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Supplement of

Drivers of reduced permafrost cooling efficacy of equatorial stratospheric aerosol injection in the Eastern Arctic compared to a moderate emission pathway

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Introduction

We use simulations from the G6sulfur and G6solar experiments from GeoMIP6, based on output from six coupled Earth System Models. Multi-model means are analyzed, and further details on data processing and analysis can be found in the Data and Methods section of the main text. No known imperfections or anomalies are identified in the datasets.

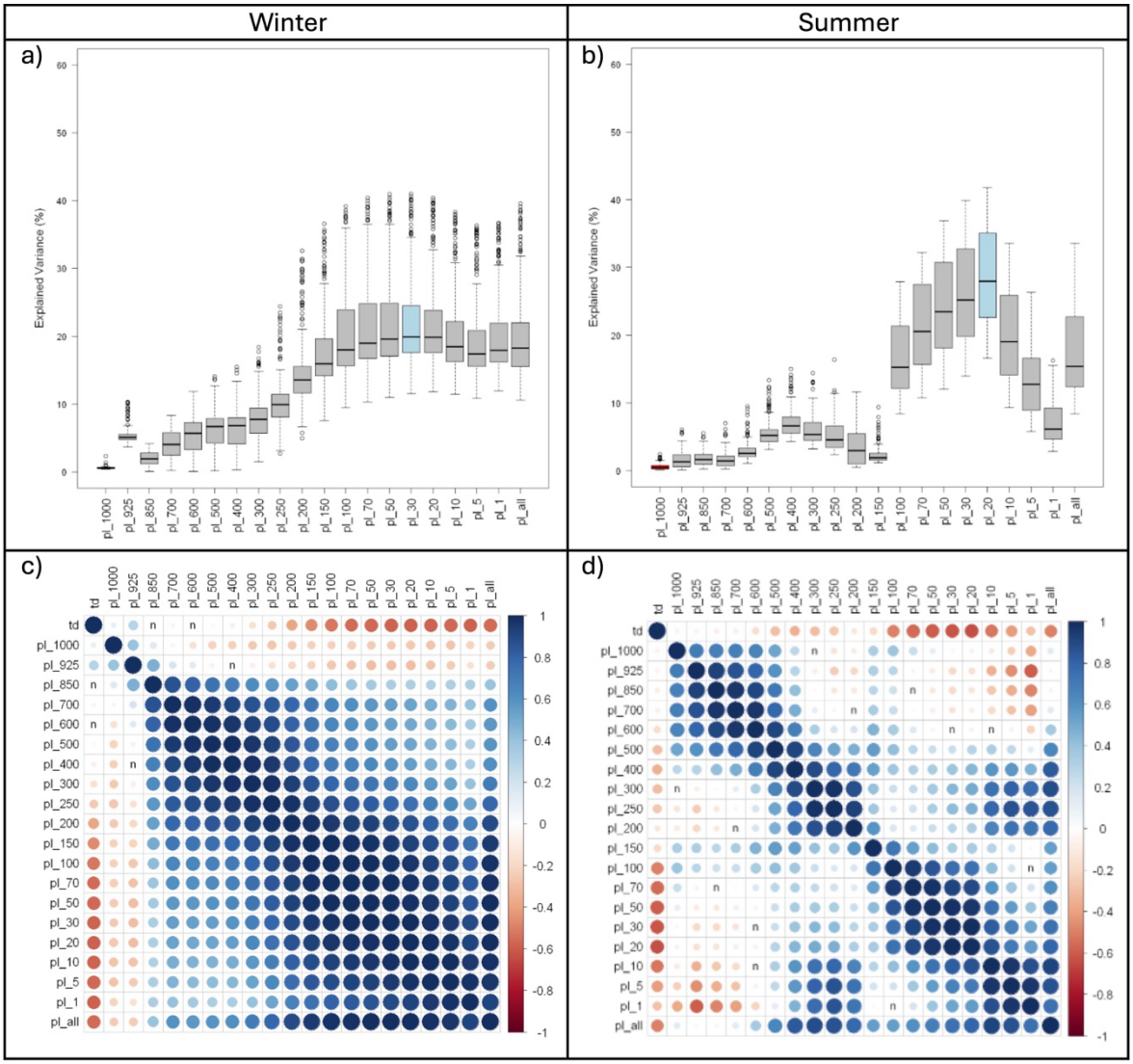


Figure S1. Eastward wind in the Eastern Hemisphere. Top row: explained variance (%) for summer permafrost thaw depth (td) by eastward wind, per hPa level over the Eastern Hemisphere. Blue and red are highest, respectively, lowest explained variance. **(a)** Winter (DJF). **(b)** Summer (JJA). Bottom row: correlation of eastward wind on different pressure levels (hPa) with summer permafrost thaw depth (td) over the Eastern Hemisphere. Direction of the correlation: blue is positive, red is negative. Strength of the correlation is represented by the size of the circle. 'n' in boxes stands for non-significant. **(c)** Winter (DJF). **(d)** Summer (JJA).

