

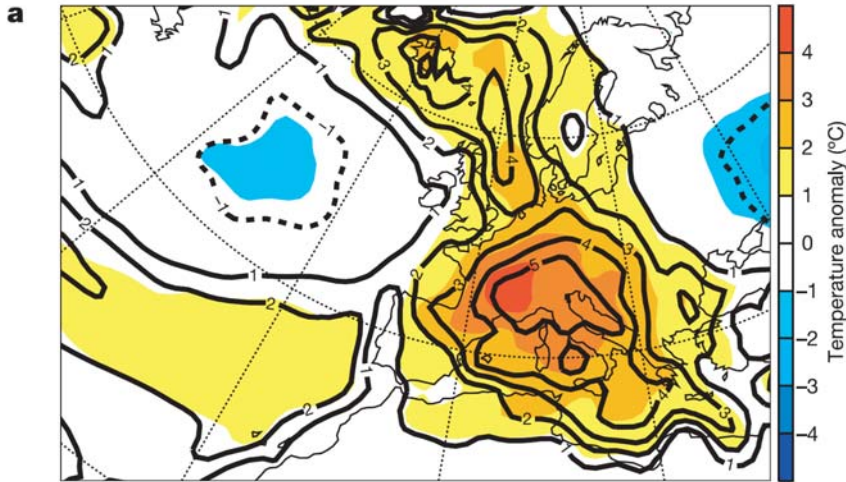


Arctic heat waves – a risk assessment

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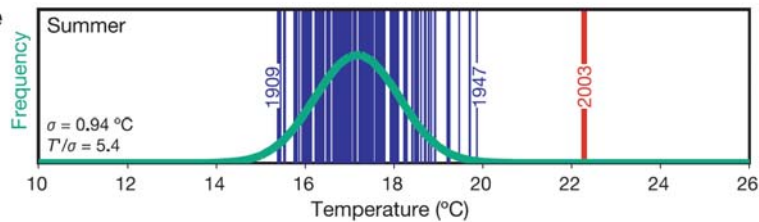
European heat wave in 2003 (Schär et al 2004, Nature, 427)



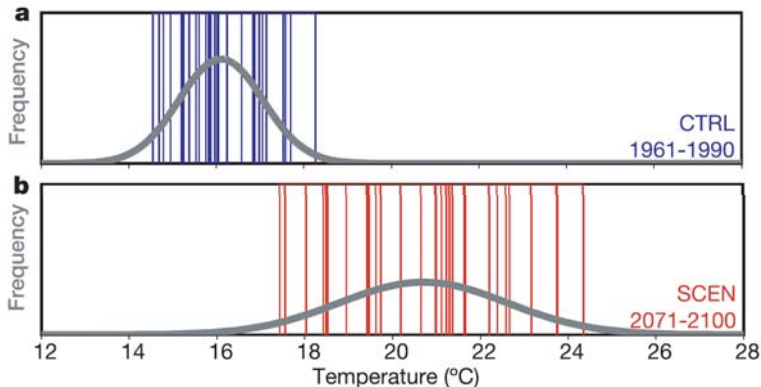
A record-breaking heatwave affected the European continent in summer 2003

The anomaly is 3C larger than 1961-1990 mean, which is a 5.4σ excess.

Return value w.r.t 1990–2002 climatology: $\tau=46000y$ (with lowest value of 9000y)



A 50% increase in σ increases the probability by a factor of 150 => Large sensitivity to var change!

