STRING : A new drifter for HF radar Validation

Rammou, A.-M.[1], Zervakis, V.[1], Bellomo, L.[2], Kokkini, Z.[1], Quentin, C.[2], Barbin, Y.[2], Mantovani, C.[3] and Kalampokis, A.[4]

[1]Department of Marine Sciences, University of the Aegean, Greece
[2]Mediterranean Institute of Oceanography, Université de Toulon, France
[3]Istituto di Scienze Marine, Consiglio Nazionale delle Ricerche, Italy
[4]Dipartimento di Scienze e Tecnologie, Universita degli Studi di Napoli "Parthenope", Italy

University of the Aegean
Department of Marine Sciences
University Hill, Mytilene 81100, Greece
am.rammou@marine.aegean.gr

regions at the centre of development

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Introduction

High-Frequency radars (HFR) are an effective mean of remotely monitoring sea-surface currents, based on recording the Doppler-shift of radio-waves backscattered on the sea surface. The most common surface drifter used for validation is the CODE-type drifter [1].

However the difference between the HFR and the drifter velocities can be significant in the presence of shear.

$$U_C = \frac{1}{D}\int_{-D}^{0} U(z)\,dz$$, current speed by CODE

$$U_{HF} = 2k\int_{-\infty}^{0} U(z)\,e^{2kz}\,dz$$ [2], current speed by HFR , k is the wavenumber of the resonant sea-scattering waves.

In this work we propose a new design of exponentially-shaped sails for the drogues of CODE-based drifters, so that the HFR-derived velocities and the drifter-based velocities can be directly comparable, regarding the way of vertically averaging the velocity field.

Drifter Design

The net forcing acting on a drifter in the presence of shear in the upper 1m thick layer is :

$$F = \rho_s C_D^s \int_{-D}^{0} L_s(z)\left(U(z)-U_D\right)^2 dz \pm \rho_W C_D^w U(z) A_W \left(U_W - U_D\right)^2$$

,where $L_s(z)$ is the width of the sail at depth z from the surface. Then, the drifter's speed that minimizes F is:

$$U_D = \frac{1}{As}\int_{-D}^{0} U(z)L(z)\,dz + \varepsilon U_w$$

The drogue sail shape that makes the drifter's speed an exponentially-weighted average was designed so that $L_s(z) = L_s(0)\,e^{2kz}$ and the total sail area was kept identical to the CODE drifters'.

+- depending on the direction, ρ_s and ρ_w : the densities of sea water and air, C_s^D and C_w^D : the drag coefficients of the subsurface and of the exposed to the wind part of the drifter, A_s and A_w : the areas of the corresponding drifters' parts. U(z): the velocity field from surface to depth z, εUw windage.

Conclusions

- The STRING drifter behaves identically to CODE in the absence of velocity shear.
- Significantly different velocities can be expected in the presence of velocity shear.
- The use of an upward looking ADCP can contribute to the validation of drifter's behavior.

Three experiment were conducted so far:

Gargano, Italy	November 2013
Lemnos, Greece	October 2014
Trieste, Italy	November 2013, presented here

