UNIVERSITY OF TARTU
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Climate Change in Estonia – warmer weather patterns or more warm weather patterns?

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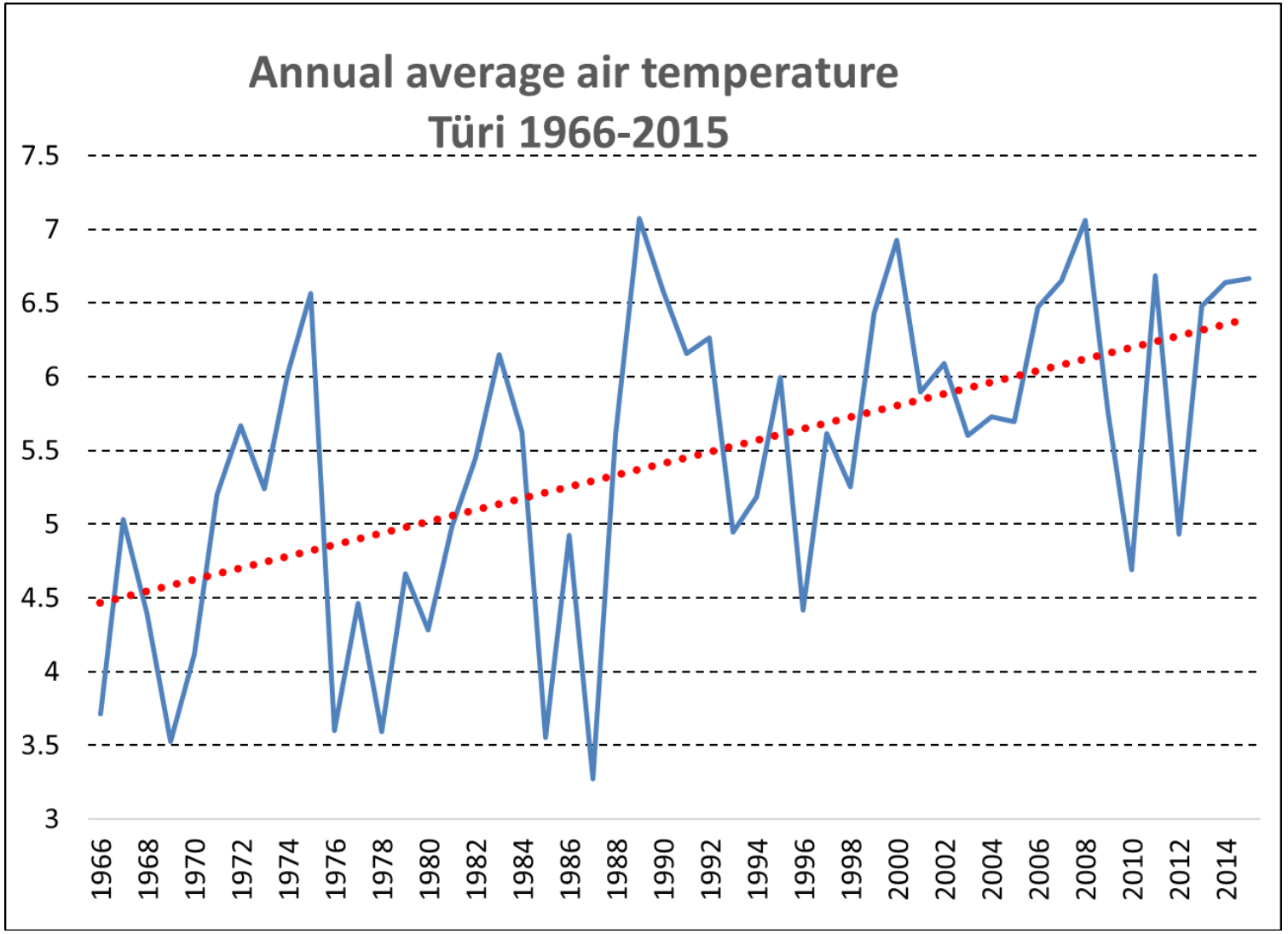
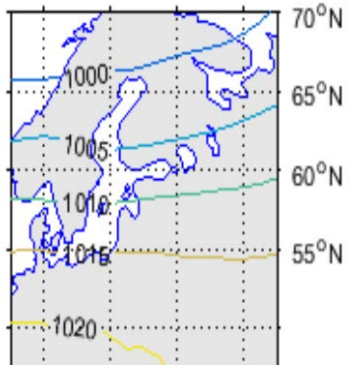
Motivation

