Antrag auf ein Testprojekt am DKRZ

- mit 1000 Knotenstunden
- und 2TiB Plattenplatz

per Mitte Oktober 2021

Antragsteller: Hans von Storch, Institut für Küstendynamik, Helmholtz Zentrum HEREON, Geesthacht; hvonstorch@web.de; 0171 212 2046

Hintergrund: Es handelt sich um die Fortsetzung einer Kooperation mit der Ozean-University of China, Qingdao, Prof. X. Chen über das Aufkommen und die Signifikanz von kleinskaliger hydrodynamische interne Variabilität („Rauschen“) Im Gelbem Meer und in der Ostsee. In den zurückliegenden Jahren sind dazu eine Reihe von Publikationen entstanden mit Doktoranden aus Qingdao (China) unter der Anleitung von Hans von Storch und Xueen Chen (siehe unten).

Der ehemalige HZG/HEREON-Institutsleiter Hans von Storch ist inzwischen entpflichtet; seine Arbeiten sind nicht als zentral in der Programmatik des Instituts für Küstendynamik eingeordnet, sodaß ihm ein signifikanter Zugriff auf DKRZ-Ressourcen des HEREON nicht möglich ist.

Das Projekt gliedert sich in zwei Teilprojekte:

a) **Gelbes Meer**, Mrs. Lin Lin, aufgrund eines genehmigten Anstrages bei China Scholarship Council (CSC) zum Thema*: Internal variability of the Bohai and Yellow Sea ecosystem-phytoplankton bloom.* Frau Lin Lin wird unter der Anleitung von Hans von Storch für 1 Jahr, beginnend in Oktober 2021, forschen.
Des geht dabei um: “Simulating the seasonal variation of the bloom and spatial pattern of the bloom intensity with coupled ecosystem-hydrodynamic model FVCOM-ECOSMO in the Bohai and Yellow Sea, and analyzing the impact of hydrodynamics internal variability on the regional and local ecosystem.” Die Arbeiten sind in vier Blöcke aufgeteilt:
“1) A small ensemble of hydrodynamic simulation of Bohai and Yellow Sea for 10 years with 2km resolution in Bohai and 10km resolution in the Yellow Sea
2) Determination of the internal variability level of hydrodynamic noise in the Bohai and in the Yellow Sea.
3) Coupling the FVCOM with ecosystem model ECOSMO. Simulation of the Bohai and Yellow Sea seasonal variation and spatial pattern of bloom.
4) Determination of the scale-dependent the signal-to-noise ratios of internal variability and external forcing in the ecosystem variability. “
Die ersten beiden Arbeitsschritte sind für das kommende Jahr vorgesehen, während Frau Lin Gast bei HEREON sein wird. Dabei werden zwei Publikationen erwartet, einmal zur Saisonalität der Intensität und der regionalen Manifestation des Rauschens, und die Limitierung des Rauschens durch die Gegenwart von Tiden.
Das verwendete Modell wird im Anhang beschrieben.
Bis dato kann der Ressourcenbedarf nicht mit ausreichender Sicherheit angegeben werden; daher wird es einen regulären Antrag erst im Frühjahr 2022 geben.

b) **Ostsee,** Mrs. Fan Wenxin. Ankunft in Deutschland noch unklar wegen Visavergabe. Gemeinsame Betreuung mit Dr. Ute Daewel.
Titel der Untersuchungen mit dem Ziel einer Promotion: „*Deriving spatiotemporal statistics of eddies in the Baltic Sea and its significance on the surface drift spreading*".
Eine ausführliches Planungsdokument liegt vor. Demnach ist für die erste Phase vorgesehen**: "**The research strategy will follow to some extend the work of CSC-student Zhang Meng at Helmholtz-Zentrum Geesthacht (HZG; Zhang et al., 2019) on eddies in the South China Sea. To do so, she made use of the output of a 10-km grid resolution eddy- permitting ocean model, covering the time 1950-2010. First, the model was shown to compute a realistic large-scale state; then an eddy-detecting and tracking algorithm was developed and used to derive the aforementioned statistics. In our case, we will make use of a 70 years simulations of the combined North Sea/Baltic Sea with a grid resolution of 2 km. Even finer gridded data will be used, when it becomes available at HZG or elsewhere. In this phase, Dr. Ute Daewel of HZG will join the supervision of Ms. Fan. A by-product may be a visualization of beddy-movement for several years, using software available at the German Climate Computer Center (DKRZ)."

Auch hier gilt es, nach der Ankunft der Studentin zunächst die technischen Details zu klären, um dann zum nächsten regulären Antragstermin ein Vollantrag zu stellen.

