A new formula for expressing the combined effect of wind and low temperature on the cooling of exposed skin was introduced in North America in November 2001. This formula is largely based on established engineering correlations of wind speed and convective heat transfer. The formulation it replaced was based on the results of an impromptu experiment that Paul Siple and Charles Passel carried out during the United States Antarctic Expedition, 1939-41. Although the resources available on the expedition limited the sophistication of their experiment, it became the best-known result of a century of Antarctic research. Siple and Passel (1945) simply measured the time it took to freeze water in a small plastic bottle suspended from a post on the roof of the expedition building. From these observations, they derived the Wind Chill Index (WCI), a three- or four-digit number representing the rate of heat loss of the cylinder per unit surface area.

The 2001 calculation is for a person moving through the air at walking speed. For the reference still-air condition, the calculation assumes a minimum air speed of 1.34 m s\(^{-1}\), which is the average walking speed of American pedestrians, young and old, crossing intersections in studies of traffic light timing (Knoblauch et al. 1995). When there is wind, it is assumed that the adult is walking into the wind (worst case) and so the walking speed is added to the wind speed at face level when calculating the WCT.

Finally, the wind speed at face level was assumed to be two-thirds of that measured at the 10-m height of the weather stations. This was based on an analysis by Steadman (1971) and refers to the ratio of wind speeds in an open field. The ratio in an urban area could be considerably smaller. This ratio must depend on the stability of the lower atmosphere, being smaller at night and early morning than in the afternoon; however, no correction for time of day was included in the model. Ideally, wind speeds for public consumption would be measured at the lower height (1.5m).
CONCLUSION. Wind chill is not a neat and simple package. A person's exposure to wind is determined by their surroundings and their activity relative to the wind direction. Time of day affects the lapse rate and the ratio of the wind at 10 m to the wind at face level, and physiology affects how they react to it. Because one's experience of the equivalent temperature depends on facial skin temperature, which varies from person to person because cheek thermal resistances vary widely, WCT is not an ideal way to express the combined effect of wind and low temperature. Ideally, an index of wind chill should be invariant with respect to individual differences or stated so that it can be individually calibrated with experience, as was the original three- or four-digit Wind Chill Index that Siple and Passel (1945) created. However, the public seems to have a strong preference for the equivalent temperature format (Maarouf and Bitzos 2000), a deceptive simplification that only seems to be easier to understand.

Wind chill is an evolving concept. Wind chill equivalent temperature charts might someday include solar heating effects; improved prediction of time to frostbite and more sophisticated time-dependent models of skin cooling in wind. The short-term effects of wind chill are of interest, as many people in the modern world are not exposed to the wind for long enough to reach a steady-state skin temperature. Consideration might also be given to modifying the assumed value of internal thermal resistance to tailor the chart more directly to the average person. An up-ward adjustment of the steady-state core temperature and minimum wind speed could result in a chart that applies more directly to people engaged in tasks that have moderately high rates of energy expenditure, such as recreational cross-country skiers or runners. Another niche calculation might be a marine wind chill chart, incorporating the cooling effects of fog or spray. It seems unlikely that another half century will go by before wind chill is again upgraded.