AGRICULTURAL DROUGHT PREDICTION OVER THE UNITED STATES

Kingtse Mo
Climate prediction Ct. NCEP/NWS/ NOAA
With contributions from LiChuan Chen

A tribute to
Late Masao Kanamitsu
(Kana) 1943- 2011
A Golden Light in the climate community

CAN WE USE SOIL MOISTURE FROM THE CFSV2 FOR SEASONAL PREDICTION?

Procedures:

1. Monthly mean SM from CFsv2 seasonal forecasts
2. 8 member ensemble
3. Bias correction and spatial downscaling (BCSD) for each member of ensemble.

How do we define leads:

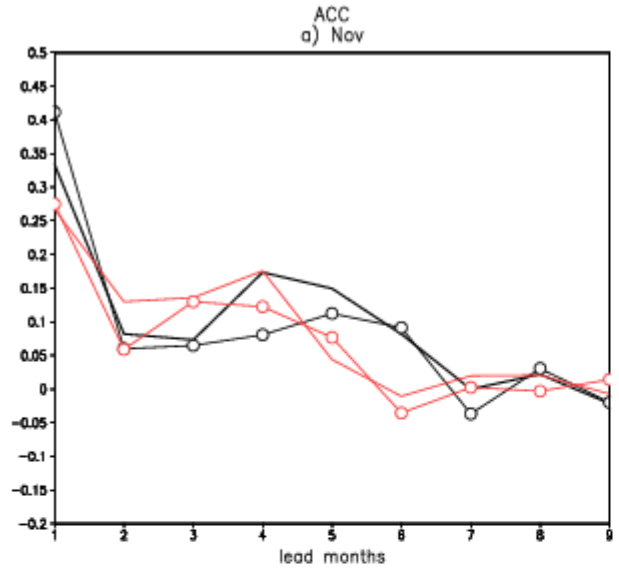
E. g. Feb

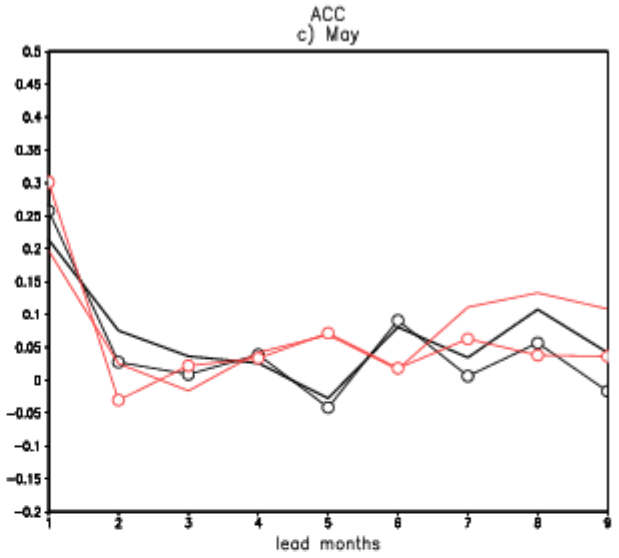
4 members from IC s from Feb 5 and Jan 31

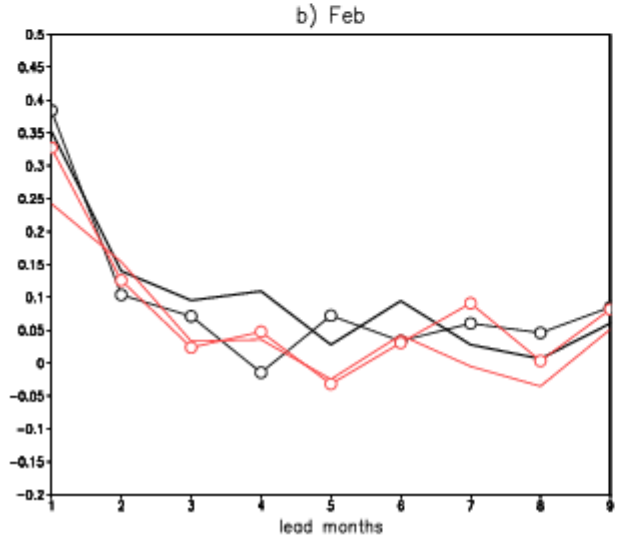
Lead 1 : verified against Feb ensemble NLDAS

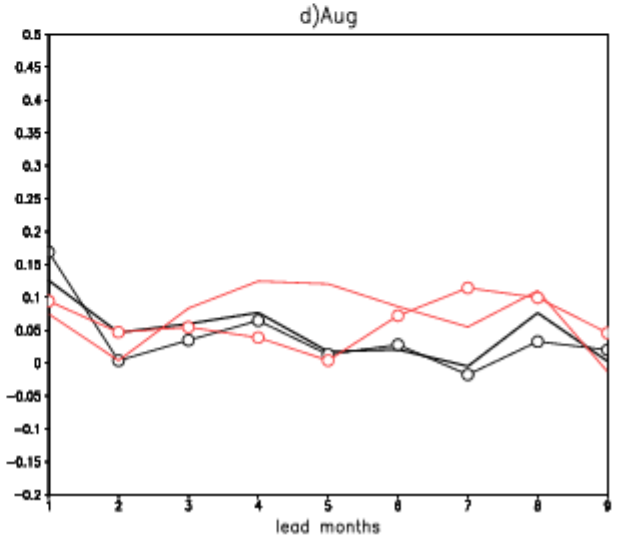
Lead 2: verified against March ens_NLDAS

ACC FOR CFSV2 MONTHLY MEAN P









CFSv2

CFSv1

open circles: 8 members

No circles 16 members

For lead 1: 8 -member cfsv2 Is the best After that, we do not Care.

