A comparative study on cloud radiative forcing over Sri Lanka and Indian monsoon region

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ABSTRACT

Total and high clouds are comparatively less over Sri Lanka compared to Bay of Bengal. Though the clouds over Sri Lanka and Bay of Bengal are of similar height, the cloud optical thickness is less over Sri Lanka when compared to Bay of Bengal. The subsidence appears to suppress the cloud growth over Sri Lanka. During summer monsoon season only middle and high clouds are present over Sri Lanka, possibly advected from faraway places by tropical easterly jet. The magnitudes of shortwave CRF (Cloud Radiative Forcing) and longwave CRF are less when compared to Bay of Bengal but equal in magnitude. Hence near cancellation of shortwave CRF and longwave CRF is found over Sri Lanka. The CRF components show a strong seasonal cycle over Bay of Bengal but such seasonality is absent over Sri Lanka. Among the middle and high clouds, altocumulus, cirrus and cirrostratus are predominantly over Sri Lanka. It is found that cirrus and cirrostratus clouds influence the NCRF (Net CRF) over Sri Lanka but the influences are opposite in nature. Present study suggests that as the cirrus cloud cover increases, the NCRF is tending to be positive. But in case of cirrostratus, increase in cloud cover leads to higher cooling. Complex interaction between these two clouds with radiation may be the cause for the observed near cancellation of shortwave CRF and longwave CRF over Sri Lanka.

1. Introduction

Clouds exert a large influence on the radiation budget of the earth-atmosphere system. They reflect a fraction of the incoming solar radiation and thereby cool the system and trap a fraction of the outgoing longwave radiation and thereby warm the system. Clouds of different types, cloud top heights, cloud fraction and micro-physical properties influence the radiance balance differently. For example, net cloud radiative forcing is negative over the sub-tropical low cloud regions, positive over regions covered by cirrus clouds, near zero over the tropical deep convective clouds and negative over the Indian summer monsoon region *(Kiehl and Ramanathan, 1990; Kiehl 1994; Rajeevan and Srinivasan, 2000; sathiyamoorthy et al, 2004).*

By affecting micro and macro-physical properties of the clouds, prevailing atmospheric circulation over a region is found to influence the radiation budget (e.g. *Sohn and Smith, 1992; Bony et al, 1997)*. Earlier studies pointed out that the unusual subsidence motion occurred during 1998 El Nino reduced the cloud top height and thereby influenced the net cloud radiative forcing (NCRF) over the Western Pacific warm pool region. *Sathiyamoorthy et al (2004)* suggested that the horizontal spreading of Asian summer monsoon cloud tops by the strong wind shear associated with the upper tropospheric tropical easterly jet stream increases the cloud cover amount which helps to reflect the solar radiation more effectively. Increased reflection leads to an unusual cooling by clouds over the Asian Monsoon Region (AMR). By this way, the tropical easterly jet has a profound influence on the radiation budget over the Asian monsoon region. *Bony et al (1997)* showed that the changes in large scale vertical motion accompanying sea surface temperature (SST) changes is the reason behind the strong dependence of shortwave cloud radiative forcing (SWCRF) and longwave cloud radiative forcing (LWCRF) to SST.

Several observational and modeling studies were made to understand the climate sensitivity feedback process of the clouds. Some of them pointed out that there is a large spread of cloud feedback among the climate models that may be a major source of uncertainty for climate sensitivity estimates *(Cess*