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DATA PAPER

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The gravity database for Belgium

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Abstract

Data and metadata products based on intensive terrestrial gravity measurements covering the Belgian territory have been established compliant to the new ISO19115-1 profile for gravity-related data. A short historical introduction on gravity measurements on the Belgian territory is presented, starting with the first gravity measurement in 1892. This paper focuses on gravity data acquired after 1971, which marks the adoption of IGSN71 as a reference for the world network by the International Association of Geodesy (IAG). Next to a complete dataset containing all Belgian gravity data, the available gravity data were reduced to the corresponding

Dataset

This article describes the dataset of Belgian relative gravity measurements. One dataset is created containing all Belgian relative gravity measurements, for detailed analysis all gravity stations were reduced to the respective acquisition. For each gravity acquisition campaign, metadata concerning acquisition and processing are made available. Metadata are published via the Belgian Federal Geodata Portal www.geo.be, maintained by the National Geographic Institute (NGI), distribution of the dataset is facilitated by the Royal Observatory Belgium (ROB). Following details provide the identifier for the general dataset, specific datasets per gravity acquisition campaign can be traced back using the parent dataset. All gravity data described in this study result from the joint forces of Royal Observatory Belgium, National Geographic Institute, Geological Survey Belgium and several other federal and regional institutions. The authors of this research are merely the creators of the metadata and the resulting consultable database.

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Version: 1.0

measurement campaign, enabling determination of specific metadata (e.g. used gravimeter, tide system parameters, time of acquisition, etc.). New gravity and spirit levelling measurements were executed by the Royal Observatory Belgium and the National Geographic Institute (Federal Mapping Agency) to validate the *g*-value at the historical reference base station 'Carte du Ciel' in Brussels. Taking into account the instrumental errors and the varying ground water content, the retrieved data are validated and approved for use in further research.

KEYWORDS
Belgium, gravity data, metadata, reference levels

1 | INTRODUCTION

Belgium is a country with one of the densest gravimetric measurement coverages in the world. This was mainly motivated by several applications in geodesy, geology, mining and metrology during the last century. This was also favoured by the smooth topography and the dense communication network. Although the first gravity measurement in Belgium was already executed in 1892, this paper focusses on the measurement campaigns executed after 1971, with the introduction of IGSN71 (Morelli *et al.*, 1972). Except for a few isolated acquisition campaigns, the systematic survey of the whole country was initiated in 1986 by late Christian Poitevin, a physicist at the Royal Observatory Belgium (ROB). During the '90s of the last century, Michel Everaerts continued the research. The year 2002 marks the end of the systematic gravity measurement campaigns of the Belgian territory (Everaerts and De Vos, 2012). In section 11, all Belgian gravity measurement campaigns are individually described in detail. For each dataset the title and unique identifier are reported in 'Table 1*: overview of recovered gravity data*'. The location of the measurements is shown in 'Figure 1*: map of the gravity measurements in Belgium*' campaign (see: Table 1 and Figure 1).

To the best of the authors' knowledge, it is the first time an effort is carried out to create a database containing all relative gravity data on a national level, at least as far as the open-access nature of the data is concerned, as well as the compliance with the recently developed metadata structure of the International Association of Geodesy (IAG) and its International Gravity Field Service Central Bureau (IGFS CB) (Vergos *et al.*, 2018). By presenting the gravimetric measurements short yet concise in the following chapters, supplemented with the ISO19115-1 metadata, Web Map Service (WMS) and download-page, the authors and responsible authorities aim to facilitate the access to gravity data, which is often a tedious task. Furthermore, the authors encourage future research using the available data.

2 | DATA ACQUISITION

The first gravity measurement in Belgium was performed in 1892 by the '*Service Géographique*' of the French Army, using a pendulum. A value of $g = 9.81169$ m/s^2 was measured in the '*Salle voûtée*' at the Royal Observatory Belgium (ROB) in Brussels (Everaerts and De Vos, 2012). Using a Von Sterneck instrument with Invar pendulums #96, #97, #98, #99, the first Belgian gravity network of first order was completed in 1928, consisting of 24 stations with an error of ±30 μm/s^2. To date, gravity is usually measured using a relative gravimeter: in Belgium, several relative gravimeters have been acquired over the years, starting with the acquisition of a Nörgaard #256 gravimeter in 1946 (Malmletning, 1948). Figures 2 and 3 show respectively the Von Sterneck and Nörgaard #256 gravimeter.

