Universiteit Utrecht

SEAWAD

Saw-tooth bars on the ebb-tidal deltas of the Wadden Sea

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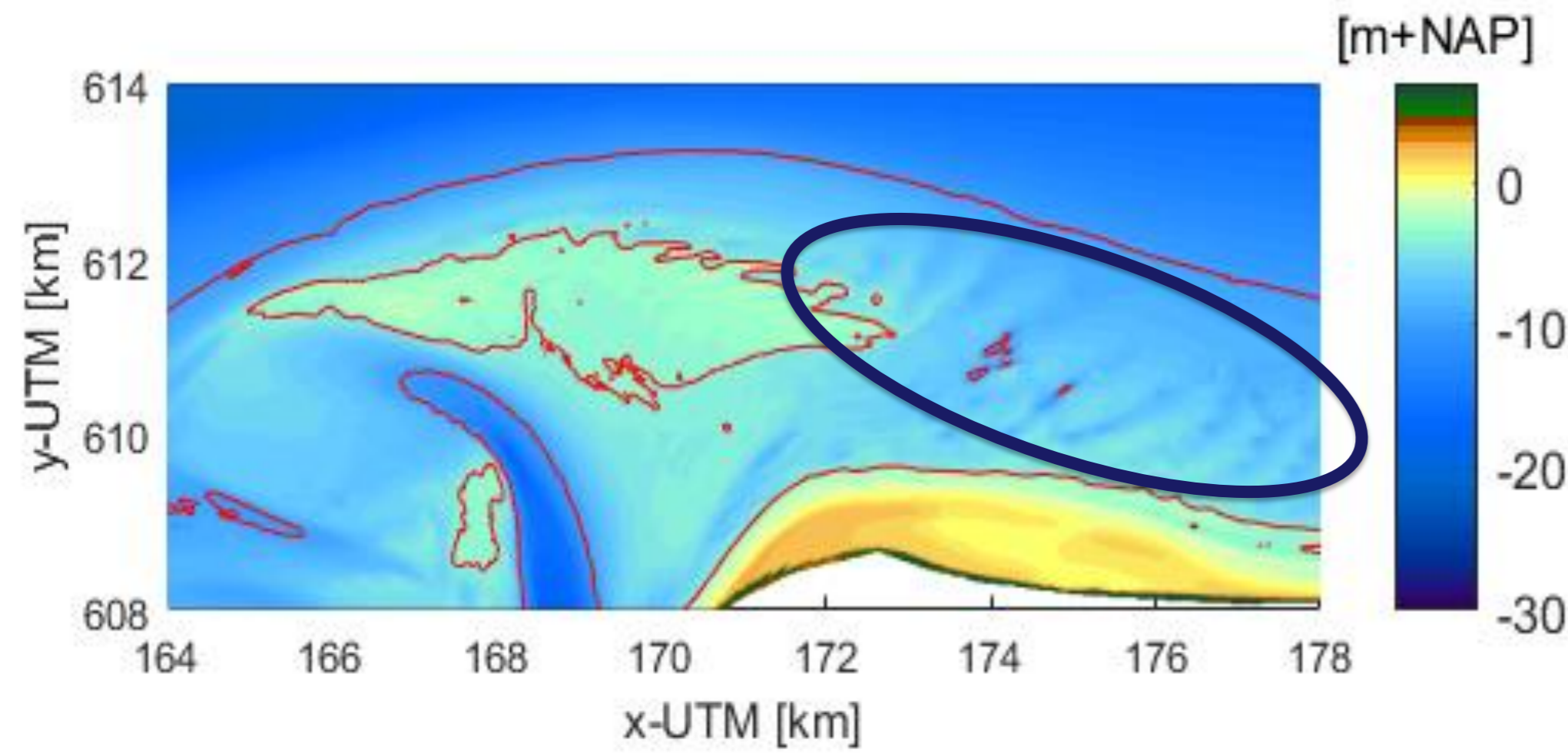l.b.brakenhoff@uu.nl

1. Introduction

Figure 1. Saw-tooth bars at the Ameland ebb-tidal delta, 2005.

