CARPET 3: Questions and Answers

Arne Theil, November 18, 2024

Change-Log

Date	Description
1-6-2018	Administrative: Q_{15}, Q_{16}, Q_{17} added. Technical: Q_{24} on the modeling of solid state VTS radar added.
5-6-2018	Administrative: Q_{18} on a trial version added. Technical: Q_{25} on beamshape loss added.
14-6-2018	Administrative: VAT number of TNO added to A_{13}.
20-6-2018	Administrative: Q_{19} and Q_{20} on the difference between the DLL and Python.
20-6-2018	Administrative: Q_{21} and Q_{22} on the encryption of the CARPET 3 settingsfile.
20-6-2018	Administrative: Q_{23} on Internet usage.
20-6-2018	Administrative: Q_{24} on credit card payment.
20-8-2018	Technical: Q_{26} on the beam squint of an end-fed SWG (slotted waveguide) antenna added.
20-8-2018	Technical: Q_{27} on the 'eye-shaped' PPI-view diagram of the detection probability.
24-8-2018	Technical: Q_{28} on the usage of the KML-file.
13-9-2018	Technical: Q_{29} on the usage of the KML-file.
24-9-2018	Administrative: Q_{25} on a 'free evaluation version'.
3-10-2018	Technical: Q_{30} on a coastline that is hard to discern.
4-10-2018	Technical: Q_{31} on black rings in PPI-view diagrams.
10-10-2018	Technical: Q_{32} on the upwind/downwind factor.
15-10-2018	Technical: Q_{33} on obtaining TERMET files.
24-9-2018	Administrative: Q_{26} on TNO's address.
13-12-2018	Technical: Q_{34} on 'The Question' added.
13-12-2018	Technical: Q_{35} on line-of-sight added.
25-3-2019	Technical: Q_{36} on non-coherent integration and the received powers diagram.
29-3-2019	Technical: Q_{37} on the Blake-chart added.
29-3-2019	Technical: Q_{38} on the number of pulses and the number of bursts.
1-4-2019	Technical: Q_{39} on TERPEM and tracking radar.
9-4-2019	Administrative: Q_{27} on multiple users on a single PC.
3-5-2019	Technical: Q_{40} on CARPET 2 and 3 comparison.
14-5-2019	Technical: Q_{41} on the spatial resolution of the GeoTIFF output.
14-5-2019	Administrative: Q_{28} on installation on a server.
23-5-2019	Technical: Q_{42} on the number of CPU cores.
23-5-2019	Technical: Q_{43} on airborne radar.
20-6-2019	Technical: Q_{44} on the cumulative detection probability.
28-8-2019	Technical: Q_{45} on the antenna pattern.
3-10-2019	Administrative: A_{15} has been modified.
8-10-2019	Administrative: Q_{29} on error 0xc000007b.
9-10-2019	Administrative: Q_{30} on the cost for renewing the license.
9-10-2019	Technical: Q_{46} on the production of an ASCII-file with the CARPET settings.
9-10-2019	Technical: Q_{47} on the usefulness of the Python plug-in.
25-10-2019	Administrative: Q_{31} on the renewal of the license file. The answer A_{29} technical has been modified: target height must be specified with respect to the terrain height at the location of the sensor.
15-11-2019	Administrative: Q_{13}, VAT number corrected ('NL' was missing).
14-1-2020	Administrative: Q_{32} on moving CARPET to another platform.
30-1-2020	Technical: Q_{48} on the calculation of the receiver 'noise floor'.
30-1-2020	Technical: Q_{49} on the Python plug-in, CARPET as 'engine' to generate IQ data.
2-4-2020	Administrative: Q_{33} on volume discounts.
12-2-2020	Technical: Q_{50} on NumPy in the Python plug-in.
4-2-2020	Administrative: A_{28} has been expanded.
21-2-2020	Technical: The word 'target' was missing in Q_{43} technical. We sincerely apologise.
21-4-2020	Administrative: A_{34} on a license period shorter than two years.
14-7-2020	Technical: On the Doppler filter gain of surfaceclutter (Q_{51}).
4-9-2020	Technical: On the ease-of-use (Q_{52}).
22-9-2020	Technical: On multi-radar performance assessment (Q_{53}).
26-10-2020	Administrative: On 'A referral was returned from the server' when executing the installer (Q_{35}).
2-12-2020	Administrative: On a 32-bits version of CARPET 3 (Q_{36}).
24-1-2021	Technical: On radar coverage studies (Q_{54}).
2-1-2021	Administrative: On 'A referral was returned from the server' when trying to uninstall CARPET (Q_{37}).
5-2-2021	Technical: On the number of pulses and the number of bursts (Q_{55}).
14-4-2021	Administrative: Is a re-purchase cheaper? (Q_{38})
17-5-2021	Administrative: On missing libraries under CentOS 7. (Q_{39})
19-11-2021	Administrative: On the retrieval of SRTM files. (Q_{40})
16-12-2021	Administrative: On the use of 'Log4J'. (Q_{41})
6-4-2022	Technical: Why the P_{ft}-curve shifs to the left if you increase target speed (Q_{56}).

Date	Description
2-6-2022	Technical: On a reported problem with a curved computer display (Q_{57}).
2-6-2022	Technical: On switching off forward reflection at the earth's surface (Q_{58}).
3-8-2022	Technical: On disappearing dead zones (Q_{59}).
28-9-2022	Technical: On SRTM1 (30 m) and SRTM3 (90 m). (Q_{60}).
14-10-2022	Technical: Under Linux: on a clash between Qt lib-files, Q_{61}.
25-10-2022	Technical: On oversized fonts, Q_{62}.
14-4-2023	Technical: On the pulse canceller and the number of pulses, Q_{63}.

1 Administrative

Q1: Is there a reseller discount?
A1: No.

Q2: Would you please provide a quote to purchase CARPET basic version with TERPEM plug-in?
A2: Prices of CARPET 3, including plugs-ins, are published on the TNO website, please visit www.tno.nl/carpet. Generally, quotes (or quotations) are not provided.

Q3: A CARPET 2 license is not time-limited, is it?
A3: No, but TNO will stop servicing CARPET 2 from March 2018 on.

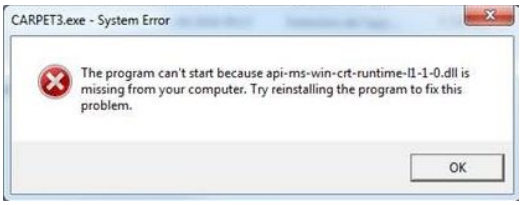
Q4: Are new CARPET 3 licenses transferable? We are upgrading to new computers in roughly a month. Would it be possible to transfer a CARPET 3 license to the new PC?
A4: Certainly, a CARPET 3 license is transferable. The procedure is as follows:

- Un-install (remove) CARPET 3 on the 'old' PC
- Install CARPET 3 on the 'new' PC
- E-mail the license file which is generated on the new PC to TNO
- TNO will validate the license file and return the validated license file
- Replace the un-validated license file on the new PC with the validated license file

Q5: Does the 2 year expiry of the CARPET 3 license disable the software completely? Or can CARPET 3 still run with an expired license, but no updates/support are available?
A5: What will happen is that CARPET will 'fall back' to demo-mode. It's capabilities will be seriously reduced.

Q6: Please, could you explain us the instructions to update one of our licenses of CARPET 2 to CARPET 3?
A6: An upgrade to the base-version (no plug-ins are active) is only possible if a CARPET 2 license was delivered less than two years ago. Please send an e-mail to carpet@tno.nl.

Q7: When I start CARPET 3 I get the following:



A7: Update Windows (Windows button, Gear wheel (Settings), Update and security). If this doesn't help, install the DLL that is mentioned, you can download it from the Microsoft website.

Q8: I have installed CARPET 3 but it didn't generate a license file.
A8: The license file is generated during initial start-up. In case of an MS Windows operating system, please look in directory `C:\Users\...\AppData\Local\TNO\CARPET`. You can also use use File - Open License File Directory to locate the license file, see Figure **??**.

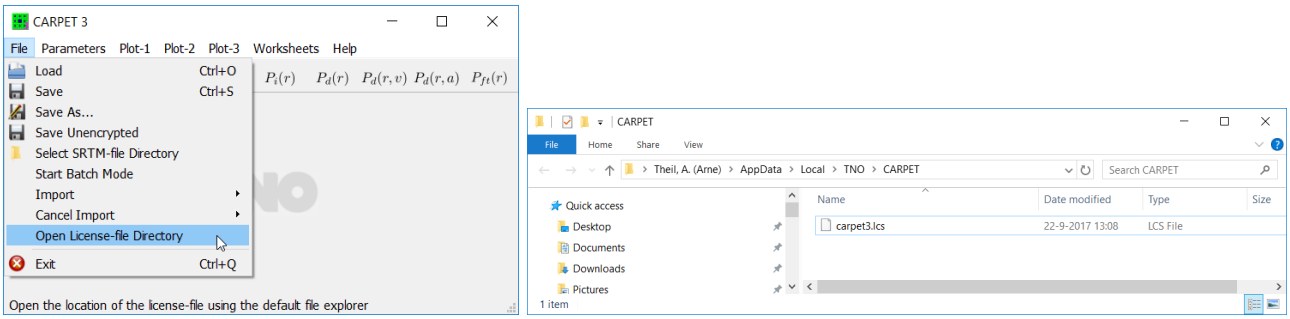


Figure 1: CARPET's facility to locate the license file.

Q$_9$: Is there an OS X (Apple) version of CARPET 3?
A$_9$: Not at the moment, we welcome two so-called 'launching customers' to make this happen. Since the GUI and graphics of CARPET 3 have been made with Qt and Qwt respectively, it is fairly straightforward, as shown in Figure **??**. Linux? Same story, see Figure **??**.

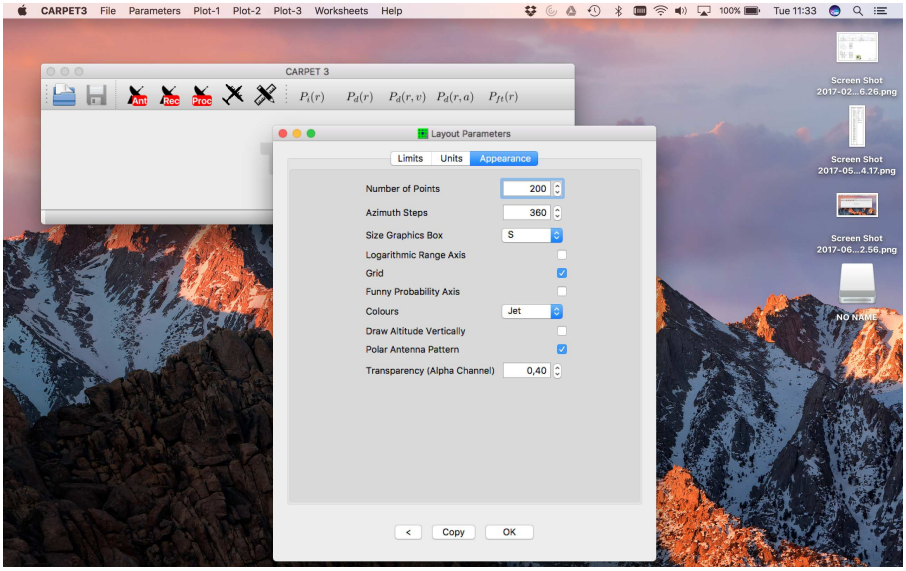


Figure 2: CARPET 3 on OS X: nearly ready.

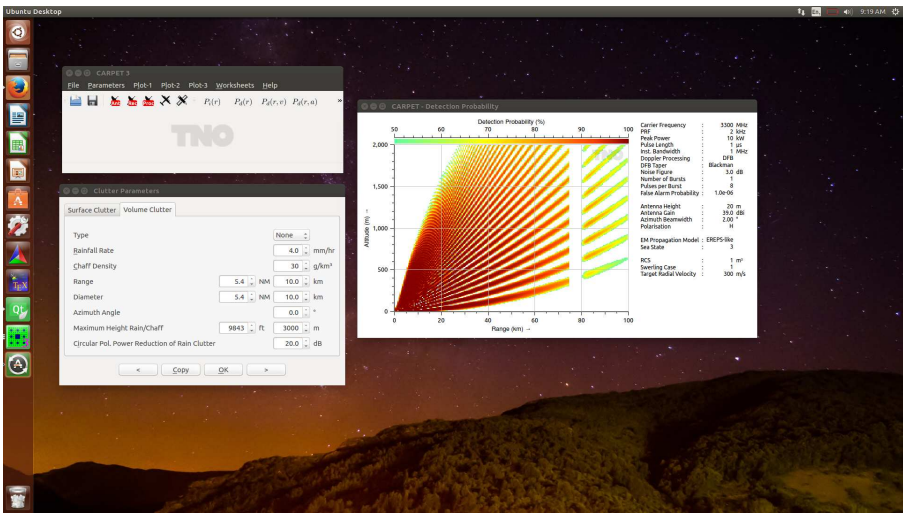


Figure 3: CARPET 3 running under Ubuntu Linux 16.04 LTS with the Unity window manager, also nearly ready.