2.1 | Second Belgian gravimetric network (1948)

Using the Nörgaard #256, Louis Jones from the Military Geographic Institute (MGI, the predecessor of NGI) completed the second Belgian gravimetric network in 1947–1948. The network consisted of 381 stations, of which 25 base stations, gravity was established with an error of ±6.9 μm/s^2 (Jones, 1949). The resulting Bouguer anomaly map was published as the fifth map in the first atlas of Belgium (Jones, 1958). In 1981, Poitevin 1981 revalidated all the data.

2.2 | Mons (1960)

To investigate the eastern part of the Mons Basin, the Polytechnical Faculty of Mons measured 241 stations using the Worden #194 gravimeter (Haldar, 2013).

2.3 | Dinant Basin (1962)

From 1960 to 1962, *Belgian Shell S.A.* and the *Bataafse Internationale Petroleum Maatschappij N.V.* acquired gravity

TABLE 1 Overview of recovered gravity data (identifier is used in the data distributed by NGI & ROB)

Year	Location	Identifier
1948	2nd Belgian gravimetric network	2a7bde24-3f90-46e3-b99f-84a34b5b7ee2
1960	Mons	afb20b44-3257-458a-bee5-2e9b3250b37e
1962	Dinant basin	2a9e12cc-671c-4d19-8fe2-4f1fa1b042ca
1962	Kempen, Antwerp	2f49f0dd-b10a-43e7-b679-9f87985bddfa
1972	Extension 1948 (northeast Belgium)	56876576-4c53-4798-970e-bad5aeb9a2dd
1977	Hamoir	3bc69e12-4de2-4066-8d10-464b0f02ab87
1979	Visé-Puth anomaly (redone 2000)	9fb8c9db-9903-4029-b3d7-8611e9806bb6
1985	Diksmuide	b8f61795-f66d-4998-a5ee-2c1a0eedce35
1986	Ardooie	bf921bc6-4ad4-4014-929d-2cce8c8dc3ef
1987	Bree	49ae7446-403a-4a43-9618-0a89ee9498a8
1991	Oudenaarde	b5aa635d-23e1-4fec-ae91-80c5915ac544
1993	Geraardsbergen	21266adb-7ba7-4a85-8176-29f5334ef2d3
1995	Zonnebeke	7f07f997-09e8-414b-b680-5b344d27695b
1995	Brussels	84572648-eb17-4213-aec3-ea9fc99d3591
1996	Eeklo	69c5c350-cea1-43dc-b0be-e79e489c5268
1996	Central-Belgium	25fc7431-8aba-4f64-810a-c44a9a19c04a
1996	Luxembourg	43e73c3a-a27d-4a82-b7ac-7e033728d59a
1998	Dendermonde – Hasselt – Andenne- Meuse	82c50b49-7a99-4b3c-b960-c9a273a3944d
1998	Stavelot	551adf8f-5e7c-4b4b-9810-4e415f4b0eed
1999	Neufchâteau	bb8e1d9d-6e14-4e61-a269-b2ecebde26f5
1999	Kempen	067daf95-3a6a-4b13-9985-3f19eaece840
2000	Philippeville	9281d7dd-b5b0-4511-afeb-b582b35b3a90
2000	Waremme	6477ee0a-0007-4dae-b3b0-d7094553e5c0
2001	Liège	d5eae64a-89f3-41b9-b8ab-a39b33132829
2002	West-Flanders	c8806e4c-540b-4663-a1d7-fc415b8dcd86
2002	Kempen, Antwerp	f04c9f26-403c-40f3-9b74-da7f00341455
2002	Hasselt	ae33b261-45b4-41aa-ae4b-aa8e250c9f1c
2017	Bree	fceab14a-3cd7-4918-a9e3-bc0b8f3c923b

data over the Dinant Basin, the area of Namur-Wépion and the area of Rochefort, at the Massif de Serpon, using the Worden #399 gravimeter. Reports mention the acquisition of 2,982 stations, of which 42 are base stations (Everaerts and De Vos, 2012). However, only 2,915 of the original stations are recovered in current research.

