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Representing small scale runoff generation and sub-surface flow patterns, induced by micro-topography, on a coarser grid using superficial rill storage height variations.

Sven Frei & Jan H. Fleckenstein

sven.frei@uni-bayreuth.de; Department of Hydrology, University of Bayreuth

BACKGROUND

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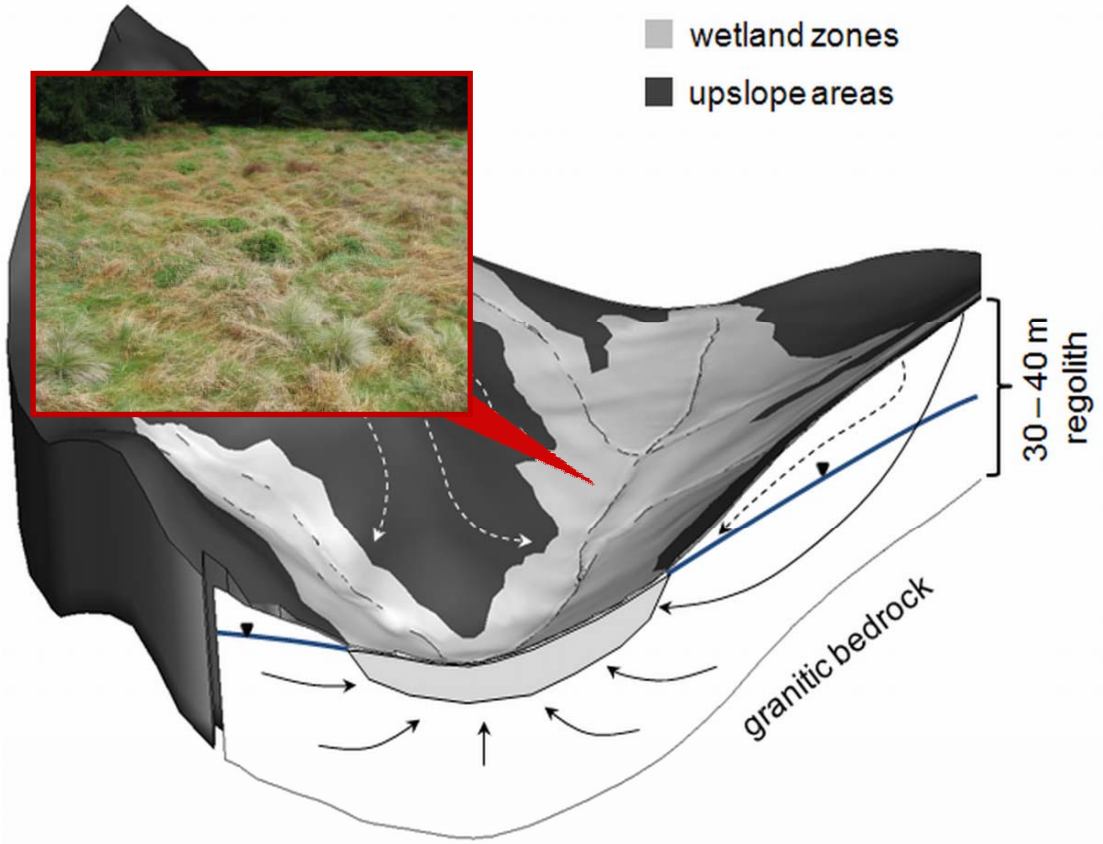
Lehstenbach Catchment:

- ~4.2 km²; located in North-Eastern Bavaria
- 1/3 of area: riparian wetlands
- areas controll event runoff generation & water quality
- wetlands show pronounced micro-topographical structures (***hollow*** & ***hummock*** sequences)



influence of micro-topography on

- ✓ runoff generation
- ✓ subsurface flow patterns
- ✓ biogeochemical settings

} HGS modeling studies

EVENT - RUNOFF GENERATION

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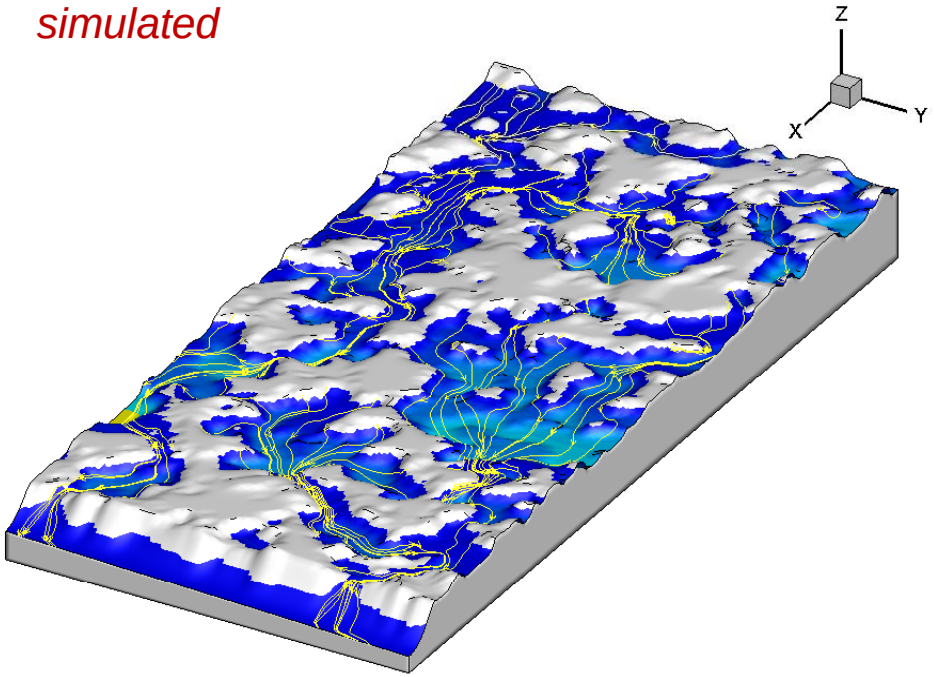
simulated



observed

high flow → dominated by surface runoff

Contents lists available at ScienceDirect

Advances in Water Resources

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

Effects of micro-topography on surface–subsurface exchange and runoff generation in a virtual riparian wetland — A modeling study

