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Assessment of tidal circulation and tidal current asymmetry in the Iroise sea with specific emphasis on characterization of tidal energy resources around the Ushant Island.

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We use the current velocity time series recorded by High Frequency Radars (HFR) to study circulation in highly energetic tidal basin - the Iroise sea. We focus on the analysis of tidal current pattern around the Ushant Island which is a promising site of tidal energy.

The analysis reveals surface current speeds reaching 4 m/s in the North of Ushant Island and in the Fromveur Strait. In these regions 1 m/s is exceeded 60% of time and up to 70% of time in center of Fromveur. This velocity value is particularly interesting because it represents the cut-in-speed of the most of marine turbine devices.

Tidal current asymmetry is not always considered in tidal energy site selection. However, this quantity plays an important role in the quantification of hydrokinetic resources. Current velocity times series recorded by HFR highlights the existence of a pronounced asymmetry in current magnitude between the flood and ebb tide ranging from -0.5 to more 2.5. Power output of free-stream devices depends to velocity cubed. Thus a small current asymmetry can generate a significant power output asymmetry. Spatial distribution of asymmetry coefficient shows persistent pattern and fine scale structure which were quantified with high degree of accuracy. The particular asymmetry evolution on both side of Fromveur strait is related to the spatial distribution of the phase lag of the principal semi-diurnal tidal constituent M2 and its higher order harmonics. In Fromveur, the asymmetry is reinforced due to the high velocity magnitude of the sixth-diurnal tidal harmonics.

HF radar provides surface velocity speed, however the quantification of hydrokinetic resources has to take into account the decreasing of velocity with depth. In order to highlight this phenomenon, we plot several velocity profiles given by an ADCP which was installed in the HFR study area during the same period. The mean velocity in the water column calculated by using the ADCP data show that it is about 80% of the surface current speed. We consider this value in our calculation of power to make the power estimation of marine turbine devices more realistic.

Finally, we demonstrate that in the region of opposing flood-versus ebb-dominated asymmetry occurring over limited spatial scale, it is possible to aggregated free-stream devices to provide balanced power generation over the tidal cycle.

Keywords : Tidal circulation, current asymmetry, tidal energy, HF radar, Iroise Sea.