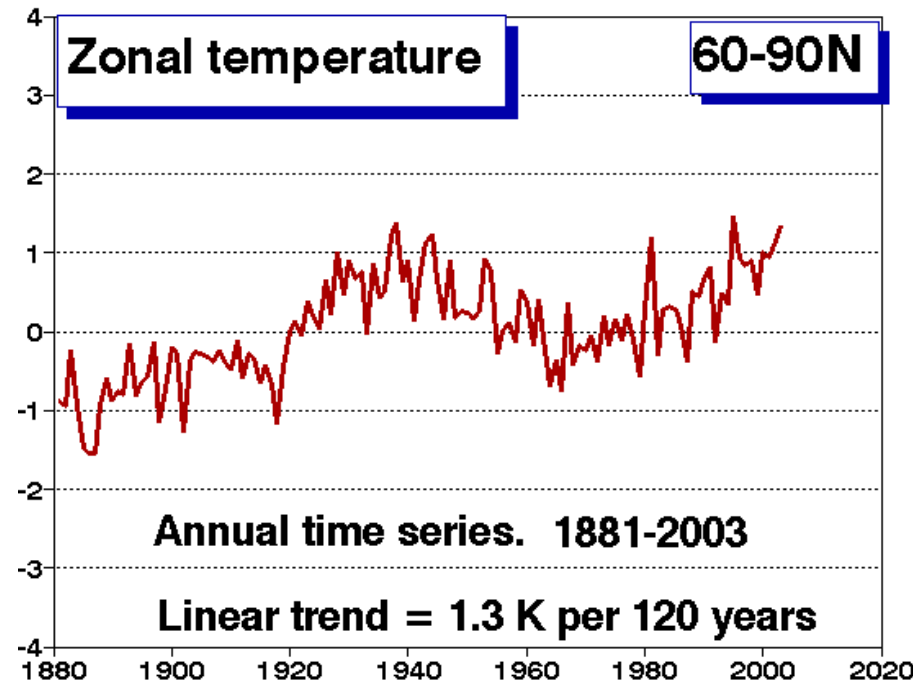
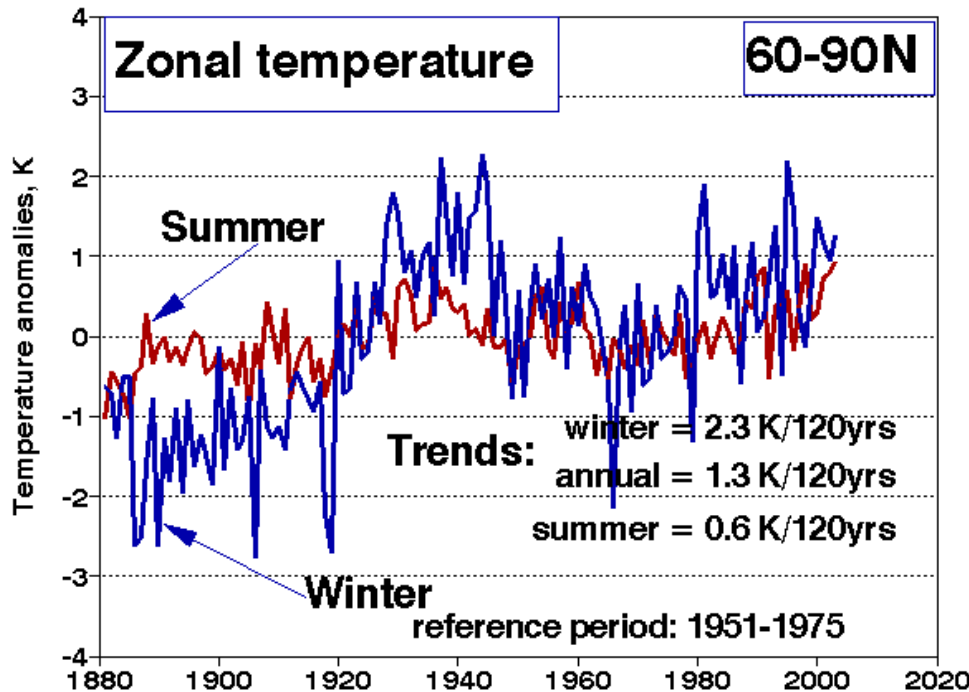


We are in a changing variability regime!

Prudence simulations show that the 03 event can Occur every second year at the end of the century

