Running for the PYRN Award

Investigating patterns of pond and lake distributions to enhance the modeling of Arctic surface inundation

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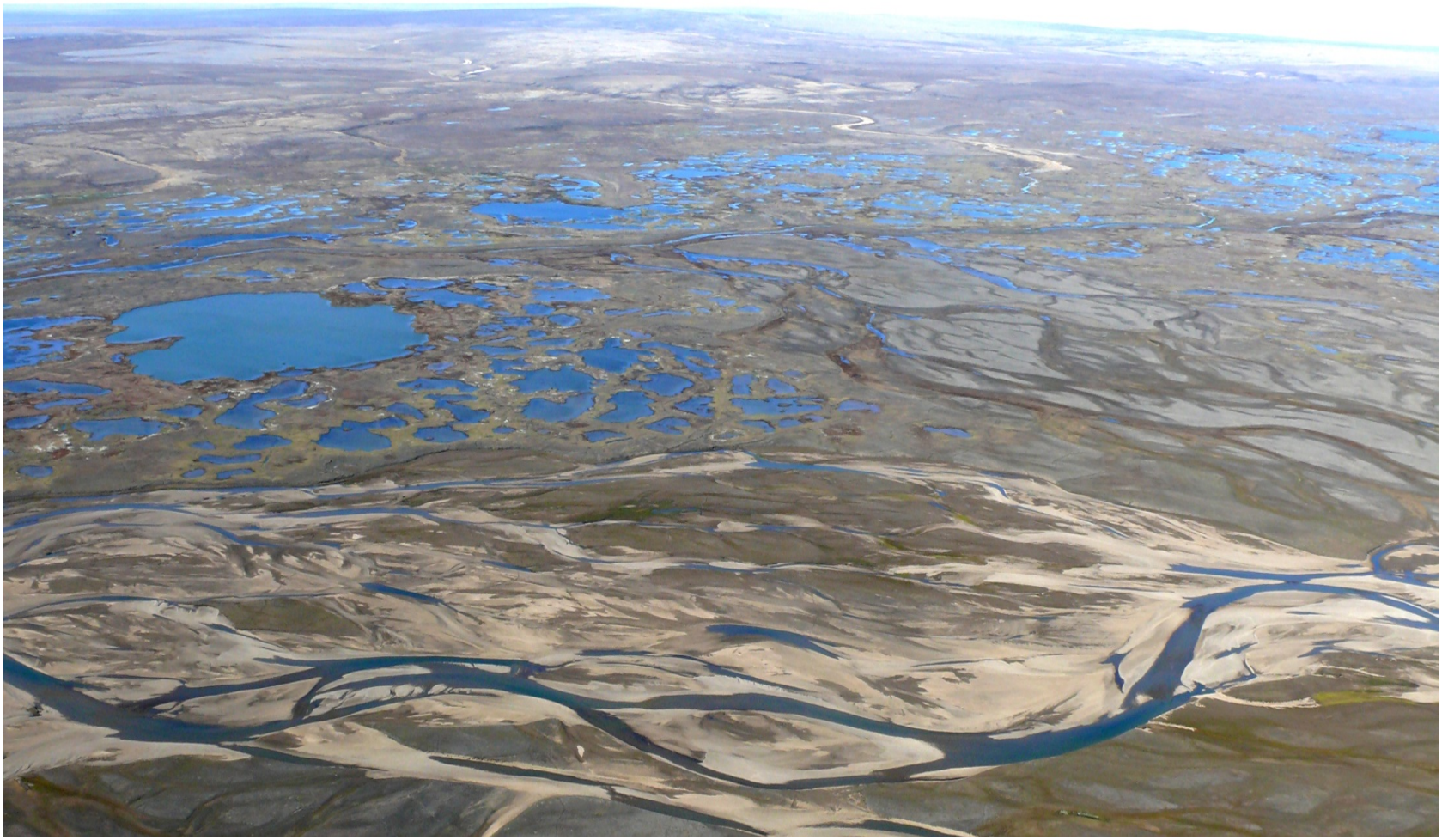
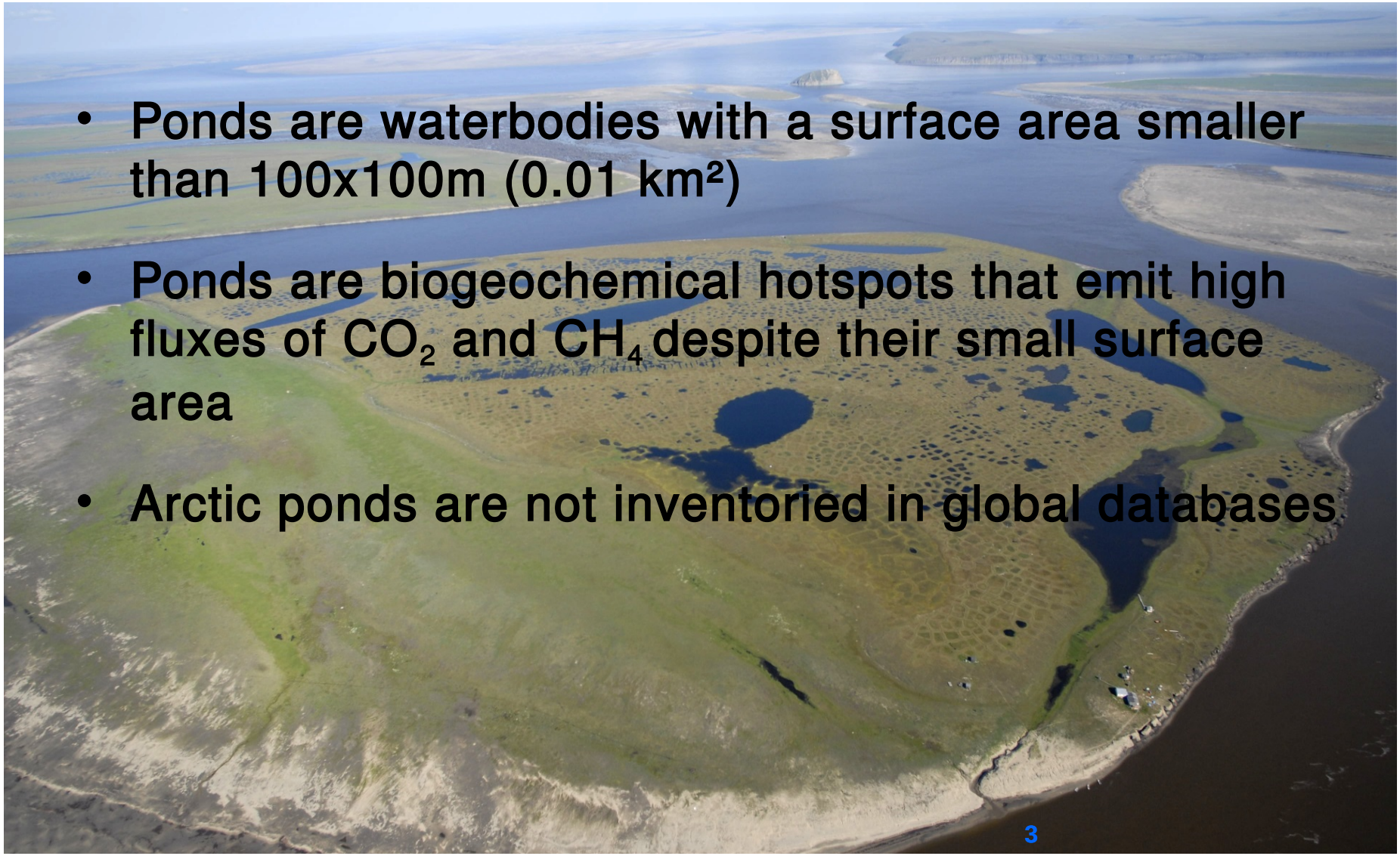
Polar Bear Pass, Canadian High Arctic

