Current data assimilation and drift forecast models for search and rescue

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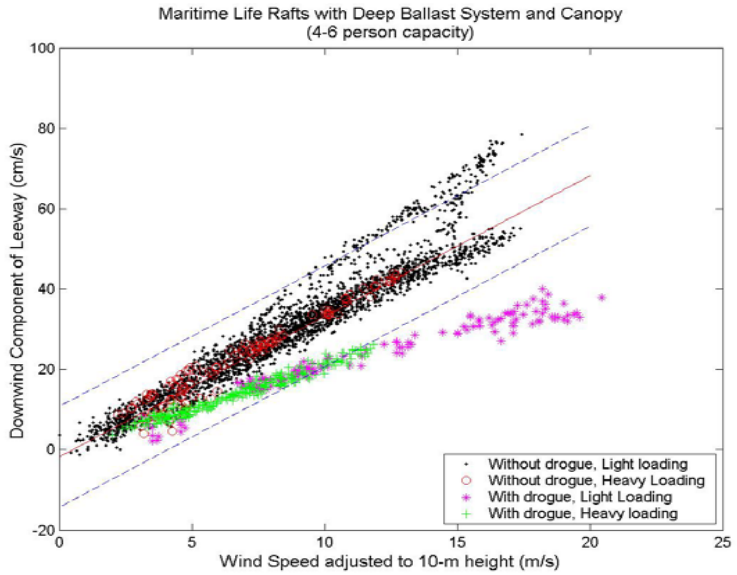
Operational Drift forecast Models :

Used by Rescue Coordination Centres for Search & Rescue (SAR) operations and oil spills mitigation

Used for prediction of trajectories of objects lost at sea in order to minimize search areas

These models nowadays are ensemble models based on a stochastic approach and combining metocean forecast data with various models of the hydrodynamic behaviour of drifting objects.



Hydrodynamics :

The Leeway method (Breivik, 2008) used by USCG and Norwegian RCCs.

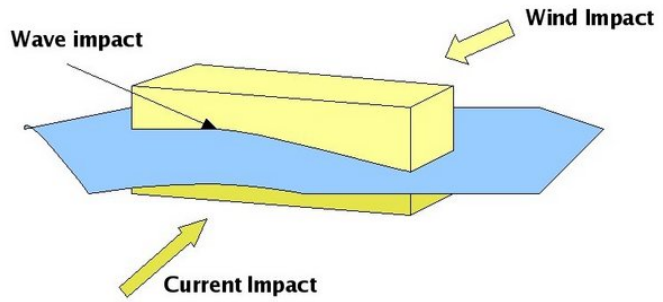
> *"Leeway is the motion of the object induced by wind (measured at 10 m reference height) and waves relative to ambient current (measured between 0.3 m and 1.0 m depth)."* (Allen &al., 1999)

Drift properties are described by mean of their Leeway coefficients:

$$L_d = a_d W_{10} + b_d + \varepsilon_d$$
$$L_{c+} = a_{c+} W_{10} + b_{c+} + \varepsilon_c$$
$$L_{c-} = a_{c-} W_{10} + b_{c-} + \varepsilon_c$$

The "static" method (Pavec, 2008):

Drag forces and drift speed are evaluated at each time step considering the object at equilibrium under the combined action of wind, waves and current.



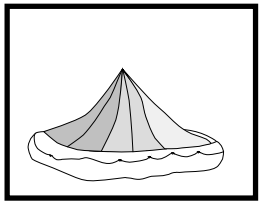
Stochastic approach:

Based on MonteCarlo method : Each drift simulation is run for a large number of objects, each with slightly different characteristics depending on uncertainties on different parameters (such as initial time and location, draught, length and beam).

Trajectory is then obtained by evaluating at each time step the location corresponding to the highest probability of presence of the object (highest density).

Drift Forecast Model

Object :



Type

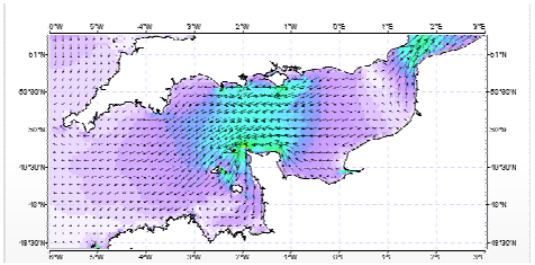
Hydrodynamic properties/Leeway coefficients

Estimated last « known » Position

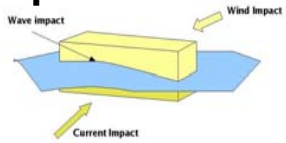
Estimated Date & Time

Environmental forecast

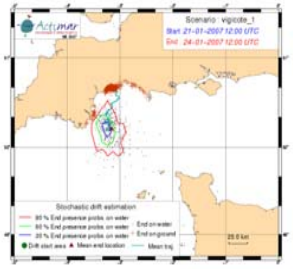
Wind, Currents, Waves



Computation module



Trajectories estimates for a large number of objects, taking into account uncertainties on parameters



