



*Supplement of*

## **Storylines of future drought in the face of uncertain rainfall projections: a New Zealand case study**

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7 EC-Earth3 displays a less significant increases in MSLP in similar positions to those shown  
8 in CNRM-CM6-1 in both OND and DJF. This weaker high, coupled with the generally  
9 increased moisture availability means there are only minor precipitation changes of vary-  
10 ing signs across New Zealand. A Figure analogous to Figures 2 and 3 in the main text  
11 for EC-Earth3 is shown here as Figure 1.

12 AWI-CM-1-1-MR has a significant drying signal across the North Island and the upper  
13 portion of the South Island. Here, a weaker MSLP anomaly is positioned over New Zealand  
14 in OND when compared to CNRM-CM6-1, but coupled with reduced moisture availabil-  
15 ity produces reduced precipitation over this period. Significant rainfall induced by in-  
16 creased moisture availability in JFM compensates the OND drying in the lower portion  
17 of the South Island resulting in minimal precipitation changes over this region in aggre-  
18 gate. A Figure analogous to Figure 1 for AWI-CM-1-1-MR is shown as Figure 2.

19 GFDL-ESM4 shows a dry signal for similar reasons to CNRM-CM6-1, but as the posi-  
20 tioning of the increase in MSLP during OND occurs directly over New Zealand in GFDL-  
21 ESM4 is drier overall. A Figure analogous to Figure 1 for GFDL-ESM4 is shown as Fig-  
22 ure 3.

23 There are now major synoptic changes occurring over New Zealand in NorESM2-MM  
24 and thus only minor precipitation changes of varying signs across New Zealand. Figure  
25 analogous to Figure 4 for GFDL-ESM4 is shown as Figure 6.

