Drift prediction by models: What influences the uncertainties?

Valérie Dulière[1], Silvia Massmann[2] and Pierre Daniel[3]

[1]Royal Belgian Institute for Natural Sciences, Operational Directorate Natural Environment (previously RBINS-MUMM), Brussels, Belgium.
[2]BSH, Hamburg, Germany. [3]METEO-FRANCE, Direction de la Prévision, Division Marine et Océanographie, Toulouse, France

Context

Providing reliable information on drift model performance is a difficult task since drift experiments at sea are costly and complex to organize.

Goal

The main goal is to discuss how currents, winds and waves affect the buoy estimated trajectories and how uncertainties in the weather and sea conditions change trajectory predictions. To this end, a number of model simulations have been performed using different models to estimate the drift of a CEFAS buoy that became detached on 9th December 2012 and for which recorded GPS positions were made available.

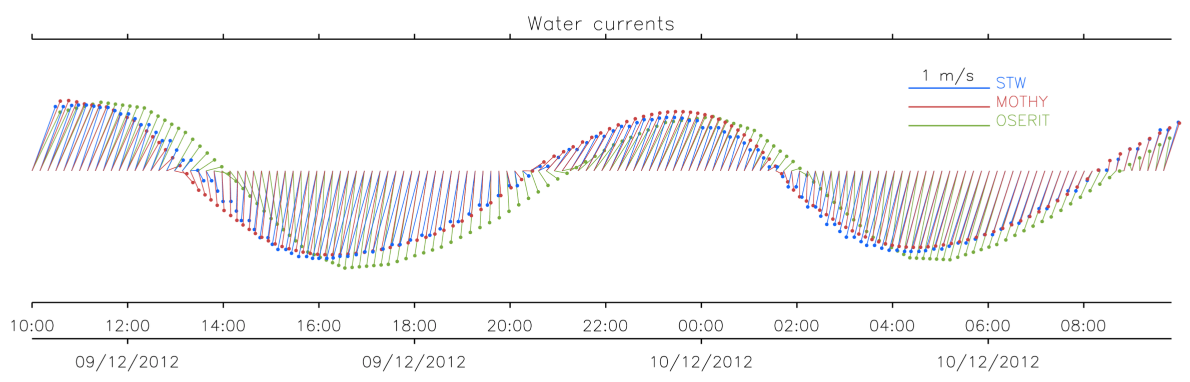
The drift models

Seatrack Web has been developed in cooperation between SMHI, FCOO, FMI and BSH and bases on the drift model BSHdmod.L, which is operationally used at the BSH since the 1990s. It is able to use different wind and current forcing fields. Here we use COSMO-EU winds from the German Weather Service (DWD) and water currents from the North and Baltic Sea circulation model BSHcmod in 15-min resolution. BSHcmod has a 5-km resolution in the region of drift. The Stokes drift uses a wave spectrum derived from the wind field (Liungman et al, 2013).

MOTHY has been developed at Meteo-France and has been operational since 1994. It calculates the main drift component from the wind and tide data. It parameterizes the upper ocean drift from wind speed using a sophisticated Ekman type scheme. Atmospheric forcing used here is from ARPEGE model of Meteo-France, with a spatial resolution over the North Sea of 0.1 , and wind analyses every 6 hours. The spatial resolution of the ocean currents is about 5 km.

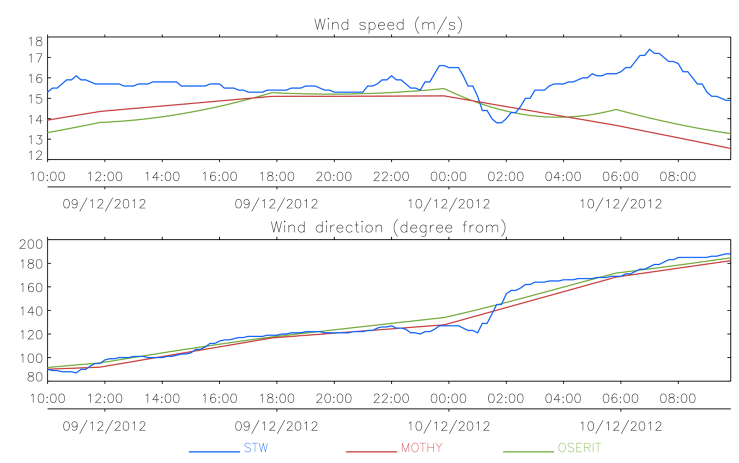
OSERIT has been developed at the DO Nature at RBINS. It includes a user-friendly web interface that allows selecting many processes (*e.g.* the effect of wind and water currents or the Stokes drift). OSERIT uses atmospheric conditions as forecasted by the UK Met Office, hourly hydrodynamic conditions as forecasted by MUMM's operational hydrodynamic models (with a 5-km resolution in the region of drift) and sea state as forecasted by MUMM's operational version of the model WAM.

