Determining characteristics of sand strips on a narrow beach using video monitoring

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Introduction

Sand transported by the wind can form zebra-like stripes, known as sand strips. They are common bedforms in wet aeolian systems, but their characteristics and dynamics are not well understood. They provide insight into which wind conditions and beach characteristics result in high aeolian transport rates. This is important for narrow beaches, where many potential transport events do not result in actual events.

Goals

- Characterise sand strips from long term (multiple years), hourly, high resolution video imagery, focussing on their wavelength, migration velocity and coverage.
- Study the dependence of these characteristics on wind velocity and direction.

Used data

- Argus video images from the Coast3D tower at Egmond aan Zee (2005-2010), the Netherlands.
- KNMI weather data from IJmuiden, 13 km south of the Coast3D tower.

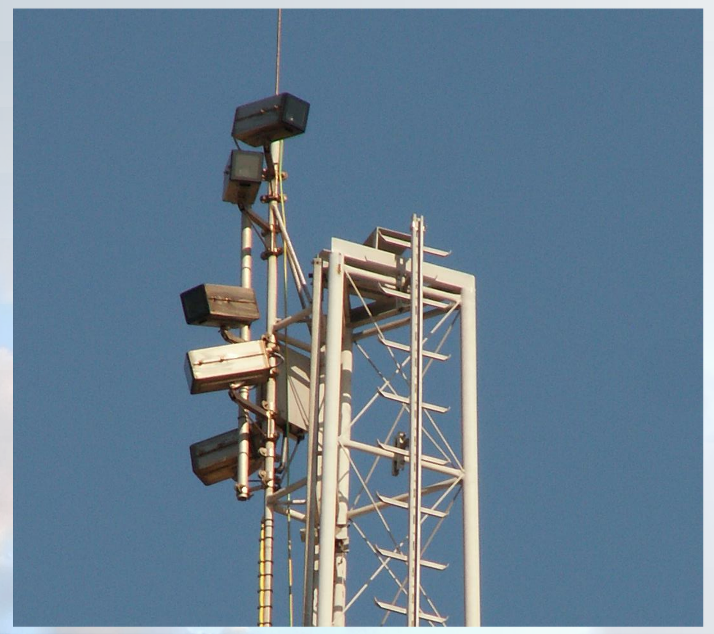


Figure 1: the Argus cameras of the Coast 3D tower (photo: B.G. Ruessink).

