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Carbon storage in the South Atlantic Ocean. Assessing time trends in C_{ant} with a novel, multiple-cruises variant of the MLR-technique: *Time Series Residuals* (TSR)

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We present and apply the *Time Series Residuals* (TSR) approach, a novel variation of the MLR technique (Wallace, 1995). The new approach allows the evaluation of time trends in C_T in datasets comprising multiple cruises in a region of interest.

The TSR methods evaluates, on a per-water mass basis, the time trends of the residuals of a single multivariate linear regression performed on the data from all cruises in the dataset. This technique exploits the premise that the use of regression coefficients that were derived using all data from a given time interval, will, for the oldest cruises in that interval yield predictions for C_T that are too high, and for the youngest cruises are too low. The temporal distribution of the residuals of the regression reflects the rate of increase of C_T in a water mass, which is attributed to uptake of C_{ant} from the atmosphere.

Due to the increasingly rapid buildup of C_{ant} in the atmosphere, the rate of buildup of C_{ant} in the ocean will not be constant through time, and thus neither throughout a water mass. Rather, this rate will be higher at the formation region and lower further 'downstream' (this 'older' water was ventilated at times of lower atmospheric C_{ant}). In order to retain this characteristic upon application of our method, the dependence of the evolution of C_T on the distance from the formation region of the water mass is quantified as a function of Apparent Oxygen Utilization (AOU), the value of which can be considered to be an indication of water mass ventilation age.

A notable benefit of this method is that the rate of change of C_T is parameterized on the basis of only AOU and water mass fraction (as derived from *Optimum Multiparameter Analysis*, OMP). Hence, the results obtained from time-stamped cruise datasets such as GLODAP (Key et al., 2004) and CARINA (Key et al., 2010) are easily projected onto high-resolution climatologies such as the World Ocean Atlas 2005 (Levitus, 2006), as is done in the present study.

Application to data of 68 cruises performed in the South Atlantic Central Water between 1972 and 2009 yields trends in C_T ranging from +0.1±0.2 μmol kg^{-1} year^{-1} for the interior part of the water mass to +0.7±0.1 μmol kg^{-1} year^{-1} close to the formation region of the same water mass. The spatially integrated rate of storage is calculated to be 103±12 TgC year^{-1}. Results for the other water masses in the South Atlantic Ocean, obtained in similar fashion, add up to a total rate of uptake of C_{ant} of 0.4±0.1 PgC year^{-1} for the region south of the Equator between the longitudinal boundaries of 65ºW (Drake Passage) and 30ºE.