Eidgenössische Technische Hochschule Zürich
Swiss Federal Institute of Technology Zurich

The changing ozone depletion potential of N_2O in a future climate

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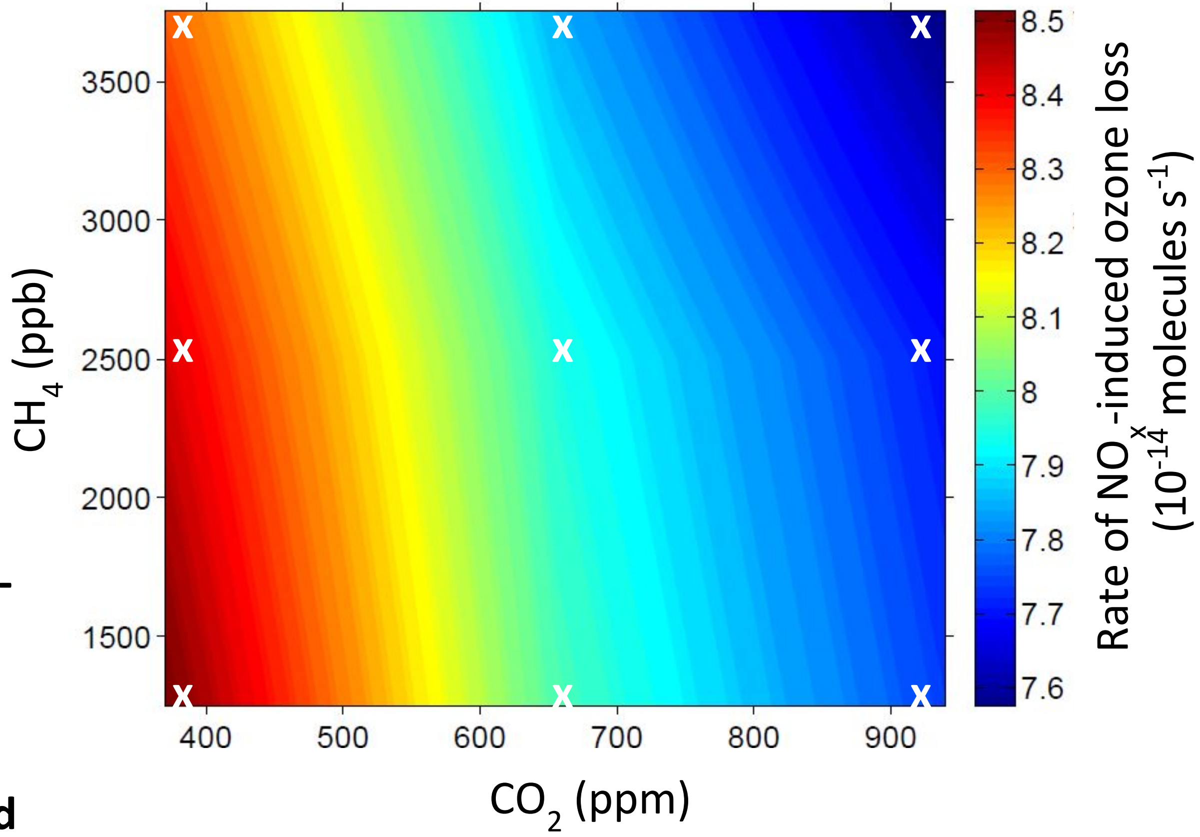
Revell *et al.*, GRL, 2015

Increasing CO_2 and CH_4 lead to less N_2O-induced ozone destruction



Results from the SOCOL chemistry-climate model: 9 year 2100 time-slice simulations based

