Forecasting primary production in the Nordic Seas and the Arctic

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Outline

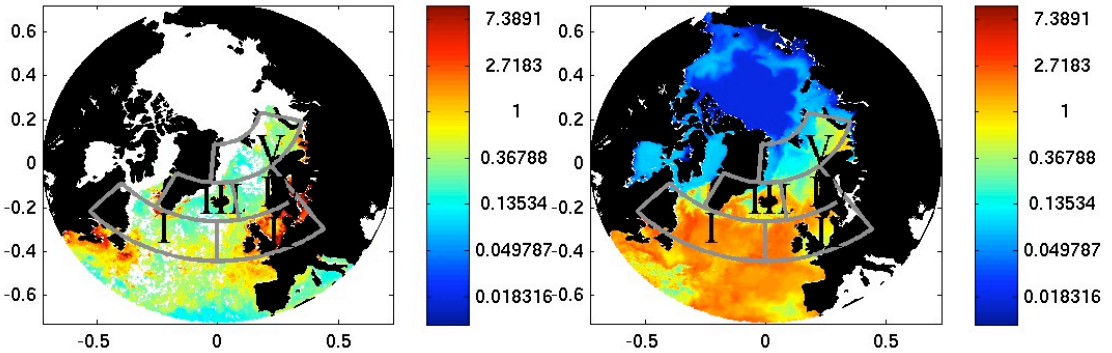
- Forecasting system
- What are the requirements for a primary production forecasting system (discussion)?
  - For the MyOCEAN project we are going to produce forecasts of nutrients, chlorophyll, and phytoplankton biomass.
- Future plans

Forecasting system

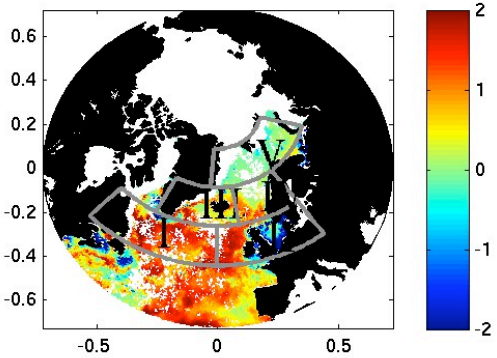
- Physical model: TOPAZ-system
  - NERSC version of HYCOM.
  - Ensemble Kalman Filter (EnKF) assimilation of sea-ice and sea surface temperature.
  - The assimilation of ARGO profiles is under development.
- Biogeochemical Model
  - NORWECOM
  - Nutrients: Silicate, Nitrate, Phosphate
  - Phytoplankton: diatoms and flagellates
  - Organic material: detritus and biogenic silica
  - Oxygen

