Modeling dynamics of tundra plant communities on the Yamal Peninsula

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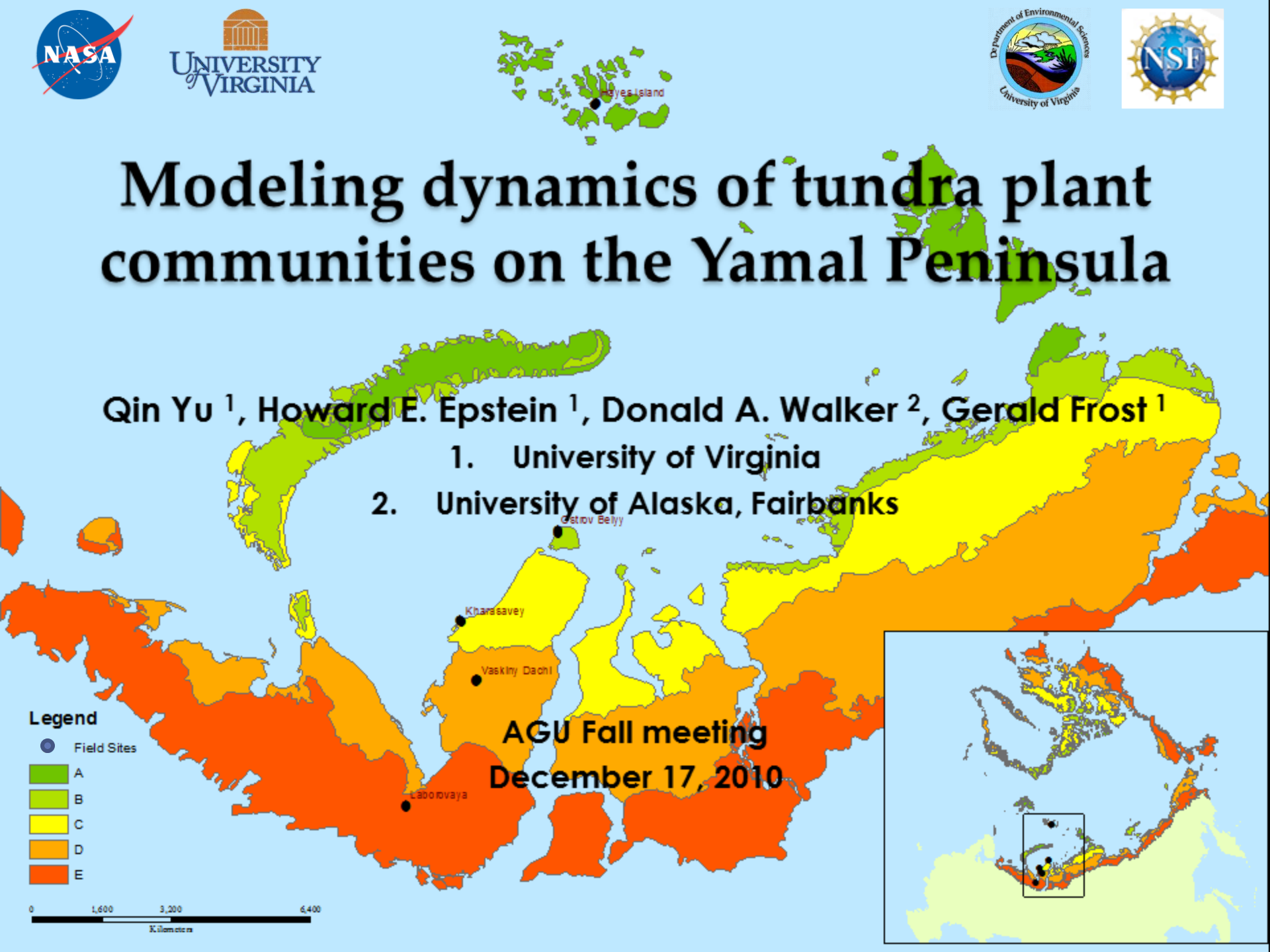