The forcing



The water currents used are similar but with phase shifts among the different forcing. This is especially true for the water currents used in OSERIT.

Winds used in MOTHY and OSERIT are similar. Winds used in Seatrack Web are globally stronger than in other models.

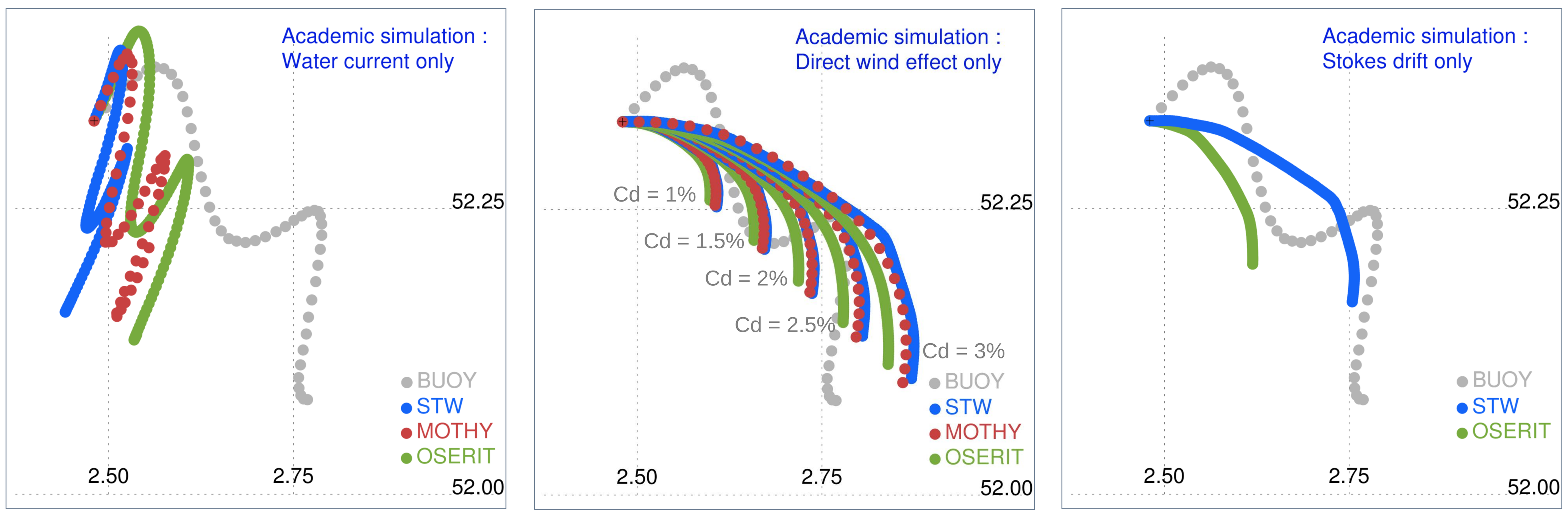


Academic model simulations

Several academic simulations have been performed **to isolate the effect** of the water currents, wind and Stokes drift on the buoy drift trajectory.

