Supporting Information for "Machine learning-based detection of weather fronts and associated extreme precipitation in historical and future climates"

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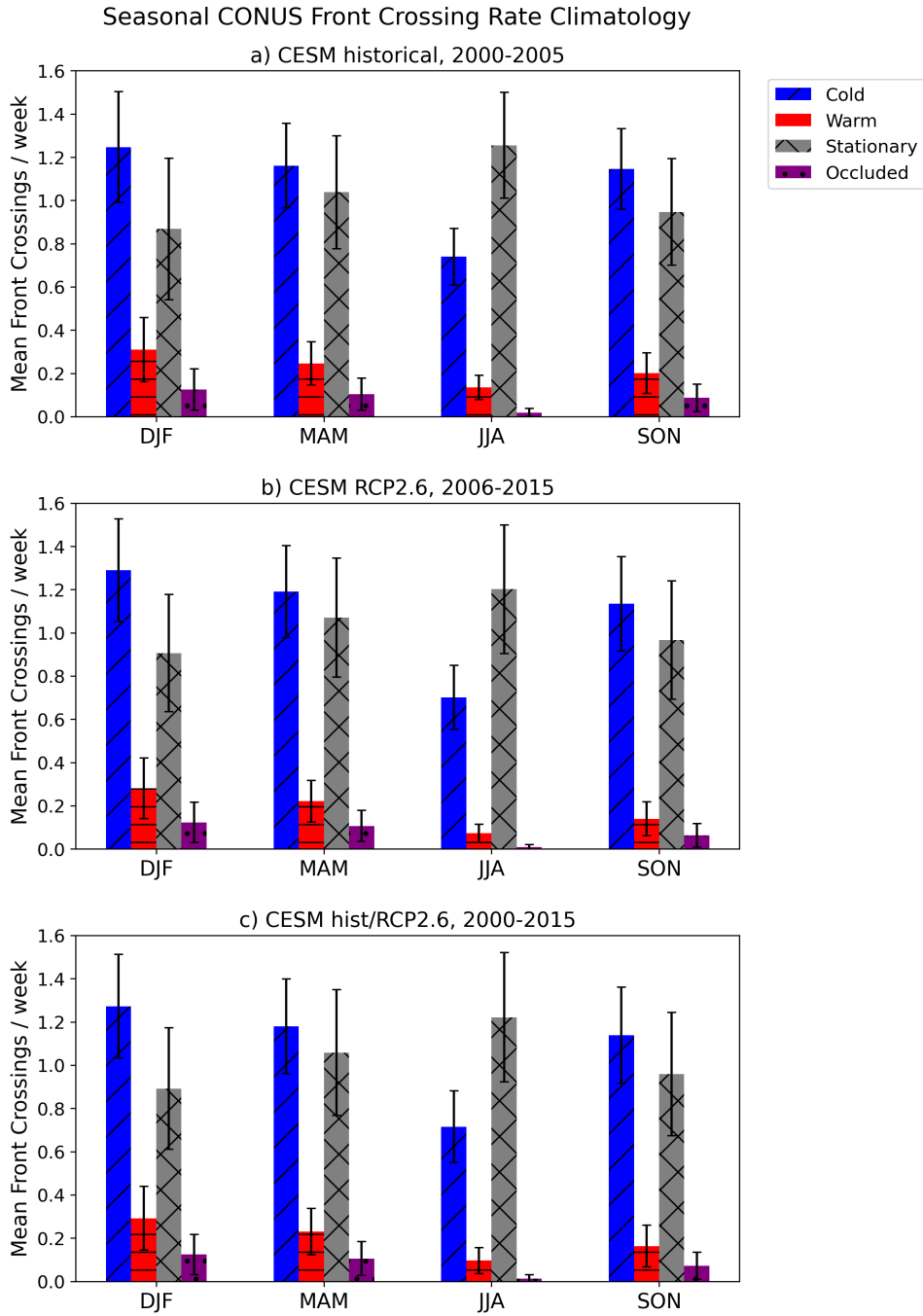
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Figure S1. Seasonal CONUS averaged front crossing rate climatologies (fronts/week) for cold fronts in blue diagonal hatching, warm fronts in red horizontal hatching, stationary fronts in grey cross hatching, and occluded fronts in purple dotted hatching. a) CESM historical simulation, 2000-2005. b) CESM RCP2.6 simulation, 2006-2015. c) CESM combined historical/RCP2.6 climatology, 2000-2015. Error bars show plus or minus the standard deviation across years and front types for each simulation.
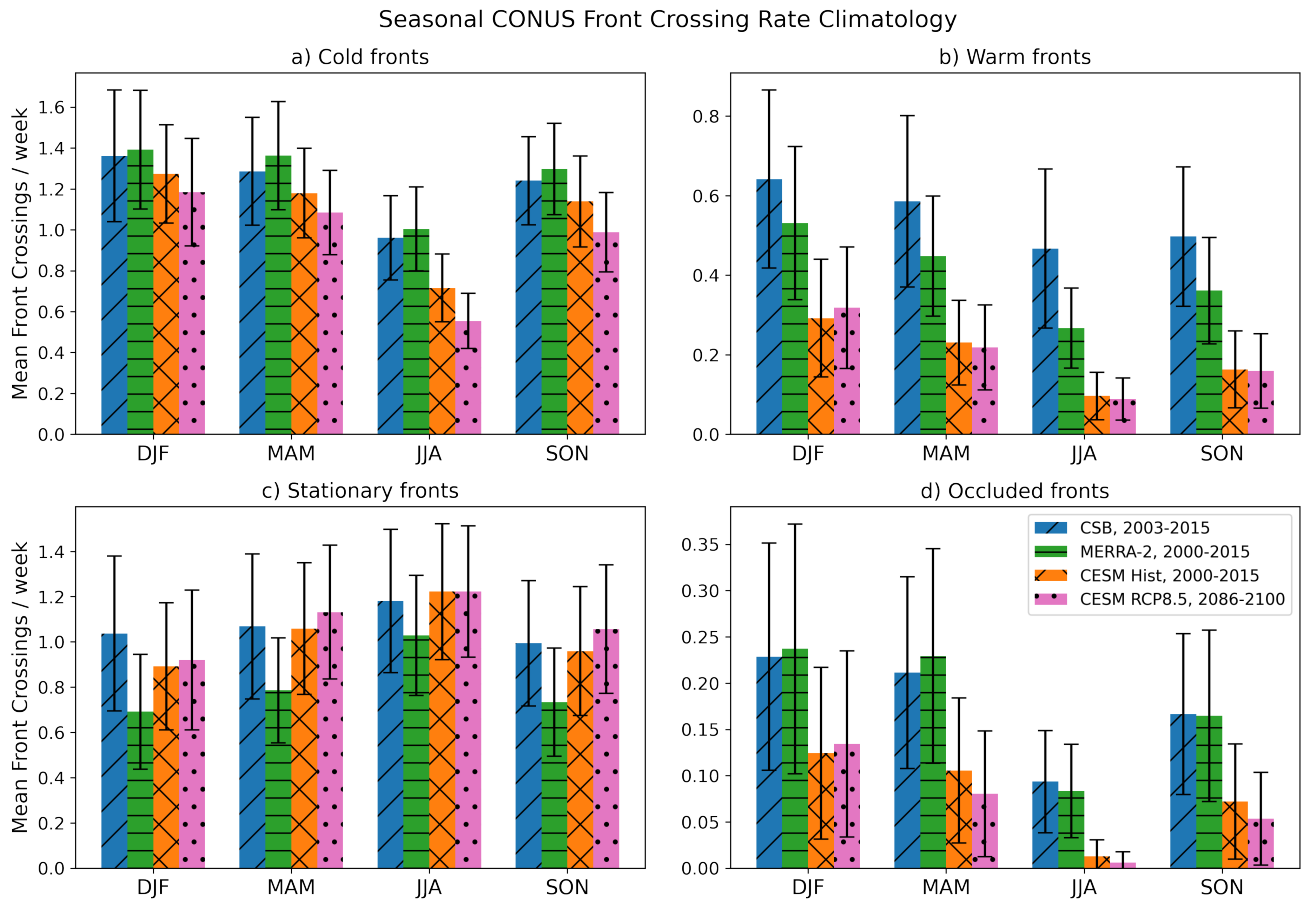
Figure S2. Seasonal CONUS averaged front crossing rate climatologies (fronts/week) for a) cold, b) warm, c) stationary, and d) occluded fronts. Coded Surface Bulletin (CSB) dataset (2003-2015) in blue diagonal hatching, MERRA-2 reanalysis dataset (2000-2015) in green horizontal hatching, CESM historical simulation (2000-2015) in orange cross hatching, and CESM RCP8.5 simulation (2086-2100) in pink dotted hatching. Error bars show plus or minus the standard deviation across years and front types for each simulation.

