Soil moisture forecasts based on the CFSv2 forecasts

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Objectives

Are CFSv2 forecasts add any skill to the soil moisture forecasts based on persistence or ESP?

- We compare
- A) Seasonal soil moisture forecasts directly from cfsv2 seasonal forecasts vs persistence
- B) ESP vs CFSv2_vic forecasts by forcing the VIC using daily P, Turf and surface winds from the CFSv2 forecasts (CFSV2_VIC)

VIC(simulation)

- Purposes:
- (a) Initial conditions for CFSv2_VIC run ;
- (b) Verification
- Model: VIC_4.0.6 their current operational model
- Forcing: derived from observations
- Period : 1 Jan 1979 to Dec 2010
- Initial conditions 31Dec1978 from the UW simulation from 1916.

Cross validation

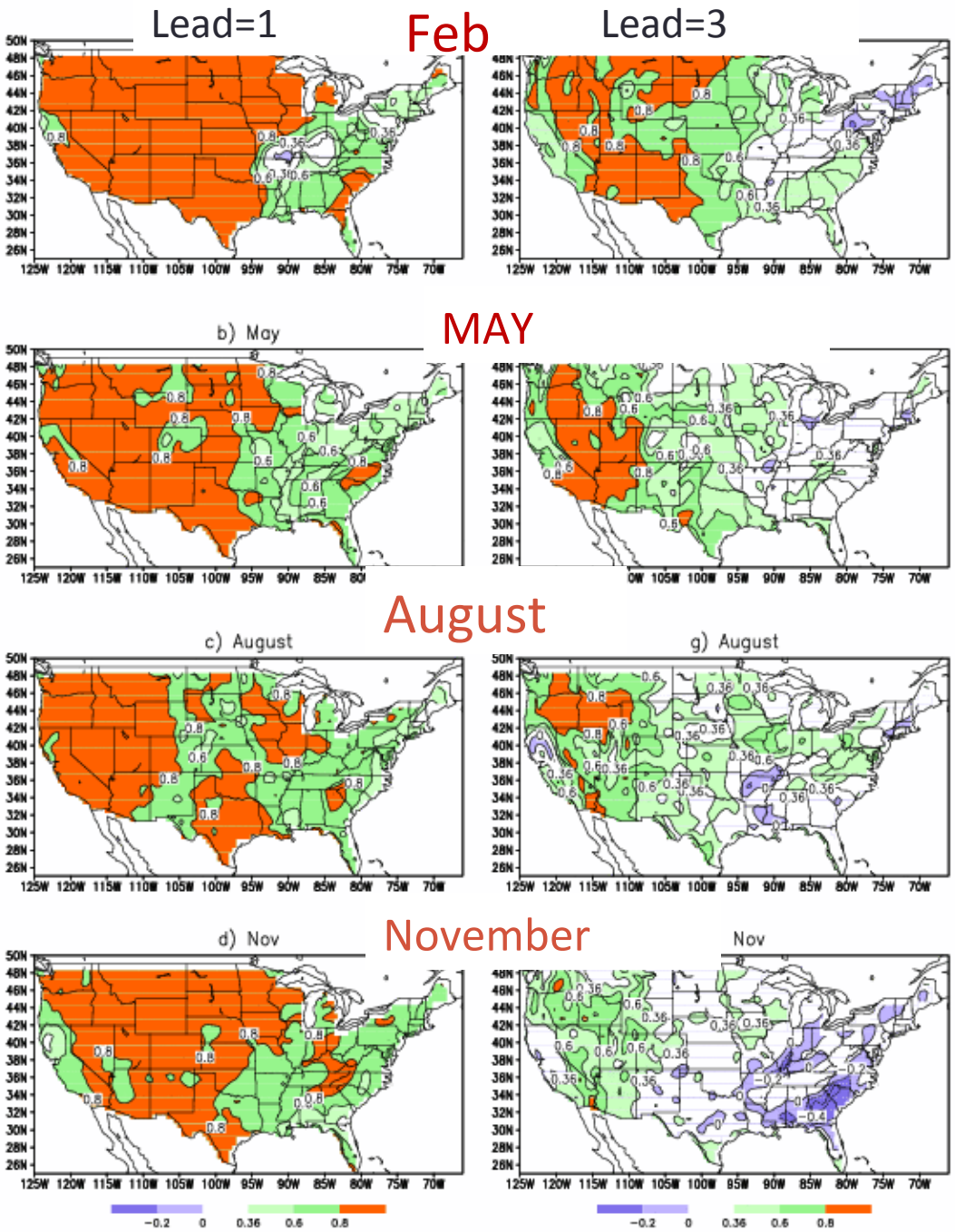
- Forecast period 1982-2009

- BCSD Error correction for all SM fcsts (probability mapping, Wood et al 2005)
- All parameters of the BCSD correction and anomalies were determined from data in the training period based on a VIC (simulation)
- After error correction, SM for the target month is verified against the corresponding SM anomalies from the VIC(sim)

