

# South Atlantic's Surface Circulation: A Note

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## ABSTRACT

SSTs of the South Atlantic suggest there is a side by side surface circulation with northward cold water to the east and southward warm water to the west. Then logic predicts that both currents should be stronger in the southern hemisphere summer than in winter in order to maintain the heat balance, because the upper 100 m of the water column absorbs more solar energy in summer, especially at lower latitudes. This prediction is confirmed by the seasonal variation of the deflection angle of the sea surface isotherms in the middle of the ocean, measured counterclockwise from the east, which are highest in summer and lowest in winter. It is assumed that the stronger the north/south component of a current is, the greater the deflection is of the isotherm from constant latitude.

## 1. INTRODUCTION

Two previous notes by the present author relevant to the surface circulation of the South Atlantic have appeared recently [1, 2]. In the earlier one [1], a comparison was made between the SSTs of the eastern tropics of the Atlantic and Pacific Oceans. Based on the world atlas of SSTs (H. O. 225), it was found in all monthly mean charts that the equatorial Atlantic is significantly colder than the equatorial Pacific in the east. This observation is mainly due to the cold surface water flowing north on the eastern side of the South Atlantic and apparently slightly crossing the equator about half the time. (There is a cold current (Humboldt) moving north up the coast of South America too, but it has a much longer way to go. It apparently does not cross the equator and has an altogether smaller effect on the eastern tropics.)

In the second note, a comment was made about the unusual and startling shape of several of the surface isothermal lines in the middle (north/south and east/west) of the South Atlantic, particularly those that are more nearly parallel to lines of constant longitude than latitude. If it were up to the sun alone, isotherms are expected to follow latitude lines. This concept originated from century's old comments by climate conscious authors, like Humboldt.

A corollary to the climate concept is that a surface current with a north/south component is likely to make a deflection in an isotherm that otherwise would be parallel to a latitude line. Then it stands to reason that the corollary can be extended to say: for a given direction of northerly or southerly flow, every-

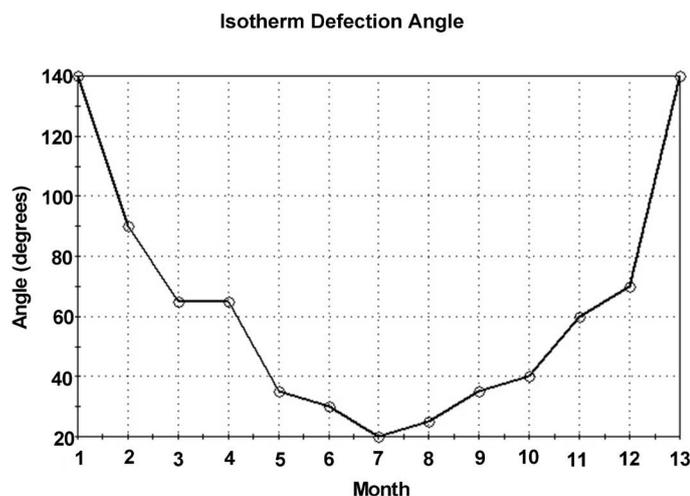
thing else being equal, the stronger the north/south component is, the greater the deflection of the isotherm will be. Application of the amended corollary follows below as an expansion of the second earlier note [2].

## 2. PROPOSITION

What the SSTs strongly suggest is that the surface circulation of the South Atlantic consists of two parts: a cold flow going north and a warm flow going south, which both occur all year round. Existing subsurface data are consistent with this idea also. Coming from studying the North Pacific's surface circulation, there is a contrast in that the cold and warm flows are side by side in the South Atlantic whereas in the North Pacific they are vertically superimposed for the most part with the warm flow above the cold flow. Assuming the heat budget of the South Atlantic's surface circulation is always operating, then how does the side by side circulation, which fills the space between continents, deal with the fact that more solar energy is absorbed in top 100 m of the water column in the southern hemisphere summer than in the winter? In addition, assume that once established the side by side configuration cannot change into a different type of configuration of the cold and warm flows, that the thickness of the surface flows are fixed, and that the North and South Atlantic exchange of heat is insignificant. There is only one way to answer the question in that case; both cold and warm flows should speed up in summer.

Application of the climate corollary comes next. First, a parameter is needed, and even a fairly crude one will suffice as it turns out. Look to the isotherms in the middle of the South Atlantic, from 10 to 20 W longitude and half way from the equator to the southern tip of South Africa (about 35 S). For each month in that middle region find the nearest isotherm passing by or through and measure the angle of a straight line segment counterclockwise from the east with a protractor. **Figure 1** contains the results. Crudeness of the angle comes in part from neglecting the difference in distance of a degree of longitude and a degree of latitude. Since small differences of the angle parameter are not involved in the discussion below, its usefulness stands out.

As shown in **Figure 1**, the angle varies systematically from lowest in the winter to highest in the summer, which is predicted from the climate corollary to mean that the north and south flows are strongest in summer and weakest in winter. By far the greatest deflection of an isotherm in the middle of the ocean takes place in January (1 = J in **Figure 1**). In fact, the angle is more than 90 degrees, so the isotherm



**Figure 1.** Angle in degrees of the isotherm in the middle of the South Atlantic Ocean measured counterclockwise from due east in H. O. 225 and plotted as a function of month (1,2,3.... = J,F,M... and 13 is a repeat of 1).

is bending over backwards so to speak. That isotherm has the shape of a large “S” with long arms and it drew my attention right away when opening the atlas because it is in the chart on the very first page!

### 3. DISCUSSION

One feature of the side by side circulation pattern of the surface currents of the South Atlantic is that the separate Coriolis forces of the northward and southward flows are opposed in the middle of the ocean and presumably cancel each other out most of the time and on the average.

How can one independently check the truth of the proposition that in the summer the surface currents of the South Atlantic flow faster than they do in winter? Existing data may not be sufficient, and gathering new data in the middle of an ocean is usually very expensive. Perhaps some sort of monitoring project could take place on an island on the Mid-Atlantic Ridge (Tristan da Cunha may be too far south, Saint Helena is a possibility).

What ultimately drives the surface circulation at all times of the year is a horizontal pressure gradient related to the fact that at sea level the temperature decreases with increasing latitude. This is an unstable situation.

A better understanding of the surface circulation of the South Atlantic may help unravel the puzzle of the exaggerated wet/dry seasonal signal in the Amazon basin, where in the dry season the water mark on the trees 40 ft high can be seen.

### 4. CONCLUSIONS

SST data in a classical world atlas are analyzed leading to a prediction that the large-scale surface currents of the South Atlantic should be significantly stronger in the southern hemisphere summer than in winter. Additional data are welcomed at anytime to compare with this prediction.

### CONFLICTS OF INTEREST

The author declares no conflicts of interest regarding the publication of this paper.

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