Mixed sediments of the Belgian Coast and the Scheldt. Modelling and Comparison with Satellite data

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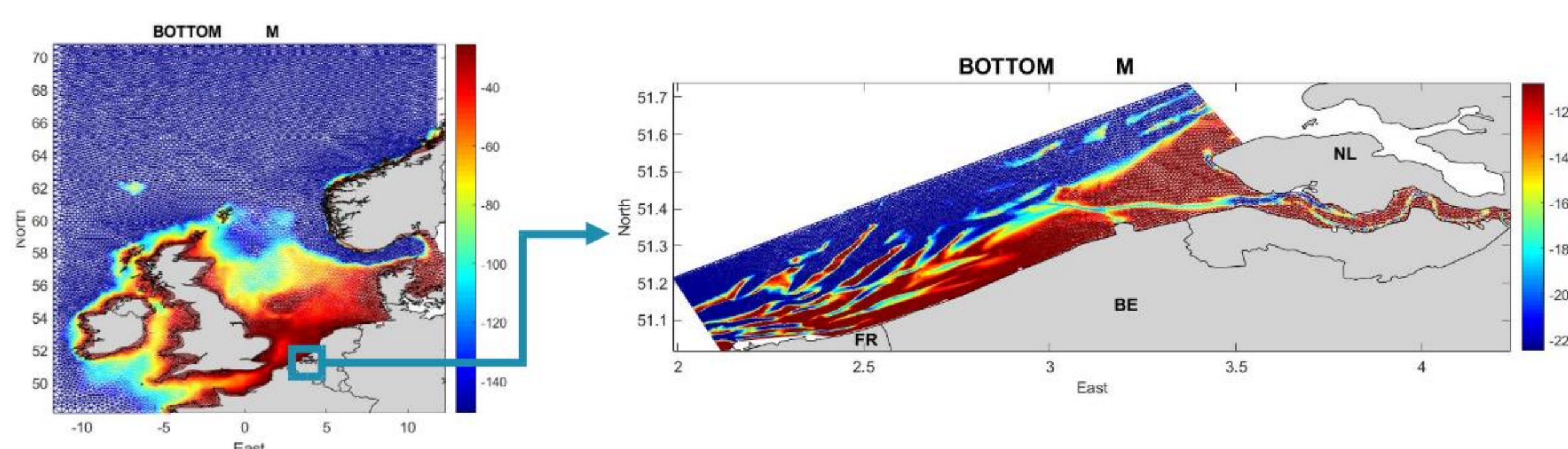Juan Sebastian Escobar Ramos

Purpose

The aim is to model sediment transport patterns in the coastal zone taking into account mixed sediments: sand which is the basis of the coastal protection system and mud that highly affects the coastal ecosystem. Both sand and mud have an impact on dredging activities in the coastal zone. Satellite imagery providing spatial patterns of suspended particular matter (SPM) is used to compare with model results.

Model set up

A coupled 2D model was set up with the open source TELEMAC 2D (hydrodynamics), TOMAWAC (waves) and SISYPHE (sediments) modelling train.

