Royal Netherlands
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Evaluating the performance of online photolysis during on 2006

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TM meeting, SRON, 25-11-10

Overview

- Introduction of the photolysis of O2
- Seasonal and regional differences in tropospheric composition.
- Global comparisons against measurements
- Chemical budget terms

Model set-up

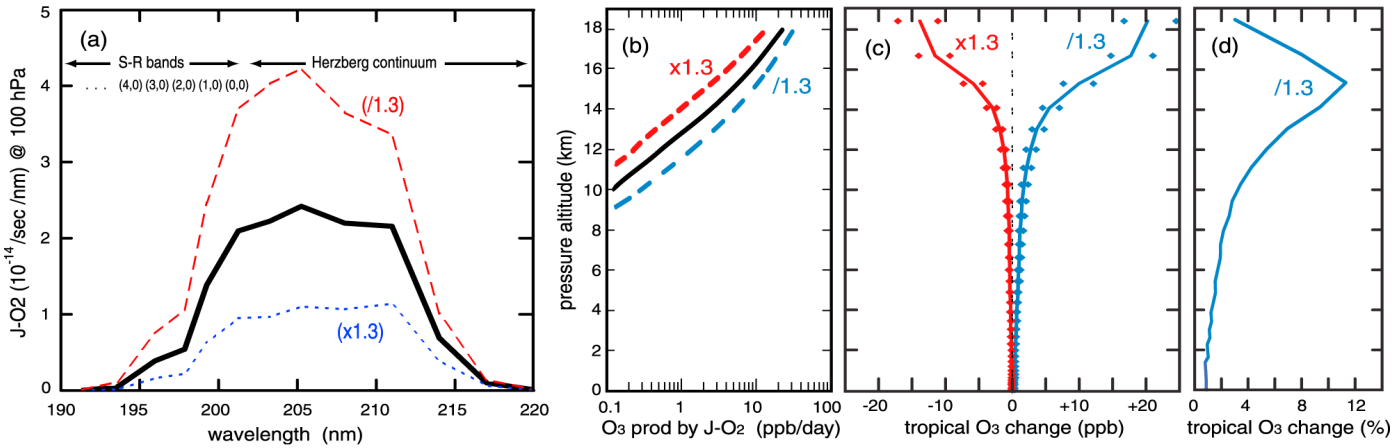
- Vertical resolution: 34 vertical layers (benchmark settings)
- Horizontal resolution: 3° x 2°
- ECMWF meteorology: ERA-interim re-analysis
- 1 year spin-up (1998) – 10 yr simulation (1999-2008)
- O3 column: Multi-Sensor Re-analysis (Van der A et al, 2010)

Emission inventories

- Anthropogenic : RETRO-REAS hybrid. Changing emissions for India/China/SE Asia (1999-2008)
- Biomass burning : GFEDv2 monthly or 8-day (where available)
- Biogenic : GEIA/Lathiere

CLIMATE simulation ongoing: fixed anthropogenic dataset for 2000

Addition of J_{O2}



Prather, GRL, 2009

Additional Reactions

$$O_2 + hv \rightarrow O^{3P} + O^{3P}$$

$$O^{3P} + O_2 \rightarrow O_3$$

$$O^{3P} + O_3 \rightarrow$$

O^{3P} is not explicitly declared in EBI scheme of TM5 !!

Old vs New approach

- Global J values not constrained using tropical AFGL profile in online approach.

- Updated absorption co-efficients (σ) and quantum yields (ϕ) for most J values.

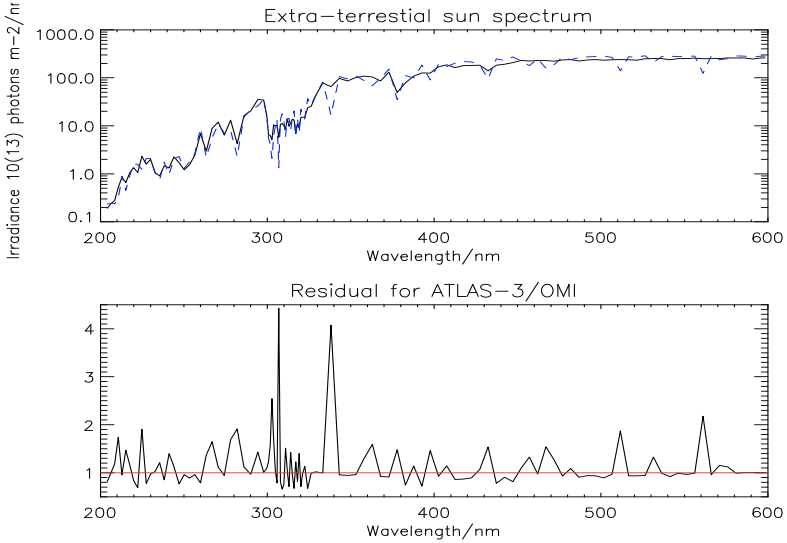
- Use of different band limits/scaling λ for $\theta > 71°$.

- Application of constraints for calculating scaling ratios (F_{abs} cannot be too small).

Error analysis vs full RT solution presented in Williams et al (2006)

