Definition of Meteorological Extreme Events

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1. BACKGROUND

“ Extreme Weather Impacts on European Networks of Transport “

ROAD TRANSPORT ***(Analysis by Finnish Met Institute, 2012)*** http://ewent.vtt.fi

Finland : Average annual road accident costs ⇔ **226 million €**

✓ Estimated annual savings based on current weather services ⇔ **36 million €**

Europe : Average annual road accident costs ⇔ **20 billion €**

✓ Estimated annual savings based on current weather services ⇔ **3,4 billion €**

✓ *100% forecast accuracy estimated to increase benefits by* ***240 million €***

Most of this is due to:

Adverse – Severe – Extreme – High-Impact Weather

1. BACKGROUND : Goals

- ✓ Need to gain a better understanding of the **impacts** of adverse weather on transport and traffic operations…
  - *Snow, rain, fog, poor visibility, slipperiness …*
- ✓ Need to develop and promote strategies and tools to mitigate **impacts** of adverse weather, and to promote best practices and guidelines…
- ➲ BUT : First need to understand the meaning of "adverse"… "severe"… "extreme"… "high-impact" ⇔ Highly **multi-disciplinary** issue !

There is a pre-requisite for common understanding of adverse weather within various different disciplines:

- Traffic engineering, traffic management, meteorology…

2. DEFINITIONS

SEVERE

EXTREME

HIGH-IMPACT

RARE

ADVERSE

Multi-dimensionality !

2. DEFINITIONS

SEVERE

Adjective : **rigorous; violent; very strict; unsparing; hard to endure; inflicting** (physical) **discomfort or hardship.**

Latin origin : severus. *Antonym* : mild.

EXTREME

Adjective : **exceeding the ordinary-usual-expected; highest limit or degree; outermost; greatest; very violent; stringent.**

Latin origin : extremus. *Antonyms* : moderate; mild.

HIGH-IMPACT

Noun : **shocking or striking effect or influence; forceful contact.**

Latin origin : impactus.

RARE

Adjective : **uncommon; unusual; infrequent; seldom occurring or found.**

Latin origin : rarus. *Antonyms* : abundant; common; usual.

2. DEFINITIONS

ADVERSE

Adjective : **harmful; unfavorable; inclement.**

Latin origin : adversus. *Antonyms* : advantageous, propitious.

✓Does not sound as bad as "severe".

✓Adverse weather, in general, can cause **some** disruption but does not necessarily lead to very large losses and, hence, cannot commonly be considered as severe or high-impact. May be used as a general term for “unfavorable” weather conditions, though...

Risk = Hazard probability * human vulnerability

2. DEFINITIONS

Severe Events

- ✓ Cause large losses
  - of human lives
  - of money
  - for the environment
- ✓ Can be estimated by expected losses ⇔ Risk estimation
  - Probability of event
  - Exposure to event (number of exposed people)
  - Vulnerability of society to event
- ✓ Are a function of both the meteorological event ***and*** state of human affairs
  - E.g. increased traffic volumes ⇔ Increased exposure to meteorological features affecting traffic

2. DEFINITIONS

Extreme Events

- ✓ Extreme **values** of specific meteorological variables causing damage
  - Heavy rainfall ⇔ Flash flooding
  - Large amounts of precipitation ⇔ Flooding
  - Heavy snowfall ⇔ Malfunctioning of all transport, electricity lines etc.
  - Very strong winds ⇔ Malfunctioning of sea and air transport, falling trees etc
  - Very high temperatures ⇔ Notorious health effects
  - Very low temperatures ⇔ Increased energy consumption
- ✓ Defined as taking maximum values and/or exceeding pre-existing (measured) high (low) thresholds
- ✓ Generally rare events
  - E.g. 1% probability of occurence during a given year at a given location

2. DEFINITIONS

High-impact Events

✓ Typically severe events

i. Short-duration weather events
   - Fast-moving, strong cyclone
   - Convection-induced heavy precipitation
   - Overnight freezing of road surfaces due to cooling of atmospheric surface layer caused by outgoing radiation