RMSE and Correlation

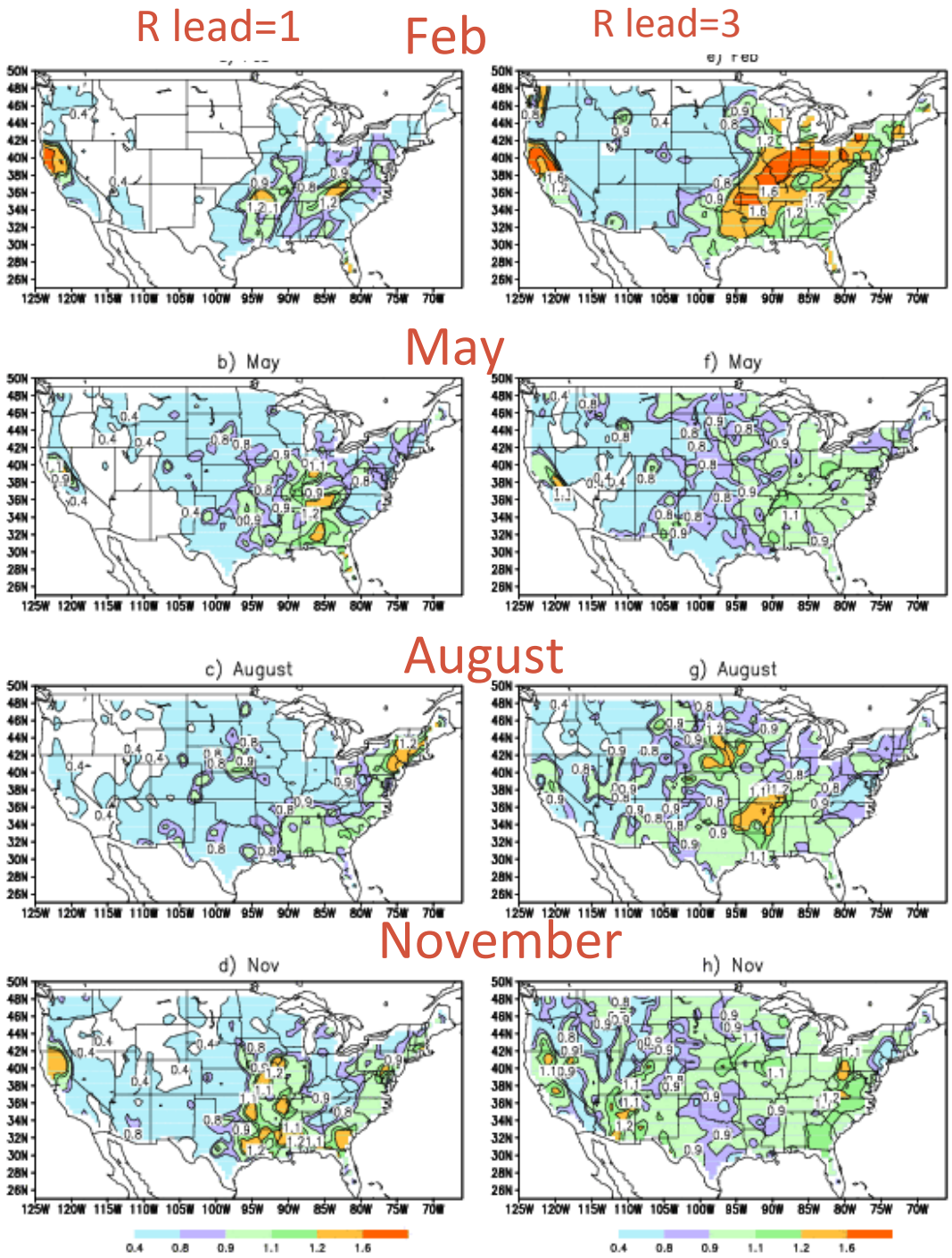
- RMSE– normalized by the standard deviation of the VIC(SIM) R> 1 no skill
- R ratio
- R(exp1/exp2)= RMSE(exp1)/RMSE (exp2)
- If R< 0.8, then Exp1 is more skillful than Exp2
- If 0.8<R<1.2 They are comparable
- If R>1,2 Exp2 is more skillful than Exp 1

Shukla and Lettenmaier 2011



correlation for persistence

1. Forecast skill is seasonally and regionally dependent
2. At lead 1, forecasts based on persistence are statistically significant.
3. At lead 3, forecasts over the western interior region are significant
4. Skill is highest for Feb, and lowest for Nov.



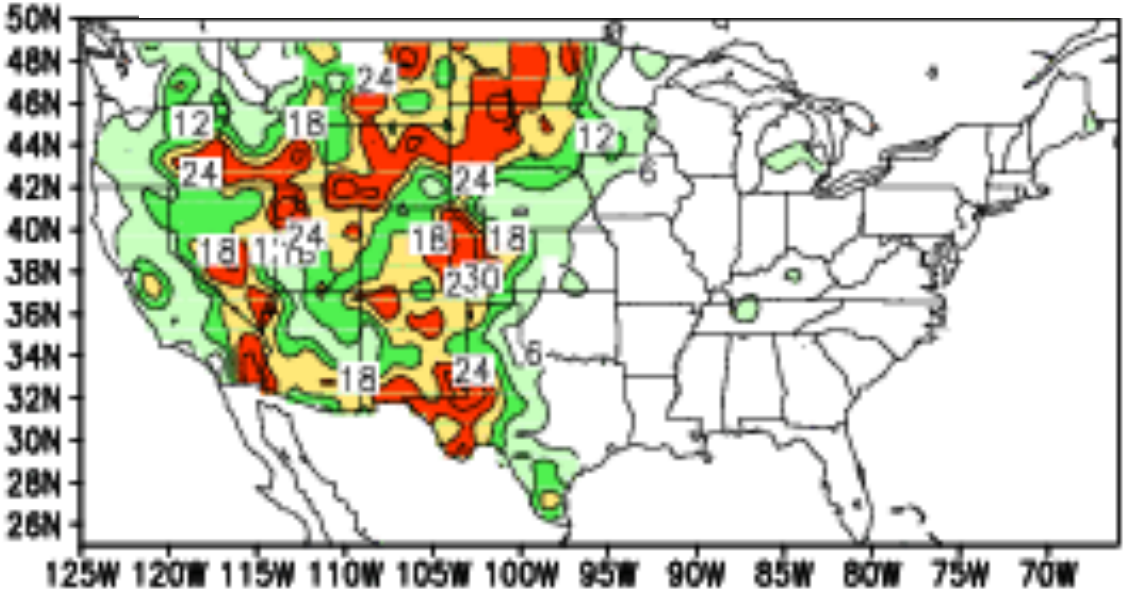
R(persist/CFSv2)

