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Space Technology for Climate Adaptation and Mitigation [1] (6A)

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SPACE AND UNDERWATER PNT FOR CLIMATE CHANGE MONITORING

Abstract

Global warming affects the whole Earth's climate, particularly on polar regions, where large ice volumes are continuously melting at unprecedented rate. These phenomena are also monitored by satellite-based Climate Change Monitoring (CCM) methodologies contributing to depicting the global climate evolution. However, although remote sensing satellites are very accurate in monitoring the melting glaciers, they provide scarce or no information about under-ice water characteristics. The latter ones represent a challenge for CCM, as currently only handful Ice Tethered Profilers (ITPs) provide sustained monitoring of the upper Arctic Ocean water column. Mobile platforms would represent a substantial integration of the ITPs, which move slowly with the sea ice without possibility to select the specific area where the data are collected. In this context, this paper aims at giving an overview on how capabilities provided by underwater Positioning, Navigation and Timing (PNT) technologies can support CCM. Underwater PNT is intended to be integrated with Global Navigation Satellite Systems (GNSSs) and complement CCM solutions. The main challenge in the underwater is that no standard procedure is available, especially in the case of under-ice PNT, since GNSSs are unsuitable for any underwater application due to the

electromagnetic wave dissipation in the water. Autonomous under-ice navigation is then complicated by a number of challenges, for instance the presence of floating ice. Nonetheless, the contribution of under-ice data to the CCM methodologies is of paramount importance. The role of GNSSs is still crucial in underwater missions, indeed the absence of underwater PNT can be mitigated by leveraging on GNSS surface references. Moreover, the data, collected during underwater missions, need to be georeferenced and integrated with satellite information to improve the CCM capabilities. In this way, satellite ranging observations become key enablers for the underwater exploration, asset tracking and management and data set collection. The polar ices position measurements, based on space and underwater reference assets, represent valuable data sources, which can be correlated with satellite earth observation data to improve CCM capability. This paper provides a review of the underwater PNT technologies in terms of sensors, instrumentations, and platforms, including moored beacons, remotely operated vehicles (ROVs), and autonomous underwater vehicles (AUVs), and highlights the technical challenges and possible solutions. Finally, a particular focus on environmental friendly assets such as gliders and bioinspired robots will be presented, with an analysis of the possible use cases.