Politecnico di Torino

Influence of vertical temperature gradients on outdoor sound propagation in a narrow valley

Michel Vuillermoz, Filippo Berlier, Christian Tartin,
Christian Tibone, Daniele Crea, Marco Cappio Borlino

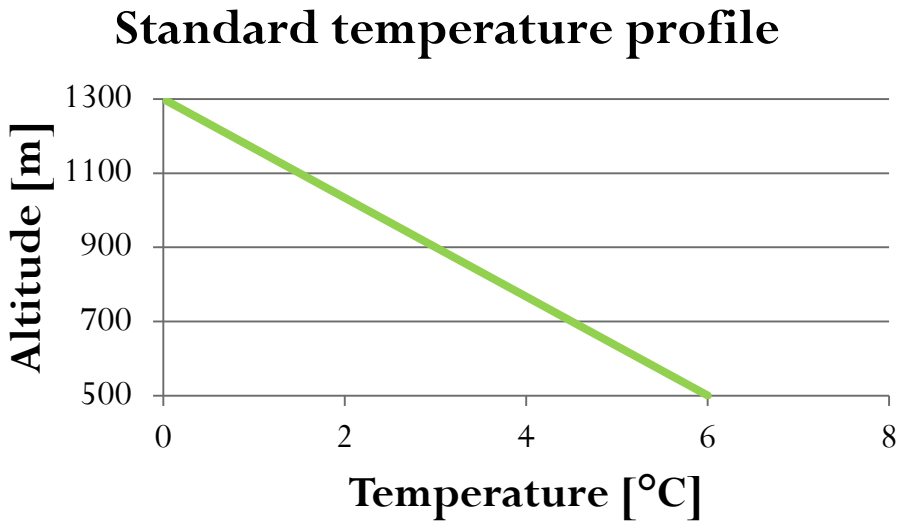
Merano - AIA DAGA 2013

Objectives

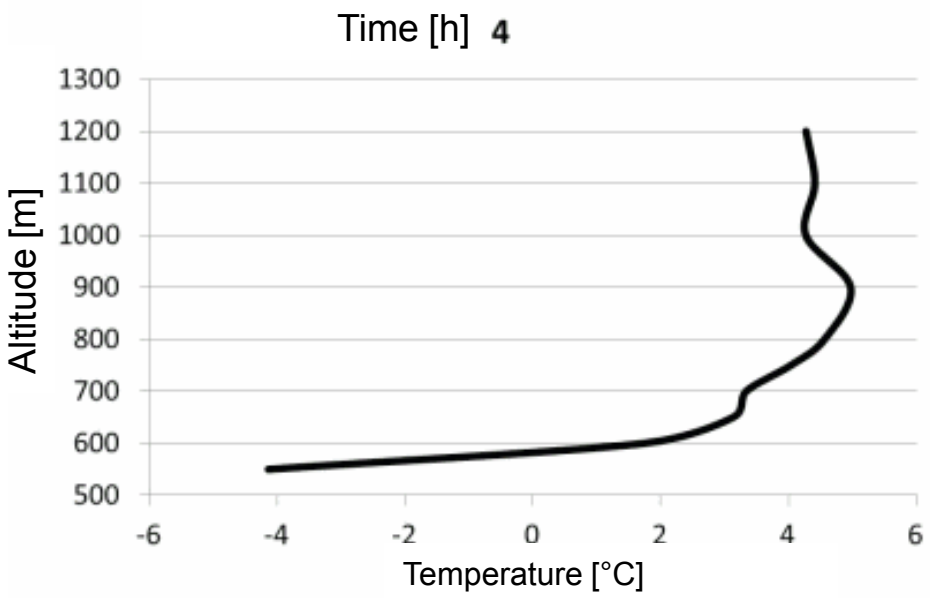
- Correlation between vertical temperature gradients and environmental noise, quantification of this correlation
- Analysis on empirical data collected by ARPA vda (2006 / 2012)
- Definition of a method to carachterize temperature profiles
- Monitoring noise level related to different meteorological conditions

