JP8.16 ASSESSMENT OF TRENDS IN SURFACE AND UPPER AIR TEMPERATURE AT VARIOUS LOCATIONS IN CANADA

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1. INTRODUCTION

Recent studies of the Canadian climate have indicated significant changes in the surface air temperature during the past five decades. The annual mean temperature has increased by about 2°C in western Canada over 1950-1998 while a slight cooling occurred in the north-eastern part of the country (Zhang et al. 2000). This pattern was pronounced during the winter and spring. It is pertinent to determine if related trends also occur in upper levels of the atmosphere. This study presents a preliminary analysis of the trends and variability in temperature at the surface and various standard upper air pressure levels at several locations in Canada.

2. DATA AND METHODOLOGY

Radiosonde observations have been taken at more than 50 locations across the country since the early 1960s. Temperature, altitude, relative humidity, wind direction and wind speed are reported at various standard pressure levels. Observations are taken every day at 00 and 12 GMT and a few stations have also additional observations at 06 and 18 GMT.

Historical observations (1961-1989) and current observations (1990-2004) were joined together in order to calculate long-term trends in temperature, altitude and relative humidity at the surface and four pressure levels (85, 70, 50 and 25 kPa) over 1961-2004. Unfortunately, quality control of the upper air data has diminished in time and the current datasets has not been through a rigorous manual quality assessment. Since changes in instruments and in observing procedures can also introduced artificial jumps in climate time series (Vincent et al. 2002), a meticulous homogeneity assessment of the upper air data should be done before the final evaluation of the trends.

Daily values were obtained by averaging the observations at 00 and 12 GMT. Monthly values are the averages of the daily values when less than 8 days are missing in the month and the annual means are computed only if all months are present. The best-fit linear trend was applied to the annual values over 1961-2004 to detect any significant changes: it was calculated only if more than 80% of the values were present. The statistical significance was assessed at the 5% confidence level using the t-test.

3. RESULTS

The annual mean temperature and relative humidity of Norman Wells are given for the surface and four pressure levels in Figure 1. The time series at the lowest part of the graph represent the temperature and relative humidity at or near the surface and the time series above are for increasingly higher altitudes. The observations at 85, 70, 50 and 25 kPa are taken at about 1.5, 3.0, 5.5 and 10.2 km altitude respectively.

Norman Wells is located in an area of strong warming in Canada where the surface annual mean temperature has increased by 2.0°C over the 44 years. The temperature at 85 kPa is warmer due to the low level temperature inversion and shows a similar trend of 2.1°C. With altitude, the trends are getting smaller, and at 25 kPa there is a cooling of 0.8°C. The relative humidity shows no significant trends at the different pressure levels during the 44 years. However, since the periods 1961-1970, 1971-1994 and 1995-2004 seem to demonstrate different behaviour, the time series need to be evaluated for discontinuities before definitive conclusions can be made (Van Wijngaarden and Vincent 2005).

