The roles of soil moisture and vegetation in surface turbulent heat flux partitioning

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Science question:

What boundary layer and land processes contribute to the diversity of observed and modeled land-atmosphere interactions?

- Discrepancies between models and observations

  Ferguson et al. 2012, Taylor et al. 2012
- Observational scatter

  Phillips and Klein 2014
- Differences among models (LES, CRMs, GCMs)

  Hohenegger et al. 2009

Opportunities to improve climate prediction

- Soil moisture initial condition and memory
- Land surface and boundary layer heterogeneity
- “Slow” variations in surface forcing (soil moisture, leaf area)
- “Fast” surface forcing (transpiration, stomatal conductance)

SGP central facility (pasture)

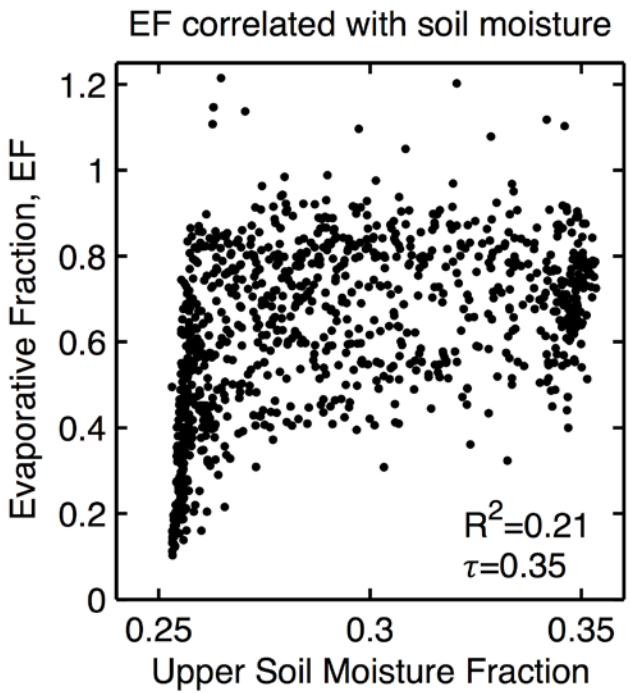
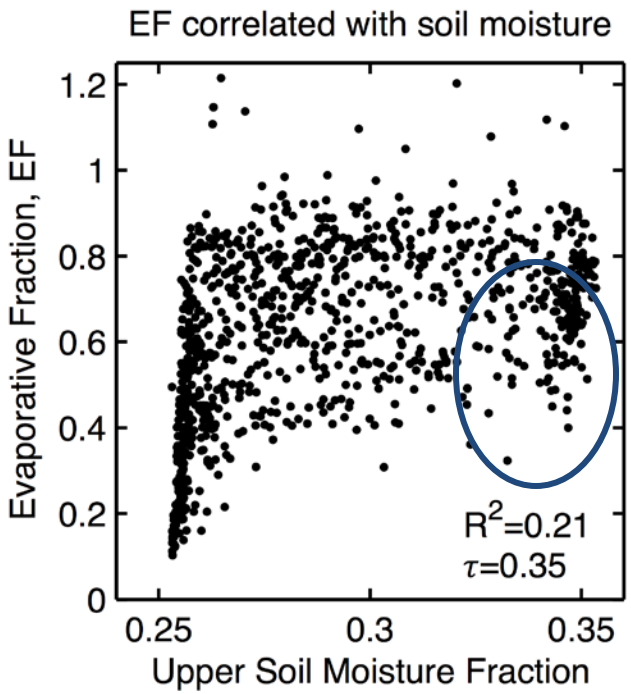


Figure: Following Phillips and Klein 2014

There is statistically-significant land-atmosphere coupling in the SGP (see also Phillips and Klein 2014), based on analysis of SWATS soil moisture and EBBR surface fluxes.