Chlorophyll – example April 2007

MODIS-aqua



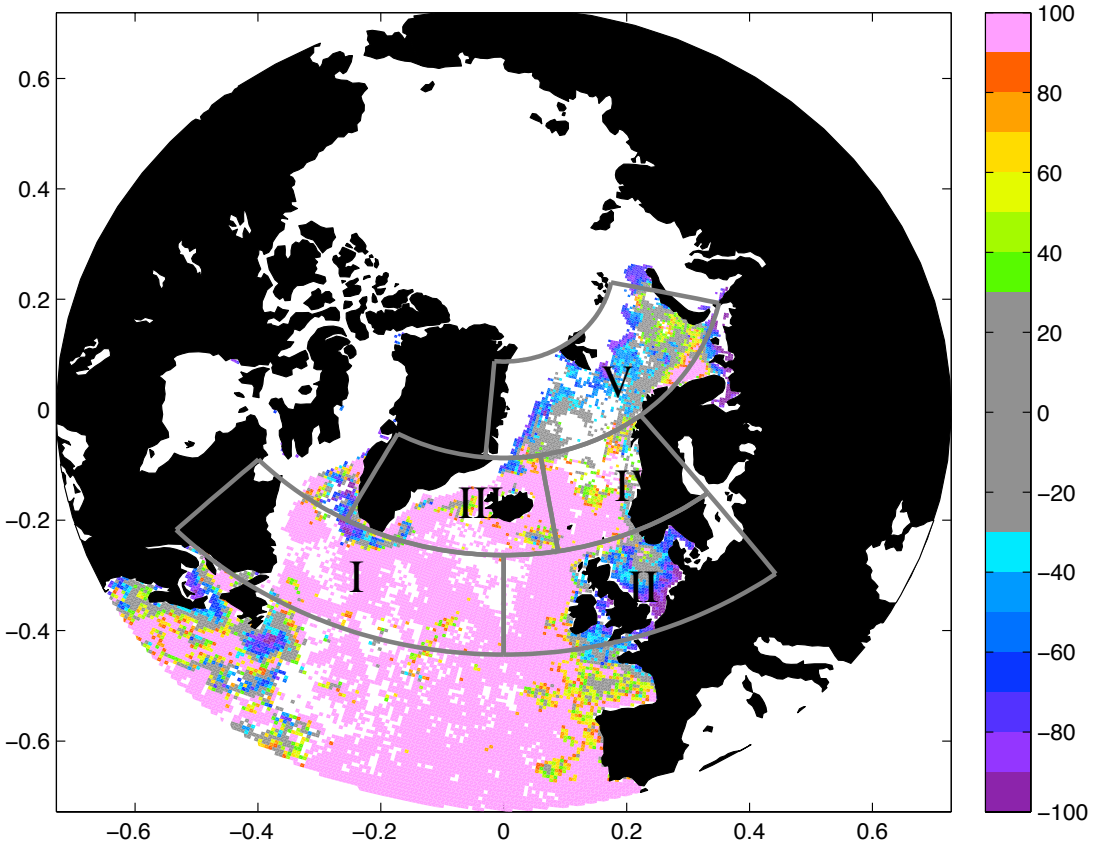
model



MODIS-aqua - model

Chlorophyll – example April 2007

Percentage model bias



Model requirements

- Obviously we can not require that the model is perfect, but how good should the results before the model should be used operationally?
- The aim of the forecast is to:
  - forecast algae blooms.
  - monitor ecological quality of the water.
  - decide if an area is subject to eutrophication
  - other???
- The quality required of the model should be decided with respect to its use, not with respect to what data are available for validation.

Model requirements

- The requirements should probably be decided before the evaluation of the model is performed.
- Ideally, the quality required should be decided by the users.
- Ideally, the validation dataset should be made with respect to the requirements.
- BUT, what are the requirements?
- Which methods should be used to evaluate the model?

Ecological quality according to the Oslo-Paris convention (OSPAR)

- N:P ratio:
  - normal: 16
  - elevated > 24
- Chlorophyll
  - normal mean: varies between areas.
  - elevated mean: ~ 50% above normal values.
- Oxygen
  - normal: > 6
  - elevated: 4-6
- How good must the model be to determine water quality?

Error quantification

- Model bias (Allen, 2007):
  - > 40% poor
  - 20%-40% good
  - 10%-20% very good
  - < 10% excellent
- Cost function (Radach and Moll, 2006)
  - < 1 very good
  - 1-2 good
  - 2-3 reasonable
  - > 3 poor
- Model efficiency (ratio of the model error to the variability of the data – Allen, 2007)
  - > 0.65 excellent
  - 0.65-0.5 very good
  - 0.5-0.2 good
  - < 0.2 poor

N:P ratio

- Normal : 16, elevated 24
- Example: If nitrate has a positive bias of 22% and phosphate has a negative bias of 22% the model will show that the values are elevated even though they are not (false alarm).
- Yet, a bias of between 20 and 40% is regarded as good.
- Without reliable runoff data (with nutrients) from land, trends in the nutrient ratios is not possible to detect.