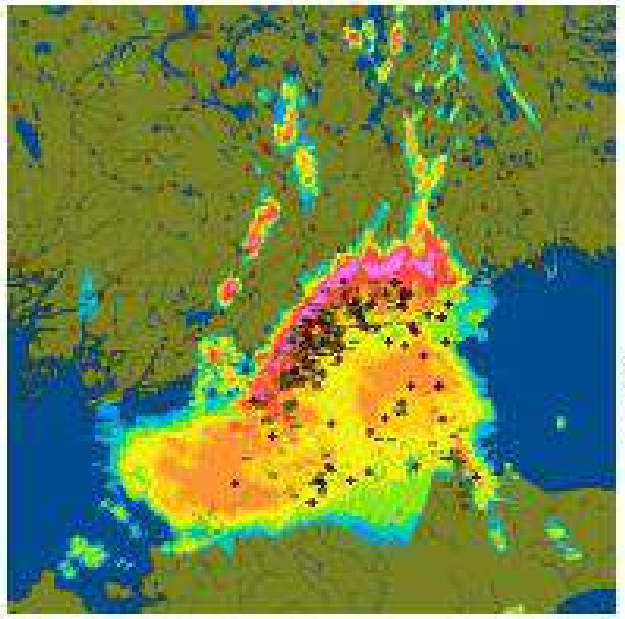
ii. Long-duration weather events
   - Blocking high pressure associated with a prolonged heat wave and drought
   - Monsoon circulation

✓ World Meteorological Organization (WMO) prefers term “high-impact” to “severe” weather to cover (i) and (ii)

2. DEFINITIONS

Rare Events

- ✓ Low probability of occurrence
- ✓ Society and environment are not adapted ⇔ Large damages when occuring
- ✓ Despite rarity, large vulnerability leads to large losses



Gulf of Finland

2. DEFINITIONS : Meteorological Variables

i. Binary (Dichotomous; Yes/No)

- ✓ **Rainfall** ⇔ no rainfall
- ✓ **Snowfall** ⇔ no snowfall
- ✓ **Strong winds** ⇔no strong wind
- ✓ **Fog** ⇔ no fog
- ✓ **Night frost** ⇔ no frost **… or Freezing of road surface temperature**

