Royal Netherlands
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Analysing the impact of 1° x 1° simulations on atmospheric composition

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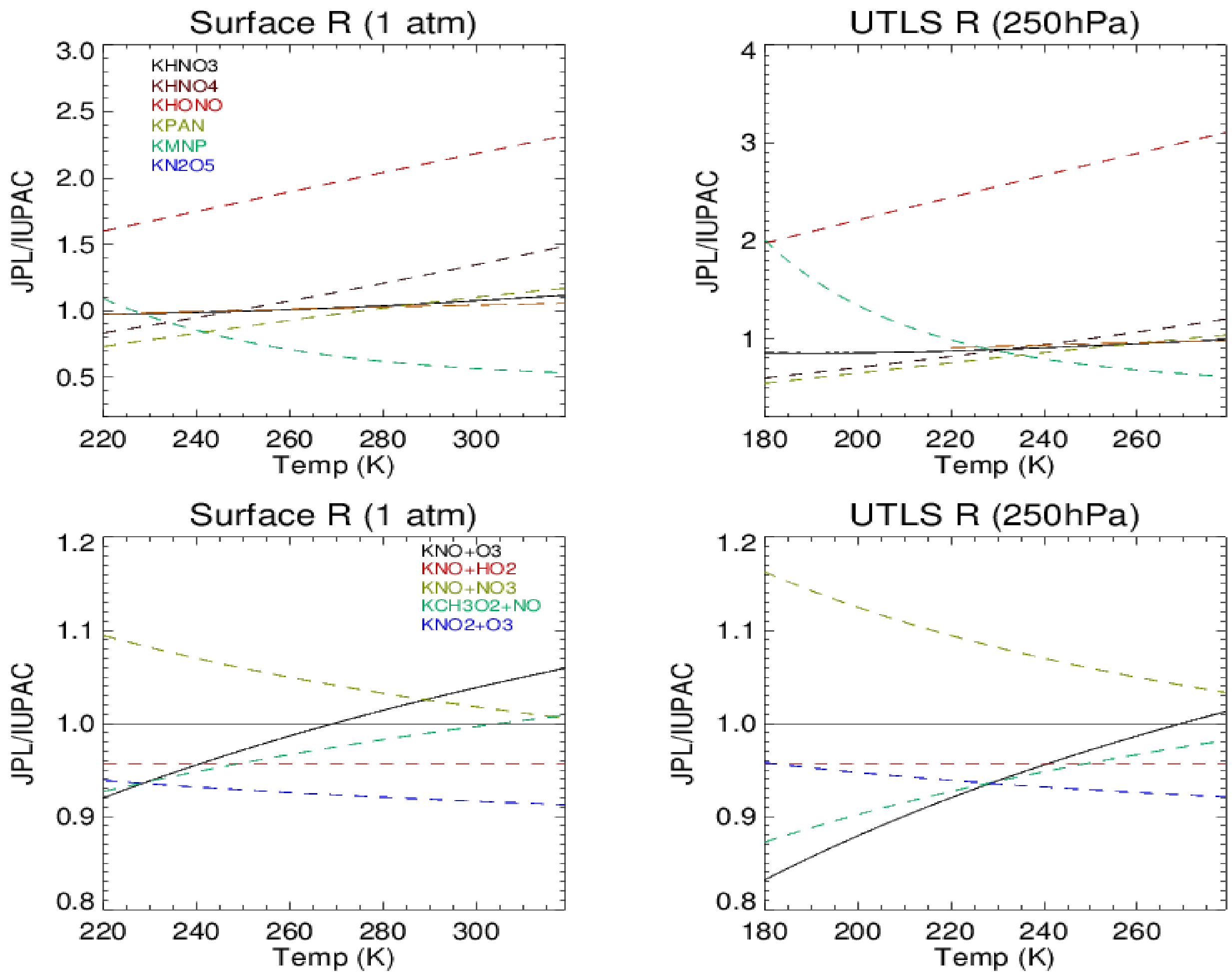
Description of mCB05v1.1

- Rate parameters all homogenized into IUPAC values with new formulation for 3 body reactions
- New N-species added : HONO, $CH_3O_2NO_2$
- NH_3 chemistry updates following Hauglestiane et al. (2014)
- Additional peroxy-radical reactions for C3 organics
- Reformulation of CH_3O_2 + HO_2 term (branching ratio added), PAN + hV
- NO_3/HO_2 conversion on aerosols

Updates in TM5-MP

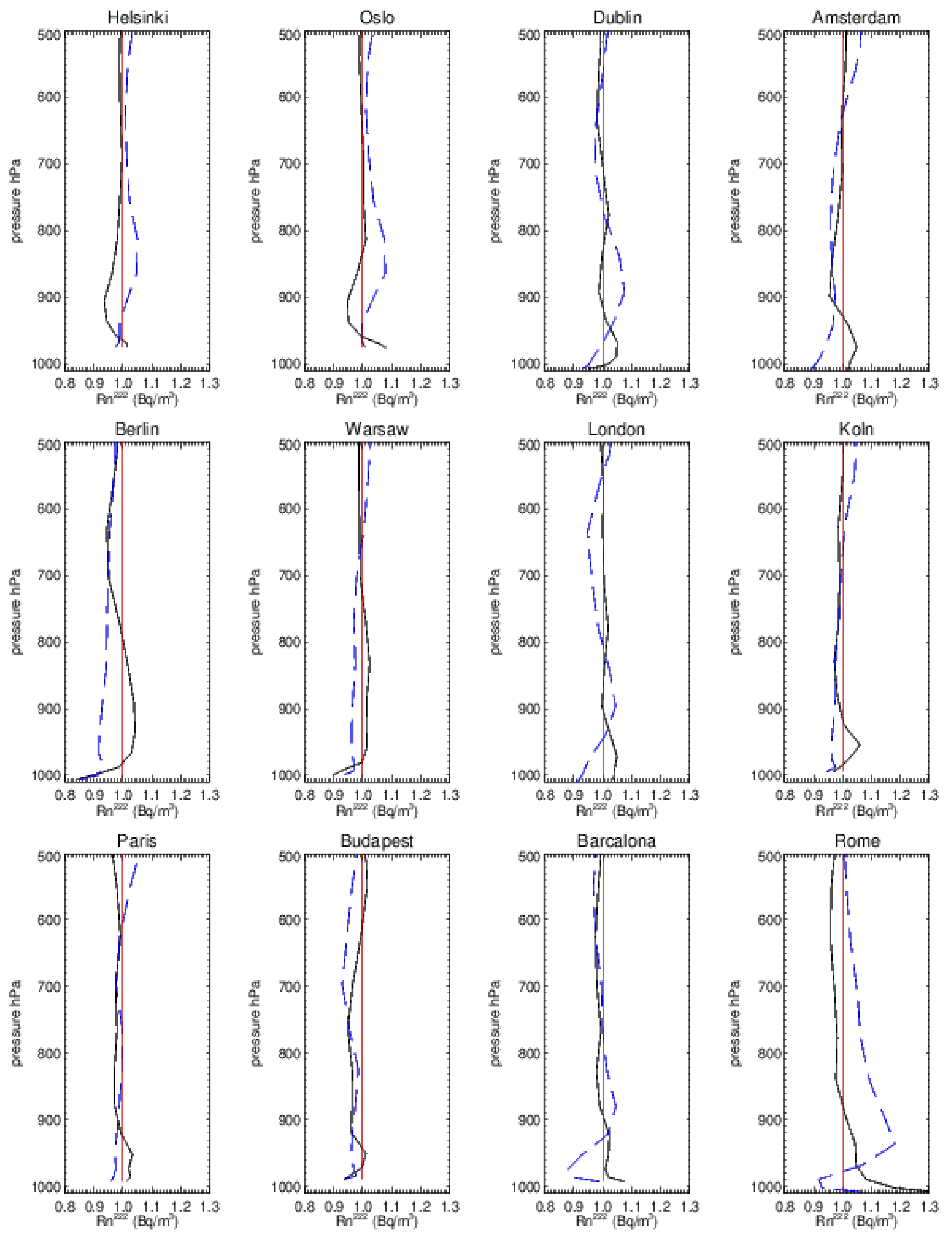
- Nudging of CO and HNO_3 in the Stratosphere using ODIN constraints
- Cloud droplet size now described using Martin et al. (1994)
- Full Evans and Jacob (2005) parameterization (T, RH)
- Latitudinal gradient in [H_2] from NOAA surface measurements (OH + H_2)

