

Melting Coasts and Toppled Blocks: Modeling Arctic coastal retreat along the Beaufort Sea Coast, Alaska

Katherine R. Barnhart^{1,2},
Robert S. Anderson^{1,2},
Irina Overeem², Cameron Wobus³,
Gary D. Clow⁴, Frank E. Urban⁴

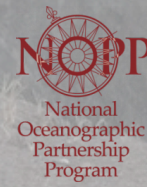
¹Department of Geological Sciences, University of Colorado, Boulder

²Institute of Arctic and Alpine Research, University of Colorado, Boulder

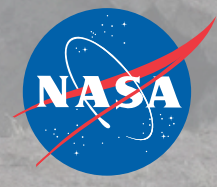
³Stratus Consulting, Inc., Boulder, CO

⁴United States Geological Survey, Lakewood, CO

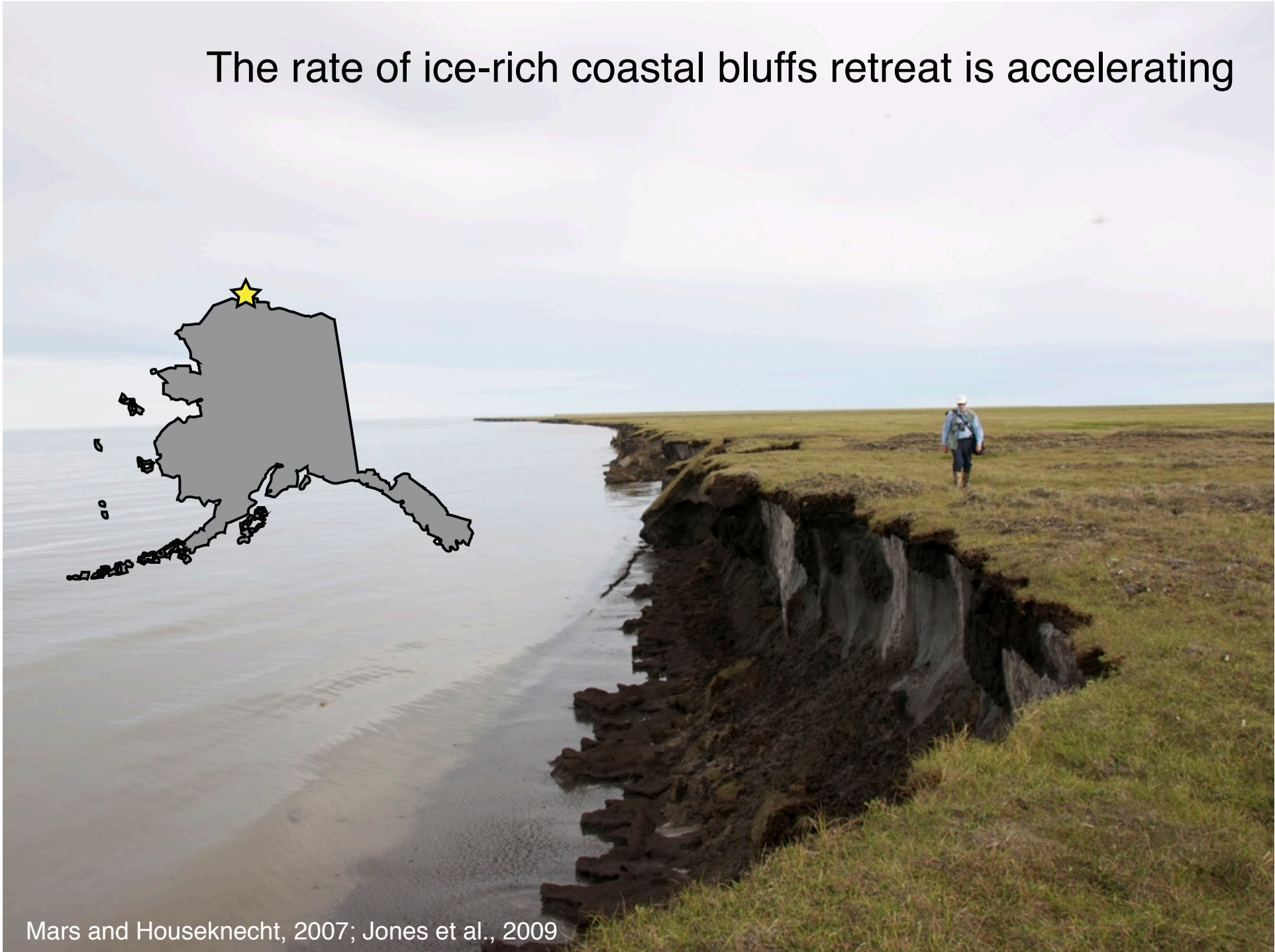
And many thanks to Adam LeWinter, Gene Ellis, and Shane Walker



