
BLAST height transformation tool

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1 Background

DTU Space has been involved in WP 3.5 of the BLAST project, developing vertical reference framework for the North Sea region. As a part of these activities, transform parameters between different vertical reference systems (VRF) have been estimated. For more details on the systems and their different properties and regions of validity, see the report [1]. Another major part of DTU's activities has been to develop a software tool to implement the transformation between the different VRF's.

The tool has been developed in the C++ programming language. Using its object oriented nature, much of the work has been encapsulated in classes and their methods. The tool described on these pages is a simple text-based program for the command line interface (CLI). However, using the classes developed, it should be a straightforward task for an experienced GUI programmer to design a graphical interface on top of it.

2 Installation

2.1 Data

The data is distributed in a zip-file, and unzips to two folders called `vrf` and `masks`. The data have to be copied to a folder where `blastraf.exe` can find them. The default location for the data is `C:\blastdata`, where the program expects to find the folders `C:\blastdata\vrf` and `C:\blastdata.masks`. However, the two data folders may be also be copied to any path on the computer. In that case, the path has to be specified in the environment variable `BLASTDATAPATH`. On Windows XP, this can be done in Control-panel – System Properties – Advanced – Environment variables.

2.2 Windows

The distributed binary file depends on the Microsoft Visual C++ 2010 redistributable package, `vc_redist_x86.exe`, which is delivered along with the executable file. The executable, `blastraf.exe`, can be copied to, and run from, any directory. We recommend copying it to a new directory at `C:\ProgramFiles\blast`.

2.3 Unix / Linux / MacOS

At this point, we do not distribute a binary for other operating systems than Windows. However, the program is written in plain C++, so compiling under other systems should be straightforward. If you wish to run *blastraf* under other systems, please don't hesitate to contact us (iein@space.dtu.dk), and we will try to provide a binary for your system.

3 Vertical reference frames

The vertical reference frames are organised in numbered categories based on countries. For each country, we can choose a vertical reference frame. For each country, there is a land system (derived from the European Vertical Reference Frame, EVRF2007 by a constant offset for each country), and a national lowest astronomical tide (LAT). Additionally, for the United Kingdom, there is defined an additional chart datum (CD), which differs from the LAT surface, and is usually lower. In fact, one may choose the chart datum option for all the countries, but in all other cases than the UK, this is the same as the LAT surface.

In addition to the national reference frames, there are also transnational height systems (such as EVRF2007, or the EGG2008). These are organised under the BLAST pseudo-country. Thus, each system can be identified by two numbers. The country code, and the system code. The codes are listed in table 1. Note the different meaning of the system codes for

Country (code)		System (code)	
Norway	(1)		
Sweden	(2)		
Denmark	(3)	Land	(1)
Germany	(4)	LAT	(2)
Netherlands	(5)	CD	(3)
Belgium	(6)		
United Kingdom	(7)		
BLAST	(8)	EVRF07	(1)
		LAT	(2)
		EGG08	(3)
		MSS	(4)
		Ellipsoid	(5)

Table 1: Vertical reference frames. Note the difference between the BLAST pseudo-country and the “traditional” countries.

the BLAST pseudo-country nr 8, when compared with the other country codes. As an example, the German land system has country code 4, system code 1 while the EGG08 geoid is identified by the combination of country code 8 and system code 3.

4 Program behaviour

The executable (*blastransform.exe* on windows machines, *blastransform* on other platforms) can be run with three different flags to influence its behaviour, **-c**, **-i** and **-f**. We will now shortly describe the influence of each option, as well as the default behaviour of the program.

4.1 Batch mode vs. interactive mode

4.1.1 Batch mode

When run without any options, the program starts in batch-mode. In this mode, the program reads a text file containing information on height points, and transforms the heights into any given VRF. A data file may contain height points in different VRFs, while the transformation can be performed into only one VRF at a time. The program asks for the following information, in this order:

- Path to file containing the height points that are to be transformed.
- Country code of the VRF that the height points are to be transformed to.
- System code of the VRF that the height points are to be transformed to.
- Output file. The results of the transformation are written to this file. Alternatively, the filename “-” can be supplied to use a default file name provide by the program. This is constructed by removing the postfix of the input filename, and replacing that with “.out”. As an example, the input file *heightpoints.dat* would result in the default output filename *heightpoints.out*.

