Geophysical Research Abstracts,
Vol. 11, EGU2009-7006-2, 2009
EGU General Assembly 2009
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Fluctuations of sediments-related optical parameters on a megatidal beach in the Eastern English Channel

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To investigate the influence of turbulence coupled with waves and tides on the re-suspension of sediments, a 4-hour field experiment was conducted on a surf-zone beach near Wimereux, France where is at the Eastern English Channel and characterized by a semi-diurnal megatide (spring tidal range > 8 m). A sensor cluster was fixed 1.5 m above the sea bed when the tidal level was low. The parameters of the particle scattering coefficient and the optical attenuation coefficient were measured as a surrogate of the suspended sediments concentration (SSC), and the water temperature, the pressure, the horizontal 2-D velocity and so on, were also simultaneously measured in a continuous mode at a frequency of 1 Hz. The parameter of pressure was used for monitoring the water level and estimating the variation of surface wave heights by removing the local averages of time series, and the pressure time series show that the experiment started with a water level of about 3.7 m at 10 o'clock and ended with 4.5 m at 14 o'clock, and that the water level reached the highest at about 12 o'clock. The time series of current direction indicate that there was a steady along-coast current with a direction of 218 degrees when the water level almost reached the largest of 6 m, i.e., when the sensors were 4.5 m under the water surface. The particle scattering coefficient and the optical attenuation coefficient exhibit a similar fluctuating trend with a correlation coefficient of 0.85 between them. Although there is a time lag of about 1000 s, a relation between the optical parameters and the square of U is observed, i.e., SSC is a function of U, where U is the vector product of the along-shore and cross-shore velocities (v and u). The cross-shore velocity u fluctuates roughly with a mean of zero, and its variation decreases exponentially with the increase of water level, which is consistent with the common sense that wave orbital motions decrease exponentially with the water depth; the variation of v is slightly different to that of u, and the mean of fluctuations changes against the occurrence of along-coast current. Power spectral analysis on the basis of Fast Fourier Transform (FFT) is used to study their scaling behaviors in an energy (E(f)) $\sim$ frequency (f) function of log(E(f)) $\sim$ -p log(f). Temperature fluctuations exhibit to be corresponding to a passive scalar turbulence, p=1.79. When f < 0.003Hz, the values of p with the fluctuations of v and u are between 5/3 and 3, and more close to 3, which may suggest a main component of wave orbital motions in the mixed behavior with turbulence. Particle scattering coefficients and water attenuation coefficients exhibit a similar scaling behavior to each other, and when f < 0.003Hz, the values of p are close to 3 and a little larger than it, which also suggests the role of wave orbital motions in the re-suspension of sediments. In this experiments, a water volume of tens to one hundred cubic centimeters were monitored for velocity measurement. However, a finer spatial resolution may be more suitable for the observation of turbulence as well as the sediments-related optical parameters.