Seasonal forecast and water resources management

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LIKE MANY OTHER developing countries in the tropics, Nigeria, amongst other things, depends on water resources management for her hydropower energy and water supply needs. Since weather and climate are important factors in hydropower generation, accurate seasonal rainfall forecasting is therefore crucial in Nigeria for the proper planning of the water resources management.

Since the beginning of this century, scientists have been engaged in studies related to the influence of Sea Surface Temperature (SST) on global climate variability. Much of the research has been centered on the tropical Pacific, where discoveries on the patterns of both Sea Surface Temperature and Pressure have led to the El Nino-Southern Oscillation (ENSO) phenomenon. In the last few years there has been much investigation of the possibilities of forecasting rainfall months two seasons ahead. Most of this work has focussed on finding empirical relationships between rainfall observed at a given time and one or more other variables observed some months earlier. The earliest work focussed on relationships between some representations of the El Nino-Southern Oscillation (ENSO phenomenon and rainfall). The ENSO indicators ranged from the Southern Oscillation Index (SOI), a sea level pressure gradient across the southern tropical Pacific Ocean, to sea surface temperatures (SST) at particular locations in the tropical Pacific (NINO1, NINO2 and NINO3). Later other variables were used including the Global Oceans Eof, North Atlantic, South Atlantic and Indian Oceans SSTs.

In East and West Africa, predictive models indicated that seasonal fluctuations in the global parameters like El-Nino/ Southern oscillation (ENSO) and SST anomalies influenced seasonal rainfall (Gbuyiro and Olaleye, 1997; Ogallo, 1988; Hastenrath, 1993; Davies et al 1985 and Ininda , 1995). High correlation between sea surface pressure, sea surface temperatures (SST), air temperature fields and SO north of latitude 10° S over Indian ocean has also been observed (Cadet , 1985).

Data and method of analysis

The study area covers the Sahel and Sudan Savanna regions in Nigeria bounded by latitudes 9° & 14°N and longitudes 3° to 14° E. The data consists of Sea Surface Temperatures (SSTs) (over central Pacific, North Atlantic, South Atlantic and Indian Oceans) and Southern Oscillation Index (SOI). The rainfall consisted of point (station) monthly rainfall, which are the most readily available for spatial and temporal climatological analyses. A total of 20 stations are used. The study covered the period 1906-2001. The methodology involves standardizing both the rainfall and global SSTs; and then computing the correlation between each of the time series in the 2 regions used and the global SSTs. The correlation technique involves both zero and lag correlations. The t - test was used to determine the statistical significance of the computed correlation at 95 % Confidence Level. Correlation of -0.3 to +0.3 was found to be statistical significant in this work.

Results and discussions

The correlations between the seasonal rainfall and SST over different oceans and regions are presented in Table 1. It is seen from Table 1 that

Table 1. Showing the various correlations between the seasonal rainfall and global oceans in the Sahel and Sudan savanna regions of Nigeria

SAHEL REGION	NATL	SATL	INDO	NINO3	SUDAN SAVANNA	NATL	SATL	INDO	NINO3
MASST	0.38	-0.22	-0.15	-0.13	MASST	0.36	-0.23	-0.16	-0.14
AMSST	0.41	-0.27	-0.17	-0.22	AMSST	0.38	-0.27	-0.17	-0.21
JASSST	0.40	-0.38	-0.36	-0.38	ASSST	0.36	-0.35	-0.33	-0.36
Correlation between JJAS seasonal rainfall and the various Oceans									
MASST	0.08	0.23	-0.25	-0.25	MASST	0.06	0.23	-0.24	0.08
AMSST	0.19	0.24	-0.33	-0.33	AMSST	0.20	0.23	-0.32	0.17
JASSST	0.21	0.22	-0.35	-0.34	JASSST	0.21	0.21	-0.34	0.19
Correlation between AO seasonal rainfall and the various Oceans									
MASST	-0.15	-0.39	-0.35	-0.25	MASST	-0.16	-0.37	-0.34	-0.24
AMSST	-0.16	-0.40	-0.34	-0.26	AMSST	-0.7	-0.38	-0.33	-0.25
JASSST	0.22.	–0.38	-0.38	+.032	JASSST	0.22	-0.37	-0.35	-0.33

