Alaska Coastal Tundra Vegetation’s Links to Climate

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Main Results

- Beaufort greening linked to both warming and cooling in summer and changes in the local/regional atmospheric circulation
- WRF simulation shows increase in winds speeds over the Beaufort Sea in response to warming adjacent land surface
- East Bering browning linked with decline in spring snow depth, and overall reduction in moisture of the landscape in summer

Alaska Arctic NDVI Trends

Normalized Difference Vegetation Index

NDVI = (NIR – RED) / (NIR + RED)

A satellite derived indicator of above-ground biomass

- Lowest NDVI near areas with greatest sea ice concentration
- NDVI increasing throughout the pan-Arctic
- Increasing NDVI related to decreased sea ice (e.g. Bhatt et al. 2010)
- Warmer summers in most coastal Arctic tundra regions

Beaufort and East Chukchi have local climate mechanism

- Beaufort High has weak trends, different monthly trends
- Correlated with sea ice concentration
- Mixed trends in summer cloudiness/temperature
- Changes more local
- Sea breeze known to exist on Beaufort Sea coast (e.g. Moritz 1977)
- Land/sea temperature contrast is changing
- How is the sea breeze circulation changing?

WRF: Enhanced sea breeze with warmer land surface

- WRF model v3.3 applied to investigate impact of warming Beaufort tundra region on local/regional atmospheric circulation
- Add/subtract 3°C anomaly to/from reference simulation
- 30 day simulation: 15 June – 15 July 2010

Conclusions

- Beaufort and East Chukchi NDVI increase linked with both warming and cooling, changes in local/regional circulation
- East Bering NDVI decline linked with reduced spring snow water equivalent, summer precipitation and drying landscape
- Additional analysis of WRF simulation needed to address response of convection to imposed anomalies in surface temperature in the Beaufort region

References

- Barrow station cloudiness: http://wiki.landscapetoolbox.org
- East Chukchi, decreasing in East Bering
- Summer Warmth Index (SWI) = sum of monthly T > 0°C
- East Bering browning linked with decline in spring snow depth, and overall reduction in moisture of the landscape in summer
- Why is NDVI declining?
- NDVI GIMMS3g+, Pinzon et al. (2010)
- Climate Forecast System Reanalysis (CFSR), Saha et al. (2010) available online: http://cfос.ncep.noaa.gov/cfsr/
- Ocean Heat Content from PIMOS, Steele et al. (2011)
- GPCP Combined precipitation data set v2.2, Huffman et al. (2011) available online: http://www.ncdc.noaa.gov/osclwmso/wcdace/ncdc1.html
- June 850hPa wind speed
- POS - REF - NEG - REF
- Anomaly applied to Reference (REF)
- Temperature
- Wind speeds are enhanced (red) when positive (negative) anomalies are applied in the simulation
- Sea breeze is enhanced with warmer Beaufort region
- Largest response in winds is over the ocean
- NDVI, SWI significantly correlated (Bhatt et al. 2010)
- East Bering is nearly ice free by summer
- NDVI declining throughout summer
- Bering sea has reduced heat content
- Spring Snow Water Equivalent (SWE) is decreasing
- Summer precipitation is also decreasing
- Lakes are drying in the region
- Similar changes noted by local Native Elders (e.g. Fienuip-Riordan and Rearden 2012)
- NDVI is likely reduced due to drier conditions

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