
Topographic maps, devices, and smartphone apps – a comparison

Peter Jordan

These days, fewer people are using paper maps on hiking and ski trips, and more people are using smartphone mapping apps. This winter, a group of us got together to compare several different apps, and also looked at how they compare to GPSs and old-fashioned maps.

Paper maps (and their equivalent as printable PDF files)

There are several options for paper topographic maps. The most familiar maps for most people are the 1:50,000 federal government topographic maps, which have been around since the 1950s. In the Kootenays, most of these maps were last updated in the 1980s. Usually they have a contour interval of 100 ft, and they have a 1 km grid (the “UTM” or Universal Transverse Mercator grid). Some newer maps have 40 m contours, but these were interpolated from the old 100 ft contours, so there is a slight loss of precision.

For decades, these maps were the most useful ones for outdoor use. They were printed on high-quality paper which was somewhat waterproof and stood up well to heavy use. Recently the printing and distribution of the maps has been outsourced, and the paper quality is somewhat variable. So if you can get your hands on old maps, they’re worth keeping.

If you use a GPS, or if you try to refer to published GPS coordinates for things like huts or trailheads, you are likely to find that the UTM coordinates on the 1:50,000 maps are slightly off. (Techno-nerd alert – the following may be obscure to some readers.) This is because the geographic datum used for older maps is NAD 27 (North American Datum 1927), while newer maps use NAD 83 or WGS 84 (World Geodetic System 1984) (these last two are essentially the same). The difference between the old and new grids is around 200 m in the Kootenays (which can be quite significant if you’re searching for the snow-covered Grassy Hut). The datum is always noted in the legend in the map margin, along with the magnetic declination.

The federal government topographic mapping has been distributed as a digital database in several formats, for use by software developers and map publishers. Paper maps which are essentially identical to those published by the government are available in some retail stores. (Valhalla Pure sells good-quality 1:50,000 maps printed by GoTrekker. These are the same as the government-produced maps, with the addition of hillshading.) Several digital versions of the 1:50,000 maps are used by developers of smart-phone mapping apps – the most common is called Toporama.

Beginning in the 1980s, the BC government produced new 1:20,000 maps with 20 m contours. These maps are made using digital technology – the raw data are stored as a grid of points with about 80 m spacing, with additional points in complex terrain. The maps have some errors (big ones in some map sheets), but in general, they are more detailed and accurate than the older 1:50,000 maps. The BC government produced these maps mainly for internal use and to sell the data to industry, and they made no effort to make them available to the general public. They were never sold as paper maps.

Recently, the BC government has made these maps available free on a web site, in “geo-PDF” format. These are PDF (Portable Document Format) files which can be viewed on a computer or

smartphone. They are georeferenced, which makes it possible to view them in mapping software while showing your present location, as well as waypoints and tracks. The maps can be downloaded from this site:

<https://www2.gov.bc.ca/gov/content/data/geographic-data-services/topographic-data/topographic-map-viewer>

GPS (Global Positioning System) devices

GPSs have been around since the 1980s, but they came into wider use after about 2000, when the US military stopped degrading the satellite signals. The technology has greatly improved over time, and GPS receivers are now incorporated into smartphones and many other devices.

Dedicated GPS devices haven't changed much since 2000, nor has the price dropped, but they are still very useful for outdoor recreation and for work purposes such as forestry. Consumer-level GPS units (and smartphones) have a useful resolution of about 10 m, provided satellite reception is good. (It may not be good in narrow valleys or under dense forest.)

Garmin is the biggest manufacturer of GPS units, and they make many models. I use the Garmin GPSmap 64s which is a popular model for recreation. This model, and several similar ones, use micro-SD cards (a smaller camera data card) to store maps. GPS units can be used on their own without added maps, but their usefulness is greatly increased if you add maps. Garmin is very much into copy protection and charging high prices for everything, so maps cost money.

Presently the price of a GPSmap 64s with the BC Backroads maps (which are based on the BC government 1:20,000 maps) is about \$465. Without any added maps, it's about \$340. Maps for almost anywhere in the world can be purchased on micro-SD cards which can be swapped into the GPS unit, or they can be downloaded (at a cost, as they have to be Garmin-compatible) and added to empty space on an existing card.