ONR



The rate of ice-rich coastal bluffs retreat is accelerating



Mars and Houseknecht, 2007; Jones et al., 2009



6/20/08 2:00 PM



June 20th, 2008 to July 28th, 2008
2 hours between each frame

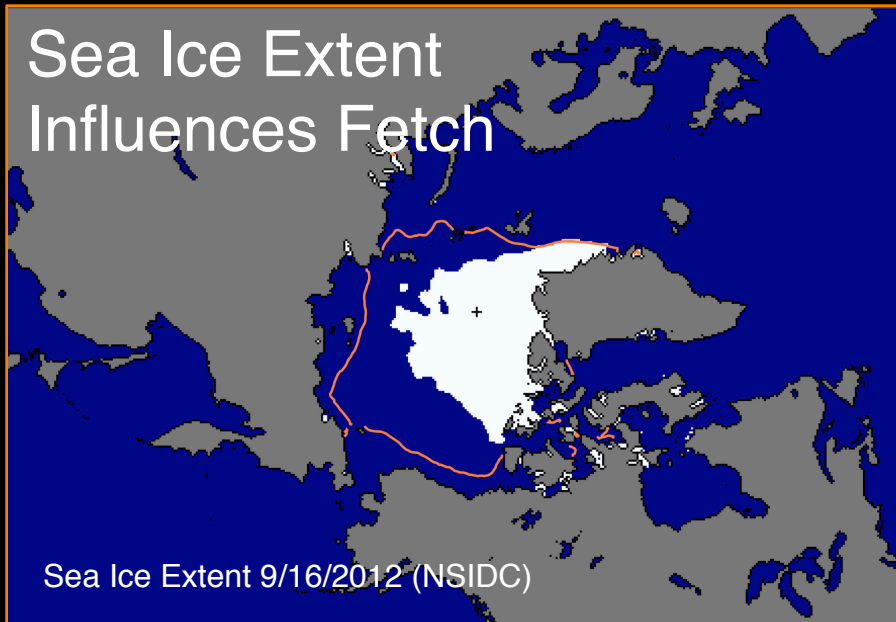
Nearshore Sea Ice



Ice Rich Substrate



Sea Ice Extent Influences Fetch

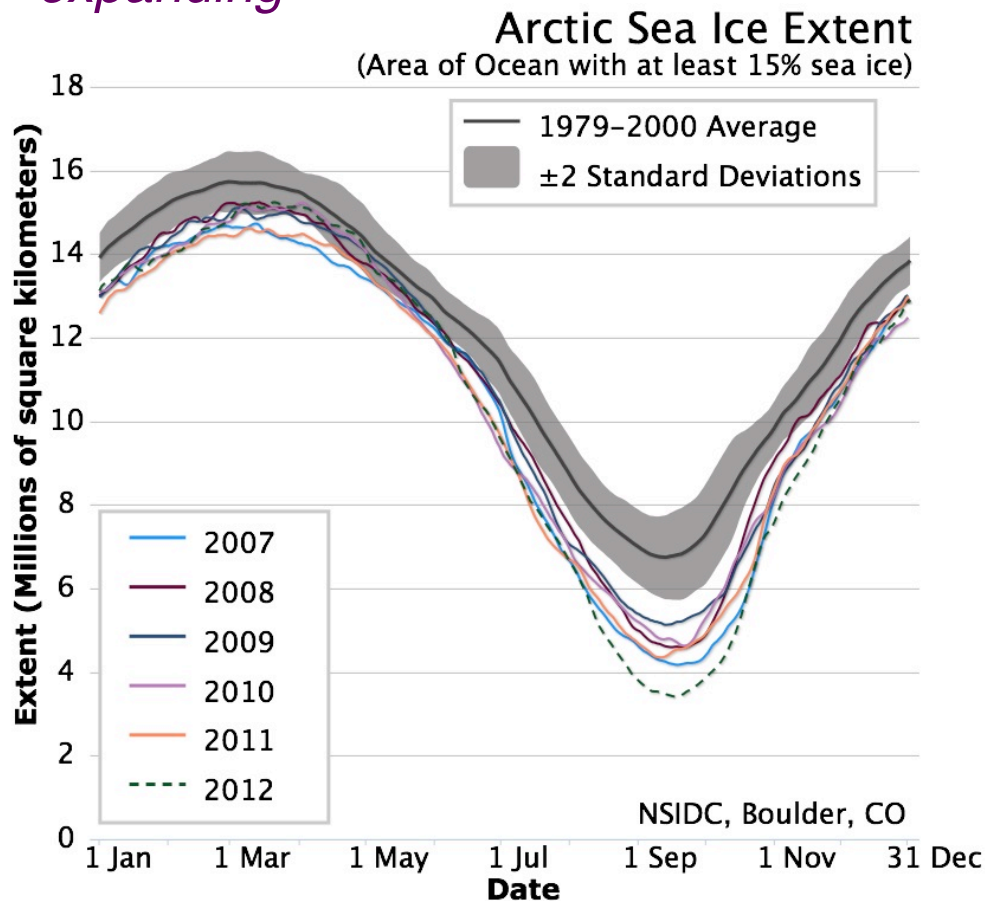


Sea Ice Extent 9/16/2012 (NSIDC)

