Changes in the shape of summer temperature distributions and the probability of extremes

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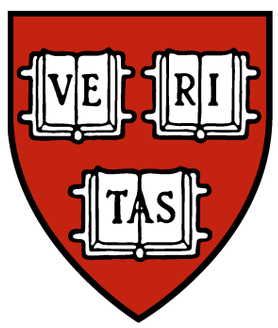
9 February 2016
CVCWG meeting, Boulder, CO



Fearless collaborators

Andy Rhines
UW

Martin Tingley
IAG

Peter Huybers
Harvard

Three sections of the talk

daily temperature data, non-normality, and quantile regression

changes in the shape of summer temperature distributions

comparison with the large ensemble

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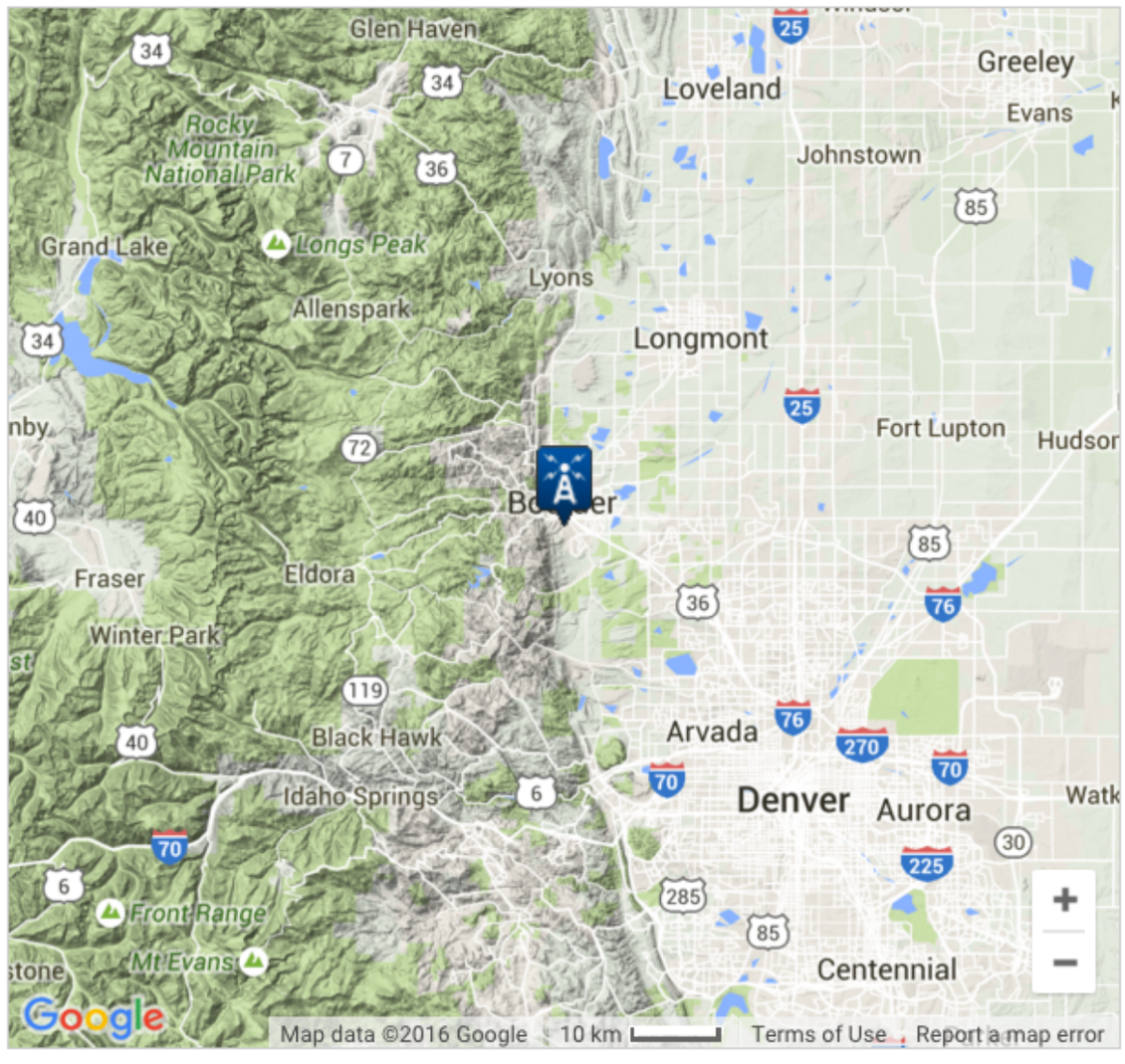
Data source: global historical climatology network

Daily Summaries Station Details

STATION DETAILS	
Name	BOULDER, CO US
Network:ID	GHCND:USC00050848
Latitude/Longitude	39.9919°, -105.2667°
Elevation	1671.5 m

PERIOD OF RECORD	
Start Date[1]	1893-10-01
End Date[1]	2016-01-24
Data Coverage[2]	96%

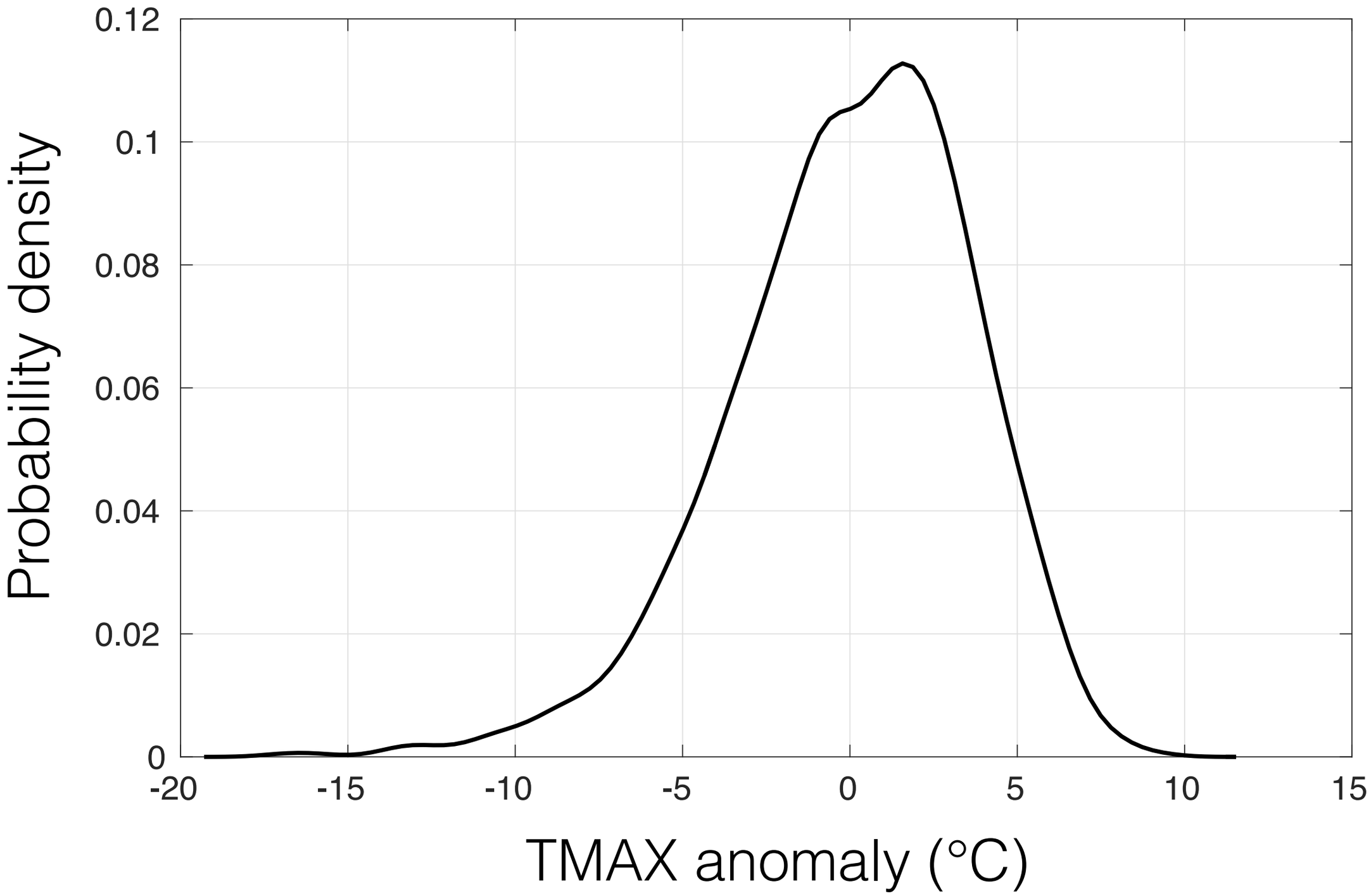
ADD TO CART



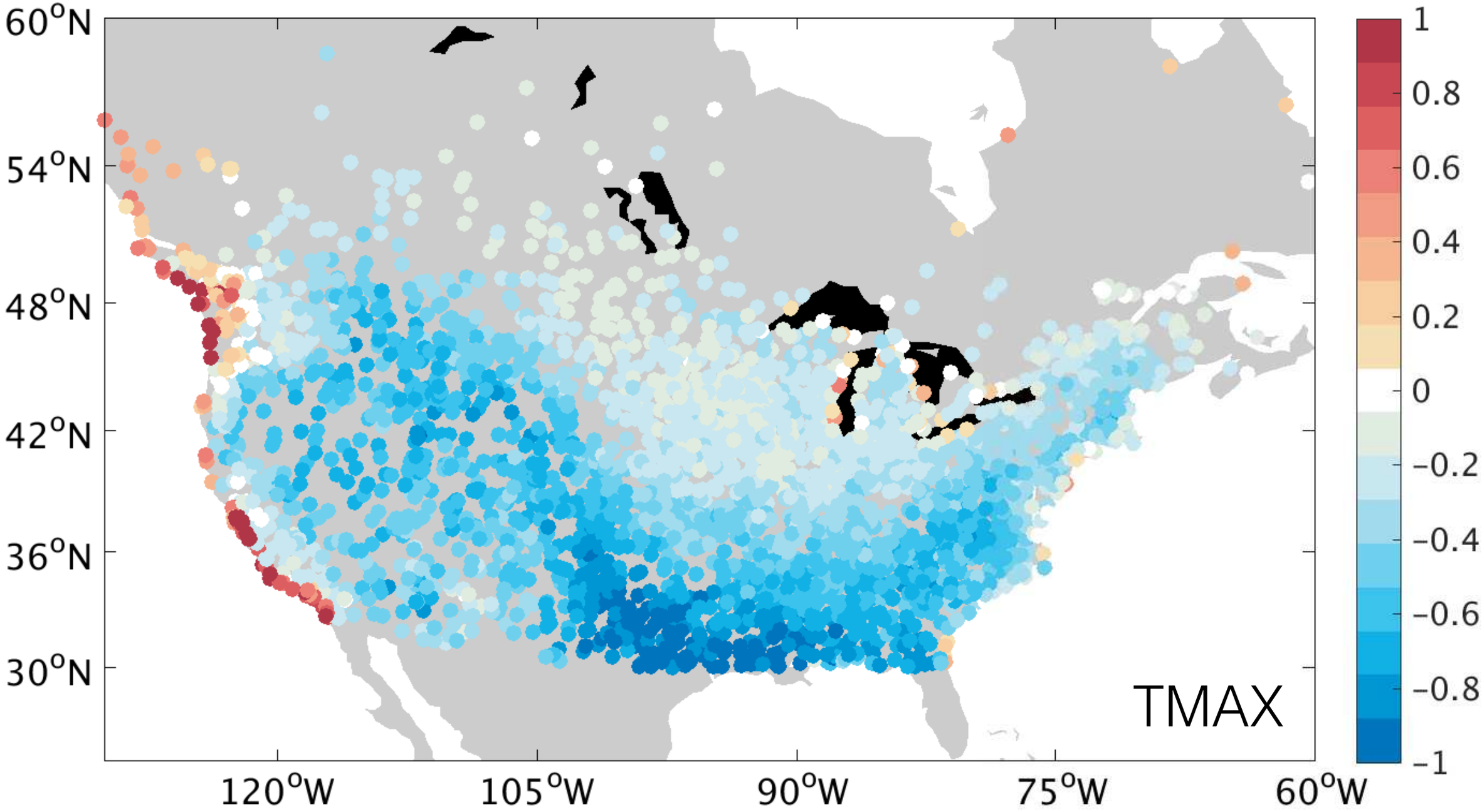
Contains daily maximum and minimum temperatures from weather stations

