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Supplement of

Spatiotemporal methods for estimating subsurface ocean thermal response to tropical cyclones

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In this supplemental document, we present a comprehensive set of figures to illustrate the coefficients and fits from the seasonal mean field, Gaussian process, and thin-plate spline models.

S1 Seasonal mean field fits

Here we present the seasonal mean fields, as well as the raw and adjusted temperature differences, at all depths, for the entire set of profile pairs.
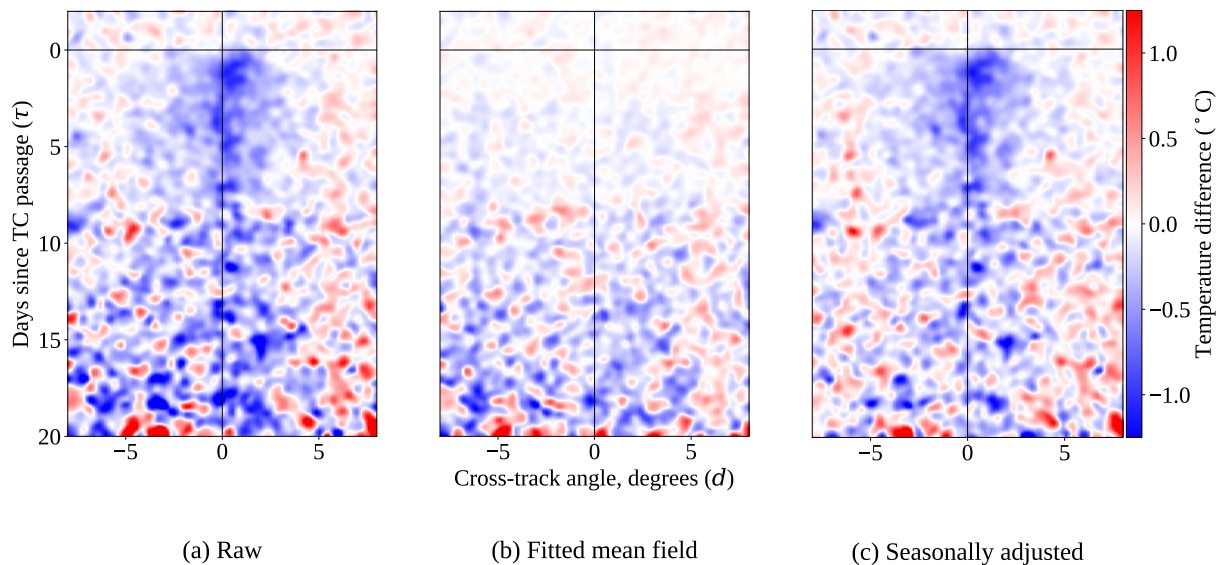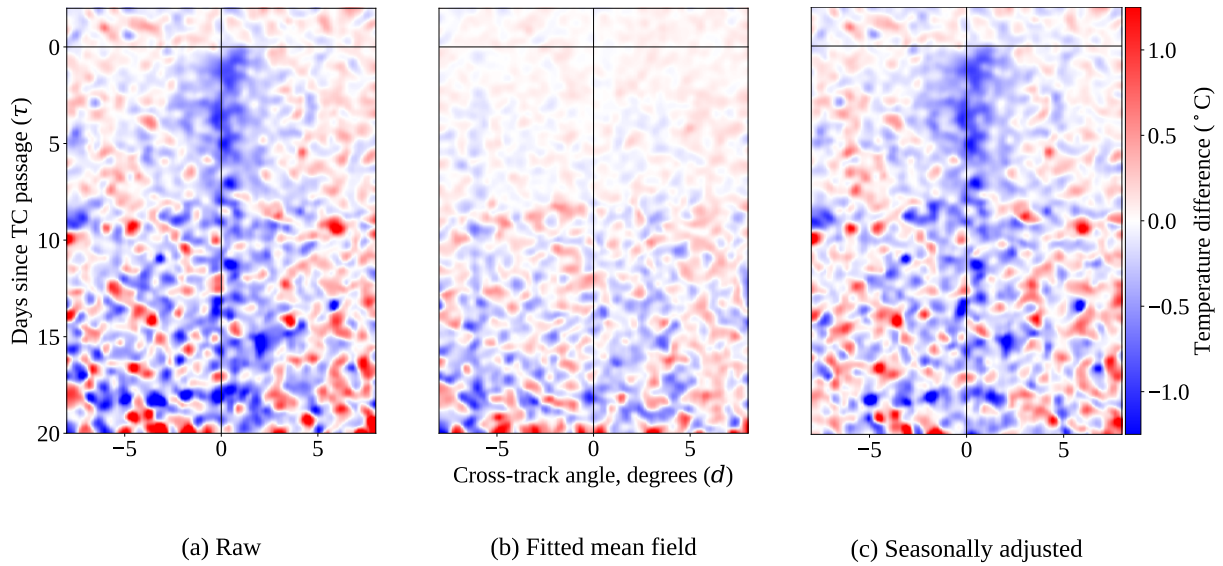

(a) Raw (b) Fitted mean field (c) Seasonally adjusted

Figure S1. Pressure level: 10 dbar

(a) Raw   (b) Fitted mean field   (c) Seasonally adjusted

Figure S2. Pressure level: 20 dbar

(a) Raw   (b) Fitted mean field   (c) Seasonally adjusted
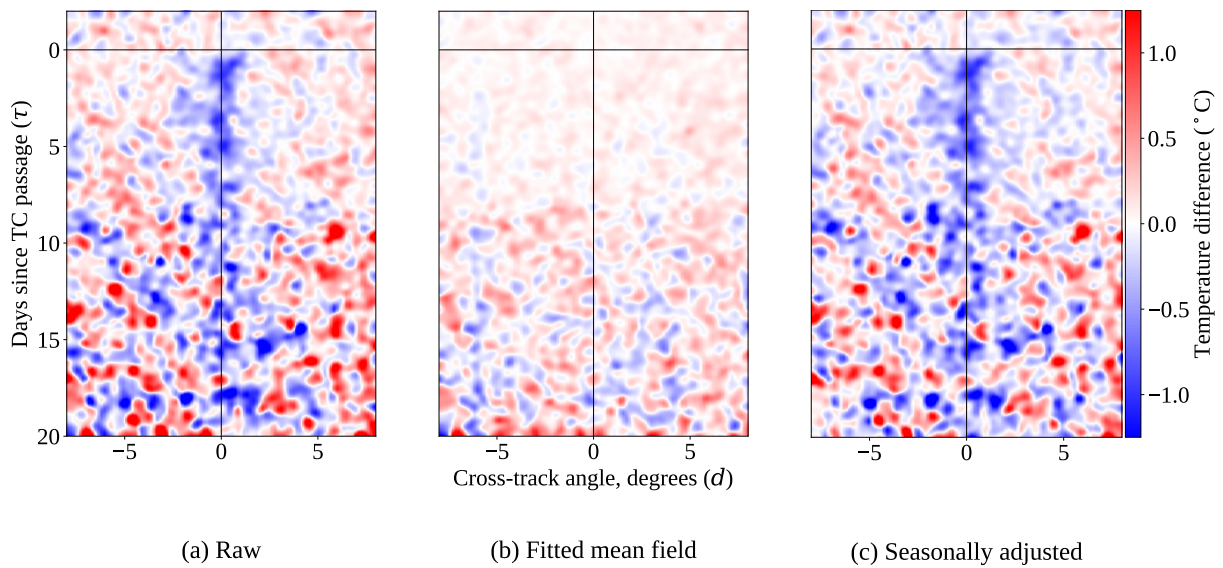
Figure S3. Pressure level: 30 dbar

(a) Raw   (b) Fitted mean field   (c) Seasonally adjusted
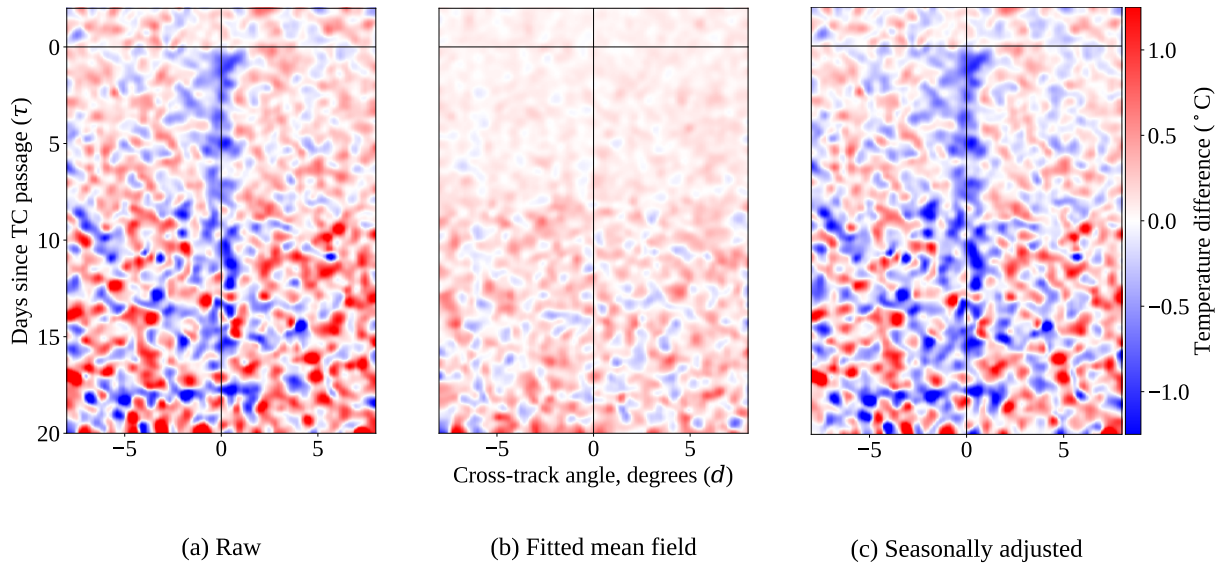
Figure S4. Pressure level: 40 dbar

(a) Raw   (b) Fitted mean field   (c) Seasonally adjusted
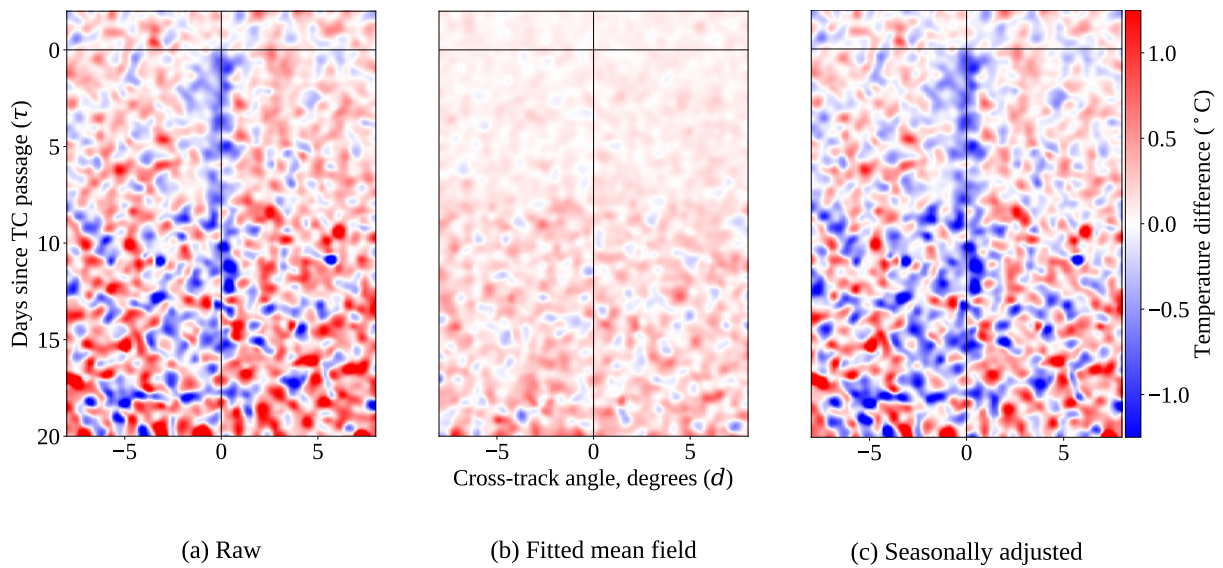
Figure S5. Pressure level: 50 dbar

(a) Raw   (b) Fitted mean field   (c) Seasonally adjusted
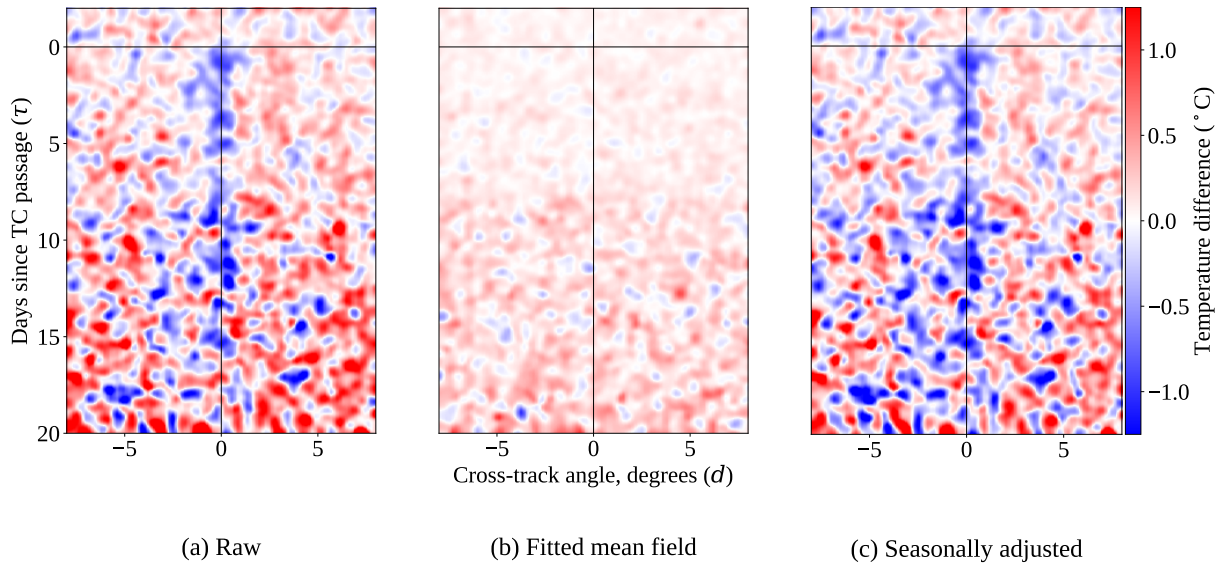
Figure S6. Pressure level: 60 dbar