Maps

Trajectories

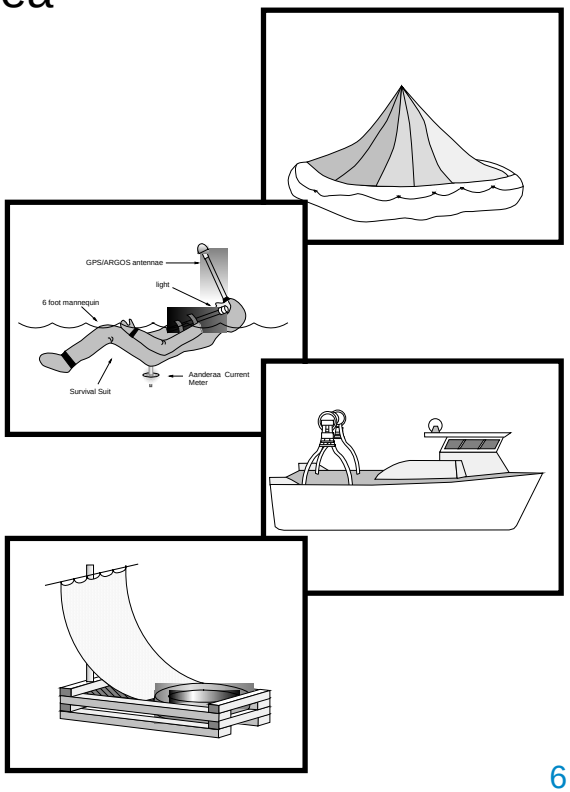
Presence probability areas

Field Tests

Leeway approach requires building a coefficients database for a large range of objects differing in

- size
- over water/submerged volume ratio…

Field tests consist in letting the object drifting at sea while simultaneously recording its location and parameters characterizing the environmental forcing.



Mandatory parameters :

- Wind (magnitude and direction)
- Velocity of the object relative to water

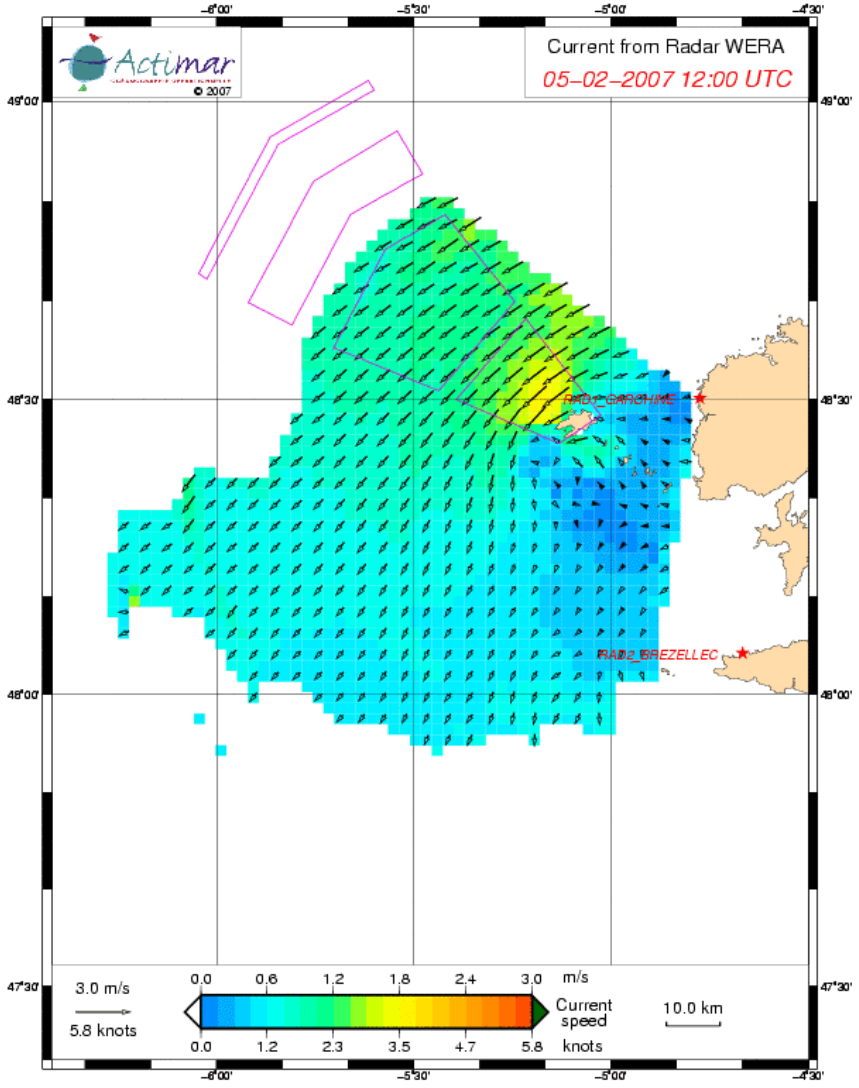
Field tests also valuable for validation of drift forecast models