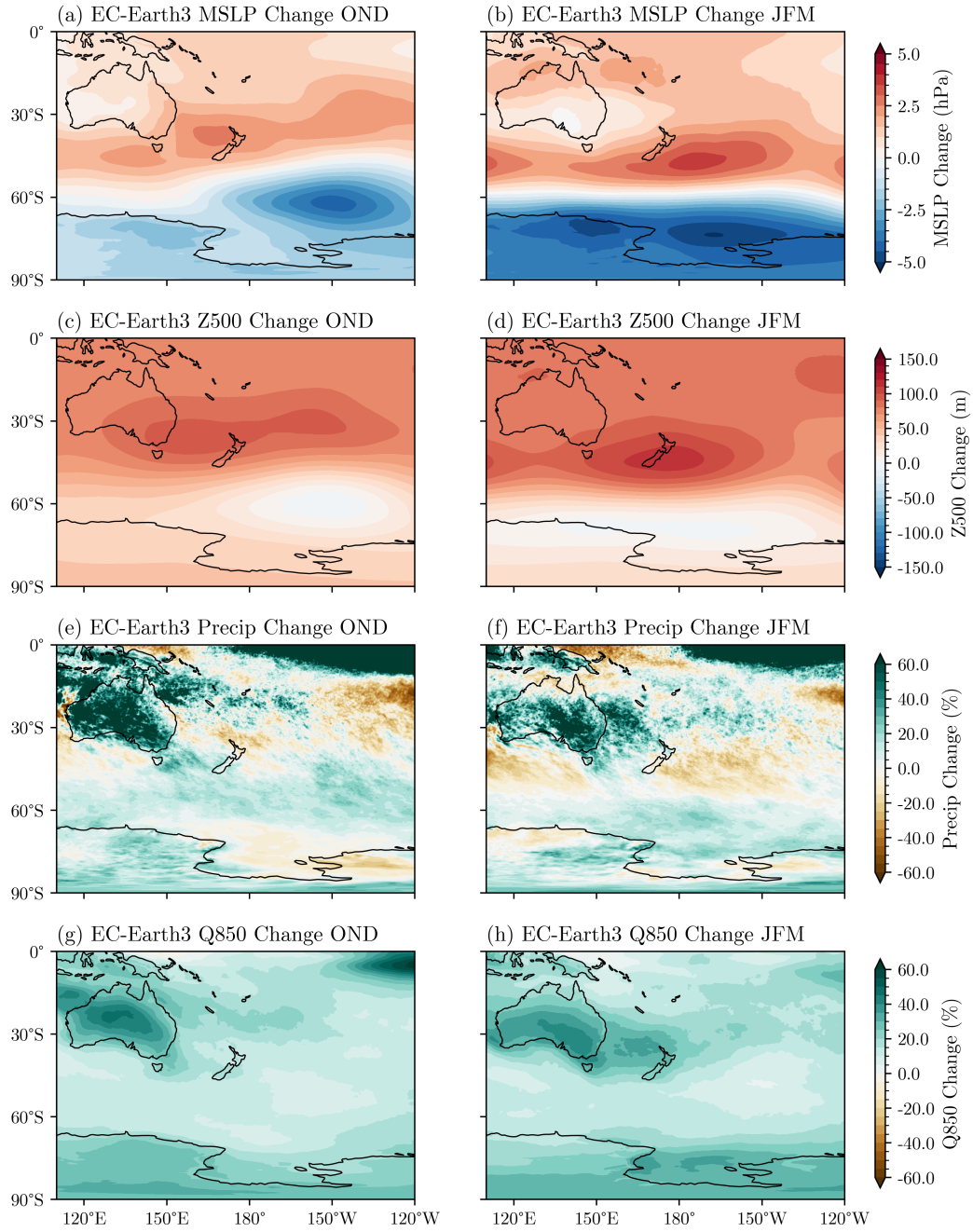


Figure S1: Changes in large scale conditions between 1985-2014 (historical) and 2070-2099 (SSP370) for the ACCESS-CM2 model. (a-b) Changes in mean sea level pressure (MSLP) in (a) (OND) and (b) (JFM) between 1985-2014 in the Historical period and 2070-2099 in SSP370. (c-d) Similarly to (a-b) but for changes in geopotential height ( $Z$ ) at 500 hPa. (e-f) Similarly to (a-b) but for precipitation. (g-h) Similarly to (a-b) but for specific humidity ( $Q$ ) at 850 hPa.

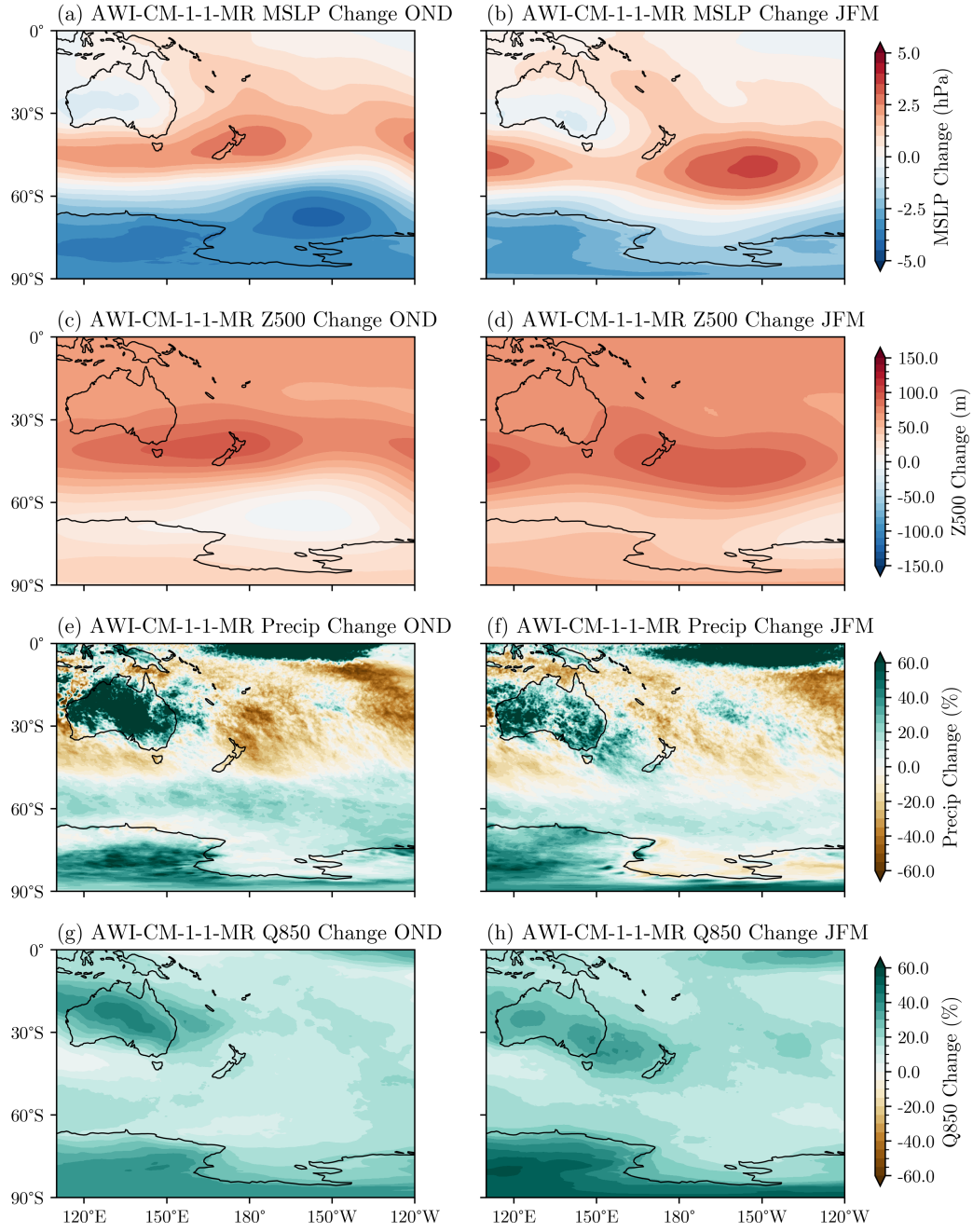


Figure S2: The Same as Figure 1 but for AWI-CM-1-1-MR.