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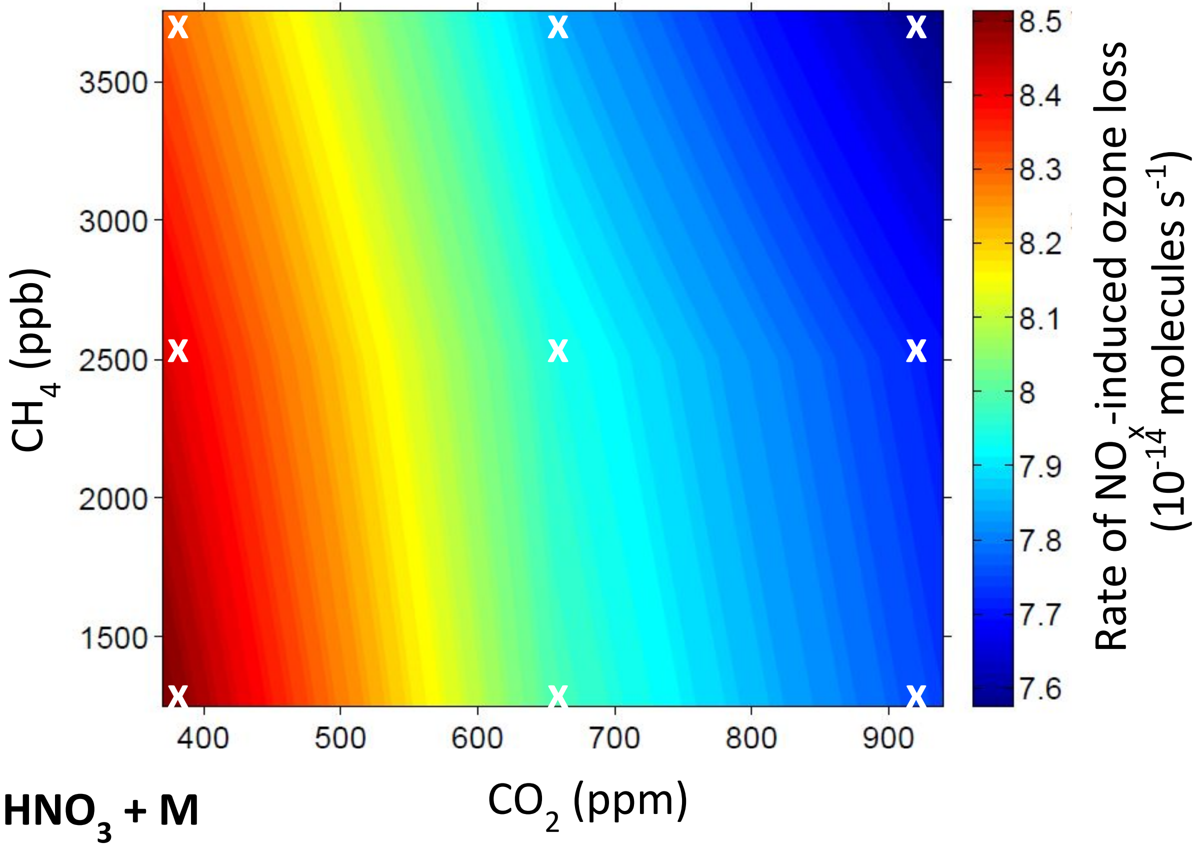
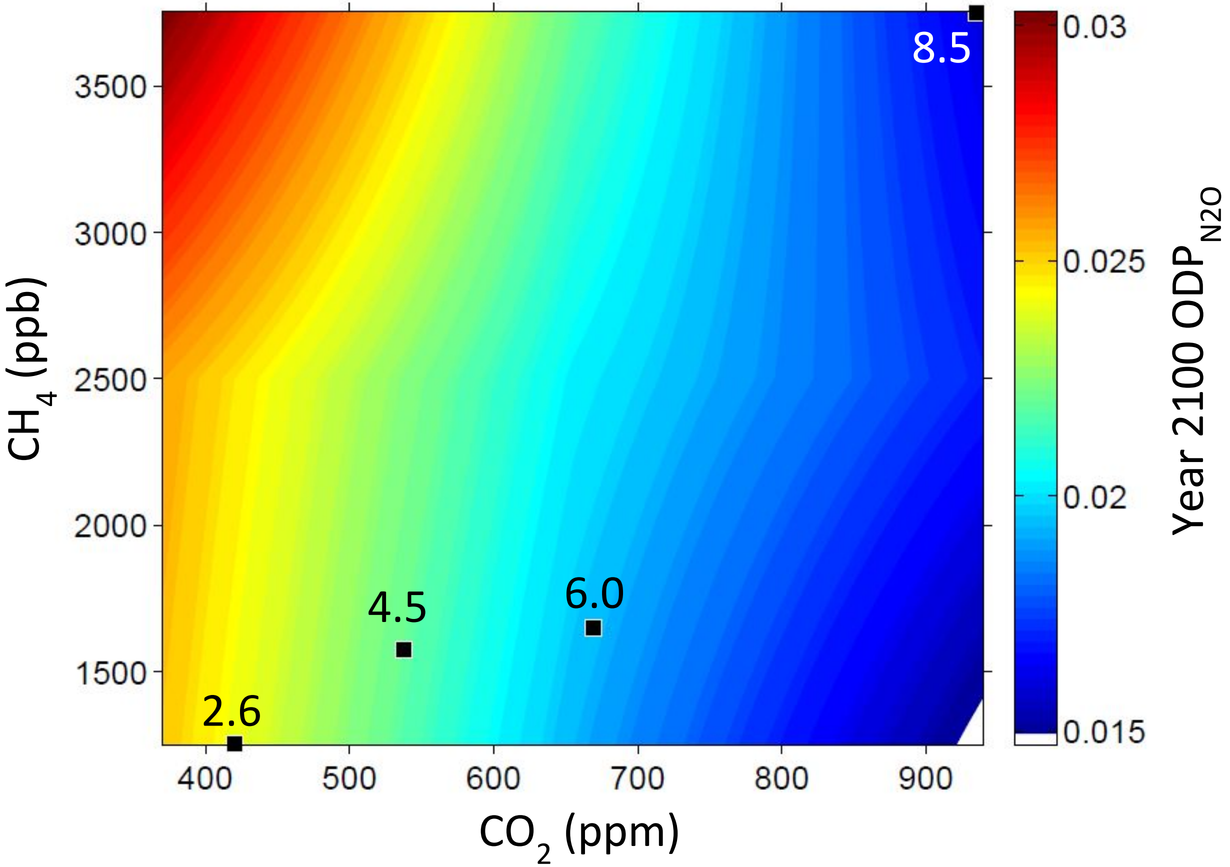


