Accelerated increases in global and Asian summer monsoon precipitation from future aerosol reductions

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Future aerosol in the Shared Socioeconomic Pathways

- Range from rapid reductions to initial increases (to 2050)
- Similar aerosol pathways in SSP2-4.5 and SSP5-8.5, but very different CO2 changes
- Does aerosol play a dominant role in near-term climate change?
Future aerosol in the Shared Socioeconomic Pathways

Global emissions:

- Range from rapid reductions to initial increases (to 2050)
- Similar aerosol pathways in SSP2-4.5 and SSP5-8.5, but very different CO2 changes
- Does aerosol play a dominant role in near-term climate change?

Anticipated response:

- Aerosol dominated
- GHG dominated

Wilcox et al., 2020, ACPD
Global mean responses

- Little aerosol influence on global temperature
- Global precipitation increases are faster in scenarios with faster aerosol reductions

Wilcox et al., 2020, ACPD
A quick look at Asian precipitation in CMIP6

- Dry over India and northeast China, wet elsewhere
- Monsoon circulation too weak and too zonal
- Anomalies between models and observations comparable to size of anomalies between different observational datasets

Wilcox et al., 2020, ACPD
Asian summer (JJA) monsoon responses

- Aerosol changes are the dominant influence on Asian summer monsoon precipitation until the 2040s
- GHG changes dominate by 2100

Wilcox et al., 2020, ACPD

https://www.atmos-chem-phys-discuss.net/acp-2019-1188/
The Asian dipole

- Recent observations show a rapid reduction in Chinese aerosol optical depth alongside a continued increase in optical depth over India.
- This pattern continues until 2040-2050 in SSP2-4.5 and SSP5-8.5.

Samset et al., 2019, Nat. Geosci.; Wilcox et al., 2020, ACPD
South Asian summer (JJA) monsoon responses

- Precipitation increase suppressed over South Asia in SSPs with dipole aerosol patterns

Wilcox et al., 2020, ACPD

Anomalies for 10 year periods vs. 1980-2014 from an anthropogenic aerosol only version of SSP2-4.5 (SSP2-4.5-aer) with CanESM5

https://www.atmos-chem-phys-discuss.net/acp-2019-1188/
Conclusions

• Large uncertainty in future aerosol emission pathways
  ‣ Unlikely to be important for global temperature
  ‣ Potentially important for near-term changes in global and regional precipitation, and regional temperature changes

• Faster precipitation increases in scenarios with faster anthropogenic aerosol reductions
  ‣ Greenhouse gases become the dominant factor in differences in the response between scenarios in the mid-late 21st century

• Near-term increases in South Asian summer monsoon precipitation are suppressed in scenarios where decreases in Chinese aerosol occur alongside continued increases over India