

Staying Warm in Winter

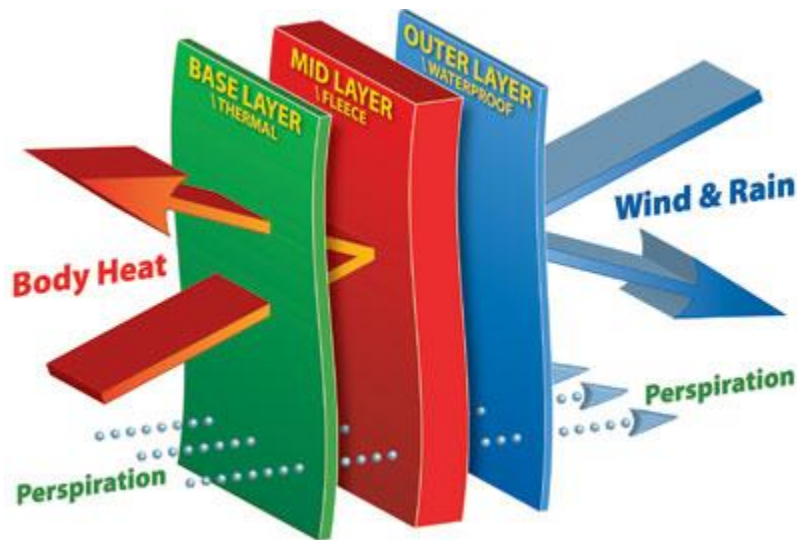
By Dexter Robinson

Part 1 – Introduction and Base Layer

Doing outdoor winter activities is not about being cold; it is about being warm in a cold place.

This article will explore how to stay warm in winter to enjoy outdoor activities. It will focus on layering with clothing that is currently available.

THE KEY TO BEING WARM IN WINTER IS TO STAY DRY. The basic strategy for dressing for the outdoors in winter hasn't changed much in the last few decades. **IT IS ALL ABOUT LAYERING.**



You should wear multiple layers rather than one thick bulky layer so that when you get warm, you can slowly begin to adjust or remove layers. If you wear a bulky jacket or parka for all your insulation and then start sweating into it, you will be completely exposed when you take it off. It is better to wear a couple of insulating layers and a shell on the outside to regulate your body temperature and avoid sweating. What clothing we select and how we manage our layers have the common goal of keeping us as dry as possible.

WISE layering system

The Wilderness Education Association invented an acronym for this layering system called WISE. It stands for wicking, insulation, sheltering, and extremities/extra.

Part 1 will focus on the base layer which needs to move moisture away from the skin. A wicking layer of wool, polyester, silk, nylon, spandex, or other synthetics should draw

sweat into the fabric moving water through fibers away from skin. It should be quick drying, odor resistant, and handle extremes of physical activity. Your base layer should be in close contact with your body and fit snugly and comfortably. In addition to wicking away moisture the base layer helps to protect your skin from extreme cold by reducing the speed at which you lose body heat.

For your upper body you want to wear a thin long sleeve shirt - the thinner the better. For your lower body you want a layer similar to your upper body, that is, thin long underwear similar in thickness to the upper body.

On one of my first summer hiking trips in the Whites I planned to meet the rest of a group at a trail junction on the Carter Ridge. The air was moist with clouds blowing thru and I perspired as I climbed to the ridge. While waiting to meet the others I started to get cold and shiver so I added a sweater layer but I was still cold. I then walked fast up and down the trail to generate heat but I was still shivering. Adding a rain jacket also had no effect. Finally I changed my base layer T-shirt. Once I did that it was like flipping a switch. I immediately warmed up so much that I had to remove a layer. Keeping the base layer dry is critical for staying warm no matter what time of year. The other layers may do little to warm you once the base layer becomes wet. Fabric choices and layer management are also important in keeping you dry and warm.

Base layer fabrics

There are two categories of base layer clothing: synthetics and natural fabrics. The most common base layer fabrics for winter outdoor sports are polyester, merino wool, nylon, and silk.

Below are their basic characteristics. Note that these characteristics depend greatly on the thickness and porosity of the fabric. Cotton is included for comparison.

