

The temperature increase in Greenland has accelerated in the past five years

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Introduction

The change of annual Greenland's temperature was 2-6 °C from 1873 to 2012, and the change of winter was larger than other seasons, which was 5.7°C(Box et al.,2002; Hanna et al.,2012).

NAO, GBI, AMO and tropical forcing may influence the change of Greenland's temperature (Ding et al.,2014; Hanna et al.,2015).

Scientific problems

- (1) How did the Greenland's temperature change during the period 2013 ~ 2017?
- (2) Do other climate indexes and variables play important roles in influencing Greenland's temperature?
- (3) What are the contribution rates of important variables to changes in Greenland's temperature?

Data and methods

Data source

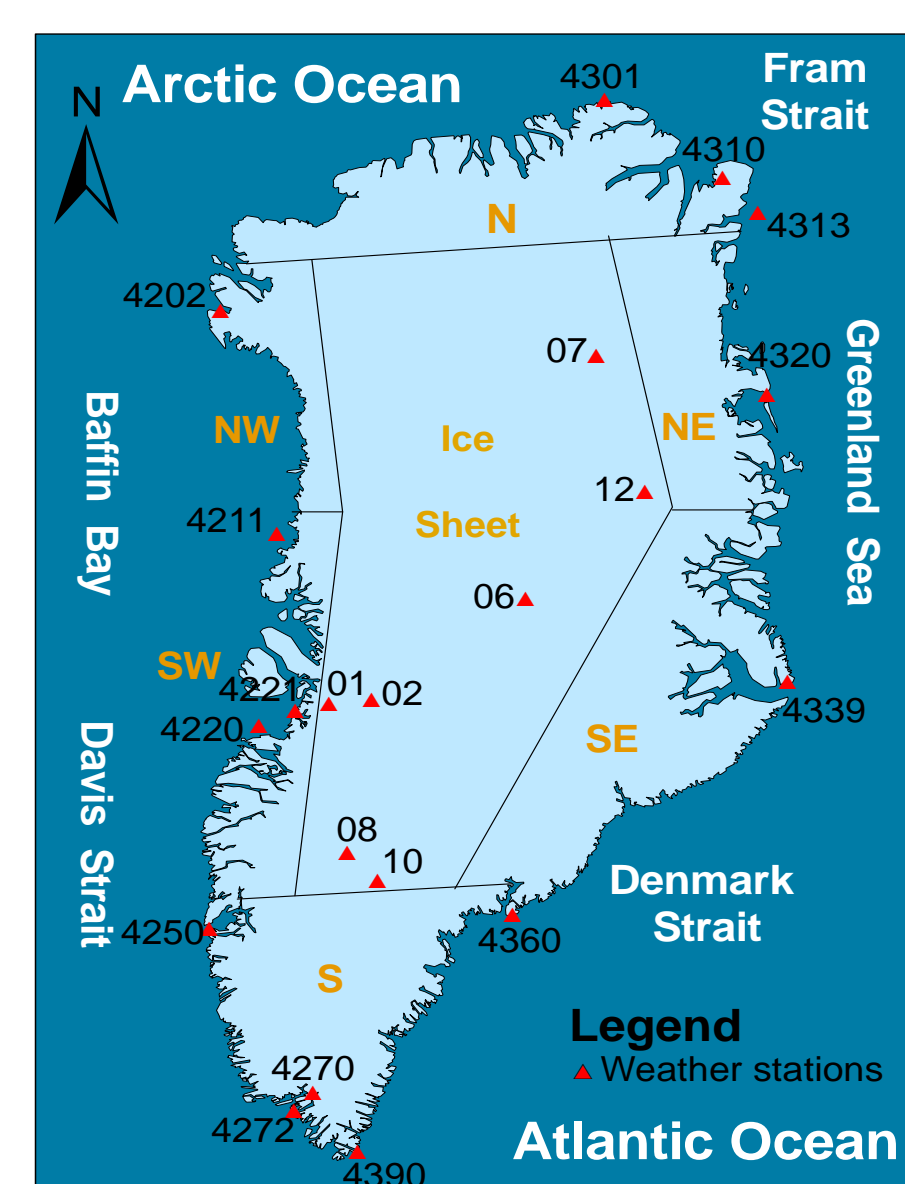


Fig.1 Study area

Coastal air temperature data:

Danish Meteorological Institute, Berkeley Earth

Inland air temperature data:

GC-Net; see Steffen et al., 1996; Steffen and Box, 2001

Atmospheric and ocean climate index data:

Twenty-eight climate indexes were downloaded from:

<https://www.esrl.noaa.gov/psd/data/climateindex/es/list/>, and

https://www.esrl.noaa.gov/psd/gcos_wgsp/Timeseries/GBI_UL/

Greenhouse gas (GHGs) data:

<https://www.esrl.noaa.gov/gmd/ccgg/aggi.html>

Methods

Determine the temperature change trend:

Mann-kendall test

The teleconnection relationships between temperature and climate indexes:

Pearson correlation analysis

Variable importance:

Random forest model

Contribution rate calculation:

Multiple linear regression equation

Results

Temperature variation over the past 66 years (1952~2017)

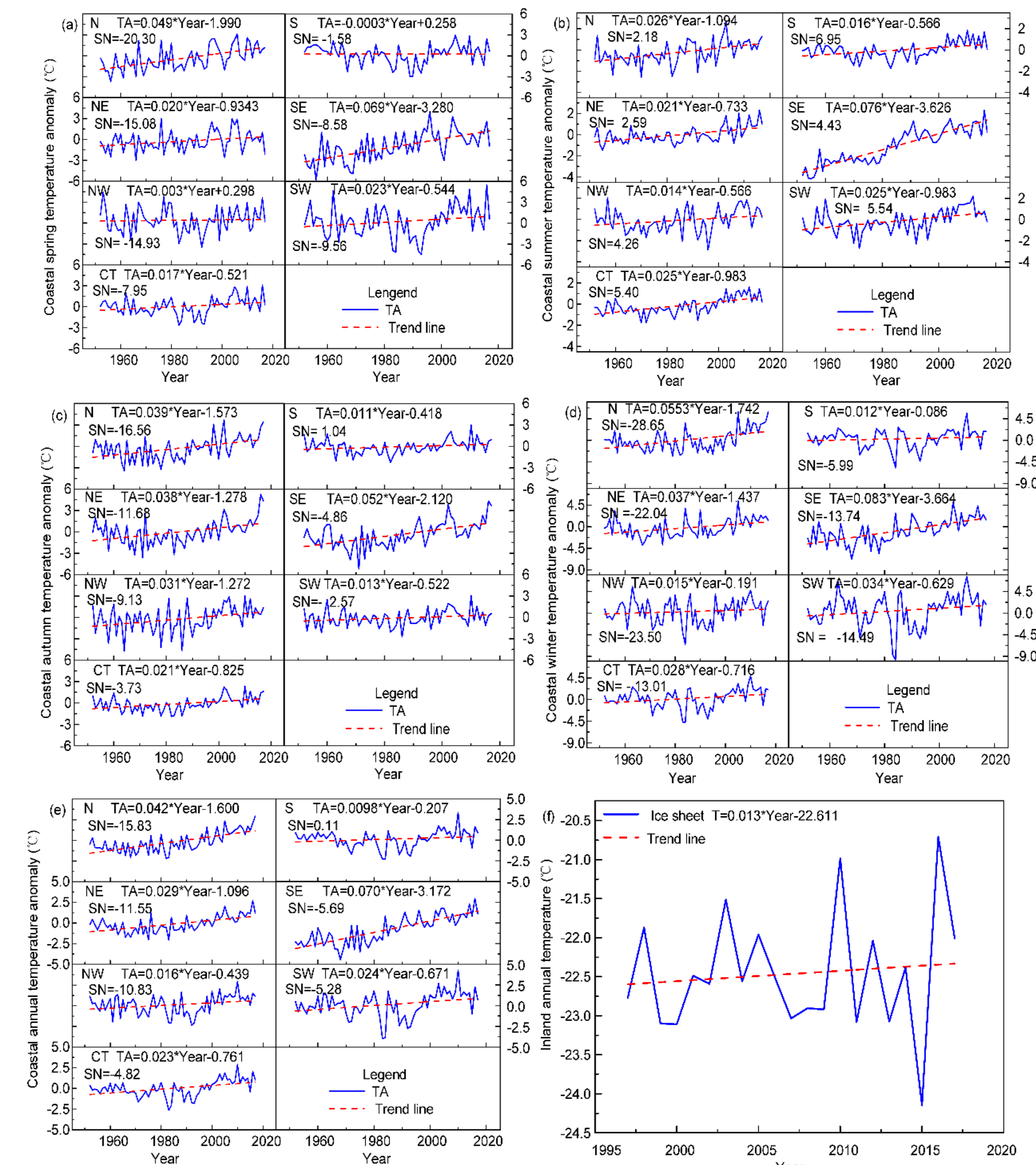


Fig.2 Greenland surface air temperature changes during 1952 ~ 2017. SN represents the average temperature during the period 1981 ~ 2010, and TA is the temperature anomaly relative to the 1981 ~ 2010 mean temperature. The coastal Greenland's temperature increases during 1952 ~ 2017 in most regions, but in most seasons, the southern region of the island experiences little change. The southeastern and northern regions are hotspots of warming, and the temperature in the eastern coastal region of the island changes more than that in the western region. The seasonal climate tendency rate exhibits large differences at different latitudes.

