Micrometeorological data for Cnossos sound propagation model

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  CNOSSOS-EU

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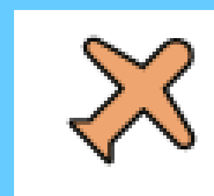
Noise Pollution

The WHO defines noise above 65 decibels (dB) as noise pollution, noise becomes harmful when it exceeds 75 decibels (dB) and is painful above 120 dB.

Causes of the noice pollution

- **The important of the meteorology for the noise propagation**

- **Wind direction and profile**
- **Temperature and humidity profiles**
- **Atmospheric stability**

Noice propagation

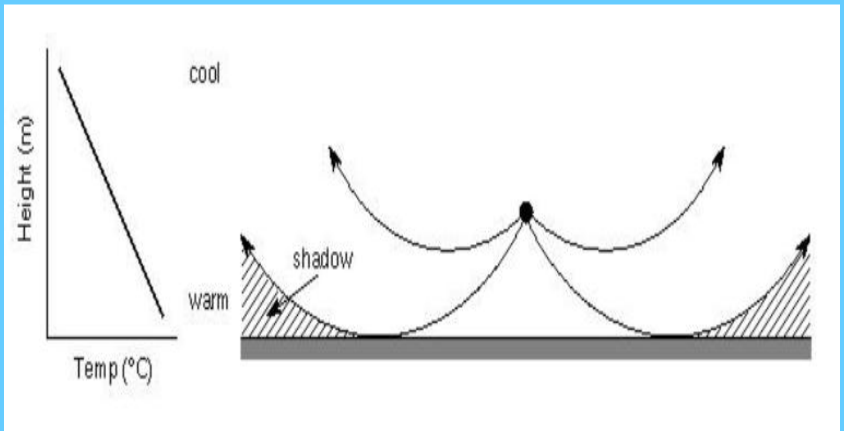


Fig 1: the sound propagation without wind in daytime

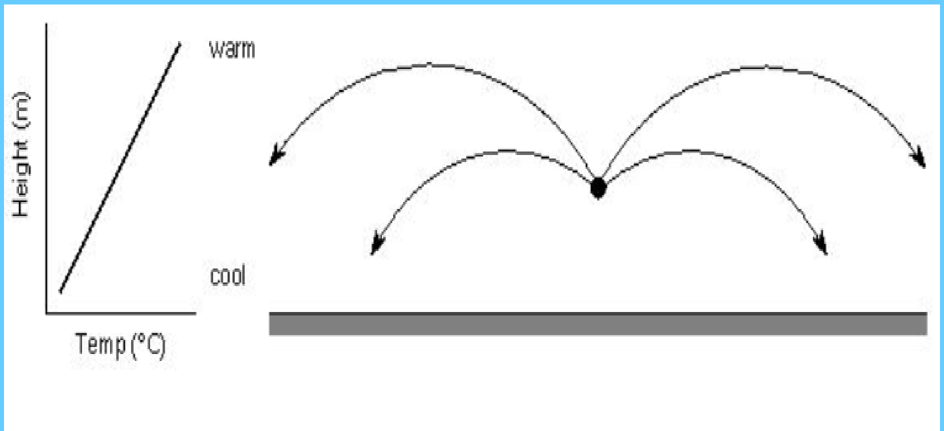


Fig 2: the sound propagation without wind in nighttime

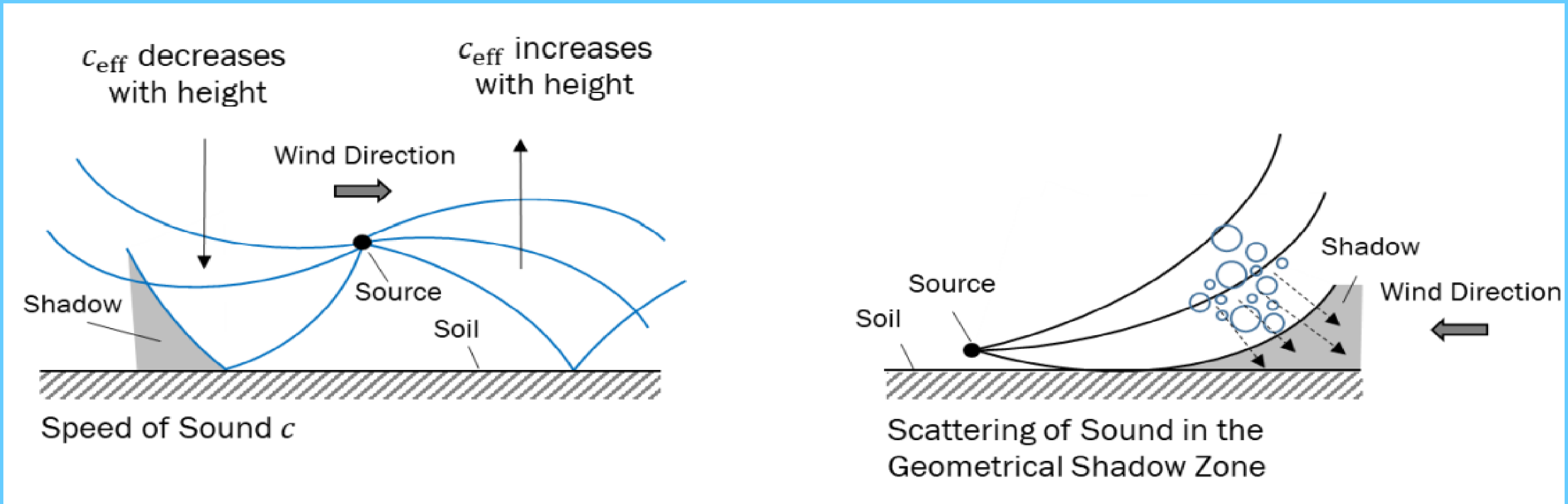


Fig 3: the sound propagation with wind

The wind speed profile:

$$u(z) = \frac{u^*}{k}\left(2 * \ln\left(\frac{z}{z_0}\right) - \Psi_M(\frac{z}{L})\right)$$

The correction value is given by:

The correction value of the temperature profile is given by:

$$\Psi_H = \begin{cases} 2 * \ln\left(\frac{1+x}{2}\right) + \ln\left(\frac{1+x^2}{2}\right) - \arctan(x) + \frac{\pi}{2} & for\ L < 0 \\ -\frac{5z}{L} & for\ L > 0 \end{cases}$$

