Short term forecasting of barge motions

using an

OCTANS-III

on board

ACERGY/Polaris
Nigeria
April-May

Short term forecasting of barge motions is a complex problem. In this short paper we review some results about a new processing of the motion measurements carried out on board the offshore barge ACERGY/Polaris,

Figure 1 shows the drawing of the Polaris barge. The first Octans unit (Oct-238) is located in the MétéoMer staff container-office, the second Octans unit (Oct-690) is close to the J-lay tower winch. The sampling output period is 500 ms (2 Hz). Octans provide six attitude outputs :

1. three displacements : Heave, Surge, Sway ;
2. three angles : Pitch, Roll, Heading.

The methodology described below has been developed on measurements carried out from April, 30 at 14:30 to May, 01 at 14:30. The step of the time series involved hereafter is dt=1s.

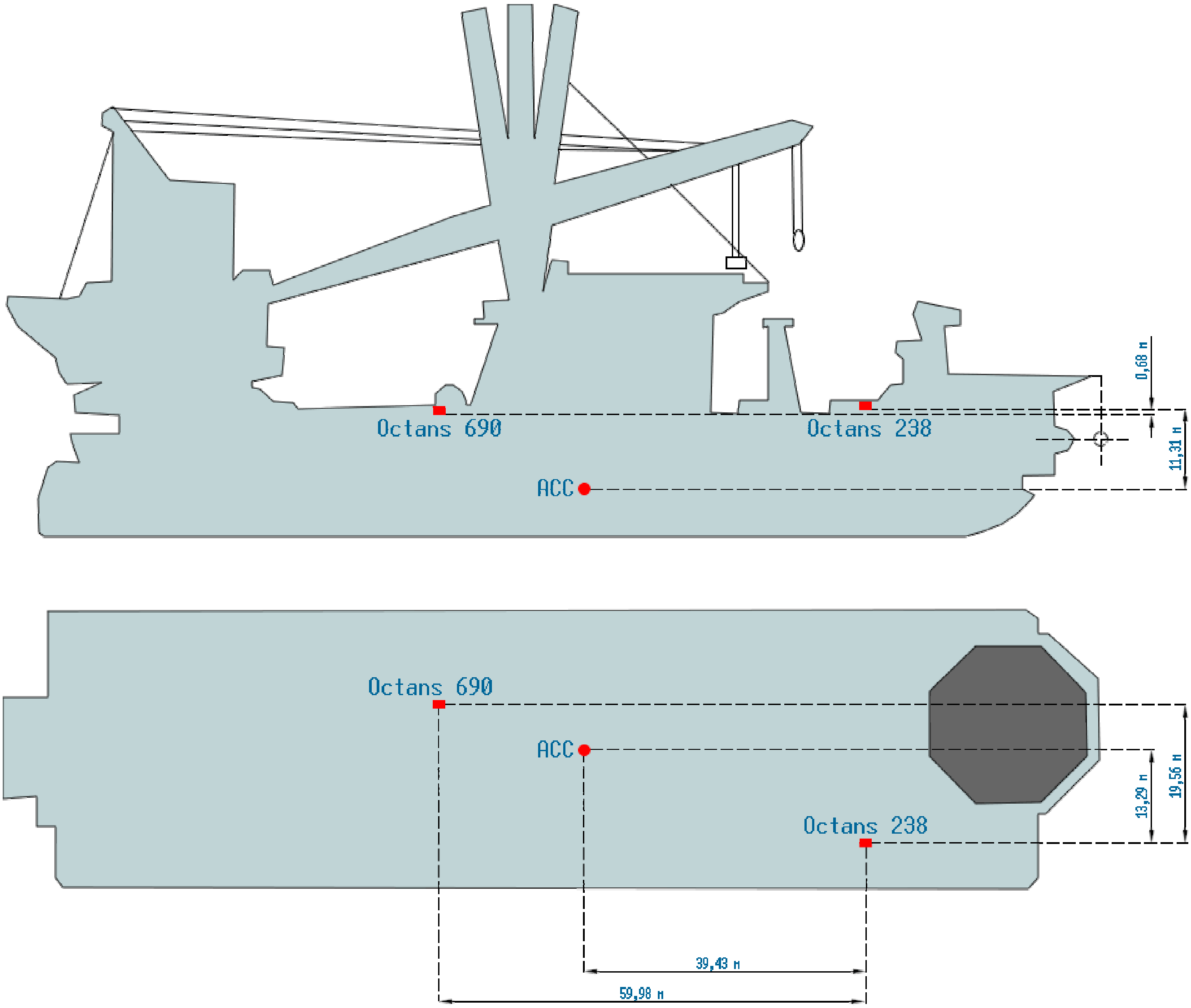

Figure 1 : ACERGY/Polaris. Octans and MRU-Jlay locations

I - Heave signal

Figures 1 and 2 show two time series at the beginning of the measurement period. Unquestionably, the signal is mainly composed of a beat frequency generated by the combination of two close frequencies (with periods close to 10-11s).

II - Methodology

Our methodology is based on FFT analysis. Separating two frequencies that are very close to each other impose to perform high frequency analysis (weak df) and therefore, a long time series (Tm long). The beat frequency to be analyzed is a signal of several minutes period. If the analyses are performed on very long time series the result would be inaccurate because during this period of time, the phenomenon to be found may have changed.

The method is called ZIP (Zero filling Interpolation Processing). The numerical calculations are based on a substitution of zeroes for numerous data points in order to increase the frequency resolution of the spectrum analysis. Commonly, FFT algorithms are based on time series of N data where N is a power of 2. Given time series composed with N=1024 data points (global length of time : Tm~17 mn) only the first N1=768 data are stored in the program (time length :12.8 mn). The data ranking from 769 to 1024 are substituted by zeroes. Thus, the frequency resolution is df~0 .001 Hz.

