Why we need to document and understand terrestrial ecosystem change in the New Arctic

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Documenting terrestrial ecosystem changes is critical to understanding and predicting changes in carbon exchange and energy balance across the rapidly changing and consequently New Arctic. As the region warms, the balance of photosynthesis and respiration is likely to shift to respiration and may release old stored carbon from the soils (accumulated over thousands of years) back to the atmosphere (**FIG 1**). As plants become larger with warming (**FIG 2**), less energy is expected to be reflected back to the atmosphere and the region may warm further. As these changes to the physical environment happen, the competitive balance between plant species is expected to change, resulting in earlier development for some species and changes in abundance (**FIG 3**). These changes in the timing of plant development and abundance of plant species are likely to impact herbivore populations and are of importance to the peoples of the region. Therefore, the US funded sites that were originally established as part of the International Tundra Experiment (ITEX; **FIG 4**) in the mid 1990's came together to establish an Arctic Observatory Network (ITEX-AON) in order to document and understand terrestrial ecosystem change across the US Arctic (**FIG 5**).

Release of Stored Carbon

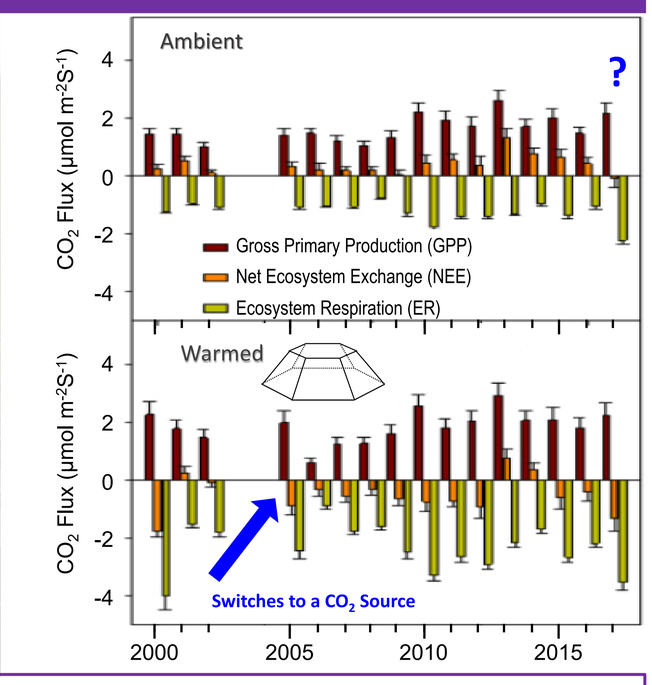

FIG 1 Experimental warming at Utqiaġvik results in a release of carbon from the ecosystem during the summer. Long-term observations suggest that the control plots may be on the cusp of switching from a sink of carbon to a source. These changes have the potential to contribute to climate change.

Increase in Plant Stature

FIG 2 Tundra plants generally grow taller when it is warmer. For example, the inflorescence length of the sedge *Carex aquatilis* shows a clear relationship with temperature (expressed as Thawing Degree Days – calculated by summing the daily temperatures for the growing season). This relationship is consistent across years (each point is the mean of a field season), sites (from cooler Utqiaġvik-blue to warmer Atqasuk-red), and treatments (warmed-open circles and ambient-closed squares).