Differences in rate parameters



Impact on convection

- **Profiles of ^{222}Rn compared using averages of rebinned 1° x 1° data.**
- **Ratios of mean 1° x 1° / 3° x 2° to remove the influence of variable emission fluxes due to resolution.**
- **Largest differences below 700hPa**
- **Some locations exhibit significant differences (Oslo) and some quite similar (Paris).**

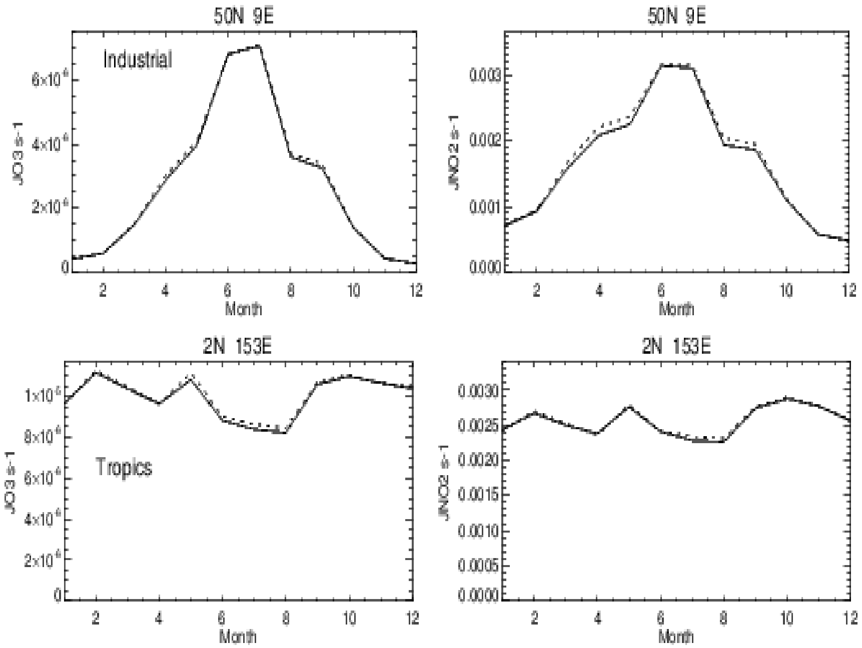


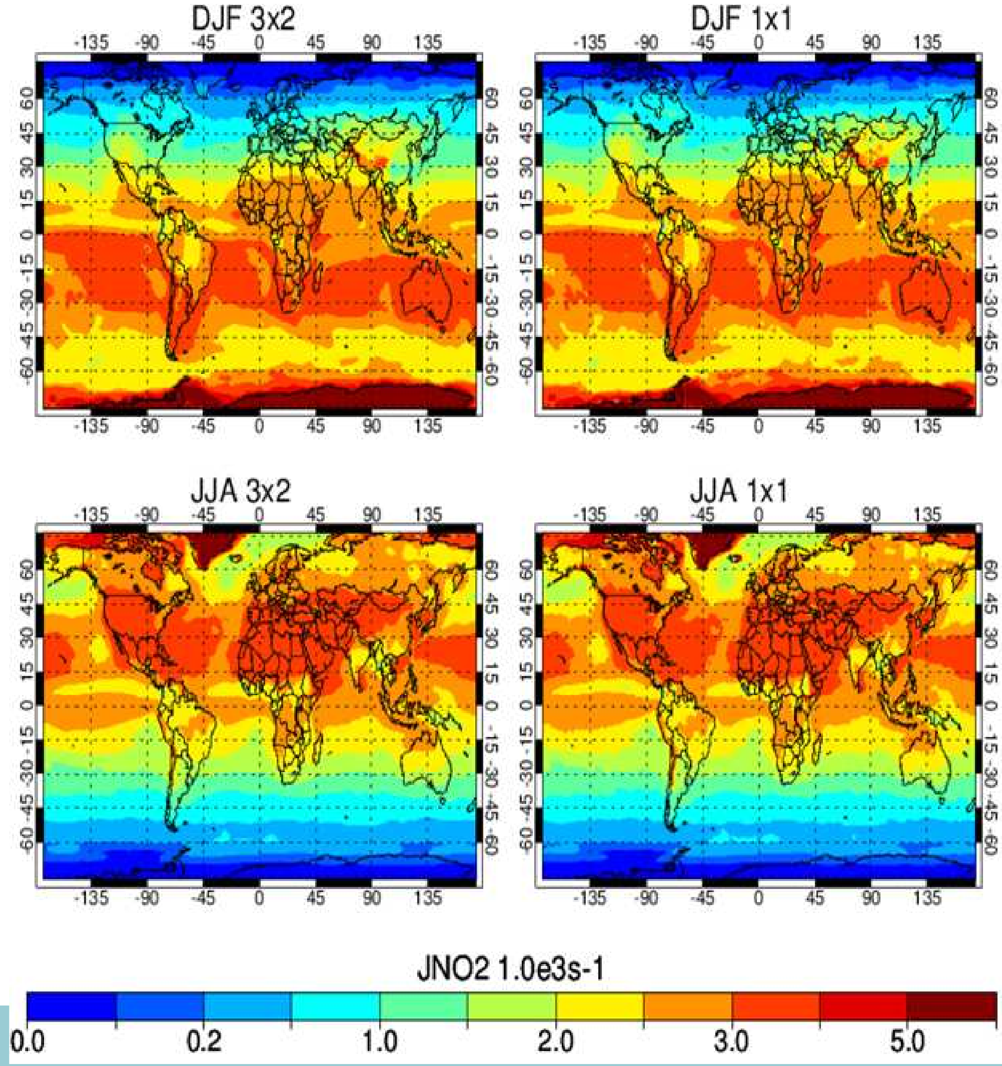
Jan (black), July (blue)

Minimal Impact on J values

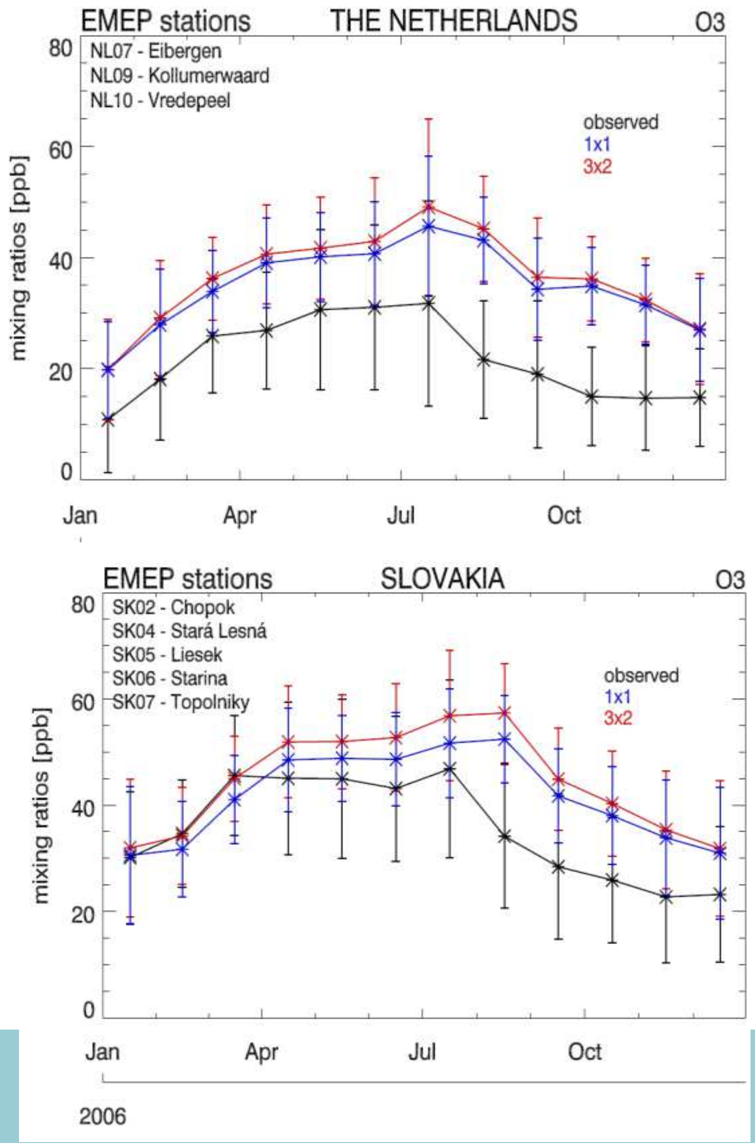
- Differences in monthly mean J values in the order of a few %

