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Institut für
Theoretische Physik III

# Long-term persistence in climate and the detection problem

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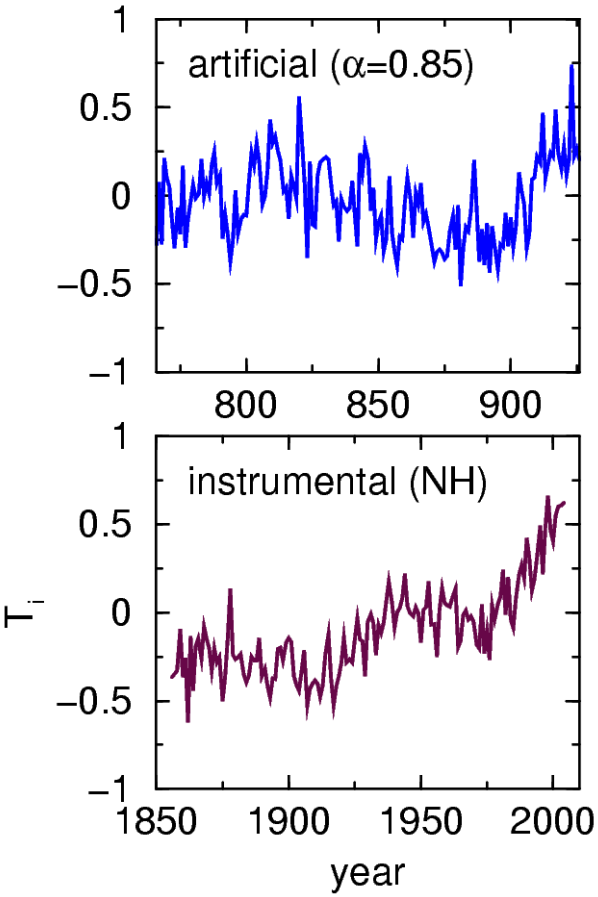
# We know:

- Long-term correlations exist in temperature records and lead to
  - a large variability and
  - a pronounced mountain-valley structure that resembles trend-like behavior

# Question:

- Can the recent increase in the temperature of the Northern Hemisphere (NH) be attributed to these long-term correlations?



