

The importance of air mass condition on energy fluxes at a coastal arctic wetland

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Evidence of an altered surface energy balance

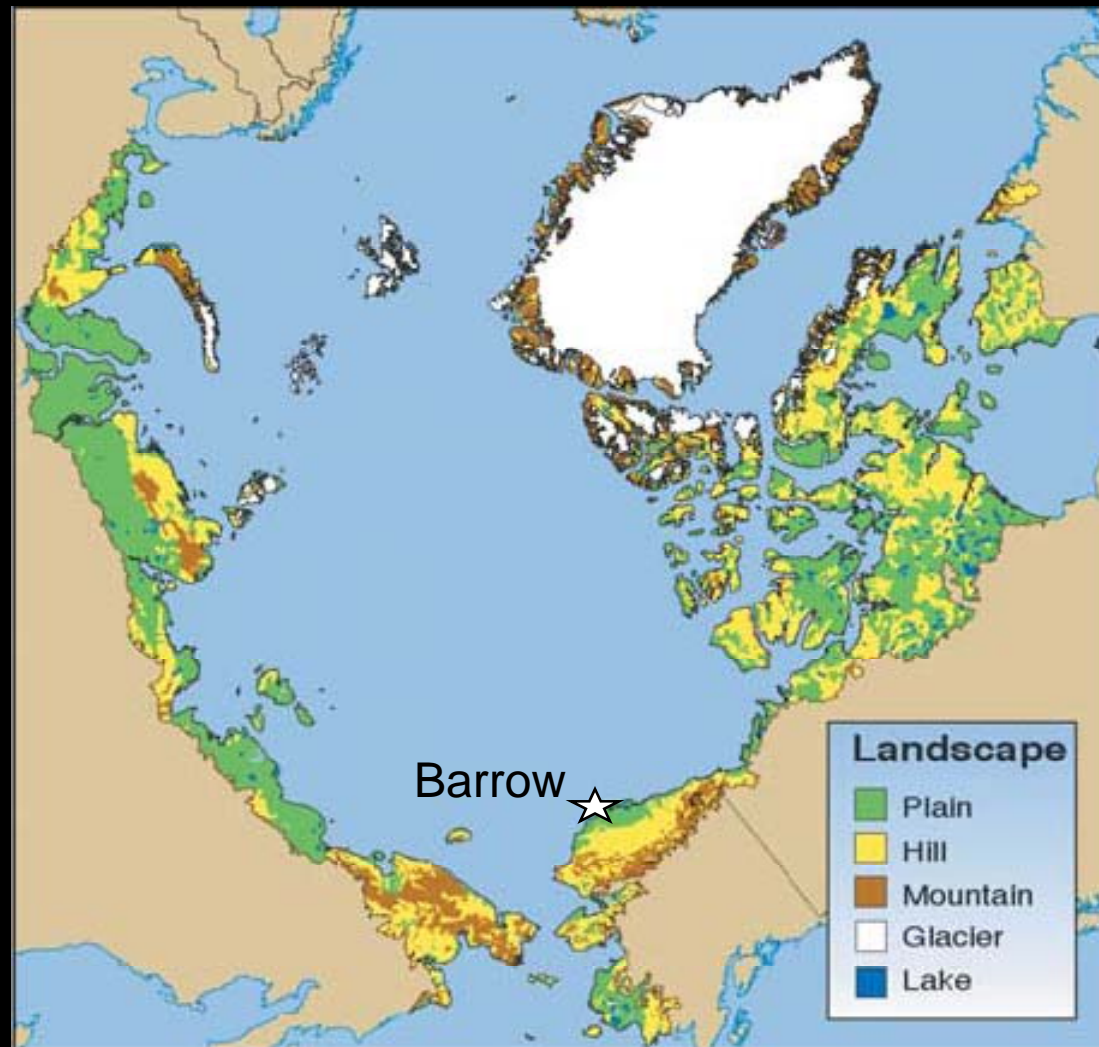


Pond formation
[Jorgenson *et al.*, 2006]

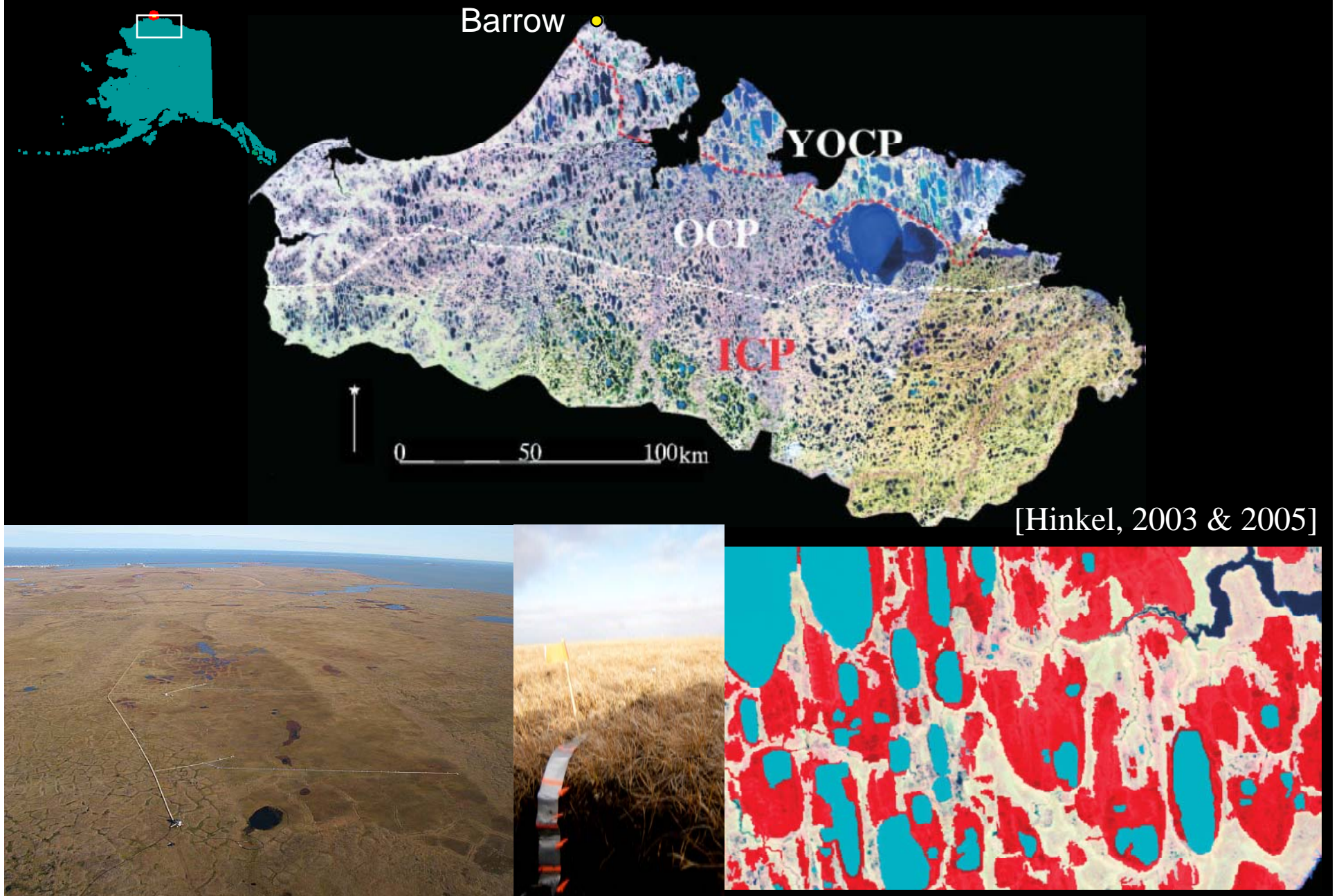
Shrinking ponds
[Yoshikawa & Hinzman, 2003]



