Continuous discontinuities: comparing observed and modelled sea ice deformation features

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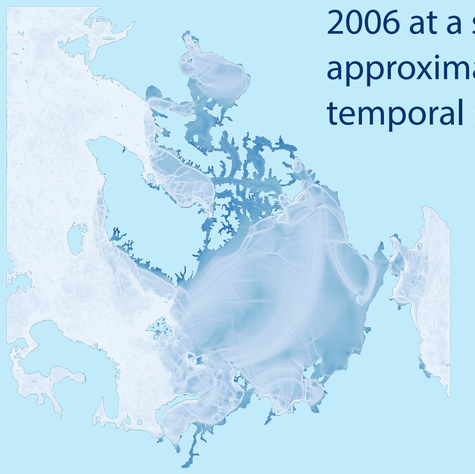
Introduction

The impact of the change in Arctic sea ice coverage on the global climate requires a thorough understanding of ice dynamics. Sea ice motion is mainly driven by wind, ocean currents and internal ice stress.

On time scales of days to weeks, linear kinematic features, such as leads and ridges, evolve on spatial scales ranging from meters to tens and hundreds of kilometers. Similar features also emerge in numerical sea ice models when the resolution of the simulations is increased to a few kilometers. We will develop tools to evaluate their realism in simulations with the help of satellite-based observations.

Model setup

We use Arctic-wide MITgcm simulation data for 2006 at a spatial resolution of approximately 4.5 km, with a temporal resolution of 1 day.



MITgcm example: total deformation, log scaled, 2006-01-04

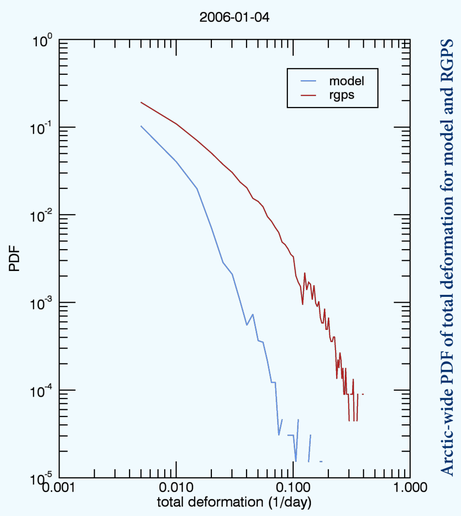
RGPS example: total deformation, log scaled, 2006-01-04

Satellite observations

Our method development is based on the RGPS dataset. The RGPS has a spatial resolution of 12.5 km, and a temporal resolution of 3 days.

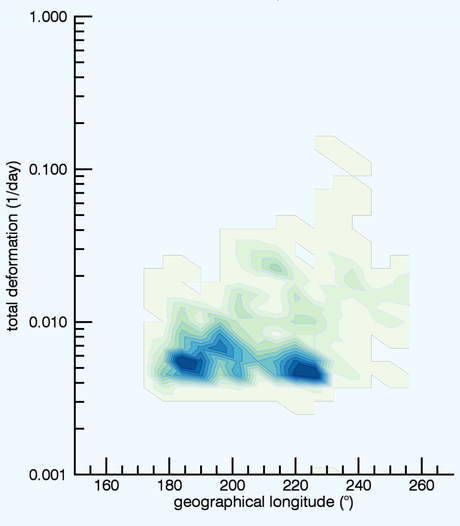
Model evaluation

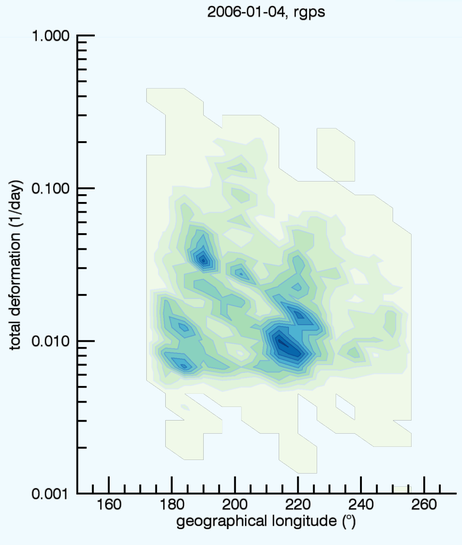
- scaling properties of sea ice deformation → comparison only meaningful at the same spatial and temporal scales
- resampling of model velocities to RGPS resolution
- total deformation from 3-day aggregate model velocities
- model results underestimate deformation (as expected)