From Fig.2f, we can see that the inland annual temperature has displayed an increasing trend over the past 21 years (1997 ~ 2017) with a rate of increase of 0.13 °C decade⁻¹, and the annual inland temperature has exhibited the same change trend as the coastal temperature.

Coastal temperature changes in the past 5 years (2013 ~ 2017)

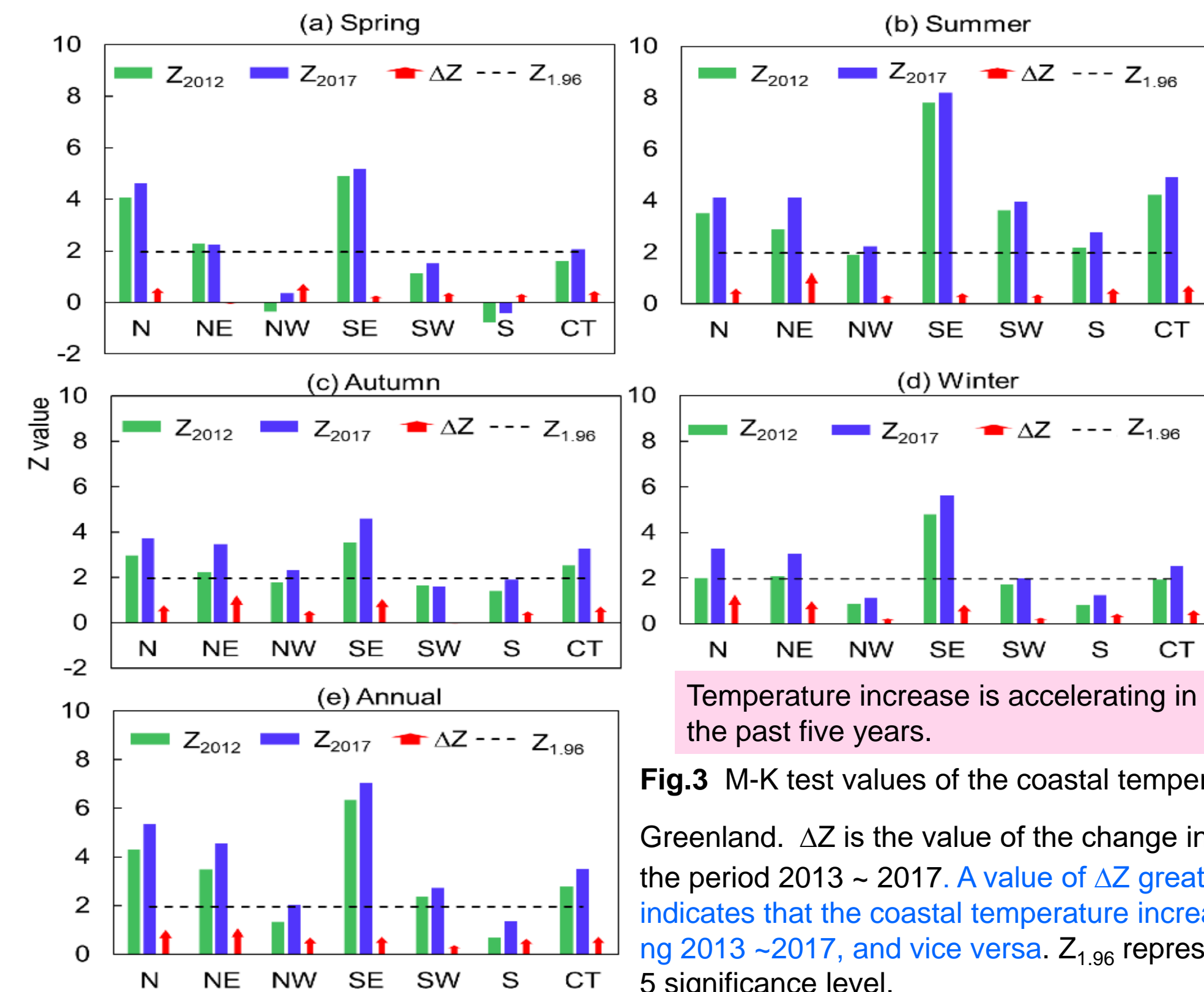


Fig.3 M-K test values of the coastal temperatures in Greenland. ΔZ is the value of the change in Z during the period 2013 ~ 2017. A value of ΔZ greater than 0 indicates that the coastal temperature increased during 2013 ~ 2017, and vice versa. Z₁₉₈ represents a 0.05 significance level.

