INITIAL GLOBAL CONTROL NETWORK AND MOSAICKING OF ISS IMAGES OF TITAN. Brent Archinal, Tammy Becker, Ella Lee, and Ken Edmundson, Astrogeology Science Center, U. S. Geological Survey (2255 N. Gemini Drive, Flagstaff, AZ 86001, USA, barchinal@usgs.gov).

Introduction: The Cassini mission has returned an abundance of data about the surface of Titan. To maximize the science return from these data and to assist with planning for Cassini and future missions, we have begun the process of rigorously registering images and ancillary data from Cassini's ISS and RADAR instruments into a single, consistent, precise global Titan reference frame and have created the first controlled near global (all longitudes, +45° to -65° latitude) ISS mosaic of Titan. This has been done via a controlled, photogrammetric least squares bundle adjustment.

Methods: ISS images (938 nm and MT1 filters) have been chosen based on those used for existing uncontrolled mosaics [1]. Processing is done with ISIS3 [2]. Images are radiometrically calibrated (*cisscal*), surface features enhanced using MT1 images [1], and image tie points seeded and measured (*pointreg*). Manual tie points are measured between ISS and RADAR images, since RADAR images currently have higher resolution and (likely) accuracy, given they are unaffected by spacecraft pointing errors. Bundle adjustment solutions are then done (*jigsaw*) [3] using fixed locations for the RADAR points, and solving for lat/long of other points as well as spacecraft orientation and position. A spherical model with radius 2575 km is used for Titan's shape and an updated RADAR derived model for orientation [4]. Improvements have been made in the preprocessing of images (compared to [1]), e.g., rather than independently registering successive flyby images to each other and updating SPICE only for the "master" image, all images are included in the solution process and are updated.

Intermediate solutions are performed and improved by remeasuring outlier points, flyby by flyby. These already show substantial improvements in the relative positioning of the images, and can also be used to substantially improve the visibility of features by averaging overlapping data (Figure 1). Eventually data from all flybys are combined and overall solutions done. The results of our best global solution so far are shown in Figure 2 and this table:

Number images	702
Number flybys	21 (full and partial)
Number points	7848
Number fixed points	50 (to RADAR positions)
Number measures (X&Y)	48542
Global solution RMS	1.25 pixels
Mean square positional error	1.6 km (on points)
Maximum residual	16.5 pixels

Relevance: Geodetically controlling the Titan datasets together enables the intercomparison and analysis of Cassini data and thus directly supports the best and intended use of these data. The creation of coordinate systems, coordinate frames, and controlled mapping products is strongly supported via a number of advisory groups in a variety of contexts [14]. To our knowledge, this is the first publication describing such work for Titan.

Future Work: This controlled network and mosaic can be further improved and additional data added, so it can be used for specialized investigations in the exploration of Titan, including retargeting features for change detection or to acquire higher resolution data. Among many possible uses are the investigation of two key scientific issues: 1) Searching for and documenting changes on Titan's surface, including lake margins [6, 7] and dark and bright surface patterns thought to signal precipitation, drying, and evaporite formation [8-11]; and 2) Solving for pole position, spin rate and changes in spin rate to constrain Titan's internal structure and lay a foundation to document evidence of an internal ocean [12-14]. The current results and any future processing will also facilitate investigations on: a) the global shape of Titan; b) surface albedo changes; c) seeing or setting limits on the size of topographic features; d) improving the efficiency of image targeting; e) improving the registration of any co-acquired VIMS images; and f) improving photometric correction of ISS and VIMS images.

We are seeking to continue to expand this network, by including ISS and RADAR images from all relevant flybys, and in particular extending coverage to higher latitudes. Further improvements can also be made to improve the efficiency of processing and to optimize the statistical weighting of parameters to produce the most accurate geodetic solutions. The resulting image mosaics will contribute fundamentally to many of the important science investigations noted above. The RADAR-ISS control network and associated mosaics will provide a solid reference frame for the current Cassini mission and future exploration of Titan.

