PREDICTION OF BEACH SURFACE MOISTURE WITH MODFLOW MODELED GROUNDWATER FLUCTUATIONS FOR THE PURPOSE OF AEOLIAN SAND TRANSPORT

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INTRODUCTION

Surface moisture exerts a strong control on aeolian transport from the beach toward the foredune and shows substantial spatiotemporal variability influenced by tide-induced groundwater fluctuations. According to Delgado-Fernandez (*2011, Geormorphology*) when surface moisture exceeds about 10% by mass, it prohibits aeolian sand transport entirely no matter what windspeed. Here we explore groundwater dynamics by using the ModFlow model in order to predict surface moisture and subsequently sand availability for aeolian transport, based on the 10% countour line of surface moisture. First, careful calibration of the ModFlow model is therefore most important in the intertidal zone, where the change in variability of sand is at its largest. Second, predicted surface moisture maps are compared to measured TLS-based surface moisture maps. Finally, implications for the sand availability maps are discussed.

MODEL

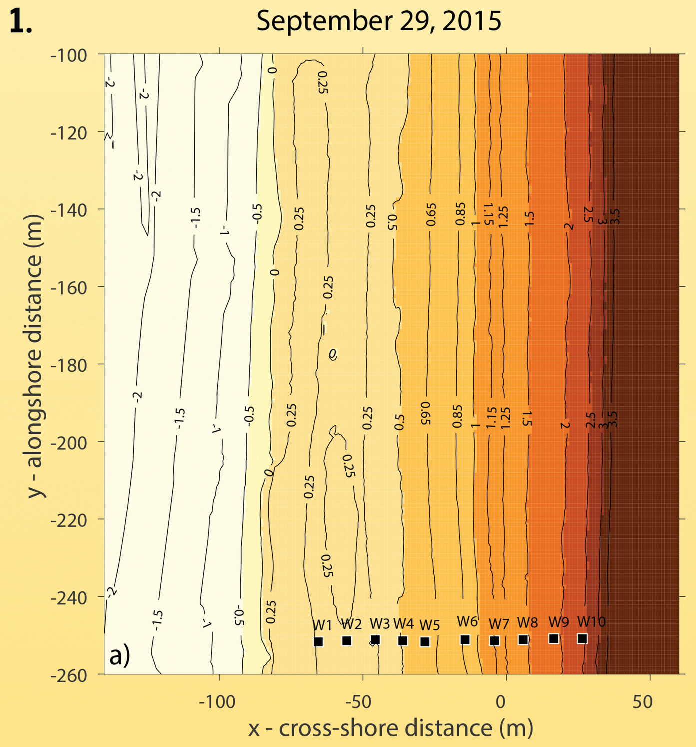
$$\frac{\partial h}{\partial t} = \frac{KD}{n_e}\left(\frac{\partial^2 h}{\partial x^2} + \frac{\partial^2 h}{\partial y^2}\right)$$

thickness (D) = 15m (constant)
effective porosity (n_e) = 0.3
hydraulic conductivity (K) = calibrated

seaside boundary condition: Dirichlet (fixed head)
lateral sides and landward boundary condition: no flow

RESULTS

1.



2.

