Seasonal Soil Moisture Forecasts

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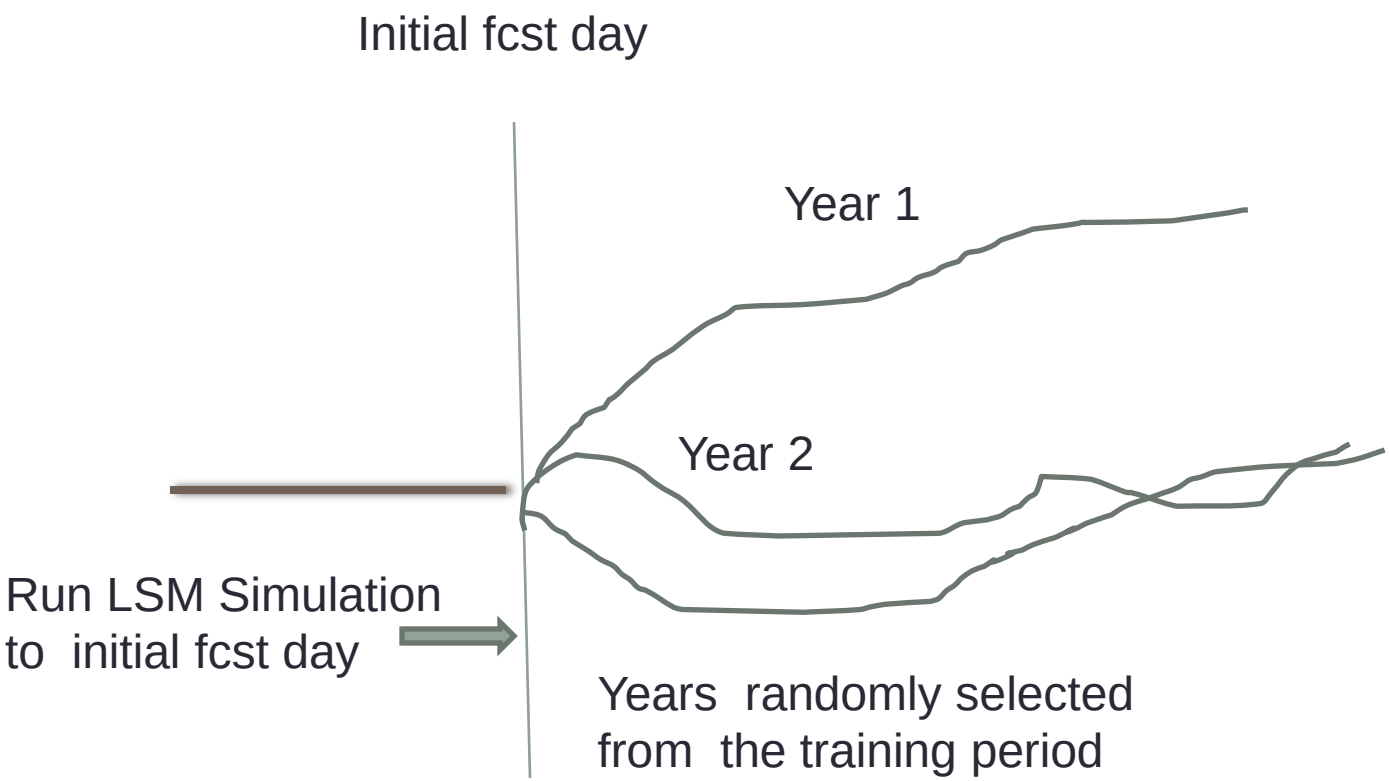
Objectives

1. The ESP_VIC does well, why??
2. Do CFSv2_VIC forecasts add any skill to the soil moisture forecasts based on ESP?
3. Do the current forecast tools capture drought?
4. Recommendations

VIC(simulation)

- Purposes:
  - (a) Initial conditions for CFSv2_VIC & ESP_VIC run ;
  - (b) Verification
  - Details
- 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.

Ensemble Streamflow Forecasts (ESP)



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

ESP-VIC vs CFSv2-VIC

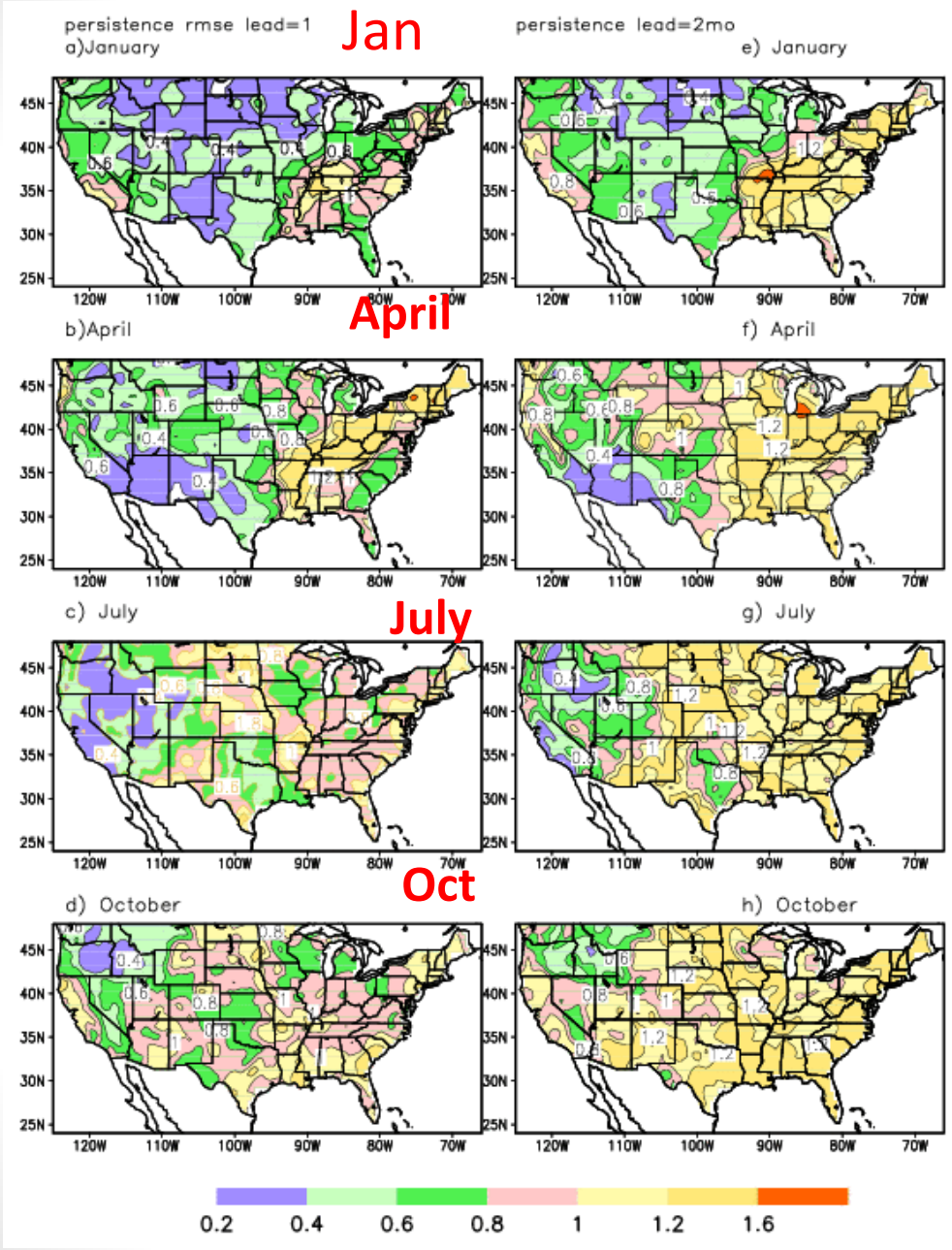
- ESP_VIC and CFSv2-VIC have the same initial conditions taken from the VIC(SIM) at the forecast date
- ESP_VIC --- forcings are taken from randomly sampling the P, T and winds from historical training period
- CFSv2_VIC – forcings are taken from the CFSv2 P, T and wind fcsts after the BCSD correction with parameters determined from the training period
- SM outputs also went through the second stage BCSD correction with parameters determined from the training period
- SM forecasts are crossly validated.
- Period 1982-2009
- Forecasts Ics : Jan, April, July and Oct
- ESP 20 members, CFSv2 (16 members)

