

# **Lightning and Polarimetric Radar Behavior of Incipient Thunderstorms in CHUVA**

**Earle Williams, MIT;  
Enrique Mattos, CPTEC;  
Luiz Machado, CPTEC  
Antonio Saraiva, INPE**

**CHUVA Workshop  
University of Sao Paulo  
Sao Paulo, Brazil  
May 8-10, 2013**

# Outline

- **Observational facilities**
- **Identification of 20 incipient thunderstorms**
- **Evolutionary sequence**
- **Thresholds on size for a cloud-to-ground flash**
- **Constraints on multi-stroke behavior**
- **Peak currents in initial ground flashes**
- **Dual-polarimetric behavior**
- **Conclusions**

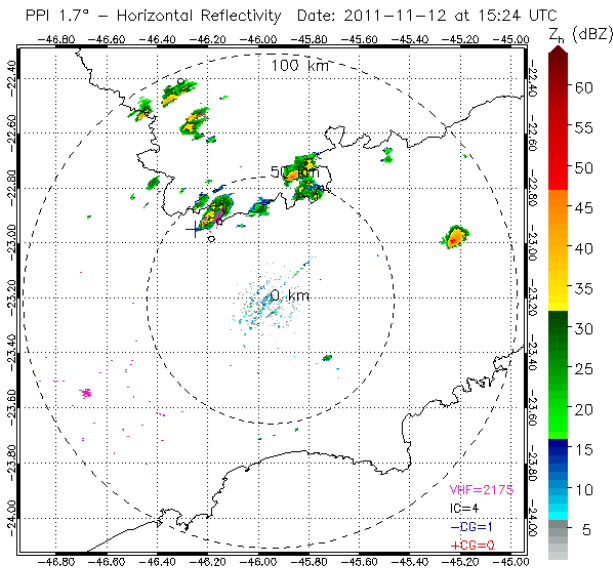
# Observational Facilities in CHUVA

- **Lightning Documentation (intracloud and cloud-to-ground flashes/strokes)**
  - **Lightning Mapping Array (VHF)**
  - **Brasildat**
  - **GLD360**
  - **LINET**
- **Radar Documentation**
  - **X-POL radar at UNIVAP (reflectivity and differential reflectivity)**

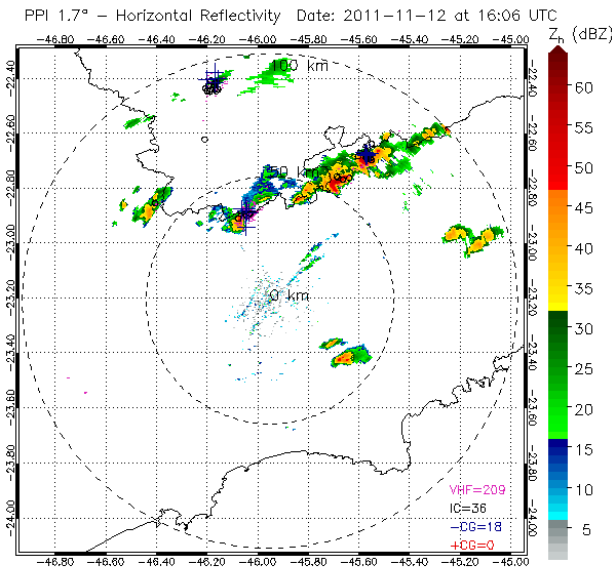
# Isolated thunderstorm viewed from UNIVAP November 9, 2011



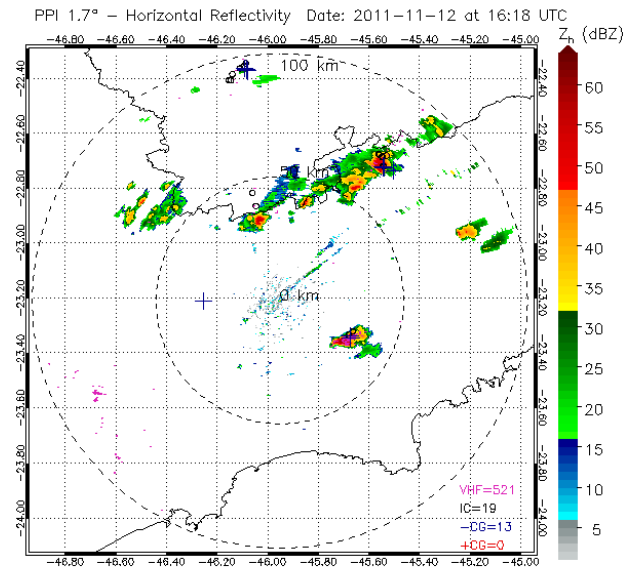
# Incipient thunderstorm development November 12, 2011