1. **If R< 1 : persistence has higher skill (blue)**
2. If R>1 CFSv2 has higher skill (red)

1. At lead 1, persistence dominants
2. At lead 3, for areas over the western region, persistence still has higher skill
3. The eastern region during Feb , CFSv2 has 'higher' skill, but the skill is too low to make any difference

Reason that persistence does well

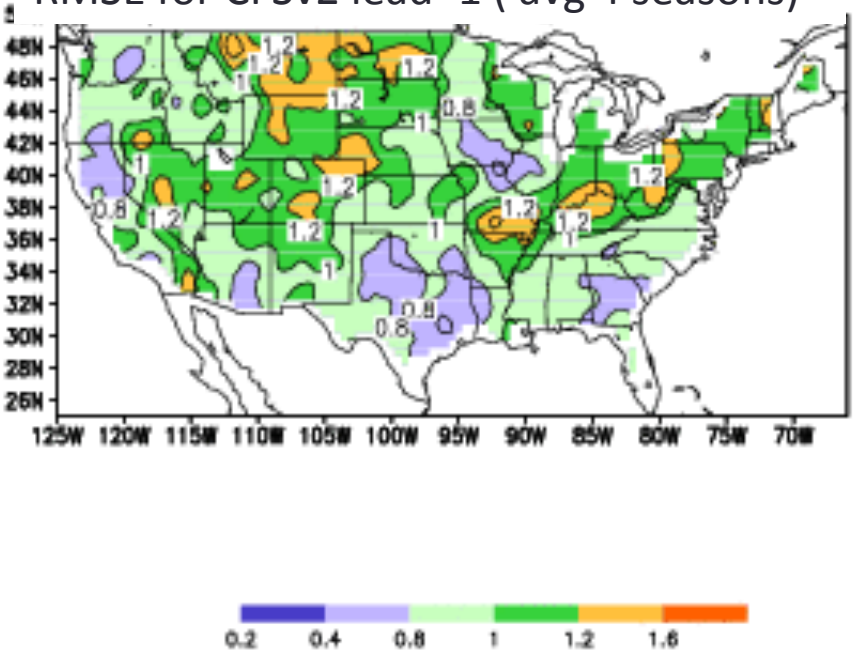
Characteristic time To



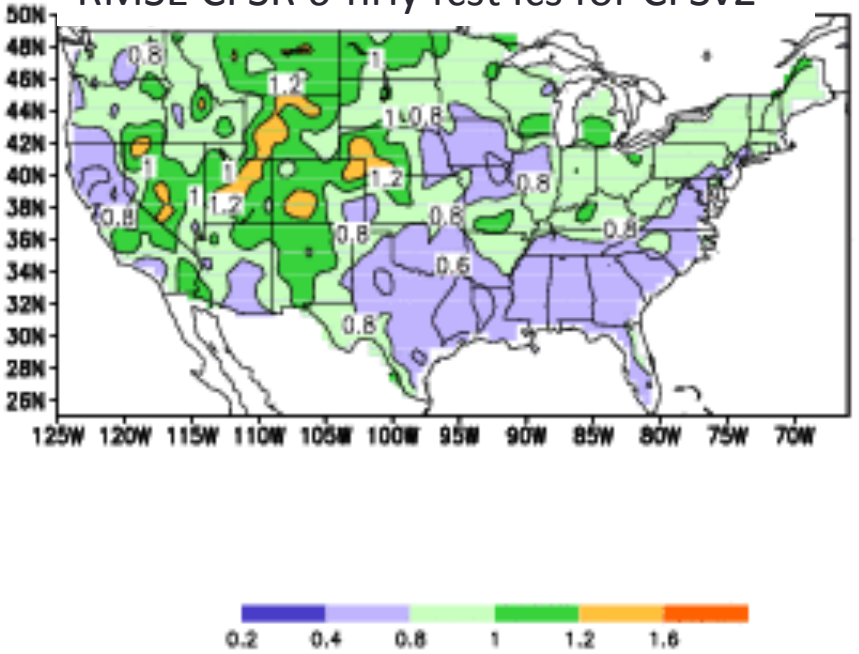
SM has high persistence over the western region=> high skill

Reason that CFSv2 did poorly

RMSE for CFSv2 lead=1 (avg 4 seasons)