More CH_4:

$OH + NO_2 + M \rightarrow HNO_3 + M$

The ODP of N_2O is sensitive to CO_2 and CH_4 concentrations



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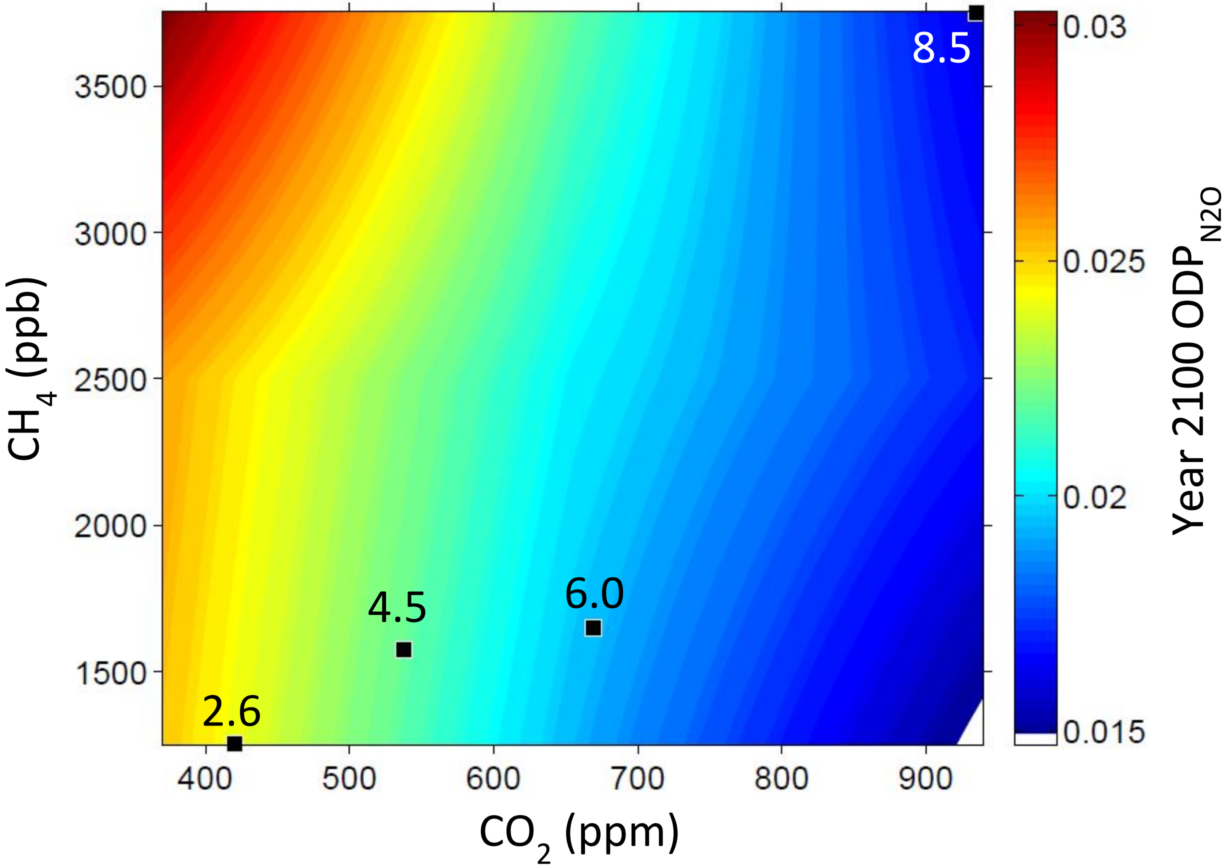

