M140A

Understanding Recent Arctic Tundra Vegetation Changes

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Main Results

- **Trends of Tundra SWI, NDVI, and Snow Water Equivalent are Heterogenous.**
- **Areas adjacent to increased open water (sea ice declines) display largest warming increases.**
- **Incorporating the role of snow is IMPORTANT, however, Arctic snow data is problematic.**
- **Changes in Arctic moisture and it's mechanisms deserve further attention.**

Motivation and Methods

Goal: Understand tundra-climate relationships

Data: 1) Use 25 km resolution SSMI passive microwave Bootstrap Sea Ice Concentration (SIC); **2)** AVHRR Surface Temperature (T_s); **3)** GIMMS Normalized Difference Vegetation Index 3G $NDVI_{3g}$ for the Arctic over the 1982-2010 period. **[Raynolds et al. 2012, Pinzon et al. 2011]**

NDVI = (NIR-R)/(NIR+R)
NIR: spectral reflectance in near-infrared band (0.725-1.1 μm) & R: red chlorophyll absorbing portion of spectrum (0.58-0.68 μm)

Methods: Standard climate trend and correlation analysis techniques applied to regional (Modified Treshnikov basins) time series of Maximum NDVI, Time Integrated NDVI, Summer Warmth Index, and sea ice concentration constructed using data within 50-km of Arctic coastlines (ocean & land) .

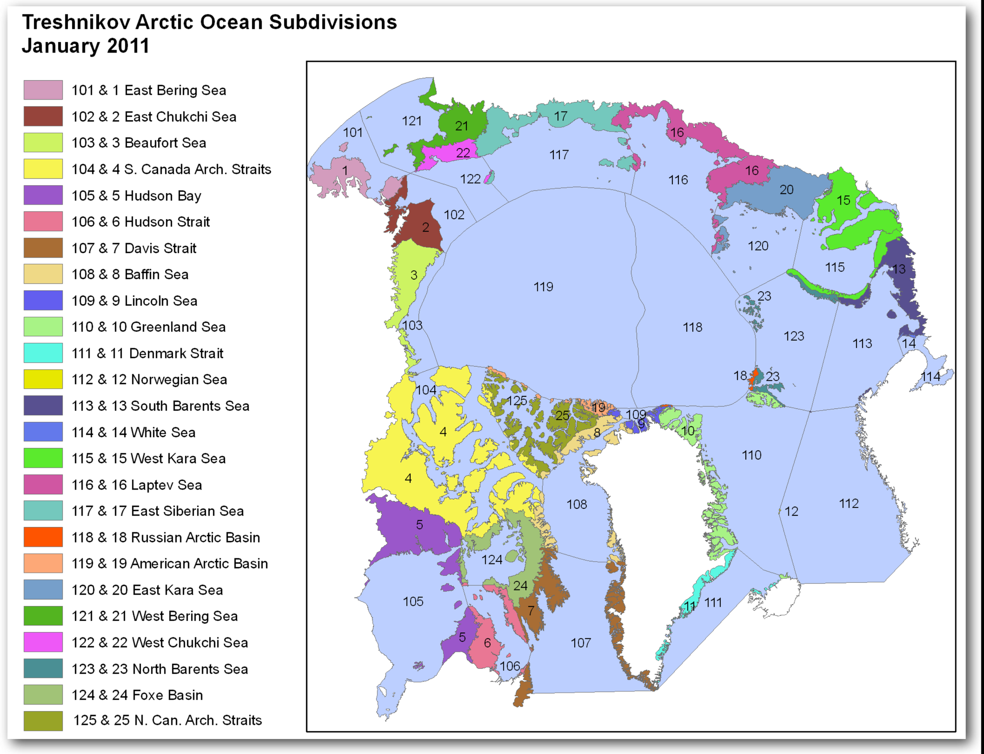


Figure 1. The new 2011 Updated Treshnikov divisions.

