

HELCOM-BONUS BalticAPP Workshop
Stockholm, March 2017

SMHI

Projections on the Baltic Sea state under changing climate and society

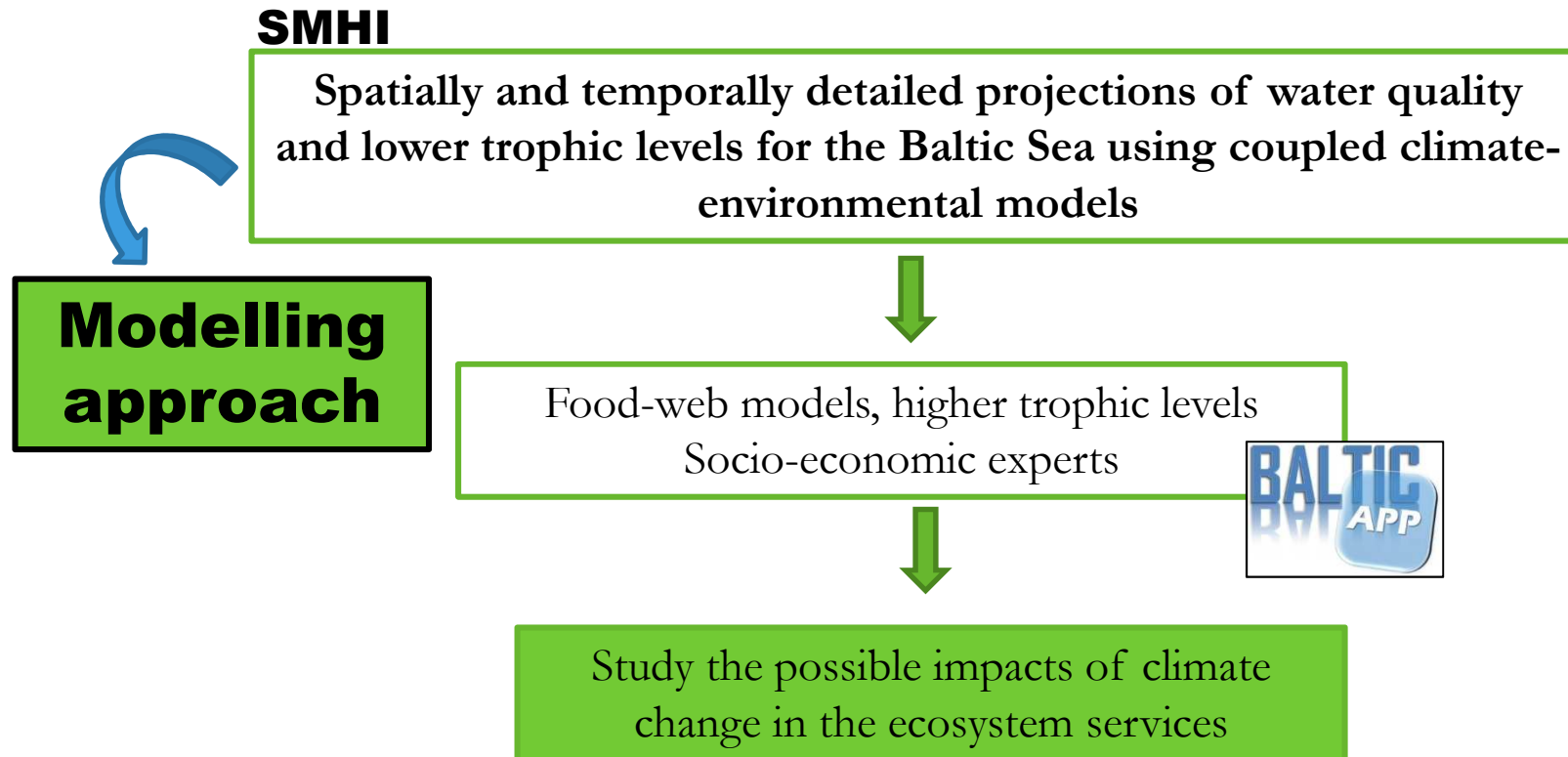
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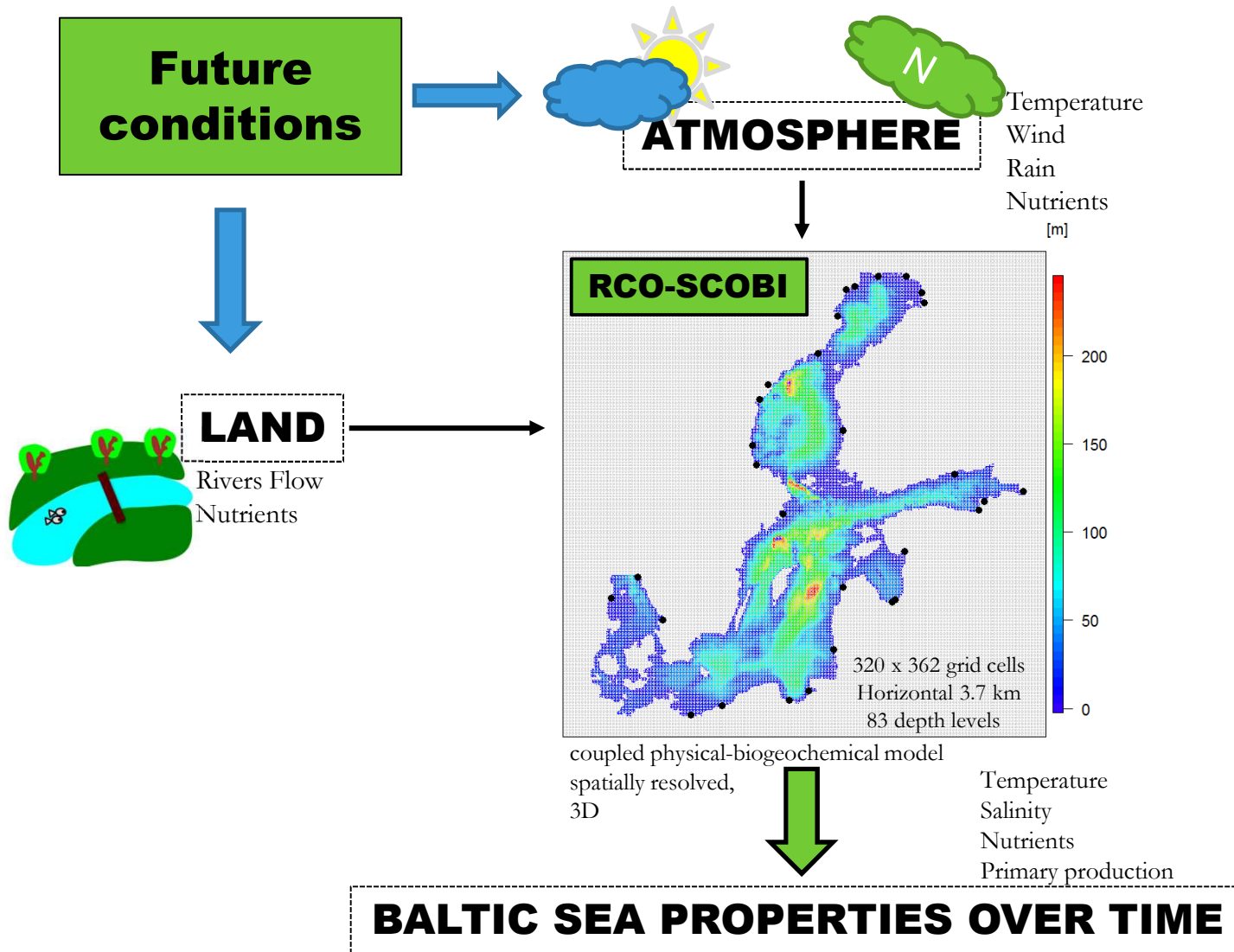


