

# Wind chill estimate

March 16, 2006

The last paragraph of the subsection on **Wind chill estimate** on page 476-7 should be replaced by the following text:

The main consequence of the above estimate is that the heat loss grows with the square-root of the velocity, thus confirming the observation that a higher velocity has the same effect as a larger temperature excess. Let the actual temperature excess be  $\Theta = T_0 - T$  where  $T_0$  is the exposed surface temperature and  $T$  is the wind temperature, and let the actual wind velocity be  $U$ . Then the heat loss will be the same for a temperature excess  $\Theta^* = T_0 - T^*$  and a wind speed  $U^*$ , provided  $\Theta^* \sqrt{U^*} = \Theta \sqrt{U}$ . Solving for the fictive wind temperature  $T^*$  we find,

$$T^* = T_0 - (T_0 - T) \sqrt{\frac{U}{U^*}} . \quad (30.36)$$

This is the essential part of the first *wind chill formula* by Siple and Passel (1945), who — after measuring cooling rates of water in plastic containers — arrived at the following slightly modified empirical expression for the fictive temperature,

$$T^* = T_0 - (T_0 - T) \left( \sqrt{\frac{U}{U^*}} + 0.47 - 0.22 \frac{U}{U^*} \right) . \quad (30.37)$$

The parameters were chosen to be  $T_0 \approx 33^\circ\text{C}$  and  $U^* \approx 5 \text{ m/s}$ <sup>1</sup>. When the value of the expression in the parenthesis equals unity, we have  $T^* = T$  so that there is no wind chill effect. This happens for  $U = 0.37U^* \approx 1.85 \text{ m/s}$ , roughly the speed of a walking human, which is quite reasonable. The formula makes no sense for lower speeds, because the fictive temperature then will be higher than the wind temperature.

**Example 30.0.1:** At  $0^\circ\text{C}$  a wind speed of  $U = 10 \text{ m/s}$  corresponds to a fictive wind temperature of  $T^* \approx -14^\circ\text{C}$  according to (30.37). The modern formula yields instead  $T^* \approx -7^\circ\text{C}$ .

Paul Allen Siple (1908-68). *American Antarctic explorer. Accompanied (as an Eagle Scout) the first Byrd expedition to Antarctica in 1928-30. Participated in Byrd's second expedition 1933-35 as a chief biologist. Coined the term "wind chill" in 1939.*

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<sup>1</sup>The Siple-Passel formula was used by the *US National Weather Service* from 1973 but became in 2001 replaced by a somewhat more conservative expression based on modern theory and experiments. See <http://www.nws.noaa.gov/om/windchill> .