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## Changes in winter warming events in the Nordic Arctic Region

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# Warm spell and rain-on-snow events at Svalbard: 26 Jan-9 Feb 2012

Station	Days $T_{\max} > 3^{\circ}\text{C}$	Precipitation
Svalbard airport	11	70 mm (37% of 190 mm annual normal)
Ny Ålesund	10	272 mm (71% of 385 mm annual normal)

**Impacts:** Ground ice,

starving reindeers,

snow avalanches



# Aim:

## Study changes and trends in winter warming events in the Nordic Arctic region

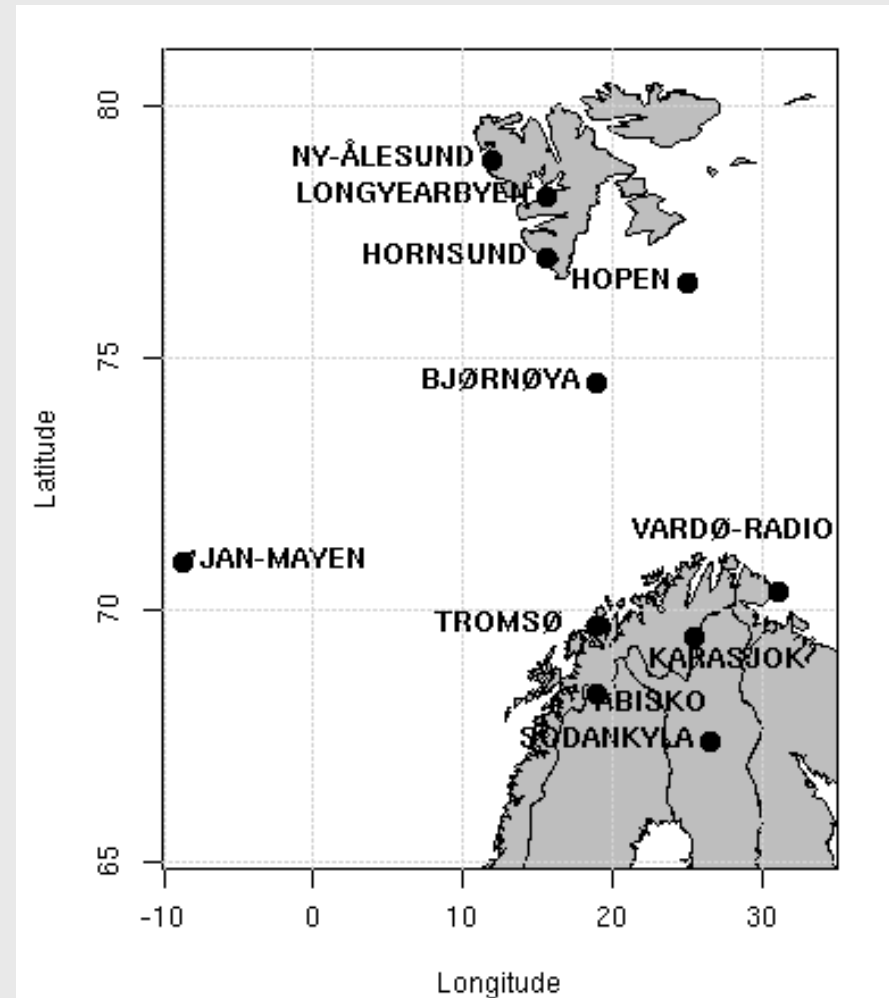
**Past 50-100 years**

Present climate (past 15 years)

Future 50-100 years

### 11 weather stations:

- Longest time series
- 7 stations with > 90 years of precipitation and temperature observations

