

# Spatial Variability in Clouds, Precipitation, Surface fluxes, and Soil properties at the ARM SGP Site

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# Outline

- Motivations/goals
- Spatial variability of precipitation, clouds & surface/land properties
- Representativeness of central facility
- Summary

# Why study spatial variability of ARM obs?

- ARM SGP central facility (CF) measurements have been widely used for understanding cloud-related processes and land-atmosphere (L-A) coupling, but how well does it represent the area? Time scale?
- Besides the CF, ARM has a dense network at SGP to allow us to examine the spatial variability of those geophysical parameters important to clouds and L-A coupling.
- Better observation-based understanding is critical to improve the representation of these relevant physical processes in climate models.
- The observed spatial variability in surface/land properties provides a better constraint to surface conditions and sub-grid variability for cloud modeling (CRM/LES)

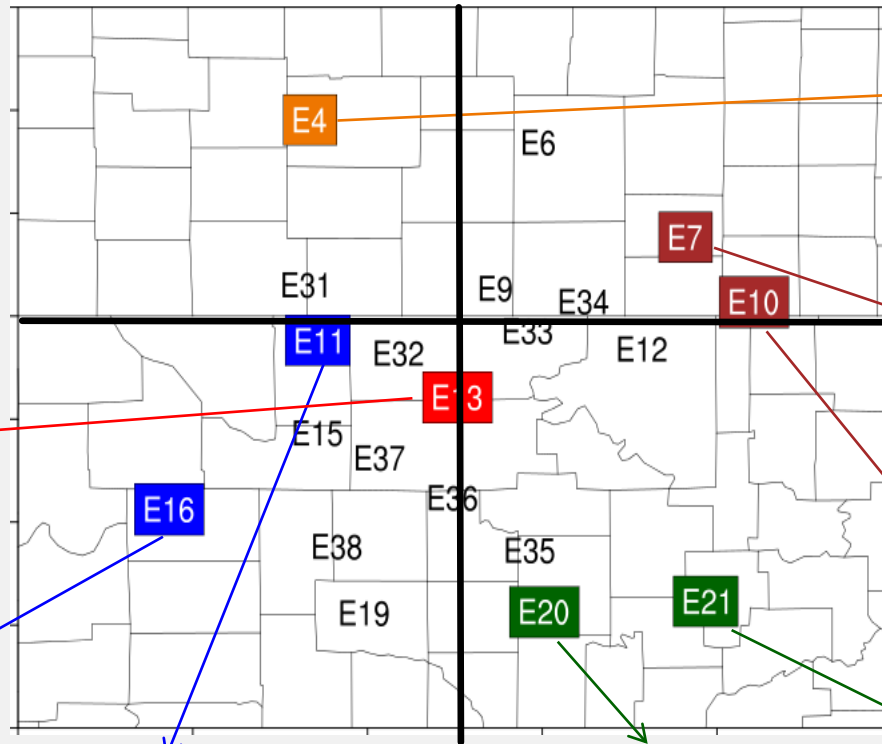
# Current status of ARMBE 2DGRID/STNS

- Facilitate studies related to spatial variability
- Year 2011 data is releasing to ARM archive

Surf V	Datastream	Site N
T, q, precip	MET	9
Radiation fluxes	QCRAD, RADFLUX	21
Latent & sensible heat flux	BAEBBR, ECOR	8, 5
Soil moisture	SWATS, EBBR	12
...	...	...

# SGP - various types of surface/soil

~3.5°x3.5°



Rangeland  
(ungrazed)  
Cobbly-Loam



Pasture  
Silt Loam



Alfalfa  
Silt Loam



Forest  
Stony-Fine  
Sandy Loam

Pasture, wheat  
Silty Clay  
Loam



Wheat  
Silt Loam



Alfalfa  
Fine Sand



Pasture  
Silt Loam

- ARBME 2DGRID/STNS: 21 sites in 2011
- A few sites (color) can study correlations.

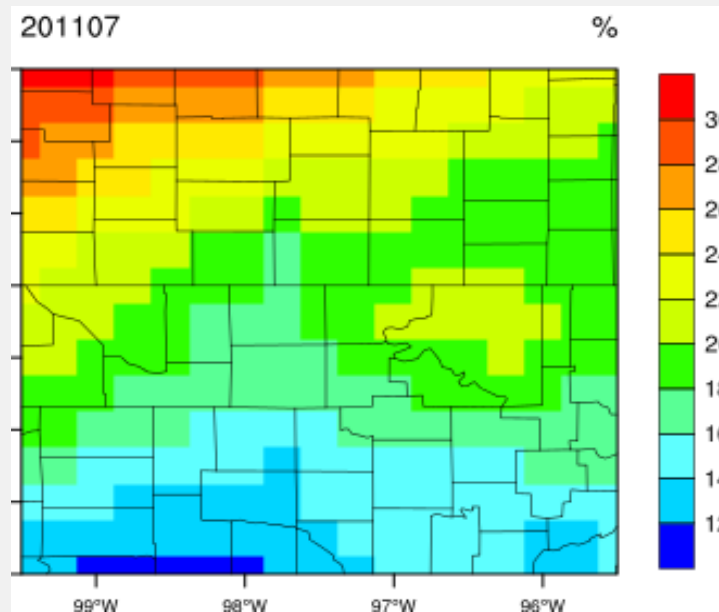
(<http://www.arm.gov/sites/sgp/geoinfo>)

