Climate Responses to Recent Major Wildfires as Simulated in E3SM2 and CESM2

Recent Results from both Large Ensembles and SMYLEs

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E3SM2 Response to CMIP6 Biomass Burning Emissions

Key Point: E3SM2 exhibits spurious warming to CMIP6 biomass emissions (post 1997)

- **Fasullo et al. 2022 GRL**: demonstrated NH extratropical warming in response to CMIP6 biomass emissions during GFED

- **Fasullo et al. 2024 ESD**: demonstrates a similar sensitivity in E3SM2 LE (right)

- Users of E3SM2 should exercise caution.

- See poster by Julie Caron.

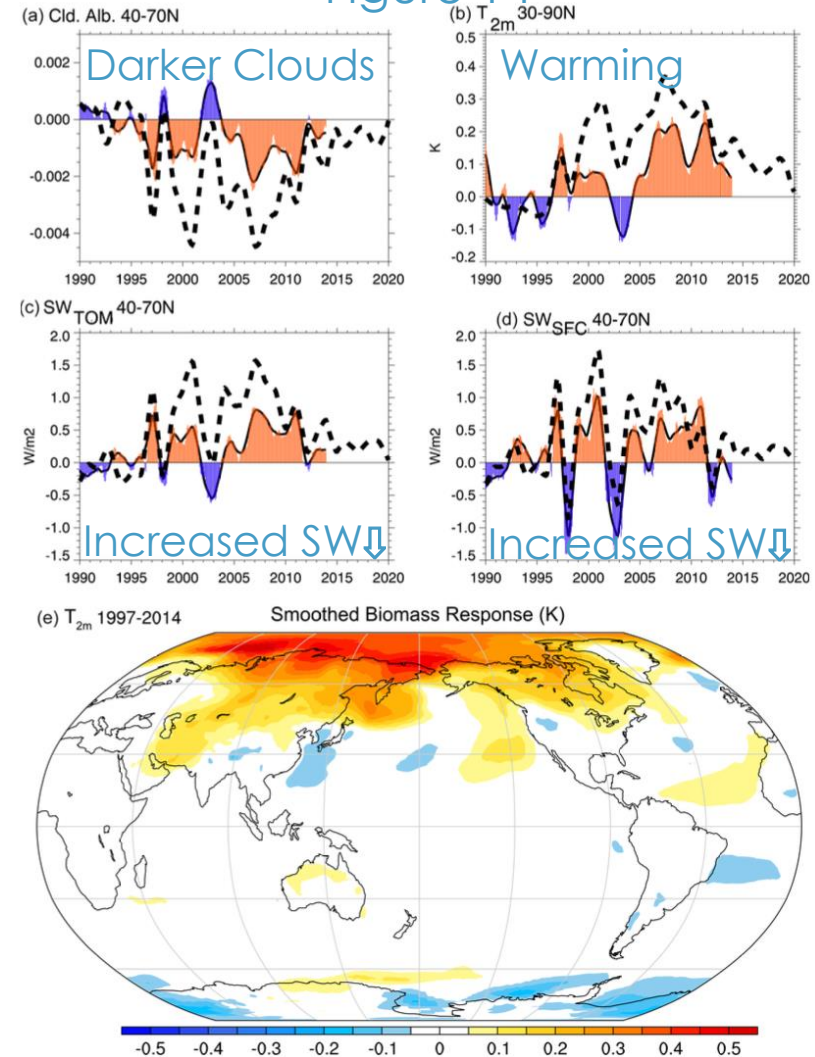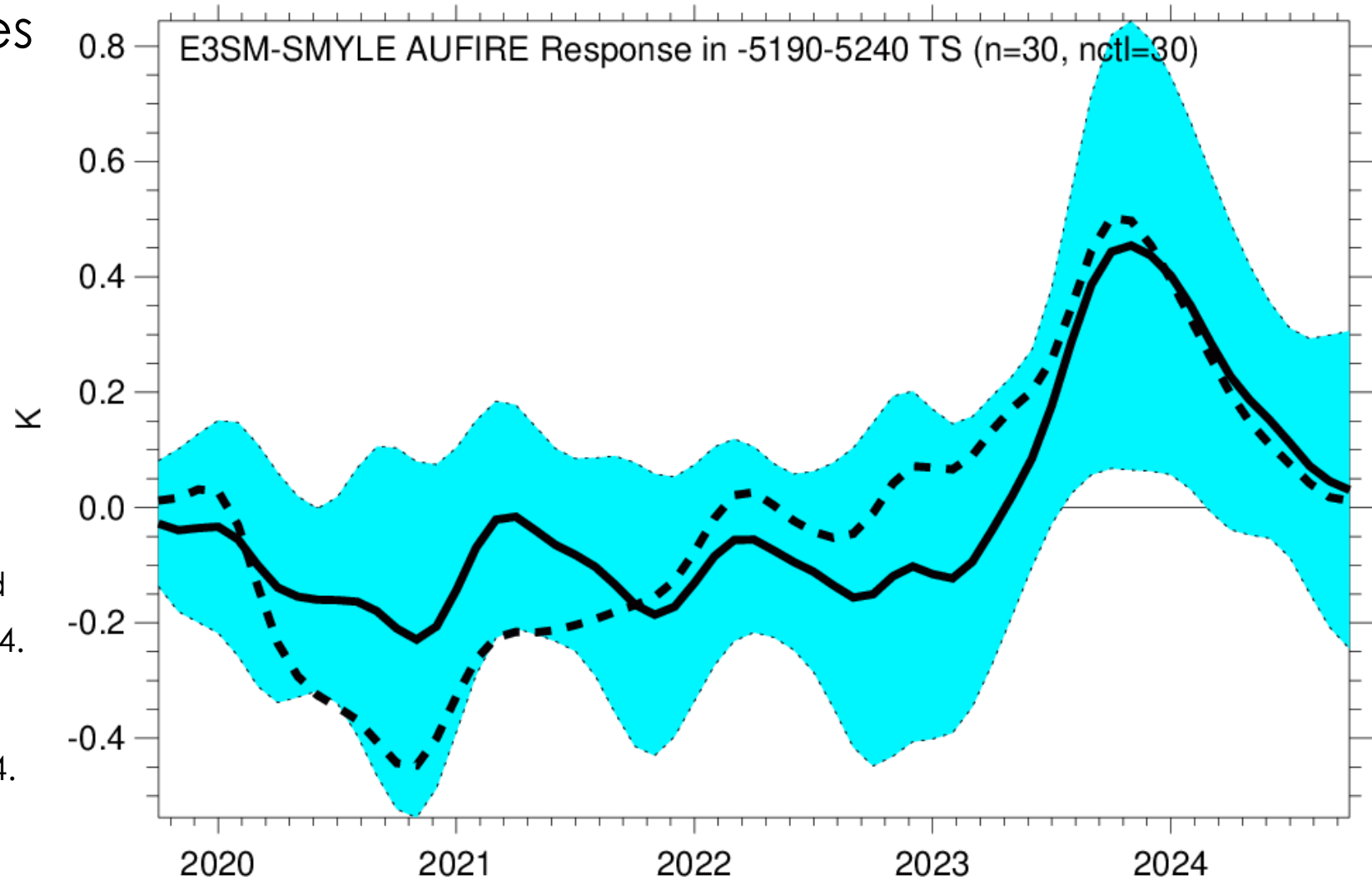Fasullo et al. 2024, ESD
Figure 14

