Project: **1003**

Project title: **SMART-CHAOS**

Principal investigator: **Maik Thomas**

Report period: **2017-07-01 to 2018-06-30**

The combination of scientific sensors and subsea telecommunication cables would benefit a wide range of scientific areas. The so called SMART cables (Scientific Monitoring And Reliable Telecommunications) could supplement or replace existing observing systems and provide long-term, high-resolution in situ measurements for ground-truthing satellites, improving tsunami early warning systems and supporting ocean and climate research (Howe et al. (2015)).

In 2016/2017 preliminary data assimililation studies were conducted in the project SMART-CHAOS. Synthetic ocean bottom pressure (OBP) measurements were assimilated in an identical twin study into the ocean model MPIOM.

The goal for 2017/2018 was to extend the data assimilation framework to the coupled atmosphere-ocean model ECHAM6/MPIOM. In the second half of 2017 difficulties in the implementation of the data assimilation framework into MPIOM arose, hindering the attempt of a coupled atmosphere-ocean data assimilation. Instead, fraternal twin studies were conducted and synthetic observations from the regional ocean model (ROMS) were assimilated into the ocean model MPIOM. The data assimilation framework was prepared to accommodate not only observations from SMART cables but also from other ocean observing systems, such as DART buoys and GRACE.

Different data assimilation techniques were employed to assimilate synthetic observations of OBP from SMART cables into MPIOM. Largest improvements in ocean dynamics were obtained with the local Singular Evolutive Interpolated Kalman (SEIK) filter with a localization radius of 2000 km (cf., fig. 1).

In the fraternal twin study synthetic observations of OBP are generated from a global high resolution ocean simulation from ROMS. These observations are assimilated into MPIOM and the result is compared to an unconstrained simulation with MPIOM of the same time span. In the data assimilation experiment the representation of OBP is improved by up to 40% (cf., fig. 2), and sea surface height (SSH) by up to 30%. The correlations are improved by up to 0.5 for both variables.

By assimilation of observation data from individual cables the influence of each cable on global ocean dynamics has been established. Largest influence is simulated for the two cables connecting Hawaii to New Zealand and Japan to New Zealand. Each of the cables reduces the error in the surrounding area by up to 30% and the global error by 7%.

References:

Howe, B. M., and Workshop Participants, From space to the deep seafloor: Using SMART submarine cable systems in the ocean observing system, Report of Workshops, 9-10 October 2014, Pasadena, CA, and 26-28 May 2015, Honolulu, HI, (2015).

Nerger, L., Hiller, W. & Schröter, J. PDAF-the parallel data assimilation framework: experiences with Kalman filtering: in Use of High Performance Computing in Meteorology (Zwieflhofer, W. & Mozdzynski, G.) 63–83 (2005).

Pham, D. T., Verron, J. & Gourdeau, L. Filtres de Kalman singuliers évolutifs pour l'assimilation de données en océanographie. C. R. Acad. Sci. 326, 255–260 (1998).

Weber, T., Saynisch, J., Irrgang, C., Thomas, M., Constraining ocean models with ocean bottom pressure from SMART cables, JGR: Oceans (submitted)