2.4 | Antwerp (1962)

Ordered by the *Société Campinoise de Recherche et d'Exploitation Minérale* and *Petrofina S.A.*, the MGI acquires 575 gravity stations, among them 219 base stations, in the Campine area between Antwerp and Turnhout. Because of the unknown accuracy, Poitevin (1981) reported on the possibility of provoking sensible distortions in calculations when using this dataset. However, data of 568 stations were recovered and incorporated in the calculations by Everaerts and De Vos (2012). The data of these 568 stations are published in this research.

2.5 | Extension 1948 (1972)

In 1961, MGI initiated a gravity measurement campaign in the northeast of Belgium to map the negative Flanders anomaly in detail. The network measurements started in 1962 and were discontinued for unknown reasons in 1972. Six thousand two hundred and eighty gravity stations were acquired in the framework of the Belgian gravimetric network 1947–1948. All 6,280 gravity stations are recovered in this research.

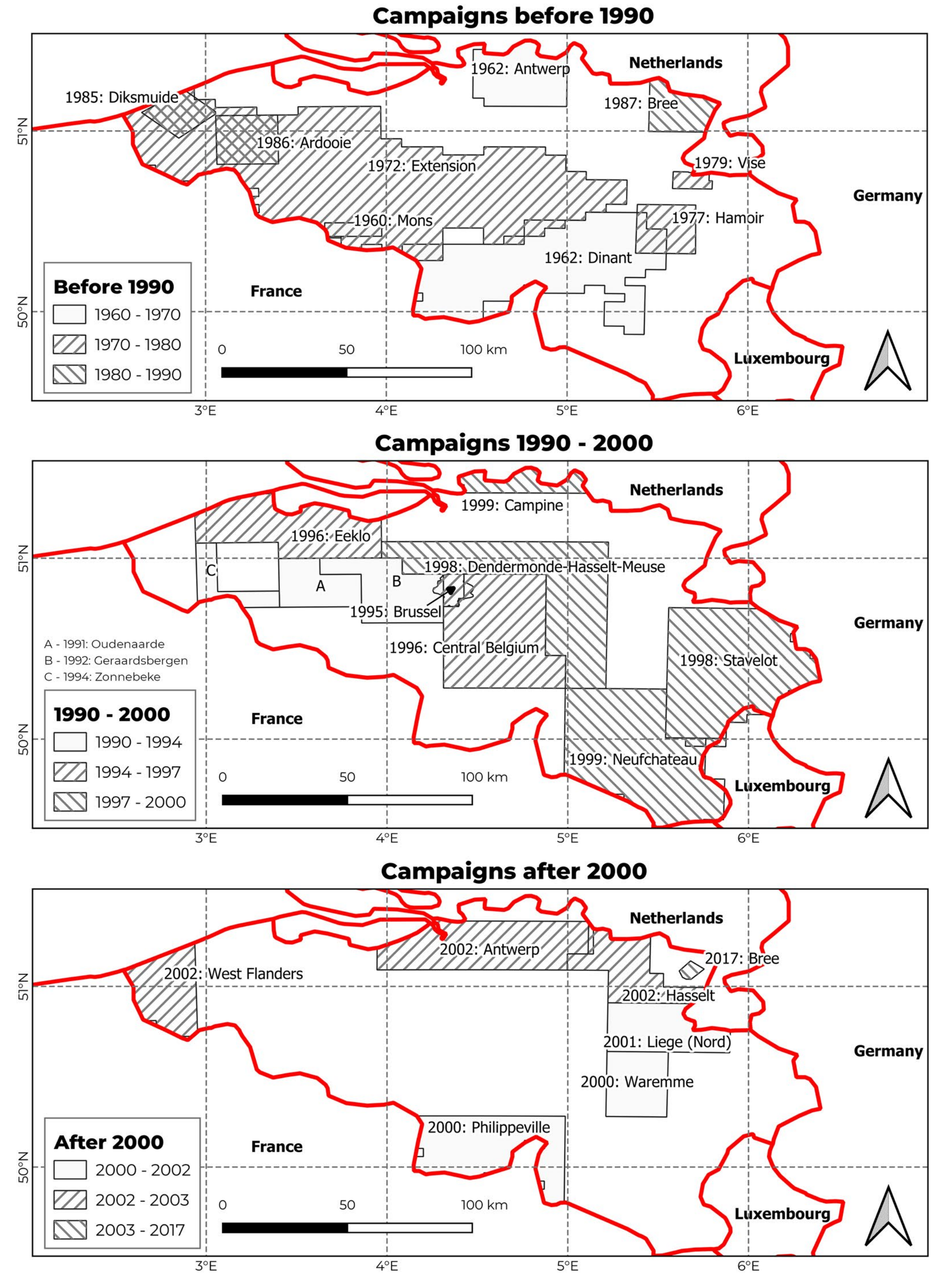

FIGURE 1 Map of the gravity measurements in Belgium

2.6 | NGI (1977)

