



MARINE CLOUD BRIGHTENING

RESEARCH PROGRAM

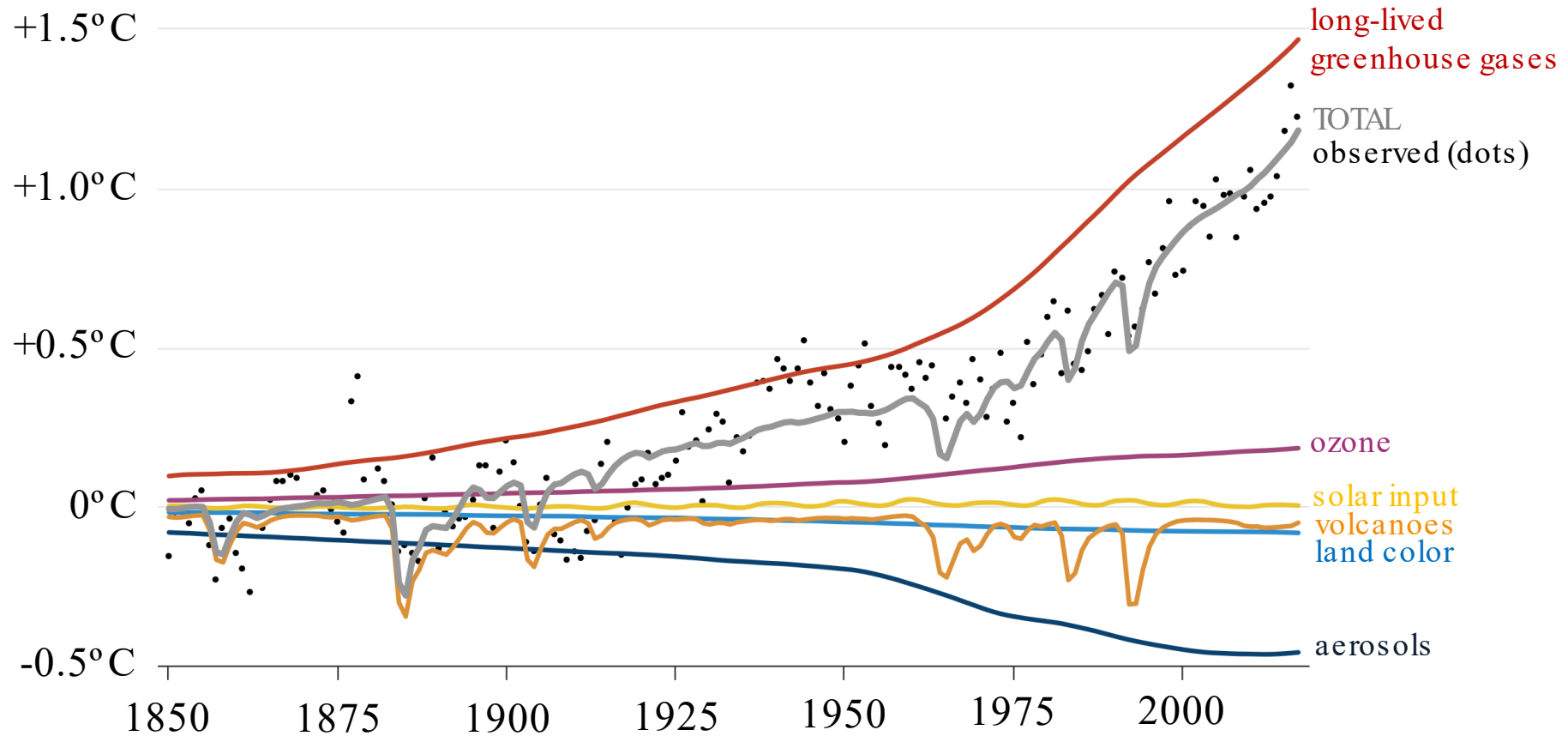
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Project P.I.