Characteristic/Fabric	Polyester	Merino Wool	Nylon	Silk	Cotton
Fabric type	Synthetic	Natural	Synthetic	Natural	Natural
Breathability	Decent	Excellent	Poor	Decent	Excellent
Water absorption performance	Excellent (Absorbs up to 0.4% of its own weight in water)	Decent (Absorbs up to 33% of its own weight in water)	Excellent (Absorbs more than Polyester but less than Merino wool)	Decent (Absorbs up to 30% of its own weight in water)	Poor (Absorbs up to 2500% of its own weight in water)
Durability	Good	Decent	Excellent	Excellent	Good
Moisture-wicking performance	Excellent	Good	Excellent	Good	Poor
Drying time	Excellent	Decent	Excellent	Excellent	Poor
Weight	Excellent	Decent	Excellent	Excellent	Decent
Feels	Synthetic	Soft, non itchy	Synthetic	Soft non itchy	Soft, non itchy
Warmth when wet	Poor	Excellent	Poor	Good	Poor
Odor-resistance	Poor	Excellent	Poor	Good	Decent
Non-allergenic	No	Yes	No	Hypoallergenic	Hypoallergenic
Price	Excellent	Decent	Excellent	Poor	Excellent

(from besthiking.net)

The chart illustrates why cotton is a poor choice for outdoor winter activities. If you wear a cotton base layer it will likely get wet from perspiration, melting snow, or a cold rain, resulting in a significant loss of heat. According to the US Search & Rescue Task force “Water conducts heat away from the body 25 times faster than air because it has greater density.” Having wet clothing in winter can be dangerous. It often leads to hypothermia.

“Wetness is the enemy of warmth. People caught in bad weather with wet clothes might as well be naked” *Dr. Murray Hamlet, retired director of the Cold Research Division for the US Army Research Institute of Environmental Medicine, Natick MA*

Some current examples of synthetic base layers include:

Helly Hansen Lifa Stripe Crew, material: 100% polypropylene
 Arc'teryx Rho LT Zip-Neck, materials: 84% polyester, 16% elastane

REI Co-op Lightweight Base Layer Half-Zip Top, materials: 92% polyester, 8% spandex
Patagonia Capilene Cool Lightweight, materials: 37% polyester, 63% recycled polyester

And some natural fabric base layers:

Smartwool Merino 150 Crew, materials: 87% merino wool, 13% nylon
Black Diamond Solution 150 Merino Crew, materials: 78% merino, 22% polyester
REI Merino Midweight Half-Zip, material: 100% merino wool
Icebreaker Oasis Crewe, material: 100% merino wool

For more base layers and a comparison chart of some current base layers check out:
[Current Best Baselayers](#)

Also check: [Is Merino Wool Better than Synthetic](#)

Part 2 – The Middle or Insulating Layer

This part continues exploring the layering system by discussing the Insulating or middle layer.

- Traps warmth, loose fit, breathable
- Fabric choices
- Must stay dry
- May have more than one
- Ventilation options
- Ease of adding or removing

Insulating layers vary widely. Their role is to trap and retain warmth against the body, creating a comfortable airspace between the wicking layer and the exterior shell. The more air space, or loft, the warmer you are, just like the down comforter on your bed. Unlike the base layer it should fit LOOSE to help create air space. It should also be breathable so as to transfer any moisture from the base layer.

For thousands of years wool has been an insulating layer since one could stay warm when it got wet. When serious mountaineering began in the 18th century wool was typically used for heavy coats, hats, and socks. The use of wool for mountaineering continued right into the 20th century with tweed jackets. But the downside of wool was that it could be bulky, itchy, and took a long time to dry.



Mountaineer George Mallory (on the right) disappeared 800 feet from Everest's summit in 1924. His body was discovered in 1999 and revealed clothing made of gabardine, wool, cotton, and silk. A recent project replicated Mallory's clothing and tested the outfit on Everest. Researchers found the gear "highly effective at providing protection at high altitude... excellent at trapping air next to the skin..." and "...lighter than modern gear." Most telling was that, while it was being tested, "all the other climbers thought the (replica) jacket was stylish and wanted to know where they could buy their own versions of the clothes!" (from the "Evolution of Mountaineering Gear" by Pete Takeda, [The Filson Journal](#))

As technology advanced in the 20th century, people began to search for new fabric options. The goal was to improve on the limitations of the natural fabrics like wool, silk, cotton, and linen. There was a migration to synthetic fabrics such as nylon, polyester, acrylic, and rayon.

Nylon, the first fully synthetic fiber, was developed in the 1930's at DuPont by American researcher Wallace Carothers. It had a sensational debut as a replacement fabric for women's silk stockings. Nylon is usually found paired with other fabrics that are natural or semi-synthetic.

In 1941 a group of British scientists applied Carothers' work with synthetic fibers to create the first commercial polyester fiber it called Terylene marketed in the U.S. as Dacron.

