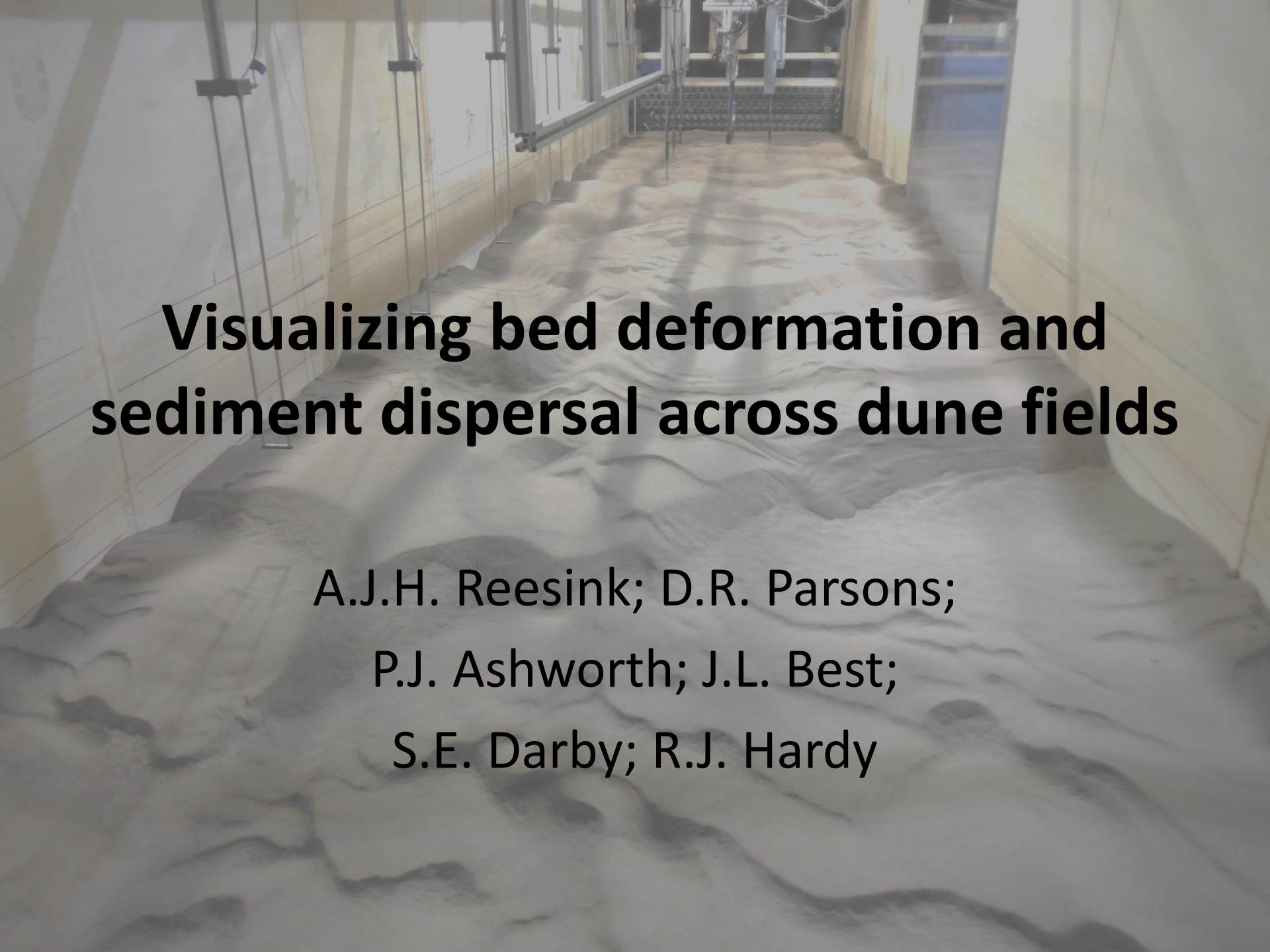


Visualizing bed deformation and sediment dispersal across dune fields

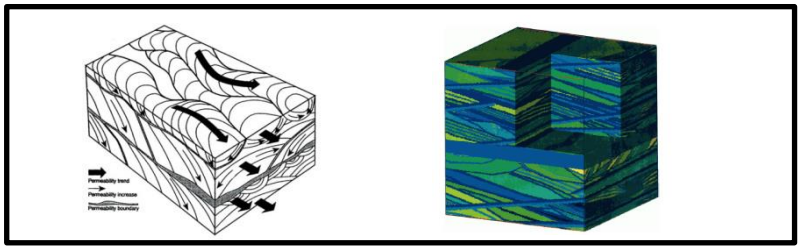
A.J.H. Reesink; D.R. Parsons;

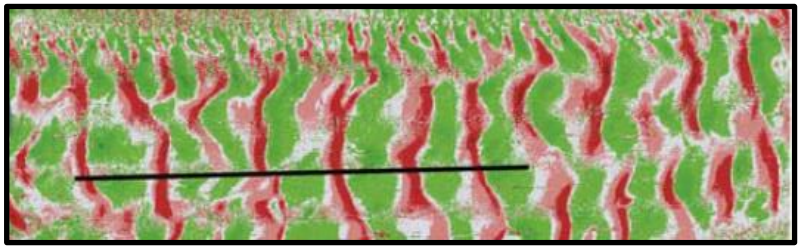
P.J. Ashworth; J.L. Best;

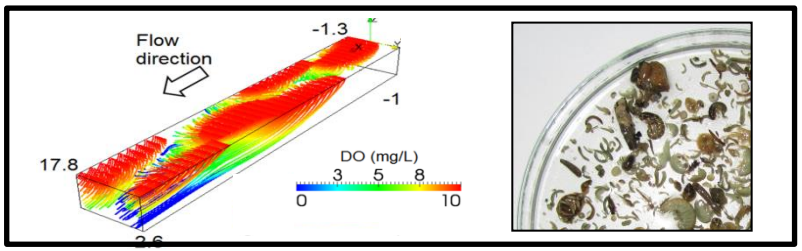
S.E. Darby; R.J. Hardy

Dunes… Why care?