PROBLEM: Saw-tooth bars are shore-oblique sandbars, found on all Dutch and most German ebb-tidal deltas (Figure 1). Because of their large dimensions (H~1 m, L~500 m) they might significantly affect sediment transport, but their general characteristics are not well known.

AIM: to determine the characteristics of saw-tooth bars.

2. Methods

Bathymetries were studied for all Dutch and German ebb-tidal deltas between 1970 and 2015. The following characteristics were analysed:

a. Bar height

b. Wave length

c. Bar orientation

d. Crest length and depth of occurrence

e. Migration speed

Variation around running mean bathymetry
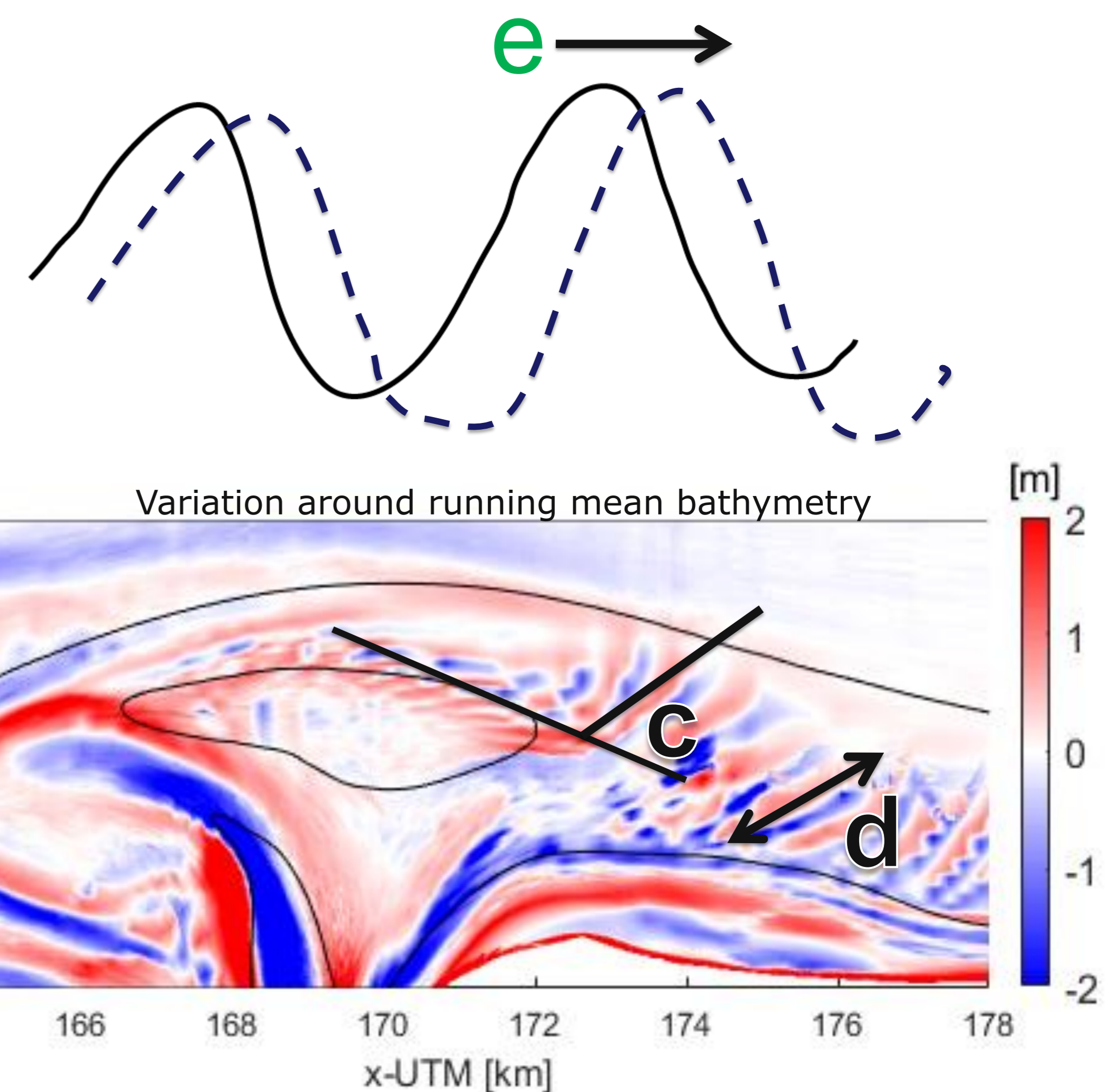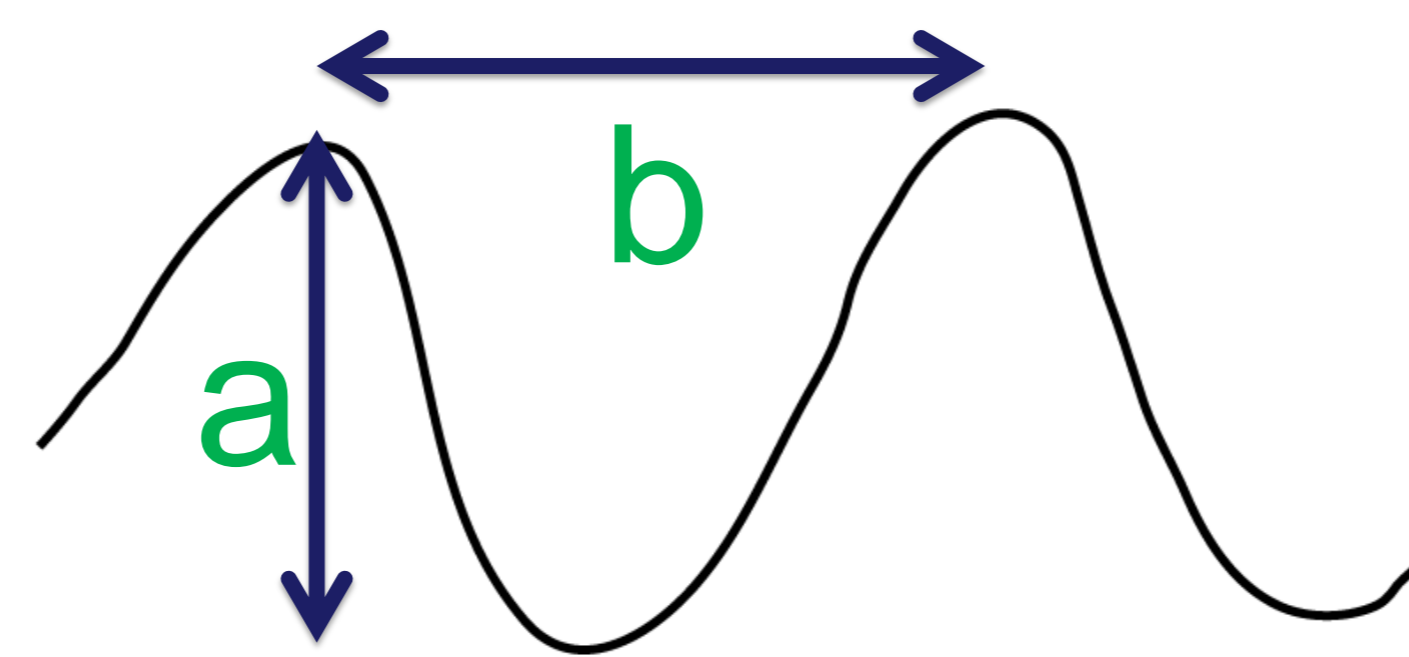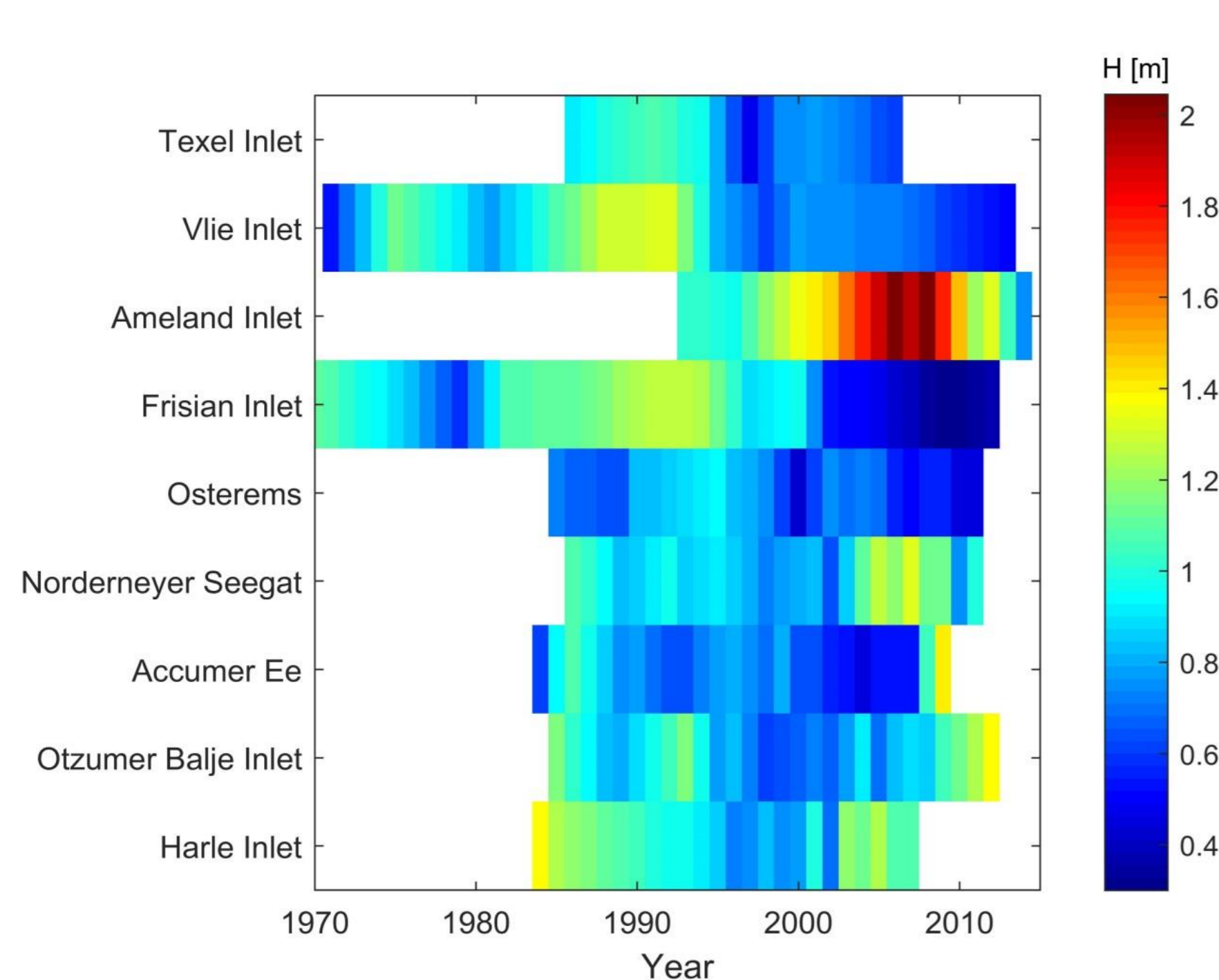
3. Results