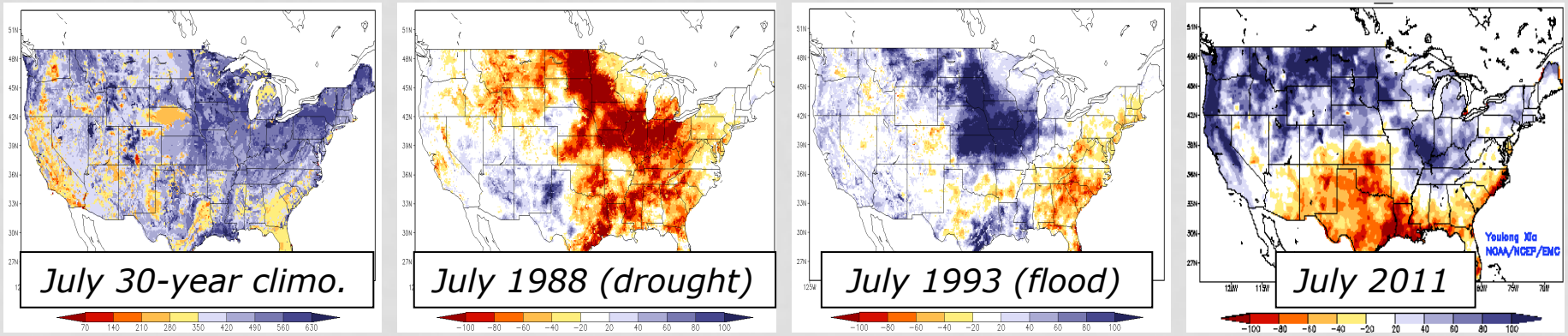
HOW TO VERIFY SM?

1. CFSR- 6-hr forecasts in the analysis – forecast cycle. The CFSR also provides IC s for the CFSv2 forecasts.
2. North American Land Data Assimilation (NLDAS) ensemble

NCEP operations: North American Land Data Assimilation System (NLDAS) (Youlong Xia and Mike Ek)

- Models: Noah, SAC, VIC, Mosaic land models run uncoupled
- Forcing: CPC observed precipitation and atmos. forcing from NCEP North American *Regional Climate Data Assimilation System*
- outputs: 1/8-deg. land & soil states, surface fluxes, runoff & streamflow.
- Land model runs for 30-year.
- **Anomalies** used for **drought monitoring**; supports *National Integrated Drought Information System*.

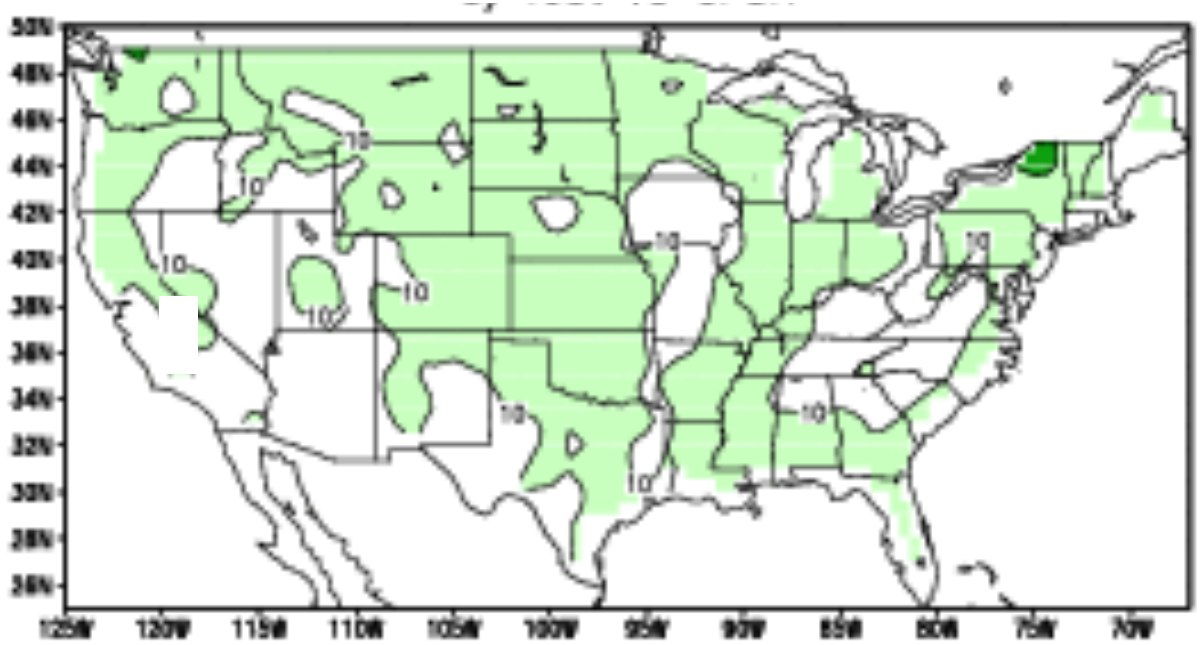
www.emc.ncep.noaa.gov/mmb/nldas



NLDAS four-model ensemble monthly soil moisture anomaly

SKILL DEPENDS ON THE VERIFYING DATA SETS (RMS FOR SM%)

