

Residential exposures to ELF and RF

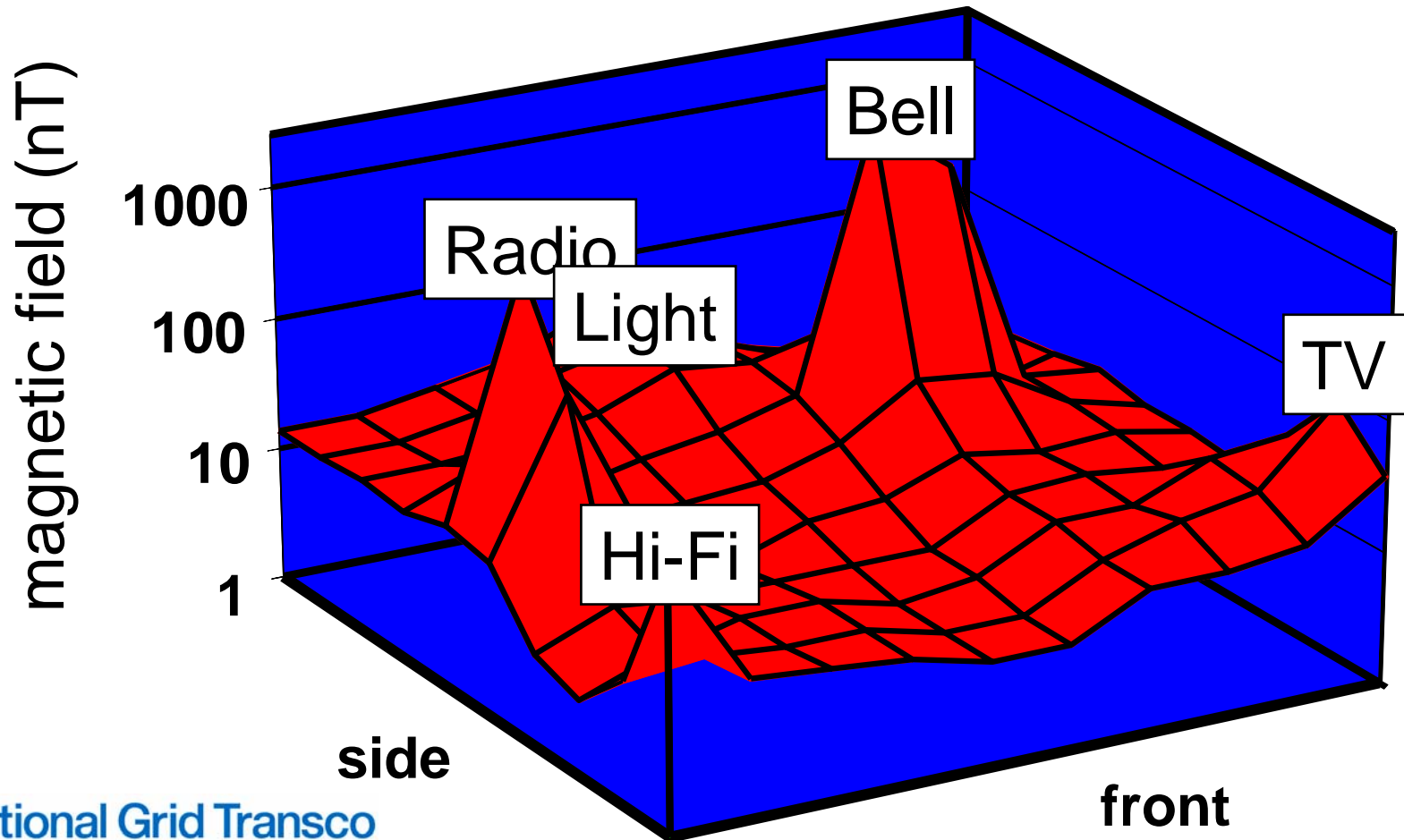
John Swanson

National Grid Transco

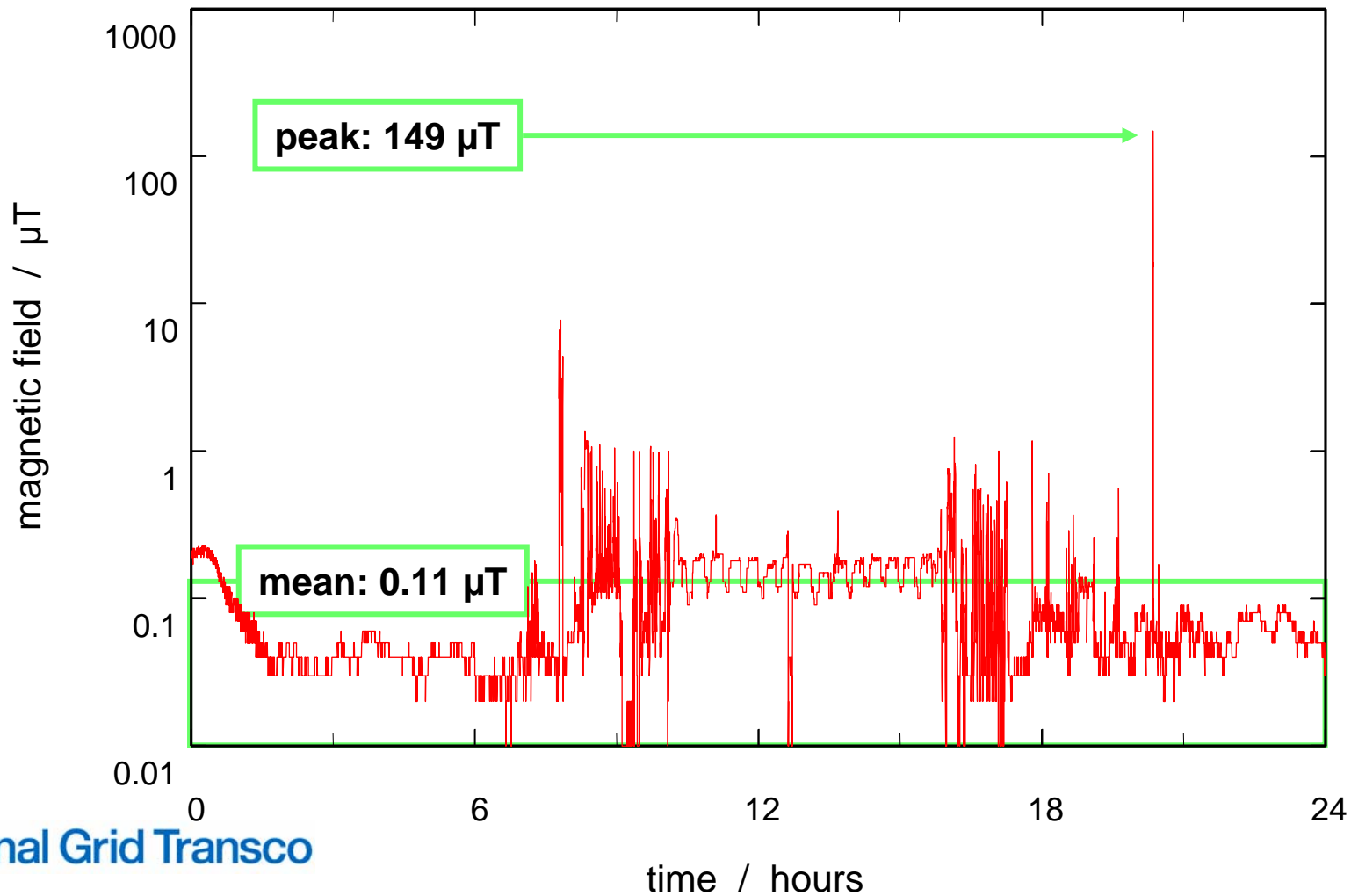
ELF: Sources of exposure

	size	spatial variation	experienced by
Power lines	Medium ($<10 \mu\text{T}$)	Slow (10's m)	$<1\%$ (all of the time)
Appliances	High ($<1000 \mu\text{T}$)	Rapid ($<1 \text{ m}$)	100% (usually rarely)
Background (distribution)	Low ($<1 \mu\text{T}$)	Medium (1-10 m)	100% (all of the time)

