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Earth System Dynamics
Discussions

Interactive comment on "Organization of Dust Storms and Synoptic Scale Transport of Dust by Kelvin Waves" *by* A. K. Pokharel and M. L. Kaplan

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Dear Sir/Madam,

We hereby submit our following responses in regards to comments/suggestion of 2nd referee on "Organization of Dust Storms and Synoptic Scale Transport of Dust by Kelvin Waves" to be considered for publication in Earth System Dynamics Journal as follows:

Referee comments (RC2) General and specific comments: This is an interesting work concerning the large-scale dust transport in the vicinity of mountain ranges and the organization of dust storms by Kelvin waves in sequence to evolving finer scale atmospheric processes. In my opinion, the authors have taken excellent attention into the evolution of different scales of motion and methodology details to infer the hypoth-

esis proposed for examination. This study is unquestionably a commendable effort with appropriate schematics to demonstrate the atmospheric processes (blocking of air near the mountains and mesoscale geostrophic adjustments in conjunction with geostrophic imbalances) and dust transport by Kelvin waves directed parallel to the mountain barriers. Relevant aspects of ESD are considered in this study with adequate figures and tables to substantiate the details. Also, the advanced modelling tools and datasets available are used for the analysis to substantiate the hypothesis proposed in this study. In all sense, I am fully convinced with the arguments and rationale presented in the study, and I do not really see any pitfalls in the reporting. Therefore, I recommend the manuscript for publication with a few minor concerns in figures for better clarity to the readers, given in the following. My minor concerns are: 1. Figures are little bit clumsy to decipher the details. Contours can be a bit smoother for clarity, and the colours could be lighter (e.g., Figure 6) 2. Section 2.1.1: Surface stations described in the study (lines 35-40) can be marked in Figure 3 similar to Figure 9. 3. For better reading in the vertical cross-section figures, locations can be marked with vertical line in tune with the text.

1 Referee comment: My minor concerns are: 1. Figures are little bit clumsy to decipher the details. Contours can be a bit smoother for clarity, and the colours could be lighter (e.g., Figure 6).

Our response: We appreciate your comments/suggestion. Figures have been clarified by adding additional information on them (e.g. Figures 6a, 6b, and 6c of the revised manuscript). Actually, contours in Figures 6a, 6b, and 6c are temperature contours plotted to show the strong temperature gradient over the region of interest. For this lower contour values are taken, which produce line more granularity and less smoothing. This kind of contours are quite helpful to see the strong temperature difference and the strong wind flow. On the other hand if we plot smooth contours with the help of higher values of contours they produce contour lines with more smoothing that appears less jagged, but won't meet our expectation of seeing a strong temperature gradient.

2 Referee comment: Section 2.1.1: Surface stations described in the study (lines 35-40) can be marked in Figure 3 similar to Figure 9.

Our response: We appreciate your suggestion. We have added new Figures 2b and 8b in the revised manuscript, and surface stations described in the study are marked on them.

3 Referee comment: For better reading in the vertical cross-section figures, locations can be marked with vertical line in tune with the text.

Our response: We appreciate your suggestion. We have marked locations in the vertical cross sections by the vertical lines to tune with the text (e.g. in new Figures 7a, 7b, 7g, 11a, 11b, and 11e of the revised manuscript).

Sincerely, Ashok Kumar Pokharel

Interactive comment on Earth Syst. Dynam. Discuss., https://doi.org/10.5194/esd-2019-28, 2019.

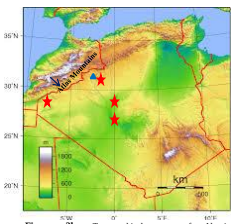

Figure 2b: Topographical map of Algeria (http://www.carte-algerie.com/carte-algerie/carte-topographique-algerie.jpg) in which the red star indicates surface stations (Bechar, Tindouf,Timimoun, and Adrar) which experienced the dust storms on 2 March 2004 (source: wunderground.com). The blue colored triangle indicates soundings station at Bechar in Algeria.

Fig. 1.

Figure 6

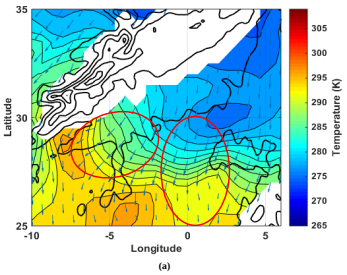

Fig. 2.

