Seasonal variation of salinity on the island of Tatuoca and its influence on the vertical component of the geomagnetic field

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Abstract

The salinity intrusion behavior in the Pará River estuary presents daily, monthly and seasonal variations. The salinity pattern follows the river discharge, with high discharge from January to May and low discharge from August to November (ANA, 2015). Thus, Tatuoca Island (figure 1), located 12 km from the coast and sorrounded by the Pará River, was chosen as the object of study of the geomagnetic field variation according to changes in the water salinity. The island contains a magnetic observatory, which allows the data to be cleaner because it is further away from the large centers.

Introduction

The Pará River Estuary, that also is called Marajó Bay, is one of the largest estuaries in Brazil with a mouth that is approximately 60 km wide. It is a highly dynamic region, and the river's flow rate is associated with the energy of the tides.

Based on monthly averages for eighty years preceding from National Operator of the Electrical System (ONS, Operador Nacional do Sistema Elétrico), water discharge reaches a maximum (24,000 m³/s) in April and a minimum (2,300 m³/s) in September, as can be seen in figure 2.

The saline intrusion occurs during low discharge period in the Pará River Estuary (Bezerra et al., 2011; Baltazar et al., 2011). In this case, the salt presence produce different processes in the estuary (e.g. stratification, advctive, and diffusive processes, etc.). The salinity is an important parameter in decisions made by public and private environmental managements. Furthermore, salt intake variations within an estuary has influence over hydrodynamic and fine sediment dynamics.

For this work the vertical component of the geomagnetic field (Z) was used to compare its variation in periods of high salinity and lower salinity, that is, in non-rainy and rainy seasons, respectively.

The Z component points toward the surface, therefore changes in the magnetic field close or inside the subsurface can be measured by this component, as well as changes in the water.

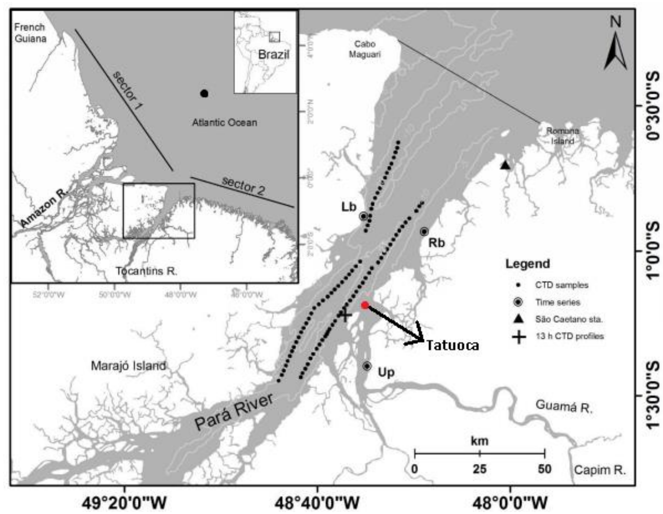

Figure 1. Map showing the location of Tatuoca and the stations used for the river salinity evaluation.

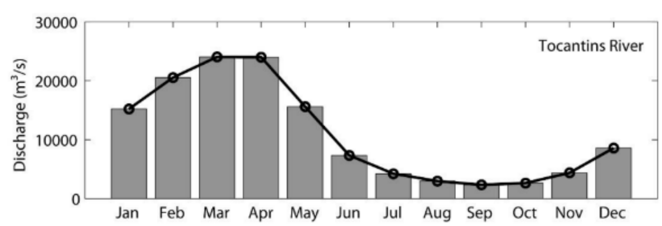

Figure 2. Annual water discharge of the Marajó Bay.

Method

The stations used according to Renan Peixoto (2016) were distributed along the Pará River, as shown in figure 1. The stations were on the right bank, RB station in Colares Island; on the left bank, LB station on the Marajó Island, both about 60 km from the mouth of the river; and the third station, called UP station in Belém city, about 120 km from the mouth.