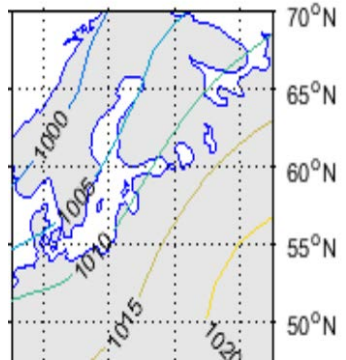
- The climate in the Baltic Sea region, including in Estonia, has been warming particularly fast
- The annual average temperature in Estonia has risen **about 2 °C**



But why? Is climate like a gas stove? Climate = weather + weather+…+weather

- From synoptic climatology's point of view:
  - Is this warming caused by changes in the **frequency of weather patterns**?
  - Or by changes in the characteristics of weather patterns?
    - i.e. has **warmer weather** started accompanying those weather patterns?





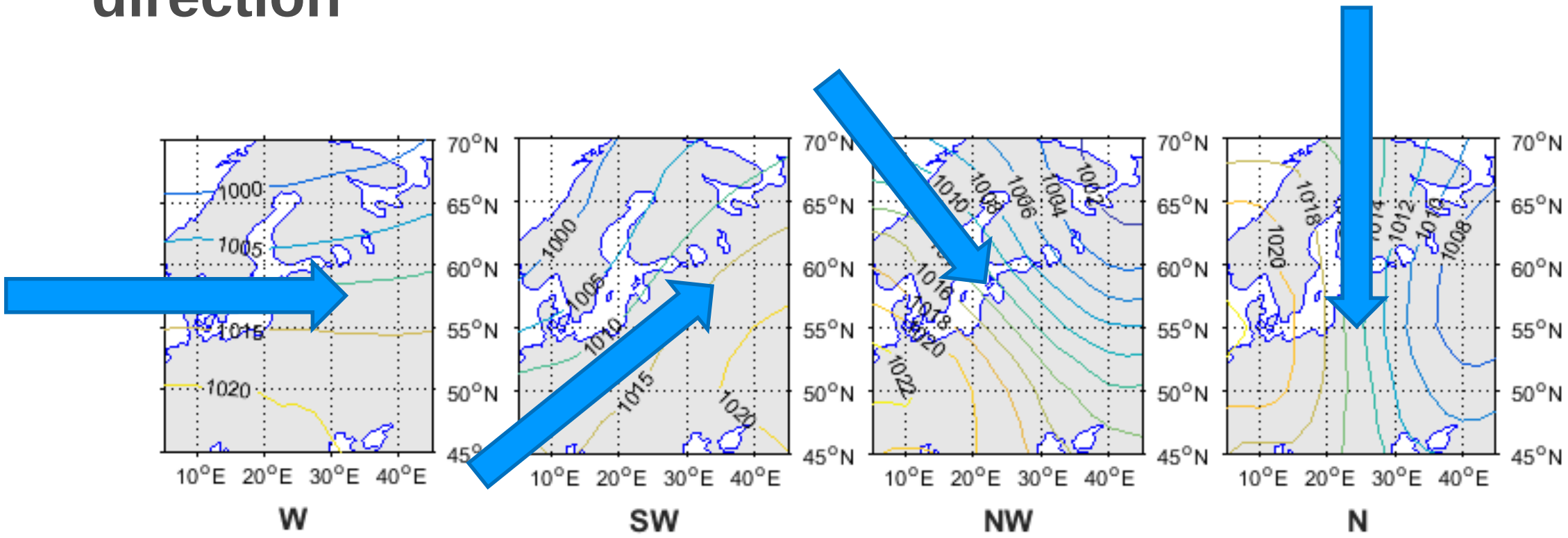
Data and methods: weather types

- Chosen is the ansamble of the 12 best (Huth et al. 2015) classifications what characterise the air temperature in the Baltic Sea region
- 9 type classifications (reality: 8-10 types)

  KRZ08,KRZ09,JCT10,LIT09,CAP09,CAP10,GWT08, GWT10,CKM09,CKM10,HCL09,HCL10
- The software package cost733class (Philipp et al. 2014)
- The air pressure data from NCEP/NCAR reanalysis (Kalnay et al. 1996) was used for calculating classifications

