Introduction to PicoR-Ice

SNAME Presentation Notes

Slide 1 – Title

Thank you, SNAME Arctic, for your kind invitation to speak. This goes back to an excellent presentation earlier in the year (2018) by Bruce Calderbank on ice-related marine casualties in Canada. I asked if a blatant commercial presentation might be in order. Following last month's update on the Arktos evacuation vehicle, the chairman invited me to deliver today's presentation on PicoR-Ice. Thank you again.

Slide 2 – The PicoR-Ice System

PicoR-Ice is a ground-penetrating radar (GPR), the same technology you see on cable TV documentaries of treasure hunts and archaeological digs. But PicoR-Ice focuses on ice and snow thickness measurements. It is "non-invasive," reducing need for drilling in ice. It processes radar returns and displays the underfoot reflection pattern instantly. And the entire system fits in a very manageable carrying bag, seen here on my back deck table with a standard champagne bottle for scale.

Slide 3 – System Spec Sheet

We have an engineering audience here today and so the system specifications are essential. A few highlights. Optimum ice thickness measurement down to 2 metres underfoot; snow layer thickness to 3 metres. Accurate to 2-3 cm. Transmission frequency of 1700 MHz trades off depth of penetration for increased resolution, important for operational underfoot thickness calculations. 30 to 60 pulses per second. When running vehicle-based survey, maximum vehicle speed of 40 km/h. The sensing technology is enclosed in a rugged and compact transmit-receive package (show actual module to audience).

Slide 4 – System Components (animated)

Here is the full PicoR-Ice system. The transmit/receive antenna, GPS receiver, USB connector cable, a laptop computer (not part of the basic deliverables, but if you need a laptop, we'll get you one), and, finally, to give an idea of scale and the compactness of the whole system, a standard cup of coffee (our version of the geologist's rock hammer; not in the basic deliverables either).

Slice 5 – Hand-Held Operation (animated)

One person can use PicoR-Ice (two are advisable for on-ice work). Global Positioning System GPS receiver plugs into computer USB port. GPR antenna plugs into a second USB port. All is powered from the laptop computer battery; control of size and duration of power supply rests with the user. Antenna is carried about 50 cm above surface. In this example, a special chest-harnessed platform has been rigged to hold the laptop computer.

Slide 6 – Screen Display Step-Through (animated)

This is the simple program screen. I have rigged a visual sequence of how the display is activated and how data are recorded. The large button display is well-suited to a tablet computer touch screen. If using a standard laptop, make sure you set the cursor at the largest, highest contrast setting (outdoor use). Press Start; a connection message appears. "Device on" message appears when connection made with the antenna. In real life, a radargram will appear in the black part of the screen. Press "Start Record" to record the radar display data. The instantly calculated thickness of snow or ice appears in the upper right display box.

The most powerful component of PicoR-Ice is the one we cannot actually see – the software and its several algorithms specially coded to display ice or snow layers while calculating instantaneous thicknesses based on up to 60 pulses per second.

Pressing "Stop" ends radar pulse activity and you can move over to another survey line without disconnecting the PicoR-Ice program. Pressing "Close" will exit the PicoR-Ice program.

Slide 7 – Video Interlude (exit Presentation and launch Ural River video)

I will now show this display in action. The following video was taken earlier in the year. You can see a view of the ice-covered river that our surveyor is about to cross on foot. The PicoR-Ice screen display shows the "zebra stripe" pattern of the radargram scrolling left to right. The calculated ice thickness is continually updated and displayed in the upper right of the screen display. Thickness is fluctuating between 35 and 45 cm so our man is pretty safe.

Slide 8 – Field Experience Asia

PicoR-Ice has a proven record, with 100 units in service in Siberia and in the Moscow region. These areas shown (Gulf of Ob, Sungari River, Sakhalin offshore, Lake Baikal, Severnaya Zemlya) should be of particular interest to this audience.

Slide 9 – Gulf of Ob example (courtesy of ESTRA)

Here is a sample output from the Gulf of Ob. The user has chosen to activate the ice thickness calculation algorithm and to display three horizons (green lines). The algorithm is sensing the dielectrics of ice and applies the thickness calculation to that layer (145 cm thick). A second, unmeasured, horizon has been detected between the antenna and the ice surface. The on-site observer, of course, identified the snow layer.

Slide 10 – Ob River example (courtesy of ESTRA)

This example was taken from a car-mounted antenna. It is interesting because of the irregular ice horizons that appear on the radargram. The value of PicoR-Ice is less that it displays a true-to-lift surface profile than that its 30-60 pulses per second can return an accurate instantaneous thickness measurement (in this case 112 cm). The operator in the car needs to know immediately the thickness of ice.

