Ground measurements of the vertical E-field in Israel and Armenia

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- **Introduction**
- Results
- Summary

Introduction

- The global electric circuit: what we need?
  Battery: Thunderstorm
  Charge: free electrons and ions

- IP: ~300-350 kV
- Jz: ~2 pAm/m²

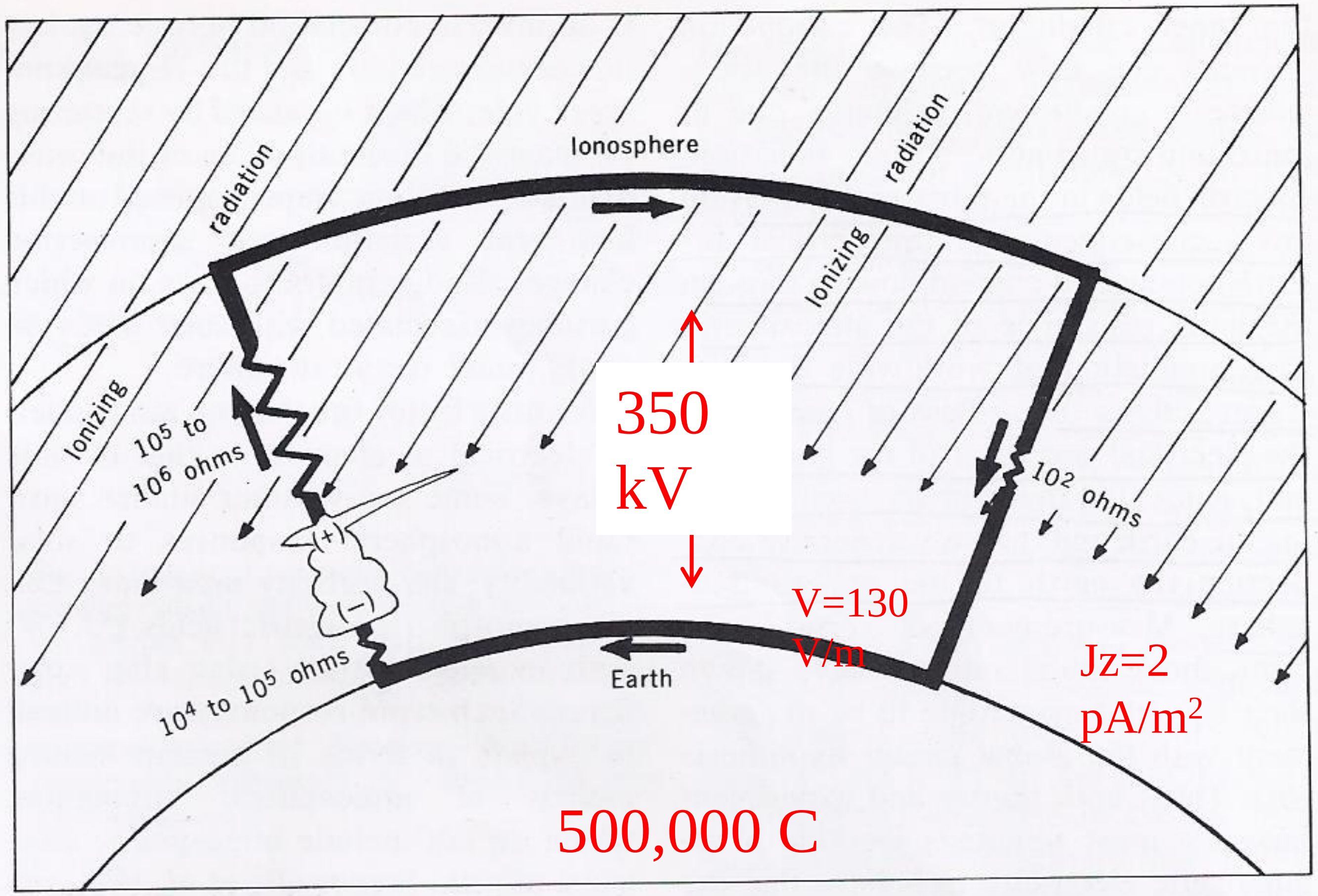
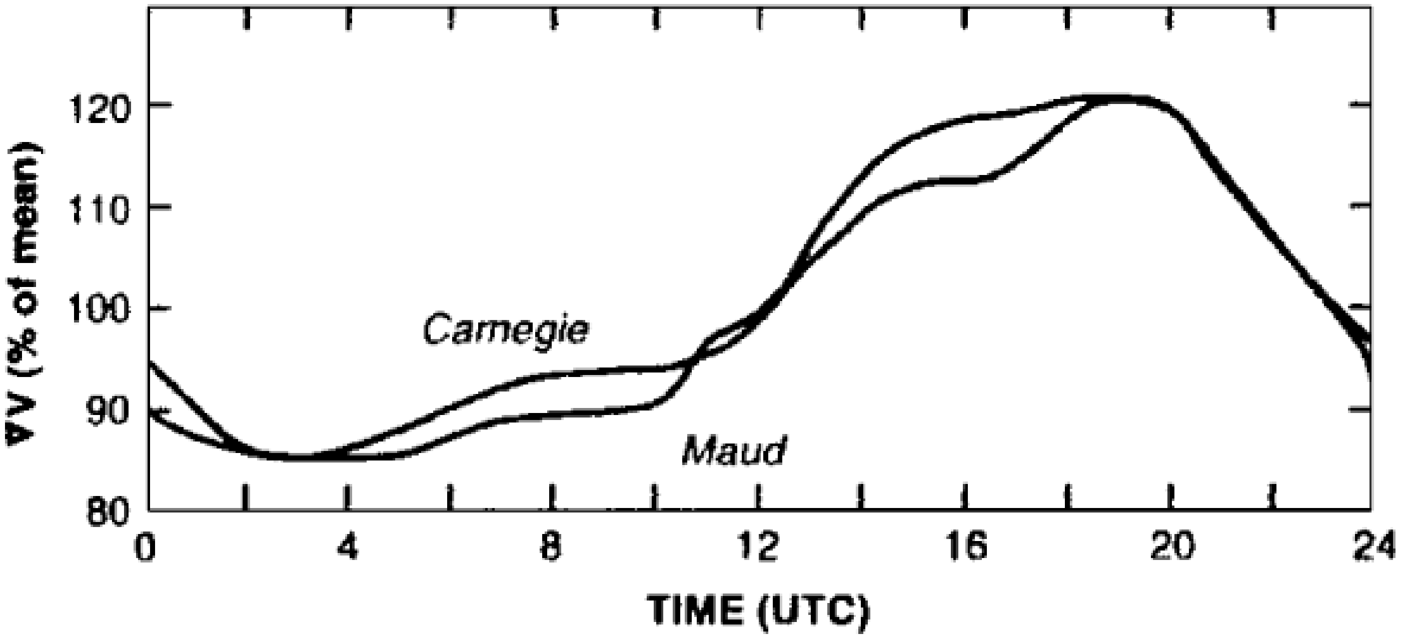


Fig. 3. Schematic of the global atmospheric electrical circuit illustrating relationships between resistive elements. The arrows indicate the accessibility of the controlling resistive element above the thunderstorm generator to the varying component of the ionizing radiation (*15*).

