Zooming in(to) the TM5 tropospheric chemistry benchmark version

Vincent Huijnen

Crete, June 2010

TM5-Benchmark study of trop. gas-phase chemistry

Specs:

- Uses proj/chem/base/branches/merge (m7-stuff is switched off)
- Evaluated on glb3x2, 34L (od-meteo) for the year 2006, using modified RETRO emissions
- Focus on large scale features & global budgets
- Detailed model documentation & evaluation submitted to GMDD
- Output model data is stored at ecfs:/nk9/benchmark/merge/TM06Y4B
- IDL Post-processing tools available from huijnen@knmi.nl
- The name of this version is: TM5-chem-v3.0, and chemistry-part can be retrieved from svn with revision number 3304

Some interesting budgets (Tg yr^{-1})

OH production

$O(^1D)+H_2O$	1578
$NO+HO_2$	956
O_3+HO_2	392
Remaining	406
Total gain (Tg /Tmol)	3332 / 196

CO

Emissions	1159	Deposition	184
Trop. Production	1169	Trop. Loss	2120
Strat. Production	15	Strat. Loss	44
Total gain	2343	Total loss	2348
Total burden	353	Lifetime (days)	55

CH_4

Trop. OH loss	475
Strat+surf loss Assumed:	70
Lifetime (whole atmosphere)	7.9 yr
Trop. Burden	4826

Stevenson: 8.45 yr +/- 0.38

O_3 ***Stevenson: 556 Tg +/- 154***

Stratospheric inflow	421	Deposition	829
Trop.prod.	4289	Trop. loss	3881
Trop. Burden	312	Lifetime (days)	24.2

Stevenson: 22.2 days +/- 2.2

Strat-Trop Exchange: metrics & evaluation

Model - method	STE-flux
TM5-chem-v3.0 - f1a	421
TM5-chem-v3.0 - f2	454
TM5-chem-v3.0 - f3	637
TM4 / TM5 (Stevenson) - f1b	508 / 871
Ensemble (Stevenson) - f1b	556 +/- 154

Definition of troposphere:

f1a: monthly mean, zonal-average [O3] < 150 ppbv

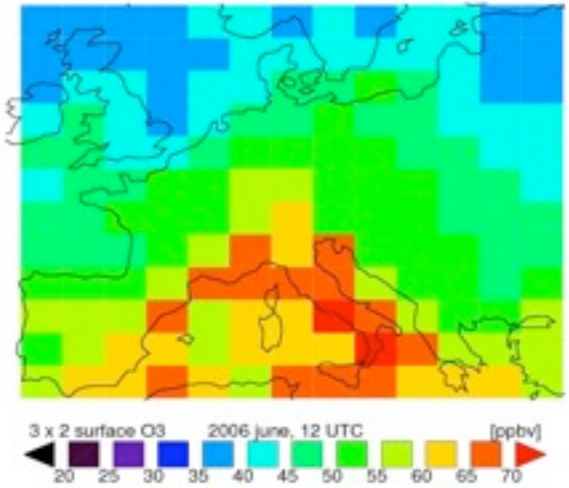
f2: Troposphere: extra-tropics: p > 220 hPa ; tropics p > 100 hPa

f3: O3t marked tracer

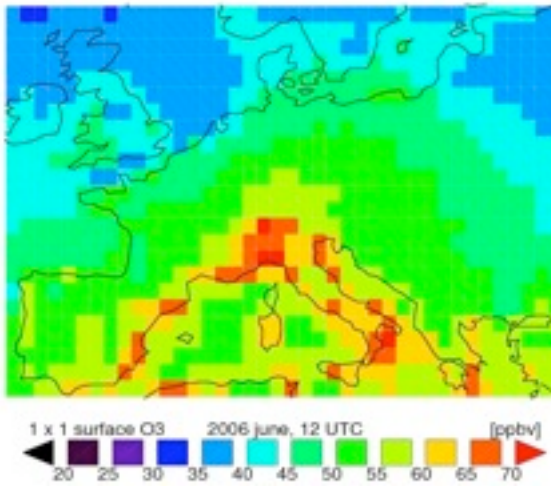
f1b: Stevenson et al. (2006): “monthly mean [O3] < 150 ppbv