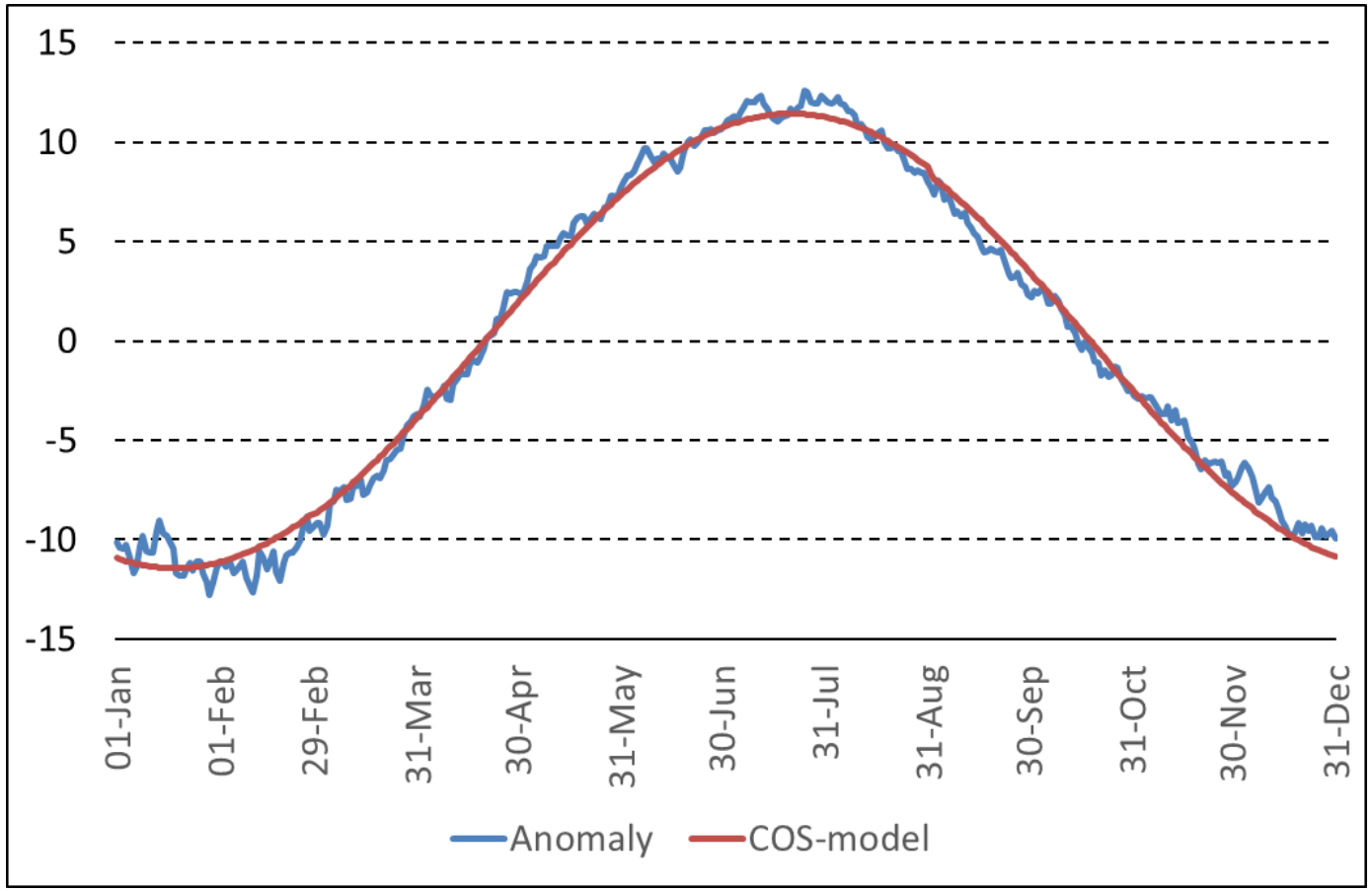
Methods

- Weather types of different classifications were compared to each other on the basis of the **similar air flow direction**



