INTERNATIONAL PACIFIC RESEARCH CENTER
IN THE SCHOOL OF OCEAN AND EARTH SCIENCE AND TECHNOLOGY AT THE UNIVERSITY OF HAWAI'I AT MĀNOA

January 4, 2018

Using historical observations after volcanic eruptions to reconstruct stratospheric circulation patterns

Detailed tracking of stratospheric winds in the tropics has only been possible since regular weather balloon soundings began at some near-equatorial stations in the early 1950's. One particularly predictable pattern that has emerged is in the winds along the equator, which show regular swings in the prevailing wind direction from easterlies to westerlies and back, roughly every couple of years (28 months on average). This pattern, called the quasi-biennial oscillation (or QBO), had a surprising hiccup in 2016, breaking a routine that had lasted for at least 27 cycles. (See our previous **press release**.) The disruption in the predictability of the QBO pattern prompted many to consider how to understand the QBO better in order to predict when the reliable pattern may change again and affect the winter weather patterns that follow it.

Recent research, published in *Weather*, by IPRC climate modelers Kevin Hamilton and Takatoshi Sakazaki, investigated the possibility of using historical observations after large equatorial volcanic eruptions to learn about the properties of the stratospheric winds of the QBO during those periods. By examining the progressive onset and character around the world of colorful sunsets generated by the eruptions, scientists can calculate factors like direction, speed, and jet center position of the upper atmosphere winds at the time. Extending the record of stratospheric wind characteristics can perhaps give further insight into the variability of the QBO over time, increasing the chances of predicting anomalies like the one in 2016 or in determining whether their likelihood is increasing with climate change.

"Any actual pre-1953 wind observations are very valuable as contributors to reconstructing the QBO record," states Hamilton. "We want to show that observations of the effects of volcanic aerosols…can provide credible estimates of the equatorial stratospheric wind at the time (of the eruption)."

Hamilton and Sakazaki compiled historical accounts of the effects noted around the world after the eruptions of Krakatoa (1883), St. Vincent and Mt. Pelee (1902), and Mt. Pinatubo (1991). The most notable effects,

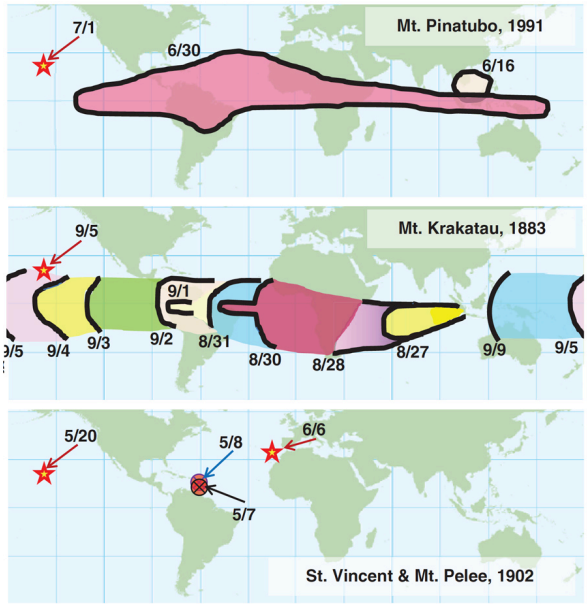

Figure from Hamilton and Sakazaki (2017) illustrating historical data used to make conclusions about QBO winds at the times of the eruptions.

commonly, were brilliant sunsets or sun haloes due to the volcanic aerosols lofted high into the atmosphere. The more recent Pinatubo eruption proved to be a useful opportunity to groundtruth the technique by providing observations of the distribution of volcanic aerosols analogous to those recovered for the prehistorical eruptions, but during a time when actual atmospheric wind measurements are available for comparison. Results suggest that historical observations could accurately supply information about prevailing wind direction and peak wind speeds, with some clues of what latitude the wind jet was located, all useful details to help characterize the instantaneous state of the QBO.

Hamilton and Sakazaki also identified 19 more candidate eruptions between 1800 and 1952, volcanoes of high explosivity index and within 16 degrees of the equator. Mining observations from the past could provide further opportunity to extend the QBO record back two centuries.