

*Performance Characteristics of  
Forecasts based upon a Lagged  
Ensemble from the NCEP CFS.*

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# *Purpose*

- A lagged ensemble presents a trade-off between ensemble size and skill.

(The ensemble size is increased by including older, less skillful members.)

- Compensate for this by giving higher weight to members from more recent runs.

Question: How best to determine the weights.

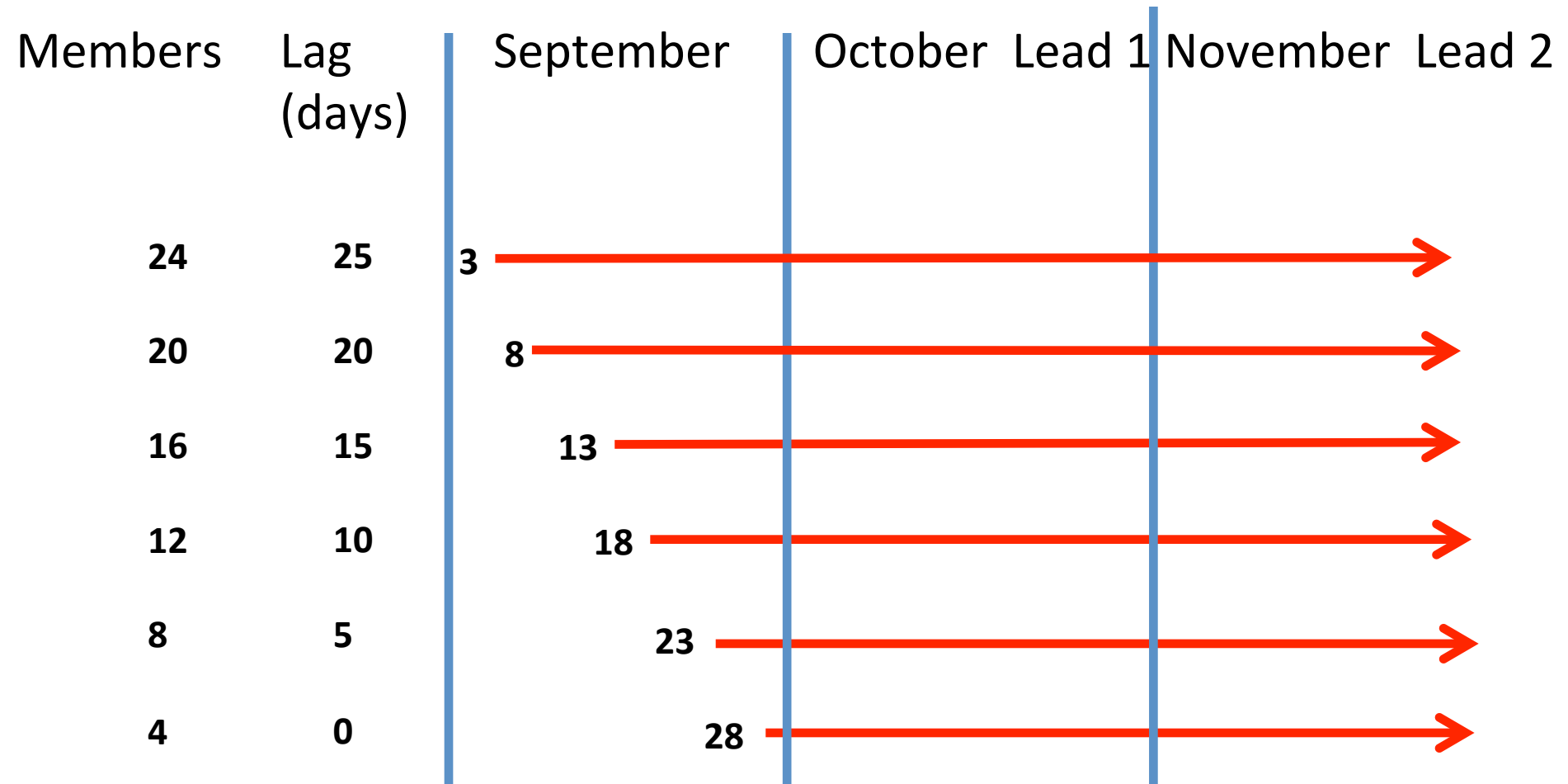
Requirements:

- Objective and automatable
- Fast
- Scientific or statistical basis.

# Climate Forecast System Ensemble

*Initial time*

*Forecast*



# *CFS Version 2 Nino 3.4 SSTs*

- 4 runs per day (0, 6, 12, 18 Z)
- Currently runs every day
- Hindcast runs archived every 5<sup>th</sup> day
- Data 1982-2010
- Bias Correction applied to older data  
( 1982-1999 slightly different bias than recently)
- Forecasts are for 1-month mean Nino 3.4 SSTs.