Iroise Sea Trial

Field test conducted with a 20’Container

Location:

Iroise Sea, Britanny, France
(48°15’ N, 5°10’W)



Together with
European Interreg project LOSTCONT
-Action de l’Etat en Mer
-CEDRE
-SASEMAR
-IPTM

Cedre

Action de l’Etat en Mer

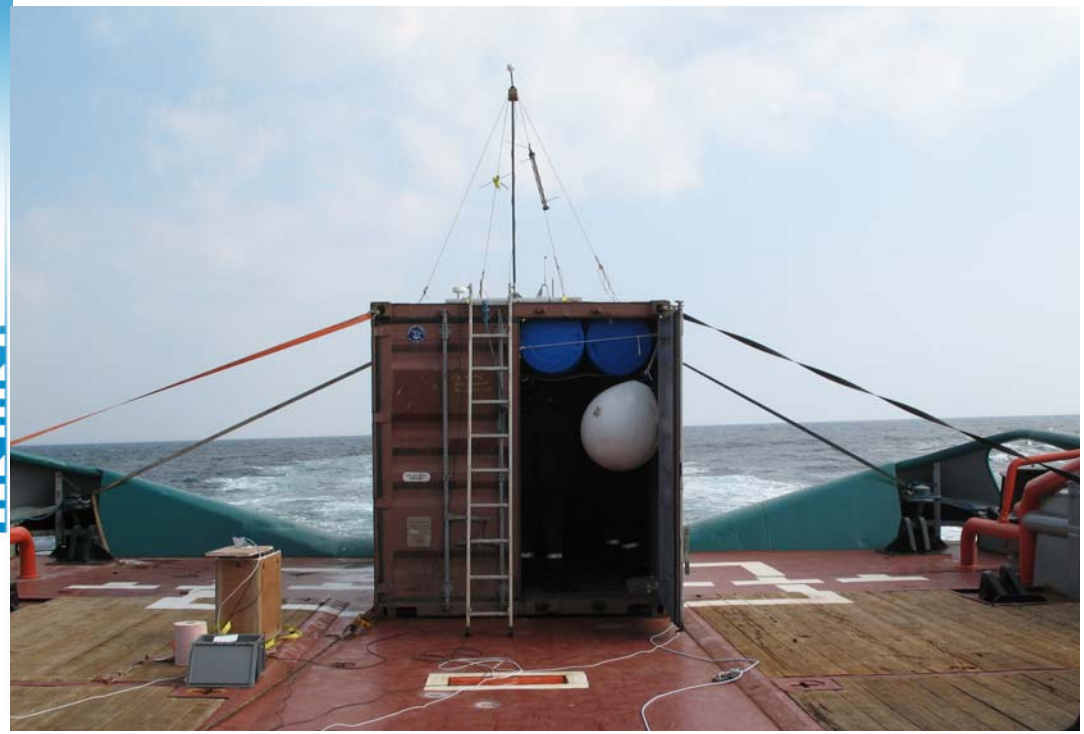
20 ‘ Container

20’ x 8’ x 8’6 ’’ (6.1m x 2.44m x 2.59m)

420 kg weight on floor

5.8 m^3 floats under ceiling (80% immersion)

Appertures on floor for quick water filling



Measurement :

Wind :

Anemometer on top of container

Current :

HF Radars

Currentmeter attached to container

Waves :

Directional buoy « Les Pierres Noires »

Hindcast models

Container position :