ii. Multi-category

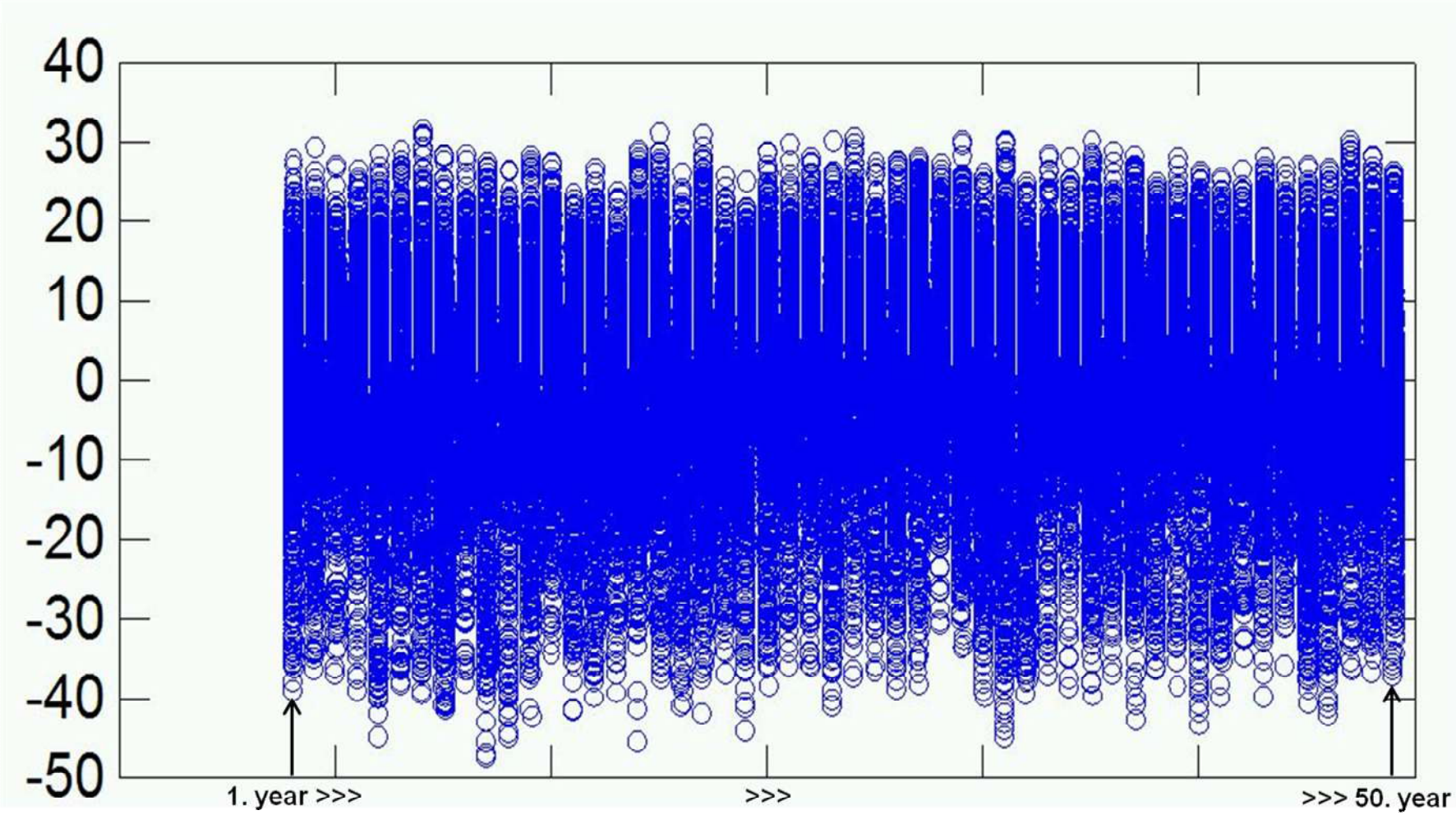
- ✓ **Rainfall >>> Heavy precipitation**
- ✓ **Snowfall >>> Heavy snowfall**
- ✓ **Strong winds >>> Gale force**
- ✓ **Road surface temperature**

} with various thresholds

$T_s < -30^oC$ … $-1^oC < T_s < +1^oC$ … $50^oC < T_s$

3. ILLUSTRATION of DEFINITIONS

Temperature distribution at a cold station in Finland (50 years, c. 55000 observations)



