



*Supplement of*

## **Warming effects of reduced sulfur emissions from shipping**

**Masaru Yoshioka et al.**

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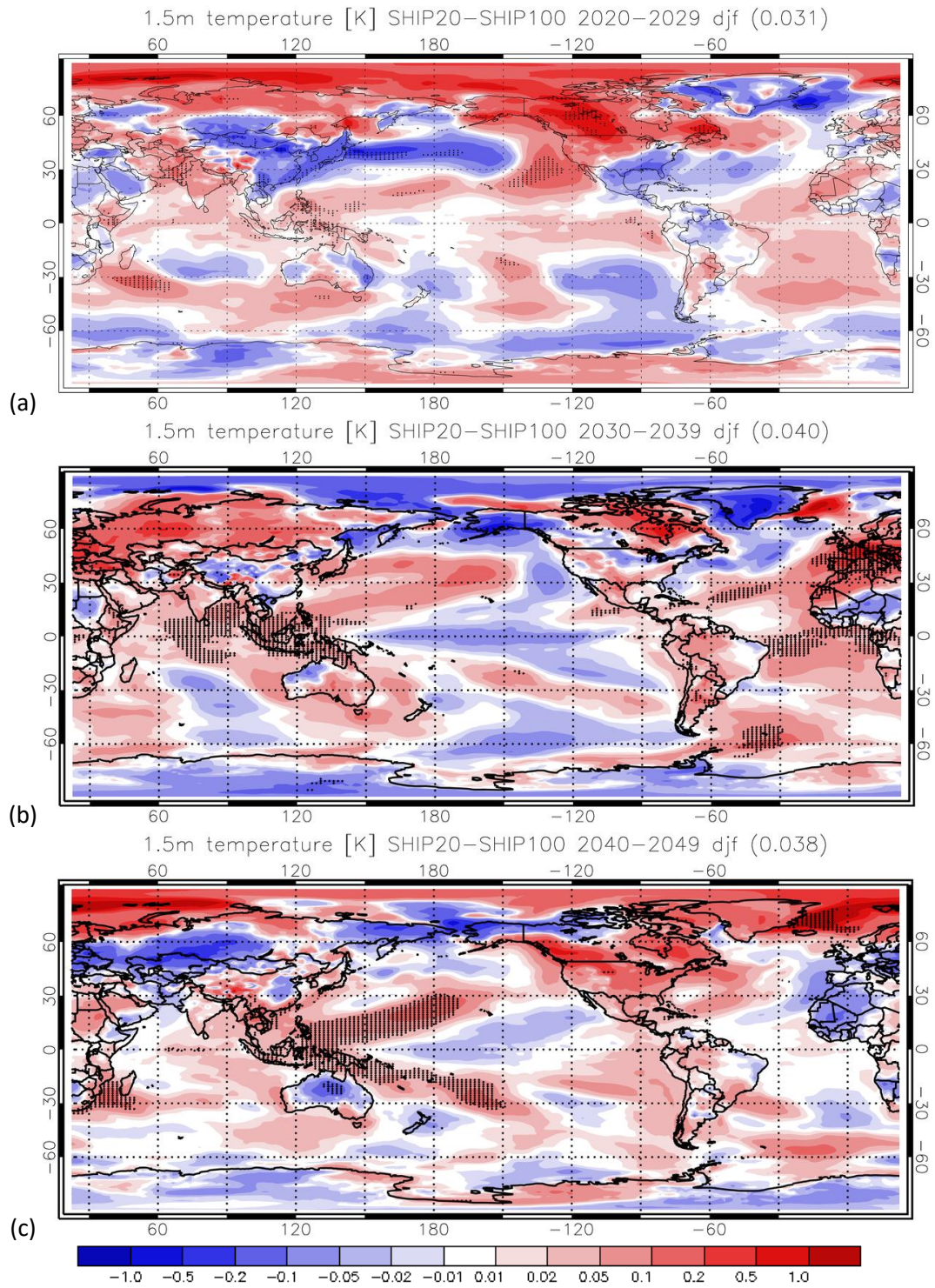


Figure S1. Same as Figure 4 but for DJF.

