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Helmholtz-Zentrum Geesthacht
Centre for Materials and Coastal Research

Sea-state contribution to sea-level variability in the European Seas

A. Bonaduce[*,1], J. Staneva[1], S. Grayek[1], J-R Bidlot[2], Ø. Breivik[3]

[*] Nansen Environmental and Remote Sensing Center (NERSC) and Bjerknes Center for Climate Research, Norway
[1] Helmholtz-Zentrum Geesthacht (HZG), Germany
[2] European Centre for Medium-range Weather Forecasts (ECMWF), UK
[3] Norwegian Meteorological Institute and University of Bergen, Norway

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UNIVERSITY OF BERGEN

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Outline

- **Experimental Set-up**
  GCOAST system: ocean-wave coupled experiments
- **Signature of wave-induced processes**
  sea-state leading contributions focusing on surge extremes
- **Key messages**

Reference
Bonaduce, A., Staneva, J., Grayek, S., Bidlot, J.R., Breivik, Ø. *Sea-state contributions to sea-level variability in the European Seas.* Ocean Dynamics (2020). https://doi.org/10.1007/s10236-020-01404-1

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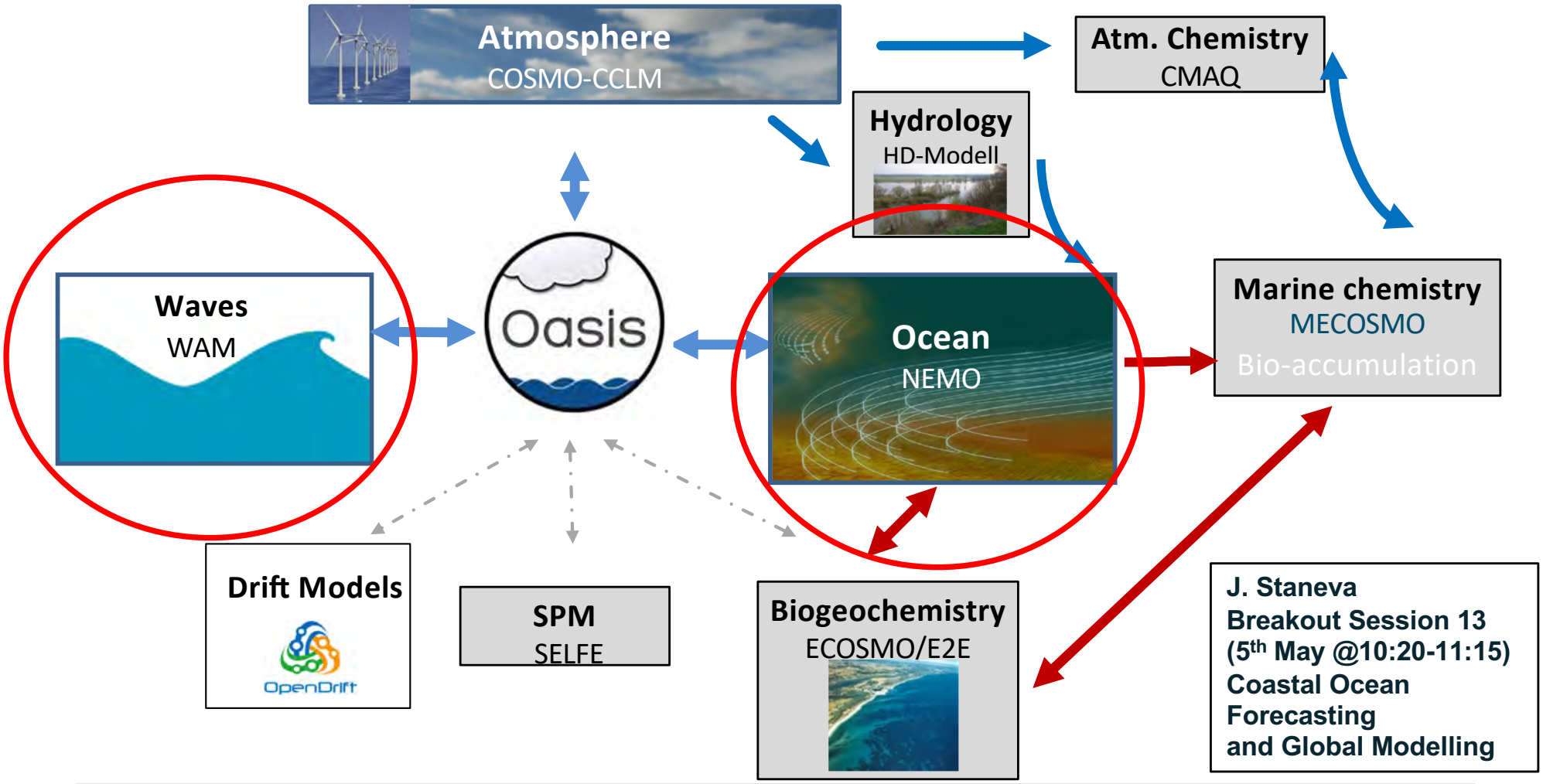
GCOAST Model system