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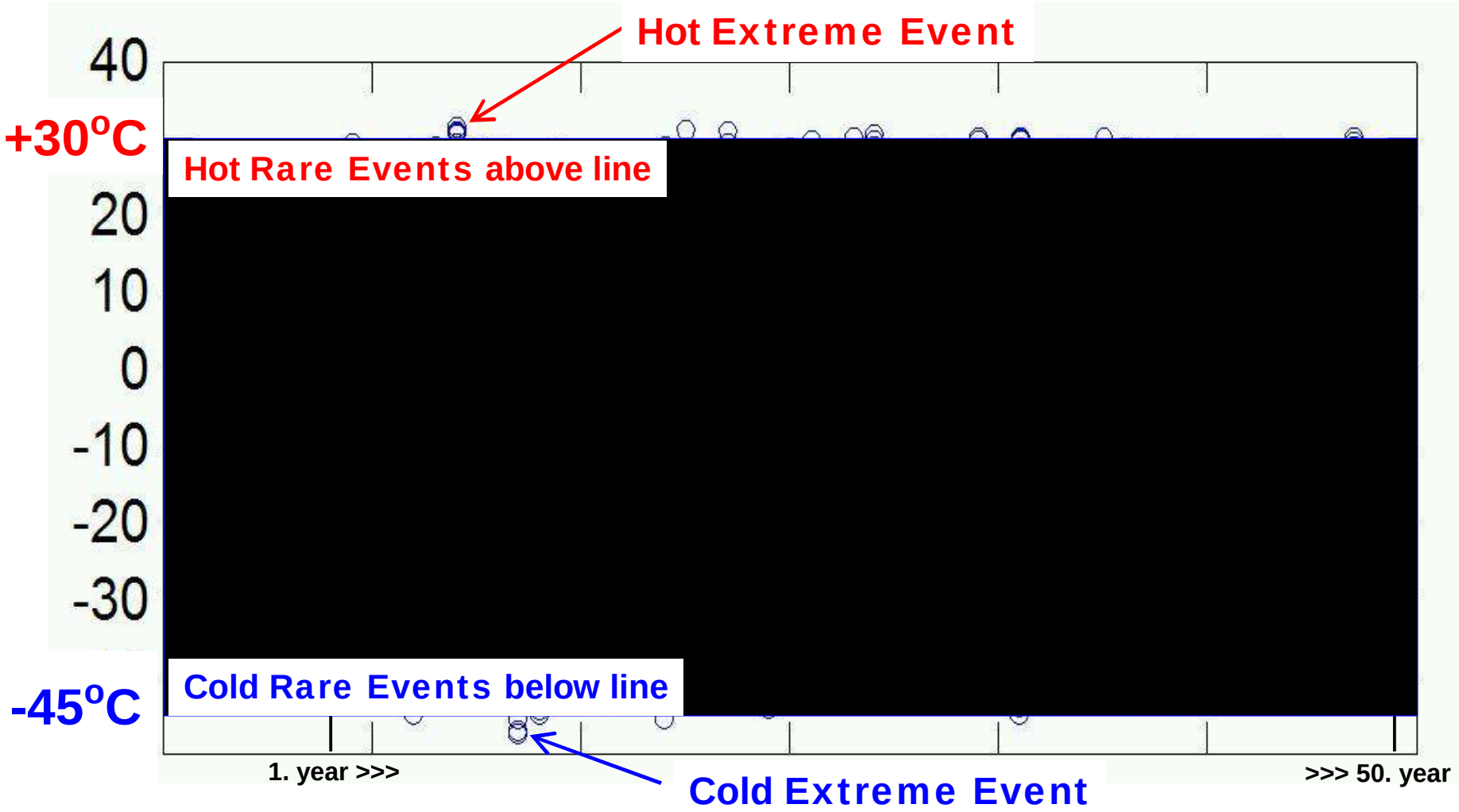

