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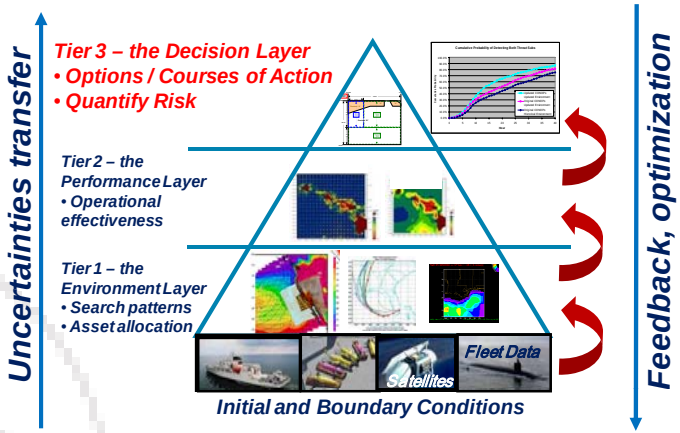
PARTNERING FOR MARITIME INNOVATION

Decision support during REP10



Courtesy: CNMOC, adapted

R. Grasso, M. Cococcioni,
J. Chiggiato, B. Mourre, M. Rixen

MREA10, Lerici, Italy, 18-22 October 2010

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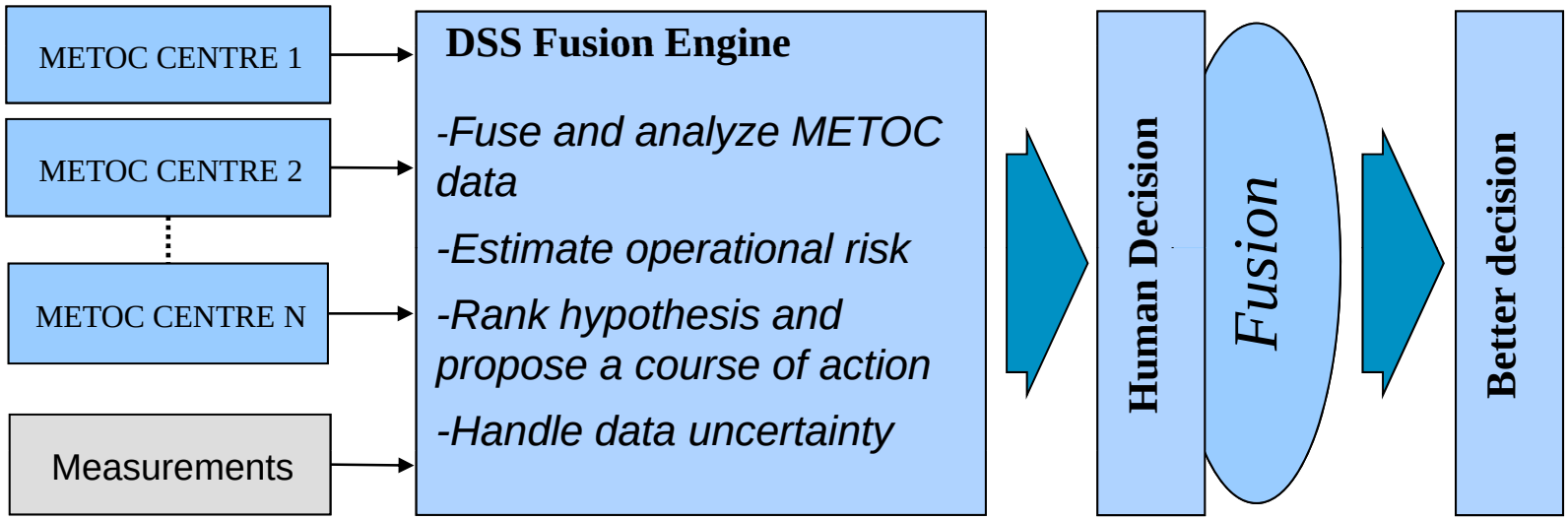
Outline

- Decision support systems (DSSs) overview
- The DSS experiment during REP10
- Results
- Conclusions and future work