Wave-induced forcing

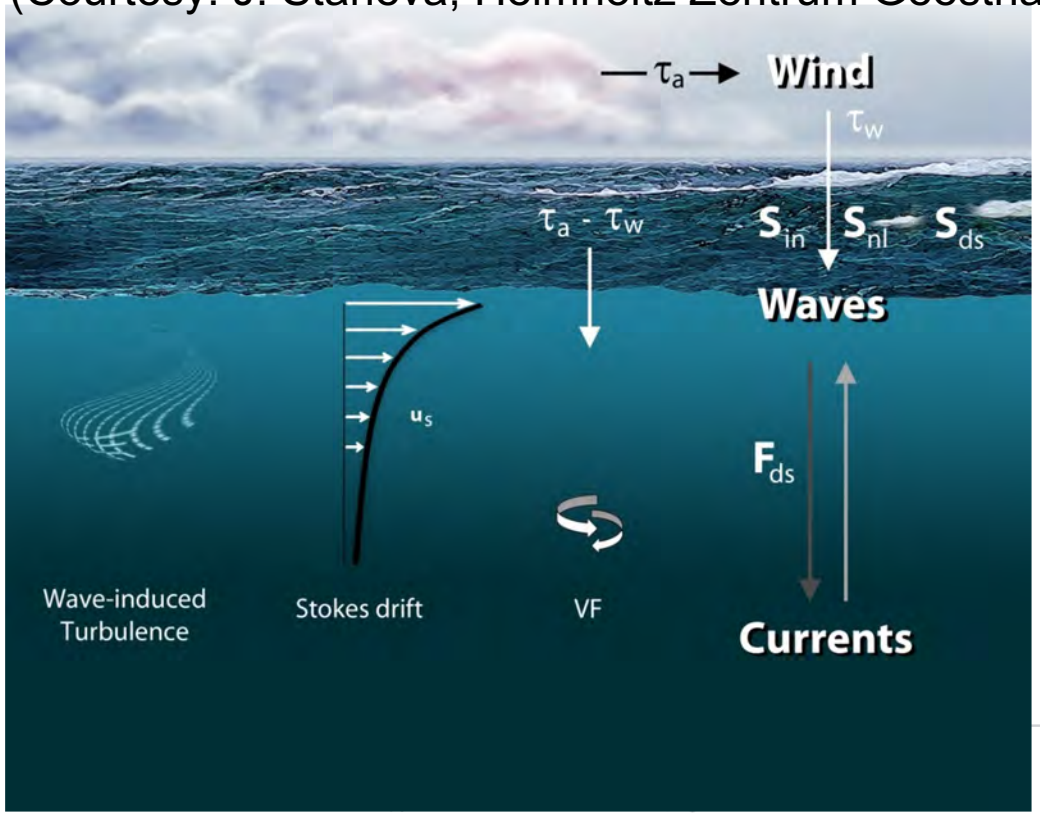
The ocean model takes into account the following **wave effects**

