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Observed changes in the tidal constants in the Río de la Plata estuary

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A long-term tidal record for the upper Río the la Plata estuary is explored for changes in the astronomical constants. To minimize the estimation error, data were filtered applying a recursive Notch filter centered at the M2 frequency before the harmonic analysis. This analysis was done over periods of one year lagged one month to obtain a monthly time series of M2 amplitude and phase. Spectral analysis applying MultiTaper Method and Singular Spectral Analysis (SSA) reveals a long term trend and significant periodicities at 6.5, 3.5 and 2.5 years in M2 amplitude and phase. Those periods coincide with the scales of inter-annual variability in the runoff to the estuary, mainly associated with the ENSO cycles. A Multi-Channel SSA of the M2 harmonic constants and the runoff shows that more than 75% of the joint variance can be explained by a trend and cycles at the above-mentioned periods. Increase (decrease) in the runoff is accompanied by reduction (increase) of the amplitude and increase (decrease) of the phase, and seems to be, in a large extent, the result of variability in the depth due to changes in the discharge to the estuary. Changes in the phase can be understood in terms of changes in the celerity of the tidal wave -which propagates as a free Kelvin wave in the estuary- due to changes in depth. Numerical experiments are been conducted to identify the causes of the amplitude variability and to determine the portion of the estuary which is sensitive to these changes.