Teleconnection relationships between the coastal Greenland's temperature and climate indexes

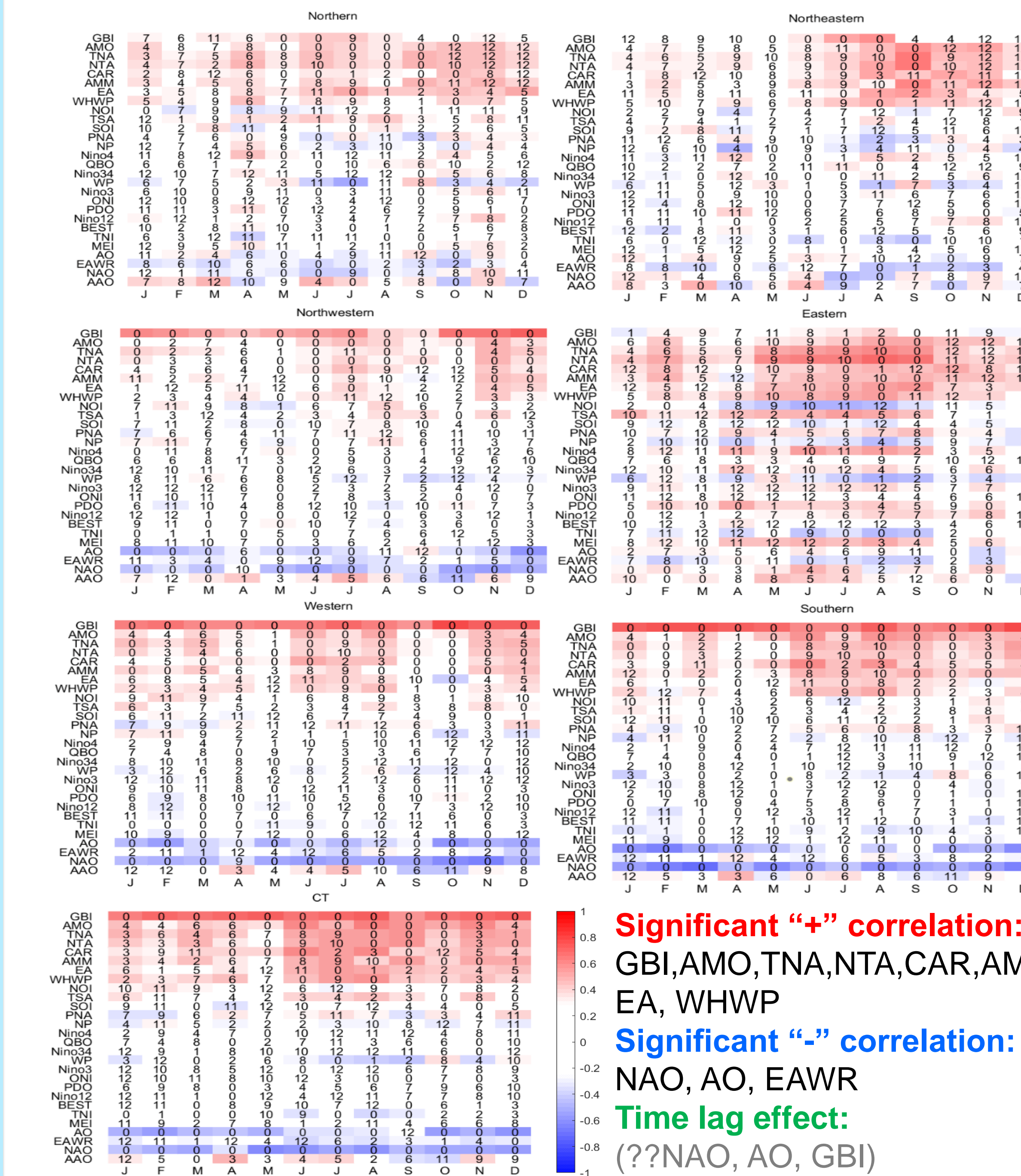


Fig. 4 Teleconnection relationships between coastal Greenland's temperatures and climate indexes. Significant correlations ($p < 0.05$) correspond to correlation coefficients that are larger (less) than 0.25 (-0.25), which are represented by red (blue) colors. It should be mentioned that the numbers in the figure refer to the time lag (months), which ranges from 0 ~ 12 months, corresponding to the strongest correlation.

