Multimodel seasonal forecast for climate

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1. Extended Abstract:

This study is based on an 8 –member model forecast of seasonal climate. We use the FSU atmospheric global spectral with the Hamburg ocean model for this work. The model and data specification are as follows:

Global Coupled Model**:** T- 63 with 14 levels for Atmosphere, E-grid (74X87) with 17 layers for Ocean Model

Regional Model**:** 0.5°× 0.5°

Experiment:

A **(Arakawa – Schubert)**	K **(FSU- modified Kuo)**
OR **(Emissivity absorbtivity radiation code)**	NR **(Band model radiation code)**

Eight member models:

i) Global Coupled Model:
- a) GANR
- b) GAOR
- c) GKNR
- d) GKOR

ii) Regional Model:
- e) RANR
- f) RAOR
- g) RKNR
- h) RKOR

Period of Experiment:

1. Ocean spin-up (Jan 1 1979 to Jan 1 1986) is followed by daily-coupled data assimilation over starting from Jan 1, 1986 to the present time.
2. Seasonal to multiseasonal forecast experiments covering years: Jan, 1987 to till date.
3. Precipitation anomaly super-ensemble was constructed using cross-validation technique and is being studied.

4. We are currently running some start date experiment with a regional spectral model at resolution of 0.5°× 0.5° over North America (10°N to 50°N, 230°E – 300°E) as well as India.

Here we include the following 8 experiments.
Where,

G => global model

R => regional model

NR => a new radiation algorithm based on a band model

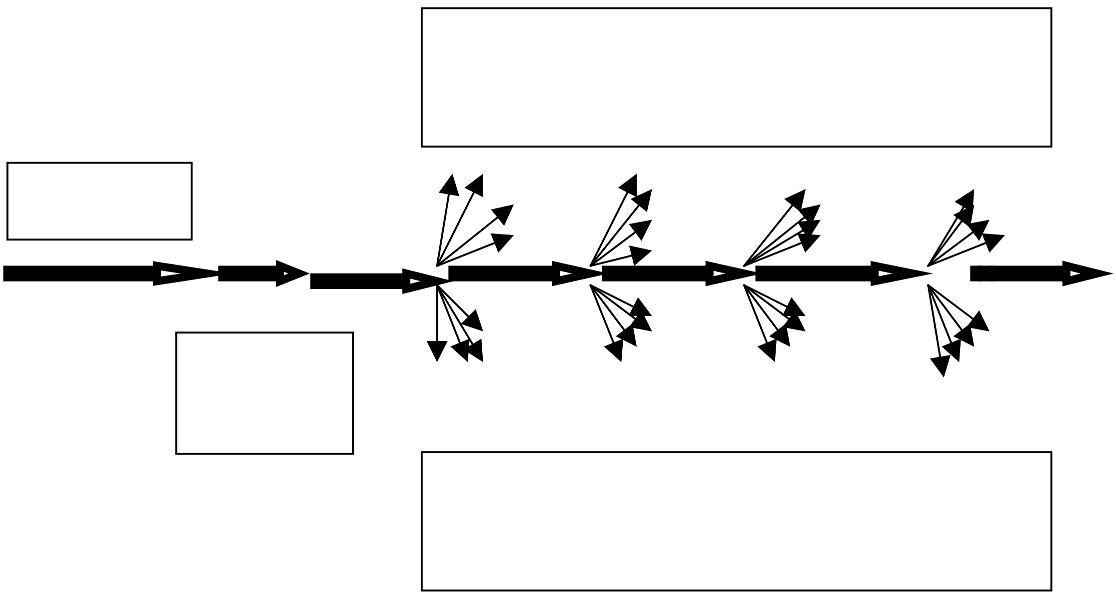
OR => an old radiation algorithm

A => Arakawa Schubert cumulus parameterization and

K => a modified Kuo cumulus parameterization algorithm.