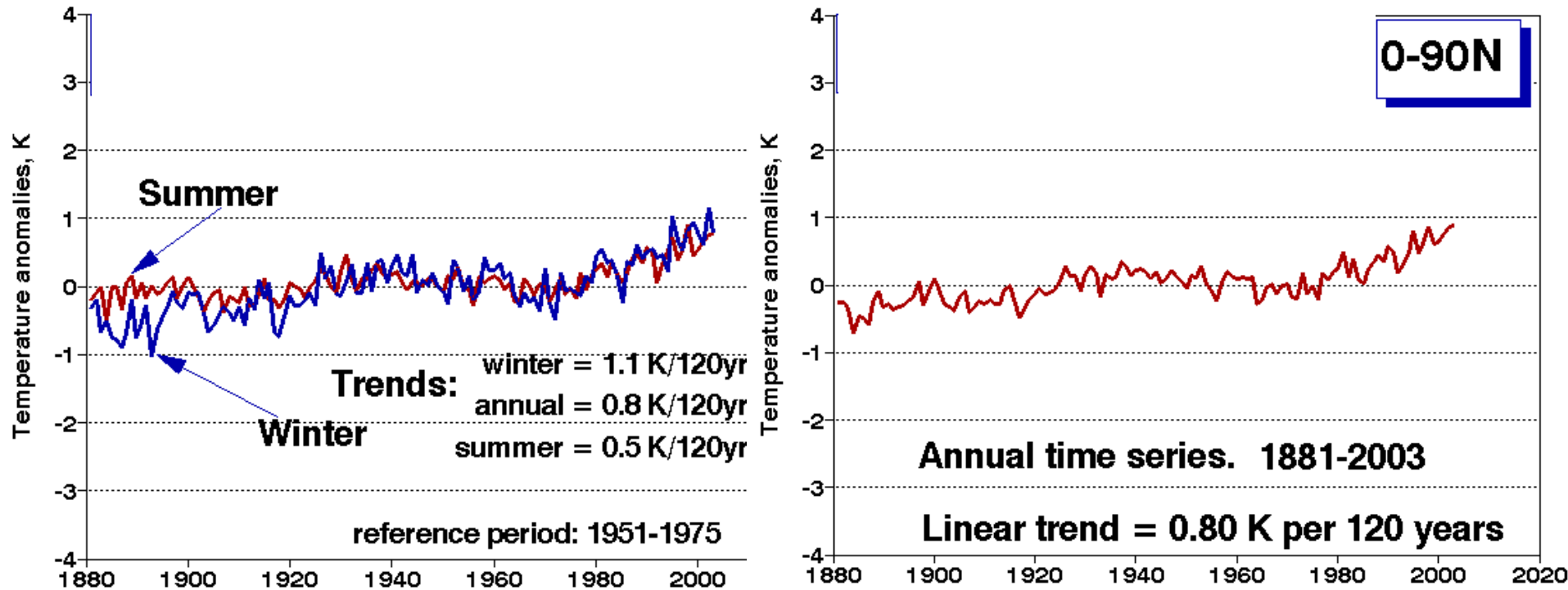
Arctic zonal temperature anomalies

(within 60°-90°N latitudinal zone)



- Winter, summer, and annual anomalies, 1881-2003 period
- All linear trends significant at the 0.01 level
- (available from CDIAC, Lugina et al. 2003, updated).

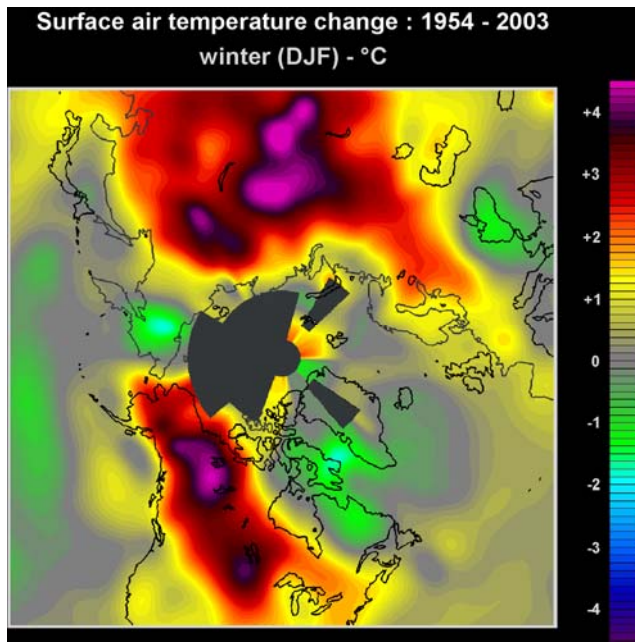
Northern Hemisphere temperature anomalies