a. Bar height

Figure 2. Bar height through time for all inlets.

• Bar heights vary between 0.5 and 2 m.

• The maximum of 2 m is only observed at the Ameland inlet; in general heights are ~1 m.

• At many ebb-tidal deltas the bar height is cyclic. Cycle length varies between inlets, and even per inlet.

b. Wave length

Figure 3. Bar length distribution per tidal system.

• Average wave length is 644 m.

• Mean wave length per inlet decreases in easterly direction.
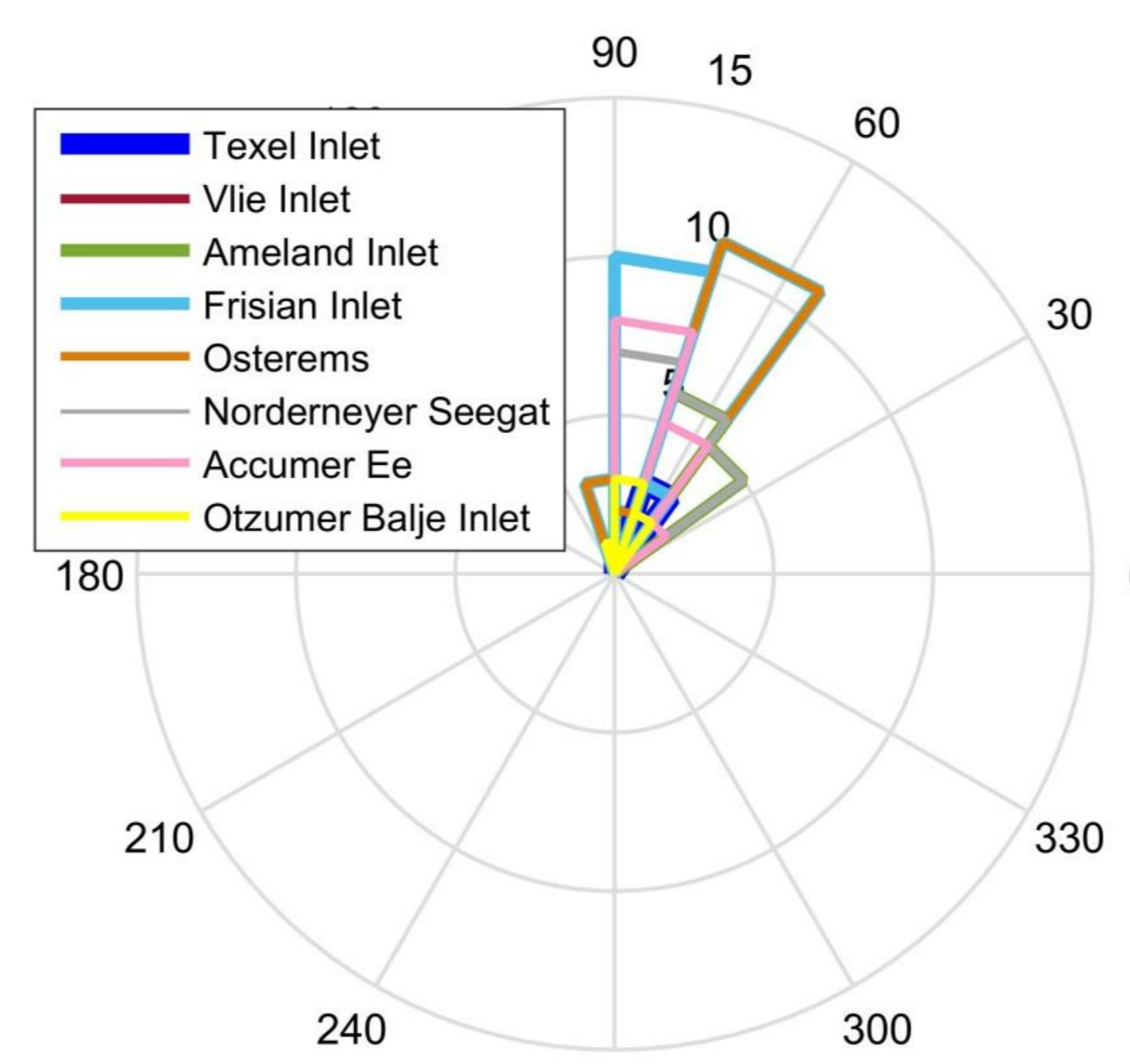
c. Orientation

Figure 4. Angle between bars and -4-m contour.

• Orientation roughly constant in space and time.

• Average angle between bar crests and -4-m contour is 69º.

• Average angle between bar crests and downdrift shoreline is 51º.

d. Crest length and depth of occurrence

Figure 5. Shore-normal bar crest length versus slope of the shoreface between -4 and -10 m.

• Bar crest lengths are between 500 and 2500 m.

• Higher slope ➔shorter shore-normal crest length

• Depths of occurrence are in between -3 m NAP and -12 m NAP.