Annual Mean Front Crossing Rate
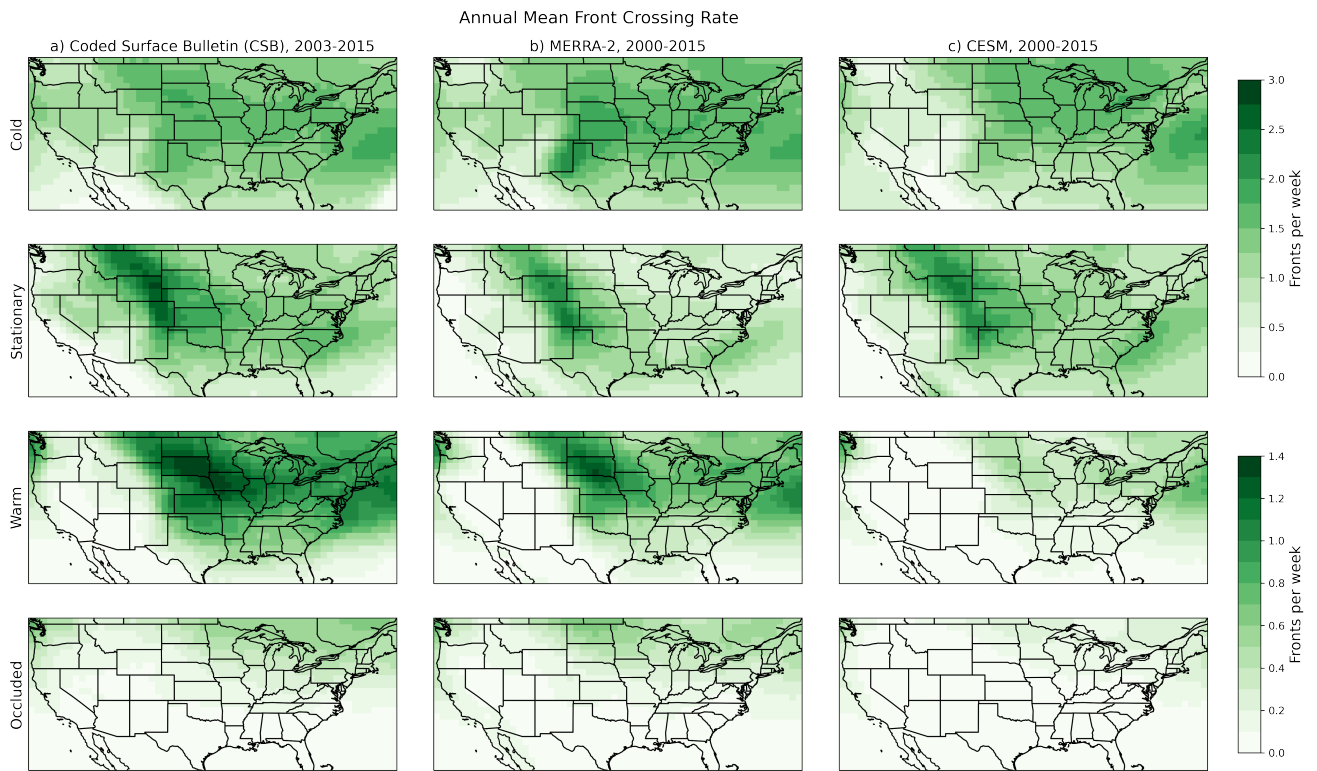
Figure S3. Annual mean front crossing rates (fronts/week) for four different front types in each row (cold, stationary, warm, and occluded fronts). a) Coded Surface Bulletin (CSB) dataset (2003-2015). b) MERRA-2 reanalysis dataset (2000-2015). c) CESM historical simulation (2000-2015). Note the differences in color scale for cold and stationary fronts (top rows) and warm and occluded fronts (bottom rows).

