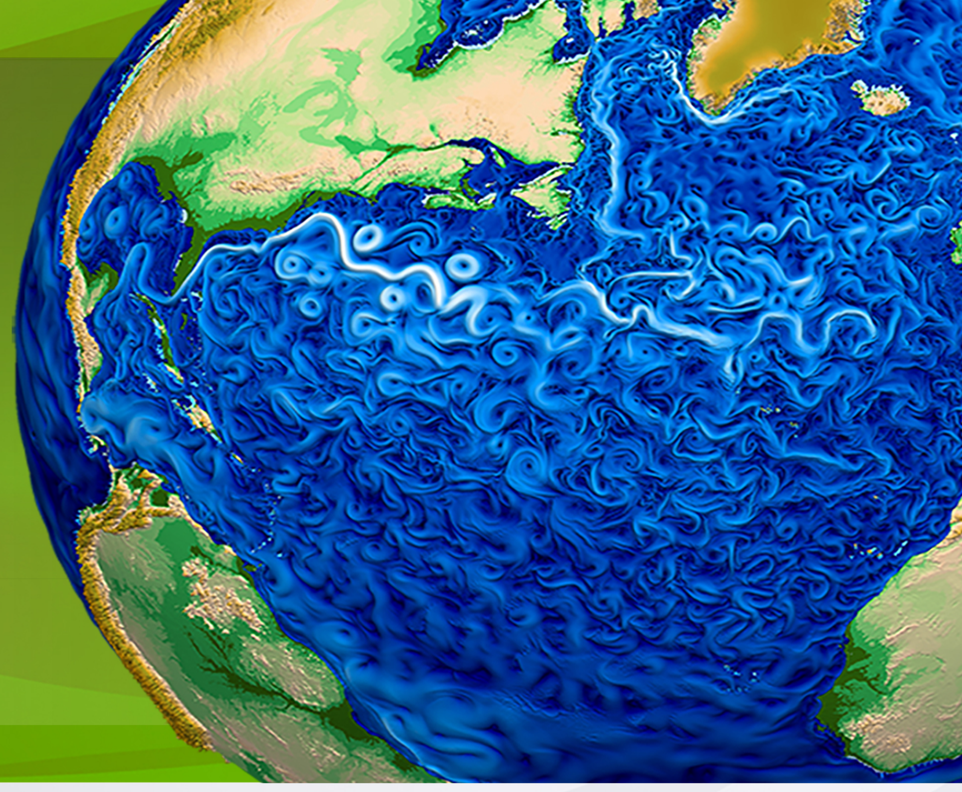

R: Spatial distributions and radiative forcing of aerosols in ACME v1

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Objective and Summary

Objective:

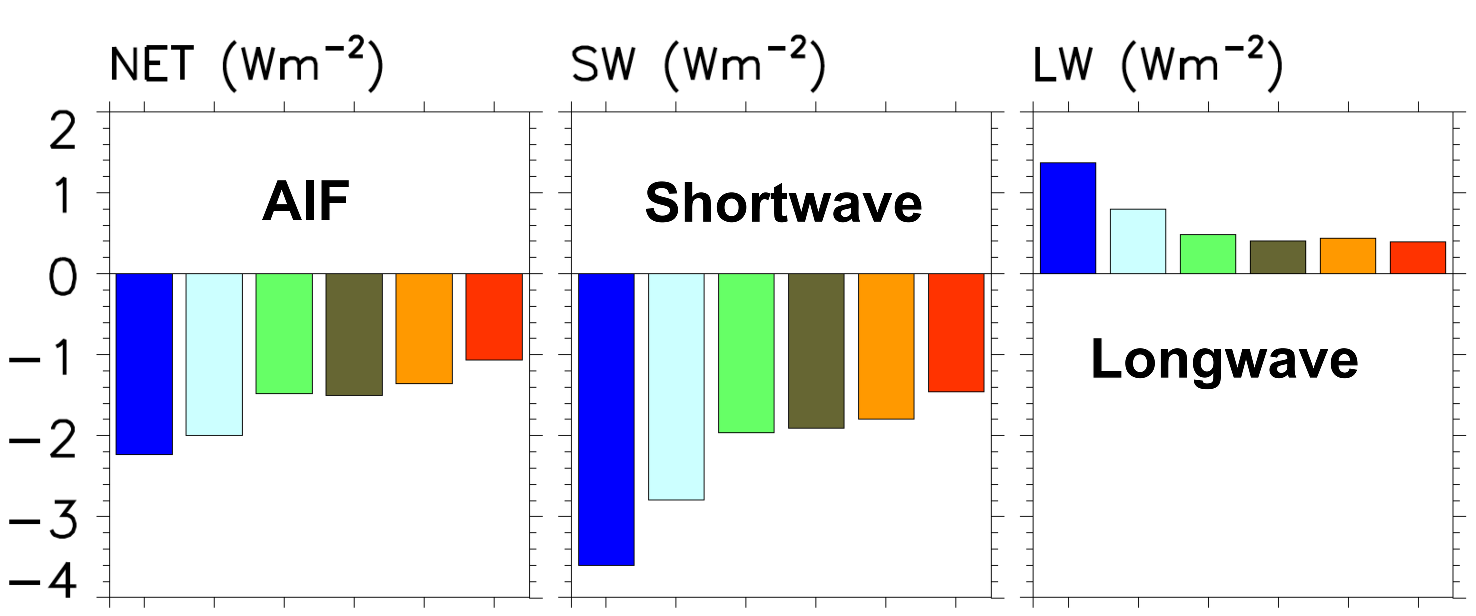
Several new treatments to the representations of aerosols and cloud-aerosol interactions have been implemented in the ACME v1. This study is to assess their impact on aerosol spatial distributions and radiative forcing. We also explored ways to further tune down aerosol indirect forcing (AIF) and to understand the AIF sensitivities.