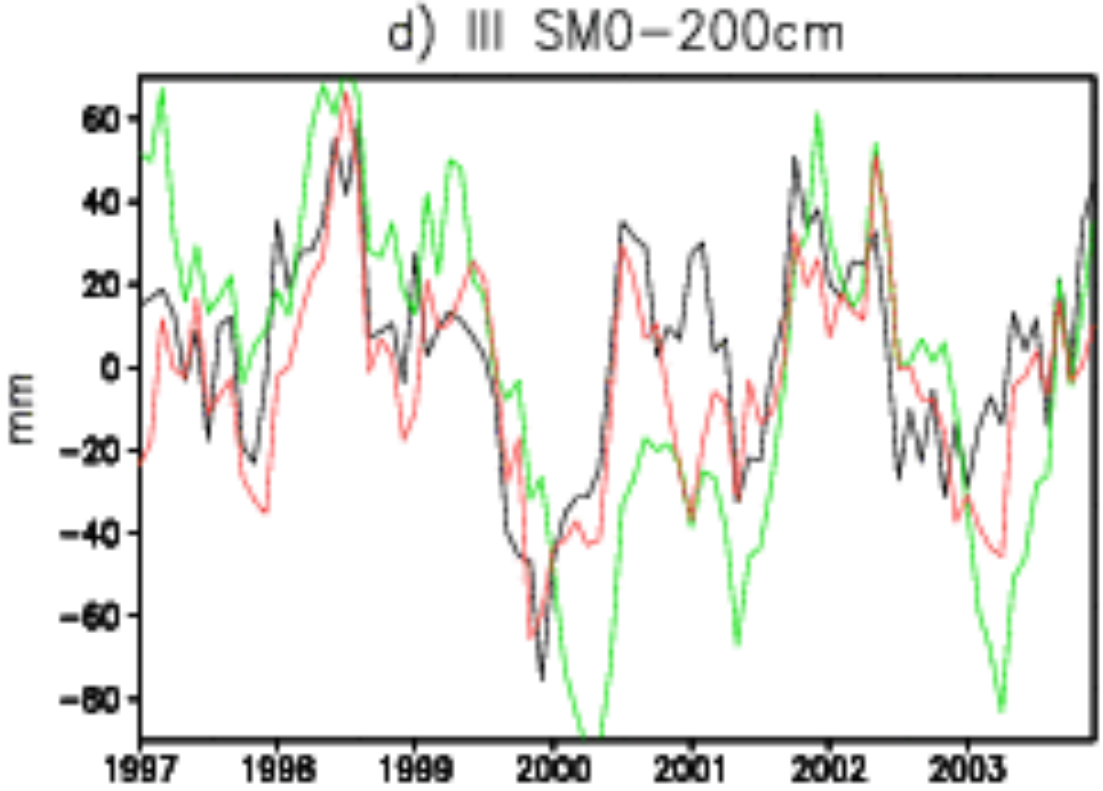


RMSE CFSR 6-hrly fcst Ics for CFSv2



Low skill for CFSv2 is due to errors in the initial conditions taken from CFSR 6-hrly fcsts

Verification against the soil moisture from the Ill water Survey



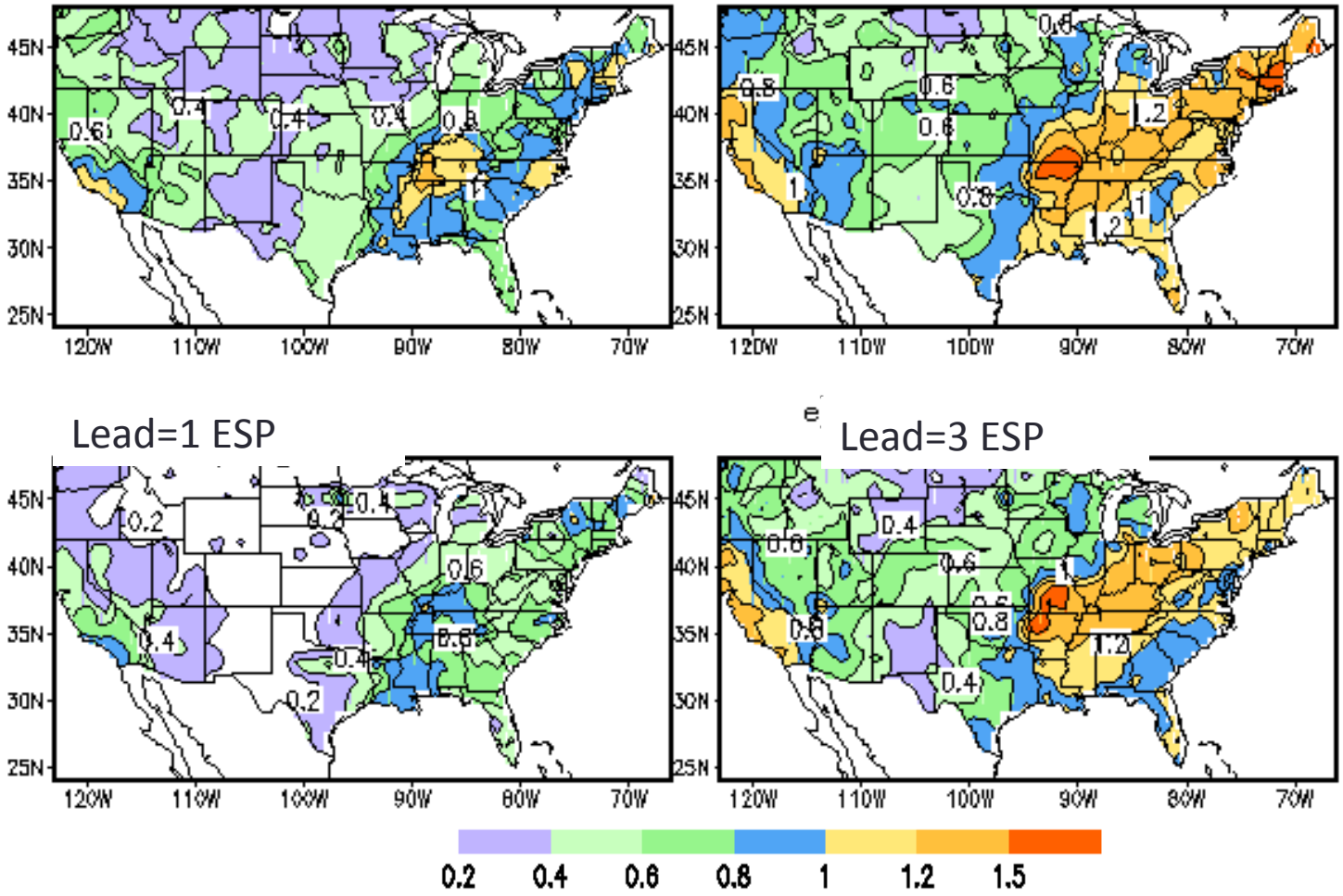
Black-obs,
Red -VIC(sim)
Green- CFSR 6hr fcsts

