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ABSTRACT: Approximately 1700 billion tons of soil carbon are stored in the northern circumpolar permafrost zone, more than twice as much carbon than currently contained in the atmosphere. Permafrost thaw, and the microbial decomposition of previously frozen organic carbon, is considered one of the most likely positive feedbacks from terrestrial ecosystems to the atmosphere in a warmer world. Yet, the rate and form of release is highly uncertain but crucial for predicting the strength and timing of this carbon cycle feedback this century and beyond. Here we report results from an ecosystem warming manipulation —the Carbon in Permafrost Experimental Heating Research (CiPEHR) project— where we increased air and soil temperature, and degraded the surface permafrost. We used snow fences coupled with spring snow removal to increase deep soil temperatures and thaw depth (winter warming) and open top chambers to increase growing season air temperatures (summer warming). We show that experimental warming that caused permafrost degradation led to a two-fold increase in net C uptake by the ecosystem during the growing season, in line with decadal trends of ‘greening’ tundra across the region. However, warming also enhanced winter respiration, which entirely offset growing season C gains. Winter C losses may be even higher in response to actual climate warming, and in that scenario, could be expected to more than double overall net C losses from tundra to the atmosphere. These results highlight the importance of winter processes in determining whether tundra acts as a C source or sink, and demonstrate the potential magnitude of C release from the permafrost zone that might be expected in a warmer climate. Furthermore, this initial response to warming quantifies the vulnerability of organic C stored in near surface permafrost to temperature change, and corresponds to the initial stages of permafrost degradation observed from a thaw gradient at the same location.