FIS Ski Jumping wind + gate compensation explained

Wind @ Measurement Point 1 Measurement Point 2 Measurement Point 3 Measurement Point 4 Measurement Point 5

- Define positive direction ↑, negative direction ↓

- Calculate forwards projected vectors for all wind measurements, e.g. for measurement point 1:

\[
\alpha \approx \cos(\alpha) = \frac{x_1}{2.5} \quad \alpha = 17^\circ
\]

\[
x_1 \approx 2.39 \text{ (m/s)}
\]

- Do same for measurements 2-5 to obtain \( x_2 - x_5 \). Note that \( x_4 \) will yield a negative value and \( x_5 \) a zero.

- Calculate the total average wind \( a \) using a weighted average from all measurement components \( x_1 - x_5 \), according to:

\[
a = \frac{c_1 x_1 + c_2 x_2 + c_3 x_3 + c_4 x_4 + c_5 x_5}{c_1 + c_2 + c_3 + c_4 + c_5},
\]

where \( c_1 - c_5 \) are “pre-calculated” weight coefficients. Measurements closer to the downhill are of bigger importance and thus have higher \( c \) factors, depending on the hill.

- The total average wind contribution \( a \) is multiplied with a hill-dependent coefficient \( k \), which will give the total factor to add to the jumper’s points.

**Ex. Engelberg 2011.** During the first jump of Anders Bardal, the wind average was \( a = -0.91 \text{ m/s} \). Wind factor for the Engelberg large hill is \( k = 9.09 \) [points per m/s], gate factor \( g = 7.40 \) [points per m]. The gate was lowered by 1 step (0.5 m) for Bardal. Calculate the total compensation.

Bardal will receive

\[-a \cdot k + \frac{1}{2} g = 12\]

points extra to his total points (with FIS’ approximation).
**Pros**

- No round restarts needed, gate can be lowered mid competition
- Parameters can easily be adjusted, straightforward calculation
- More “fair” than no compensation at all

**Cons**

- The model only considers winds in the plane of the jumper’s velocity. Side winds are omitted, although they can affect the jump negatively.
- The point compensation is *directly proportional* to the total average wind $a$. Such a model cannot approximate the penalty well enough for both small and large winds. A large change in wind should yield an even larger point compensation compared to a small change of wind (figure). This requires nonlinear calculation, or at least a more advanced linear relationship.

- Turbulence (change of velocity in wind during a jump) is not considered
- The model does not consider the length of jump (longer jump = longer subject to positive/negative winds)

**Conclusions**

- Model is adequate for “fine weather” competitions with small ($< 1$ m/s) wind variations
- Compensation for a small gate change works adequately
- Competitions where both the gate and wind varies significantly are beyond the scope of this model
- Length of jump should be considered in future models, critical especially in flying hills