Institute of Coastal Research
Research Unit Operational Systems

RU 3 Helmholtz-Zentrum Geesthacht
Centre for Materials and Coastal Research

Are we prepared for future extremes? The 2013 Elbe flood

Dr. Yoana G. Voynova

Elbe River Estuary (ESA)

Change in Heavy Precipitation

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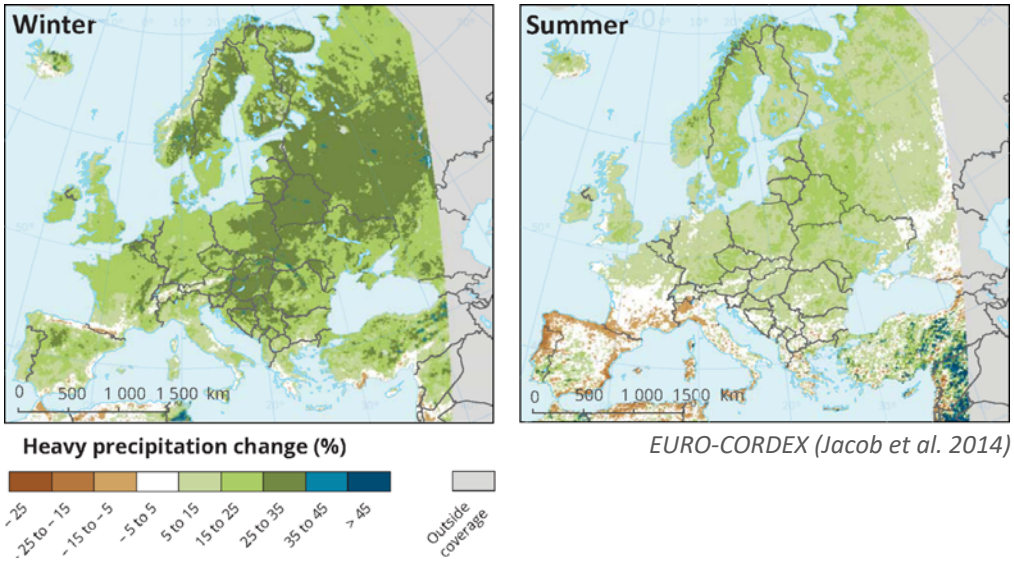

EURO-CORDEX (Jacob et al. 2014)

- Heavy precipitation and extreme floods will significantly increase by 2100
  (IPCC, 2014; Hirabayashi et al. 2013; Aflieri et al. 2015)

The 2013 Extreme Flood

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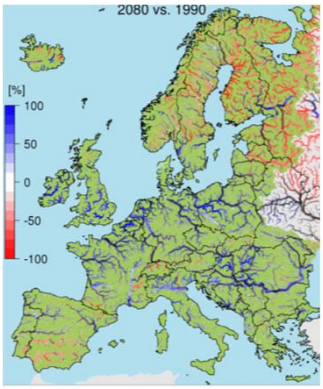
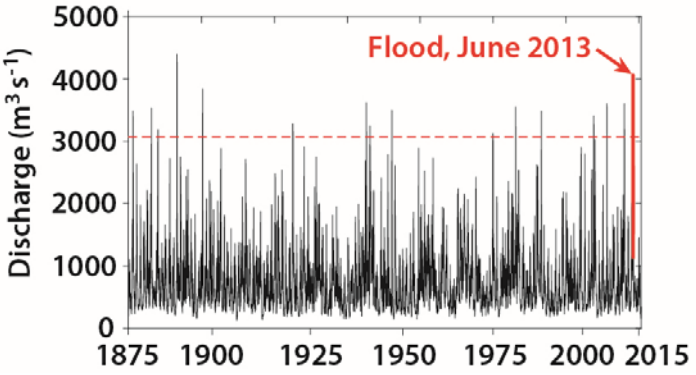


Aflieri et al. 2015; EEA, 2015



Voynova et al. 2017

- June 2013 flood was highest summer discharge in 140 years
- 20-60% of the major floods took place in the last 15 years

Nutrient Loading to the Coast

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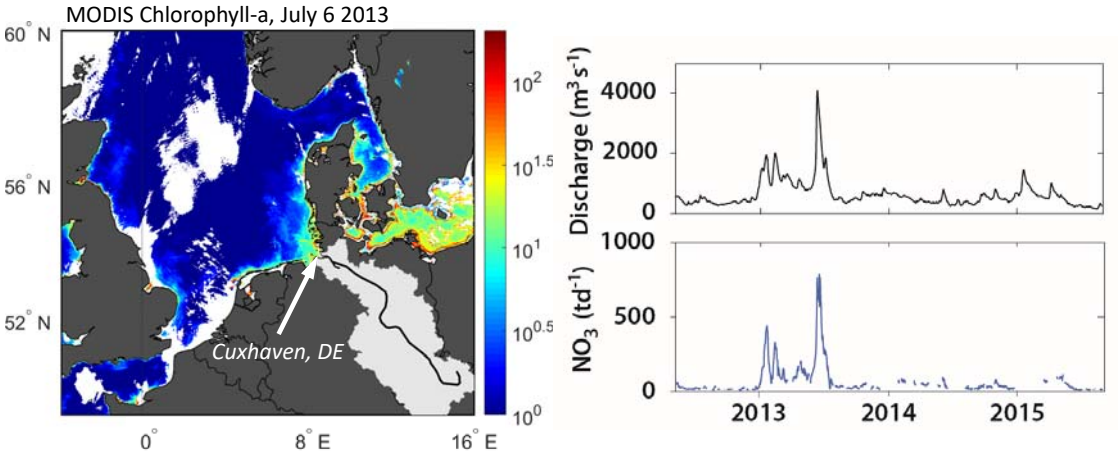