AGU Fall meeting

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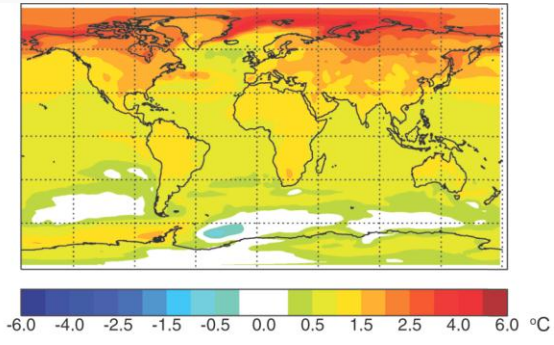
Outline of Talk

- **Research objectives**
- **ArcVeg – Arctic tundra vegetation dynamics model**
  - Plant Functional Types used in ArcVeg
  - Modeling setup
- **Simulating climate warming and grazing effects on tundra plant communities**:
  - Temporal climate change effects
  - Grazing effects
- **Discussion and Conclusion**

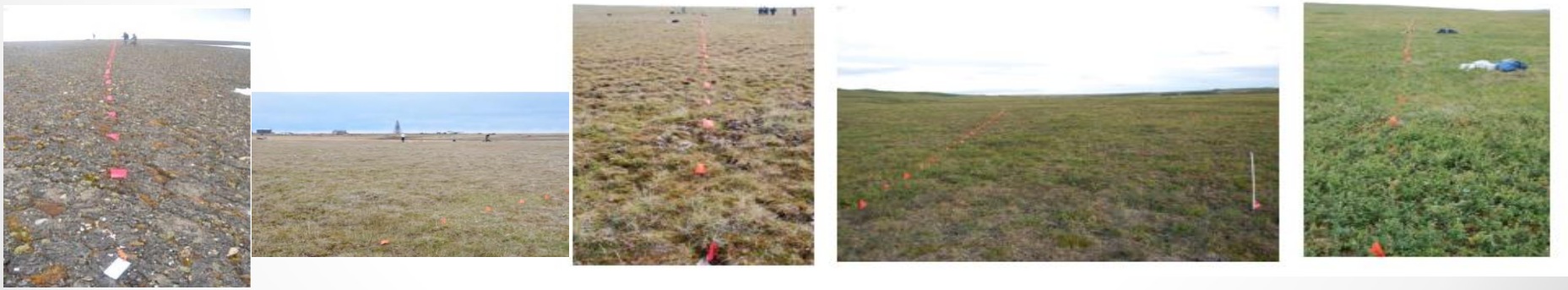
Research Objectives

- How does climate change and herbivory affect tundra vegetation dynamics?
- Do these effects differ along the latitudinal tundra gradient?



