UPDATING THE GLOBAL MAP OF TITAN FLUVIAL FEATURES AND INVESTIGATING DOWNSTREAM RADAR BRIGHTNESS TRENDS. A. D. Maue[1], D. M. Burr[1], J. S. Levy[2], and E. Nathan[2], [1]University of Tennessee, Knoxville TN, [2]Colgate University, Hamilton, NY; (amaue@vols.utk.edu).

Introduction: Fluvial features are widespread across the surface of Saturn's moon, Titan [1,2]. Global maps of these features have yet to include the most recent Titan flyby data. We identify fluvial morphologies and map their lengths as polylines in all available radar image swaths. As on Earth, the mapped features commonly exhibit branching morphologies and occasionally terminate at lakes [3]. Toward the poles, fluvial features appear radar-dark relative to the surrounding surface, interpreted to reflect the presence of extant liquid hydrocarbons indicated by their smooth surface and emissivity as reported for Titan's liquid methane lakes [3]. These features stand in contrast to those at the mid-to-low-latitudes, where fluvial features are more commonly radar-bright relative to their surroundings—an observation that has been linked to the presence of highly backscattering spheroidal cobbles [4]. To study the processes of fluvial transport and deposition on Titan, we select a subset of the most prominent radar-bright fluvial features to analyze more closely.

In this work, we update the global map of fluvial features to include nearly all image swaths and investigate specific radar-bright fluvial features for possible sedimentological trends.

Titan data: Owing to Titan's dense atmospheric haze, radar wavelengths are used for deriving images of the body's surface. The Cassini RADAR instrument produced Synthetic Aperture Radar (SAR) image swaths, as well as altimetry, scatterometry, and radiometry datasets [5]. We utilize incidence- and noise-corrected SAR images which report pixel values as the unitless radar backscatter, sigma naught (σ^0). Titan SAR images have an optimum spatial resolution of 350 m/pixel, enabling the identification of km-wide features at best. In the Descent Imager/Spectral Radiometer (DISR) images taken at low altitude by the Huygens probe, smaller fluvial features can be seen. These optical images clearly demonstrate the expected fractal quality of natural river networks and thus the prevalence of fluvial activity below SAR resolution [2] that may influence sedimentology. The widespread resolved and sub-resolution fluvial networks, as well as the rounded cobbles seen at the Huygens landing site [6], strongly imply extensive fluvial sedimentary processes across the moon. In addition to global mapping, this work further investigates evidence for fluvial sedimentation in Titan's drainage networks through analysis of σ^0 trends.

Linear mapping: The most recent SAR-based global mapping efforts utilized swaths through Titan flyby T-71, investigating morphologies [1] and relevant fluvial processes [2]. In the former, morphological classifications of 51 networks in SAR and DISR images as commonly rectangular indicated tectonism may be influencing fluvial network structures, although dendritic and parallel networks suggest that such influence is not uniform [1]. An expanded distribution of mapped features has the potential to test these findings and add statistical significance to similar spatial analyses.

Recent updates. The Cassini mission has since reached its conclusion and the final radar images are anticipated to be released in April 2018. With these 14 additional SAR swaths, we will be able to produce a final hydrological map at the end of the Cassini mission.

With fluvial features delineated as polyline networks, morphological attributes can be identified and quantified. One valuable characteristic is the flow direction. For heavily branching networks, the downstream direction is inferred from the direction of tributary confluence (**Fig. 1**). Additional evidence for flow direction comes from inferred downstream depositional sites such as lakes and/or upstream sources such as high-roughness terrain. Finally, slope aspect derived from sparse elevation data [7] can provide more direct evidence for the expected flow direction at present.

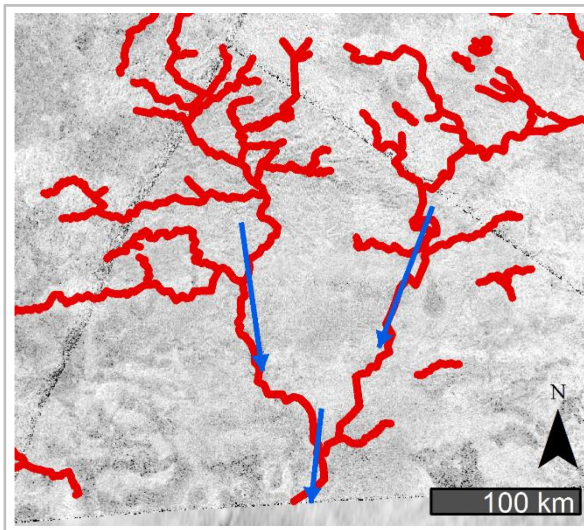

Figure 1. Example of a radar-bright fluvial feature at 140°W, 10°S mapped as polylines (red lines) exhibiting rectangular morphology with inferred flow directions (blue arrows).

Radar brightness trends: Modeling of radar backscatter indicates that radar brightness in some fluvial features southeast of Xanadu correlates to the grain size of transparent cobbles [4]. This effect is greatest for clasts with diameters approximating (or a factor of a few greater than) the wavelength of the reflected microwaves (~2 cm). Rounded cobbles (e.g., sediment at the cm-to-dm scale) are expected based on the in-situ surface images of the Huygens landing site [6].

