Vegetation response to extreme climate events and grazing on the Mongolian plateau from 2000-2010

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Introduction

Extreme climatic events on the Mongolian Plateau have lead to severe summer droughts as well as extreme winters in the last decade. The objectives of this study are to quantify spatio-temporal changes in vegetation greenness anomalies using long term earth observation data records and possibly explain the climate drivers of these anomalies using meteorological data trends. Our research questions are: What are the vegetation responses to these climate extremes, over space and time in the last decade as compared to long term means on the plateau? Were there any significant differences between the biomes, especially during the extreme summer drought of 2000-02 & 2009 and winter *dzud* of 2010?

Also, in order to determine the role of grazing on CO2 fluxes in the desert steppe, paired eddy covariance (EC) systems were used to measure gross ecosystem production (GEP), Respiration (Re), net ecosystem exchange (NEE) and microclimate on grazed and ungrazed steppe in 2010 (wet year) and 2011 (dry year).

Eddy Covariance and ground measurements

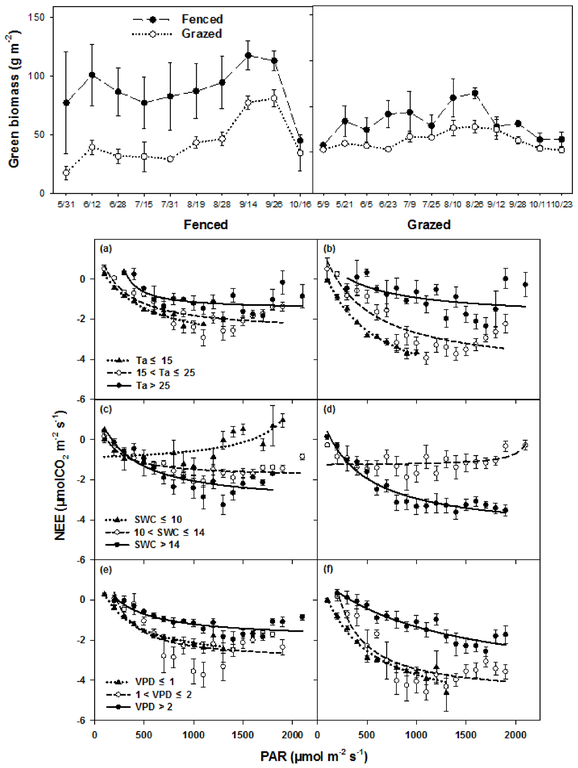


Figure 1: Seasonal variations of green biomass in the fenced and grazed desert steppes in 2010 and 2011.

Figure 2: Daytime NEE light response curves under different air temperature (T_a, °C), volumetric soil water content (SWC, %), and vapor pressure deficit (VPD, kPa) levels during the vegetation active periods of DOY 221-249 in the fenced and grazed steppes in 2010.

Figure 3: Standardized anomalies of EVI2, White sky albedo and EVI in 2001 (a,c,e) and 2009 (b,d,f) summer drought. Negative VI anomalies correlate with positive albedo anomalies (a & e correlate with c). VI anomalies are also validated by TRMM 2001 & 2009 July-August anomalies (g & h

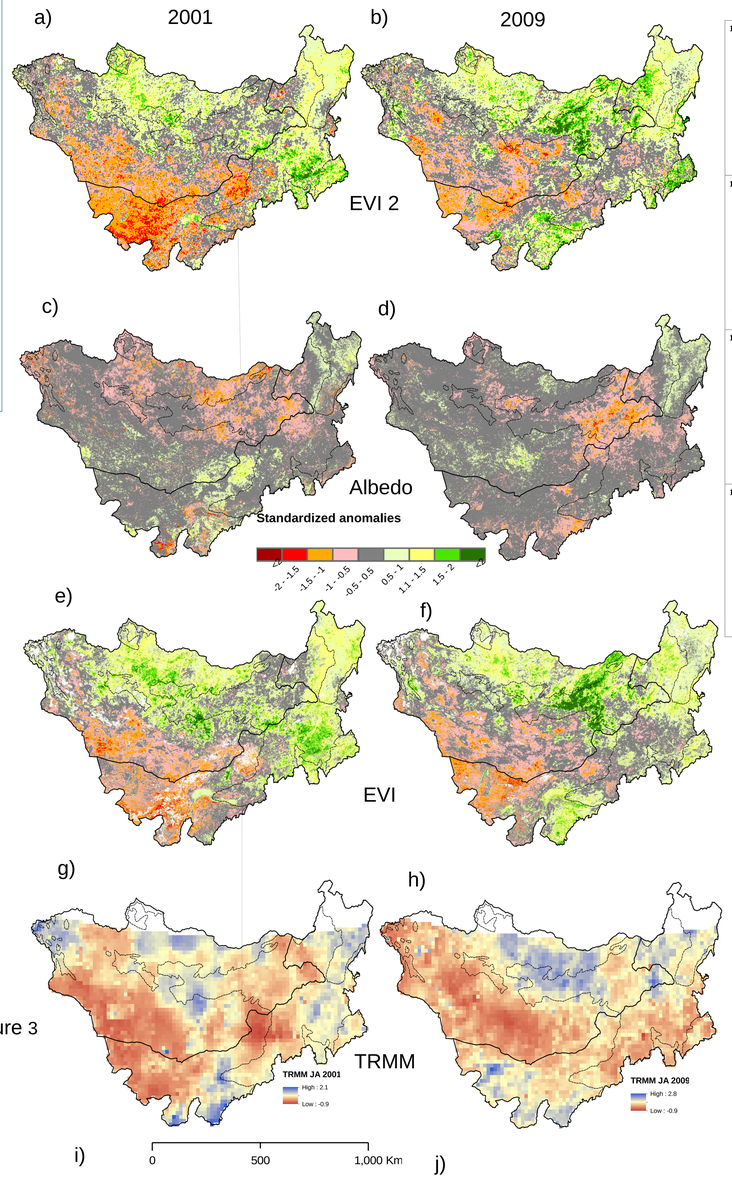


Figure 3

Figure 4 (contd.)The distributions of dry years are not statistically different ($p < 0.001$) from relatively wet years in the grassland biome as compared to the desert biome suggesting that the grasslands ecosystems are more stable than deserts. Areas under negative VI anomalies in both desert and grassland biomes (> -1) were correlated with positive albedo anomalies (<1).