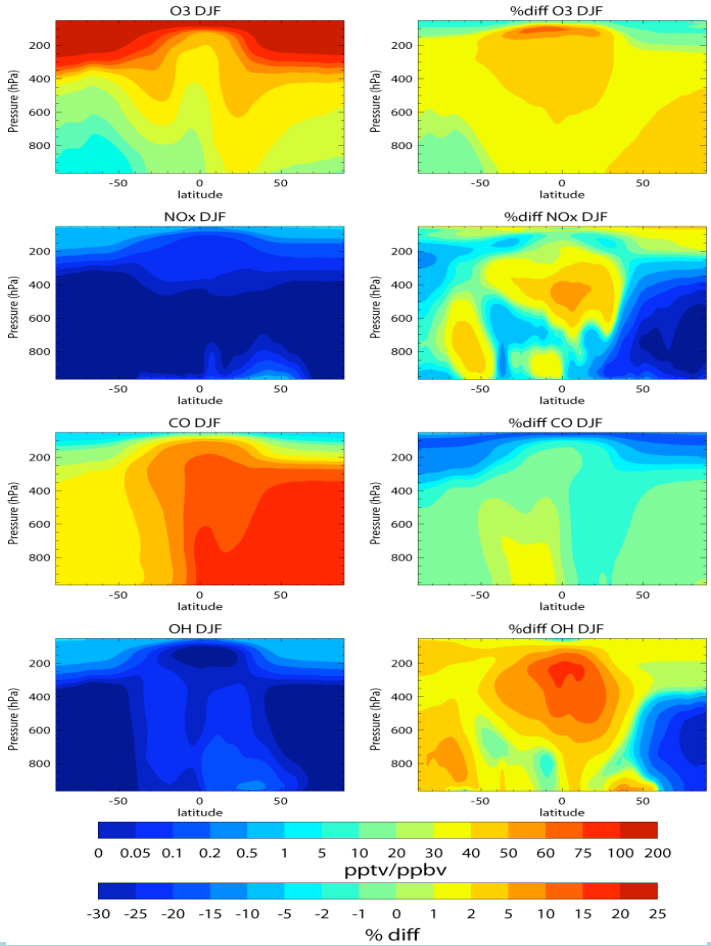
Old vs New approach

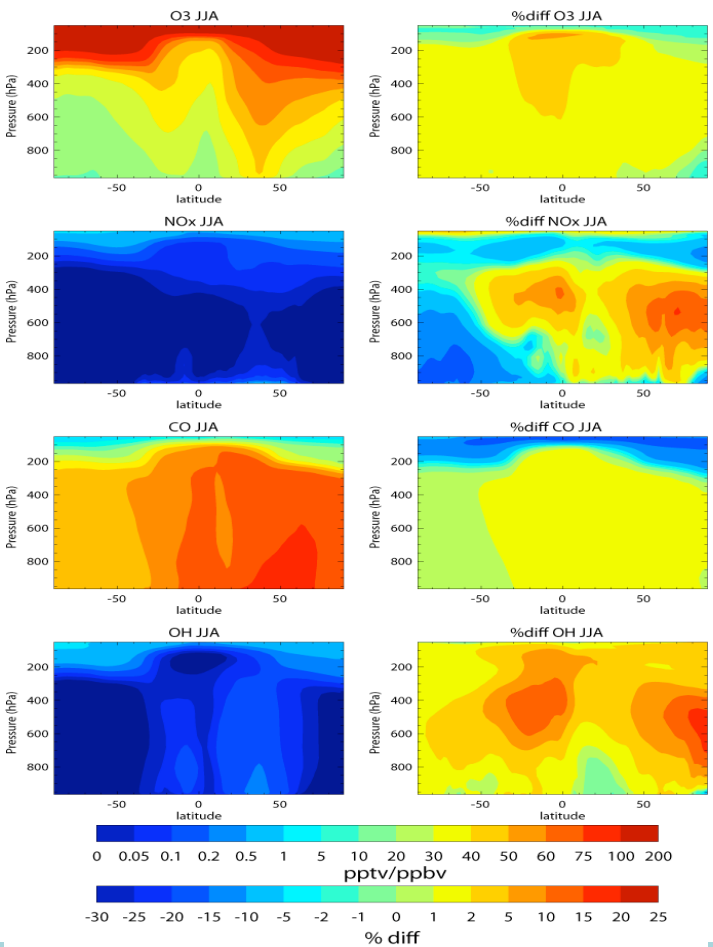
- Adopting of new TOA solar spectrum (Dobber et al., 2008)



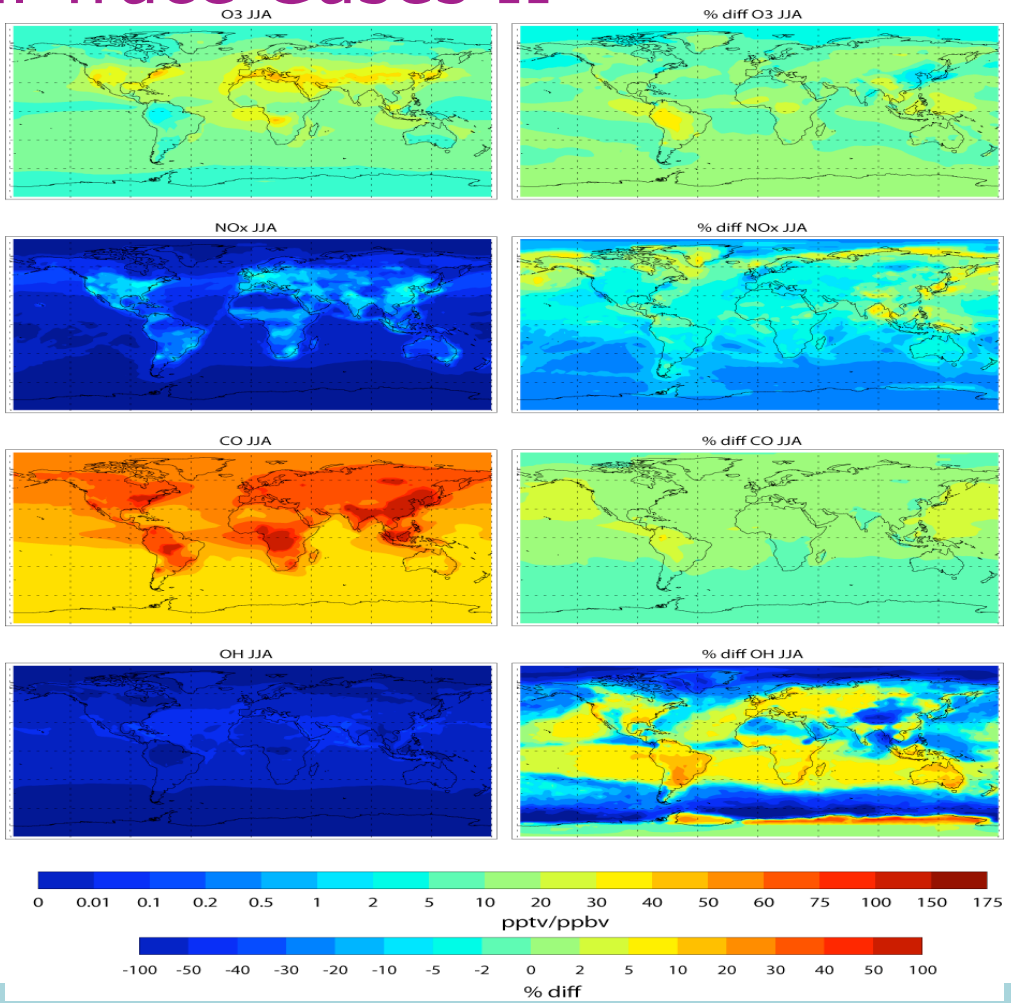
Typically larger differences
In the UV spectral region than
The visible