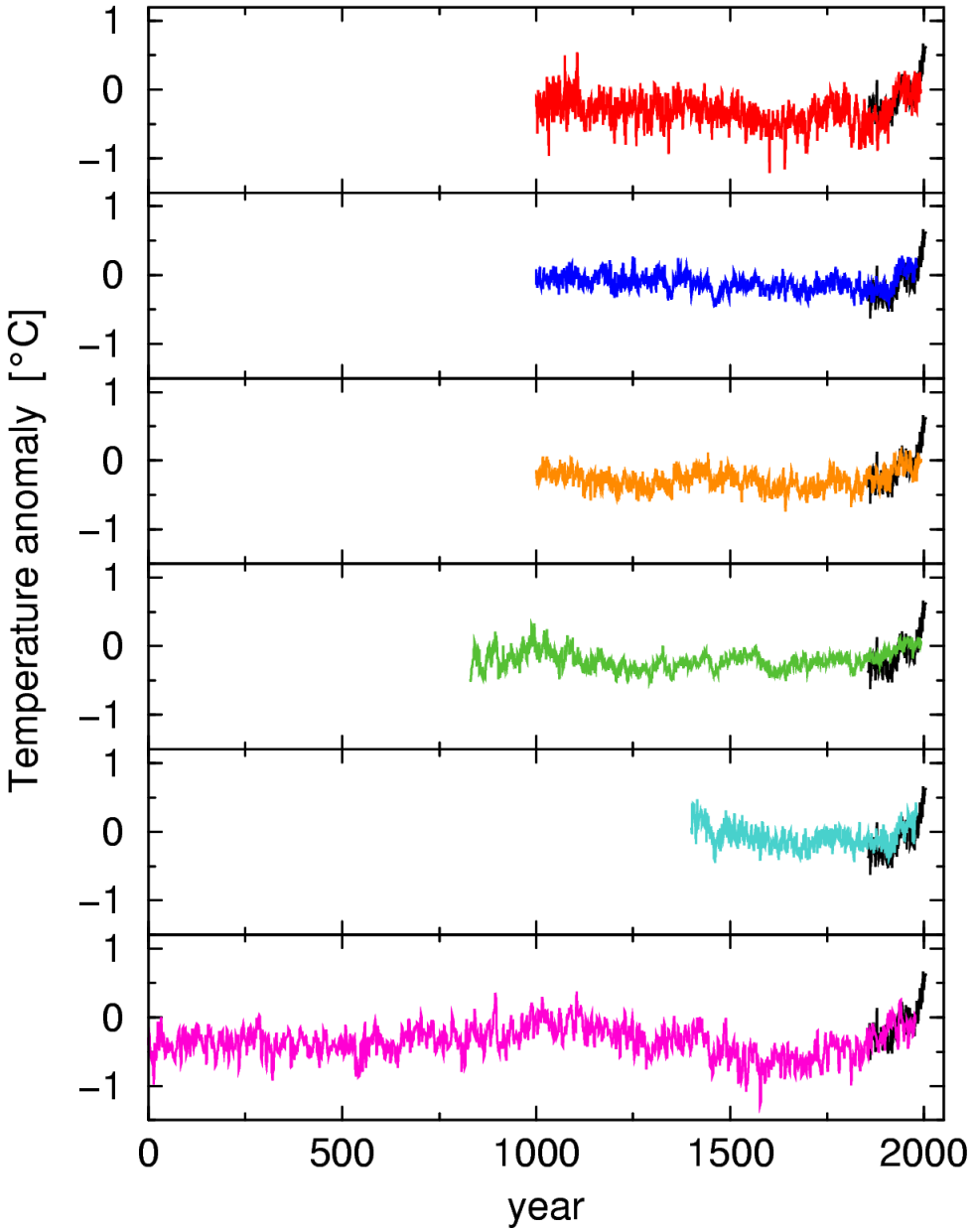
# Our approach:

a) We analyze several centennial NH temperature reconstructions applying *Detrended Fluctuation Analysis* (DFA) and find that their variability can be attributed to long-term correlations.

b) We compare the variations of the reconstructions with the most recent temperature changes in the instrumental record.

c) We obtain an indication whether the recent warming can be related to natural factors or not.

# Considered temperature reconstructions (NH)




**Jones**, P.D., et al.,
Holocene 8(4), **1998**

**Mann**, M.E., et al.,
Geophys. Res. Lett. 26(6), **1999**

**Briffa**, K.R.,
Quat. Sci. Rev. 19(1-5), **2000**

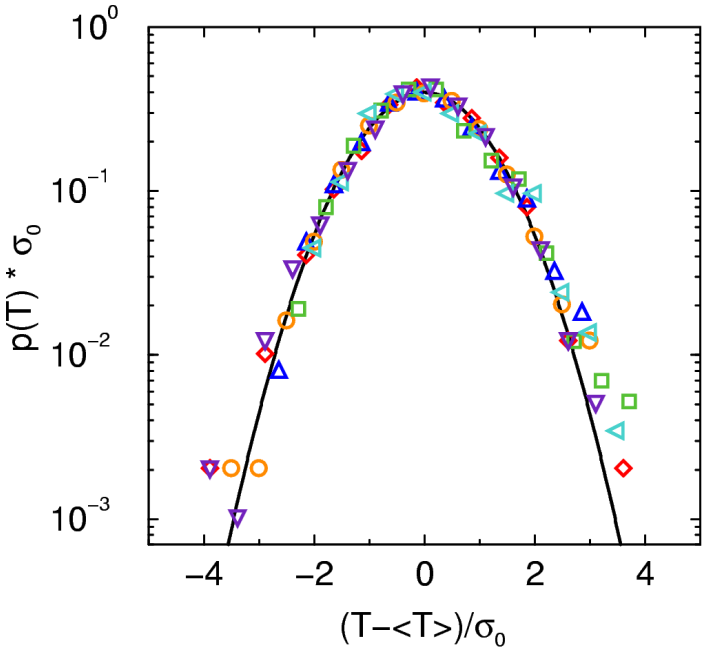
**Esper**, J., et al.,
Science 295(5563), **2002**