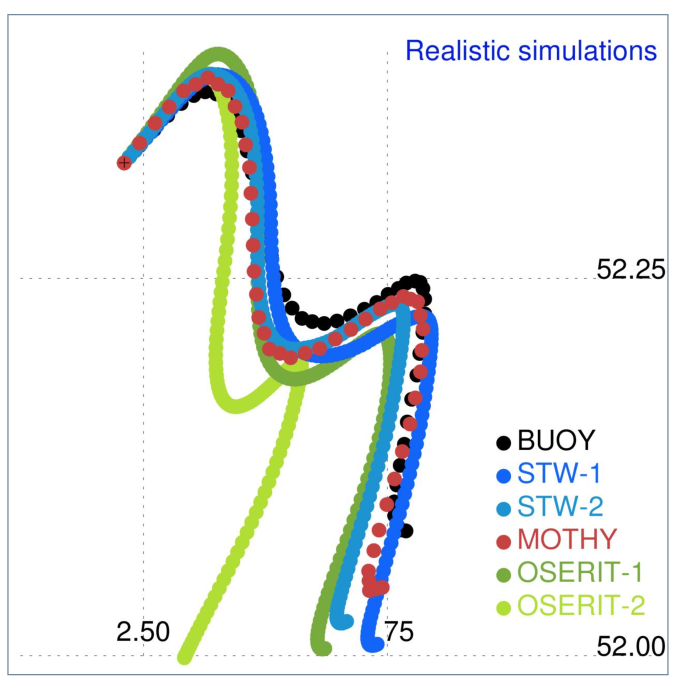
Results of simulations with the **currents** effect only show buoy positions that are **7 to 10 km** distant from each others after one day.

Several wind drag coefficients (cd) have been tested in simulations with wind effect only. Results show that **wind drags between 1 and 3%** lead to total travelled distances from **10 up to 40 km** after 1 day. For the same drag coefficient, buoy positions as estimated by the models are 1 to 2.5 km apart from each other after 1 day.



Finally, the effect of the **Stokes drift** is different in Seatrack Web and OSERIT (**10 km apart** after one day). This is due to the different parameterizations.

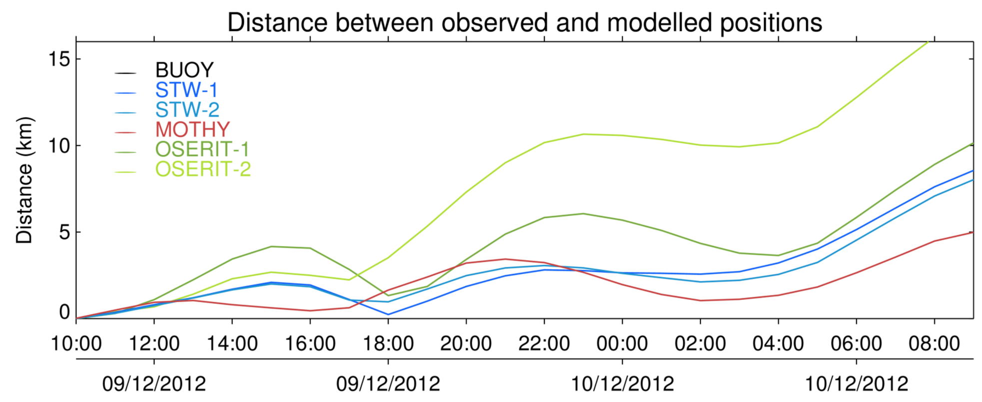
Realistic simulations



Realistic model simulations have also been carried out. An immersion coefficient of 90% was chosen for MOTHY. STW-1 and OSERIT-1 used a strong wind drag coefficient and no Stokes drift while STW-2 and OSERIT-2 used a low wind drag coefficient (or no wind) and the Stokes drift.

Results show good agreement with the buoy observed trajectory. After 1 day, most model estimated positions of the buoy are within 10 km from the observed one.

These realistic simulations suggest that the separation between direct wind drag on an object and displacement of the object by waves needs further investigation. Measured wind drag coefficients include all physical wind induced displacements (wind+waves), and are not strictly related to immersion levels.



Conclusion and perspectives

This first step to evaluate and understand the discrepancies among different drift models showed that the water currents, but also the choice of the wind drag coefficient and the way the Stokes drift is parameterized all play an important role in the model estimation of the drift trajectory.

The next step will be to compare the three drift models exchanging the weather and sea conditions among them.

Abbreviations

CEFAS (Centre for Environment, Fisheries & Aquaculture Science)
FCOO (Danish Defence Centre for Operational Oceanography), www.fcoo.dk
FMI (Finish Meteorological Institute), www.fmi.fi
RBINS (Royal Belgian Institute for Natural Sciences)
SMHI (Swedish Meteorological and Hydrographic Institute), www.smhi.se

References

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- Liungman, O., Mattsson, J. and Massmann, S. (2013): Scientific Documentation of Seatrack Web: physical processes, algorithms and references.
- MOTHY: http://www.meteorologie.eu.org/mothy/

Aknowledg.

We acknowledge the **CEFAS** for providing the access to the buoy positions