Integrating Tower EC, Satellite Remote Sensing and Ecosystem Modeling to Identify Changes in Hydrology and Carbon Fluxes across the Alaskan Arctic

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The University of Montana · NTSG · ABoVE Arctic Boreal Vulnerability Experiment · The University Of Sheffield. · San Diego State University

Phenology

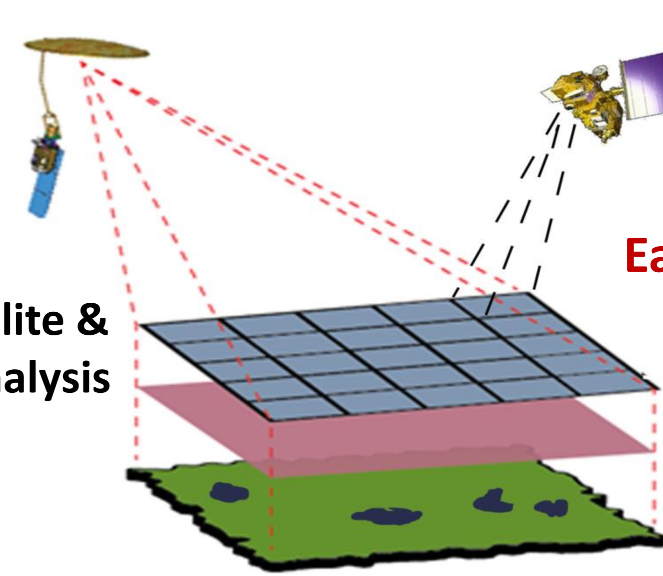
Surface Flooding

Identifying Changing Arctic Environments

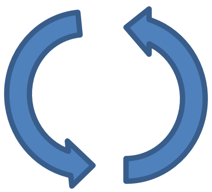
Plant Productivity

Soil Carbon Cycling

Satellite & Reanalysis Data



Monitor Changing Earth Surface Properties



Flux Towers & In Situ Sensors

Integrate with Ecosystem Modeling for Regional Carbon Observing System [1,2]

$$GPP = \varepsilon \times PAR \times FPAR$$

$$\varepsilon = \varepsilon_{max} \times f(VPD) \times f(T_{min}) \times f(\theta)$$

$$R_{aut} = (1\text{-}CUE) \times GPP$$

NPP

C_{met} C_{str} C_{rec}

$$R_{het} = f(C_{pool}, T_s, \theta)$$

$$R_{CH4} = (R_o \times \varphi_s) \times C_{pool} \times Q_{10}^{(Ts-Tp)/10}$$

Aerobic vs Anaerobic

C_{CH4}

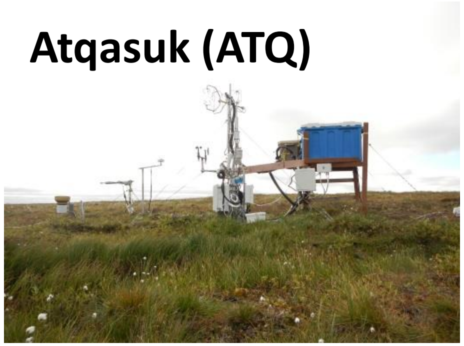
Plant Soil Diffusion Ebullition

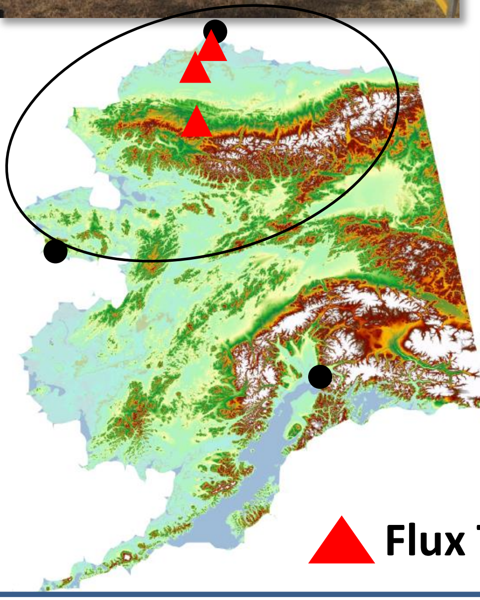
[1]Watts et al. 2014 *Biogeosciences* [2]Kimball et al. 2015 *SMAP L4_C User Guide*