IPCC 2007

Photo: D.A. Walker

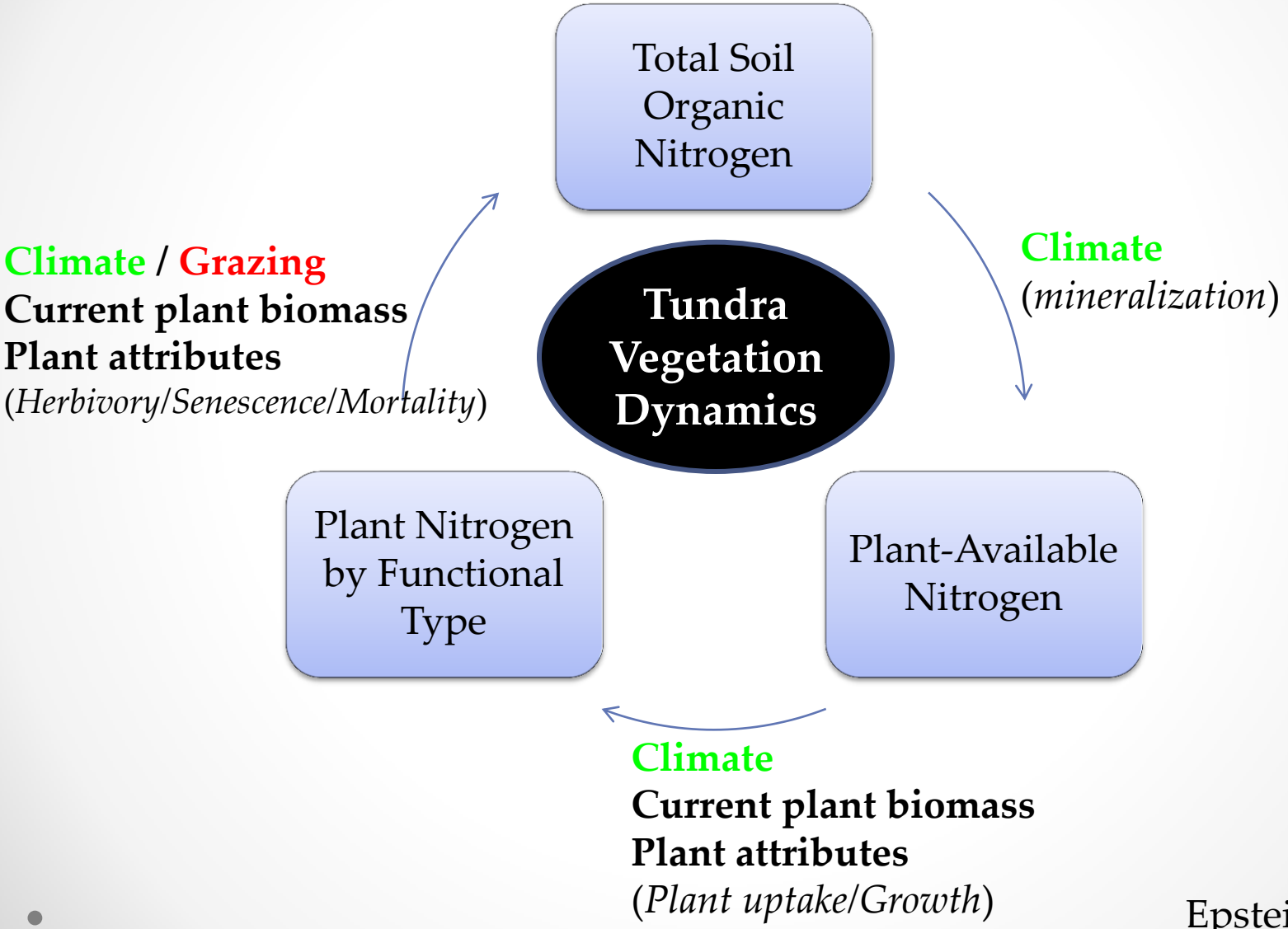


A B C D E

High Arctic **Low Arctic**

Zonal vegetation at Hayes Island (subzone A), Ostrov Belyy (subzone B), Kharasavey(subzone C) Vasikiny Dachi (subzone D), and Laborovaya (subzone E). Note the increasing greenness with warmer temperatures toward the south. Photo: D.A. Walker.