([http://www.xdc.arm.gov/data\\_viewers/sgp\\_surfchar/soil\\_and\\_land\\_links.html#top](http://www.xdc.arm.gov/data_viewers/sgp_surfchar/soil_and_land_links.html#top))

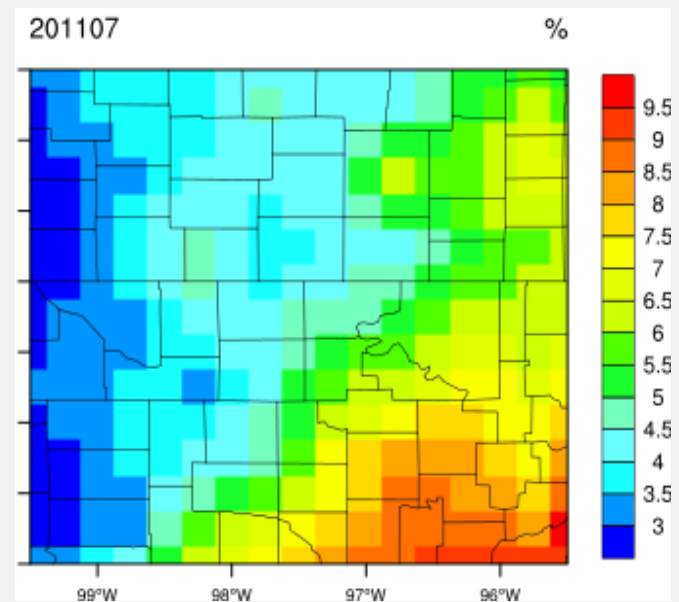
# Spatial variability in Clouds

July 2011

## High cloud cover



## Low cloud cover

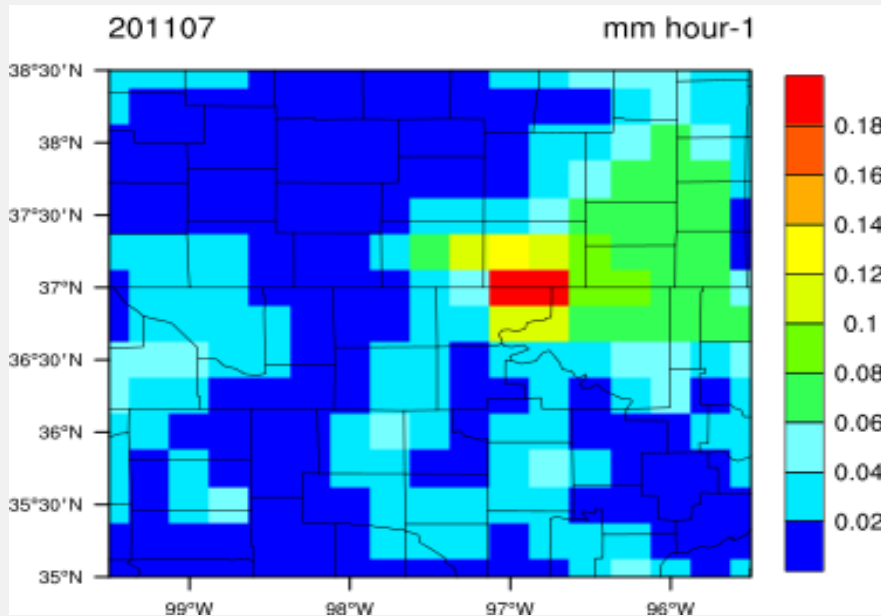