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

Lead=1 Lead=2

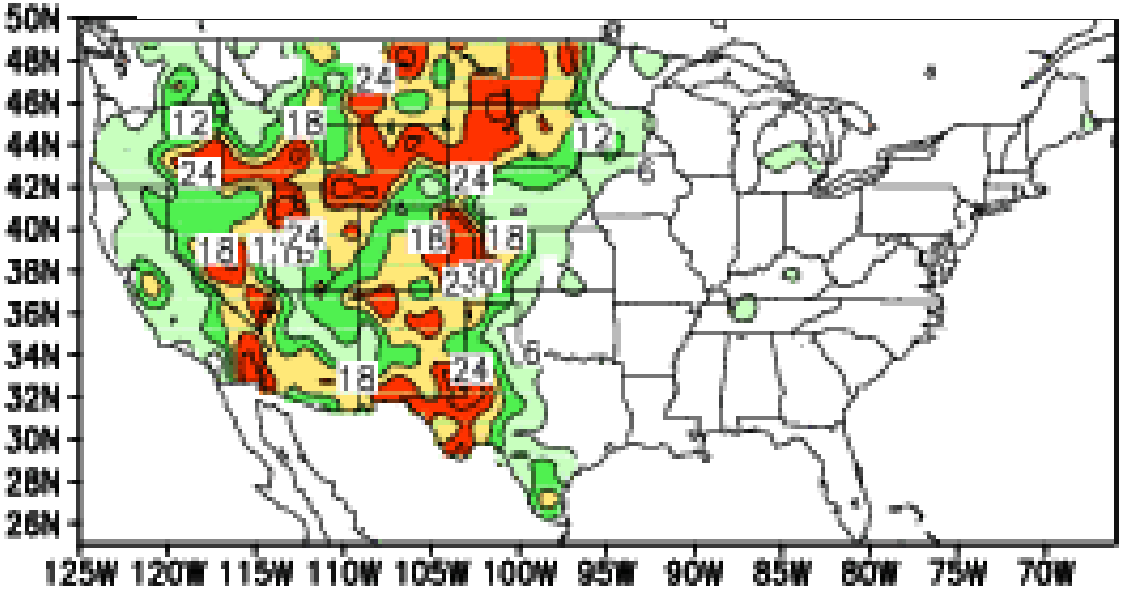


RMSE for persistence

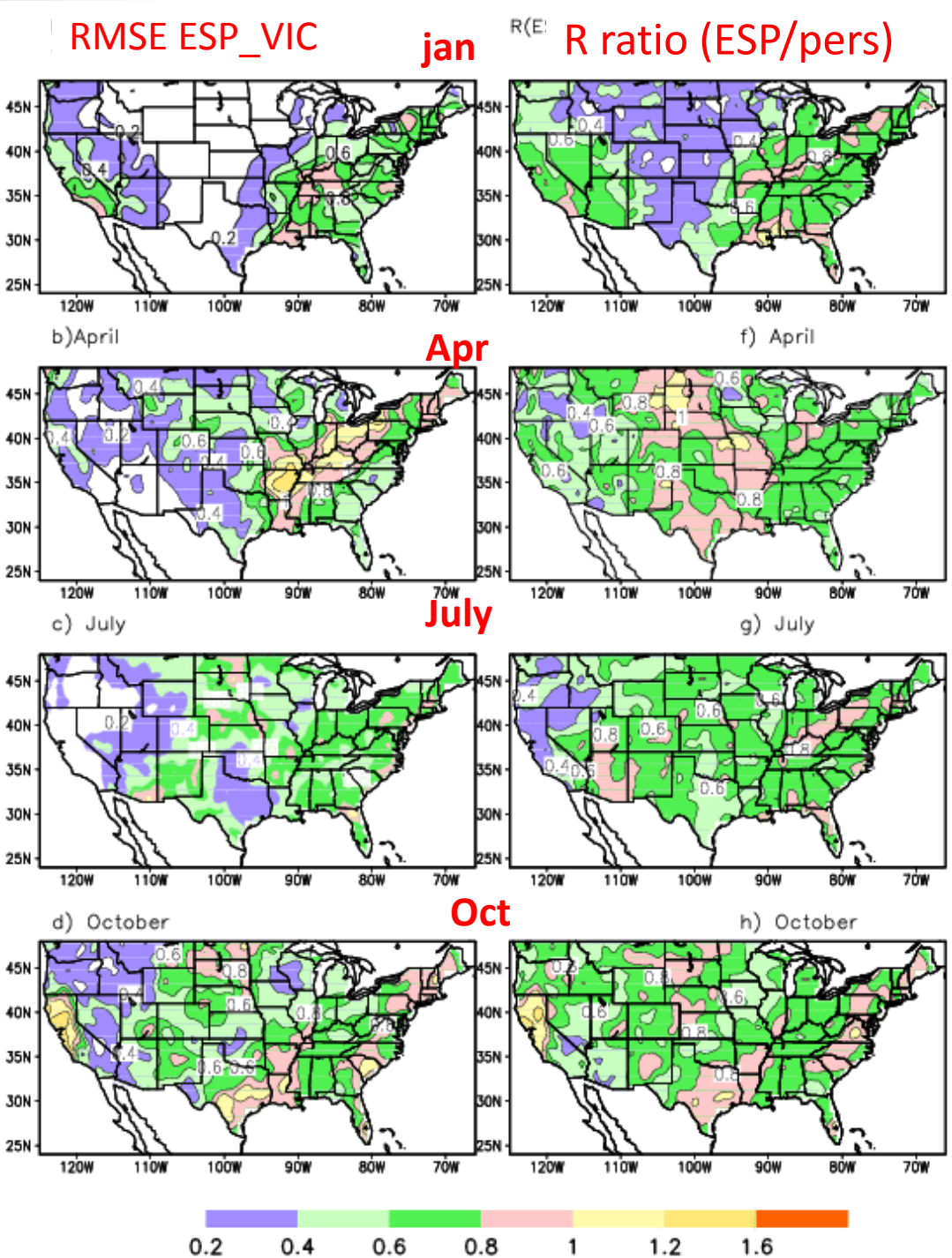
1. Forecast skill is seasonally and regionally dependent
2. At lead 1, forecasts based on persistence are statistically significant.
3. At lead 2, forecasts over the western interior region are significant
4. Skill is highest for Jan, and lowest for July ,Oct

Reason that persistence does well

Characteristic time To



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



ESP20 & persistence lead=1mo

1. Both persistence and ESP20 are statistically significant at lead=1mo
2. Skill is higher over the western region
3. **R<1 ESP20 is better than persistence all the time**

WHY does ESP beat persistence?