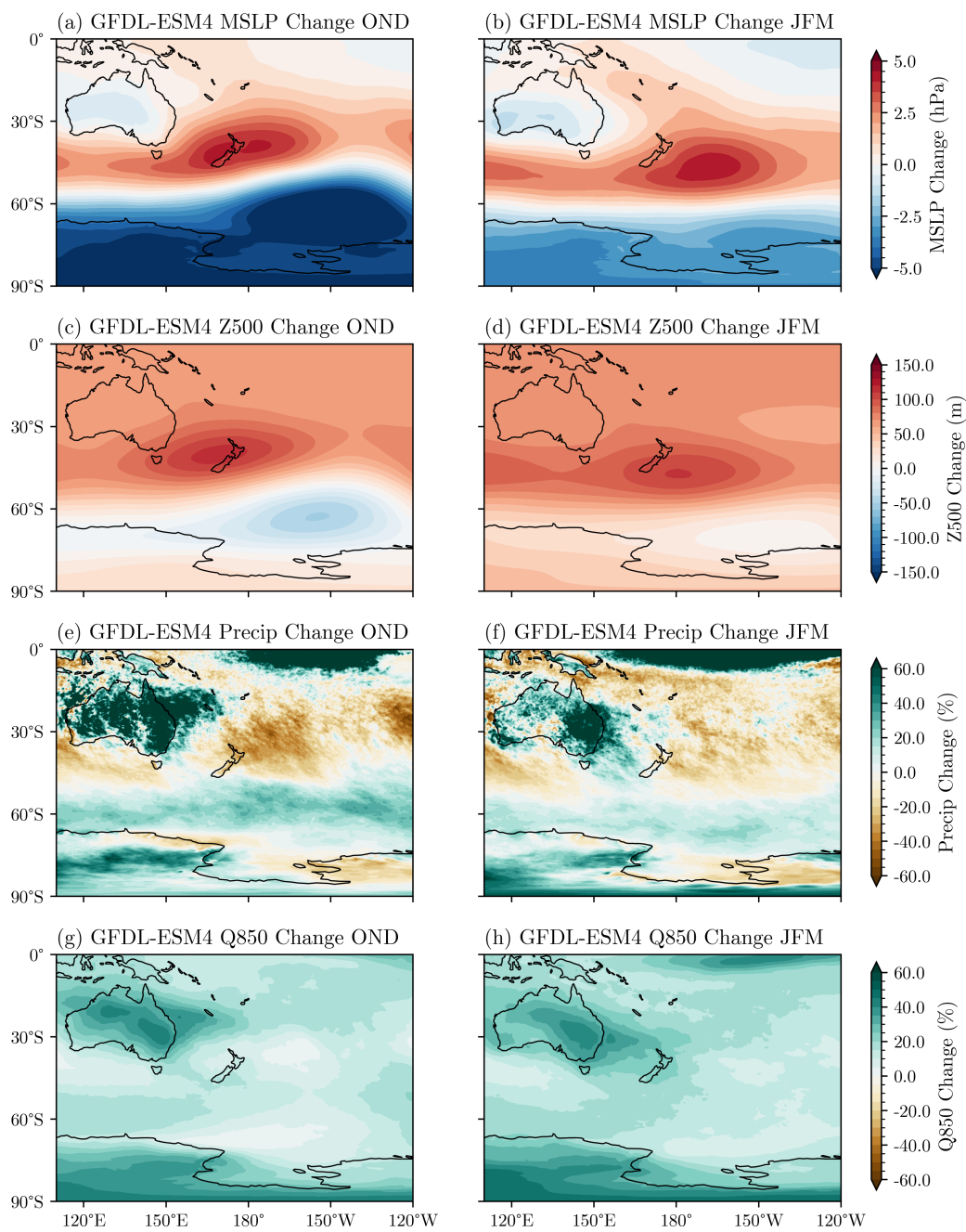


Figure S3: The Same as Figure 1 but for GFDL-ESM4.

