Simulations of the 2001 Indian Summer Monsoon Onset with a General Circulation Model

M. Bollasina[a], L. Bertolani[a] and G. Tartari[b]

[a]*Climate Research Division, Epson Meteo Center, Milan, Italy (massimo.bollasina@epson-meteo.org)*

[b]*Water Research Institute, National Research Council, Milan, Italy*

Abstract: Land-atmosphere interactions, in terms of heat and moisture fluxes, are very important processes in the evolution of the Indian monsoon. A series of sensitivity experiments was conducted with a general circulation model of the atmosphere in order to study the influence of vegetation and soil characteristics on the onset of the Indian summer monsoon. Differences in model results are analysed, both in terms of general circulation features and precipitation distribution. The results confirm that the detailed specification of surface boundary conditions is crucial and lead to great differences in the evolution of the monsoon. Soil and vegetation prescription, however, seems to act in a complex and quite conflicting way and can result dissimilar to observations in specific regions.

Keywords: General circulation model; Monsoon; Sensitivity study

1. INTRODUCTION

The Asian summer monsoon is one of the more studied processes with general circulation models. It has been recognized that monsoon evolution is strictly dependent on land surface boundary conditions [e.g., Fennessy et al., 1985; Douville et al., 2001]. A proper GCM representation of the complex interactions between land and atmosphere is still to be completely improved. The goal of this study is to establish the ability of the CEM GCM (Centro Epson Meteo General Circulation Model) in simulating the basic features of the Asian summer monsoon during the onset phase (May-June). Sensitivity analysis to the specification of heterogeneous land characteristics (vegetation fraction and soil types) is performed.

2. MODEL CHARACTERISTICS AND SIMULATIONS OF THE INDIAN MONSOON

The CEM GCM is based on the National Centers for Environmental Prediction (NCEP) Global Spectral Model (GSM), adapted to run on Compaq Alpha XP1000 computers. The model physics is based on the 1997 NCEP Medium Range Forecast model [Roads et al., 1999] and includes: a three-layer soil model, parameterisation of large-scale and convective precipitation, gravity wave drag, radiation-cloud interaction. The vertical coordinate of the model, widely used in global and regional models, is the sigma coordinate [Philips, 1957], and the spacing is prescribed such that higher resolution is obtained near the earth surface and at the tropopause (assigning a value of 1000 hPa to surface pressure, 8 levels are below 800 hPa and 7 levels above 100 hPa).

CEM GCM was run at T62 horizontal resolution (about 200 km) and with 28 unevenly spaced sigma vertical levels, and a time step of 20 minutes. Physical processes were computed every time step, except for radiation calculations (every three hours). Ensemble lagged simulations were performed starting from 00Z of 2/3/4/5 May 2001 until the end of June. The initial conditions were provided by NOAA GDAS 1° x 1° global gridded analysis, interpolated on the 192 x 94 gaussian grid. The model was forced with weekly observed sea surface temperature (SST) provided by NCEP.

A number of sensitivity experiments (each set being the average of the four simulations) was performed to study the influence of employing heterogeneous boundary conditions at the surface: 14 vegetation classes and 12 soil types. Vegetation types on the gaussian grid were obtained from Matthews [1983], while soil types were derived from Wilson and Henderson-Sellers [1985]. To characterize vegetation in the model, the vegetation fraction is specified using the International Satellite Land Surface Climatology