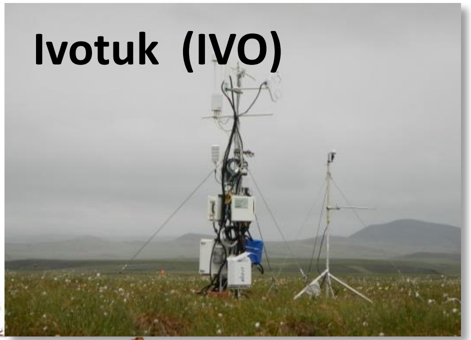
North Slope Tower Transect

Climate Variability

	BEO/BES	ATQ	IVO
Elev. (m)	6	15	568
MAT (°C)	-12.6	-9.7	-7.9
MSP (mm)	72	100	210
ALD (cm)	-36	-50	-60





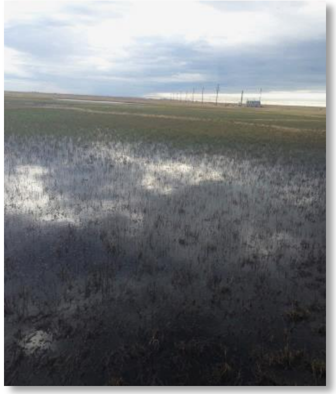


Vegetation Communities

BES/BEO: Inundated & polygonal tundra (grass, sedge, moss)