Year 2000 ODP_{N2O}	
0.015	SOCOL
0.017	Ravishankara *et al.*, 2009
0.019	Daniel *et al.*, 2010; Fleming *et al.*, 2011

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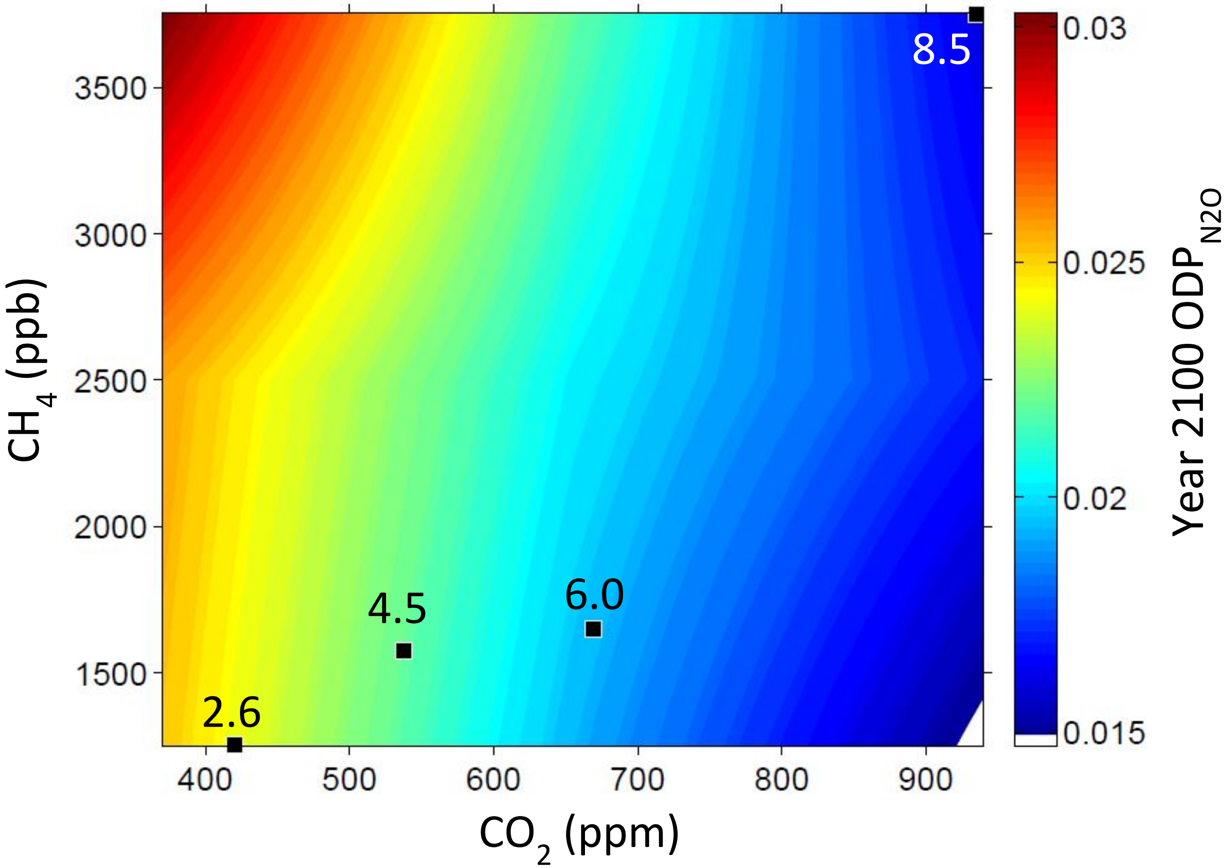

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Year 2100 ODP_{N2O}	
RCP 2.6	0.024
RCP 4.5	0.022
RCP 6.0	0.019
RCP 8.5	0.016