Surface O3 in TM5 zoom run; June 2006

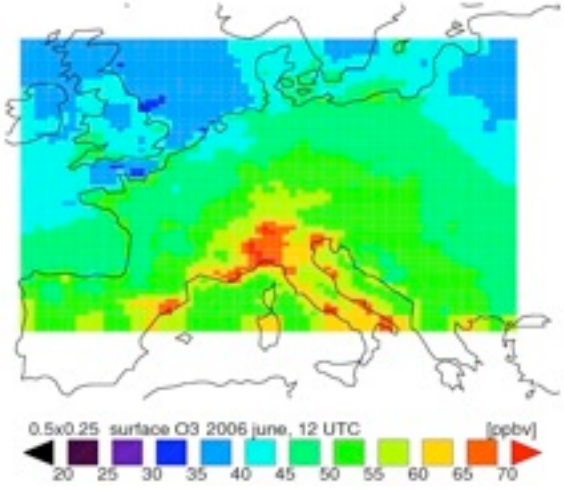
Model monthly mean @ 12 UTC



3x2

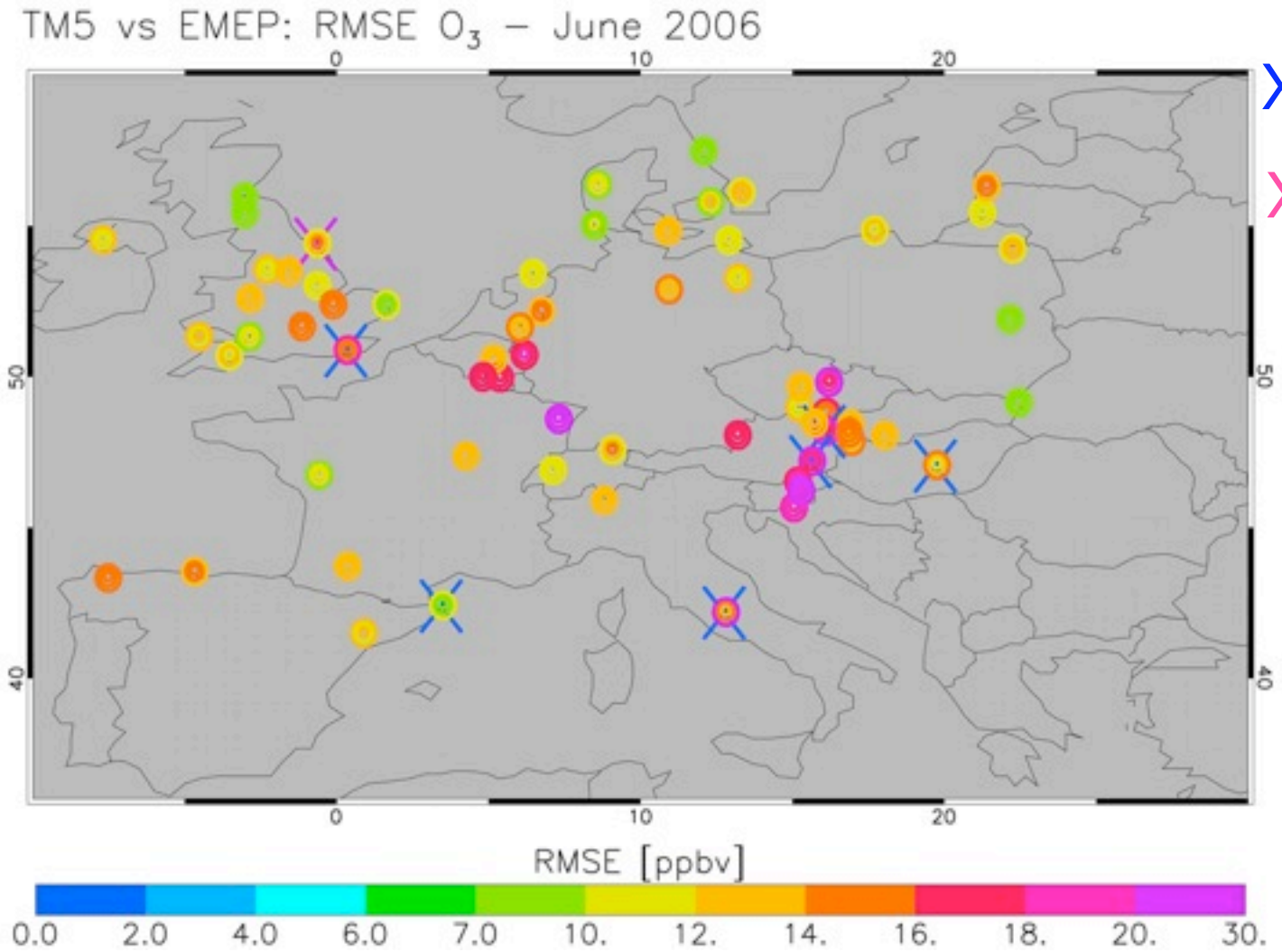


1x1



0.5x0.25

