

Geophysical Research Letters

Supporting Information for

**No Evidence for Strongly Enhanced Northern Hemisphere Cooling
from Extratropical Versus Tropical Eruptions**

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Table S1

Figures S1 to S6

	Tropical Eruptions	Extratropical eruptions
Toohey et al. 2019	765, 899, 916, 928, 973, 1001, 1029, 1107, 1125, 1170, 1229, 1257*, 1275, 1343, 1388, 1452, 1553, 1586, 1594, 1640, 1653, 1762, 1809, 1831, 1861, 1883, 1902, 1963, 1982, 1991	798, 853, 1180, 1201, 1212, 1328, 1508, 1567, 1667, 1730, 1739, 1912
Burke et al., 2023	765, 899, 916, 928, 973, 1001, 1029, 1107, 1125, 1170, 1229, 1257*, 1275, 1343, 1388, 1553, 1586, 1594, 1600, 1640, 1653, 1762, 1809, 1831, 1861, 1883, 1902, 1963, 1982, 1991	536 [†] , 626 [†] , 798, 853, 1182, 1201, 1212, 1328, 1453, 1508, 1567, 1667, 1730, 1739, 1912
Our Figs. 2b, S3, and S4	765, 899, 916, 928, 973, 1001, 1029, 1107, 1125, 1170, 1229, 1257*, 1275, 1343, 1388, 1553, 1586, 1594, 1600, 1640, 1653, 1762, 1809, 1831, 1861, 1883, 1902, 1963, 1982, 1991	798, 853, 1182, 1201, 1212, 1328, 1453, 1508, 1567, 1667, 1730, 1739, 1912
Our Fig. 3 and S5 (3-6 TgS only)	899, 1001, 1762, 765, 1861, 928, 1963, 1982, 1653, 1125, 1388, 1902	1453, 1730, 1912, 1328, 1667, 1739, 1212, 1201
Our Fig. 4 only (shown with black labels)	858, 1190, 1285, 1458, 1673, 1694, 1815, 1822, 1835, 1967	1783 [‡] , 939 [‡] , 822, 904, 756, 1766, 1646

* 1257 CE eruption is too large to be visible in the plot range of any of our figures or those in the main text of either Toohey et al. (2019) or Burke et al. (2023), but is included in the regression analyses of all studies (including our Fig. 2b), and is used in our Fig. 4 paleoproxy analysis.

† We exclude the 536 and 626 CE events due to extremely limited tree ring data before 750 CE, making it highly uncertain if current reconstructions are representative of Northern Hemisphere extratropical temperature. These events had been excluded from the Toohey et al. (2019) regression analysis but used in that of Burke et al. (2023).

‡ The 1783 Laki and 939 Eldgja eruptions are two large partly-effusive eruptions widely held to have had a climate effect. All other eruptions that are in our Fig. 4 but not Fig. 2b had been excluded by Toohey et al (2019) due to temporal proximity to a preceding eruption.

Table S1. The eruptions incorporated into our analyses, as well as those of Toohey et al. (2019) and Burke et al. (2023).

