

Requirements for forecasting marine systems – a non-modeller's view

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Those who have knowledge, don't predict.

Those who predict, don't have knowledge.

-Lao Tzu, *6th Century BC Chinese Poet*

Forecasting is the art of saying what will happen,

and then explaining why it didn't!

-Anonymous

Prediction is difficult, especially if it involves the future.

Nils Bohr

Prediction is easy, getting it right is the difficult part!

Prediction is easy, getting it right is the difficult part!

What does "right" imply?

- Some quantifiable measure of how well the model fits the observations
- For future projections where we won't have observations need some quantifiable measure of the **uncertainty**.

Nomenclature

Projection – IPCC uses this to refer to model-derived estimates of future climate.

Forecast/Prediction - When a projection is branded "most likely" it becomes a forecast or prediction.

Scenario - A scenario is a coherent, internally consistent and plausible description of a possible future state of the world. It is not a forecast; rather, each scenario is one alternative image of how the future can unfold.

Why forecast?

- Fisheries Assessment
 - *Ecosystem Approach to Fisheries Management*
- Future Climate Scenarios
- Many other reasons (HABs, MPAs, etc.)
 - *Model depends on the question you are trying to address*

What kind of Models?

Models are simplification of our world-
Cannot expect them to produce results that explain everything.

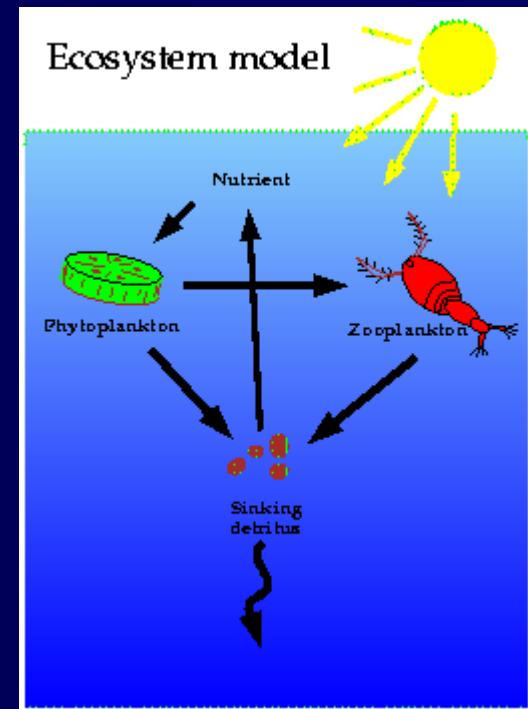
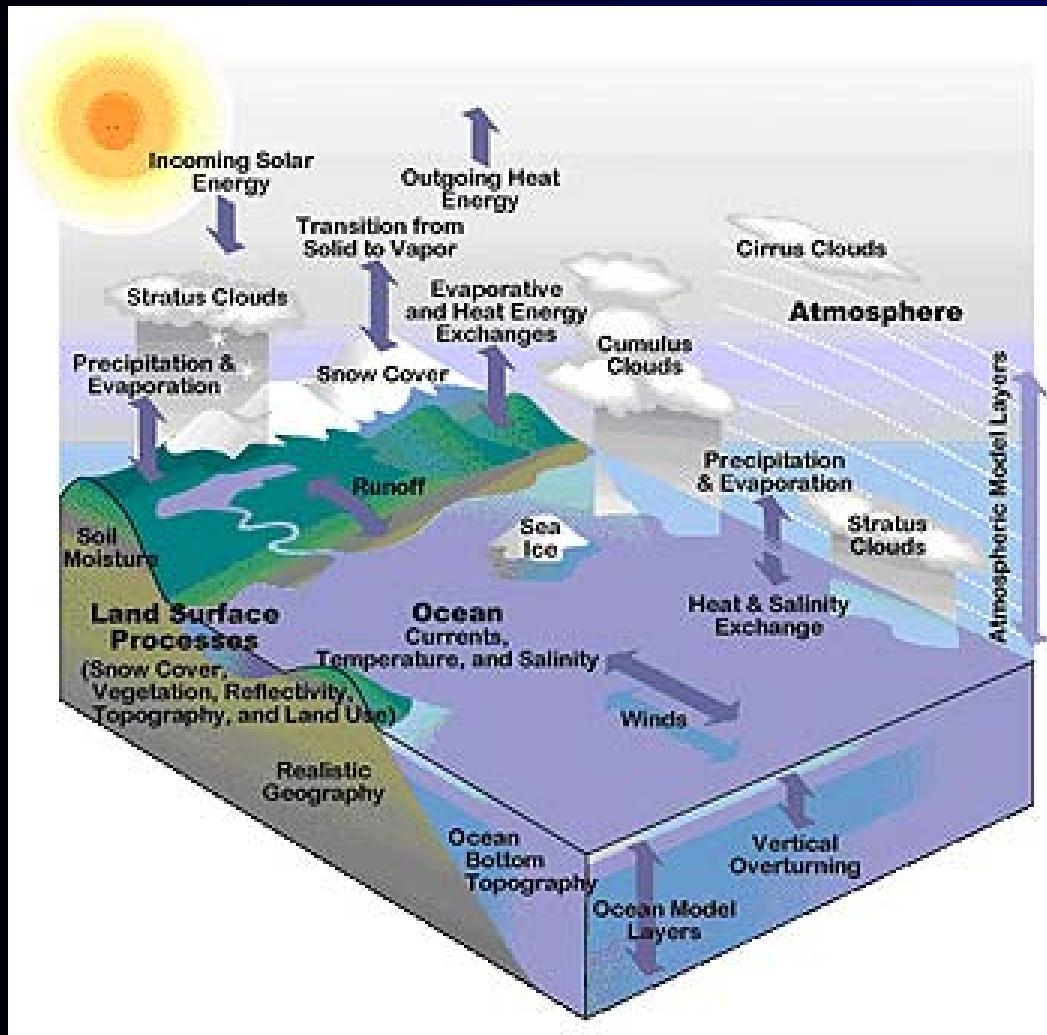
Types of models vary greatly in complexity:
conceptual, analytical, statistical, size spectra,
food-web models, end-to-end dynamical models.

