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Strat-Trop + chemistry scheme and sectoral emissions in the UKCA

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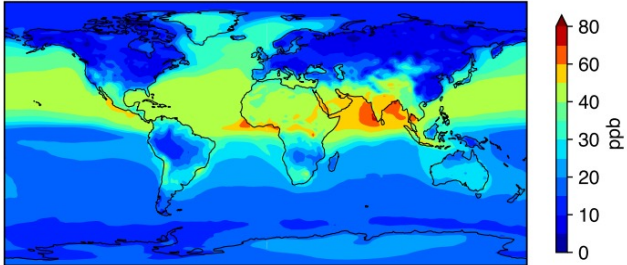
2021/03/26

- Underestimation of surface O₃ levels in industrial regions of China – high NO titration; insufficient O₃ production
- Large abundances of reactive VOCs such as alkenes and aromatics make substantial contributions to O₃ production in China but the UKCA lacks these tracers
- Based on Strat-Trop chemistry scheme, more reactive VOCs – C₃H₆, C₄H₁₀ and Toluene and relevant reaction products are added as ‘proxies’ of alkenes, butanes, aromatics

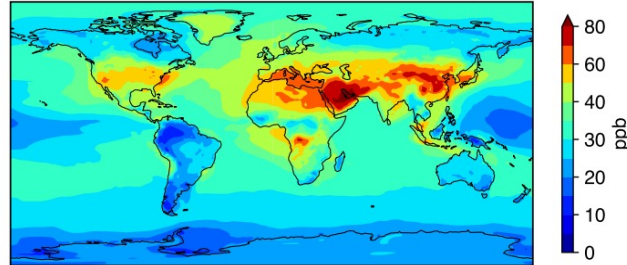
- We are keen to look at O₃ diurnal variation instead of monthly mean
- 5 emission sectors for anthropogenic emissions:
industry, power plants, residential, transportation, agriculture (only for NH₃ emissions)
- Diurnal and vertical profiles can be imposed on each emission sector
- `main/branches/dev/zhenzeliu/vn11.1_CHEM_UPD_UKESM1`

Comparison between Strat-Trop + and the standard Strat-Trop

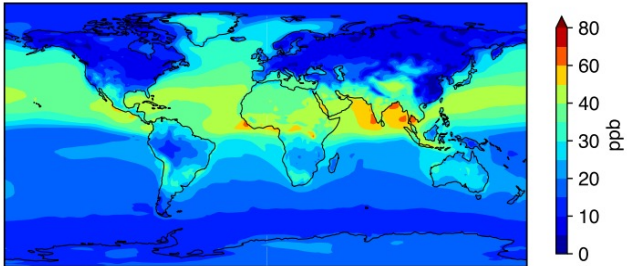
(a) Surface O₃ conc. (Strat-Trop +; 2004-2014, DJF) 26.8



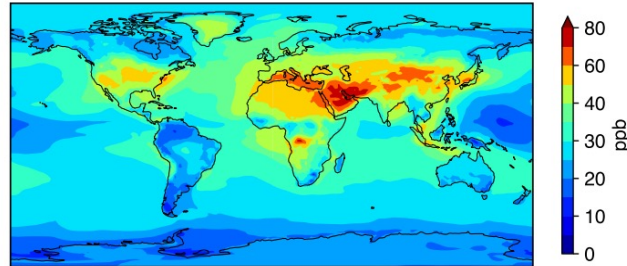
(b) Surface O₃ conc. (Strat-Trop +; 2004-2014, JJA) 33.9



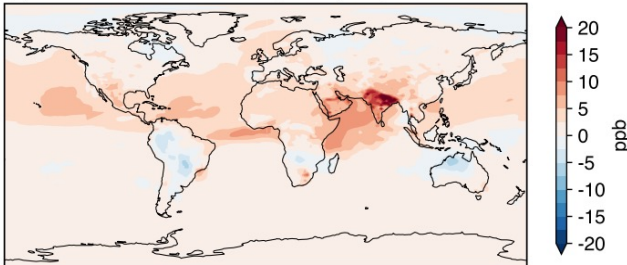
(c) Surface O₃ conc. (Standard; 2004-2014, DJF) 24.7



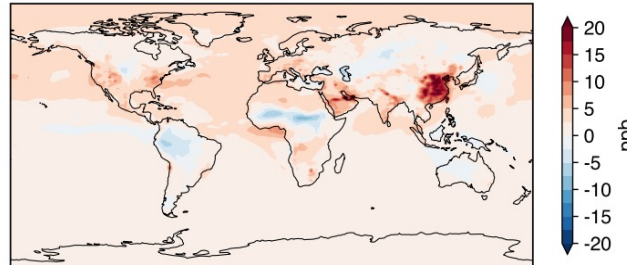
(d) Surface O₃ conc. (Standard; 2004-2014, JJA) 32.0



(e) Difference in O₃ conc. (a - c) + 2.0



(f) Difference in O₃ conc. (b - d) + 1.8



Similar patterns as the standard one but with regional differences, particularly in E. Asia and S. Asia

