Geophysical Research Abstracts
Vol. 16, EGU2014-4089, 2014
EGU General Assembly 2014


# Understanding tree growth in response to moisture variability: Linking 32 years of satellite based soil moisture observations with tree rings

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Climate change induced drought variability impacts global forest ecosystems and forest carbon cycle dynamics. Physiological drought stress might even become an issue in regions generally not considered water-limited. The water balance at the soil surface is essential for forest growth. Soil moisture is a key driver linking precipitation and tree development. Tree ring based analyses are a potential approach to study the driving role of hydrological parameters for tree growth. However, at present two major research gaps are apparent: i) soil moisture records are hardly considered and ii) only a few studies are linking tree ring chronologies and satellite observations.

Here we used tree ring chronologies obtained from the International Tree ring Data Bank (ITRDB) and remotely sensed soil moisture observations (ECV_SM) to analyze the moisture-tree growth relationship. The ECV_SM dataset, which is being distributed through ESA's Climate Change Initiative for soil moisture covers the period 1979 to 2010 at a spatial resolution of 0.25°. First analyses were performed for Mongolia, a country characterized by a continental arid climate. We extracted 13 tree ring chronologies suitable for our analysis from the ITRDB. Using monthly satellite based soil moisture observations we confirmed previous studies on the seasonality of soil moisture in Mongolia. Further, we investigated the relationship between tree growth (as reflected by tree ring width index) and remotely sensed soil moisture records by applying correlation analysis. In terms of correlation coefficient a strong response of tree growth to soil moisture conditions of current April to August was observed, confirming a strong linkage between tree growth and soil water storage. The highest correlation was found for current April (R=0.44), indicating that sufficient water supply is vital for trees at the beginning of the growing season. To verify these results, we related the chronologies to reanalysis precipitation and temperature datasets. Precipitation was important during both the current and previous growth season. Temperature showed the strongest correlation for previous (R=0.12) and current October (R=0.21). Hence, our results demonstrated that water supply is most likely limiting tree growth during the growing season, while temperature is determining its length.

We are confident that long-term satellite based soil moisture observations can bridge spatial and temporal limitations that are inherent to in situ measurements, which are traditionally used for tree ring research. Our preliminary results are a foundation for further studies linking remotely sensed datasets and tree ring chronologies, an approach that has not been widely investigated among the scientific community.