In 1977, NGI measured 1,126 gravity stations along the 1st order national levelling network (Second General Levelling) using a Worden gravimeter. These data could not be recovered.

2.7 | Hamoir (1977)

Using a Worden gravimeter, the NGI measured 396 stations in the area of Hamoir (covering the area on Belgian topographic map 49). Three hundred and eighty-two of the original stations are recovered in the Hamoir dataset.

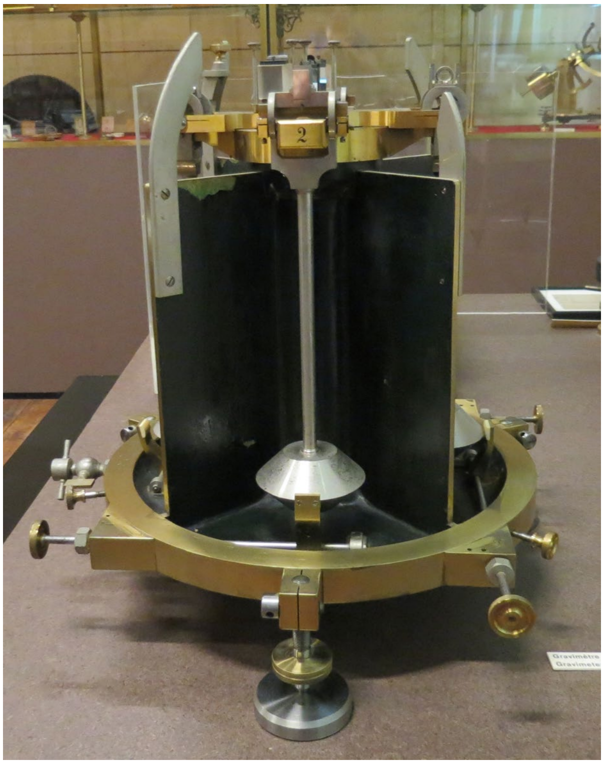

FIGURE 2 Von Sterneck gravimeter

FIGURE 3 Nörgaard #256 gravimeter

2.8 | FOBGN78 (1978)

In 1978, the NGI and ROB collaborate with the Belgian Metrological Service, the Catholic University of Leuven and the University of Liège to establish the new First-Order Belgian Gravity network 1978 (FOBGN78). This network consists of 38 stations, of which two are situated in Luxembourg, and has an accuracy of 0.1 μm/s^2. Five different gravimeters were used to construct this network: LaCoste-Romberg G#3, G#336, G#434, G#487 and D#31. Although the original data could not be recovered, a description is given by Poitevin (1979).

2.9 | Visé-Puth anomaly (1979)

A gravity survey was executed by *Prakla-Seismos GmbH* over the Visé-Puth anomaly around Maastricht. Everaerts and De Vos (2012) report 481 measured gravity stations: 170 in Belgium, 200 in the Netherlands and 111 in Germany, none of these data could be recovered (Bless *et al.*, 1981). However, new measurements were executed in the early 2000s, which were partially retrieved: 106 stations, accompanied by the unpublished report '*Levé gravimétrique de la Région de Visée*' (Everaerts, 2013) indicating the use of the Scintrex CG5#40542 gravimeter and an RTK-GNSS receiver. The GNSS-receiver allowed an exact determination of the position of the stations with an accuracy of ±2 cm. One hundred and six stations were recovered and published in this research (see also: Skiba *et al.*, 2010).

2.10 | Diksmuide (1985)

In 1985, Electrobel commissioned the acquisition of 3,003 stations covering 400 km^2 in the area of Diksmuide, which was executed by the *Compagnie Générale de Géophysique* (CGG). In '*La Banque de Données gravimétriques Belge*' by Poitevin (1981), the use of LaCoste-Romberg gravimeters D#11, D#12, D#16 and D#317 are reported. Details of this dataset are mentioned in Table 1.