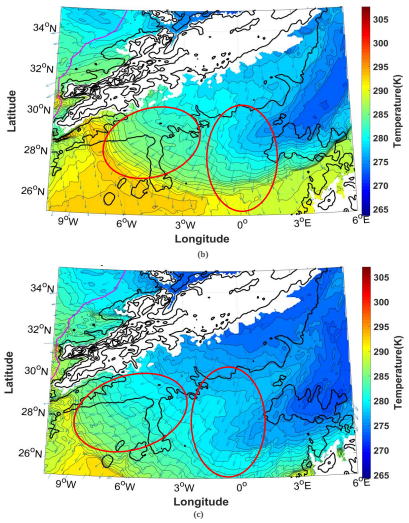

Figure 6 a. Temperature and wind speed/direction at 925 hPa on 1800 UTC March 2, 2004 (54 km resolution MERRA product) (Pukhare, 2016). Blue arrow lines indicate the wind flow. **b.** Temperature and wind speed/direction at 925 hPa on 1800 UTC March 2, 2004 (6 km resolution WRF product). Blue arrow lines indicate wind flow. The red circled areas represent the turning of the one wind component to the right in response to the Coriolis force and another component was turning to the left away from the mountains farther north and east as it goes south-southwestwards. **c.** Temperature and wind speed/direction at 925 hPa on 2200 UTC March 2, 2004 (6 km resolution WRF product). Blue arrow lines indicate wind flow. The red circled areas represent the turning of the one wind component to the right in response to the Coriolis force and another component was turning to the left away from the mountains farther north and east as it goes south-southwestwards.

Fig. 3.

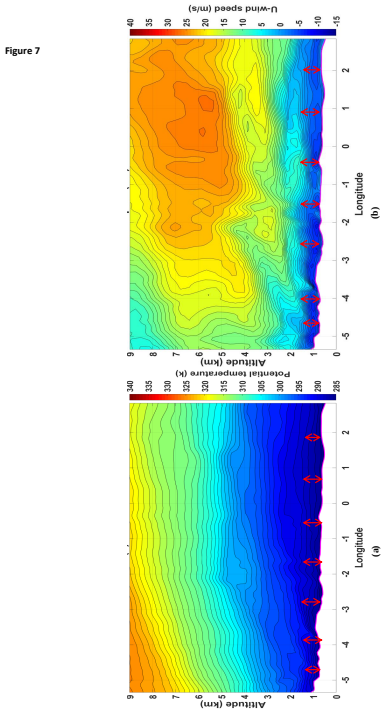
Figure 7
U-wind speed (m/s)
Longitude
(b)
Altitude (km)
Potential temperature (K)
Longitude
(a)
Altitude (km)

Fig. 4.

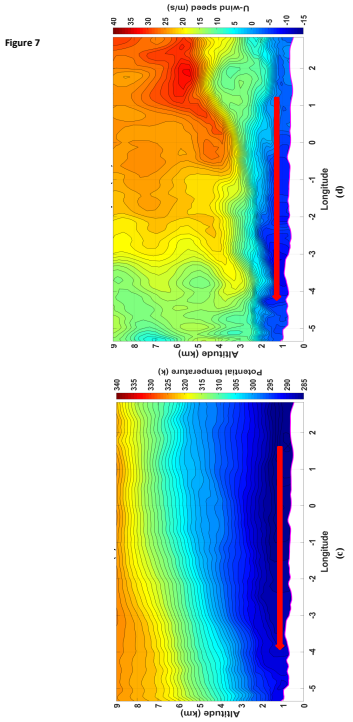
Figure 7
U-wind speed (m/s)
Longitude
(b)
Altitude (km)
Potential temperature (K)
Longitude
(c)
Altitude (km)

Fig. 5.

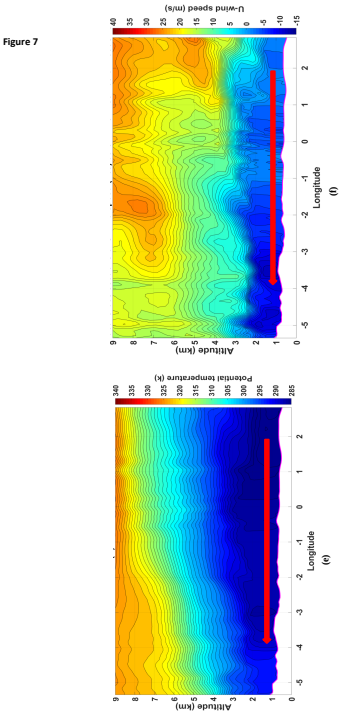

Fig. 6.