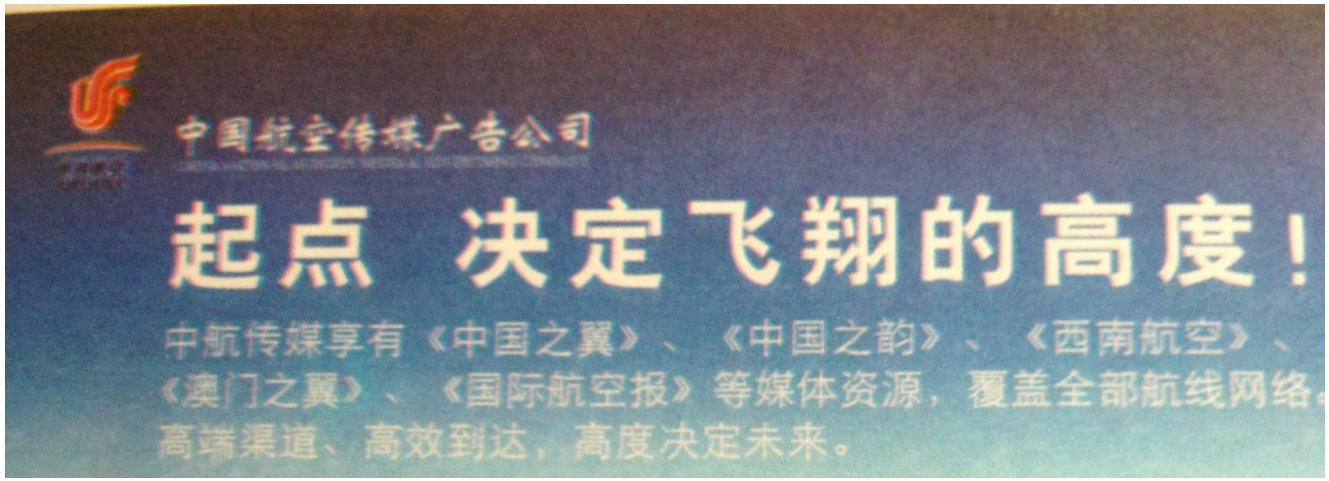
1. Initial conditions:

- Shukla and Lettenmaier (2011) stressed the importance of the initial conditions for the hydroclimate forecasts of soil moisture anomalies and runoff.
- The ESP has more complete initial conditions than the persistence
- E G.: persistence only knows soil moisture
- ESP20 knows soil moisture, snow water equivalent and surface temperature

2.Climatology

- ESP knows the climatology. It knows how the forcing evolves according to the climatology, the persistence does not

An important element to the success of SM forecasts



Initial starting point determines how high you can fly

----------China airlines boarding pass

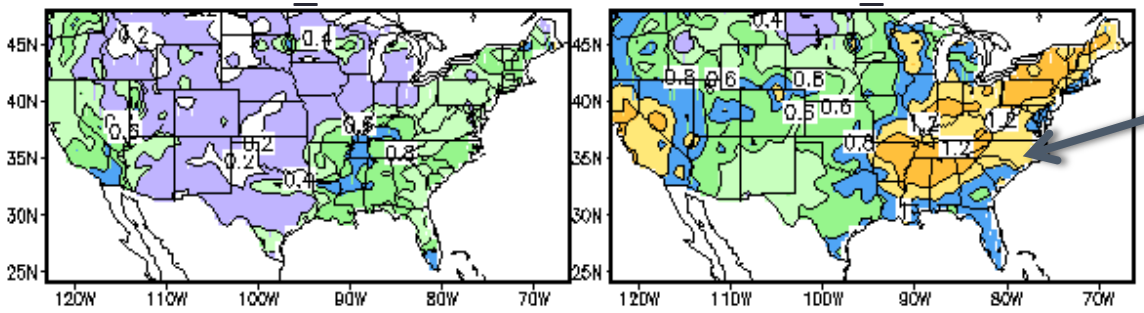
Can CFSv2 forecasts help?