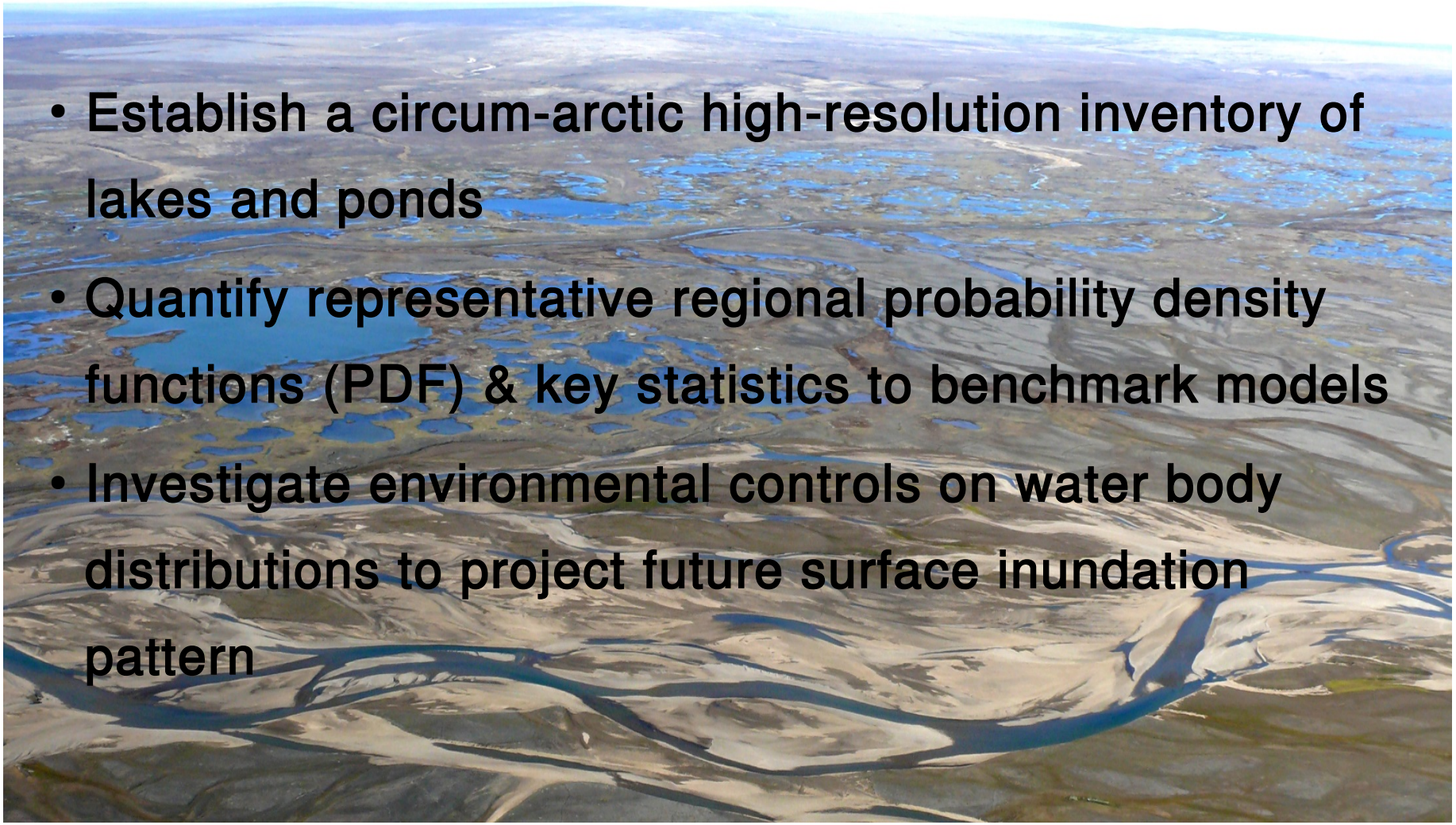


Small ponds – large impact



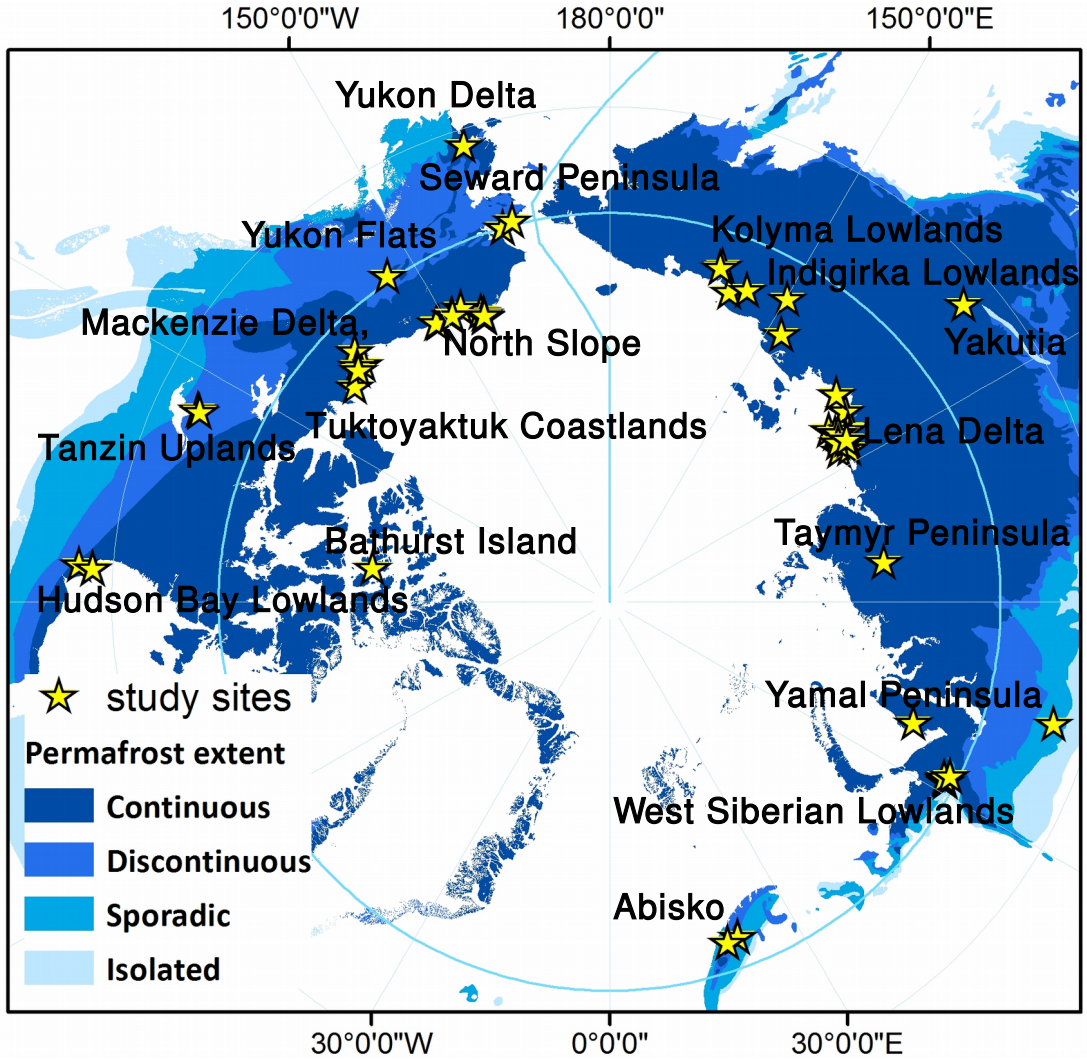
- Ponds are waterbodies with a surface area smaller than 100x100m (0.01 km²)
- Ponds are biogeochemical hotspots that emit high fluxes of CO_2 and CH_4 despite their small surface area
- Arctic ponds are not inventoried in global databases

Goals



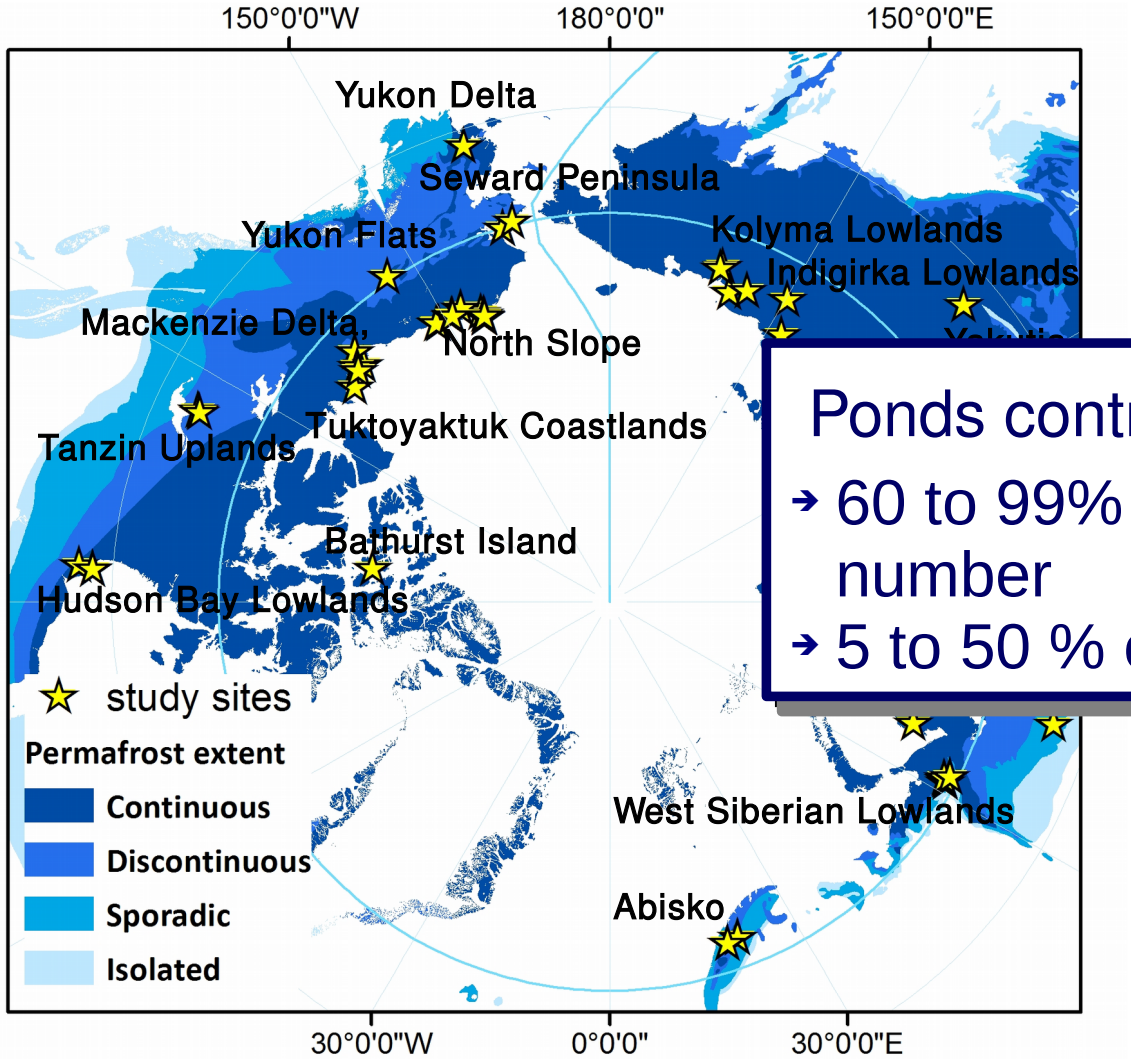
- Establish a circum-arctic high-resolution inventory of lakes and ponds
- Quantify representative regional probability density functions (PDF) & key statistics to benchmark models
- Investigate environmental controls on water body distributions to project future surface inundation pattern