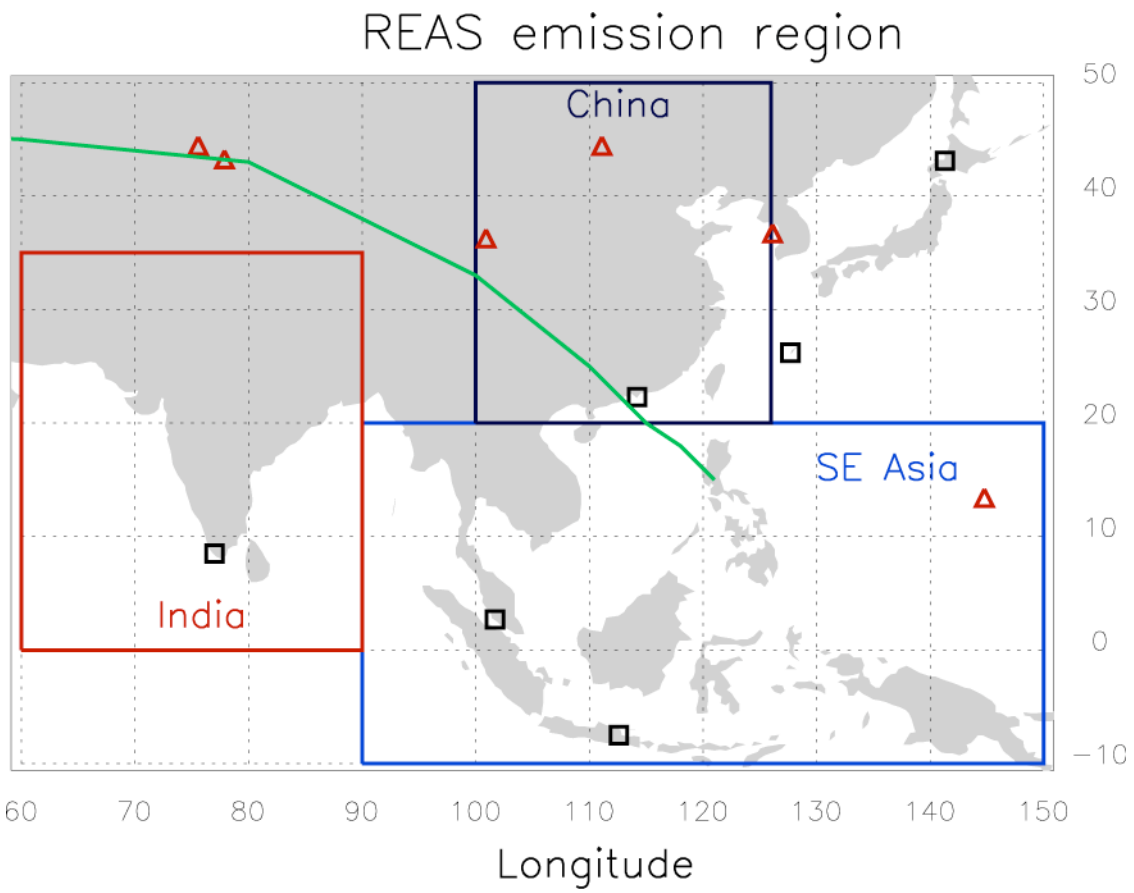
Differences in Seasonal Trace Gases I





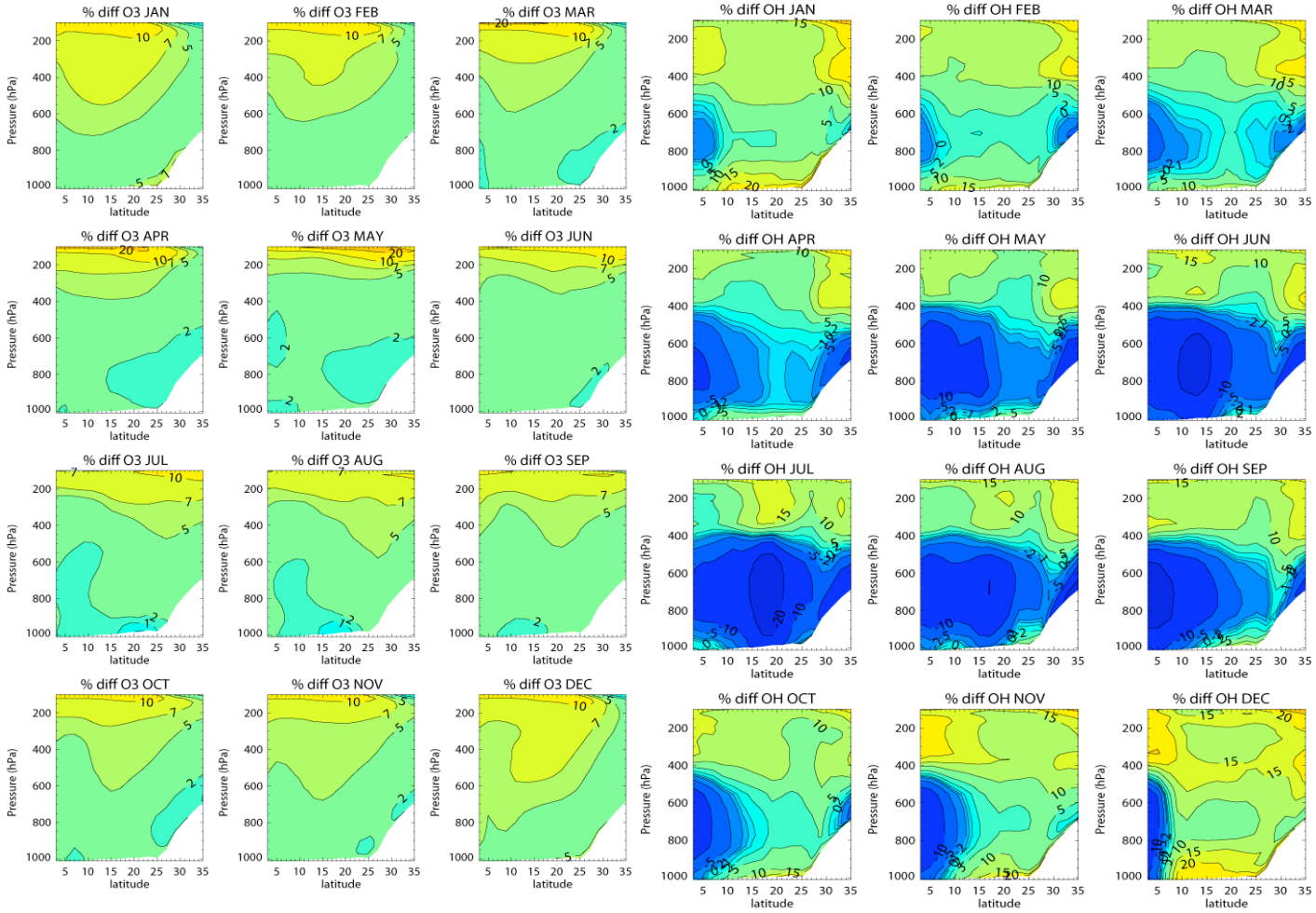
Differences in Seasonal Trace Gases II