Ocean-effects 135 km inland



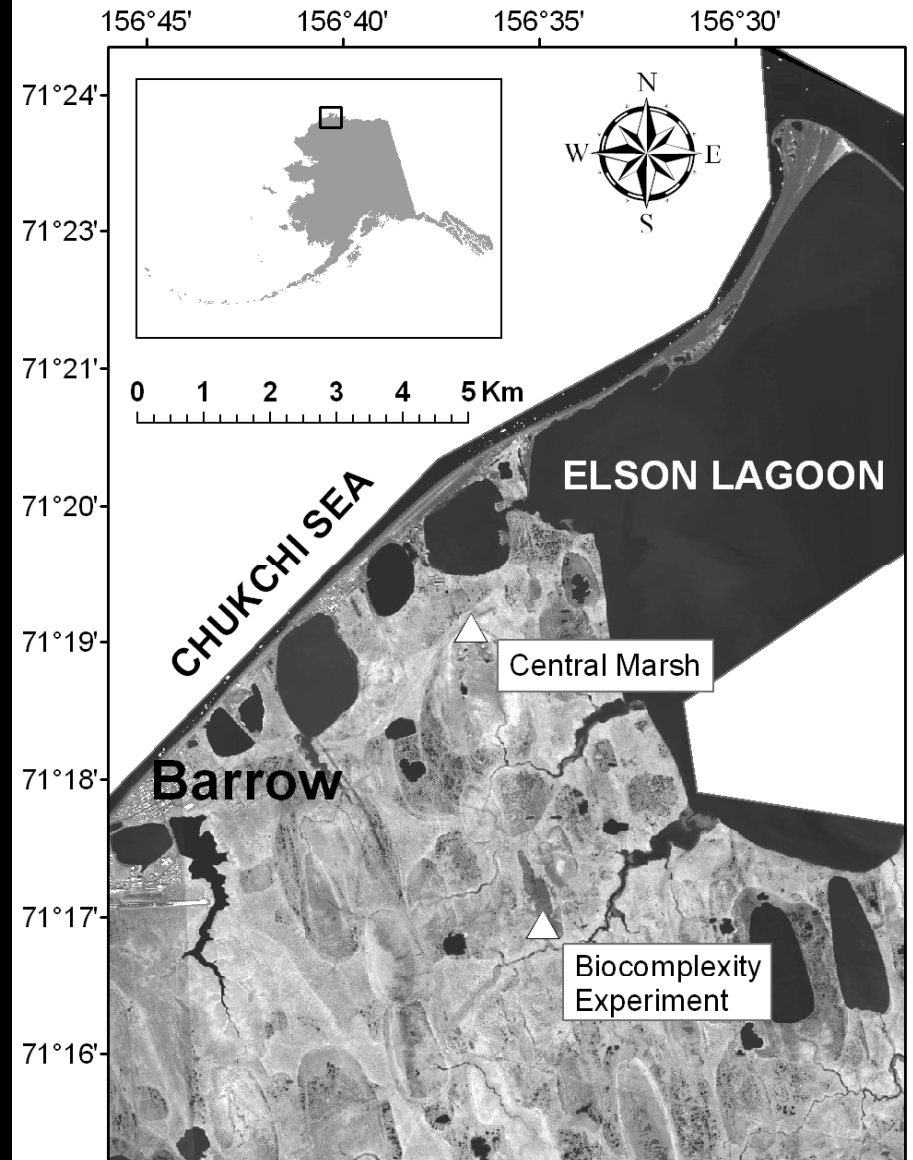
Drained lakes: 50 % of Arctic Coastal Plain



Desert wetlands

- Precip. 170 mm (74 mm Jun-Aug)
- Evapotranspiration > Precip. (Jun-Aug)
 - 2 mm/day in summer
- Low hydraulic gradients
 - 2 mm spring runoff
- Low seasonal soil storage capacity

What factors controls coastal wetland evapotranspiration?