GPS units are much more rugged than smartphones. The 64s (and similar models) is waterproof, and uses AA batteries. GPS units have navigation functions that are not available or are less functional on smartphone apps. However, a disadvantage is that the screens are small, and not nearly as bright and high-resolution as smartphone screens. Because of this, and because of the cost of maps, smartphone apps that simulate the functions of a GPS are becoming more popular.

A useful feature of GPS units is the ability to record waypoints and tracks. Waypoints and tracks from elsewhere can also be copied onto your GPS before a trip. Waypoints are an essential feature, and they are very simple to record and use. For example, they can show where a trailhead or cabin is, or where you hid your bicycle in the bush before beginning a hike. Tracks are a bit more difficult to use, and take up a lot of storage space (less of a problem these days with gigabytes of storage on memory cards). They are useful for things like recording the route of a trail to draw on maps or to pass on to friends. Some people like to use tracks to keep a record of how far they've skied or what elevation they've gained and lost on a trip.

Waypoints and tracks are stored as files in the GPS. The common storage format is called GPX. If you plug your GPS into a computer, it's seen as an external hard drive, and you can copy the GPX files to your computer or vice-versa. The GPX files can be used in Garmin Basecamp software (which is free) and also can be viewed in Google Earth.

Smartphone mapping apps

In the last few years, smartphone map and GPS apps have become very popular. These apps are often free or cheap, and many maps are available on the internet. Of course the initial cost of a smartphone is high compared to a GPS, but you probably have a smartphone already.

Smartphone apps have a considerable advantage, which is that the screen is bright and highly visible compared to the screen on a GPS unit. A disadvantage is that smartphone batteries are usually good only for about a day of use, so it's not really practical to use them on multi-day trips in the backcountry (unless you also carry a backup battery and solar panel). Batteries in a GPS unit are also only good for a day or two, but they use AA batteries which are easily replaceable in the field. Recording tracks can greatly reduce battery life on a smartphone, but it doesn't seem to make any difference on a GPS unit.

With most smartphone apps, you don't need to be connected to the internet to use them. Maps can be saved ("cached") to your smartphone memory to be used offline. It's advisable to turn your smartphone to airplane mode when using it as a GPS, to save battery life. Also, smartphones can interfere with avalanche transceivers, so they should always be in airplane mode (or off) while backcountry skiing.

I have found that my phone (an iPhone 6) is quite sensitive to low temperature, and will stop recording a track, or even turn itself off, if it gets too cold. If I keep it in an inside pocket to keep it warm, it won't reliably record a track because satellite reception is reduced. Some other people don't seem to have this problem, so various makes of smartphone are probably different when it comes to low-temperature performance. For normal navigation (that is, not recording tracks), this isn't an issue – you can keep the phone in a warm pocket, and pull it out only when you need to look at it.

There are many smartphone apps available, and many are free, or at least have a free introductory version as well as more advanced version which you have to pay for. However, be aware that there is no such thing as a "free" app. The companies which develop these apps make their money by tracking your movements, and selling the data to Google or Facebook or whoever will pay for it ("the product is you"). (So next time you illegally cross the border, or hunt on private land, or go Christmas shopping in a big-city mall, you may want to turn your smartphone off.)

We compared several popular smartphone mapping apps, and this is what we came up with. Most apps are available both in iOS (Apple iStore) and Android versions.

Avenza PDF Maps (the newer version is just called Avenza Maps)

This app has been around for a while, and it is very popular for professional use by people who work in the bush, like forestry workers and firefighters. Avenza is a Canadian company, based in Toronto.

It works by loading maps in the geoPDF format onto your phone. These maps can then be viewed on your screen, just as they would appear in Adobe Reader on your computer, or if printed. Your present location is displayed, along with your coordinates which can be shown in UTM metres or in degrees and minutes. Waypoints and tracks can be recorded, and exported or

imported as GPX or KML files. An additional feature which makes it popular for foresters and other outdoor workers is that photos and field notes can be recorded and linked to the waypoint. A variety of maps are available to download from the Avenza Map Store (typically a few \$ each, but sometimes free). The best selection is for Canada and the US, but there are also some from overseas. (This seems to be limited – for example, I didn't find any useful topographic maps for hiking areas in the Alps.) Locally, a good selection of maps is available for purchase – for example, Nelson area mountain bike trails and BC Backroads maps. The federal government 1:50,000 map sheets in the Toporama format are available free on the map store. Topographic maps for the US at a scale of 1:24,000 are also available free.

