Spatiotemporal behavior of climatic characteristics determining evolution of forest ecosystems in Siberia in the second half of XX century

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It is well known that both global and regional climate changes influence biological processes occurring in different ecosystems. In particular, they determine forest productivity that plays important role in global carbon balance forming. The paper presents investigation results for climate indices dynamics (duration of growing season and its mean temperature, sum of degree day temperature, precipitation amount) that determine evolution of forest ecosystems in Siberia over the period from 1974 to 2000. The ECMWF data and observations of the weather stations in Siberia were taken as initial data.

Purpose

To study particular climatic indices behavior that determine evolution of forest ecosystems using data of meteorological model and instrumented observations obtained at weather stations' network on the Siberian territory.

Climatic indices

- Annual average temperature,
- Duration of growing season and its mean temperature,
- Sum of degree day temperature with daily mean temperature higher than 5 °C,
- Annual precipitation.

Data

- Data of ECMWF atmospheric model [2] with 0.5°x0.5° resolution averaged by 10 days period for the time range 1974 – 2006;
- Observations of 119 stations located in Siberia over period 1974 - 2000. These stations have continuous observation series for the time period chosen.

Fig.1. Weather stations considered.

Climatic indicators

Annual mean temperature

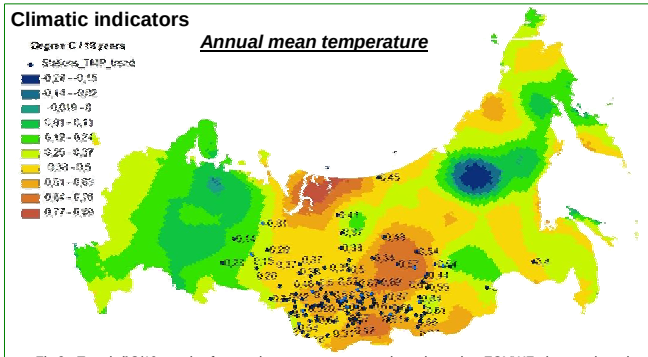

Fig.2. Trend (°C/10years) of annual mean temperature based on the ECMWF data and station observations, Russia, 1974 – 2000.

ECMWF data: the highest trend of 0.5 – 1.3 °C/10 years in the north of West Siberia and in the south of East Siberia.
Weather stations: 0.74 °C/10 years.

Annual precipitation

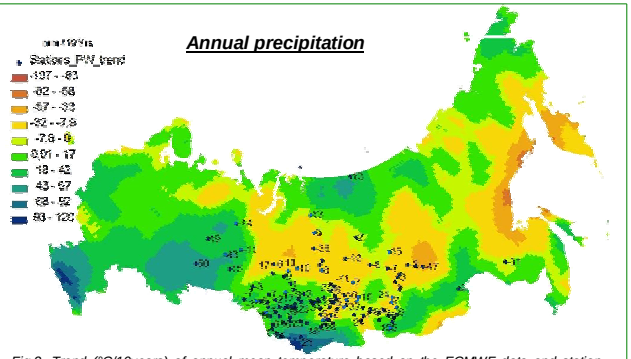

Fig.3. Trend (°C/10years) of annual mean temperature based on the ECMWF data and station observations, Russia, 1974 – 2000.

Weak negative trend of -7.8 mm/10years in the central part of Siberia. Precipitation increase, approximately by 13–17 mm per 10 years is indicated only in the north part of Siberia.

Vegetation period duration

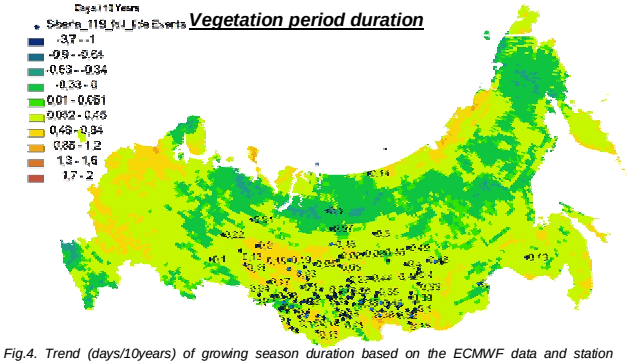

Fig.4. Trend (days/10years) of growing season duration based on the ECMWF data and station observations, Russia, 1974 – 2000.

ECMWF and observation data: increase of growing season duration of 2–3 days per 30 years in the central and south parts of Siberia. In the north part of Siberia reanalysis data present trend of growing season duration of –1 days/30 years, while observation data give 1-2 days/10 years.

Average temperature of growing season

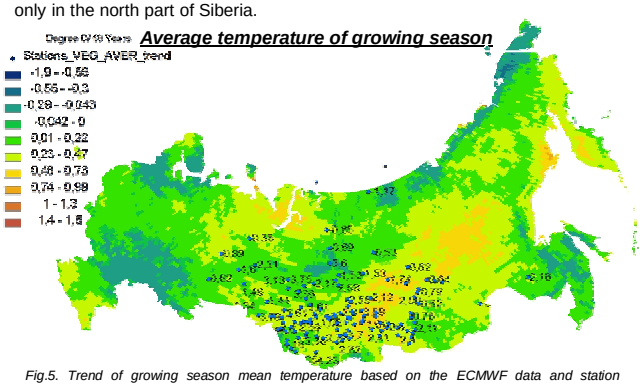

Fig.5. Trend of growing season mean temperature based on the ECMWF data and station observations, Russia, 1974 – 2000.

Observation data: 1.5 - 3.7 °C/10 years in the south part of Siberia, – 0.8 - –1.2 °C/10years in the north.
ECMWF data: 0.2 – 0.6 °C /10years in the south part, while there no significant changes on the north.

Sum of degree day temperature

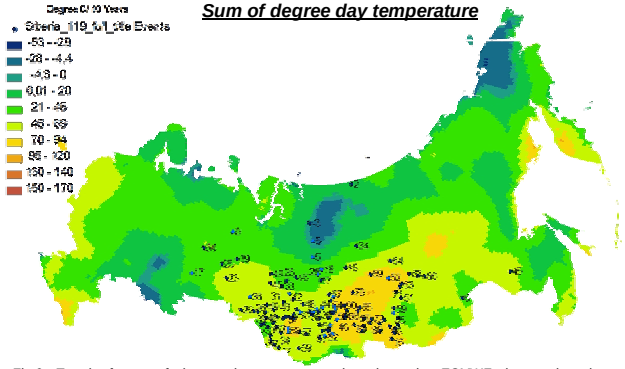

Fig.6. Trend of sum of degree day temperature based on the ECMWF data and station observations, Russia, 1974 – 2000.

Conclusion

- Trend of calculated characteristics have shown spatial inhomogeneity in temperature behavior on the territory of West and East Siberia.
- The highest trends of annual mean temperature equaled 0.5 – 1.3 °C/10 years are in the north of West Siberia and in the south of East Siberia.
- Precipitation increase, approximately by 13–17 mm per 10 years is indicated only in the north part of Siberia.
- Increase of growing season duration by 2-3 days in the central and south parts of Siberia for all period under study (27 years).
- As a whole, reanalysis and observation data are in a good agreement except some regions (shown by blue dots).

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