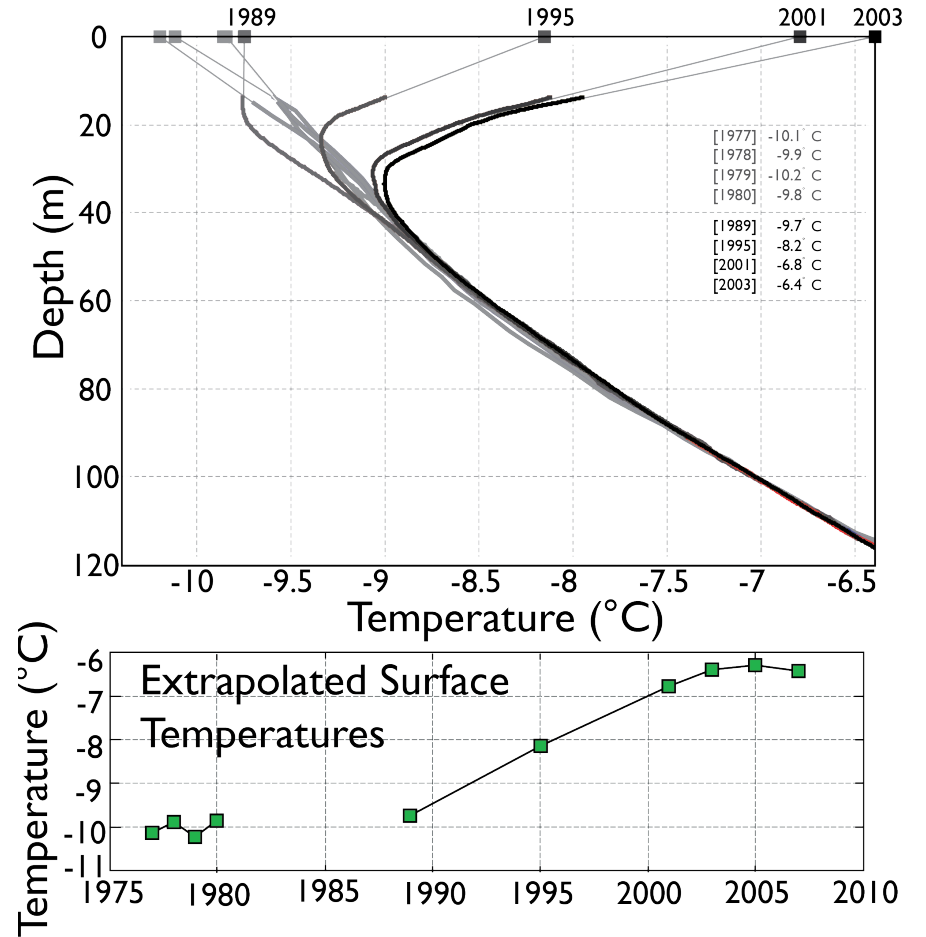


The Arctic Environment is Changing

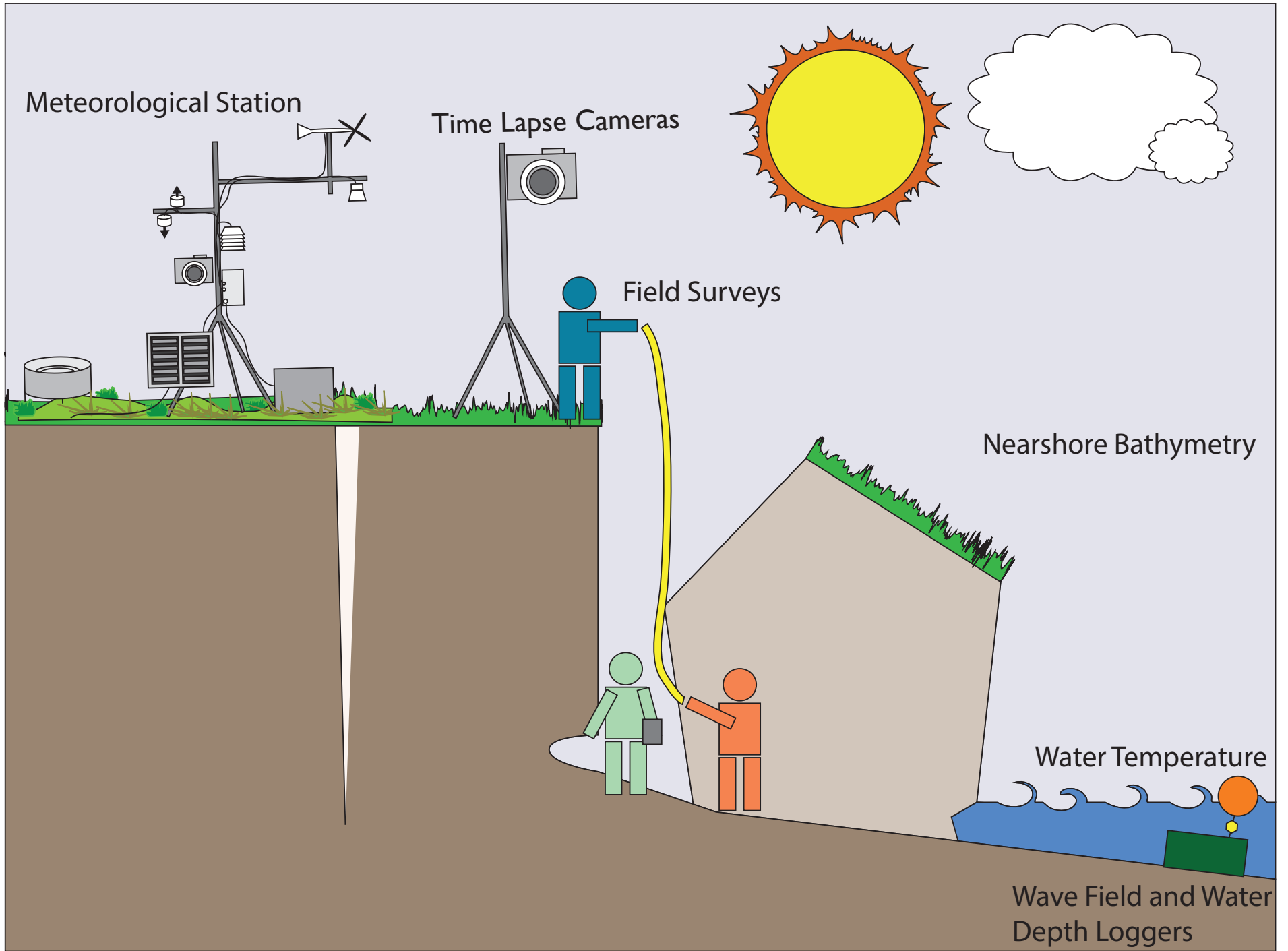
Sea ice-free season is expanding

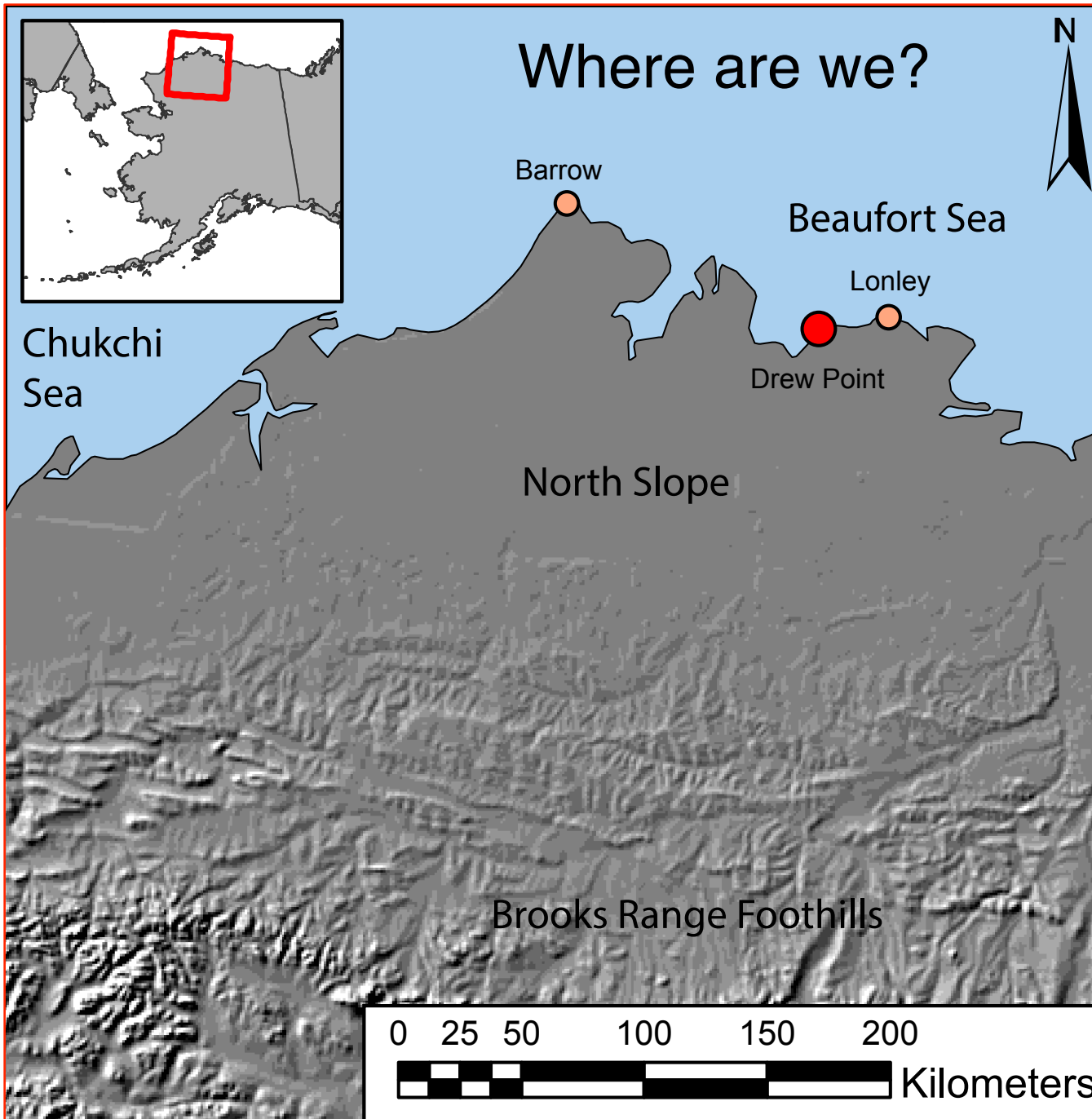


East Lake Teshekpuq, Arctic Alaska



Permafrost temperature is increasing





Not your standard landscape



High Ice Content



3-5 m High Bluffs

Failure on Ice Wedge Faces to Form Toppled Blocks



