DETECTING THE REGIONAL EMERGENCE OF CLIMATE SIGNALS WITH MACHINE LEARNING IN A SET OF STRATOSPHERIC AEROSOL INJECTION SIMULATIONS

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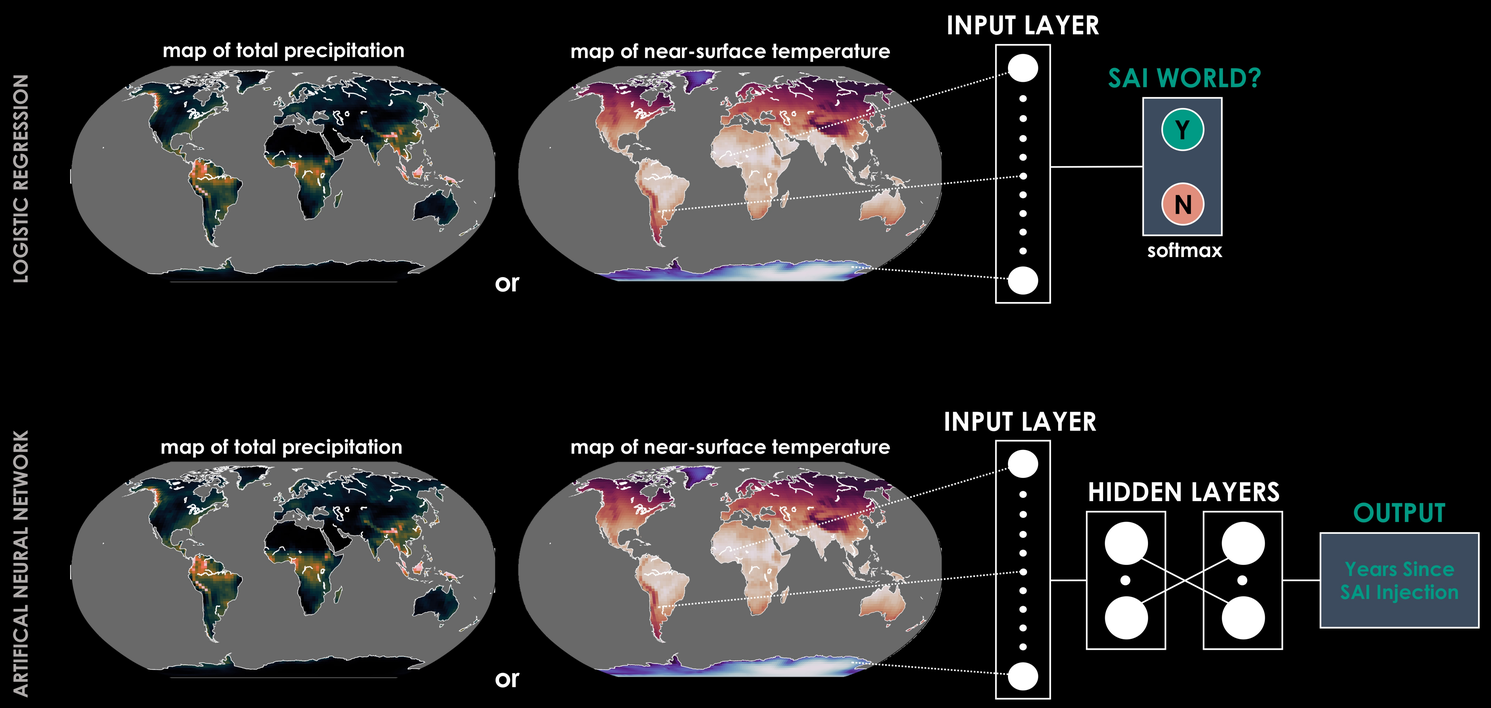
Data-driven methods can identify whether a world is under the influence of climate intervention by learning regional climate signals



