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OSCAR MODEL DEVELOPMENT AND VERSION 15.2

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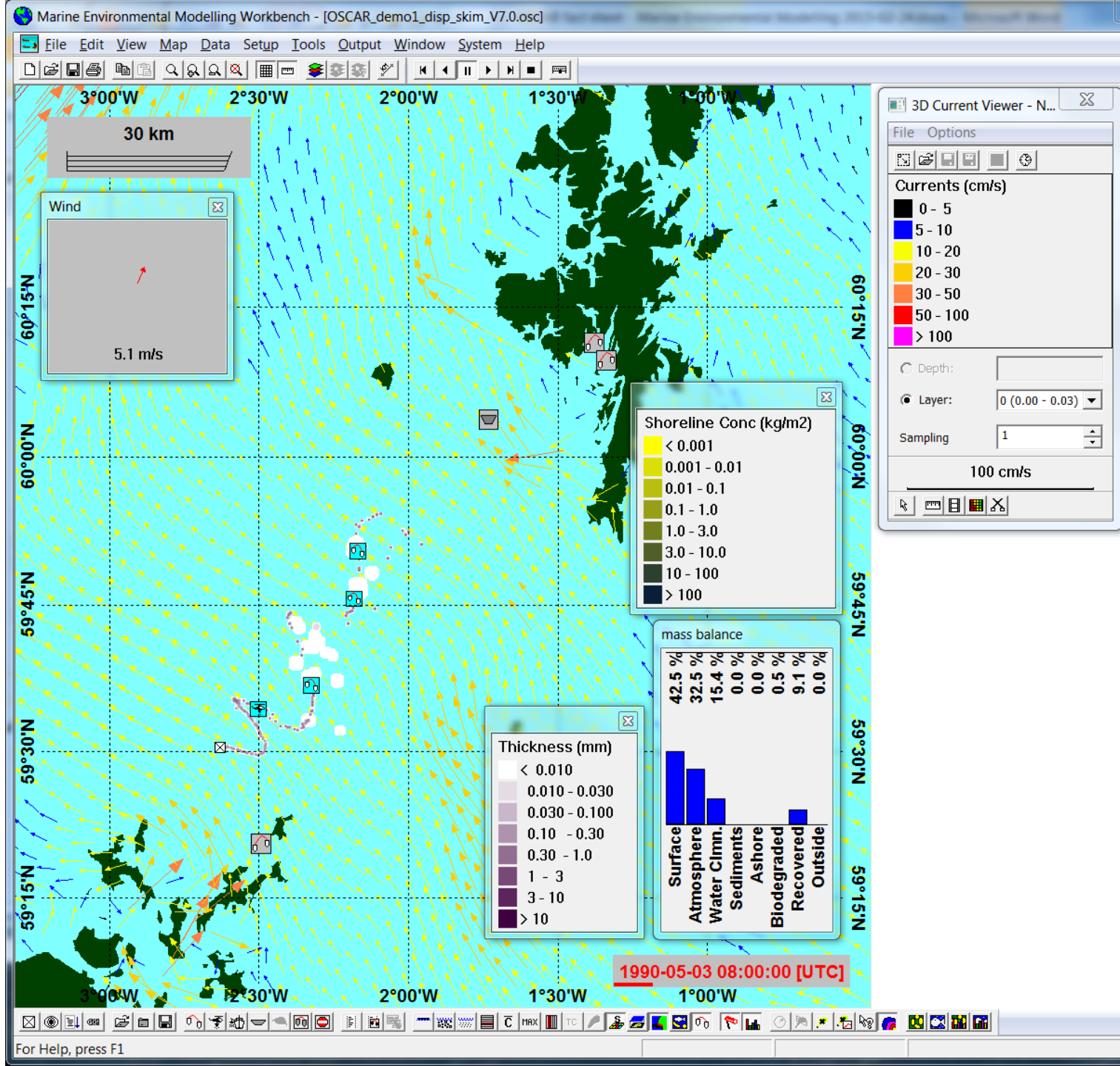
OSCAR overview