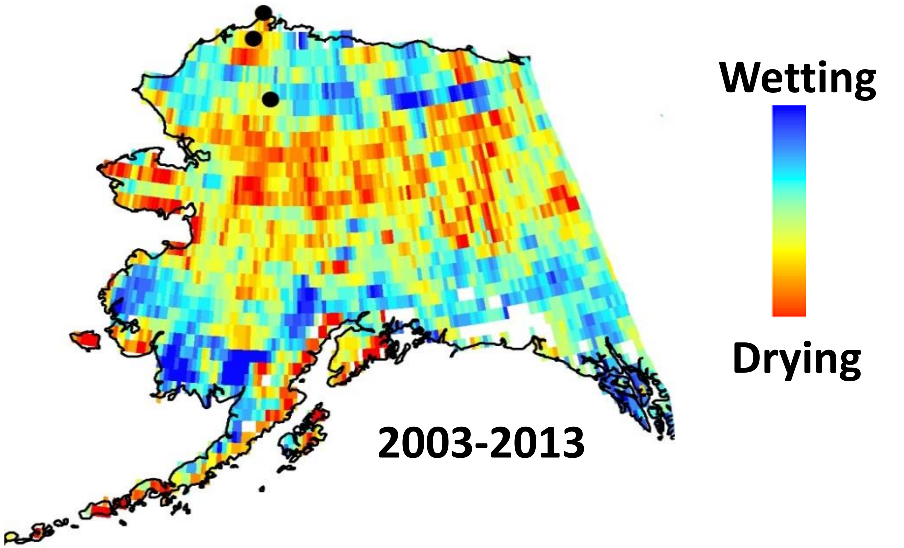
ATQ: Moist sedge tundra & tussock

IVO: Tussock tundra & dwarf shrub, moss and lichen

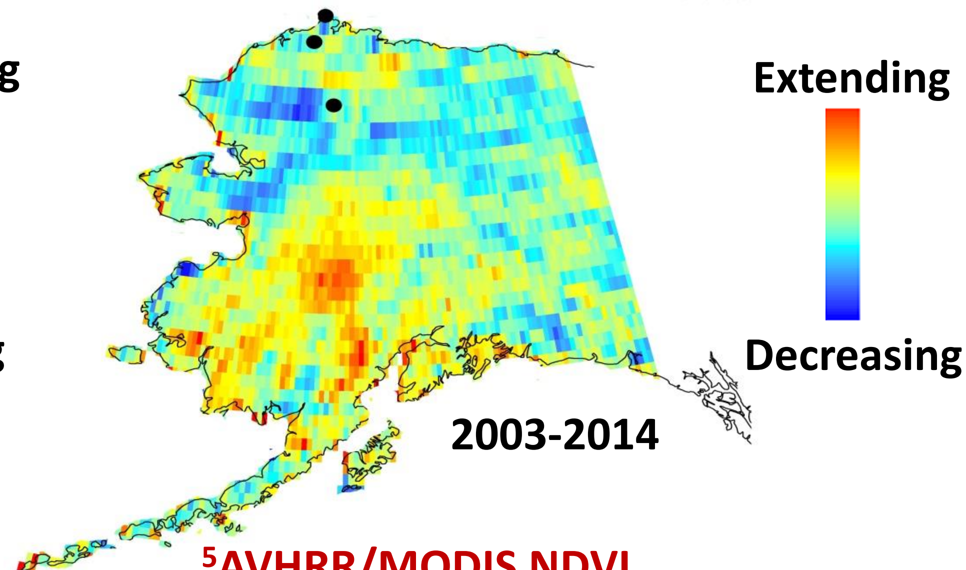


Satellite Observations: Monitoring Regional Change