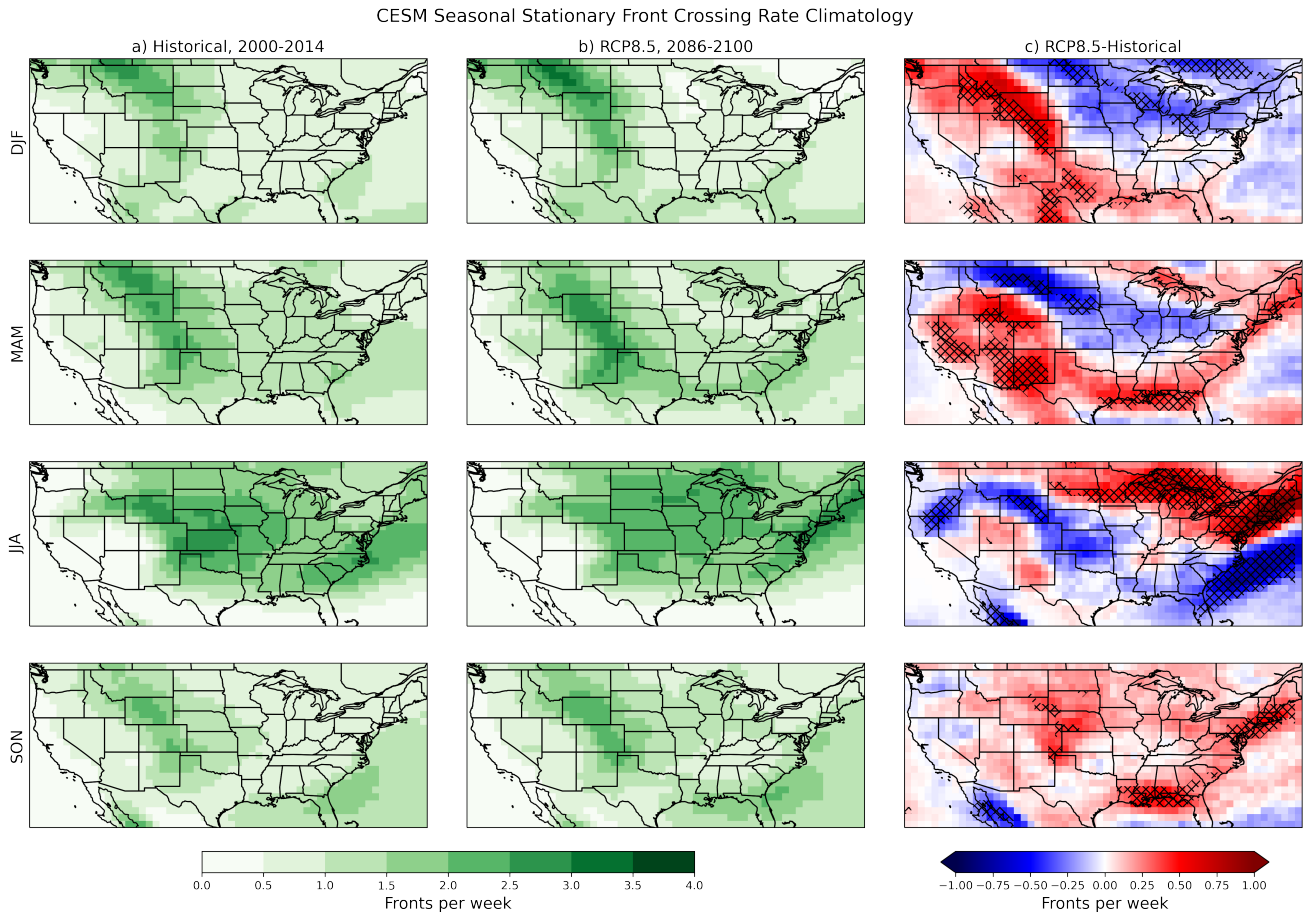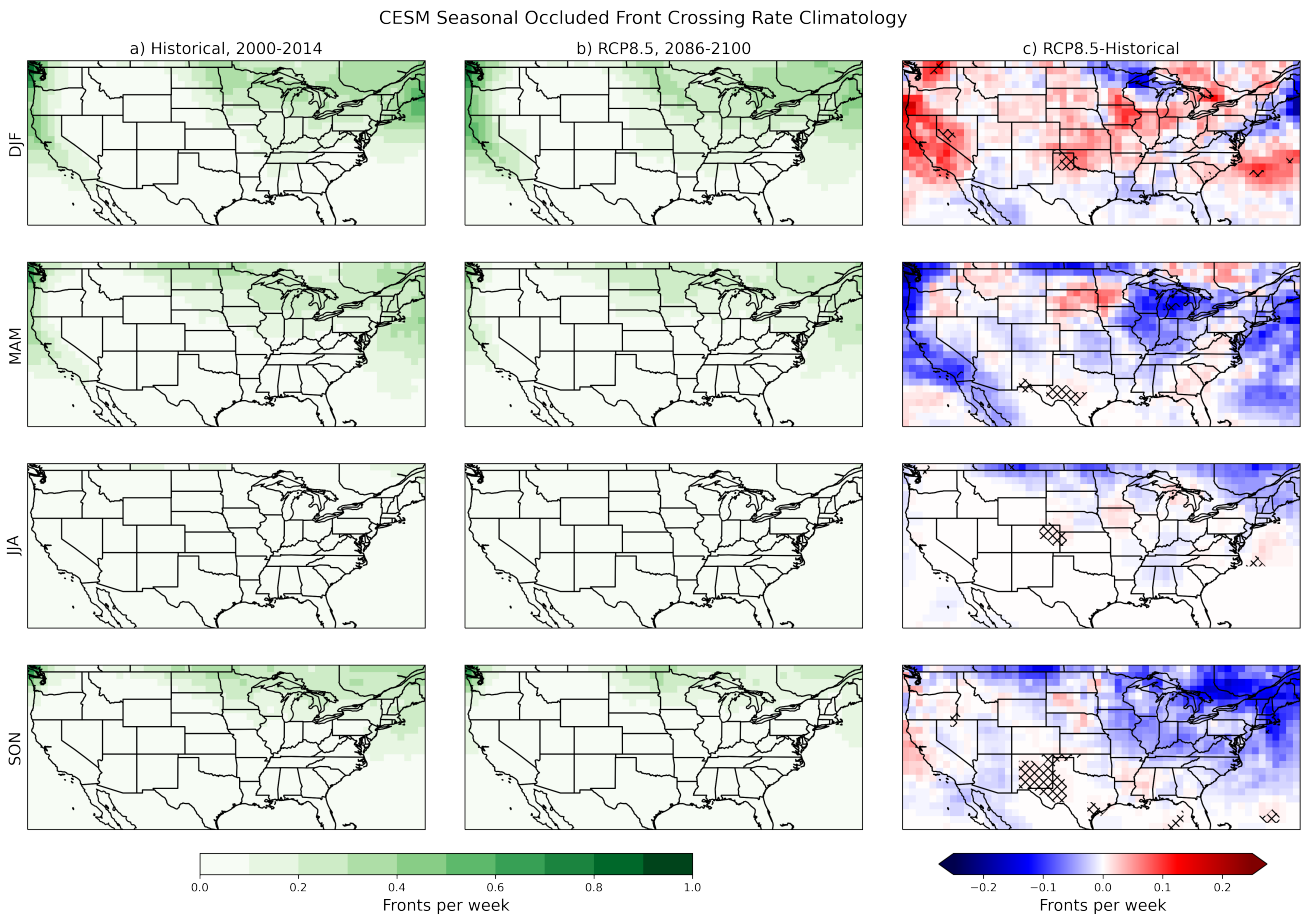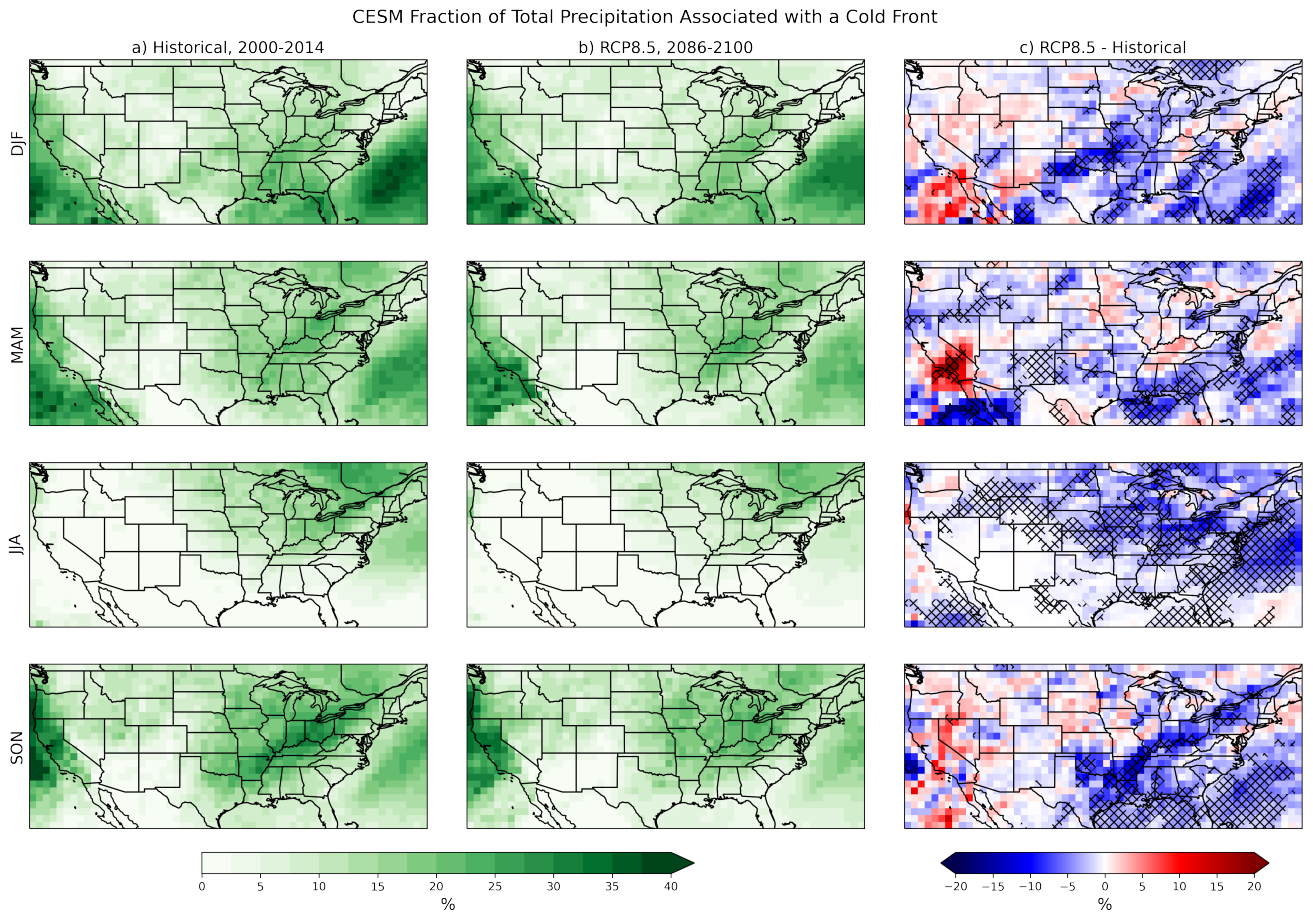CESM Seasonal Cold Front Crossing Rate Climatology
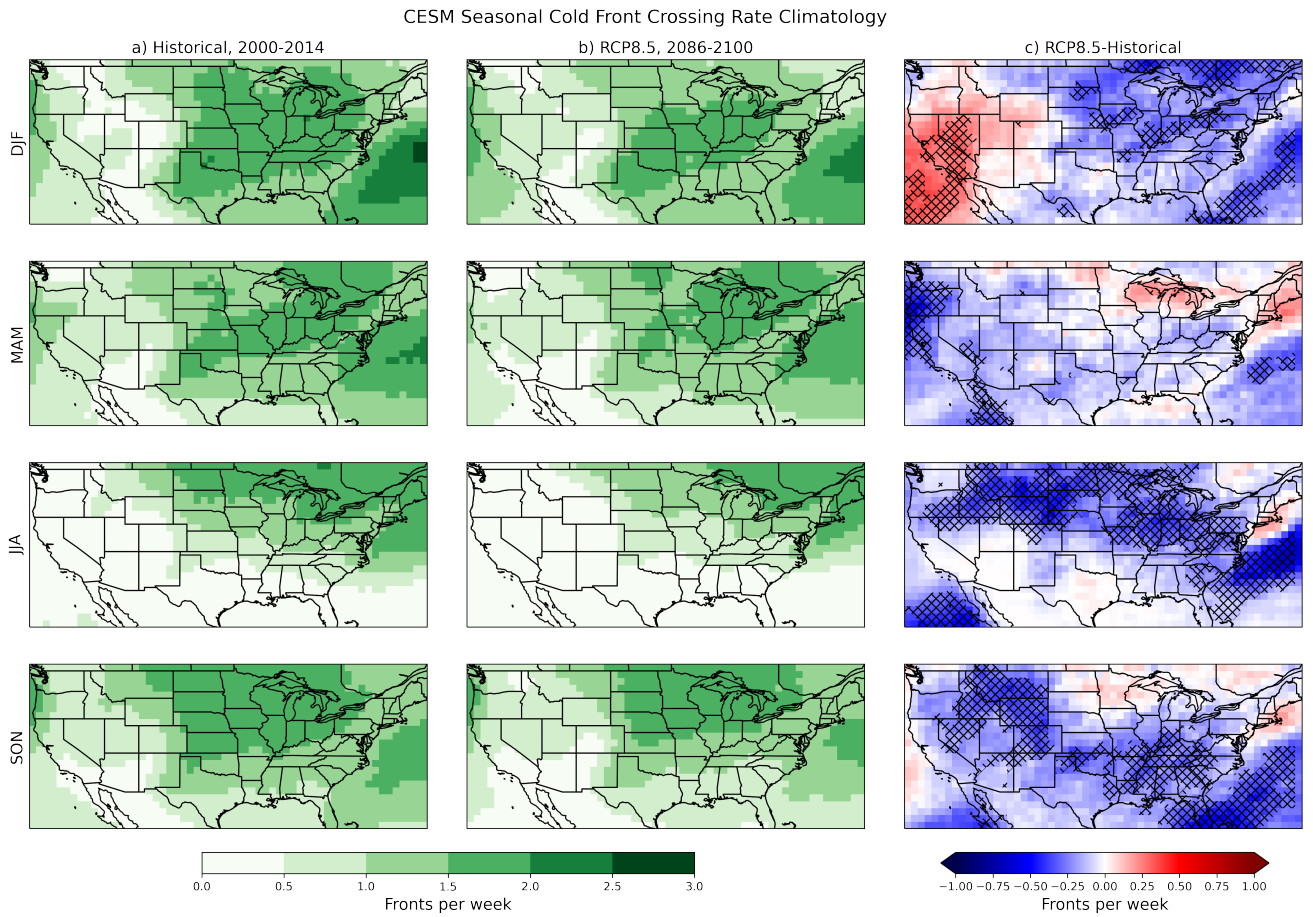