Evaluation of surface O3 in TM5 zoom run



X: improvement

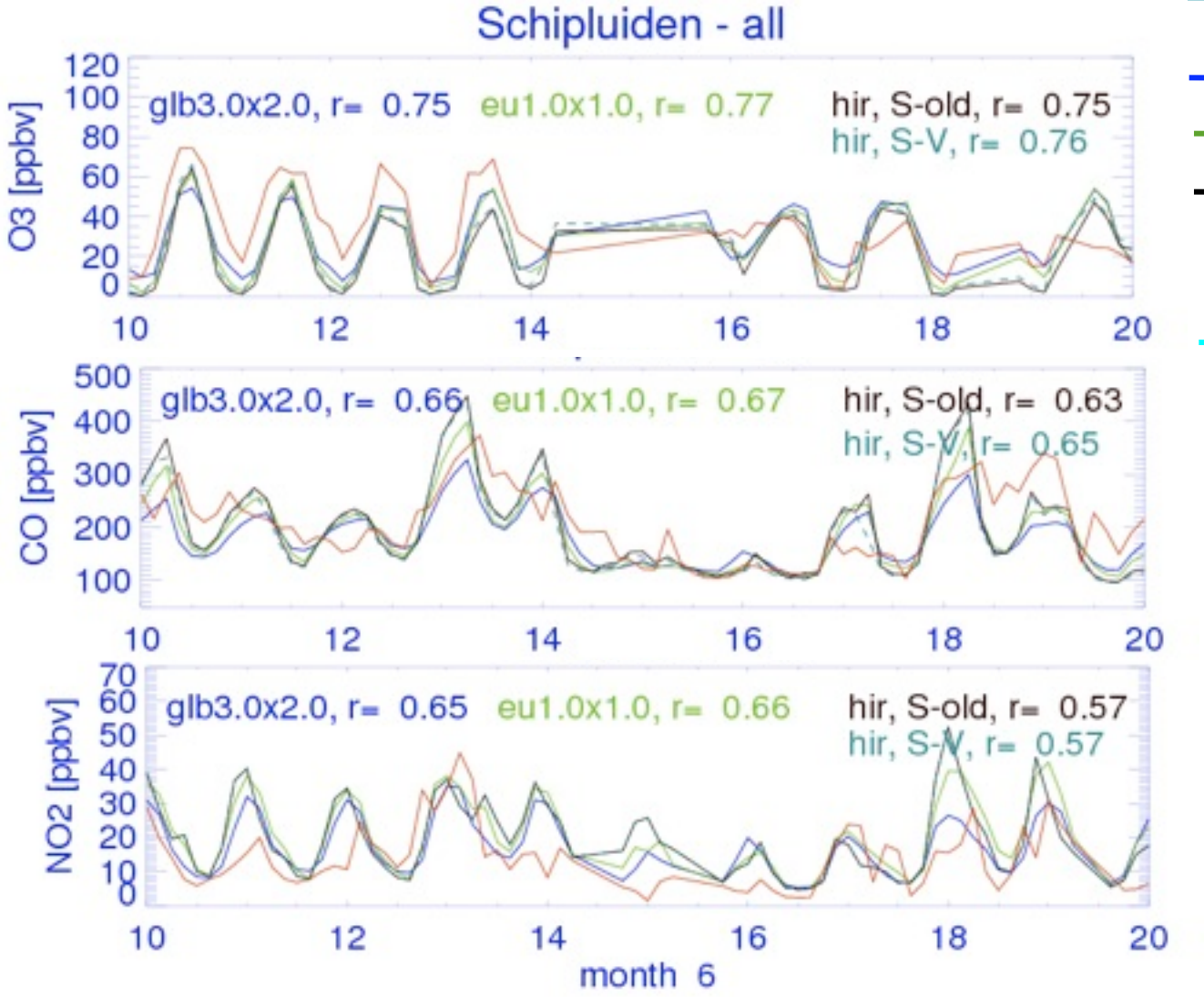
X: gets worse

3x2

1x1

0.5x0.25

O3, CO and NO2 at LML station 'Schipluiden'



