What Can We Learn from Satellite Altimetry over Salt Flats? A Case Study Using CryoSat-2 over Salar de Uyuni

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1. Motivation

- 2002: Fricker et al. conduct a kinematic GPS survey over Salar's eastern lobe to provide ground truth for ICESat laser altimeter
- 2008: Borsa et al. identify the correlation between Uyuni's topography and geoid

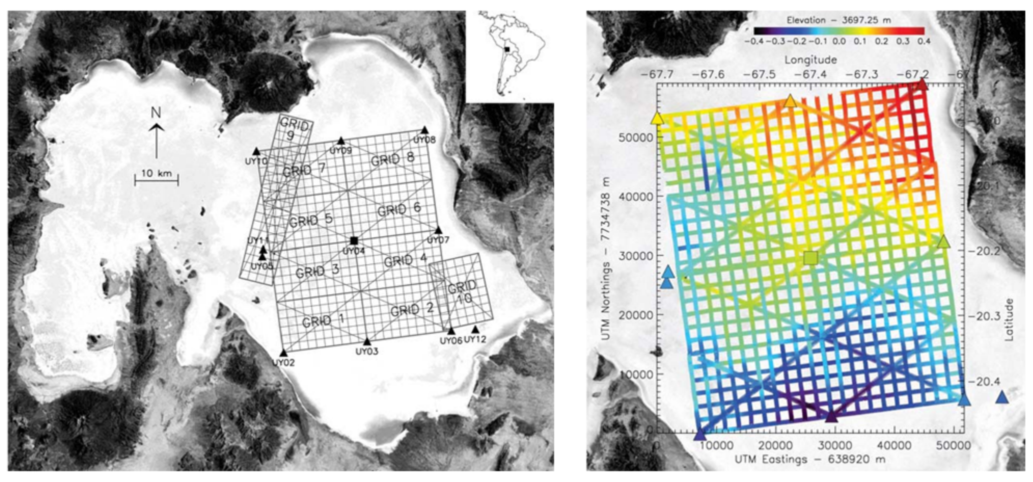

Figure 1: (left) Landsat image of the Salar de Uyuni, showing the major components of the GPS survey, (right) Post-processed GPS trajectories from the Salar de Uyuni, color coded for elevation (Borsa et al., 2008a)

- 2008: Borsa et al. show that the topography created by salt redistribution approximates the local equipotential surface

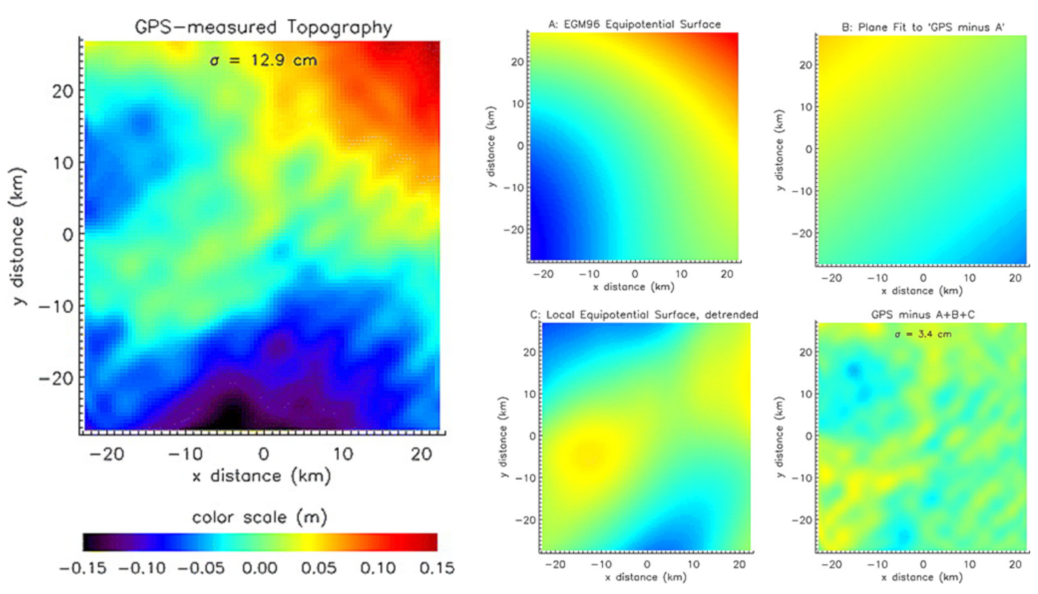

Figure 2: (left) Topography of Salar de Uyuni from GPS (DEM), (right) A: EGM96 equipotential surface, B: Plane fit to 'GPS - A', C: Detrended local equipotential surface, D: The short-wavelength topography (DEM minus A + B + C) (Borsa et al., 2008b)