Summary:

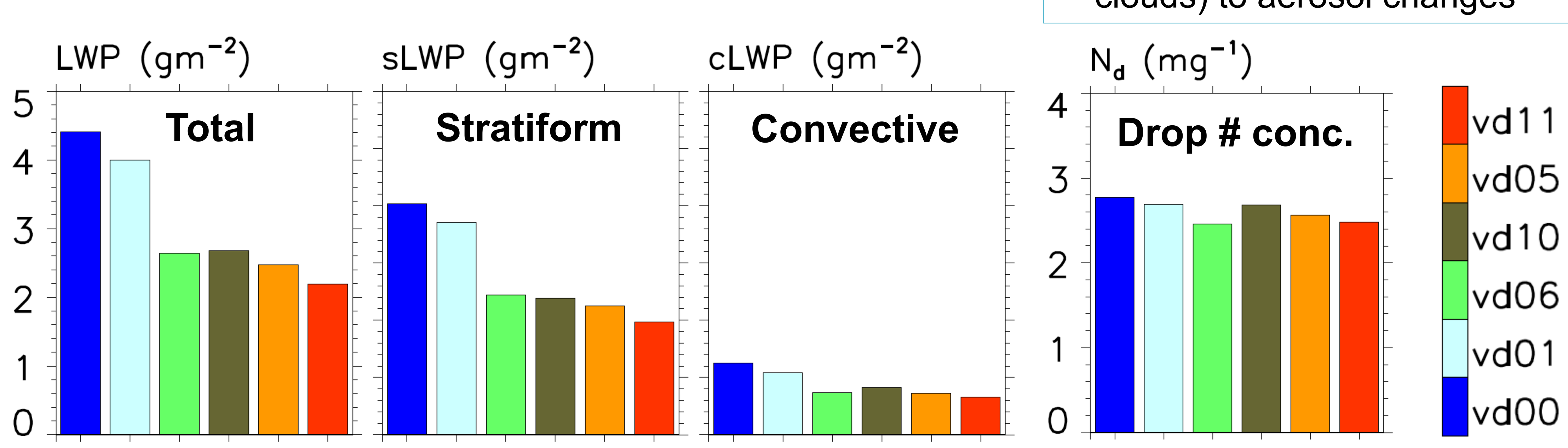
- New SOA gas emissions datasets are produced for ACME simulations
- Aerosol spatial distributions (e.g., AOD, vertical profiles, near-surface concentrations) are significantly improved due to some of the new aerosol/cloud treatments and the new emissions
- The advanced treatments and initial tuning of TOA radiation gave a strong AIF (SW -3.6; NET -2.2 W m^{-2}), but we managed to reduce the forcing to a reasonable range (SW -1.5; NET -1.1 W m^{-2}), according to 5-year stand-alone atmosphere simulations
- The strong AIF is due to a large increase in the present-day liquid water path (LWP,) as opposed to drop number (N_d) that has a much smaller sensitivity to tuning
- Further investigation is needed to understand the aerosol effects
- We have also explored other ways to reduce AIF (e.g., a lower bound of cloud droplet number; new cloud-to-rain autoconversion schemes)