# *Post Processing*

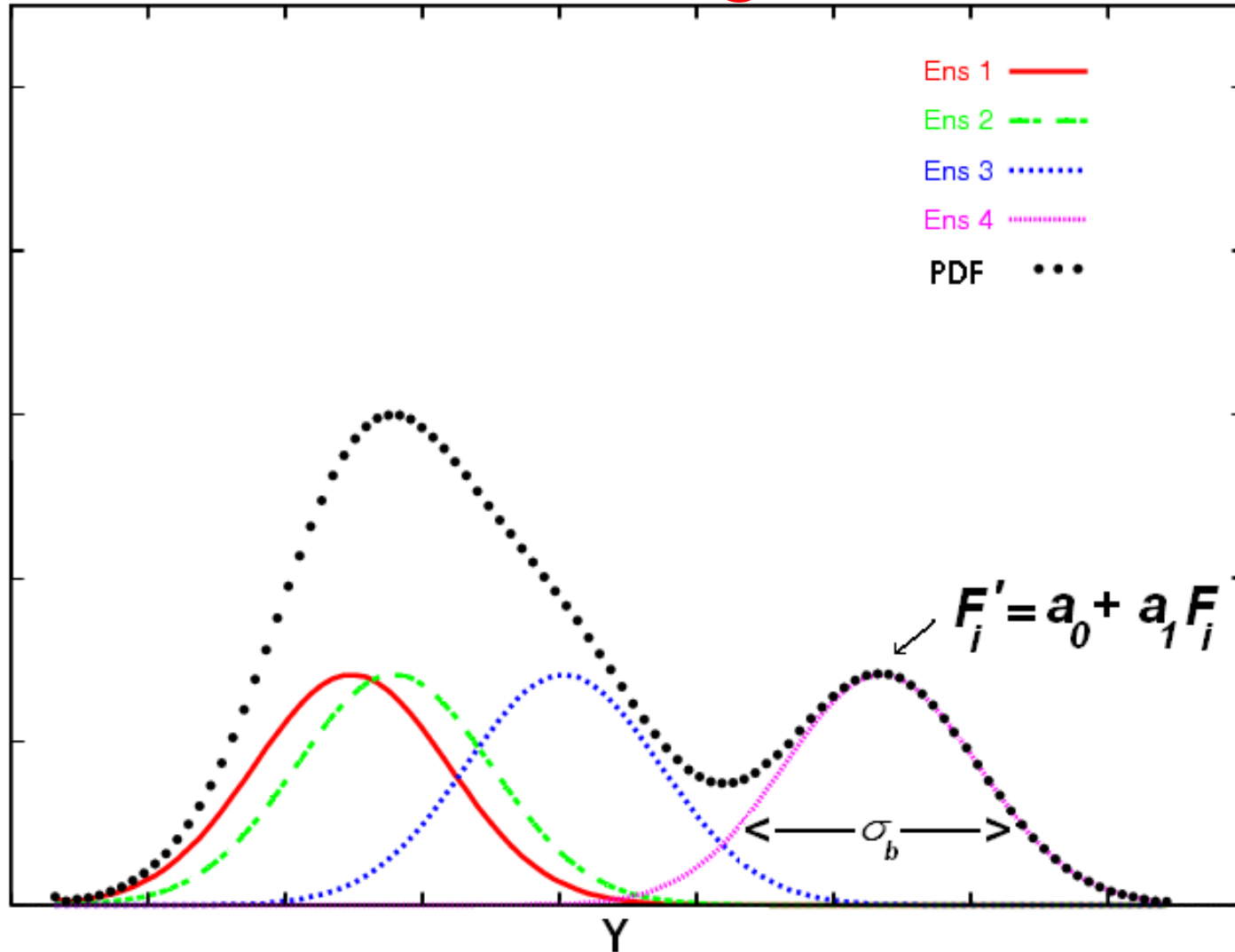
## *Ensemble Regression*

- A regression model developed for use with ensemble forecasts.
- Provides an *expected regression equation* between the best member and the observation
- Requires an estimate of the probability that a member will be closest to the observation

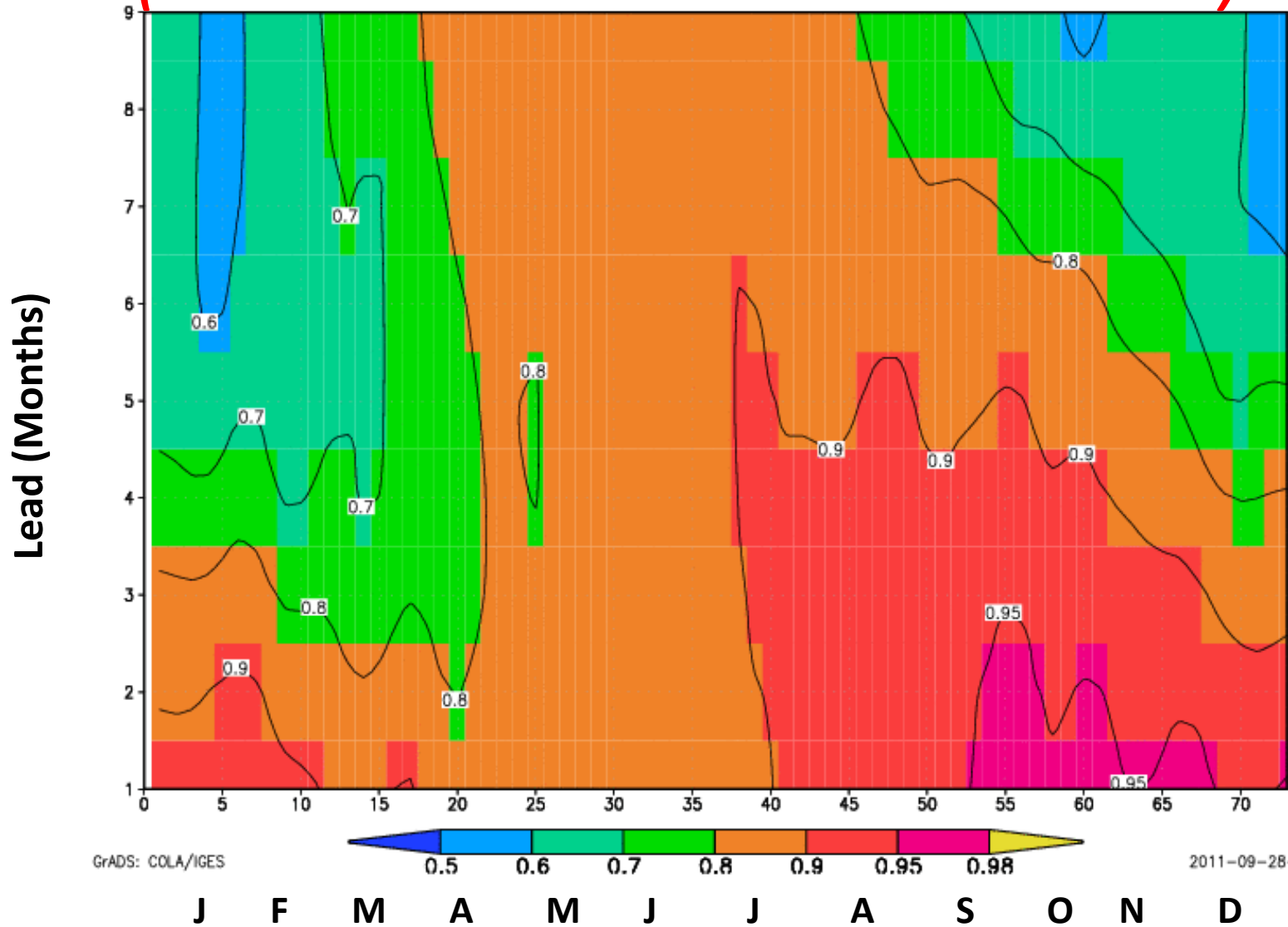
## *Ensemble Regression (continued)*

- Theory indicates that the ‘best member’ equation is identical to the regression derived from the ensemble mean
- Apply the equation to individual members.
- Place expected regression error distribution around individual members

