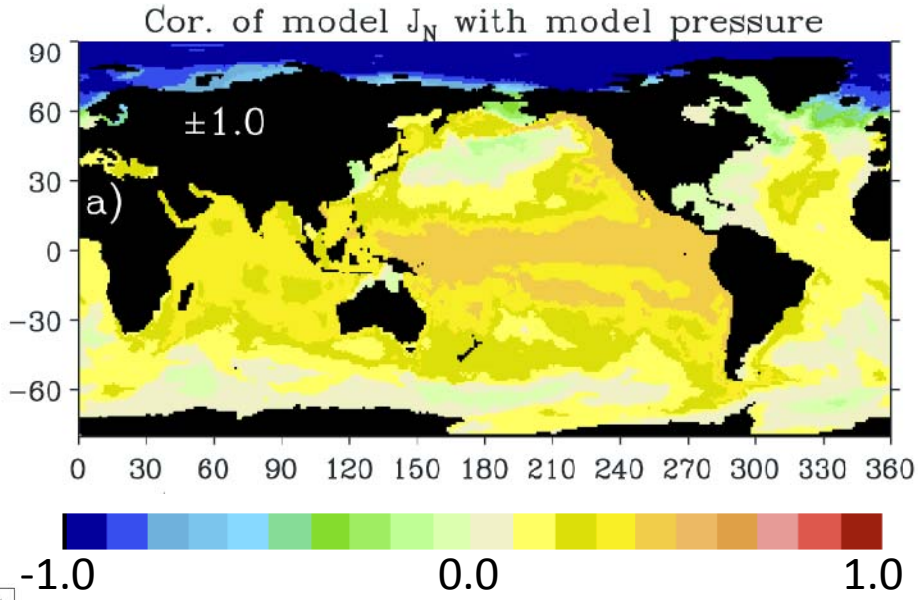
"Observations and Mechanisms of Near-Uniform Sea Level and Ocean Bottom Pressure Fluctuations Spanning the Arctic Ocean and the Nordic Seas"

Ichiro Fukumori, Ou Wang, and William Llovel
(JPL/Caltech)

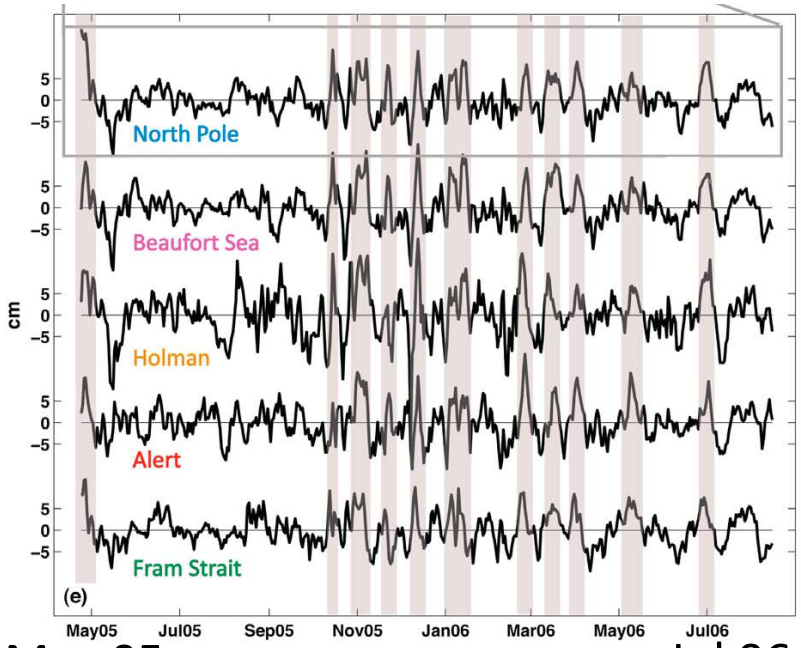
Thanks to P.Heimbach & G. Forget (MIT); M.Watkins, C.Boening, D.Wiese, V.Zlotnicki (JPL); R.Kwok (JPL)

Coherent Basin-wide Arctic Variations

Hughes and Stepanov (2004)

