



Supplement of

Intensity and dynamics of extreme cold spells of the 21st century in France from CMIP6 data

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S1 Introduction

This document contains the Z500 anomaly and standard deviation maps of the 10 CMIP6 models used with KACE-1-0-G for SWG simulations of extreme cold spells in the article *Intensity and dynamics of extreme cold spells of the 21st century in France from CMIP6 data*: BCC-CSM2-MR, CanESM5, CESM2-WACCM, CNRM-ESM2-1, EC-Earth3, FGOALS-g3, IPSL-CM6A-LR, MPI-ESM1-2-LR, MRI-ESM2-0 and NorESM2-LM. We also report the boxplots of cold temperatures SWG simulations (TG15d) for each of those 10 CMIP6 models.

S2 Z500 anomaly maps

Figures S1 to S10 correspond to Z500 anomaly maps for the SWG simulations from 10 CMIP6 models.

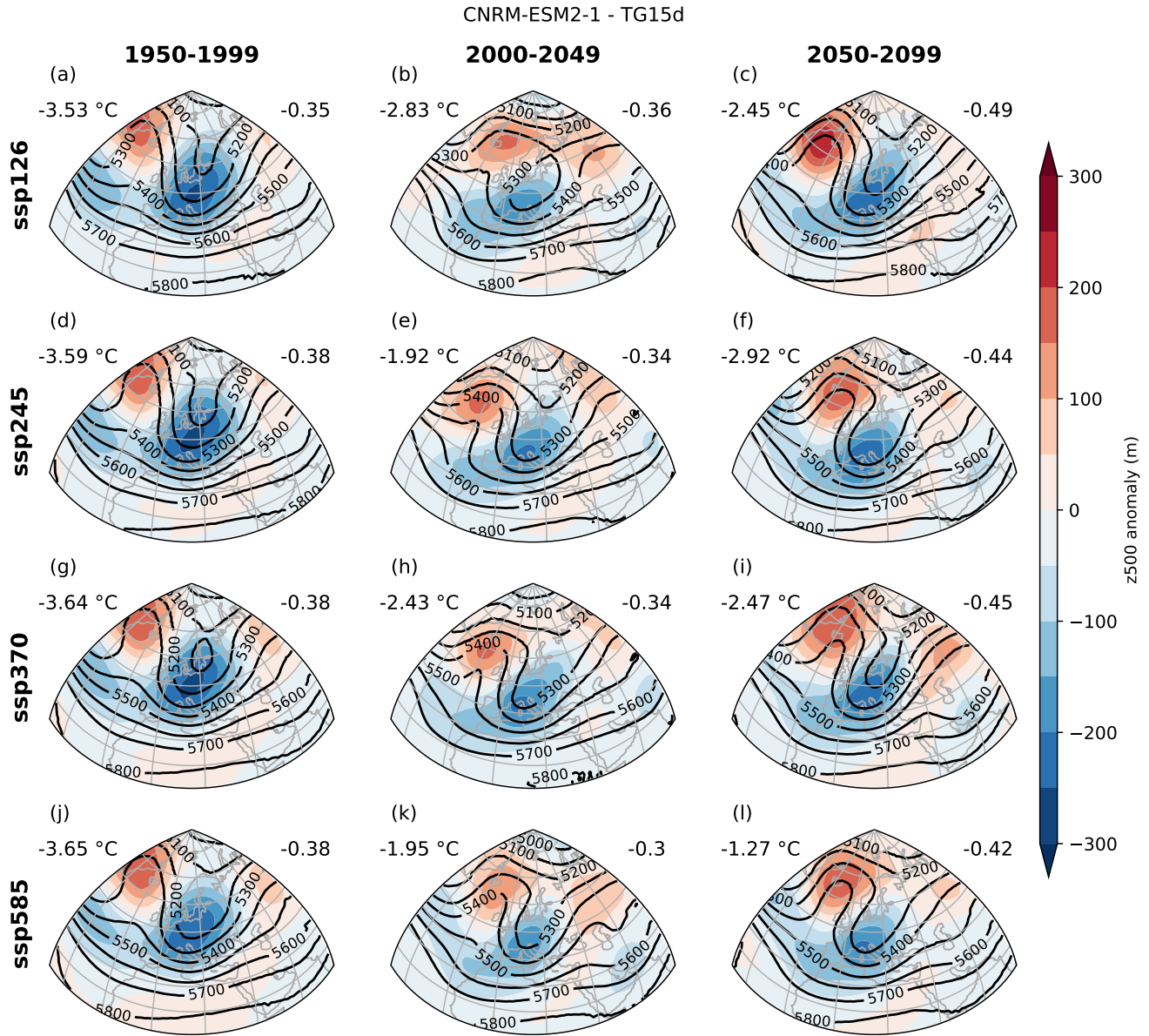


Fig. S1. Absolute values (contours, in m) and anomalies (shaded areas, in m) with respect to 1950-1999 of 500-hPa geopotential height (Z500) for the 10% coldest SWG simulations (i.e. 100 trajectories) for each period (columns) and SSP (rows) in CNRM-ESM2-1.

S3 Z500 standard deviations maps

10 Figures S11 to S20 correspond to Z500 standard deviation (sd) maps for the SWG simulations from 10 CMIP6 models.

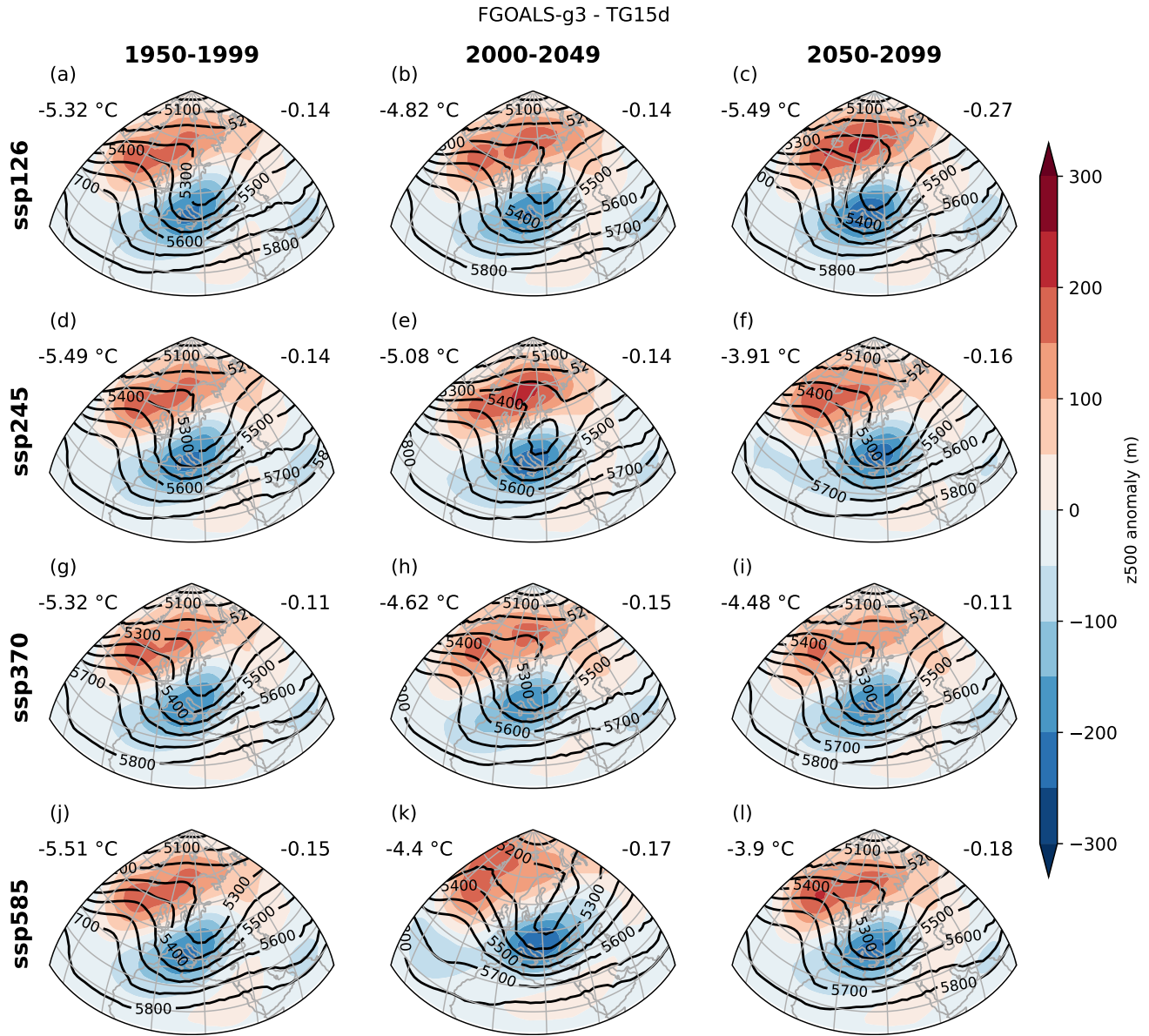


Fig. S2. Absolute values (contours, in m) and anomalies (shaded areas, in m) with respect to 1950-1999 of 500-hPa geopotential height (Z500) for the 10% coldest SWG simulations (i.e. 100 trajectories) for each period (columns) and SSP (rows) in FGOALS-g3.

S4 SWG simulations with importance sampling on atmospheric indices

Figures S21 to S30 correspond to Z500 anomaly maps for the SWG simulations from 10 CMIP6 models.

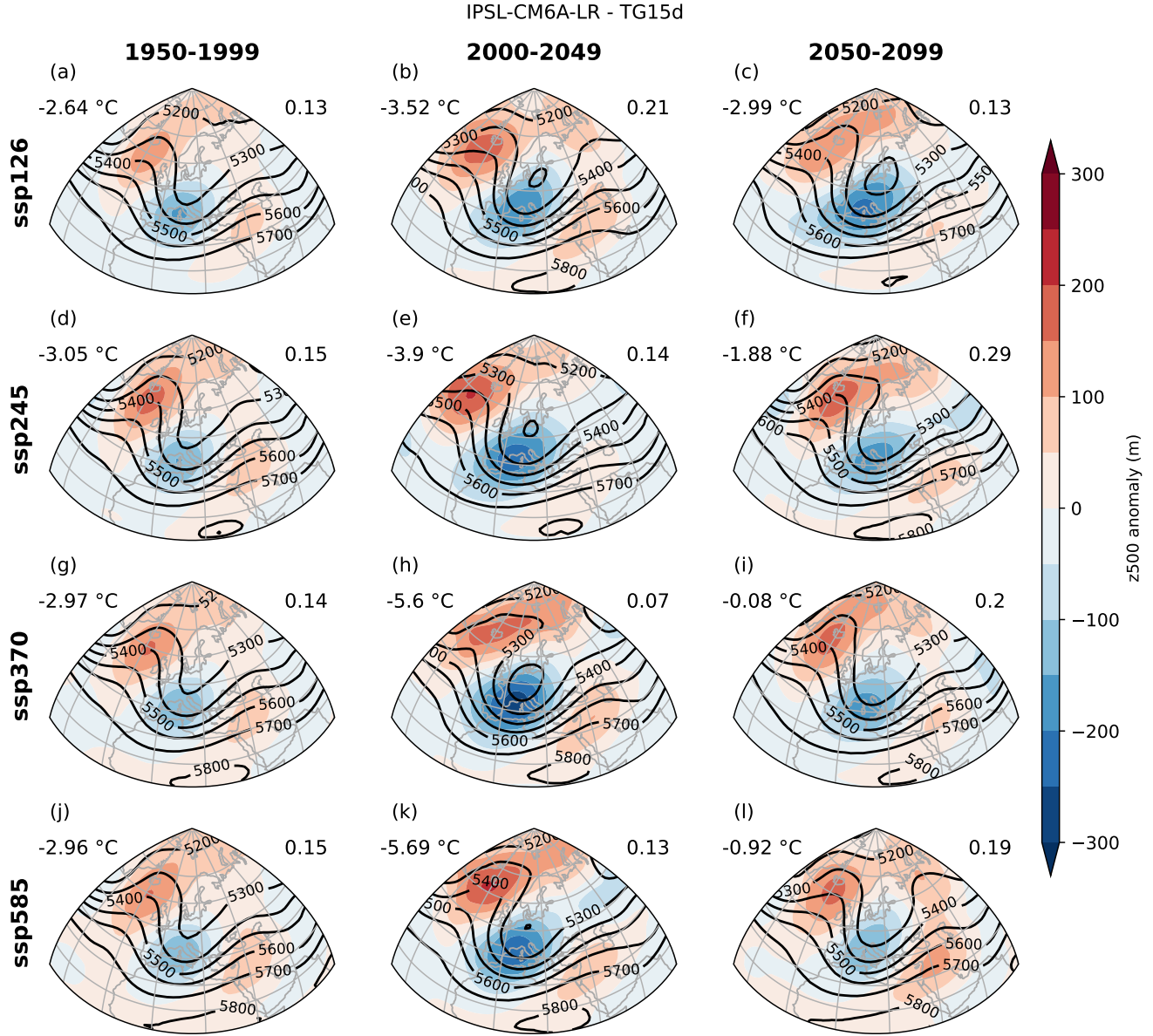


Fig. S3. Absolute values (contours, in m) and anomalies (shaded areas, in m) with respect to 1950-1999 of 500-hPa geopotential height (Z500) for the 10% coldest SWG simulations (i.e. 100 trajectories) for each period (columns) and SSP (rows) in IPSL-CM6A-LR.

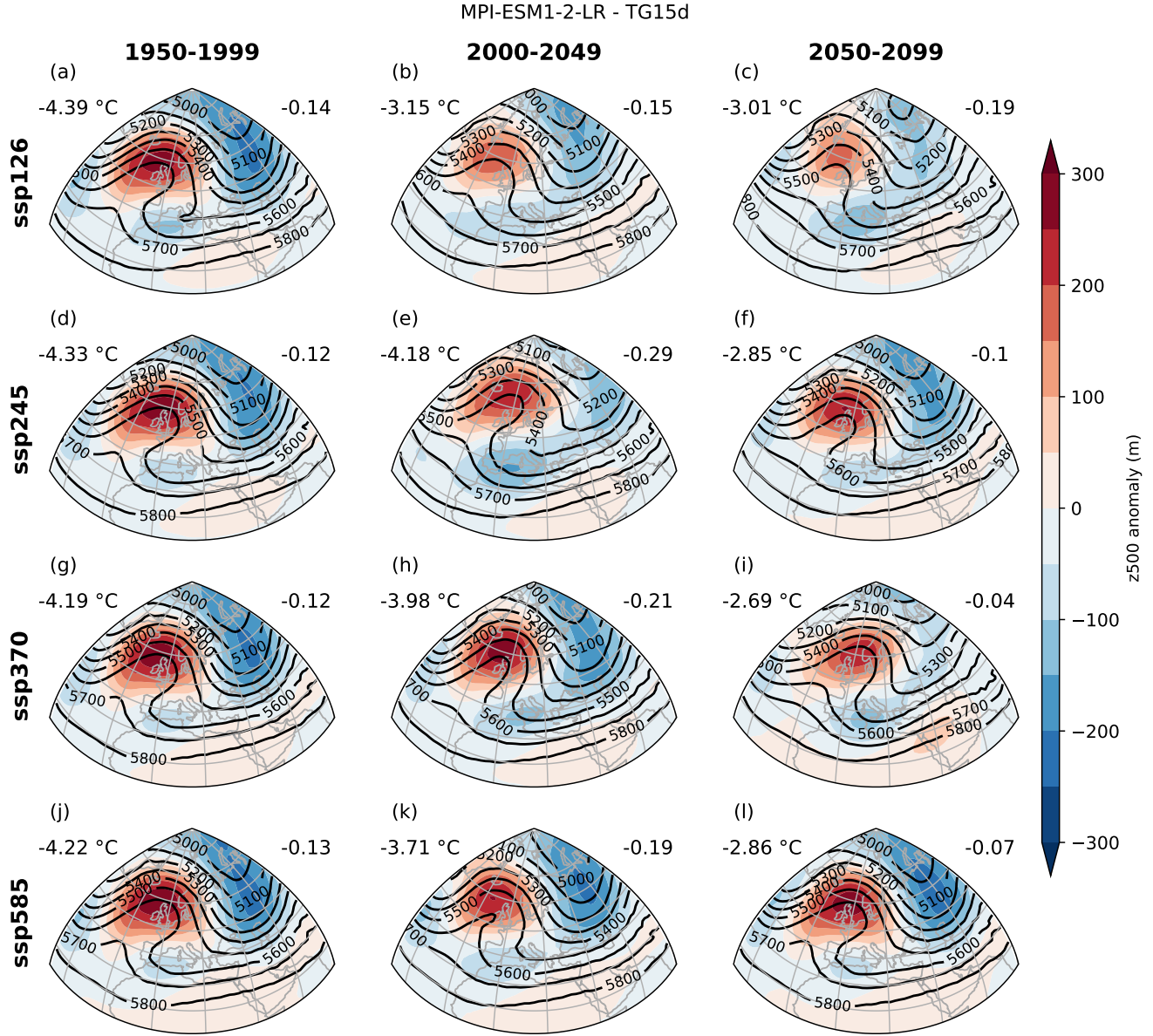


Fig. S4. Absolute values (contours, in m) and anomalies (shaded areas, in m) with respect to 1950-1999 of 500-hPa geopotential height (Z500) for the 10% coldest SWG simulations (i.e. 100 trajectories) for each period (columns) and SSP (rows) in MPI-ESM1-2-LR.