Conversely, areas under positive VI anomalies (<1), correlated with negative albedo anomalies (> -1), were explained in part by irrigated agriculture in IM and cropland expansion in north central OM, suggesting that the vegetation anomalies were not false positives caused by clouds and/or aerosol contaminated pixels.

Results

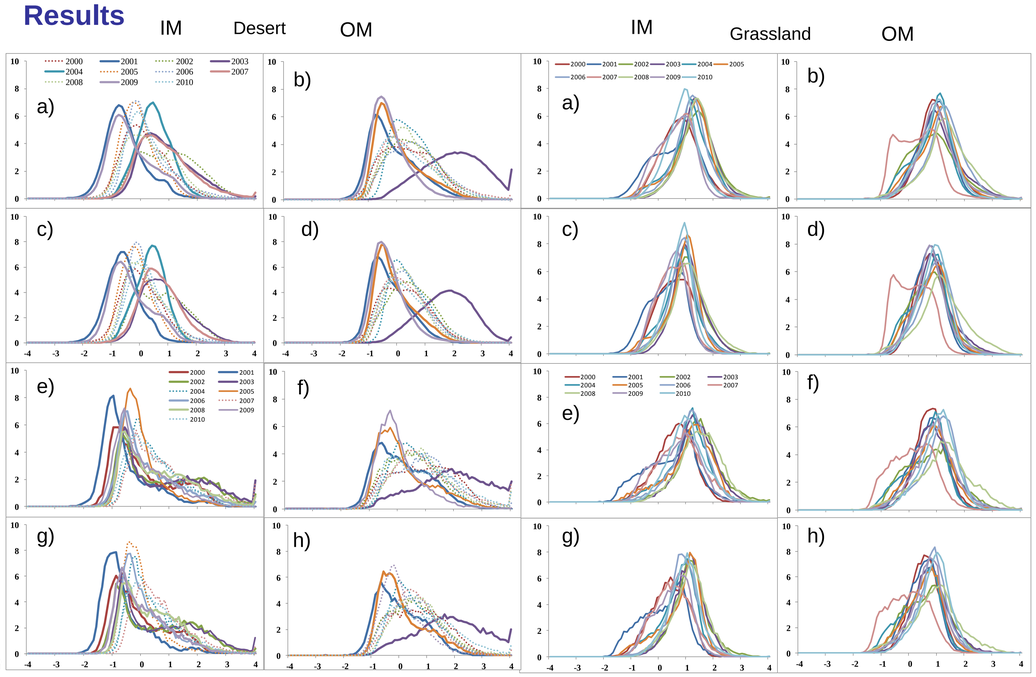
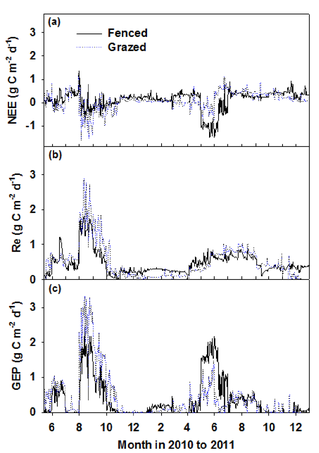


Figure 4: Frequency distributions of standardized MODIS EVI & VIP EVI2 July-August (a, b, e, f) and June-July-August (c, d, g, h) anomalies in the desert biome (2000-2010) for Inner Mongolia (IM) and Outer Mongolia (OM). Positively skewed drought years in the desert biome (severe droughts 2001, 2005, 2009) are characterized by the majority of negative anomalies (< -1 σ) with peak values between -1.5 and -0.5 std. and are statistically different ($p < 0.001$) from relatively wet years (2003, 2004 & 2007). VIP EVI2 is based on a longer term mean (1981-2010) than MODIS EVI.



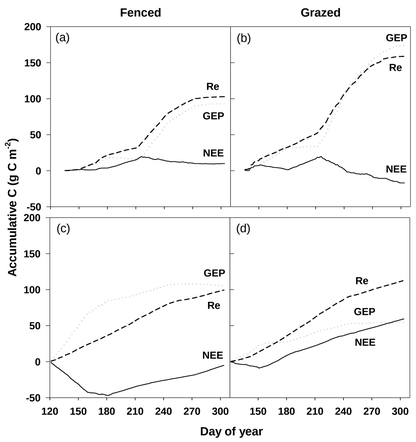


Figure 5. Daily variation of NEE (a), Re (b), and GEP (c) for the fenced and grazed desert steppes in 2010(wet year) to 2011 (dry year).

Figure 6. Two growing seasons accumulative variations in NEE, Re, and GEP for the fenced and grazed desert steppes

Ongoing work

We are running RAMS climate forecast simulations based on different land cover datasets to understand the impacts of recent land use change on the surface energy budget. Under a variety of atmospheric conditions, we seek to identify whether statistically significant shifts in temperature and rainfall are caused by modified land cover in the last decade.

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