At the same time, a wide band spectrum is computed with a frequency resolution Δf. This spectrum will be used to detect the peaks over the high resolution spectrum.

II.1 - Spectrum analysis

Let us focus on such a time series from the Octans_238 unit at the beginning of the measurement period (t0= 04/30 at 14:30). On figure 3, red impulses show the distribution of the high resolution (df) spectrum. The green histogram gives the associated wide band spectrum (here Δf~0 .008 Hz). The peak of frequency on the high resolution spectrum is assessed inside each band of the wide band spectrum. Only the two first modes are considered.

In this example, the two following peak periods have been extracted : T1=10.78 s et T2=11.77 s.

II.2 - Short term forecasting

The forecast signal is then recomposed using the two frequencies f1 anf f2 (with Ti=1/fi). Referring to the time series being studied, on figure 4, the total and the bi-modal signals are superimposed during the first 768 seconds from t0). Following this step, one could forecast the signal during the time stage [768 : 1024] s.

Using this methodology, figure 5 and 6 show the comparison of the measured and predicted heave signals for two time series :

- t0= 04/30 at 14:30 ;
- t0= 04/30 at 15:00.

Our method is only a first approach of a more complex problem. Nevertheless it could be very promising to support offshore handling operations. Obviously the numerical computations would be based on more components, particularly, the components close to 15 and 20 s associated to pitch and roll movements which distort the beat signal generated by the combination of the two close frequencies f1 and f2.

Moreover, there is still an unknown effect : what are the barge movements generated by the dynamic positioning system?

