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Outstanding Student Poster & PICO Contest

Utrecht University

STW connecting innovators

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Cross-shore variability in wind characteristics over a beach-foredune profile

Introduction

Aeolian transport from the (intertidal) beach is the primary source of foredune sand supply. Models that aim to predict this supply often use regional wind characteristics. The presence of a high and steep foredune can, however, cause the (local) wind characteristics on the beach to deviate substantially from the overall regional values. **Our objective** is to study the spatial variability in wind characteristics (mean speed, direction and turbulence) on a beach using field data for different regional wind directions. This study serves as an initial step towards a more realistic aeolian transport model incorporating local wind conditions.

How do wind characteristics evolve over a beach-foredune profile?

1) Mean wind speed ($\bar{u}$)
2) Wind direction
3) Turbulent Kinetic Energy (TKE)

Methodology

Field experiment

- 6-week field campaign
- Autumn 2015
- Beach south of Egmond aan Zee

- cross-shore ultrasonic anemometer array (*Fig. 1*)
- 4-6 devices at 90 cm above the bed.

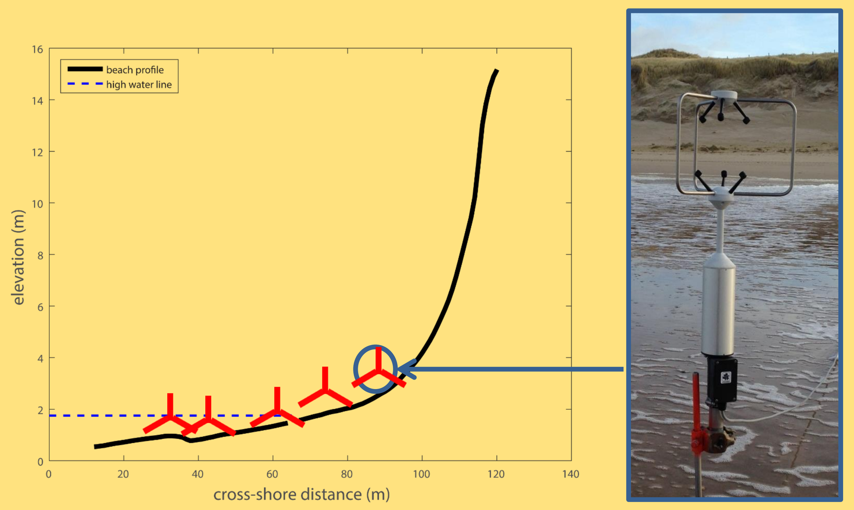
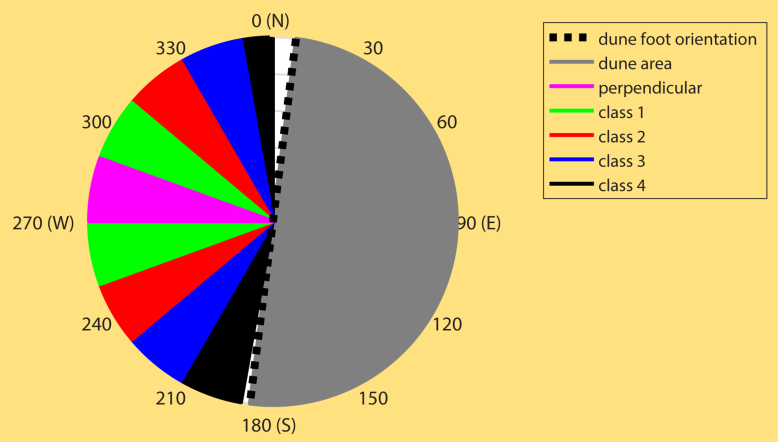


Fig 1: Field setup. Cross-shore array (left) with 4-6 ultrasonic anemometers (right).



Perpendicular	270°- 290°	
Class 1	250°- 270°	290°- 310°
Class 2	230°- 250°	310°- 330°
Class 3	210°- 230°	330°- 350°
Class 4	190°- 210°	350°- 360°

Fig 2: Wind direction classes.