- Data from ARMBE2DGRID

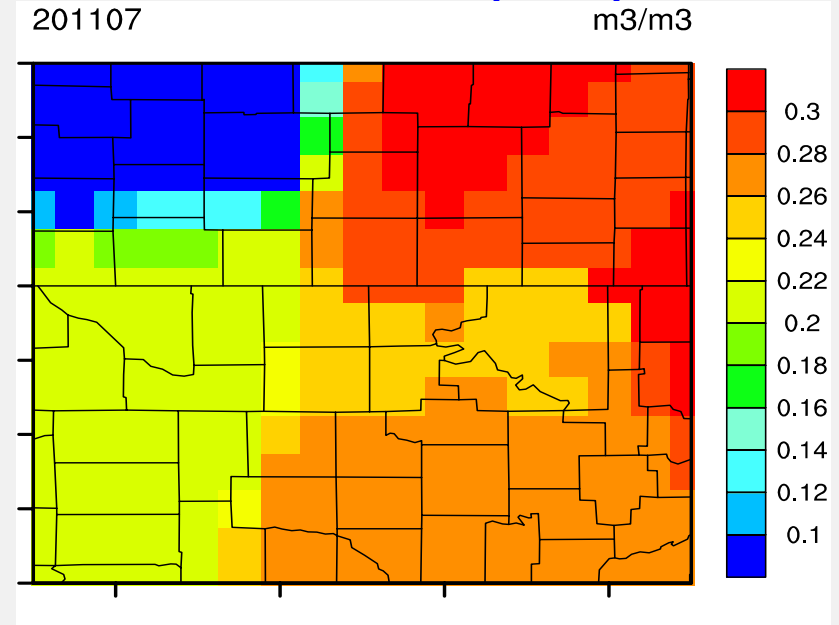
# Spatial variability in Precipitation and Soil Moisture

July 2011

Precip

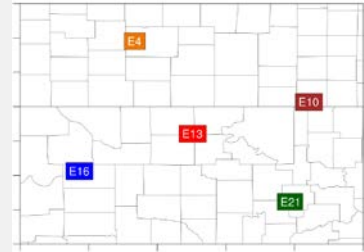


Soil moisture (5 cm)

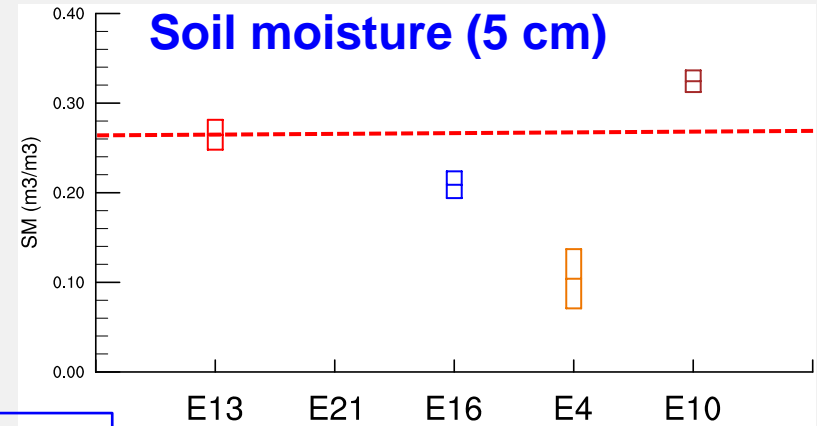
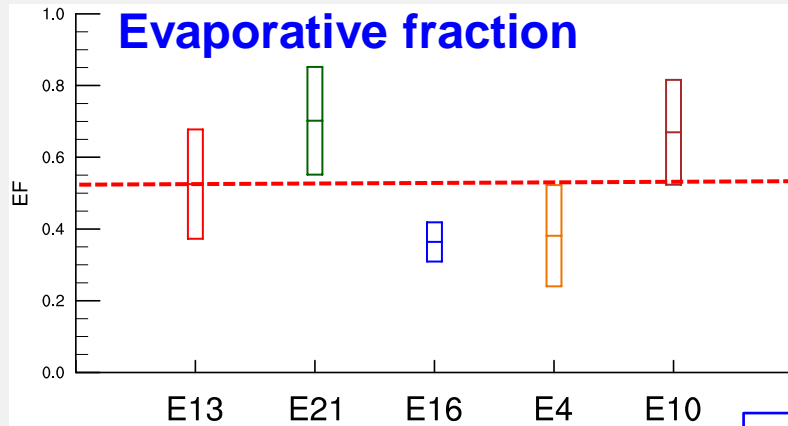