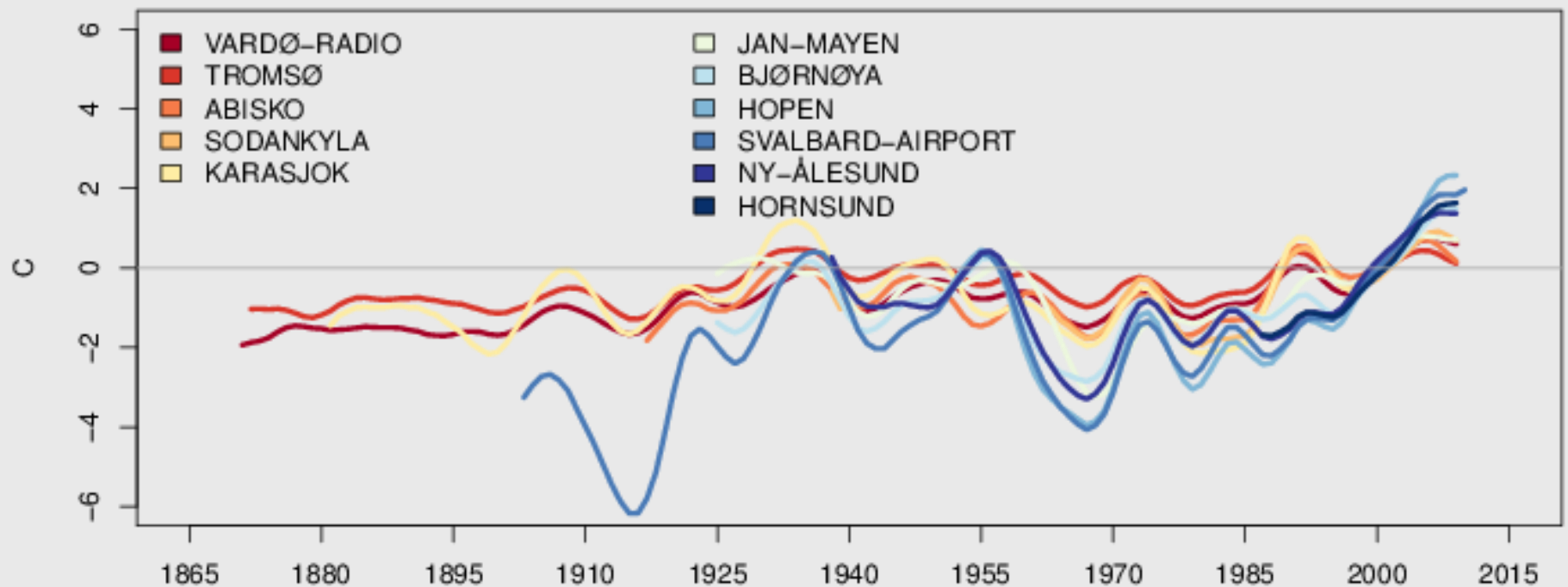


# October-April temperature deviation, relative to 1985-2014

## Mainland

(Sweden, Norway, Finland)

## Arctic islands



# Warm spell day definition no. 1:

Fixed threshold for all stations

Threshold = 0°C:

- Transition between liquid and frozen water. Selected to study impacts of changing winter climate on melting snow and ice.

Index	Description	Type
$T > 0^{\circ}\text{C}$	No. days with daily mean temperature exceeding 0°C	Frequency
$\Sigma(T > 0^{\circ}\text{C})$	Positive degree day sum	Intensity
$T > 0^{\circ}\text{C} \ \& \ P > 0 \text{ mm}$	No. winter days with rain	Frequency
$\Sigma(P)$ for days with $T > 0^{\circ}\text{C} \ \& \ P > 0 \text{ mm}$	Precipitation sum for rainy winter days	Intensity