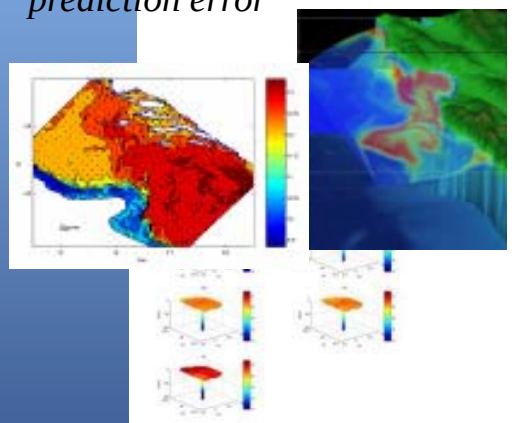
Environmental DSSs



Assess the future impact of the environment on maritime operations

DSS: the fusion engine

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



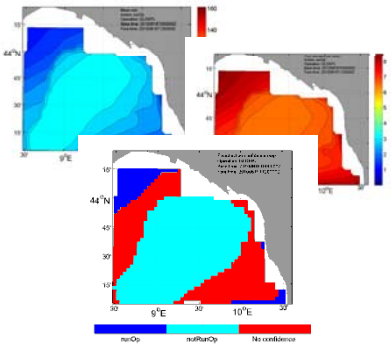
DSS Fusion Engine

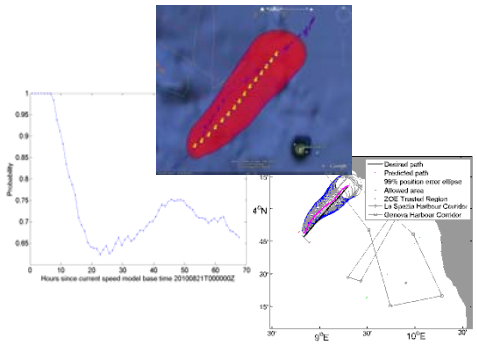
Ensemble/Super ensemble stochastic forecast system

Fuzzy logic (FL) based expert system

Model based (MB) DSS

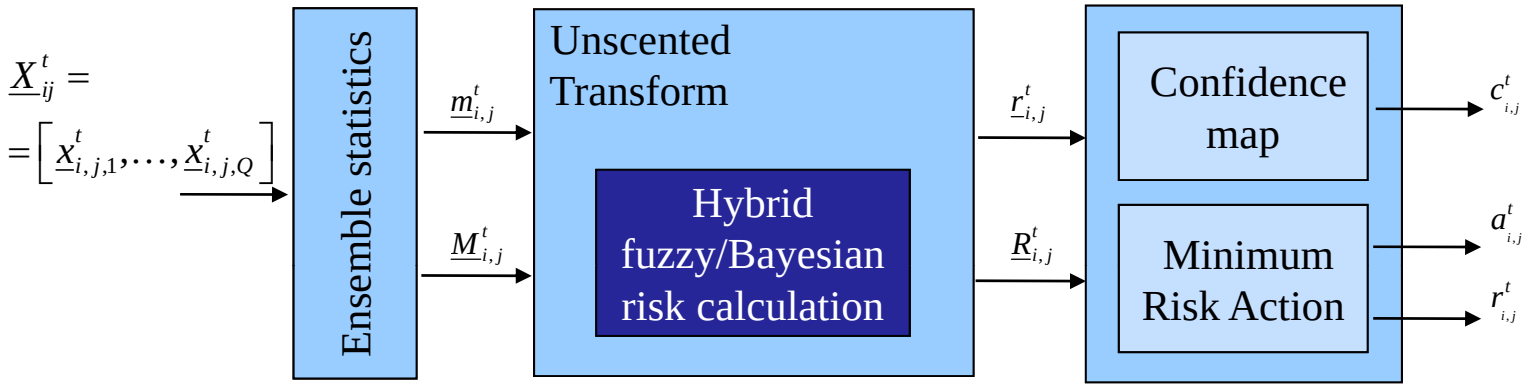
- *Rule base system embedding knowledge of experts of the domain*
- *Provides operation risk assessment, course of action and reliability indexes*





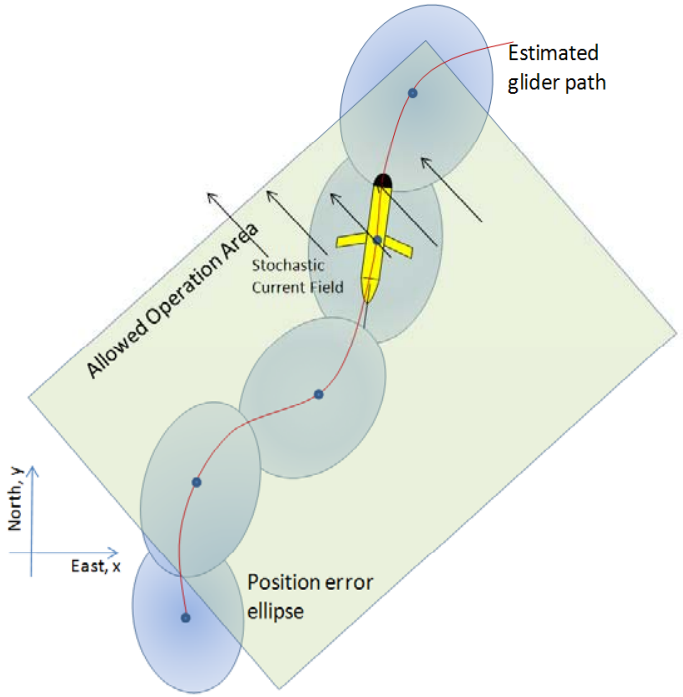
- *Embed formal dynamical model of mission assets*
- *Estimates asset state and state uncertainty*
- *Provides risk indexes*