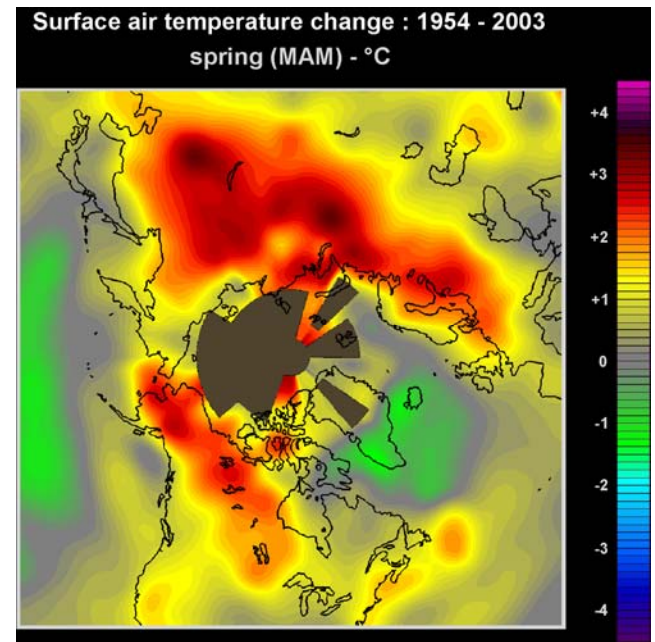
- Winter, summer, and annual anomalies, 1881-2003 period
- All linear trends significant at the 0.01 level
- (available from CDIAC, Lugina et al. 2003, updated).

