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TECHNICAL NOTE

The Bermuda Triangle mysteries: an explanation based on the diffraction of heat waves

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Abstract—Studies based on actual meteorological records [E. C. Njau, *Nuovo Cimento* **15C**, 17–23 (1992)] as well as analytical methods [E. C. Njau, *Proc. Ind. Natn. Sci. Acad.*, **61A** (4) (1995); *Renewabvle Energy* **4**, 261–263 (1994)] have established the continuous existence of a series of large-scale, Eastward-moving heat waves along the Earth's surface, whose individual crests and troughs are stretched approximately along the geographical North–South direction. In moving across the American continent, these waves encounter a line of physical barriers formed by the lofty Rocky and Andes ranges of mountains, which is continuous except for a significant gap or opening between Columbia and Mexico. This line of physical barriers consistently maintains a maximum height of 3000–4000 m between latitudes 40°S and 55°N except for a significant opening or slit located between Mexico and Columbia where the maximum height hardly exceeds 600 m. The Eastward-moving heat waves are thus incident obliquely on an approximately single-slit barrier when crossing the American continent and those parts of the waves which filter through this single slit essentially form some kind of single-slit diffraction (heat) patterns in, around and past the Bermuda Triangle. These diffraction heat patterns give rise to corresponding weather and ocean patterns which, to a large extent, account for the mysteries already noted in the Bermuda region.

1. INTRODUCTION

The Bermuda Triangle (also known alternatively as the "Devil's triangle") is a vaguely triangular part of the North Atlantic Ocean whose current boundaries are marked by Bermuda, the Southern U.S. coast and the Greater Antilles. The boundaries of this triangle are supposed to enclose an area in which mysterious disappearances of ships, aircrafts and yachts have taken place. These boundaries are, therefore, varied by writers as new "mysteries" are reported outside the previously known boundaries.

Reports dating as far back as mid-19th century list some mysteries that have been repeatedly taking place in the Bermuda Triangle [1–4]. Included in these reported mysteries are disappearances without any subsequent traces or explanation of more than 20 airplanes, 50 ships and several yachts. All these mysterious disappearances have been substantiated and recorded by the U.S. navy and Coast Guard [1–4]. For some of the ships which disappeared, distress radio signals were not received prior to their disappearance as is normally the case. According to recent reports, some rescue aircraft missions flying over the Bermuda Triangle vanished mysteriously and neither their passengers nor remains of the aircraft involved have been traced ever since.

Attempts to advance convincing explanations for the above-mentioned Bermuda Triangle mysteries have not succeeded so far [5, 6]. Previously proposed causes of the mysteries include extraordinary fields of some forces and mischief by unidentified flying objects (UFOs). However, all these proposals were subsequently disproved by scientific research.

Recently, there have been new speculations that the Bermuda Triangle mysteries may be caused by unexplained turbulence and other atmospheric disturbance. These speculations are based on the fact that violent downward air currents and violent storms do frequently occur in the Bermuda Triangle. Even these new speculations have not succeeded in explaining the mysteries partly because the causes of the unusual turbulence and other violent atmospheric disturbance on which they are based are not yet known. This situation has resulted from a follow-up of scientific studies which indicated that the Bermuda Triangle does not have the peculiarities needed to frequently generate the turbulence and other violent atmospheric disturbance mentioned above.

In this paper, we illustratively describe some physical processes which systematically give rise to abnormal turbulence and violent atmospheric disturbance in the Bermuda Triangle. We thereafter show that it is this turbulence and violent atmospheric disturbance that is a possible cause of the Bermuda Triangle mysteries. Finally we point to the possibility that the causes of the Bermuda Triangle mysteries may be closely related to the causes of El Nino events.

2. ANALYSIS

Perhaps among the most interesting meteorological phenomena discovered recently are a series of global heat waves that systematically drift Eastwards along the Earth's surface [7–9]. These global heat waves, whose crests and troughs span the geographical North–South direction, have been clearly deduced from actual meteorological records [7, 8]. Details regarding the physics and theory of these global heat waves may be found in Njau [9]. For consistency and simplicity we shall hereinafter refer to these global heat waves simply as *heat waves*.