Summer Warmth, MaxNDVI & Open Water Trends

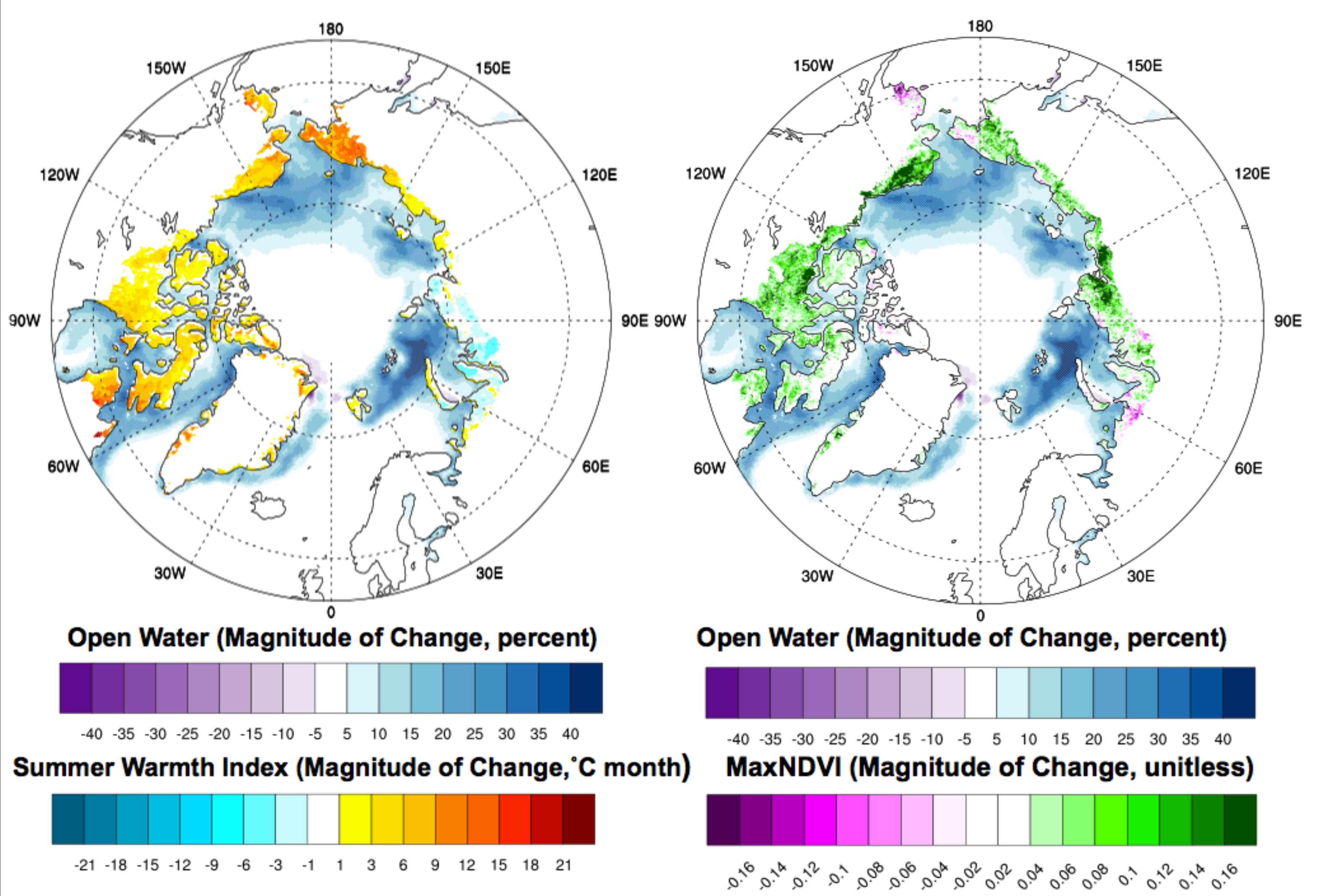


Figure 2. Trends for summer (May–August) open water (left and right panels), annual MaxNDVI (right panel) and land-surface summer warmth index (annual sum of the monthly mean temperatures > 0°C) (left panel) derived from AVHRR thermal channels 3 (3.5–3.9 μm), 4 (10.3–11.3 μm) and 5 (11.5–12.5 μm). Trends were calculated using a least squares fit (regression) at each pixel. The total trend magnitude (regression times 29 years) over the 1982–2010 period is displayed.