Initial radar echo

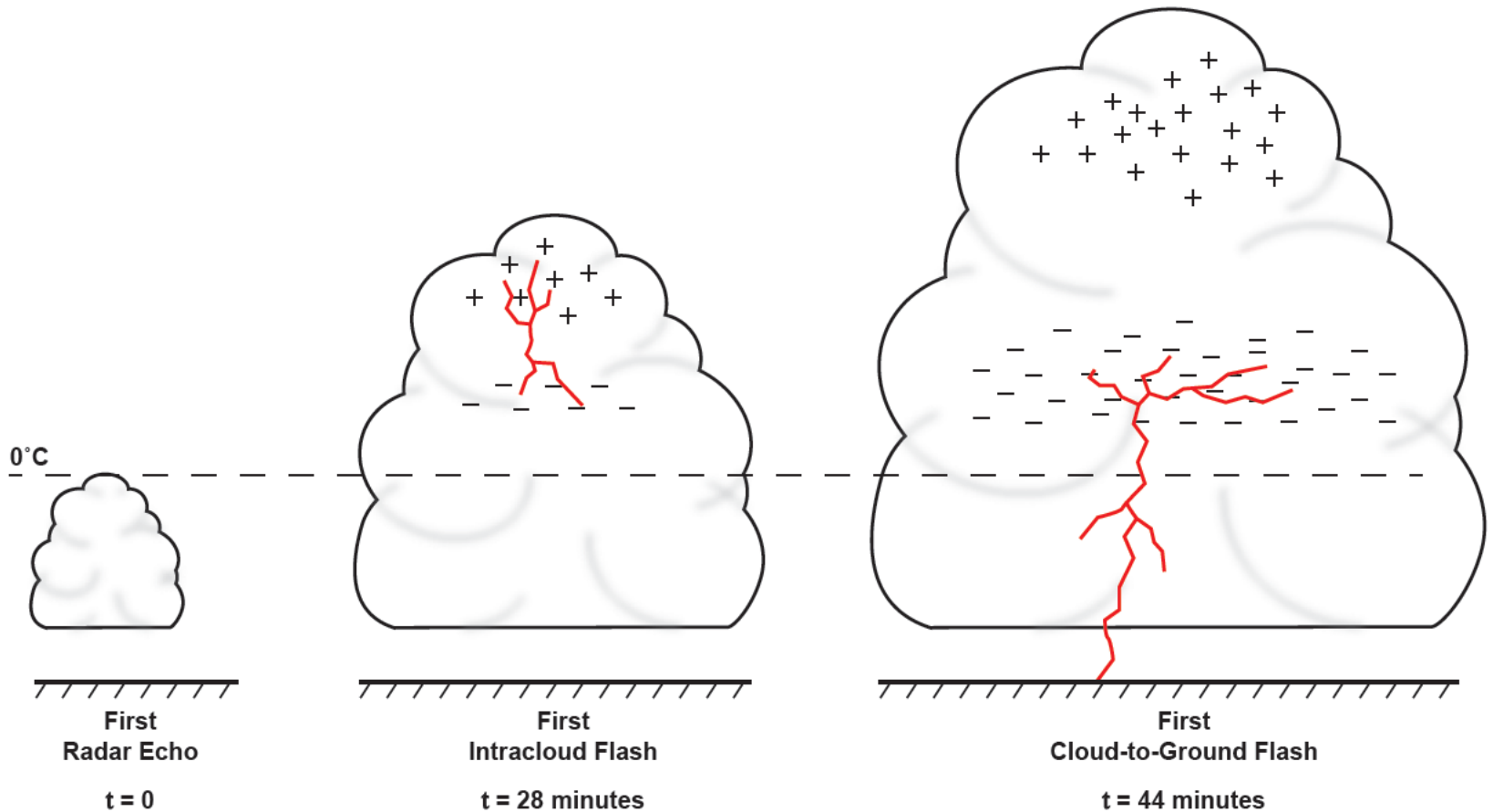


Initial intracloud flash