2.11 | Ardooie (1986)

In 1984, Christian Poitevin established an intense partnership with the National Geographic Institute (NGI) and the Geological Survey Belgium (GSB) for the acquisition of gravity data over the whole country with a density of 1 point/km^2. This collaboration resulted in the establishment of the '*Centre de Géophysique Interne*' (CGI). Concurrently to the systematic acquisition of gravity data in Belgium, this institute also aimed at collecting and centralizing gravity data in the former Belgian colonies and mandate territories (Congo, Rwanda and Burundi).

The first project of the CGI, commissioned by the Geological Survey of Belgium (GSB), was to acquire gravity data and map the Flanders anomaly in the region of Ardooie. This measurement campaign consisted of 593 stations, of which all points could be recovered in current research, covering 696 km^2. The unpublished report '*Levé gravimétrique de la Région d'Ardooie*' (Poitevin, 1987) was recovered by the NGI, describing the complete process of planning, acquisition and processing, as well as the final results. The LaCoste-Romberg G#487 and D#32 were utilized for measuring gravity. Using least-squares adjustment, one obtained an internal precision (mean square error, MSE) of 0.65 μm/s^2. For more information regarding processing and validation of the data, we refer to the report, which is available as part of the recovered data.

2.12 | Bree (1987–1989)

Following the acquisition in Ardooie, the GSB ordered gravimetric measurements of a 604 km^2 area around Bree. ROB and NGI organized measurements at 587 stations using the LaCoste-Romberg D#32 gravimeter. In the unpublished report '*Levé gravimétrique de la Région de Bree*' (Poitevin, 1990) an internal precision (MSE) of 0.8 μm/s^2 is mentioned. All reported stations are recovered in current research.

2.13 | Oudenaarde (1991–1992)

Commissioned by the Flemish Region, NGI, ROB and GSB measured 802 gravity stations, of which 795 in the target area of 800 km^2 around Oudenaarde. As with the previous campaign in Bree, this network was surveyed with the LaCoste-Romberg D#32 and had an internal precision of 0.8 μm/s^2, it was connected to the network of Ardooie. The unpublished report '*Levé gravimétrique de la Région d'Oudenaarde*' (Poitevin, 1992) is retrieved, discussing planning, acquisition, processing and the final results. All reported stations are recovered in current research.

2.14 | Geraardsbergen & Zonnebeke (1995)

In the period 1992–1995, the NGI and ROB measured two networks in the area of Geraardsbergen (1992–1993) and one network in the area of Zonnebeke (1994–1995). The two networks in Geraardsbergen consist respectively of 635 and 652 stations, covering 1,280 km^2 at 1 point/km^2. All original stations are recovered in this current research. The unpublished report '*Levés Gravimétriques des Régions de Geraardsbergen et Zonnebeke*' (Poitevin, 1995) was retrieved from the archives of the ROB, describing for example preparations, measurement conditions, used apparatus or processing parameters. The original measurements were executed using the LaCoste-Romberg D#32 with the absolute station of Brussels (Uccle/Ukkel) as the basis and were connected to the first order gravity network of Oudenaarde with a least-squares adjustment resulting in an internal precision (MSE) of 0.65 μm/s^2. The two networks are combined in one file (see Table 1).

The network in Zonnebeke, established in 1994–1995, using the LaCoste-Romberg D#32, consists of 476 stations covering 476.5 km^2. With the absolute station of Brussels as basis and a least-squares adjustment connection to the networks of Ardooie and Oudenaarde, an MSE of 0.48 μm/s^2 was achieved.

2.15 | Brussels (1995)

A high-density network of 2.5 points/km^2 was measured in the Brussels Region. Covering 162 km^2, a total of 415 stations was measured using the LaCoste-Romberg D#32. The unpublished report, '*Levé Gravimétrique de la Région de Bruxelles-Capitale*' (Poitevin, 1996) reports an MSE of 1.0 μm/s^2. All stations are recovered in current research.

