# ASSESSEMENT OF TEMPERATURE, PRECIPITATION AND SNOW DEPTH VARIATIONS DURING THE LAST 100 YEARS IN THE FORMER SOVIET UNION (FSU)

Jean-Michel FALLOT and Roger G. BARRY [1]


## ABSTRACT

A climatological study is made of regional variations in temperature, precipitation and snow depth observed in the FSU during the last 50 - 100 years. Analysis, methods and some results of the January trends for these 3 parameters are presented.


## 1. INTRODUCTION

Trends in temperature, precipitation and snow depth observed during the 20th century are valuable indicators of global climate change. Only a few studies of these trends have been carried out in the Eurasian continent. Winter-spring snow cover in the Former Soviet Union (FSU) represents almost 60% of the northern hemispheric total area; its variations are of climatic significance (Barry et al., 1994).

Daily temperature, precipitation and snow depths up to 1983-84 for 284 stations in the FSU have recently become available. About 70 stations have recorded climatic data since the late 19th century. The satellite snow cover record spans only 22 years. The purpose of this study is to characterize the variations of temperature, precipitation and snow depth observed during the last 50 - 100 years in different regions of the FSU.

## 2. METHODS

Quality checking of data was first required to correct erroneous values in the original files : some suspected errors that cannot be corrected may remain and affect the results. Time-series are calculated for individual months in 51 locations distributed along several west-east transects (figure 1). Stations with 80-100 year records have been selected, but some stations with shorter records have been included in order to explore the different regional climates in the FSU.

Principal component analysis and cluster analysis are performed on the time-series to identify different regions in the FSU according to their specific trends for each parameter. Because of missing values in most time-series before 1927, this analysis is limited to 1927-83.

## 3. RESULTS

An example of the time-series results is presented for January. Figure 1 show the regionalization of the FSU derived from principal component analysis and cluster analysis on the mean January temperature time-series. Coherent regions can be identified for temperature that are in good agreement with examination of the 51 time-series of the FSU. Regionalization performed for mean January precipitation (not shown) reveals great local variations in eastern Siberia and around the Black Sea which strongly influence the results for this parameter : most regions include only one or two stations in these areas. This illustrates the problem of local variability in precipitation data for modelling studies. The same problem is observed for snow depth.

Figure 2 shows the January temperature time-series at 10 locations representing each region derived from principal component analysis. To smooth the interannual variations, 5-year running means have been calculated. The same locations were chosen for precipitation and snow depth (figure 3), despite strong local variation in these variables.

- <u>Temperature trends in January</u> (figure 2) :

A warming trend is detected from 1890 to 1920 or 1930 in European Russia and western Siberia from 50°N northwards (Archangelsk, Gorki) and also in north central Siberia (Viljujsk, Verkhojansk). Mean January temperature remains constant after 1930, except for colder periods observed around 1941 and 1967 in European Russia and western Siberia; a cooling trend is measured in the northern regions of this area after 1950 (Archangelsk).

[1] National Snow and Ice Data Center (NSIDC), Cooperative Institute for Research in Environmental Sciences (CIRES), University of Colorado, Campus Box 449, Boulder, Co 80309-0449 (USA).