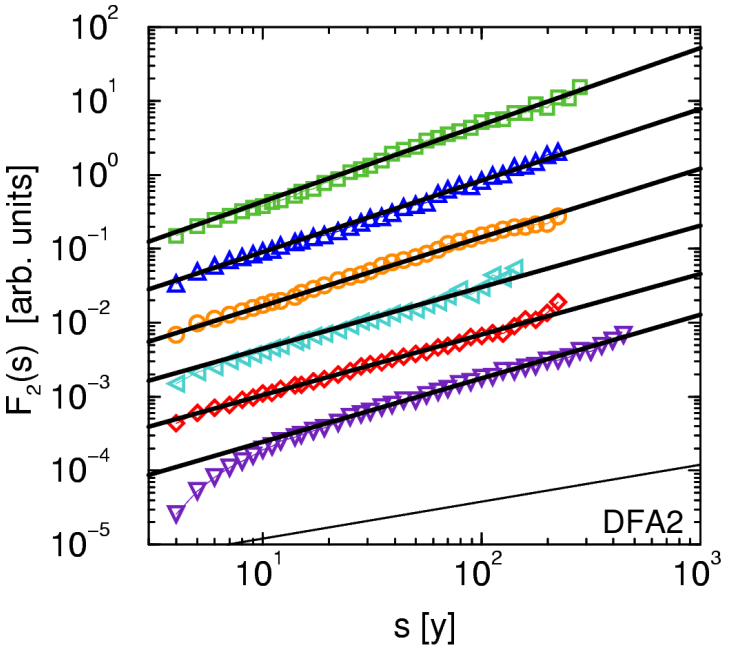
**McIntyre**, S. and McKitrick, R.,
Energy Environ. 14(6), **2003**

