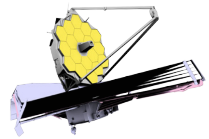
NASA's James Webb Space Telescope:



Observations of Titan

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After the end of the Cassini mission in 2017, the James Webb Space Telescope (JWST) beginning in 2018 will provide an important tool for keeping track of the changing seasons on Saturn's moon, Titan. As Saturn slowly circles the Sun, Titan undergoes a 29.5 (Earth) year annual cycle, and will be in northern summer when JWST begins observations. Spectral imaging using the integral field units (IFUs) of NIRSpec and MIRI, and targeted filter imaging with NIRCam will allow long-term monitoring of the changing spatial distributions of gases, clouds and hazes, and thereby reveal the interplay of chemistry and dynamics in response to the seasonal cycle.

Example Titan Science Investigations:

- Atmospheric Composition: With a near-IR spectral resolution ~10× higher than Cassini VIMS, NIRSpec can investigate the spatial distribution of tropospheric methane, while MIRI can make a detailed survey of stratospheric gases in the mid-IR (Fig. 1)
- Clouds: A cloud monitoring campaign at selected near-IR wavelengths will build on the long-term database of clouds tracked by Cassini and ground-based observatories (see overleaf).
- Hazes: NIRSpec in IFU mode can spectrally image (R~2700, 0.1") Titan over seasonal time scales, allowing monitoring of seasonal changes in haze distribution.
- Surface Temperatures: At 19 μm Titan's atmosphere is mostly transparent, allowing MIRI to measure the disk-average surface temperature over time.
- Surface changes: JWST NIRSpec and NIRCam can see Titan's surface in methane-free spectral 'windows', allowing monitoring of surface albedo changes due to rainfall, geologic activity or sea shrinkage.

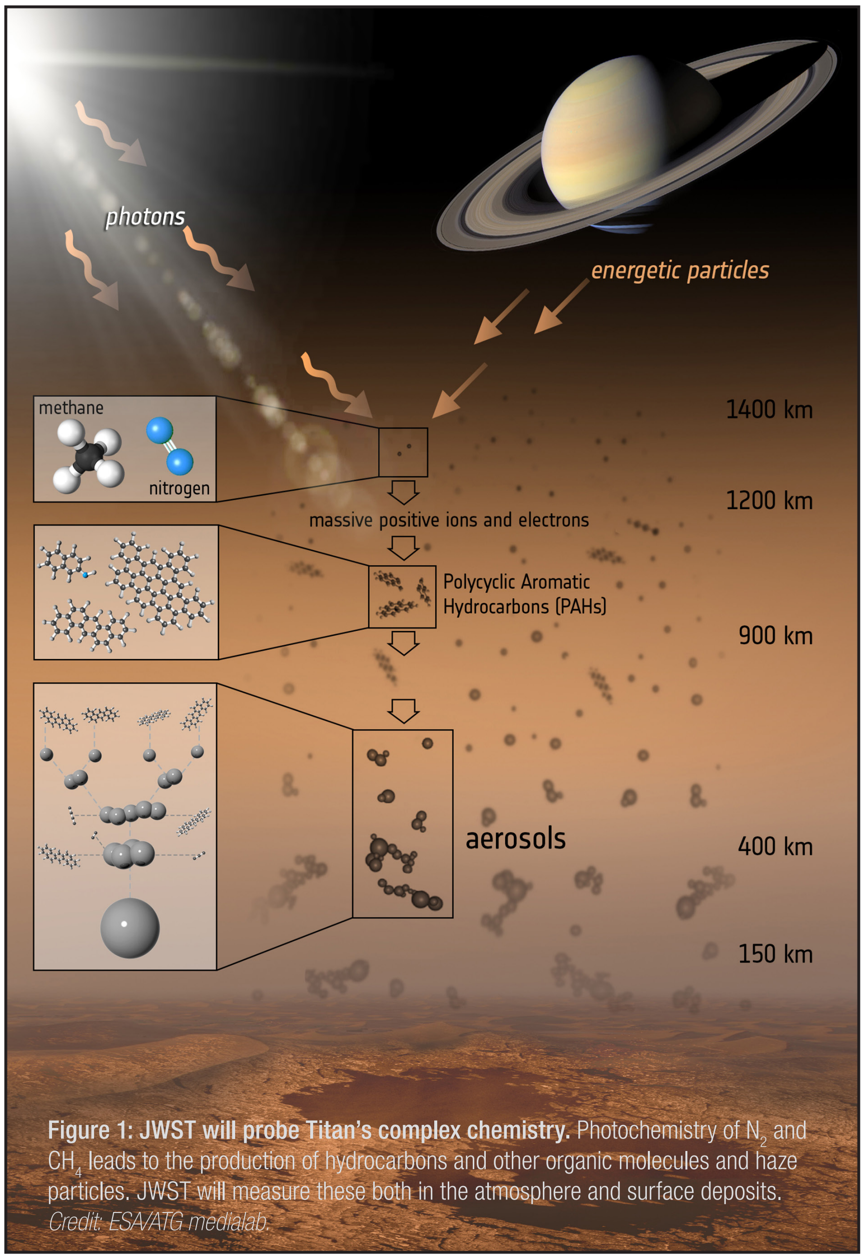

Figure 1: JWST will probe Titan's complex chemistry. Photochemistry of N_2 and CH_4 leads to the production of hydrocarbons and other organic molecules and haze particles. JWST will measure these both in the atmosphere and surface deposits. *Credit: ESA/ATG medialab.*