Drastic reduction in surface water

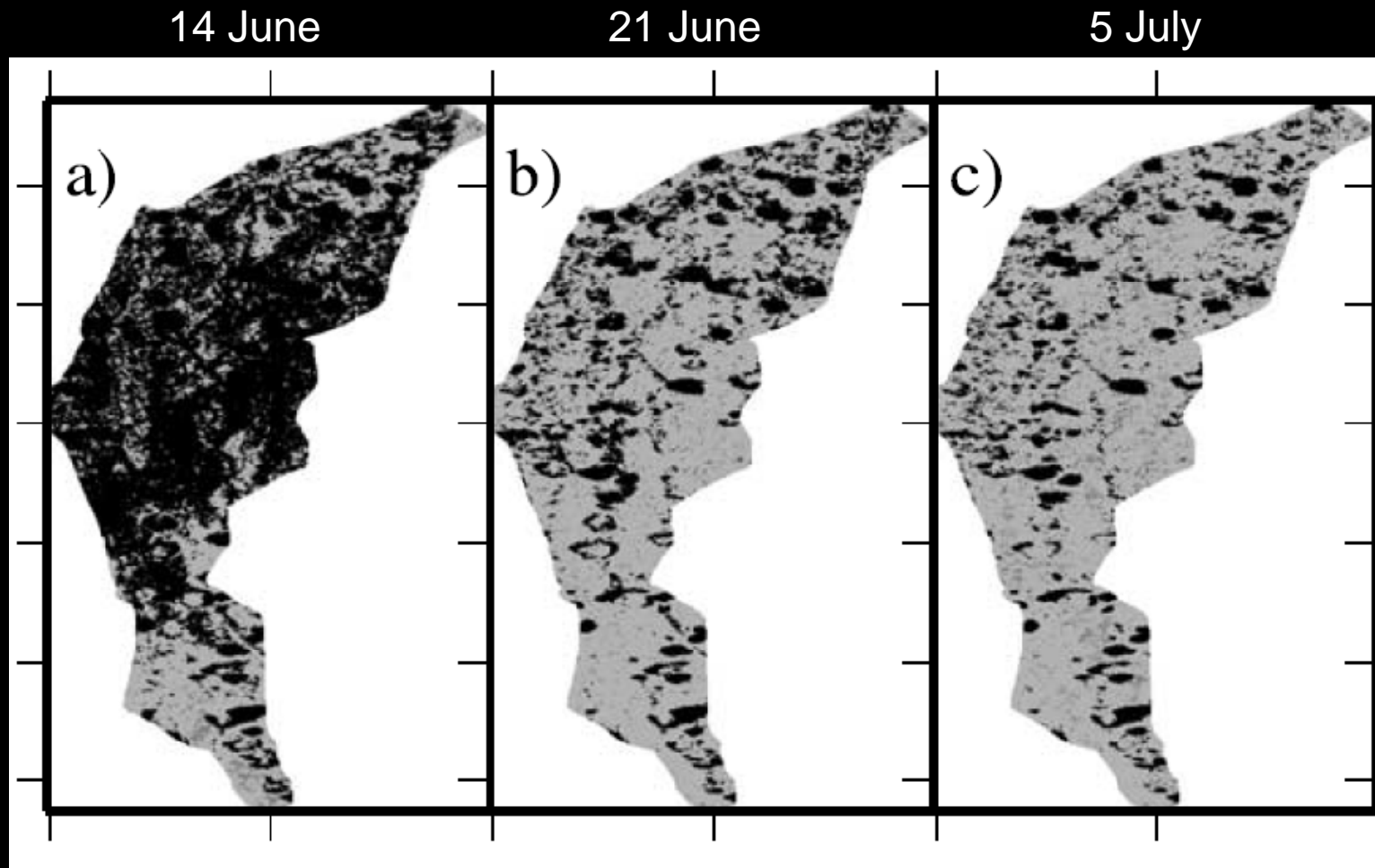
Spring



Summer

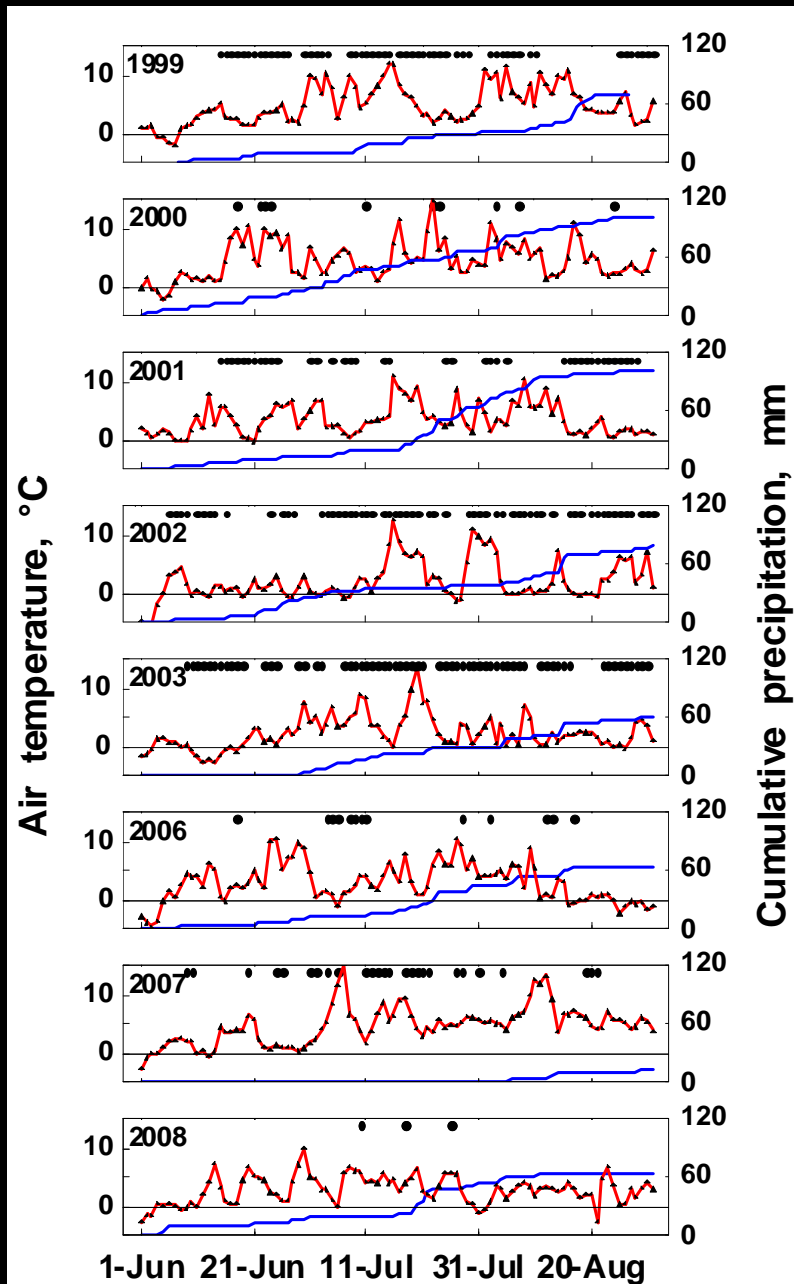


Inundated area varies 15 to 67%