Ice Wedge Polygons



Thaw Lakes on the Coastal Plain

Erosion occurs only when there is no sea ice

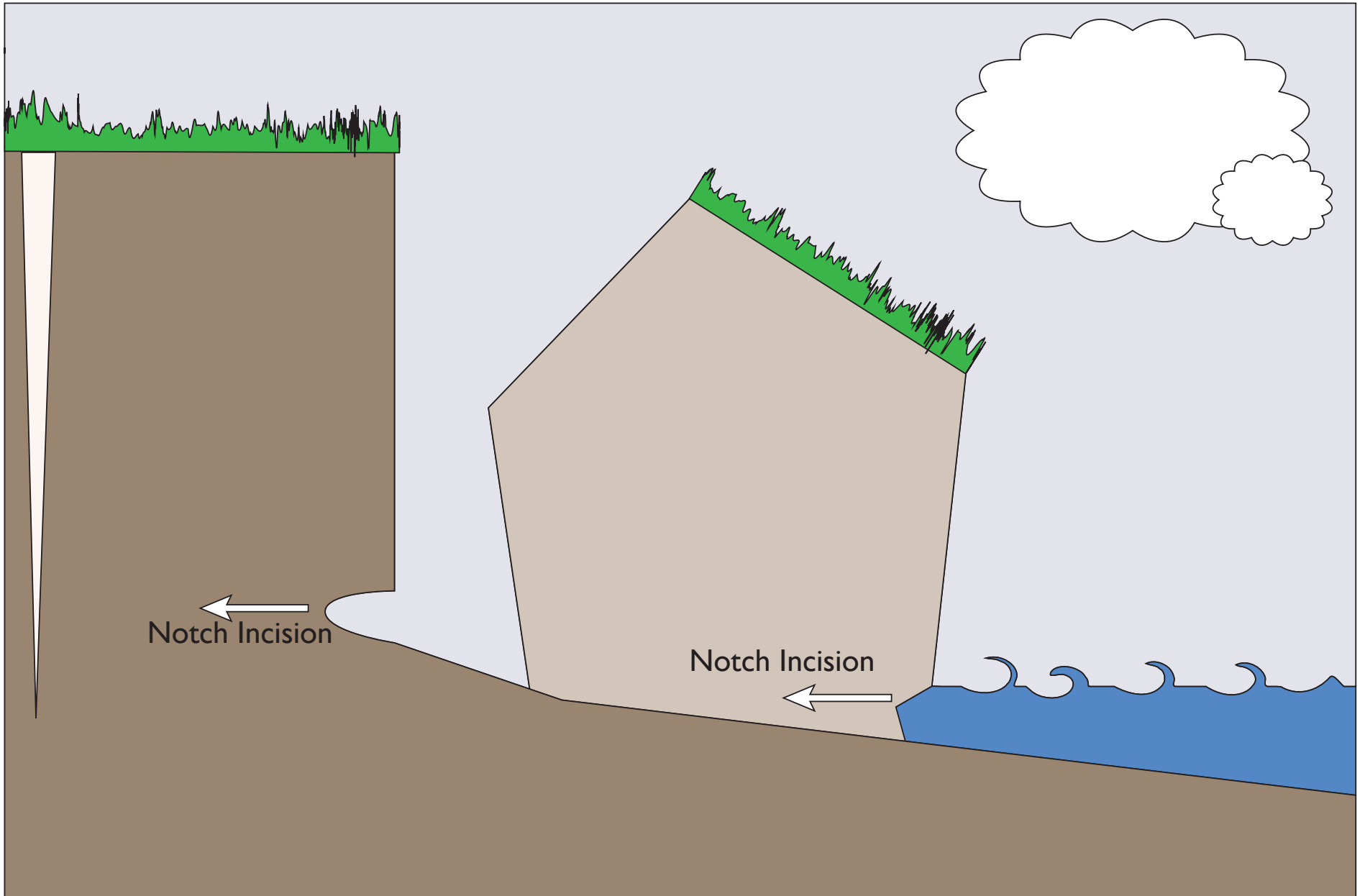


6/20/08 2:00 PM

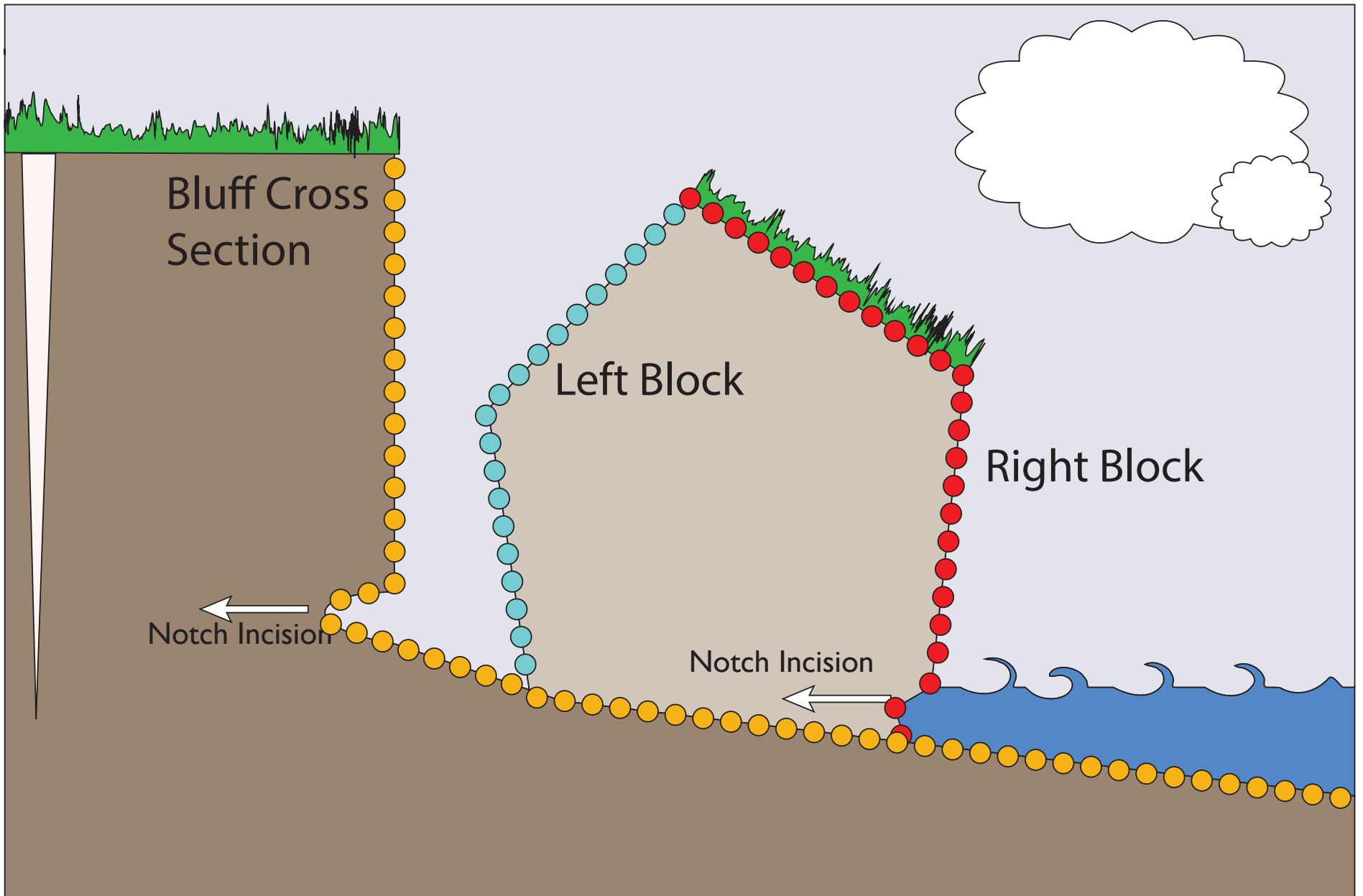


June 20th, 2008 to July 28th, 2008
2 hours between each frame

Horizontal Notch Incision



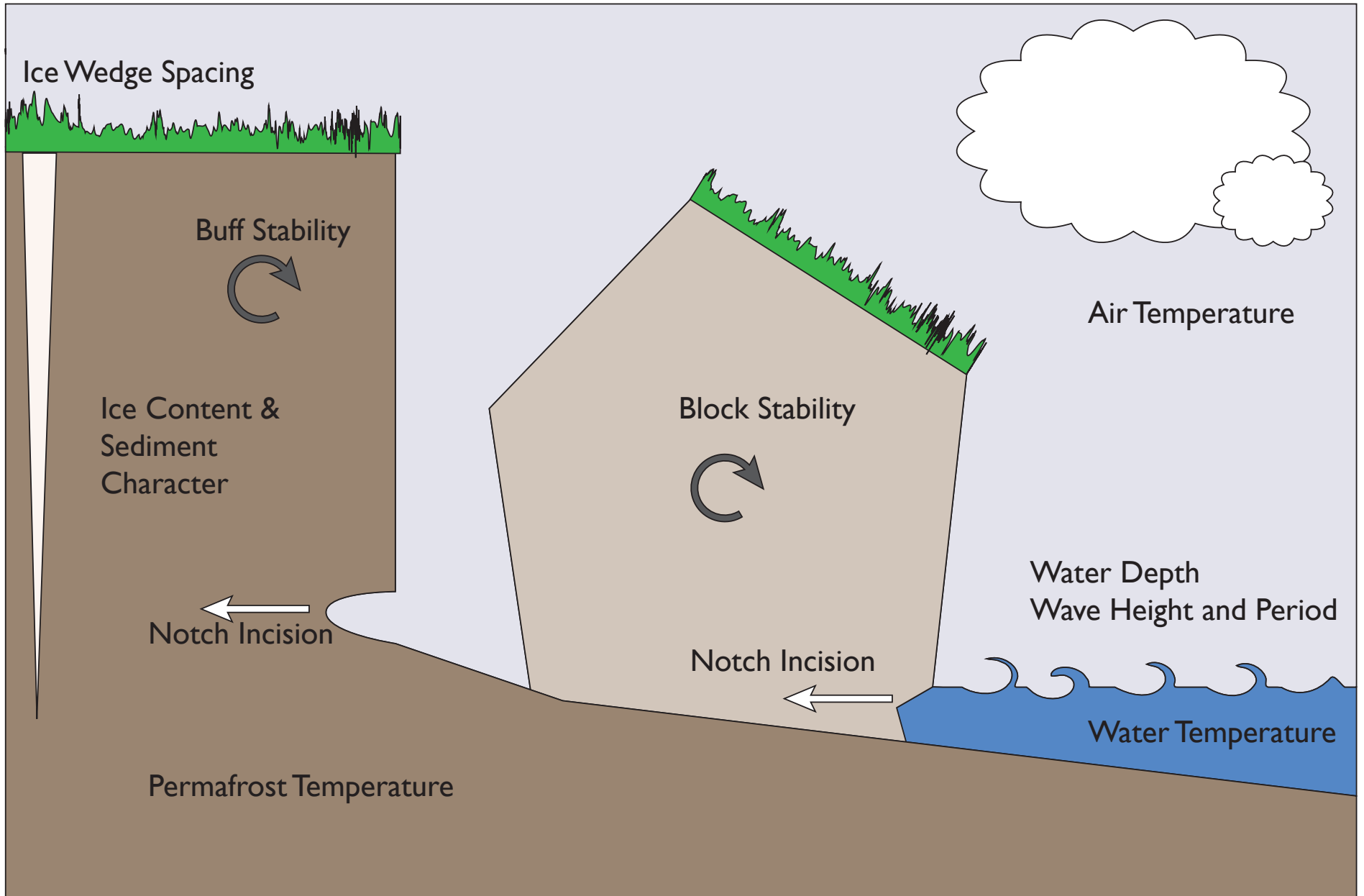
Horizontal Notch Incision



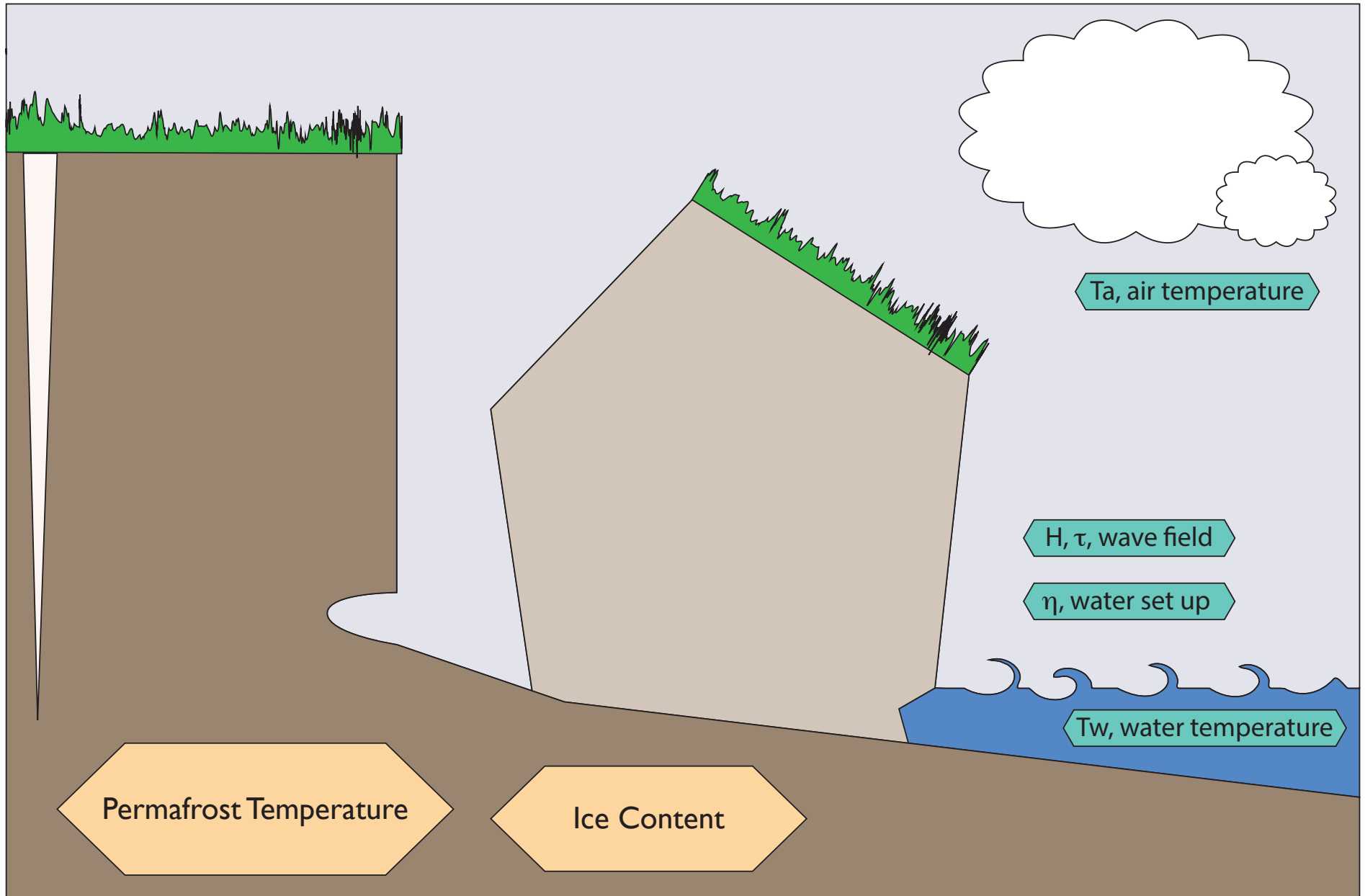