3x2 deg

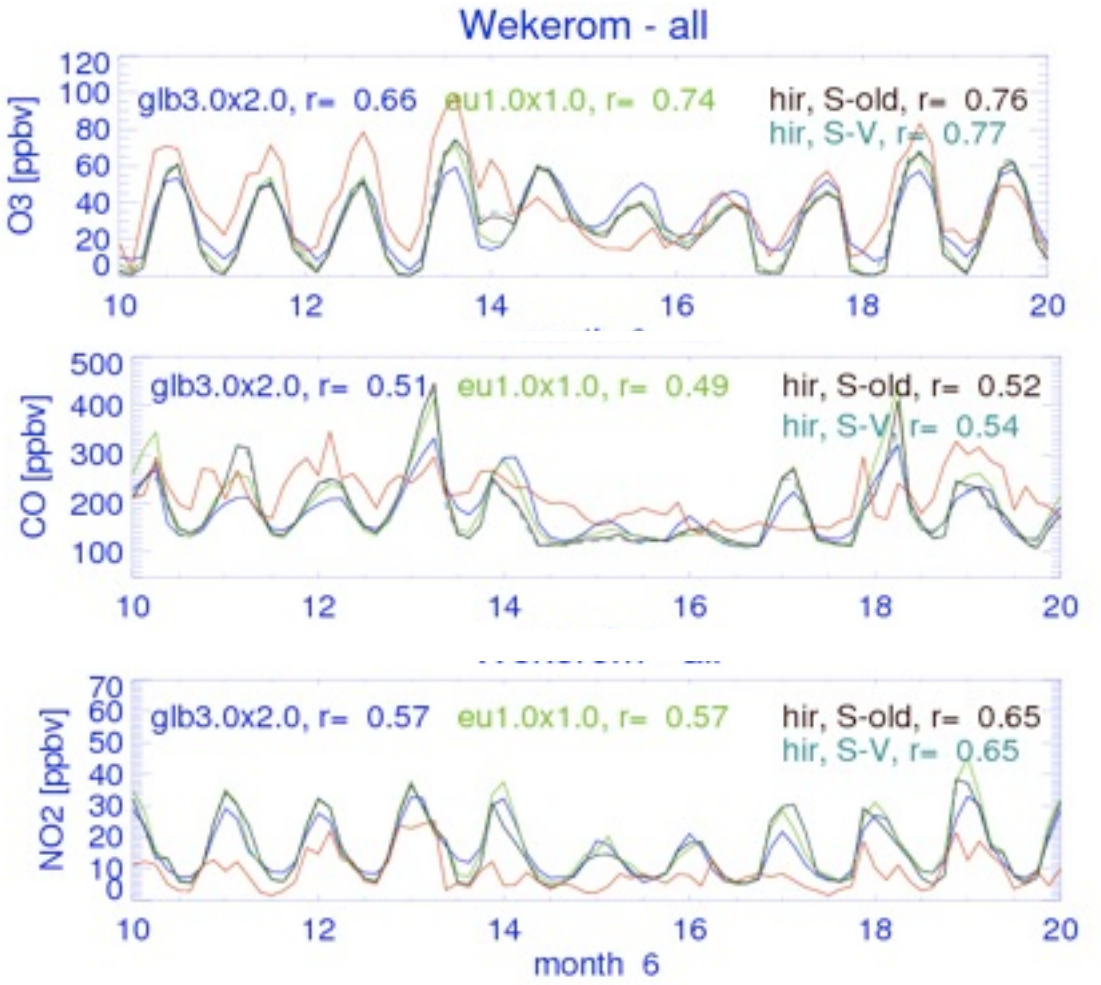
1x1 deg

.5x.25 deg, *Sampling at end*

.5x.25 deg, *Sampling after 'v'*

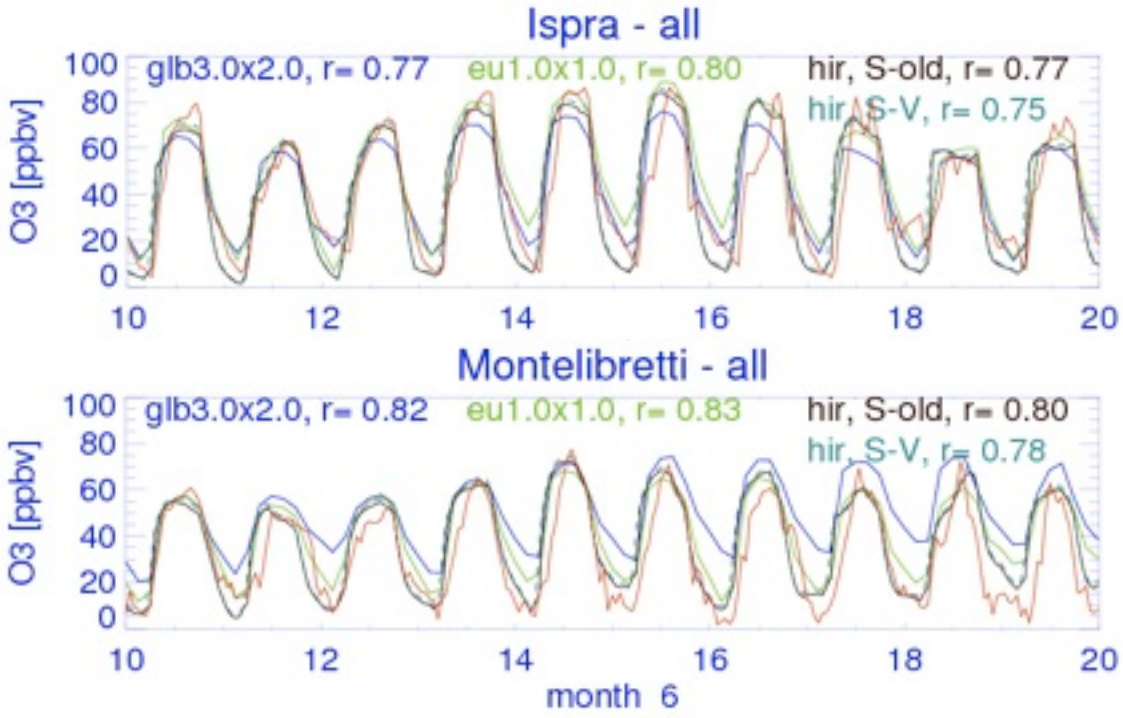
obs

O3, CO and NO2 at LML station 'Wekerom'



- 3x2 deg
- 1x1 deg
- .5x.25 deg, *Sampling at end*
- .5x.25 deg, *Sampling after 'v'*
- *obs*