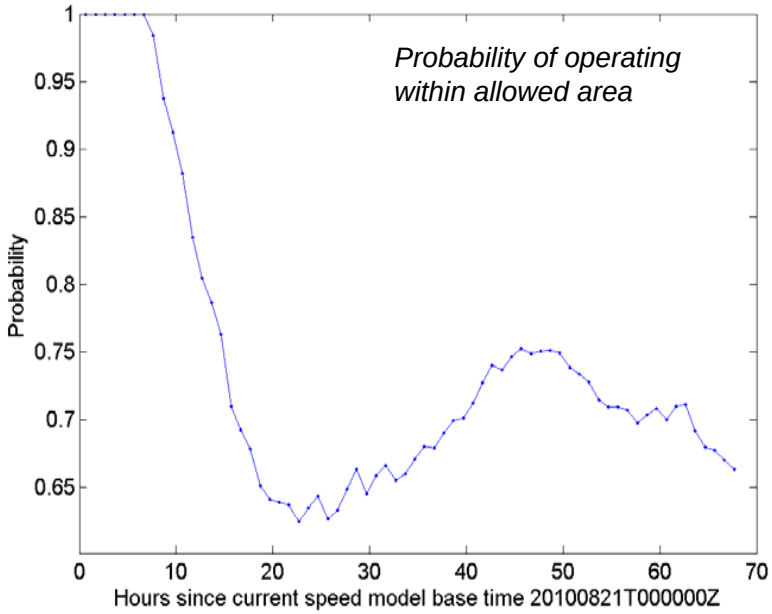
FL-DSS



- The risk model is considered as a non-linear mapping between the input METOC space and the action risk output space
- The risk model is wrapped by the UT to provide statistic estimation of the action risk from the METOC statistics
- Risk confidence levels are then estimated to provide decision reliability information to the decision maker

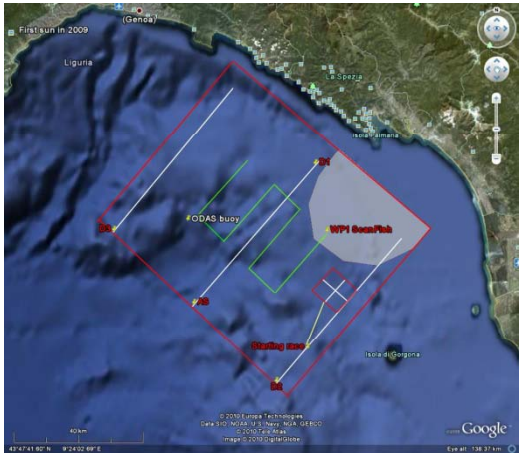
MB-DSS for gliders





- Estimate future position and associated uncertainty of a glider using sea current stochastic forecasts, glider kinematic model and Unscented Kalman Filter (UKF) prediction step
- Calculate risk indexes to support decision on future actions on glider mission plan (example: probability of operating within allowed area)
- *In general support pilots improving their awareness and alertness*

