Abstract

A numerical experiment examing the transient response of climate to a gradual increase in atmospheric CO_2 concentration at a compound annual rate of 1 % has been performed with a coupled atmosphere-ocean general circulation model (CGCM) developed at the Meteorological Research Institute (MRI). The model is characterized by two aspects; a relatively high resolution of the oceanic component in the low latitudes to simulate El Niño phenomena and an elaborate sea ice model to simulate seasonal variations in sea ice coverage and thickness.

Time integration has been performed up to 70 years in the future over which time the CO_2 concentration doubles. The globally averaged surface air temperature increases 1.6 °C during this period. The atmospheric response to the CO_2 increase is slow in the Southern Hemisphere and over oceanic areas. However, the surface air temperature increase in the high latitudes in the Northern Hemisphere is not dominant until year 50. This speed of CO_2-induced warming is affected by interdecadal variations of sea ice found both in the transient and in the control runs. It is also suggested that leads in sea ice act as a strong negative feedback on changes in sea ice volume, affecting the timing of the warming.

Analysis of sea surface temperature shows that the dominant air-sea coupled mode in the model is very close to what is observed. This mode shows interannual variations in the Pacific with a dominant period of about 6 years, which is close to the typical time scale of El Niño. It also shows variations of interdecadal time scales, with implication of predictability over a few decades.