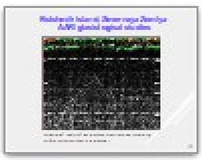
Slide 11 – Gulf of Ob Frozen to Bottom (courtesy of ESTRA)

Here we see an operator's interpretation that the ice layer extends to the bottom. The two horizons are not parallel and the lower horizon does define what appears to be an expected bottom profile.

Slide 12 – Gulf of Ob Nearshore (courtesy of ESTRA)

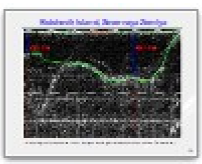
Still in the Gulf of Ob, this profile was taken near shore. We see a combination of PicoR-Ice algorithm and user interpretation to pick out the snow layer near the shoreline.

Slide 13 – Bolshevik Island Glacier (courtesy of ESTRA)



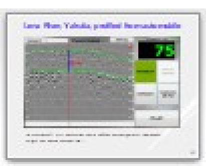
This is an interesting experimental use of PicoR-Ice. The system was set to measure snow depth. The 1700 MHz frequency provided high resolution snow depth data at the surface. Depth penetration was considerably greater but at the cost of resolution. The presence of a sub-surface rock protrusion was still detected.

Slide 14 – Bolshevik Island Glacier part 2 (courtesy of ESTRA)



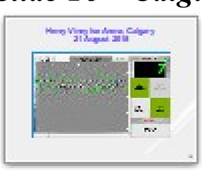
This is a mosaic covering 5 km of snow thickness profiling over a glacier on Bolshevik Island in Severnaya Zemlya. This was a test of signal penetration of PicoR-Ice and of the algorithm's capability to return a depth measurement. In this case, we see a measured snow depth of 455 cm, which exceeds the posted specification of the sensor for snow depth.

Slide 15 – Lena River profile from Automobile



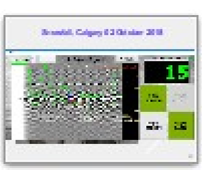
Change to another location, this one on the Lena River. We see a clear continuous 75 cm thickness in the return. We see a dip in the pattern to the left of the image, leading us to ask whether there might have been a nearshore cover of snow which could depress the ice level of the ice surface.

Slide 16 – Calgary Ice Arena



Canatec took delivery of its Picor-Ice unit during the summer. The closest ice thickness test opportunity was on the ice rink of the Henry Viney Arena in northeast Calgary. This was a hand-held transit and so we see some bouncing of the green horizon lines. This segment was run outward from one boundary of the ice. Rather than drill a calibration hole (!), we asked the arena attendant about actual ice thicknesses – 10 cm at the outer perimeter and 3 cm at centre ice.

Slide 17 – Fresh Snow Fall in Calgary (animated)



On 02 October, last month, we had a significant snowfall in Calgary. A measured 15 cm fell on my RV pad. The PicoR-Ice system was run over the pad as well as over rougher boundary areas. The 15 cm thickness was confirmed.

Slide 18 – PicoR-Ice in Russia (animated) (courtesy of ESTRA)

There are 100 PicoR-Ice units in service in Russia. This is a market that runs long surveys from vehicle-mounted antennas. There is also a significant public sector use. The Russian Federation actually has a specific state Ministry responsible for rescue and save transport, particularly in ice-covered areas.

Slide 19 – PicoR-Ice in Canada (animated)

When we first saw the PicoR-Ice concept, our reaction was, “Wow! This is so compact and (relatively) low-priced. The individual should carry this to the field.” And it is a personal tool that we, most immediately, are trying to sell in order to generate revenue to run a long-line survey using Transport Mode. But such a survey needs to be done this winter, either with funds support or as part of a practical survey by a paying buyer.

And here, at the behest of ESTRA’s Andrey Zerkal, I emphasize the portable nature of the PicoR-Ice antenna which contains no batteries that would otherwise be turned away by air carriers.

Slide 20 – Upcoming Developments (animated)

ESTRA is bringing on line some new features – display on Android hand-held units; an enhanced ice thickness measurement algorithm; a next-generation system optimized for measurement of thick snow covers.

Slide 21 – Thank you for your attention

ESTRA LLP’s thank you slide and Internet link for further information.

(This presentation was composed in the Open Source .odp format but is being distributed in Power Point format as well. Some Open Source features may not transfer directly to other formats)

Slide 22 – Question on setting system parameters (animated)

From the basic Program screen, right-click toward the right of the display. This calls up a sub-menu with a “Parameters” option that can then be selected. This, in turn, displays the Parameters input screen where the user can make several adjustments to the way in which PicoR-Ice will function.

Slide 23 – Question on detecting subsurface ice cracks

ESTRA acquired a good example from work on the Sungari River in China. It shows how a subsurface disturbance to the ice cover may appear on the real-time on-screen display.