- Data from ARMBE2DGRID

# How does surface energy partition?



$$EF = LE / (LE + H)$$

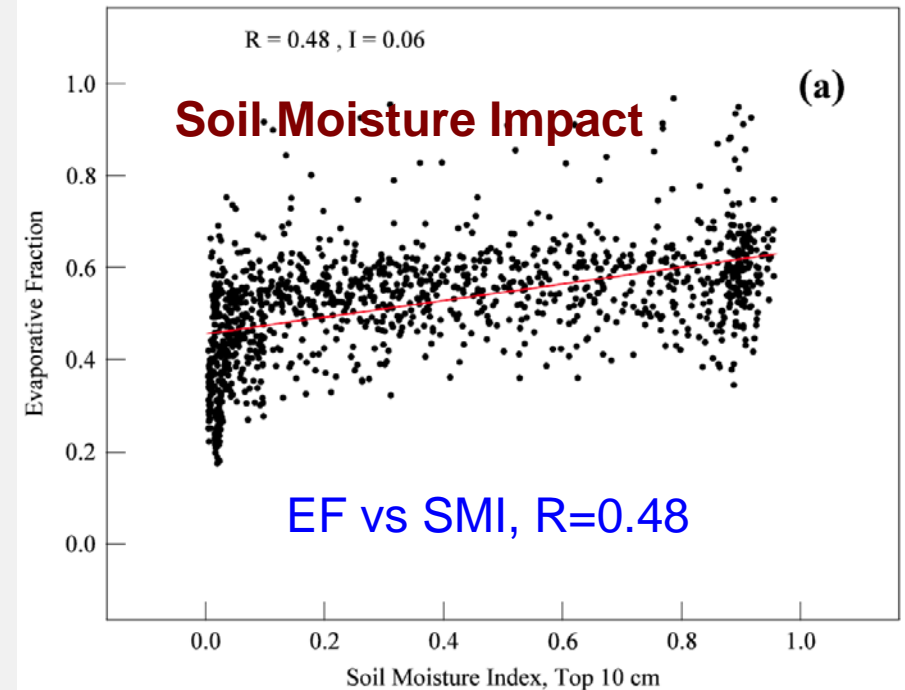
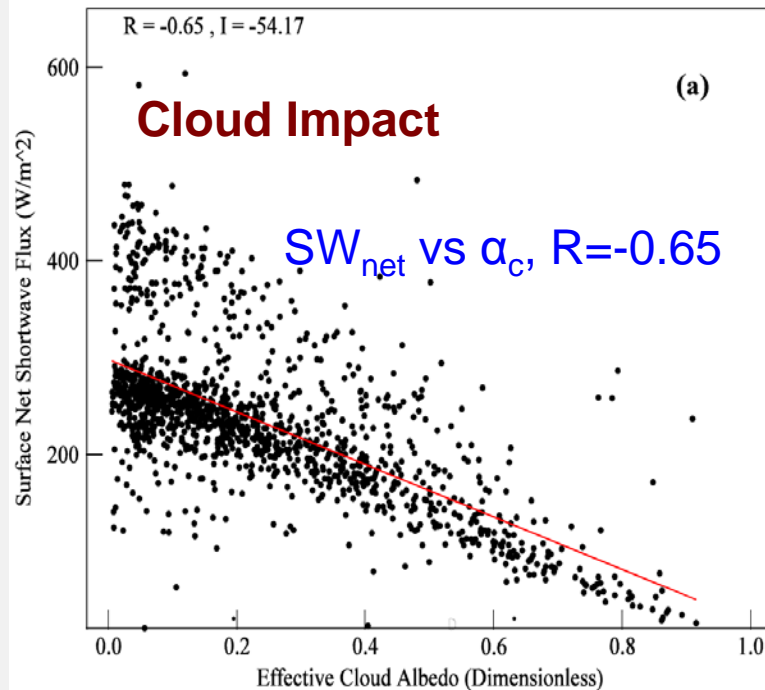


2011/05-08

- Moisture-limited ( $0.1 < B < 4$ ,  $B=H/LE$ )
- Greater evaporative fraction (EF) on the east
- EF is primarily determined by soil moisture and temperature (not shown).