Case study

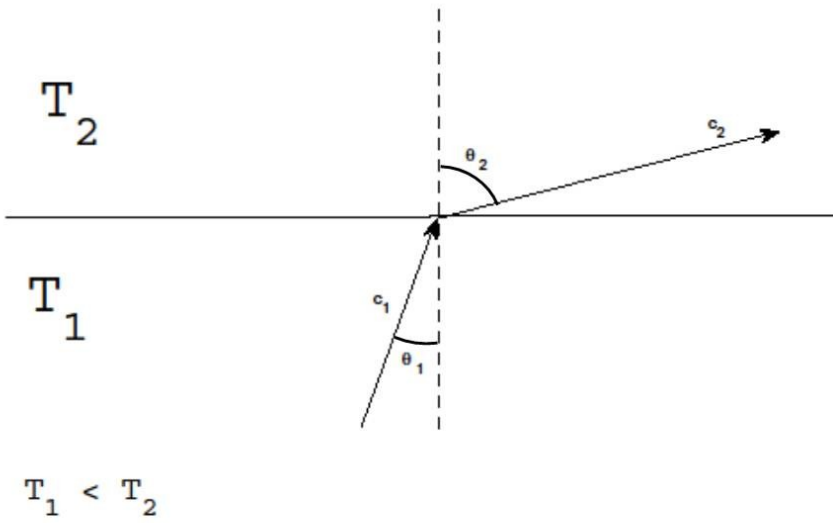
Thermal inversion

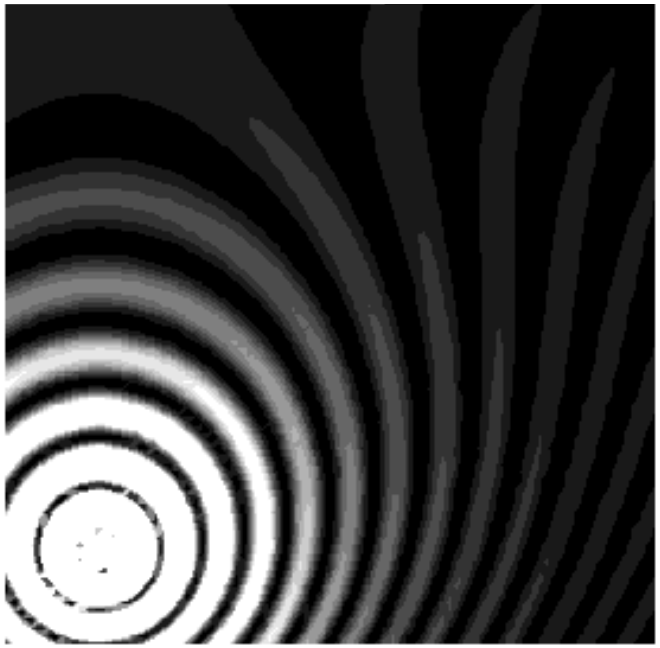


Aosta city
12 January2012



Phenomenon

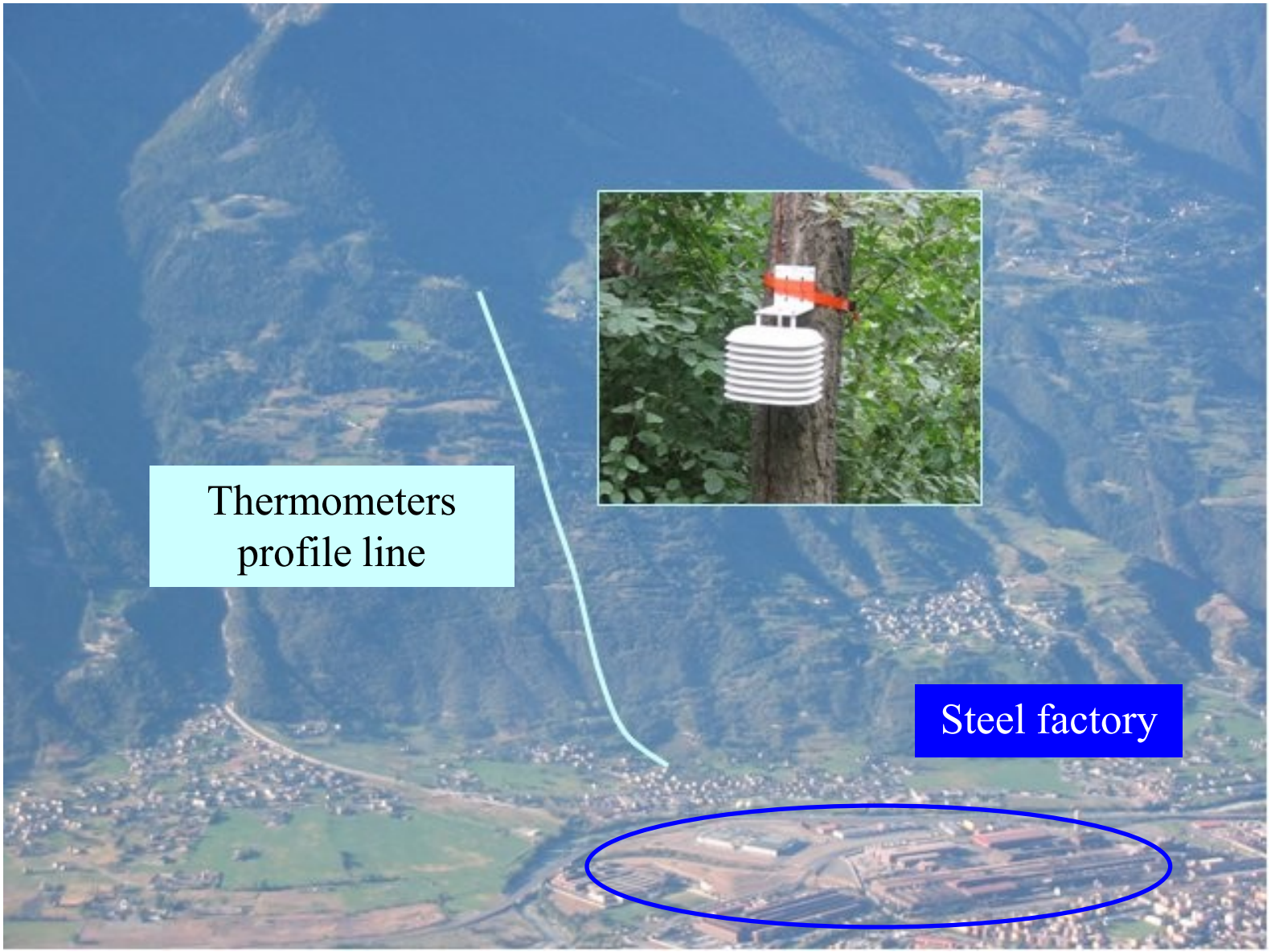




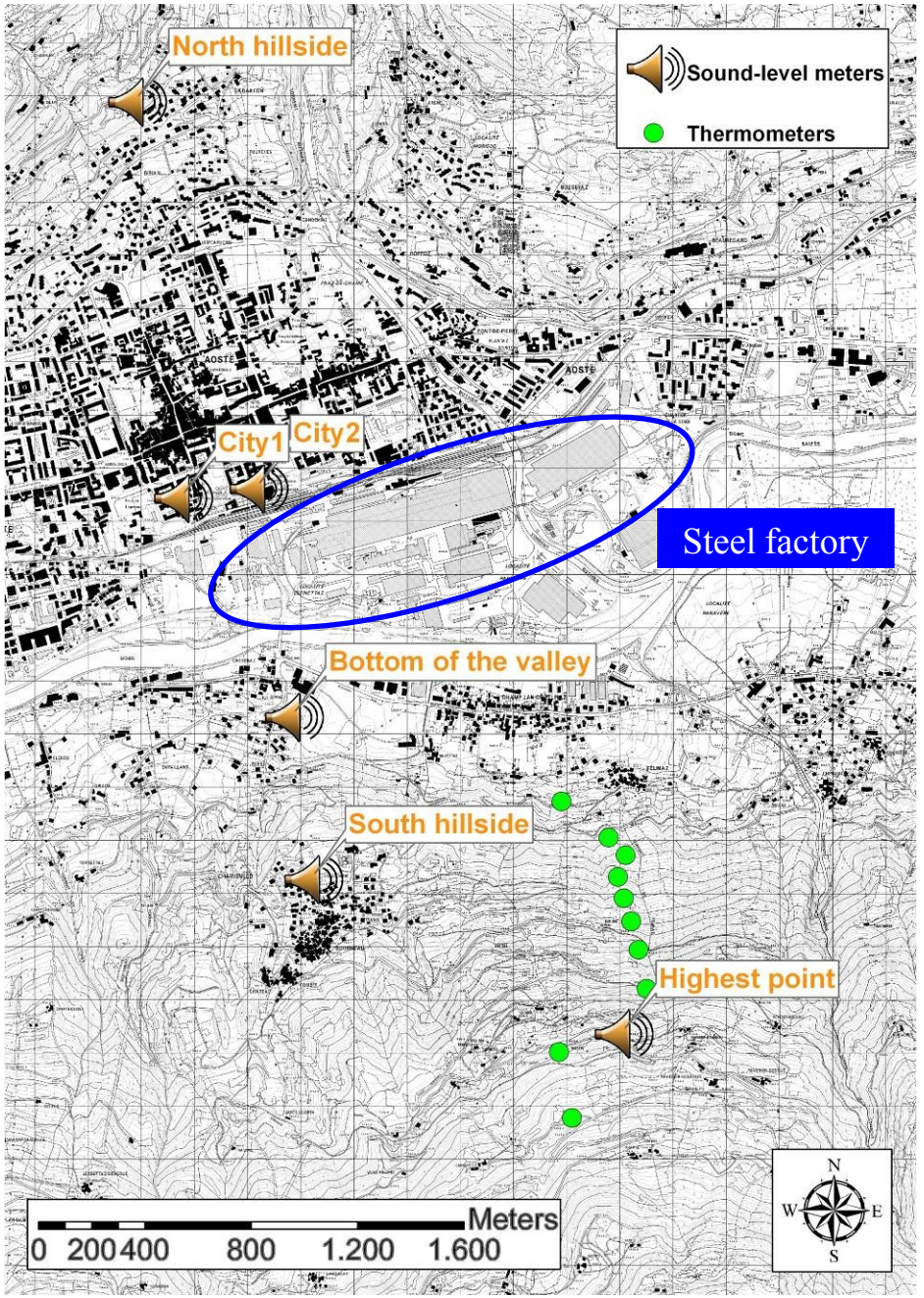
- $\frac{\sin\theta_1}{\sin\theta_2} = \frac{c_1}{c_2}$