O3 at other (EMEP) stations



3x2 deg

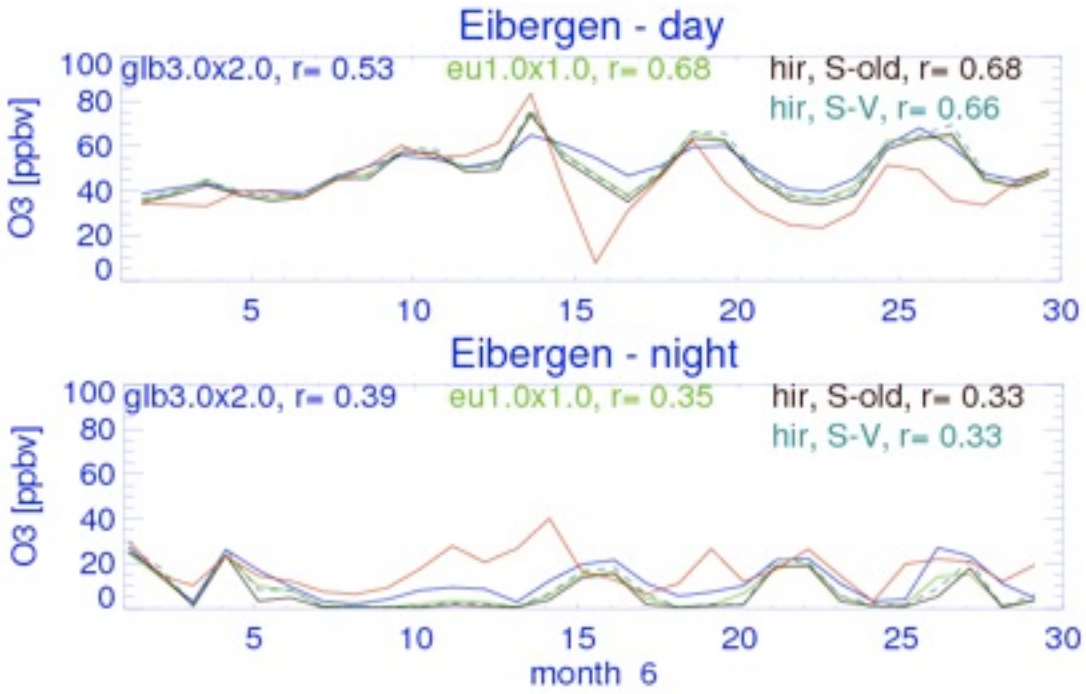
1x1 deg

.5x.25 deg, *Sampling at end*

.5x.25 deg, *Sampling after 'v'*

obs

O3 evolution taking 15h or 3h values…



3x2 deg

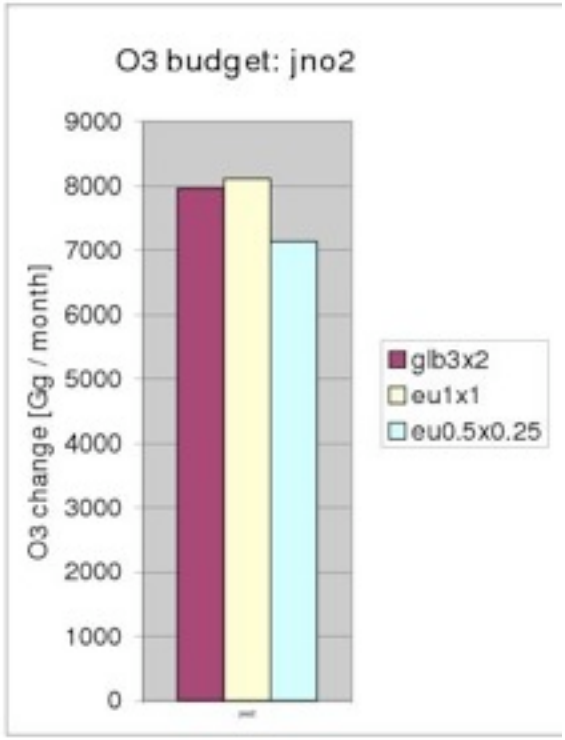
1x1 deg

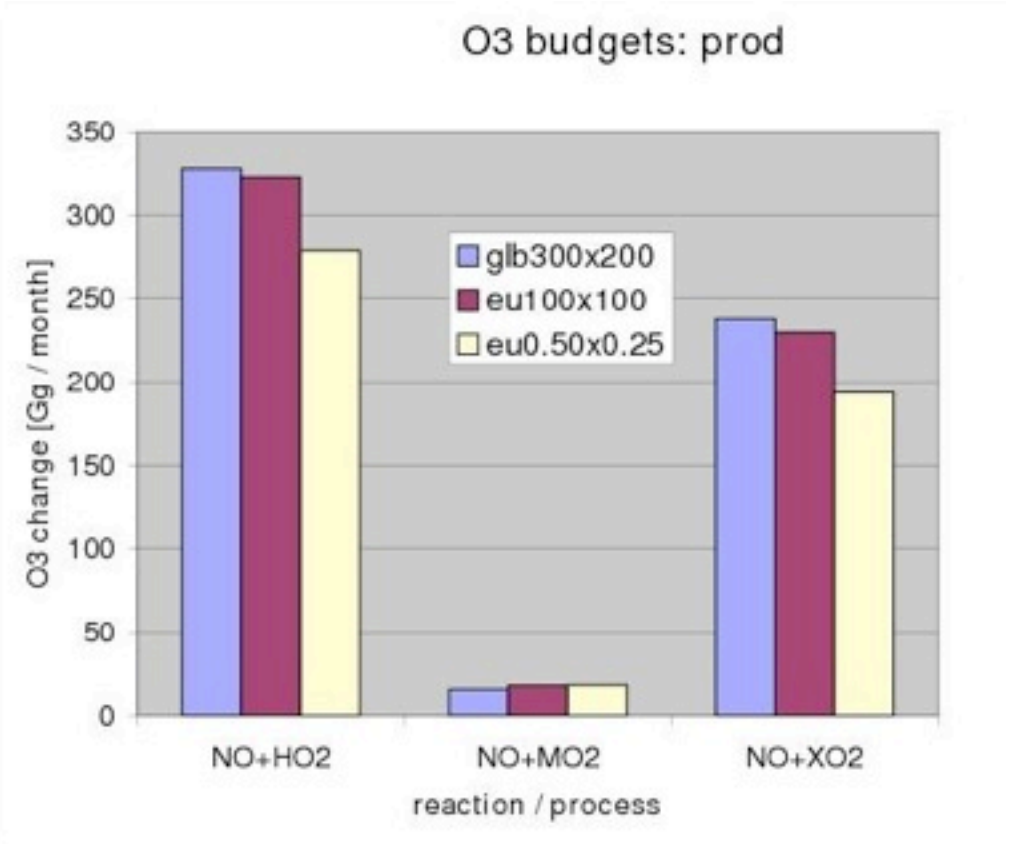
.5x.25 deg, *Sampling at end*

.5x.25 deg, *Sampling after 'v'*

obs

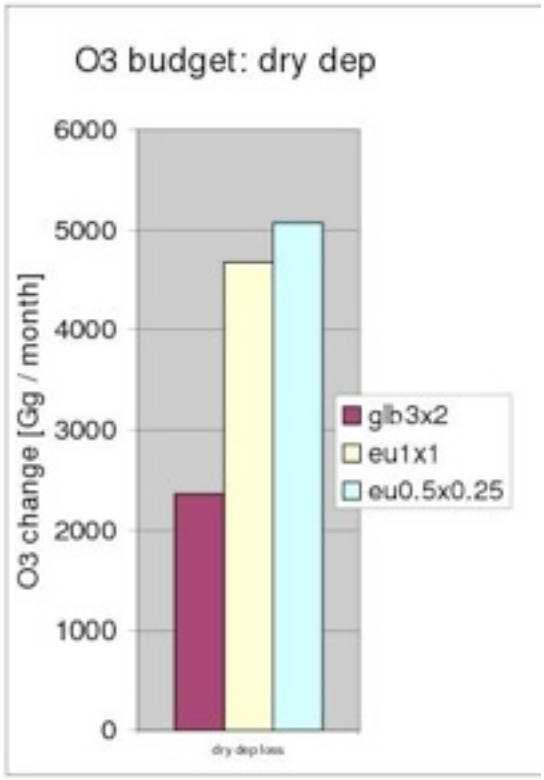
Budget calculation over BL in zoom region