2.16 | Eeklo (1996)

A network of 403 stations was measured in the region of Eeklo, covering 1,960 km^2 (1 point/5 km^2). The reference station is the absolute station of Uccle-Observatoire ($g = 9.811{,}172{,}720 \pm 180$ nm/s^2) transferred to the '*Carte Du Ciel*' reference point by eleven repeated links using the LaCoste-Romberg D#32 (see: '*2. validation*' for more information regarding the reference stations). The network was connected to the 1st order Belgian Gravimetric Network and the networks of Oudenaarde, Geraardsbergen and Zonnebeke. In the processing, an accuracy of 0.78 μm/s^2 was obtained by least-squares adjustment. The unpublished report '*Levé Gravimétrique de la Région d'Eeklo*' is available on request (Everaerts, 1996). All reported stations are recovered in current research.

2.17 | Central Belgium (1996)

The British Geological Survey (BGS) measured a network consisting of 2,973 points in central Belgium. The area in the rectangle Nivelles – Dinant – Namur – Leuven covers approximately 2,973 km^2. No information regarding the used gravimeter or internal precision is available, and it is noteworthy that the g-values are measured only up to 1 μm/s^2. All reported stations are recovered in current research.

2.18 | Luxembourg (1996)

The Grand Duchy of Luxembourg was one of the first countries in the world with a national gravimetric network, realized by Cagniard *et al.* (1948), consisting of 371 stations (which were also recovered for this research). Over time, the information about the network got lost; in 1989, attempts were made to recover the network. Because of the use of the barometric levelling technique, the network had a typical height precision of 1.5–3 m, further research into the recovered documents proved imprecisions of the original gravimetric measurements themselves. For this reason, in 1996, the ROB together with the Luxembourg *Administration du Cadastre et de la Topographie* (ACT), established a new gravimetric network which was tied to the Belgian network. Covering 2,596 km^2 with 509 stations, a density of 1 point/5 km^2 was achieved, using the LaCoste-Romberg D#32. The absolute station '*Centre Universitaire de Luxembourg*' was used as a reference station ($g = 9.809{,}604{,}075 \pm 22$ nm/s^2, measurement performed on 20–21 August 1996 by the FG5#202). Using least-squares adjustment, an MSE of 0.71 $\mu m/s^2$ was achieved. The unpublished report of this project, '*Levé Gravimétrique de la Grande-Duchesse de Luxembourg*', was recovered and available on request (Everaerts, 1996). All reported stations are recovered in current research.

2.19 | Belgian Continental Shelf (1997)

Commissioned by the GSB, *Marine Gravity Acquisition Ltd.* installed a LaCoste-Romberg#S90 on board of the Belgian scientific vessel 'Belgica' to measure gravity along parallel lines. By doing continuous measurements along 293.5 nautical miles, 39,114 gravity measurements were recorded from 14 to 19 September 1997. Unfortunately, the retrieved data appeared to be erroneous. A provisional operators report was made available for confidential perusal by the *Operational Directorate Natural Environment* of the *Royal Belgian Institute of Natural Sciences* but did not give more information.

2.20 | BLGBN98

The third first-order Belgian Base Network 1998 (BLGBN98) consists of 41 base stations, calibrated with eight absolute points established with the FG5#202 absolute gravimeter. As this network is extensively discussed in Everaerts *et al.* (2001), it is only mentioned in this research for the sake of completeness.

2.21 | Dendermonde–Hasselt (1998)

Unlike the previous gravity acquisition campaigns, the following measurements were not executed by the responsible authorities but outsourced to the private company *Geophysik GGD* (Leipzig, Germany). A first 1 station/km^2 network was measured between Dendermonde and Hasselt over a north-south extension of 20 km. The first network was supplemented by a second 1 station/km^2 network between Hasselt and Andenne/Ciney over a width of 24 km. These two networks combined consist of 3,205 stations according to Everaerts and De Vos (2012). However, 3,203 stations were retrieved in current research. All stations were measured with one of the following gravimeters: LaCoste-Romberg G#503, G#865, G#885 and G#890. All of the reported stations are recovered in current research.

2.22 | Stavelot (1998)

In a period of 6 months, a network of 745 stations was measured in the Haute Ardenne area around Stavelot, using the LaCoste-Romberg D#32. The measurements were executed to enhance the knowledge of the gravity field in the '*Stavelot Massive*'. This network covers 3,725 km^2, bringing the density to 1 station/5 km^2. The unpublished report '*Levé gravimétrique de la Région de Stavelot*' was retrieved (Everaerts, 1998), reporting the connection of the network to the Belgian first order gravity network FOBGN78 and the fundamental station of Membach with, at the time, a g-value of $9.810{,}467{,}26 \pm 20$ nm/s^2. Using a least-squares adjustment, an MSE of 10.4 µgal was achieved. The reported stations are recovered in current research.

