Integrated Earth System Modeling for the Baltic Sea Region

Baltic Earth
Earth System Science for the Baltic Sea Region

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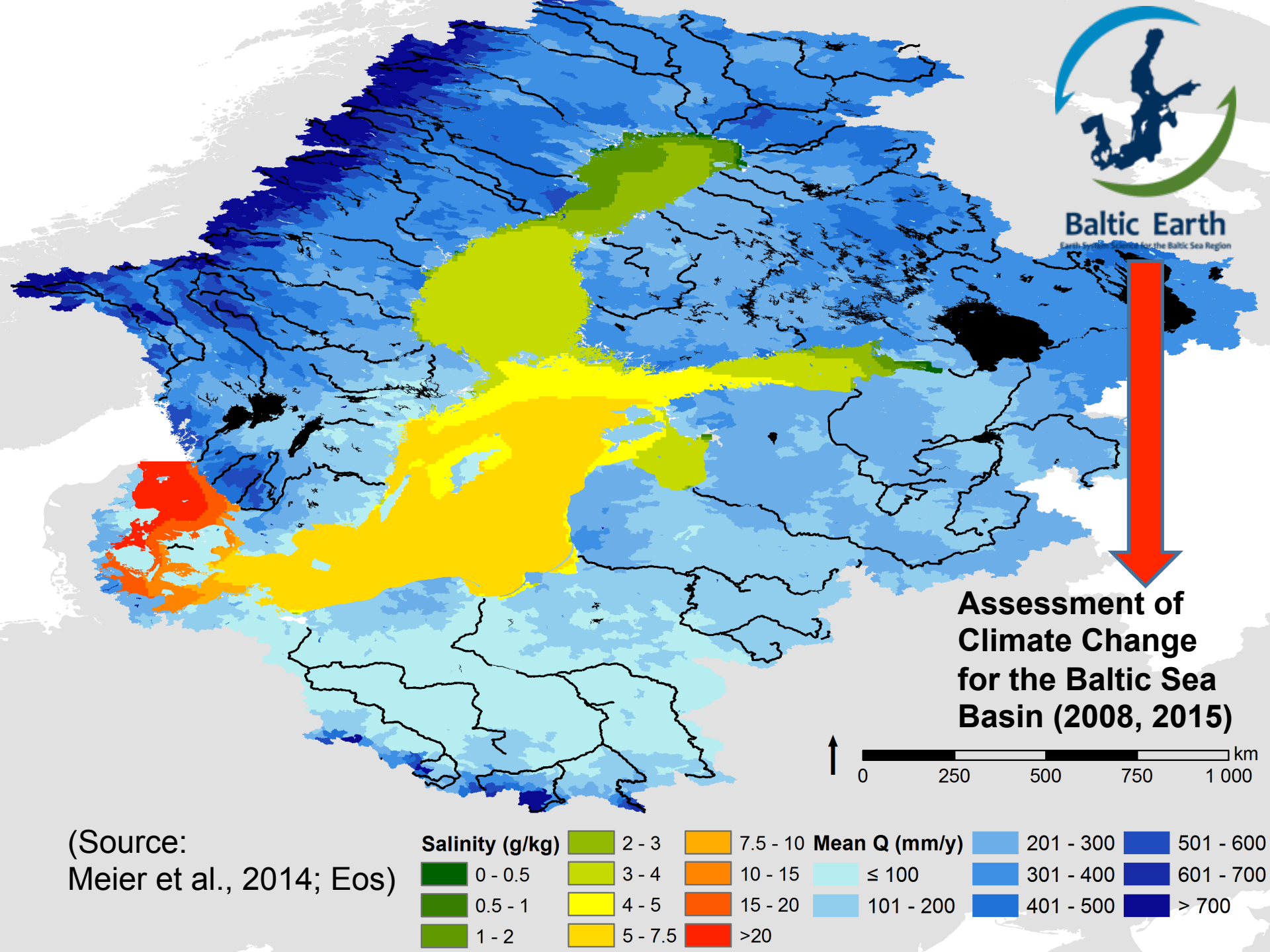

(Source:
Meier et al., 2014; Eos)

Earth System Science for the Baltic Sea region

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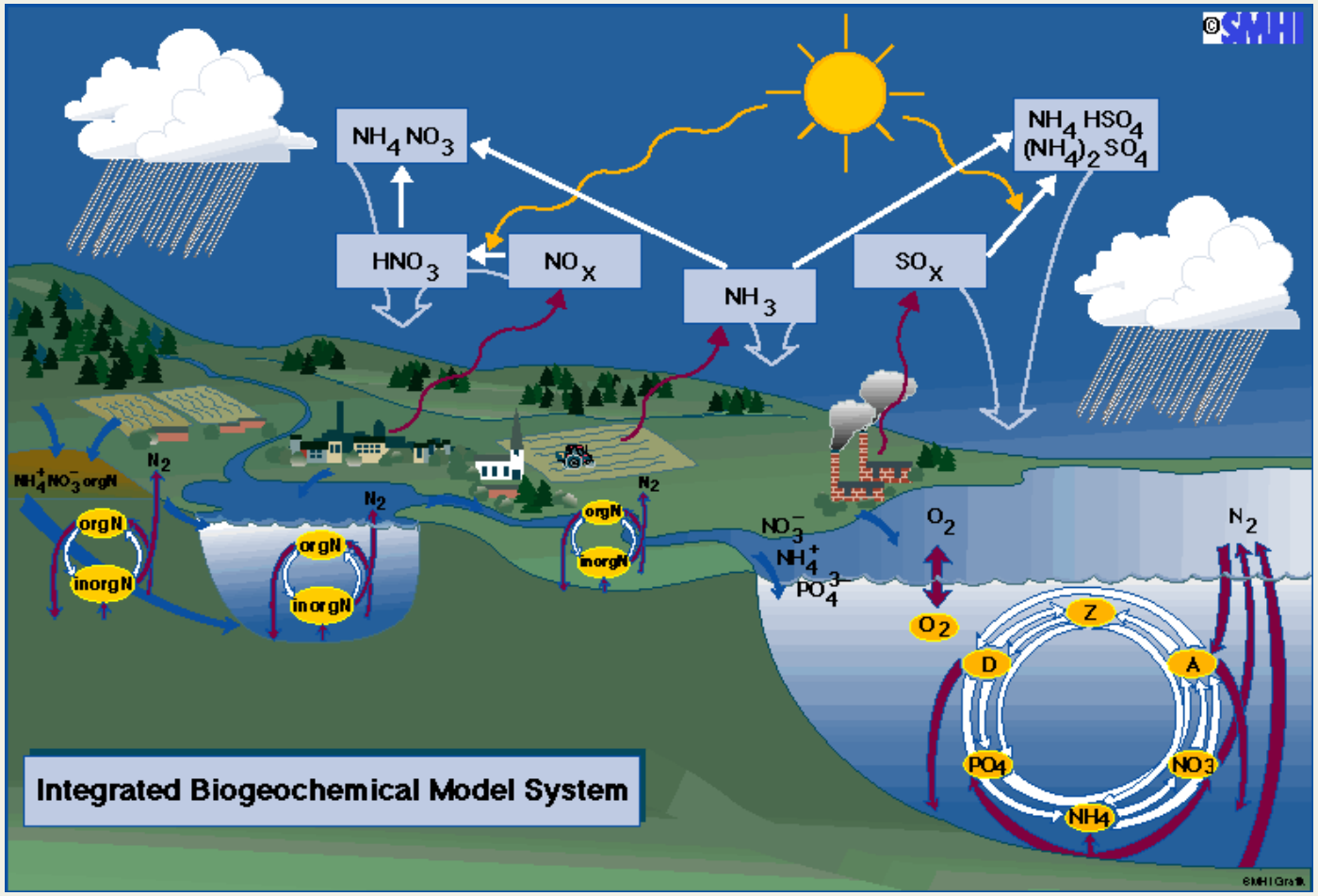
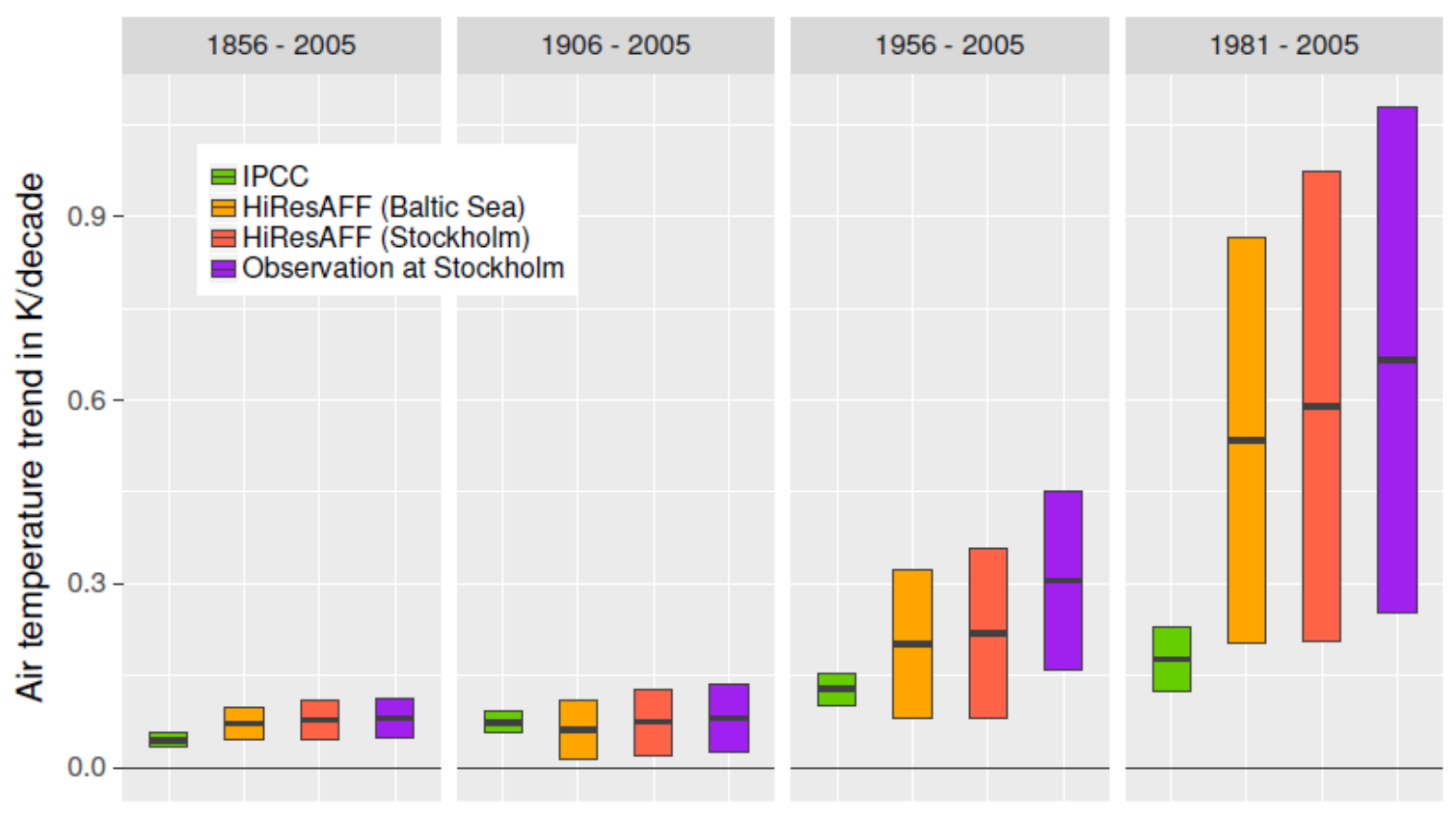
www.baltic.earth