[Updated Bhatt et al. 2010]

Snow Water Equivalent trends are heterogenous

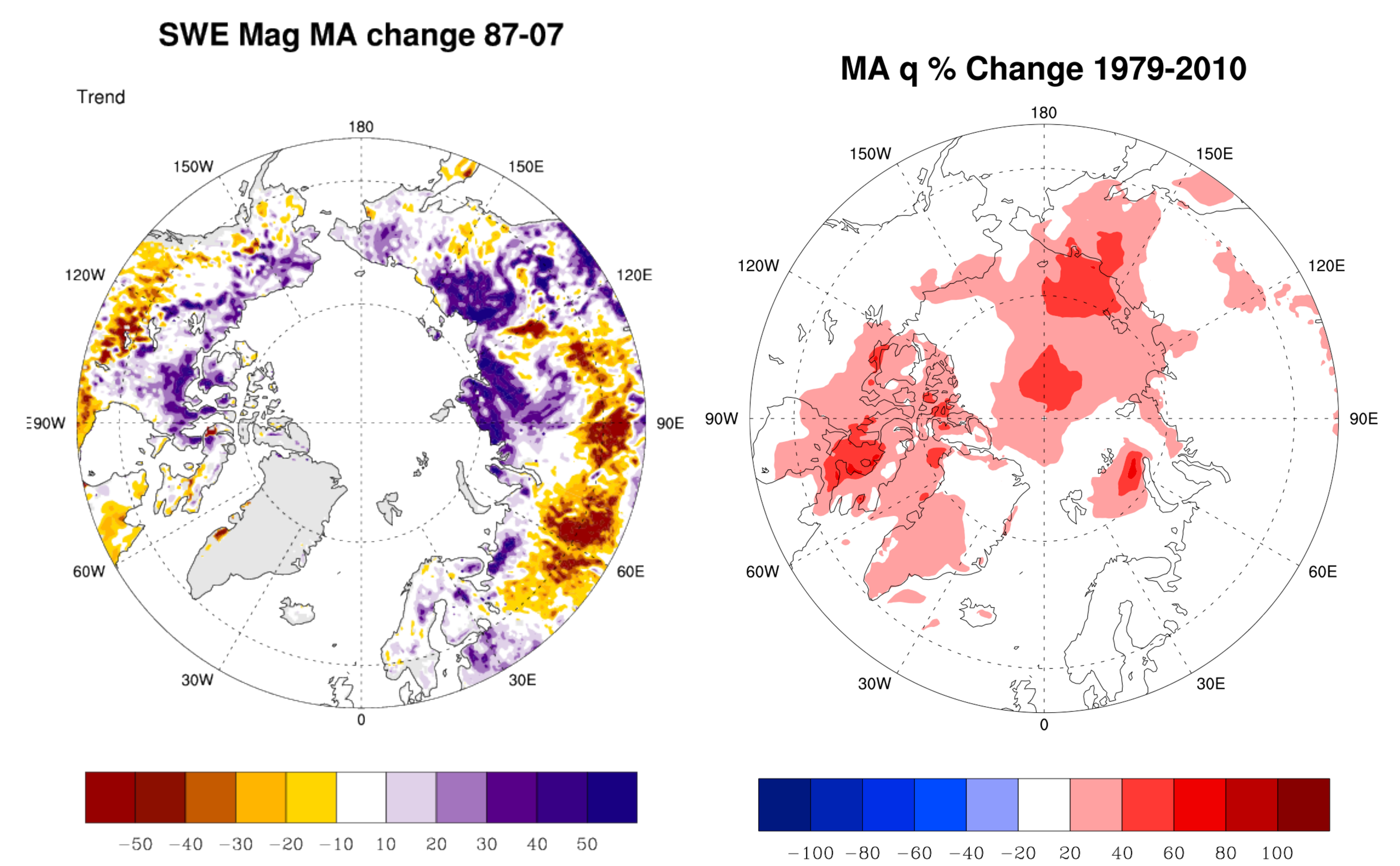


Figure 3. Trends for spring (May–April) Snow Water Equivalent (SWE) (left panel) and specific humidity (right panel). The SWE data are remote sensing data from SSM/I and the specific humidity data are from the CFSR reanalysis. Trends were calculated using a least squares fit (regression) at each pixel. Trends are displayed as magnitudes for SWE and percent change for q over the 1987–2007 and 1979-2010 periods, respectively.

- **Snow Water Equivalent trends suggest more spring snow in High Canadian Arctic and central Eurasia - consistent with TINDVI trends.**
- **Specific humidity trends from CFSR Reanalysis display increases in Spring.**

Can CFSR Reanalysis fill in observational gaps?