The permutations of these algorithms within the FSU global and regional model provide 8 separate models that were utilized in the experimentation program. These are described as follows:

Schematic Diagram of experiment:



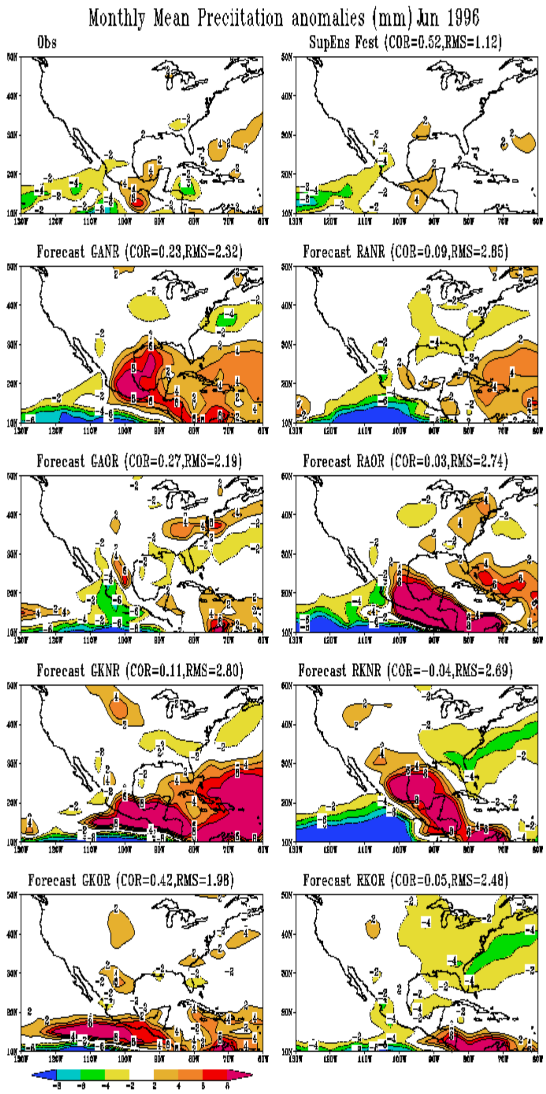
The methodology for the construction of the superensemble weights and the subsequent seasonal climate forecasts follow our previous study, Krishnamurti et al. (2000).

2. Prediction of monthly mean precipitation anomalies:

We show examples forecast skills of precipitation anomalies in the following illustrations.

In these illustrations, anomalies are defined as departures from a 20-year monthly climatology based on Xie and Arkin (1997) data sets covering the years 1979 to 1999. The top two panels show the observed anomalies and the superensemble forecast based anomalies of predicted rains. The remaining 8 panels show the rainfall anomalies predicted by the eight member models.

a)



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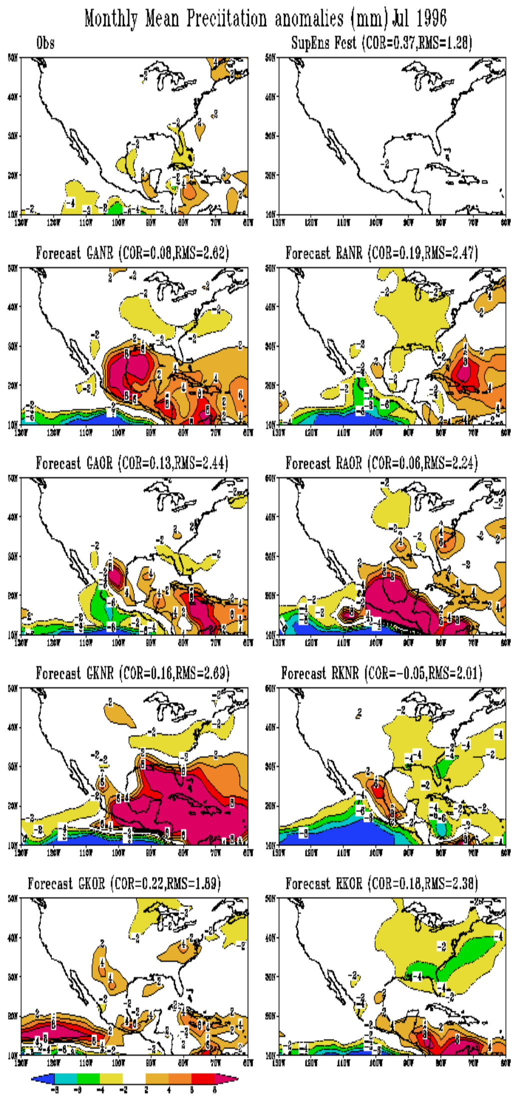


c) d)

