GC21Q-0080. Why we need to know the future changes in Northern Eurasia?

In recognition of NEESPI -- Northern Eurasia Earth Science Partnership Initiative -- and its Chief Scientists

Herman H. Shugart Alexander S. Isaev

Pavel Groisman[1,2], Dmitry Streletskiy[3], & Alexander Olchev[4]

1) Hydrology Science and Services Corp., Asheville, North Carolina, USA
2) North Carolina State University, The Cooperative Institute for Satellite Earth System Studies (CISESS), Asheville, North Carolina, USA
3) George Washington University, Washington, District Columbia, USA
4) Moscow State University, The Russian Federation

Three major scientific objectives to intensify studies in Northern Eurasia:

- **Unique climatic and environmental changes in the Eurasian Arctic**
- **Control of the global terrestrial carbon cycle by taiga**
- **In the drylands of Northern Eurasia, ongoing changes are already leading to severe socio-economic consequences.**

The Arctic is a region of the most robust climatic change (warming, cryosphere retreat, variable and intense poleward heat transport by atmospheric circulation and ocean currents). North Atlantic and North American parts of the Arctic differ from the Russian Arctic. In the future, changes in both these parts of the Arctic can be also significant *but different*. Therefore, it would extremely contra-productive to delay studies in this part of the world. => In the Arctic, *we have an essential field for joint research and fruitful exchange of information and ideas,* whatever the future "political climate" will be. It will be too dangerous to act differently.

Nearly all Eurasian Boreal Forest Zone is in Russia. Species composition in this Zone differs from Canadian and Alaskan taiga and is unique. Here, changes in carbon cycle (above and below the surface, including wetlands and permafrost *have a potential to affect the global carbon balance. It would be unpractical to invest big into worldwide* carbon control measures and left unknown its dynamics in Russian taiga.

.In drylands of Northern Eurasia, population growth, cryosphere retreat, and increasing water deficit may lead to unpredictable socio-economic consequences (example, Syria).

INTRODUCTION

Environmental changes manifest themselves differently across the Earth, even when they are caused by "global" changes such as changes in atmospheric composition (greenhouse gases and atmospheric aerosols). They may have different amplitudes, sign, and geographic pattern causing intertwined consequences and feedbacks that spread beyond the regions where they initially originated. Northern Eurasia and its adjacent seas is one of such Earth components:

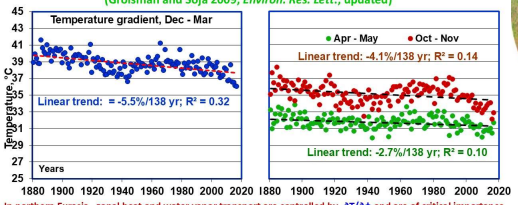
- **In its north**. The Arctic Ocean and its expanded coastal seas (mostly in the Eastern Hemisphere) is quickly losing its seasonal ice cover. This affects the thermohaline circulation in North Atlantic, the surface energy budget of the Arctic, the meridional temperature gradient (the temperature difference between equatorial and polar regions), and the intensity of the atmospheric westerlies (heat and moisture transport from the Atlantic Ocean into the interior regions of Northern Eurasia).
- **In its central taiga region**. The gradual Siberian permafrost thaw and northward shifts of the forests into the tundra zone and of the steppe and forest-steppe zones into the forested areas are affecting the global carbon budget dynamics because the near half of terrestrial carbon resides in this region (forest, wetland, and permafrost).
- **In the southern drylands of Northern Eurasia.** The major peril of the environmental changes here is the water deficit that is exacerbated by exponential population growth. Agriculture technology advances and political stability are required across the numerous states of this region to avoid socio-economic crises that are blooming here now and/or in the nearest future.

Possible consequences of the surface air temperature meridional gradient, $-\partial T/\partial \varphi$ decrease:

- Weakening of the westerlies
- Northward shift of the extratropical cyclone trajectories
- More frequent cold season blocking conditions of atmospheric circulation over Eurasia (cf., Mokhov et al. 2006)
- More frequent penetration of "tropical weather" (e.g., late tropical cyclone remnants) in the extratropics (first report: Vetroumov 1977, *Soviet Meteorol. and Hydrol.*).

Decrease in surface air temperature meridional gradients over the Northern Hemisphere estimated as a difference of tropical mean zonal temperature (zone 0°- 30°N) and polar mean zonal temperature (zone 60°N - 90°N)

(Groisman and Soja 2009; *Environ. Res. Lett.*; updated)

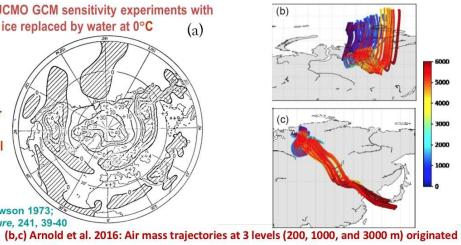


THE EURASIAN ARCTIC

Why should we be concerned?

