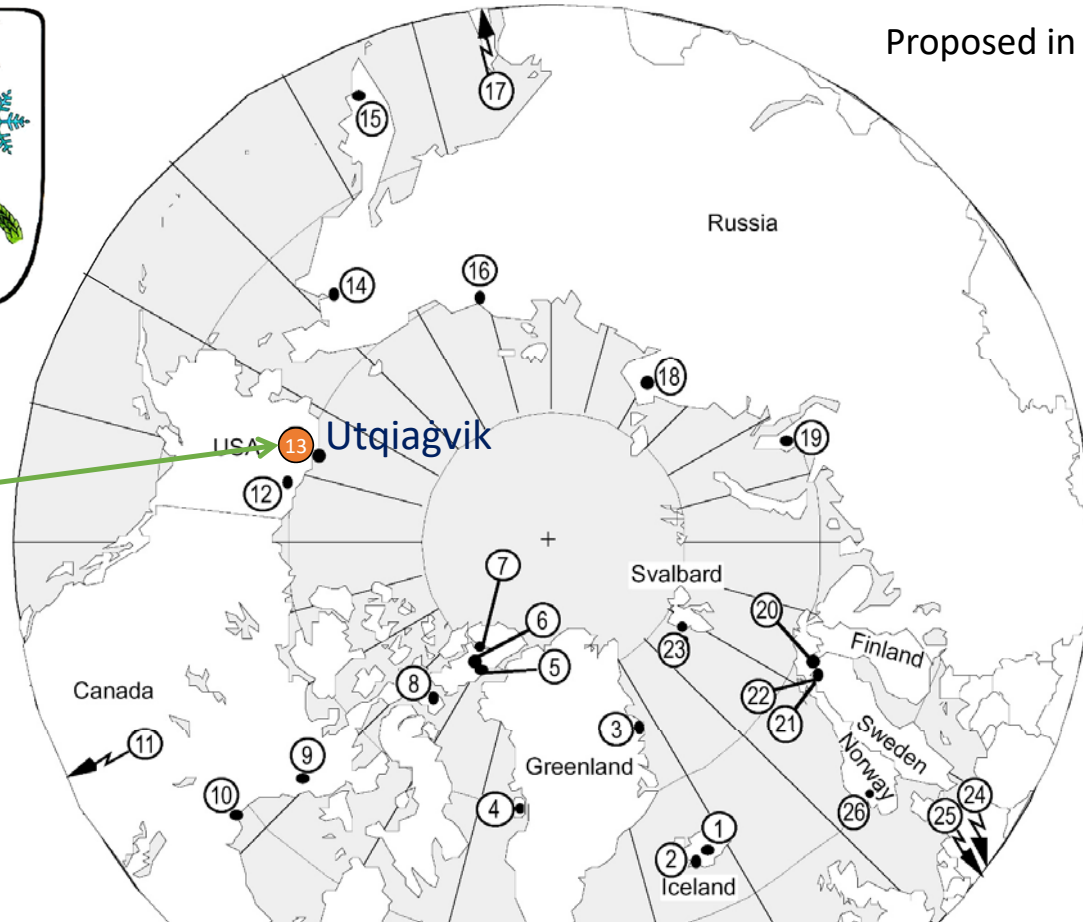


Changes in Vegetation Cover Across the Landscape Over Time at Atqasuk and Utqiagvik, Alaska

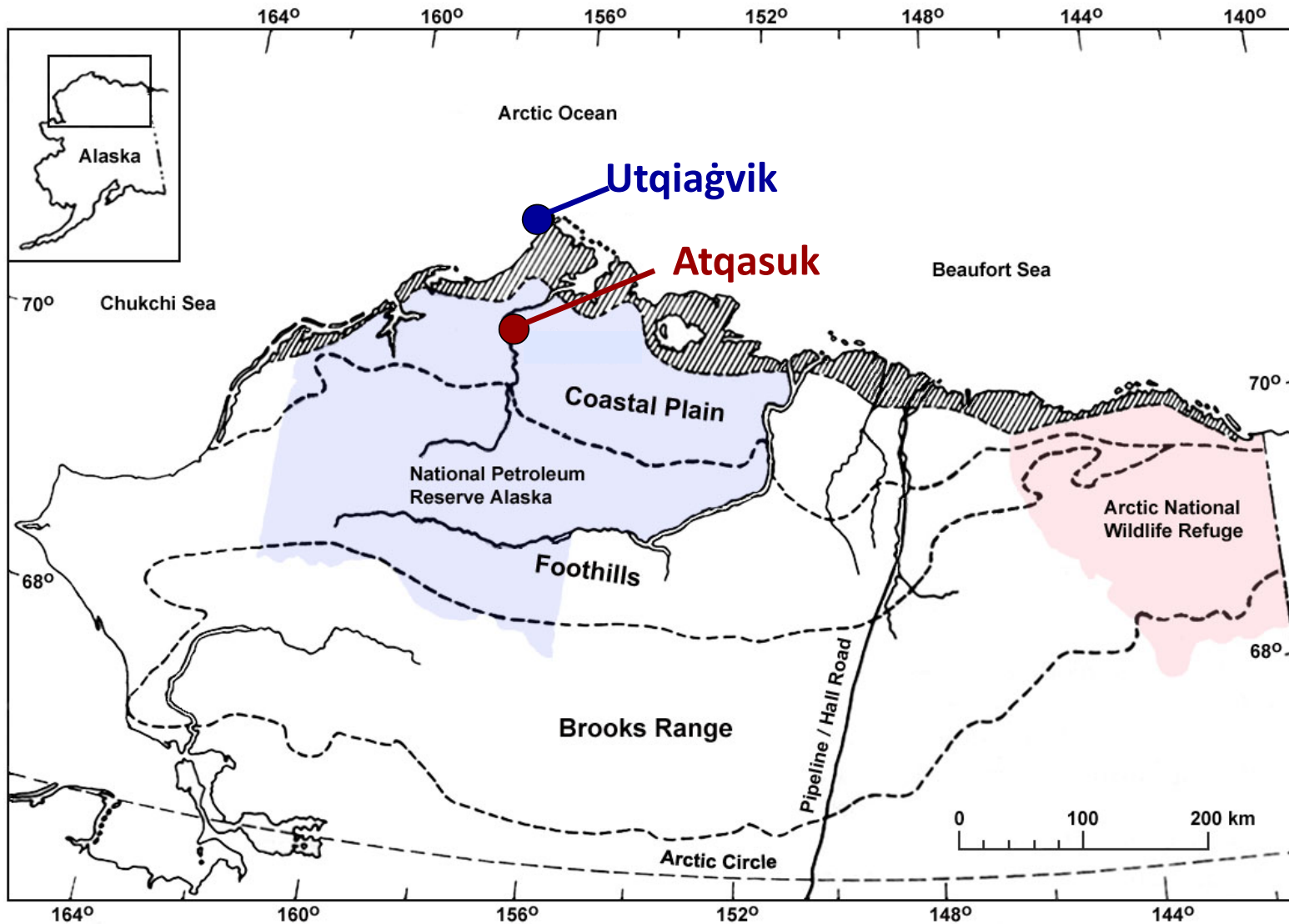
Jacob Harris
Robert Hollister
Grand Valley State University
Arctic Ecology Program
April 25, 2018



Proposed in 1990



The original **I**nternational **T**undra **E**xperiment sites
*agreed on a common warming manipulation
to simulate climate change*



Part of the

Beginning in 2009



Arctic Observatory Network

Collaborative Research: Sustaining and amplifying the ITEX AON through automation and increased interdisciplinarity of observations

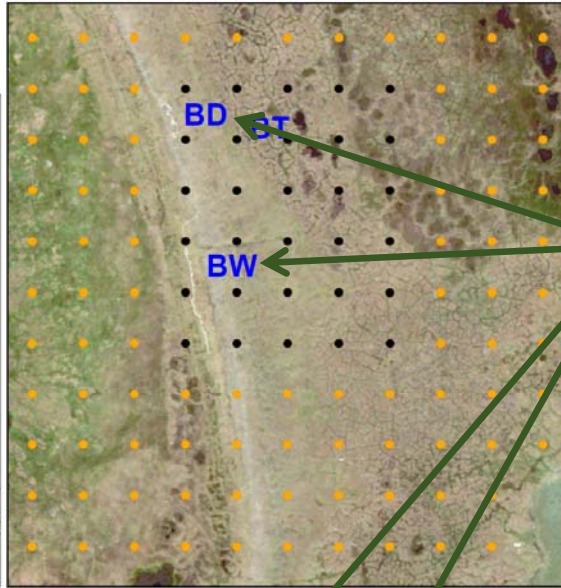
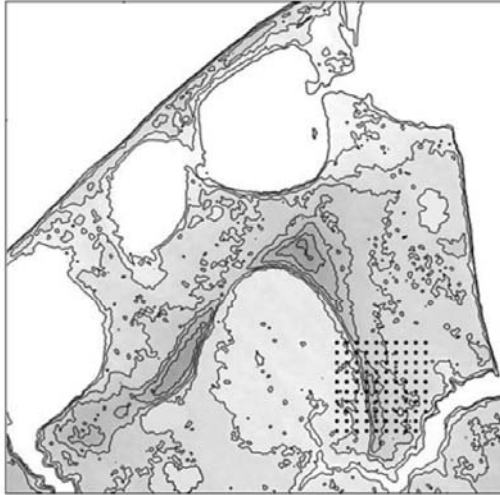
Funding: National Science Foundation

Collaborators:

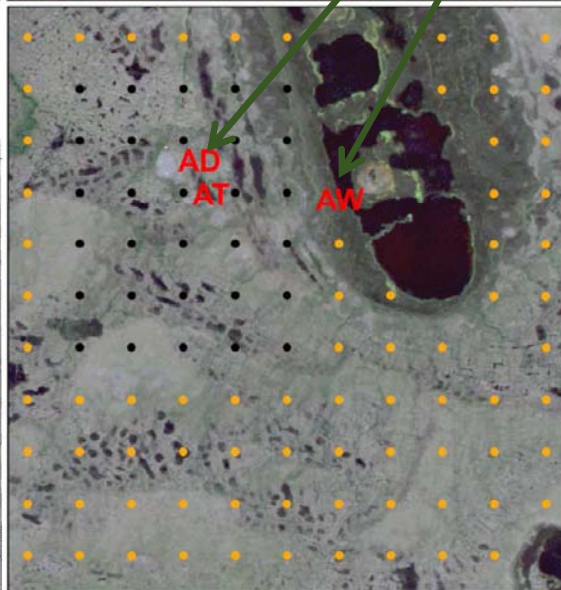
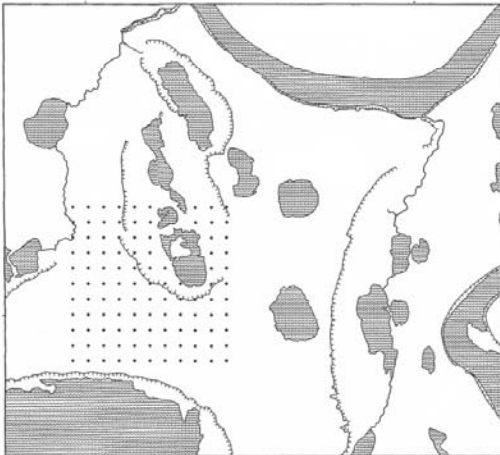
FIU, Florida International University

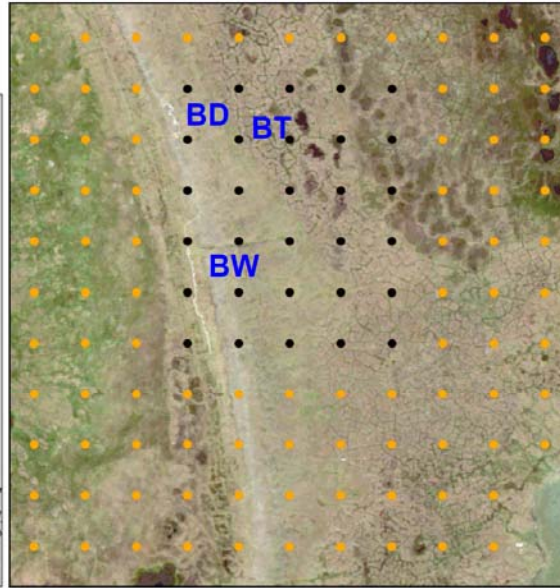
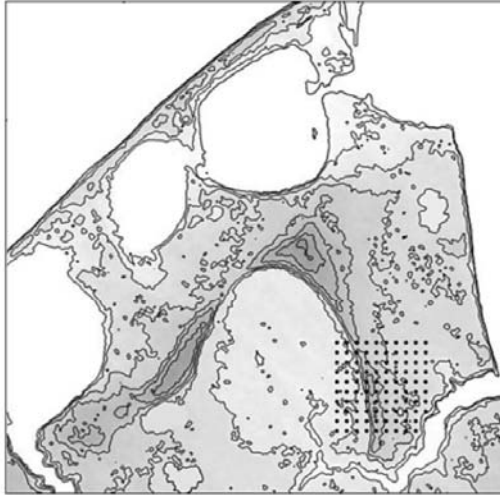
UTEP, University of Texas at El Paso

UAA, University of Alaska at Anchorage



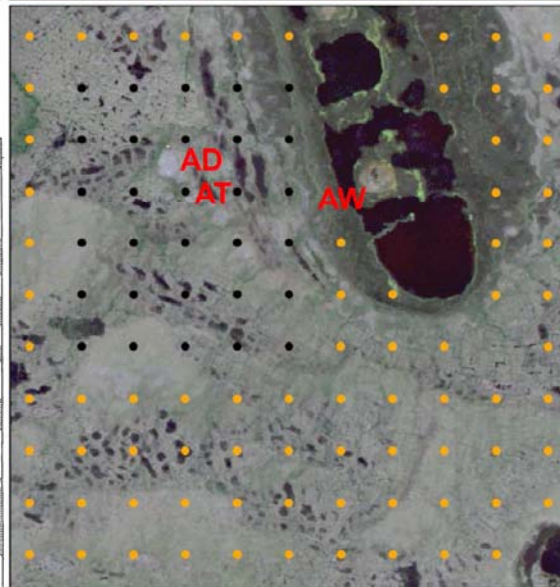
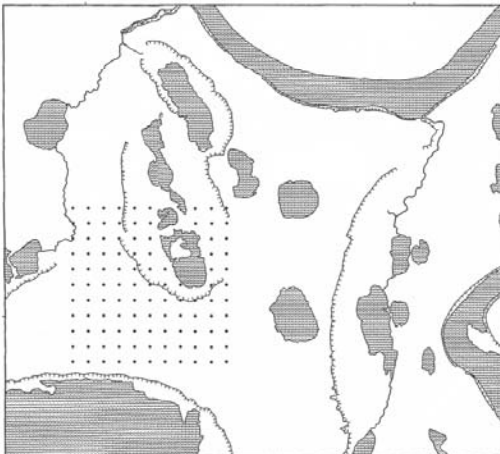
Sites are nested within the Arctic System Science grid (ARCSS)

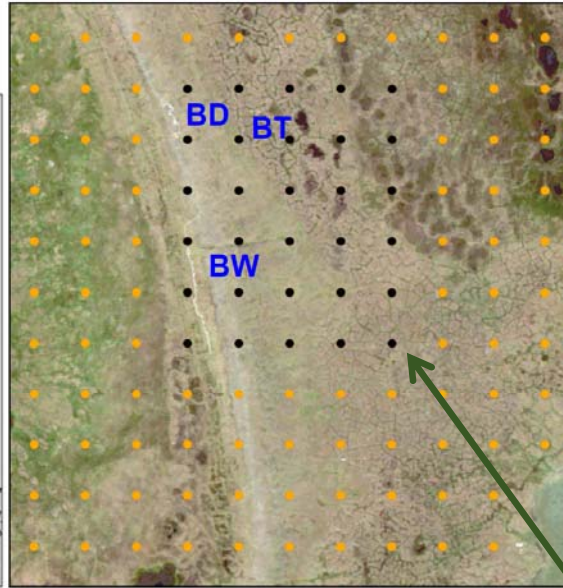




Sites are nested within the Arctic System Science grid (ARCSS)