PeRL: Permafrost Region Pond and Lake Database



- high-resolution circum-arctic inventory of ponds and lakes
- 25 contributors from 14 institutions
- classifications of RS imagery
- summer conditions
- min. resolution of 5 m
- min. pond size of 100 m²
- over 50 sites
- wide range of environmental conditions

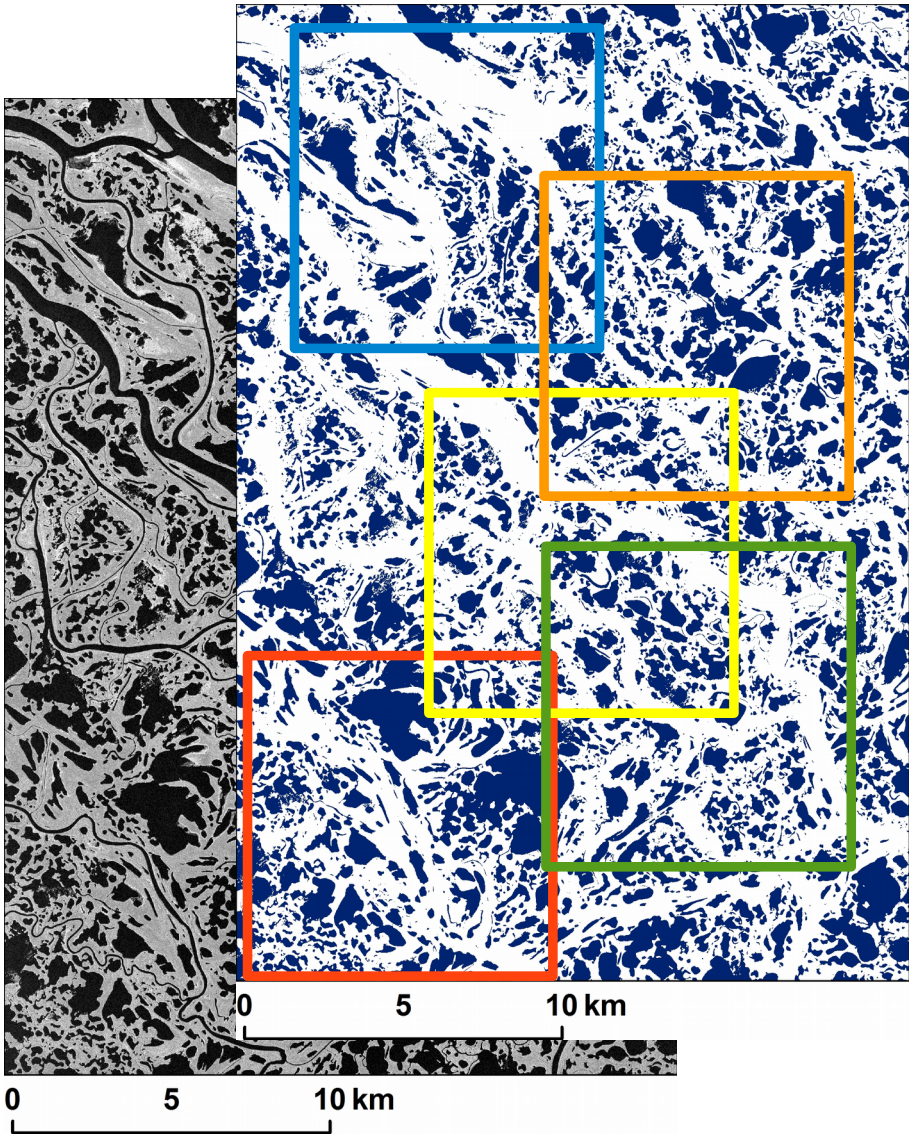
What are global databases missing?