Data analysis

- Data are 10 Hz, three-dimensional velocities
- Processed into 5-minute mean wind characteristics
- Regional winds: IJmuiden weather station
- subdivision of onshore winds in bins of 20˚ (Fig. 2)

Results

1. Wind speed

- $\bar{u}$ decreases in downwind direction
- $\bar{u}$ at the waterline can be 1.5 times higher compared to values at the dunefoot
- Downwind decrease in velocity is less pronounced for the more alongshore wind conditions (class 3 and 4) see Fig 3.

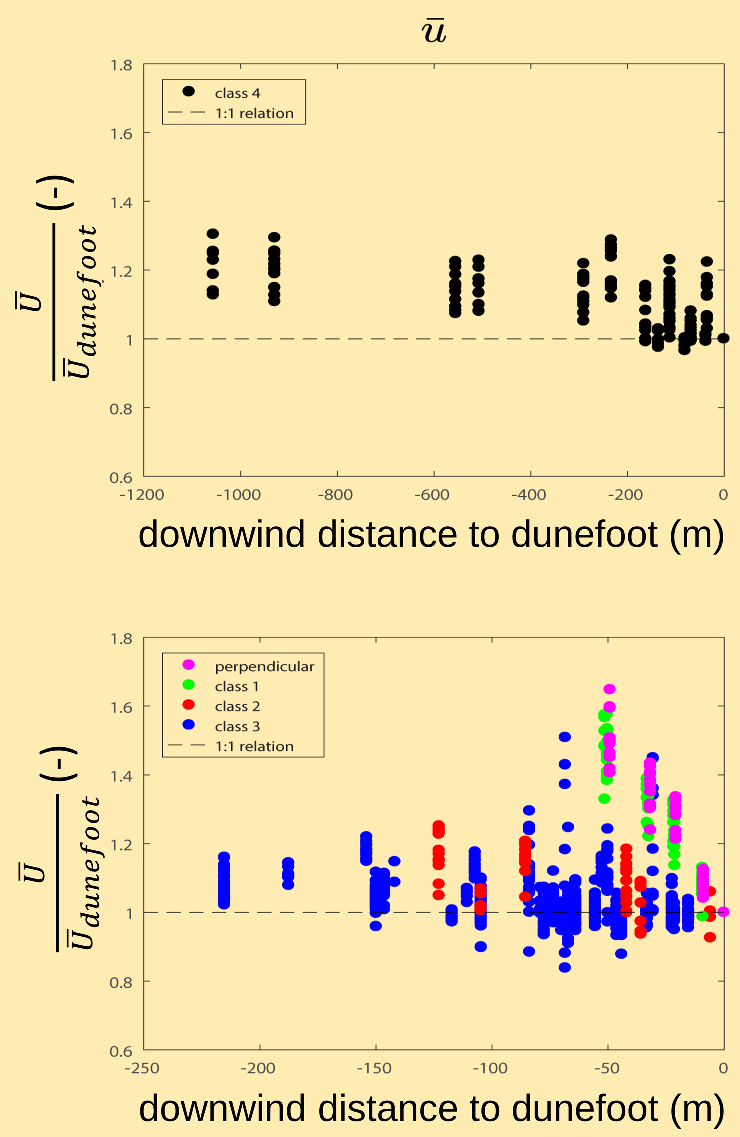


Fig 3: Relative mean wind speed as function of downwind distance to dunefoot for alongshore (upper) and oblique onshore winds (lower).

