



# Investigating changes in the Arctic using remotely operated vehicles

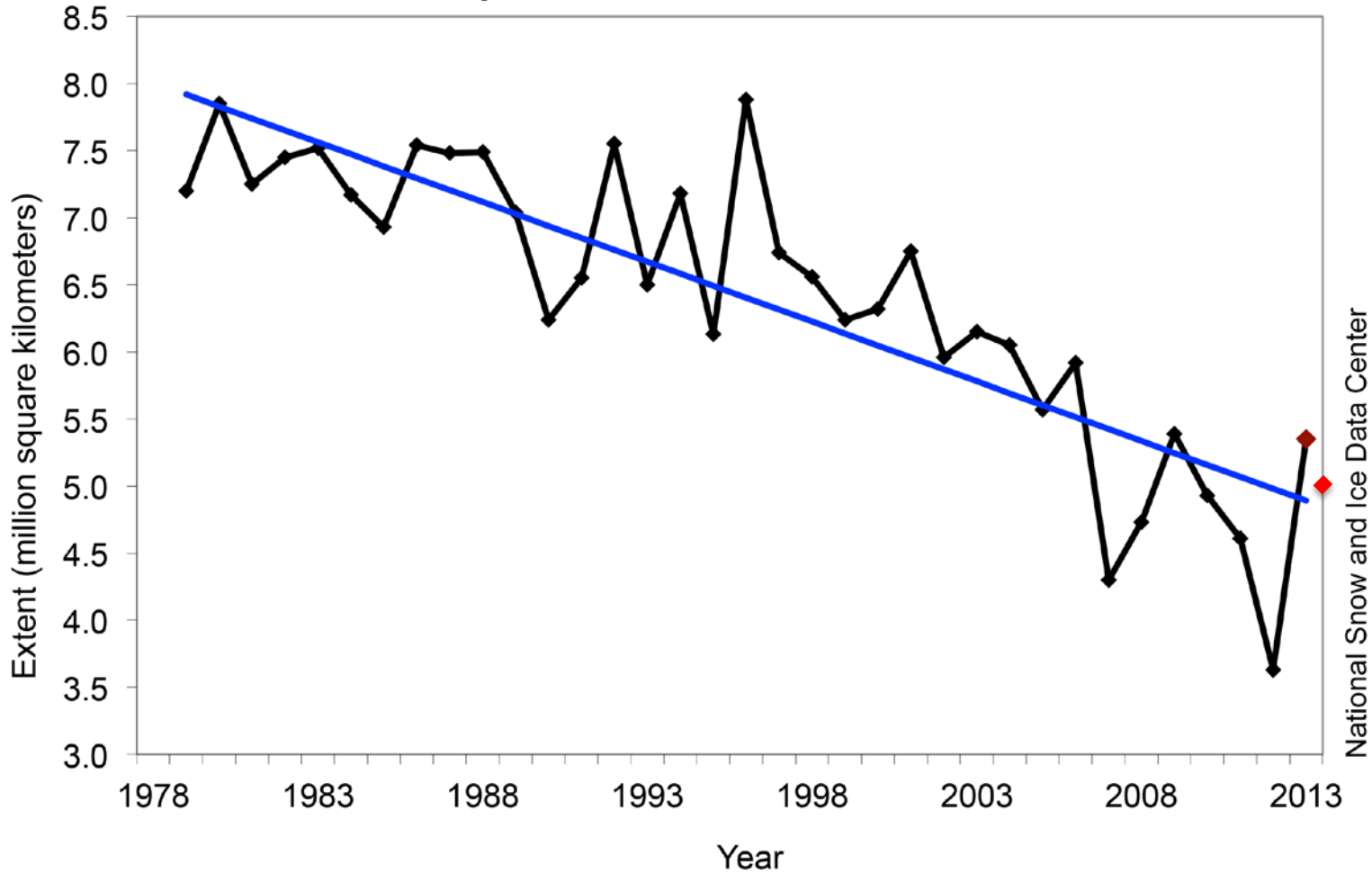


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M. Nicolaus, F. Wenzhöfer, M. Jakuba, C. German

