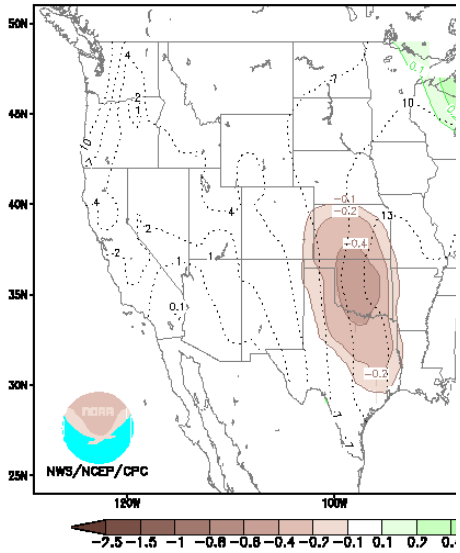
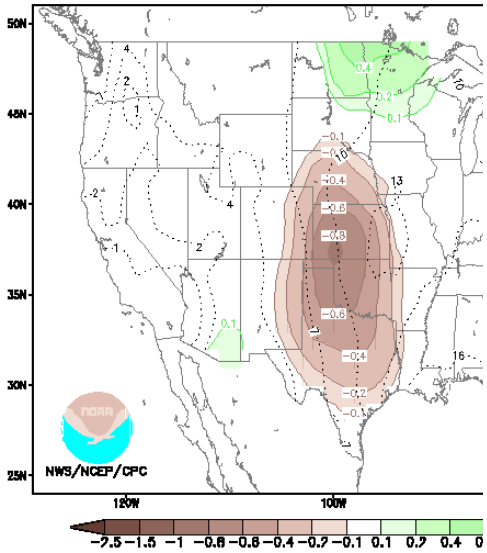
Exploring changes in the dependability of seasonal climate forecasts due to spatial and temporal downscaling

Jeanne M. Schneider and Jurgen D. Garbrecht
USDA ARS Grazinglands Research Laboratory
El Reno, OK

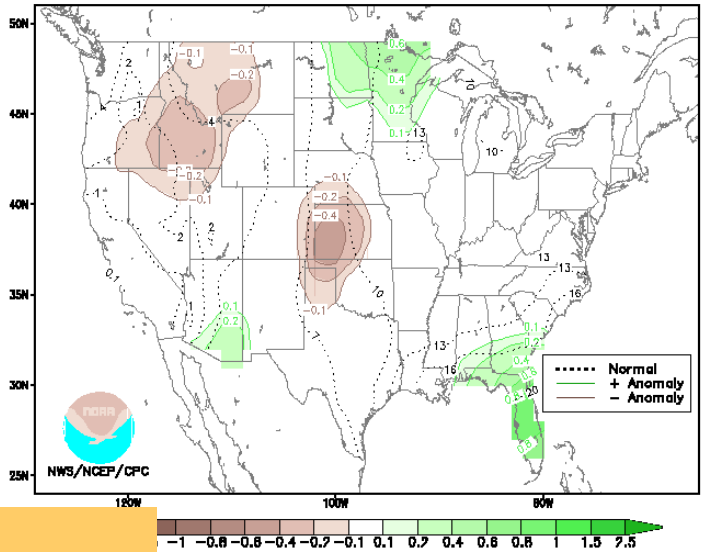
Most Likely Precipitation Anomaly (inches) Outlook, 1.5 Month Lead for AMJ 2006