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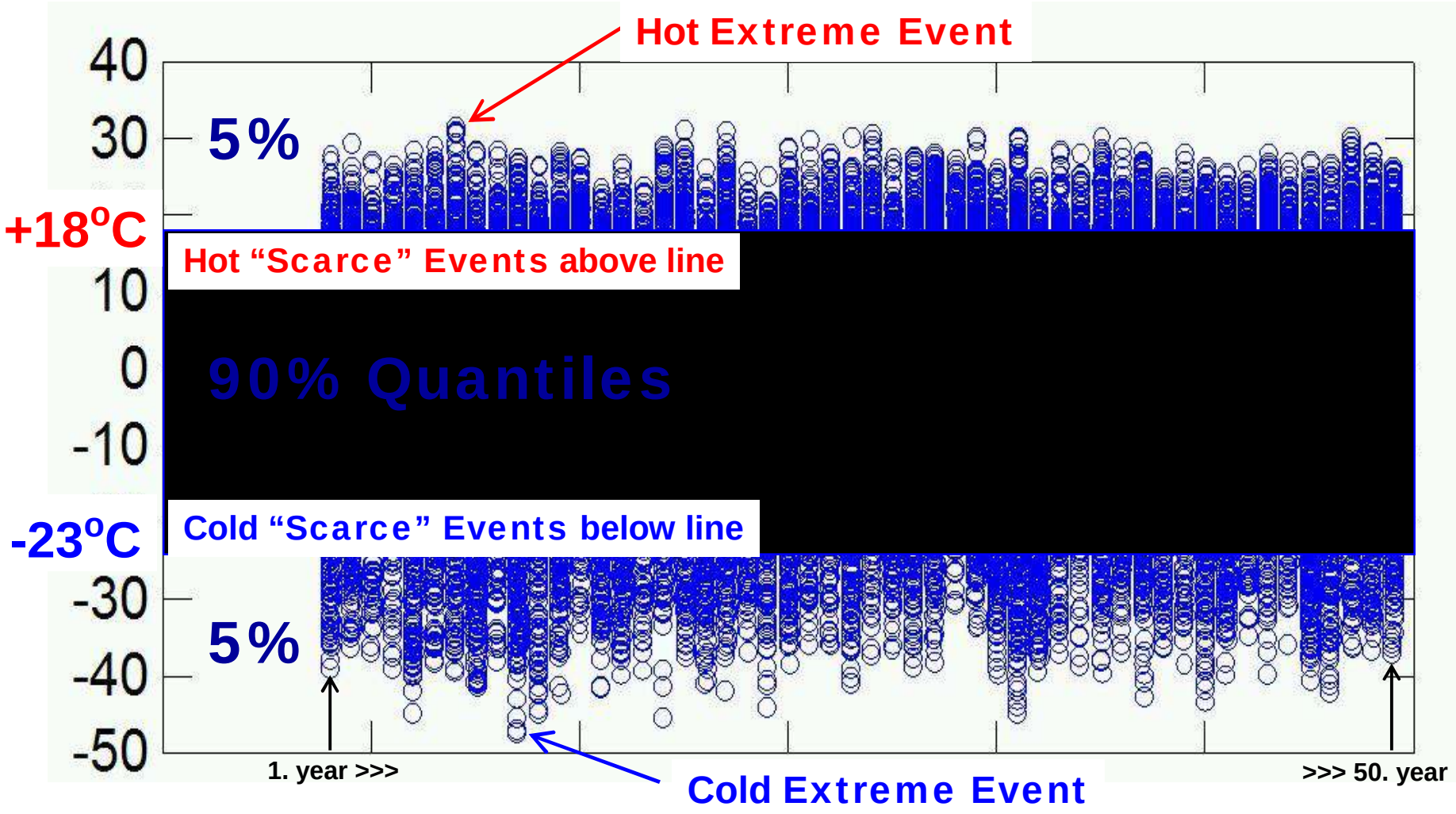