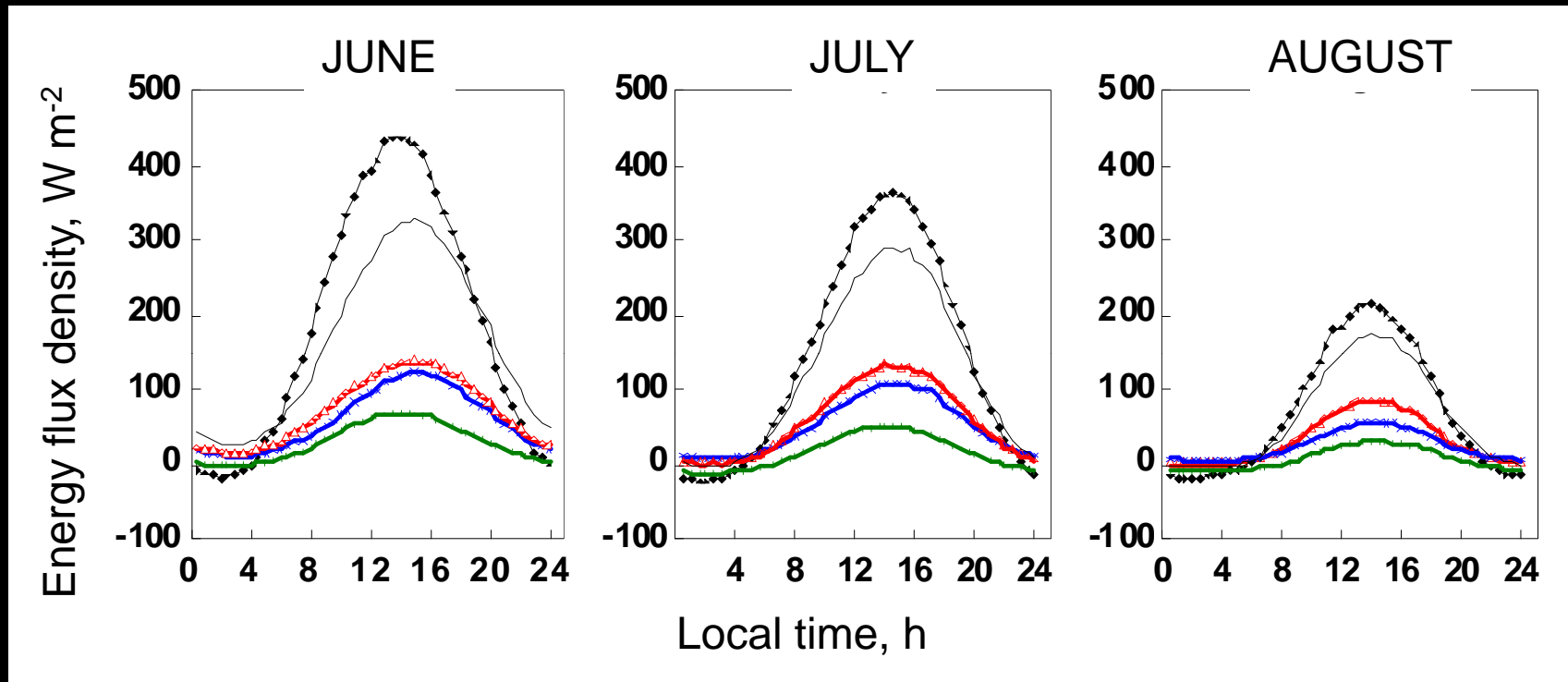
Change in saturated extent of the Putuligayuk River basin (470 km²) from classified SAR

Directly measured ET from 8 summers



2007: Warm + low precip.