- Hydraulic roughness & *flooding*
- Permeability & porosity of *reservoirs*
- *Sediment transport*
- Hyporheic zone & “live habitat”







Dune fields in dynamic equilibrium

- As dunes migrate downstream, they deform

JOURNAL OF GEOPHYSICAL RESEARCH, VOL. 114, F00A04, doi:10.1029/2008JF001220, 2009

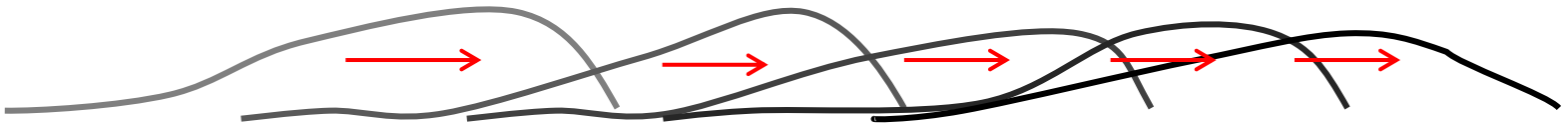
Click Here for Full Article

Nature of deformation of sandy bed forms

Brandon McElroy[1] and David Mohrig[1]

Received 6 January 2009; revised 12 May 2009; accepted 1 June 2009; published 6 August 2009.

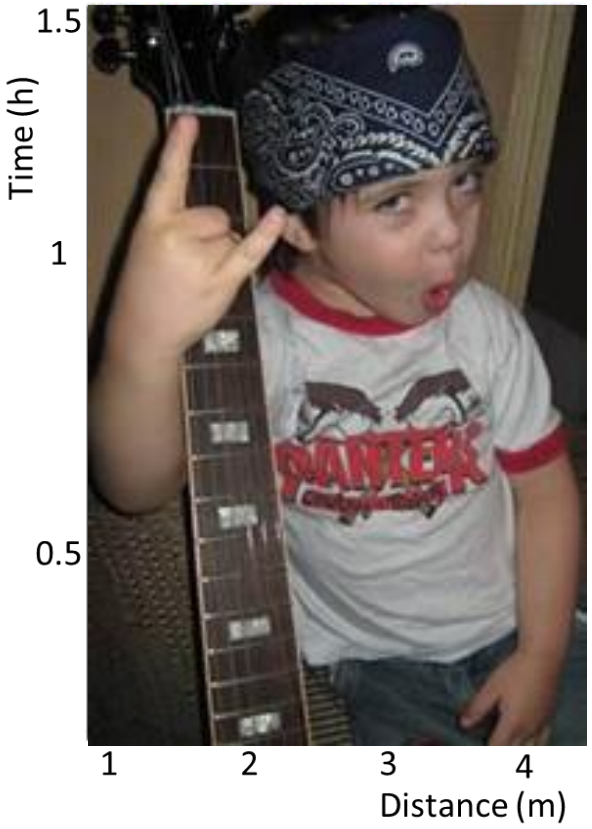
[1] We explore a stochastic component of topographic evolution of sandy river beds and its relationship to bed material flux. The behavior of trains of mobile bed forms can be decomposed into two independent constituents, translation and deformation. Translation is



