ESTIMATION OF SAND FLUX FROM LINEAR DUNES USING HIGH-PRECISION SATELLITE MEASUREMENTS AND NUMERICAL MODELLING. A. Lucas[1], C. Narteau[2], S. Rodriguez[1], S. Courrech du Pont[3], O. Rozier[2], A. Spiga[4], Y. Callot[5], A. Garcia[1]. [1]AIM, LADP, Université Paris-Diderot, CEA-Saclay, Gif/Yvette, France (dralucas@astrogeophysx.net), [2]IPGP, Sorbonne Paris Cité, Université Paris Diderot, [3]MSC, Sorbonne Paris Cité, Université Paris Diderot, [4]LMD, IPSL, UPMC, Paris, France, [5]Archéorient, Université Lumière Lyon 2, France.

Introduction: Although linear dunes are the most common dune type on Earth and Mars [5], estimation of sand flux relies essentially on the migration speed of barchan dunes [1–4]. In addition to problems associated to multi-directional winds, this is mainly due to the lack of a complete understanding regarding linear dune growth, either by extension of lateral migration [6, 7]. In a topographic induced dune field on Earth, we present here high-resolution satellite imagery analysis in order to assess sand fluxes at the crest of linear dunes. We will then discuss the implication in terms of landscape dynamics and climatic conditions that occur at present day in different places of the Solar System including Mars and to some extent Titan, the largest Saturn's moon.

Methodology: High-resolution aerial and/or satellite imagery allow assessing the planetary dune morphodynamics over time at length scales of dune fields. If these images have been extensively used on Mars [8], they have not been fully exploited on Earth. To tackle this problem, stereo acquisitions have been used to retrieve by photogrammetry the morphologies of linear dunes in remote places of Niger with a precision of 0.7 m. Using temporal sequences of images, sediment fluxes can then be derived from dune growth using the precise shape of dunes. We compare these new measurements with the growth rate predicted by [9] accounting for local wind measurements and/or the output of global atmospheric reanalysis models. In addition, we introduce similar flow conditions in numerical simulations to investigate the conditions under which these linear dunes may nucleate and develop.

Results: Accounting for more than 50 years of observations in the erg of Fachi-Bilma (Ténéré desert, Niger), we demonstrate that linear dunes elongate in the direction of the resultant sand flux with no lateral migration. Extending away from topographic obstacles in a zone of low sediment availability experiencing bimodal winds conditions, these finger-like structures are ideal to isolate for quantifying sand flux parallel to the crests [9]. From the pure elongation of linear dunes in the field (Figure 1) and the fine dune shape derived from the high-resolution satellite imagery, we can also estimate the loss of sediment at the dune tip as well as the sand flux in the inter-dune area. In addition, our numerical simulations show how deposition downstream of any topographic obstacles (hills, vegetation…) provides the fix source of sediment that stabilizes the dune (Figure 2). The whole evolution sequence is identified from nucleation to silk's segmentation and barchan ejection.

Discussion and conclusion: Together with sand fluxes perpendicular to the barchan dune crests, this study indicates that sediment flux parallel to the crest of linear dunes can now be used to infer the local wind regimes. We started to apply this methodology on Mars as well as on Titan accounting for the available data set and GCM predictions [10]. We will discuss the implied sediment fluxes and their implications concerning changes in climatic forcing and landscape dynamics.

References: [1] Long & Sharp, (1964), *Geophys. Soc. America, 75, 149–169*. [2] Hastenrath (1967), *Zeitschrift fur Geomorphologie, 11, 300–331*. [3] Ahmedou et al., (2007), *J. Geophys. Res. 112*. [4] Elbelrhiti et al., (2008), *J. Geophys. Res. 113*. [5] Livingstone & Warren (1996), *Aeolian geomophology*. [6] Tsoar et al, (2004), *Geomorphology 57,293–302*. [7] Telfer, (2011) *Earth Surface Processes and Landforms, 36, 1125–1135*. [8] Bridges et al., (2012) Nature, *485, 339*. [9] Courrech du Pont S. (2014), *Geology, 42, no. 9, 743-746*. [10] Lucas et al. (2014), *Geophys. Res. Lett., 41*.