CFSv2 vs CFSR



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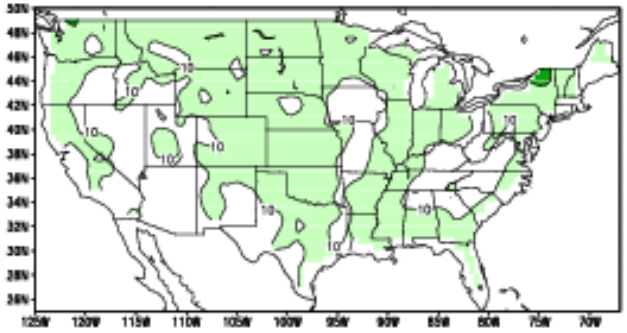
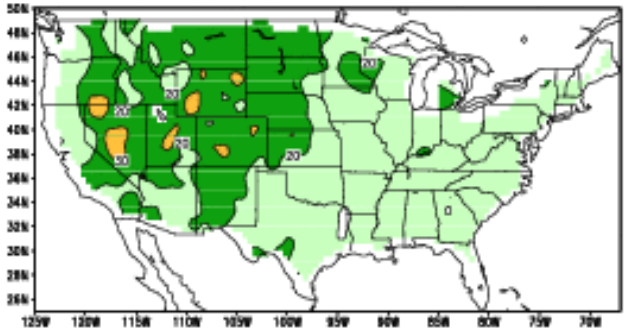
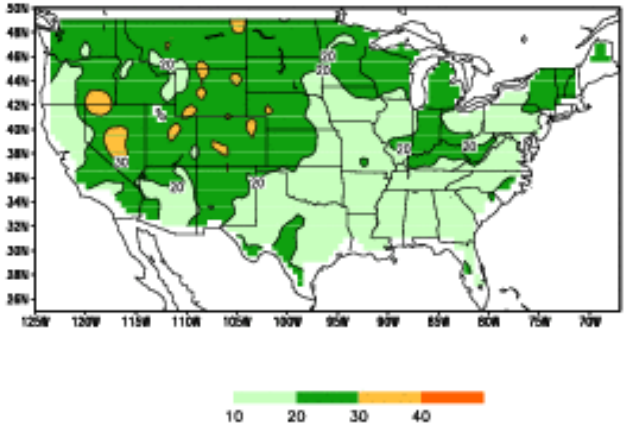