2. Research Questions

- Can Salar de Uyuni serve as a reference surface for quality assessment of CryoSat-2?
- Can we benefit from Uyuni's flatness to develop new outlier detection schemes?
- How accurate and precise does the altimetry derived time series model salt redistribution in Salar de Uyuni?
- Is it possible to monitor the geoid undulation over salt flats using satellite altimetry?

3. Case Study and Dataset

- World's largest salt flat
- Located in southwest Bolivia
- 3,656 meters above sea level
- Strong reflections similar to ice sheet
- Seasonal flooding dissolves salt surface and thus keeps it leveled

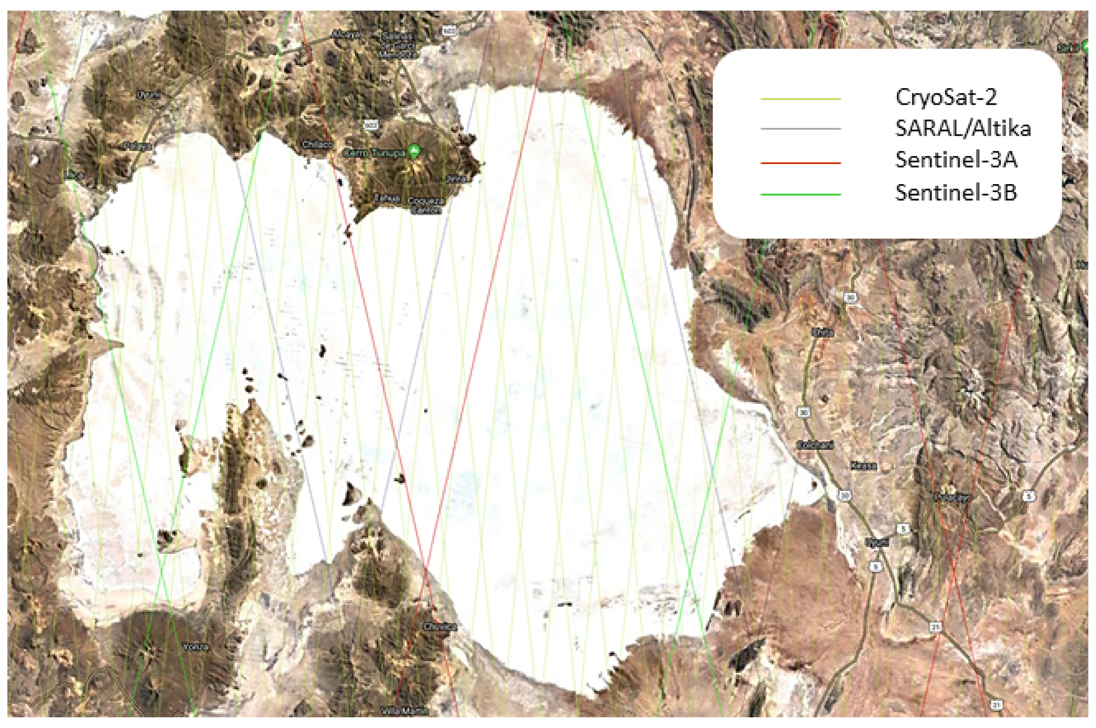

Figure 3: Ground track pattern of CryoSat-2, SARAL/Altika, Sentinel-3A, and B over Salar de Uyuni (http://hydrosat.gis.uni-stuttgart.de)

- CryoSat-2 (revisit time: 369 days with 30 day sub-cycle, mode changed from SIN to LRM in Oct. 2014)
- SARAL/Altika (revisit time: 35 days)
- Sentinel-3A (revisit time: 27 days)
- Sentinel-3B (revisit time: 27 days)