$$c = \sqrt{kRT}$$

Thermometers location



Sound-level meters location



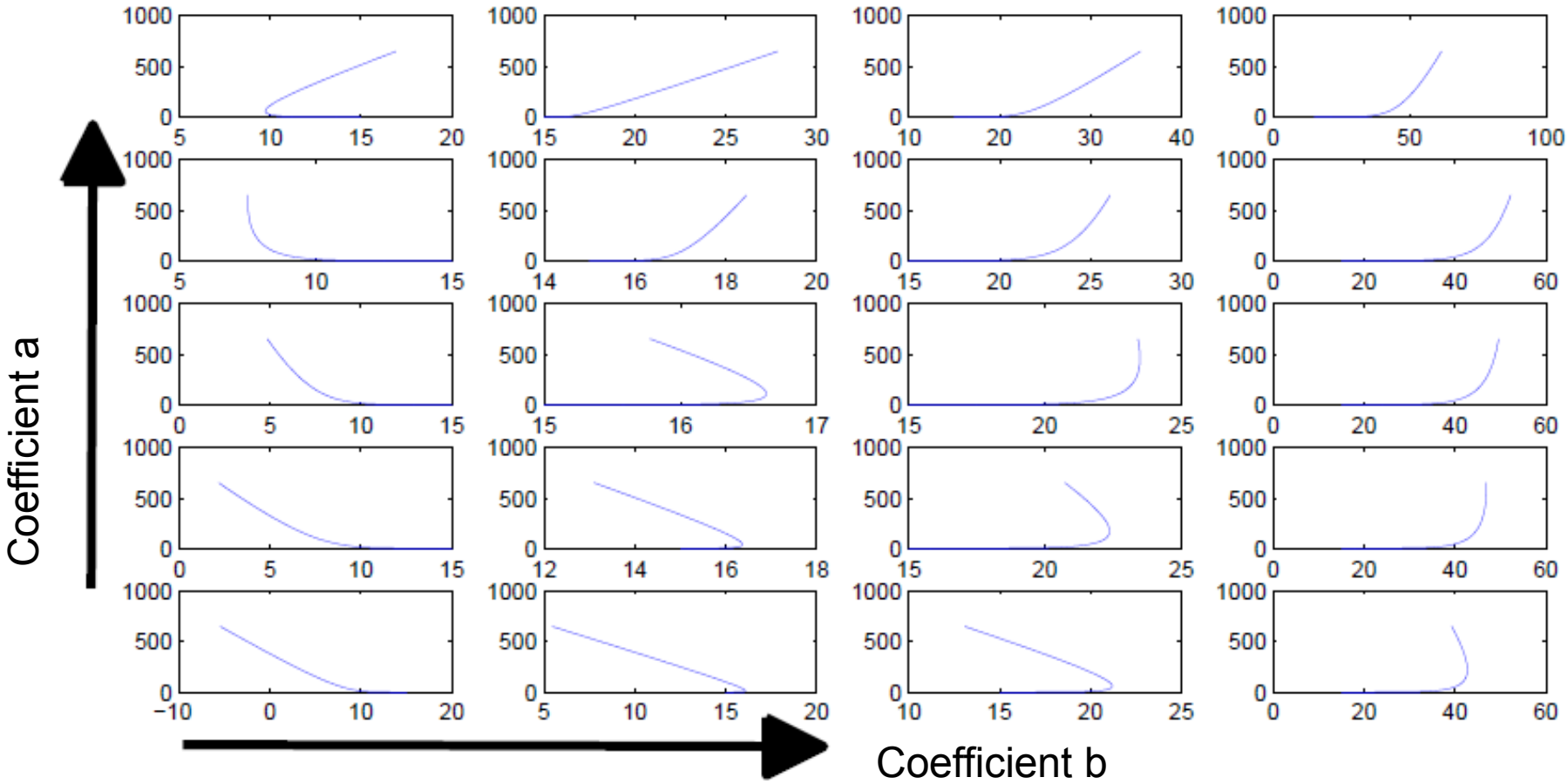
Profiles decription method

- $$c_{ad} = \sqrt{kRT(z)} \approx$$
$$\approx c_0 + \frac{\frac{1}{2}(kR)}{c_0}(T(z) - T_0) \approx$$
$$\approx c_0 + a \ln\left(1 + \frac{z}{z_0}\right) + b \cdot z$$

a: bending

b: slope

Correlation: Thermal profiles - coefficients

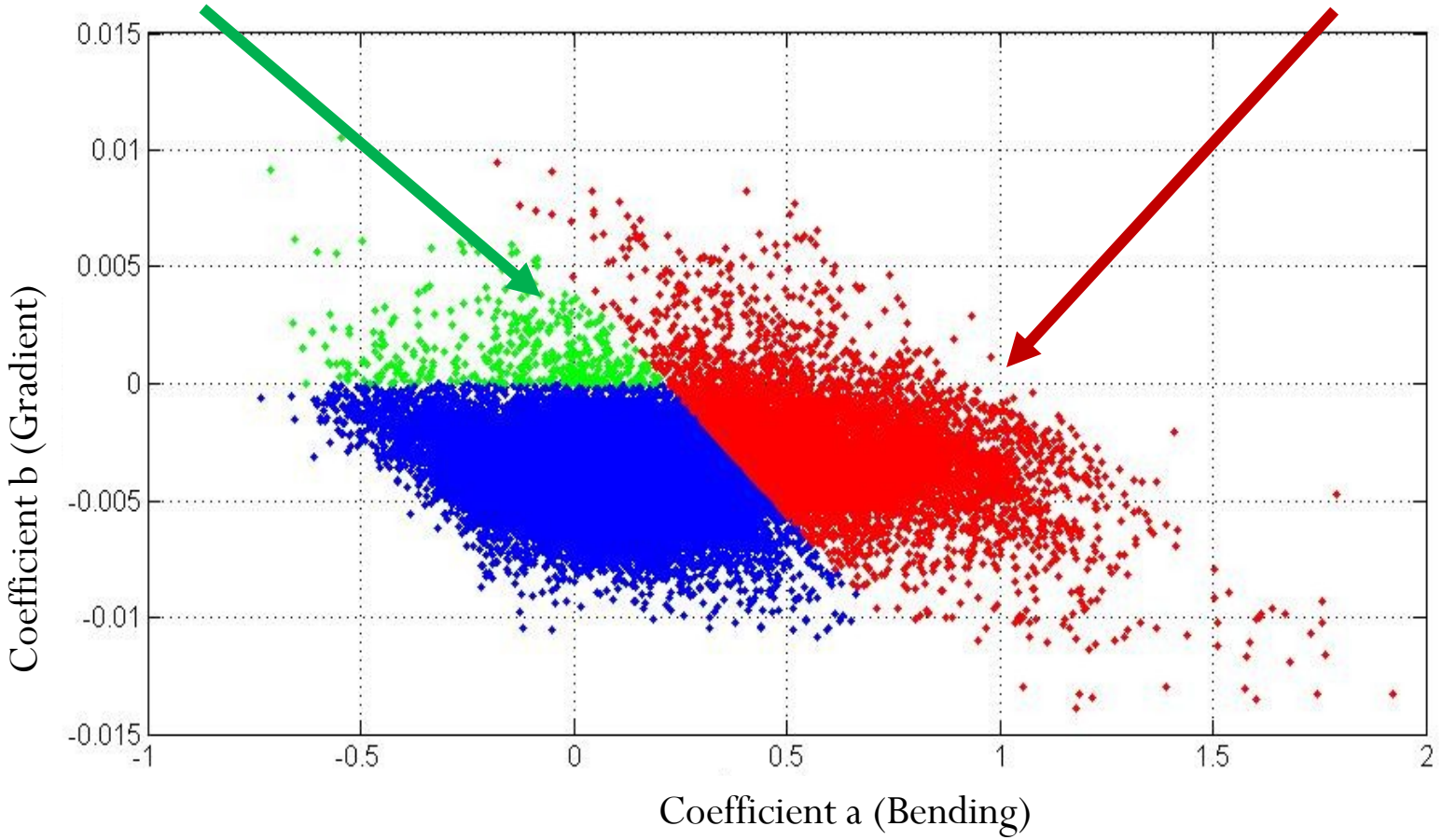


Correlation Thermal profiles- coefficients

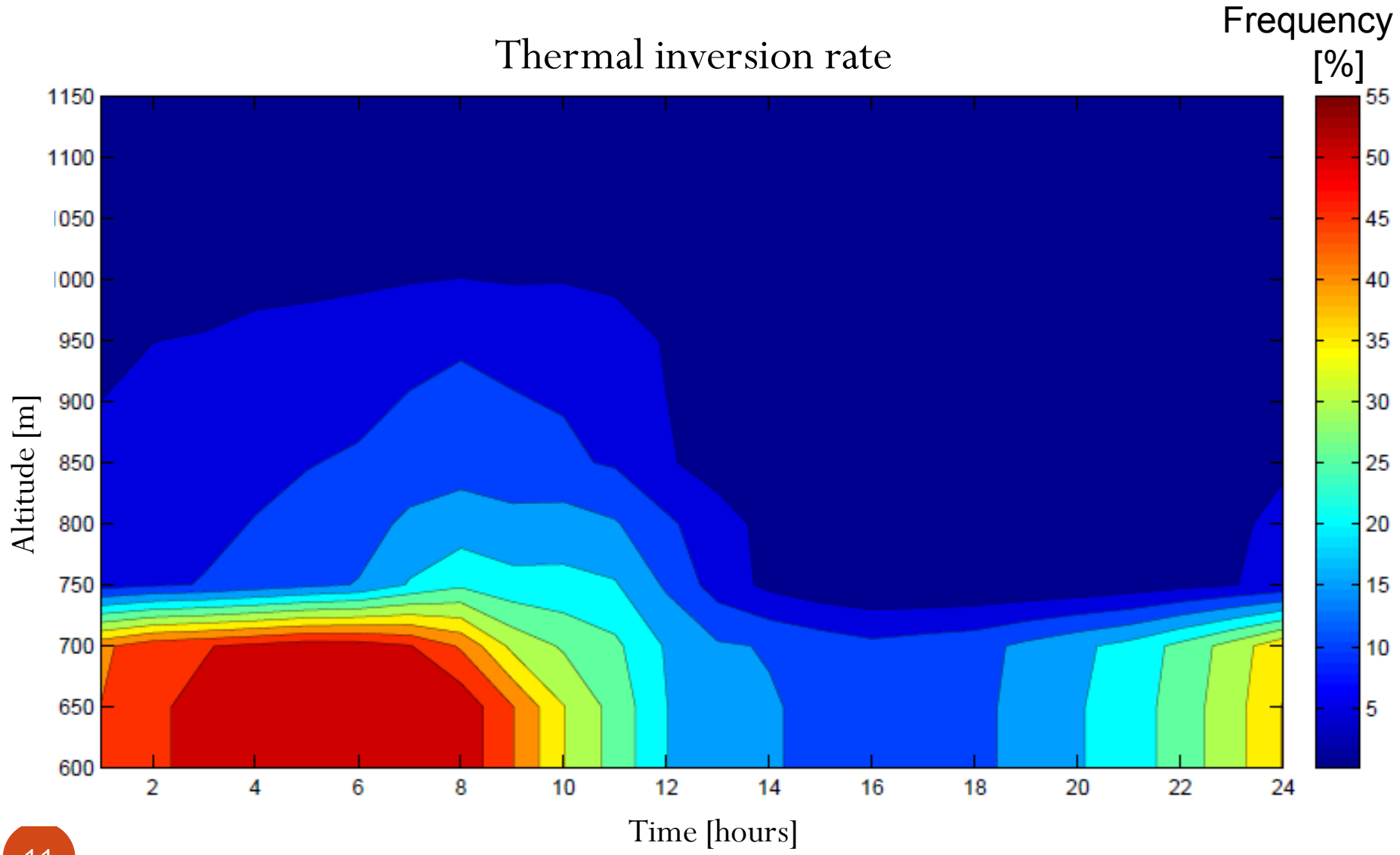
Thermal inversion on the whole profile= 2,18 %