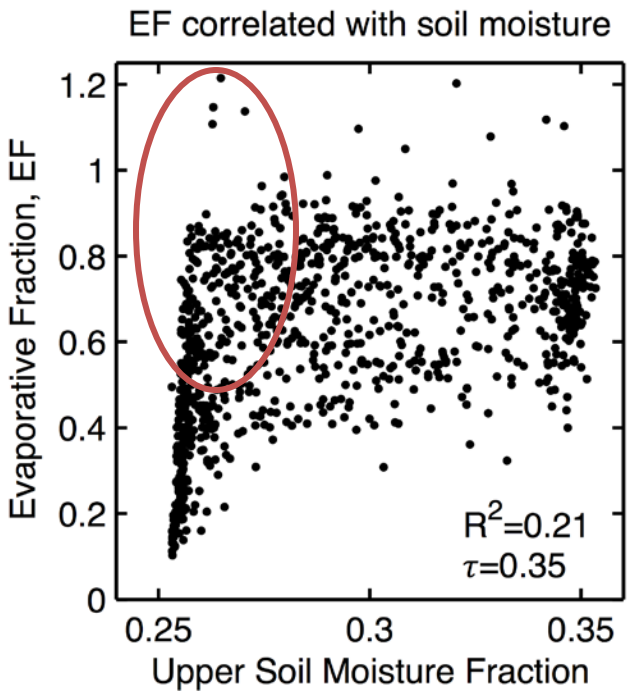
SGP central facility (pasture)



Weak correlations might reflect:

- shading by vegetation

SGP central facility (pasture)



Weak correlations might reflect:

- shading by vegetation
- transpiration from deeper soil

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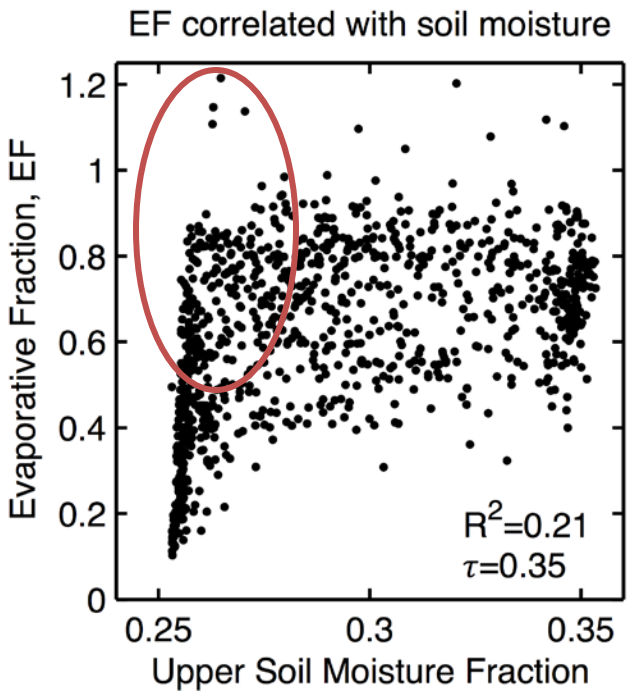
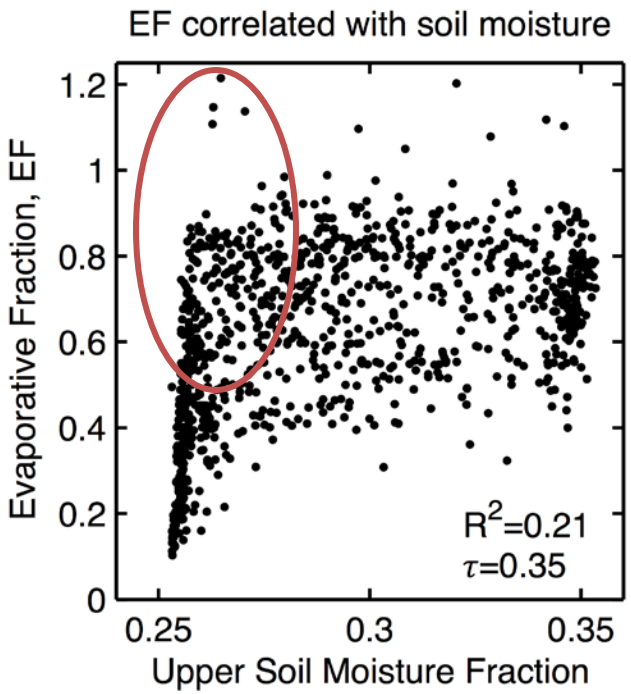