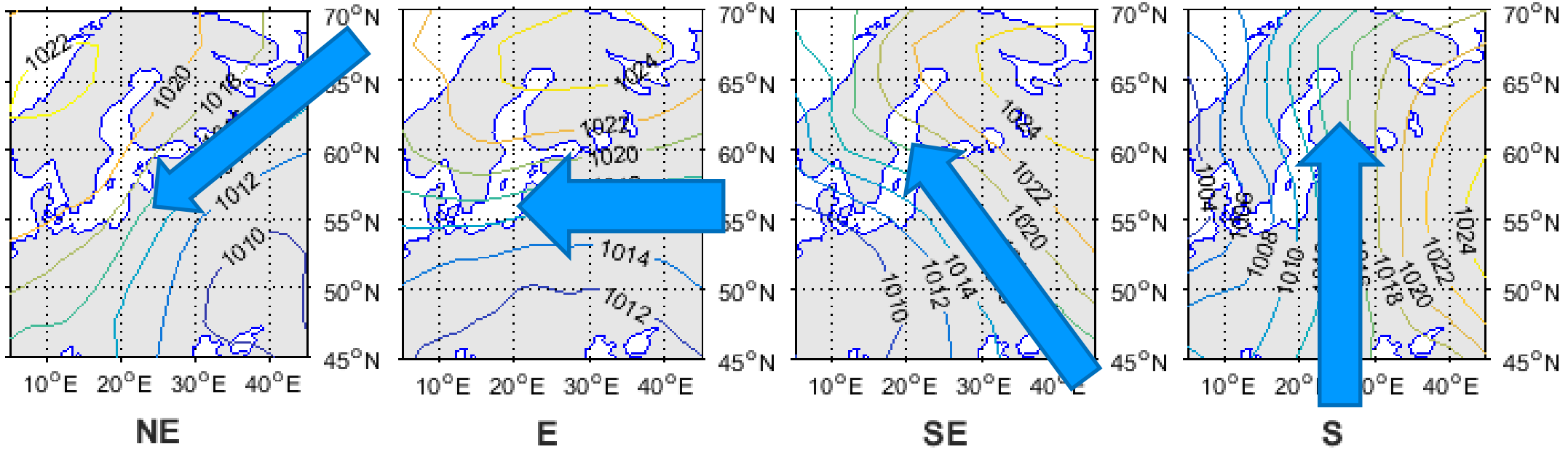
Data and methods: air temperature

- Period of 1966-2015
- Jõhvi, Türi, and Vilsandi meteorological stations
- **The daily temperature anomalies**
  - Long term average
  - Modelled by cosine function
  - X=-11,429·cos(0,017098·t+(-2,40077))



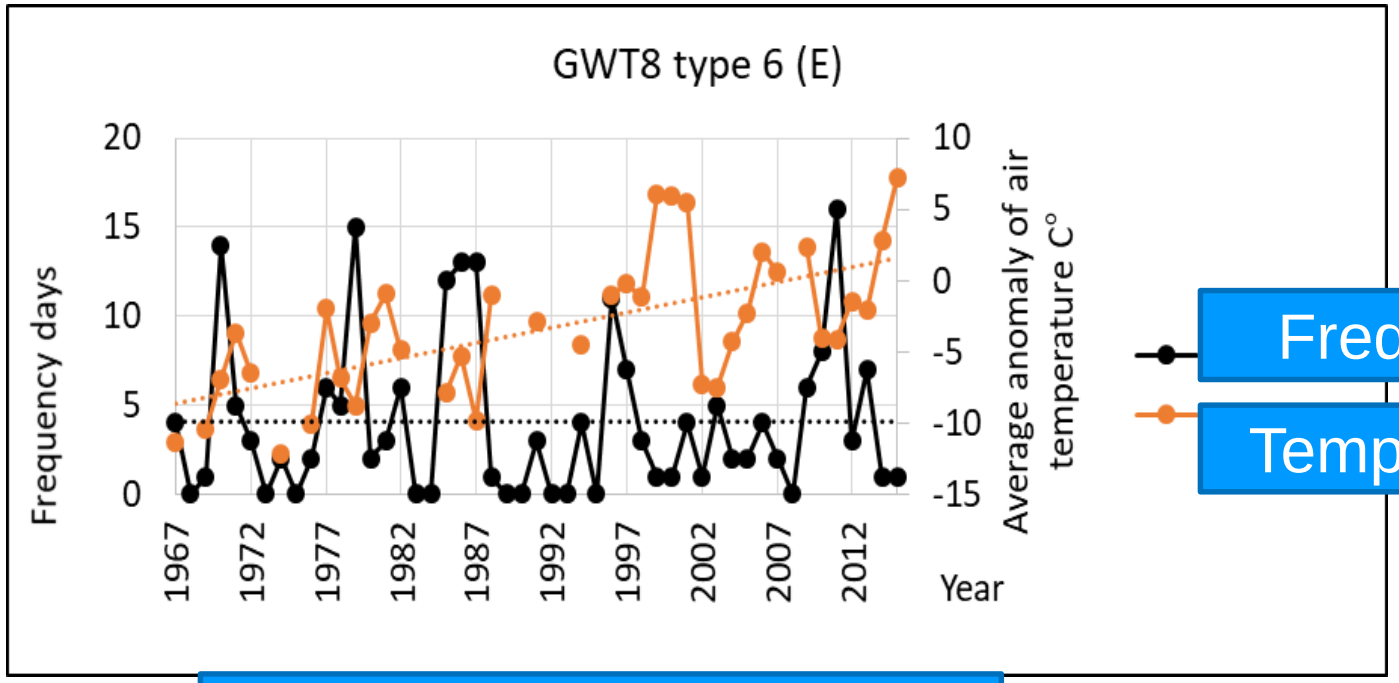
Temperature anomalies are used to characterize weather types