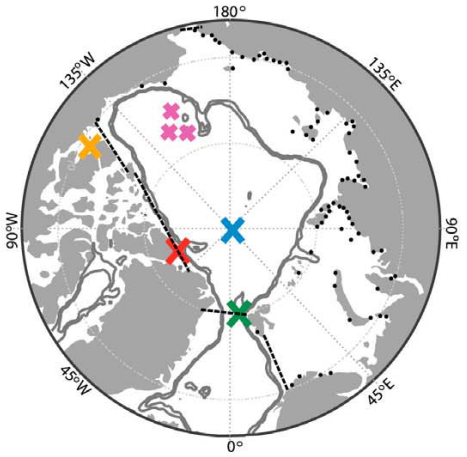


±5 cm



May 05

Jul 06



Peralta-Ferriz et al. (2011)

Fraction of Variance Explained: $1-\frac{\mathrm{var}(a-b)}{\mathrm{var}(a)}$

Data (GRACE & AVISO)

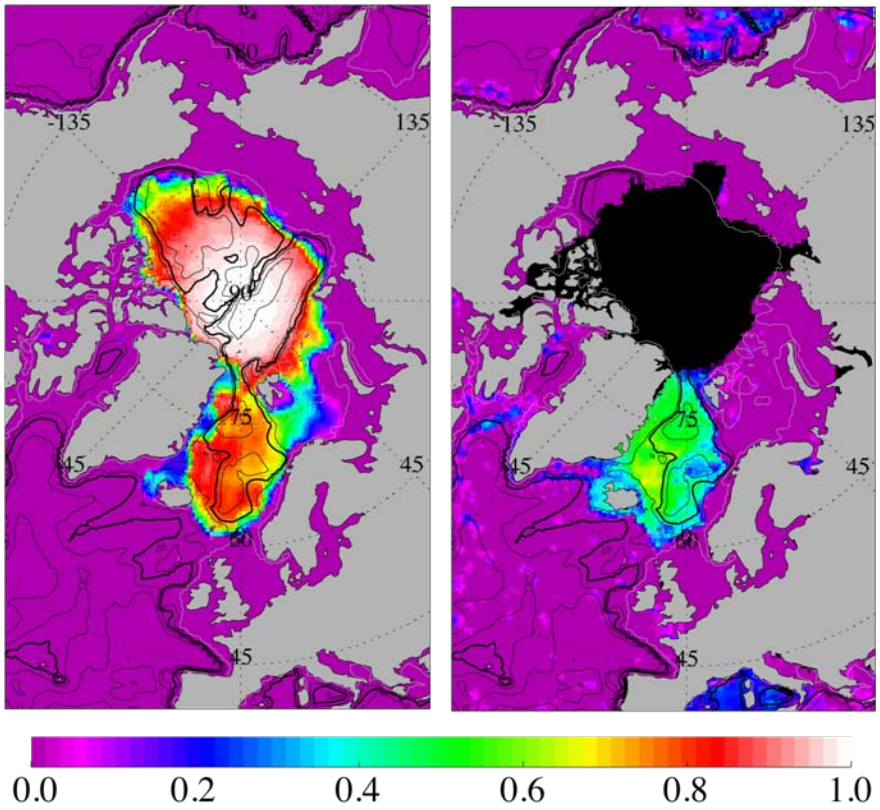
