

Breakout Session Report

ARM/ASR Virtual User and PI Meeting June 21-24, 2021

Session Title: Interactions among the land surface, convective boundary layer, clouds and aerosols

Number of Attendees: 50 approximately

Summary Authors: Larry Berg and Yunyan Zhang

Breakout Description

This breakout session aims to

- 1) Use ARM data and high-res models as the tool to improve our understanding on the impact of land surface on boundary-layer turbulence and cloud dynamics/morphology
- 2) Diagnose model biases on the interface between atmosphere and land surface
- 3) Improve model parameterization in representing the interaction and feedbacks between land surface, convective boundary layer, clouds and aerosols

The overarching theme for this breakout session was focused on land-PBL-cloud processes observed by ARM data and how these processes are represented in models. This breakout focused on process studies at local and diurnal scales and included

- 1) results from long-term SGP data analysis, LES/cloud permitting model studies, and regional and climate model simulations
- 2) updates on ARM land surface / boundary layer profiling measurements and data development
- 3) updates and results from recent and upcoming field campaigns
- 4) updates from the recent AmeriFlux workshop co-sponsored by ARM/ASR –
“Improving understanding of land atmosphere interactions through integration of surface flux and atmospheric boundary layer”

The recorded session is at

https://drive.google.com/drive/folders/1n1J_pOJXsvS26ul3eBRP5-P9oycR59x6

Main Discussion

Specifically, this breakout included a range of scientific talks, updates associated with field studies, and discussion amongst the attendees.

Three AGU-style talks

1. Effects of Surface Energy Partitioning on Convective Organization: An observational and modeling case study in the US Southern Great Plain. (Yi Dai)
2. Determining Spatial Scales of Soil Moisture – Cloud Coupling Pathways using Semi-Idealized Simulations (Koichi Sakaguchi)
3. Improved Understanding of Land-Atmosphere Interactions Using Observations and Models (Dave Turner)

Six lightning talks

The lightning talks were selected to highlight posters in the session after the breakout.

1. An overview of irrigation impact on land-atmosphere-cloud interactions (Yun Qian)
2. Observational evidence of the land cover effect on shallow cumulus clouds over the U.S. Southern Great Plains (Jingjing Tian)

Breakout Session Report

ARM/ASR Virtual User and PI Meeting June 21-24, 2021

3. Observational and modeling studies of cloud-surface decoupling over land and ocean (Youtong Zheng)
4. Warm season PBL evolutions from lidar observations, LASSO and single column model simulations at the SGP site (Zhien Wang)
5. A decentralized approach in modeling organized convection and its impacts on continental boundary layers at SGP (Roel Neggers)
6. Using ARM Data to Evaluate Convection-Permitting Simulations on the Summertime Surface Climate Over the Central United States (Hongchen Qin)

Five short updates from workshops or field campaigns

1. AmeriFlux Workshop on land-atmosphere interaction (Manuel Helbig)
2. Lidar and PBL profiling instruments (Rob Newsom)
3. SAIL (Dan Feldman)
4. TRACER (Virendra Ghate and Mike Jensen)
5. SEUS (Chongai Kuang)

A short discussion on

Planetary boundary layer profiling layout and setting around SGP and SEUS sites

Key Findings

- Using WRF at cloud permitting resolution, Yi Dai and co-authors found that convection is better organized over wet soil conditions and surface latent heat fluxes are enhanced along the cold pool driven gust fronts. They suggested slantwise gust front updraft should be considered in cold pool parameterizations.
- Using WRF simulations, Koichi Sakaguchi and co-authors focused on responses of surface and atmosphere to soil moisture forcing and found that vertical velocity and surface divergence only responds to soil moisture forcing at the sub-meso scale, e.g., 1.5-7.5 km, where clouds form first and then upscale to mesoscale quickly.
- Tim Wagner, Dave Turner and the team illustrated an established methodology of polygon measurement networks to characterize the advection of water vapor and temperature using AERI and Doppler Lidar. They showed that the 75 km distance between SGP boundary facilities are in the optimal range to balance low error/uncertainties and a significant advection signal. They further demonstrated the valuable application of such methodology in charactering PBL budget terms in the land-atmosphere local coupling metrics, e.g. the encroachment and entrainment and suggested on potential similar layout/setup at both SGP and SEUS.
- Yun Qian gave a brief overview of recent publications on the irrigation effect on land-atmosphere interactions.
- Jingjing Tian used ARM surface measurement and GOES satellite data and found the shallow cumulus tends to occur more often over forest than over grassland. When the clouds have an earlier onset time, e.g. 11 to 13 local time, shallow cumulus' occurrence has a stronger preference at the heterogeneity scale of 3 to 9 km.
- Youtong Zheng emphasized the role of warm advection in the cloud-surface decoupling over ocean and summarized a methodology using remote sensing to characterize coupling versus decoupling between continental clouds and land surface.
- Zhien Wang showed a framework using Raman and Doppler Lidar data and LASSO data that was used in comparison with CCPP-SCM simulations.