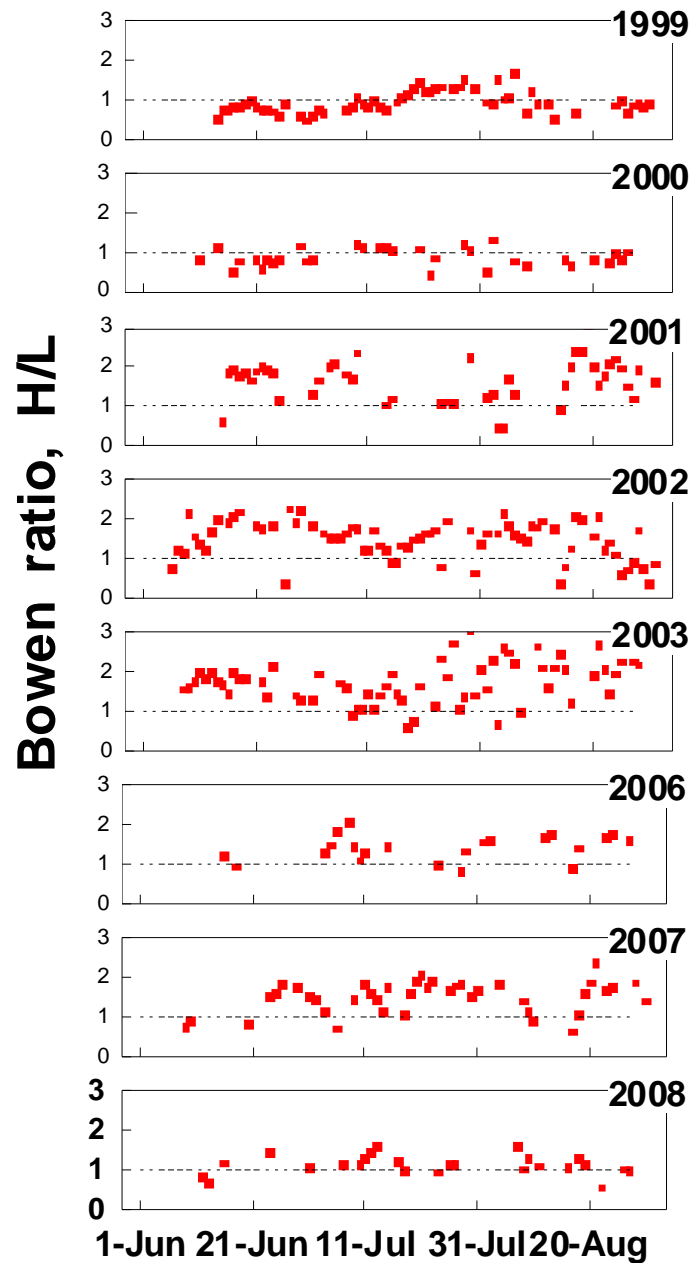
Sensible > Latent > Ground heat flux



- △— Sensible
- ×— Latent (evapotranspiration)
- +— Ground
- ◆— Net radiation
- Sensible+Latent+Ground

Sensible > Latent heat flux

$$\text{Bowen Ratio} = \frac{\text{Sensible}}{\text{Latent}}$$



1.42 ± 0.58

1.40 ± 0.38

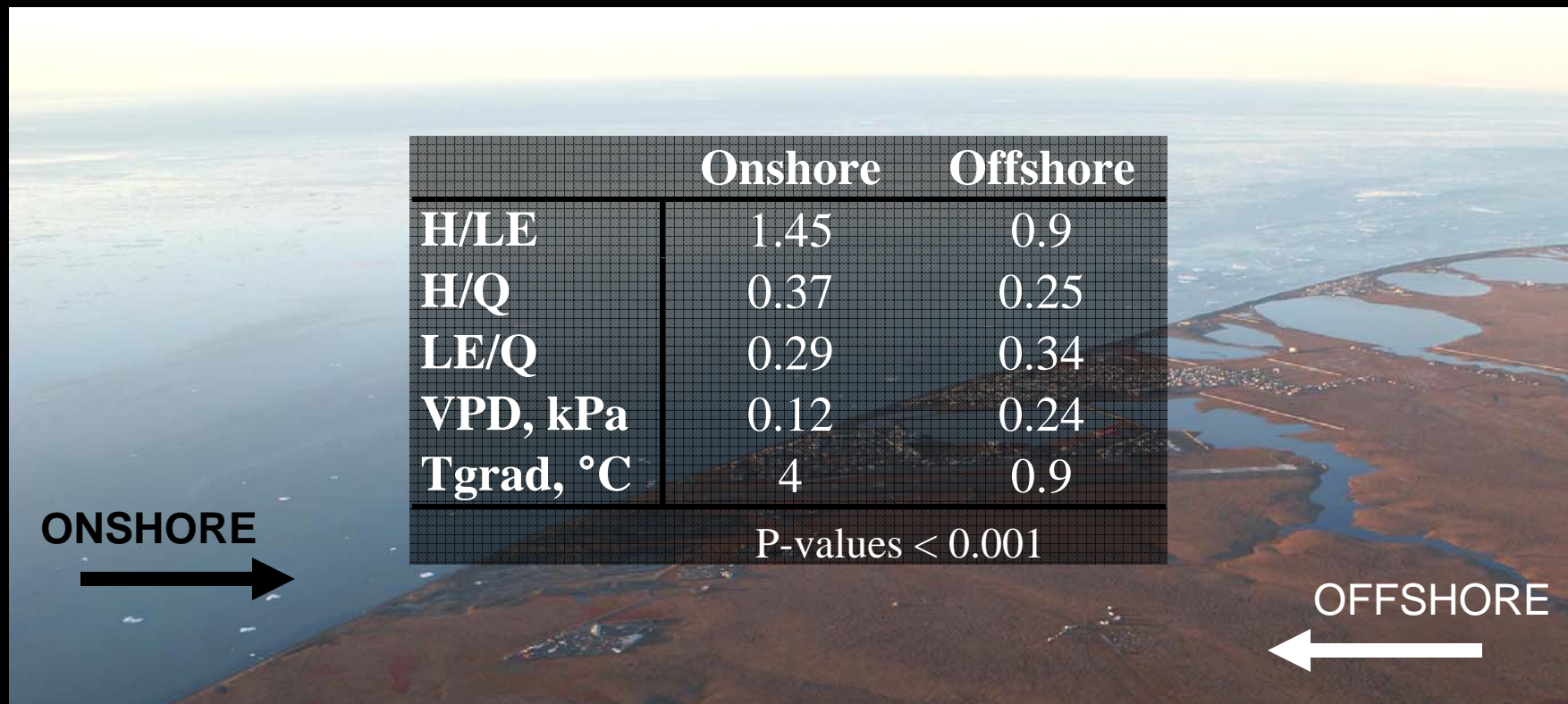
The importance of air mass

- * Onshore winds favored the sensible heat flux (normalized to Q_{net})
- * Offshore wind supported the latent heat flux