Figure S4. As in Figure 3, for cold fronts. Note the changes in color scale relative to Figure 3.
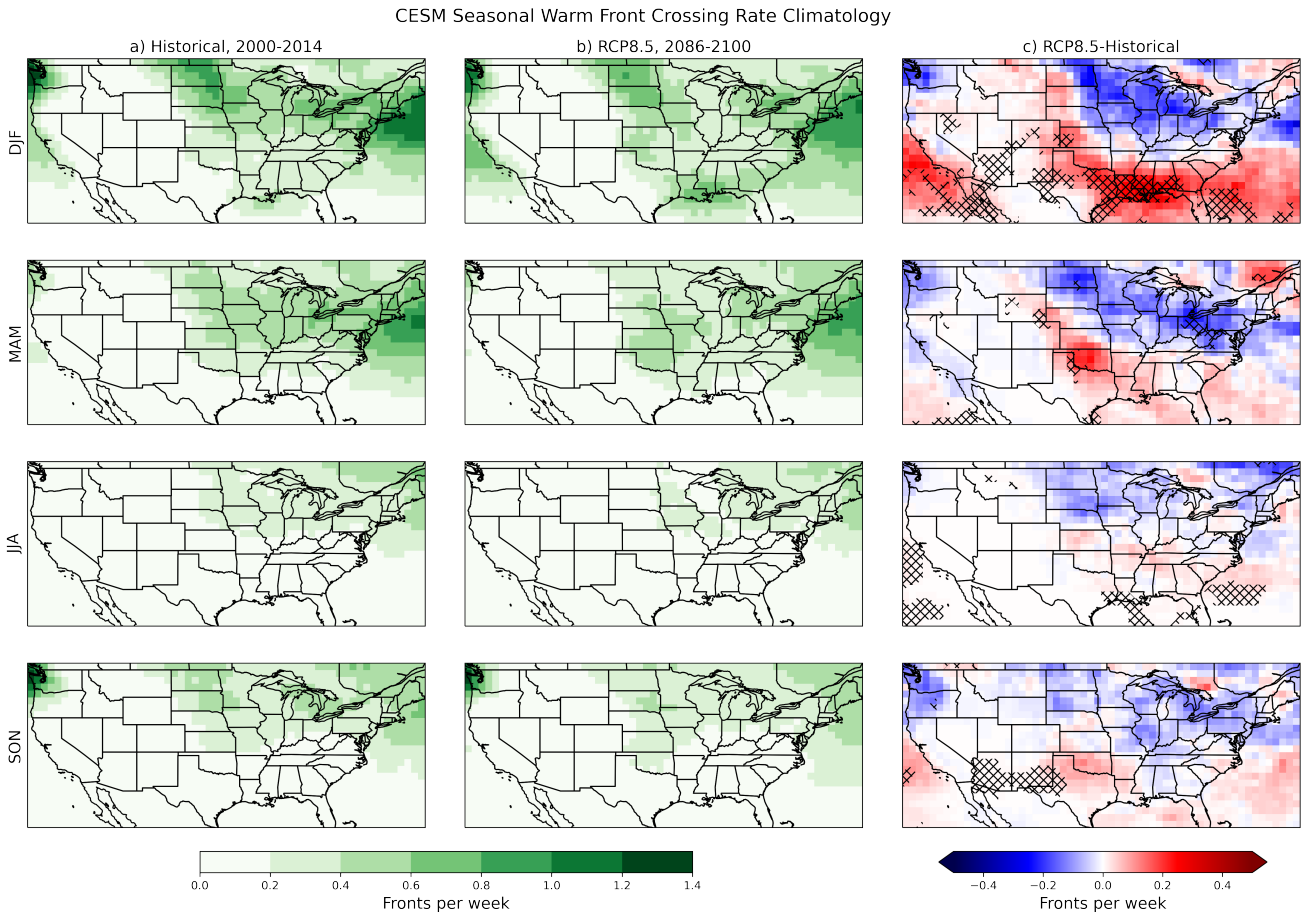
Figure S5. As in Figure 3, for warm fronts. Note the changes in color scale relative to Figure 3.