- Simulates oil spills and oil spill response
- Effects on biota possible with bioparticles
- Extensive and unique oil database
  - Oils studied experimentally at SINTEF to understand oil behavior when spilled at sea
- Covers relevant environmental compartments:
  - Surface
  - Subsurface
  - Shoreline
  - Seabed sediment
- Stochastic runs for environmental risk assessment



History and development

- Oil spill research group established at SINTEF, Trondheim in the 80s
- Mark Reed (MR) joined in the early 90s and started building OSCAR
- OSCAR has since been developed alongside experimental work at SINTEF and elsewhere
  - Subsea blowouts and associated droplet sizes
  - Droplet sizes under breaking waves
  - Ecotoxicology: exposure to fish eggs and plankton
  - Oil biodegradation in water column and sediment
- Development happens through projects, mostly with O&G companies. Equinor, Total, BP, Petrobras, Shell, AkerBP, Vår Energi, and many others.
- Maintenance made possible from a commercial license
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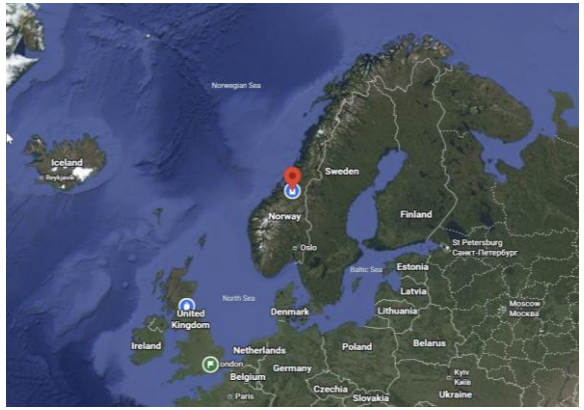

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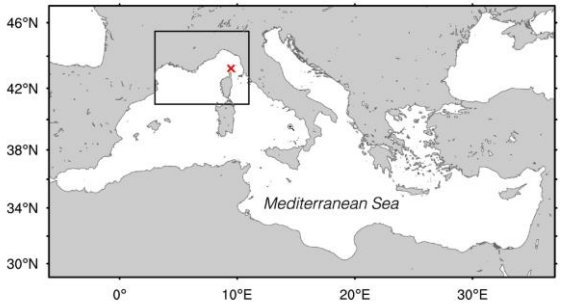
Model development and environmental risk



Ulysse-Virginia collision and oil spill, October 2018. Image by APF.
Map from Liubartseva et al. 2020

- OSCAR is continuously developed and improved based on best available knowledge
  - Lab studies
  - Field experiments
  - Large accidental oil spills
- When simulating the Ulysse-Virginia oil spill, OSCAR simulated too much dispersion of the high viscosity oil.
- OSCAR version 13 (2021) introduced changes to balance this, leading to more oil on the surface.
- Versions 13 and 14 were not used for risk assessment in Norway due to errors in another model component
- Version 15 (2025) is now in use, and shows a general increase in risk on sea surface and shorelines

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How to tell if a new version is better?

- In light of the increased risk, it was considered necessary with a deeper evaluation
- Offshore Norge funded a comparison study between versions 11 and 15
- The following cases were compared:
  - The Braer oil spill (Shetland, 1993) ~ 85.000 tonnes Gullfaks crude
  - The Statfjord 2007 oil spill ~ 4500 m^3 Statfjord A oil
  - Ulysse-Virginia oil spill (2018) ~ 500 m^3 bunker fuel oil
  - Deepwater Horizon (2010) ~ 9000 m^3/day for 84 days
  - Lab studies: droplet size measurements from Johansen et al. (2015) and Li et al. (2017)
- Conclusion: v. 15 was better compared to Ulysse-Virginia, but had a regression in direct comparison with lab studies and Braer case.