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| DRIVERS OF TEMPERATURE CHANGE



Source: carbonbrief.org

<https://www.carbonbrief.org/analysis-why-scientists-think-100-of-global-warming-is-due-to-humans/>

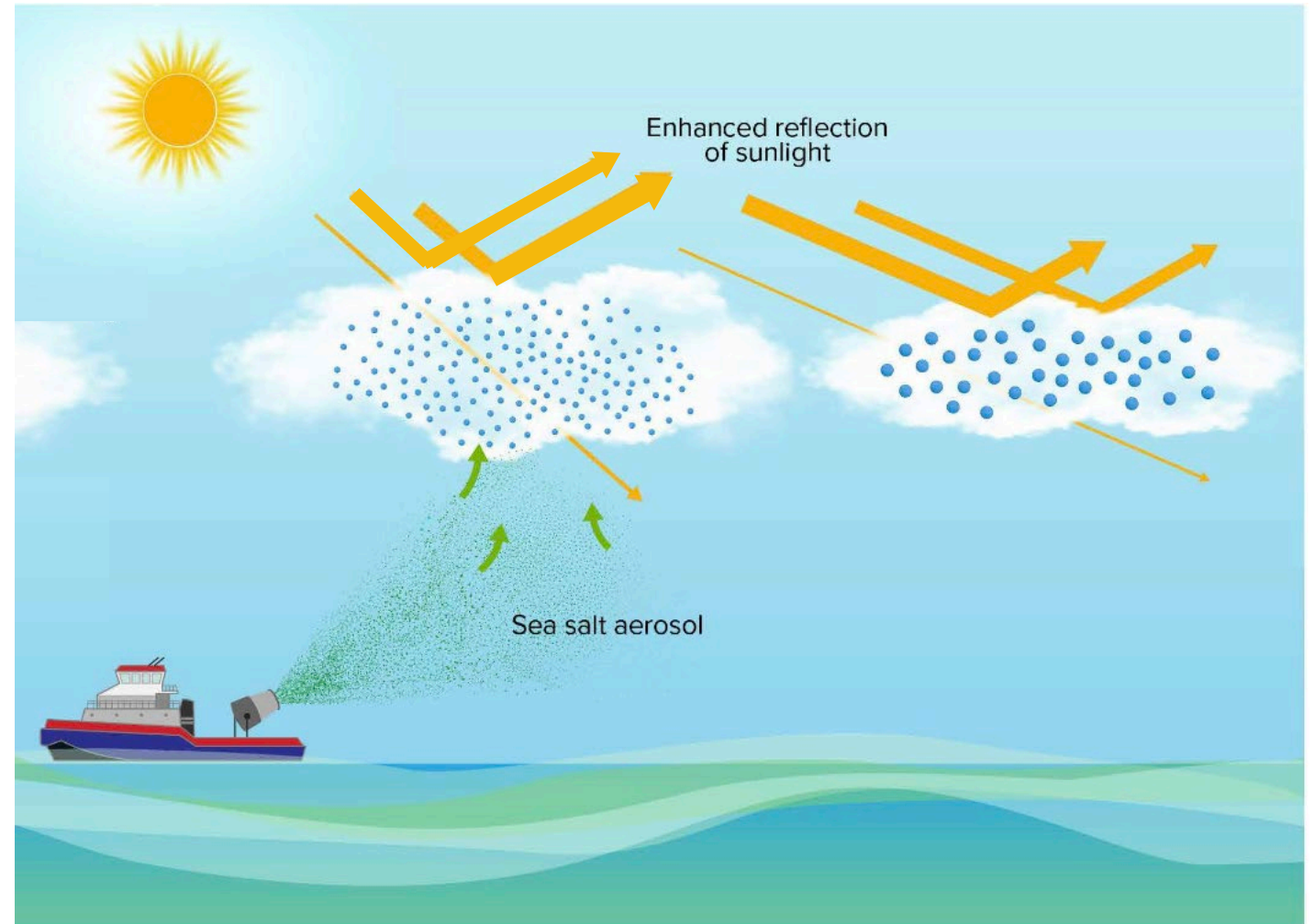
IDEA:

BRIGHTEN CLOUDS WITH SEA-SALT SPRAY instead of pollution

Estimate:

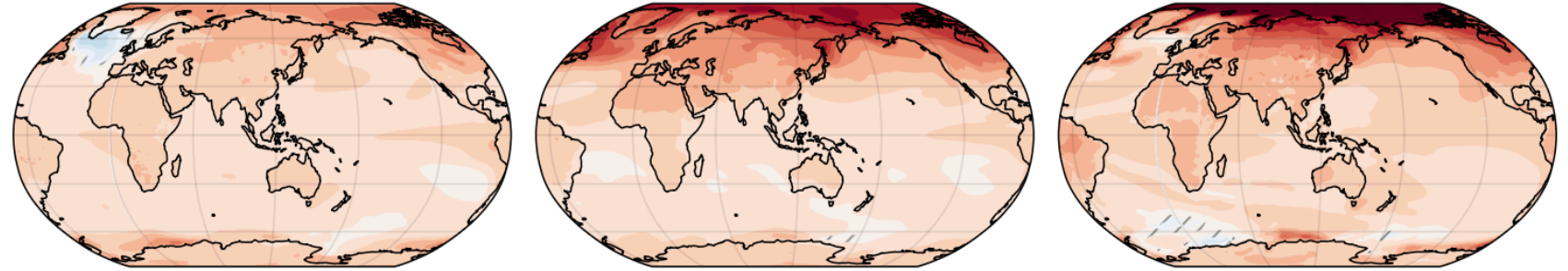
Several thousand ships,
each spraying $\sim 10^{15}$ - 10^{16} particles/sec
into regions of marine clouds,
could offset a substantial fraction of
warming from doubling CO_2 .

Source: ¹Salter et al., Phil. Trans. R. Soc. A (2008) 366, 3989–4006;
²Private communication, Prof. Rob Wood.