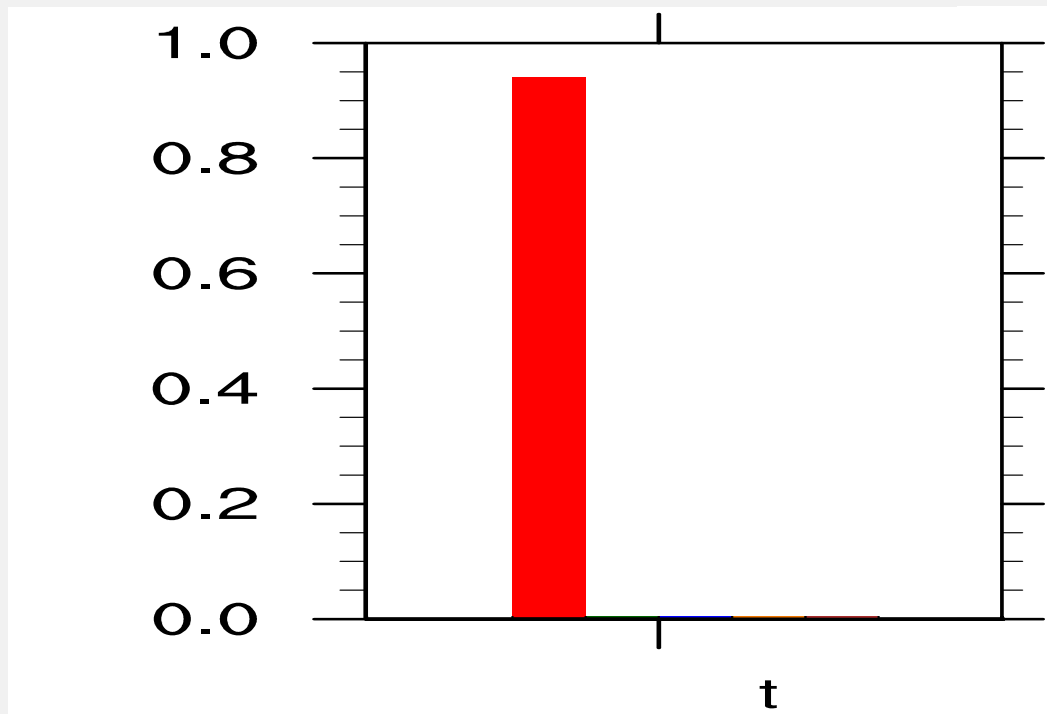
# L-A coupling manifested in warm-season at the SGP CF – *Phillips and Klein (2014)*



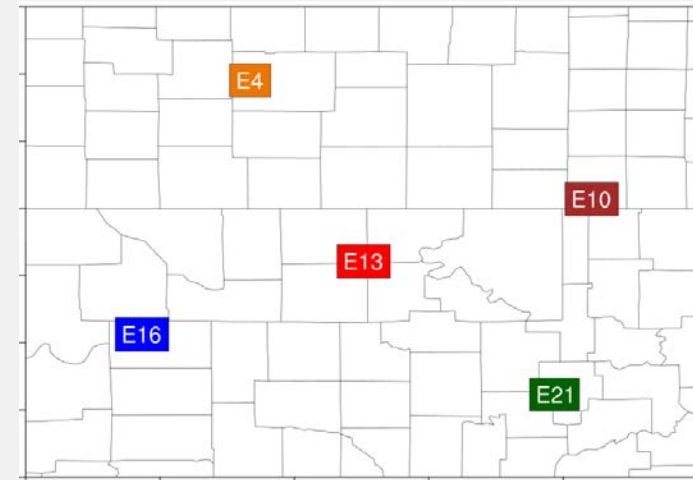
*Phillips and Klein, 2014*

- Atmosphere's energetic forcing on surface is **substantial**, with variability controlled by clouds.
- Land's energetic feedbacks are **weak**.