The main usefulness of Avenza Maps is its ability to load maps from external sources in the geoPDF format. Anyone who has access to ArcGIS (a widely used professional GIS system) can make geoPDF maps. The KMC recently made such a map for the Evening Ridge-White Queen backcountry ski area (<http://kootenaymountaineeringclub.ca/mountain-info/maps/>). A very good map of the Paulson cross-country ski trails is available from the Castlegar Nordic Ski Club (<http://www.castlegarnordic.ca/trails-map-0>). The Nelson Nordinc Ski Club has a more basic, but still useful, trail map (http://nelsonnordicski.ca/?page_id=24). It's worth putting Avenza Maps on your phone just to have the cross-country trail maps.

BC government 1:20,000 map sheets (see link above) are available free and can be loaded into Avenza. Maps from this and other external sources are downloaded onto your computer, and from there to your phone using iTunes (for Apple devices) or the equivalent for Android users. They can also be transferred wirelessly using Dropbox. Loading maps can take a while, as Avenza has to process the map and convert it from Adobe PDF format to its own format.

With the free version, you can only load 3 maps from external sources (that is, maps that aren't obtained from the Avenza map store) onto your phone at one time. This is a significant limitation for most users. However you can unload the maps, and load three different ones when you want to go to a new area. You can upgrade to the paid version for about \$40 per year, which allows you to load as many external maps as you want. (There is also a more expensive professional version, which doesn't have any additional features useful for recreational users.)

Gaia GPS

This is a popular mapping app, from a company based in California. There is a free version which provides a quite detailed topographic map, and all the typical GPS functions such as your present location and coordinates, waypoints, and tracks – these can be imported and exported.

The maps work in a very different way than with Avenza. On an index map, you go to the area of interest, and the program automatically downloads the map data and caches it in your phone's memory, for offline use later. In BC, the map data it uses is the BC government 1:20,000 topographic database. It doesn't download map sheets; rather, it downloads the raw point data, and then it automatically generates contours on the fly for the area you are viewing. This is very impressive technology, and it is quite fast. It appears to use less storage capacity than Avenza to cover the same area. The maps are seamless, and you don't see the transition from one map sheet to the next. If you zoom in, contours are shown with an interval of 10 m. This is rather

misleading, as it makes the map appear more detailed and accurate than it really is – the 10 m contours are fictitious, since the precision of the original maps is really only 20 m.

The maps have very good visibility and contrast, which is an advantage in bright light conditions. The app is easy to use, and doesn't require any special technical expertise.

The maps show quite a few trails. These seem to have been obtained from a community of users who have contributed tracks. Popular areas (e.g. the mountain bike trails near Blewett) have many redundant trails, not all of which are likely to be accurate. If you are online, some of the trails link to photos and other information provided by users – a mixed blessing, as there's no way to verify how accurate the information is.

There is a paid version (called a membership subscription) for about \$35 a year. This enables you to download maps from additional sources, including satellite imagery. There appears to be a good variety of map sources for Canada and the US, and for a few European countries, for paid members. According to their web site, it is possible for paid users with technical expertise to georeference their own maps and import them into the app. (I don't have a paid subscription, so I haven't tried any of these features.)

Topo Maps Canada (this appears to be available on the Apple site only)

This is a very simple free app which has been around for a while. It displays the federal government 1:50,000 maps, and that's all. However, it's free and very easy to use. It has basic GPS functions, such as waypoints (called flags) and tracks (called trails), which can be imported and exported. There is a very basic navigation function, which gives you the distance and bearing to a flagged location.

To download maps, you click on the areas of interest on a base map. The maps are downloaded as tiles (about 10 km square), not as map sheets. Once downloaded, the maps are saved in memory for offline use.

There are two sources of map data: Canada Base Map, which you don't want to use; and Toporama, which gives you the 1:50,000 maps, more or less as they appear on printed paper maps. The contour interval is 40 m, and treed areas, streams, and roads (not up-to-date) are shown. The maps are seamless, and you don't see the map sheet boundaries.