- The types were divided into **'warm'** and **'cold'** for a given **season** according to temperature anomalies



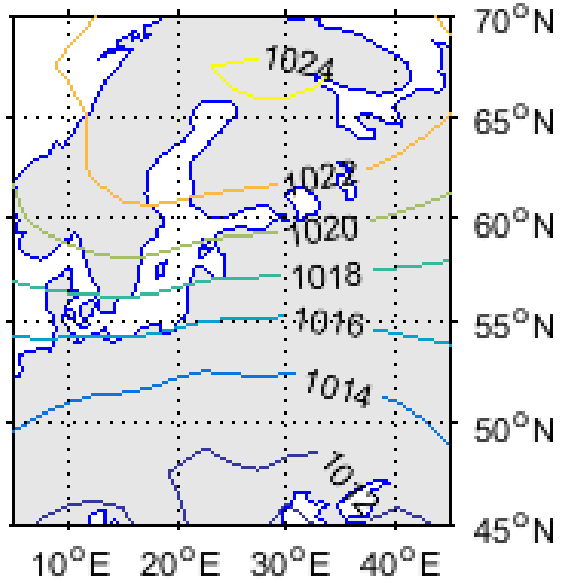
NE	E	SE	S
Cold in winter Cold in summer	Cold in winter Warm in summer	Warm in every season	Warm in summer

Changes in time series were analysed using linear trends (p<0.05)



Frequency

Temperature

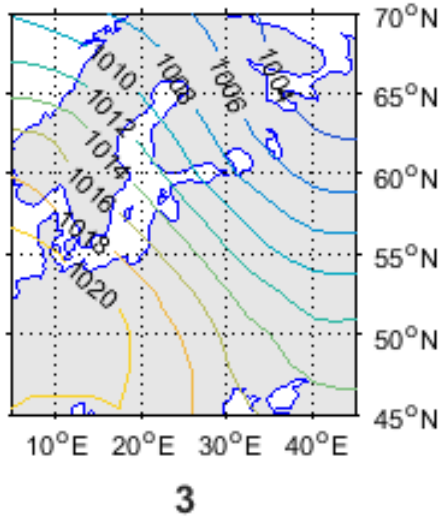


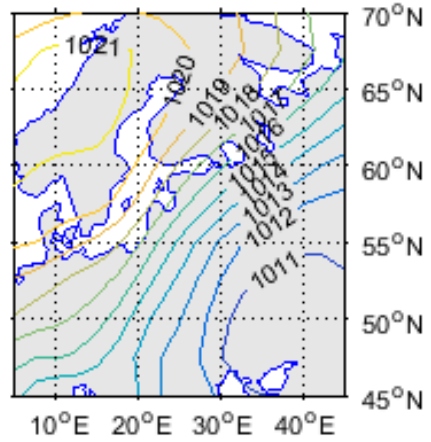
6

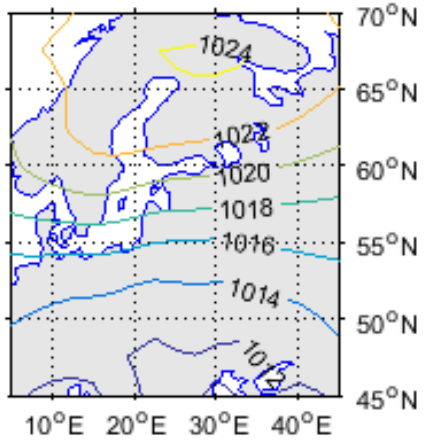
Winter

Results

- Trend analysis shows that there are **only a few** statistically significant **changes** in the **frequency of circulation types**
  - Spring – the frequency of E and NE flow types has **decreased**
  - NW types has **increased**