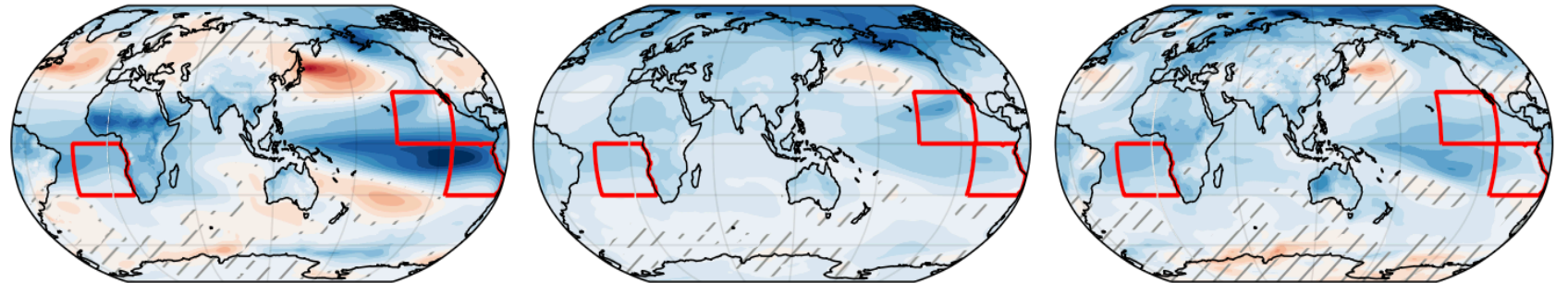


TEMPERATURE CHANGE, 2025 to 2055

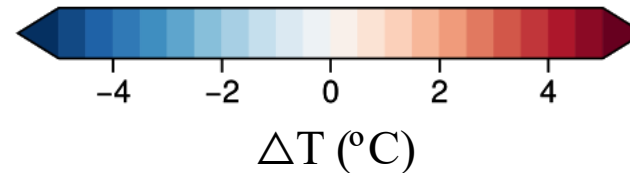
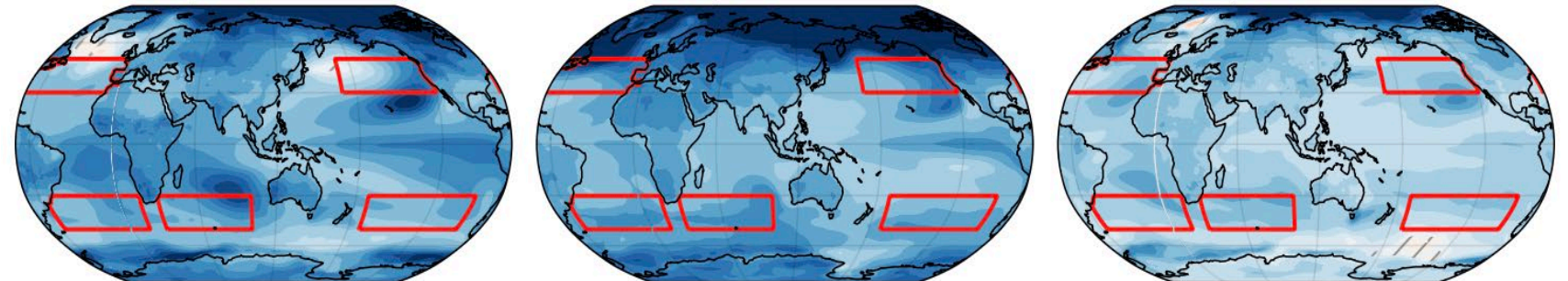
In a “mid-range” GHG emissions scenario (SSP2-4.5)