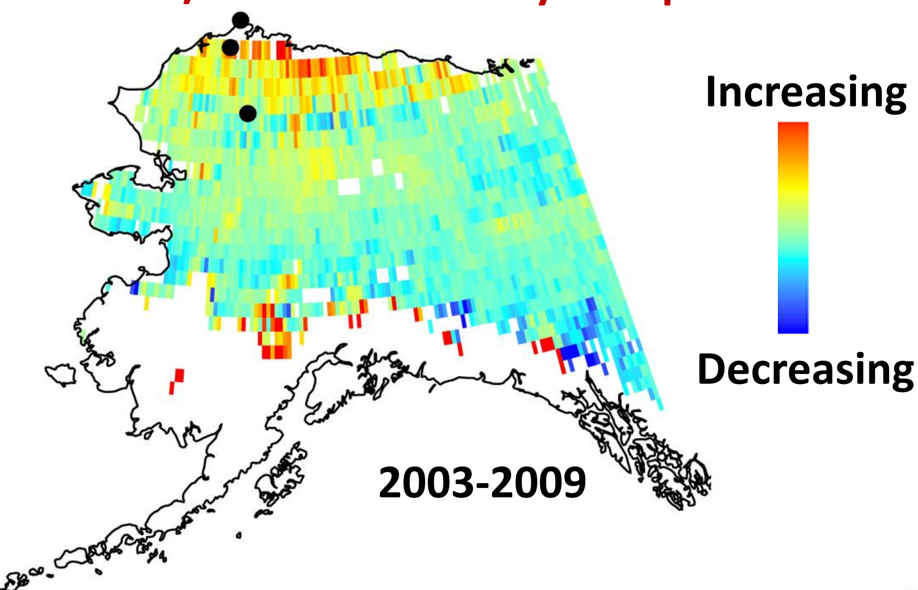
[1,2]AMSR Surface Water



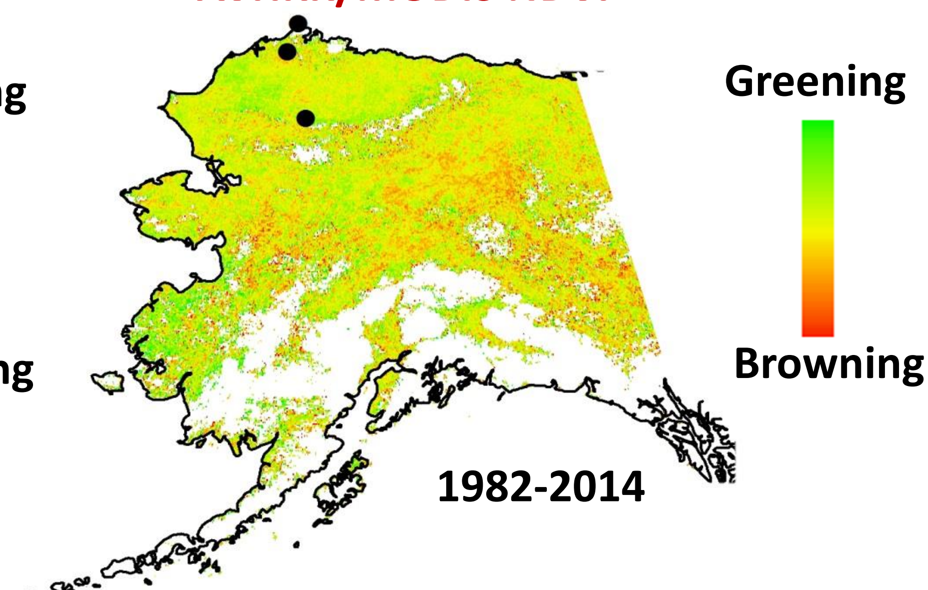
[3]AMSR Non-Frozen Season



[4]SSMI/MODIS Active Layer Depth

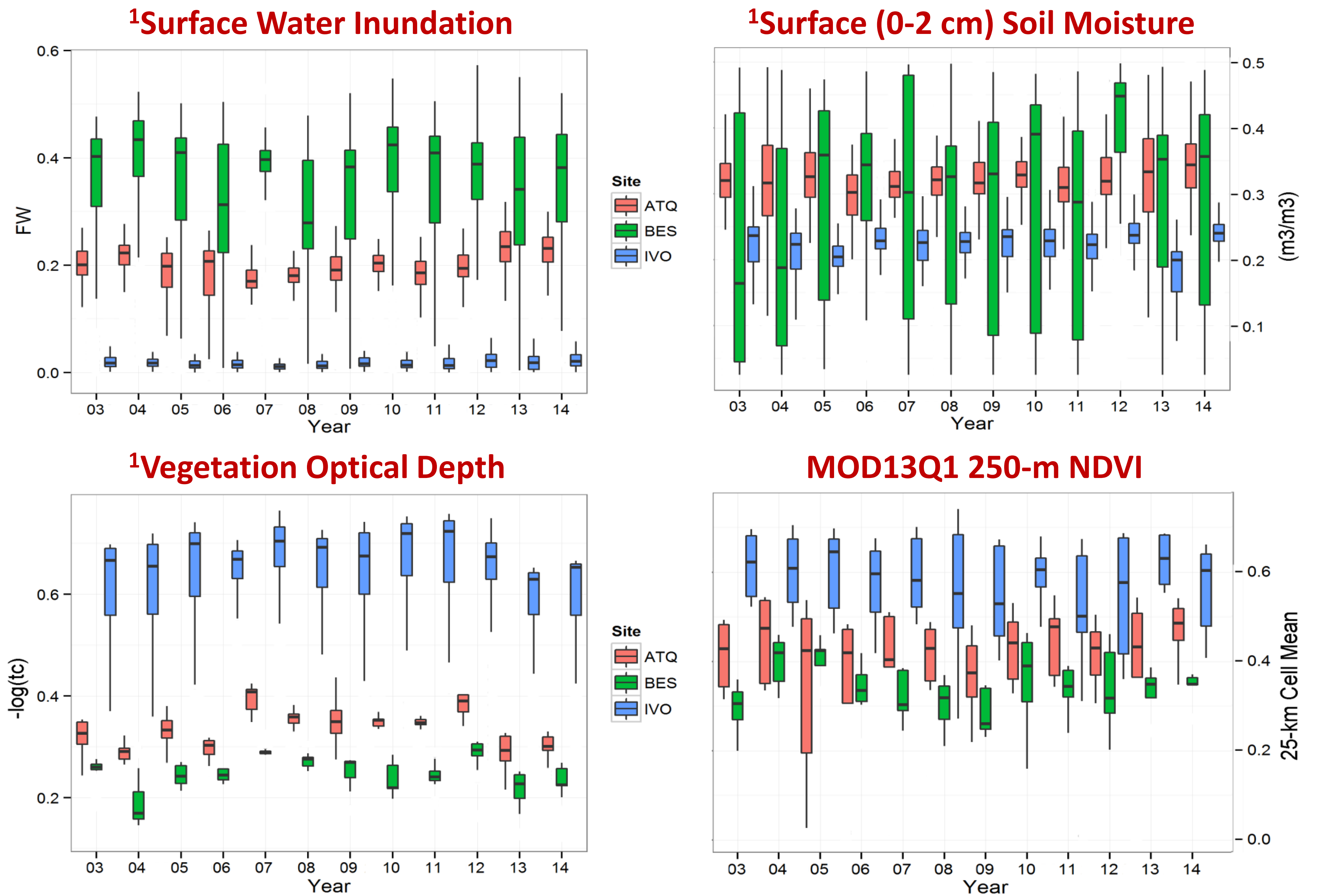


[5]AVHRR/MODIS NDVI