Changing Vegetation Composition

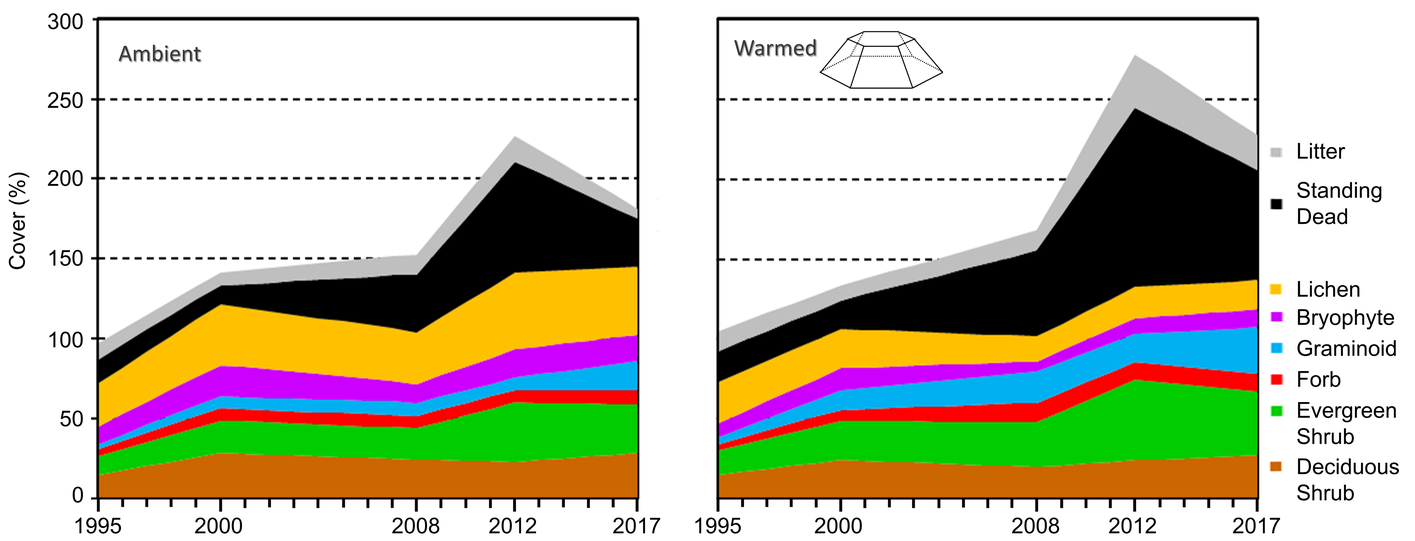

FIG 3 The composition of tundra communities is changing as the region warms as seen by the percent cover of the major plant growth forms at Utqiaġvik. Some of these changes can be attributed directly to warming (such as an increase in shrubs), while others are a result of changes in hydrology, disturbance and herbivore populations which may have direct or indirect linkages with warming. Understanding these complex feedbacks is a major focus of ITEX-AON.

International Tundra Experiment (ITEX)

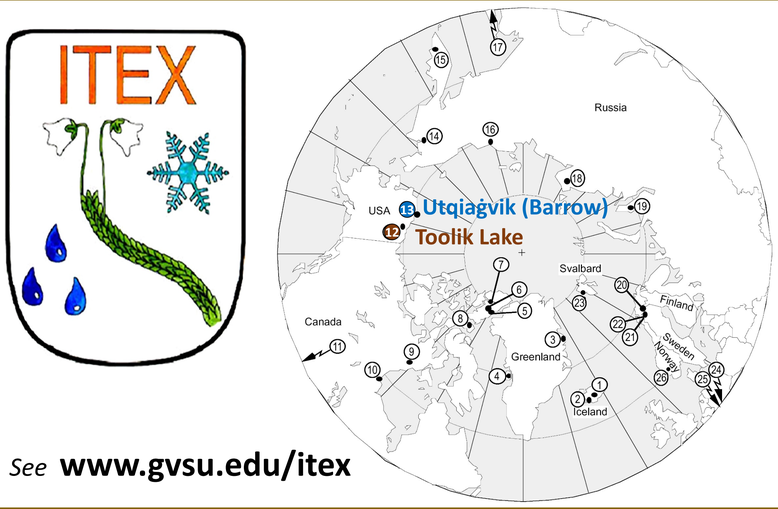

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FIG 4 The US-led sites at Utqiaġvik and Toolik Lake were among the first ITEX sites (both were established in 1994). The focus of ITEX is on understanding ecosystem change across the tundra biome. The power of ITEX is the ability to perform synthesis across many sites due to common protocols.

