Clim. Past Discuss., 9, C2605–C2608, 2013
www.clim-past-discuss.net/9/C2605/2013/

Climate of the Past Discussions
Open Access

Interactive comment on "A probabilistic model of chronological errors in layer-counted climate proxies: applications to annually-banded coral archives" *by* M. Comboul et al.

A. Juillet-Leclerc (Referee)

Anne.Juillet-Leclerc@lsce.ipsl.fr

Received and published: 15 November 2013

In this paper, authors develop a probabilistic model of chronological errors in layer-counted climate proxies applied to annually-banded coral archives. In order to improve chronology of proxy records and thus to help to reconstruct environmental conditions, they propose a sophisticated method allowing age uncertainty to be estimated and optimized. I am not expert in probability, however I am familiar with coral calcification processes and growth rates, which are the major factors related to chronology.

Indeed, sampling dedicated to paleoclimatic studies is generally conducted along the main growth axis and thus, chronology lies on the estimation of extension rate shown

Full Screen / Esc
Printer-friendly Version
Interactive Discussion
Discussion Paper

by Porites (coral species most often analyzed) during the time, which varies following several factors, among them temperature. There is another growth mode: the infilling of the porous material resulting of the primary framework building. The combination of the two growth rates determines the density fluctuations reflected on X-ray pictures (Lough & Barnes, 2000). Several evidences drove me to assume that the two growth rates correspond to independent mechanisms (Juillet-Leclerc & Reynaud, 2010 and a paper accepted by GCA). Anyway, chronology is only linked to linear extension, in contrast to density. Time scale derived from linear extension is totally biologically mediated. Therefore, it is highly variable leading to high fluctuations of age uncertainty and geochemical tracer records. The same event may be reflected by different growth and proxy signal patterns following the coral genus, different colonies of the same genus, different sampling transects performed on a single coral head, due to various physiological behaviors. References are abundant in the literature (among them, Wellington et al., 1996; Leder et al., 1996; Linsley et al., 1999; Stephans et al., 2004; Maier et al., 2004.....). The effect due to chronological errors is thus not the main cause of loss of coherency among records, high individual variability is an inherent feature of coral archives even on a small oceanic area. However, the coherency shown by multi proxy signals measured on a single sample (Juillet-Leclerc et al, 2006), thus following identical chronology, could be used to strengthen a timing model. In this context, questions raised by the need to establish a reliable chronology of coral records cannot be only solved by probability. Although de Ridder (2004) method was not based on probability but on the strong periodicity shown by proxies strongly affected by seasonality, I am surprised that these investigations are never mentioned.

Variability between interannual and multidecadal scales highlighted in the manuscript could be due to the proxy itself and not to age perturbation. For instance, it is assumed but not mentioned that δ18O is linear during the time. However, Crowley et al. (1999) stressed possible mismatch between inter and intra annual time scales. But this paper remained totally ignored by the paleo-climatologist community.

CPD
9, C2605–C2608, 2013

Following the relationship (6) the oxygen isotopic ratio is depending on SST and SSS during the time, SSS being regionally determined versus seawater δ18O. The latter dependence may vary during the time (Delcroix et al., 2011) due to oceanic advection. In addition, the high variability already described is not taken into account, making the forward model poorly realistic.

Delcroix T., G.Alory , S.Cravatte , T.Corrège and M.J.McPhaden (2011) A gridded sea surface salinity data set for the tropical Pacific with sample applications, Deep-Sea Research, 158, 38-48. De Ridder, F., R. Pintelon, J. Schoukens, D. P. Gillikin, L. André, W. Baeyens, A. de Brauwere, and F. Dehairs (2004) Decoding nonlinear growth rates in biogenic environmental archives, Geochem. Geophys. Geosyst., 5, Q12015,doi:10.1029/2004GC000771. Crowley, T.J., T.M. Quinn and W.T. Hyde (1999) Validation of coral temperature calibrations, Paleoceanography, 14, 605-615. Juillet-Leclerc, A., S. Thiria, P. Naveau, T. Delcroix, N. Le Bec, D. Blamart, and T. Corrège (2006), SPCZ migration and ENSO events during the 20th century as revealed by climate proxies from a Fiji coral, Geophys. Res. Lett., 33, L17710, doi:10.1029/2006GL025950. Juillet-Leclerc A. and Reynaud S. (2010) Light effects on the isotopic fractionation of skeletal oxygen and carbon in the cultured zooxanthellate coral, Acropora: implications for coral-growth rates Biogeosciences 7, 893–906. Juillet-Leclerc A., S. Reynaud, D. Dissard, G. Tisserand and C. Ferrier-Pagès, Light is an active contributor to vital effects of coral skeleton proxies, accepted in Geochim. Cosmochim. Acta. Leder J.J., Swart P.K., A.M. Szmant and R.E. Dodge, The origin of variations in the isotopic record of scleractinian corals: I. Oxygen, Geochim. Cosmochim. Acta, 60, 2857-2870, 1996. Linsley B.K., R.G. Messier and R.B. Dunbar, Assessing between-colony oxygen isotope variability in the coral Porites lobata at Clipperton Atoll, Coral Reefs, 18, 13-27, 1999. Lough J.M. and D.J. Barnes, Environmental control on growth of the massive coral Porites, Journal of Exp. Mar. Biol. Ecol., 245, 225-43, 2000; Maier, C., Felis, T., Pätzold, J. and Bak, R.P.M.: Effect of skeletal growth and lack of species effects in the skeletal oxygen isotope climate signal within the coral genus Porites, Mar. Geol. 207, 193– 208, 2004. Stephans, C.L., Quinn, T. M., Taylor,

F. W. and Corrège, T.: Assessing the reproducibility of coral-based climate records, Geophys. Res. Lett., 31, L18210, doi:10.1029/2004GL020343, 2004. Wellington, G.M., R.B. Dunbar and G. Merlen, Calibration of stable oxygen isotope signatures in Galapagos corals, Paleoceanography, 11, 467-480, 1996.

Interactive comment on Clim. Past Discuss., 9, 6077, 2013.