Geophysical Research Abstracts
Vol. 13, EGU2011-4149, 2011
EGU General Assembly 2011

The Diurnal Variation of the Persian Gulf Summertime Low Level Jet

Evangelia-Maria Giannakopoulou (1) and Ralf Toumi (2)

(1) Imperial College London, Department of Physics, SPAT group, London, United Kingdom (e.giannakopoulou08@imperial.ac.uk), (2) Imperial College London, Department of Physics, SPAT group, London, United Kingdom (r.toumi@imperial.ac.uk)

Although the summertime low-level jet (LLJ) over the Persian Gulf, known as Shamal, is well-documented theoretically, few observational and numerical studies have been performed during the past five decades to explain its development. In this study, the Weather Research and Forecasting (WRF) model accurately simulates the LLJ's vertical structure, nocturnal features and strong diurnal variation of the wind maxima (25 m/s) at 300-500 m levels. The one-way nested simulation with the highest horizontal resolution of 3 km also provides compelling evidence of the strong clockwise rotation of the wind direction. The north-westerly LLJ frequently occurs over the mid-Gulf and is oriented parallel to the coastal mountains, while the Zagros Mountains in Iran serve as a barrier.
The case study period can be divided into a spatial extensive period (strong winds over the Gulf and Iraq) and a less-extensive period (strong flow only over the Persian Gulf). Results from a control simulation appear to confirm a previously proposed theory regarding the LLJ inertial oscillation due to frictional decoupling. Although the inertial ageostrophic wind oscillation explains the periodic night-time wind maximum, it does not provide the only physical mechanism responsible for the Shamal characteristics. Orography, mountain slope and land/sea-breeze account for the Shamal diurnal wind direction. The results from a zero terrain height experiment reveal the importance of the daily heating and cooling of the Iranian sloping orography that controls, for the whole study period, the diurnal cycle of the wind direction. The Zagros Mountains not only provide a barrier for blocking the north-westerly winds but also block the easterly monsoon airflow which maximizes the wind speed.
This case study also extends an existing theoretical study in order to understand how and in what amount the Zagros Mountains' slope and width affect the Shamal flow. Both novel Gaussian terrain experiments (with shallow and steep slopes) feature a jet-like flow over the Persian Gulf. Only during the less-extensive period does the Iranian Mountains' slope significantly affect the Shamal. The steep slopes cause larger wind speeds by stronger blocking. However, the shallow slopes reveal a stronger diurnal varying wind direction due to larger heating and cooling of the sloping terrain. It is also shown that during the less-extensive period, the land-breeze and the lower friction over the sea increase the intensity of the LLJ over the Gulf. The land and sea-breeze circulations also modulate the LLJ behaviour in terms of the diurnal changes in the zonal geostrophic wind component. This is significantly different from the widely-studied Midwest LLJ.