Magnetic field in UK home



24 hour personal exposure



Contribution of appliance peak to exposure

Appliance: 150 μ T 30 seconds

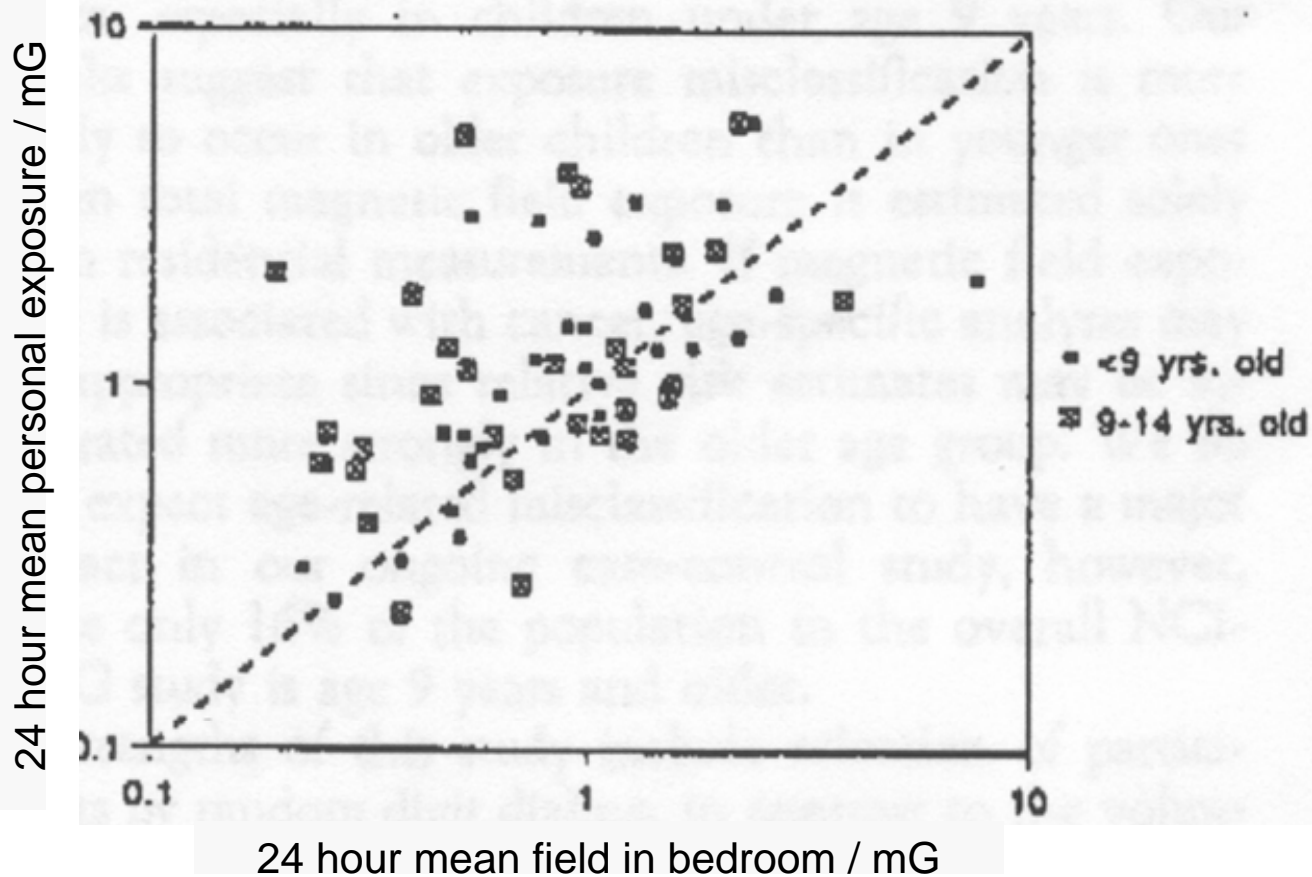
Background: 0.1 μ T 24 hours

- B: 5%
- B²: 800 times
- For appliance=background: B^{1.09}

Possible metrics for ELF

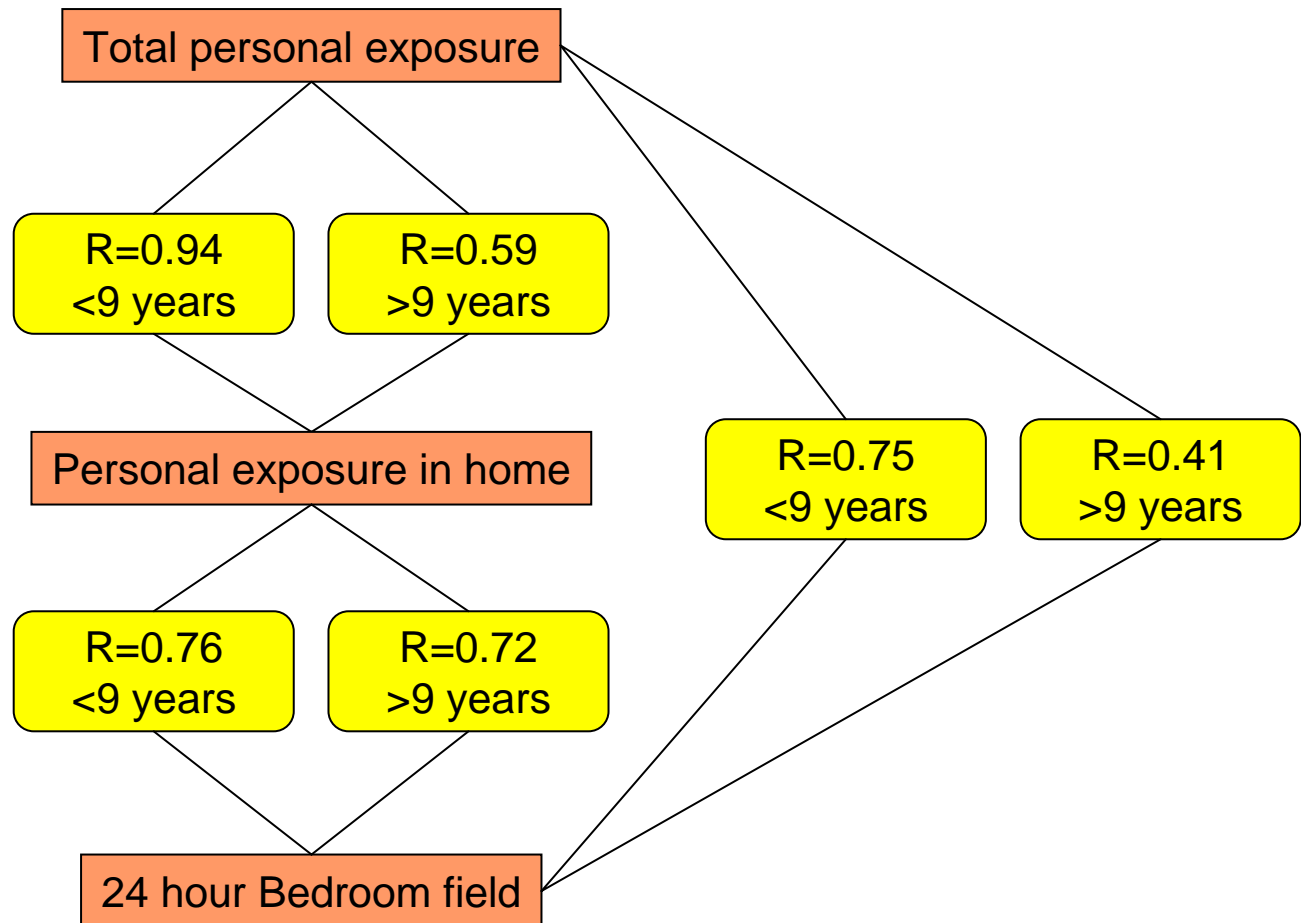
- Average
 - B
 - B²
- Threshold
- Peak
- Polarisation
- Waveform
 - harmonics
 - transients
- Rate of change/intermittency
- AC/DC
- Power line specific
 - characteristic of the field
 - SES
 - mobility
 - E field
 - corona ions
- Contact currents

