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Application of dynamic meso-scale model to study atmospheric features and air pollution dispersion in Sri Lanka

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ABSTRACT

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During the Northeast monsoon (NEM) in Sri Lanka thunderstorm activities are concentrated to the southwest corner of the island. The lightning data measured by Lightning Locating Project (LLP) in February 1999 and by Lightning Imaging Sensor (LIS) project (NASA) give sufficient evidence on this. Though the heaviest precipitation in NEM is reported in the windward side, the eastern and northeastern regions, lightning flashes appear as banners over lee side of the central mountain area. The flashes are much more frequent over the land, but appear mostly in the late afternoon with a maximum around 18 LST. Numerical simulations by a higher-order closure numerical model show the evidence of lightning flashes occurrence within the lee-side wake. A counter rotating vortex pair is often evident in the wake. The formation of positive and negative vortices shows a diurnal variation. The incoming trade wind splits at the upstream region, tends to flow around the mountain massif and forms a convergence area over the lee side. A reversed flow is visible in between the vortex pair at some hours enhancing the convergence. This convergence area is clearly visible over satellite images. According to the model simulations significant precipitation occurred over the convergence area. Two case studies for day-time and night-time show the relationship between the lightning banners and the convergence area of the wake. During the NEM, the stability of the lowest part of the atmospheric boundary layer (BL) over the sea is statically neutral or weakly stable. Friction in combination with vorticity causes vertical winds. The effect of the combination of vorticity and vertical velocity can be expressed by the helicity. It is shown that potential vorticity and the helicity calculated from positive vorticity and related positive vertical wind agrees in time, space and strength with the lightning flash occurrence both out over the sea and the land. Further the possibility of severe thunderstorm environment is examined through weather indices, K-index and SWEAT index. Dispersion of air pollutants in NEM is analyzed and the effect of wake and vortices on pollutant concentration is examined in the same case studies.