...plus MCB in 3 sub-tropical regions

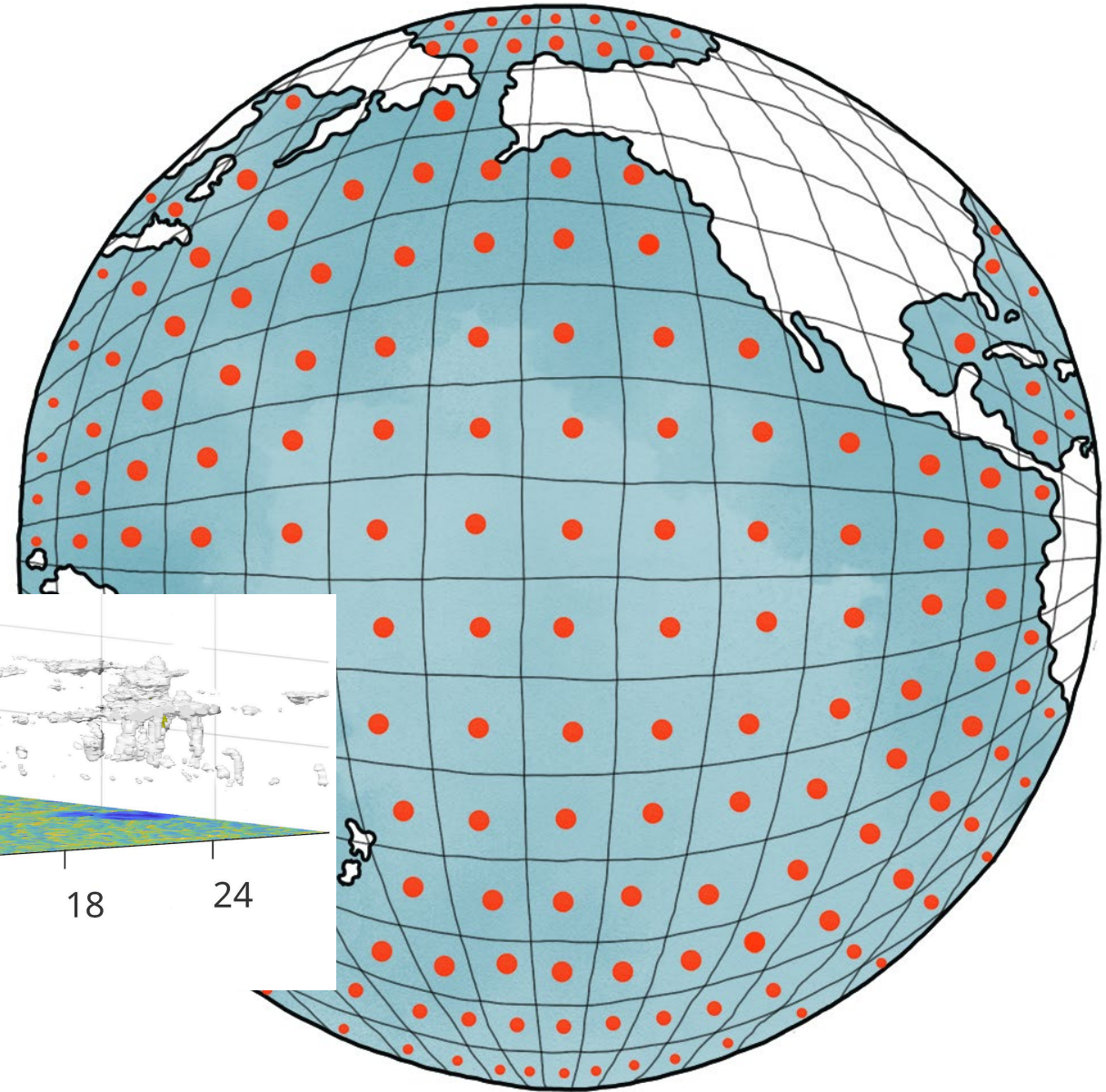
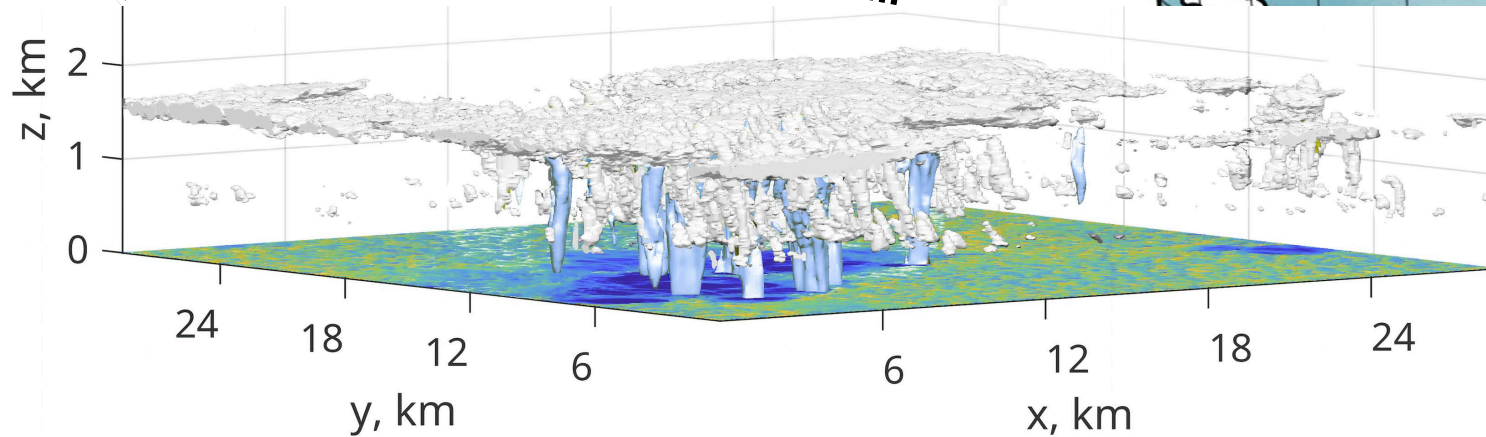
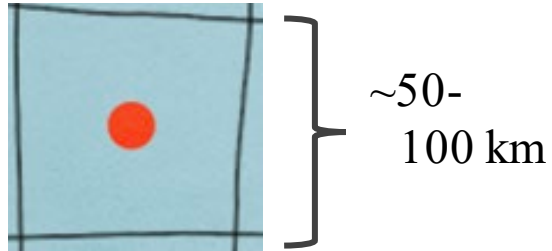