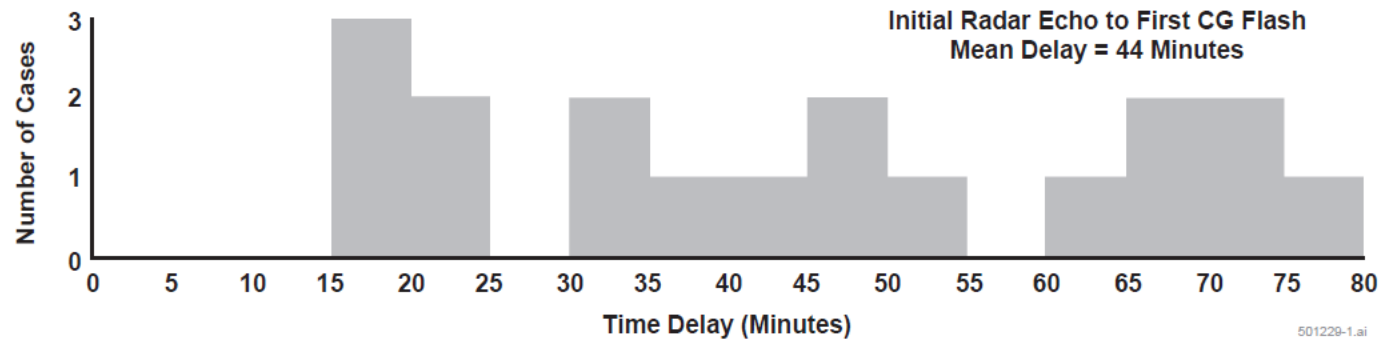
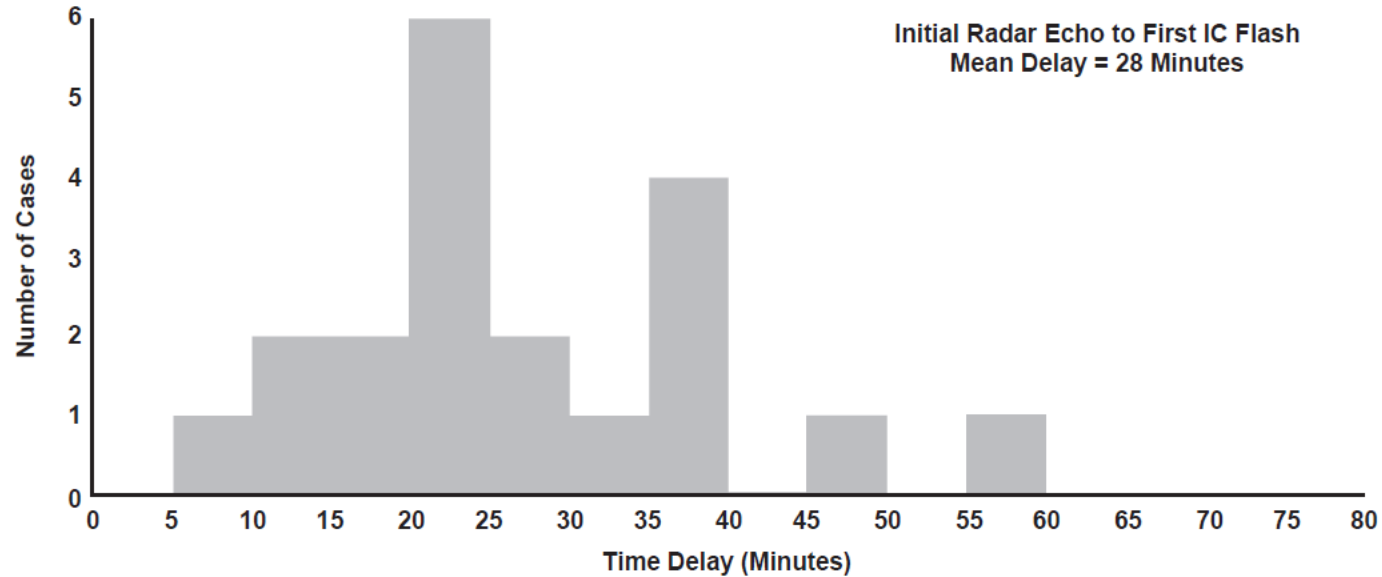