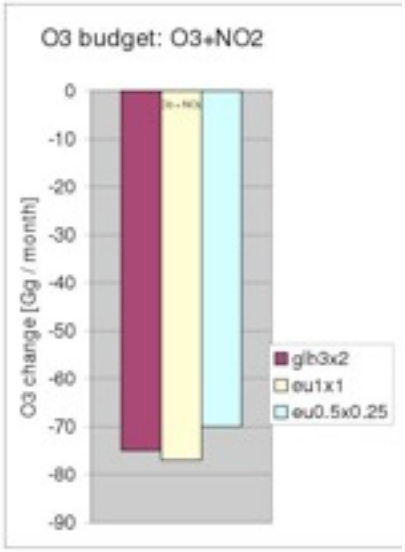


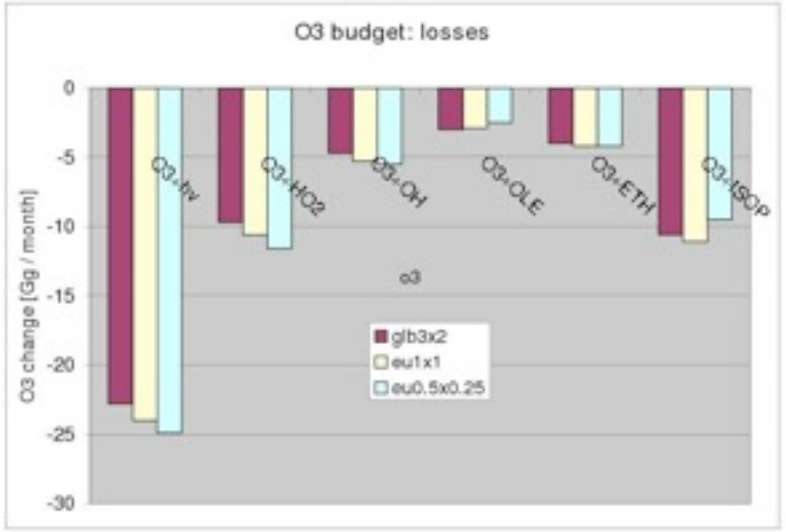


less O3 production…

Budget calculation over BL in zoom region

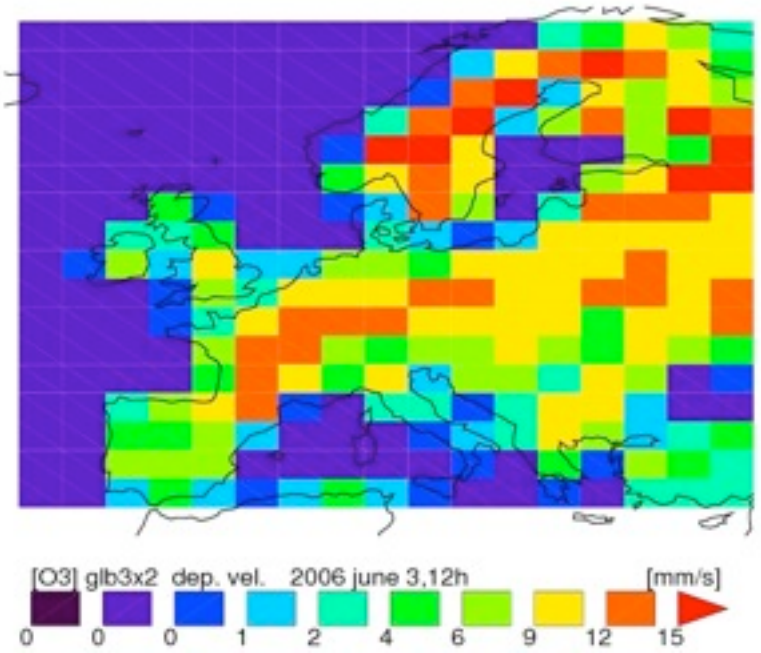


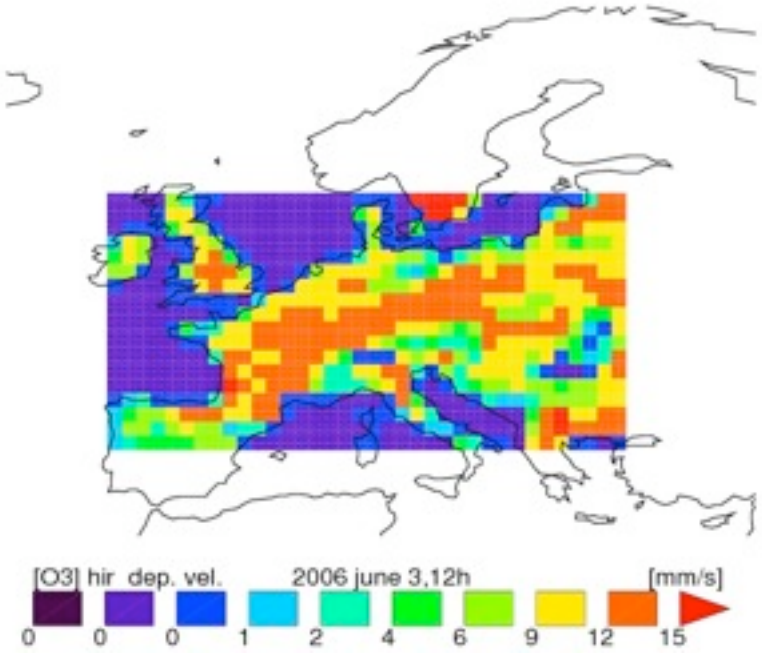




…More O3 dry dep…

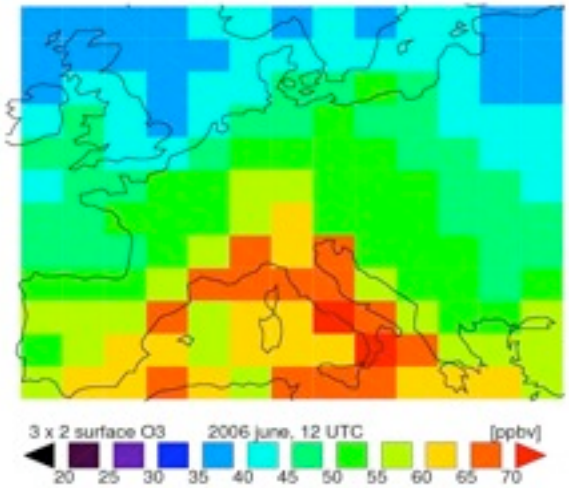
Deposition velocities @ 12h