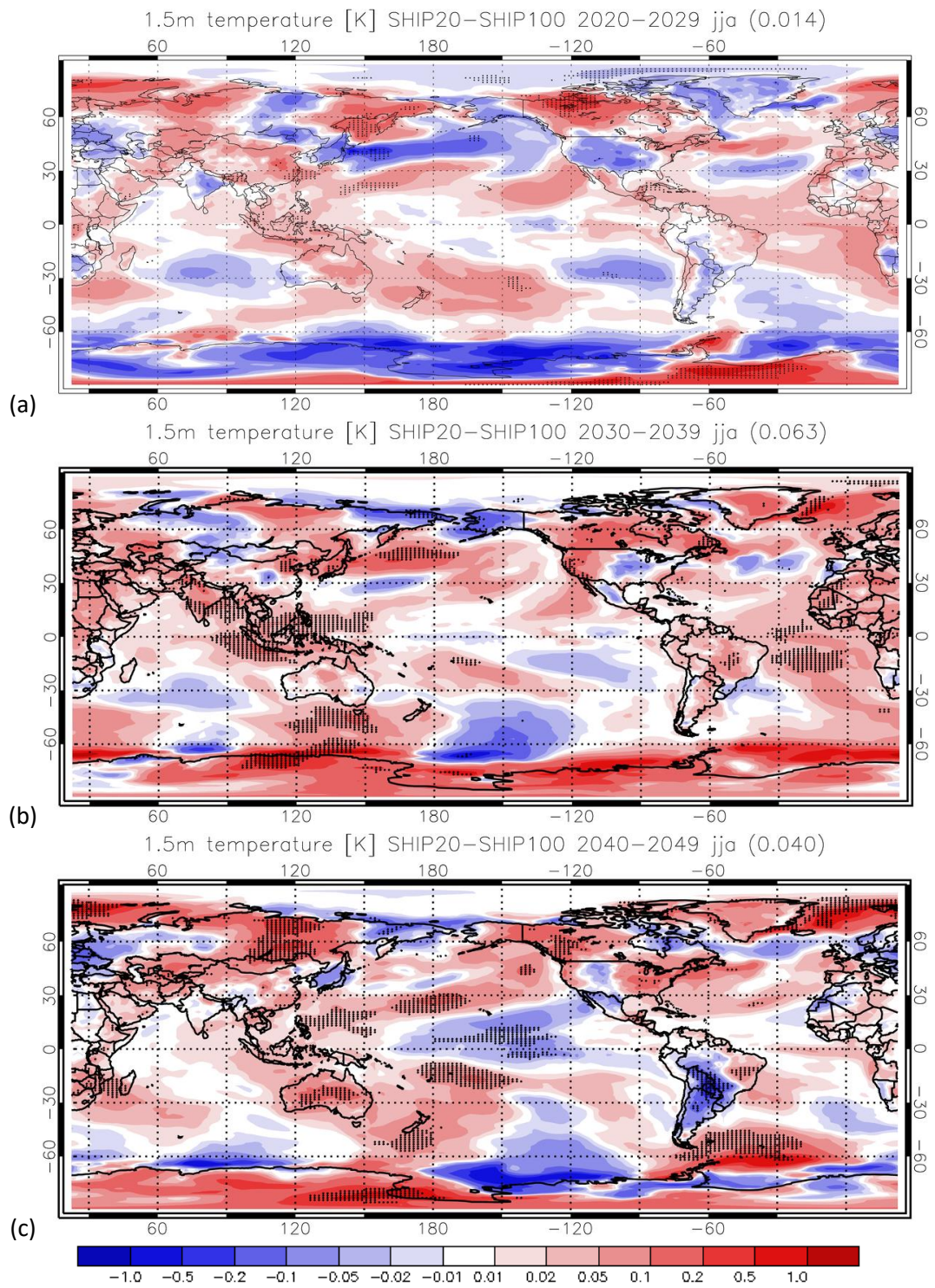
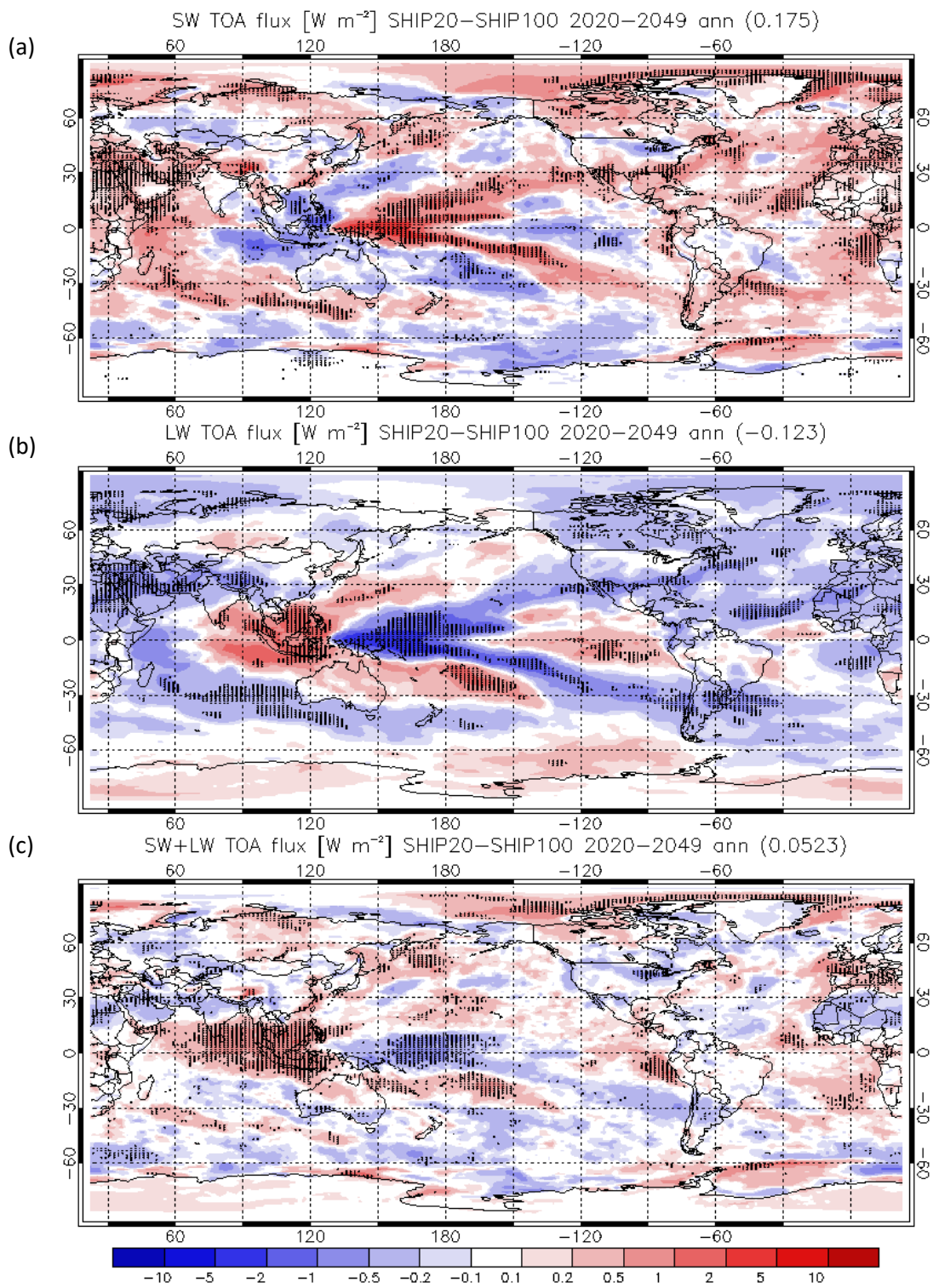