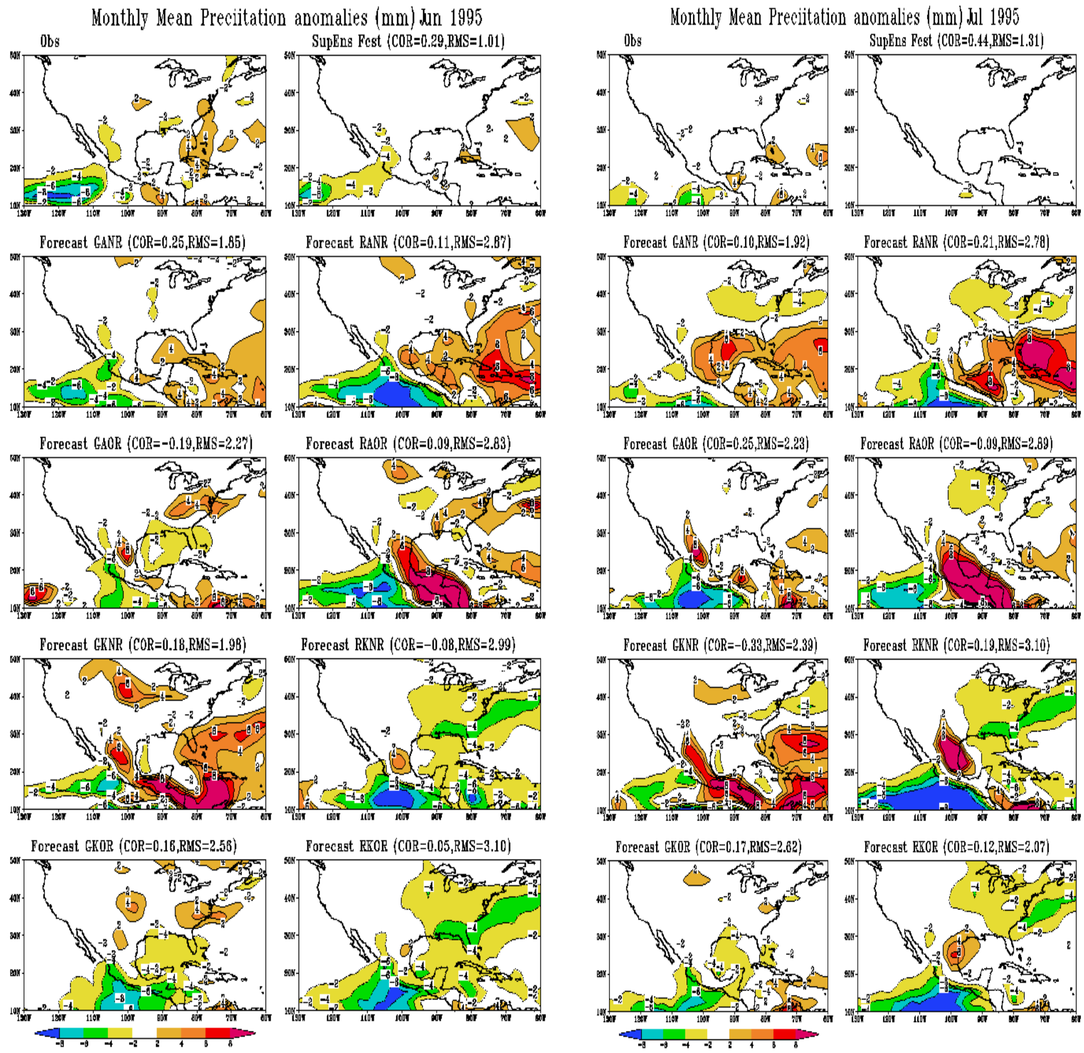


Fig. 1 Monthly mean precipitation anomalies for a) June 1996, b) July 1996, c) June 1995 and d) July 1995.

On top of each of these panels we show the correlations and rms errors of the forecasts with respect to the observed measures. By far the largest anomaly correlations are seen for the superensemble (0.50), which compares with values as 0.23, 0.27, 0.11, 0.42, 0.09, 0.03, -0.04 and 0.05 for the eight models. The least rms error of the superensembles 1.12 compares with values such as 2.32, 2.85, 2.19, 2.74, 2.80, 2.69, 1.98 and 2.48 for the member models. These are very robust results for the anomaly correlations for the superensemble suggesting that one and two months climate forecasts of rainfall anomalies are very promising at this stage. Similar results may be seen in figs 1b, 1c and 1d. Comparing such results for June 1996 (first month),

