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A new project to monitor the Ocean Heat Content and the Earth Energy imbalance from space: MOHeaCAN

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The Earth Energy Imbalance (EEI) is a key indicator to understand the Earth's changing. However, measuring this indicator is challenging since it is a globally integrated variable whose variations are small, of the order of several tenth of W.m-2, compared to the amount of energy entering and leaving the climate system of ~340 W.m-2. Recent studies suggest that the EEI response to anthropogenic GHG and aerosols emissions is 0.5-1 W.m-2. It implies that an accuracy of <0.3 W.m-2 at decadal time scales is necessary to evaluate the long term mean EEI associated with anthropogenic forcing. Ideally an accuracy of <0.1 W.m-2 at decadal time scales is desirable if we want to monitor future changes in EEI. The ocean heat content (OHC) is a very good proxy to estimate EEI as ocean concentrates the vast majority of the excess of energy (~93%) associated with EEI. Several methods exist to estimate OHC:

- the direct measurement of in situ temperature based on temperature/Salinity profiles (e.g. ARGO floats),
- the measurement of the net ocean surface heat fluxes from space (CERES),
- the estimate from ocean reanalyses that assimilate observations from both satellite and in situ instruments,
- the measurement of the thermal expansion of the ocean from space based on differences between the total sea-level content derived from altimetry measurements and the mass content derived from GRACE data (noted "Altimetry-GRACE").

To date, the best results are given by the first method based on ARGO network. However ARGO measurements do no sample deep ocean below 2000 m depth and marginal seas as well as the ocean below sea ice. Re-analysis provides a more complete estimation but large biases in the polar oceans and spurious drifts in the deep ocean mask a significant part of the OHC signal related to EEI. The method based on estimation of ocean net heat fluxes (CERES) is not appropriate for OHC calculation due to a too strong uncertainty (±15 W.m-2).

In the MOHeaCAN project supported by ESA, we are being developed the "Altimetry-GRACE" approach which is promising since it provides consistent spatial and temporal sampling of the

ocean, it samples the entire global ocean, except for polar regions, and it provides estimates of the OHC over the ocean's entire depth. Consequently, it complements the OHC estimation from ARGO. However, to date the uncertainty in OHC from this method is close to 0.5 W.m-2, and thus greater than the requirement of 0.3 W.m-2 needed to a good EEI estimation. Therefore the scientific objective of the MOHeaCan project is to improve these estimates :