Equipment for Activities at Outside Temperatures of -50°C

I. Clothing

This text describes the basics of "how to" protect the body at extreme cold temperatures during physical work based on experience of three months cycling in Greenland during winter time (http://www.mountainbike-expedition-team.de/Greenland/greenland.html) and during a three weeks stay in central Siberia servicing a field climate station (http://www.mountainibike-expedition-team.d/siberia/sib.html). There is a vast difference between clothing during rest or during hard physical activities. If one understands the principles of clothing at cold outside temperatures, one can understand how it is possible to live in cold climates even without the usual "high technology" equipment. Even people living in Siberia, North Canada, or Greenland apply the same principles of clothing only using different materials, and avoiding physical activities during extreme coldness.

The first layer: underwear

Water in its liquid form at outside temperatures of –25°C can be a severe problem for the skin, and from –35°C on it will be dangerous. At temperatures below –50°C contact with fluids most of the time is lethal for the skin tissue. The most important rule therefore is to stay dry. Even without physical activity the body sweats about 0.05 to 0.08 liters of water per hour. In high altitude and in extreme coldness it may even be more (so drink a lot!!). This water vapor should disappear from the skin immediately, since water molecules in water vapor can transport energy across hydrogen bonds, thus leading to cold temperature accessing the inner layers.

Underwear therefore is an important layer to help to keep the skin dry. There are a number of manufacturers of different quality (and price) for aiming for different purposes. There is **polartec material** (e.g. *The North Face, Jack Wolfskin*) and even better is underwear of **pure polypropylen** (e.g. *Helley Hansen*), and for extreme coldness underwear is available of Polypropylen with a layer of wool woven onto it (e.g. *Craft of Sweden*) which is suitable to keep the body warm and dry.

The second layer: fleece

As a second layer Fleece is most suitable to keep the warm body temperature inside. A **fleece 300** Jacket and pants (e.g. *The North Face*) or **R3-jacket** (e.g. *Patagonia*). The pants should be dungarees for better protection of the kidneys and should be of fleece 300.

A warm reserve layer: wool and down

As an additional layer (if it is colder than expected, one is not adapted, or not working physically) a sweater of thick **sheep wool** very well suitable. Also a **down jacket** is a suitable protection. Down jackets have the advantage of a very small packing volume. However, down materials have a "disadvantage" at extreme coldness: they should never come in contact with moisture.

Someone sweating and now changing to a resting activity will need about 20 minutes to be dry with the above combination of clothing layers. However, during this time one will be cold already. With a wool sweater it is no problem to directly wear it, thereby of course prolonging the time until the skin is dry again. With down jackets one needs to be more careful considering condensation of water vapor in the downs: I recommend to not wear the down jacket as long as one can stand allowing the body to dry. If one is physically working while wearing the down jacket, there will be water vapor crystallizing in the downs and freezing there. If the jacket is then packed back to its small volume, the structure is destroyed and the jacket will be less

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"fluffy" next time. Therefore avoid compressing down jackets directly after having worn them over a sweating body. Also NEVER take the down jacket inside a warm room. This will lead to melting of the ice crystals in the downs and wet down has no insulation. Only take down jackets inside if you are sure that it has time to dry completely. If there is no hut and oven available one should take care to buy down jackets with dark colors: even the weak polar sun may be able to sublime the ice crystals in the downs during the day.

Sensitive body parts: hands and feet

Hands and feet are the body parts with the highest sweating activity, and they are farthest from the hart. The true art of survival in polar regions is to find the right material to keep hands and feet warm and dry without reducing the agility too much.

Feet: Socks also have to function according to the multilayer principle. The fist layer of socks should be thin **polypropylen socks** or silk socks. A second layer can be of fleece socks or sheep **wool socks** to keep the foot dry. The best wool socks are made of dog wool!

Good boots for temperatures below –40°C are available from the manufacturers *Sorel* and *Kamik* (Canada). The inside part is made from filt with an aluminum insulation layer. These inner boots can be dried over night next to an oven or inside the sleeping bag.

Hands: Fingers are first affected by cold temperatures: they become stiff and start hurting. This severely inhibits the possibility of fine movements and the use of tools (e.g. did you ever try to start a cooking stove with cold and stiff fingers...). One should always carry a pair of **mittens** (two sizes larger), they have the best warming effects. However, it is not possible to work with them. Wearing gloves, every single finger is exposed to the cold. Therefore a compromise is to wear a layer of very thin **silk gloves** directly on the skin. Although they wear off very quickly, they keep the fingers dry and allow a minimum of protection of fine movements are necessary (e.g. changing the film of a camera, etc.). On top of the silk gloves one should wear **fleece gloves** with a windbloc layer (one size larger) or thick **wool gloves**. It is important that gloves have long sleeves.

One can also use polar gloves consisting of an inner fleece glove in combination with a neoprene outer shell. These gloves allow to do rough work (starting a generator, carry stuff, hold skiing poles, chop wood, etc.) while fully protected. There are also polar gloves with a Gore Tex outer shell available. They have a weaker insulating function compared to neoprene gloves since neoprene is impermeable to water vapor. With neoprene the inner glove needs do be dried over night due to the water vapor accumulating under the impermeable neoprene layer.

Red cheeks and cold nose: keep your head warm

The first layer on the head should be a thin skull cap with neck protection. They are available of thin polypropylen or of thicker fleece. A combination of both already gives very good protection. One can further protect the head with a cap (wool or fleece) or a headband. The neck part can be wrapped with a scarf of wool or fleece. At temperatures below –25°C it becomes increasingly important to protect the lung from cold air. Therefore a face mask is recommended.

The chill-factor: outside in the wind

GoreTex jackets and pants are wind tight. However, one has to consider what to wear beneath. If you are moving a lot and sweating, it may be sufficient to only wear the underwear and one or two layers of fleece. Then, wind has to be very strong to cool you down. Wearing GoreTex jackets and pants does keeps the wind out, but keeps more of the water vapor in. At temperatures below -20°C the water vapor leaving the inner layer will freeze at the inside of the GoreTex clothes thereby reducing the permeability to water vapor. When taking off the jacket/pants in the evening on only needs to turn them inside-out and brush off the crystallized water vapor. The jacket should have a hood to protect the head against strong winds.

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Special issue: eyes

Eyes need to be especially protected at high wind speeds. Then **skiing glasses** with double layered screens are very useful (e.g. *Bollé*). Most manufacturers offer versions also for people wearing normal glasses. If there is no wind, glasses are not necessary, even at temperatures below –40°C (personal experience), but this may differ individually.

If you are regularly wearing glasses, you should consider using a plastic frame, since metal glasses may freeze to the skin. Even at –50°C the moisture produced by the skin and during breathing is enough to freeze cold metal to the skin causing frost bites at the nose. Metal glasses have another disadvantage: due to the changes in temperature the size of the frame may slightly change leading to the glasses to fall out! However, also a plastic frame can cause problems: it may break easily when outside temperatures are below –40°C. Wrapping glasses with fleece can be an option to reduce the stress on the skin, however it has to be done in a perfect way, since you won't have the possibility to fine adjust it with bulky gloves.

The only problem with glasses in general is that they will fog rather fast with the water vapor from breathing. There are alcohol solutions available to avoid condensation, but it remains tricky. Wearing a face mask reduces the fogging of glasses.

Questions?

Please contact me at the e-mail address (andy_h@mountainbike-expedition-team.de) for further questions and hints. The issue of correct clothing at extreme temperatures is very difficult and yet so important. There are not too many people around sharing their knowledge about arctic experiences in such a way, and most of the sales persons in outdoor stores don't know much about this particular extreme case.

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