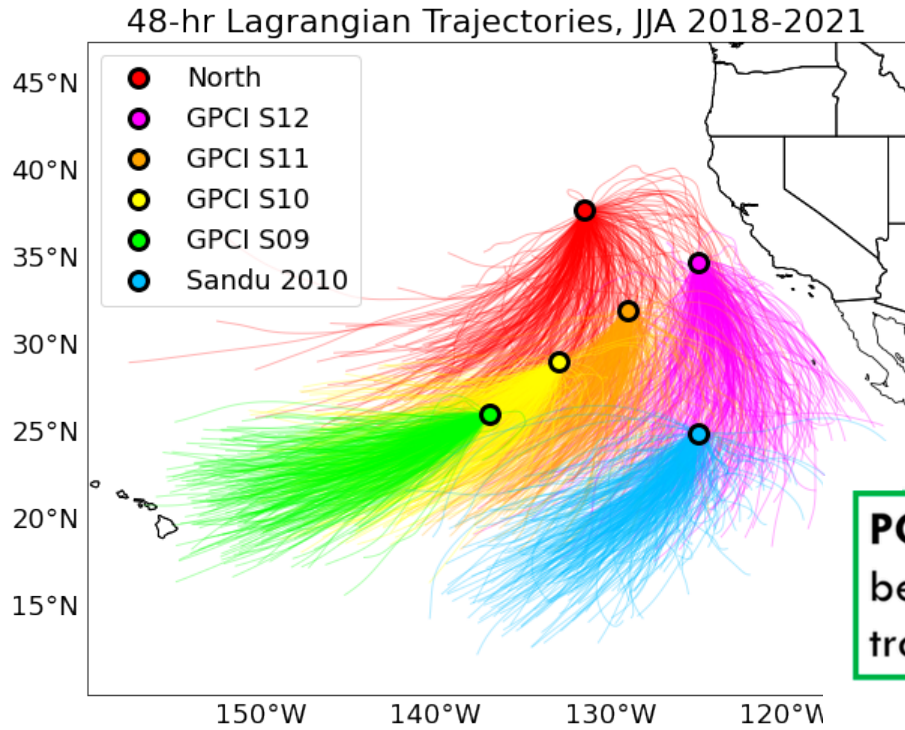
...plus MCB in 5 mid-latitude regions



GLOBAL MODELING OF CLIMATE IMPACTS OF MCB

Global model resolution:



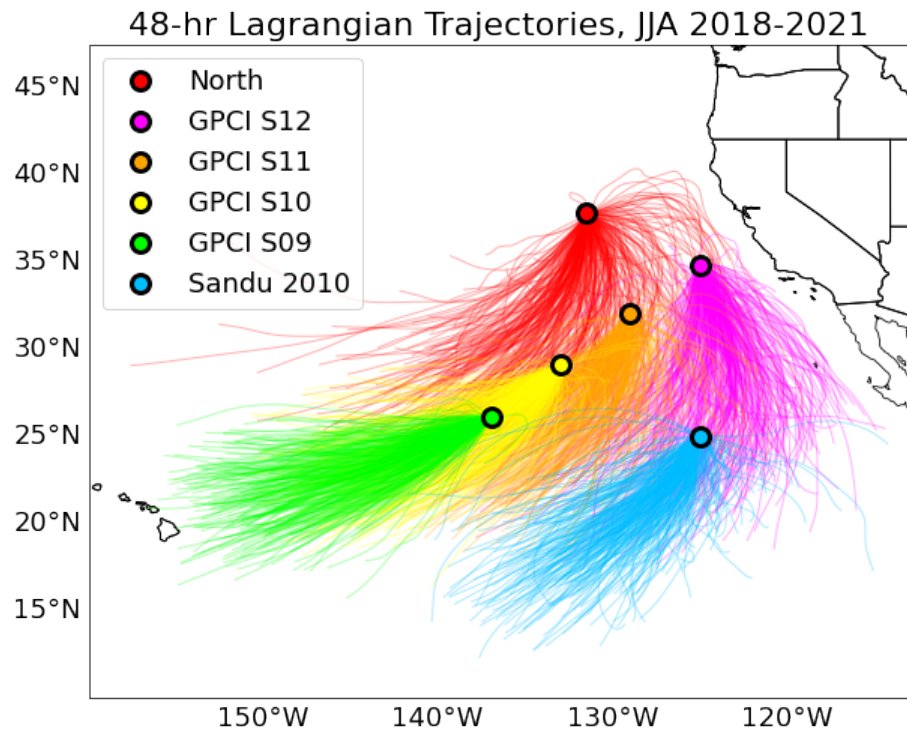


ASSESSING MARINE CLOUD BRIGHTENING POTENTIAL using Principal Component (PC) analysis & cloud-resolving models

