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Explaining the 11-year periodicity in Neptune's atmosphere with Voyager 2 data

Karen Aplin (1) and R Giles Harrison ()

(1) University of Oxford, Physics Department, Oxford, United Kingdom (karen.aplin@physics.ox.ac.uk), (2) University of Reading, Department of Meteorology, Reading, United Kingdom

Long-duration observations of Neptune's brightness at two visible wavelengths, made since the 1970s by Lockwood and co-workers [e.g. 1], give a disk-averaged estimate of variations in the planet's clouds and atmospheric aerosol. Brightness variations have previously been associated with the 11-year solar cycle [1], through two solar-modulated mechanisms, firstly, ultraviolet-related colour changes [2], or galactic cosmic ray (GCR)-related nucleation effects on atmospheric particle formation. Over 40 years of brightness data (1972–2014) are used here to show, with physically realistic modelling, that ultraviolet and GCR are likely to be modulating Neptune's atmosphere in combination rather than as alternatives.

Existence of the cosmic ray mechanism is further supported by the response of Neptune's atmosphere to an intermittent 1.5- to 1.9-year periodicity during the mid-1980s. This occurred in GCR and, critically for its use in mechanism discrimination, not the solar ultraviolet. This periodicity was detected both at Earth, and in GCR measured by Voyager 2, which was close to Neptune at that time. The similar coincident variability in Neptune's brightness suggests nucleation onto GCR ions. Both GCR and ultraviolet particle modulation mechanisms are expected to occur more rapidly than the subsequent atmospheric transport processes.[2]

[1] Lockwood, G. W. & Thompson, D. T. Photometric variability of Neptune, 1972–2000. Icarus 156, 37–51 (2002).
[2] Aplin, K. L. & Harrison, R. G. Determining solar effects in Neptune's atmosphere. Nat. Commun. 7:11976 doi: 10.1038/ncomms11976 (2016)