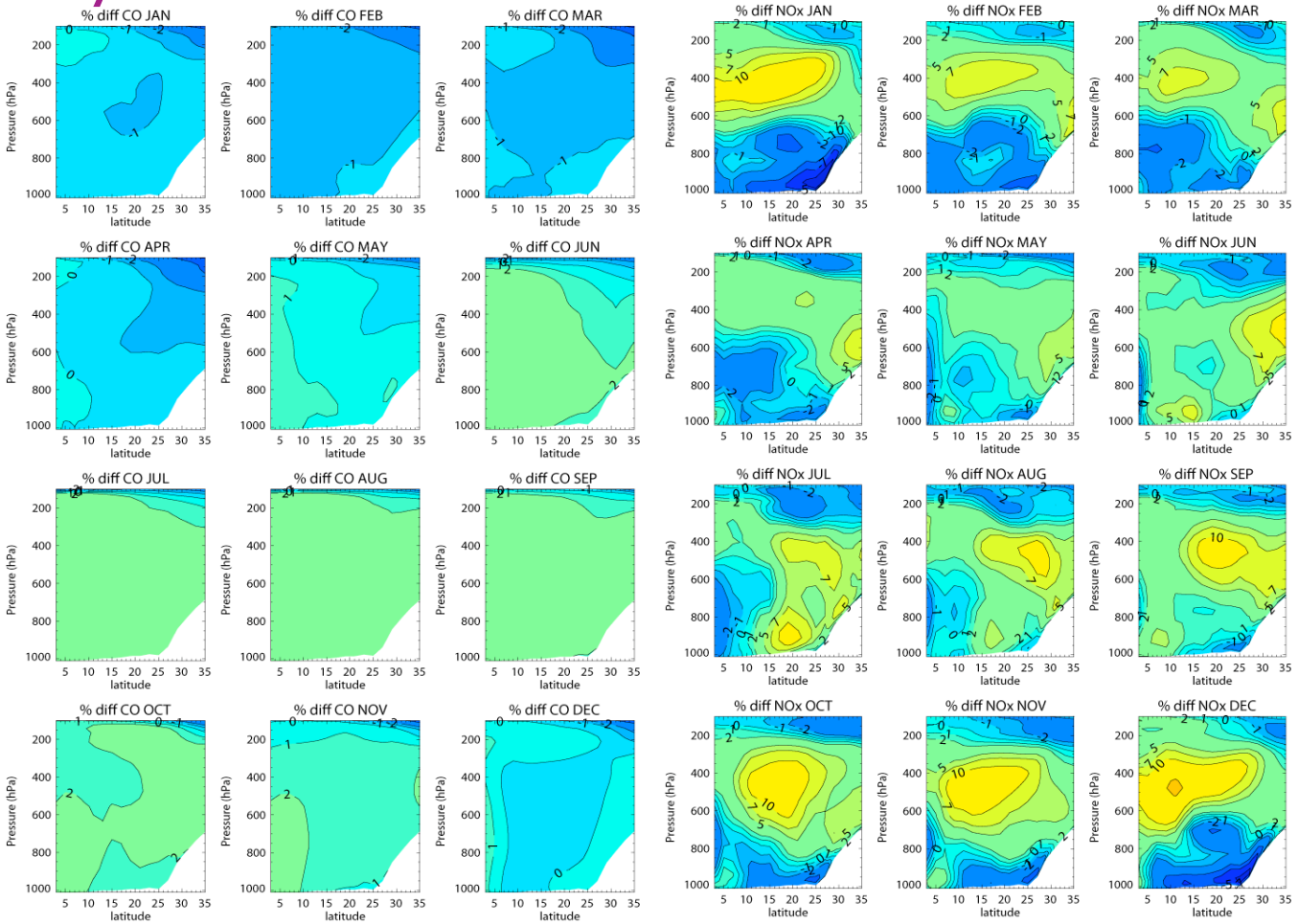


Δ CMDL surface stations □ Ozonesonde stations — CARIBIC flights

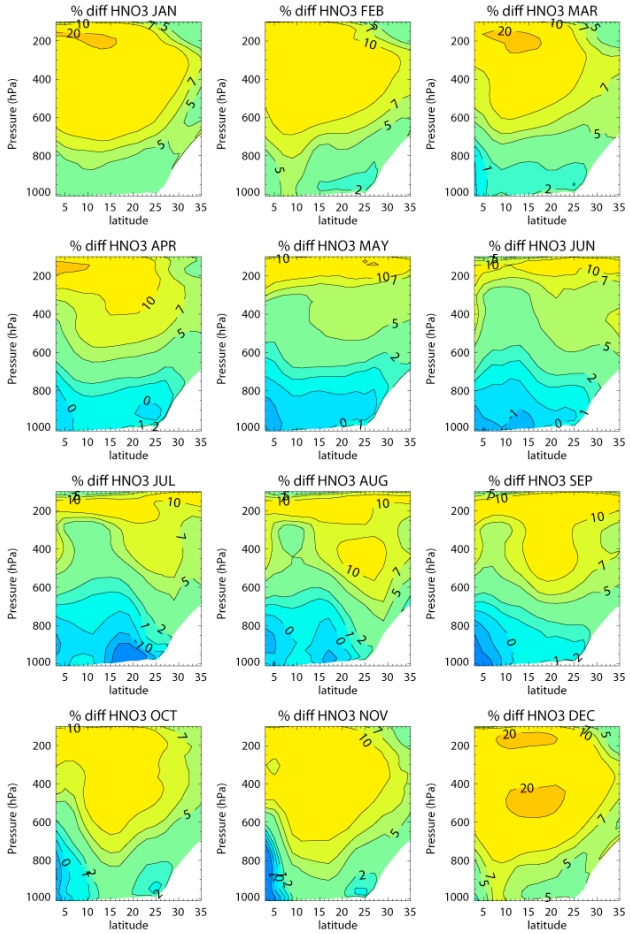
Monthly differences over India : O_3 and OH