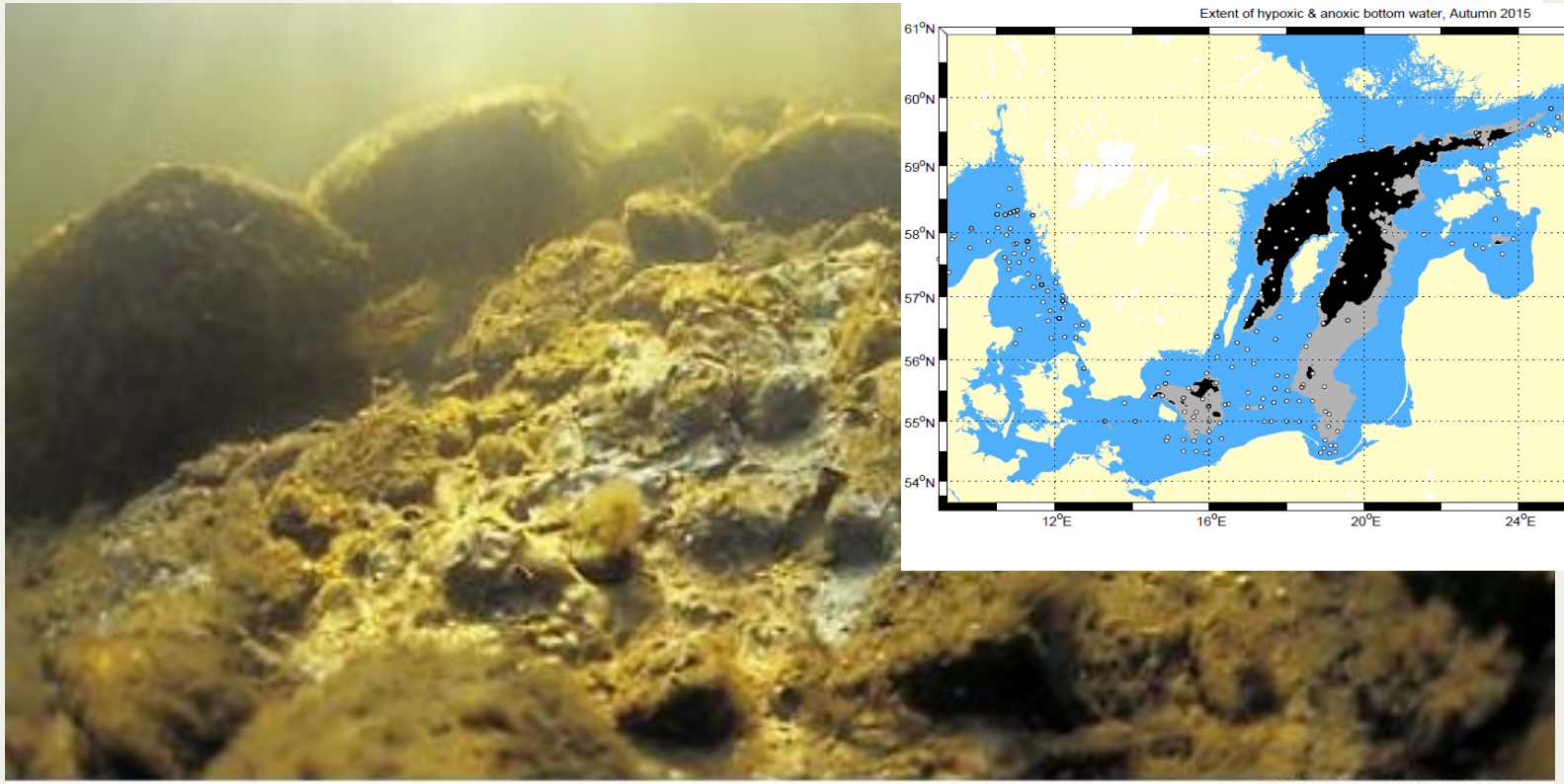
Earth system science treat the Earth as an integrated system and seeks a deeper understanding of the physical, chemical, biological and human interactions that determine the past, current and future states of the Earth

Baltic Sea as laboratory for climate change and environmental drivers

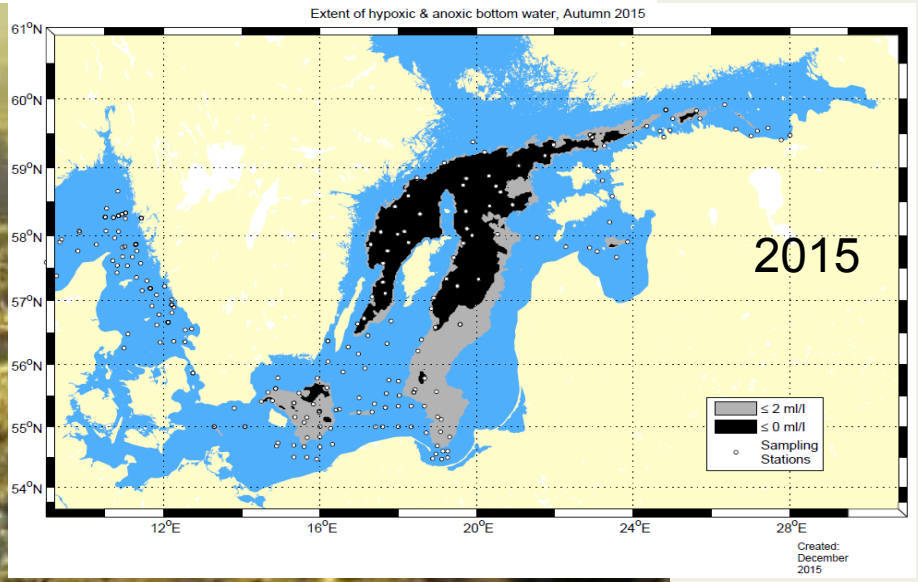


(Source: Kniebusch et al., submitted manuscript)