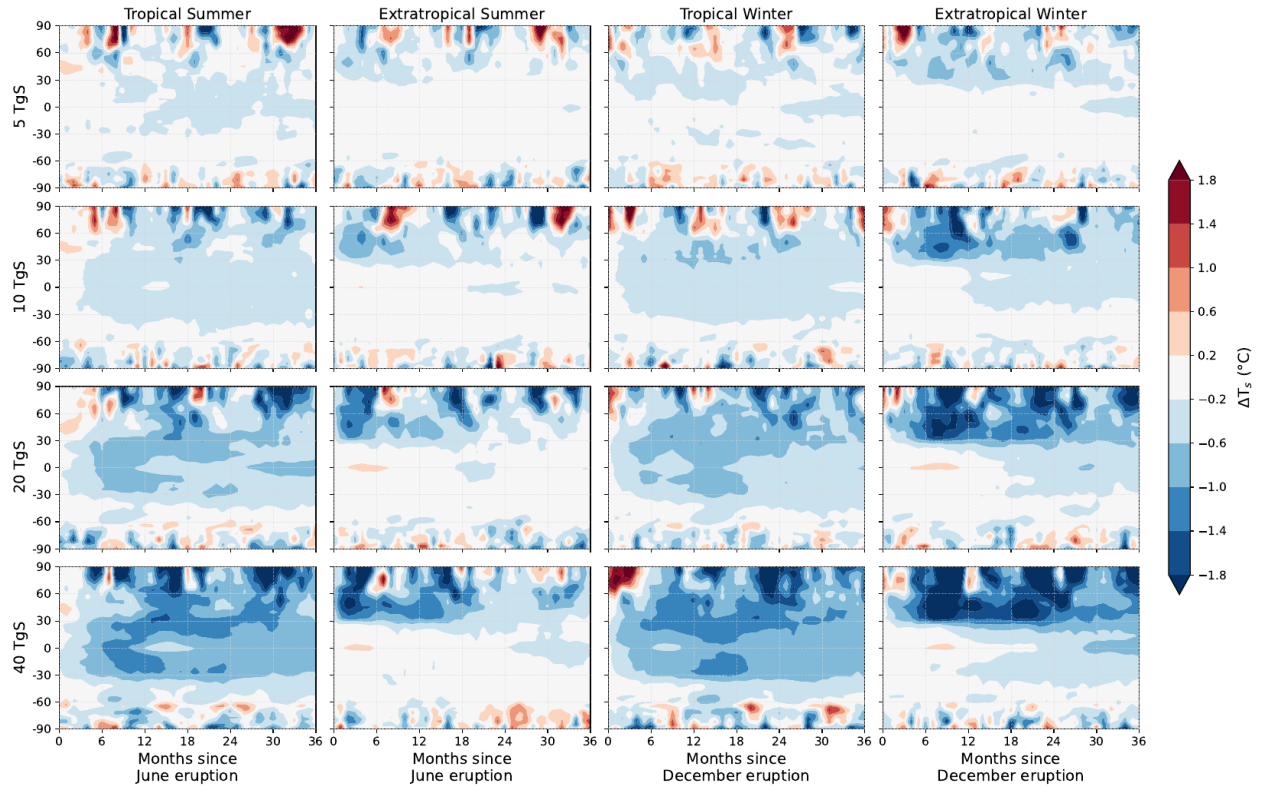


Figure S1. Zonal means of the ensemble-mean surface temperature anomalies from GISS simulations, for each of the simulated eruption cases. Anomalies are calculated relative to a 6-year pre-eruption baseline period.

