Pre-Trained U-Net Model to Improve the Himawari Sea Surface Temperature Data Gap Filling

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Satellite sea surface temperature (SST) images serve as valuable resources for diverse applications like climate monitoring, ocean modeling, and marine ecology. However, cloud cover often introduces data gaps, diminishing the temporal and spatial resolution and impeding spatiotemporal analysis. To address this challenge, we propose gap filling method based on the state-of-the-art deep neural network model, U-Net. Our approach involves two key steps: firstly, pretraining the U-Net model on a diverse dataset of L4 SST images, which serve as gap-free products generated by merging satellite observations with numerical models and in situ measurements. Leveraging L4 SST images as surrogate ground truth enables us to simulate a wide range of SST values with varying gap patterns, enhancing the model's generalization ability. This choice is motivated by the scarcity and heterogeneity of ground truth data for training deep learning models, as different regions and seasons exhibit distinct gap patterns, noise levels, and SST distributions, requiring adaptive and robust models. L4 SST images provide a substantial and consistent data source that helps overcome these challenges and improves gap filling quality. Secondly, we fine-tune the pretrained model on a specific target domain, using real satellite observation SST product values, thereby further enhancing the method's accuracy and efficiency. To validate the efficacy of our approach, we conduct a comparative analysis with DINEOF, a widely used method for satellite image gap filling based on empirical orthogonal functions. Our results showcase the superiority of the U-Net-based method in delivering continuous and consistent SST data.

Keywords: Sea Surface Temperature; Himawari-8; Gap Filling; U-Net