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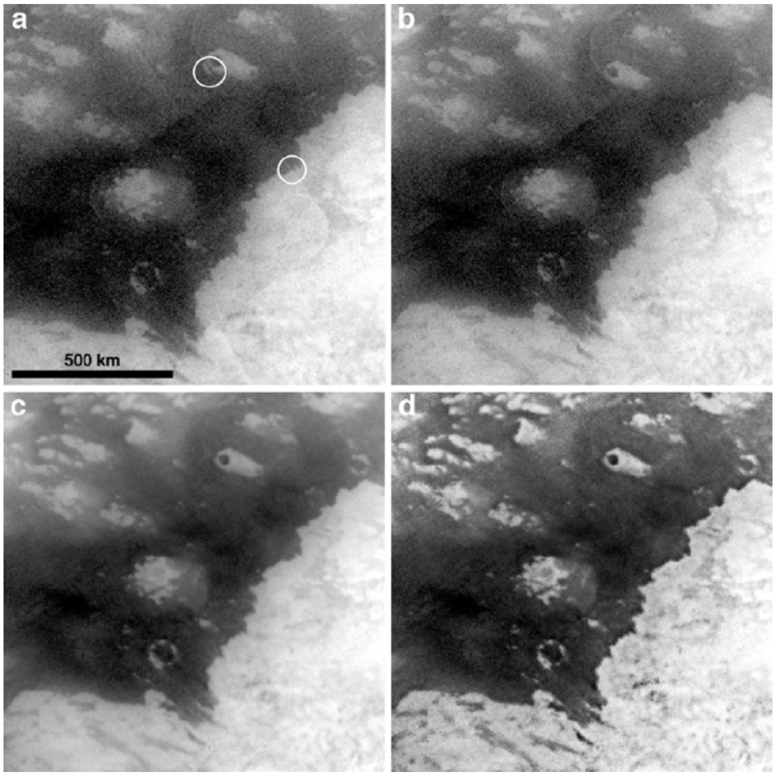

Figure 1: A close-up of a controlled S15 (T8) flyby mosaic showing the boundary between the dune field Shangri-La (dark) and Xanadu (bright). Input images for all versions have been processed by using corresponding MT1 images to enhance surface features. (a) Uncontrolled mosaic using a priori SPICE information. At each pixel of the mosaic the information from the image with highest resolution is used. Note offsets of features (circled) along image boundaries. (b) Controlled mosaic, based on a triangulation solution performed with jigsaw. Mismatches at image boundaries have been reduced or eliminated. (c) Same as b, but at each point all the available overlapping images (up to 9) have been averaged together, eliminating visible seams and improving the signal to noise ratio so that surface features can be seen more clearly. (d) Same as c, after additional enhancement by a high pass filter at 25-km scale to further emphasize local surface features. Such enhancement is only effective after controlling and averaging the images, because it would otherwise amplify noise and image seam mismatches.

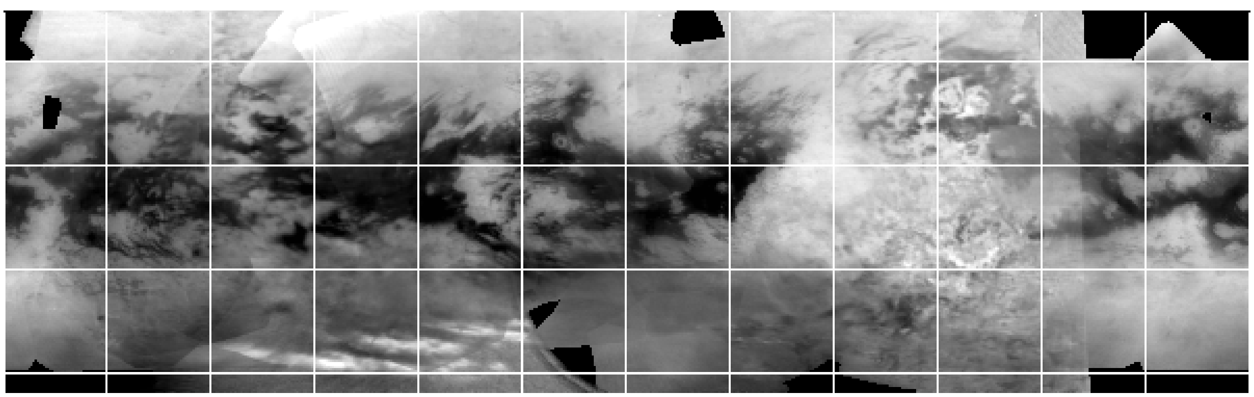

Figure 2: Initial global controlled ISS mosaic of Titan, Equirectangular projection with a 30° grid spacing, covering +45° to -65° latitude and longitude from 360° to 0° W (left to right). North is up and east is to the right. This mosaic is generated from averaged images, which would not be possible at such resolution had the images not been controlled. Images are included from Titan flybys and Cassini Saturn orbits: S08, S15, S17, S18, S25, S27, S28, S29, S30, S31 (T32/T33), S32, S34, S38, S39, S43, S49, S50, S51, S55, and S56. Not all available data has been used, resulting in some holes and lower resolution areas. No cosmetic improvements (filtering, sharpening, etc.) have been attempted. This version is 60x smaller than the full resolution controlled mosaic. Clouds (white streaks) are visible at lower left center.