



Modelling of spatial and temporal
variations in offshore sand waves.

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Predicting migration of sand
waves based on shapes only,
without temporal information

An aerial photograph of sand dunes, showing their characteristic wave-like shapes. The dunes are illuminated from the side, creating soft shadows and highlights that emphasize their undulating forms. The color palette is muted, consisting of various shades of blue, teal, and grey.

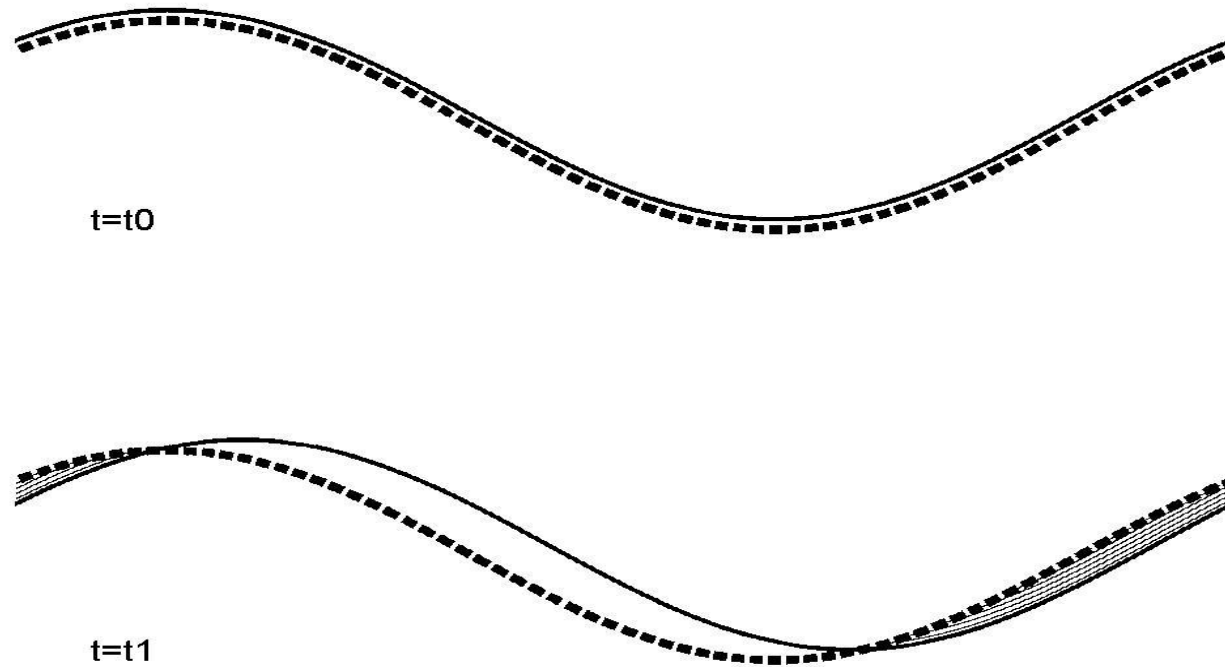
Predicting migration of sand
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A morphological footprint of time

?

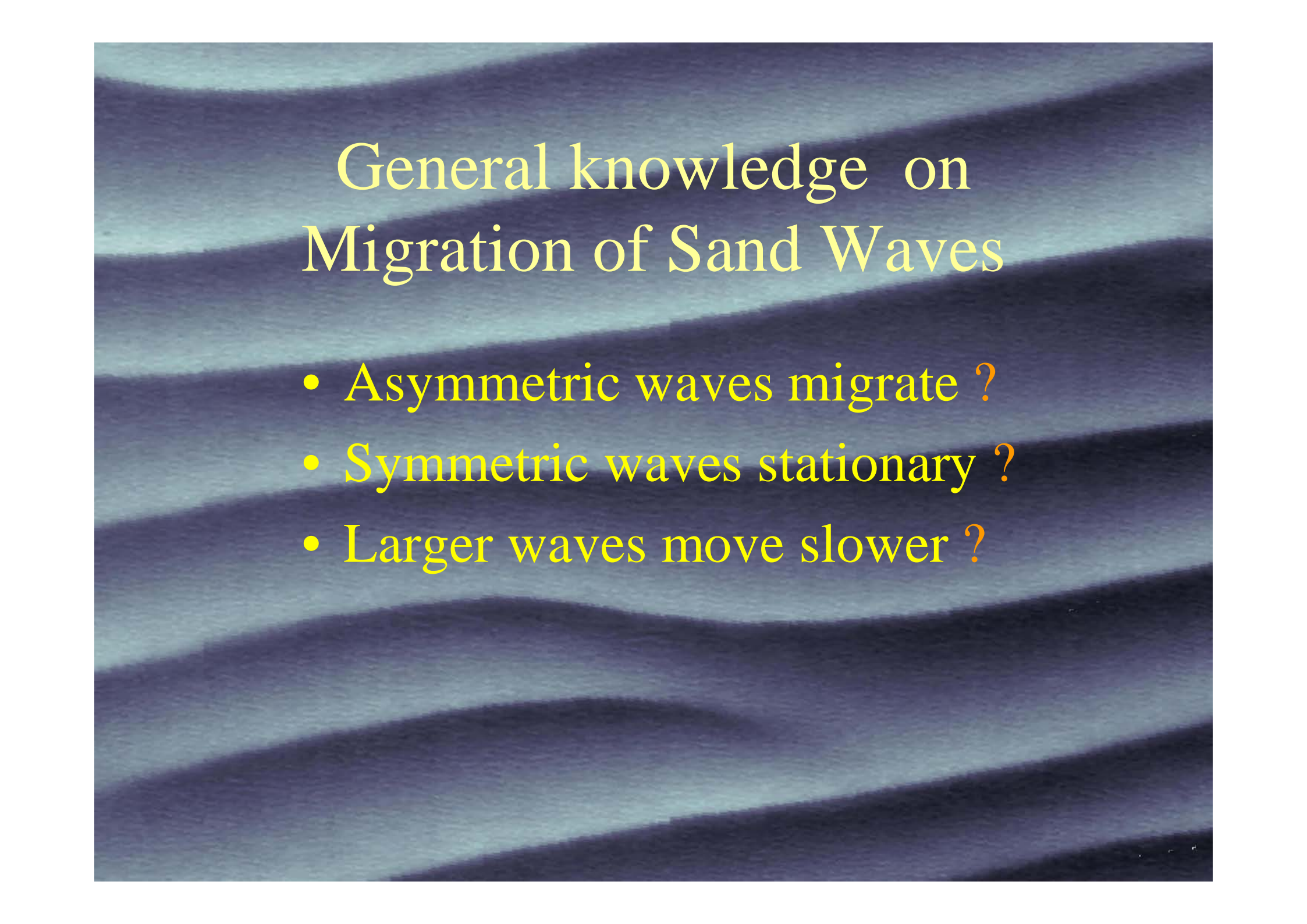
The Importance of Sand Wave Migration

- Safety of pipelines



The Problem

- Morphological time scale sand wave ∞ decades
- Economic time scale oil companies: year
- No time to survey over long periods
- Models: time scale difficult to determine

An aerial photograph of a vast desert landscape featuring numerous sand dunes. The dunes are arranged in a series of parallel ridges and valleys, creating a rhythmic pattern across the terrain. The lighting is soft, highlighting the undulating shapes of the sand. The text is overlaid on the upper portion of the image.