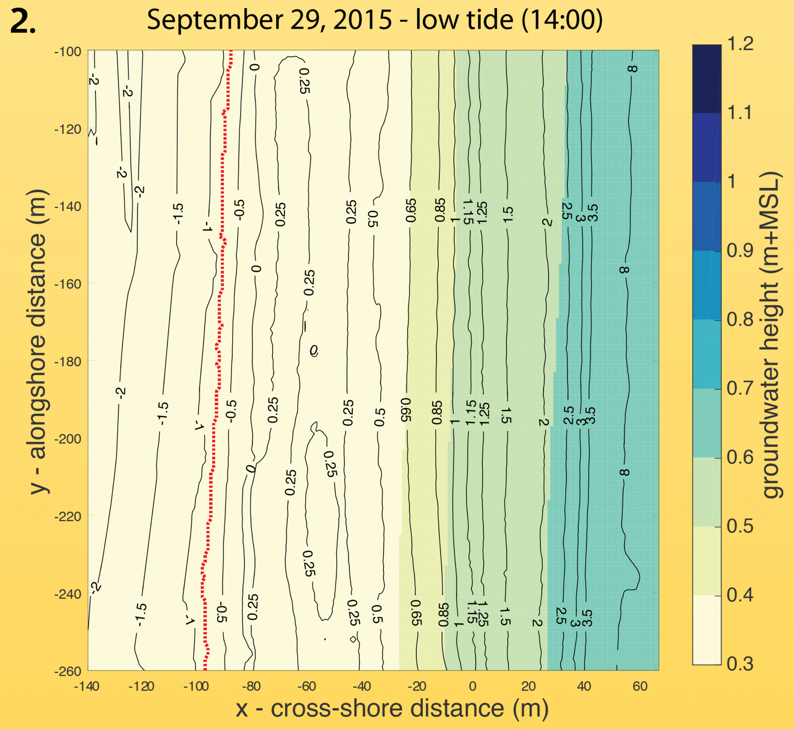
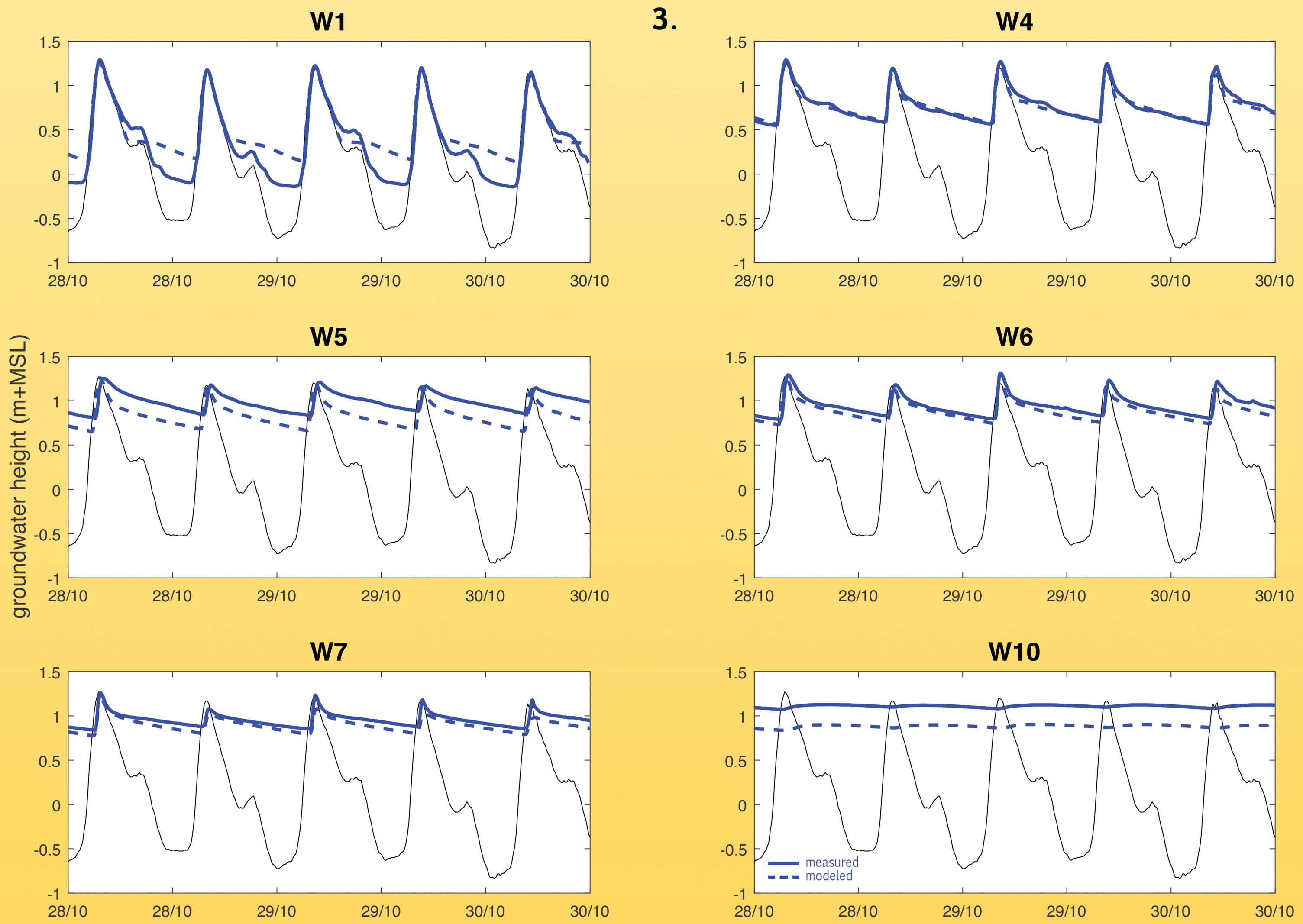


Fig. 1 shows the TLS-measured DEM used as input for the ModFlow model when morphology was relatively smooth. **Fig. 2** shows an example of a modeled groundwater map during low water. **Fig. 3** shows a comparison between modeled and measured groundwater height for the locations of 6 wells. More emphasis was put on the calibration of the intertidal beach for which r^2 was ~ 0.7–0.95 and RMSE 3–6 cm. The further away from the sea, the more the lack in modeled recharge from the dune has an effect on the overheight, e.g. W10 has a bias of 35 cm.