**Moberg**, A., et al.
Nature 433(7026), **2005**

http://www.ncdc.noaa.gov/paleo/recons.html

# Distribution and correlation



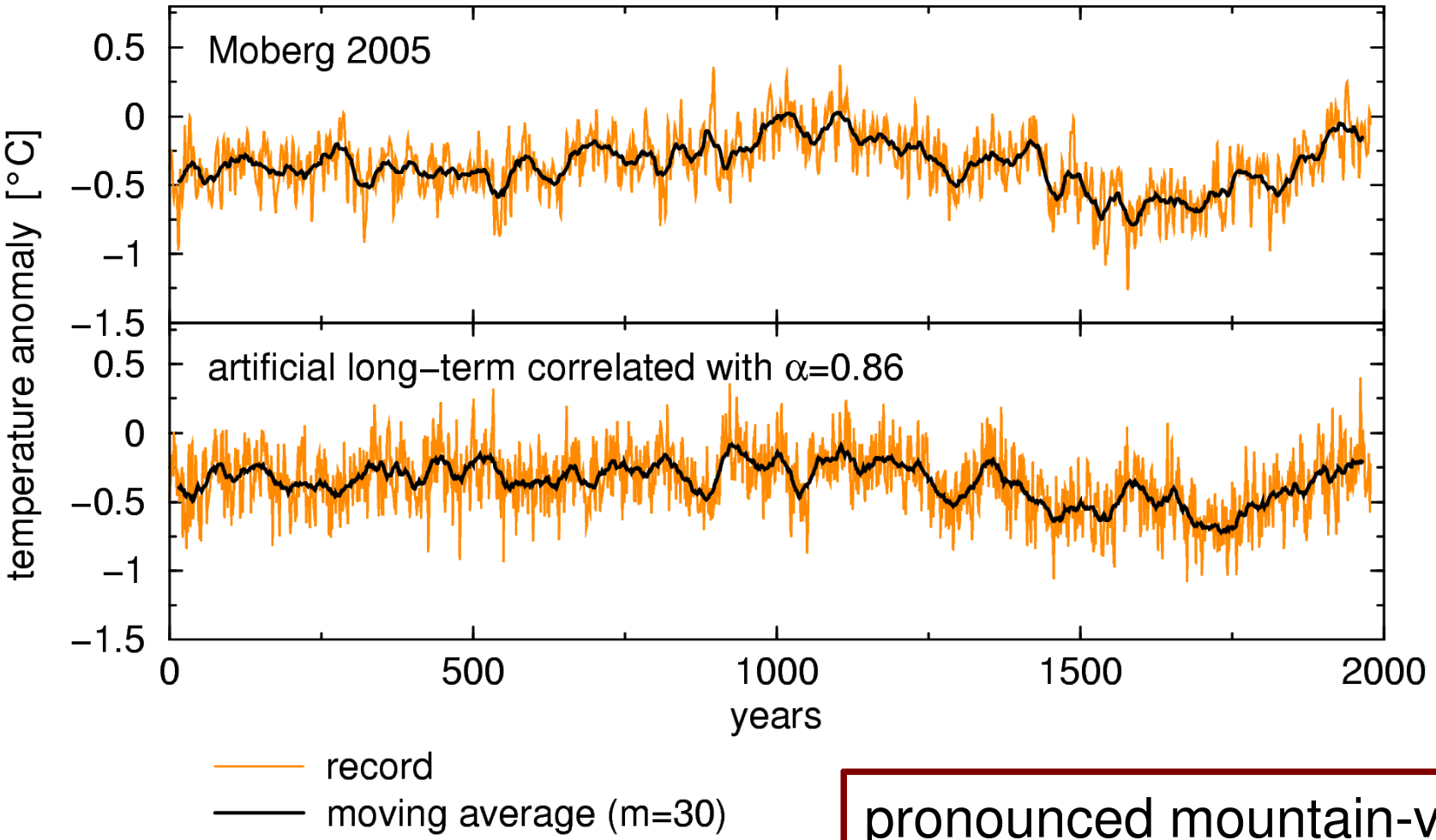

| | α | γ |
|---|---|---|
| Esper2002 | 1.04 | ≈0 |
| Mann1999 | 0.97 | 0.06 |
| Briffa2000 | 0.93 | 0.14 |
| McIntyre2003 | 0.83 | 0.34 |
| Jones1998 | 0.82 | 0.36 |
| Moberg2005 | 0.86 | 0.28 |

($C(s) \sim s^{-\gamma}$, see previous talk by S. Havlin)

approximately Gaussian

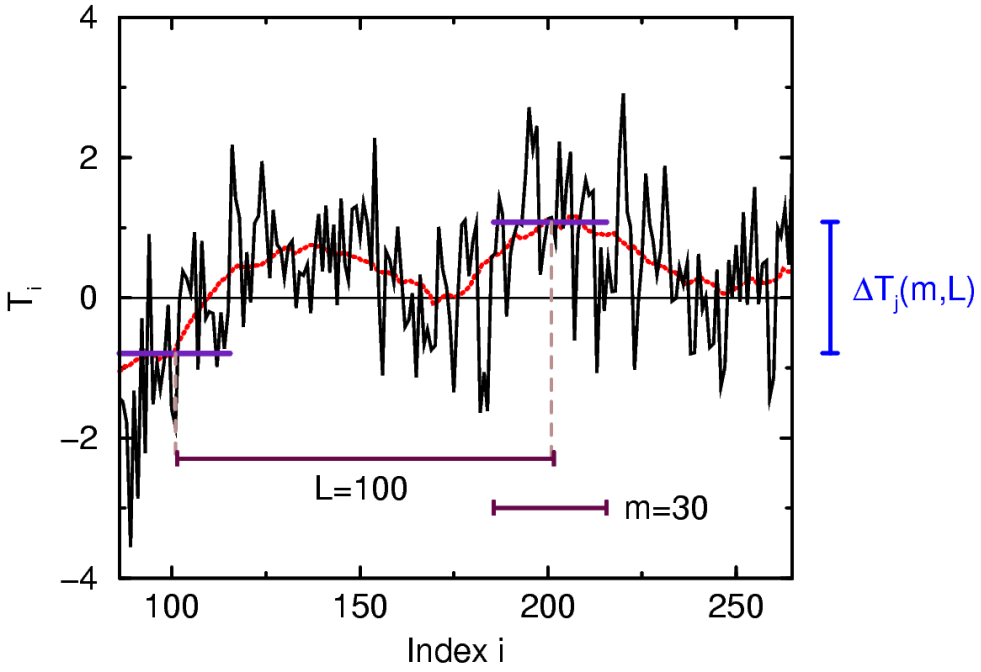
long-term correlations on scales up to centuries