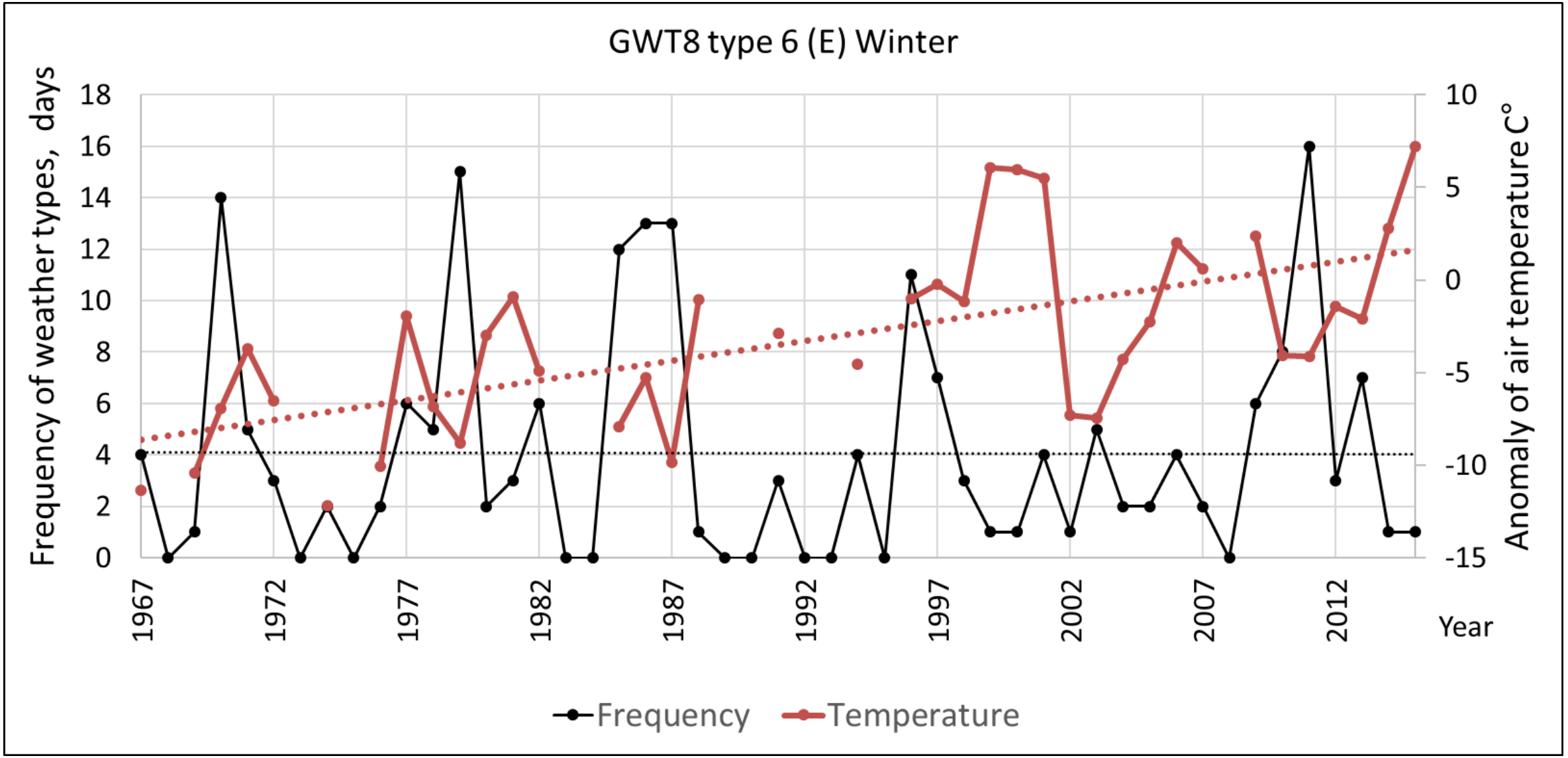


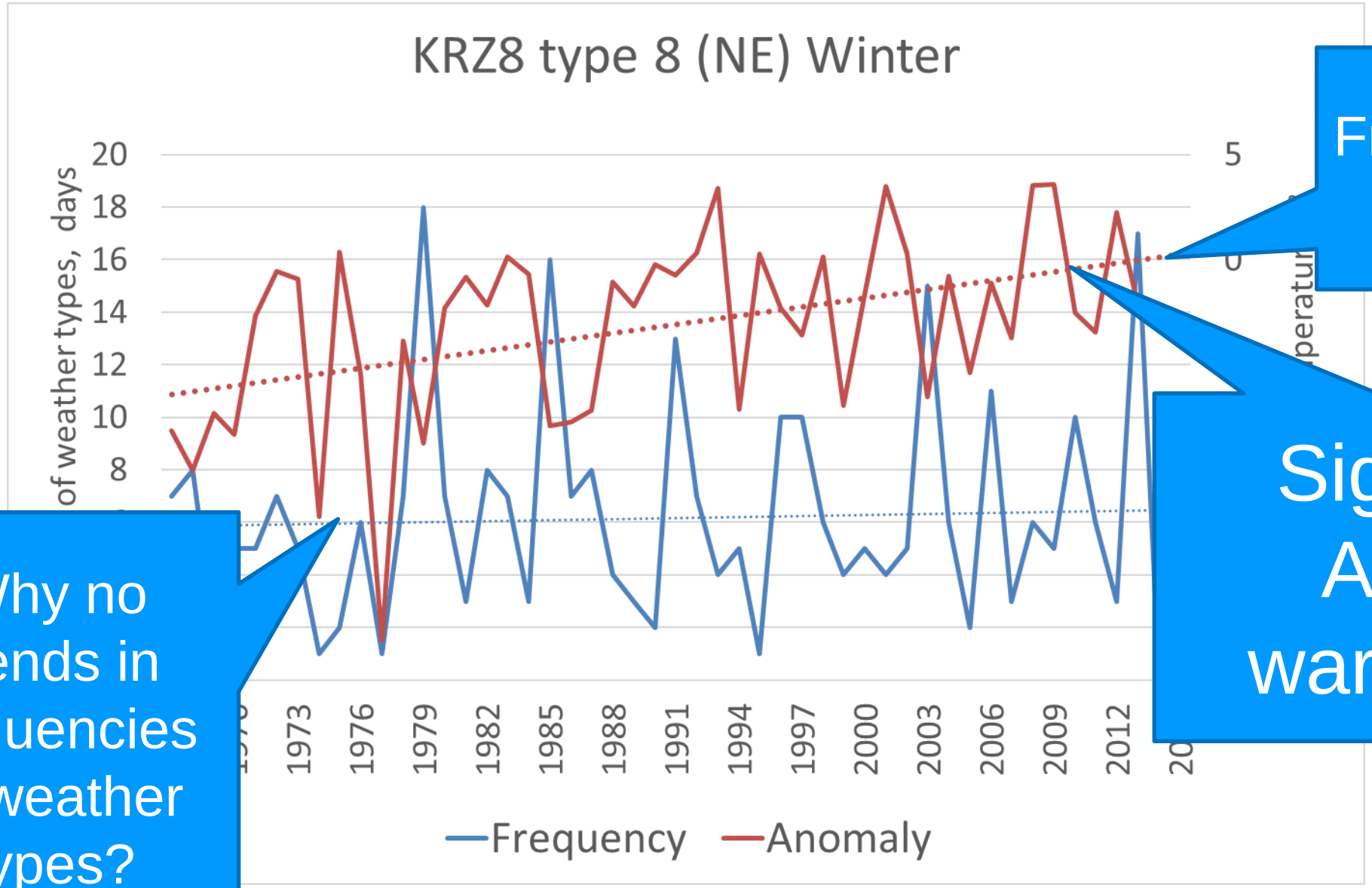




Results

- However, there is **increasing trend in all temperatures** accompanying circulation types
- A particularly **great warming** has taken place in **winter 'cold' types**
  - Air temperatures accompanying E types in winter have risen ca 5 degrees


GWT8 type 6 (E) Winter
Frequency of weather types, days
Anomaly of air temperature C°
Year
Frequency
Temperature
0
2
4
6
8
10
12
14
16
18
-15
-10
-5
0
5
10
1967
1972
1977
1982
1987
1992
1997
2002
2007
2012



From -6 °C to 0 °C

Signs of Arctic warming?

Why no trends in frequencies of weather types?