Personal exposure compared to field in home USA, children



Personal exposure compared to field in home

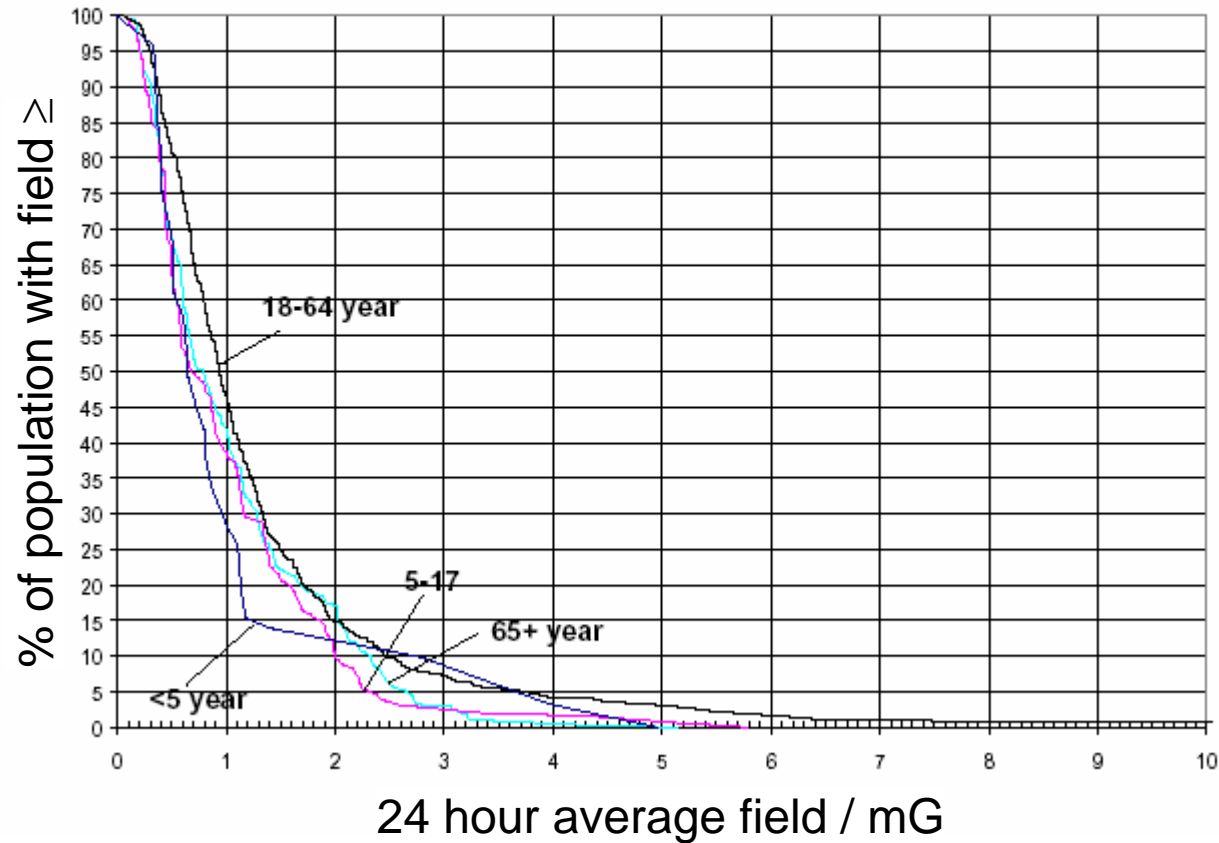
USA, children



Exposure variation with age

USA

Estimated Distributions of 24-Hour Average Magnetic Fields for Different Age Groups



Exposure variation with age

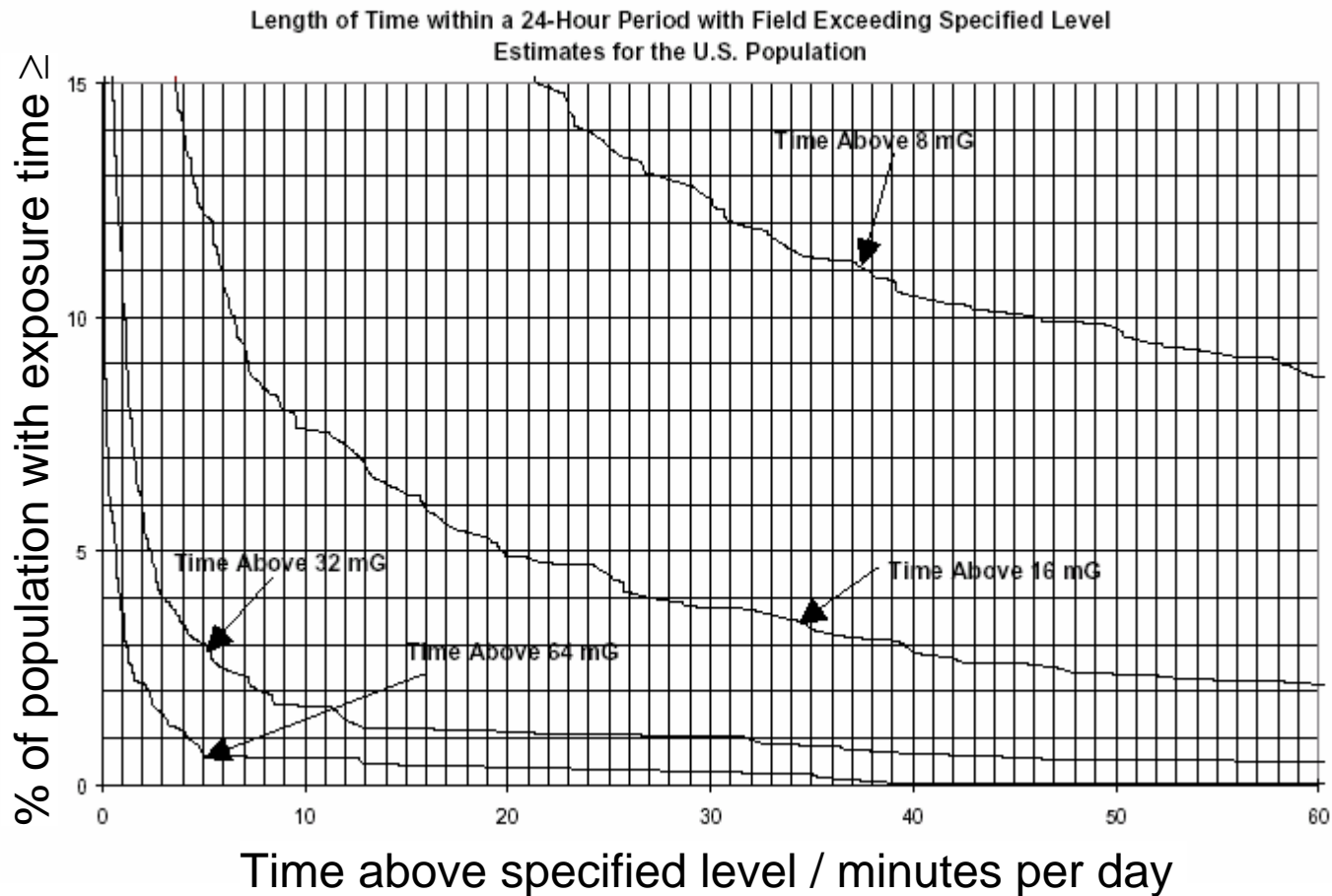
USA

	50 th percentile	90 th percentile
Pre-school	65	276
School age	68	200
Working age	94	245
Retirement age	79	232