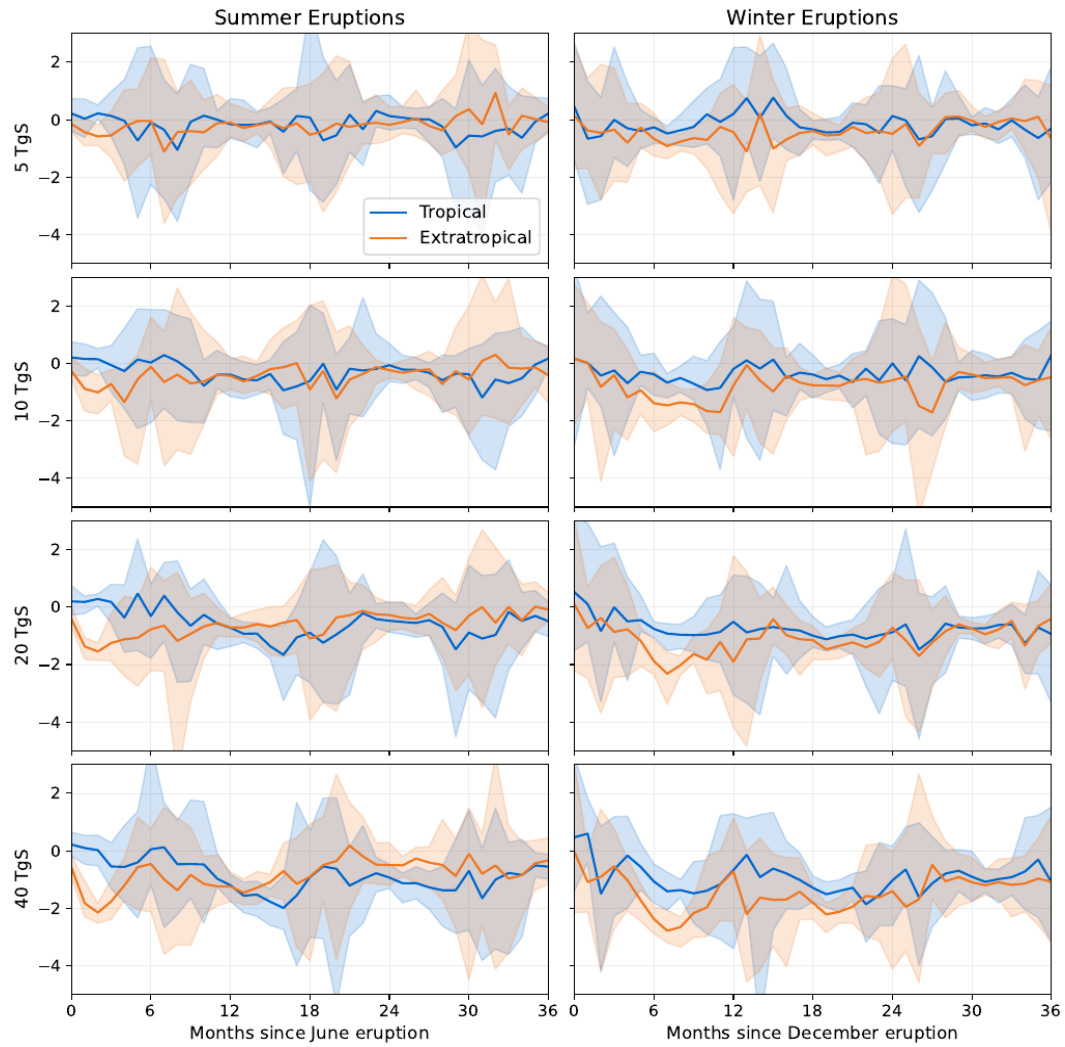


Figure S2. Time series of NHET land-mean surface temperature anomalies from GISS simulations. Means are shown for both tropical (blue lines) and NHET eruption locations (orange lines), while shaded areas show the full spread among ensemble members.