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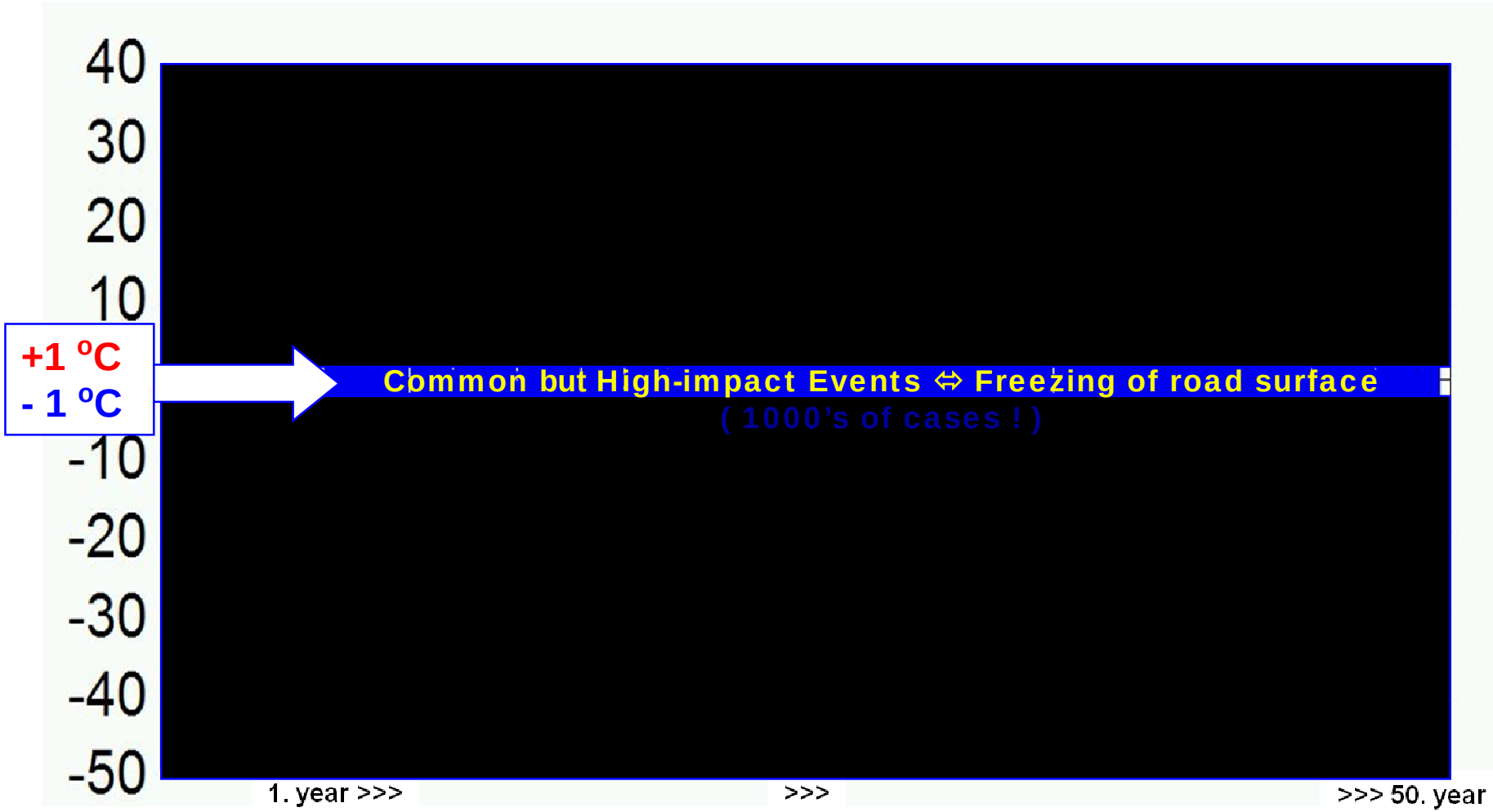