Most Likely Precipitation Anomaly (inches) Outlook, 2.5 Month Lead for MJJ 2006

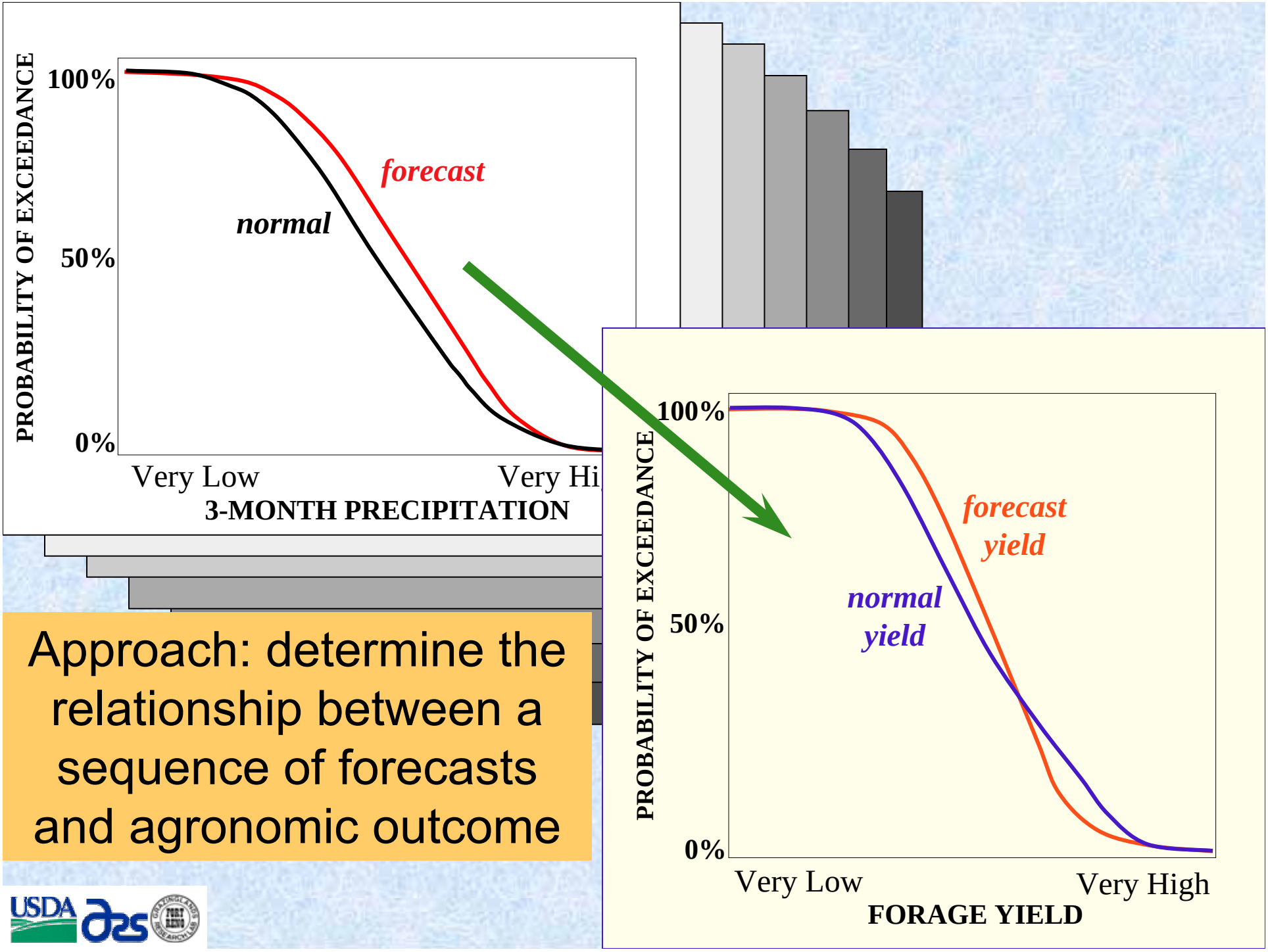


Most Likely Precipitation Anomaly (inches) Outlook, 3.5 Month Lead for JJA 2006



Need to get from these scales…

…to local, growing season scales.



Approach: determine the relationship between a sequence of forecasts and agronomic outcome

Questions:

Do we loose forecast reliability as we go downscale in space and time?

If so, how much?

Is it different for different variables

(precipitation vs. temperature)

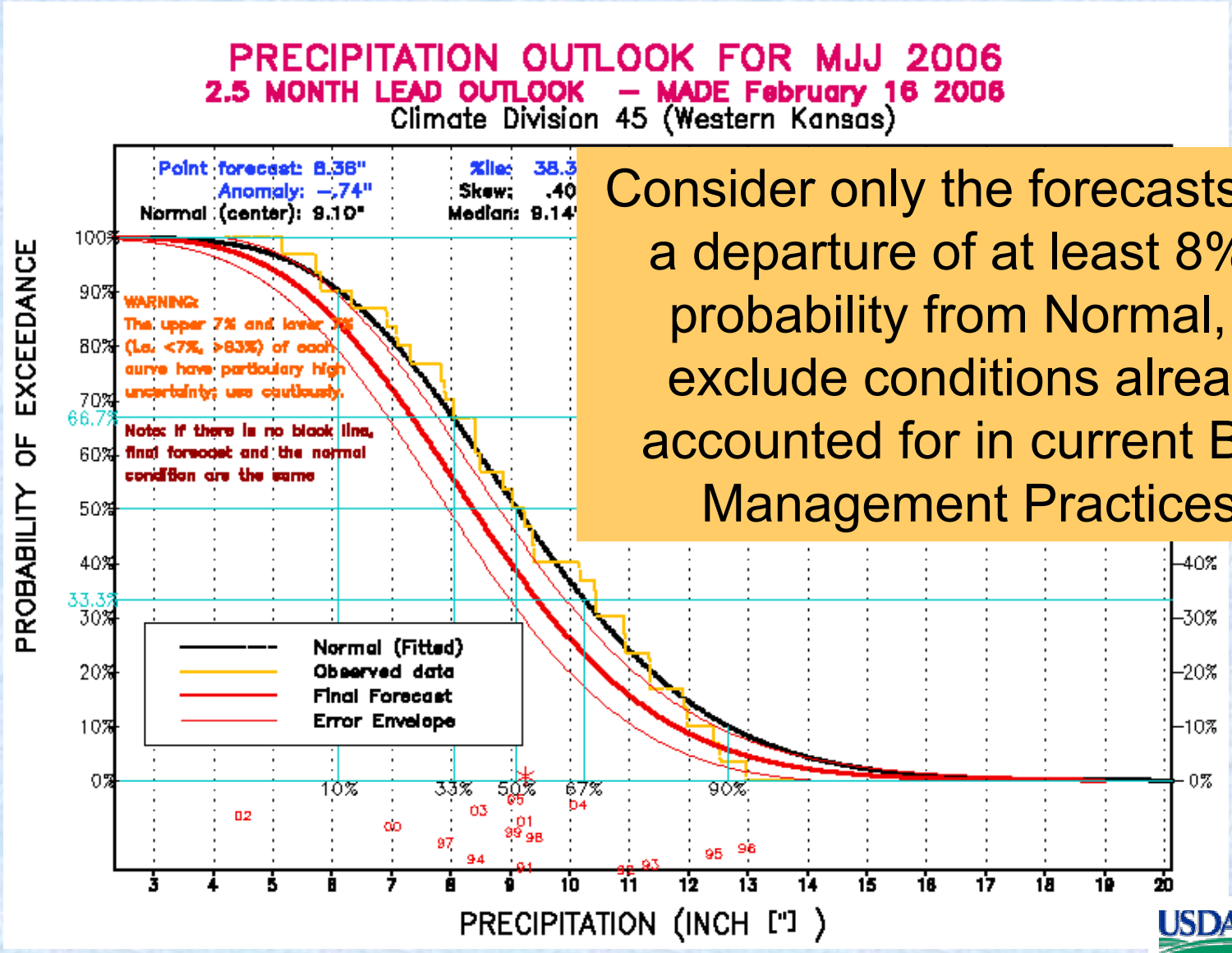
or direction (wet vs. dry,

warm vs. cool)?

Where? When?