Initial cloud-to-ground flash

# Evolution of isolated CHUVA thunderstorms

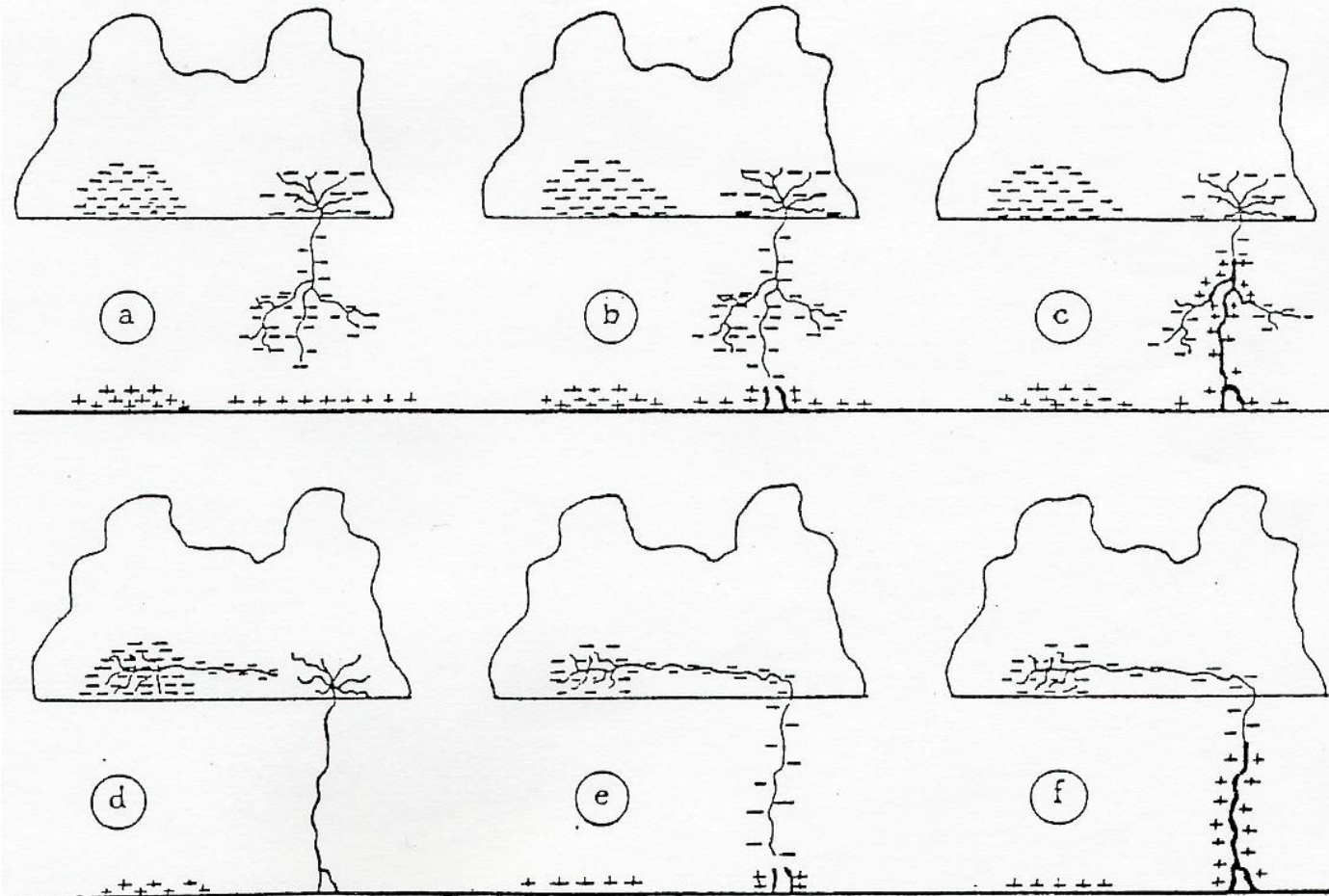


# First Radar Echo to First Lightning Flash



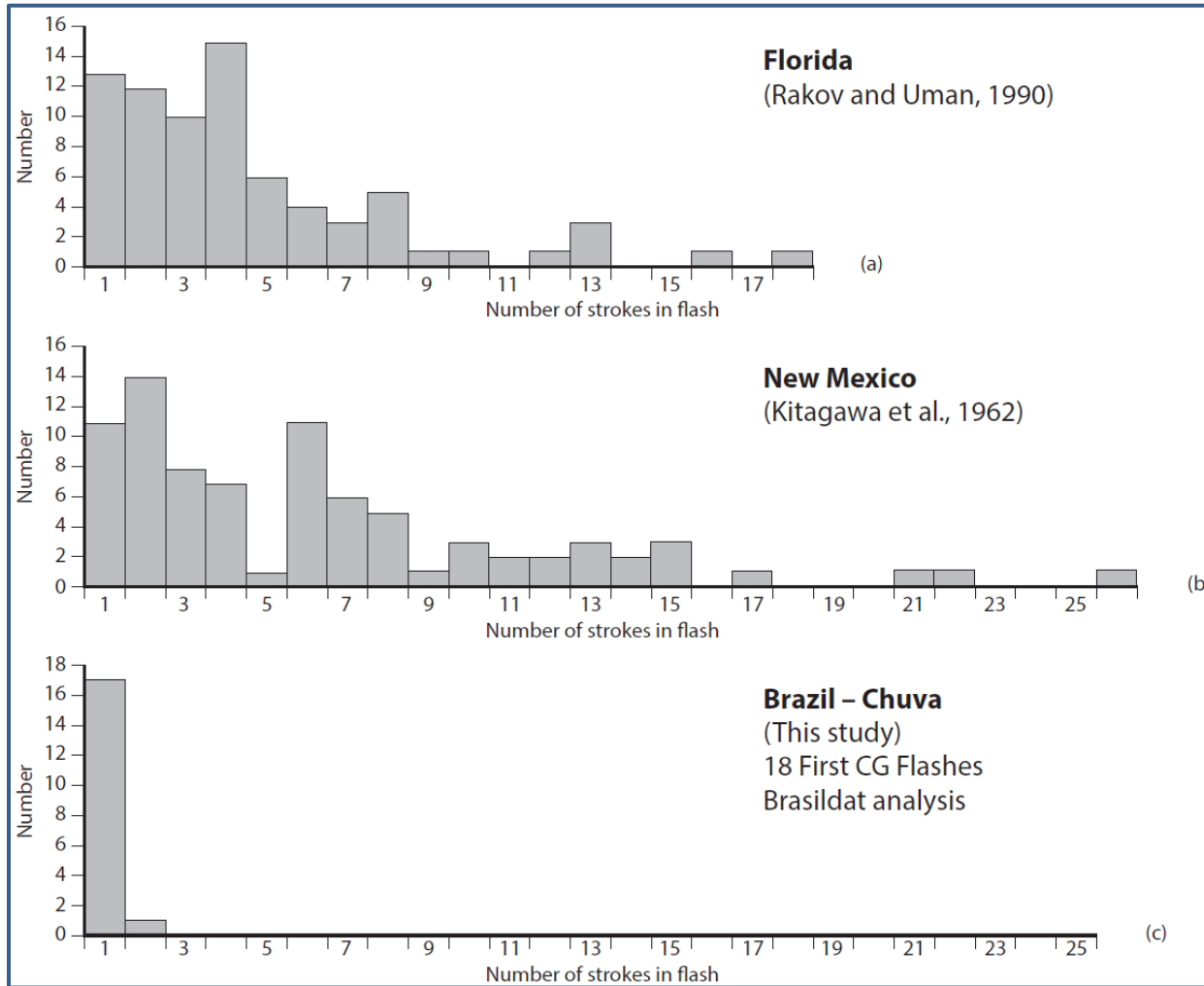
# An Early Explanation for Multiple Strokes: Clumps of Charge