Evapotranspiration:

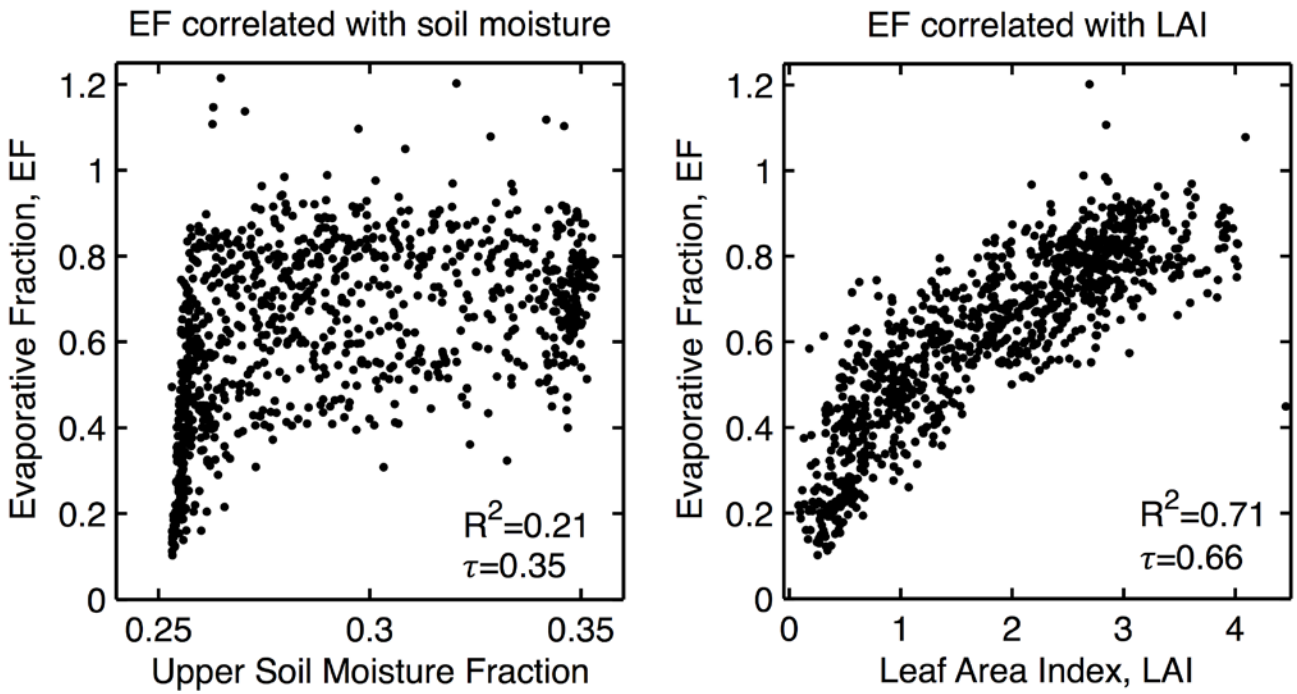
$$E = E_B + E_V + E_W$$

SGP central facility (pasture)



Leaf area index can be estimated at site-level from the multi-filter radiometer value-added product.

