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Vorticity dynamics and thrust during VRS[1] OMER SAVAS, UC Berkeley, RICHARD GREEN, University of Glasgow, FRANCIS CARADONNA, NASA Ames Research Center — Under certain conditions of rapid descent of a rotorcraft, the vortices that usually trail below a rotor disk to form the helical vortex wake collapse into a ring-like structure around the plane of the disk, which is known as the vortex ring state (VRS). The formation and subsequent breakdown of the ring-like vortex is accompanied by large thrust excursions. In axial descent the thrust excursions are aperiodic, while in non-axial descent a periodicity on the order of several tens of rotor revolutions is observed. We discuss here experimental observations of the phase relation between the thrust cycle and vorticity distribution. The experiments were performed in a towing tank using a three-blade rotor. Rotor thrust was measured by strain gages and the vorticity fields using PIV. The flow structure as marked by vorticity distribution highlight the changes in the flow topology during the VRS cycles contrast the flow behavior at the leading and the trailing edges. The flow over the trailing edge exhibits large variations, whereas that over the leading edge is more tamed. Maxima of the VRS thrust oscillations correlate well with the maxima of enstrophy observed at the trailing edge of the rotor disk.

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