Evaluating the causes of uncertainty in budgets of tropospheric O_3 and related gases in a chemistry climate model.

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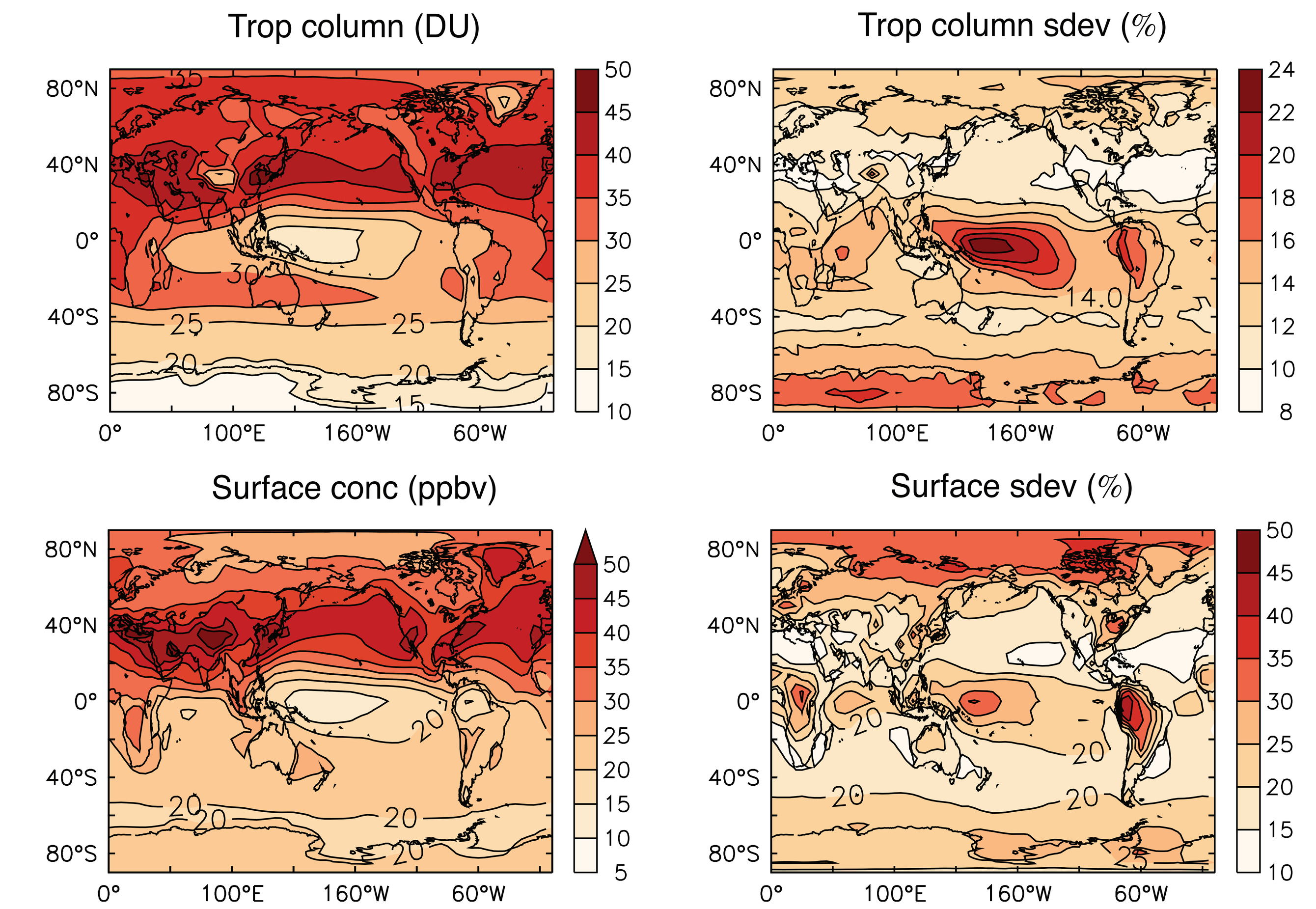
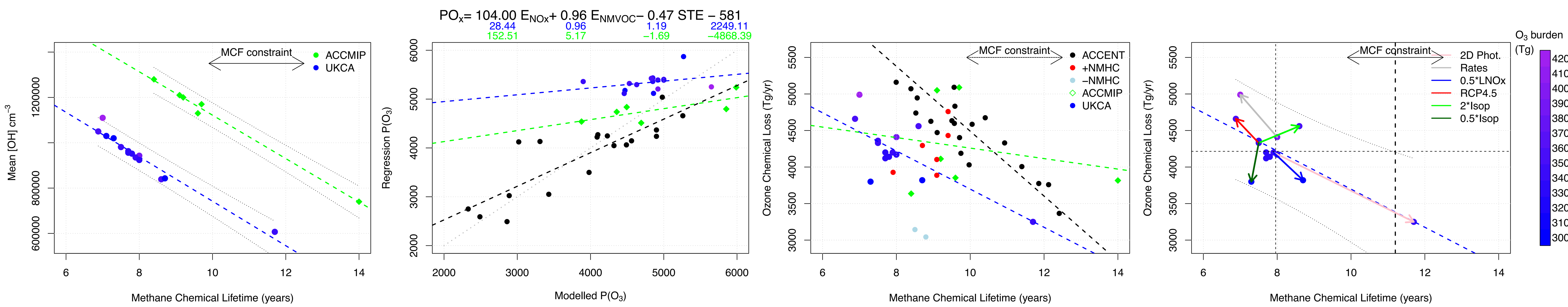
Chemistry-climate models have grown considerably in the levels of complexity they include to simulate key processes in the composition and chemistry of the atmosphere. The results of 15 simulations with the UM-UKCA model are shown. The simulations look at assessing the impacts of changing a range of parameters within the model setup. These include: changing photolysis schemes, changing chemical kinetic data, adding the reaction HO_2 + NO -> $HONO_2$, changing deposition schemes and changes to the emissions of VOCs and NOx.