SGP central facility (pasture)



Evaporative fraction is better explained by vegetation than soil moisture

SGP central facility: pasture and crops

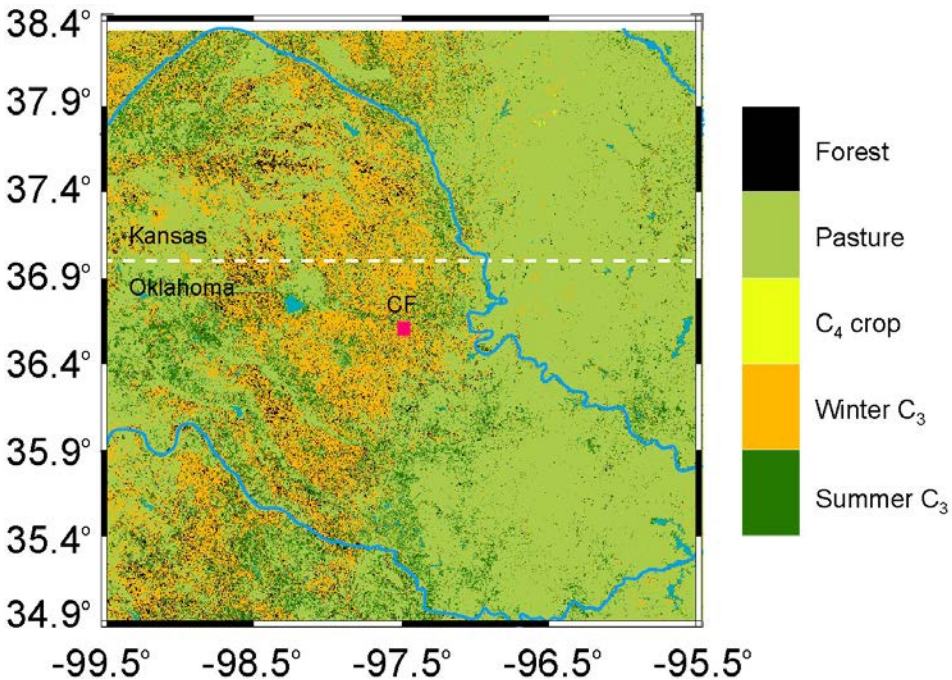
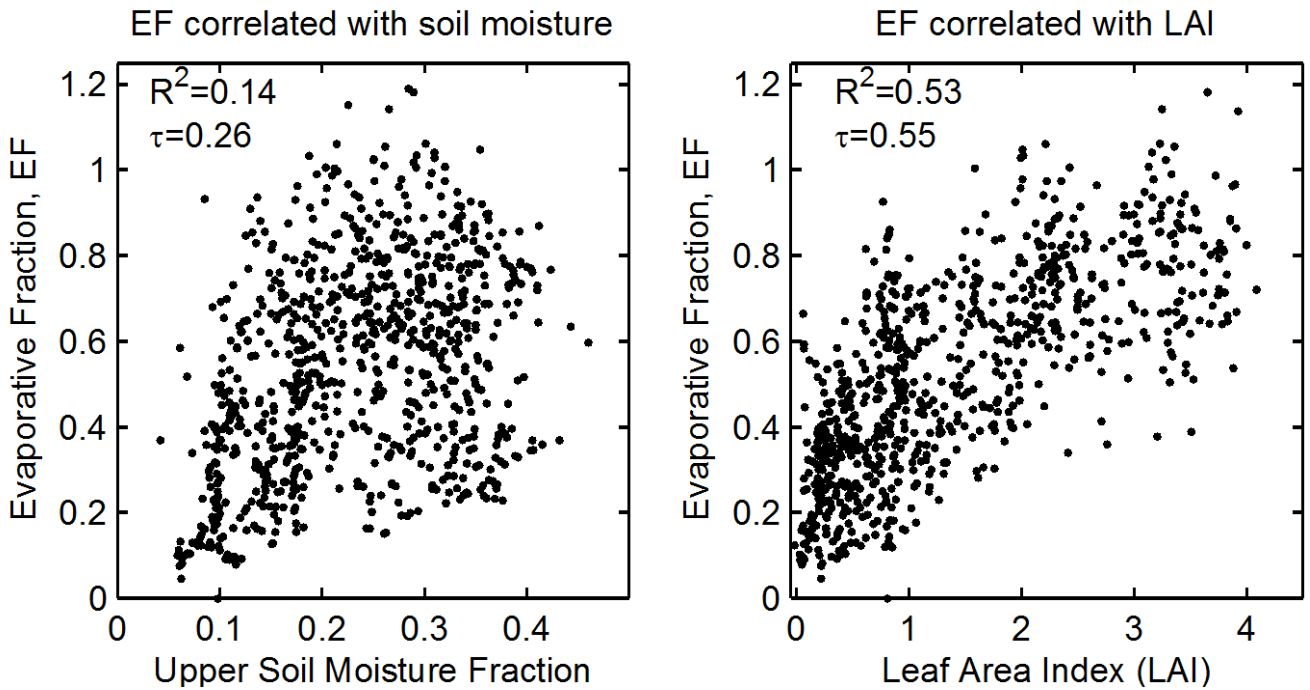