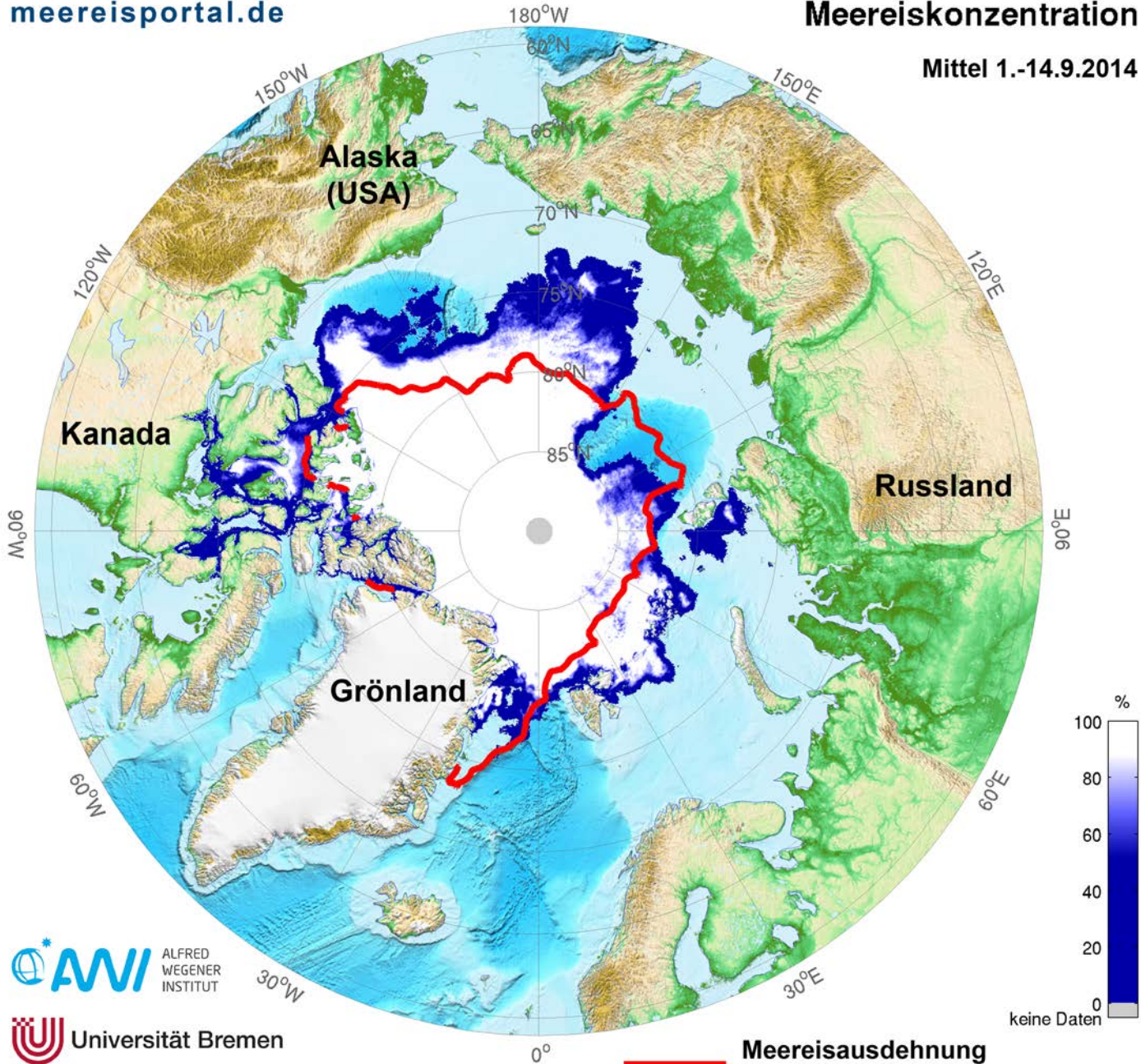
# Changes in the Arctic

## Average Monthly Arctic Sea Ice Extent September 1979 - 2013



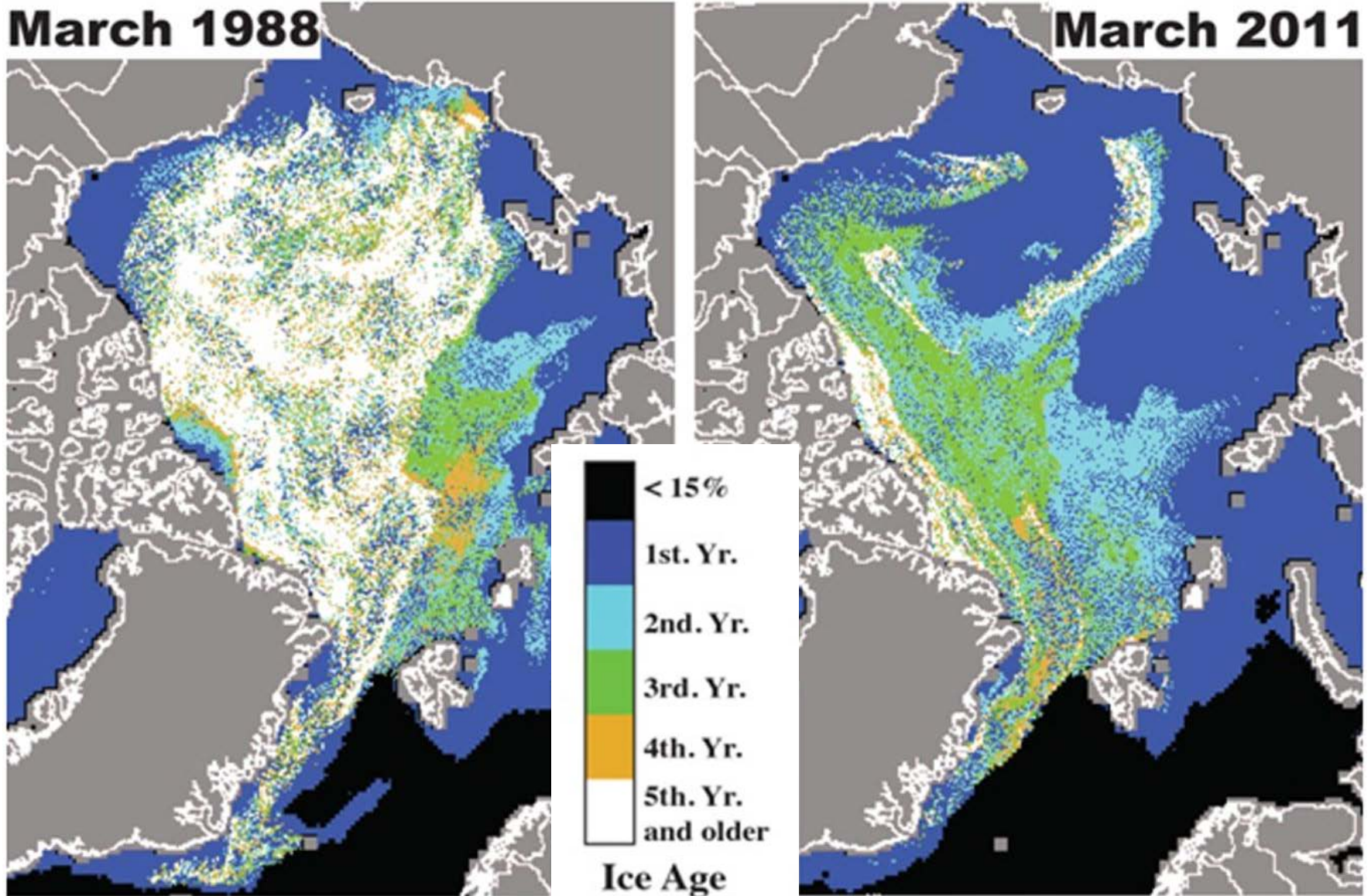
National Snow and Ice Data Center







# Sea ice age

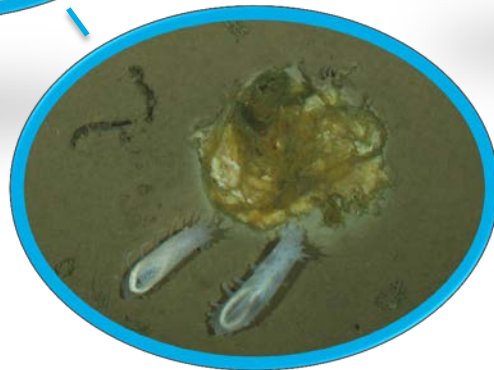
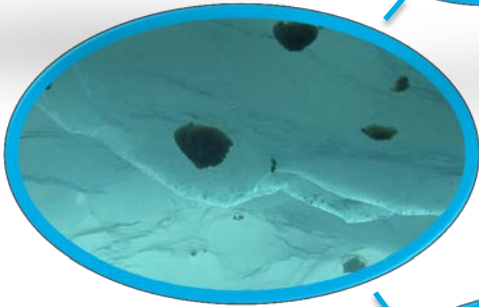
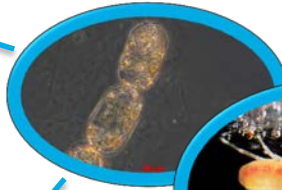