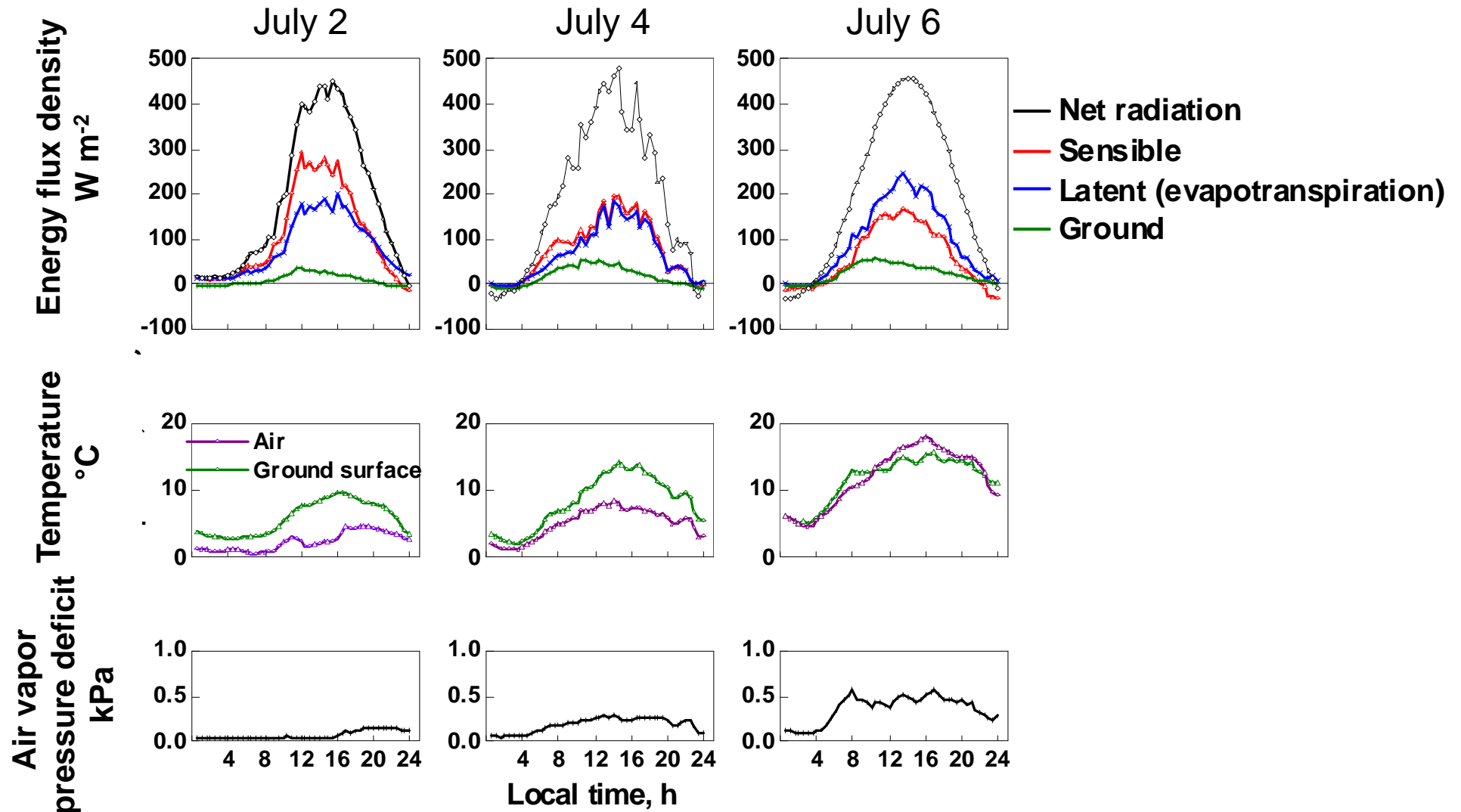
↓ Air vapor pressure deficit ↑
↑ Ground surface to air temperature gradient ↓

