4)	11.2 (24.9)	322 (12.8)	226 (11.6)
N_2O_5 + aero	6.3 (5.9)	0.1 (14.3)	1.7 (12.0)	4.5 (3.9)
N_2O_5 + cloud	3.2 (-1.9)	0.1 (-)	0.7 (4.8)	2.5 (0.8)
N_2O_5 Dep.	0.3 (-3.0)	-	0.1 (-)	0.2 (-7.5)