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Single-ping ADCP measurements in the Strait of Gibraltar

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In most Acoustic Doppler Current Profiler (ADCP) user manuals, it is widely recommended to apply ensemble averaging of the single-pings measurements, in order to obtain reliable observations of the current speed. The random error related to the single-ping measurement is typically too high to be used directly, while the averaging operation reduces the ensemble error of a factor of approximately $\sqrt{N}$, with N the number of averaged pings. A 75 kHz ADCP moored in the western exit of the Strait of Gibraltar, included in the long-term monitoring of the Mediterranean outflow, has recently served as test setup for a different approach to current measurements. The ensemble averaging has been disabled, while maintaining the internal coordinate conversion made by the instrument, and a series of single-ping measurements has been collected every 36 seconds during a period of approximately 5 months. The huge amount of data has been fluently handled by the instrument, and no abnormal battery consumption has been recorded. On the other hand a long and unique series of very high frequency current measurements has been collected. Results of this novel approach have been exploited in a dual way: from a statistical point of view, the availability of single-ping measurements allows a real estimate of the (a posteriori) ensemble average error of both current and ancillary variables. While the theoretical random error for horizontal velocity is estimated a priori as $\sim$2 cm s^{-1} for a 50 pings ensemble, the value obtained by the a posteriori averaging is $\sim$15 cm s^{-1}, with an asymptotical behavior starting from an averaging size of 10 pings per ensemble. This result suggests the presence of external sources of random error (e.g.: turbulence), of higher magnitude than the internal sources (ADCP intrinsic precision), which cannot be reduced by the ensemble averaging. On the other hand, although the instrumental configuration is clearly not suitable for a precise estimation of turbulent parameters, some hints of the turbulent structure of the flow can be obtained by the empirical computation of zonal Reynolds stress (along the predominant direction of the current) and rate of production and dissipation of turbulent kinetic energy. All the parameters show a clear correlation with tidal fluctuations of the current, with maximum values coinciding with flood tides, during the maxima of the outflow Mediterranean current.