General knowledge on Migration of Sand Waves

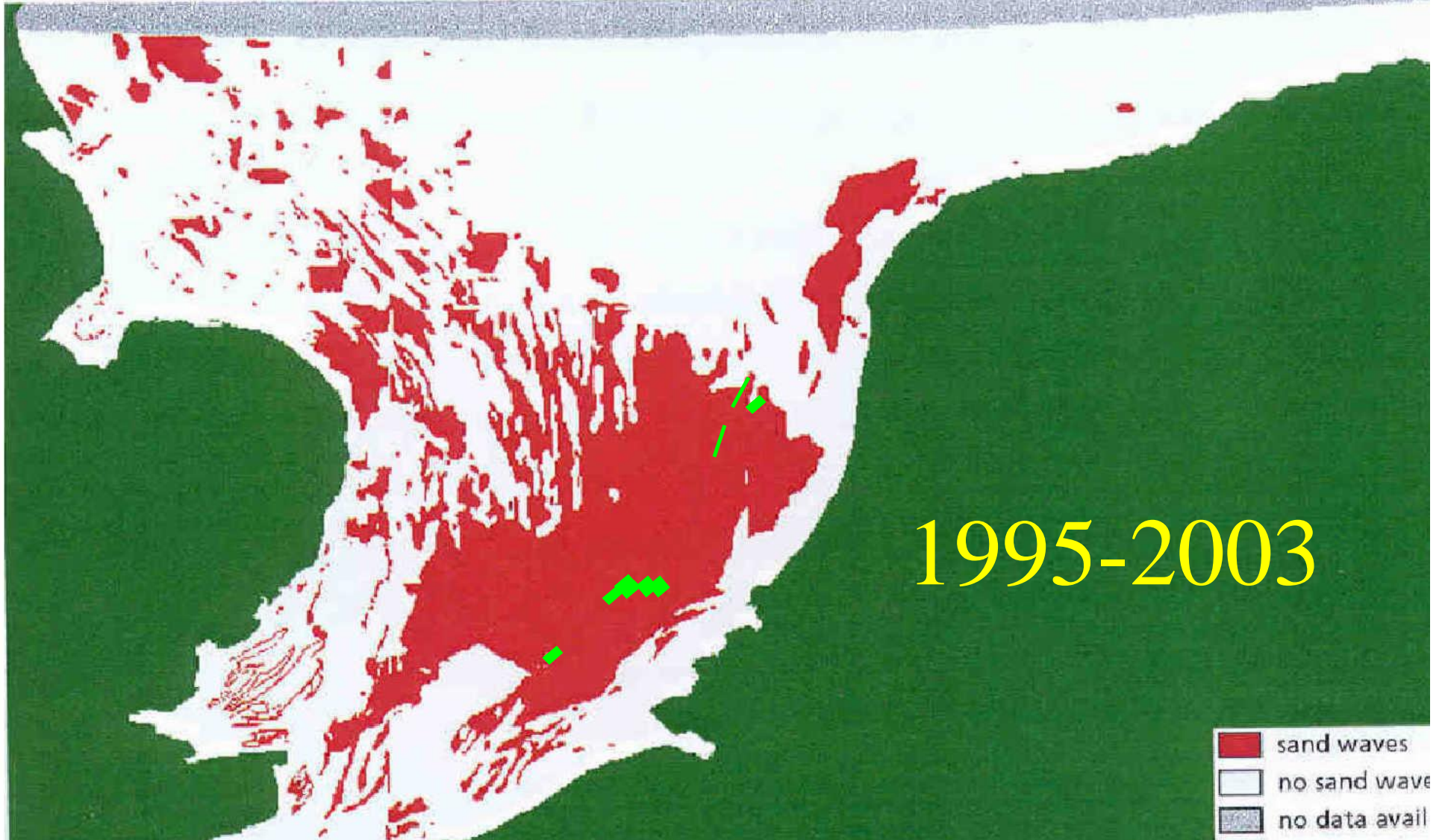
- Asymmetric waves migrate ?
- Symmetric waves stationary ?
- Larger waves move slower ?

The background of the slide is a photograph of sand dunes. The dunes are illuminated from the side, creating a series of dark, shadowed ridges and lighter, sunlit troughs. The overall color palette is a mix of deep blues, purples, and greys, giving it a somewhat ethereal or twilight appearance. The text is overlaid in a bright yellow color, which stands out against the darker background.

The question

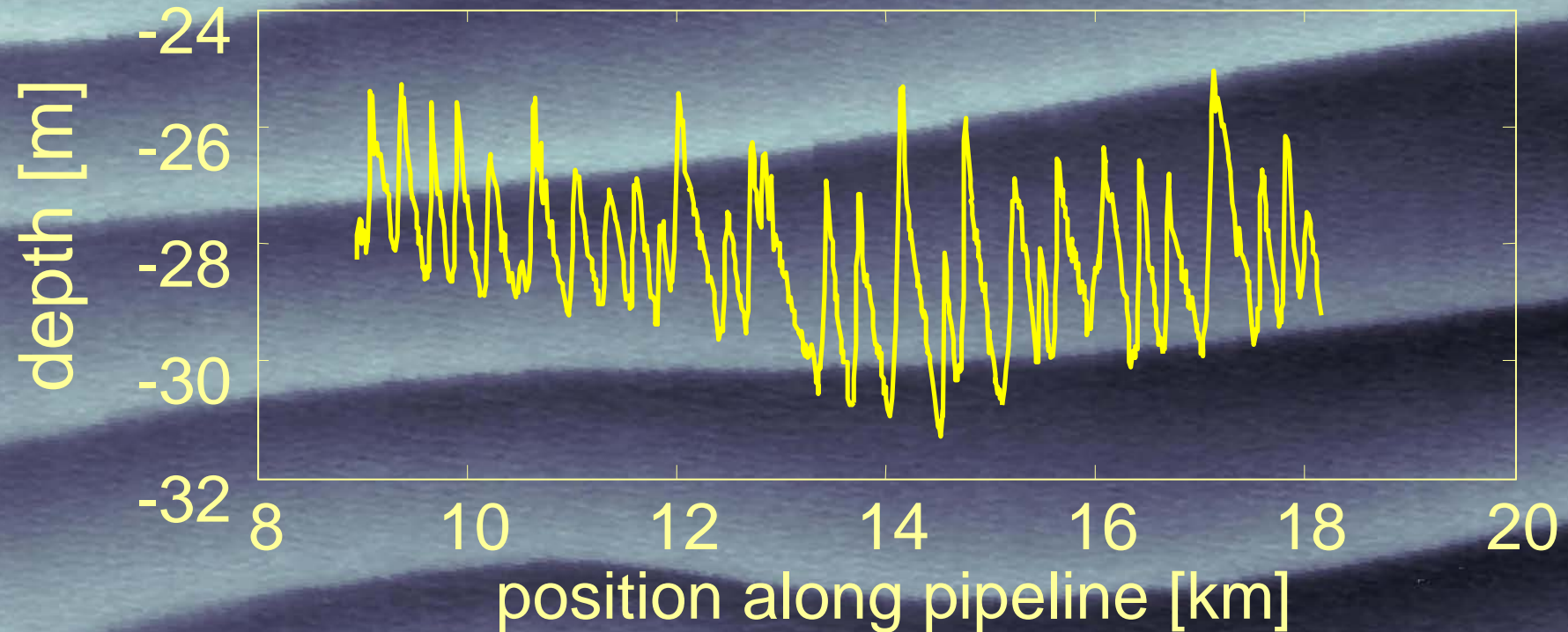
Can the shape of sand
waves tell us
something about the
migration rate?