(a) Raw   (b) Fitted mean field   (c) Seasonally adjusted
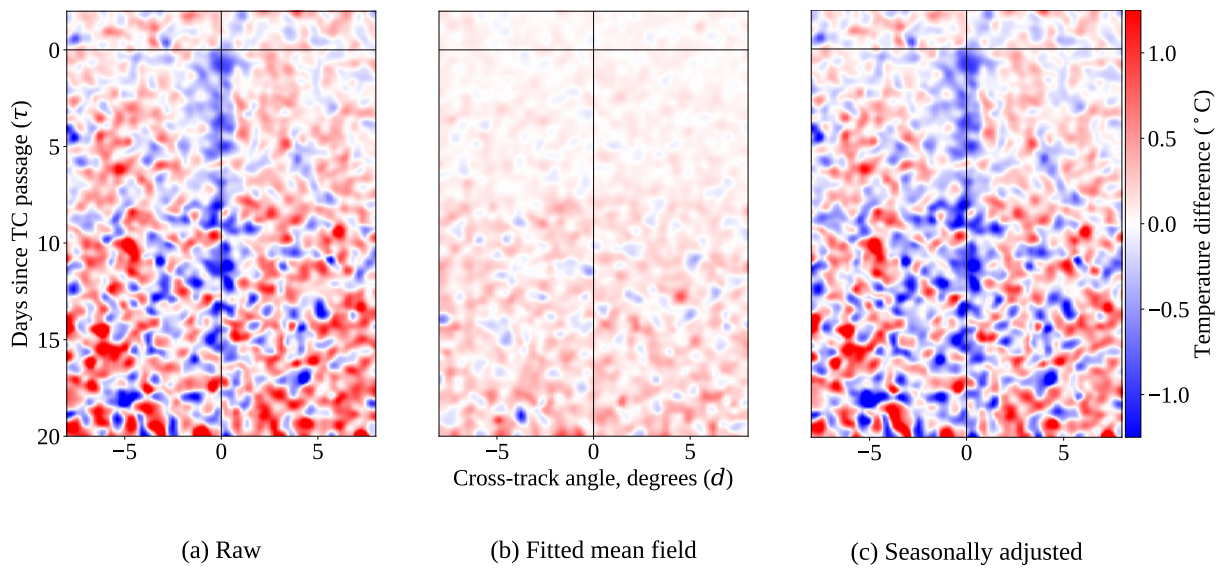
Figure S7. Pressure level: 70 dbar

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(a) Raw   (b) Fitted mean field   (c) Seasonally adjusted
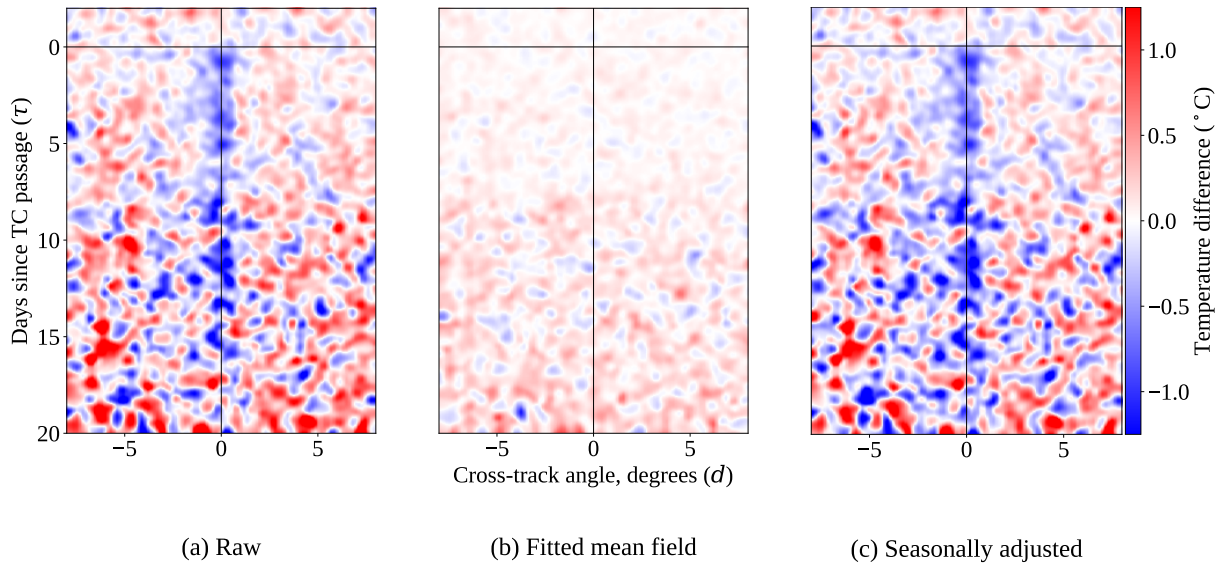
Figure S8. Pressure level: 80 dbar

(a) Raw   (b) Fitted mean field   (c) Seasonally adjusted
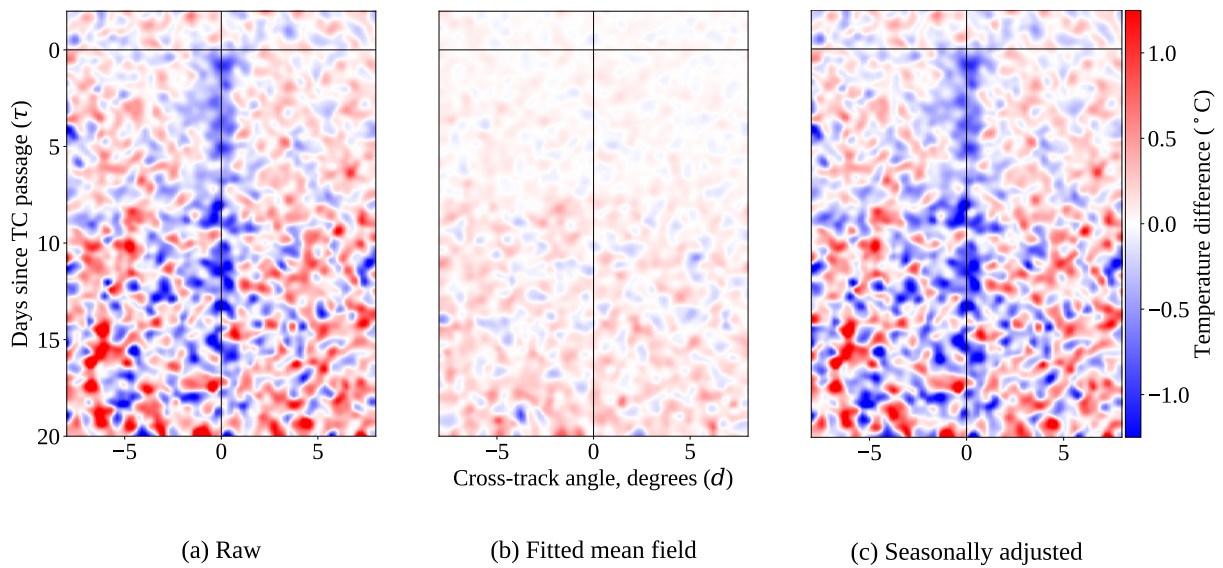
Figure S9. Pressure level: 90 dbar

(a) Raw   (b) Fitted mean field   (c) Seasonally adjusted
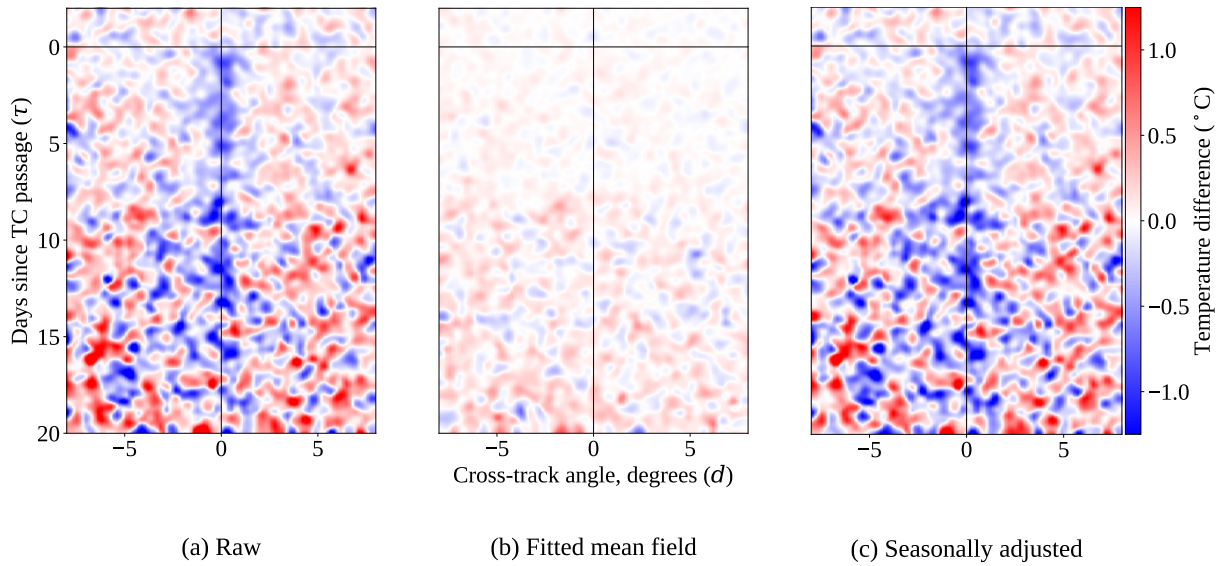
Figure S10. Pressure level: 100 dbar

(a) Raw   (b) Fitted mean field   (c) Seasonally adjusted
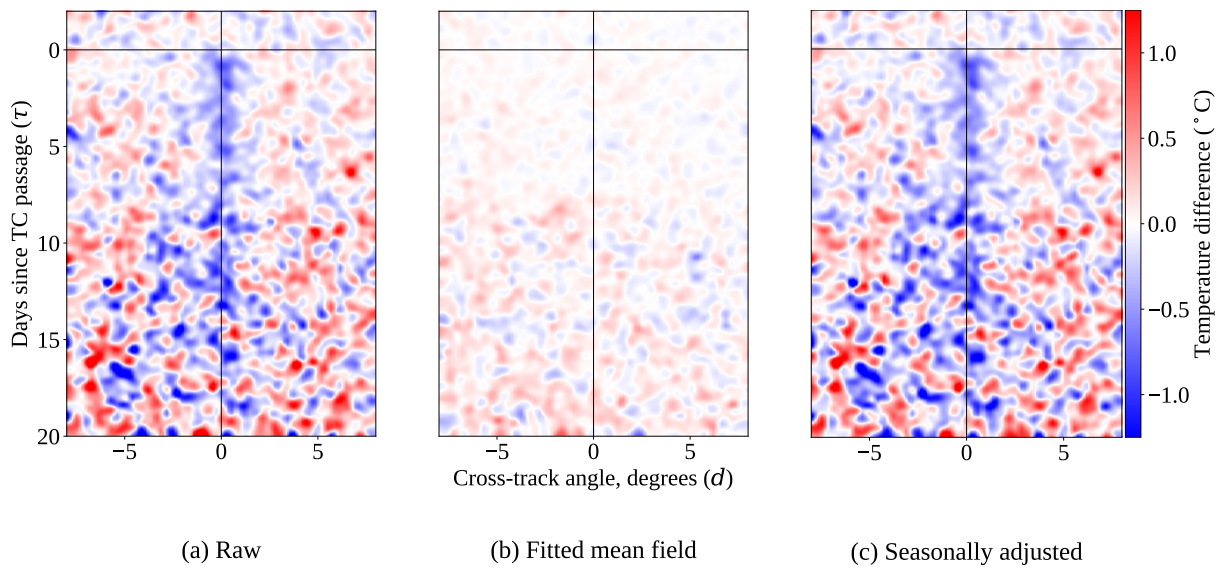
Figure S11. Pressure level: 110 dbar

(a) Raw　　　　　　　　(b) Fitted mean field　　　　　　　　(c) Seasonally adjusted
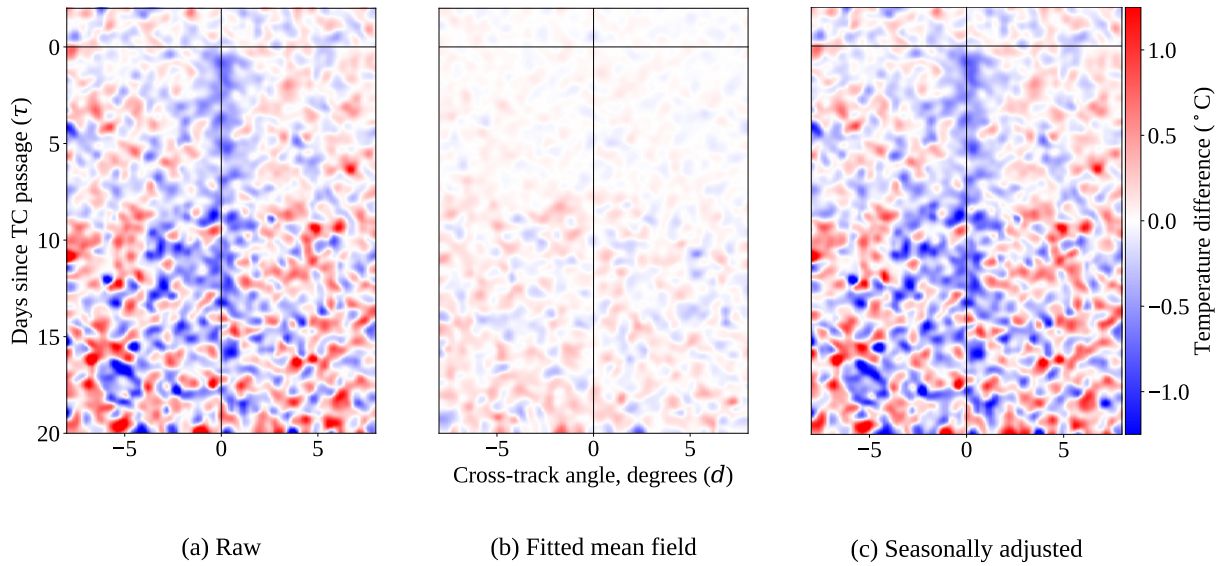
Figure S12. Pressure level: 120 dbar

(a) Raw　　　　　　　　(b) Fitted mean field　　　　　　　　(c) Seasonally adjusted
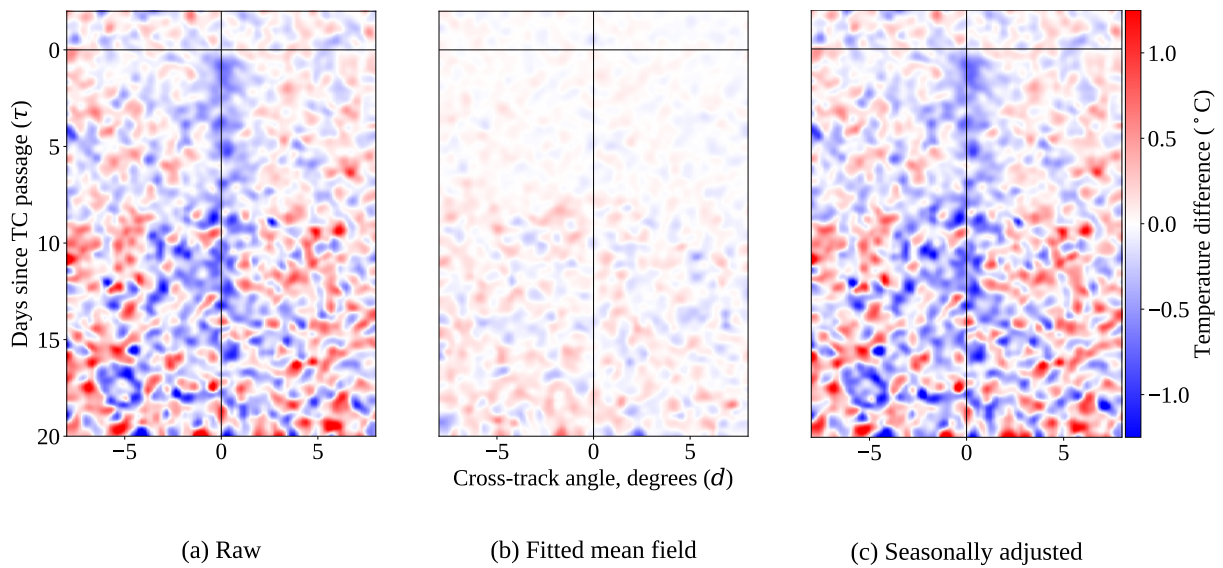
Figure S13. Pressure level: 130 dbar