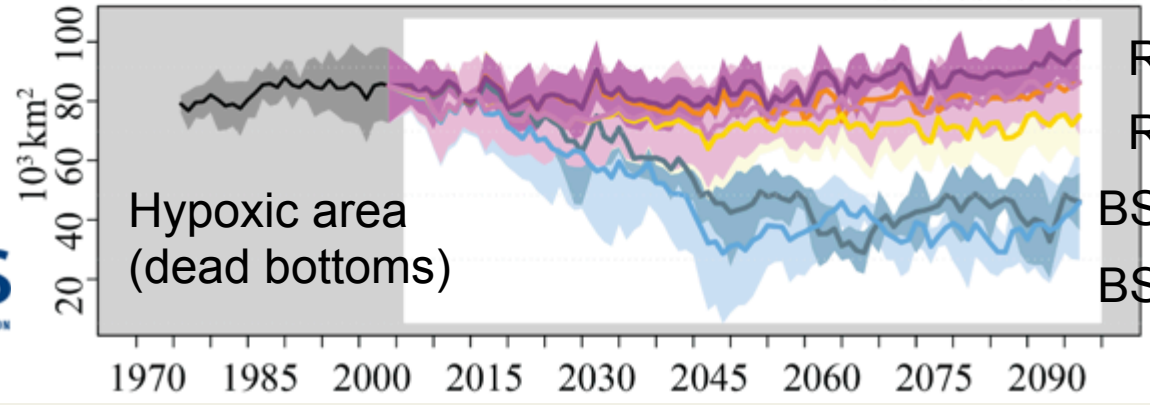
BSAP RCP4.5 RCP8.5
Reference RCP4.5 RCP8.5
Worst RCP4.5 RCP8.5
Historical



J. Lokrantz/Azote



Source: Saraiva et al., submitted manuscript (SMHI)



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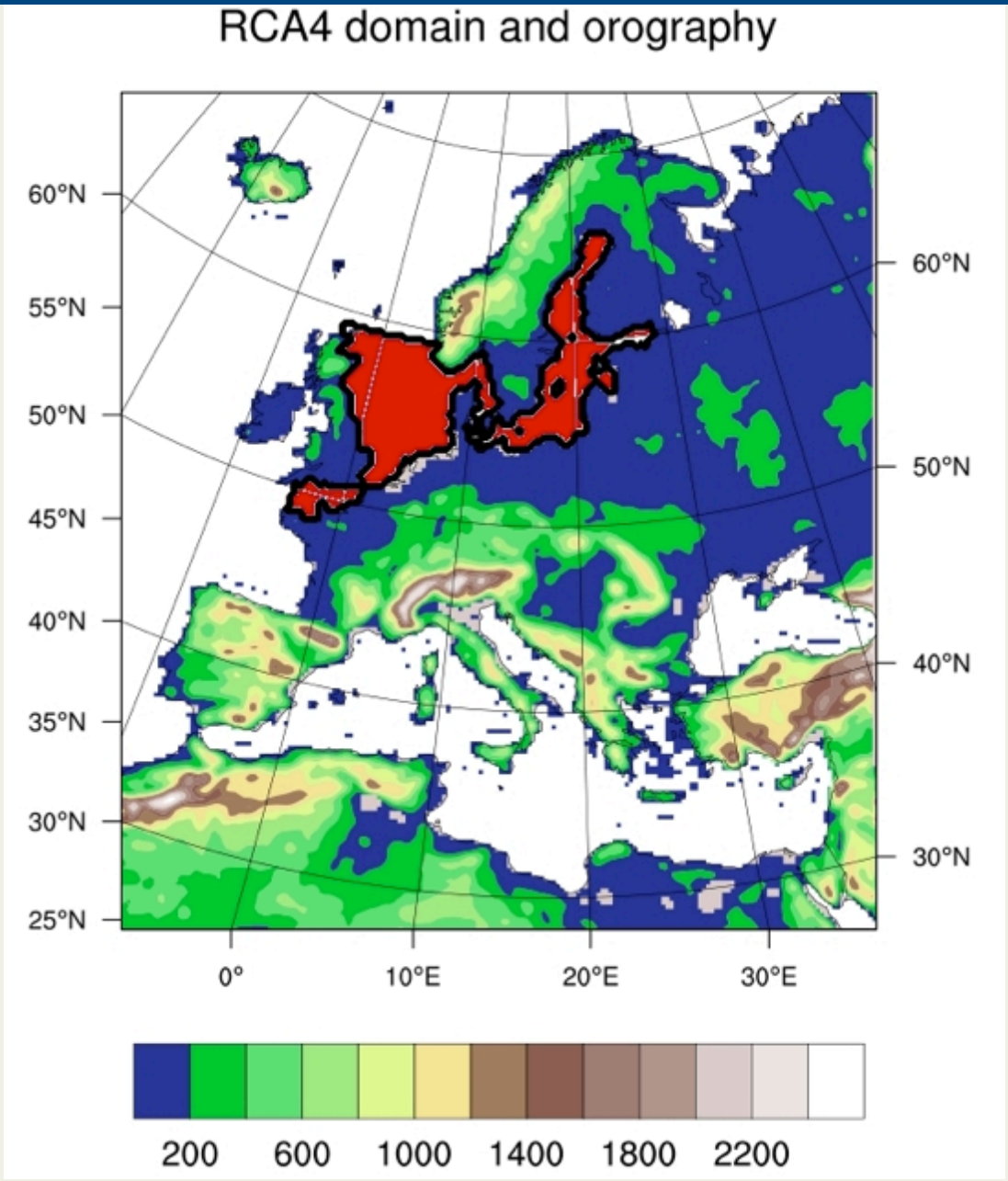
Baltic Earth working groups on modeling

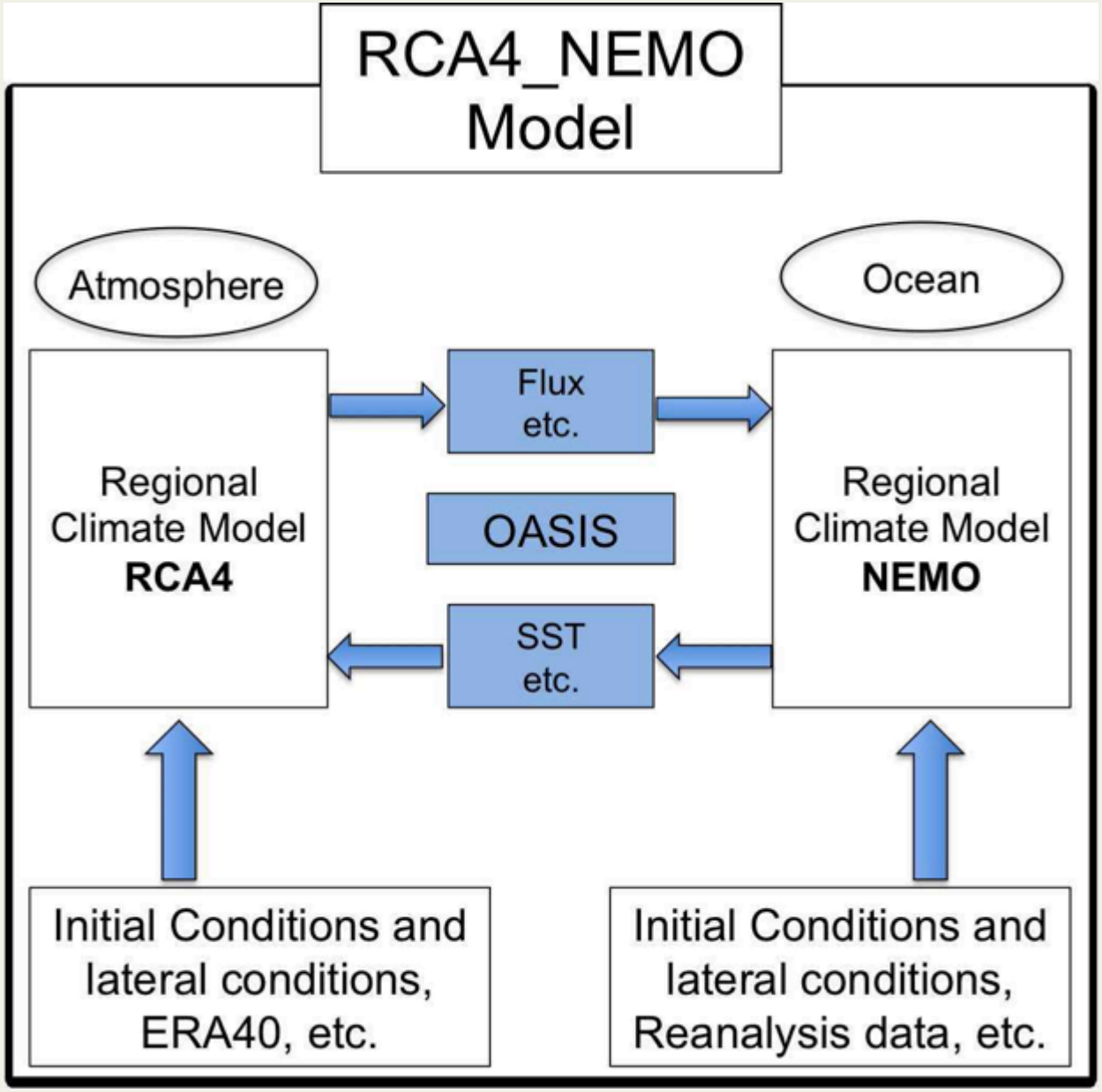
1) Coordinated experiments with coupled atmosphere-ocean models (5 institutes with 5 RCSMs)
2) Assessment of scenario simulations (completed, 6 institutes, 21 scientists)
3) Assessment of ocean models (proposed)