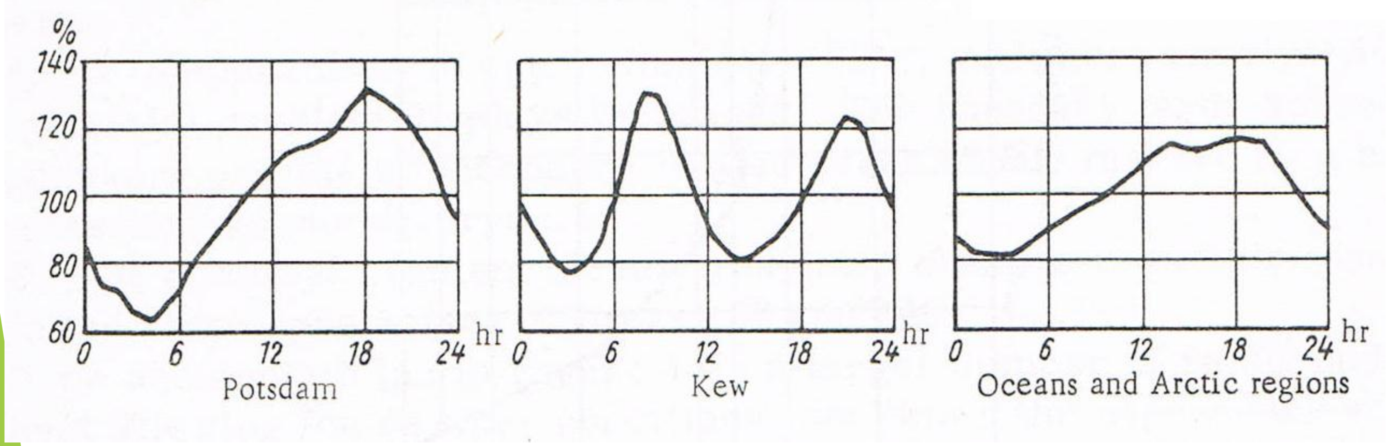
Markson 1980

Vertical Electric field (Ez) near ground

- *Carnegie* curve
- Diurnal variation of the Ez over land and ocean



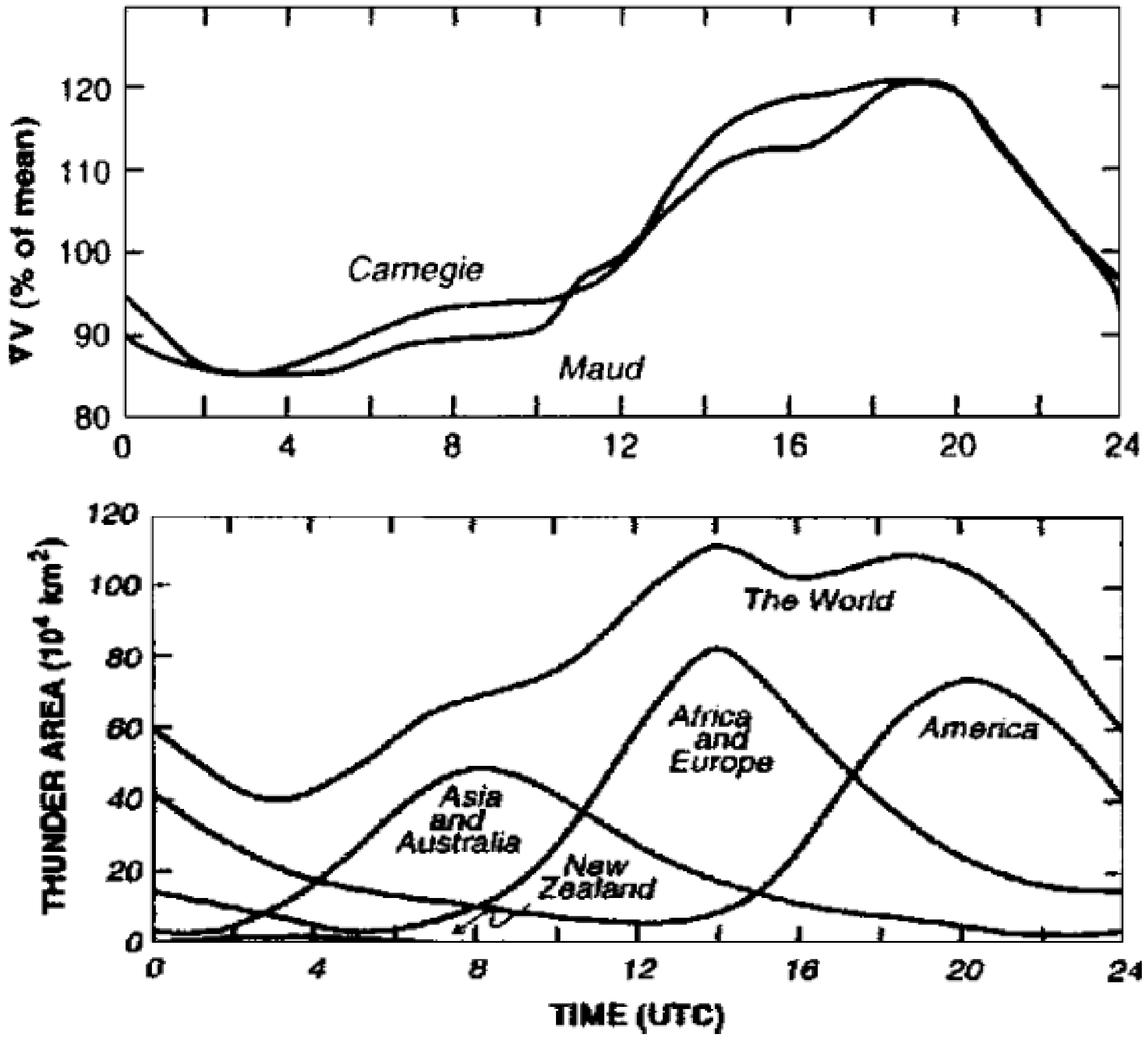
Harisson 2012



Israël 1970

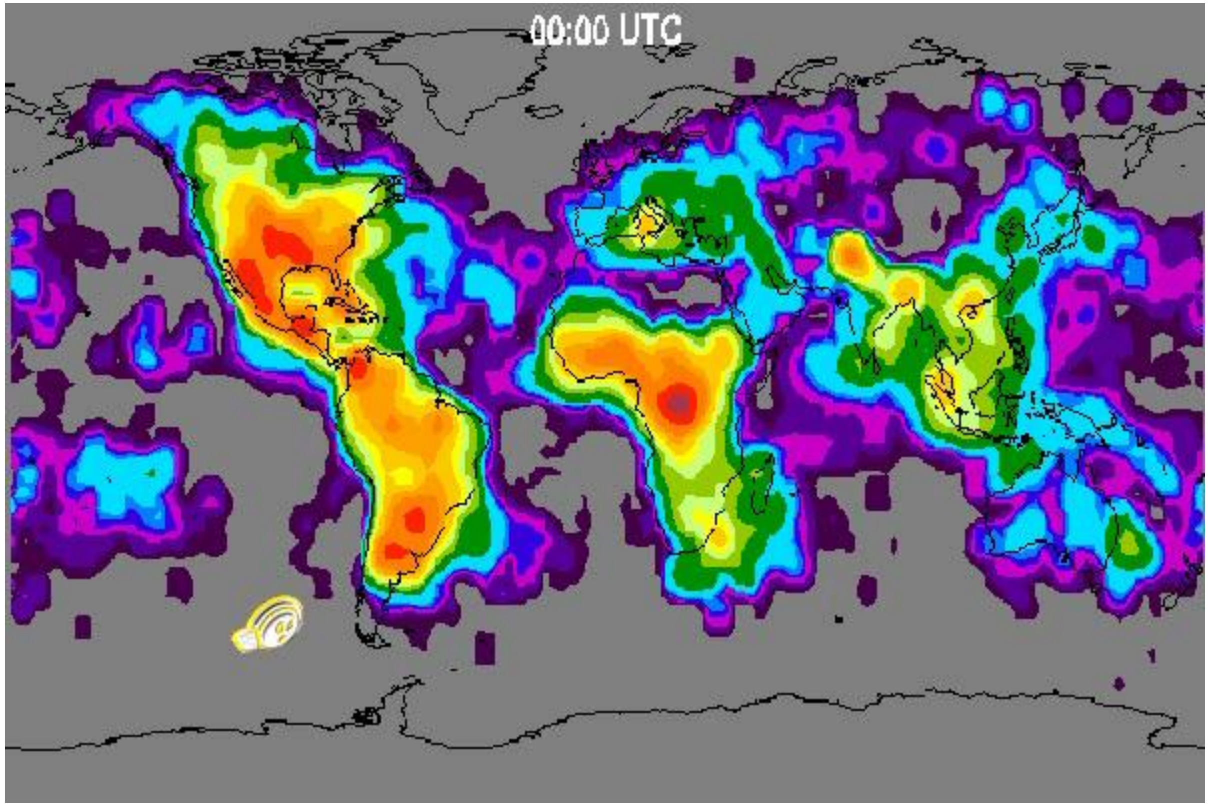
Ez and lightning connection

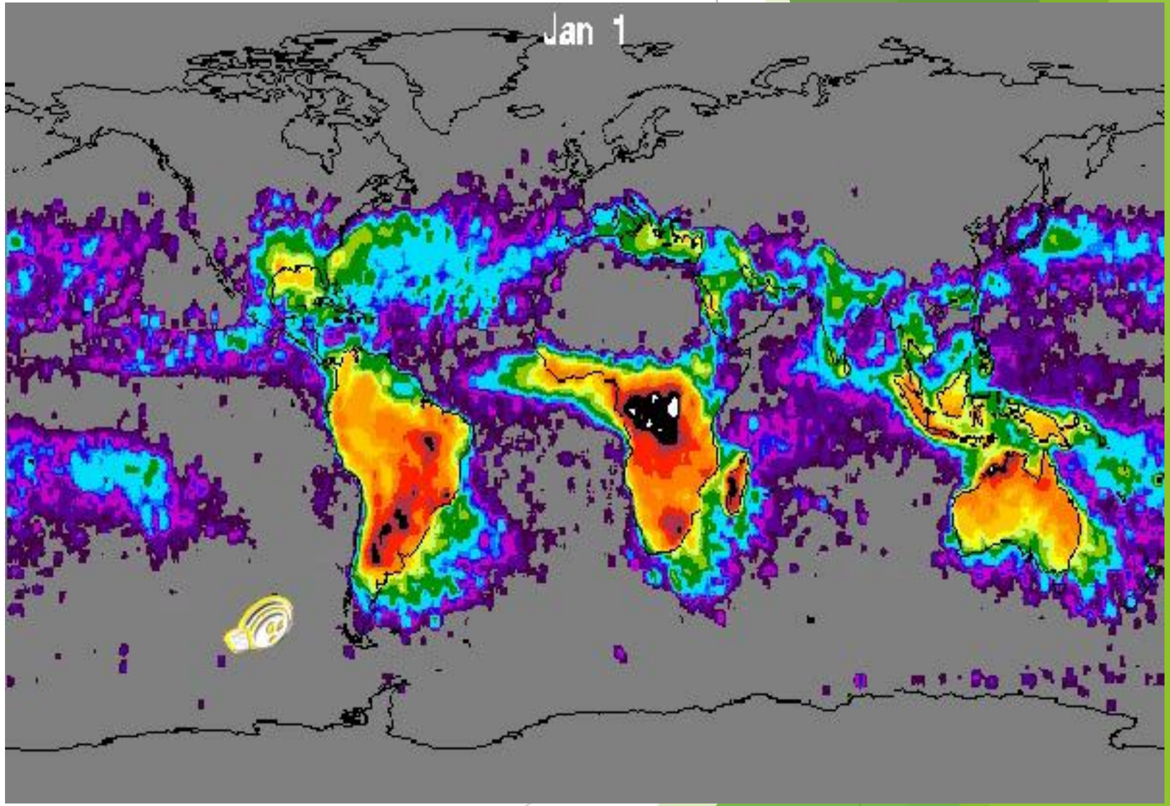
- Whipple (1929) found positive correlation between global thunderstorms activity to the *Carnegie* curve