Version 15.2

- To address the regressions, version 15.2 was developed and released
- 15.2 was made available for testing in January 2025
- Next slides show results from comparison study of model versions and the conclusion from the report

Fixed regression against lab experiments

- Note: lab experiments are performed under limiting conditions.
- Droplet size measurements from OPV 2025 enable comparison against field-measured droplet sizes (Mostaani et al. 2026)

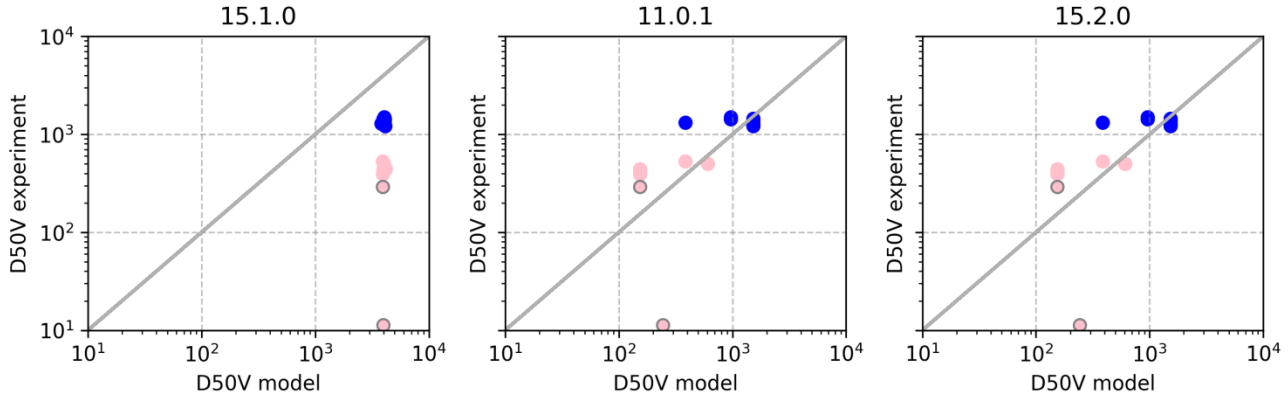

Figure A.1: Median droplet sizes from experiments compared to median droplet sizes from the droplet size models. Data points in blue are from [1], and data points in pink are from [2]. Data points from oil treated with dispersant are shown with gray edge color.

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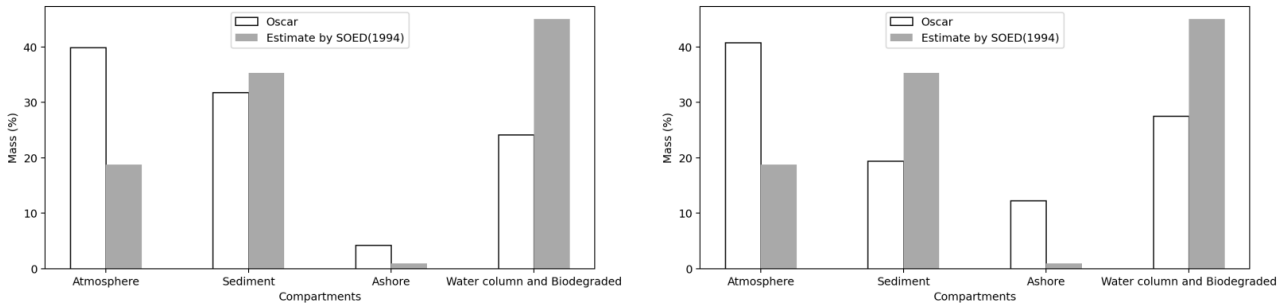
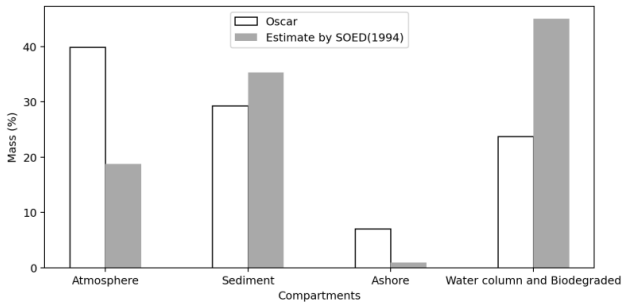
Fixed regression against Braer



