Precipitation as a Potential Climate Driver of Vegetation Trends in Southwest Alaska

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Main Findings

- AVHRR-based NDVI shows declining productivity trends in the Yukon-Kuskokwim Delta region, in contrast with the circumpolar Arctic
- Gridded monthly precipitation datasets show significant variability and reveal high uncertainty in precipitation climatology across Alaska
- Precipitation decline is likely not a key reason for the declining NDVI trends in the Yukon-Kuskokwim Delta Region

Hypothesis and Motivation

What are the possible climate drivers of observed vegetation trends in southwest Alaska, and can precipitation explain the recent browning in the YKD?

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)

- AVHRR derived Maximum-NDVI indicates a recent decline in growing season vegetation productivity in southwest Alaska’s Yukon-Kuskokwim Delta (YKD), since 1995.
- Circumpolar Arctic shows an overall positive trend in NDVI associated with increasing temperatures.
  - Southwest Alaska (East Bering Sea) region has experienced a comparatively large increase in the summer warmth index, >10°C month, during the growing season at >95% (Bhatt et al, 2010)
- Can growing season (June, July, August) precipitation variability account for the anomalous recent browning in the YKD?

Data and Methodology

- Monthly gridded precipitation data (accessible at http://www.esrl.noaa.gov/psd/data/gridded/tables/precipitation.html)
  - Climate Prediction Center Merged Analysis of Precipitation (CMAP)
  - Global Precipitation Climatology Project (GPCP)
  - National Centers for Environmental Prediction Reanalysis (NCEP)
  - NOAA’s Precipitation Reconstruction over Land (PREC/L)
  - University of Delaware Precipitation (UDP)
  - European Centre for Medium-Range Weather Forecasts-Interim reanalysis (ERA-Interim)
- ERA-Interim downregridded to 20 km grid (Bieniek et al, 2016)
- ERA-Interim used as comparison dataset due to its improved spatial representation of precipitation in Alaska (Bieniek et al, 2016)

Table 1: Time series correlation to Bethel WSO

<table>
<thead>
<tr>
<th>Precipitation Source</th>
<th>ERA-Interim</th>
<th>CMAP</th>
<th>GPCC</th>
<th>NCEP</th>
<th>PREC/L</th>
<th>U Del</th>
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</thead>
<tbody>
<tr>
<td>JJA precipitation</td>
<td>0.46</td>
<td>0.83</td>
<td>0.89</td>
<td>0.79</td>
<td>-0.33</td>
<td>0.71</td>
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<tr>
<td>Time series</td>
<td>Time series</td>
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</tbody>
</table>

NDVI trend maps derived from Landsat TM/ETM+ and MODIS permit intercomparison of GIMMS-3g trends for 2000–2016. The high spatial resolution of Landsat (30m) and MODIS (500m) are also useful for evaluating potential climate drivers and resolving “hotspots” of NDVI change that pertain to local disturbance (e.g., coastal erosion, fire) and vegetation changes (shrub expansion) rather than broad scale climate drivers.

Both MODIS and Landsat TM/ETM+ record generally corroborate the browning observed by GIMMS-3g in coastal areas—but not in inland areas, many of which have seen a rapid increase in the shrub cover. Taken together, the three time-series suggest trends follow a coastal-inland gradient which may be related to regional climate drivers.

Conclusions (or just more questions?)

- Precipitation datasets are highly variable and difficult to interpret
- Data are showing both increasing and decreasing trends, but which is right?
- Precipitation alone does not account for NDVI decline in YKD
- More to the story than precipitation
- Other climate variables to consider: clouds, wind, extreme events

Intercomparison of NDVI datasets

- Trends also show little agreement between datasets
  - Two strong negatives = ERA-1, U.Del; Two strong positives = CMAP, GPCC
  - Bethel trend is positive at 36 mm over the 34-year period

Some datasets are closer than others (to Bethel at least)

Acknowledgements

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