Remotely sensed big data for the oceans and polar regions

The oceans, which account for 71% of the Earth’s area, and the polar regions, the largest cold source on Earth, jointly play crucial roles in energy exchange and circulation, and in climate change (e.g. McGuire, Chapin, Walsh, & Wirth, 2006). In particular, against the background of global climate change, both the Arctic and Antarctic are experiencing profound changes (Bracegirdle, Connolley, & Turner, 2008; Jeffries, Overland, & Perovich, 2013), and the interactions between the oceans, polar regions and the atmosphere are closer than ever. Remote sensing has become one of the main research tools in ocean and polar studies (Lubin, Ayres, & Hart, 2009). At the same time, the amount of acquired data is undergoing explosive growth (Ma et al., 2015), thus leading oceanography into the era of “big data”.

Although there is no agreed definition of big data, the “5 V” characteristics of volume, velocity, variety, veracity and value are commonly used to distinguish big data from other types of data. Satellite and airborne remote sensing data can be considered representative of big data and, along with the development of modern information techniques such as machine learning and cloud computing, have been associated with many advances in Earth observation. Using remote sensing data, particularly big data, the past, present and future of the oceans and polar regions can be better understood. To support the development of remote sensing big data, this Special Issue, "Remotely Sensed Big Data for Ocean and Polar Regions", contains relevant research, review and data articles aimed at highlighting the recent progress made in the field of remote sensing big data as applied to the ocean and polar regions.

Sea surface wind and waves are two important parameters related to the air–sea interface and play a crucial role in the interactions between sea ice and ocean dynamic processes in the Arctic Ocean. To provide high-resolution ocean wind and wave data that have wide coverage, Li, Wu, and Huang (2021) developed an ocean wind and wave dataset based on Sentinel-1 synthetic aperture radar (SAR) that covered the pan-Arctic Ocean. This dataset, which covers the regions above 60°N, has a spatial resolution of around 2 km and covers the period from January 2017 to May 2021. Based on comparisons with scatterometer data, the SAR-retrieved wind data were found to have an accuracy of 1.23 m s−1 and the SAR-retrieved significant wave height was found to have an RMSE of 0.66 m from a comparison with altimeter data. The development of this dataset will support offshore construction as well as shipping safety and security in the Arctic and further contribute to studies of the changing Arctic.

Sea ice research is an essential component of studies of climate change in the Arctic, and the sea ice concentration (SIC) is one of the basic parameters used to describe the distribution of sea ice. Chen, Zhao, Pang, and Ji (2021) proposed a daily SIC product for the Arctic based on FY-3D Microwave Radiation Imager (MWRI) brightness temperature (TB) data. This product was calculated by applying the Arctic Radiation and Turbulence Interaction Study Sea Ice (ASI) algorithm to data with a 12.5-km resolution that were
acquired between January 2018 and June 2020. The mean bias between this MWRI SIC product and the AMSR2 SIC data was 4.24%, which is better than the performance of the published MWRI SIC product based on the Enhanced NASA Team (NT2) algorithm. The MWRI SIC product can be used as the basis of records of sea ice extent.

The sea surface temperature (SST) is one of the most important factors in climate change monitoring, and sea surface temperature anomalies (SSTAs) develop in space and time before dissipating. Xue, Xu, and He (2021) designed a process-oriented algorithm and developed a global SSTA dataset that includes details of both the spatial structure and temporal evolution of SSTAs. This dataset, named GDPSSTA, consists of three datasets and two relationship files covering the period from January 1982 to December 2009. In contrast to remote sensing SST datasets, GDPSSTA provides information about the evolution of SSTAs with time. The dataset can be used to help analyze the development of SSTAs, which may benefit the understanding of processes related to climate change, such as ENSO.

The impervious area coverage is a key indicator of urbanization in the circumpolar Arctic. Xu et al. (2022) developed an accurate and complete circumpolar Arctic man-made impervious areas (CAMI) map with a resolution of 10 m for the year 2000. CAMI is based on Sentinel-1, Sentinel-2, OpenStreetMap and ArcticDEM data that were combined using the Google Earth Engine and uses a random forest classifier model to generate the map. A comparison with three existing impervious area products gave an overall accuracy of 86.36% and a kappa coefficient of 70.73% for CAMI. This map can be used to support evaluations of infrastructure vulnerability and environmental sustainability in the Arctic.

Interactive ocean visualization, which combines different ocean observation techniques and computer simulation technology, is in great demand in the era of marine science big data. Wang, Li, Zhang, and Li (2021) constructed a unified visual data resource service and presented a component-based interactive visualization structure for use with multi-dimensional, spatiotemporal ocean data. These proposed schemes should enhance the ability to deal with high volumes of multi-source data and provide decision support for the solution of ocean-related problems, thus aiding the realization of the United Nations Sustainable Development Goals (SDGs).

Oceanographic data constitute a reliable basis for scientific research into ocean dynamics, climate change, the global water and carbon cycles, and other fields. Qian, Huang, Yang, and Chen (2021) carried out a review of data science for oceanography. Based on a review of the definitions of “big data” and “small data” in ocean science, the various available data sources, ocean data storage management, analysis methods and applications of ocean science data, the authors analyze the present situation and make predictions regarding the use of big and small data in ocean science. It is concluded that ocean science has developed into the data-driven stage and that great opportunities exist but that it will take a long time to realize comprehensive big data for the ocean. To better understand and manage the ocean, the authors propose that an increase in the amount of available oceanographic data is needed and that the number of ways in which these data are applied should also increase.

Disclosure statement

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Xiao-Ming Li

International Research Center of Big Data for Sustainable Development Goals, Beijing, China

Key Laboratory of Digital Earth Science, Aerospace Information Research Institute, Chinese Academy of Sciences, Beijing, China

lixiaoming@aircas.ac.cn