# Climate system





# The sea-ice ecosystem





# Observations are sparse



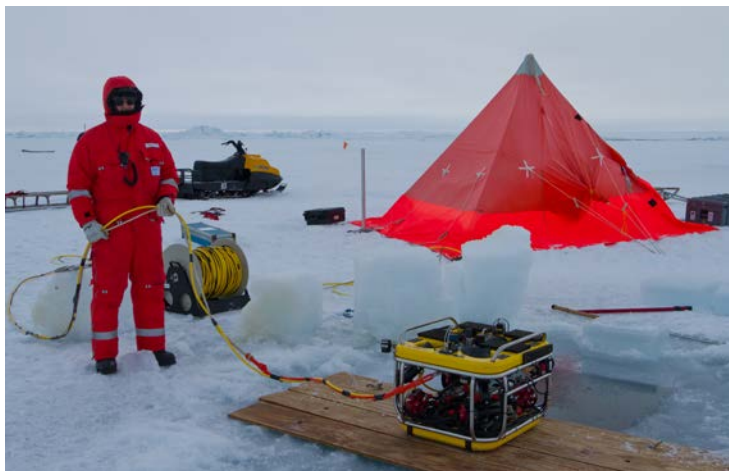
# Typical sea ice sampling vs. ROV



# Observation class ROV



**Weight:** 60 kg  
**Range:** 200 m  
**Operators:** 2-3



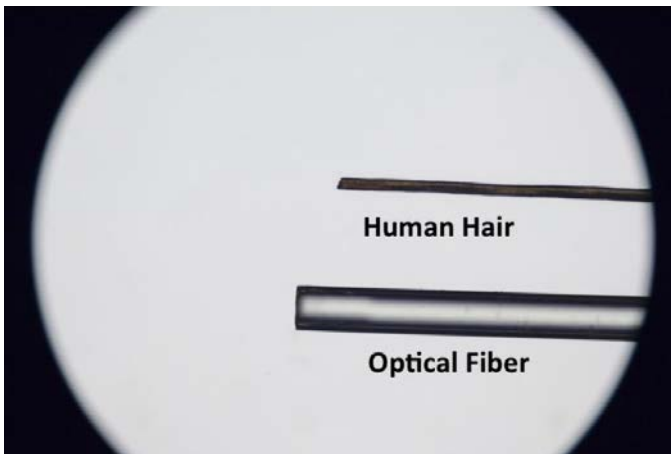
- operated from the ice
- high maneuverability
- limited payload