Need all kinds!

A good forecaster is not smarter than everyone else, he merely has his ignorance better organised.

-Anonymous

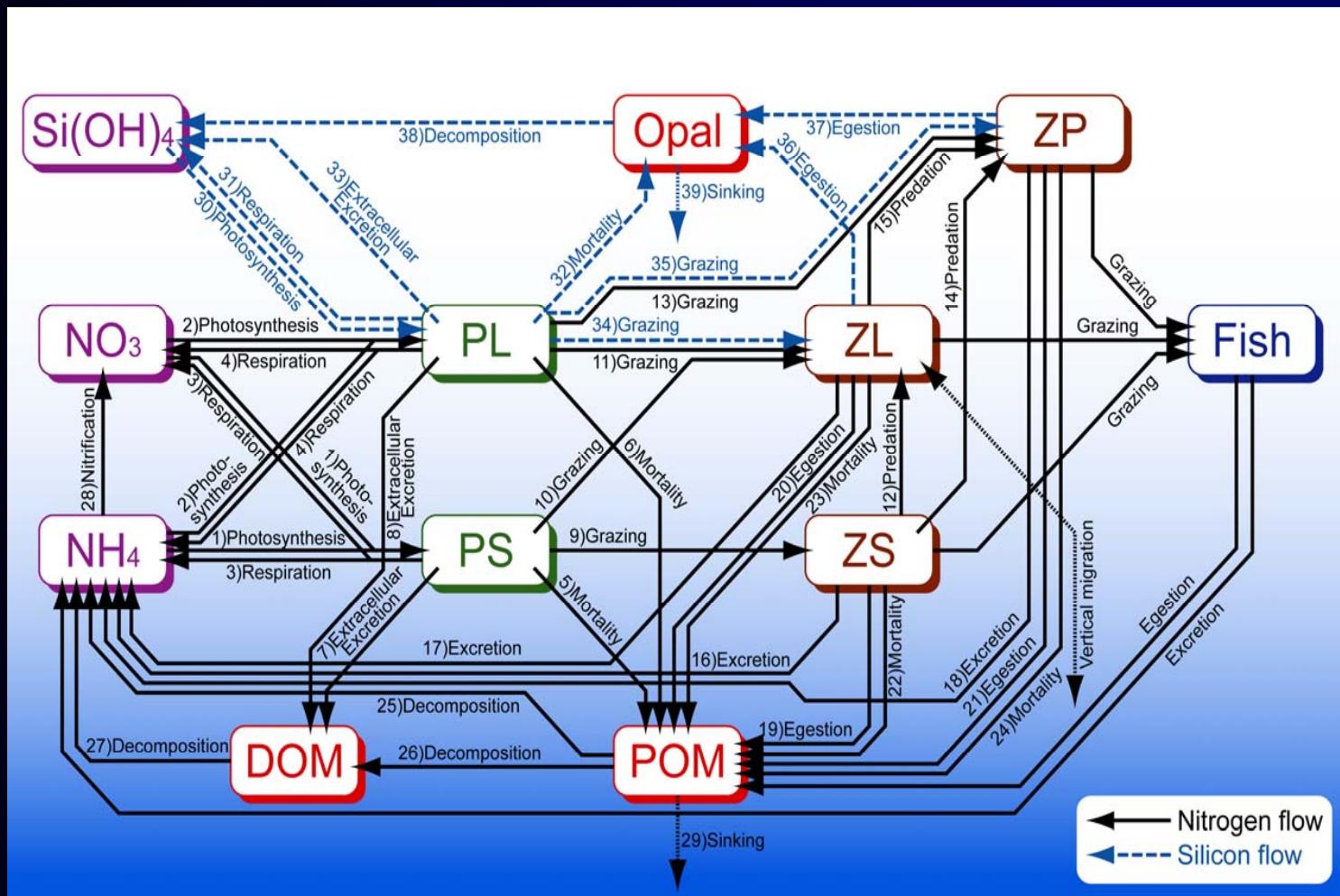
What kind of Models?