(a) Raw   (b) Fitted mean field   (c) Seasonally adjusted
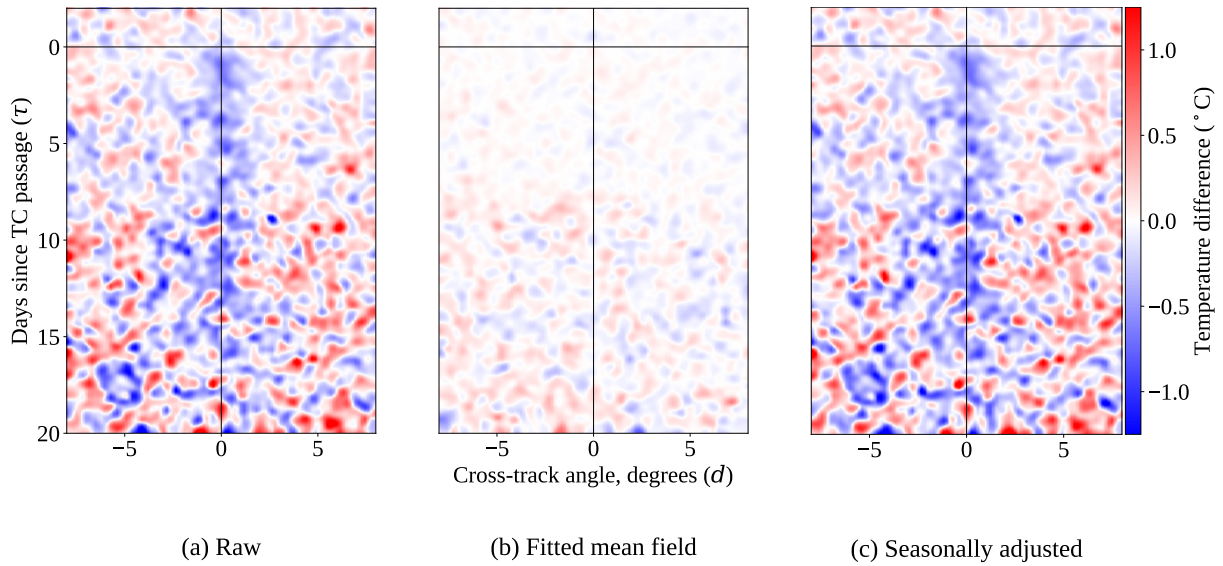
Figure S14. Pressure level: 140 dbar

(a) Raw   (b) Fitted mean field   (c) Seasonally adjusted
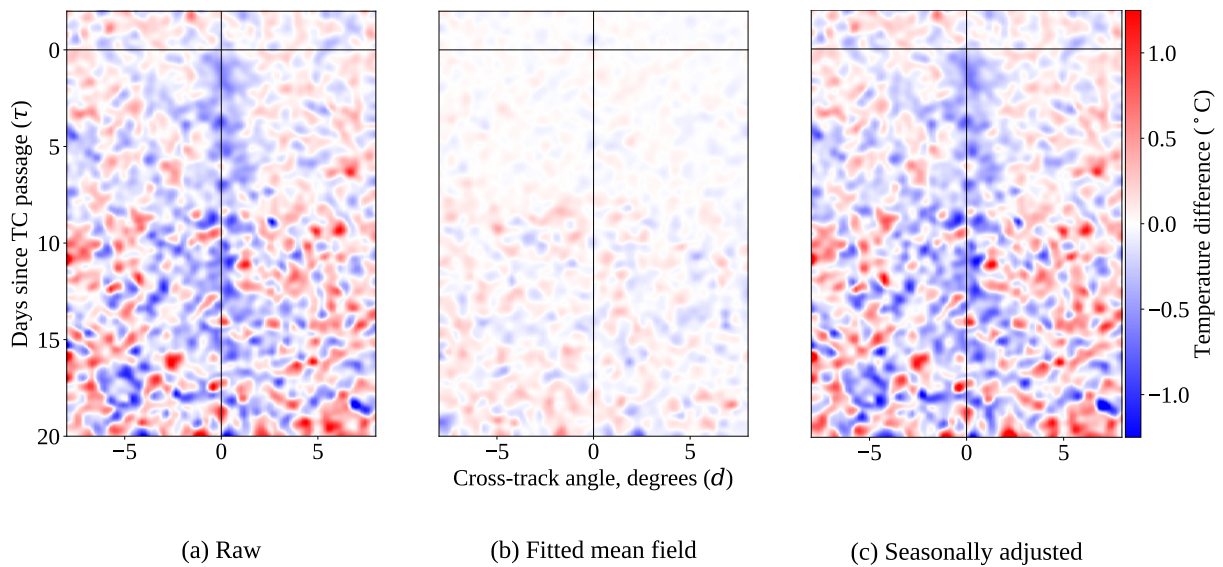
Figure S15. Pressure level: 150 dbar

(a) Raw   (b) Fitted mean field   (c) Seasonally adjusted
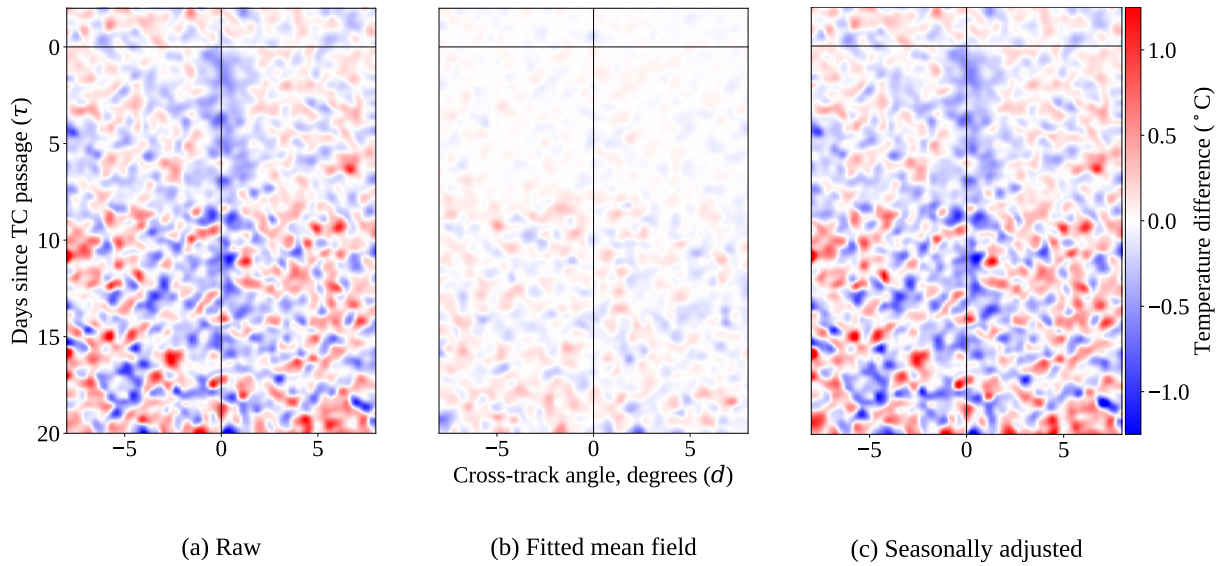
Figure S16. Pressure level: 160 dbar

(a) Raw   (b) Fitted mean field   (c) Seasonally adjusted
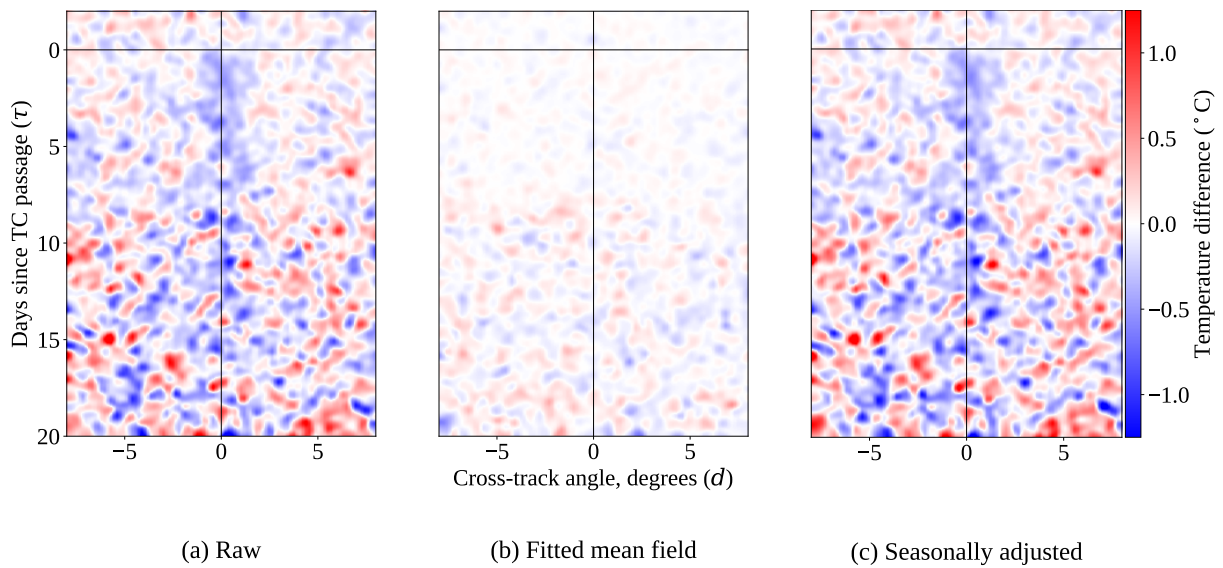
Figure S17. Pressure level: 170 dbar

(a) Raw   (b) Fitted mean field   (c) Seasonally adjusted
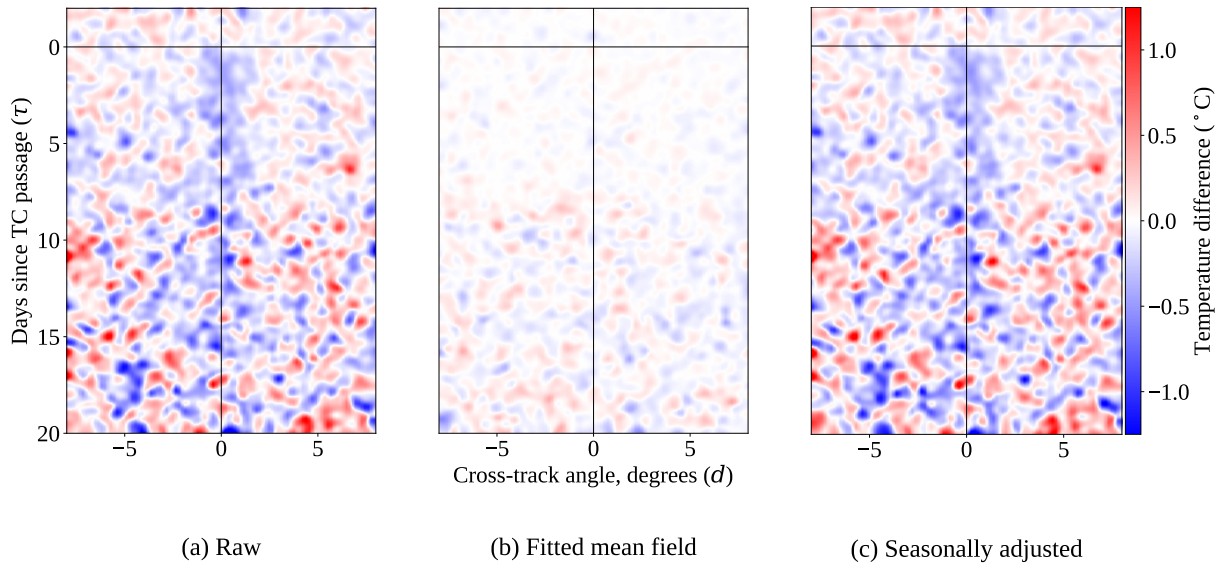
Figure S18. Pressure level: 180 dbar

(a) Raw   (b) Fitted mean field   (c) Seasonally adjusted

Figure S19. Pressure level: 190 dbar

(a) Raw   (b) Fitted mean field   (c) Seasonally adjusted

Figure S20. Pressure level: 200 dbar
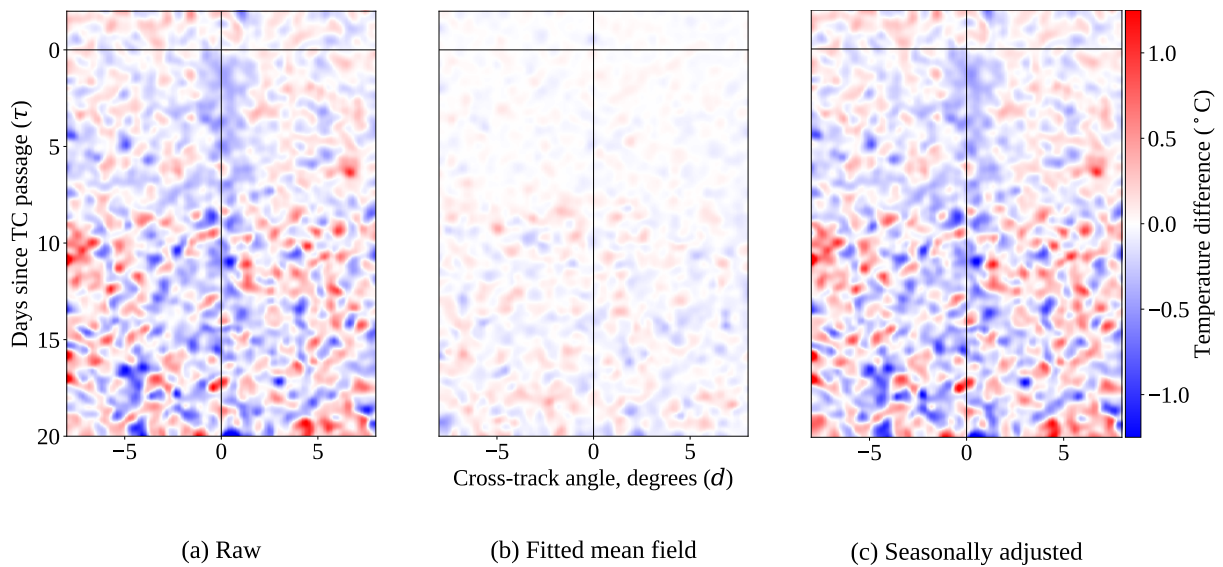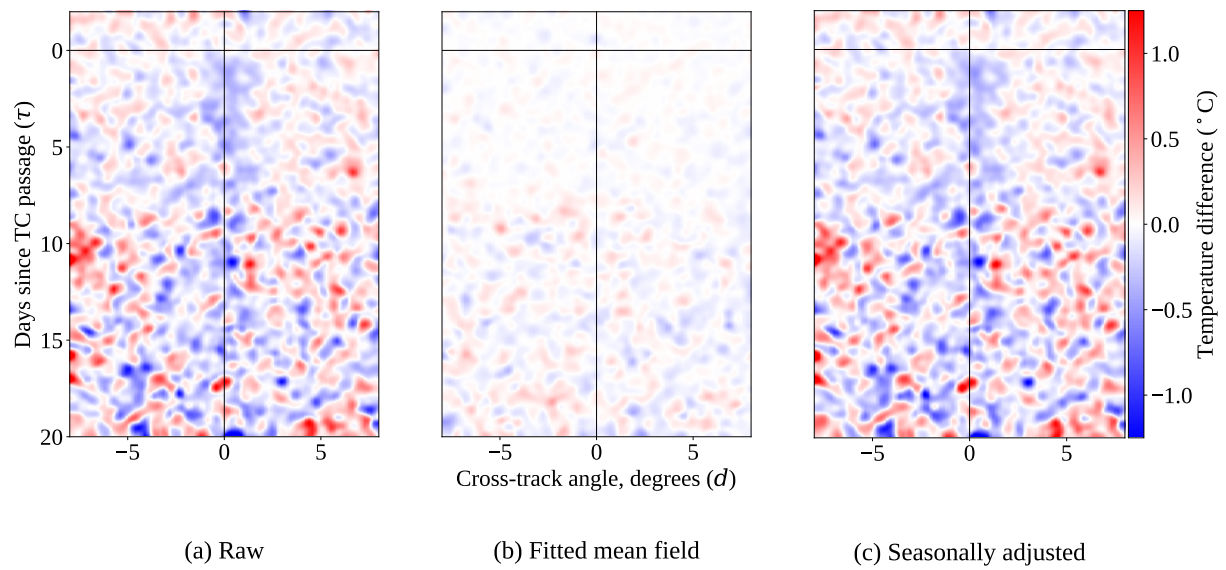
S2   Thin-plate spline fits

Here we present the thin-plate spline fits at all depths, for profile pairs incidental to TCs which were hurricane-strength (sustained winds of at least 64 knots) at time of passage.