# Hybrid-ROV



**Weight:** 1800 kg  
**Range:** 20 km  
**Operators:** 5-8

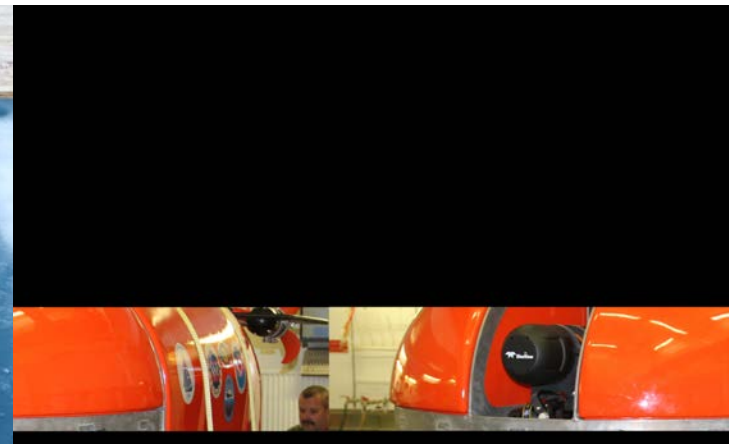
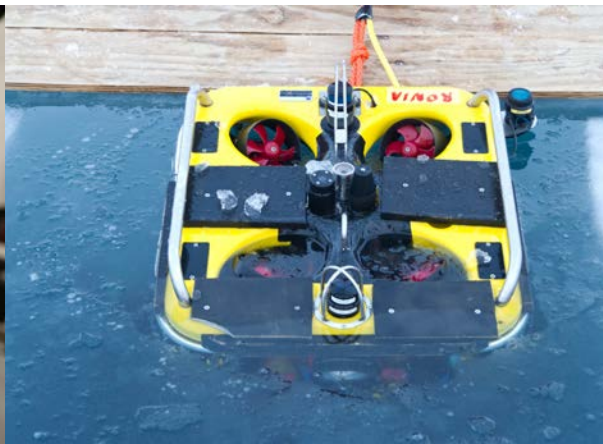
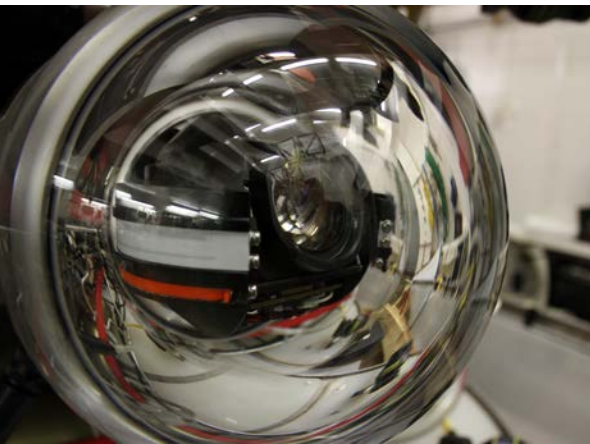


- operated from the ship
- limited maneuverability
- navigation relative to ice
- autonomous capabilities



# Interdisciplinary sensor suite

- Sonars (Altimeter/ Multibeam)
- Cameras (HD/ upward looking)
- Light sensors
- CTD / Fluorometers