4. Preliminary Results

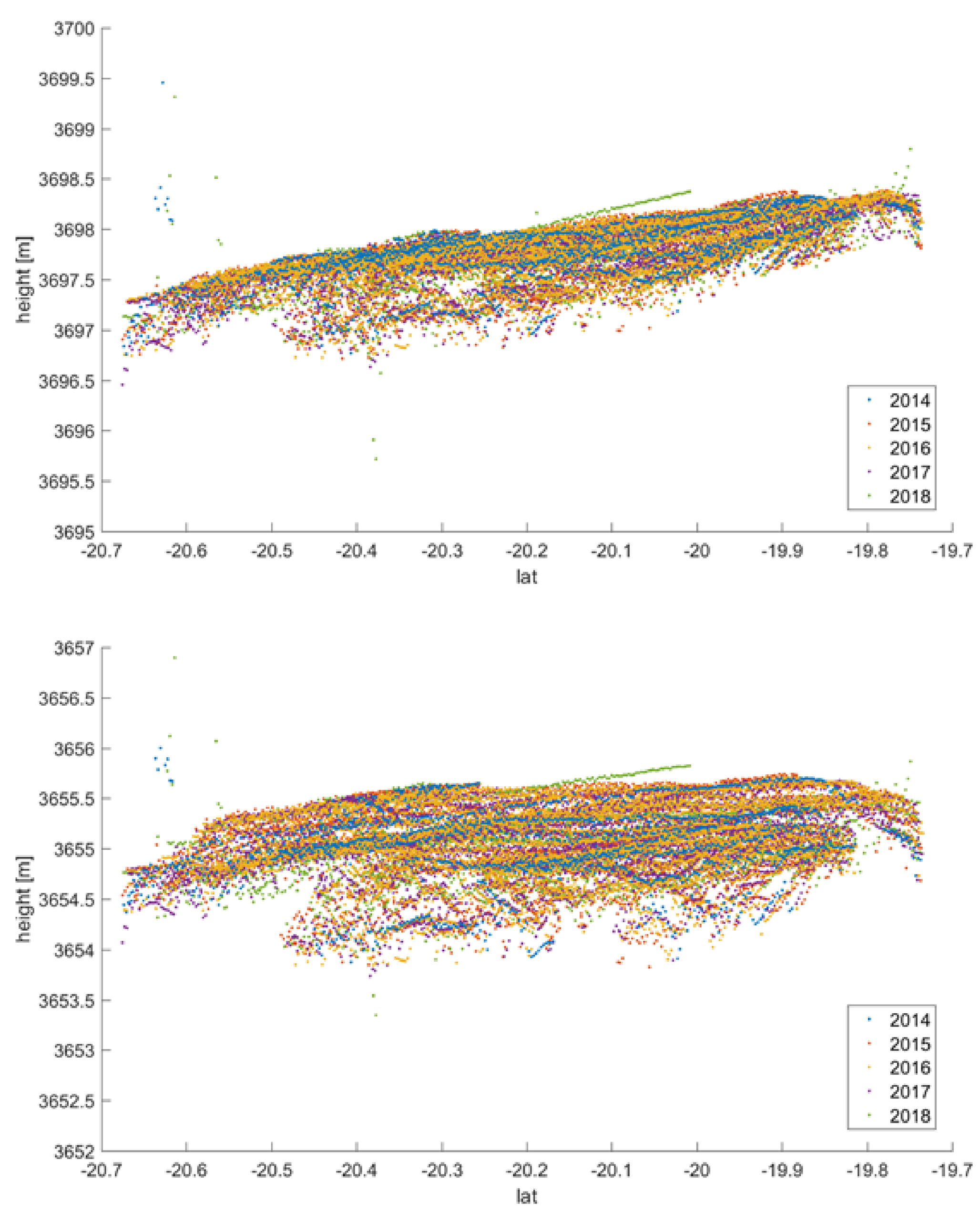

Figure 4: (top) Ellipsoidal height, (bottom) Orthometric height (coarse outlier detection is applied)

- About 1 m height variation for the whole region (GPS measurements in 2002 show about 80 cm height variation within the eastern lobe)
- Confirming the proposed concept by Borsa et al. (quantitative evaluation required)