# Probability density function of ensemble regression



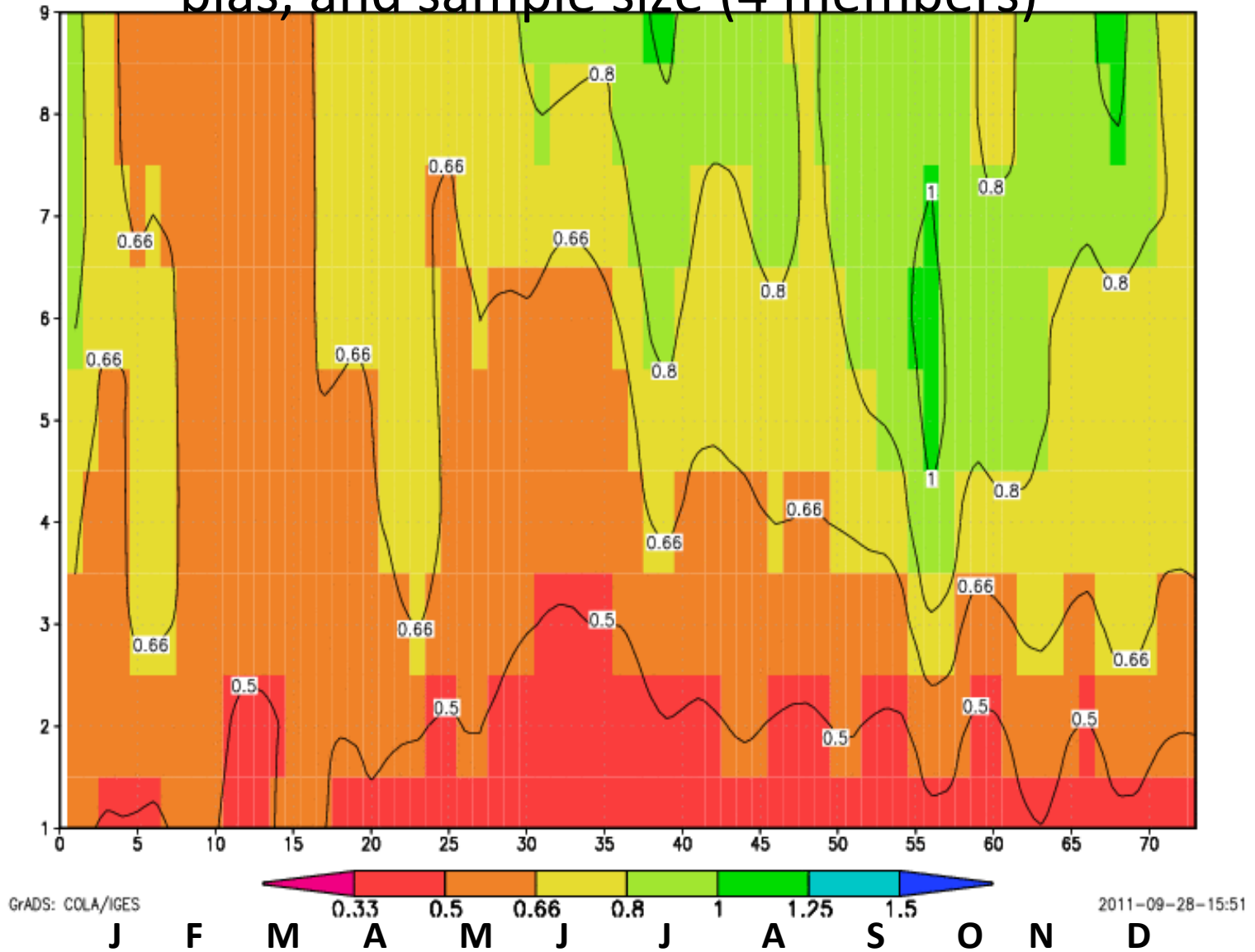
# *Skill of Ens. Regression Equation (Correlations ensemble means)*





# Accuracy of CFS spread

Ratio of ensemble spread to expected spread for skill, bias, and sample size (4 members)

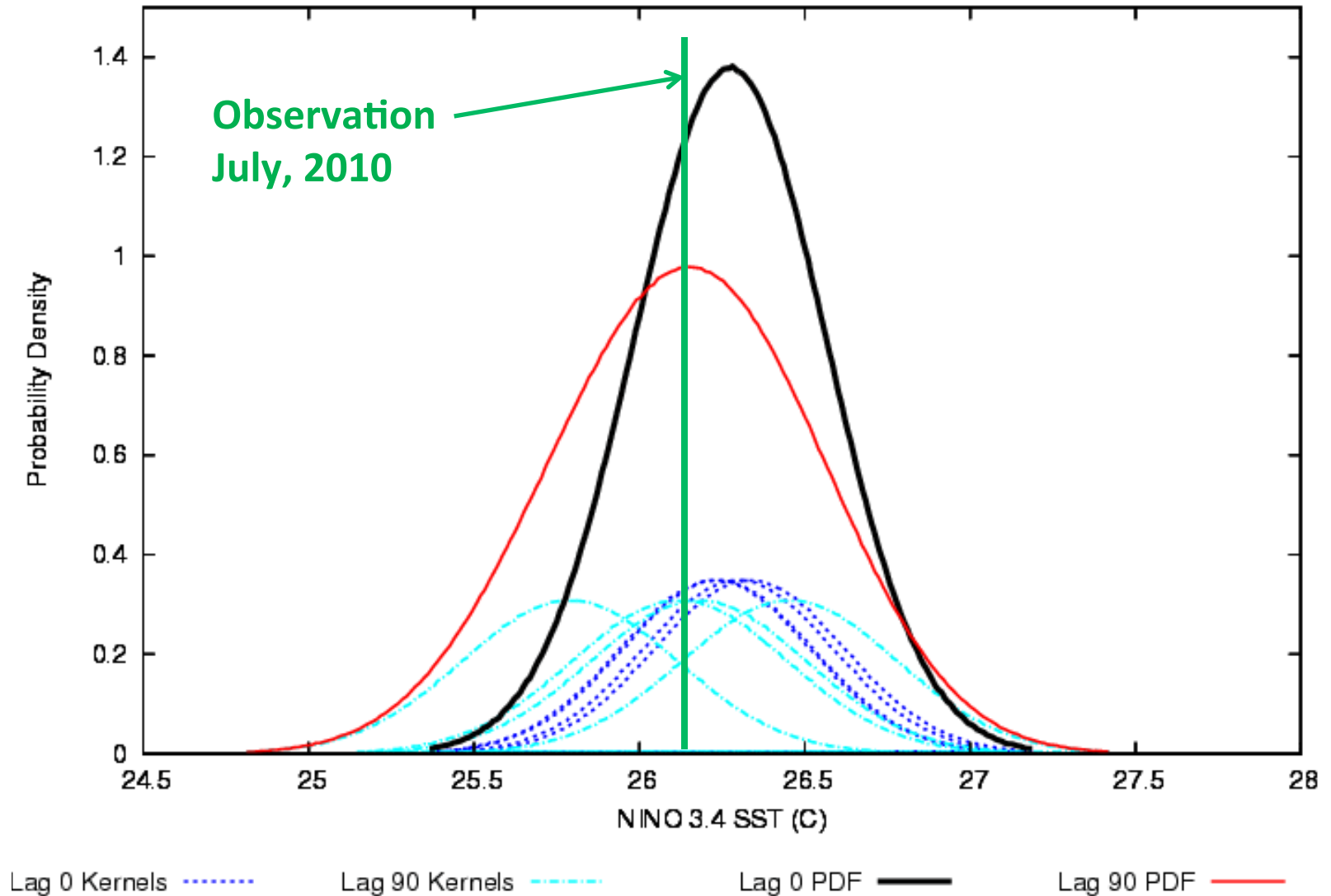


# *Member Weighting*

- Ensemble regression theory needs the probability that a member is closest.
- Group members by units of equal skill  
(Each of the 4 daily members equally skillful)
- Compute 4-member PDF's for lagged ensemble separately
- Compute PDF's on dependent data in second pass through data
- Find the PDF's from each ensemble group
- Highest PDF indicates the which group produced the best member