NPZ

Climate

What kind of Models?



NEMURO-Fish

Need to improve process understanding

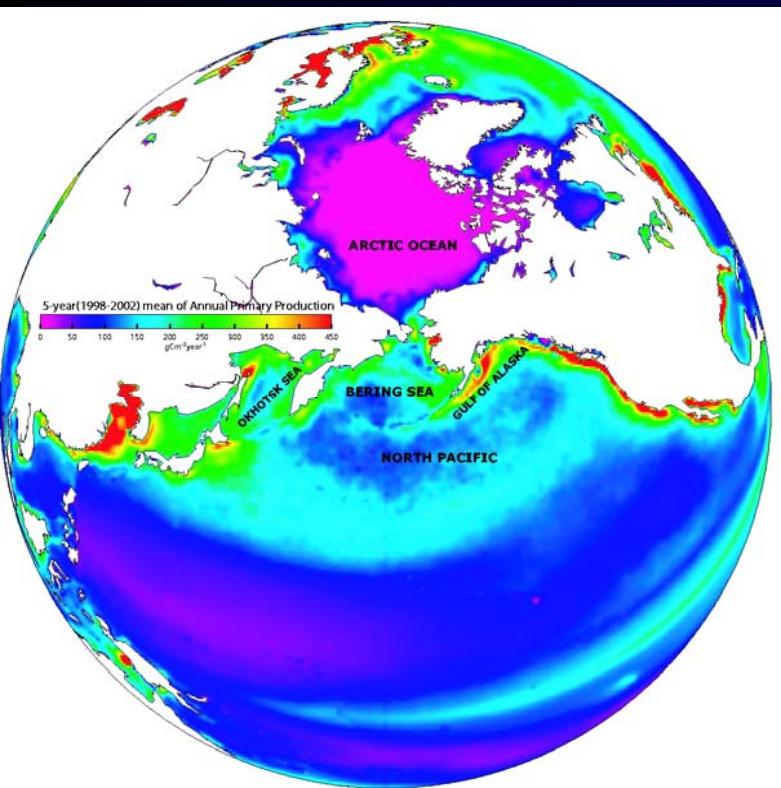
- To make sure that the most important processes to the question at hand are included in the model.
- To improve the parameterization of the processes
- This requires modellers, observationalists and field data, lab studies

Interaction with observationalists

Observationalists and Modellers need to work closer together.