Very interesting interactions take place between the heat

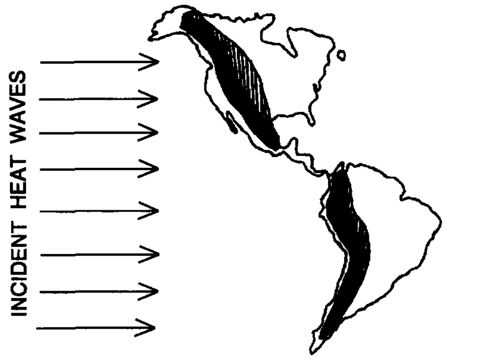
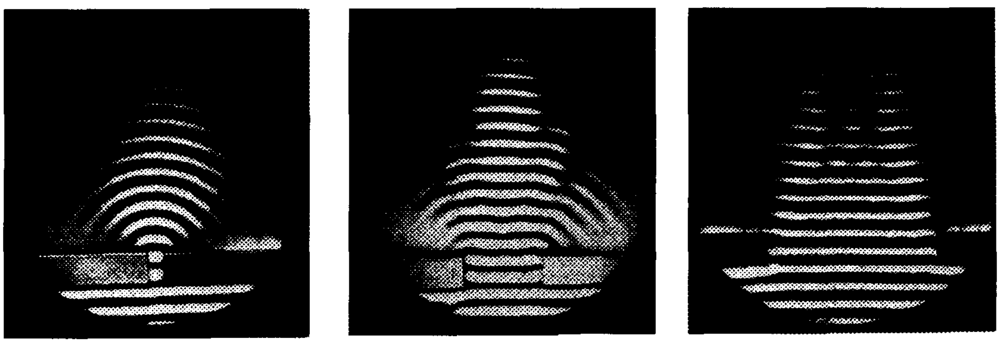


Fig. 1. An idealised representation of the physical barrier formed by the Rocky and Andes ranges of mountains. This physical barrier is continuous except for a significant opening between Mexico and Columbia as ideally illustrated above.

waves and the chain of Rocky and Andes mountains of the American continent, the latter acting as a barrier to the former. In some climatology books [10], the Andes and Rocky mountain ranges are approximated into a continuous line of high mountain barriers extending from Alaska down to the Southern part of Argentina except for a significant gap between Mexico and Columbia. In this paper, we shall make use of this approximation in the rather idealised form shown in Fig. 1. There is ample justification for Fig. 1 in the literature. For example, Bryson and Hare [11] state that the continuous barrier formed by the chain of Rocky mountains mostly deflects all zonal flows incident on it, and according to Kendrew [12], the barrier formed by the continuous chain of Andes mountains is a very effective meteorological barrier between the regions on either side. This implies that Eastward-moving heat waves incident on the Rocky–Andes line of mountains are mostly denied penetration except for the significant gap or opening between Mexico and Columbia as ideally illustrated in Fig. 1. On this basis, and also as shown in Fig. 1, the Rocky–Andes line of mountains effectively acts as some kind of single-opening or single-slit barrier to the Eastward-moving heat waves. Consequently, those portions of the wave fronts of the heat waves which manage to pass through the single slit form heat diffraction patterns Eastwards of this single slit (which itself extends from Mexico to Columbia). The theory and science behind single-slit diffraction patterns is adequately treated in standard textbooks such as Ref [13, 14]. Therefore, it is not necessary for us to repeat these well known details here. We can, however, illustrate the salient physical characteristics of these single-slit diffraction patterns. To this end then, Fig. 2 illustrates how these patterns change as the width of the single slit changes, and Fig. 3 illustrates how the patterns change as the wavelengths of the incident heat waves change. It is clearly noted in Figs 2 and 3 that the degree to which the waves bend round the edges of the barrier increases as the ratio Wavelength of waves/Width of slit increases. Indeed, Fig. 3 is very important in this case because the heat waves incorporate a whole range of individual waves at differing wavelengths as elaborated in Njau [7–9].