# *Best member example*

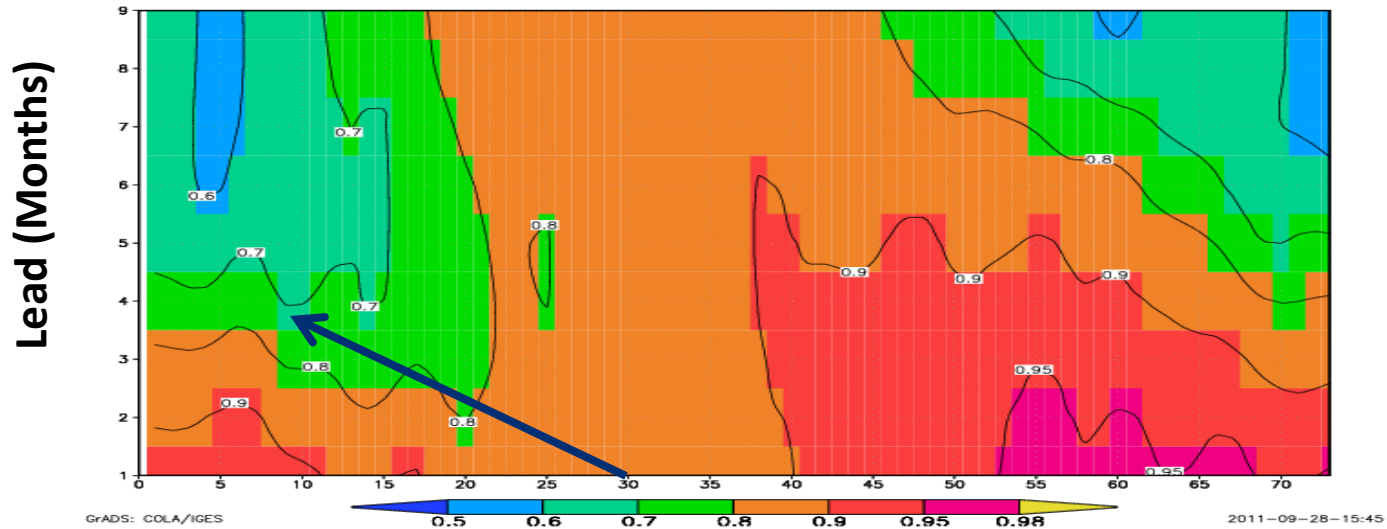
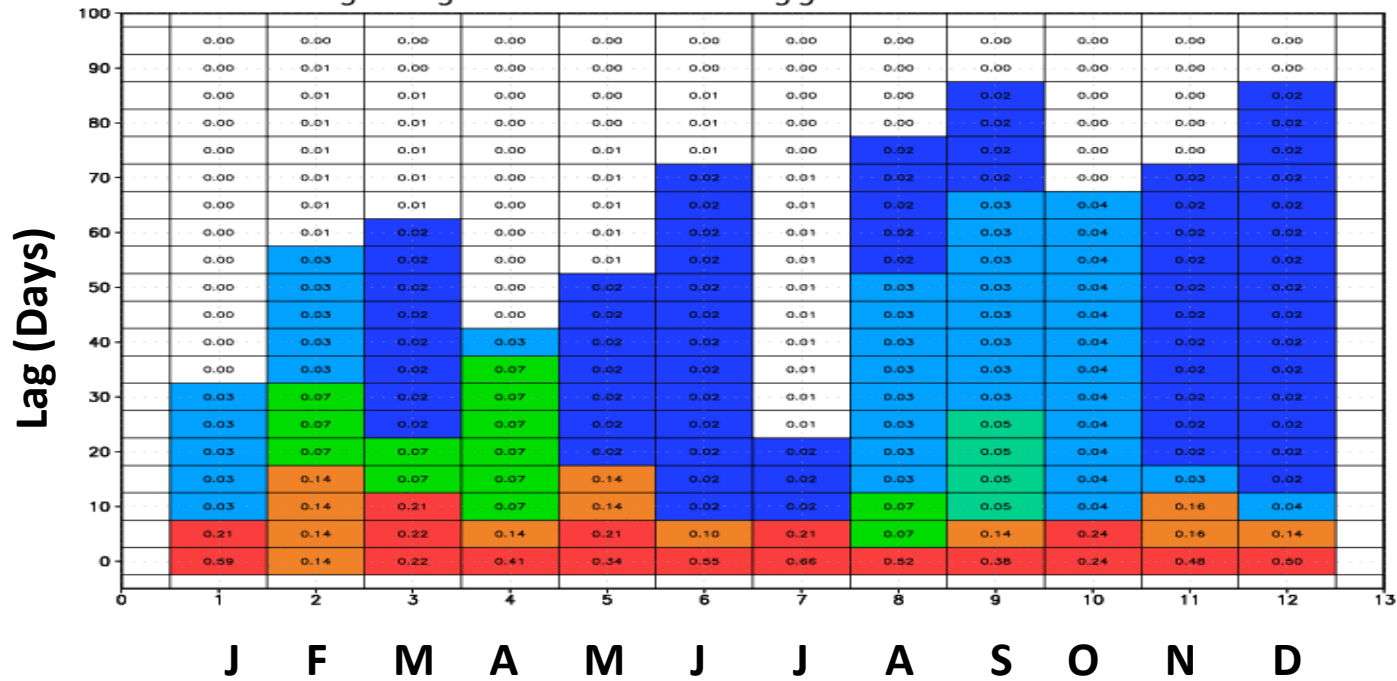
Forecast from 6/30 Lead 1 and 3/27 Lead 4 for July 2010