2. Wind direction

- Local wind steering of the regional wind increases in downwind direction (perpendicular and class 1) see Fig 4.
- Downwind increase of local wind steering is less pronounced for the more alongshore wind conditions (class 3 and 4) see Fig 4.
- Large differences between regional and local wind directions

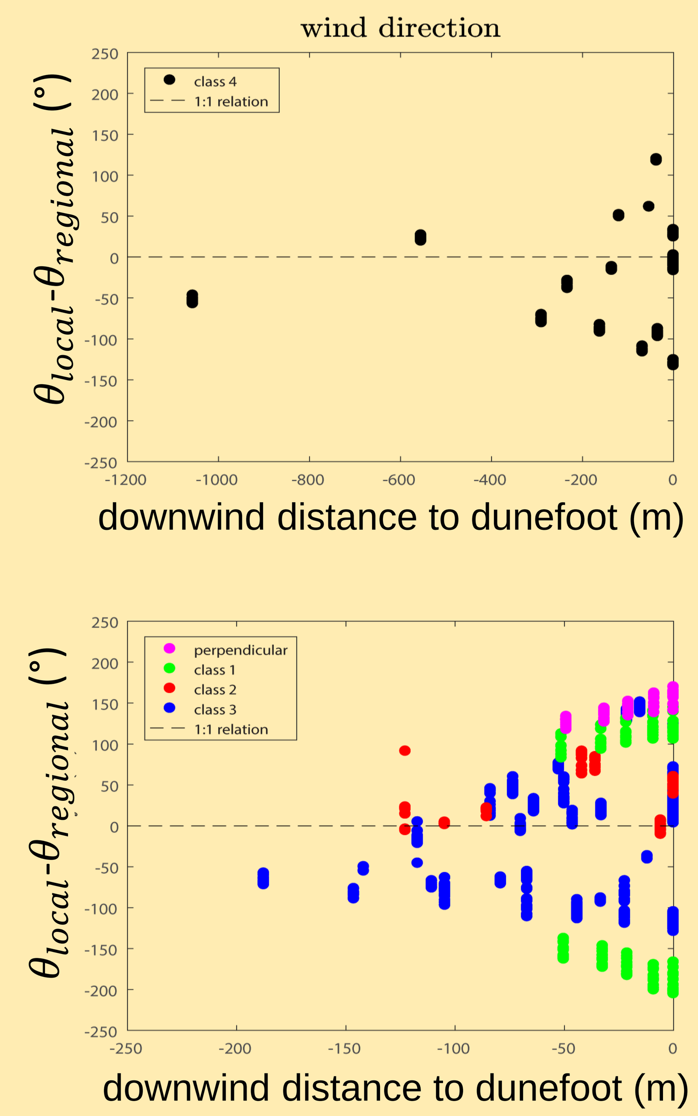


Fig 4: Steering of the regional wind as function of downwind distance to dunefoot for alongshore (upper) and oblique onshore winds (lower).

3. TKE

- TKE is related to $\bar{u}$ during onshore conditions (Fig 5)
- TKE does not show a clear downwind trend (Fig 6)