Data quirks: changes in location, thermometers, time of observation

Example: Boulder summer temperature anomalies



Most non-coastal stations have negative skew



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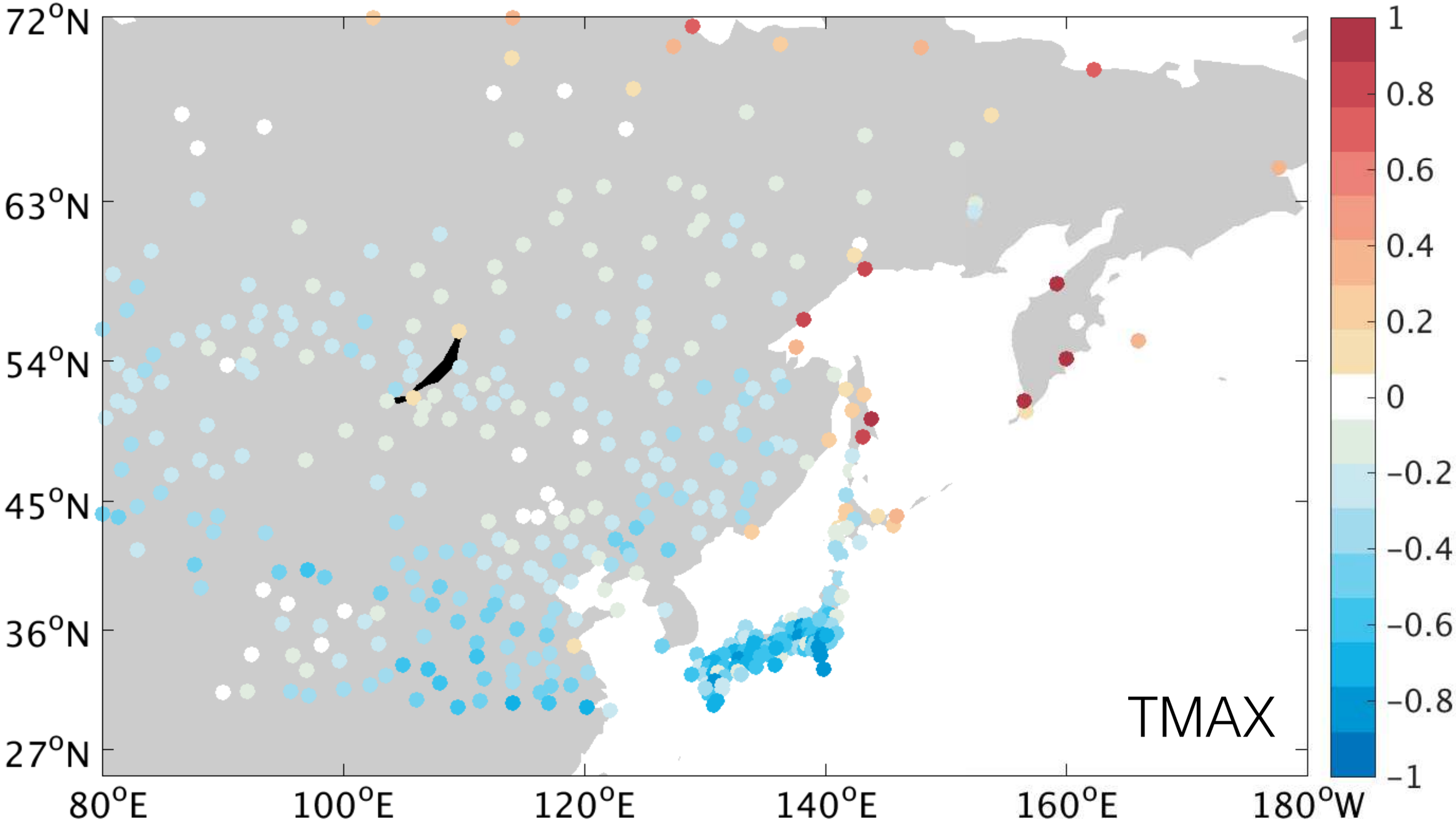
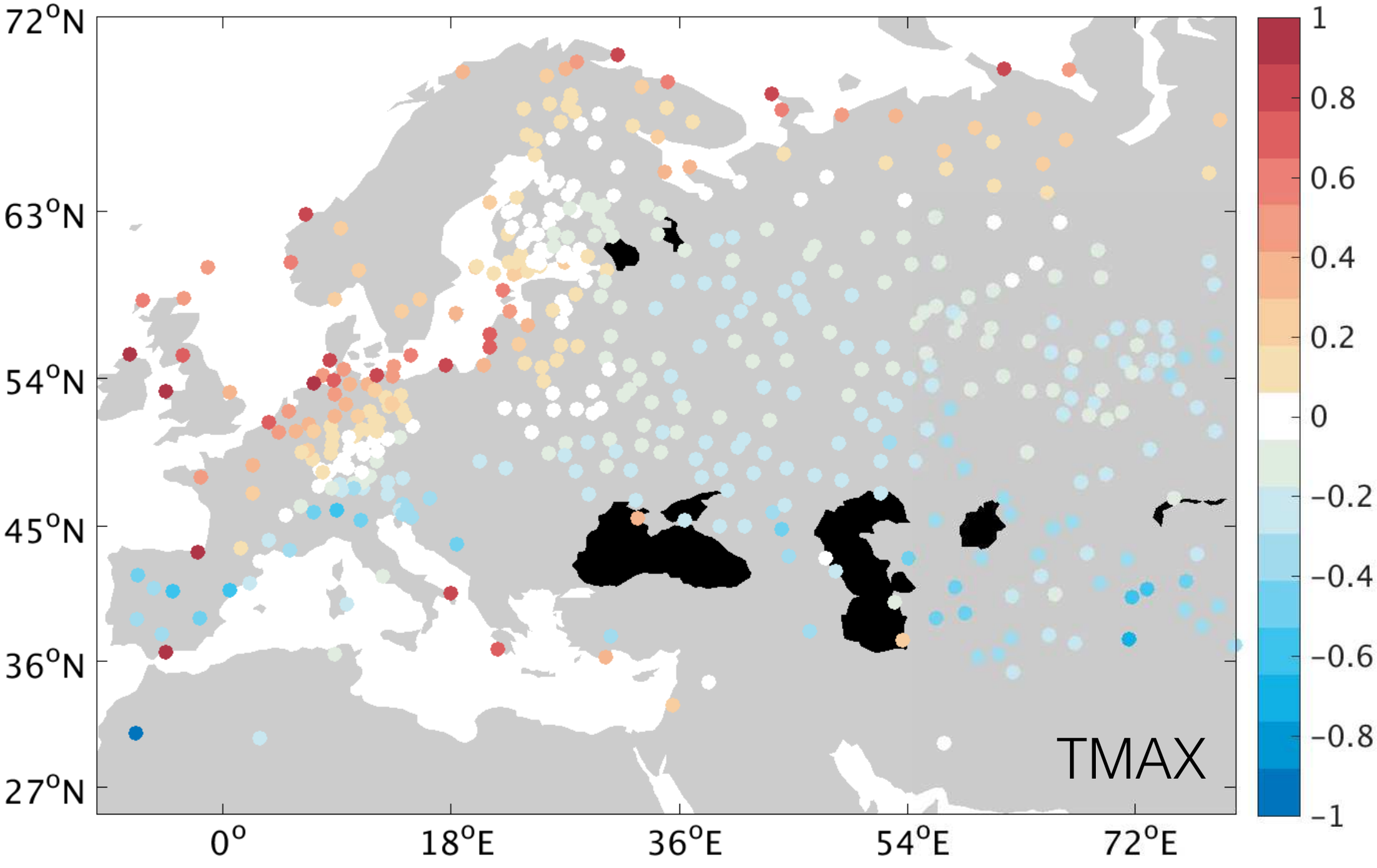
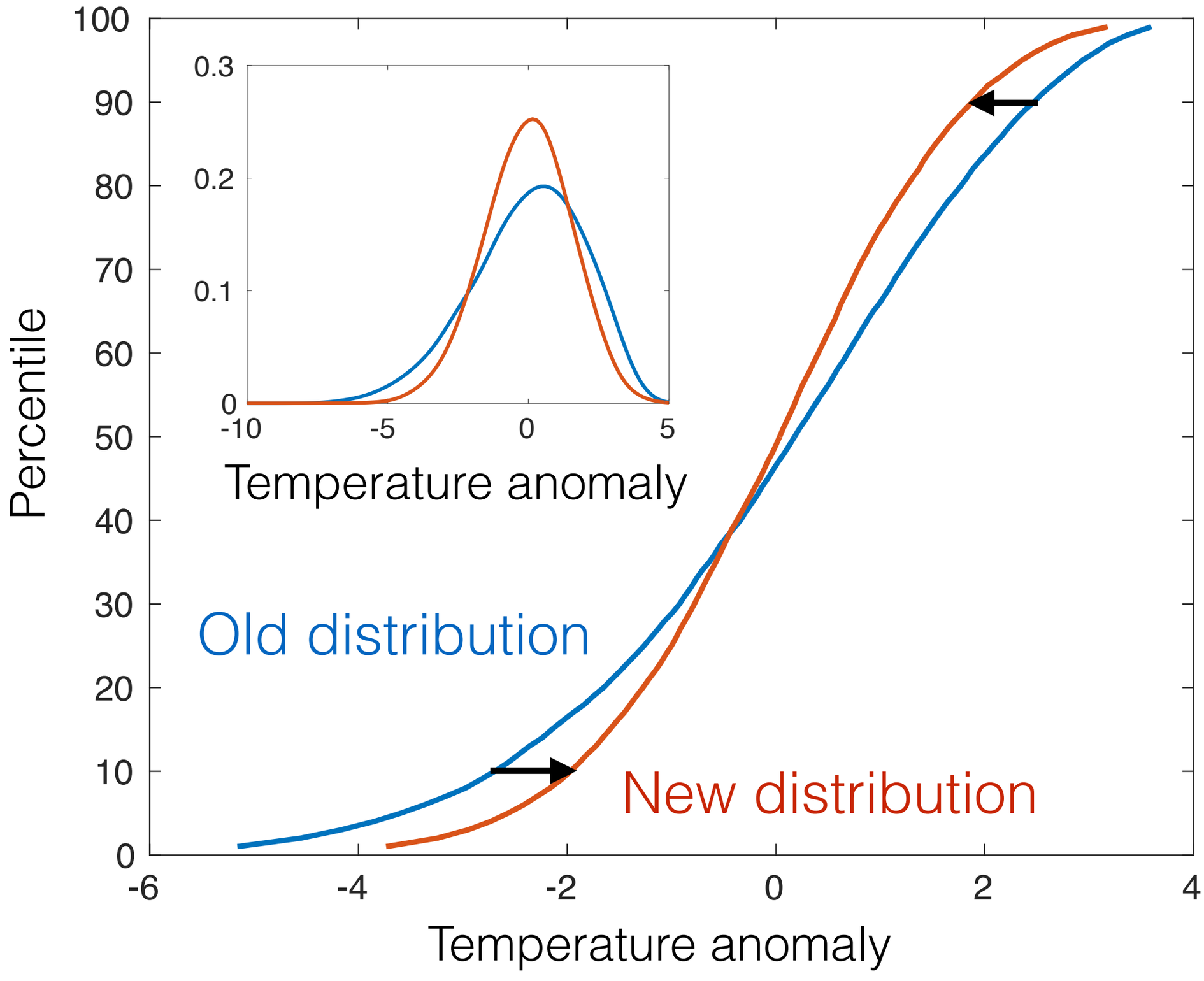


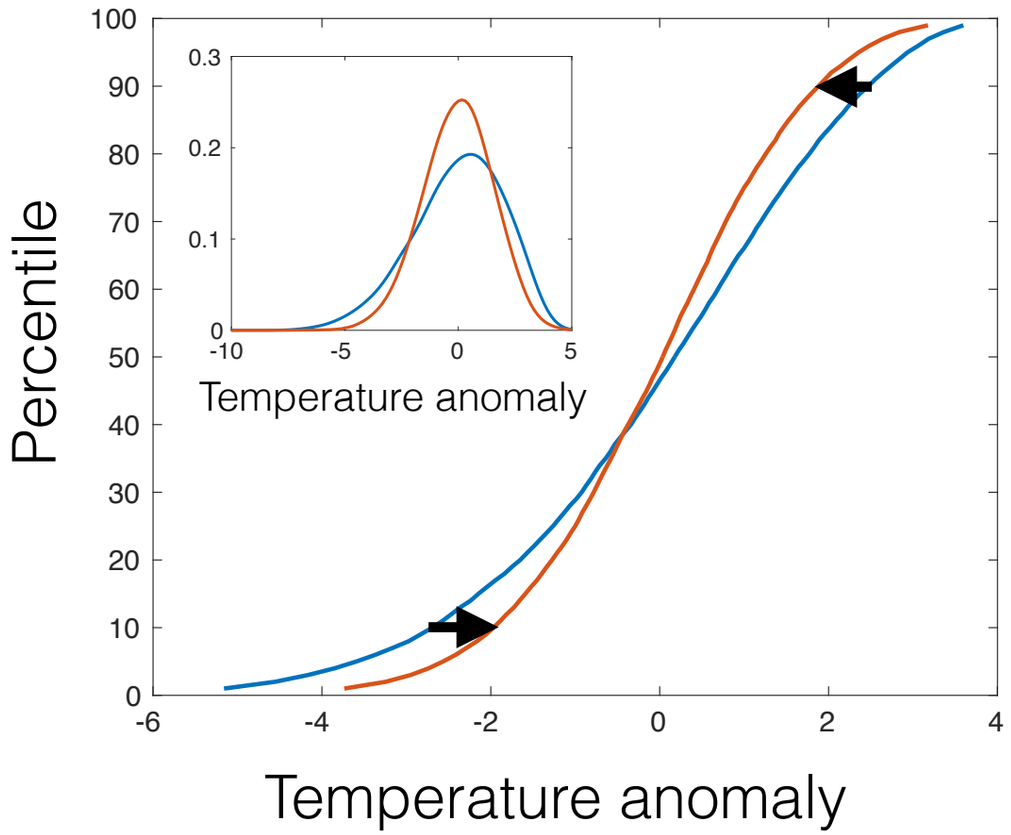
In Europe, coastal influence on skewness extends inland