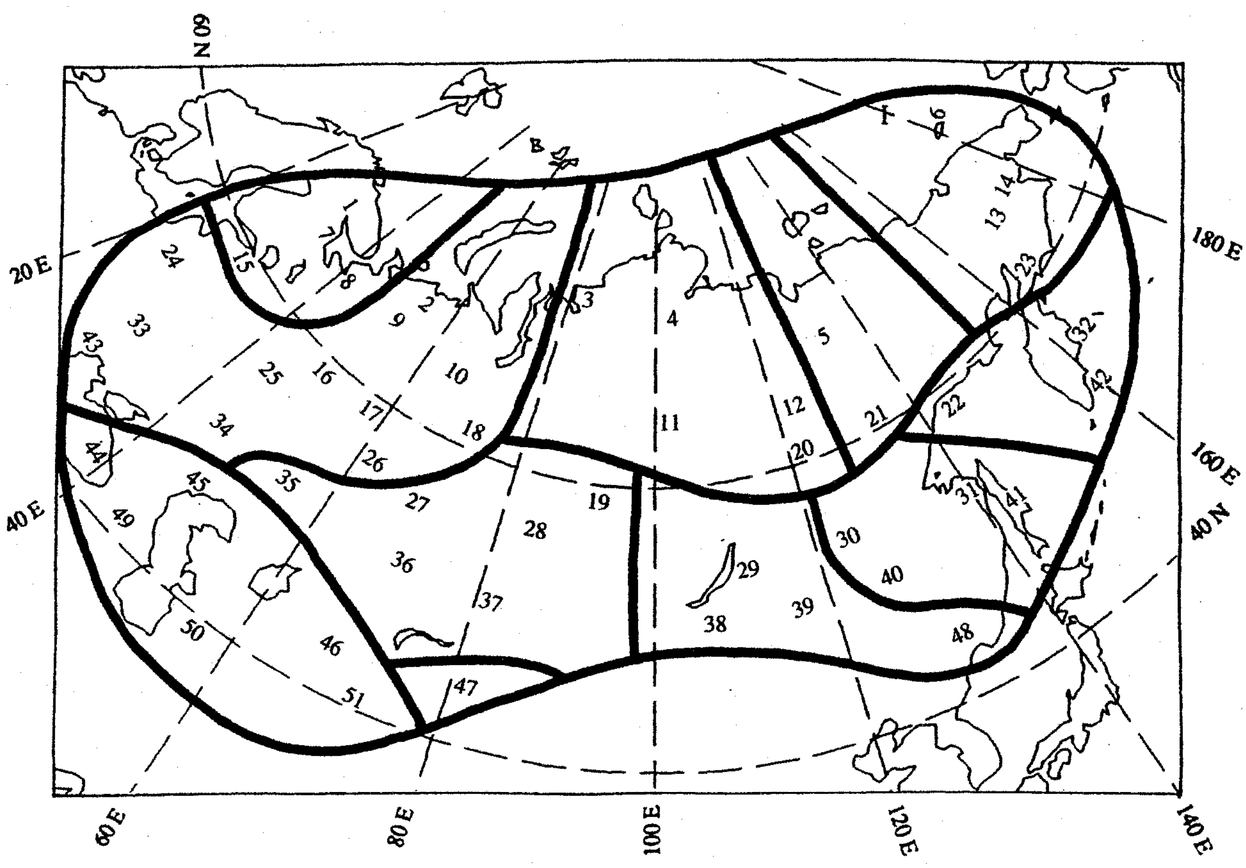


Figure 1 : Location of the 51 selected stations in the Former Soviet Union (FSU) and regionalization of the FSU based on mean January temperature time-series (thick line).