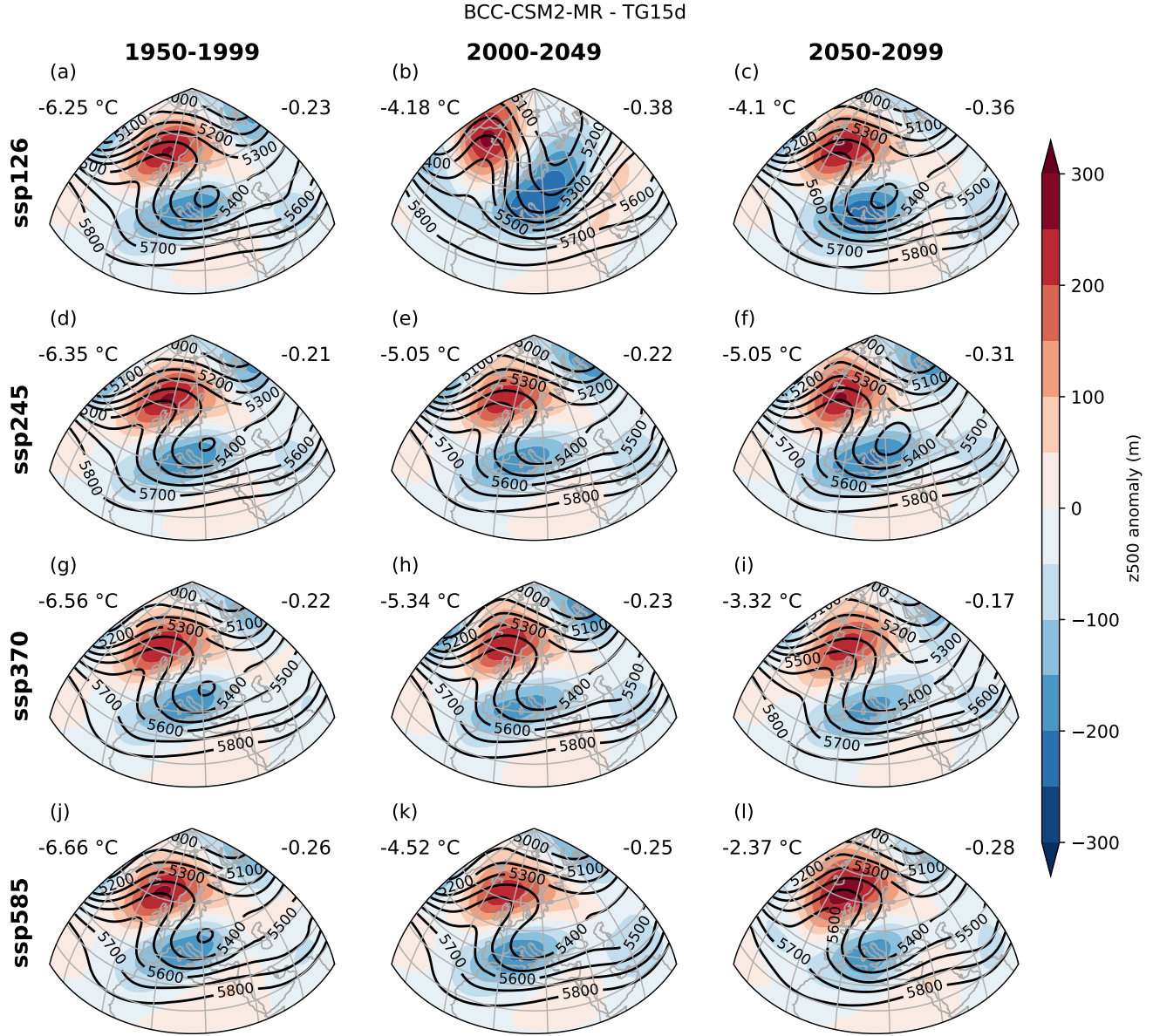


Fig. S5. Absolute values (contours, in m) and anomalies (shaded areas, in m) with respect to 1950-1999 of 500-hPa geopotential height (Z500) for the 10% coldest SWG simulations (i.e. 100 trajectories) for each period (columns) and SSP (rows) in BCC-CSM2-MR.

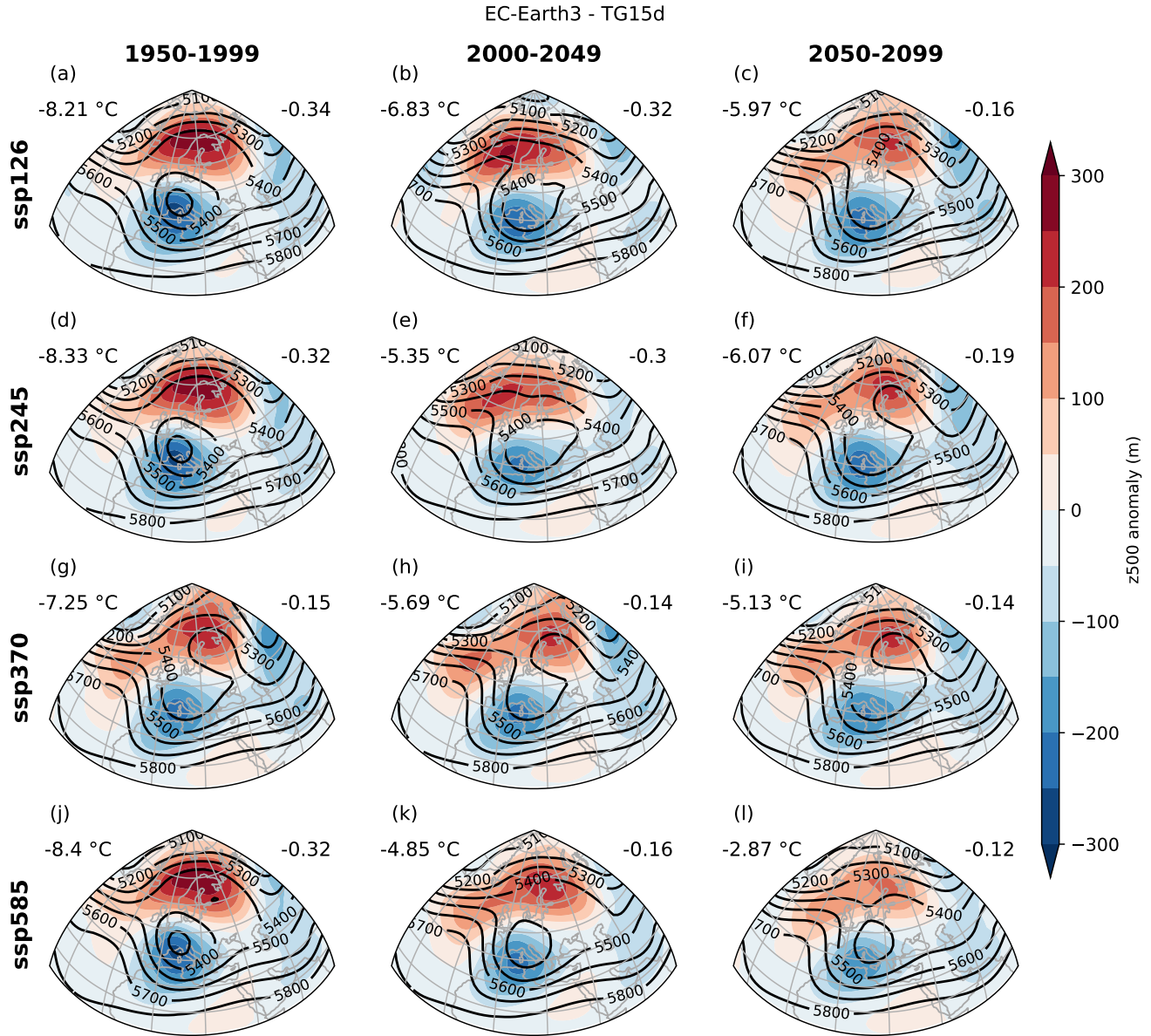


Fig. S6. Absolute values (contours, in m) and anomalies (shaded areas, in m) with respect to 1950-1999 of 500-hPa geopotential height (Z500) for the 10% coldest SWG simulations (i.e. 100 trajectories) for each period (columns) and SSP (rows) in EC-Earth3.

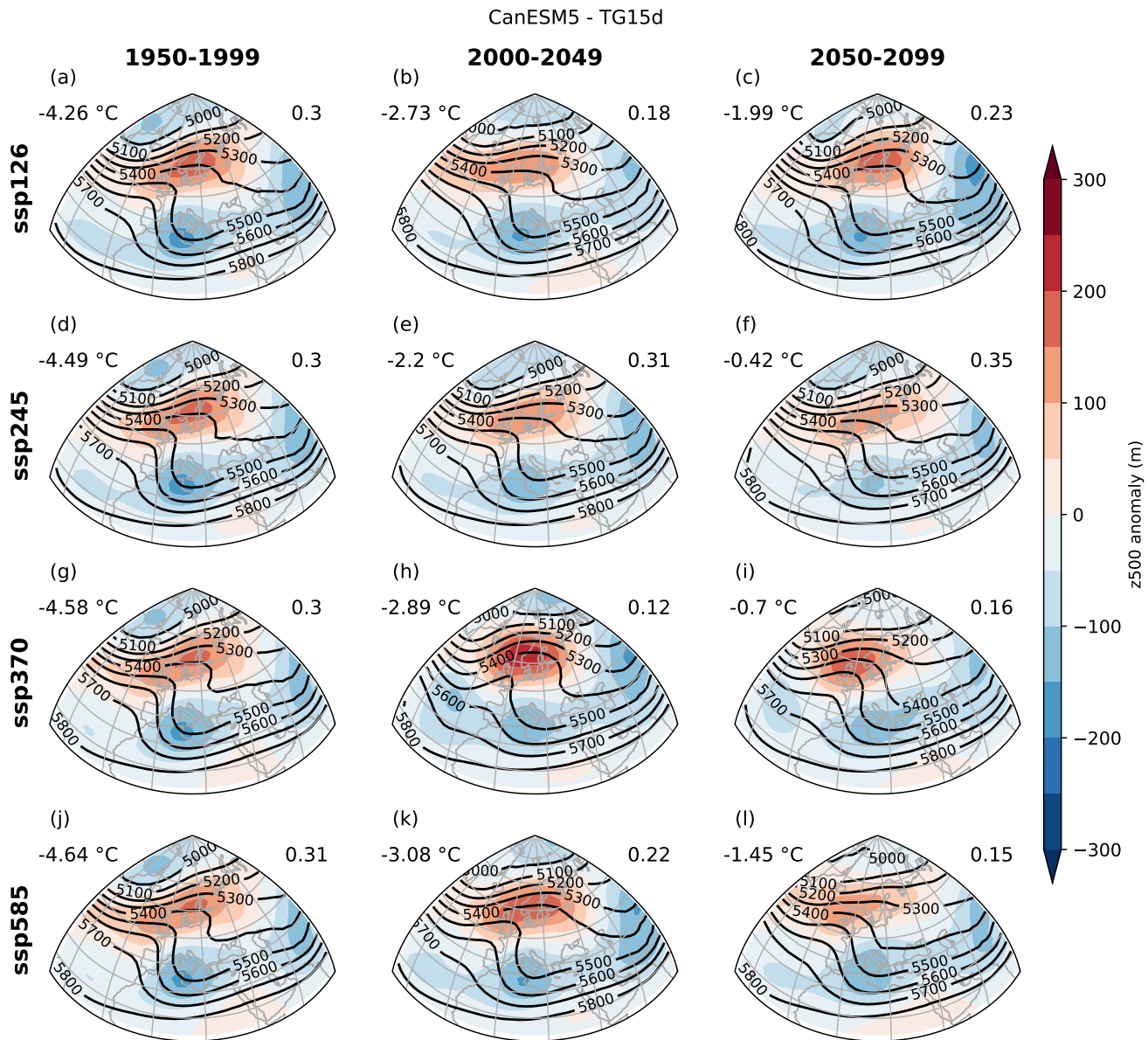


Fig. S7. Absolute values (contours, in m) and anomalies (shaded areas, in m) with respect to 1950-1999 of 500-hPa geopotential height (Z500) for the 10% coldest SWG simulations (i.e. 100 trajectories) for each period (columns) and SSP (rows) in CanESM5.