Teilprojekt "Gelbes Meer": Model description:

The regional ocean model used in future study is based on an Unstructured-grid Finite Volume Community Ocean Mode (FVCOM, version 3.2.2). The greatest advantage of the finite-element method is its geometric flexibility. To provide an accurate fitting of the irregular coastal boundary, triangular grid meshes of arbitrary spatially dependent size are used. FVCOM discretizes the integral form of the governing equations. Since these integral equations can be solved numerically by flux calculation over an arbitrarily sized triangular mesh, the finite-volume approach is better suited to guarantee mass conservation in both the individual control element and the entire computational domain (Chen et al., 2007). It has been widely adopted for exploring the coastal and regional ocean dynamics (Chen et al., 2007; Ge et al., 2015; Lai et al., 2015; Xuan et al., 2017). The current version of FVCOM is fully coupled ice-ocean-wave-sediment-ecosystem model system with options of various turbulence mixing parameterization, generalized terrain-following coordinates, data assimilation schemes, and wet/dry treatments with inclusion of dike and groyne structures under hydrostatic or non-hydrostatic approximation (Chen et al., 2007).

Model configuration:

A general model configuration used in the following study is given below:

The Mellor and Yamada level 2.5(MY-2.5) turbulent closure model (Mellor and Yamada, 1982) and Smagorinsky eddy parameterization method are used to calculate the vertical and horizontal diffusion, respectively. The model domain covers the Bohai and Yellow Sea (31.885°-40.942°N and 117.572°-126.915°E) (Fig. 1a). The Bohai and Yellow Sea are shallow, with average depths of 18 m and 44 m, respectively. The open boundary across the Yellow Sea extends from Qidong in China eastward to the southern tip of the Korean Peninsula, and radiation boundary condition is used. The grid resolution is approximately 1 km along coastal region to 8 km near the open boundary and 30 layers in vertical. Six-hourly surface forcing data are from the National Centers for Environmental Prediction (NCEP) Climate Forecast System Version 2 (CFSv2) data, with a global resolution of 0.20°×0.20°, including the sea surface temperature, cloud cover, air pressure, wind, specific humidity, evaporation, precipitation, and heat flux.

Aim:

To simulate the hydrodynamic characteristics of the Bohai and Yellow Sea, and analyzing tide effects on the internal variability in the Bohai and Yellow Sea.

The main work content:

(a) Analyze weather there is a link between the seasonal cycles of stratification and of noise generation. To do so, we need to have four members of a multiyear simulation (3 or 5 years) with tides with slightly different initial conditions.

(b) Determine the dynamics of a marginal sea differ when tides are present.

Reference:

Chen, C.S., Huang, H.S., Beardsley, R.C., Liu, H.D., Xu, Q.C., Cowles, G., 2007. A finite- volume numerical approach for coastal ocean circulation studies: comparisons with finite difference models. J. Geophys. Res. 112 (C03018), 1–34. https://doi.org/10. 1029/2006JC003485.

Ge, J., Shen, F., Guo, W., Chen, C., Ding, P., 2015. Estimation of critical shear stress for erosion in the Changjiang Estuary: a synergy research of observation, GOCI sensing and modeling. J. Geophys. Res. Oceans 120, 8439–8465. https://doi.org/10.1002/ 2015JC010992.

Lai, Z., Ma, R., Gao, G., Chen, C., Beardsley, R.C., 2015. Impact of multichannel river network on the plume dynamics in the Pearl River estuary. J. Geophys. Res. Oceans 120, 5766–5789. https://doi.org/10.1002/ 2014JC010490.

Mellor, G. L., and T. Yamada, 1982: Development of a turbulence closure model for geophysical fluid problems. *Reviews of Geophysics*, **20,** 851-875, https://doi.org/10.1029/RG020i004p00851.

Xuan, J., Huang, D., Pohlmann, T., Su, J., Mayer, B., Ding, R., Zhou, F., 2017. Synoptic fluctuations of the Taiwan Warm Current in winter on the East China Sea shelf. Ocean Sci. 13, 105–122.

Previous publications of the group of Hans von Storch with significance for the proposed Testprojekt:

1. Geyer, B., T. Ludwig, and H. von Storch, 2ß21: Reproducibility and regional climate models - seeding noise by changing computers and initial conditions. *Communications Earth & Environment 2,17,* DOI 10.1038/s43247-020-00085-4
2. Tang, S., H. von Storch, and Chen X, 2020: Atmospherically forced regional ocean simulations of the South China Sea: Scale-dependency of the signal-to-noise ratio. *J. Phys. Oceano.* 50, DOI 10.1175/JPO-D-19-0144.1 133-144
3. S Zhang M., H. von Storch, Wang, D., Chen X., and Li D., 2019: Statistics of travelling eddy variability in the South China Sea, 1950-2010. *Ocean Dyn.* 69: 879-898. 10.1007/s10236-019-01282-2
4. Tang, S., H. von Storch, Chen X., Yhang M., 2019: "Noise" in climatologically driven ocean models with different grid resolution. *Oceanologia* 61,300-307. DOI 10.1016/j.oceano.2019.01.001
5. Zhang M., and H. von Storch, 2017: Towards downscaling oceanic hydrodynamics - Suitability of a high-resolution OGCM for describing regional ocean variability in the South China Sea. *Oceanologia* 59, 166-176, DOI 10.1016/j.oceano.2017.01.001