The DSS experiment in REP10



Preparation of the REP10 experiment

FL-DSS set up

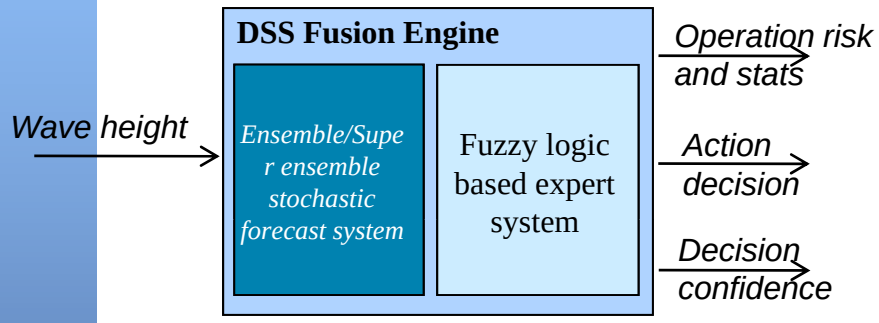
MB-DSS set up

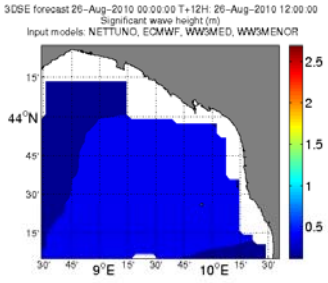
Integration

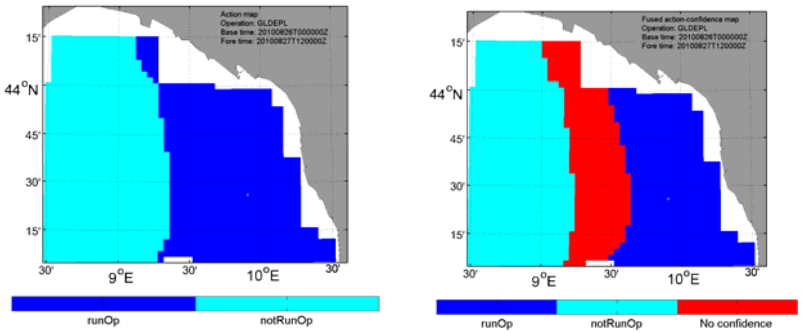
Test and validation

- FL-DSS Operations (OPs): glider deployment, glider surfacing/Tx, divers, naval refueling
- FL-DSS Actions: runOp, notRunOp
- METOCs: wind speed, current speed, significant wave height, water visibility, vessel traffic density
- Products: OPs traffic light maps, OPs confidence maps, OPs action risk and stats, glider position forecasts and uncertainty, probability of operating in dangerous areas