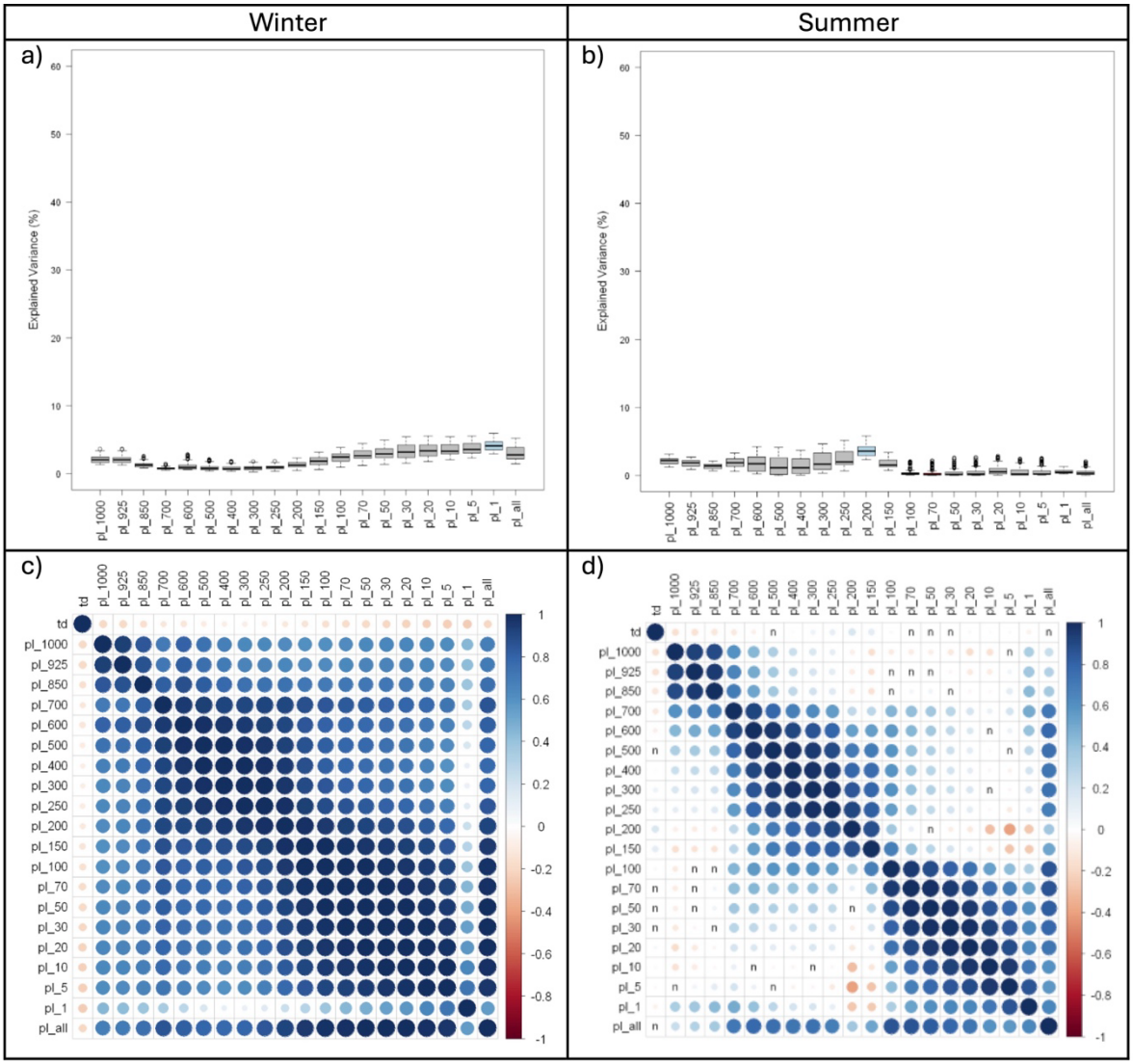


Figure S2. Eastward wind in the Western Hemisphere. Top row: explained variance (%) for summer permafrost thaw depth (td) by eastward wind, per hPa level over the Western Hemisphere. Blue and red are highest, respectively, lowest explained variance. **(a)** Winter (DJF). **(b)** Summer (JJA). Bottom row: correlation of eastward wind on different pressure levels (hPa) with summer permafrost thaw depth (td) over the Western Hemisphere. Direction of the correlation: blue is positive, red is negative. Strength of the correlation is represented by the size of the circle. 'n' in boxes stands for non-significant. **(c)** Winter (DJF). **(d)** Summer (JJA).

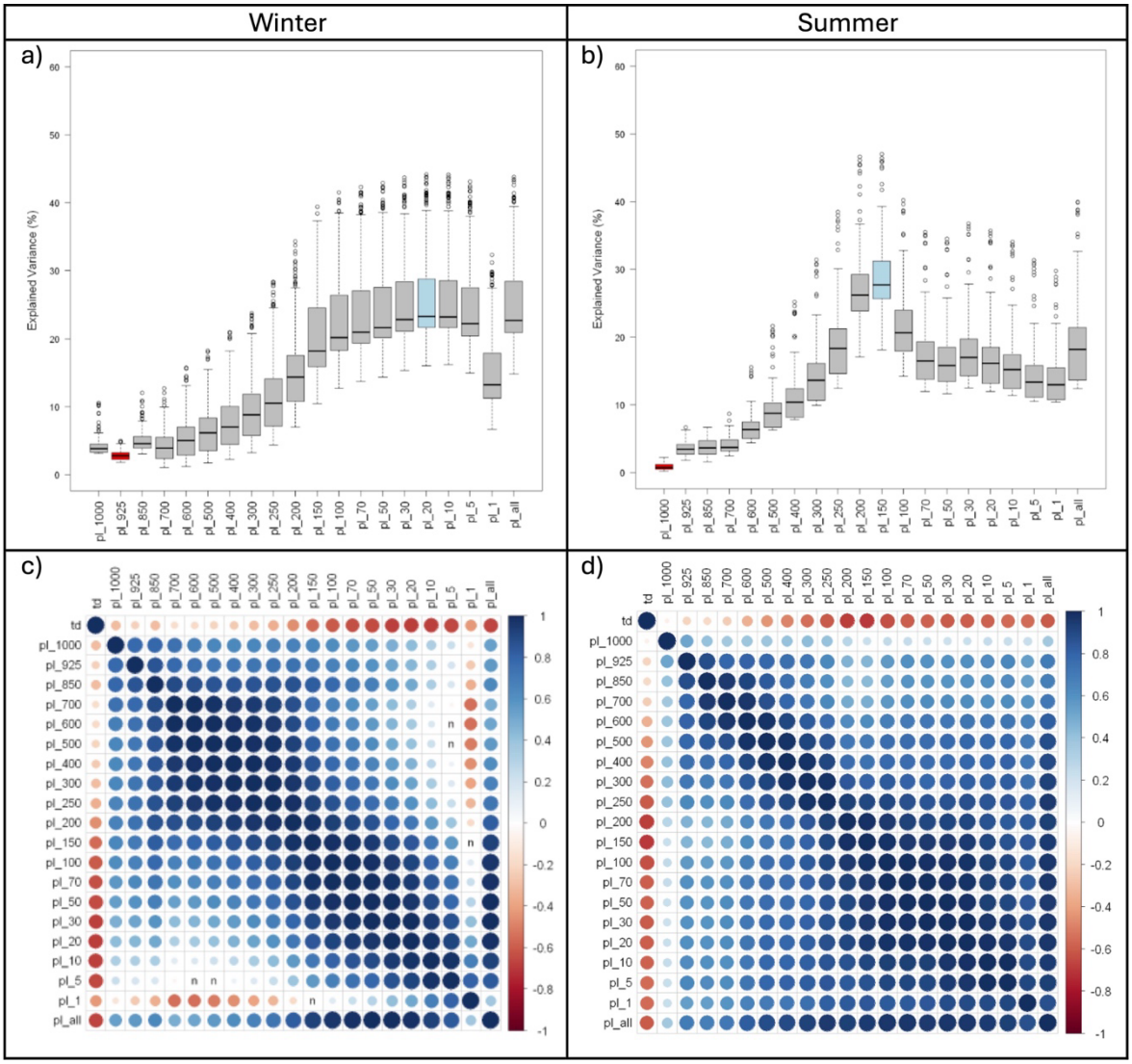
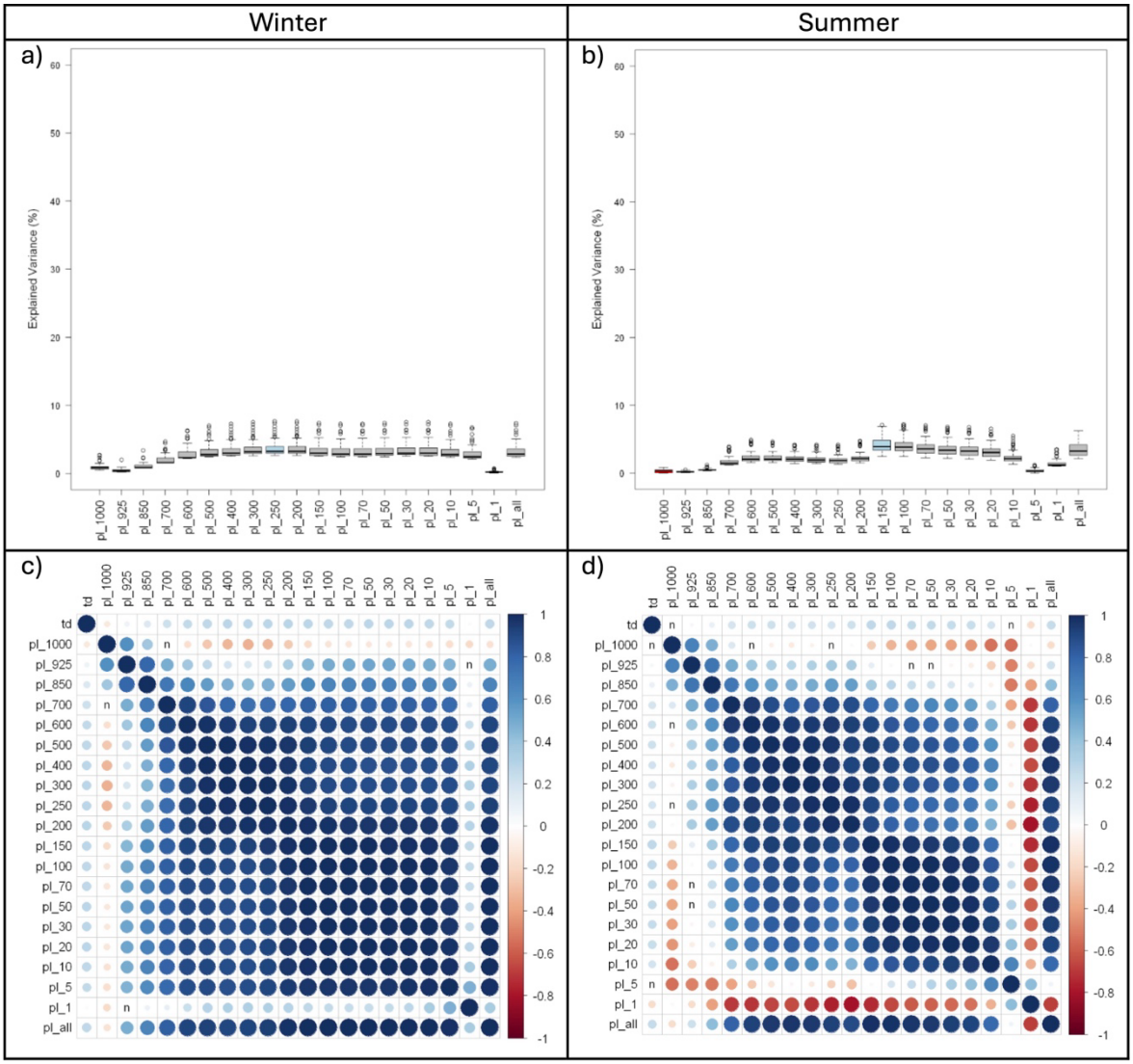