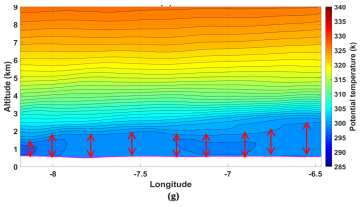

Figure 7 a. Vertical cross sections of potential temperature at 31.1˚ N on 0700 UTC March 2, 2004 (6 km resolution WRF product). Red arrows (up and down) indicate region of sinking of air column (blocking of air). **b.** Vertical cross sections of u-wind speed at 31.1˚N on 0700 UTC March 2, 2004 (6 km resolution WRF product). Red arrows (up and down) indicate region of blocking of air. **c.** Vertical cross sections of potential temperature at 31.1˚N on 1100 UTC March 2, 2004 (6 km resolution WRF product). Red arrow indicates generation of Kelvin waves (cold air surge). **d.** Vertical cross sections of u-wind speed component at 31.1˚ N on 1100 UTC March 2, 2004 (6 km resolution WRF product). Red arrow indicates generation of Kelvin waves. **e.** Vertical cross sections of potential temperature at 31.1˚N on 1500 UTC March 2, 2004 (6 km resolution WRF product). Red arrow indicates Kelvin wave (cold air surge) over time. **f.** Vertical cross sections of u-wind speed at 31.1˚N on 1500 UTC March 2, 2004 (6 km resolution WRF product). Red arrow indicates Kelvin wave over time. **g.** Vertical cross sections of potential temperature at 28.85˚N on 1500 UTC March 2, 2004 (6 km resolution WRF product). Red arrows (up and down) indicate warm air column of vertical stretch of isentropes.

Fig. 7.

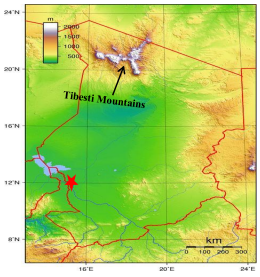

Figure 8b: Topographical map of Chad (https://www.pinterest.com.au/pin/510877151474548010). The red star in this map shows surface station at Ndjamena in Chad which captured the dust storms from 0600 UTC on December 8 to December 9, 2011 (source: wunderground.com) (Pokharel et al., 2017b).

Fig. 8.

Figure 11

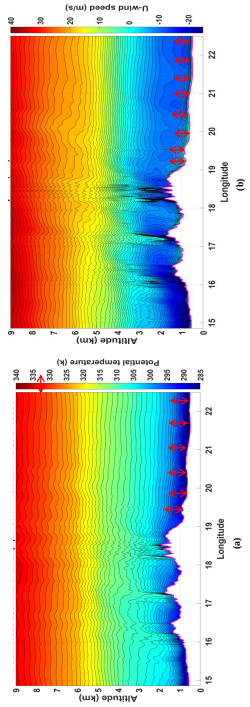

Fig. 9.

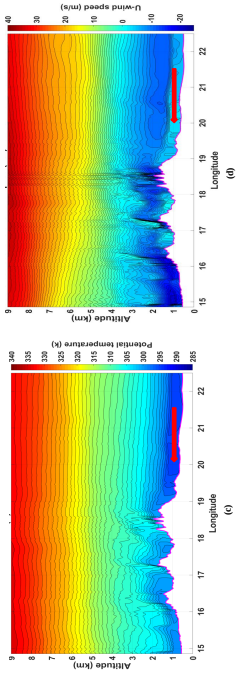

Fig. 10.

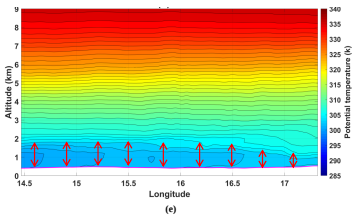

Figure 11 a. Vertical cross sections of potential temperature at 21.57˚ N on 0700 UTC December 8, 2011 (2 km resolution WRF product). Red arrows (up and down) indicate possible stability of the atmosphere. **b.** Vertical cross sections of u-wind speed at 21.57˚N on 0700 UTC December 8, 2011 (2 km resolution WRF product). Red arrows (up and down) indicate blocking of the air. **c.** Vertical cross sections of potential temperature at 21.57˚N on 1100 UTC December 8, 2011 (2 km resolution WRF product). Red arrow indicates Kelvin wave (cold air surge). **d.** Vertical cross sections of u-wind speed at 21.57˚ N on 1100 UTC December 8, 2011 (2 km resolution WRF product). Red arrow indicates Kelvin wave. **e.** Vertical cross sections of potential temperature at 18.89˚N on 1500 UTC December 8, 2011 (2 km resolution WRF product). Red arrows (up and down) indicate warm air column of vertical stretch of isentropes.

Fig. 11.