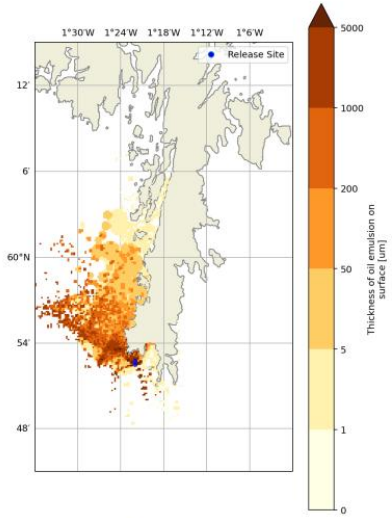
(a) Version 11.0.1

(b) Version 15.1.1

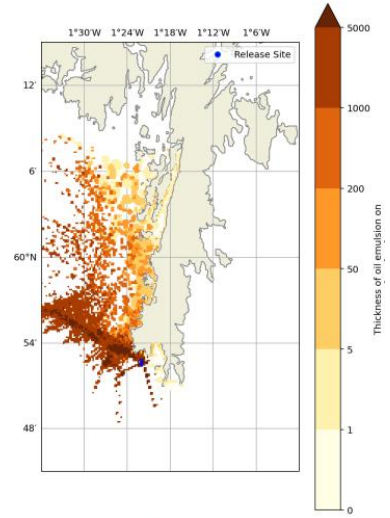


(c) Version 15.2.0

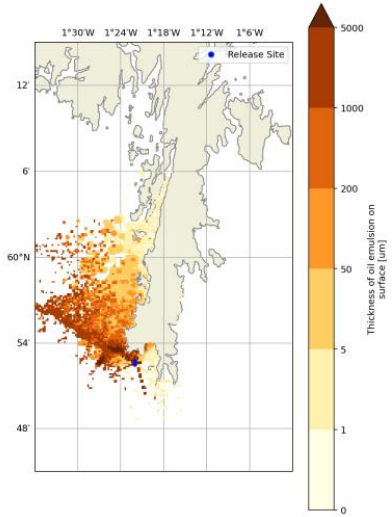
Figure A.9: Mass balance at end of simulation (20 days) compared with with reported data