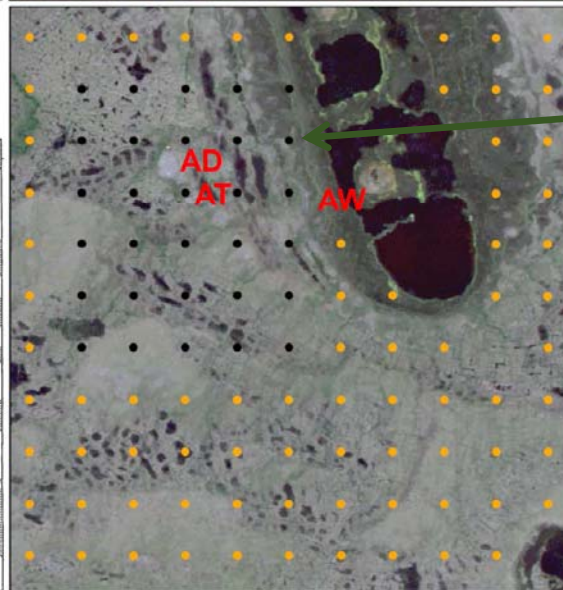
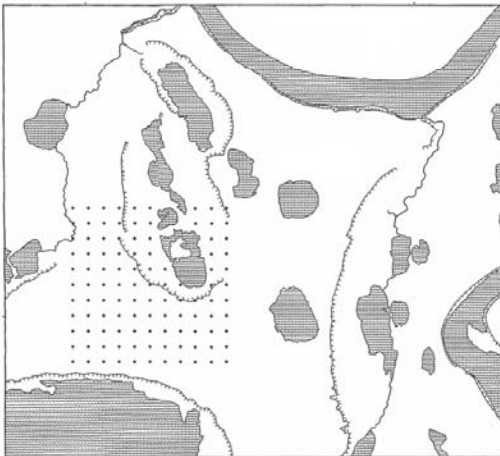
100 point grid
(1 plot every 10 m)
spread across
1 kilometer²



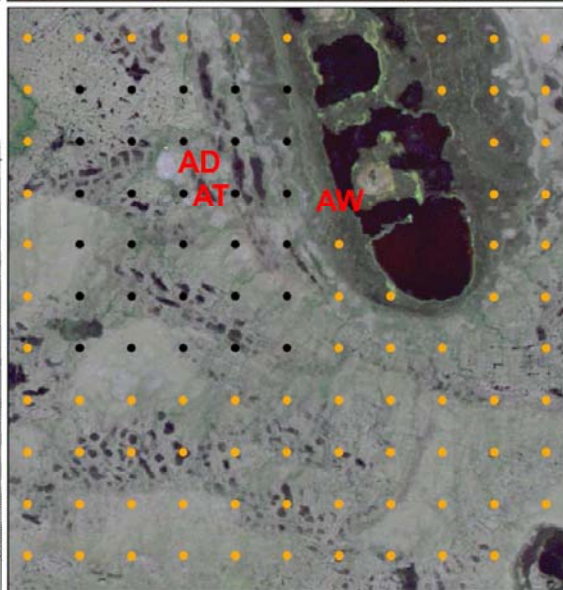
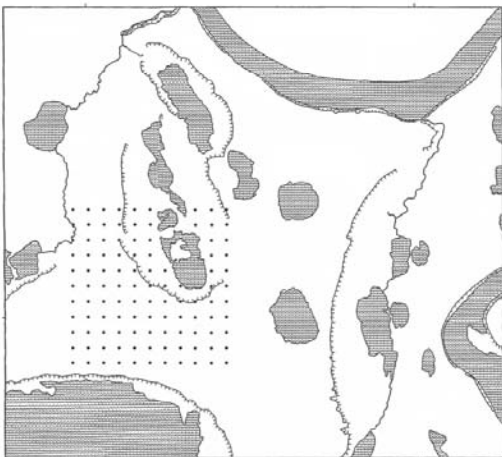
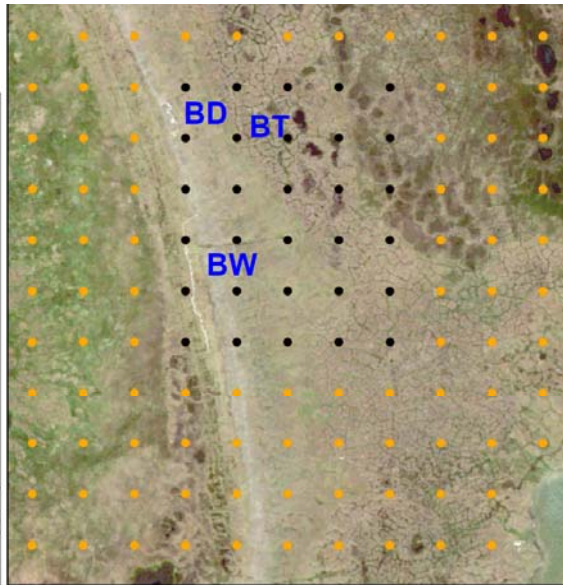


Sites are nested within the Arctic System Science grid (ARCSS)

100 point grid
(1 plot every 10 m)
spread across
1 kilometer²



Black dots represent a subset of the grid (annually sampled)

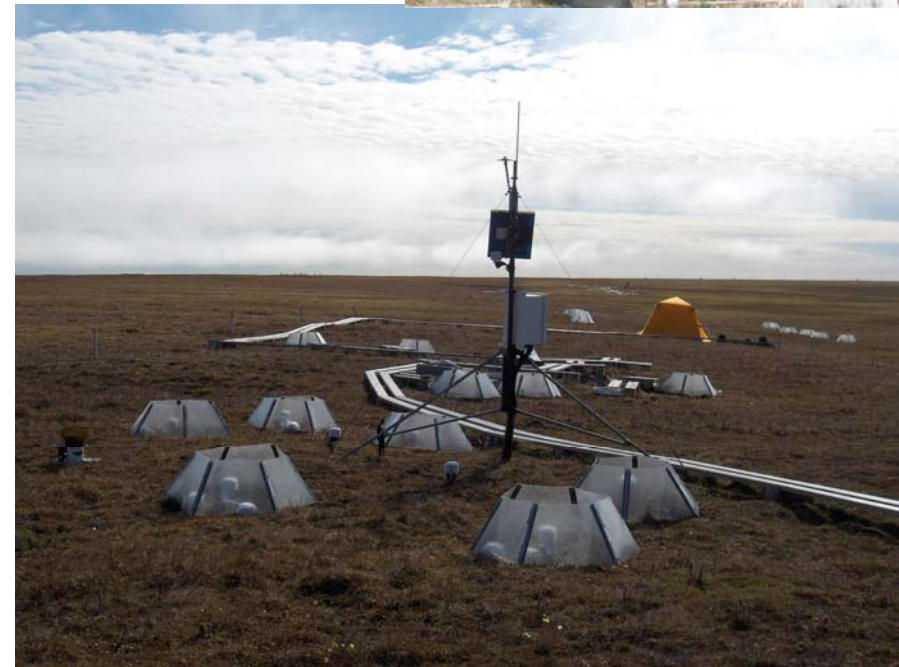


Research Goals

- Does vegetation cover change over time?
- Can vegetation changes be correlated with environmental factors?

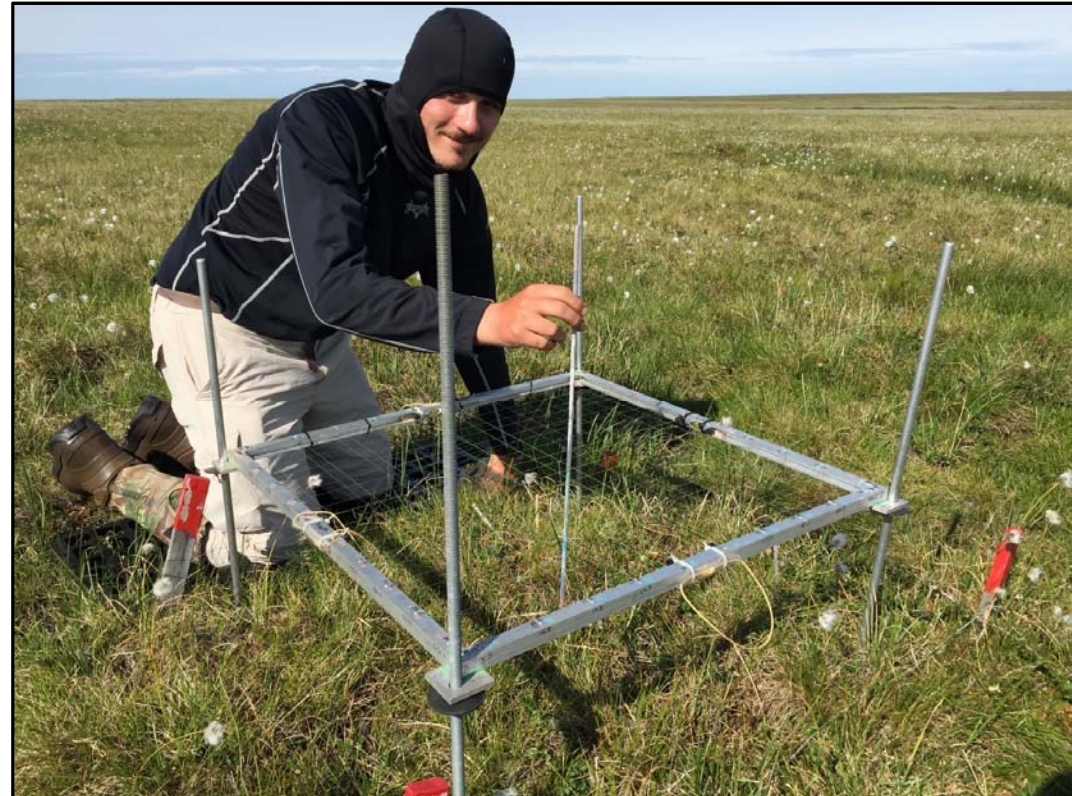
Methods: environmental data

- precipitation
- average air temperature
- thaw depth
- soil moisture
- soil temperature



Methods: vegetation sampling

- 100 point frame placed over each plot and aligned with permanently placed markers.
- All plant hits recorded
- Sampling was done within a two week window, relative to the very first ever date of sampling
- Ensures consistent sampling window



Methods: vegetation sampling

- All species are used
- Vascular plants identified to species
- Non-vascular organisms identified to genus
- Plants were lumped by growth form
- Standing dead and litter counted as separate groupings

Deciduous shrubs

- DSHR (*Betula nana*, *Salix pulchra*, *Salix rotundifolia*, and *Salix Polar*)



Evergreen shrubs

- ESHR (*Vaccinium vitis-idaea*, *Cassiope tetragona*, *Ledum palustre*, *Empetrum nigrum*)



Forbs



- FORB (*Potentilla hyparctica*, *Saxifraga* spp., *Ranunculus* spp. *Petasites frigidus*, *Papaver hultenii*, *Pedicularis* spp.)

Graminoids



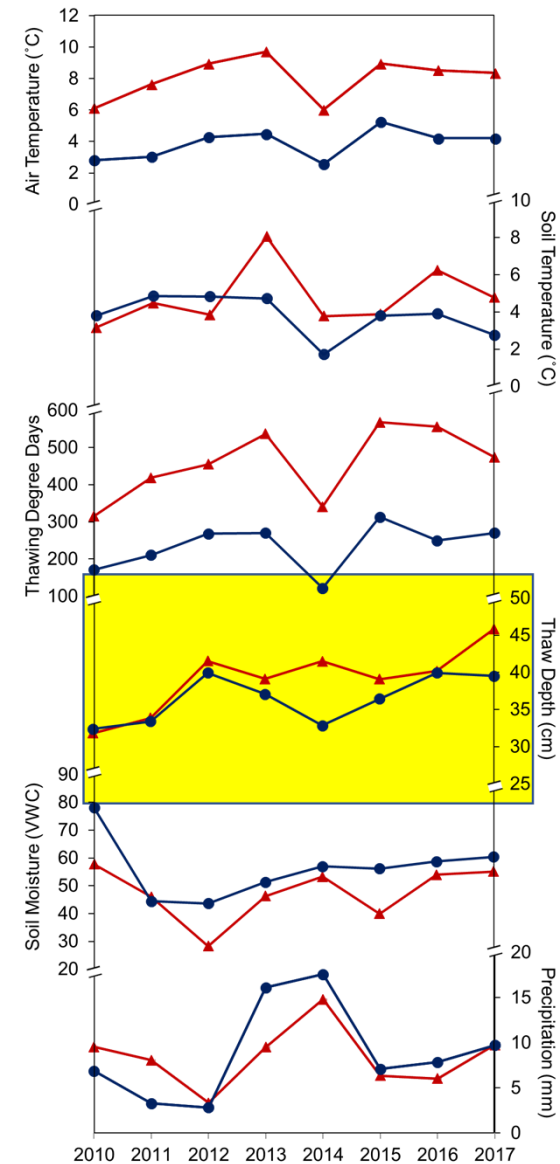
- GRAM (*Poa Arctica*, *Arctagrostis latifolia*, *Arctophila fulva*, *Alopecurus alpinus*, *Luzula arctic*, *Luzula confuse*, *Hierochloe alpina*, *Hierochloe pauciflora*, *Carex aquatilis*, *Carex rotundata*, *Carex stans*, *Eriophorum angustifolium*, *Eriophorum vaginatum*, *Eriophorum russeolum*)