Comparison between Strat-Trop + and the standard Strat-Trop

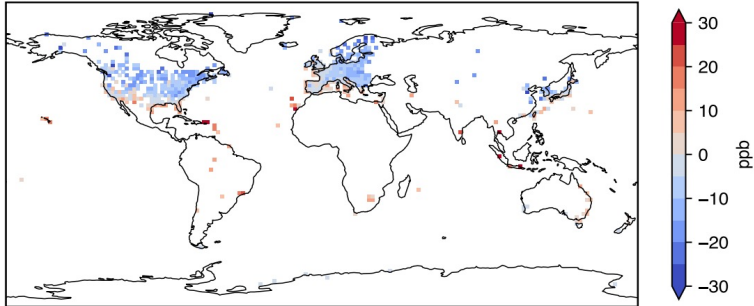
| | Strat-Trop Troposphere | Strat-Trop + Troposphere | Strat-Trop PBL | Strat-Trop + PBL |
|--|------------------------|--------------------------|----------------|------------------|
| O₃ burden (Tg) | 357.7 | 376.2 | 18.3 | 19.6 |
| O₃ lifetime (days) | 22.4 | 22.2 | 4.8 | 4.8 |
| O_x net Prod (Tg year⁻¹) | 982.7 | 1088.1 | 284.3 | 262.7 |
| Total Prod (Tg year⁻¹) | 5846.3 | 6243.3 | 993.7 | 1023.1 |
| HO₂+NO | 3862.6 | 4120.8 | 588.2 | 600.8 |
| MeOO+NO | 1274.1 | 1459.8 | 226.2 | 253.3 |
| RO₂+NO | 560.8 | 499.7 | 152.4 | 140.0 |
| Other | 148.7 | 163.0 | 26.9 | 29.0 |
| Total Loss (Tg year⁻¹) | 4863.6 | 5155.2 | 709.4 | 760.3 |
| O(¹D)+H₂O | 2451.5 | 2552.4 | 408.7 | 430.3 |
| HO₂+O₃ | 1563.9 | 1582.7 | 174.5 | 184.4 |
| OH+O₃ | 681.3 | 842.5 | 71.1 | 87.4 |
| O₃+Alkene | 106.4 | 106.4 | 34.7 | 34.8 |
| Other | 60.5 | 71.2 | 20.5 | 23.3 |
| O_x deposition | 1055.6 | 1166.6 | 739.1 | 806.5 |
| O₃ dry deposition | 882.9 | 935.9 | 672.2 | 716.1 |
| NO_y deposition | 172.7 | 230.7 | 66.9 | 90.5 |
| STE | 72.9 | 78.5 | / | / |

~ 5 % higher tropospheric O₃ burden

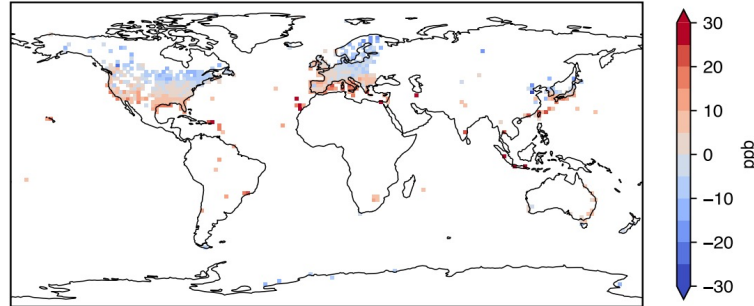
similar O₃ lifetime

Evaluation against TOAR O₃ data

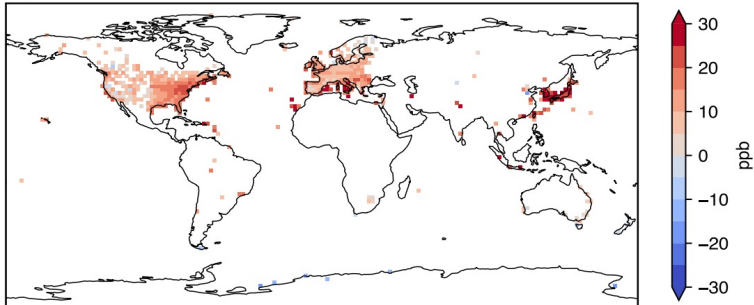
(a) Surface O₃ model bias in DJF over 2004-2014



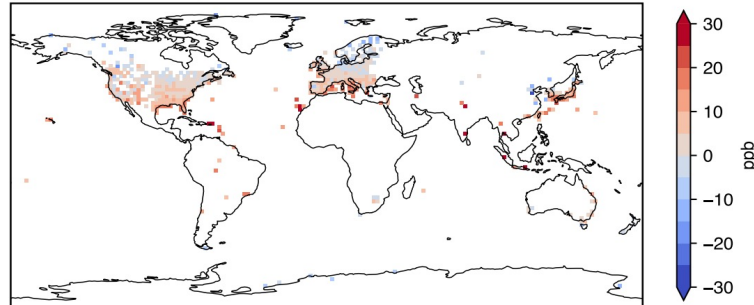
(b) Surface O₃ model bias in MAM over 2004-2014



(c) Surface O₃ model bias in JJA over 2004-2014



(d) Surface O₃ model bias in SON over 2004-2014



Systematic bias low in winter and bias high in summer – other processes in the model that are sensitive to seasons might not be quite right