S. Frei [a], G. Lischeid [b], J.H. Fleckenstein [a,c,*]

[a] Department of Hydrology, University of Bayreuth, Germany
[b] Leibnitz Centre for Agricultural Landscape Research, (ZALF), Germany
[c] Helmholtz Center for Environmental Research (UFZ), Germany

SUBSURFACE RESIDENCE TIMES

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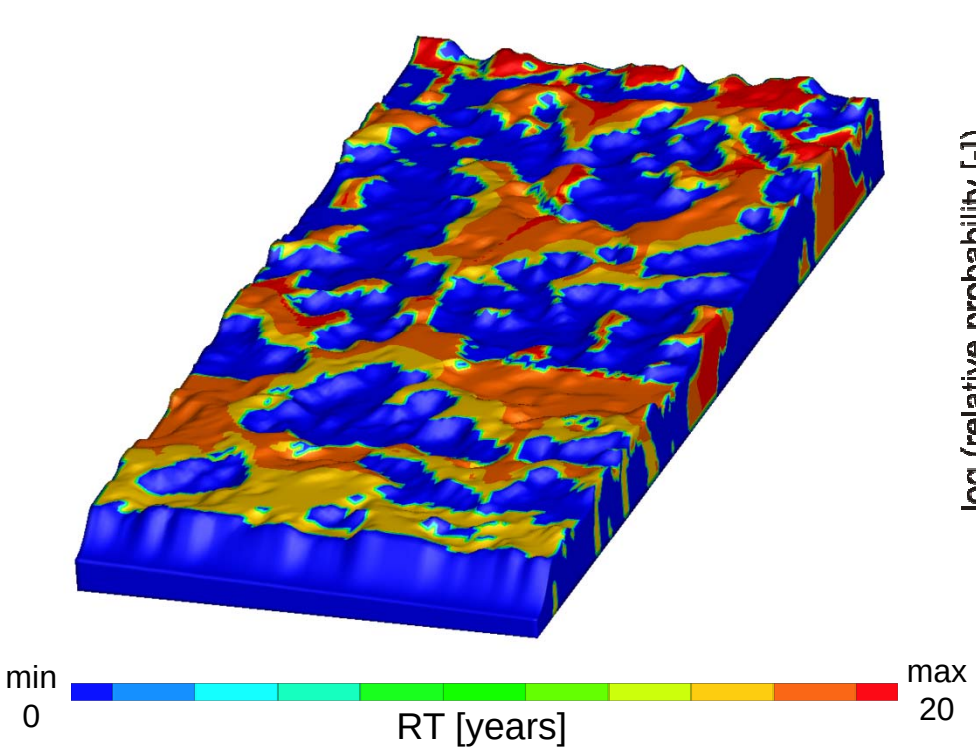