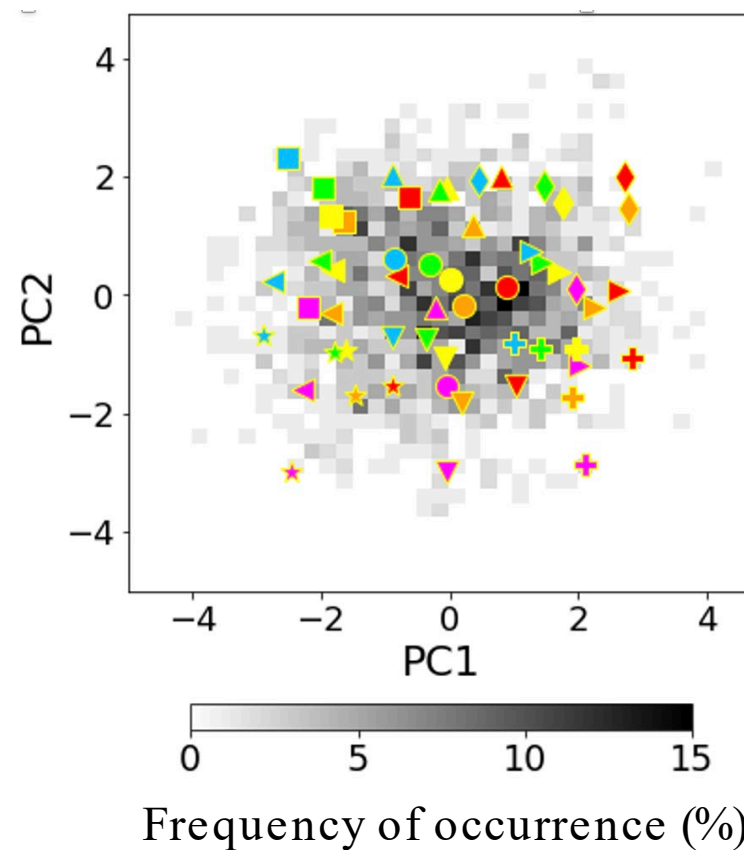
PCA inputs: 8 variables (differences between beginning and end of the trajectory, and along-trajectory means for CCFs: WS , q , ω , and EIS)

2 CCFs (SST and P_{MSL}) and cloud variables are excluded from PCA.

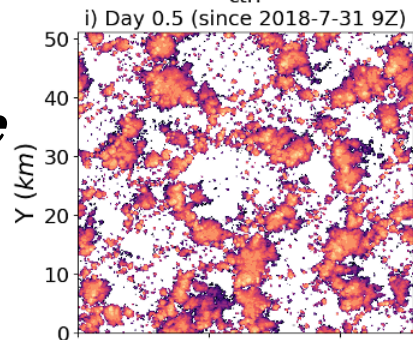
	PCA Inputs (8 variables)								Excluded Variables (2 CCFs and cloud variables)							
	ΔWS_{10m} ($m s^{-1}$)	Δq ($g kg^{-1}$)	$\Delta \omega$ ($Pa s^{-1}$)	ΔEIS (K)	WS_{10m} ($m s^{-1}$)	q ($g kg^{-1}$)	ω ($Pa s^{-1}$)	EIS (K)	CF (%)	SST ($^{\circ}C$)	P_{MSL} (hPa)	log(CERES LWP)	log(N_d)	log($< N_a >$)	MODIS CTH (km)	log(Precip)
PC1	-0.03	-0.38	0.02	0.78	-0.43	-0.72	0.48	0.48	-0.07	-0.47	0.21	-0.04	-0.06	-0.17	0.15	-0.1
PC2	0.6	-0.56	0.23	0.39	-0.15	0.29	0	-0.74	-0.34	0.38	0.12	-0.05	-0.37	-0.19	0.02	0.19



