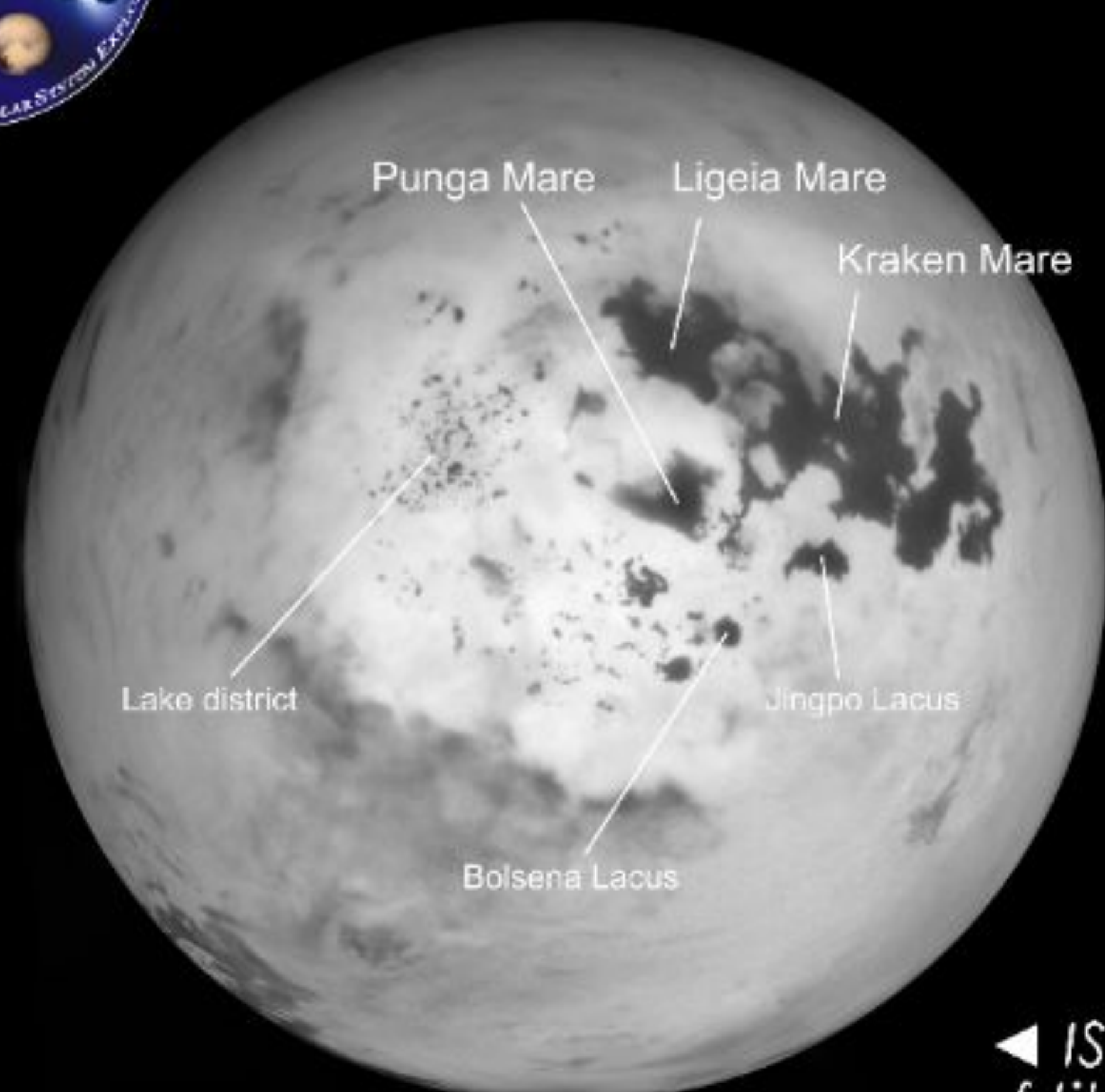




# The Exploration of Titan's Methane Seas

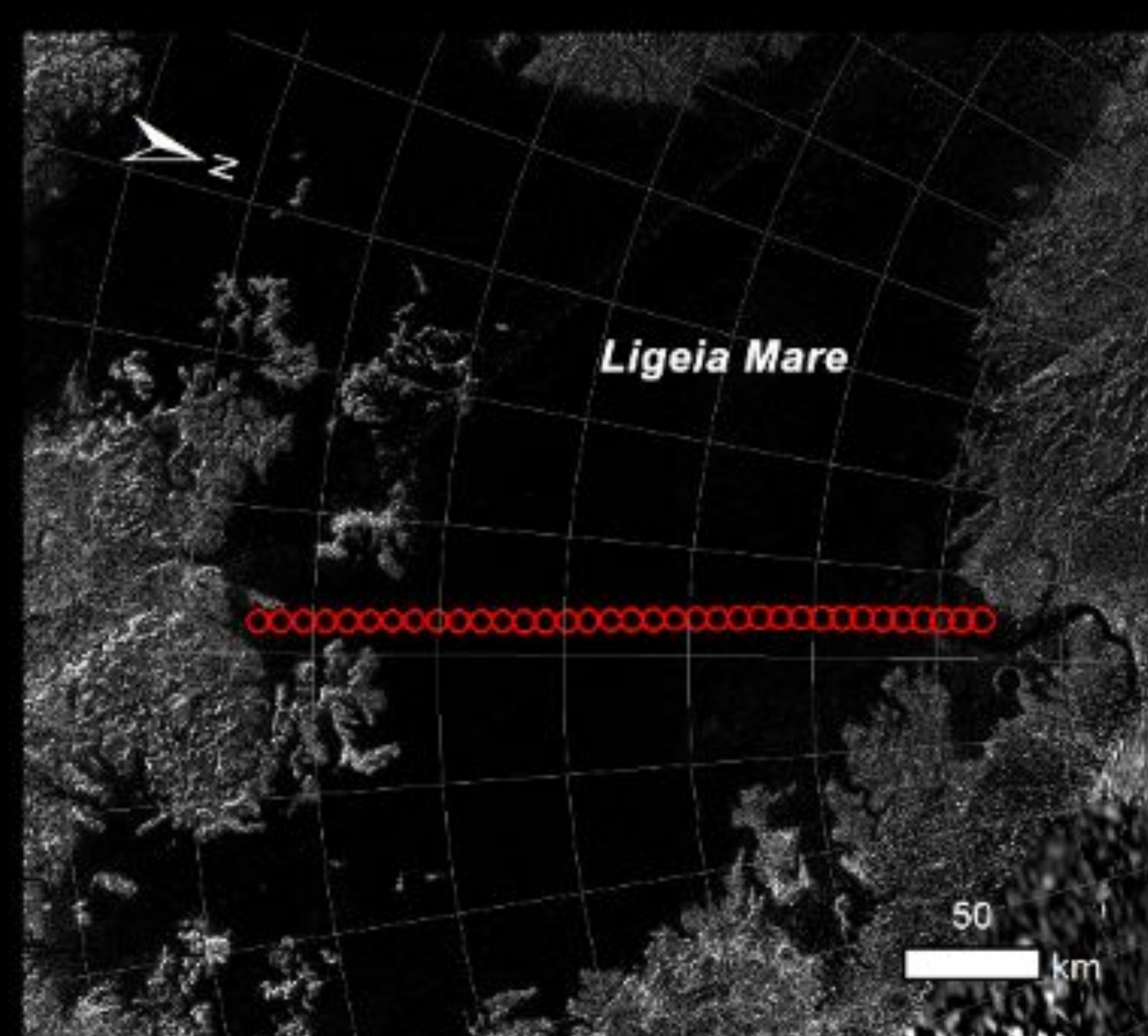
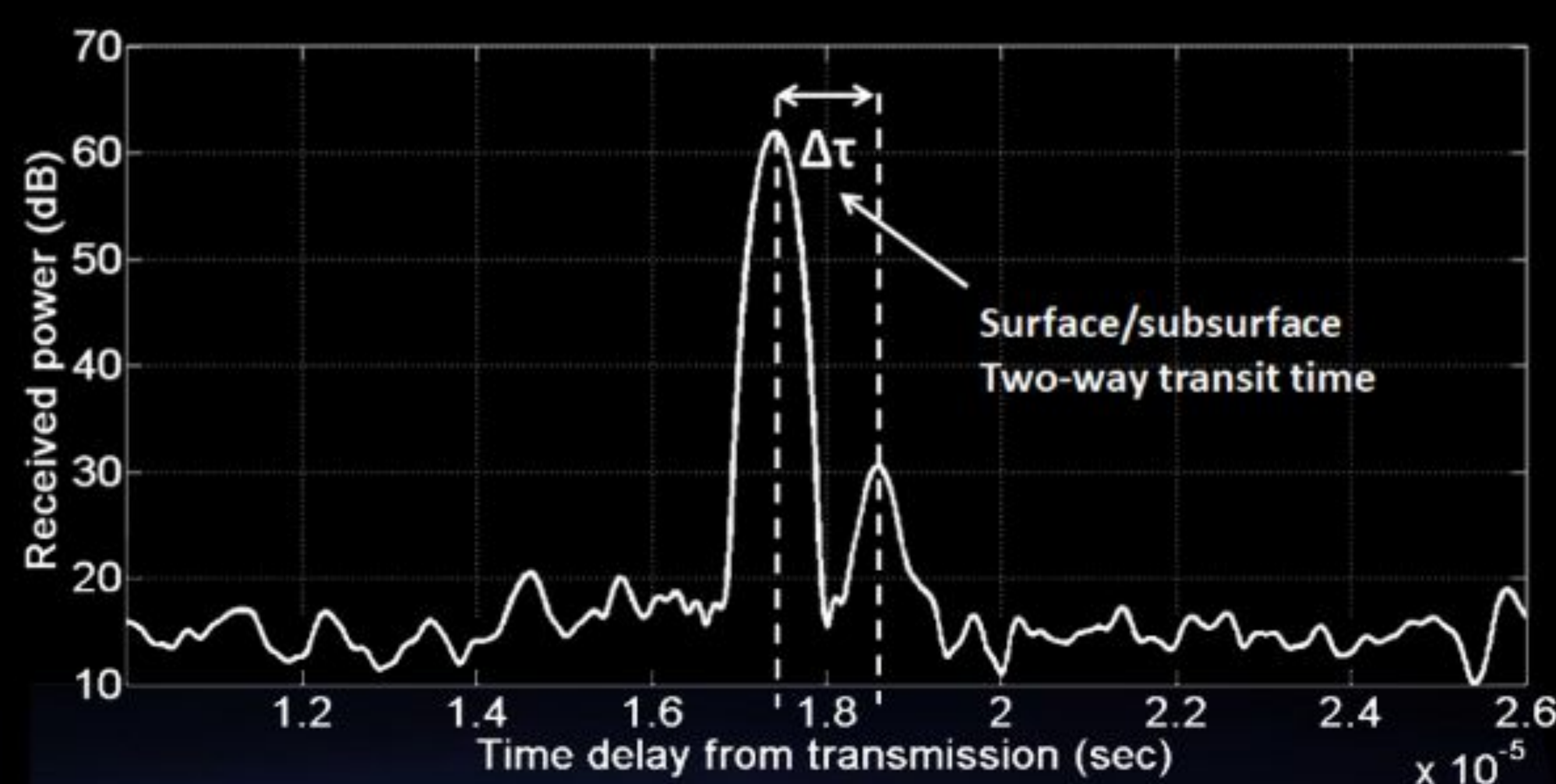


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ISS photomosaic of Titan's North Pole

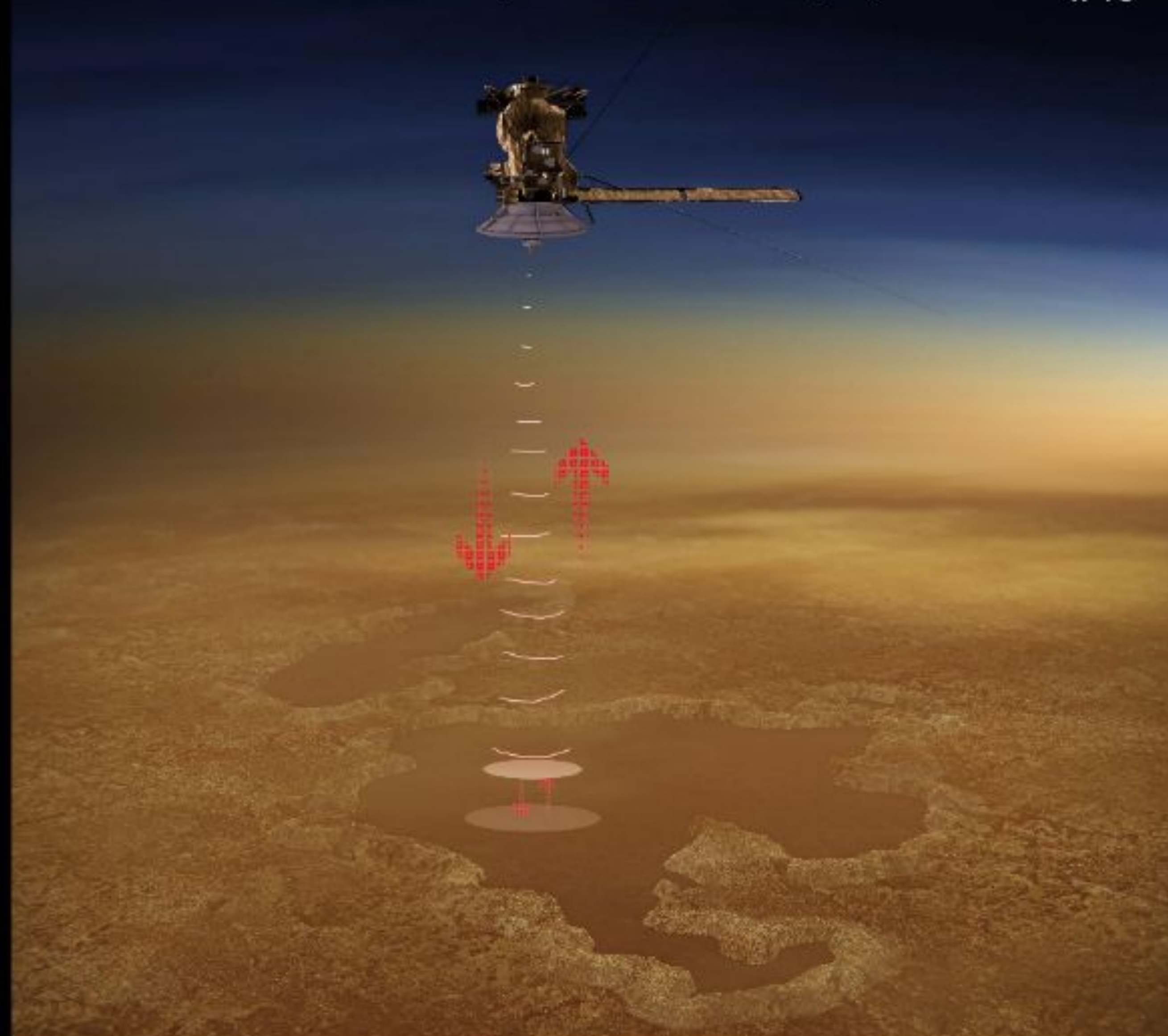
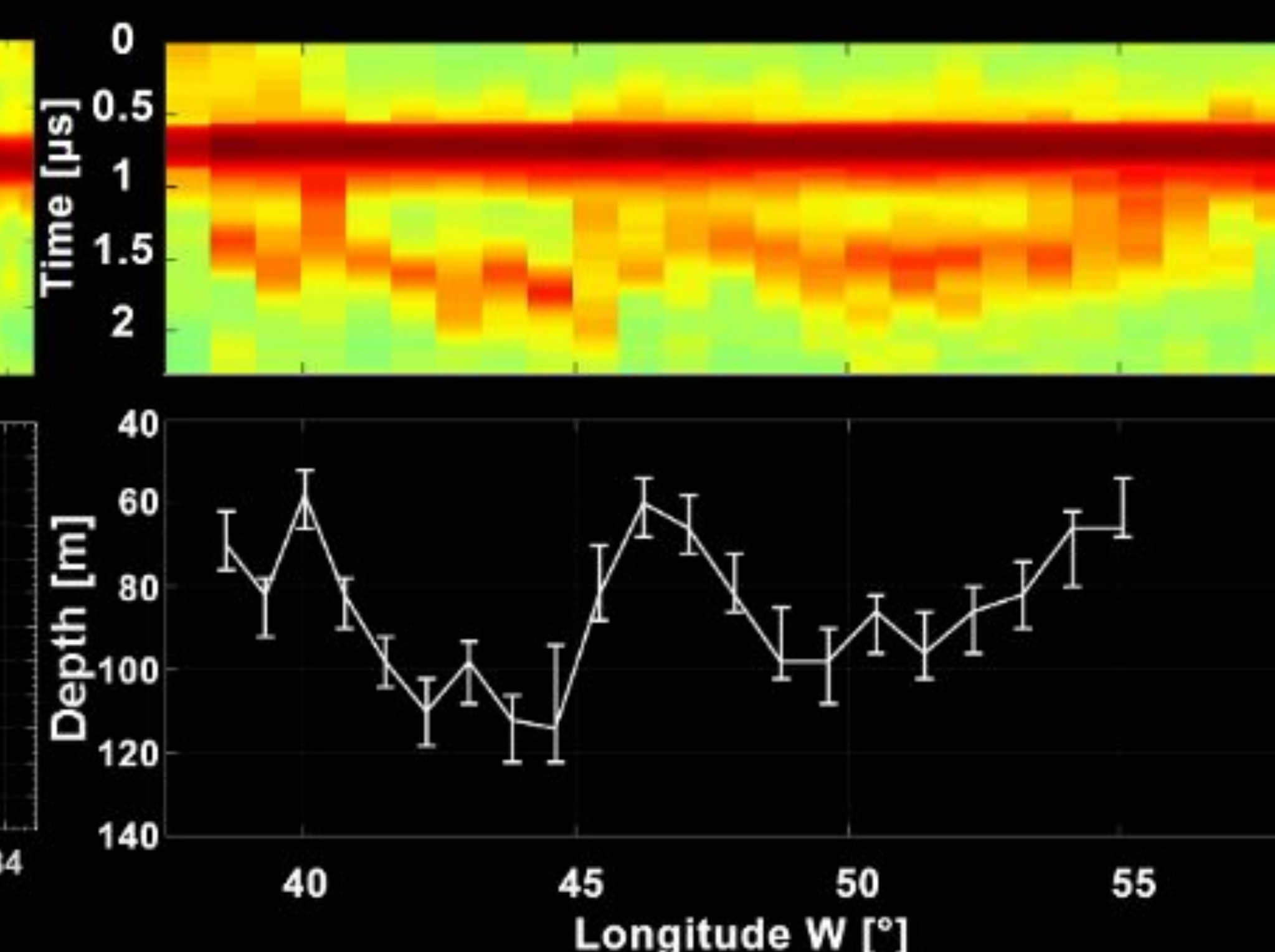
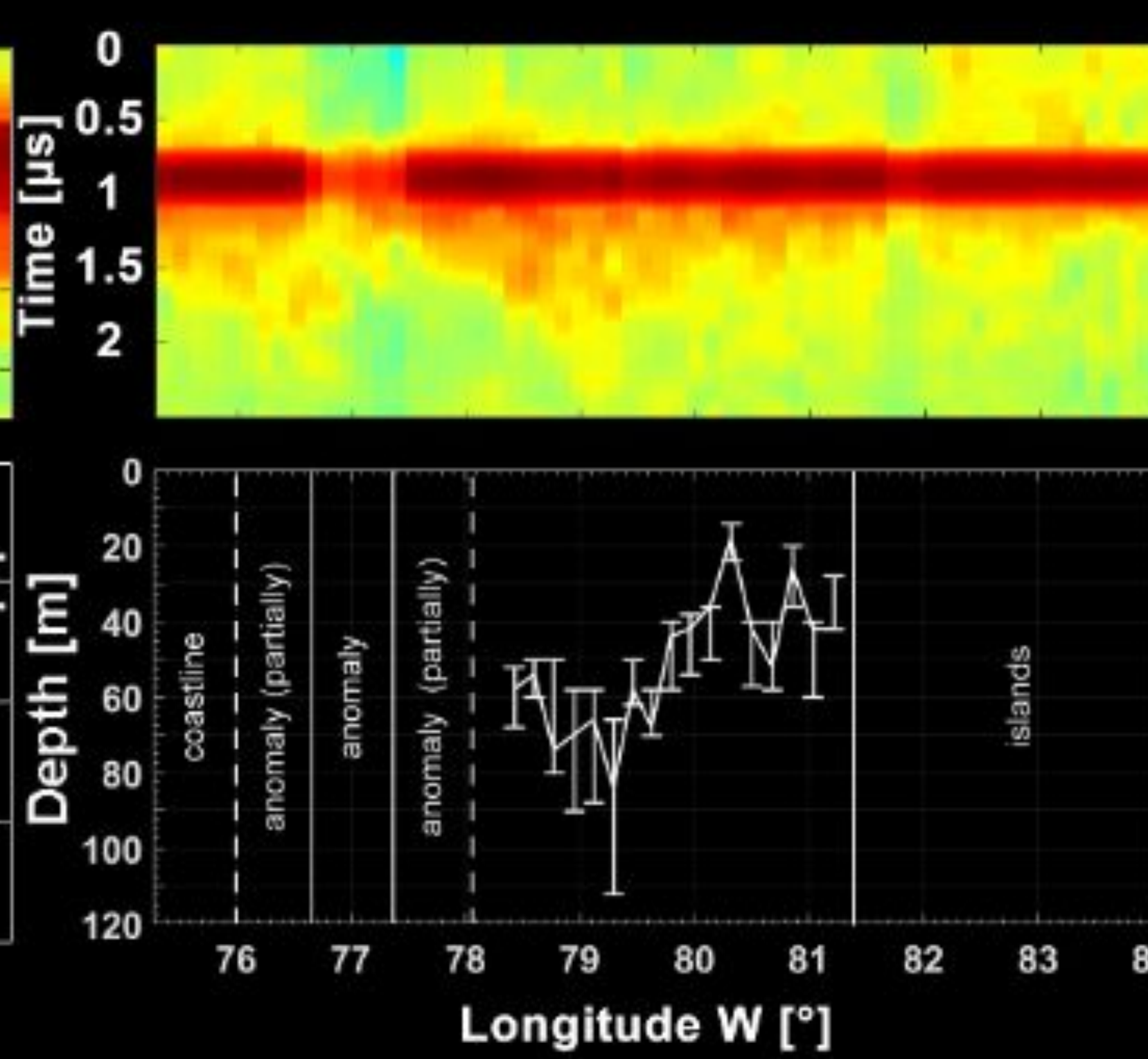
