A high resolution fully coupled atmosphere ocean sea ice model to investigate polynya processes in the Laptev Sea

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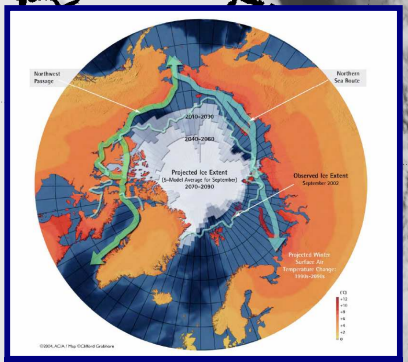
1. BMBF project Laptev Sea: Polynya systems face changes

(IFM Geomar Kiel, AARI St. Petersburg, AWI Bremerhaven, Uni of Trier, ADW Mainz)
embedded in the IPY-project "Complex Investigations of Seasonal Cycle in the Arctic Seas"

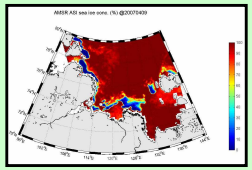
- Circumpolar polynyas are of vital importance for the ice production and feedback processes regarding energy and water budget
- Dramatic environmental changes are forecasted to occur in the Shelf areas of the Siberian Arctic during this century (-> Economic impact) (see Figure)
- Polynyas play crucial role in the Arctic Climate and global ocean circulation
- Key region Laptev Sea: freshwater supply (Lena river), ice formation, salt release, strong turbulent heat fluxes
- Analysis of spatial and temporal variability of sea ice in the Laptev Sea show a large degree of uncertainty about the role of dynamic and thermodynamic factors and possible feedback mechanisms in the atmosphere-seaice ocean system (Bareiss and Görgen, 2005)



Projected Change in Ice Extent (ACIA, 2004)

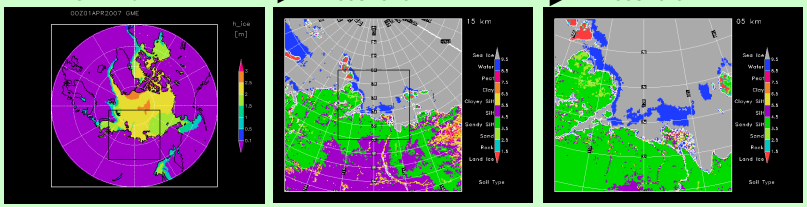
2. Model Setup

- The atmospheric global model GME
- The atmospheric meso-scale mode COSMO (Consortium for Small-scale Modeling, Deutscher Wetterdienst): 15 km and 5 km
- Sea ice cover from remote sensing data



Initial sea ice cover 9 April 2007 (AMSR – 6.25km)

GME – 40km → **COSMO-15km** → **COSMO- 5km**



- Finite Elemente Sea Ice Ocean Model FESOM (AWI Bremerhaven)

Initial ocean temperature and salinity (WOA-2005) →

FESOM
> Hydrostatic ocean circulation model
> AWI sea ice model (EVP rheology)