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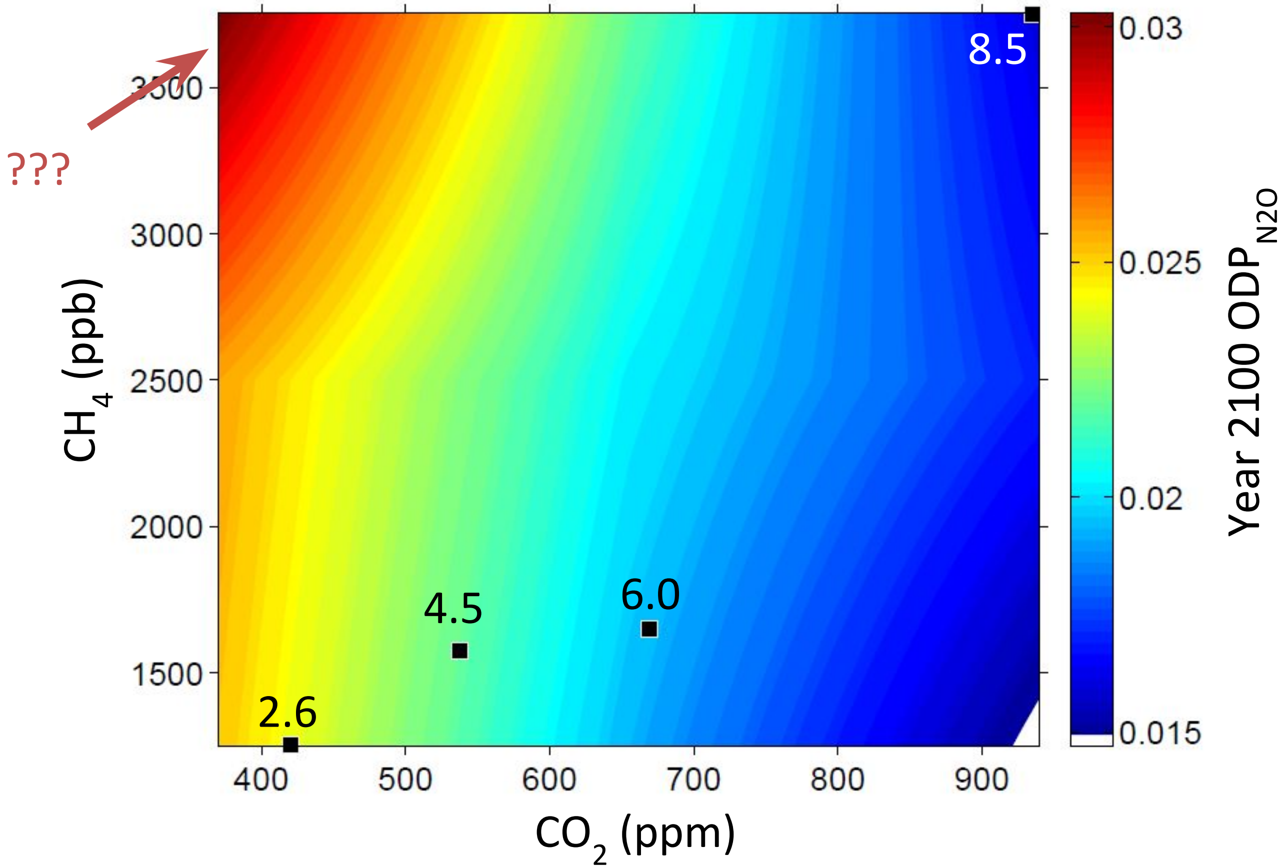

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ODPs for N_2O quantify ozone loss due to N_2O, relative to ozone loss due to CFC-11

$$\mathrm{ODP}_{\mathrm{N2O}} = \frac{m_{\mathrm{CFC11}} \times \tau_{\mathrm{N2O}} \times \Delta\mu_{\mathrm{CFC11}} \times [\Delta O_3]_{\mathrm{N2O}}}{m_{\mathrm{N2O}} \times \tau_{\mathrm{CFC11}} \times \Delta\mu_{\mathrm{N2O}} \times [\Delta O_3]_{\mathrm{CFC11}}}$$

- Molecular mass
- Atmospheric lifetime
- Prescribed change in the surface mixing ratio
- The resulting change in global-mean total column ozone