Whipple 1929

Global distribution of lightning





Credit: NASA website

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Four years of fair weather Research

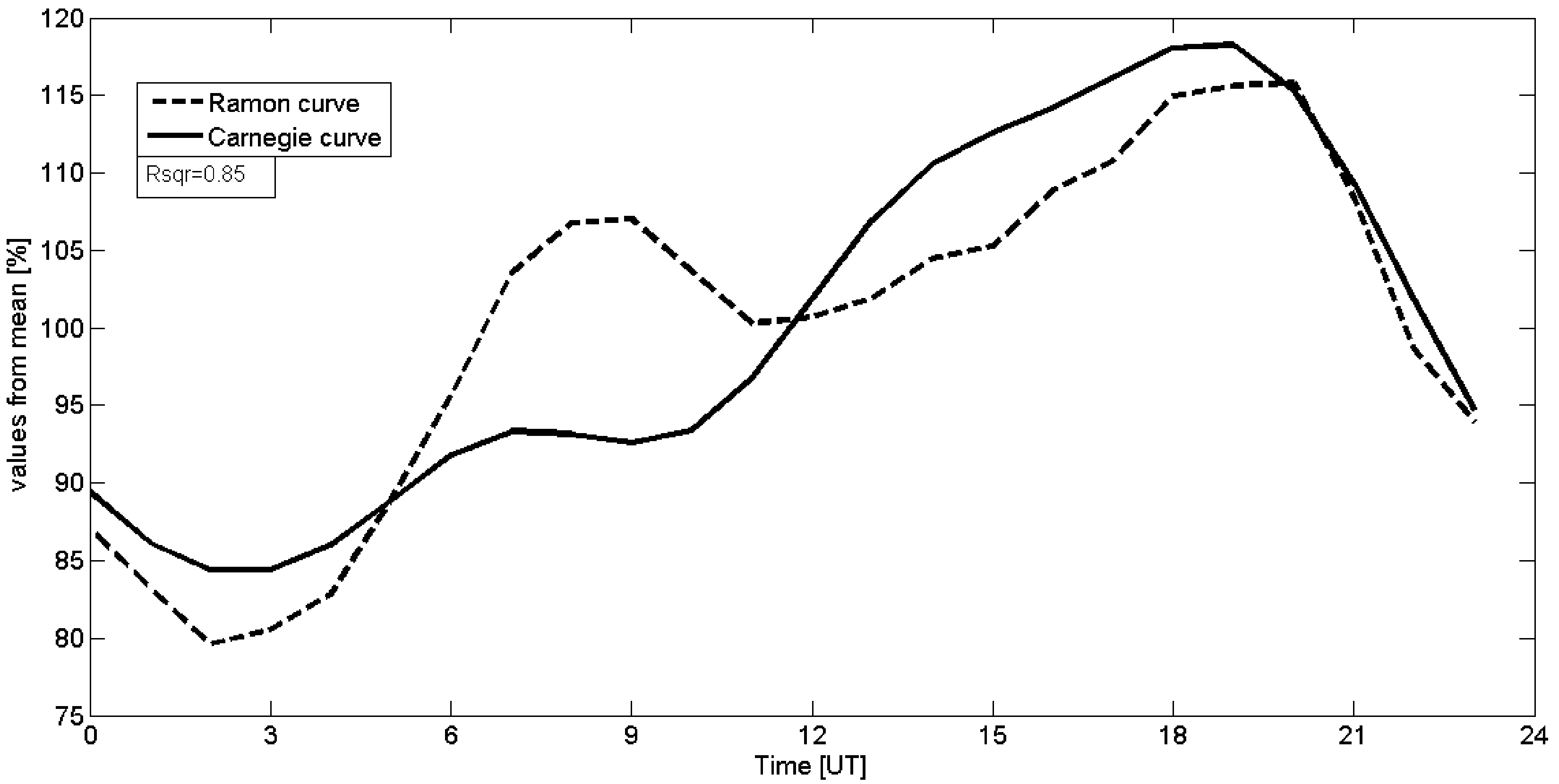
(Yaniv et al 2016 Atmospheric research)

- Presenting first ground measurements of Ez from low latitude arid area (Mitzpe Ramon) and from a mountain station (Hermon).