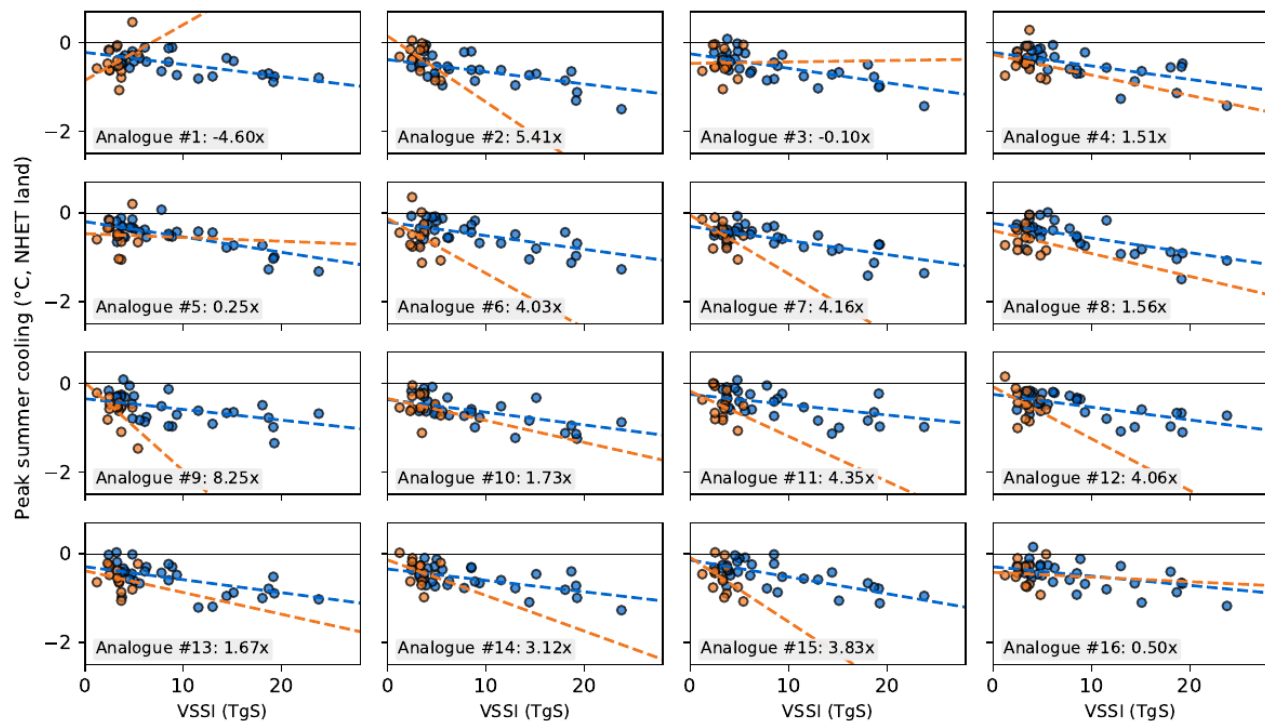


Figure S3. Lack of reliability of the linear regressions method. The estimated extratropical-to-tropical cooling ratio (text in grey box) is presented for each of the first 16 of 100,000 randomly sampled analogues of the paleoproxy cooling record, alongside the individual synthetic eruption events (blue and orange points for tropical and extratropical events, respectively) and the resulting linear regressions (dashed lines) over which the ratio of slopes is calculated. The 1257 CE Samalas eruption is included in the tropical regressions but is outside the plotting range.