Schonland 1938

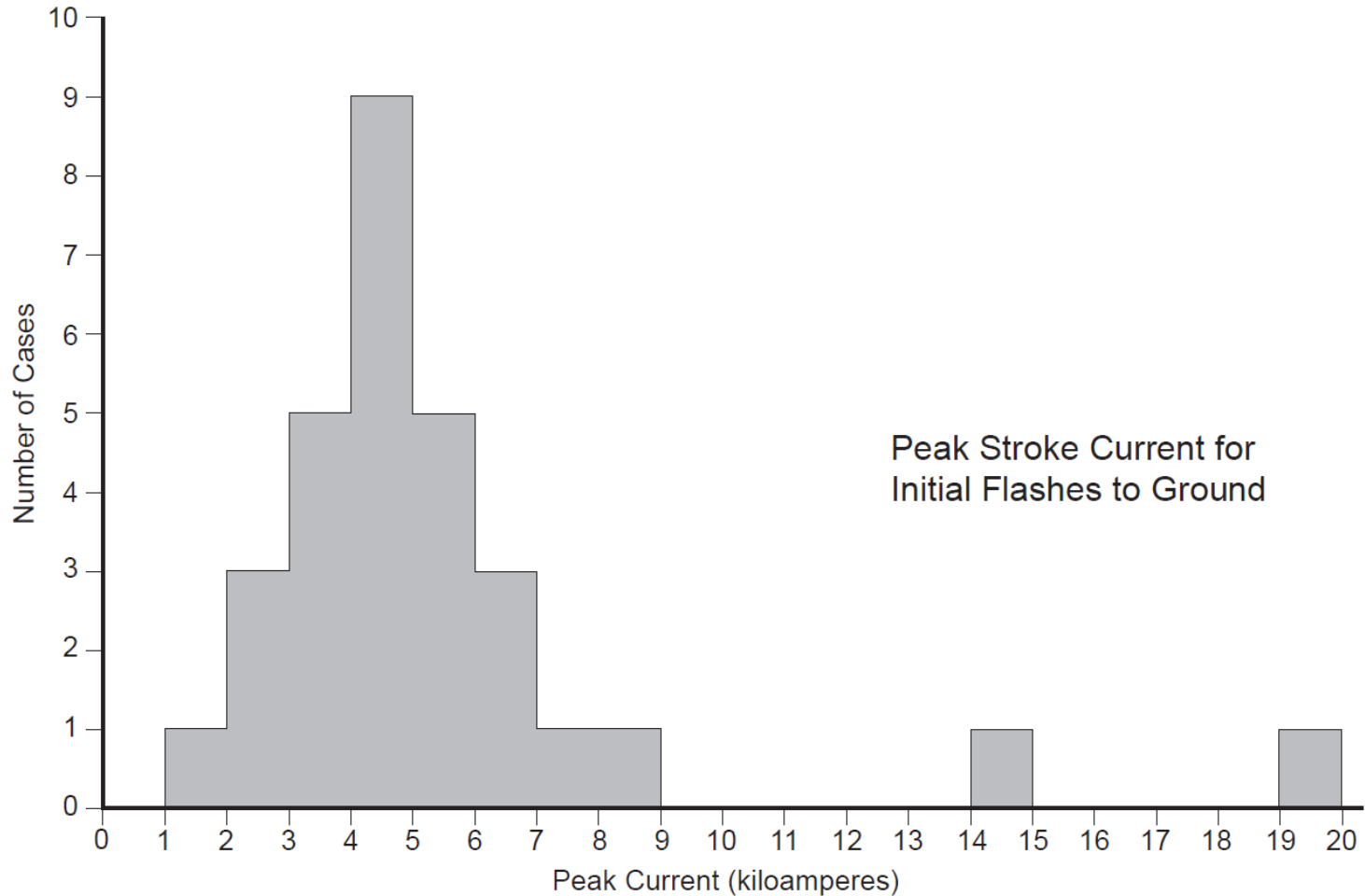




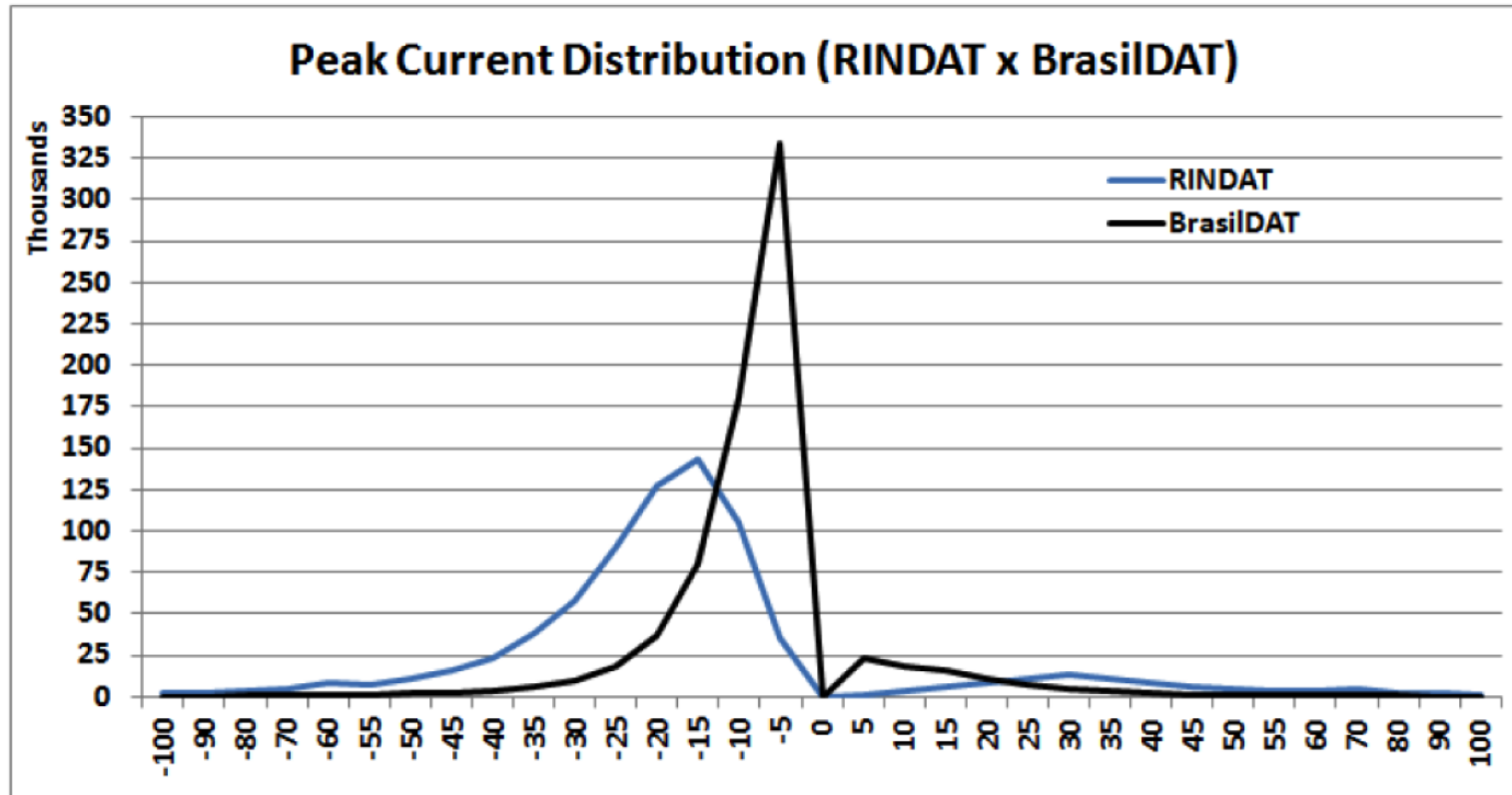
# Stroke Multiplicity of Cloud-to-Ground Lightning Flashes



