Land-Atmosphere-Cloud Interactions (LACI) Plenary Session

- Plenary talk #1: Joe Santanello (1:30-2:00)
- Plenary talk #2: Pierre Gentine (2:00-2:30)
- Discussion of Science Questions (2:30-4:00)
  - Question #1: led by Yunyan Zhang, with science nugget presented by Steve Klein
  - Question #2: led by Margaret Torn, with science nugget presented by Ian Williams
  - Question #3: led by Larry Berg, with science nugget presented by Alex Guenther
- Review of Data Products: Shaocheng Xie (4:00-4:10)
- Measurement needs: Introduction by Yunyan and Jim Mather (4:10-5:00)

Land-Atmosphere-Cloud Interactions (LACI) Plenary Session

Session Goals

- Develop set of overarching ASR relevant science questions to focus and prioritize research efforts
  - How important is the *influence of the land surface* on the boundary-layer turbulence and structure, cloud life cycle, and precipitation?
  - What *boundary layer and land processes contribute to the diversity of soil moisture-precipitation feedbacks* observed in nature and simulated in models [LES, CRMs, Mesoscale Models (MMs), GCMs]?
  - How do feedbacks between *biogenic emissions, biomass burning, SOA,* boundary layer, and clouds influence the cloud lifecycle?
- Provide feedback to ARM in regards to measurements at field sites
- Fodder for off-line discussions throughout the week

Proposed Science Questions (1 of 3)

How important is the influence of the land surface on the boundary-layer turbulence and structure, cloud life cycle, and precipitation?

- ***Diurnal Cycle of LACI***
  - Partitioning of sensible and latent heat fluxes
  - Surface radiation balance, both direct and diffuse
  - Photosynthesis
  - Cycle of precipitation over the SGP
  - Connection between soil moisture and ET
- ***Surface Heterogeneity***
  - New data products for the SGP-how many stations do we need?
  - How good is the representation of PDFs of thermodynamics and dynamics as applied in GCM and mesoscale models?
  - Land cover, land use, surface albedo, then surface fluxes for different types, what is the role of irrigation, put measurements over unirrigated areas
- ***Boundary Layer/Turbulence***
  - What are the relevant scales? How does the surface heterogeneity impact the relevant scales?
  - New measurement tools for looking at turbulence
- ***Flow Regime***
  - Local vs. non-local moisture source
  - What are the relevant diagnostics? Water isotopes?

Proposed Science Questions (1 of 3)

How important is the influence of the land surface on the boundary-layer turbulence and structure, cloud life cycle, and precipitation?

- ***Diurnal Cycle of LACI***
  - How do land surface process impact the diurnal cycle of the boundary layer structure, and the occurrence and spatial extent of clouds and precipitation?
  - What is the effect of soil moisture anomaly (dry or wet) on the surface flux partitioning, carbon flux, boundary layer turbulence structure and cloud occurrence? What is the role of ground water, irrigation, and phenology? Which soil moisture is most important at ARM sites: near-surface, root zone layer, or ground water?
- ***Surface Heterogeneity***
  - How large is the flux-foot print of clouds seen at the ARM sites? What does that tell us about the relevant spatial scales?
  - What is the impact of land-surface heterogeneity on the PDFs of thermodynamic variables and vertical velocity, and their relationship with clouds and precipitation? Are our representations in models consistent with observations?
  - How is land-surface heterogeneity represented in models and how does it impact the PDFs of variables in the PBL?
- ***Boundary Layer/Turbulence***
  - What are the long-term boundary layer turbulence statistics at ARM sites? How do they compare to the representations in models? What is the impact of entrainment at the PBL top on the thermodynamic properties, trace gases, and aerosol in the PBL?
  - What is the role of longwave flux divergence on the surface energy balance and its impact/coupling with the boundary-layer turbulence
- ***Regime***
  - What is the impact of the surface on cloud pool dynamics and the life cycle of convection?
  - How can we define local vs. non-local (including wave dynamics) effect of LACI?

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Proposed Science Questions (2 of 3)

What boundary layer and land processes contribute to the diversity of soil moisture-precipitation feedbacks observed in nature and simulated in models [LES, CRMs, Mesoscale Models (MMs), GCMs]?

- ***Scale dependence of feedback pathways***
  - LAI, direct/diffuse radiation
- ***Regional and local scale transport***
  - Surface and sub-surface water transport, needs to be treated as model scale decreases
- ***Impact of Clouds***
  - Direct/diffuse radiation, shading of surface (magnitude of energy that is available), explicit in LES, parameterized in MMs and GCMs

Proposed Science Questions (2 of 3)

What boundary layer and land processes contribute to the diversity of soil moisture-precipitation feedbacks observed in nature and simulated in models [LES, CRMs, Mesoscale Models (MMs), GCMs]?

- ***Scale dependence of feedback pathways***
  - What are the proper linkages between soil moisture, boundary-layer, clouds, and precipitation in nature and how are they simulated in models? How do they change as a function of scale?
  - How do those linkages change in different flow and hydrological regimes? How does the change in PBL state (shallow/deep, dry/humid…) define the feedback sign between surface fluxes and clouds?
- ***Regional and local scale transport***
  - How do we quantify relative roles of local moisture sources and regional-scale transport over a range of spatial and temporal scales
  - Can we use high-resolution models coupled with land models to improve the representation in large-scale models (e.g. MMs and GCMs)?
- ***Impact of Clouds***
  - How does radiative cloud forcing (shading and enhanced diffuse radiation) impact the surface sensible and latent heat flux, carbon flux, and biogenic emissions, as well as their spatial structure?

Proposed Science Questions (3 of 3)

How do feedbacks between biogenic emissions, SOA, boundary layer, and clouds influence the cloud lifecycle?

- ***Surface processes***
  - ***Land surface use, biogenic emission and carbon cycle, climate stress and photosynthesis process***
  - ***Diurnal cycle of biogenic emission, relative uncertainties related to drought and temperature stress***
  - ***Removal of gases, chemicals (dry or wet)***
  - ***Transport of chemical composition or aerosol***
  - ***Relative contribution during the life cycle of aerosol during emission or deposition***
  - ***Seasonal dependent transport of aerosols into SGP and impact on clouds, bioburing or other sources***
- ***Boundary-layer processes***

Proposed Science Questions (3 of 3)

How do feedbacks between biogenic emissions, biomass burning, SOA, boundary layer, and clouds influence the cloud lifecycle?

- ***Surface processes***
  - What are the important links between land use, soil moisture, biogenic emissions, carbon fluxes, and clouds over a range of landscapes (from the Amazon to the Artic)?
  - How well do our models represent these links?
  - How do changes in the land use influence changes in biogenic emissions?
  - What are the uncertainties in biogenic emissions and SOA formation? How do we quantifying them?
- ***Boundary-layer processes***
  - How does vertical mixing (with alternating cycles of high and low RH) change SOA?