nT

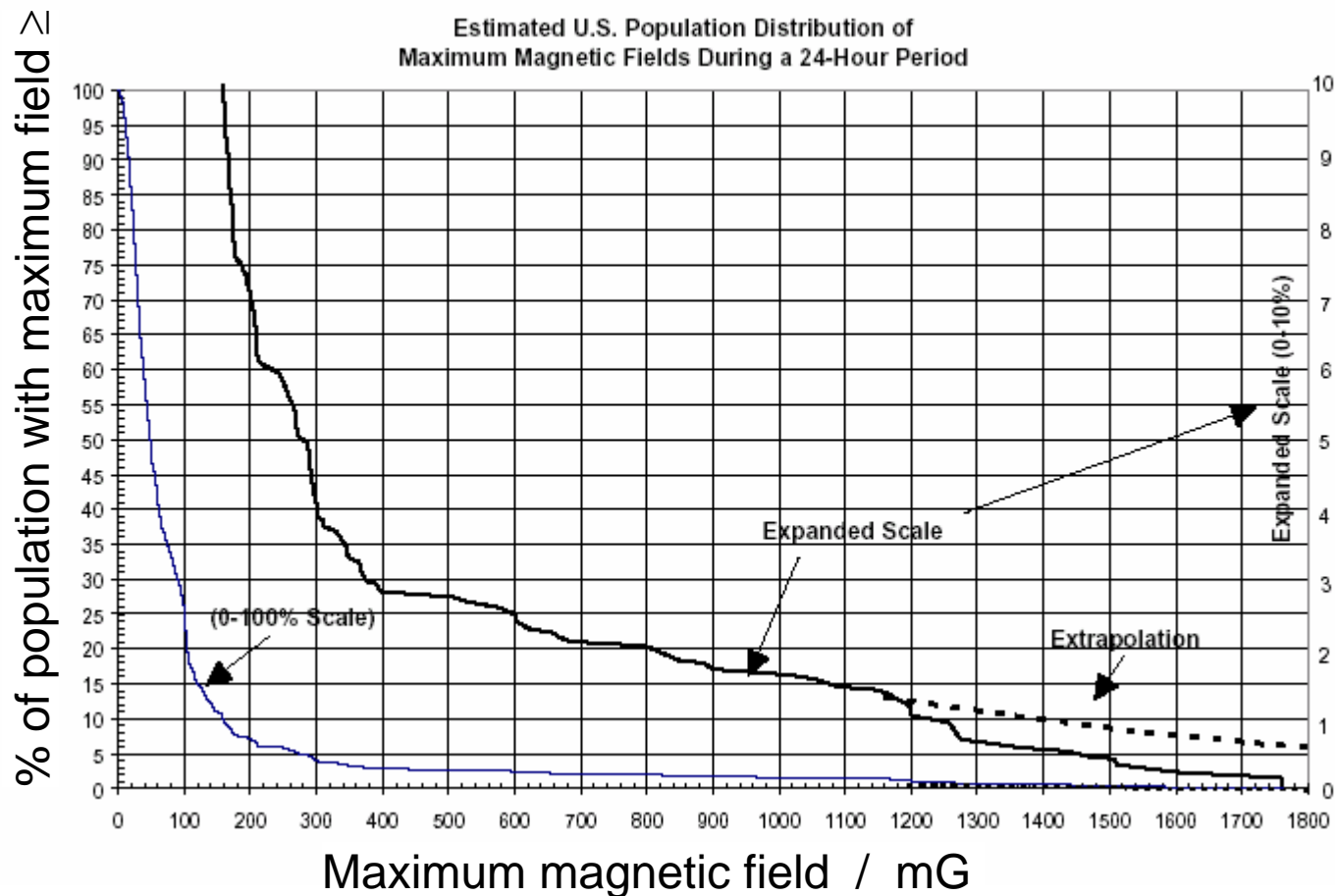
Time above thresholds

USA, whole population

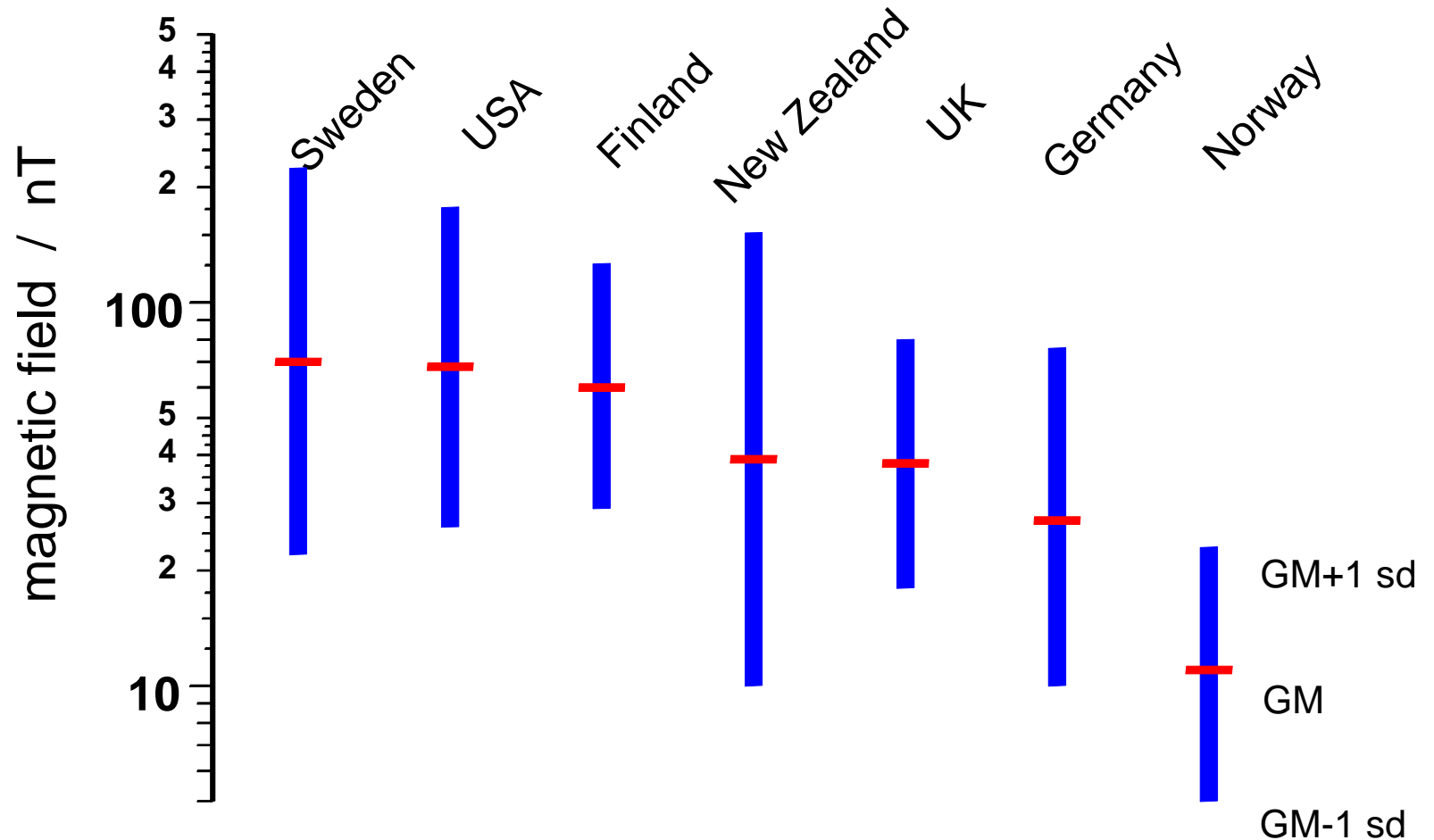


Maximum magnetic field

0.5 second sampling

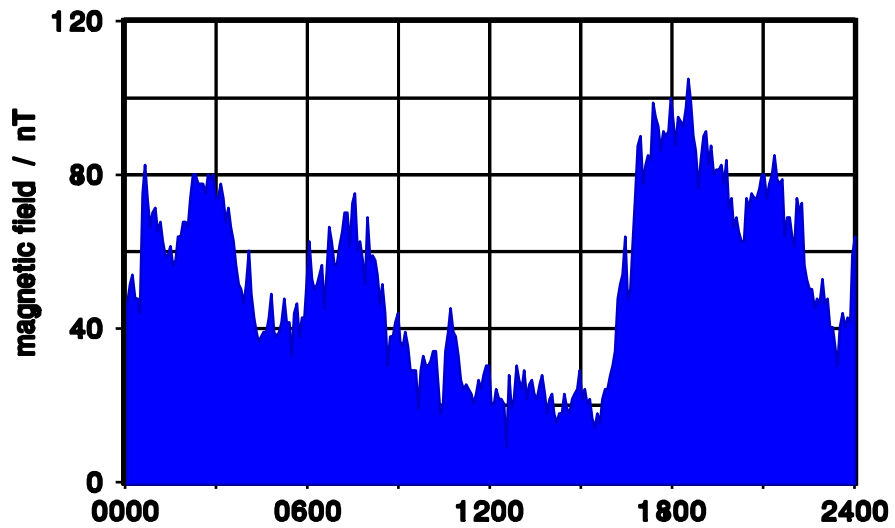


Residential fields in different countries

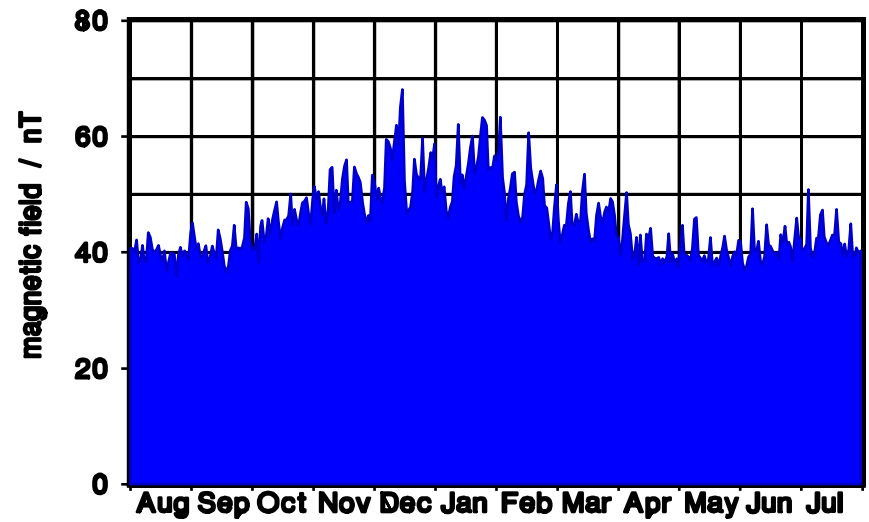