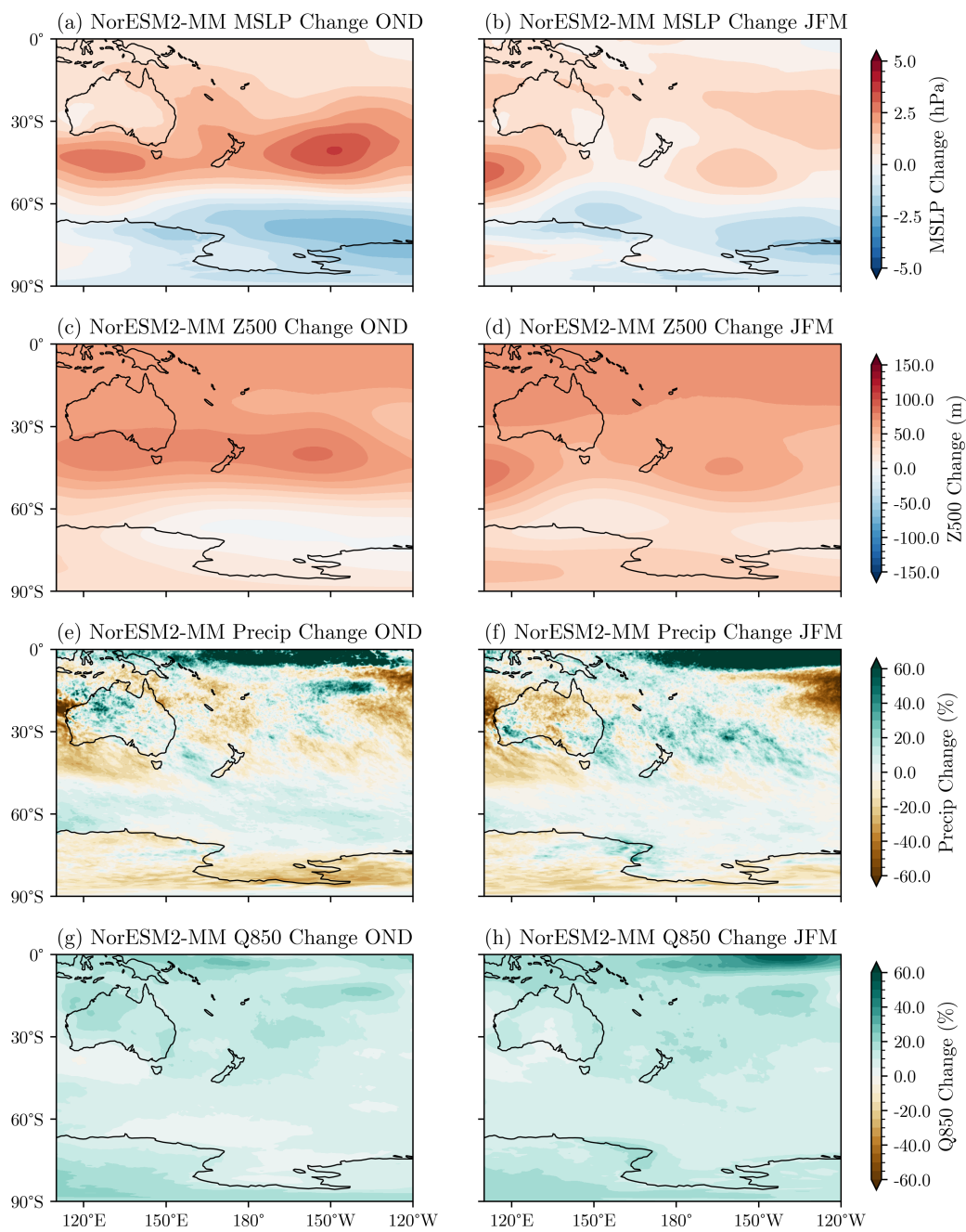


Figure S4: The Same as Figure 1 but for NorESM2-MM.