# How well does the CF represent the SGP region?

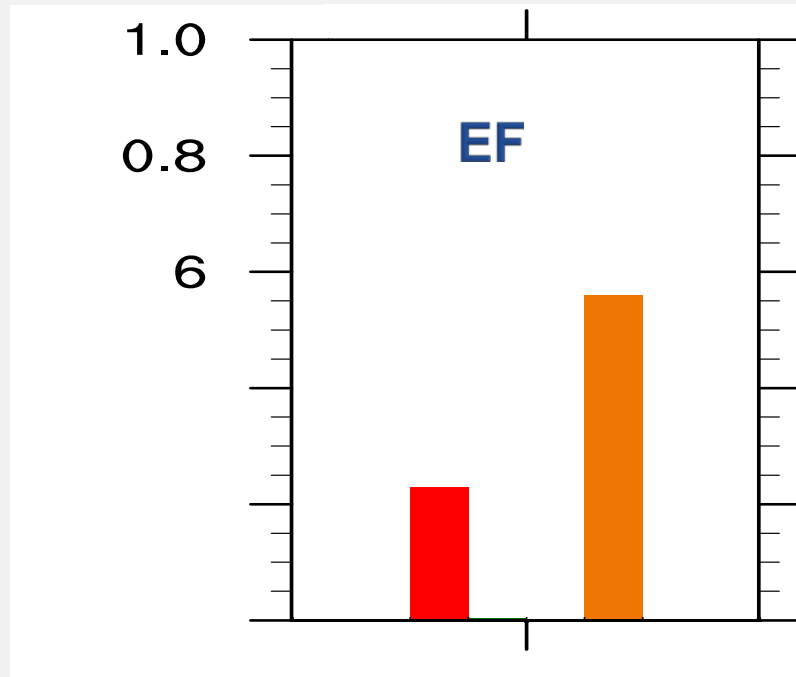


## The cloud impact

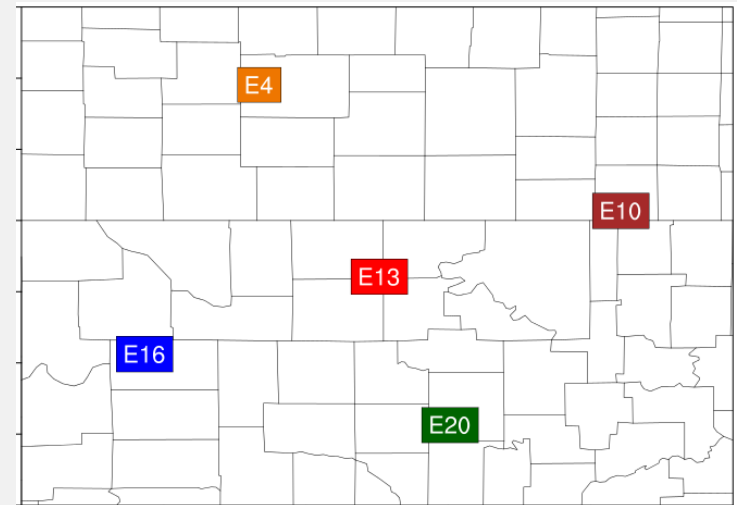


- R calculated from **daily means**
- On daily mean scale, cloud's impacts on surface energy have **small** spatial variability.
- $SW_{net}$  is highly correlated w/ cloud albedo ( $R > 0.9$ ).

# How well does the CF represent the SGP region?

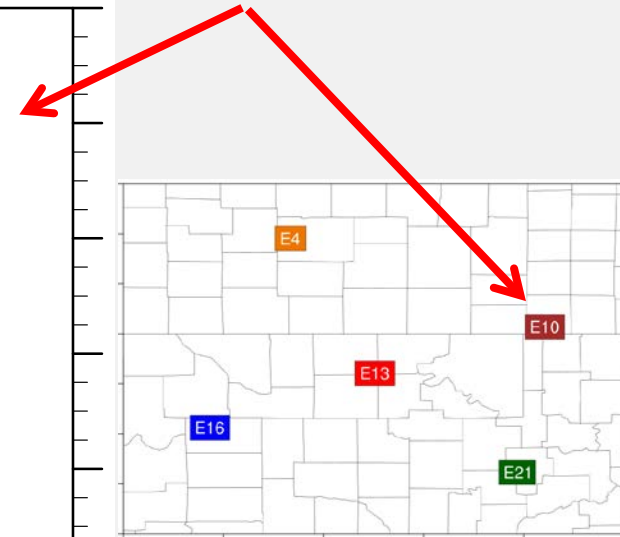
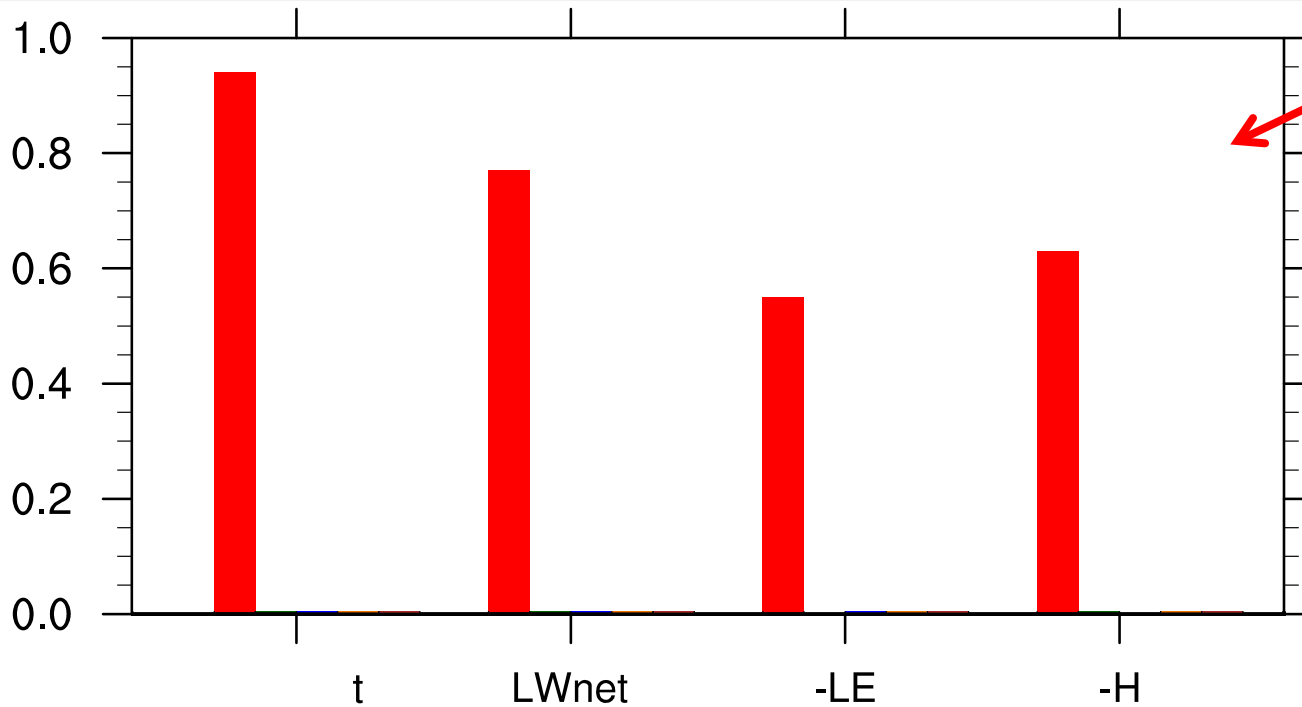