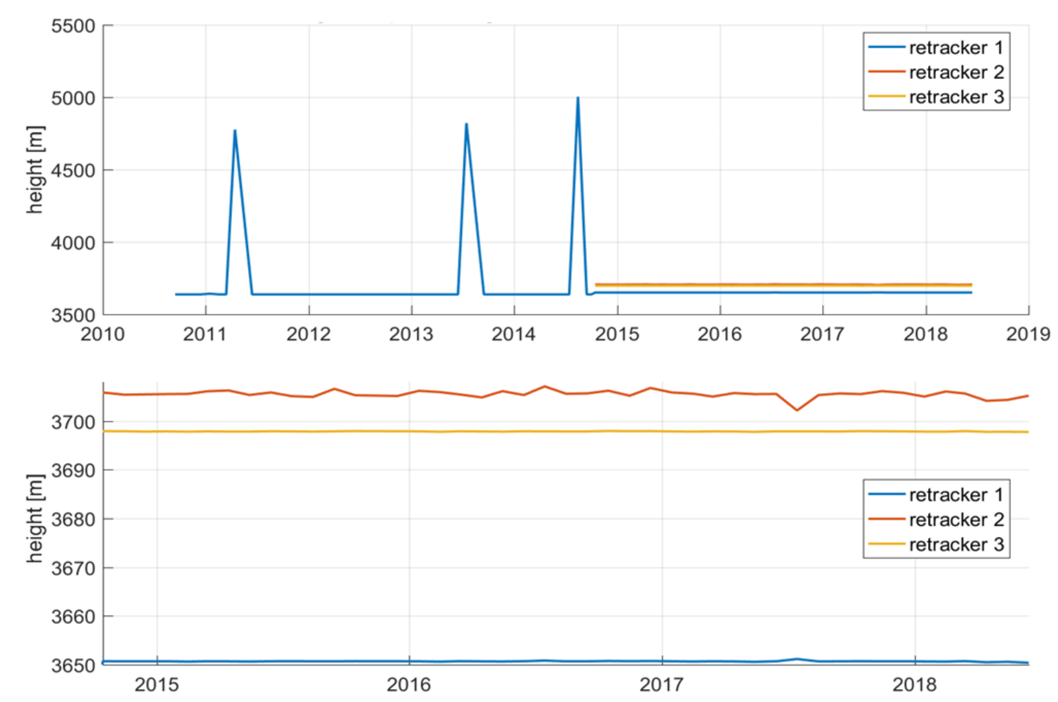

Figure 5: (top) SIN and LRM over the Uyuni, (bottom) Operational trackers

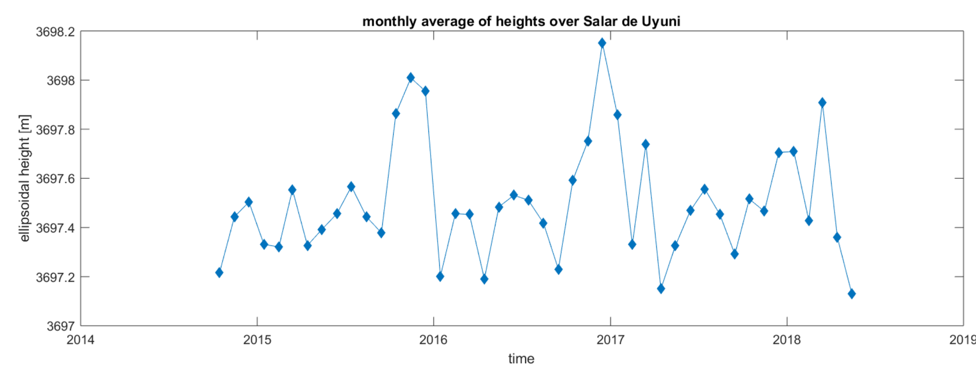

Figure 6: Monthly average of heights over Salar de Uyuni

- Seasonal behavior
- Loss of spatial resolution

5. Next Steps

- Outlier detection
- Waveform analysis
- Multi-mission satellite altimetry
- Monitoring local geoid undulation (?)

References

Fricker, H. A., Borsa, A., Minster, B., Carabajal, C., Quinn, K., & Bills, B. (2005). Assessment of ICESat performance at the salar de Uyuni, Bolivia. Geophysical Research Letters, 32(21).

Borsa, A. A., Fricker, H. A., Bills, B. G., Minster, J. B., Carabajal, C. C., & Quinn, K. J. (2008). Topography of the salar de Uyuni, Bolivia from kinematic GPS. Geophysical Journal International, 172(1), 31-40.

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