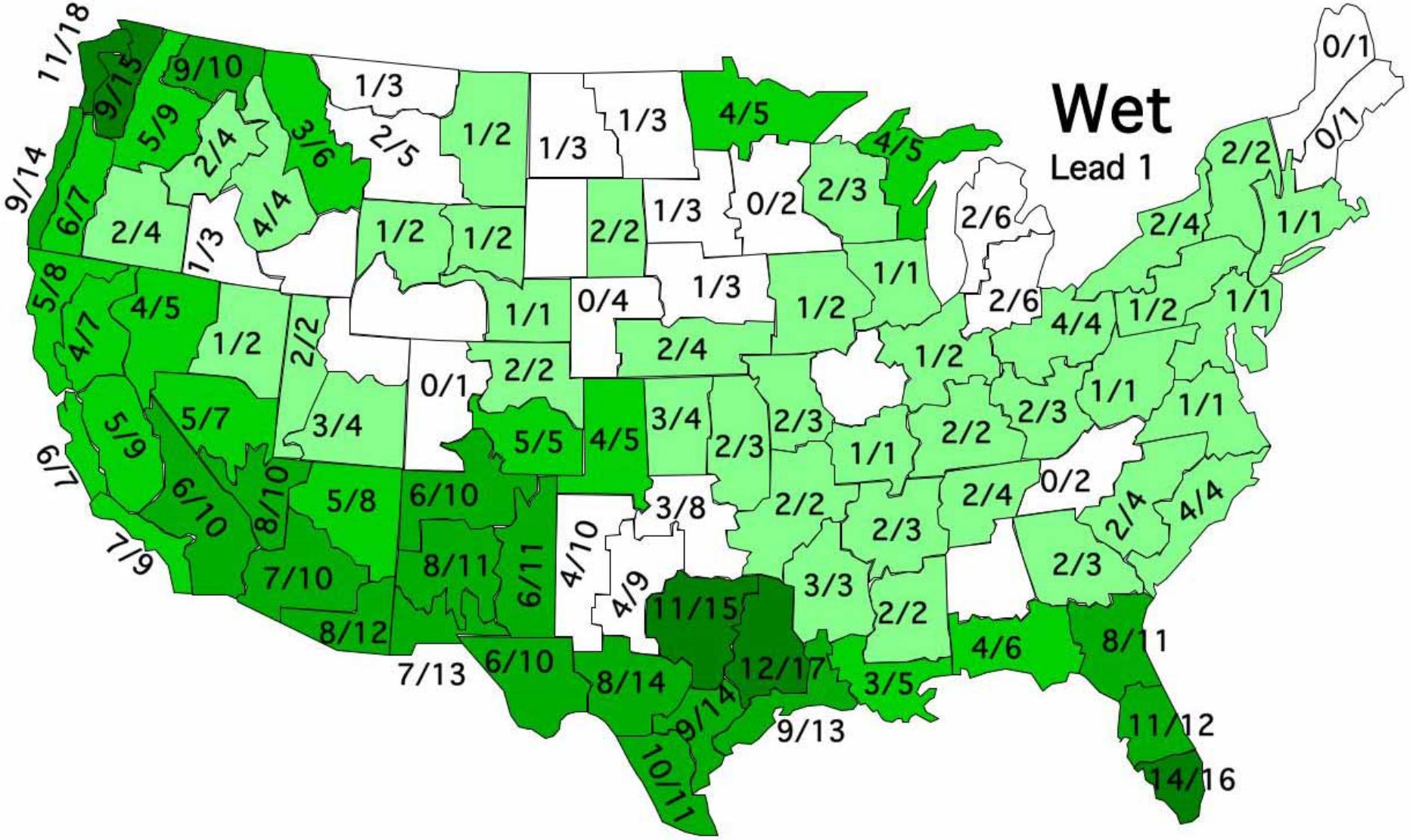
Is there any utility remaining in the downscaled forecasts?

Dependability: our agriculture-centric, two-category measure of forecast reliability.