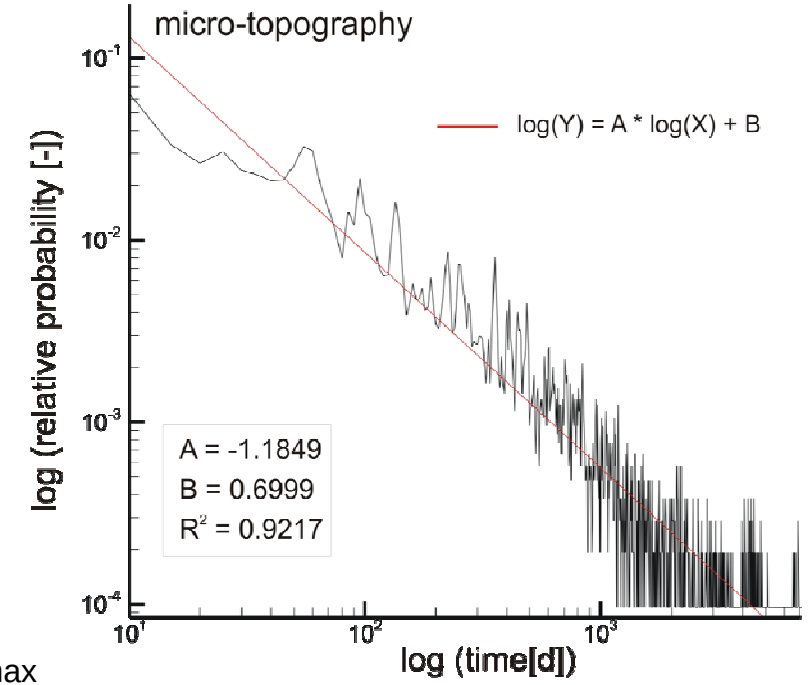

micro-topography → power law distributed RT

article in preperation

HOT SPOT FORMATION

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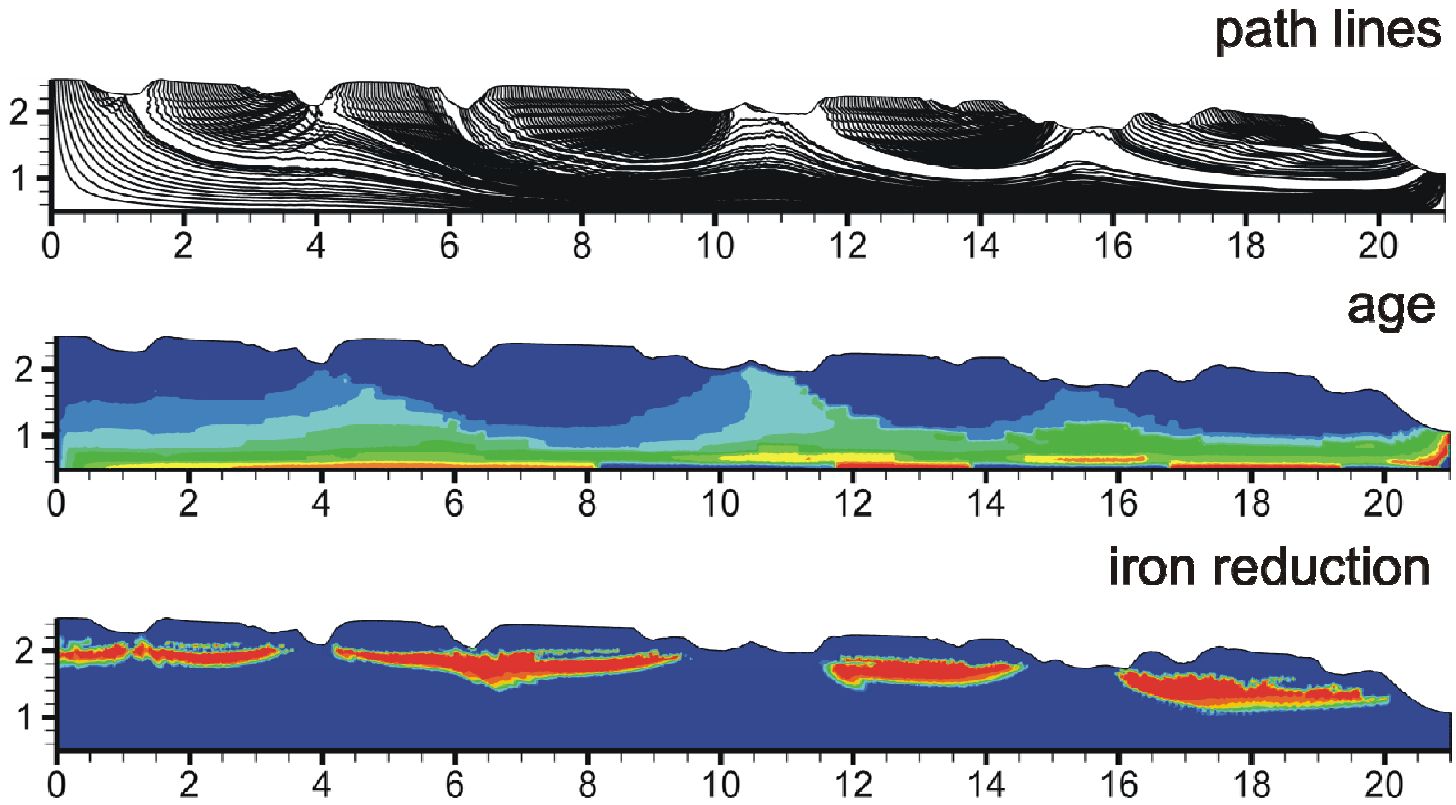

micro-topography → formation of biogeochimcal hot spots

article in preperation

PROBLEM

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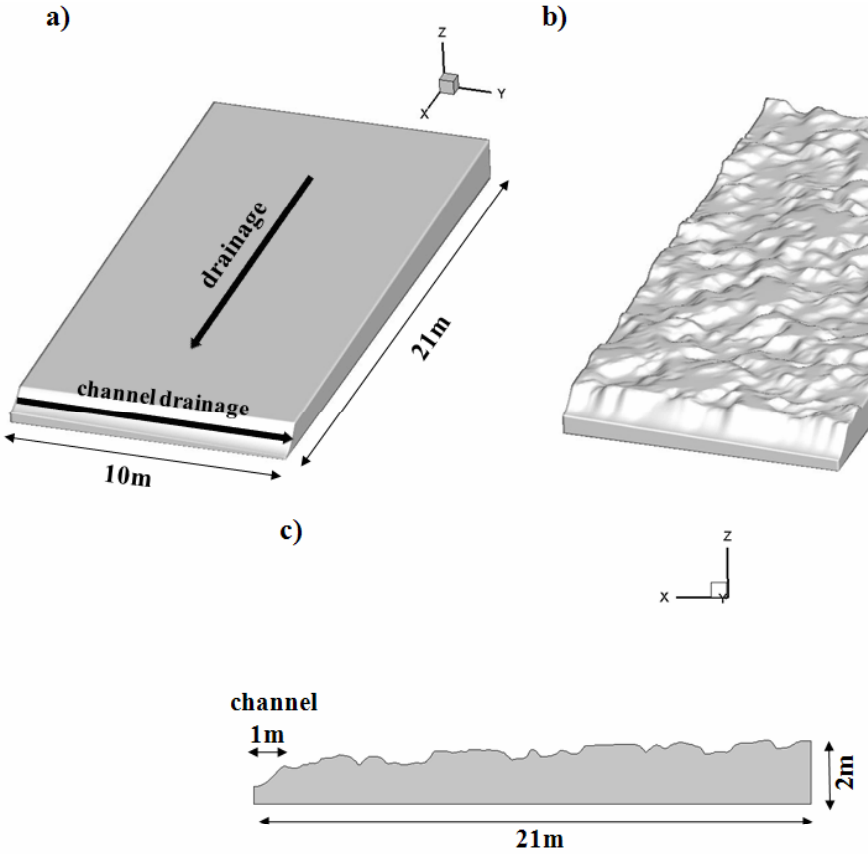

complex subsurface flow

variably saturated flow

integrated surface runoff

complex surface runoff
(surface flow networks)

high grid resolution
(231.000 nodes)

\+ non-parallel version of HGS

extremly long computation times
(48 days for a yearly simulation)

How to speed it up???

