Impacts of the assimilation of satellite sea surface temperature data on volume and heat budget estimates for the North Sea

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Seawater temperature simulations are important for climate change research, fishery management, coastline protection, ecological balance maintenance, and weather predictions. In this work, the different mechanisms controlling the heat budget of the North Sea are investigated based on a combination of satellite sea surface temperature measurements (OSI SAF SST) and numerical model simulations (NEMO-WAM). Lateral heat fluxes across the shelf edge and into the Baltic Sea as well as vertical ocean-atmosphere heat exchange are considered. To extend and improve predictability capabilities of the model system, a 3-D variation (3DVAR) data assimilation scheme is applied, that combining measurements from satellites and data from the numerical model. The DA technique contains assumed model error correlations that depend on the mixed layer depth derived from a coupled circulation/ocean wave model. The simulated seawater temperature is improved both at the surface and at greater water depths. DA changes the current velocity field and decreases the lateral advective volume/heat exchanges between the North Sea and the Atlantic, thus yielding an increased heat flux from the Atlantic into the North Sea and more heat flux from the sea to the atmosphere. The largest DA impact on volume/heat transport is found in the Norwegian Channel, where the dominant process is Eulerian transport, followed by tidal pumping and wind pumping, while other processes, such as Stokes transport, annual mean wind driven transport, and tide-wind interaction-derived transport, are negligible. Further analysis reveals an acceleration of the along-shelf current at the northern edge of the North Sea and a decrease in the horizontal pressure gradient from the Atlantic to the North Sea. DA changes the velocity field inside the Norwegian Channel, which in turn reduces the Eulerian transport of heat and water outward from the North Sea. This study improves our understanding of the relations between model physics and DA, which is important for integrating multiple models within a DA framework.