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Low tropospheric wind profile diurnal regimes during winter and spring according to ICON-LAM and Doppler wind profiler at a desert site

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StreamLine XR Doppler LiDAR measurements during the four months of January-April 2022 provided first time high resolution temporal and spatial measurements of the boundary layer wind profile variability over Sde-Boker, located in the central Negev desert. This work presents characterization and comparison of the daily low tropospheric wind profile according to measurements and simulations with the new regional ICON-LAM (ICOsahedral Nonhydrostatic weather model in a Limited Area Mode) model with a convection-permitting resolution of ~2.5 km.

Two main regimes of daily wind profile are observed:

- “Regular days”, with no sharp wind direction change. Most of these days present westerly component flow in the boundary layer (BL) up to 500-1000 m a.g.l, and typical daily variability of the boundary layer height (BLH) according to the solar heating with or without wind direction shear above the BL. Such events are mostly under high pressure from the West. Winter lows present strong (> 5 m/s) westerly flow with constant BLH.
- “Transitional days” presenting sharp wind direction change in the BL (at least 90° within an hour). Their frequency is ~ 30% during February-April, while during January single event occurred. The synoptic conditions present pronounced change in the synoptic gradients or mild synoptic gradients allowing the development of local mountain breeze. Mild gradients may occur under winter highs, Red Sea trough approaching winter lows and Sharav lows.

  Case studies of each group and their synoptic pressure gradients at the lowest troposphere (1000-500 hPa) are presented. The comparison between the model and measurements has temporal and vertical spatial resolutions of 1-hour and 100 m accordingly. Two sets of predictions from 12 UTC and 0 UTC initializations are separately applied.

  The absolute differences between the predicted and measured wind direction and speed are mostly up to 40 °and 3 m/s during the case studies. The predicted sharp wind direction transition times of the "transitional days" cases are 1-2 hours earlier than their measured counterparts. Due to this mismatch, large differences between the predicted and measured wind directions are observed (~ 100°). The 12 UTC initialization better predicts the transition times.

January-April monthly absolute mean errors (AME) of wind direction and wind speed are 7°– 40 ° and 0 – 3.6 m/s (events with speed > 1 m/s). The biases are mostly -15 °– 22 ° and -1 – 1 m/s. The model nicely reconstructs the variability of the wind profile.