RMSE Lead=1

RMSE Lead=3

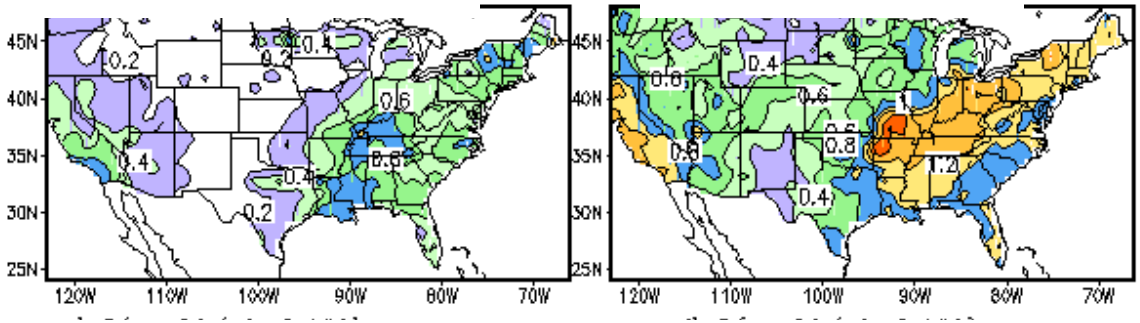
CFSv2_VIIC

CFSV2_VIC



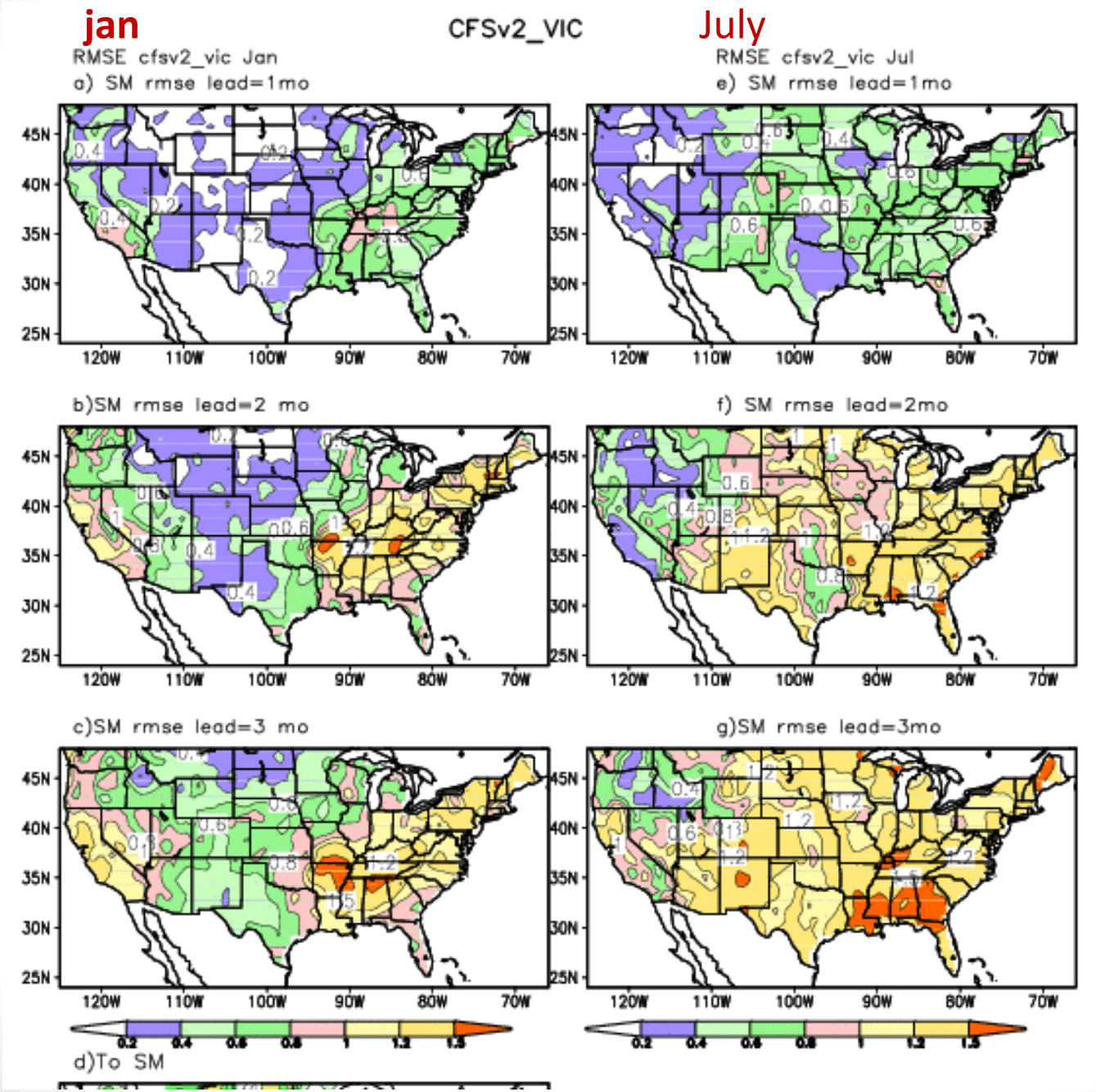
ESP

ESP



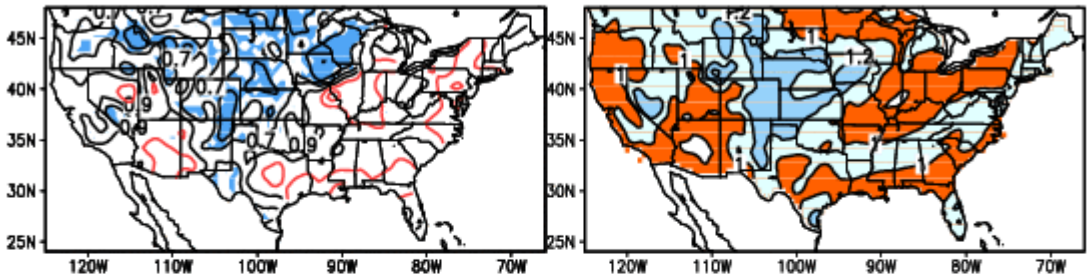
CFSv2_VIC is better but skills are low

- 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.


jan
CFSv2_VIC
July
RMSE cfsv2_vic Jan
a) SM rmse lead=1mo
RMSE cfsv2_vic Jul
e) SM rmse lead=1mo
b)SM rmse lead=2 mo
f) SM rmse lead=2mo
c)SM rmse lead=3 mo
g)SM rmse lead=3mo
d)To SM
45N
40N
35N
30N
25N
120W
110W
100W
90W
80W
70W
0.2
0.4
0.6
0.8
1
1.2
1.5

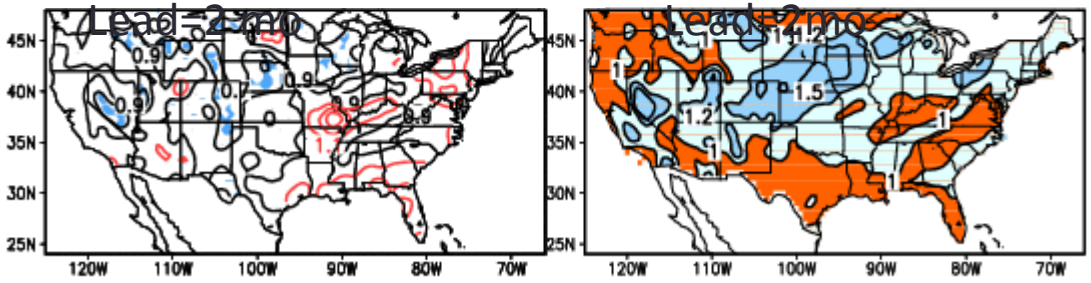
CFC_VIC skill vs P skill (Jan fcst)