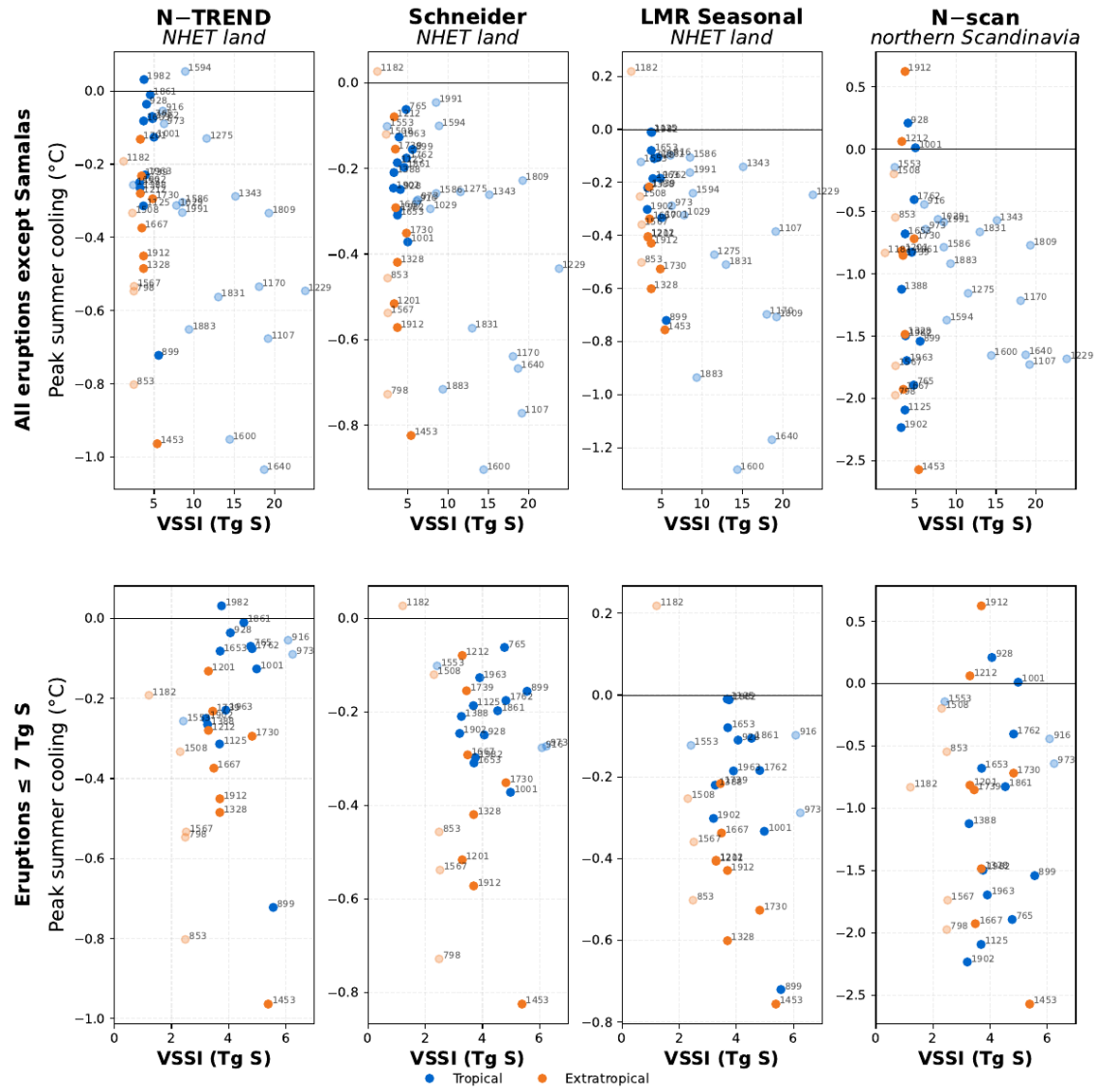


Figure S4. Peak summer NHET cooling versus stratospheric sulfur injection for tropical (blue) and extratropical (orange) eruptions in temperature datasets used in this study. Points show observed cooling from each post-750 CE eruption used in Burke et al. (2023), with dark colors highlighting the 3-6 Tg S range of events used in our analysis, and years labeled adjacent to all points. The top row shows all eruptions except Samalas, while the bottom row zooms in on eruptions ≤ 7 Tg S.