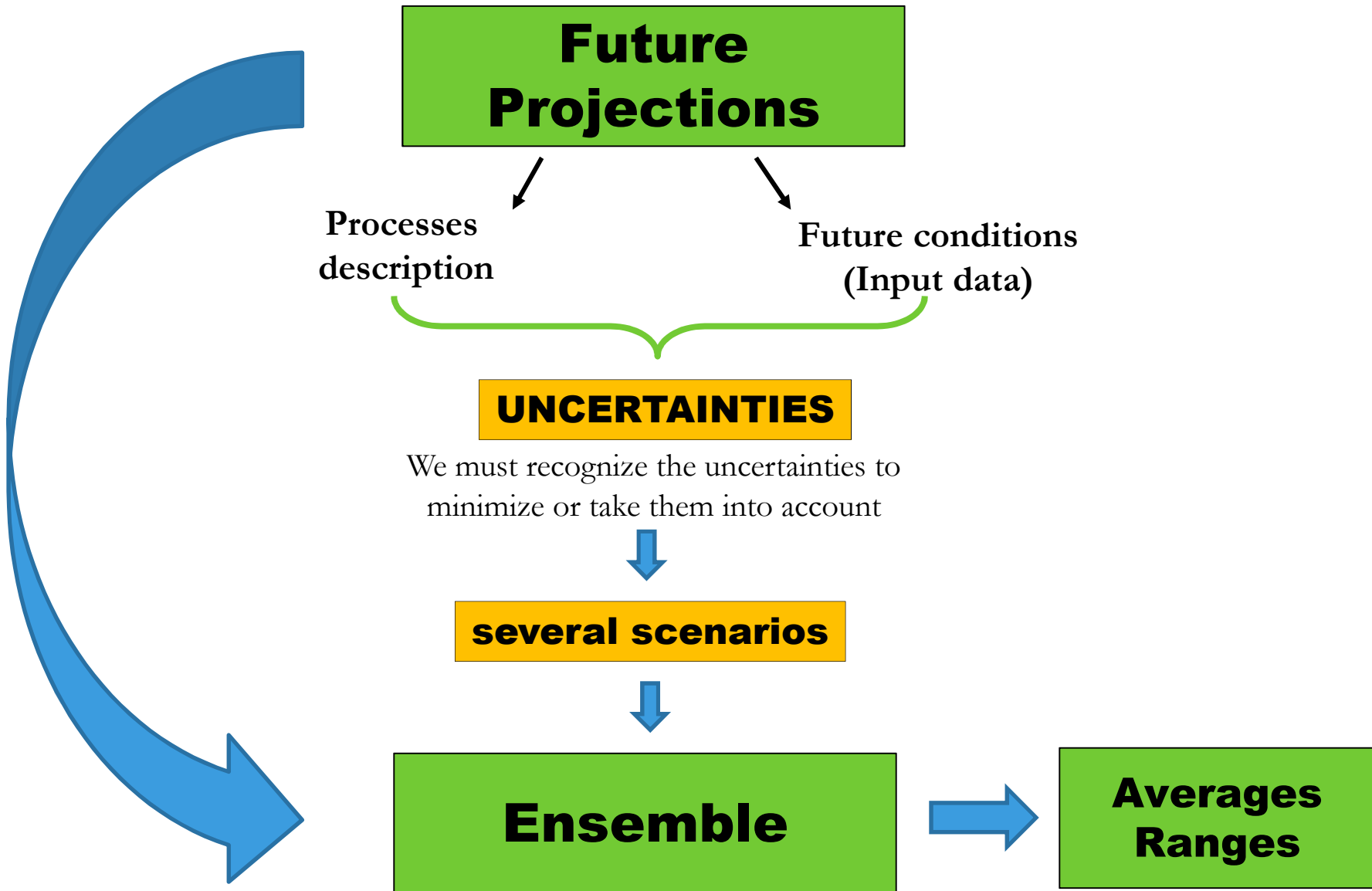
Aim

The BalticAPP project studies both the supply and demand of marine ecosystem services across the entire Baltic Sea region in the coming 80-100 years.



Modelling approach





Future atmosphere

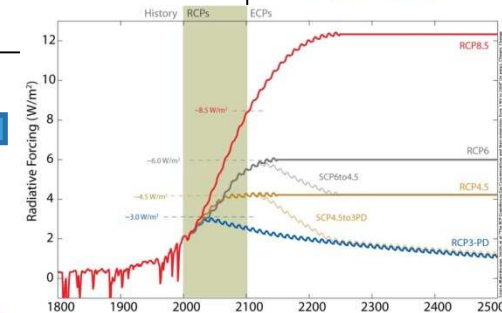
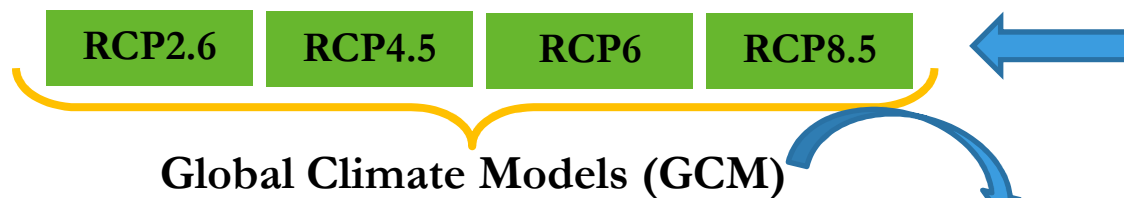


REPRESENTATIVE CONCENTRATION PATHWAYS (RCPs)

Used in the IPCC 5th assessment report on climate change (AR5, 2013/2014)

Four RCPs, defined by total radiative forcing (cumulative measure of human emissions of GHGs) pathway and level by 2100.

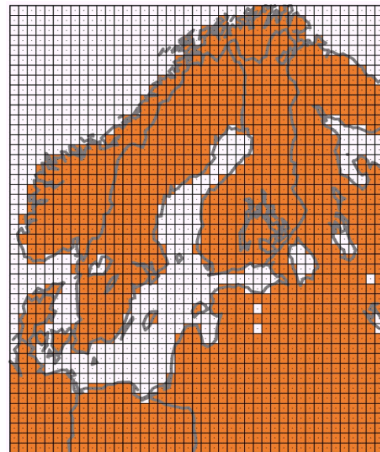
IPCC
INTERGOVERNMENTAL
PANEL ON
CLIMATE CHANGE



Global Climate Models (GCM)

250 – 600km

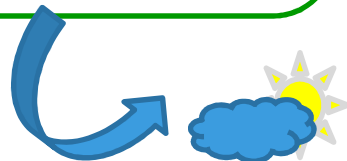
Regional Coupled Climate Model
RCA4-NEMO



0.22 degree, atmosphere
about 3.7 km, Water
Wang et al. 2015

RCMs available

- A MPI-ESM-LR
<http://www.mpimet.mpg.de>
- B EC-EARTH
<https://www.knmi.nl>
- C IPSL-CM5A-MR
<http://www.gfdl.noaa.gov>
- D HadGEM2-ES
<http://www.metoffice.gov.uk2>





Atmosphere

How different are the future projections?

