ECOSUPPORT

Advanced modeling tool for scenarios of the Baltic Sea ECOsystem to SUPPORT decision making

Co-ordination: Markus Meier,
SMHI and Stockholm University

ICES/HELCOM Working Group on
Integrated Assessments of the Baltic Sea (WGIAB)
Rostock, Germany
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Objective

… to calculate the combined effects of changing climate and changing human activity (nutrient load reductions [runoff and airborne], coastal management, fisheries) on the BS ecosystem

ECOSUPPORT Participants:

11 institutes from 7 Baltic countries, plus 1 associated partner:

1. Markus Meier, Swedish Meteorological and Hydrological Institute (SMHI), Sweden
2. Thorsten Blenckner, Baltic Nest Institute, Resilience Centre, Stockholm University(BNI), Sweden
3. Boris Chubarenko, Atlantic Branch of P.P. Shirshov Institute of Oceanology, Russian Academy of Sciences (ABIORAS), Russia
4. Jonathan Havenhand, Tjärnö Marine Biological Laboratory (TMBL), Göteborg University, Sweden
5. Brian MacKenzie, Technical University of Denmark, Danish Institute for Fishery Research (DTU), Denmark
6. Thomas Neumann, Baltic Sea Research Institute Warnemünde (IOW), Germany
7. Jan-Marcin Weslawski, Institute of Oceanology Polish Academy of Sciences (IOPAS), Poland
8. Urmas Raudsepp, Marine Systems Institute at Tallinn University of Technology (MSI), Estonia
9. Tuija Ruoho-Airola, Finnish Meteorological Institute (FMI), Finland
10. Eduardo Zorita, GKSS-Research Centre Geesthacht GmbH (GKSS), Germany
11. Björn-Ola Linnér, Center for Climate Science and Policy Research (CSPR), Linköping University, Sweden

Associated partner: Anna Gårdmark, Swedish Board of Fisheries

-3 year project: Jan. 1, 2009 – Dec. 31, 2011

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Cod in a Future Low-Nutrient Baltic?

Reduced
eutrophication

Fewer sprat
& herring

Less prey

Reduced carrying
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Less prey

Reduced carrying
capacity for cod

Less decomp.
of organic matter

Better O_2 in
spawning areas

Increased repro.
success & recr.

Climate Change, Eutrophication, and Cod in the Future Baltic:

Increased precipitation and runoff loading of nutrients; warmer T

↓

Frequent and longer periods of anoxia?

Reduced nutrient loading; more storms

↓

Fewer and shorter periods of anoxia?

-outcome not clear

-requires process modelling – ECO-SUPPORT

MacKenzie et al. 2002
CJFAS

DTU

ECOSUPPORT Approach

-will combine different models and outputs to enable modelling of entire Baltic foodweb

-to be used for scenario simulations of how Baltic Sea foodweb will respond to changes in forcings such as:

- -climate
- -nutrient loading (eutrophication, oligotrophication)
- -fishing

Eco-Support Workpackages

WP no.	Title	WP leader
1	Drivers related to changing climate and changing river- and airborne nutrient loadings due to anthropogenic acitvities	E. Zorita, GKSS
2	Impact on Baltic Sea nutrient cycles, autotrophs and zooplankton	B. Gustafsson, BNI
3	Impact on the foodweb	B. MacKenzie, DTU-Aqua
4	Impact of socioeconomic and regional development, case studies	U. Raudsepp, MSI
5	Co-ordination, data management, DSS, dissemination, and outreach activities	M. Meier, SMHI

Foodweb-Fish related Workpackages

WP2: Impact on Baltic Sea nutrient cycles, autotrophs and zooplankton

2.1 Model validation of biogeochemical processes
2.2 Validation of the long-term biogeochemical variability
2.3 Scenario simulations of biogeochemical cycles

WP3: Impact on the foodweb

3.1 Process validation of foodweb models
3.2 Scenario simulations of the food web
3.3 Quantification of uncertainty of future food web projections