Contribution rates of climate indexes and GHGs to coastal temperature change

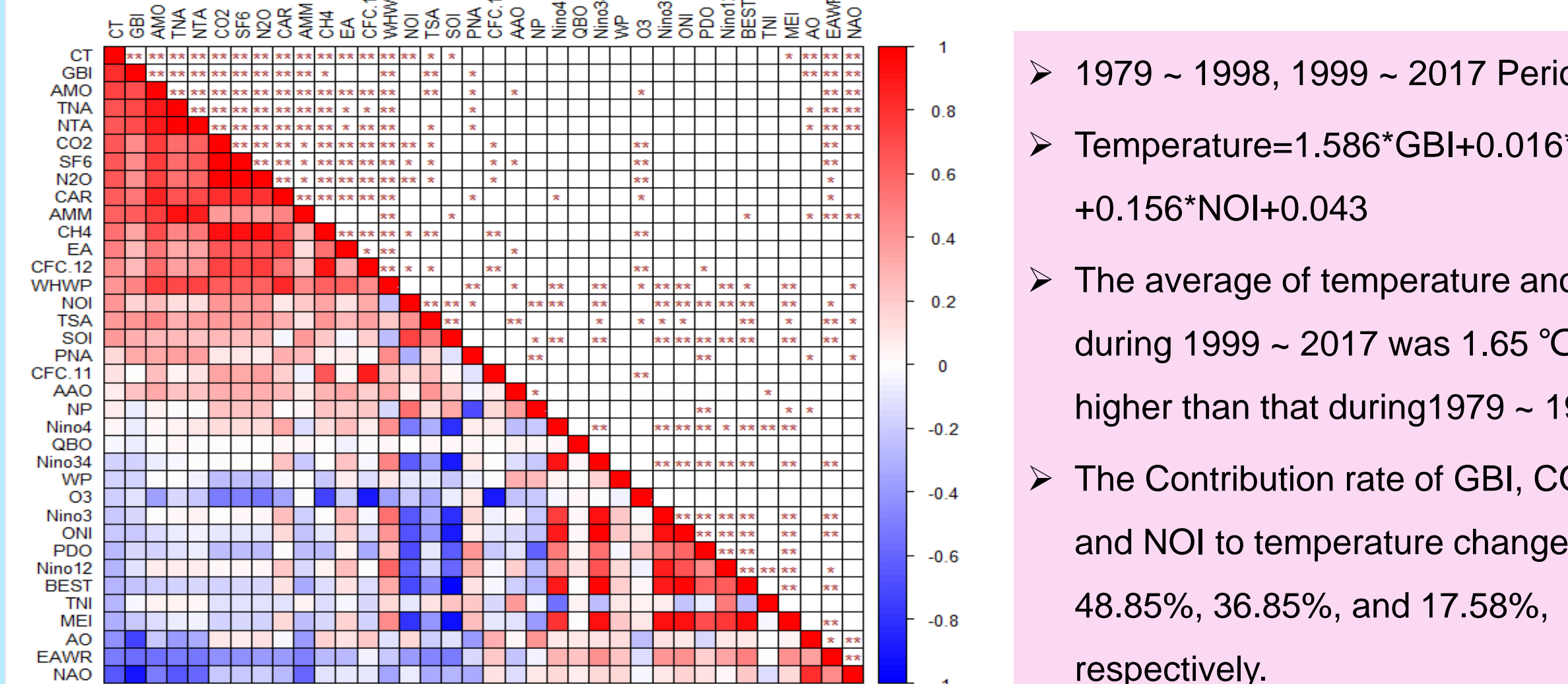


Fig. 5 Pairwise correlations of variables. * and ** represent variables that are significant at significance levels of 0.05 and 0.01, respectively.

Conclusions

The annual coastal composite temperature (CT) during period 2011~2017 increased by 0.91 °C relative to the 1981 ~ 2010 baseline. And the change of winter was larger than other seasons, which increased 1.55°C.

The annual inland temperature change trend during the period 1997 ~ 2017, revealing an increase of 0.13 °C decade⁻¹, which is the same change trend as the trend of the coastal temperature change.

Temperature increase is accelerating during 2013 ~ 2017 in Greenland.

GBI, NAO,AMO, GHGs(CO₂,N₂O,SF₆, CH₄) and NOI were important factors influencing the Greenland's temperature change.

The Contribution rate of GBI, CO₂ and NOI to temperature change was 48.85%, 36.85%, and 17.58%, respectively.

Key References

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