R ratio(ESP/CFSv2)
Lead=1mo



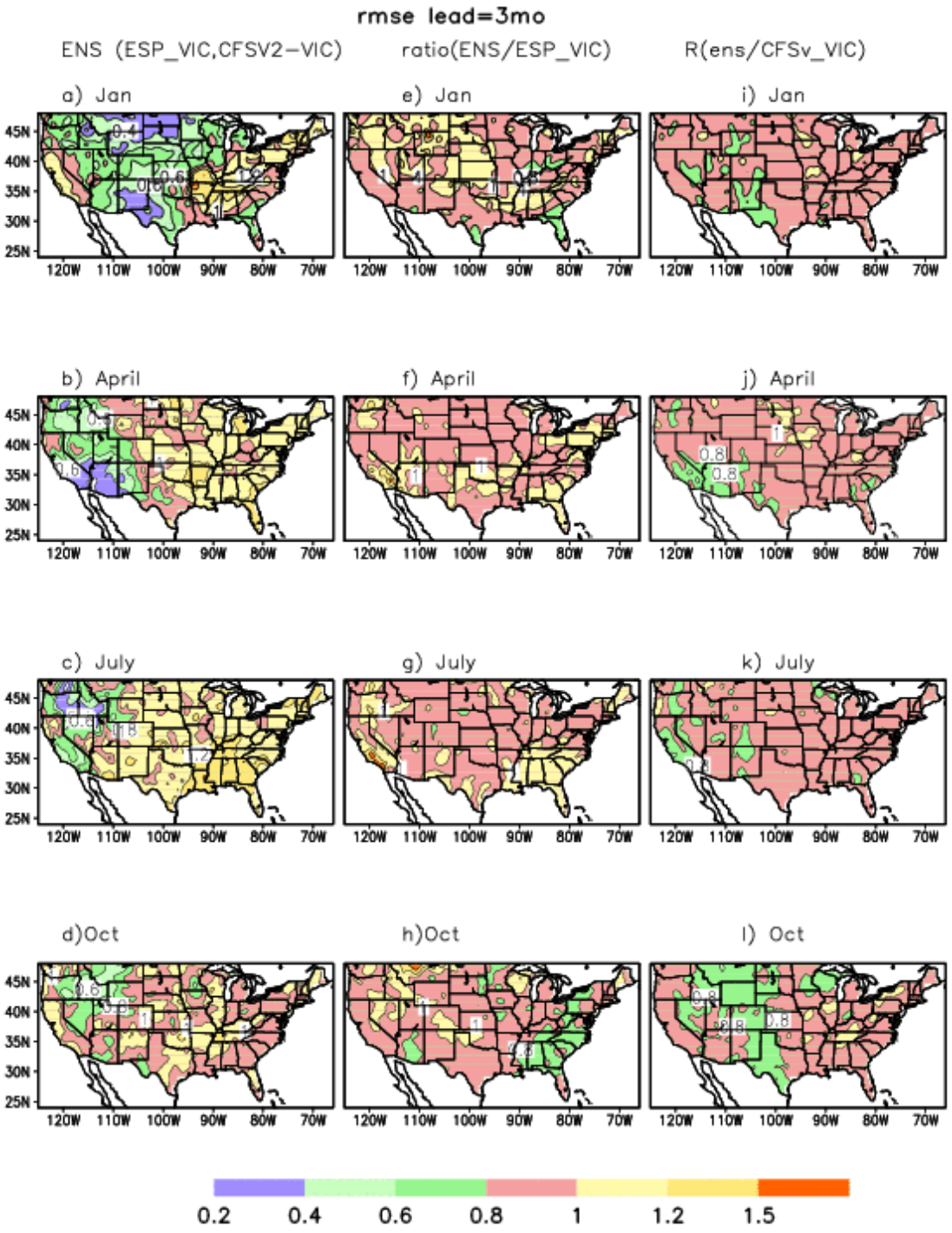
RMSE CFSv2 P
Lead=1mo

Blue ESP is better
Red CFSv2 is better



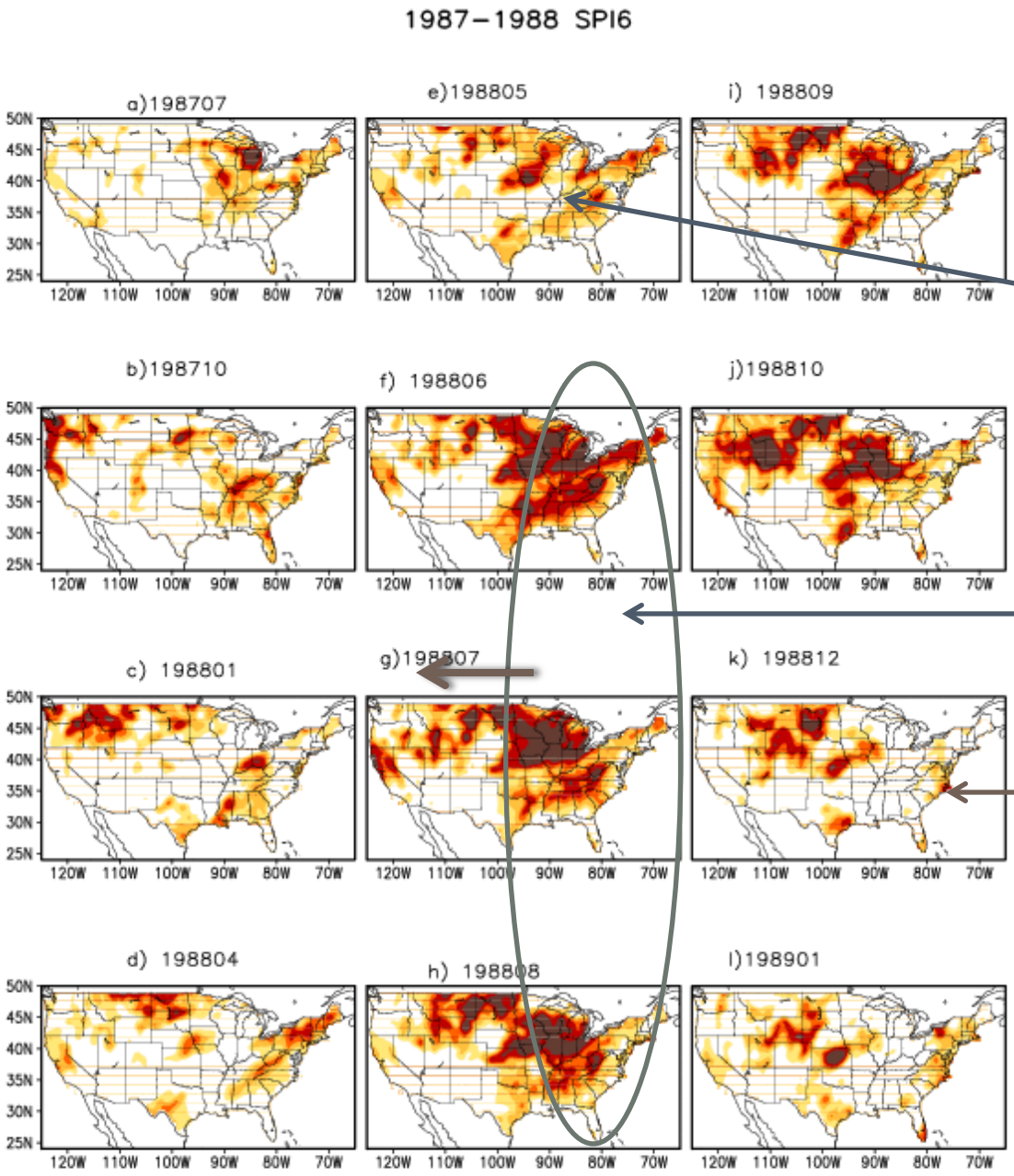
Blue P skill is low
Red P is skillful

Over the east region, if P is skillful , CFS_VIC can contribute to the skill (red)



Skill for the ensemble fcst btw eps20 and cfs_VIC

1. Ensemble fcsts are more skillful than the esp_VIC and CFSv2_VIC alone for all leads
2. These are equally weighted ensemble
3. The weighted ensemble DOES NOT has high skill than the equally weighted ones



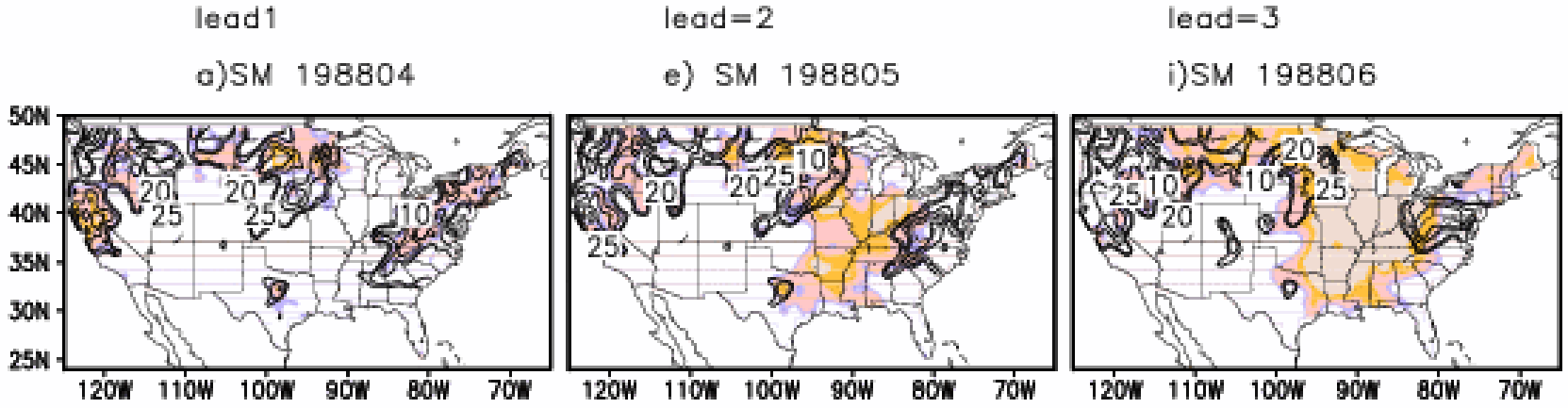
1988 drought over the central U. S.