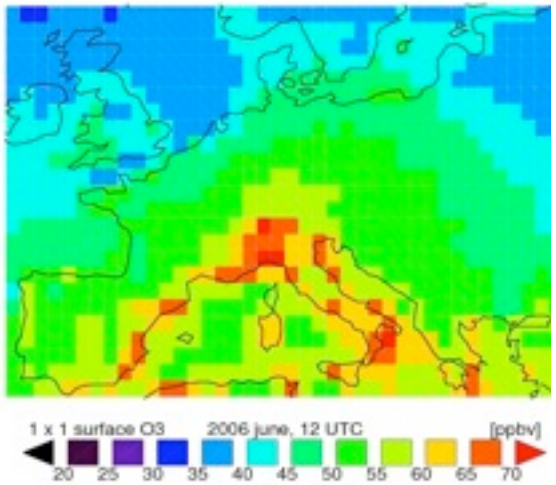


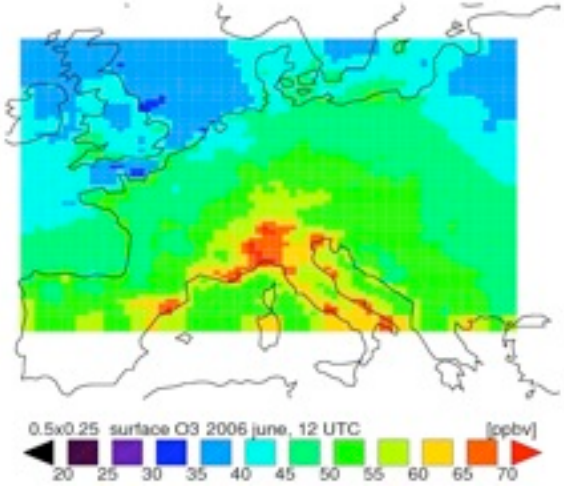


…on average dep vel. identical at different resolutions!
(Velocities calculated at 1x1 deg are coarsened to 3x2)

Surface O3 in TM5 zoom run; June 2006







3x2 1x1 0.5x0.25

…mean O_3 concentrations in BL similar (except Mediterranean)
Compensated by mixing with FT?

