Analysis of the relationship between climate and NDVI variability at global scales

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1. Introduction: interannual variability in modeled (CASA) C flux is in part caused by interannual variability in NDVI (FPAR) (Fig. 1).

2. Justification: Is interannual variability in NDVI explained by climate? Here we examine the sensitivity of NDVI to interannual variability in precipitation and temperature.

3. Data:

   Table 1. Data sets used.

   \begin{tabular}{|l|l|l|}
   \hline
   Resolution & Spatial (°) & Temporal Period \hline
   GIMMS 3g NDVI & 0.08 & Semimonthly 1981-2010 \hline
   GPCP precipitation\textsuperscript{6} & 2.5 & Monthly 1979-2009 \hline
   CRU climatology\textsuperscript{3} & 0.5 & Monthly 1961-1990 (base) \hline
   GIS temperature anomaly\textsuperscript{4} & 2 & Monthly 1880-2010 \hline
   \end{tabular}

   • Data sets used: long record; global coverage; consistent with data sets of higher quality (Fig. 2);
   • Use of TRMM precipitation (40°N-40°S, 0.25°, semimonthly, 1998-2010)\textsuperscript{2} gives the same result.

4. Methods:

   4.1. Conducted Pearson’s correlation analyses at pixel level with varying lags (of NDVI response to climate) on:
   - 1982-2009 NDVI – precipitation anomaly time series (monthly, 1×1°);
   - 1982-2010 NDVI – temperature anomaly time series (monthly, 0.5°×0.5°);
   4.2. Accounted for first-order temporal autocorrelation following Dawdy and Matalas (1964)\textsuperscript{2}. Only significant correlation coefficients (r values with corrected p values <0.05, two-tailed t-test) are shown.

5. Results:

5.1. NDVI – precipitation anomaly correlations:

Fig. 3 NDVI – precipitation correlations for the whole time series (1 month lag).

• Results using monthly precipitation here were consistent with those using accumulative precipitation (not shown.)
• Strongest for 1-month preceding precipitation;
• Significant in 36% of land pixels;
• Positive in arid and semiarid areas where grasslands and shrublands are the dominant land cover types.

Fig. 4 Averaged r values of the whole time series vs. lags for different land cover types in different regions (error bars: 1σ).

• Higher herbaceous cover (forests \rightarrow woody savannas \rightarrow savannas \rightarrow closed+open shrublands & grasslands);
• Stronger correlations and clearer 1-month peak lag pattern.

5.2. NDVI - temperature anomaly correlations:

Fig. 5 NDVI – precipitation correlations for May (left) and August (right) in central US.

• Early growing season (May): NDVI most sensitive to precipitation during winter and spring;
• End of growing season (August): NDVI most sensitive to more recent precipitation.

Fig. 6 For the whole time series (no lag).

• Strongest for current month temperature (Fig. 6&7);
• Significantly positive in 40% of total land pixels, and 77% of these pixels are north of 35°N (Fig. 6);
• Not associated with land cover types.

Fig. 7 Averaged r values vs. lags for different regions.

• This study confirms a mechanism producing variability in modeled NPP:
   - NDVI (FPAR) interannual variability is strongly driven by climate;
   - The climate driven variability in NDVI (FPAR) can lead to much larger fluctuation in NPP vs. the NPP computed from FPAR climatology (Fig. 8).

Acknowledgements: This work is supported by NASA’s Carbon Monitoring System project and Carbon Cycle Science element of the Terrestrial Ecology Program.

References:

Fig. 8 Annual NPP modeled from variable FPAR vs. from FPAR climatology.