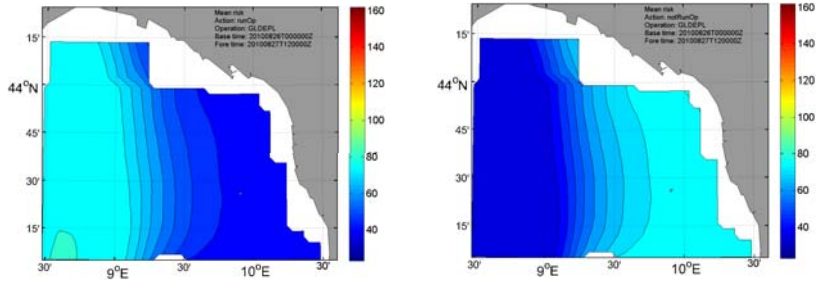
Results: FL-DSS, Glider Deployment



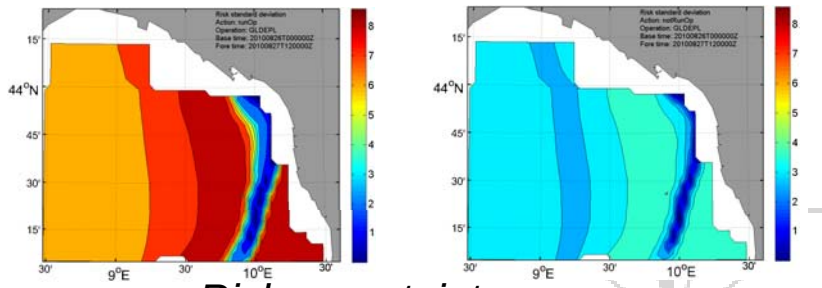




Traffic light maps

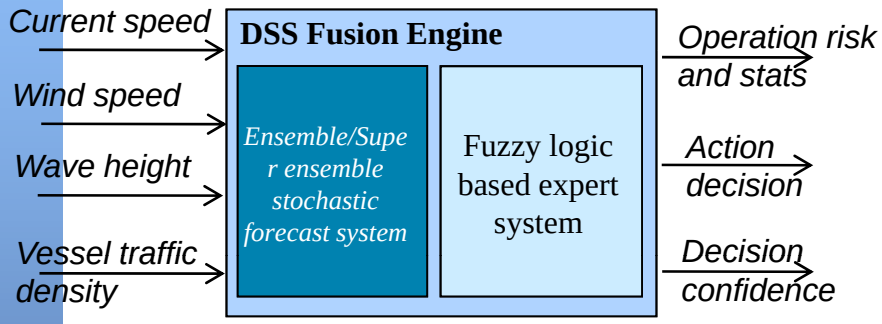


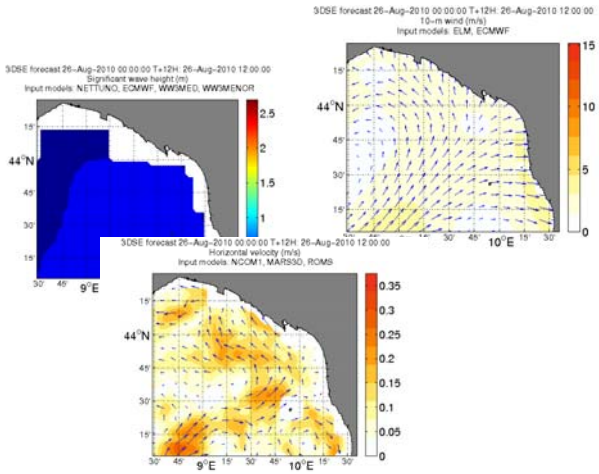
Risk maps

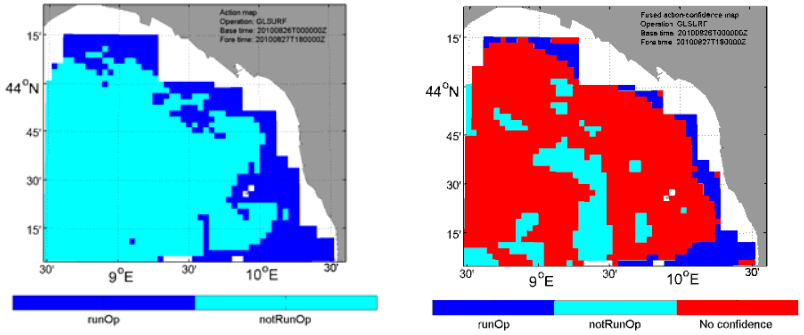


Risk uncertainty maps

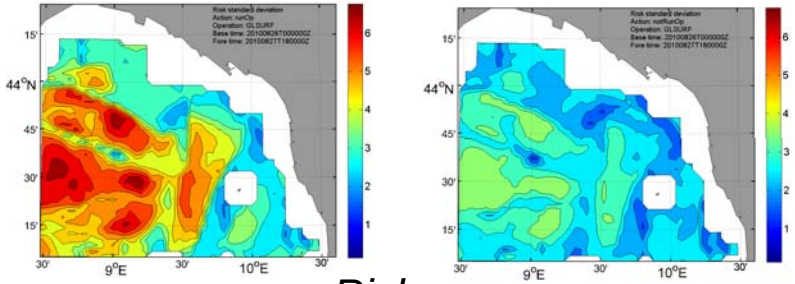