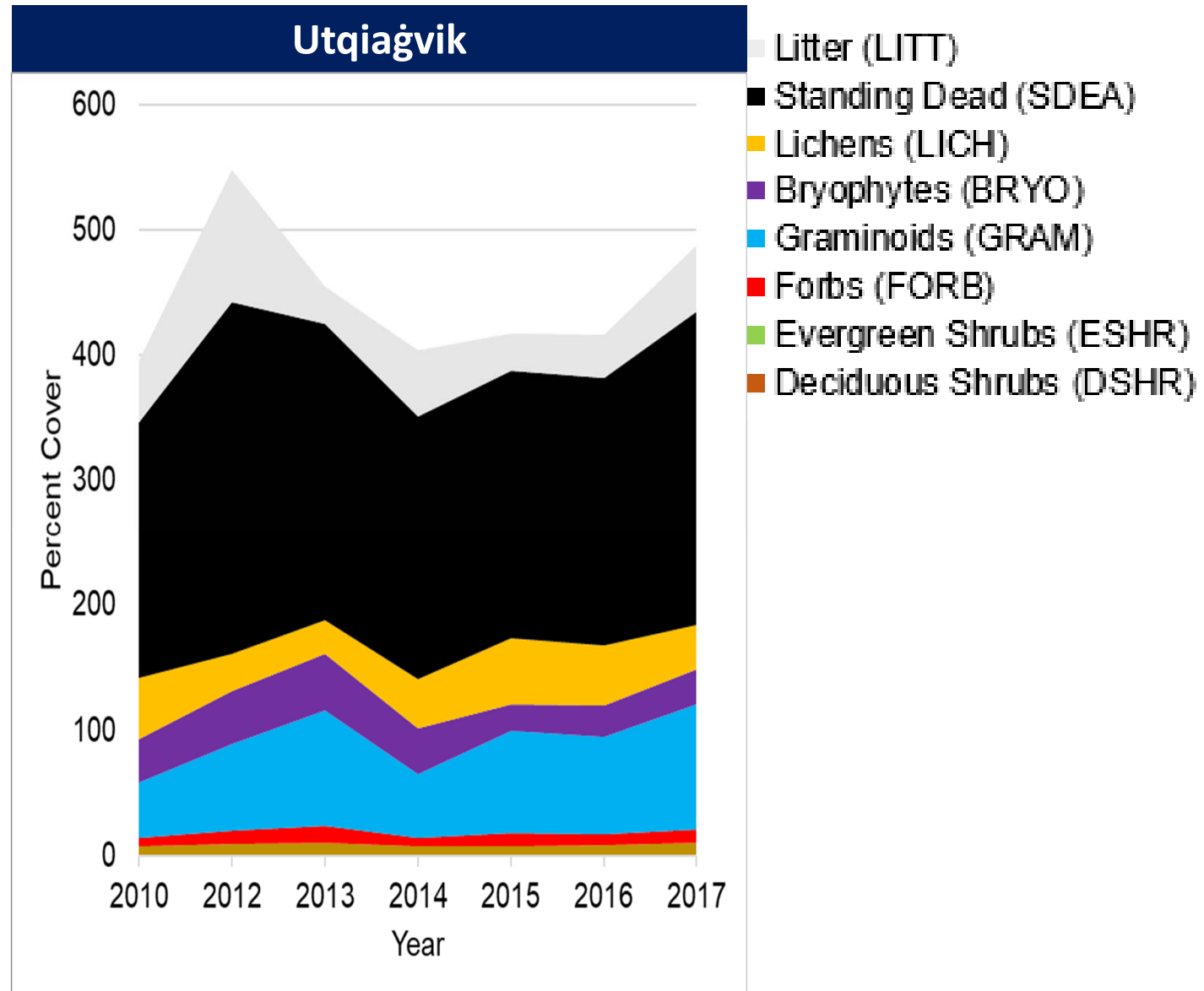
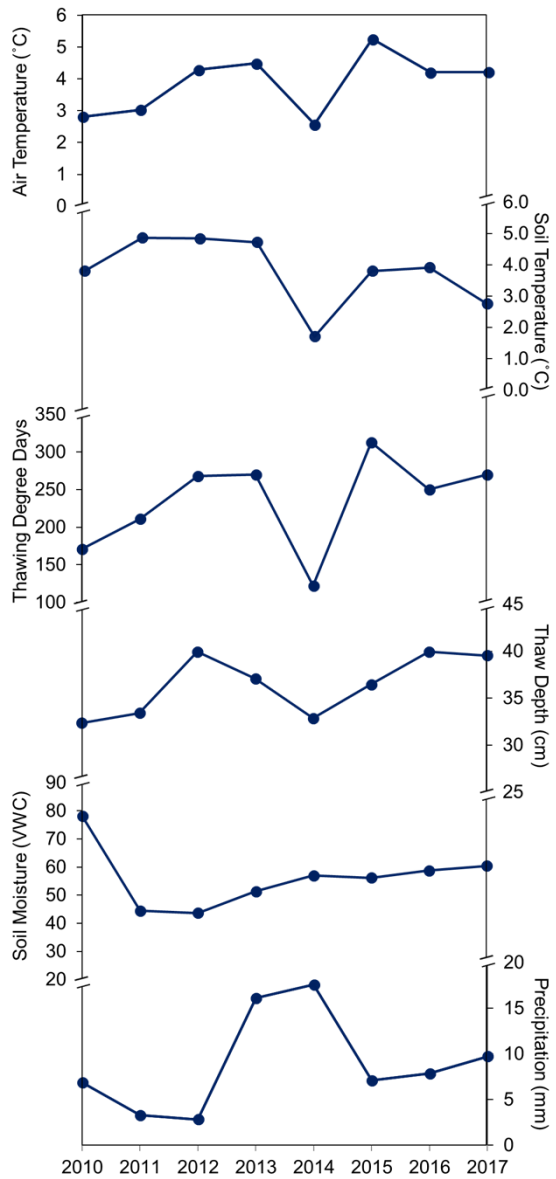
Methods: statistical analysis

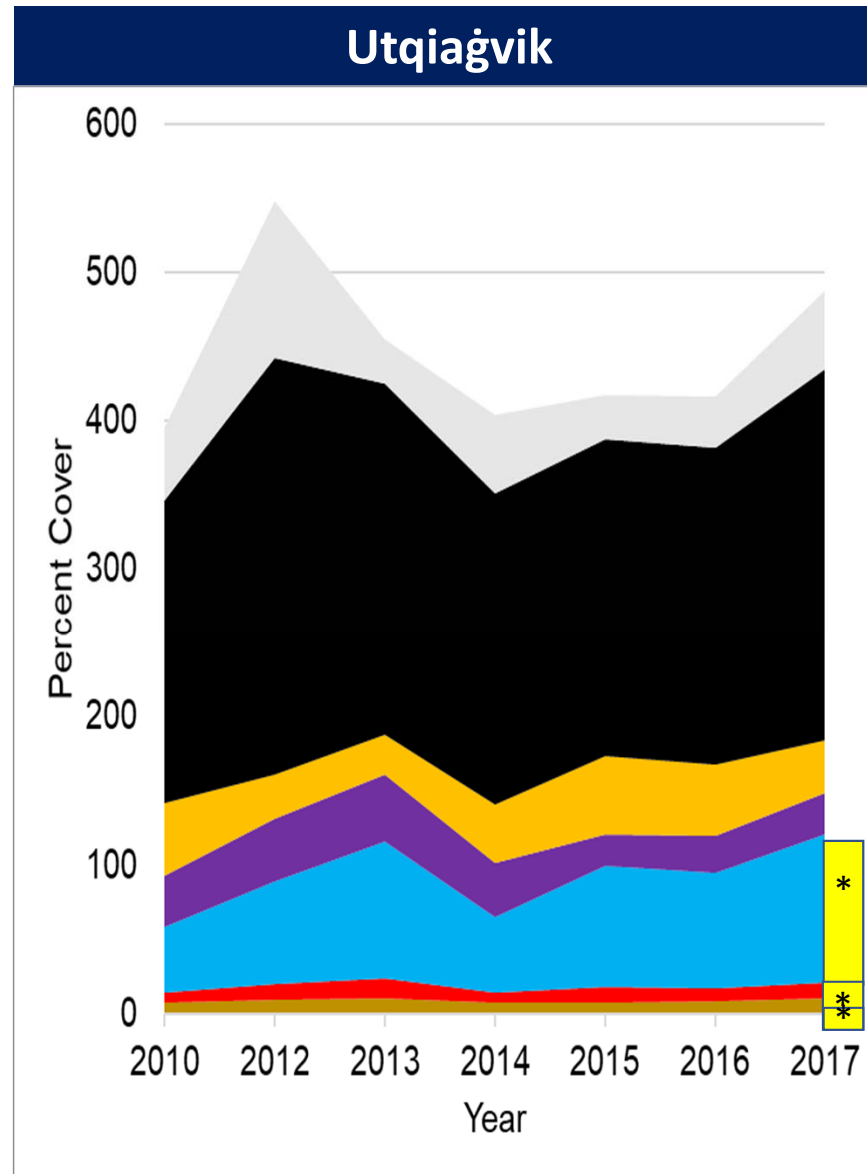
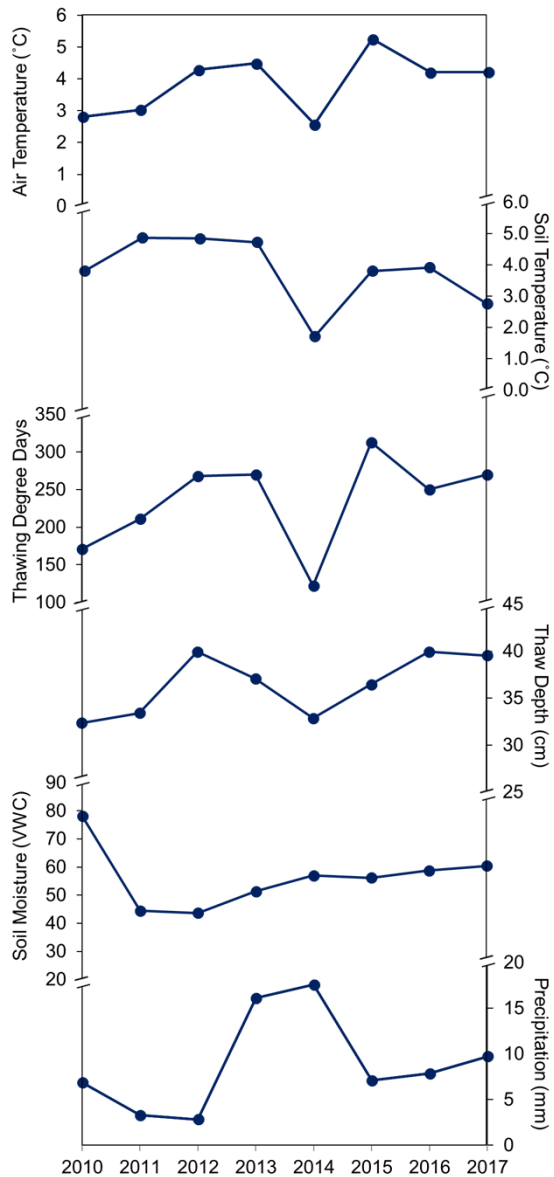
- Shapiro-Wilks normality test; data fit assumption of normality
- R^2 values obtained through simple linear regression
 - Includes relationships within the broad growth forms and between growth forms and environmental variables:

Results and Discussion: environmental data

- Only statistically significant trend was in Atqasuk thaw depth
- Red = Atqasuk
- Blue = Utqiagvik

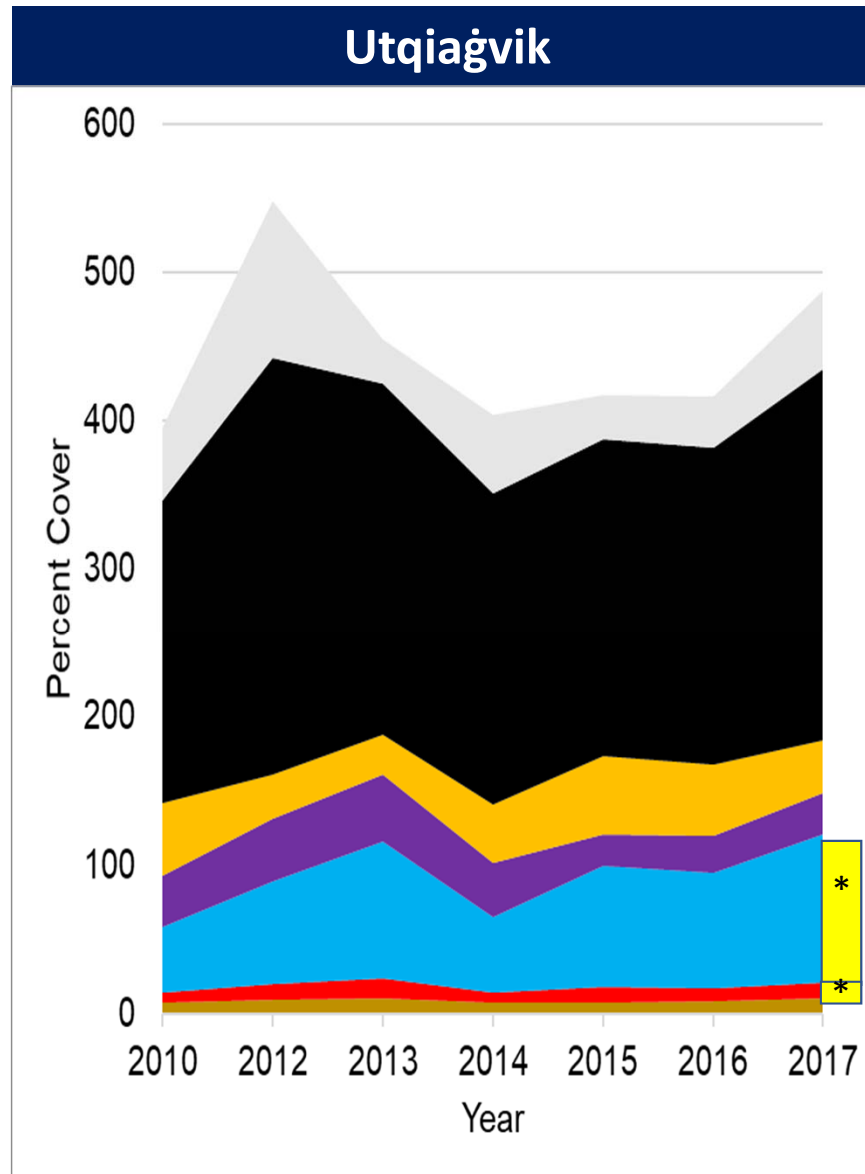
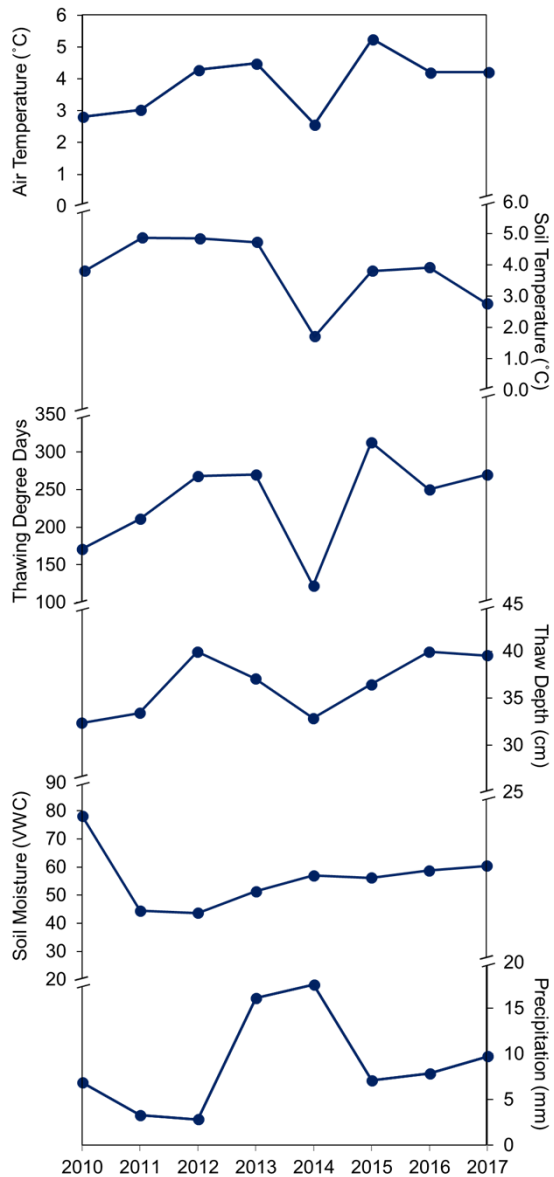






