

Project Abstract – ICON-4C4M

The project ICON for Coupled Carbon Cycle Climate Modeling – Ocean (ICON-4C4M-O) is part of the **Extramurale Forschung** initiative funded by the Deutscher Wetterdienst (DWD) for the period 2024–2027. It contributes to the broader community-driven effort ICON-4C4M, which aims to develop a fully coupled and interactive global carbon cycle within the ICON-XPP Earth system model. ICON-4C4M-O is conducted in close collaboration with the land component ICON-4C4M-L, led by Prof. Sönke Zaehle at the Max Planck Institute for Biogeochemistry.

One of the main objectives of the project is to include an extended nitrogen cycle in the ocean biogeochemistry model HAMOCC. The revised formulation explicitly resolves ammonium (NH_4^+) and nitrite (NO_2^-), alongside nitrate (NO_3^-), nitrous oxide (N_2O), and dinitrogen (N_2), enabling a mechanistic representation of nitrogen transformation pathways under both oxic and anoxic conditions. These include dissimilatory nitrate reduction to ammonium (DNRA), stepwise nitrification, denitrification, and anammox. With the extension of the nitrogen cycle, the main climate-relevant nitrogen species will be represented. Furthermore, air-sea fluxes of ammonia (NH_3) will be introduced and the flux of nitrous oxide (N_2O) as a major greenhouse gas will be improved. The outcome of the ICON-4C4M project will lay the foundation for a comprehensive Earth system model with an interactive nitrogen cycle between the ocean and land components.