DE GRUYTER OPEN J. Geod. Sci. 2016; 6:1–33

Research Article Open Access

P. Häkli*, M. Lidberg, L. Jivall, T. Nørbech, O. Tangen, M. Weber, P. Pihlak, I. Aleksejenko, and E. Paršeliūnas

The NKG2008 GPS campaign – final transformation results and a new common Nordic reference frame

DOI 10.1515/jogs-2016-0001
Received January 25, 2015; accepted January 29, 2016

Abstract: The NKG 2008 GPS campaign was carried out in September 28 – October 4, 2008. The purpose was to establish a common reference frame in the Nordic-Baltic-Arctic region, and to improve and update the transformations from the latest global ITRF reference frame to the national ETRS89 realizations of the Nordic/Baltic countries. Postglacial rebound in the Fennoscandian area causes intraplate deformations up to about 10 mm/yr to the Eurasian tectonic plate which need to be taken into account in order to reach centimetre level accuracies in the transformations.
We discuss some possible alternatives and present the most applicable transformation strategy. The selected transformation utilizes the *de facto* transformation recommended by the EUREF but includes additional intraplate corrections and a new common Nordic-Baltic reference frame to serve the requirements of the Nordic/Baltic countries. To correct for the intraplate deformations in the Nordic-Baltic area we have used the common Nordic deformation model $NKG\_RF03vel$. The new common reference frame, NKG_ETRF00, was aligned to ETRF2000 at epoch 2000.0 in order to be close to the national ETRS89 realizations and to coincide with the land uplift epoch of the national height systems. We present here the realization of the NKG_ETRF00 and transformation formulae together with the parameters to transform from global ITRF coordinates to Nordic/Baltic realizations of the ETRS89.

Keywords: common NKG reference frame; ETRF2000; ETRS89; intraplate deformations; ITRF; postglacial rebound; transformations

***Corresponding Author: P. Häkli:** Finnish Geospatial Research Institute, National Land Survey, Finland; Email: pasi.hakli@nls.fi
M. Lidberg, L. Jivall: Lantmäteriet, Sweden
T. Nørbech, O. Tangen: Kartverket, Norway
M. Weber: Danish Geodata Agency, Denmark
P. Pihlak: Estonian Land Board, Estonia

1 Introduction

1.1 Background

Modern society relies on spatial data that is referred to an accurate terrestrial reference frame. The satellite positioning systems are based on global reference frames, of which the International Terrestrial Reference Frame (ITRF) has become a *de facto* standard. In these global reference frames, coordinates of objects are kinematic due to dynamics of the Earth, *e.g.* plate tectonics. In Europe, the Eurasian tectonic plate has a rigid motion of roughly a couple of cm/yr towards NE in these global reference frames. Traditionally, the label "kinematic reference frames" have been used, even if the naming is not fully logical.

Kinematic coordinates, however, are not suitable for many practical applications and instead, reference frames with static or minimized variations in coordinates are widely used in georeferencing. In Europe, the IAG Reference Frame Sub-Commission for Europe (EUREF) has defined the European Terrestrial Reference System 89 (ETRS89) to be co-moving with the Eurasian plate in order to avoid time variations of the coordinates due to plate motions [1]. The relation between the ITRF reference frames and ETRS89 realizations is given in the EUREF memo [2] as a 14-parameter transformation. This transformation considers rigid plate motions by using angular velocities of the Eurasian plate allowing to minimize station velocities in the ETRS89.

In the Fennoscandian area the postglacial rebound (PGR) phenomenon causes internal deformations to the Eurasian plate that are not taken into account in the *de facto* EUREF transformation given in [2]. The magnitude of the PGR reaches up to about 1 cm/yr in the vertical, and some millimetres a year in horizontal components, see *e.g.* [3]. The Nordic and Baltic ETRS89 realizations were es-

I. Aleksejenko: Latvian Geospatial Information Agency, Latvia
E. Paršeliūnas: Vilnius Gediminas Technical University, Lithuania

Table 1: Nordic and Baltic ETRS89 realizations.

Country	Country ID	Name of realization	ETRF version	Realization epoch	Reference
Denmark	DK	EUREF-DK94	ETRF92	1994.704	[4]
Estonia	EE	EUREF-EST97	ETRF96	1997.56	[5]
Faroe Islands	FO		ETRF2000	2008.75	[6]
Finland	FI	EUREF-FIN	ETRF96	1997.0	[7]
Latvia	LV	LKS-92	ETRF89	1992.75	[8]
Lithuania	LT	EUREF-NKG-2003	ETRF2000	2003.75	[9]
Norway	NO	EUREF89	ETRF93	1995.0	[10]
Sweden	SE	SWEREF99	ETRF97	1999.5	[11]

tablished mostly in the 1990's (Table 1) meaning already 10–20 years of deformations compared to present-day coordinates. The magnitude of the PGR and time span mean that these deformations need to be taken into account in the most georeferencing applications and in maintenance of national reference frames.

