Methane storms as a driver of Titan's dune orientation.

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Titan's equatorial regions are covered by eastward oriented linear dunes. This direction is opposite to mean surface winds simulated by Global Climate Models (GCMs) at these latitudes, oriented westward as trade winds on Earth [1, 2].

Here, we propose that Titan's dune orientation is actually determined by equinoctial tropical methane storms producing a coupling with superrotation and dune formation [3].

Using meso-scale simulations of convective methane clouds [4] with a GCM wind profile featuring the superrotation [5, 6], we show that Titan's storms should produce fast eastward gust fronts above the surface (see Figure 1). Such gusts dominate the aeolian transport. Using GCM wind calculations and analogies with terrestrial dune fields [7], we show that Titan's dune propagation occurs eastward under these conditions (see Figure 2).

Finally, this scenario combining global circulation winds and methane storms can explain other major features of Titan's dunes as the divergence from the equator or the dune size and spacing. It also implies an equatorial origin of Titan's dune sand and a possible occurence of dust storms.

References: :[1] Lorenz et al. (2006), *Science,* 312, 724-727. [2] Lorenz & Radebaugh (2009), *Geophysical Research Letter,* 36, 3202. [3] Charnay et al. (2015), *Nature Geoscience* (in press). [4] Barth & Rafkin. (2007), *Geophysical Research Letter,* 34, 3203. [5] Charnay & Lebonnois (2012), *Nature Geoscience,* 5, 106–109. [6] Lebonnois et al. (2012), *Icarus,* 205, 719–721. [7] Courrech du Pont, Narteau & Gao (2014), *Geology,* 42, 743–746.

Figures:

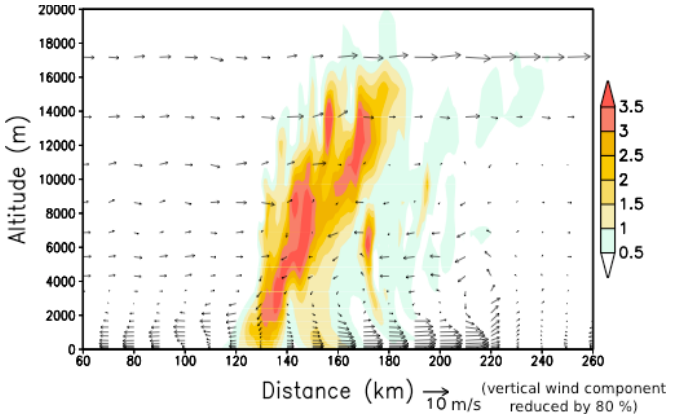

Figure 1: 2D simulation of a methane storm developping under the wind shear produced by the supperotation. Colors correspond to the mixing ratio of condensed methane and vectors to wind direction and speed. A gust front appears in front of the storm and propagates eastward.

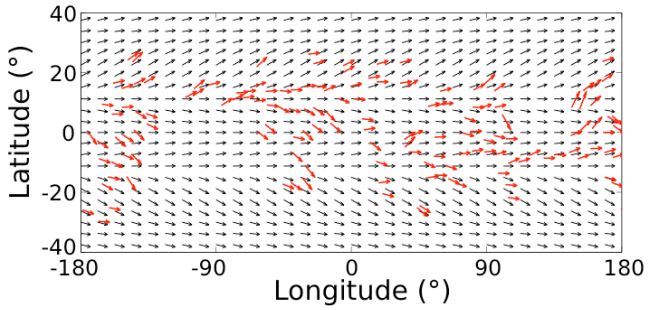

Figure 2: Map of dune orientation observed with Cassini's Radar (red vectors) and predicted by the GCM including the effect of storms (black vectors)