Time variations

Diurnal

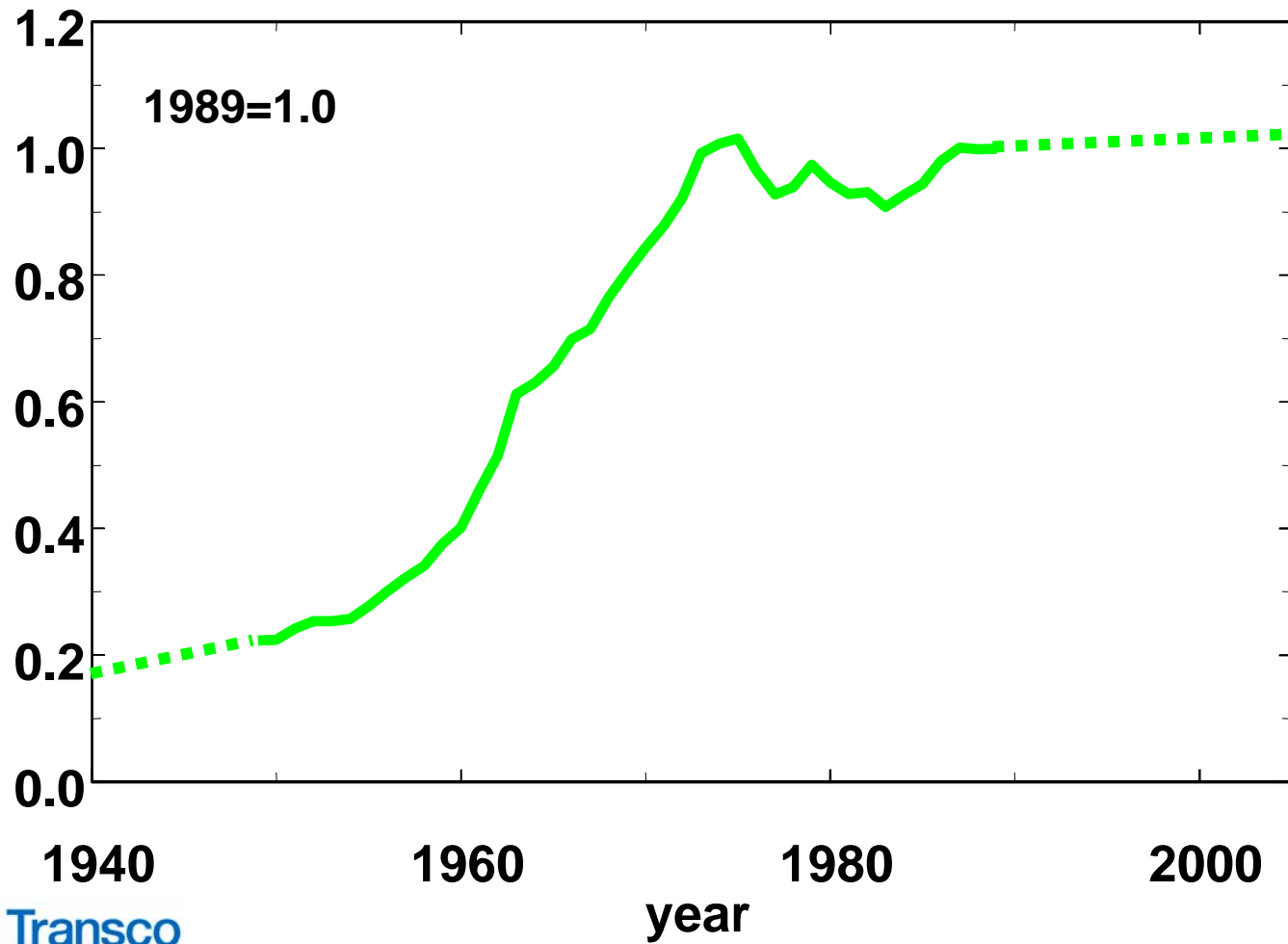


Annual



Long-term variations

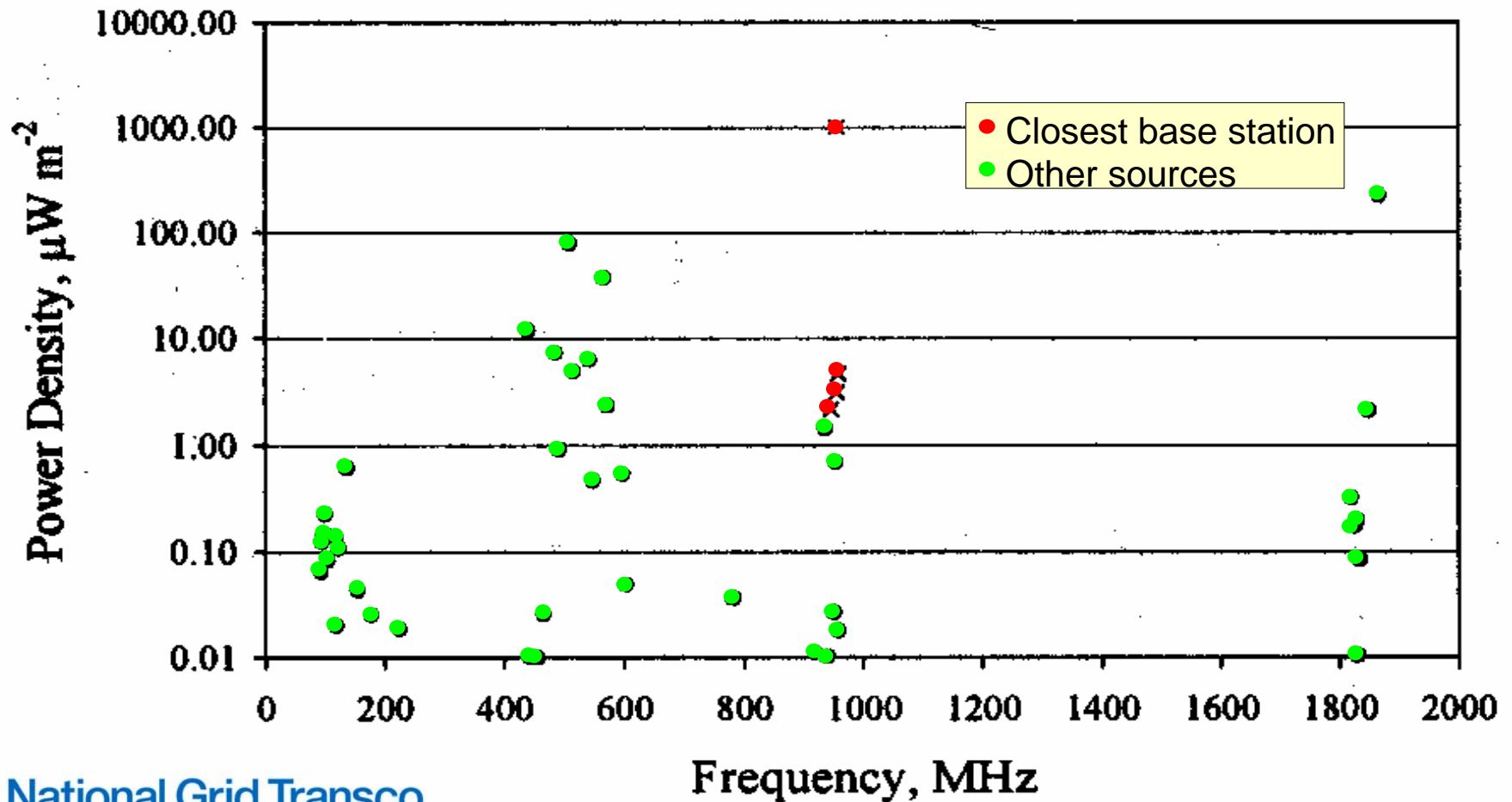
England and Wales 1949-1989, calculated



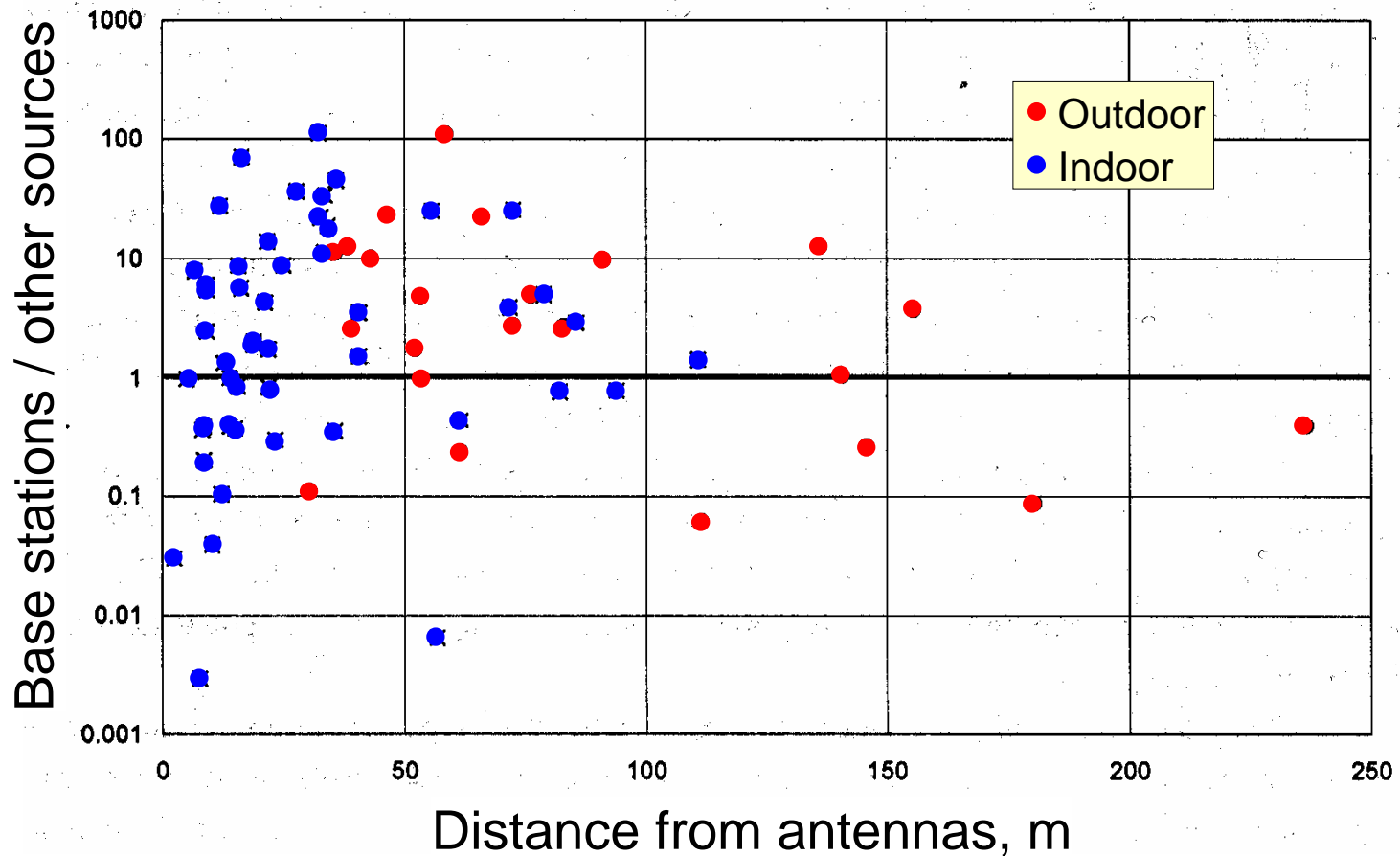
RF: sources of exposure

		Frequency Hz	Other sources:
VLF	TV/VDU	10^4	ating
LF	Article survei	10^5	ating
MF	AM radio	10^6	ating
HF	Short-wave b	10^7	ating
VHF	FM radio	10^8	
	TV	$0.5-1 \times 10^9$	
UHF	Cellular comms	$0.4-2 \times 10^9$	
	Microwave cooking	2×10^9	
SHF	Radars	$0.1-4 \times 10^{10}$	
EHF	Microwave comms	$0.2-2 \times 10^{10}$	Microwave diathermy