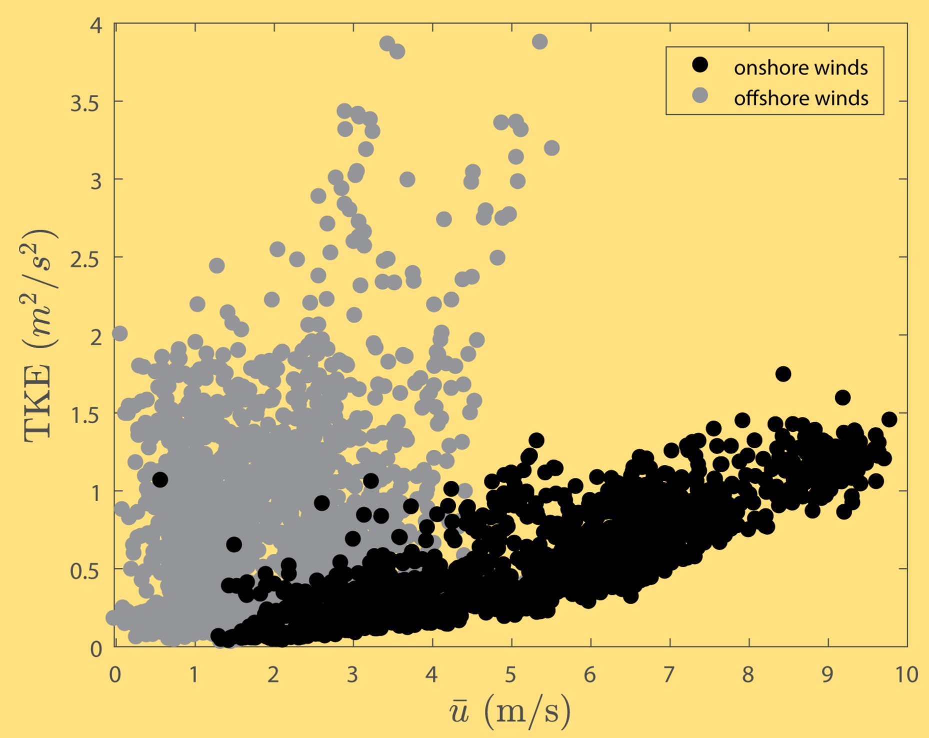


Fig 5: TKE as function of velocity

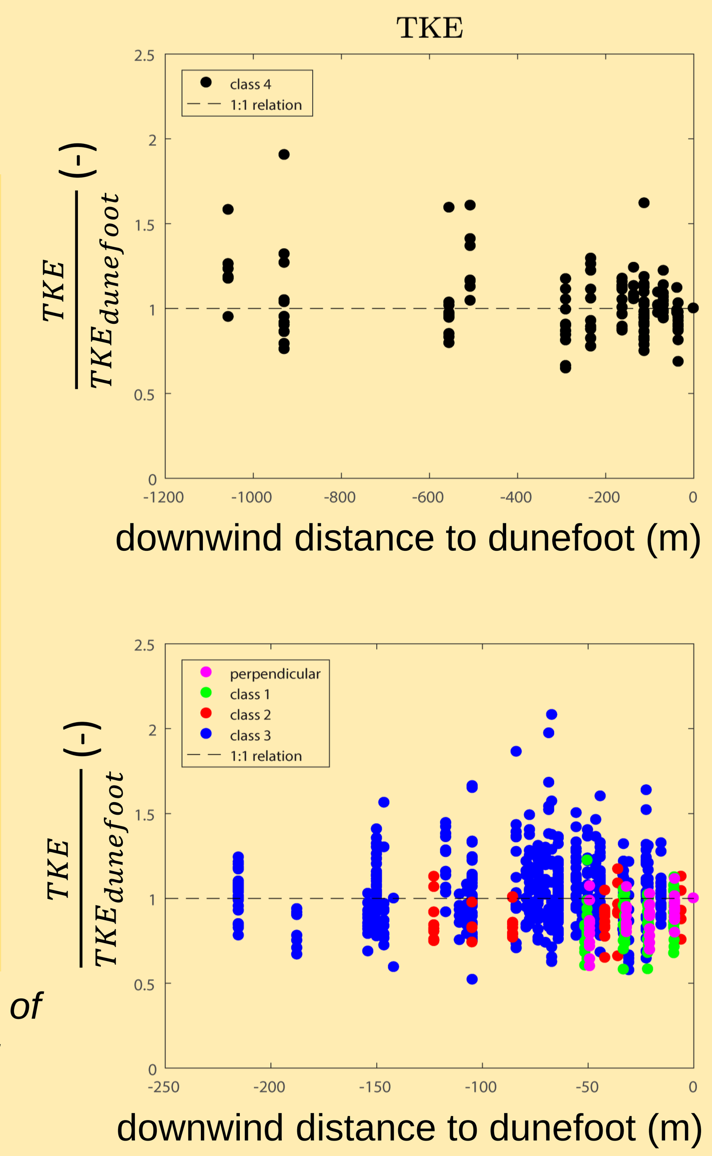


Fig 6: Relative TKE as function of downwind distance to dunefoot for alongshore (upper) and oblique onshore winds (lower).

Conclusions

1) The mean wind speed decreases in downwind direction for obliquely onshore winds. Alongshore winds are more constant over the beach and only show a drop in velocity near the dunefoot.
2) The steering of local winds increases towards the dunefoot, so the winds become more shore-parallel.
3) During onshore winds TKE is related to the mean wind speeds. However, contrary to the mean wind speed, TKE is constant across the beach.

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