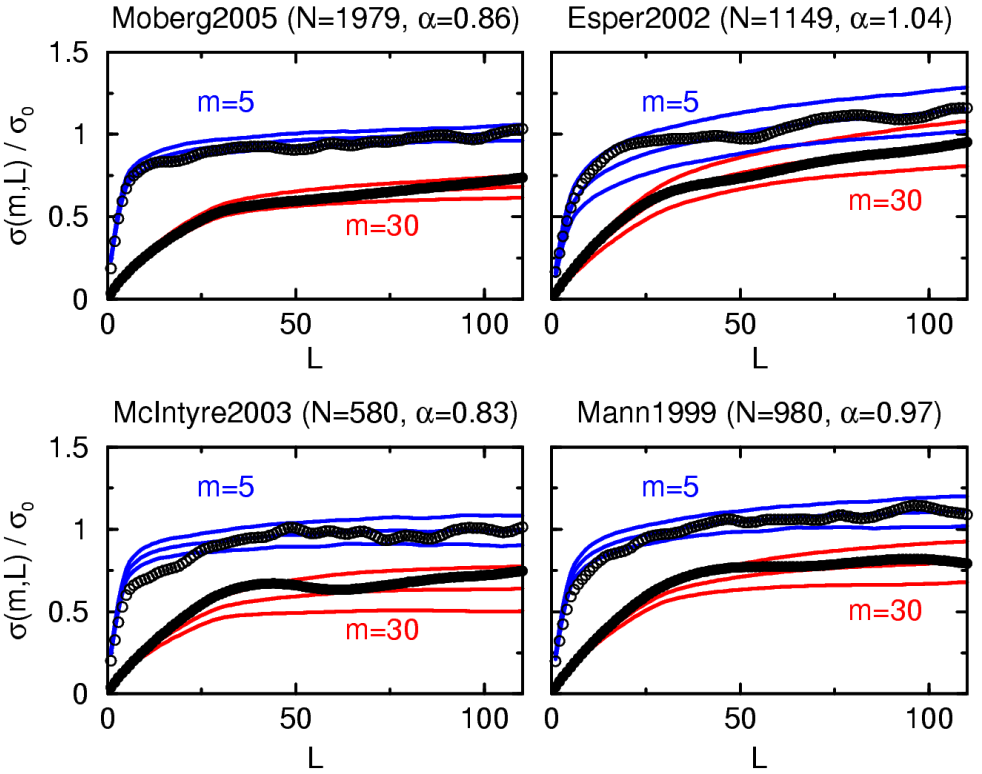
# Enhanced variability




pronounced mountain-valley structure by long-term correl.

