Local and global impacts of C_1-C_3 alkyl nitrate photochemistry and emissions on tropospheric ozone

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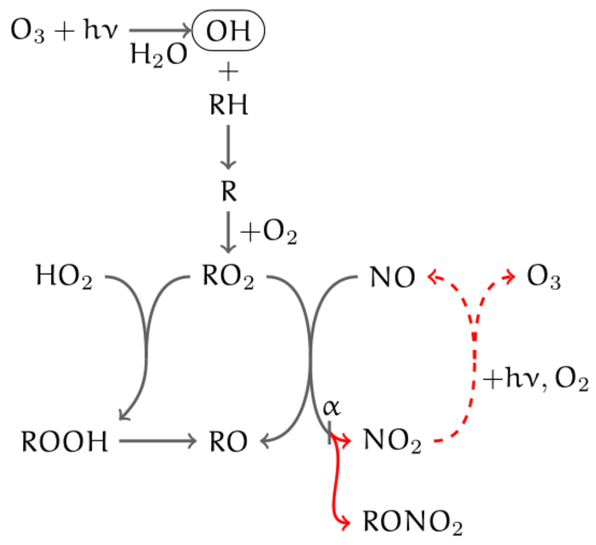
Introduction

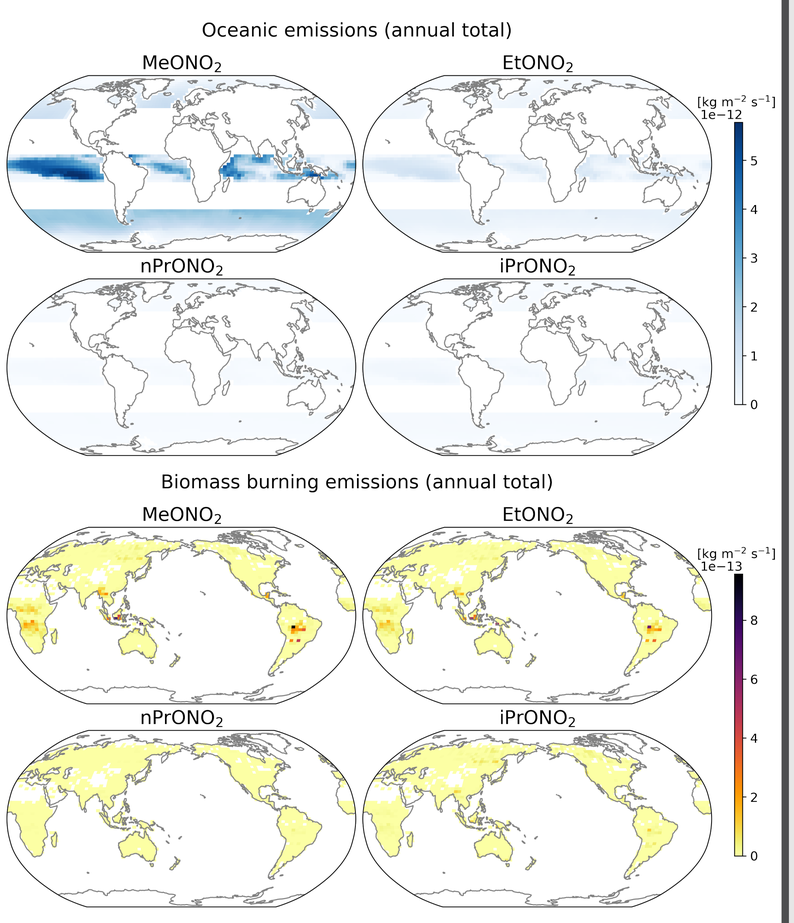
Alkyl nitrates ($RONO_2$) are directly emitted and photochemically produced from the oxidation of hydrocarbons in the presence of NO. Their formation terminates tropospheric O_3 production by temporarily storing the active form of nitrogen. Due to a relatively long lifetime of a few days to a few months, **$RONO_2$ can be destroyed far away from their sources by photolysis or OH oxidation, releasing NO_2 to the local atmosphere and altering O_3 concentrations**.