Figure S3. Northward wind in the Eastern Hemisphere. Top row: explained variance (%) for summer permafrost thaw depth (td) by northward wind, per hPa level over the Eastern Hemisphere. Blue and red are highest, respectively, lowest explained variance. **(a)** Winter (DJF). **(b)** Summer (JJA). Bottom row: correlation of northward wind on different pressure levels (hPa) with summer permafrost thaw depth (td) over the Eastern Hemisphere. Direction of the correlation: blue is positive, red is negative. Strength of the correlation is represented by the size of the circle. 'n' in boxes stands for non-significant. **(c)** Winter (DJF). **(d)** Summer (JJA).



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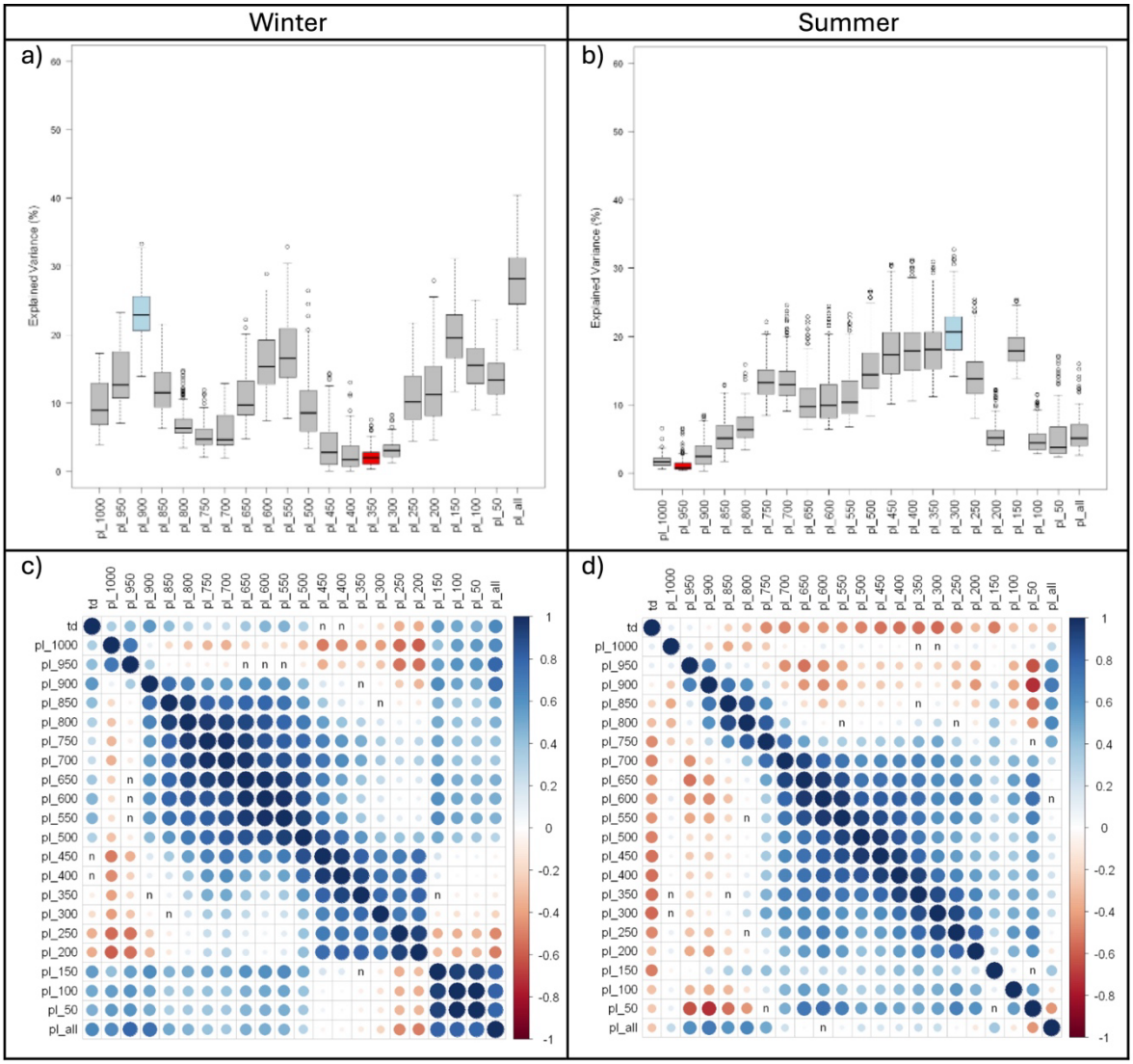
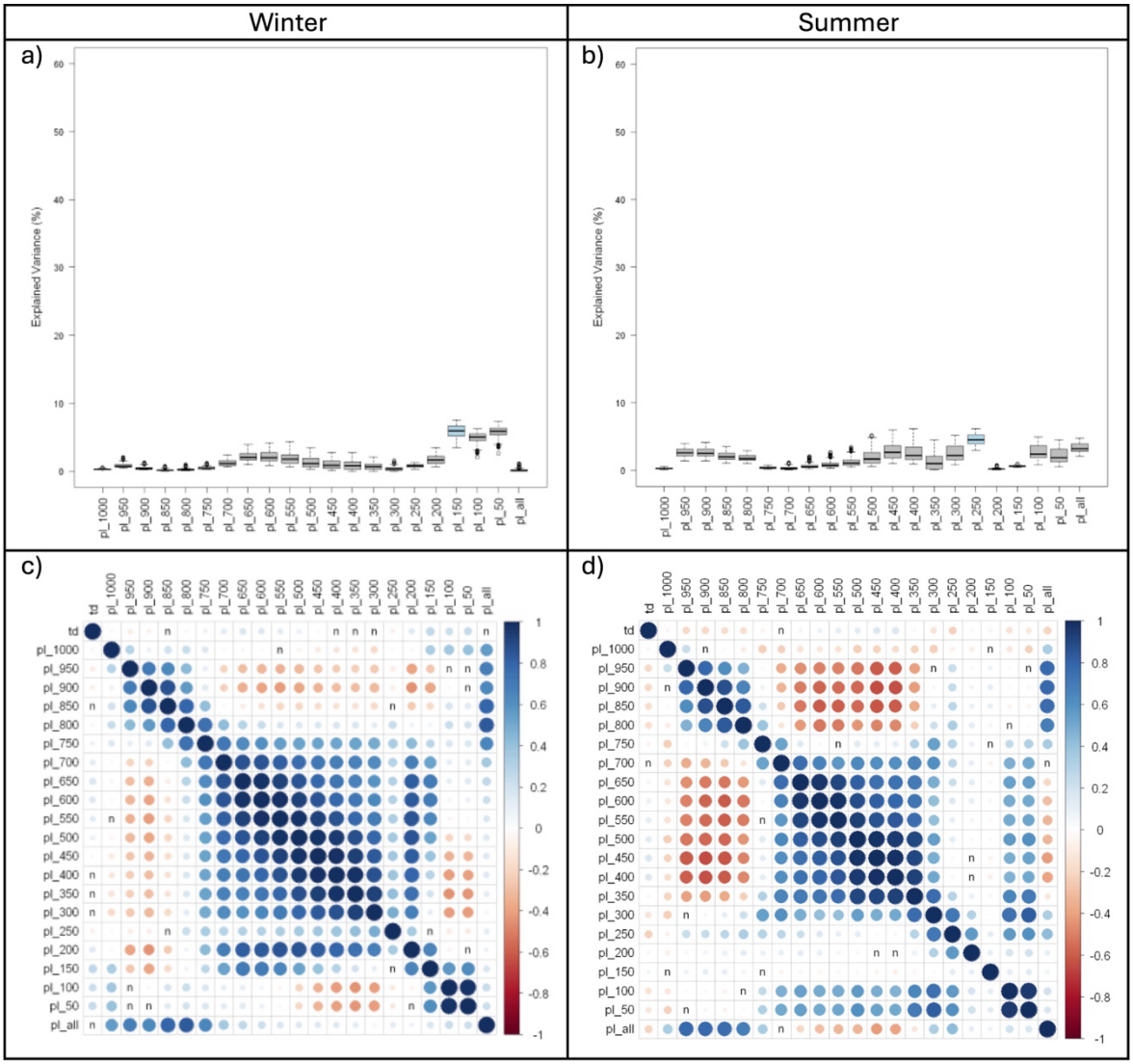