1. Comparing with SM observations from IlL. water survey indicates CFSR has large errors

Ensemble streamflow prediction vs persistence (JAN)

Lead 1 persistence

Lead=3 persistence



Lead=1 ESP

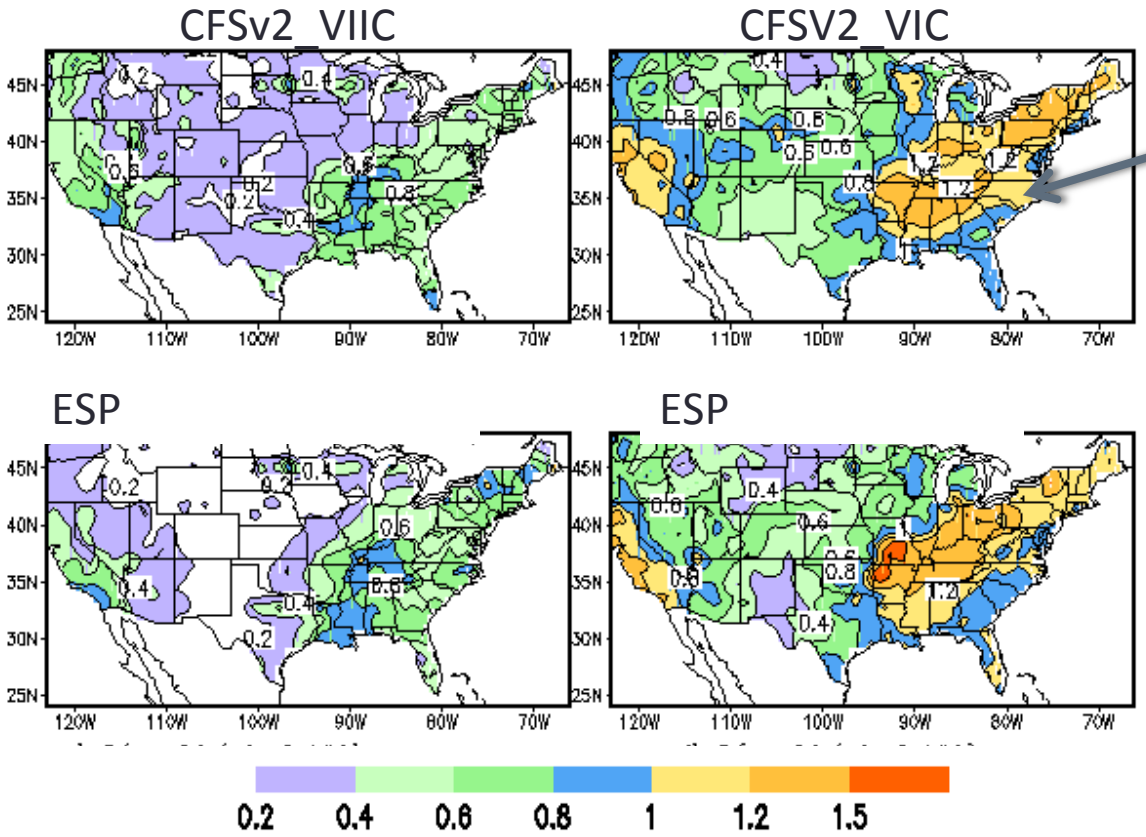
Lead=3 ESP

- **For all leads, ESP has higher skill than persistence.**
- **For SM and runoff fcsts, the initial conditions are extremely important for short leads on seasonal time scales**

Can CFSv2 forecasts help?