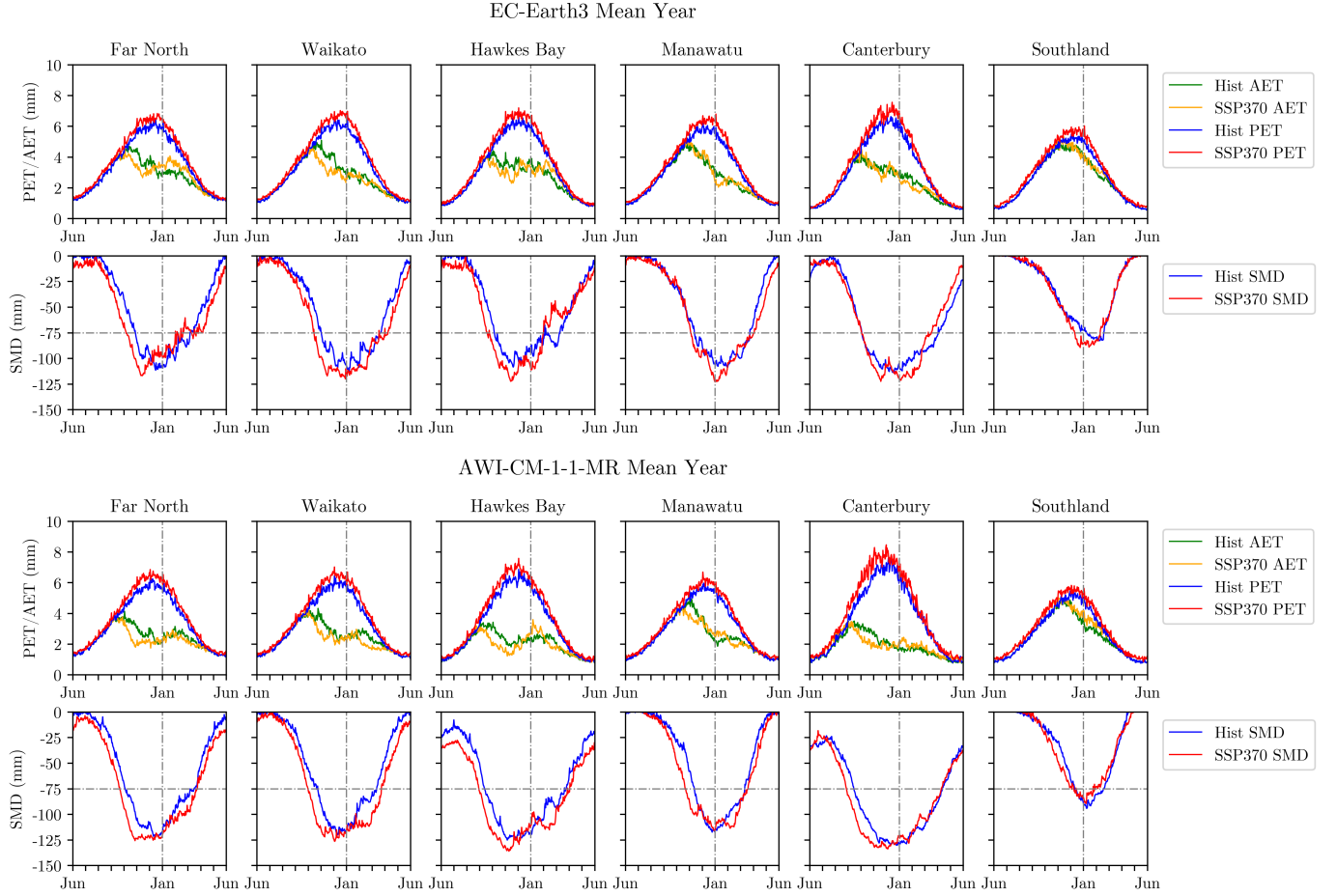


Figure S5: First Row/Third Row: Day-of-year mean values of Historical (blue) and SSP370 (red) PET, alongside Historical (green) and SSP370 (orange) values of AET, across the six agrarian locations in this analysis. Second Row/Fourth Row: Day-of-year mean values of Historical (blue) and SSP370 (red) SMD, across the six agrarian locations in this analysis. The EC-Earth3 model is depicted in the top two rows, the AWI-CM-1-1-MR model is depicted in the bottom two rows.