Q$_{10}$: Does my computer need to be connected to the internet during install?
A$_{10}$: No. (Obviously, Internet comes in handy to download the install-files and to e-mail the license

file.)

Q$_{11}$: Can I run CARPET on a PC that does not have access to the Internet?
A$_{11}$: Provided you have a means to transfer the CARPET 3 install file, and possibly also SRTM terrain-height files, to this PC, the answer is affirmative. The install script and CARPET itself do not approach the Internet during run-time.

Q$_{12}$: Do you have distributors for your software?
A$_{12}$: No.

Q$_{13}$: What are the Payee name, the payment terms and the incoterms?
A$_{13}$:

- Account Holder: TNO, Netherlands Organisation for Applied Scientific Research
- Name of Account: TNO Accounts Receivable
- TNO Address: Anna van Buerenplein 1, 2595 DA The Hague, Netherlands
- Bank Name: ING Bank N.V.
- Bank Address: Weena 501-505, 3013 AL Rotterdam, Netherlands
- International Bank Account Number (IBAN): NL46INGB0651267862
- BIC/SWIFT: INGBNL2A
- VAT number of TNO: NL002875718B01
- Payment Terms: Advance Payment
- Incoterms: Download and install instructions will be issued when the payment has arrived.

Q$_{14}$: Where are the plug-ins?
A$_{14}$: The plug-ins are in the executable code. The license file controls which plug-ins are enabled.

Q$_{15}$: Would you be able to provide me with the License Agreement for CARPET 3?
A$_{15}$: The disclaimer, which must be accepted during install, reads as follows:
By installing or using CARPET (Computer Aided Radar Performance Evaluation Tool) and the associated CARPET manual you accept all terms below.

CARPET and the technical descriptions and procedures as described in the CARPET manual are provided 'as is', without warranty of any kind. The authors of the manual titled 'CARPET (Computer-Aided Radar Performance Evaluation Tool): Radar Performance Analysis Software and User's Guide', and the Netherlands Organisation for Applied Scientific Research TNO make no warranties, expressed or implied, that the equations and procedures in the manual or its associated software are free of error, or are consistent with any particular standard of merchantability, or will meet your requirements for any particular application. They should not be relied on for solving a problem of which the solution could result in injury to a person or loss of property. Any use of the program or the manual is at the user's own risk.

The authors and TNO own all intellectual property rights concerning CARPET and the CARPET manual. The user is not allowed to modify, copy, reverse engineer, rent, sublicense or in any way distribute CARPET and the CARPET manual to third parties.

The authors and TNO disclaim all liability for direct, indirect, incidental, special or consequential damages, including lost profits, resulting from use of CARPET and its manual, including all technical descriptions, equations and procedures therein, even if they have been advised of the possibility of such damage. In any event, the liability of the authors and of TNO in connection with CARPET and its manual will be limited to the amount paid for the program, if any. TNO and the authors have no express or implied obligation to provide maintenance, support, updates, enhancements or modifications, nor to continue to make the program or any feature thereof available nor introduce any products or services compatible with the program.

CARPET shall not be re-sold or re-exported or otherwise disposed of, contrary to any applicable export control law or regulation, including but not limited to European Union Regulations.

CARPET shall not be supplied in any way, directly or indirectly, to an entity/person in or from North Korea, Syria, Russia, Iran, Sudan, the Crimea Region of Ukraine, People's Republic of China (PCR) and Saudi Arabia. CARPET shall not be supplied in any way, directly or indirectly, to an entity or person that is on any other export control restricted lists including any entity that is, to the best of our knowledge owned 50% or more, directly or indirectly, by such restricted entity or person.

CARPET shall not be applied to support any nuclear activity or unsafeguarded nuclear fuel-cycle activity, or the development of chemical or biological or nuclear weapons, or missiles capable of delivering such weapons.

In case of a country that is subject to an arms embargo decided by the European Commission, the Organization for Security and Co-operation in Europe (OSCE), or an arms embargo imposed by a binding resolution of the Security

Council of the United Nations, CARPET shall not be used by a military end-user, or for a military end-use[1].

CARPET shall not be used in any activity that may infringe human rights or threaten the public security.

This agreement is governed by the laws of The Netherlands. Any disputes arising out of or in connection with this agreement shall exclusively be referred to the competent courts of The Hague, the Netherlands.

Q_{16}: Is CARPET 3 a cloud based solution?
A_{16}: No. CARPET 3 is 'plain' executable code and does not need access to the Internet. On the Microsoft Windows operating system, the program comes with a series of so-called dynamic link libraries (DLL's).

Q_{17}: Are plug-ins time-limited to 2 years, just as the CARPET 3 base version?
A_{17}: Indeed, the plug-ins are time-limited as well.

Q_{18}: Can I get a trial-version of CARPET 3?
A_{18}: TNO does not issue licenses for a very limited period. What you could do, however, is to install CARPET 3 and to *not* submit (e-mail) the license file that CARPET creates. The license-file-less version of CARPET 3 will have limited functionality, but does provide an impression of its capabilities.

Q_{19}: What is the difference between the DLL option and the Python plug-in?
A_{19}: DLL: The user's program 'talks with' the CARPET 3 DLL, *i.e.*, gives instructions to the DLL and asks questions from the DLL. The DLL must be 'linked against' the user's own program. The current CARPET 3 DLL has a C++ interface. Using the DLL from a C++ program is therefore straightforward. If the user's own program is written in C, FORTRAN, or MATLAB, TNO has to write a C-wrapper around the DLL. We will do this as soon as we have a 'non C++ launching customer' for the DLL.
Python: CARPET 3 GUI can load, save, edit and execute a program that is written in Python 3. All CARPET settings can be manipulated, diagrams can be made and saved. Two example programs are given in the CARPET 3 manual. This option is an extremely elegant and powerful feature of CARPET 3.

Q_{20}: Is there a difference in functionality between the DLL and the Python plug-in?
A_{20}: There is some difference in functionality: You can produce and save diagrams in the Python environment, also see the second example in the CARPET 3 manual. Doing this with the DLL demands quite a bit of coding effort.

Q_{21}: While I understand that CARPET 3 now writes encrypted settings files, how far does this extend? *I.e.*, will it still write the results of modelling to unencrypted text files such that these can be read into MATLAB and manipulated from there or are these also encrypted, and if so how do you unencrypt them?
A_{21}: TNO prefers to not release information about the encryption mechanism that it uses. The methodology that you describe is currently not possible with CARPET 3. There is an alternative methodology that is much more elegant and also less elaborate: the Python plug-in.

Q_{22}: Is there any option for writing CARPET 3 parameter files unencrypted or are they encrypted only?
A_{22}: CARPET 3 GUI cannot write unencrypted settings files.

Q_{23}: When performing coverage modelling in conjunction with the TERPEM light plug-in and terrain data previously downloaded, is it possible to do this completely offline such that no record of where the location being modelled will be sent to anyone or anything outside of the computer the modelling

[1]For the purposes of this paragraph, 'military end-use' means: (a) incorporation into military items listed in the Common Military List of the European Union, (b) use of production, test or analytical equipment and components therefore, for the development, production or maintenance of military items listed in the above mentioned list, (c) use of any unfinished products in a plant for the production of military items listed in the above mentioned list.

is being performed upon?
A$_{23}$: Yes, CARPET 3 does not need access to the Internet. So the terrain information that CARPET 3 requires must be present on the system / file shares of the system that runs CARPET 3.

Q$_{24}$: How do I make a credit card payment for the invoice?
A$_{24}$: TNO can arrange a payment request by VISA/Mastercard. You'll the get an e-mail from VISA/Mastercard. Once you confirm this, the payment will be settled.

Q$_{25}$: Is CARPET 3 available as a free evaluation version license for non-commercial use only?
A$_{25}$: No, also see A$_{18}$.

Q$_{26}$: To whom should I send the purchase order?
A$_{26}$: Although a purchase order is not really required by TNO (filling in the order form on the Internet will do), you can send or e-mail it to TNO The Hague, Radargroup, PO-box 96864, 2509 JG The Hague, Netherlands. The e-mail address is carpet@tno.nl.

Q$_{27}$: When we install CARPET on a specific PC can any user logged into that machine execute CARPET?
A$_{27}$: No, the current license is not only tied to a specific computer, but also to a specific user. So in case multiple users want to be able to run CARPET on a specific computer, one could perhaps define a user account that multiple users can utilize.

Q$_{28}$: Can we install CARPET 3 on a server?
A$_{28}$: Yes. Note, however, that the number of 'instances' is limited to 1, meaning that only a single user can run CARPET at a time. Please access CARPET via a remote desktop, using RDP (Remote Desktop Protocol). When you run the CARPET executable, which is sitting on a share of the server, on the client, using the file sharing protocol SMB (Server Message Block), you will run into problems since the license file is on the server. TNO has no short-term solution for this configuration (unless you are willing to purchase more licenses).

Q$_{29}$: When I try to operate CARPET 3 the application is unable to run and gives an error (0xc000007b). Besides that, there is no license directory (folder) existing under `C:\Users\($user)\AppData\Local\TNO`.
A$_{29}$: This problem could be solved by installing Visual C++ Redistributable Package 2015, which is available at the Microsoft Website. We thank the questioner, he found the solution himself.

Q$_{30}$: Is the cost to renew the license reduced, compared to the cost at purchase?
A$_{30}$: No. This 'business model' (*excusez les mots*) has been adopted in order to be able to actively maintain and expand CARPET (and to update the Q&A document).

Q$_{31}$: I am using CARPET 3 and it will expire on November 1, 2019. I want to continue using it, can you please give me a quote?
A$_{31}$: You can use the order form on the Internet (www.tno.nl/carpet) for the renewal of the license file. Please also have a look at **A$_{2}$** administrative.

Q$_{32}$: I have a new PC. How can I move CARPET to this new PC?
A$_{32}$:

- Download and install the latest installer from `https://www.tno.nl/media/14249/carpet-3-win64.zip`.
- Unzip and run the program on the new PC.
- Start CARPET 3 and let it create a new license file.
- E-mail the newly created license file to `carpet@tno.nl`. TNO will provide a validated license file.
- Uninstall CARPET on the 'old' PC.

Q33: Is there a volume discount?
A33: No.

Q34: I was wondering if it is possible to get a quote for CARPET 3 license for 1 year? Same question for the plug-ins. Or is the standard 2 years the only possible option?
A34: We have to inform you that we do not deviate from the licensing approach as you have seen online, and therefore a 2 year licensing period is the only option.

Q35: When I execute the installer on a Microsoft Windows workstation I get the following message:

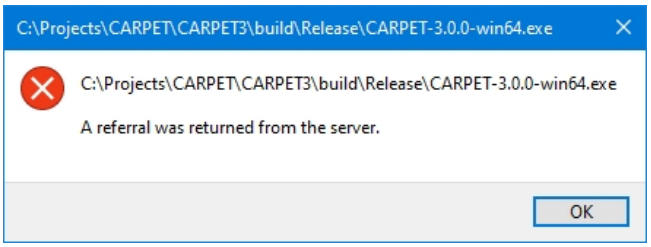


Figure 4: A somewhat mysterious message, issued by the Microsoft Windows operating system.

What does this mean? What now?
A35: Some people say that this is caused by the so-called SmartScreen facility of Windows Defender. The following might help:

- Launch the Windows Command prompt `cmd` and run it as administrator (a bit tricky, see Figure **??**.
- Go to the directory in which the install file (`CARPET-3.0.0-win64.exe`) sits using the `cd`-command.
- Execute the installer.