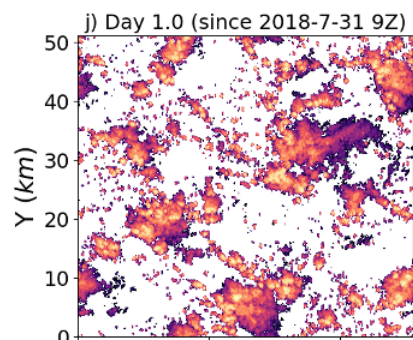
ASSESSING MARINE CLOUD BRIGHTENING POTENTIAL using Principal Component (PC) analysis & cloud-resolving models



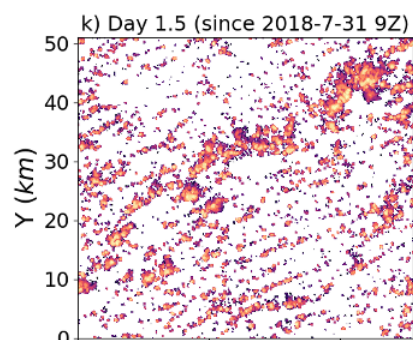
Baseline case



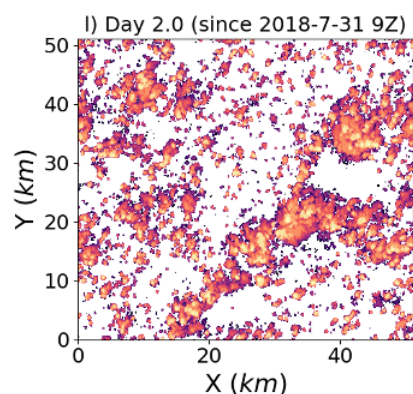
Day 0.5



Day 1.0

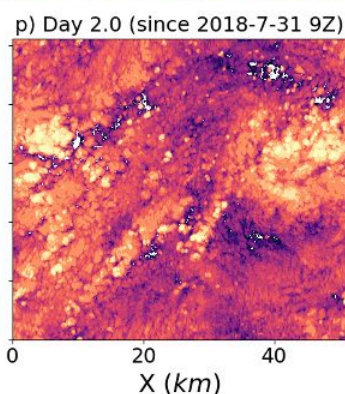
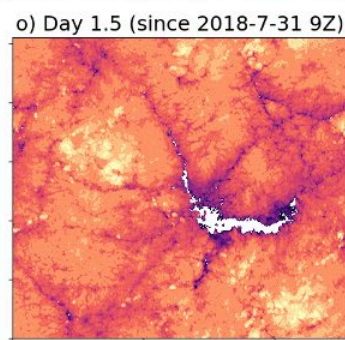
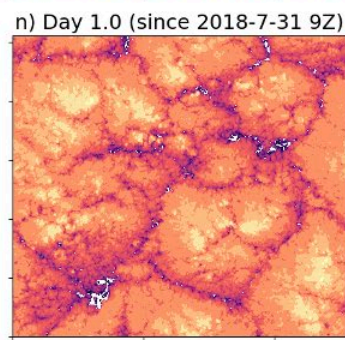
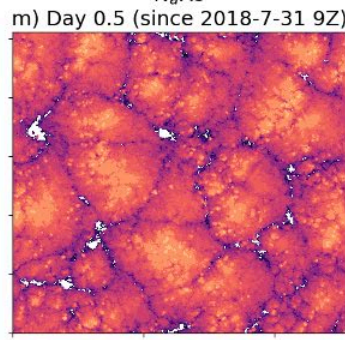


Day 1.5



Day 2.0

With Aerosol injection



Cloud-resolving model simulations

Run simulations for the cases identified in PC analysis, using:

- Observed conditions (“baseline”)
- & adding in aerosol injection (“MCB” run)
- Compare baseline cloud evolution to observed cloud evolution
 - Test of model fidelity
- Quantify MCB affect on clouds
 - Test of cloud-brightening potential