Quality of image-based manganese nodule abundance assessment

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Manganese nodules are a marine mineral resource and are considered for deep sea mining operations. These nodules constitute an important element of the deep sea habitats they occur in and their abundance and size frequencies have an impact on occurring fauna. Assessing the distribution of nodules is traditionally done with a combination of large-aerial hydro-acoustic mapping linked with ground-truthing by physical sampling. While hydro-acoustics provide large aerial coverage (km^2/h) with low resolution (m/px), physical sampling provides low aerial coverage (cm^2/h) with high resolution (mm/px). To bridge these two separate data domains, optical imaging has successfully been applied as it provides medium aerial coverage (ha/h) and resolution (cm/px).

Extracting quantitative data from optical images is traditionally done by effortful manual image annotation. More recently, multiple automated and semi-automated image analysis algorithms have been proposed. These algorithms are usually tuned for one specific data set or use case. The application of these algorithms to other optical imagery data sets is one necessity to prove their robustness. As manual annotations of manganese nodules are scarce and focus on nodule counts rather than exact nodule delineations, quantitative assessment of the quality of detection algorithms in the form of e.g. precision and recall is not possible at the moment.
Apart from the within-data comparison, a link to the traditional sampling strategies is required. These strategies are the de-facto standard for aerial mapping of habitats and assessing seafloor substrate composition (including manganese nodules). In the case of physical sampling, statistic variations in the natural nodule abundance can bias the sampling outcome. In the case of hydro-acoustic sampling, small-scale natural variations in abundance that are relevant to mining as well as habitat composition can be occluded due to the limited resolution. Using optical imaging as a bridge technology enables to extract more robust nodule abundance data.

This presentation will include results on comparing different nodule detection algorithms, will show the challenges in correlating physical sampling derived data with optical imagery data and shows potential applications for habitat assessment using the presented algorithms.

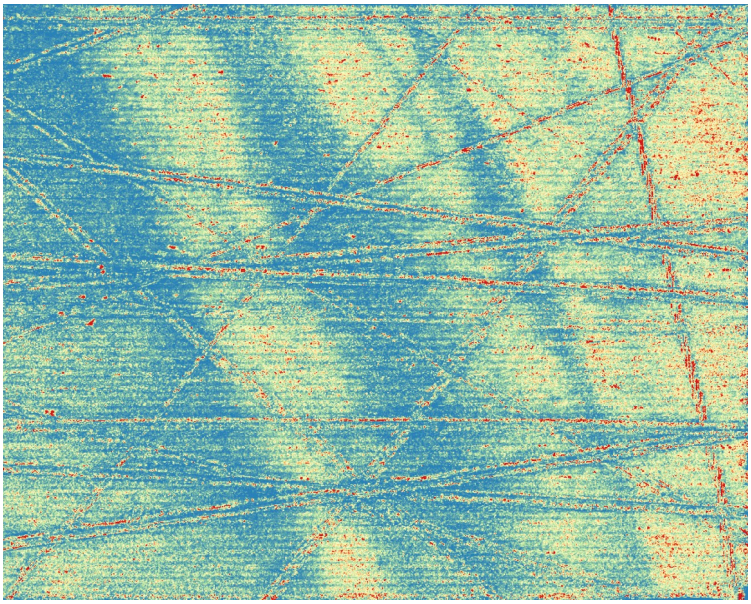

Figure 1: Nodule coverage of the seafloor (in %) within the central DISCOL Experimental Area in the Peru basin. An area of 500x400m has been optically mapped entirely. The nodule abundance assessment was conducted at a resolution of 0.25x0.25cm^2/px. The nodule abundance follows the bathymetric variations of less than 5m. Physical disturbances of the seafloor in the form of linear plough marks are clearly visible, scattered throughout the entire area.