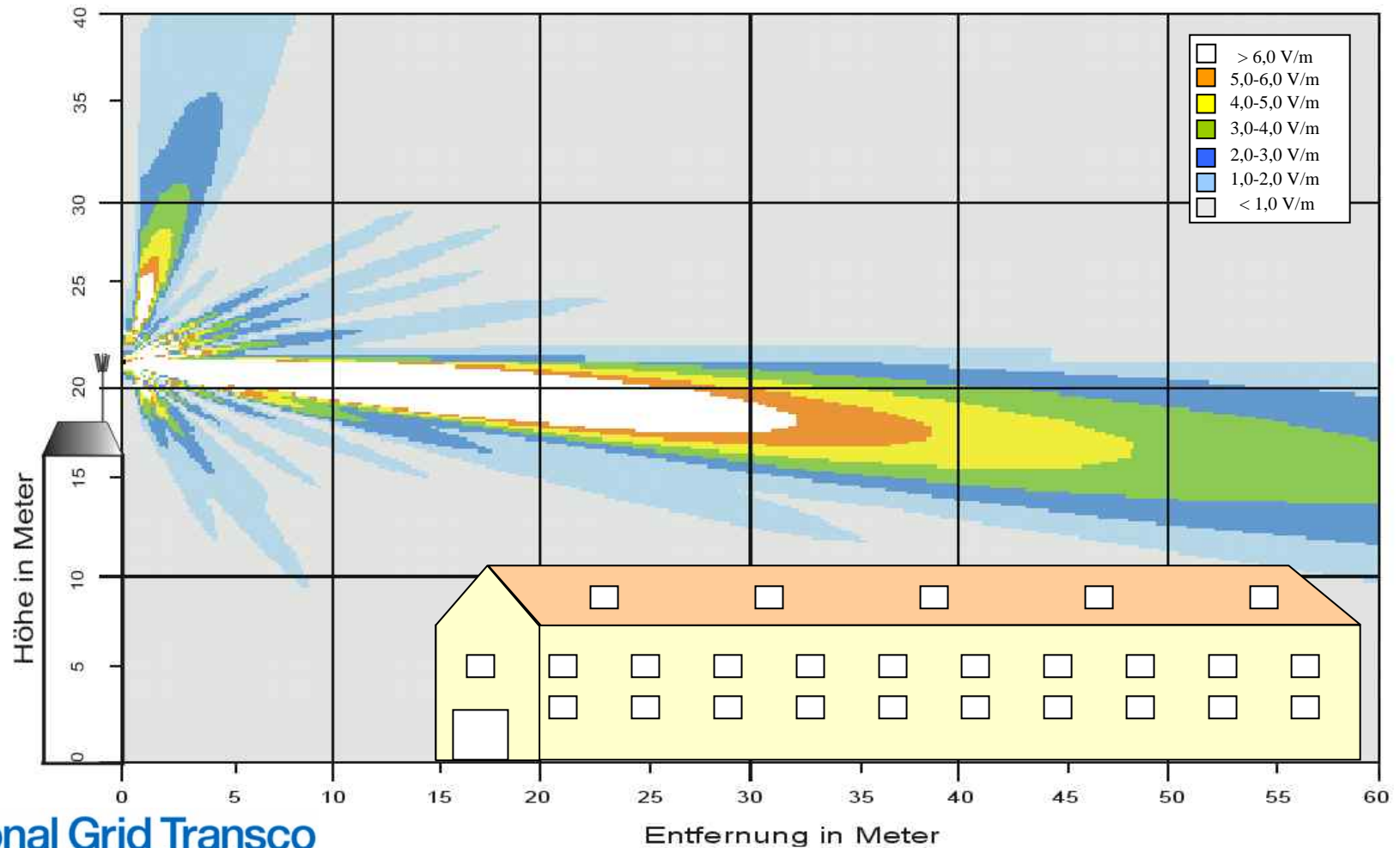
Measured rf spectrum



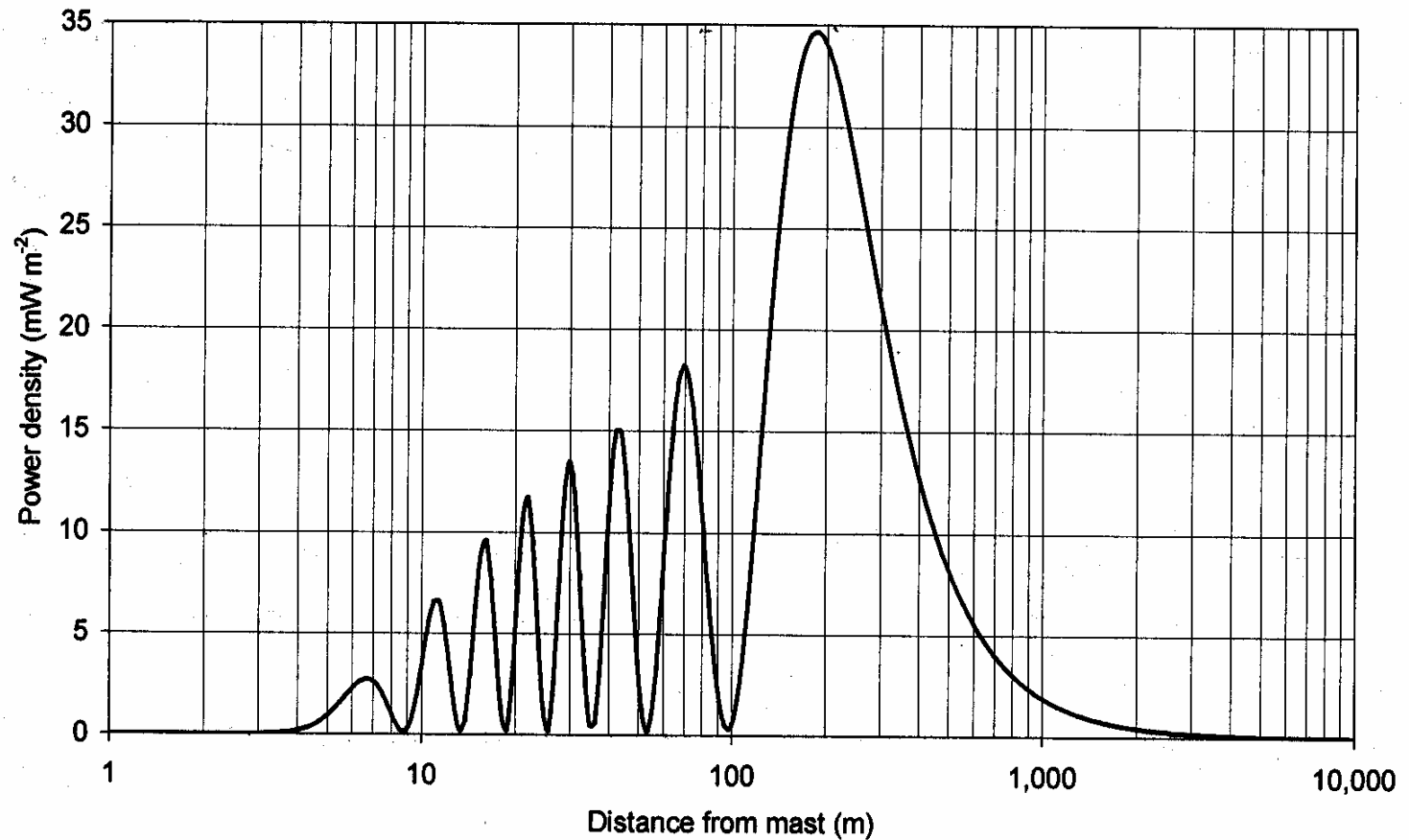
Base stations compared to other sources



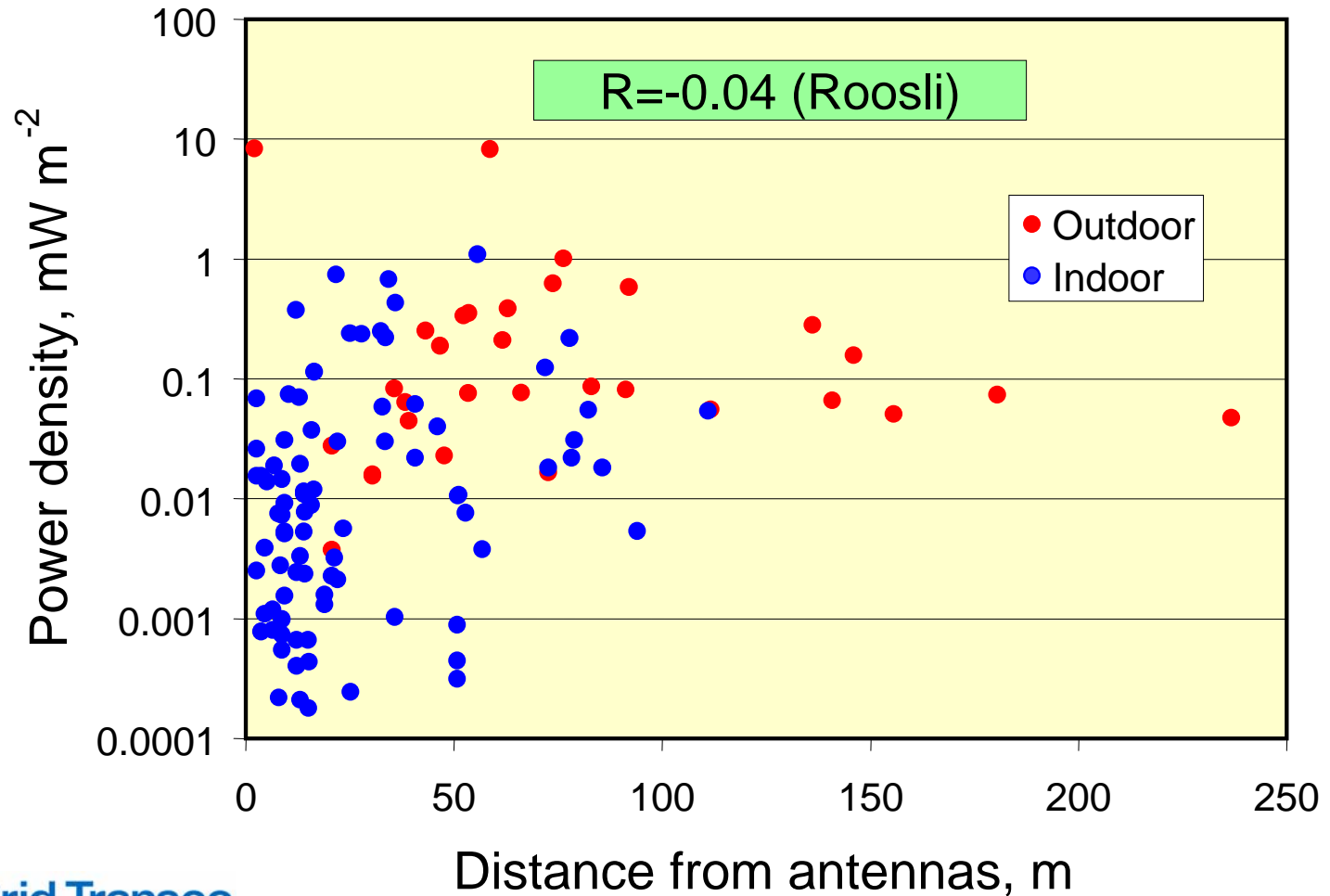
Field distribution from base station



Calculated ground-level power from base station



Base stations: exposure vs distance



RF exposure levels

Broadcast

Maximum
100 mW m⁻²

Typical
0.05-0.2 mW m⁻²