Figure 14. Monthly (bars) and 12-month running-mean (solid line) ensemble-mean responses to variable biomass emissions in E3SM2 for **(a)** cloudy-sky albedo, **(b)** T_{2m}, **(c)** SW_{TOM}, and surface net shortwave flux (SWSFC) **(d)**. The associated sensitivities of CESM2 (12-month running mean) are also shown (dashed lines). **(e)** The spatial pattern of warming in response to CMIP6 biomass emissions (versus smoothed).

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Climate Response to 2019-2020 Aus Wildfires in E3SM2

Key Point: E3SM2 corroborates CESM2 in simulating a multi-year cooling due to the Aus wildfires.

- **Fasullo et al. 2023 Sci Adv**: identified a prolonged La Niña response to the fires in CESM2-SMYLE.

- Here we reproduce that result using E3SM2-SMYLE. The initial response is a modest prolonged cooling (~0.2 K) followed in 2023/24 by a warming in 2023-24.

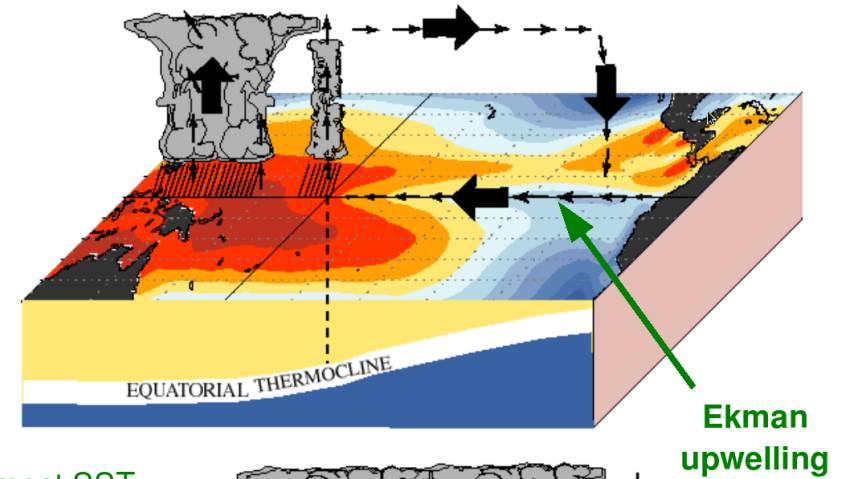- The fire exert a detectible influence on ENSO through 2024.

Fasullo et al., *in prep*.

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ENSO-wildfire Interactions

Key Point: Wildfire is an important aspect of ENSO.

- ENSO impacts drought and fire weather globally – what role does fire play in coupled ENSO evolution?

- In Fasullo et al. 2024 (JCLIM) the effects of biomass emissions on the coupled evolution of ENSO are examined in CESM2.

- Coupled fire improves CESM2's ENSO: 1) less variance, 2) greater asymmetry.

Normal

Ekman upwelling

rain follows warmest SST;
surface winds converge onto rainy/warm zones

El Niño

EQUATORIAL THERMOCLINE

NOAA/CPC

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