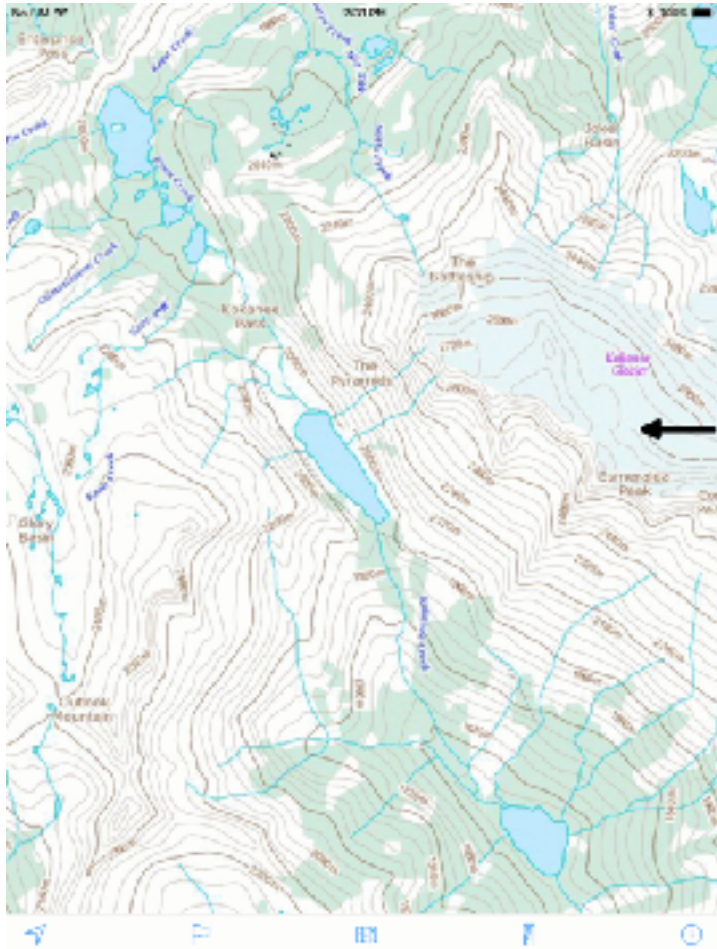
The maps do not have a north arrow (they're always oriented north), a scale bar, or a kilometre grid. This is somewhat disconcerting if you're used to using paper maps. However there is a distance tool – you can easily drag a line or curve on the map, and the distance is displayed.

Canada Topo Maps (for Android)

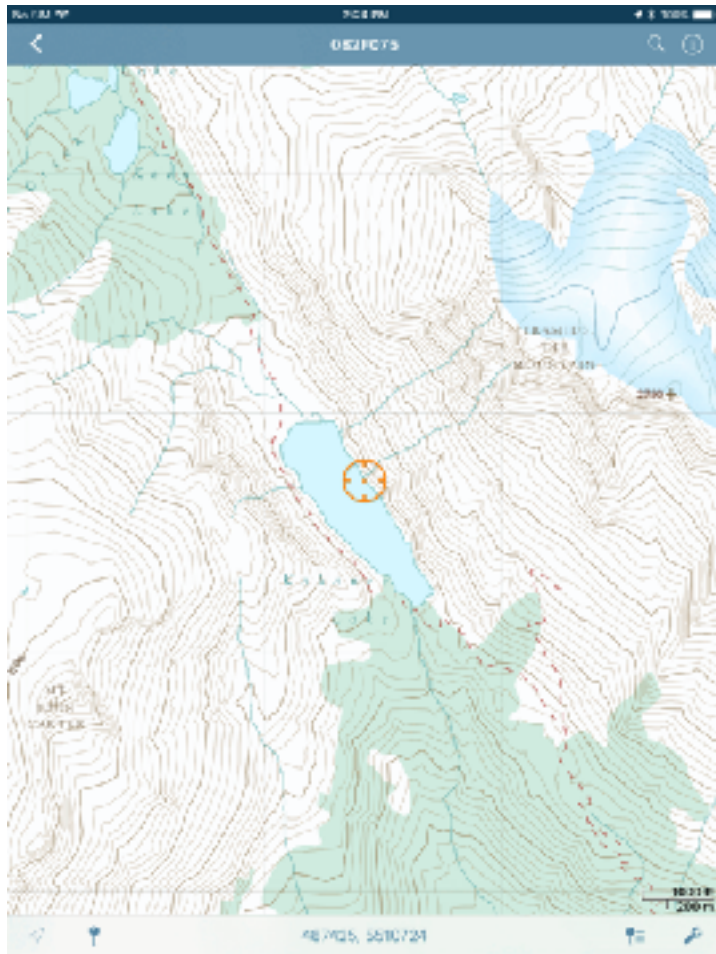
This similarly named app was pointed out to me by Llewellyn Matthews. (I don't have an Android device, so I can't try it out.) The two apps are not related in any way – this app is from a German company (ATLOGIS), that from its web site looks like it has a lot of products and expertise worldwide in mapping and remote sensing. From the app description, its maps use the Canada 1:50,000 maps including Toporama, as well as satellite imagery, and it has lots of GPS functions. There is a free version and a pro version for \$16 (US\$?). Looks like it's worth a try.