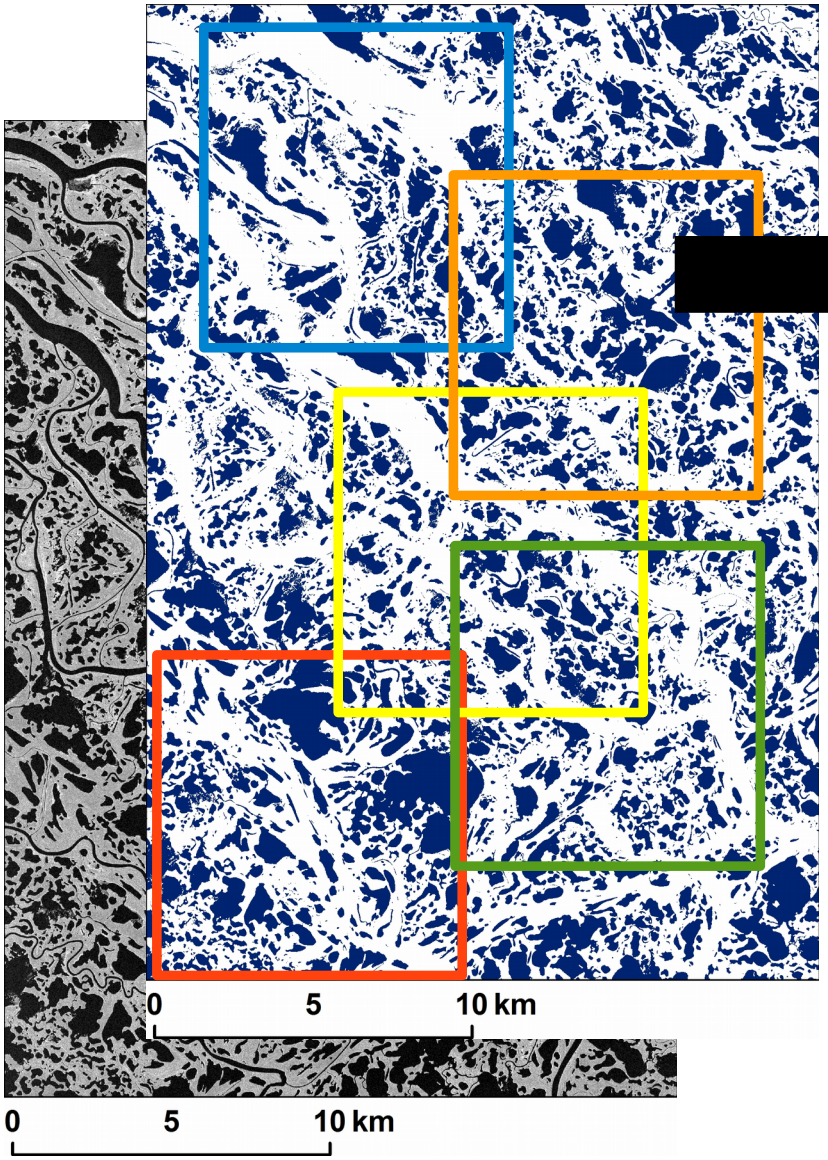
Ponds contribute

- 60 to 99% of the water body number
- 5 to 50 % of the water body area

Regional key statistics

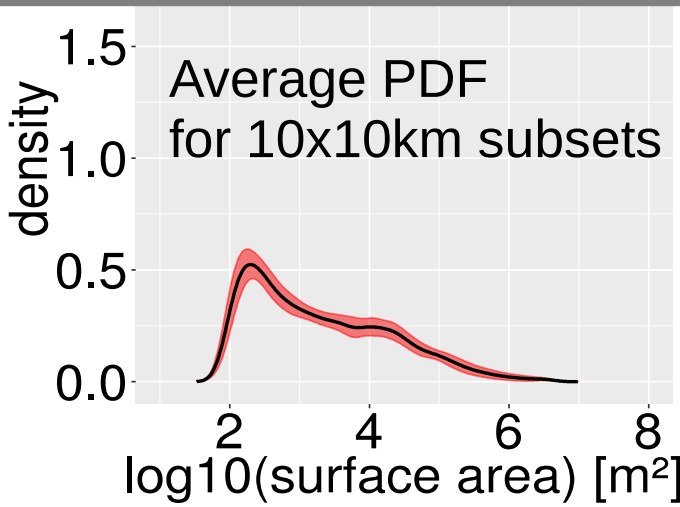


Regional key statistics



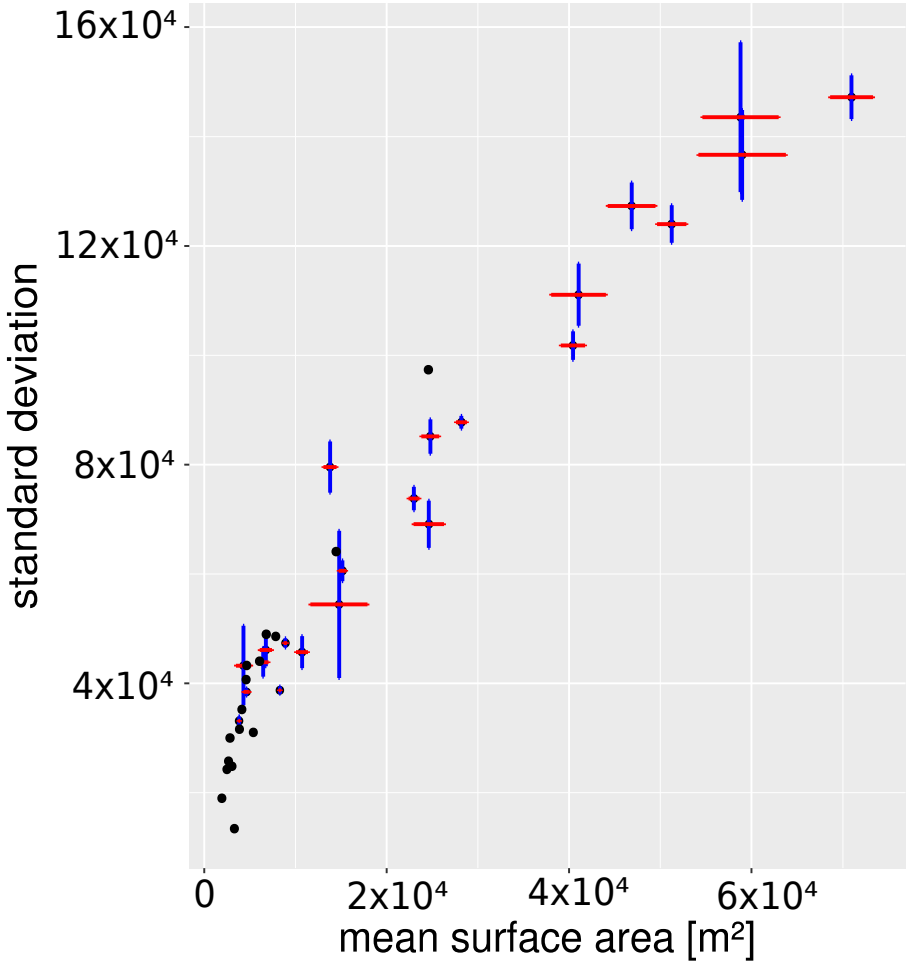
Key statistics + uncertainty

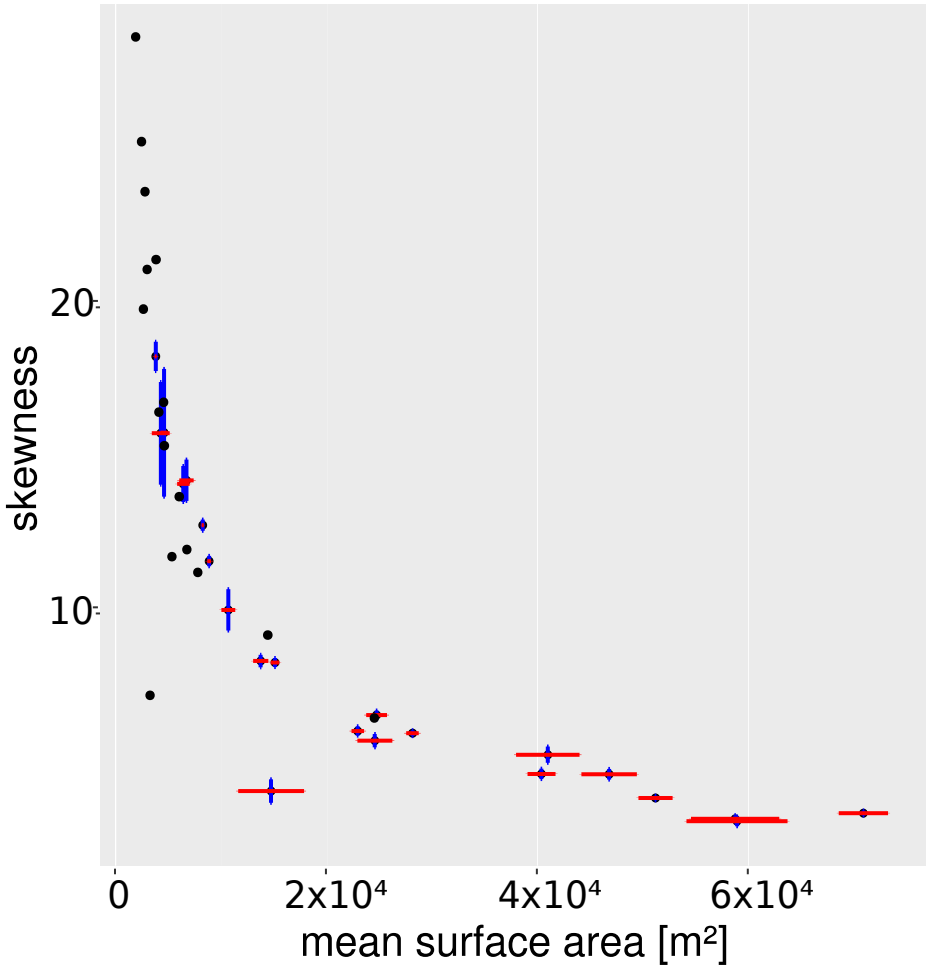
- areal fraction
- density per km²
- PDF moments:
  - *mean waterbody surface area*
  - *standard deviation*
  - *skewness*



PDF moments across space

ponds and lakes <= 10^6 m²





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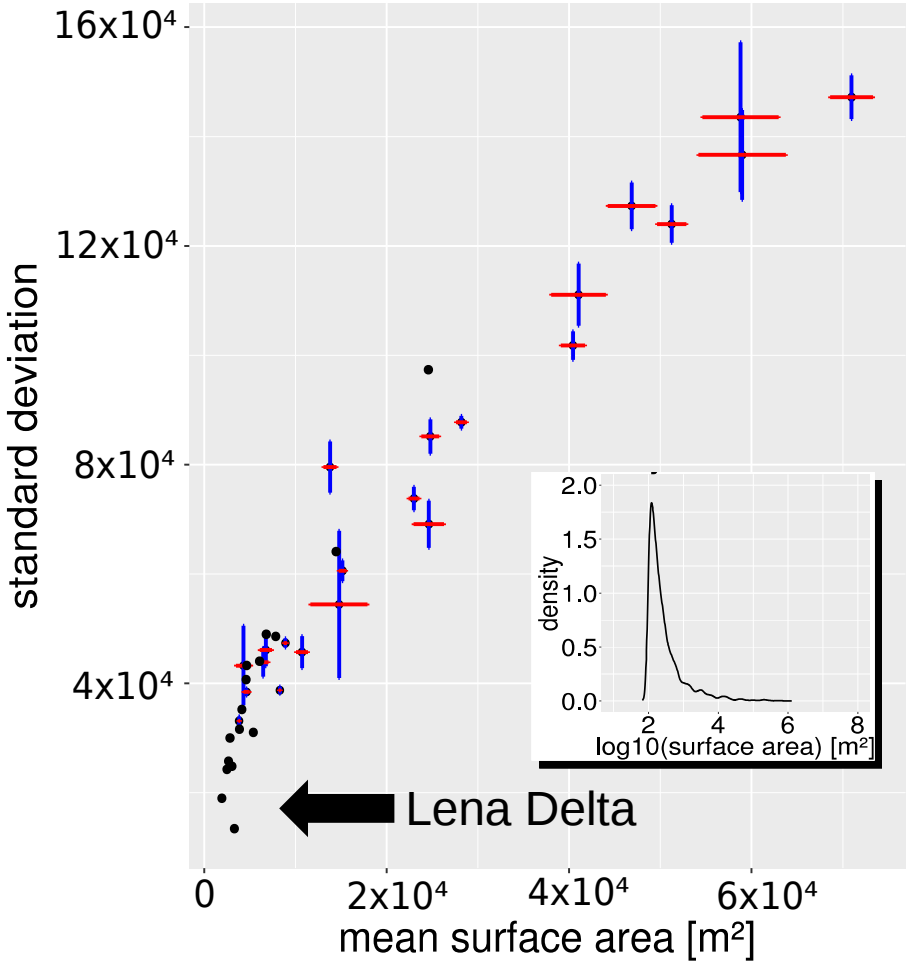