- North Sea: shallow shelf sea
  thermally stratified and nutrient limited in summer
- Flood increased nutrient loads from Elbe 5-50 fold (NO_3^-+ NO_2^-, NH_4^+, PO_4^{3-}, Si)

Impact on the Coast

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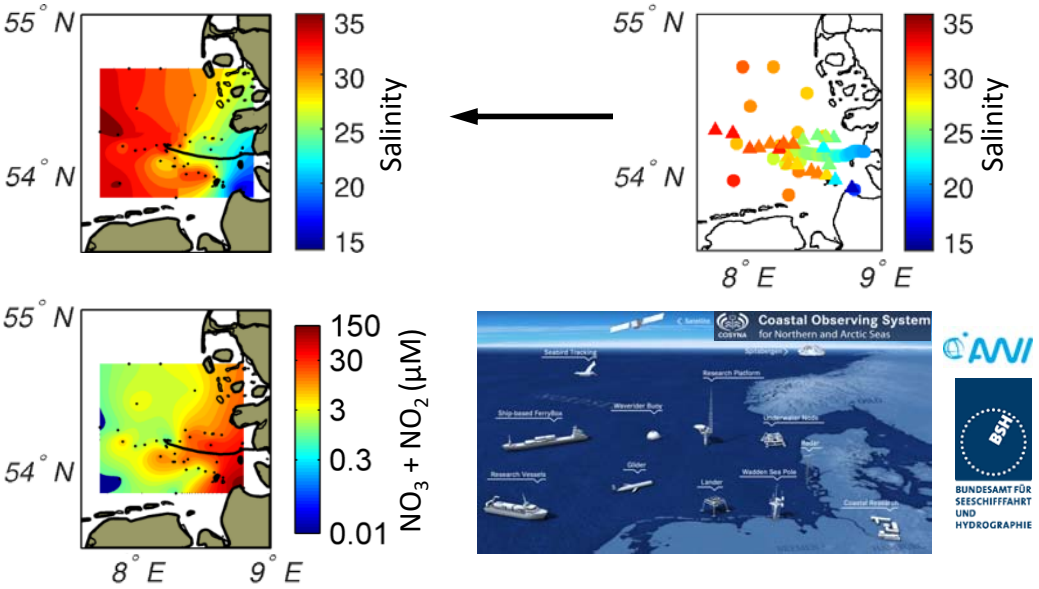

- Injection of low-salinity, nutrient-rich water into surface mixed layer

Impact on the Coast

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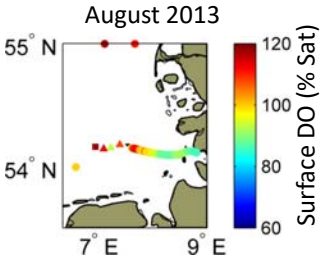
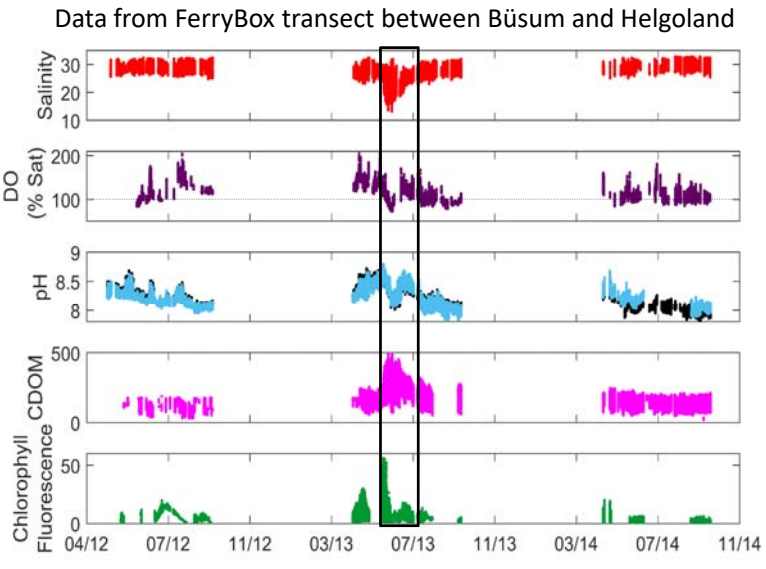


3-4 days:

- Salinity < 15
- DO < 100 %
- low pH, high DOM

1-2 months:

- depressed salinity
- coastal bloom
- high pH, DO > 100%



Impact on Stratification and Bottom Oxygen Depletion

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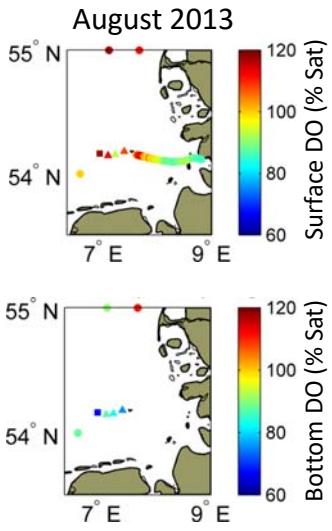
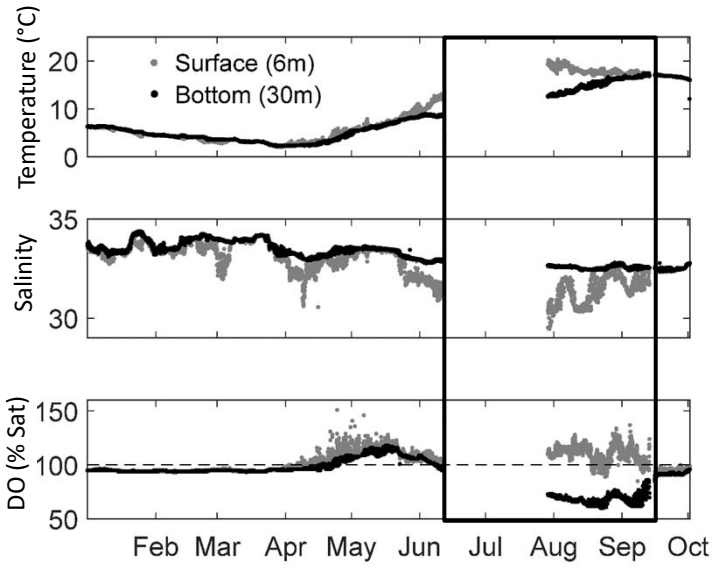


↓ DO in bottom mixed layer



Outlook: Modeling Extreme Floods

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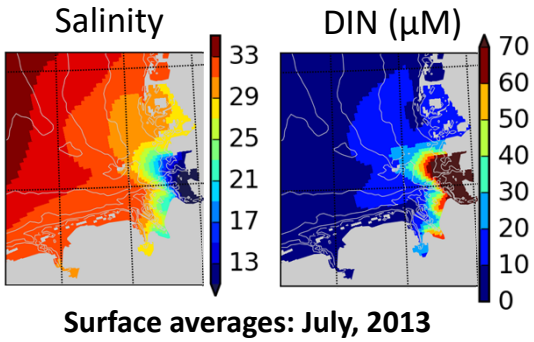


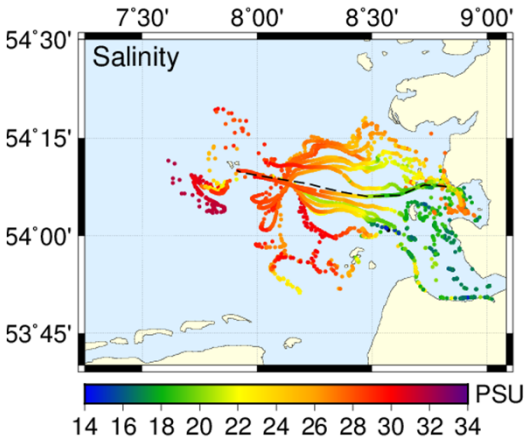
Surface averages: July, 2013

Kerimoglu et al. in prep

Challenges

- Can a biogeochemical model (**RU1**) capture an extreme flood?
- Could extreme floods induce hypoxia on the coast?

Synoptic plot: June 15, 2013



Callies et al. in prep

- Inferring 2D spatial fields (**RU2**) from 1D observations

Summary and Outlook

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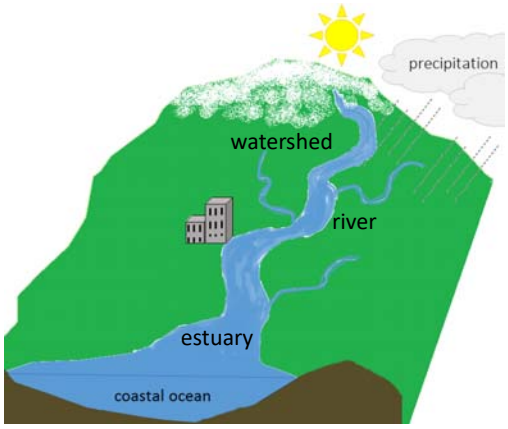
Extreme floods

- increase in frequency (already observed)
- can alter nutrient and carbon loads, coastal cycling
- can enhance water column stratification and bottom water oxygen depletion



Outlook

- predict and follow extreme floods
  Watershed → River → Estuary → Coast

DANUBIUS-RI

MOSES

- quantify short-term (1-2 months) and long-term (> 1 season) impacts on coastal carbon and nutrient cycles