Based on the anticipated link between radar brightness and fluvial cobbles, we isolate select radar-bright fluvial features to examine downstream radar brightness changes that may be indicating grain size trends. Radar-bright fluvial features that are sufficiently wide (>few pixels) and long (>50 km) are mapped as polygons. Radar-bright pixels are captured in segments moving down the length of the feature (**Fig. 2**), from which representative values can be calculated.

Conclusions and Future Work: The global map of Titan's fluvial features is being updated using the final radar swaths of the Cassini mission (**Fig. 3**). The result is a product that can enable the most robust hydrologic analyses of Titan to date and may persist until the arrival of a future spacecraft, possibly decades in the future. We will also examine large radar-bright fluvial features for possible radar-brightness trends than can then be put in a global sedimentological context. The measured downstream changes in radar brightness will be related to expected rates of abrasion for icy sediment, as determined with the Titan Tumbler [8,9].

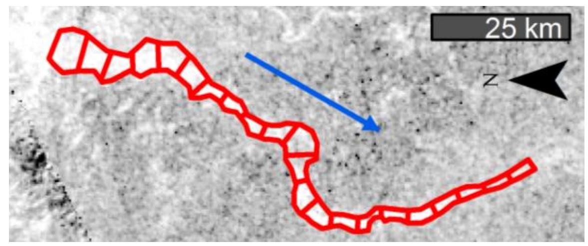

Figure 2. Example a large radar-bright fluvial feature at 119°W, 19°S mapped as polygonal segments (red lines) with inferred flow direction (blue arrow).

References: [1] Burr et al. (2013) *Icarus, 226*. [2] Burr et al. (2013) *GSAB, 125.* [3] Stofan et al. (2007) *Nature, 445*. [4] Le Gall et al. (2010) *Icarus, 207*. [5] Elachi et al. (2004) *Space Sci. Reviews*, *115*. [6] Tomasko et al. (2005) *Nature*, *438*. [7] Corlies et al. (2017) *GRL, 44*. [8] Levy et al. (2017) *LPSC XLVIII*, Abs. #1105. [9] Maue et al. (2018) *LPSC XLIX*, Abs. #1113.

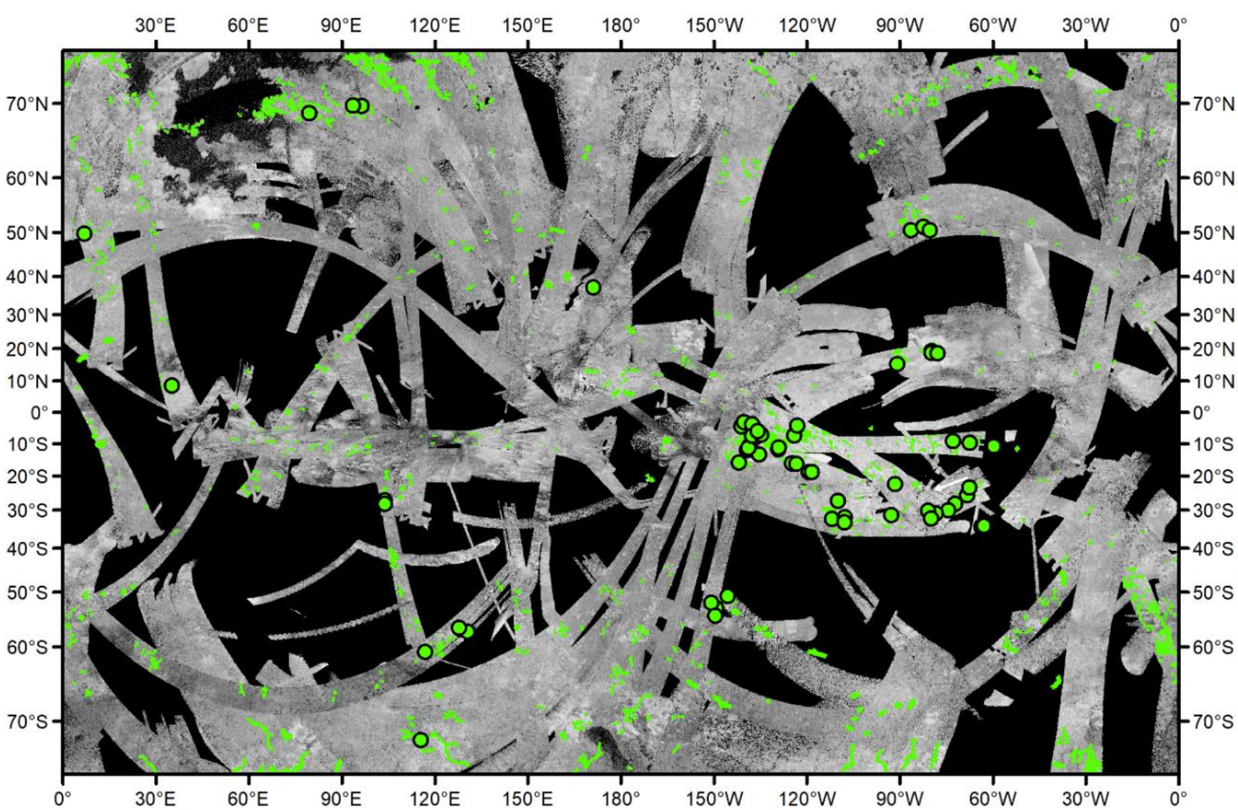

Figure 3. Preliminary mapping of fluvial features over SAR swaths of Titan up through T-98 with polylines (green lines) and sites of predominate radar-bright features (green dots).