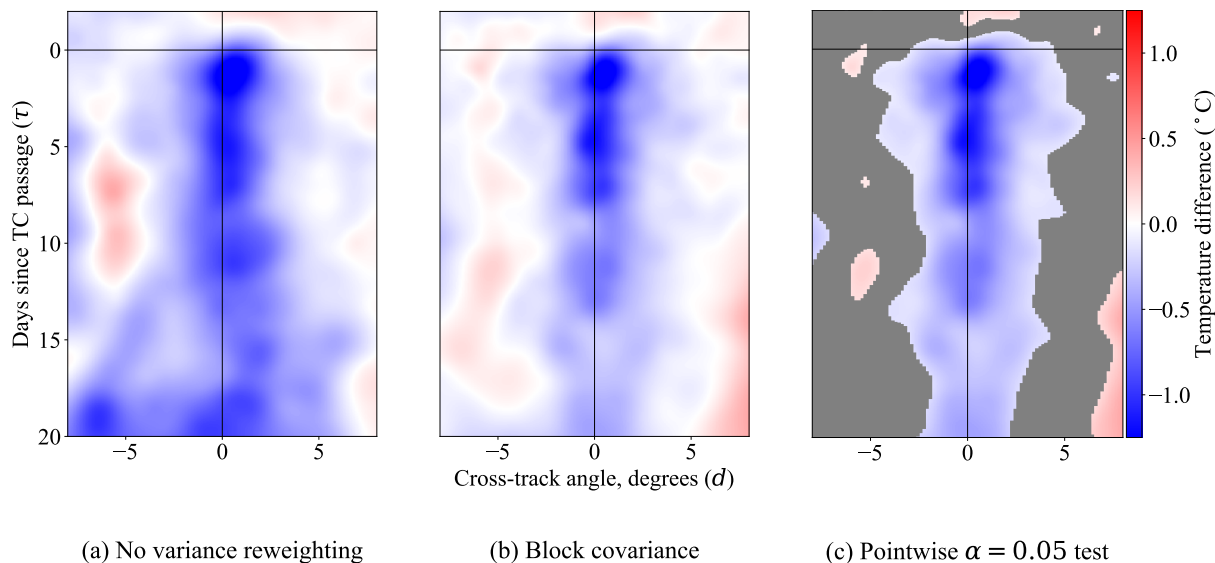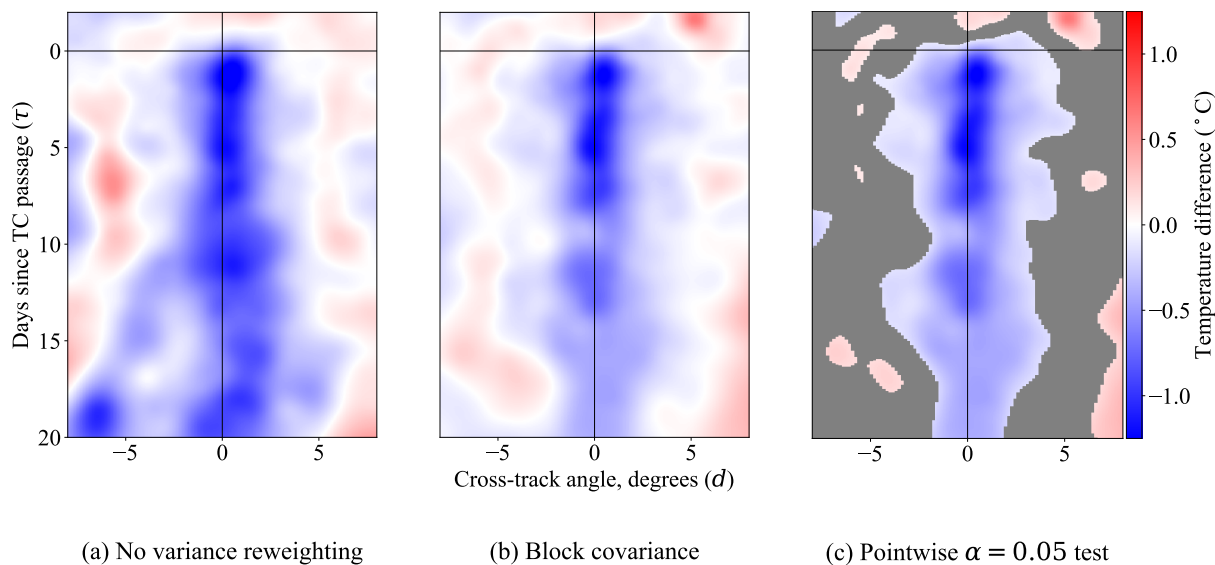(a) No variance reweighting   (b) Block covariance   (c) Pointwise $\alpha = 0.05$ test

Figure S21. Pressure level: 10 dbar

(a) No variance reweighting   (b) Block covariance   (c) Pointwise $\alpha = 0.05$ test

Figure S22. Pressure level: 20 dbar

(a) No variance reweighting   (b) Block covariance   (c) Pointwise $\alpha = 0.05$ test
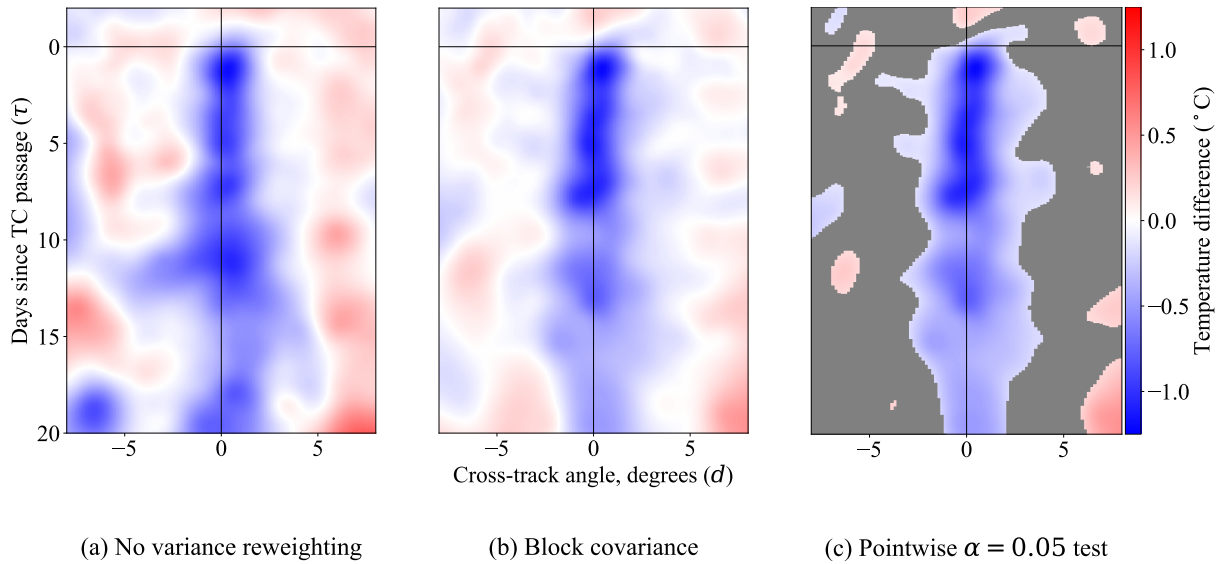
Figure S23. Pressure level: 30 dbar

(a) No variance reweighting   (b) Block covariance   (c) Pointwise $\alpha = 0.05$ test
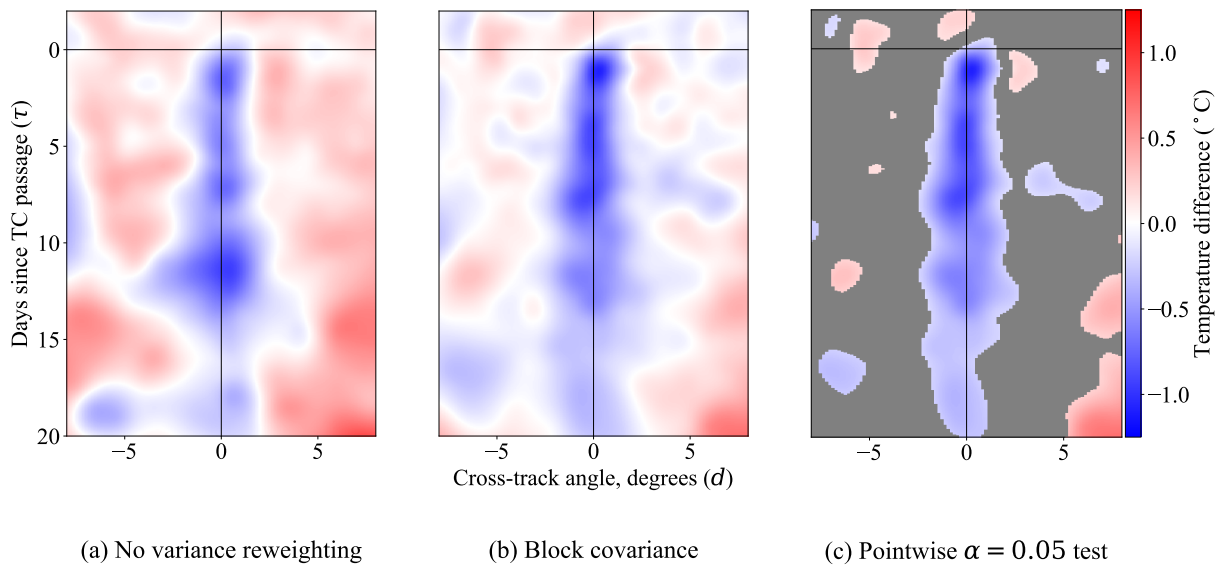
Figure S24. Pressure level: 40 dbar

(a) No variance reweighting   (b) Block covariance   (c) Pointwise $\alpha = 0.05$ test
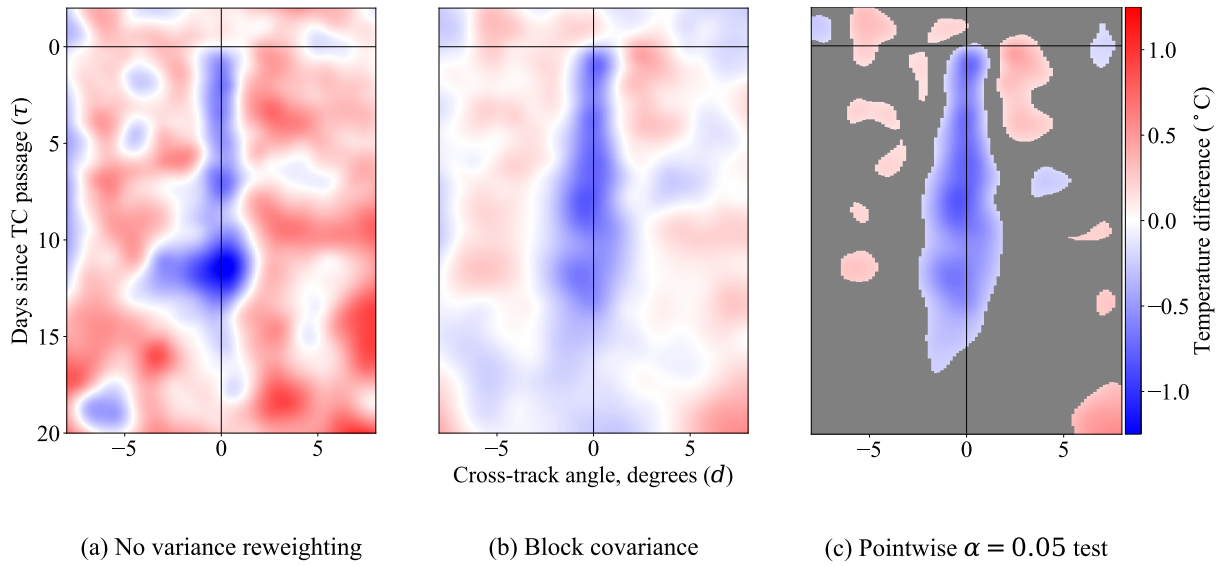
Figure S25. Pressure level: 50 dbar