Description	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
Kinetic data	2005 IUPAC +JPL	2005 IUPAC +JPL	2012 IUPAC +JPL	2012 IUPAC +JPL	2012 IUPAC +JPL	2012 IUPAC +JPL	2012 IUPAC +JPL	2012 IUPAC +JPL	2012 IUPAC +JPL	2012 IUPAC +JPL	2012 IUPAC +JPL	2012 IUPAC +JPL	2012 IUPAC +JPL	2012 IUPAC +JPL	2012 IUPAC +JPL
NMVOC emissions	ACCHIST 2000	ACCHIST 2000	ACCHIST 2000	ACCHIST 2000	ACCHIST 2000	ACCHIST 2000 + interactive CH_4	ACCHIST 2000 + biogenic MeOH	ACCHIST 2000	ACCHIST 2000 + biogenic MeOH	ACCHIST 2000 + biogenic MeOH	ACCHIST 2000 + biogenic MeOH + 2*Isoprene	ACCHIST 2000 + biogenic MeOH + 0.5*Isoprene	ACCHIST 2000 + biogenic MeOH + 0.5*LNOx	ACCHIST 2000 + biogenic MeOH + 0.5*SNOx	ACCHIST 2000 + biogenic MeOH
Photolysis scheme	Fast-JX	Fast-JX	Fast-JX	2D climatology	Fast-JX	Fast-JX	Fast-JX	Fast-JX	Fast-JX	Fast-JX	Fast-JX	Fast-JX	Fast-JX	Fast-JX	Fast-JX
Deposition scheme	2D fixed rates	2D fixed rates	2D fixed rates	2D fixed rates	Wesley	Wesley	Wesley	Wesley	Wesley	Wesley	Wesley	Wesley	Wesley	Wesley	Wesley
Chemistry Scheme	Std CheST	Std CheST + Butkovskaya	Std CheST + Butkovskaya	Std CheST + Butkovskaya	Std CheST + Butkovskaya	Std CheST + Butkovskaya	Std CheST + Butkovskaya	Std CheST + Butkovskaya	Std CheST + Butkovskaya + Isop1	Std CheST + Butkovskaya + Isop2	Std CheST + Butkovskaya + Isop1	Std CheST + Butkovskaya + Isop1	Std CheST + Butkovskaya + Isop1	Std CheST + Butkovskaya + Isop1	Std CheST + Butkovskaya
Species in radiation	O_3, CO_2, CH_4, N_2O, CFC's, HCFCs	O_3, CO_2, CH_4, N_2O, CFC's, HCFCs	O_3, CO_2, CH_4, N_2O, CFC's, HCFCs	O_3, CO_2, CH_4, N_2O, CFC's, HCFCs	O_3, CO_2, CH_4, N_2O, CFC's, HCFCs	O_3, CO_2, CH_4, N_2O, CFC's, HCFCs	O_3, CO_2, CH_4, N_2O, CFC's, HCFCs	CO_2, CH_4, N_2O, CFC's, HCFCs	O_3, CO_2, CH_4, N_2O, CFC's, HCFCs	O_3, CO_2, CH_4, N_2O, CFC's, HCFCs	O_3, CO_2, CH_4, N_2O, CFC's, HCFCs	O_3, CO_2, CH_4, N_2O, CFC's, HCFCs	O_3, CO_2, CH_4, N_2O, CFC's, HCFCs	O_3, CO_2, CH_4, N_2O, CFC's, HCFCs	Nudged to ERA-interim

Results from ACCMIP



(**above**) The figure above compares the results of the multi model ensemble ACCMIP tropospheric O_3 output (Young et al., 2013). The same climate and emission scenarios are used in this study and the variability in the ACCMIP data serve as motivation for this work.



(**left**) O_3 budget data and key metrics (methane lifetime, tropospheric mean [OH]) are presented and compared with results from a subset of ACCMIP models and ACCENT and TAR model data.

(**above**) The ensemble mean is used to asses variability between experiments. Each plot shows the relative difference (%) at the surface for the individual experiment to the ensemble mean. For O_3 we show that variations of isoprene emissions (within the current uncertainty bounds) lead to tropospheric O_3 variations which are similar to the variability seen in the ACCMIP models. Inclusion of the reaction HO_2+NO->$HONO_2$ has a big impact on our simulations, as does changing our photolysis code (OH is shown to reduce over land dramatically).

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References: Butkovskaya et al., JPCA (113), 11327-11342, 2009; Wu et al., JGR-A (112), 2007; Young et al., ACP 13, 2063-2090, 2013;