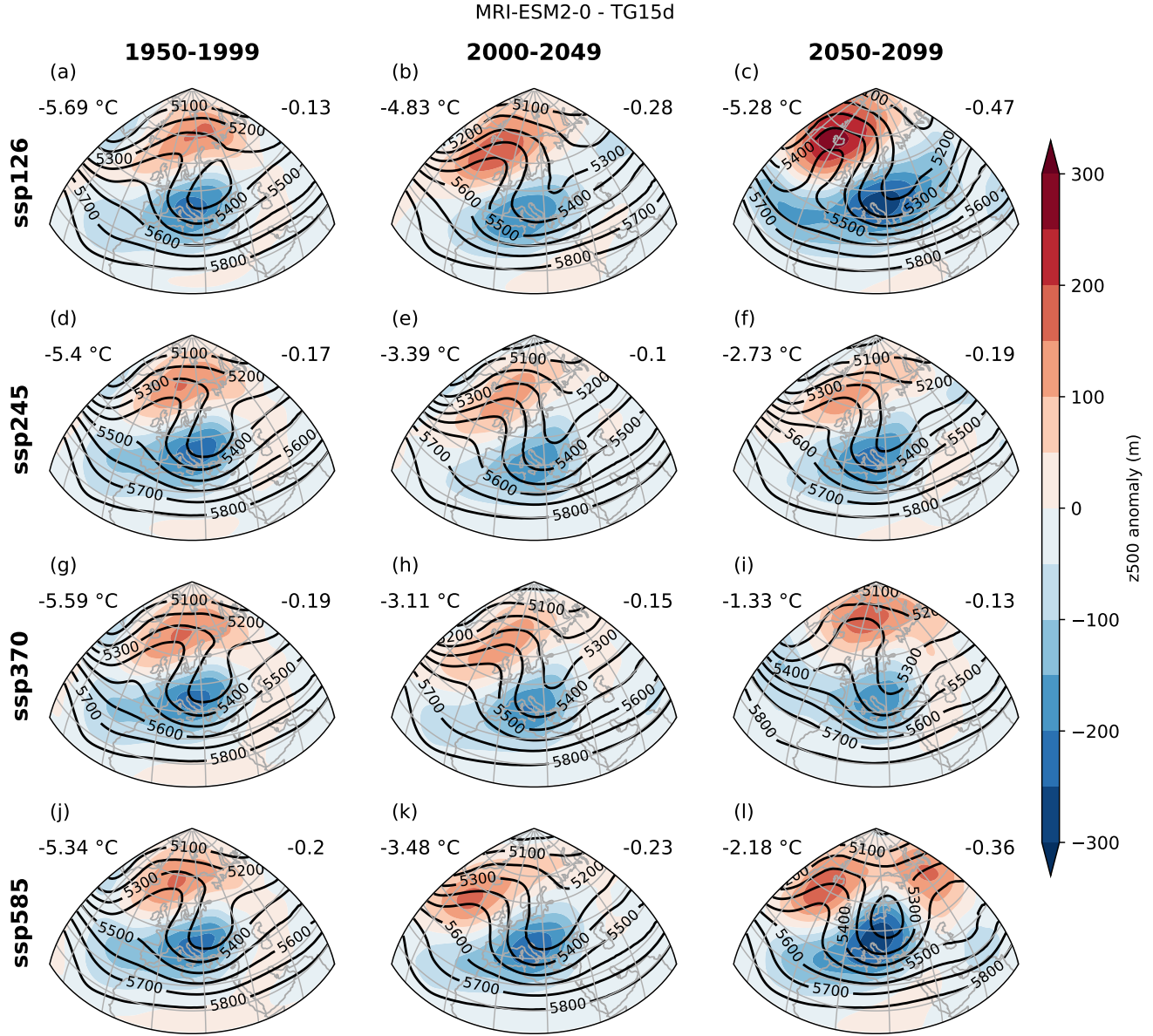


Fig. S8. Absolute values (contours, in m) and anomalies (shaded areas, in m) with respect to 1950-1999 of 500-hPa geopotential height (Z500) for the 10% coldest SWG simulations (i.e. 100 trajectories) for each period (columns) and SSP (rows) in MRI-ESM2-0.

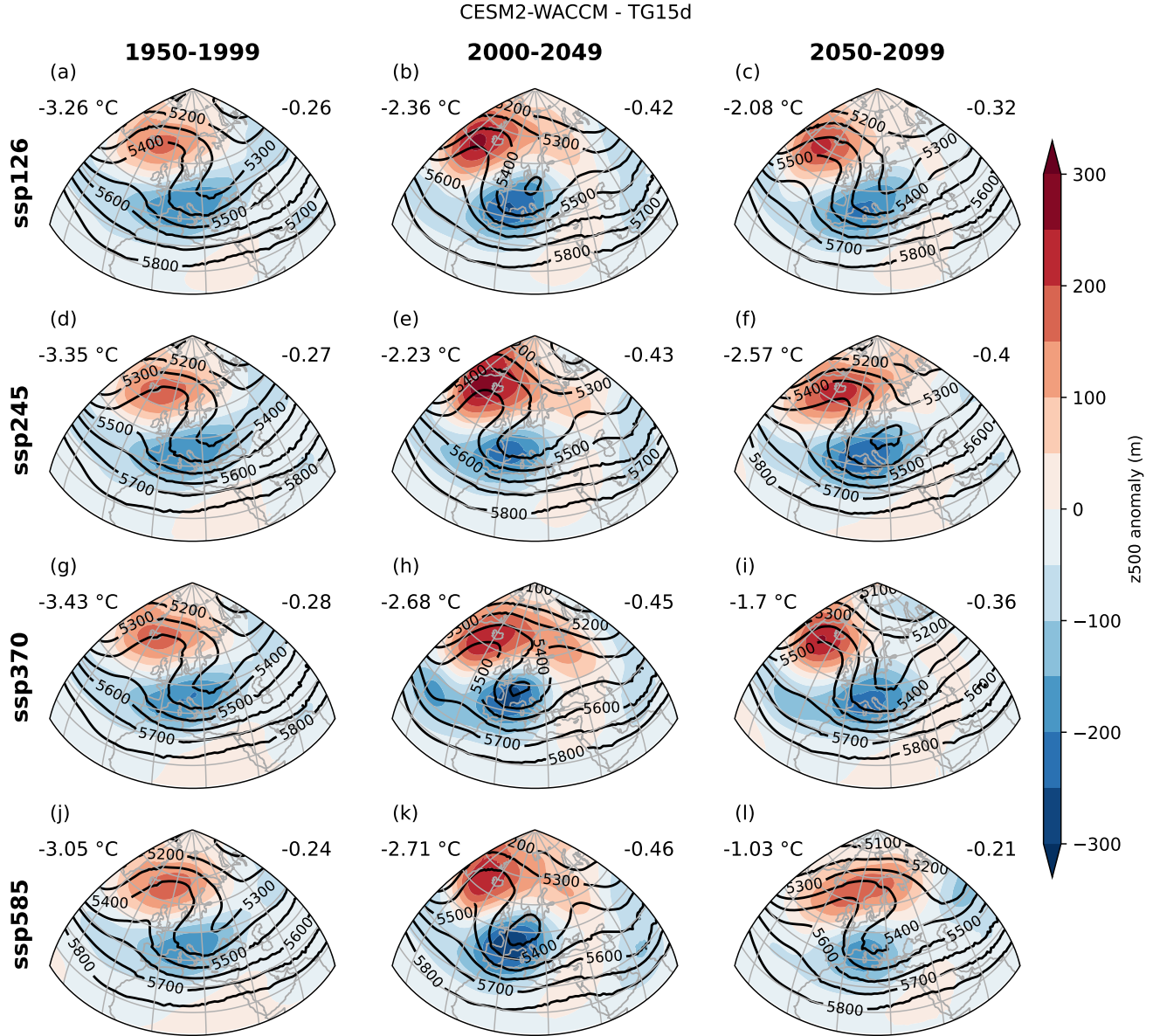


Fig. S9. Absolute values (contours, in m) and anomalies (shaded areas, in m) with respect to 1950-1999 of 500-hPa geopotential height (Z500) for the 10% coldest SWG simulations (i.e. 100 trajectories) for each period (columns) and SSP (rows) in CESM2-WACCM.

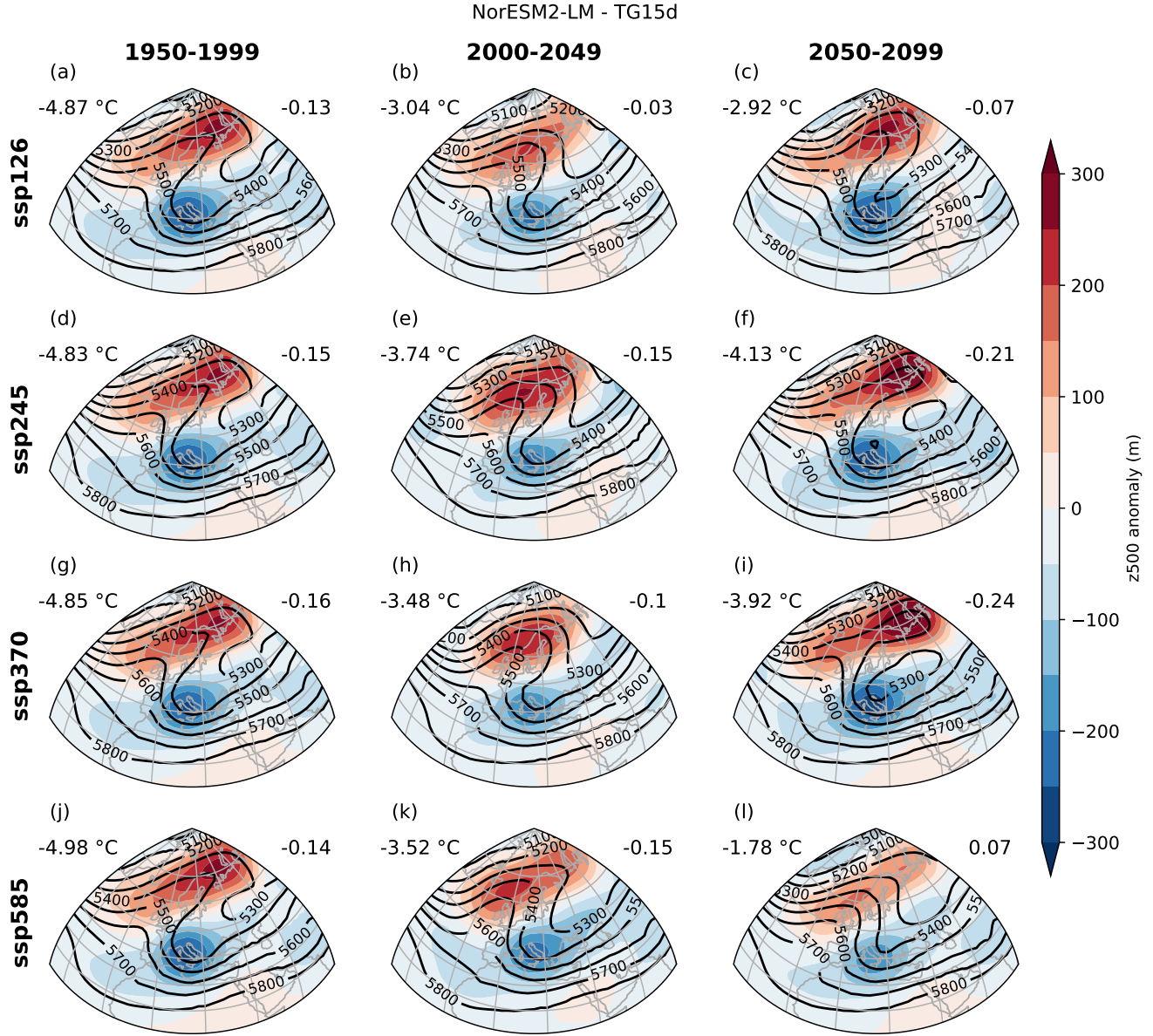


Fig. S10. Absolute values (contours, in m) and anomalies (shaded areas, in m) with respect to 1950-1999 of 500-hPa geopotential height (Z500) for the 10% coldest SWG simulations (i.e. 100 trajectories) for each period (columns) and SSP (rows) in NorESM2-LM.

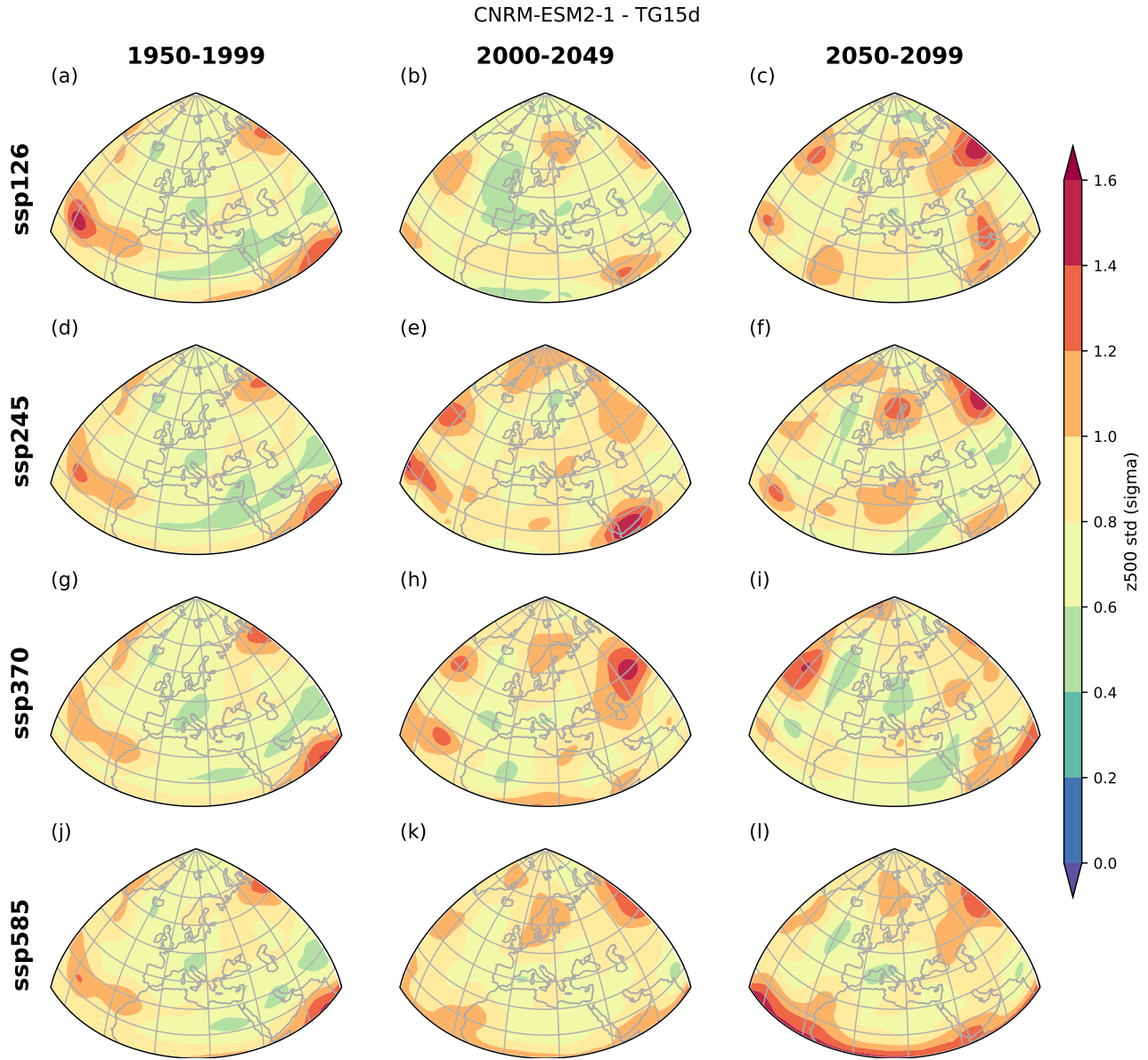


Fig. S11. Standardized standard deviation (shaded areas, σ) and anomalies with respect to 1950-1999 standard deviation of 500-hPa geopotential height (Z500) for the 10% coldest SWG simulations (i.e. 100 trajectories) for each period (columns) and SSP (rows) in CNRM-ESM2-1.