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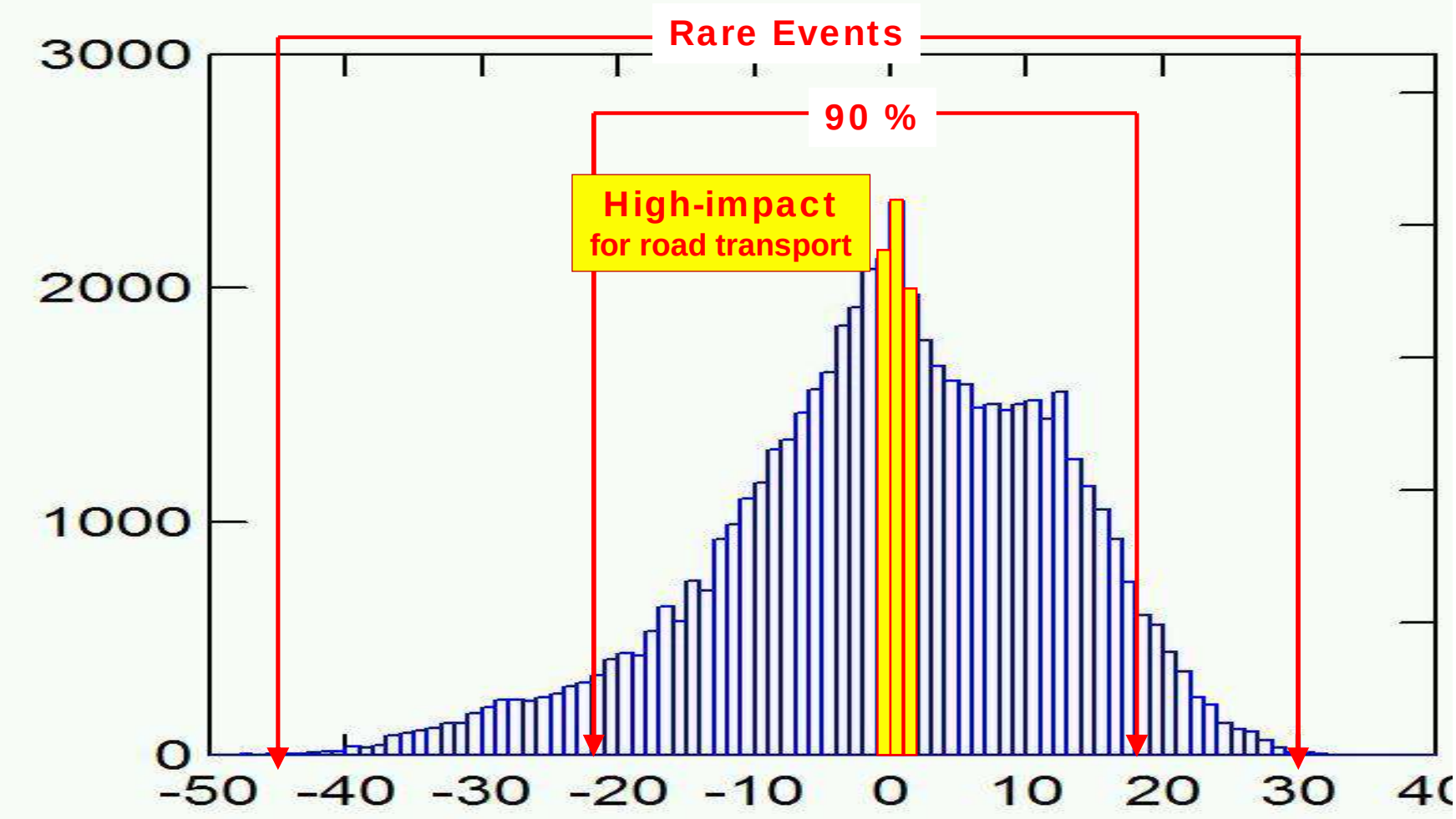
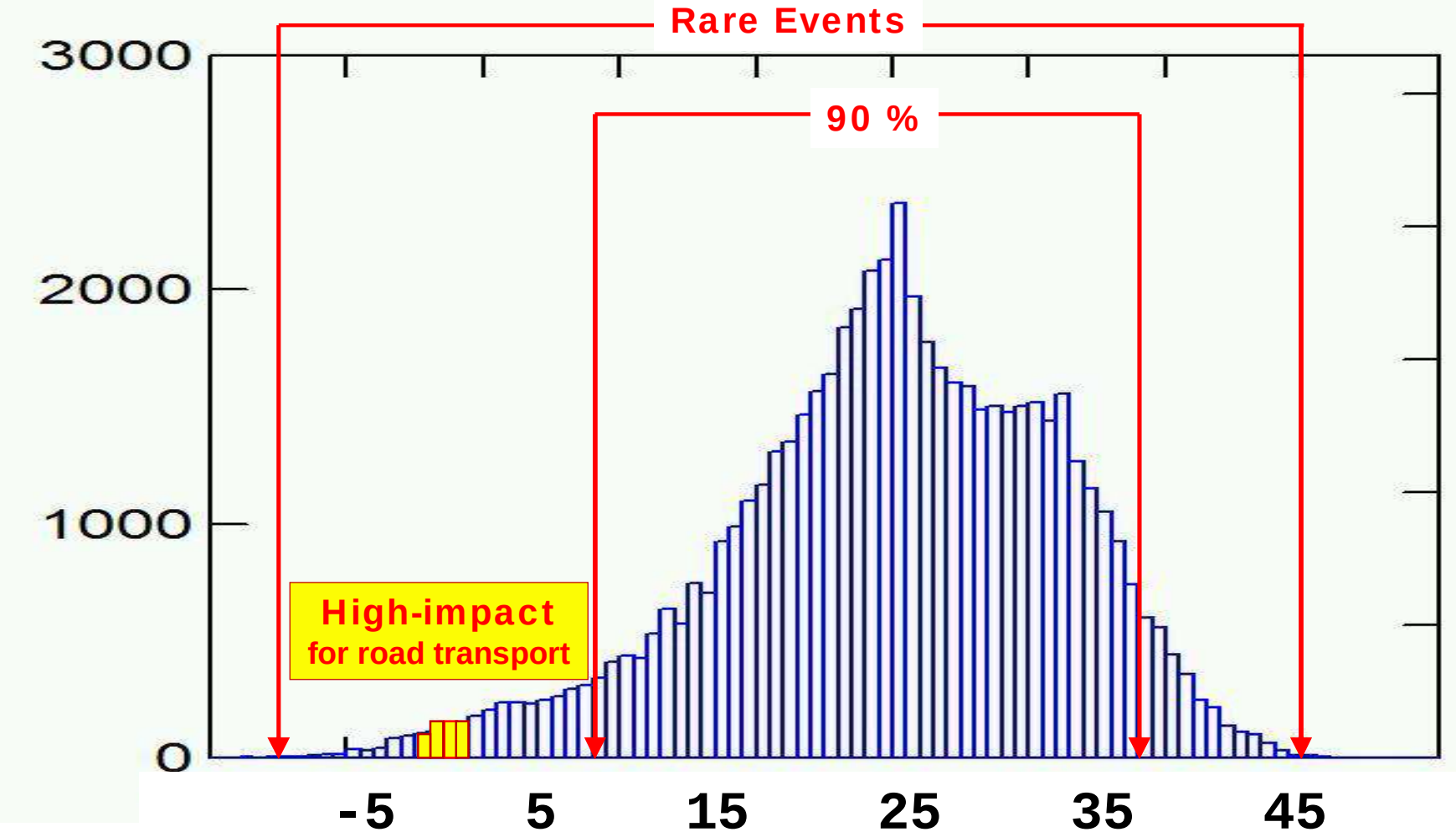
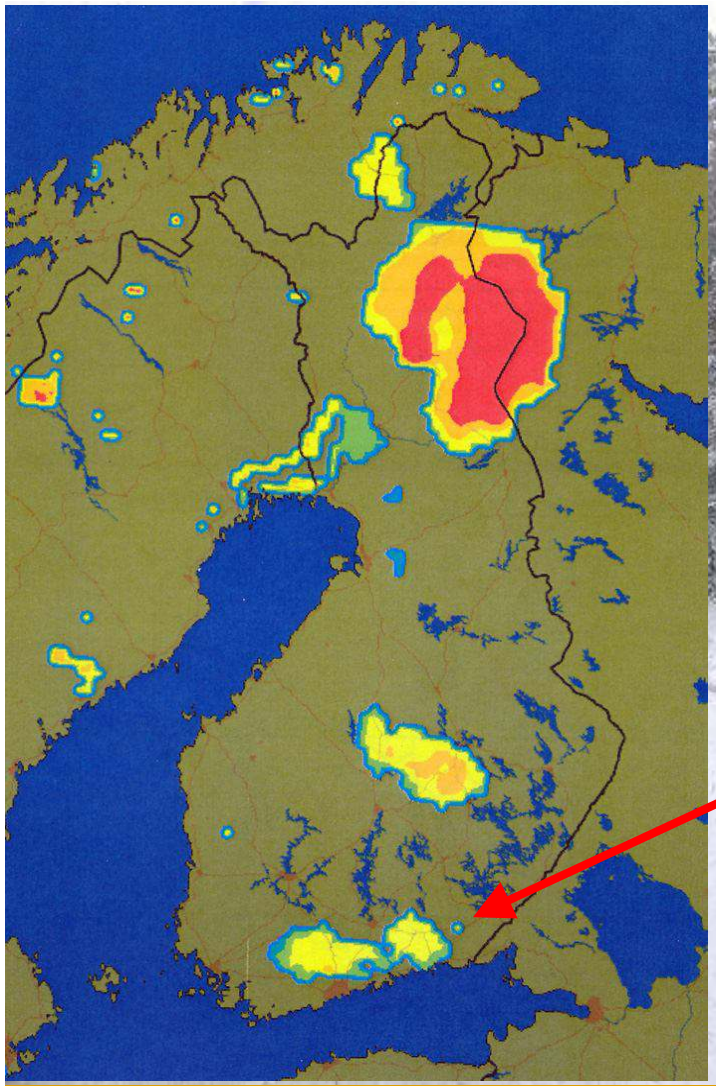


3. ILLUSTRATION of DEFINITIONS

Temperature distribution at a HYPOTHETIC station maybe somewhere in S. Europe



SEVERE ! HIGH-IMPACT ! ADVERSE !



SEVERE ! EXTREME ! HIGH-IMPACT ! RARE ! ADVERSE !

Thank You for Your Attention