reduction of grid resolution without loosing too much process complexity

→ rep. micro-topography by superficial rill storage height variations

RILL / DEPRESSION STORAGE

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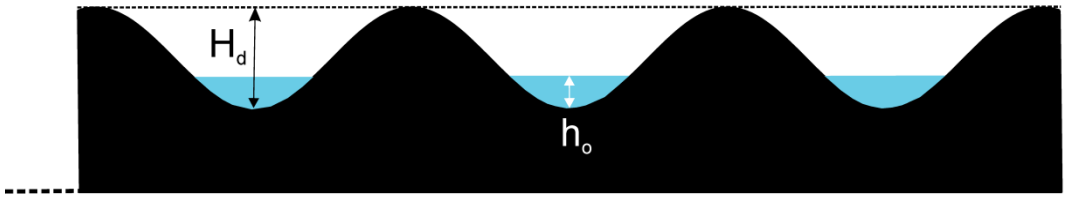
Definition (HGS Manual):

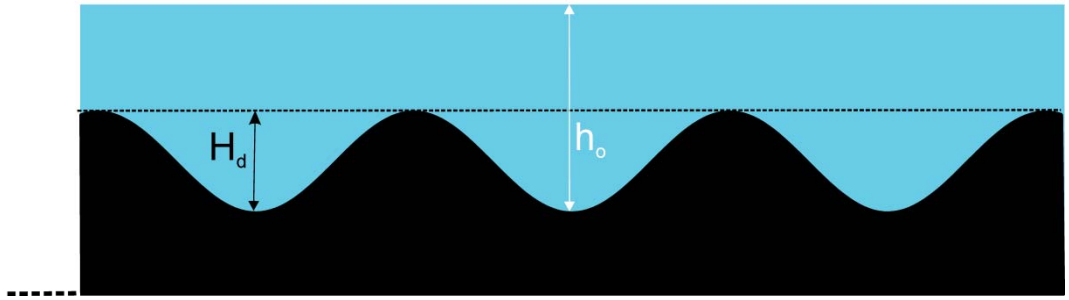
It represents the amount of storage that must be filled before any lateral surface flow can occur. Microtopographic relief, relative to the scale of the finite elements in the grid, is included in rill storage and can have a substantial impact on hydrograph shape [*Woolhiser et al.*, 1997].

$h_o <= H_o$ ⟶ no lateral surface flow



→ implemented within HGS to account for *surface flow retention* due to micro-topography and/or vegetation

$h_o > H_o$ ⟶ lateral surface flow



H_d: rill storage height [L]

h_o: ponded water depth [L]

SUPERFICIAL RILL STORAGE VARIATIONS

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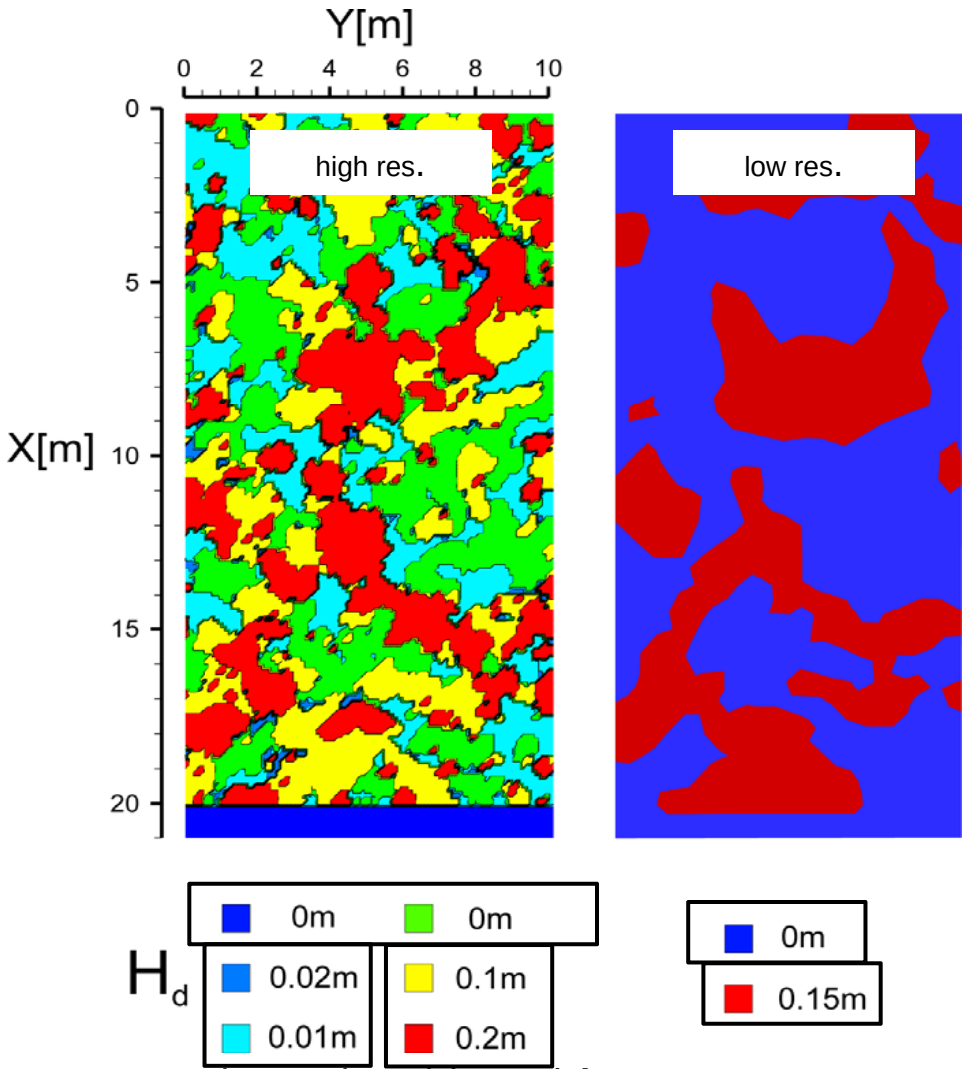
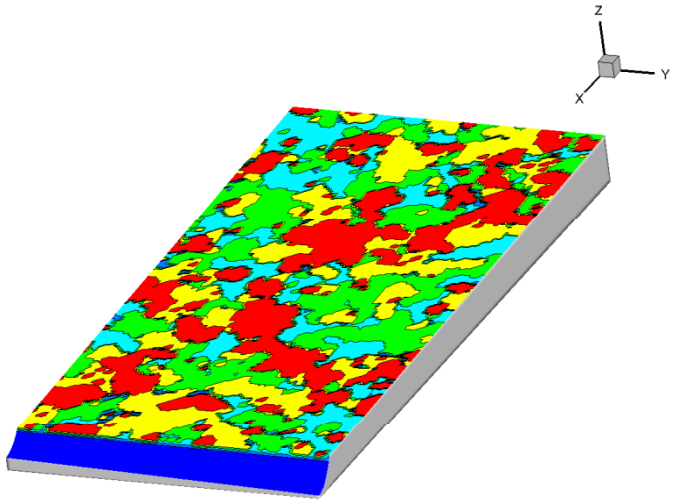