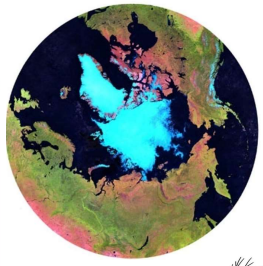
- changes in this small sliver of the globe affect major agricultural and industrial regions in the mid-latitudes

One of the first UCMO GCM sensitivity experiments with polar ice replaced by water at 0°C



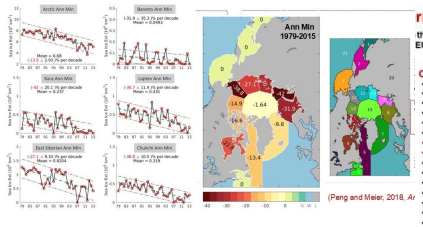
Changes in January surface air temperature. The Arctic becomes warmer by up to 40° C but the latitudinal belt south of 60°N over land becomes colder by up to 8°C. Newson 1973; *Nature*, 241, 39-40

(a) Newson 1973; (b,c) Arnold et al. 2016: Air mass trajectories at 3 levels (200, 1000, and 3000 m) originated from the polluted region of the city of Norilsk for 1-7 (b) and 8-14 (c) January 2015.



Terra-MODIS RGB, July-Sept 2008, 250 m resolution Cloud free composite. (Trishchenko *et a* 2009). Please, note large areas of ice-free water in the Arctic during this three-months-long season.

Sea ice retreat in Eurasian Arctic



rnational collaboration in divided world

the 20 Mb list of entities & persons that are blocked from the financial collaboration EU, and UK state institutions retrieved from "*treasury.gov_ofac_downloads_ctrylst*".

Sanctions List Search (treas.gov)

Country	# of sanctioned people and entities
Russia	too many entries
Iran	too many entries
China	509
Ukraine	217
Venezuela	185
Belarus	176
UK	154
USA	73
Malta	60
India	28
Saudi Arabia	23
Liechtenstein	9
Sweden	7
San-Marino	1
Vatican	0

BOREAL ZONE OF EURASIA

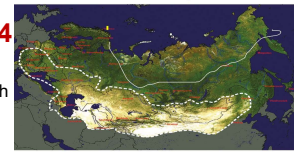
The main goal of the Low Carbon Development Strategy in Russia is to adapt the Russian economy to the global energy transition, reduce GHG emissions and achieve carbon neutrality by 2060.

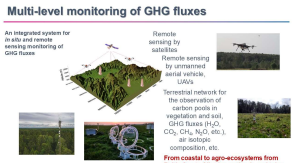
The main activities of the decarbonization program are:

- ✓ Implementing a low and zero carbon economy,
- ✓ Promoting the use of secondary energy resources,
- ✓ Developing technologies to increase GHG uptake and reduce emissions from natural ecosystems,
- ✓ Supporting technologies for GHG capture, use, and recovery.

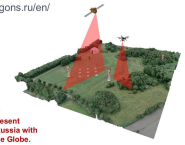
Siberia is the region that is prone to forest fires (by some estimates: ~ 10^7 ha /yr). Most of Siberia is in the permafrost zone. Low precipitation and rough terrain of Eastern Siberia (that assists runoff) leave soil above the permafrost relatively dry. If the permafrost were absent (e.g., thaw), the present weather conditions is some areas would correspond to dry steppe.

Over the entire Siberia, frequency of the summer days with Keetch-Byram Drought Index, KBDI, above "non-zero" 90th percentile has increased during past century in the range of 60% to 115%.





For more information:
https://carbon-polygons.ru/en/



It would be very useful to corroborate/merge the present carbon cycle studies in Russia with ongoing efforts across the Globe.

DRYLANDS OF EURASIA

The latest publication devoted to Eurasian Drylands:
Jiquan Chen et al. 2024: Natural assets, changes, and variations of the socioeconomic-environmental systems along the Asian drylands belt *Environ. Res.: Ecology* 3 045005.

- In this paper, the authors considered three key integrated measures of the socio-economic systems of 23 entities in drylands of Eurasia:
  - ecosystem water use efficiency (WUE),
  - human appropriation of net primary production (HANPP), and
  - human appropriation of water resources (HAWR).
- **Since 1980s, an increased variability as well as spikes in**

CONCLUSIONS

The Arctic is a region of most robust and systematic climatic and environmental change. The changes here are regionally distinctive and their consequences are different for Western and Eastern Hemispheres. It will be contra-productive to delay and/or separate studies in the Arctic whatever future "political climate" will be.

t would be risky and unpractical to invest big into the global carbon cycle nanagement without comprehensive information about the carbon dynamics n the Russian taiga.

n drylands of Northern Eurasia, population growth, cryosphere retreat, and ncreasing water deficit *per capita* may lead to unpredictable socio-economic consequences. governmental reactions are *needed as soon as possible* to nitigate these potential crises.