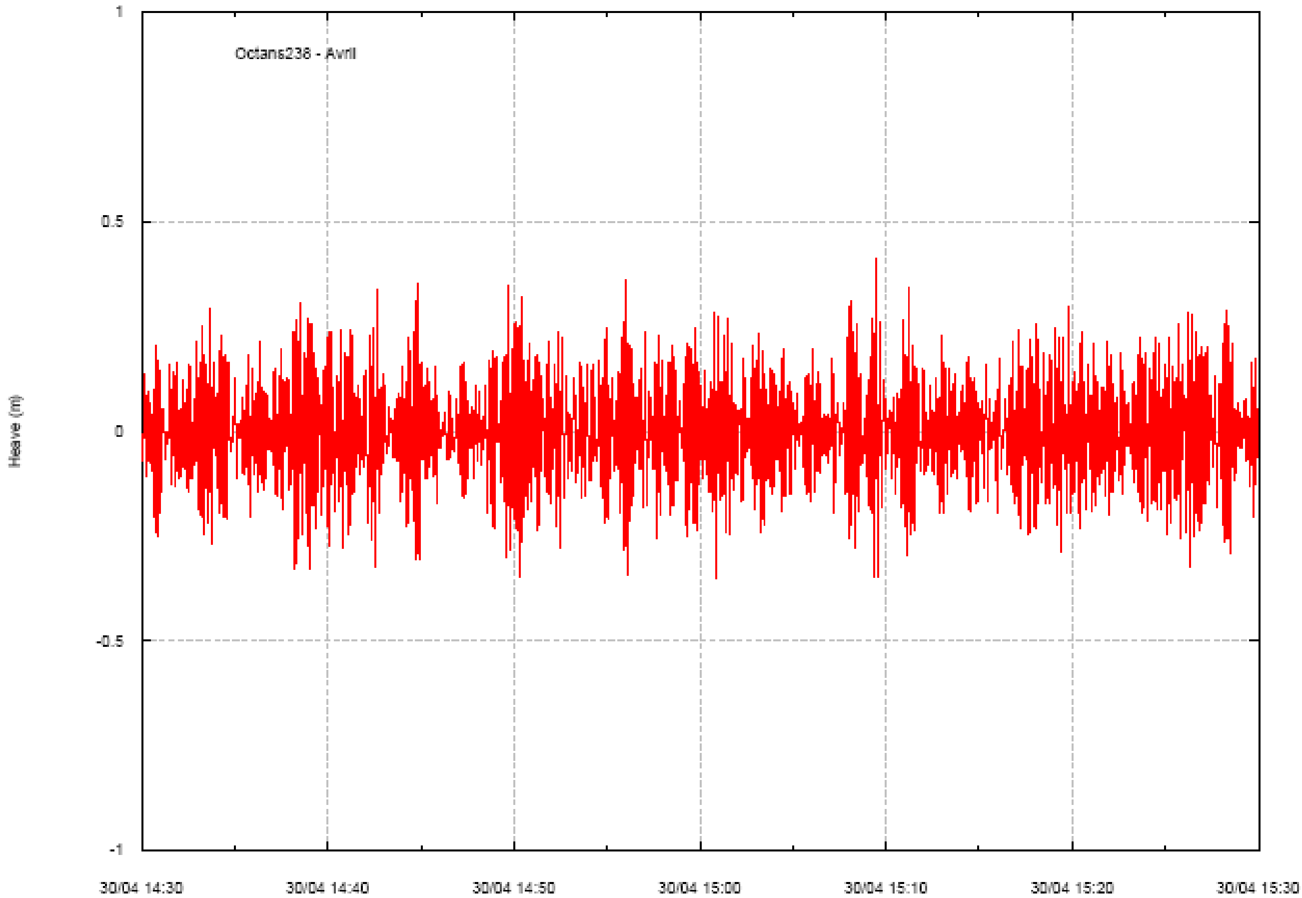

Figure 1 : Heave (m) time series from Octans_238 on 30/04/08 between 14:30 and 15:30.