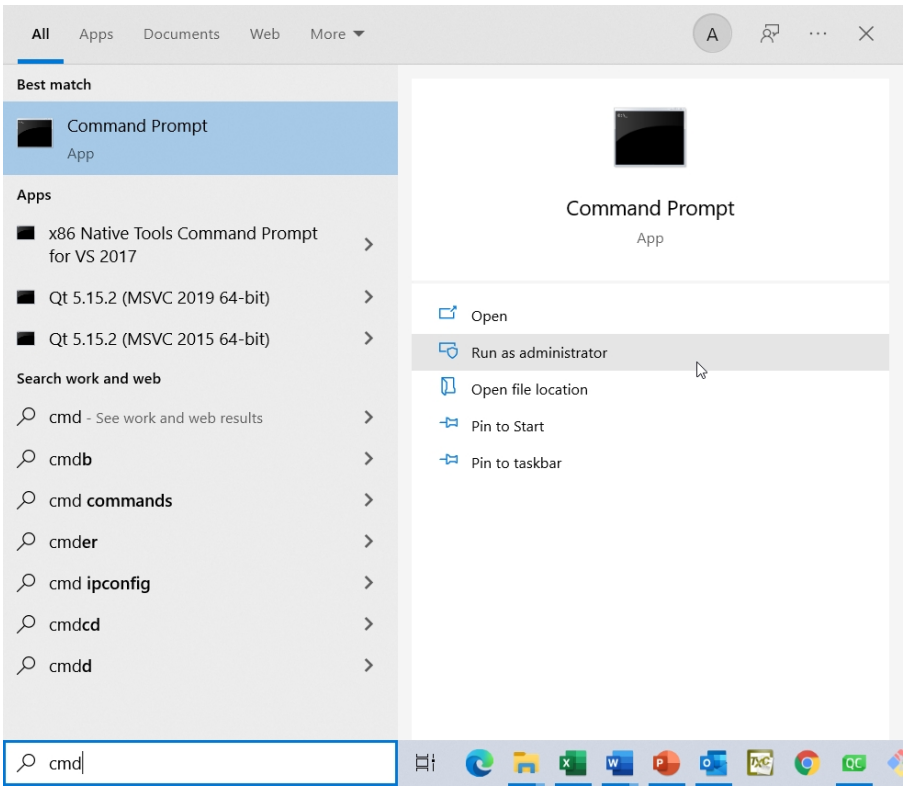


Figure 5: Run `cmd` as administrator.

However, there are more recipes. One MS Windows expert provided the following potential solution:

- Before you continue to apply the solutions below, first make sure that UAC (User Account Control) is already disabled on your system. To do that, go Control Panel - User Accounts and click at Change User Account Control Settings option.
- At the User Account Control Settings window, drag the slider at the lower position to completely disable UAC.
- Restart your MS Windows computer and then try to run the CARPET installer.

If the problem persist then continue to the solutions mentioned below.

- Right-click at the install application that gives the error and select Properties.
- At Compatibility tab, click Change settings for all users.
- Check the 'Run this program as an administrator' checkbox and then click OK twice to close program's properties.
- Run the CARPET installer. The 'A referral was returned from the server' error should be gone.

Another MS Windows expert, however, suggested the following:

- Start the Local Group Policy Editor (gpedit.msc).
- Check 'Computer Configurations - Windows Settings - Local Policies - Security Options - User Account Control - Only elevate executables that are signed and validated'.
- Set to 'Disabled'.
- Then restart your MS Windows computer.
- Run the CARPET installer. The 'A referral was returned from the server' error should be gone.

A fifth expert of the MS Windows operating system suggested the following:

- Hold the Windows Key and press 'R'.
- Type 'regedit', then press 'Enter' in order to bring up the so-called Registry Editor.
- Navigate to HKEY_LOCAL_MACHINE\Microsoft\Windows\CurrentVersion\Policies\System.
- Open 'ValidateAdminCodeSignatures' and set 'Value data' to '0'.
- Open 'EnableUIADesktopToggle' and set the 'Value data' to '0'.
- File - Exit

And here is another (sixth) suggestion which also involves an adaptation of the so-called 'MS Windows registry file':
reg add "HKLM\SOFTWARE\Microsoft\Windows\CurrentVersion\Policies\System"
/v "ValidateAdminCodeSignatures" /t REG_DWORD /d "0" /f

Please contact us in case neither of these recipes work. One solution that will certainly work is the following:

- Install one of the Linux variants on the workstation (PC).
- Ask TNO to provide a Linux version of CARPET 3.

Note: TNO can also provide a MacOS version of CARPET 3.

Q_{36}: Can I please have a 32 bits version of CARPET 3?
A_{36}: We're afraid that that is rather difficult for us. You could install Linux on your vintage workstation, in order to make it speedier. We'd be happy to provide a 64 bits Linux version of CARPET 3.

Q_{37}: When I attempt to uninstall CARPET I get a warning box that says that a referral was returned from the server. But which server is meant? What am I to do?
A_{37}: Right-click on the Windows symbol (flag) and start the Windows PowerShell (Admin). Navigate to `C:\Program Files\CARPET 3`, then type `\.Uninstall.exe)`. That should do the trick. We do not know which server is meant.

Q38: Can I buy it at a discount when I repurchase my license after two years?
A38: There are no discounts for re-purchases.

Q39: I installed Linux-CARPET-3 on our CentOS system and it seems the following libraries are missing: libxcb-icccm.so.4, libxcb-image.so.0, libxcb-keysyms.so.1, libxcb-render-util.so.0, libxcb-icccm.so.4, libxcb-image.so.0, libxcb-keysyms.so.1, libxcb-render-util.so.0. How come?
A39: The TNO IT-expert states the following: 'Amazing. When I installed a CentOS VM (Virtual Machine) with the Gnome desktop, these libraries were present. The fix is the following command: `sudo yum install xcb-util-wm xcb-util-image xcb-util-renderutil xcb-util-keysyms`.'

Q40: I'm trying to download SRTM3 (90 m) files from the USGS website but I cannot find these files. What am I to do?
A40: We advise that you use SRTM1 (30 m) data instead. These data can be downloaded from https://dwtkns.com/srtm30m/. Please do not store SRTM1 (30 m) and SRTM3 (90 m) data in the same directory (or 'folder'). In case your version of CARPET 3 does not support SRTM1 (30 m), please download the latest version from https://www.tno.nl/media/14249/carpet-3-win64.zip.

Q41: Due à la récente annonce d'une faille de sécurité majeure concernant la bibliothèque 'Log4J' développée par la fondation Apache, pourriez vous nous indiquer, si la bibliothèque est utilisée, pour chaque logiciel/application que nous utilisons: version de Log4j utilisée, si il est impacté par la faille de sécurité, s'il existe un patch disponible, s'il existe un contournement possible, quelles peuvent être les perturbations induites.
A41: CARPET 3 is entirely written in C++. No use is made of Log4J.

2 Technical

Q$_1$: Is it possible to import a CARPET 2 settings file? I get an error box when I select File - Load.
A$_1$: Select File - Import - CARPET 2 Settings.

Q$_2$: Why does a P_d versus range diagram report a different detection range than a P_d versus range and height diagram, see the figure below?

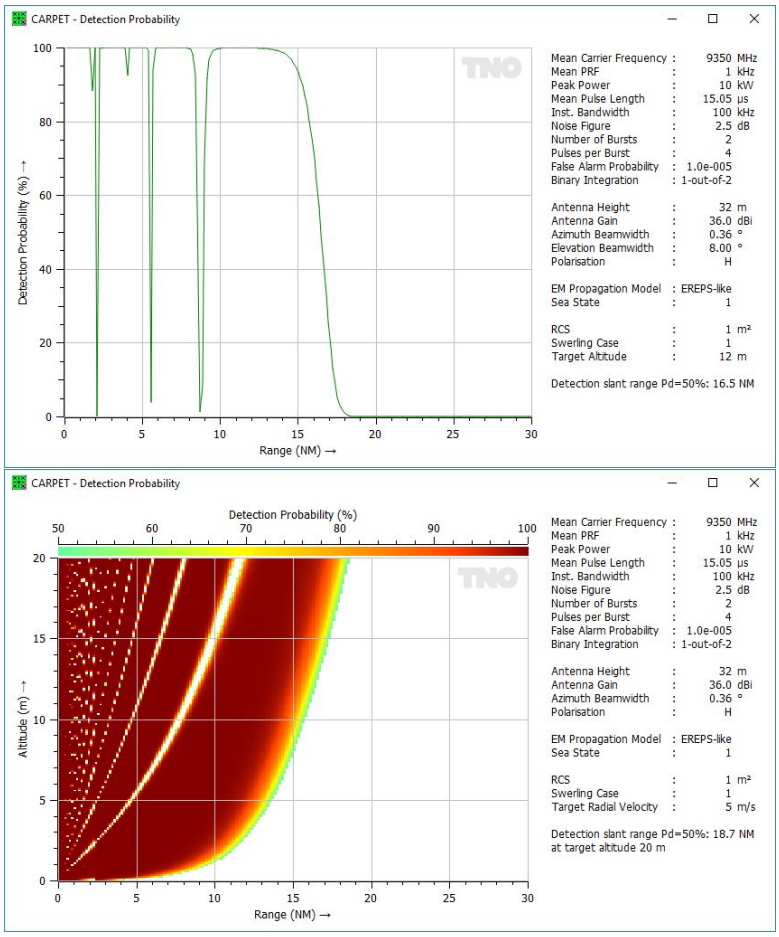


Figure 6: The upper diagram reports a 16.5 NM detection range, whereas the lower diagram reports a 18.7 NM detection range.

A$_2$: If P_d is calculated over range, CARPET figures out the most distant range where a certain P_d threshold-value (specified in the Layout dialogbox) is obtained. If P_d is calculated versus range and altitude, this procedure is executed for each altitude. Given the set of maximum ranges per altitude, the maximum is subsequently determined. The two findings may well be different.

Q$_3$: Is there a way to plot the Probability of Detection where the graph highlights the range for a P_d different than 90% on the bottom right?
A$_3$: Change the P_d in the Layout dialogbox.

Q$_4$: How do I set the pulse compression gain?
A$_4$: CARPET calculates the pulse compression gain, G_{pc}, from the uncompressed pulse length, τ_u (s), and the instantaneous bandwidth, B (Hz), according to:

$$G_{pc} = \tau_u \cdot B \tag{1}$$

Note: Checkbox 'PC' in the Transmitter dialogbox must be in the on-position.

Q5: Can I use CARPET to evaluate an FMCW radar?
A5: CARPET is not optimum to simulate an FMCW radar. Clearly, one can mimic such a system, *e.g.*, by ensuring that the product of peak power and duty cycle equals the average power transmitted by the FMCW radar. However, an important aspect as isolation between transmit and receive antenna, is not being modeled. Also, the receiver noise level is not dependent on range. The CARPET results will therefore be optimistic unless suitable loss factors are introduced.

Q6: What are the technical differences between CARPET 3 and CARPET 2?
A6: CARPET 3 without plug-ins is quite similar to CARPET 2. Most importantly, the cumulative detection probability diagram has been replaced by a firm track probability diagram. The vast majority of the new features are in the plug-ins, as described in https://www.tno.nl/media/8896/finallythere.pdf.

Q7: Can CARPET 3 simulate a solid-state VTS radar?
A7: The fact that RF power is generated with solid-state devices rather than a magnetron tube is not relevant.
The latest generation VTS radar system apply different waveforms per dwell, each waveform having its own pulse length, pulse repetition frequency, radar frequency and number of pulses per burst. Relatively short pulses are needed to provide short-range radar coverage (a relatively deep dead zone is inherent to long pulses). Pulse compression is also applied. Pulse responses are integrated within a burst. CARPET (2 and 3) supports pulse integration using a Doppler filter bank, staggered PRF MTI is currently not supported. Detections per burst are combined, often according to post-detection binary integration logic (M-out-of-N, CARPET 3 only).
CARPET 3 augmented with the multi-burst plug-in is clearly better equipped to simulate solid-state VTS radars than CARPET 2, which is not able to simulate multiple different bursts per dwell.

Q8: Why does CARPET use a comma (,) to show the decimal fraction?
A8: CARPET 3 adopts this from the operating system. To change it in the case of Microsoft Windows 10: right-click on the Windows logo (flag), Control Panel, Change date time or number formats, Additional settings, Decimal symbol.

Q9: Which DTED types can be imported?
A9: CARPET 3: 3 arc second SRTM, which can be downloaded from
https://dds.cr.usgs.gov/srtm/version2_1/ .
CARPET 3.1, however, scheduled before the end of 2018, will use the Geospatial Data Abstraction Library (GDAL), so that an extensive number of raster formats will be supported. For details we refer to http://www.gdal.org/ .

Q10: We are getting an error: 'SRTM directory does not exist.' What now?
A10: Select the directory where CARPET is to find SRTM terrain-height files (with filename extension `hgt`), as shown in Figure **??**. The Windows version of CARPET 3 saves this location in the so-called registry file. Windows users can utilize regedit (Windows 10: right-click Windows-flag - run - regedit) to verify that the directory (or 'folder' in windows-speech) is properly saved, see Figure **??**. Additional SRTM files can be downloaded from http://dds.cr.usgs.gov/srtm/version2_1/ .