Your choice of insulation should depend on the exertion range of your winter activities as well as how your body reacts to cold temperatures, changing weather, and activity location.

Common Insulation Types

- **Wool** is a traditional mid layer material with good insulation even when damp. It absorbs and transfers moisture but does not feel wet even when it holds significant moisture. A wool shirt or light weight wool jacket can be significantly less expensive than other choices. The downside of wool is that it takes a longer

to dry compared to other choices. A merino wool blend is another option. A traditional wool example is the L.L. Bean Maine Guide Zip-Front Jac-Shirt.

- **Fleece** became available in 1979 thanks to Malden Mills and Patagonia. It was a new, light, strong pile fabric meant to mimic, and in some ways surpass, wool. Polyester fleece serves the same purpose by maintaining its insulating properties when damp, with the added advantages of being lighter and drying quicker than wool. It comes in multiple weights: 100, 200, and 300. Examples are the Columbia Fast Trek™ II Full Zip Fleece and the Patagonia R1 Fleece 1/2-Zip Pullover.
- **Down** has several variations. Natural down utilizes plumules from ducks and geese to provide the most warmth for the least weight and bulk provided it doesn't get wet. Down jackets are ultra light, ultra warm and ultra packable. Down is rated on fill power ranging from about 450 to 900. Fill power is the volume in cubic inches that one ounce of the down fills up. Higher quality down has a higher fill number indicating a warmer down. The downside of down is its cost and the special care required to clean it. An example is the Marmot Hype Down Jacket.
- **Water-Resistant Down** treated with a polymer helps down handle dampness. Like down, it is ultra light, ultra warm and ultra packable. Unfortunately it is costly and its wet performance lags behind synthetics. An example is the Rab Microlight Alpine Down Jacket.
- **Down/Synthetic Insulation** combines the performance benefits of two types of insulation. Some designs blend the down and synthetic fills together and use that blend throughout the jacket while others put down in certain areas, like the core, and the synthetics in other areas, like the arms or sides. Another benefit of this jacket is that it costs less than a down jacket. An example is the Arc'teryx Thorium AR Down Hoodie.
- **Synthetic Fiberfill** such as polyester fiber is used similarly to down, but does not have as good warmth:weight ratio. However, it is less expensive, provides better insulation when wet, dries quickly, and absorbs very little moisture. There are brands of very fine fiberfill like Thinsulate, PrimaLoft, or Thermolite that provide higher warmth for a given thickness. An example is the REI Co-op Revelcloud Insulated Hoodie
- **Wool/Synthetic Insulation** combines wool with a synthetic material to create sheets of insulating fill. Jackets that use this blend benefit from wool's ability to insulate when damp and its resistance to odor. An example is the Icebreaker Tropos Insulated Jacket.

The same layering rules apply with insulating layers – with the exception of wool or fleece they must stay dry in order to be effective. Multiple thin layers rather than one thick layer work better for breathability and layer management. For example you can put a fleece vest over a thin wool sweater that sits on the base layer. Consider a hoody which significantly increases warmth while adding little in weight or bulk.

When evaluating layers consider how well it can ventilate. A thin jacket style layer with a full or quarter zip will provide more ventilation options than a pull over sweater. Also consider how easy and quick you can change the layer. This becomes important in a group led activity when stops tend to be short to avoid cooling down. .

Down is generally put on when standing around for a period of time. . For high exertion activities like mountain climbing most people find down too hot to wear. Since everyone’s metabolism is different you need to experiment with different insulating layer combinations to find what works best for you.

Some links for further reading:

[Winter Hiking Insulating Layers](#)

[What is Merino Wool](#)

[Synthetic vs. Natural Fabrics in Clothing](#)

Part 3 – Sheltering or Outer Layer

This part continues exploring the WISE layering system by discussing the **S**heltering or outer layer.



- Protection from the elements, handles sweat
- Soft and hard shell jackets
- Hard shell jacket features
- Soft and hard shell pants
- GORE-TEX® jackets
- Alternatives to GORE-TEX

Just as it sounds, this outer layer protects you from the wind and various forms of precipitation like rain and snow. Sheltering clothes must not only offer protection from the elements they must also handle sweat produced by our bodies. The sheltering layer should cover the entire body usually with a hooded jacket for the upper half and pants for the lower half.