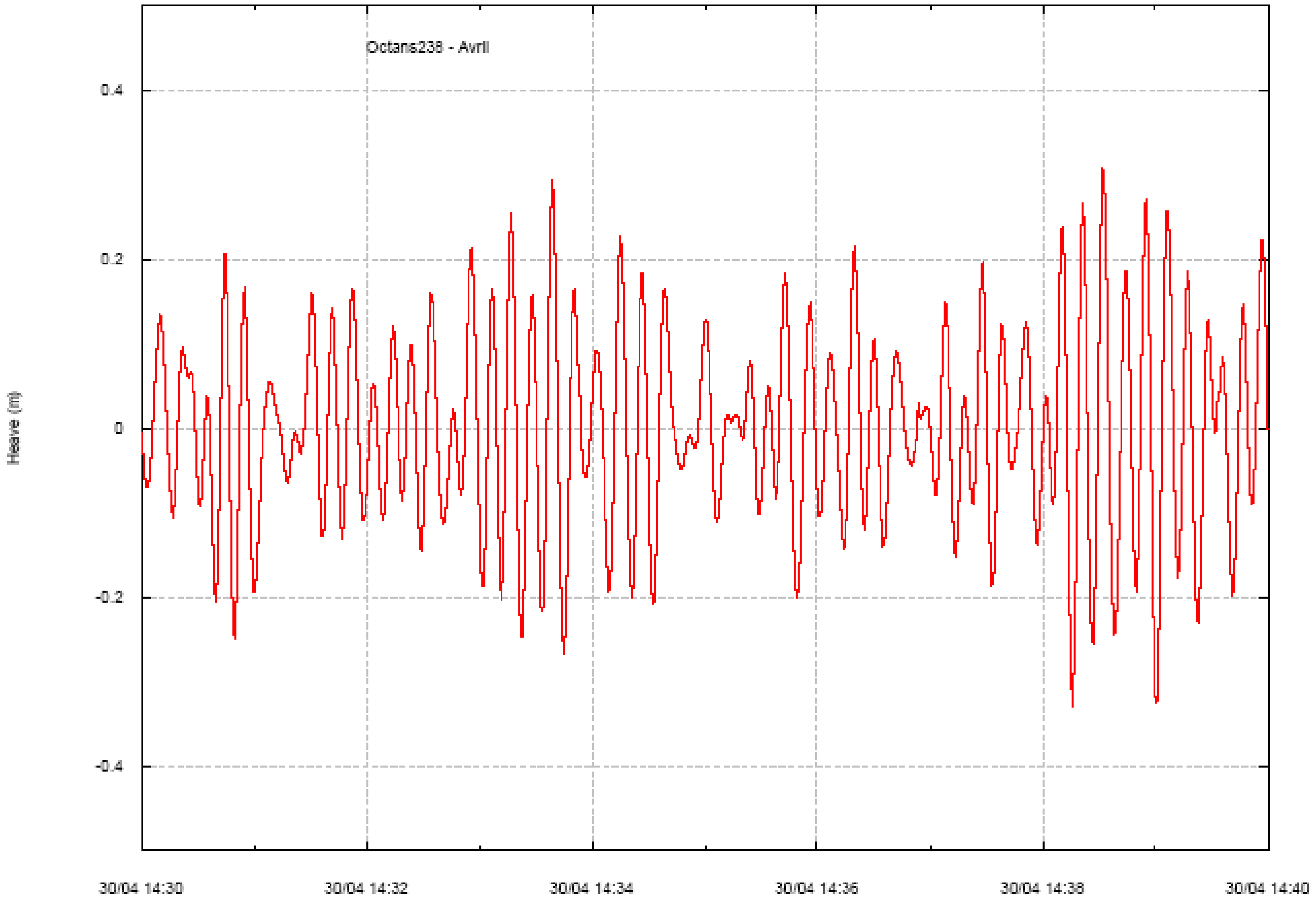

Figure 2 : Heave (m) time series from Octans_238 on 30/04/08 between 14:30 and 14:40