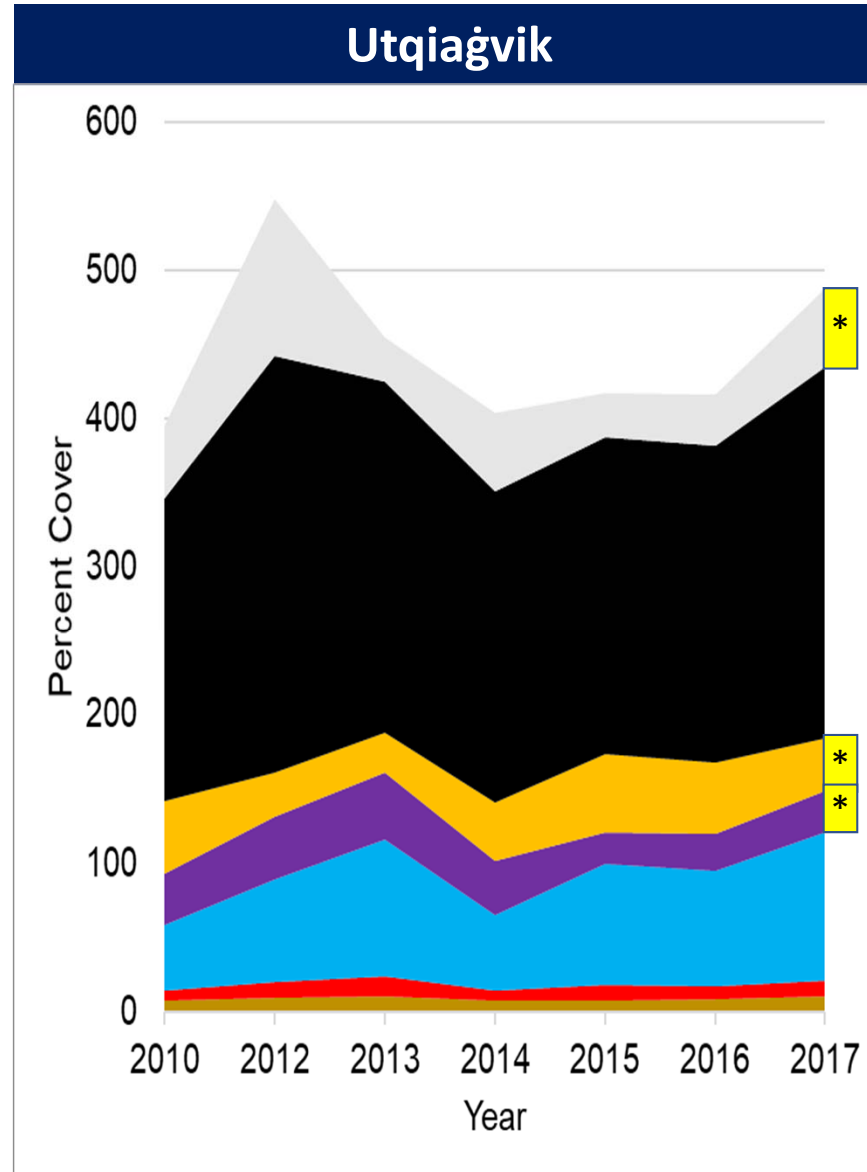
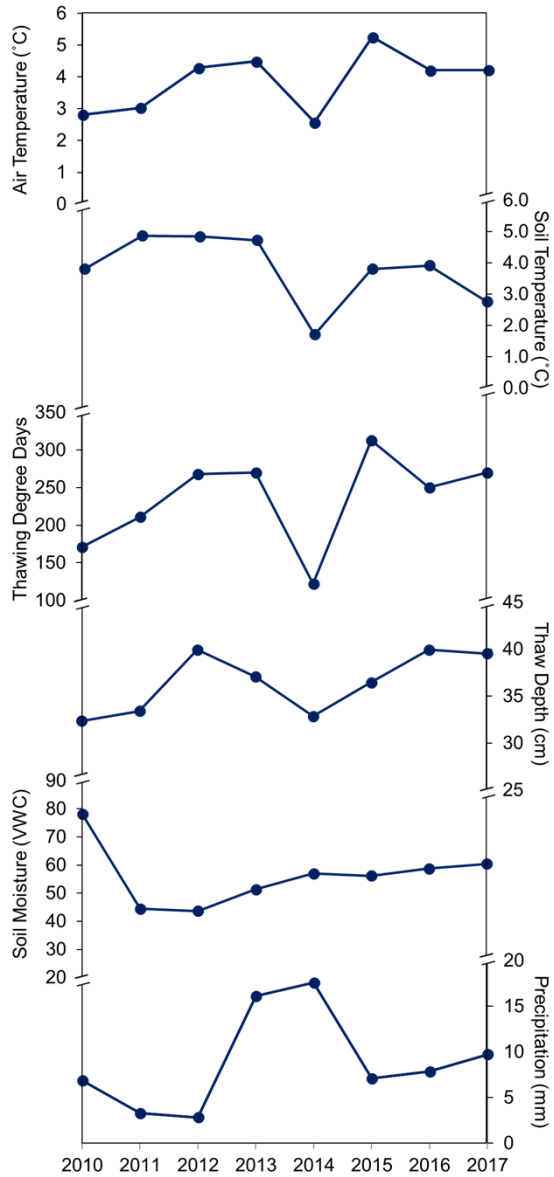
- Litter (LITT)
- Standing Dead (SDEA)
- Lichens (LICH)
- Bryophytes (BRYO)
- Graminoids (GRAM)
- Forbs (FORB)
- Evergreen Shrubs (ESHR)
- Deciduous Shrubs (DSHR)

Deciduous shrubs correlate with graminoids and forbs ($R^2=0.72$, $p=0.02$ and $R^2=0.63$, $p=0.03$)



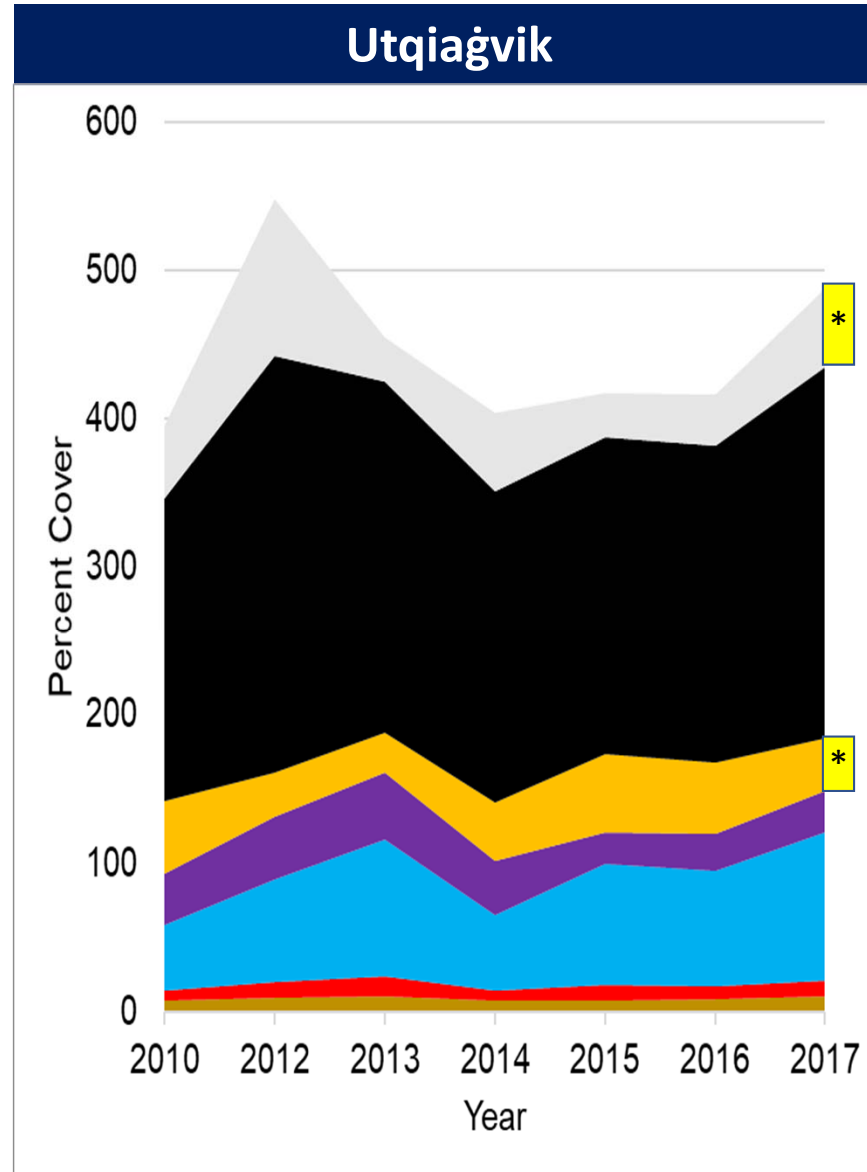
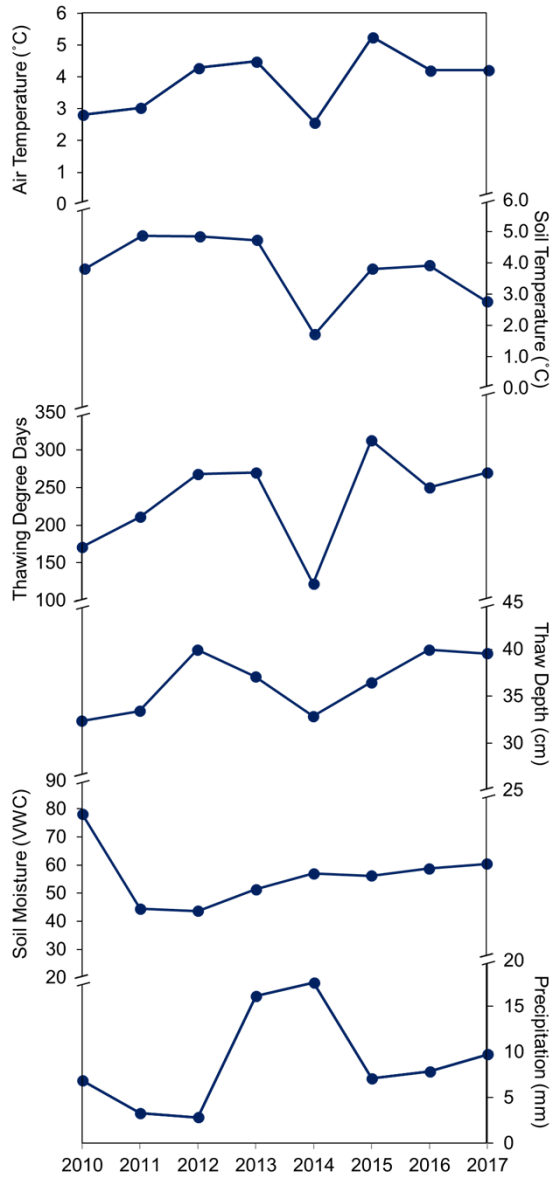
- Litter (LITT)
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- Lichens (LICH)
- Bryophytes (BRYO)
- Graminoids (GRAM)
- Forbs (FORB)
- Evergreen Shrubs (ESHR)
- Deciduous Shrubs (DSHR)

Forbs and
graminoids
correlate ($R^2=0.65$,
 $p=0.03$)



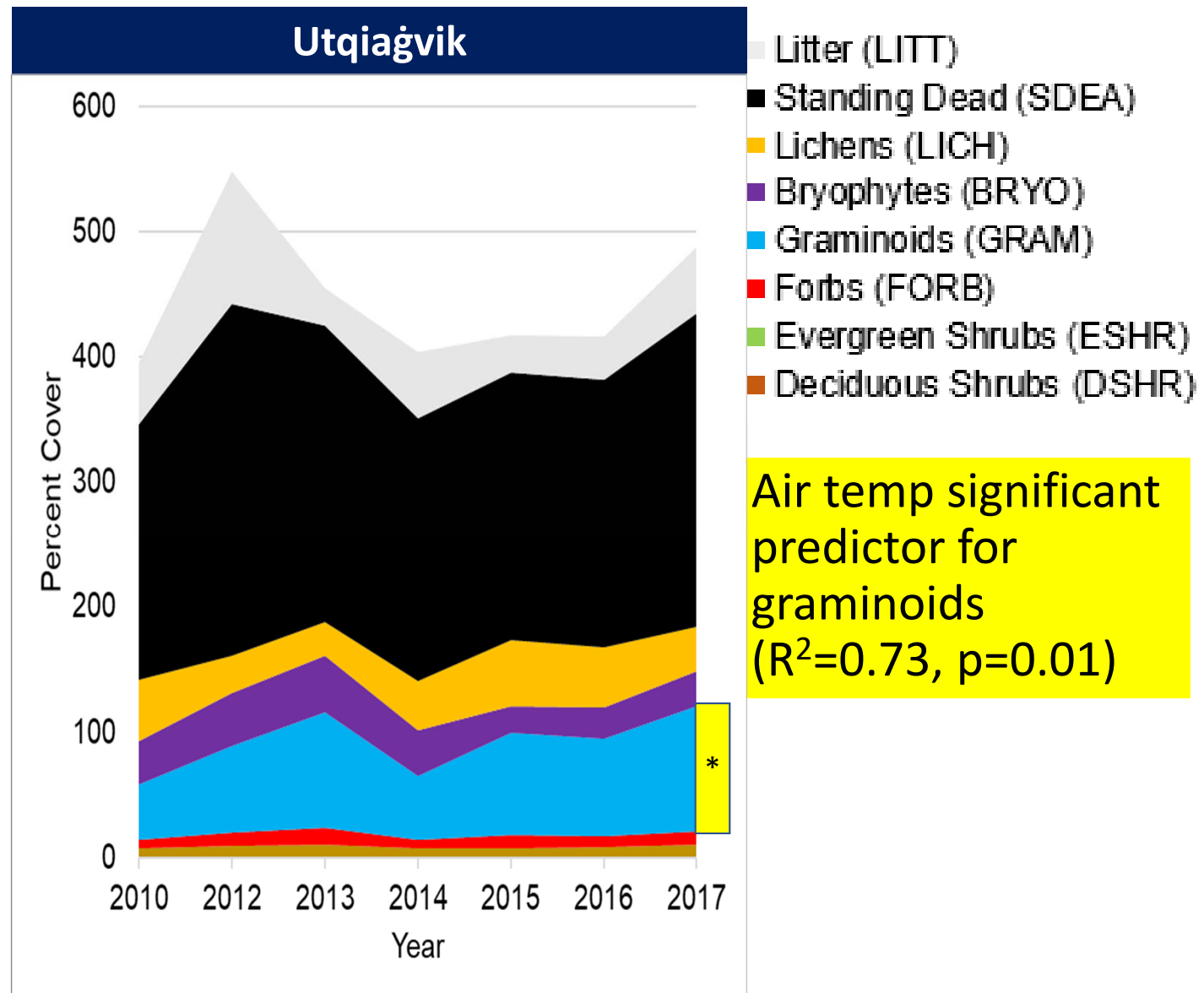
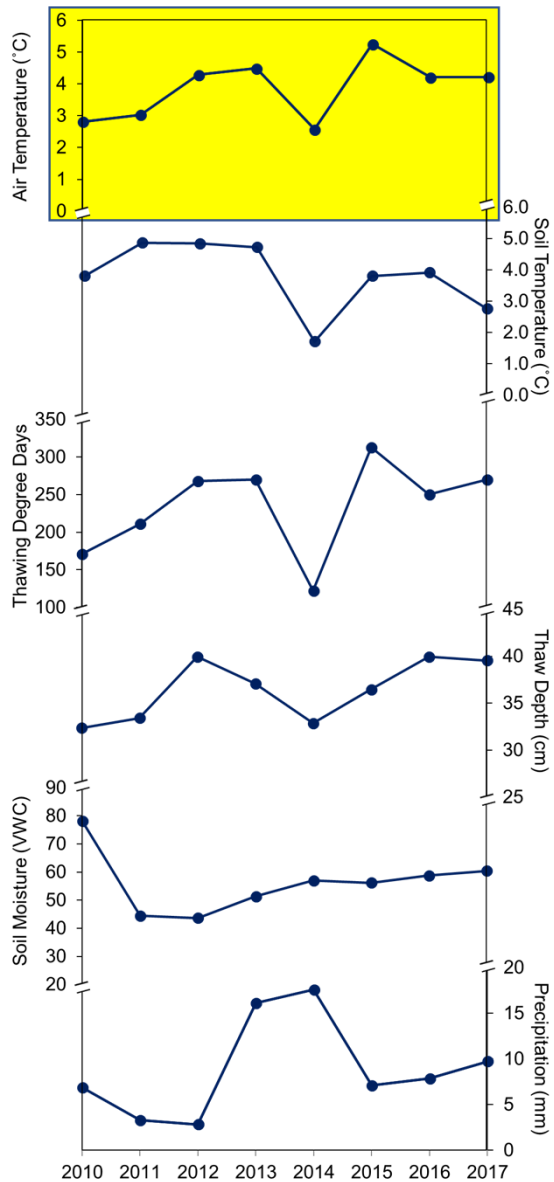
- Litter (LITT)
- Standing Dead (SDEA)
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- Graminoids (GRAM)
- Forbs (FORB)
- Evergreen Shrubs (ESHR)
- Deciduous Shrubs (DSHR)