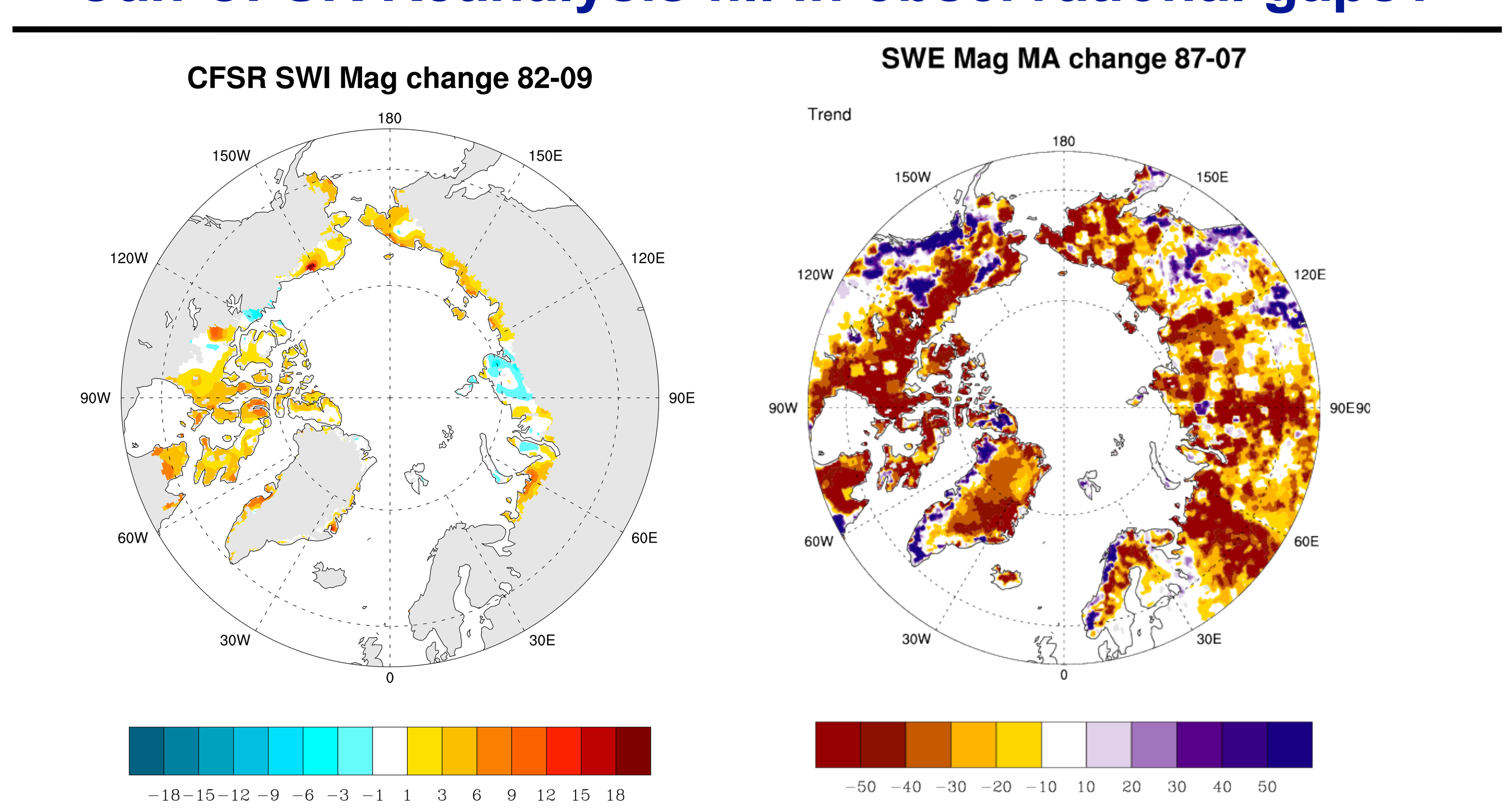