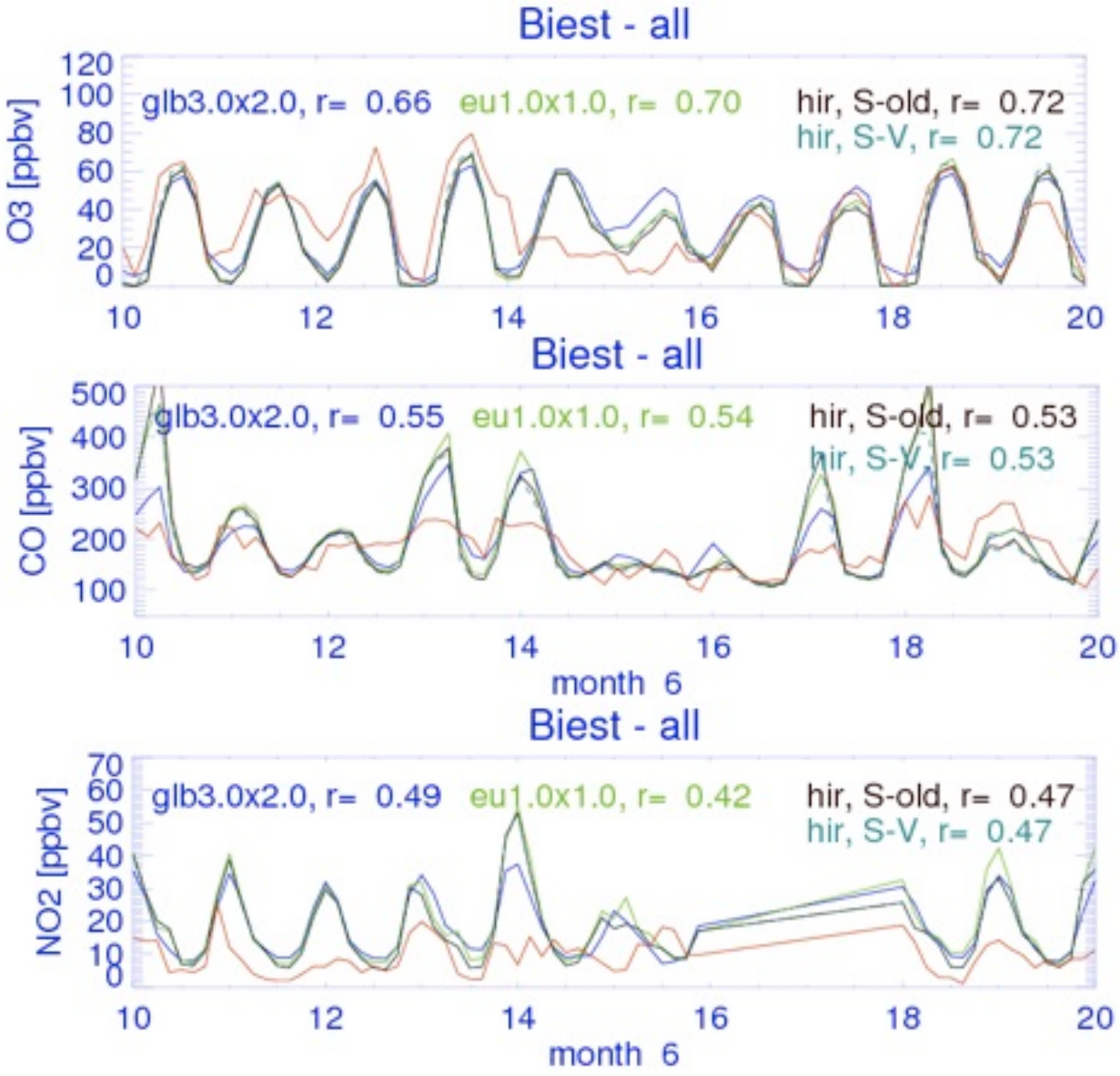
To be continued (?)

Summary

TM5-gasphase benchmark version (TM5-chem-v3.0) is submitted to GMDD
- Version is well documented & well evaluated
- O3 STE is quite low

Zoom up to 0.5x0.25 deg:
- Effect of zoom is marginal; O3 variability remains too low.
- At high-res: decreased production (JNO2) & increased O3 dry dep.
- But concentrations remain similar -> compensated by FT?

Suggestions for improvement:
- emission treatment: introduce diurnal / weekly cycles
- dep. vel. always on 1x1 - > should be done at high res.
- extend VOC chemistry?


Biest - all
O3 [ppbv]
glb3.0x2.0, r= 0.66
eu1.0x1.0, r= 0.70
hir, S-old, r= 0.72
hir, S-V, r= 0.72
Biest - all
CO [ppbv]
glb3.0x2.0, r= 0.55
eu1.0x1.0, r= 0.54
hir, S-old, r= 0.53
hir, S-V, r= 0.53
month 6
Biest - all
NO2 [ppbv]
glb3.0x2.0, r= 0.49
eu1.0x1.0, r= 0.42
hir, S-old, r= 0.47
hir, S-V, r= 0.47
month 6