- Modeller's to help determine what, where and how often observationalists should measure.
- Observationalists should provide more feedback on model results (requires available model results, positive criticisms)
- All motherhood statements but not generally done (improving but do we need formal procedure?)

Need Comparative Model Studies



1. Ecosystems are complex – helps determine what is a fundamental process and what is unique.
2. Provides insights that one cannot obtain by looking at a single ecosystem
3. Single model applied to several ecosystems, different models applied to single ecosystem
4. Sharing modelling approaches

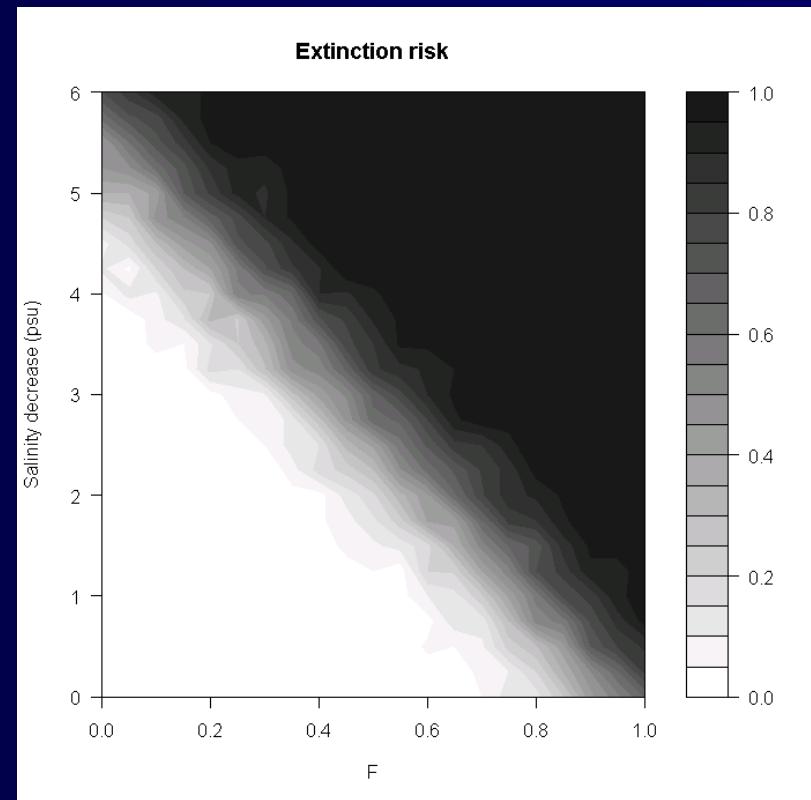
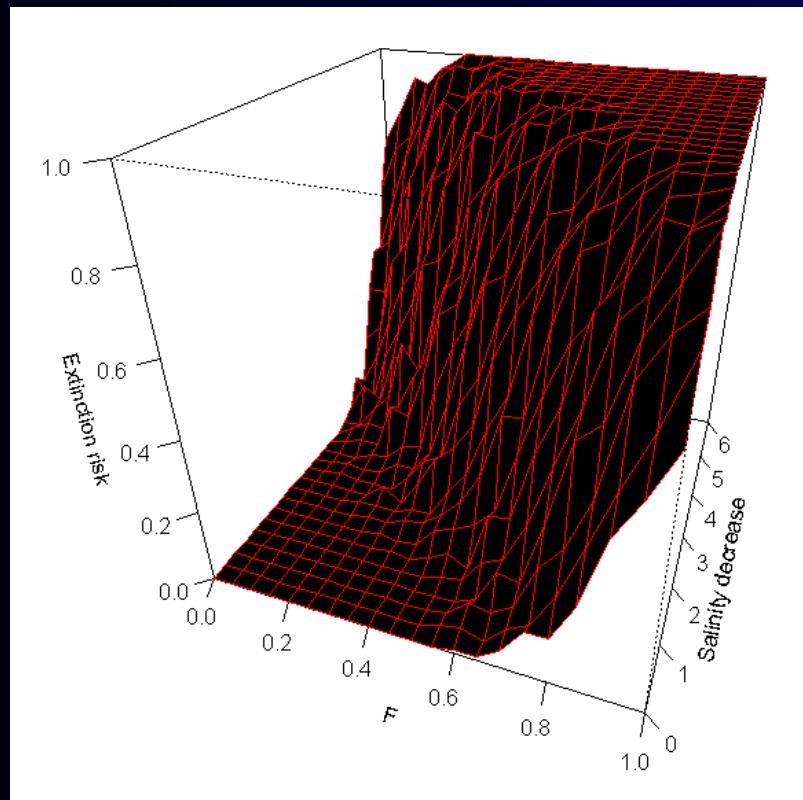
Need to include Fishing Effects