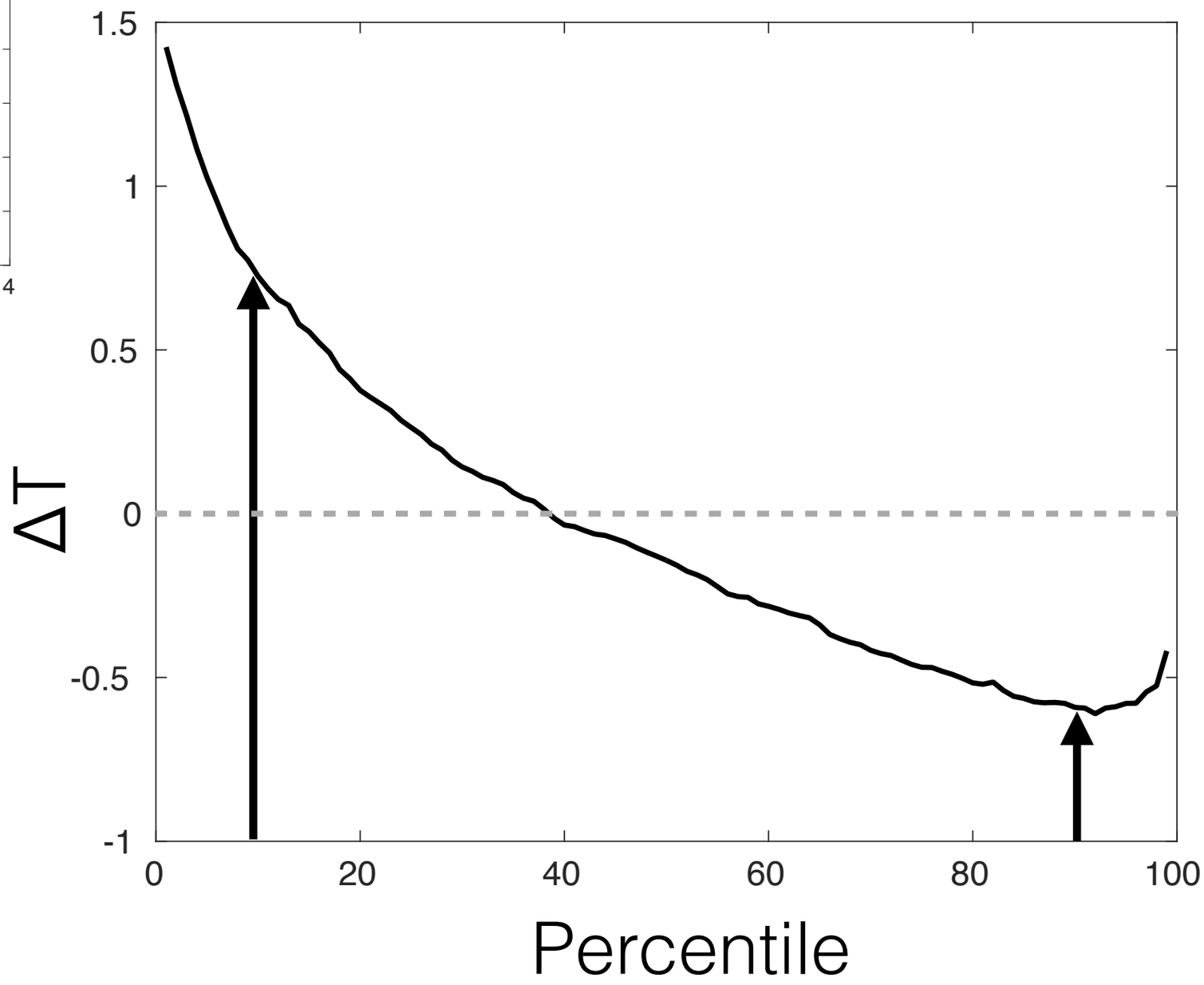


Example: decreasing variance and skewness



Change in quantile function across percentiles





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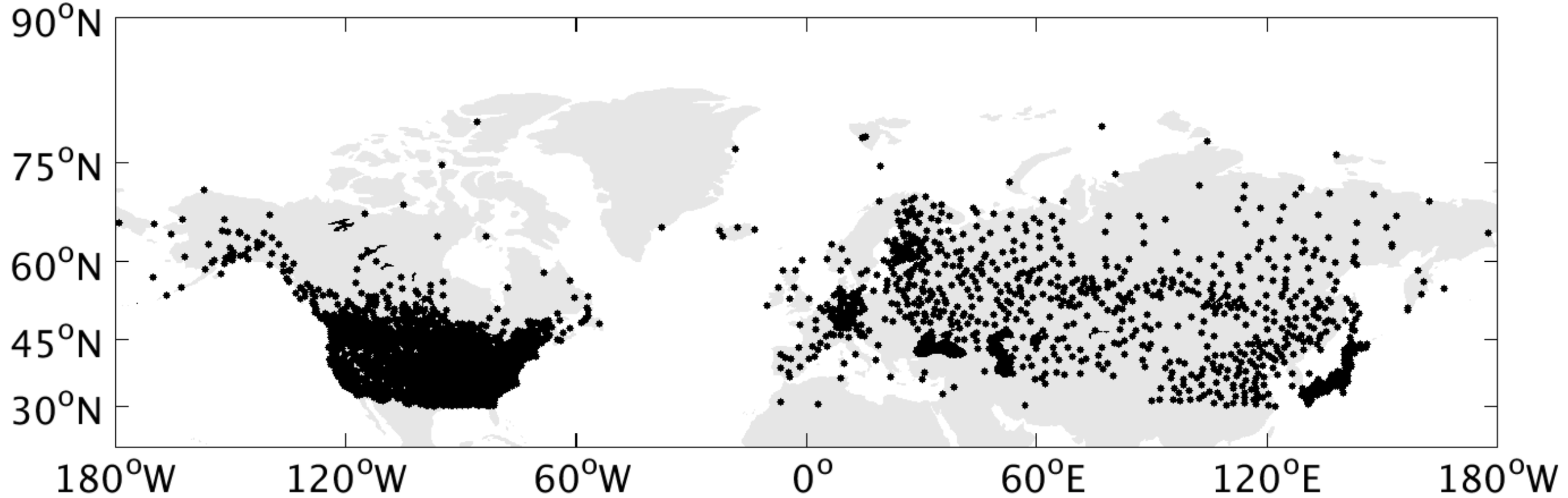
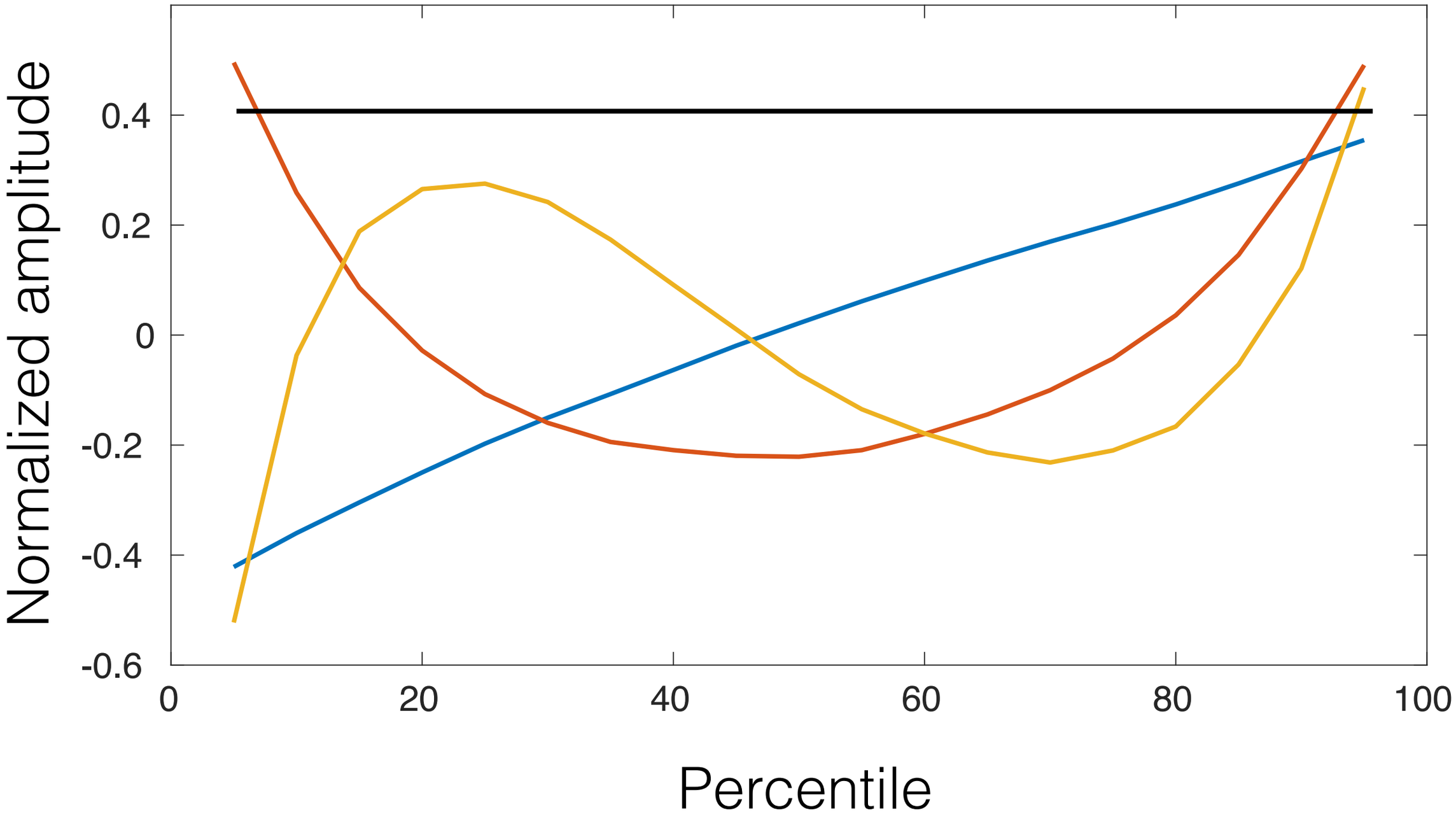
Analysis of NH extratropics (30-90N)

