Seasonal changes of the ice-ocean-atmosphere-terrestrial system on the Yamal

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Main Points for Yamal: **Strong increase in summer coastal open water, but weak land temperature and NDVI trends**
Positive fall increases in open water, land temperatures and NDVI.

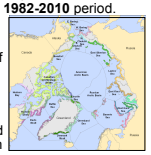
Motivation and Methods

Goal: Investigate the role of seasonality in current understanding of tundra-climate relationships

Data: Use 25 km resolution SSMI passive microwave Bootstrap Sea Ice Concentration (SIC), AVHRR Surface Temperature (T_s), and new GIMMS $NDVI_{3g}$ for the Arctic over the **1982-2010** period.

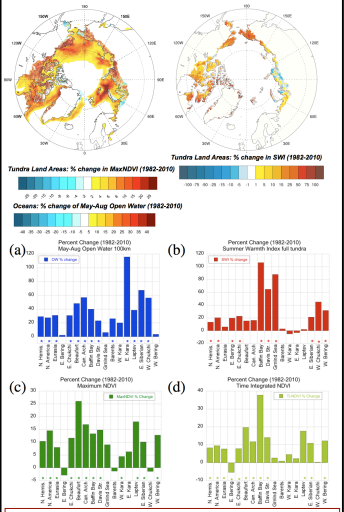
Methods:

- Trend and correlation analysis applied time series of Maximum NDVI, Time Integrated NDVI, Summer Warmth Index and Sea ice concentration.
- Full tundra domain over land and over ocean within 100-km of Arctic coastlines .



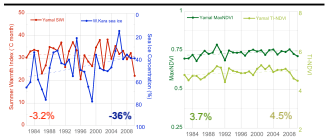
Map delineating study regions.

Trends in Open Water, MaxNDVI & SWI



- **MaxNDVI and temperature trends are larger in N. America**
- **SWI trends very small from Barents to Laptev, consistent with TI-NDVI trends.**
- **E. Bering/W.Chukchi display MaxNDVI & Ti-NDVI decline.**
- **W. Kara displays increases as well as decreases in SWI and MaxNDVI (spatial trend plots).**

Large Variability and Significant Correlations

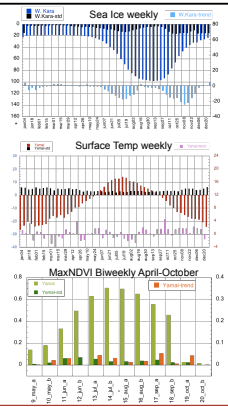


Detrended Correlations (Significance bold(95) & italic (90))		
	TI-NDVI	Sea-Ice
SWI	0.62	-0.39
TI-NDVI		*-0.34*

- **MaxNDVI weakly correlated with sea ice and SWI.**
- **Correlations using summer open water area are similar to those with sea ice.**

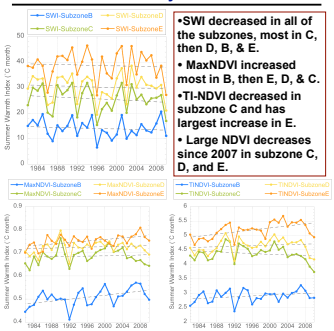
- **Sea ice concentration (100km coastal zone) displays significant decreases (blue).**
- **SWI shows a small decrease from 1982-2010 (red).**
- **NDVI (greens) displays small positive trend but show a decline since 2007.**

Seasonality of Trends & Variability



- **Largest sea ice declines are in spring and fall.**
- **Surface temperatures show fall warming and primarily cooling during spring and summer.**
- **MaxNDVI increases most near peak and in fall. In contrast, Beaufort region MaxNDVI increased more and the increases are largest during summer peak season.**

Yamal SWI & NDVIs by Bioclimate Subzone



- **SWI decreased in all of the subzones, most in C, then D, B, & E.**
- **MaxNDVI increased most in B, then E, D, & C.**
- **TI-NDVI decreased in subzone C and has largest increase in E.**
- **Large NDVI decreases since 2007 in subzone C, D, and E.**

Take Home Message

- **Greening over Yamal is smaller than that in other parts of the Arctic.**
- **Large decrease in the North Kara Sea May-Aug open water corresponds to virtually no change in land temperatures or NDVI.**
- **There is generally good correspondence between changes in both max NDVI and TI-NDVI with changes in SWI.**
- **Land temperatures have warmed slightly in fall and even cooled in summer.**
- **Large amplitude natural variability strongly influences year-to-year values.**

References

- Pinzon, J. E., et al., 2011 (in prep), A revised AVHRR 8-km NDVI Data Set - Compatibility with MODIS and SPOT Vegetation NDVI Data.
- U.S. Bhatt, D.A. Walker, M.K. Raynolds, J.C. Comiso, H.E. Epstein, G.Jia, R. Gens, J.E. Pinzon, C.J. Tucker, C.E. Tweedie, and P.J. Webber, 2010: Circumpolar Arctic tundra vegetation change is linked to sea-ice decline, Earth Interactions, Vol. 14, No. 8: 1-20. doi: 10.1175/2010EI315.1..

Acknowledgements

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