- Finding the Global and Local impact on the diurnal Ez values over annual and seasonal time scale

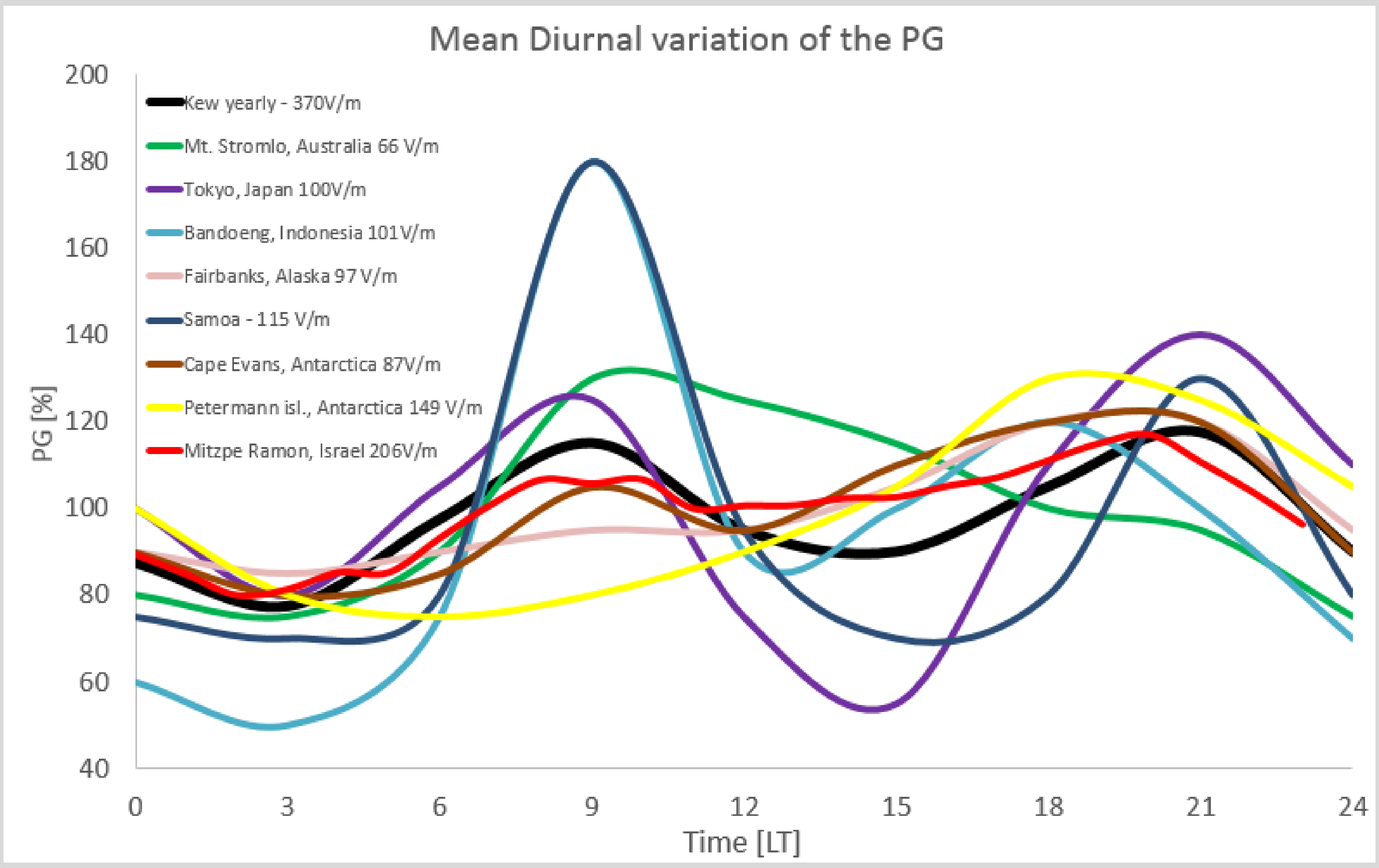
The Ramon and Carnegie curves

- Ramon curve 200 fair weather days. (Yaniv et al 2016)