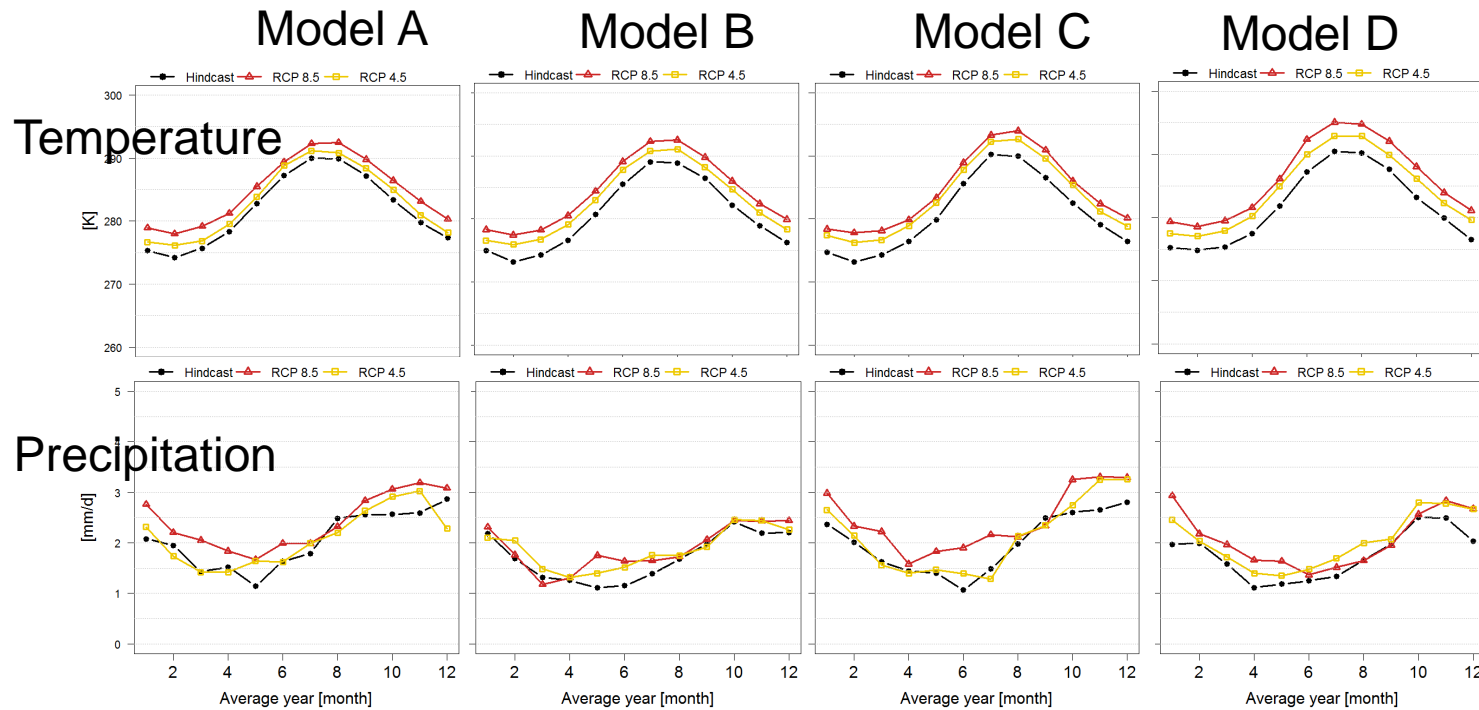
Gotland Deep, hindcast (1980-2005) vs future (2070-2099) for each RCMs