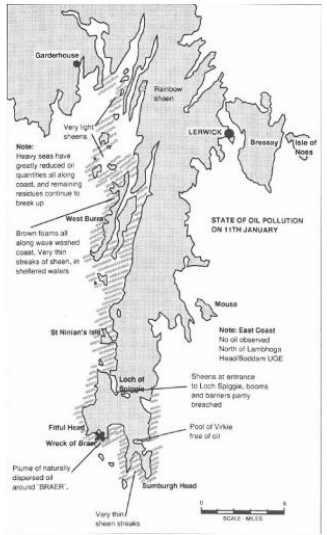
(a) Version 11.0.1



(b) Version 15.1.1



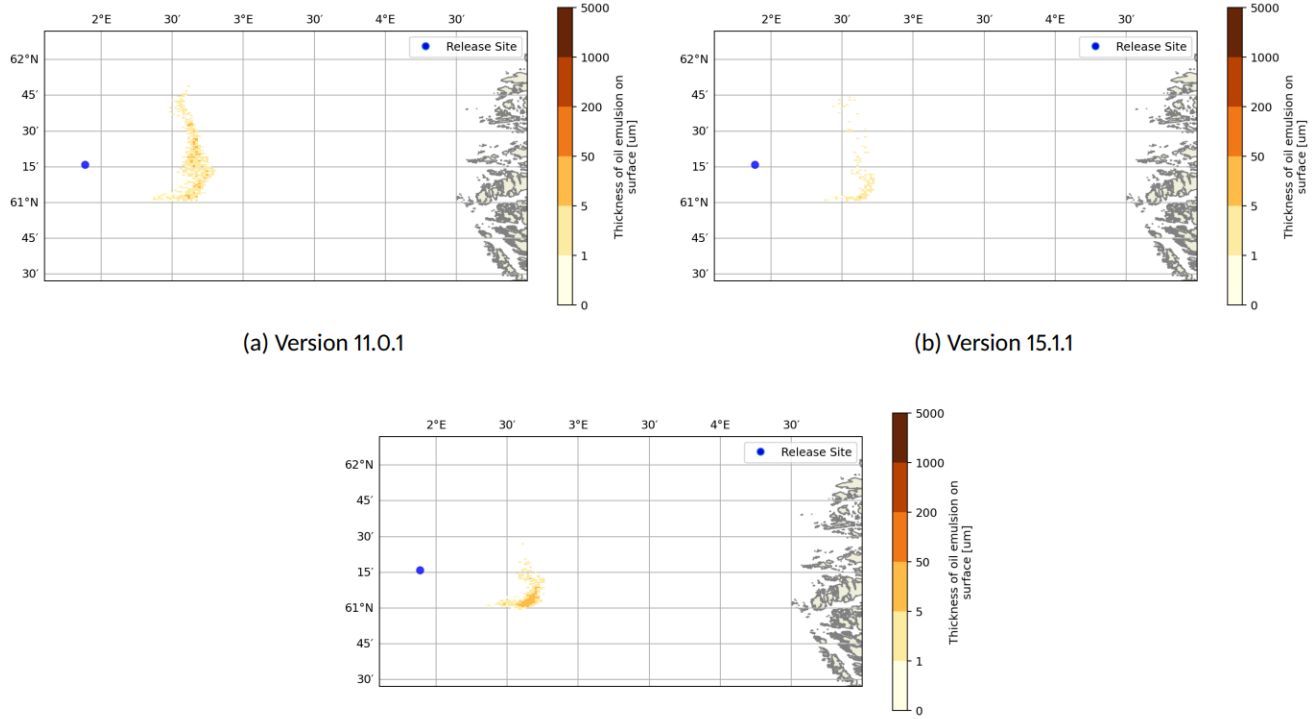
(c) Version 15.2.0



(d) Observation

Figure A.7: Model comparison with observation 6 day after start of spill

Statfjord: similar mass balance, possibly more accurate transport with 15.2

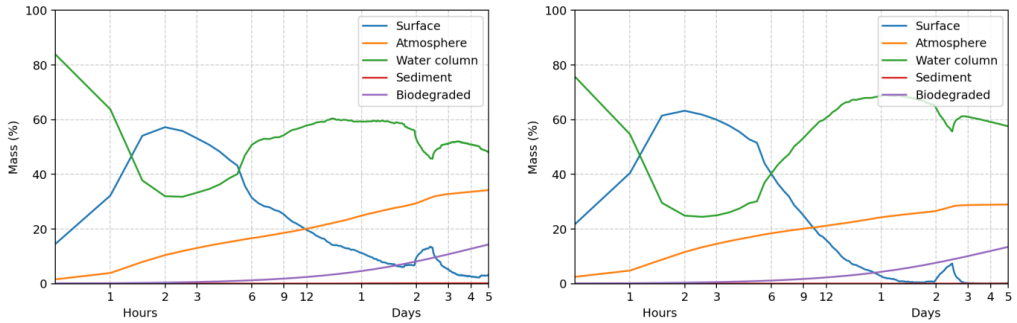


(a) Version 11.0.1

(b) Version 15.1.1