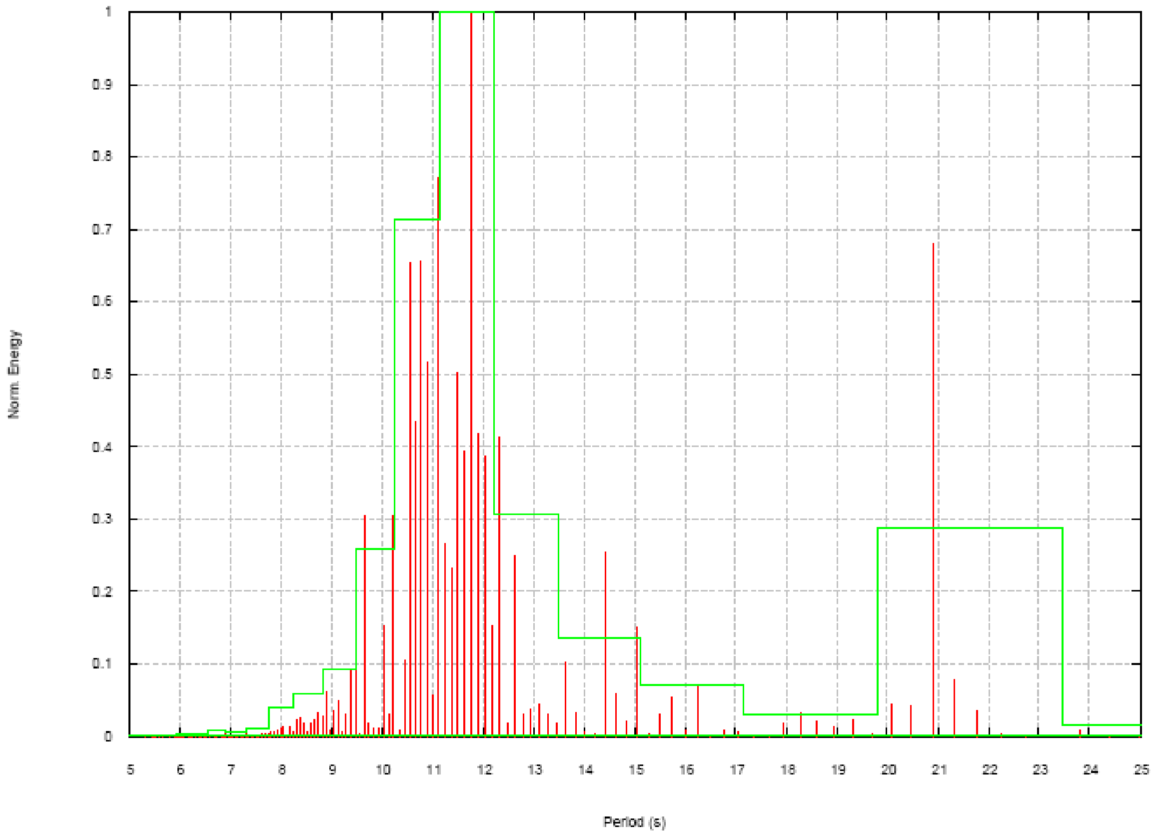

Figure 3 : Spectrum from Octans_238 heave (m) data (t0= 30/04/08 at 14:30).

High resolution spectrum (—), wide band spectrum (—).

