ID22 MODEL TYPE II REGRESSION FOR LAGRANGIAN VALIDATION OF HF RADAR VELOCITIES IN THE NW IBERIAN PENINSULA.

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ABSTRACT

Two designs of lagrangian low-cost drifting buoys have been developed in order to monitor the ocean surface dynamics in the North-west Iberian Peninsula and provide ground-truth observations that can be used to assess the performance of High Frequency (HF) Radars of RAIA observatory from 2020 to 2022. Since regression model type I, which is typically used in buoy-HF radar antennas validations, does not consider the presence of errors in the observations from both instruments, regression model type II was proposed to instrument intercomparison. Furthermore, a new metric was developed to better assess both model types regressions in lagrangian validations.

Keywords - Drifting Buoy, HF Radar, Observing System, Lagrangian validations.

The antennas of the HF Radar systems are routinely calibrated through transponders to obtain the Antenna Pattern Measurement (APM), which allows correcting the signals received by the antenna [1]. However, this type of remote-sensing technology is subject to various sources of uncertainty, some arising from space-time scale limitations and others intrinsic to the antenna technology itself. For this reason, regular validation exercises against independent surface velocity data from in situ instruments is highly recommended to ensure the quality of HF radar-derived observations Within this context, drifting buoys are very useful tools to conduct lagrangian validations [2].

LOW COST LAGRANGIAN BUOYS.

Two models of drifting buoys, named SPOT and GPRS, were developed at IIM-CSIC [3] based on specific communication capabilities (satellite/Iridium or cellular/GPRS) and height of the water column, were probed by the different antennas of the HF radar system of RAIA observatory. To minimize wind-drag, both models have a low aerial to underwater surface ratio (lower than 1:45). The buoys were constructed using standard PVC materials and off-the-shelf GPS/communication electronics to keep costs at a minimum.

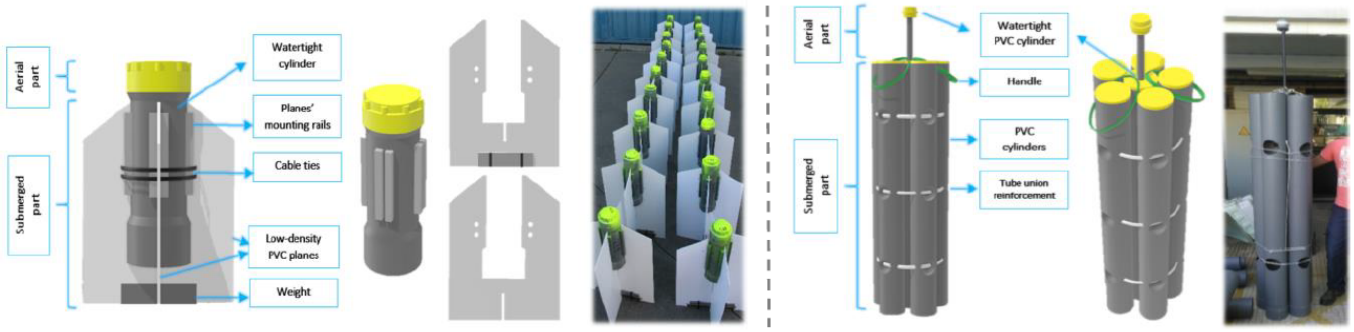

Fig 1. GPRS (left) and SPOT (right) buoys.

VALIDATION METRICS

To validate the data obtained by the antennas, the velocities of the surface currents given by the radial and total vectors of the HF radar were compared with current velocities provided by drifting buoys as they pass through the radar cells. In the comparisons, the standard deviations (variances) of both the data from the buoys and the HF radar were taken into account to reject or include the observations into the comparisons, i.e. to filter out mean values with associated standard deviations above a stablished threshold.

Traditionally, these comparisons are based on metrics such as the root mean square error (RMSE) and the statistics derived from the linear regressions type I (slope, intercept, coefficient of determination and probability of rejection). In type I regression models, the data from one of the instruments works as a predictor variable (X, generally observations from buoys or other instrument) while those from the other work as a predicted variable (Y, generally the HF radar velocities), where only the predicted variable contains error. This does not suit to reality since both instrument measurements have uncertainties associated to intrinsic errors (from the corresponding device electronics) and to natural variability (the currents). Therefore, regression model type II was proposed to do the comparations, since it includes errors in both, predictor and predicted, variables [4][5].

Starting with two sets of paired (buoy-HF radar) mean values, one set unfiltered and other filtered, and applying two different regression models to them, four sets of regression results were obtained, each with its own statistics and adjustment coefficients. Since both regression models are linear and single-variable, the regression coefficients are the intercept (a) and the slope (b). The statistics metrics used were the correlation coefficient (R), the variance ($Var(Y)$) of the estimate (Y) generated by the regression, and the root mean squared error (RMSE) or root mean square deviation (RMSD).

Usually, the RMSD is used as one of the most important criteria to compare linear regression models, the lower RMSD value the better model adjustment. Using this criterion, the selected regression model, out of 4 possible, for most of the HF antennas was the “filtered model type I”. However, this criterion also came with a collateral, nearly always the selected regression also had a much lower variance of the estimate (*Var*(*Y*)) than the variance of the original observed data (*Var(Y)*). That is, the regression model selected produced estimates with too low variance, which is unrealistic.

To solve this issue, a new metric was developed to select the best model, the Root Weighted Square Difference (RWSD), which considers the original standard deviation (*SD(Y)*) of the original data and the standard deviation of the regression estimate (*SD(Y)*).

$$RWSD^2 = \left(SD(\hat{Y}) - SD(Y)\right)^2 \cdot w_\sigma + RMSD^2 \cdot w_R$$
$$w_\sigma + w_R = 1$$

Using this new metric, with W_σ=0.75 for ensuring that the standard deviation of the estimated values is equal or greater than original data, the selected models for most of the cases were the “filtered model type II”.

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