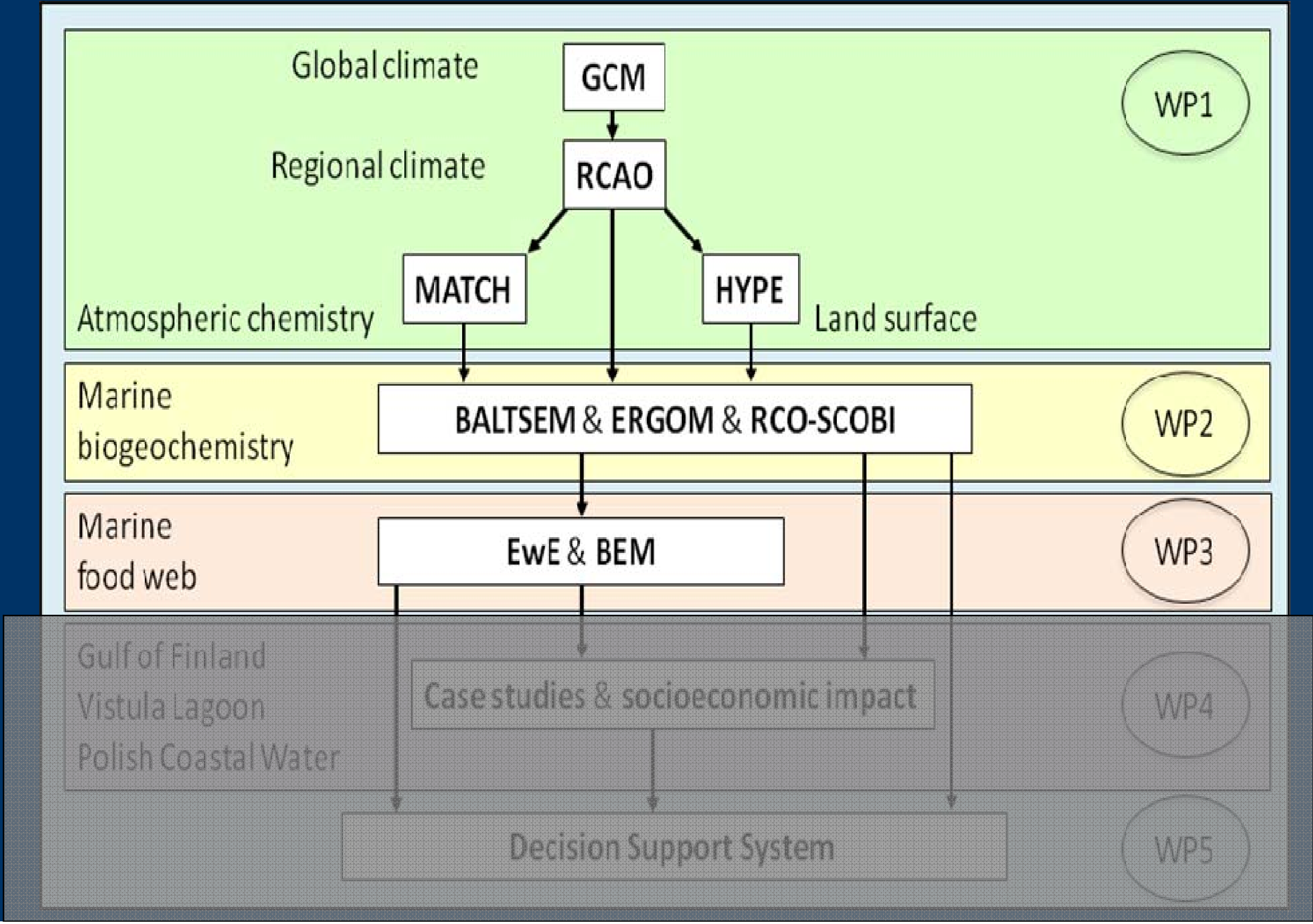
Available Models

Climate

Physical oceanographic-biogeochemical (lower trophic levels of food web)
-"NPZD"

Foodweb and fish populations

ECOSUPPORT Model Hierarchy



Available Models

Climate

-RCAO/ECHAM5/A1B
-RCAO/ECHAM5/A2

-RCAO/HadCM3/A1B
-RCAO/HadCM3/A2 or B2

= 2 different regionalized versions of global climate models (GCMs)
-each will be used for 2 different IPCC CO_2 emission scenarios