Significant differences with wind direction



H = sensible heat flux
LE = latent heat flux
Q = net radiation

Increased air vapor pressure deficit favors ET

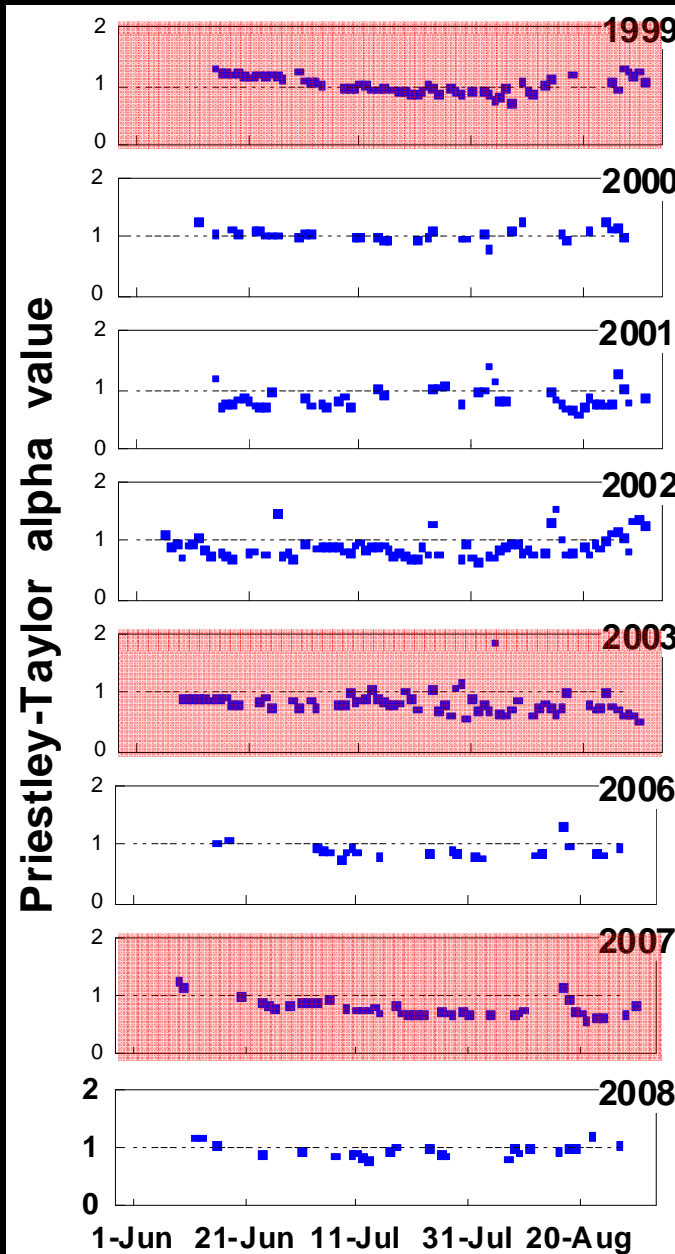


Potential to evaporate more water

$$LE = \alpha \left[\frac{s}{s + \gamma} \right] Q_a$$



Alpha value
Wetland ~ 1.26



0.98 ± 0.36

0.90 ± 0.19

Wind direction: 0.93/1.08

Summary

- The evapotranspiration at arctic coastal wetland is reduced due to:
 - Presence of maritime air mass
 - Large temperature gradients
 - Limited air vapor pressure deficits
 - Canopy resistance (soil moisture)

Barrow at midnight



Conclusion

- Future evapotranspiration rates will likely remain dampened
 - Projected increase in air temperature may increase the near-surface soil moisture gradient between areas affected by coastal and continental climate, leaving the coastal wetlands less prone to soil drying.