(a) No variance reweighting   (b) Block covariance   (c) Pointwise $\alpha = 0.05$ test
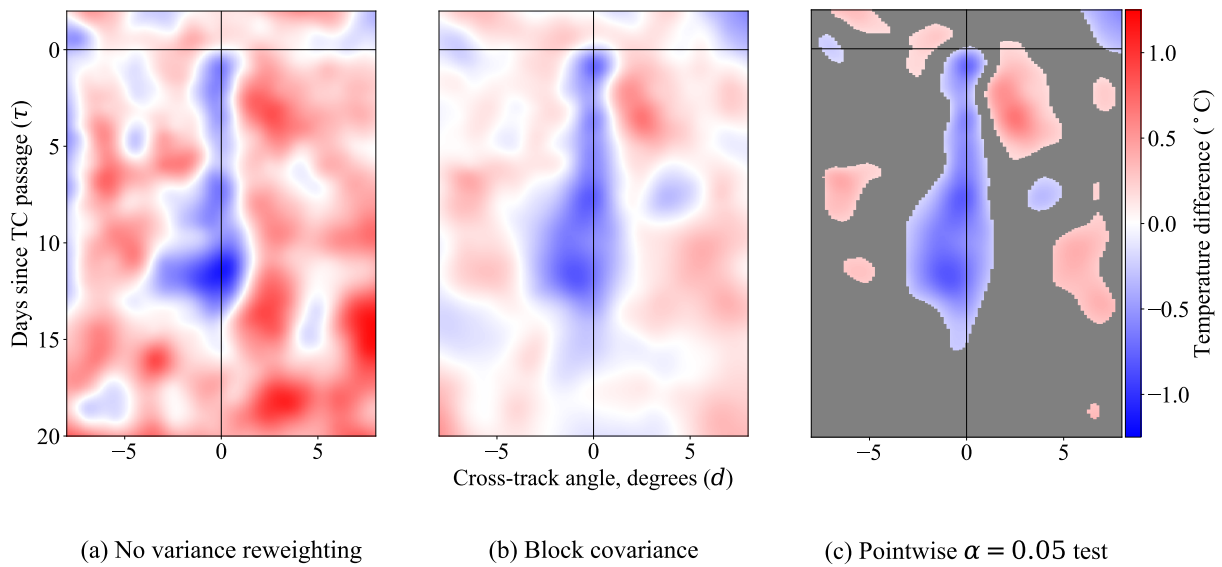
Figure S26. Pressure level: 60 dbar

(a) No variance reweighting   (b) Block covariance   (c) Pointwise $\alpha = 0.05$ test
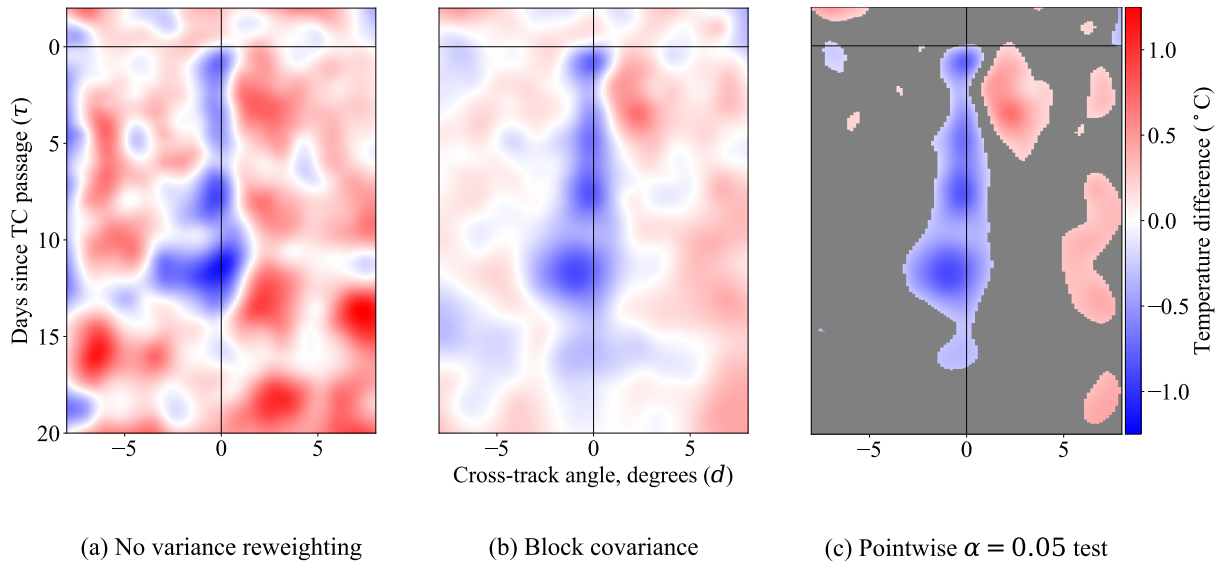
Figure S27. Pressure level: 70 dbar

(a) No variance reweighting   (b) Block covariance   (c) Pointwise $\alpha = 0.05$ test
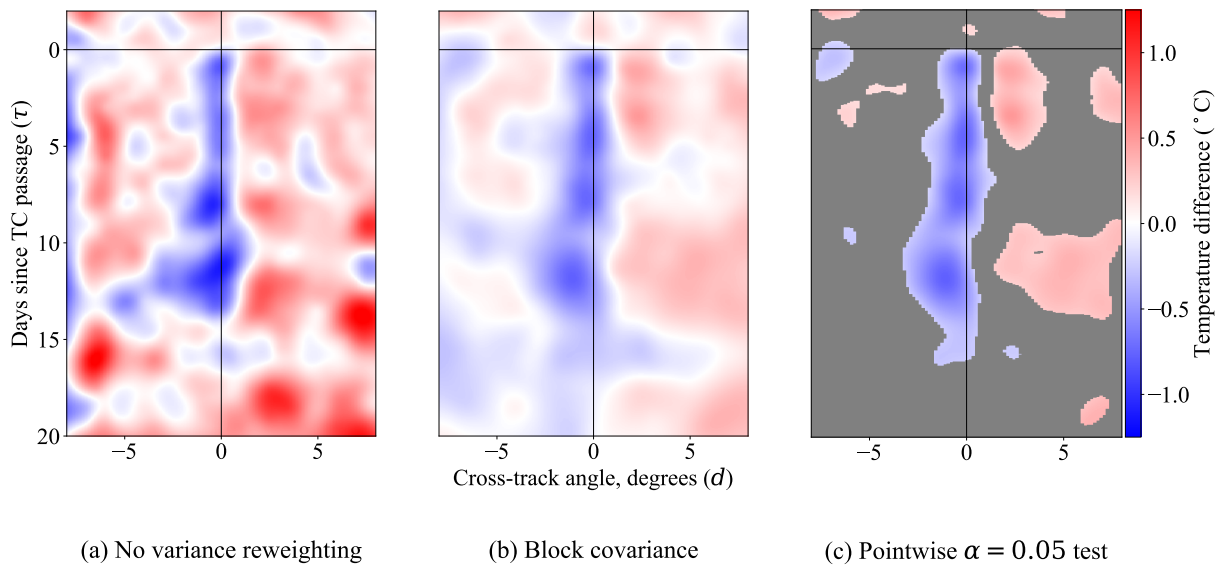
Figure S28. Pressure level: 80 dbar

15

(a) No variance reweighting   (b) Block covariance   (c) Pointwise $\alpha = 0.05$ test
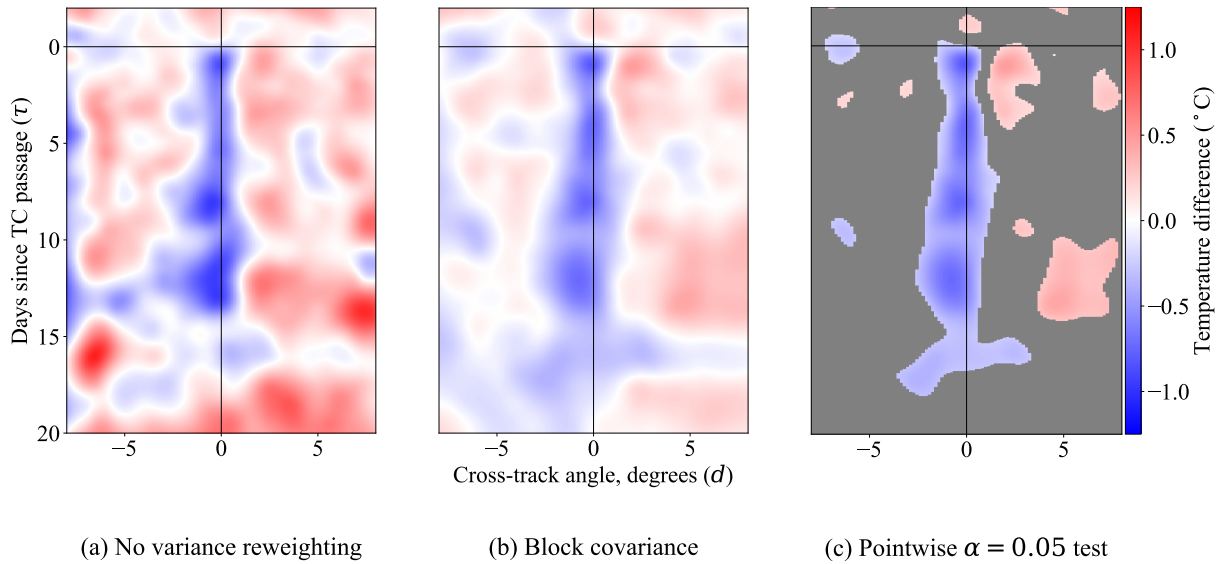
Figure S29. Pressure level: 90 dbar

(a) No variance reweighting   (b) Block covariance   (c) Pointwise $\alpha = 0.05$ test
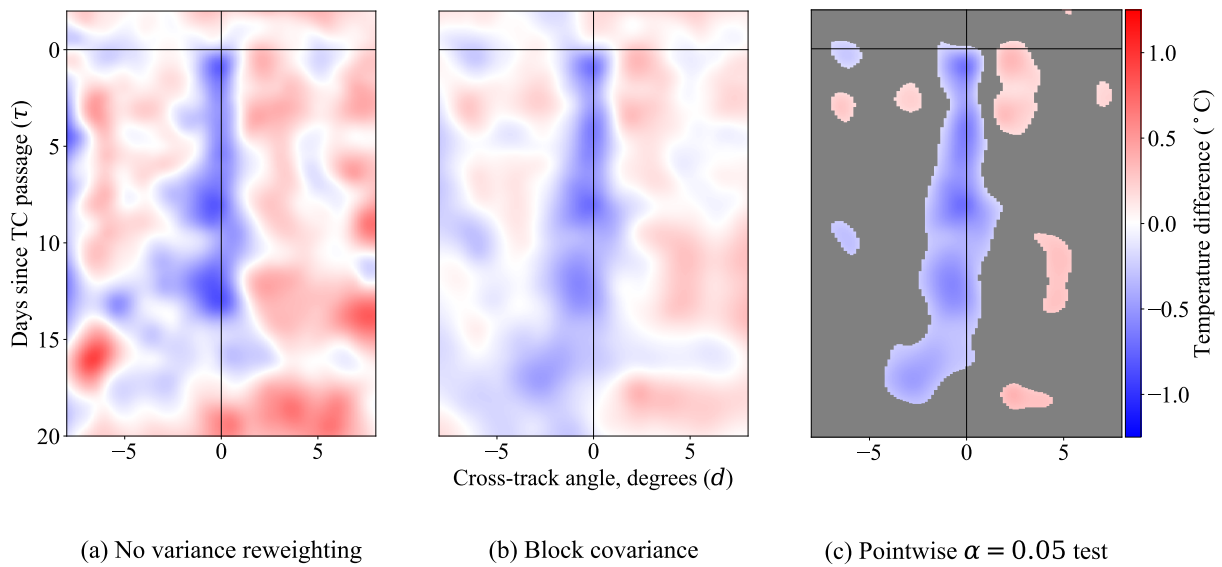
Figure S30. Pressure level: 100 dbar

(a) No variance reweighting

(b) Block covariance

(c) Pointwise $\alpha = 0.05$ test
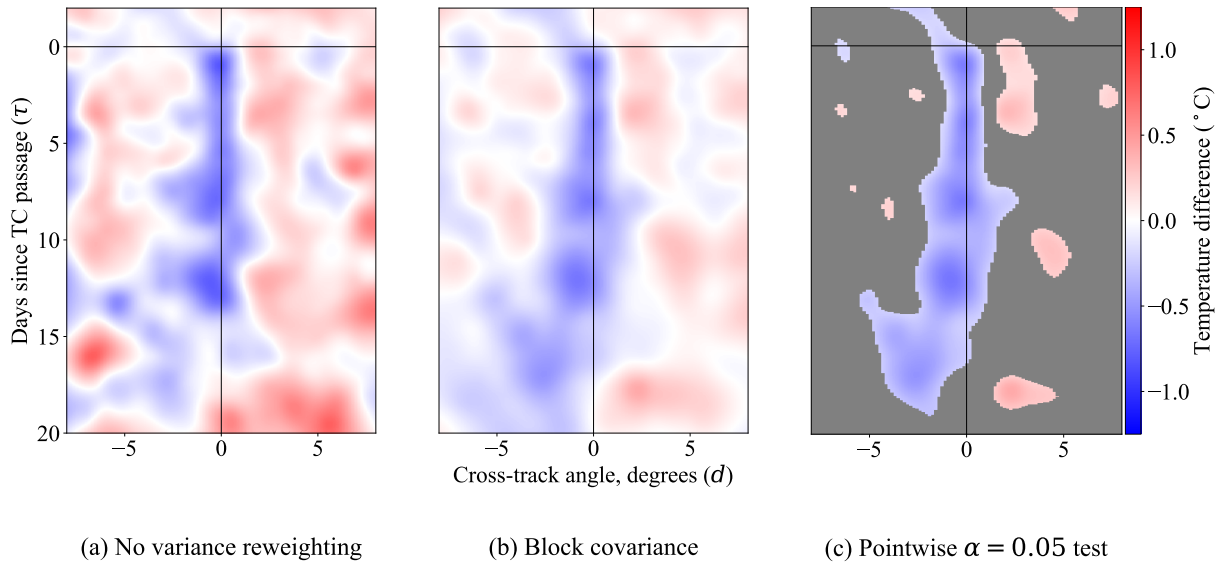
Figure S31. Pressure level: 110 dbar

(a) No variance reweighting

(b) Block covariance

(c) Pointwise $\alpha = 0.05$ test
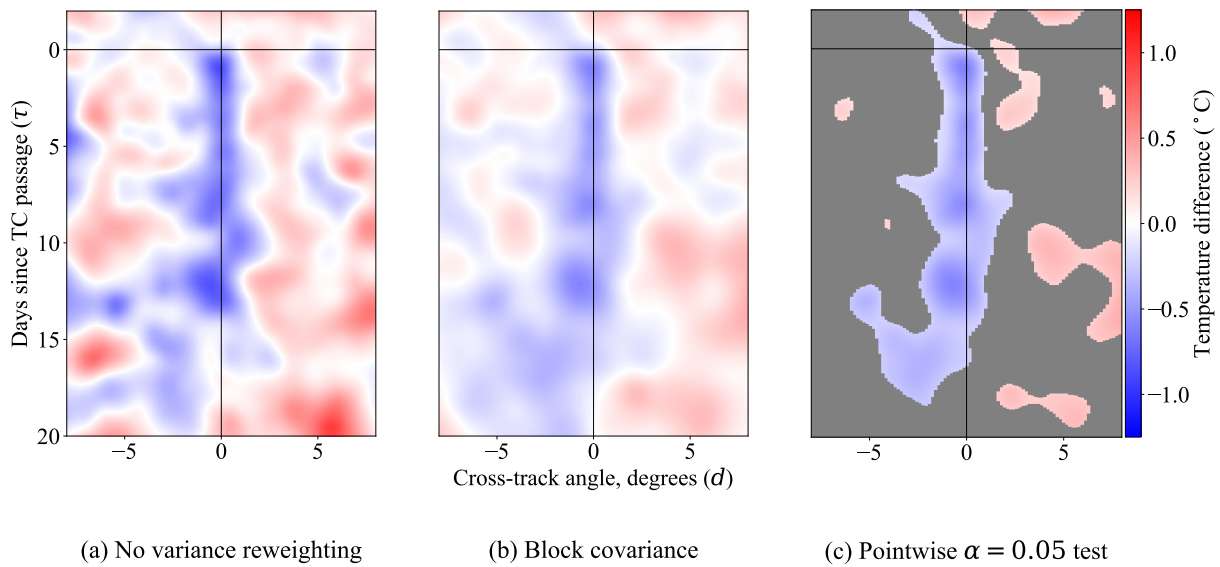
Figure S32. Pressure level: 120 dbar