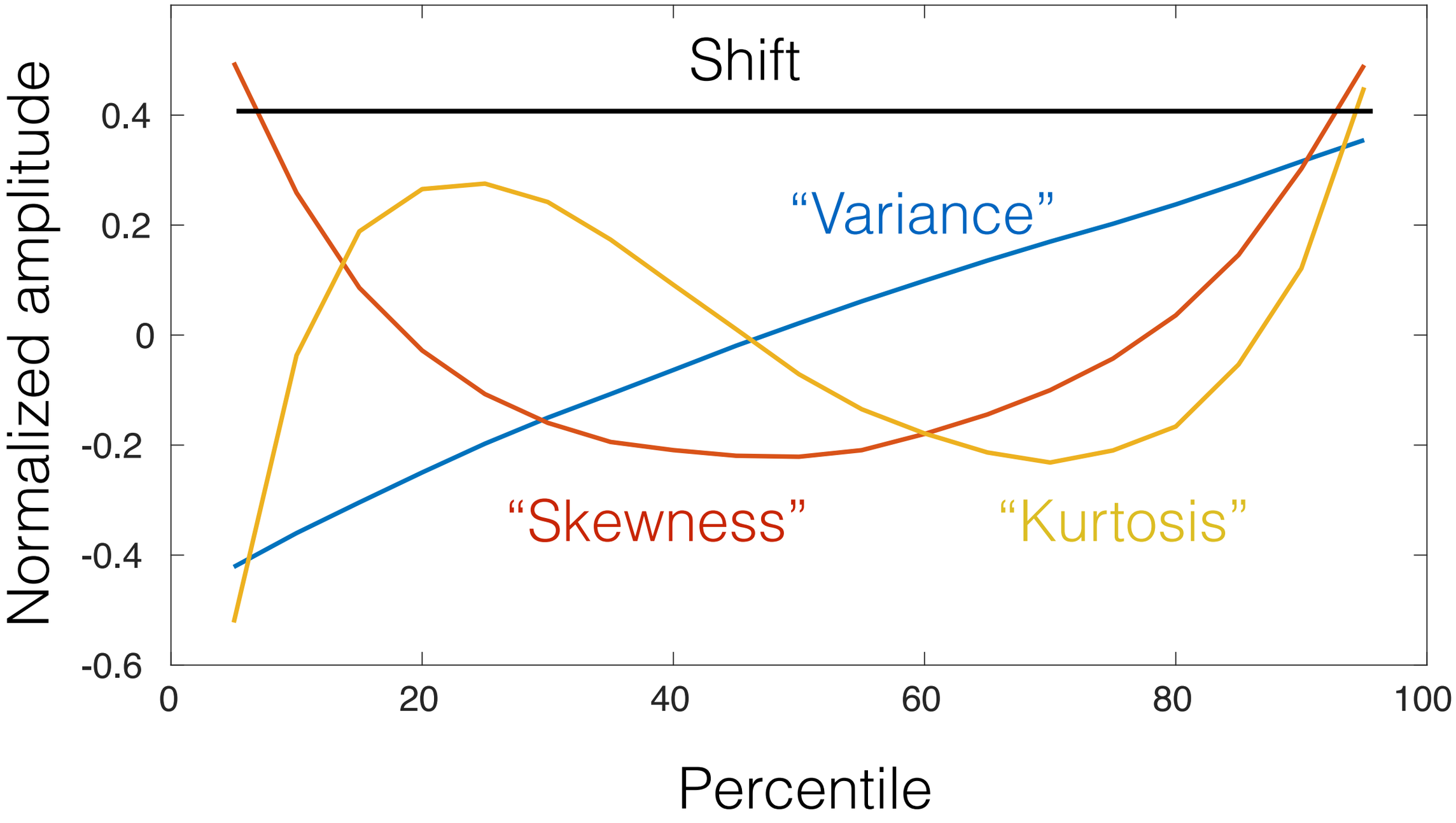


Location of stations that have sufficient data from 1980-2014

Dominant patterns of variability in quantile space



Dominant patterns of variability in quantile space



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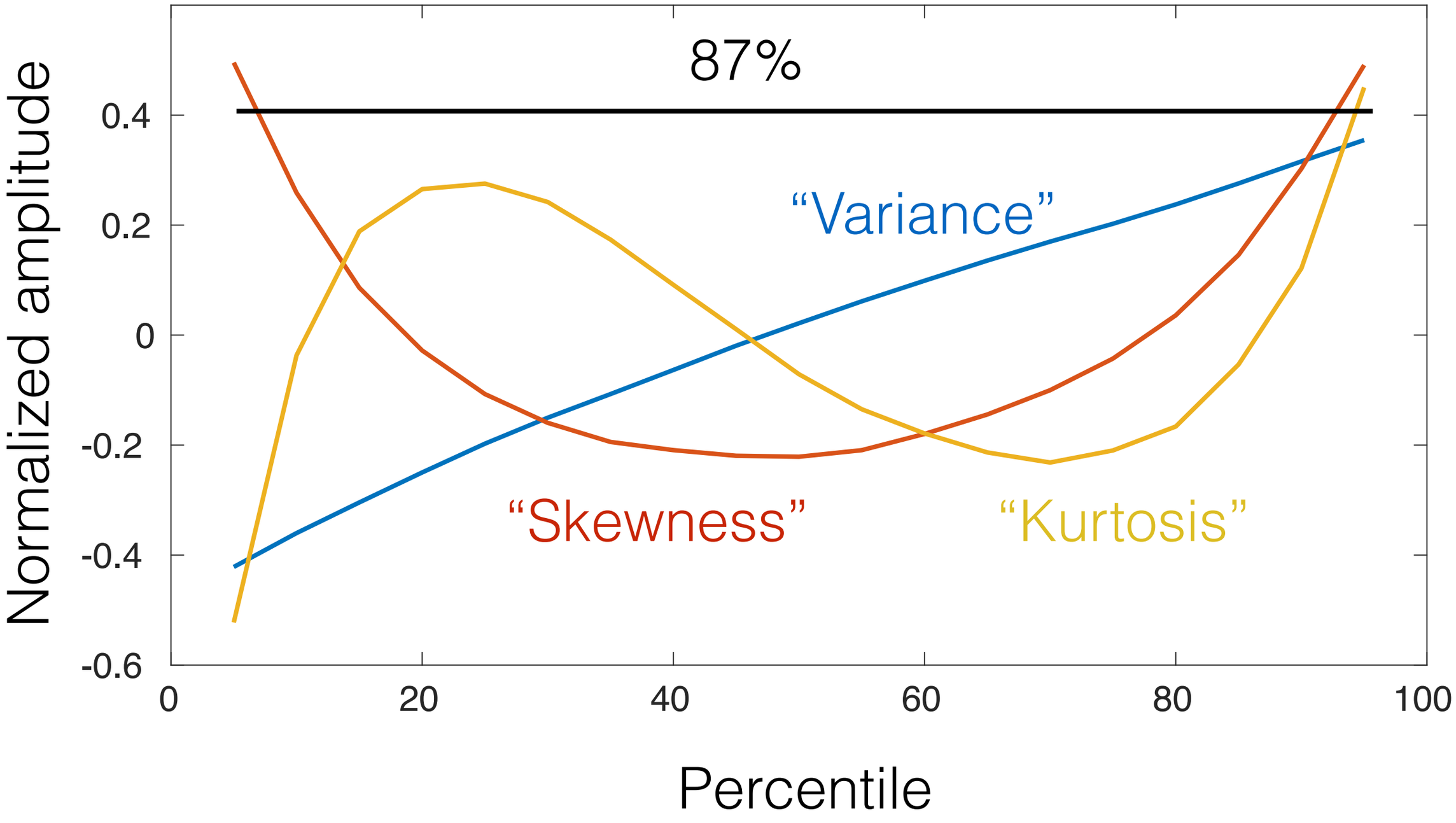
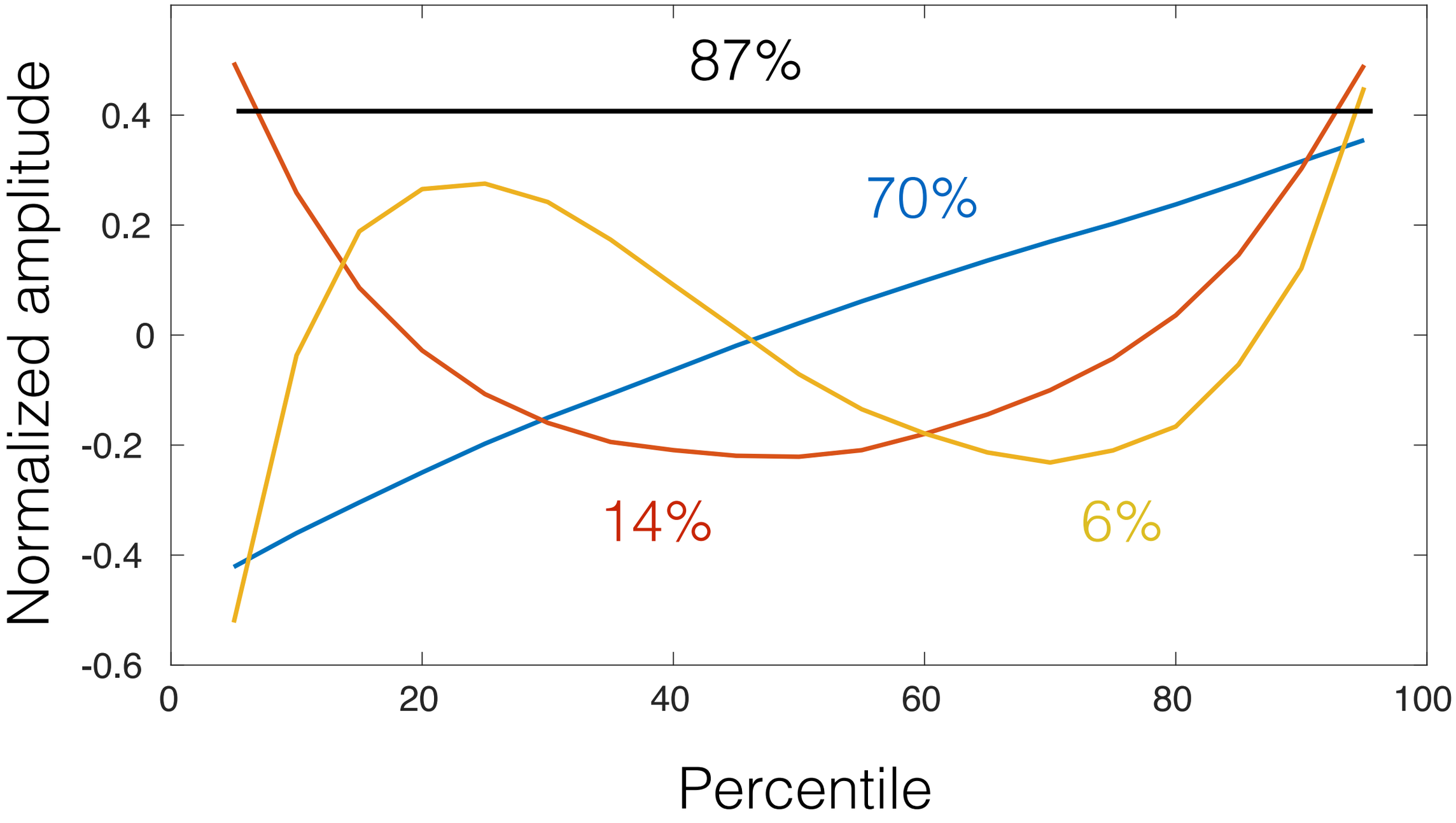


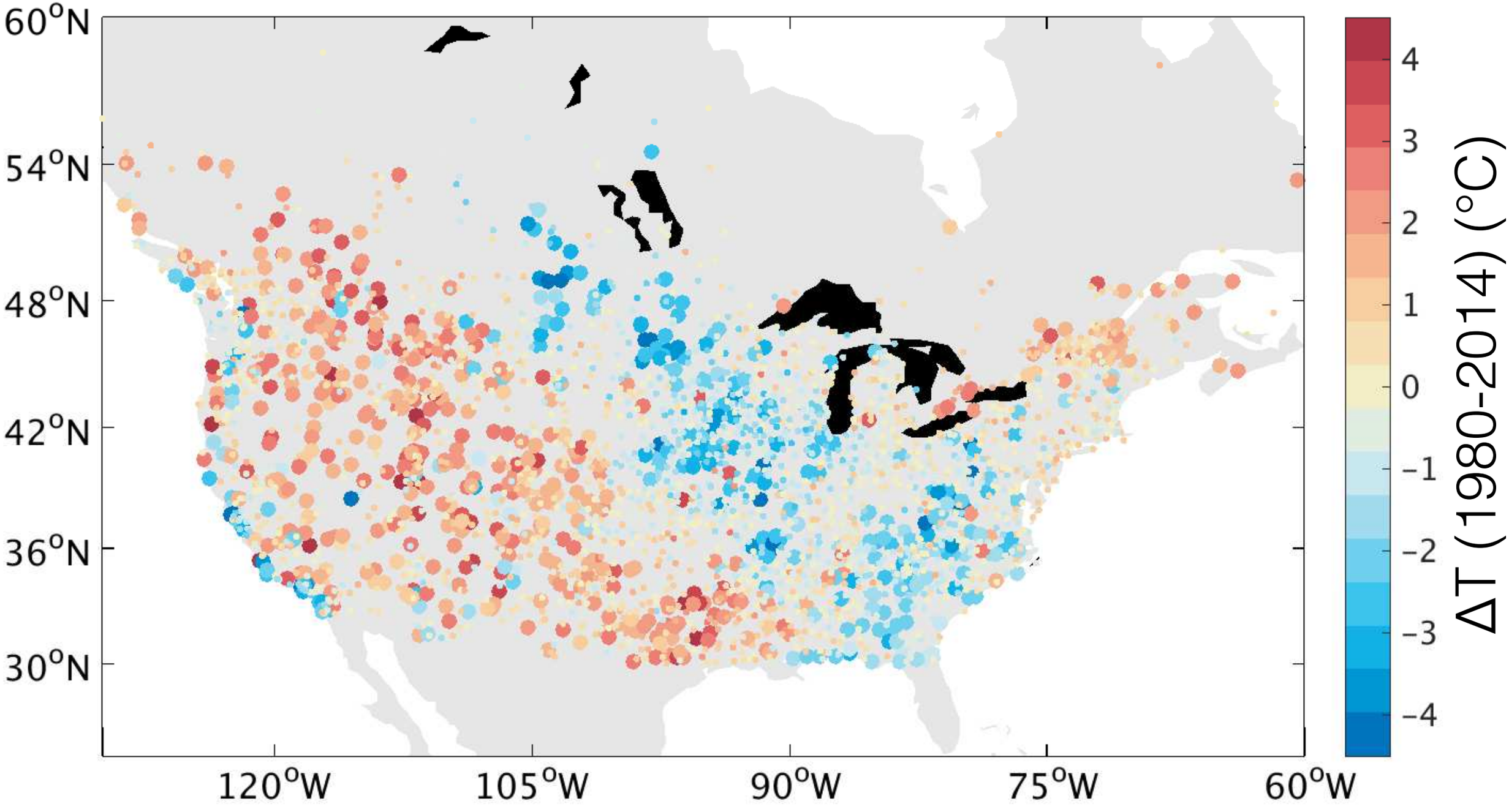
Mean shift explains 87% of variance globally for **TMAX**