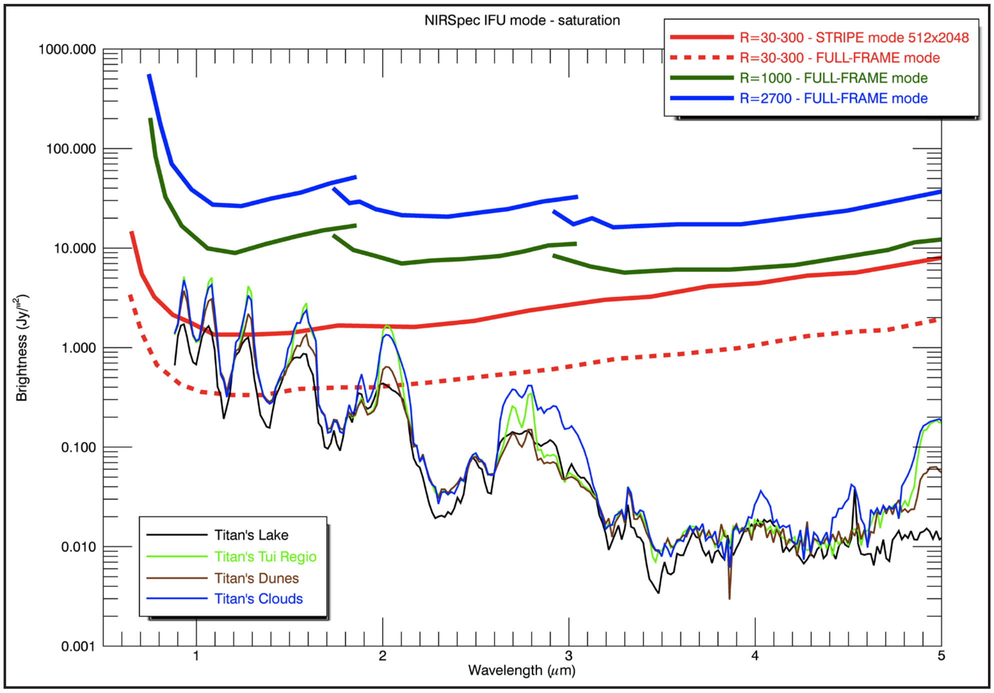

Figure 2: Separation of terrain types with NIRSpec. The spectral diversity of terrains on Titan as recorded by the Cassini VIMS instrument (thin lines), compared to brightness saturation limits for various resolutions, single-frame read-out, of NIRSpec in integral field mode (thick lines).

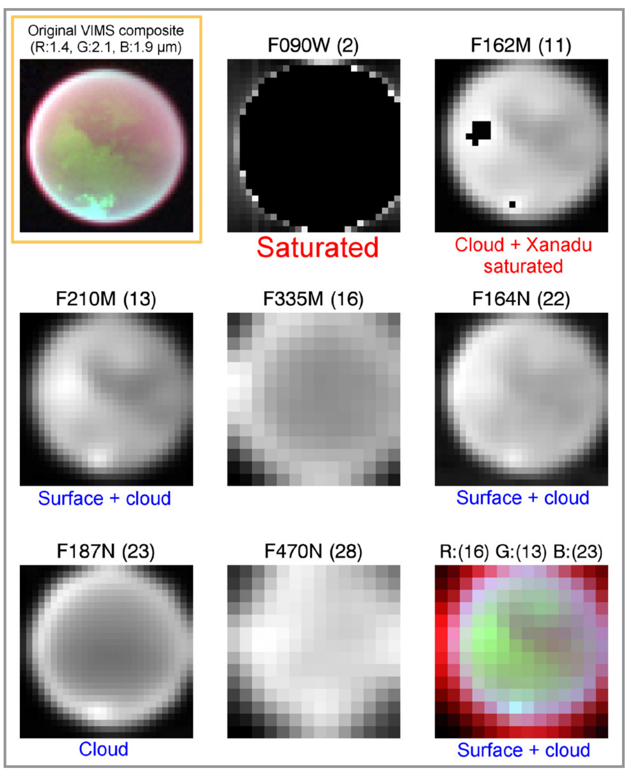

Figure 3: Surface and cloud imaging with NIRCam. Predicted appearance of Titan in various filters. Some shorter wavelength filters (e.g. 0.9 µm) will saturate at the single-frame readout time. Longer wavelength filters will allow detection of surface features and seasonal monitoring of the atmosphere (gas, clouds and haze).

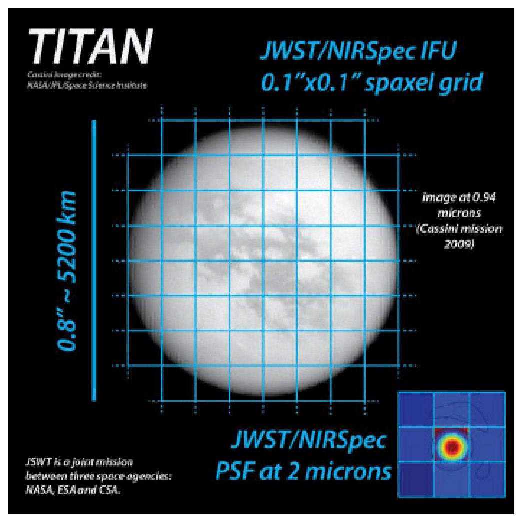

Figure 4: Resolving Titan's disk with NIRSpec IFU imaging. The typical angular size of Titan (0.8") is compared to the NIRSpec resolution at 2 µm (0.1"), showing that approximately 8×8 pixels are obtained on the solid body disk. The visible atmosphere adds another ~500 km (1 pixel) in size. Image shows part of the IFU 3"x3" field (30x30 pixels).

Credits:
Fig.s 2 & 3. produced by S. Rodriguez, Université de Paris-Diderot, for the JWST Titan Focus Group.
Fig. 4 from Norwood et al., "Solar System Observations with JWST", 2014.