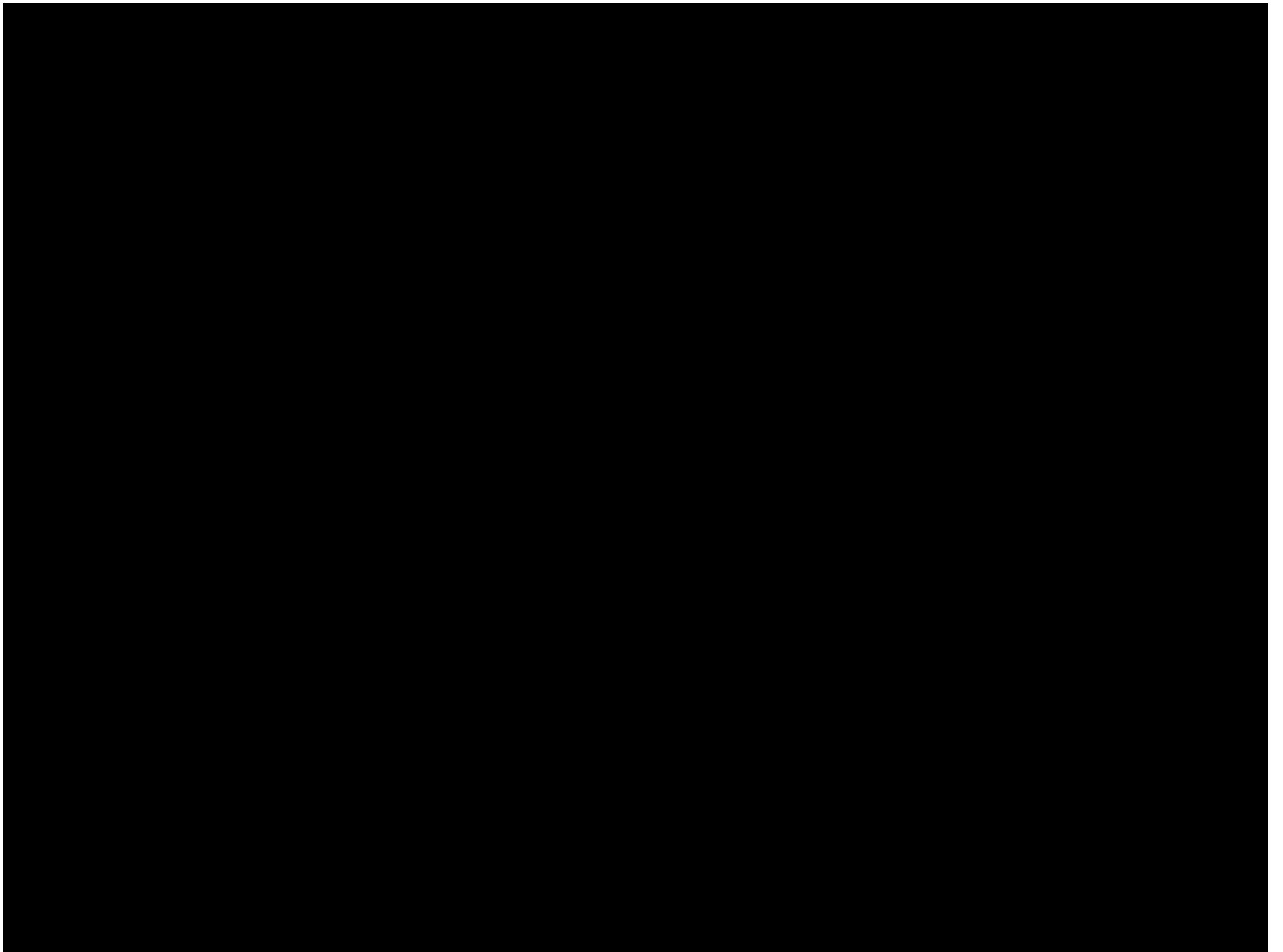


Photo: Rena Bryan

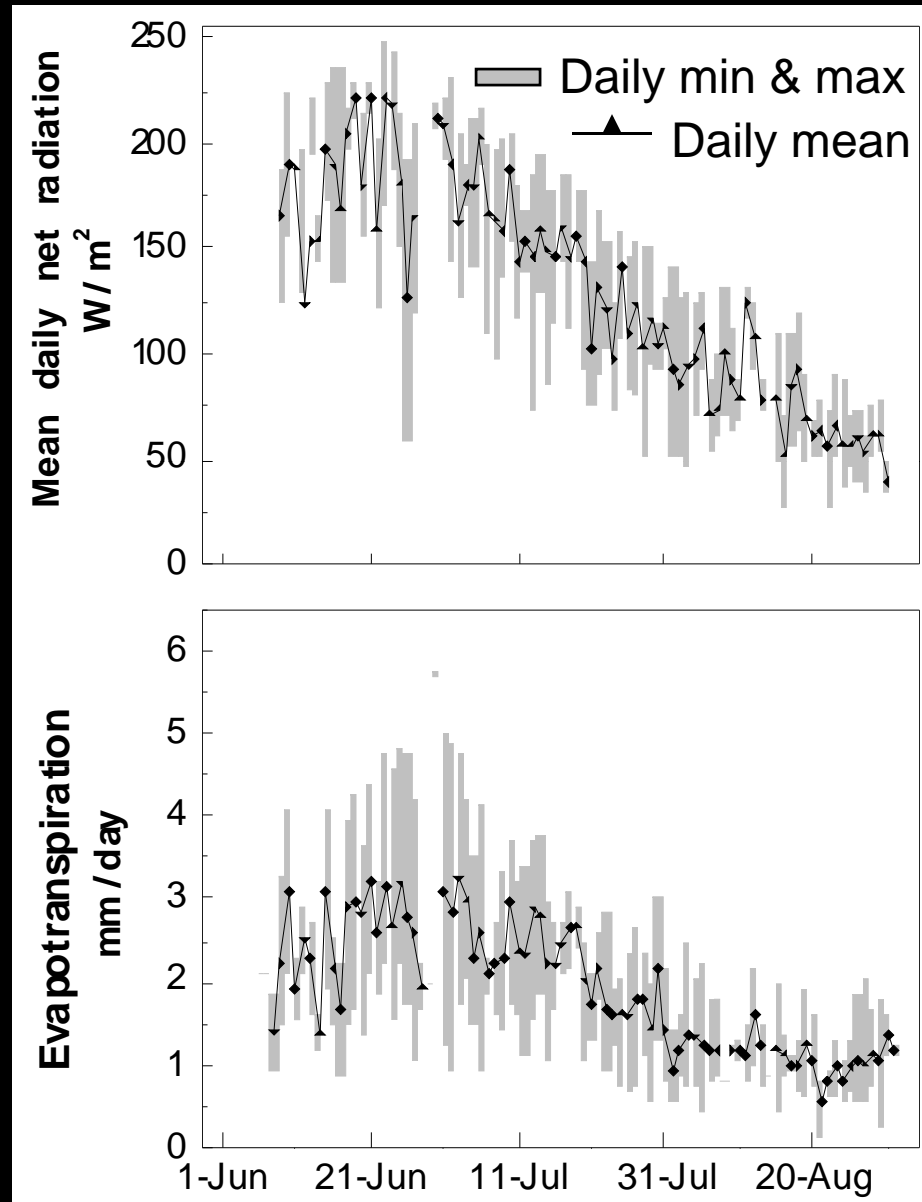
Projecting the future of Arctic wetlands requires *a Holistic Approach*

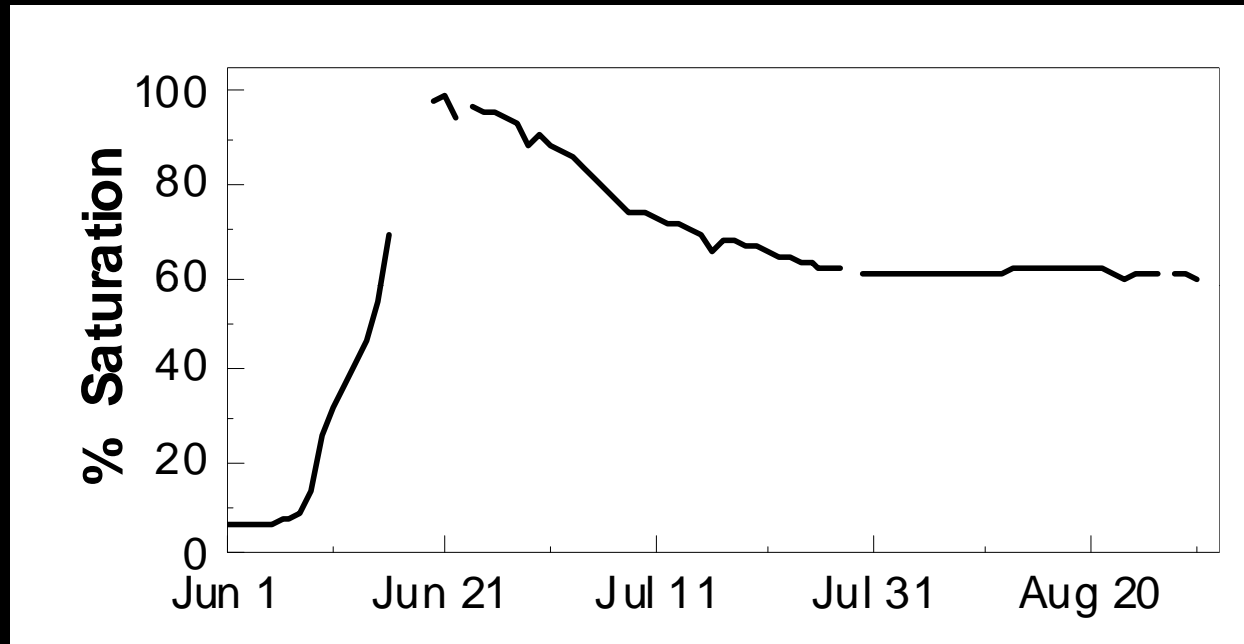
- **Timing**
- **ET partitioning/
vegetation change**
- **Permafrost**





Evapotranspiration 0.15 – 5.73 mm/day





Soil moisture in the upper 10 cm in 2007 presented as % liquid saturation