Dominant patterns of variability in quantile space

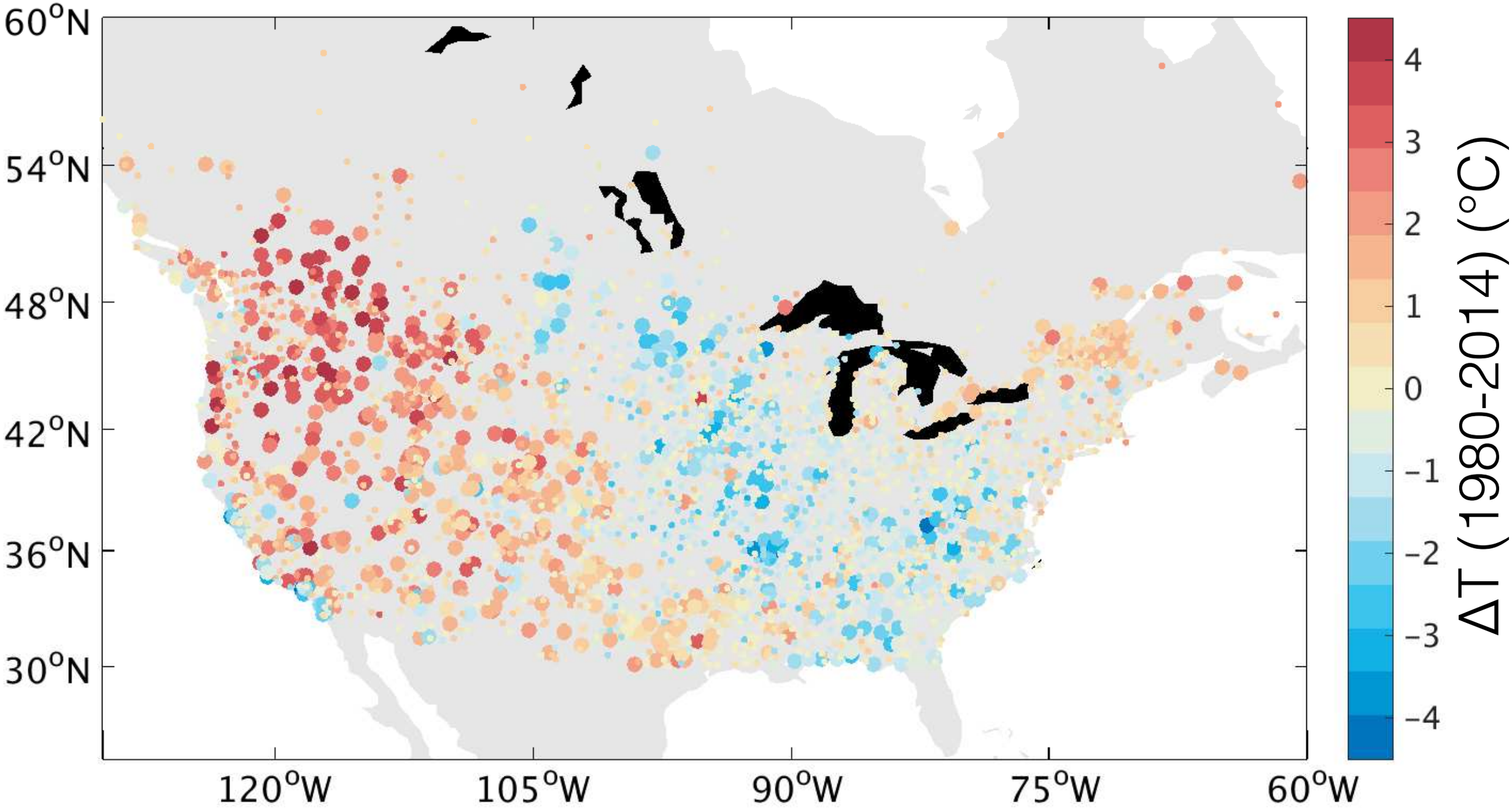


Mean + three basis functions explain 98.7% of variance

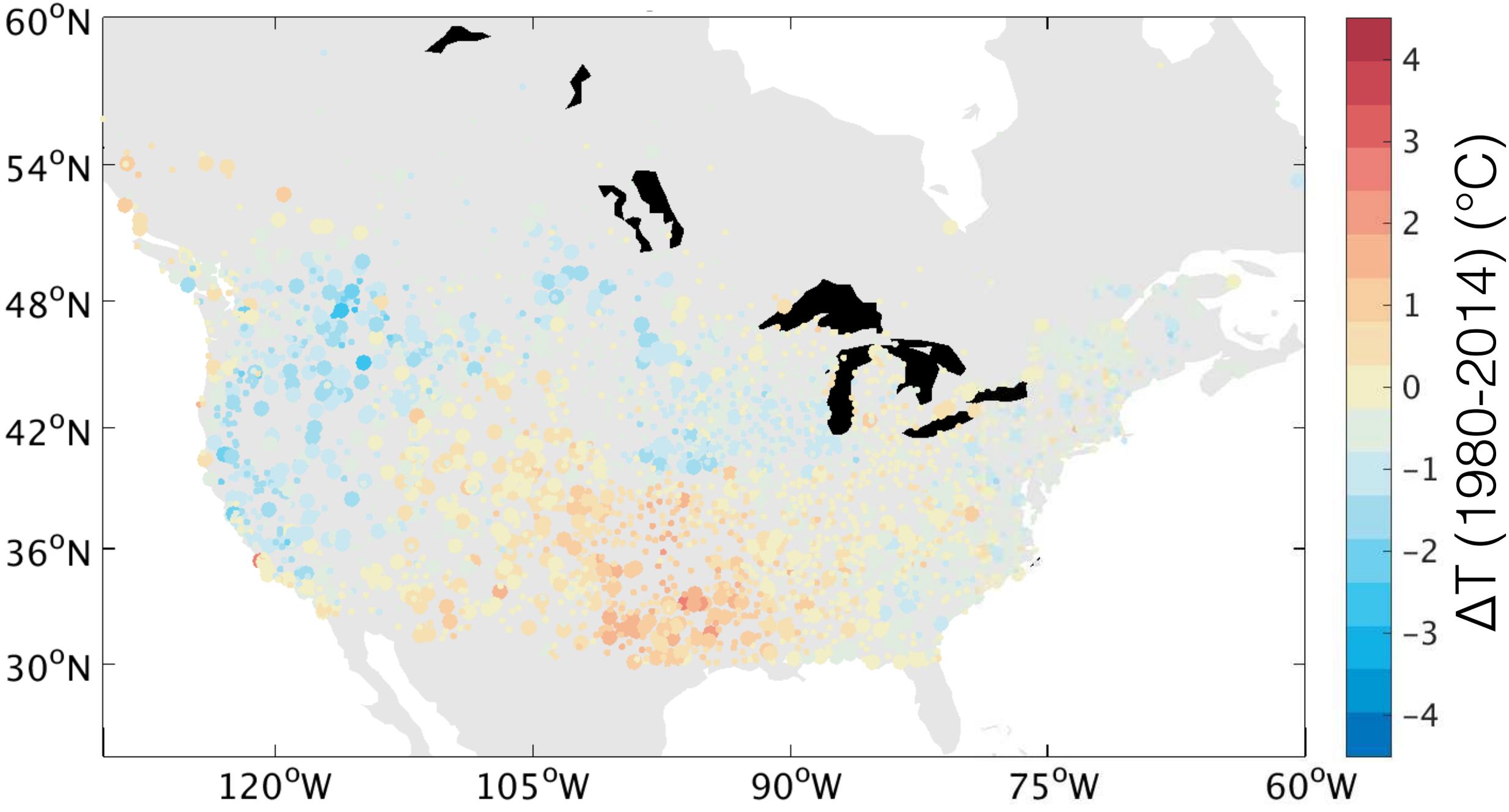
Total change in 95th percentile of TMAX (1980-2014)



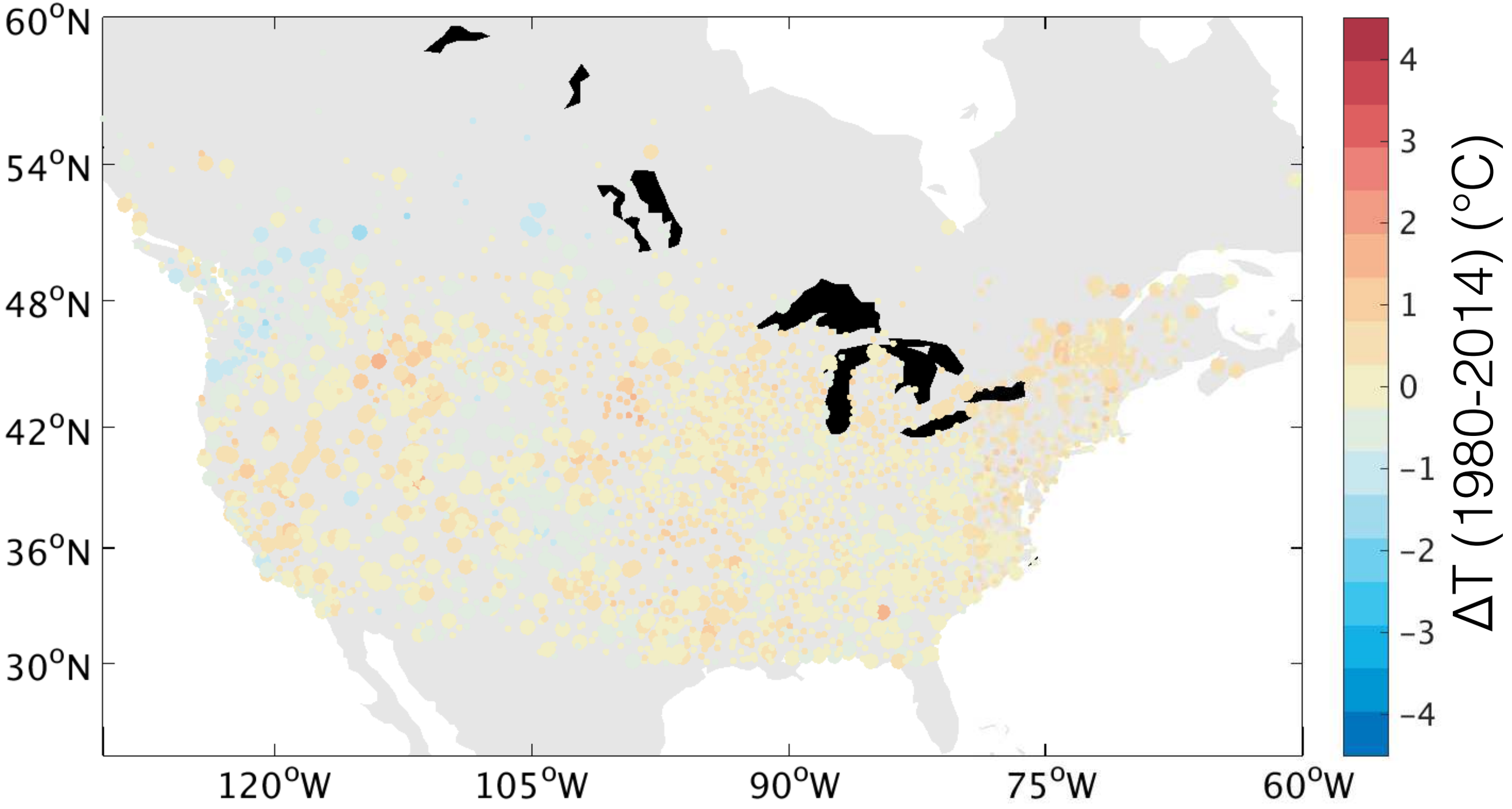
Change in 95th due to mean shift



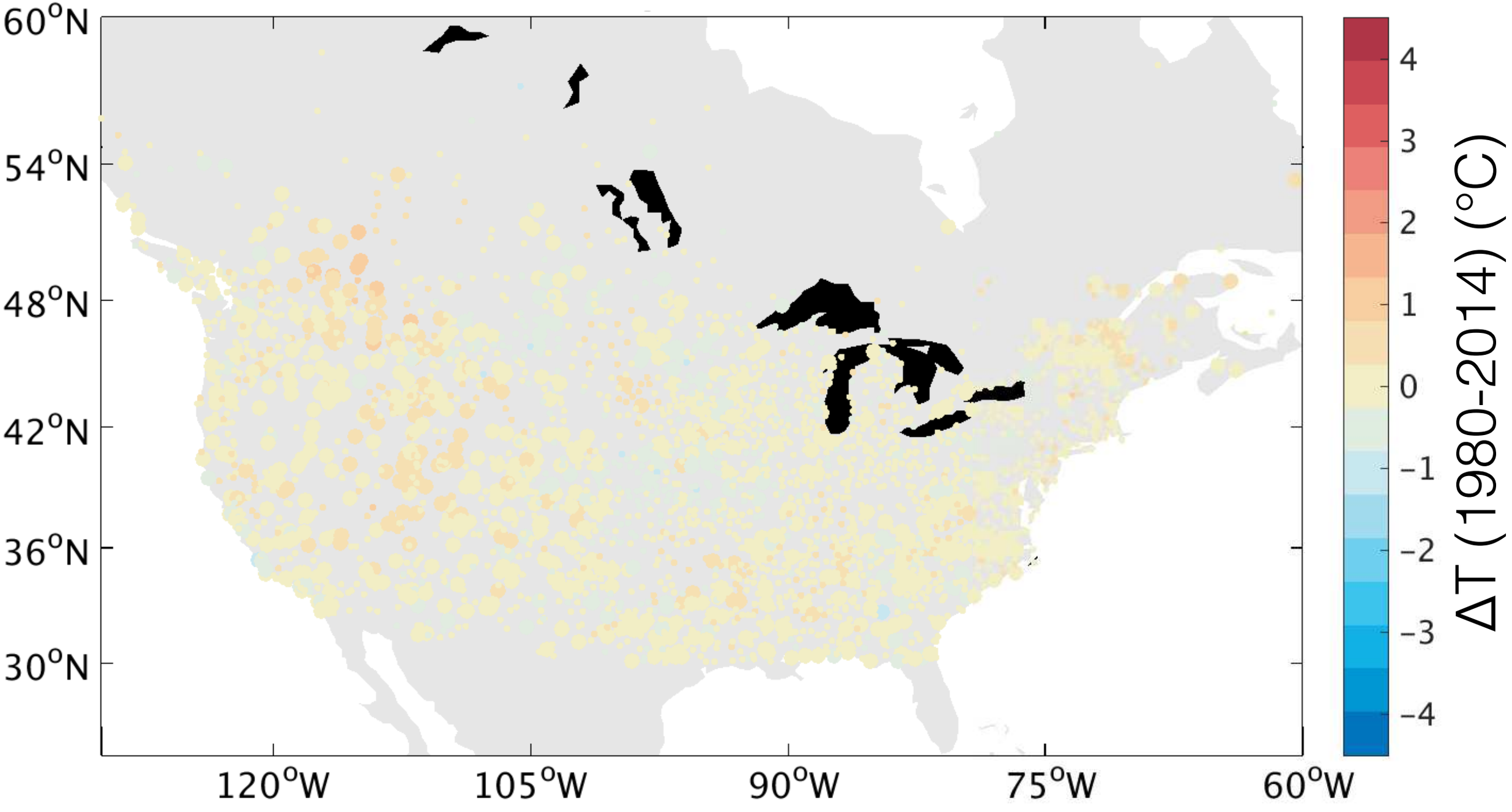
Change in 95th due to variance basis function



