Observations of aeolian activity on the deflation floor of a foredune trough blowout

1. Introduction

Background
Blowouts in coastal foredunes provide efficient pathways for wind-driven sand transport inland. In this way, blowouts affect beach-dune sand budgets and facilitate landward dune migration under sea-level rise.

Problem definition
We have limited empirical data and understanding of the short-term (hours) aeolian activity in blowouts and how this activity builds up to longer term blowout dynamics. Data in Hesp and Pringle (2001) indicate that, in contrast to common belief, aeolian activity may not be limited to winds blowing parallel to the blowout axis but can occur for virtually all winds with an onshore component (180° wide arc).

1.1 Aim
To study the dependence of aeolian activity in a trough blowout on offshore wind speed and direction for a wide range of conditions.

2. Methodology

Field site
The study site is a trough blowout (Fig. 1a) in the foredune of Dutch National Park Zuid-Kennemerland (Ruessink et al., 2018). The blowout is rectangular in shape, with an ≈100 m-long and 25-m-wide deflation floor and steep, ≈10-m high lateral walls (Fig. 1b). The main blowout axis is 280°N.

Field data
The data used here was collected between October 10, 2022 and March 31, 2023 and consists of (i) photographs of the deflation floor taken by a time-lapse trap camera every one to two hours during the day, (ii) 10-min. average wind speeds and directions at 1-m height measured by 4 ultrasonic anemometers (SA1 to SA4 in Fig. 1b), and (iii) 10-min. wind speeds and directions (at 10-m height) from a nearby offshore meteorological station.

Conditions
During the 5.5-month study period offshore wind speeds ranged between 0.2 and 21.5 m/s. Winds approached the study site mostly from southern and southwesterly directions, and were thus highly oblique to the blowout axis but can occur for virtually all winds with an onshore component (180° wide arc).

3. Image classification

Based on Delgado-Fernandez and Davidson-Arnott (2011) and Hage et al. (2018), the aeolian activity in all good-quality images was manually classified in: (0) no activity, (1) traces, and (2) transport (Table 1). Classes (1) and (2) were subdivided in two subclasses based on the intensity of the aeolian activity. In total, 1,237 images were classified: (0) 733, (1) 226, of which 116 in 1a and 100 in 1b, and (2) 278, of which 158 in 2a and 120 in 2b.

<table>
<thead>
<tr>
<th>Class</th>
<th>Subclass</th>
<th>Activity</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>None</td>
<td>No aeolian activity; also not in a sequence of images.</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>a</td>
<td>Minor traces</td>
<td>Change in image sequence limited to small part of the deflation floor</td>
</tr>
<tr>
<td></td>
<td>b</td>
<td>Moderate traces</td>
<td>Change in image sequence on most of the deflation floor; migration of sand patches; no streamers (Fig. 1a)</td>
</tr>
<tr>
<td>2</td>
<td>a</td>
<td>Medium transport</td>
<td>A few individual streamers, sometimes together with unstructured sand patches (Fig. 2a)</td>
</tr>
<tr>
<td></td>
<td>b</td>
<td>Strong transport</td>
<td>Streamers on the entire deflation floor, often together with slipface-less, large-scale bedforms (Fig. 2b)</td>
</tr>
</tbody>
</table>

4. Main findings

4.1 The intensity of aeolian activity lessens for the most oblique angles (>70° from the blowout axis) because the wind increasingly bypasses the blowout.

4.2 For larger approach angles from the blowout axis, the wind increasingly bypasses the blowout. Accordingly, strong transport is no longer seen for such oblique winds, even though the offshore wind speed may still exceed 10 m/s.

5. Conclusions

5.1 Virtually any, sufficiently strong wind with an onshore component (≥ 10° from blowout axis) can induce aeolian activity on the deflation floor.

5.2 The intensity of aeolian activity lessens for the most oblique angles (>70° from blowout axis) because the wind increasingly bypasses the blowout.

In agreement with Hesp and Pringle (2001), the main implication of the present work is that the long-term evolution of blowout morphology may not be primarily governed by winds blowing parallel to the blowout axis but by winds from a wide range of approach angles.