Aeolian sand sorting and megaripple formation

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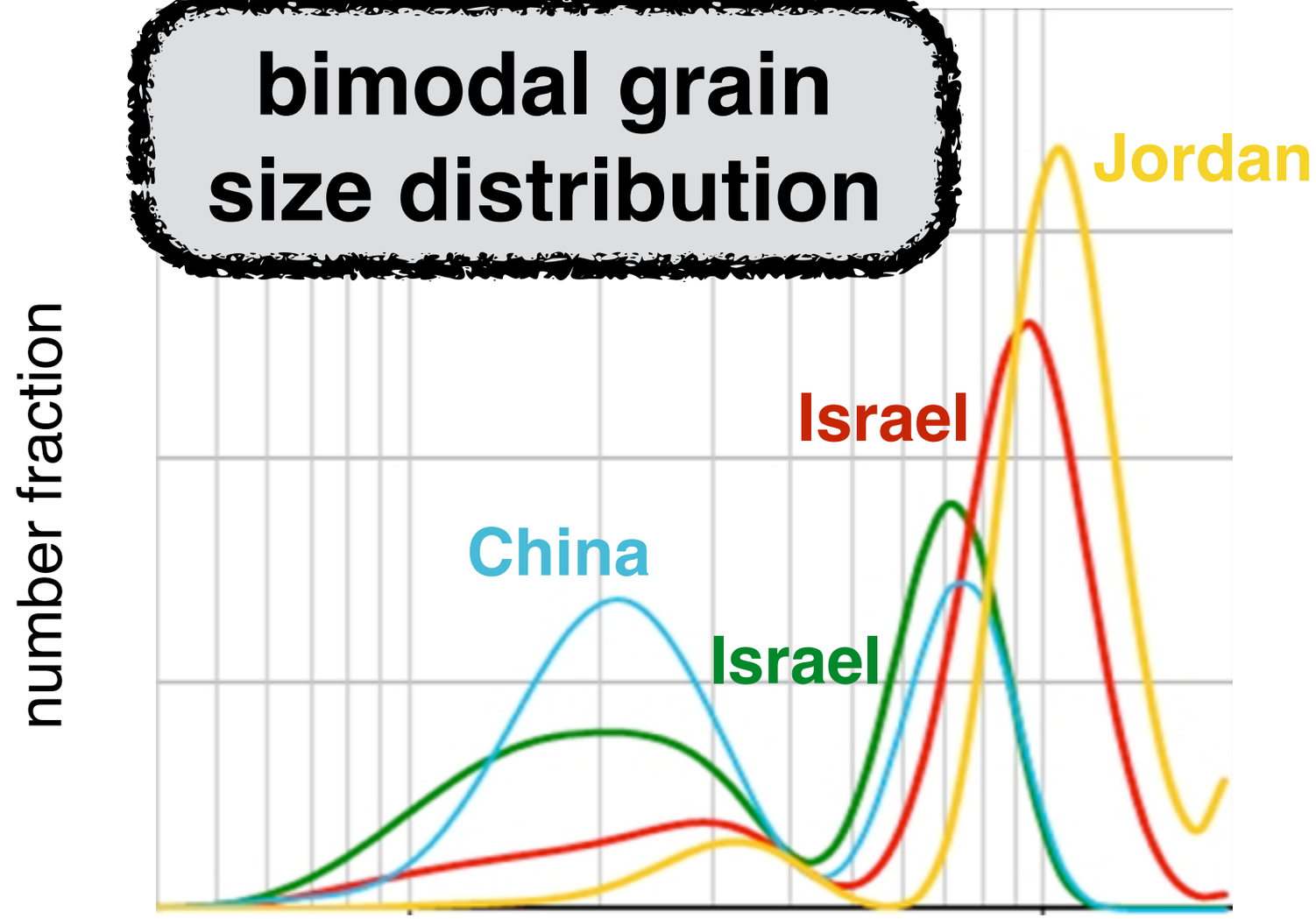
UNIVERSITÄT LEIPZIG

GIF

megaripples

megaripples

bimodal grain size distribution



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Aeolian Research

journal homepage: www.elsevier.com/locate/aeolia

Evolution of megaripples from a flat bed

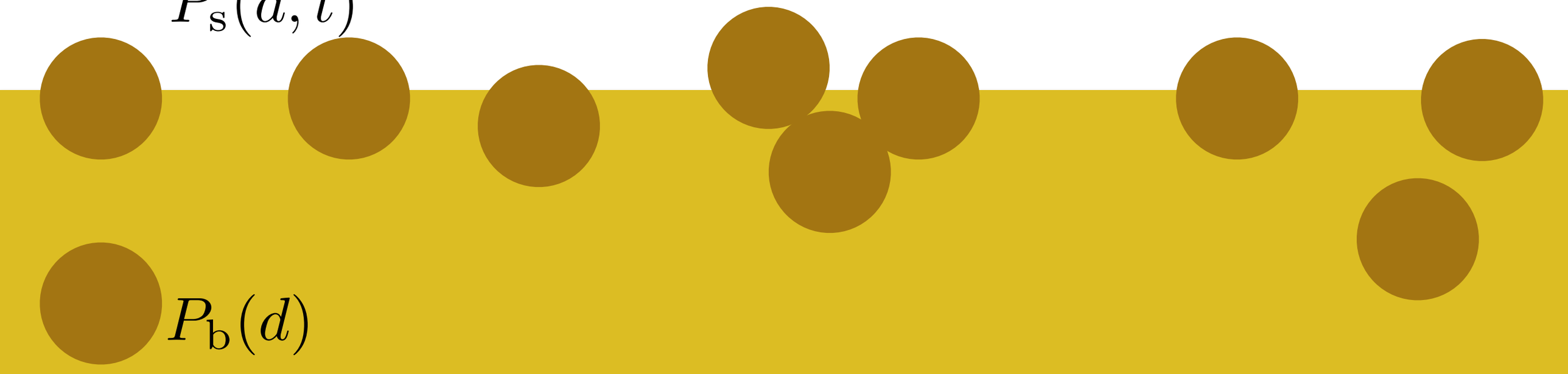
Hezi Yizhaq [a,*], Itzhak Katra [b], Ori Isenberg [a], Haim Tsoar [b]

sand sorting

sand sorting

grain size
distributions:

$P_{\mathrm{s}}(d,t)$



$P_{\mathrm{b}}(d)$

sand sorting

erosion bulk

$$\partial_t P_\mathrm{s}(d,t) = -\phi(d) P_\mathrm{s}(d,t) + \overline{\phi} P_\mathrm{b}(d)$$

grain size distributions:

$$\overline{\phi} = \int \mathrm{d}d\, \phi(d) P_\mathrm{s}(d,t)$$

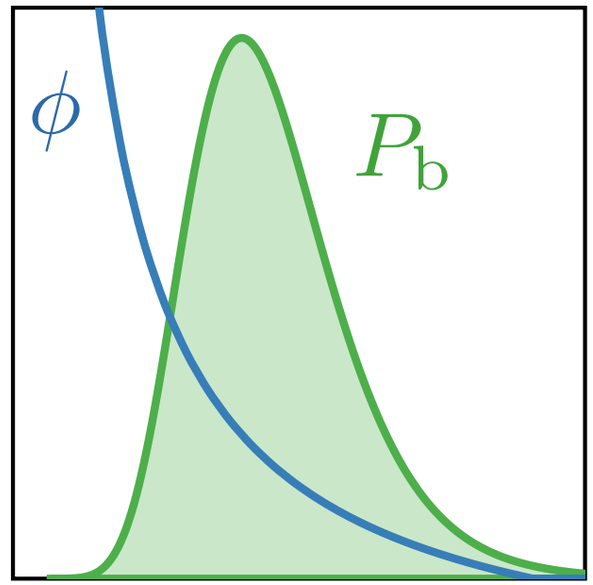
$P_\mathrm{s}(d,t)$

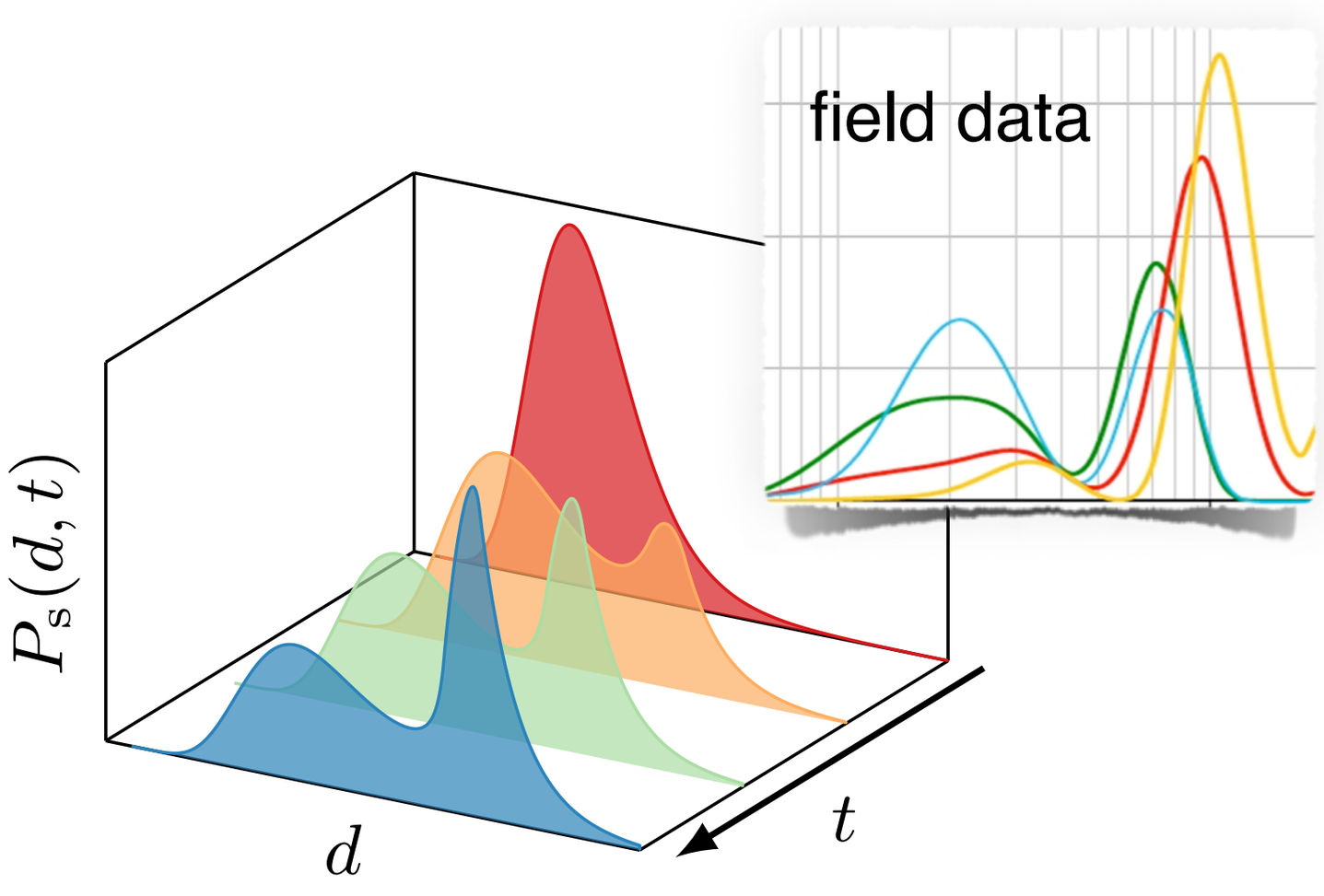
$P_\mathrm{b}(d)$

sand sorting

$$\partial_t P_\mathrm{s}(d,t) = -\phi(d) P_\mathrm{s}(d,t) + \overline{\phi} P_\mathrm{b}(d)$$