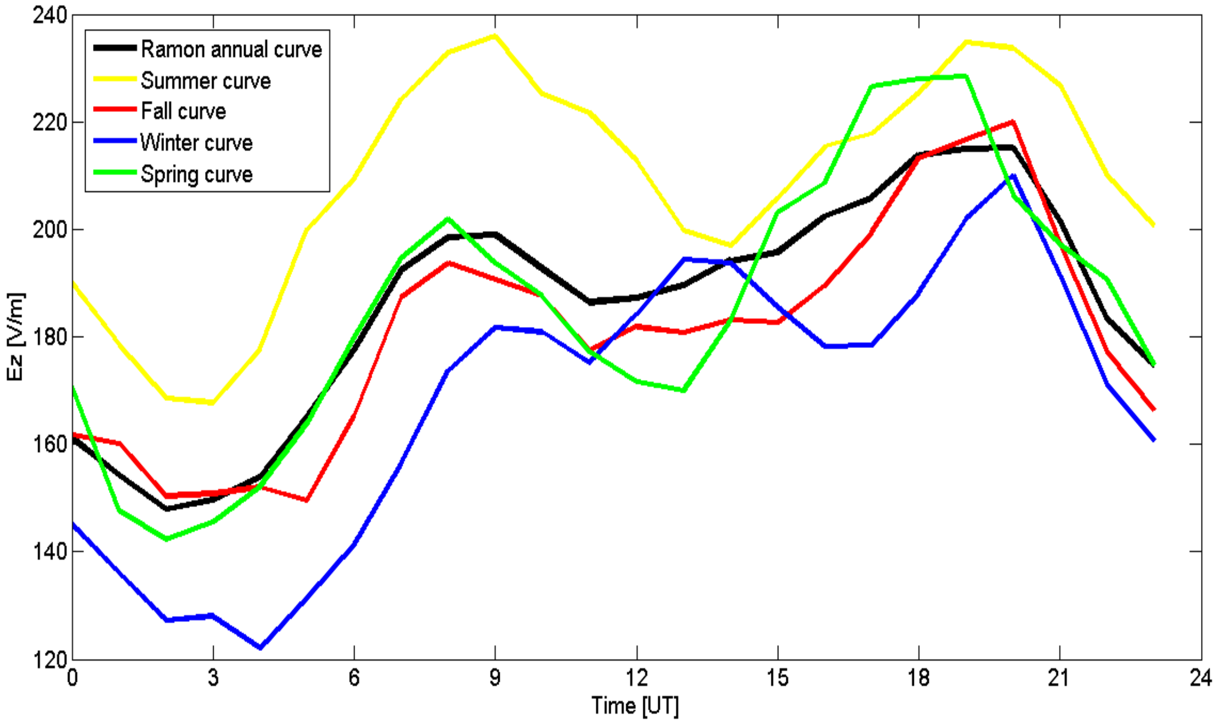
Other Diurnal Ez land curves

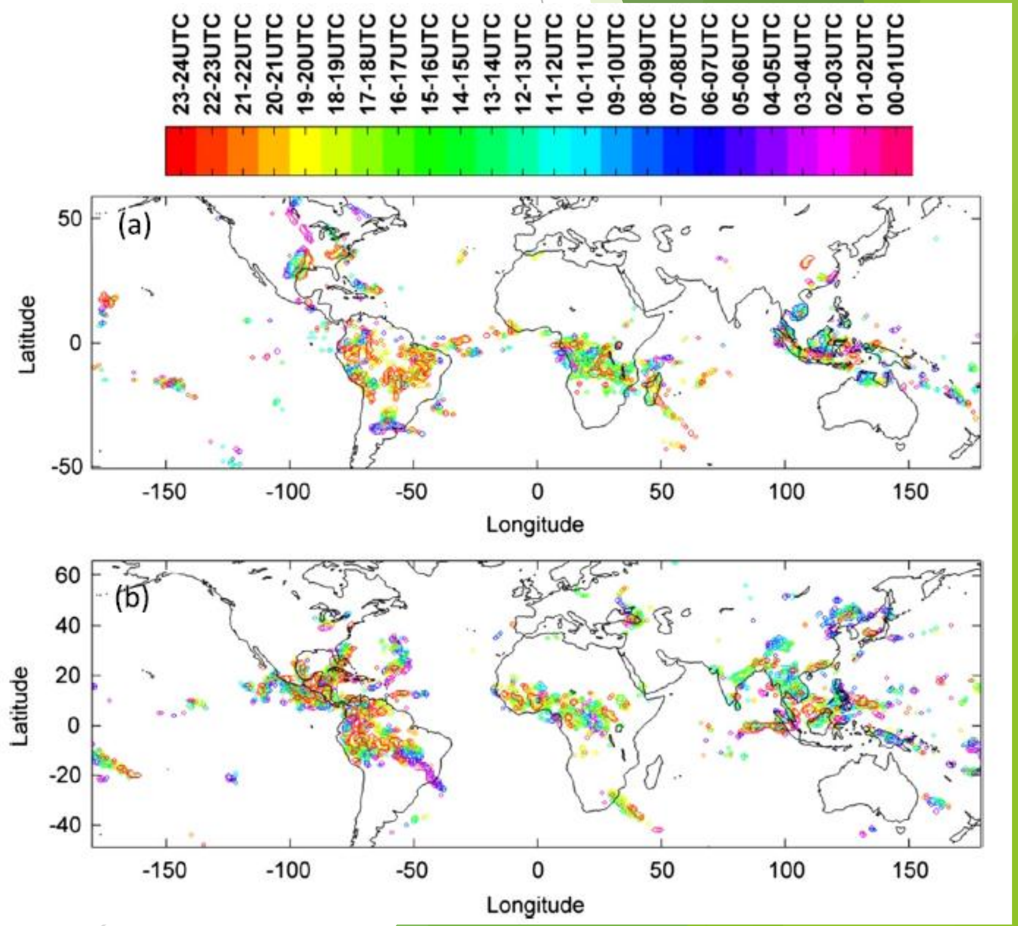
Israël 1970



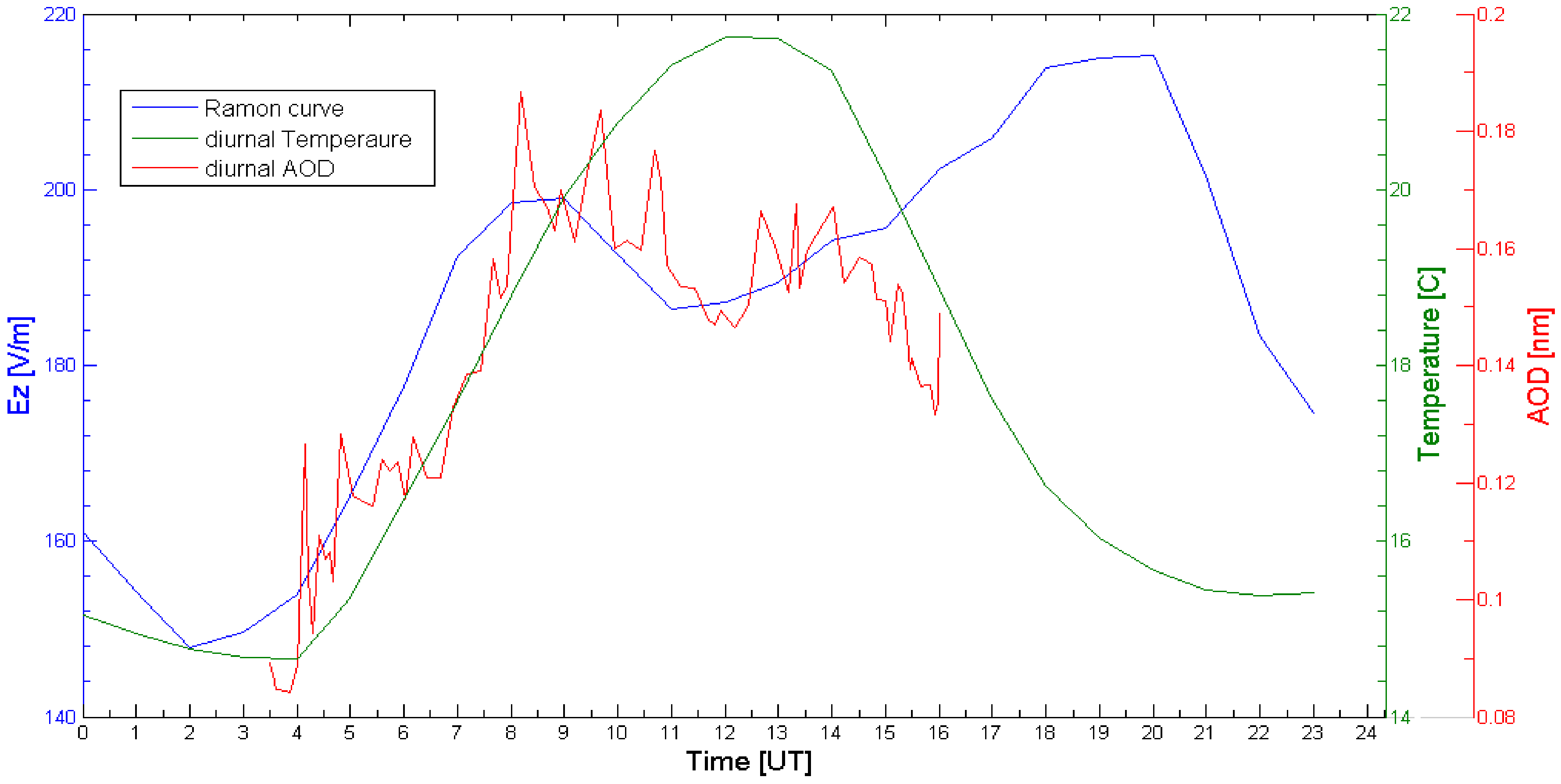
Seasonal analysis
Summer to Winter lightning intensity