[1]Watts et al. 2014 *ERL;* [2]Du et al. 2015 *In-Review;* [3]Kim et al. 2015 *ERL;* [4]Park et al. 2015 *RSE*; [5]Didan et al. 2010 *IGRSS*

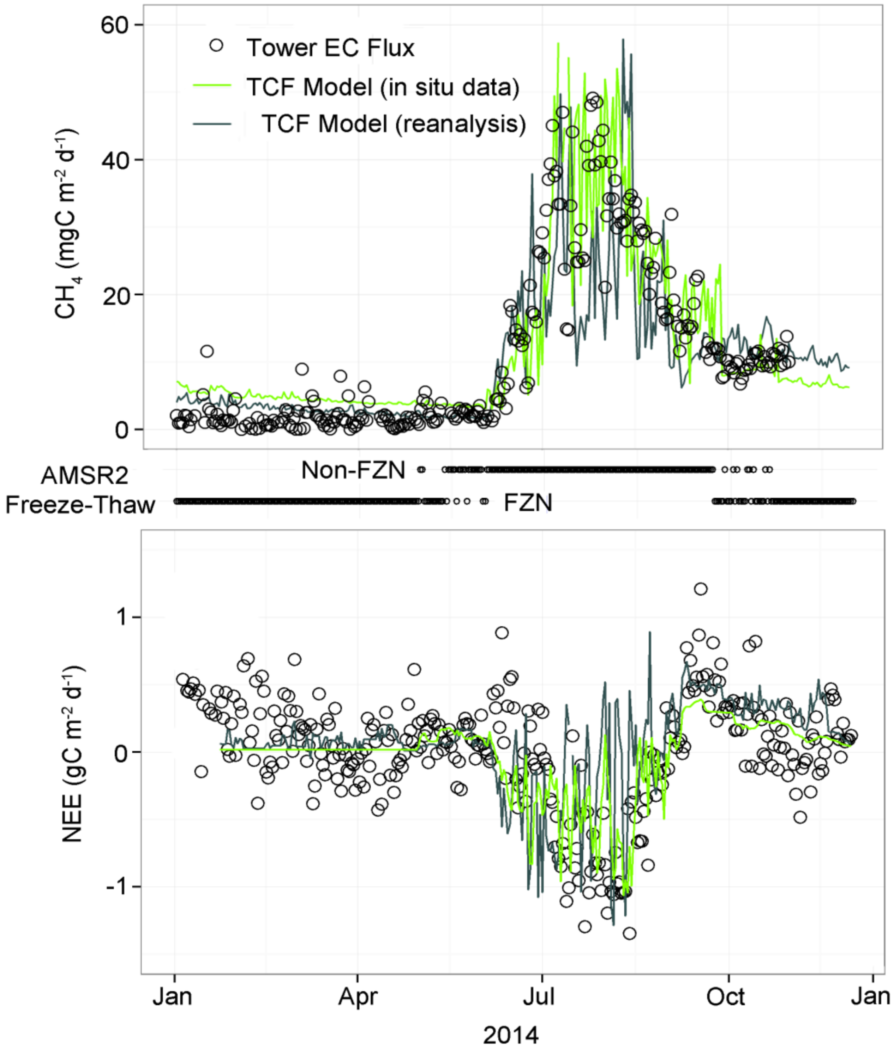
Satellite Observations: Monitoring Tower Transects