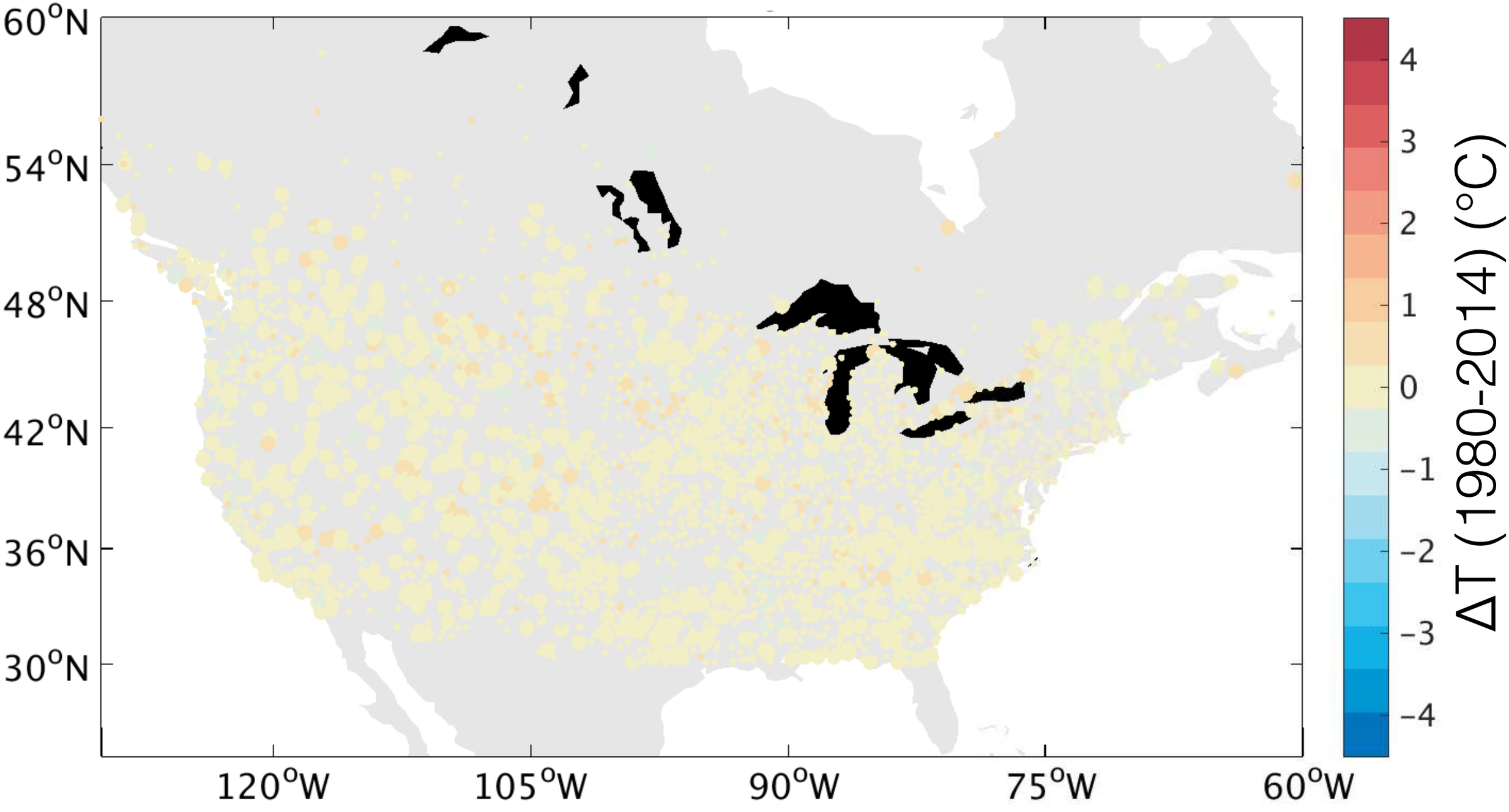
Change in 95th due to skewness basis function



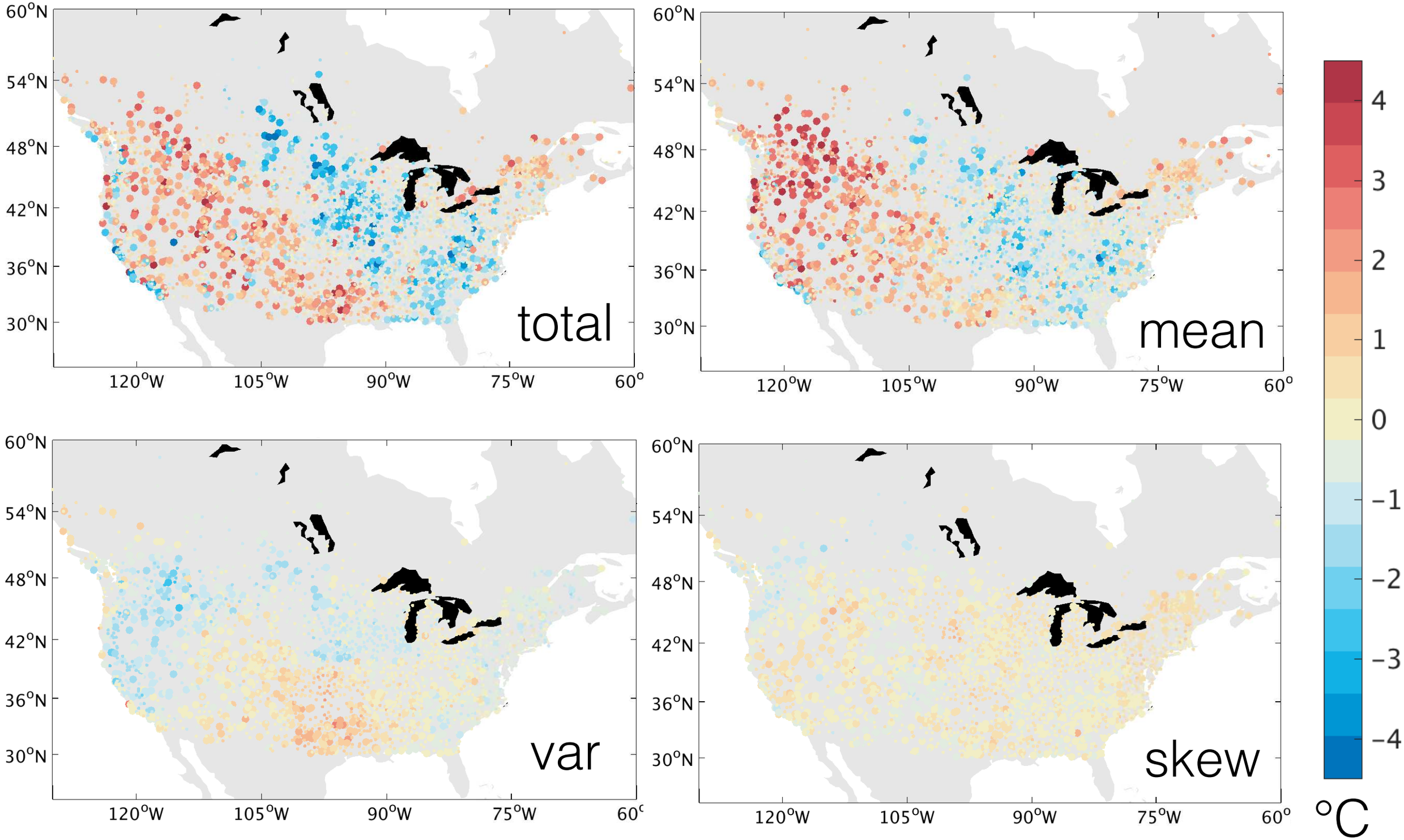
Change in 95th due to kurtosis basis function



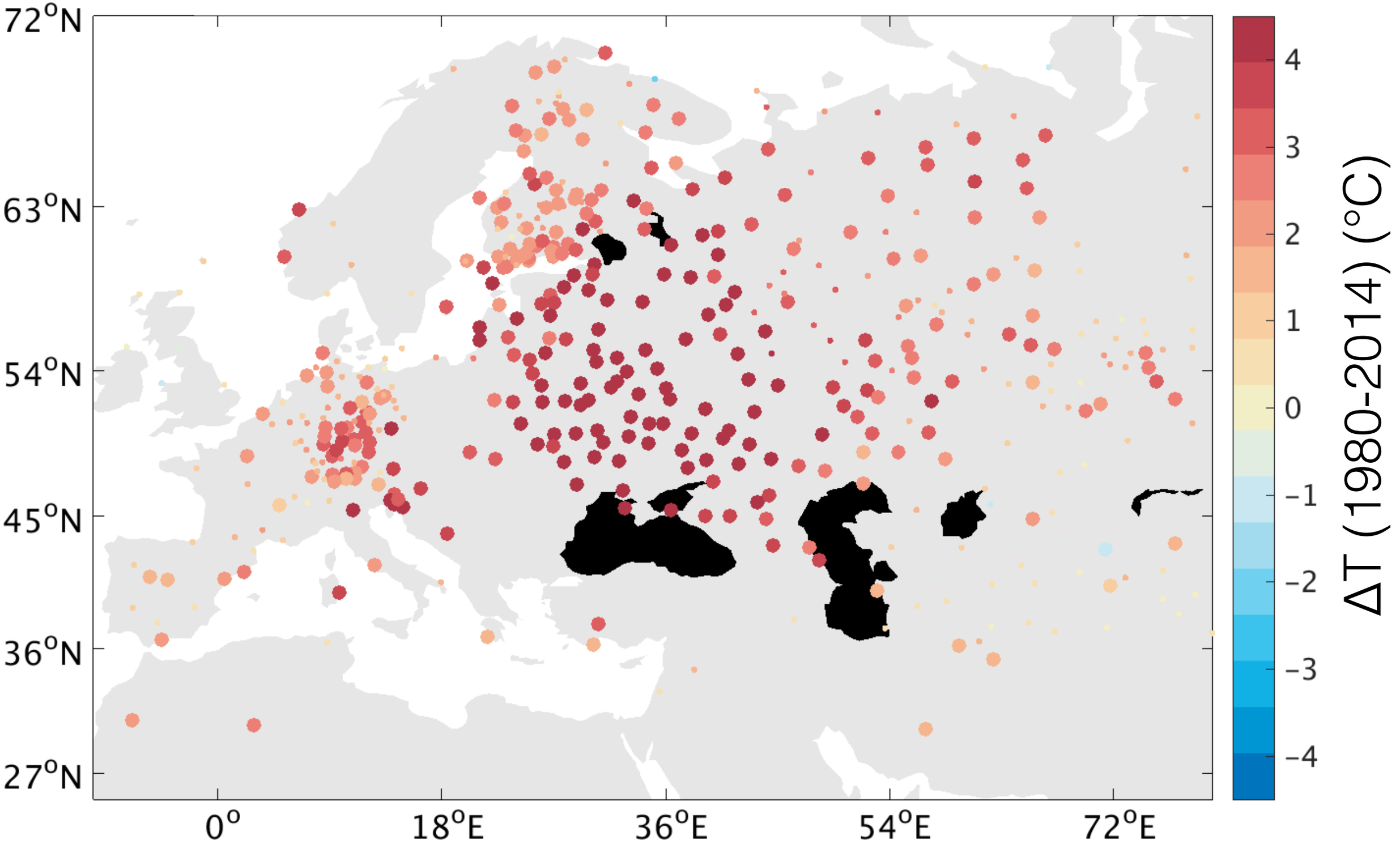
Residual change in the 95th percentile



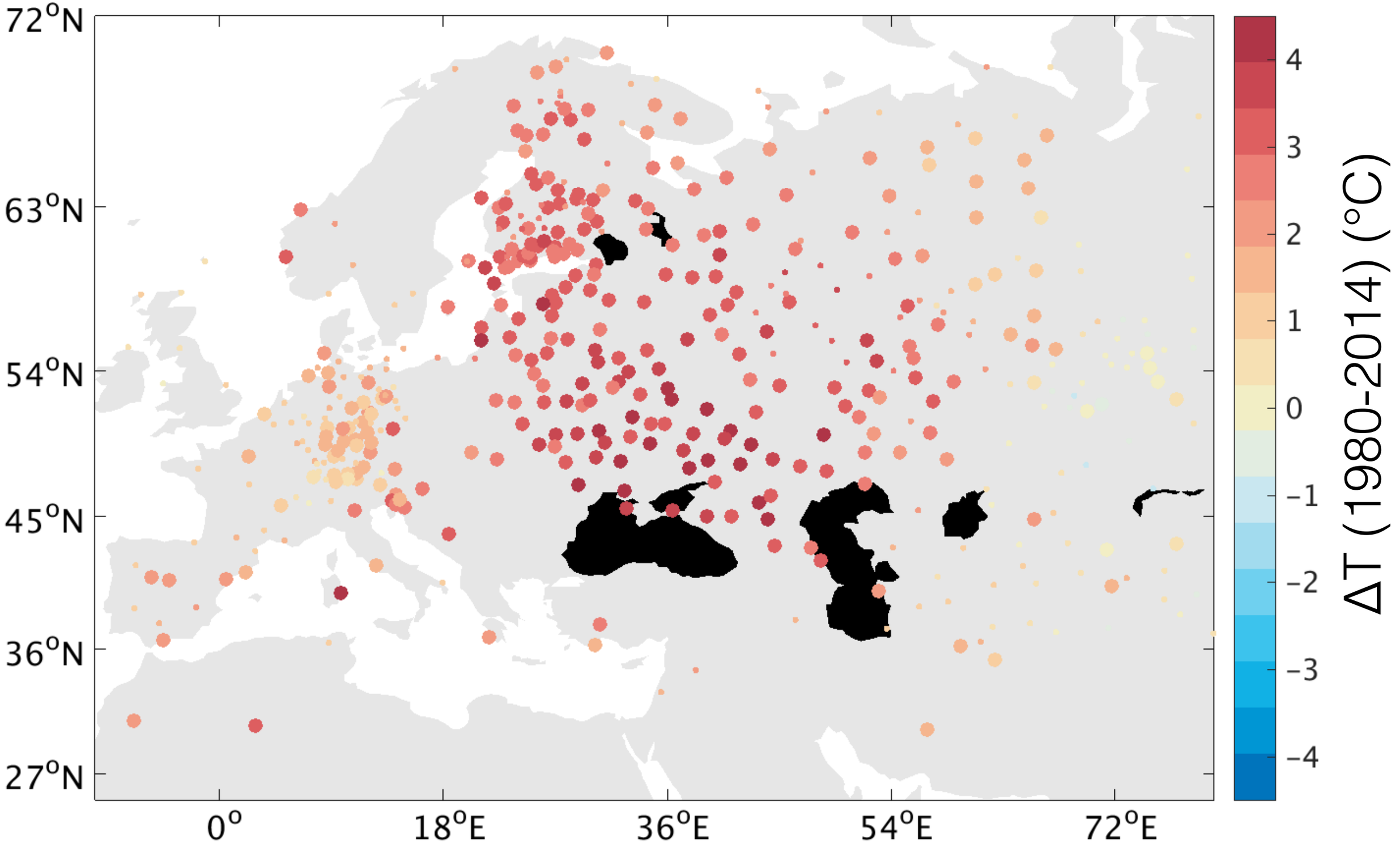
Distinct spatial patterns for mean and variance