$$\phi(d) = \begin{cases} d^*/d - 1\,, & d < d^* \\ 0\,, & d > d^* \end{cases}$$





sand sorting

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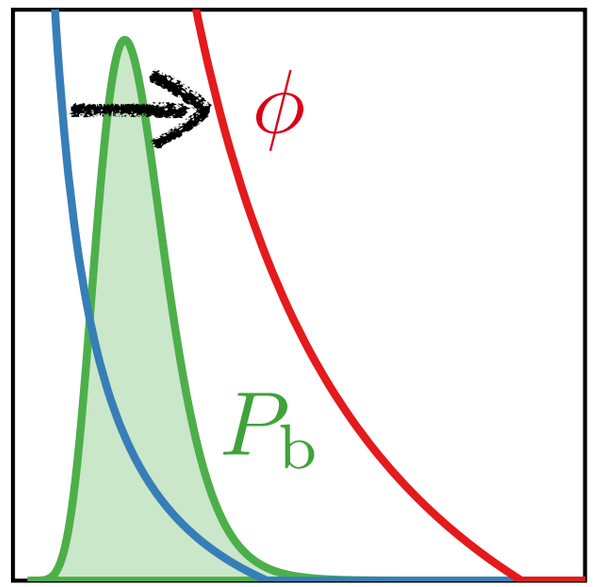
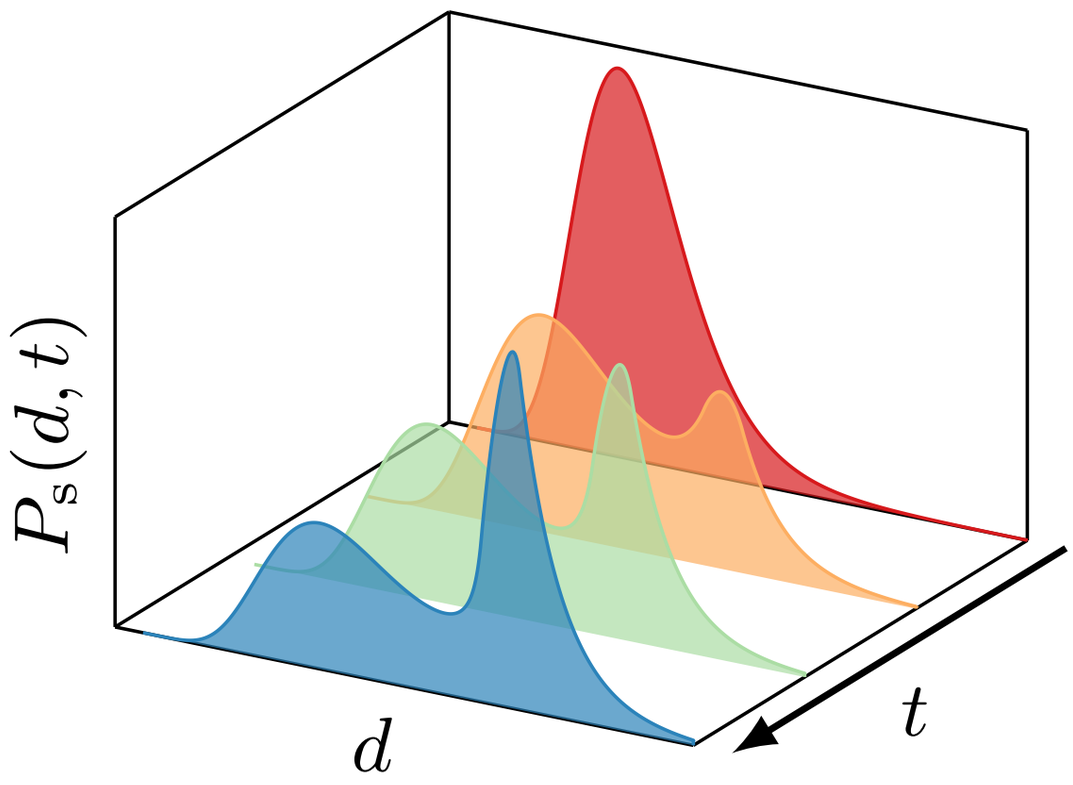
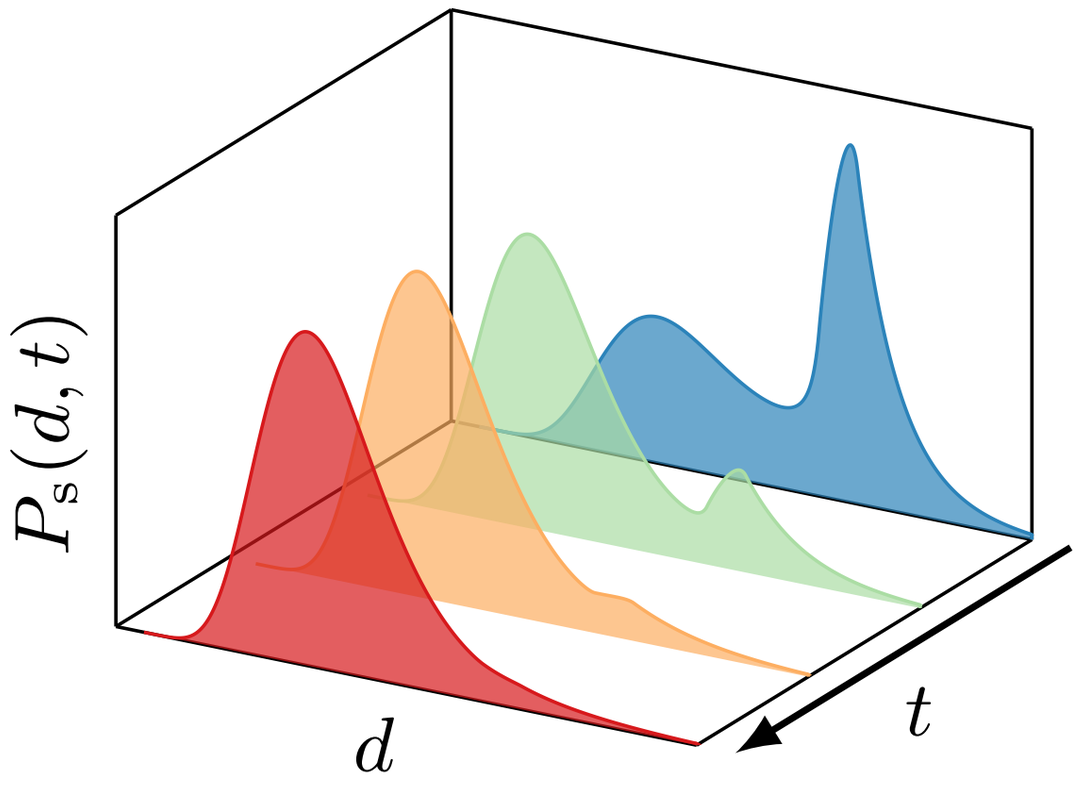