To obtain this information, the program reads standard input (std). Therefore, the information can be supplied by hand through the terminal. Alternatively, the options may be written to a text file and provided to the program by using the redirection operator <.

Assume we have typed height data into the file *heightpoints.dat*, and want to transform those points into the European vertical reference frame (EVRF2007) system, we write the following to a text file, say *options.cmd*

```
heightpoints.dat 8 1 heightpointsTransformed.dat
```

Subsequently, we give the following command on the command line:

```
blastransform.exe < options.cmd
```

This will result in the heights of the points described in the file *heightpoints.dat* to be transformed into the EVRF2007 reference frame, and the results written to the file *heightpointsTransformed.dat*. For specifying the height system of the points in the input file, refer to section 5

4.1.2 Interactive mode

When run with the flag **-i**, *blastransform.exe* starts in interactive mode. In this mode, it is possible to type in information interactively. First, the user is prompted to type in an output file name. Subsequently, the programs enters a loop where it asks for the following information

- Country code of the VRF in which point height is given.
- System code of the VRF in which the point height is given.
- Latitude of the height point.
- Longitude of the height point.
- Height of the height point in the VRF specified above.

- Country code of the VRF that the height points are to be transformed to.
- System code of the VRF that the height points are to be transformed to.

At the end of each loop, the transformed height is calculated and the results written on screen. To end the program, type -1 for the country code. At this point, the results of all the transformations will be written to the output file specified.

5 Data format

The data format used by *blastransform.exe* is static. This means that each data file describes the data as it is, but does not contain any commands to the program itself on how to transform the data. Commands to *blastransform.exe* are given exclusively via standard input.

A data file may contain any number of header records. These are marked by the letter “#” at the beginning of the line. Any whitespace at the beginning of any line is ignored. All lines whose first non-whitespace character is not “#” are interpreted as height point data. The format of a line containing such data is

```
ID lat lon h country system
```

where

ID is a point identification, and can be any string.

lat is the point latitude.

lon is the point longitude.

h is the height of the point in the reference system described by the last two entries:

country is the country code, according to table. 1.

system is the system code, according to table 1.

As an example, the following is a legal input file:

```
# this is a comment
# also this
#The data is as follows:
#ID      lat  lon      h      country  system
pt1      55.1  8.4      2      1        1
2        56.3  9.8      3      2        1
33293    57.8  10.34    4      2        1
heightpt 57.8  10.321   5      8        5
```

5.1 Output – the option -c

When writing the results of height transformation to a file, we use the data format described above. The default behaviour is to write the data description line

```
#ID      lat  lon      h      country  system
```

as a comment, immediately before the first data point. The line

```
# Height point list transformed using the BLAST height\
  system transformation tool
```

is also written as a comment in the first line of the file. When repeatedly transforming the same data file, this can of course lead to the same comment being repeated many times, but we find this an important security feature, to prevent any misunderstanding on the origin and format of the data.

When working in batch mode, the default behaviour is to keep the comments that were in the input file. In case comments are not desired, the program can be run with the option `-c`. In that case, the output file is written without any comments at all.

6 Masks

In [1] it is discussed in some detail, that some of the vertical reference frames are valid only within a limited area. Some systems can not be reliably extrapolated arbitrarily outside their “natural habitat”. To reflect this, along with each system we provide a “validity mask”. Each such mask covers the natural extent of the corresponding system, plus an overlapping zone of 3 km, in which all the systems can be reliably extrapolated. When performing a transformation, the program checks whether or not the point is within the validity mask of both systems. If that is not the case, the transformation is not performed, but the string `nan` (Not A Number) is returned instead.

In certain cases, it can be justifiable to ignore the validity region of a system. This is in particular true for the national height systems on the European continent, where all the land systems are defined via a constant offset from the EVRF2007 system. To override the mask check in such cases, the program can be run with the `-f` (for force) option. Note that while this program is in general intended for people who know what they are doing, this is in particular true for the usage of the `-f` switch. Extrapolating a system for long distances outside of the region of validity may introduce an error of dozens of centimetres or even meters.

References

- [1] G. Strykowski, O. Andersen, and R. Forsbert. BLAST vertical datums: conventions and decisions. Technical report, DTU Space, 2010. [1](#), [5](#)