Coefficient distribution

Thermal inversion partially on the profile = 18,27 %

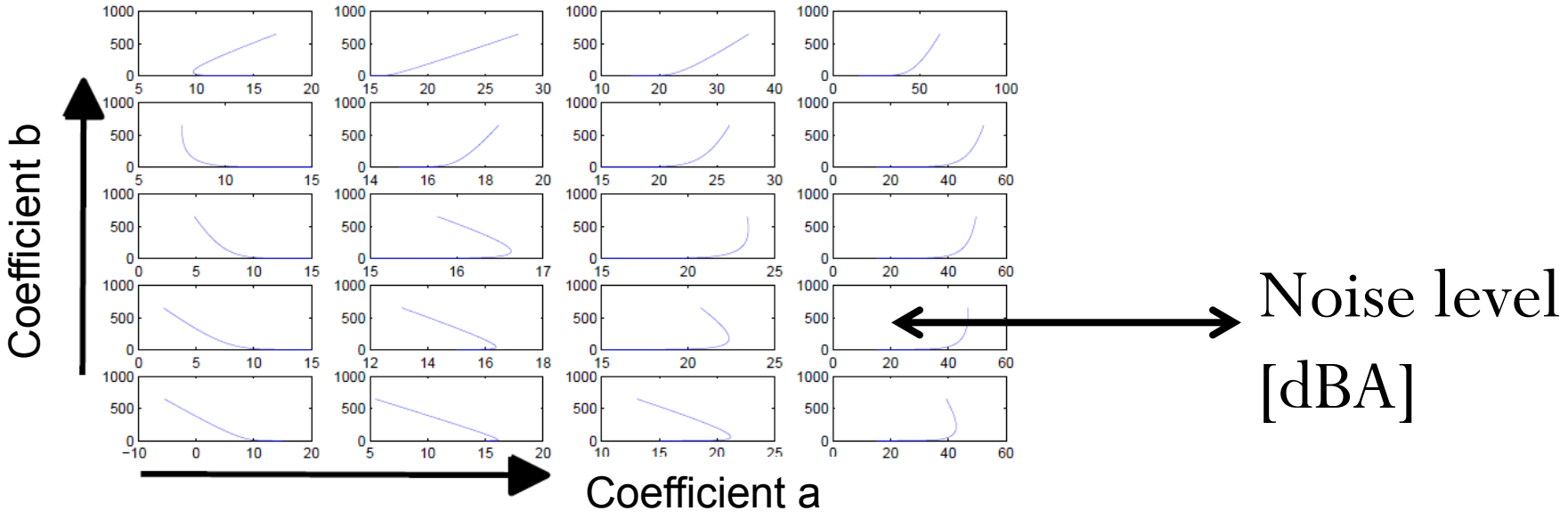


Thermal inversion situations

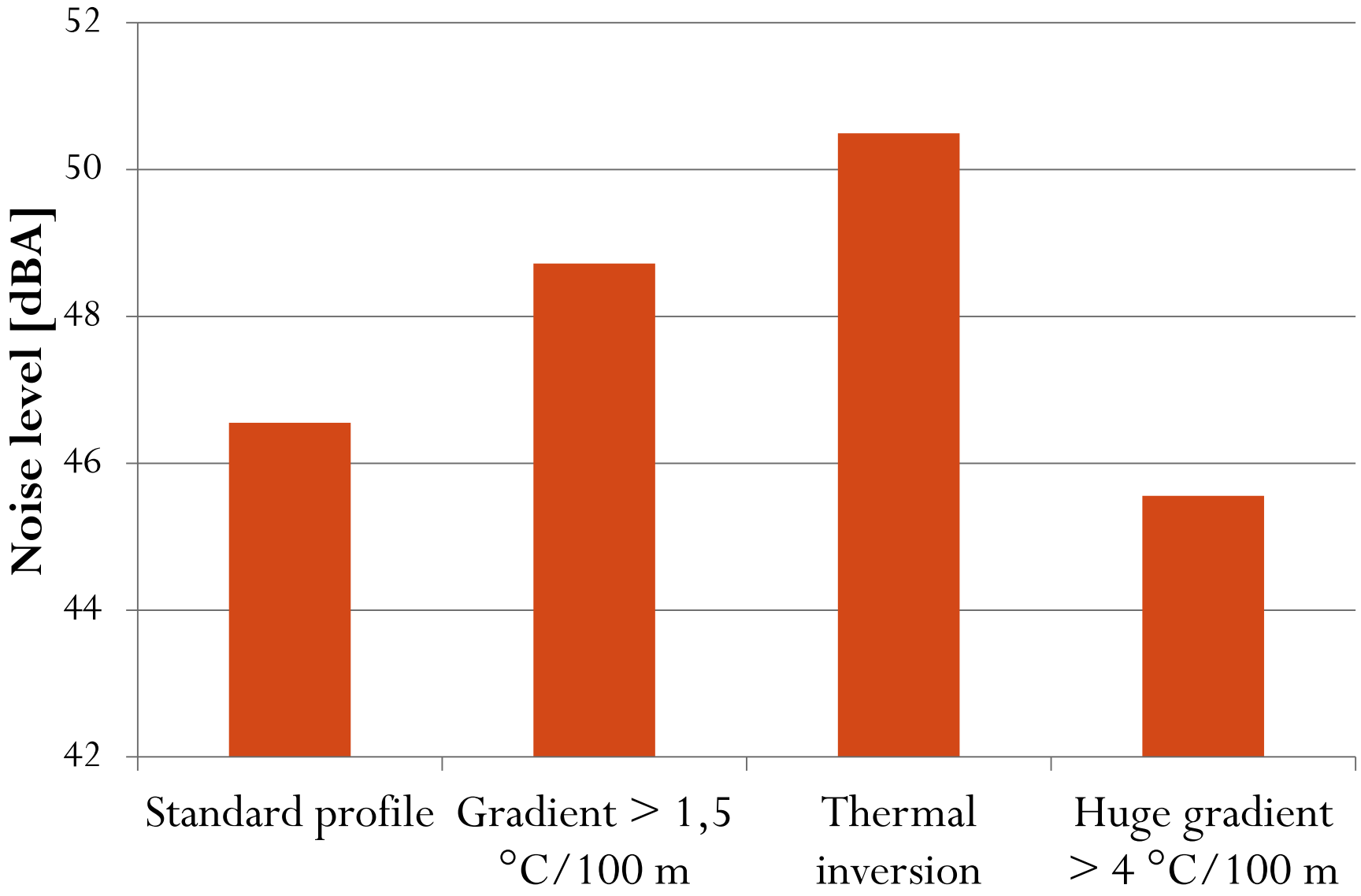


Reasons for the classification

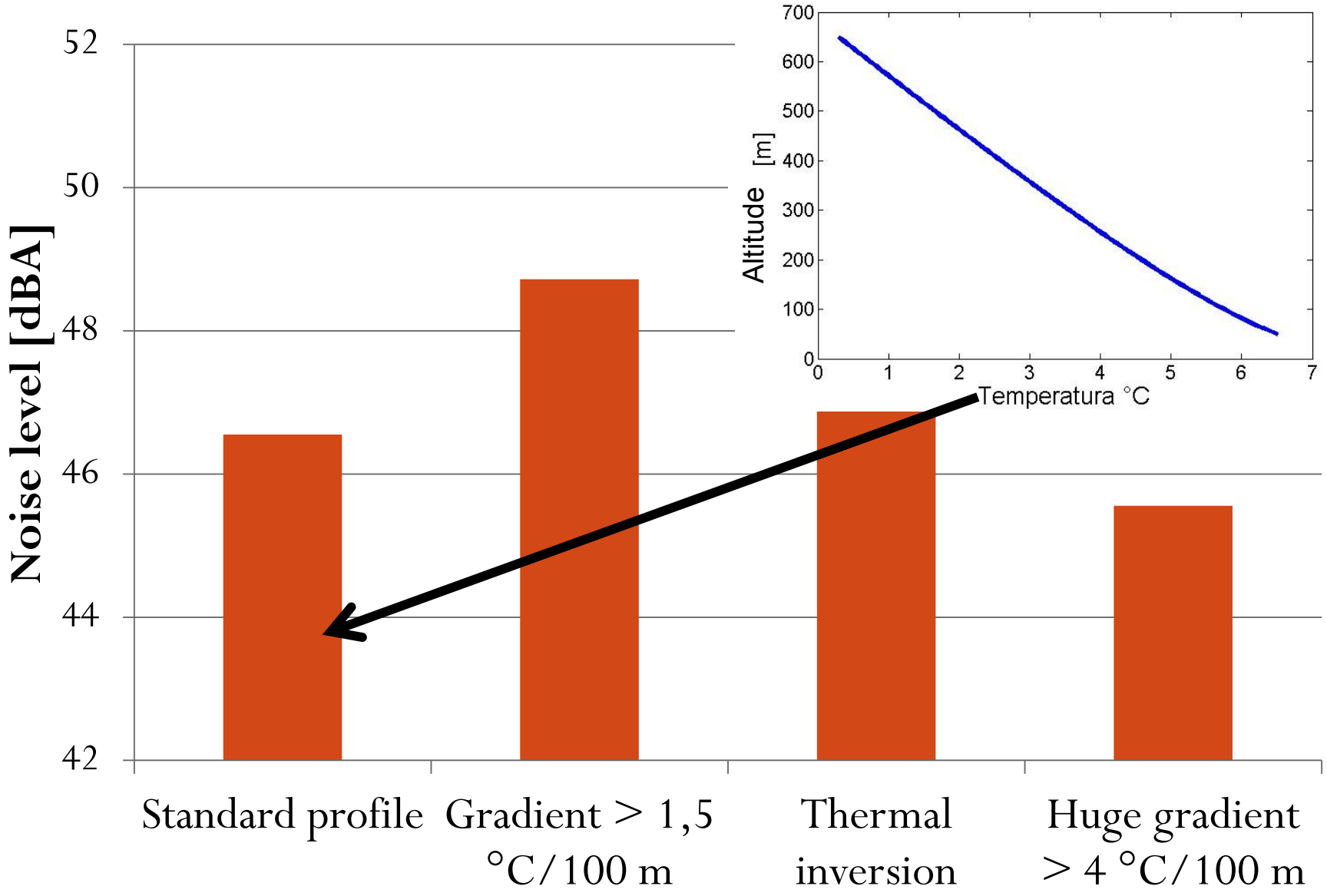