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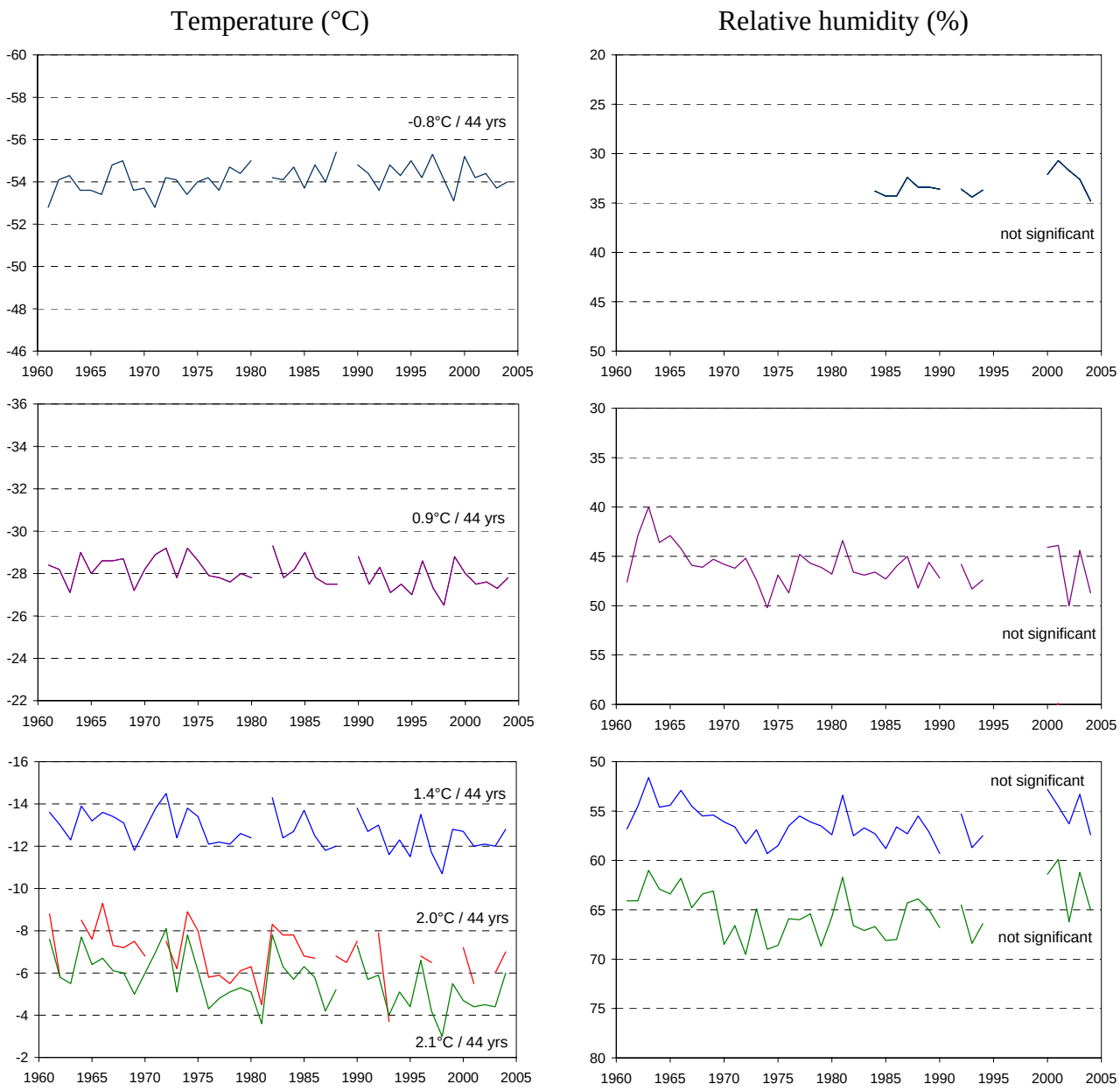

Figure 1: Annual mean temperature and relative humidity at Norman Wells, NWT, 1961-2004 for different pressure levels (surface – red, 85 kPa – green, 70 kPa – light blue, 50kPa – purple, and 25kPa – dark blue).

