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Morphology of valley systems on Titan – a comparative study

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Introduction

Titan's surface is characterized by the presence of fluvial valleys [e.g. 1,2]. In this work the various forms in which fluvial erosion occur are compared. Preliminary results are presented that specify the abundance of the valleys (related to latitude and spectral unit), their branching complexity and stream order, and simple morphological parameter such as lengths and width. Jaumann et al, 2008 [3] investigated channel morphologies to quantify the intensity and frequency of atmospheric rainfall events. Here, a more global approach is chosen to study the zonal distribution of Titan's channels. The radar brightness that possibly indicates recent active channels (radar dark) as well as former channels (radar bright) was also taken into account.

Database

The identification of channels was based on Cassini RADAR-data captured between October 2004 and February 2008. To characterize the morphology of those channels, quantities like lengths and width of the riverbed and the size of the catchment area were added.
VIMS-mosaics of the area between 30°S and 30°N were used to map the spectral units. VIMS-data were converted into false-color RGB-composits that display Titan's near-infrared reflectance in atmospheric windows (R: 1.58µm/1.28µm, G: 2.0µm/1.28µm, B: 1.28µm/ 1.08µm). An assignment of the fluvial channels to the VIMS-spectral units was based on a combined analyze of VIMS- and RADAR-data in a Geographic Information System (GIS).

Global View

Traces of fluvial erosion cover the entire surface of Titan (see Fig. 1). Fluvial valleys in form of single channels or networks of channels could be found at the equator [1], at midlatitudes [4], and at

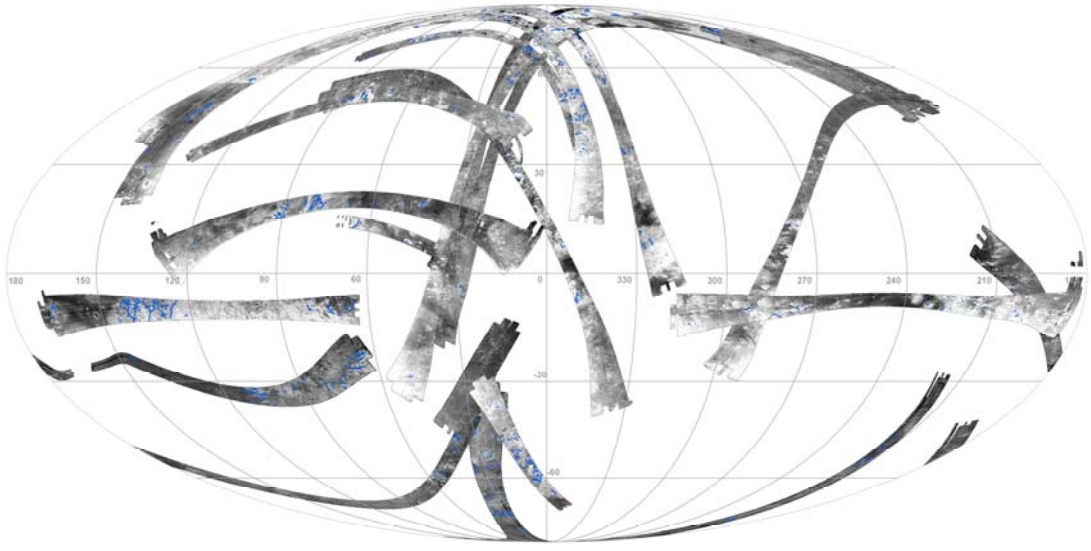

Figure 1: *Global map of Titan (Mollweide projection). Fluvial valleys are superimposed (in blue) on the Radar swaths.*

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Titan's north pole [5]. There are also lots of regions, where channels are almost entirely missing. Therefore the distribution of Titan's channels could tell us a lot about Titan's climate (presence or absence of precipitation) as well as its geology, e.g. the relative age of the morphological units.

The total number of channels per square kilometre peaks north of 60°N and between 30°S and 60°S. Most of the lakes are exposed at Titan's north pole [6]. Here, lots of channels with complex branching morphologies are visible in Radar observations (see Figure 2). These networks seem to be spatially comprehensive except for the lake areas. The number of fluvial valleys in relation to the correspondding area decreases between 30°N and 30°S and at Titan's south pole. Near Titan's equator and at northern mid-latitudes large areas are covered by dunes. In these regions fluvial valleys are widely separated or absent.

Branching fluvial valleys also occur near Titan's equator (see Figure 3) although those valley systems are not spatially comprehensive. The amount of draining liquids per unit area must be smaller than those at Titan's north pole. Furthermore, equatorial channel networks often appear bright in Radar images, indicating a dry river bed and excluding recent rainfall events. The dendritic behaviour indicates a development through an areal distributed source, such as precipitation.

Spectrally, the majority of channels is located on the VIMS-bright unit and just a small percentage occurs exactly on the dark blue spectral unit. More than 50% of fluvial valleys are located less than 100km away from the blue unit indicating a correlation between fluvial deposits and blue spectral appearance.

Conclusions

Comprehensive and widely ramified channel networks with high stream orders appear at north polar areas. By contrast, at mid-latitudes and at Titan's equator single channels and channels with lower stream orders dominate the scenario. As an exception, Xanadus channels have a lot of tributaries although their radar-bright appearance indicates that they are inactive in recent times and signify rainfall events only in the past. It could be stated that recent erosion occurs near Titan's north pole with comparably large amounts of liquids while erosional features south of 60°N are possibly inactive today and/or buried.

These results must be regarded as preliminary since the recent radar coverage is not comprehendsive and it is certain that the actual spatial resolution of the sensor is not sufficient to resolve narrower valleys.

Acknowledgements

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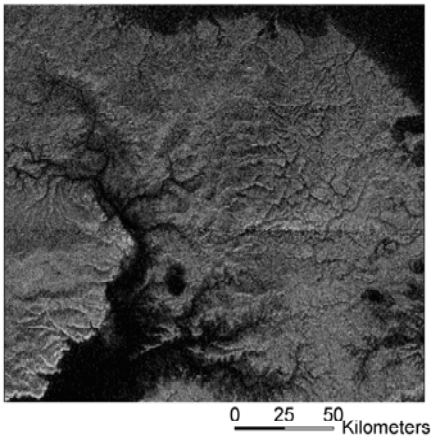

Figure 2: *Valley system at high northern latitudes. Cassini Radar, T028, 04/10/2008.*

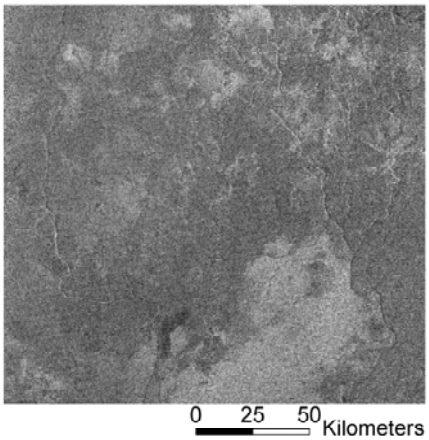

Figure 3: *Valley system at southern mid-latitudes. Cassini Radar, T007, 09/07/2005.*