We used the highest quality pixels for our MODIS and VIP products, with MODIS monthly mirrors and MODIS13A3, land surface temperature (LST, MOD11A2) and shortwave White Sky albedo (MCD43B3) with a spatial resolution of 1km were used. We also tested EVI2 from Vegetation Index and Phenology (VIP) MEASURES product and the monthly TRMM 3B43v7 product to validate the VI anomalies

- We used the highest quality pixels for our MODIS and VIP products, with pixel reliability flag = 0 to exclude cloud and/or aerosol contaminated pixels using quality control (QC) bit masks.
- We stratified the heterogeneous Mongolian plateau into its constituent biomes (desert, grassland and forest) and major political divisions (Inner Mongolia & Outer Mongolia) to enable the comparison of vegetation between biomes and to avoid confounding effects in interannual comparisons of anomaly trends.
- We plotted frequency histograms of the anomalies to track the temporal variation over the decade and then binned the data using MATLAB® software to quantify negative large anomalies (< -1) as percentage of vegetated area.

Figure 1: Standardized anomalies (July-August 2010) of MODIS-derived EVI, (MOD13A3), on the Mongolian Plateau, as compared to decadal mean, overlaid with terrestrial ecoregion (WWF) biome boundaries, desert (D), grassland (G), forest (F).

Figure 2: 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) respectively. January-February LST anomalies in 2001 and 2010 (i & j).

Results

- Positively skewed drought years in the desert biome (severe droughts 2001, 2005, 2009) are characterized by the majority of negative anomalies (< -1) or 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 EVI is based on a longer term mean (1981-2010) than MODIS EVI.
- 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.

Future work

We will validate these vegetation anomalies with TRMM rainfall anomalies and < -1 PDSI.

Acknowledgements:
This study was supported by the NASA LCLUC Program (NN-H-04-Z-YS-005-N), Natural Science Foundation of China (30923002), the Outstanding Overseas Scientists Team Project of CAS, and the State Key Basic Research Development Program of China (2007CB106800).