Figure S5. Mass fraction of cloud liquid water in the Eastern Hemisphere. Top row: explained variance (%) for summer permafrost thaw depth (td) by mass fraction of cloud liquid water, per hPa level over the Eastern Hemisphere. Blue and red are highest, respectively, lowest explained variance. **(a)** Winter (DJF). **(b)** Summer (JJA). Bottom row: correlation of mass fraction of cloud liquid water on different pressure levels (hPa) with summer permafrost thaw depth (td) over the Eastern Hemisphere. Direction of the correlation: blue is positive, red is negative. Strength of the correlation is represented by the size of the circle. 'n' in boxes stands for non-significant. **(c)** Winter (DJF). **(d)** Summer (JJA).



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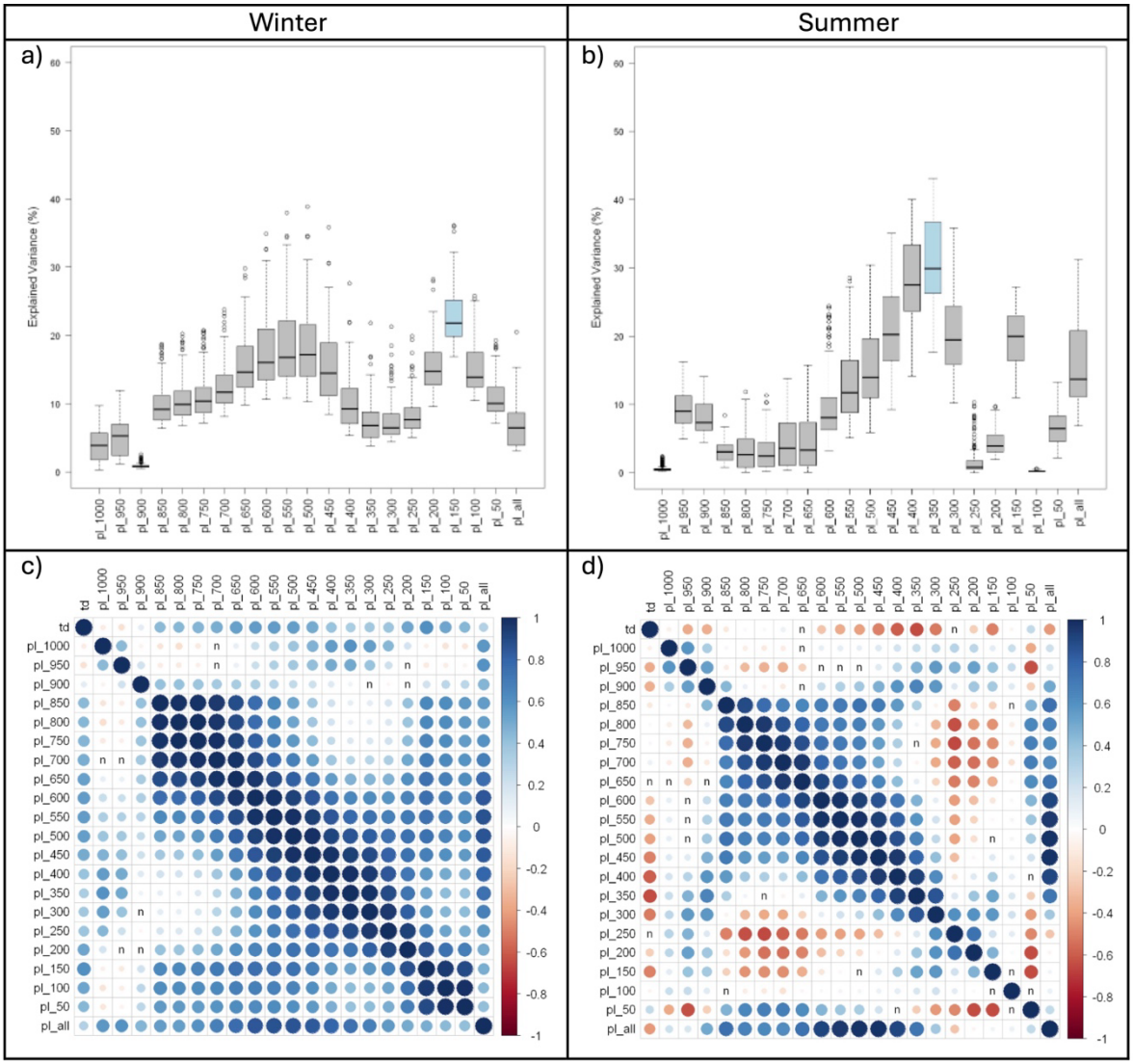

