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Preface: Ernst Maier-Reimer and his way of modelling the ocean

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Ernst Maier-Reimer was one of the most influential ocean model developers of modern times and at the same time a modest person (Hasselmann, 2013). As both a researcher and a supervisor of young researchers, he had a major impact on the field. In the past three to four decades, a substantial part of Ernst's research was dedicated to the numerical simulation of biogeochemical matter cycles in the global ocean.

Being a physicist by education, Ernst's oceanographic career started with numerical modelling of ocean currents at the oceanographic department ("Institut für Meereskunde") of Hamburg University in the 1970s. After becoming a member of the then newly founded Max Planck Institute of Meteorology, he developed the global coarse-resolution Large Scale Geostrophic Ocean General Circulation Model (Maier-Reimer et al., 1993). Through his innovative combination of computational gridding, implicit numerical algorithms, and filtering methods, this "LSG" could use a long time step of 1 month. That model became by far the fastest dynamical global ocean model ever. In the 1980s, when supercomputers were only slowly emerging, the "LSG" was the only ocean model which could provide fully equilibrated prognostic water masses in the entire ocean within practical integration times. For any scientist who needed to run the global ocean repeatedly into full equilibrium, the "LSG" was the model of choice. In addition, Ernst provided a further dynamical ocean model (HOPE; see Marsland et al., 2003) that in contrast to the LSG allowed finer resolution and improved reproduction of ocean variability.

In the 1980s, the need for sound projections of climate under growing human-induced CO_2 emissions became pronounced. Ernst provided – through collaboration with the Scripps Institution of Oceanography – the first interactive physical–biogeochemical ocean carbon cycle climate model (Bacastow and Maier-Reimer, 1991; Maier-Reimer and Hasselmann, 1987). Soon, further additions to the model were made (Maier-Reimer, 1993), including an ecosystem model inspired by the work of Fasham et al. (1993) and later on an interactive water column–sediment module based on the concept of Archer et al. (1993). Quantification of ocean CO_2 uptake, ocean primary production, and paleo-climatic carbon cycle changes could now be conducted in a dynamical framework, making kinematic box models partly redundant.

This did not go unnoticed by ocean researchers who were working on ocean biogeochemistry more from the observing side. They approached Ernst in order to employ his model as a laboratory for exploring their ideas. Fruitful collaborations between Ernst and Egon T. Degens, Wallace S. Broecker, and many other colleagues developed.

In the 1990s, Ernst extended his physical and biogeochemical ocean models for use in coupled state-of-the-art Earth system models. The HAMOCC Model (Hamburg Ocean Carbon cycle Circulation Model) became an archetypal model version for marine carbon cycle modules in Earth system models. Olivier Aumont was strongly influenced by HAMOCC in building the PISCES model, the ocean biogeochemistry model coupled to the NEMO dynamical ocean model (Aumont et al., 2003). Over the years, more and more – coupled – tracer cycles were implemented into HAMOCC. The internal consistency of the model and its excellent mass conservation contributed to the credibility of the results produced.

Ernst was an excellent scientist who also had a broad range of knowledge outside of his key expertise. For students and colleagues, he always took time for discussions and to help them solve their problems. Many master theses and PhD theses in the field of ocean modelling were only successful because of Ernst's advice and support, especially in critical situations when the "chips were down". A visit to Ernst's office in many cases could solve the modelling problems in an instructive and practical way. Ernst's key talent was his ability to separate the important from the less important. His models were elegant, efficiently programmed, and suited the purpose for which they were created.

This special issue of *Biogeosciences* aims at honouring Ernst's work. It brings together some of his former colleagues and students to commemorate his contributions and to show how his way of thinking, modelling, and quantifying continues to be present in ongoing work. The issue includes papers on additions of new tracer cycles to ocean biogeochemical models (Archer and Blum, 2018; Pätsch et al., 2018; van Hulten et al., 2017), on important questions related to ocean biogeochemical processes and their impacts on tracer distributions (Aumont et al., 2017; Rixen et al., 2019), and on tracer transport within the ocean (Ayache et al., 2017; Racapé et al., 2018; Rae and Broecker, 2018). Further papers address the topics of climate dynamics and impacts (Gaye et al., 2018; Heinze et al., 2018; Schwinger et al., 2017; Segschneider et al., 2018) as well as a critical appraisal of geoengineering (Lauvset et al., 2017). The collection is rounded off with a paper on model complexity (Kriest, 2017) and an outlook paper (Hense et al., 2017).

We are grateful to all the kind colleagues who contributed to this issue. And in the end, this special issue would not have been possible without the lifework of Ernst Maier-Reimer. We owe much to him.

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