21 FEBRUARY 2001 : UNDERSTANDING THE INDIAN OCEAN AND ITS INFLUENCE ON CLIMATE

Professor D Anderson, ECMWF - Introduction to the oceanography of the Indian Ocean region - sta@ecmwf.int

The indian ocean exhibits much larger variability in its current structure than any other ocean. In this talk an outline of the major current systems, the Somali current, the Wyrtki jets, the transient and reverse undercurrents, the Leewin current and the Indonesian throughflow will be given. The role of planetary and Kelvin waves in controlling many of these currents, and their interannual variability will be discussed. Despite being poorly observed, some picture of the Indian ocean's role in climate is beginning to emerge.

Professor J Slingo, University of Reading - Introduction to the meteorology of the Indian Ocean region - j.m.slingo@reading.ac.uk

The role of the Indian Ocean region as a primary heat source for the global circulation will be presented. The particular geography of the Indian Ocean region leads to a strong seasonal cycle which is characterised by the Australian and Asian Summer Monsoons. The mean seasonal evolution of the atmospheric circulation over the Indian Ocean will be described, as well as subseasonal weather variations, such as monsoon active/break cycles and tropical cyclones. The interannual variability of the monsoons has a profound effect on rainfall for countries surrounding the Indian Ocean, such as India and East Africa. The factors that influence these year to year variations, particularly El Nino, will be introduced.

Dr E Whitcombe, Royal Hospital for Neuro-disability - Monsoon and mortality: Variations on an Indian theme - EWBKRM@aol.com

The great famine years of the late 19th century in British India were characterized not only by exceptional mortality but also by extreme climatic variation: unusually prolonged high temperature interrupted by violent rains. The events of two such 'extreme' years in contrasting regions of the south-east and north-west of the Indian subcontinent, reconstructed in detail from contemporary meteorological and medical records, are the point of departure for our systematic study of seasonal variation in climate and in disease in South Asia, with special reference to cholera and malaria, 1875-1900. We show, from an analysis of monthly meteorological and medical observations, characteristic regional patterns of seasonal variation in climate and in mortality and how we propose to expand this analysis into a database for British India 1860-1940 for use in simulation and prediction.

Professor P Webster, University of Colorado - Exploring the interaction of the ocean and the atmosphere in the Indian Ocean regime - pjw@oz.colorado.edu

Observational studies have shown that the Asian-Australasian monsoon system exhibits variability over a wide-range of space and time scales. These variations range from

intraseasonal (20--40 days), annual, biennial (about 2 years), longer term interannual (3--5 years) and interdecadal. Despite this range of variability, the South Asian monsoon (at least as described by Indian precipitation) exhibits a smaller range of variability during its summer pluvial phase than variability exhibited in other climate systems of the tropics. For example, drought or flood rarely extend to multiple years, with rainfall oscillating biennially from slightly above average to slightly below average precipitation.

We argue that variability of the monsoon is regulated by negative feedbacks between the ocean and the atmosphere. The annual cycle of the heat balance of the Indian Ocean is such that there is an ocean heat transport from the summer hemisphere from the summer hemisphere resulting principally from wind-driven Ekman transport. Given the configuration of the low-level monsoon winds, the Ekman transport is in the opposite sense to the lower tropospheric divergent wind. The cross-equatorial ocean heat transport is large with amplitudes varying between +2 PW (northward) in winter and --2 PW (southward) in summer. Thus, the wind-induced heat transport works to cool the summer hemisphere upper ocean while warming the winter hemisphere.
Similar regulation occurs on interannual time scales. For example, during anomalously strong northern hemisphere monsoon summers (typically a La Nina), strong winds induce a stronger than average southward flux of heat. When the monsoon is weak (typically an El Nino), the wind-driven ocean heat flux is reduced. In this manner, the monsoon regulates itself by reducing summer hemisphere sea-surface temperatures during strong monsoon years and increasing it during weak years. In this manner, the monsoon is self regulating.

It is noted, however, that the ocean heat transport theory of monsoon regulation does not necessarily allow heat anomalies to persist from one year to the next. Furthermore, the theory does not include the Indian ocean dipole as a dynamic entity. Finally, we develop a more general theory in which the slow dynamics of the dipole are integral components of a sequence of processes that regulate the monsoon, thus minimizing radical year to year departures of the monsoon from climatology.

Dr D Lawrence, University of Colorado and University of Reading - Results from the Jasmine experiment - dml@met.reading.ac.uk

The intraseasonal variability of the south Asian monsoon is an important component of the monsoon system, largely controlling the large-scale oscillations between active and inactive (or break) phases over south Asia. The Joint Air-Sea Monsoon INteraction Experiment (JASMINE), held in the Indian Ocean during the summer of 1999, was designed as the first comprehensive study of the coupled ocean-atmosphere system in the eastern Indian Ocean and the southern Bay of Bengal. Observations made during the field phase of JASMINE sampled both prolonged break and active phases of the monsoon resulting in an unprecedented amount of research quality data defining the atmospheric and ocean state during intraseasonal transitions of the monsoon.

Dr E Black, University of Reading - An observational study of the relationship between Indian Ocean temperatures and East African rainfall - emily@met.reading.ac.uk

In 1997-1998, Indian Ocean sea surface temperatures were unusually high off the African coast and low near Sumatra. This resulted in the reversal of the normal climatological gradient in Indian Ocean SST - with the SST increasing from east to west rather than from west to east. We present an analysis of 128 years of SST data which puts the 1997-8 event in the context of long-term variability in Indian Ocean SST. It is shown that the evolution of a strong, reversed SST gradient often coincides with high East African rainfall. For example such a pattern in SST developed in 1961 - the same year as devastating floods in Kenya. Thus, improved understanding of this Indian Ocean phenomenon may lead to greater predictability of rainfall on the surrounding continents.

Dr L Ferranti, ECMWF - Seasonal forecast studies of the extreme East African rainfall of 1997 - lferranti@ecmwf.int

How well east African rainfall anomalies of autumn/winter 97/98 were predicted by the ECMWF seasonal forecast? The role of anomalous sea surface temperatures in forcing changes in the east African climate is investigated by means of atmospheric model response experiments.

Dr D Conway, University of East Anglia - Extreme flooding events and lake level changes in East Africa: Recent events and historical precedents - d.conway@uea.ac.uk

Towards the end of 1961 an extreme rainfall event occurred that extended over much of East Africa stretching across the Indian Ocean to India. This event caused widespread flooding, rapid and prolonged increases in the levels of many lakes in East Africa and significant economic disruption. During the last few months of 1997, in a similar fashion to 1961, heavy rainfall caused flooding across East Africa. This paper will assess the spatial and temporal nature of both events and survey the historical records for other events with similar characteristics. An analysis of the effects upon Lake Victoria levels and river flows in the region, particularly in the Nile and Congo river basins, is presented