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Improvements to a global ocean data assimilation system through the incorporation of Aquarius surface salinity data

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The Aquarius/Satelite de Aplicaciones Cientificas (SAC)-D satellite, an L-band passive radar system has been providing global maps of sea surface salinity (SSS) since 25 August 2011. In parallel with the ongoing satellite observations, assiduous efforts for reducing measurement errors have been made along with detailed validation campaigns. As a result, there are multiple possibilities for new science. For example, the new SSS field obtained on completion of a few annual cycles of Aquarius measurements will support detailed climate studies and should greatly improve our understanding of the ocean freshwater cycle.

In order to enhance the description of oceanic processes by using Aquarius SSS data we make use of a data assimilation approach, which has the advantage of providing four-dimensional analysis fields incorporating the limited observational data within the framework of established dynamical models. Hence, we aim to merge Aquarius data into the global ocean data assimilation system developed in the Meteorological Research Institute and then assess its impacts on the upper-ocean field.

Positive effects by incorporating the Aquarius data can be seen in several regions in the global ocean, although uncertainty in the Aquarius data is expected to be large in some regions. Around the Indonesian maritime continent, the Aquarius data assimilation reduces the SSS biases that may arise due to the use of excess precipitation in the atmospheric reanalyses. Comparison with buoy data lends support to the use of the Aquarius data in this region, although the land fractions involved (0.02) are above the more severe level used for the open ocean (e.g., 0.0005). In other regions with large effects, model biases in the SSS field due to the defects in both the forcing field and the model (resolution and parameterizations) reported in previous studies are reduced by the Aquarius data assimilation. Furthermore, other parameters such as subsurface temperature are affected by the new data through the water-mass formation processes. These results indicate the importance of Aquarius data in deriving improved representations of the global ocean from dynamical models.

Previous studies pointed out that Argo and Aquarius data are highly complementary, with Argo data vital for analyzing and correcting biases in Aquarius data and Aquarius data able to resolve temporal and spatial SSS variability missed by Argo. Our results are consistent with this view and demonstrate a route through to a possible integration of these data sources by using data assimilation methods. It is demonstrated that the improved representation in the SSS variability can influence other variables in the upper ocean. This can be attributed to the both background error covariances and dynamical processes (e.g., strong vertical mixing in the surface mixed layer and subduction from it). Although further studies for validating and reducing the errors in Aquarius data are required, these results underline their great importance for describing and predicting the global climate.

Keywords: sea surface salinity, Aquarius, data assimilation, ocean estimatation, maritime continent, stratification