Problem 1: Poor individual behaviour

Large numbers of dunes & long periods of time

Versus… few dunes & short periods of time

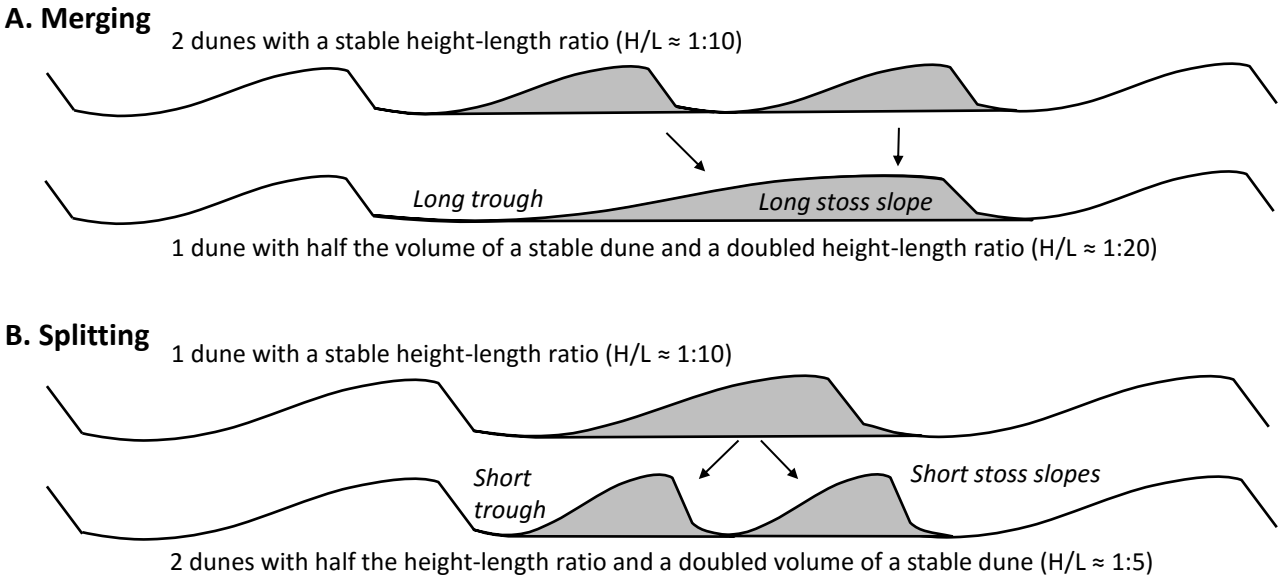


Problem 2: Poor group behaviour

Different populations are known to have contrasting behaviour…

Kleinhans et al, 2007

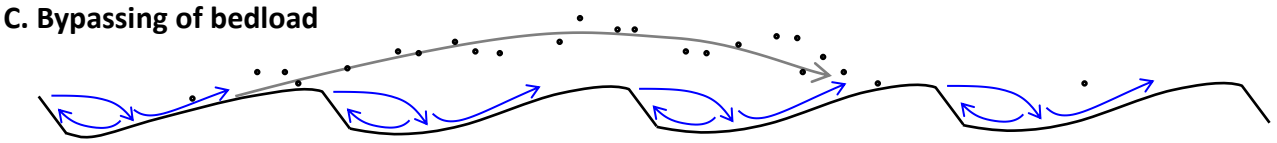
Point 1) Dune growth & decay



1. Dune adaptation (to changes in flow) is always a response of a population, not of individuals
2. Dune adaptation results in local deficit and surplus of sediment, and hence, more variable sediment transport…

Reesink et al., 2016, almost in review

Point 2) Sediment redistribution



Naqshband et al., 2014

Martin & Jerolmack, 2013

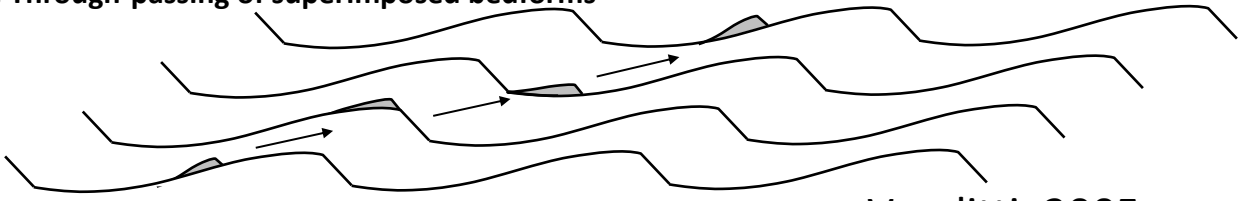
Gabel, 1993

Rubin & McCulloch, 1980

Reesink et al., 2016, almost in review

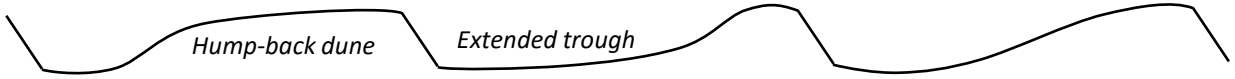
Sediment redistribution

G. Through-passing of superimposed bedforms



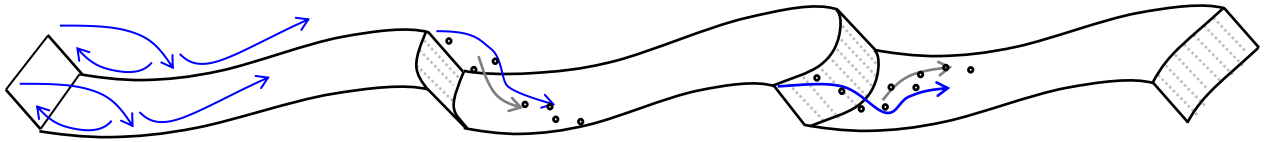
Venditti, 2005

H. Geometric change



Reesink & Bridge, 2009

I. Cross-stream sediment transfer



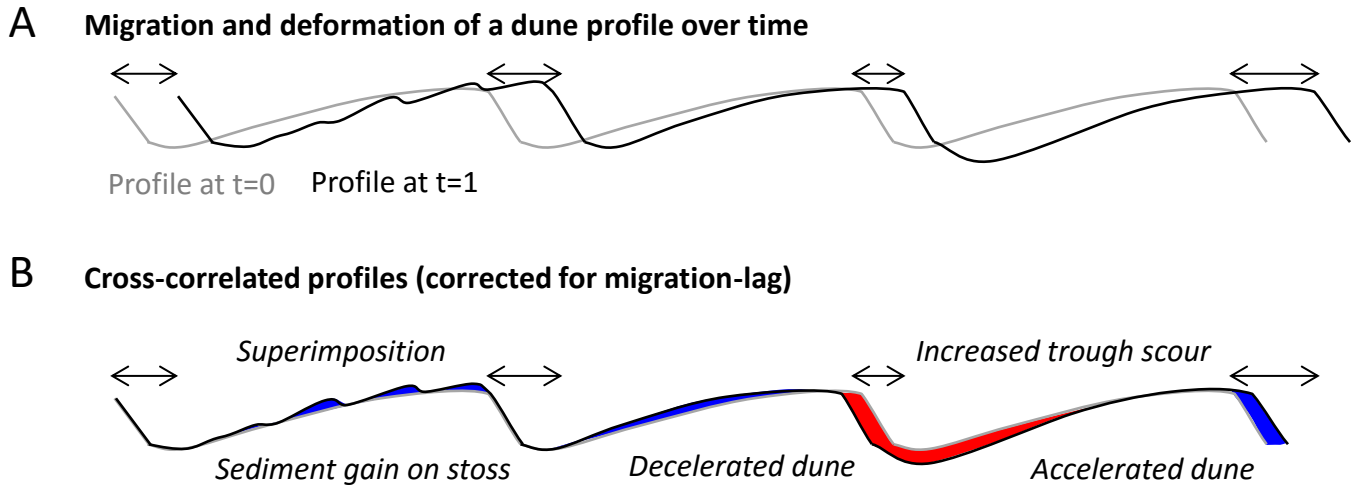
Allen, 1982

- Multiple mechanisms are unlikely to yield a single, universally applicable response…

