FIELD STUDY OF WIND TIDE IN SEMI-ENCLOSED SHALLOW BASINS

Caroline Paugam, Université de Toulon, AMU, CNRS/INSU, IRD, Mediterranean Institute of Oceanography (MIO), UM 110, Toulon, caroline.paugam@mio.osupytheas.fr
Damien Sous, Université Pau Pays Adour - E2S UPPA, SIAME - MIRA, anglet, sous@univ-tln.fr
Vincent Rey, Université de Toulon, AMU, CNRS/INSU, IRD, Mediterranean Institute of Oceanography (MIO), UM 110, Toulon, vincent.rey@univ-tln.fr
Samuel Meulé, Aix Marseille Univ, CNRS, IRD, INRAE, Coll France, CEREGE, Aix-en-Provence, France, meule@cerege.fr

INTRODUCTION

The aim of the study is to understand the wind effect on mean water level variation in semi-enclosed shallow basins. The studied physical phenomenon is nearly steady water surface tilting due to wind stress, the so-called wind tide (Platzman (1963)). During strong wind conditions, wind tides can have significant consequences on low-lying areas such as submersion and flooding. Two field sites are monitored in the S-E of France to characterize wind tides and more specifically to understand the relative effect of wind magnitude and depth on the mean water level dynamics.

FIELD SITES AND METHOD

The present analysis relies on water level measurements carried out in Berre and Vaccarès lagoons, France, see Figure 1. Both lagoons have comparable wind exposure and horizontal extension but strongly differ by their depth: the averaged depths are approximately 7 meters in Berre lagoon and 2 meters in Vaccarès lagoon. In Vaccarès lagoon, monitoring are performed from June 2019 to provide long-term pressure and temperature measurements. Two stations are deployed in the N-W and the S-E parts of the lagoon, corresponding to the axis of the prevailing winds in the area.

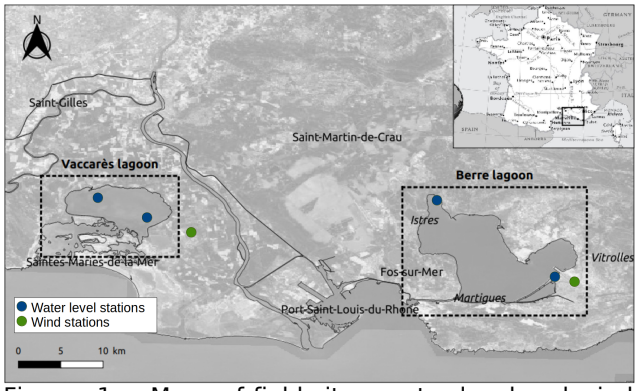

Figure 1 – Maps of field sites, water level and wind stations

A similar experimental setup is used in the Berre lagoon thanks to the HTM-NET network (Rey *et al.* (2020)). Two stations are deployed in the N-W and S-E parts of the lagoon since February 2019.

Wind tides are studied using the 1-D steady form of the depth-averaged shallow water momentum equation that reflects the depth-averaged local balance between surface slope (S) and wind stress. The consequent linear dependence of S on the effective wind speed (projected wind speed according to the reference axis of each lagoon) squared (V_e^2) is used to determine the drag coefficient (C_D).

PRELIMINARY RESULTS

The data analysis confirmed the robustness of such a simple approach in the present context. The results highlight the presence of wind tides in the two field sites with non linear but symmetric behaviors observed in opposite wind conditions: the higher the wind speed, the steeper the slope of the free surface (Figure 2). A significant depth effect is observed, with greater surface tilting in the shallower Vaccarès lagoon both due to the direct depth effect in the momentum balance and an increase of the surface drag coefficient C_D. Using the assumption of constant, i.e. wind-independent, C_D allowed a good match with the observations for moderate wind speeds for both sites. However, the prediction fails in case of strong winds, suggesting that other physical parameters should be taken into account for the C_D parameterization.

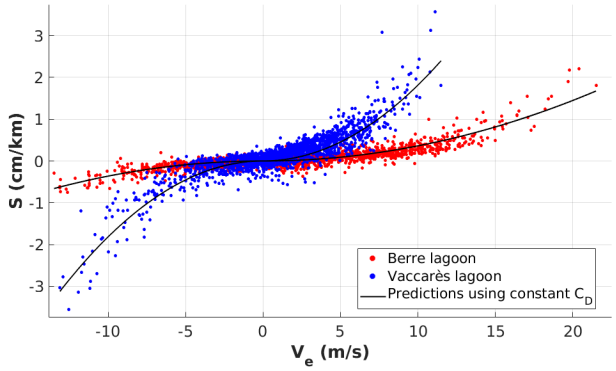

Figure 2 – S versus V_e in Berre (red) and Vaccarès (blue) lagoons and predictions using a constant C_D

REFERENCES

Platzman (1963). The Dynamical Prediction of Wind Tides on Lake Erie. In Platzman,G. W., editor,The Dynamical Prediction of Wind Tides on Lake Erie, Meteorological Monographs, p.1–44.

Rey, Dufresne, Fuda, Mallarino, Missamou, Paugam, Rougier, Taupier-Letage (2020). On the use of long term observation of water level and temperature along the shore for a better understanding of the dynamics: Example of Toulon area, France. Ocean Dynamics, 70:913–933.