The Maximum Wave Height Acquisition from CFOSAT SWIM Based on Machine Learning

Wang Jiuke [1] Aouf Lotfi [2]

[1] National Marine Environmental Forecasting Center, China, [2] Meteo France, France

Abstract:

The maximum wave height (Hmax) is an extremely important factor that has a significant impact on the safety of maritime activities. However, the Hmax is much less investigated than significant wave height (SWH) in the wave remote sensing. Nowadays, radar altimeters and CFOSAT provide the SWH operational but without Hmax products. A method of obtaining the Hmax from CFOSAT SWIM Level 2 parameters is presented. The buoys are the most reliable way to observe the Hmax, but the collocations between buoys and CFOSAT tracks are too few to perform the supervised learning training. The ERA5 wave reanalysis from the European Centre for Medium-Range Weather Forecasts (ECMWF) is one of the most accurate datasets. However, the obvious bias and scatter index of Hmax are found from the comparison between ERA5 and buoys located west of France. A machine learning model is firstly built to reduce the error of ERA5 Hmax. Then the corrected ERA5 Hmax is collocated with CFOSAT observations and used for the training target of SWIM Hmax retrieval. The SWIM parameters both from SWIM nadir and boxes, including the SWH, wavelength and wave partition information, are used to obtain the Hmax based on machine learning. The CFOSAT data in 2021 are used to train the Hmax machine learning model while the data in 2020 are used to perform the independent validation. The bias, RMSE and scatter index of CFOSAT Hmax are 0.01m, 0.51m, 16%, while 0.77m, 1.09m, 19% are for the ERA5. Therefore, this study provides a perspective to obtain the Hmax from satellite remote sensing for further applications such as marine forecasts.

基于海洋二号 B/C、中法海洋卫星宽刈幅海浪观测以及哨兵 1 号海浪方向谱观测同化的研究

王久珂 [1]　Aouf Lotfi [2]

[1] 国家海洋环境预报中心，[2] 法国气象局

海浪最大波高（Hmax）是一个对海上活动的安全具有重大影响的极其重要的海浪统计要素，然而在海浪遥感中，相较于对于有效波高（SWH）遥感的研究，对 Hmax 的研究相对要少得多。现如今星载雷达高度计与中法海洋卫星（CFOSAT）的业务化海浪遥感产品中仍然没有提供最大波高产品。本研究提出了一种从 CFOSAT 搭载的海浪微波波谱仪（SWIM）L2 级参数中获取 Hmax 的方法。

浮标是观察 Hmax 的最可靠方法，但浮标和 CFOSAT 观测之间的时空匹配数据太少，无法执行监督学习训练。欧洲中期天气预报中心（ECMWF）的 ERA5 海浪再分析数据是目前世界上最为准确的海浪数值再分析数据集之一。然而，从 ERA5 与法国西部浮标的比较中发现，ERA5 给出的 Hmax 存在明显的系统偏差（Bias）和较高的分散指数（Scatter Index）。

我们首先建立了机器学习模型来订正 ERA5 的 Hmax，然后将校正后的 ERA5 数据与 CFOSAT 的观测进行时空匹配，将经过订正后的 ERA5 的 Hmax 作为 SWIM 反演 Hmax 的训练目标。基于机器学习技术建立了 Hmax 的计算模型，该模型使用来自 SWIM 星下点与两侧 box 的海浪遥感参数，包括有效波高、波长和波能分区信息来计算海浪 Hmax。我们使用 2021 的 CFOSAT 数据用于训练 Hmax 机器学习反演模型，使用 2020 年的数据用于对该反演模型的精度进行独立检验。根据检验，CFOSAT 计算得到的 Hmax 的偏差、均方根误差和分散指数分别为 0.01m、0.51m、16%，而 ERA5 的偏差、均方根误差和分散指数分别为 0.77m、1.09m、19%。因此，本研究为从卫星遥感中获取 Hmax 提供了一个可能的思路，显示了其在业务化海洋预报中应用的潜力。