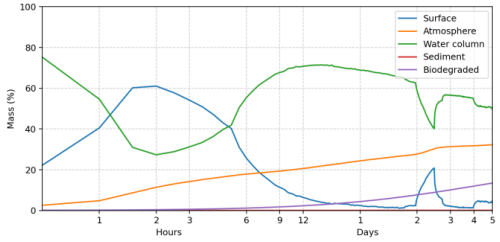
(c) Version 15.2.0

Figure A.13: Surface oil thickness 2 days after release



(a) Version 11.0.1

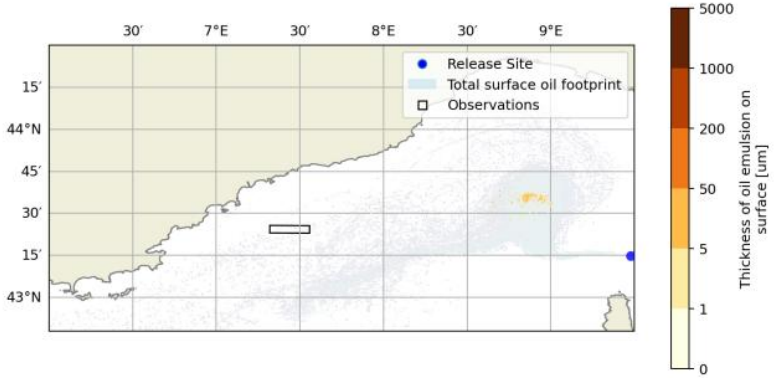
(b) Version 15.1.1



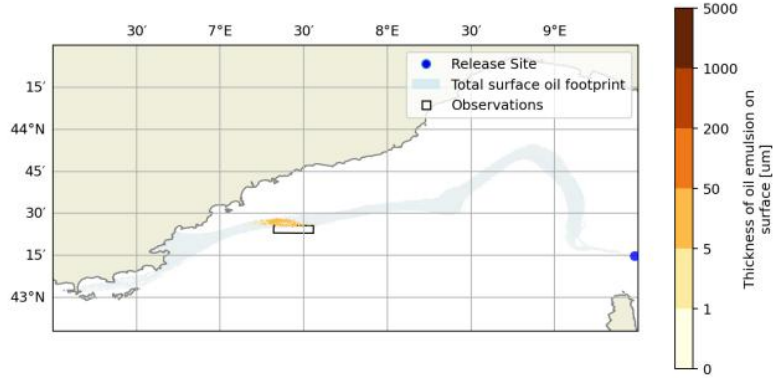
(c) Version 15.2.0

Figure A.15: Mass balance comparison between model versions

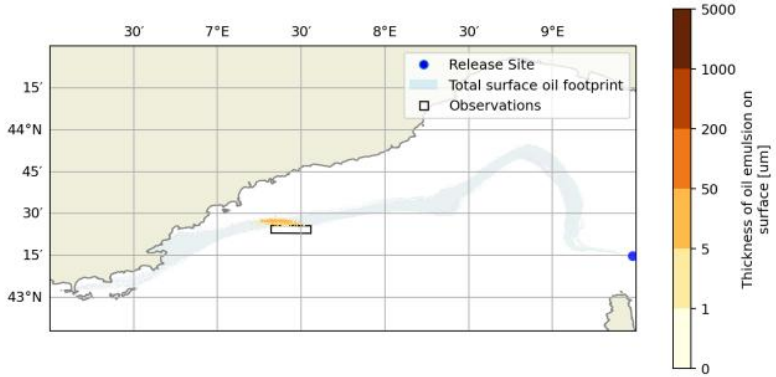
Ulysse-Virginia: Maintains improved transport