(a) No variance reweighting   (b) Block covariance   (c) Pointwise $\alpha = 0.05$ test
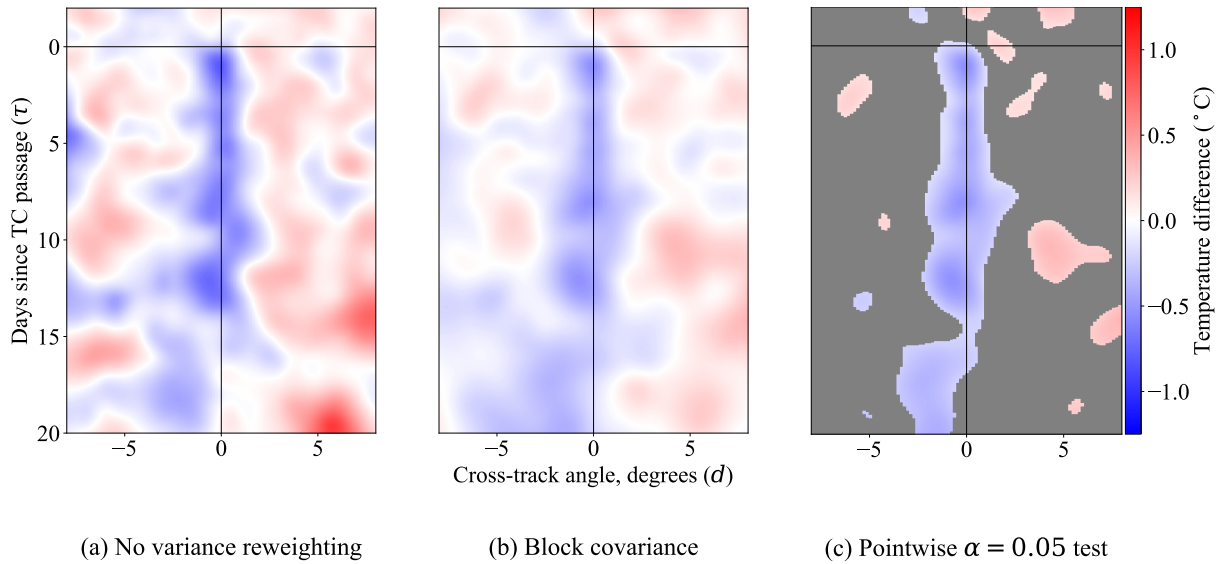
Figure S33. Pressure level: 130 dbar

(a) No variance reweighting   (b) Block covariance   (c) Pointwise $\alpha = 0.05$ test
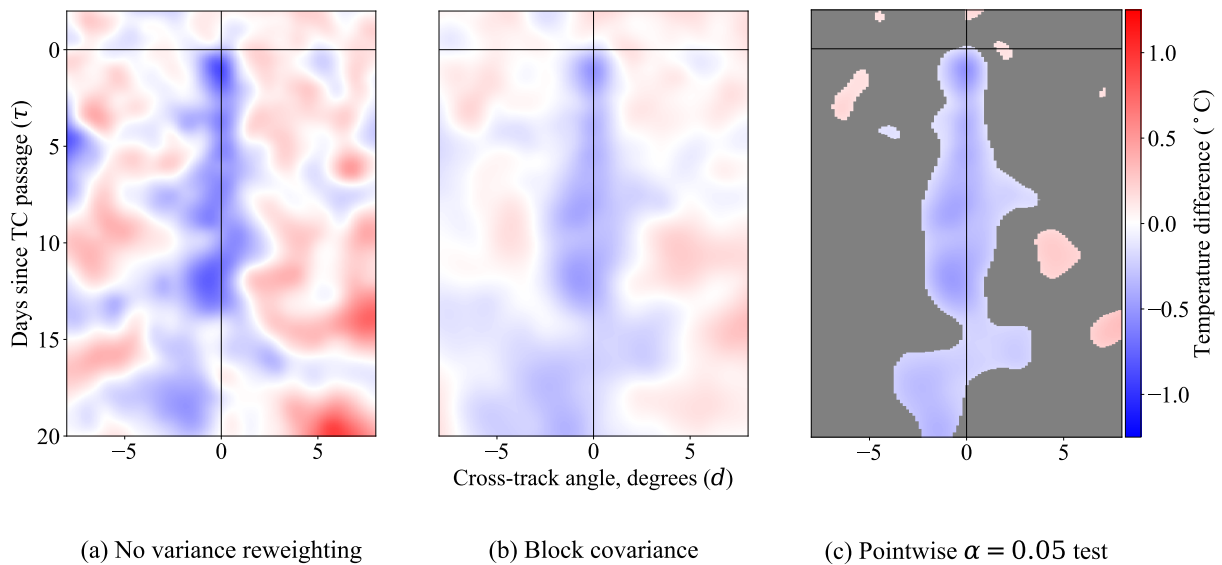
Figure S34. Pressure level: 140 dbar

(a) No variance reweighting   (b) Block covariance   (c) Pointwise $\alpha = 0.05$ test
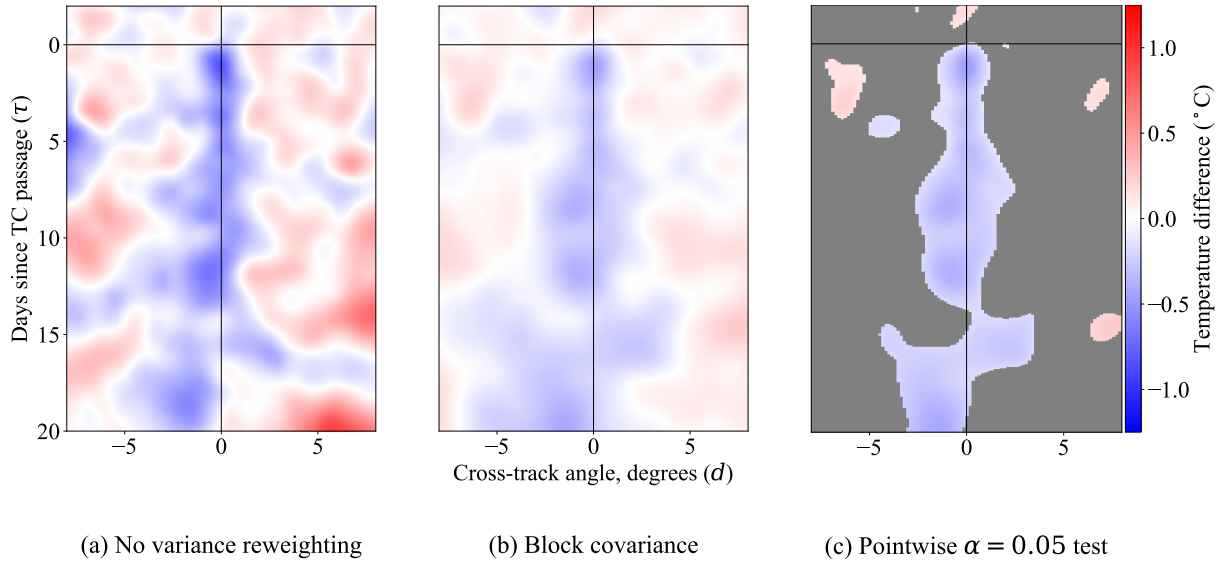
Figure S35. Pressure level: 150 dbar

(a) No variance reweighting   (b) Block covariance   (c) Pointwise $\alpha = 0.05$ test
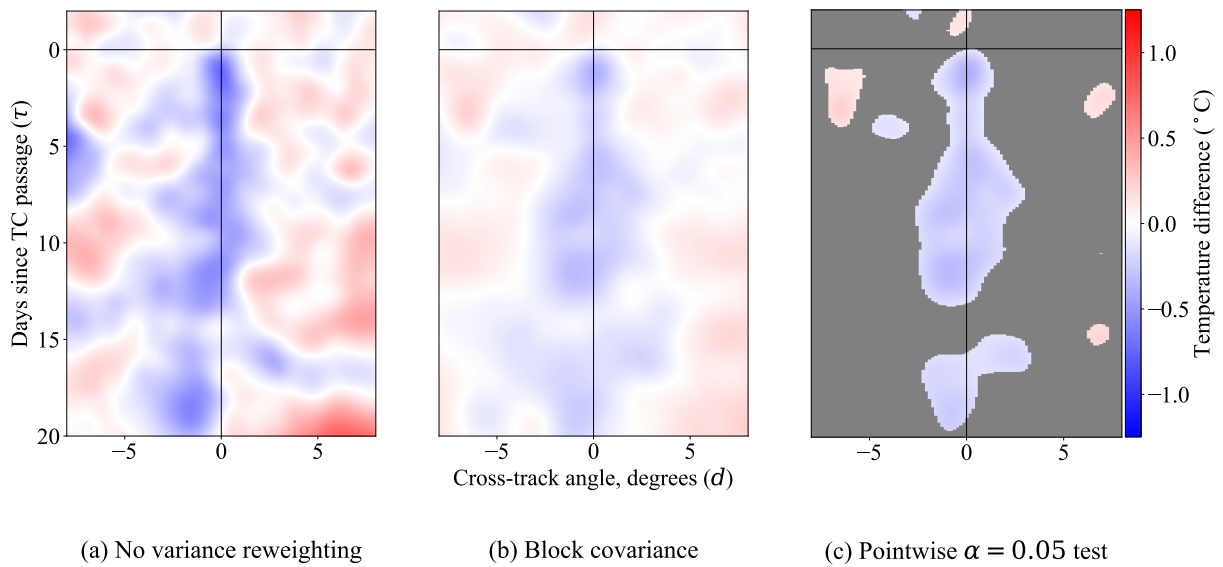
Figure S36. Pressure level: 160 dbar

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(a) No variance reweighting   (b) Block covariance   (c) Pointwise $\alpha = 0.05$ test
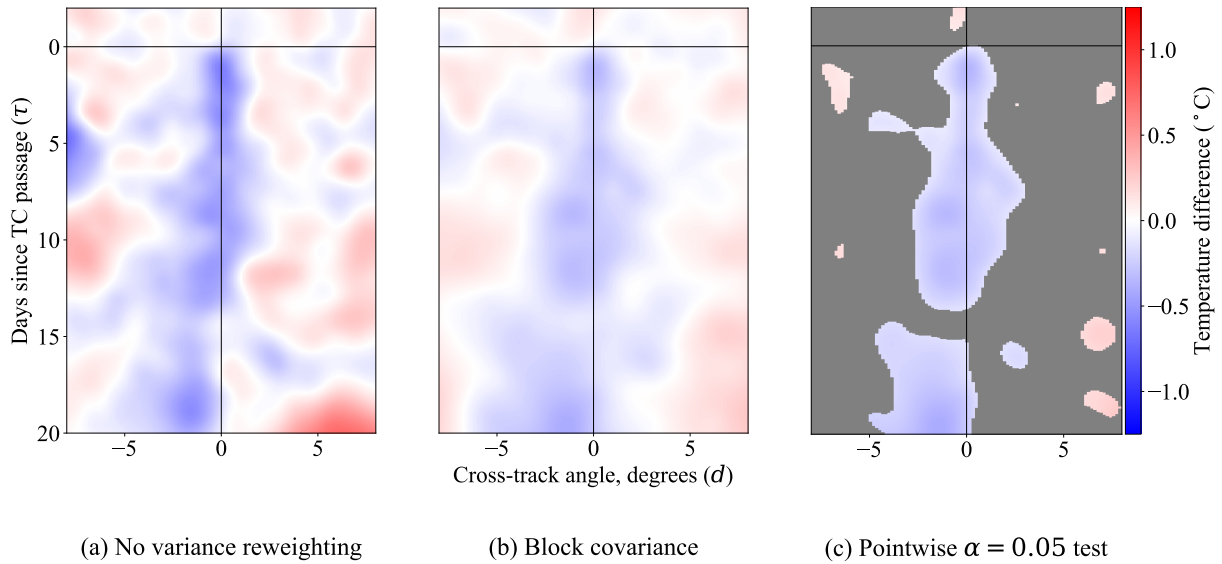
Figure S37. Pressure level: 170 dbar

(a) No variance reweighting   (b) Block covariance   (c) Pointwise $\alpha = 0.05$ test
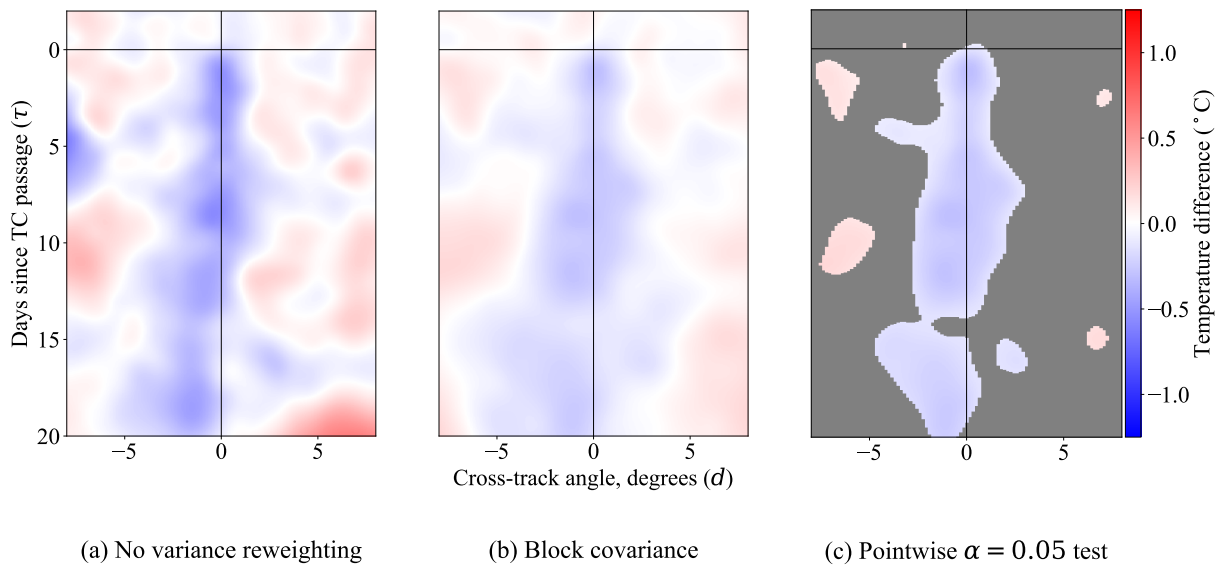
Figure S38. Pressure level: 180 dbar