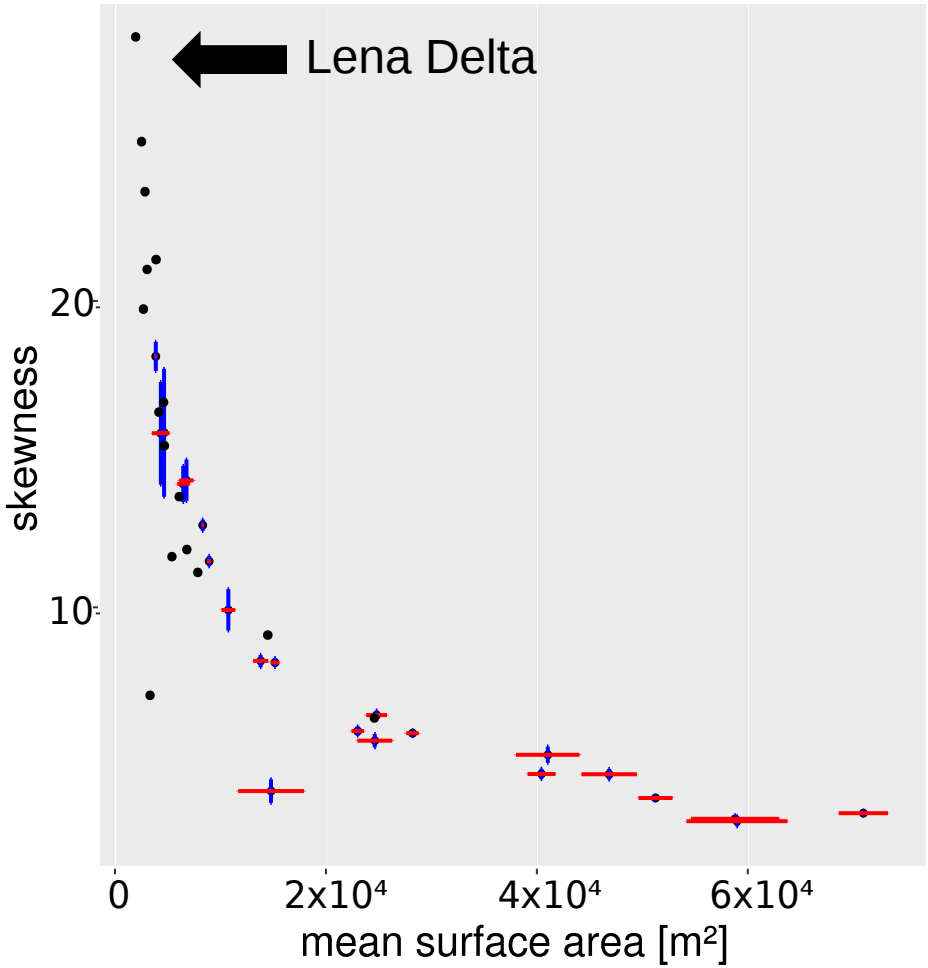

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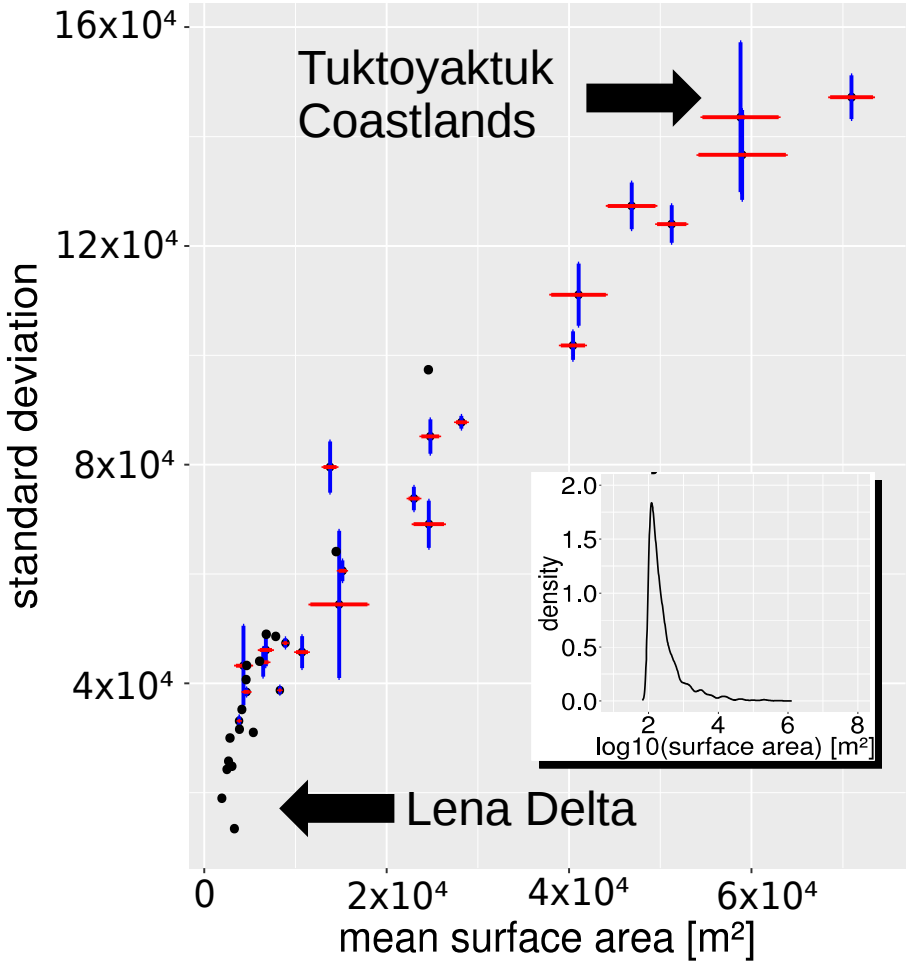