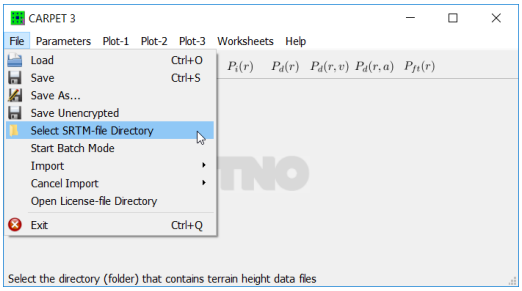


Figure 7: Select SRTM directory.

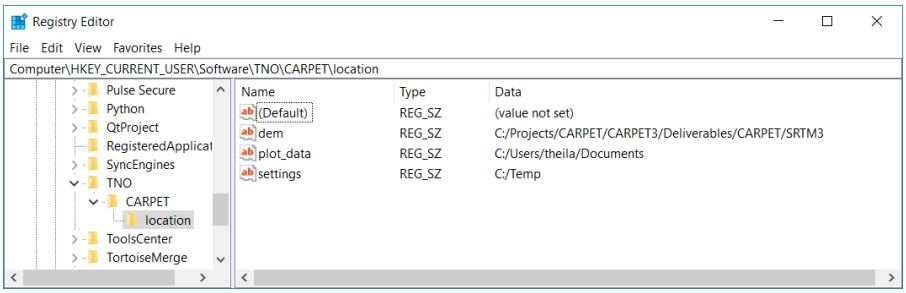


Figure 8: Regedit, revealing the directory where CARPET 3 expects SRTM files to be, in this case `C:/Projects/CARPET/CARPET3/Deliverables/CARPET/SRTM3`.

Q$_{11}$: Do the SRTM terrain-height files have to be unzipped?
A$_{11}$: Yes, the file name extension is '`hgt`', *e.g.*, `N44E008.hgt`. One file contains 2,884,802 byte of data.

Q$_{12}$: How do we load the STRM files (terrain profile) into the software after downloaded it?
A$_{12}$: Put the SRTM files in a specific directory and specify the directory where CARPET is to locate the file(s), see the answer to Q$_9$.

Q$_{13}$: Can we edit the terrain profile?
A$_{13}$: Not with CARPET.

Q$_{14}$: The vertical coverage diagram seems to be cut off at 79.8 NM, independent on target RCS or transmit power, see Figure **??**. How is this problem solved?
A$_{14}$: Our gut-feeling is that the specified instrumented range (in the Processing dialog box) cuts off the range coverage. Please check this.

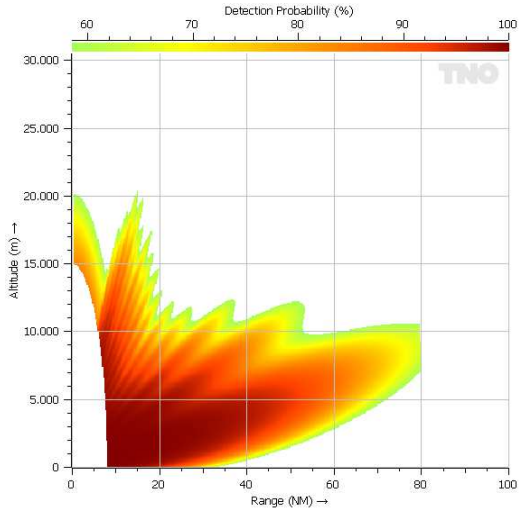


Figure 9: Vertical coverage diagram, cut off in range.

Q$_{15}$: What is 'The Answer' in 'Help'?
A$_{15}$: 42, the Answer to the Ultimate Question of Life, the Universe and Everything. This Answer was first calculated by the supercomputer Deep Thought after seven and a half million years of thought. This shocking answer resulted in the construction of an even larger supercomputer, named Earth, which was tasked with determining what the question was in the first place. (Thank you, http://hitchhikers.wikia.com/wiki/42.)

Q$_{16}$: Does CARPET support other modulation methods, such as LFM / NLFM?
A$_{16}$: CARPET 3 allows for a specification of a pulse compression loss. CARPET 3 does not posses an explicit (detailed) model of the pulse compressor.

Q$_{17}$: Do you have some relevant information on the N-out-of-M post-detection binary integration process?
A$_{17}$: There are numerous publications of this process, which a search on the Internet will reveal. One reference is *Principles of Modern Radar* by Mark A. Richards, James A. Scheer, William A. Holm, Scitech Publishing Inc., Chapter 3, p.109.

Q$_{18}$: How can we specify a different sensor location?
A$_{18}$: Just fill in the sensor coordinates in the Sensor Location dialogbox, see Figure **??**. Obviously, a TERPEM license is required for radar performance assessment in terrain.

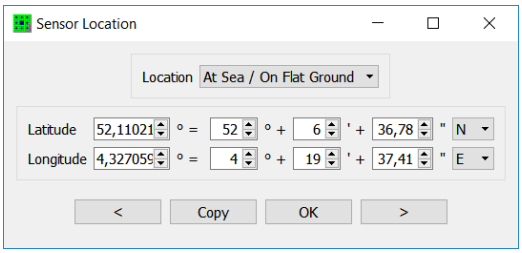


Figure 10: Sensor location dialogbox.

Q$_{19}$: How do I check the sensor location that I set in the software is correct with respect to the hgt file? I want to make sure that the hgt file for specific terrain is correctly and properly read by the software, and the sensor location is also set correctly?
A$_{19}$: Let's give an example. The WGS84 latitude-longitude co-ordinates of the Mont Blanc (highest mountain in Europe) are 45°49' 58" and 6°51' 53". We specify these coordinates in the Siting dialogbox and, subsequently, make a Terrain - Height Map diagram. Results are shown in Figure **??**. When we zoom-in we see that the sensor is slightly South of the summit. Apparently, the specified latitude should have been more accurate.

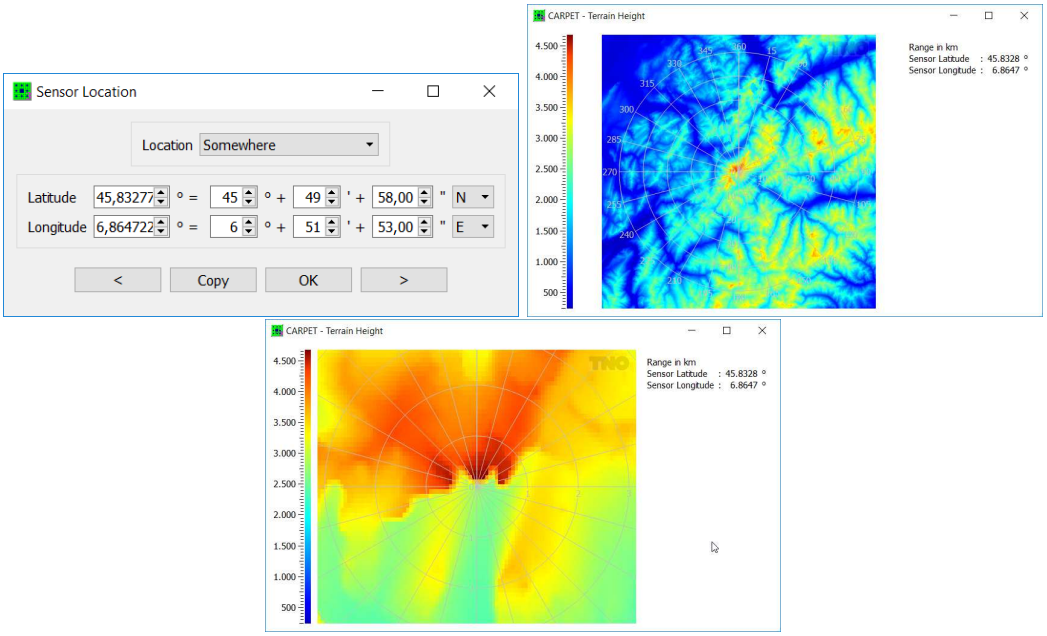


Figure 11: A failed attempt to place the radar at the summit of the Mont Blanc.

Q$_{20}$: When I plot the Detection Probability versus Range, the plot contains a lot of multipath dip (even in the lower range of 10-30 NM), see Figure **??**. Do you know why? Those dips go away as I increase the Sea State. But that doesn't seem right, or did I do something wrong?
A$_{20}$: Multipath dips are caused by destructive interference between the target response in the direct

ray and the target response in the reflected ray. If you increase the sea state, the sea surface will be rougher and the indirect component (towards the receive antenna) will be weaker, which causes the multipath effect to become less pronounced.

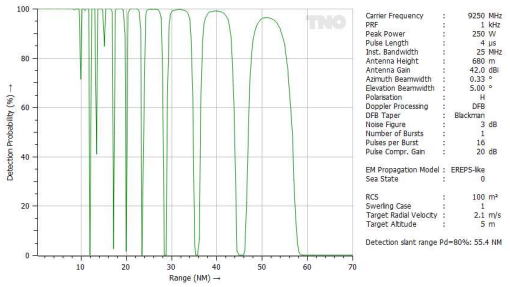


Figure 12: Multipath dips at X-band. The antenna altitude is 680 m (!), the target altitude is 5 m.

Q_{21}: My radar is close to the sea. How should I set the TERPEM terrain type?
A_{21}: If the radar is close to the sea and is looking out over the sea, the advice is to set the ground conditions (Surface Type) to be sea water. For radar frequencies above a few hundred MHz, the ground constants don't make much difference to the results.

Q_{22}: If I place my radar at (latitude,longitude)=(1.24,103.87), I get a nasty looking terrain-height map, like so:

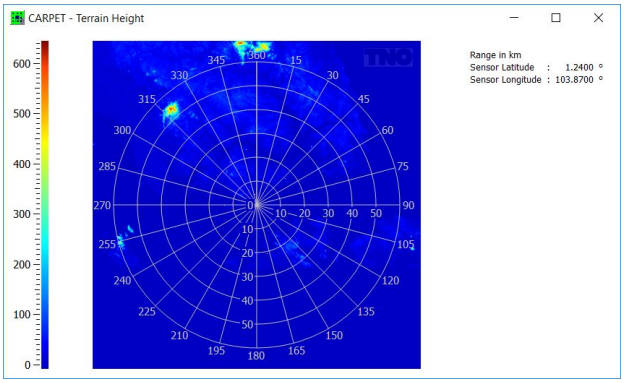


Figure 13: Nasty looking terrain-height map.

A_{22}: TNO has added Jet^2 and Jet^3 colormaps, which provide much better results.

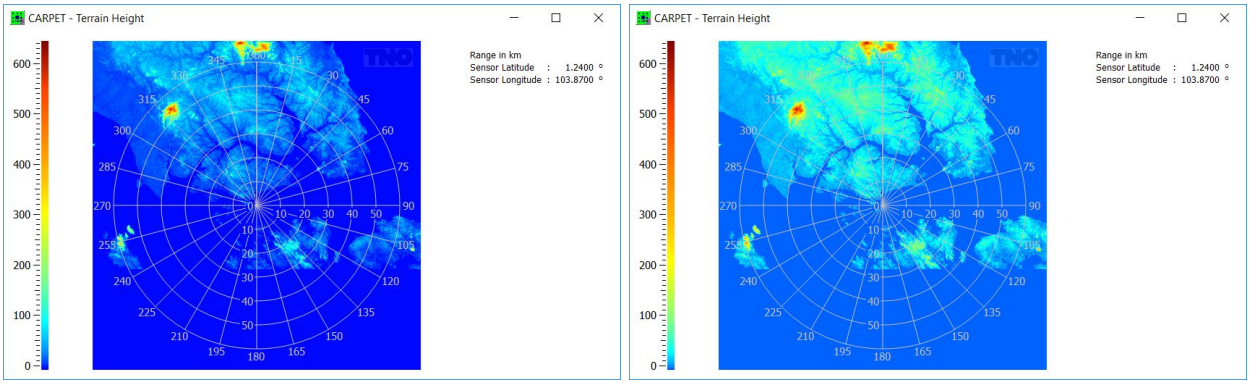


Figure 14: Better and best looking terrain-height maps.

Q$_{23}$: Can you please explain raincloud range, diameter and azimuth angle more clearly?
A$_{23}$: Figure **??** will be added to the manual.

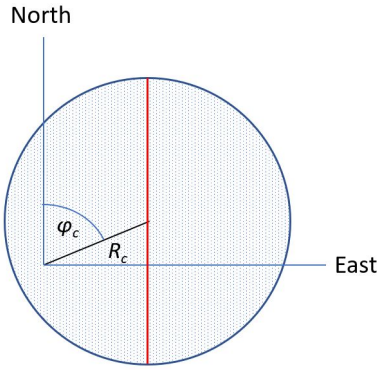


Figure 15: R_c is the range to the centre of the raincloud, ϕ_c is the azimuth angle (from North) to the centre of the raincloud. The red line denotes the diameter of the raincloud.

