Cloud climatology from ISCCP data

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1. Introduction

Clouds are crucial component of Earth's climate due to their important role in the radiative balance and hydrological cycle. Cloud climatologies have been developed from two types of data sources; one from satellites and the other from ground-based and aircraft observations. The ground-based and aircraft data is greatly limited by the amount of temporal and spatial coverage compared to satellite observations that provide continuous data over entire globe across the wide range of spatial and temporal scales. Most of the earlier cloud climatologies derived from surface observations (Eastman et al., 2011) and satellite data (Miller and Feddes, 1971) have reported on the cloud amount only, while studies of other cloud properties such as cloud top temperature climatology are lacking. Nonetheless, changes in cloud-type (such as cloud-top height and water content) may well affect radiation field as much as variations of cloud amount (Chen et al., 2000)**.** The radiative forcing of variety of cloud types is different (Hartmann et al., 1992) depending on the properties of clouds namely thickness, height, water or ice content and shape. For example, the abundant low-level clouds provide the largest contribution to the net energy balance of the Earth on a global average basis, thereby exerting strong cooling effect due to high albedo (Hartmann et al., 1992), while mid-level clouds display varied radiative effects (Sassen and Wang, 2012). Based on the above scientific background, climatology of cloud amount and cloud top temperature from International Satellite Cloud Climatology Project (ISCCP) data is studied for both low-level and mid-level clouds in the present paper.

2. Data

The International Satellite Cloud Climatology Project (ISCCP) (Rossow and Schiffer, 1999) D2 data is used, which provides global monthly cloud type amount and other cloud characteristics reported in a 280-km equal area box from July 1983 to December 2009. The cloud amount (%) represents the fractional area covered by clouds as observed from the satellites. The cloud amount is estimated by evaluating each pixel of 5 km across for a particular level by counting the number of pixels that are marked as cloudy and dividing by the total number of pixels in a region of about 280 km across. Low-level and mid-level clouds are classified using their radiance-derived cloud top pressure as per ISCCP cloud classification (http://isccp.giss.nasa.gov/cloudtypes.html). A detailed description about the classification of clouds and cloud amount computation at High, Mid and Low levels is available from the ISCCP report (http://isccp.giss.nasa.gov/ products/products.html).

The climatology of cloud amount and cloud top temperature based on the period 1984-2009, for four seasons defined as average over December-January-February (DJF), October-November (ON), June-July-August-September (JJAS) and March-April-May (MAM) is obtained in this study.

3. Results

Climatology of cloud amount is illustrated over 0-360°; 40°S-40°N for four seasons namely MAM, JJAS, ON and DJF respectively in Figure 1, I(a-d) for low-level clouds and in Figure 1, II(a-d) for mid-level clouds. Likewise, cloud top temperature climatology is shown in Figure 1, III(a-d) and Figure 1, IV(a-d) for low-level and mid-level clouds respectively. Cloud amount climatology of low-level and mid-level clouds during all the four seasons reveal predominance of low-level clouds over the ocean while mid-level clouds dominate over the land, except during JJAS season, when mid-level clouds are present over tropical oceans also. Seasonal variations in low-level cloud amount are small, except over North America, North Africa and Australia (Figure 1, I(a-d)). Mid-level cloud amount demonstrates seasonal variations only over North America and Asia (Figure 1, II(a-d)).

Cloud top temperature climatology of both low-level clouds (Figure 1, III(a-d)) and mid-level clouds (Figure 1, IV(a-d)) indicates high temperatures (270 K- 280 K) over tropics, with seasonal movement of clouds having high top temperature toward mid-latitude in the respective summer hemisphere. Considerable seasonal changes in cloud top temperature of low-level clouds over North America, North Africa, Asia and Australia are evident (Figure 1, III(a-d)).