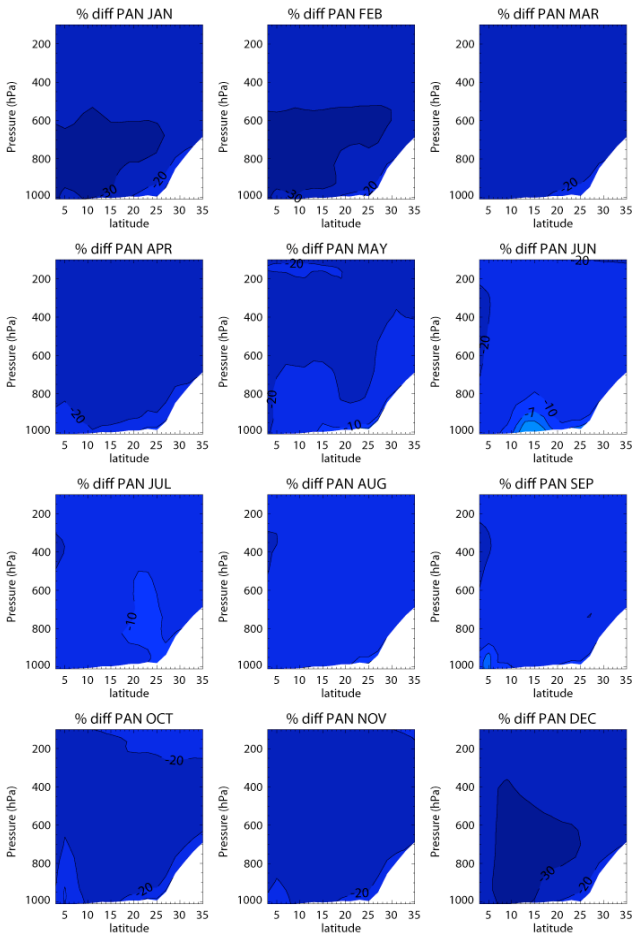


Monthly differences over India : CO and NOx



Monthly differences over India : N Reservoirs



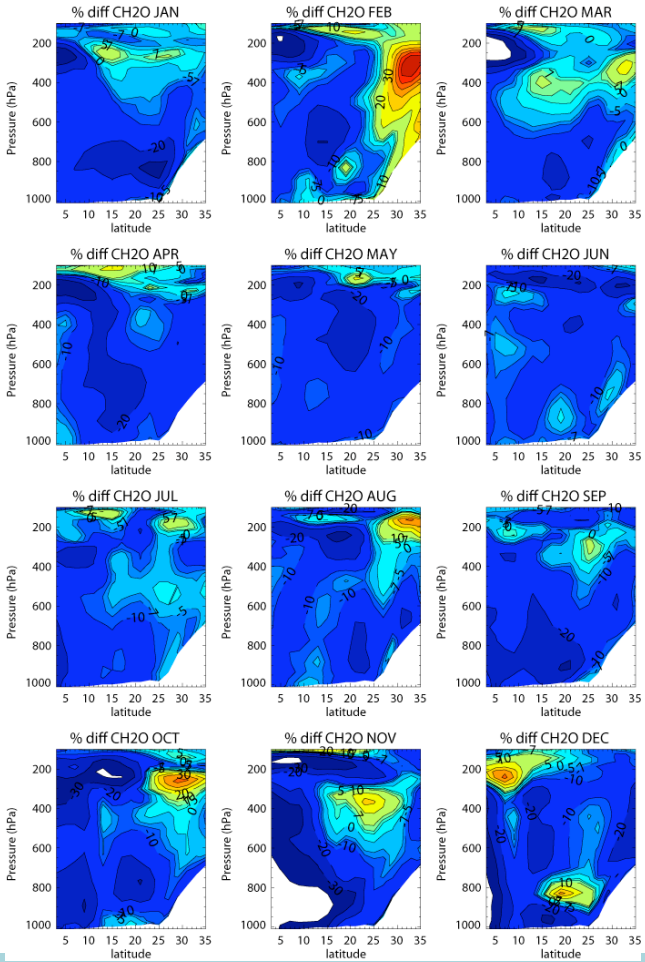


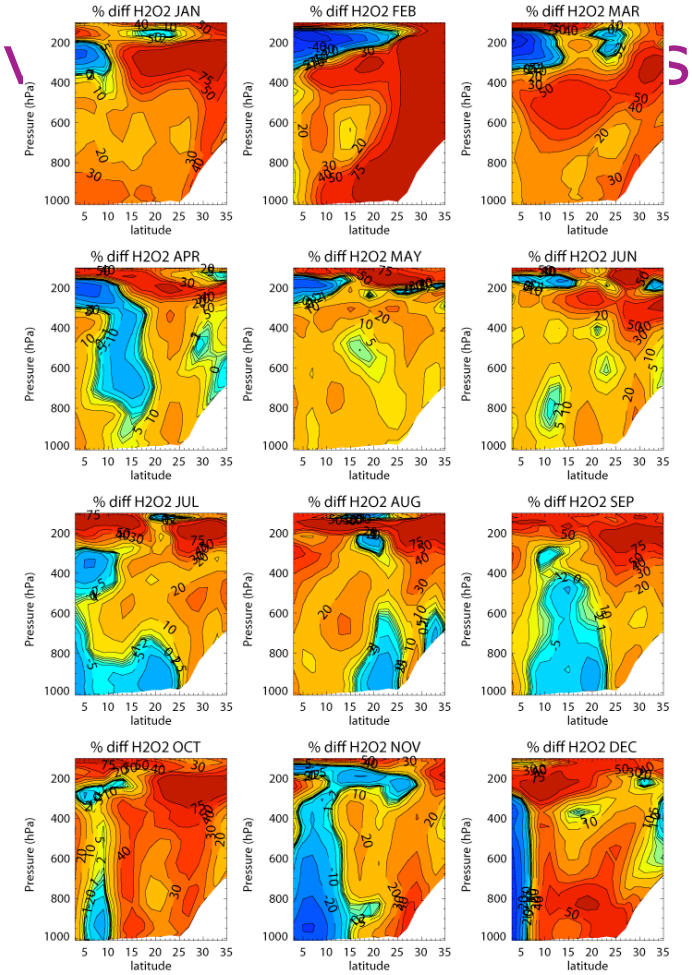
~4% global increase in loss of N via wet dep of HNO3 (~1 Tg N yr^{-1})

~8.8% global decrease in loss of N via wet dep of ORGNTR(~1 Tg N yr-1)