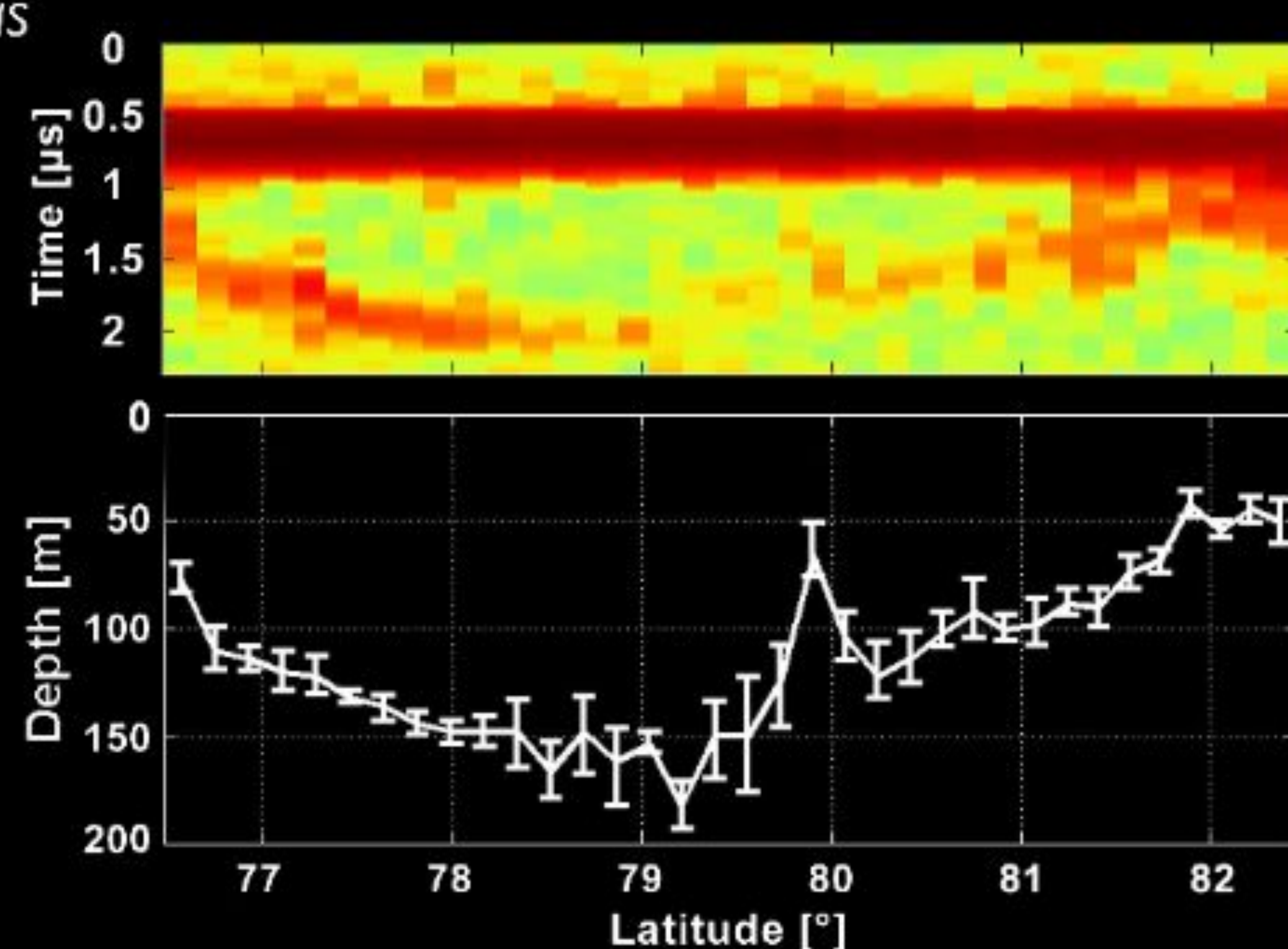
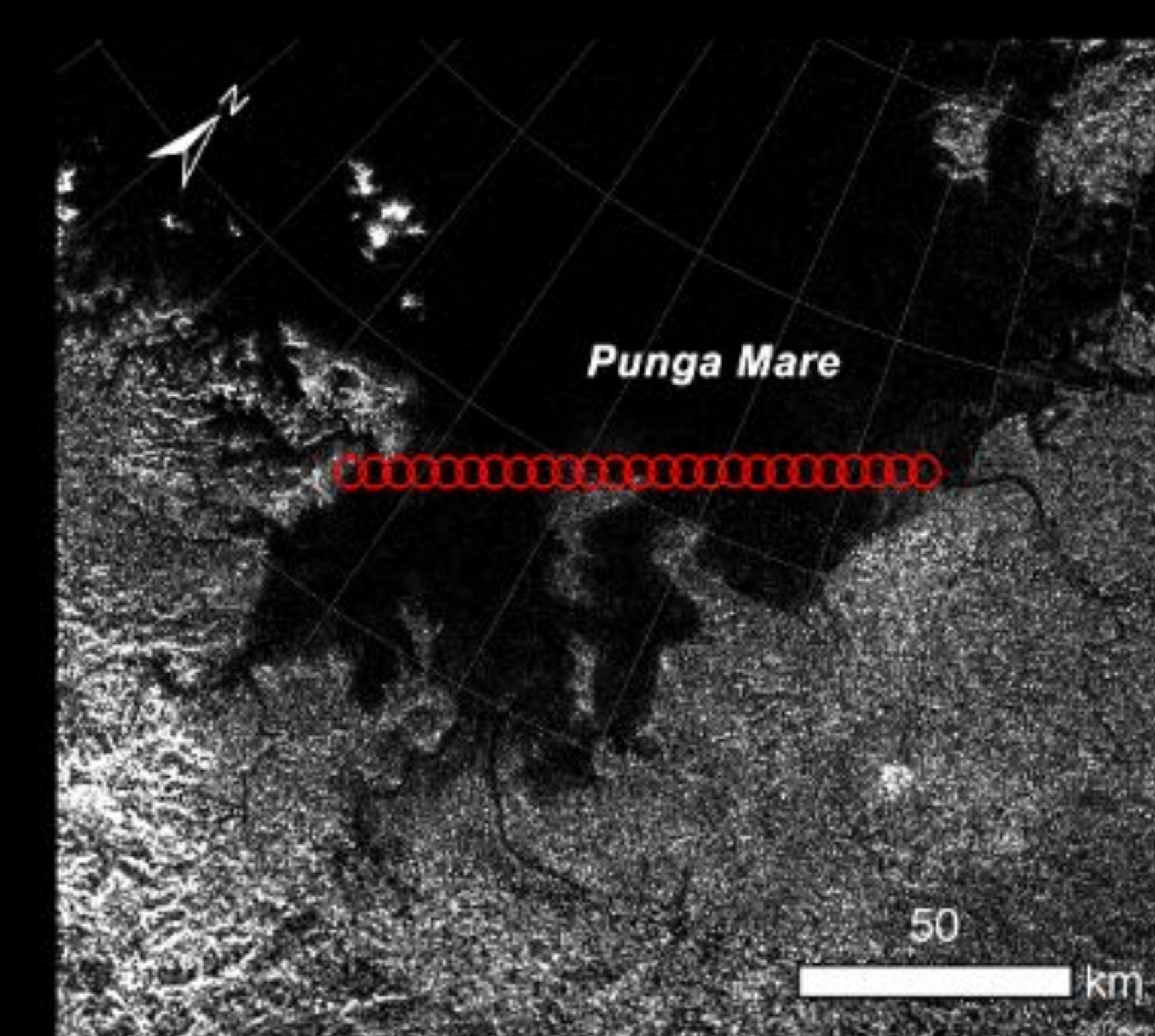
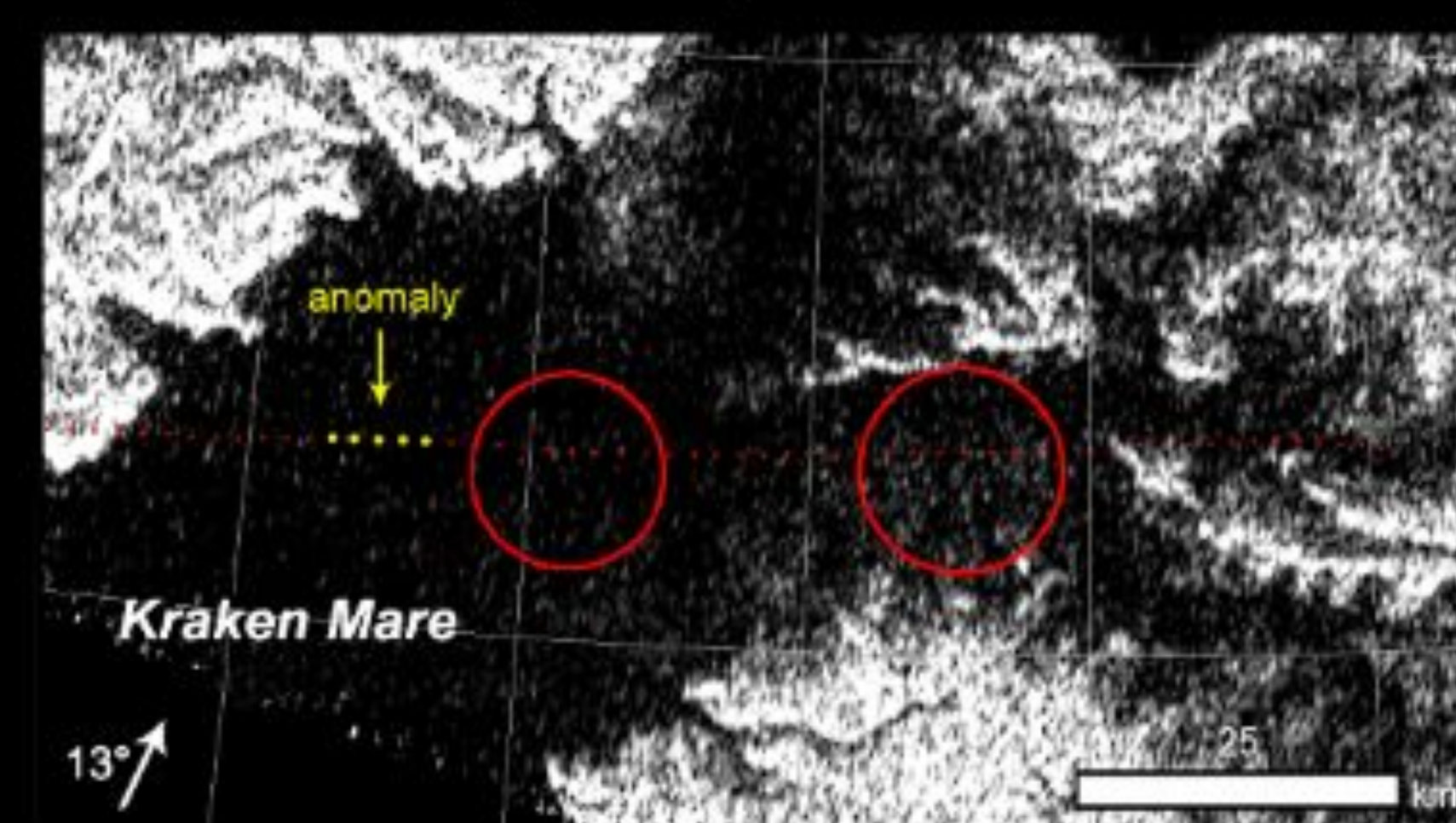
The Cassini radar receives one echo from the flat surface of the sea and a later reflection from the sea floor. This delay is proportional to the sea depth. ▼



◀ The bathymetry of Ligeia Mare

The bathymetry of Punga Mare ▶

▼ The bathymetry of Kraken Mare