AIS transponder

Argos beacons

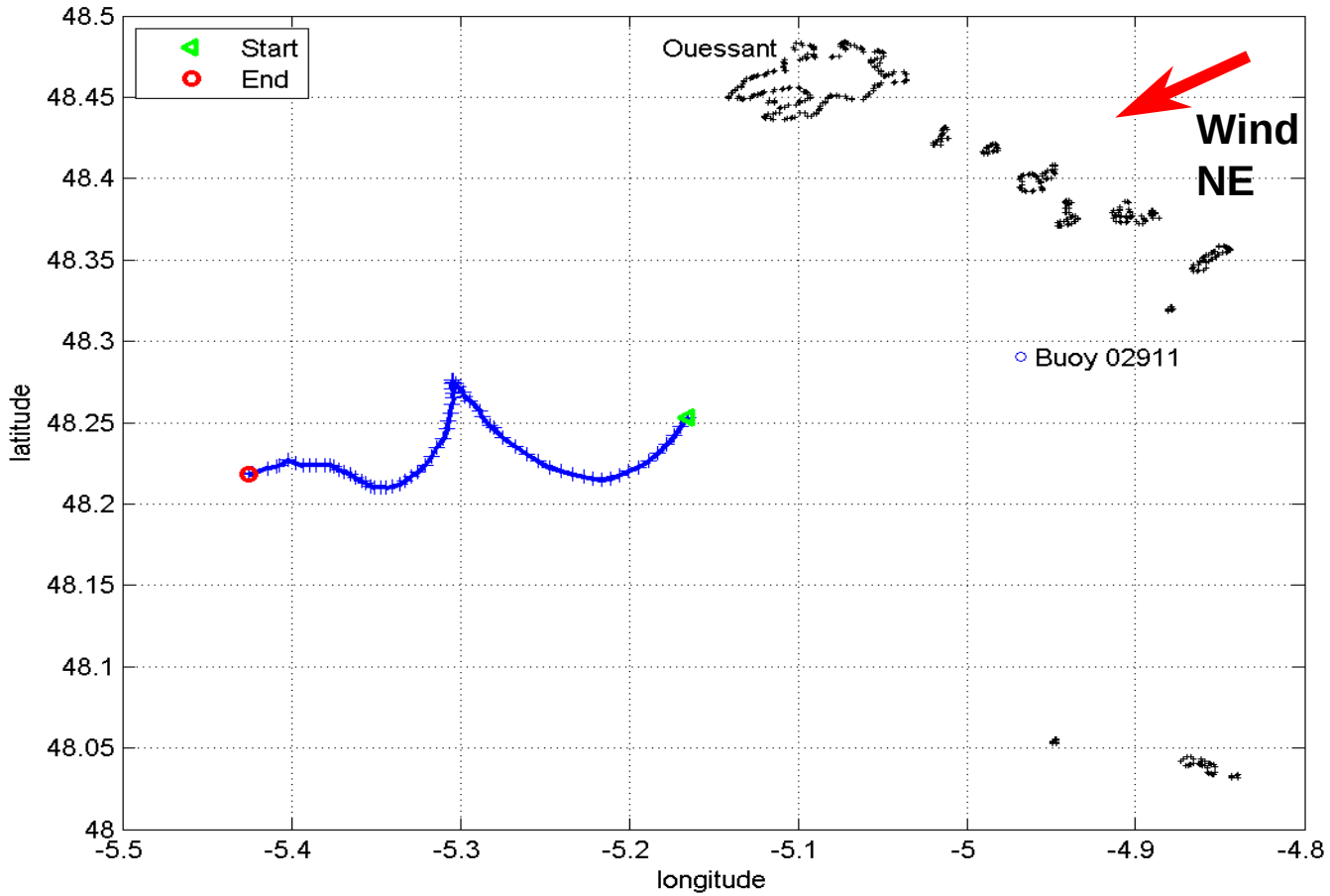
Iroise Sea Trial

Iroise Sea Trial

Trial Duration : 24 hours

Total drifting distance : 16.8 Naut. miles

Mean speed : 0.7 kts

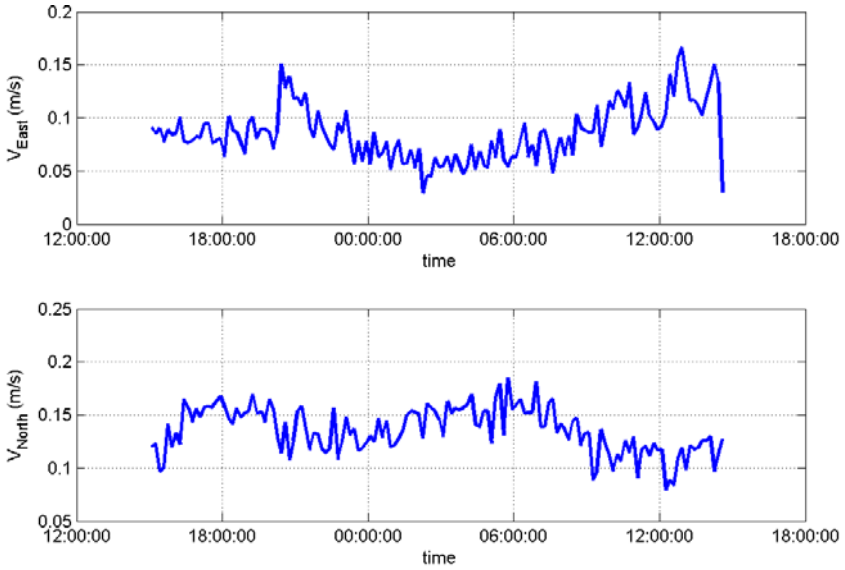


Environmental data

Currentmeter data :