CESM Seasonal Stationary Front Crossing Rate Climatology

a) Historical, 2000-2014   b) RCP8.5, 2086-2100   c) RCP8.5-Historical

Figure S6. As in Figure 3, for stationary fronts.

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CESM Seasonal Occluded Front Crossing Rate Climatology

Figure S7. As in Figure 3, for occluded fronts. Note the changes in color scale relative to Figure 3.

CESM Fraction of Total Precipitation Associated with a Cold Front

a) Historical, 2000-2014   b) RCP8.5, 2086-2100   c) RCP8.5 - Historical

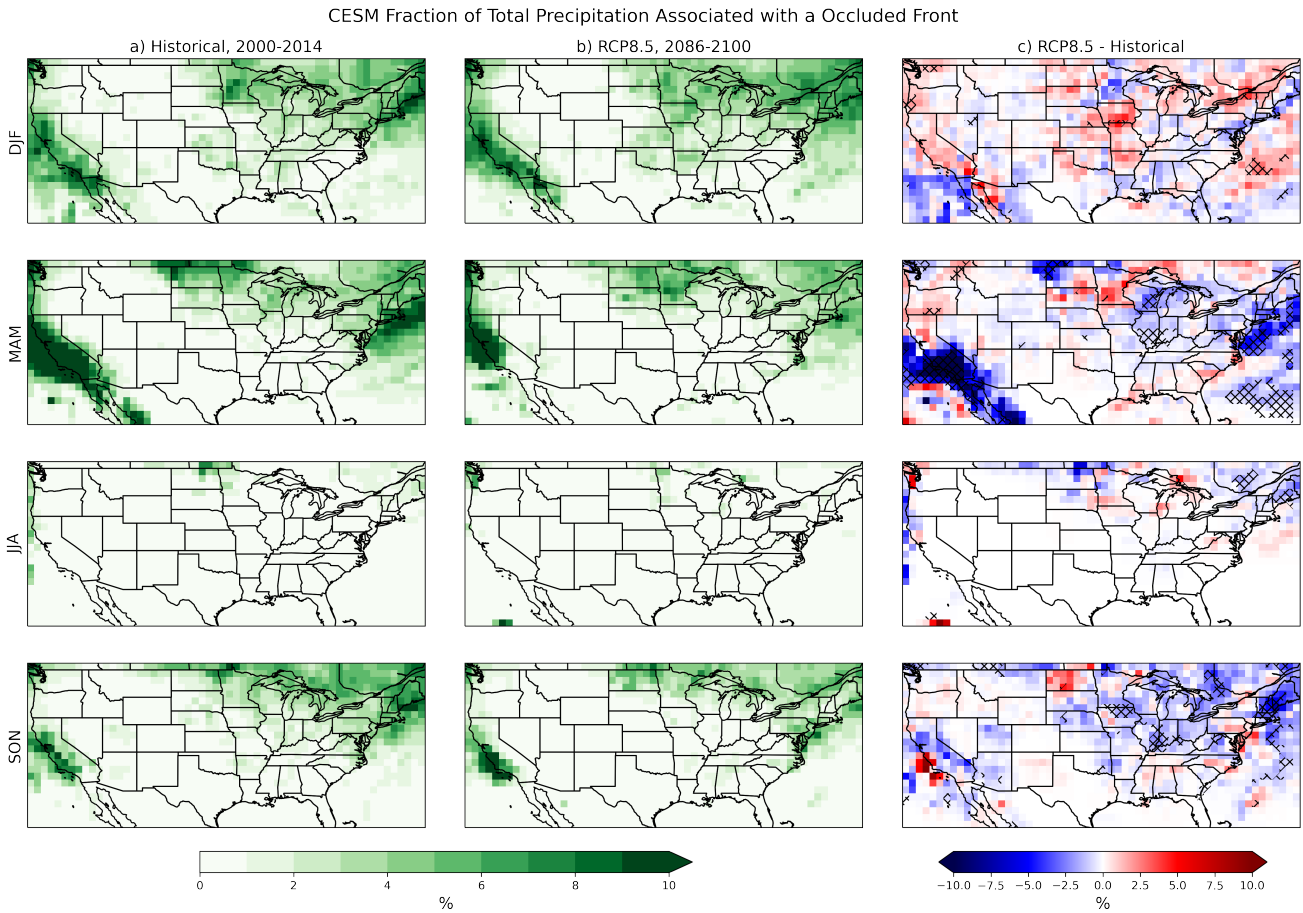**Figure S8.** As in Figure 5, for cold fronts. Note the changes in color scale relative to Figure 5.