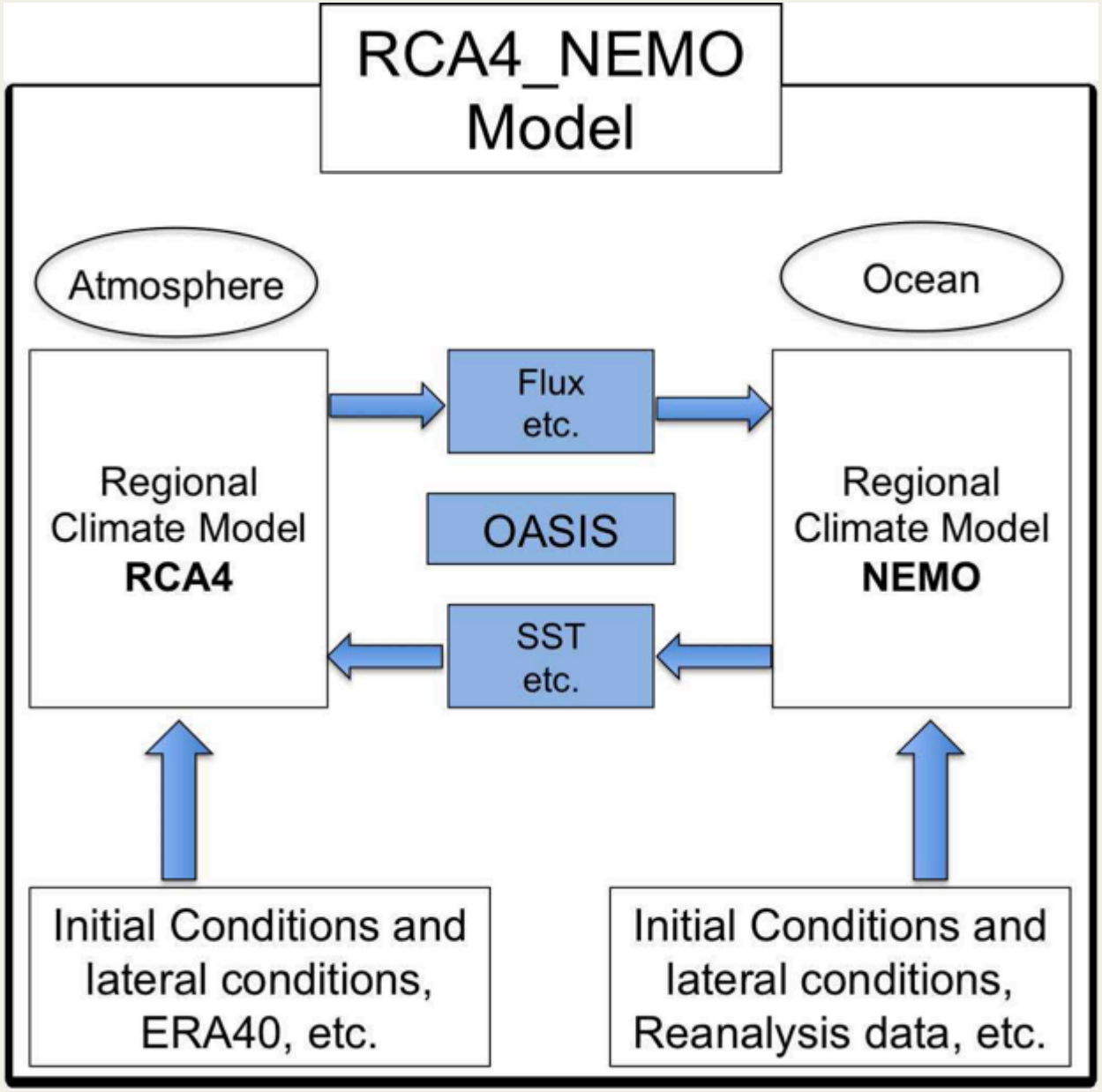
SMHI's regional climate models:

RCAO (Source: Döscher et al., 2002)

RCA-NEMO (Source: Wang et al., 2015)



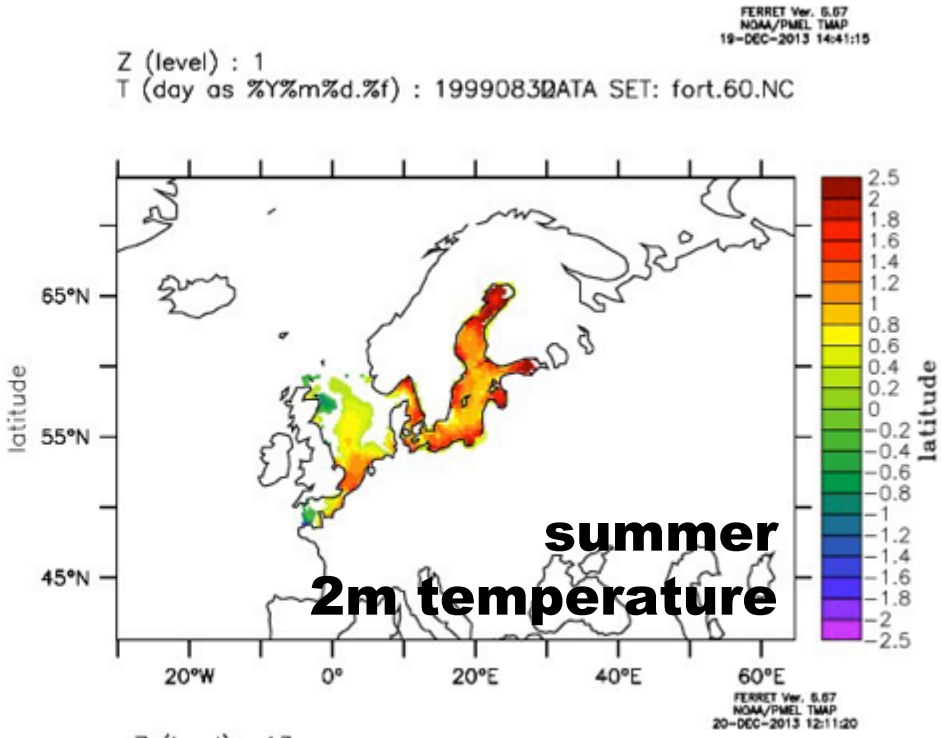

RCA4_NEMO Model
Atmosphere
Ocean
Regional Climate Model RCA4
Flux etc.
OASIS
SST etc.
Regional Climate Model NEMO
Initial Conditions and lateral conditions, ERA40, etc.
Initial Conditions and lateral conditions, Reanalysis data, etc.