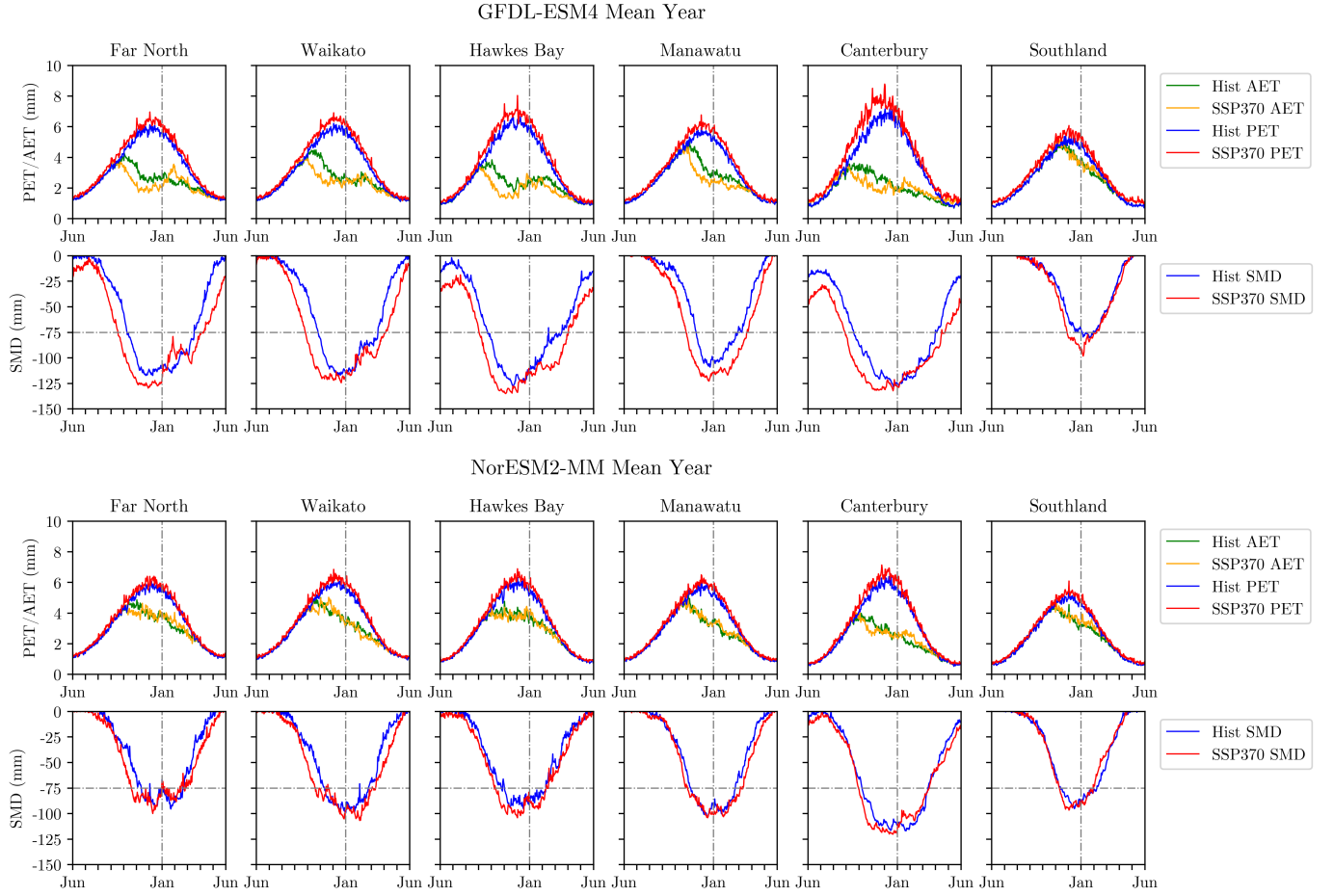


Figure S6: The same as Figure S6 but for GFDL-ESM4 in the top two rows, and AWI-CM-1-1-MR in the bottom two rows.

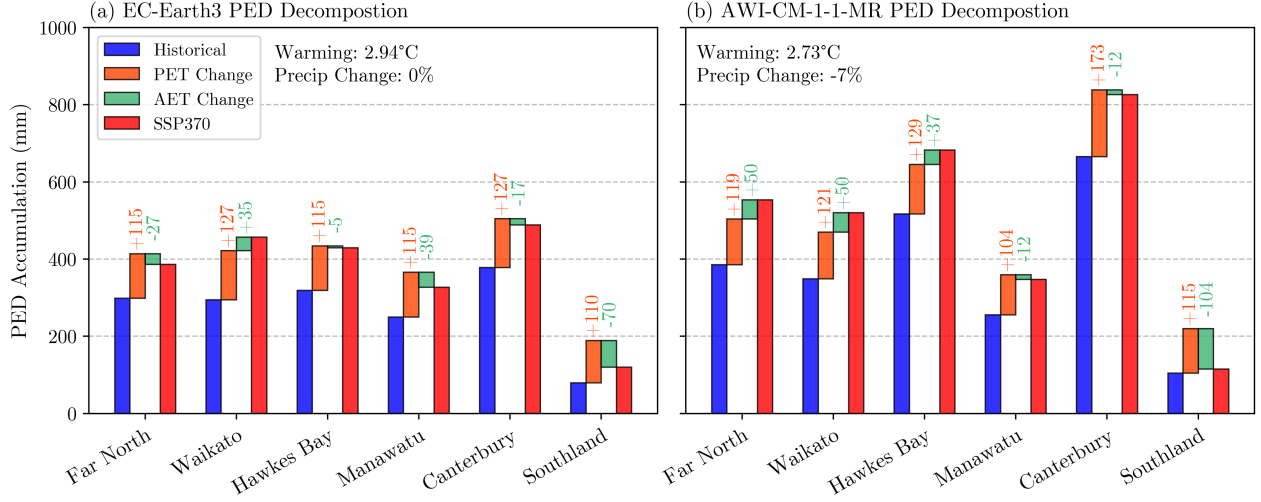


Figure S7: Decomposition of changes in PED accumulation at the end of a mean June-July water year from the mean year in the Historical period (blue), to the mean year in the Future period (red) into contributions from changes in PET (orange), and AET (green). Panel (a) depicts these changes for EC-Earth3, and panel (b) for AWI-CM-1-1-MR. Numbers above the PET and AET bars indicate the magnitude of their contribution to the change in PED, this means increases in AET provide a negative contribution to PED, while decreases in AET provide a positive contribution.