The temperature profile :

$$\mathrm{T}(z) = T_0 + \frac{T^*}{k}\left(\ln\left(\frac{z}{z_0}\right) - \Psi_H(\frac{z}{L})\right)$$

The correction value of the temperature profile is given by:

$$\Psi_H = \begin{cases} 2 * \ln\left(\frac{1+x}{2}\right) & for\ L < 0 \\ -\frac{5z}{L} & for\ L > 0 \end{cases}$$

Where $x = \left(1 - \frac{16z}{L}\right)^{\frac{1}{4}}$

The sound speed profile :

$$c(z) = c_0 \sqrt{\frac{T(z)}{T_0}} + u(z)$$

The equation of noise propagation effected by all the meteorological data:

$$c(z) = A * \ln\left(1 + \frac{z}{z_0}\right) + Bz + c_0$$

the profile coefficients A and B can determined as
During the daytime (stability classes S_1, S_2 and S_3)

$$B = \frac{u^* \cos(\alpha)}{kL} + \frac{1}{2}\frac{c_0}{T_{ref}}\left(0.74\frac{T^*}{kL} - \frac{g}{c_p}\right)$$

The nighttime: (stability classes S_4, S_5)

$$B = 4.7\frac{u^* \cos(\alpha)}{kL} + \frac{1}{2}\frac{c_0}{T_{ref}}\left(4.7\frac{T^*}{kL} - \frac{g}{c_p}\right)$$

The ceofficient A still the same during the whole day :

$$A = 4.7\frac{u^* \cos(\alpha)}{kL} + \frac{1}{2}\frac{c_0}{T_{ref}}\left(4.7\frac{T^*}{kL}\right)$$

25 stability classes (5 x 5)

A = -1 strong upwind

...