2.23 | Neufchâteau (1999)

Continuing the research in Haute Ardenne, a 6-month gravity measurement campaign in the region of Neufchâteau was executed in 1996, covering 3,780 km^2 with 784 stations (1 point/5 km^2). Gravity was measured using the LaCoste-Romberg D#32. The measured network was tied to the Bastogne station of FOBGN78 and the absolute station of Humain ($g = 9.810{,}021{,}218 \pm 160$ nm/s^2), together with connection to two nodes, Érezée and Neuville, of the network of Stavelot. An MSE of 0.84 $\mu m/s^2$ was achieved in the processing of this network. The unpublished report '*Levé gravimétrique de la Région de Neufchâteau*' was retrieved and available on request (Everaerts, 1999). The reported stations are recovered in current research.

2.24 | Kempen (1999)

For the calculation of a geoid for the Netherlands, extra gravity stations on Belgian territory were required. Four hundred and forty-one stations were acquired, covering an area of 2,800 km^2 (1 station/5 km^2). Original data points are retrieved, but no further information could be found. The reported stations are recovered in current research.

2.25 | Waremme & Philippeville (2000)

Again, continuing the research in the Walloon area, two networks were measured centred on Waremme and Philippeville, consisting respectively of 248 and 439 stations, covering respectively 1,200 and 2,000 km^2 (1 point/5 km^2). Measurements were executed using the LaCoste-Romberg D#32. For the Philippeville network, connections were made with the absolute station of Dourbe ($g = 9.810{,}181{,}512 \pm 139$ nm/s^2), together with two nodes of the Haute Ardenne network (Achène and Gros-Fays). Using least-squares adjustment, an MSE of 0.94 µm/s^2 is achieved. The network of Waremme was connected to the absolute station of Humain ($g = 9.810{,}021{,}217 \pm 18$ nm/s^2, measurements performed on March 16–17, 1999 by the FG5#202, together with two nodes of the Stavelot network (Fexhe and Esneux), leading to an MSE of 0.70 µm/s^2. The unpublished report '*Levés gravimétriques des Régions de Waremme et Philippeville*' was retrieved. The reported stations are recovered in current research under two separate identifiers (see Table 1).

2.26 | Liège (2001)

Commissioned by the GSB, *Geophysik GGD* acquired gravity data north of Liège, including the area measured in 1979 (Visé-Puth). One thousand two hundred and one gravity stations were measured. As data were acquired by a private company, no extra information regarding processing and/or accuracy could be retrieved. The LaCoste-Romberg G#548 and G#890 were deployed. The reported stations are recovered in current research.

2.27 | West-Flanders and Kempen (2002)

Commissioned by the Flemish region, the private company FUGRO measured two networks: one in West-Flanders consisting of 2,206 stations and one in Antwerp (Kempen) consisting of 1,098 stations, both networks were planned with a 1 station/km^2 density. Ashtech Z12-Surveyor GPS receivers and Scintrex CG3 gravimeters #9507288, #9507283 and #326 were used for localization and gravity acquisition. The network was tied to BLGBN98. The recovered data can be found under two separate identifiers (see Table 1).

2.28 | Hasselt (2002)

Commissioned by the GSB, Geophysik GGD carried out a survey between Hasselt and the Dutch border. The network consists of 1,161 stations covering 1,160 km^2. LaCoste-Romberg G#548 and G#890 gravimeters were deployed, no extra information could be retrieved regarding acquisition, processing, final results or accuracy is available. The gravity data are recovered in current research.

2.29 | Bree (2017)

Commissioned by the Flemish Institute for Technology (VITO), CGG measured 166 gravity stations on a regular grid with 500 m spacing, covering an area of 40 km^2 and centred on Bree and Maaseik. Using the Scintrex CG5#40664, a network with an MSE of 0.44 µm/s^2 was determined. The survey report is available for perusal at VITO, metadata are published in current research (see Table 1).