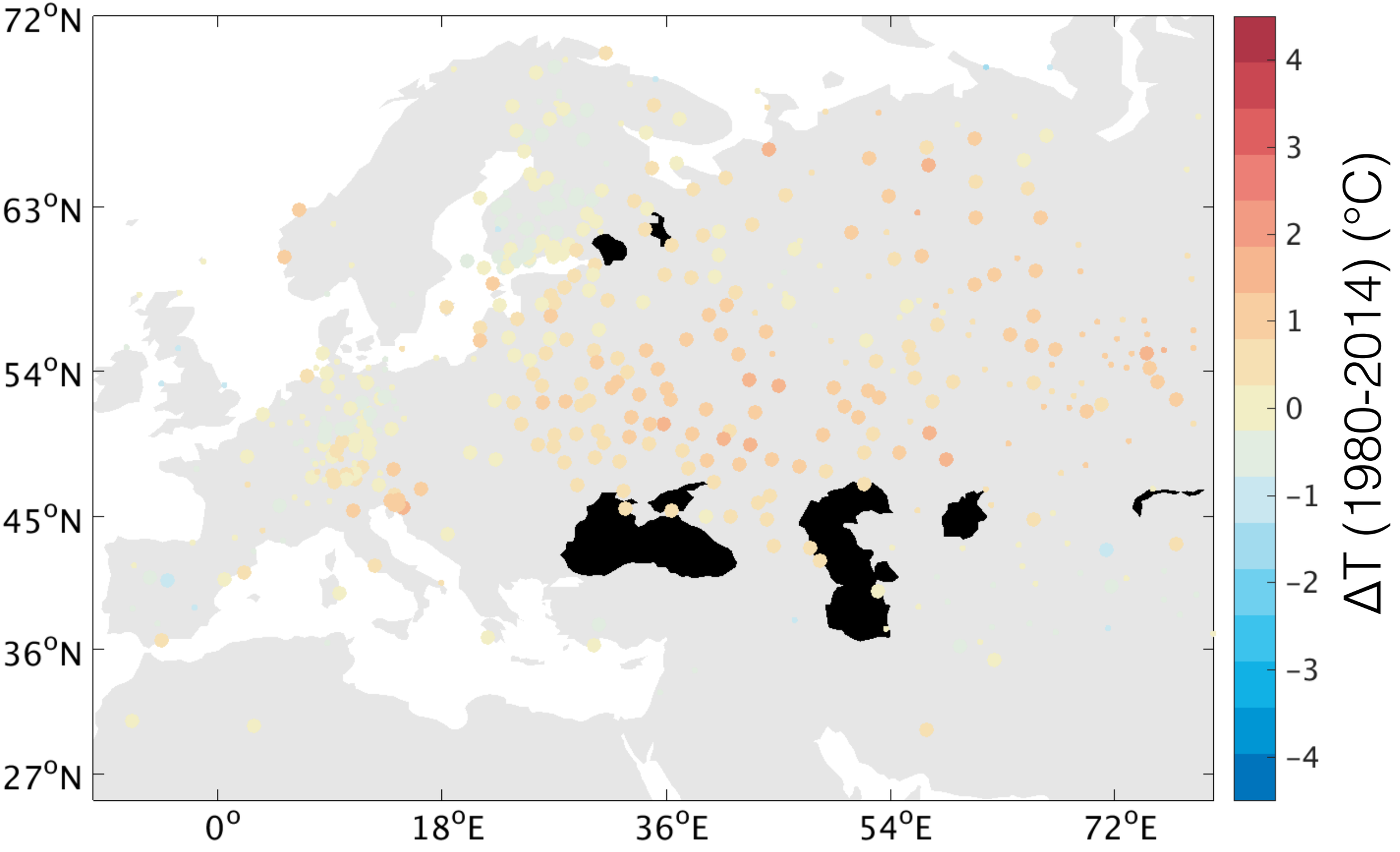
Total change in 95th percentile of TMAX (1980-2014)



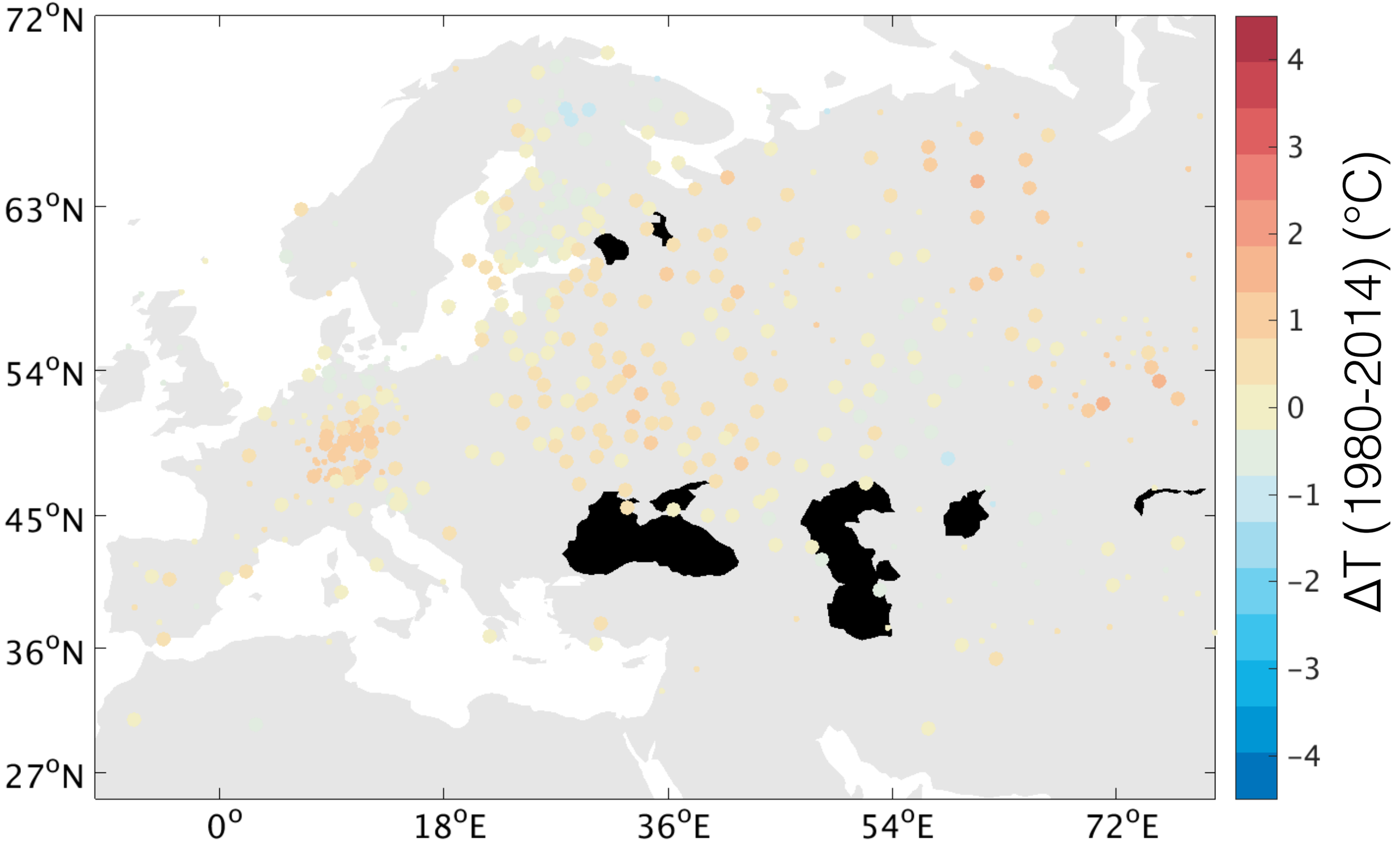
Change in 95th due to mean shift



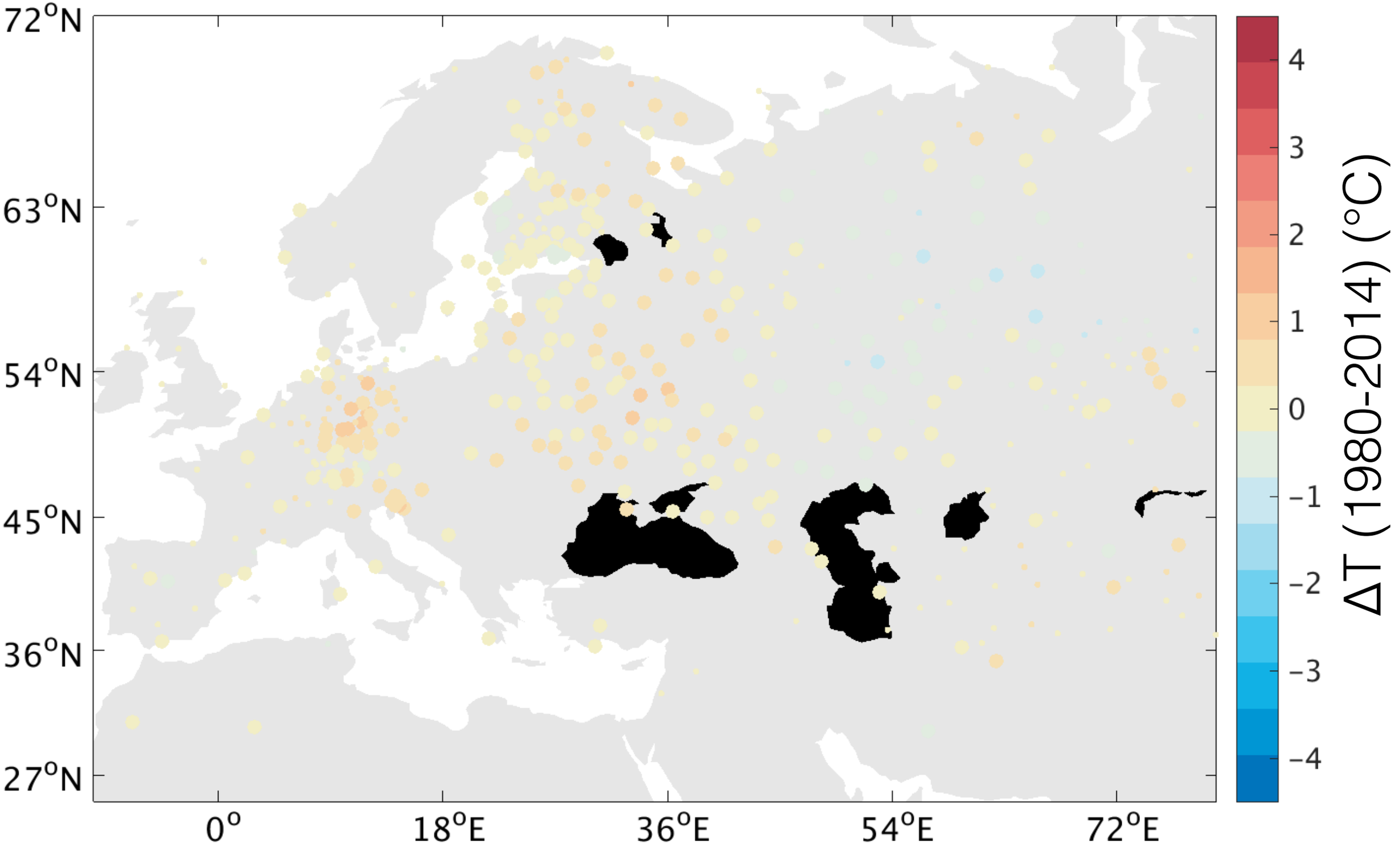
Change in 95th due to variance basis function



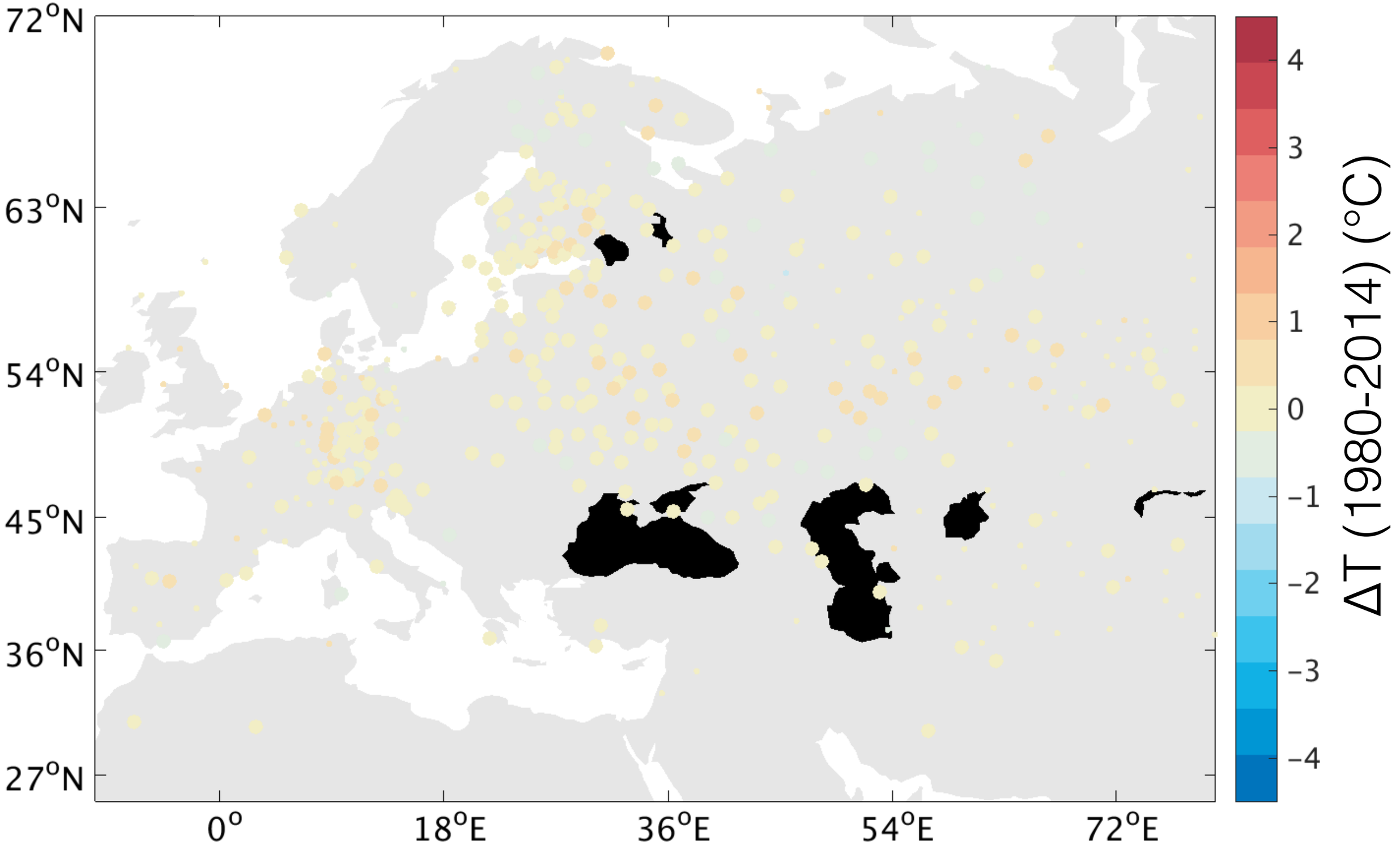
Change in 95th due to skewness basis function