Results: FL-DSS, Glider Surfacing/Tx



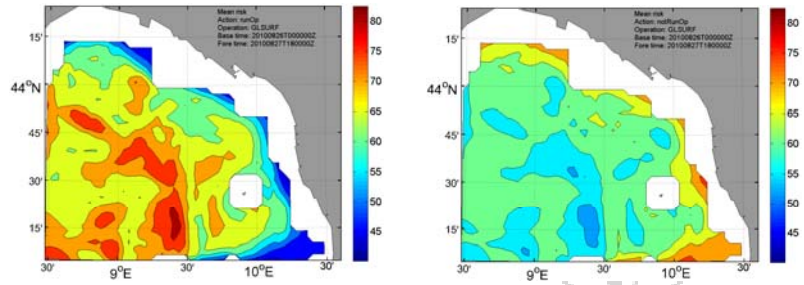




Traffic light maps

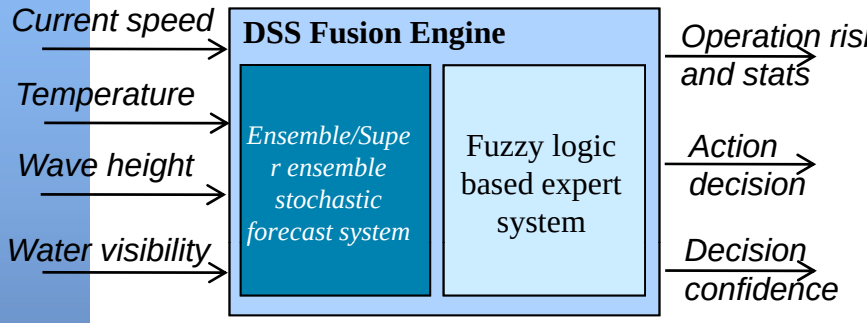


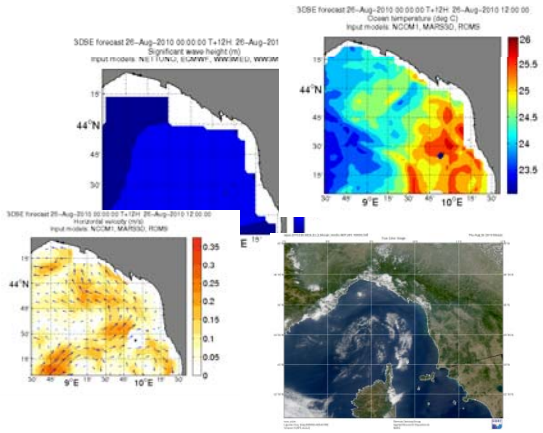
Risk maps

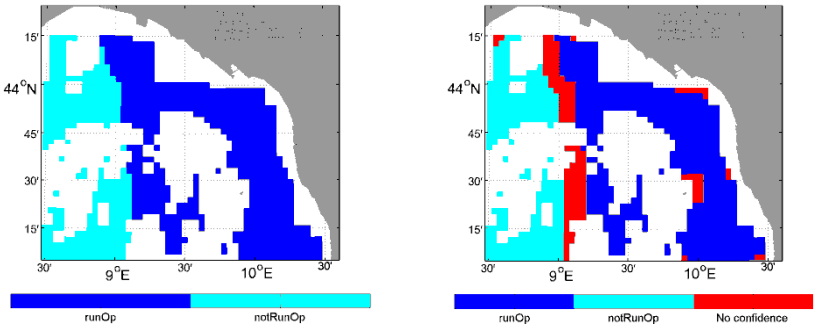


Risk uncertainty maps

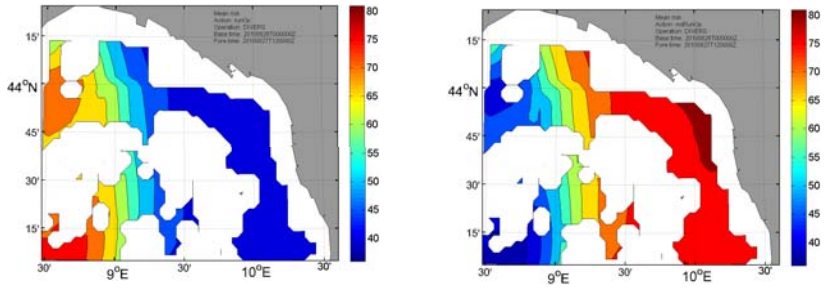
Results: FL-DSS, Divers