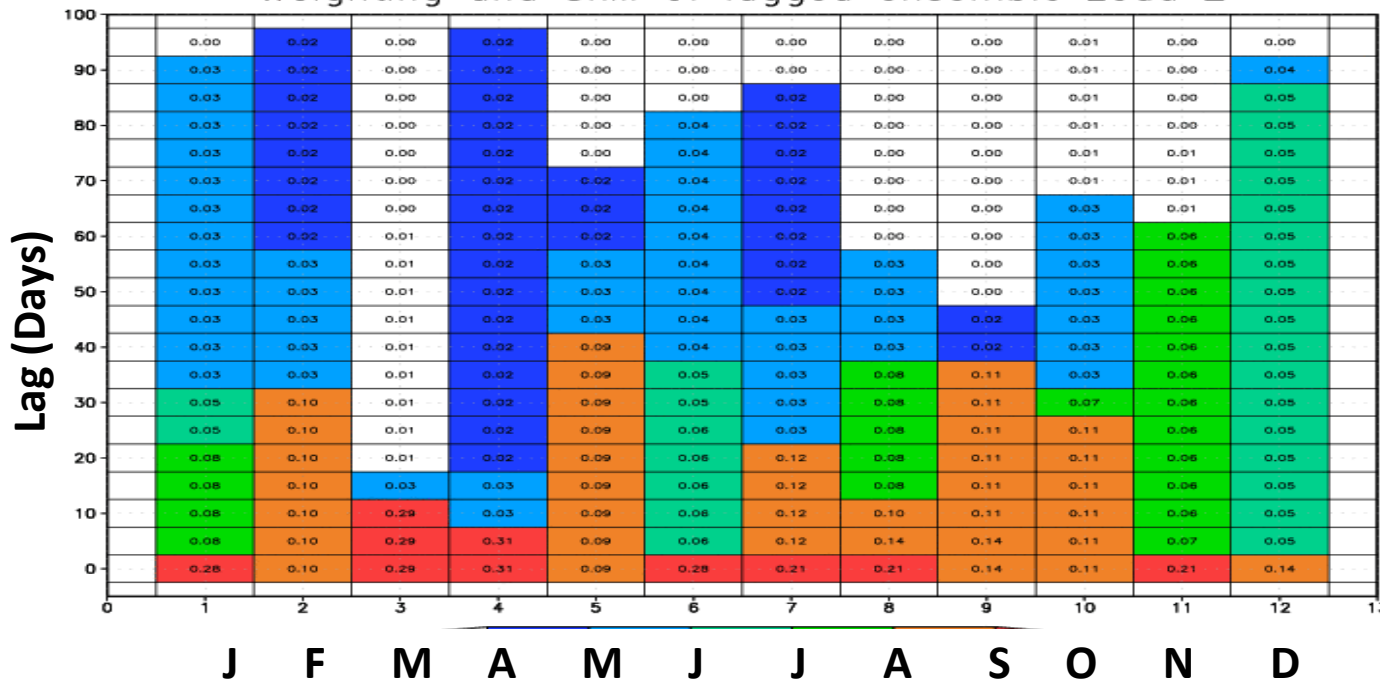
# *Smoothing*

- More recent members must have equal or higher  $P(\text{best})$  than older ones. (Otherwise combine member sets and average  $P(\text{best})$  values together)

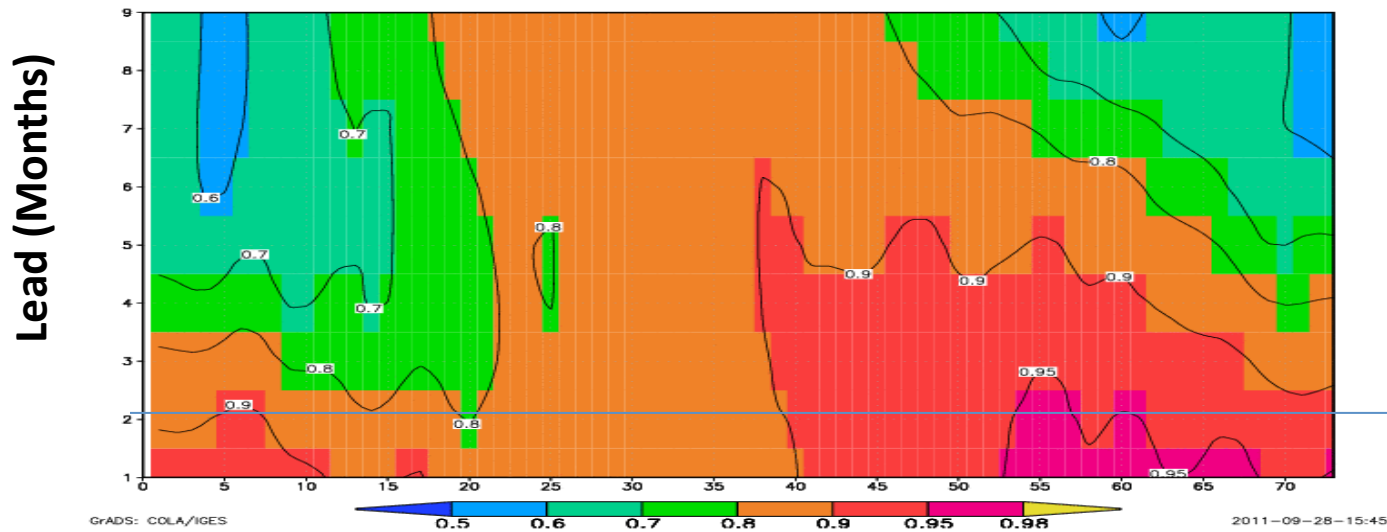
# Weighting and Skill of lagged ensemble Lead 1



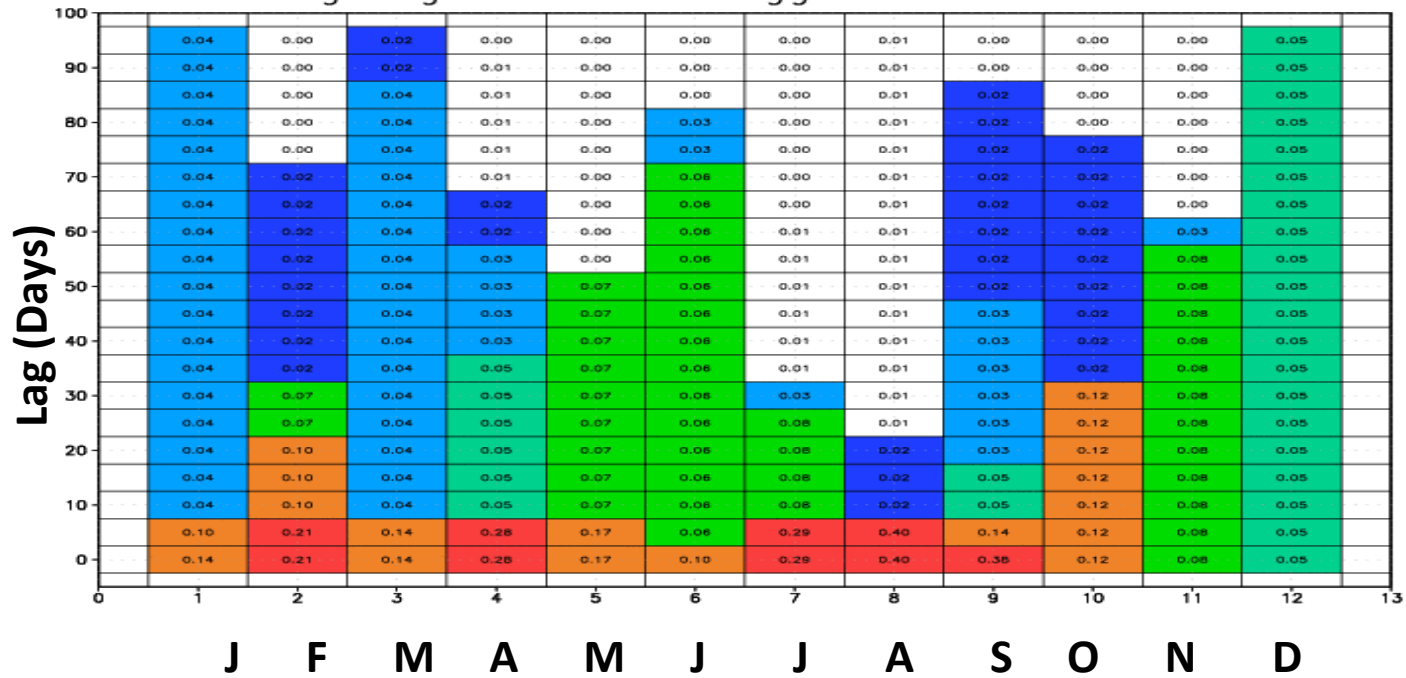
## Weighting and Skill of lagged ensemble Lead 2