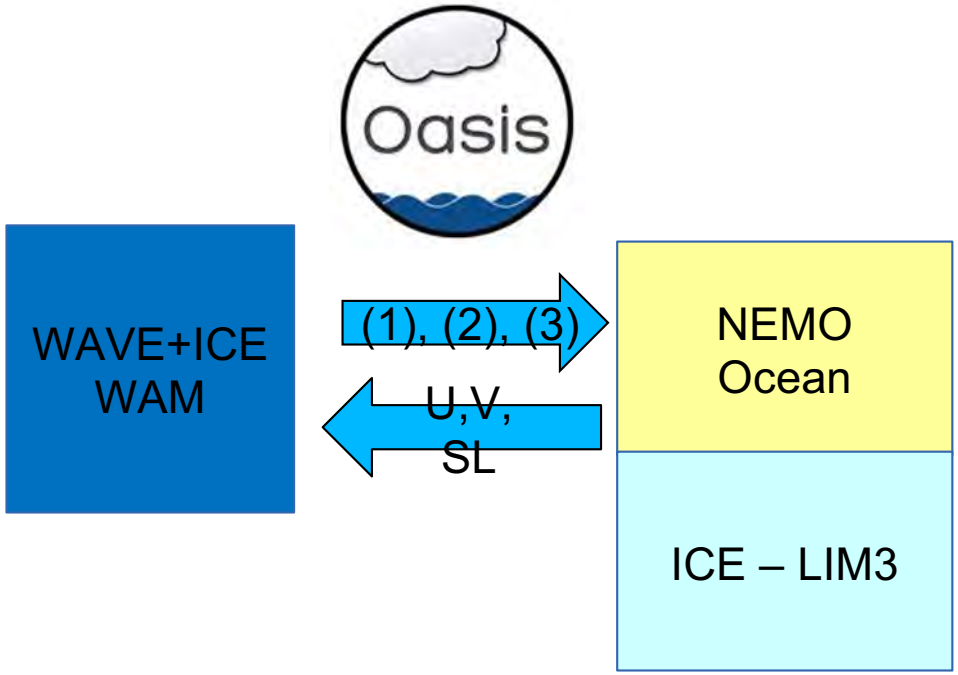
(1) **The Stokes-Coriolis forcing** (STOC; additional contribution to currents)

(2) **Sea state dependent momentum flux** (TAUOV; wave-modified drag coefficient)

(3) **Sea state dependent energy flux** (PHIOC; additional turbulent kinetic energy due to breaking waves)

(Courtesy: J. Staneva, Helmholtz Zentrum Geesthacht)