RCP 8.5

RCP 4.5

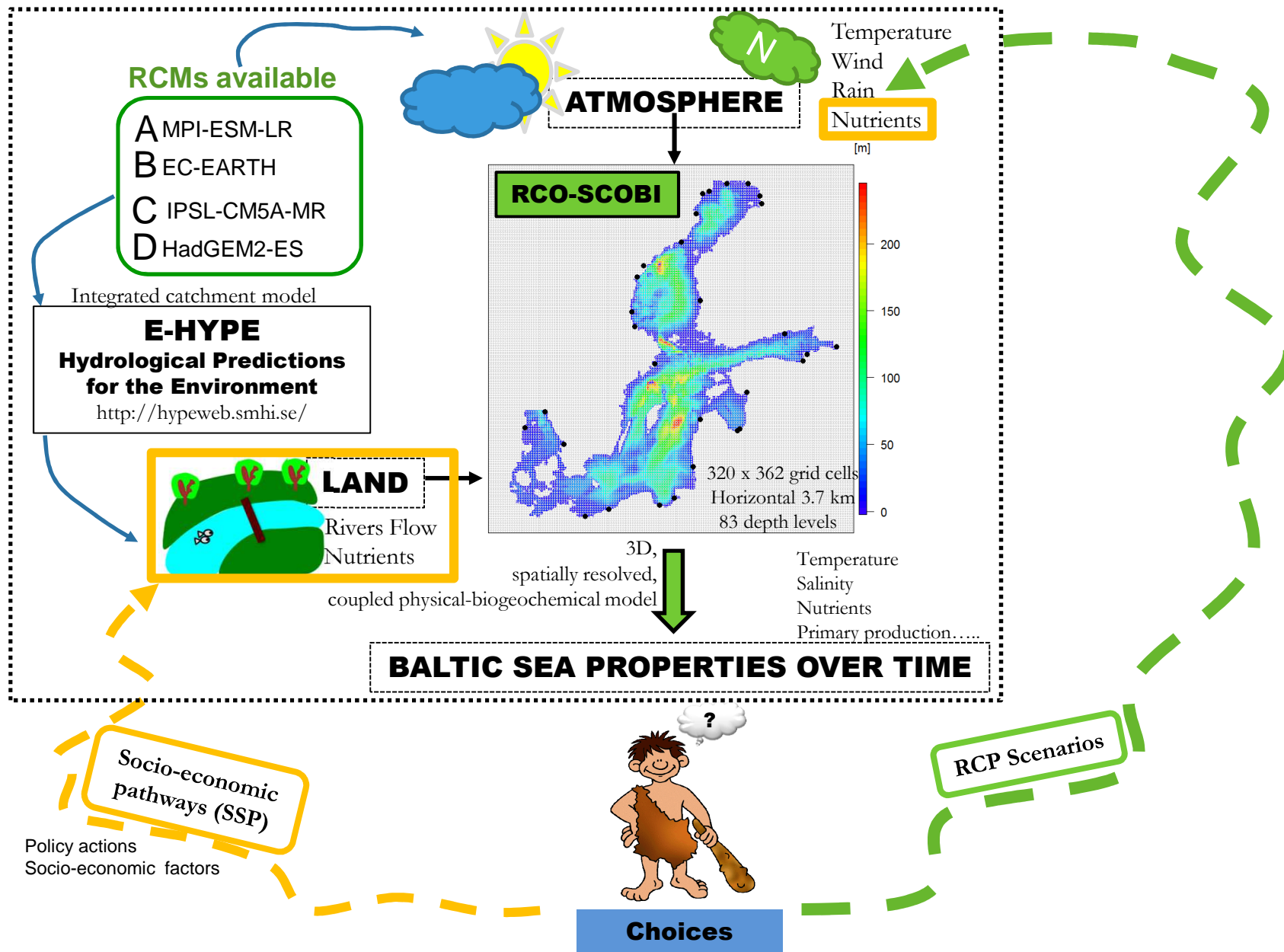
Hindcast

Model A : MPI-ESM-LR
 Model B: EC-EARTH
 Model C:IPSL-CM5A-MR
 Model D: HadGEM2-ES

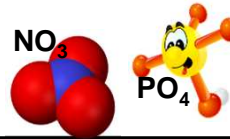


- ❖ Seasonal pattern does not change in the future
- ❖ Differences between present and future climatology are significant
- ❖ There are differences between the models

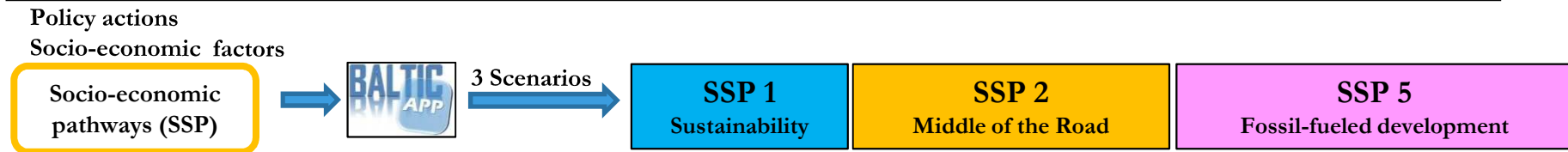
Modelling approach



Future nutrient loads



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BSAP, Baltic Sea Action Plan

- ❖ From 2020, nutrient loads are constant at the levels proposed by the Baltic Sea Action Plan
- ❖ From 2012 to 2020, a linear decrease is assumed from the current loads to the BSAP loads