moderate wind

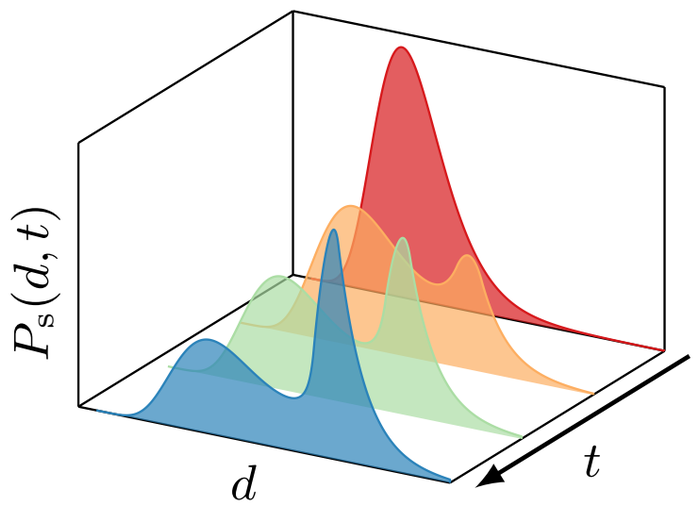


storm

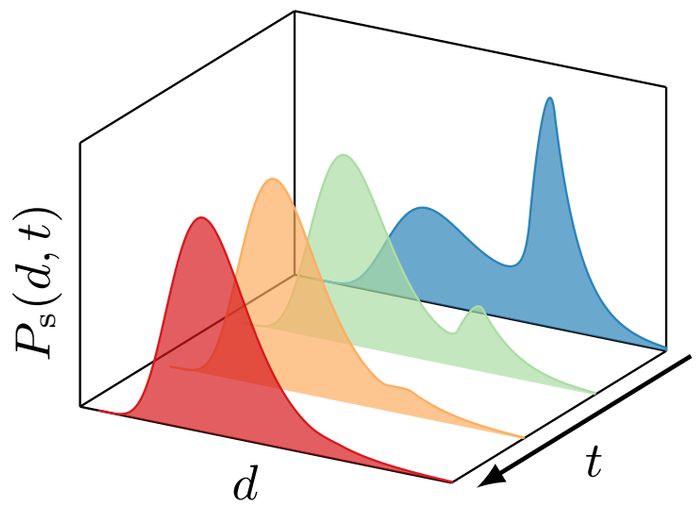


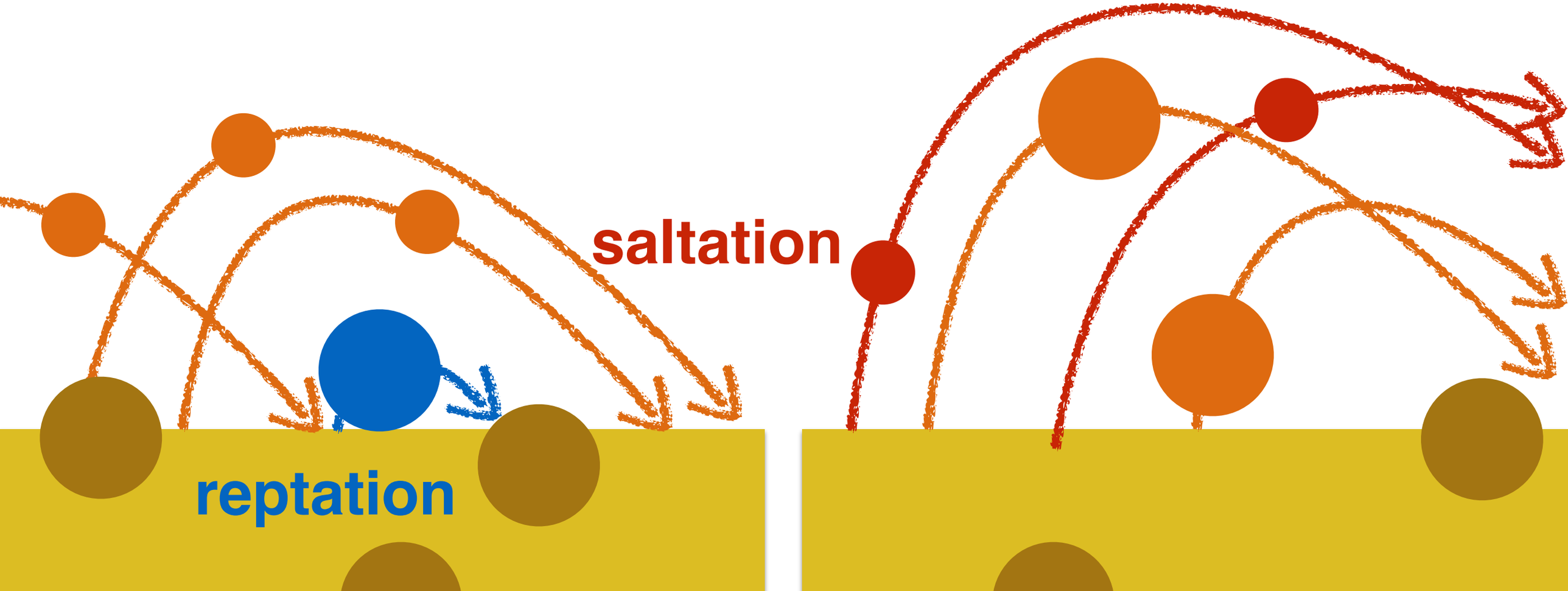
transport modes

moderate wind



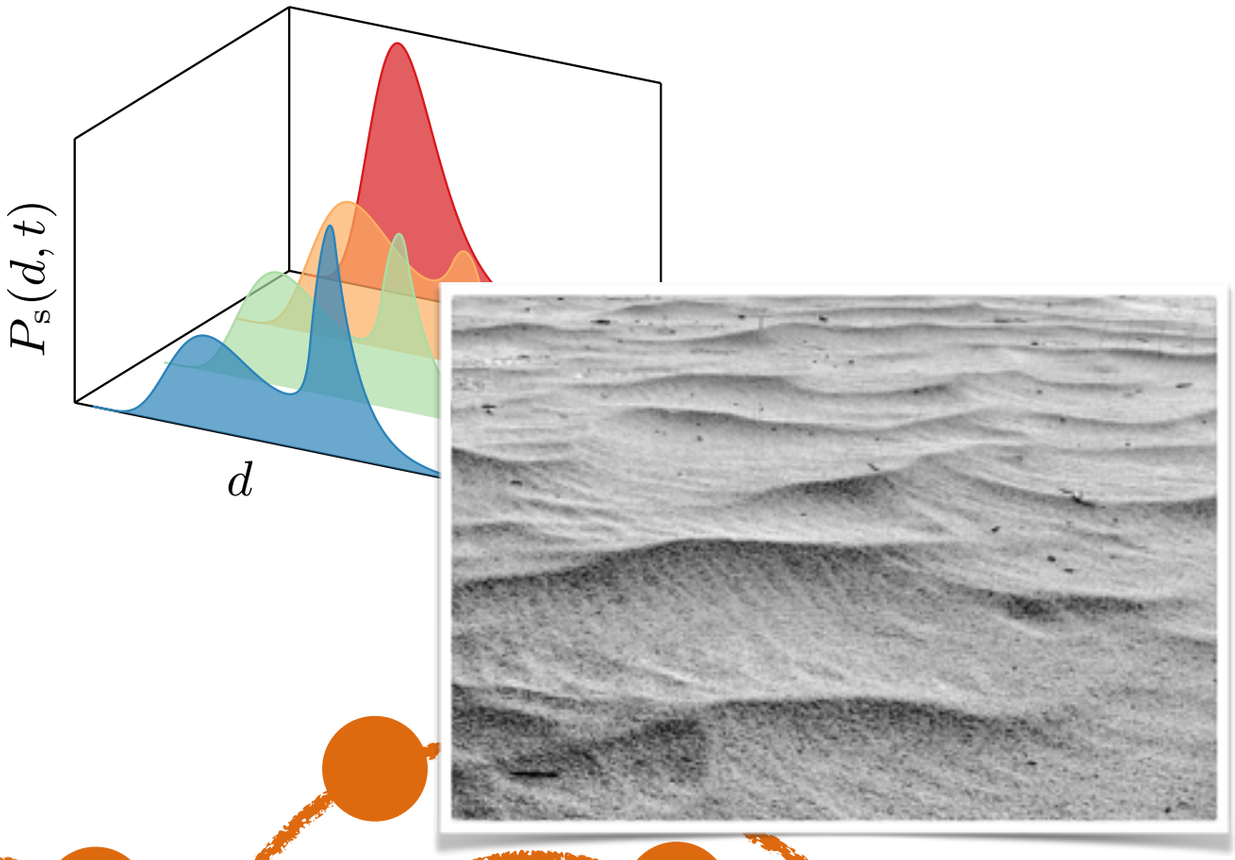
storm