It includes the friction law of (Bi and Toorman, 2015), which is valid in all flow regimes, improving the modelling of intertidal morphodynamics.
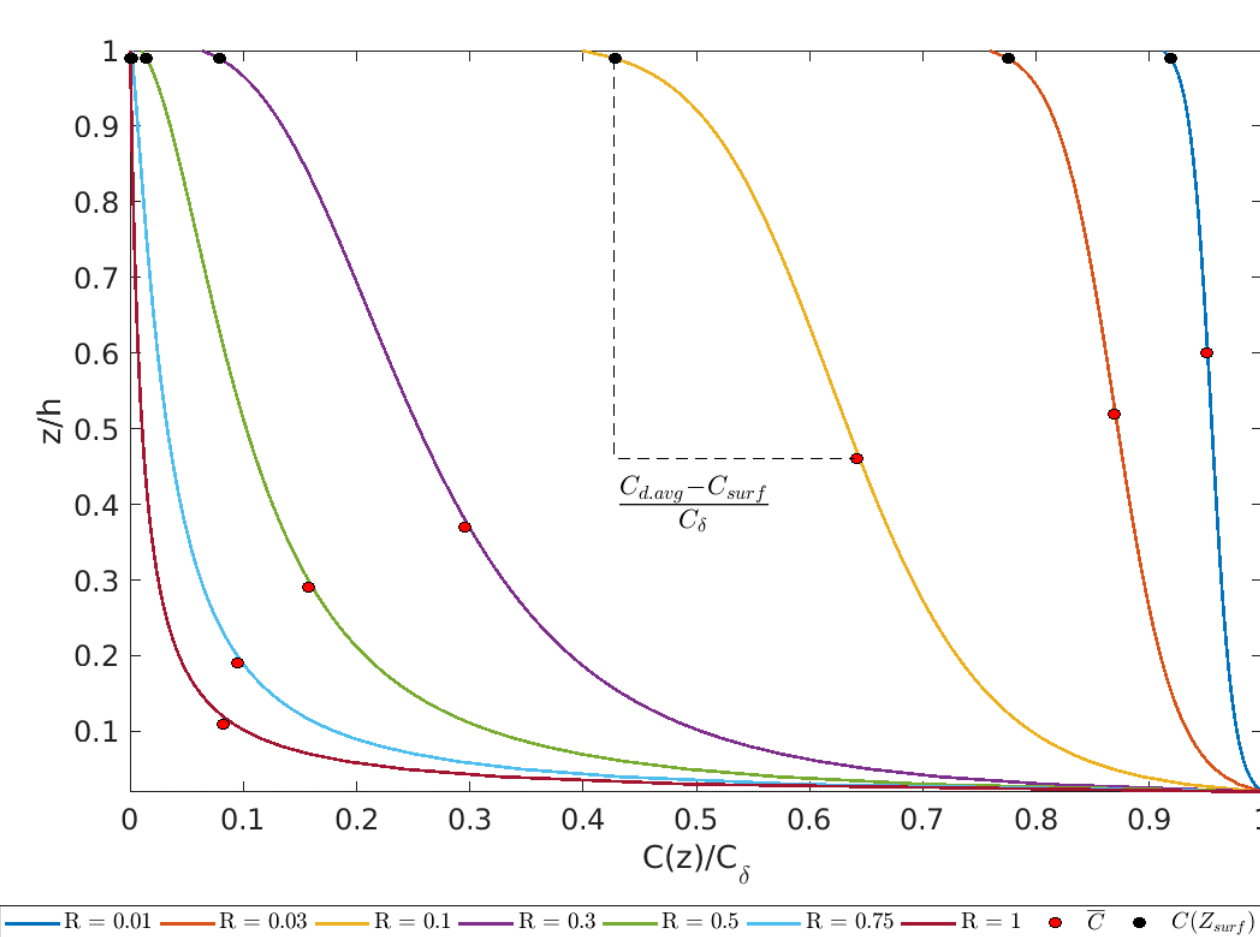

Grid of the North Sea model (NSG) , and a nested model of the Belgian Coast and the Western Scheldt (BCG). The NSG runs hydrodynamics and waves, and generates boundary conditions for the BCG which simulates hydrodynamic, waves and mixed-sediment processes.

Conversion algorithm

Depth averaged suspended sediment concentration differ considerably from near surface concentration.

To allow comparison with observed SPM an algorithm based on Rouse suspension profiles (Van den Eynde, 2018) is used for conversion.
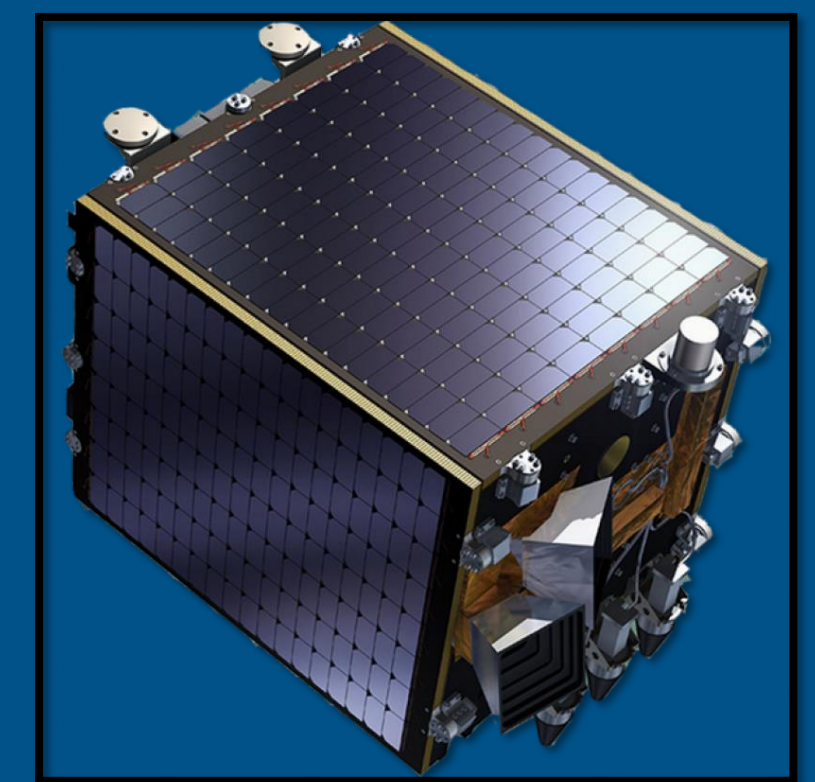