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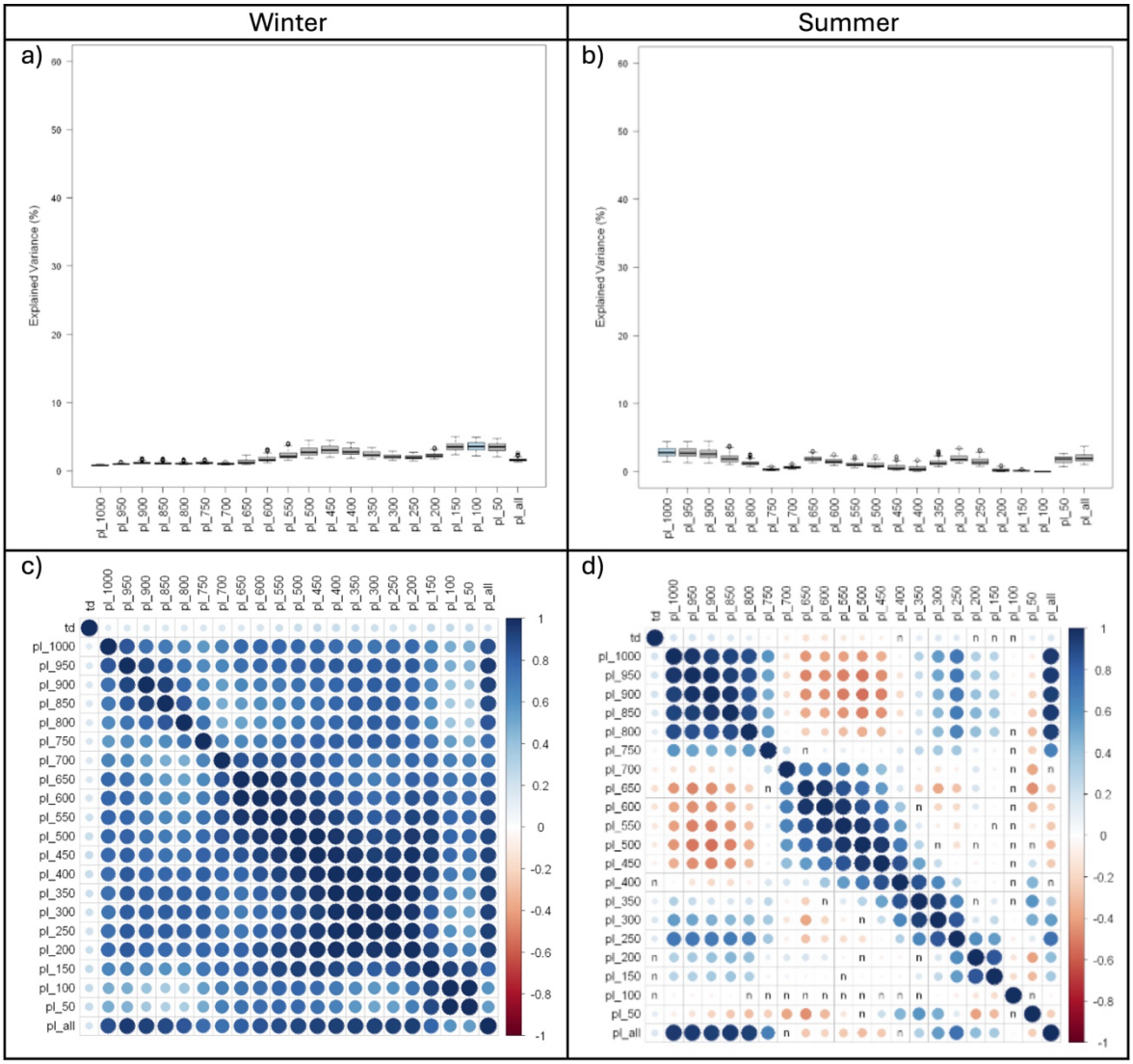

Figure S8. Mass fraction of cloud ice in the Western Hemisphere. Top row: explained variance (%) for summer permafrost thaw depth (td) by mass fraction of cloud ice, per hPa level over the Western Hemisphere. Blue and red are highest, respectively, lowest explained variance. **(a)** Winter (DJF). **(b)** Summer (JJA). Bottom row: correlation of mass fraction of cloud ice on different pressure levels (hPa) with summer permafrost thaw depth (td) over the Western Hemisphere. Direction of the correlation: blue is positive, red is negative. Strength of the correlation is represented by the size of the circle. 'n' in boxes stands for non-significant. **(c)** Winter (DJF). **(d)** Summer (JJA).