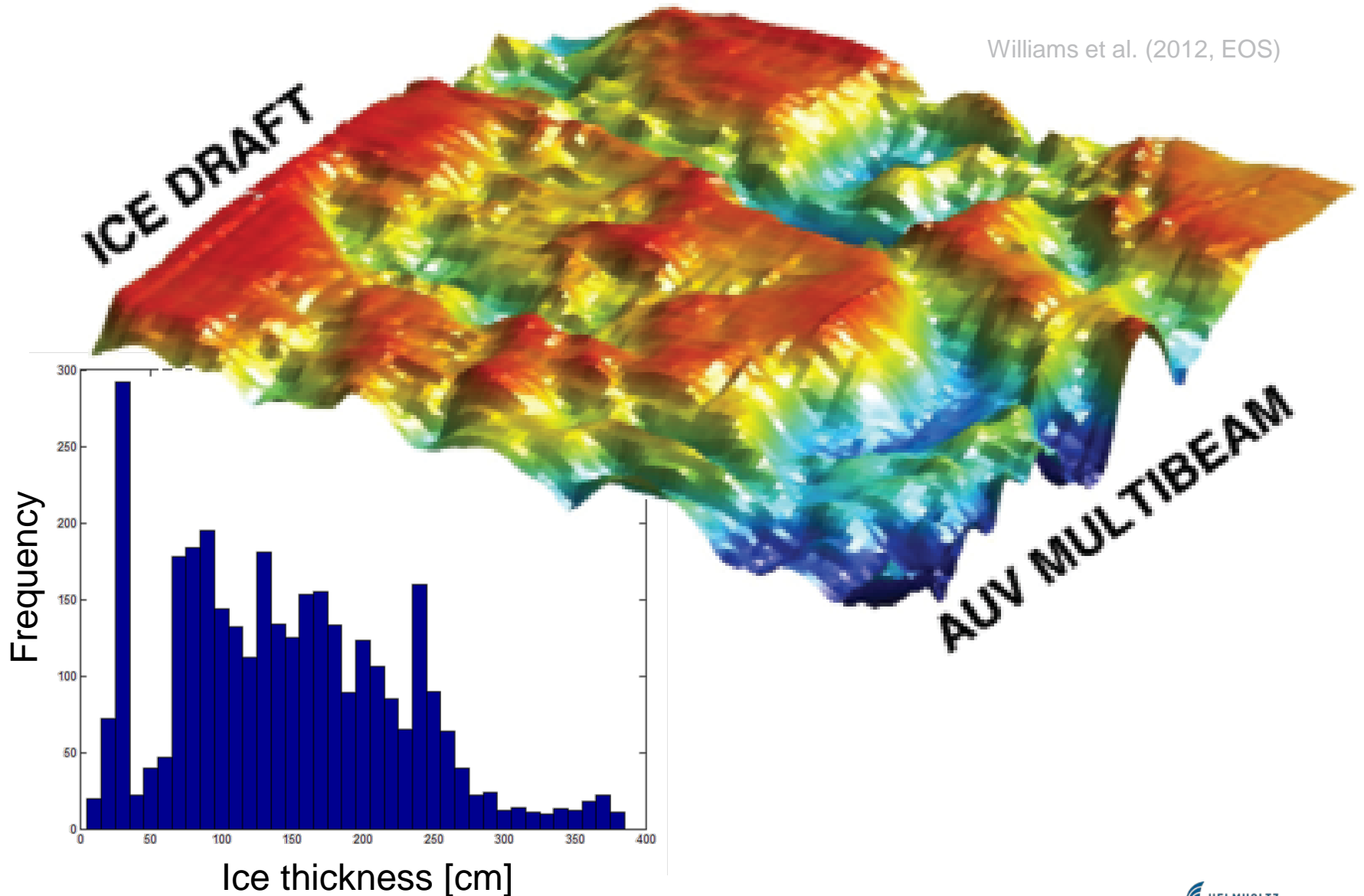


# Under-ice video

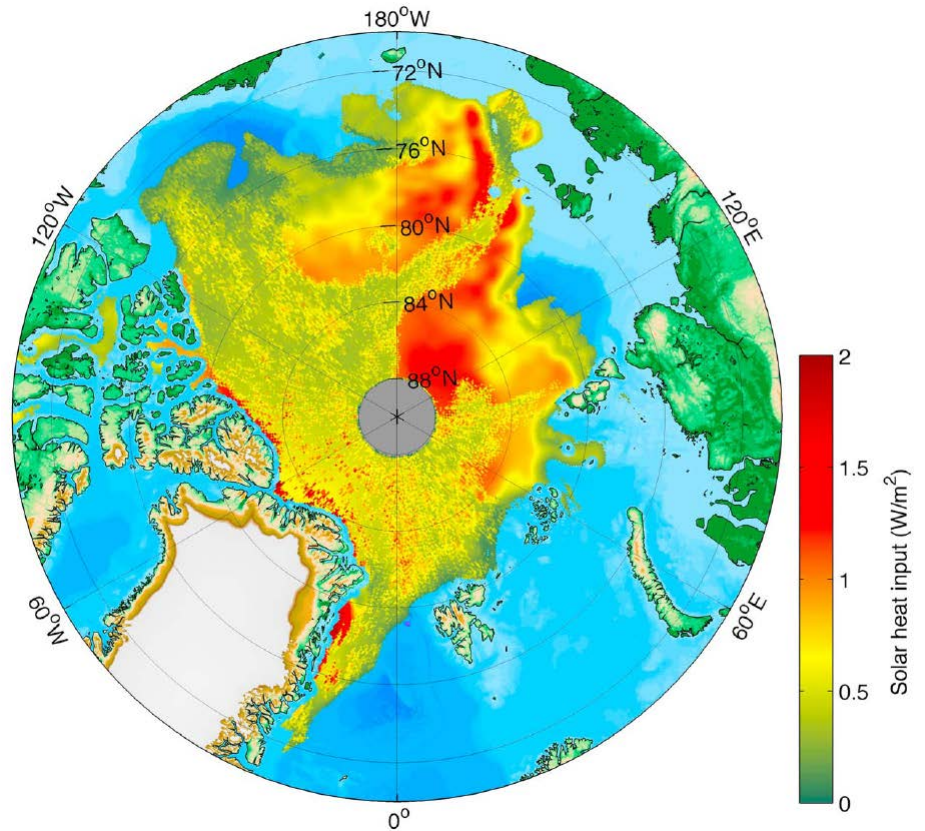
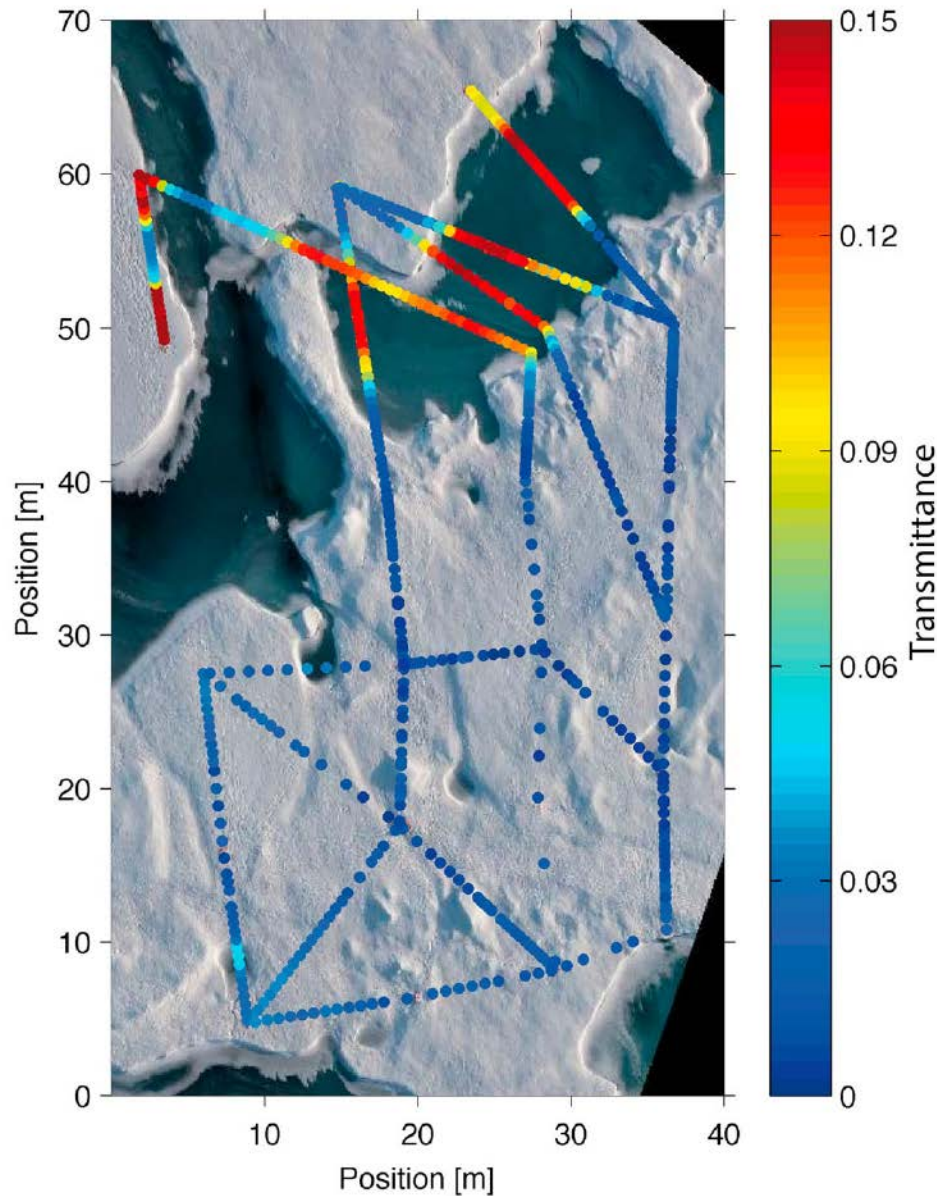