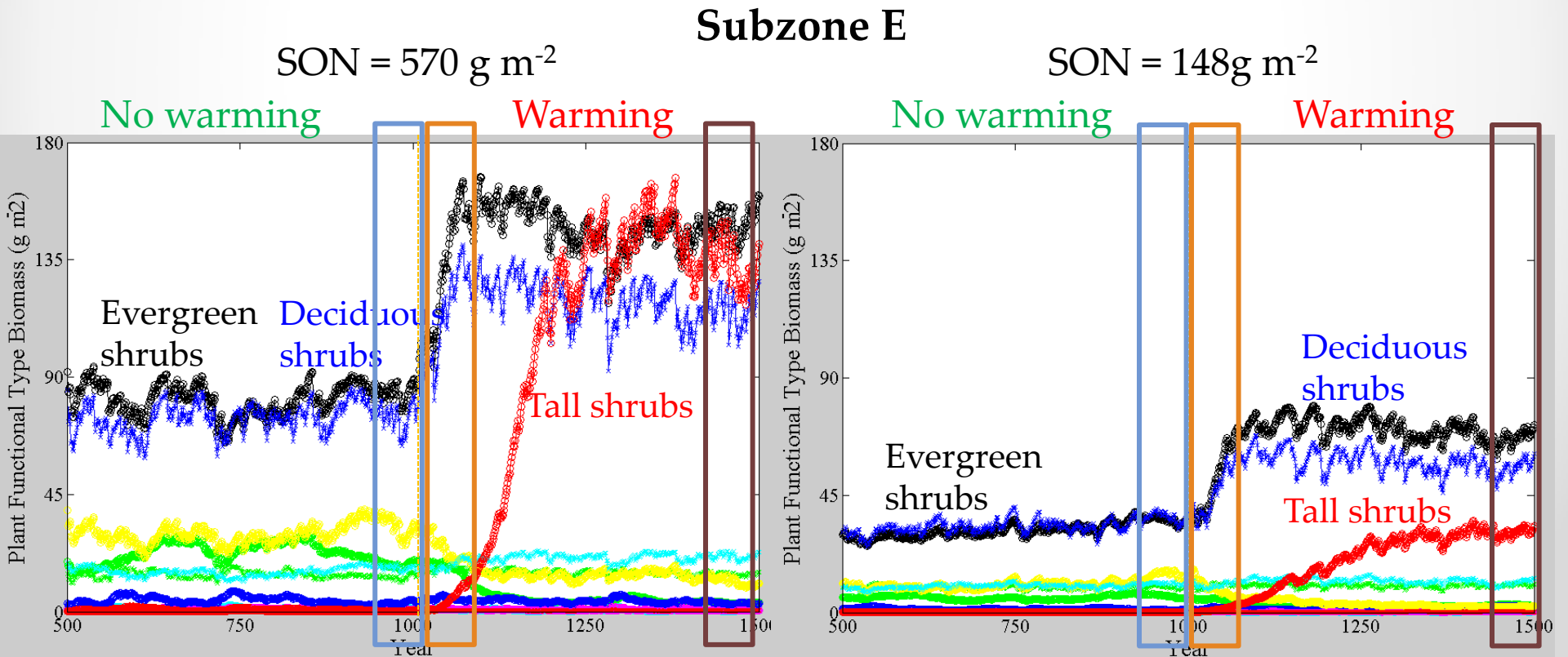
ArcVeg – Arctic tundra vegetation dynamics model



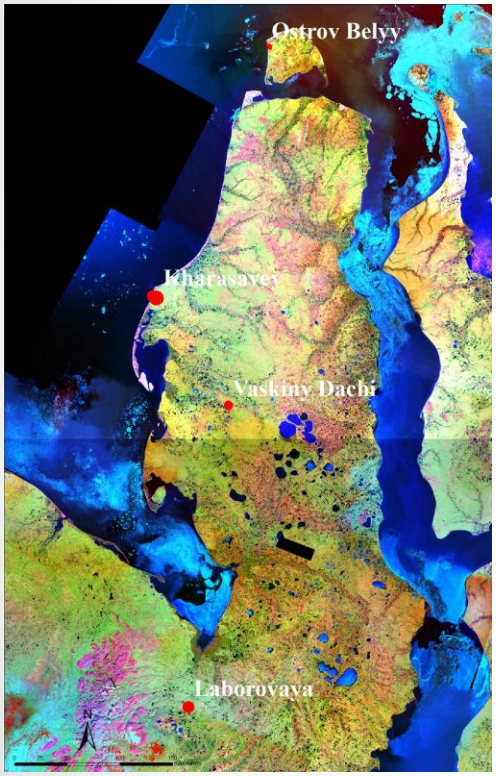
Epstein et al. 2000

Plant functional types in ArcVeg

- 12 Plant functional types include: mosses, lichens, sedges, grasses, deciduous shrubs, evergreen shrubs, etc.
- Grazing preference is an attribute of the model controlling PFT dynamics