Sheltering layers can vary widely from a simple wind-resistant nylon jacket to a multi-layer mountaineering shell parka. In general, sheltering layers fall into two categories: soft shell and hard shell. Soft shell jackets feature a good range of motion, breathability, and are wind and water resistant. They are made of woven nylon or polyester and are intended for highly aerobic activities with more emphasis on breathability than protection from the elements. They fall in the middle ground between jackets that offer light insulation and waterproof hard shells. This makes soft shell jackets usable year round. An example of a soft shell jacket is the Outdoor Research Ferrosi hooded jacket.

However, soft shell jackets are not suitable for continuous rain and snow conditions. In that case you need a hooded hard shell jacket that is lightweight, breathable, and waterproof for all-weather use. Typically a hard shell jacket is made of nylon with either a polyurethane coating, a GORE-TEX membrane, or a GORE-TEX alternative. Similar to other layers, cotton should be avoided since it absorbs and retains moisture.

Here is a list of features to look for in a hard shell jacket:

- Ventilation
- Adjustable hood
- Hip-belt compatible pockets
- Zippered pockets
- Two-way front zipper
- Adjustable wrist closures
- Draw cord hem closure
- Large enough to layer underneath

Ventilation features such as side zippers or pit zips to vent off perspiration are important. Pit zips are zippers near the arm pits. I recommend having pit zips on your

hard shell although they are becoming less common as manufacturers focus more on increasing breathability.

If it has front pockets make sure they are high enough up on your body so as to not interfere with the backpack hip belt.

Not all hard shells have pockets. It's great to have some zippered pockets not just on the outside but at least one on the inside for things like your phone and food you don't want to freeze. Outer pockets are good for things like snacks, hats, and extra gloves. The more things that are accessible the less you will have to take off your pack to retrieve them. Unfortunately it has gotten more difficult to find a hard shell jacket that has all of these features, even ones that retail at over \$600.

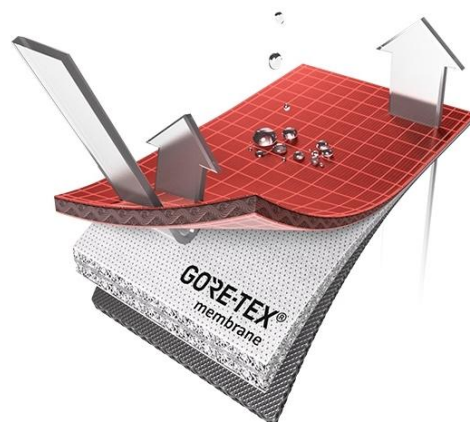
The choice of a sheltering layer will depend on your outdoor activity, location, terrain, and weather. Waterproof non-breathable shell jackets, e.g. coated nylon, are best suited for light or no physical activity otherwise you will likely perspire and saturate the other layers.

For pants the simplest sheltering option is wind and waterproof nylon over a base layer relying on the airspace between the two for additional insulation. Other options for pants include soft shell pants, hard shell or snow pants, wool pants, and even nylon or nylon blend 3-season hiking pants. Depending on the weather and temperature you may want to wear a long underwear base layer under your choice of pants.

For better control of your body temperature you should avoid putting on a sheltering layer until conditions warrant it.

GORE-TEX®

In 1969 William and Bob Gore discovered a way of producing a fabric that was impervious to precipitation but not perspiration. The GORE-TEX® membrane has about 9 billion pores per square inch. Each pore is approximately $\frac{1}{20,000}$ the size of a water droplet, making it impenetrable to liquid water while still allowing the more volatile water vapor molecules from perspiration to pass through.



The outer layer of GORE-TEX fabric is coated on the outside with a Durable Water Repellent (DWR) treatment. The DWR prevents the main outer layer from becoming wet, which would reduce the breathability of the whole fabric. However, the DWR is not responsible for the jacket being waterproof. Without the DWR the outer layer would become soaked preventing breathability. The wearer's sweat being produced on the inside would fail to evaporate, leading to dampness. This might give the false impression that the fabric is leaking. Wear and cleaning will reduce the performance of the GORE-TEX fabric by wearing away this DWR treatment but the DWR can be restored.

A simple raincoat introduced in the early 1970's set off an outerwear revolution with a jacket that was lightweight, waterproof and breathable for all-weather use.

GORE-TEX has become the standard by which all other similar fabrics are compared.