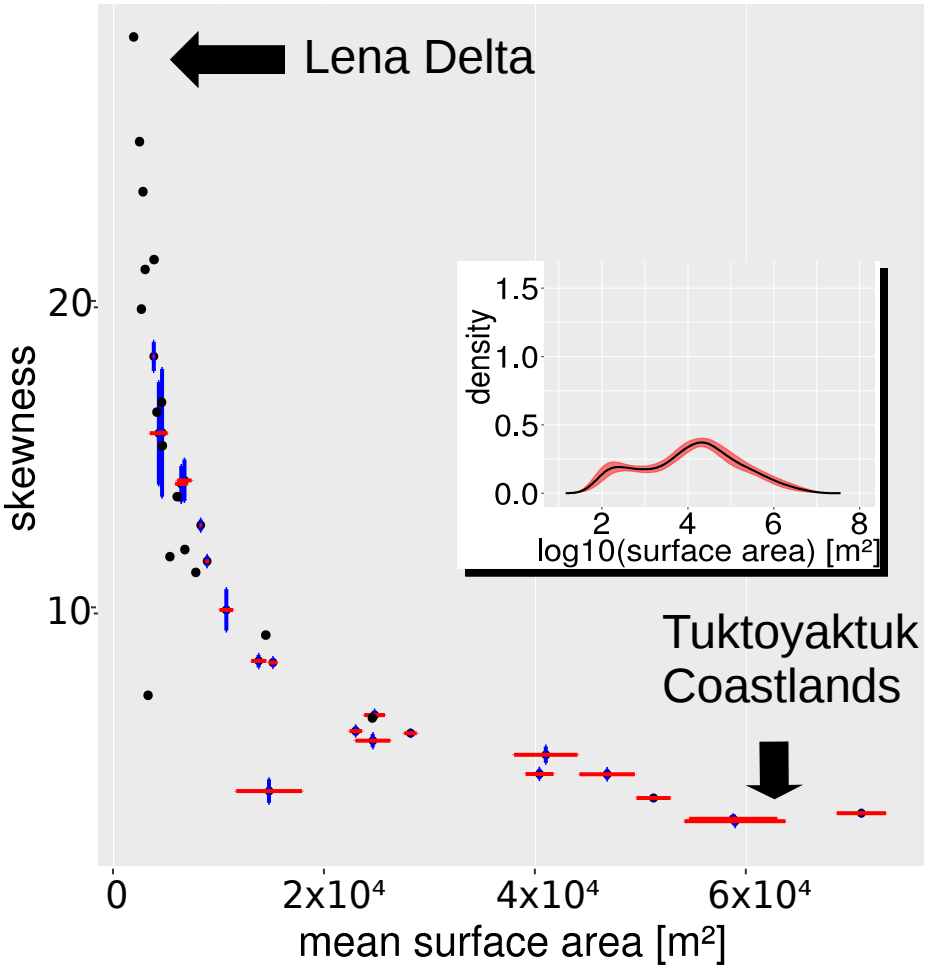

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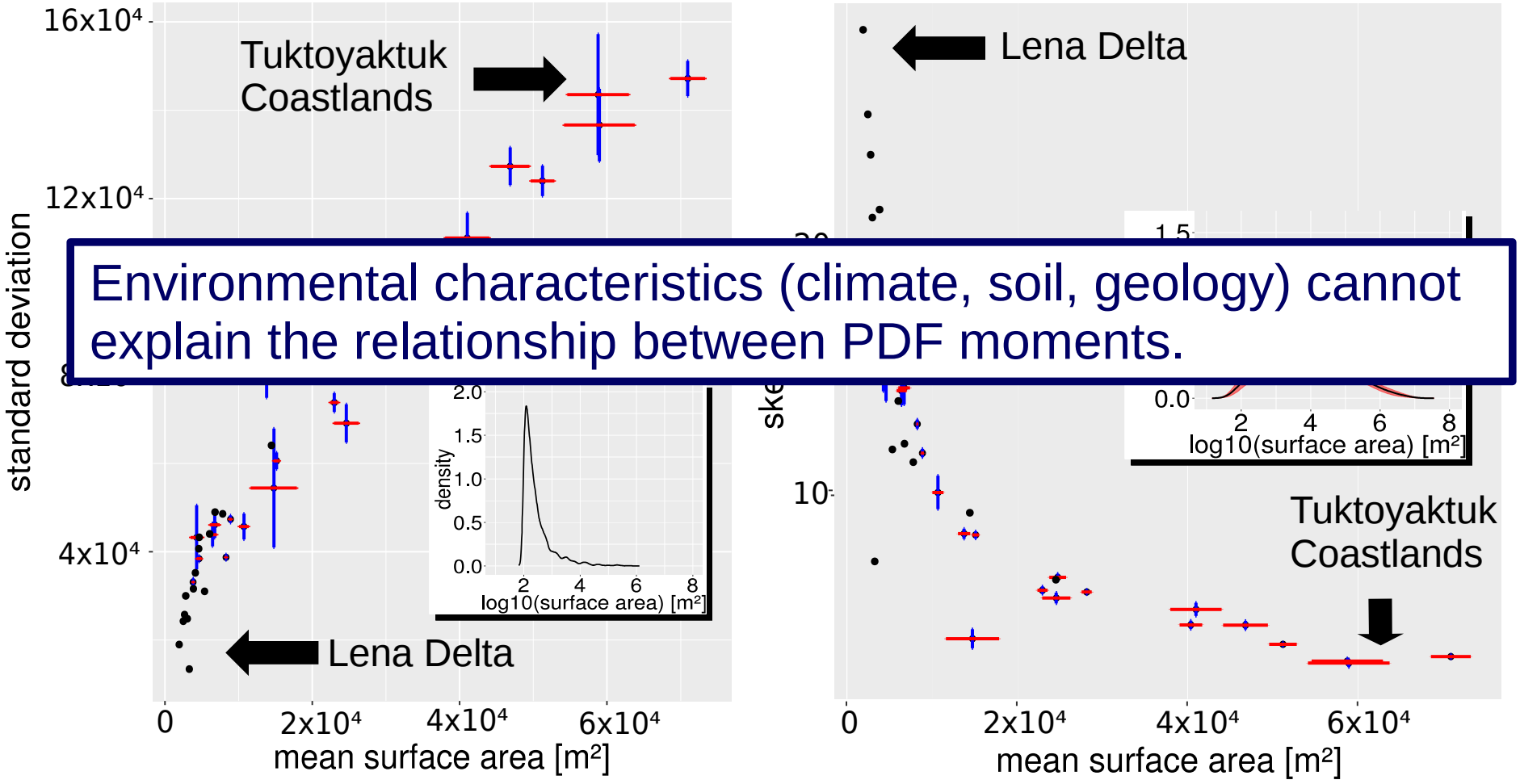
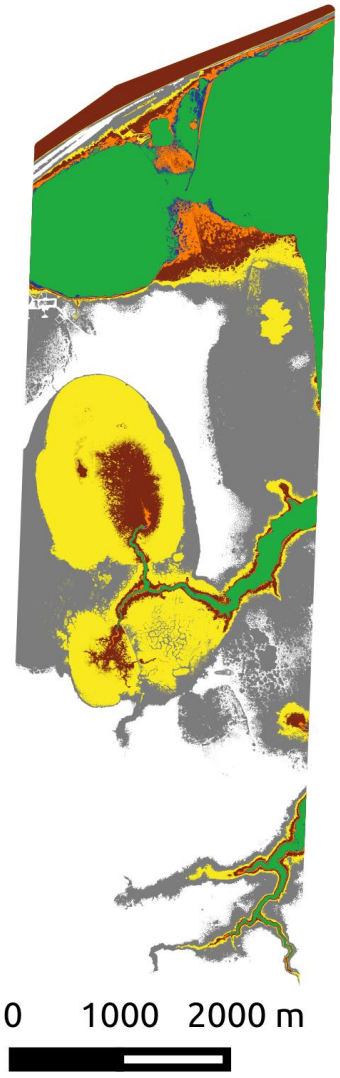


Environmental characteristics (climate, soil, geology) cannot explain the relationship between PDF moments.

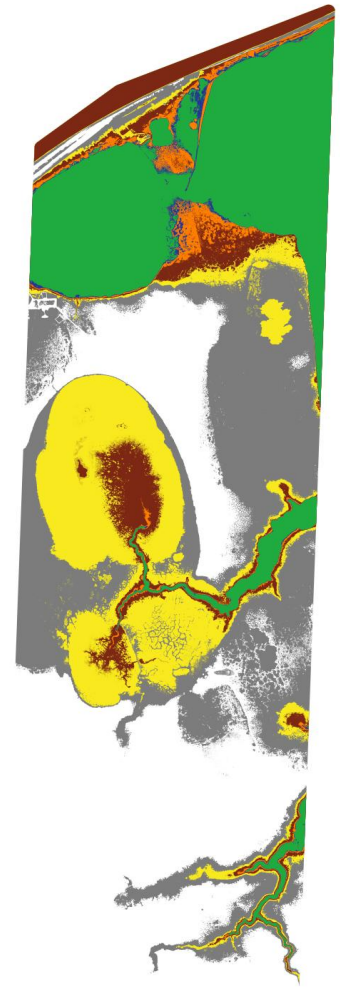
Space + water



LiDAR DEM,
0.5 m spatial resolution,
15 cm vertical accuracy

Simulating different landscapes with varying fractions of lowland areas that fill with water