Reference

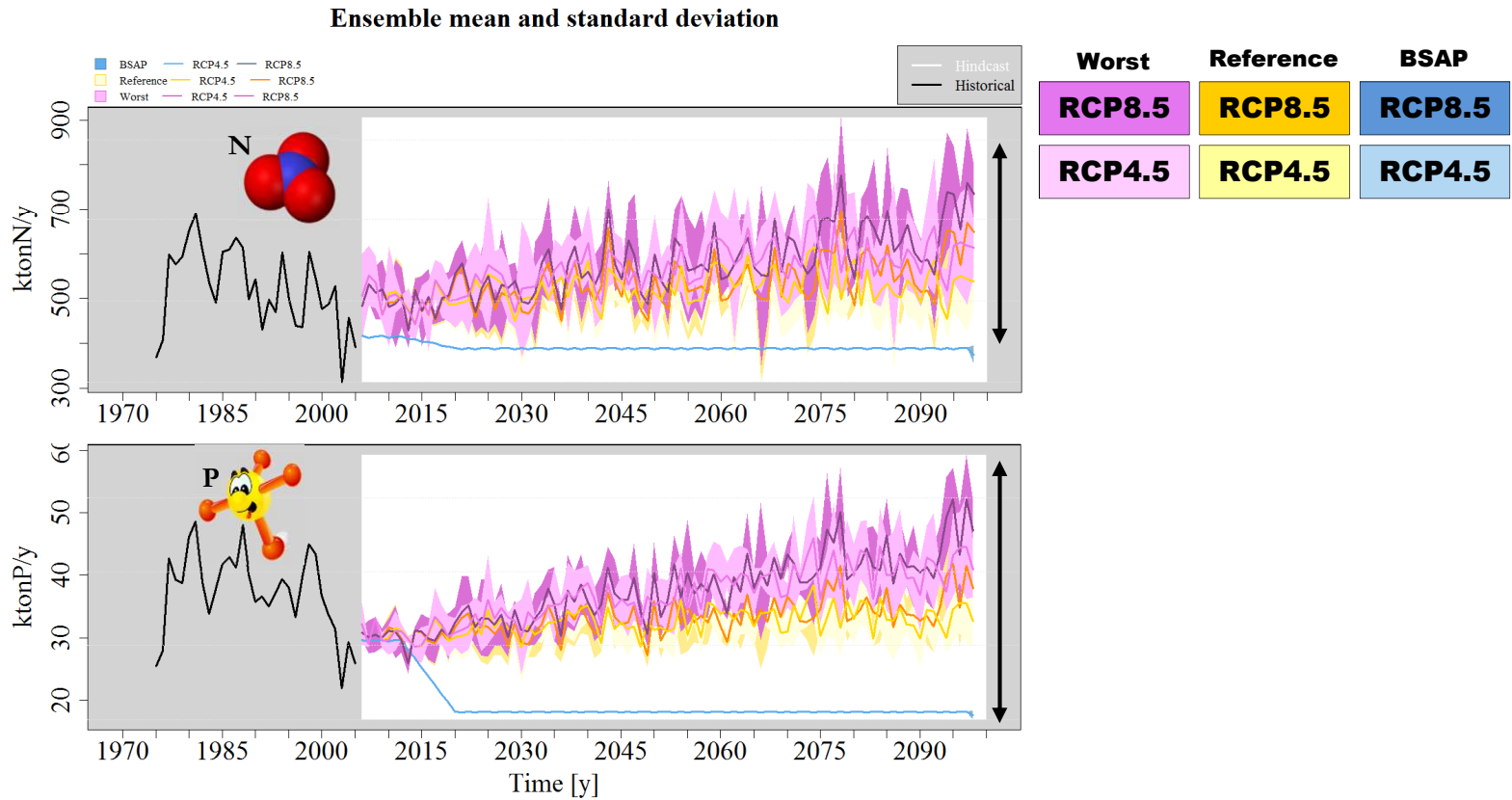
- ❖ *Status quo* scenario
- ❖ Nutrient sources are assumed to be maintained at the same level
- ❖ Changes in nutrient loads are only an effect of environmental conditions and not socio-economic changes
- ❖ Loads are estimated by E-HYPE model assuming the different global climate models projections for the atmosphere conditions

Worst Scenario

- ❖ Loads changes (compared with the current loads) were estimated by Kari et al.
- ❖ Loads changes were applied to the reference scenario for each RCP's and model scenarios
- ❖ Results from the combination of climate effect and socio-economic effects