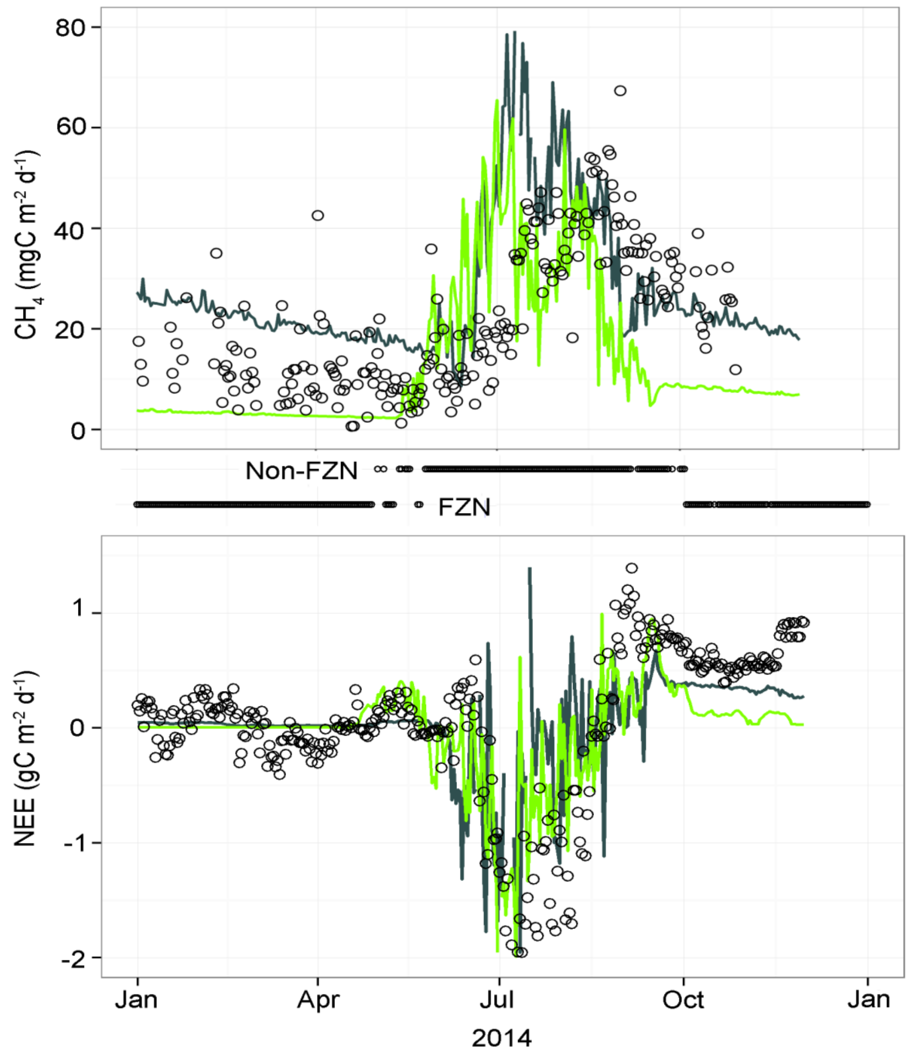
[1]AMSR-E/2 Daily Land Parameter Retrievals: http://www.ntsg.umt.edu/project/amsrelp

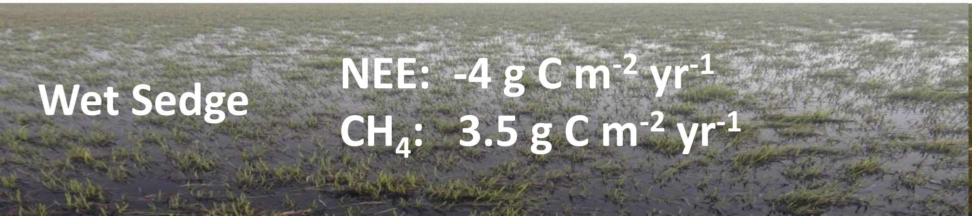
Ecosystem Modeling & Tower Carbon Fluxes