Non-dimensional concentration for multiple (Rouse) suspension profiles. The near surface concentration can be very different from the depth averaged one if the suspension is not homogeneous, thus the conversion algorithm becomes necessary. z is the elevation in the water column measured from the free surface, Z_{surf} is an elevation near the surface, h the water depth $C_{d\,avg}$ is the modelled depth averaged concentration, C_{surf} the near surface concentration, C_δ the concentration near the wall.
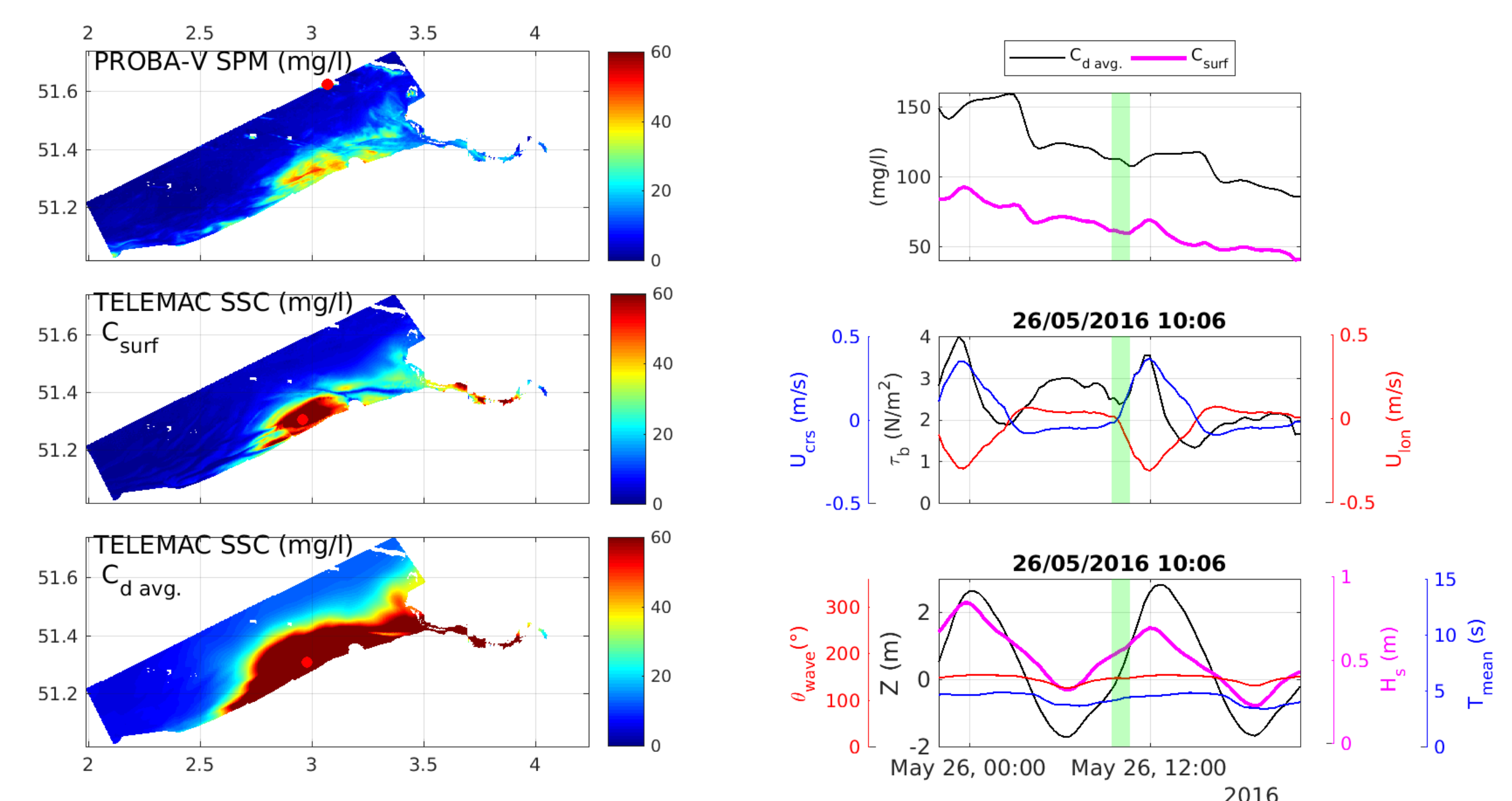
Satellite data