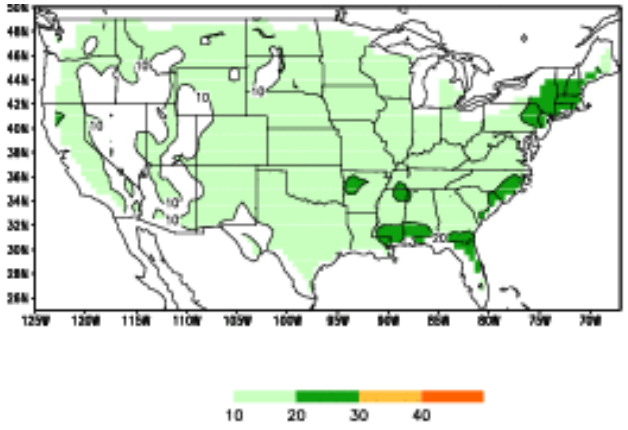
CFSR vs NLDAS_ens



CFSv2 vs NLDAS_ens

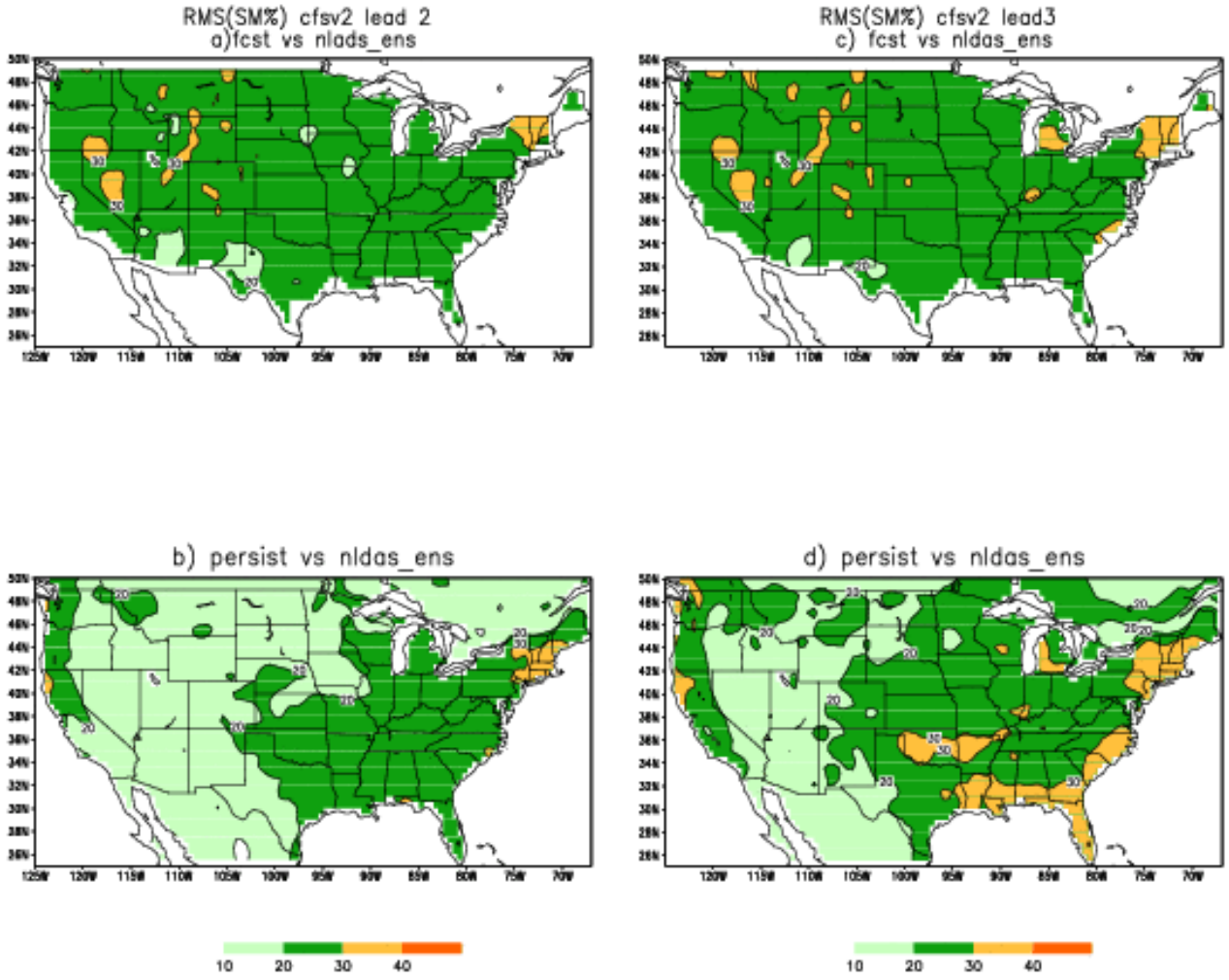


NLDAS_ens persistence



- 1. Verify against CFSR inflates skill
- 2. CFSv2 inherited errors from IC s which degrade fcsts
- 3 CFSv2 fcsts do not beat persistence

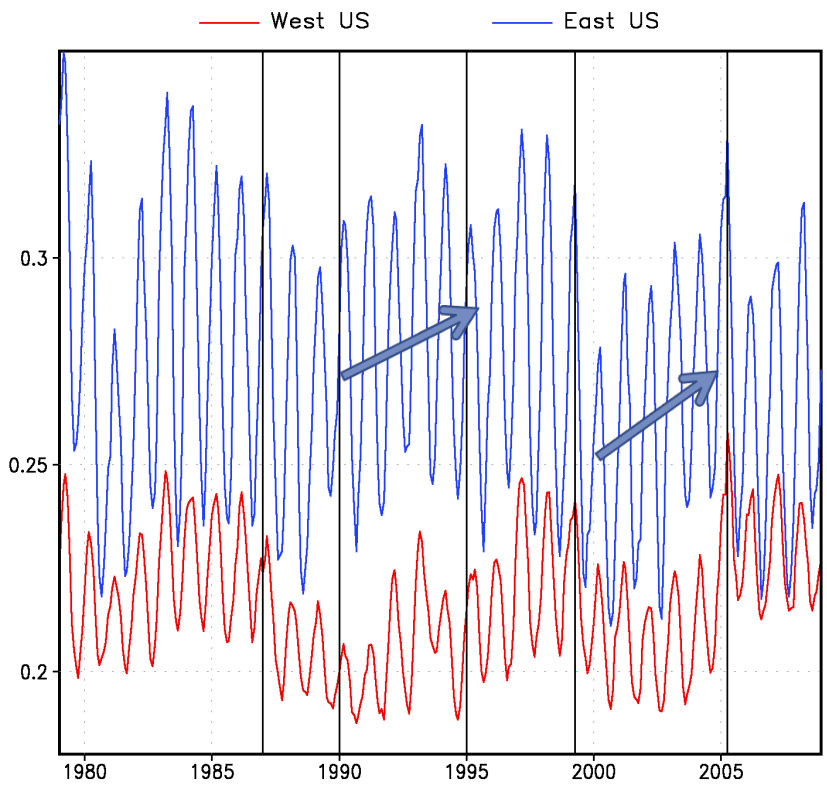
CFSV2 FCST LEAD 2 AND 3



- Fcsts for lead2 and lead3 have little skill;
- They do not beat persistence over the western interior region

Always ask WHY ???
Kana

CFSR SM SPIN UP



Volumetric total SM fraction
Monthly mean for the
West: (25-48N,97-125W)
East: (25-48N, 45-97W)