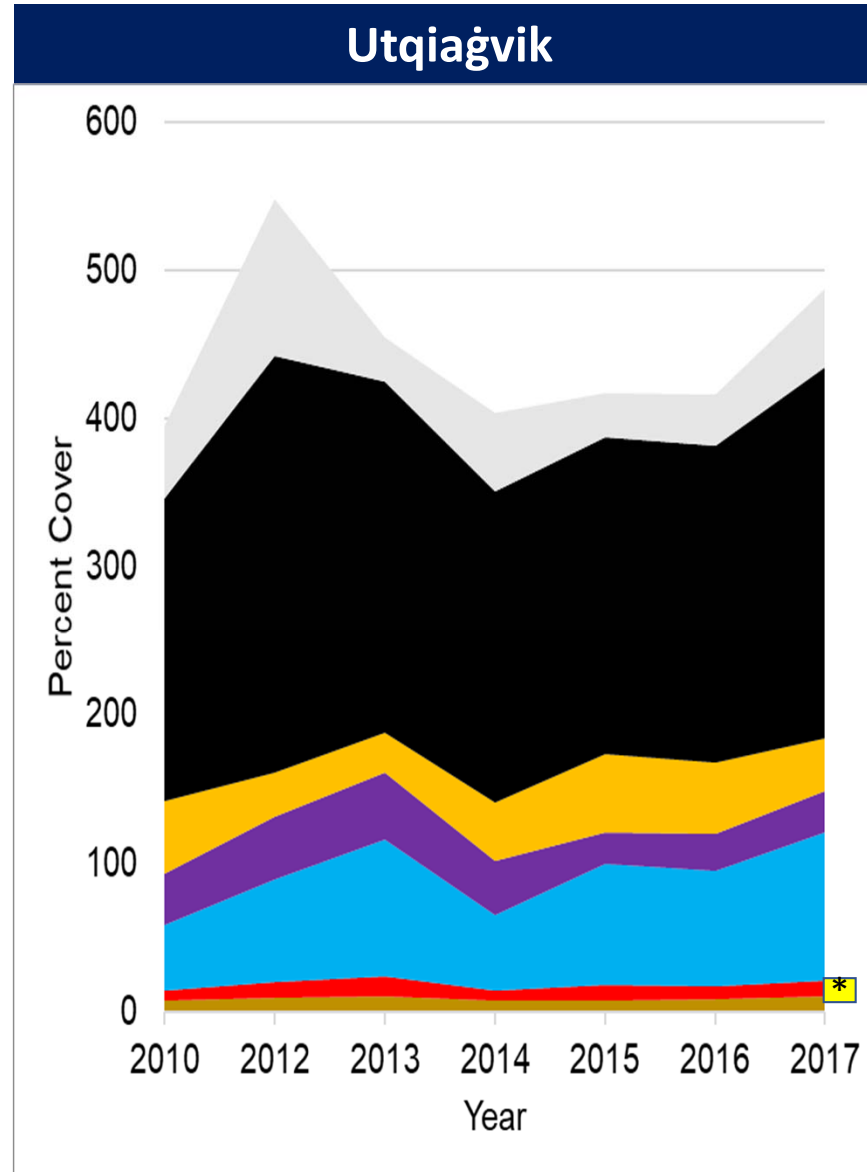
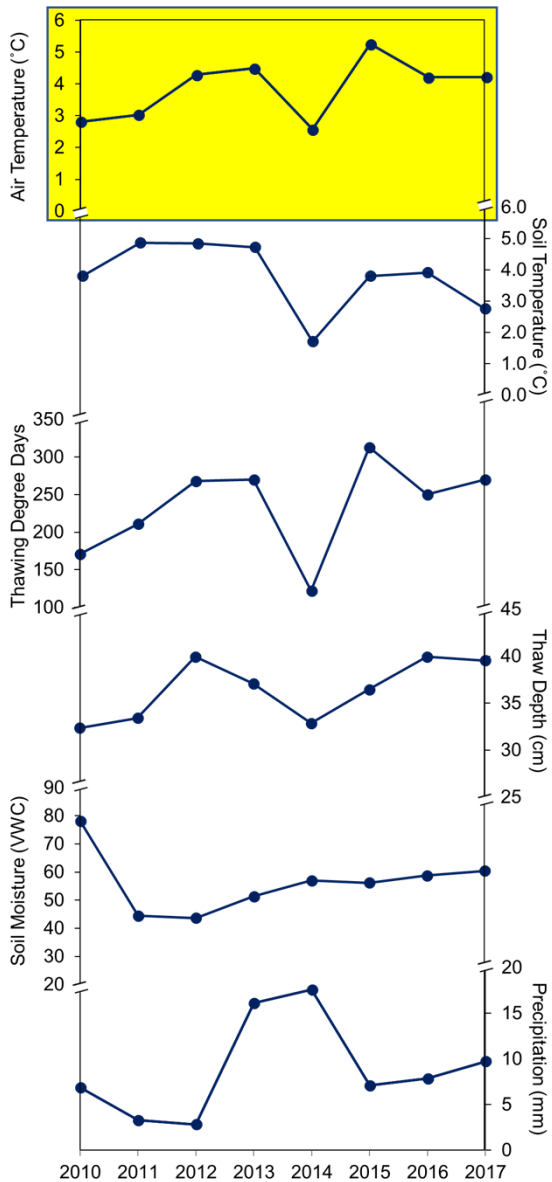
Bryophytes correlate with lichens and litter ($R^2=0.87$, $p<0.01$ and $R^2=0.65$, $p=0.03$)



- Litter (LITT)
- Standing Dead (SDEA)
- Lichens (LICH)
- Bryophytes (BRYO)
- Graminoids (GRAM)
- Forbs (FORB)
- Evergreen Shrubs (ESHR)
- Deciduous Shrubs (DSHR)

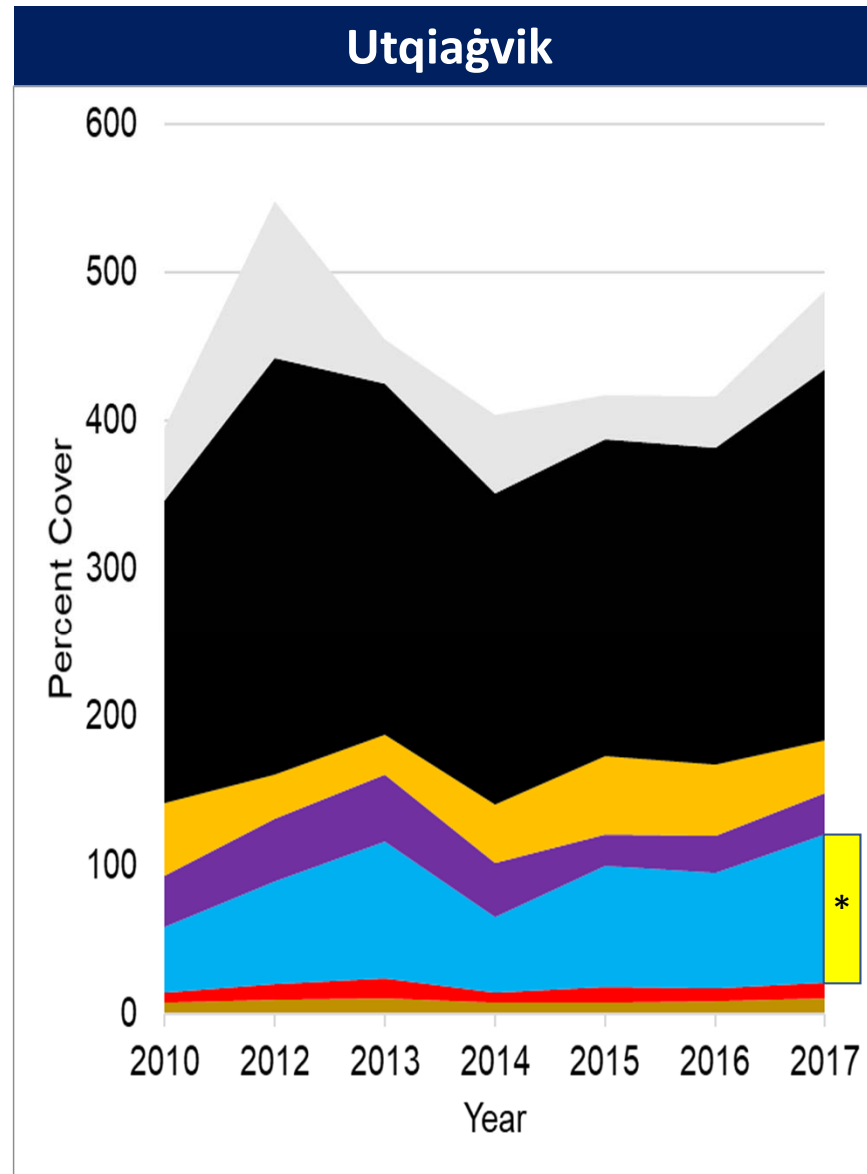
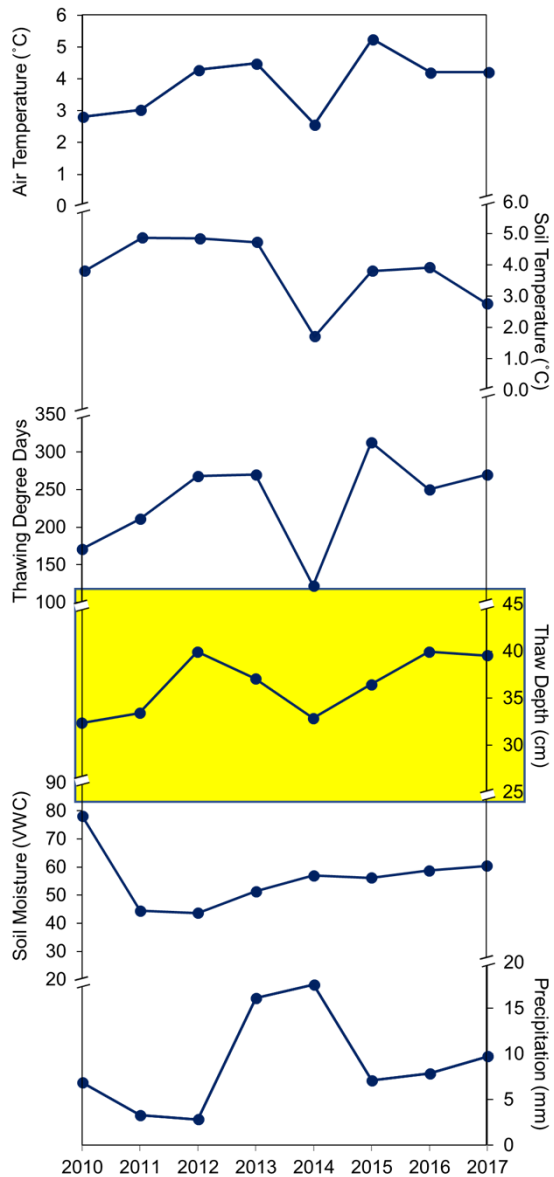
Lichens correlate with litter ($R^2=0.70$, $p=0.02$)





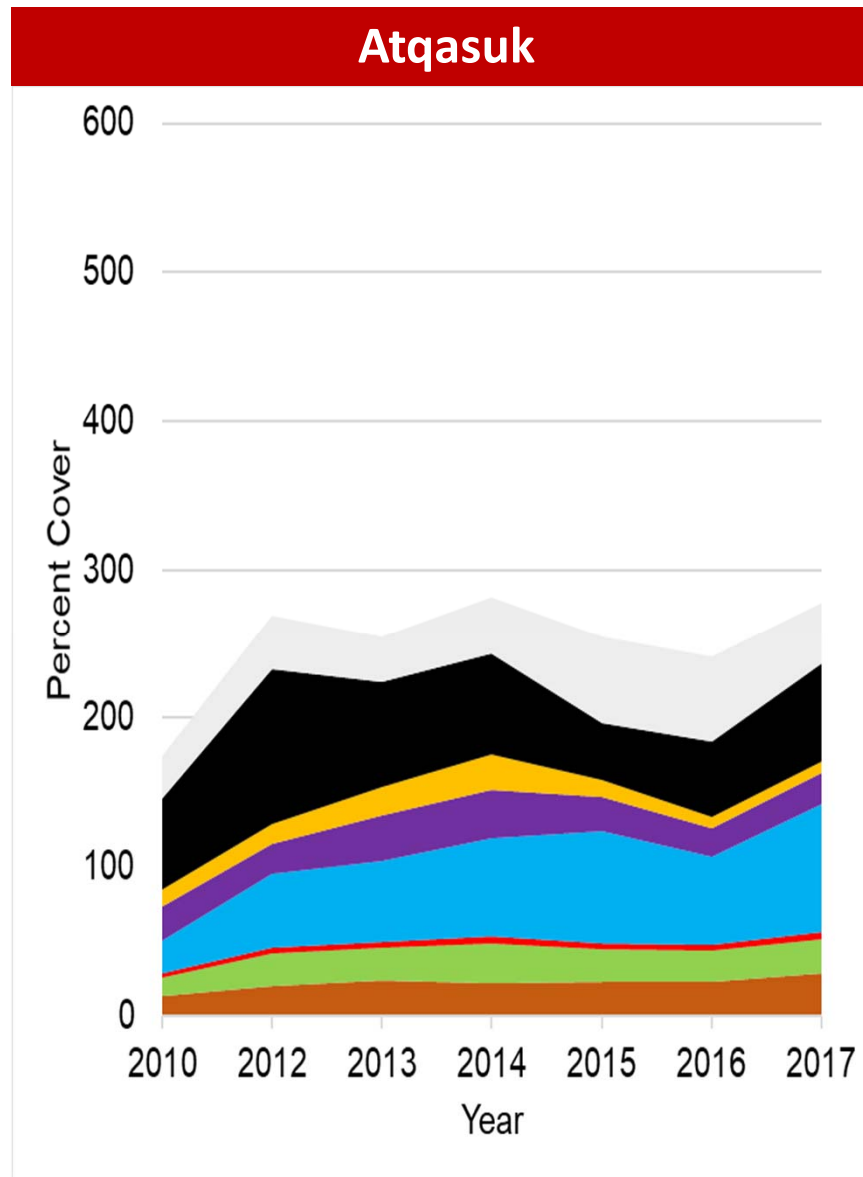
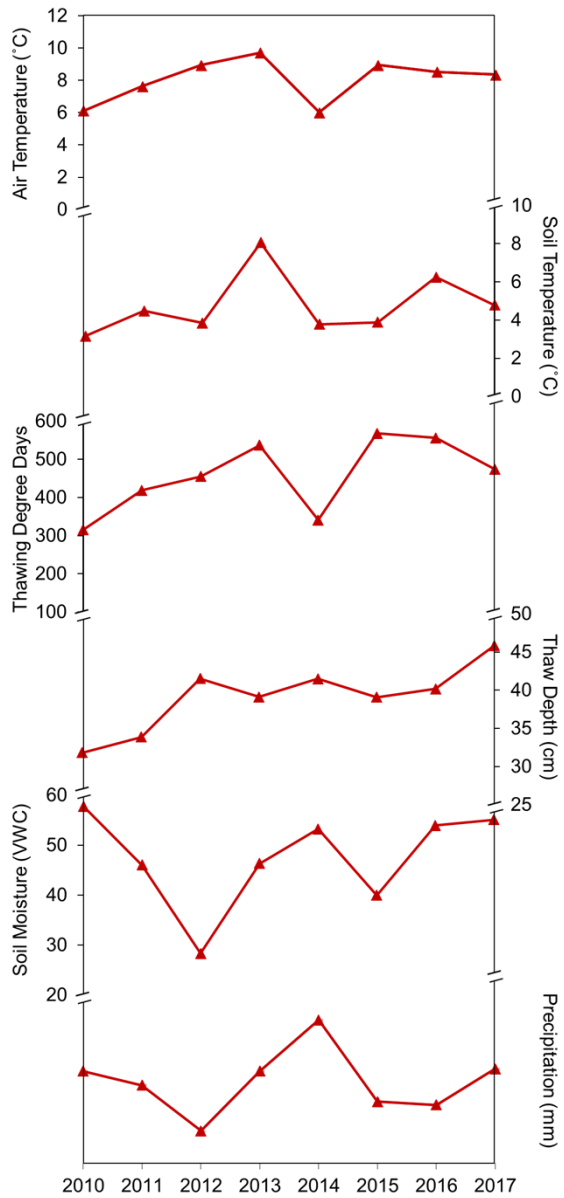
- Litter (LITT)
- Standing Dead (SDEA)
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- Bryophytes (BRYO)
- Graminoids (GRAM)
- Forbs (FORB)
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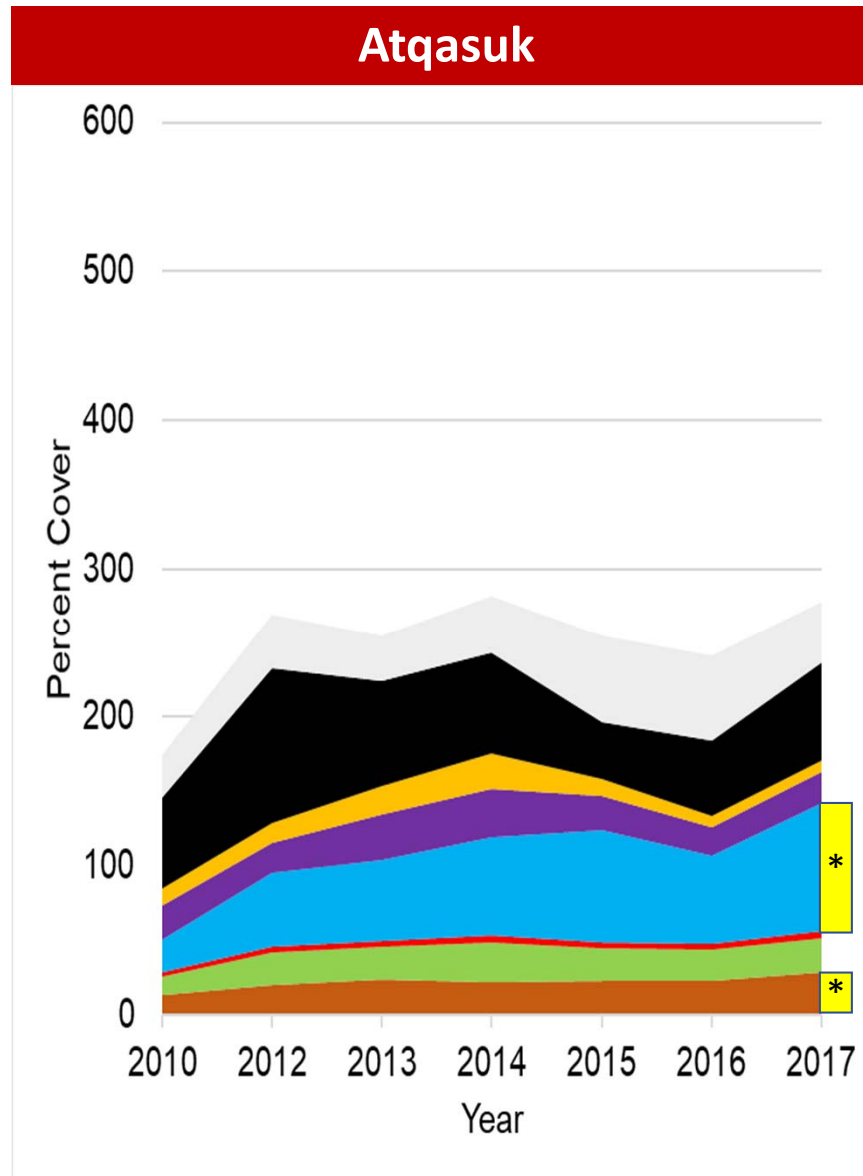
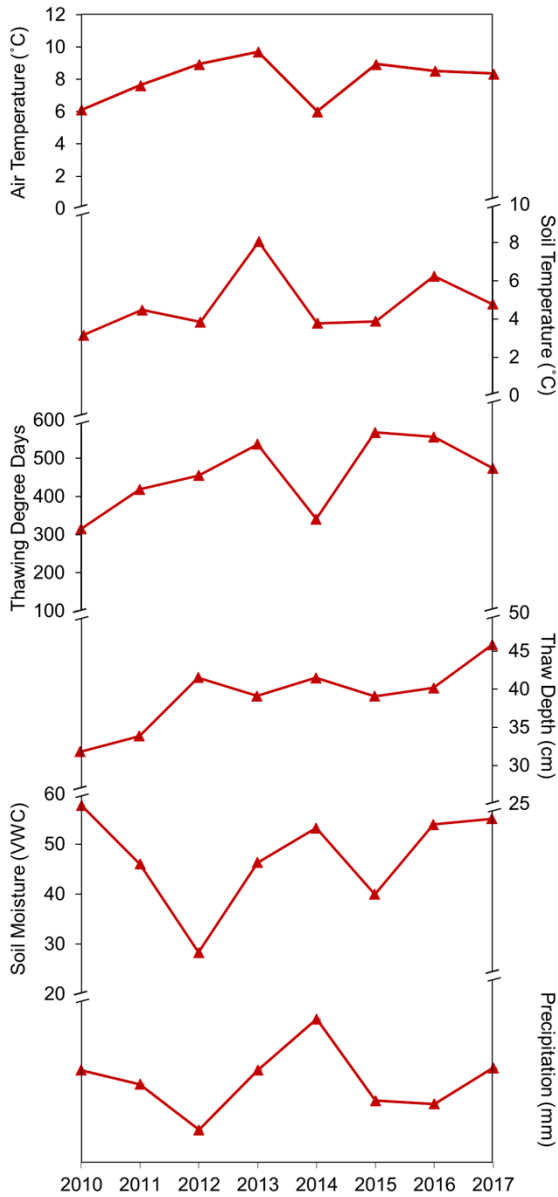
Air temp significant predictor for forbs ($R^2=0.59$, $p=0.04$)