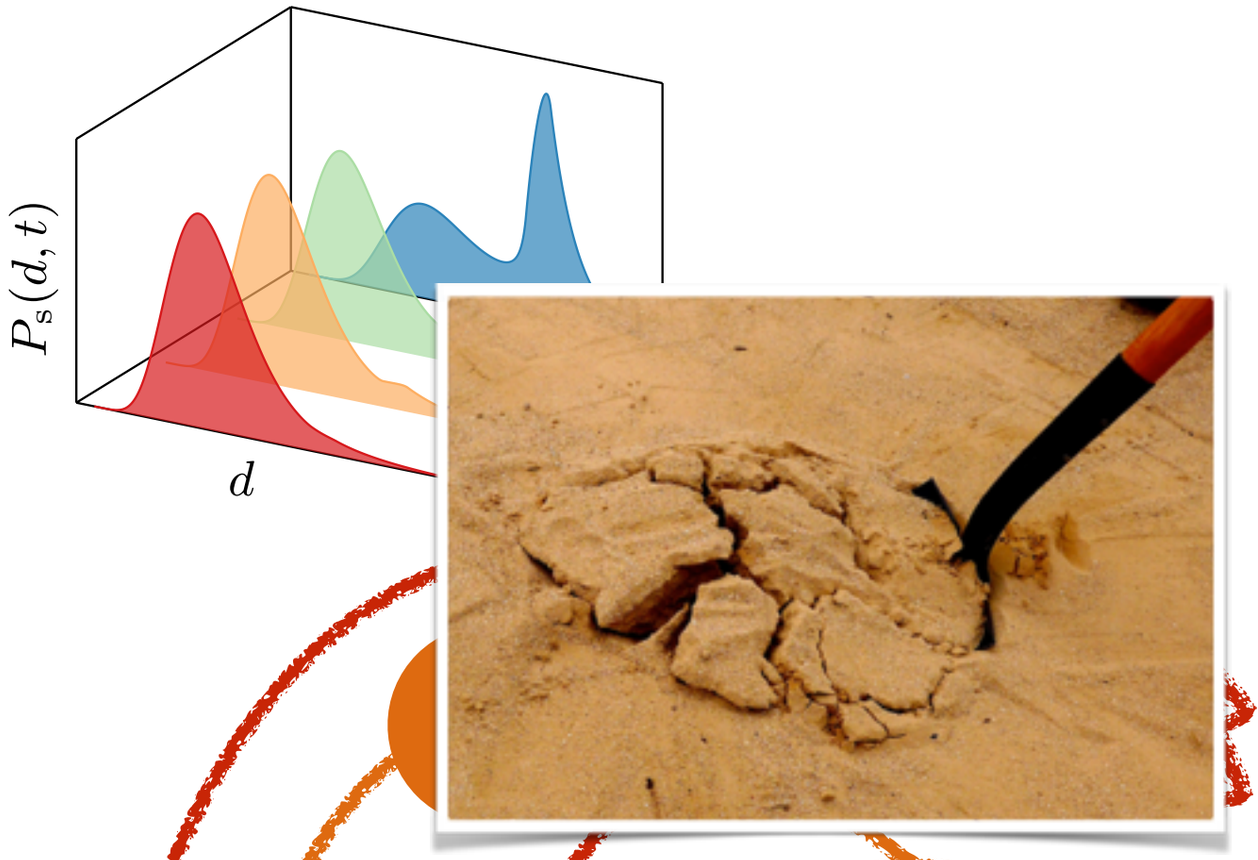


transport modes

moderate wind



storm



saltation

reptation

reshuffling
+
ripple flattening

τ_{rep}

τ_{t2}

stagnation

sorting
+
structure
formation

no transport