Available Models

Climate

Physical oceanographic-biogeochemical (lower trophic levels of food web)
-"NPZD"

-BALTSEM (BNI model)
-ERGOM (IOW)
-RCO-SCOBI (SMHI)

-each will be forced by climatic-oceanographic data from the 2x2 combination of climatemodels and CO_2 emission scenarios

Available Models

Climate

Physical oceanographic-biogeochemical (lower trophic levels of food web)
-"NPZD"

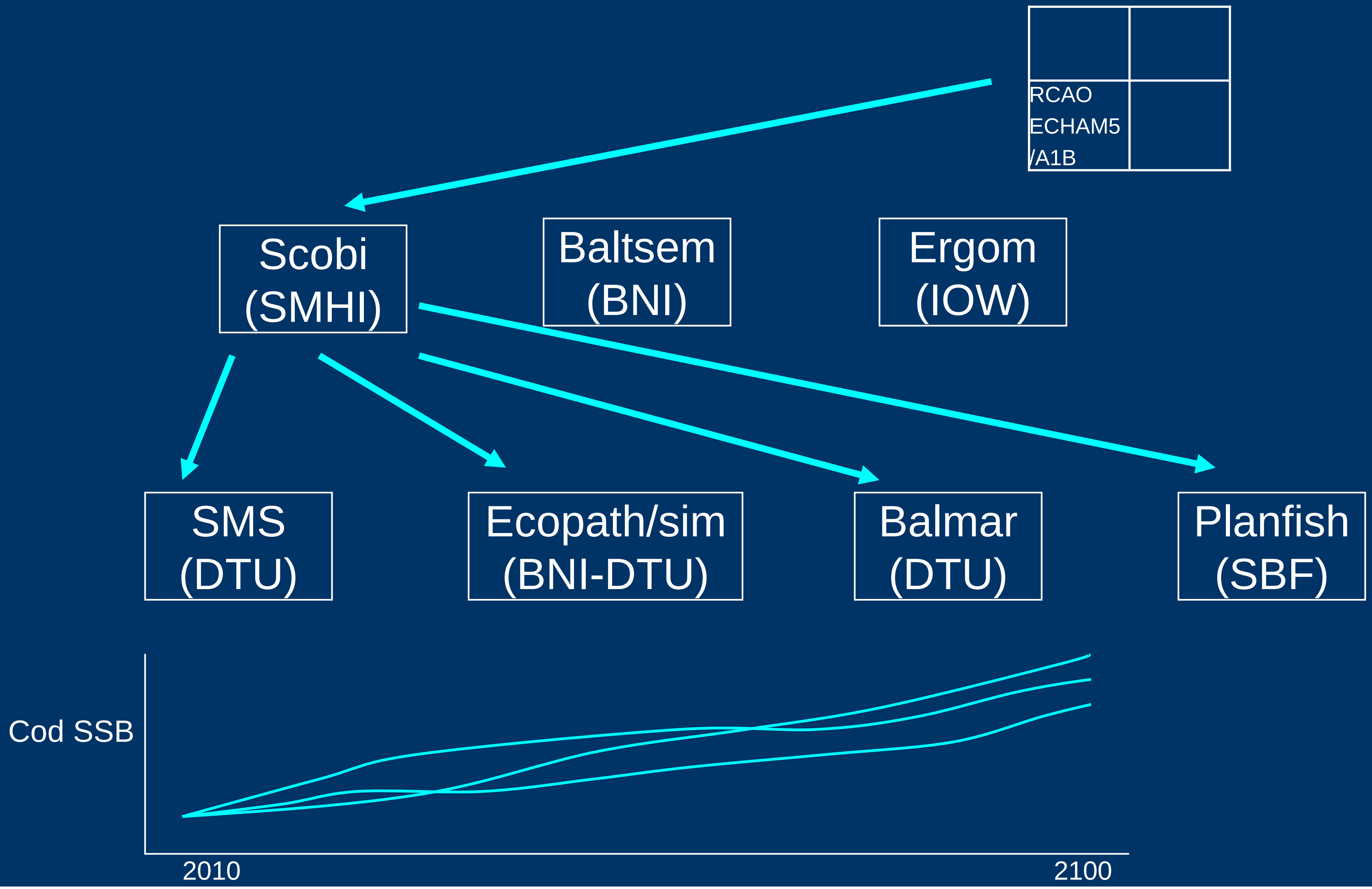
