Anthropogenic aerosols modulated 20th-century Sahel rainfall variability via their impacts on North Atlantic SST

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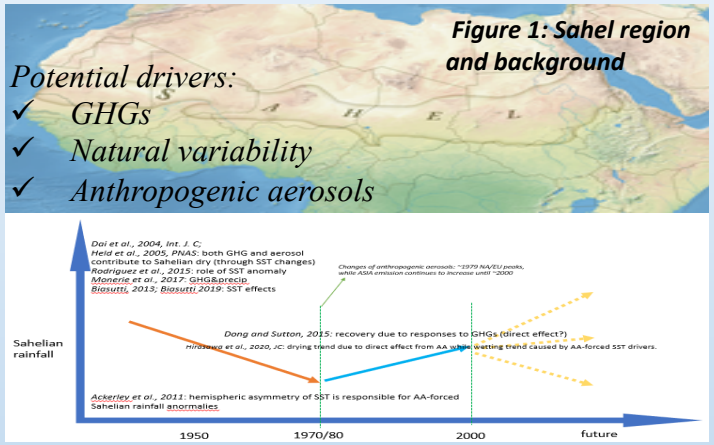
Background

20th-century Sahel rainfall: A severe drought and a subsequent recovery of Sahel rainfall during the past century



Observational datasets & models

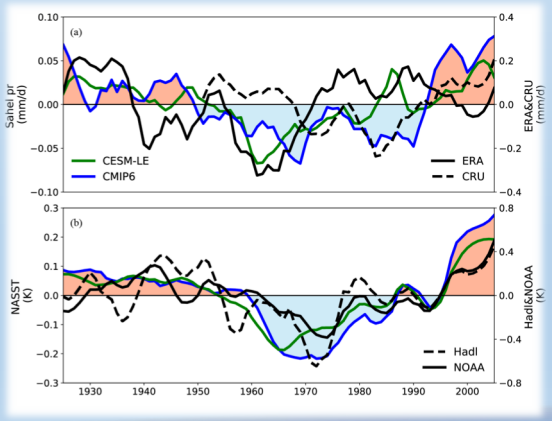
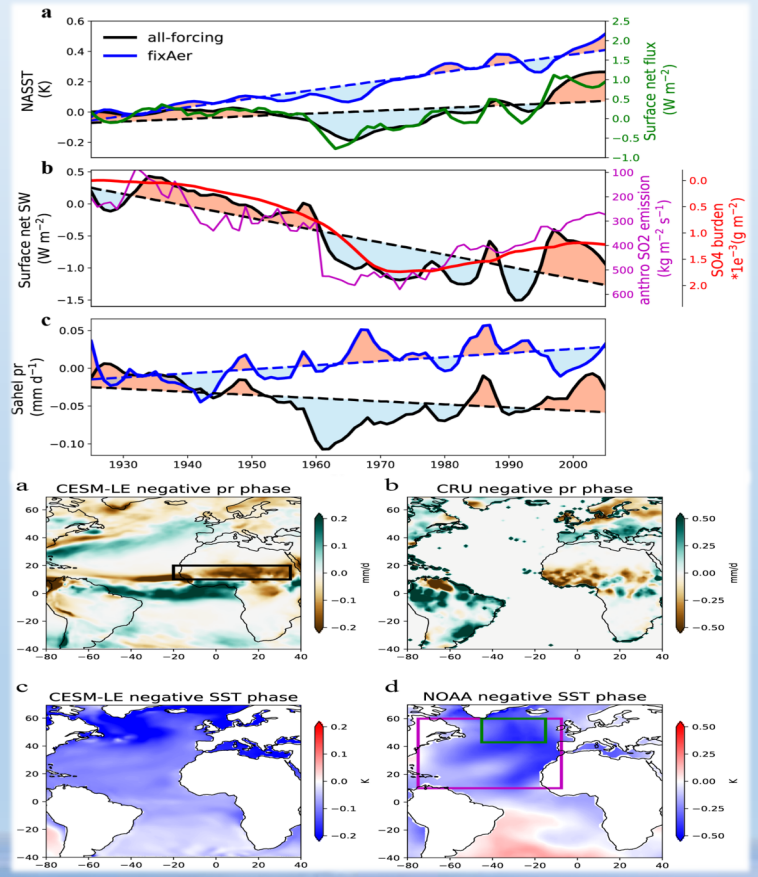