- Litter (LITT)
- Standing Dead (SDEA)
- Lichens (LICH)
- Bryophytes (BRYO)
- Graminoids (GRAM)
- Forbs (FORB)
- Evergreen Shrubs (ESHR)
- Deciduous Shrubs (DSHR)

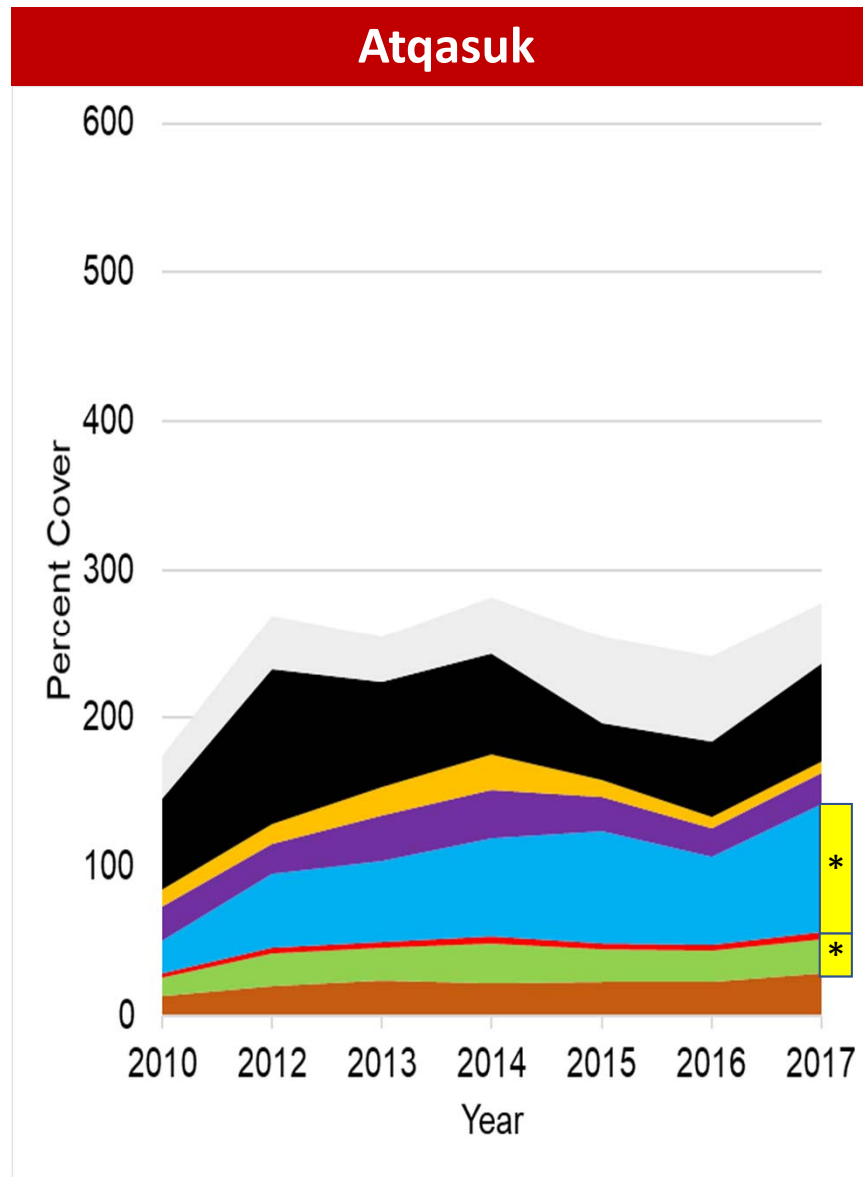
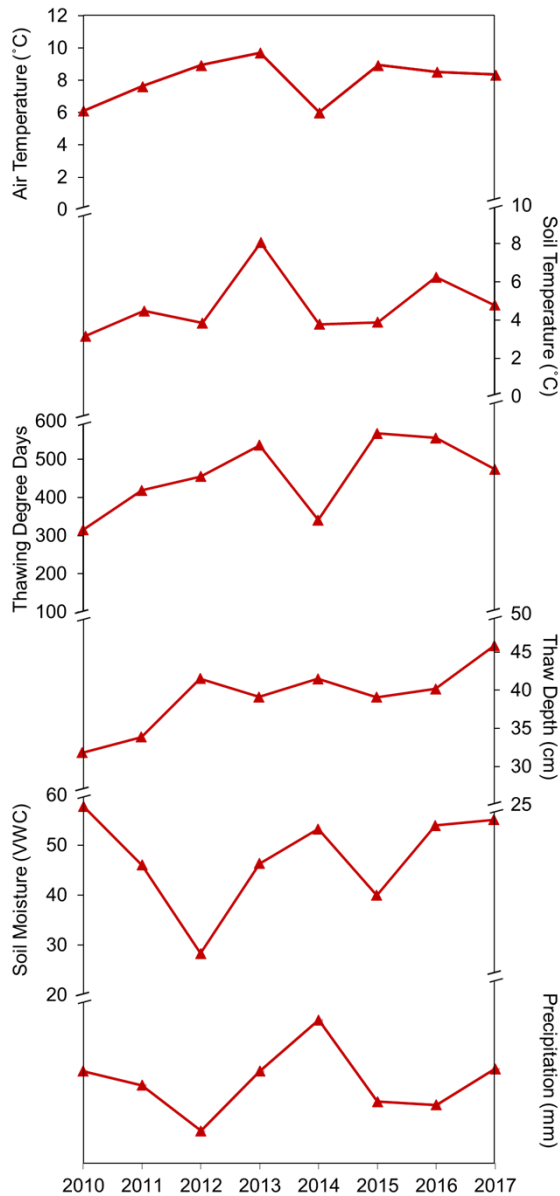
Thaw depth
significant predictor
for graminoids
($R^2=0.56$, $p=0.05$)





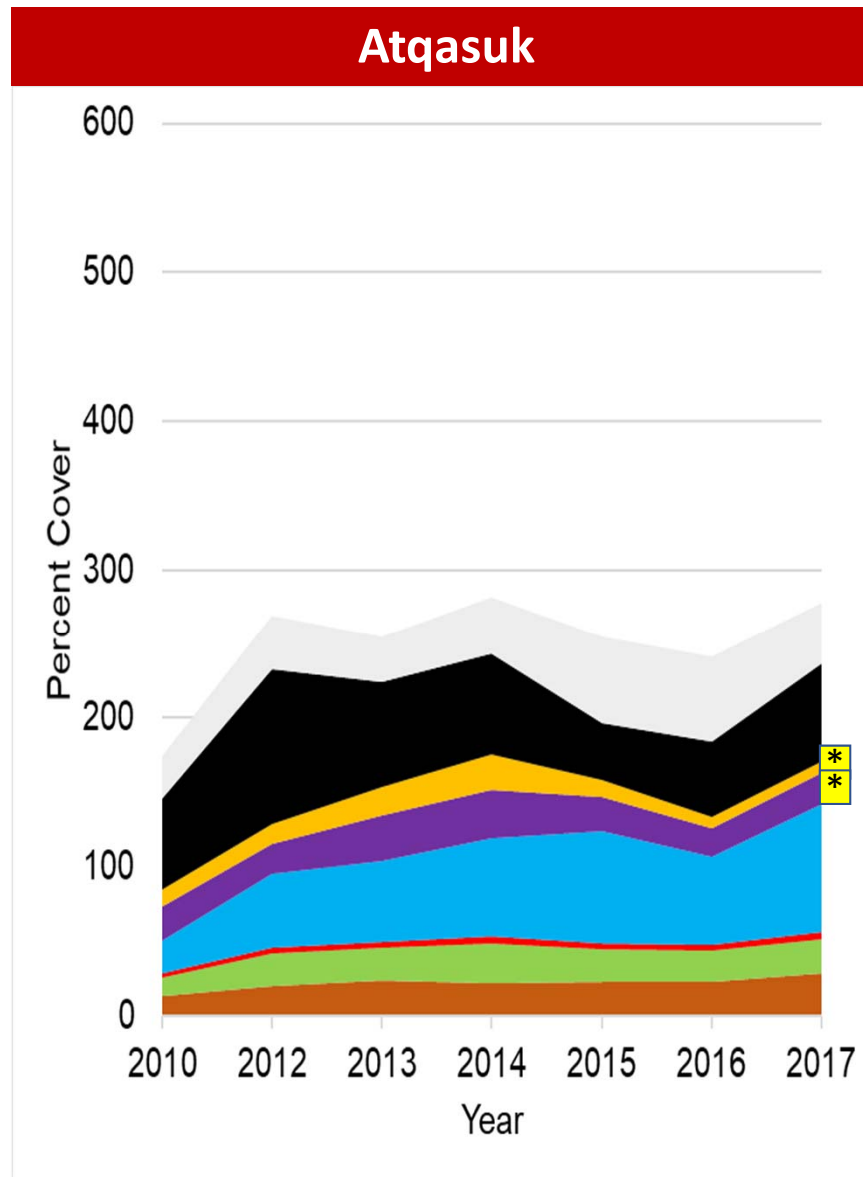
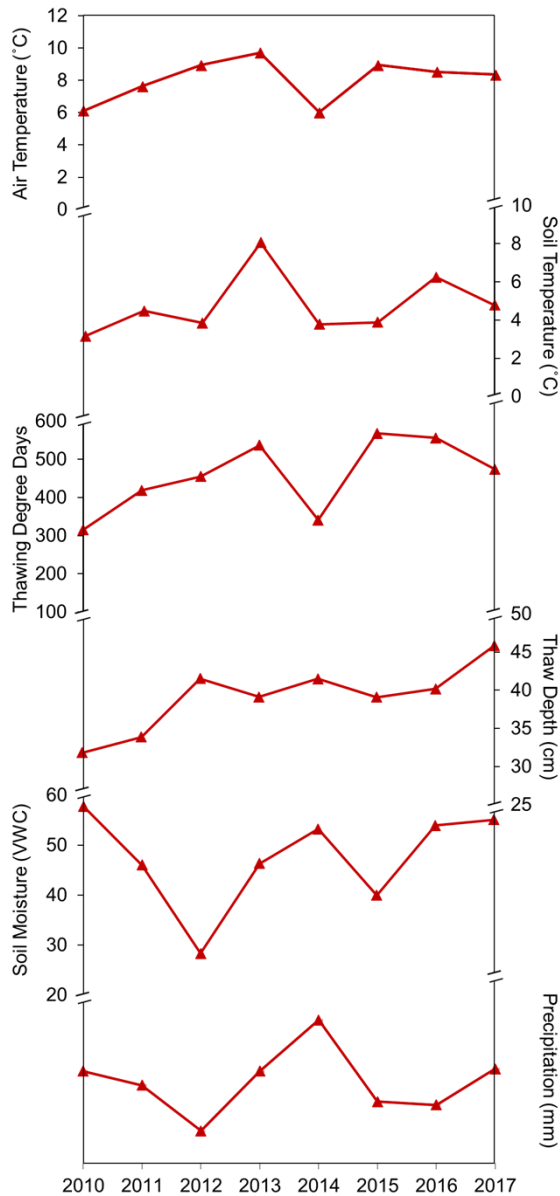
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- Graminoids (GRAM)
- Forbs (FORB)
- Evergreen Shrubs (ESHR)
- Deciduous Shrubs (DSHR)