Space + water



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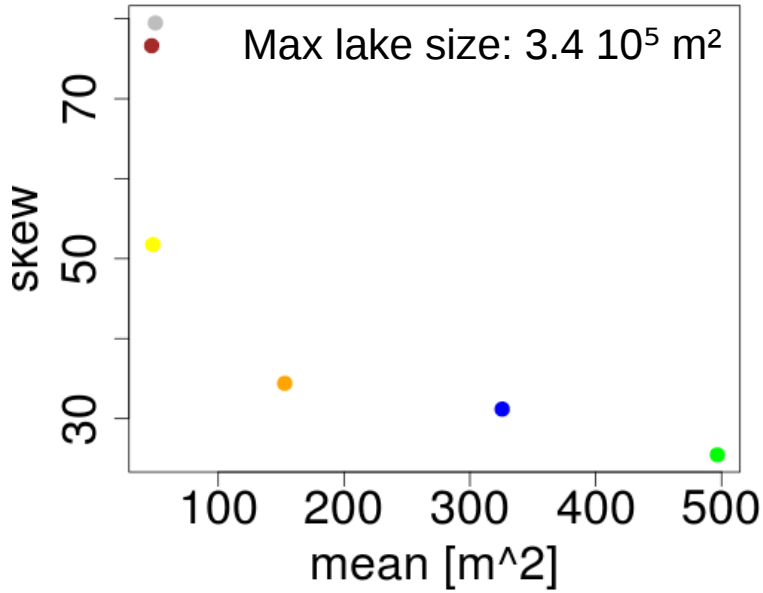
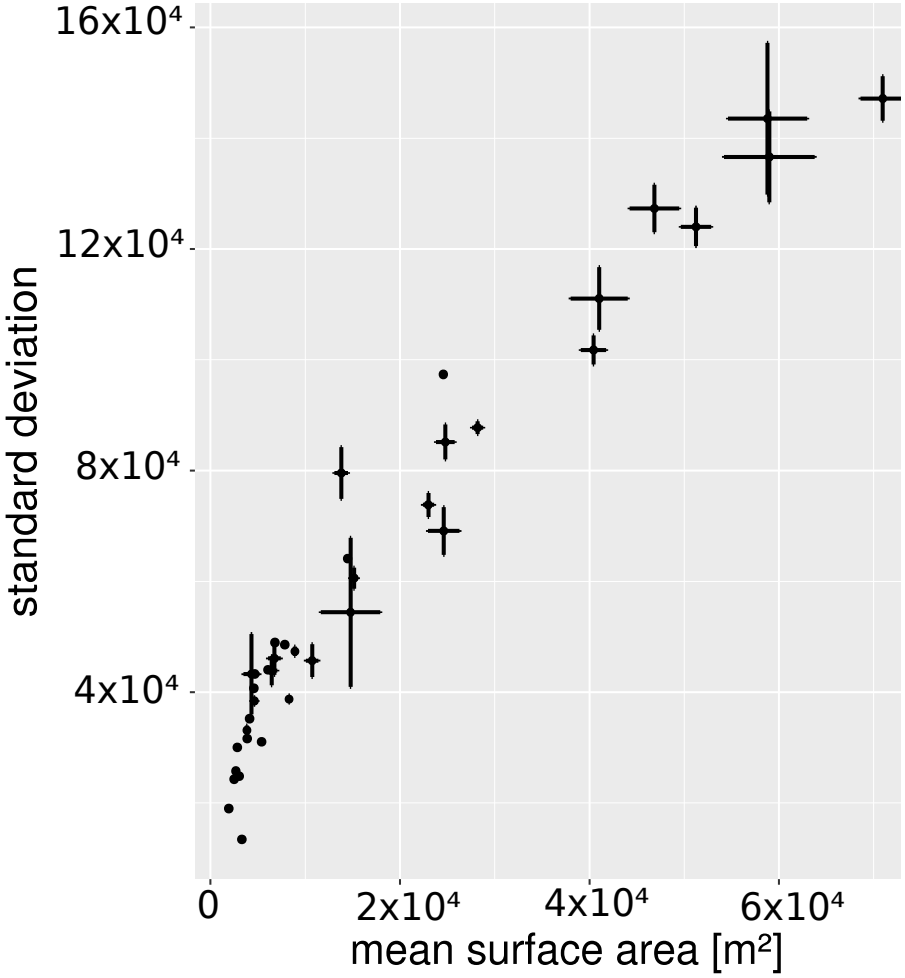
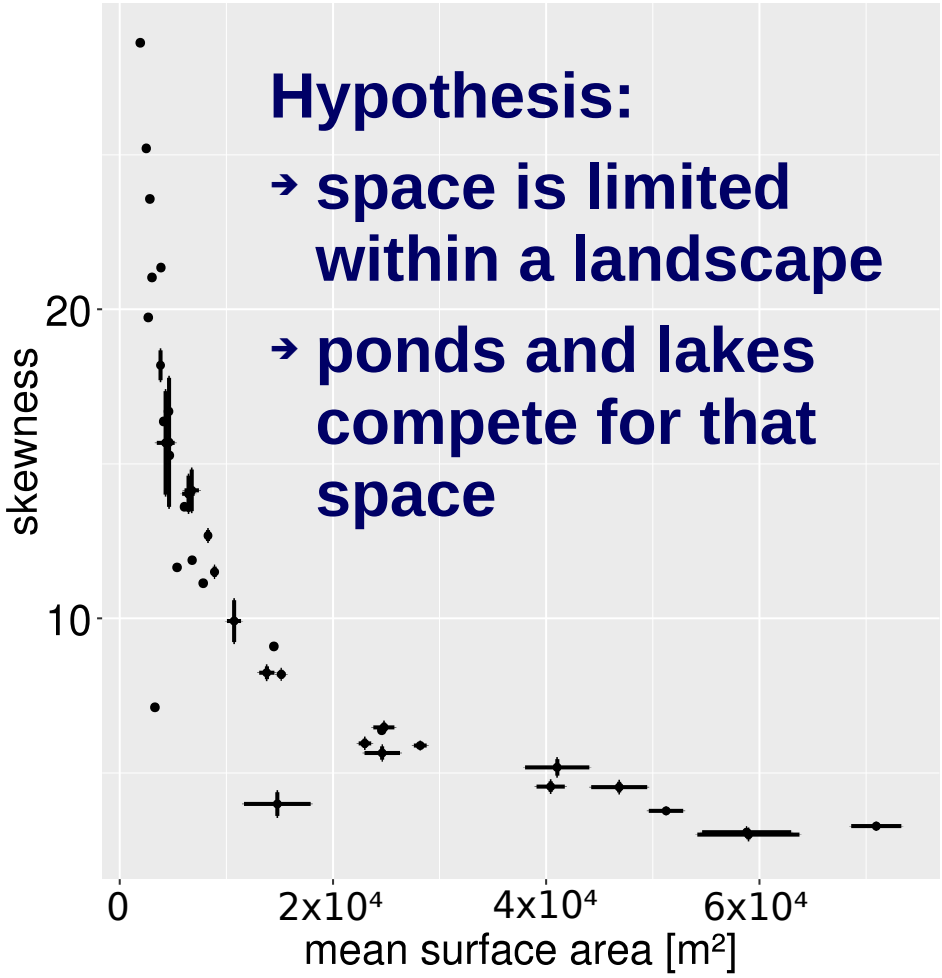


→ **Topography defines the available space where water bodies can form and persist.**

