Fog on Titan detected by Huygens lander

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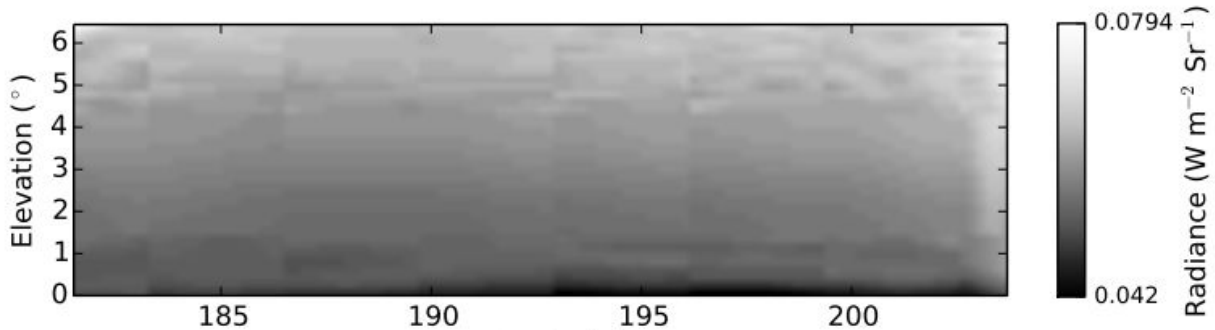

(a) Cropped, calibrated image.

Credit: arXiv:1603.04413 [astro-ph.EP]

Titan, the largest moon of Saturn, with its thick, dense atmosphere, is of special interest for scientists studying atmospheric features on other worlds. While the presence of fog on Titan was revealed in 2009 thanks to data provided by NASA/ESA Cassini spacecraft, a new study shows that this phenomenon is also visible from ground observations conducted by the ESA Huygens lander. A paper describing the new findings appeared online on Mar. 14 in the *arXiv* repository.

Huygens was released by the Cassini spacecraft and landed on Titan on January 14, 2005. It gathered crucial scientific data while descending through the nitrogen-dominated atmosphere for 2.5 hours and transmitted a signal for about 70 minutes after touchdown before contact

was lost. It provided a variety of in situ measurements that are to this day bringing new insights on this curious planet-like moon.

One of the new findings was derived from the data collected by Huygens' Side Looking Imager (SLI). A team of researchers from York University in Toronto, Canada, led by Christina Smith, has found that methane fog is also visible from the surface of Titan.

"The process of detecting this fog was, we took the Huygens Side Looking Imager data from data archives, restricting the images to those taken after landing," Smith told *Phys.org*.

To detect the feature, a total of 82 SLI images were calibrated, processed and examined. The team calibrated this subset of images and processed them using a variety of techniques. The technique that revealed these features most clearly was with mean frame subtraction. According to the scientists, the calibrated images show a smooth vertical radiance gradient across the images, with no other discernible features.

"We made an average frame from the whole data subset and subtracted that average frame from each individual frame, highlighting changes from the average frame. It was in six of these mean frame subtracted images that we found linear features," Smith revealed.

They evaluated possible origins and determined that these features most likely originate from the presence of a fog bank close to the horizon that rises and falls during the period of observation.

"Clouds were considered, but no consistent movement across the frame was detected, so this is unlikely. A superior mirage was considered, but there was no temperature inversion detected on descent, so again, this is considered unlikely. We considered a background rise, but due to several considerations our most likely explanation—in our opinions—is that this

feature is due to a fog bank rising and falling," Smith noted.

A fog bank also explains the difference between the predicted sky radiance in the non-mean frame subtracted images: The observed radiance of the sky decreases more than the predicted radiance. "Therefore, for the aforementioned reasons, the presence of a fog bank that rises and falls over the course of the observing period is considered the most likely explanation for the observed feature," the paper reads.

Titan harbors a thick atmosphere composed primarily of nitrogen (over 90 percent), followed by methane and smaller fractions of other components. Methane clouds have been detected from both terrestrial telescope observations and satellite observations at a variety of altitudes. It has been hypothesized that methane cycling, similar to the Earth's hydrological-cycling, occurs on Titan. Smith emphasized that new findings from Huygens' SLI show that even "older" data can offer new insights on Titan's atmosphere.

"It's impossible to say what can be learned in the future," she concluded.

More information: Possible ground fog detection from SLI imagery of Titan, arXiv:1603.04413 [astro-ph.EP] arxiv.org/abs/1603.04413

Abstract
Titan, with its thick, nitrogen-dominated atmosphere, has been seen from satellite and terrestrial observations to harbour methane clouds. To investigate whether atmospheric features such as clouds could also be visible from the surface of Titan, data taken with the Side Looking Imager (SLI) on-board the Huygens probe after landing have been analysed to identify any potential atmospheric features. In total, 82 SLI images were calibrated, processed and examined for features. The calibrated images show a smooth vertical radiance gradient across the images, with no other discernible features. After mean-frame

subtraction, six images contained an extended, horizontal feature that had a radiance value that lay outside the 95% confidence limit of the predicted radiance when compared to regions higher and lower in the images. The change in optical depth of these features were found to be between 0.005 and 0.014. It is considered that these features most likely originate from the presence of a fog bank close to the horizon that rises and falls during the period of observation.