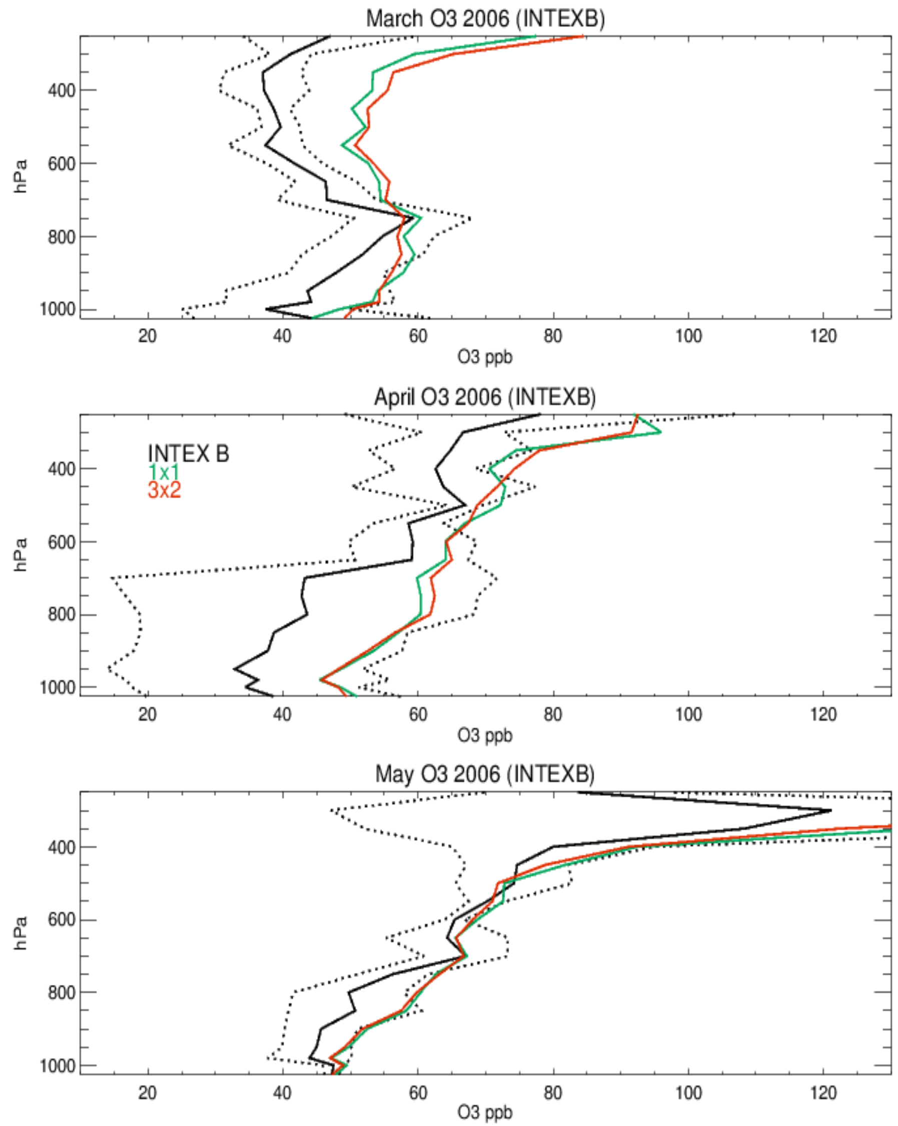
- JCH2Oa = +0.9%
  JCH2Ob = +1.0%
  JMEPE = +1.0%