Foodweb and fish populations

-Ecopath/Ecosim (BNI, DTU-Aqua) – entire foodweb from nutrients-PP-ZP-fish
-MSVPA/SMS (DTU-Aqua) – hydrography-fish
-BALMAR (DTU-Aqua, Uni. Hamburg) – hydrography-ZP-fish
-PLANFISH (SBF) – hydrography-ZP-fish

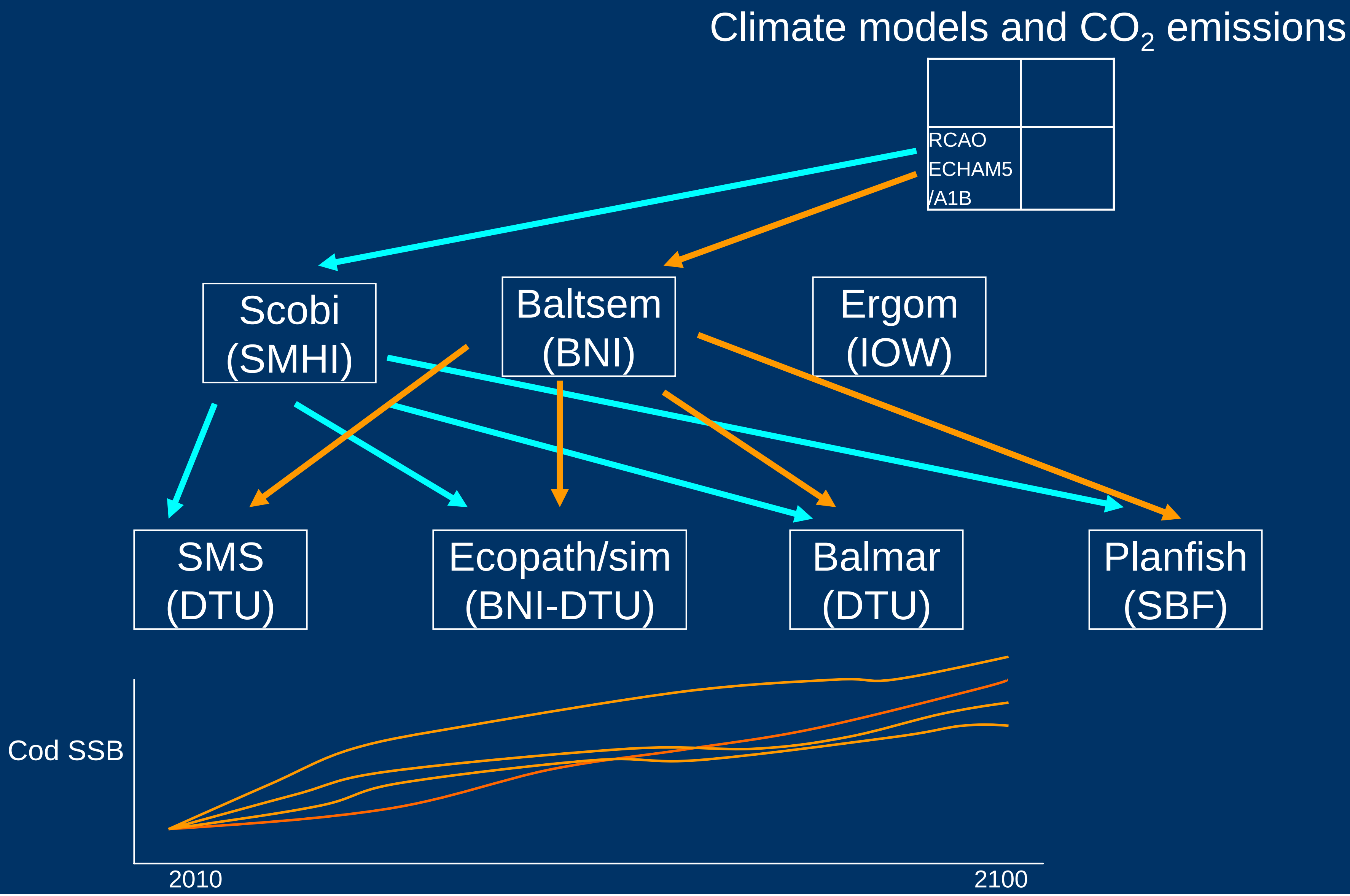
-bioclimatic envelope modelling (GU) – emphasis on physiological tolerances to T, S, O_2, pH for mapping species ranges