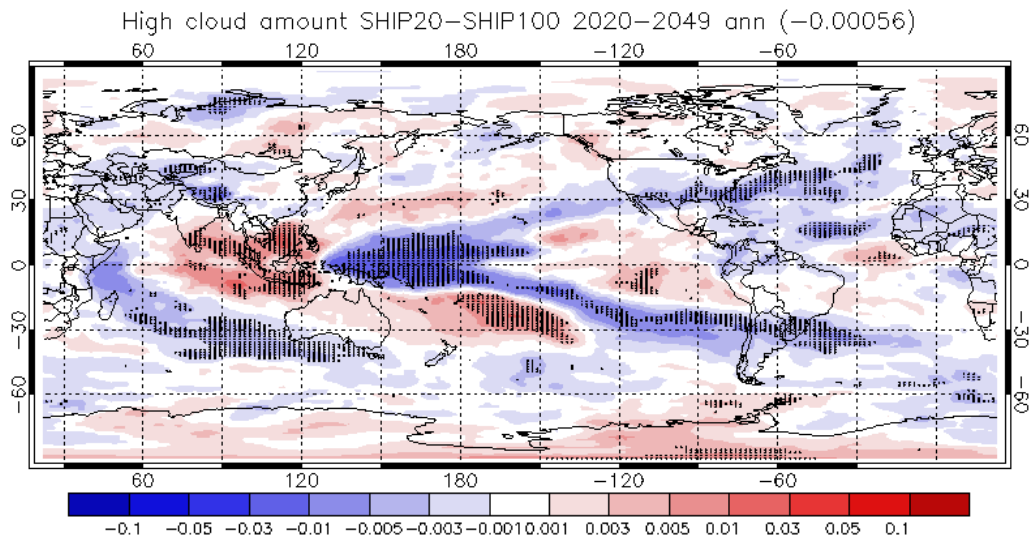


