Project MOPS
Marine Opportunity Passive Systems

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***Abstract*— The main purpose of this paper is to present a new project of research called MOPS dedicated to the use of the GNSS signals for the oceanography and the sea surface monitoring.**

I. Introduction

The observation of the ocean surface using electromagnetic sources of opportunity (GNSS signals for instance) constitutes a green research topic for several years. Indeed, different American and European research teams have recently developed passive airborne or satellite systems that can observe the reflexion of the GNSS signals by the ocean surfaces. And, the so obtained results show that the GNSS signals provide a relevant source of opportunity for the sea surface monitoring. In the case of a GNSS observer situated at few dozens of meters above the sea, there are very few operational passive systems and the measured information usually remains sparse (sometimes limited to the sea level monitoring).

Yet, in the vicinity of the sea surface, our recent simulation studies have shown that the scattered GNSS is significantly influenced by the time evolving sea surface. These results suggest that the scattered GNSS signals are for the moment not used to their maximum. Innovative signal processing algorithms and new inverse problem methods could most certainly transform the GNSS receivers as a very powerful source of advanced oceanographic information.

This is the reason why a group of researchers from Brest (north-west of France) have very recently created the project MOPS (Marine Opportunity Passive Systems) to study the feasibility of passive systems in the vicinity of the sea surface for the oceanographers. Due to the complexity of this objective, this project has to manage different scientific academic domains (Electromagnetics, signal processing, oceanography,...). In fact, the project MOPS will integrate various skilled scientists who closely collaborate to develop an experimental testbed at a Brest coastal spot.

A. Experimental testbed

This experimental testbed will be based on different high speed passive recording systems (with different sample rates) and associated with an operational off-shelf system (oceanpal system), see figure 1.

The multiplication of recording devices will be a major asset since it will give a reliable stream of digital data that could be fruitfully analyzed, treated and validated. More precisely, our testbed will enable to manage different scales of time. A very short term of recording (of the order of the carrier wave period) is adapted to analyze the interaction between the electromagnetic wave and the sea surface. If we consider a time scale from several milliseconds to several minutes, the recording seems more appropriate for signal processing. Moreover, it is to be noted that our testbed has to provide us with long term periods of observation (from hours to several weeks) too, and so the recorded data could be statistically correlated to oceanographic evolutions.

In fact, the testbed of the project MOPS will offer the possibility to confront different experimental or commercial recording devices of GNSS signals for the sea surface monitoring. In this sense, this testbed could be a very useful tool for open collaborations and new experimental developments.

B. Methodology

Although the experimental part is of a great importance, the testbed is only the tip of the iceberg for the project MOPS. Indeed, the precise quantified measurements of the GNSS signals in a referenced maritime environment has to be considered as a support for more academic and theoretical researches.

As presented in figure 2, we think that an advanced passive system based on GNSS signal for sea surface monitoring is the result of electromagnetic modeling, signal processing and oceanographical analysis.

In terms of electromagnetic models, the scattering from a time evolving rough sea surface observed at few dozens of meters above appears as a difficult problem. On one hand, the asymptotic approaches are unappropriated since they only consider global statistical properties of the sea surface and do not explicitly take into account the movement of the surface. On the other hand, the interaction of the signal emitted by the GNSS satellites with the sea involves a large surface compared to the carrier wavelength (about 20cm). And, the

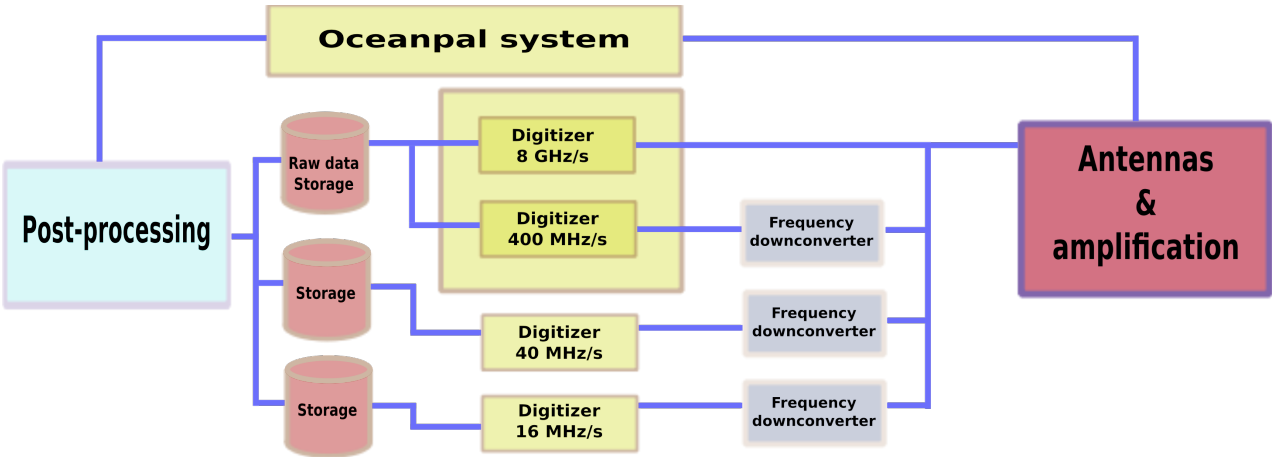

Fig. 1. Experimental testbed structure.

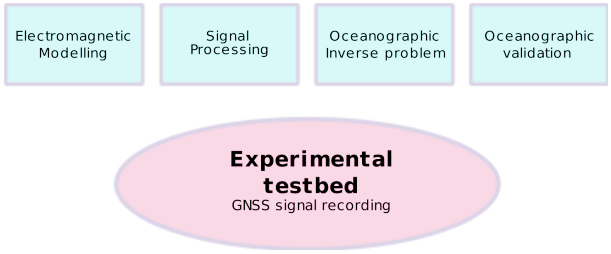

Fig. 2. The MOPS project: fields of expertise and applications.

time evolution more increases the computation complexity of the numerical approaches.

Yet, in preliminary studies, our recent simulations, based on simplified models, have shown that the movement of the sea surface can be observed from a decorrelated GPS signal in the vicinity of a maritime environment. These promising simulations need to be confirmed, but suggest that more rigorous electromagnetic models will probably lead to interesting results.

Similarly, in conjunction with the electromagnetic modeling, the signal and the data processing of the experimental recordings have to develop original methods to extract the relevant information. Long term integration, sophisticated statistical analysis or many others approaches have to be investigated to provide highly efficient methods in the concept defined by the project MOPS.

As a matter of fact, the electromagnetic modeling and the data processing will be developed in the purpose of the oceanography for the coastal areas. The inverse problem that translates electromagnetic signals into oceanographical data is the reason why for the project MOPS.

At the moment, two PhD students start their research activities in electromagnetics and signal processing. A bit later, another one will investigate the inverse problems of the oceanographical models.

Nevertheless, the theoretical developments will not be restricted to these academic activities and the project MOPS intends to include external researches and develop scientific collaborations.

II. Conclusion

Finally, the most important to remember is that one of the major purpose of the project MOPS is to initiate national and international collaborations in the field of passive coastal surveillance systems.

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