IPRC INTERNATIONAL PACIFIC RESEARCH CENTER
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Unexpected changes in high-level winds surprise scientists and challenge the world's weather forecast systems

One of the most repeatable, predictable phenomena of atmospheric winds threw scientists for a loop last February by breaking its long-standing routine. However, a study published this week in *Science* presents a mechanism to explain this unexpected and unprecedented disruption. The international group of atmospheric scientists was led by Scott Osprey of the National Centre for Atmospheric Science (NCAS) at the University of Oxford, and included IPRC's Kevin Hamilton, recently retired Professor of Atmospheric Sciences, and Chunxi Zhang, Atmospheric Modeling Specialist, at the University of Hawai'i at Mānoa.

High altitude (16-50 km) winds above the equator typically oscillate between prevailing eastward and westward wind-jets, with a period of about 2-3 years. This pattern (Fig. 1) of descending and alternating directional wind-jets, called the Quasi-Biennial Oscillation (QBO), has held since weather balloons began taking the appropriate measurements in January 1956 (27 cycles!). In February 2016, though, the pattern was unexpectedly disrupted when an anomalous westward wind-jet formed during an established eastward phase (red arrow). The presence of this jet could not be explained by the mechanism understood to drive the QBO: the vertical transport of momentum in the atmosphere.

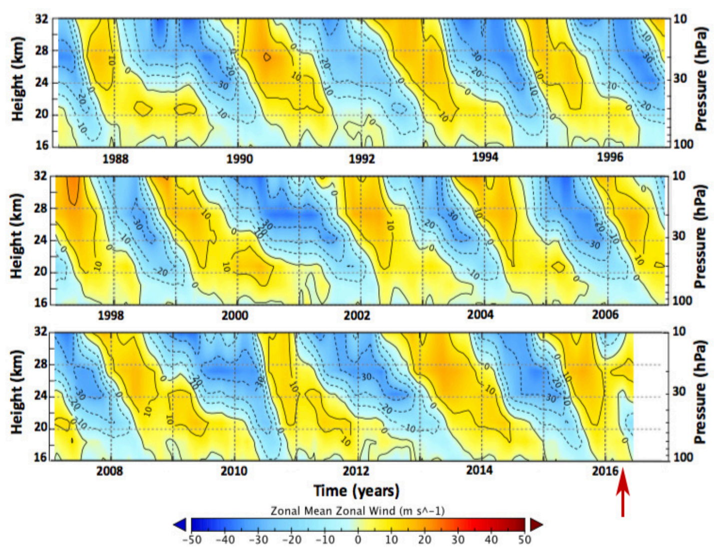

Figure 1. Vertical profile through time (from 1987 to 2016) of prevailing, high-level equatorial winds for the last thirteen QBO cycles. Yellow tones indicate eastward wind-jets; blues are westward winds. Red arrow highlights when the pattern was disrupted.

The predominance of one wind direction over the other is important for forecasters, particularly in predicting the weather patterns that will dominate Northern Europe each winter.

"If we can get to the bottom of why the normal pattern was affected in this way, we could develop more confidence in our future seasonal forecasts," explains Osprey.

In an effort to understand the disruption of the QBO pattern, and find an underlying mechanism that may have generated the disturbance, the group analyzed four types of data: direct, in situ wind observations by balloons; global model assimilation of balloon and satellite observations;

global model predictions of the atmosphere several months into the future; and free-running global climate models.

“Dr. Hamilton and I, at IPRC, helped initiate this investigation by analyzing the winds directly measured by balloons at many locations near the equator. We then devised a quantitative measure of how extremely unusual the behavior this year has been,” said Zhang.

The primary cause of the QBO disruption that was determined by the study was atmospheric waves transporting momentum from the Northern Hemisphere southward to the equatorial region, thus causing the formation of a westward wind-jet, which disrupted the eastward flow. Analysis of very long term computer climate simulations illustrated that one model spontaneously produced similar disruptions of the QBO, but with a frequency of less than once per century.

“The development of the upper level winds in early 2016 caught all the experts by surprise,” explained Hamilton, “and we cannot be completely sure of how the disruption in the QBO will be resolved. It seems mostly likely that there will be a return to typical QBO behavior through the rest of 2016 into 2017, although reversed in polarity: winter of 2016/2017 was expected to be westward dominated and may instead be eastward dominated again.”

Bundle up, Europe; that means that your winter looks likely to have more storms and heavy rain!

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Citation:

Osprey, S.M., Butchart, N., Knight, J.R., Scaife, A.A., Hamilton, K. Anstey, J.A., Schenzinger, V., and Zhang, C. An unexpected disruption of the atmospheric Quasi-Biennial Oscillation. *Science* doi: 10.1126/science.aah7277 (2016)

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