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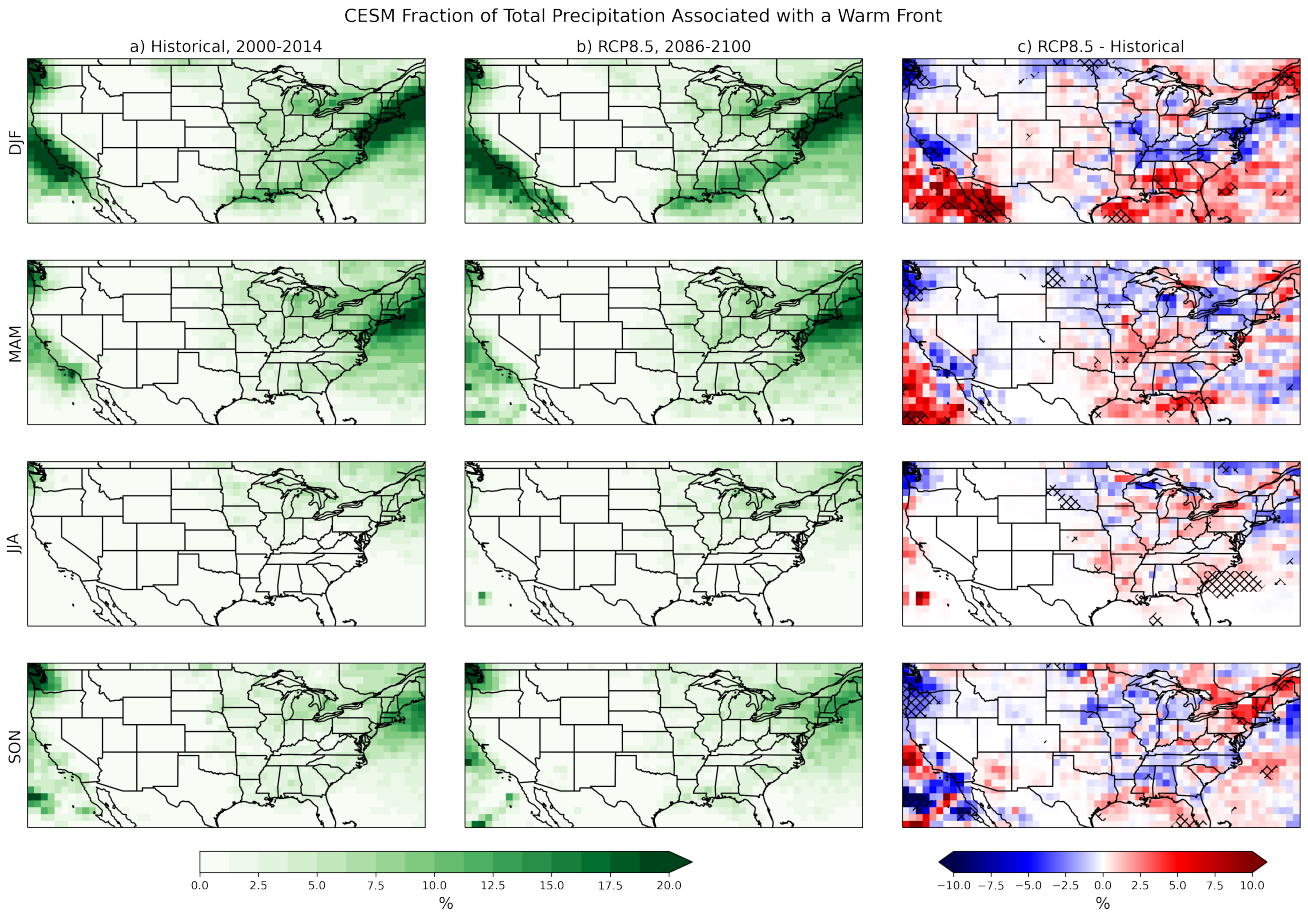
Figure S9. As in Figure 5, for warm fronts. Note the changes in color scale relative to Figure 5.

CESM Fraction of Total Precipitation Associated with a Stationary Front
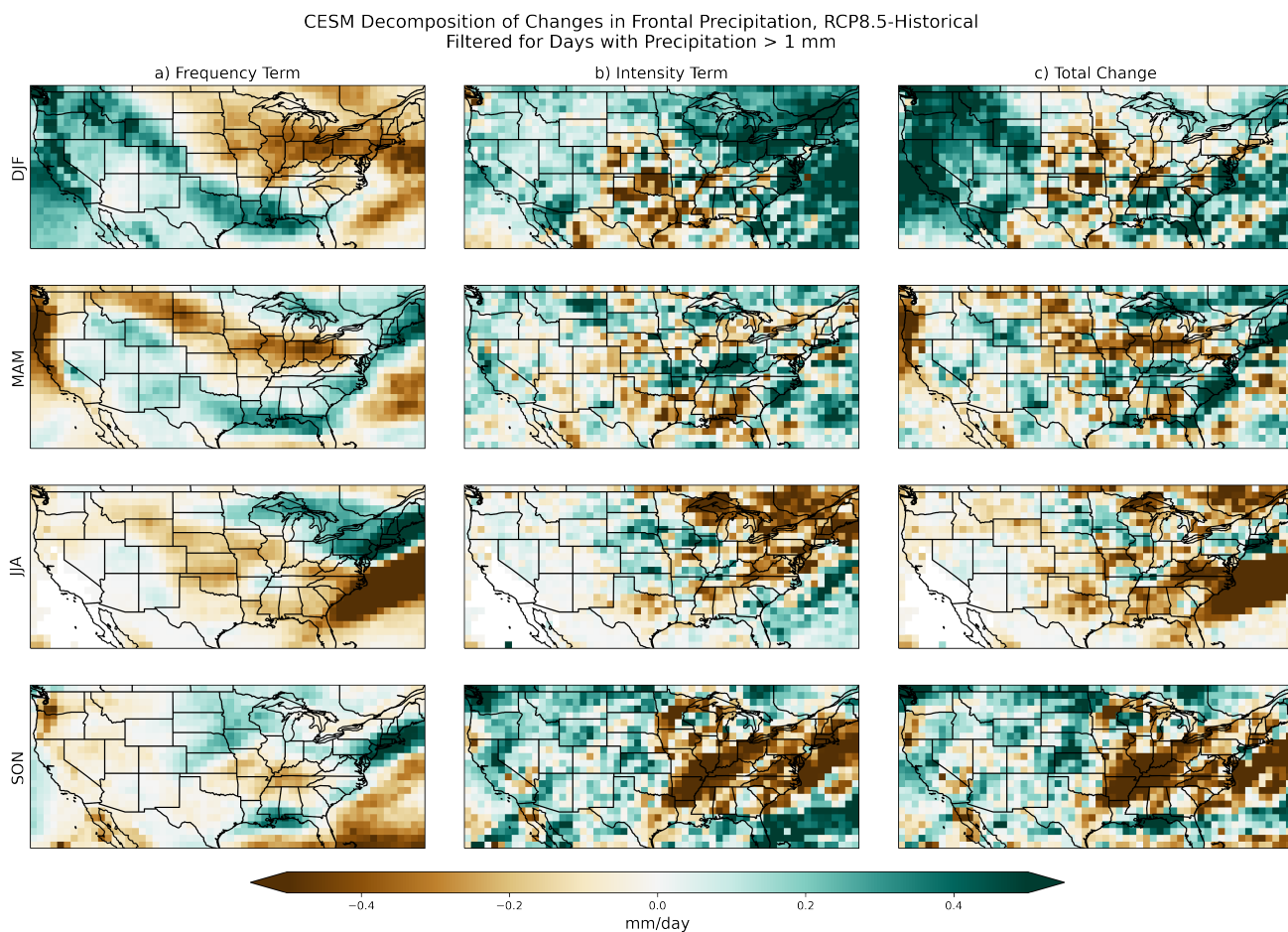