a=OBP
b=OBP@NP

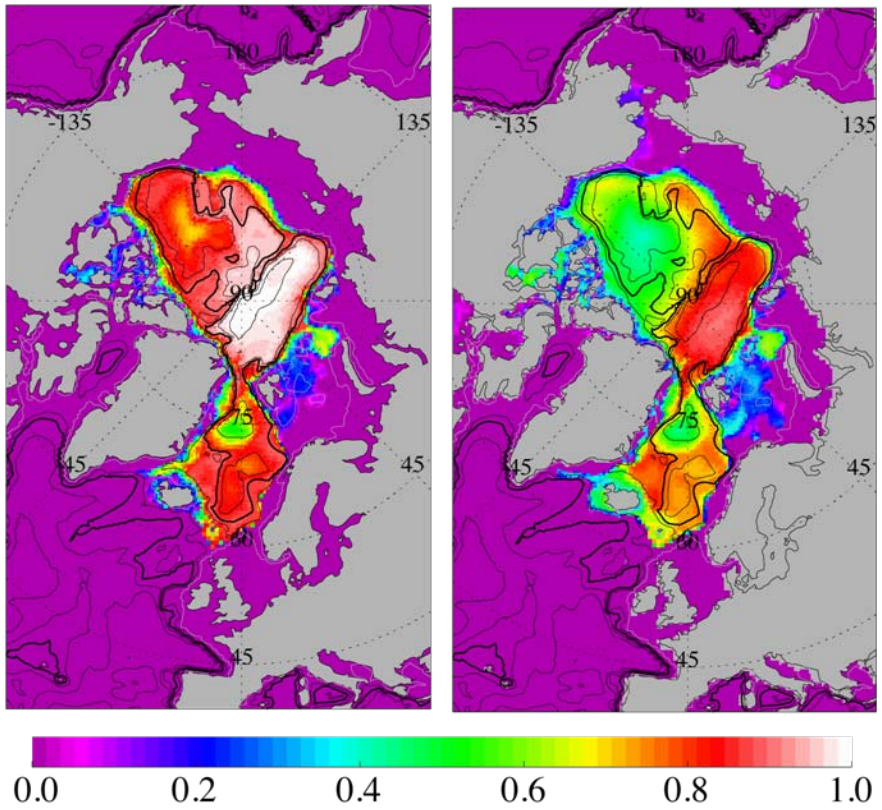
a=SSH
b=Mean Arctic OBP

Model (ECCO V4)

a=OBP
b=OBP@NP

a=SSH
b=Mean Arctic OBP



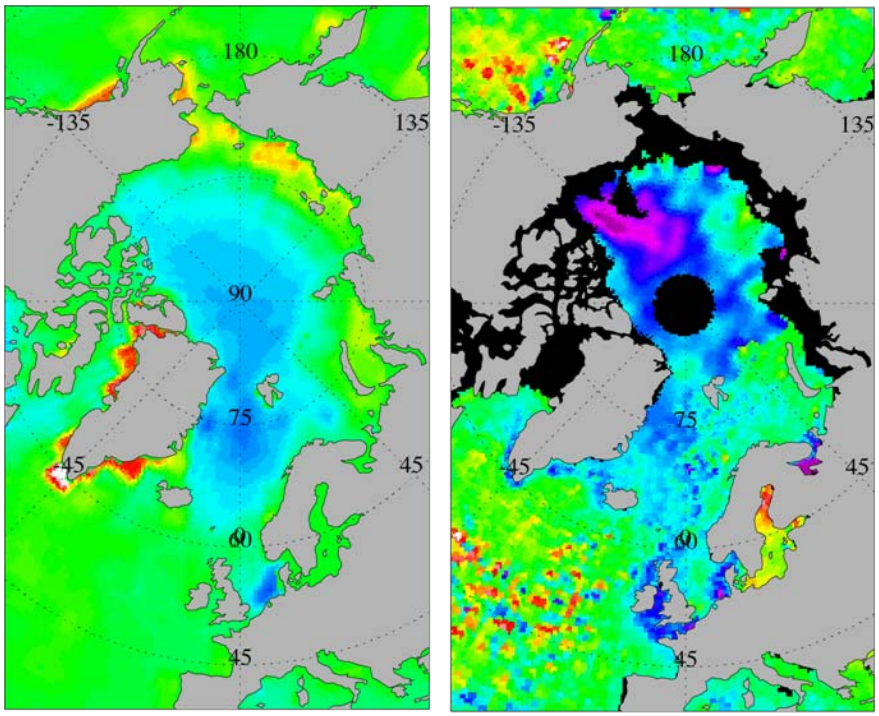


OBP & SSH Anomalies (February 2005)