Figure: Torn et al. 2011

Analyses were repeated for the CF crop field using the "co2flx" datastream (soil moisture and surface fluxes).

SGP central facility (crops)



Evaporative fraction is better explained by vegetation than soil moisture

SGP central facility (crops)

Daytime CO_2 uptake is indicative of stomatal conductance.

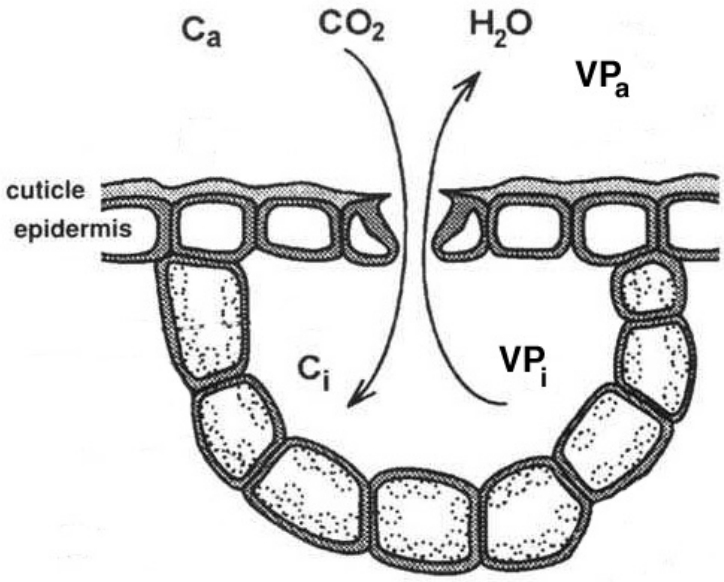
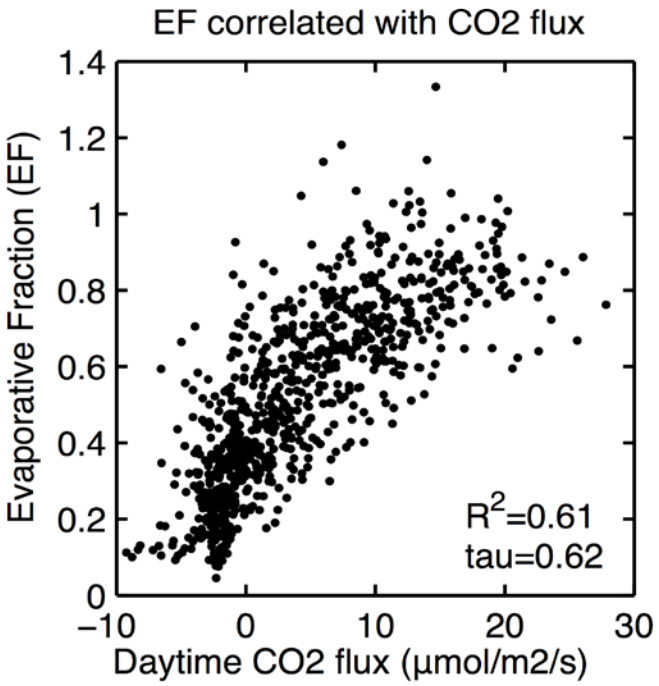