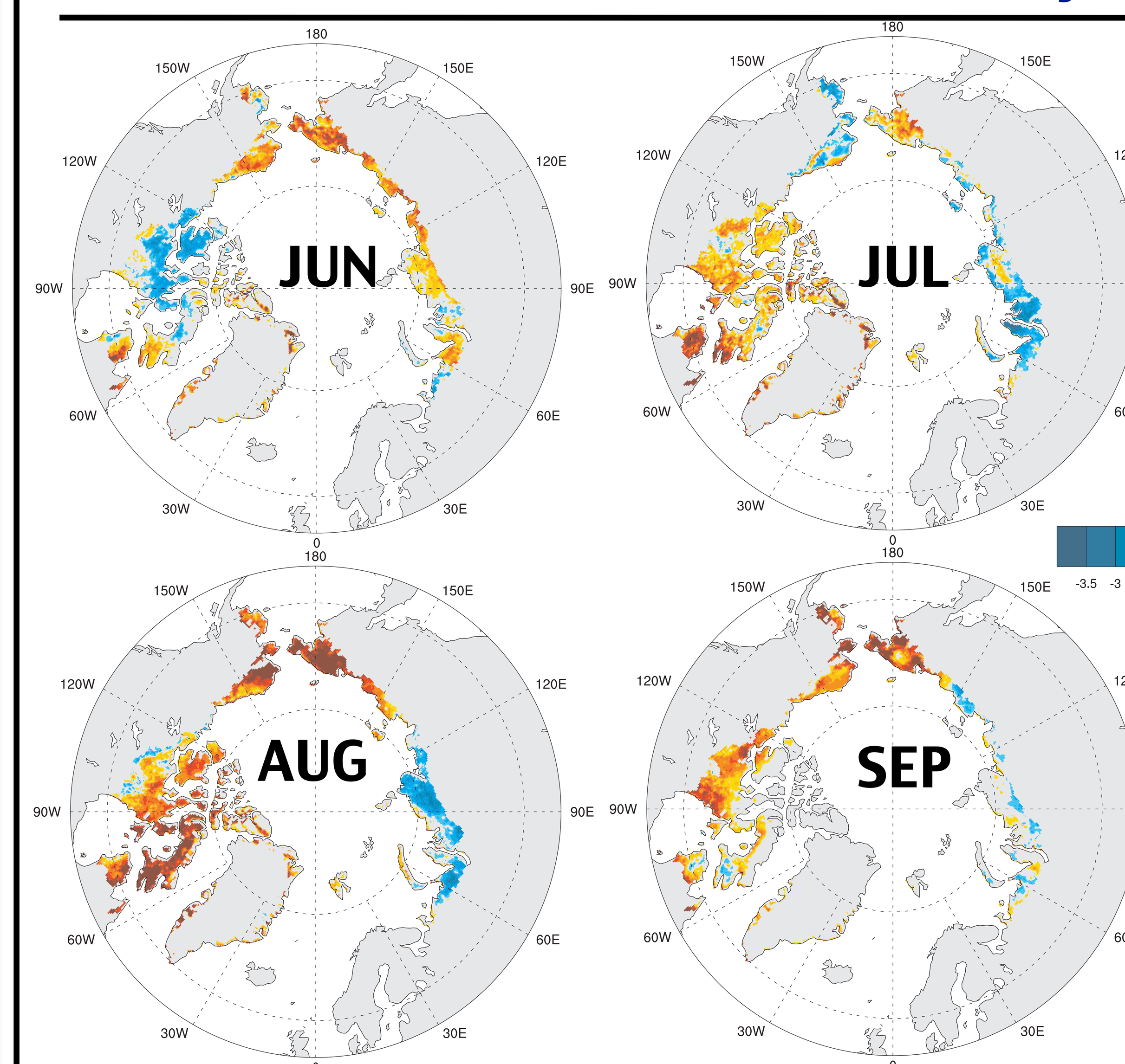