Mean Local Drift speed :

19.6 cm/s (0.38 kts)



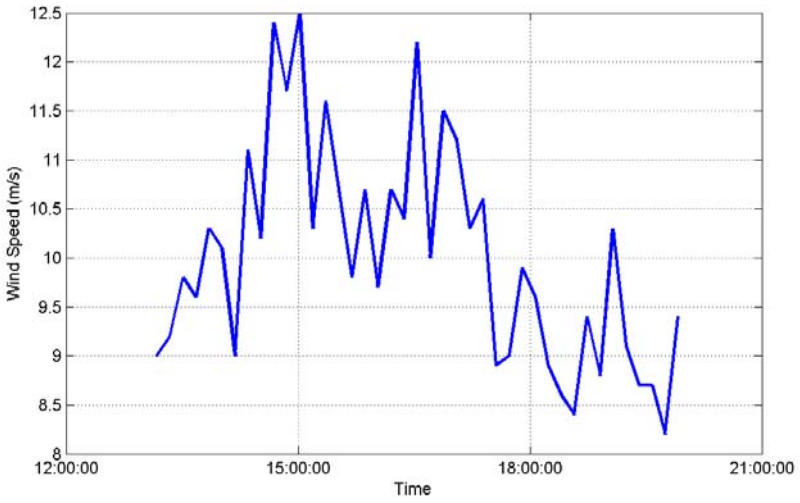
Anemometer data :

Mean wind speed (7 hours):

North-easterly

10 m/s (19.5 kts),

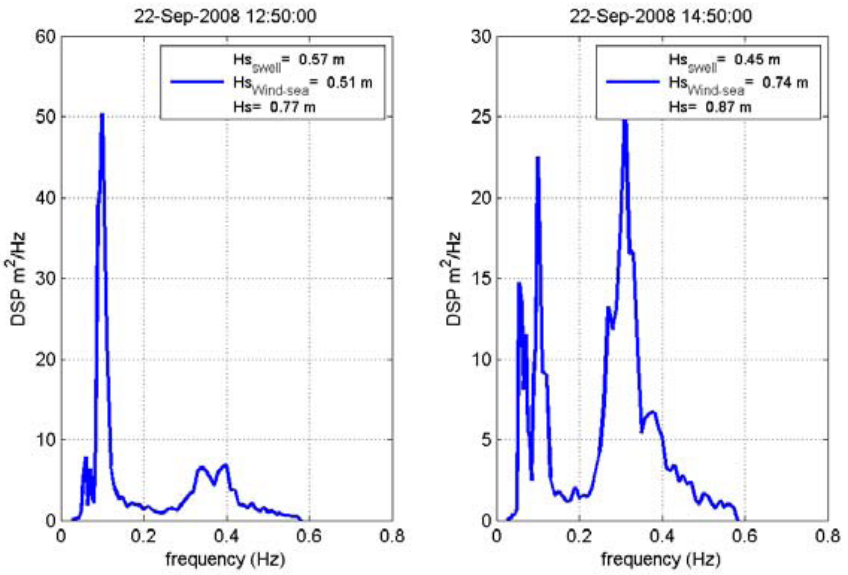
gusts 28 kts



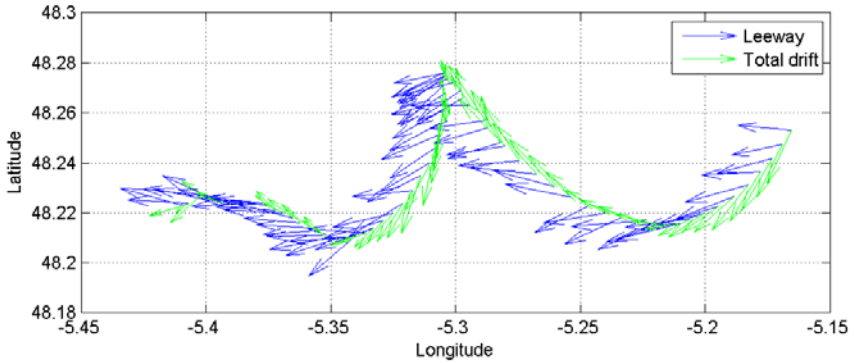
Environmental data

Wave data :

superimposition of a swell from west-northwest with an average SWH ~ 1.33 m and a wind-sea, driven by the local north-easterly wind, with an average SWH ~ 0.54 m



Trajectory and Leeway Speed



Drift Speed & Leeway Speed

Drift Speed (Speed over Ground) :

Mean : 36.5 cm/s (0.7 kts)

