

Vertical coupling by convections over the Indonesian maritime continent

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Observations have shown that surface insolation, tropospheric cloud activity and stratospheric gravity waves take maxima over the Indonesian maritime continent (IMC). The cloud activity has diurnal and annual cycles dominantly on land, in contrast to intraseasonal and interannual variations mainly over oceans. The diurnal-cycle local circulation cell has a horizontal scale of around 100 km, and each major island and the whole IMC have zonal scales of 1,000 and 5,000 km, respectively. 14-year hourly 25 km-resolution cloud-top height data are analyzed to show spectral slopes of around -2 for frequency, and -5/3 and -3 respectively for higher and lower zonal wavenumbers (with a border of about 400 km in zonal wavelength), as have shown already for gravity waves.

Theoretically the insolation may excite two categories of diurnal/annual cycles in the atmosphere. One has globally continuous (day-night and summer-winter hemispheric) phase structure as tides and seasonal marches, and the other has local/regional phase structures mainly due to heat contrasts around coastlines as sea-land breeze and monsoon circulations. All of them are interacted with each other (also with equatorially symmetric Hadley circulation) over the IMC. For example, on land, clear sky from sunrise until noon permits maximum heating by insolation and makes rainy season in the hemispheric summer. The parasol effect is suppressed, because clouds are active on land in the evening. A boreal winter monsoon surge intensifies the northern Hadley cell and also diurnal-cycle rainfall in the austral summer rainy season.

The diurnal-cycle local circulation cell is a superposition of upward and downward propagating gravity waves, and the upward component is propagated toward the stratosphere. The tall cloud tops of conditionally unstable troposphere push the tropopause upward and generate gravity waves in the strongly stable stratosphere.

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