Mezuman et al 2014

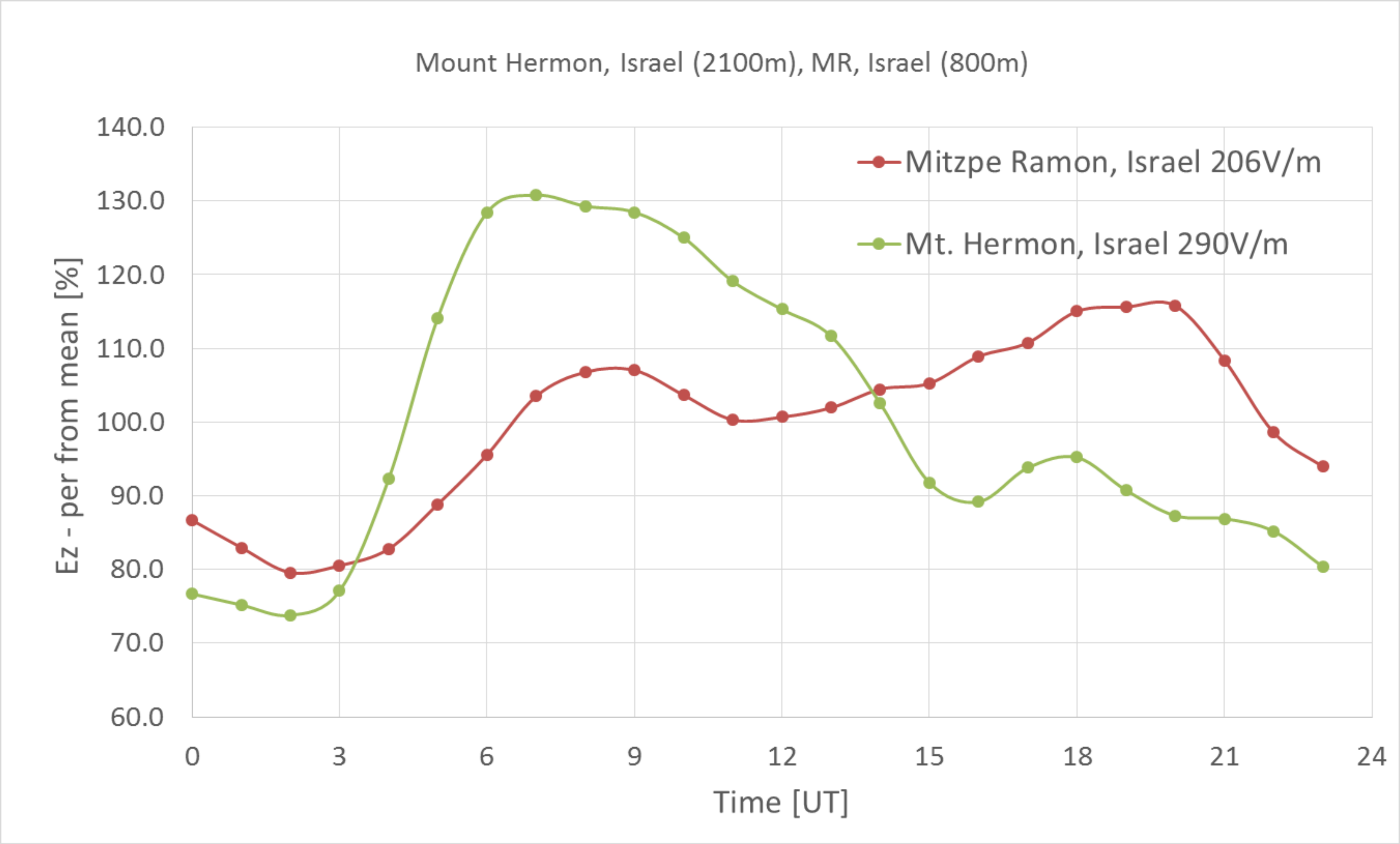




Local impact – morning aerosols

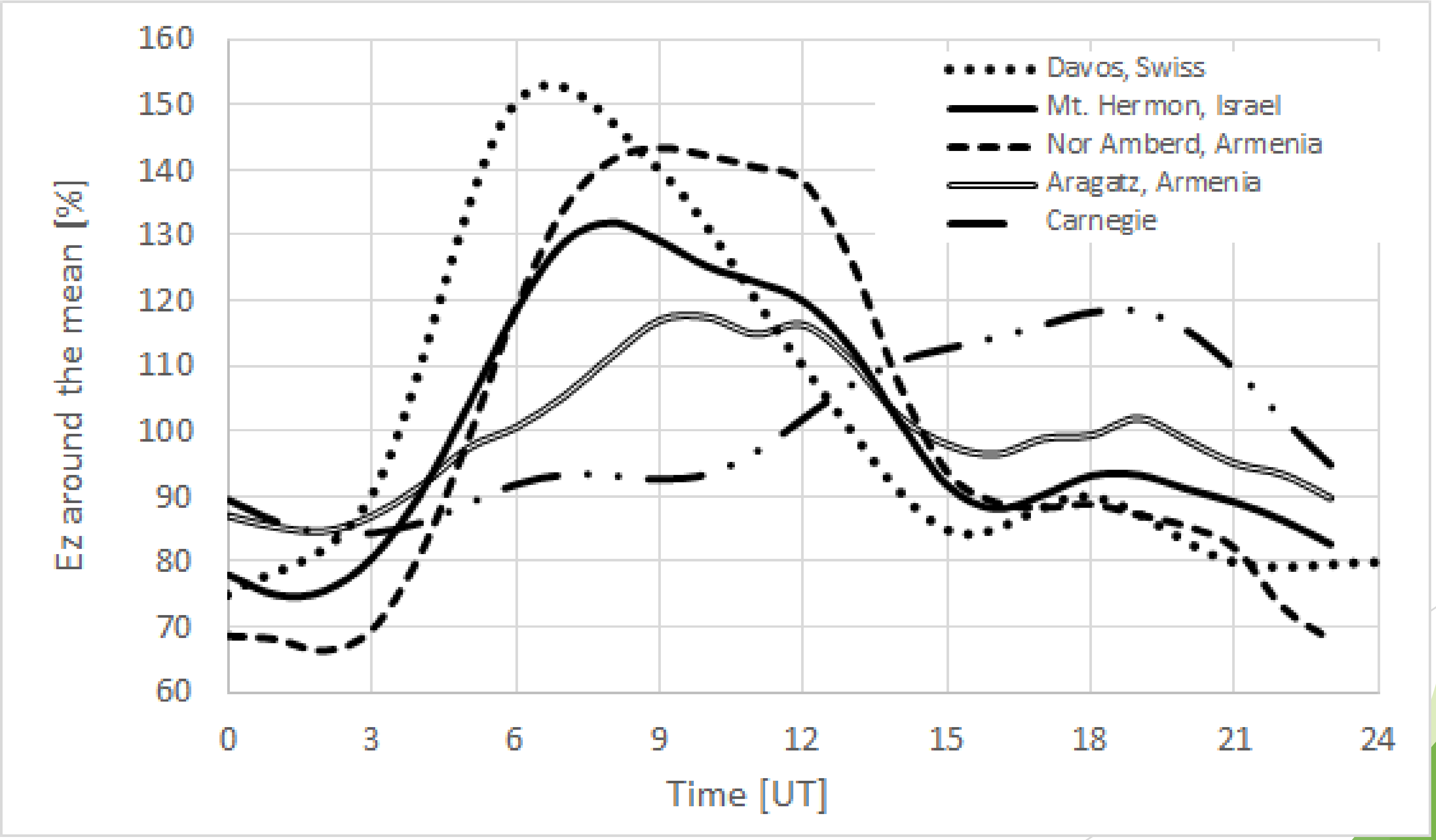


Results – Ramon - Hermon curves



Mountain curves

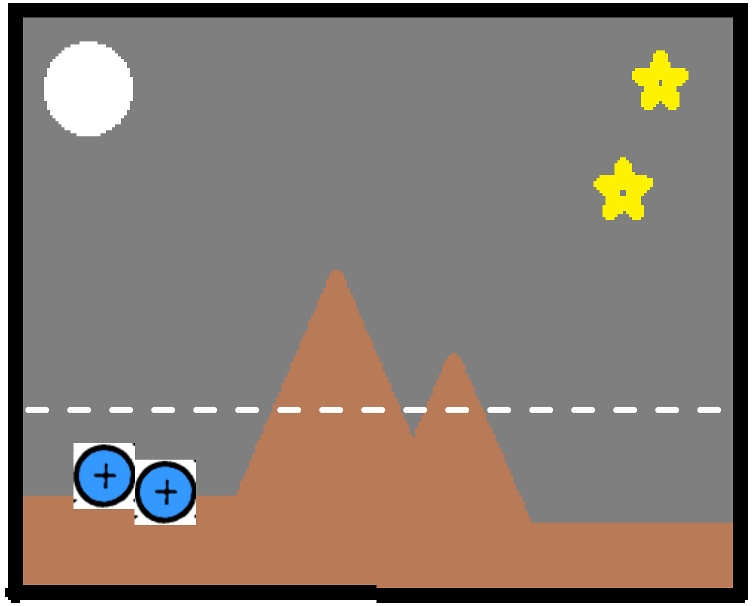
(Yaniv et al 2016 – **Ground-based measurements of the vertical E-field in mountainous regions and the "Austausch" effect -** under review - Atmospheric Research)

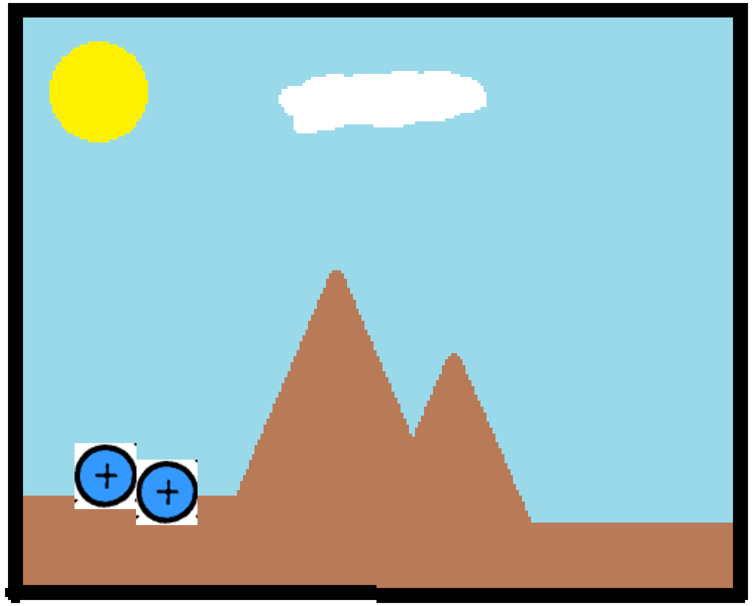


Mechanism

- Night: Inversion layer trap the the free charge in valley. The charge attach the aerosols in what known as “electrode effect”.

