Zooming out: from local snapshots to a pan-arctic inventory of Arctic ponds and lakes

Sina Muster, AWI, Germany
Kurt Roth, University of Heidelberg, Germany
Anne Morgenstern, AWI, Germany
Annett Bartsch, Vienna University of Technology, Austria
Guido Grosse, AWI, Germany
Moritz Langer, AWI, Germany
Julia Boike, AWI, Germany

The millions of ponds and small lakes in Arctic lowlands have been identified as biogeochemical hotspots with high process rates regarding the turnover of energy and carbon. The rapidly warming Arctic climate does affect the surface inundation due to changes in the water balance and/or permafrost degradation which directly alters the exchange of energy and carbon between the surface and the atmosphere. However, these water bodies with surface areas smaller than 1 km² are not captured on a global scale due to the low resolution of global maps. High-resolution imagery enables the mapping of ponds and small lakes but provides only limited coverage. This study aims to identify landscape-specific parameters which allow upscaling high-resolution but local water body size distributions to the pan-arctic scale.

Water bodies are mapped from aerial, TerraSAR-X and Kompsat-2 imagery with resolutions of 4 m and higher in nine major Arctic landscapes in Russia (Lena River Delta, Yamal Peninsula, Kolyma Lowlands), Canada (Canadian High Arctic, Mackenzie River Delta, Yellowknife) and Alaska (Barrow Peninsula, Yukon Delta, Seward Peninsula). Water body size distributions are parameterized via their mean, standard deviation and skewness. We assess (i) similarities between the high-resolution distributions and existing regional and global water body databases, as well as (ii) the variability of water body size distributions within and between regions, and (iii) relate regional differences to hydrological, geomorphological and permafrost processes.

Ponds make more than 95% of the total number of water bodies in all landscapes except the Mackenzie Delta, where they contribute only about 75%. Within-landscape variability is low in all study areas which allows the estimation of regional distributions. The statistical properties of these regional distributions can be used to incorporate ponds and small lakes into larger-scale climate and ecosystem models. This study provides a pan-arctic estimate of small ponds and lakes that represents a baseline against which to evaluate climate-induced changes in the distributions of Arctic water bodies.