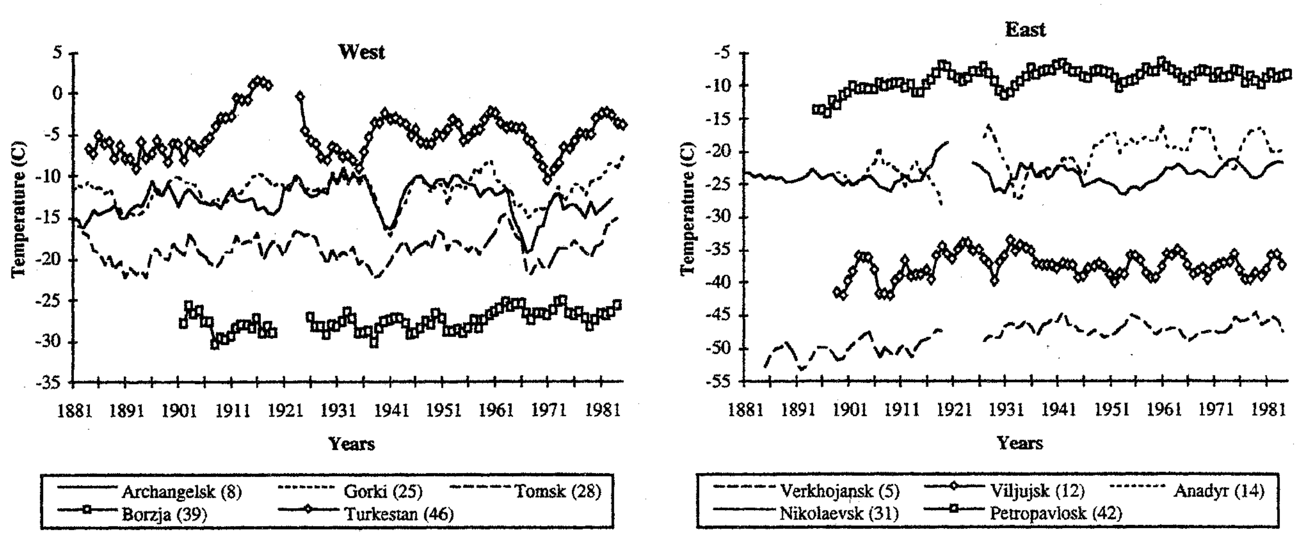


Figure 2 : 5-year running means of mean January temperature at selected stations in the FSU. *Number after each station refers to the locations in figure 1.*

January temperature remain constant or increase slightly in central and eastern Siberia south of 60°N (Borzja, Nikolaevsk) during the 20th century. A warming trend is recorded in the first half of the 20th century in far eastern Siberia (Petropavlosk, Anadyr). No long-range trend can be detected during the 20th century for the regions located south of 50°N (Turkestan) : cold January months are recorded in different years than to the north and a very mild period occured around 1916 in central Asia.

- Precipitation trends in January (figure 3, on the left) :

Mean January precipitation tends to increase in most regions of the FSU after 1930 or 1940. This increase is more marked in European Russia and western Siberia from 50°N northwards (Gorki, Archangelsk, Tomsk) : a wetter period is also recorded in these regions between 1890 and 1925. On the other hand, precipitation remains approximately constant or increases slightly in central Siberia (Borzja, Viljujsk, Verkhojansk) and in the regions located south of 50°N (Turkestan) during the 20th century.

January precipitation varies strongly in eastern Siberia near the Pacific coast (Nikolaevsk, Petropavlosk, Anadyr). A contrast appears in the January precipitation with rather dry months before 1940 followed by much wetter conditions. Very wet January months recorded around 1895 and 1915-20 at Petropavlosk seem to result from measurement or reporting errors.

- Snow depth trends in January (figure 3, on the right) :

Snow depth January time-series vary strongly from one location to another in the FSU and no general long-range trend can be detected from the graphs. Some local trends are present from 55°N northwards but they change significantly from one region to another. Higher fluctuations are once again detected in eastern Siberia near the Pacific coast. Snow depth has remained constant during the 20th century south of 55°N.

Higher snow depths are recorded at the beginning of the 20th century in most regions of European Russia and western Siberia (where measurements are available) from 50°N northwards : they can be connected with higher mean January precipitation during this period. Higher mean snow depths and snow falls were also recorded in the Austrian Alps from 1900 to 1920. In contrast, the progressive increase of mean January precipitation in most regions of the FSU after 1940 has no noticeable effect on the mean January snow depths : these values also depend on mean temperature and precipitation measured during early winter.

## 4. DISCUSSION

Regional trends can be detected from time-series analyses for mean January temperature in the FSU; more local variations affect precipitation and snow depth. Further statistical analyses are needed to identify regional trends and allow better regionalization for these 2 parameters. Other statistical analyses are planned to quantify the variations, periodicities and trends in the temperature, precipitation and snow depth on some typical time-series for each region during the last 100 years. Further investigations are needed of possible errors detected in the precipitation and snow depth data at stations in eastern Siberia.

Time-series for other months are being prepared : preliminary results for March and November show different trends from January. Time-series in November also reveal some regional trends. Variations in the snow depth and precipitation during the 20th century are well correlated in the FSU from 55°N northwards for this month : both parameters show an increasing trend from 1945 to 1975, or 1983, except in eastern Siberia. On the other hand, trends in March strongly vary at a local scale and relationships between temperature, precipitation and snow depth time-series are weak for this month.

## ACKNOWLEDGEMENTS

This work was supported by NOAA-ESDIM No. NA27GP00232. We thank D. Hoogstrate for his help with data checking.

## REFERENCES

Barry R.G., Fallot J.-M. and Armstrong R.L. (1994) : "Assessing decadal changes in the cryosphere : Eurasian Snow Cover", Preprints Fifth Conference on Global Change Studies, January 24-28, 1994, Nashville, Tennessee. American Meteorological Society, Boston, MA, p. 148-155.