- Create a clear correlation between temperature profiles and noise levels (similar profiles ↔ average noise)
- Time and meteorological conditions imposed



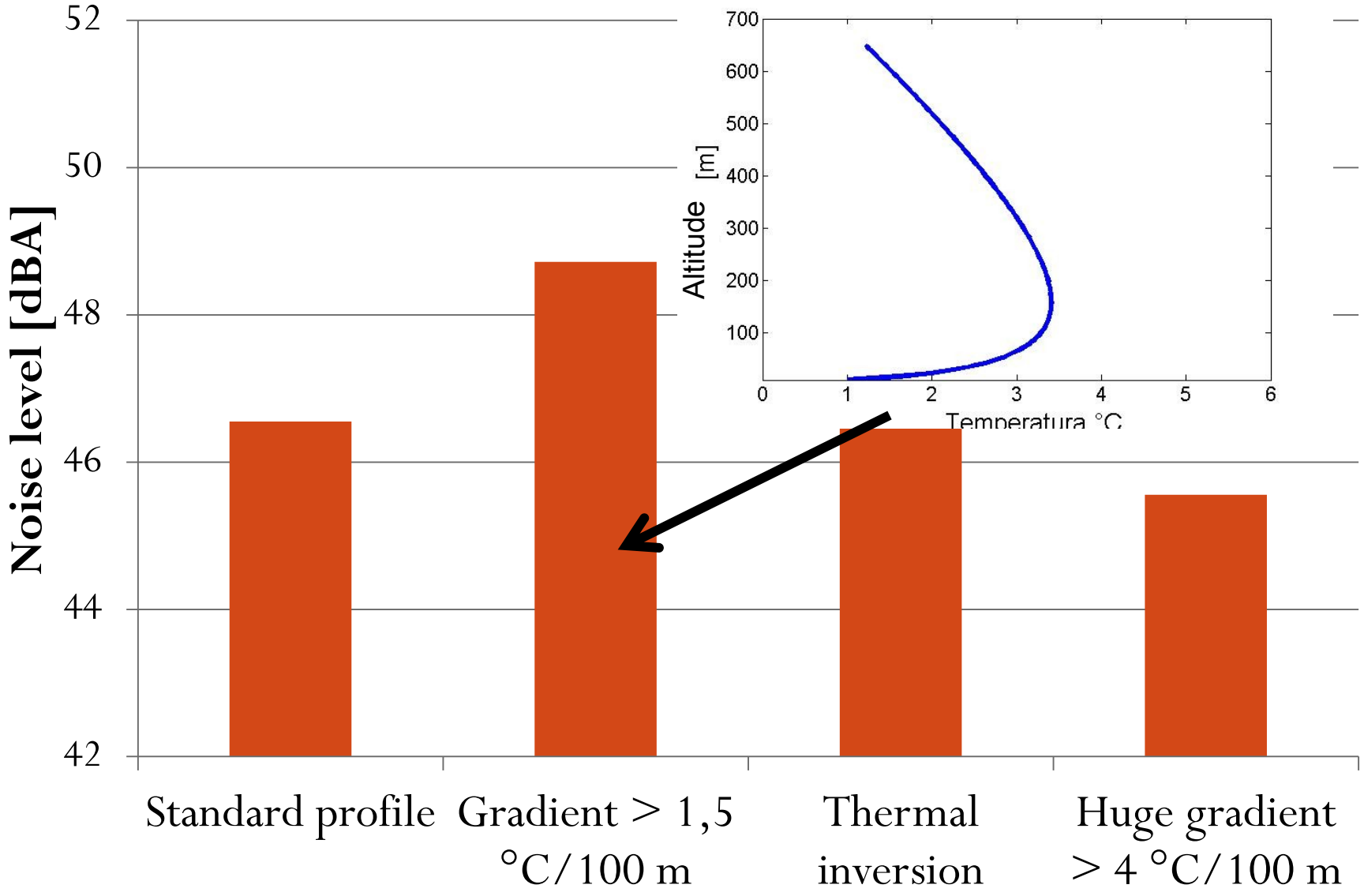
South hillside L95 [dBA] – 200 [m] above the source



