The long-term dynamics of Global and Arctic Temperatures. Are they predictable?

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The Arctic region determines climate over the whole Northern Hemisphere and North Atlantic Seas in particular. Understanding the Arctic climate dynamics in the near future is vitally important for several ambitious projects, such as year-round navigation from Europe to Asia through the North-east Passage or oil and gas production over the Arctic shelf. "Climatic boundaries" of the Arctic are limited by the July 10˚C isotherm. The outlined area exceeds the traditional geographical boundaries of the Arctic and extends from the western Arctic Seas to the Bering Sea of the East.

The Global temperature started to rise in the 18-th century and has been growing for almost 200 years. In general, this grows can be expressed as a slow "age-long" linear ascending trend, that roughly is 0.6^{O}C/100 years.Following the above described age-long linear trend, the Global temperature has risen slowly for the last 150 years, and at the same time experienced some 60-70-years fluctuations.

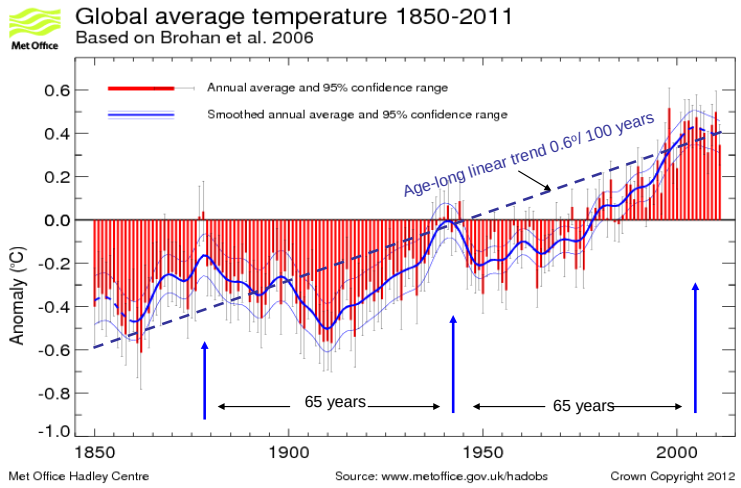
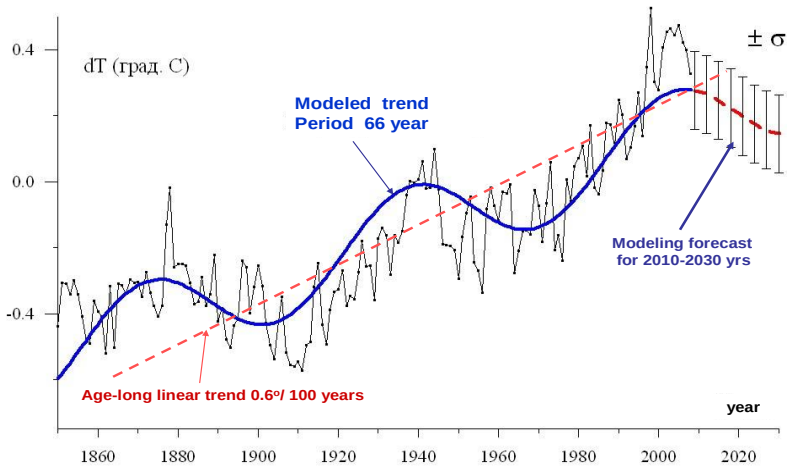


Fig.1. 160-year dynamics of the Global temperature anomaly*(Hadley Center Data)*

On the background of the age-long ascending trend, the Global temperature showed some 60-years cyclic fluctuations, with the maxima in the 1880s, 1940s, and 2000s.

The Time-Frequency Spectral analysis of the long-term historical temperature time series for the last 1000 years (O^{18} content in the Greenland glacier ice cores, the Arctic pine tree rings and the Californian Mountain pine tree rings) shows the domination of 60-70 year harmonics in the long-term temperature dynamics. These periodical 60-70years fluctuations were well manifested for the entire last millennium.

Based on the results of these analysis a prognostic model of Global temperature dynamics was developed.