20

(a) No variance reweighting   (b) Block covariance   (c) Pointwise $\alpha = 0.05$ test
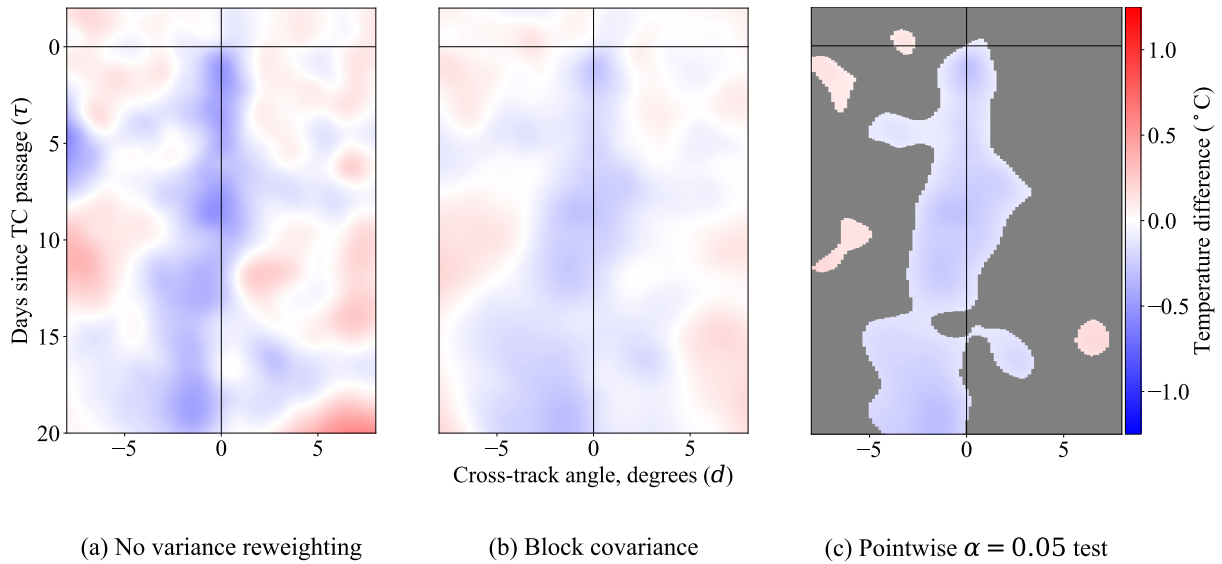
Figure S39. Pressure level: 190 dbar

(a) No variance reweighting   (b) Block covariance   (c) Pointwise $\alpha = 0.05$ test

Figure S40. Pressure level: 200 dbar

S3 Vertically averaged fits
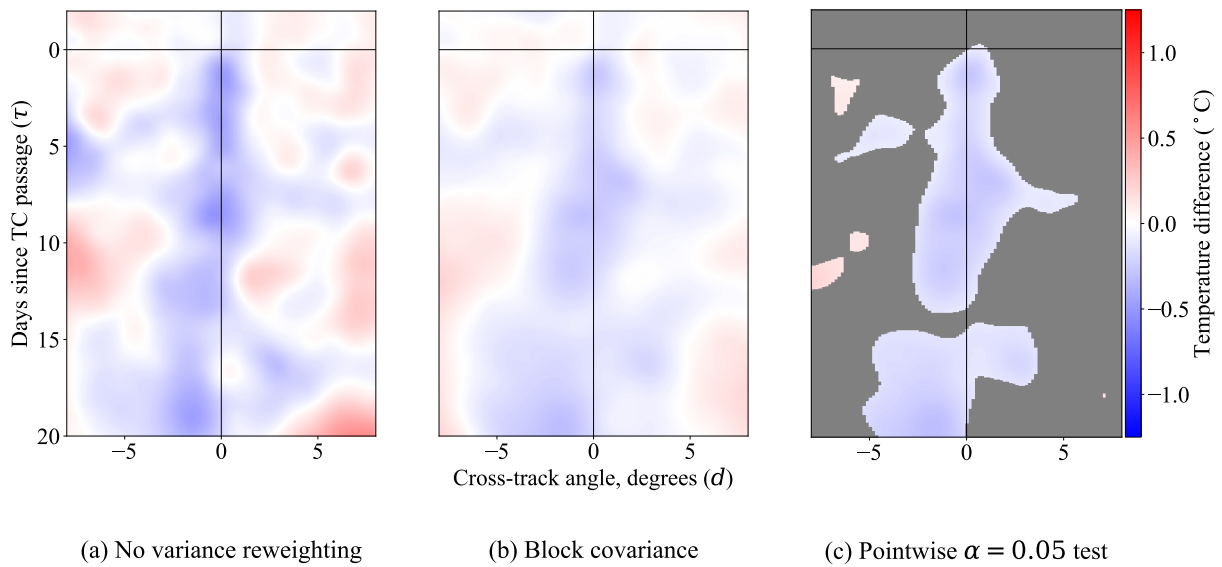
10   Here we present the corresponding plots for the vertically averaged temperature difference analysis, as described in Section 5.6.
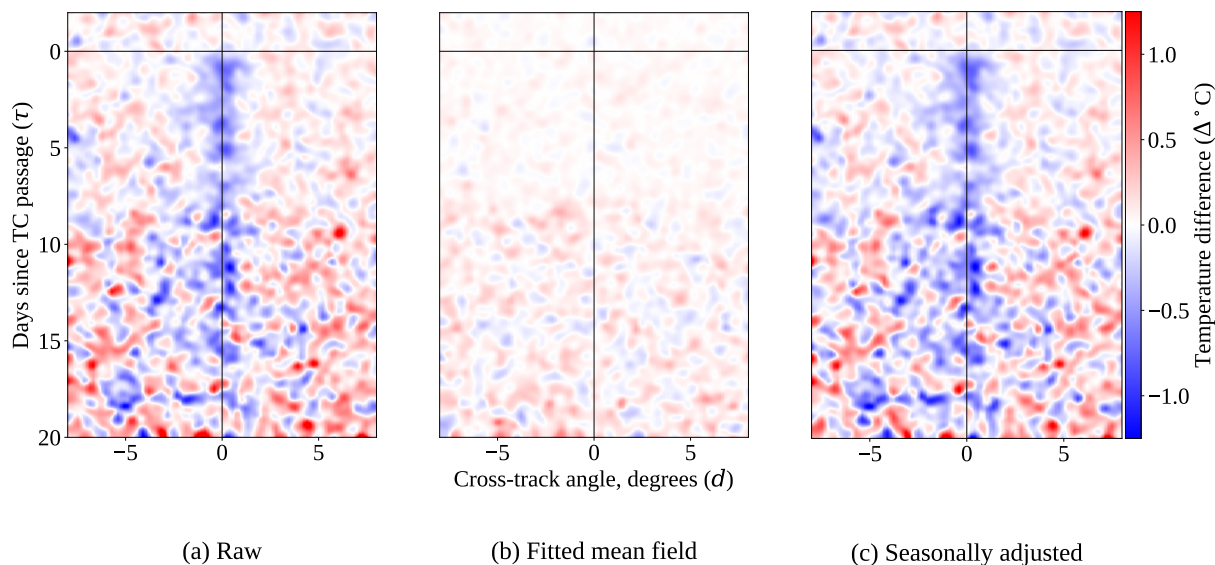

(a) Raw   (b) Fitted mean field   (c) Seasonally adjusted

Figure S41. The temperature differences and fitted seasonal mean field are lightly smoothed by an isotropic Gaussian kernel smoother with a bandwidth of $\sigma = 0.2$.

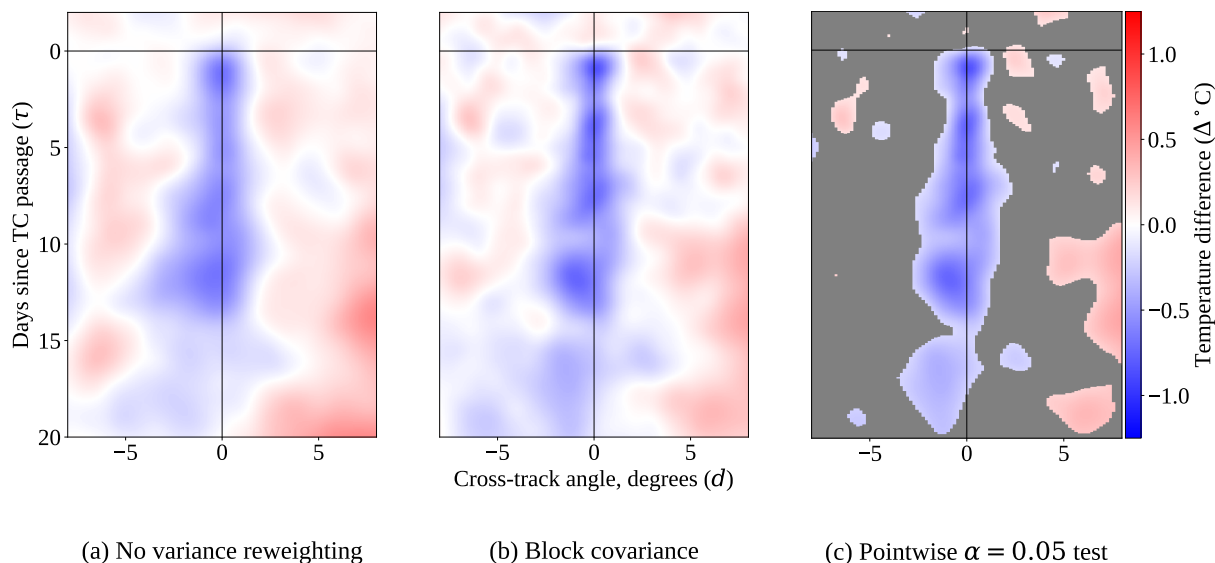(a) No variance reweighting   (b) Block covariance   (c) Pointwise $\alpha = 0.05$ test

Figure S42. Thin-plate spline fits for profile pairs incidental to a TC of hurricane-strength (sustained windspeed of at least 64 knots) at time of TC passage.

S4 Seasonal mean field fits

S4.1 Seasonal adjustments

We plot the seasonal adjustment fitted to each profile pair in our dataset, at each pressure level $z = 10, 20, \ldots, 200$, as well as for the vertically averaged temperature profiles. This set of plots complements Figure 5a and is provided for completeness. At pressure levels $z = 30$ through $z = 150$, we observe an overall warming effect over the timespan of our data.
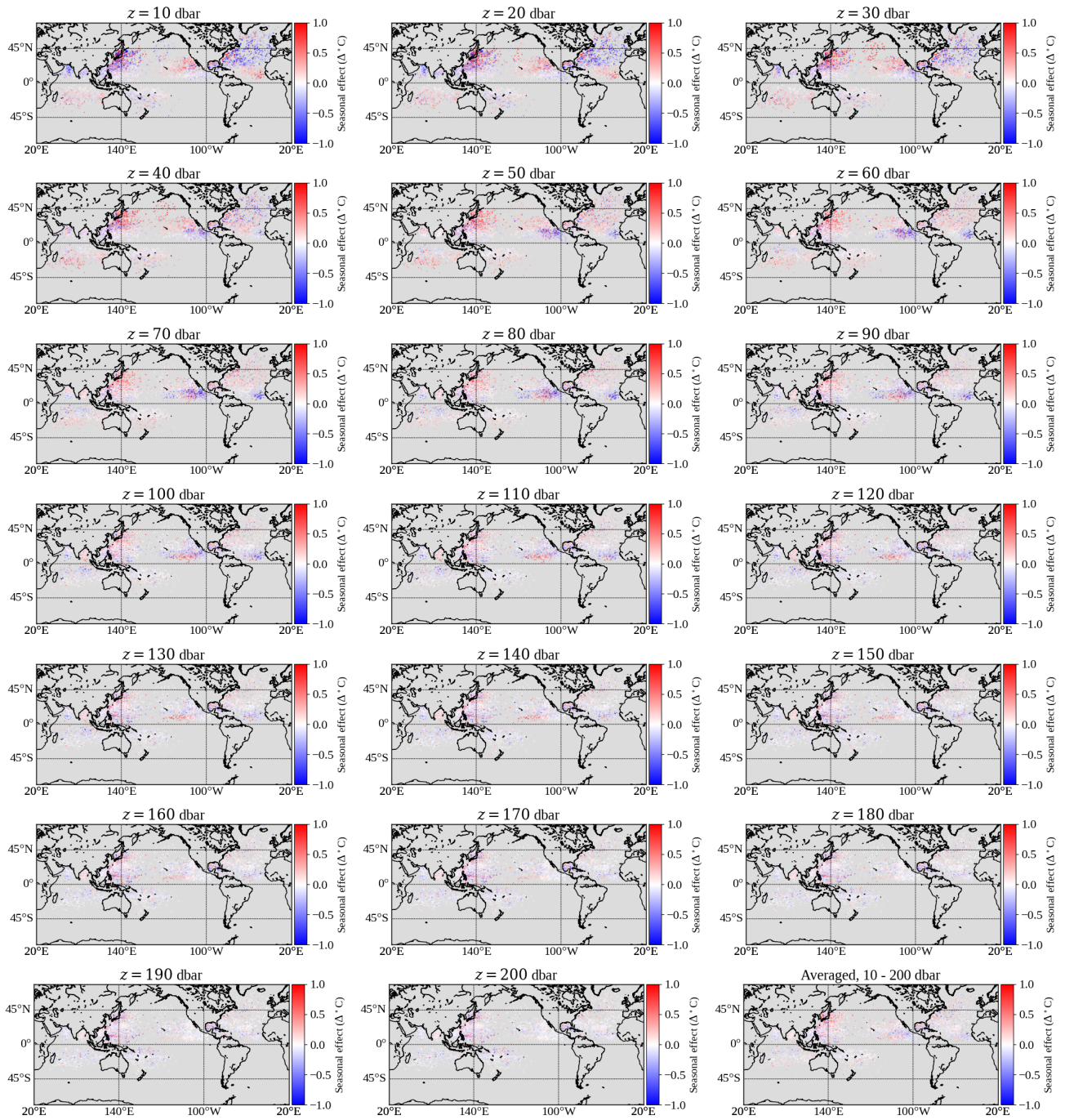
Figure S43. Seasonal adjustments at varying pressure levels.

S5 Gaussian process model fits

In this section, we plot the Gaussian process model coefficients fitted in Section 4.4, as well as the variances for the seasonally adjusted temperature differences implied by these coefficients.