# Warm spell day definition no. 2:

*Variable* threshold determined using station climatology

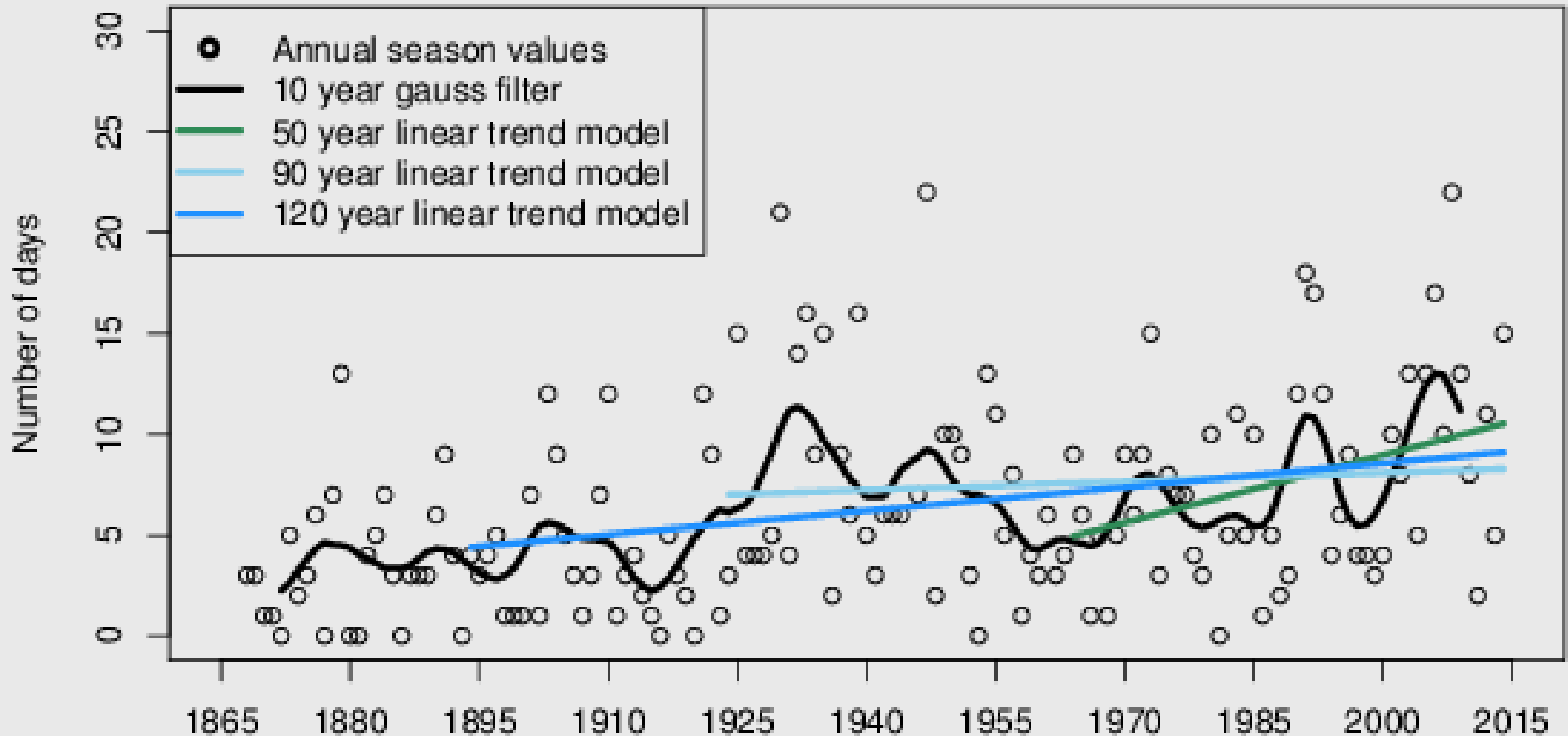
Threshold = 90th percentile of temperature climatology from the latest 30-year reference period (1985-2014)

- for each season
- for each station
- Applied to determine extremes for a station

Index	Description	Type
$T > T_{90}$	No. of days with daily mean temperature exceeding 90th percentile temperature threshold	Frequency