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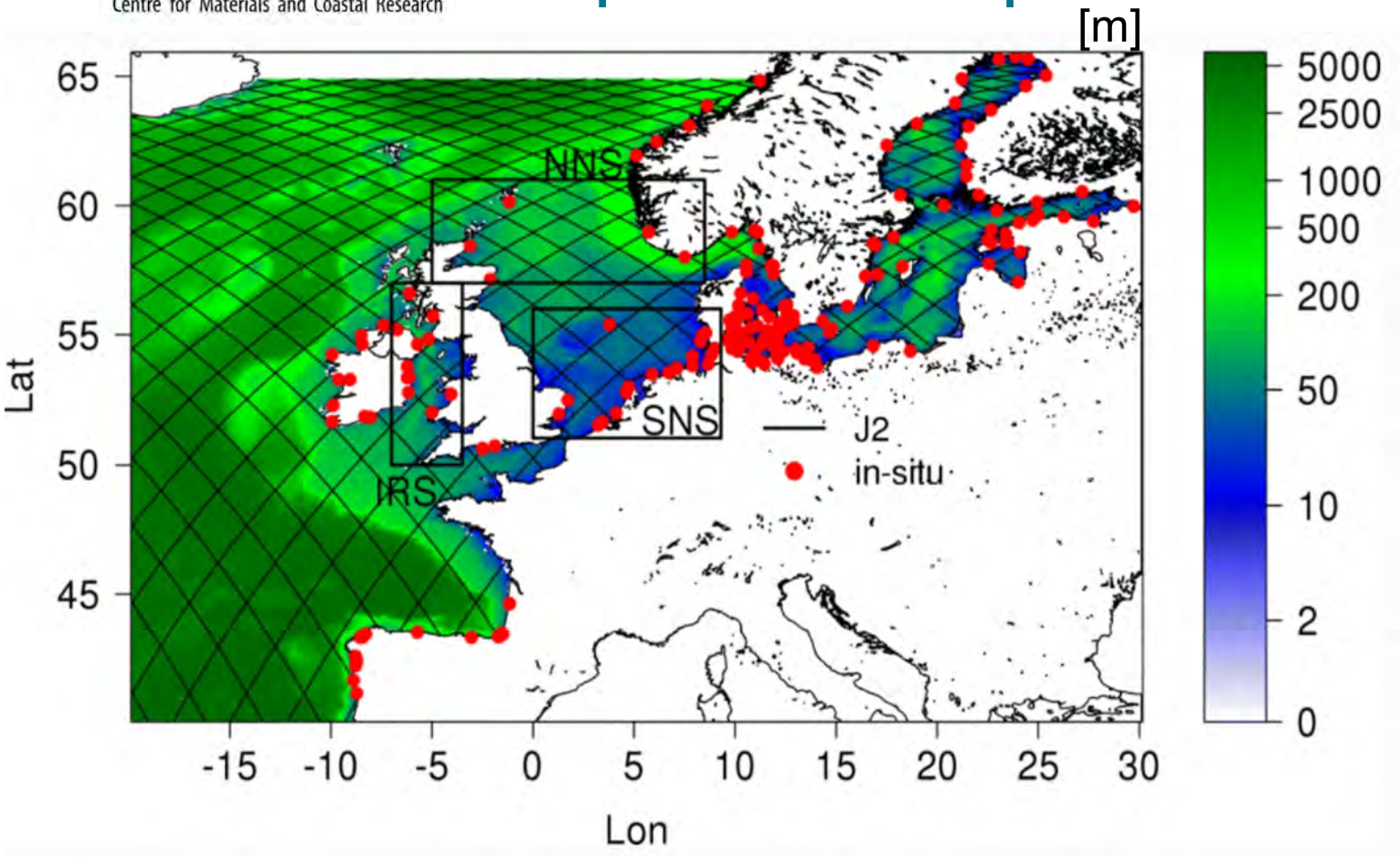
Experimental Set-up



horizontal res.:
3.5 km

- **in-situ**
  CMEMS INS-TAC
- **remote sensing**
  CMEMS – TAPAS
- **sub-regions**
  - SNS
  - NNS
  - IRS

	Time-window	ATM	BDC	WIPs
EXP0	2010–2018	ERA5 (Hersbach et al. 2020)	AMM7 (O'Dea et al. 2012)	
EXP1	2010–2018			ALL
EXP2	2013			STOC+TAUOV
EXP3	2013			STOC+PHIOC