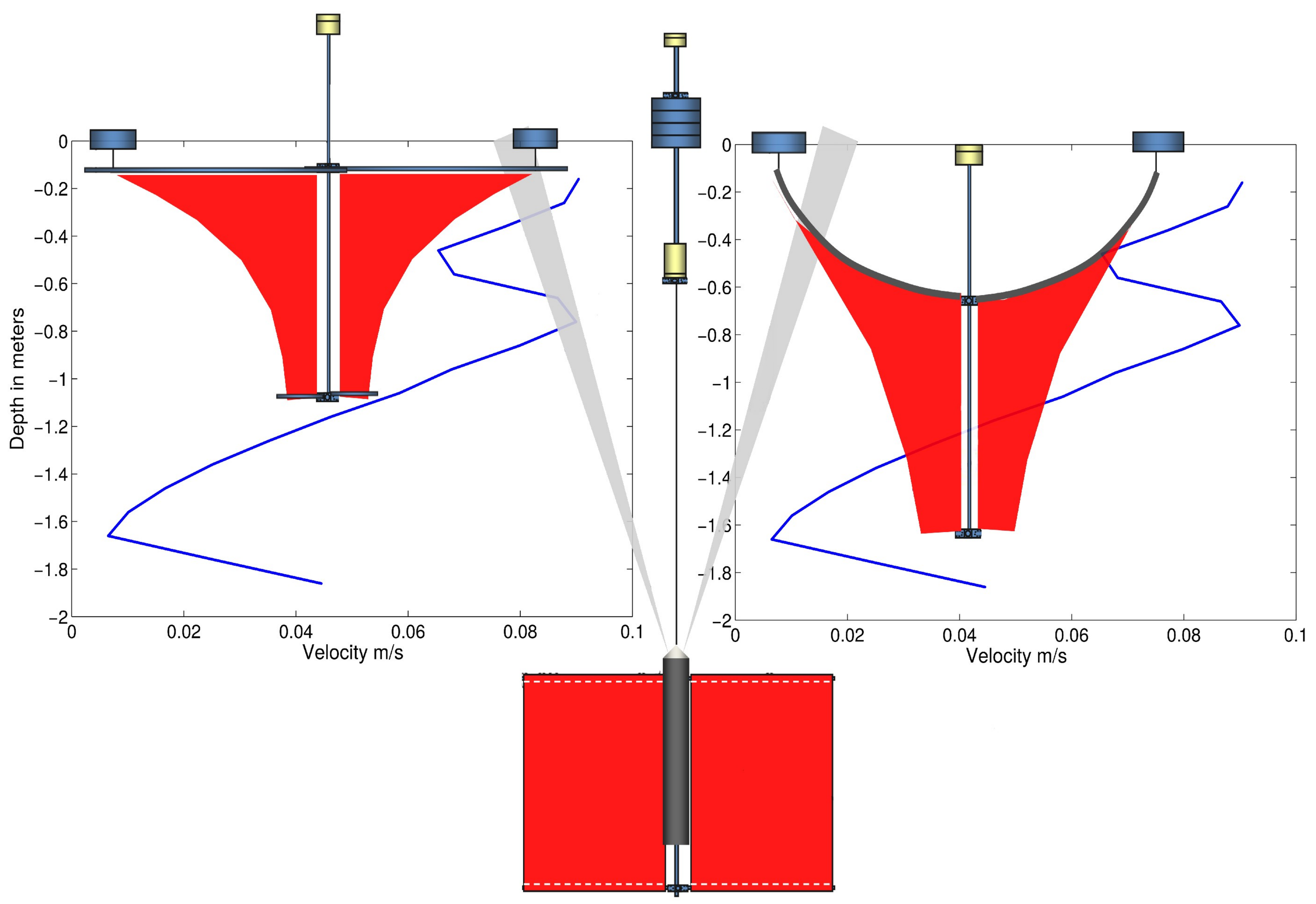

Figure1. The presence of velocity shear during the Trieste experiment as measured by an upward looking Aquadopp ADCP attached on a subsurface drifter. The STRING drifter was deformed once deployed in the water due to its long sail antenna. This resulted to a deviation of the deployed STRING drifters from theoretical estimates.