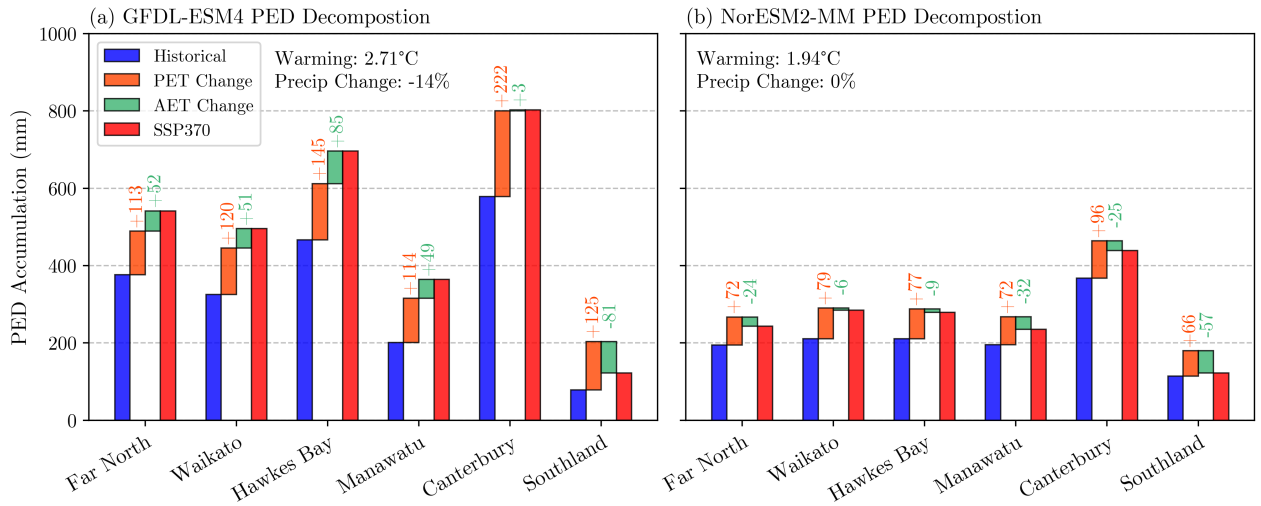


Figure S8: The same as Figure S7, but for (a) GFDL-ESM4, and (b) NorESM2-MM.