Future nutrient loads

Riverine N and P



Differences between scenarios are significant

4 Global Climate Models



2 RCP's



3 Nutrient Scenarios

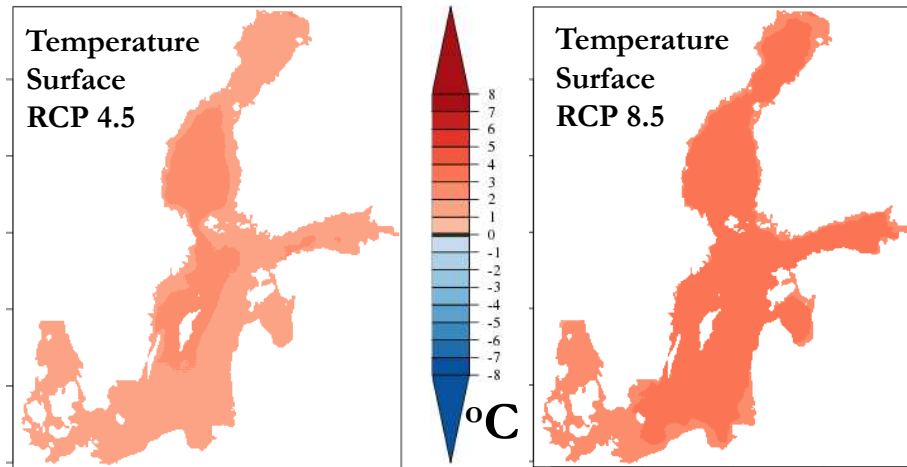


First results

Annual average changes between future and present
2069-2088 and 1976-2005

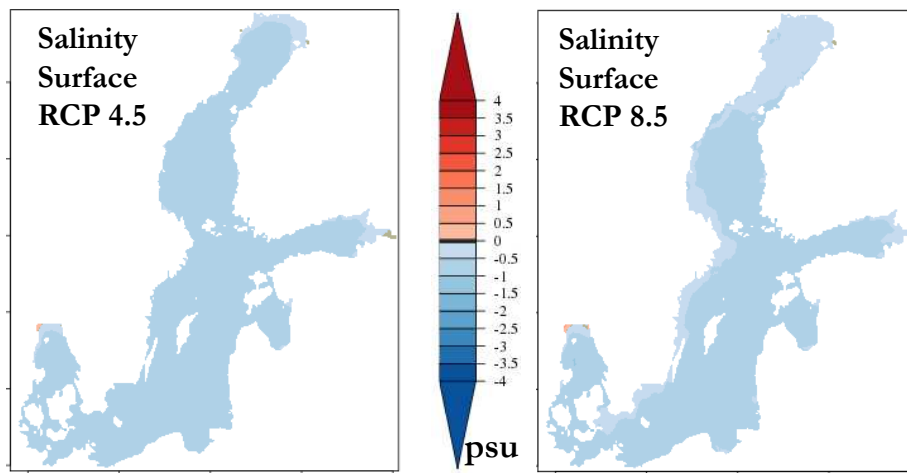


Temperature changes



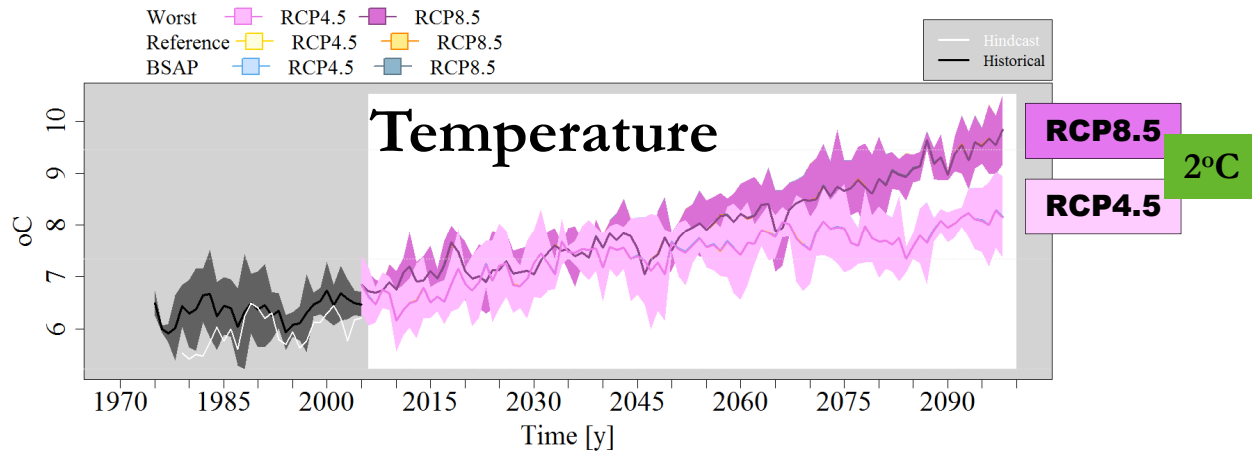
- ❖ RCP 8.5 scenario shows a temperature change with a maximum of 4 °C; most of the area shows an increase above 3 °C
- ❖ RCP 4.5 the increase is below 3 °C
- ❖ Salinity with a maximum of 1.5 psu decrease in RCP 8.5 and 1 psu in RCP 4.5