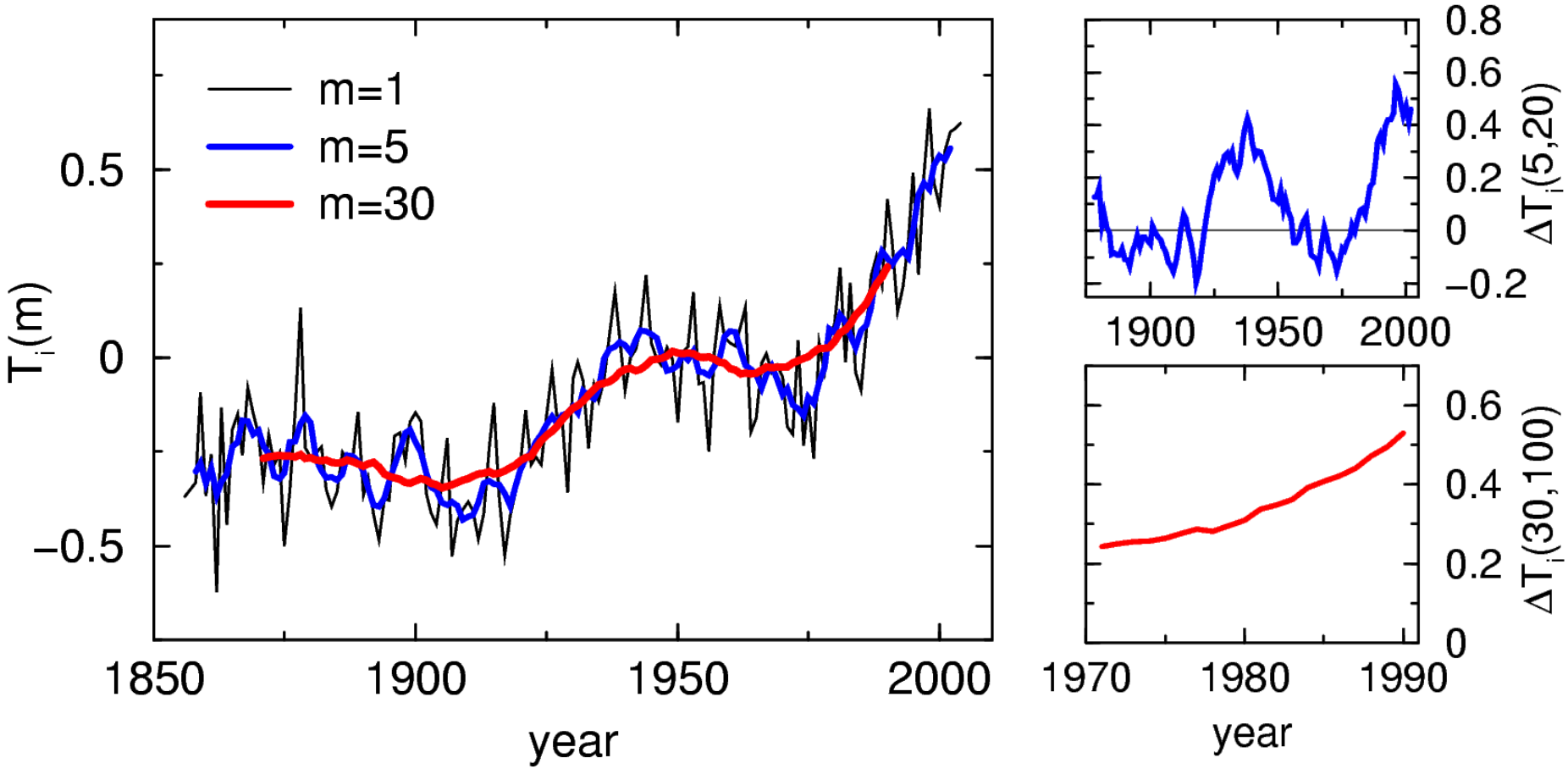
# Moving average differences $\Delta T_j(m, L)$ and standard deviation $\sigma(m, L)$



