Derivation of Pan-Arctic Soil Decomposition, Heterotrophic Respiration and Net Ecosystem Carbon Exchange
Using AMSR-E and MODIS Data
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Abstract
We have developed an approach for regional assessment and monitoring of land-atmosphere carbon dioxide (CO₂) exchange (NEE) and soil heterotrophic respiration (Rₜ) for boreal forest and arctic tundra ecosystems. Using synergistic satellite remote sensing observations from AMSR-E and MODIS, we use C- and X-band brightness temperatures from AMSR-E to extract surface wetness and temperature, and MODIS land cover, Leaf Area Index (LAI) and Gross Primary Production (GPP) information to represent vegetation structure and productivity. Calibration and validation activities involve comparisons between satellite remote sensing data and boreal-arc Arctic CO₂ eddy flux tower data and biophysical measurement networks and hydro-ecological process model simulations. We analyze spatial and temporal anomalies and environmental drivers of NEE at daily, weekly and annual time scales. We find strong linear correspondence between AMSR-E surface emissivities and surface temperatures at 6.9 and 36.5 GHz horizontal and vertical polarizations. Preliminary results indicate that the 36.5 GHz channel yields better surface temperature performance, while 6.9 GHz channel yields unambiguous identification of RFI. We integrated existing satellite-based measurements of vegetation structure (LAI) and productivity (GPP) from MODIS with AMSR-E derived land surface temperatures and moisture fields within a simple physically based carbon algorithm to derive spatially explicit estimates of Rₜ and NEE for the pan-arctic basin and Alaska at daily, weekly and monthly intervals. We compared satellite data derived NEE with site based measurements and BIOME-BGC process model simulations at boreal and arctic CO₂ eddy flux tower sites. These results show generally good agreement between satellite based results and site network measurements and ecosystem process model simulations of Rh and NEE spatial and temporal dynamics. While the satellite based results capture regional patterns in Rh and NEE, our ability to represent sub-grid scale surface heterogeneity is limited by the coarse (25-60km) spatial resolution of the AMSR-E footprint. Our results also indicate that carbon cycle response to climate change is non-linear and strongly coupled to arctic surface hydrology. This work was undertaken at The University of Montana and Jet Propulsion Laboratory, California Institute of Technology, under contract with the National Aeronautics and Space Administration.