PDF moments across time

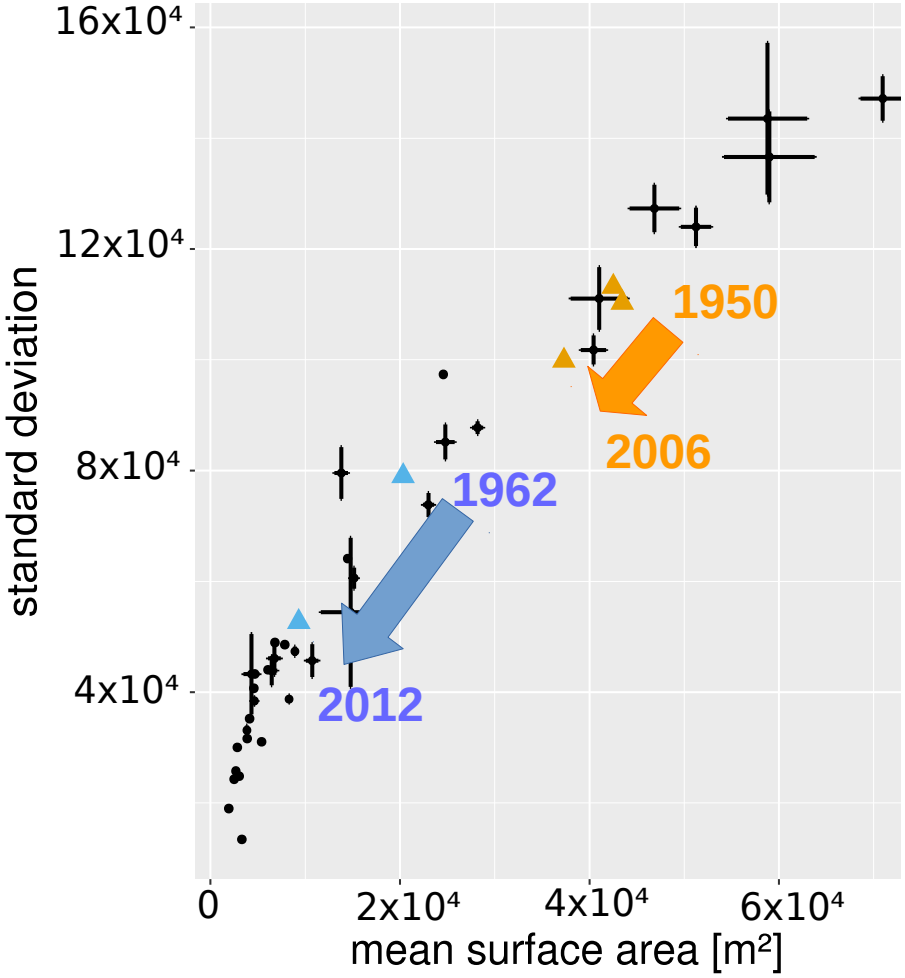


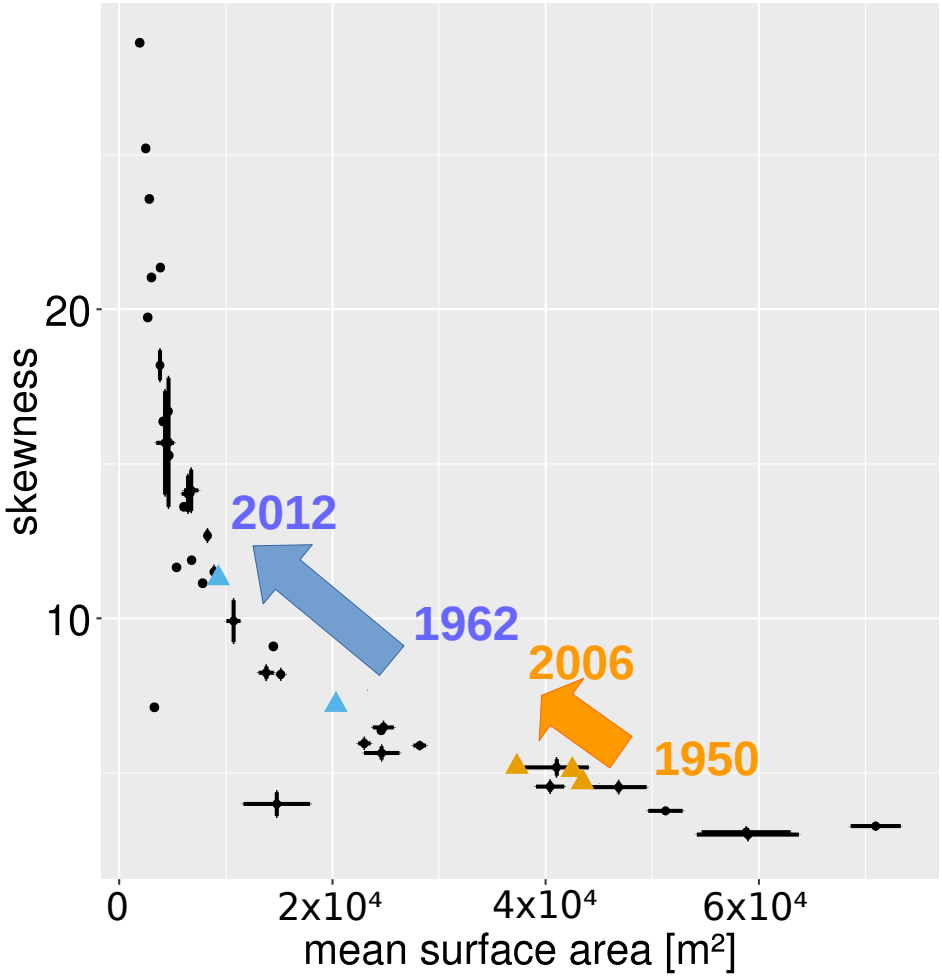


Hypothesis:

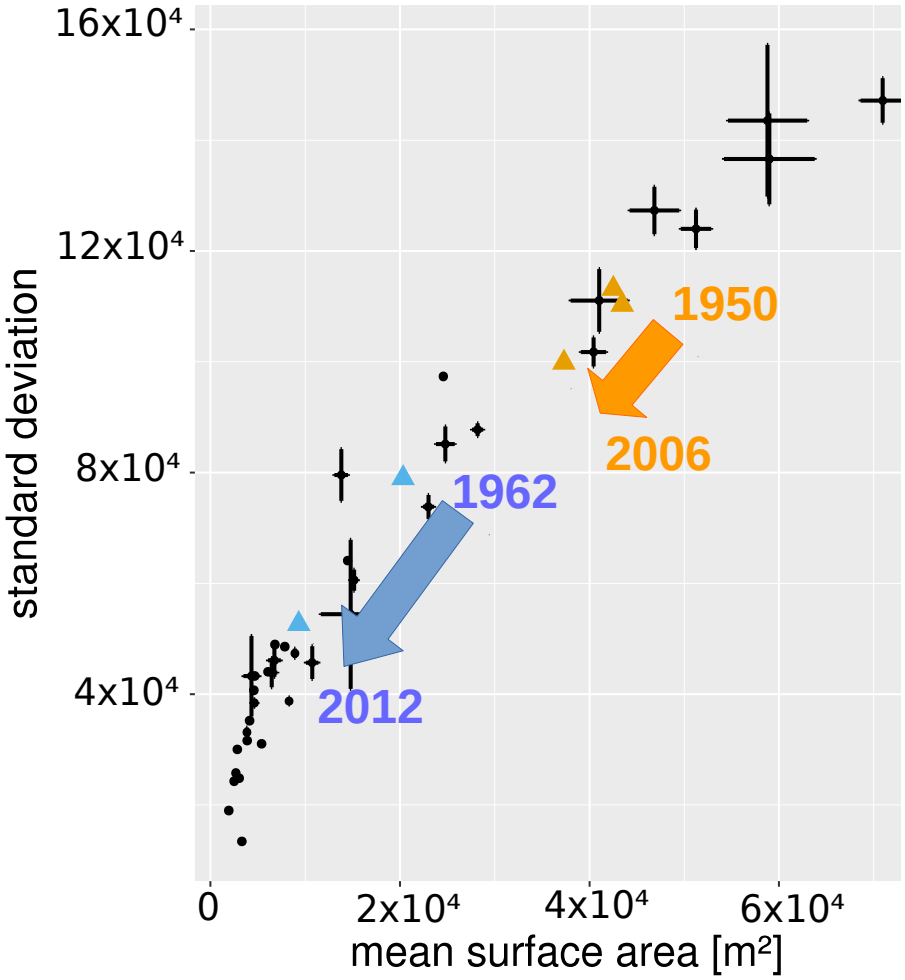
- **space is limited within a landscape**
- **ponds and lakes compete for that space**

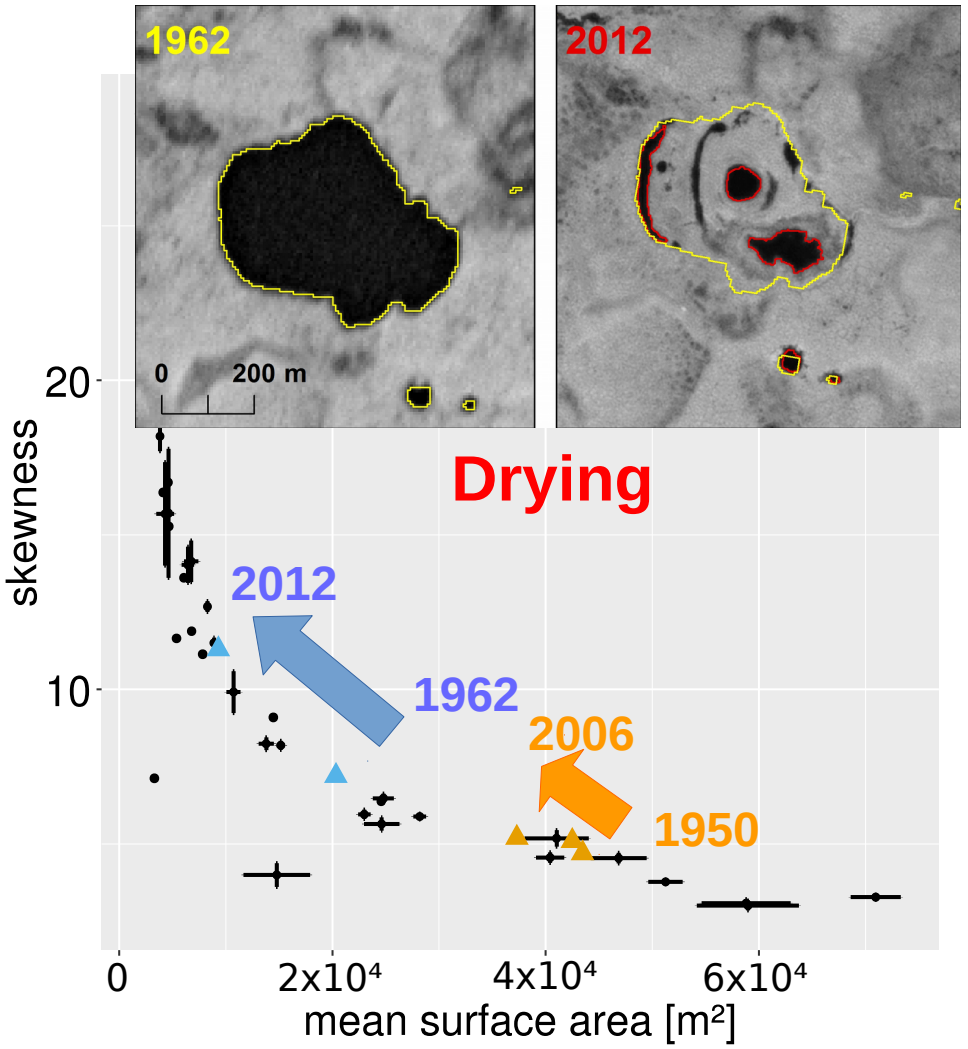
PDF moments across time





PDF moments across time





Summary and conclusions

- PeRL provides for the **first time estimates** of circum-arctic surface inundation **including ponds.**
- **key statistics** of pond and lake distributions including uncertainty can be used **to benchmark models .**
- **PDF moments** are a powerful tool **to reproduce and predict evolution of ponds and lakes.**
- permafrost degradation and a warming climate might alter space and water in the landscapes in a way that it also alters these relationships.


Thank you!