Data analysis Sand Waves 9 Datasets



Sand Waves

Data 1D

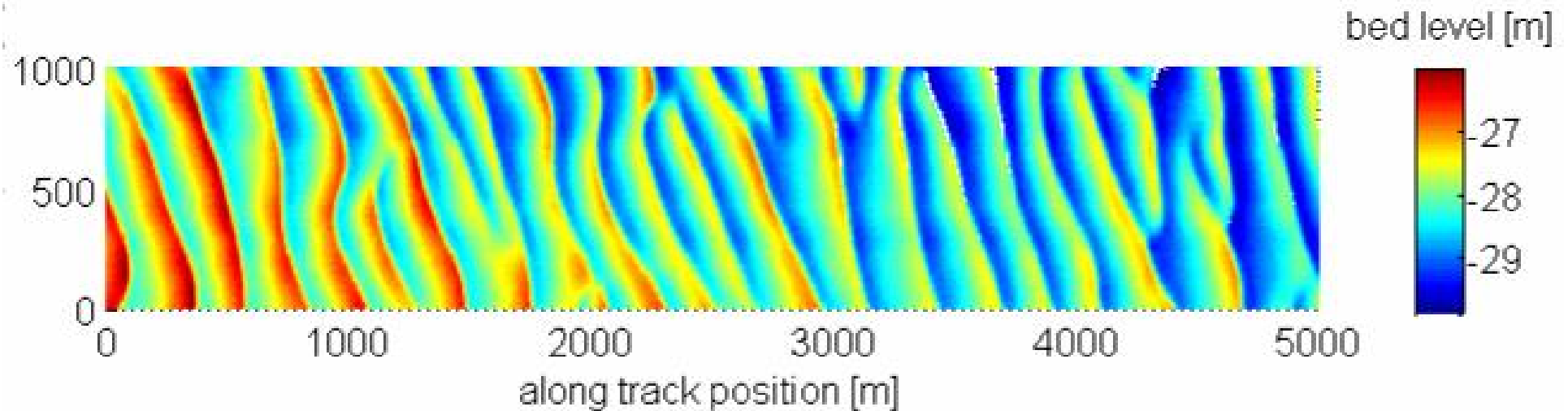


Single-beam echo-soundings

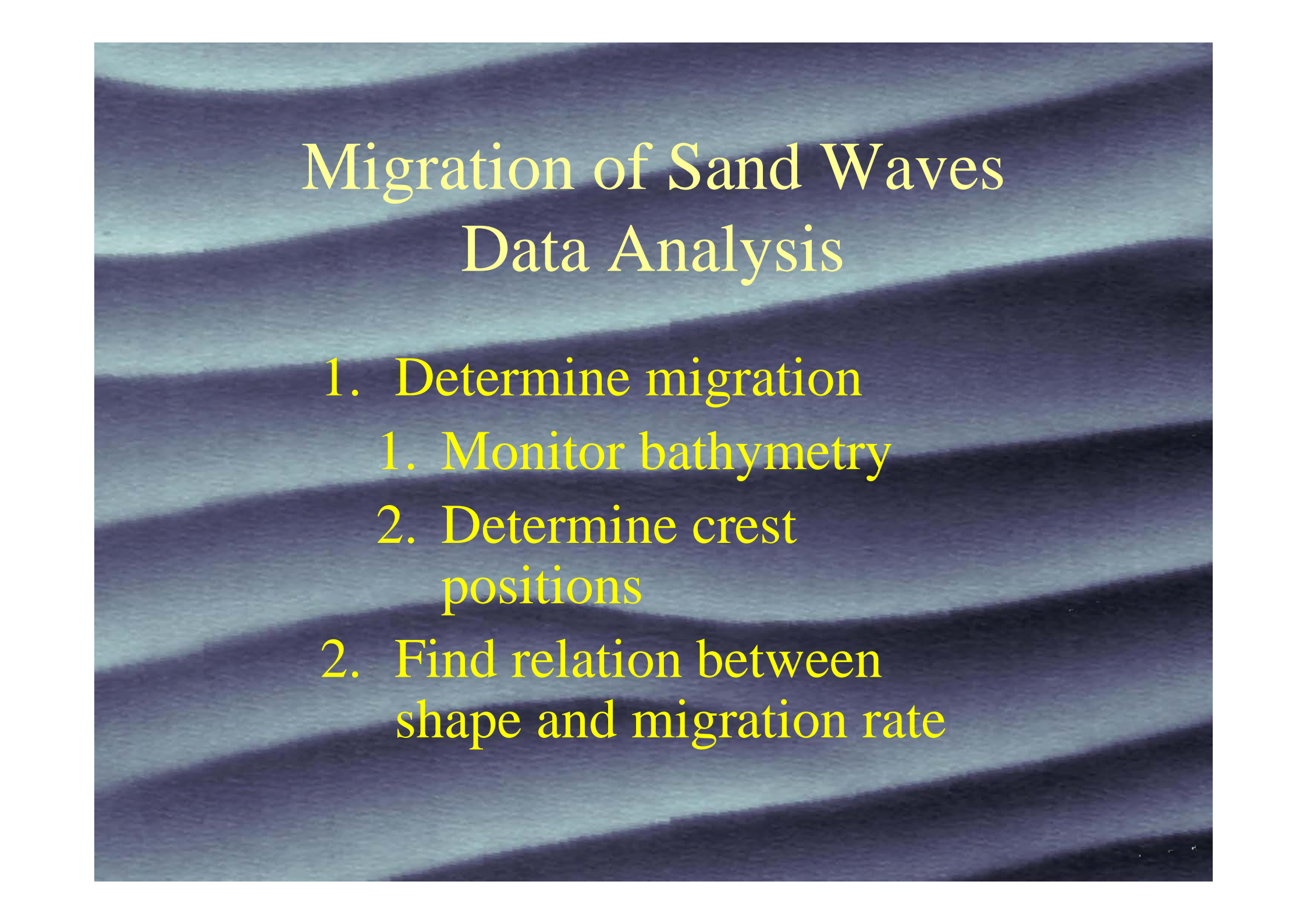
High resolution in 1D

High accuracy positioning

Sand Waves Data 2D



Multi-beam echo-soundings
High resolution in 2D
Accuracy positioning varies in time