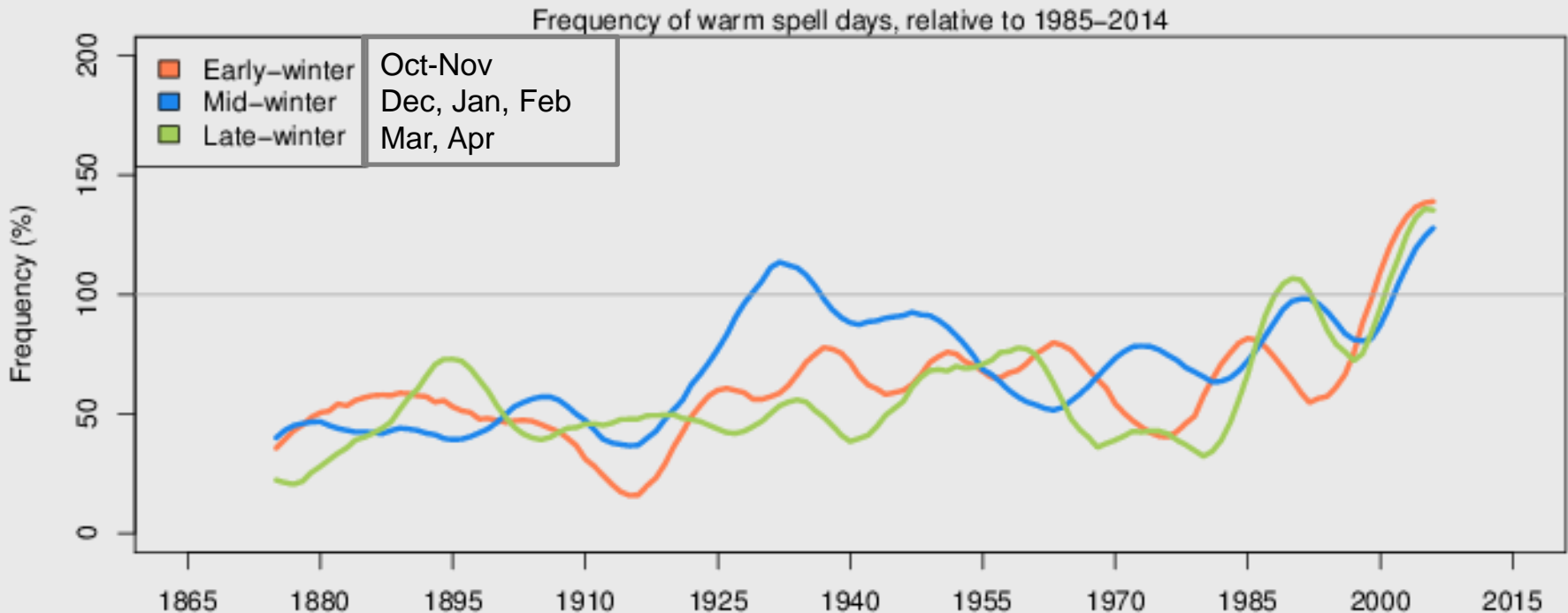
# Warm spell days per year for mid-winter at Vardø station