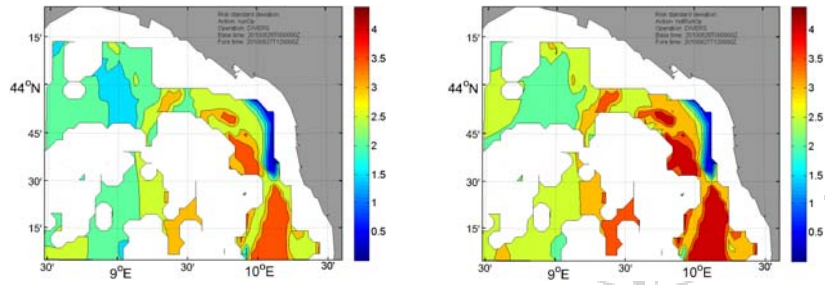




Traffic light maps



Risk maps



Risk uncertainty maps

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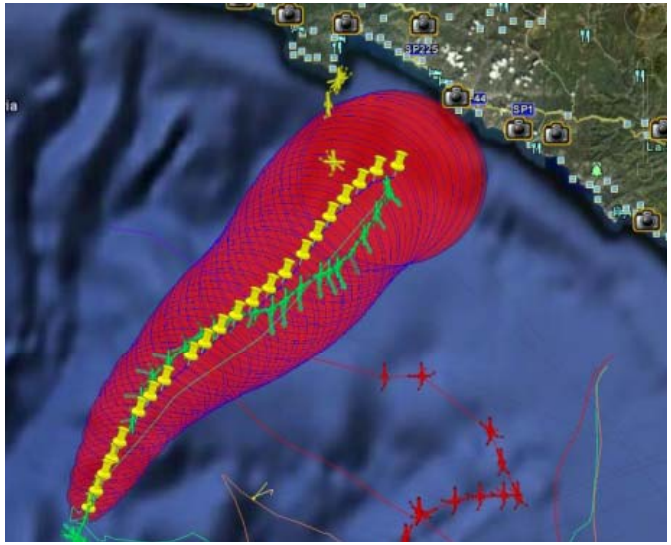
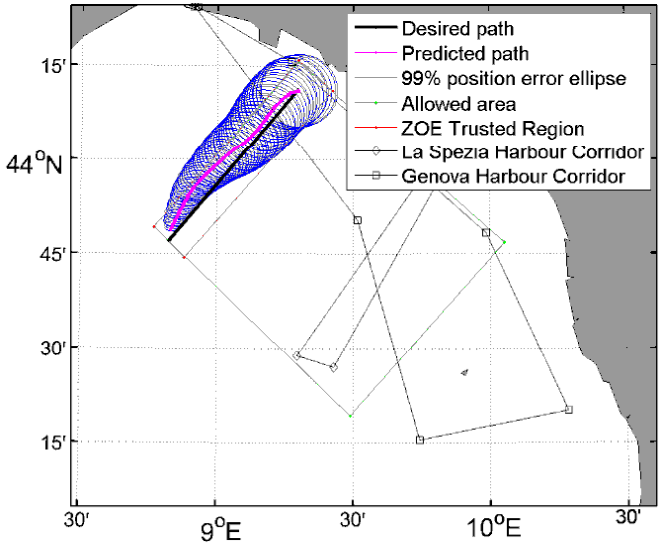
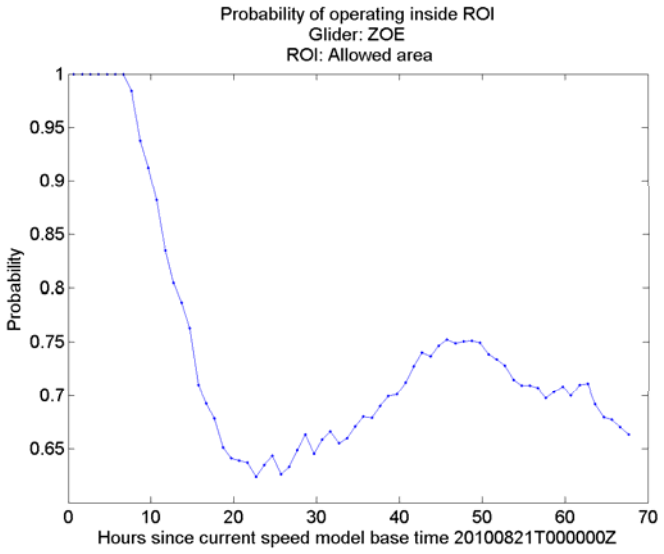
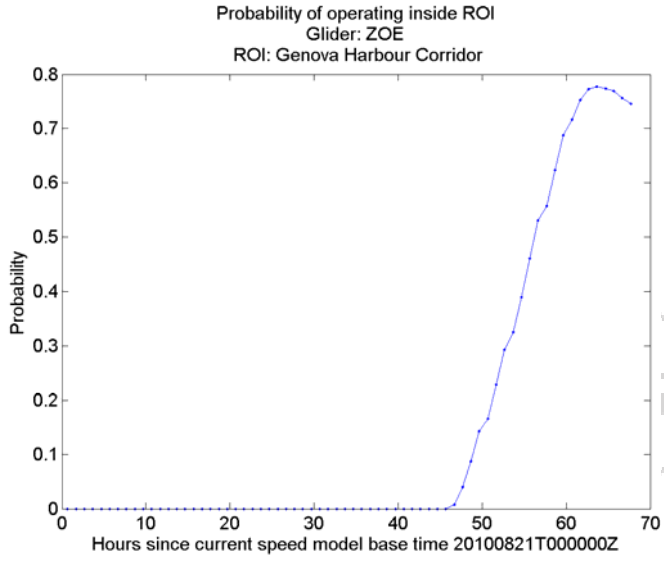
Results: MB-DSS

