Geophysical Research Abstracts
Vol. 18, EGU2016-915, 2016
EGU General Assembly 2016

Tides and lake-level variations in the great Patagonian lakes: Observations, modelling and geophysical implications.

Eric Marderwald (1,2,3), Andreas Richter (1,2,3), Martin Horwath (3), Jose Luis Hormaechea (1), and Andreas Groh (3)

(1) Facultad de Ciencias Astronómicas y Geofísicas , Universidad Nacional de La Plata, Argentina., (2) CONICET, Argentina., (3) Institut für Planetare Geodäsie, Technische Universität Dresden, Germany.

In Patagonia, the glacial-isostatic adjustment (GIA) to past ice-mass changes (Ivins & James 2004; Klemann et al. 2007) is of particular interest in the context of the determination of the complex regional rheology related to plate subduction in a triple-junction constellation. To further complicate the situation, GIA is overlaid with load deformation not only due to present ice mass changes but also due to water-level changes in the lakes surrounding the icefields and the ocean surrounding Patagonia. These elastic deformations affect the determination of glacial-isostatic uplift rates from GPS observations (Dietrich et al. 2010; Lange et al. 2014). Observations of lake tides and their comparison with the theoretical tidal signal have been used previously to validate predictions of ocean tidal loading and have revealed regional deviations from conventional global elastic earth models (Richter et al. 2009). In this work we investigate the tides and lake-level variations in Lago Argentino, Lago Viedma, Lago San Martín/O'Higgins and Lago Buenos Aires/General Carrera. This allows us to test, among other things, the validity of tidal loading models.

We present pressure tide-gauge records from two sites in Lago Argentino extending over 2.5 years (Richter et al. 2015). These observations are complemented by lake-level records provided by the Argentine National Hydrometeorological Network. Based on these lake-level time series the principal processes affecting the lake level are identified and quantified. Lake-level changes reflecting variations in lake volume are dominated by a seasonal cycle exceeding 1 m in amplitude. Lake-volume changes occur in addition with a daily period in response to melt water influx from surrounding glaciers. In Lago Argentino sporadic lake-volume jumps are caused by bursting of the ice dam of Perito Moreno glacier. Water movements in these lakes are dominated by surface seiches reaching 20 cm in amplitude. A harmonic tidal analysis of the lake-level time series from Lagos Argentino and Viedma yields the amplitudes and phases of the lake tides for the four major tidal constituents M2, S2, O1 and K1. The maximum amplitude, corresponding to the semi-diurnal moon tide M2 in Lago Argentino, amounts to 3 mm.

For the four lakes under investigation the theoretical amplitudes and phases of seven constituents (Q1, O1, P1, K1, N2, M2 and S2) are modelled accounting for the contributions of both the solid earth's body tides and the ocean tidal loading (Marderwald 2014). Both contributions involve a deformation of the earth surface and of the equipotential surfaces of the gravity field. For the load tide computation the global ocean tide model EOT11a (Savcenko and Bosch, 2012) and the Gutenberg-Bullen A earth model (Farrell, 1972) was applied and the conservation of water volume is taken into account. The comparison of the tidal signal extracted from the lake-level observations in Lagos Argentino and Viedma with the lake tide models indicates a phase shift which is most likely explained by an 1 hour phase lag of the employed global ocean tide model in the region of the highly fragmented Pacific coast.

REFERENCES:

Farrell, W. E., (1972). Deformation of the Earth by Surface Loads. Rev. Geophy. Space Phy., 10(3):761-797.

Ivins, E., James, T., 2004. Bedrock response to Llanquihue Holocene and present-day glaciation in southernmost South America. Geophys. Res. Lett. 31 (L24613). Doi:10.1029/2004GL021500.

Klemann, V., E. R. Ivins, Z. Martinec, and D. Wolf (2007), Models of active glacial isostasy roofing warm subduction: Case of the South Patagonian Ice Field, J. Geophys. Res., 112, B09405, doi: 10.1029/2006JB004818.

Lange, H., Casassa, G., Ivins, E. R., Schröder, L., Fritsche, M., Richter, A., Groh, A., Dietrich, R., (2014). Observed crustal uplift near the Southern Patagonian Icefield constrains improved viscoelastic Earth models. Geophysical Research Letters, DOI: 10.1002/2013GL058419.

Marderwald ER, 2014. Modelado de las mareas de grandes lagos patagónicos. Licenciatura thesis, Universidad Nacional de La Plata, Argentina.

Richter, A., Marderwald, E., Hormaechea, J.L., Mendoza, L., Perdomo, R., Connon, G., Scheinert, M., Horwath, M., Dietrich, R. (2015): Lake-level variations and tides in Lago Argentino, Patagonia: insights from pressure tide gauge records. Journal of Limnology (accepted), doi:10.4081/jlimnol.2015.1189.

Richter A, Hormaechea JL, Dietrich R, Perdomo R, Fritsche M, Del Cogliano D, Liebsch G, Mendoza L, 2009. Anomalous ocean load tide signal observed in lake-level variations in Tierra del Fuego. Geophys. Res. Lett. 36:L05305.

Savcenko, R., and W. Bosch (2012), EOT11a - Empirical Ocean Tide Model from Multi-Mission Satellite Altimetry. Deutsches Geodätisches Forschungsinstitut (DGFI), Munich, Report Number 89.