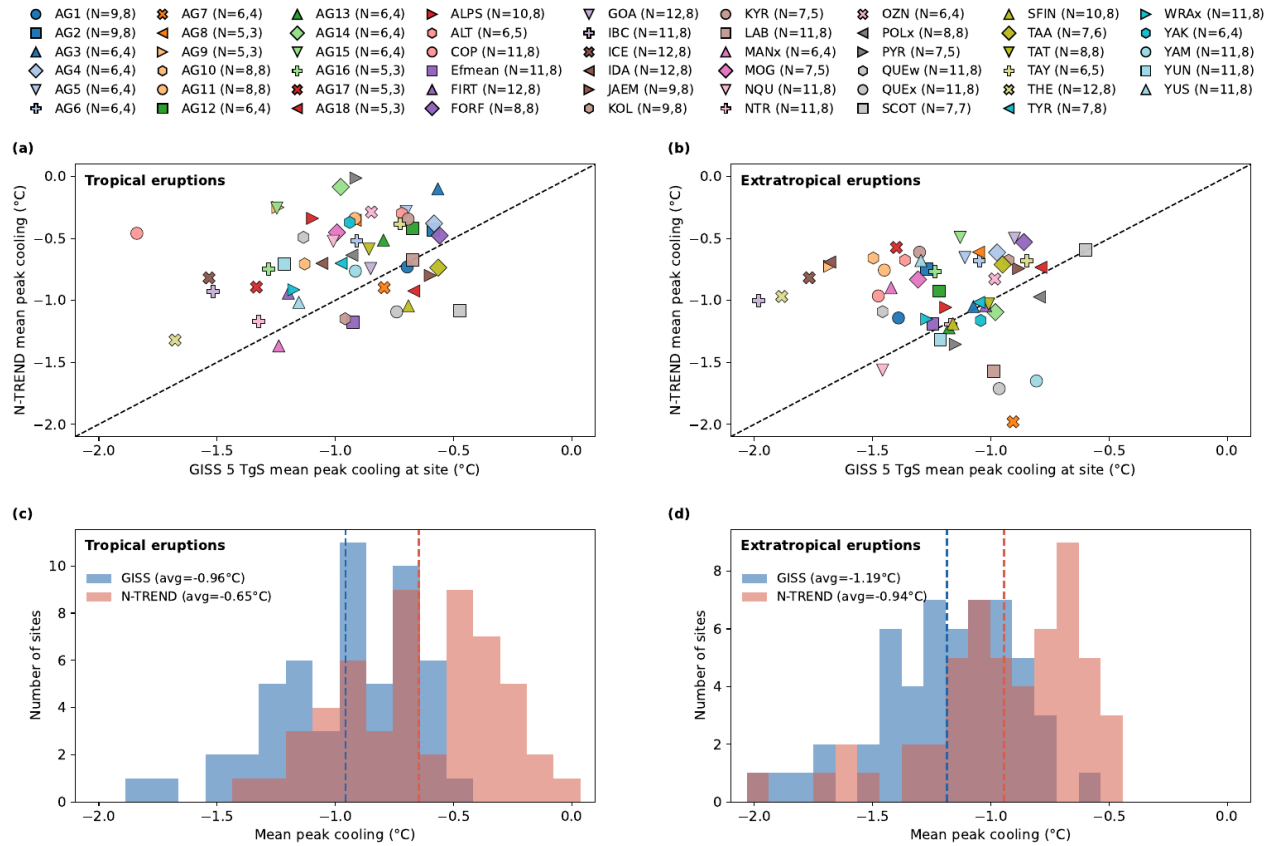


Figure S5. Comparison between GISS and N-TREND at tree ring locations. Calculations are as in Fig. 3, with N-TREND values being peak cooling averaged across all 3-6 TgS tropical (left column) and extratropical (right) eruption events, and each GISS value being equivalent calculations from the mean among simulated 5 TgS eruptions. The legend at top identifies tree ring records by their name used in N-TREND, and for reference we include in the legend the number of 3-6 TgS eruptions covered by each site (format: N = # of tropical eruptions, # of extratropical eruptions). The top row of the figure shows each site individually compared to a 1-to-1 line (dashed line), while the bottom row compares peak cooling across the distributions formed by all tree ring records.

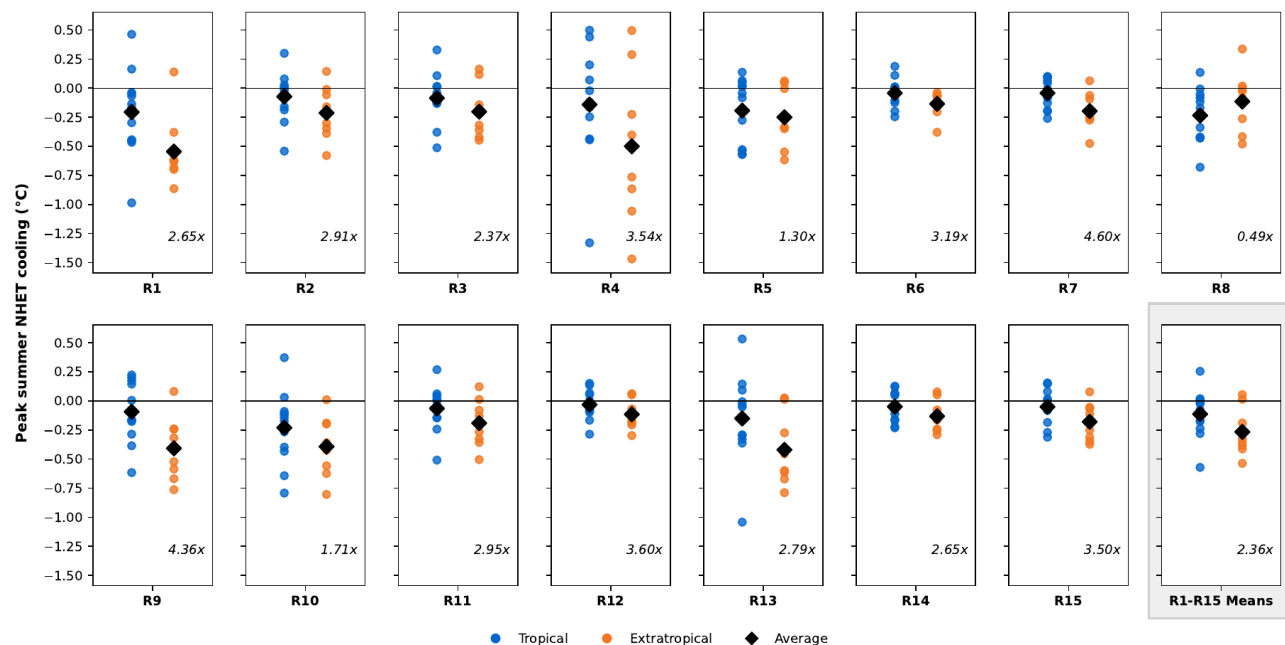


Figure S6. Analysis of 3-6 TgS eruptions as in Fig. 3 but using 15 tree ring temperature reconstructions from Büntgen et al. (2021). Mean results (lower right subplot) are calculated by averaging the peak cooling of each eruption event after this metric is computed separately in each of the 15 reconstructions. We note that this approach yields distinct results from direct use of the mean reconstruction (“Rmean”) provided in the Büntgen et al. (2021) dataset.