## The soil moist impact



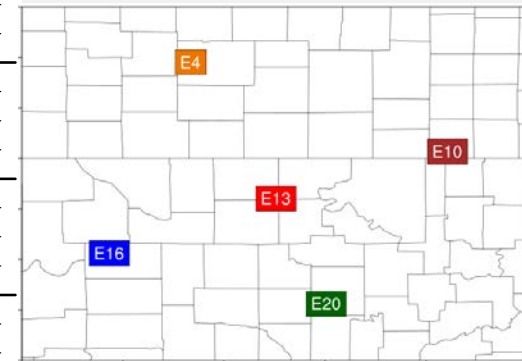
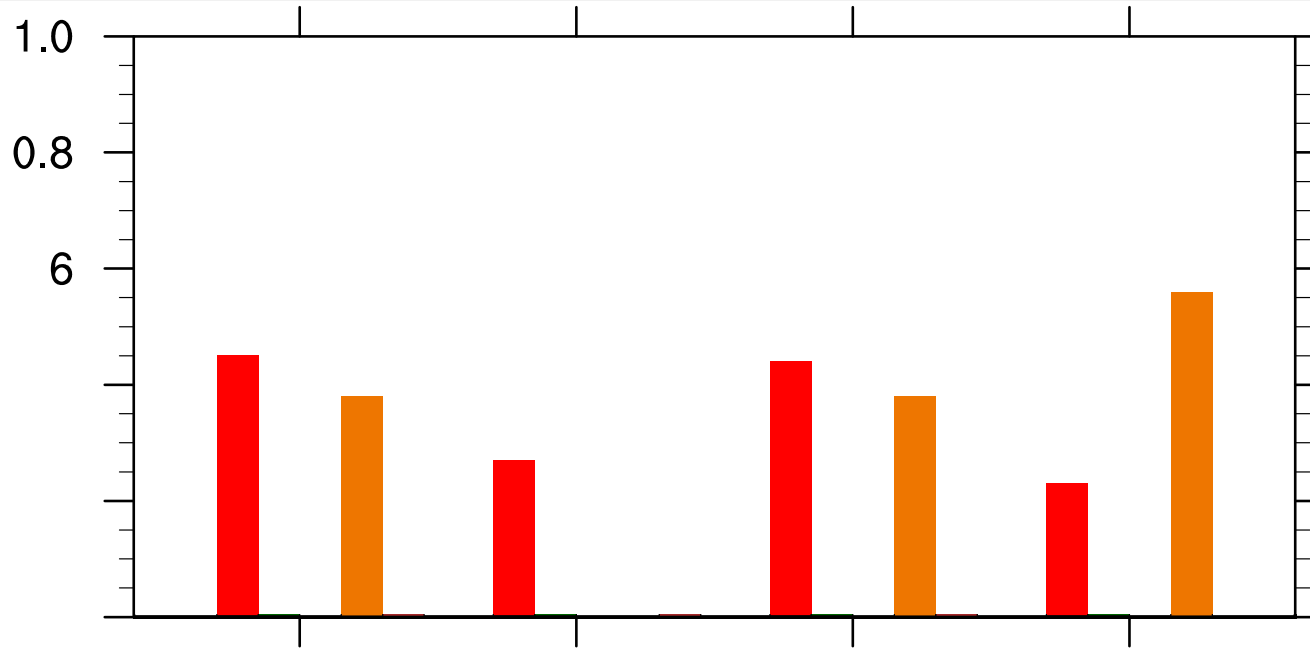
- Dependences on 5-cm soil moisture index (SMI) are generally **weak**.
- Not significant at sites **E16** and **E10**.

# What about other parameters? – the cloud impact



- R calculated from **daily means**
- On daily mean scale, cloud's impacts on surface energy have **small** spatial variability.
- $SW_{net}$  covaries **strongest** with cloud albedo.