Data

GRACE

AVISO & ICESAT

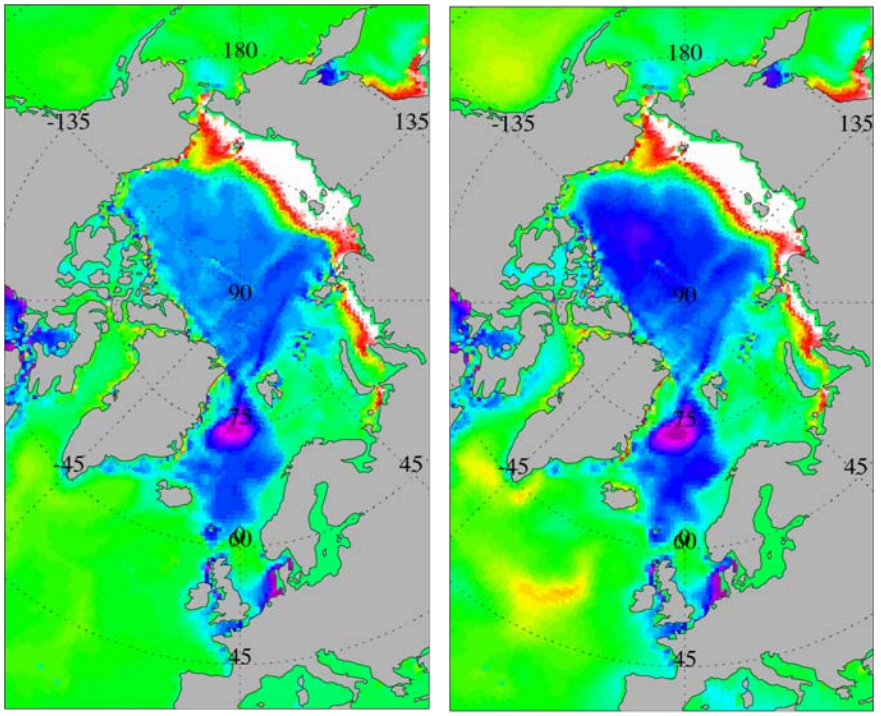


(Equivalent) Sea Level (cm)

Model (ECCO V4)