Model setting

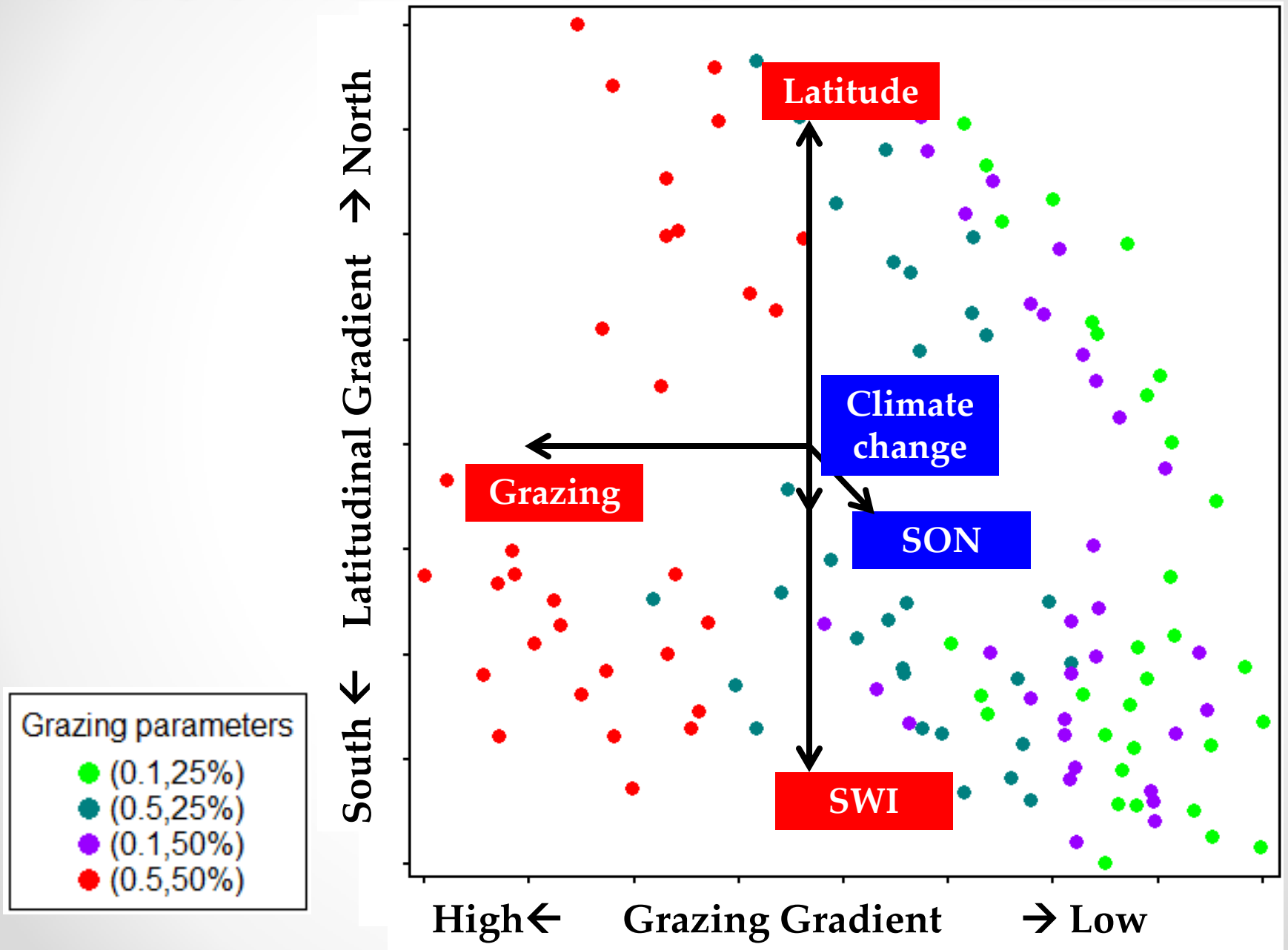


ArcVeg simulations were conducted with field collected parameters:

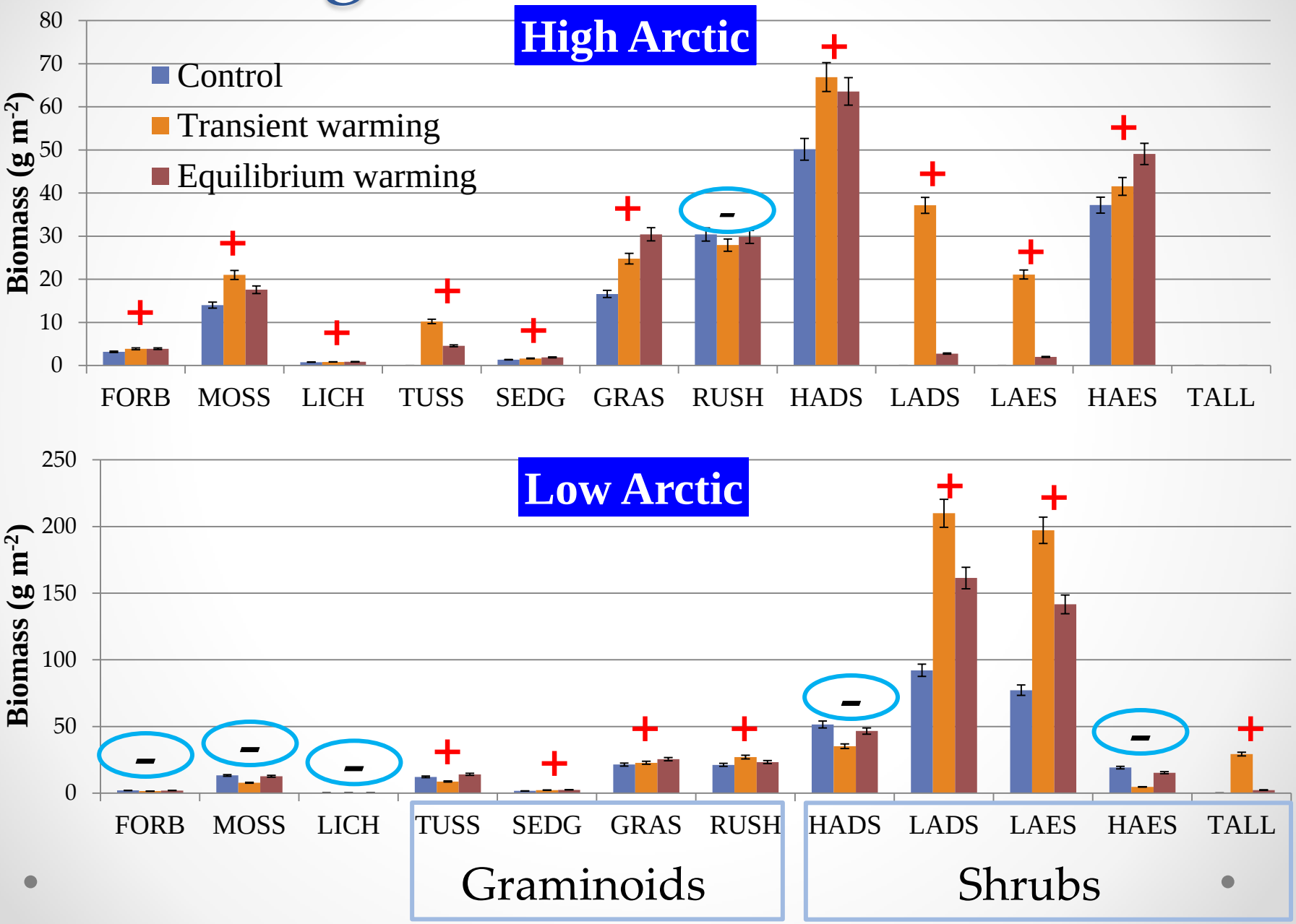
- **Bioclimate subzones**
- **Soil nutrients – soil organic nitrogen**
- **Grazing: (0.1, 25%), (0.1, 50%), (0.5, 25%), (0.5, 50%)**
- **Climate warming: 2°c transient warming and equilibrium warming**

Subzone	sites	N%	%Sand	Active Layer Depth(cm)	SON (g/m^2)
A	KR-1	0.11	60.08	33.60	449
A	KR-2	0.10	81.40	32.80	277
B	BO-1	0.03	36.50	49.98	227
B	BO-2	0.01	83.76	77.60	145
C	KH-1	0.06	24.47	56.33	844
C	KH-2	0.07	65.60	75.50	599
D	VD-1	0.03	28.90	71.75	271
D	VD-2	0.04	38.28	68.60	202
D	VD-3	0.05	92.80	113.80	135
E	LV-1	0.06	18.00	81.20	570
E	LV-2	0.01	93.60	114.60	148