Figure 2: Detrended NASST and Sahel rainfall from simulations and observations

- ✓ *CESM-LE*
- ✓ *CMIP6*
- ✓ *CRU*
- ✓ *Hadley*
- ✓ *NOAA SST*

Results

Changes in regional aerosols emission can drive multidecadal Sahel rainfall variability. Here we combine ensembles of state-of-the-art global climate models (the CESM-large ensemble and CMIP6 models) with observational datasets to demonstrate that anthropogenic aerosols have significantly impacted twentieth-century Sahel rainfall multidecadal variability through modifying NASST. We show that aerosol-induced multidecadal variations of downward solar radiative fluxes over the North Atlantic cause NASST variability during the 20th century, altering the intertropical convergence zone (ITCZ) position and dynamically linking aerosol effects to Sahel rainfall variability.



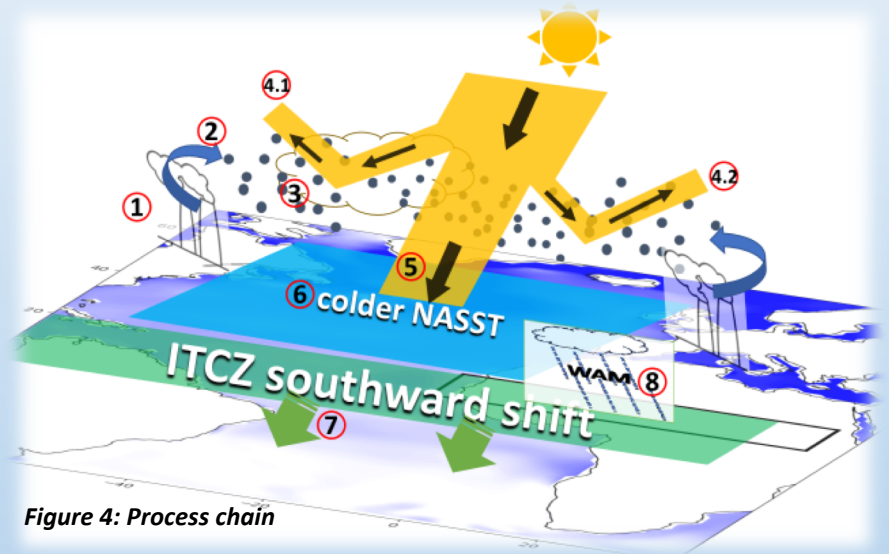


Figure 4: Process chain

1. *anthropogenic emissions*
2. *enhanced aerosol formations*
3. *aerosol-cloud interactions*
4. *4.1 solar radiation reflected by clouds*
5. *4.2 solar radiation reflected by aerosols*
6. *reduced surface fluxes*
7. *colder North Atlantic Sea surface*
8. *Southward shift of ITCZ*
9. *Weakened Western African Monsoon*

Figure 3: CESM-LE simulated radiaves fluxes, sulphate emissions and burden over North Atlantic ocean, NASST and Sahel rainfall for all-forcing and fixAer simulations. Also shown are the spatial pattern of NASST and rainfall during a negative phase in CESM-LE and observations.

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- ❑ Detrended NASST and Sahel rainfall
- ❑ Connections between NASST and Sahel rainfall
- ❑ Aerosol impacts on NASST

- Through direct and indirect radiative effects
- rather than ocean dynamics
- ACI contributed the most uncertainties