Models need to be used to determine interaction between climate and fishing and explore effects of management strategies on stocks under climate change scenarios.

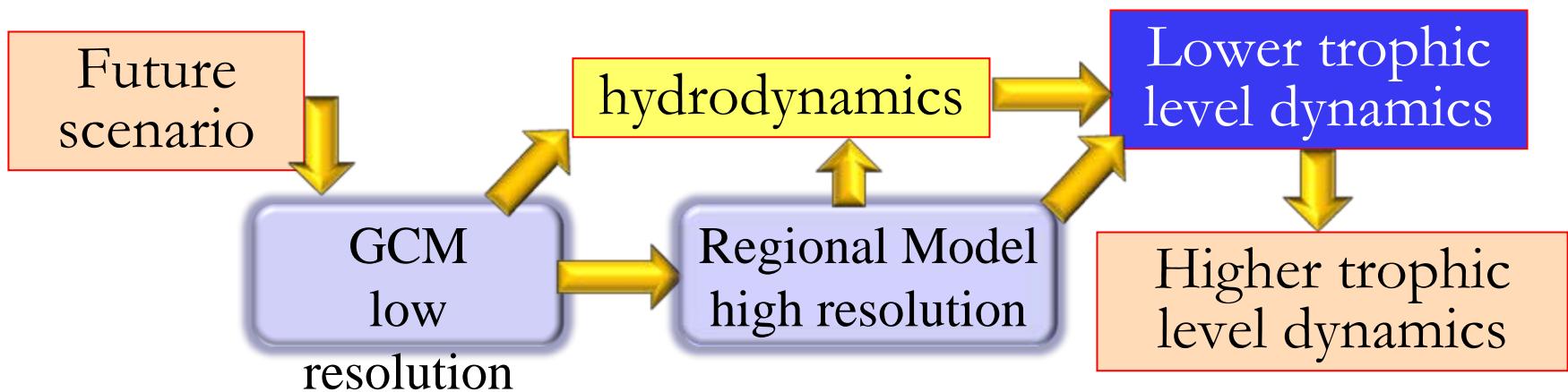
Fishing and Climate

Multivariate autoregressive models of Baltic cod under increasing salinities.



Developing Regional Impacts of Global Change

- Need Regional Models
- IPCC provides Climate Change scenarios from GCMs: **present day** from 1960-to present and **future** up to 2100. Multi-Model Dataset (ensemble runs) of climate scenarios (ipcc-data.org)
- Use IPCC scenario's for '**downscaling**' GCMs output by regional models for hydrodynamics (and biota) in regional seas