# Sea ice thickness/ topography

Williams et al. (2012, EOS)



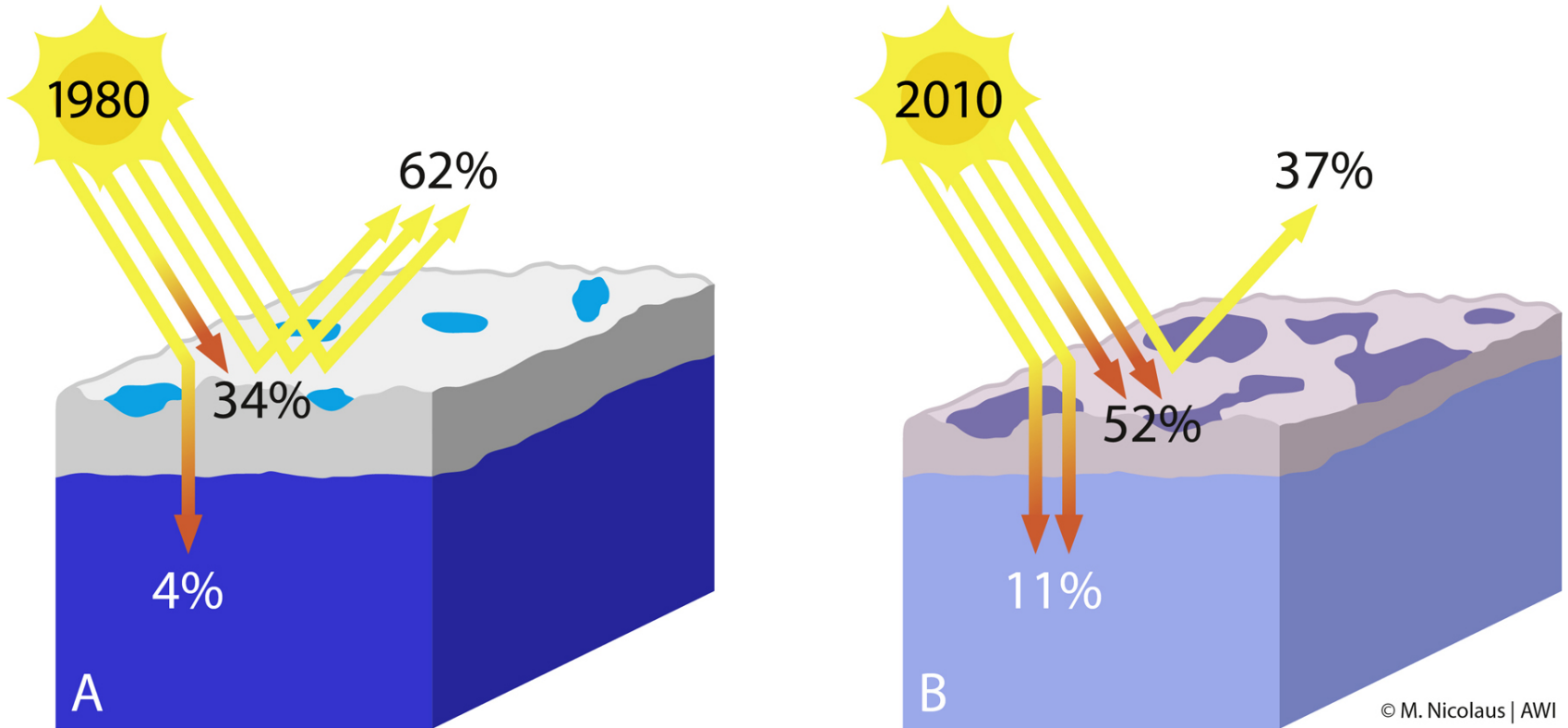
# Mapping of light conditions



Nicolaus et al. (2012, GRL)

