

# Weakened geomagnetic field, Cosmic rays & the Resurgence of Yellow Fever



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## Abstract

The yellow fever outbreak in Brazil poses a serious public health threat, within Brazil and possibly on a wider global scale. Research on the environmental factors underlying yellow fever virus outbreaks may provide useful insights into their occurrence. The study suggests that a lowering of the geomagnetic field strength and a consequent sudden increase of cosmic rays in Mexico in 2015 were associated with the yellow fever outbreak in Brazil. Potential mechanisms by which weakened geomagnetic field and cosmic ray activity may influence yellow fever outbreaks as well as other viral epidemic outbreaks in humans are discussed. We suggest that surveillance strategies should include an early warning system for tracking the geomagnetic field and cosmic ray activity.

## Short Communication

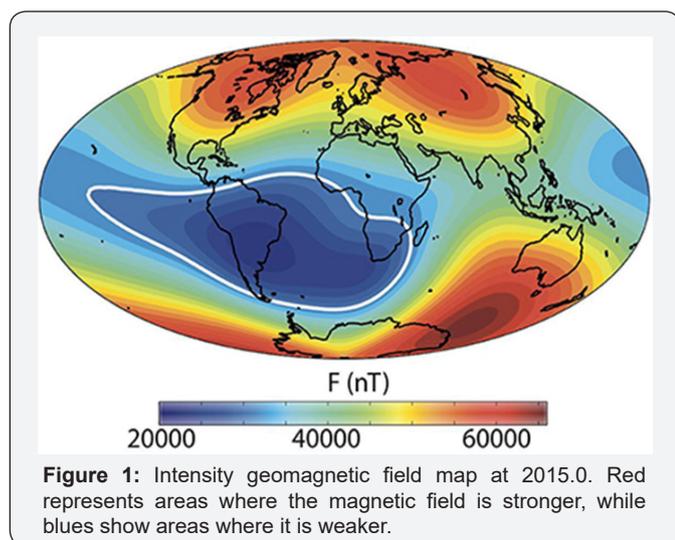
Whilst Brazil is still recovering from the recent Zika virus outbreak, the south-east of this country has been struck by the largest outbreak of Yellow Fever (YF) in Latin America many decades. This outbreak, which began in 2016, has rapidly and alarmingly spread eastward, reaching the most populated regions of Brazil where vaccine coverage is inadequate, so raising public health concern about high rates of urban transmission and the spread of YF beyond Brazil's national borders. Other viral diseases that appeared to flare up in South America roughly at the same time include the arboviruses dengue and chikungunya. Although climate change and poor hygiene are cited as causes for this sudden resurgence of viral disease, it is possible that a more fundamental reason exists, and its discovery could have a profound effect in determining public health strategy.

It is generally known that the Earth's magnetic field acts like a giant invisible bubble that shields the planet from the various mutagens such as solar particles, cosmic rays, and also electrically charged cometary dust particles including virions. Severe disruption of the magnetic field barrier would permit the ingress of damaging cosmic ray particles and also charged virus particles from outside the Earth. In the absence of other plausible causes is to such externally induced processes that we may be forced to turn in order to explain the unusual patterns of viral incidence we have witnessed in recent years.

The role of cosmic rays in causing genetic changes is well known. It is also known that at times of low sunspot activity the Earth's magnetic field is less able to protect the Earth from energetic cosmic rays, including galactic cosmic rays, and charged macromolecules including virions. One particularly strong effect that has recently come to light is a decrease in the Earth's magnetic field in the Southern Hemisphere, straddling land masses in South America and Africa. The geomagnetic map shown in Figure 1 was obtained in 2015 at a time when many of the new pandemics of viral disease which we have discussed actually started sweeping across South America and Africa. We think this is unlikely to be a coincidence.

New data released by the European Space Agency (ESA) reveals that our geomagnetic field is weakening by around 5% a year, which is nearly ten times faster than previous estimates [1]. Furthermore, the field is weakening faster in some places than others. For example, the South Atlantic Anomaly (SAA) is a large depression of the Earth's magnetic field strength characterized by values of geomagnetic field intensity around 30% lower than expected for those latitudes and covers a large area in the South Atlantic Ocean and South America. According to the monitoring data of ESA's Swarm satellite, the Earth's magnetic poles may be getting ready to flip, and the South Atlantic Anomaly where the field is particularly weak has moved steadily westward and weakened further by about 2% [2].

Previous studies have suggested that the vector mosquito responsible for these viral diseases is sensitive to the geomagnetic field, and a weakening of the field can increase the mosquito's reproductive speed and density [3]. YF is mostly transmitted to humans by bites from infected *Aedes spp*, especially *Aedes aegypti*. The rapid weakening of Earth's magnetic field in the SAA region probably speeds up the rapid increase of the mosquito population and thus promotes the rapid spread of the yellow fever virus.



**Figure 1:** Intensity geomagnetic field map at 2015.0. Red represents areas where the magnetic field is stronger, while blues show areas where it is weaker.

At present, solar activity is at its lowest in the past 100 years. The sunspot cycle (No.24) that peaked in 2014 showed the lowest sunspot number recorded since 1906 with many consecutive days of very low sunspot numbers in 2016/17 [4]. Cosmic rays reach a maximum intensity when the earth's magnetic field is weakening dramatically and the sun is least active. According to the World Data Center for Cosmic Rays (WDCCR), there was a sudden increase of cosmic rays in Mexico in January 2015 and continued throughout the year [5] and this was probably the cause of the ZIKV and YF outbreak.

A new study has revealed that solar radiation and cosmic rays are both physical mutagens promoting natural genetic mutation/recombination, and the recombination could in our view include incorporation of charged virions that are admitted due to the weakened geomagnetic field. This process can lead to the emergence of modified viruses like those responsible for pandemic influenza [6]. The recent Zika virus outbreak may have been linked to a systematic increase in the flux of cosmic rays and a general decline of sunspot activity [7]. Phylogenetic

analysis of two yellow fever virus (YFV) samples collected during the current Brazilian epidemic revealed the 2016/17 epidemic virus is a new genetic lineage [8]. The weakened magnetic field and enhanced cosmic rays had evidently both contributed to the severe YFV outbreak.

Thus, we make the bold suggestion that a surveillance of the magnetic field, sunspot numbers and cosmic ray activity may serve as a potential warning of future pandemics. Together with other epidemiological factors, such information might prove useful for strategic disease control planning of YFV as well as other pandemic-causing viruses.

## Acknowledgement

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[http://www.esa.int/Our\\_Activities/Observing\\_the\\_Earth/Swarm/Earth\\_s\\_magnetic\\_heartbeat](http://www.esa.int/Our_Activities/Observing_the_Earth/Swarm/Earth_s_magnetic_heartbeat)

## Author Contributions

These authors contributed equally to this work.

## Competing Interests

The authors have declared that no competing interests exist.

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