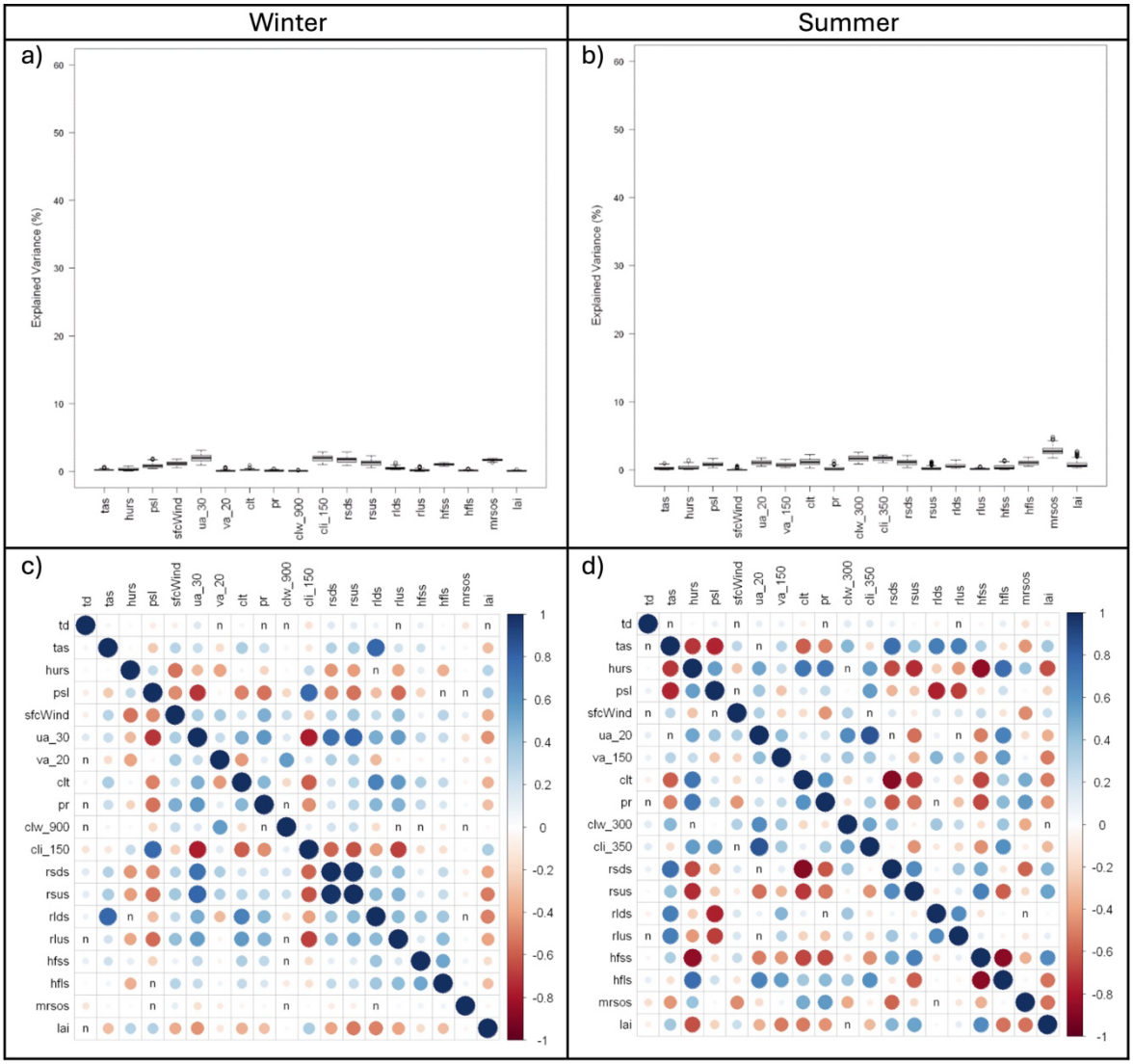

Figure S9. Explained variance and correlation for summer permafrost thaw depth in the Eastern Hemisphere, G6solar-ssp245 difference. Top row: explained variance (%) for summer permafrost thaw depth (td), per predictor and season over the Eastern Hemisphere for the G6solar-ssp245 difference. Predictors are: tas (near-surface air temperature), hurs (near-surface relative humidity), psl (sea level pressure), sfcWind (near-surface wind speed), ua (eastward wind at indicated hPa level), va (northward wind at indicated hPa level), clt (total cloud cover percentage), pr (precipitation), clw (mass fraction of cloud liquid water at indicated hPa level), cli (mass fraction of cloud ice at indicated hPa level), rsds (surface downwelling shortwave radiation), rsus (surface upwelling shortwave radiation), rlds (surface downwelling longwave radiation), rlus (surface upwelling longwave radiation), hfss (surface upward sensible heat flux), hfls (surface upward latent heat flux), mrsos (moisture in upper portion of soil column), lai (leaf area index). **(a)** Winter (DJF). **(b)** Summer (JJA). Bottom row: correlation matrix of the drivers per season. Direction of the correlation: blue is positive, red is negative. Strength of the correlation is represented by the size of the circle. 'n' in boxes stands for non-significant. **(c)** Winter (DJF). **(d)** Summer (JJA).

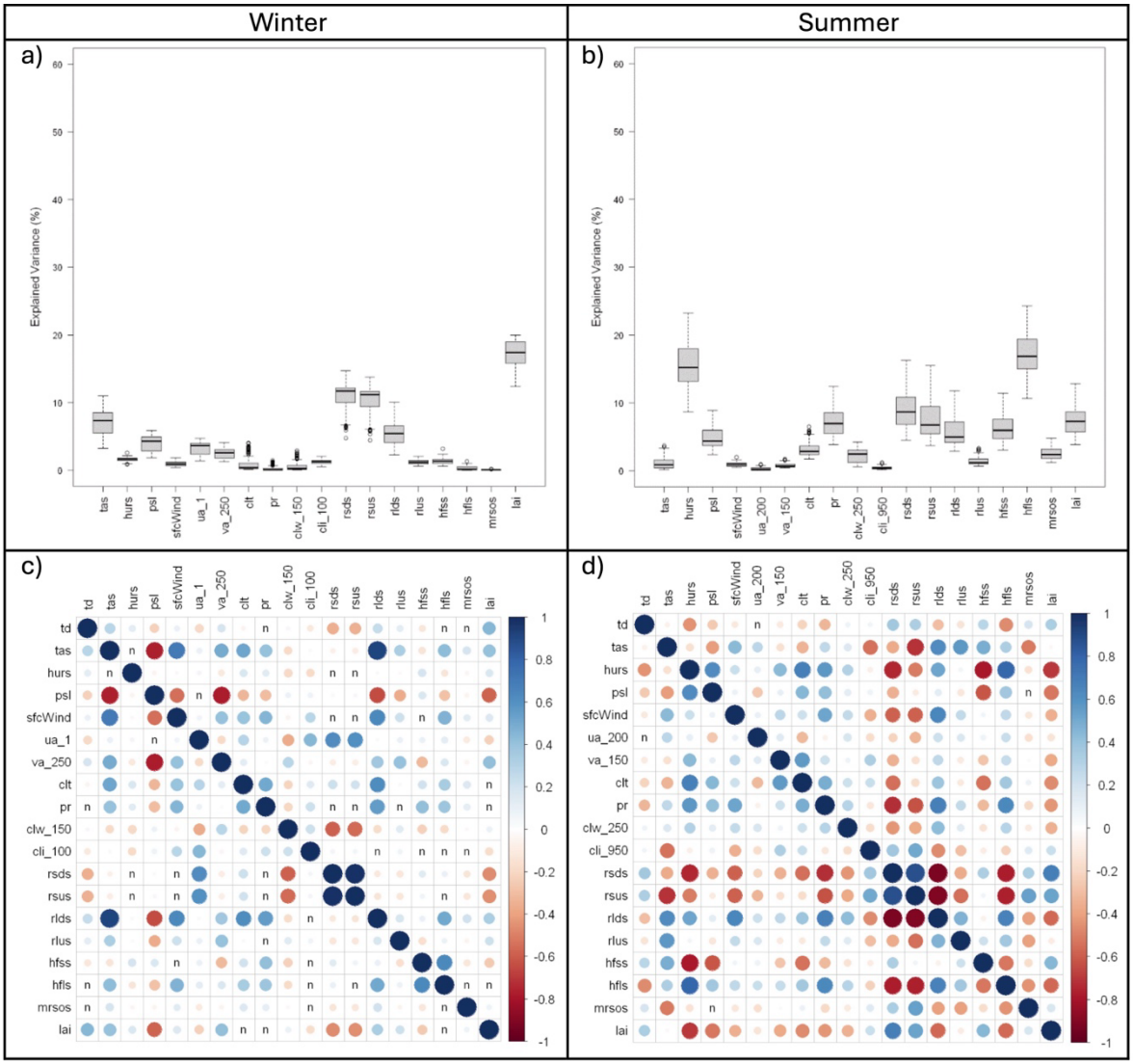

Figure S10. Explained variance and correlation for summer permafrost thaw depth in the Western Hemisphere, G6solar-ssp245 difference. Top row: explained variance (%) for summer permafrost thaw depth (td), per predictor and season over the Western Hemisphere for the G6solar-ssp245 difference. Predictors are: tas (near-surface air temperature), hurs (near-surface relative humidity), psl (sea level pressure), sfcWind (near-surface wind speed), ua (eastward wind at indicated hPa level), va (northward wind at indicated hPa level), clt (total cloud cover percentage), pr (precipitation), clw (mass fraction of cloud liquid water at indicated hPa level), cli (mass fraction of cloud ice at indicated hPa level), rsds (surface downwelling shortwave radiation), rsus (surface upwelling shortwave radiation), rlds (surface downwelling longwave radiation), rlus (surface upwelling longwave radiation), hfss (surface upward sensible heat flux), hfls (surface upward latent heat flux), mrsos (moisture in upper portion of soil column), lai (leaf area index). **(a)** Winter (DJF). **(b)** Summer (JJA). Bottom row: correlation matrix of the drivers per season. Direction of the correlation: blue is positive, red is negative. Strength of the correlation is represented by the size of the circle. 'n' in boxes stands for non-significant. **(c)** Winter (DJF). **(d)** Summer (JJA).