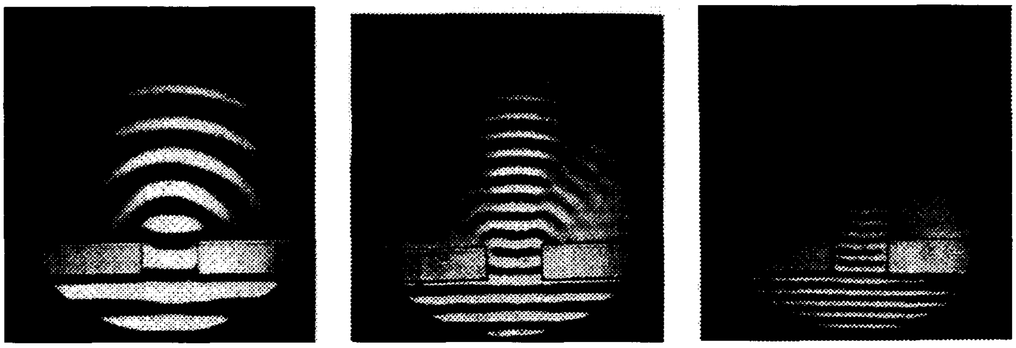
In both Figs 2 and 3, the waves involved are incident normally on the single slit, but in what is shown in Fig. 1, the waves are not incident normally upon the Mexico-to-Columbia single slit. Since the heat waves fall onto the latter slit at a non-zero angle to the slit normal, the resultant diffraction patterns are also essentially at a non-zero angle to the slit itself. Each individual feature or contour in these patterns is shaped into a protruding tongue whose front-most apex lies approximately along the discontinuous line shown in Fig. 4. In the case that the crest of a large-wavelength heat wave is incident on the Mexico-to-Columbia slit, this protruding tongue will definitely take the form of an elongated warm (and hence relatively low pressure) zone with its axis approximately along the discontinuous line in Fig. 4. Such an elongated warm and relatively low-pressure zone would be a structure into which air streams from the sides and rises up more or less as in the intertropical convergence zone (ITCZ).

After examining as many satellite weather images (which include the Bermuda Triangle) as we could possibly get, we have found that the ITCZ-type of weather conditions mentioned above are not uncommon at and near the Bermuda Triangle. A representative example is illustrated in



(a) (b) (c)

Fig. 2. Typical illustration of single-slit diffraction patterns involving an aperture of: (a) small width; (b) relatively medium width; (c) relatively wide width. Note that the frequency of the waves involved is constant.



(a) (b) (c)

Fig. 3. Typical illustration of single-slit diffraction patterns involving an aperture of constant width and waves having: (a) low frequency; (b) relatively medium frequency; and (c) relatively high frequency.

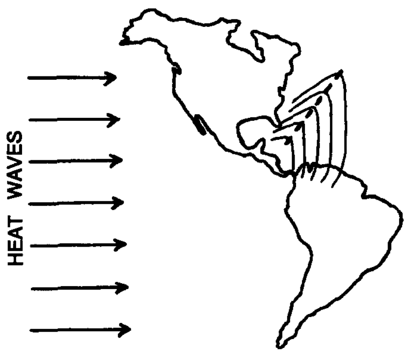


Fig. 4. Since the heat waves shown in Fig. 1 are not incident normally on the single slit or opening shown in the same figure, each maximum or minimum structure in the resultant diffraction patterns takes the form of a protruding tongue. The front tip or apex of such a protruding tongue lies approximately along the discontinuous line sketched above.

Fig. 5. The weather image in the latter figure was taken on 19 February 1993 by METEOSAT3 [15].

What happens if the heat waves incident upon the Mexico–Columbia single slit have relatively small wavelengths? In this case, the protruding tongue mentioned above will consist of a tight packing of alternate warm and cold (and hence relatively low-pressure and high-pressure) zones in and around the Bermuda Triangle akin to the colour packings on a zebra. Such a serial and tight-packed area of alternating warm (and hence relatively low-pressure) and cold (and hence relatively high-pressure) zones essentially gives rise to at least the following two main phenomena.

Firstly, as may be easily deduced from standard weather textbooks [16, 17], such a serial and tightly packed structure gives rise to turbulence and other violent atmospheric disturbance including strong downward and upward air currents. It is these very types of weather conditions that have been reported to mercilessly frequent the Bermuda Triangle [1–6, 18]. Moreover, if the serial and tightly-packed air temperature zones described above are mapped onto the ocean below (as would be expected), then the water at the top of the ocean will be characterised by an alternating series of warm and cold strips in such a way that the warm strips get gradually cooler as one moves towards the U.S. coast from approximately the discontinuous line in Fig. 4. A clear consequence of such an oceanic pattern of warm and cold strips is the corresponding creation of oceanic convection currents in and around the Bermuda Triangle whose lower loops flow away from the U.S. coast onto the Ocean's interior. Such convective currents will tend to drift objects drowning in the Bermuda Triangle deeper into the interior of the North Atlantic Ocean, at the bottom of which they will finally settle. Indeed, this appears to explain why no traces of the over 100 ships, aircraft and yachts which have disappeared in the Bermuda Triangle region have ever been spotted in the ocean in and around this very region. Secondly, the serial packing of alternating warm and cold atmospheric zones described above would strongly hamper successful surface-to-surface radio communication at the frequencies used for communications by ships and aircraft. This is due to the fact that at these frequencies, radio waves have a refractive index n that strongly depends on (air) temperature as follows [19]:

$$n = \frac{Ap}{T} + \frac{Be}{T^2}, \tag{1}$$

where A and B are constants, T is absolute air temperature, p is atmospheric pressure and e is water vapour pressure.