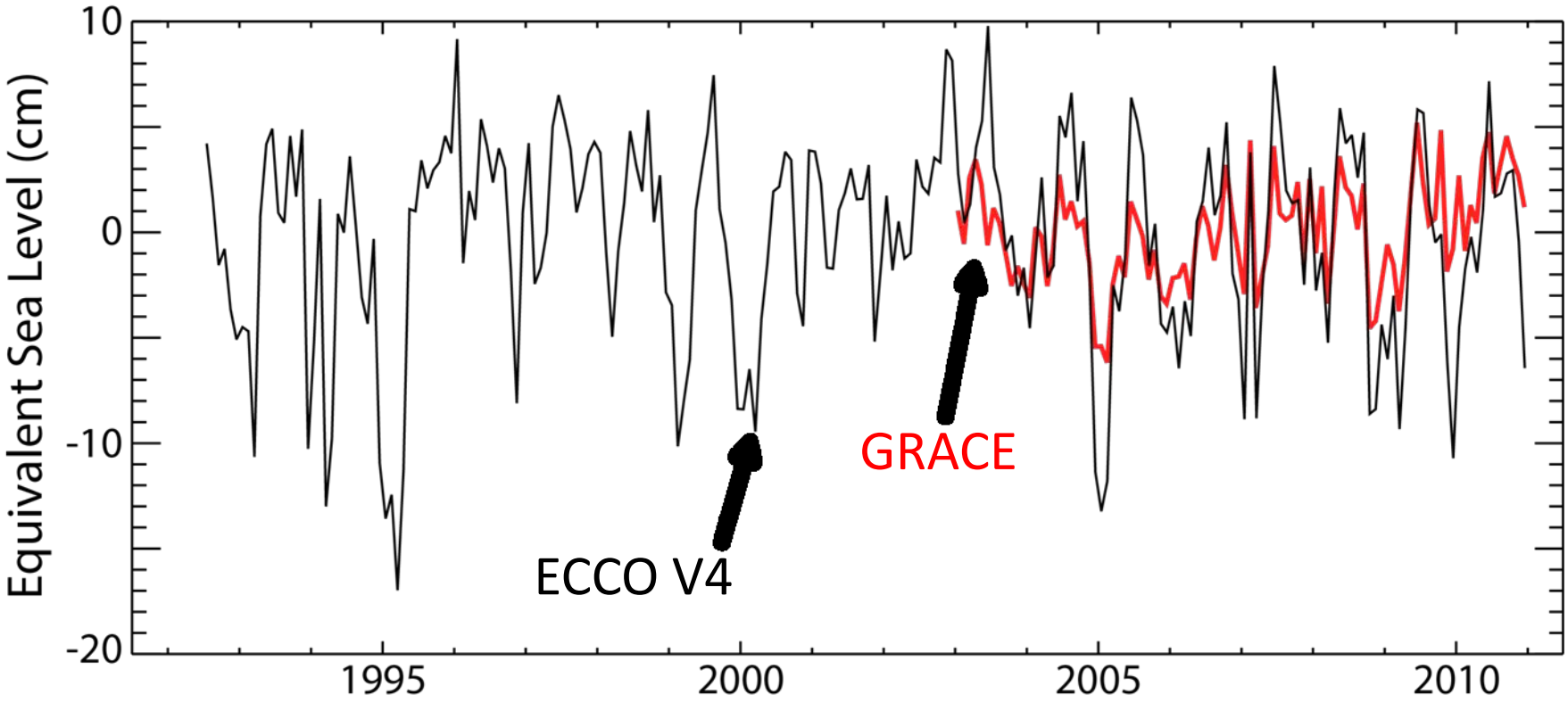
OBP

SSH



(Equivalent) Sea Level (cm)

Arctic Mean OBP Time-Series



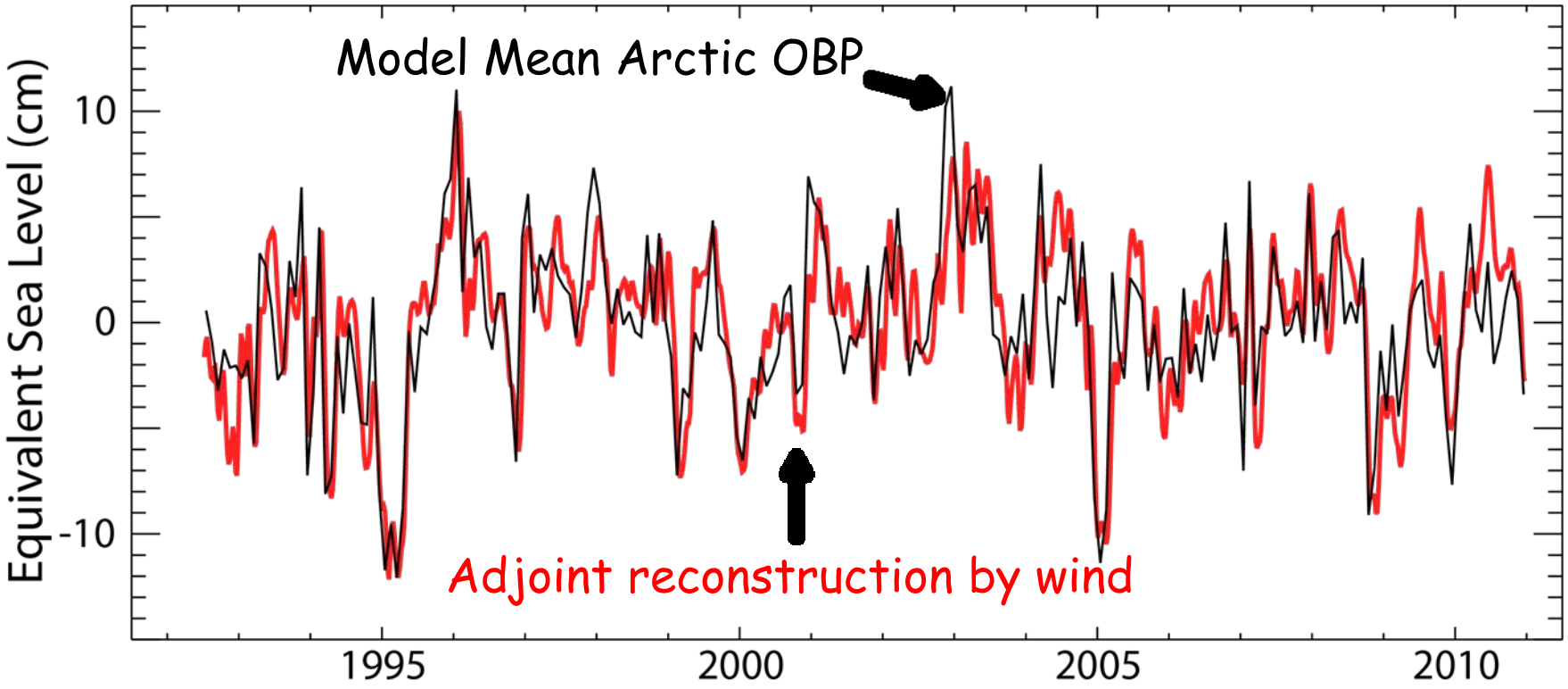
Causal Mechanism (forcing)