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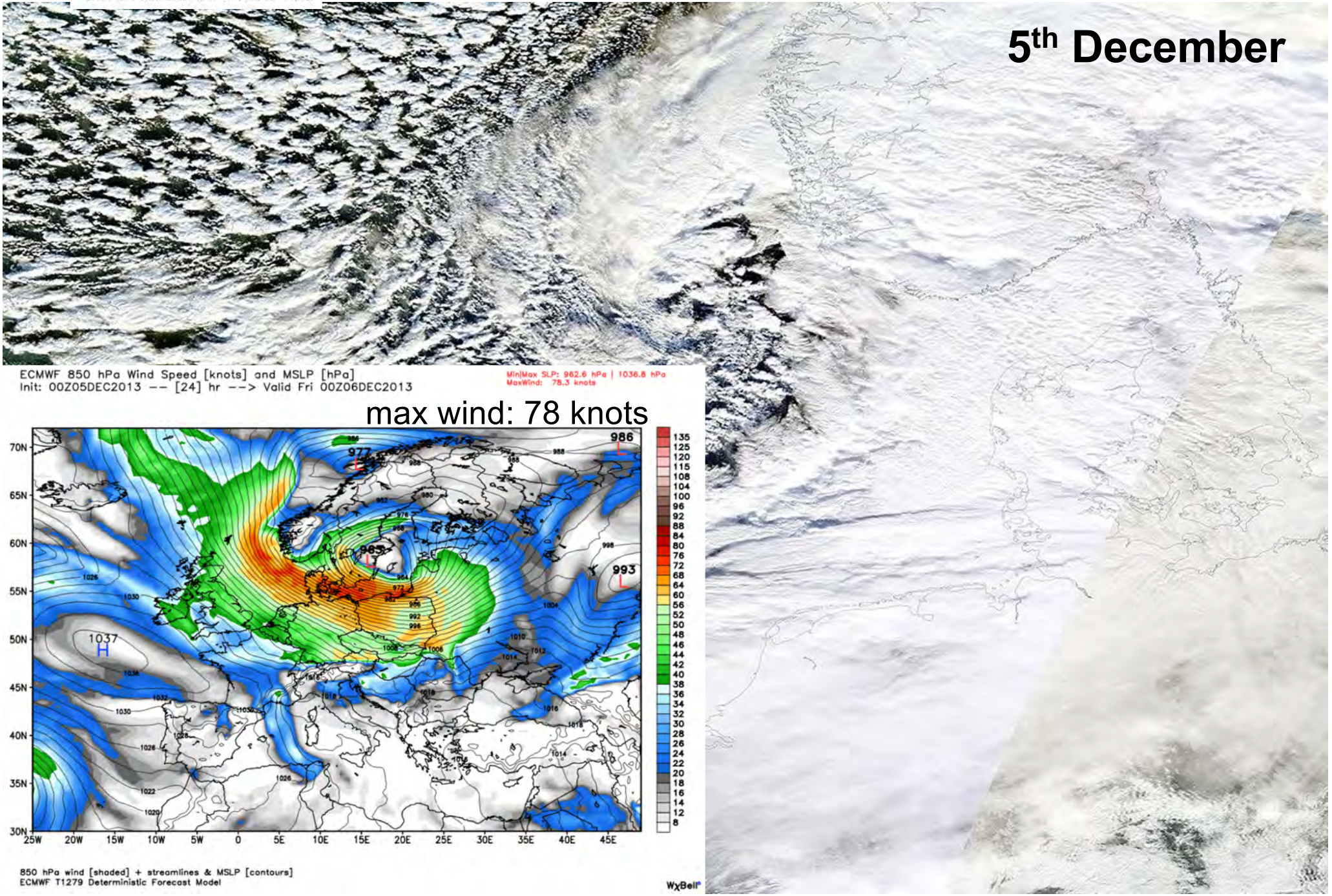
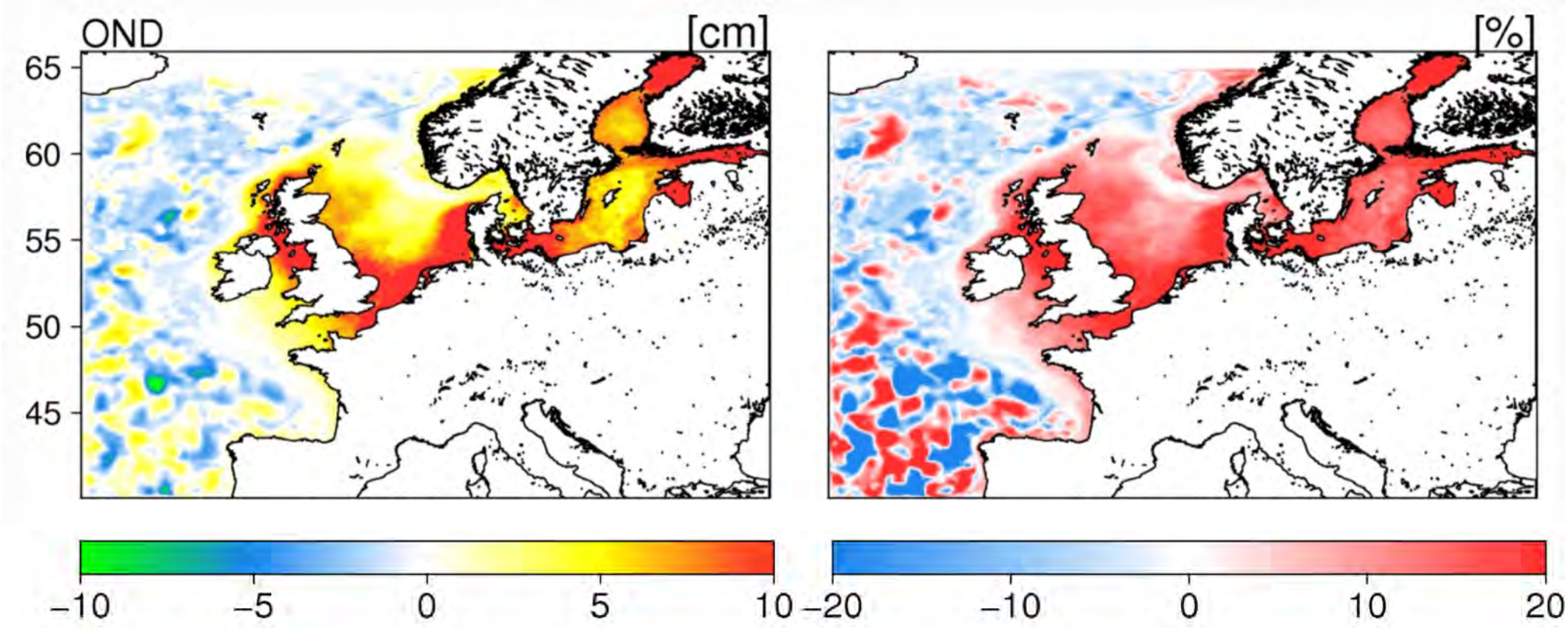
Xaver Storm: 4th – 6th December 2013

