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Investigation of sea breeze and foehn in the Dead Sea valley with remote sensing observations and WRF model simulations

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The atmospheric dynamics in the Dead Sea Valley has been studied for decades. However, the studies relied mostly on surface observations and simple coarse-model simulations, insufficient to elucidate the complex flow in the area. In this seminar I will present a first study using high resolution (temporal and spatial) and sophisticated both, measurements and modeling tools. We focused on afternoon hours during summer time, when the Mediterranean Sea breeze penetrates into the Dead Sea Valley and sudden changes of wind, temperature and humidity occur in the valley.

An intense observations period in the area, including ground-based remote sensing and in-situ observations, took place during August and November 2014. The measurements were conducted as part of the Virtual Institute DEAd SEa Research Venue (DESERVE) project using the KITcube profiling instruments (wind lidars, radiometer and soundings) along with surface Energy Balance Station. These observations enabled analysis of the vertical profile of the atmosphere at one single location at the foothills of Masada, about 1 km west of the Dead Sea shore.

High resolution (1.1 km grid size) model simulations were conducted using the Advanced Research Weather version of the Weather Forecast and Research mesoscale model (WRF). The simulations enabled analysis of the 3D flow at the Dead Sea Valley, information not provided by the observations at a single location. Sensitivity tests were run to determine the best model configuration for this study.

Our study shows that foehn develops in the lee side of the Judean Mountains and Dead Sea Valley in the afternoon hours when the Mediterranean Sea breeze reaches the area. The characteristics of the Mediterranean Sea breeze penetration into the valley and of the foehn (e.g. their depth) and the impact they have on the boundary layer flow in the Dead Sea Valley (e.g. sudden changes in temperature, humidity and wind) are conditioned to the daily synoptic and mesoscale conditions. In the synoptic scale, the depth of the seasonal pressure trough at sea level and the height of inversion layers play a significant role in determining the breeze and foehn characteristics. In the mesoscale, the intensity of the Dead Sea breeze and the humidity brought by it determines the

outcomes at the time of Mediterranean Sea breeze penetration and foehn development. Dynamically, the foehn is associated with a hydraulic jump.

Hypothetical model simulations with modified terrain and with warmer Mediterranean Sea surface temperature were conducted to reveal the relative contribution of each of these factors and of their synergism on the observed phenomena. The information provided by the factor separation study can be useful in future climate projections, when a warmer Mediterranean Sea is expected.

The forecasting feasibility of foehn and the sudden changes in the Dead Sea valley 24 hours in advance using WRF is suggested following the present study. These forecasts can be most valuable for the region affected by pollution penetration from the metropolitan coastal zone.