Aerosol Indirect Effects in ACME v1

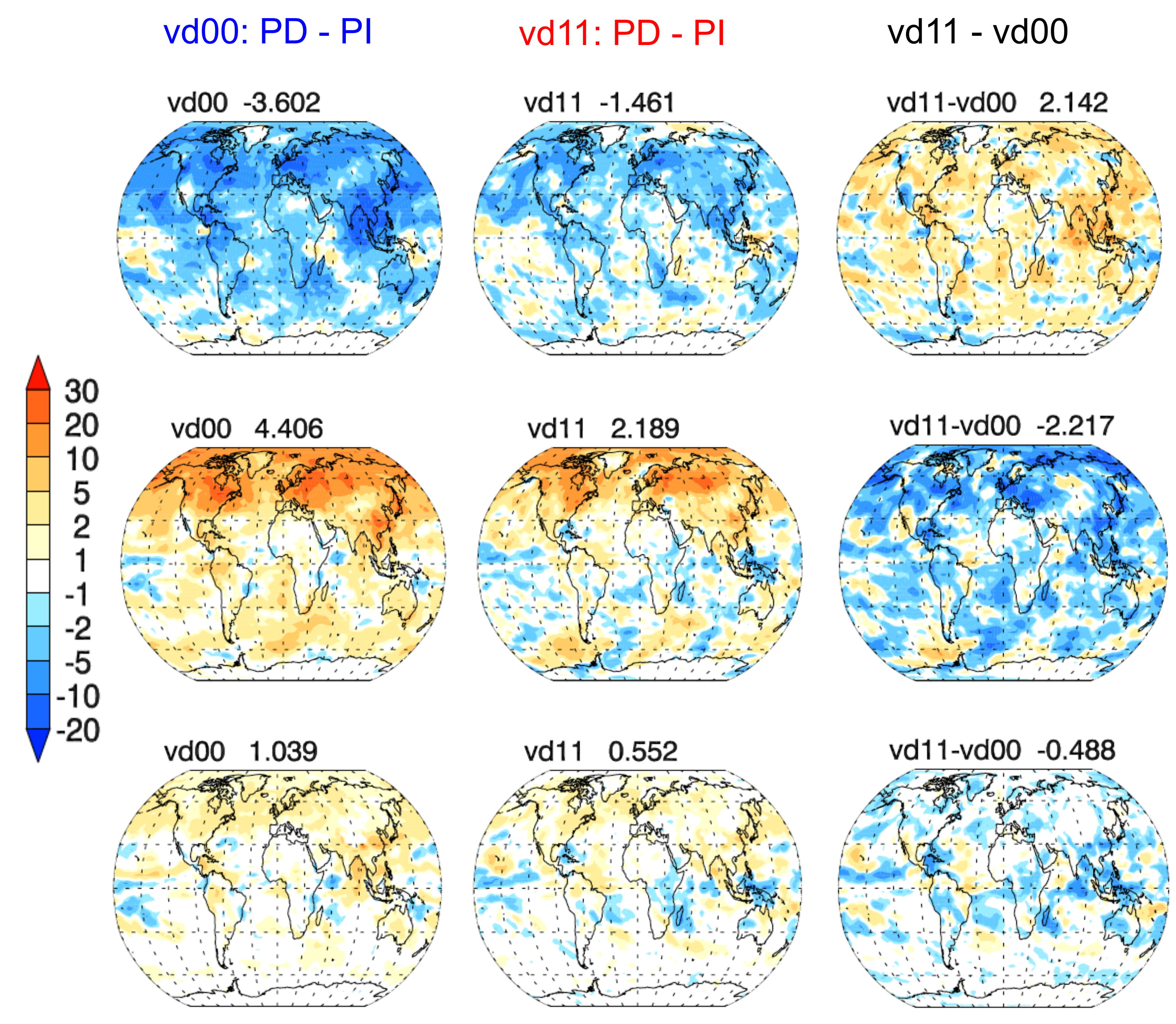
Changes due to present-day (PD) vs. pre-industrial (PI) aerosols



- AIF is sensitive to ice nucleation parameterization (vd00 vs. vd01) and cloud-to-rain autoconversion parameterization (vd01 vs. vd05,vd06, vd10 and vd11)
- The sensitivity is dominated by response of LWP (in both straiform and convective clouds) to aerosol changes