Started to develop 198805

Intensification 198806-198808 and shifted to Northwest

demise

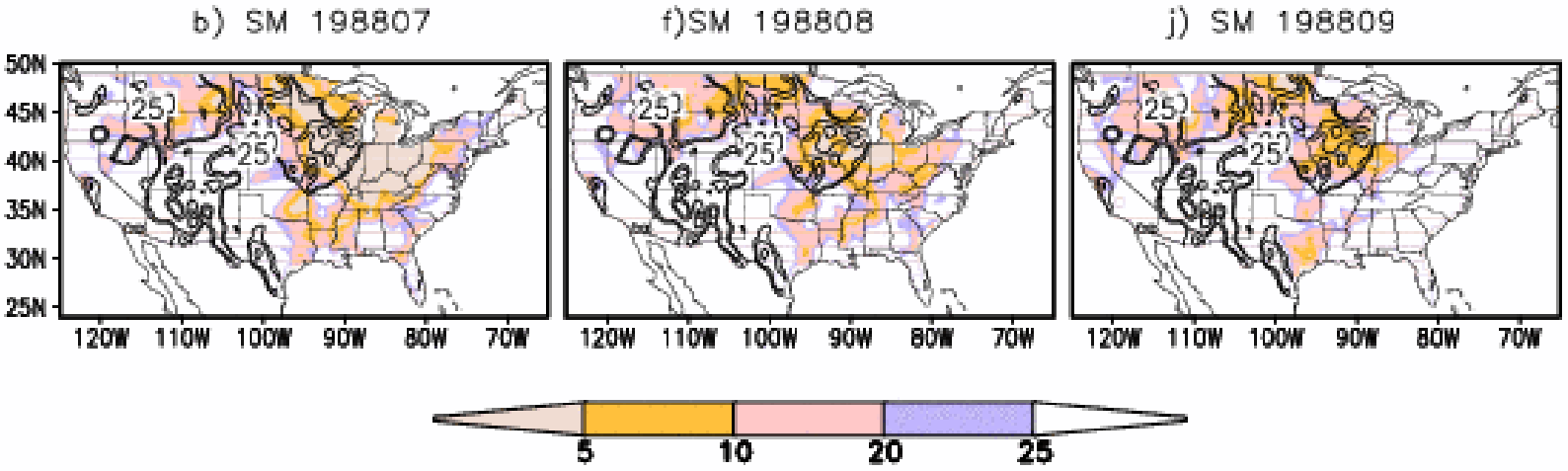
SM fcsts Ics=198804



Colored –simulation contoured fcsts

ICS: 198804 missed the development of drought

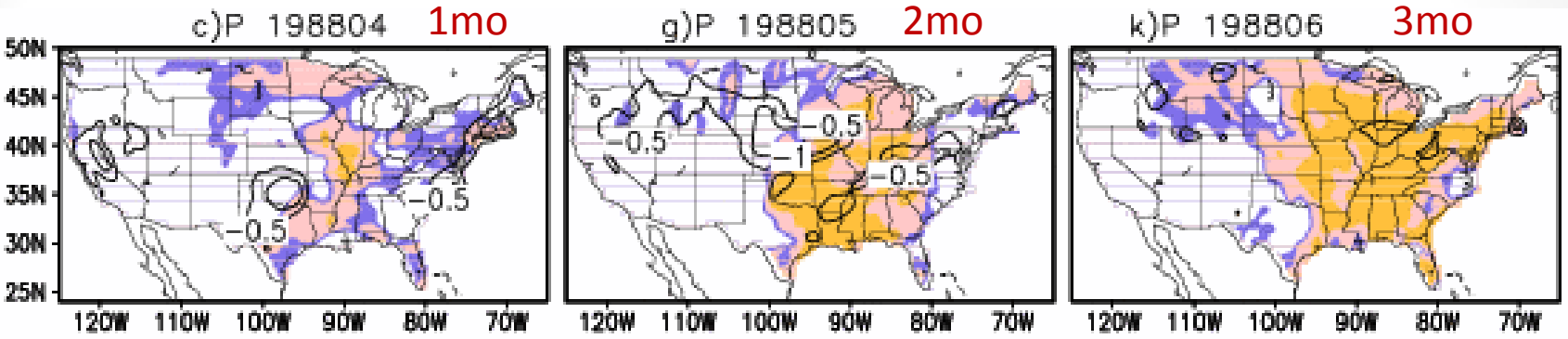
SM fcsts Ics=198807



IC=198807 Still missed the drought intensification and westward shift

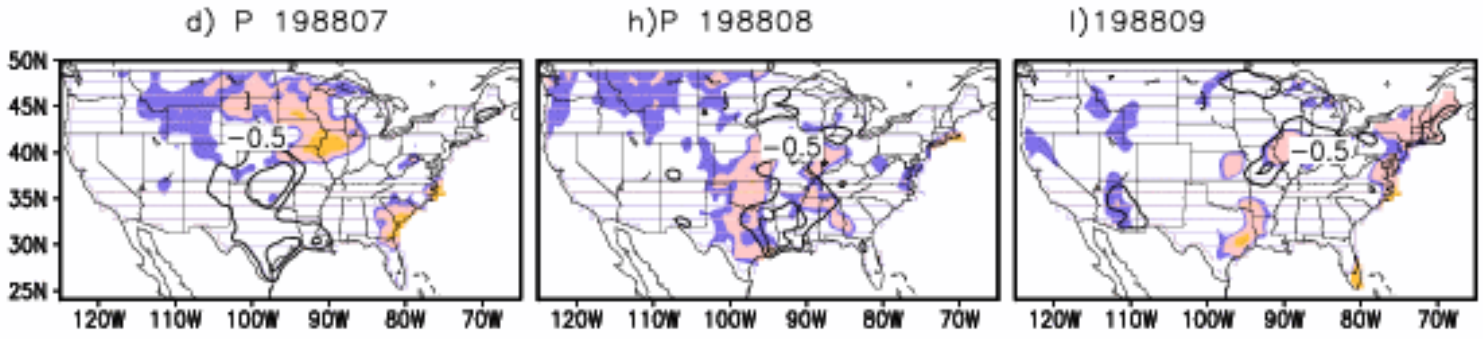
CFSv2 p fcsts after the BCSD correction

Ics-=198804



P fcsts missed the dryness over the Central eastern U. S

Ics=198807

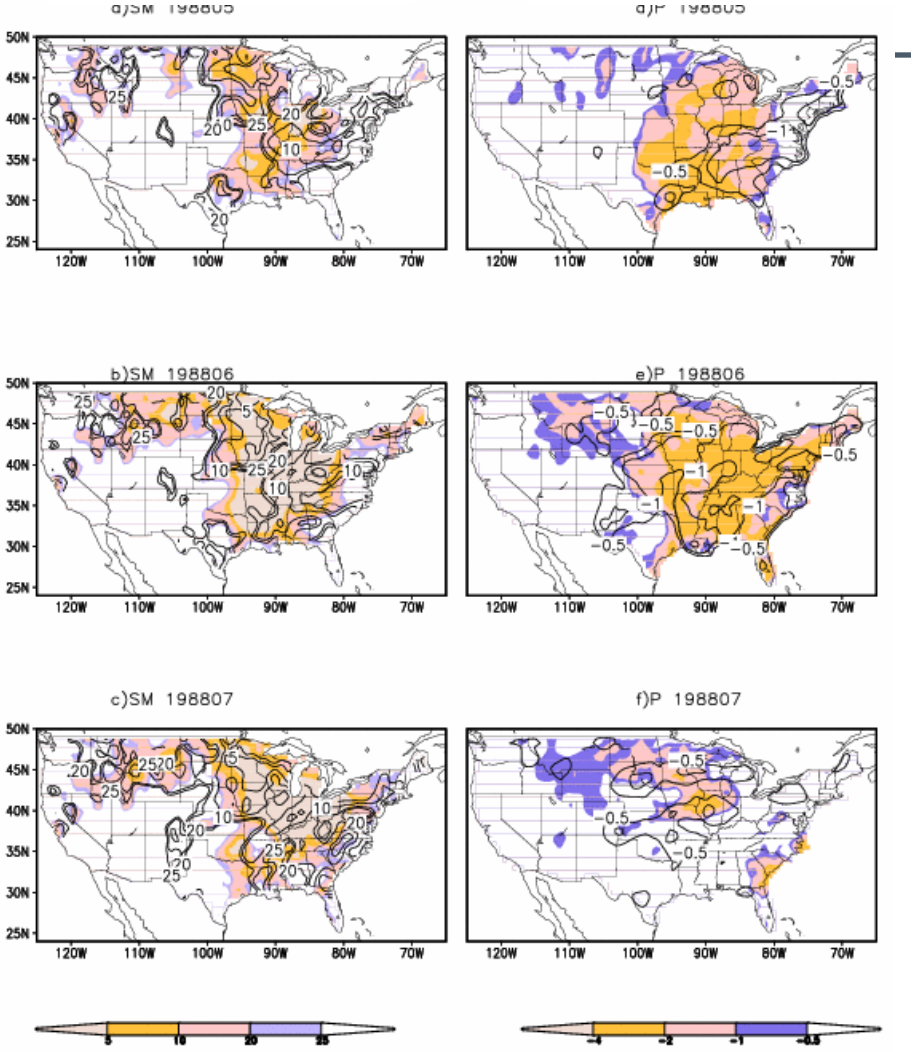


When the P fcsts are skillful, CFSv2_VIC captures drought. (colored (verification), contours (fcst)

SM CFSv2-VIC

CFSv2 P fcst

Ics=198805



May 1988
Lead=1mo

June 1988
Lead=2mo

July 1988
Lead=3mo

Conclusions

- ESP should be the new metric for climate forecasts to beat
- Take care of the initial conditions – no spinup problems (please!!) .
- Over the west coast and the eastern U.S. where the region is dynamically active, if P is skillful, CFSv2 can contribute to skill