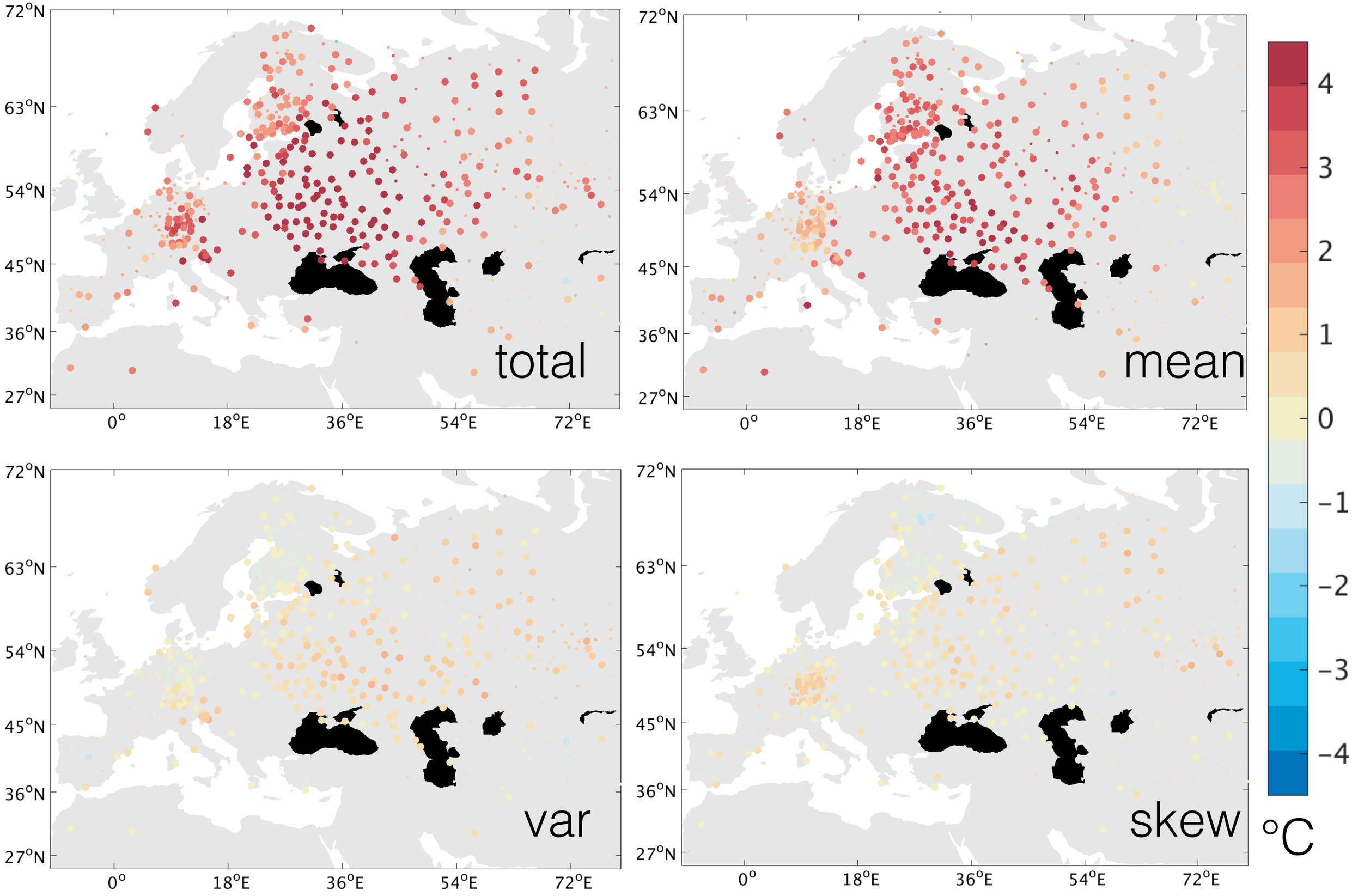
Change in 95th due to kurtosis basis function



Residual change in the 95th percentile



Variance acts to amplify 95th percentile in TMAX



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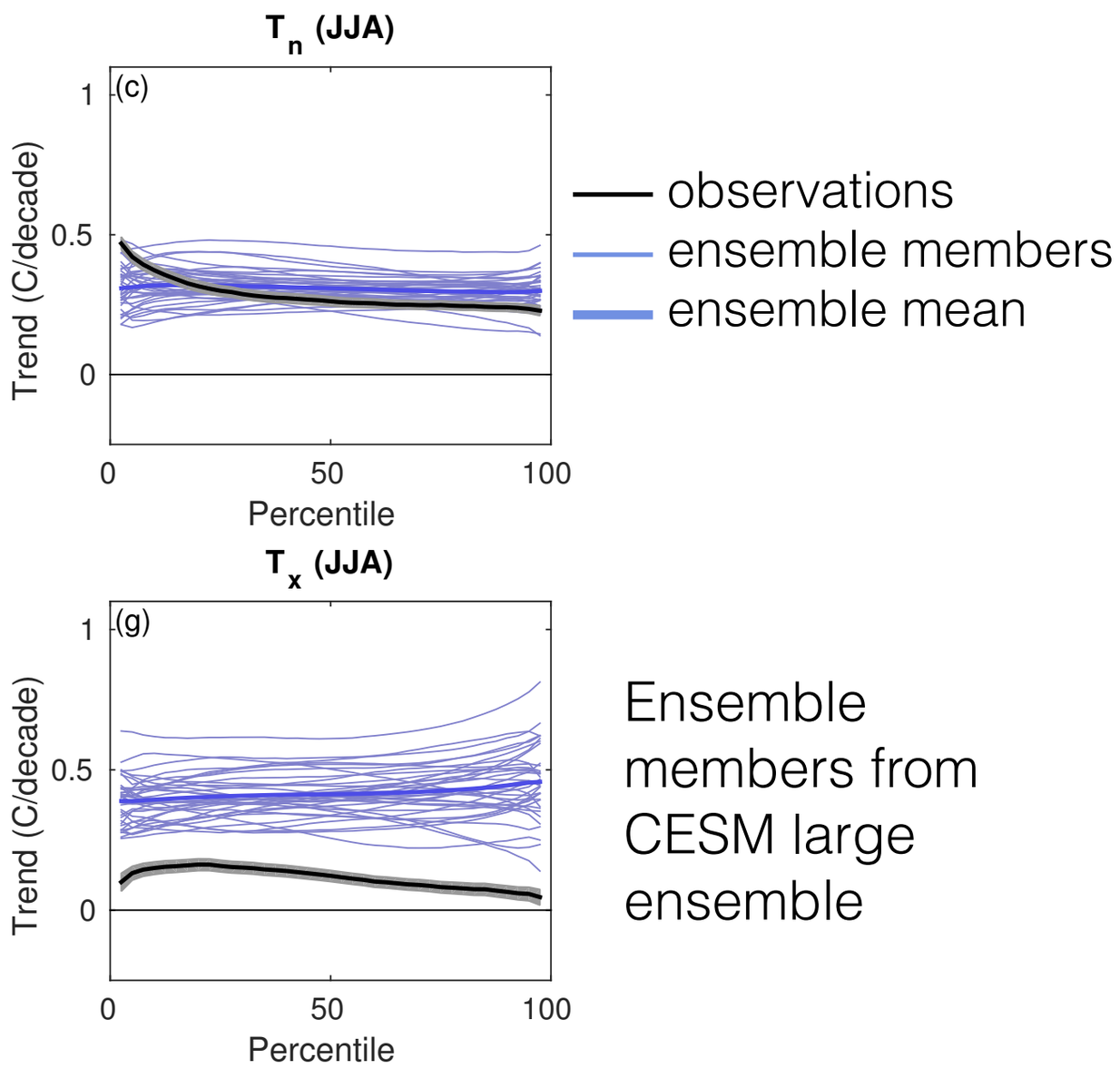
Summer: ΔT relatively flat across percentile space

Trends for continental US from 1979-2014

TMIN



TMAX

Ensemble members from CESM large ensemble

Figure from Andy Rhines

Observations generally within envelope of ensemble members

Trends for continental US from 1979-2014

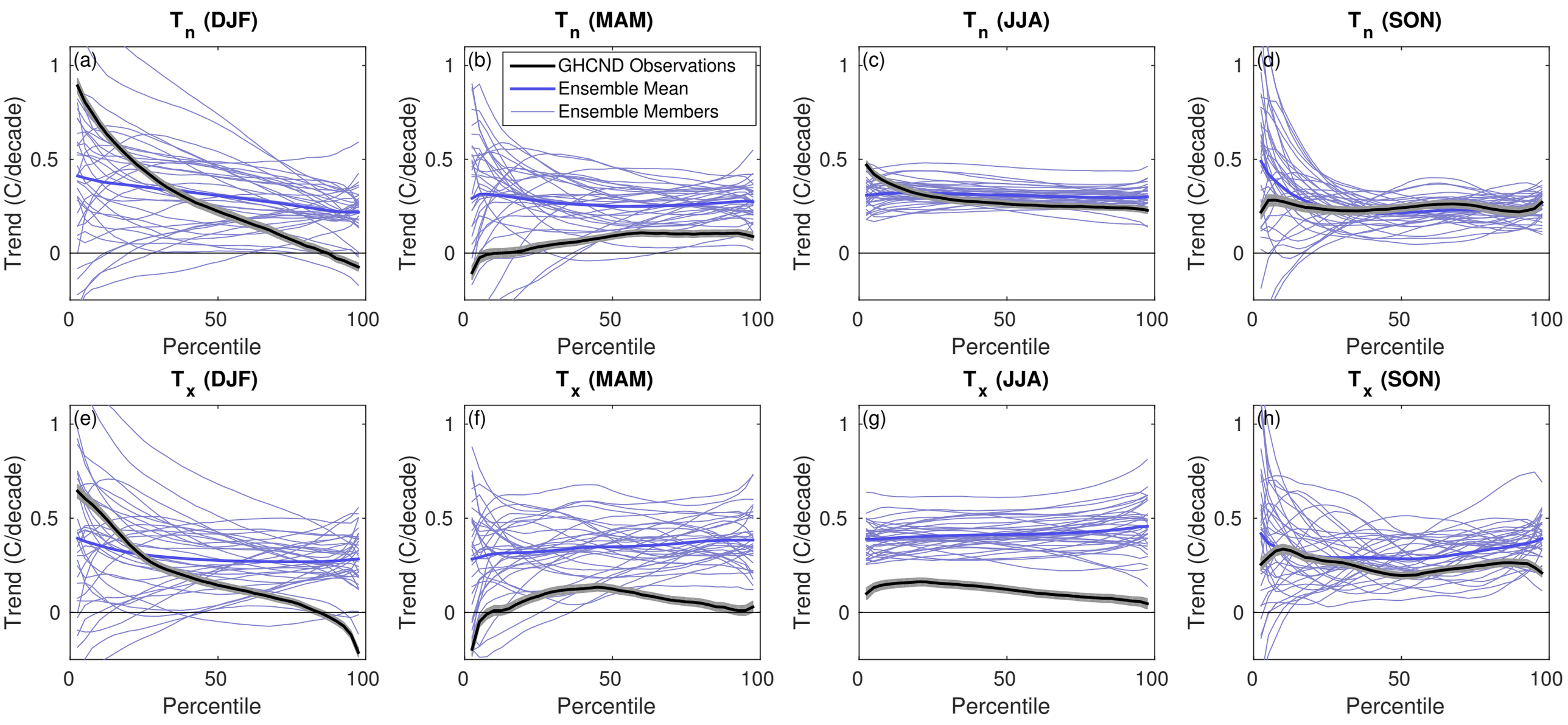


Figure from Andy Rhines

Final thoughts

Daily temperature distributions are non-normal, and changes in their shape can be estimated using quantile regression.

Changes in summer temperature distributions can largely be explained by a ‘shift’, but changes in the variance, skewness, and kurtosis control amplify or damp extremes.

Quantile trends from the large ensemble are variable compared to the observations. Future work will compare ensemble members with different behaviors in quantile space.