- the 90th percentile threshold temperature



# Warm spell days per year: Vardø station - 3 winter seasons

**Example: the 90th percentile threshold temperature**

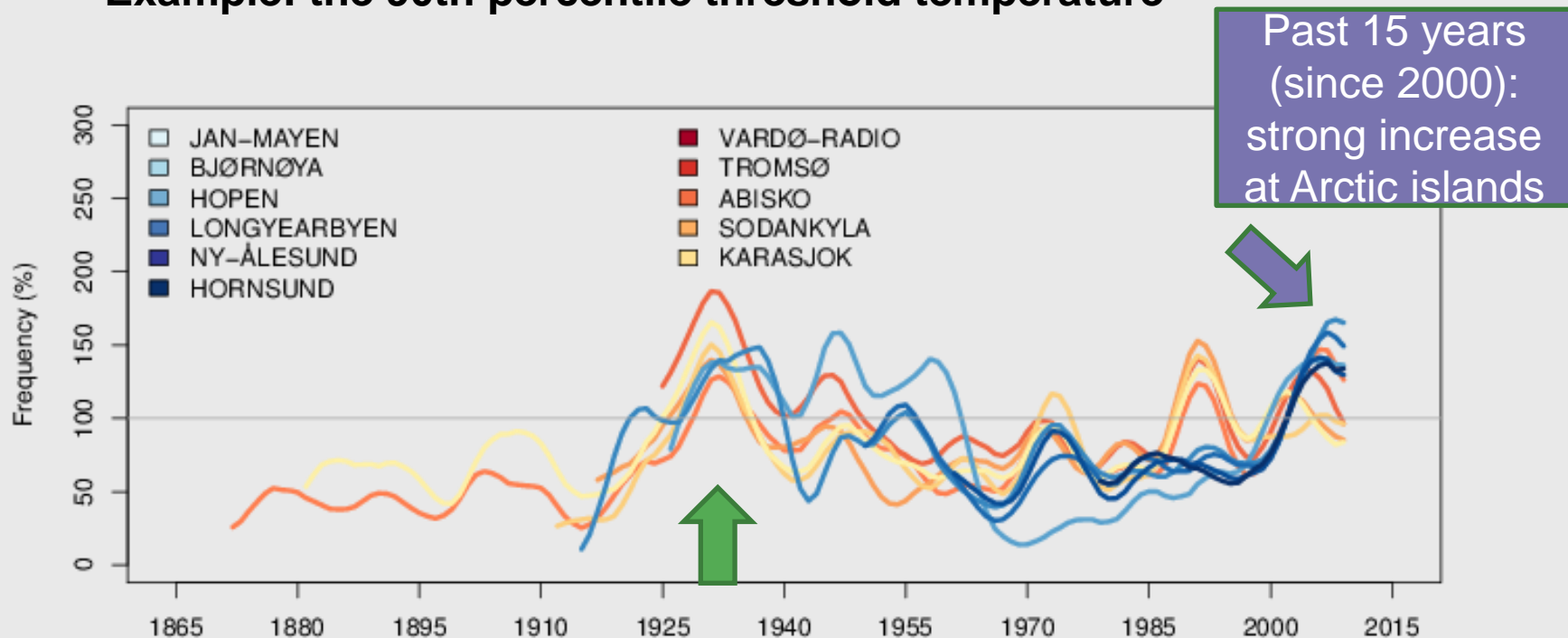


- Mid-winter: Strongest natural variability. 1920/30's winter climate similar to present climate.
- Early/Late-winter: Strongest change past 50 years