Recommendations

- For SM forecasts, skill comes from the initial conditions for the short leads.=>
- Have a better initial conditions (NLDAS)

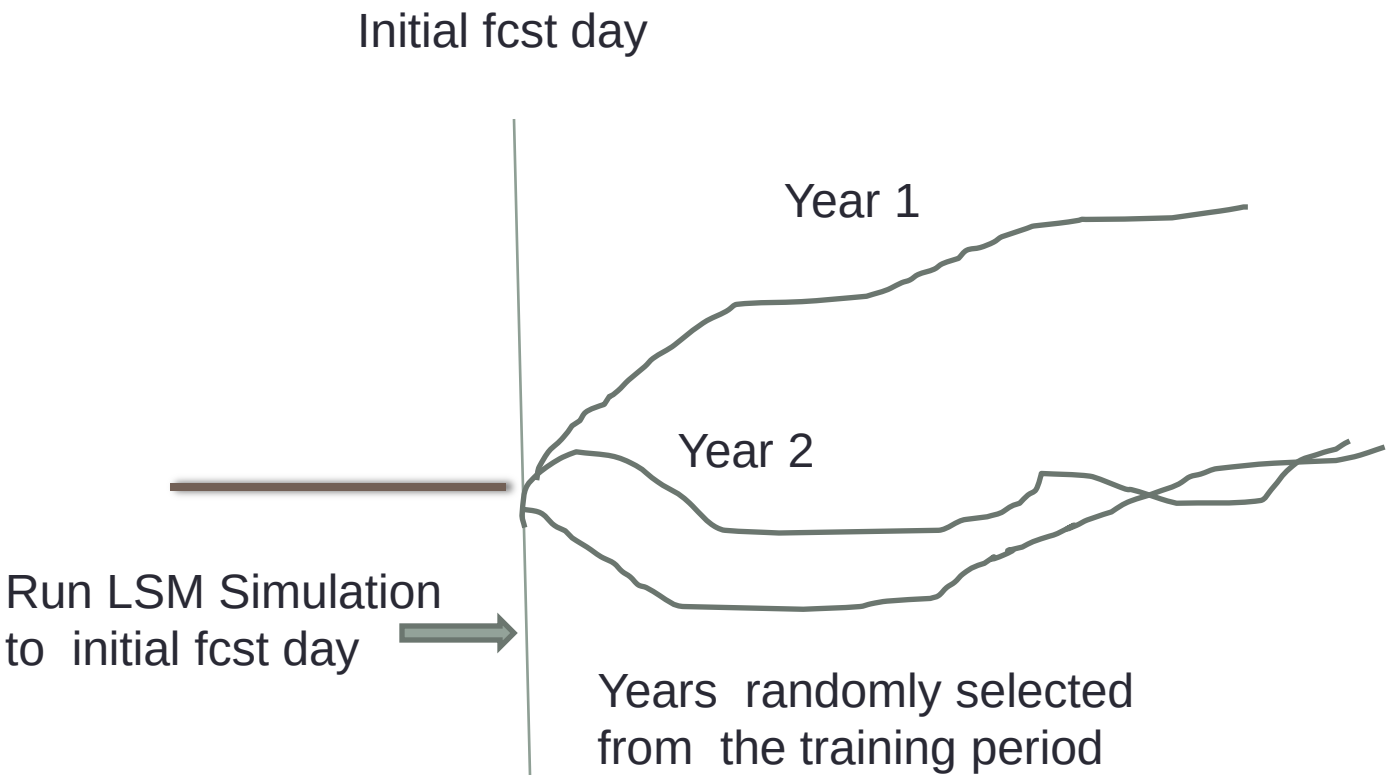
1. avoid spin-up problems
2. Improve the NLDAS by having better station data inputs and better Precipitation analysis
3. Improve snow and SM inputs (satellite, data assimilation)
4. Improve land_surface models
5. Have better insitu data for verification

Recommendations continue

- For longer lead, improve P fcsts by improving statistical post processing (better ensemble weighting, better error correction etc)
- Multi model ensemble (MME)
- Improve GCM precipitation forecasts. For summer, precipitation forecast skill is low. How to improve the model physics (convection scheme, cloud radiation physics) is still a challenge.
- Understand predictability ---
- Global drought information system (GDIS)
- know why and under what conditions a particular tool works

Back ground slides

Ensemble Streamflow Forecasts (ESP)