hummocks → *NO surface runoff*



Two different models:

1) *high resolution + rill storage variation*
   (231.000 nodes; planar)
2) *low resolution + rill storage variation*
   (20.900 nodes; planar)

VS.

→ *original micro-topography model*
(231.000 nodes; 3D micro-topo)

→ *planar reference*
(231.000 nodes; planar without rill storage variation)

off

EVENT - RUNOFF GENERATION

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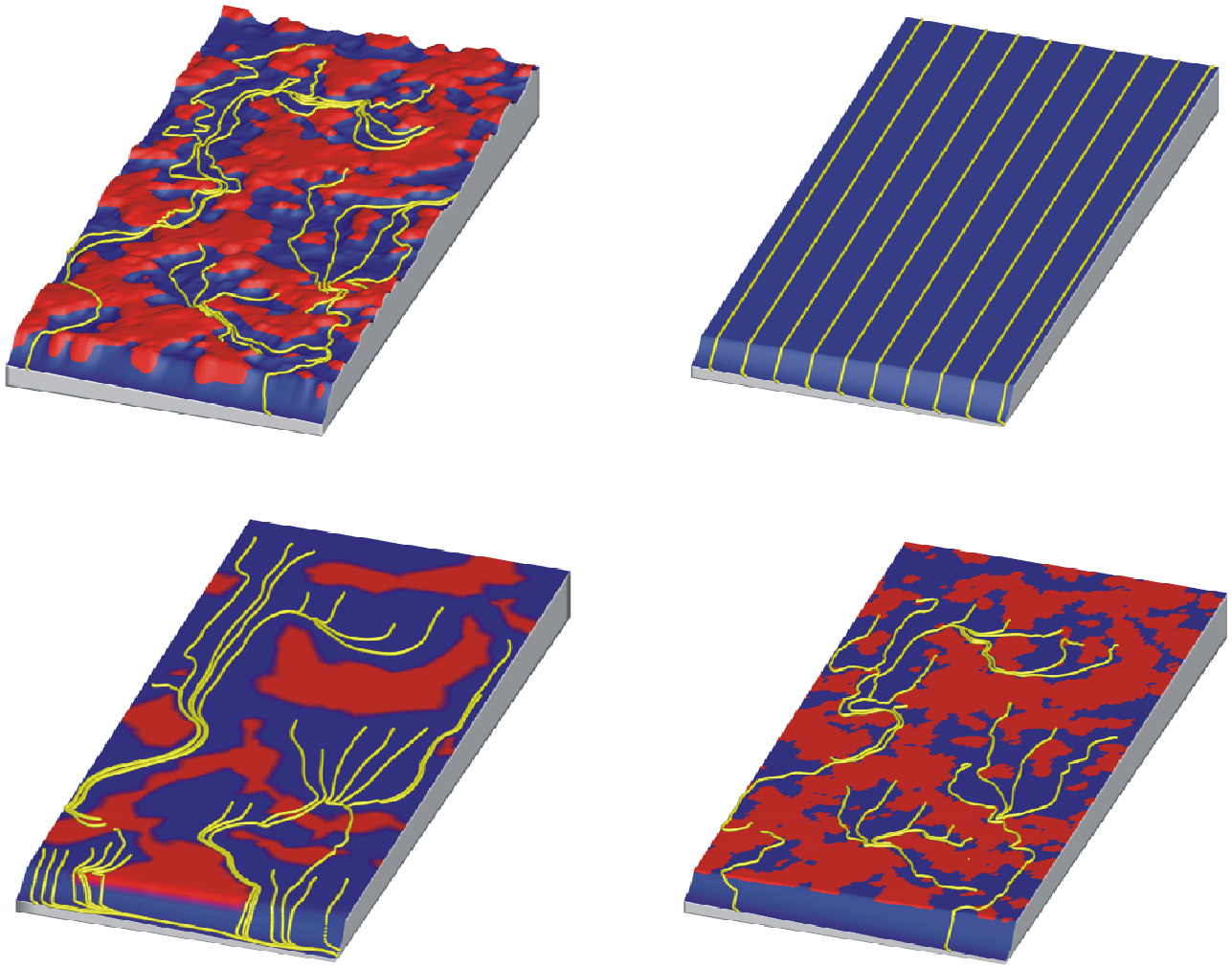

hummocks

hollows

surface flow (networks)