CFSR has the SPIN UP problem

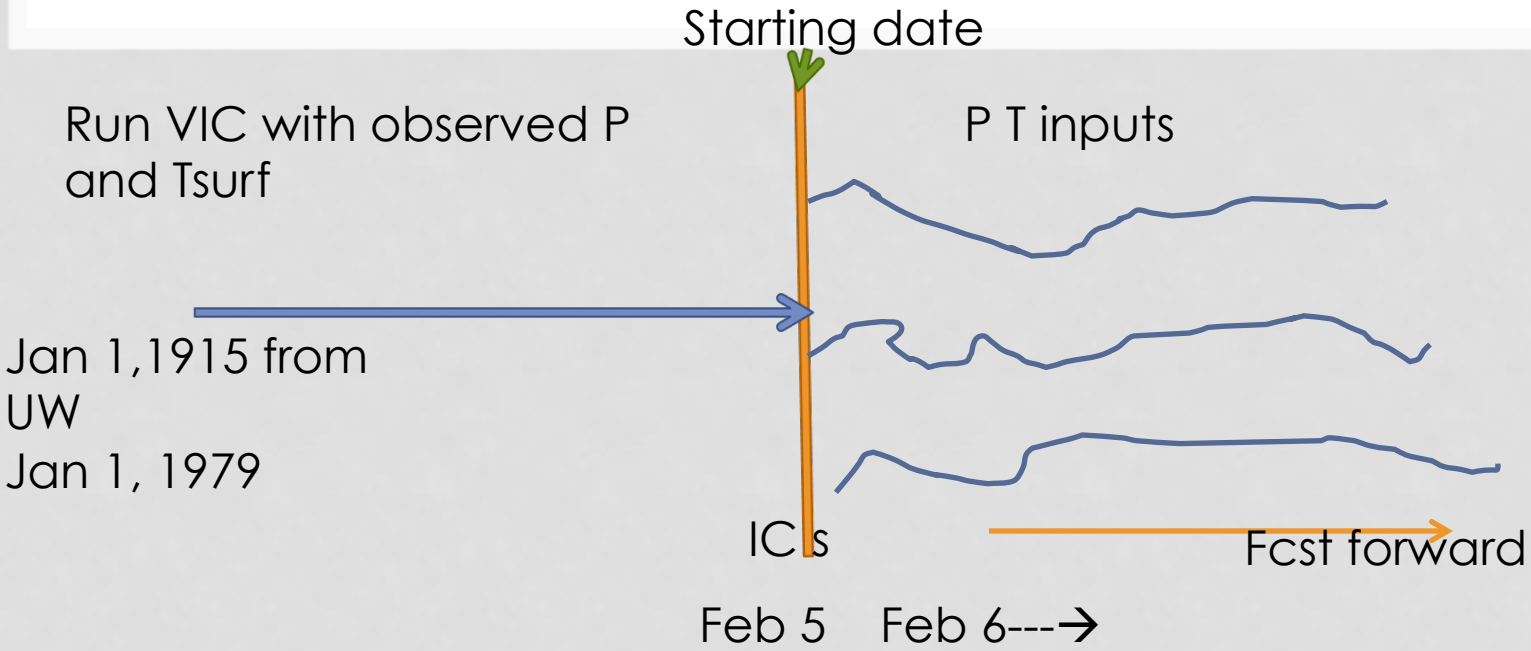
From Wanqiu Wang

CONCLUSION 1

- To verify against CFSR inflates skill because the ICs from CFSv2 are taken from CFSR.
- If we verify against the NLDAS-ens, CFSv2 SM forecasts are worse than persistence for lead1.
- The SM errors come from the IC s.

New discovery often came from unexpected results.---Kana

HYDROCLIMATE FCSTS



P and Tsurf input data

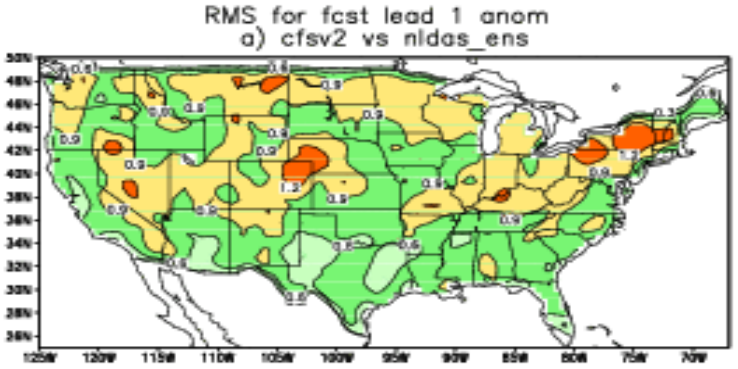
- We will use daily forecasts

VIC (CFS V2) EXPERIMENTS

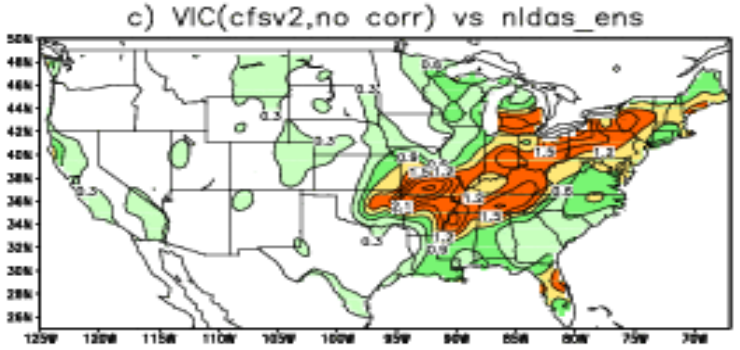
- Two sets of runs for February
- 8 member ensemble
- A. No correction VIC(CFSV2, no corr)
- B. Apply the BCSD correction to the monthly mean T and P. VIC(cfsv2)
- For daily forecasts, we make sure that the monthly means of daily P and T are the same as the corrected monthly means.