August 13th, 2010- August 22nd, 2010
15 minutes between each frame

Numerical model for coastal erosion



What controls the rate of submarine erosion?



We use three different formulations for submarine erosion

T_w , water temperature

H, τ , wave field
(height, period)

η , water set up

Submarine Erosion
Formulation

$$\dot{e} = f(T_w, H, \tau, \eta)$$

Submarine Erosion Rate

We use three different formulations for submarine erosion

T_w , water temperature

H, τ , wave field
(height, period)

η , water set up

Submarine Erosion
Formulation

$$\dot{e} = f(T_w, H, \tau, \eta)$$



Submarine Erosion Rate

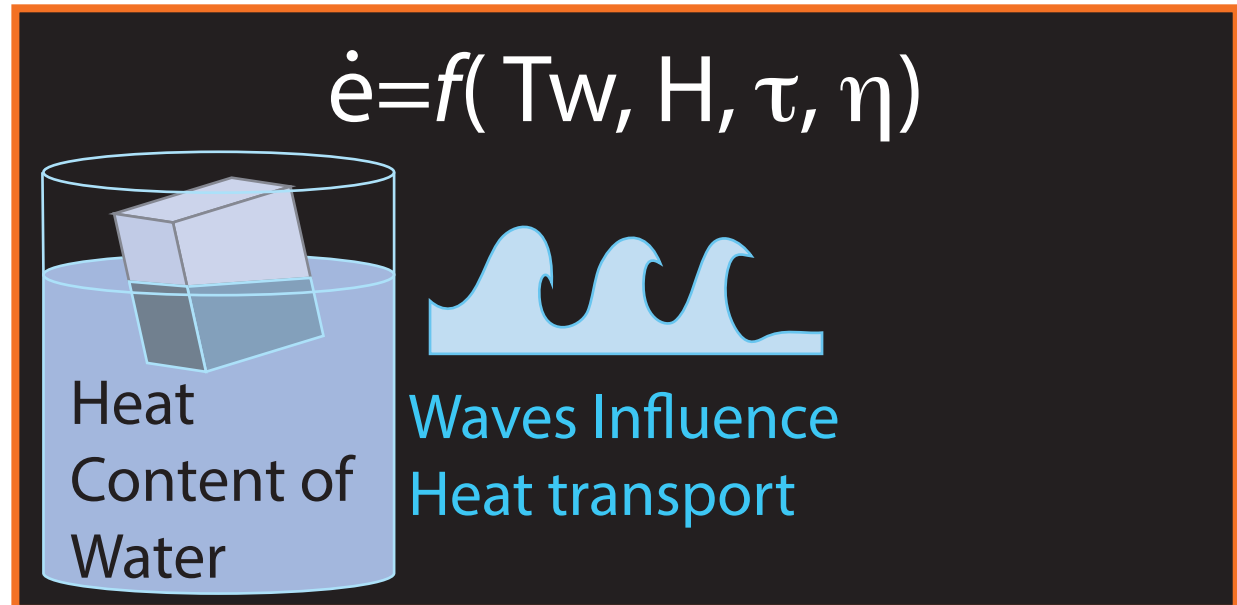
We use three different formulations for submarine erosion

T_w , water temperature

H, τ , wave field
(height, period)