Q$_{24}$: What package do you recommend to evaluate modern solid-state VTS radars systems?
A$_{24}$: The multi-burst plug-in is needed, since these radars generally come with multiple pulse lengths. You might want to consider the multi-scatterer target plug-in as well, since ships, especially large ships, are no single point targets, given the spatial resolution properties of typical VTS radar systems.

Q$_{25}$: I have a scenario in rain. I noticed that when I increase the beamshape loss, the detection probability increases. Does that make sense?
A$_{25}$: Though this might look counter-intuitive, it does make sense. In case of a narrow-beam radar, the volume that causes rainclutter backscatter shrinks with the square of the beamshape loss if the raincloud is sufficiently high. The target response decreases with the beamshape loss. In case the radar beam illuminates the earth's surface, the surfaceclutter backscatter reduces with the beamshape loss. The volumeclutter backscatter may still decrease with more than the beamshape loss, dependent on the elevation antenna pattern and the height of the rain cloud. This causes the SNR to increase and hence the detection probability.

Q$_{26}$: I have an end-fed slotted waveguide antenna and a radar that applies pulse compression. Does CARPET 3 model the effect of beam squint and beam widening during the emission of a chirp (frequency modulated waveform)?
A$_{26}$: Clearly, these phenomena can seriously affect the system's resolving capability in azimuth; one shouldn't only consider the azimuth antenna beamwidth. CARPET 3 currently does not model these phenomena. Please contact TNO in case one wishes to have this effect investigated.

Q$_{27}$: I get a strangely looking PPI-view detection probability diagram, as shown in Figure **??**. Can you clarify this?

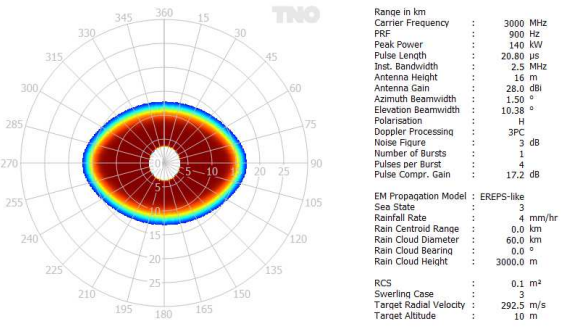


Figure 16: Strangely looking PPI-view diagram of the detection probability.

A$_{27}$: The wind direction is 0°. Thus, the rainclutter is most effectively suppressed if the antenna

bearing is either 90° or 270°. Most rainclutter is received while looking up-wind or down-wind. To illustrate this, received powers diagrams versus target radial speed for wind directions 0° and 90° are shown in Figure **??**.

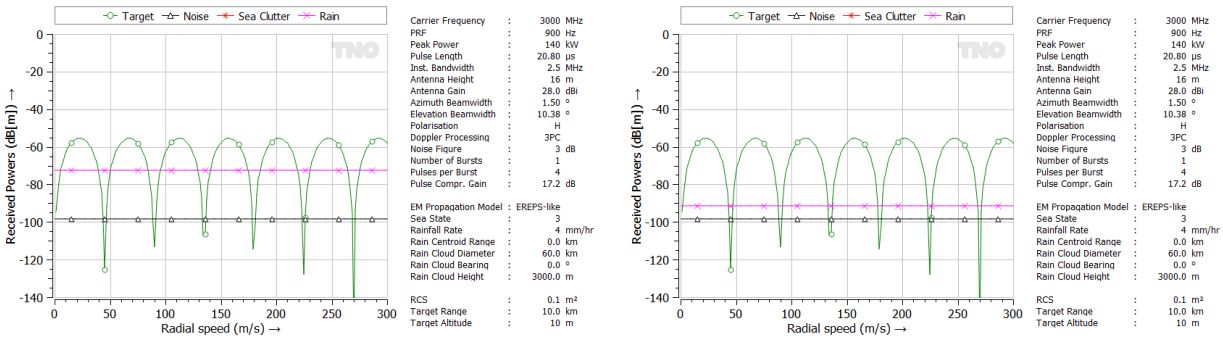


Figure 17: Diagrams that reveal an increased rainclutter level when looking up-wind (left diagram) rather than cross-wind (right diagram). The Doppler filter is a three-pulse canceler.

Q$_{28}$: Can I overlay CARPET's PPI-view image of the detection probability on Google Maps?
Q$_{28}$: CARPET 3 can produce a so-called KML (Keyhole Markup Language) file, which you can import in Google Earth (so not in Google Maps), see Figure **??**. You may probably want to adapt the 'transparency' a bit (in the Layout dialogbox) on order to get a nice picture.

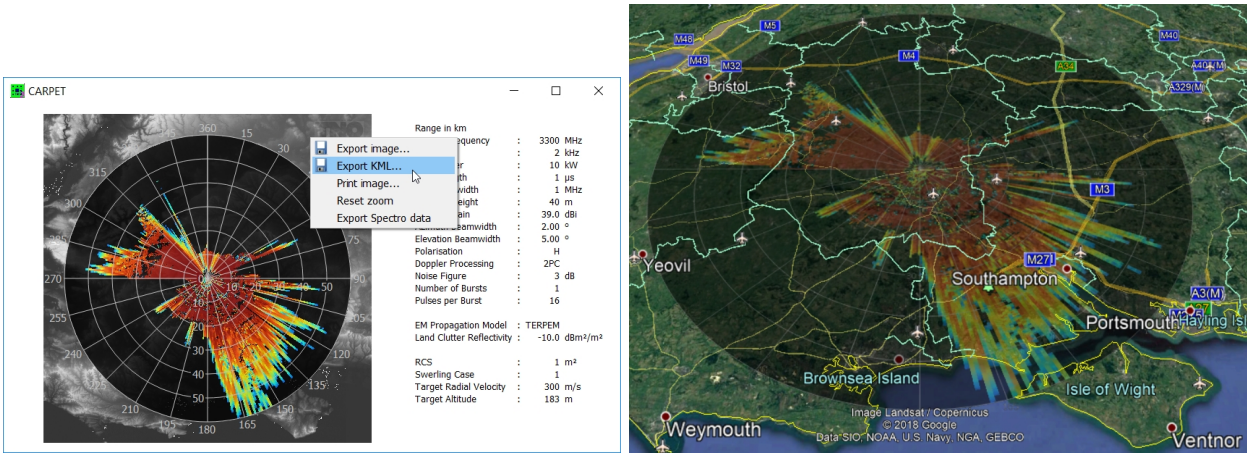


Figure 18: Illustration of the KML-file usage. The radar is close to the Stonehenge prehistoric megalithic monument, in the United Kingdom.

Q$_{29}$: How did you make the Google Earth picture showing the coverage of the coastal radar in the North-West of The Netherlands (Figure **??**)?
A$_{29}$: Our 'secret':

- Purchase the TERPEM plug-in (in case you haven't got that plug-in yet).
- Position the radar (Siting dialogbox).
- Set the transparency to 0.8 (Layout - Appearance dialogbox).
- Set the detection probability limit to 10% (Layout - Limits dialogbox).
- Set the target altitude at a proper value, realize that this altitude is with respect to the height of the terrain at the location of the radar.
- Make the diagram, *i.e.*, either the detection probability in PPI-view or the firm track probability in PPI-view.
- Right-click the picture and save to KML.
- Double-click the KML-file *et voila*. You can switch on or off the 50, 80 and 90% contours.

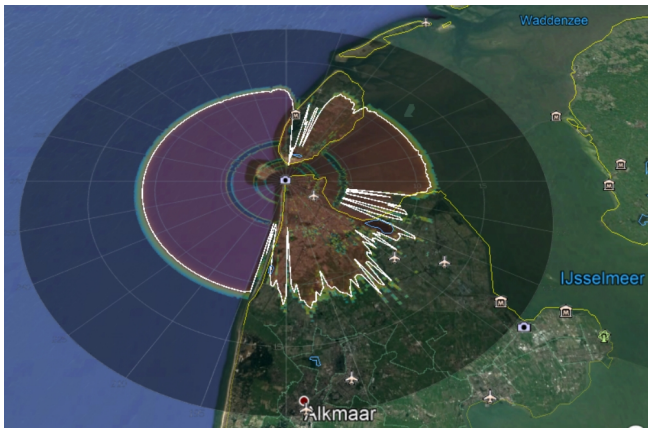


Figure 19: PPI-view diagram of the firm track probability, projected on Google Earth. The contour is at 80%.

Q$_{30}$: I place my radar at a coast. When I make a diagram of the terrain it looks as if the radar is some distance from the shore. However, it looks OK in Google Earth, via the KML file. What's going on?

A$_{30}$: Apparently, the shore doesn't show, even when the Jet[3] colourmap is applied. To fix this, TNO has added a colourmap that can be defined by the user, see Figure **??**. So users can define their own colourmap and also the levels at which the colours are applied.

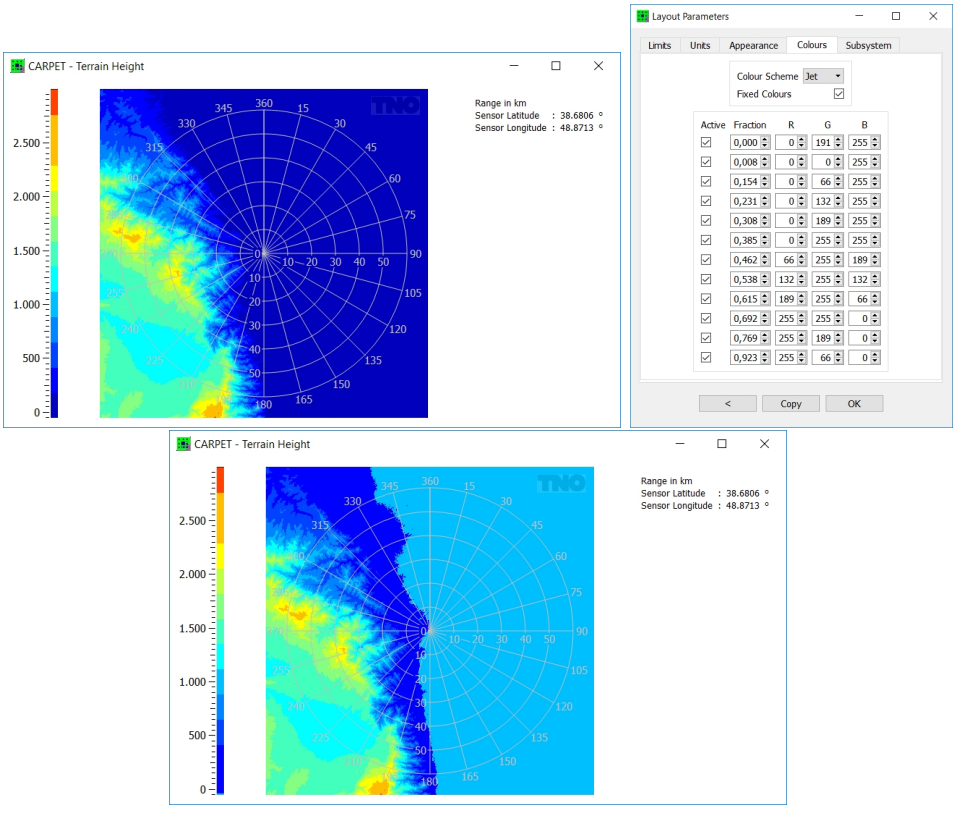


Figure 20: Top-left: Terrain-height map, Jet colourmap. Top-right: layout dialogbox revealing a user-defined colourmap. Bottom: Terrain-height map, using user-defined colours.

Q$_{31}$: My PPI-view diagram of the detection probability shows black rings, which, I am told, are a consequence of reflection at the sea surface (multipath effect). I understand that the rings are not present when using CARPET 2. Can that be true?

A$_{31}$: No, unless:

- A cumulative detection probability diagram of CARPET 2 is compared with a detection probability diagram of CARPET 3.
- The sea states are different.

We'd like to take the opportunity to point out that a radar's plot extractor usually has no memory; it doesn't know how it performed in previous scans of the antenna. Hence, the cumulative probability diagrams (in CARPET 2) was replaced by a firm track probability diagram (CARPET 3). You can presumably get rid of the rings in the confirmed track probability diagram if you 'relax' the track loss criterion, *e.g.*, 6 subsequent misses rather than 3. Whether this is allowed depends on the architecture of the track algorithm. Alternatively, the multi-scatterer target plug-in, which provides a more realistic model in the case of an extended target, can perhaps be utilised.

Q$_{32}$: The multipath dip in the North direction is wider than the multipath dip in the South direction, see Figure **??**. Are you sure this is correct?