RMSE Lead=1

RMSE Lead=3



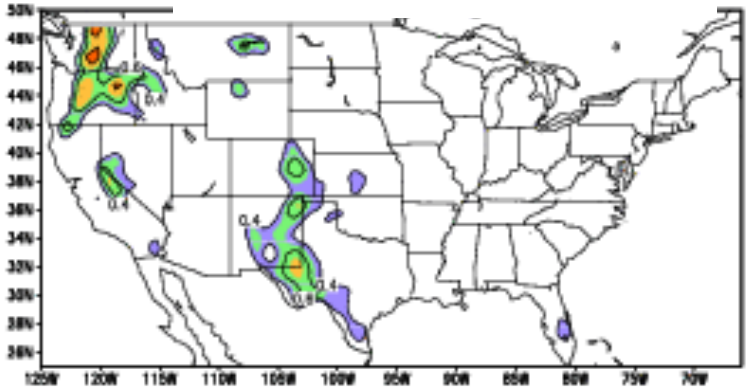
CFSv2_VIC is better but skills are low

- Over the western interior region, the ESP has slightly higher skill.
- Over the Eastern US the stormy region and the west coat , knowing forecasts helps.

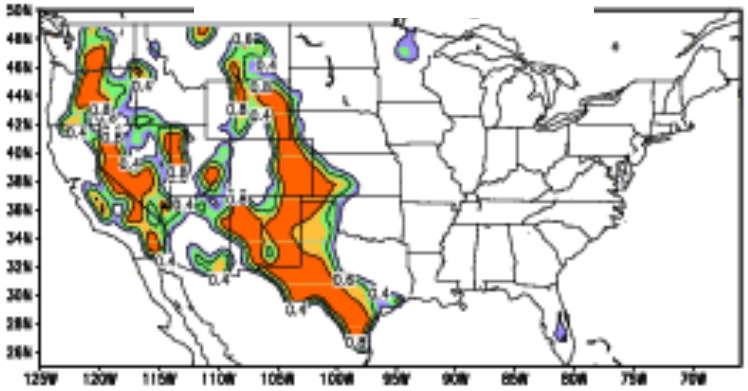
CFSV2_VIC & ESP : How different are they?

Taken into consideration of spread, the percentage of years, the differences between the CFSv2_VIC and ESP are statistically significant at the 5% level