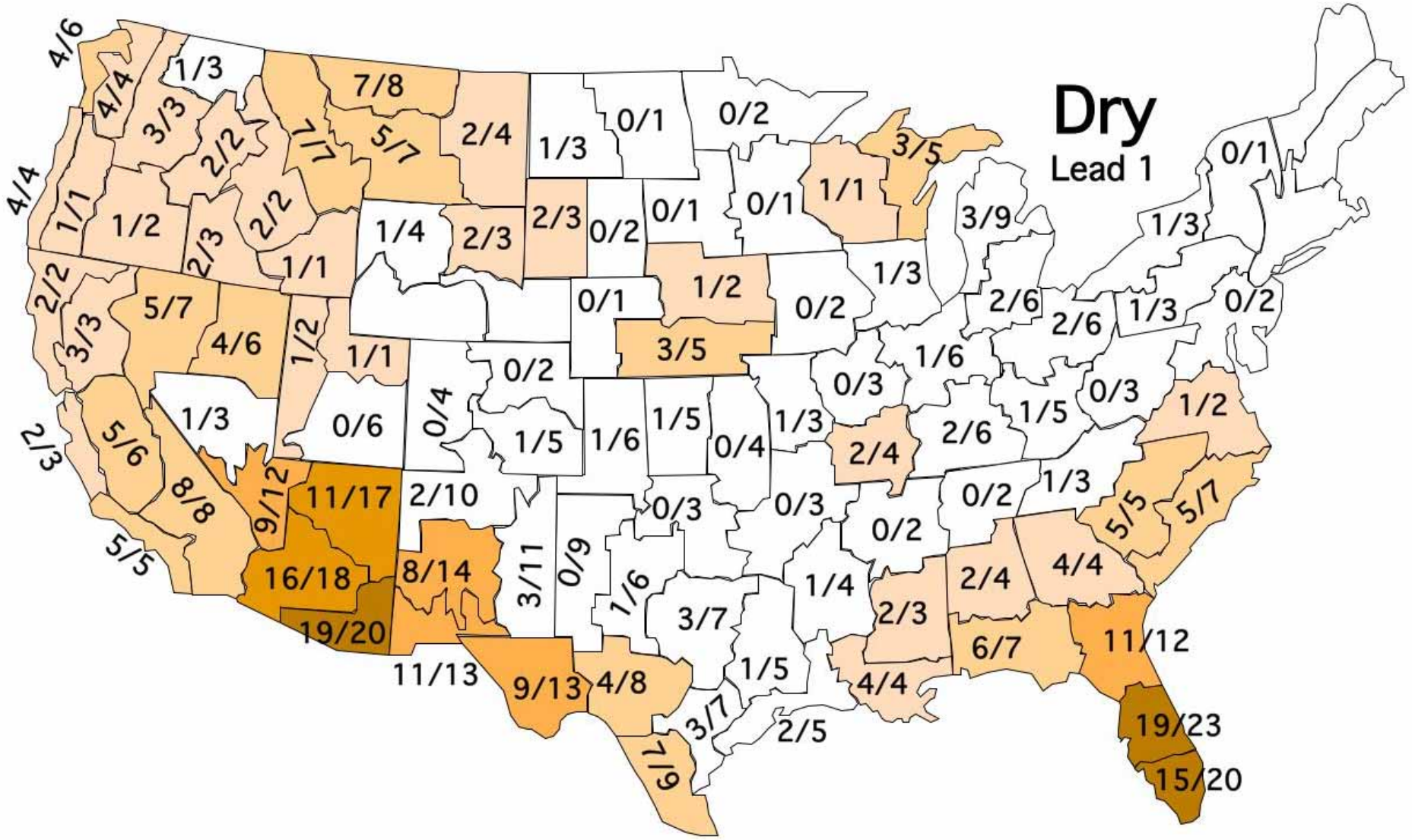


Consider only the forecasts with a departure of at least 8% in probability from Normal, to exclude conditions already accounted for in current Best Management Practices.

Dependability at the shortest lead time
JFM 1997 - JFM 2005 (97 forecasts)



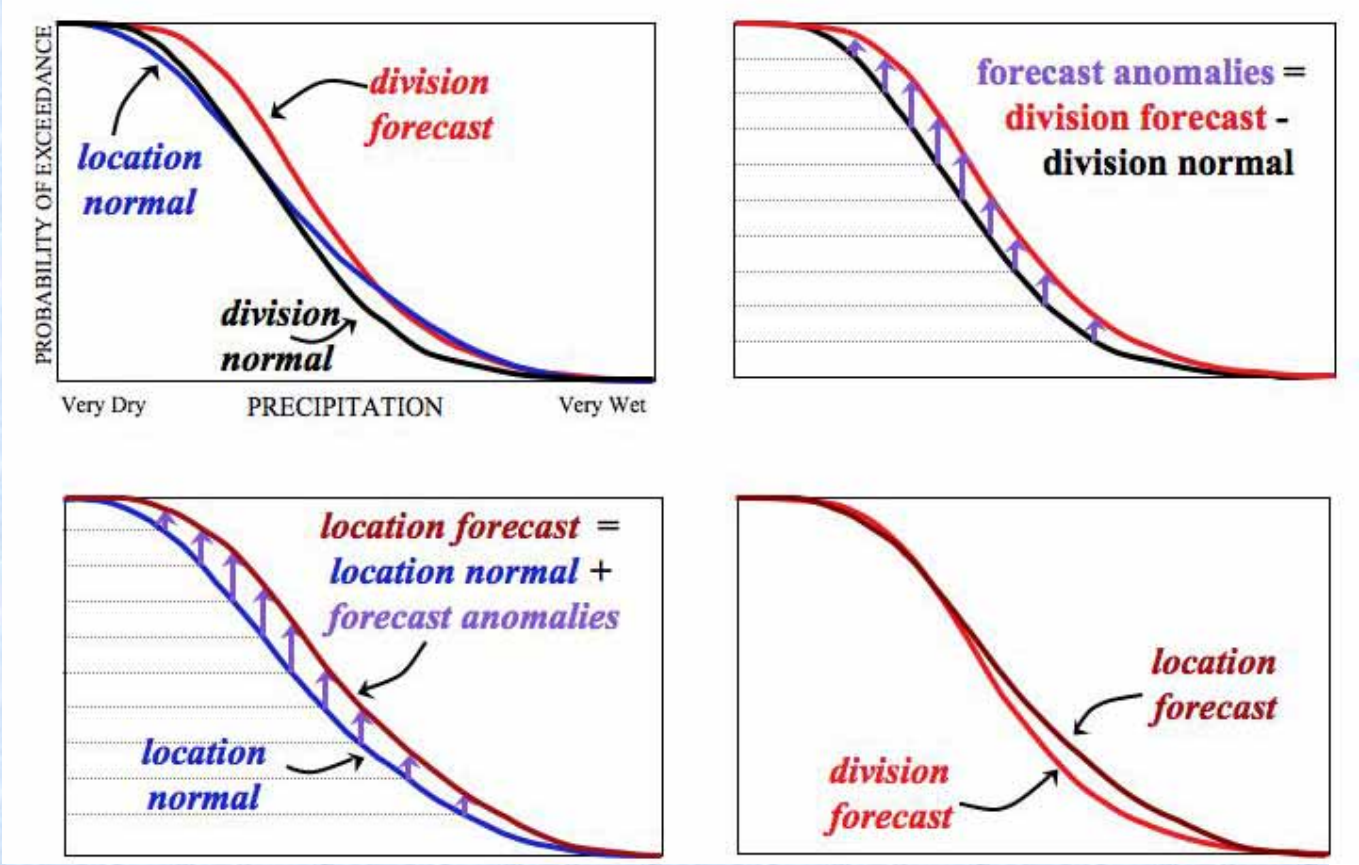
Dependability at the shortest lead time
JFM 1997 - JFM 2005 (97 forecasts)



Spatial downscaling

We assume that the shift in probability at the Forecast Division scale applies to all sub-areas and locations within it.