Deciduous shrubs correlate with graminoids ($R^2=0.88$, $p<0.01$)



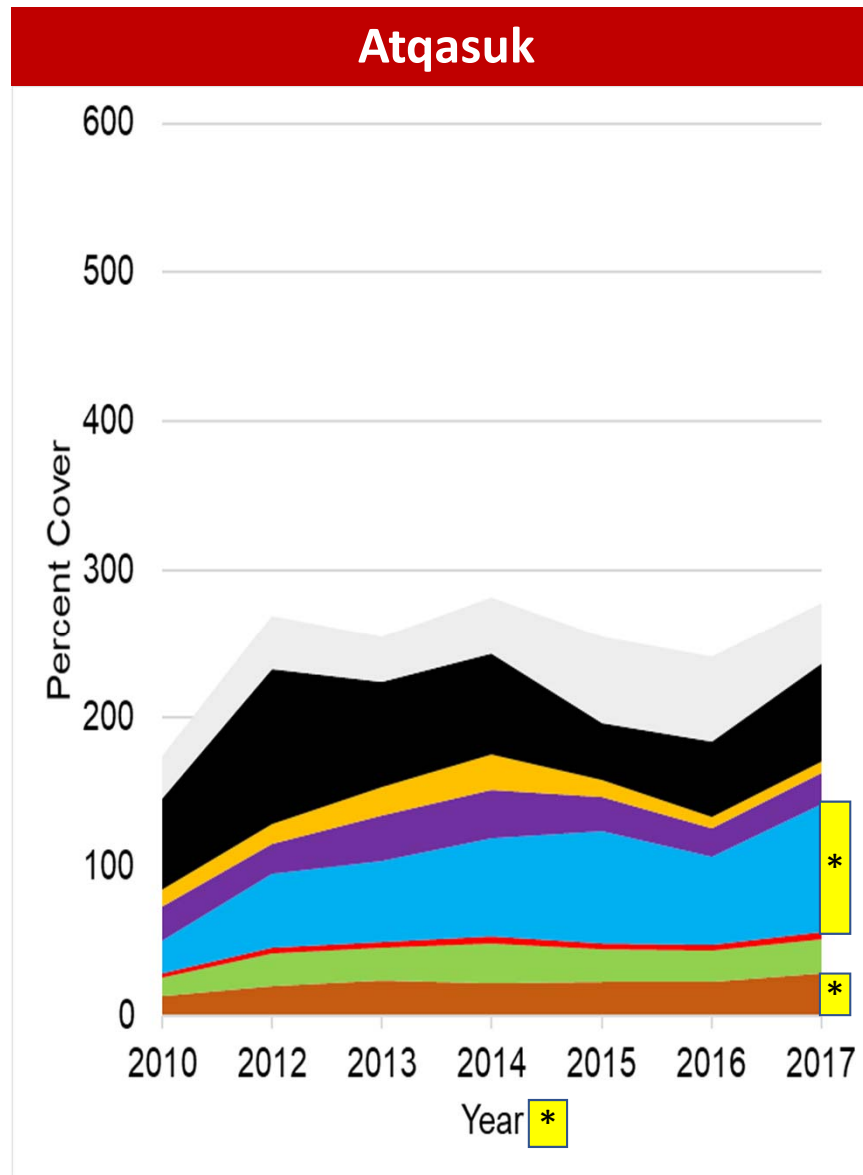
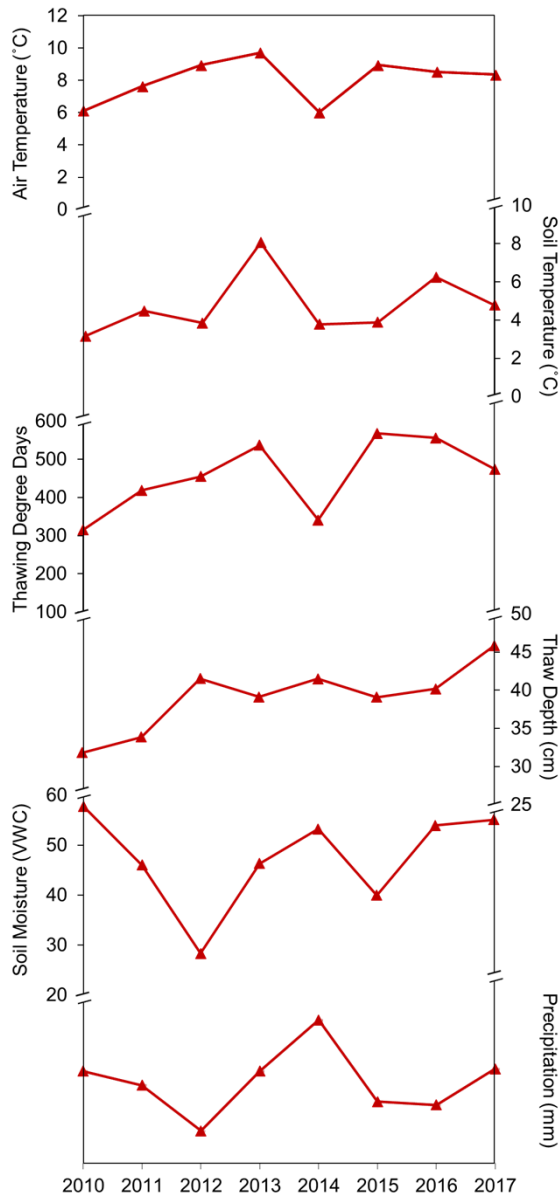
- Litter (LITT)
- Standing Dead (SDEA)
- Lichens (LICH)
- Bryophytes (BRYO)
- Graminoids (GRAM)
- Forbs (FORB)
- Evergreen Shrubs (ESHR)
- Deciduous Shrubs (DSHR)

Evergreen shrubs correlate with graminoids ($R^2=0.60$, $p=0.04$)

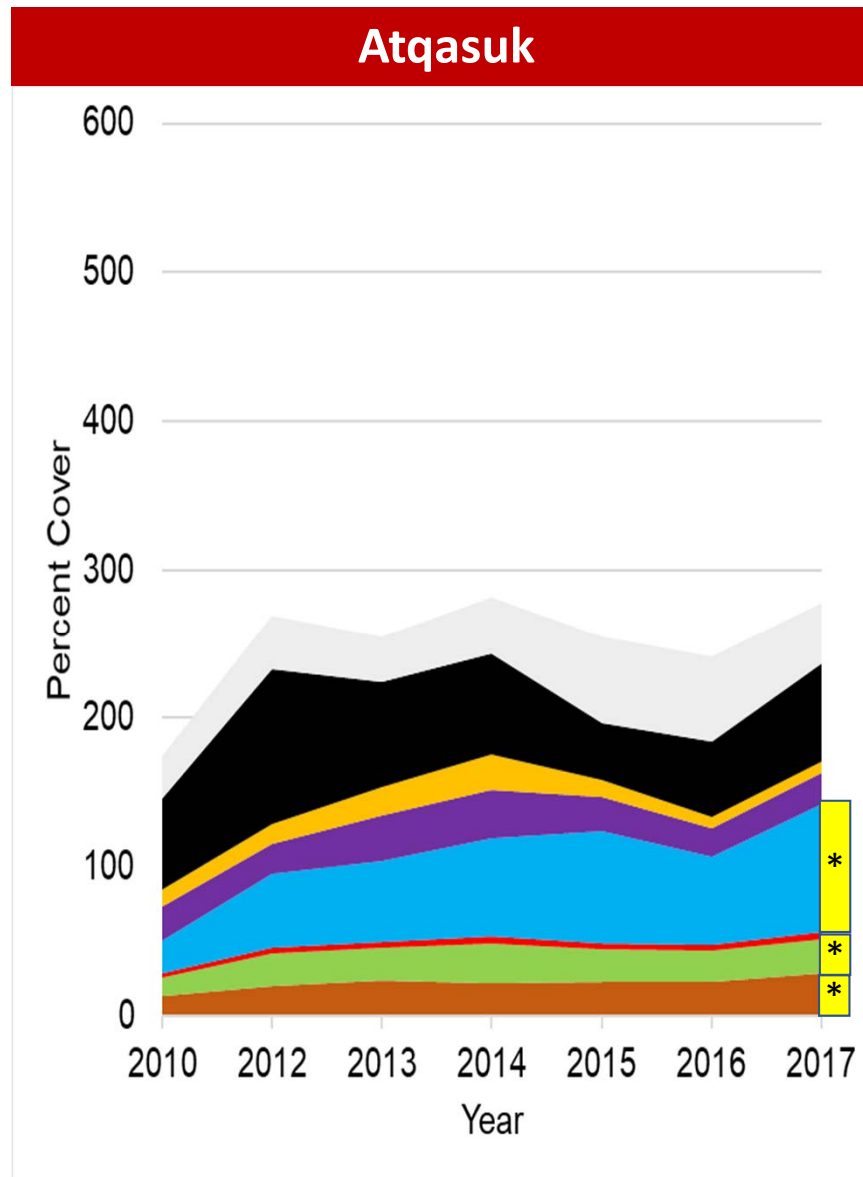
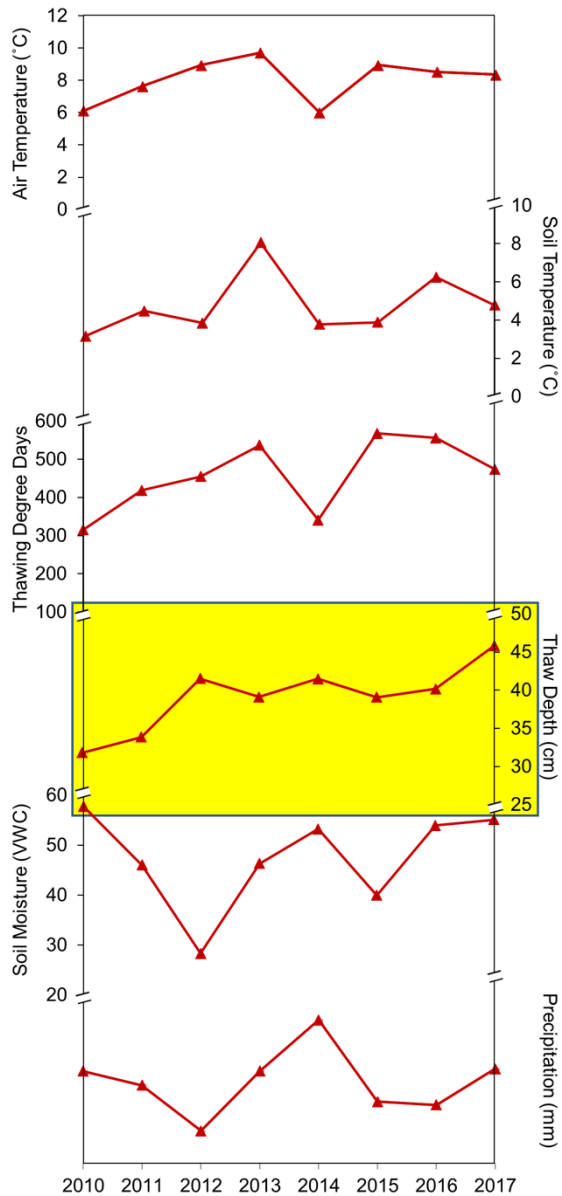


- Litter (LITT)
- Standing Dead (SDEA)
- Lichens (LICH)
- Bryophytes (BRYO)
- Graminoids (GRAM)
- Forbs (FORB)
- Evergreen Shrubs (ESHR)
- Deciduous Shrubs (DSHR)

Bryophytes correlate with lichens ($R^2=0.86$, $p<0.01$)



Year is a significant predictor for deciduous shrubs and graminoids ($R^2=0.84$, $p<0.01$ and $R^2=0.81$, $p=0.01$)



- Litter (LITT)
- Standing Dead (SDEA)
- Lichens (LICH)
- Bryophytes (BRYO)
- Graminoids (GRAM)
- Forbs (FORB)
- Evergreen Shrubs (ESHR)
- Deciduous Shrubs (DSHR)

Thaw depth is a significant predictor for deciduous shrubs, evergreen shrubs, and graminoids ($R^2=0.81$, $p=0.01$, $R^2=0.69$, $p=0.02$, and $R^2=0.73$, $p=0.01$)

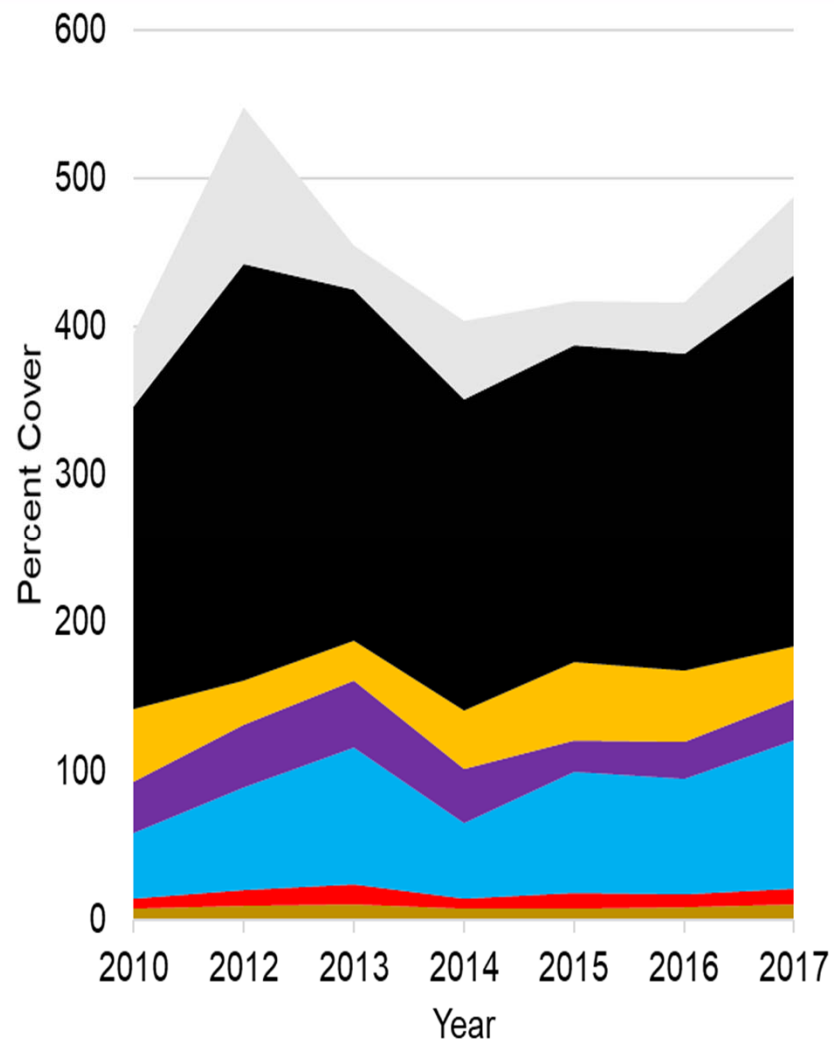
Results and Discussion: growth form correlation

- Utqiagvik
 - Deciduous shrubs correlate with forbs and graminoids ($R^2=0.63$, $p=0.03$) and ($R^2=0.72$, $p=0.02$)
 - Graminoids correlate with forbs ($R^2=0.65$, $p=0.03$)
 - Bryophytes correlate with lichens ($R^2=0.87$, $p<0.01$)
 - Air temperature correlates with forbs and graminoids ($R^2=0.59$, $p=0.04$) and ($R^2=0.73$, $p=0.01$)
 - Thaw depth correlates with graminoids ($R^2=0.57$, $p=0.05$)