a) Historical, 2000-2014   b) RCP8.5, 2086-2100   c) RCP8.5 - Historical
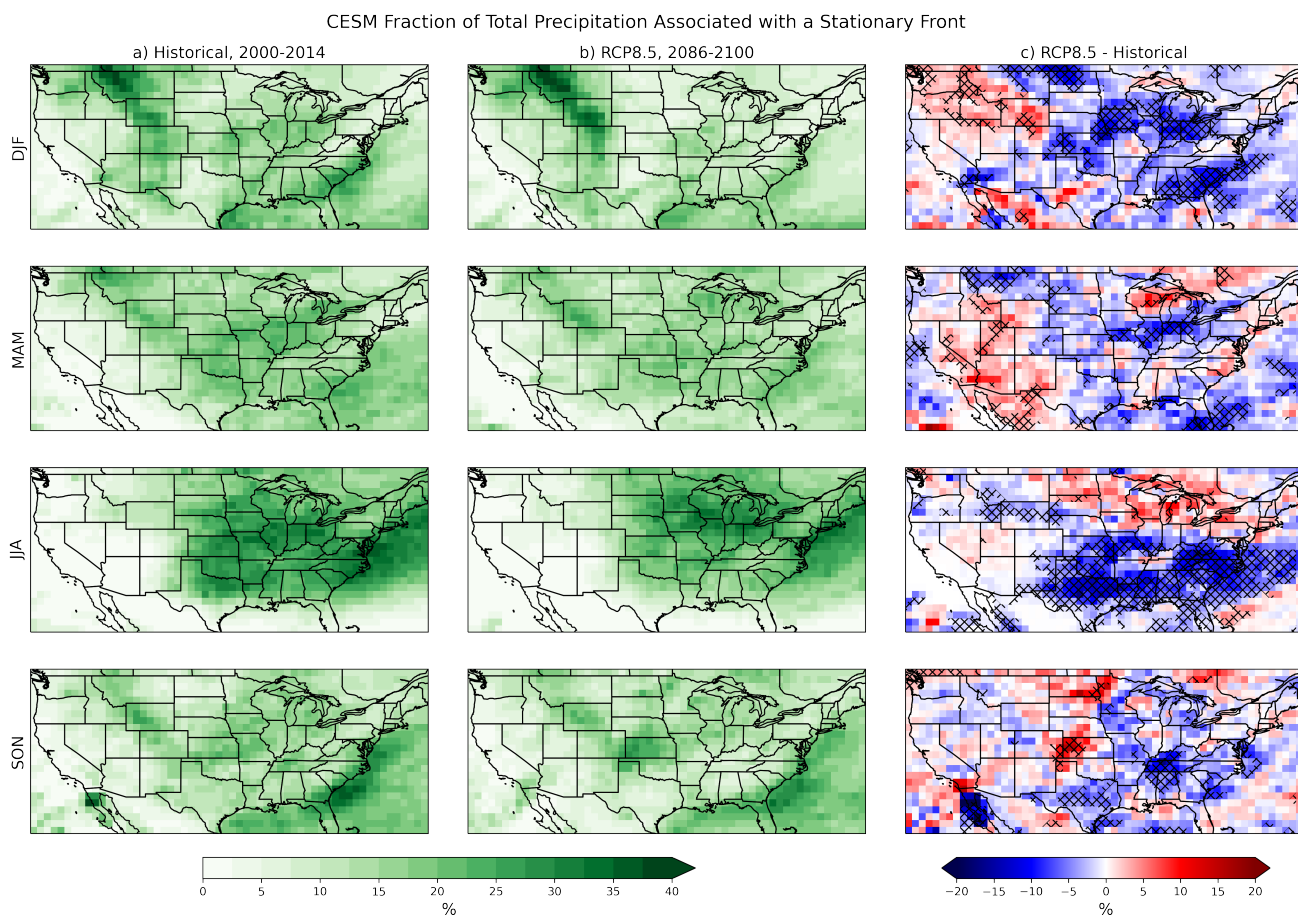
Figure S10. As in Figure 5, for stationary fronts. Note the changes in color scale relative to Figure 5.

CESM Fraction of Total Precipitation Associated with a Occluded Front

Figure S11. As in Figure 5, for occluded fronts. Note the changes in color scale relative to Figure 5.

CESM Decomposition of Changes in Frontal Precipitation, RCP8.5-Historical
Filtered for Days with Precipitation > 1 mm

Figure S12. As in Figure 6, with the precipitation output filtered for days with precipitation greater than 1 mm.

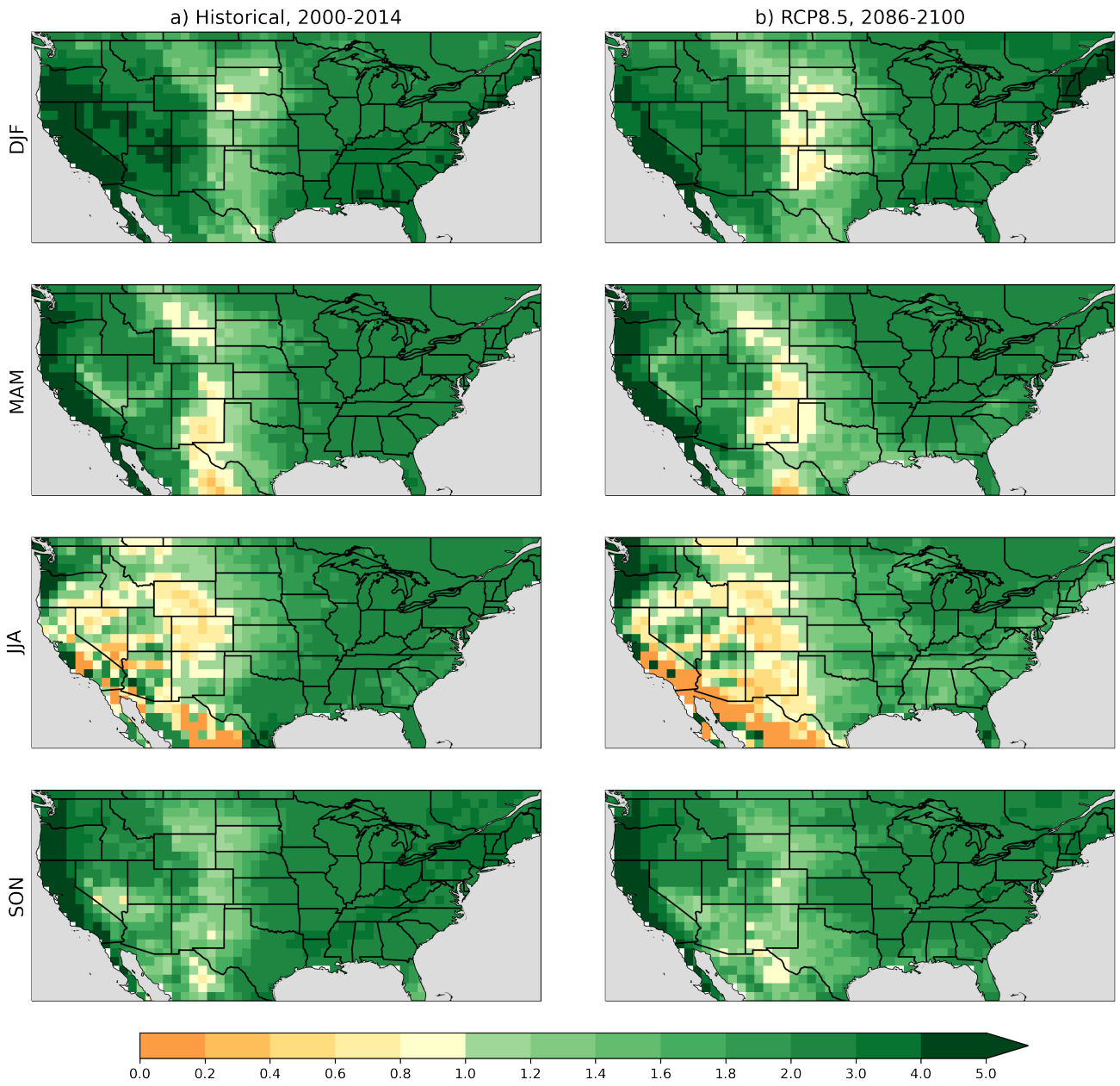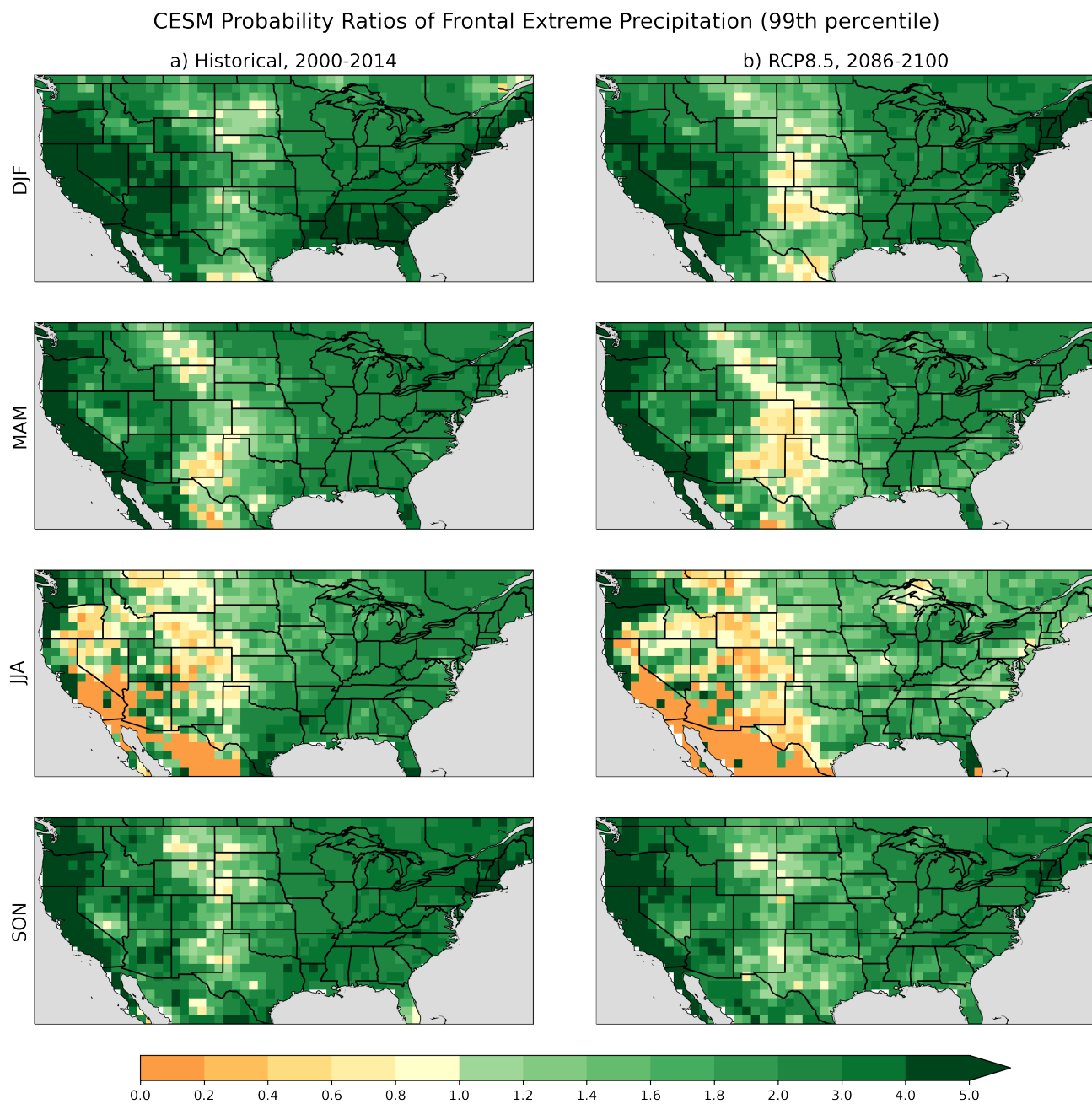CESM Probability Ratios of Frontal Extreme Precipitation (95th percentile)