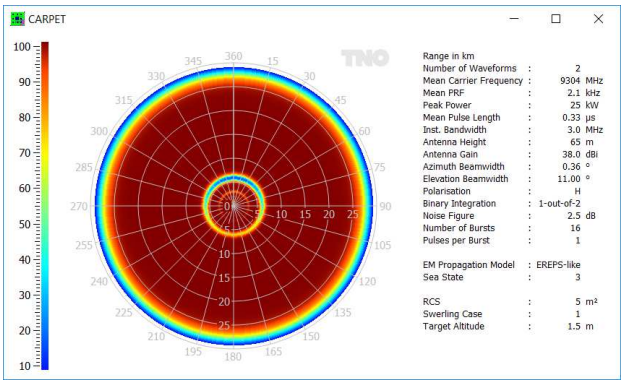


Figure 21: PPI-view diagram of the single scan detection probability.

A$_{32}$: This is a consequence of the upwind-downwind factor of the Georgia Tech seaclutter model.

Q$_{33}$: Can I download TERMET files for my simulations?
A$_{33}$, provided by Kenneth Craig: The TERMET files that can be read into CARPET are actually output files from the TERMET program. So there is no 'database' of TERMET files to download. The 'database' (such as it is) comprises a global set of refractivity statistics files and a global set of processed radiosonde ascent files. The TERPEM program manipulates these to produce the TERMET .met files. The radiosonde ascent data used in TERMET has already been processed to eliminate bad data and to convert the PTH data to refractivity. These TERMET input files could in principle be made available for download, but can not be read into CARPET without further processing. At present these files are considered to be part of the TERMET package.

If the customer just wants a way of feeding single radiosonde ascents into CARPET then the raw ascent data is freely available (*e.g.* from
https://www.ncdc.noaa.gov/data-access/weather-balloon/integrated-global-radiosonde-archive)
and CARPET can already import radiosonde codes. TERMET is not needed for this. If the customer wants global statistics of radiosonde ascents, or wants to look at time sequences of radiosonde ascents, TERMET may be useful.

Q$_{34}$: If we wait long enough, does 'The Question' get addressed as a new menu item?
A$_{34}$: Certainly, the intention of the CARPET developers is to keep the program up-to-date. It is yet, however, not clear when 'The Question' will become available.

Q$_{35}$: Line-of-sight to the terrain can be further away than line-of-sight to the target, see Figure **??**. How is this possible?

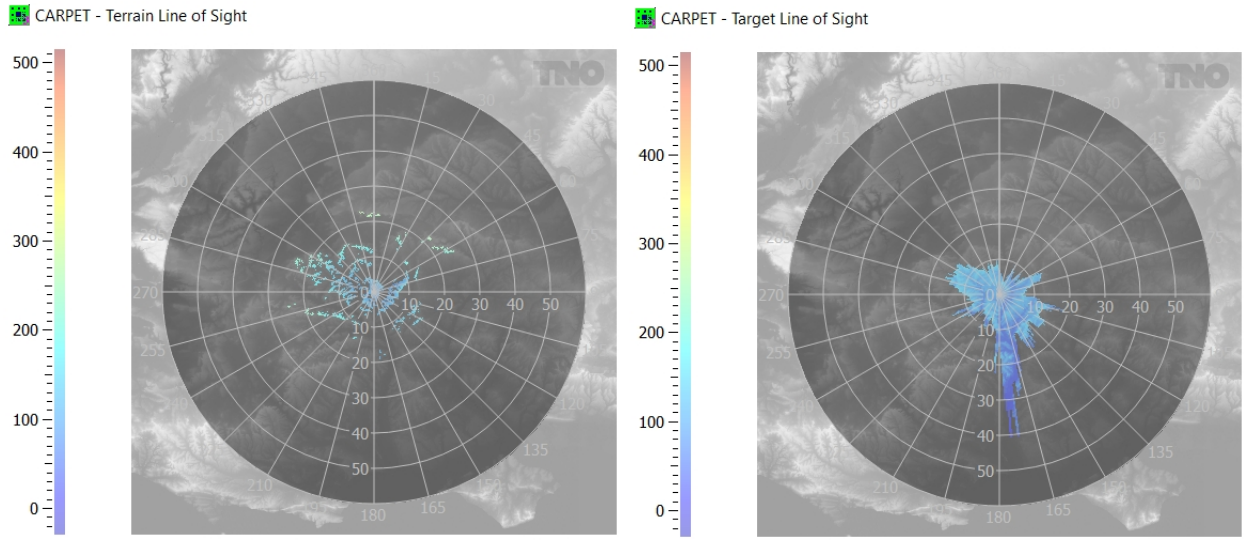


Figure 22: PPI-view diagrams. Left: terrain line-of-sight. Right: target line-of-sight. The target altitude is 50 m above the terrain at the location of the sensor.

A$_{35}$: Currently, CARPET 3 assumes a fixed target altitude, so not a terrain-following altitude profile. In case the terrain height is larger than this fixed target altitude, the terrain can be visible while the target is not. We plan to support terrain-following profiles in a next release of CARPET.

Q$_{36}$: I do not see the effect of non-coherent integration in the received powers diagram.
A$_{36}$: Indeed. But you ought to see the effect of non-coherent integration in the detection probability diagram. As explained in the CARPET manual, the number of pulses that is non-coherently integrated (and the Swerling case) is considered in the process that calculates the detection probability from the signal-to-noise-ratio. Examples are provided in Figure **??**.

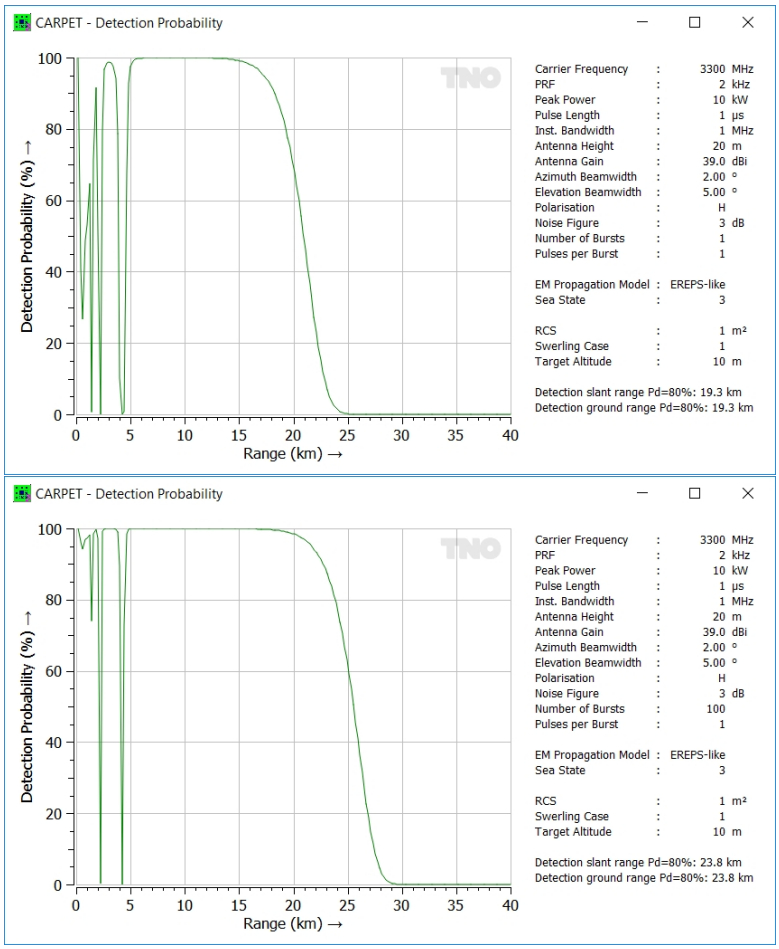


Figure 23: Illustration of the effect of non-coherent integration. 100 responses are non-coherently integrated in the diagram shown at the bottom. Non-coherent integration is not applied in the diagram shown at the top.

Q$_{37}$: I see a substantial difference between the detection range according to the Blake-chart and the detection range according to the CARPET diagram. Why is this?

A$_{37}$: Please realise that a Blake-chart uses several simplifications, which are not being used in a CARPET detection probability diagram. One aspect, for instance, is the radial speed of the target. The Blake-chart has no such thing as target radial speed. One has to derive some sort of 'mean Doppler filter gain' and consider this in the Blake-chart. CARPET on the other hand, determines Doppler filter gain given the target's radial velocity, the number of pulses per burst and the (pre-Doppler-Fourier Transform) amplitude weighting function. The Doppler filter gain for the clutter component is determined as well. If one chooses the radial velocity unfavourable, there is poor benefit from coherent integration since both clutter and target responses are amplified. The comparison with the Blake-chart will completely fail in this case, as illustrated in the Figures below. (It is for this reason that CARPET can average detection probabilities within a certain radial velocity interval.) Another aspect is the multipath phenomenon. A vertical coverage diagram, such as the one displayed in Figure **??** can have distinct 'fingers' (or 'lobes') as a consequence of the multipath effect. The Blake-chart utilises only a single pattern propagation power factor. Under certain conditions, however, the Blake-chart is in agreement with CARPET results. These cases are discussed in the CARPET manual, Section 5.2.

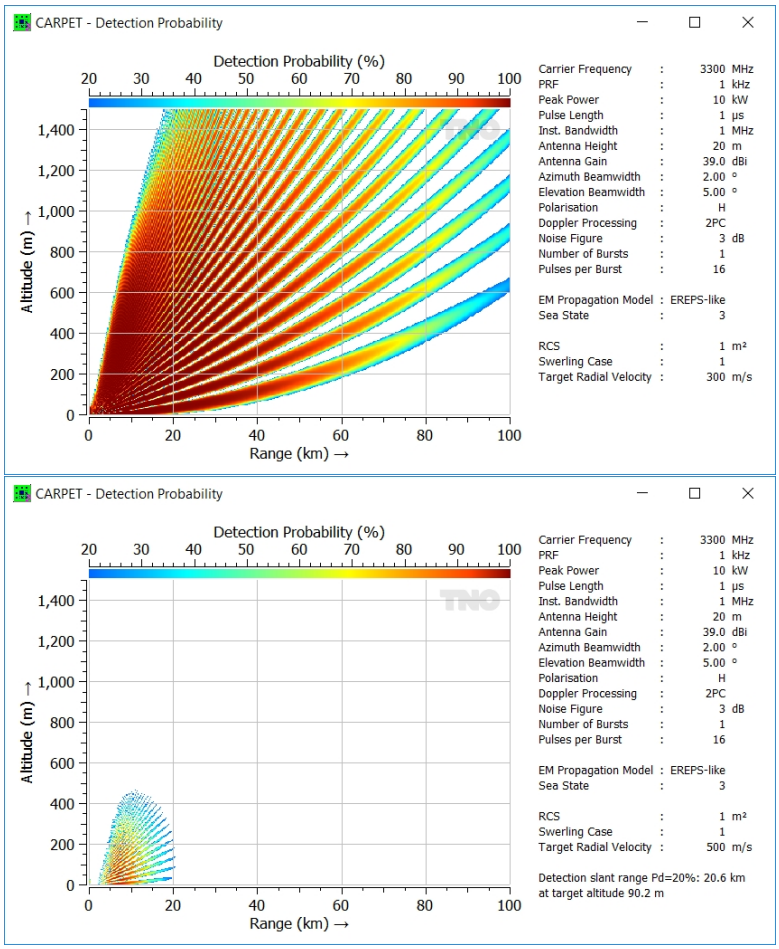


Figure 24: Illustration of multipath lobes (or 'fingers'). The difference between the diagram at the top and the diagram at the bottom is solely caused by the radial speed of the target.

Q$_{38}$: If I increase the number of pulses per burst while both pulse canceller and the Doppler filter bank are off, nothing changes. Do you perhaps know why this is the case?
A$_{38}$: Coherent integration is switched off, apparently the radar (mode) is 'non-MTI'. The number of responses that is non-coherently integrated is defined by the number of bursts, so not by the number of pulses. CARPET treats this situation as if there is a single pulse. If you would like to integrate the responses non-coherently, specify a specific number of bursts and set the number of pulses to unity.

Q$_{39}$: Why can't I use TERPEM and a tracking radar?
A$_{39}$: A so-called 'TERPEM run' is executed once per azimuth line. In the case of a tracking radar, the antenna pattern changes as the target position changes, so that multiple TERPEM runs must be executed for most diagrams. This will severely affect the execution time. TNO plans to build a 64 bits version of CARPET in the near future, which hopefully, runs faster. We will then reconsider the combination TERPEM and tracking radar.