Lead 1

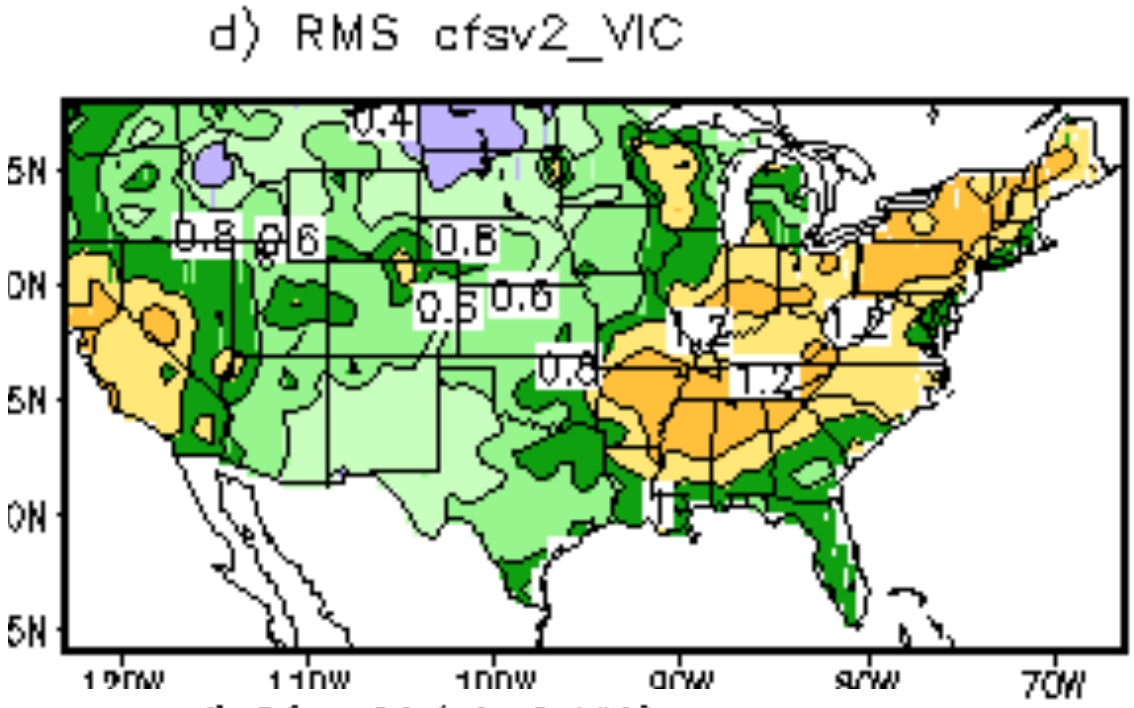


Lead=3

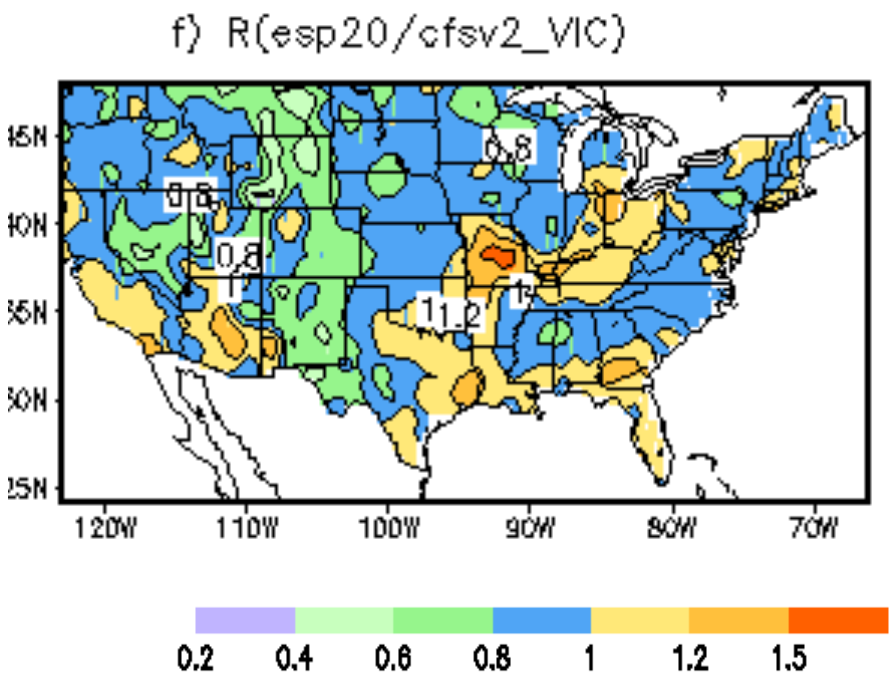


Lead=1 month, there is no statistically significant differences

Lead 3, over the western region, there are differences

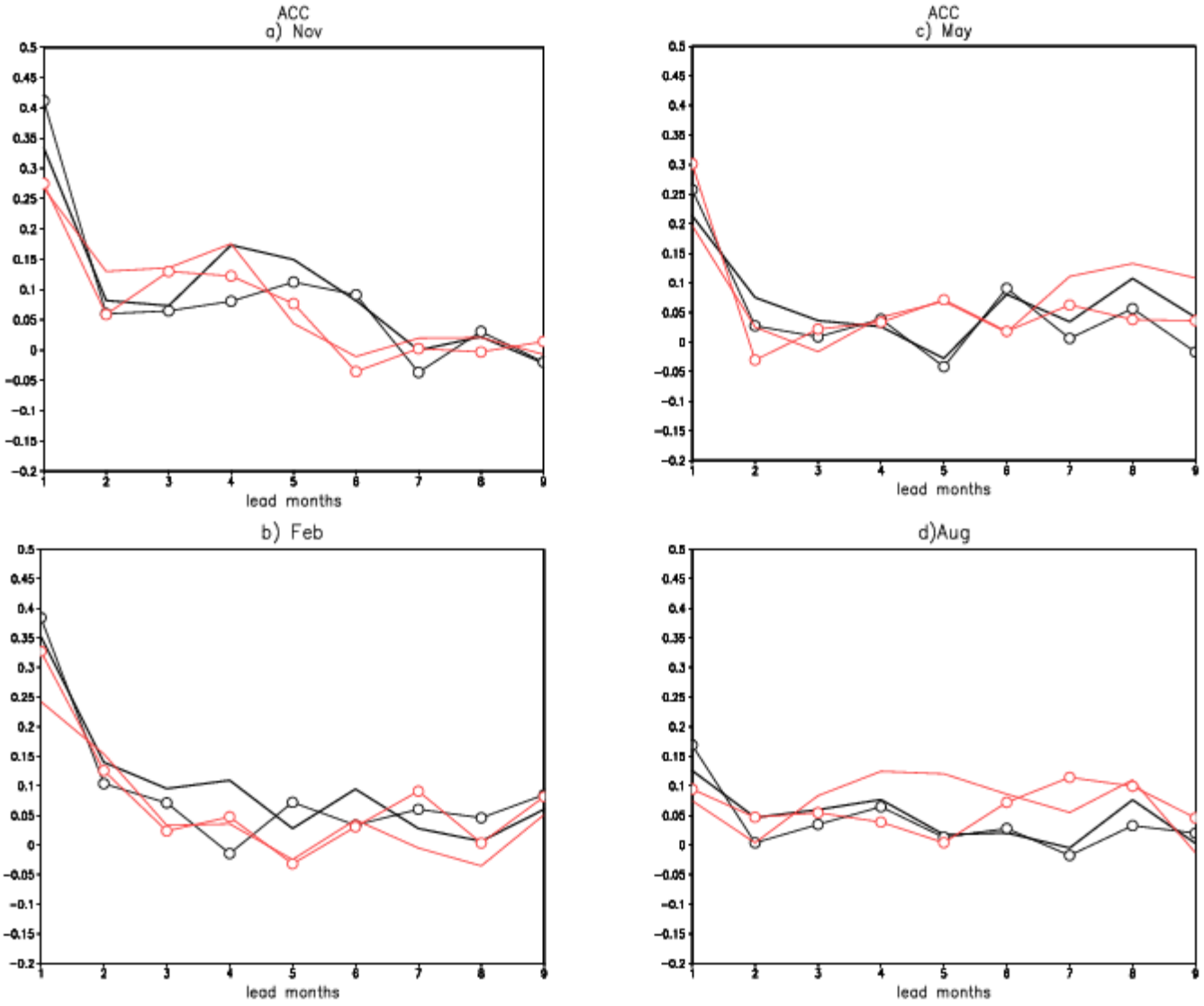


Over the eastern region, skill at lead=3 months is low and spread is high



Over the western region, esp20 has slightly higher skill

ACC for CFSv2 monthly mean P
Better than Cfsv1, but after lead=1 skill is very low