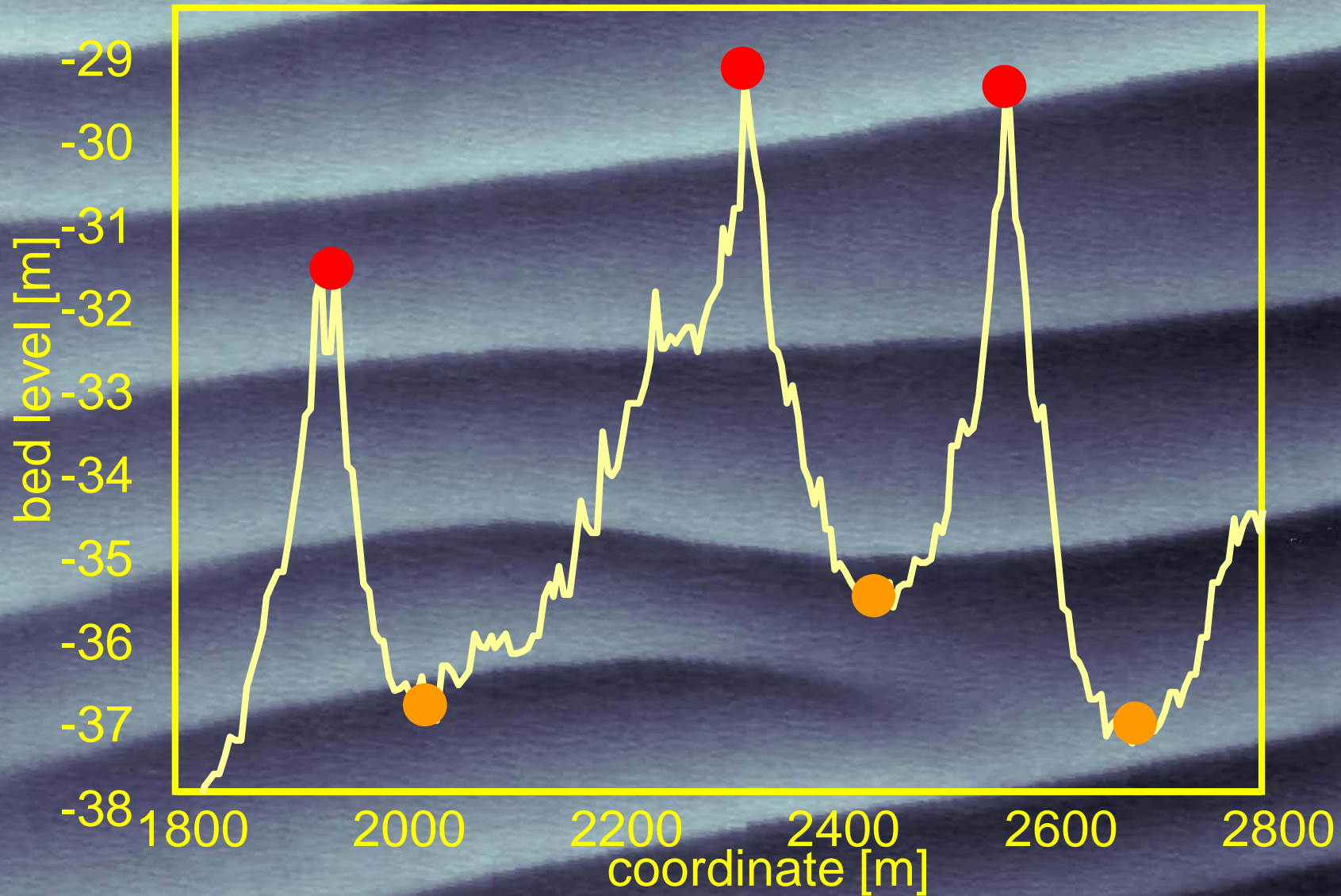
Migration of Sand Waves

Data Analysis

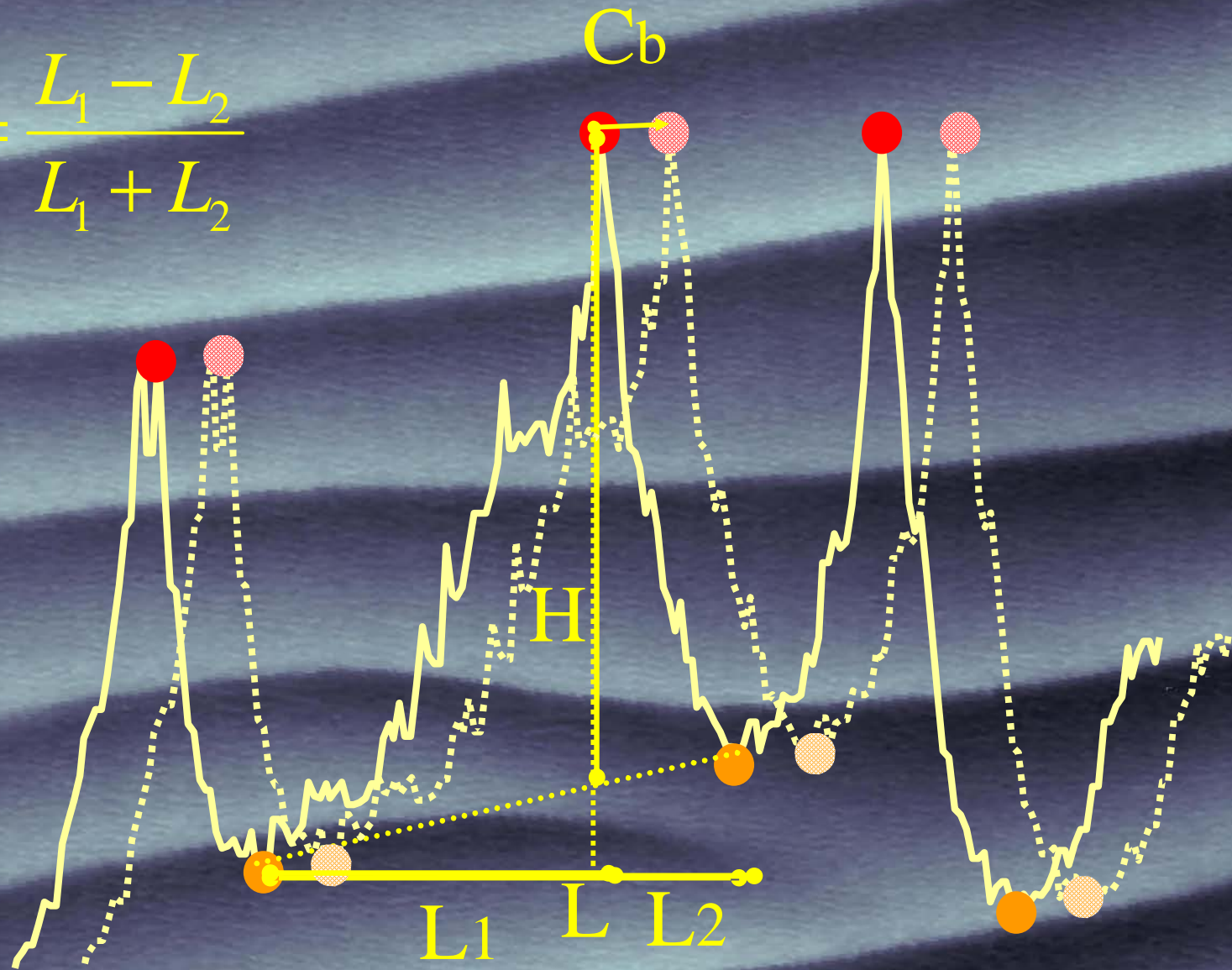
1. Determine migration
 1. Monitor bathymetry
 2. Determine crest positions
2. Find relation between shape and migration rate