5th December



Surge Differences in 2013

95th percentile **surge difference between EXP1 and the reference** experiment



The different **patterns observed over the shelves and in the Atlantic** can be explained by looking at the **leading contributions of wave-induced processes.**

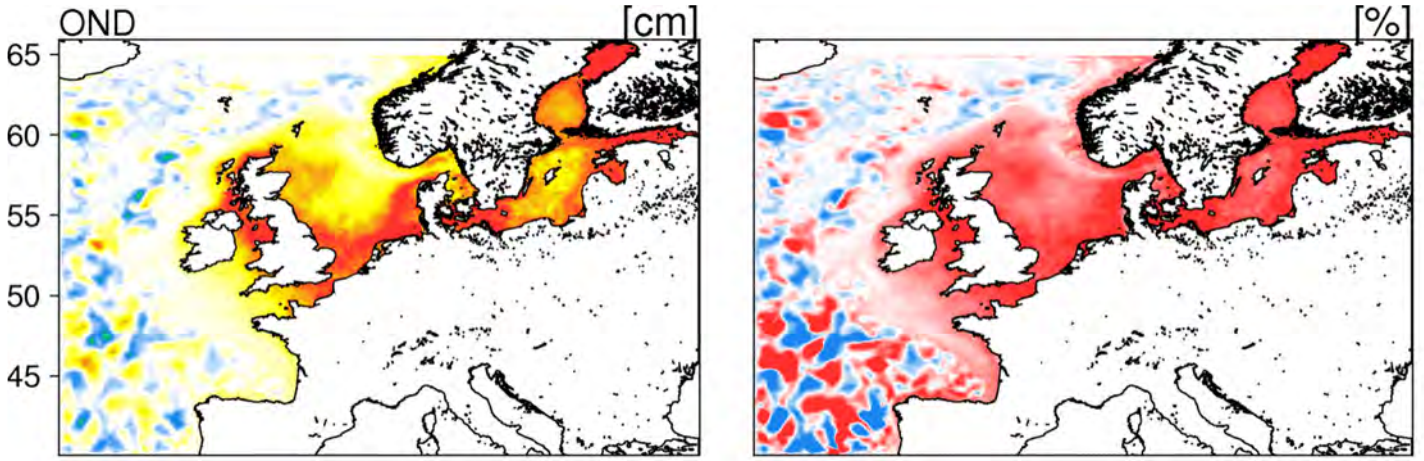
→ **Sensitivity**

Sensitivity to wave-induced processes (2013)