Preliminary Results

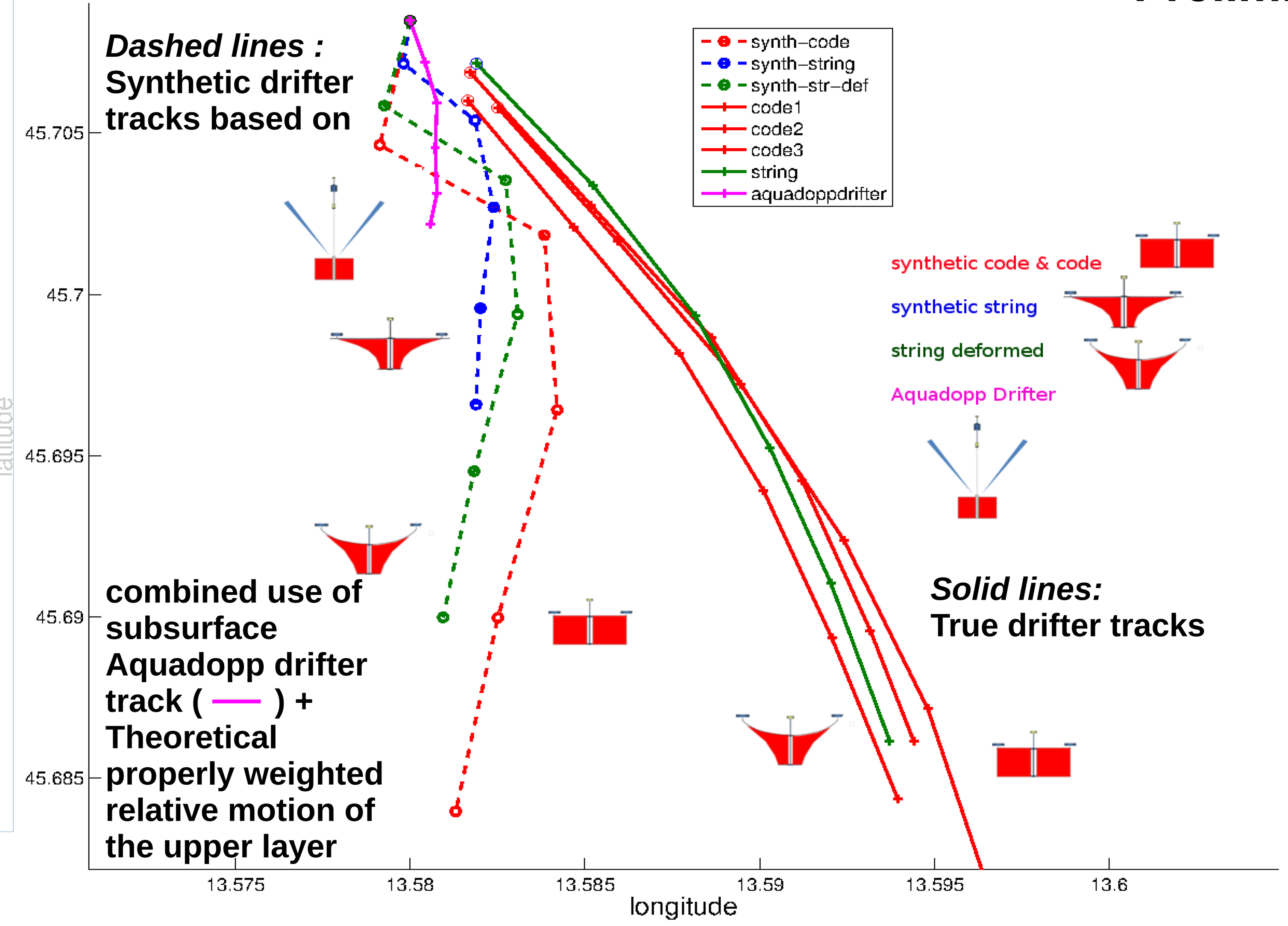

Figure2. The trajectories of the true drifters (solid line), CODE (red), STRING (blue) together with the synthetic trajectories (dashed line) for CODE (red), STRING (blue) and STRING-deformed (green). The synthetic trajectories are based on the Aquadopp drifter track (magenta solid line) plus the theoretical properly weighted relative motion of the upper layer.

The synthetic drifter velocities were calculated for each kind of drifter including the true-deformed STRING :

$$U_{synthetic} = U_{AqqppDrifter} + \frac{1}{D}\int_{-D}^{0} U_{by\ Aqdpp}\,L(z)\,dz$$

Where $L(z) = 1$ for CODE and $L(z)=e^{2kz}$ for STRING. For the deformed STRING the estimation of $L(z)$ was based on its deformed shape.