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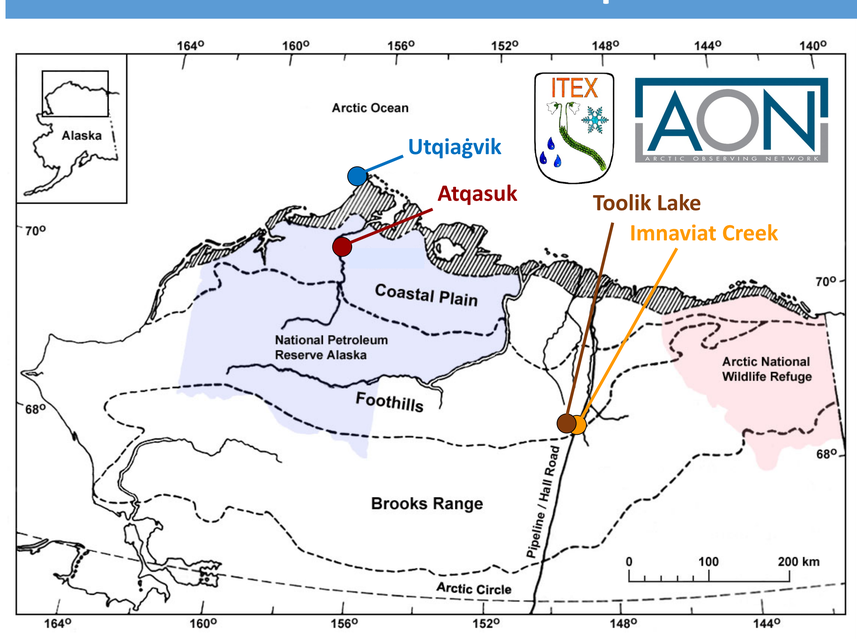
International Tundra Experiment - Arctic Observatory Network (ITEX-AON)



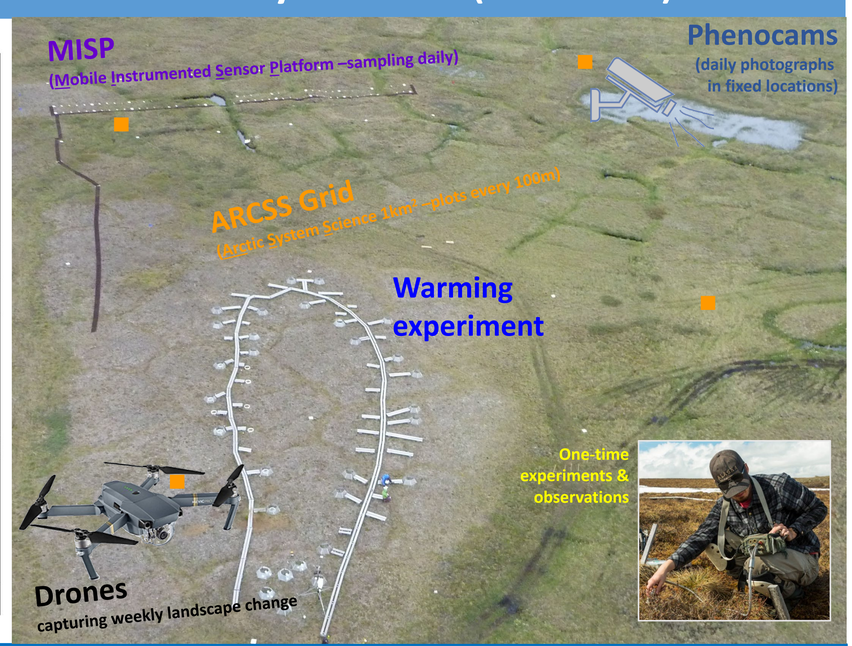


FIG 5 ITEX-AON is a collaborative project between GVSU, FIU, UTEP, and UAA. The field sampling occurs primarily within Arctic System Science (ARCSS) grids established in the early 90s to document ecosystem change at Utqiaġvik, Atqasuk, Imnaviat Creek, and Toolik Lake. Within each ARCSS grid there is an integrated sampling regime which includes plots, a long-term warming experiment, a mobile instrumented sensor platform (run across a 50m transect), drone sampling, fixed phenocams, and many one-time observations or experiments. The project will also synthesize soil carbon and phenocam sampling across the ITEX network and gather information on local community usage of plants. The goal is to identify the drivers of ecosystem change across the landscape and communicate the implications of the observed changes with the public.