Fig,2. Dynamics of Global temperature for the period of 1850 - 2008 and modeling forecast for the period of 2010- 2030s. *(Lyubushin,Klyashtorin,2012)*

This model includes both "slow" age-long ascending linear trend and relatively fast 60-70 year temperature fluctuations. According to the model, a gradual decrease of the global temperature is expected to occur from the early 2000s until the 2030s. The recent instrumental measurements shows that the Global temperature has not increased for the last 12 years, and slightly decreased for the last 5 years. The ascending phase of Global temperature cycle came to the end by the early 2000s. The next, descending phase of Global temperature has already started and it is likely to continue until the 2030s.

The Arctic temperature undergoes some 60-years regular fluctuations with maxima around 1940s and 2000s, yet unlike the Global air temperature, it does not show an age-long ascending trend.

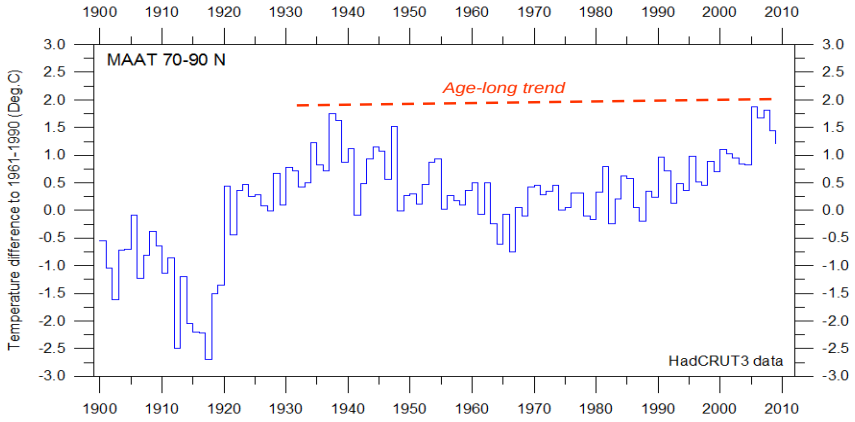


Fig.3. The Arctic air temperature dynamics (1900-2010). (*Humlum, Ole, 2011)*

According to Headley Center Data, age-long ascending trend is absent and last Arctic temperature maximum of 2000s does not exceed the corresponding maximum of the 1940s.

The data summarized by the Arctic and Antarctic Research Institute of Russia (AARI) also suggest that the Arctic temperature undergo to some 60-years variation with the maxima manifested in the 1940s and 2000. No reliable age-long ascending trend was found. The descending phase of the regular 60-years Arctic temperature cycle stated in the early 2000s and is likely to continue until 2030s.

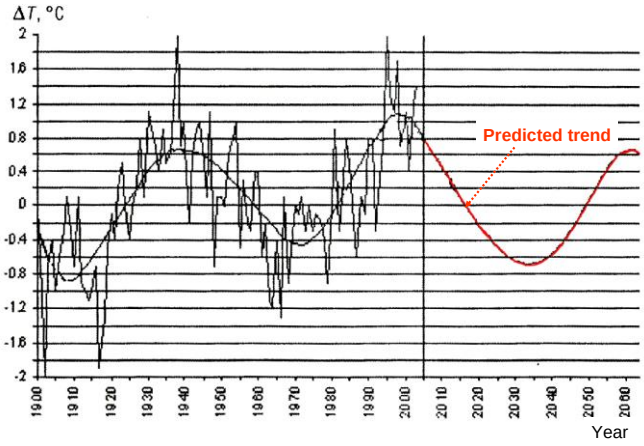


Fig.4. The Arctic air temperature dynamics (1900-2005) and its predicted trend. *(Frolov,I.et al. 2009)*

For the last 100 years, the Arctic temperature undergo 60-years fluctuations however unlike the Global temperature, it does not show ascending age-long trend.

The Sea Ice Area dynamics follows the Arctic temperature, yet with the some 8 years lag period.

The Atlantic spring-spawning herring stock dynamics follows synchronously the Arctic temperature dynamics and the Northeast Arctic cod stock recruitment dynamics is some 8 years «behind» of the Arctic temperature.

References:

Headley Center Data. http://hadobs.metoffice.com

Humlum, Ole, 2011. www.climate4you.com

Frolov,I. et al.,(2009). Climate Change in Eurasian Arctic Shelf Seas. Centennial Ice Cover Observations. Praxis Publishing Ltd, Chichester, UK, 164 p

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