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On the Ability of Airborne Electro-Magnetic Systems for Areal Indirect Measurement of Seawater Temperature/Salinity with Depth Resolution

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The quick and areal assessment of temperature/salinity correlated sea water conductivity down to depths of several 10-meters could be of exceedingly value to the study of ocean-atmospheric processes.
Here, the opportunities and constraints of an airborne EM (AEM) method are discussed and a system is proposed which may accomplish this task. Aero-geophysical measurements potentially provide a valuable tool for completing conventionally measured data sets as they can be performed over a wide area, even under difficult circumstances, within short time. A most desirable opportunity in course of such measurements is the ascertainment of the dynamics of ocean-atmospheric interactions which necessitates repeated and reproducible measurements. Current AEM systems can't accomplish this task adequately due to their system immanent signal drift, calibration errors and - in some cases - bad signal to noise ratio.
The development of comprising concepts for advancing state of the art HEM-systems to a valuable tool for data acquisition in ocean-atmospheric research is mainly based upon the research undertaken in course of the project HIRISK (FWF L-354 N10, supported by the Austrian Science Fund) and different studies on model data as well as real data acquired by the helicopter-borne EM (HEM)-system of the Geological Survey of Austria.
The methodology comprises comprehensive experimental testing on an existing HEM system serving as experimental platform and the setup of a numerical model which is continuously refined according to the results of the experimental data. The model then serves to simulate the experimental as well as alternative configurations and to analyze them subject to their drift behavior. Finally, concepts for minimizing and correcting the drift as well as calibration – especially provided by the unique situation of the EM measurement above seawater - are derived and tested. Different test data – stationary on ground as well as in flight – show a clear correlation between the drift in raw voltage data and temperatures of critical system components. Post-processing for compensating for the drift of HEM-data is done by different approaches: In the first temperature dependent transfer functions of the transmitter- and receiver section are modeled on the basis of system temperature data and a correction is derived. In a second approach the drift of the system is analyzed by multivariate methods including a broader set of system parameters. Taking advantage of the special measurement situation above seawater, consistency tests on the data are possible which allow further improvements of the data quality. This is shown on different HEM-data acquired above sea and evaluated in simulations. In an outlook an advanced measurement system design and integrated data modeling scheme is depicted which resolves signal variations caused by the system, by changes in the measurement geometry or caused by the conductivity distribution in the seawater if critical system parameters are considered and proper calibration is conducted. From this, in depth temperature/salinity variations could be derived in flight down to depths limited by the skin depth of the applied EM-field (meters to several 10 meters) which can't be accomplished by satellites with that spatial and depth resolution nor by vessels with that spatial extend within a comparable short time.