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On-going changes of glaciers in Eurasian Arctic

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Abstract:

According the latest assessments (Randolph Glacier Inventory ver.3.2., 2014) in high latitude Eurasian Arctic the glaciers and ice caps occupy 85428 km^2 (Svalbard = 33837 km^2, Franz Josef Land 12762 km^2, Novaya Zemlya 22128 km^2, and Severnaya Zemlya 16701 km^2).

On-going changes of glaciers in Eurasian Arctic are manifested in different aspects, which include:

- Geometry changes:
  - Glaciated area
  - Ice surface elevation
- Changes of glacier mass balance
  - Field measurements
  - Remote measurements
    - Surface melting (detection of water appearance at surface – by passive and active satellite systems)
    - Volume changes (satellite altimetry – ICESat…)
    - Mass changes (satellite gravimetry – Grace…)
    - Iceberg production (ice thickness measurements &ice velocity)
- Changes of glacier dynamics
  - glacier surges
  - ice shelves disintegration
- Changes of internal structure of glaciers (hydrothermal state).

In general, in last decades the area, volume and mass of the ice bodies on the archipelagoes have decreased, but in details these changes have strong spatial and temporal variability. It is not only effect of climatic variability but also results from different glacier morphology and shape of fjords, and intensity of glacier/sea water interaction. Retreat rates were an order of magnitude higher for marine-terminating outlets than for land-terminating glaciers.

Latest regional mass budget estimates (based on GRACE data) for the four archileagoes are −22.6 ± 15.5 Gt yr^{-1} in 2004-2008, −10.5 ± 10.3 Gt yr^{-1} in 2004-2012.

Important but still poorly known factor in ice losses and mass balance state is calving on marine-terminating fronts. Data on Severnaya Zemlya shows dynamic instability of marine-terminating glacier basins, where the ice-cap calving rate increased from 0.6 Gt yr^{-1} in 1995 to 3.0 Gt a yr^{-1} in 2000–02, but has recently decreased to 1.4 Gt yr^{-1} due to a likely slowdown of the largest ice stream.

Total melt days on Severnaya Zemlya and Novaya Zemlya is statistically anti-correlated with regional late summer sea ice extent.

Prominent events with drastic visible changes of glaciers on archipelagoes were: surge of the Nathorstbreen glacier system, Svalbard, started during winter 2008–2009; vast disintegration of Matusevich Ice Shelf, Severnaya Zemlya, in September 2012; “slow surge” of Vavilov Ice Cap lobe, Severnaya Zemlya, accelerated in 2012-2013.

Long-term climatic change transforms the hydrothermal state of glaciers (their internal temperature field and liquid water content in ice that registered by radio echo sounding profiles and borehole measurements) and might change their rheology and stability.