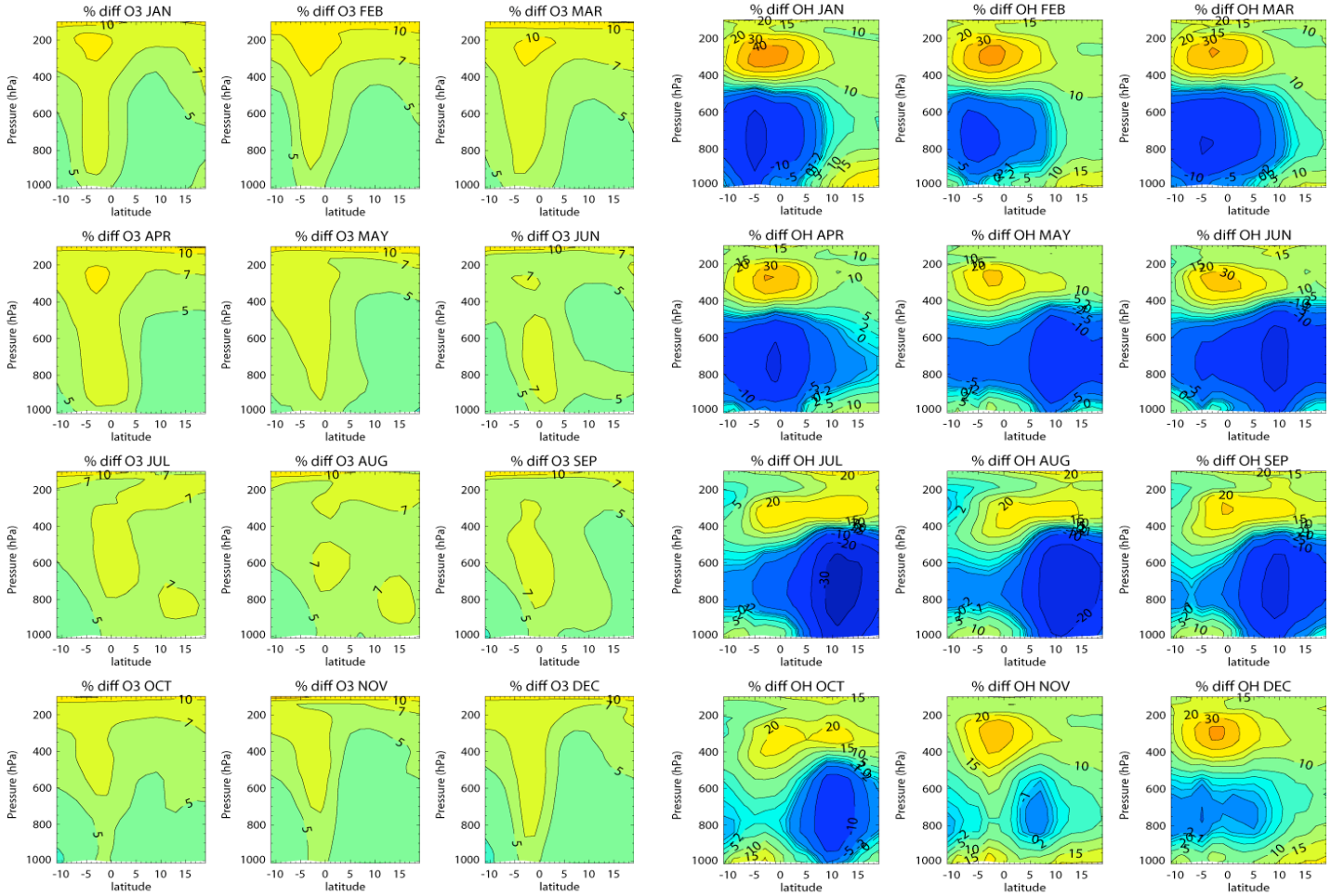
~27% decrease in global [PAN]