Reesink et al., 2016, almost in review

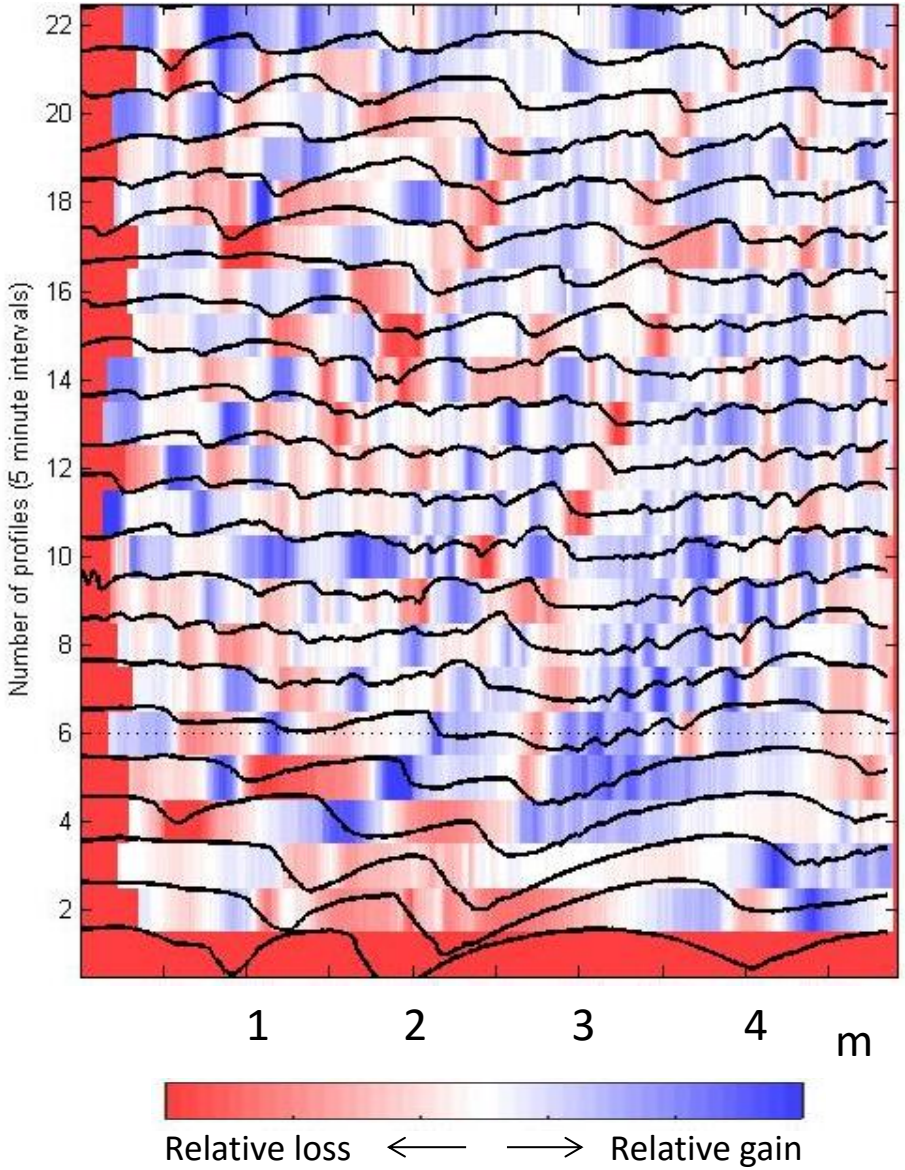
Point 3) Visualising deformation

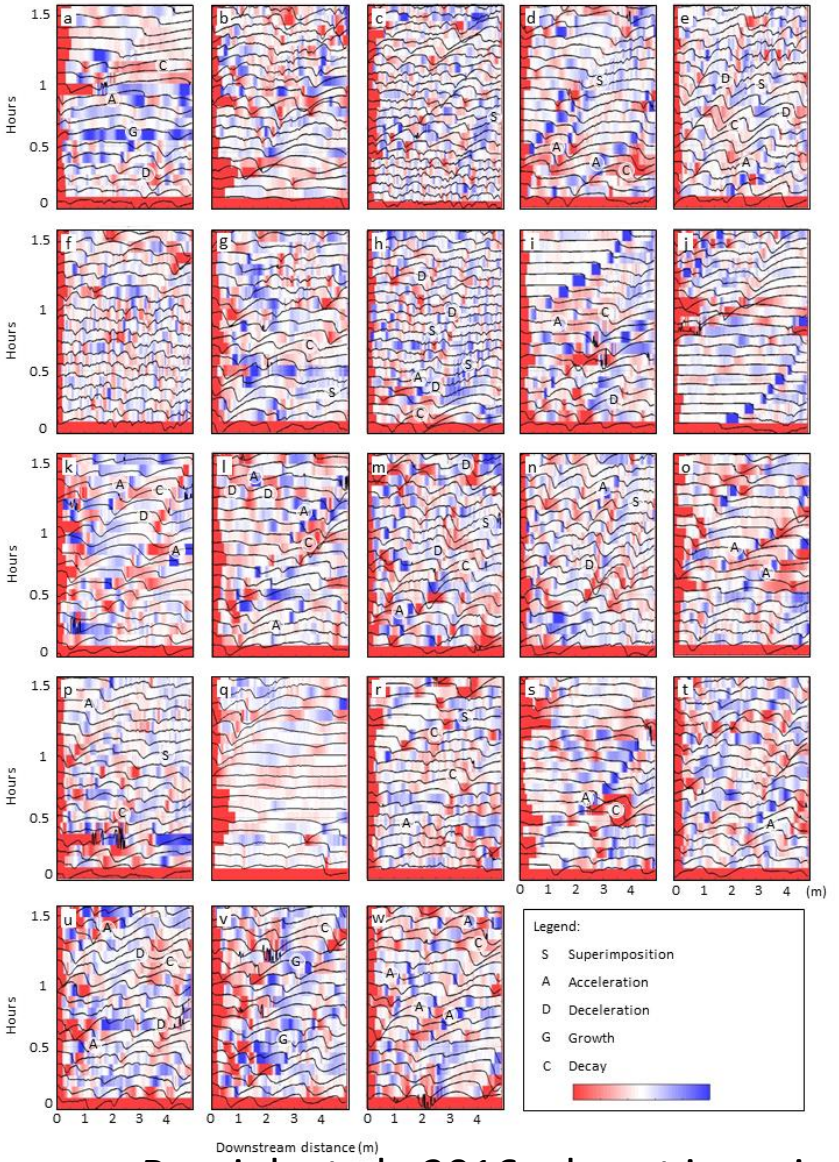
- Different sediment dispersal mechanisms have different ‘signatures’ (residuals after cross-correlation)



Reesink et al., 2016, almost in review

Visualised deformation!