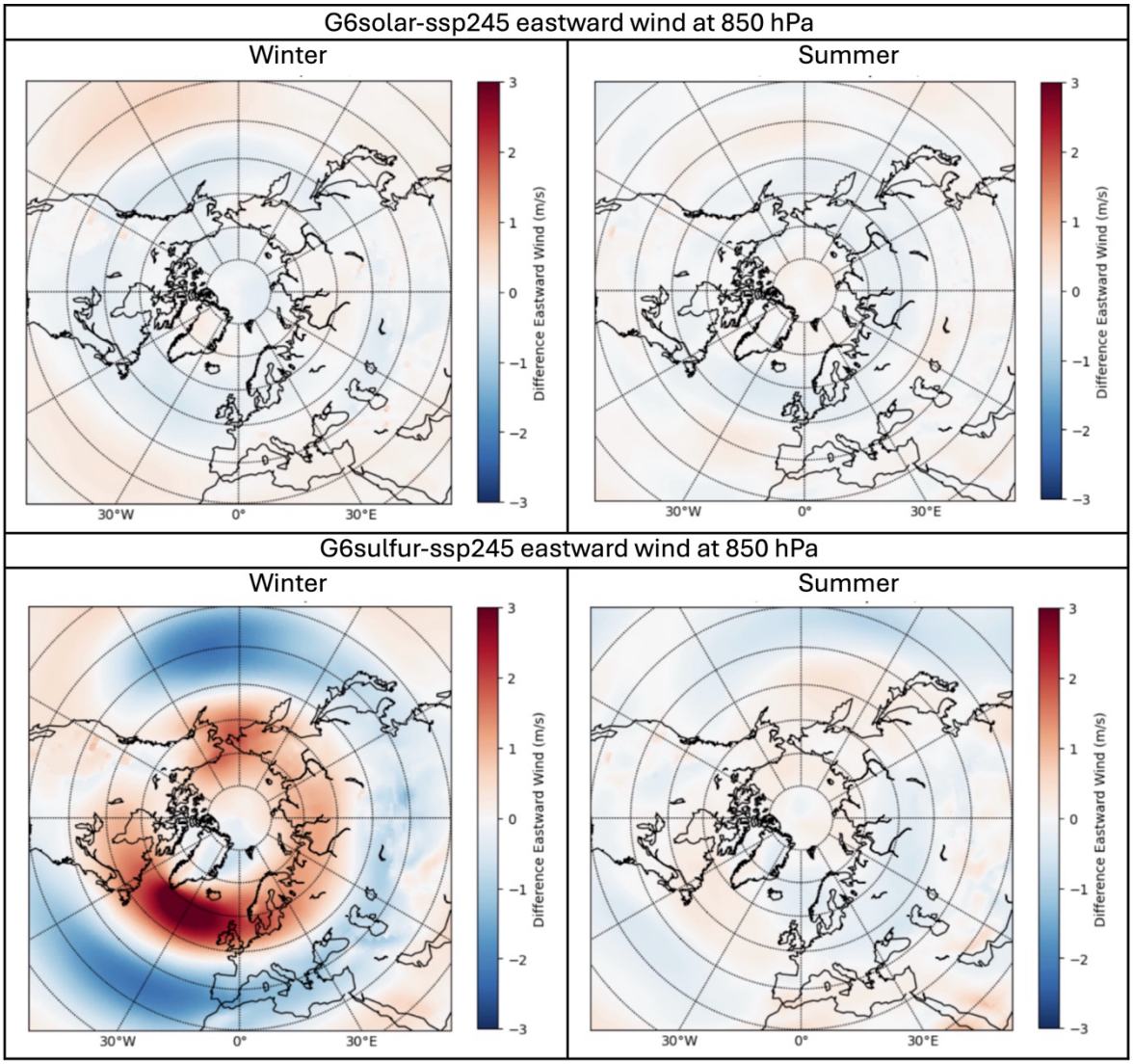

Figure S11. Zonal wind in the troposphere. Difference in eastward wind (m/s) at the 850 hPa level. Winter (DJF) and summer (JJA). Top row: G6solar-ssp245. Bottom row: G6sulfur-ssp245.

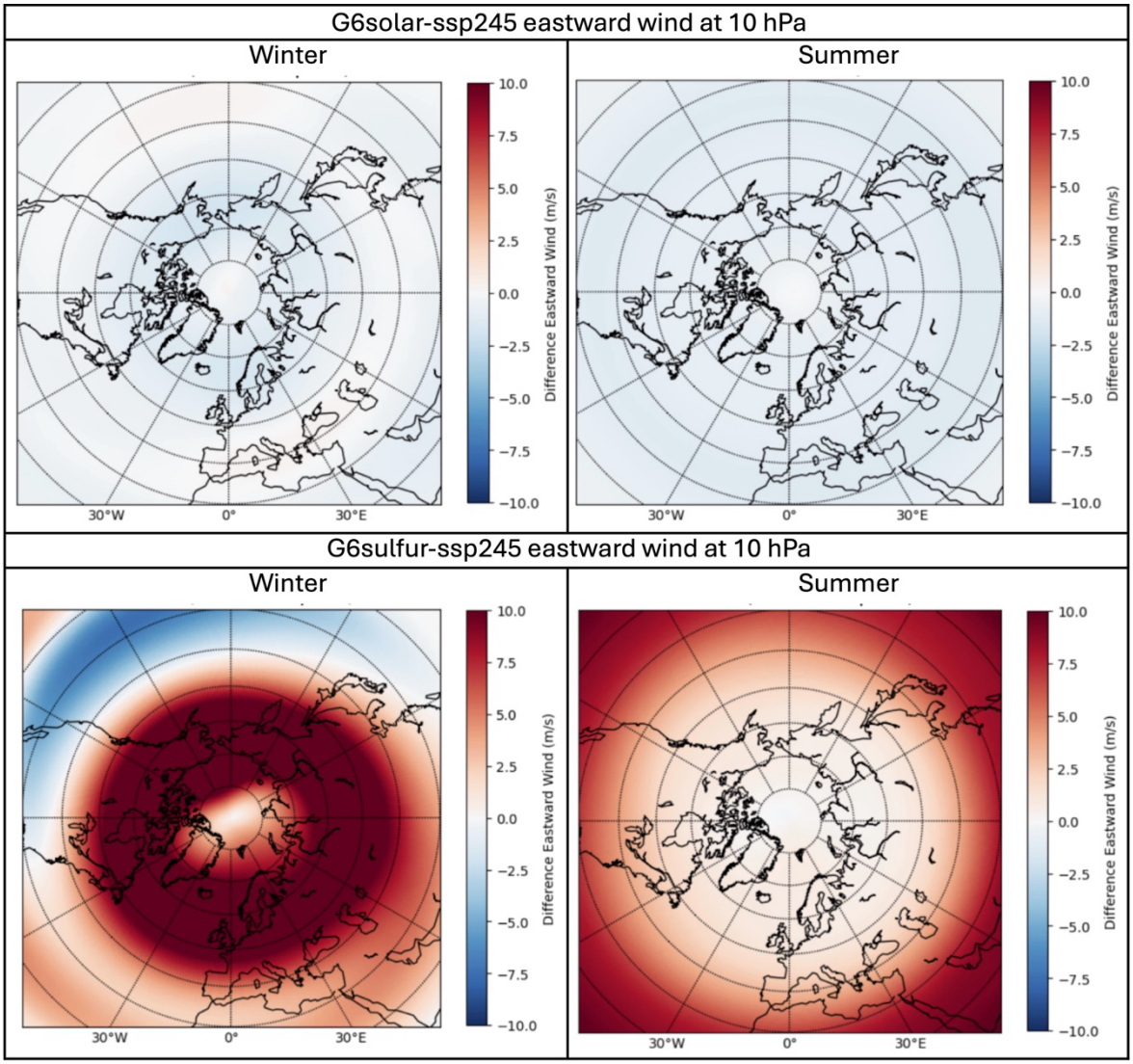

Figure S12. Zonal wind in the stratosphere. Difference in eastward wind (m/s) at the 10 hPa level. Winter (DJF) and summer (JJA). Top row: G6solar-ssp245. Bottom row: G6sulfur-ssp245.