Titan is the only world in our solar system hosting open bodies of liquid on its surface. Filled with liquid methane and other organics, Titan's lakes and seas represent an outstanding opportunity for exploration in which Cornell has played an important role since the 1970s with Carl Sagan. From 2004 to 2017 the Cassini spacecraft performed 127 close flybys of Titan and used its radar and infrared instruments to peer through Titan's thick atmosphere finally giving scientists a detailed view of its elusive surface. Cassini discovered that Titan has clouds, rain, lakes and rivers of liquid hydrocarbons, as well as a subsurface ocean of salty water.

We performed our first bathymetric measurements following the T91 observation of Ligeia Mare, the second largest sea of Titan (49,000 square miles) that resulted in a max depth along the observed profile of about 530 feet and in a composition of 71% methane, 12% ethane and 17% nitrogen. The seafloor reflections appear as echoes delayed in time with respect to the strong reflection from the sea surface (see left panel). Estimations of the composition of the liquid can be made by comparing laboratory results for the measurement of the loss tangent of liquid hydrocarbon mixtures with the accurate measurement of the specific attenuation of the liquid shown by the echoes received by the Cassini radar.

After the success of the Ligeia experiment, similar ones were executed for Punga and Kraken Mare. The results of the latter, in particular, have been published only recently (Dec. 2020) and reopened the debate over the necessity of further exploration missions. In 2009, NASA chose the robotic rotorcraft lander Dragonfly as the next mission to Titan. This probe is scheduled to arrive in 2034 and explore the equatorial area near the Selk crater to assess Titan's microbial habitability and study its prebiotic chemistry.

## Selected publications

- Poggiali et al., (2020). The bathymetry of Moray Sinus at Titan's Kraken Mare. *JGR: Planets*, Volume 125, Issue 12.
- Hayes, A. G. (2016). The lakes and seas of Titan. *Annual Review of Earth and Planetary Sciences*, 44, 57–83.
- Mastrogiuseppe et al. (2014). The bathymetry of a Titan sea. *GRL* 41, 1432–1437.
- Lunine et al. (1983). Ethane Ocean on Titan. *Science*. Vol. 222, Issue 4629, pp. 1229–1230.
- Valerio Poggiali's Poster Room: Apr 23, 2021 02:00 PM ET (US and Canada)  
Zoom Meeting ID: 926 6022 8862  
Passcode: 955523