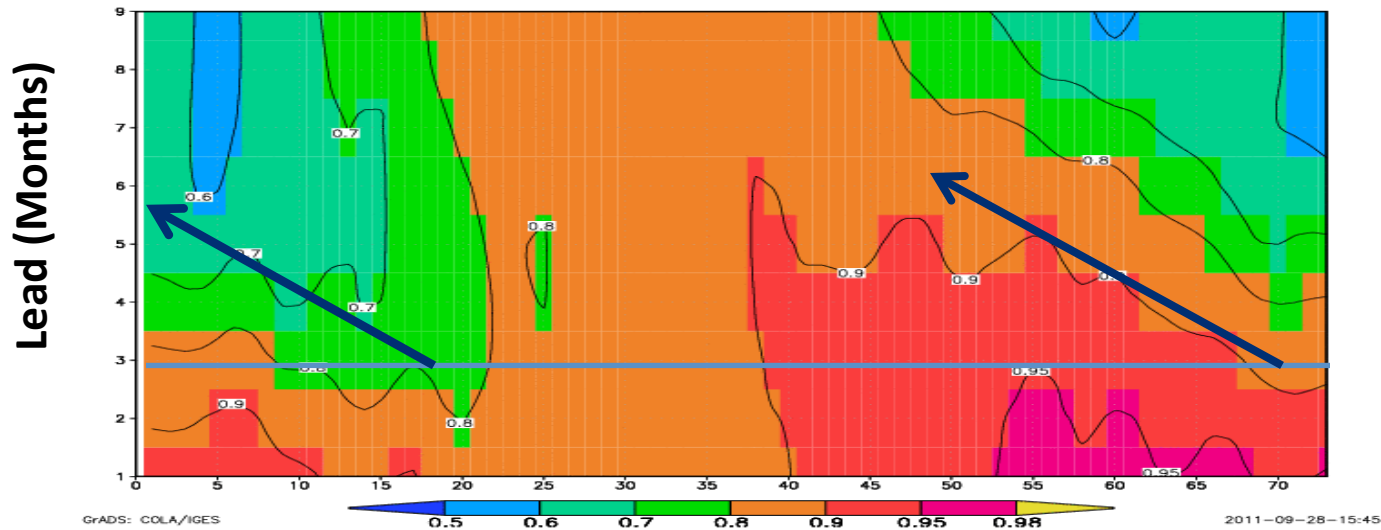
**Weighting**  
**High (.2+)**  
**Moderate (.045-.19)**  
**Low - Less than eq. wts (.025-.044)**  
**Negligible (.015-.024)**



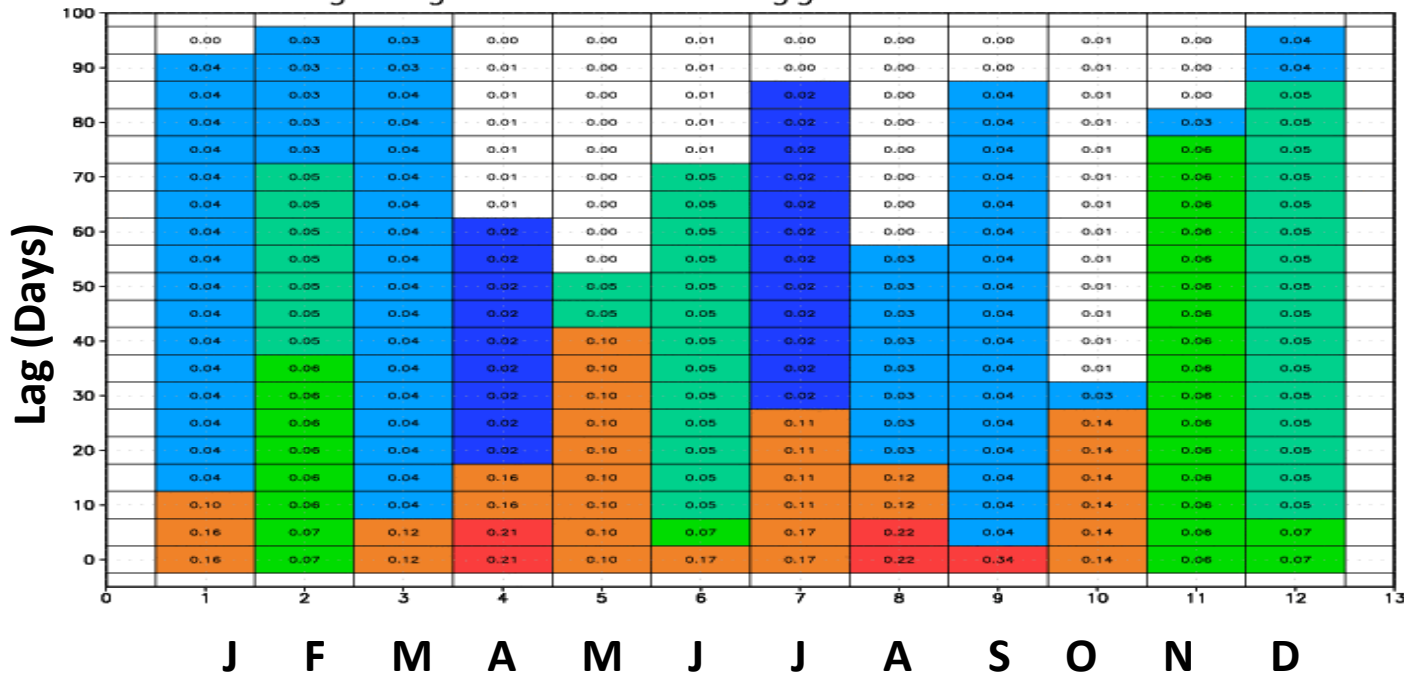
# Weighting and Skill of lagged ensemble Lead 3