$$\Delta T_s$$

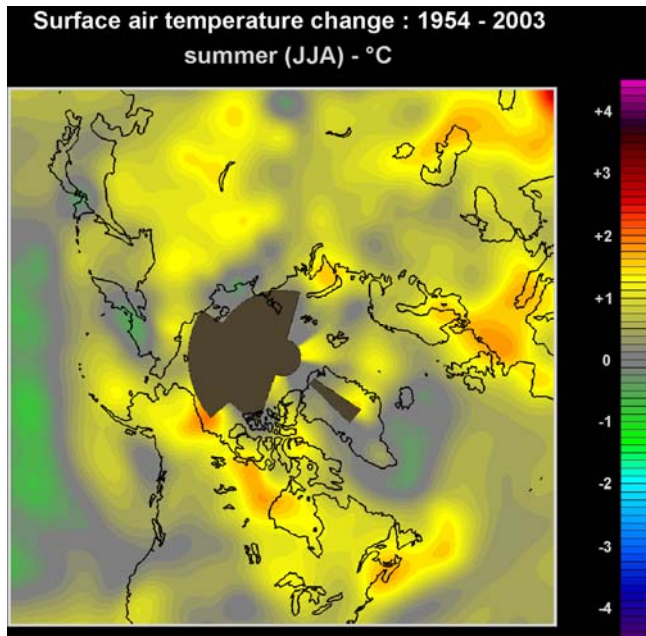
DJF



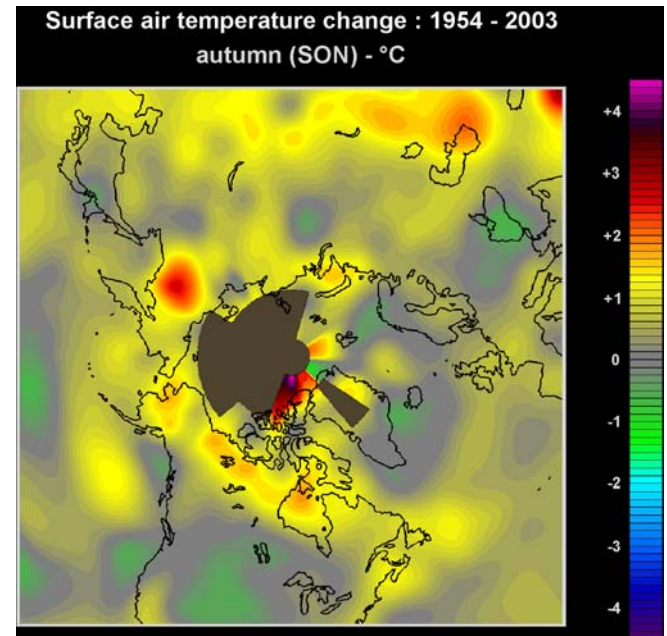
MAM



JJA

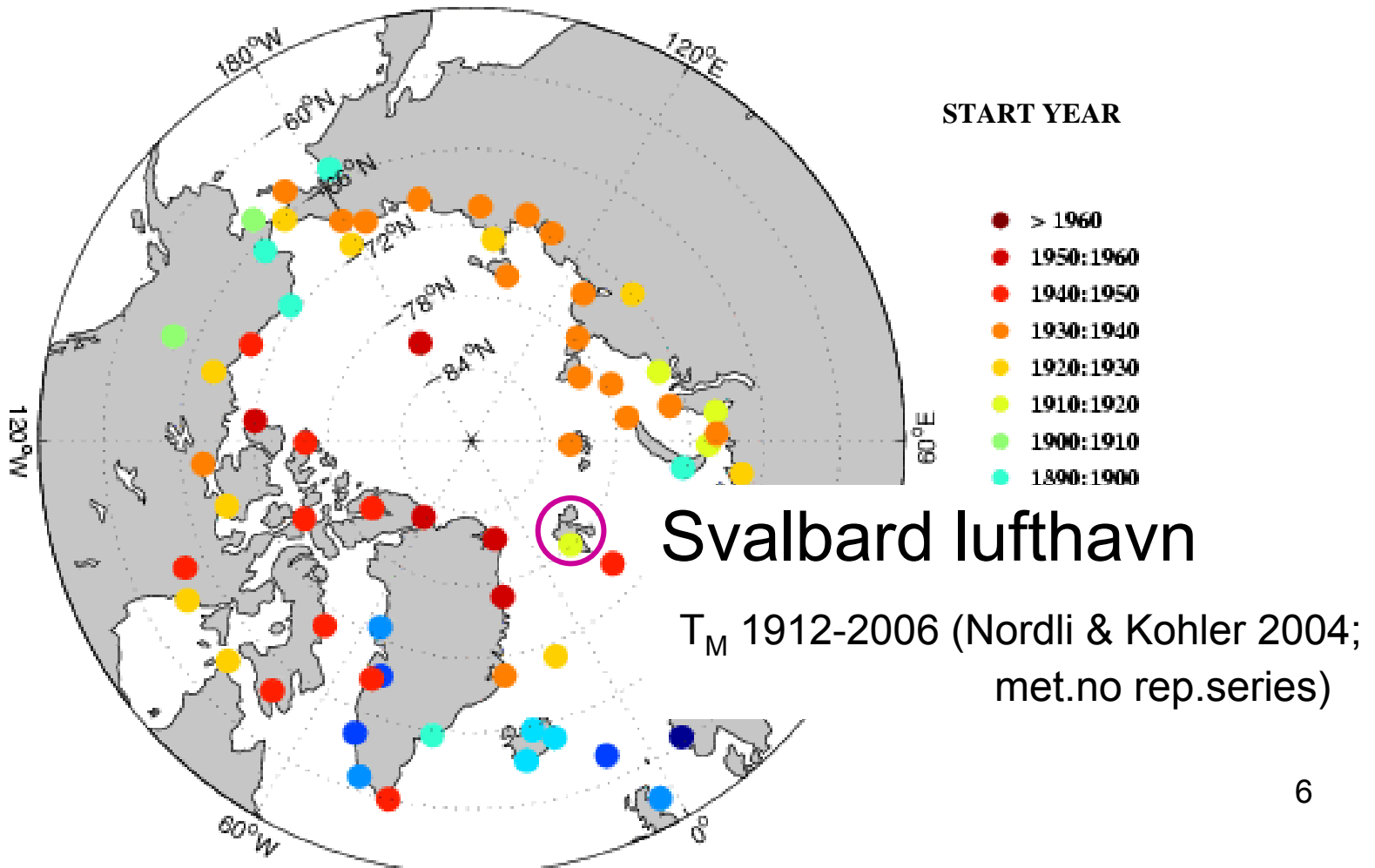


SON



HISTORICAL TEMPERATURE RECORDS

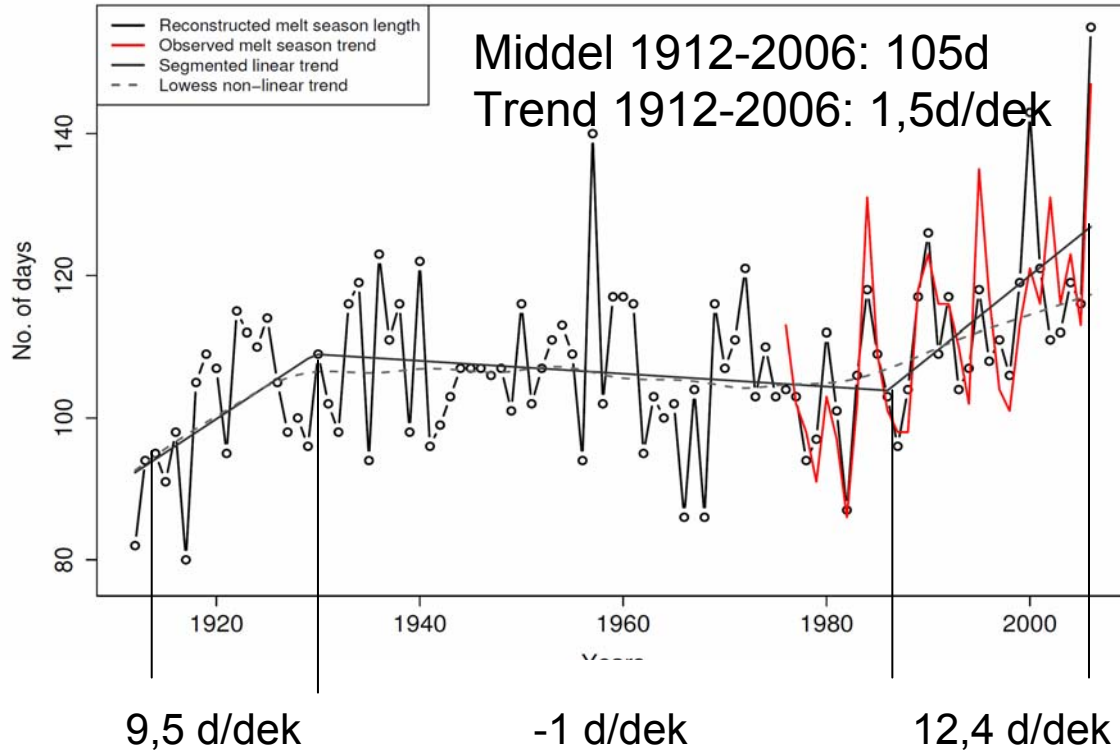
QUALITY CHECKED ARCTIC STATIONS FOR CLIMATE STUDIES



Hetebølger på Svalbard?

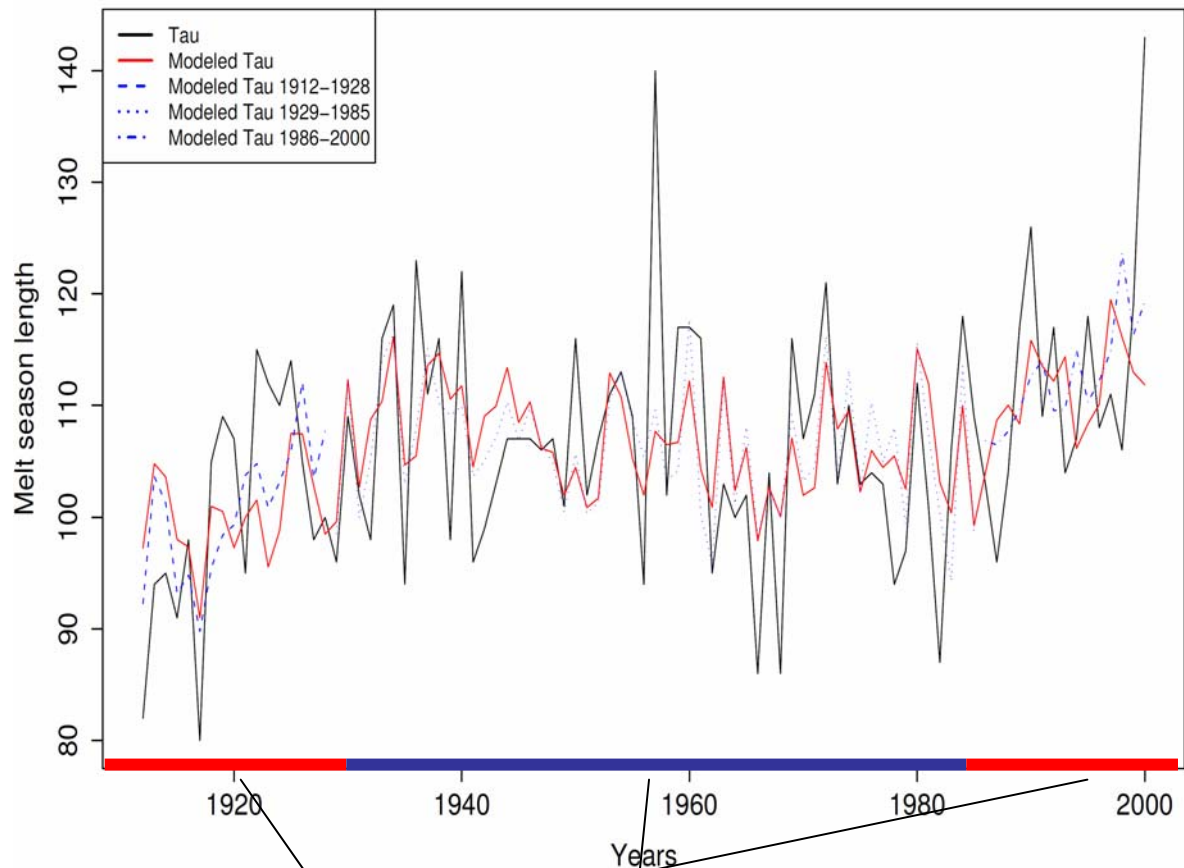
- Temperaturserien indikerer svært moderate endringer variabilitet & ekstremer
- Energikrevende smelteprosess begrenser positive utslag
- Lengden på smeltesesongen vil være en mer følsom indikator
- $\tau = \# \text{ dager } T > 0^{\circ}\text{C}$ (4d på rad)
- Kun månedsverdier tilgjengelig -> rekonstruerer daglige data vha splines