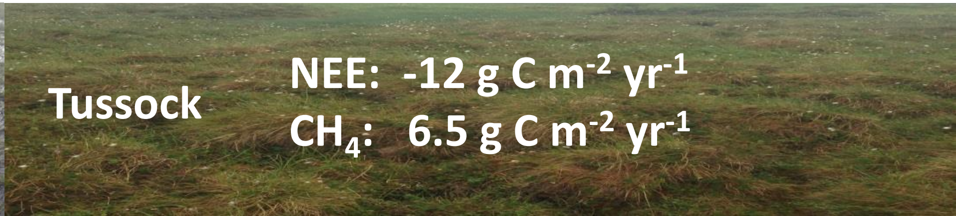
BES



IVO

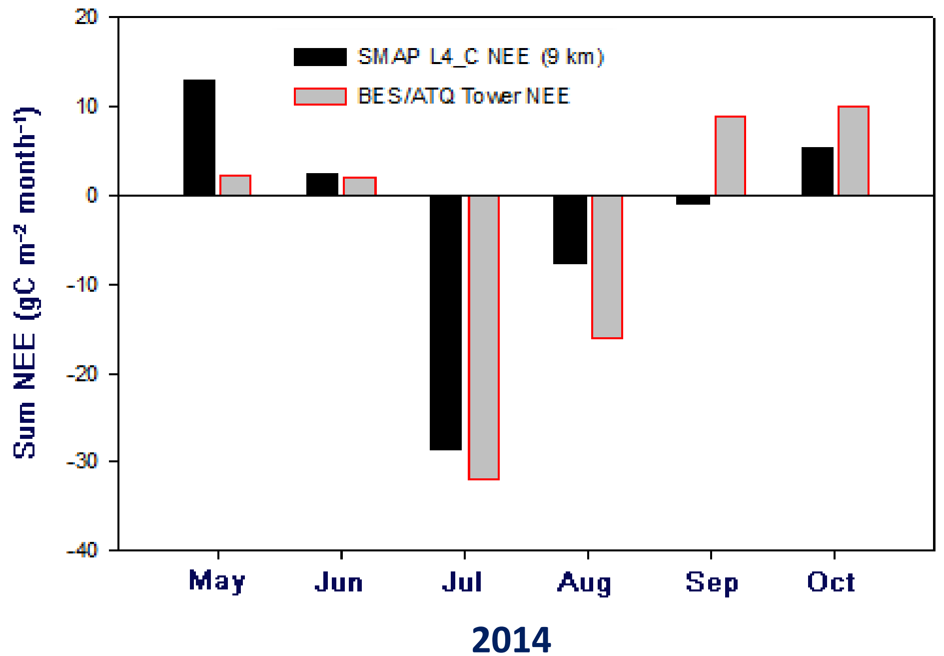






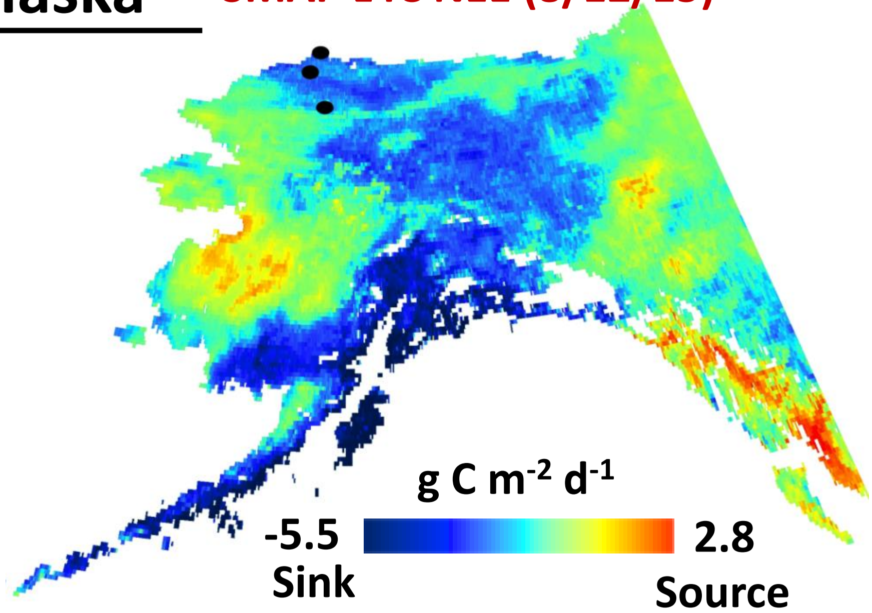
Scaling Carbon Fluxes to Regional Alaska