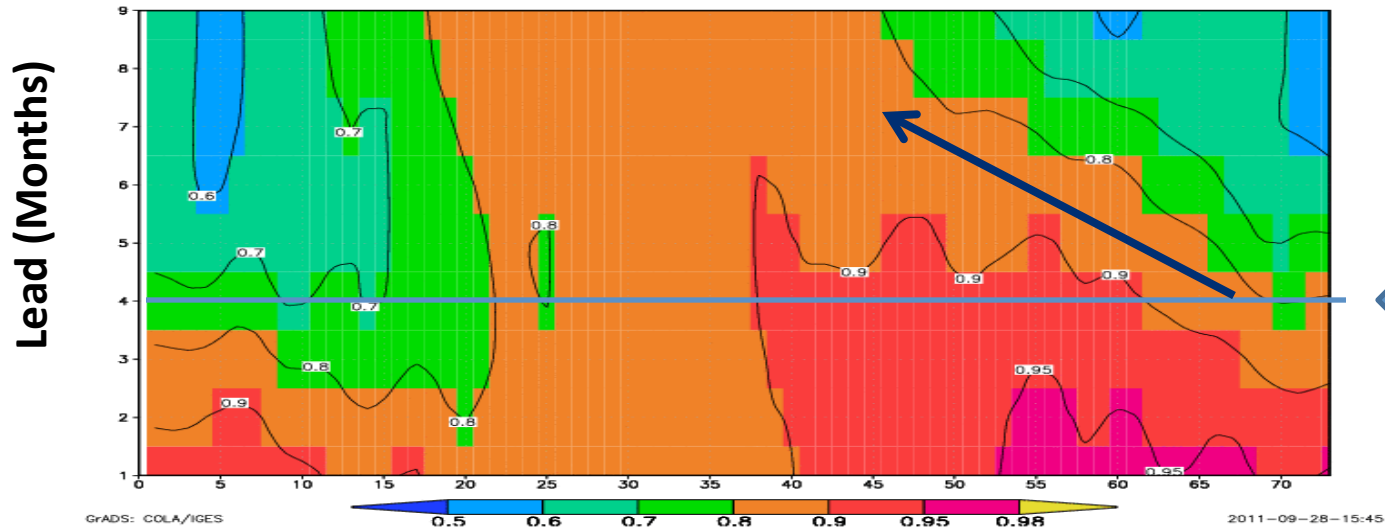
**Weighting**  
**High (.2+)**  
**Moderate (.045-.19)**  
**Low - Less than eq. wts (.025-.044)**  
**Negligible (.015-.024)**



# Weighting and Skill of lagged ensemble Lead 4

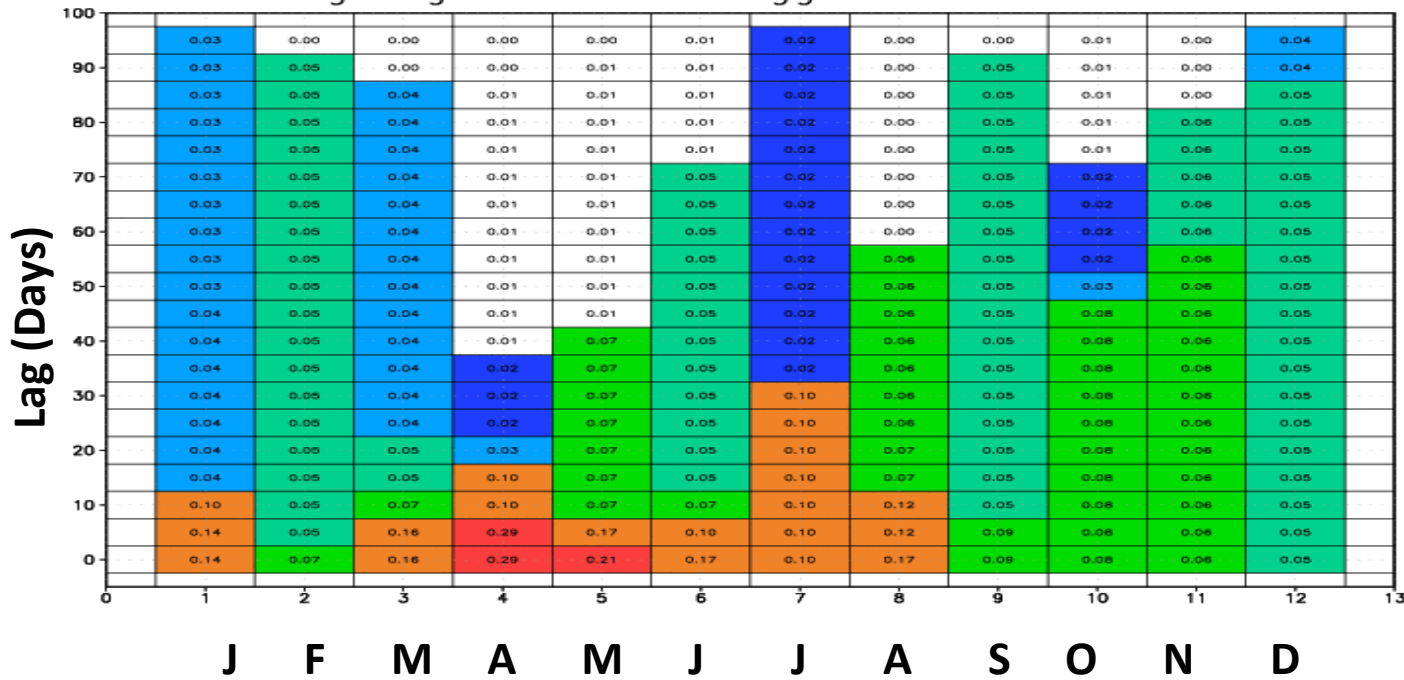


**Weighting**  
**High (.2+)**  
**Moderate (.045-.19)**  
**Low - Less than eq. wts (.025-.044)**  
**Negligible (.015-.024)**