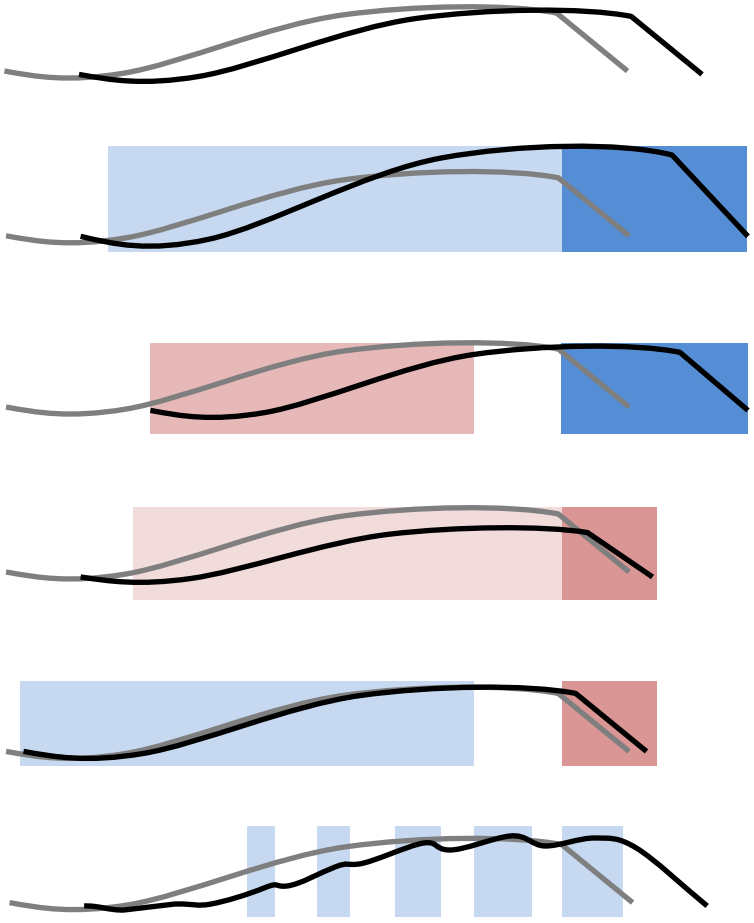




Reesink et al., 2016, almost in review

Interpretations

- No change in shape
- Growth
- Acceleration
- Decay
- Deceleration
- Superimposition