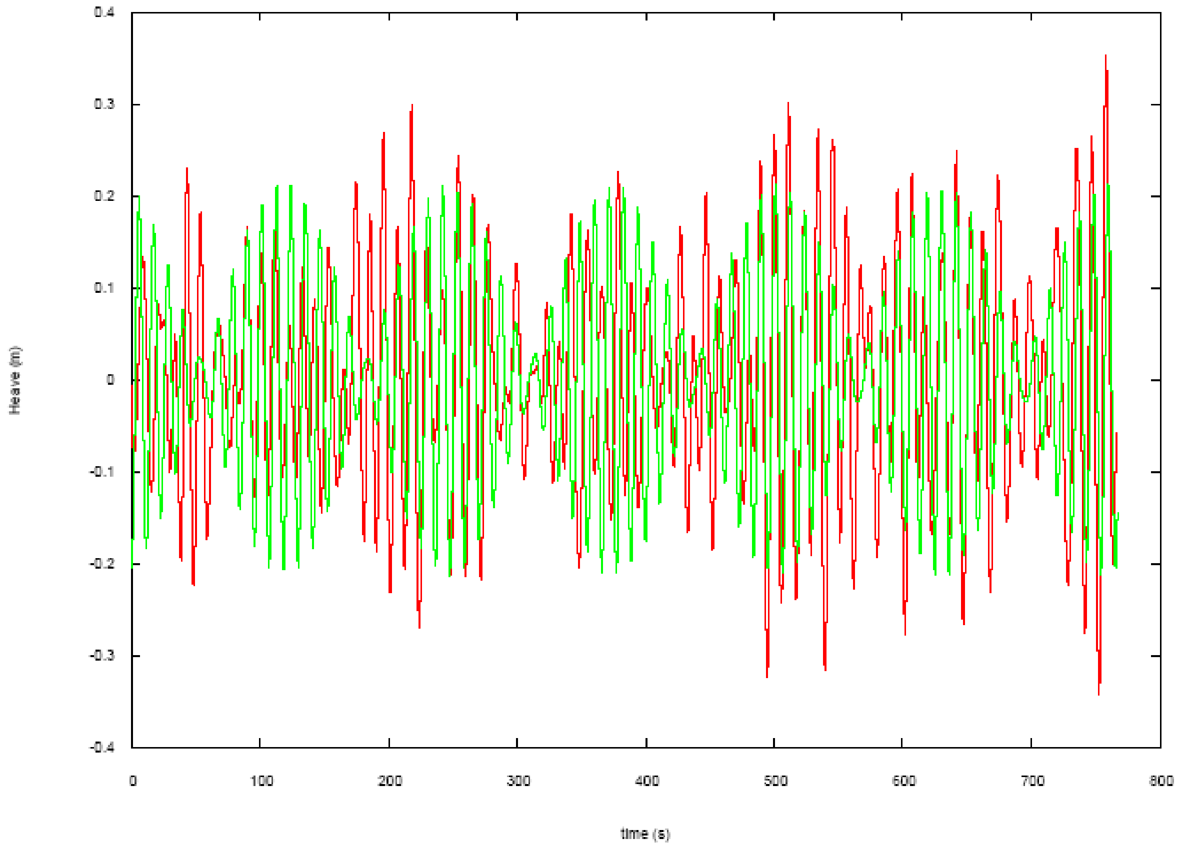

Figure 4 : Octans_238 - Total (—) and recomposed (—) heave signals using the two frequencies f1 & f2 selected during the analysis period [0 :768] s (t0= 30/04/08 at 14:30).