# What about other parameters? – the soil moisture impact



- Dependences on 5-cm soil moisture index (SMI) are generally **weak**.
- Many are **NOT significant**. **No BLUE**

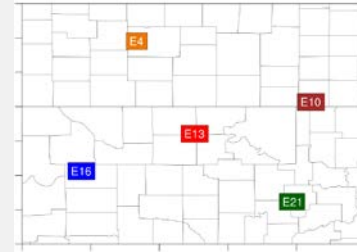
# Summary & Discussion

- Large spatial variability exists at SGP associated with the heterogeneity of surface/soil types and cloud variability.
- On daily mean scale, the cloud impact on surface energy budget (e.g.,  $SW_{net}$ ) is strong and CF results could well represent the whole SGP domain.
- In contrast, land feedback to atmosphere via soil moisture is generally weak with large spatial variability. Therefore, results only using CF may not be robust.
- Our study suggests that ARM emphasize on deploying collocated measurements in its future plan to facilitate cloud modeling and L-A interaction studies.

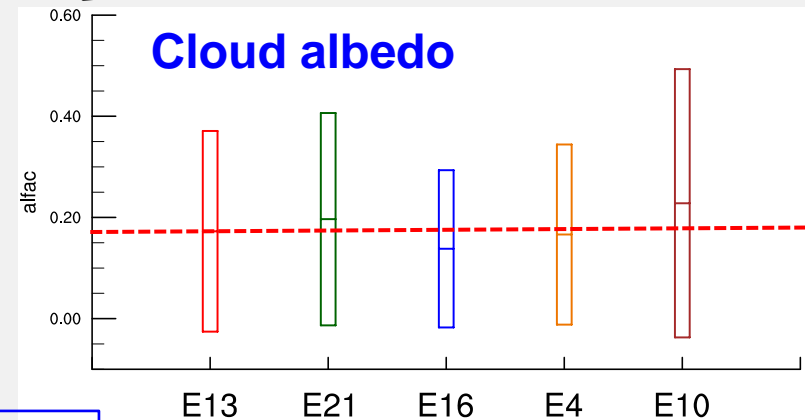
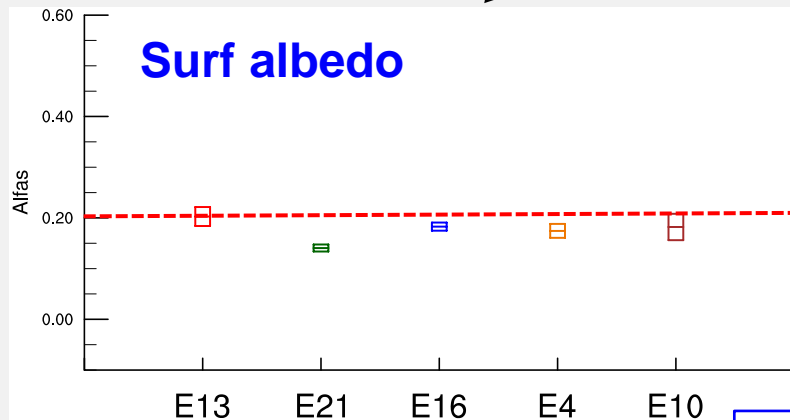
# Thank you



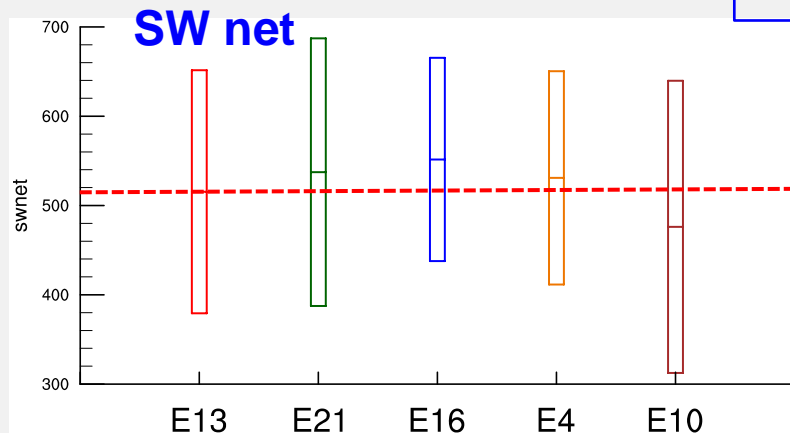
# Clouds dominate variability in surf $SW_{net}$



$$SW_{net} = (1 - \alpha_s) * (1 - \alpha_c) * SW_{dn(clear)}$$



2011/05-08



- Much greater variability in cloud albedo than surface albedo
- Clouds dominate variations of surface radiation and reduce the mean differences due to surface types.