- [1]**Beta release of NASA SMAP L4 Carbon Maps**
  - Radiometer informed soil moisture & temp.
  - 9 km spatial res. & daily NEE, GPP, Reco fluxes
  - Data from April 2015 onward

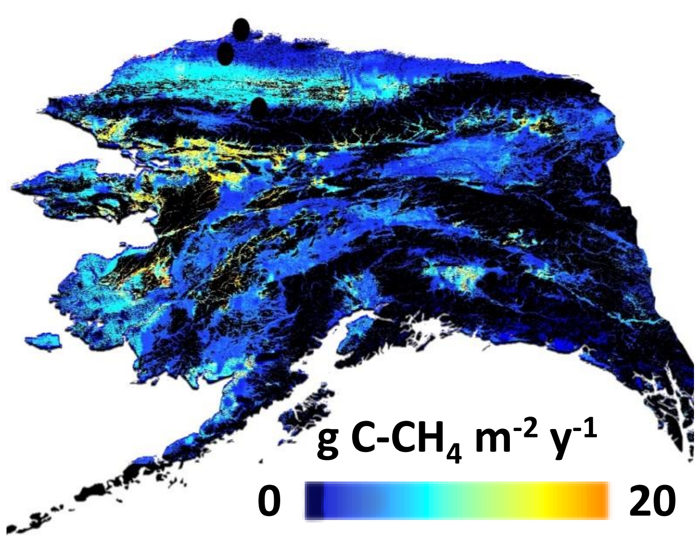


- **Off-line 1 km TCF CH_4 Flux Model**
  - Regional validation using tower data (5+ sites)
  - Evaluation against airborne & tall tower obs., inverse models

SMAP L4C NEE (8/12/15)

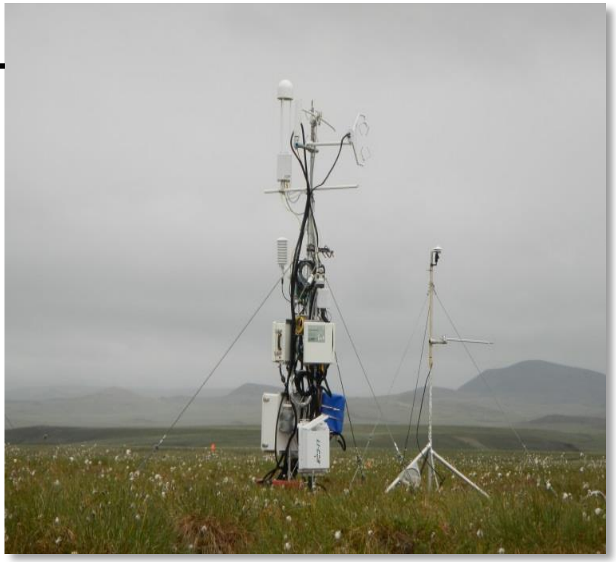


Regional CH_4 Modeling



[1]SMAP L4 Global Daily Carbon Products: http://nsidc.org/data/SPL4CMDL

Project Summary & Conclusions



- **Continuous flux tower operations needed!**
  - Quantify cold season fluxes; spring/autumn periods
  - Capture interannual variability in NEE & CH_4
  - Extend tower network in Alaska to represent heterogeneous tundra environments

- **Integrate tower obs., remote sensing & modeling**
  - Satellite data driven modeling captures flux variability; detects transitions from carbon sink to source
  - Carbon budgets: NEE + terrestrial (& lake) CH_4 emissions
  - Enhance Arctic monitoring through daily passive microwave retrievals (*e.g. surface wetness/temp., frozen/non-frozen conditions, vegetation dynamics, permafrost degradation*)

Thank You!

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