North American Gross Primary Productivity: Regional Characterization and Interannual Variability

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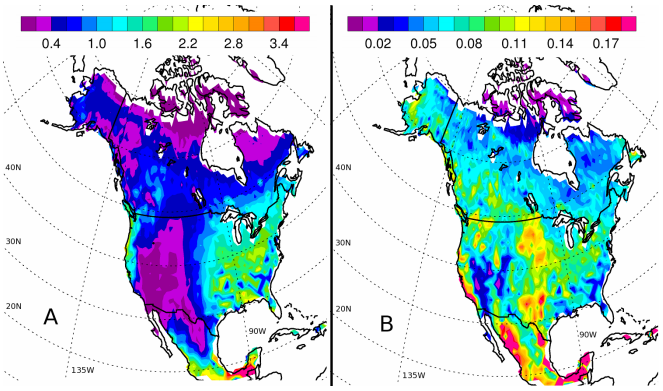
ABSTRACT

It is appealing to link large-scale ecophysiological behavior to modes of climate variability such as El Niño/Southern Oscillation (ENSO) or Northern Annular Mode (NAM; here considered synonymous with North Atlantic Oscillation, NAO). Previous studies (i.e. Schaefer et al., 2002; Russell and Wallace, 2004) have shown a link between NAM and carbon uptake in the Eurasian continent, in the form of extended growing season and increased Gross Primary Productivity (GPP) during the the positive phase. In North America, identifying definitive relationships has been more elusive.

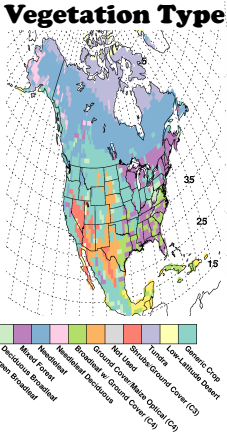
In this study, we evaluate North American GPP from a modeling standpoint. Annual productivity, variability, and seasonality is shown, and we break down continental-scale GPP in terms of regional and seasonal contribution. We also regress GPP variability against variability in meteorological forcing mechanisms.

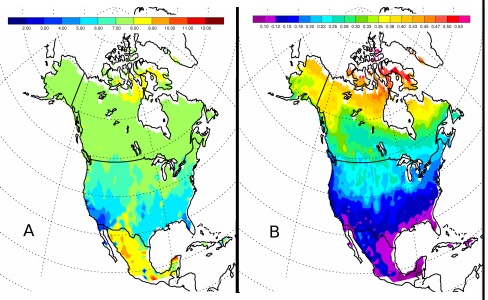


Mean Annual GPP (kg/m2)

Standard Deviation: Annual GPP

Vegetation Type





Month of Max GPP

Fraction of Annual GPP in Max Month

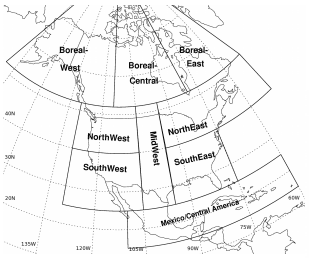
Simulation Tidbits

Model: SiB3 **Years:** 1983-2006 **Grid:** 1x1 Cartesian

Meteorology: NCEP2, Precipitation Scaled to GPCP

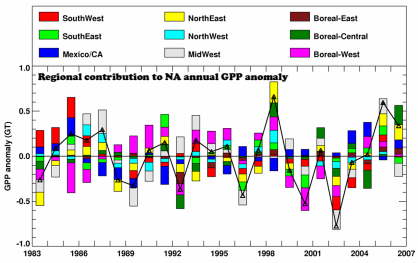
Vegetation: DeFries and Townshend, 1994

Phenology: GIMMSg NDVI (Tucker 2005)

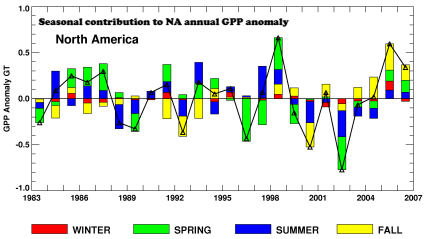


- Boreal-West and MidWest stand out, but no single region dominates annually
- Spring tops seasonal variability in 11 of 24 years; Summer (7) and Fall (6) are secondary
- Soil Moisture is preferential to precipitation for its integrative nature, and determines variability in south; Temperature north
- Single mechanism explains more variability in arid regions
- Lags: Temperature has small signal for growing season expansion, negative impact in summer (heat stress); Precipitation only has direct effect in summer
- Annual GPP variability on continental-scale does not correlate with modes of climate variability (ENSO, NAM)

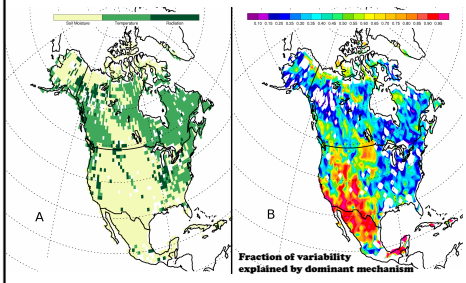
Is Continental GPP Variability Determined by Region?



Or Season?

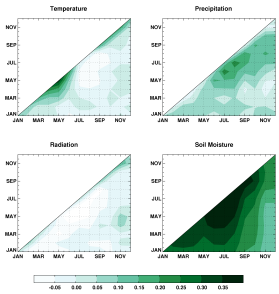


What Mechanisms Explain Annual GPP Variability?



Fraction of variability explained by dominant mechanism

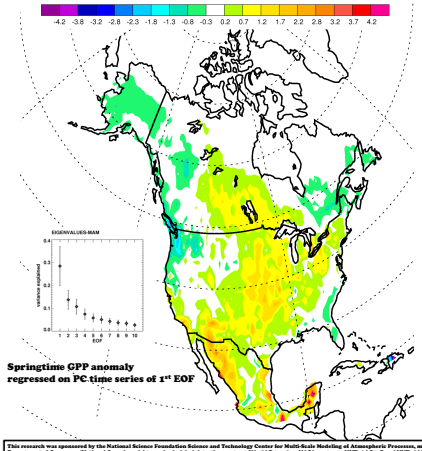
Time Lags



Above: Monthly mechanism anomaly, lag-correlated with GPP

Do Patterns Emerge?

g/m² (spring)



Springtime GPP anomaly regressed on PC time series of 1st EOF

- Springtime: first eigenvalue is significant, following North et al. 1982
- No significant eigenvalues for other seasons, or annually
- Spring GPP variability regressed on PC time series of 1st EOF shows mid-continent strength
- This pattern is not correlated with a single mechanism (temperature, soil moisture, precipitation) or mode of climate variability (ENSO, NAM)
- How is this pattern determined? Right now we cannot explain it in terms of a single, coherent mechanism

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