Poster #1-4

Remote Sensing of Mycorrhizal Distributions

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Terrestrial biosphere models notoriously underestimate the importance and complexity of the carbon (C) land sink. Often these models are limited by the scalability of empirical knowledge about belowground ecosystem processes, specifically regarding the C costs of nutrient acquisition (Shi et. al, 2016). The interplay between C costs and nitrogen (N) acquisition in plants is mediated by symbiotic relationship with mycorrhizal fungi (Terrer et. al, 2016; Shi et. al, 2016). Plant C allocation to mycorrhizal fungi vary and strongly affect N acquisition and differences in mycorrhizal type at the phylum level have significant implications for biogeochemical cycling. Nearly all trees make arbuscular mycorrhizal (AM) or ectomycorrhizal associations (ECM). Plant species that associate with ECM fungi can utilize excess CO_2 resulting in increased biomass without N availability limitations, whereas AM plants are limited in their ability to increase biomass under increased CO_2 by N availability (Terrer et. al, 2016). The incorporation of plant mycorrhizal-identity into terrestrial biosphere models would greatly increase the accuracy of predictions about ecosystem responses to climate change. However, incorporating empirical knowledge about differences between mycorrhizal type into modelling efforts requires a spatial understanding of mycorrhizal distributions. A recent effort by Fisher et al. (2016) made substantial strides classifying forests by mycorrhizal type, through developing a model that links canopy-spectral properties across the plant phenological cycle to plant mycorrhizal identity.

My research builds from the methodology of Fisher et al. 2016, expanding the application from four temperate forests in the U.S. to the global scale. I use reflectance and reflectance derivatives derived from Landsat 8 data coupled with plot level mycorrhizal composition to build global maps of forest mycorrhizal compositions. To do this, I normalize by plant phenology to derive predictor variables aiming to capture six phenological timepoints: leaf flush(T_1), green up (T_2), peak green (T_3), early leaf senescene (T_4), late leaf senescence (T_5), and leaf abscission (T_6). I am building and validate models at the plot level and apply a unified model to entire Landsat scenes. Currently, we have forest inventory analysis (FIA) plot data with percent mycorrhizal type for 38,000 plots across the eastern half of the United States. I am contacting principal investigators for Smithsonian CTFS-ForestGEO network to expand these analyses to the global scale. Both CTFS-ForestGEO and FIA networks, provide massive amounts of forest species composition data collected using a standardized methodology. I am linking the abundance of ground data to Landsat 8 satellite imagery using Google Earth Engine. The products from this research, maps of global mycorrhizal distribution at 30-meter resolution, will be the first to represent plant-mycorrhizal type at this scale with the use of empirical ground data that has not been spatially interpolated. Furthermore, these outputs have the potential to become a widely used data product in terrestrial biosphere models, such as the community land model. The inclusion of this information into modelling efforts will drastically improve the accuracy of our understandings of vegetation responses to increased CO_2 concentrations (Terrer et. al, 2016).

References

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