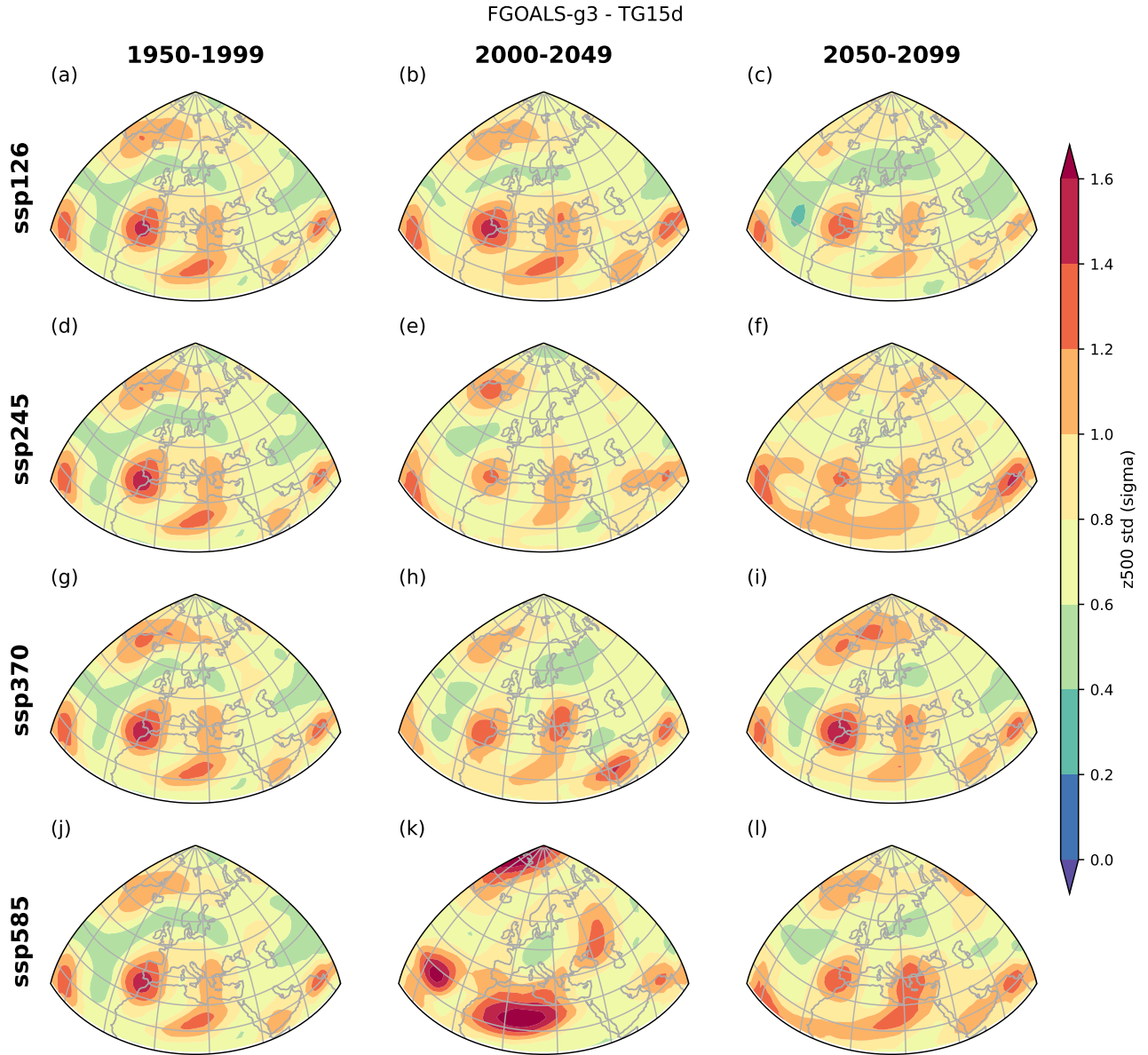


Fig. S12. Standardized standard deviation (shaded areas, σ) and anomalies with respect to 1950-1999 standard deviation of 500-hPa geopotential height (Z500) for the 10% coldest SWG simulations (i.e. 100 trajectories) for each period (columns) and SSP (rows) in FGOALS-g3.

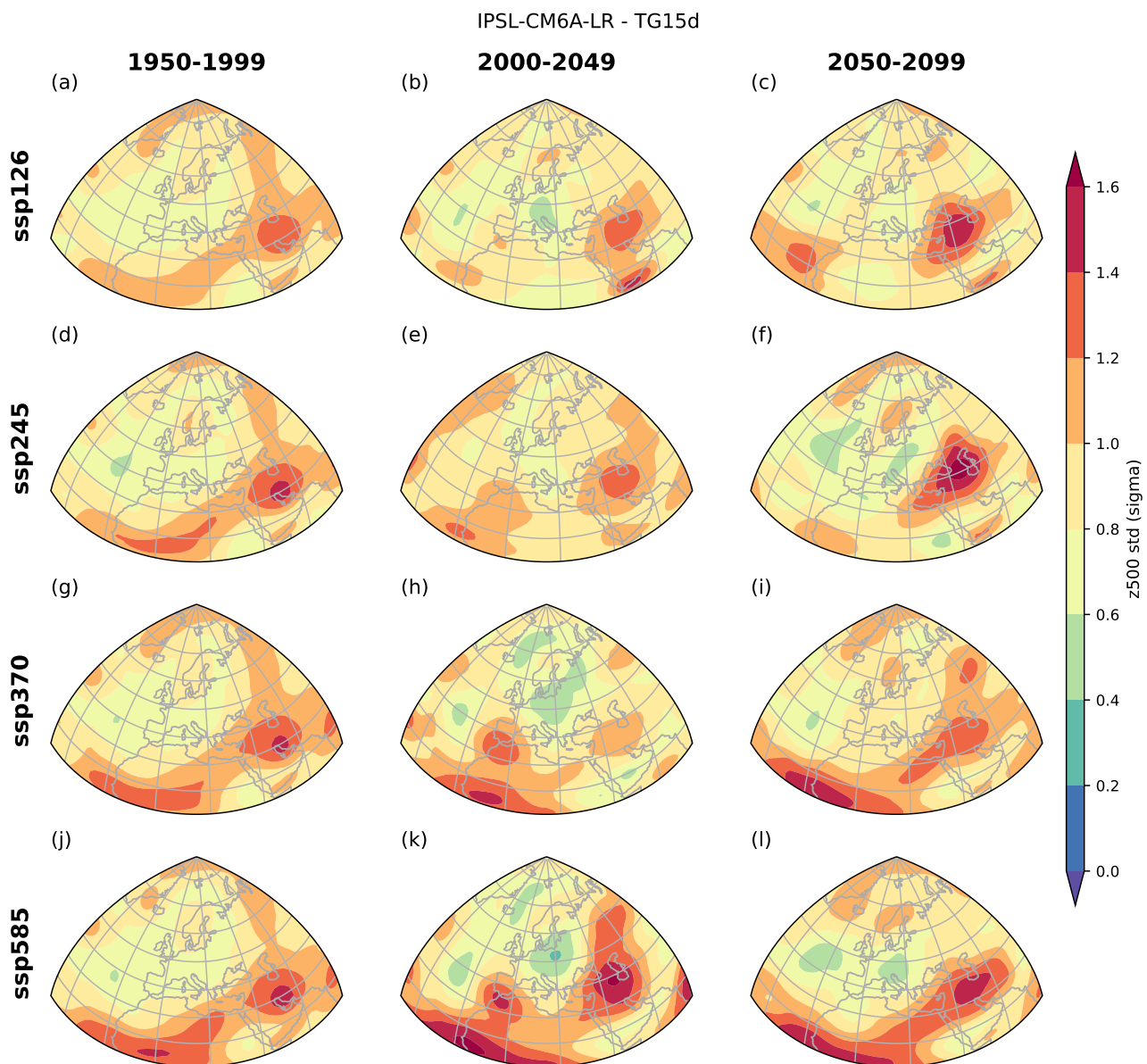


Fig. S13. Standardized standard deviation (shaded areas, σ) and anomalies with respect to 1950-1999 standard deviation of 500-hPa geopotential height (Z500) for the 10% coldest SWG simulations (i.e. 100 trajectories) for each period (columns) and SSP (rows) in IPSL-CM6A-LR.

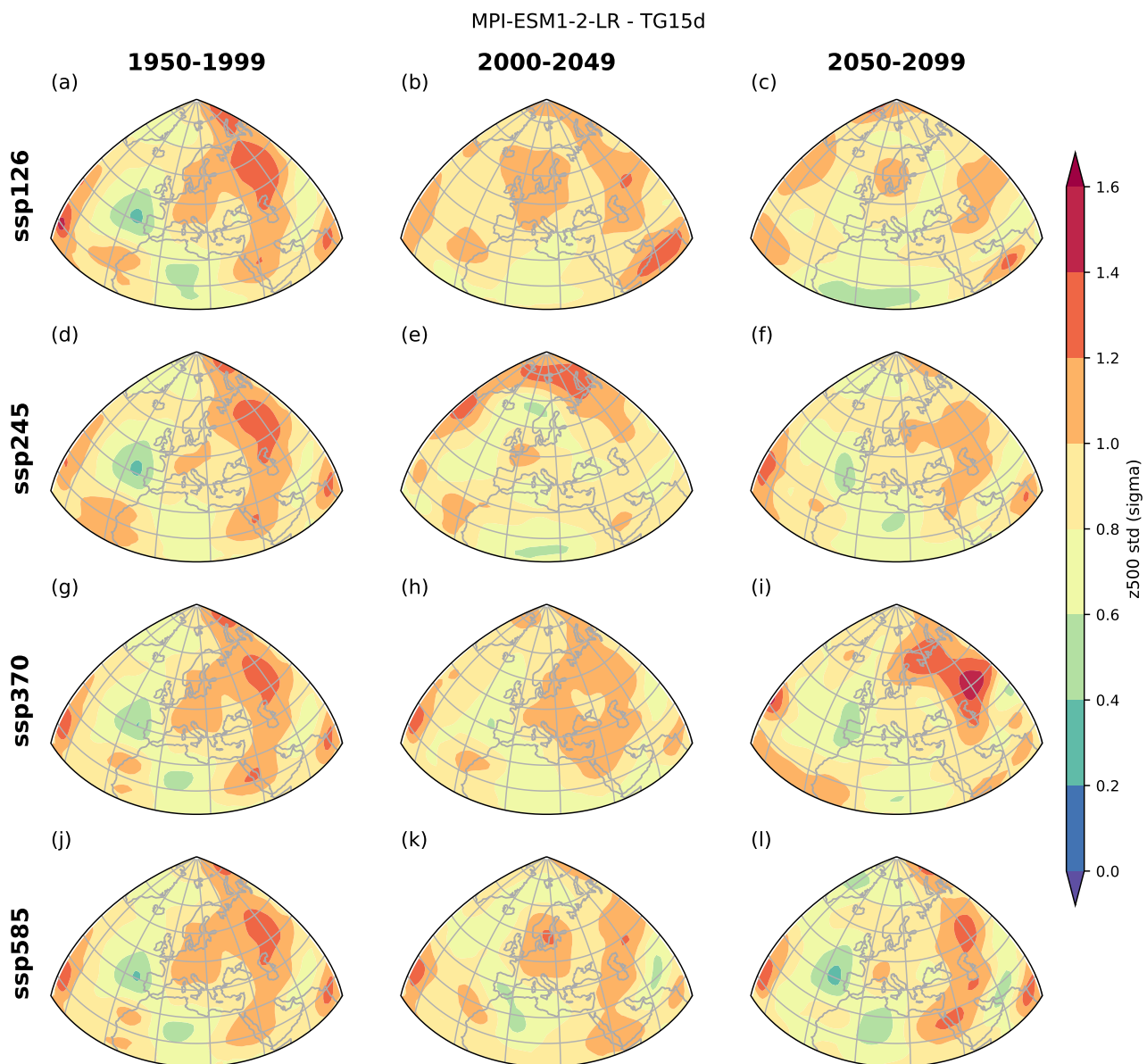


Fig. S14. Standardized standard deviation (shaded areas, σ) and anomalies with respect to 1950-1999 standard deviation of 500-hPa geopotential height (Z500) for the 10% coldest SWG simulations (i.e. 100 trajectories) for each period (columns) and SSP (rows) in MPI-ESM1-2-LR.

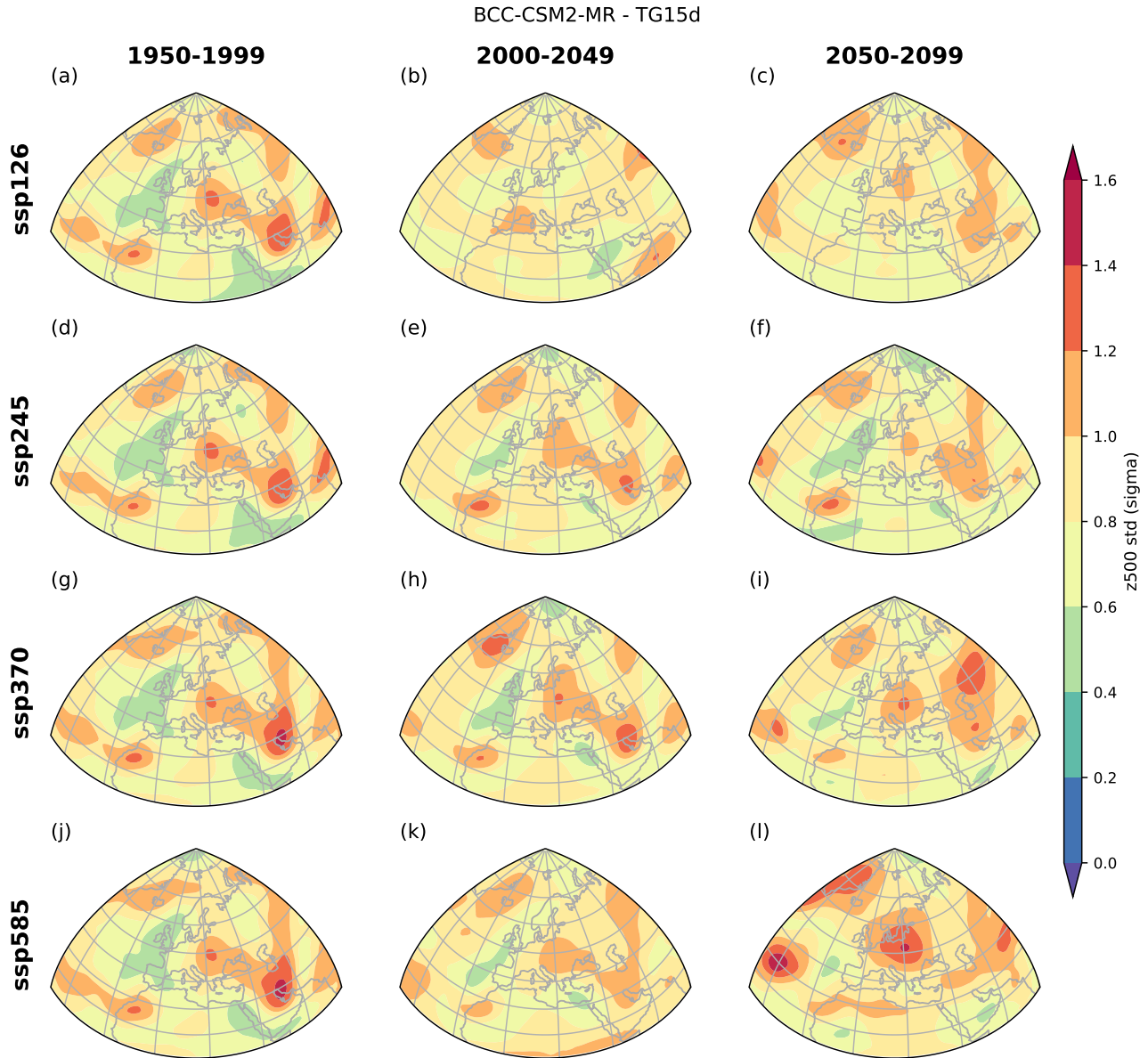


Fig. S15. Standardized standard deviation (shaded areas, σ) and anomalies with respect to 1950-1999 standard deviation of 500-hPa geopotential height (Z500) for the 10% coldest SWG simulations (i.e. 100 trajectories) for each period (columns) and SSP (rows) in BCC-CSM2-MR.