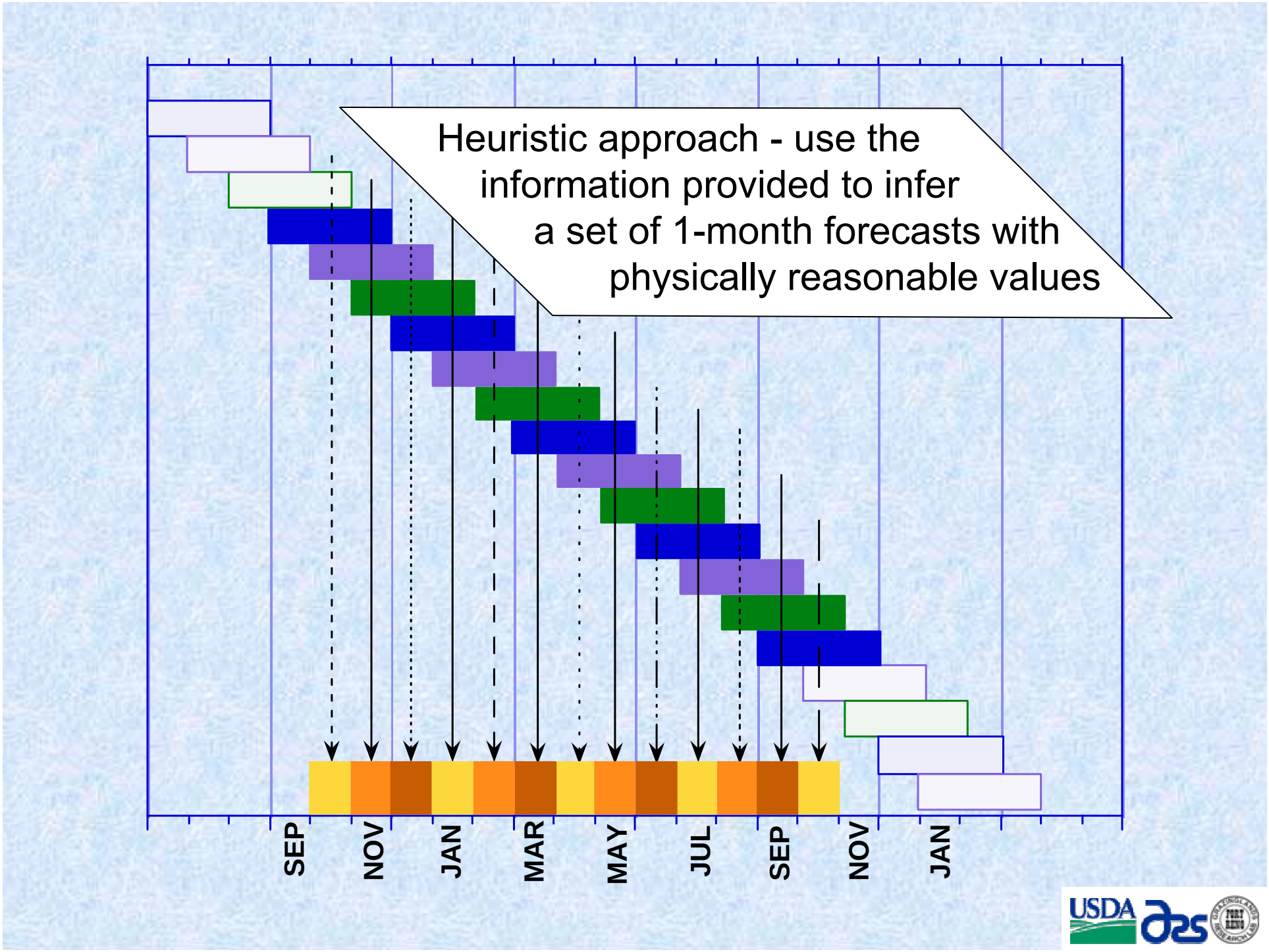
This 1-to-1 mapping assumption is *not* based on correlations between statistics at the different scales.



Temporal disaggregation

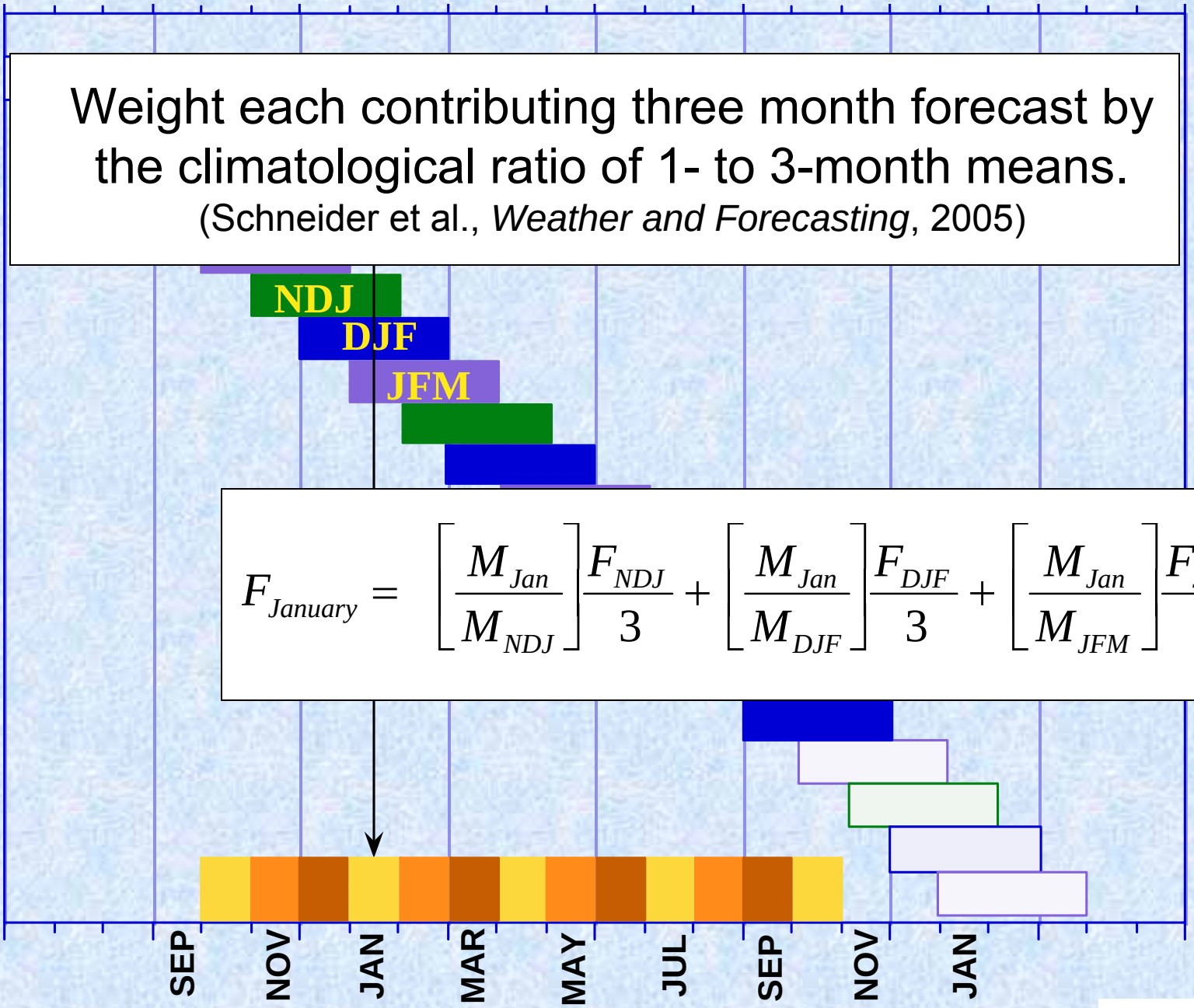
Accomplished in two steps:

1) 3-month to 1-month
2) 1-month to ensemble of sequences of daily values (using a custom weather generator named SYNTOR)


Heuristic approach - use the information provided to infer a set of 1-month forecasts with physically reasonable values
SEP
NOV
JAN
MAR
MAY
JUL
SEP
NOV
JAN

Weight each contributing three month forecast by the climatological ratio of 1- to 3-month means.

(Schneider et al., *Weather and Forecasting*, 2005)

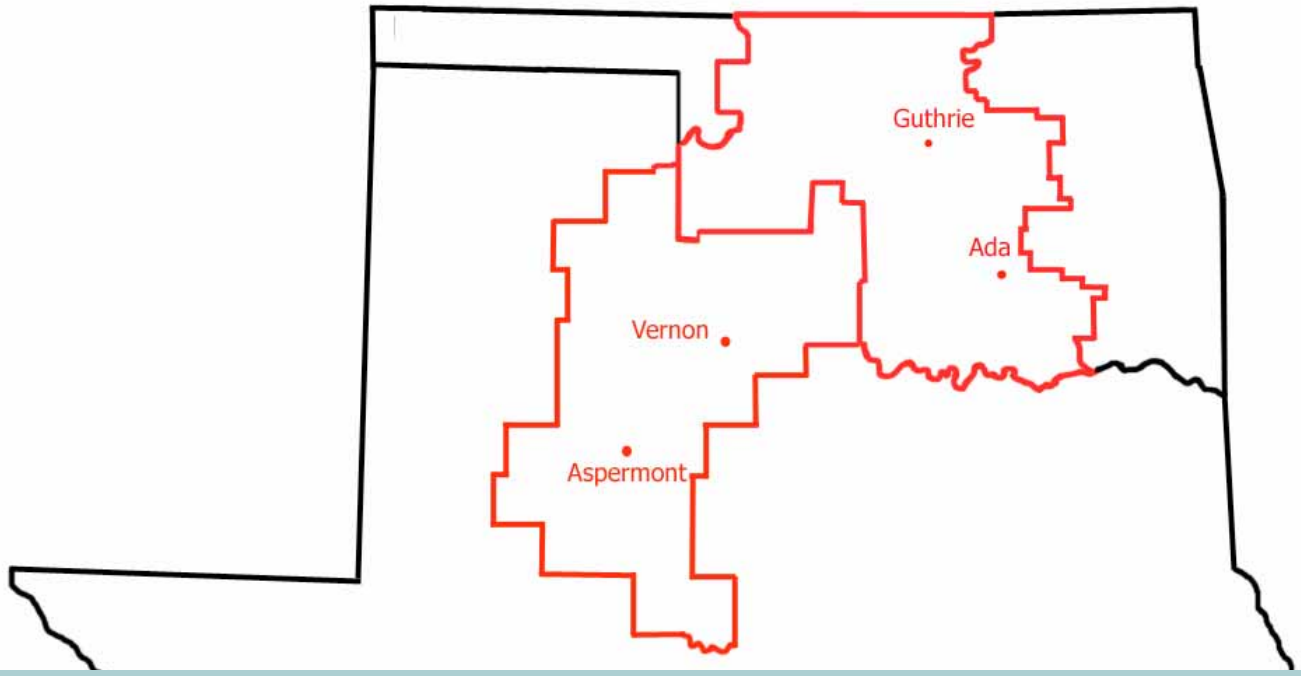


$$F_{January} = \left[\frac{M_{Jan}}{M_{NDJ}}\right]\frac{F_{NDJ}}{3} + \left[\frac{M_{Jan}}{M_{DJF}}\right]\frac{F_{DJF}}{3} + \left[\frac{M_{Jan}}{M_{JFM}}\right]\frac{F_{JFM}}{3}$$

Second step in time disaggregation

Use the 1-month mean and a modified weather generator to create an ensemble of sequences (≥ 500 members) of daily weather, each with the statistical characteristics of the downscaled mean and local higher order statistics.

Beware random number generators: check that all resulting sequences actually do reflect the input statistics.