Examples

The following screenshots (from an iPad) show some examples from each program, which illustrate the general appearance of each app, as well some of their limitations.



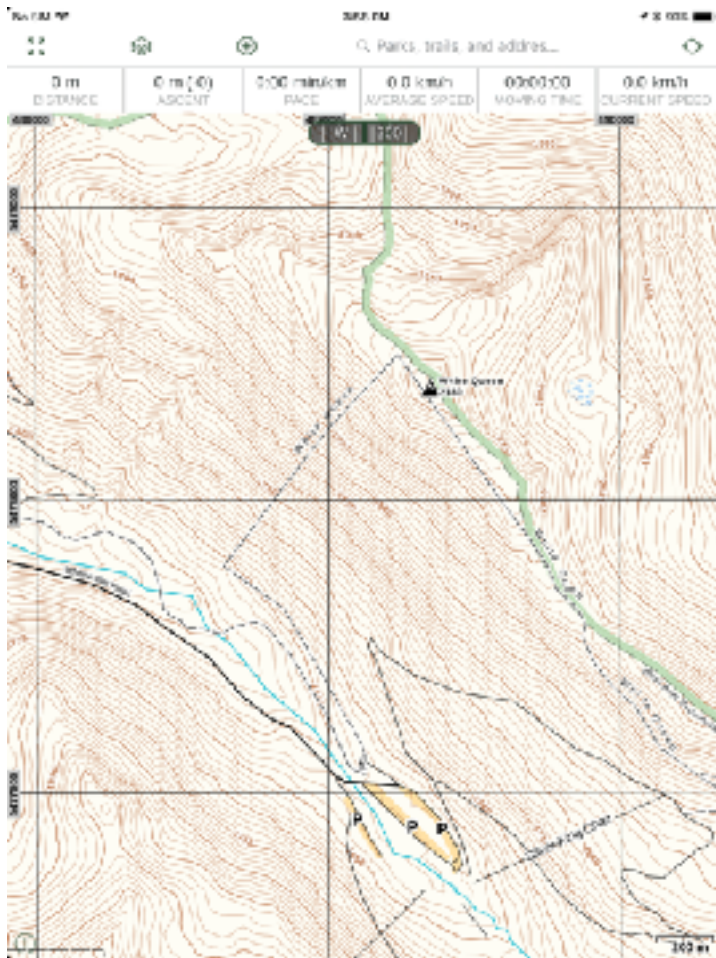
Topo Maps Canada screenshot, showing the area around Kokanee Lake. The map is essentially as it would appear on a 1:50,000 paper map, except the km grid is not shown. Some trails are marked, although these are incomplete. The arrow shows a discontinuity between two adjacent map sheets (82F/11 and 14), illustrating that there are some inaccuracies in the topographic database.



Screenshot of Avenza Maps showing the same area, part of the BC mapsheet 082F075. The map appears exactly as it would on a printed map. Note, some of the names are a bit funky, and some peaks are not named. There are not very many contour labels. The coordinates are shown for the bullseye at the map centre. The tools in the margin enable you to record waypoints and tracks, import and export data, and change settings.



The same area in Gaia GPS. Although the contours appear more detailed, this is misleading, as the topographic database is exactly the same as on the Avenza map. Naming of peaks is inconsistent. For some reason, there is a slight discontinuity along the same mapsheet boundary as in the Topo Maps Canada example.



Another area (White Queen, near Whitewater ski hill) as it appears in Gaia GPS. This example shows vertical banding with an 80 m spacing, indicating a small systematic error in the grid point elevations used to generate the contours. Also, the White Queen “trail” shown is quite inaccurate – it was probably based on a user-supplied GPS track which was improperly recorded.

The bottom line

All the apps reviewed are quite useful, although Topo Maps Canada is less functional than the others.