Methodology

find images with strips

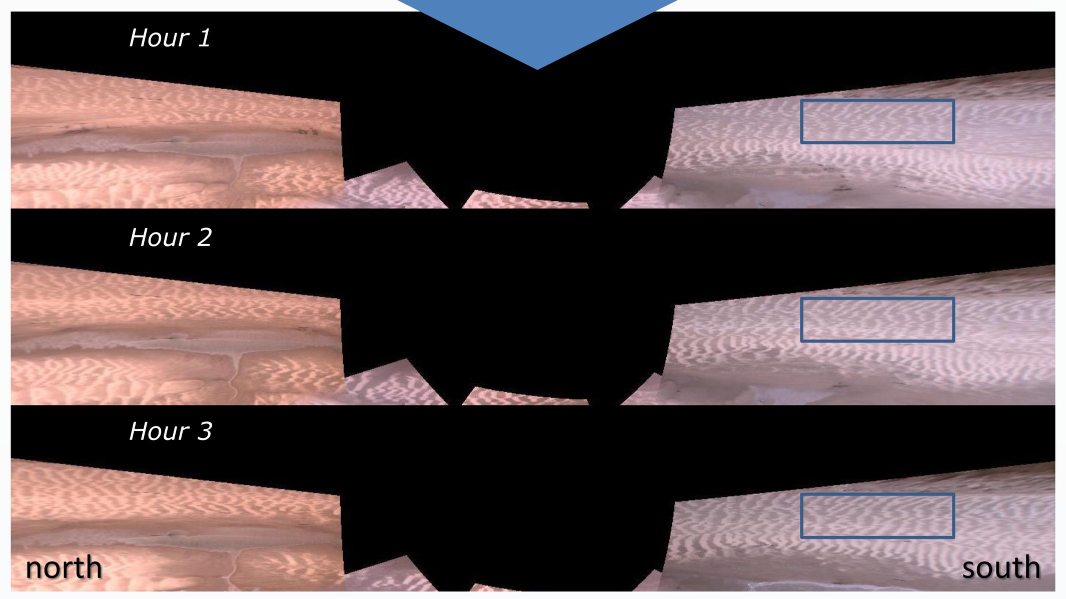
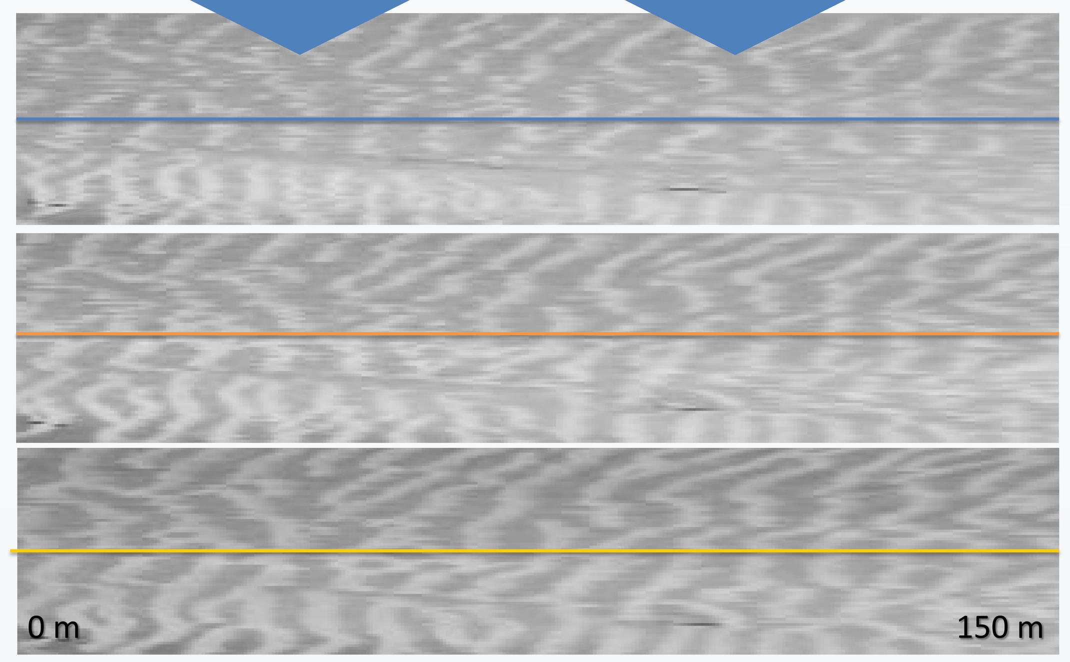


Figure 2A Rectified Argus images with sand strips from three subsequent hours taken on the same day (01-04-2008). The used dataset consists of multiple days showing aeolian transport. The horizontal (alongshore) and vertical (cross-shore) distances are respectively 1200 and 200 m.