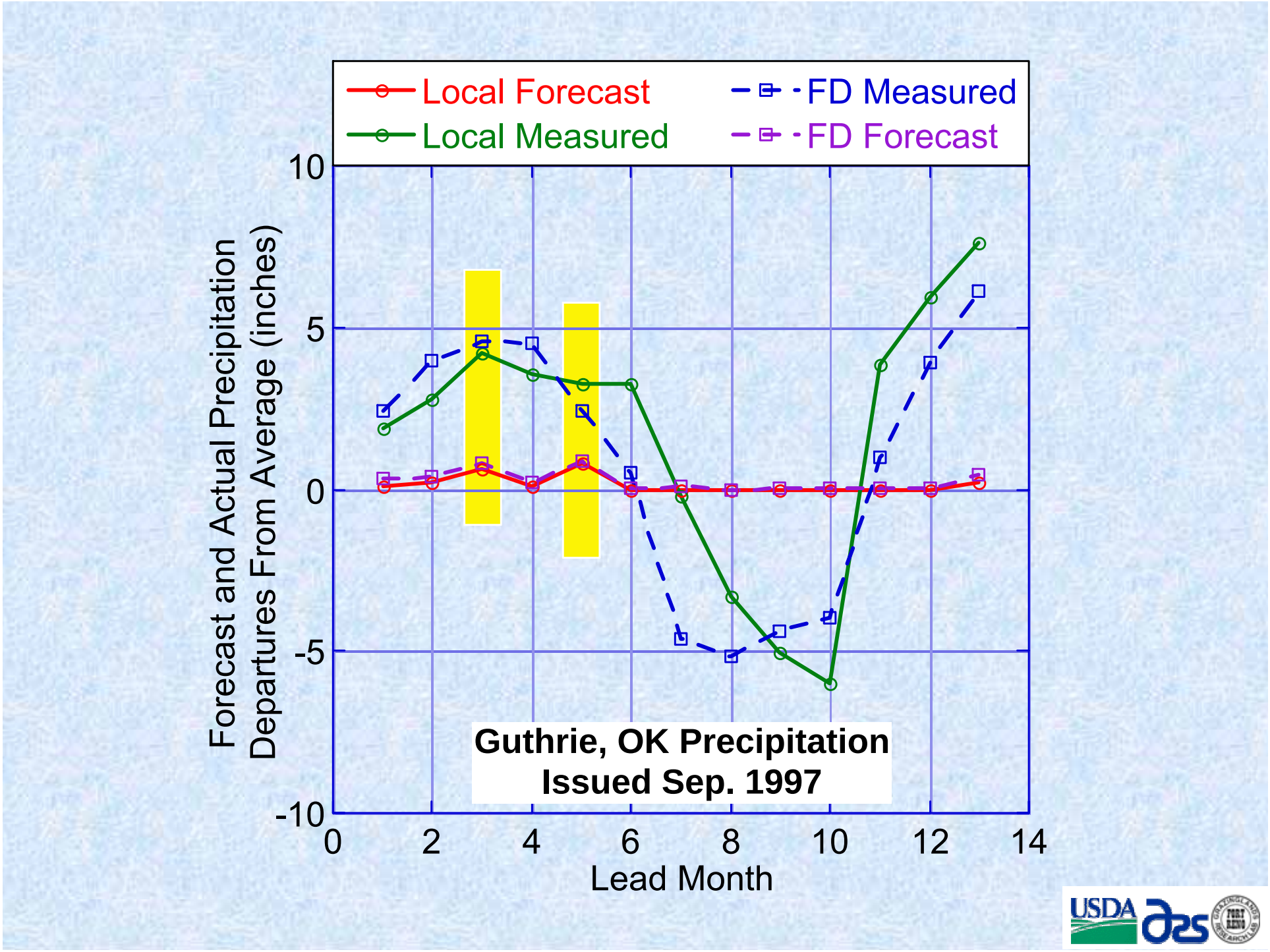


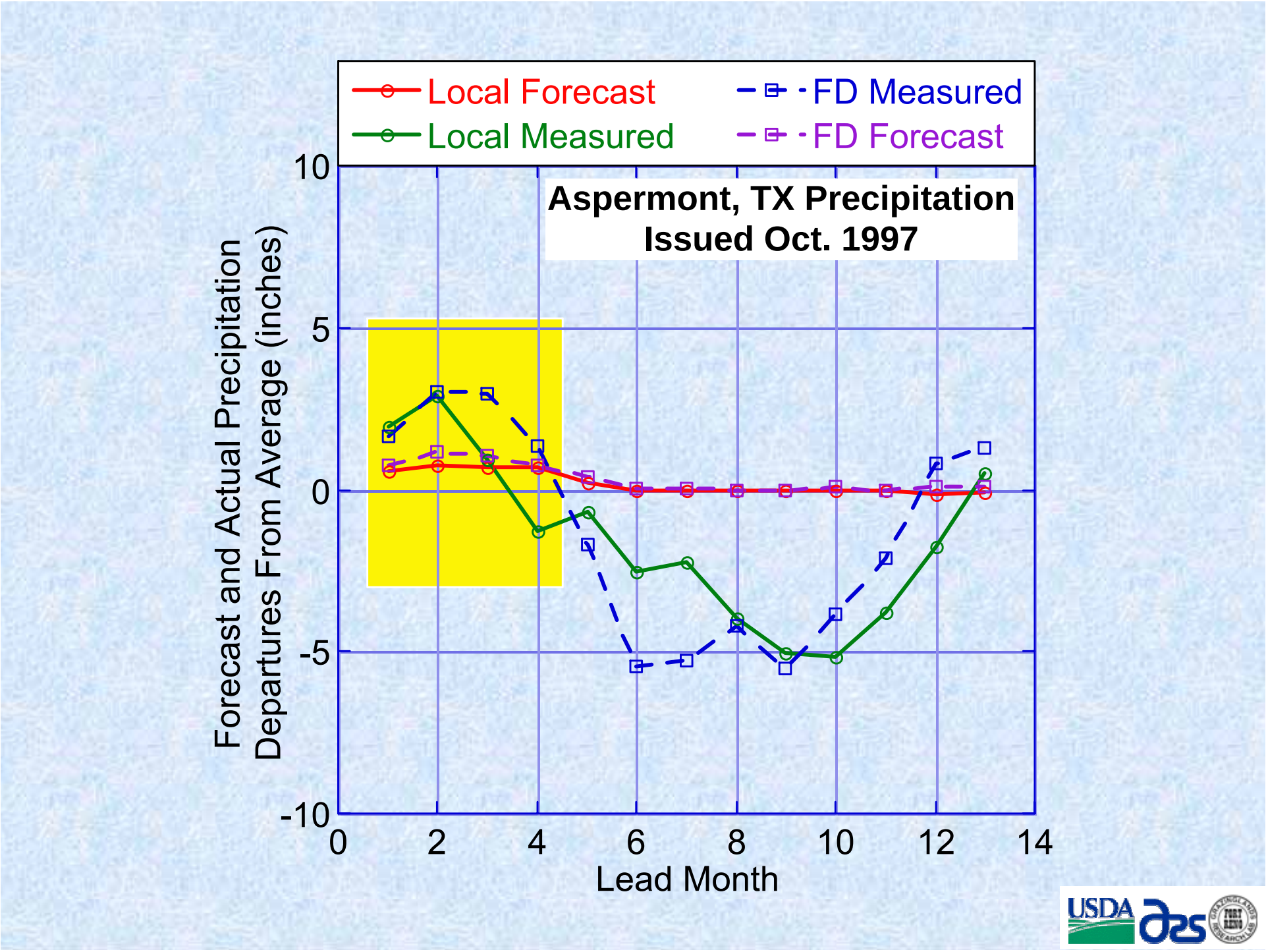
Initial exploration as we refine our analysis techniques:

4 Stations in Oklahoma and north Texas,

‘97-'98 El Niño driven forecasts,

issued July 1997 - March 98


Local Forecast
Local Measured
FD Measured
FD Forecast
Forecast and Actual Precipitation
Departures From Average (inches)
10
5
0
-5
-10
0
2
4
6
8
10
12
14
Lead Month
Guthrie, OK Precipitation
Issued Sep. 1997
USDA
ars


Local Forecast
Local Measured
FD Measured
FD Forecast
Aspermont, TX Precipitation
Issued Oct. 1997
Forecast and Actual Precipitation
Departures From Average (inches)
10
5
0
-5
-10
0
2
4
6
8
10
12
14
Lead Month

As expected, the loss of dependability tracks with the correspondence between the regional and local 3-month total precipitation.