RMS FOR VIC(CFS) VS NLDAS_ENS

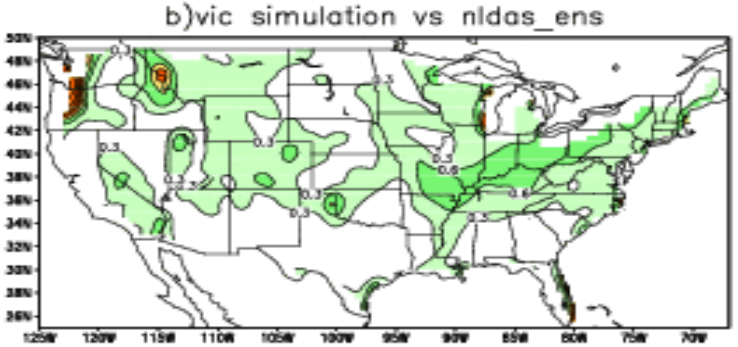
CFSv2 lead 1 fcsts



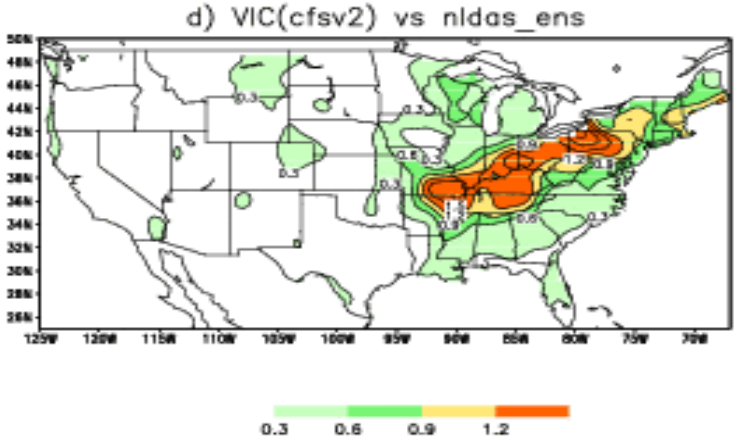
VIC(cfsv2 no corr)



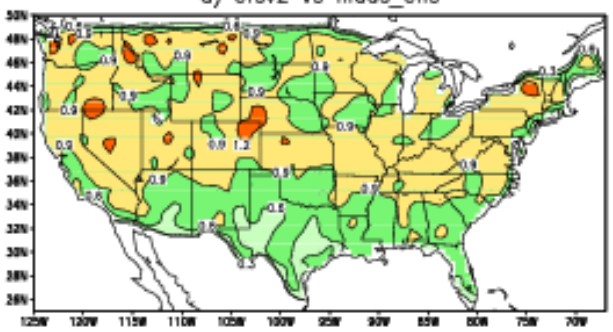
VIC simulation

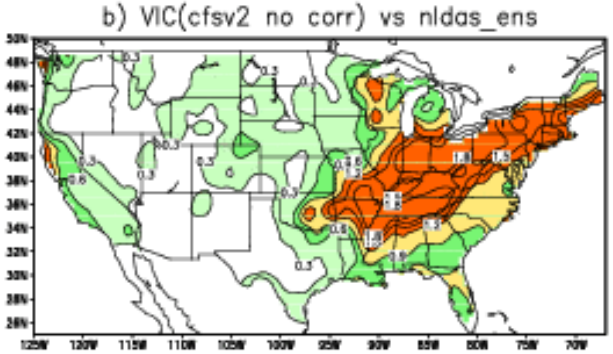


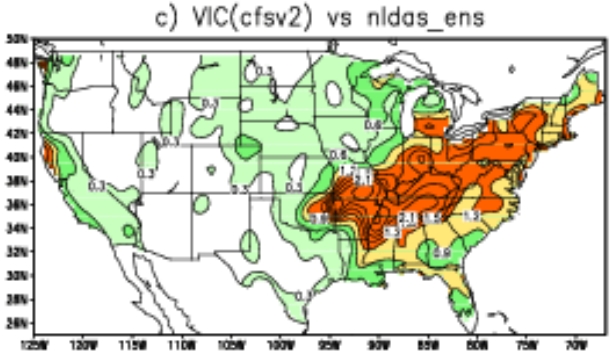
VIC(cfsv2 corrected)