Mean Arctic OBP

Gradient by adjoint

forcing i at location $\mathbf{x}$, time T-t

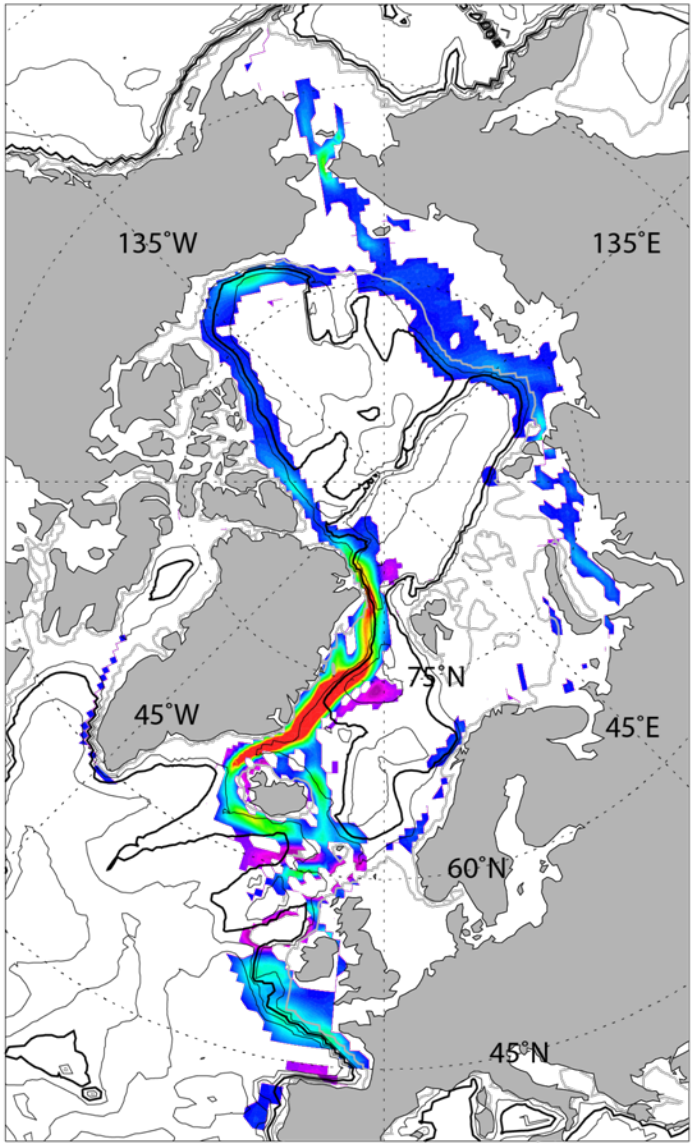
$$J(T) \approx \sum_{i,\mathbf{x},t} \frac{\partial J(T)}{\partial \phi_i(\mathbf{x}, T-t)} \delta\phi_i(\mathbf{x}, T-t)$$



Causal Mechanism (location)

