Stronger cooling response to the aerosol indirect effect

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BACKGROUND

- In a linear energy balance framework, $\Delta N = F + \lambda \Delta T$, a universal feedback parameter, λ, is usually assumed such that the effective radiative forcings can be added linearly, as done in e.g. IPCC AR6

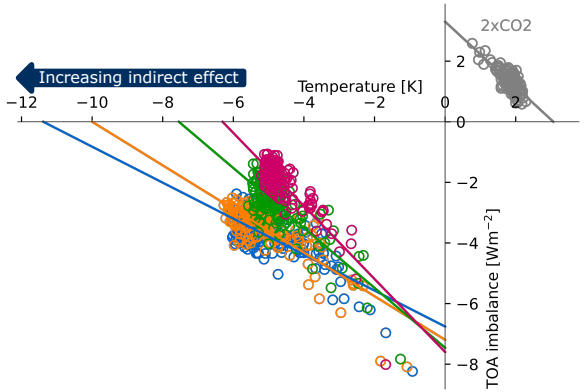
METHOD

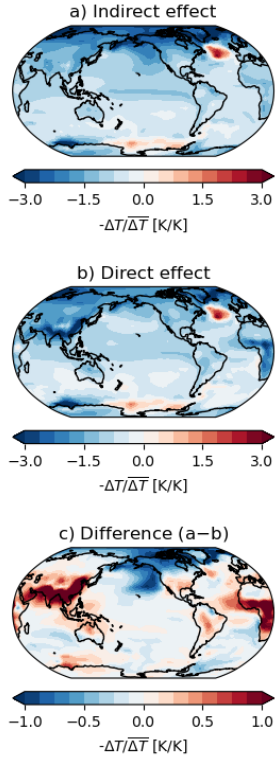
- Experiments with aerosol forcing abruptly applied and held constant were run in the MPI-EMS1.2, which uses the simple plume aerosol parameterisation
- The aerosol forcing was enhanced in two ways:
  - Increased direct effect through increased aerosol emissions
  - Increased indirect (cloud) effect through an enhanced Twomey effect

CONCLUSION

- The climate response to forcing from the aerosol indirect effect is stronger than that of the direct effect
- Indirect aerosol forcing gives a less negative feedback parameter (λ) than forcing from carbon dioxide; that is, the forcing efficacy is much larger than 1
- A stronger response to the indirect effect may help reconcile estimates of the ECS from different lines of evidence, and give a less negative constraint on historical aerosol forcing

*The aerosol indirect radiative effect causes **more cooling** than the direct effect*





RESULTS

- Stronger indirect effect results in a less negative feedback parameter (λ) and a stronger temperature response than carbon dioxide or the direct aerosol effect
- The response to the direct effect is localised to the emission source, while the indirect effect causes a remote response
- The forcing from the indirect effect is stronger in areas that are initially pristine