a) Historical, 2000-2014

b) RCP8.5, 2086-2100

Figure S13. As in Figure 8, for 95th percentile precipitation.

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CESM Probability Ratios of Frontal Extreme Precipitation (99th percentile)

a) Historical, 2000-2014   b) RCP8.5, 2086-2100

Figure S14.   As in Figure 8, for 99th percentile precipitation.

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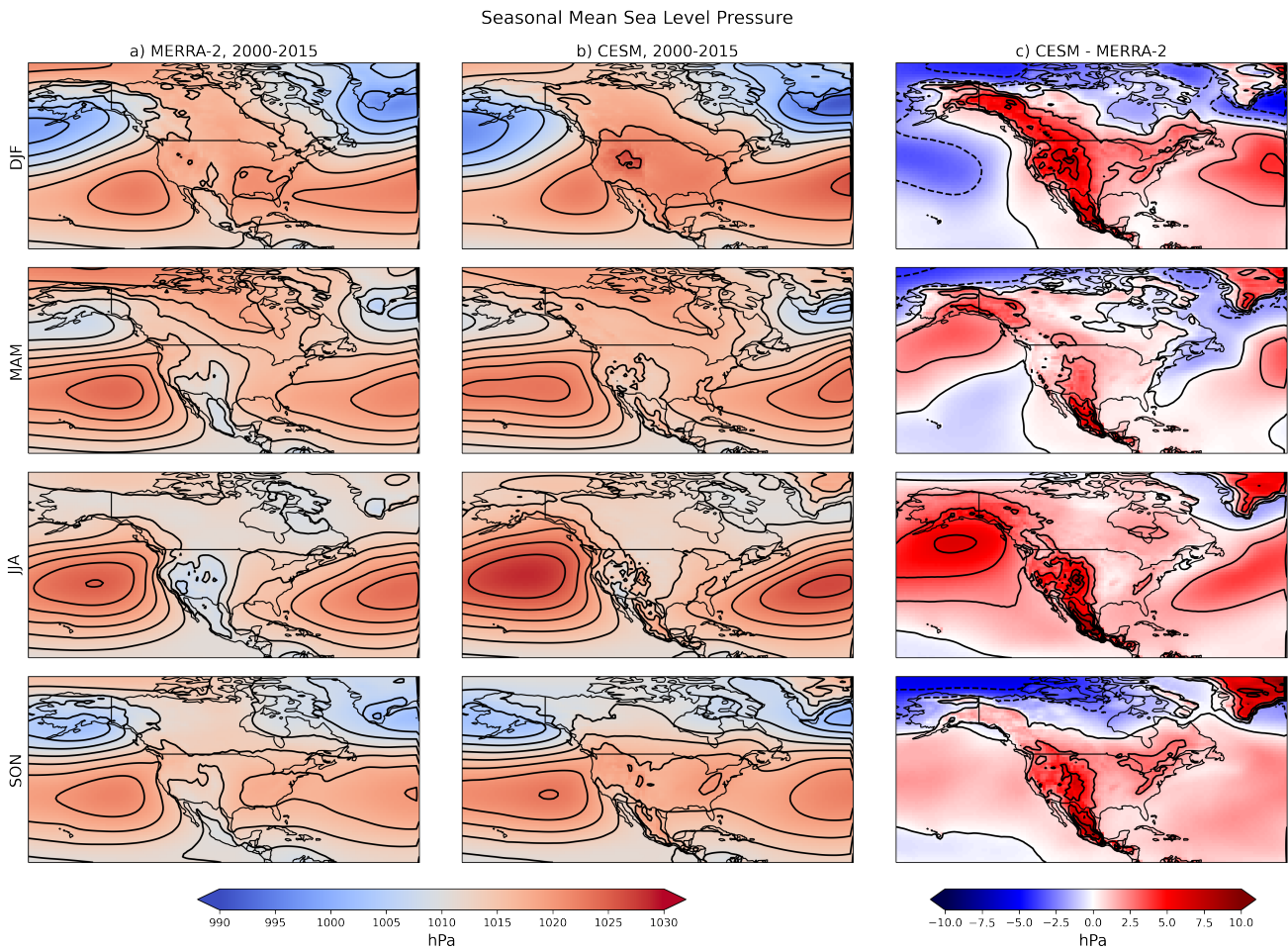
Figure S15. Seasonal mean climatology of sea level pressure (hPa) shown as contours (black lines, solid for positive values and dashed for negative values) and filled contours (shading). a) MERRA-2 reanalysis, and b) CESM output, both 2000-2015. c) The spatial difference for each season.

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