Std :16 cm/s

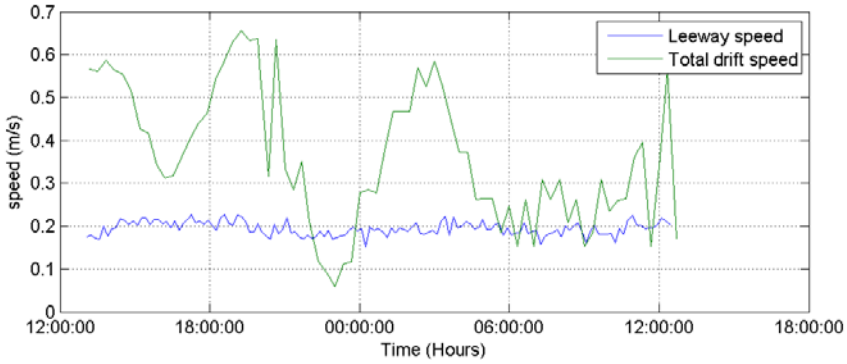
Large variability

Relative Speed :

Mean :19.5 cm/s (0.38 knts)

Std : 1.6 cm/s

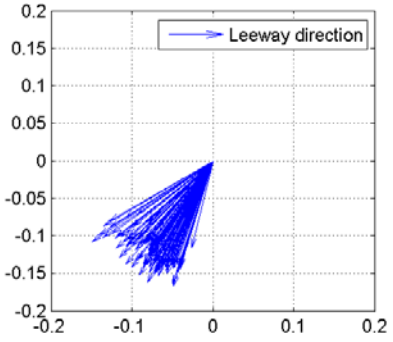
Steady

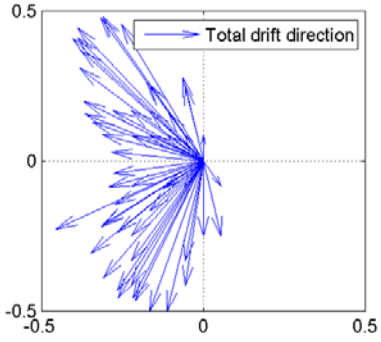


Leeway Direction

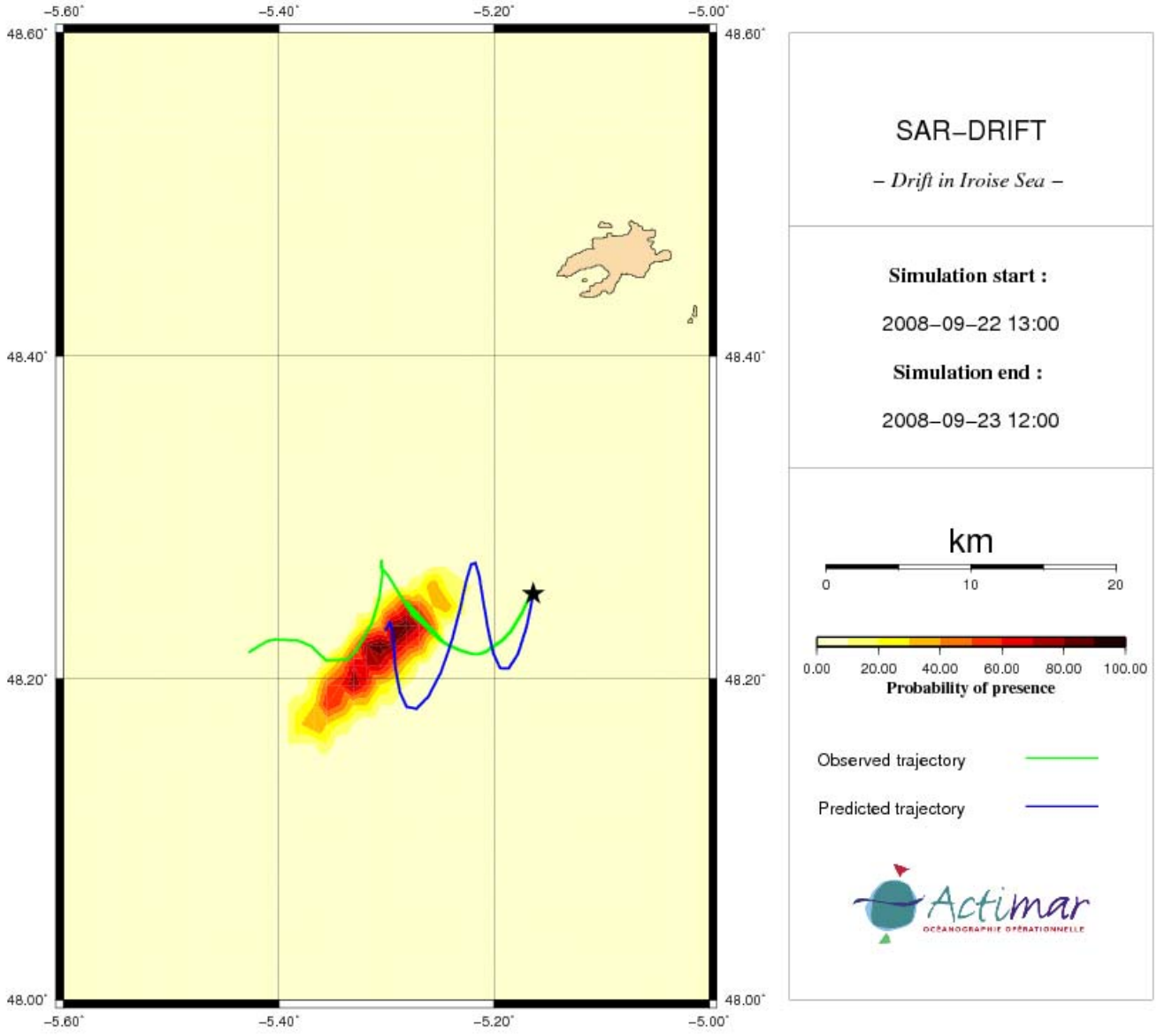
Leeway direction is restricted to the south to west quadrant as a result of the action of the northeasterly wind and wind-sea