Results and Discussion: growth form correlation

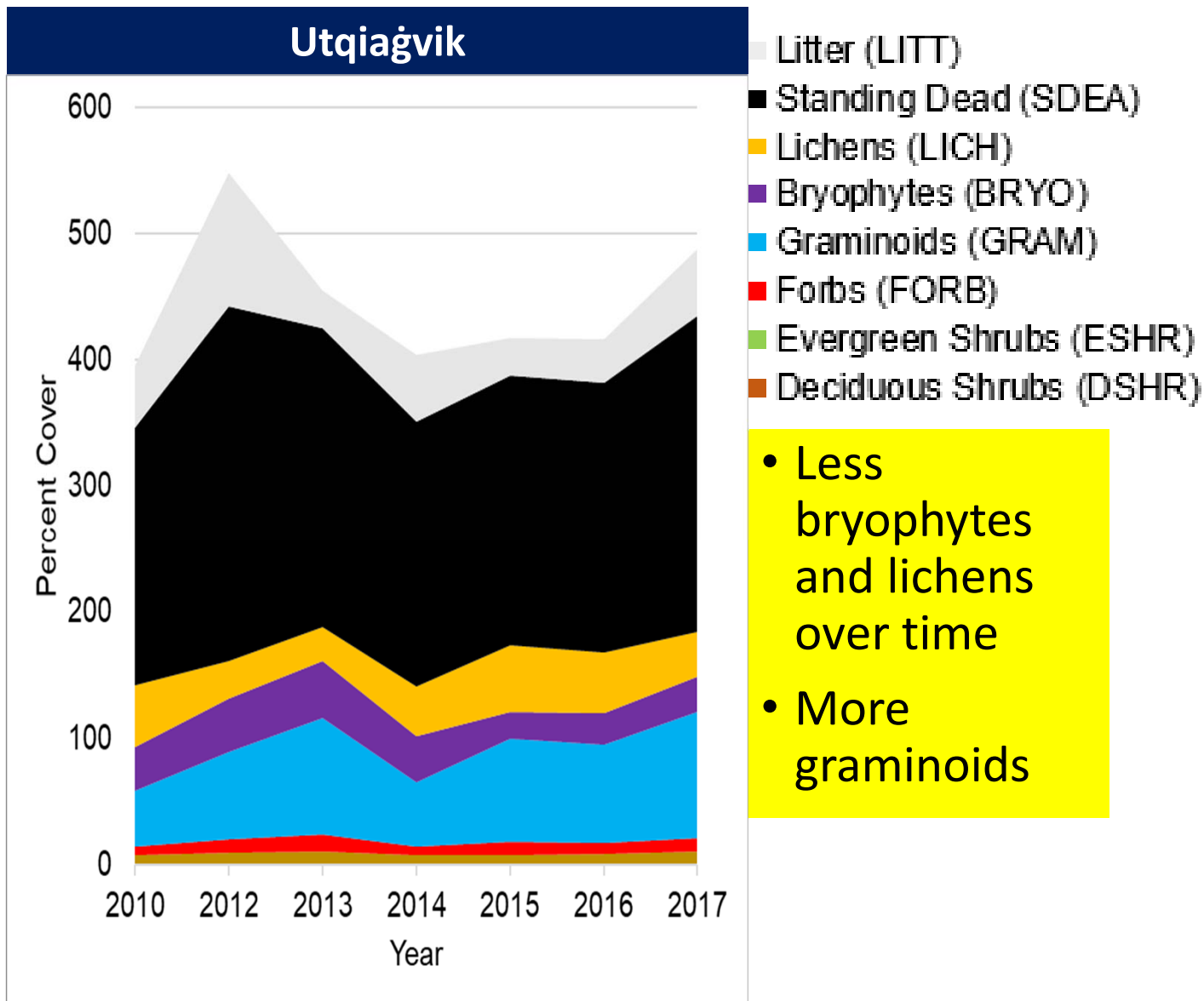
- Atqasuk
 - Deciduous shrubs correlate with graminoids ($R^2=0.88$, $p<0.01$)
 - Evergreen shrubs correlates with graminoids ($R^2=0.60$, $p=0.04$)
 - Bryophytes correlate with lichens ($R^2=0.86$, $p<0.01$)
 - Thaw depth correlates with deciduous shrubs, evergreen shrubs, and graminoids ($R^2=0.83$, $p<0.01$), ($R^2=0.69$, $p=0.02$), and ($R^2=0.73$, $p=0.01$)

Utqiagvik

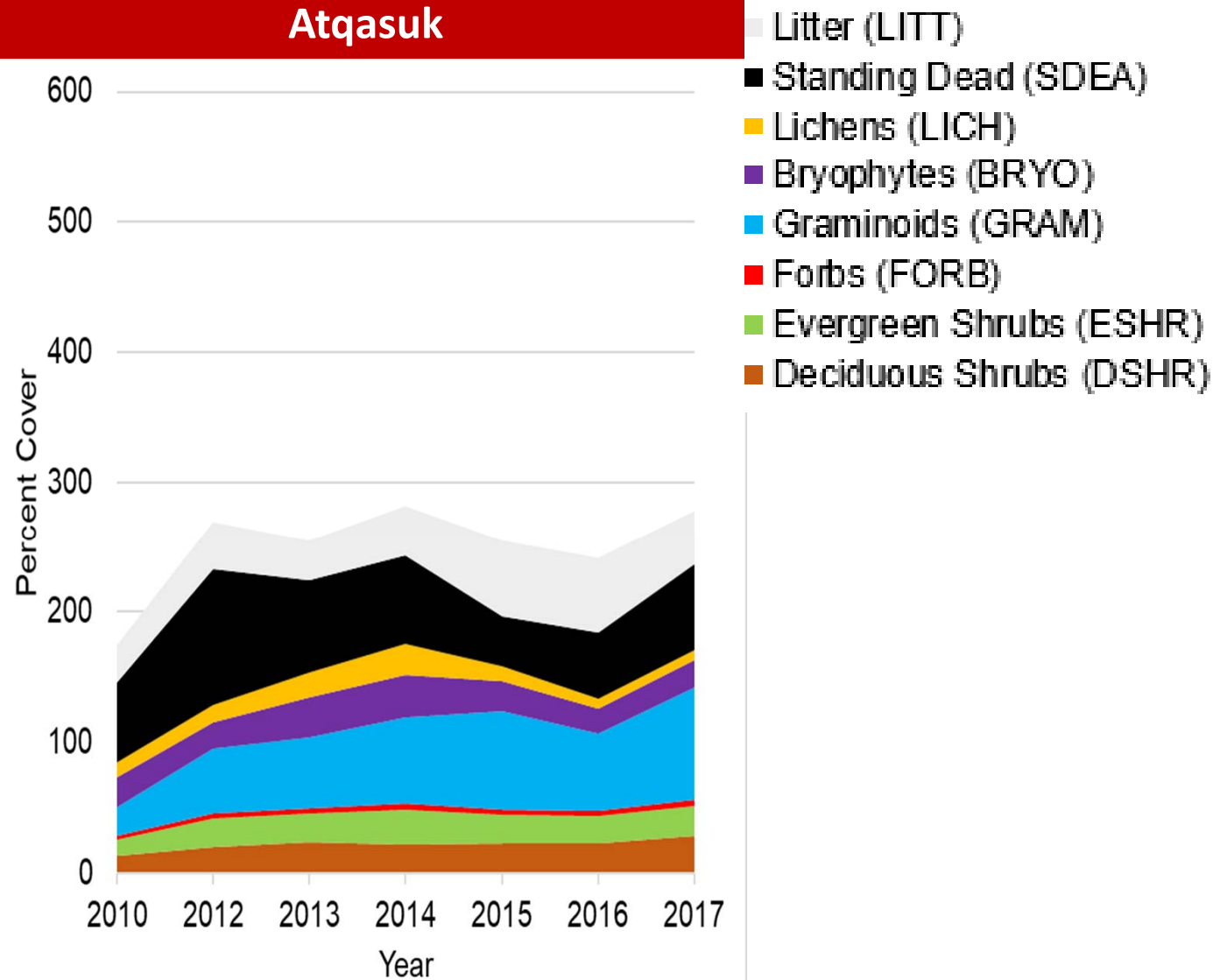


- Litter (LITT)
- Standing Dead (SDEA)
- Lichens (LICH)
- Bryophytes (BRYO)
- Graminoids (GRAM)
- Forbs (FORB)
- Evergreen Shrubs (ESHR)
- Deciduous Shrubs (DSHR)

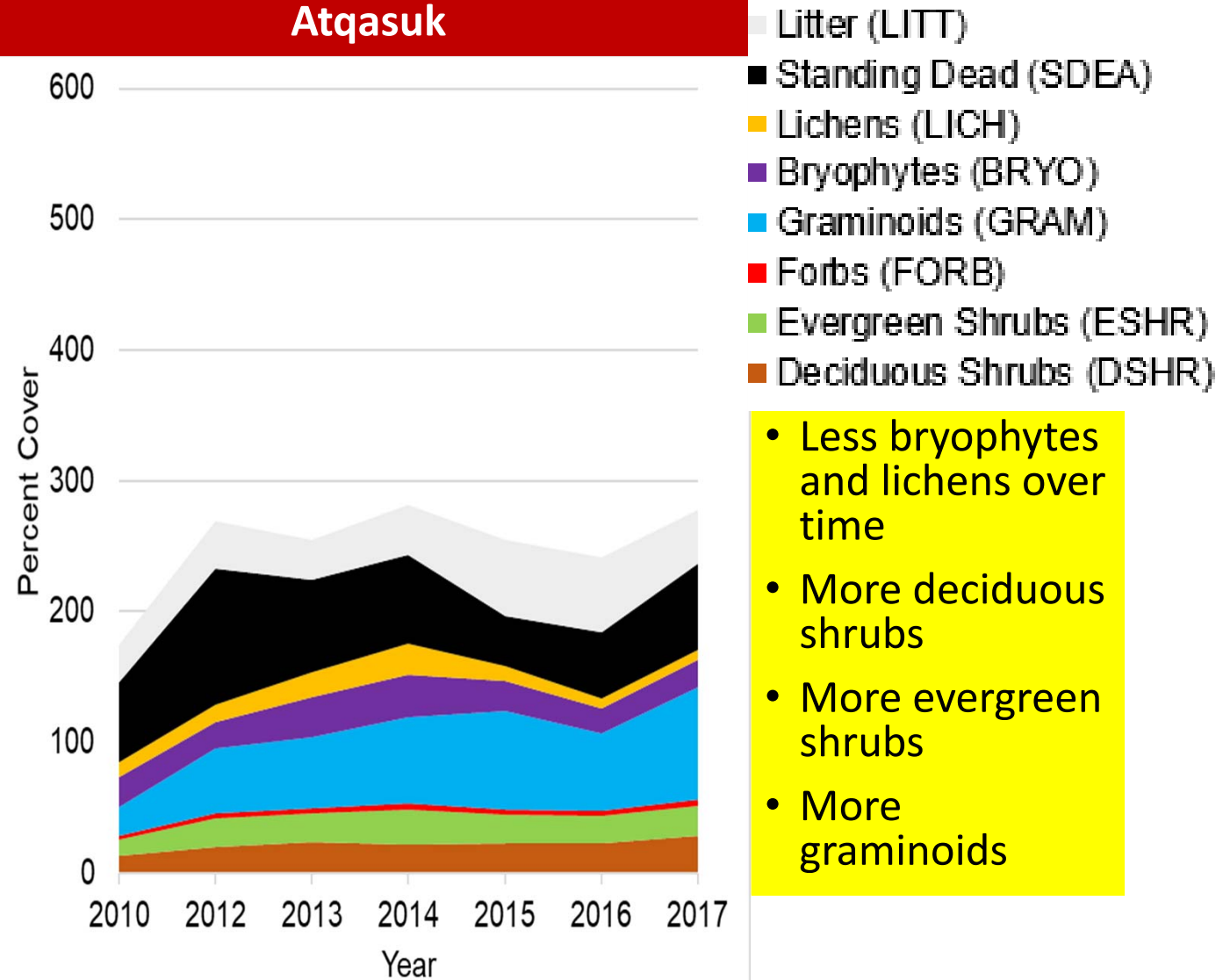
Utqiagvik



Atqasuk



Atqasuk



Conclusion

- Temperature effects (air temperature, thaw depth) seem to be the most obvious driver of cover change in this study
- Optimizing environmental variable data ranges may help to elucidate if the other selected variables have any real influence on driving cover change vegetation groups
- Analysis at the species level may reveal differences between species within groups.

Acknowledgements

Thank you to International Tundra Experiment (ITEX) network, the National Science Foundation, the Ukpeagvik Inupiat Corporation (UIC), the University of Texas at El Paso (UTEP), Florida International University (FIU), and the Grand Valley Arctic Ecology Program for the logistical support and assistance provided during the field seasons. We thank the communities in Alaska.

Questions &
Suggestions?



R ² values	Utqiaġvik							
	DSHR	ESHR	FORB	GRAM	BRYO	LICH	SDEA	LITT
Deciduous Shrubs (DSHR)	1	–	0.63	0.72	0.07	0.19	0.00	0.53
Evergreen Shrubs (ESHR)	–	1	–	–	–	–	–	–
Forbs (FORB)	0.63	–	1	0.65	0.10	0.23	0.00	0.39
Graminoids (GRAM)	0.72	–	0.65	1	0.04	0.00	0.06	0.12
Bryophytes (BRYO)	0.07	–	0.10	0.04	1	0.87	0.19	0.65
Lichens (LICH)	0.19	–	0.23	0.00	0.87	1	0.02	0.70
Standing Dead (SDEA)	0.53	–	0.00	0.06	0.19	0.02	1	0.22
Litter (LITT)	0.00	–	0.39	0.12	0.65	0.70	0.22	1
	DSHR	ESHR	FORB	GRAM	BRYO	LICH	SDEA	LITT
Year (YEAR)	0.19	–	0.03	0.46	0.36	0.13	0.01	0.11
Air Temperature (ATEM)	0.34	–	0.59	0.73	0.10	0.03	0.01	0.02
Soil Temperature (STEM)	0.17	–	0.42	0.09	0.09	0.07	0.09	0.04
Degree Day Sums (DDSU)	0.28	–	0.56	0.65	0.10	0.04	0.01	0.01
Thaw depth (THAW)	0.50	–	0.35	0.57	0.03	0.01	0.10	0.05
Soil Moisture (SWVC)	0.27	–	0.40	0.19	0.14	0.18	0.44	0.17
Precipitation (PREC)	0.00	–	0.07	0.07	0.14	0.22	0.05	0.06

R ² values	Atqasuk							
	DSHR	ESHR	FORB	GRAM	BRYO	LICH	SDEA	LITT
Deciduous Shrubs (DSHR)	1	0.56	0.25	0.88	0.00	0.01	0.02	0.19
Evergreen Shrubs (ESHR)	0.56	1	0.55	0.60	0.15	0.19	0.01	0.11
Forbs (FORB)	0.25	0.55	1	0.32	0.39	0.41	0.04	0.04
Graminoids (GRAM)	0.88	0.60	0.32	1	0.00	0.01	0.08	0.34
Bryophytes (BRYO)	0.00	0.15	0.39	0.00	1	0.86	0.00	0.15
Lichens (LICH)	0.01	0.19	0.41	0.01	0.86	1	0.28	0.21
Standing Dead (SDEA)	0.02	0.01	0.04	0.08	0.00	0.28	1	0.38
Litter (LITT)	0.19	0.11	0.04	0.34	0.21	0.21	0.38	1
	DSHR	ESHR	FORB	GRAM	BRYO	LICH	SDEA	LITT
Year (YEAR)	0.81	0.39	0.09	0.84	0.03	0.11	0.51	0.18
Air Temperature (ATEM)	0.39	0.09	0.04	0.03	0.05	0.12	0.25	0.02
Soil Temperature (STEM)	0.21	0.04	0.01	0.03	0.05	0.00	0.00	0.00
Degree Day Sums (DDSU)	0.37	0.09	0.07	0.27	0.07	0.17	0.43	0.09
Thaw depth (THAW)	0.83	0.69	0.39	0.73	0.00	0.00	0.08	0.05
Soil Moisture (SWVC)	0.00	0.06	0.00	0.00	0.02	0.01	0.01	0.27
Precipitation (PREC)	0.01	0.10	0.10	0.17	0.03	0.02	0.33	0.42