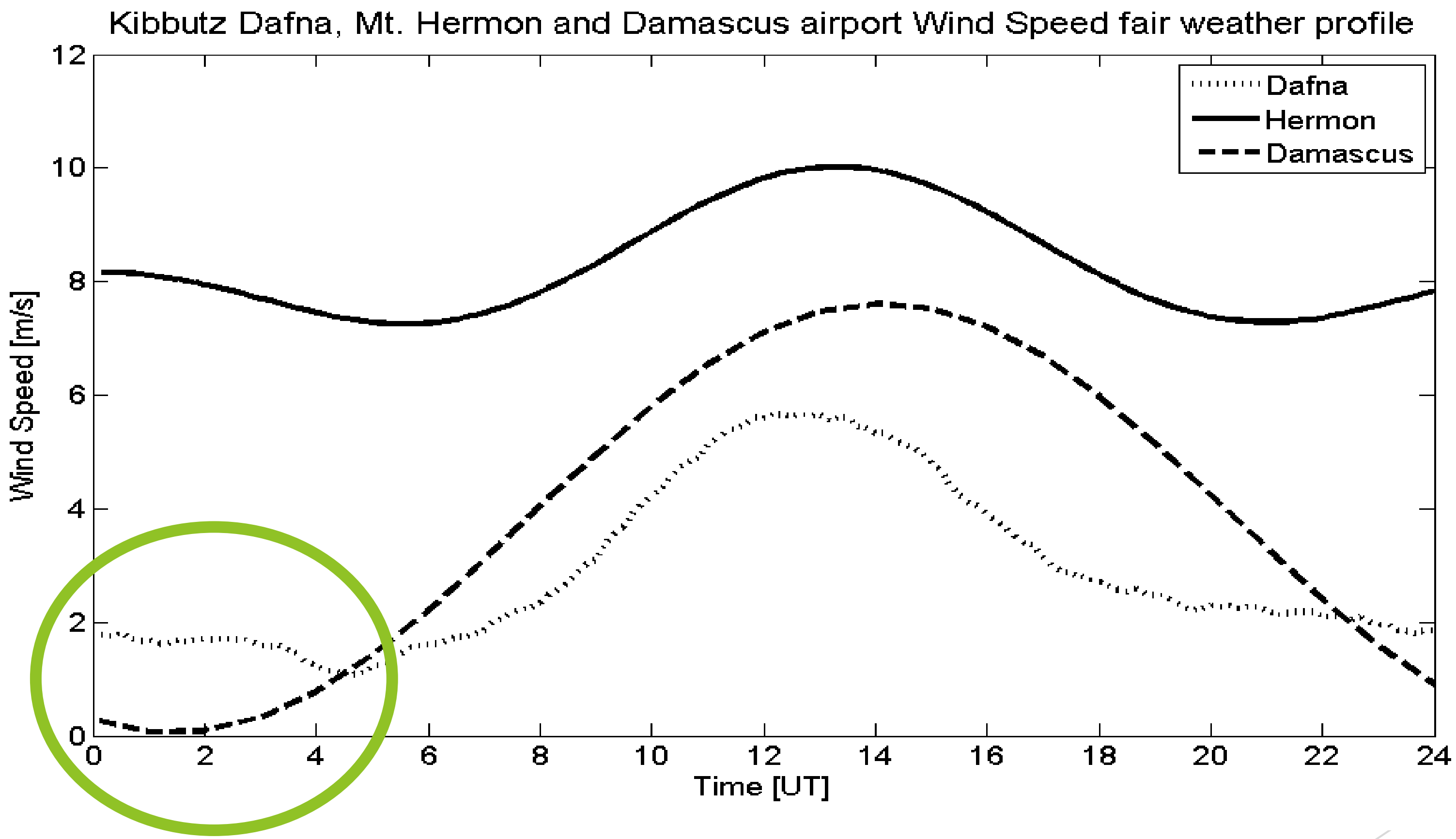
Morning: Solar heating uplift the charge with convection and adiabatic wind to the mountain tops, lowering conductivity, Increasing Ez in what known “Austausch”