# Mid-winter (Dec-Feb) warm spell days for all stations, relative to 1985-2014

Example: the 90th percentile threshold temperature

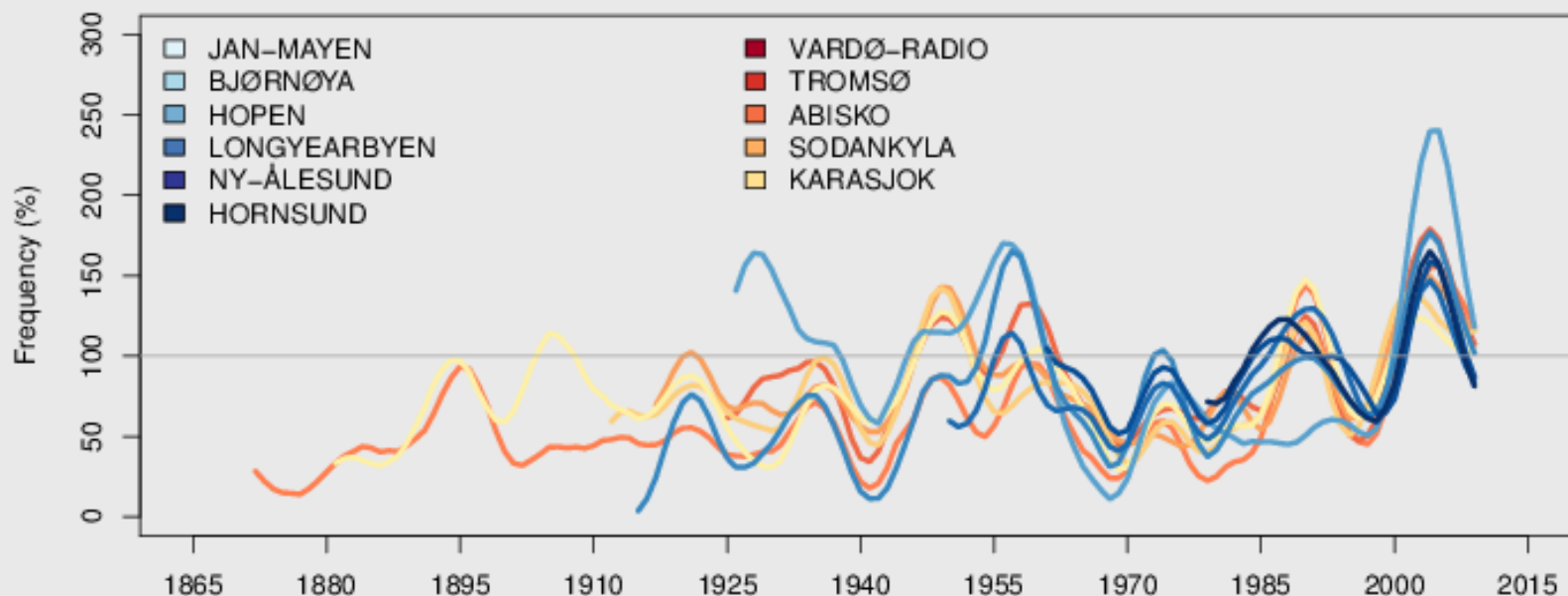


Past 15 years (since 2000): strong increase at Arctic islands

1920s, 1930s: Mid-winter warm spells

# Late-winter (Mar-Apr) warm spell days for all stations, relative to 1985-2014

Example: the 90th percentile threshold temperature



# Linear trends for all stations

- the 90th percentile threshold temperature (Oct-April)

Station	50 years	90 years	120 years
Jan-Mayen	27.6	-5.7	-
Svalbard airport	17.9	-	-
Bjørnøya	17.2	5.4	-
Hopen	16.1	-	-
Vardø	15.6	7.5	10.9
Sodankylä	14.8	7	-
Abisko	13.2	4	-
Tromsø	11.1	1.6	3.6
Karasjok	10.8	6.2	5.2

## All stations:

- Past 90 years: small changes (all stations)
- Past 50 years strongest increase in warm spell days.
  - Arctic islands on top of the list

# Linear trends for all stations

-number of days with  $T > 0^{\circ}\text{C}$  (Oct-April)



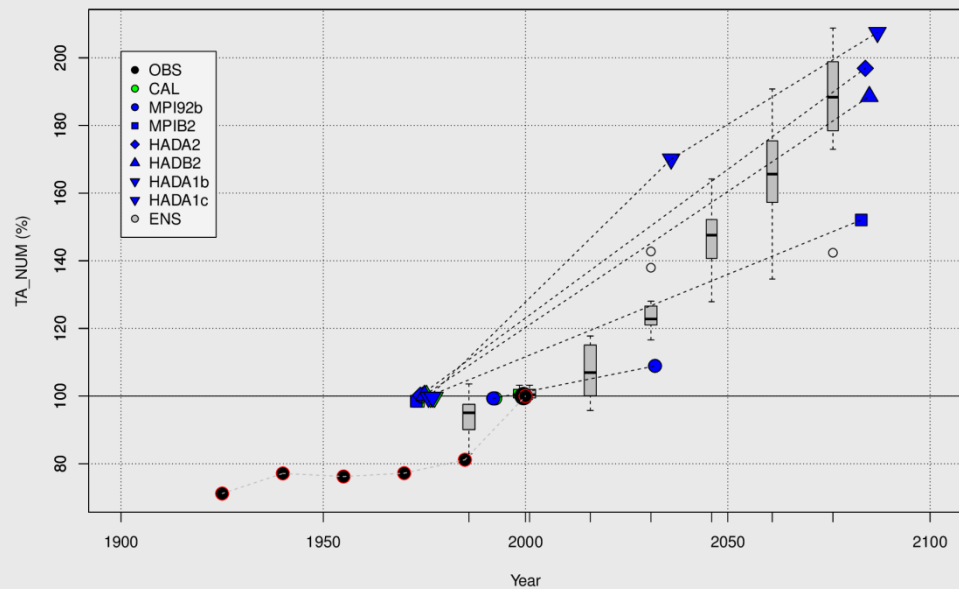
Station	50 years	90 years	120 years
1. Jan-Mayen	46.0	1.3	-
2. Vardø	36.2	19.7	25.0
3. Bjørnøya	33.5	13.6	-
4. Tromsø	25.4	5.7	8.0
5. Abisko	16.0	5.7	-
6. Sodankylä	15.6	10.9	-
7. Karasjok	12.4	7.2	7.5
8. Svalbard airport	10.7	-	-
9. Hopen	10.6	-	-