It was used the diurnal variation data from the Z component from April 2014 to March 2016. It was made a monthly average for each of the 25 months, using only the quiet days, according to the International Service of Geomagnetic Indices (ISGI). Then, the seasonal variation of the river salinity was compared with the vertical component variation through the years.

Results

Figure 3 shows the salinity variation for the 3 river stations. Figure 4 shows the average monthly variation for 6 months of 2014 and 2015. It can be seen in figure 3 that the months with higher salinity corresponds to October to March. This same pattern can be seen in figure 4, where the month with the higher Z variation is October.

Figure 5 represents the amplitudes variation for the same months of the figure 4, but comparing Z to H component. It is clear that the horizontal component of the geomagnetic field (H) has a more pronounced amplitude variation for all the months studied, when compared to Z component. This means that Z follows a pattern in the amplitude variation, even in more rainy periods.

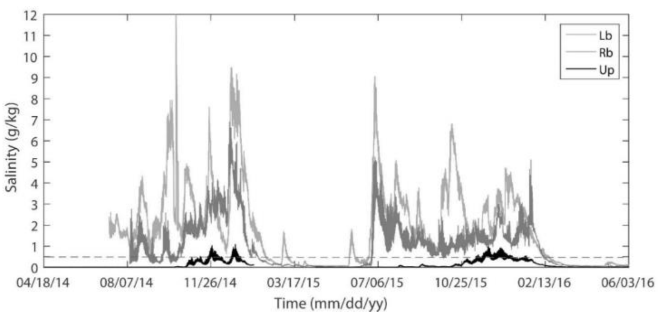

Figure 3. Salinity variation for the 3 stations used, from 2014 to 2016.

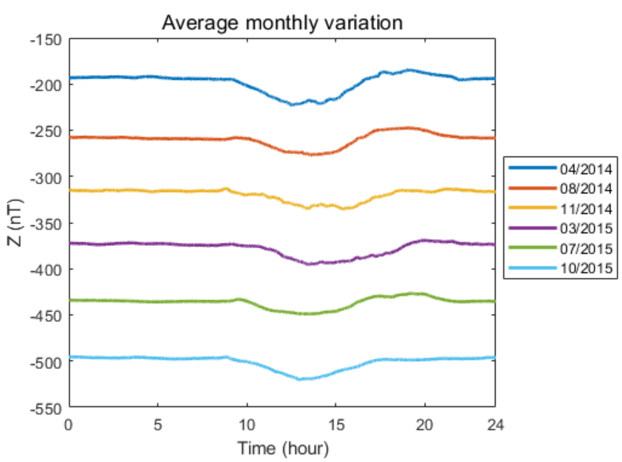

Figure 4. Average monthly variation of the vertical component of the geomagnetic field, for Tatuoca.

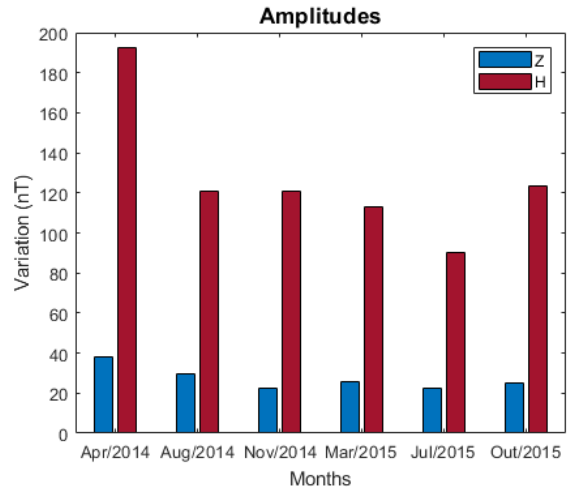

Figure 5. Comparison of the monthly amplitude for both H and Z geomagnetic components.

Conclusions

In the less rainy period, salinity had a more pronounced variation, including between tides, than in the rainy season, which shows the influence of rainfall on the distribution of this parameter, as well as the influence of river discharge (Marcus Vinicíus et al, 2015).
In periods less rainy and with lower discharge of the Pará River, the values obtained for Z were higher than those for rainy periods, where there is a decrease in the salinity of the water.

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