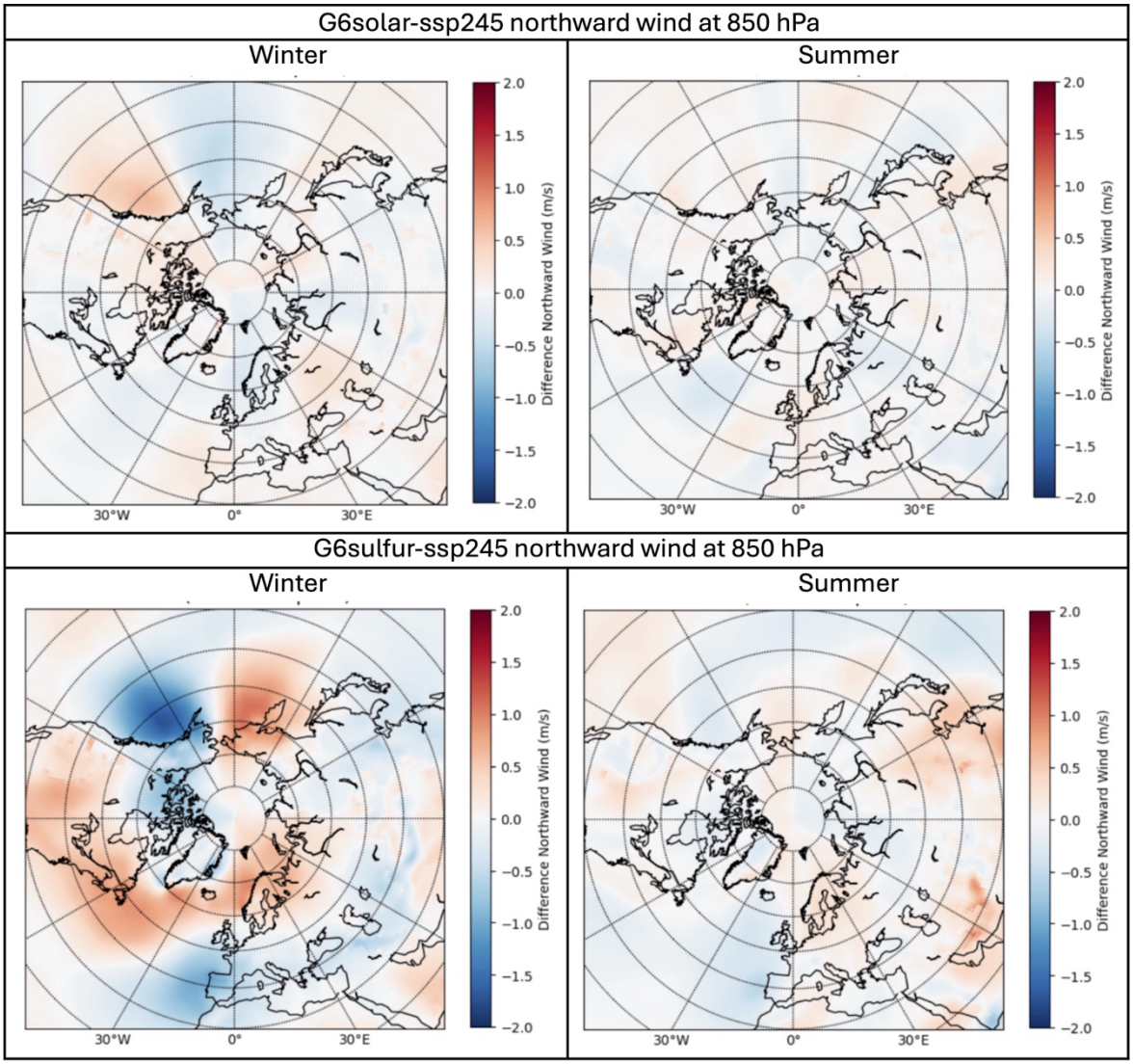

Figure S13. Meridional wind in the troposphere. Difference in northward wind (m/s) at the 850 hPa level. Winter (DJF) and summer (JJA). Top row: G6solar-ssp245. Bottom row: G6sulfur-ssp245.

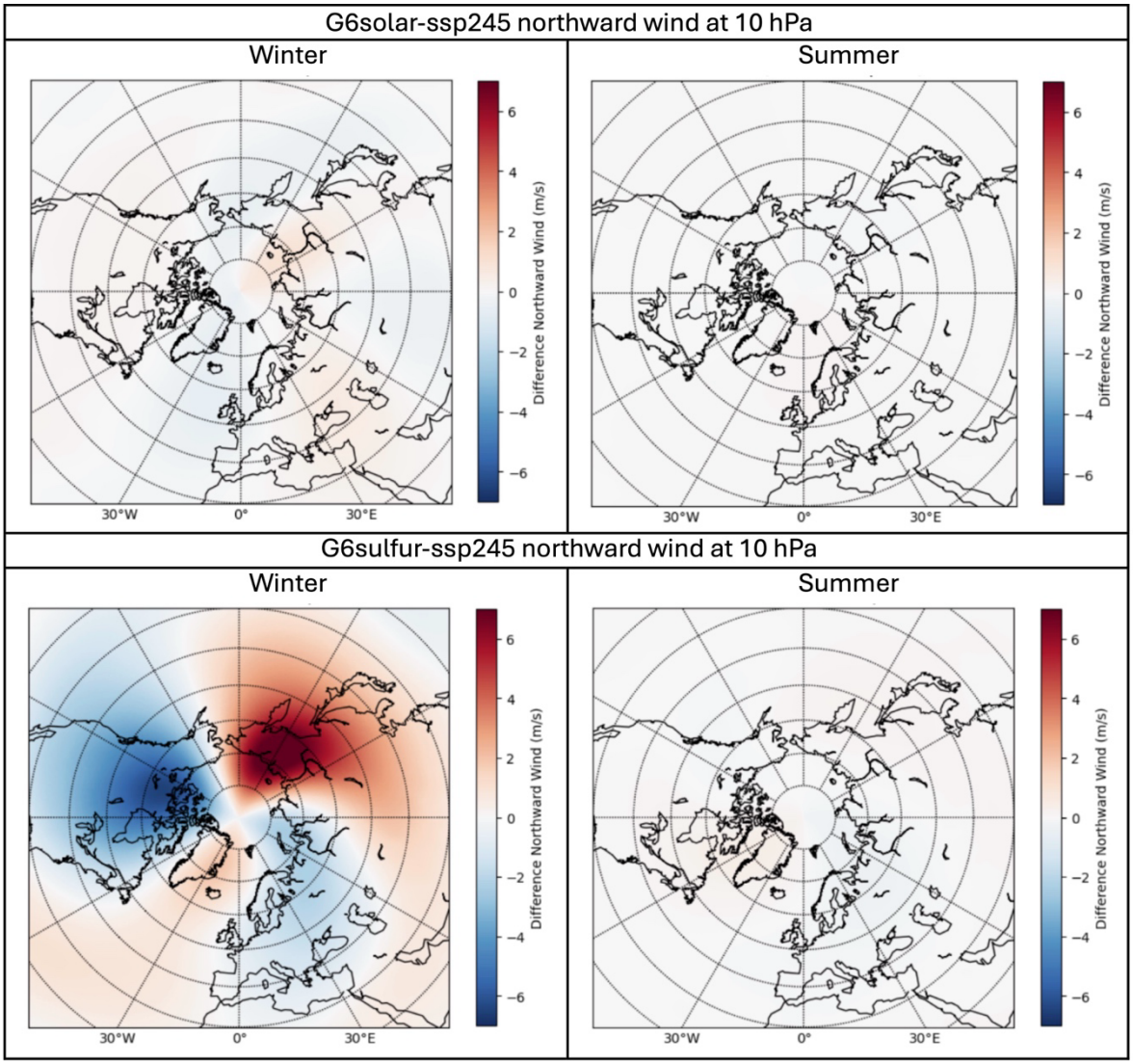

Figure S14. Meridional wind in the stratosphere. Difference in northward wind (m/s) at the 10 hPa level. Winter (DJF) and summer (JJA). Top row: G6solar-ssp245. Bottom row: G6sulfur-ssp245.