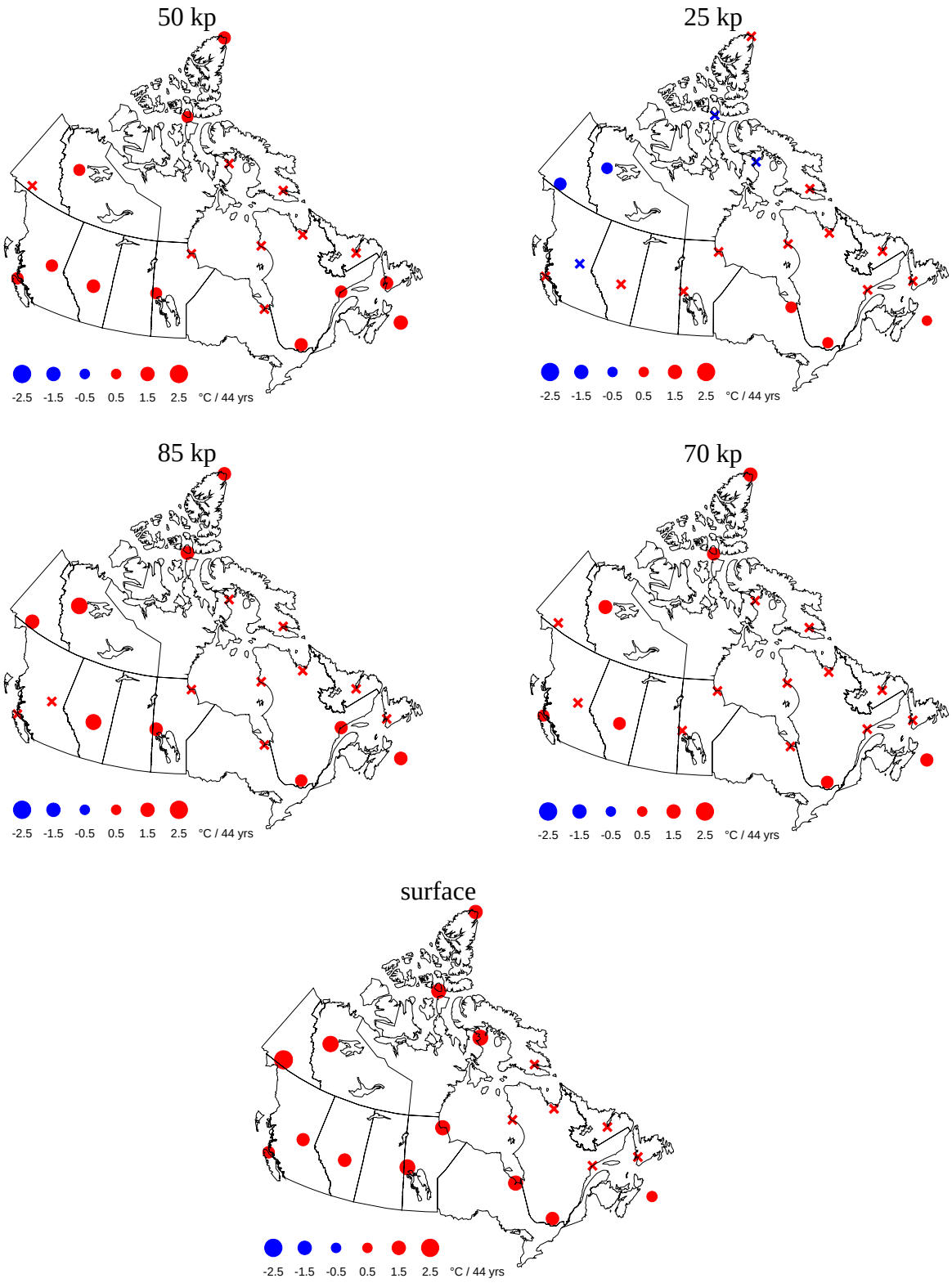

Figure 2: Trends in upper air annual temperatures for 1961-2004. Crosses indicate trends not significantly different from zero at the 5 % level.

Figure 2 presents the trends in the upper air annual temperatures. Only 19 stations across Canada have sufficient observations to calculate the trends over 1961-2004. At the surface level, the station data illustrate a warming of about 1.5 to 2.0°C almost everywhere across the country although the trends are not significant in the northeast. Overall, with lower pressure levels, there are less significant increasing trends and their magnitudes are getting smaller. Often there is a small increase in altitude corresponding to the warming in upper air. Finally, it seems that the strong warming observed at the surface mostly disappears in the high atmosphere and that at 25 kPa a few stations even show a cooling over the past 44 years.

4. REFERENCES

Van Wijngaarden, W.A., and L.A. Vincent, 2005: Examination of discontinuities in hourly surface relative humidity in Canada during 1953-2003. Submitted to the Journal of Geophysical Research.

Vincent, L.A., X. Zhang, B.R. Bonsal and W.D. Hogg, 2002: Homogenization of daily temperatures over Canada. Journal of Climate, 15, 1322-1334.

Zhang, X., L.A. Vincent, W.D. Hogg and Ain Niitsoo, 2000: Temperature and precipitation trends in Canada during the 20th Century. Atmosphere and Ocean, 38, 395-429.