Impact on tropospheric ozone



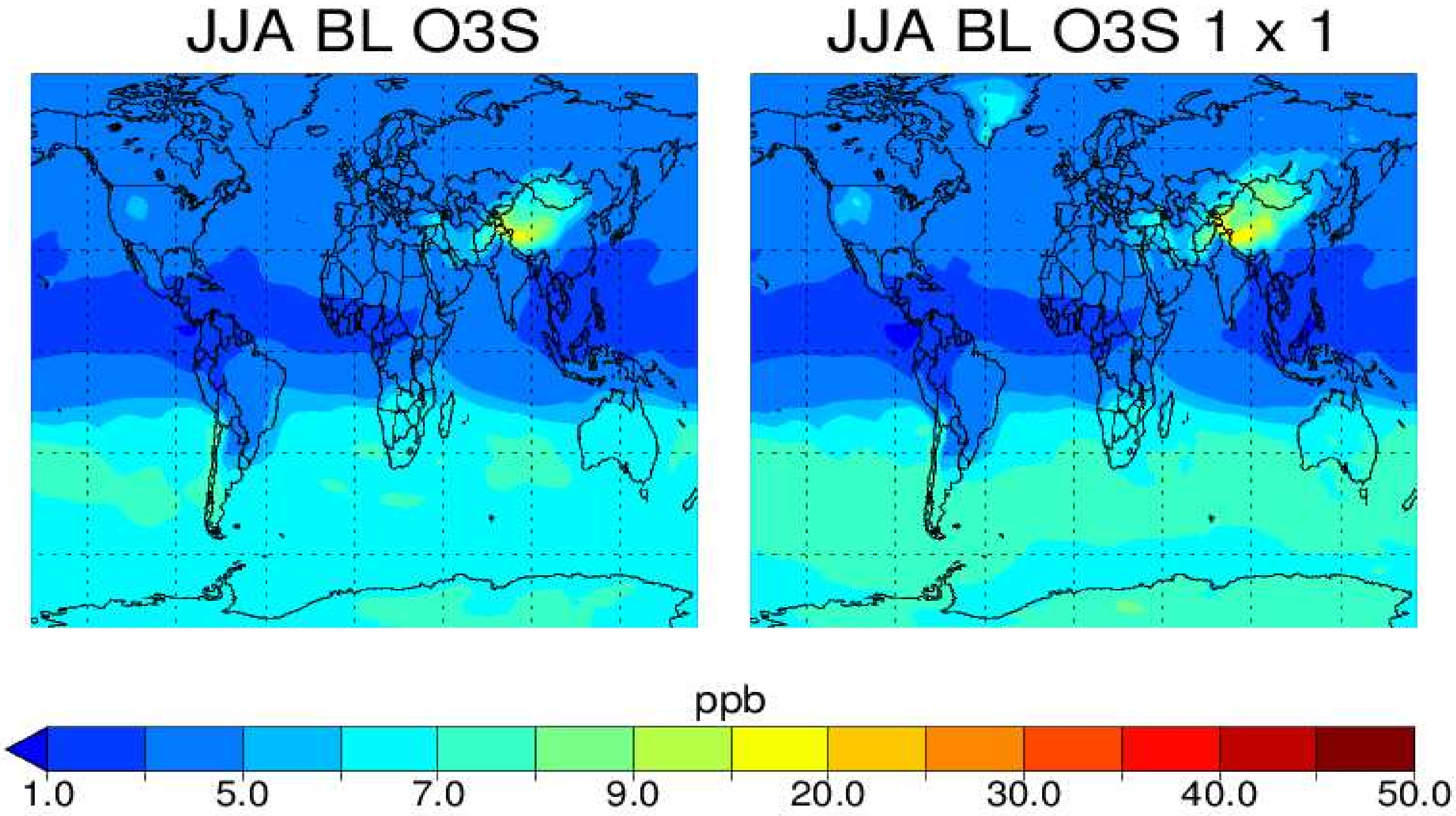


Budget analysis (Trop O_3) % change

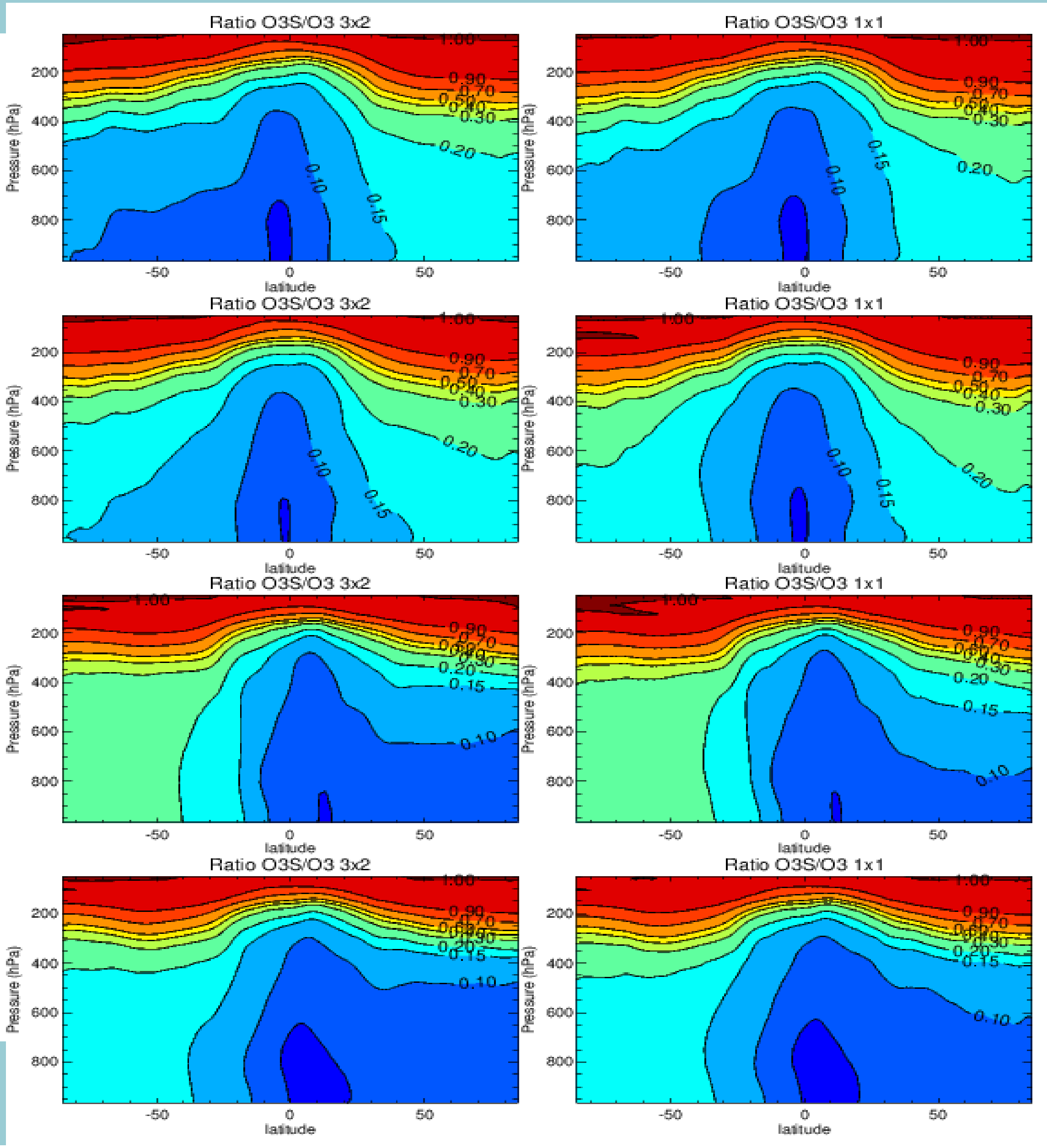
	Global	SH	Tropics	NH
Net STE	950 (43.5)			
Trop Prod.	5005 (11.1)	356 (9.7)	3386 (16.2)	1263 (-2.3)
Trop Dest.	5014 (3.0)	418 (2.7)	3711 (4.1)	885 (-1.6)
Trop Burden	445 (-14.5)	67 (7.3)	161 (26.5)	217 (-51.7)
O3S Trop Burd.	166 (-50.0)	16 (-12.5)	18 (-54.8)	131 (-82.2)
Deposition	941 (-0.9)	111 (-0.7)	461 (-0.1)	370 (-1.9)

- **Large hemispheric differences in net production term between high and low NO_x emission scenarios**
- **Significant increase in titration component and low NO_x recycling (~5-10%)**
- **Large STE component at 1° x 1° : ~2* 1° x 1° literature value**
- **Minimal changes in dry deposition flux indicating changes are throughout the column**

Stratospheric O_3 : Down-welling component

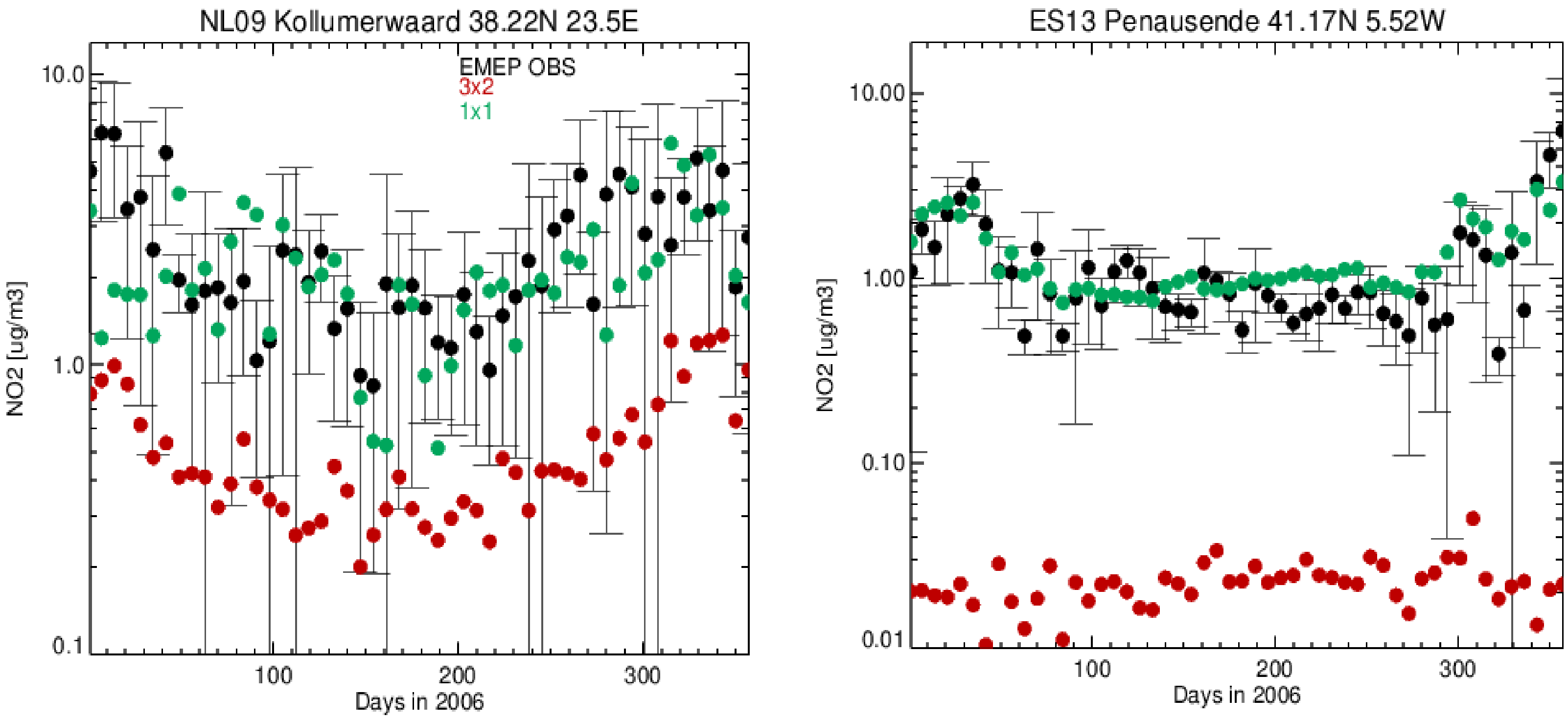


O_3S/O_3



Ratio O3S/O3 3x2
Ratio O3S/O3 1x1
Ratio O3S/O3 3x2
Ratio O3S/O3 1x1
Ratio O3S/O3 3x2
Ratio O3S/O3 1x1
Ratio O3S/O3 3x2
Ratio O3S/O3 1x1
Pressure (hPa)
latitude