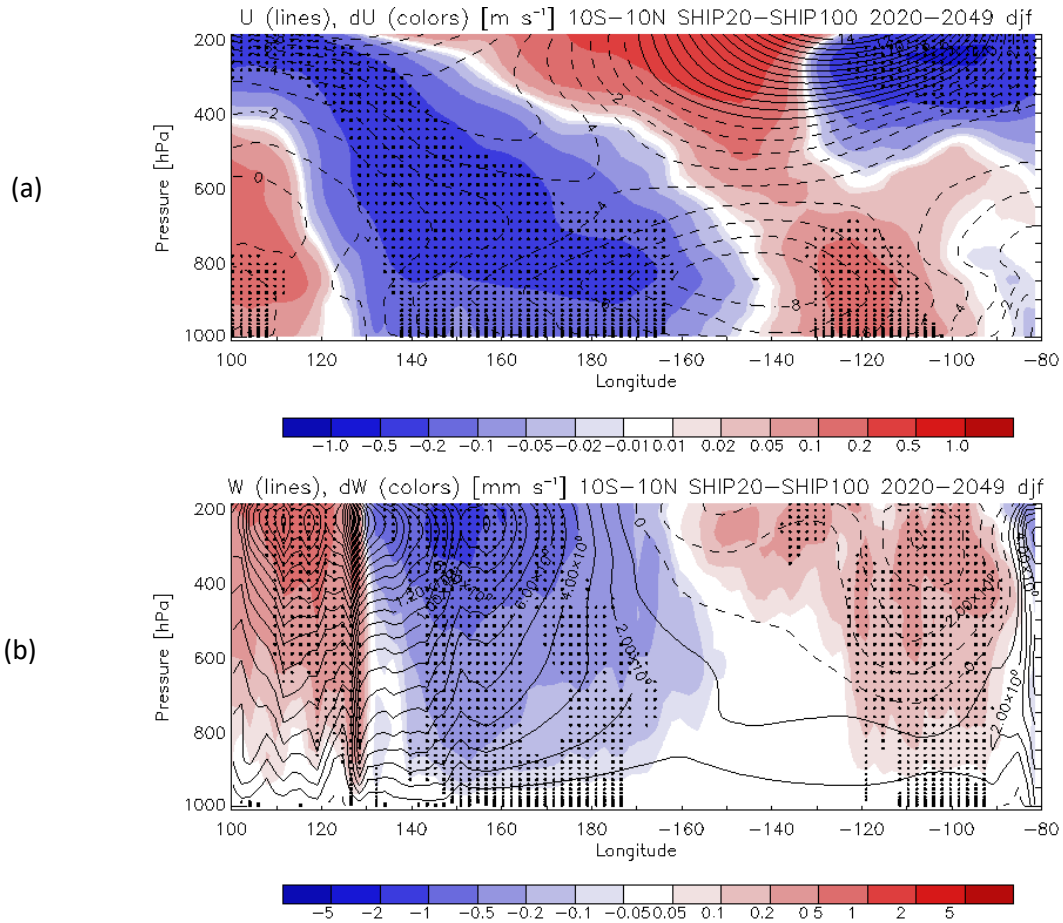
Figure S2. Same as Figure 4 but for JJA.