Q$_{40}$: I did a comparison between CARPET 2 and CARPET 3. I noted two aspects: a) the power levels are different, b) in the presence of rain, the detection ranges differ. Can you please explain this?
A$_{40}$: CARPET 3 indeed applies a different so-called 'reference-plane' than CARPET 2, in order to ease the comparison with the Blake-chart worksheet. This explains why the power levels are different. The second aspect relates to the Processing Loss of CARPET 2. This specific loss was applied (in CARPET 2) to both the target and the clutter responses, perhaps somewhat illogically. If you set this loss to 0 dB, CARPET 2 and 3 match also in the presence of rain. Given the more detailed loss specification of CARPET 3, Processing Loss was eliminated in CARPET 3.

Q41: I find the spatial resolution of the GeoTIFF output somewhat disappointing. What now?
A41: The spatial resolution is given by the number of azimuth angles and the number of range points. As per May 14$^{\text{th}}$ 2019, TNO has doubled the number of range points to 1000. It is also advised to specify the maximum range (Layout - Limits dialogbox) as low as possible.

Q42: I have quite a neat PC with 40 logical processors. When I make a PPI-view diagram of the P_d, CARPET seems to utilise only eight processors?
A42: That is correct and indeed suboptimal. In the latest version of CARPET 3, many more processors will be utilised, as illustrated in the Change-log document.

Q43: Can I simulate an airborne radar against a maritime surface target by giving the ship an (unrealistic) high speed, equal to the ground speed of the airframe?
A43: Not really, since the surface clutter will be Doppler-shifted as well. So: either wait for the airborne radar plug-in, or provide funding to TNO to develop this specific plug-in.

Q44: Why has the cumulative detection probability diagram been eliminated? What should I use in stead?
A44: The cumulative detection probability is a quantity that does not match with the way that the signal processing, up to and including tracking, is organised in modern radar systems. How is the radar supposed to remember P_d-values in all previous scans? Modern radar systems have a tracker or multi-scan correlator that suppresses false alarms. Hence, firm track probability is offered in CARPET 3, rather than cumulative detection probability. The user has to specify two features of the tracker: the track initiation criterion and the track loss criterion. In the case that a radar system does not possess a local tracker, our advice is to evaluate the single scan detection probability.

Q45: Is it true that I can define an unrealistic vertical antenna pattern?
A45: Yes, CARPET 3 currently does not check if the antenna pattern that is being specified is physically feasible.

Q46: I would like to find out if there is a way to export simulation settings from CARPET?
A46: ASCII-formatted output of CARPET settings is currently not supported. Obviously, it is extremely straightforward to write ASCII-output of CARPET settings using the Python plug-in.

Q47: Is the Python plug-in useful?
A47: As a near-daily user of CARPET, the author of this document finds the Python plug-in very useful and time saving. Another CARPET-user states the following: 'I am getting on very well with the automation interface as a whole. It has taken a little while to get going, but appears very useful and significantly more efficient than the process we were using to automate CARPET 2.'

Q48: I change the dissipative loss in the antenna, but the system's noise floor seems not to change. How come?
A48: The reason is actually explained in the CARPET manual, in Section 6.2.1. Please realise that the dissipative loss in the antenna affects the antenna temperature. If the galactic activity is discarded, however, CARPET assumes an antenna temperature of 290 K, so the dissipative loss is not being considered. You will see that when you do not discard the galactic activity, the dissipative loss does affect the antenna temperature.

Q49: Can CARPET generate IQ data? I want to test my own Doppler filtering and detection algorithm, using the Python plug-in.
A49: There are several issues involved when one wants to derive (coherent) IQ data from the received powers. The nut that is hardest to crack is undoubtedly the generation of clutter data. CARPET relies upon clutter with 'mean' Doppler spectral properties, *i.e.*, Doppler frequency shift and Doppler spectral width, quantities that are dependent on the antenna's azimuth angle, the wind direction

and the rotational speed of the antenna. Generating time series that fulfill these properties, on a pulse-to-pulse basis, is challenging. Without additional funding, TNO can not provide this demanded functionality. We have, however, added functionality to the Python plug-in so that received powers versus range can be queried. An example of a Python program that uses this functionality is given in the latest version of the CARPET manual.

Q$_{50}$: It seems that I cannot utilise NumPy in the Python plug-in?
A$_{50}$: To remedy this obvious shortcoming, CARPET 3 now comes with Python 3.8 on board.

Q$_{51}$: An S-band radar integrates sixteen pulses coherently, and applies a Hamming taper. The PRF is 833 Hz. I would expect the surface clutter to be effectively suppressed, after all, the sidelobe level of the Doppler filter response curves is 40 dB 'down', but this doesn't seem to be the case. Why not?
A$_{51}$: Your Doppler filter response curves are shown in Figure **??**.

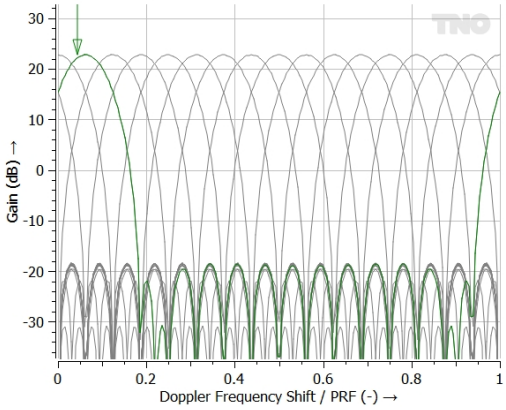


Figure 25: Doppler filter Response cuves.

Indeed, the sidelobes are 40 dB down the mainlobe. Note, however, that the SCNR-improvement due to Doppler filtering does not hold for three of the sixteen filters. It depends on the radial speed of the target which Doppler filter is active. The first blind speed in your case is 46 m/s (according to $v_b = \frac{\lambda \cdot PRF}{2}$). Discarding Doppler filter straddling losses, the SNR improvement due to Doppler filtering is approximately 10.2 dB ($10 \cdot \log_{10} 16 - L_t$, L_t is taper loss, approximately 1.8 dB). Received power curves versus target radial speed without and with Doppler filtering are shown in Figure **??**. Like SCNR-curves are shown in Figure **??**.

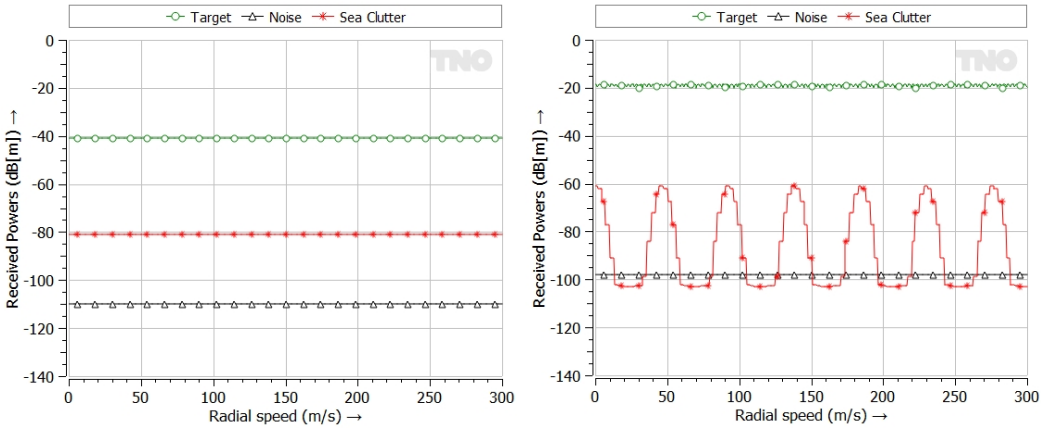


Figure 26: Received powers versus target radial speed. Left: no Doppler filtering, Right: 16-point Doppler filter bank.

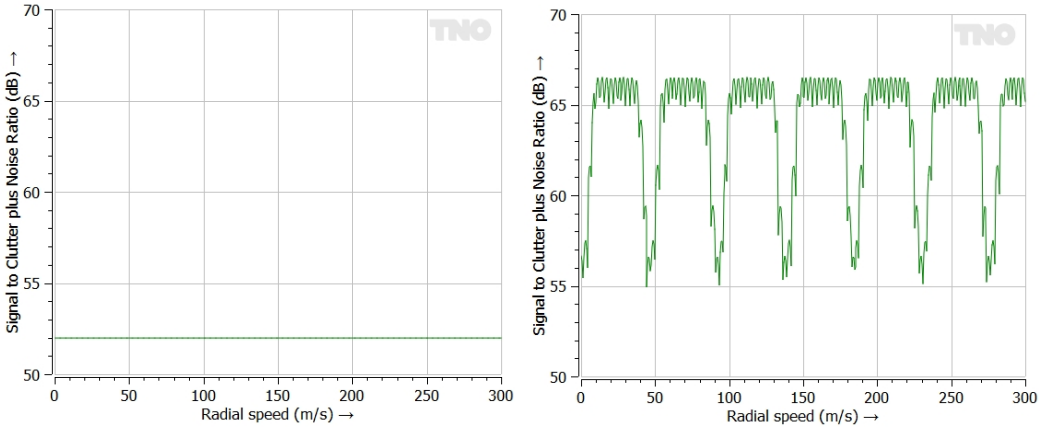


Figure 27: SCNR versus target radial speed. Left: no Doppler filtering, Right: 16-point Doppler filter bank.

If we average from zero m/s to the first blind speed, the velocity-averaged improvement of the SCNR is 10.2 dB when surface clutter is absent. With surface clutter enabled, the improvement appears to be 4.3 dB. We have assumed seaclutter in these simulations with 7.6 m/s wind speed.

Q_{52}: How easy is it to use CARPET?
A_{52}: Well, we often receive compliments with respect to the ease-of-use. Clearly, however, 'a certain level' of radar expertise is required. Though CARPET 3 tests numerical input on 'reasonableness', ludicrous combinations of values can be made, which leads to rubbish-in, rubbish-out. Please realize that TNO is available for consultation.

Q_{53}: We want to simulate the coverage of many radar sites simultaneously. How can we do that?
A_{53}: CARPET 3 is a single-radar performance assessment program. However, with the Python plug-in, it is relatively easy to do analyses for multiple radars. The graphical output can be combined in programs such as QGIS and ArcGIS.

Q_{54}: I would like study radar coverage and I would like to know if the basic version of CARPET will be enough to do so.
A_{54}: If landmasses are involved, the TERPEM plug-in is required.

Q_{55}: I have a question, something I have never fully understood since I have been using CARPET and I should have asked before... What is the meaning of the terms 'bursts' and 'pulses'? I have always considered the 'bursts' as the number of hits on the target during the dwell time: so, I thought it was something related to the radar PRF, antenna rotation speed and antenna beam width. For example, if I have a magnetron radar and PRF = 2 kHz, antenna speed 22 RPM and antenna beam width of 1° I have a dwell time of 7.58 ms and 15 hits on the target, so I used to consider the number of bursts to be 15. Is this correct or not? And what about solid state radar with pulse compression? Here we do not have pulses but waveforms, each one with several pulses, say M. In case I have the same situation as above, is the number of bursts still 15? And what about the number of pulses? Is it the number of the pulses I have in my waveform (Pulses = M)?
A_{55}: You must distinguish between coherent integration, which requires a solid-state radar, and non-coherent integration. The number of pulses is the number of echoes that is coherently integrated. The number of bursts is the number of responses that is non-coherently integrated. So, an old fashioned magnetron radar that integrates (non-coherently) N pulses can be specified with Number of Bursts is N and Number of Pulses is 1. An advanced coherent radar that integrates coherently N pulses after which M outputs of the integrator are non-coherently integrated must be specified with Number of Bursts is M and number of Number of Pulses is N.

Clearly, all the pulses must fit in a dwell, *i.e.*, the Number of Bursts times the Number of Pulses times the PRI must be less than the time that the beam is aimed at the target, which depends on the rotation rate of the antenna and the antenna beamwidth. CARPET doesn't check this explicitly, so

it's up to the user of CARPET. Note however, that CARPET does indicate the time that it takes to transmit the specified waveform.

We do not know if the number of 15 in the example that you give is correct. Surely, 15 pulses fit in the dwell, but if the radar architecture is such that 15 pulses are non-coherently integrated must be asked at the radar manufacturer.

Certain radars vary the PRF, RF and possibly also number of pulses that are coherently integrated from burst to burst, for instance to eliminate dead zones in range and/or velocity. If you want to simulate such radars you should have the multi-burst plug-in.

Q$_{56}$: I noticed that when I increase target speed, the firm track probability curve shifts to the left, see Figure **??**. Why is this?