Data Analysis

Shape & migration

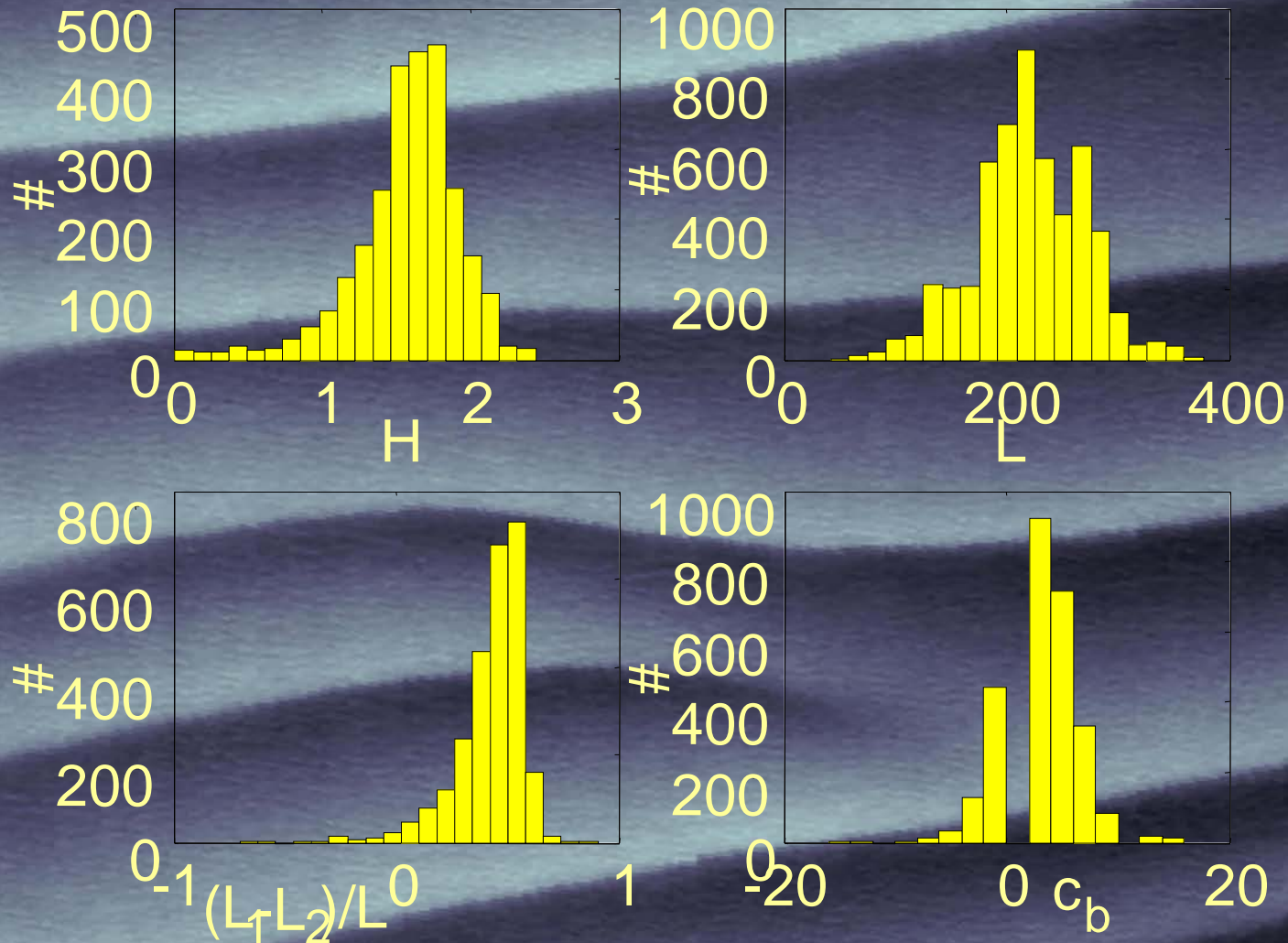


$$As = \frac{L_1 - L_2}{L_1 + L_2}$$



Estimating Characteristics

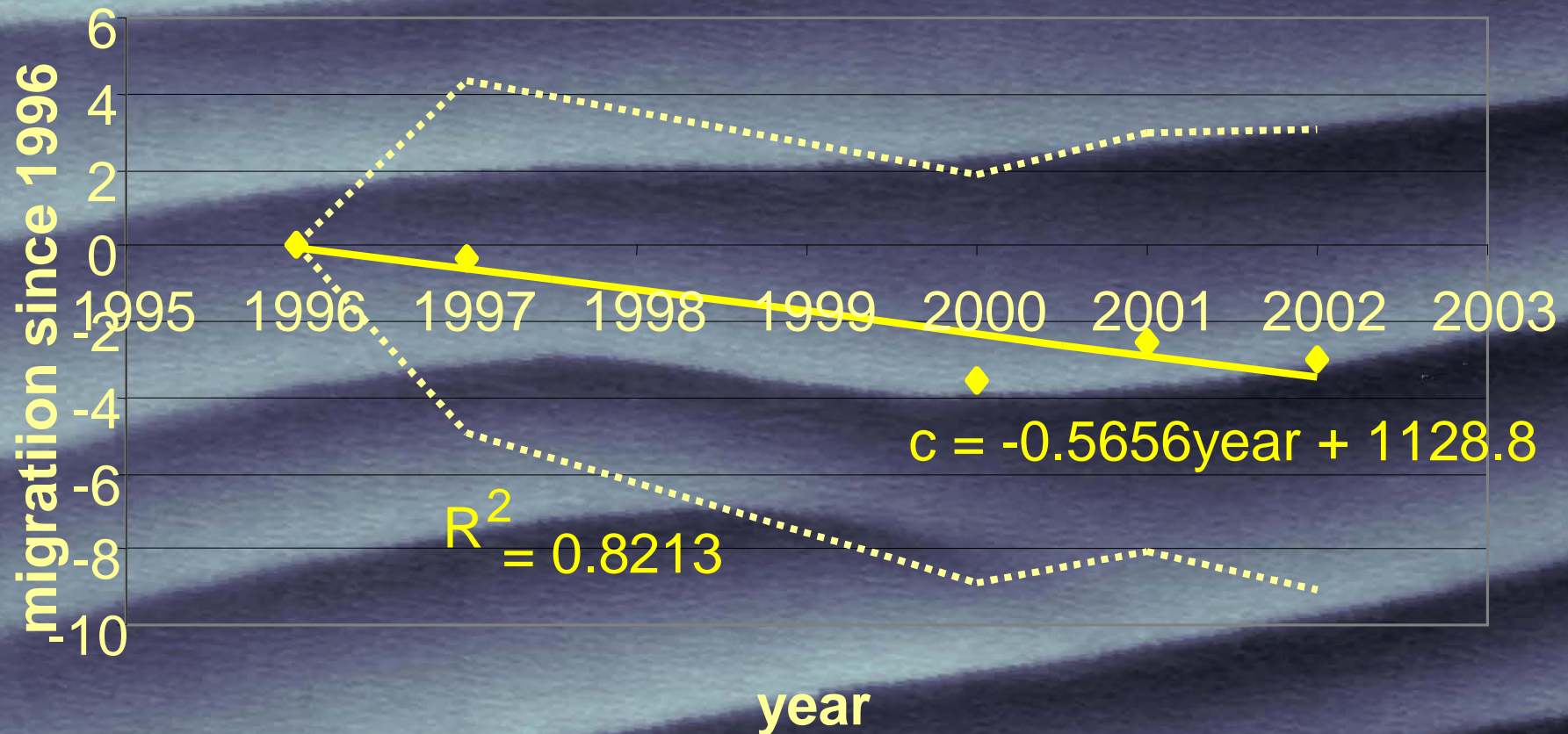
Test against measured data



Estimating Characteristics

Test against measured data

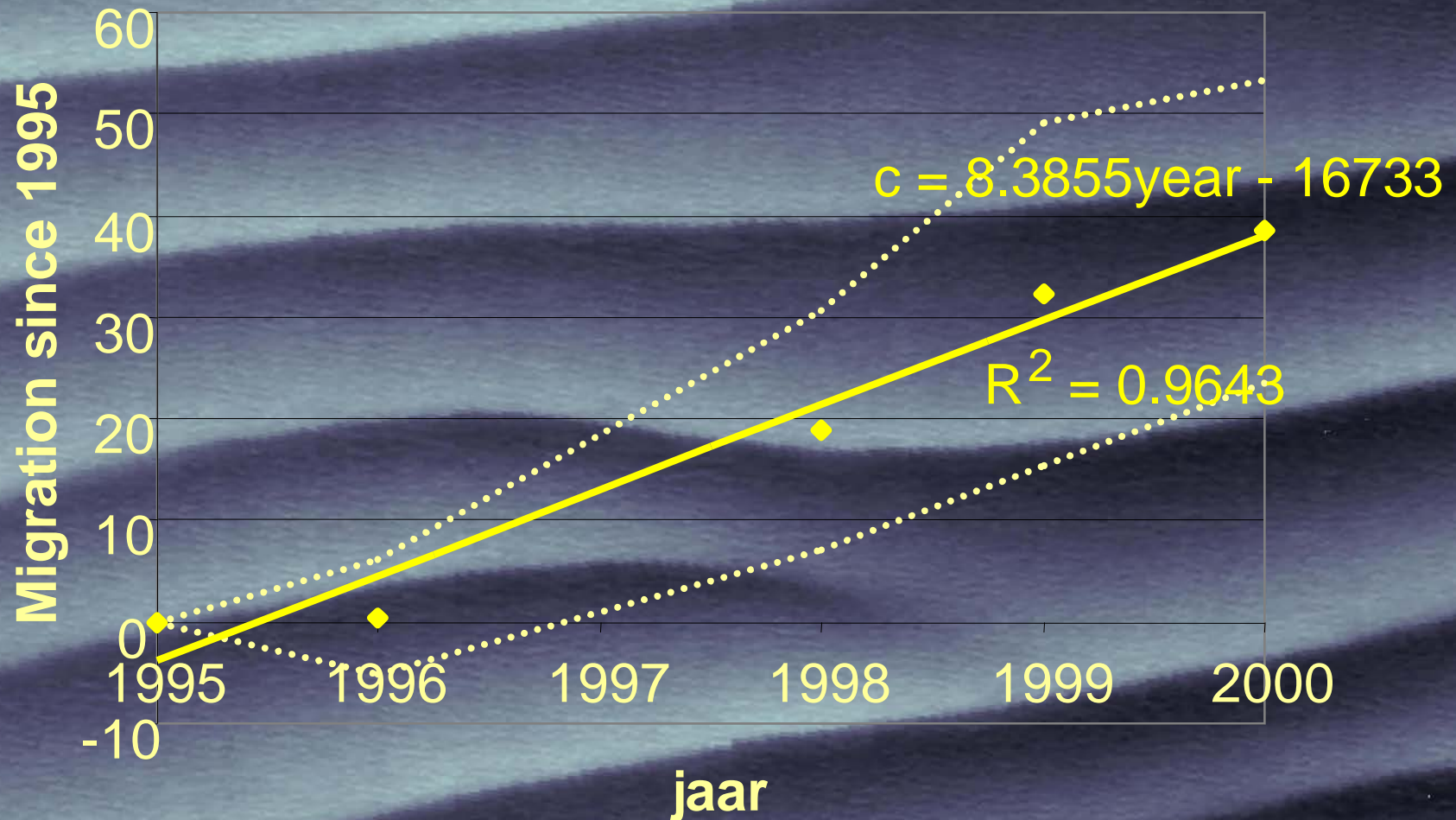
Euro 1



Estimating Characteristics

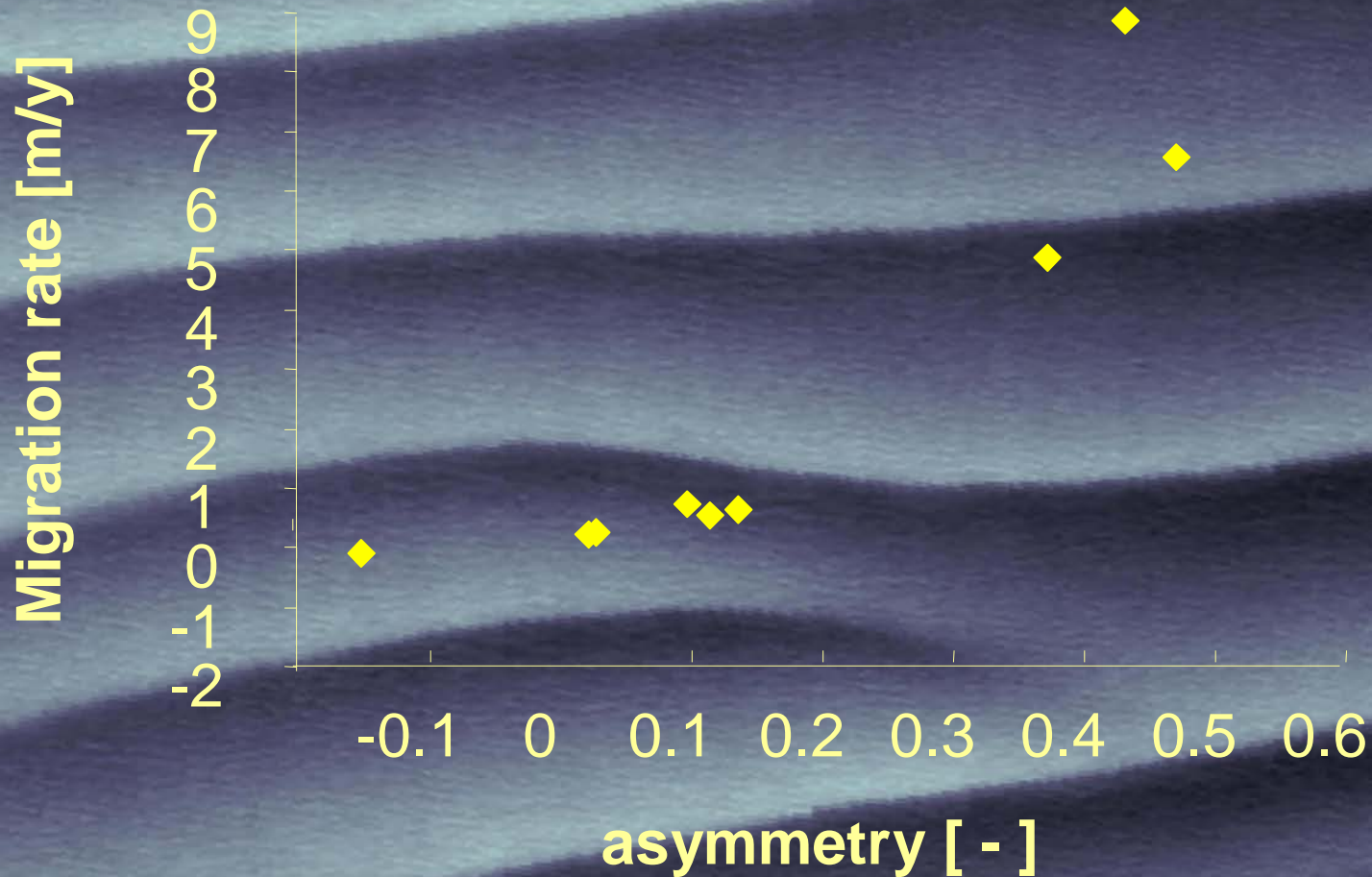
Test against measured data

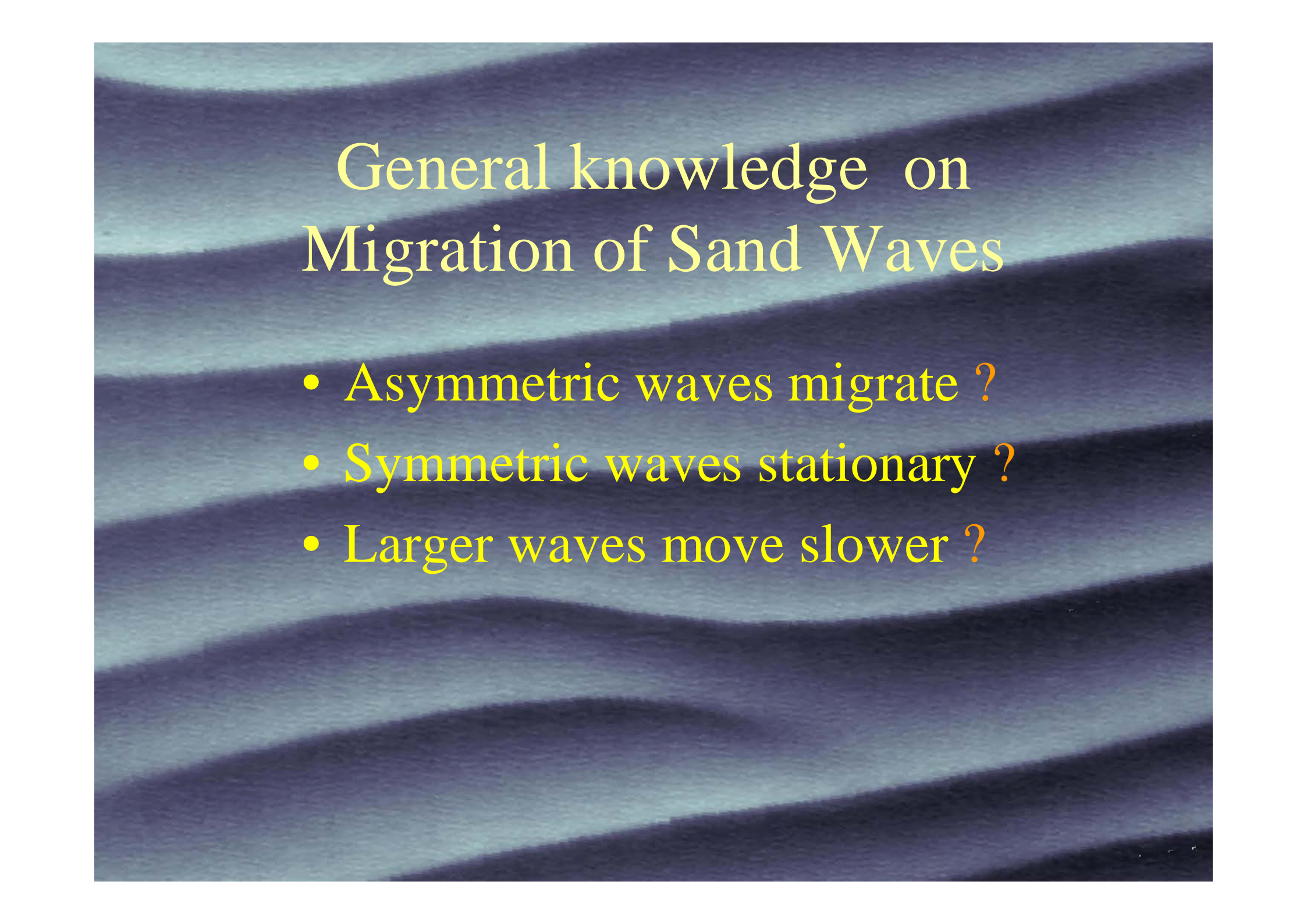
Pipeline 1



Predicting migration