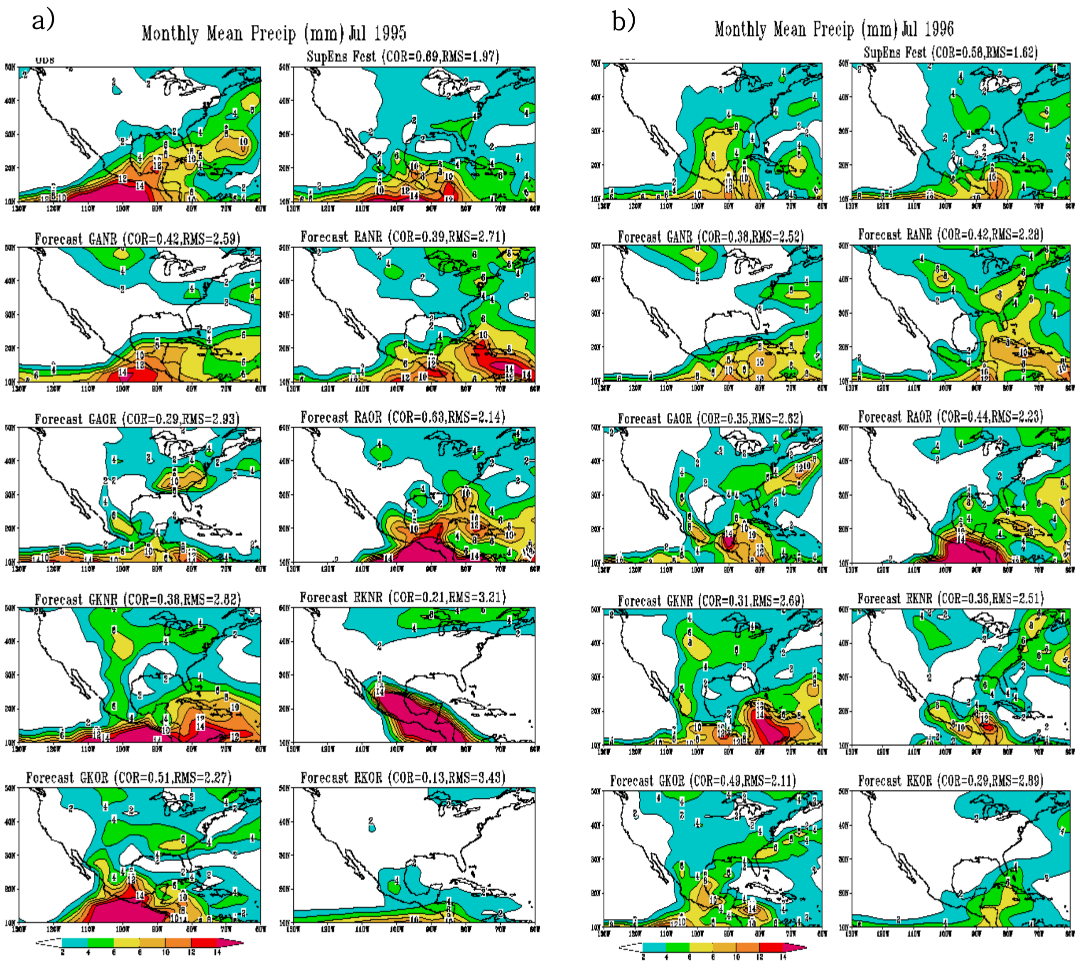


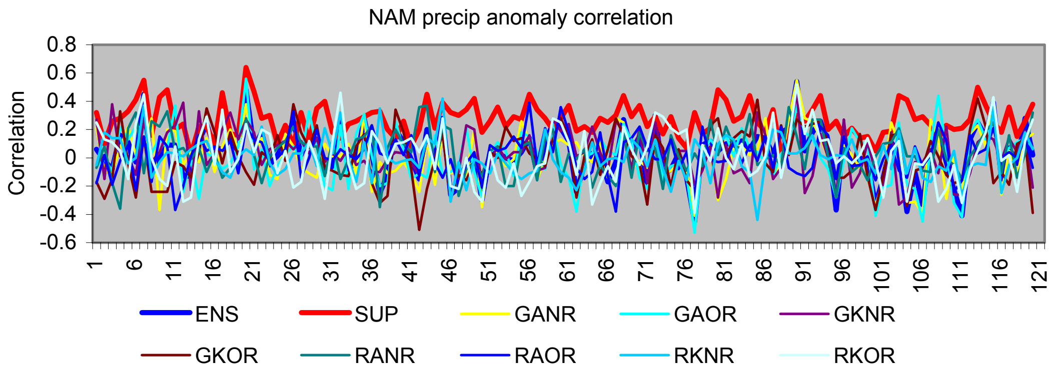
Fig. 2 Monthly mean precipitation for a) July 1996 and b) July 1996.