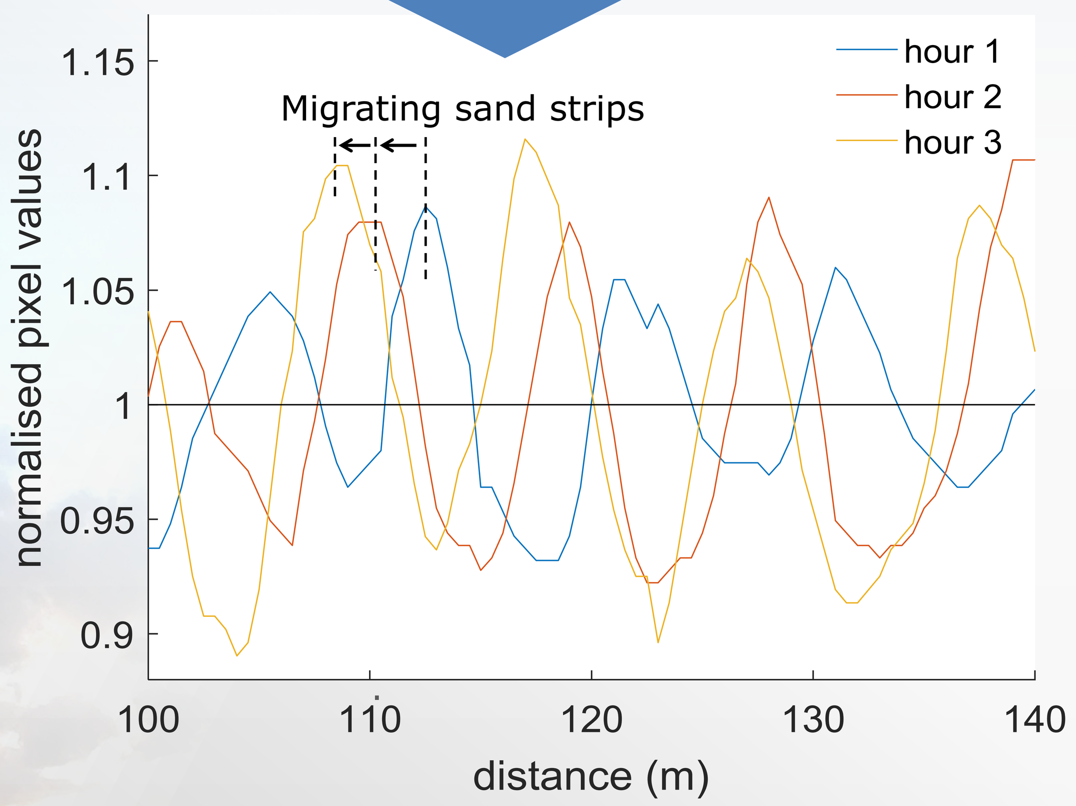
select area with strips

turn greyscale



B: Greyscale cutouts of the images in Figure 2A (area in blue rectangles).

use pixelvalues



C: The sand strips create a sinusoid pattern in the pixel values (lines in Figure 2B, zoomed in), where high values correspond to light colours. Cross-correlation was used to determine the wavelength of the pattern and how much the signal had shifted through time. This was done for all pixel rows in all images.

