Introduction: Titan possesses subtle but distinctive structural geological features, such as ridges and linear terrain boundaries, and potentially structurally controlled morphological features such as valleys and lakes. These features can be used to study Titan’s stress field and may represent or reflect interactions with regional or global structural patterns. If indicative of a global pattern, then the precise configuration may indicate the cause, such as orbital eccentricity, orbital recession or progression, and/or nonsynchronous rotation. We use Cassini’s Synthetic Aperture RADAR (SAR) and HiSAR (a high-altitude single beam imaging mode) data of Titan with emphasis on the structural interpretation of tectonic elements. Also, we have applied the SARTopo [1] technique to obtain surface height estimates with ~10 km horizontal resolution and ~75 m vertical resolution along each Cassini SAR swath, providing topographic information co-located with SAR imagery for a better understanding of the outlined lineaments.

Structural mapping: We are focusing on structural mapping of Titan’s surface using Cassini SAR and high-SAR imaging data to identify tectonic elements and produce Geographic Information System (GIS) based maps of lineaments, to understand local, regional and global scale tectonic patterns. A preliminary analysis of SAR and high-SAR imagery of Titan’s surface has revealed several lineaments associated with elongated ridges, terrain boundaries, drainage patterns, and other endogenic and exogenic modifications that might be linked to or affected by tectonic elements. An example is reported in Figure 1, covering the Xanadu and Hotei Arcus area. In these areas lineaments with NW-SE and NE-SW trends are identified, along with a more complex conjugate ENE-WSW and WNW-ENE lineament pairs. In the Xanadu area, similar NW-SE and NE-SW lineaments have been previously reported [2]. The ENE-WSW/WNW-ENE pair appear to be the oldest and has a low intersection angle $\alpha=30^\circ$, while the NE-SW with NW-SE set has a higher intersection angle $\alpha=60^\circ$. This configuration suggests a change in the stress regime from low to high stress angle vectors in the icy shell. The low angle conjugate system implies a shear component, perhaps in a more ductile regime, while the high angle system may indicate a more brittle deformation.

Detail of the complex conjugate ENE-WSW and WNW-ENE lineament pair is shown in Figure 2. The ENE-WSW and WNW-ENE lineaments extend for several hundreds of kilometers, while the NW and NE pair only to a few hundreds of kilometers or so.

Figure 2. Inferred low angle conjugate system with left lateral shear component at the southwestern edge of Xanadu.
SARTopo surface height estimates at the edges of several structural features of the Xanadu region give additional information on the delineated lineaments. The example reported in Figure 3, shows sharp transition occurring at intersecting NE-SW and WNW-ESE lineaments.

Figure 3. SARTopo T44 (beam 12 transect) overlaying SAR T44 in the Xanadu area. Along the SARTopo transect sharp transitions occur along the NE-SW lineaments for which the observable offset is in the order of 300 to 400 meters.

**Stress modeling:** Tectonic inferences, including their ambiguities and assessments, can be tested against predictions from global stress models [e.g. 3]. A plausible assumption, supported by recent gravity data [4], is that Titan is largely differentiated into a silicate core and a water mantle, at least partially icy. The presence of a global subsurface ocean, and a decoupled, viscoelastic lithospheric ice shell, are invoked in most recent Titan interior models [5, 6].

The structural mapping of Titan is the first step needed to quantify and address whether Titan exhibits tectonic elements reflecting its dynamic state. These findings can be then corroborated and analyzed by independent computer assisted time sequence sorting [7,8] and independent stress modeling, as based on gravitational potential theory [4].