Maritime Decision Support Systems Validation during REP10 Cruise

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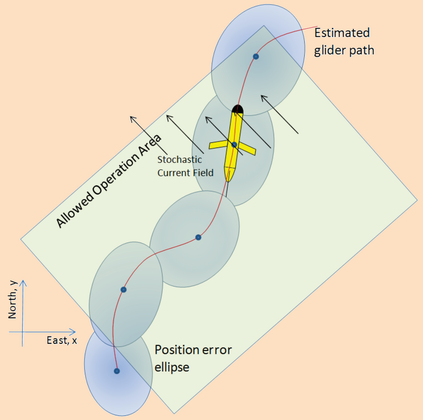
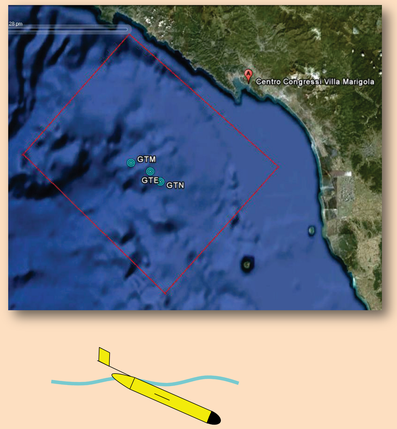
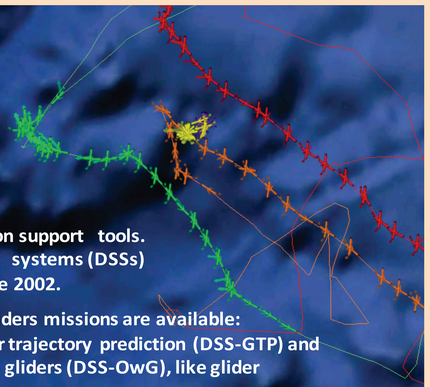
Abstract

During the REP10 cruise a METOC officer and a hydrographic officer, both from the Royal Netherlands Navy, have helped in defining a methodology for validating two Decision Support Systems (DSSs) developed at NURC.
Important guidelines in designing similar validation experiment involving human experts have been drawn from this pilot study.





1. REP10 cruise



Planning missions involving gliders is not an easy task since the planning is heavily affected by meteorological and atmospheric (METOC) conditions.

From this comes the need for decision support tools. NURC is developing decision support systems (DSSs) for generic maritime operations since 2002.

Today two systems for supporting gliders missions are available:
- a decision support system for glider trajectory prediction (DSS-GTP) and
- one for supporting operations with gliders (DSS-OwG), like glider deployment and recovery.

Such systems need the validation of human experts (decision makers, METOC officers, hydrographic officers, etc).

The aim of this pilot study is to develop a methodology for human validation of such decision support tools.

2. Method

We have asked the human experts to provide us the forecasts of the positions of gliders (Greta in the picture) for different instants.

Moreover, we have asked them to judge how much difficult would it be to deploy/ recover gliders at that forecasted positions.

Experiment 1: What will the positions of the gliders be in the future?*

Greta
1.G.1 What will the positions of Greta tomorrow morning (GTM)?
1.G.2 What will the positions of Greta and be tomorrow evening (GTE)?
1.G.3 What will the positions of Greta and be the day after tomorrow, morning (GTN)?
...

**Put your forecasts on a Google Earth kml file*

Experiment 2: Difficulty level in recovering the gliders at the forecasted positions

Greta
2.G.1 How difficult would it be to recover Greta tomorrow morning in its forecasted position (GTM)?
□ Easy □ Not So Difficult □ Difficult □Very Difficult
2.G.2 How difficult would it be to recover Greta tomorrow evening in the forecasted position (GTE)?
□ Easy □ Not So Difficult □ Difficult □Very Difficult
2.G.3 How difficult would it be to recover Greta the Day after tomorrow, morning in the forecasted position (GTN)?
□ Easy □ Not So Difficult □ Difficult □Very Difficult
...