Base station

Maximum
10 mW m⁻²

Typical
outdoors
0.01-1 mW m⁻²

Typical
indoors
<0.1 mW m⁻²

Children?

spend more time indoors

use of handsets

dosimetry different

RF fields inside buildings

variation over 1 m cube

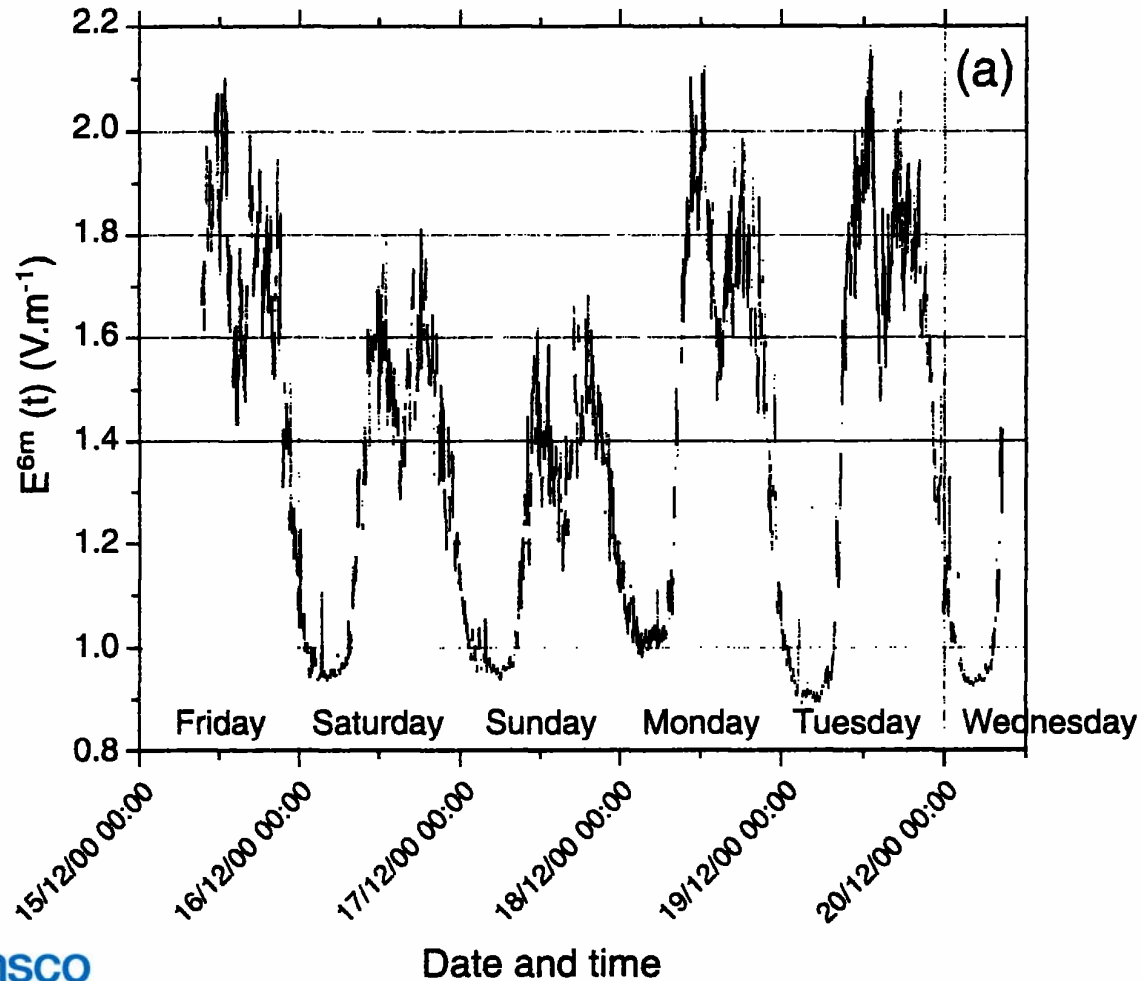
$$E_{\max}/E_{\text{mean}}$$

2-5

$$E_{\max}/E_{10\%}$$

2-14

Base station: time variation



Base stations: long-term variation