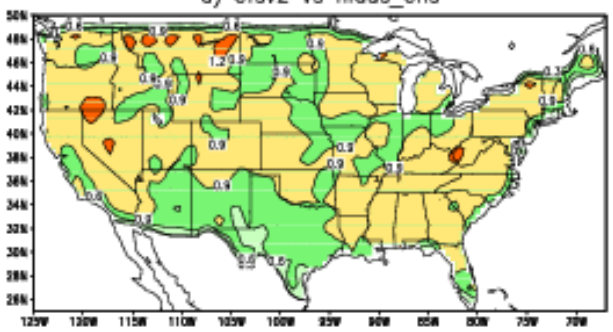
Lead 2

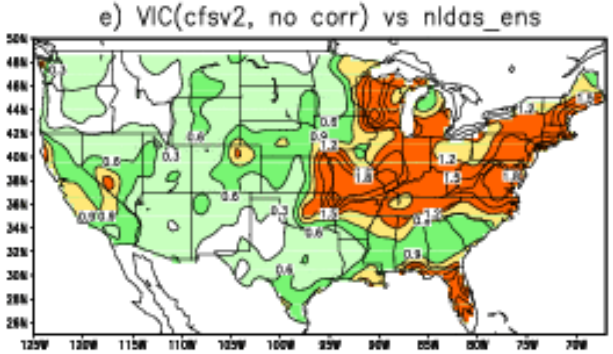


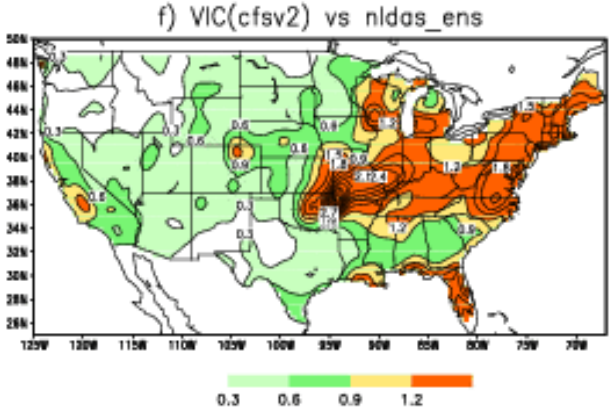




Lead 3







CFSv2

VIC(cfsv2) no correction

VIC(cfsv2) corrected

CONCLUSIONS 2

- VIC(cfsv2) is more skillful over the western region because the IC s are better and SM has high persistence over the western region.
- VIC(cfsv2)—error correction only improves the fcsts slightly for lead 1
- Errors over the Ohio Valley come from both the CFSv2 errors and the difference between the VIC model and the NLDAS_ens models.
- This suggests that multi model or multi method ensemble will help.
- Skill mask is a must for forecasters to use your fcsts

ESP (ENSEMBLE STREAM FLOW FCST) EXPERIMENTS

- ESP: P and T inputs from any year observed P T from Feb 6-end of April.
- Experiment design : February ICs

(a) There are 6 warm , 6 cold ENSO events during 1979-2009

(b)For each year, we made 12 runs with PT inputs provided by randomly selected 4 warm, 4 cold and 4 neutral years.

e. g ESP fcst for 1983 Feb : 12 runs

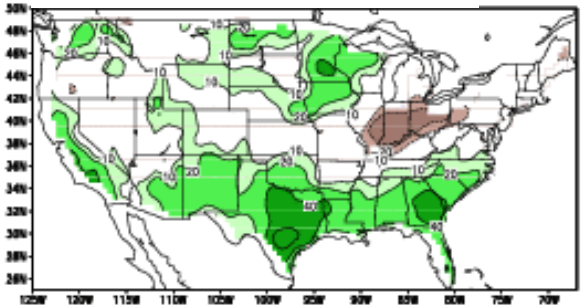
warm1987,1992 ,1998 2003,

Cold 1989,1999,2000,2008

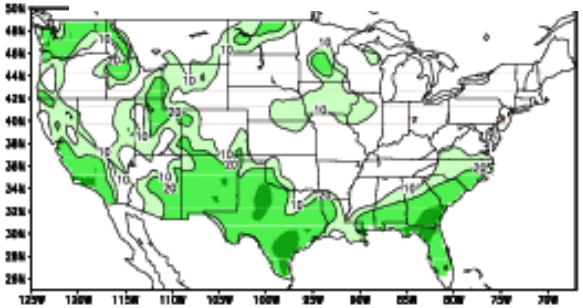
Neutral: 1990, 1993,1997,2004

SM ANOMALIES FOR WARM ENSO EVENTS(LEAD1)