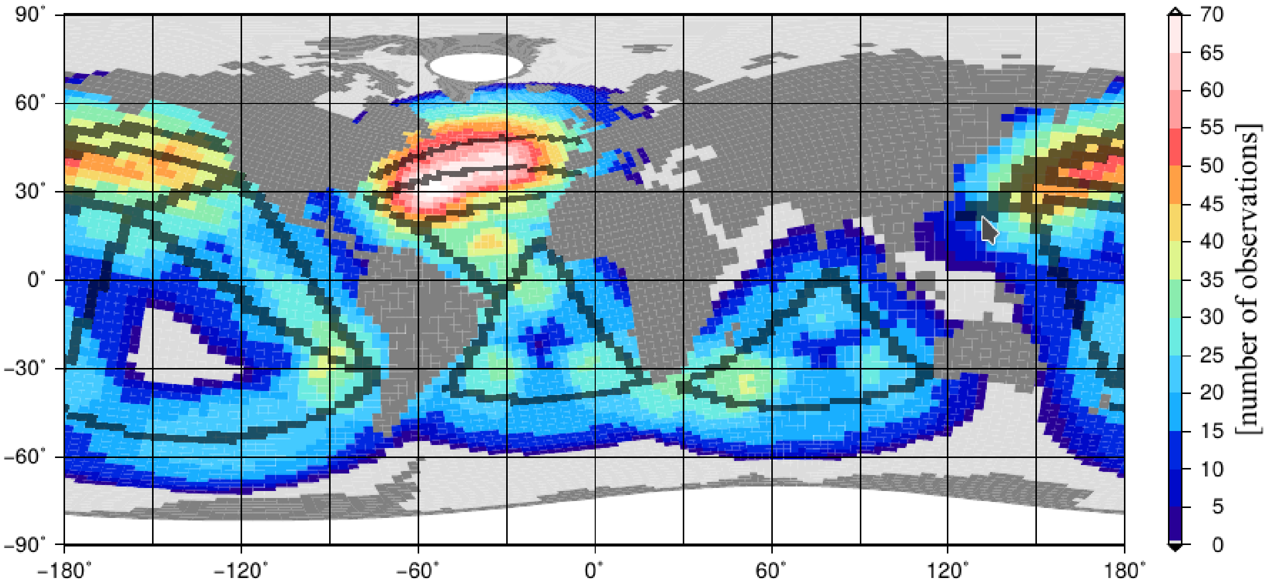

Fig. 1: Number of observations available at each grid cell of the GR30 ocean grid for the local SEIK filter with a localization radius of 2000 km. Gray lines indicate location of possible future SMART cable sensors. The light gray areas indicate locations outside of a 2000 km radius of the SMART cables.

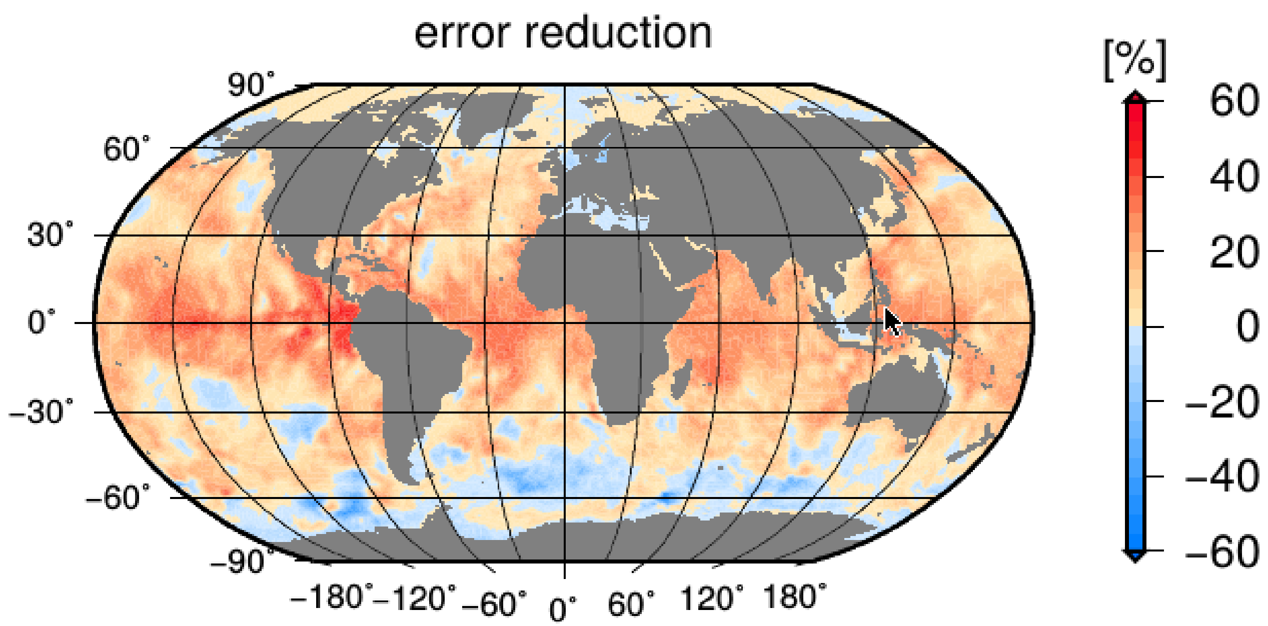

Fig. 2: Reduction of the error of OBP as obtained by data assimilation of synthetic OBP observations with the local SEIK filter over a period of one month.