Melt season length 1912 - 2006



Reasonable reconstruction

Which processes matter?



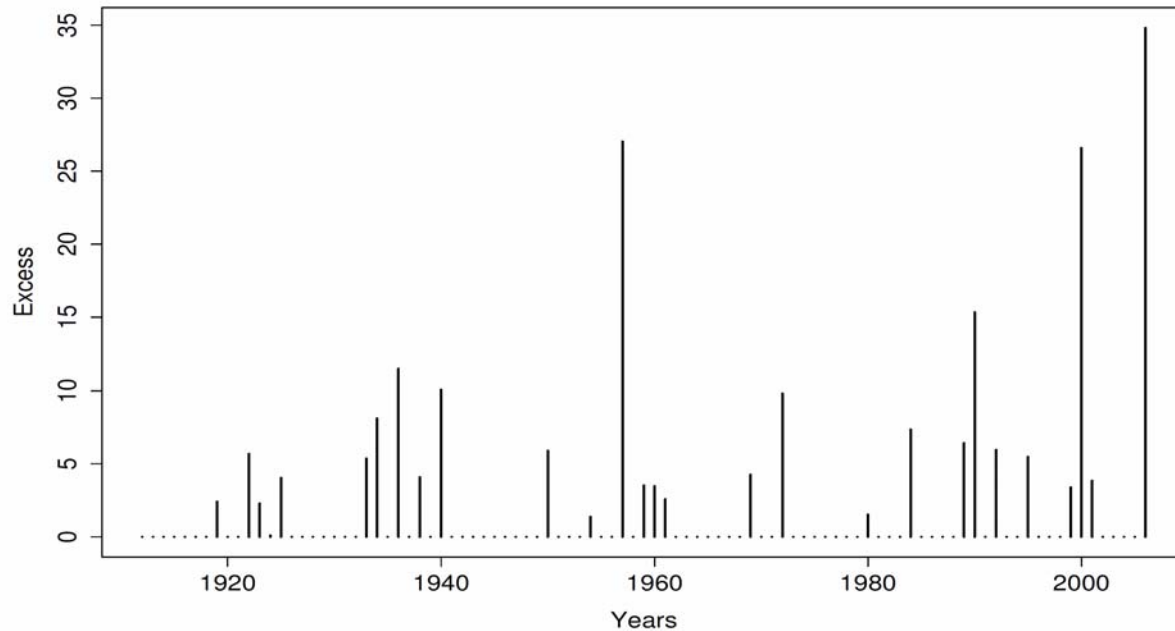
$$\tau = \alpha + \underbrace{\beta_1 T_{nh}}_{NH-temp} + \underbrace{\beta_2 PC2^S}_{summer-NAO} + \underbrace{\beta_3 PC2^W}_{previous-winter-EOF2} + \varepsilon$$