Salinity changes

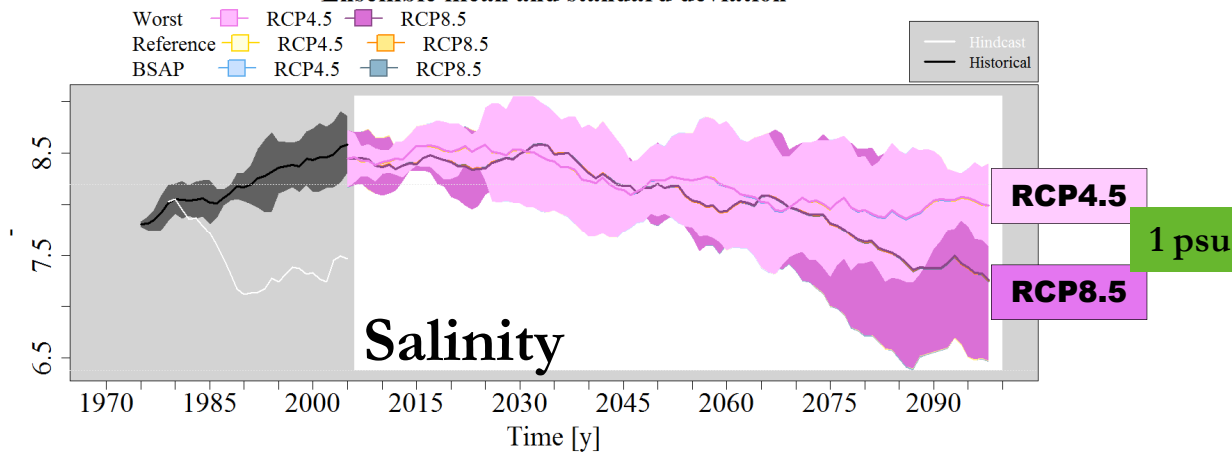
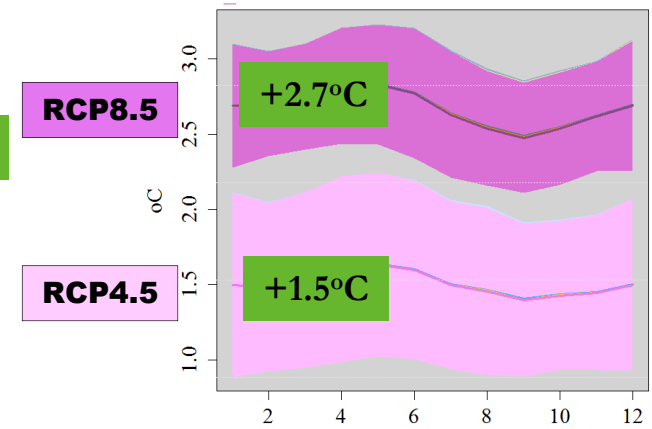


First results:

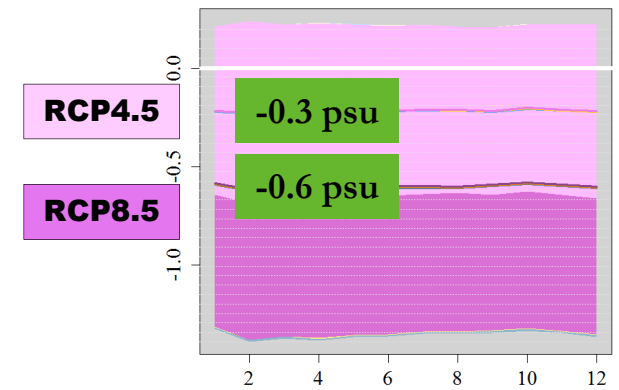
Average in the Baltic Sea



Temperature changes



Salinity changes





Best way of dealing with uncertainties

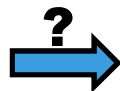
Large ensemble of model simulations

- ❖ 4 Global climate models downscaled projections as atmosphere forcing
- ❖ 2 RCP scenarios
- ❖ 3 Nutrients scenarios that represent 3 SSP scenarios
- ❖ Integrated catchment model results(E-Hype) to project runoff changes
- ❖ RCO-SCOBI, a coupled physical-biogeochemical model with already proven good descriptions of the main processes in the Baltic Sea
- ❖ Cooperation with other fields of knowledge

First results

Seasonal patterns of temperature and salinity do not change significanty

Average	RCP 4.5	RCP8.5
Temperature	+1.5°C	+2.7°C
Salinity	-0.3 psu	-0.5 psu



Nutrient cycle
Primary production
Demand of oxygen



Decision support system

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Thank you!!

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