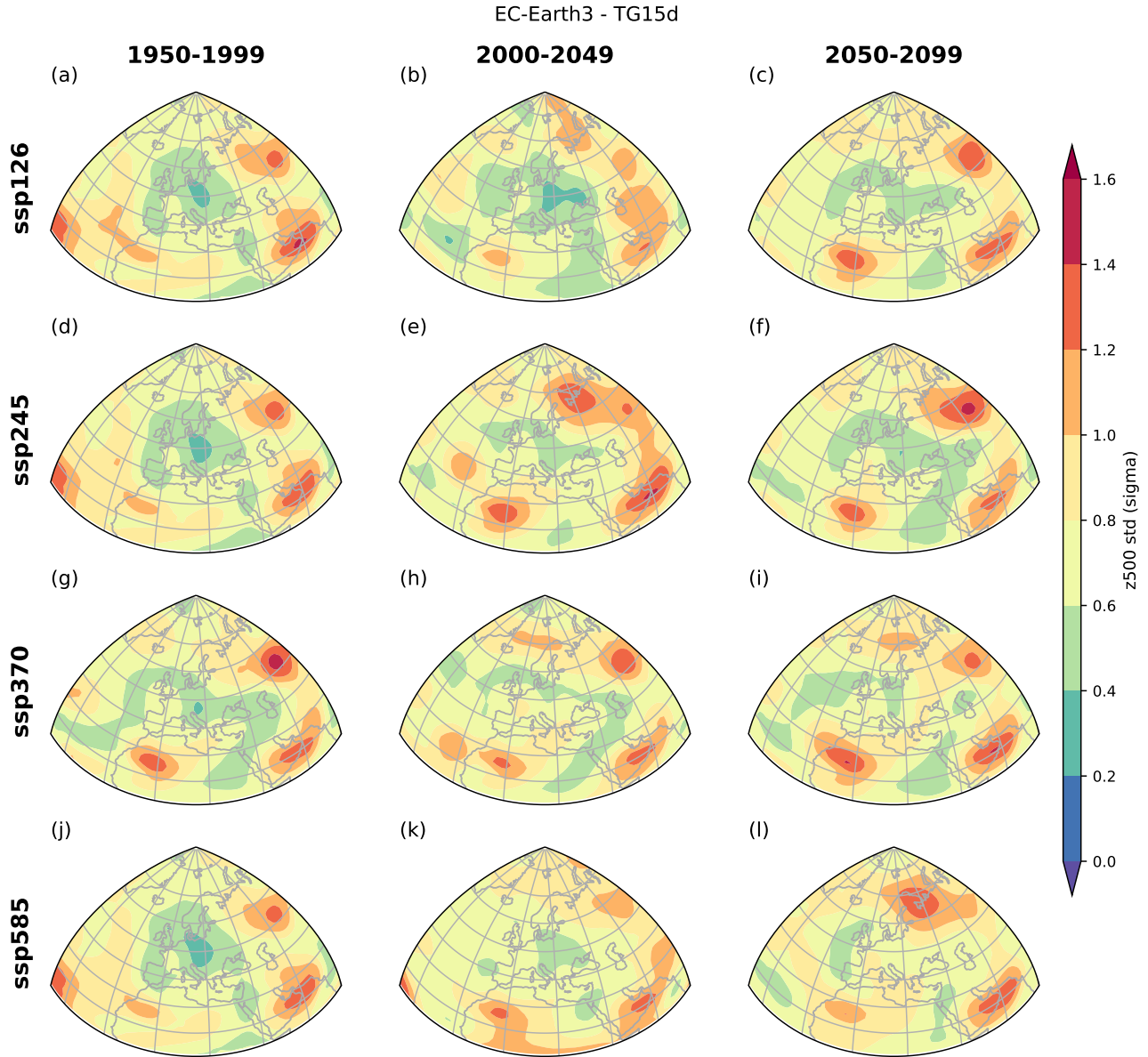


Fig. S16. Standardized standard deviation (shaded areas, σ) and anomalies with respect to 1950-1999 standard deviation of 500-hPa geopotential height (Z500) for the 10% coldest SWG simulations (i.e. 100 trajectories) for each period (columns) and SSP (rows) in EC-Earth3.

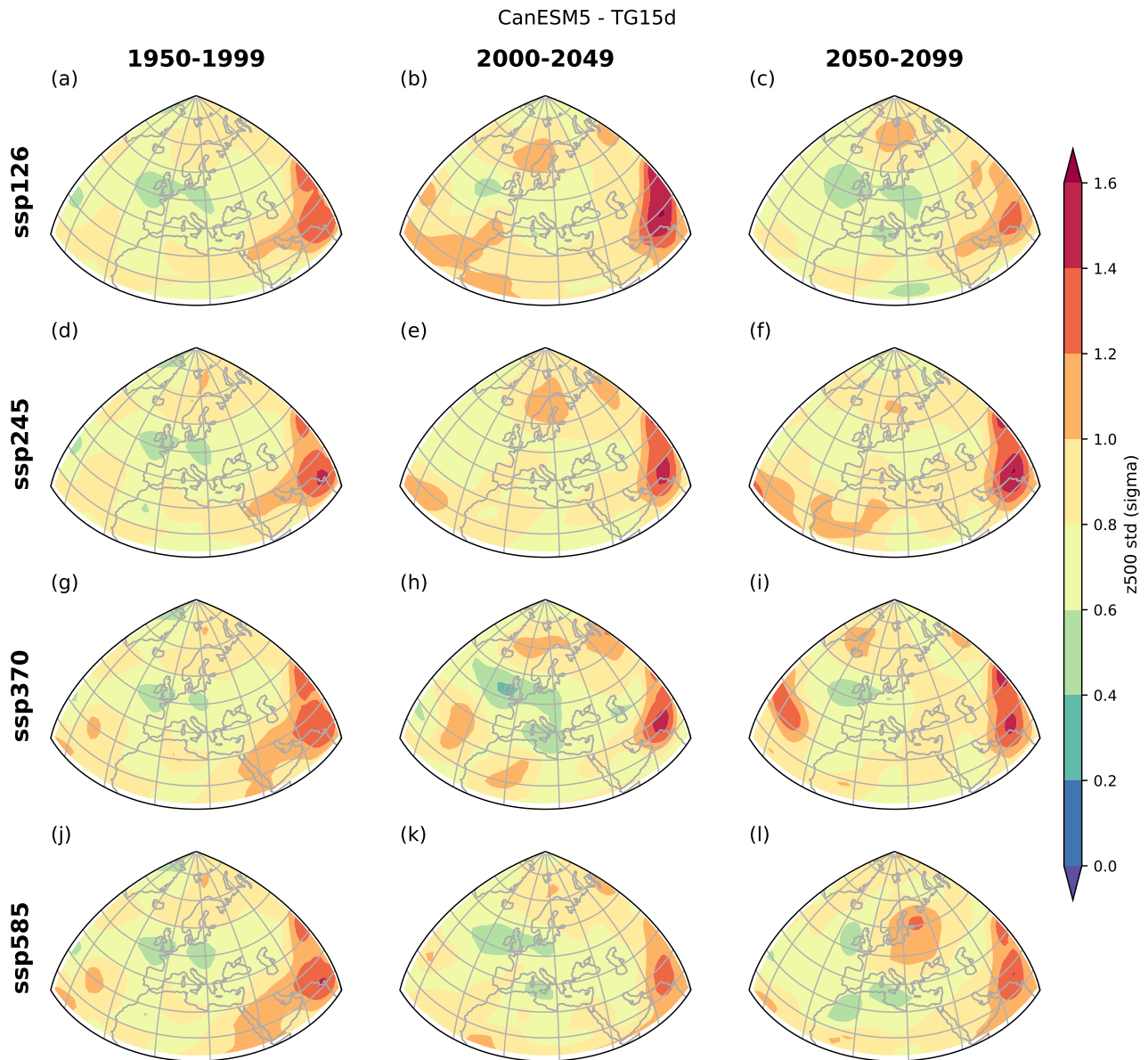


Fig. S17. Standardized standard deviation (shaded areas, σ) and anomalies with respect to 1950-1999 standard deviation of 500-hPa geopotential height (Z500) for the 10% coldest SWG simulations (i.e. 100 trajectories) for each period (columns) and SSP (rows) in CanESM5.

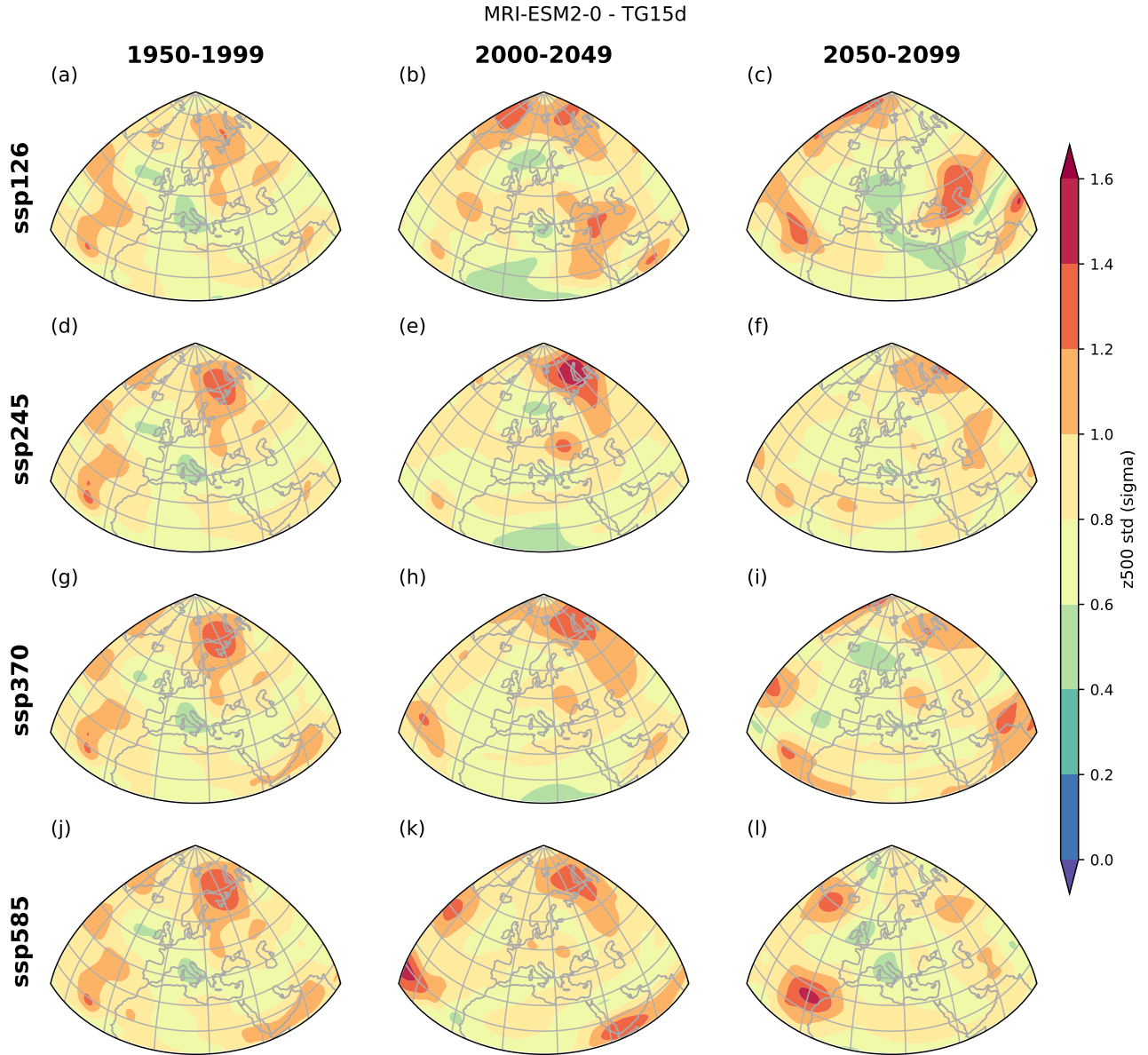


Fig. S18. Standardized standard deviation (shaded areas, σ) and anomalies with respect to 1950-1999 standard deviation of 500-hPa geopotential height (Z500) for the 10% coldest SWG simulations (i.e. 100 trajectories) for each period (columns) and SSP (rows) in MRI-ESM2-0.

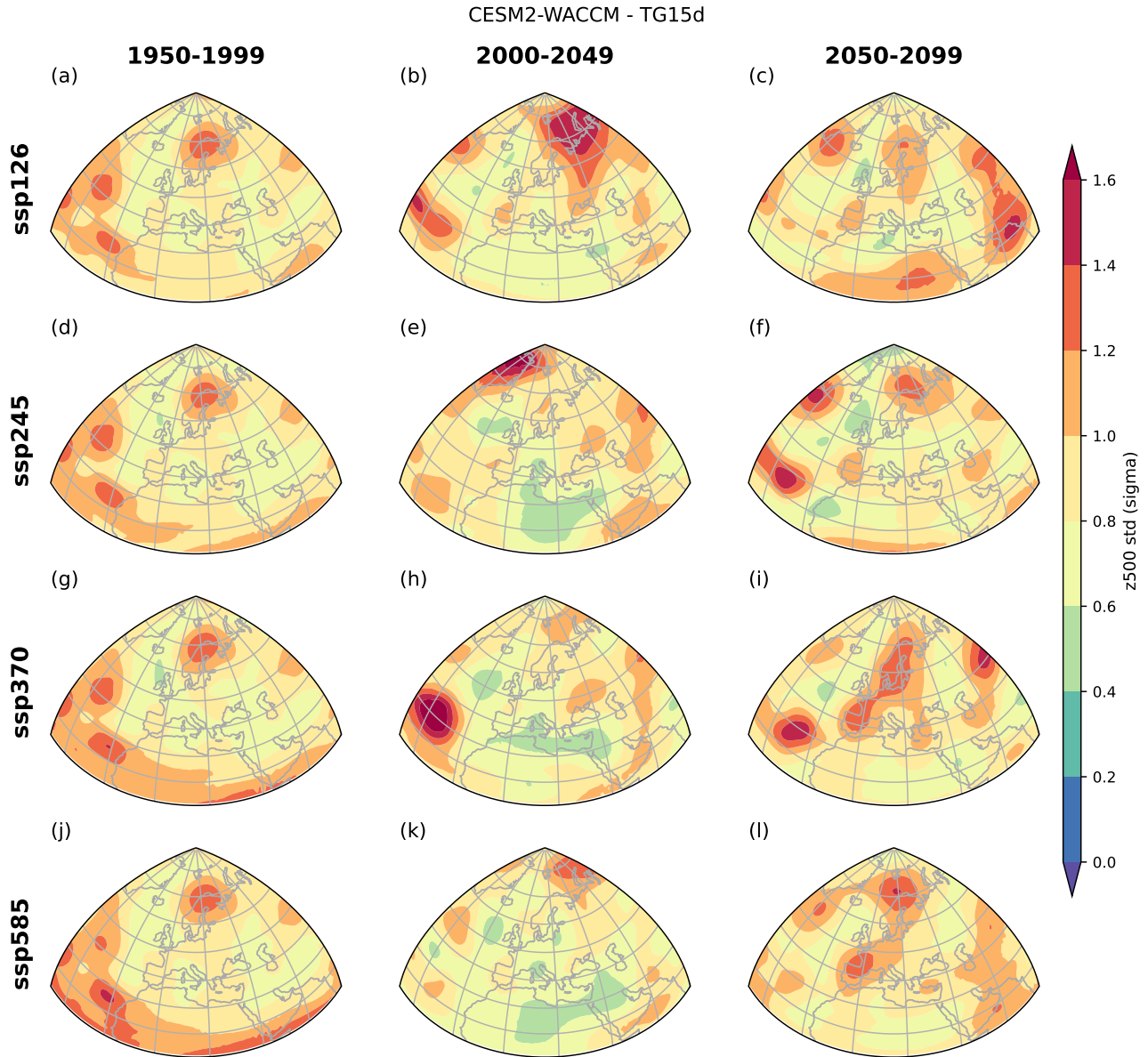


Fig. S19. Standardized standard deviation (shaded areas, σ) and anomalies with respect to 1950-1999 standard deviation of 500-hPa geopotential height (Z500) for the 10% coldest SWG simulations (i.e. 100 trajectories) for each period (columns) and SSP (rows) in CESM2-WACCM.