T_{nh} – Jones et al (1999) Rev Geoph
 EOFs (1766-present) - Casty et al (2007), ClimDyn

Modeling of excesses

$$Z_t = \tau - u(t)$$

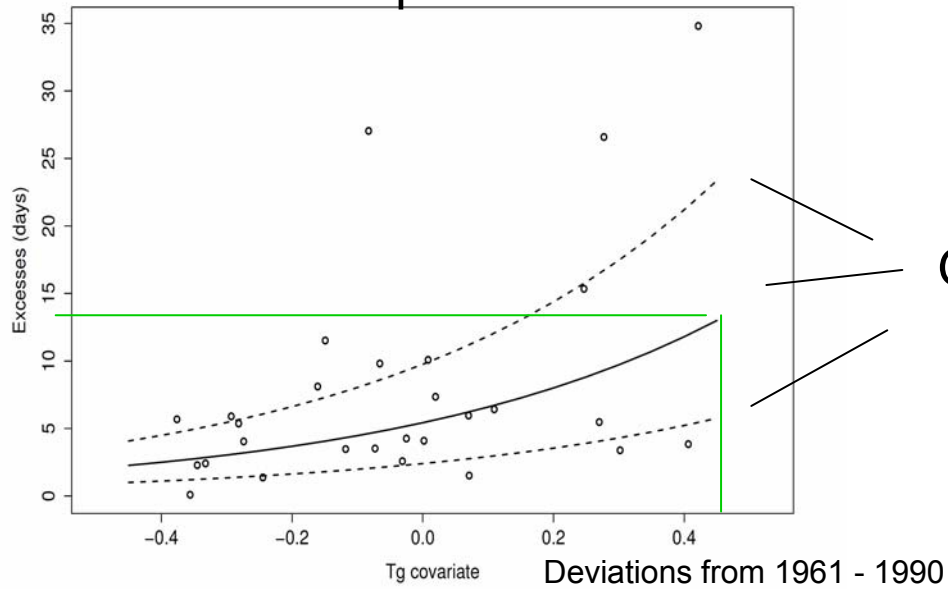
Time varying threshold to meet stationarity requirements, mean $u=111$.



General Pareto Distribution (GPD)

$$\Pr(Z \leq z \mid Z > 0) = H(z) = 1 - \left(1 + \frac{\xi z}{\sigma}\right)^{-\frac{1}{\xi}}$$

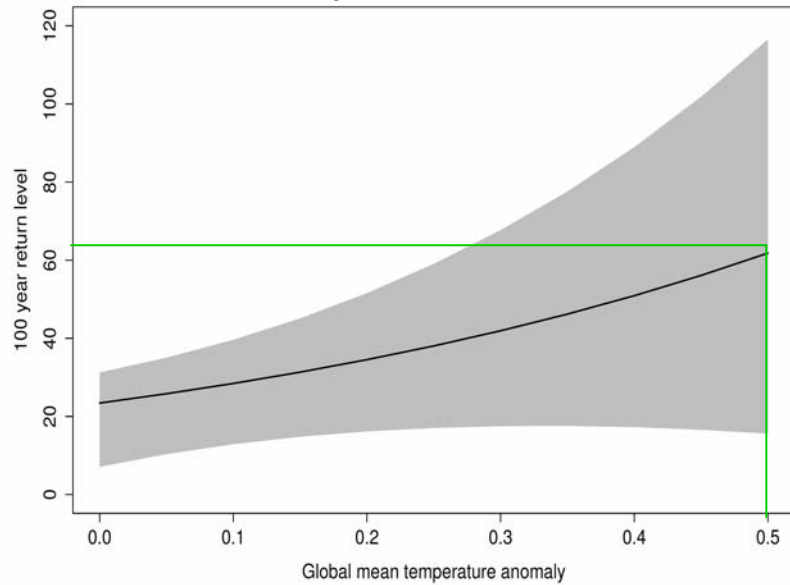
Scatterplot of z



GPD median + quartiles

b)

100 y return value



Should polar bears be worried?



They probably should ☹️