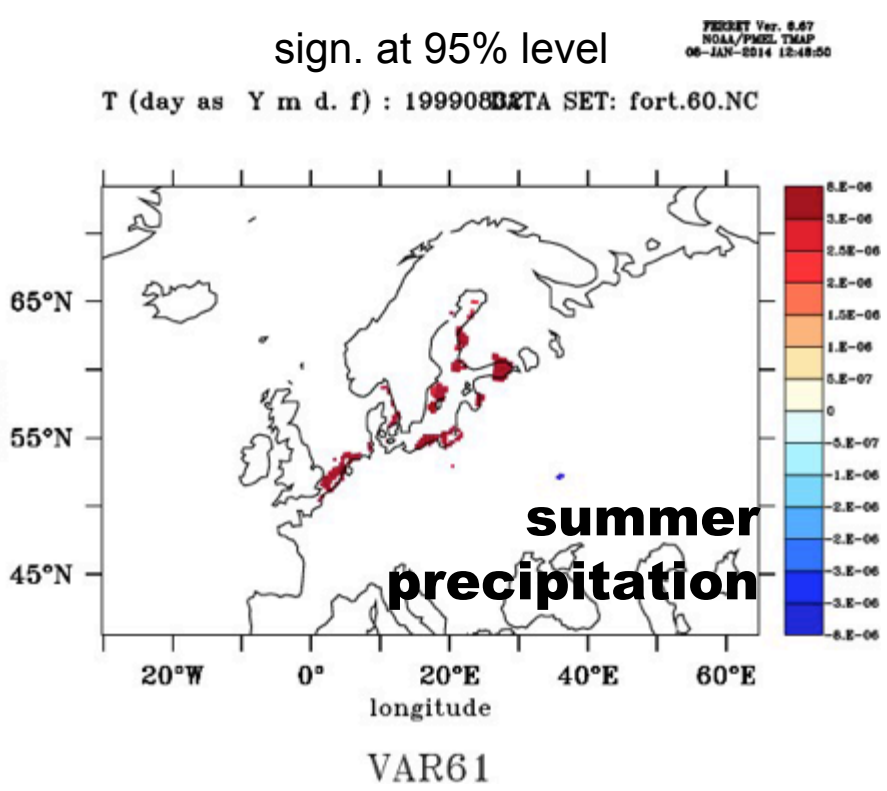


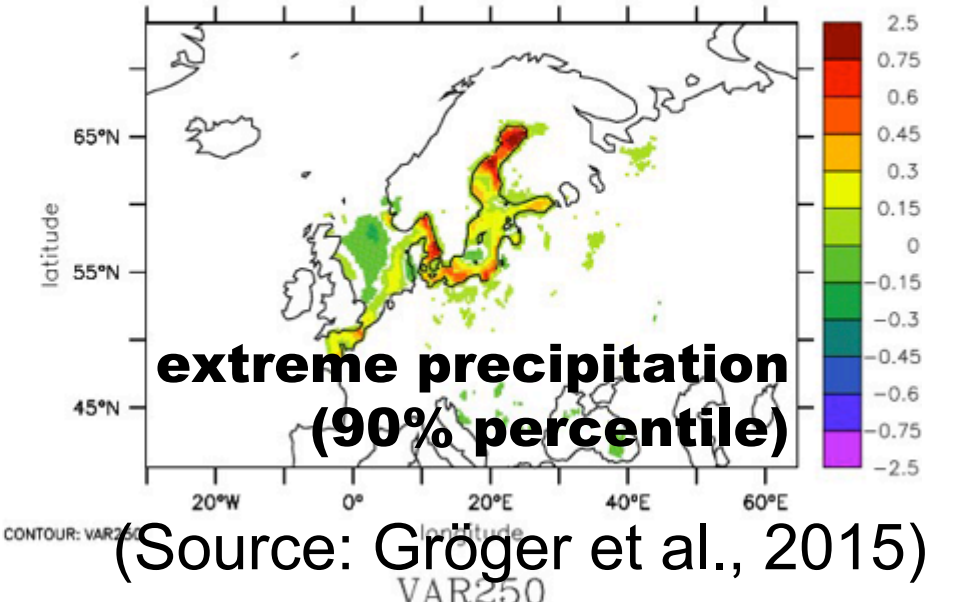
Additional components:

- sea ice
- waves
- marine biogeochemistry
- (marine food web)
- sediments
- land surface and hydrology
- lakes
- (dynamic land vegetation)
- (atmospheric chemistry)

