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Circumglobal wave train and the summer monsoon over South Asia: The explicit role of the surface heat low

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This study examines the influence of mid-latitude circulation on the surface heat low and associated monsoon rainfall over South Asia using the ERA40 data. A heat low index is defined to depict the surface heat low which forms over Pakistan and adjoining areas of India, Iran and Afghanistan during the summer season. The heat low divulges significant correlations with the upper level 200 hPa geopotential height anomalies over western central Asia and East Asian region and acts as a bridge connecting the mid-latitude wave train to the Indian summer monsoon.
During the positive phase of the mid-latitude circumglobal wave train, anomalous upper level high pressure develops over western central Asia. The subsidence associated with the anomalous high reduces the surface pressure in the heat low by raising the mean air temperature and anomalous uplift in the middle and lower troposphere. The increasing middle tropospheric temperature creates an inversion between the lower and upper troposphere which consequently restricts the middle and low level cloud formation above the heat low. Further, the upper level subsidence also minimizes the high cloud cover above the heat low region and hence favors more solar radiation to this area. The accruing surface heating reduces the surface pressure, resulting in further intensification of the heat low and associated monsoon circulation. Moreover, the westward accruing surface air temperature shifts the anomalous core of the heat low to the West over Iran. The westward shift in the anomalous core of the intensified heat low with its north-south orientation provokes enormous north-south pressure gradient (lower pressure over land than over sea). This in turn enables the moist southerly flow from the Arabian Sea to penetrate farther northward over northwestern India and Pakistan, where convective heating and orographic lifting expedites the convection and hence the precipitation.
Composite analysis reveals a dipole teleconnection pattern in the 200 hPa geopotential height anomalies with one center of action over western central Asia and another over northwestern China and Mongolia. This dipole is associated with the active and breaks monsoon on interannual timescale. The results presented in this study have important implications for seasonal prediction of summer monsoon over South Asia.