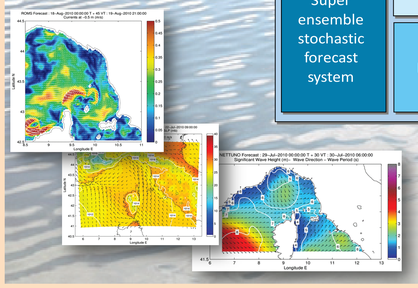
Experiment 3: are the gliders likely to exit the allowed area in the future?

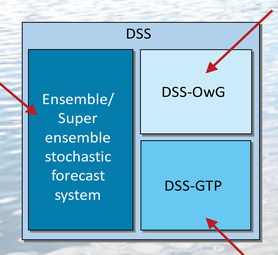
Greta
3.G.1 Will Greta exit its trusted region between now and tomorrow morning? □ Yes □ No
3.G.2 Will Greta exit its trusted region between now and tomorrow evening? □ Yes □ No
3.G.3 Will Greta exit its trusted region between now and the day after tomorrow, morning? □ Yes □ No
...

After providing them the output products of our DSSs we have asked again the same forecasts. In addition, they had to fill a questionnaire where to report opinions and evaluations.

3. The Decision Support Systems

- Fuse METOC forecast models and measurements
- Improves predictions
- Provides estimate of the prediction error



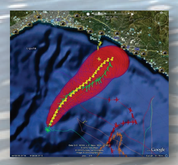


- Rule base system embedding knowledge of experts of the domain
- Provides operation risk assessment, course of action and reliability indexes
- Embed formal dynamical model of mission assets
- Estimates asset state and state uncertainty
- Provides risk indexes

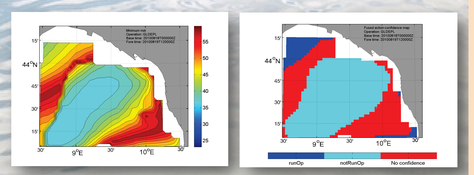
4. Products

The human experts had the following products at their disposal (accessible trough NURC's servers):
- currents at different depths;
- significant wave height;
- wind speed.

For each of them, one or more version were available, from different models. For some of them, an ensemble mean fusion of underlying models was available.



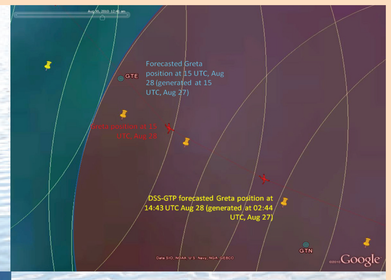
Example of product of the DSS-GTP

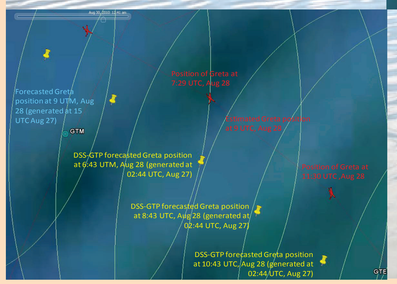


Example of products of the DSS-OwG

5. Questionnaires evaluation and first validations

We have carefully analyzed the questionnaires, being able to elicit many interesting observations.



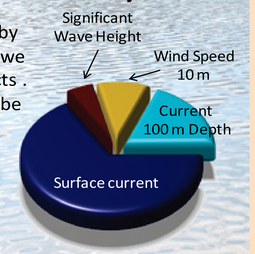


From the collected answer, we have been able to conclude that the questions were meaningful and the answers helpful.

In addition, we have overlapped the positions forecasted by the human experts with that one forecasted by the DSS-GTP (see figures).

5. Logging human experts activity

The activity of the human experts have been monitored by logging their actions on NURC servers. From this weblog we can extract information on the most downloaded products . In future experiments of this kind, web-logging needs to be empowered, by logging also the amount of time each product is displayed.



Conclusions

A methodology to evaluate the effectiveness of the DSS-GTP has been tested. We have also collected a first positive feedback on the usefulness of the DSS-GTP.

In addition, a methodology to evaluate the effectiveness of the DSS-OwG has been sketched as well. We have collected interesting feedbacks both on the validation methodology and on the usefulness and potential limitations of the products of the DSS-OwG.

In summary, important guidelines have been drawn, which will be very helpful in future validation campaigns of NURC's DSSs.

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