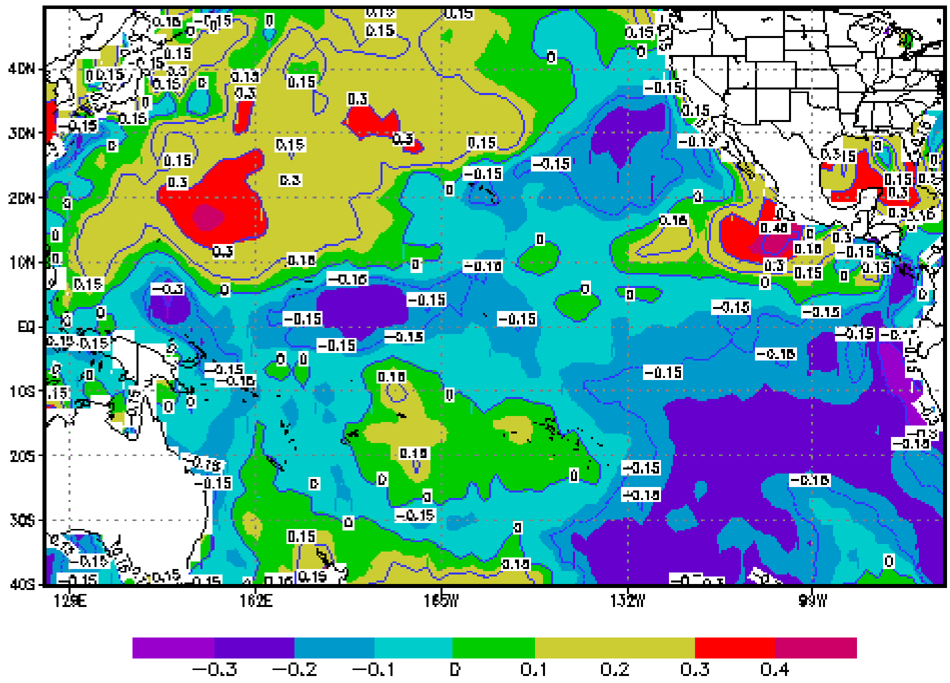

Figure 1. Spatial correlation between JAS seasonal rainfall and JASSST over NINO3 Ocean

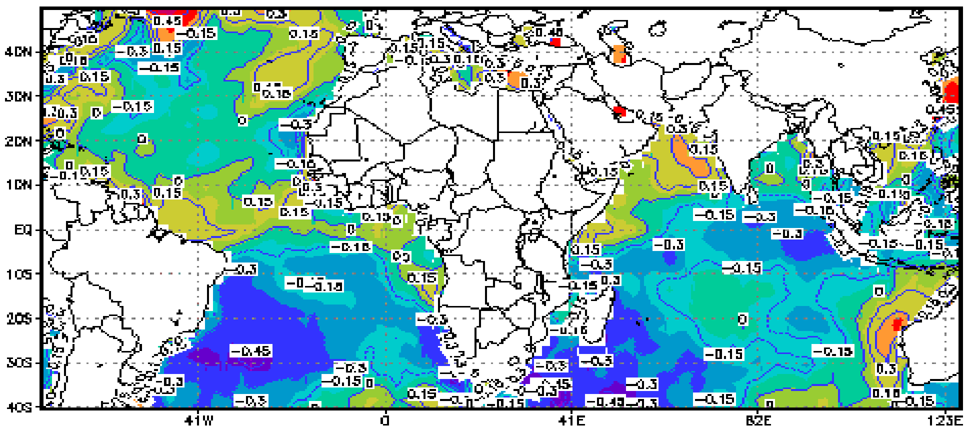

Figure 2. Spatial correlation between JAS seasonal rainfall and MASST over the Indian and Atlantic Oceans

(a) Correlations of **July-September** seasonal rainfall (JASRR) with (i)March/April SST(MASST) (ii) April/May SST(AMSST) and (iii) July-September SST(JASSST) gave positive correlations of 0.38, 0.41, 0.40 respectively for the North Atlantic Ocean(NATL) and Sahel region. The correlation between JASSST and JASRR over NATL, South Atlantic Ocean(SATL), Indian Ocean(INDO) and East Pacific(NINO3) gave values of 0.40, -0.38 , -0.36 and –0.38 respectively over the Sahel region. The results over the Sudan savanna are similar to those over the Sahel region except that lower correlations were observed.

(b) Correlations of **June-September** seasonal rainfall (JJASRR) with SST over Various Oceans and the Sahel Region indicate that significant correlations exist only between April/May SST(AMSST) and July-September SST(JASSST) in the INDO and NINO3 (–0.33 and –0.35 over the INDO and –0.33 and –0.34 over the NINO3 ocean). While for Sudan Savanna region, only the INDO had significant values of -.034 and –0.37.

(c) Correlations of **April-October** seasonal rainfall (AORR) with SST Over various regions and oceans show that the correlations between MASST and AOPR for Sahel region over SATL and INDO are –0.39 and –0.35. Correlations between AOPR and JASST for SATL, INDO and NINO3 are –0.38, -0.38 and +0.32, respectively. For the Sudan Savanna region, the correlations were similar.

Figures 1 and 2 show typical spatial correlation between JAS seasonal rainfall and JASSST over NINO3 ocean and spatial correlation between JAS rainfall and MASST over the Indian and Atlantic oceans, respectively

Conclusion

From this work, it is possible to use the relationship between the sea surface temperature over global oceans and rainfall in the Sahel and Sudan savanna regions in Nigeria to predict seasonal rainfall as early as possible. This is a big way forward since from the method it is possible to know: (i) whether the rainfall will be normal, below or above normal and (ii) the amount of expected rainfall. This will allow us to know the amount of runoff.

References

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