3 | VALIDATION

As previously described, all networks, except the network in Mol, were based on the absolute gravity measurements performed underneath the Meridian Room building (also known as '*Méridienne*') of the ROB in Brussels (Uccle/Ukkel) in 1976 by the *Istituto di Metrologia G. Colonnetti* from Turin (L. Cannizzo, G. Cerutti) and the *Istituto di Miniere e Geofisica Applicata dell´ Università de Trieste* (I. Marson). A gravity value of

$$g = 9.811{,}172{,}720 \pm 180\,\mathrm{nm/s^2}$$

was acquired, after suppressing the Honkasalo correction in 1982. The value of the absolute gravity station in the basement was transferred to the reference point '*Carte du Ciel*'. This was done by eleven repeated links using the LaCoste-Romberg D#32, leading to a gravity value of

$$g = 9.811{,}165{,}290 \pm 20\,\mathrm{nm/s^2},$$

with a TAW/DNG height of 101.918 m, as reported by Everaerts and De Vos (2012). When incorporating the error on the absolute measurements in the basement and the internal error of the transfer to the reference station '*Carte du Ciel*', a value of

$$g = 9.811{,}165{,}290 \pm 181\,\mathrm{nm/s^2}$$

was calculated for the reference point. The error of 181 nm/s^2 on the absolute value is high compared to present-day standards but was outstanding in 1976.

In order to validate the 1,976 gravity value of '*Carte du Ciel*', new measurements were executed by ROB and NGI. A high-precision spirit levelling was executed by NGI, setting the new TAW/DNG-height of the base point at *Carte du Ciel* at 101.933 m. In the period of 27 May 2018 until

1 June 2018, ROB performed gravimetric measurements using the Scintrex CG5#40542 gravimeter. Three closed loops were performed:

- ±18 hr acquisition at 'Méridienne'.
- ±6 hr acquisition at 'Carte du Ciel'.
- ±18 hr acquisition at 'Méridienne'.

By performing the measurements as described above, the drift on the gravimeter could be precisely determined while transient effects were avoided. We refer to Van Camp *et al.* (2017) for more information.

By incorporating:

- seasonal effects: 52 nm/s^2, based on gravity measurements between 2003 and 2016 (Delcourt-Honorez, 1995; Van Camp *et al.*, 2016)
- error due to the transfer from the absolute point underneath 'Salle Méridienne': 30 m/s^2;
- uncertainty of the FG5#202 absolute gravity measurement: 20 nm/s^2;

gravity at the reference station '*Carte du Ciel*' was determined as

$$g = 9.811{,}165{,}197 \pm 63\,\mathrm{nm/s^2}.$$

This means a difference of −93 ± 192 nm/s^2, which is acceptable, given the error on the 1976 and 2018 values. Hence, the Belgian gravity data recovered in this research are re-validated and approved for use in future research.

4 | DATASET LOCATION AND FORMAT

4.1 | Data

The ROB (Seismology & Gravimetry) maintains all the data, together with the NGI and Ghent University (Department of Geography—3D Data Acquisition Research Unit). Data requests can be made to all institutions. Data are distributed in simple (x, y, z, g) csv-files, other formats can be prepared on request. Bouguer and Free-Air anomalies can be calculated on request. This dataset can be obtained freely for research and educational purposes; however, if the maps or information derived from them are used in a publication, this article should be cited.

4.2 | Metadata

Each dataset in this research is accompanied by a detailed metadata file, which are published on the Belgian Federal Geodata Portal www.geo.be. These XML-files are constructed according to the standard ISO19115 metadata profile for geographic data and the new ISO19115-1 profile for gravity data (Vergos *et al.*, 2018). Metadata are created using the web-application located on http://igfsapps.topo.auth.gr/.

5 | DATASET USE AND REUSE

Currently, the datasets are used by the authors to determine a high-resolution geoid of the Belgian mainland and the marine area. Subsequently, the model will be used in vertically referencing a hydrodynamic model. Other possible usages lie mainly, but not exclusively, in the following areas of application:

- Interior mass balance and geodynamics.
- ocean circulation.
- mass exchange processes in the Earth system.

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OPEN PRACTICES

This article has earned an Open Data badge for making publicly available the digitally-shareable data necessary to reproduce the reported results. The data is available at https://doi.org/10.24414/j0dx-9n36 Learn more about the Open Practices badges from the Center for Open Science: https://osf.io/tvyxz/wiki.

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SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section at the end of the article.

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