η , water set up

Submarine Erosion
Formulation



Submarine Erosion Rate

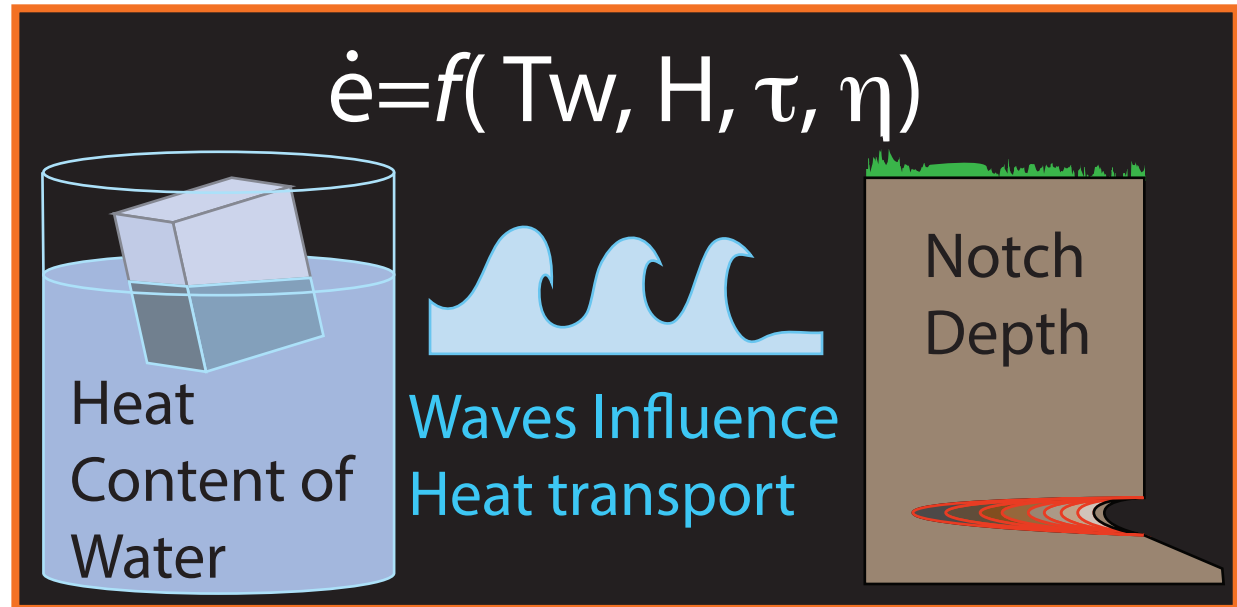
We use three different formulations for submarine erosion

T_w , water temperature

H, τ , wave field
(height, period)