• With a steeper shoreface, the bars are located in shallower depths.
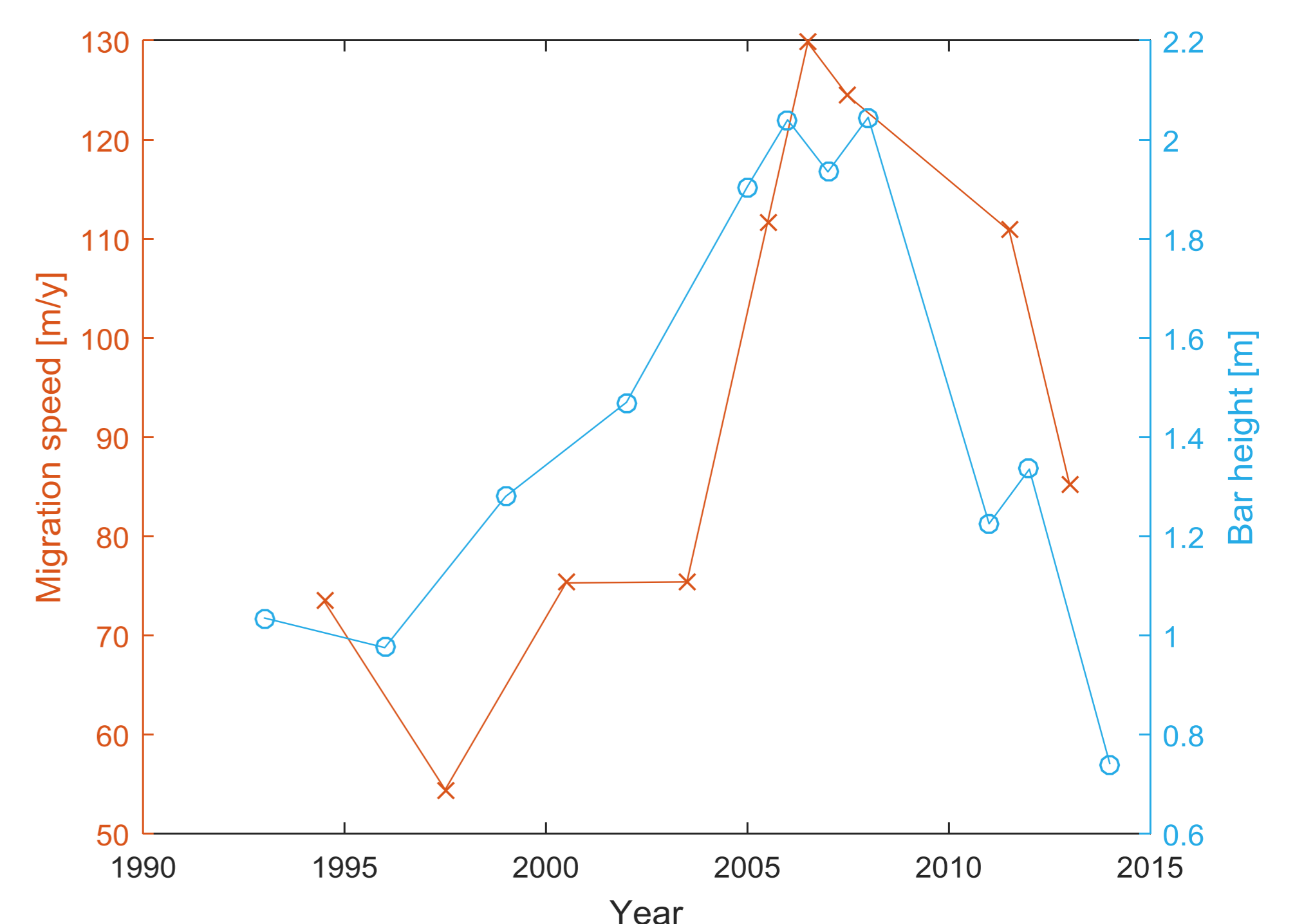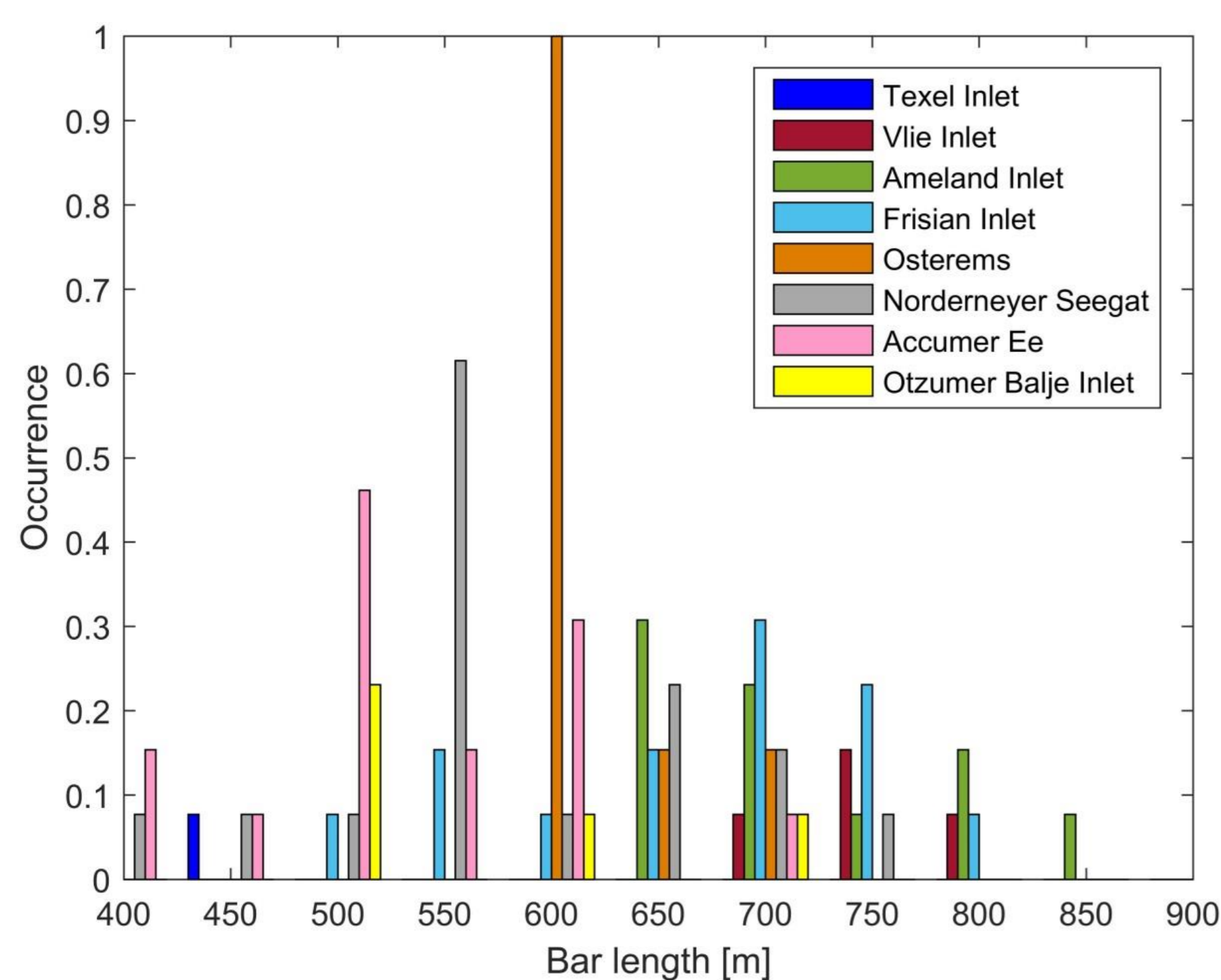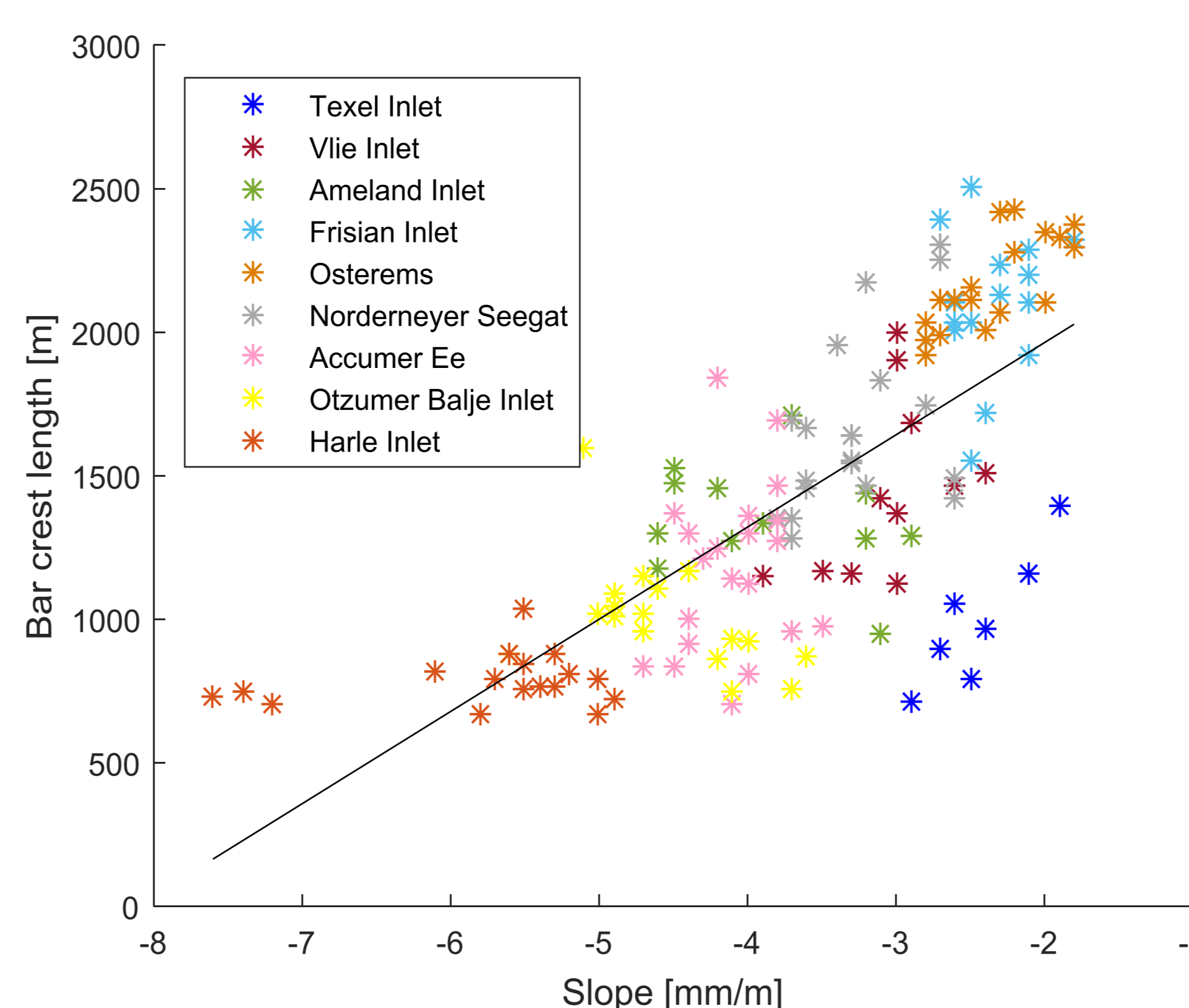
e. Migration speed

Figure 6. Migration speed and bar height through time for the Ameland inlet.

• Migration speed varies between 50 and 130 m/y.

• Migration speed follows same pattern as height.

• Not all saw-tooth bars migrate, but their morphology is similar everywhere, so their formation mechanism should be similar as well.

4. Discussion

• Dependence of length on location ➔ formation mechanism related to tide, since the tidal amplitude increases and tidal prism decreases in easterly direction as well.
• Specific alignment of delta, shoreline and main tidal current necessary?
• Parallel cycle in height and migration implies relation to cyclic channel-shoal behaviour.
• Morphodynamic instability mechanism, like shoreface connected sand ridges?

5. Conclusions

The main characteristics of saw tooth bars are:

a. Bar height ~1 m

b. Bar wave length ~644 m

c. Angle with 4-m contour ~70⁰

d. Crest length in between 500 and 2500 m

e. Migration speed ~100 m/y

The exact generation mechanism of saw-tooth bars is still unknown, this should be studied in further research.