sign. at 95% level

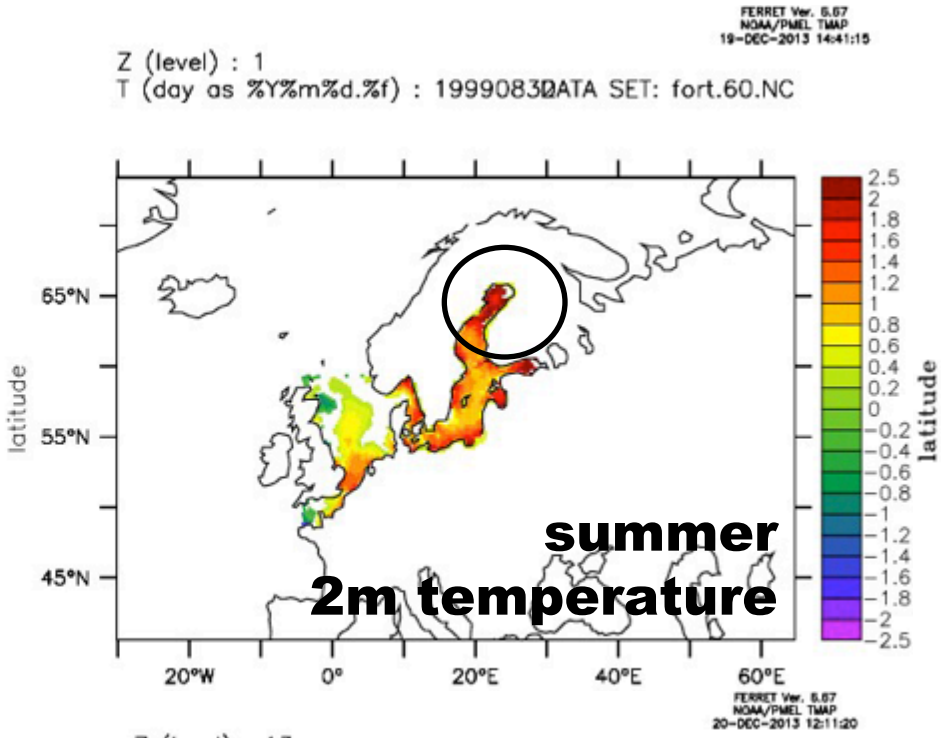




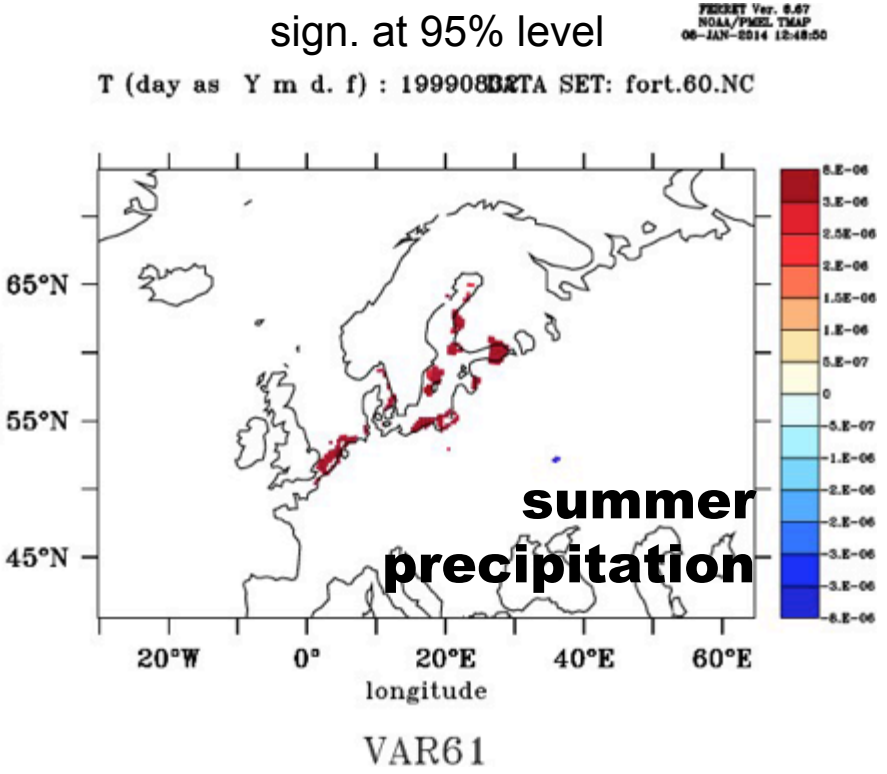


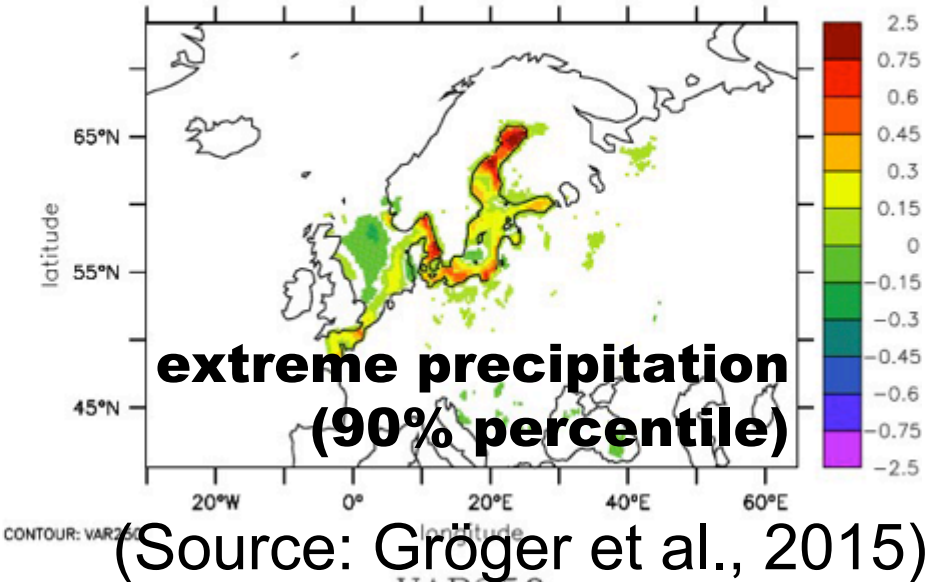
difference coupled minus uncoupled

(Source: Gröger et al., 2015)



sign. at 95% level





difference coupled minus uncoupled

Ice-albedo effect

Further: correlation with NAO, impact on mixed layer depth, potential energy anomaly

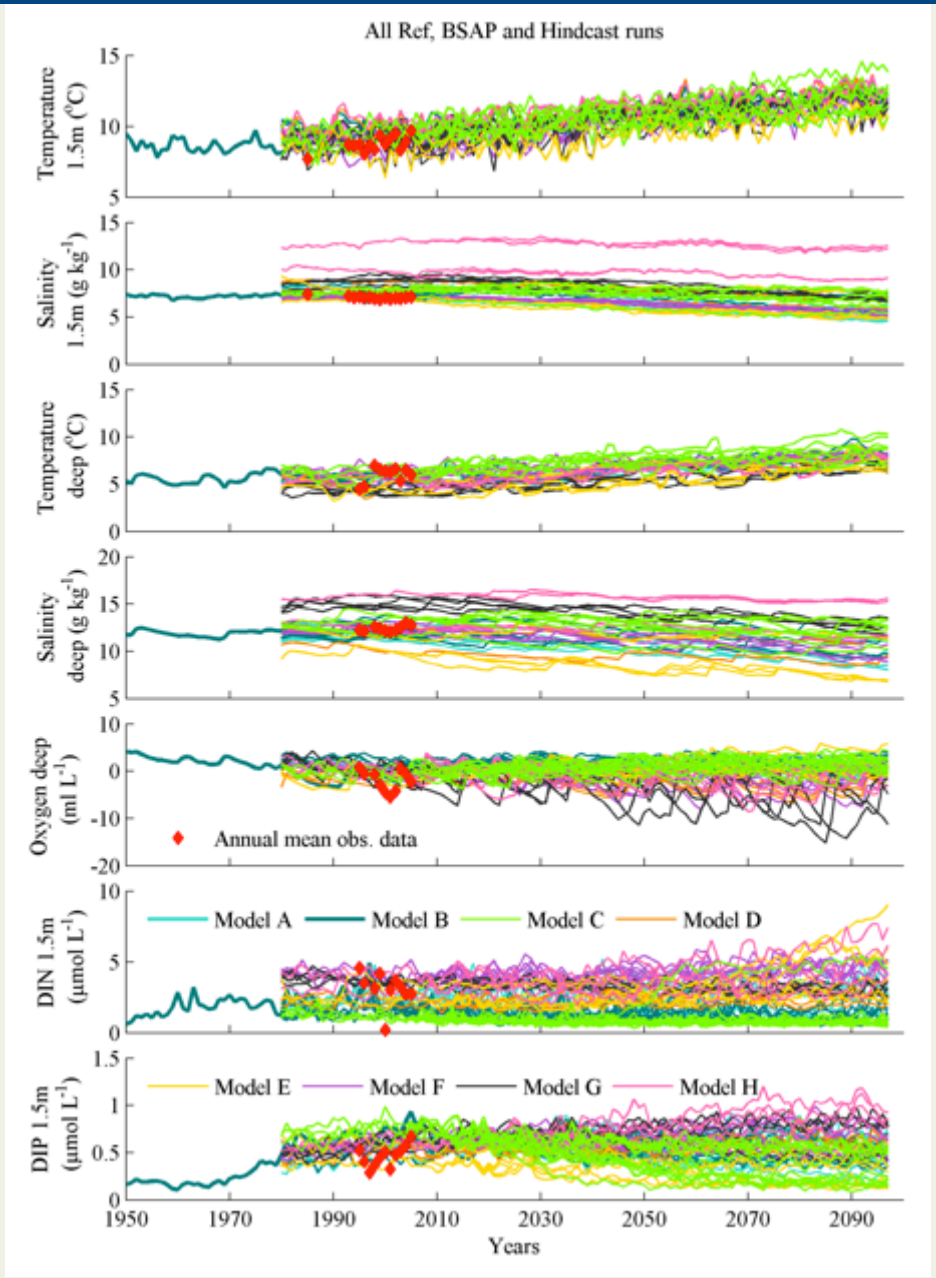
(Source: Gröger et al., 2015)

Baltic Sea: future projections

- **7 different global climate models**
- **A1B and A2 scenarios, RCP4.5 and 8.5**
- **3 realizations**
- **3 regional climate model (RCAO, CLM, RCA-NEMO)**
- **3 hydrological models**
- **6 Baltic Sea physical-biogeochemical models**
- **10 nutrient load scenarios: BSAP (- 25…- 30%) to BAU (+ 40%)**
- **Total: 29 scenario simulations**

(Meier et al., 2011; 2012; 2014; Neumann et al., 2012)

(Source: Meier et al., submitted)