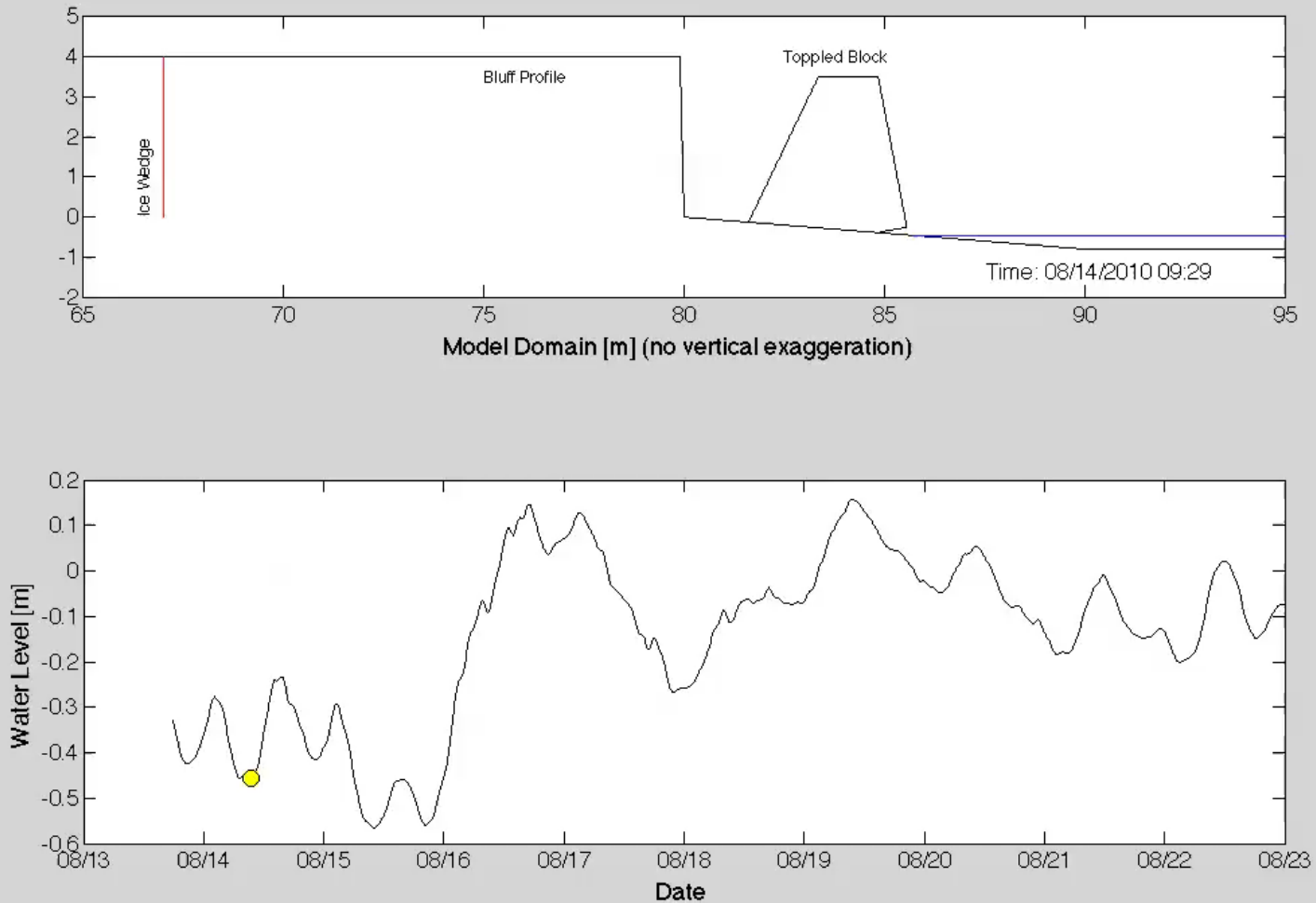
η , water set up

Submarine Erosion
Formulation

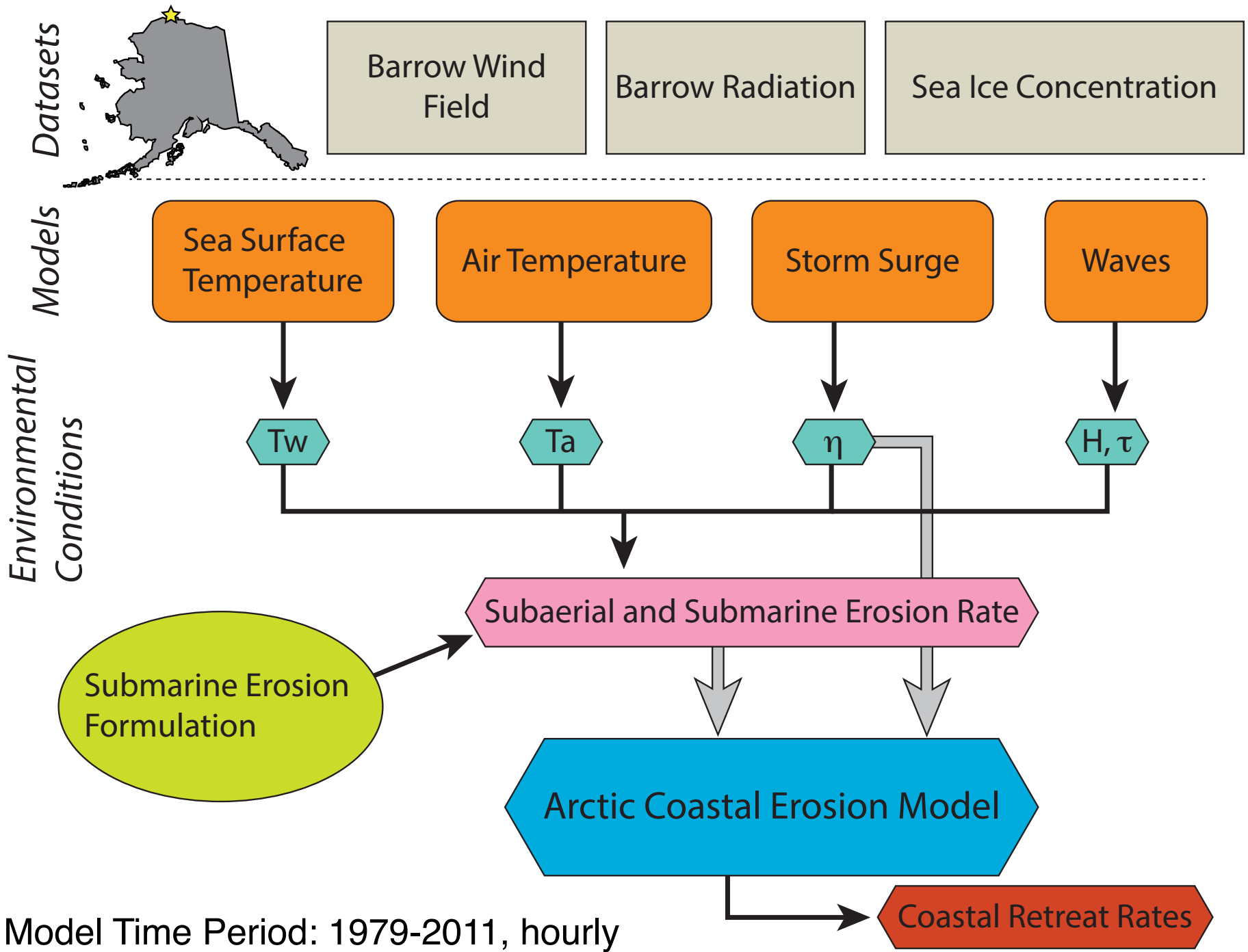


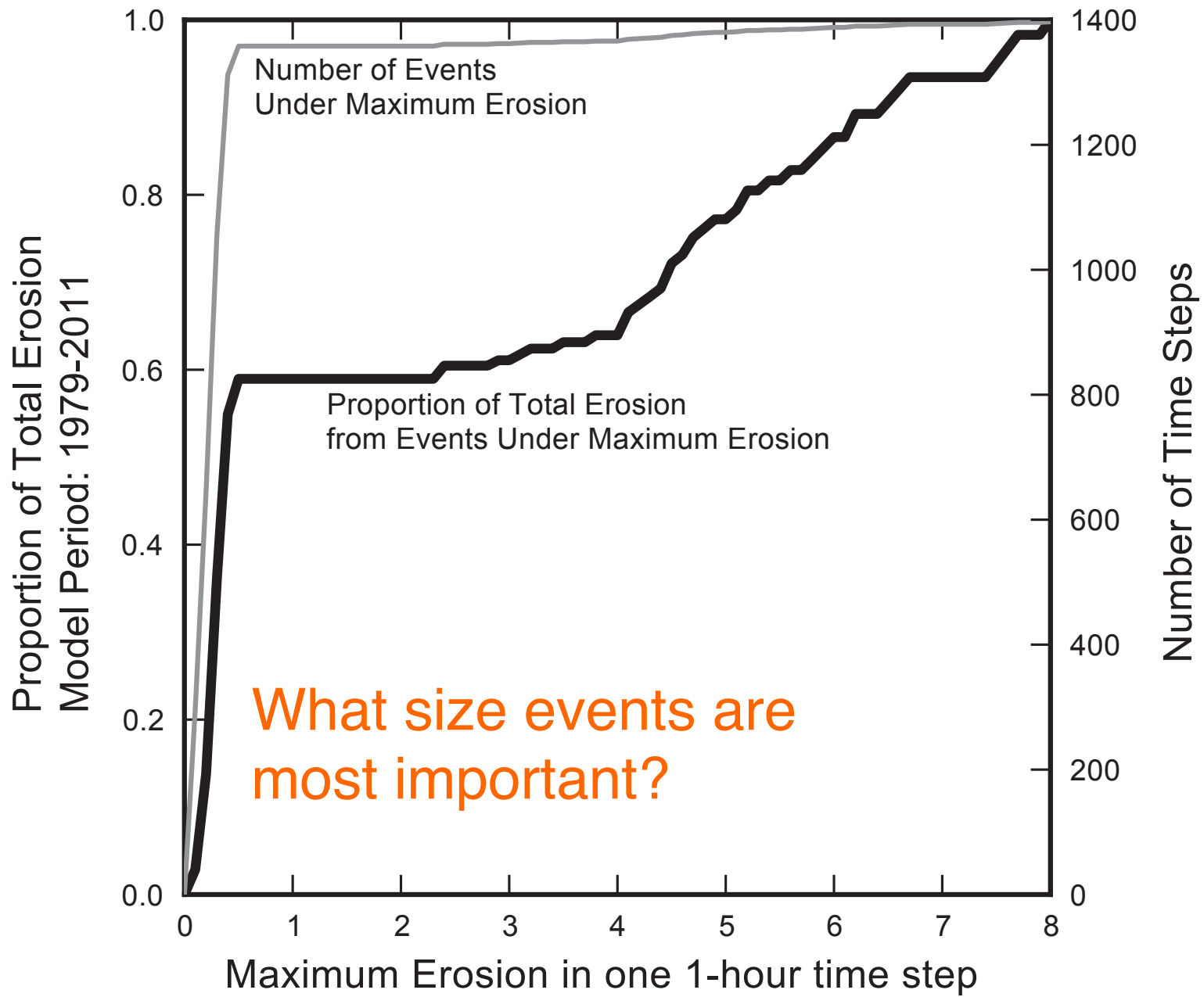
Submarine Erosion Rate

We can reproduce observed block degradation



Model is driven by observed environmental conditions





Questions?