Some Present IPCC GCMs Limitations

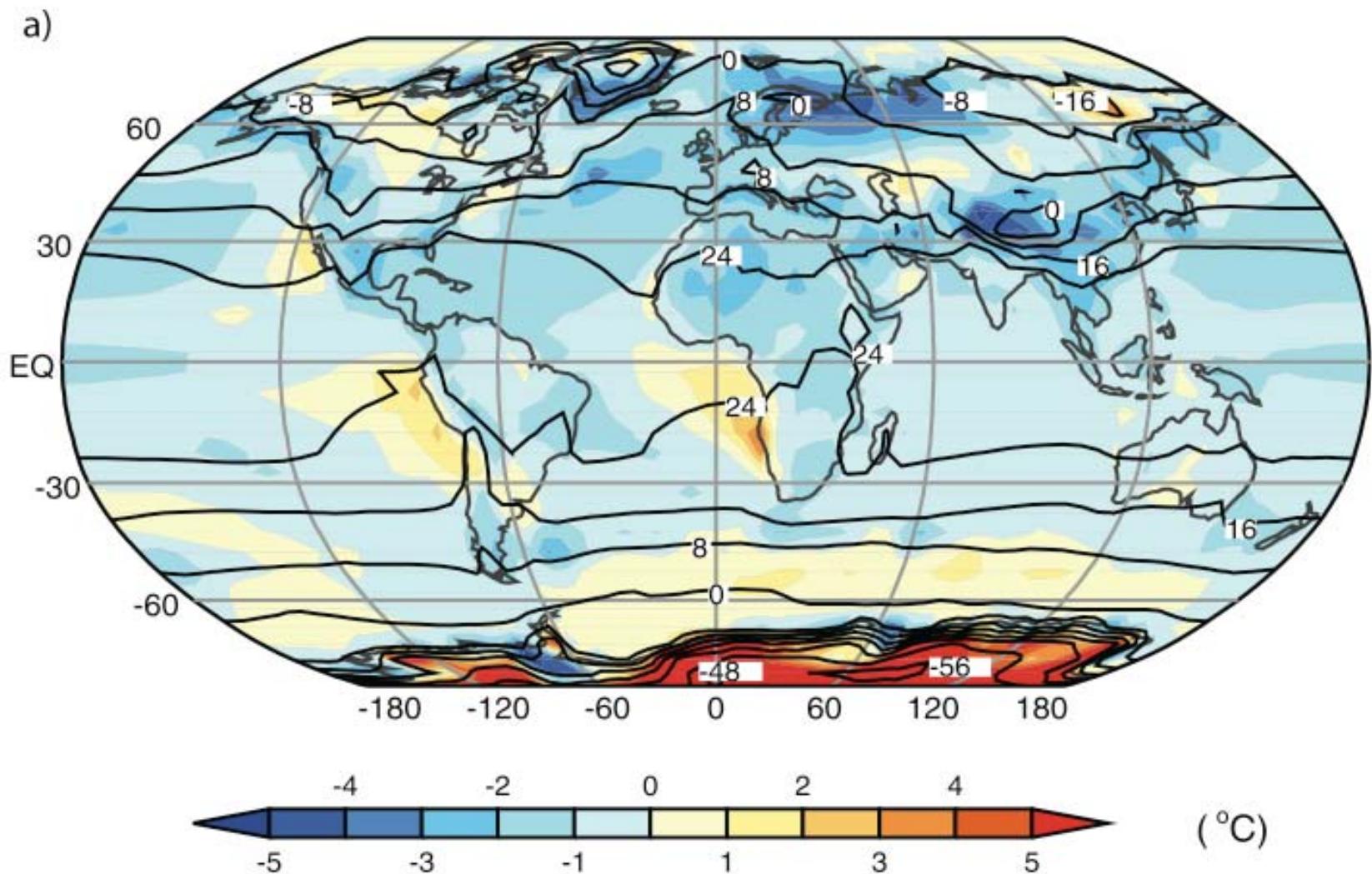
- Small to large (1-3°) scales: mixing and turbulence, friction, waves, clouds, marine optics
- Arctic sea ice conditions not well represented
- Tides, tidal variability has the potential to impact significantly on climate: e.g. (W.Munk et al., 2001)
- No variability considered (temporal, spatial) in tidal forcing (IPCC, 2007)
- Generally poor representation of ENSO, NAO, etc.

IPCC GCMs: Limitations

→ No initialisation to the present state (particular problematic for the ocean)