Total drift directions spread all over the south to north sector because of the influence of the tidal currents

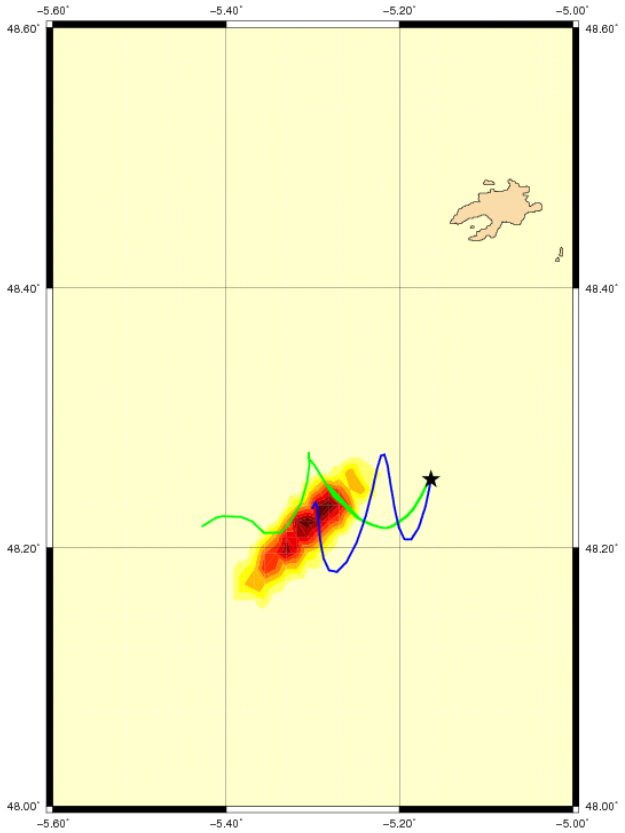




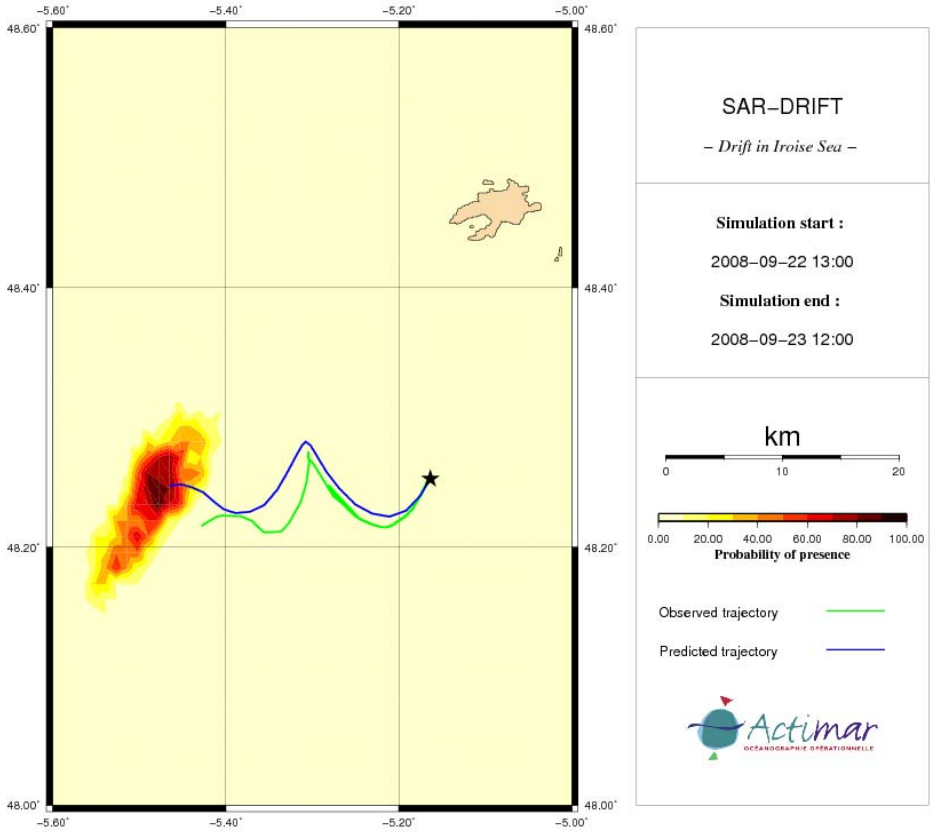
SAR-Drift forecast tool



Use of measurement data : HF radar surface current



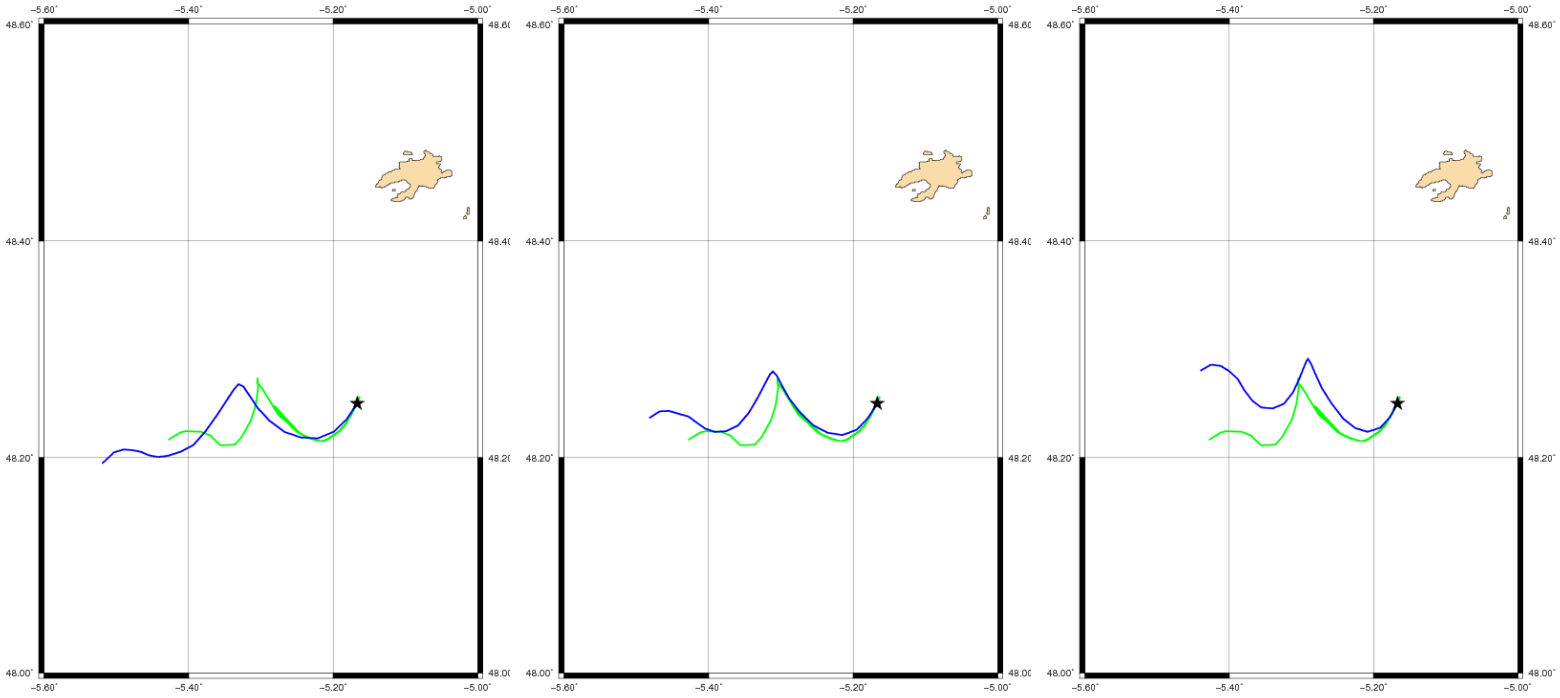
Environmental data from forecast models



Current from HF radars

Hydrodynamics

Sensitivity of the model : Influence of Draught



70% 80% 90%

Conclusions

Drift forecast models :

- Sensitive to the quality of environmental input data

- Accurate drift forecast requires high quality current and wind forecast

- Assimilation of (near) real time measurement data (in-situ or remote) can improve quality of drift forecast for SAR operations