# Peak return stroke currents (from Brasildat)

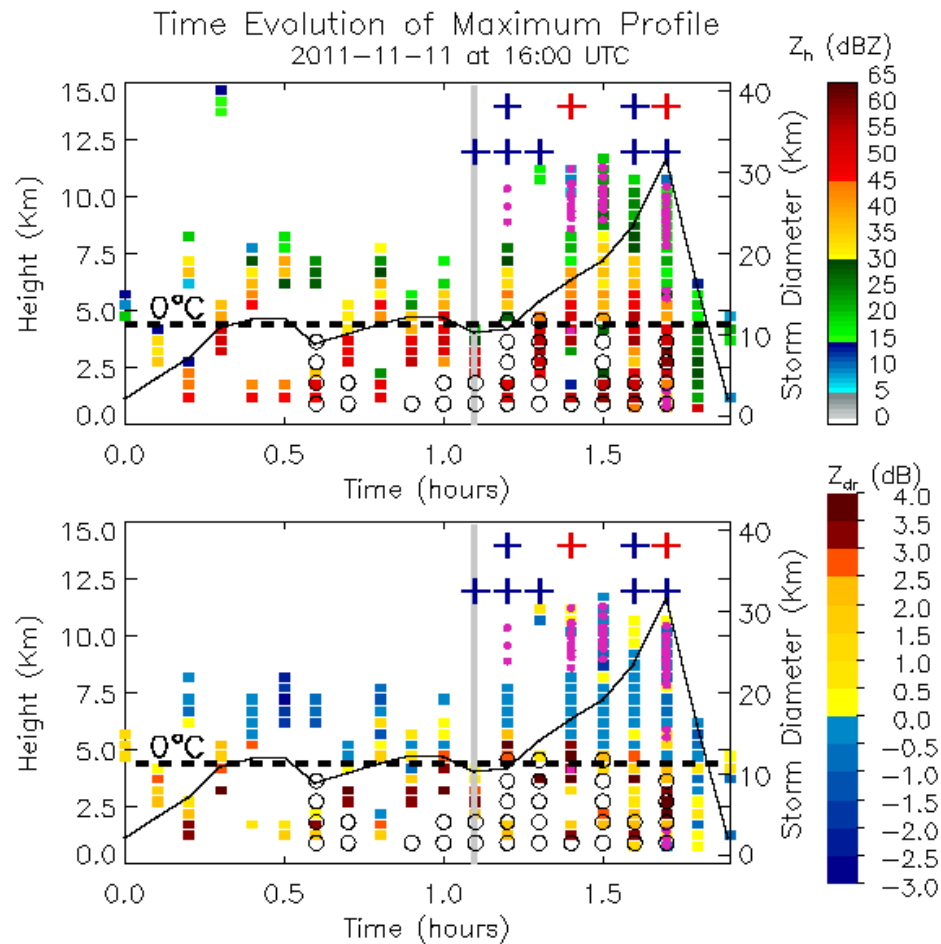


# Peak current comparisons with Brasildat and RINDAT (Naccarato et al., 2012)

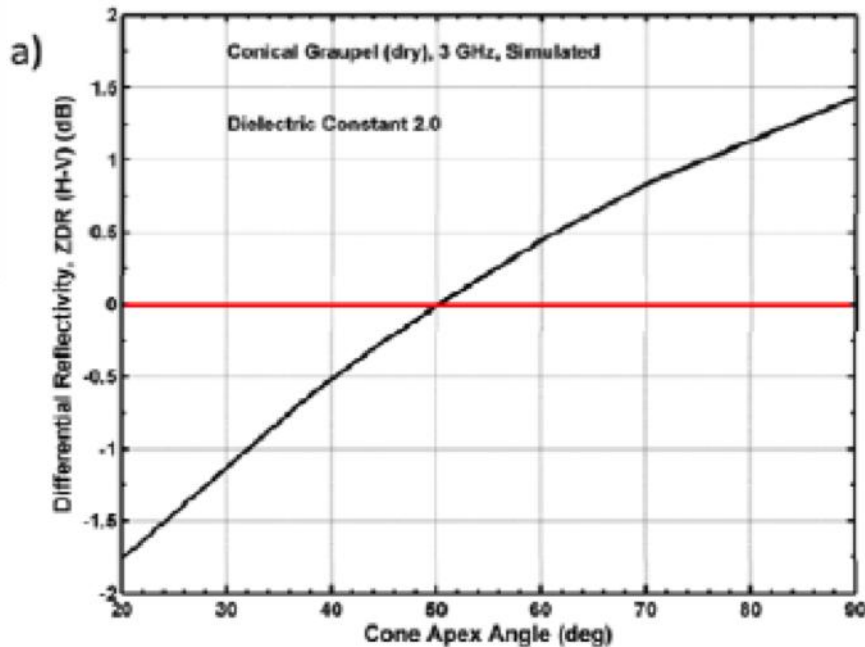


# Reflectivity, differential reflectivity and lightning

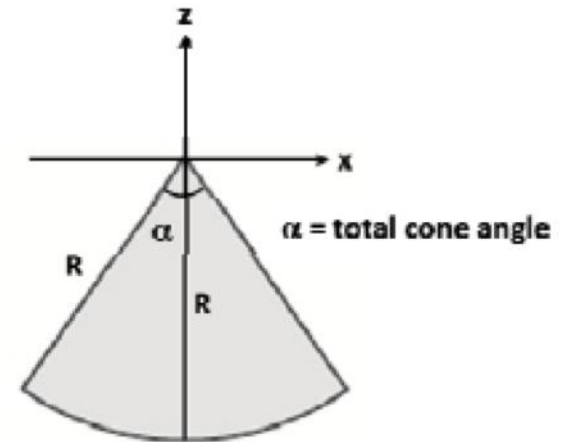
## November 11, 2011



# ZDR for Conical Graupel— Model Calculations



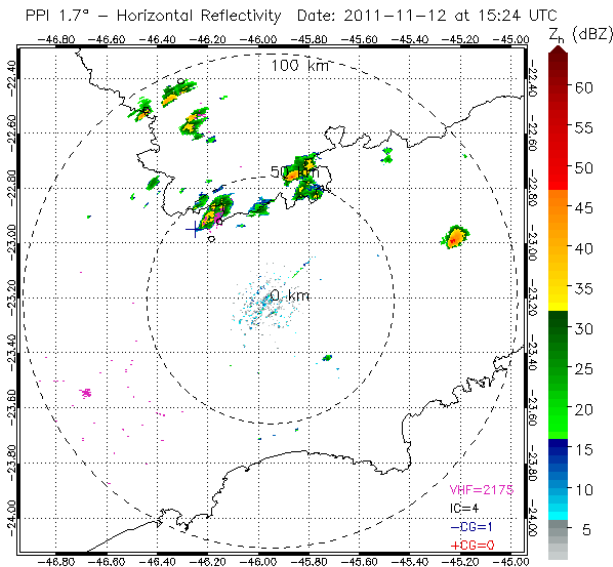
b)



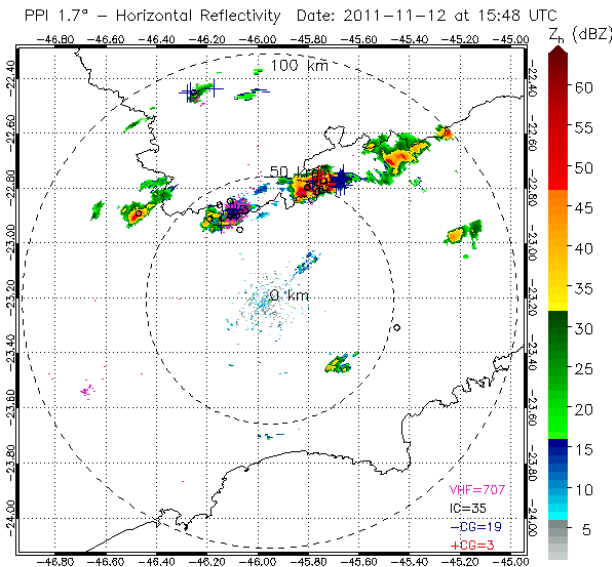
# Conclusions

- **Evolutionary sequence is identical for all cases studied and consistent with earlier studies in North America**