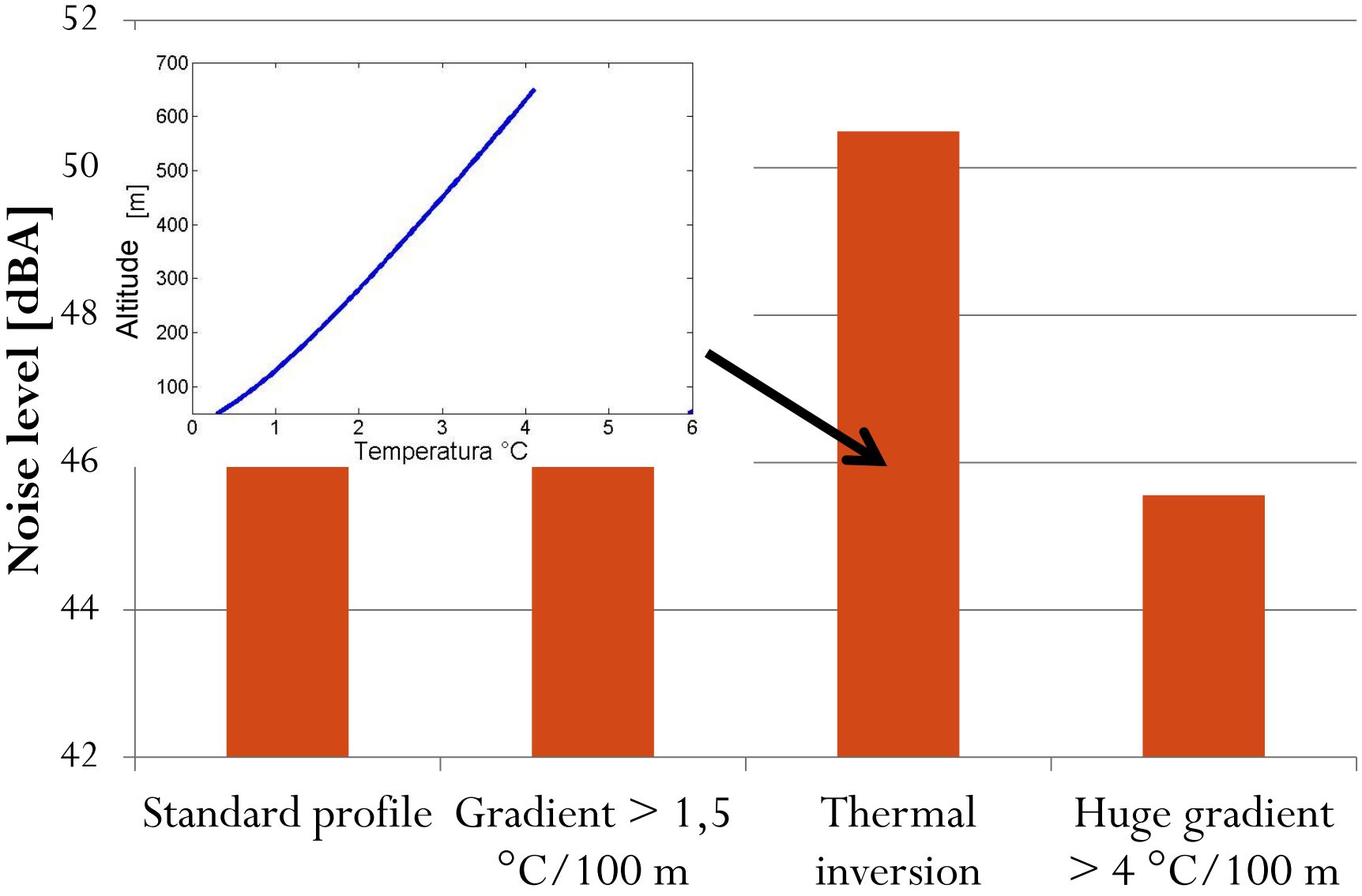
South hillside L95 [dBA] – 200 [m] above the source



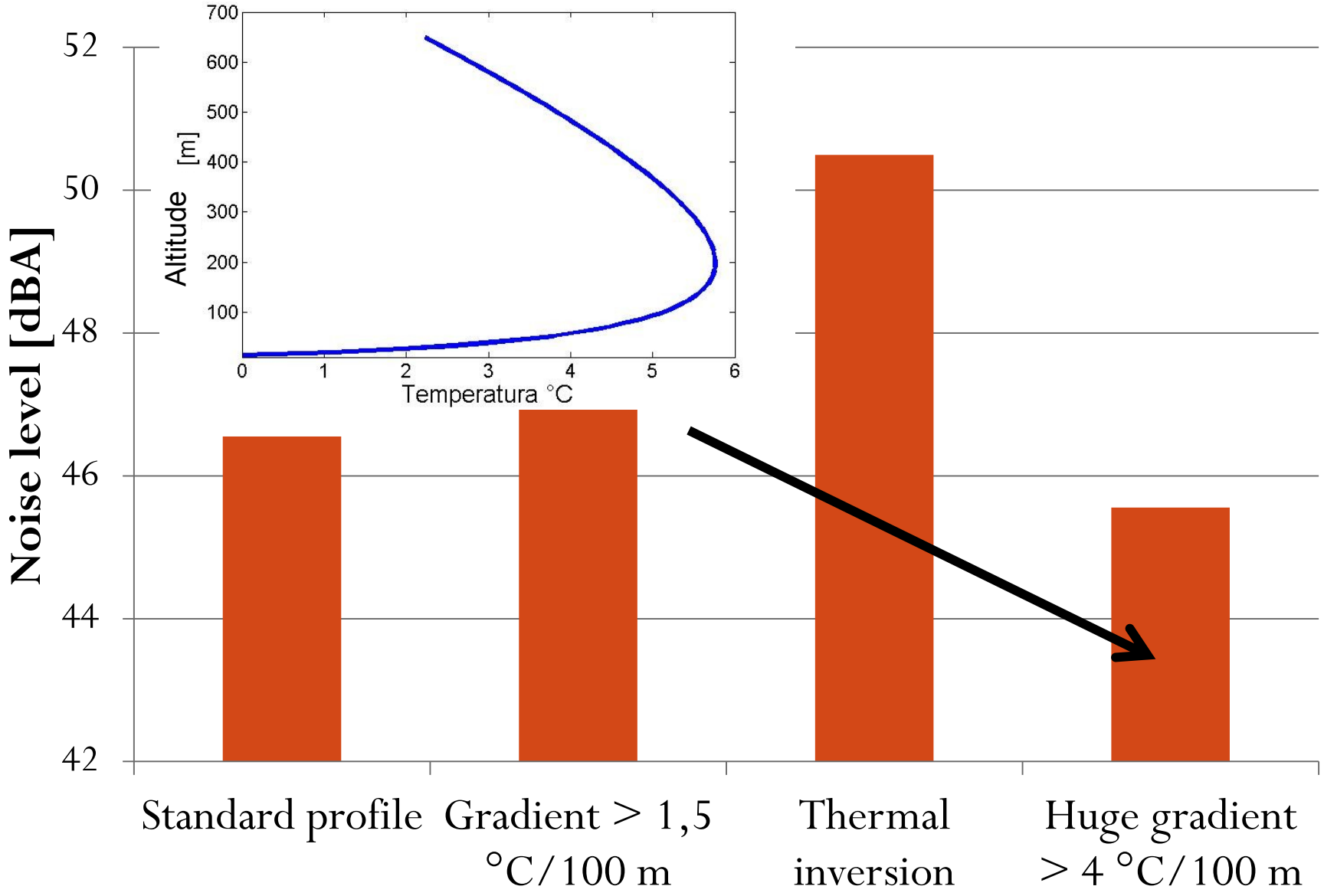
South hillside L95 [dBA] – 200 [m] above the source