Topo Maps Canada (iOS) is recommended for users who want a free, simple way to quickly get 1:50,000 map coverage. Canada Topo Maps (Android) is a different product entirely, and looks like it’s much more capable.

Gaia GPS is the most sophisticated app, and is probably the most suitable for recreational users who want detailed topographic maps, and good GPS navigation and recording features. The free version is adequate for basic use.

Avenza Maps is the most useful for technically knowledgeable users who have access to custom-made georeferenced maps, or who are willing to take the time to download 1:20,000 topographic maps from the BC government web site. With the free version, a good selection of commercial

maps can be purchased for a few dollars each. The paid version lets you load as many of your own maps as you want.

There may be other useful apps out there – these are just the most popular ones that we know about.

Peter Jordan, with help in the field from Fred Thiessen, Delia Roberts, and Elena Cigala-Fulgosi.

Useful Weather info from the Internet.

As most of us are aware, weather is a key factor in the enjoyment of the outdoors. Here are some questions that come up all the time in winter.

What's it like up at the xc ski area? Is the snow any good? Paulson xc doesn't have cell phone coverage, and the report is generally a day old, and things may well have changed.

How much new snow is there up at the pass? What is the condition of it? How is it likely to change in the next couple of days, like between now and my planned trip on Saturday?

Here are some of the sites I use, that give me useful info on what to expect. Because, being weather, it will likely be different from what it was a few days ago when you were there....or maybe it won't.

Drivebc.ca. Current temperature, snowfall since the last measurement, and the previous 12 hours, snow depth. Camera. If there's snow on the trees.... Good sign. You may notice if it's melted off. Not a good sign if there's been snowfall recently. The road often melts when the snow isn't melting, since they're using salt on it.

U of Washington Weather Radar composite

<https://www.atmos.washington.edu/weather/radar.shtml>

tells you if it's precipitating, and where the precipitation is. Takes a bit of interpretation/interpolation. The West Kootenay falls between the Spokane and Silverstar radar, so precipitation in this area sometimes doesn't show up all that well... You can interpolate in the gap. Doesn't tell you if it's snowing or raining. There are other ones like intellicast that have an algorithm that does.

Satellite imagery

Pacific infra red image from U of W. Shows you what's coming at us from the Pacific. The colour is the cloud top temperature, or surface temperature if there's no cloud. The thicker the cloud, the colder it is, generally, but most of the juice is in the lower half of the atmosphere.

https://atmos.washington.edu/~ovens/wxloop.cgi?ir_common_full+12

Pacific Visible Image...

Great for during the day. Easier to interpret than the IR.

https://atmos.washington.edu/~ovens/wxloop.cgi?vis_common+12

More U W Weather loops... Geek out if you feel the urge for more weather info...

<https://atmos.washington.edu/~ovens/loops/>

Computer Model Graphics. (Geek Alert)

I use this page every day for a quick and dirty look at what the model projections are. Useful things are the precipitation envelope on the surface panel, and the 850 millibar temperature, which basically tells you where the freezing level is going to be. The models are very good at the upper levels! 850 millibars is approximately 5k feet or 1500 metres (Strawberry Pass!)

<http://mp1.met.psu.edu/~fxg1/ewall.html>

GFS is the American model. CMC is the Canadian one. They're generally available around 8 PM in the evening for the 00z run, and same time in the morning for the 12Z one. One hour later in daylight saving time.

Computer Model Output

(Most useful one if you don't want to get too geeky)

spotwx.com.

You pick out a spot, chose a model, and get the projections for how much precipitation, temperature, sometimes freezing level, winds (not reliable) etc for the spot you pick. Remember that the spots are model heights, and the model smooths the terrain, so check out the model height you picked and correct the temperature for the difference as best you can. The average lapse rate is about 5 deg per km but it varies from 10 deg/km (summer or behind cold fronts) to inversionary. The really nice thing about spotwx is that you can get a login name and it will remember the points you've chosen for your model output. Also remember that the long range models like the GFS and Global tend to overdo the precip a little bit.

If you want a good weather discussion of ski weather for the week ahead... you can't do much better than

avalanche.ca/weather/forecast

Nice graphics, and enthusiasm. Some nice educational vids from David Jones, of EC, as well.

I've not mentioned avi hazard here. Obviously the more it snows, the more hazard, more so if it warms up and there are weak layers buried. Beyond that, I defer to the Avi experts and daily bulletins.

Chris.