3.



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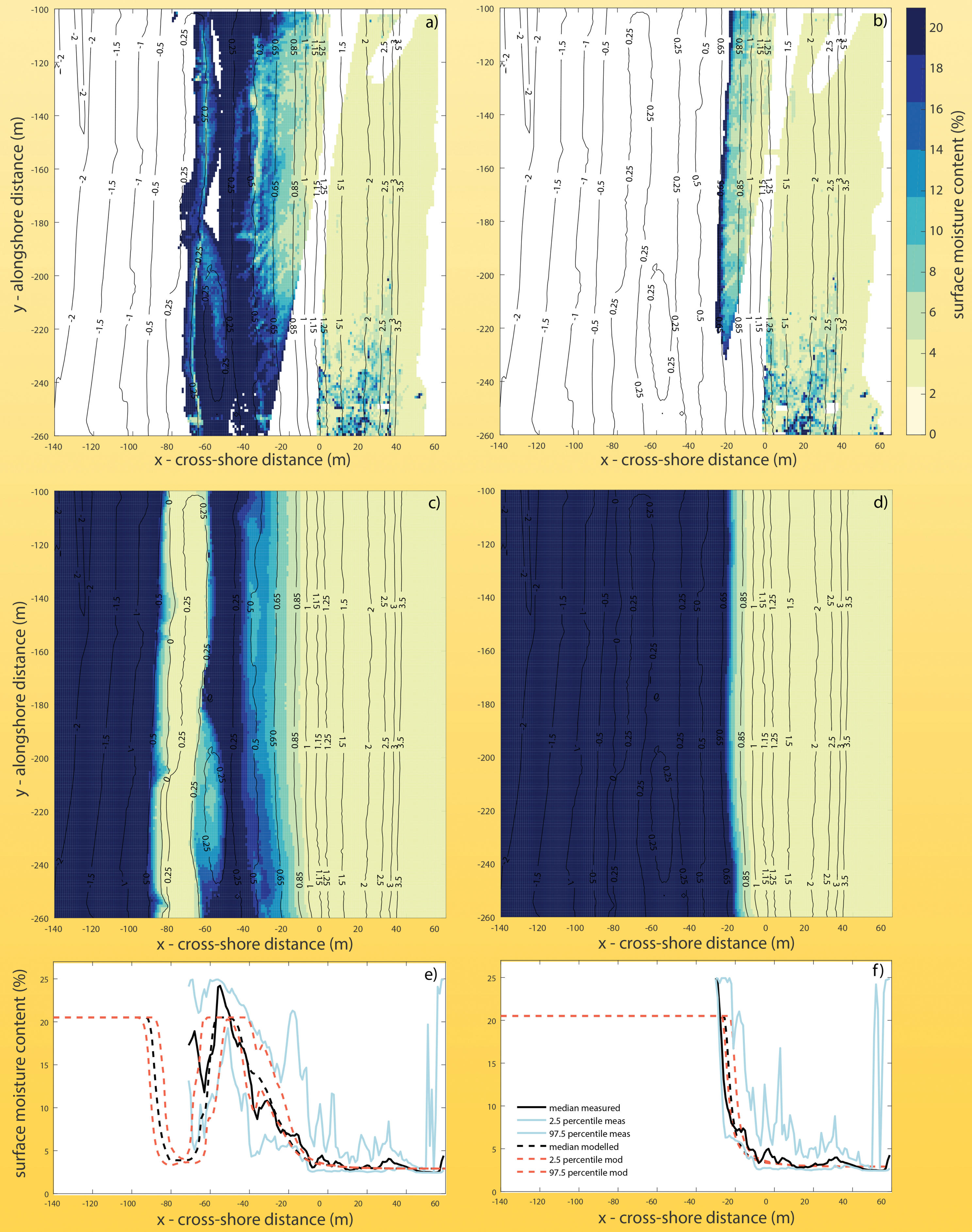

Fig. 4a and b show measured surface moisture maps during low and high water, respectively. Light yellow colors indicate low surface moisture content, e.g. on the back beach near the dune foot (~3%). Darker blue colors indicate high surface moisture content, e.g. close to the water line (~25%). **Fig. 4c and d** show modeled surface moisture maps calculated from modeled groundwater maps. Both modeled surface moisture maps show the same patterns as their measured corresponding surface moisture maps. For all measured and modeled surface moisture data a comparison is shown in **Fig. 4e and f**. Both show the median in surface moisture content over the alongshore direction for all x-coordinates in the cross-shore direction. Measured and modeled surface moisture maps capture the same general zonation in surface moisture over the entire beach. Even though the groundwater model did not capture overheight.

5.