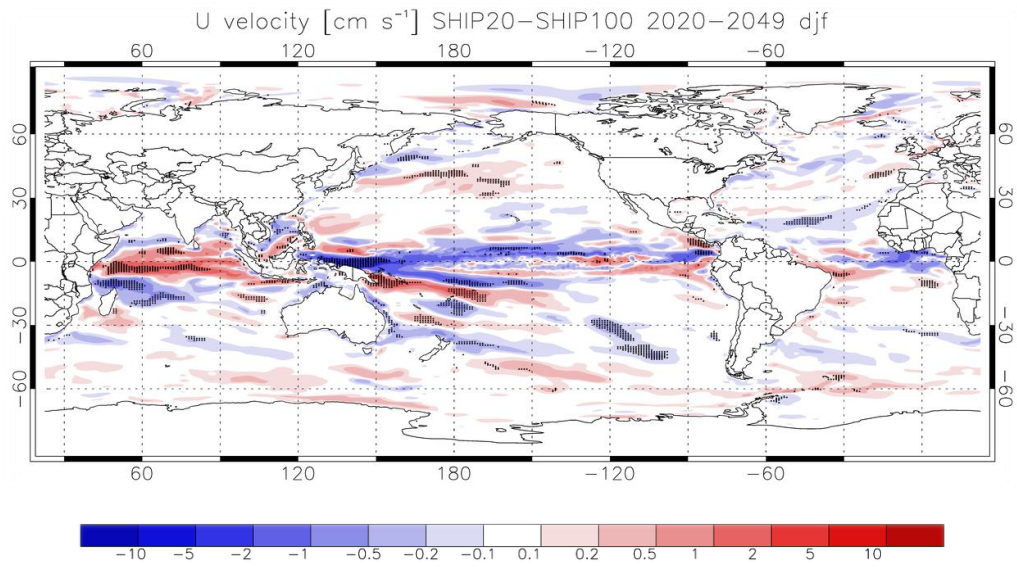
**Figure S3.** Difference (SHIP20-SHIP100) in ensemble mean (a) SW, (b) LW, and (c) net radiative fluxes ( $\text{W m}^{-2}$ ) at the top of the atmosphere. Respectively, blue and red colours indicate cooling and warming effects induced by the reduction of shipping sulfur emission.