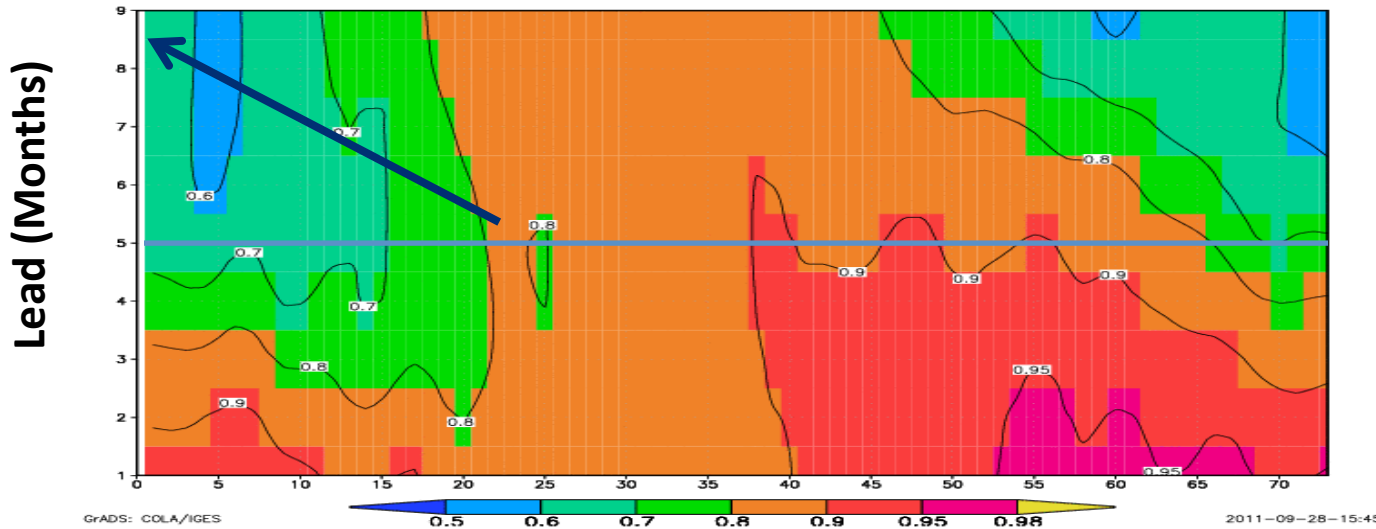




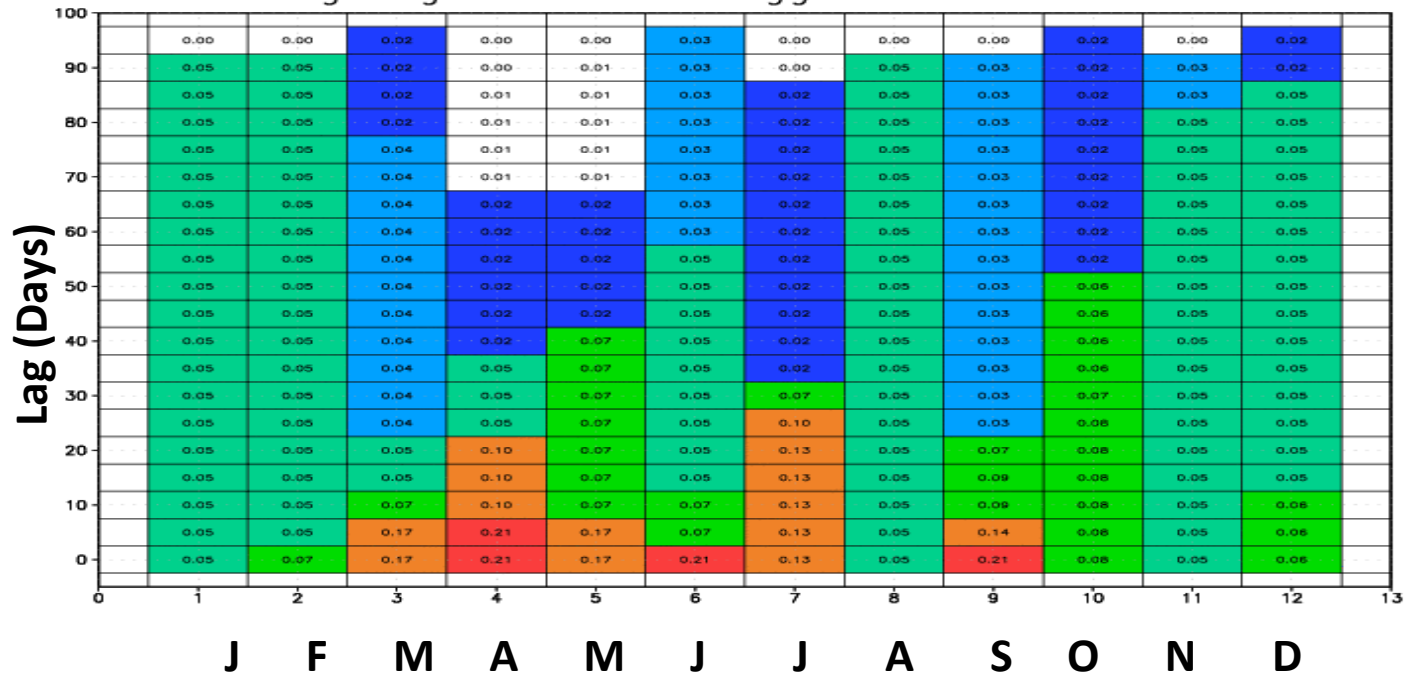
# Weighting and Skill of lagged ensemble Lead 5



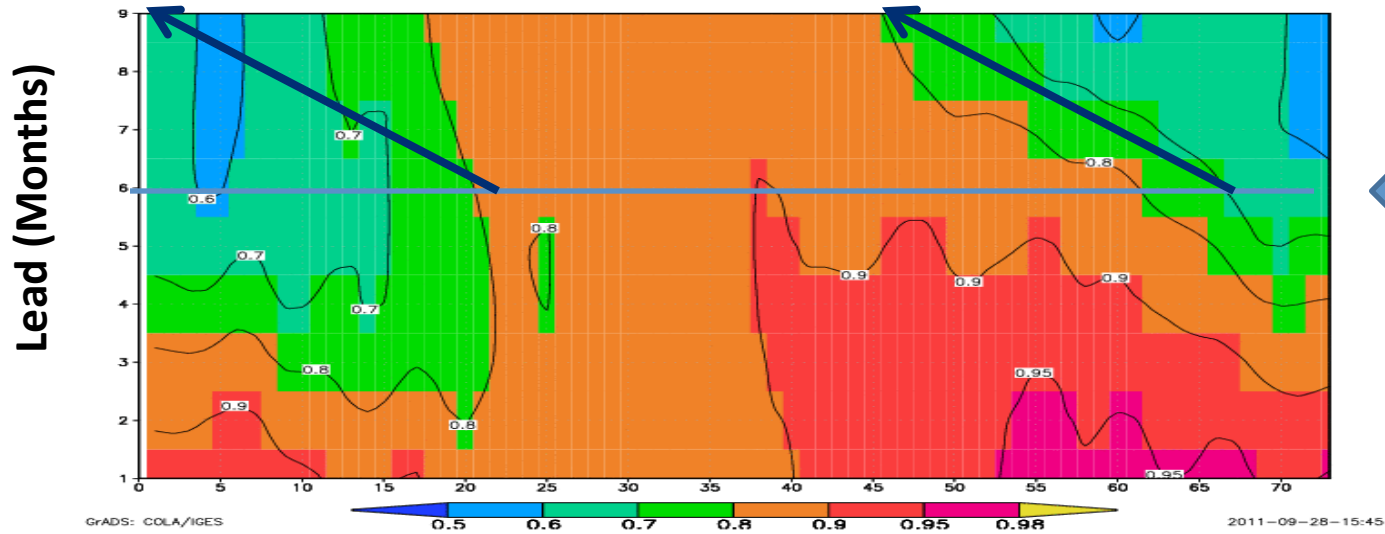
**Weighting**  
**High (.2+)**  
**Moderate (.045-.19)**  
**Low - Less than eq. wts (.025-.044)**  
**Negligible (.015-.024)**



# Weighting and Skill of lagged ensemble Lead 6



**Weighting**  
**High (.2+)**  
**Moderate (.045-.19)**  
**Low - Less than eq. wts (.025-.044)**  
**Negligible (.015-.024)**



# *Conclusions*

- An objective weighting procedure based on ensemble regression has been developed and tested
- Weighting depends mostly on the gradient of skill along which the lagged average ensemble is built.
- Short leads always heavily favor recent runs (in spite of small ensemble size).
- Front-weighting persists even at longer leads for some, but not all start times (spring and summer)