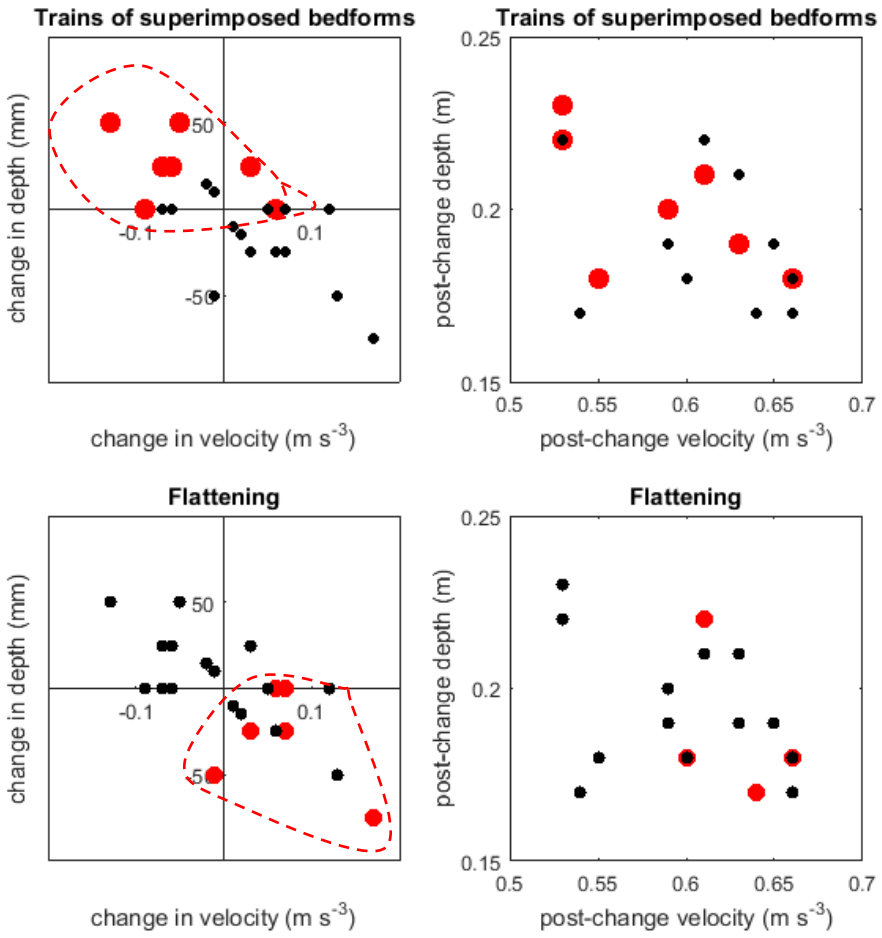


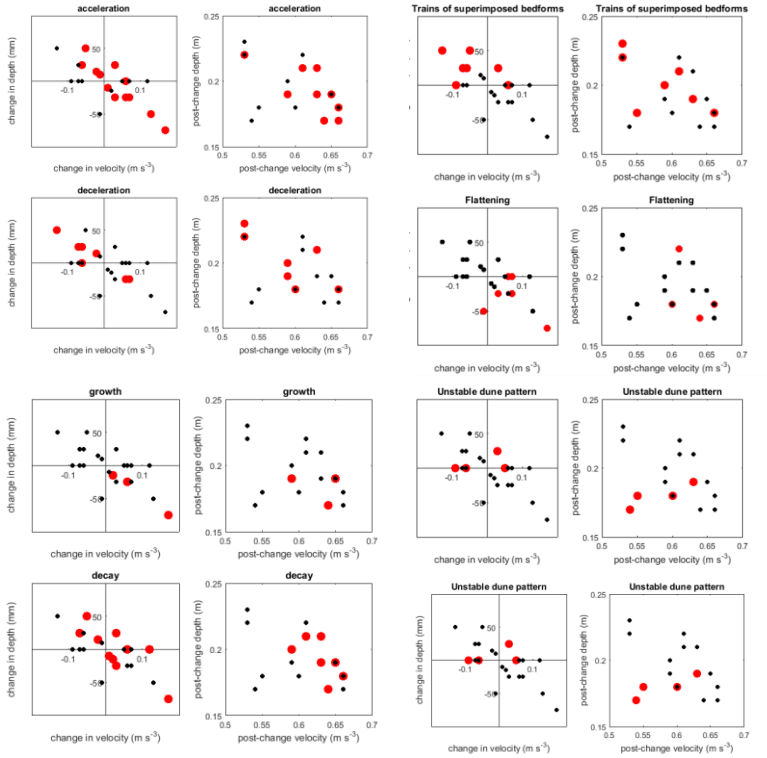
Observations

- Zones of excess/lack of deposition persist: sources & sinks of sediment within a mobile dune field
- Acceleration and deceleration of lee slopes is systematic, but often interrupted
- Trains of superimposed bedforms develop on ‘stalling & aggrading’ lee slopes

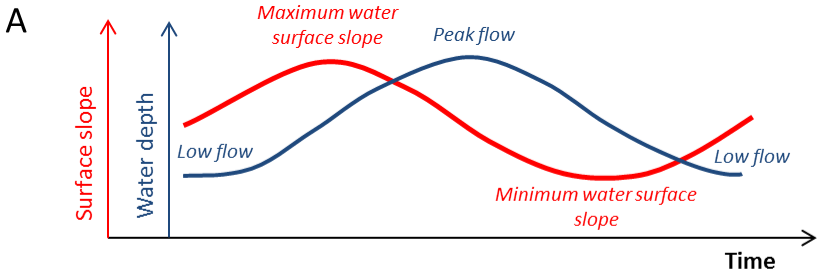
Point 4) Depth & Velocity…

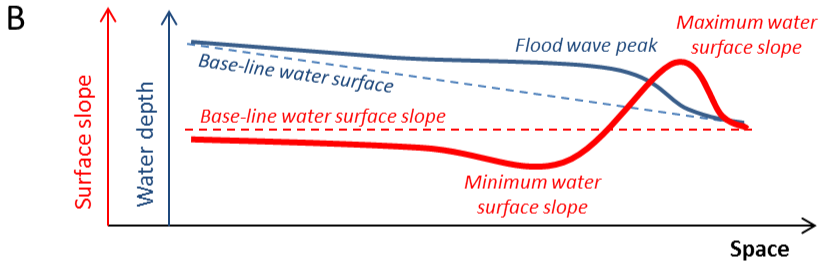
Some processes appear linked to specific conditions