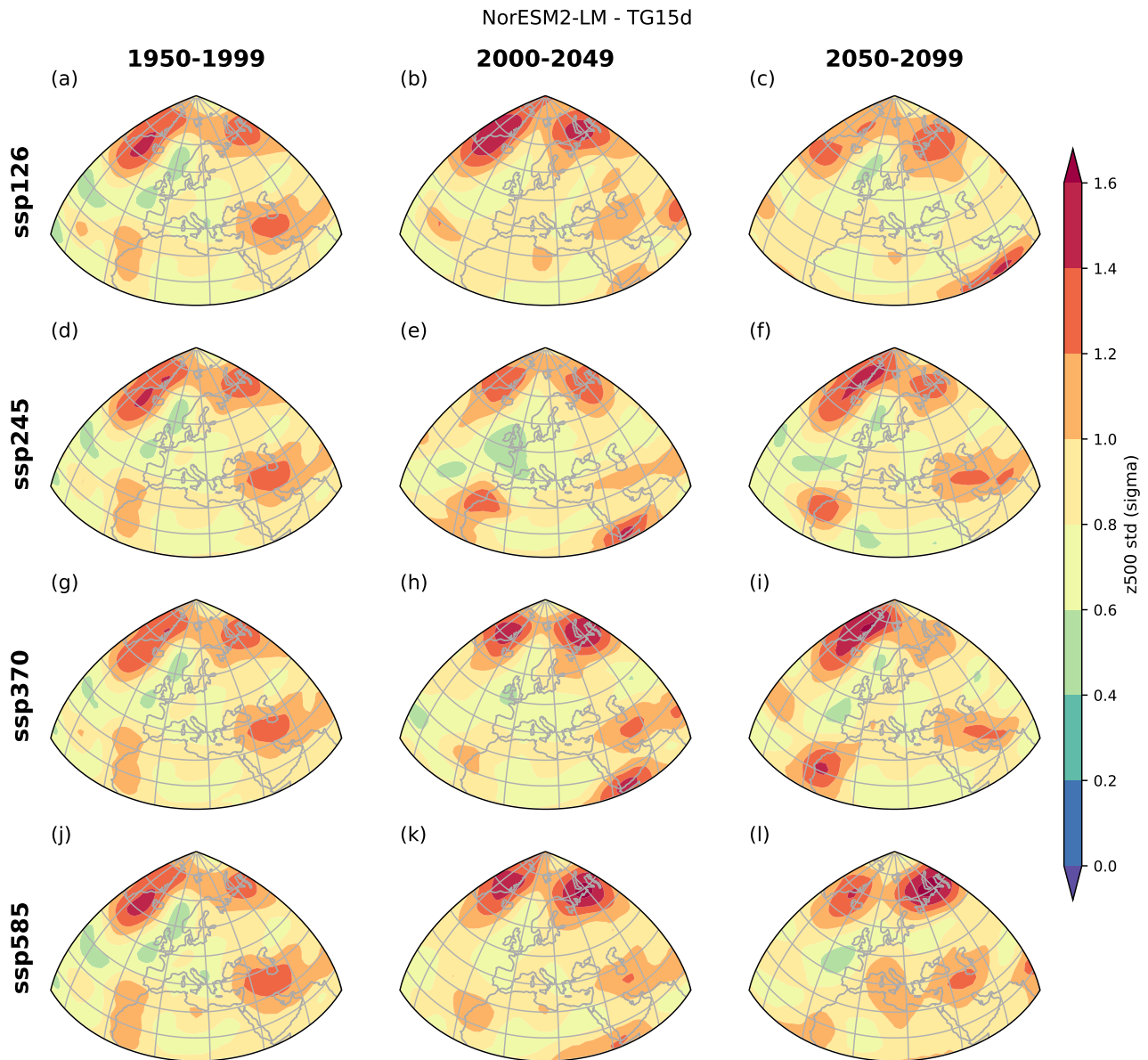


Fig. S20. Standardized standard deviation (shaded areas, σ) and anomalies with respect to 1950-1999 standard deviation of 500-hPa geopotential height (Z500) for the 10% coldest SWG simulations (i.e. 100 trajectories) for each period (columns) and SSP (rows) in NorESM2-LM.

CNRM-ESM2-1

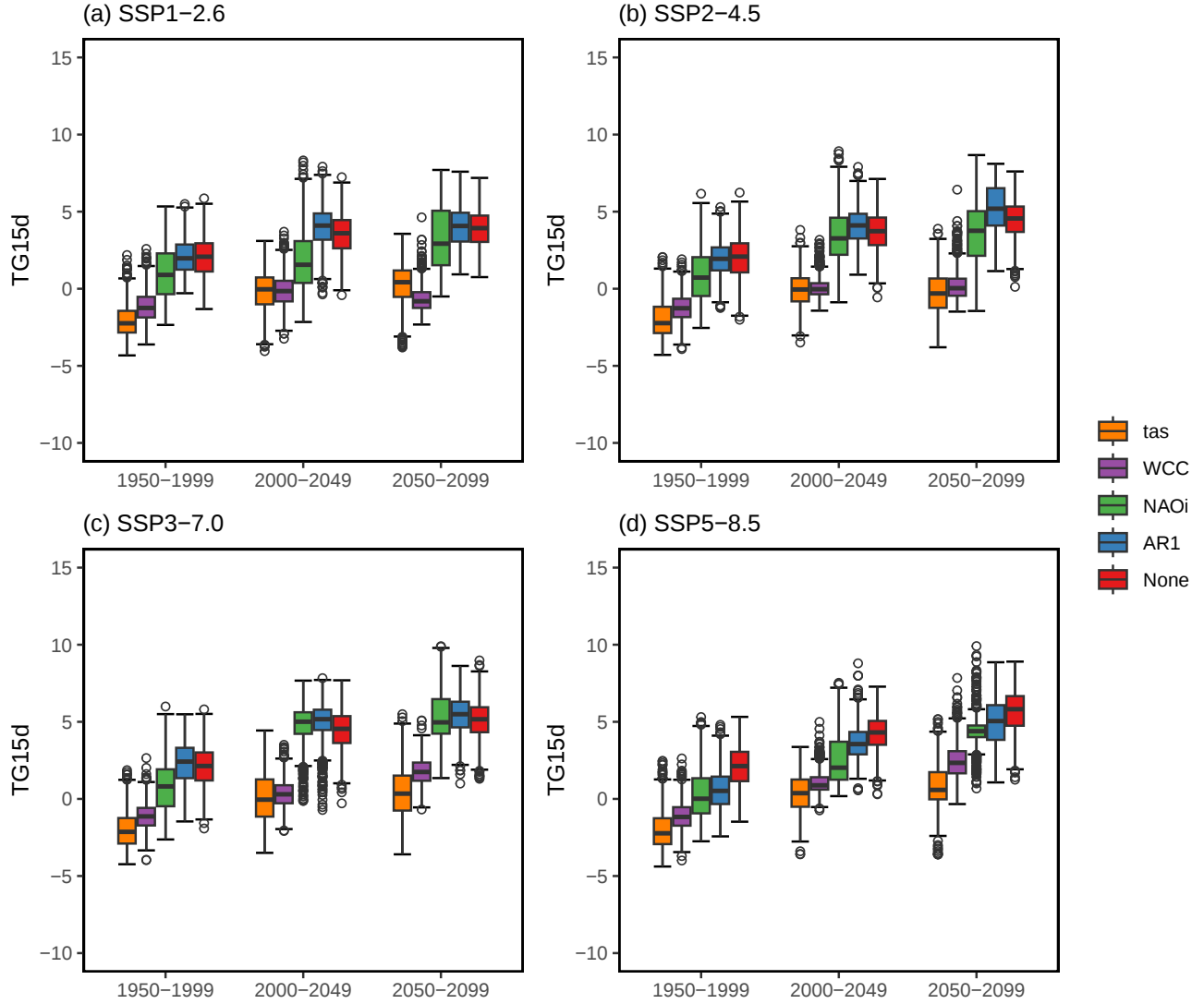


Fig. S21. Temperature (TG15d) distribution of 1000 SWG simulations for four SSPs (a-d) and three climate periods (left to right) depending on the variable used for importance sampling (colours) in CNRM-ESM2-1. Temperatures are adjusted by the median DJF temperature bias. In the box plots, the boxes represent the median (q_{50}), with the lower and upper hinges denoting the first (q_{25}) and third (q_{75}) quartiles, respectively. The upper whiskers are defined as $\min[\max(T), q_{75} + 1.5 \times (q_{75} - q_{25})]$, while the lower whiskers are formulated symmetrically. The individual points in the plot correspond to the outlying values that exceed the upper whisker or fall below the lower whisker.

FGOALS-g3

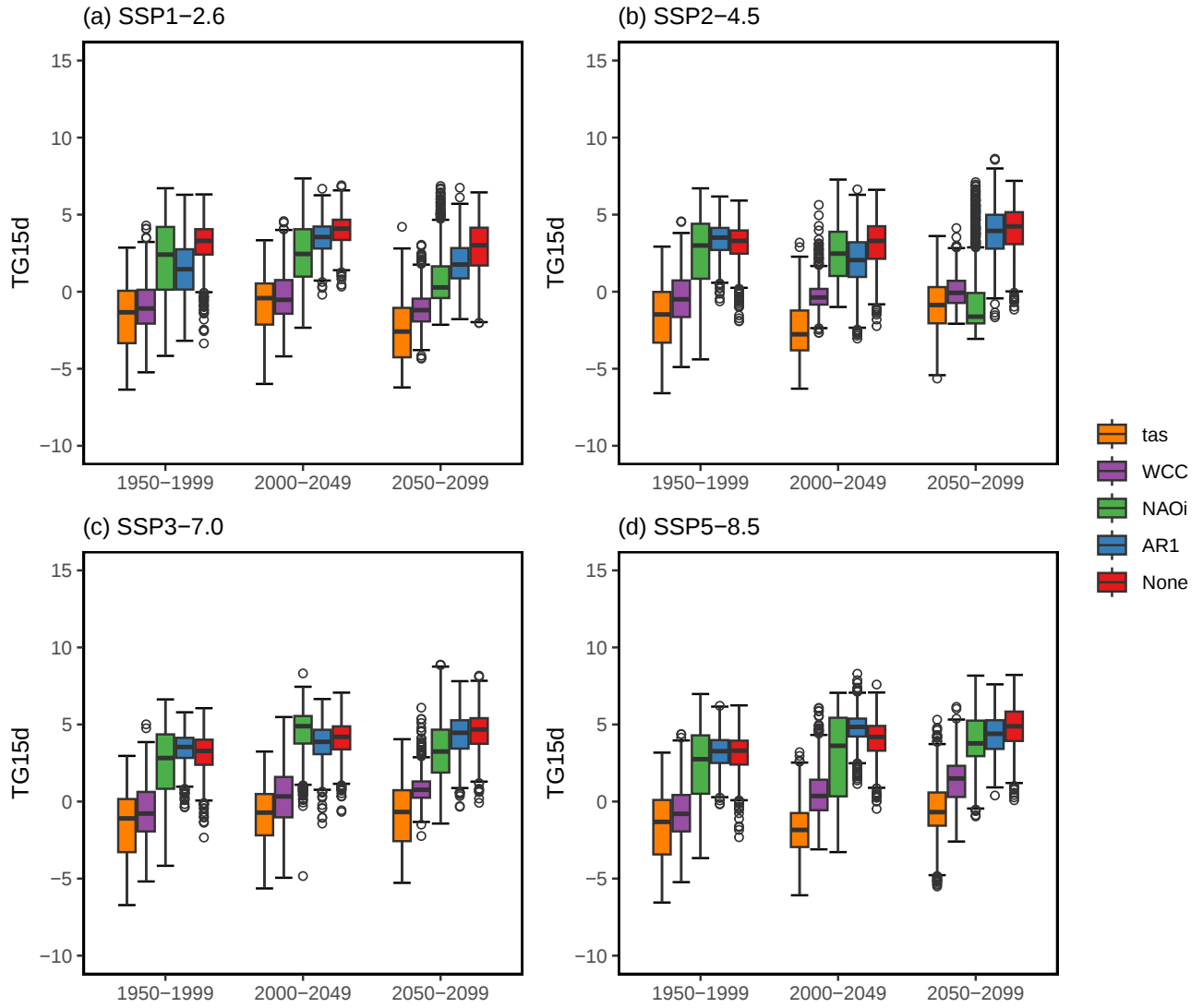


Fig. S22. Temperature (TG15d) distribution of 1000 SWG simulations for four SSPs (a-d) and three climate periods (left to right) depending on the variable used for importance sampling (colours) in FGOALS-g3. Temperatures are adjusted by the median DJF temperature bias. Boxplots are as defined in Fig. S21.