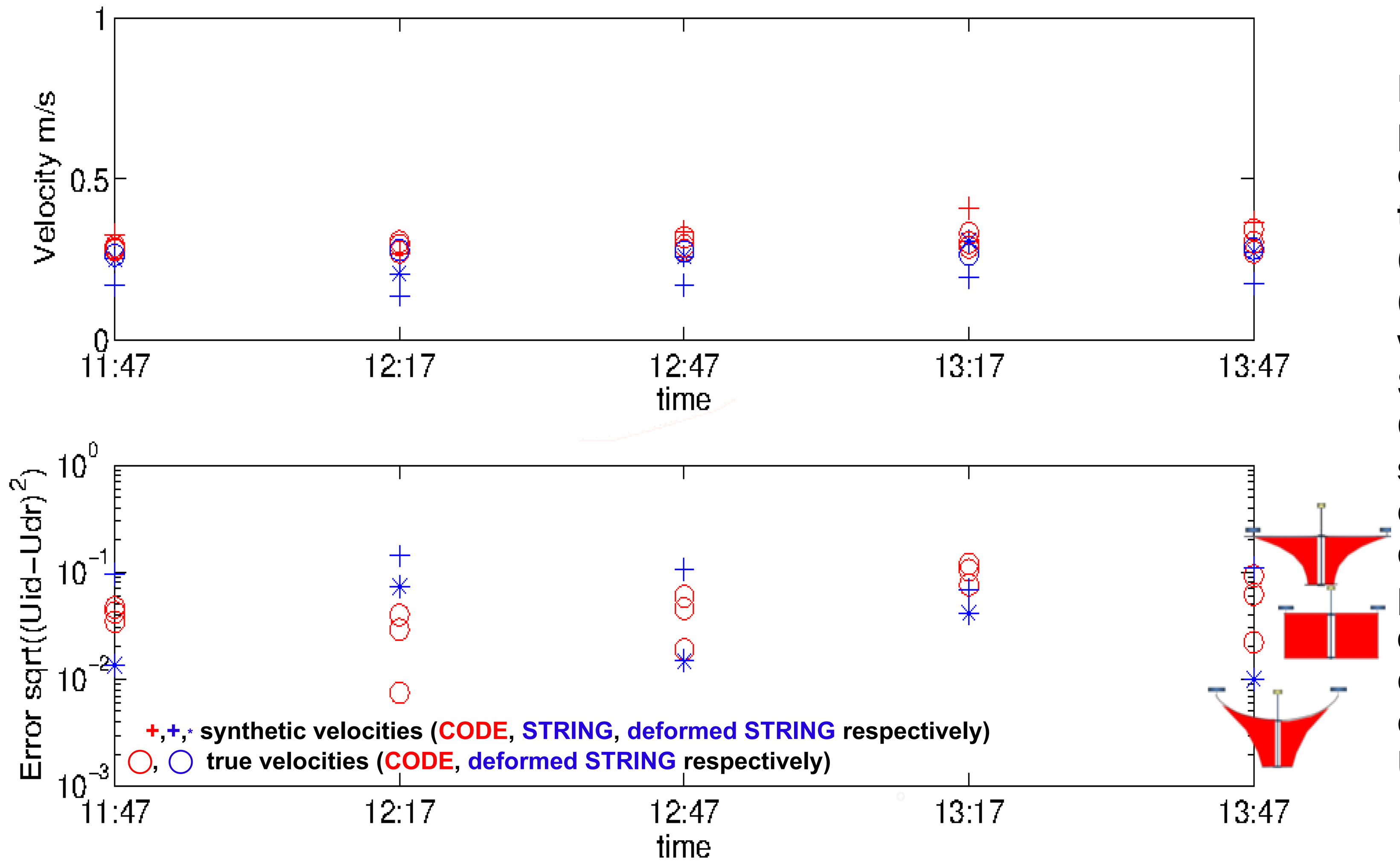

Figure 3. On the upper panel is the velocity comparison between true STRING-deformed (blue circle) and CODE (red circle) drifters, as well as synthetic STRING (blue cross), CODE (red cross) and synthetic STRING-deformed (blue star) drifters. On the lower panel the error estimated as synthetic drifters' minus true drifters' velocity, √(Uid-Udr)², is shown.

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