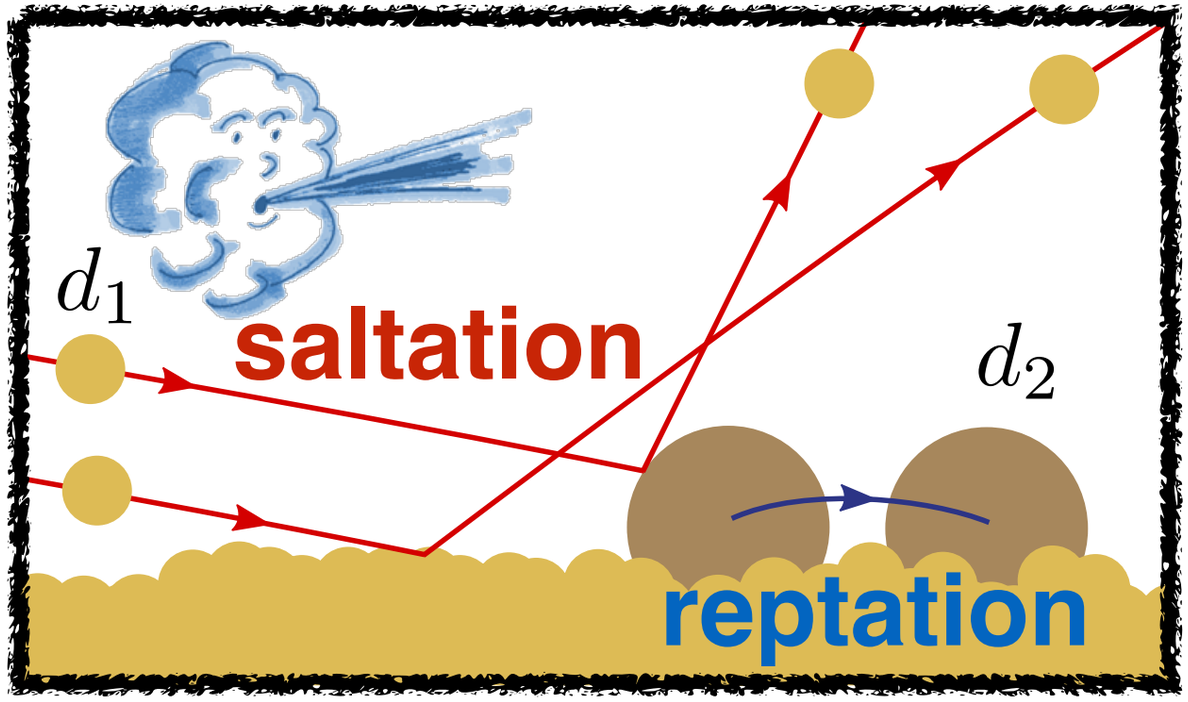
wind strength τ/τ_{t1}

grain size ratio d_2/d_1

0
2
4
6
8
10

reptation threshold

$$\tau > \tau_{\rm rep}$$



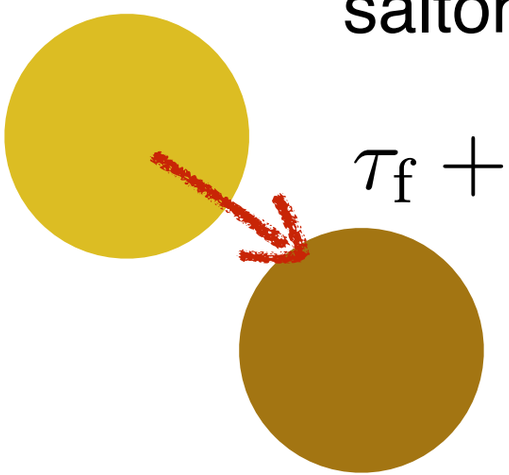
$\tau_{\rm rep} \sim 6^{-6}(d_2/d_1)^6\,\tau_{\rm t2}$