Test against measured data



An aerial photograph of a vast sand dune field. The dunes are arranged in long, parallel ridges that stretch across the frame. The lighting creates a gradient of colors from light tan on the windward slopes to deep shadows in the troughs. The overall scene is serene and emphasizes the rhythmic patterns of the desert landscape.

General knowledge on Migration of Sand Waves

- Asymmetric waves migrate ?
- Symmetric waves stationary ?
- Larger waves move slower ?

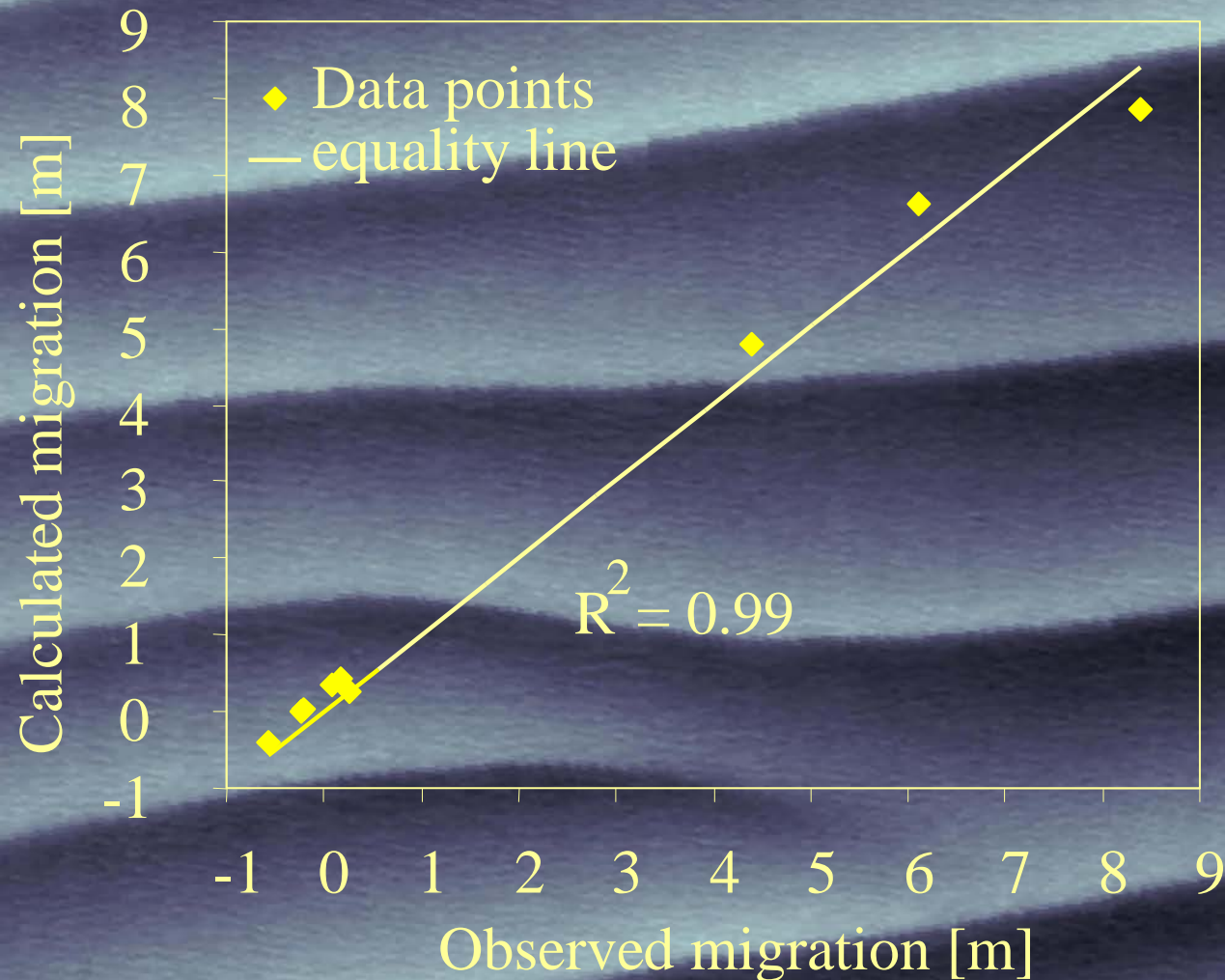
Predicting migration Parameterisation

$$c_b = 7\sigma L \frac{L}{H} A_s |A_s|$$

$$A_s = \frac{L_1 - L_2}{L_1 + L_2}$$

Predicting migration

Test against measured data



Conclusion

- Migration can be observed from time series
- Individual observations may deviate strongly, due to inaccuracies
- Observed migration < 10 m/year in North Sea

Conclusion

- Strong correlation between migration rate and asymmetry
- Migration can be predicted without temporal information

An aerial photograph of a vast sand dune field. The dunes are arranged in a series of parallel ridges and valleys, creating a rhythmic pattern across the landscape. The lighting is soft, highlighting the gentle slopes of the dunes. The text is overlaid in a bright yellow color, centered on the image.

Predicting migration of sand
waves based on shapes only,
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Sand wave shapes are a
morphological footprint of
time !