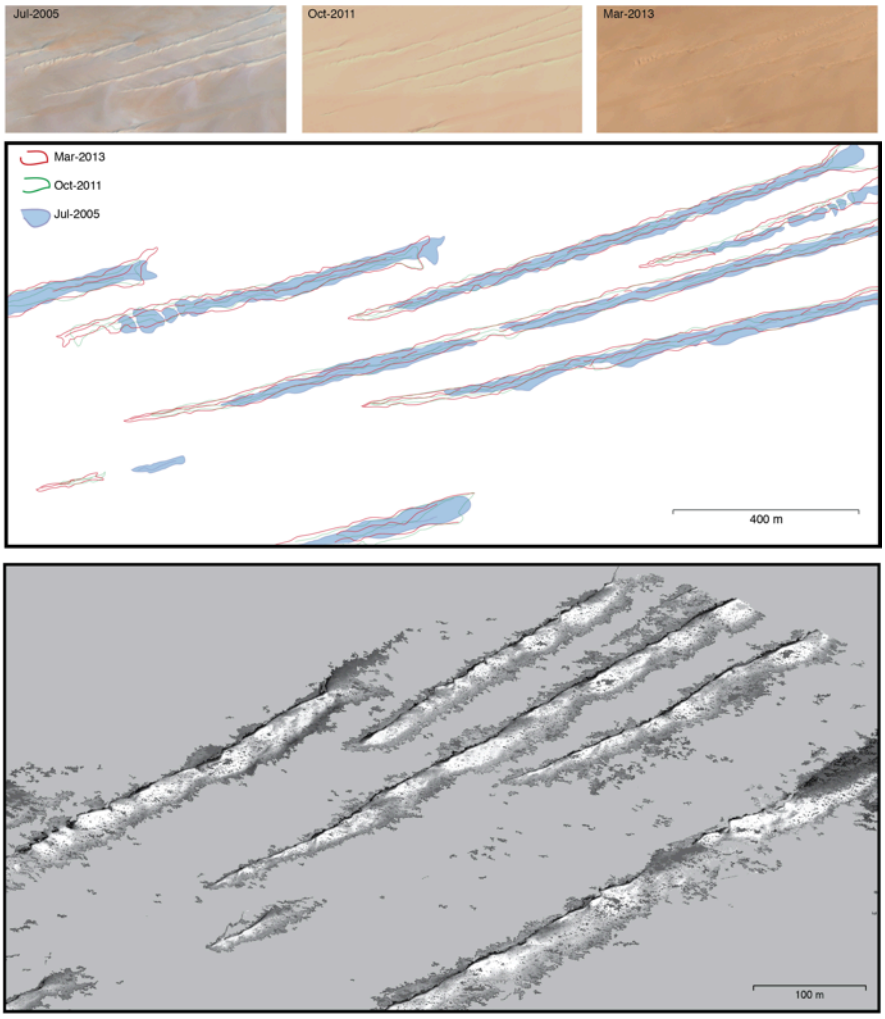

Figure 1 – (Top) High-resolution optical imagery (from Global View) from July 2005 to March 2013 over linear dunes observed in the Fachi-Bilma Erg, Niger. (Middle) Mapping of the elongation of the linear dunes. (Bottom) Perspective view of a 3D point cloud textured and derived from a Pleiades stereo pair.

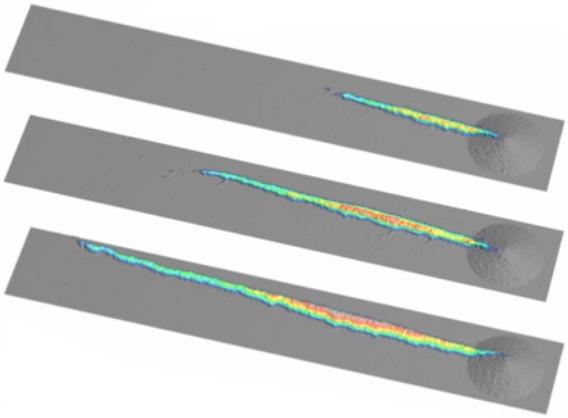

Figure 2 – Morphodynamics of finger dunes away from a topographic obstacle using numerical model and a bimodal wind regime.