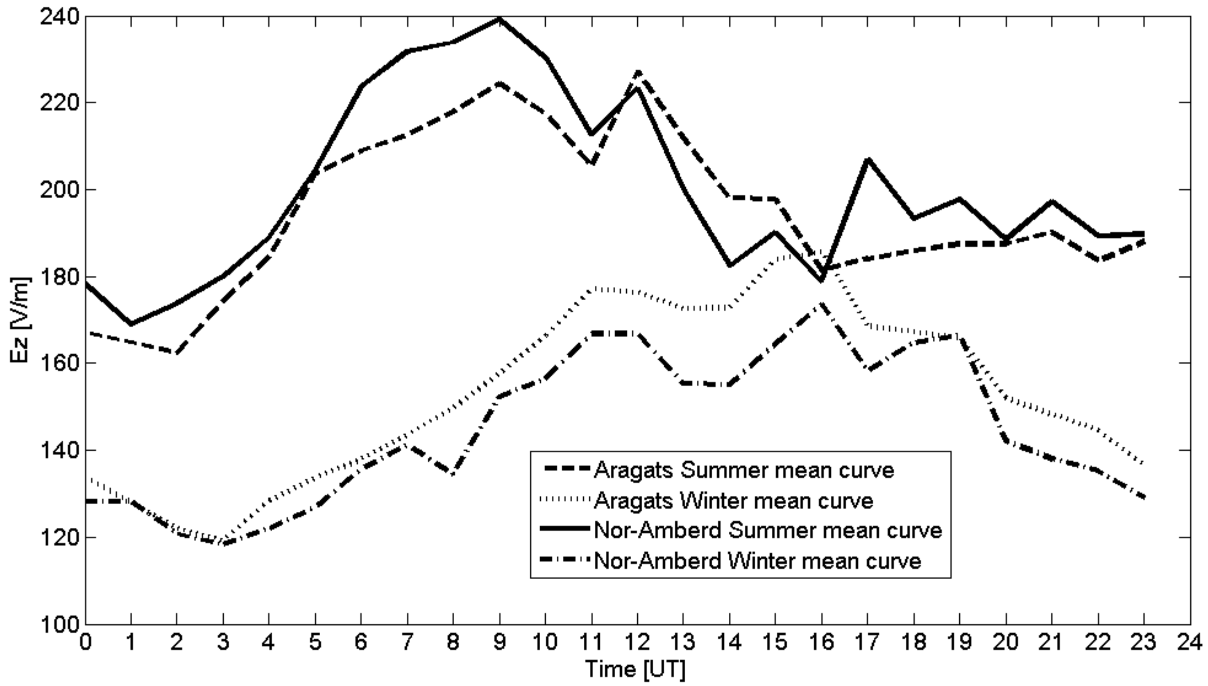
Electrode effect

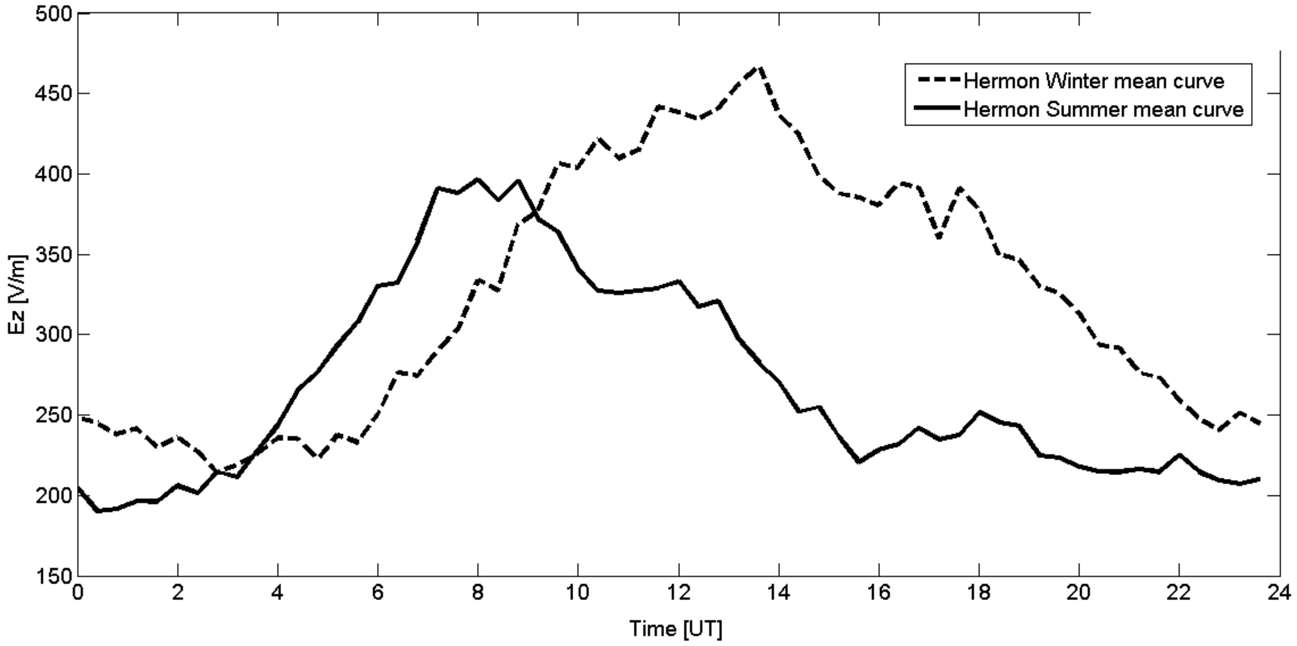
- To maintain the electrode effect we need low wind at night



Solar heating

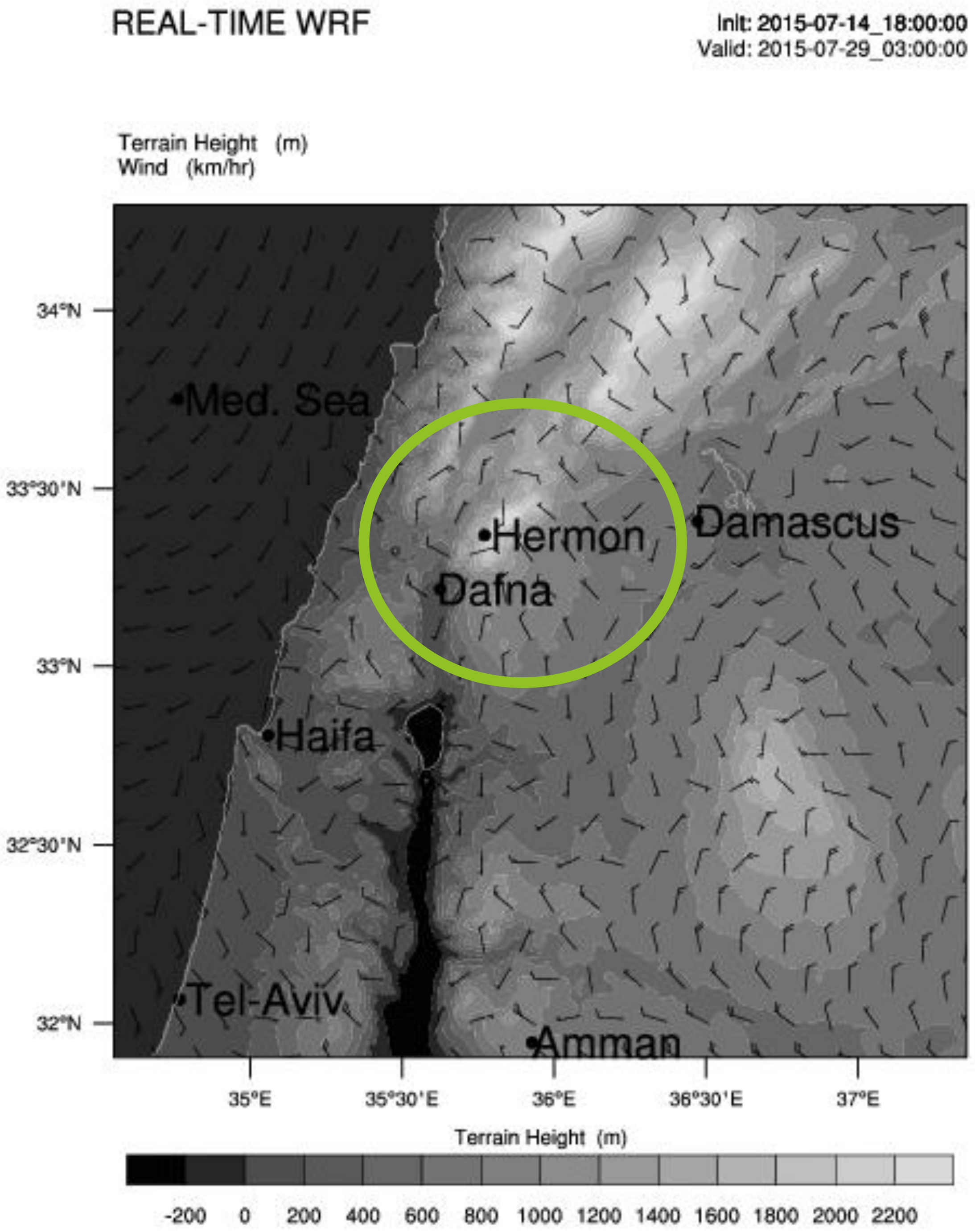
- Summer to Winter analysis show early increase of Ez in summer and late increase in the winter





Mountain is a wind convergence zone in the morning hours

- 15 days hourly average
- 05-09 winds convergence to mountain
- 09+ sea breeze dominate



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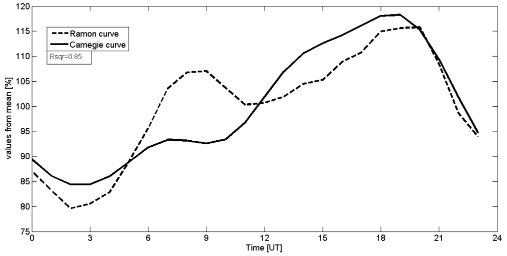

- The Ramon curve show similar trend like the Carnegie curve.
- Positive correlations were found between the Ramon curve to the Carnegie curve
- The global impact of lightning is observable on a diurnal basis.
- Local impact is due to aerosol lifting from morning heating.
- A local impact was seen on mountain stations around the world – We believe it is the "Austausch" effect.
- Charge accumulation in valleys is supported by wind speed analysis.
- Mountain tops are convergence zone to surrounding wind in morning hours.

Current work and future plans

- Current work:
- Airborne measurements of Ionization and radiation dose rate up to 35km
- Impact of dust storms on the E-field (Ez) and conduction current (Jz).

- Future work:
- Thunderstorm impact on Ez and Jz and TGE (Thunderstorm ground enhancement)
- Impact of Solar events on the Ez and Jz.
- Unmanned aerial vehicle measurements

Thank you

Ohm’s laW

- $V = I \cdot R \qquad I = \frac{V}{R}$
- $I = J \cdot A \qquad V = E \cdot l \qquad R = \rho \frac{l}{A}$
- $J \cdot A = \frac{E \cdot l \cdot A}{\rho \cdot l} \qquad \mathrm{J} = \frac{E}{\rho} = E \cdot \sigma$

GEC relaxation time

- $\tau = C \cdot R \quad \tau = \left(\frac{Q}{V}\right) \times \left(\frac{V}{I}\right) = \frac{Q}{I}\,[sec]]$
- I = Jz × A_{Earth} = Jz × $4\pi r^2$ - $Jz \cong 2\,\frac{pAmp}{m^2}$; $I \cong 1000\ Amp$
- $V = 300\ kV$; $E = 100\ {}^{V}/_{m}$; $\epsilon_0 = 8.85 \cdot 10^{-12}\ \frac{C^2}{N \cdot m^2}$
- *Gauss law*: Q= 4 πR^2 ε_o E = 450000C
- $\tau \cong 450sec \cong 5 - 10\ min$