



Characteristics of positive upward lightning measured on an instrumented tower

G. Diendorfer (1), H. Pichler (2), M. Mair (2)

(1) Austrian Electrotechnical Association (OVE-ALDIS), Kahlenberger Str. 2A, 1190 Vienna, Austria, (2) Vienna University of Technology, Institute of Power Systems and Energy Economics, Gusshausstrasse 25, 1090 Vienna, Austria (g.diendorfer@ove.at / Fax: +43 1 3705806-299 / Phone: +43 1 3705806-215)

Lightning to an instrumented tower (height 100 m) on Gaisberg, near to the city of Salzburg, is measured since 1998. From 2000-2003 we have recorded a total of 242 flashes to the instrumented tower. Lightning current is measured by digitizing (20MS/s) the output signal of a 0.25mOhm current viewing resistor (shunt) over a sampling time of 800 ms. The fast majority (236 out of 242) of the recorded flashes were upward initiated, as typical for elevated objects. 9 flashes lowered positive charge to ground and have therefore been initiated by upward negative leaders from the tower top. All these 9 positive flashes occurred during cold season or winter time (September – March). Total flash duration is in the range from 6 to 190 ms (mean 70.8 ms) and total charge transfer is in the range from 20 to 376 As (mean 130 As). Typically the observed overall current waveform exhibits a front section with significant pulsing structure lasting for about 2.1 ms (median). Recorded waveforms are very similar to measured currents of triggered winter lightning in Japan (Yoda et al., 1997, Nakamura et al., 1997). We have analyzed in detail the pulsing front section of the current waveforms. They show 25 to 89 (mean 60) current pulses with pulse duration of 27 to 44 μ s (mean 34 μ s). The pulses are superimposed on a steadily increasing continuous current. The pulse duration is comparable to the inter-step intervals of 30 to 50 μ s determined optically for negative upward leaders observed at Mont San Salvatore (see Rakov and Uman, 2003). Mean values of the peak current of these leader pulses are in the range of 1.6 to 13.7 kA. For each of the 9 flashes we have determined for the distinct pulses a mean charge transfer in the range from 0.013 C to 0.321 C. Wada et al. (2002) measured for the same type of lightning to a 200 m high chimney

in Japan a leader propagation speed of $6 \cdot 10^6$ m/s. Assuming a speed of $6 \cdot 10^6$ m/s a pulse-duration of $34 \mu\text{s}$ corresponds to a step length of 204 m, which is in the same range as the optically observed step lengths reported by Wada et al (2002). For three distinct steps Wada et al. (2002) determined a two dimensional length of 45m, 118m and 311m.