5. Future Work

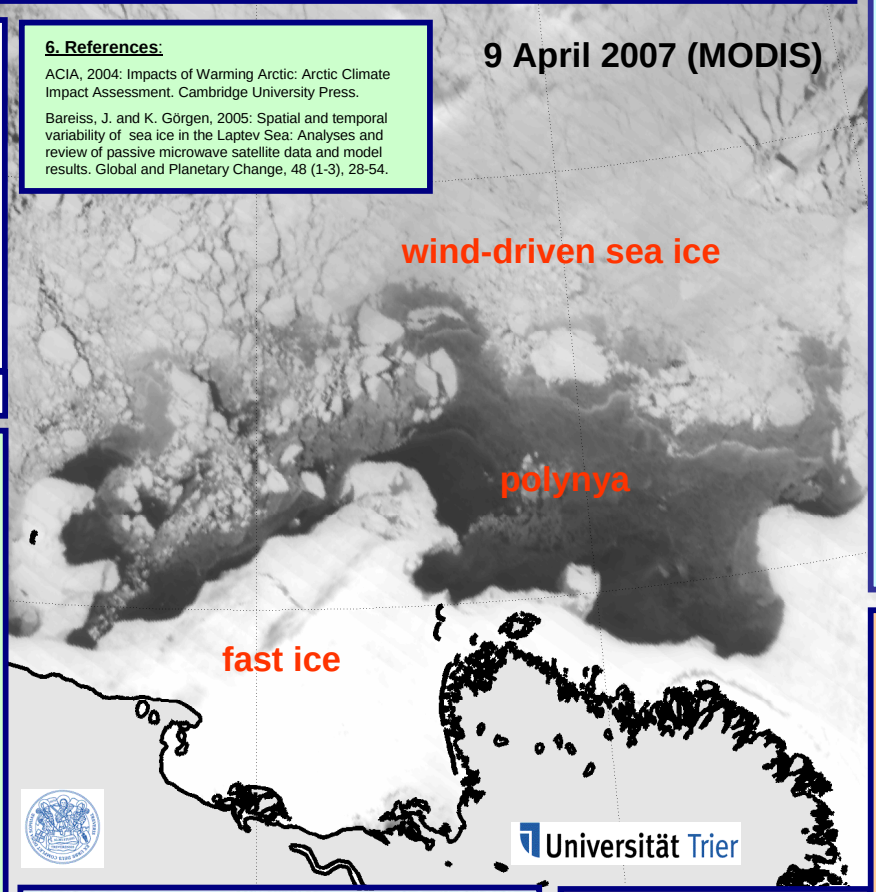
- Implementation of a thermodynamic sea ice model in COSMO
- FESOM case studies (forced with NCEP, GME)
- FESOM: Ocean Initialisation (couple of weeks, constant sea ice)
- Coupling COSMO – FESOM
  - Implementation of surface turbulence scheme from COSMO into FESOM
  - Calculation of turbulent surface fluxes in FESOM and radiative fluxes in COSMO
- Case and principle studies with coupled model system
- Verification with in-situ measurements (field experiments) and remote sensing data

Setup of field experiments in the Laptev Sea area 2008 and 2009

6. References:

ACIA, 2004: Impacts of Warming Arctic: Arctic Climate Impact Assessment. Cambridge University Press.

Bareiss, J. and K. Görgen, 2005: Spatial and temporal variability of sea ice in the Laptev Sea: Analyses and review of passive microwave satellite data and model results. Global and Planetary Change, 48 (1-3), 28-54.



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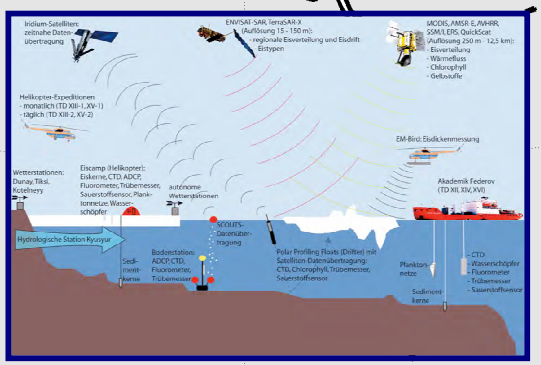
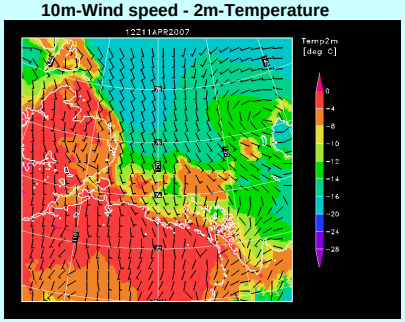


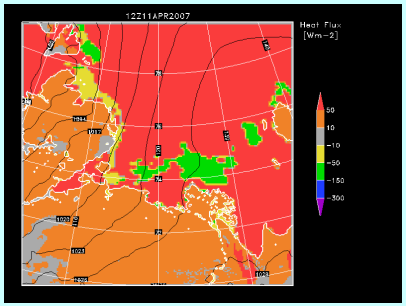
3. Case study: Offshore winds (9–12 April 07)

11 April 12 UTC (COSMO-5km)

10m-Wind speed - 2m-Temperature



Total turbulent surface heat flux - PMSL



> Surface **energy loss (negative values) of 100 Wm-2 leads to an ice formation of 3 cm per day**

4. Sensitivity studies:

Total turbulent heat flux and mean sea level pressure anomaly on 11 April 12 UTC

Above figure:
"Basic run" minus
"Run with 100 % sea ice cover"

Bottom figure:
"Basic run" minus
"Run without sea ice"