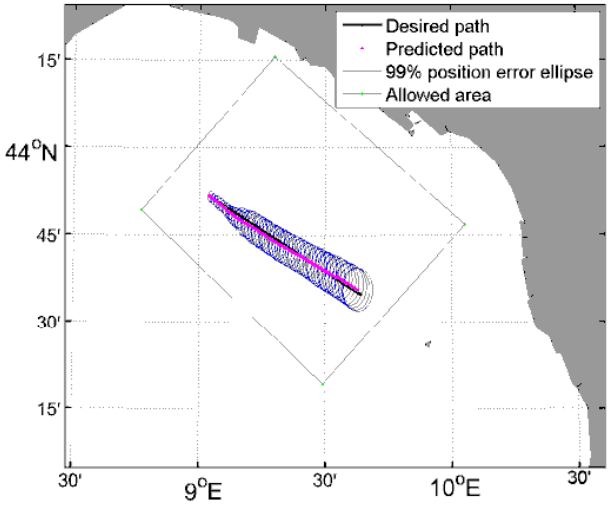


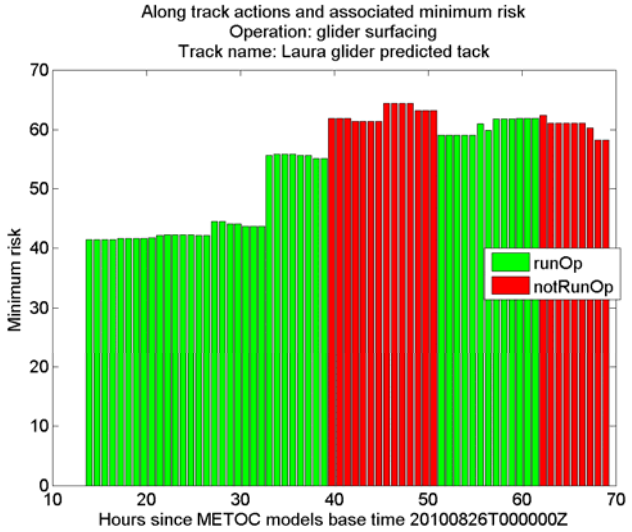


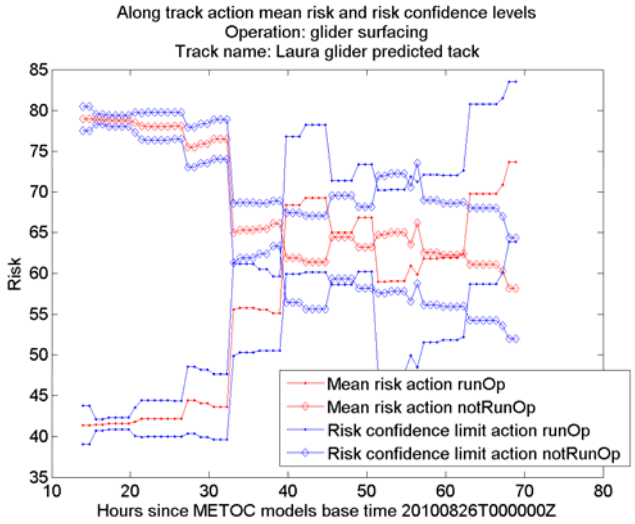


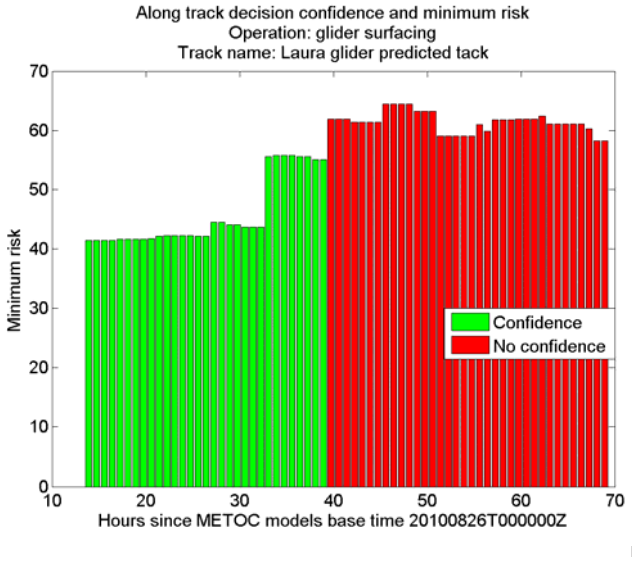


FL/MB-DSS integration, Glider Surfacing/Tx



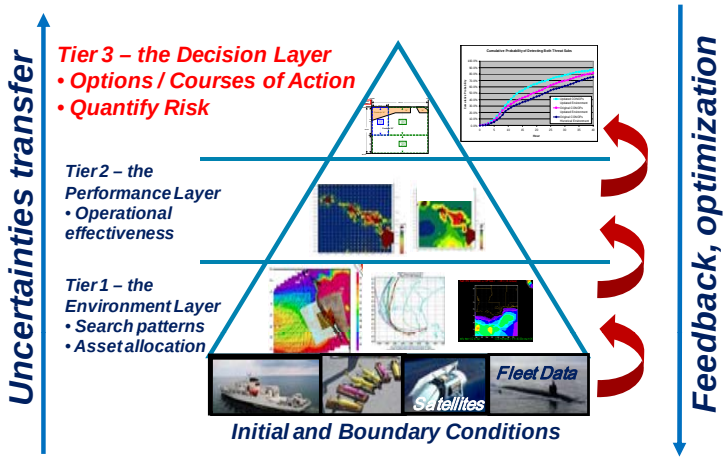






Conclusions, perspectives

- REP10 provided demonstration of the environmental pyramid including Tier 3
- A spectrum of DSS products were provided demonstrating system
  - Flexibility (embed subjective/objective knowledge, general purpose)
  - Ability to solve the cognitive work load problem and to handle uncertainty
- Implementation of a validation methodology involving METOC officers started



Courtesy: CNMOC, adapted

The future

- Preparation of REP11
- Optimization of sequence of actions
- Adaptive sampling driven by FL-DSS confidence measure