SUBSURFACE FLOW

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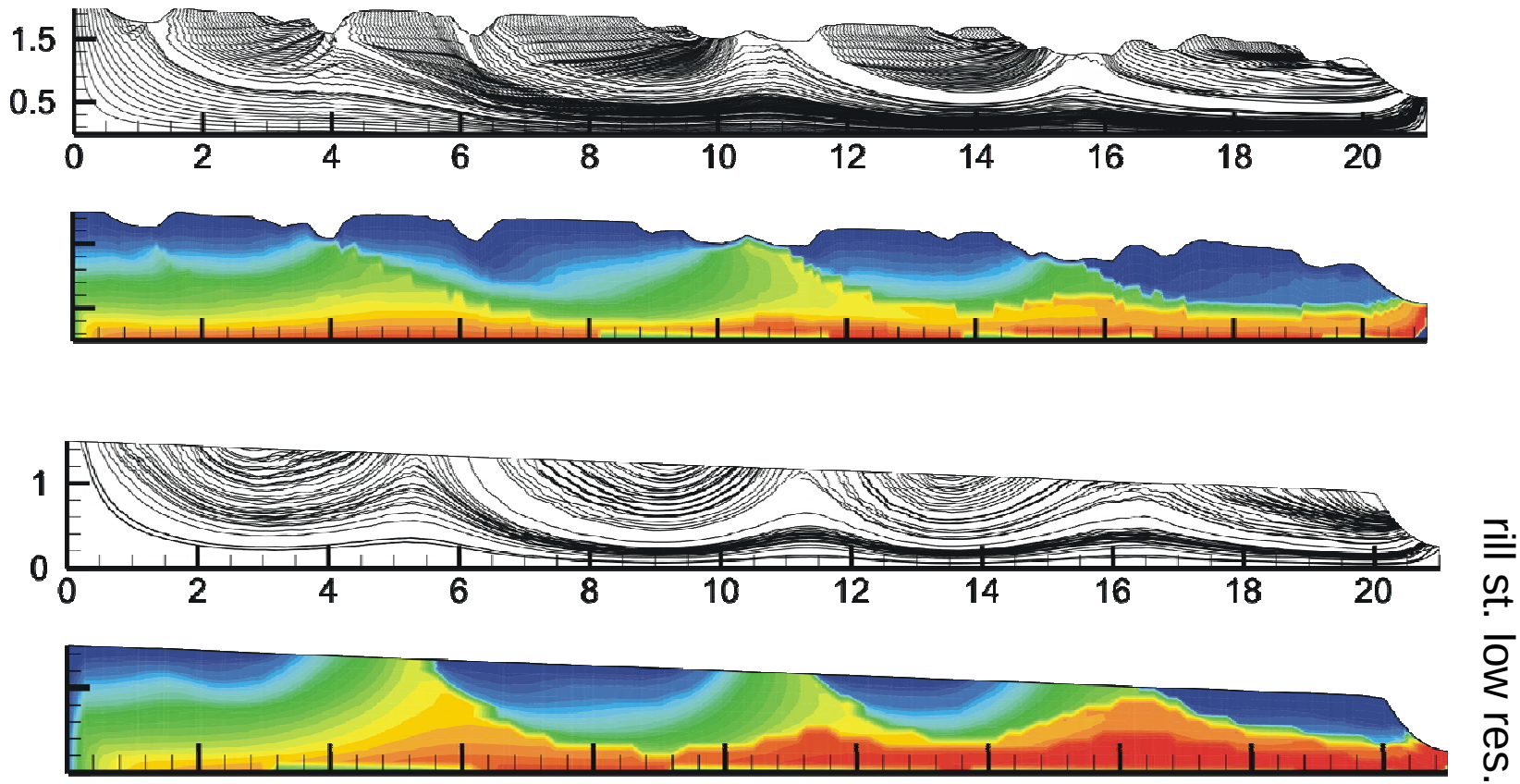

SUBSURFACE RESIDENCE TIMES

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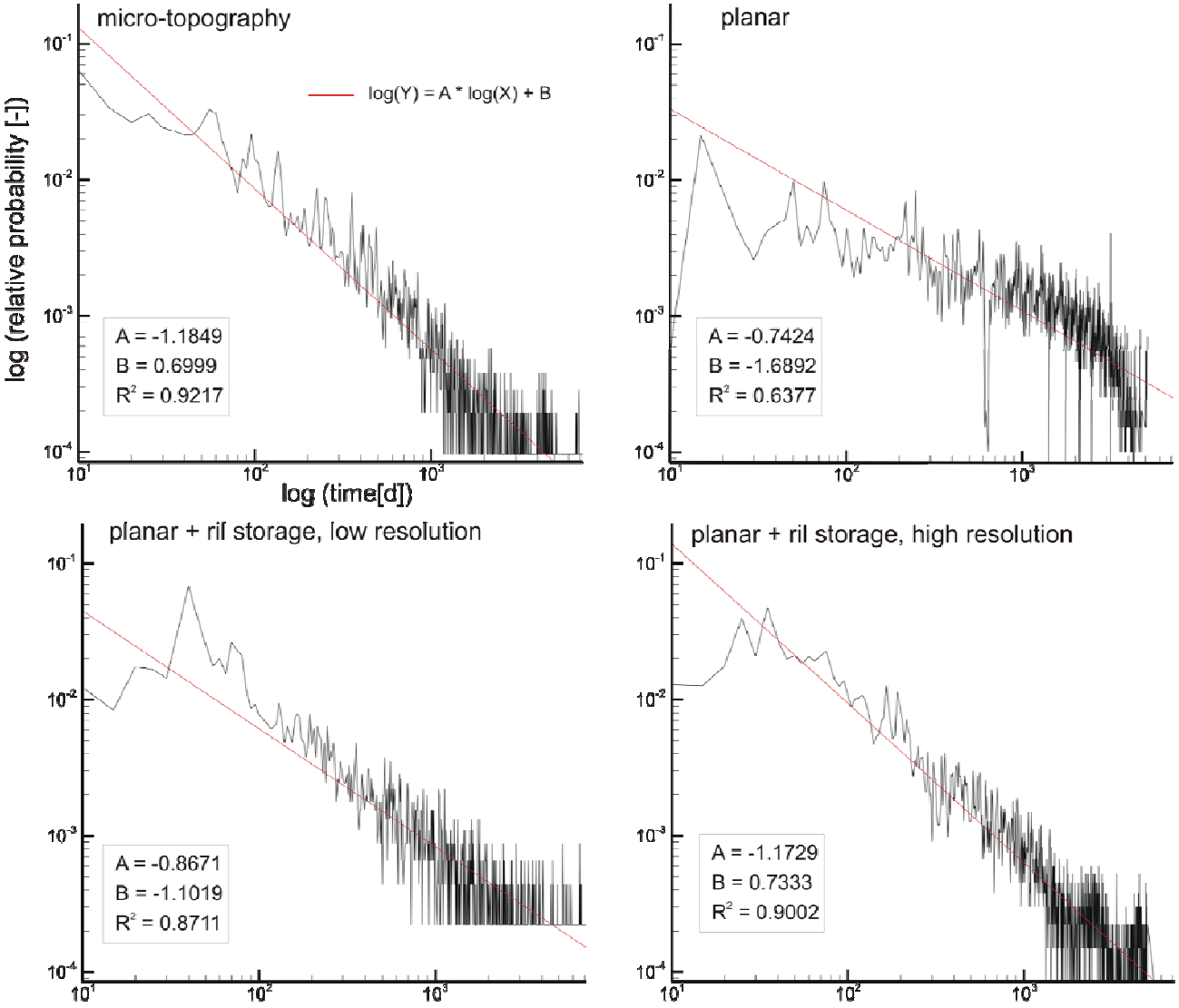