Inter-Linking Models within Eco-Support

Climate models and CO_2 emissions
for given nutrient scenario:



Inter-Linking Models within Eco-Support



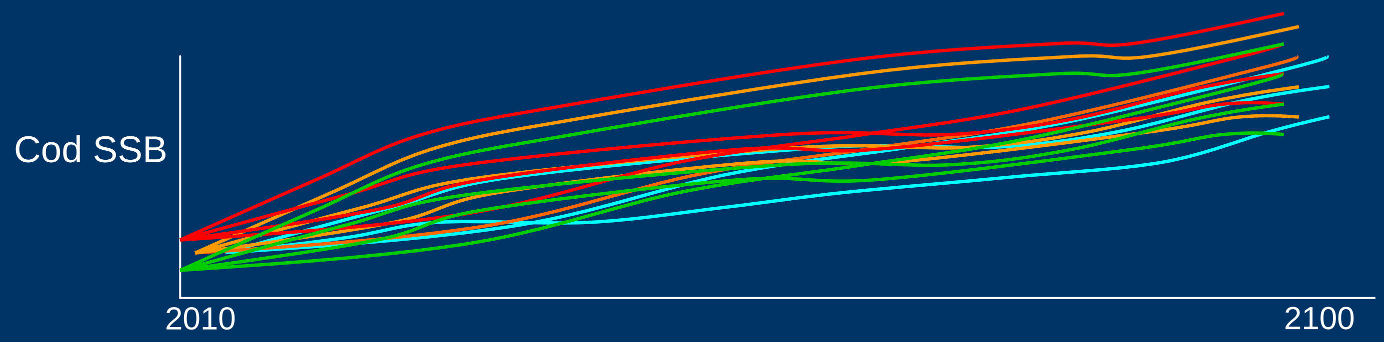
Dealing with Uncertainties

Will use approach of "ensemble averaging" across model outputs
-same approach applied in climatology, IPCC, etc.

-calculate average and uncertainty (variability) for same set of forcings but with different models

-for a given CO2, nutrient and fishing scenario, have following time series:

2 climate models x 3 NPZD models x 4 foodweb/fish models = 24 time series



Model Validation and Projection Strategy

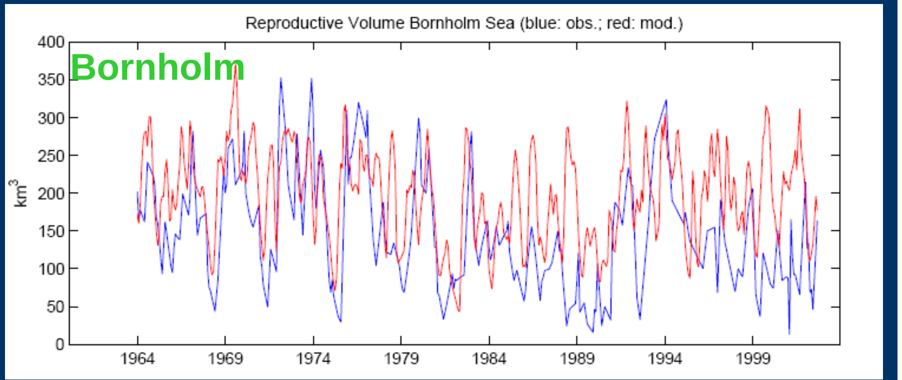
Selection of variables for biology based on existing relationships