Dominant Impact of LWP Changes on AIF

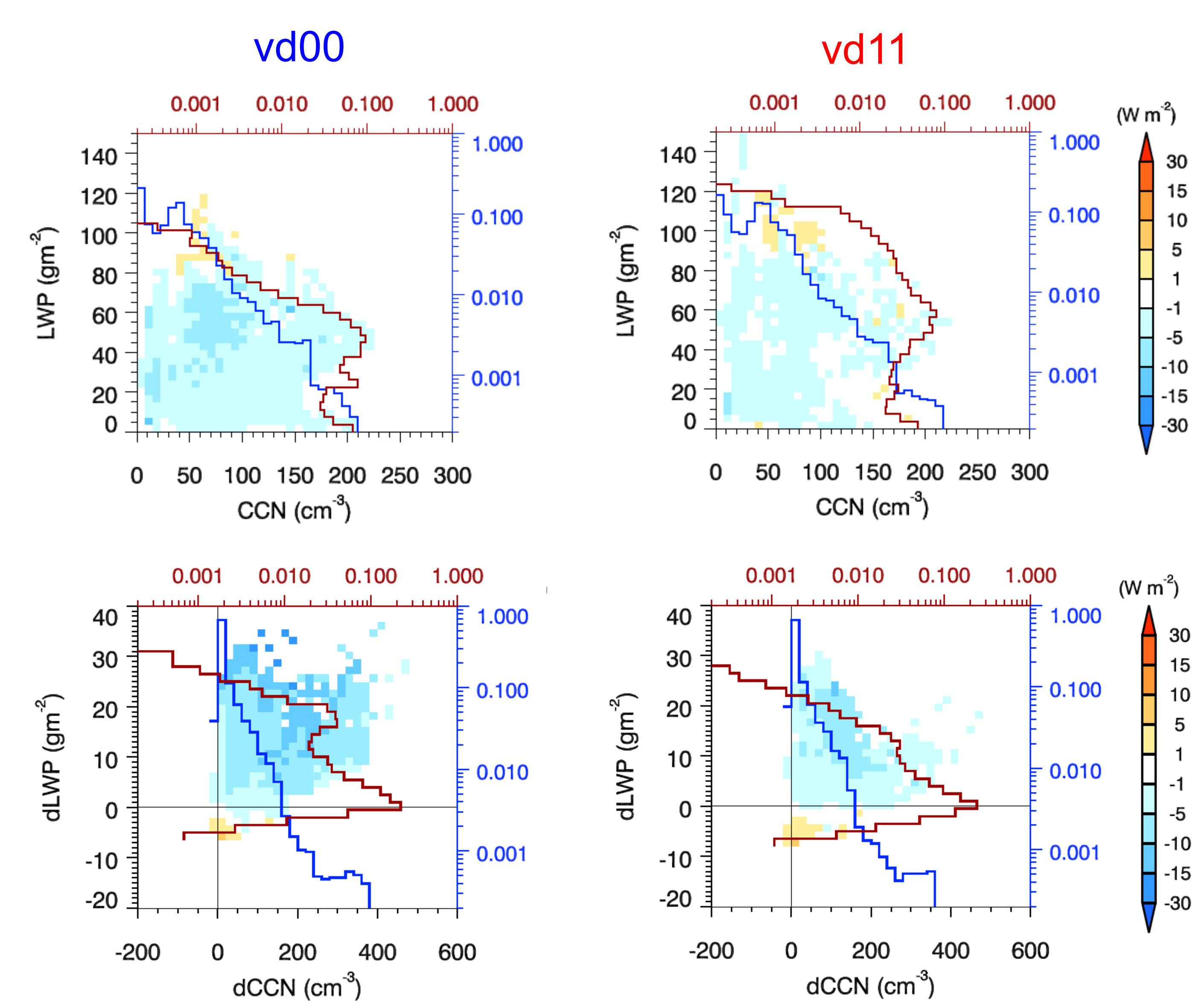


SW AIF (W m^{-2}) is mostly in the NH, but it also has a strong response to the tuning in the SH.

Changes in LWP (g m^{-2}) are in concert with SW AIF (PD vs. PI or vd00 vs. vd11).

Convective LWP (g m^{-2}) plays an important but unexpected role in the SW AIF. (Note the negative impact in the tropics.)

SW AIF as a function of LWP/CCN and dLWP/dCCN



Stronger SW AIF occurs in relatively low CCN and LWP regimes; tuning in the vd11 case significantly increases the base (PI) LWP, leading to a shift in regime-dependent AIE.

Larger LWP changes (dLWP) correspond to stronger SW AIF; Higher base LWPs in vd11 have a weaker response to aerosols and therefore a weaker SW AIF.

ACME Accelerated Climate Modeling for Energy

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