Few studies explored $RONO_2$ with a global chemistry-climate model. Here we:

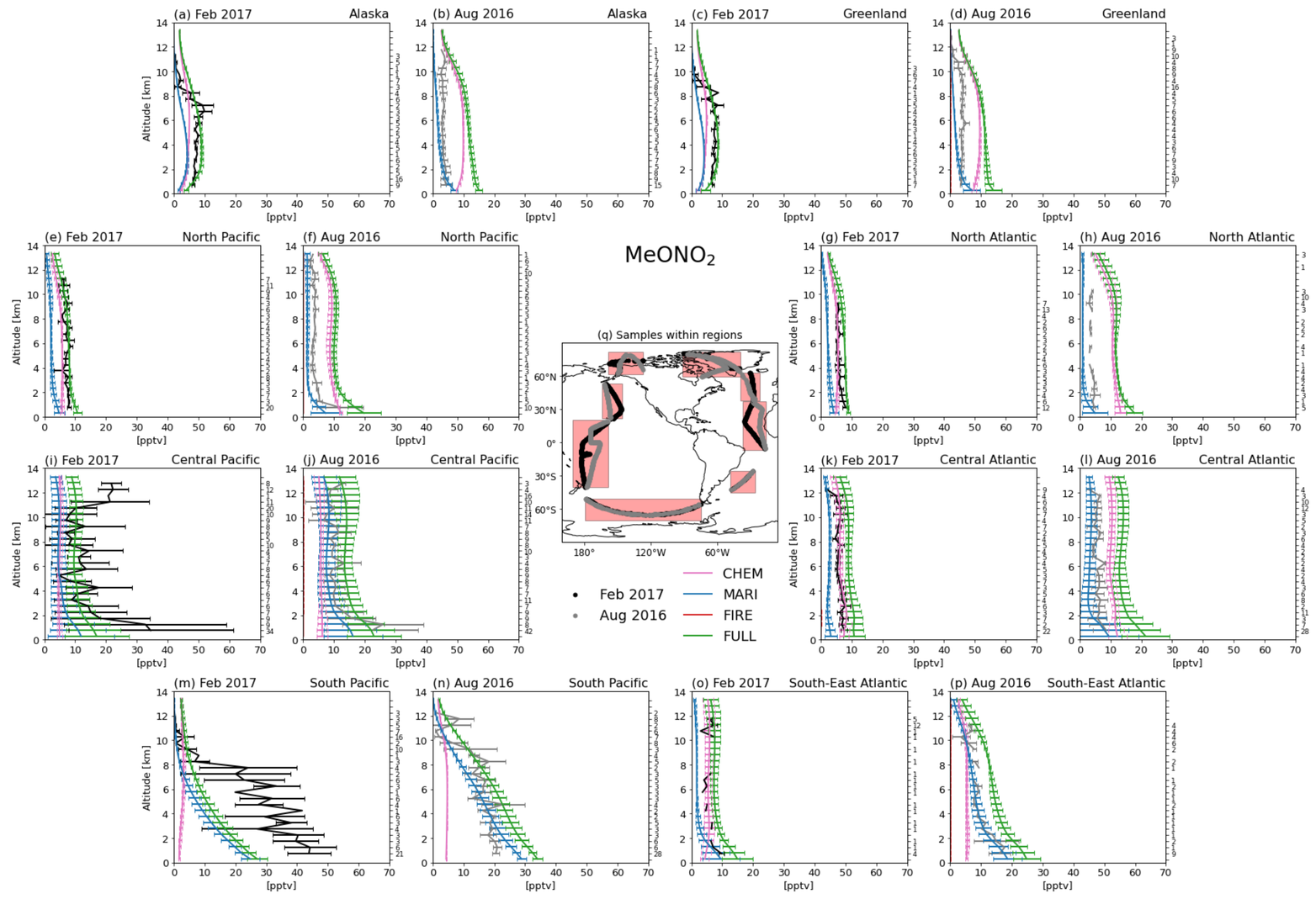
- add C_2-C_3 $RONO_2$ photochemistry and dry deposition to the chemical mechanism of the United Kingdom Chemistry and Aerosols (UKCA) model;
- derive C_1-C_3 $RONO_2$ oceanic emissions from Fisher et al. (2018) and biomass burning emissions from GFED4s (van der Werf et al. (2017));
- validate UKCA against NASA ATom-2;
- evaluate the impact of $RONO_2$ on O_3.

C_1-C_3 $RONO_2$ emissions



- Methyl nitrate ($MeONO_2$) oceanic and biomass burning emissions are stronger than emissions of other $RONO_2$ considered here.