Monthly differences ov servoirs

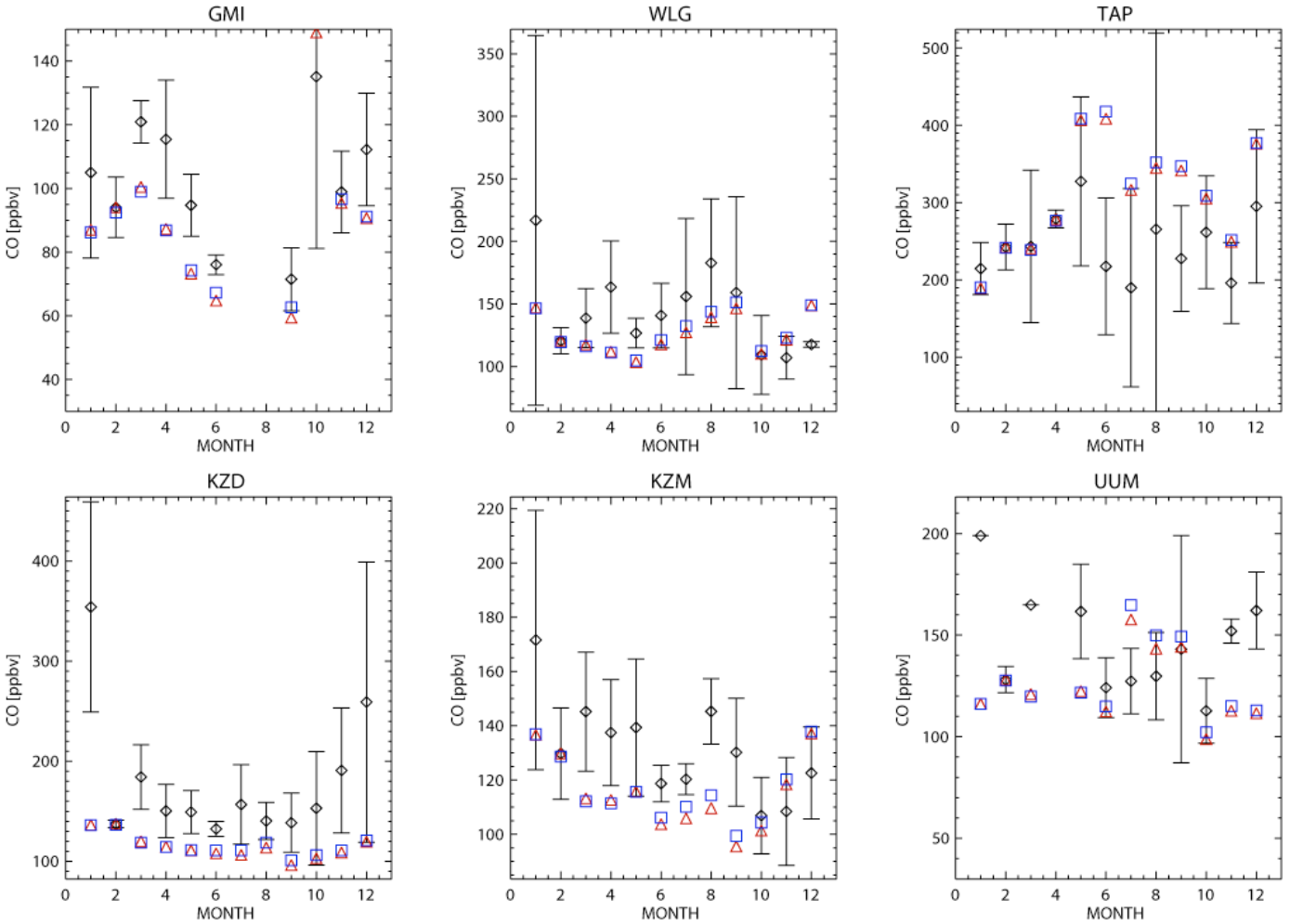




Monthly differences over SE Asia : O_3 and OH



CMDL CO comparisons in REAS region

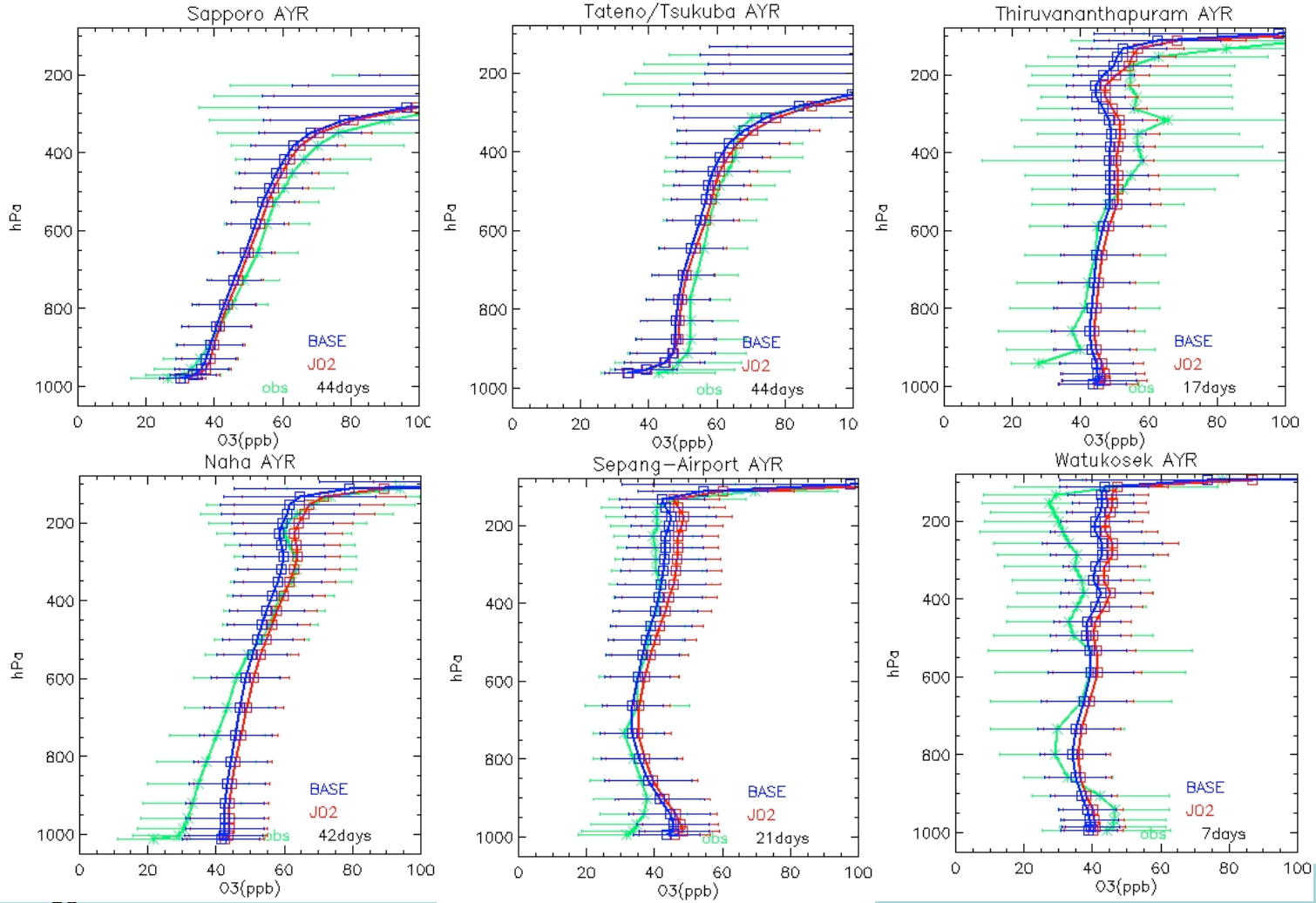


Δ OFFLINE PHOTO (BASE)

□ ONLINE PHOTO (JO2)

2-5% increase with ONLINE

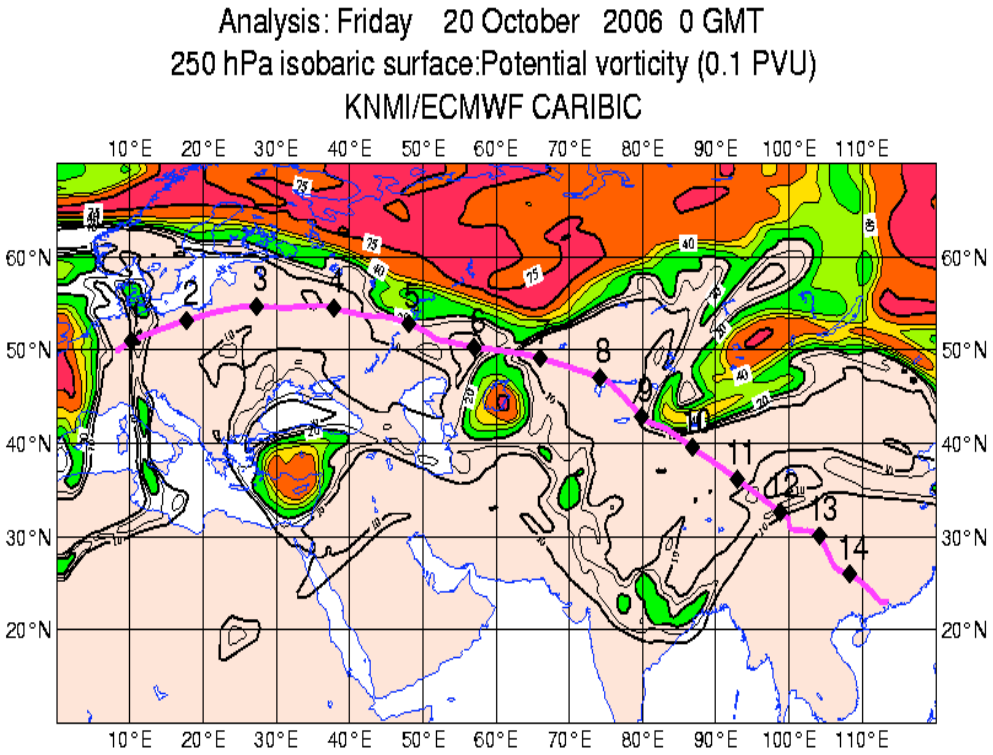
Ozonesonde comparisons in REAS region

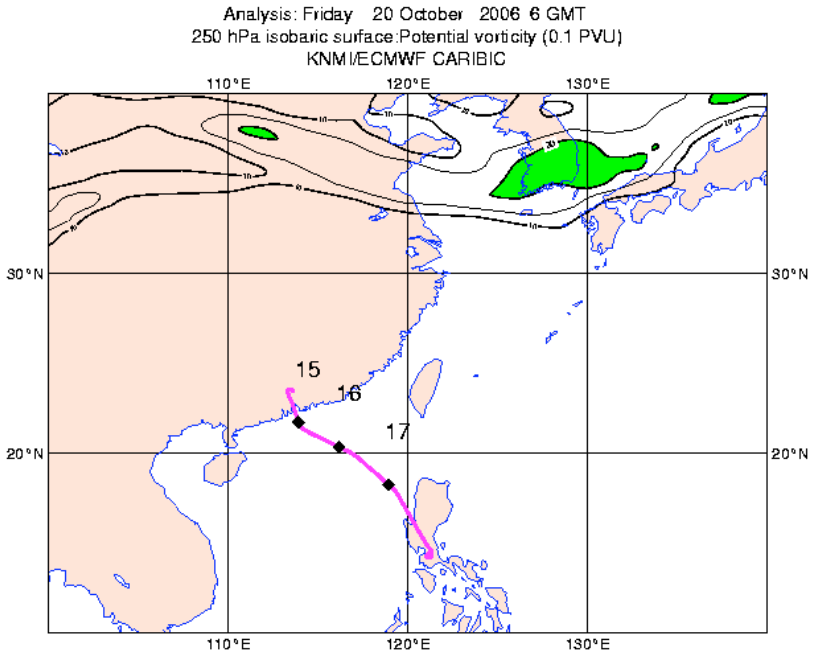


OFFLINE PHOTO (BASE)