- **The initial CG flash requires a radar-measured cell diameter of order 10-12 km**
- **Single stroke flashes are strongly preferred**
- **Peak currents of initial CG flashes are smallish**
- **Negative values of differential reflectivity predominate in the mixed phase region during initial electrification**

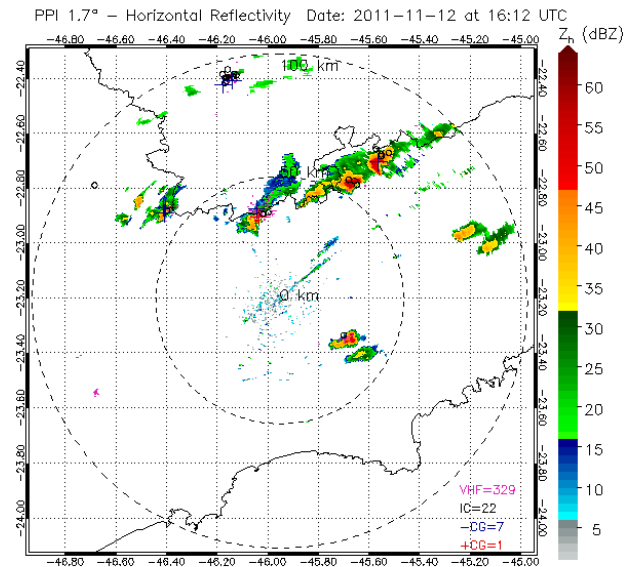
# Incipient thunderstorm development November 12, 2011



Initial radar echo



Initial intracloud flash



Initial cloud-to-ground flash

# Radar Cell Diameters at Times of Initial Lightning Flashes