S5.1 Fitted ϕ coefficients

Here we plot the ϕ parameters, fitted through maximum likelihood estimation at each pressure level $z = 10, 20, \ldots, 200$ and for the vertically averaged temperature profiles. Note that the colorscale is logarithmic.
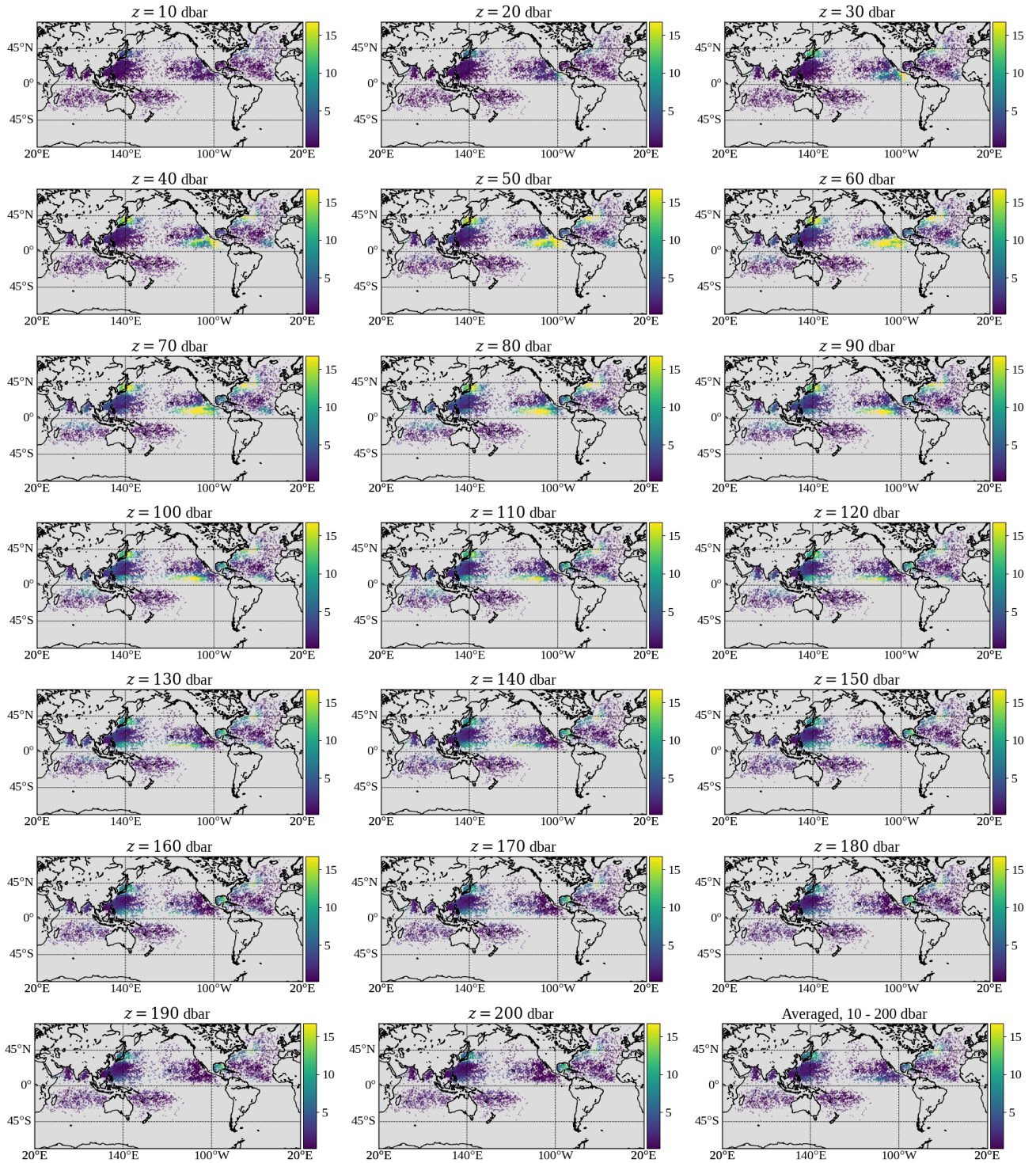
Figure S44. Fitted ϕ coefficients at varying pressure levels.

S5.2 Fitted θ_t coefficients

Here we plot the θ_t parameters, fitted through maximum likelihood estimation at each pressure level $z = 10, 20, \ldots, 200$ and for the vertically averaged temperature profiles.

Figure S45. Fitted θ_t coefficients at varying pressure levels.

S5.3 Fitted σ coefficients

Here we plot the σ parameters, fitted through maximum likelihood estimation at each pressure level $z = 10, 20, \ldots, 200$ and for the vertically averaged temperature profiles.
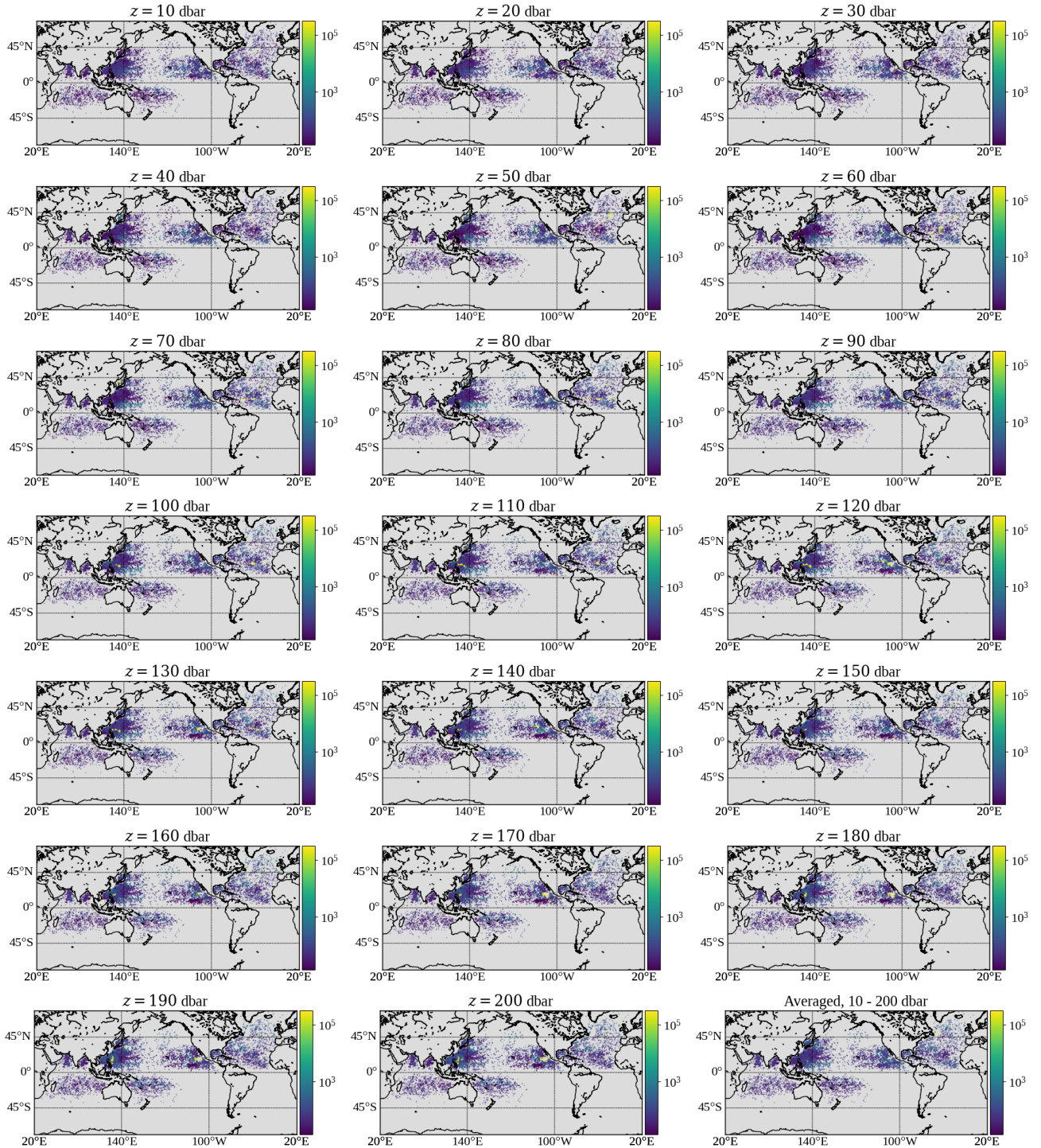
The fitted coefficients exhibit a spatial smoothness, suggesting a relative stability across the locally fitted models.
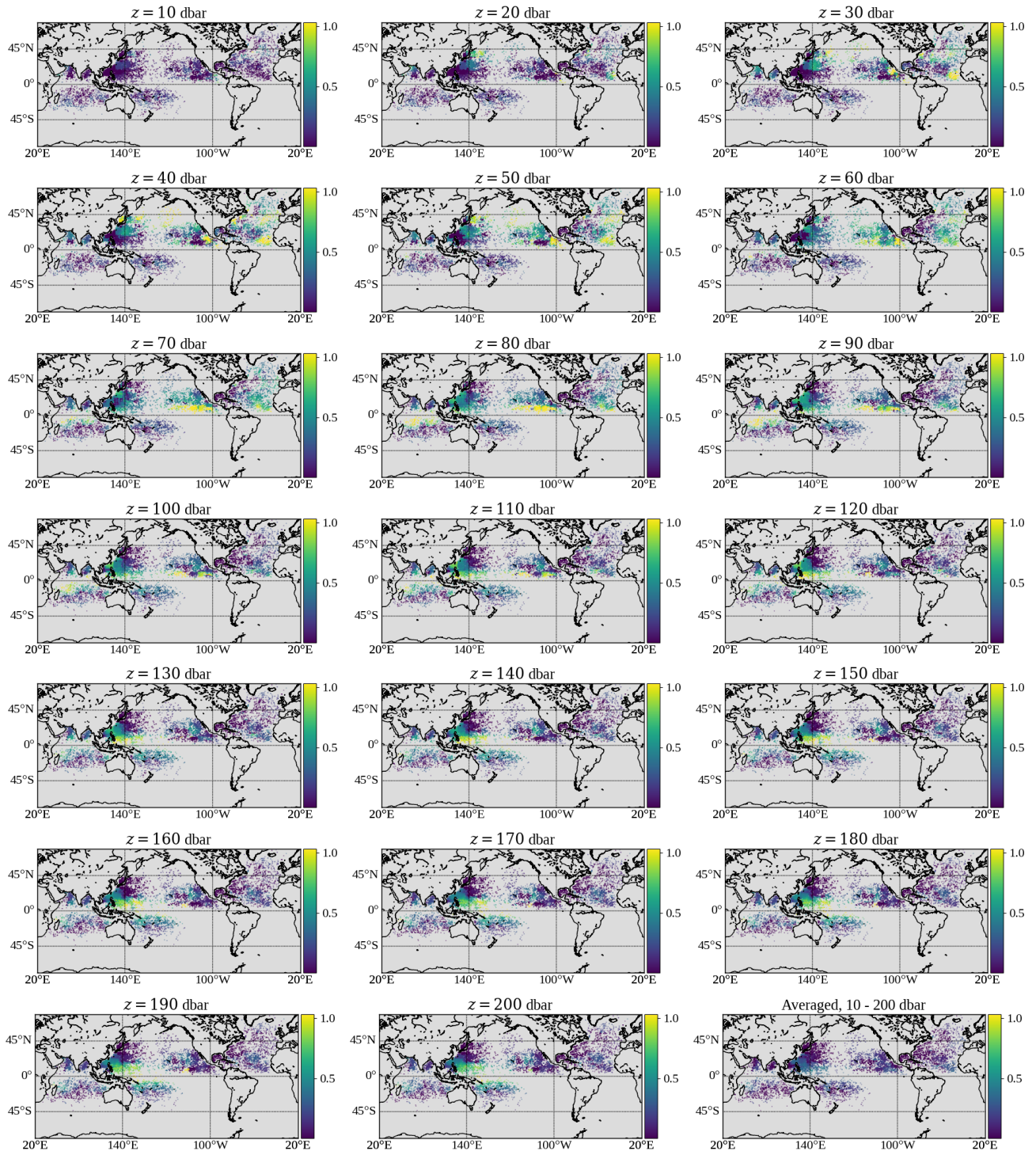
Figure S46. Fitted σ coefficients at varying pressure levels.

30   **S5.4   Fitted variances**

Here we plot the variances for the seasonally adjusted temperature differences, as fitted by way of the Gaussian process model of Section 4.4, for each of the profile pairs in our dataset. These variances are fitted at each pressure level $z = 10, 20, \ldots, 200$, as well as for the vertically averaged temperature profiles.

   Overall, we observe that the fitted variances are relatively homogeneous. Profile pairs with larger fitted variance are down-
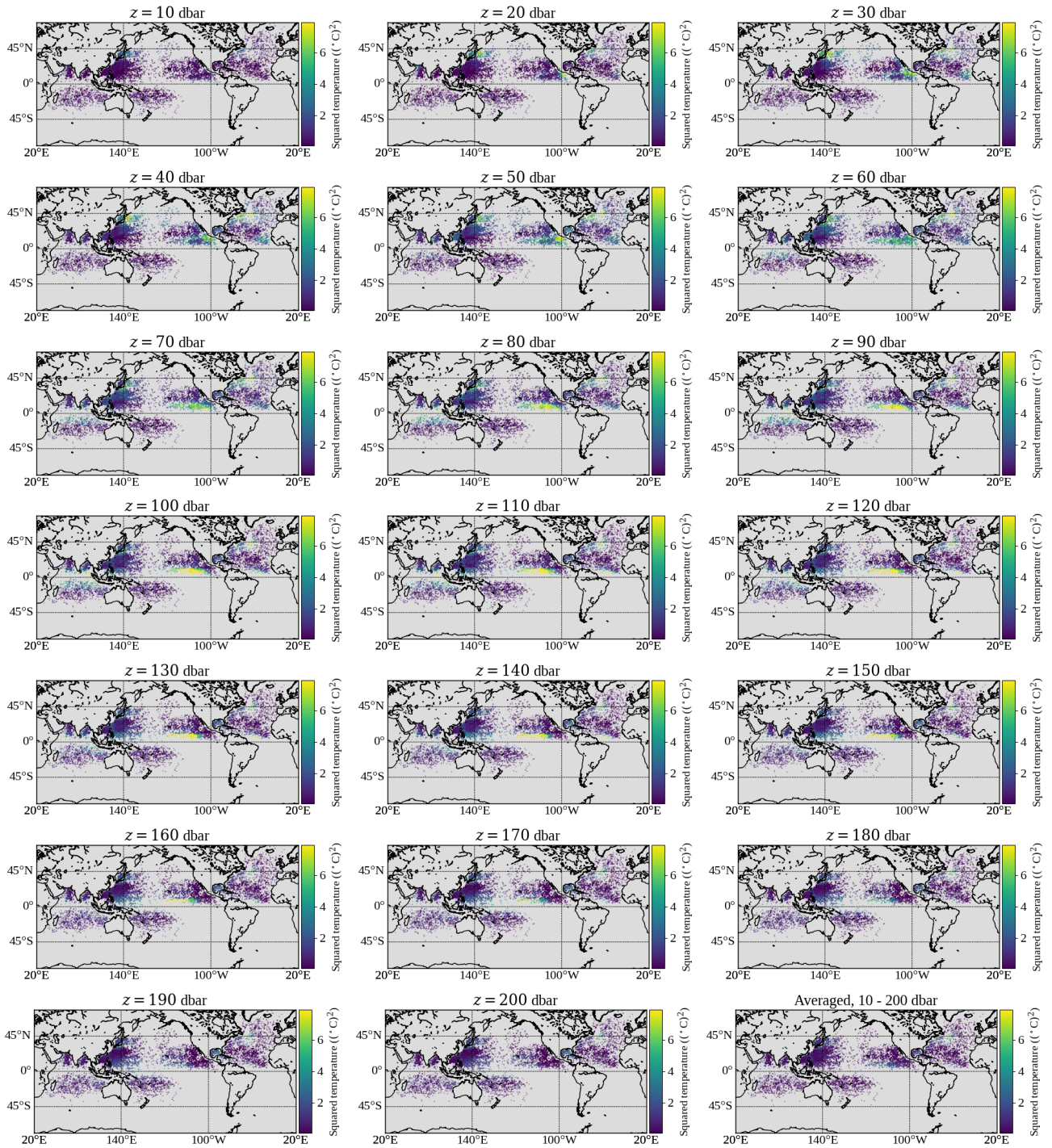35   weighted in the final thin-plate spline fit of Section 4.5.

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Figure S47. Fitted variances at varying pressure levels.