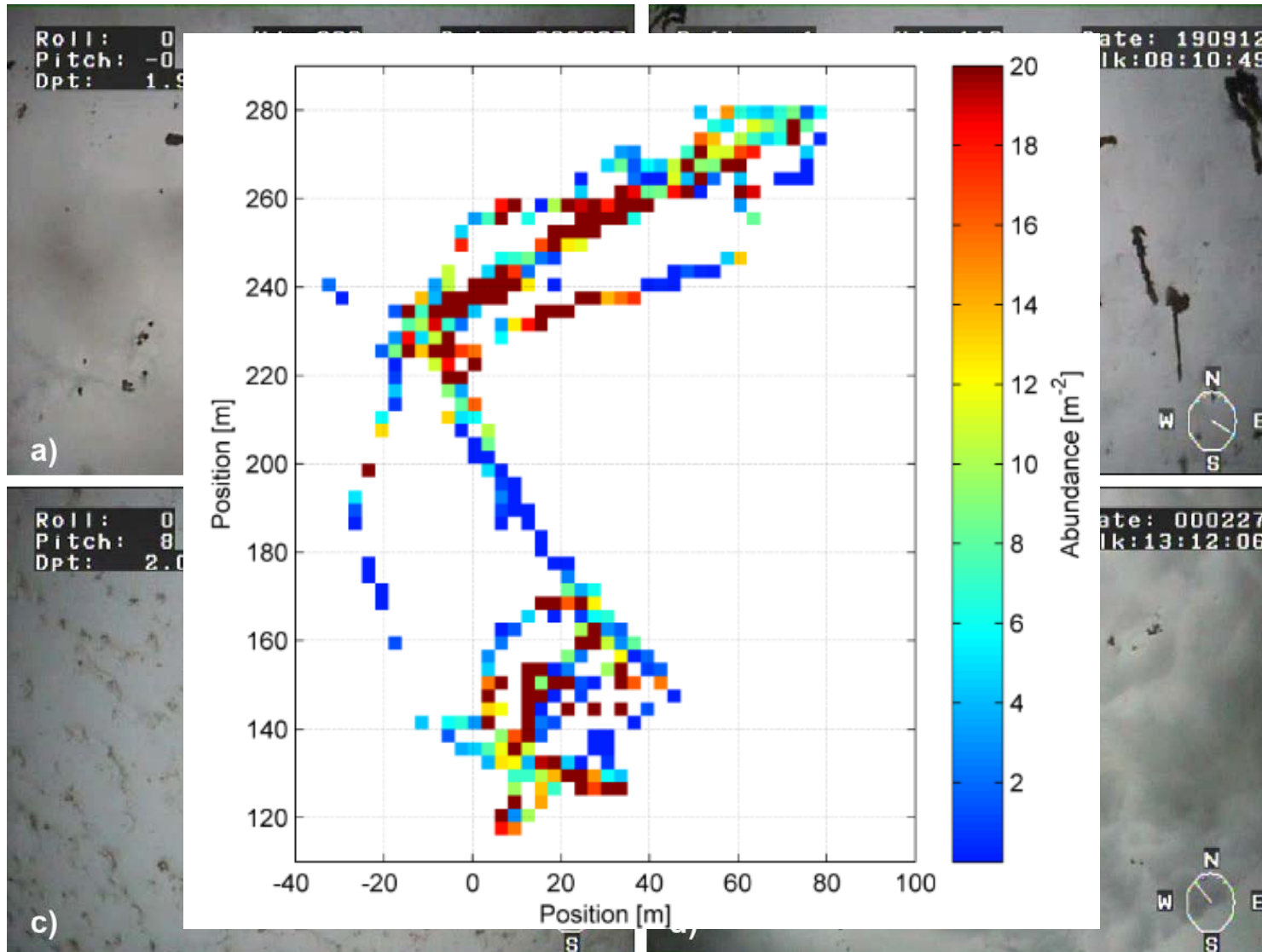


# Increased light availability

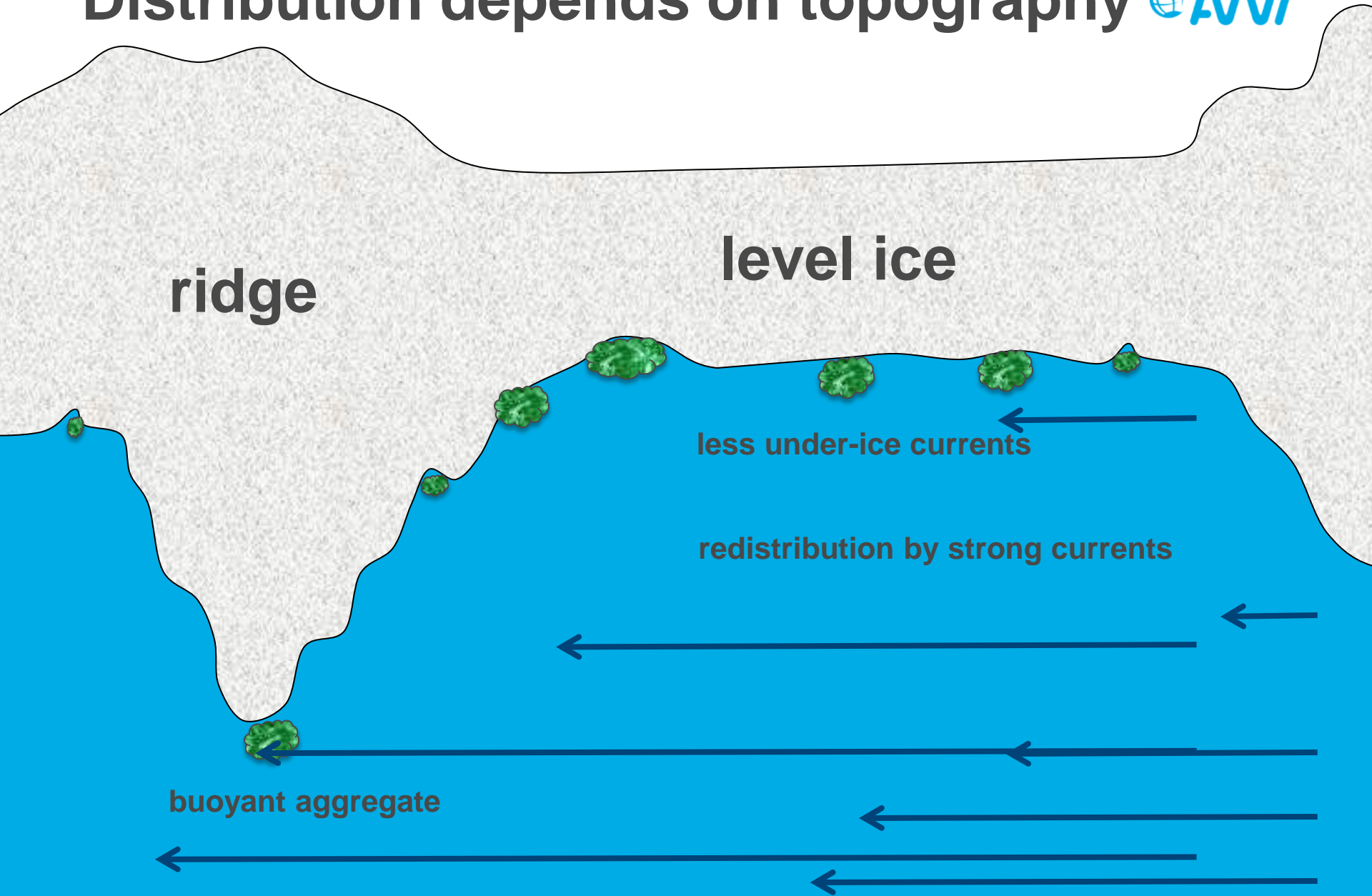


Nowadays **three times more light is transmitted through the ice** than in the 80's