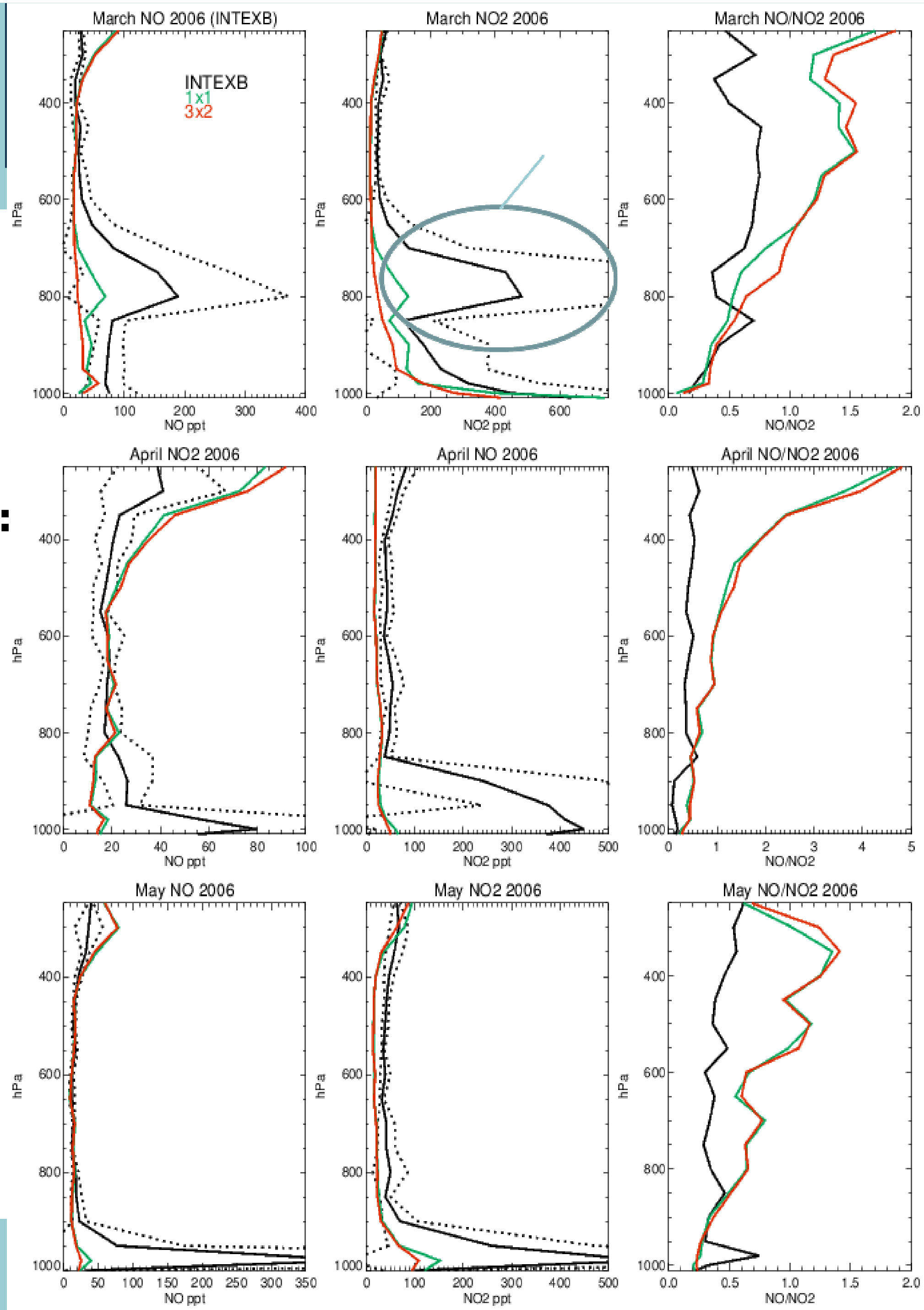
Changes in surface $[NO_2]$: weekly



- **The most dramatic increases occur due to the improvement in the temporal distribution of the emission fluxes rather than chemistry.**
- **Biases across all EMEP sites (33) : ~33% improve, ~25% degrade with remainder exhibiting no significant changes in the bias.**

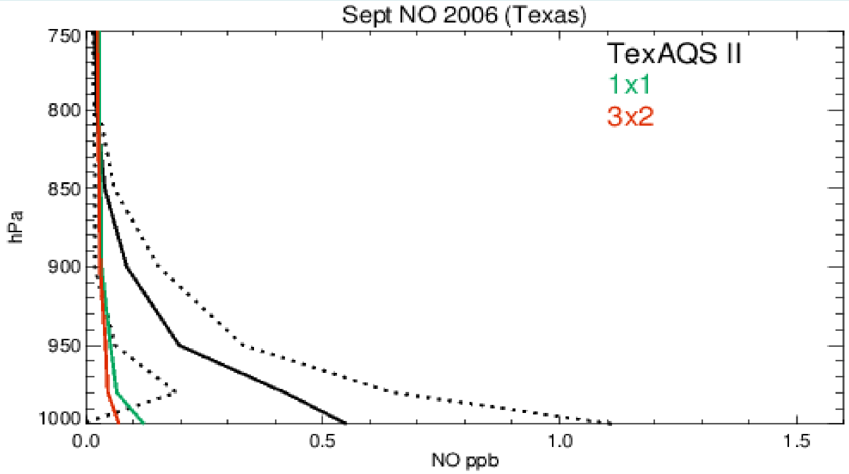
NO and NO_2 (INTEX-B)

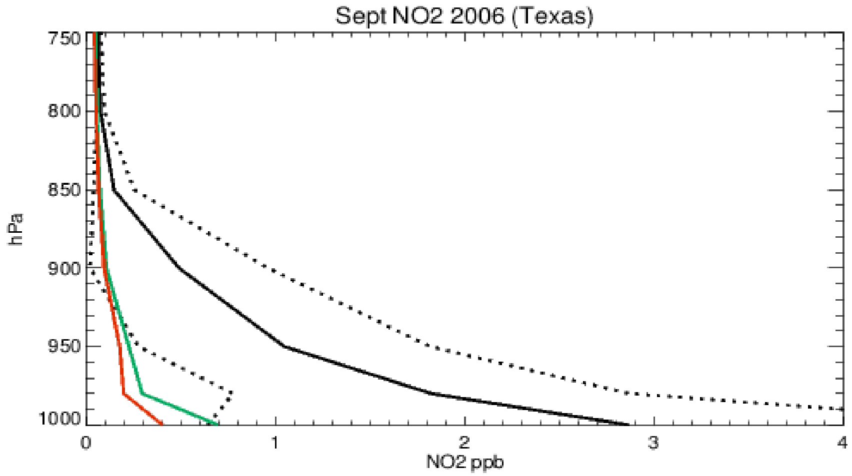
- **INTEX-B : March (Gulf of Mexico), April (Equatorial Pacific) May (Alaska)**
- **Low bias in both NO and NO_2 in BL: Missing oceanic emissions ? Take off/Landing contributions?**
- **FT mixing ratios captured well during April and May**
- **NO/NO_2 ratio realistic in BL**
- **NO/NO_2 ratio too high in UTLS across all months.**