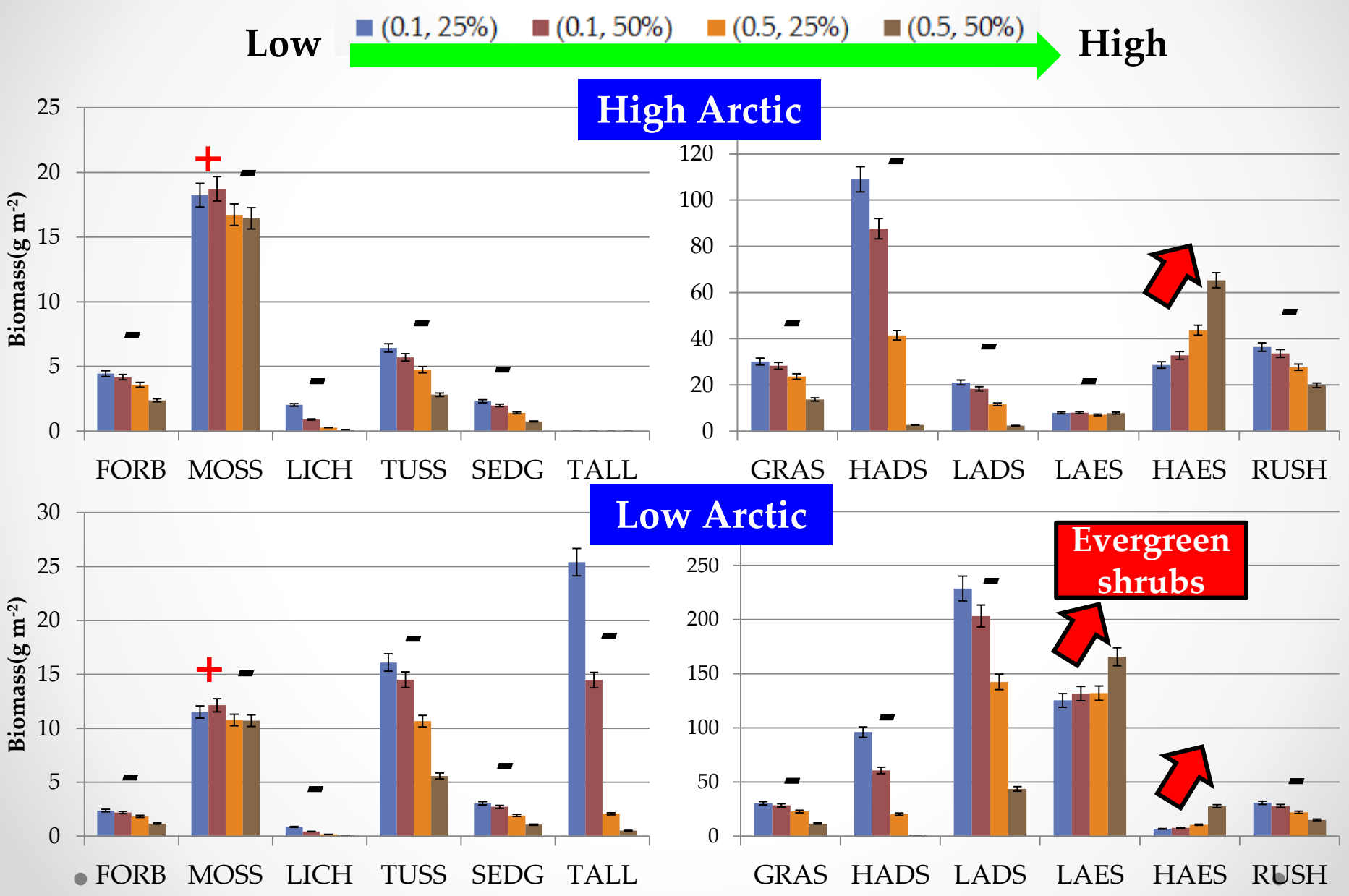
Results – NMS ordination



Warming effects on PFT biomass



Grazing effects on PFT biomass



Discussion

- Our results are consistent across a variety of soil nutrient levels; soil nutrients affect the magnitude but not the direction of change
- Simulated results suggest that:
- Grazing can be as important as the latitudinal climate gradient (~12°C) for tundra plant communities
- PFTs such as evergreen shrubs may benefit from increased grazing intensity
- Initial vegetation responses to climate change during transient warming are different from the long term equilibrium responses due to shifts in the controlling mechanisms (nutrient limitation and competition) on tundra plant communities

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