Spatial statistics

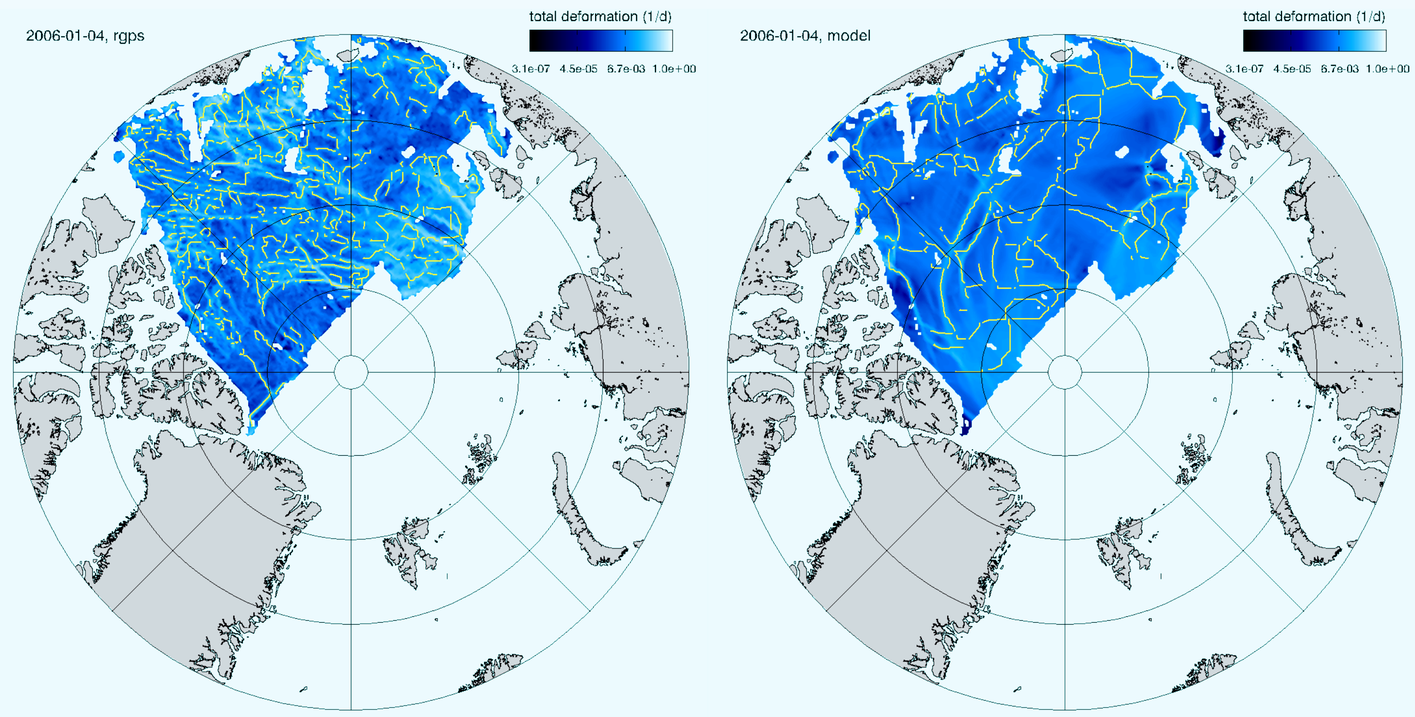
- investigation of regional characteristics allows more detailed insights into the distribution of deformation features
- example: distribution of total deformation over geographical longitude, latitude range: 70°-90°, obtained from results of the object detection





Object detection

- applied methods: image segmentation and object detection
- higher number of detected features in RGPS, model results are less detailed
- orientation of large-scale features is often consistent in both datasets
- expected results: statistics of lead distribution, number, orientation, ...



Summary

The comparison between modelled and observed sea ice deformation requires the analysis of the spatio-temporal context of the obtained deformation features. We are in the process of developing a method for the spatial analysis of sea ice lead networks which is based on a combined segmentation and object detection.

First results show the large potential of the method, but require further refinements. Once mature, the method will be applied to high-resolution sea ice deformation fields obtained from SAR images.

References:

Kwok et al. (1990) An Ice Motion Tracking System at the Alaska SAR Facility, IEEE J. of Oceanic Engineering, 15, 44-54

Girard et al (2009) Evaluation of high-resolution sea ice models on the basis of statistical and scaling properties of Arctic sea ice drift and deformation, Journal of Geophysical Research: Oceans, 114

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