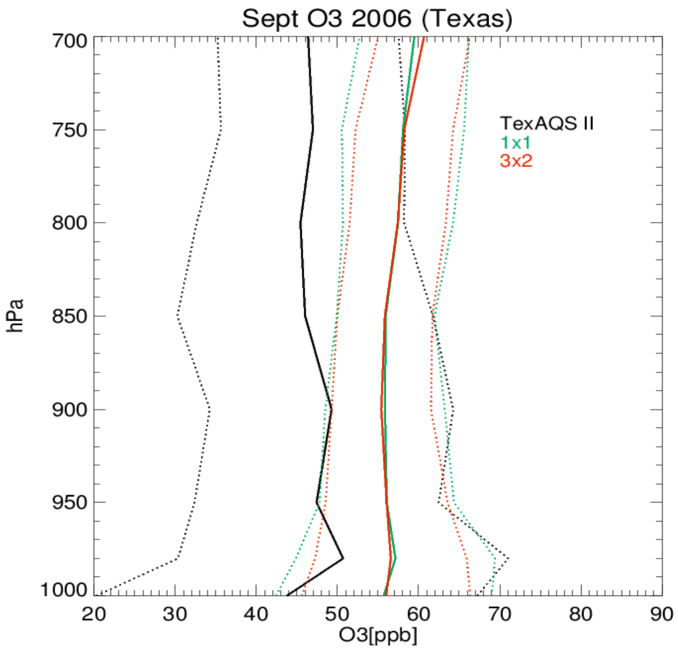


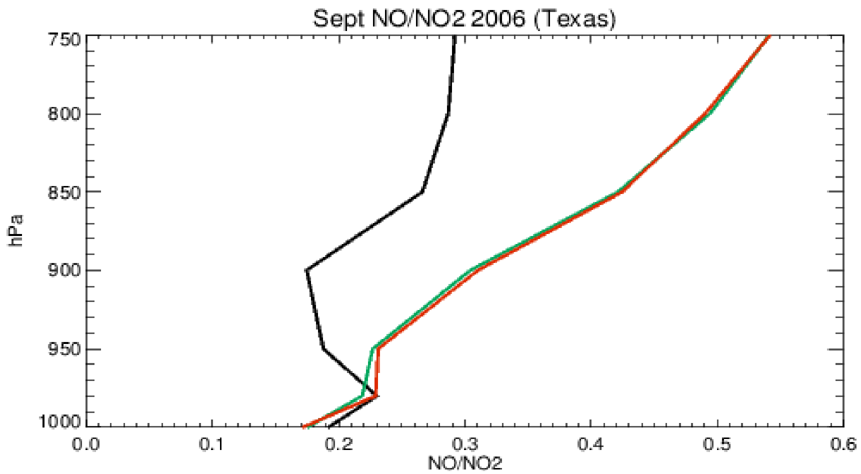
NO and NO_2 (TEXAQSII)

- **Low bias in both NO and NO_2 : underestimation in anthropogenic NO_x component**
- **Moderate reductions in the bias in the boundary layer at 1° x 1°**
- **Significant overestimations in the NO/NO_2 ratio in the lower atmosphere**
- **Peroxy-radical cycling too low?**

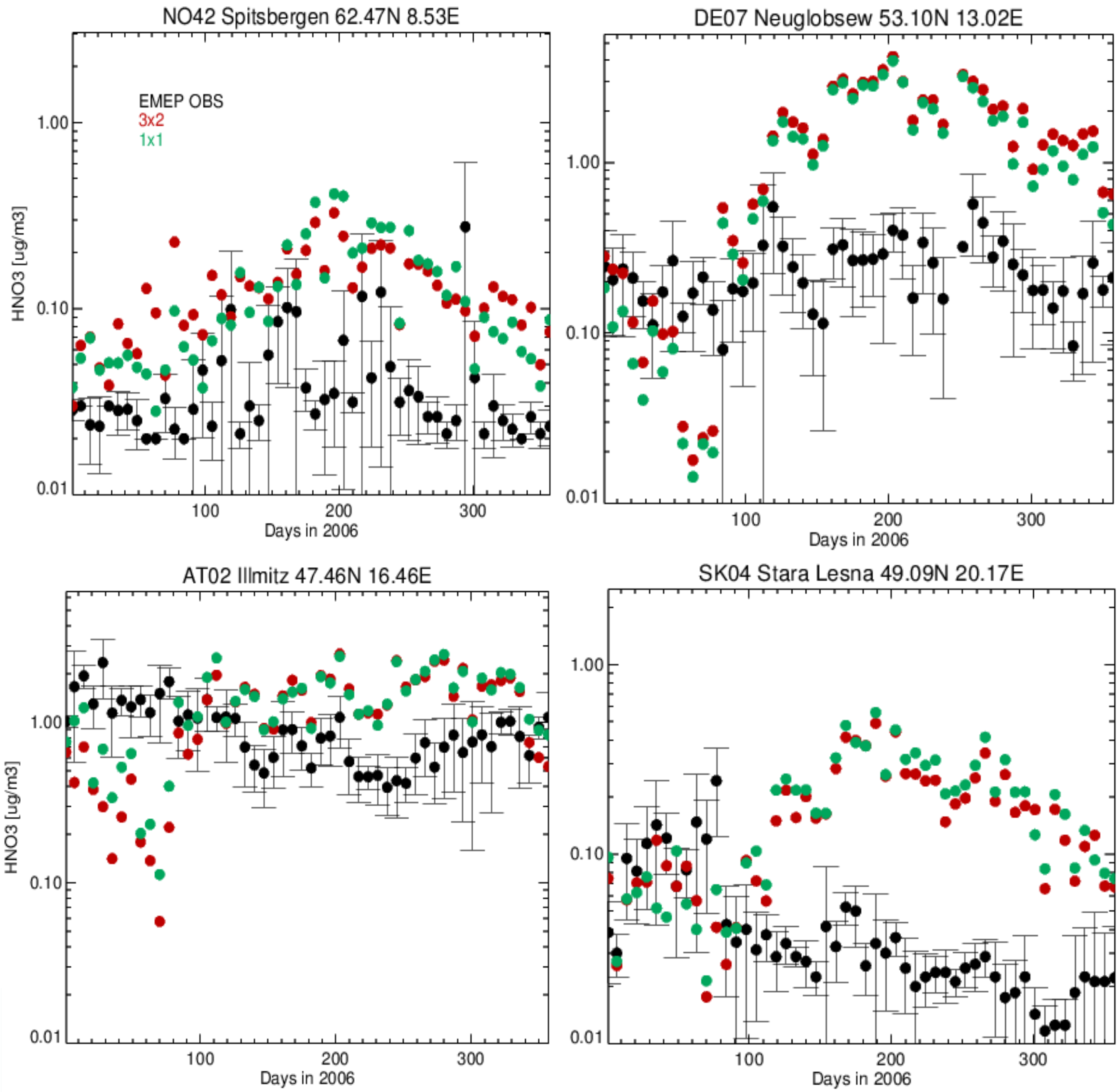








Surface HNO_3 (Europe) ; Weekly



- **Measurements show no seasonal cycle in [HNO_3]**
- **TM5-MP exhibits strong seasonal cycle (low spring)**
- **Similar [HNO_3] at 1°x1° for many weeks in polluted regions.**
- **High bias during boreal summertime across sites.**
- **No significant improvement at 1° x 1°**
- **EQSAM: How good is the conversion to NH_4NO3**