HOT SPOT FORMATION

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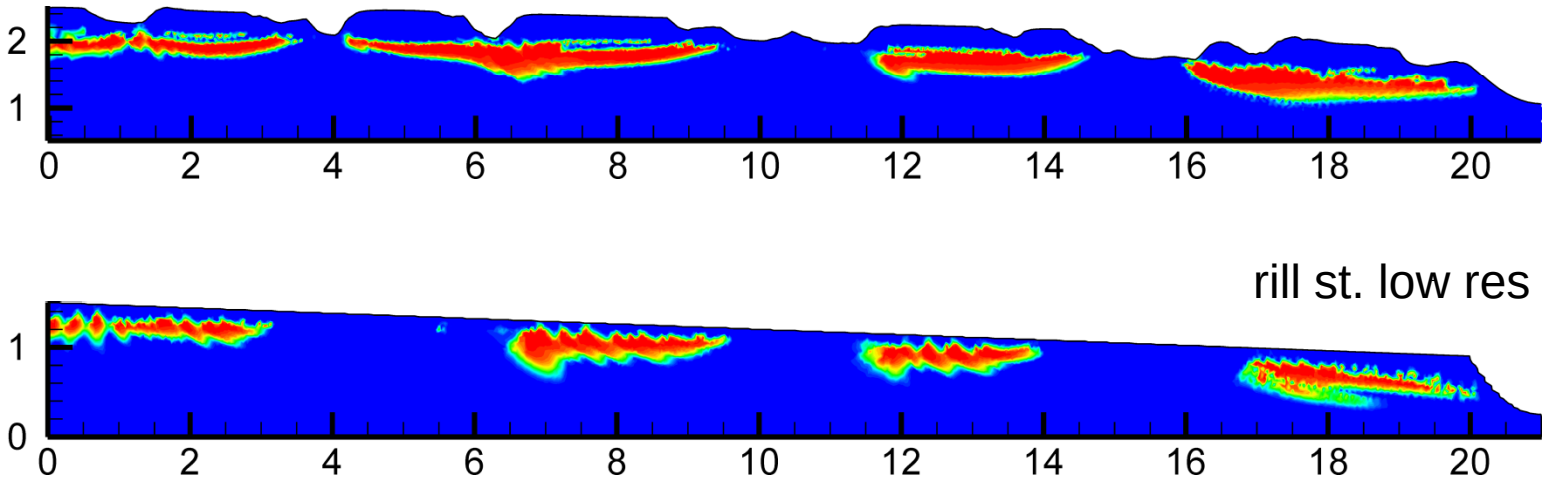

low high

iron reduction process activity

COMPUTATION

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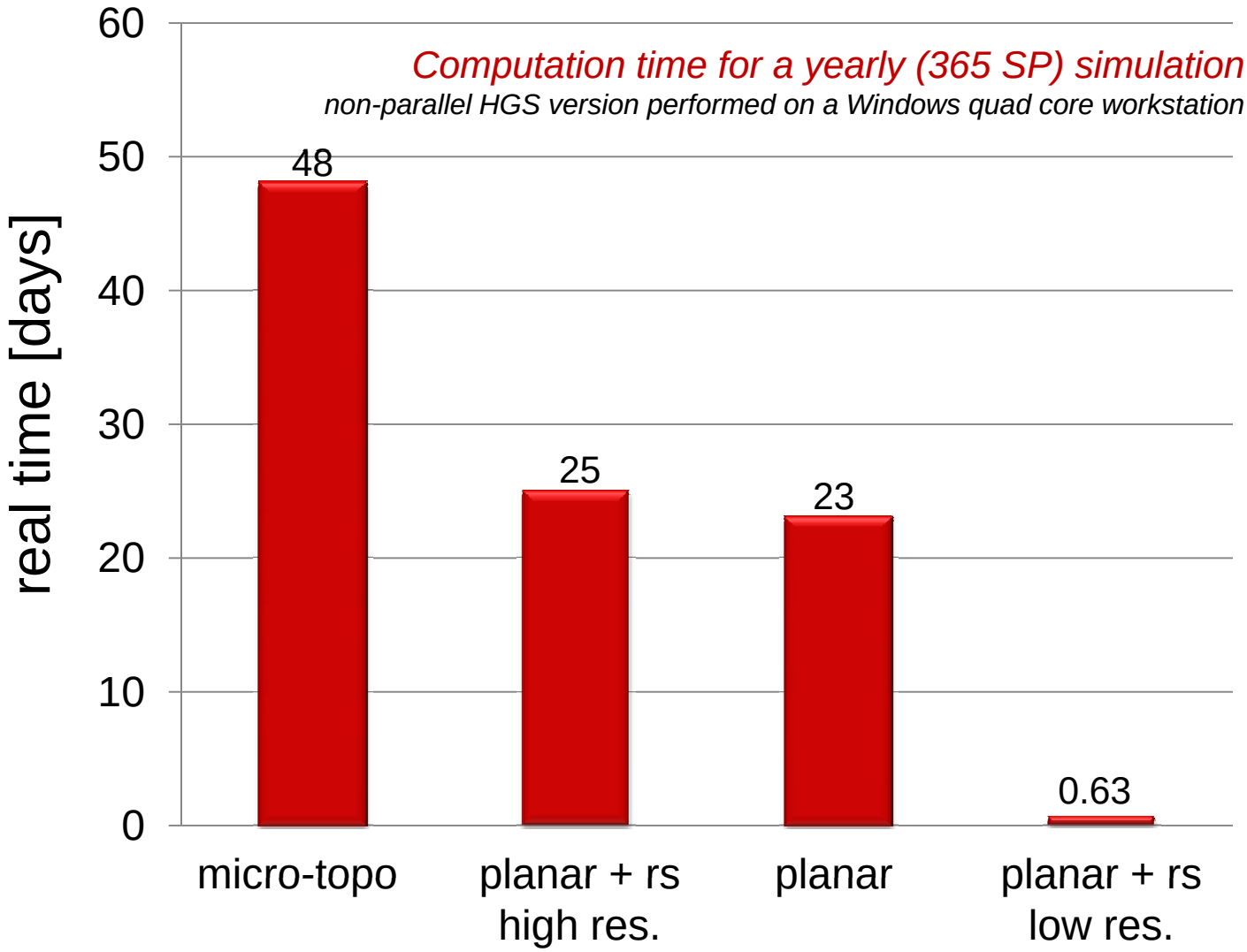

