

## Terrestrial Field Sites for Titan Analog Studies

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Titan, the largest moon of Saturn, has remarkable geophysical and geological parallels to the Earth. These include pluvial, fluvial and lacustrine environments in the lower atmosphere and on the surface – something that no other known planet or moon possesses at the present day. However, parallels also exist in the higher atmosphere where there are tropospheric and stratospheric clouds and large-scale Hadley cell circulations, in the surface dune fields, impact craters and karst terrain, and in the liquid water ocean that, at its top, may have pressures comparable to the deepest ocean waters on Earth.

Besides studying planets through spacecraft exploration, laboratory, and theoretical studies, the use of terrestrial analog environments has proven to be a productive avenue of research for understanding other worlds. Terrestrial analog environments have been used for diverse purposes in planetary science including the scientific study of geology, geophysics, geochemistry and biology, and also astronaut training, instrument development, and operations testing.

So far, the study of terrestrial field analogs to learn about Titan has remained very limited, confined mostly to dune analog study. The unspoken presumption has been that terrestrial temperatures and surface composition are too different from Titan to be of use in analog study – unlike the case for Mars analog study in Antarctica.

In this work, we propose that the number of useful Titan analog sites is much wider than currently imagined, ranging from atmospheric meteorological analogs, through surface craters, dunes and caves, rivers, lakes and seas, to sub-surface aquifers and deep ocean ecosystems (see examples in Fig. 1). We systematically evaluate each type of Titan terrain for which an analog could be imagined and consider what the most suitable analog sites might be on Earth.

Our goal is not to provide a fully comprehensive, definitive list of actual analog sites, or even types. Rather we aim to open a new discussion about the wider scope of possible Titan analog sites on Earth to encourage further work in this area.

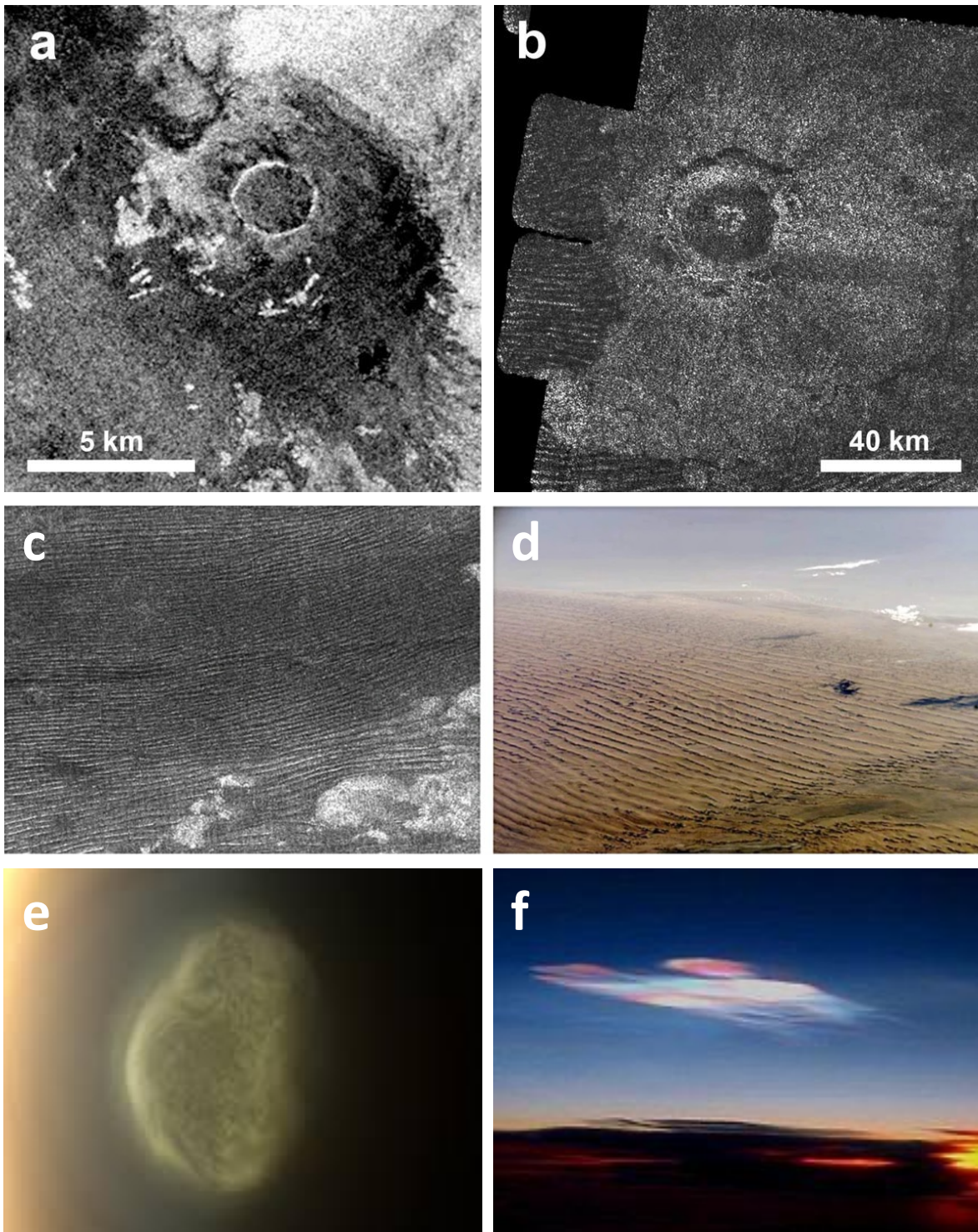


Figure 1: (a) SRTM C-Band image of the crater Roter Kamm located in the Namib desert. (b) Cassini RADAR image of Ksa crater, surrounded by the Fensal sand sea. (c) Part of the Belet sand sea on Titan, imaged by the Cassini spacecraft. (d) View of the Namibian desert on Earth, from a space shuttle. (e) Titan south polar stratospheric cloud seen June 27<sup>th</sup> 2012. (f) Polar Stratospheric Cloud, seen from the NASA DC-8 on 4 February 2003 (photograph by Mark Schoeberl, GSFC) see over Iceland.