# Quantification of algae



# Distribution depends on topography



ridge

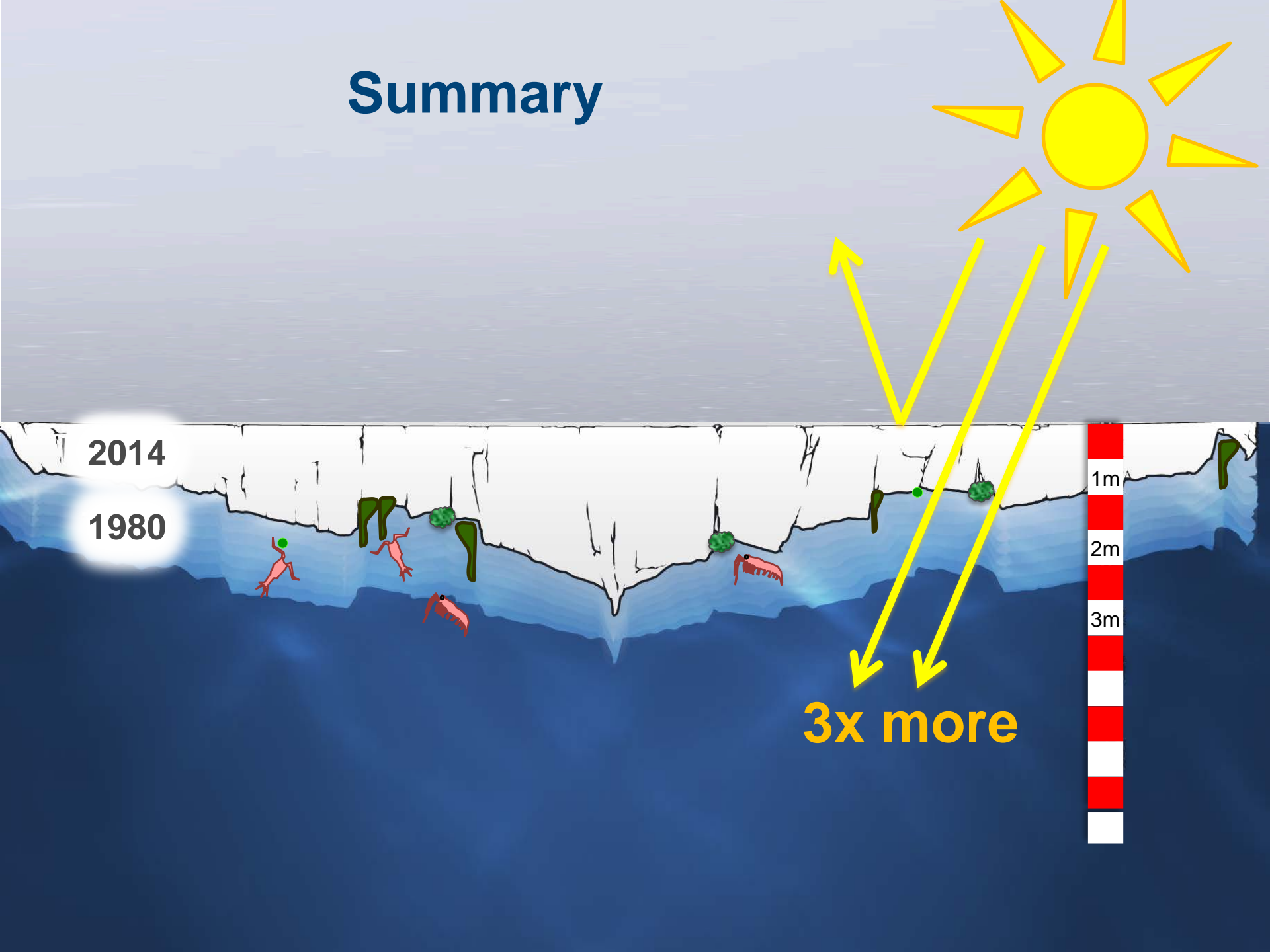
level ice

less under-ice currents

redistribution by strong currents

buoyant aggregate

# Summary





# Questions?