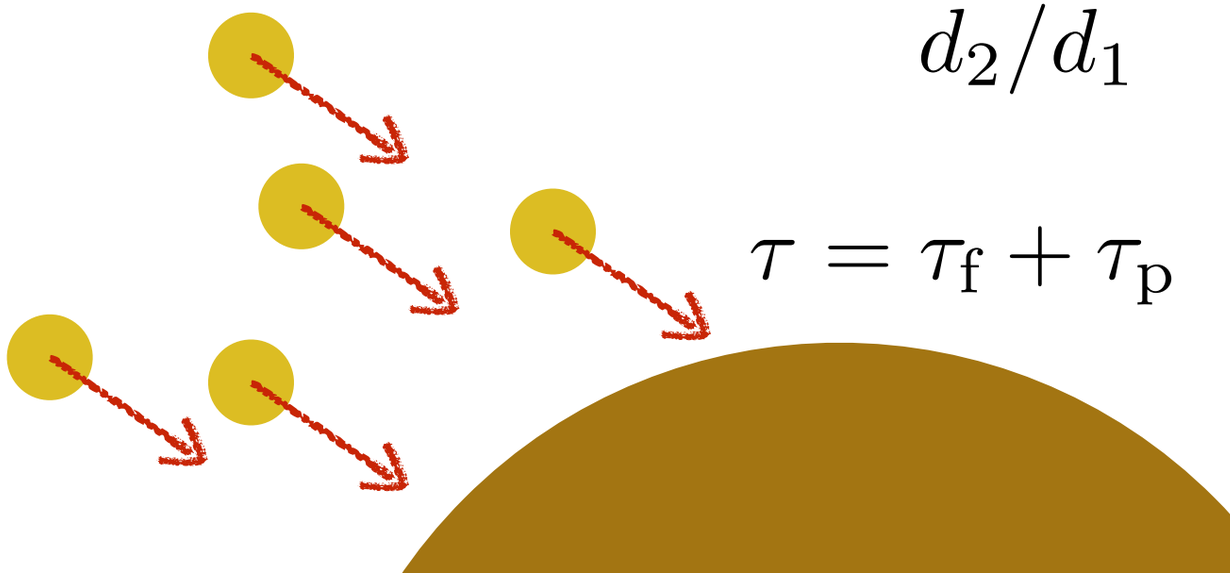
$\tau_{\rm rep} \sim \tau_{\rm t2}$

d_2/d_1

elastic collision
salton speed ~ wind

$\tau_{\rm f} + \tau_{\rm p} + \delta\tau_{\rm p}(\mathbf{r})$

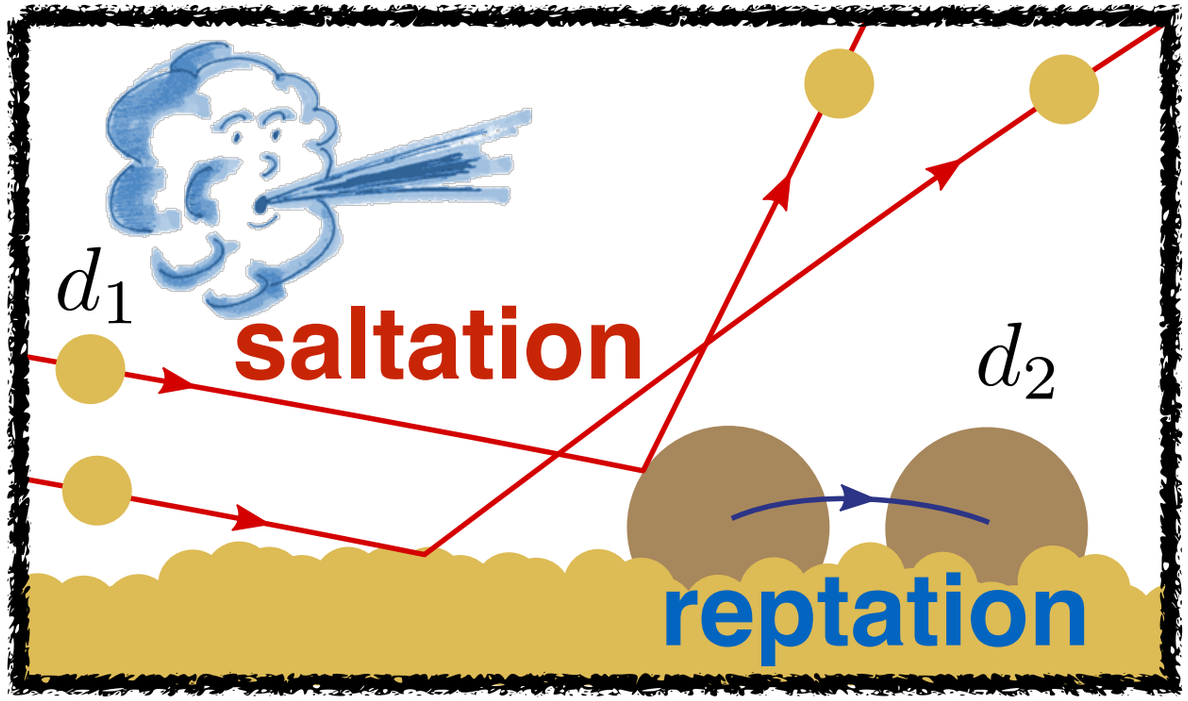




$\tau = \tau_{\rm f} + \tau_{\rm p}$

reptation threshold

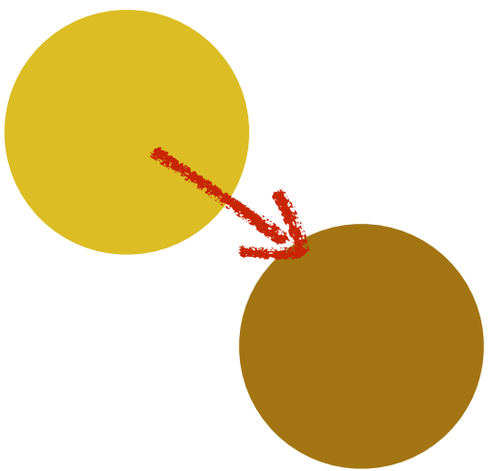
$$\tau > \tau_{\rm rep}$$

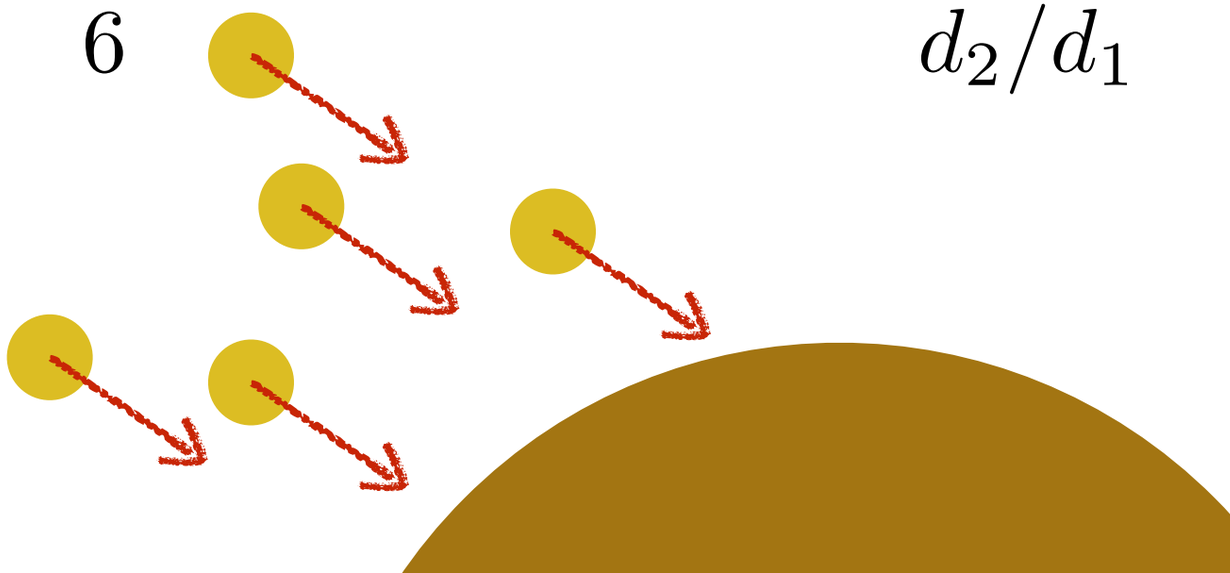


#impacts per repton hop: $\phi_1 d_2^2 T_2 = \mathcal{O}(1)$ → $d_2/d_1 \approx 6$

$\tau_{\rm rep} \sim 6^{-6}(d_2/d_1)^6\,\tau_{\rm t2}$ $\qquad$ $\tau_{\rm rep} \sim \tau_{\rm t2}$

6 $\qquad$ d_2/d_1





reshuffling
+
ripple flattening

megaripples

$\tau_{rep} \sim (d_2/d_1)^6\ \tau_{t2}$

$\tau_{rep} \sim \tau_{t2}$

stagnation

ripples

sorting
+
structure
formation

$\tau_{rep} \sim 6$

no transport

wind strength τ/τ_{t1}

0
2
4
6
8
10

2
4
6
8

grain size ratio d_2/d_1

sand sorting & megaripples

(more) sand sorting → **(larger) megaripples**

- non-equilibrium process
- dependent on wind history

- not steady-state structures
- genuinely transient