(a) Version 11.0.1



(b) Version 15.1.1 with 15° wind deflection



(c) Version 15.2.0 with 15° wind deflection

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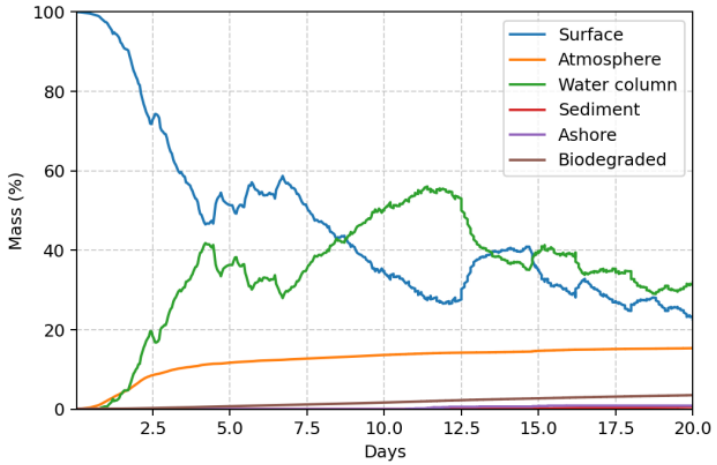
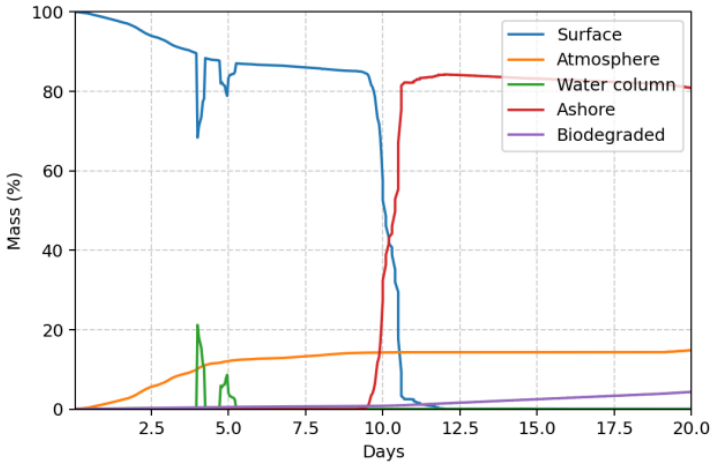
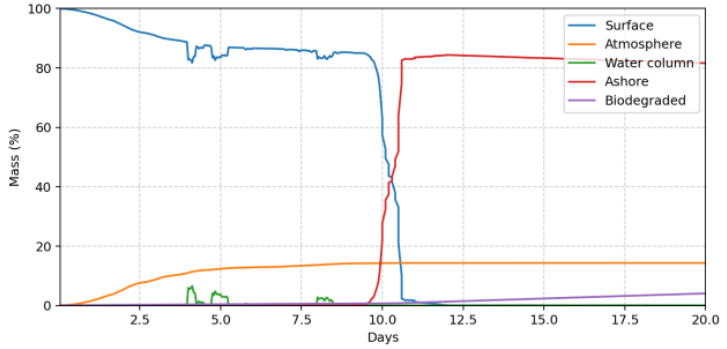
Ulysse-Virgina: Maintains improved mass balance