July 1996 (second month), June 1995 (first month) and July 1995 (second month). These are the only months for which these computations are presently completed. From our past experience we feel that similar results would be available for the entire forecast period covering each month from January 1987 to the present period. The forecasts of monthly mean rain for July 1995 and July 1996 and their correlations plus the standard deviation are displayed in Figs. (2a and b). These are the month two forecasts for July 1995 and July 1996. The poorer performances of some of the member models have very low correlations and rms errors in excess of 3 mm are apparent. The corresponding number for the best model and the superensemble are (0.63, 2.14), (0.69, 1.97). Overall it is possible to improve the results beyond the best model from a construction of the superensemble.

These same results are summarized, as domain averages, over the North American domain in fig 3 (a, b). The computational domains over the North America for the regional spectral model are same as in Figs 1 and 2. The experiments described here are preliminary and do not yet include the full range of the proposed experiments. We include here results from those experiments that had a start date of May 15 and the integrations were carried through to August 15 of each year. These results were averaged over the months June and July. We have also completed experiments that had a start date of December 15, which provided the monthly mean forecasts of January and so on. In fig 3a one can see correlation of anomalies for the member models, ensemble and superensemble.

It shows that correlation is always higher than member models and ensemble mean for the superensemble. Fig 3b shows that the rms errors of the superensemble are less than those of the member models and of the climatolgy throughout this entire period.

a)



b)

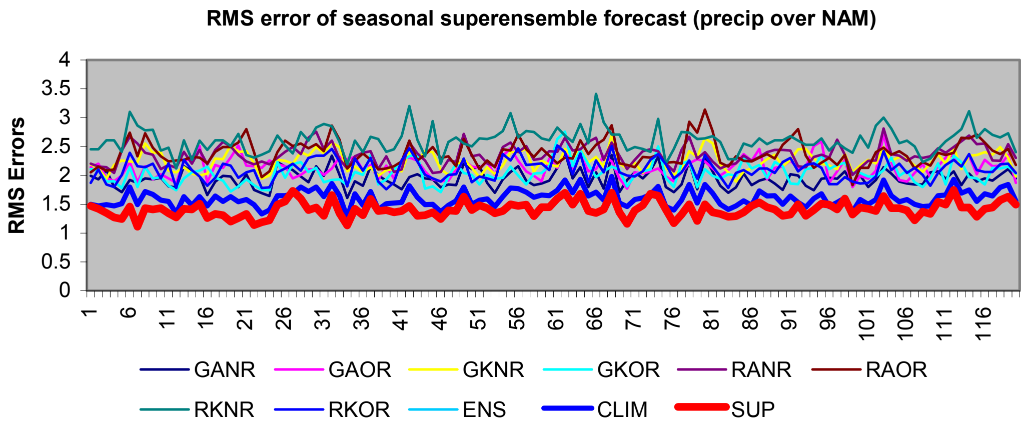


Fig. 3 a) Correlation of precipitation anomalies and b) rms errors

3. Future work:

The following Table illustrates the proposed matrix of experiments that we are currently carrying out. The major parts of these computations are being done at York Town IBM Watson Center in New York. The IBM SP3 is ideally suited for these massively parallel computations. The lower half of this matrix illustrates the completed work. Overall we anticipate a completion of the entire 15 years of multimodel climate runs by the end of the year 2002.

Table 1: Work plan of the high-resolution FSU regional model experiments

Model Versions	No. of Coupled Global runs	No. of Regional runs	Starting Year	Ending Year
FSU Spectral model with Arakawa – Schubart convection scheme + Emissivity absorbtivity radiation code	672 (230)	672 (211)	1987	2000
FSU Spectral model with Arakawa – Schubart convection scheme+ Band model radiation code	672 (230)	672 (211)	1987	2000
FSU Spectral model with FSU- modified Kuo convection scheme+ Emissivity absorbtivity radiation code	672 (230)	672 (211)	1987	2000
FSU Spectral model with FSU- modified Kuo convection scheme + Band model radiation code	672 (230)	672 (211)	1987	2000

* Number within parenthesis indicates the no of experiment already completed.

References:

Krishnamurti, T.N., C.M. Kishtawal, T. LaRow, D. Bachiochi, Z. Zhang, C.E. Williford, S. Gadgil and S. Surendran, 2000: Multi-model superensemble forecasts for weather and seasonal climate. *J. Climate*, 13, 4196-4216.

Xie, P., and P. A. Arkin, 1997: Global precipitation: a 17-year monthly analysis based on gauge observations, satellite estimates and numerical model outputs. *Bull. Amer. Meteor. Soc.,* 78, 2539-2558.