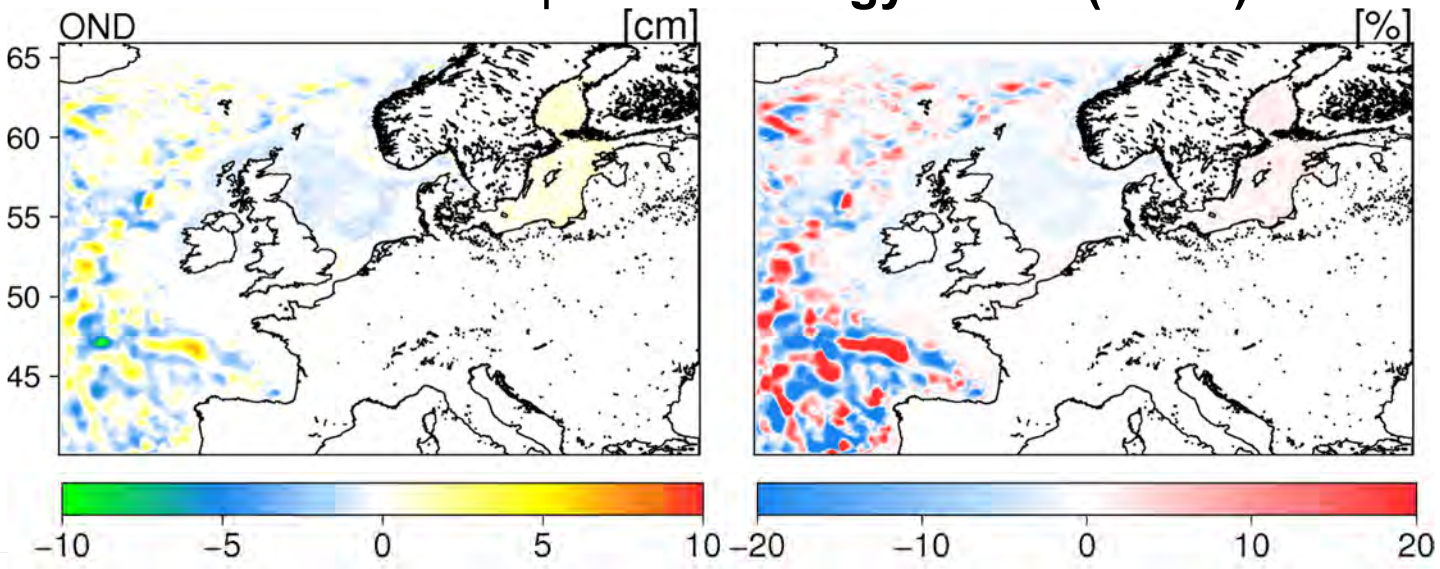
Sea-state dependent **momentum fluxes** have a major contribution in the **shelf areas.**

In the **open ocean** the interaction of **wave-modified surface stress and vertical mixing,** plays a major role.

Sea-state dependent **momentum fluxes (EXP2)**



Sea-state dependent **energy fluxes (EXP3)**



Key messages

- Wave-induced processes (**WIPs**) **significantly contribute surge variability**
- **Wave modified momentum flux** has a major contribution (~20%) over the **shelf areas**
- **Wave-modified mixing** plays a role (>10%) at the **shelf break** (e.g. Bay of Biscay).
- In the **open ocean**, the spatial patterns observed in the North Atlantic Drift and in the Bay of Biscay are driven by **the interaction of wave-modified surface stress and vertical mixing**
- In the future: **sea-state contributions** to sea-level variations and trends **over a multi-decadal temporal,** looking at **regional domains** and **global ocean**

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Thank you!

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