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River deltas on the Earth and Titan - the role of grain size

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Abstract

We performed numerical simulations of formation and development of river deltas under conditions corresponding to surfaces of Earth and Titan for different grain sizes *d* and discharges *Q*. The processes leading to formation of fluvial deposits are very similar on both celestial bodies, but there are observable differences in their morphology for the same initial and boundary conditions. These differences must be taken into account for correct interpretation of remote observations. In particular, it is found that due to difference in buoyancy, some depositional landforms on Titan are built from coarser grains than the corresponding landforms on the Earth.

1. Introduction

Observations of the Cassini probe have revealed a complex, Earth-like environment on the surface of Titan, an icy moon of Saturn. The hydrocarbon lakes and river valleys are discovered in polar regions of Titan. A river flowing through the terrain erodes the rocks and carries granular material. Material is deposited along river's course, in particular in the place where river enters a standing body of liquid. This leads to creation of river deltas. The deltas have various areas, slopes and shapes, depending on the terrain type, the discharge (related to the local slope) and the grain size [1].

2. Preliminary results

The simulations presented here were performed with uniform distribution of grains, for constant discharge at the inflow, in conditions corresponding to surfaces of the Earth and Titan. In terrestrial conditions we investigate transport of quartz grains by the fresh water. In Titan's conditions the liquid is methane-nitrogen mixture (Titanian 'rain') and the sediments are water ice grains. We consider also the effects of different composition of Titanian sediments, namely some admixture of solid hydrocarbons precipitated from the atmosphere.

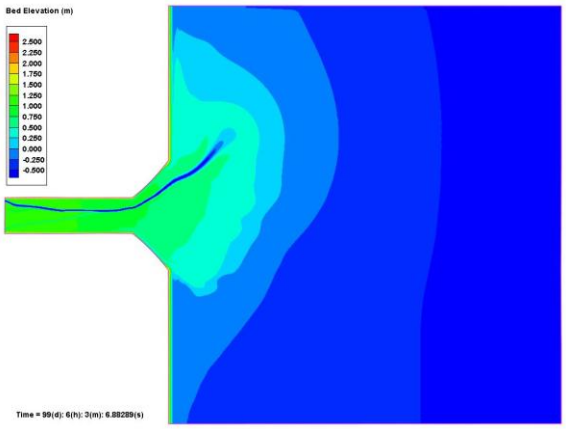

Figure 2: Bed elevation after 100 days: Earth, d=0.10 mm, Q=10 m^3/s.

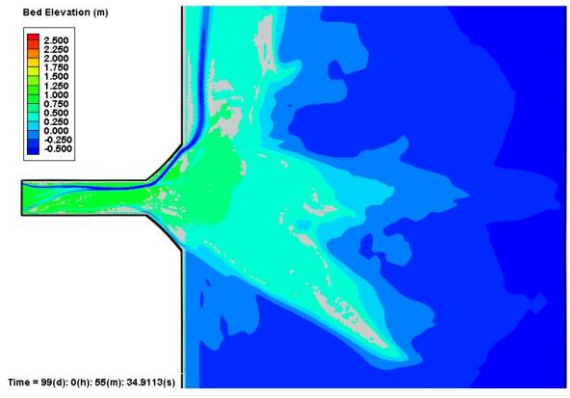

Figure 2: Bed elevation after 100 days: Titan, d=0.10 mm, Q=10 m^3/s.

3. Summary and Conclusions

The research presented here is an extension of our previous work [2].

The processes on the Earth and Titan are very similar, however the differences in development of sedimentary landforms should lead to observable differences in morphology and development of river deltas and alluvial fans. On Titan the sediments could be carried by the flow deep into the lake; sediments may become dispersed over large area and they may not form easily recognizable deposits. The relation between parameters controlling the shape and evolution of river delta is slightly different on both bodies and Titanian deposits may be built from coarser grains compared to the similarly shaped landforms known from Earth.

References

[1] Orton, G.J. and Reading, H.G.: Variability of deltaic processes in terms of sediment supply, with particular emphasis on grain size, Sedimentology, 40, 3, pp. 475-512, 1993

[2] Witek P. and Czechowski, L.: Dynamical modelling of river deltas on Titan and Earth, Planetary and Space Science 105, pp. 65–79, 2015.