Breakout Session Report

ARM/ASR Virtual User and PI Meeting June 21-24, 2021

- Roel Neggers summarized a new and significant development of EDMF by equipping it with the representation of thermal birth, movement, lifecycle, and interaction to cluster, thus the representation of the coherent structure and organized boundary layer convections in modulating mass fluxes.
- Hongchen Qin showed that surface precipitation is greatly improved in convection permitting simulations at central US, however this only alleviates the summertime warm biases to some extent with significant sensitivities to microphysics schemes adopted.
- Manuel Helbig gave a summary on the AmeriFlux workshop that many of us attended and served as speakers and breakout discussion leaders. When asked about the follow-up of the workshop for Ameriflux stations with possible thermodynamics or dynamic profiling instrument, Manuel shared some perspectives as a PI of an AmeriFlux site and advocated on the need and the desire to collaborate with atmospheric profiling experts.
- Rob Newsom gave updates on Raman Lidar and Doppler Lidar operating status, deployment and procurements. He clarified that the SGP Raman Lidar is still producing fine water vapor profiles although the (gradual) loss in sensitivity that we've seen over the last 3 years or so has resulted in slightly larger random errors in the WVMR, and a slightly lower maximum sensing heights. Rob also briefly mentioned that data product of Zi has been developed from multiple platforms and a short IOP was conducted on retrieval of turbulent fluxes and machine learning techniques were adopted in these retrievals. He also raised the question to the group " how to better use the scanning capability of doppler lidars?"
- Dan Feldman shared updates on the upcoming SAIL campaign (with NOAA SPLASH), the highly heterogeneous and complex terrain regional with significant seasonal large-scale environment changes, poses challenges in interpreting site data and intercomparison between models and observations, but also brings unprecedented opportunities to understand the land-atmosphere interaction and their impacts on regional hydrology and climate.
- Virendra Ghate gave a brief update on the ongoing TRACER IOP, the collaboration with NSF and NASA, the layout of the instruments of AMF site and also advocated activities of the PBL and other sub-focus group within TRACER.
- Chongai Kuang shared recent updates on SEUS, the comprehensive considerations of siting criteria and a hypothetical example configurations of the AMF site. They are focusing on "how to balance between all these criteria" and "how to best represent the surface heterogeneity with one AMF and possible extended facilities".

Due to the time limitation, we were not able to accommodate questions after each talk, however active discussions were carried on by zoom chat, breakout slack channel, and also at individual poster slack channels. The breakout slack channel was particularly helpful to maintain the momentum during and after the breakout by threading and so on.

We had about 15 to 20 minutes discussion towards the end of the session. It was dedicated to "PBL profiling layout and setting at SGP and SEUS sites and other upcoming field campaigns".

Particularly this group feedback to SEUS AMF and actively discussed with Chongai including:

- 1) The potential triangle setting of AERI for the benefits of cloud LWP retrievals and the characterization of advection of water vapor and temperature
- 2) The flux measurement at the interface of canopies
- 3) The partitioning between soil and plant evapotranspiration
- 4) The main site and extend sites to represent land cover heterogeneity

Breakout Session Report
ARM/ASR Virtual User and PI Meeting June 21-24, 2021

- 5) The potential contribution from AmeriFlux program on flux measurement

Dan Feldman also commented on the scanning doppler lidar capability during SAIL campaign and potential measurements on the flow along the slope.

Decisions

If applicable

Issues

If applicable

Needs

If applicable

Future Plans

If applicable

Action Items

Two AGU sessions have been proposed and associated with this focus group.

- *"H068 - Land-Atmosphere Interactions: From Bedrock to Boundary Layer"*
- *"B042 - Improving Understanding of Land-Atmosphere Interactions through Integration of Surface Layer, Atmospheric Composition, and Atmospheric Boundary Layer Measurements"*