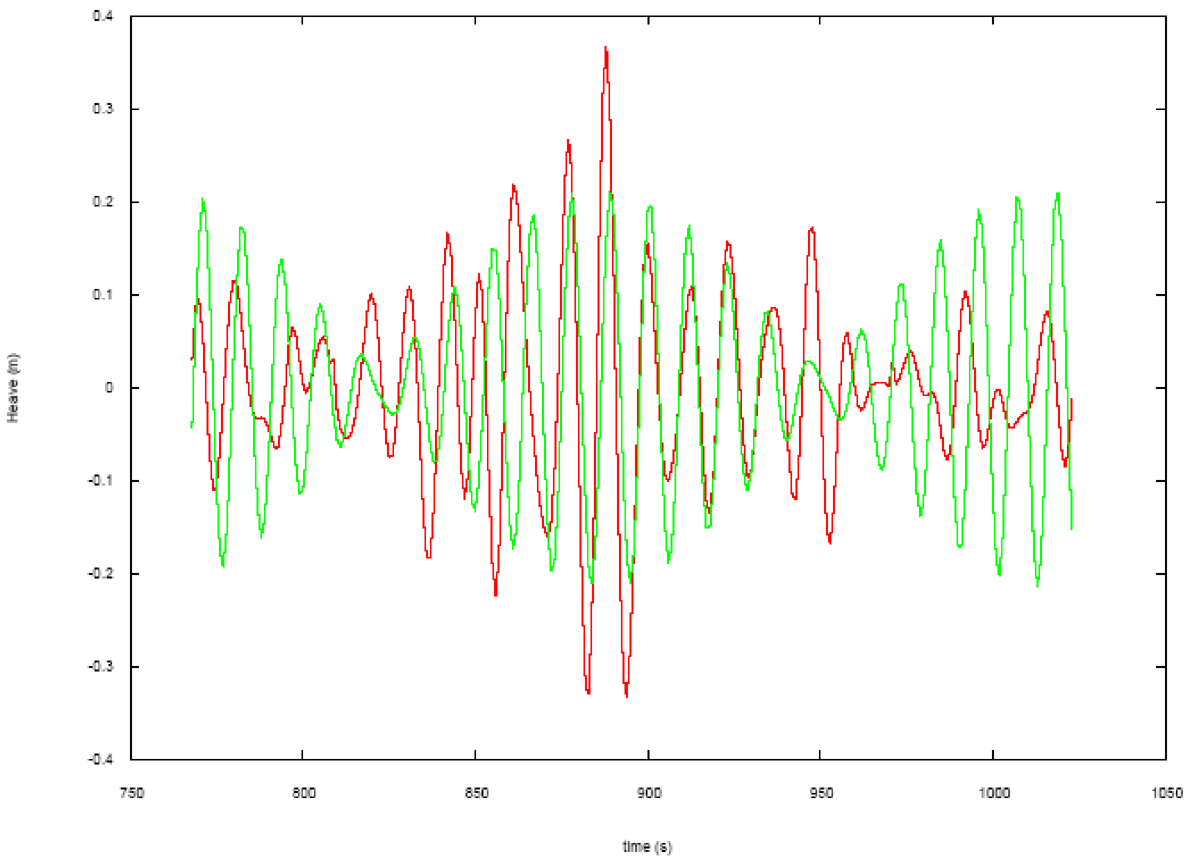

Figure 5 : Octans_238 - Measured (—) and predicted (—) heave signals using the two frequencies f1 & f2 during the period [768 :1024] s (t0= 30/04/08 at 14:30).

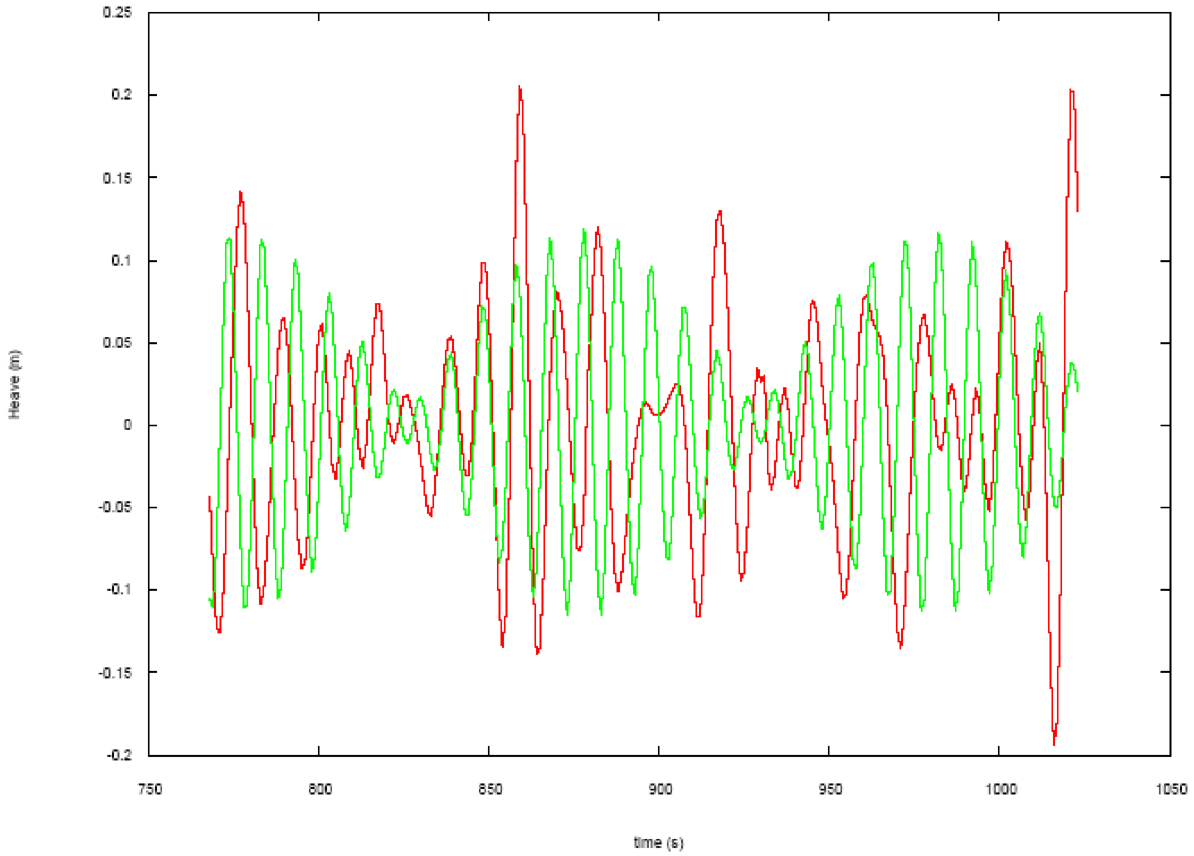

Figure 6 : Octans_690 - Measured (—) and predicted (—) heave signals using the two frequencies f1 & f2 during the period [768 :1024] s (t0= 30/04/08at 15:00).