IPSL-CM6A-LR

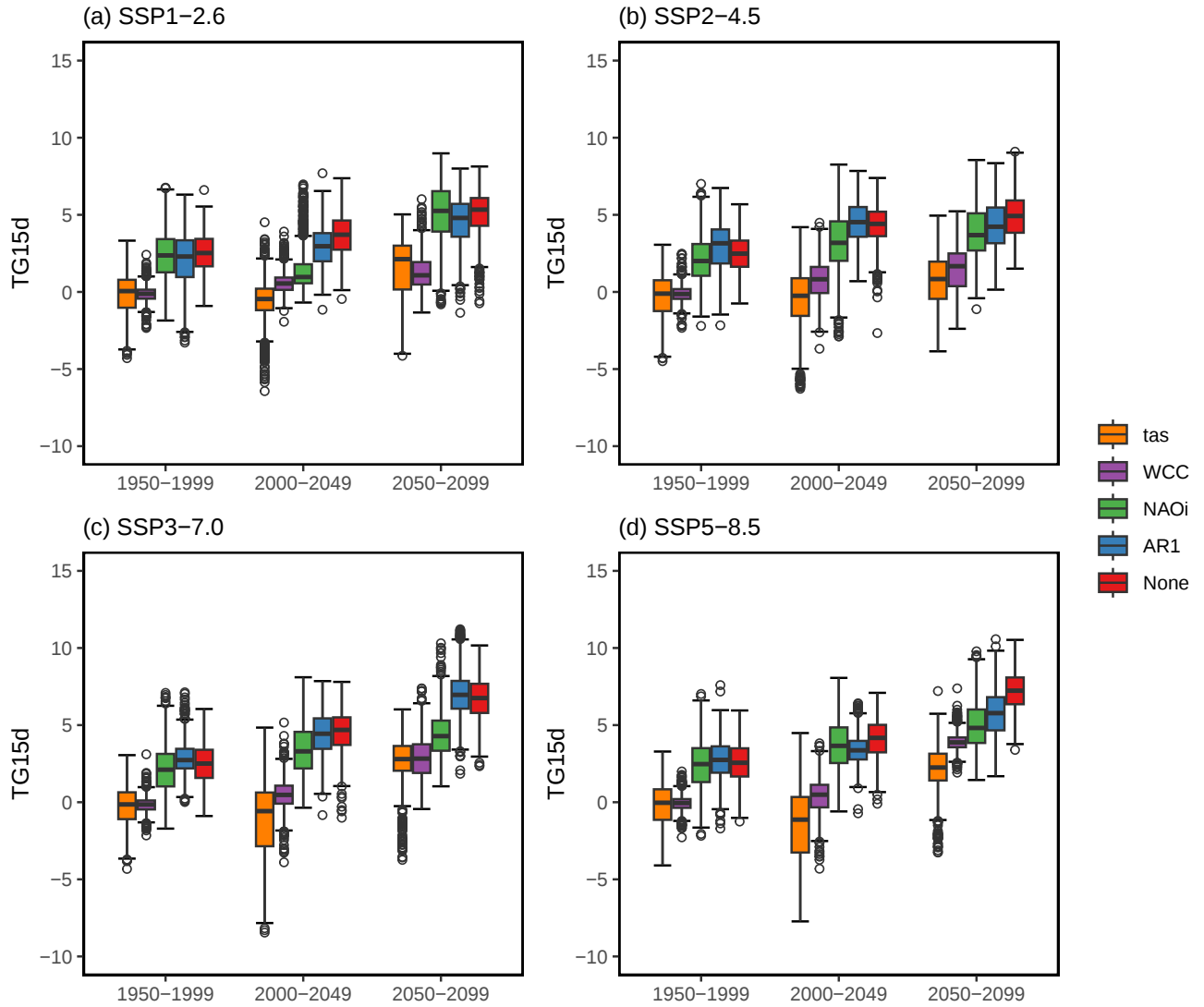


Fig. S23. Temperature (TG15d) distribution of 1000 SWG simulations for four SSPs (a-d) and three climate periods (left to right) depending on the variable used for importance sampling (colours) in IPSL-CM6A-LR. Temperatures are adjusted by the median DJF temperature bias. Boxplots are as defined in Fig. S21.

MPI-ESM1-2-LR

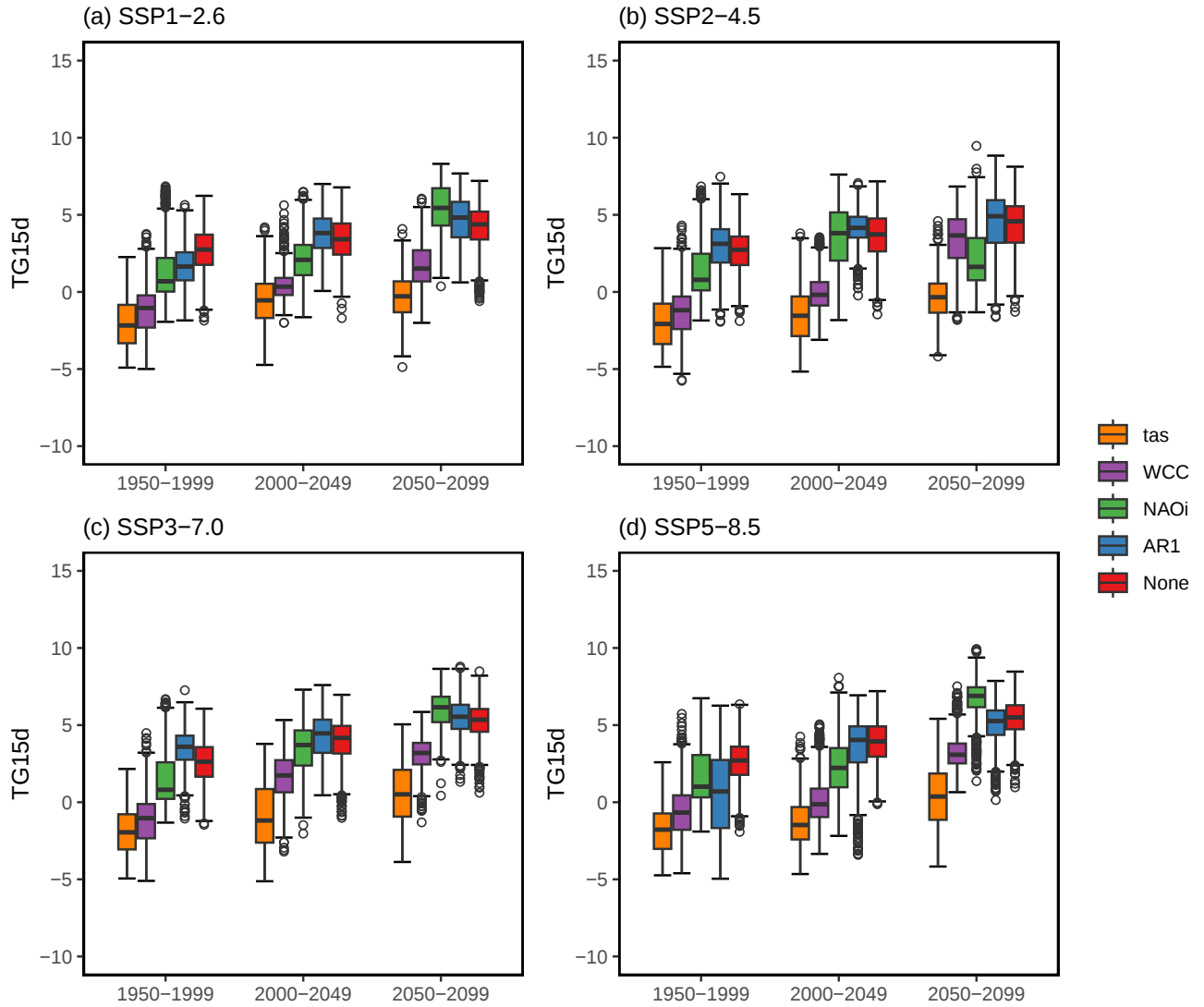


Fig. S24. Temperature (TG15d) distribution of 1000 SWG simulations for four SSPs (a-d) and three climate periods (left to right) depending on the variable used for importance sampling (colours) in MPI-ESM1-2-LR. Temperatures are adjusted by the median DJF temperature bias. Boxplots are as defined in Fig. S21.

BCC-CSM2-MR

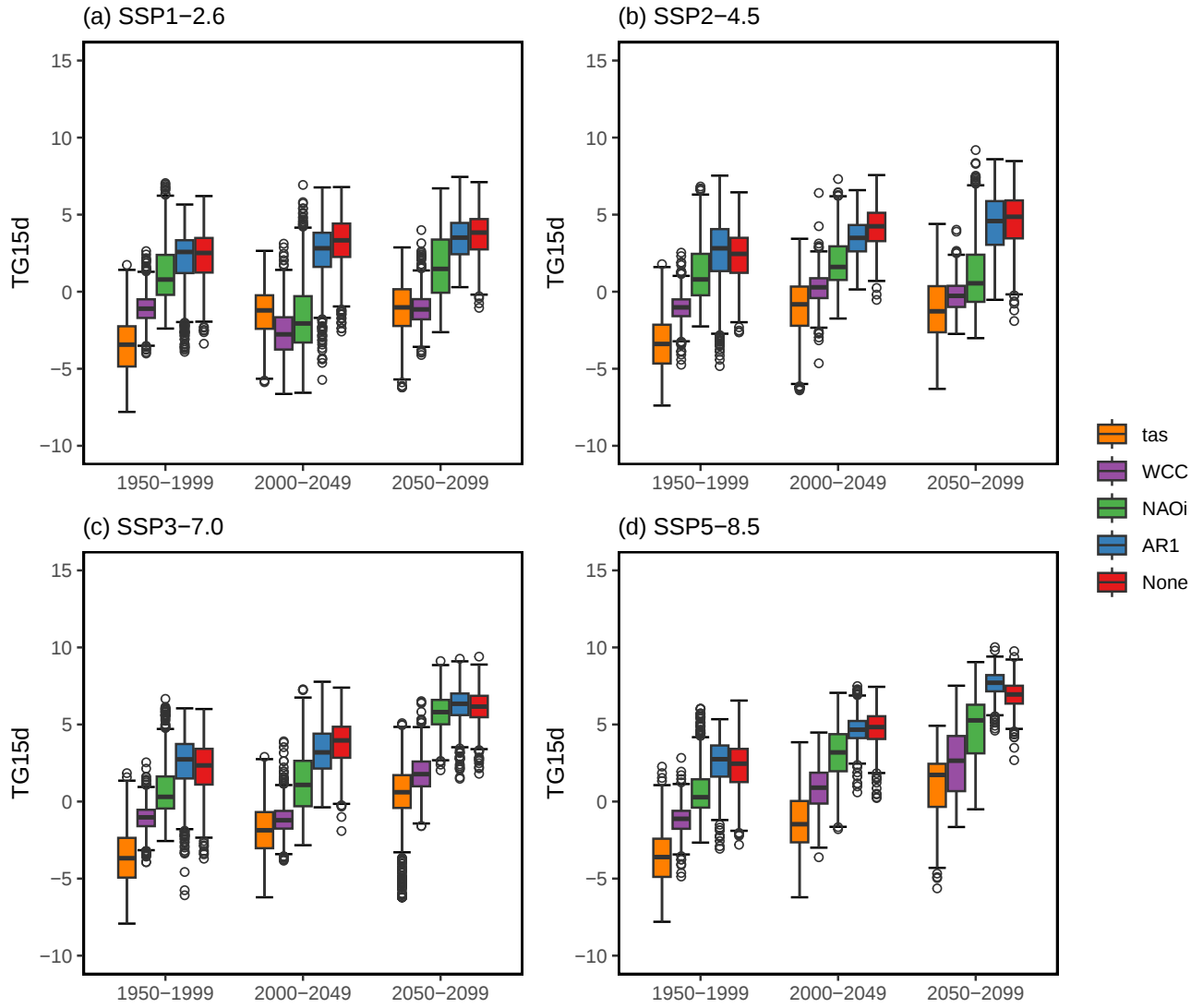


Fig. S25. Temperature (TG15d) distribution of 1000 SWG simulations for four SSPs (a-d) and three climate periods (left to right) depending on the variable used for importance sampling (colours) in BCC-CSM2-MR. Temperatures are adjusted by the median DJF temperature bias. Boxplots are as defined in Fig. S21.

EC-Earth3

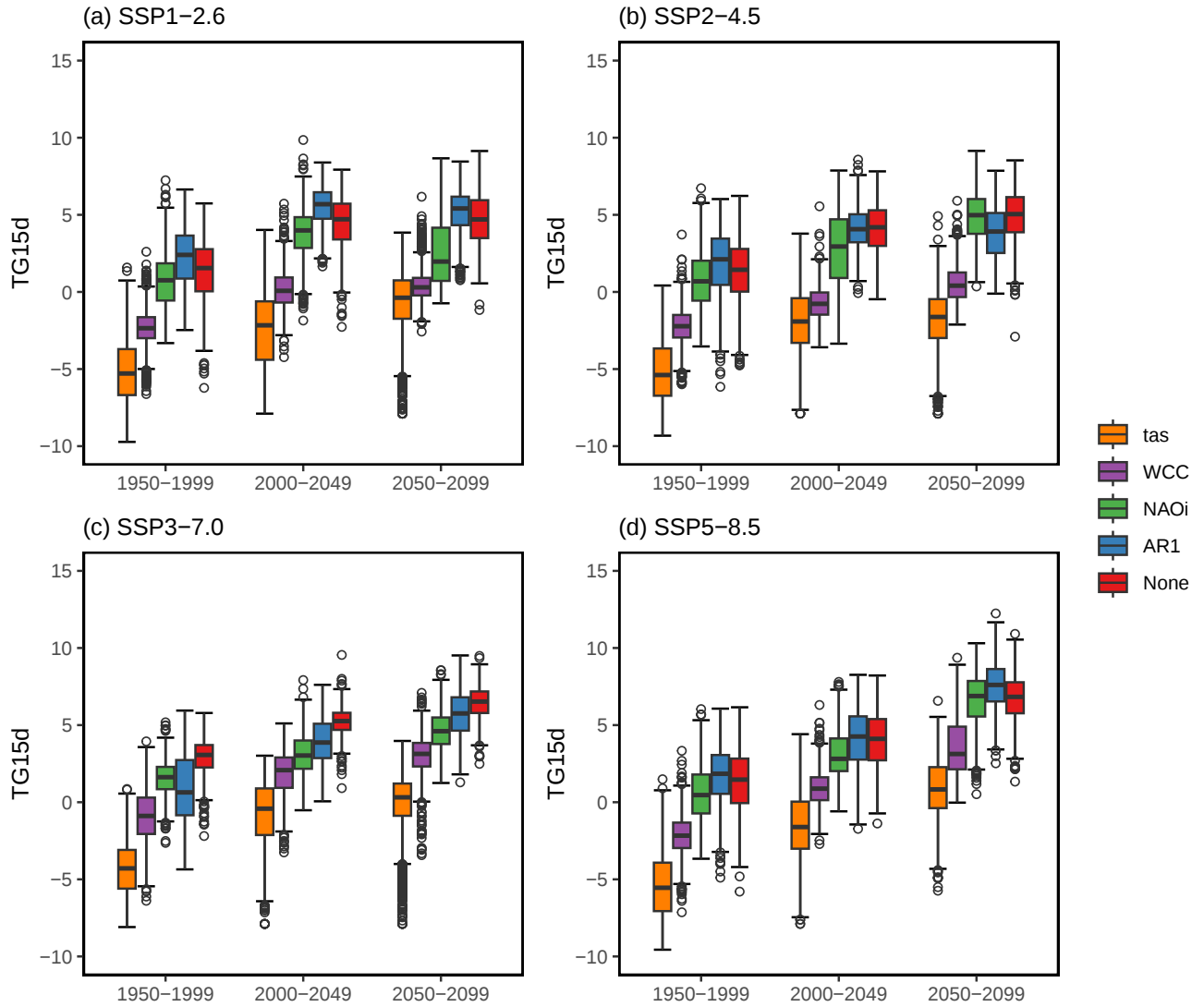


Fig. S26. Temperature (TG15d) distribution of 1000 SWG simulations for four SSPs (a-d) and three climate periods (left to right) depending on the variable used for importance sampling (colours) in EC-Earth3. Temperatures are adjusted by the median DJF temperature bias. Boxplots are as defined in Fig. S21.