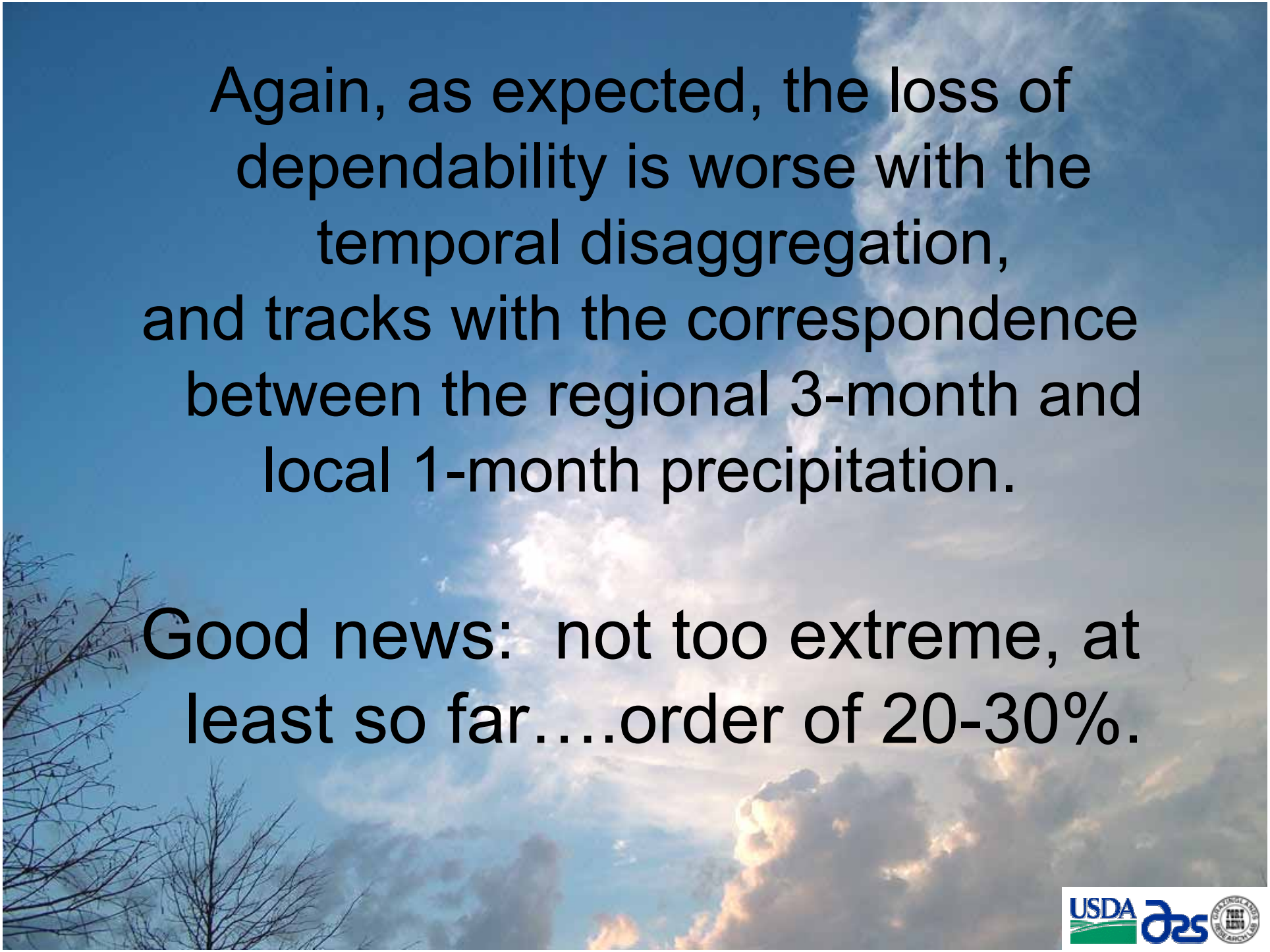
However, the loss due to spatial downscaling is relatively small for these few cases.

Aspermont, TX Precipitation
Downscaled, Disaggregated Passes for 3-month Forecasts

	3-mon FD	Hit?	3-mon local hit?	1-mon	Hit?
Cycle 4	DJF	yes	yes	Dec	yes
	JFM	yes	yes	Jan	yes
	FMA	yes	no	Feb	no
				Mar	yes
				Apr	yes
Cycle 5	JFM	yes	yes	Jan	yes
	FMA	yes	no	Feb	no
	MAM	no	no	Mar	yes
				Apr	yes
				May	no
Cycle 6	FMA	yes	no	Feb	no
	MAM	no	no	Mar	yes
				Apr	yes
				May	no

Dependability (Hits/Passes) Summary

SUMMARY	FD 3-month	Local 3-month	Local 1-month
Guthrie, OK	**11/11 100%**	**10/11 91%**	**14/20 70%**
Ada, OK	**11/11 100%**	**10/11 91%**	**13/20 65%**
Aspermont, TX	**12/15 80%**	**7/15 47%**	**18/29 62%**
Vernon, TX	**12/15 80%**	**12/15 80%**	**18/29 62%**


Again, as expected, the loss of dependability is worse with the temporal disaggregation, and tracks with the correspondence between the regional 3-month and local 1-month precipitation.
Good news: not too extreme, at least so far….order of 20-30%.
USDA ars