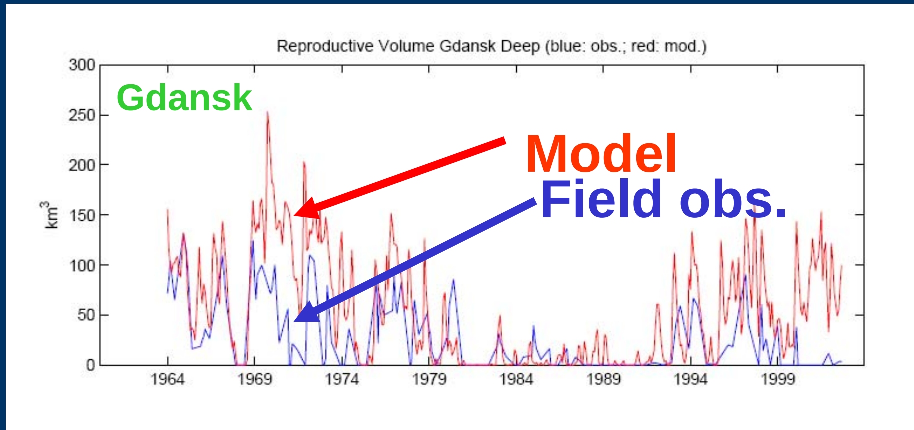
-hindcasted using Models

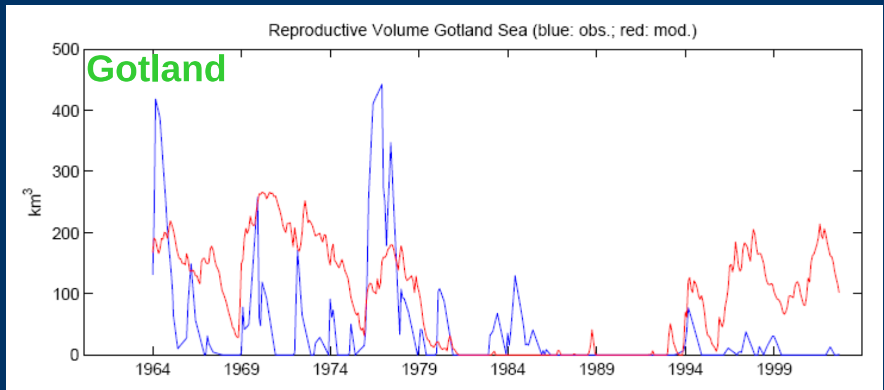
-how good are the hindcasts??

-validation/comparison with observations

Modelled (IOW) and Field Estimates of Cod Reproductive Volume







UNCOVER

-main variations seem to be in both series in most areas, but
some systematic differences also present and causes need to be identified.

Validation

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…needed for “physics” and biology

Model Validation and Projection Strategy

Selection of variables
for biology based on
existing relationships

-hindcasted using
Models

-how good are the hindcasts??

-validation/comparison
with observations

-projections for future using
Models and given CO_2 emissions

How to Make it Work

-need standard set of variables for input to our fish and foodweb models

-reproductive volume for cod by month and basin
-temperature at specific depths at specific months for sprat
(and herring?) recruitment

-temperature at specific months and depths to force fish feeding and growth rates

-abundances of key ZP species for fish feeding, etc.

Task for this meeting – identify the variables that we want to use
In hindcasts and in future projections

Selection of Forcing Variables for Fish/Foodweb Models in Ecosupport

Dep. Var.	Forcing var.	depth	area	Temporal resolution (month, season?)	Time period needed
Cod recruitment	Reproductive volume	Defined by vertical profiles of salinity and oxygen (physiological thresholds to be provided)	Bornholm, Gdansk, Gotland Arkona Basins	Monthly;	1900-2100 (1850-2100)
xxx					
xxx					
xxx					
xxx					

Conclusions

-different models to be coupled for whole ecosystem

-need to define variables for forcing our ecological models

-comments, suggestions welcome!

-thank you