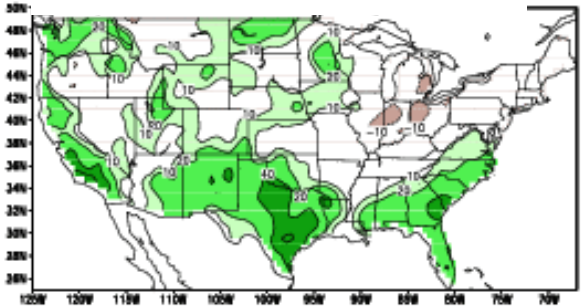
NLDAS_ens



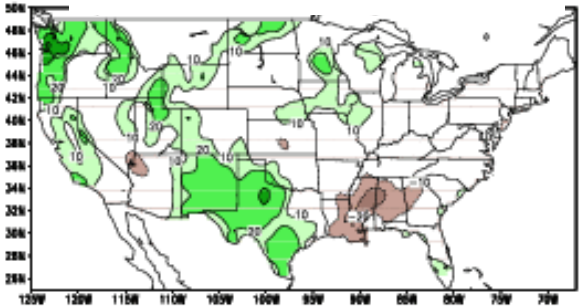
ESP cond to warm



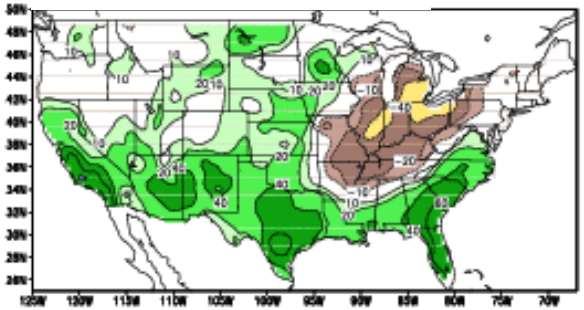
VIC simulation



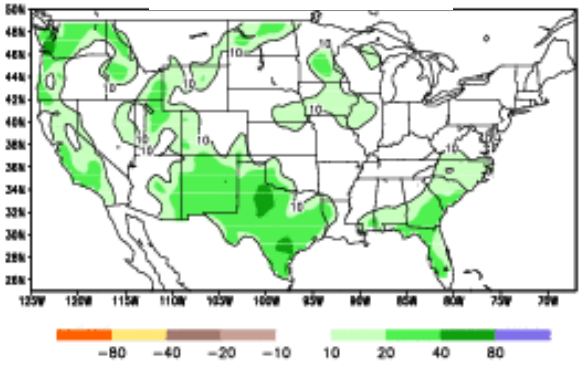
ESP cond to cold



VIC(cfsv2)



ESP all



- Similarity among the ESP cond warm, cold and all shows the importance of the IC s.
- While the general patterns are similar, ESP cond to cold has negative anom over the Southern U. S.
- For all, ESP cold and warm averaged out so the ESP captures the pattern well but anom are too weak.
-

CONCLUSIONS 3

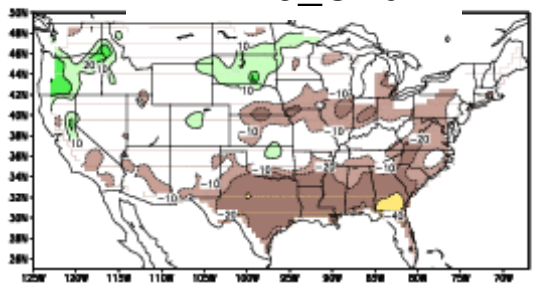
- For ESP, initial conditions play a dominant role (Shukla and Lattenmaier 2011).
- The P and T inputs play a secondary role, but they modulate the magnitudes of SM anomalies and detailed structure of the pattern.
- ENSO has strong influence on T and P over the southern states, so conditioned ESP will give better results.
- Because the cancellation of warm/cold ENSO influences, the unconditioned ESP tends to give weaker amplitudes of anomalies.

SUGGESTIONS

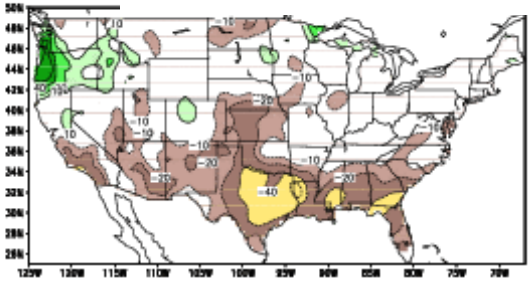
- VIC or any hydrological model will NOT correct the forecast errors from the CFS. Therefore, multi-model ensemble may help because they have errors in different places.
- For this case, monthly mean P and Tsurf errors are not systematic. Error correction does not improve forecast much. (need to test for other seasons).
- For forecasters: We need skill mask to use the forecasts intelligently.

SM ANOMALIES FOR COLD ENSO

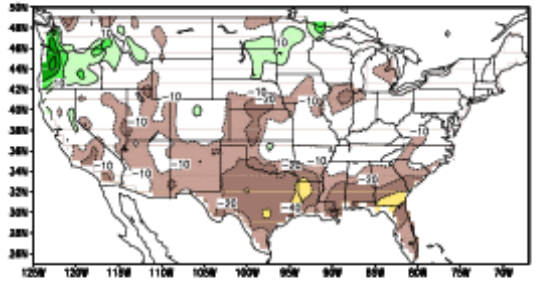
NLDAS_ens



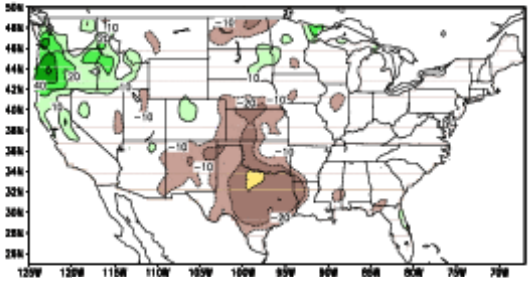
ESP Cond cold



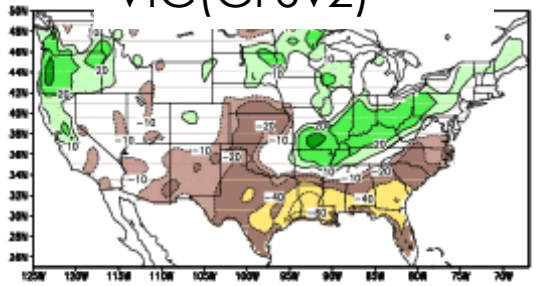
VIC_simulation



ESP cond Warm



VIC(CFSv2)



VIC all