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## **Contribution of planetary waves to the three-week total ozone reduction over Rio Gallegos, Argentina, in November 2009**

H. Akiyoshi (1), M. Kadowaki (1,2), H. Nakamura (1,3), T. Sugita (1), T. Hirooka (4), and A. Mizuno (5)

(1) National Institute for Environmental Studies, Tsukuba, Japan (hakiyosi@nies.go.jp), (2) Japan Atomic Energy Agency, Tokai, Japan, (3) Fujitsu FIP Corporation, Tokyo, Japan, (4) Kyushu University, Fukuoka, Japan, (5) Solar-Terrestrial Environment Laboratory, Nagoya University, Nagoya, Japan

Unusually low total ozone was observed for three weeks in November 2009 over the southern part of South America [de Laat et al., 2010]. The ozone reduction was also observed at the Rio Gallegos station (51.5°S, 69.3°S) in the Network for the Detection of Atmospheric Composition Change (NDACC) station by lidar, which showed ozone concentration reductions on 13-14 November in the lower stratosphere and on 22-23 November in the upper troposphere [Wolfram et al., 2012]. The successive occurrence of these ozone reductions at different altitudes resulted in a three-week reduction in total ozone. The ozone reduction is associated with the polar vortex breakup process and vortex air advection in late spring.

In this study, we analyzed the dynamical field around the latitudes over Rio Gallegos of the 37 years from 1979 to 2015, using ERA-Interim reanalysis data. The results indicate that one of the largest anomaly of geopotential height during the 37 years was in November 2009. We also show that this large anomaly may have been associated with wave activity that originated from the troposphere over the Pacific Ocean. The wave number one and two components of the 50 hPa geopotential height over Rio Gallegos in November indicated that the evolutions of the amplitude and the phase in 1980 and 2009 are considerably similar. In the 1980 case, however, a large ozone reduction did not occur in November because the ozone hole had not developed at that time, due to the low halogen content in the atmosphere. A nudged CCM simulation, in which winds and temperature were nudged toward those for 1980 with a halogen burden for 2000 shows a three-week total ozone reduction in November 1980 that is similar to that in 2009.

In conclusion, as shown by dynamical field analysis over the past 37 years, cases of polar air advection and lingering over Rio Gallegos associated with the breakup of the Antarctic polar vortex are unusual, involving only two events in 37 years; however, a low total ozone event for a few weeks in November may happen again in the future, as long as the ozone hole develops in the austral spring. Such an event will bring a high UV risk to that region.

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