The significance of the Mediterranean Sea to global climatology

by

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One can say that — " Climate affects Food Production. Food Production affects People. People affect Energy Use. Energy Use affects Climate ". Further, " We neglect any link in this chain at our peril ". The Third Annual Report to the President and Congress of the National Advisory Committee on Oceans and Atmosphere [NIERENBERG, *Chairman*, 1974] goes on to say that " *The possibility of inducing global climate change is not out of the question* ". The growing consumption of energy and the absorption of that energy into the upper layers of the oceans is all the more reason why the " ocean-atmosphere link is so important for climate. "

NEWMAN & PICKETT, 1974 (*Science*, V186, no. 4167) have looked into climatic requirements of staple crop production. Much of the world's production of staple food grains are in regions with alternate wet and dry seasons where seasonal precipitation, maximum solar radiation and temperatures are *in phase*.

An out-of-phase relationship is not conducive to great crop production. Marginal areas for cultivation have climatic variations which include drought and short growing seasons. There are zones where the *in-phase* relationship is marginal and where the ideal productive balance can be upset by extreme drought or excessive precipitation. For example, the northern half of Africa, where steep geographic gradients from humid to arid conditions exist, is vulnerable to crop failure. Climatologically, this is a case where annual isotherms and isohyets (rainfall) parallel each other. The migration of these isopleths sets up a precarious *in-phase* relationship.

Annual isopleths of temperature and rainfall are more or less parallel throughout most of continental Europe and northern Asia although the gradients are less steep and well-defined as those of North Africa. In contrast the isotherms and isohyets of the American continents are normal to each other, particularly within mid-continents. These continental differences may be explained, in part, in the orientation of the major mountain ranges where, in the Americas, the north-south orientation promotes the transport of moist air deep into mid-continent. Climatic risk is great in the Old World continents where the moisture transport is oriented more or less west to east.

The Mediterranean Sea lies between the major continental masses of the Old World. It deserves to be taken into account in terms of climatic risk to the disposition of temperature-moisture gradients. Storage of heat is brought about through westward flow, into the Atlantic Ocean over the Gibraltar Sill, where Mediterranean water with greater than normal heat and salt content sinks to great depths. The westward flow is comparable in volume transport to the eastward flow immediately above carrying Atlantic water into the Mediterranean. Temperature and moisture balances are maintained by way of influence over the Eurasian and African climates.

The Mediterranean Sea is an area of cyclogenesis and it is an evaporating basin. None of the fresh water draining into the Mediterranean basin is carried westward into the Atlantic. With a drainage area so vast that it stretches from the Equator to 60° North latitude, the water is removed by evaporation and carried aloft to be re-cycled or transported away. In-flowing North Atlantic water gives evidence of additional evaporation with an increase of salt concentration from 36.45 ‰ to 38.45 ‰. For the present

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one may assume climatic stability but the obvious dependence of the continents upon the Mediterranean Sea and its drainage basin as a moisture source and temperature modifier makes that assumption a temporary one and geologic history refutes it. Systematic observation is needed.

Fortunately, for this purpose, the Mediterranean is amenable to observation and detection of changes on a climatological scale provided that seasonal noise of the local environment can be screened out. For instance, there have been demonstrations of correlation between the salinity variations of the Adriatic Sea and the sea-ice population about Greenland. Also, the sensitivity of the Mediterranean water off Gibraltar, where a large-scale mixing process takes place, is such that the effects of the rise and fall of tide in the Bay of Cadiz can be detected and even traced across the Atlantic where it has been observed in recent Mode experiments.

A long-term series of deep observations off Bermuda have shown that the deep water has had a turning-point year in 1970, becoming cooler and fresher. With the ocean's effect on climate well-demonstrated, a system of long-terme series of observations deserves to be set up and maintained in the Mediterranean Sea.

The nature of a long-term observational program requires dogged faith and persistence. It is vulnerable to boredom and expense. However, if established reference stations are recognized as indices for manifold purposes, their justifications need not be difficult.