**Figure S4.** Difference (SHIP20-SHIP100) in ensemble annual means of high-level cloud fractions. High-level clouds indicate clouds in the levels approximately 5600-13600m.



**Figure S5.** Ensemble mean DJF zonal (positive eastward;  $U$ ;  $\text{m s}^{-1}$ ; top panel) and vertical (positive upward;  $W$ ) winds ( $\text{mm s}^{-1}$ ) in SHIP100 (line contours) over the equatorial Pacific (averaged for 10S-10N and shown for 100E-80W and surface-200hPa) and changes in  $U$  ( $\Delta U$ ) and  $W$  ( $\Delta W$ ) from SHIP100 to SHIP20 (colors). Positive (solid lines and red colors) and negative (dashed lines and blue colors) regions for  $U$  (a) show eastward and westward motions, respectively, whereas for  $W$  (b) they show upward and downward motions, respectively. Hatching indicates areas where the differences are statistically significant at a 95% confidence level.



**Figure S6.** Difference (SHIP20-SHIP100) in ensemble means of zonal component of sea surface velocity ( $\text{cm s}^{-1}$ ) in DJF. Blue and red shading indicate westward and eastward anomalies, respectively.

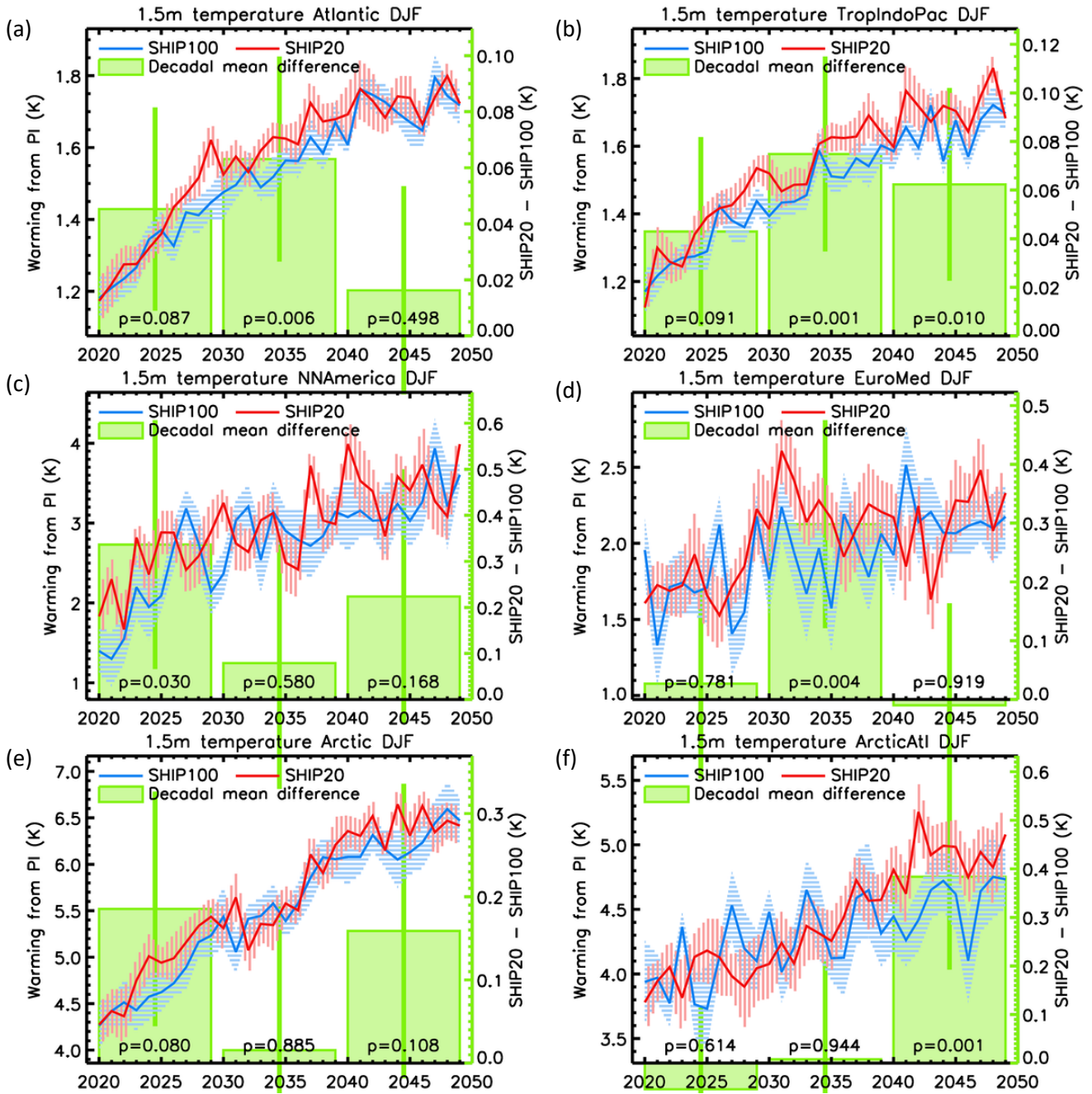


Figure S7. Same as Figure 7 but for DJF averages



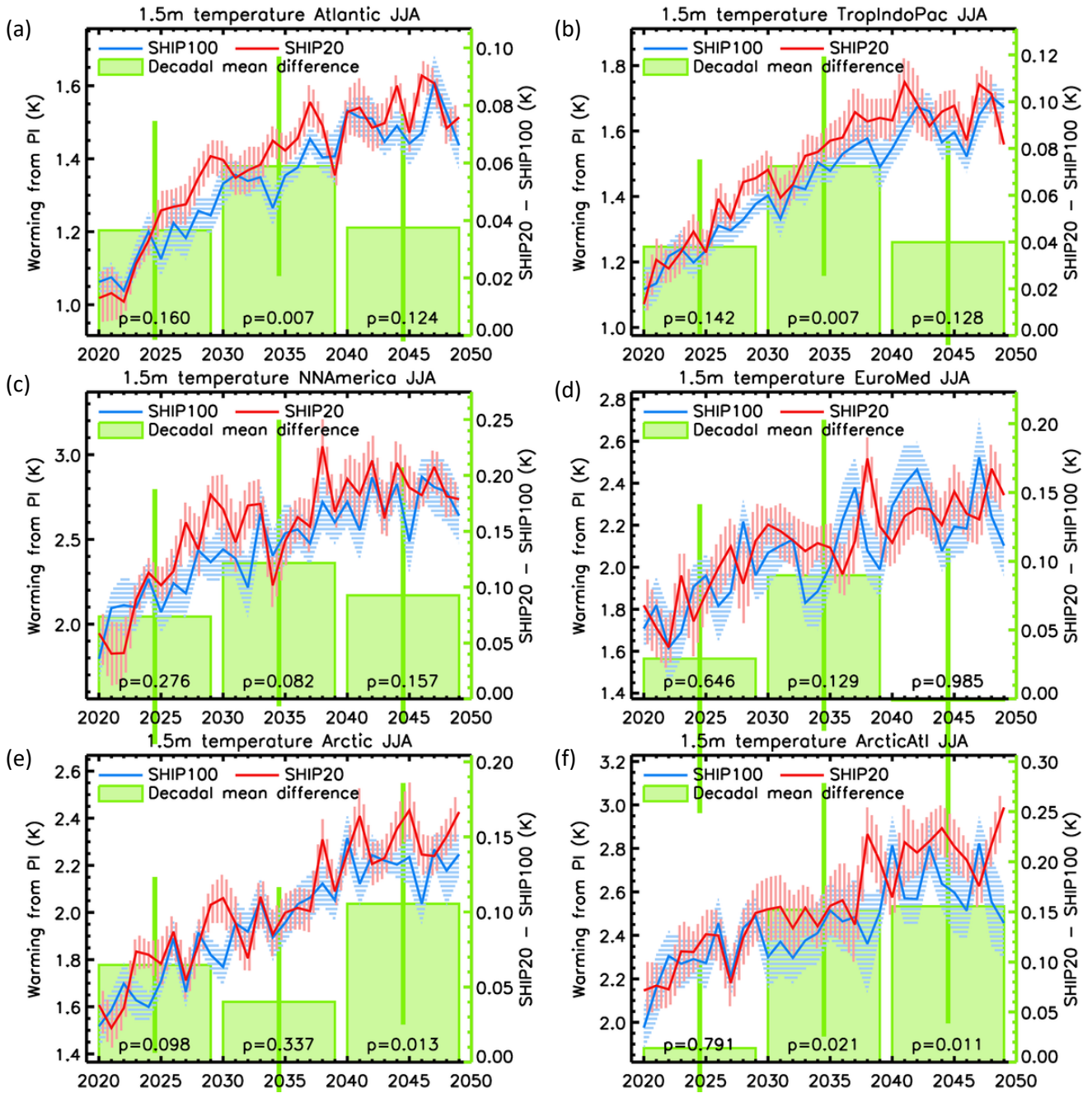


Figure S8. Same as Figure 7 but for JJA averages