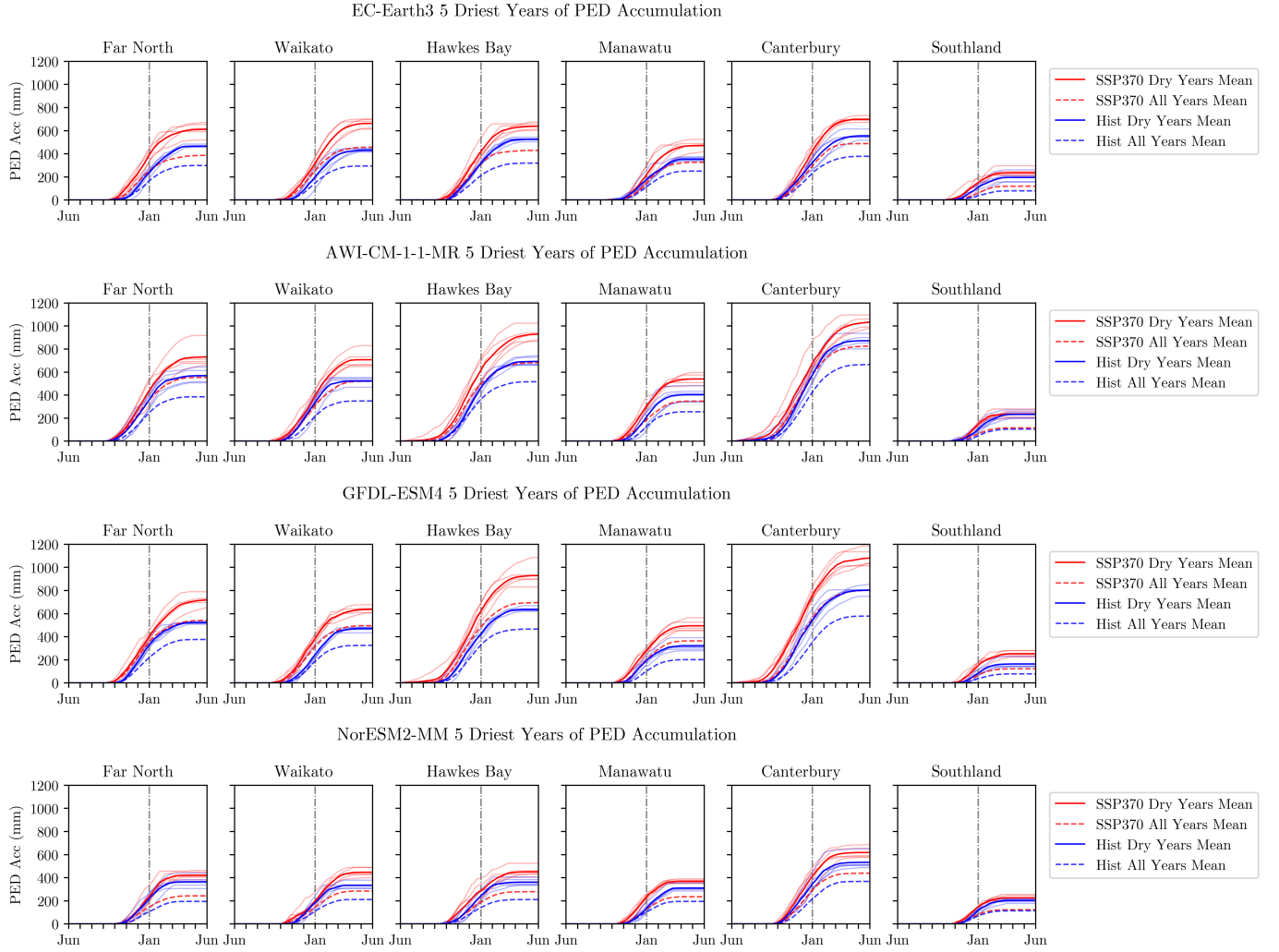


Figure S9: The five driest years of PED accumulation (light lines) and the mean of those years (solid lines) in both Historical (blue) and SSP370 (red) periods, for EC-Earth3, AWI-CM-1-1-MR, GFDL-ESM4, and NorESM2-MM. Dotted lines depict the mean PED accumulation throughout the mean year in both historical and future periods.

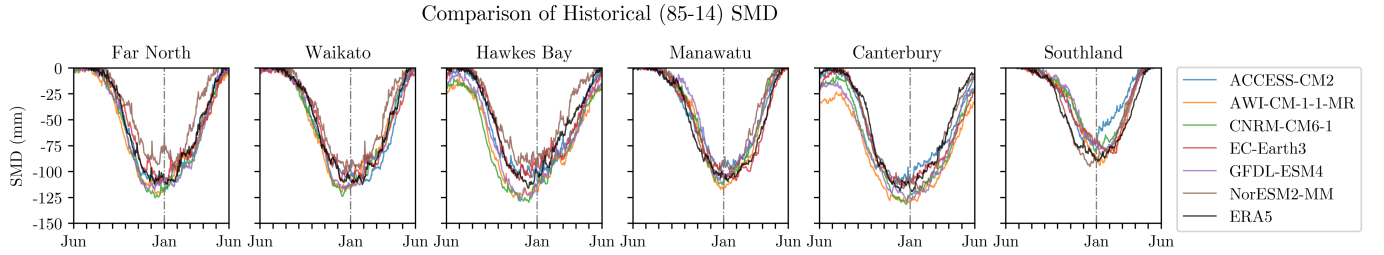


Figure S10: Soil Moisture Deficit (SMD) climatologies (1985-2014) across the historical period within the six GCMs within our ensemble, alongside CCAM RCM simulations driven by the ERA5 reanalysis over the same period.

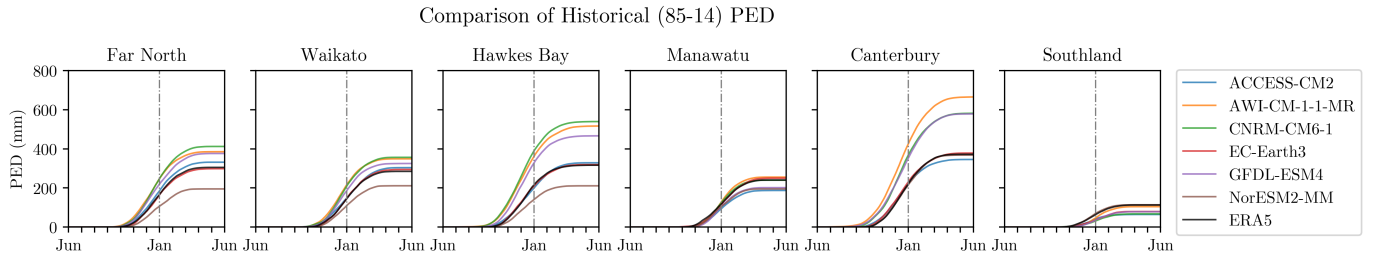


Figure S11: Potential Evapotranspiration Deficit (PED) climatologies (1985-2014) across the historical period within the six GCMs within our ensemble, alongside CCAM RCM simulations driven by the ERA5 reanalysis over the same period.