UKCA vs ATom-2



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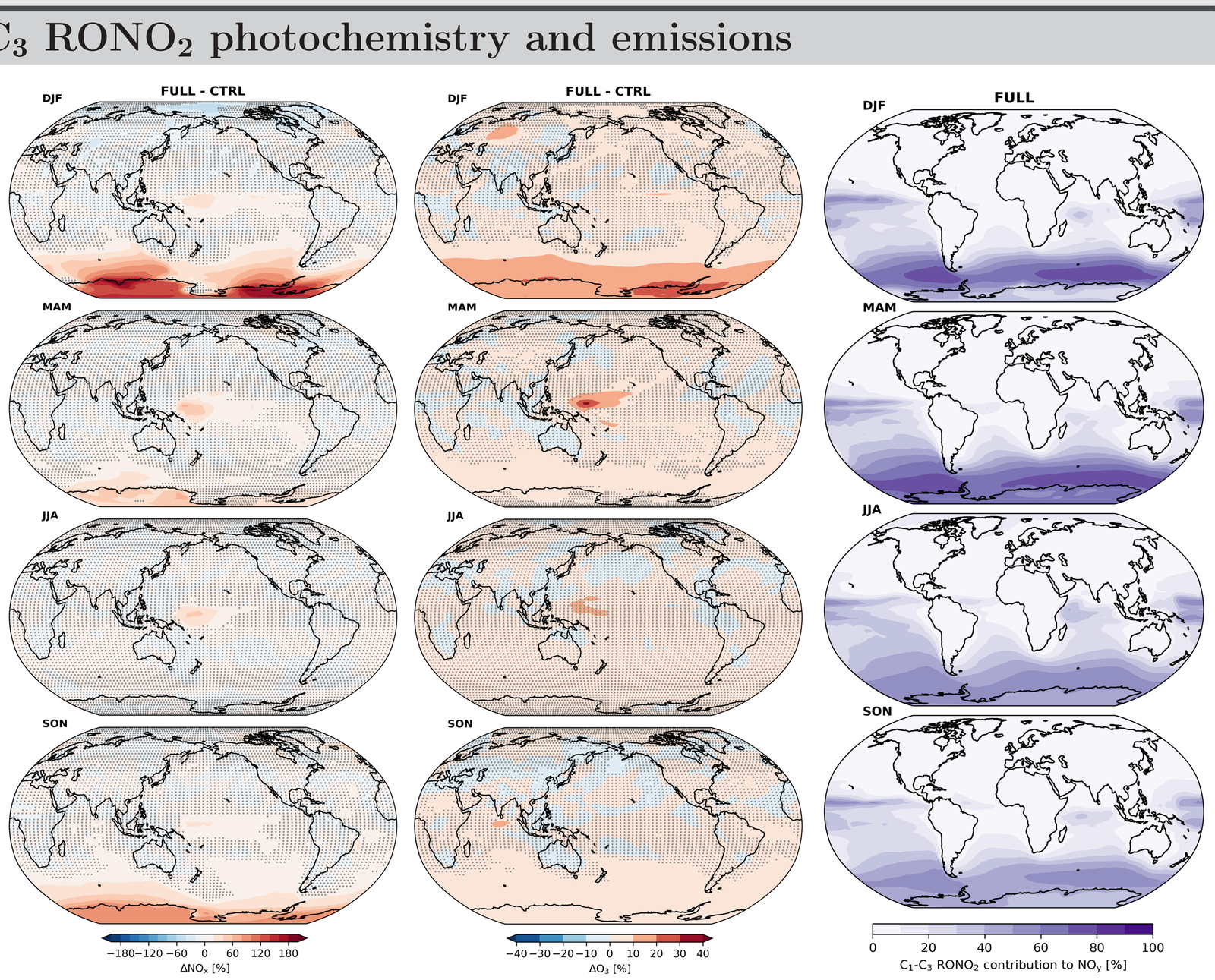
When C_1-C_3 $RONO_2$ photochemistry, dry deposition and oceanic and biomass burning emissions are included into the model (FULL simulation):

- NO_x and O_3 show a concurrent statistically significant* increase in the boundary layer (0-2 km) over the central Pacific and the Southern Ocean.
  - Over the central Pacific Ocean in MAM, NO_x increases by up to 260 ppt (66%) and O_3 increases by up to 3 ppb (32%).
  - Over the Southern Ocean in DJF, MAM and SON, with a maximum relative to other seasons increase in NO_x and O_3 occurring in DJF, with NO_x increasing by up to 7 ppt (189%) and O_3 increasing by up to 2 ppb (27%).
- C_1-C_3 $RONO_2$ contribute up to 78% to NO_y over the Southern Ocean.
- Annual mean tropospheric O_3 burden increases by 1.09±0.25%, while CH_4 lifetime decreases by 1.56±0.37%.

*Stippling shows areas where the difference between simulations with $RONO_2$ minus without $RONO_2$ is *not* statistically significant.



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