Surface temperature

Surface salinity

Deep water temperature

Deep water salinity

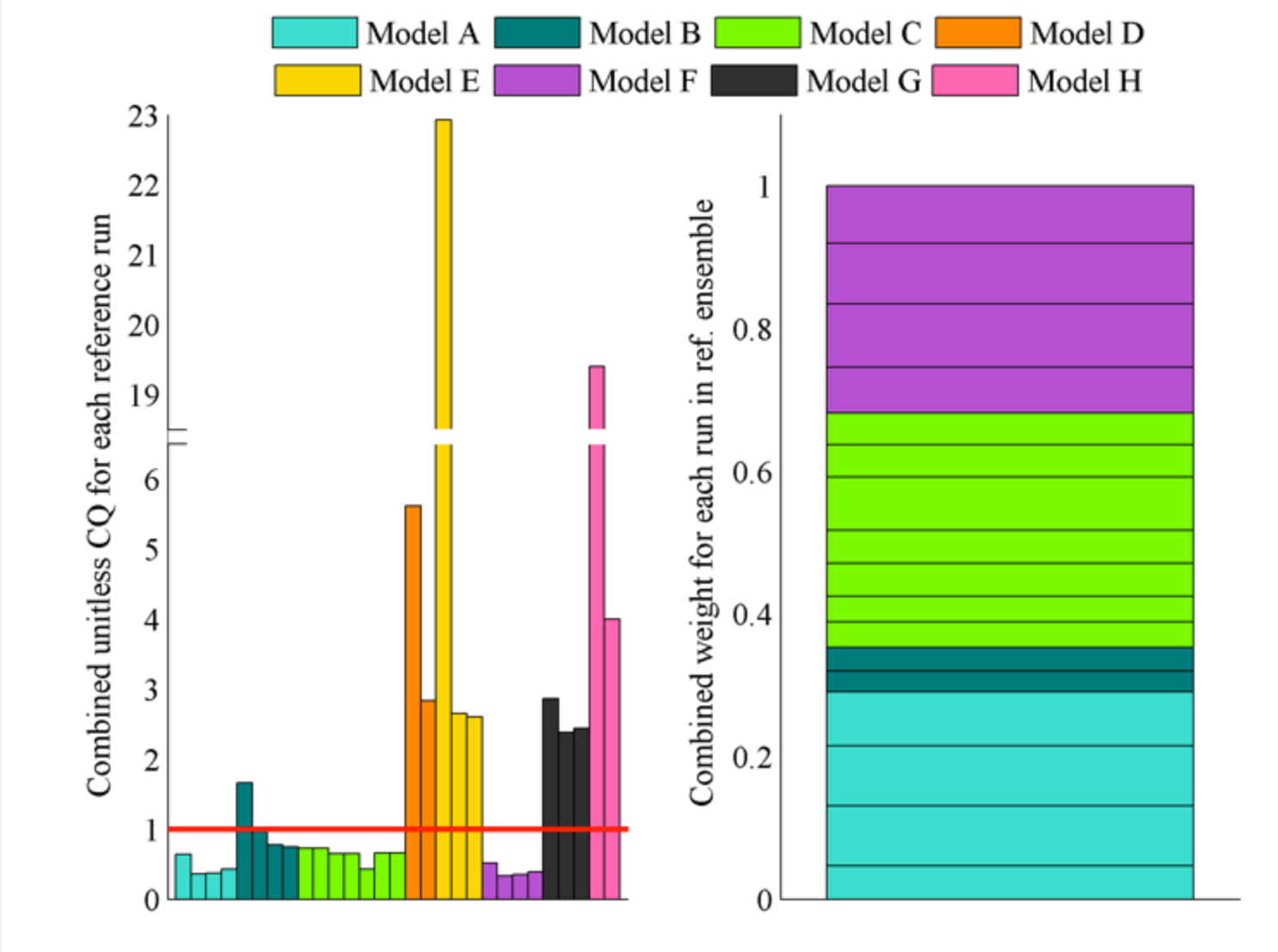
Deep water oxygen concentration

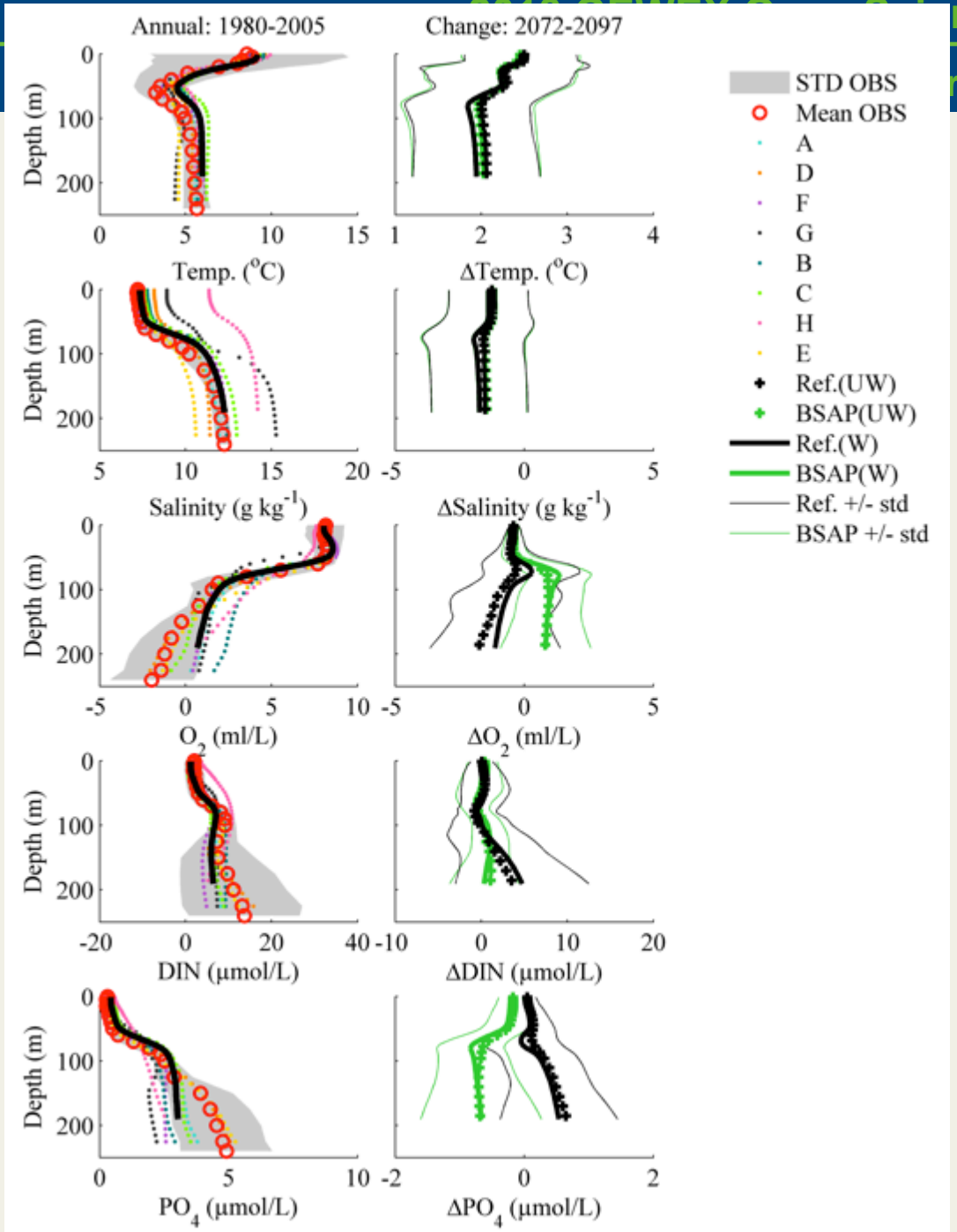
Surface DIN

Surface DIP

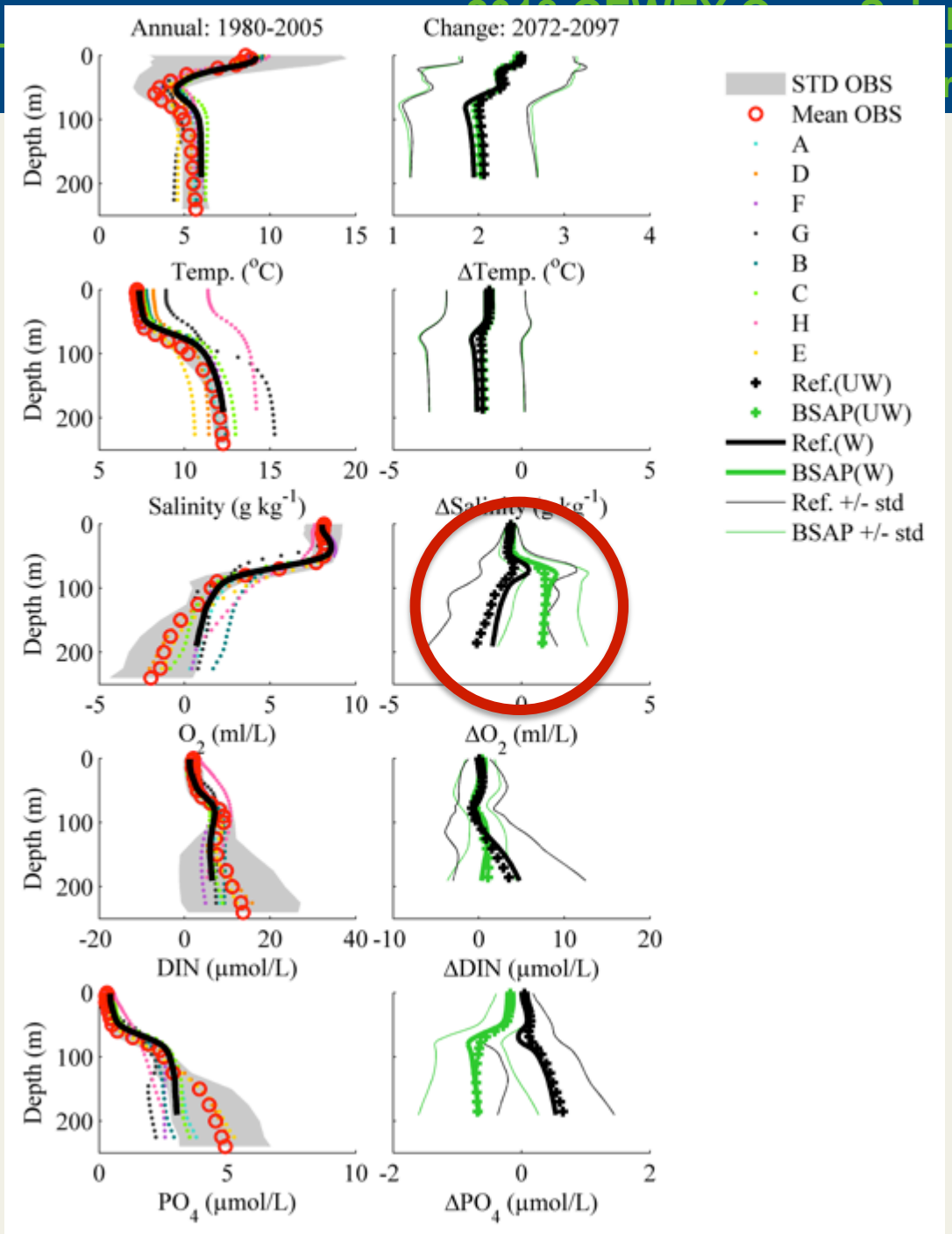
Combined cost function per model

(Source: Meier et al., submitted)