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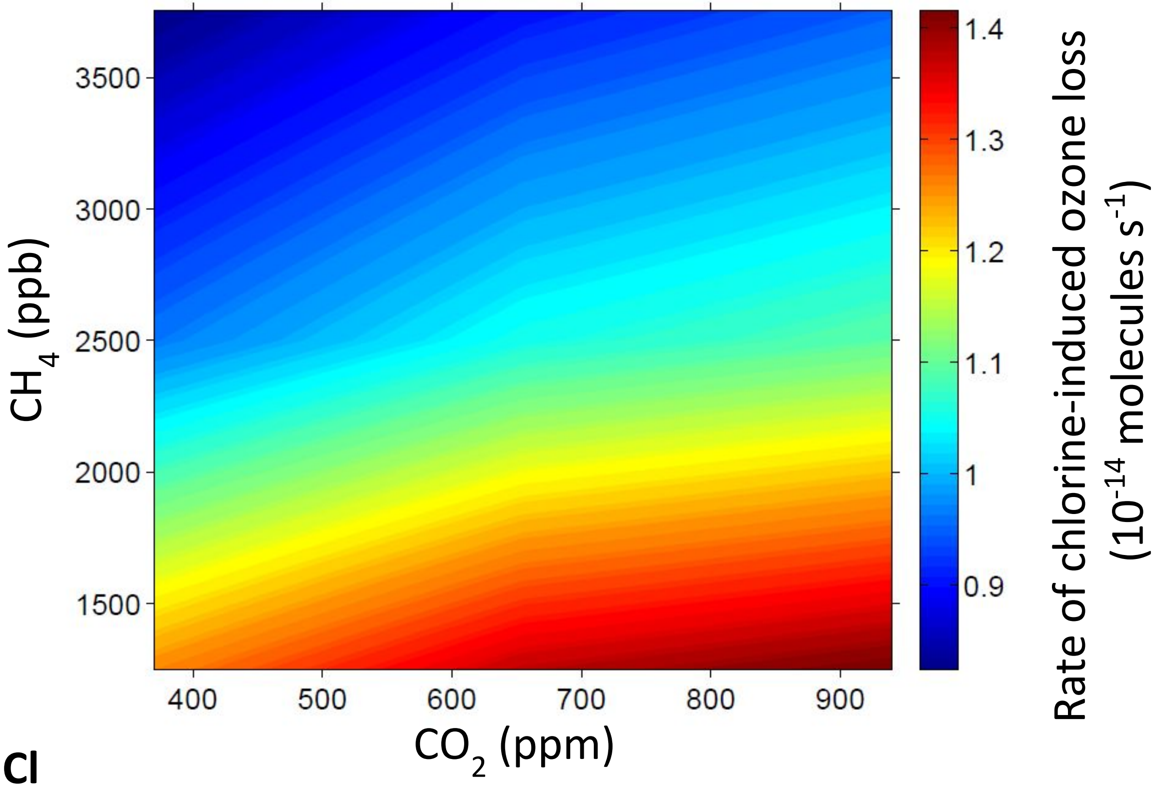
Molecular mass

Atmospheric lifetime

Prescribed change in the surface mixing ratio

The resulting change in global-mean total column ozone

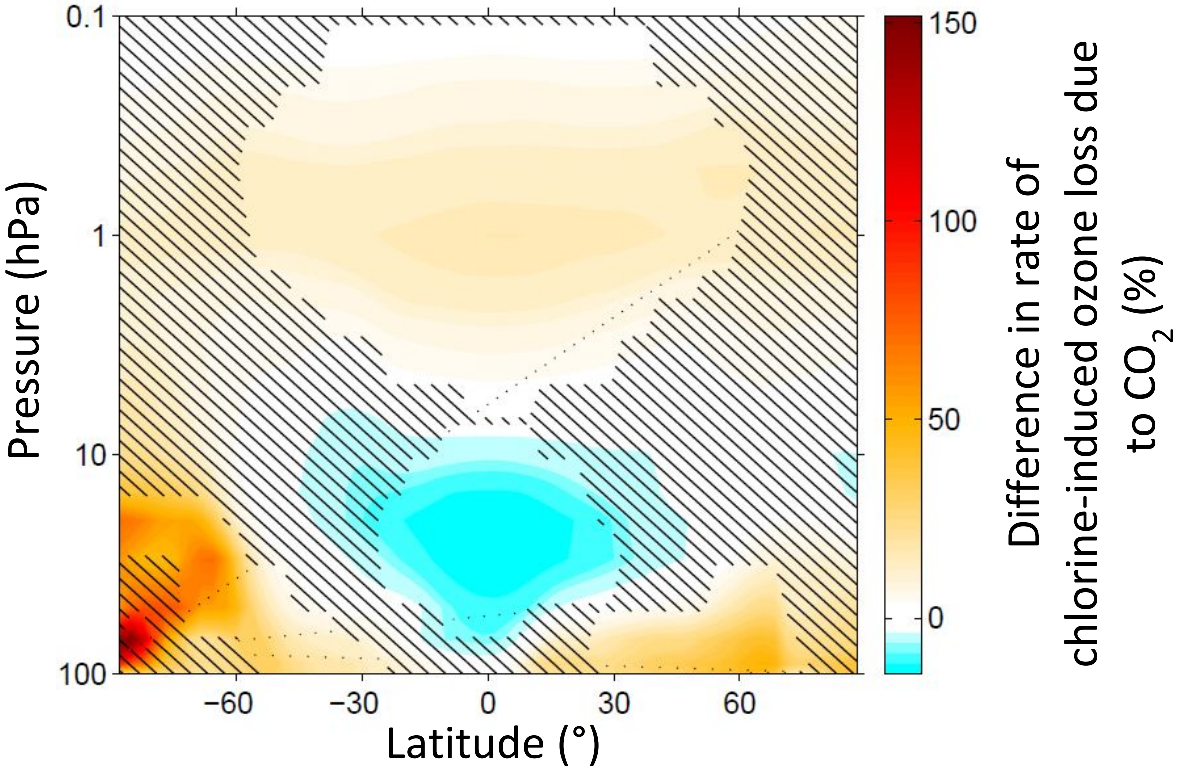
Chlorine-induced ozone destruction slows with increasing CH_4 and decreasing CO_2