(a) Version 11.0.1



(b) Version 15.1.1 with 15° wind deflection



(c) Version 15.2.0 with 15° wind deflection

Figure A.21: Mass balance comparison between model versions

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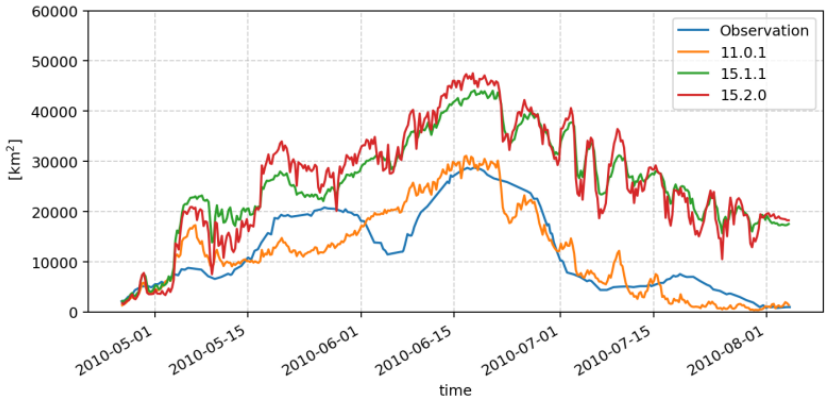
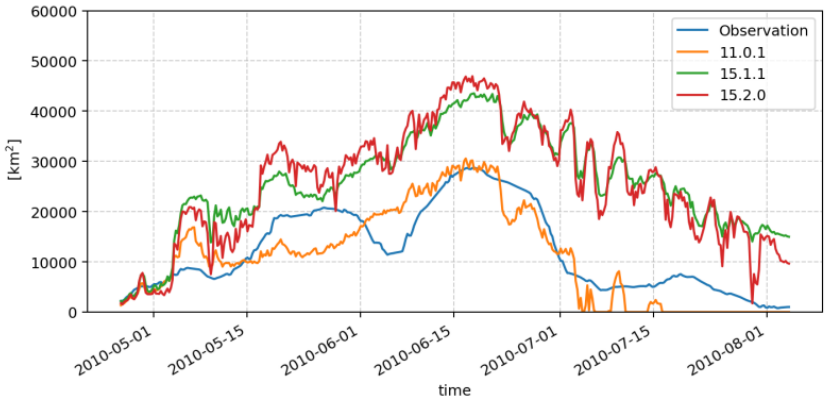
Deepwater Horizon: Hard to conclude due to lacking oil spill response simulation



(a) No removed oil mass



(b) Up to 1% oil mass removed

(c) Up to 3% oil mass removed

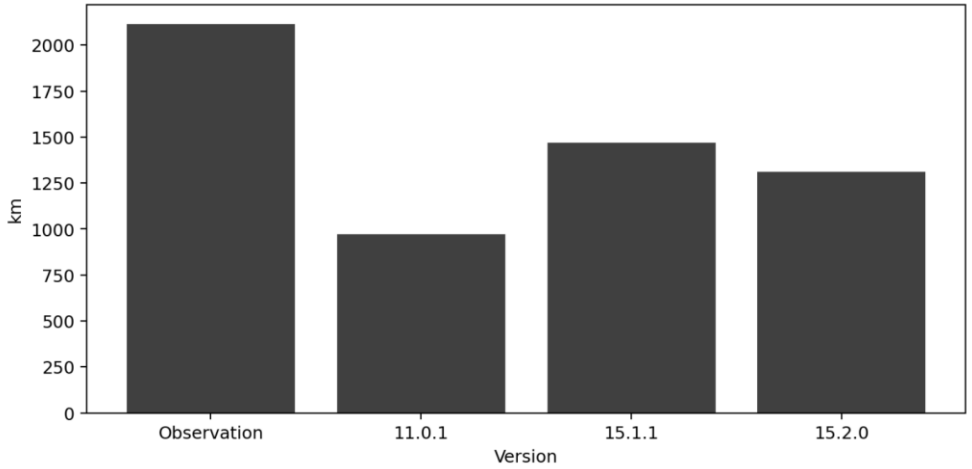


Figure A.24: Comparison of oiled shoreline against observation

Summary of comparison with known spills

- **Braer**: 15.2 gives same simulation as in 11, in particular against the observation that oil was gone after 20 days
- **Statfjord**: all versions give similar result against observation that oil was gone after 2 days, returned between 2 and 3 days, and was not observed more after 3 days
- **Ulysse-Virginia**: 15 much more accurate than 11
- **Deepwater Horizon**: Difficult to assess. Version 11 may remove too much oil from the surface since it matches observed surface area even without oil spill response

Conclusion

- Version 15.2 gives an improved comparison against observations compared to 11
- The four spill scenarios have been used to evaluate model performance during development
- There is a need to compare with more historical spills and field trials to keep increasing model performance

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