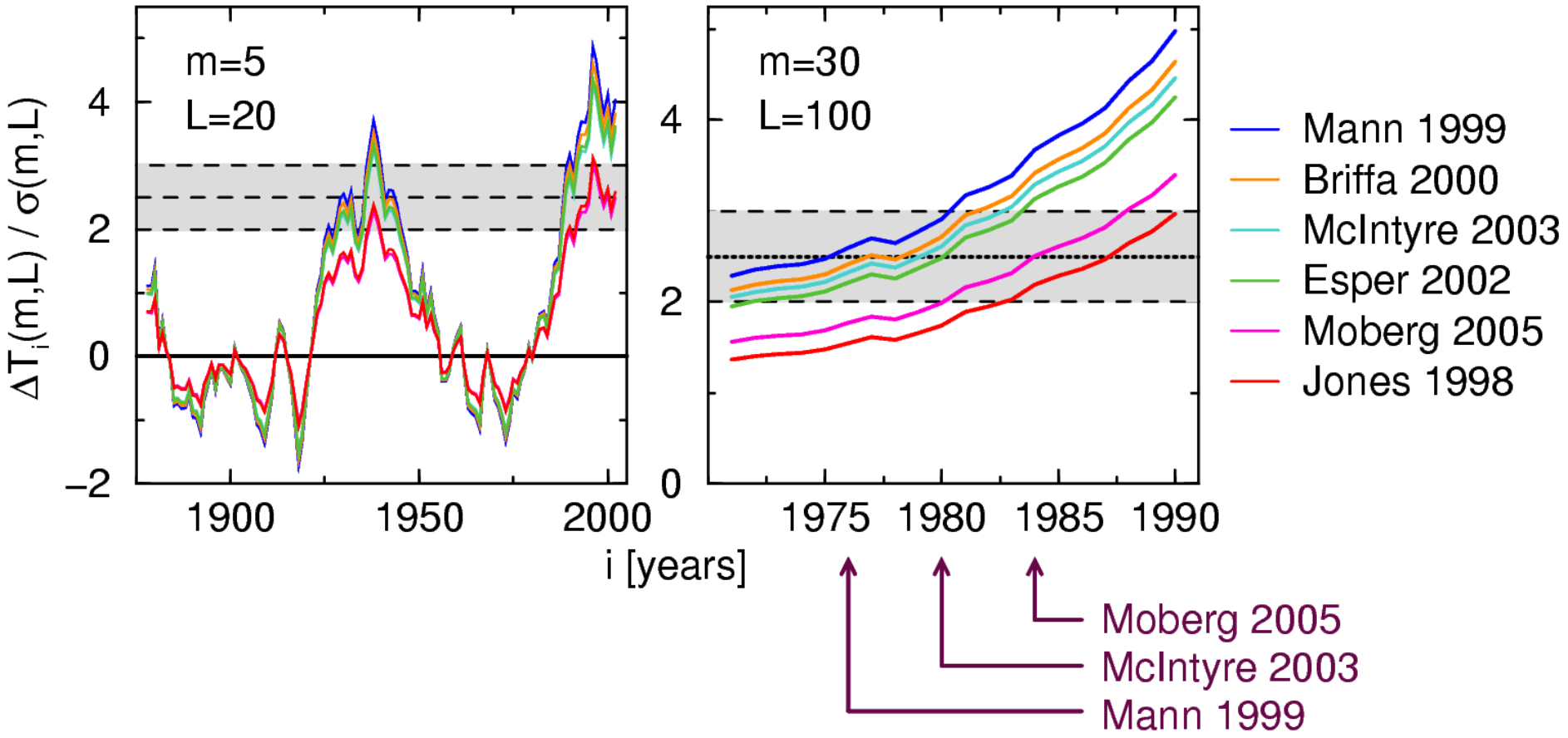




Since the $T_j$ are Gaussian-distributed, the $\Delta T_j(m, L)$ are also Gaussian distributed, characterized by standard dev. $\sigma(m, L)$

# Instrumental temperature record (NH)



# Probability analysis




Details:
D. Rybski, A. Bunde, S. Havlin, H. v. Storch,
GRL 33, L06718, 2006.