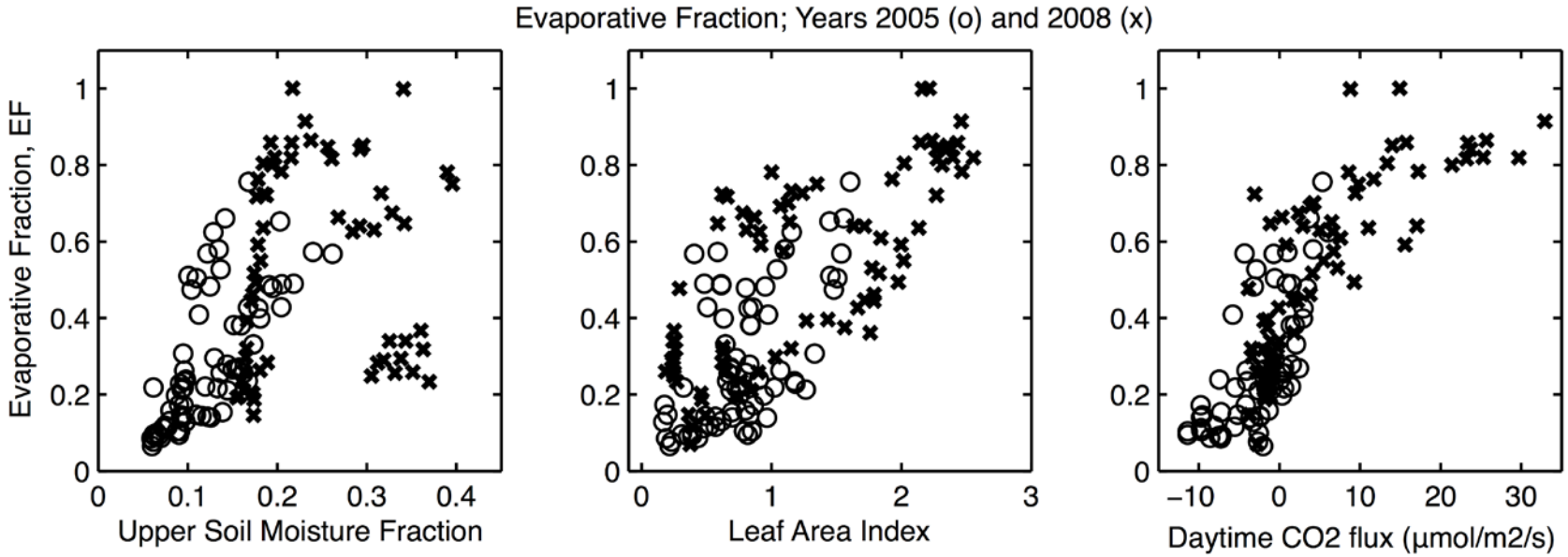
Figure: Forseth 2010

SGP central facility (crops)

Surface CO_2 uptake (co2flx datastream) helps explain low EF at intermediate-high LAI.



Maize: Years 2005 (o) and 2008 (x)



The “permanent wilting point” is indicated by reduced CO_2 uptake

Summary and related points

- Land-atmosphere coupling is affected by vegetation and is stronger than has been indicated based on soil moisture alone.

- Much of the variance in EF can be explained by the effects of vegetation on surface energy balance.

- Domain-scale CO_2 uptake (1x1deg) has been estimated in CarbonTracker (NOAA) using concentrations at the SGP CF.