Figure 4. Trends for summer (May–August) SWI (left panel) and SWE during spring (March-April) from the CFSR Reanalysis data. The total trend magnitude over the 1982–2009 and 1987-2007 period for SWI and SWE, respectively, are displayed for direct comparisons with same quantities from remote sensing data.

- **Summer Warmth Index trend from CFSR compares favorably with AVHRR.**
- **Snow Water Equivalent trend from CFSR does not resemble SSM/I trends.**

Summer Warmth Index Monthly Trends



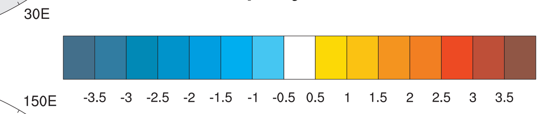
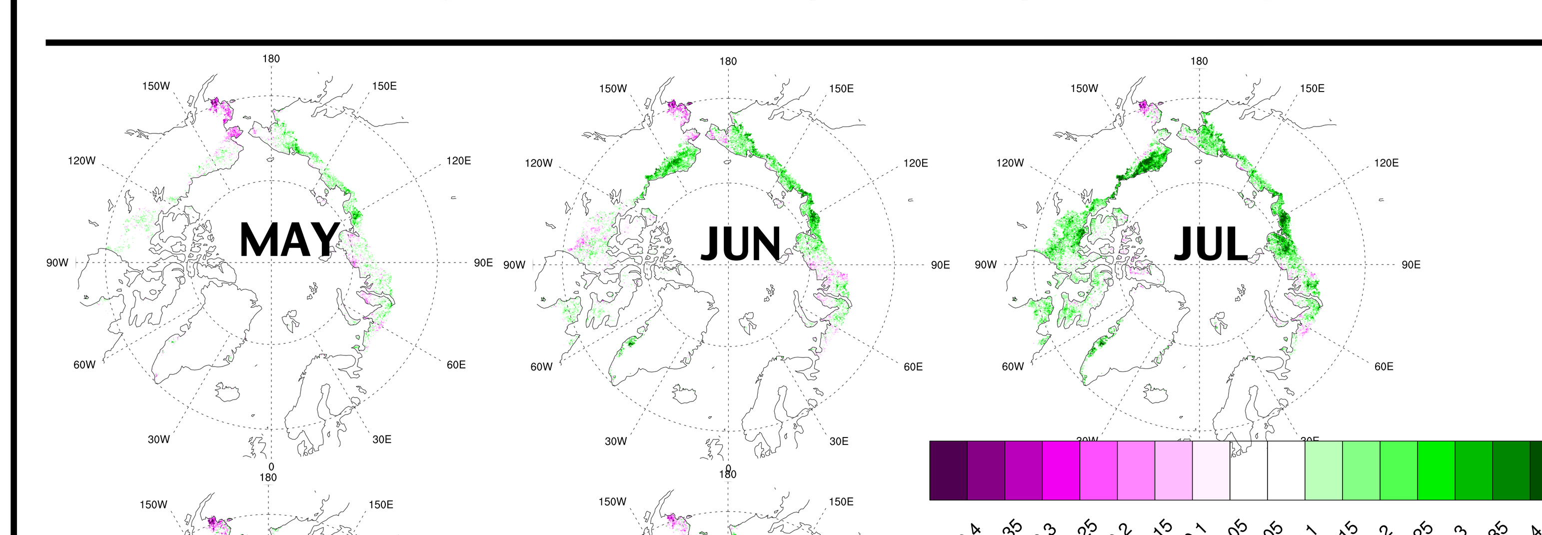


Figure 5. Trends for land-surface summer warmth index (annual sum of the monthly mean temperatures > 0°C) for various months. The total trend magnitude (regression times 29 years) over the 1982–2010 period is displayed.

- **High Canadian Arctic - Is the low June SWI due to snow?**
- **Central Eurasia is cooling during middle of summer - Is this due to clouds or circulation?**

Time Integrated NDVI (TINDVI) Monthly Trends



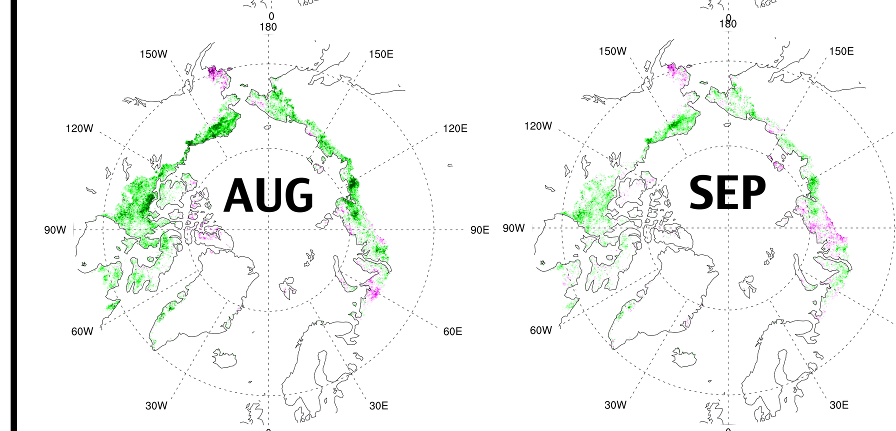


Figure 6. Trends for Time Integrated NDVI (sum of biweekly MaxNDVI). Trend magnitude from 1982–2010.

- **High Canadian Arctic - July-August greening trends.**
- **SW Alaska browning all summer!**

References

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Acknowledgements

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