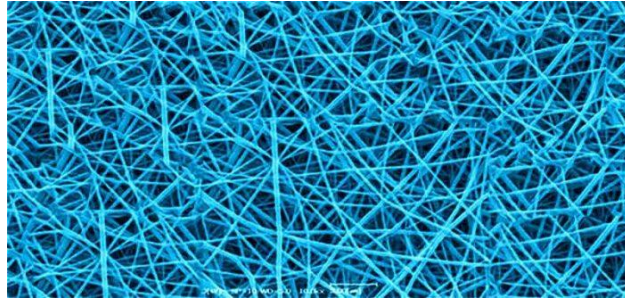
GORE-TEX today has multiple types:

1. GORE-TEX – a basic 2-layer version with durability designed for use in cities, trails, and workplaces. There is also a 3-layer version for more durability. Examples are the Patagonia Departeur Jacket with 2 layers and the Mountain Hardwear Boundary Ridge Jacket in 3 layers.
2. GORE-TEX with PACLITE – a lighter minimalist fabric, less durable, one layer with the GORE-TEX membrane bonded directly to the outer shell, no lining. An example is the REI Co-op XeroDry GTX Jacket.
3. GORE-TEX with PACLITE PLUS - basically the PACLITE version (2.) but double the layer. An example is the Mountain Hardwear Exposure/2™ GORE-TEX® Paclite® Plus Jacket.
4. GORE-TEX ACTIVE – minimalistic design, lightweight GORE-TEX membrane with fine denier performance textiles and the light c-knit backer material. A lighter version of (1.). An example is the REI Co-op Drypoint GTX Jacket.
5. GORE-TEX ACTIVE SHAKEDRY - removes the outer surface from Active Garments (4.) to make the waterproof GORE-TEX membrane the other layer. It has one less layer of durability. The membrane is the outer layer allowing one to shake off the water. It packs down small. An example is the Sitka Vapor SD Jacket.
6. GORE-TEX PRO – most rugged for extreme conditions - very dry, 3-layer construction, with a multi-layer membrane. An example is the Arc'teryx Alpha SV Jacket.

Currently GORE-TEX dominates the outerwear market. On one website (see link below) 14 of the 18 recommended hard shell jackets for 2020-2021 use GORE-TEX.

Since GORE-TEX came on the market a number of alternatives have been introduced. These include:

1. Ascentshell™: Outdoor Research's exclusive proprietary three-layer fabric, electrically spun waterproof breathable membrane that is soft to the touch. It consists of polymers that form a web that allows sweat vapors to escape but prevents water from coming in.



An example that uses this fabric is their Interstellar jacket.

2. Pertex Shield™: waterproof, windproof, breathable, lightweight and extremely packable. It comes in three laminate variants: 2, 2.5 and 3 layer which vary in durability and resistance to the elements. An example using this fabric is Outdoor Research's Helium II rain jacket.
3. eVent®: waterproof and breathable but unlike GORE-TEX eVent is a "dry system" which makes it possible for moisture to get out in an instant, without it requiring excessive body heat or outside moisture. Unfortunately, in recent years, few if any, outdoor clothing manufacturers are using eVent fabric for hard shell jackets. However, Sea to Summit does use this fabric for one model of their winter gaiters.

When shopping for a shell, be sure to wear clothes similar to your base and middle layers so you can get the appropriate size. You may have to buy a size larger to accommodate the layers underneath.

Part 4 – Extremities and Extra Items, Managing Layers

This part of the WISE layering system explores keeping the **Extremities** warm and what **Extra** items to carry. It concludes with how to manage all the layers so as to stay warm and not perspire.

- Socks, boots, and gaiters
- Hand Protection
- Hats
- Face and neck protection
- Eye protection
- Extra
- Regulating your body temperature

Socks, boots, and gaiters

Your feet are absolutely critical for enjoying outdoor winter activities. Some people wear liner socks under their winter socks to wick away moisture and prevent blisters. Winter socks are generally thicker than summer socks and like summer socks they should breathe. The preferred choice of socks these days are made of merino wool. Merino wool is breathable and adapts well to changing weather conditions, which keeps your feet more comfortable in winter as well as summer. Merino wool has evolved over time to be super lightweight, non-clammy, and has an incredible ability to resist odor. Top rated socks for winter activities include:

- Smartwool Medium Hiking Crew
- SealSkinz Trekking Thick Mid
- Falke TK2
- Darn Tough Hiker Boot Full-Cushion
- Icebreaker Hike Heavy Crew

Over the socks go your winter boots. Three season hiking boots are just not warm enough given the length of time one might be in contact with the cold air, ice and snow. You need boots with more insulation and waterproofing. The latest generation of winter hiking boots are lightweight, waterproof, and compatible with various traction devices. Some manufacturers publish the temperature range for their boots but these numbers can be misleading since it depends on the individual. A more useful unit of measure for warmth is the grams of insulation. For winter hiking in a variety of conditions and locations 400 grams of insulation is recommended.