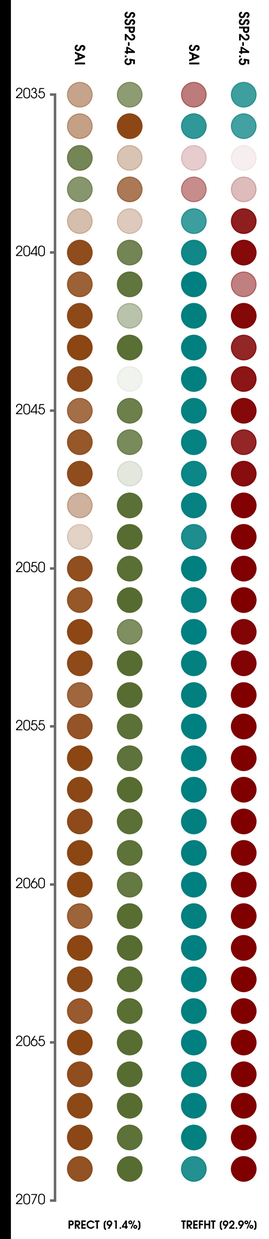
Step 1: Train logistic regression model on maps of temperature or precipitation to classify whether it is from a world under the influence of solar climate intervention (SAI) using the ARISE-SAI-1.5 experiment (CESM2(WACCM6) – SSP2-4.5).

Step 2: Train artificial neural network to identify how many years since climate intervention began in ARISE-SAI-1.5 (i.e., 2035).

The opportunity

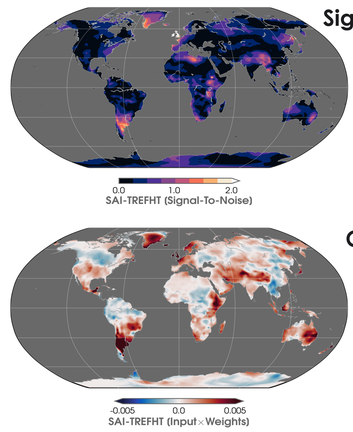
Research exploring the potential impacts of solar climate intervention, such as through stratospheric aerosol injection (SAI), is growing. However, there are large uncertainties in understanding the regional climate impacts and the range of ethical and societal concerns.

To understand the detection of regional climate signals, we use a new set of climate model experiments, called ARISE-SAI-1.5, which simulate the deployment of stratospheric aerosols to limit the global mean surface air temperature from rising above the 1.5°C level.



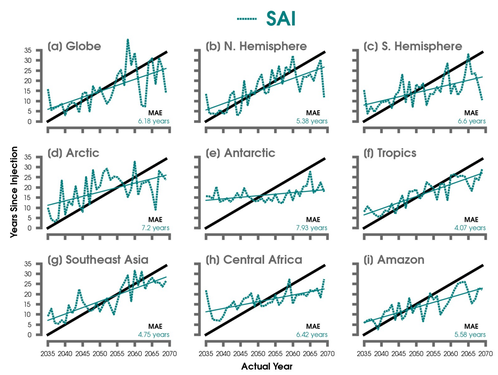
The logistic regression models are leveraging combinations of climate signals across the maps in order to make correct classifications (SAI or not).

One advantage of this data-driven approach is that we are not restricted to linear point-by-point statistics, as in many signal-to-noise metrics.



Although there is a range in regional skill, the artificial neural network can detect how many years since SAI started by spatially leveraging time-evolving temperature signals.

The network performs poorly when given maps of precipitation due to larger variability (noise).



The conclusions

Using logistic regression, we find that it takes up to one decade after stratospheric aerosol injection for the emergence of regional climate signals. We then use a more complex machine learning method (i.e., an artificial neural network) to address whether we can identify how many years it has been since the start of climate intervention. While this is a much more difficult task, we find skillful results for some locations, such as in tropical land areas. Explainability methods further reveal where the data-driven models are leveraging regional climate signals, which are usually found in areas of high signal-to-noise.