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Long-term Temperature Trends and Variability at Svalbard (1911 – 2004)

Ø. Nordli

Norwegian Meteorological Institute, Oslo, Norway (oyvind.nordli@met.no)

Introduction

Triggered climate change debate climate variations in the Arctic have caught much interest. In this vulnerable area (ACIA 2004) the temperature increase is expected to be extraordinary large. The Svalbard Airport temperature series is one of very few long-term series ($\sim$90 years) from the high Arctic. As such it is an interesting subject for studying long-term trends and variability of the Svalbard climate.

Homogenisation

The Svalbard temperature series (1911-2004) is a composite of several shorter series of measurements carried out at a few sites near Isfjorden on Spitsbergen, Svalbard. All shorter series are adjusted to be valid for the current Svalbard Airport weather station. During winter and spring the adjustments depend on temperature. The adjustment accounts for different exposure to inversions mainly caused by varying altitude. During summer and autumn the adjustments do not vary with temperature and are mainly smaller than during winter.

The early 20th century warming

An abrupt change of temperature occurred at the end of the 1910s transforming the Svalbard climate from a cold phase (1911-1919) to a warm phase (1920-1930). The cold phase was characterised by clear sky and pronounced inversions, whereas the warm phase was characterised by overcast sky and weaker and rarer inversions.

Analyses show that frequently overcast sky can partly explain the temperature increase. According to Nordli and Kohler (2004) cloud cover accounts for about 2/3 of the increase. The early 20th century warming might also partly be explained by circu-

lation changes (Hanssen-Bauer & Førland 1998) and it is also suggested that it partly is a result of decreased areas of ice cover (Benestad et al. 2002). Model experiments show that the anomaly is within the range of natural variability (Johannessen et al. 2004). Cloud cover, circulation, and ice cover interact and the 20th century warming can be considered as a result of this interaction.

Significant variations at different time scales

The significance of the various cold and warm phases is tested by using the SiZer tool (Chaudhuri and Marron 1999). For the annual data series the cold phase caused by the 20^{th} century warming turns out to be significant at all time scales from a decade to about 50 yr. At a time scale of a decade the cold phase of the 1960s is also significant.

Long-term trends

For the annual values a positive trend of 0.16 ˚C per decade was detected, significant on the 5 % level. Splitting the annual values into seasons the trends are (˚C/ decade): 0.01 (DJF), 0.42 (MAM), 0.07 (JJA), and 0.13 (SON). The trend of the autumn of 0.13 ˚C per decade is not significant at the 5 % level, whereas a smaller trend in summer (0.07 ˚C) is significant due to much smaller variability in summer than in autumn. This is an illustrative example of the difficulties of climate change detection in the Arctic. The large natural variability hampers the detection of changes. The trend in spring is significant also on the 1 % level.

Conclusions

Ninety years of uninterrupted measurements on Svalbard show a significant trend of 0.16 ˚C per decade for the annual values. During winter (DJF) no significant trend in the data is seen, whereas in spring the trend is highly significant, 0.42 ˚C per decade. The early 20^{th} century warming is a characteristic feature of the Svalbard temperature series. Frequently overcast sky during the warm phase plays an important role by suppressing ground inversions. This leads to increased temperature in particular at low level sites.

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