Chlorophyll

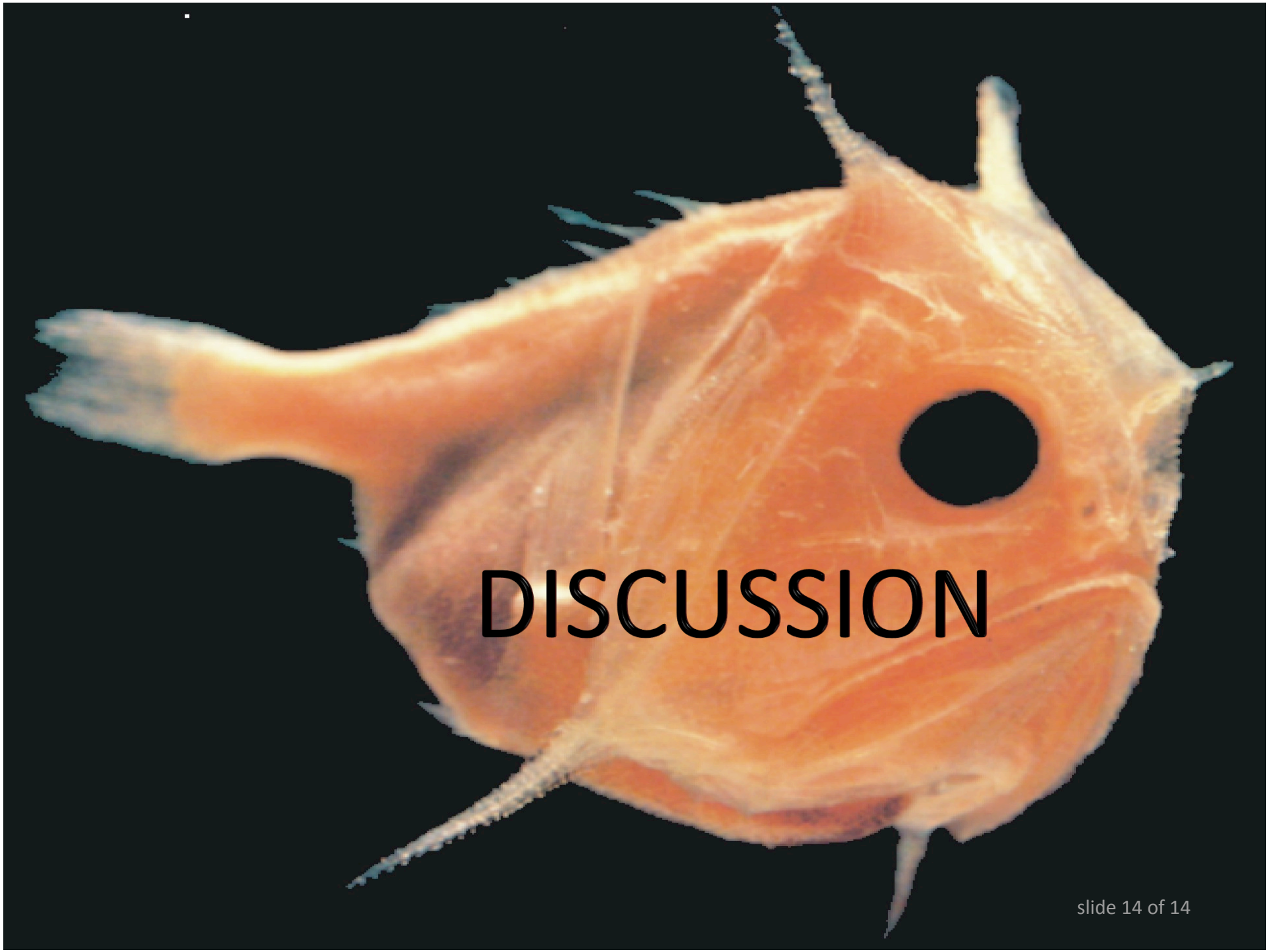
- A value of 50% above the normal mean is considered elevated.
- We have 11 years of satellite monitoring, so the ‘normal’ value should be well known.
- Although this value is best known in case 1 waters, which is probably less likely to experience eutrophication.
- What maximum error should we require on the chlorophyll results?

Oxygen

- Oxygen, normal: > 6, reduced: 4-6
- The low oxygen values often occur close to the bottom, can we reliably identify areas where the oxygen is reduced?

Future plans

- HYCOM
  - vertical and horizontal resolution
- NORWECOM
  - sensitivity analysis
  - wish list:
    - Improved advection scheme for tracers
    - Bio-optical model?
    - Benthic model?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