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Title: DETECTION AND FLAGGING OF RADIO FREQUENCY INTERFERENCE CONTAMINATION IN SMAP OCEAN OBSERVATIONS

Abstract: NASA's SMAP L-band radiometer has been supplying the scientific community with high quality ocean measurements of sea surface salinity (SSS) and wind speeds since 2015. Starting in 2023, there has been an increasing level of radio frequency interference (RFI) contaminating SMAP ocean observations which results in spurious retrieved SSS and wind speed values. The areas that are most affected are the Bay of Bengal, Gulf of Thailand, Mediterranean Sea, North Sea, Norwegian Sea, Barents Sea, Black Sea, Caspian Sea, Arabian Sea and South China Sea. Although the SMAP receiver operates within the Earth Exploration Satellite Service (passive) 1400-1427 MHz band protected under the Radio Regulations, RFI contamination of SMAP observations can be caused by unauthorized sources that transmit within this protected bandwidth or by leakage from out-of-band transmitters that operate at adjacent frequencies. The observed RFI contamination is not detected by the SMAP RFI filter that is applied during Level 1 processing. It is believed to be predominantly caused by Global Navigation Satellite System jamming within military operations that are conducted as the result of geopolitical conflicts. These jamming signals have very high power and are easily detected close to their source due to their high power. However, because they are persistent in time and cover a large range of frequency, they can easily escape the SMAP Level 1 RFI detection filters over ocean, where considerable power from the sidelobes enters the SMAP antenna field of view due to the relatively low beam efficiency (about 90%). As a consequence, transmitters operating at a distance from the observation cell can still cause significant RFI contamination. It is therefore necessary to develop additional methods that detect, flag and remove RFI in the SMAP ocean observations and that can be applied when running the SMAP salinity retrieval algorithm. We have studied various methods of identifying RFI-affected SMAP measurements over ocean during Level 2 and Level 3 processing. The most reliable RFI detection techniques are the chi-squared of the maximum likelihood estimator of the salinity retrieval algorithm, the difference in observed brightness temperature between forward and backward looking parts of the swaths, and the value of the observed 4th Stokes parameter. These detection methods do not rely on any external ancillary salinity data. We demonstrate that the number of false alarms in the RFI detection can be reduced by checking for spatial clusters of cells that are affected. Additionally, the detection rate can be improved by flagging neighbors of a cell in which RFI has been detected. We have tested and evaluated the RFI detection algorithm in various case studies and assessed missed detection and false alarm rates.