HNO_3 and PAN profiles

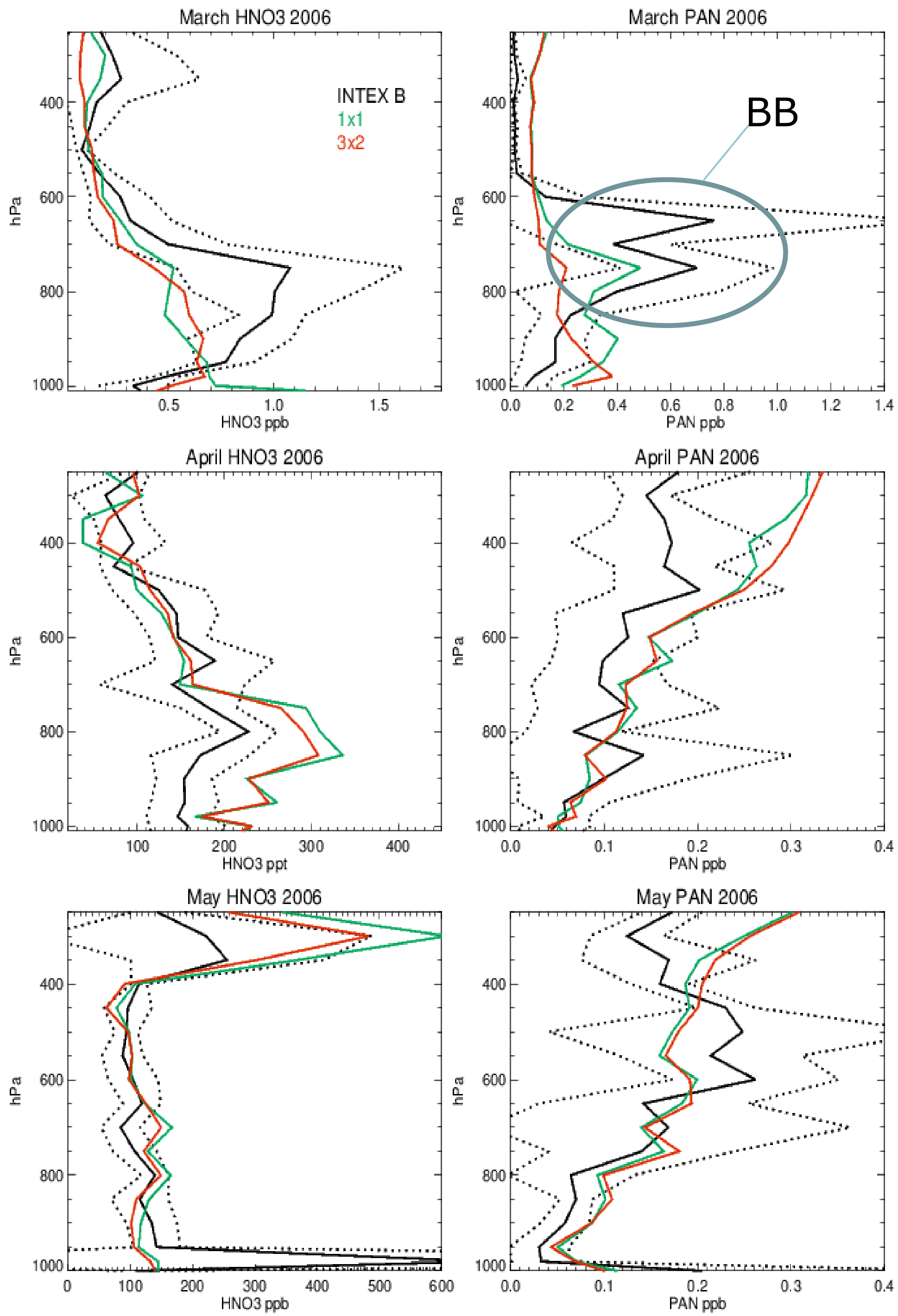
Vertical gradients captured rather well for both species.

HNO_3

- **Higher Burden at 1x1 by ~2%**
- **BL : Typically large biases for HNO_3**
- **FT/UTLS : TM5-MP captures well**

PAN

- **Indicates transport of polluted air captured better**
- **Minimal differences due to resolution**



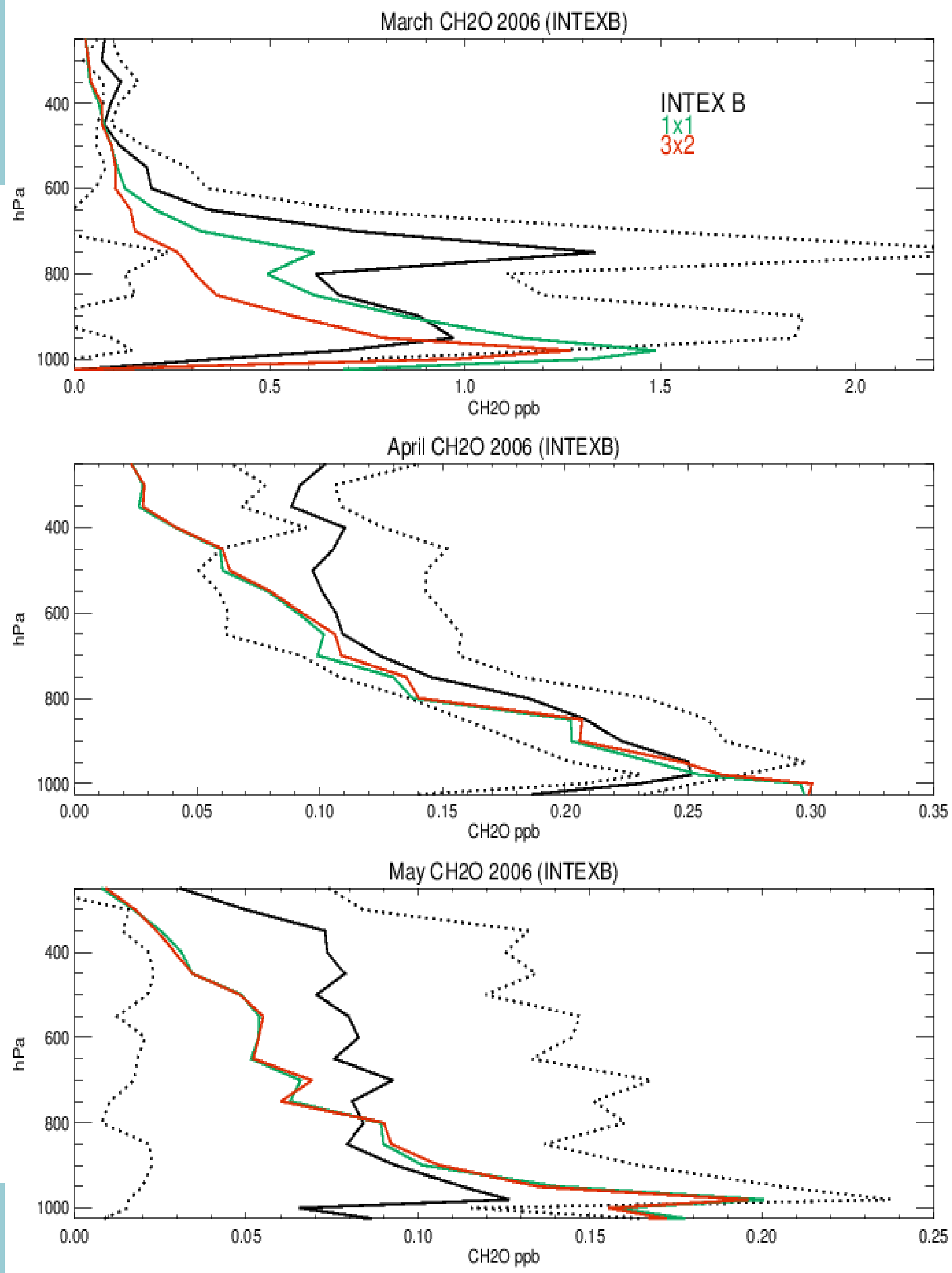
CH_2O profiles

•Previous intercomparisons have show global CTMS generally underpredict the CH_2O column in the SH and tropics
(e.g. Zeng et al., 2015)

•Comparisons show improvements at 1 x 1 are minimal in pristine locations.