The PROBA-V satellite provides daily images with a resolution of 300m as well as 5-daily images with 100m resolution. Data contains 4 spectral bands: 3 in the visible range (Blue, Red and NIR) and one band in the SWIR spectral range.
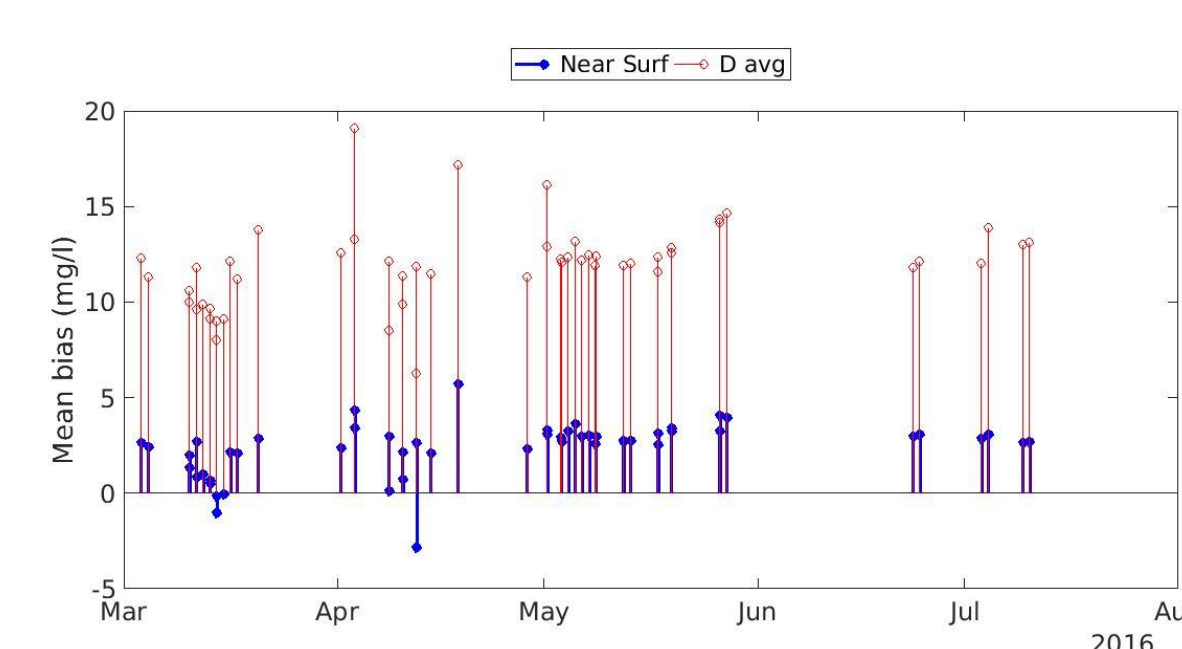

The PROBA-V satellite:
http://proba-v.vgt.vito.be/en

Results

Satellite-retrieved SPM, near-surface model SSC (C_{surf}) and depth-averaged model SSC ($C_{d\,avg}$), 26/06/2016 10:10,. U_{crs} is the cross shore velocity (perpendicular to northern boundary), U_{lon} the longshore velocity (parallel to north boundary), τ_b the bed shear stress, θ_{mean} wave the mean wave direction, Z the free surface elevation, H_s the significant wave height and T_{mean} the mean wave period. Note: The time series are taken at Zeebrugge (3° 10' 19"E - 51° 21' 15"N). NaN values in satellite image have been masked out in the model results too.

Modelled near surface suspended sediment concentrations qualitatively match observed SPM.

Total mean bias of modelled near-surface SSC and depth-averaged model SSC with respect to Satellite-retrieved SPM. The model was run for the period from 2016/03/01 to 2016/07/31, its results interpolated to a grid with the same spatial resolution of the satellite images, pixel by pixel bias was calculated and then the average is obtained. There is systematic overestimation in quantitative terms.

References

Bi, Q., Toorman, E.A., 2015. Mixed-sediment transport modelling in Scheldt estuary with a physics-based bottom friction law. Ocean Dyn. 65, 555–587.

Van den Eynde, L., 2018. Modelling of suspended matter for the Belgian coastal zone and the Scheldt estuary by means of PROBA-V remote sensing data (MSc thesis). KU Leuven. Faculty of Engineering Science.

Conclusion

The model reproduces qualitatively satellite-observed SPM concentrations.

Further work will also quantify and compare sand transport patterns.