Results

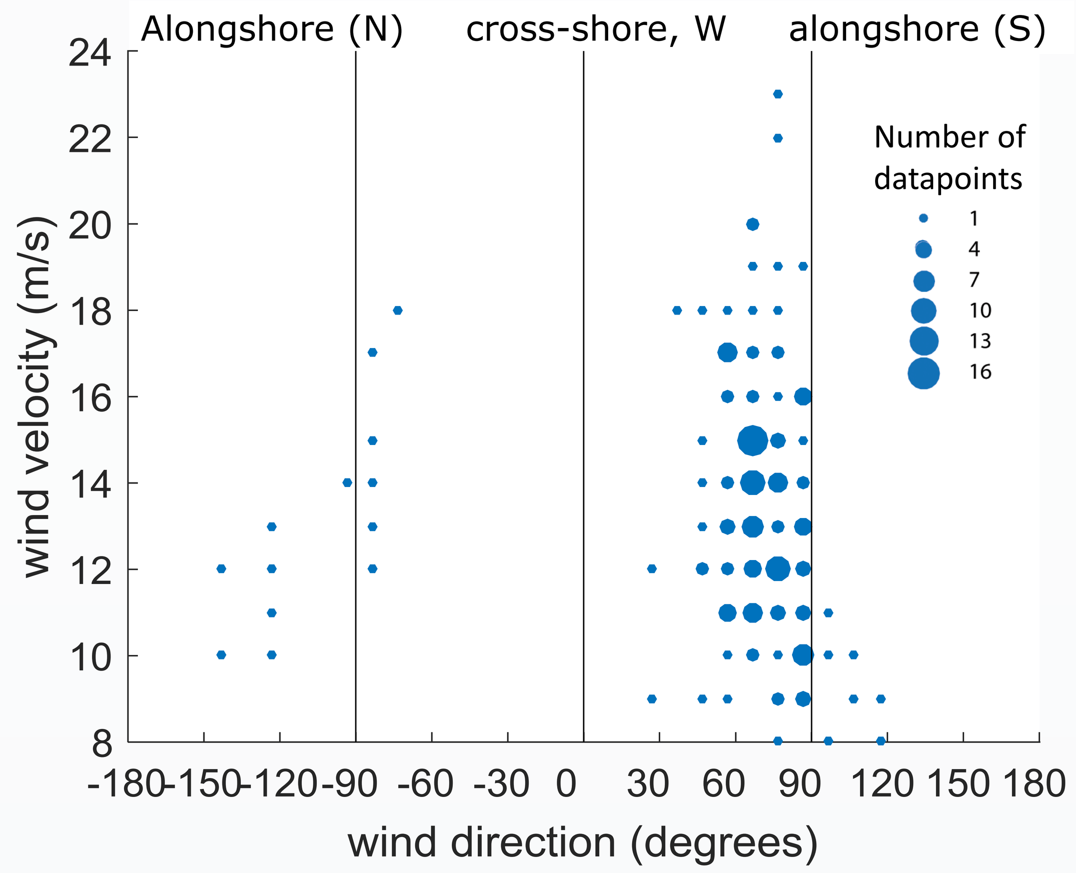


Figure 3: Wind velocity against wind direction for days with well-developed sand strips.

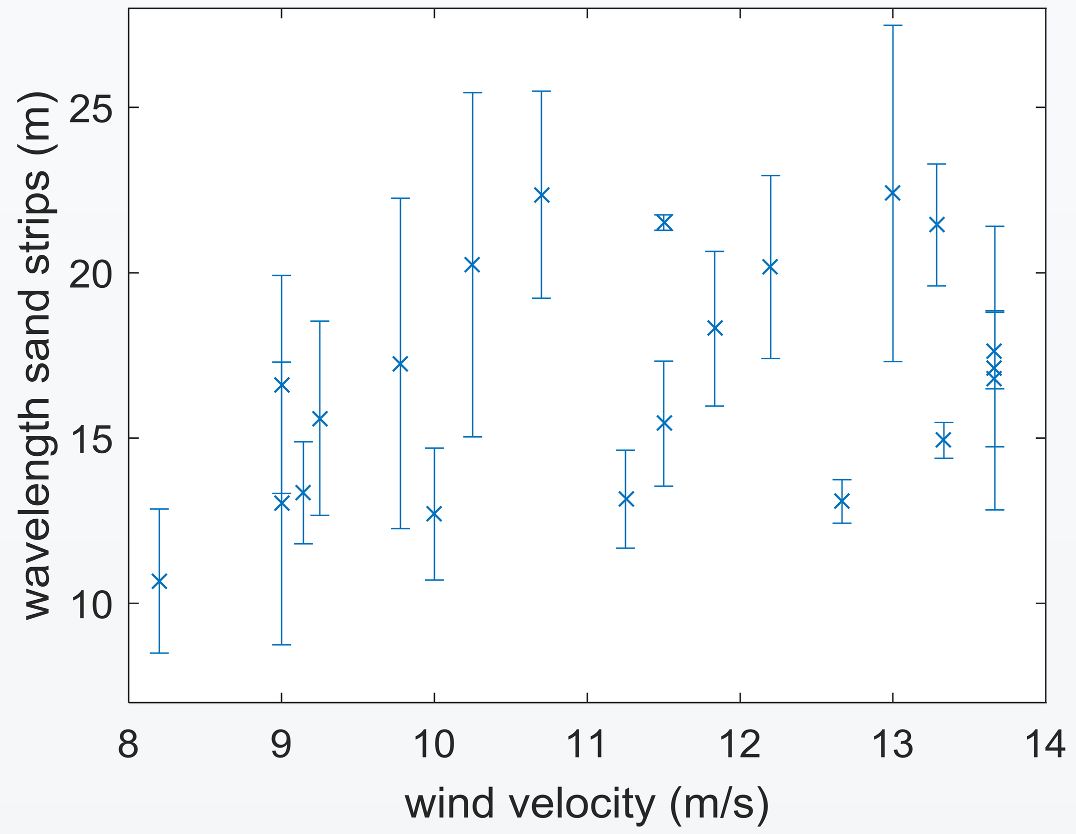


Figure 4: Mean wavelength of sand strips against the wind velocity with error bars. Each datapoint represents one day with sand transport.