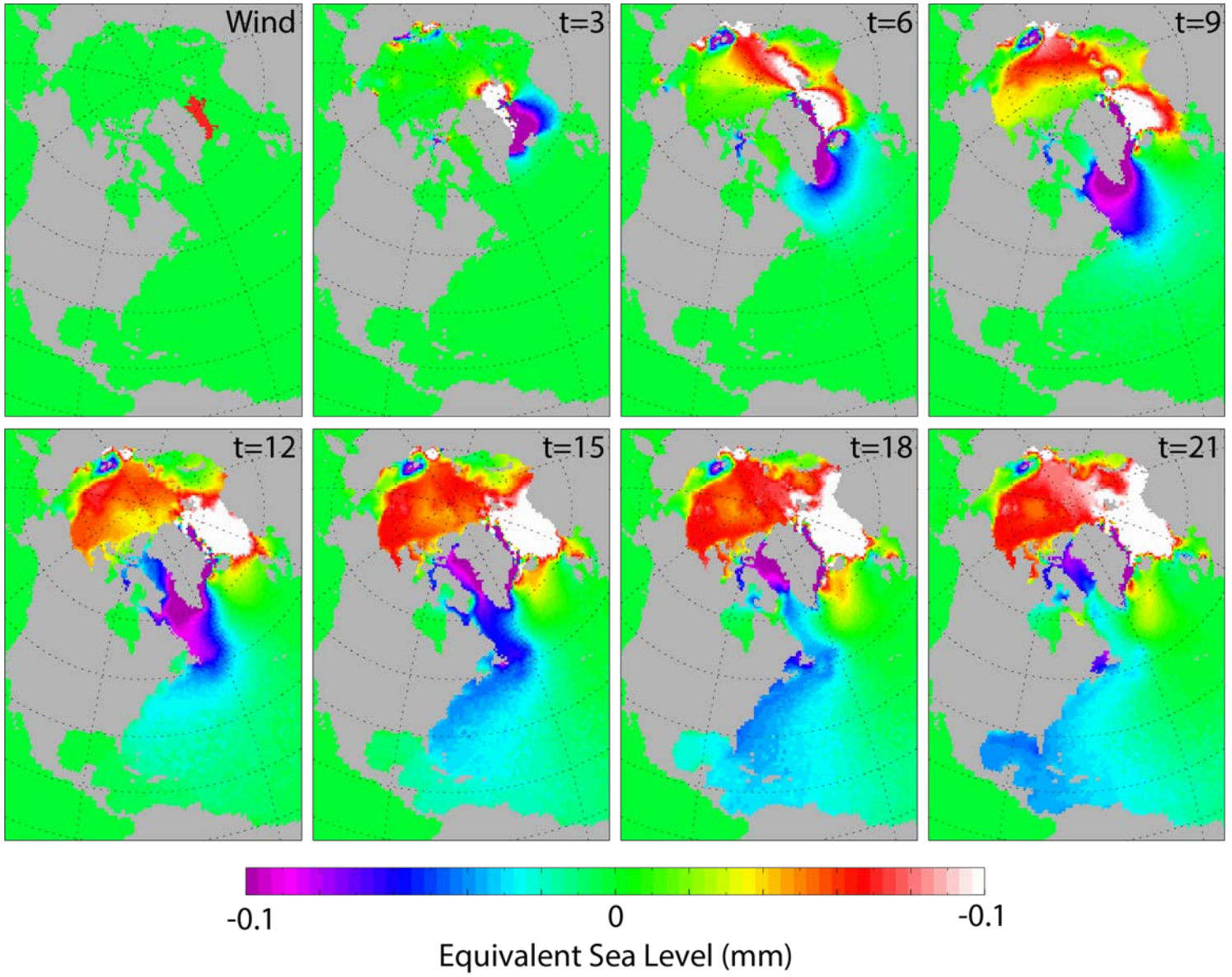
Fraction of mean Arctic OBP variance contribution per area

$$\left[1-\frac{\mathrm{var}\left\{J-\sum_{t,i=\mathrm{wind}}\frac{\partial J}{\partial \phi_i(\mathbf{x})}\delta\phi_i(\mathbf{x})\right\}}{\mathrm{var}\{J\}}\right] / dS$$



Fraction explained/km^2

OBP Response to Wind Perturbation



Conclusions

1. *Near-uniform basin-wide barotropic fluctuations* dominate sea level and ocean bottom pressure variations across the deep Arctic basin *including the Nordic Seas*,
2. The fluctuations are driven by *along-shelf winds at the shelf break* within the Arctic domain,
3. The fluctuations can be explained by *Ekman transport separating mass* between the deep and shallow/coastal regions, *Kelvin waves evacuating* the latter through the straits and leaving the deep basin anomalies behind,
4. Additional sea level measurements in the Arctic basin would help discern how the fluctuation interacts with other changes within the Arctic Ocean (e.g., freshwater input).