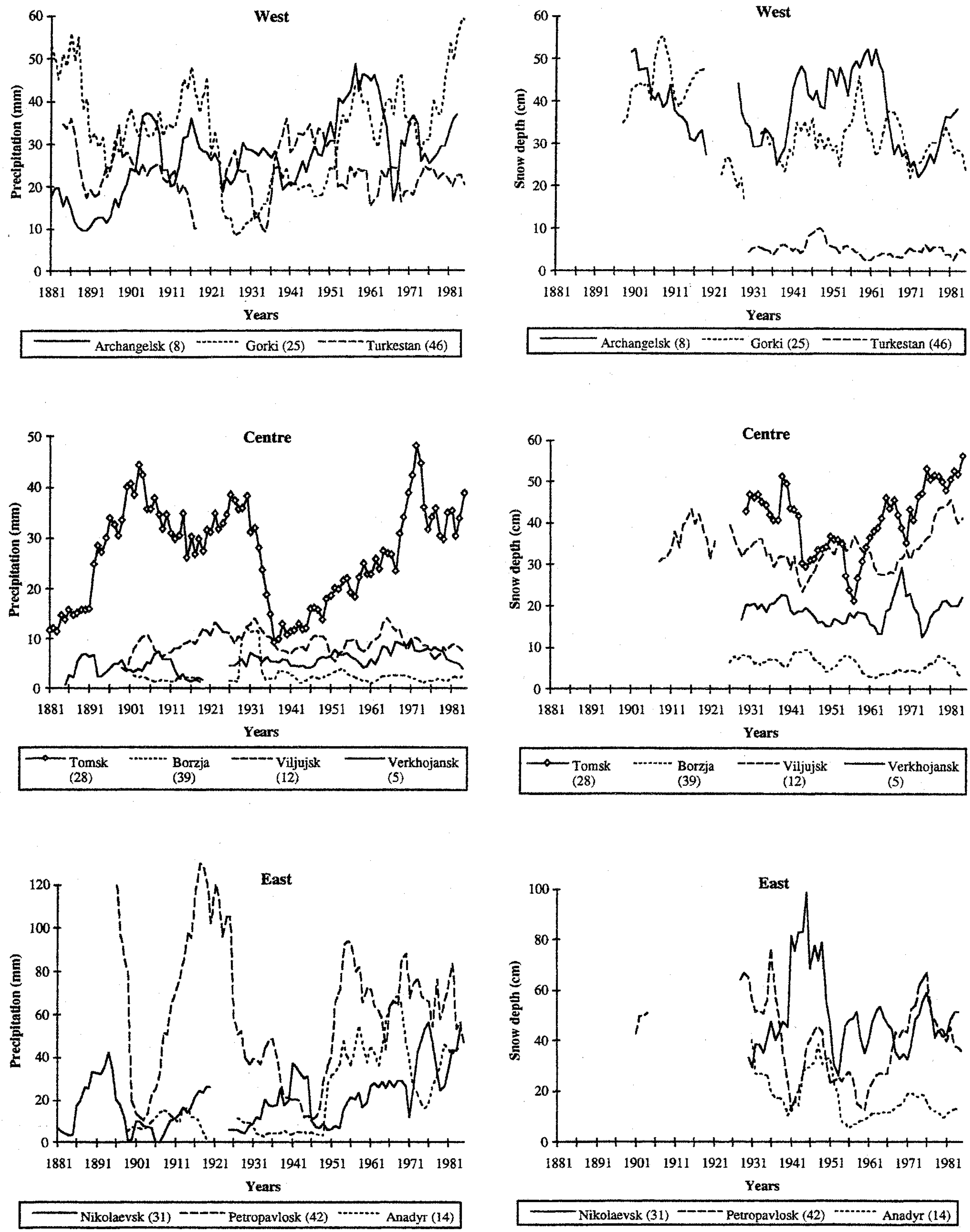


Figure 3 : 5-year running means of mean January precipitation (on the left) and snow depths (on the right) at selected stations in the FSU.
*Number after each station refers to the locations in figure 1.*