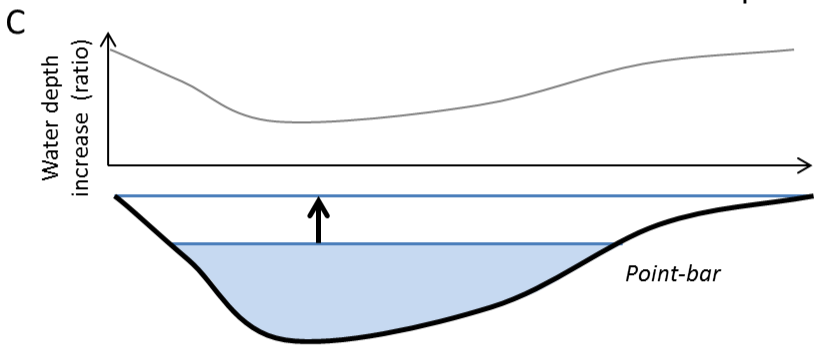


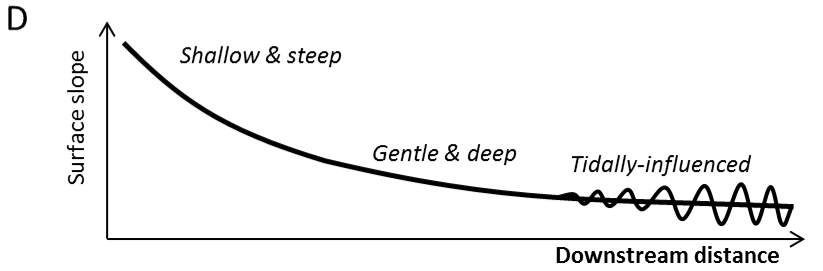


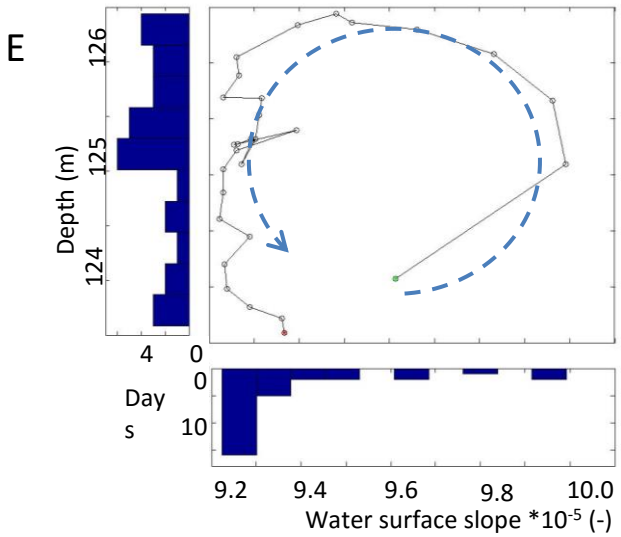
Point 5) Depth & Velocity

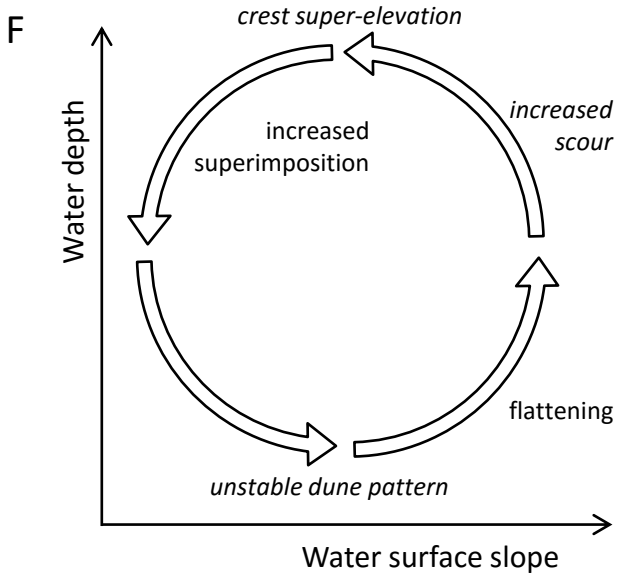










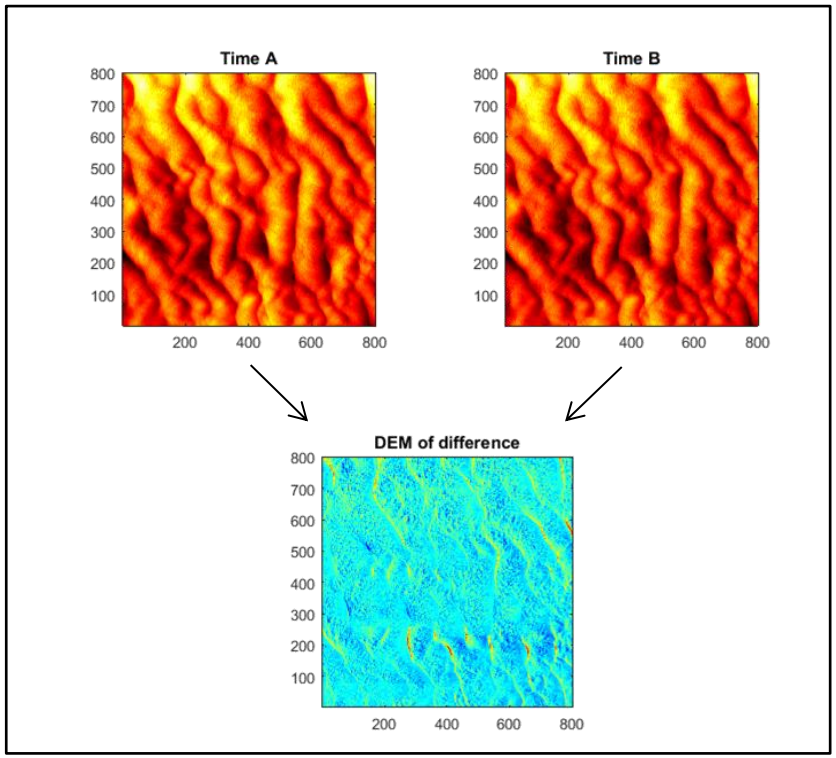


Summary

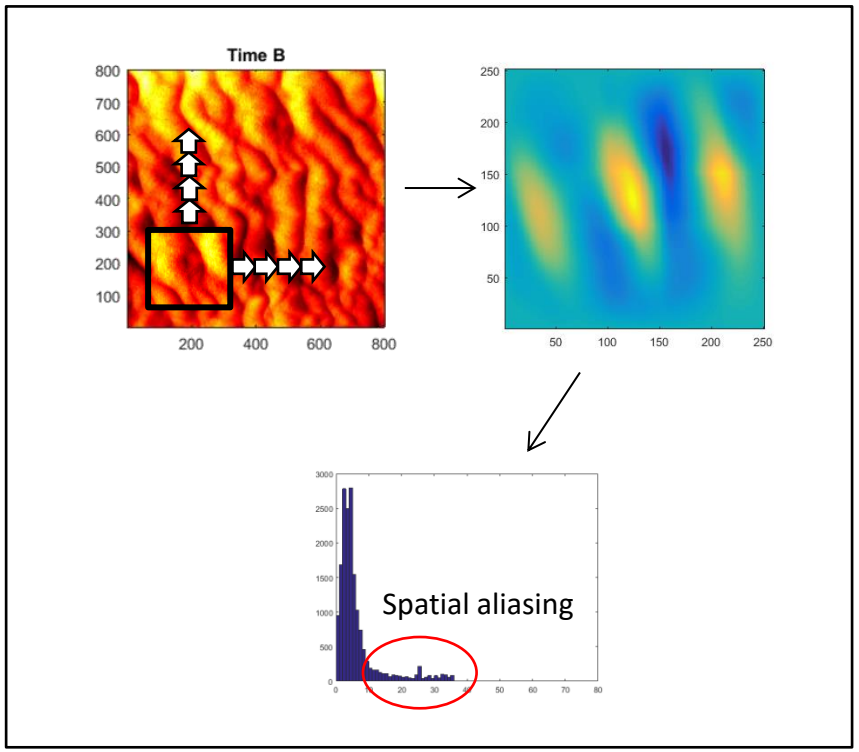
1. Dune growth/decay generates sources/sinks & variable transport
2. Multiple sediment dispersal mechanisms exist
3. We can visualise these mechanisms
4. Mechanisms vary depending on depth, slope, grain size…
5. Therefore, *dune adaptation* to floods & changes in channel shape *varies systematically*