CFSv2

CFSv1

With open circles: 8 members

No circles 16 members

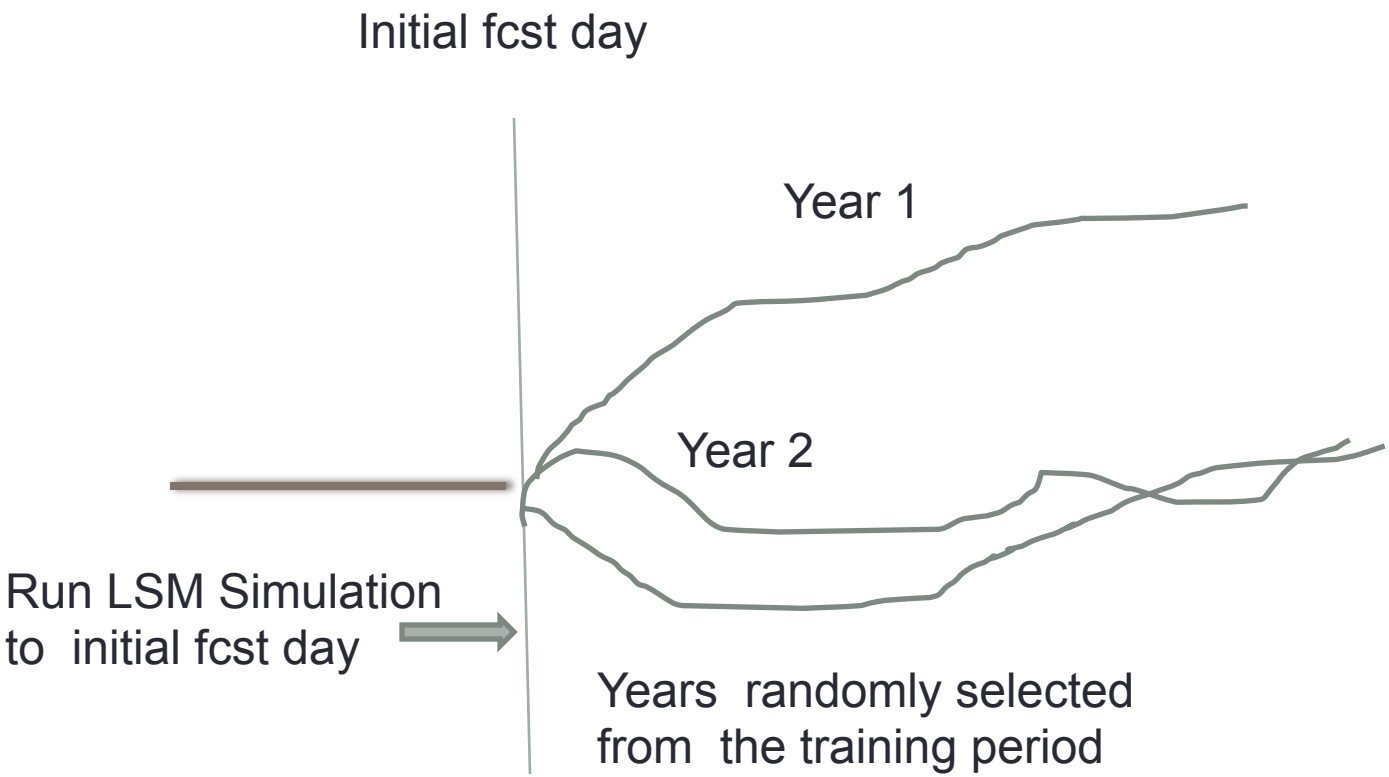
Conclusions

- For SM prediction, we need to have accurate initial conditions. Fix the spin up problem please !!!
- ESP should be the new metric for dynamic forecasts to beat
- Improve GCM P forecasts at lead > 3 months.

Recommendations

- For SM forecasts, skill comes from the initial conditions for the short leads.=> avoid spin-up problems
- If the initial conditions are good, then the CFSv2 should give better forecasts because the model takes into account of the coupling between land-atmosphere

Ensemble Streamflow Forecasts (ESP)



Daily P and Tsurf were randomly selected from the training period. They are used to derive forcing

Who are we?

- Lichuan Chen –University of Maryland CPC
- University of Washington Dr. Dennis Lettenmaier's group
- Shrad Shukla sis the ESP forecasts

CFSv2 and persistence

- Persistence– forecast for the target month M and lead t is the sum of the climatology for M+t-1 and SM anomaly for month M-1. Anomalies are determined from data in the training period.

e.g Feb 1989 persistence fcst lead 1 = anomaly for Jan 1989 +Feb climatology

- CFSv2 SM forecasts: ensemble for 8 members of SM monthly mean forecasts taken directly from CFSv2. They were treated by the BCSD correction

Soil moisture prediction

- For the western interior region west of 95W or for lead=1 to 2 months :Persistence is a good forecast tool
- Lower skill over stormy region where dynamics is important

RMS errors for persistence Jan 1982-2009

Lead=1 month

Lead=3 months