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What is lightning channel conditioning?[1] RICHARD SONNENFELD, New Mexico Tech / Langmuir Laboratory, HUGH CHRISTIAN, University of Alabama, Huntsville, DANIEL WALKER, University of Alabama, Huntsville, Earth System Science Center — A cloud-to-ground lightning flash can last as much as a second and consist of one to 20 return strokes. Some return strokes retrace channels first created by earlier strokes. The leader for an initial channel is called a stepped leader and has a propagation velocity of $\simeq 5 \times 10^5$ m/s. If another leader retraces that channel within 100 ms, it progresses much more rapidly, up to $\simeq 1 \times 10^8$ m/s. It is said that the difference between a stepped leader and a dart leader is that the dart leader proceeds on a channel which has been "conditioned", by the prior stepped leader. What is conditioning? One might assume that the channel is still hot and thus has a high population of free electrons. Radar studies by Holmes that averaged over tens of km of space found electron recombination time constants of 3–20 ms. Spectroscopic studies have also suggested channel cooling times in the millisecond range. How then, can a dart leader occur 100 ms after a stepped leader? One idea is that the free electrons recombine with Oxygen atoms creating a temporary population of $O_2{}^-$ ions. The ionization potential of $O_2{}^-$ is less than 1.5 eV, compared to 12 eV for O_2. Thus, conditioning is perhaps a "chemical" rather than a thermal process.

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