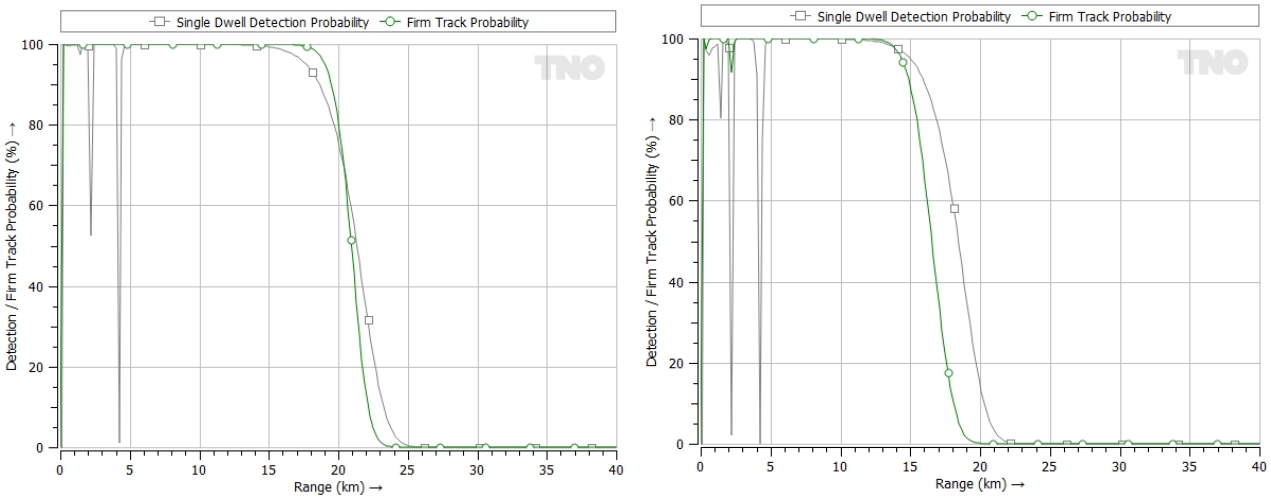


Figure 28: Firm track probability versus range. Left: 300 m/s radial speed. Right: 900 m/s radial speed.

A$_{56}$: The firm track probability at a specific range is derived from the detection probability at that specific range and from detection probabilities at ranges during previous scans of the radar, see the IEEE-article of Richard Worsham (the reference is in the CARPET manual). In your case, you have an inbound travelling target and the P_d-curve gradually goes up when the target approaches. If you increase target speed, the ranges that are considered are more widely spread, and the P_d-values that are considered are lower compared to the low-velocity case. This is the reason why the P_{ft}-value is lower when the (inbound) target travels faster. This is, we believe, in accordance with expected behaviour. A track of a fast inbound target will initially be painted on the screen at a shorter range, compared to the track of a slow inbound target.

Q$_{57}$: I now have a curved computer display. But the dialogboxes look awful, the text is much too big. How to adjust this?
A$_{57}$: Font Size has been added to the Layout dialogbox. Please re-start CARPET after a modification to the font size has been made.

Q$_{58}$: With the EREPS-like propagtion model I can switch off multipath (in the vertical plane). But is seems that I cannot do this with the TERRPEM-light propagation model. Am I right?
A$_{58}$: Ken Craig (Signal Science) provided the following answer: The simple answer to the question is 'Yes, you're right'. But if the reason for wanting to set the reflection coefficient to zero is to prevent reflections from the ground, then there are ways of getting close to this. A reason for wanting to do this would be to remove the interference lobes from the coverage diagram in order to visualise the 'mean' field due to atmospheric refraction and ground diffraction without the complication of ground reflections. I will assume that this is the case.

The simple way to do this is to set the wind speed (in the Met data) to a high value. This will produce a reduction in the reflection coefficient. (The roughness model is the Miller-Brown model

intended for sea surfaces, but it still applies for land surfaces even although the model is not really physically correct in this case.) This reduction of reflection coefficient will apply to both the parabolic equation (VPE) and ray optics (RO) sub-models. TERPEM imposes a lower limit of 0.15 on the roughness reduction factor multiplying the complex reflection coefficient, so this won't completely remove the effect of the ground. But it should still produce a reasonable reduction. (A factor of 0.15 amplitude reduction in the reflected rays means they are 16 dB down on the direct rays and so produce lobes that should be only about 1 to 2 dB deep.)

Q$_{59}$: Why don't I see dead zones because of pulse eclipsing (receiver switched off when a pulse goes out)?
A$_{59}$: This is because you have specified an eclipsing loss. Please be aware that CARPET's eclipsing loss is there to deal with radars that select PRFs randomly, so that the specified waveform is indicative rather than representative.[2]

Q$_{60}$: The landscape looks very weird, see Figure **??**. You know the cause?

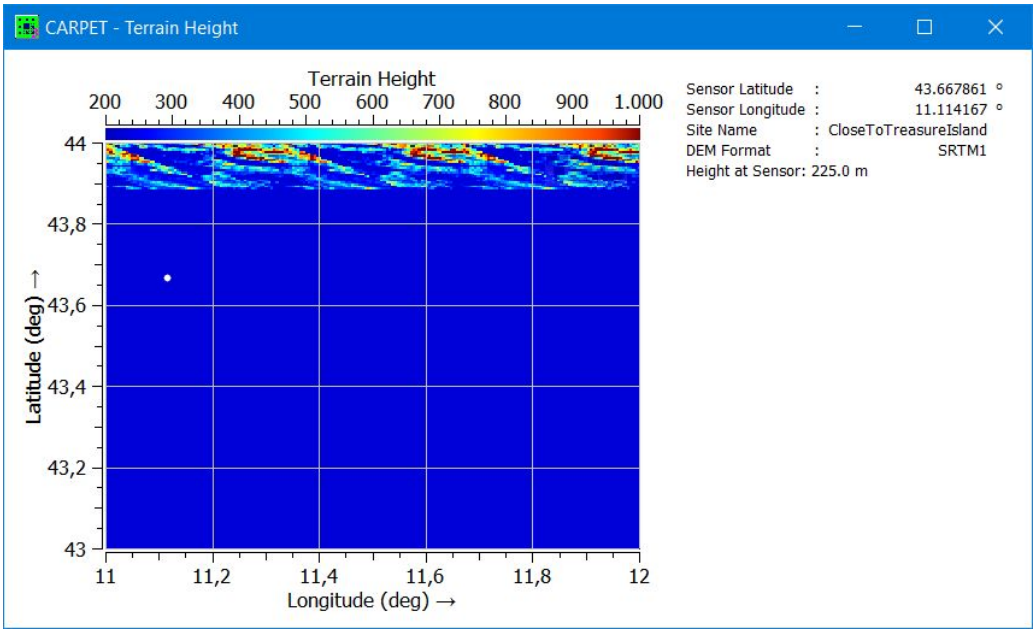


Figure 29: Strange landscape.

A$_{60}$: CARPET 'thinks' that you have SRTM1 (30 m, 25327 kbyte) tiles, while you have SRTM3 (90 m, 2818 kbyte) tiles. Apply File - Select Directory - SRTM3 (90 m) Directory, select the proper directory (or 'folder') and this will be the result:

[2]On 3rd August 2022, CARPET 3 was modified so that the initial dead zone remains in tact if an eclipsing loss is specified.

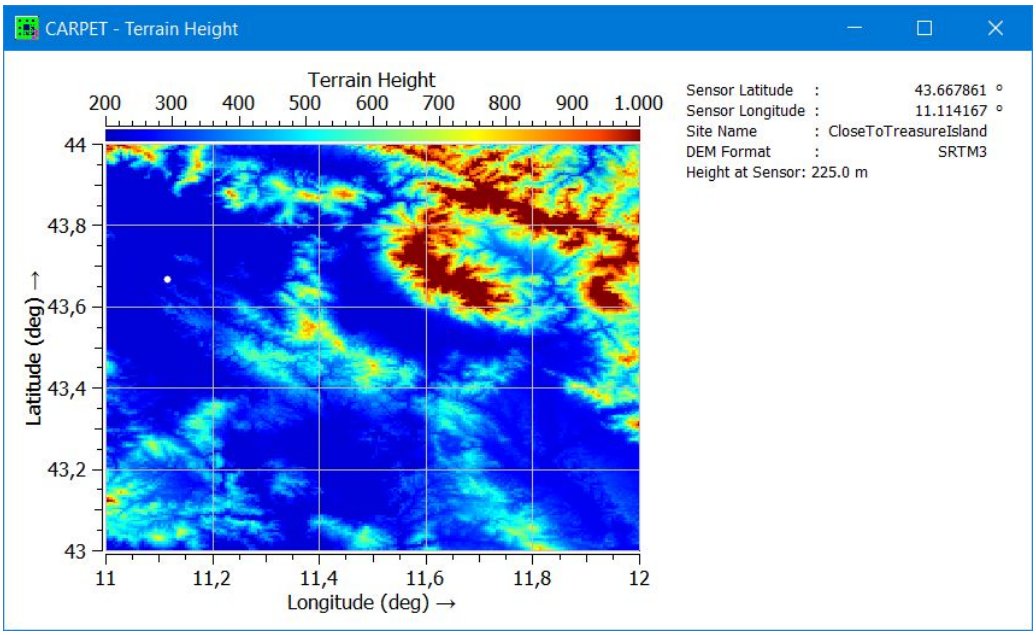


Figure 30: Proper landscape.

Q$_{61}$: On Linux: when I execute CARPET3, which is apparently installed in `/opt/tno/carpet3/bin`, I get a message that Qt library files 'clash'. What now?
A$_{61}$: You have to specify the environment variable `LD_LIBRARY_PATH`, and it has to point to the directory where CARPET3 expects Qt lib-files, which is in `/opt/tno/carpet3/lib`. On the Ubuntu 22.04 machine of the author `LD_LIBRARY_PATH` didn't exist at all, which you can see when you give the `printenv` command. The author subsequently modified the `.bashrc` file in his home-directory and added the line
`export LD_LIBRARY_PATH=/opt/tno/carpet3/lib`
Subsequently, give the command
`source ~/.bashrc`
You can check with `printenv` that the `LD_LIBRARY_PATH` environment variable now exists. Finally, execute CARPET3 by issueing the command
`/opt/tno/carpet3/bin/CARPET3`

Q$_{62}$: Upon opening up the CARPET App, it appears with all fonts and symbols very much oversized. How can I fix this?
A$_{62}$: Under Layout Appearance there is a font size editbox. Change the font size, close CARPET and restart it.

Q$_{63}$: I use a three-pulse canceller to suppress seaclutter. I noted that the P_d-curve doesn't change when I increase the number of pulses, for instance from 8 to 32. Why is this?
A$_{63}$: A three-pulse canceller implies that no more than three pulse-responses are integrated. If you want to integrate coherently more than three pulse-responses, the Doppler filter bank is more appropriate. In case of scanning radar beam, do not forget to specify an appropriate value for the beam-shape loss, since not all target echoes will experience the full antenna gain. You might find the worksheet Azimuth Beam Shape Loss useful.

Q$_{64}$: Can I change transmitter, waveform, and antenna patterns in CARPET and maintain those parameters after running the Python code multiple times?
A$_{64}$: When you re-execute a Python program, the program 'starts from scratch'. If you do not want to define the many settings in the Python program, it is easiest to save the settings in a file using `carpet.SaveConfig`. At the beginning of the python program you call `carpet.LoadConfig` which loads the settings.

```
import carpet
import os
import math
import sys
carpet.Processing_DFB = True
carpet.Processing_MTI = False
carpet.Target_Altitude = 100.0
carpet.Target_RadialVelocity = 450.0
print("Processing_DFB=",carpet.Processing_DFB)
print("Processing_MTI=",carpet.Processing_MTI)
print("Target_Altitude=",carpet.Target_Altitude)
print("Target_RadialVelocity=",carpet.Target_RadialVelocity)
plot = carpet.CarpetPlot("pd_r")
plot.wait()
carpet.SaveConfig("C:/Temp/Example.par")
```

Subsequently, you can use a program like this one.

```
import carpet
import os
import math
import sys
carpet.LoadConfig("C:/Temp/Example.par")
print("Processing_DFB=",carpet.Processing_DFB)
print("Processing_MTI=",carpet.Processing_MTI)
print("Target_Altitude=",carpet.Target_Altitude)
print("Target_RadialVelocity=",carpet.Target_RadialVelocity)
plot = carpet.CarpetPlot("pd_r")
plot.wait()
```

3 Abbreviations

ASCII	American Standard Code for Information Interchange
CARPET	Computer Aided Radar Performance Evaluation Tool
FMCW	Frequency Modulated Continuous Wave
KML	Keyhole Markup Language
PC	Personal Computer
PRF	Pulse Repetition Frequency
RF	Radio (or Radar) Frequency
SNR	Signal-to-Noise Ratio
SRTM	Shuttle Radar Topography Mission
TNO	Netherlands Organisation for Applied Scientific Research
VTS	Vessel Traffic Services
WGS	World Geodetic System