According to eq. (1), a radio signal sent (say, from a ship or an aircraft) across the stack of alternating warm and cold atmospheric zones mentioned above will most certainly be refracted away from its original or intended direction as may be shown by simple ray-tracing computations. As a result, the signal will hardly reach its intended destination. This appears to explain why distress radio signals from many of the ships that have disappeared in the Bermuda Triangle were not received prior to the disappearances, as would normally be the case. All the processes described in the last two cases are expected to feature prominently in the Bermuda Triangle according to some kind of timetable pattern. This is because the whole family of (Eastward-drifting) heat waves is continuously generated by the sampling process applied onto incoming solar radiation by the Earth due to its spin-

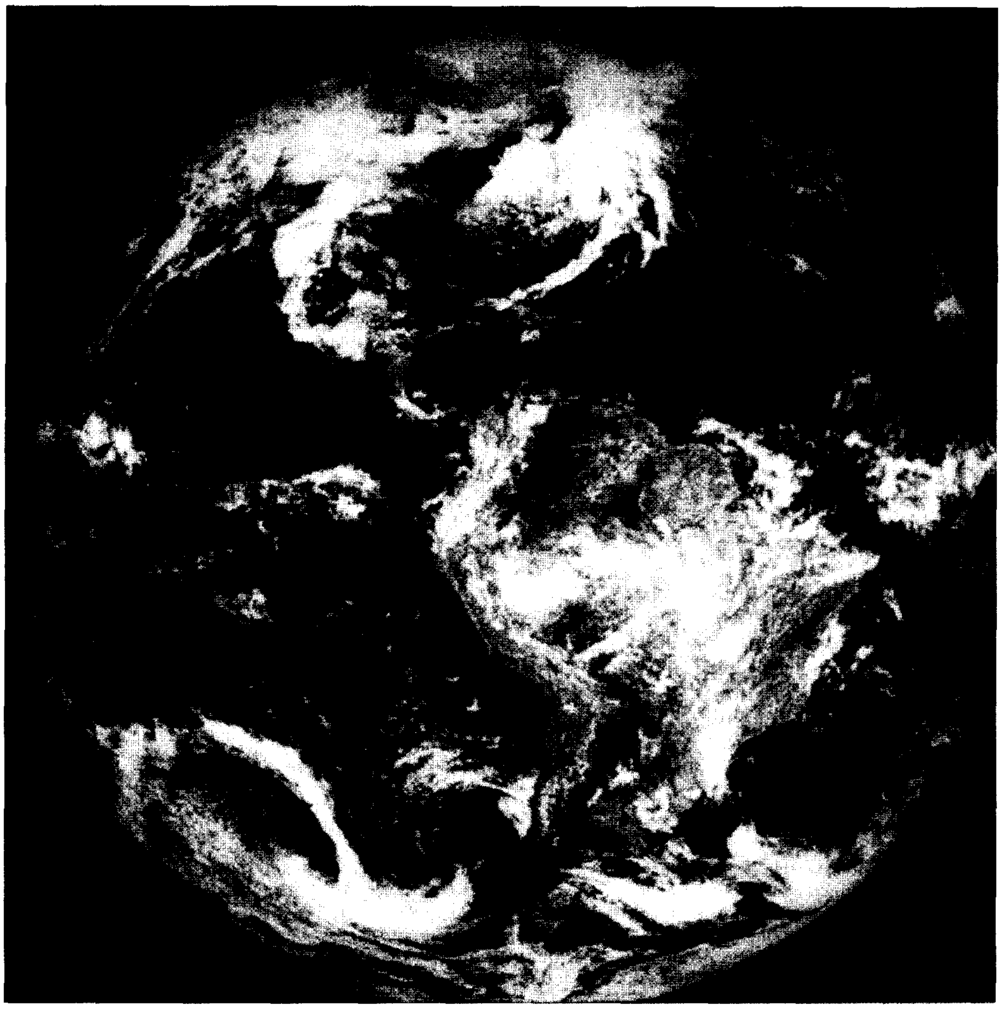


Fig. 5. A weather image taken by METEOSAT-3 on 19 February 1993, adapted from Ref. [15].