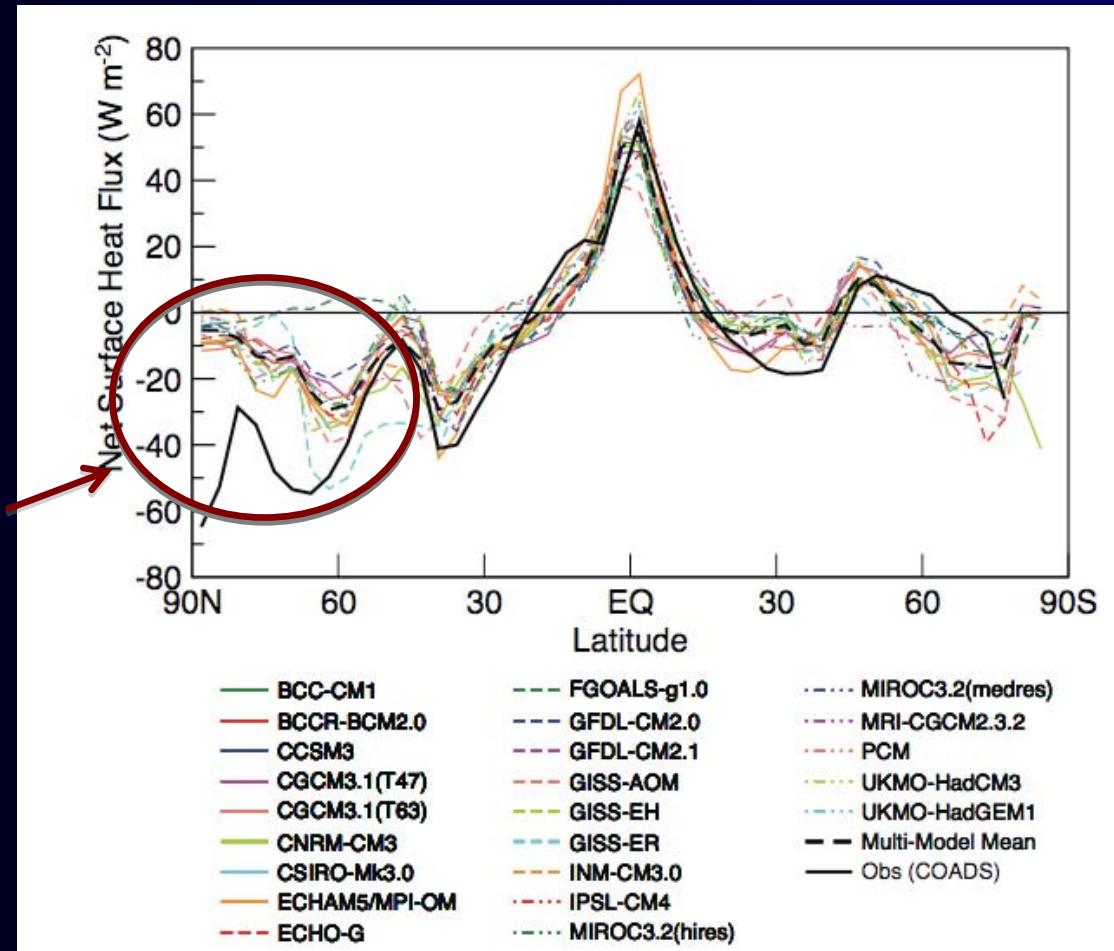
- Dr. Kevin Trenberth (*head of Climate Analysis Section, NCAR*) states:
(...) *None of the models used by IPCC are initialized to the observed state and none of the climate states in the models correspond even remotely to the current observed climate. In particular, the starting state of the oceans, sea ice, and soil moisture has no relationship to the observed state at any recent time in any of the IPCC models.*(...)
(...) *I postulate that regional climate change is impossible to deal with properly unless the (global climate) models are initialized (to the current state).*

Surface Temperature error IPCC model ensemble



Validation of global climate models

Drift
problems?
Sea-ice
problems?



Regional Climate Models

Climatic Change (2007) 81:31–52
DOI 10.1007/s10584-006-9213-4

An inter-comparison of regional climate models for Europe: model performance in present-day climate

Daniela Jacob · Lars Bärring · Ole Bøssing Christensen ·
Jens Hesselbjerg Christensen · Manuel de Castro ·
Michel Déqué · Filippo Giorgi · Stefan Hagemann ·
Martin Hirschi · Richard Jones · Erik Kjellström ·
Geert Lenderink · Burkhardt Rockel · Enrique Sánchez ·
Christoph Schär · Sonia I. Seneviratne · Samuel Somot ·
Aad van Ulden · Bart van den Hurk

**One main conclusion: →RegCM are critically affected by
the driving large-scale fields from GCM and are very similar
to GCM results**