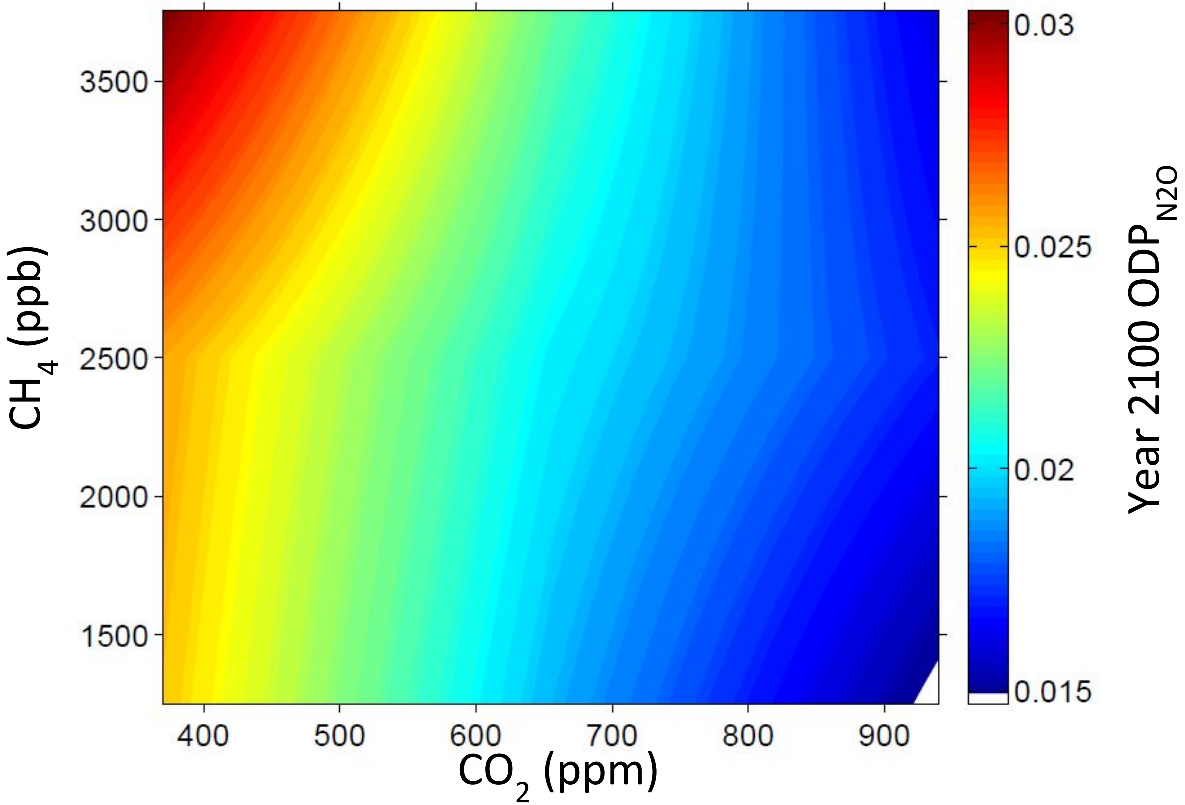
More CH_4:

$CH_4 + Cl \longrightarrow CH_3 + HCl$

The effect of CO_2 on chlorine-induced ozone destruction varies with location

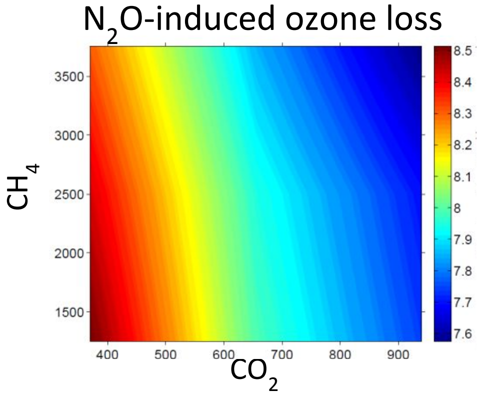


Uncertainties in atmospheric composition lead to ODPs for N_2O differing by up to a factor of two



To conclude:

- N_2O-induced ozone destruction slows with larger CO_2 and CH_4 concentrations.



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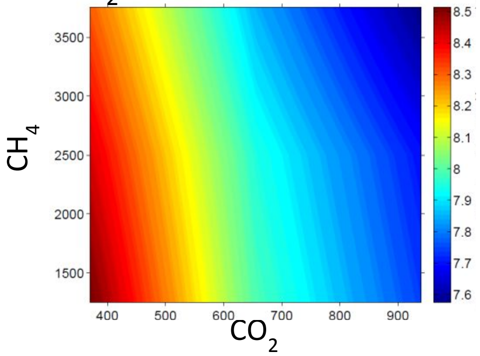
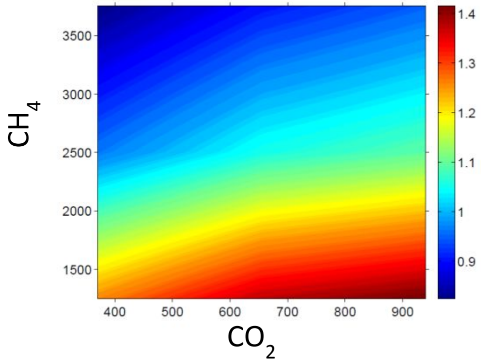
N2O-induced ozone loss



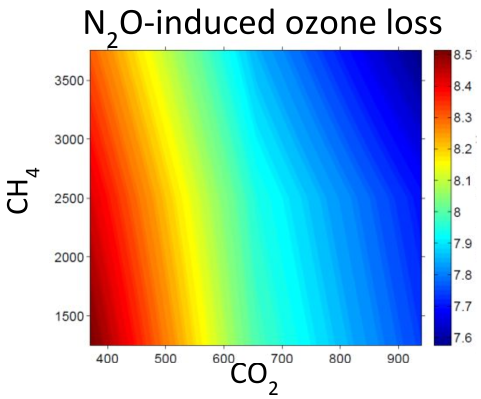
CFC-11-induced ozone loss

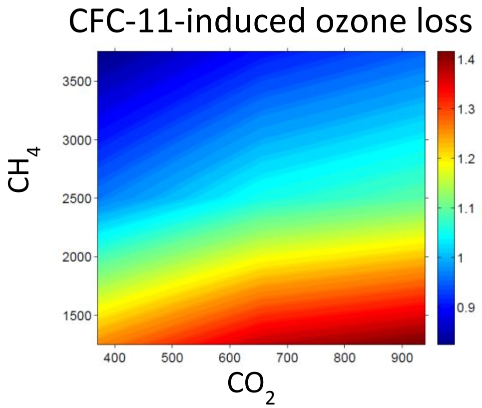


- CFC-11-induced ozone loss slows with larger CH_4 and smaller CO_2 concentrations.

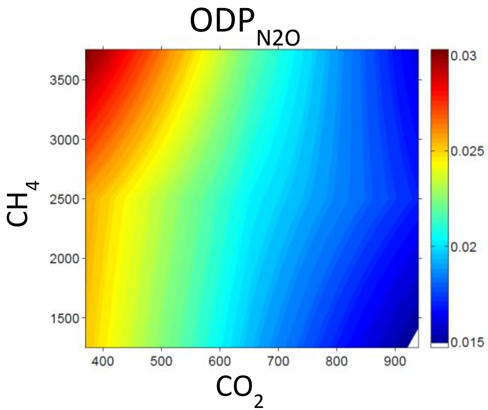
To conclude:

- N_2O-induced ozone destruction slows with larger CO_2 and CH_4 concentrations.





- CFC-11-induced ozone loss slows with larger CH_4 and smaller CO_2 concentrations.



- Uncertainties in atmospheric composition lead to a wide spread of values for the ODP of N_2O.