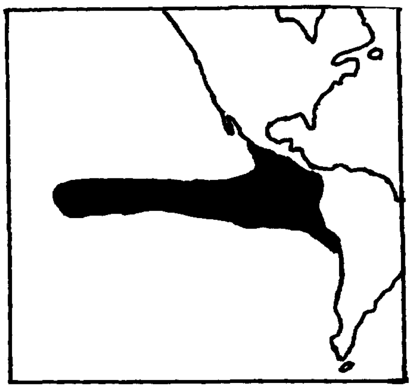


Fig. 6. The darkened region is the one in which extensive ocean warming restrictively took place just before the 1982 1983 El Nino event, adapted from Ref. [20].

ning motion as well as other phenomena in the Earth–atmosphere system [7–9]. This family also contains heat waves that range from global waves with very small wavelengths to global waves with very large wavelengths (see Ref. [7, 9]).

Finally, let us end this analysis by referring back to Fig. 1. When viewed from the Western side, the barrier of the Andes–Rocky chain of mountains illustrated in this figure is somehow concave-shaped with a focal point located in the equatorial Pacific Ocean slightly West of the Galapagos islands. This particular barrier shape would tend to focus waves incident on it from the Western side onto or near its focal point. One would, therefore, expect that whenever the crest of a large Eastward-moving heat wave is incident upon this barrier, some of its heat content will thereafter be focused and hence accumulated at or near this focal point. Such heat accumulation would be expected to give rise to significant ocean warming in the region surrounding this particular focal point. Such ocean warming has been found to precede an El Nino event [20]. For example, the 1982–1983 El Nino, which is believed to have brought the strongest warming of the equatorial Pacific in this century [21], was preceded by significant Ocean warming in the Pacific region shown in Fig. 6. An extensive sift through the literature has also shown that El Nino events are closely followed or accompanied by stormy weather conditions in the North Atlantic Ocean, approximately resembling those illustrated in Fig. 5. In particular, these events are also followed closely by turbulent and other violent atmospheric conditions in the North Atlantic Ocean region including the Bermuda Triangle. For example, while a prolonged ENSO (i.e. El Nino and Southern Oscillation) episode took place in 1993, the North Atlantic region which includes the Bermuda Triangle also experienced a "storm of the century" in March 1993 [15]. All these things tempt one to feel that there is probably some connection or relationship between the cause of the Bermuda Triangle mysteries and that of the El Nino events, but at this point in time, we strongly feel that more research in this area is needed before a concrete conclusion is reached.

3. CONCLUSION

We have illustratively described previously unknown physical processes that give rise to certain patterns of ocean convection currents as well as turbulence and other violent atmospheric disturbance (including downward and upward air currents) in the Bermuda Triangle. Furthermore, we have used these patterns to explain the mysterious disappearance of vessels in this triangle. Finally these very patterns have also been used to explain why distress radio signals were not received from most of the more than 100 ships, aircraft and yachts just mentioned before their disappearance. As remarked in the text, associations between the Bermuda Triangle mysteries and violent weather disturbances have been suggested before. However, these suggestions lacked credence partly because of failure to advance physical causes of the violent atmospheric disturbances upon which they were based.

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N.B.—After completion of this paper, we found (in a forthcoming paper) two important things that are so intimately related to the findings in this paper that they deserve a brief mention here for the benefit of forefront and fast-moving researchers.

Firstly, diffraction patterns together with associated weather processes do exist in some other regions of the world though in a manner different from that of the Bermuda Triangle phenomenon described in the text. For example, after drifting across the distribution of islands existing between Australia and South-east Asia, eastward-moving heat waves (of the type described in the text) form some (heat) diffraction patterns in the Pacific Ocean region east of the line joining Taiwan, the Phillipines and Papua New Guinea. These heat diffraction patterns essentially give rise to unusual turbulence and other chaotic atmospheric disturbances in this particular region. Besides, a detailed analysis of the range of heat diffraction patterns formed as a result of the passage of heat waves across the different land masses shows that these patterns give rise to significant turbulence and other violent atmospheric disturbances as well. If all the heat diffraction patterns similarly formed on the Earth are taken into account, a global picture of their combined influence upon weather/climate variations may be constructed. Secondly, the basic causes of El Nino events essentially include the Pacific Ocean warming mentioned in the text and which is related to the causes of the Bermuda Triangle mysteries.

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