Seasonal variation of surface and air temperatures across a range of plant functional types and climatic zones

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Background and Significance

Surface temperature (T_{sfc}) and the difference between T_{sfc} and air temperature (ΔT) control the biological function (e.g. photosynthesis, respiration, phenology) and energy balance (e.g. sensible, latent, ground heat fluxes and net radiation) of the land surface. Recently, Helliker and Richter (2008) inferred growing season leaf temperature from stable isotope analysis, and found it to be virtually constant at around 21°C from boreal to sub-tropical climatic zones. Now that the FLUXNET database provides aerodynamic surface temperature ($T_{sfc(a)}$) from sonic anemometers and radiometric surface temperature ($T_{sfc(r)}$) from four-band radiometers, it is feasible to investigate the seasonal variation of T_{sfc} and ΔT across a range of plant functional types (PFT) and climatic zones to investigate the canopy temperature convergence hypothesis of Helliker and Richter (2008) and better-quantify the influence of vegetation on the temperature of the Earth's surface.

T_{sfc} and ΔT are also important for the remote sensing of evapotranspiration. The land surface energy balance ($\lambda E = R_n - H - G$) or Penman-Monteith equation have been widely used in remote sensing, but special attention is required to accurately quantify the relationship between surface temperature and the terms of the energy balance to which T_{sfc} is coupled. For the first approach, sensible heat flux (H) has been inferred from thermal remote sensing, but $T_{sfc(r)}$ can be different from $T_{sfc(a)}$ by 2-6 ^{o}C (Huband and Monteith 1986), leading to errors in H estimates. Differences in the temperature terms across a range of PFT could be quantified using FLUXNET database to benefit the remote sensing community. For the second approach, it should be noted that P-M approaches used first order Taylor expansion for estimating saturation vapor pressure at T_{sfc}. This assumption is only valid when ΔT is very small. If ΔT is greater than 5°C, it could cause large error in estimating evapotranspiration (Paw U and Gao 1988). Quantification of ΔT across a range of PFT and climate types will reduce errors in evapotranspiration estimates under conditions where the P-M equation is not valid.

Objectives

1. Investigate the seasonal variation of T_{sfc} and ΔT, and their implications on ecophysiology in global ecosystems.

2. Quantify the difference between $T_{sfc(r)}$ and $T_{sfc(a)}$ across global PFTs.

An example for Vaira ranch

US-Var.2006.synth.hourly.mat
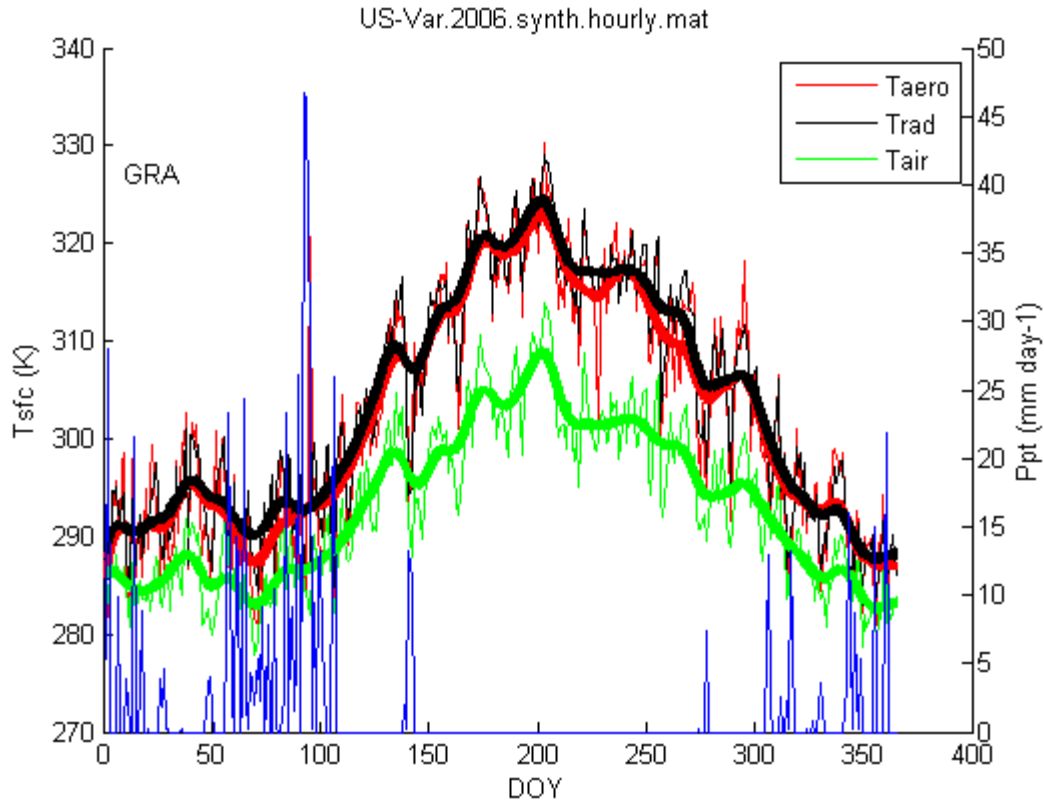
Expected sites

Sites that have at least one-year good data of sensible heat flux, air temperature and four-band radiation data will be considered in this project.

'BR-Sa3'	'CA-Qfo'	'CH-Oe2'	'FR-LBr'	KR-Hnm'	'US-ARM'	'US-MMS'
'BW-Ma1'	'CA-SF1'	'CN-Cha'	'FR-Pue'	'NL-Ca1'	'US-Aud'	'US-MOz'
'CA-Ca1'	'CA-SF2'	'DE-Geb'	'IE-Dri'	'NL-Hor'	'US-Bkg'	'US-NR1'
'CA-Ca3'	'CA-SF3'	'DE-Hai'	'IL-Yat'	'NL-Loo'	'US-Bo1'	'US-SRM'
'CA-Gro'	'CA-SJ1'	'DE-Har'	'IT-Lav'	'PL-wet'	'US-Bo2'	'US-Var'
'CA-Mer'	'CA-SJ2'	'DE-Kli'	'IT-MBo'	'PT-Mi2'	US-Dk1	'US-WCr'

'CA-Oas'	'CA-SJ3'	'DE-Meh'	'IT-Ren'	'RU-Fyo'	US-Dk2	'US-Wkg'
'CA-Obs'	'CA-TP4'	'DE-Tha'	'IT-Ro1'	'SE-Nor'	US-Dk3	'US-Wrc'
'CA-Ojp'	'CA-WP1'	'DE-Wet'	'IT-SRo'	'SE-Sk2'	'US-FPe'	
'CA-Qcu'	'CH-Oe1'	'ES-ES2'	'IT-Vig'	'UK-PL3'	'US-Goo'	

Authorship guidelines

All data providers are invited to give intellectual inputs to this study and significant intellectual inputs will lead co-authorship. Upon the approval of this manuscript, the first analysis result will be sent to PIs and intellectual input can be considered from this stage. Authorship issue will abide by LaThuile ToR.

References

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