OUTLOOK

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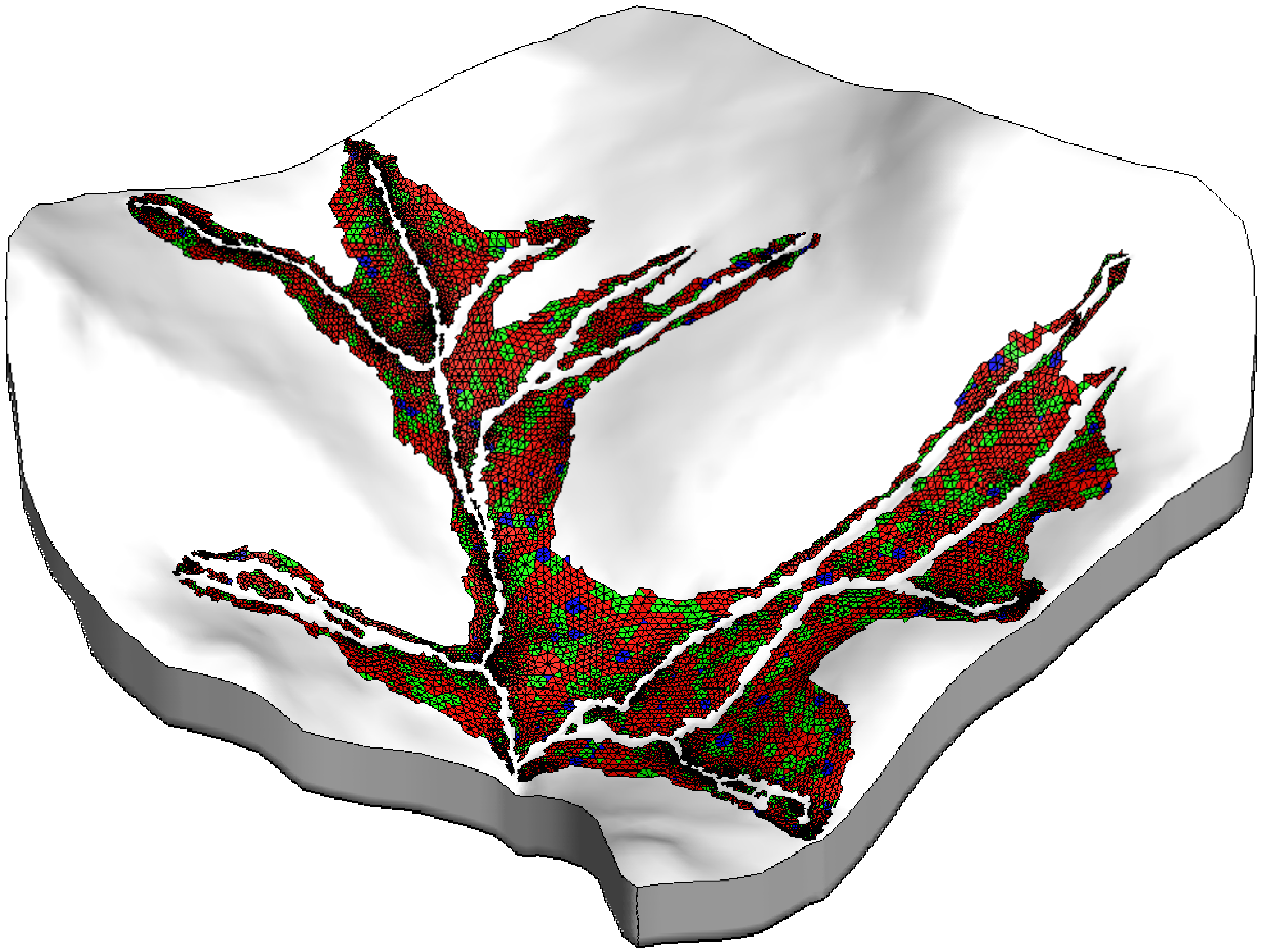

→ reproduce micro-topographical

runoff generation in a catchment scale model