References

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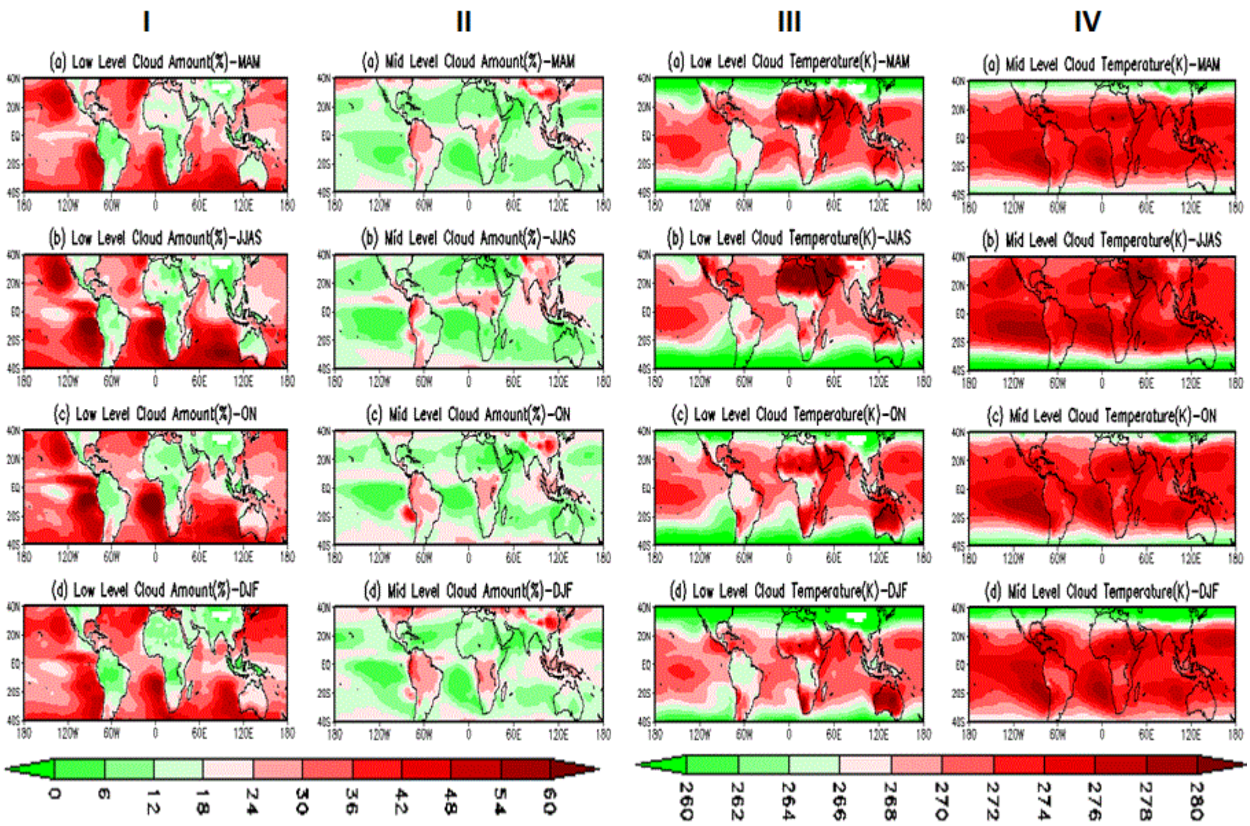

Figure 1.
I. Spatial plot of climatology of low-level cloud amount (%) averaged over four seasons :
(a) March-May (MAM) **(b)** June-September (JJAS) **(c)** October-November (ON) **(d)** December-February (DJF)
II. (**a, b, c, d**). same as Figure 1 (I a, b, c, d) respectively except for mid-level cloud amount.
III. (**a, b, c, d**). same as Figure 1 (I a, b, c, d) respectively except for low-level cloud top temperature.
IV. (**a, b, c, d**). same as Figure 1 (III a, b, c, d) respectively except for mid-level cloud top temperature.