Regional downscaling

IPCC Chapter 11

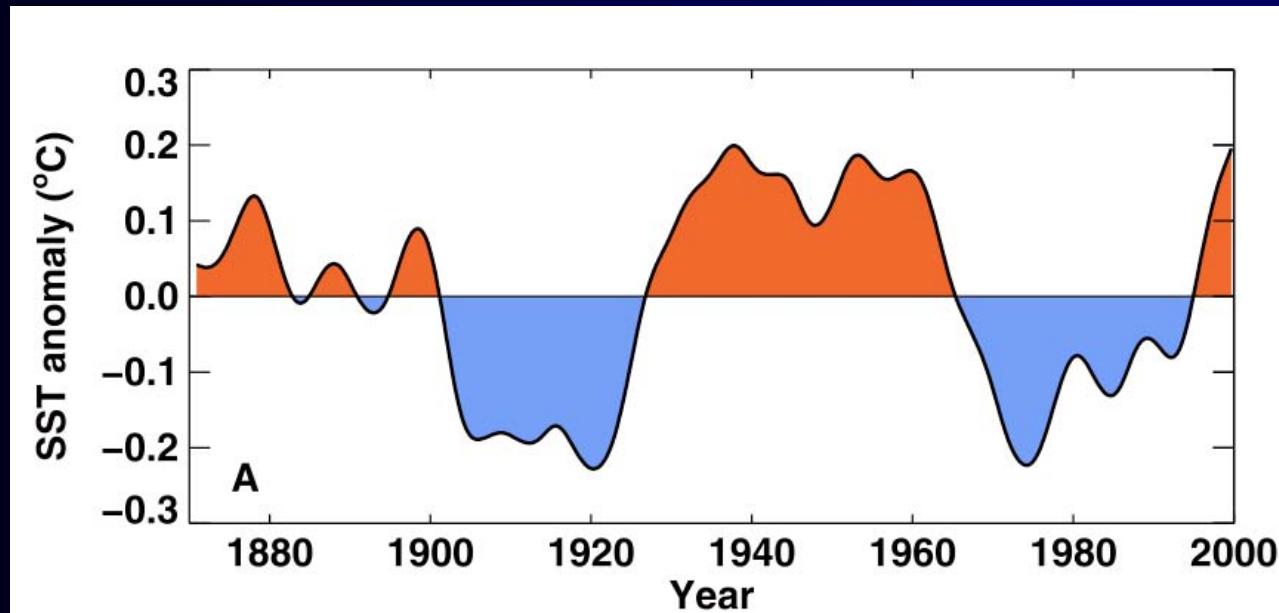
- Only very few coupled ocean-atmosphere models on the regional scale
- Fewer models do ensemble runs using different global models
- Regional models that are available mostly use previous IPCC global model assessments
- Few full dynamics ocean model → none reported in the last IPCC
- Few coupled ecosystem models → none reported in the last IPCC report

Regional downscaling

- Until GCMs improve will remain highly uncertain
- Still need to get on with it
- Need to downscale from more than one model
- Use GCMs that perform best (Overland and Wang)
- Need to provide some measure of the uncertainty together with results

Recently: Improved global decadal predictions by improving initialisation

- Doug Smith et al., 2007, Science
- Noel Keenlyside et al., 2008, Nature



Related publications indicated the importance of AMO for the NA region - Knight et al. (2005) and Knight et al. (submitted)

Keenlyside et al., 2008

...in the near future, natural decadal variability in the Atlantic and Pacific may not only override the regional effects of global warming but temporarily weaken it. Thus, a joint initial/boundary value problem has to be considered when forecasting North Atlantic sector and global climate variability for the coming decades.

Next IPCC Runs

- Going to full Earth System Models
- Many of the models will be total new with increased number of paramaterizations
- Will this lead to increased spread in model ensemble?

Conclusions

- Must continue to use a wide variety of models
- Model used depends upon the question being asked.
- Need closer ties between modellers and observationalists.
- Comparative studies between models needs to be encouraged.
- Models needed to explore interaction between climate and fisheries.

Conclusions

- Need to express quantitatively how well the models are performing
- For future projections need to develop indices of uncertainty
- GCMs need improving before we can improve regional models
- Need to get on with ecosystem projections even if they are highly uncertain.

Other points

- Don't worry about failure – it points to our lack of understanding or incorrect parameterization. We only learn when we are making mistakes.
- Expect surprises!