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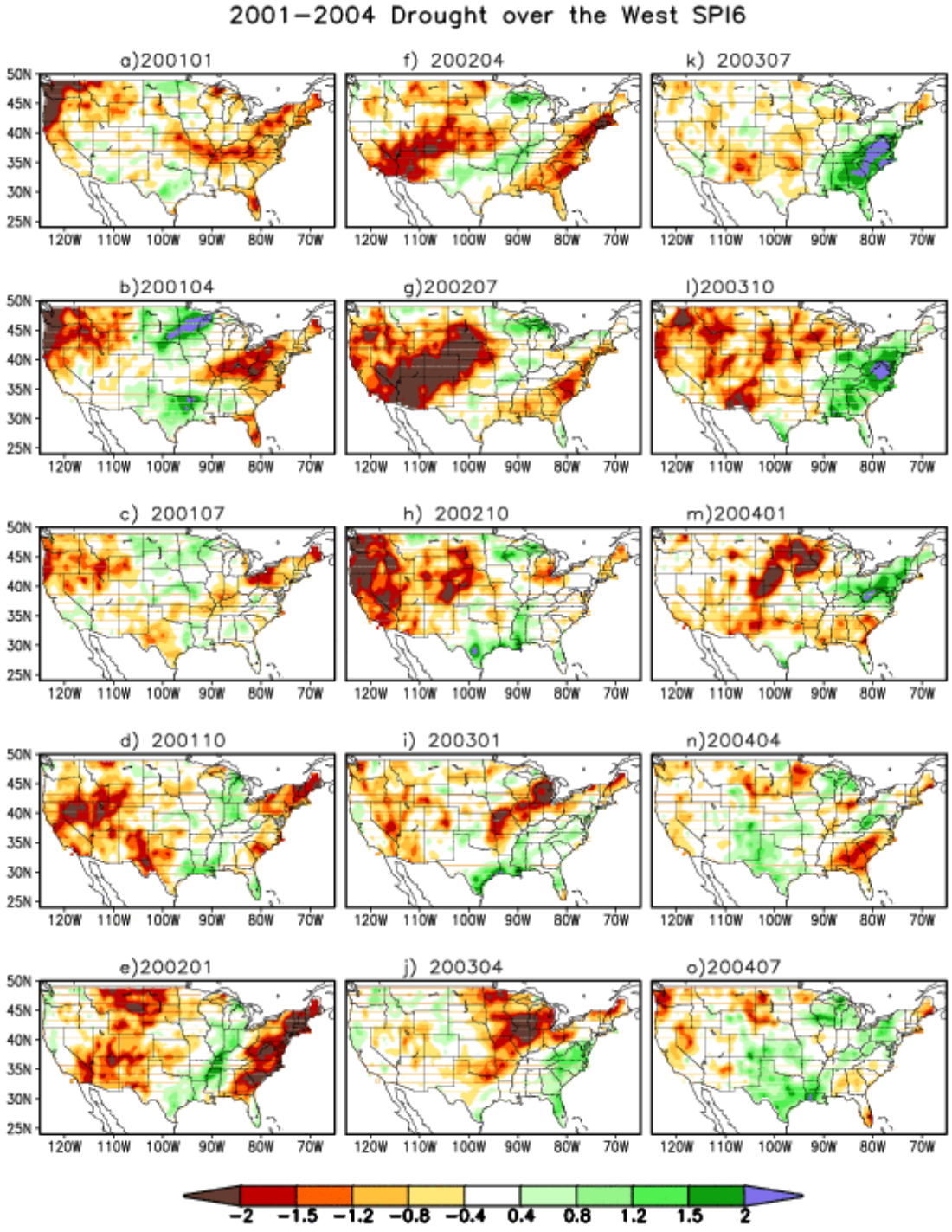
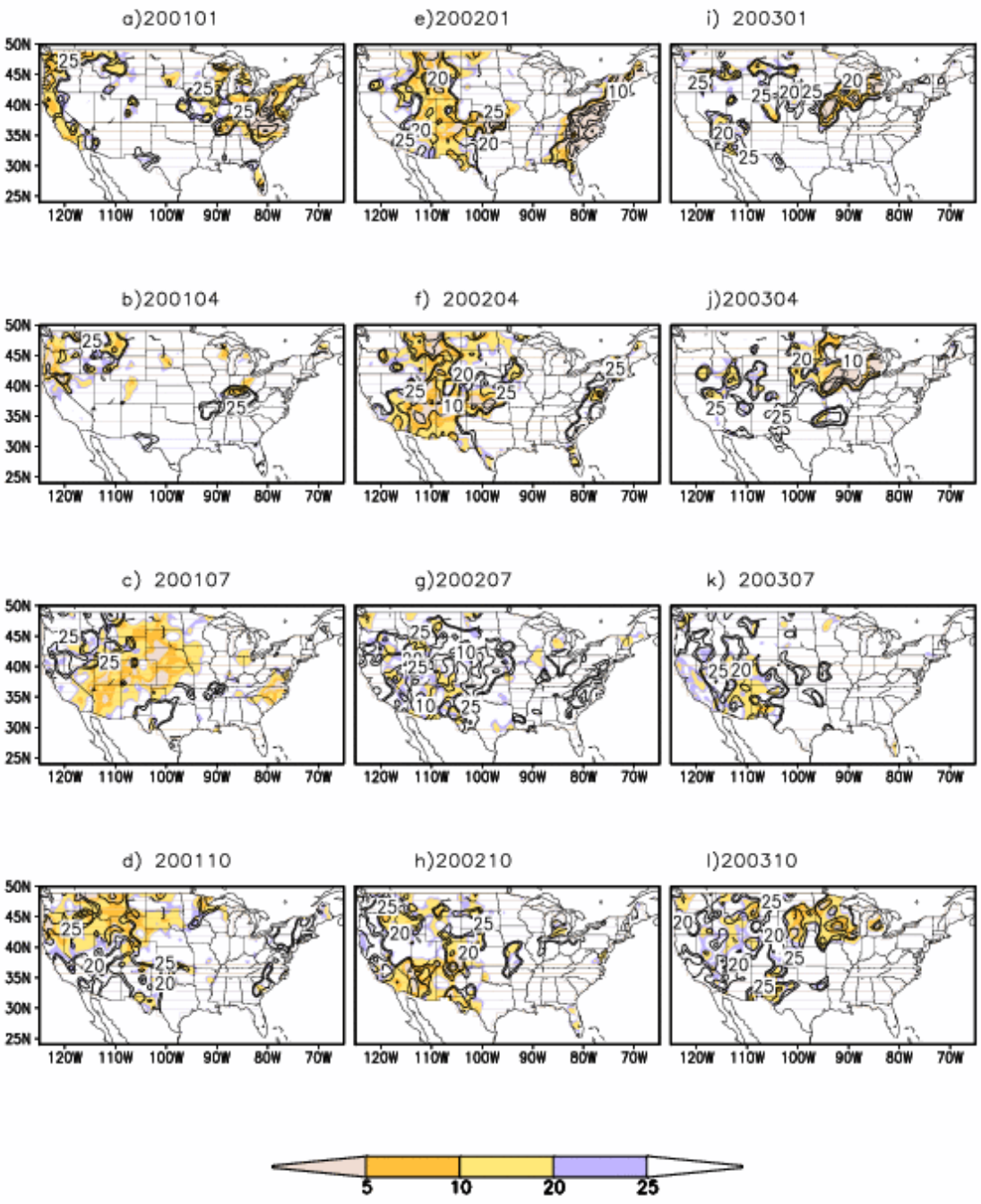

2001–2004 Drought over the West SPI6
a)200101
f) 200204
k) 200307
b)200104
g)200207
l)200310
c) 200107
h) 200210
m)200401
d) 200110
i) 200301
n)200404
e)200201
j) 200304
o)200407
50N
45N
40N
35N
30N
25N
120W 110W 100W 90W 80W 70W
−2 −1.5 −1.2 −0.8 −0.4 0.4 0.8 1.2 1.5 2


2001–2003 Drought SM fcst(shaded),nlads(contour) lead=1mo
a)200101
e)200201
i) 200301
b)200104
f) 200204
j)200304
c) 200107
g)200207
k) 200307
d) 200110
h)200210
l)200310
50N
45N
40N
35N
30N
25N
120W 110W 100W 90W 80W 70W
5
10
20
25

Global drought information system

- Why do we need it?
- 1. to understand the predictability of drought
- 2. to Improved regional drought monitoring, prediction and assessments based on globally coherent and systematic hydroclimate conditions
- 3. CFS and NMME real-time forecasts for improved hydrologic predictions world-wide
- 4. Improved understanding of global hydroclimate and the water cycle
- 5. Improved understanding of user needs for drought information