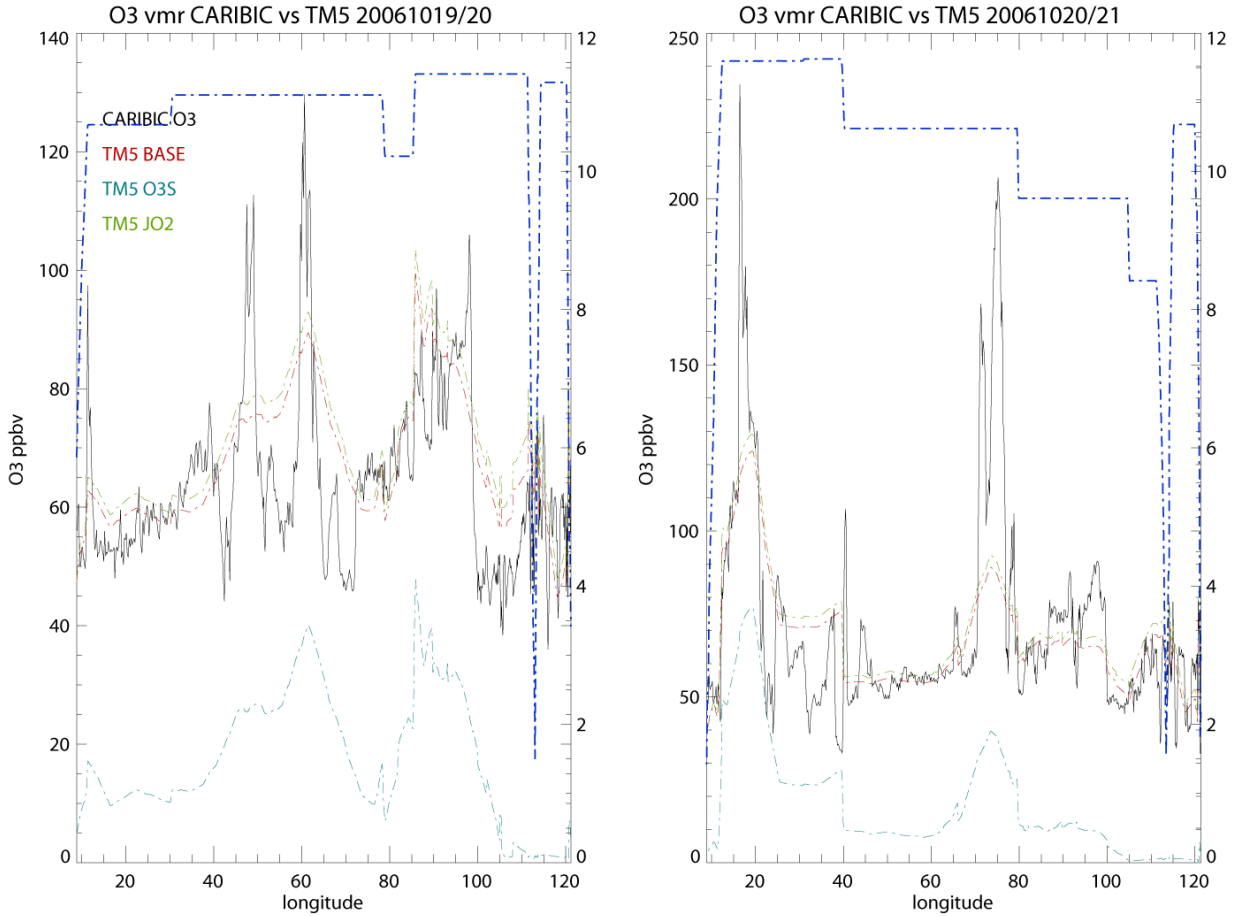
ONLINE PHOTO (JO2)

CARIBIC comparisons: Oct and Dec 2006





CARIBIC O3 comparison



Global OH Budget (2006)

	Huijnen et al. (2010)	**BASE**	**NEWPHOTO**
$O(^1D) + H_2O$	1578 (1273)	1592 (1285)	1558 (1263)
$NO + HO_2$	956 (691)	997 (716)	1035 (745)
$O3 + HO_2$	392 (265)	399 (274)	423 (291)
Remainder	406 (322)	407 (320)	363 ()
Total production	3332(2551)	3394 (2595)	3378 (2585)

Global O3 budget (2006): Tg O_3 yr^{-1}

	Huijnen et al. (2010)	BASE	NEWPHOTO
Trop. Chem. prod	4289 (3108)	4478 (3239)	4575 (3314) (+2.1%)
Trop. Chem. loss	3881 (2950)	3951 (3016)	3994 (3051) (+1.1%)
Deposition	829 (426)	836 (432)	863 (449) (+3.2%)
Strat influx	421	309	282 (-8.7%)
BO3	312	318	329 (+3.5%)
τO3 (days)	24.2	24.2	24.7

Global CO budget (2006)

	Huijnen et al. (2010)	BASE	NEWPHOTO
Emissions	1159 (770)	1146 (762)	1146 (762)
Trop. Chem. Prod	1169 (917)	1191 (921)	1260 (987) (+5.8%)
Trop. Chem. Loss	2120 (1587)	2126 (1589)	2187 (1634) (+2.9%)
Deposition	184 (105)	178 (98)	182 (101) (+2.2%)
BCO	353 (188)	324 (178)	329 (181) (+1.5%)
τCO (days)	55	55	51 (-7.3%)

Increase in ALD2 + hv and HCHO +hv account for ↑ in *in-situ* production

Conclusions

•New online photolysis routine has been run continuously for a decade without any significant degradation in abundant trace species (e.g.) CO and O3.

• In general improvements occur for O3 throughout the troposphere when compared to measurements.

•Increases in CO are limited to a few percent due to an increase in the oxidation capacity of the troposphere.

• For CO and O3 there is an increase in the tropospheric burden of ~7% and a decrease in the atmospheric lifetime of a few percent.

•Next steps: compare CH2O (SCIA/AMMA), PAN (AMMA), HNO3 (AMMA), NO2 (OMI)