South hillside L95 [dBA] – 200 [m] above the source

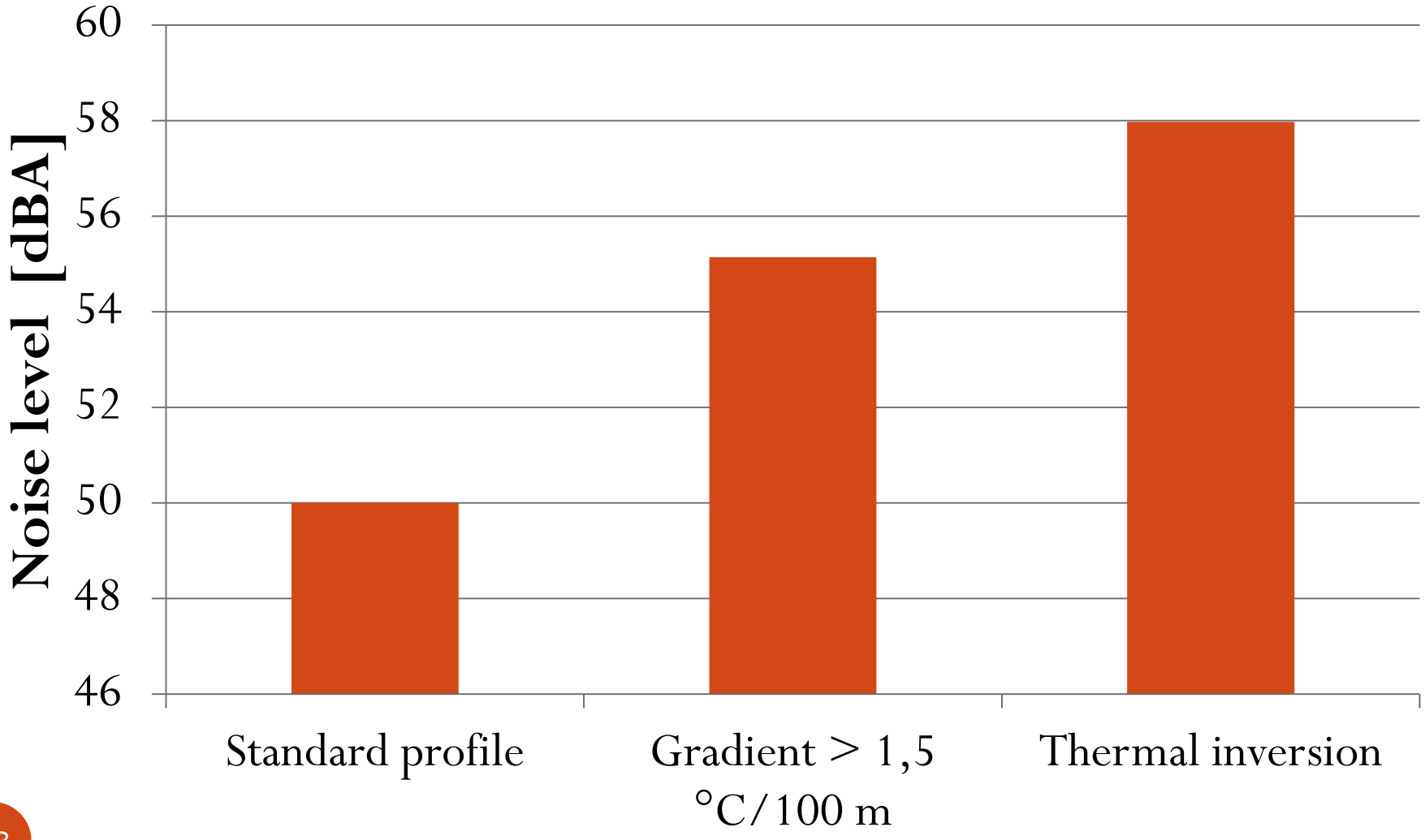


South hillside L95 [dBA] – 200 [m] above the source



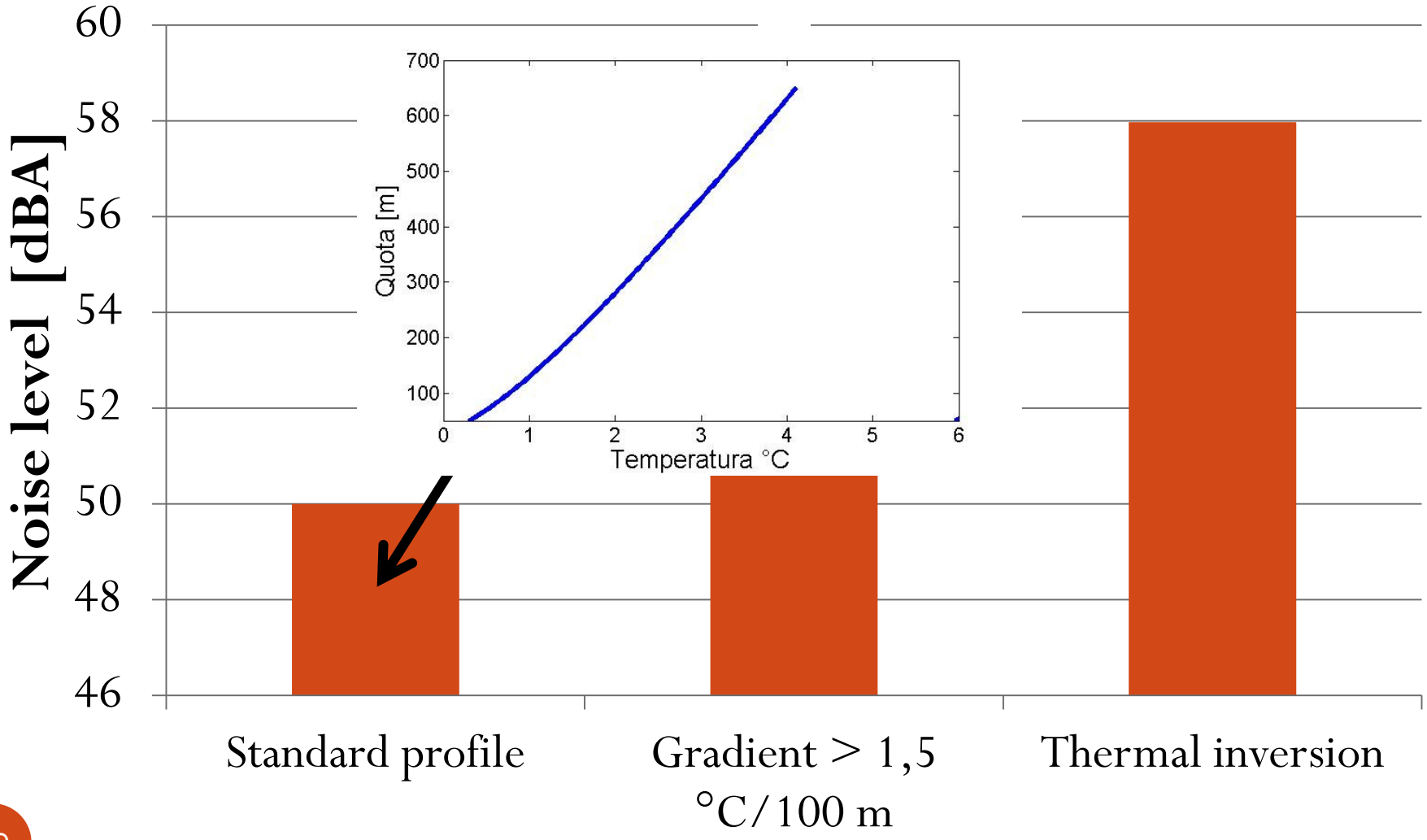
Bottom of the valley L95 [dBA]

Same altitude of the source



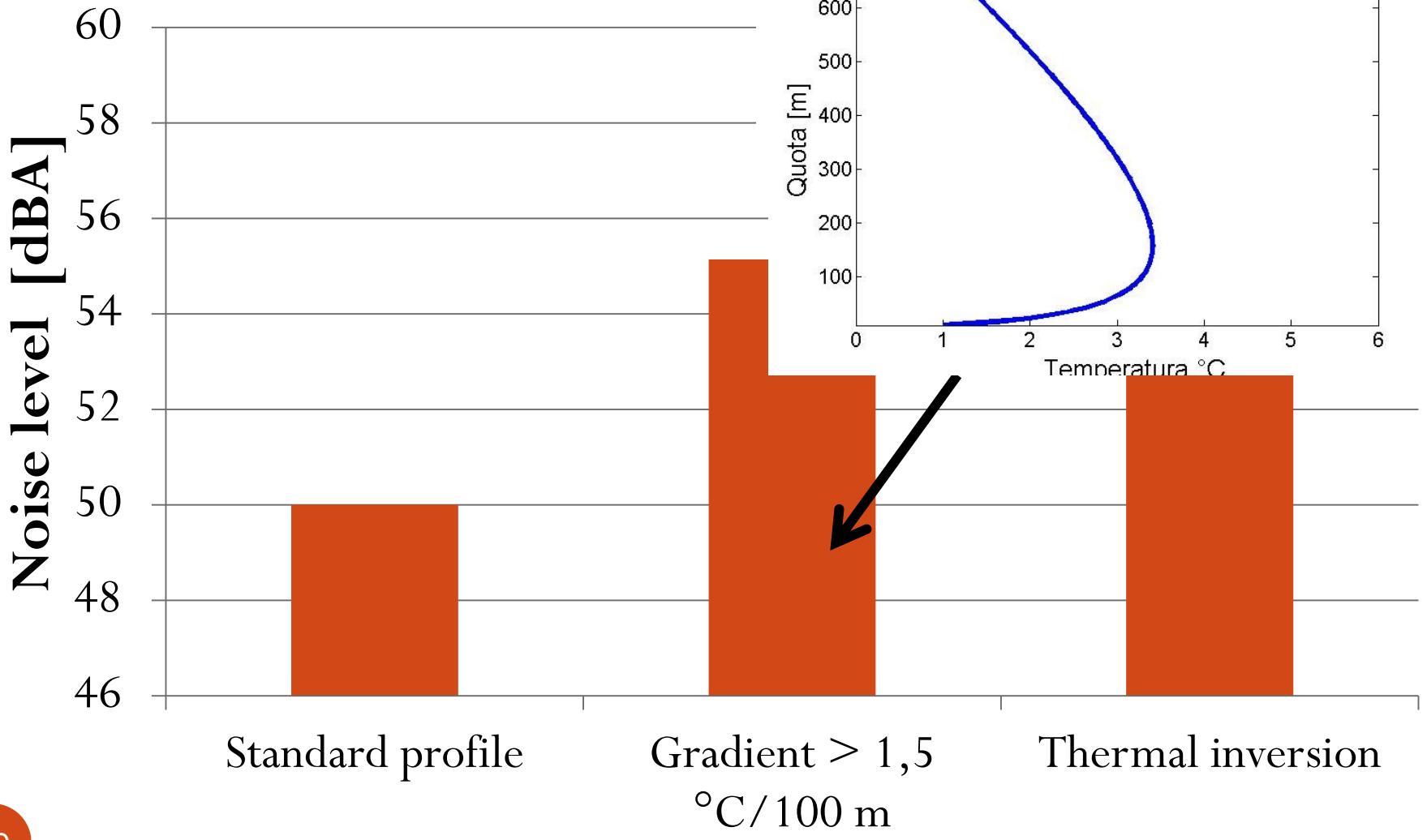
Bottom of the valley L95 [dBA]