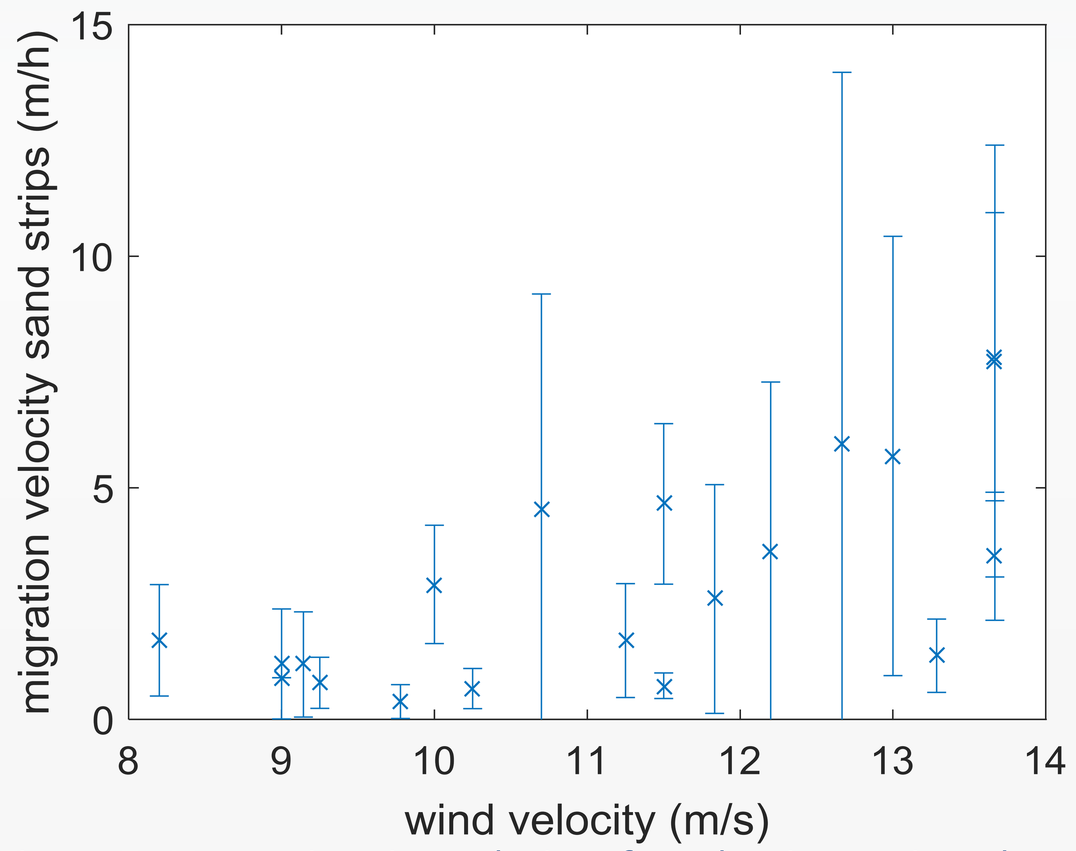


Figure 5: Mean migration velocity of sand strips against the wind velocity with error bars. Each datapoint represents one day with sand transport.

Conclusion and discussion

Goal 1: Characteristics sand strips

- Well-developed sand strips form under (almost) alongshore winds. Most sand strips come from the south to southwest, because that is the dominant wind direction at the field site (Figure 3).
- Sand strips usually appear first on the intertidal area close to the dunefoot. They spread out seaward with falling tide.
- Sand strips form under various wind velocities, as long as the wind threshold of ~ 8 m/s is exceeded (Figure 3).
- The cross-shore distance covered by sand strips ranges between 85-130 m (115 m on average).
- The wavelength ranges between 11 and 23 m (17.3 m on average).
- The migration velocity ranges between 1 to 8 m/h (3.4 m/h on average).

Goal 2: Dependence on wind velocity and direction

- There is a significant relation between the wind velocity and the wavelength of the sand strips at α = 0.05 with r = 0.46 (Figure 4).
- The relation between wind velocity and migration velocity, is also significant at α = 0.05 with r = 0.75 (Figure 5).
- The wind direction thus does not affect the wavelength and migration velocity, except that the sand strips do not develop well under shore-oblique winds.

Future research

- Study the effect of tide on sand strip development.
- Research the spatial variability of sand strip dynamics.
- Determine which wind conditions result in long term aeolian input into the foredune.

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