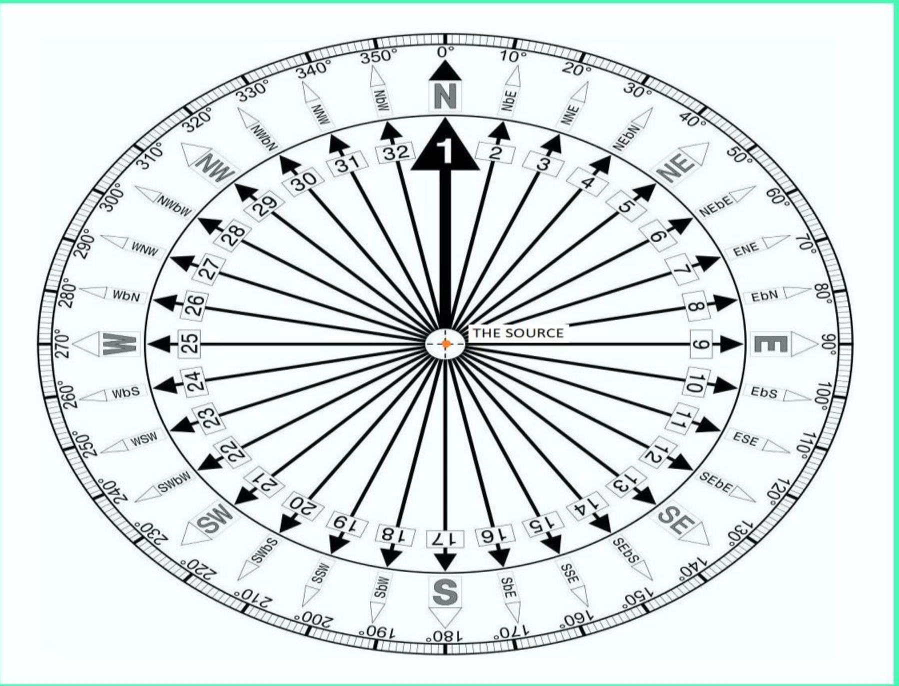
A = 0 crosswind (neutral)

...

A = +1 strong downwind

B = -0.12 ... + 0.12

From unstable to stble situations



No	A (m/s)	B (1/s)	0	10	20	…	330	340	350
1	–1,00	–0,12							
2	–1,00	–0,12							
3	–1,00	–0,12							
4	–1,00	–0,12							
5	–1,00	–0,12							
6	–0,40	–0,04							
7	–0,40	–0,04							
8	–0,40	–0,04							
9	–0,40	–0,04							
10	–0,40	–0,04							
11	0,00	0,00							
12	0,00	0,00							
13	0,00	0,00							
14	0,00	0,00							
15	0,00	0,00							
16	0,40	0,04							
17	0,40	0,04							
18	0,40	0,04							
19	0,40	0,04							
20	0,40	0,04							
21	1,00	0,12							
22	1,00	0,12							
23	1,00	0,12							
24	1,00	0,12							

Contraction of sound speed profile types (25 → 2)

Unstable and near neutral stratification (**good situations**)

$$\frac{\partial c}{\partial z} = A \cdot \frac{1}{z + z_0} + B \ < 0.07 \ \ (\mathrm{m/s})\,/\mathrm{m}$$

Stable stratification/downwind (**bad situations for us**)

$$\frac{\partial c}{\partial z} \geq 0.07 \ \ (\mathrm{m/s})\,/\mathrm{m}$$

where $z = 4$ m heigth, $z_0 = 10$ cm.

The sound level :

$$L_{LT} = 10 * \log\left(p \cdot 10^{\frac{L_F}{10}} + (1 - p) \cdot 10^{\frac{L_H}{10}}\right)$$

L_F: the sound level for near neutral and unstable stratifications (good situations)
L_H: the sound level for homogen stratifications (bad situations)
p: the probability of good situation

Thank you for
your attention