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Inversion of temperature profiles from satellite data in the tropical Atlantic based on Self Organizing Map

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This study deals with the problem of temperature inversion in the context of the ARAMIS project (Altimetrie sur un Rail Atlantique : Altimétrie et Mesure In-Situ), which survey the thermohaline structures and their variabilites in the tropical and subtropical Atlantic. The aim is to benefit from the surface global satellite coverage to determine the vertical oceanic temperature profile using neuronal approach. We use XBT and XCTD profiles available along the AX11 World Ocean Circulation Experiment merchant ship line from Europe to South America and Argo floats profiles closed to this route. We combine these temperature (T) profiles to satellite Absolute Dynamic Topography (ADT) and Sea Surface Temperature (SST) at the measurement localization. ADT is obtained from the Ssalto-Duacs mapped altimetry product from AVISO center (http://www.aviso.oceanobs.com) and SST is obtained from the AVHRR-only Reynolds product (http://www.ncdc.noaa.gov/oa/climate/research/sst/griddata.php).

The first step of the inversion methodology is build a Self Organizing Map - or Kohonen map – which allows a representation in a low dimension view of the input data. The input data are the T profiles, their latitude, ADT and SST. The learning leads to an hexagonal map of 14 by 7 nodes. The different nodes reveal a clear repartition between marked thermocline or quasi barotropic structures, deeper or shallower isothermal layer depth. These different structures are associated with different characteristics in latitude and ADT, SST and time information being useful to precise the structure.

According to these observations, we define a two-steps algorithm to select the best node using only surface data. First step is to select a limited number of nodes by a tree selection of the node using successively latitude, ADT, SST and time. Second step is to select a final node among this pre-selection considering the nearest points surface data. We use a transition matrix regrouping the probability of switching from one node to an other one. We computed the probability of the different paths using the pre-selected nodes, and select the most probable nodes.

Applying this method to a surface data field between October 1992 and October 2009 allows recovering temperature profiles along the ARAMIS route. Comparison with in-situ T profiles, belonging or not of the learning data set, leads to mean rms error less than 0.83°C. The accuracy is not constant along the route and error is maximal in the southern part, due to lack of data. In the northern part, the rms is 0.68°C. Using typical characteristics of profiles leads smaller error with for example 243 °C.m for the integrated temperature over 650 m (6.6%) or 11.6 m for the 20°C isotherm depth in the equatorial region (5°S-10°N).