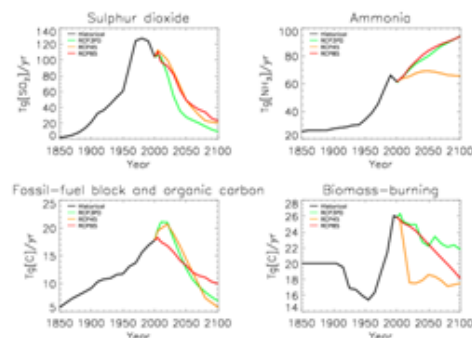


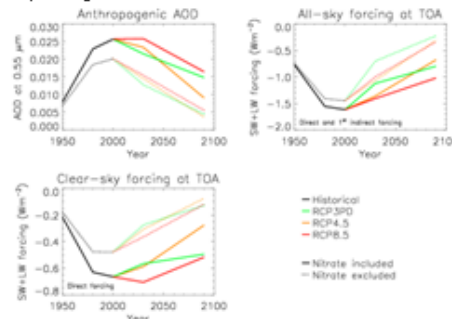
Bellouin - CMIP5 aerosol results - Impact of nitrate

- HadGEM2-ES atmosphere/ocean general circulation model at N96L38 (1.875 longitude by 1.25 latitude)
- Interactive carbon cycle with ecosystem model. Interactive ocean biology. Interactive tropospheric chemistry (NO_x , H_2O_2 , CH_4 , O_3)
- Eight aerosol species: sulphate, mineral dust, sea-salt, fossil-fuel black carbon, fossil-fuel organic carbon, biomass-burning, biogenic (fixed climatology), nitrate (not included in main CMIP5 simulations)
- Aerosols coupled with radiation (direct and indirect effects), ocean biology (mineral dust fertilisation, DMS production), chemistry (sulphur-cycle oxidants), vegetation (mineral dust emissions from bare soils).

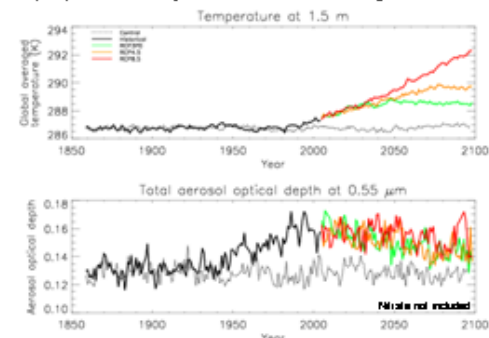
CMIP5 historical and future emissions* of aerosol precursors and primary aerosols suggest a strong decrease in emissions during the 21st century, except for ammonia.



Direct and 1st indirect forcing are from dedicated 5-year runs branching out of the main simulations. Nitrate aerosol can be added then to assess its impact on aerosol forcing. Anthropogenic aerosol optical depth and direct + 1st indirect forcing peak in the early 21st century before decreasing. The addition of nitrate slows down the rate of decrease: all-sky forcing is 2 to 4 times stronger in 2090 with nitrate included, depending on scenario.



HadGEM2-ES running with CMIP5 greenhouse gas concentrations and aerosol emissions shows a strong warming trend starting in the 1980s while total aerosol optical depth peaks around year 2000 before decreasing.



Regional aerosol surface concentrations decrease in the 21st century. In 2000, nitrate concentrations are comparable to those of sulphate in Europe and Asia. By 2090, nitrate becomes the dominant aerosol species in those regions. Sulphate and/or biomass burning remain dominant in Africa, North and South America.

Colour key for bar charts:
 SO_2 (blue), NO_2 (red),
 FF Black C. (yellow), FF Organic C. (green),
 Biomass (orange)

1. References for CMIP5 data set:
 Historical: [Trenberth et al., 2010](#)
 RCP3PD: [van Marra et al., 2007](#)
 RCP4.5: [Clarke et al., 2007](#)
 RCP8.5: [Raschke and Nakicenovic, 2007](#)