Same altitude of the source



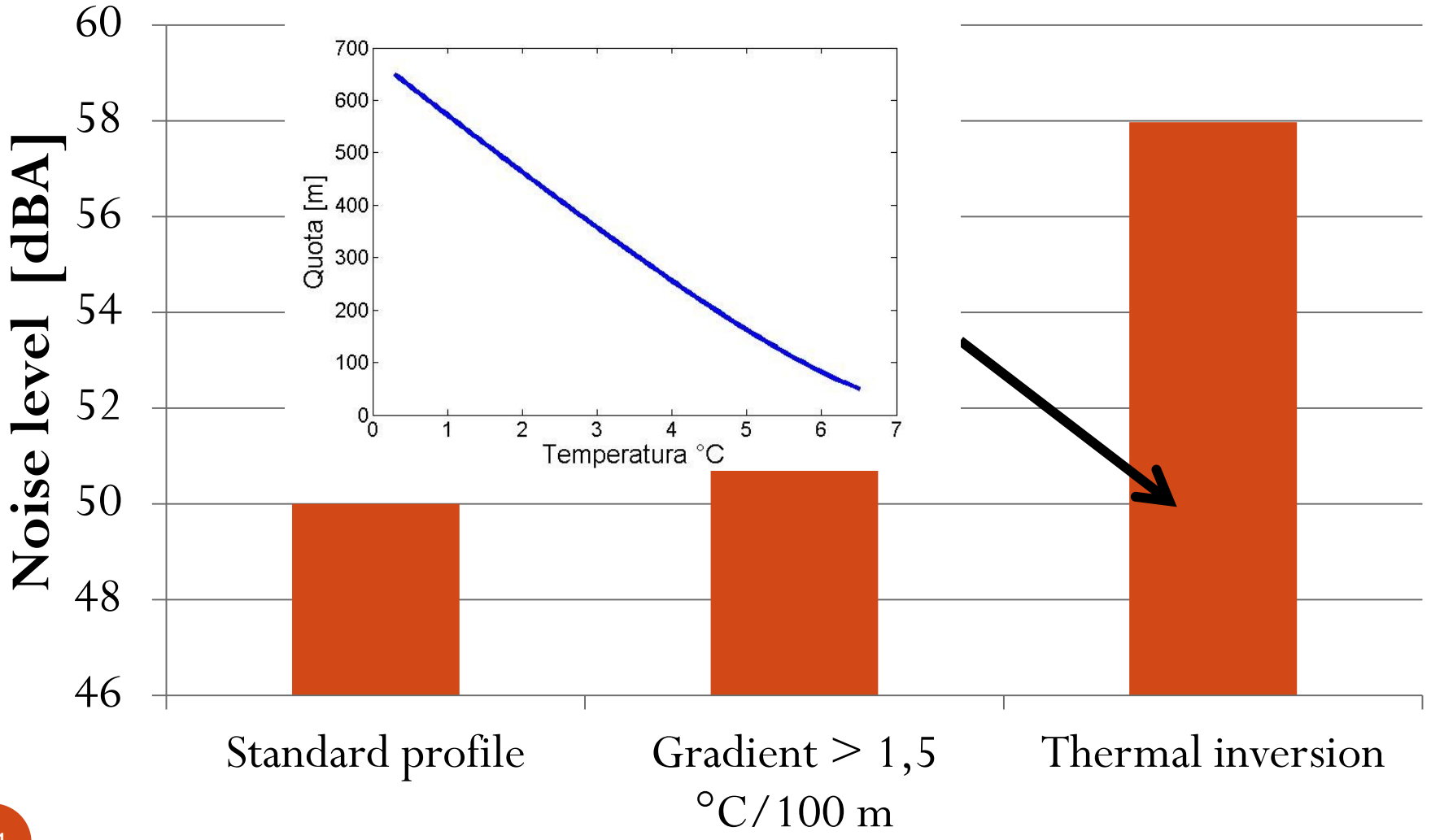
Bottom of the valley L95 [dBA]

Same altitude o[illegible]



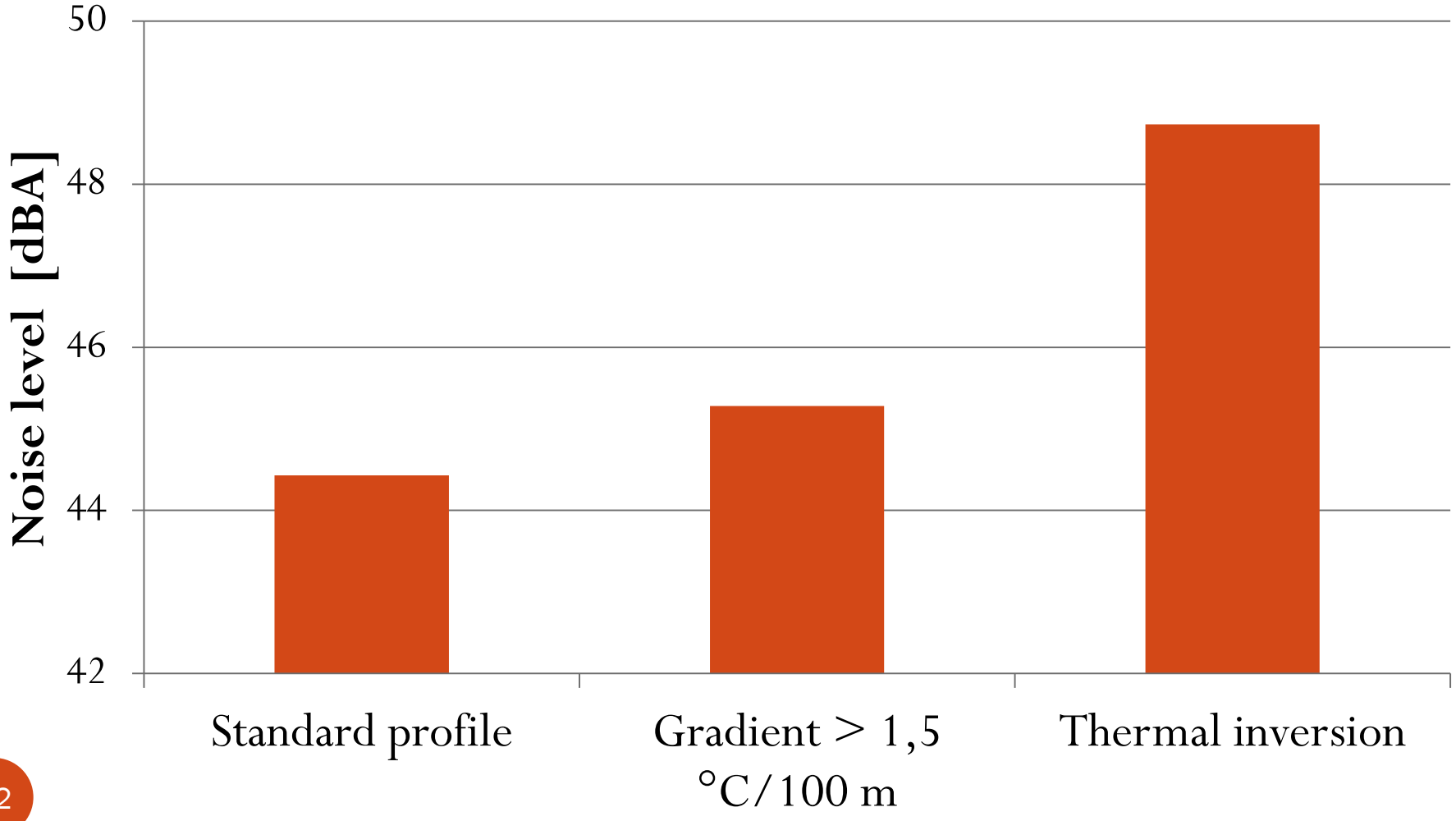
Bottom of the valley L95 [dBA]

Same altitude of the source



City 1 L95 [dBA]

Same altitude of the source



Conclusions

- Thermal inversion is a common phenomenon in Aosta Valley
- Noise increase up to 10 dB
- Increases are strongly influenced by the position and the altitude of the receptor
- The noise level increse could be a negative factor on the disturbance on population, especially during the night


Thank you for your attention