Geophysical Research Abstracts
Vol. 14, EGU2012-11817, 2012
EGU General Assembly 2012

Simulations of the tides of ancient oceans and the evolution of the Earth-Moon system

P. Nerge (1), T. Ludwig (1), M. Thomas (2), J. Jungclaus (3), J. Sündermann (4), and P. Brosche (5)

(1) Department of Informatics, University of Hamburg, Germany (petra.nerge@informatik.uni-hamburg.de), (2) GFZ German Research Centre for Geosciences, Helmholtz Centre Potsdam, Germany, (3) Max-Planck-Institute of Meteorology, Hamburg, Germany, (4) Institute of Oceanography, University of Hamburg, Germany, (5) Institute of Astronomy, University of Bonn, Germany

We will simulate the spatial and temporal characteristics of the ocean tides for the present time as well as for a time slice of the Neoproterozoic Era (∼620 Ma b.p.). A focus will be on the transfer of angular momentum between the Earth and the Moon in order to physically simulate the observed increase of day length and the Moon's distance. The numerical results will be validated against geological proxy data of the tidal spectrum of the Australian continental plate.

Subsequently, the evolution of the ocean tides under the influence of the continental drift from present time until the Neoproterozoic will be simulated. Again, a focus will be on the transfer of angular momentum between the Earth and Moon in order to physically explain the dynamical evolution of the Earth-Moon system and, therewith, the increase of day length of about 2 hours as well as the decrease of month length of about 1 day.

The simulation of the ocean tides shall be carried out with the three-dimensional Max-Planck-Institute ocean circulation model (Marsland, et al., 2003) forced by the complete lunisolar tidal potential (Thomas, 2001). A curvilinear grid with freely selectable grid poles is utilized by the model. Hence, the resolution can be efficiently increased around Australia for evaluation of our results. The simulations require exceptional performance in computing and storage that is provided by the German Climate Computing Center.

So far, the limited availability of geological proxy data has prevented a detailed quantification of the transfer of angular momentum in the Earth-Sun-Moon-system mainly due ocean tides far back in the Earth's history. Considering recent paleontological data, and advances in numerical modelling and high performance computing, we will strive to reduce these deficits. First self-consistent geological data on ocean tides, Earth's rotational parameters and orbital elements of the Moon have been provided by the research of Williams (2000) on the sediment layers of South Australia for the Neoproterozoic (∼620 Ma b.p.). Recent paleogeographical maps with detailed information that reached back to the Neoproterozoic have been made available by Li et al. (2008).

Appropriate to the uncertainties in the knowledge of the Earth's history, the whole work will be a first contribution to a statistical treatment of preferably a great many configurations as recommended by Brosche and Sündermann (2011) and will result in one considerably denser reconstruction of tidal dynamics from the Neoproterozoic until the present. Astronomers and geodesists could access the energy and angular momentum budgets for the analysis of the evolution of the Earth-Moon system; geologists as well for the analysis of periodic growth features or sedimentary rhythmites.

References:

Brosche, P. and Sündermann, J., 2011. Ozeanschwingungen und Gezeitenreibung – Zur Bewertung von Resonanzkurven. DGG-Mittlg., 1/2011, 43-50.

Li, Z.X., Bogdanova, S.V., Collins, A.S., Davidson, A., De Waele, B., Ernst, R.E., Fitzsimons, I.C.W., Fuck, R.A., Gladkochub, D.P., Jacobs, J., Karlstrom, K.E., Lu, S., Natapov, L.M., Pease, V., Pisarevsky, S.A., Thrane, K. and Vernikovsky, V., 2008. Assembly, configuration, and break-up history of Rodinia: A synthesis. Precambrian Res., 160, 179-210.

Marsland, S.J., Haak, H., Jungclaus, J.H., Latif, M. and F. Roeske, 2003. The Max-Planck-Institute global ocean/sea-ice model with orthogonal curvilinear coordinates. Ocean Modell., 5, 91-127.

Thomas, M., 2001. Ozeanisch induzierte Erdrotationsschwankungen – Ergebnisse eines Simultanmodells für Zirkulation und Gezeiten im Weltozean. Dissertation, Universität Hamburg, Fachbereich Geowissenschaften, 129p.

Williams, G.E., 2000. Geological constraints on the precambrian history of earth's rotation and the moon's orbit. Rev. Geophys., 38, 37-59.