## Past 50 years top 4 stations:

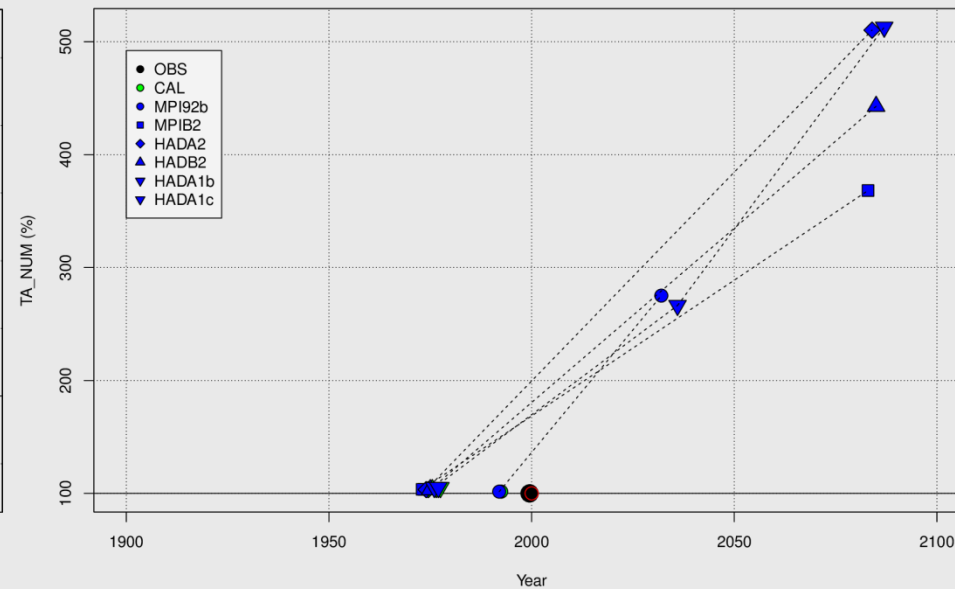
- Correspond to stations having highest winter temperatures. Coastal stations.
- Trends for positive degree days show the same strong historical increase

# Changes in warm spells the next 50-100 years ( $T > 0^{\circ}\text{C}$ )

Sodankylä (northern Finland)



Ny Ålesund, Svalbard



## Regionally downscaled scenarios:

- 14 simulations, ENSEMBLES, 25km grid scale, time period 1951-2100 (Svalbard excl.)
- 6 MET Norway simulations, 25 km grid scale
- Bias corrected temperature and precipitation data (1985-2014)

## Change in warm spell events towards 2100:

- Increase of 50-100% in Sodankylä
- Increase of 250-500% in Ny Ålesund
- Same results for other climate indices, other stations

# Summary: warm spells in winter

- **Present climate (past 10-15 years):**
  - **Frequent reports of warm spells from the Arctic. Strong impacts on ecology, avalanche activity and infrastructure.**
- **Past 50-100 years: Oct-April season**
  1. **Small changes past 90 years.**
    - **Warm winters during 1920/30s.**
  2. **Strong increasing trends past 50 years.**
    - **Winter temperatures have increased.**
- **Next 50-100 years:**
  - **The strong historical trends seem to continue the next 50-100 years.**
  - **Northern Scandinavia: doubling the number of warm spells.**
  - **Arctic islands: >3 times increase in warm spell events.**