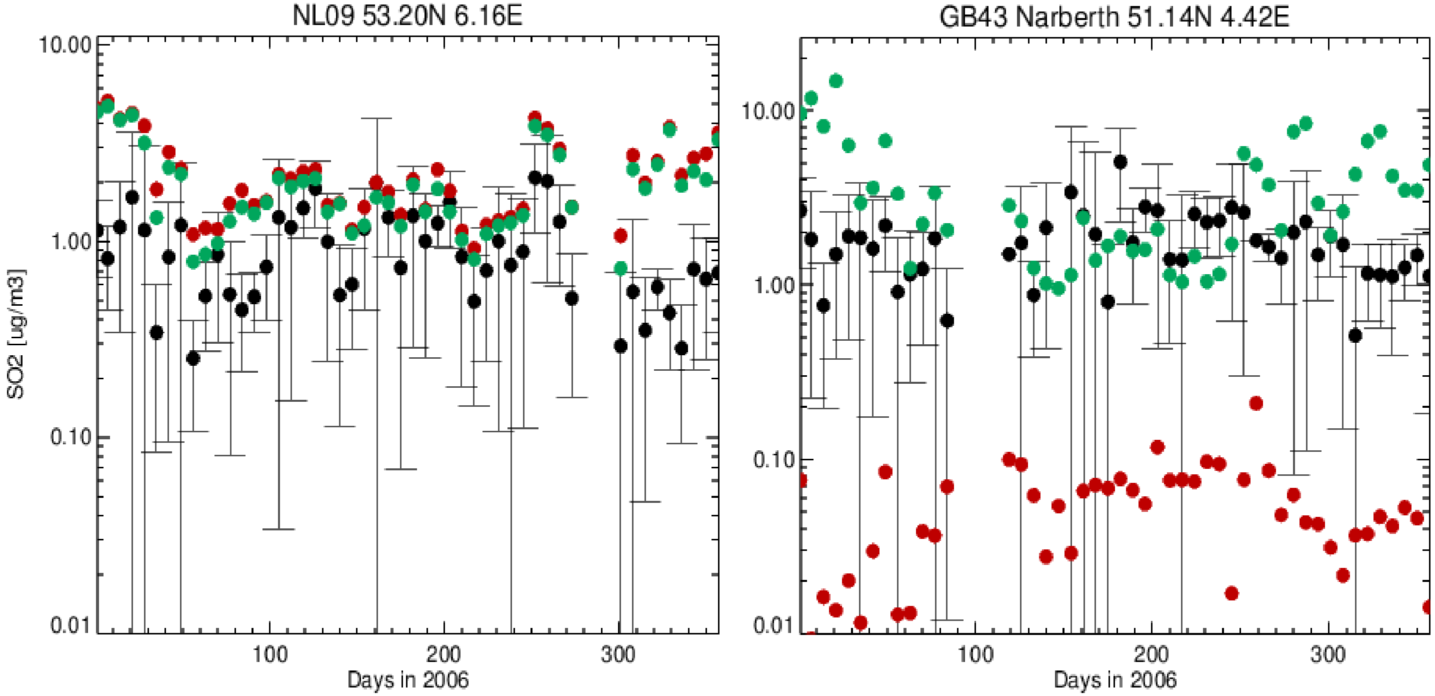
•Gradients are typically too steep

•Minimal differences due to resolution



Surface [SO_2] (Europe) : Weekly

LRT

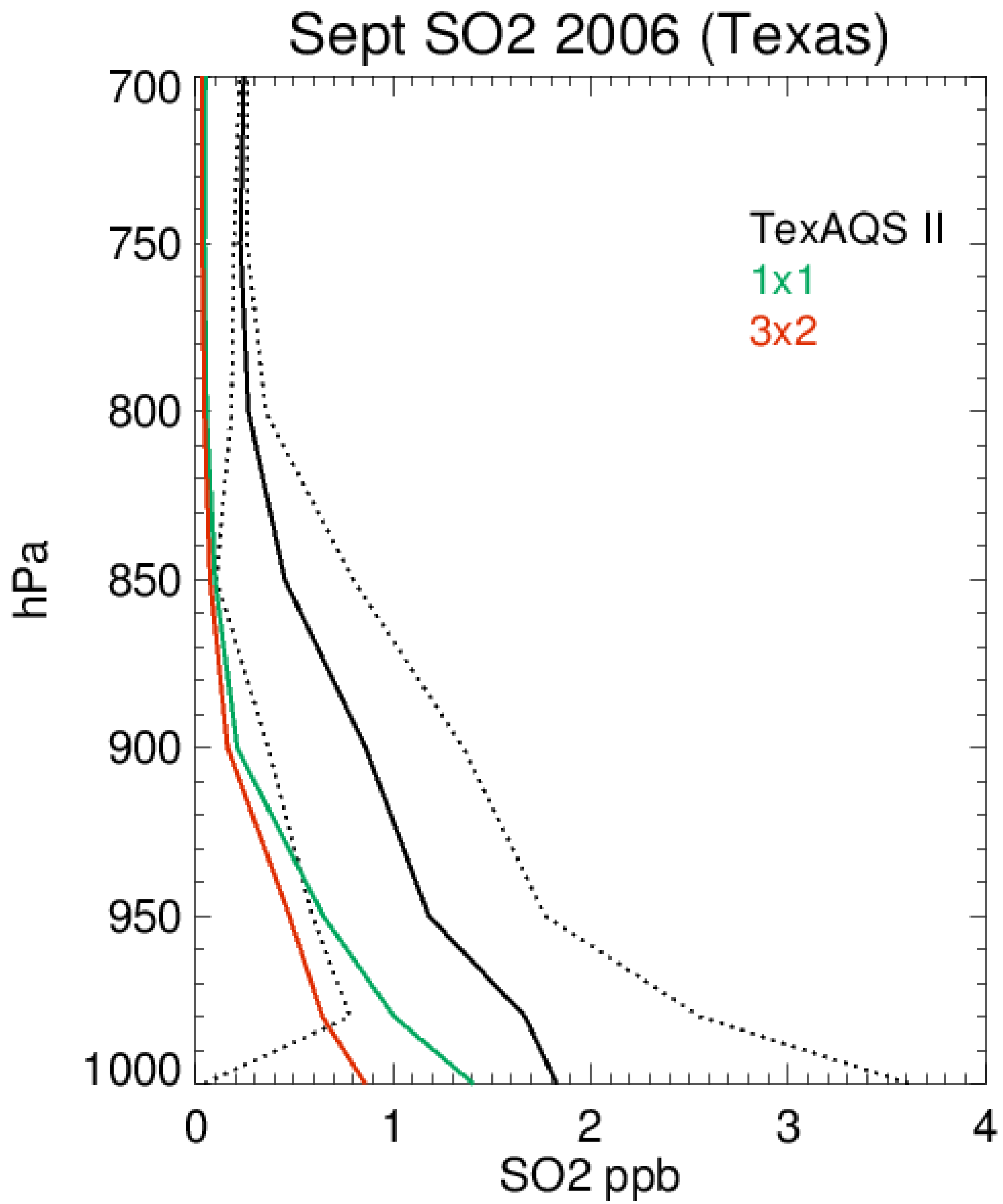


Temporal

- SO_2 from primary emission source therefore changes reflect improvements in temporal distribution
- Biases across all sites (22) : DJF ~25% improve, 25% degrade
  JJA ~ 30% improve, ~30% degrade

SO_2 profiles

- **Significant underestimate of integrated tropospheric column**
- **Low Bias reduced ~50% in the boundary layer at 1°x1°.**
- **Higher Global Burden at 1°x1° by ~3%**
- **Quality of comparison very dependent on the emission inventories employed.**



Conclusions

- **Increasing horizontal resolution introduces large hemispheric differences in tropospheric ozone and, thus, stratospheric exchange.**
- **Reduces surface bias in NH by ~3-5ppb. Does not close high bias in column.**
- **Although the temporal distribution of NO_x in TM5 is closer to the emission inventories only ~25% of cases exhibit an improvement.**
- **The NO/NO_2 ratio is consistently too high above ~800hPa suggesting too little recycling with peroxy-radicals.**
- **An artificial seasonal cycle exists in surface HNO_3 in Europe with a high bias during boreal summertime.**
- **HNO_3 and PAN are captured well in the background.**
- **Impact on CH_2O distribution is marginal.**
- **Improvements in SO_2 profiles above anthropogenic regions.**