(Source: Meier et al., submitted)



(Source: Meier et al., submitted)

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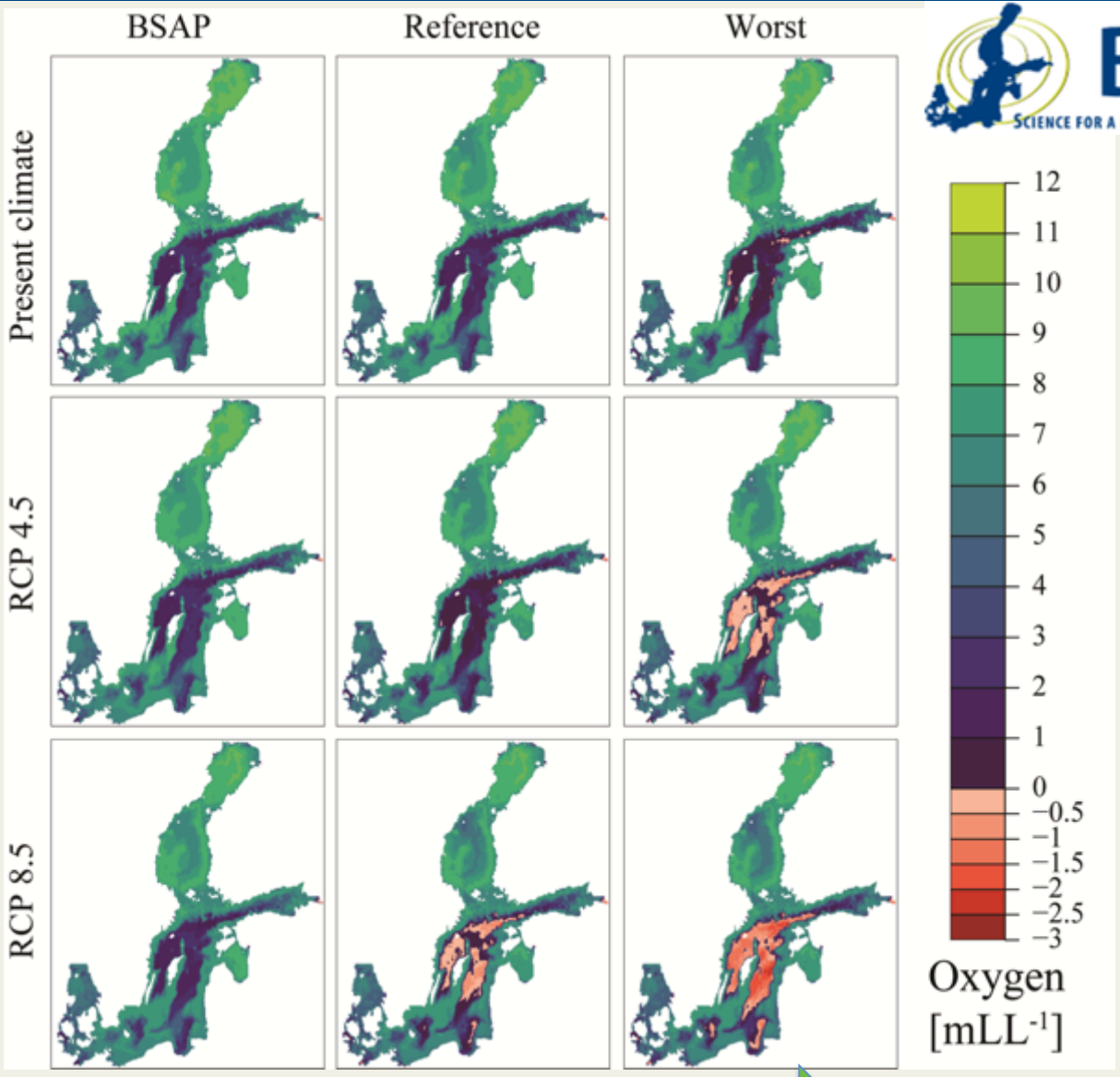
Future bottom oxygen and hydrogen sulfide concen-trations

warmer



higher loads

Source: Saraiva et al., submitted manuscript (SMHI)

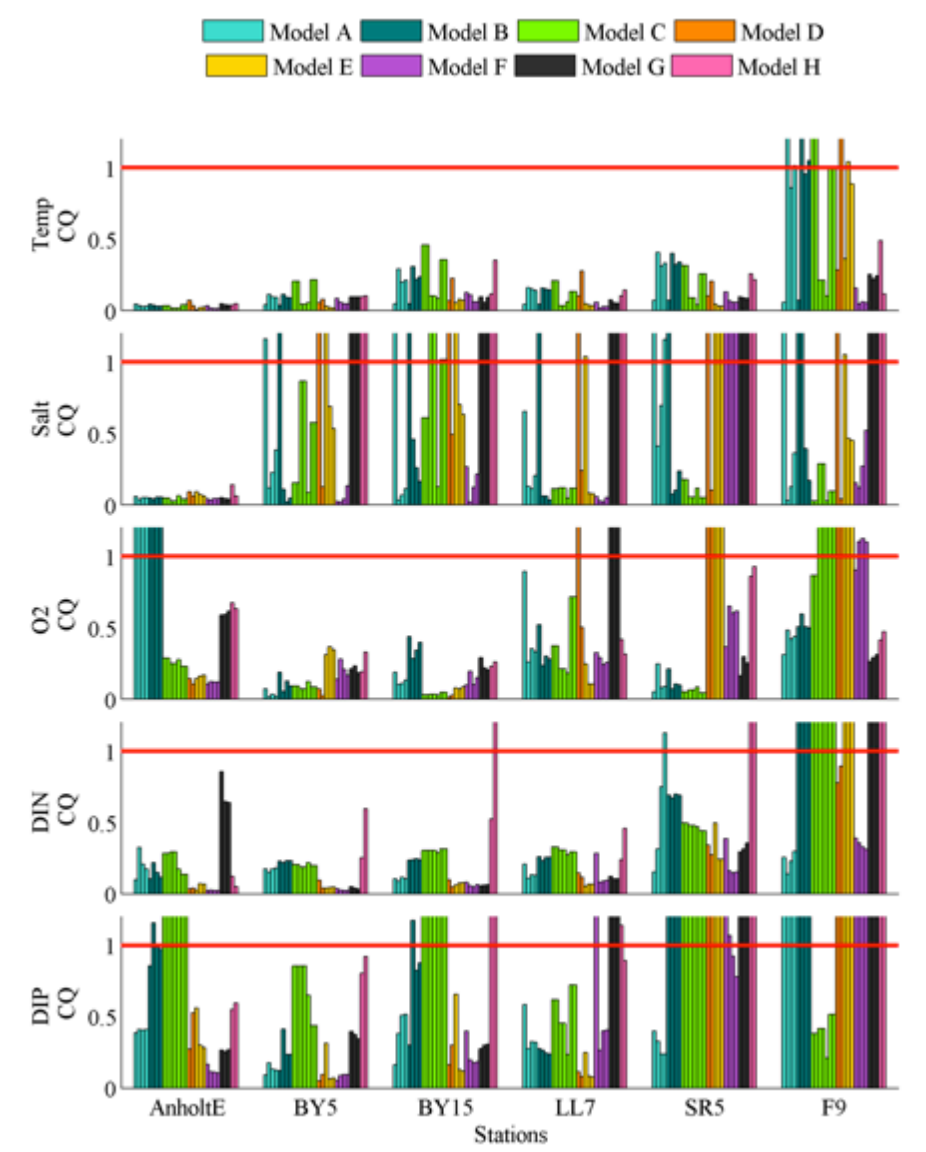
Conclusions

- Baltic Earth integrated modeling systems are powerful
- Challenges: resolution, model biases, e.g. 1) water balance is not closed, 2) unknown evolution of nutrients in the soils on long time scales
- Assessments are needed

Thank you for your attention!

(Photo: R. Prien, IOW)

Cost function



(Source: Meier et al., submitted)