- Time & space scales, and resolution, are very important – *what scale are you looking at?*

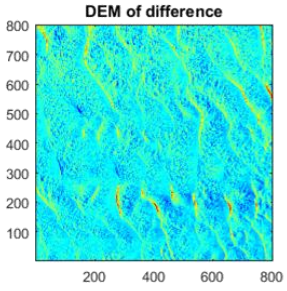
Traditional analysis



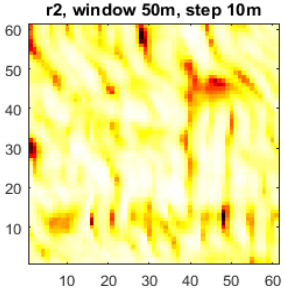
Cross-correlation



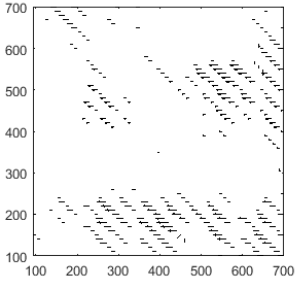
DEM of difference



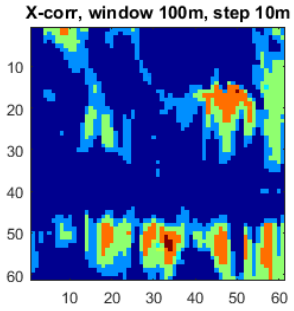
r^2 (deformation)



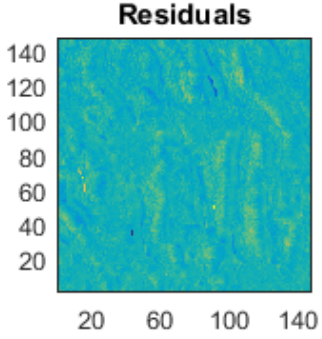
Migration vectors



Translation

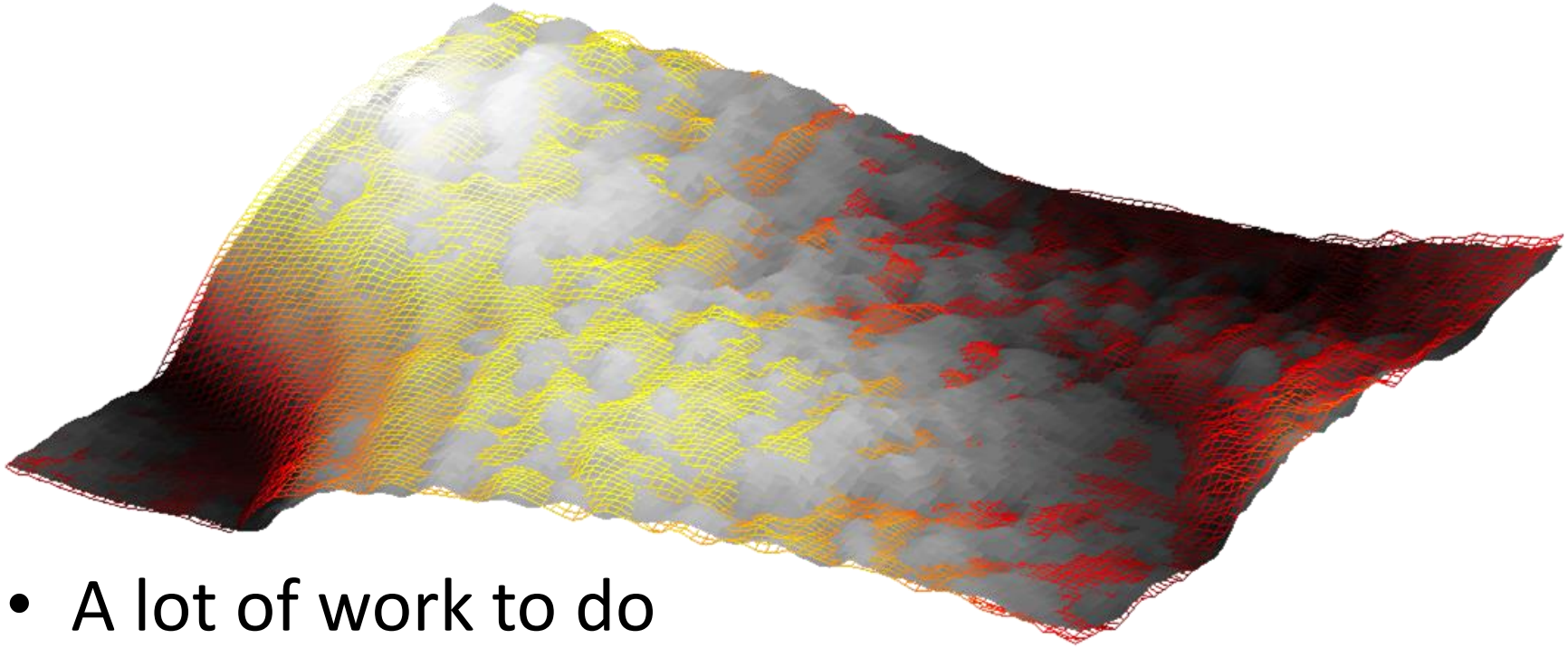


Residuals



We now have…

- A library of processes
- A way to visualise their effect on dunes
- Amazing measurements to analyse in a new way



- A lot of work to do

Questions?

Acknowledgements

This research was supported by grant NE/I014101/1 from the UK Natural Environment Research Council (NERC).