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Subtropical coral records of Northern Hemisphere climate variability - evidence for abrupt surface ocean salinity changes during the last centuries

Thomas Felis (1), Norel Rimbu (2,3,4), Martin Kölling (1), Gerrit Lohmann (2), Jürgen Pätzold (1), Henning Kuhnert (1), Atsushi Suzuki (5), Mihai Dima (2,3), and Hodaka Kawahata (6)

(1) MARUM - Center for Marine Environmental Sciences, University of Bremen, Bremen, Germany (tfelis@marum.de, +49 (0)421 65505), (2) Alfred Wegener Institute for Polar and Marine Research, Bremerhaven, Germany, (3) Department of Atmospheric Physics, Faculty of Physics, University of Bucharest, Bucharest, Romania, (4) Climed Norad, Bucharest, Romania, (5) Geological Survey of Japan, National Institute of Advanced Industrial Science and Technology, Tsukuba, Japan, (6) Ocean Research Institute, University of Tokyo, Tokyo, Japan

Subtropical corals provide an ultra-high resolution archive of past temperature and salinity variations at the sea surface. In contrast to tropical corals, which primarily document interannual variability associated with the El Niño-Southern Oscillation, subtropical coral records document mid- to high-latitude atmosphere-ocean variability. Due to their sub-seasonal resolution, these coral records allow to reconstruct climate variability for individual seasons such as boreal winter, which is still underrepresented in high-resolution proxy reconstructions of the last millennium. The northern Red Sea and the western North Pacific Ocean represent unique locations at the western and eastern margins of the Asian continent, where ocean currents transport warm tropical waters to higher latitudes, enabling coral reef growth at subtropical latitudes. Coral oxygen isotope records in the northern Red Sea (28-29° N) were shown to reflect a combined signal of aridity and temperature variations and document atmospheric variability of the Arctic Oscillation/North Atlantic Oscillation (AO/NAO). Coral Sr/Ca and U/Ca records in the western subtropical North Pacific Ocean (27° N) were shown to reflect temperature variations and document the oceanic variability of the Pacific (inter)Decadal Oscillation (PDO).

Combined analysis of oxygen isotope and Sr/Ca (U/Ca) ratios in corals enables to reconstruct past changes in salinity at annual or higher resolution. Surface ocean salinity is a major component in climate dynamics. However, continuous salinity observations in the surface ocean are scarce prior to 1970, and the magnitude of salinity changes during the last centuries is largely unknown. A coral record from the western subtropical North Pacific indicates that an abrupt regime shift toward fresher surface ocean conditions in this region occurred during the early 20th century, between 1905 and 1910 A.D.. This abrupt freshening resulted from a combination of atmospheric and oceanic advection processes, including a weakening of the westerlies that transport dry continental air from Asia to the North Pacific. New coral Sr/Ca data from the northern Red Sea, in combination with oxygen isotopes, reveal that an abrupt regime shift toward fresher surface ocean conditions occurred in this region at the end of the Little Ice Age, between about 1850 and 1855 A.D.. Possible mechanisms for this abrupt freshening in the northern Red Sea, such as the re-organization of the Northern Hemisphere atmospheric circulation at the end of the Little Ice Age, will be discussed.