An important item, actually a requirement, for your boots are winter gaiters. In addition to keeping your feet warm they prevent snow from entering your boots. Top rated gaiters for winter use include:

- Outdoor Research Crocodile
- Outdoor Research Verglas
- Black Diamond Apex GTX
- Rab Latok Alpine
- Sea to Summit Alpine eVent

Hand protection

When it comes to the hands, there are many options. Modern gloves and mittens should follow the same basic principles as the rest of outerwear - employing some form of layering, with a lighter layer next to the skin, an insulation layer, and a shell that protects your hands from the elements on the outside. Mittens are warmer than gloves but gloves allow maximum dexterity, simplifying tasks like retrieving your snacks.

A popular combination is a pair of thin liner gloves of merino wool under a heavier and waterproof glove or mitten.



Fox River Double Ragg Mittens Smartwool Liner Gloves Marmot Expedition Mittens

In extremely cold conditions expedition mittens like [Outdoor Research's Alti Mitts](#) offer additional protection. They feature a shell mitten over a removable insulating mitten. A liner glove can be added to make a 3 layer system.

Having strings attached to mittens makes it easy to remove the mittens without the risk of them blowing away or falling into the snow.

Hats

Hats provide another layer of warmth under the hood of your shell. Winter hats come in all types and thicknesses.

I generally carry at least two different hats – one thin and one thick. Both are fleece. On some NH White Mountain trips I bring an additional heavy fleece Peruvian style hat which covers my ears.

Face and neck protection

Further protection for your head can be accomplished with a balaclava, buff, or neck gaiter. All of these items come in varying thicknesses. Balaclavas vary in style with some covering part of your face and neck. A buff is simply a longer version of a neck gaiter. Buffs offer great versatility. All three insulate your neck which has major arteries close to the skin thus preventing a significant loss of heat from this area.



Blackstrap balaclava



Multifunctional buff

Eye protection

On a cloudless day in treeless snow covered areas it can be extremely bright. Leaving your sunglasses at home or in your car can lead to snow blindness or sunburn of the eyes. For windy above tree-line or exposed summits ski goggles may be required.

Extra

The “E” in the WISE acronym also stands for Extra. It is a good idea to bring along a change of socks, gloves, hats, and additional layers you can add if you find yourself getting too cold. At a minimum I always carry an extra base layer shirt just in case this layer gets damp. Also, I pack a highly compressible hooded down jacket for very cold summits, emergencies or standing around for a long time.

Regulating your body temperature

While it is helpful to know about all the clothing available for layering it doesn't address the important topic of how to regulate your body temperature to avoid perspiring.

The goal of staying warm by avoiding perspiring is achieved by adjusting your layers so as to always feel just **SLIGHTLY ON THE COOL SIDE**. But mentally this is contrary to what we usually do by piling on layers when we feel the slightest bit cold.

That's fine if you are not generating heat but for hiking and other high exertion activities you want to be proactive in changing your layers so you won't overheat. It is a balancing act between heat production and heat loss.

Often people will begin an outdoor activity with too many layers and then stop to remove layers when they find themselves perspiring. It works better to start out feeling a bit cold then adding layers, if needed, as your body adjusts to the environment and your level of heat production.

Everyone's metabolism is different so each of us may have different layers on and need to change them at different times. Consequently, if you are hiking with a group there may be frequent stops to adjust layers.

Similar to adding/removing upper body layers, adding/removing hats and face protection provides another excellent way to adjust your body temperature.

You also adjust layers based on the environment. If you are climbing a mountain the temperature drops about 3.5 degrees per 1000 feet. Changes in the current weather and wind can also affect the environment. It is best to adjust layers BEFORE an obvious change to heat production or loss happens, e.g. approaching a hill or reaching tree-line.

Under certain conditions wearing all 3 layers (base, insulating, and sheltering) may not be necessary. Wind, temperature and the level of exertion may be such that you might only need to wear your base layer or just your base and sheltering layers.

To summarize, the key to staying warm in winter is to stay dry by using a WISE layering system of carefully selected thin clothing that is proactively managed.

Some links for further reading:

[What to Wear and How to Layer It](#)

[Layering Hacks for Cold Weather and Winter Hiking](#)

[Socks for winter activities](#)

[Gaiters for winter activities](#)