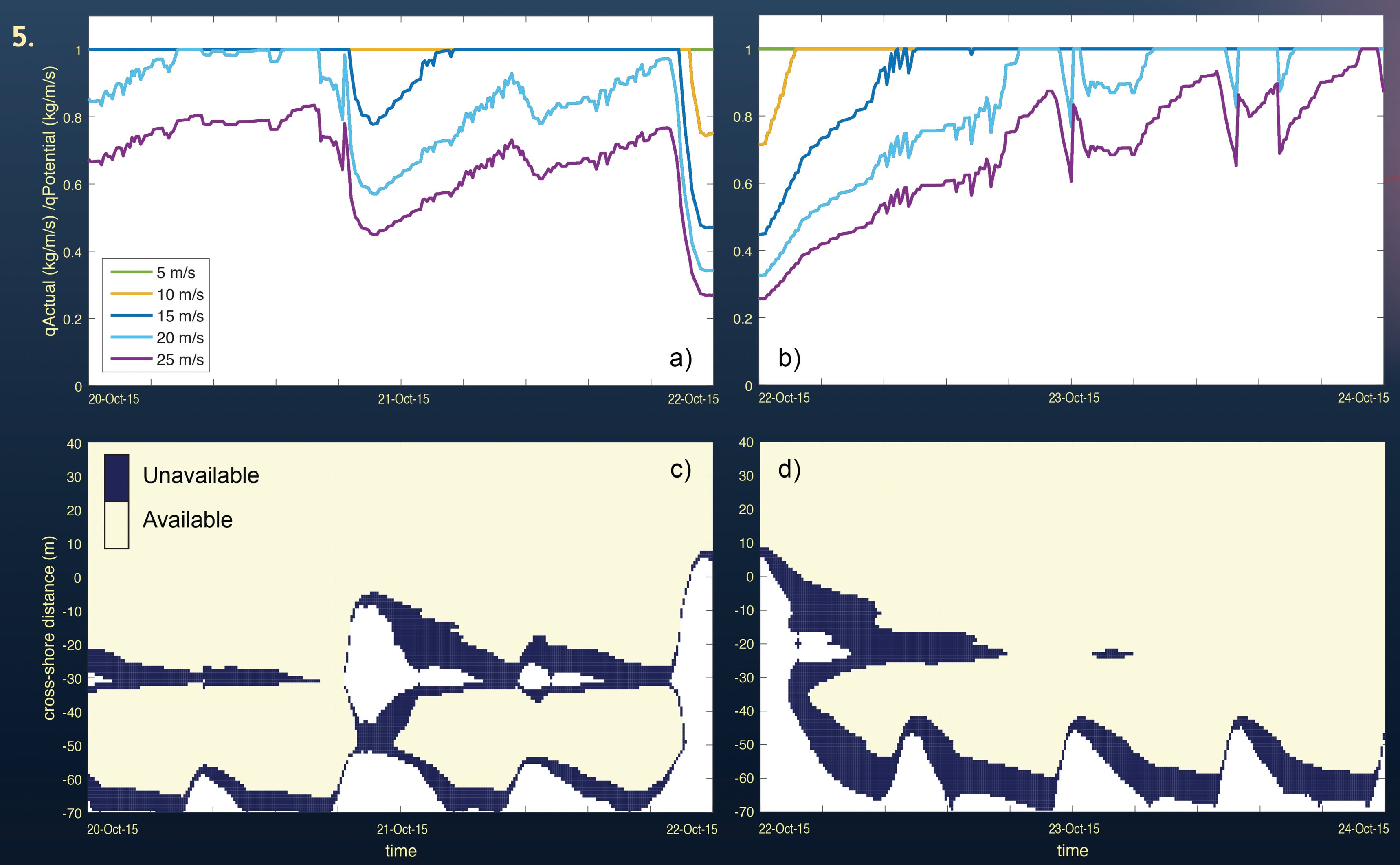

Fig. 5a and b show the ratio between actual (q_{act}) and potential (q_{pot}) sand transport in kg/m/s for five different wind speeds. If the ratio is <1 the critical fetch is not reached. **Fig. 5c and d** visualize a transect from the dune foot (top) to the sea (bottom) with a 10% surface moisture threshold over time. Indicating which part of the beach is available for aeolian sand transport.

DISCUSSION & CONCLUSION

The ModFlow model captures the general zonation in groundwater height well. However, superimposed topographic variability's are hard to include. To do so, more emphasis has to be put on sandbars and modeling of recharge from the dunes. Nevertheless, the current 2D ModFlow model allows us to investigate what the influence is of changing beach surface moisture content on the amount of aeolian sand transport. However, further research is needed to investigate if the 10% SM threshold is representable for every aeolian event, and if sand picked-up from the bar can pass a 20m wide trough. Concluding, this study has clearly shown the relation between tide, groundwater height, surface moisture content and the amount of aeolian sand transport. We can generally predict these interactions.