CanESM5

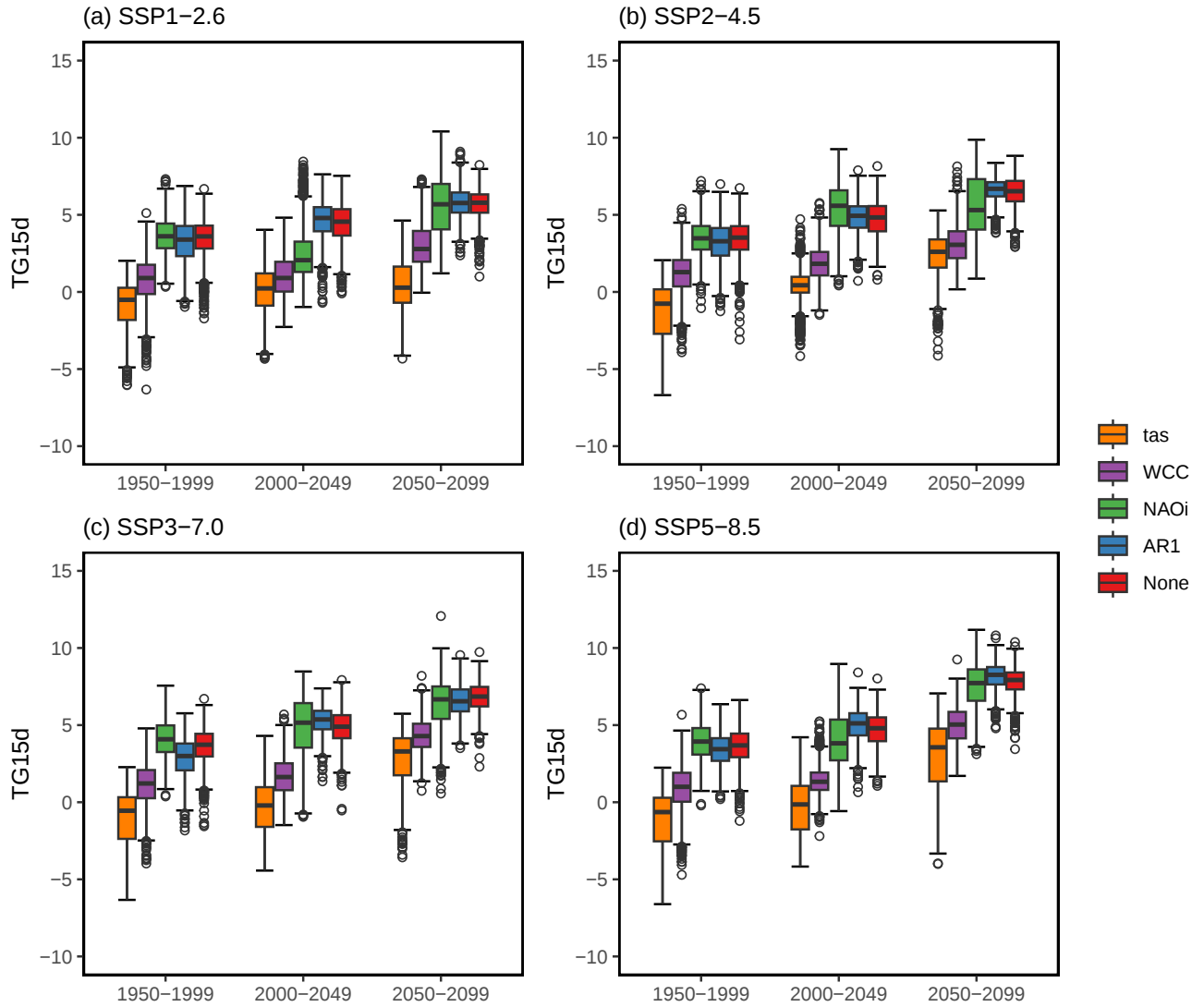


Fig. S27. Temperature (TG15d) distribution of 1000 SWG simulations for four SSPs (a-d) and three climate periods (left to right) depending on the variable used for importance sampling (colours) in CanESM5. Temperatures are adjusted by the median DJF temperature bias. Boxplots are as defined in Fig. S21.

MRI-ESM2-0

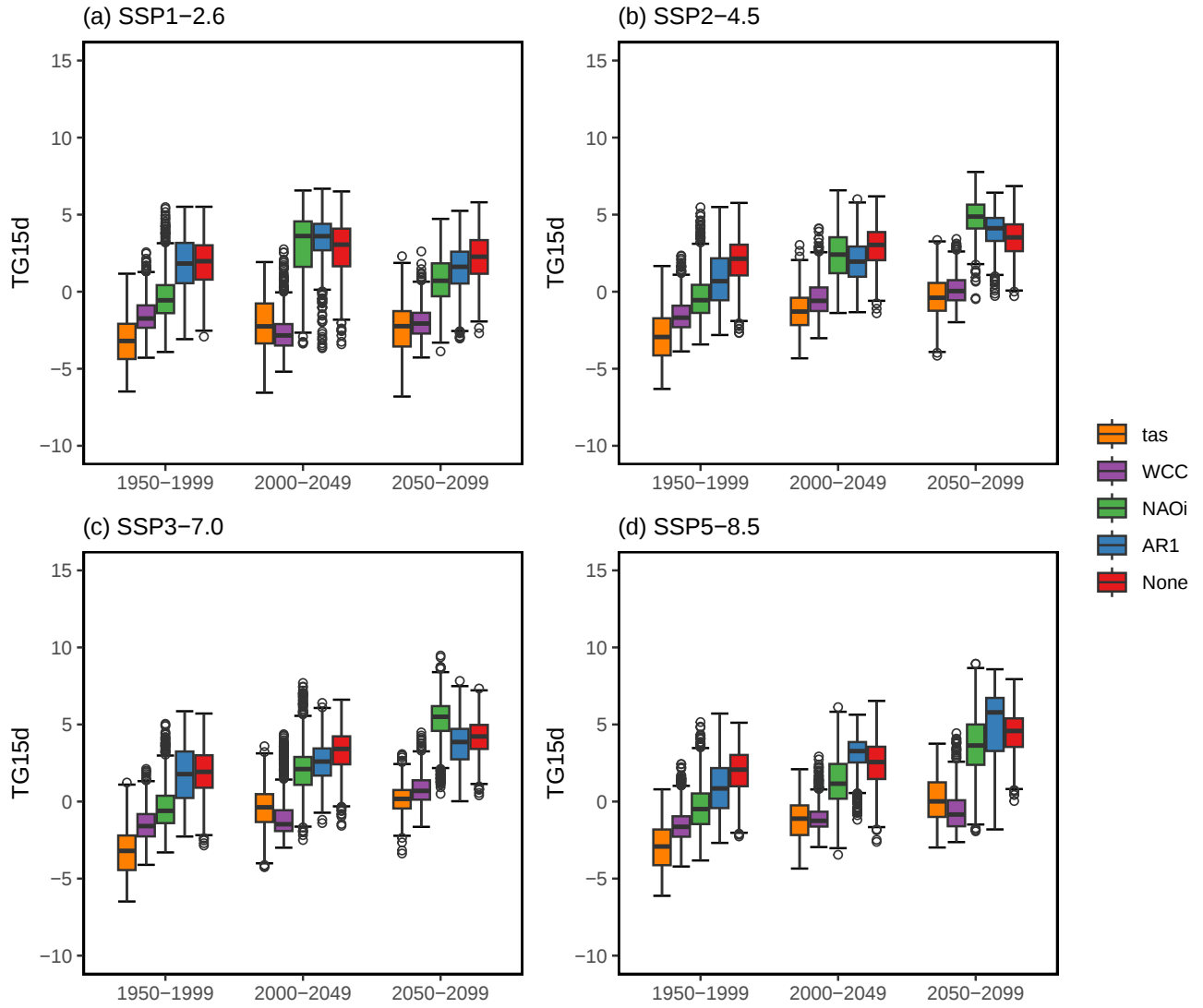


Fig. S28. Temperature (TG15d) distribution of 1000 SWG simulations for four SSPs (a-d) and three climate periods (left to right) depending on the variable used for importance sampling (colours) in MRI-ESM2-0. Temperatures are adjusted by the median DJF temperature bias. Boxplots are as defined in Fig. S21.

CESM2-WACCM

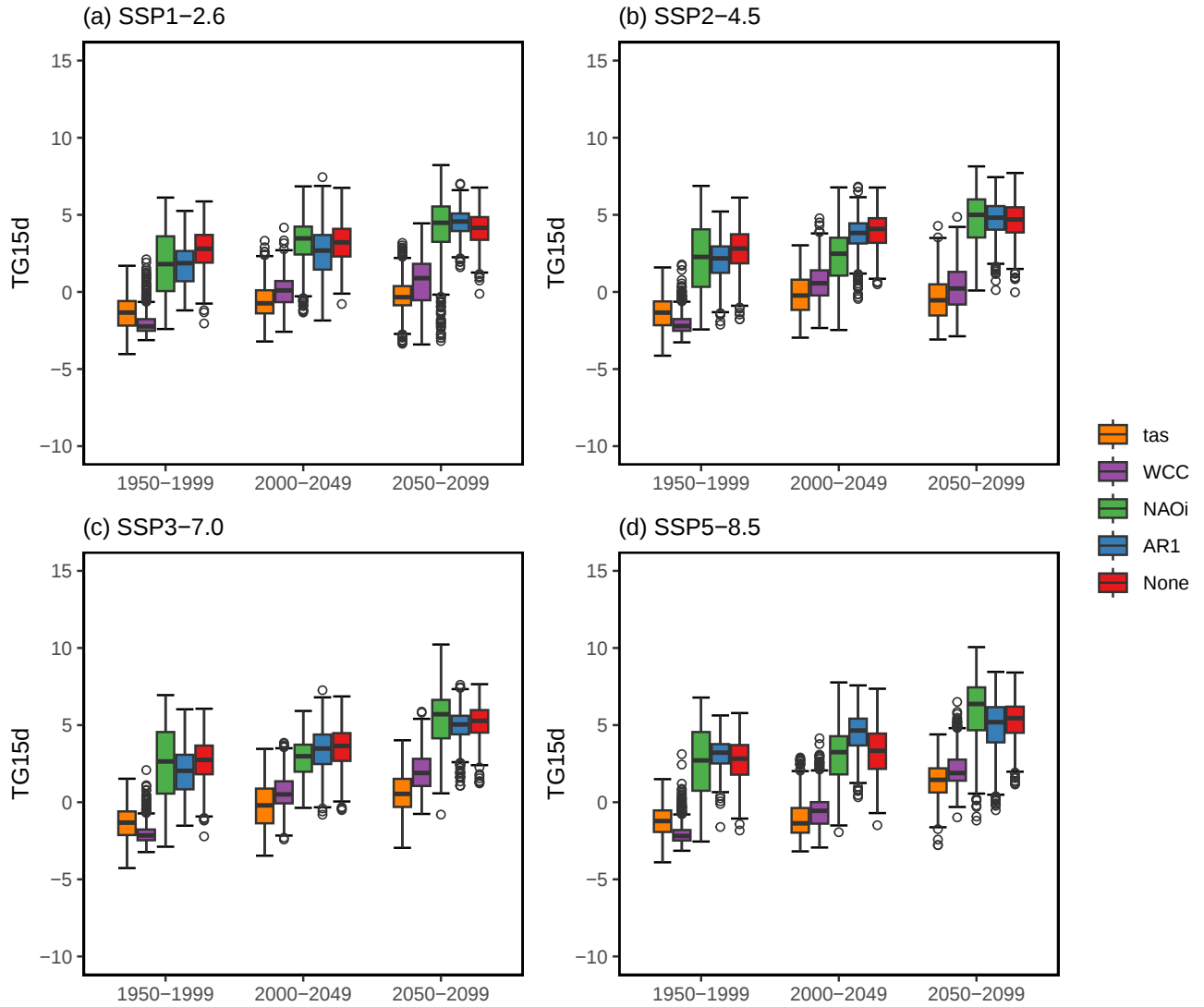


Fig. S29. Temperature (TG15d) distribution of 1000 SWG simulations for four SSPs (a-d) and three climate periods (left to right) depending on the variable used for importance sampling (colours) in CESM2-WACCM. Temperatures are adjusted by the median DJF temperature bias. Boxplots are as defined in Fig. S21.

NorESM2-LM

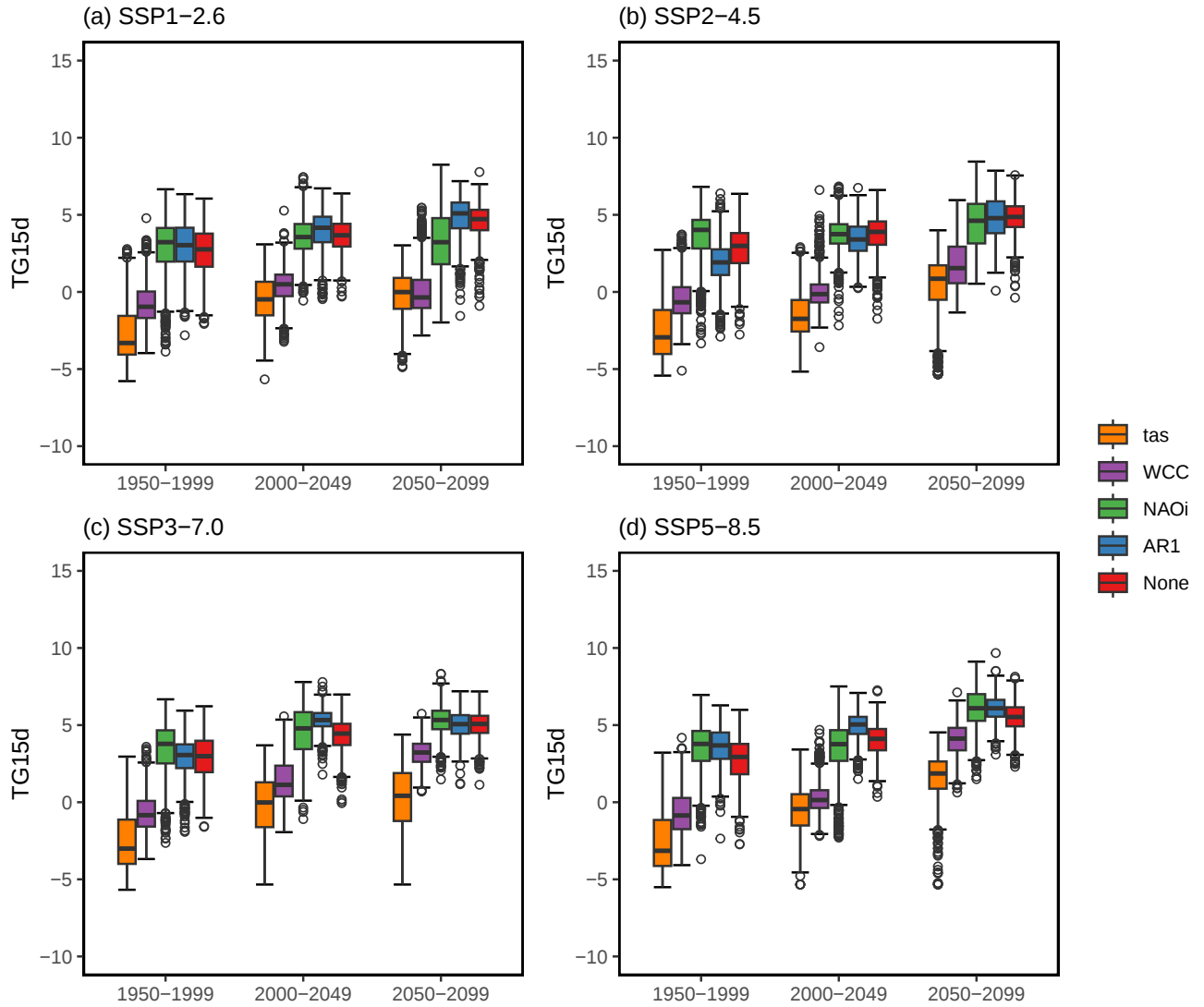


Fig. S30. Temperature (TG15d) distribution of 1000 SWG simulations for four SSPs (a-d) and three climate periods (left to right) depending on the variable used for importance sampling (colours) in NorESM2-LM. Temperatures are adjusted by the median DJF temperature bias. Boxplots are as defined in Fig. S21.