To fulfil the requirements of such applications and for easier sharing of spatial information between Nordic countries, the Nordic Geodetic Commission (NKG) established a common Nordic reference frame *NKG_RF*03 aligned to the ITRF2000 [12] based on a GPS campaign performed in 2003 (NKG2003) [13, 14]. Together with the common frame, a transformation procedure was presented in [14] as a link between the *NKG_RF*03 and the national ETRS89 realizations. The transformation includes a model *NKG_RF*03*vel* to correct for intraplate deformations in the Fennoscandian area. The horizontal part of the *NKG_RF*03*vel* model originates from the glacial isostatic adjustment (GIA) model by [15] that was aligned to ITRF2000 GNSS site velocities reduced with rigid plate velocities from the ITRF2000-PMM [12, 16] in [17]. The vertical part, NKG2005LU (ABS) model of the NKG, is constructed from tide gauge, levelling and permanent GPS data [18, 19]. The *NKG_RF*03*vel* model predictions are up to 2–3 mm/yr for horizontal and up to approx. 10 mm/yr for vertical intraplate velocities. Several studies have shown that taking into account these intraplate deformations with the NKG2003 transformation approach one may obtain cm-level accurate coordinates in the Nordic ETRS89 realizations from present-day ITRF coordinates, see *e.g.* [20, 21].

1.2 Motivation

As a continuation for the NKG2003 campaign, a second NKG GPS campaign, NKG2008, was carried out in September 28 – October 4, 2008 (epoch 2008.75) [22]. One goal of this campaign was to establish a new common reference frame and to expand it to cover whole Nordic-Baltic-Arctic region. In fact, the resulting set of coordinates is a realization of the selected reference frame (*i.e.* a coordinate list or a campaign solution aligned to that frame) rather than a new reference frame defined by the origin, orientation and scale. But for sake of simplicity, we will call the resulting coordinate list as a common Nordic-Baltic reference frame. Secondly, the transformations to national ETRS89 realizations were to be updated and to include Baltic States as well (NKG2003 transformations covered only Denmark, Finland, Norway and Sweden).

Initially the NKG2008 campaign was processed in ITRF2005 [23] but also ITRF2008 [24] became available during the project. Therefore the campaign solution is available in both reference frames [22]. Preliminary transformation tests and evaluation were presented in [25]. The purpose of this article was to continue the work: to define the common NKG reference frame and to provide new transformation parameters for the Nordic and Baltic countries. We selected to use the ITRF2008 solution of the NKG2008 campaign as the final coordinates for the transformation project.

The previous NKG common reference frame (*NKG_RF*03) was aligned to the ITRF2000 at the epoch of the NKG2003 campaign, 2003.75. Following this principle, obvious choice would be to use NKG2008 campaign solution aligned to the ITRF2008 at the epoch the campaign, 2008.75, as the common frame. However, very relevant for the present work is also the recent and on-going development in geoid determination. Gravimetric geoid models may under favourable conditions be determined to the centimetre or even sub-centimetre uncertainty level. One current activity in the Nordic-Baltic co-operation is the development of a new common geoid model [26]. To be able to successfully complete this task, a consistent set of GPS-levelling information is needed for the verification that the new geoid model agrees with the levelled heights in the height system and the heights above the ellipsoid. An important task for the NKG2008 transformation project is therefore also to provide a consistent reference frame for heights above the ellipsoid for the GPS-levelling points. This frame should be in a land uplift epoch 2000.0 (same as the new height systems in Finland, Norway and Sweden, as well as the latest realization of the EVRS (European Vertical Reference System), EVRF2007 [27]). It is also advantageous if this frame agree well with the ETRF2000, the conventional frame for the ETRS89 recommended by the EUREF technical working group (EUREF TWG) [2]. With this choice, the common frame would also have small differences to Nordic and Baltic ETRS89 realizations. These considerations favour selection of the ETRF2000 at the epoch 2000.0 as the new NKG common reference frame.

Drawback of having a common frame aligned to the ETRF2000 at epoch 2000.0 is that any (intraplate) motions between the common and other epoch (*e.g.* reference epochs of the national ETRS89 realizations or epoch of GNSS observations) need to be taken into account and most probably (depending on the transformation method) intraplate corrections applied in the ETRS89 cannot be avoided. And this, in the context of GPS campaign, would be against the recommendation by the EUREF TWG [2]. Moreover, in case of GPS campaign these motions need to be taken from some model since observed velocities are not available. On the other hand, as shown *e.g.* in studies [20, 21] the intraplate deformations need to be corrected to be able to access accurately Nordic/Baltic ETRS89 realizations from global ITRF coordinates at other epoch than the reference epochs of the national ETRS89 realizations. The $NKG\_RF03vel$ model was shown to work well for this purpose. Besides, to serve the NKG geoid project the common epoch 2000.0 is a prerequisite. It is thus obvious that we cannot fully follow the recommendations to fulfil all preset requirements. Therefore we have overbalanced the requirements and selected ETRF2000 at the epoch 2000.0 as the new NKG common reference frame and epoch, designated as the NKG_ETRF00.

2 Methods

2.1 Transformation alternatives

The developed transformation shall have several qualities: it should include at least a path between the NKG2008 solution aligned to the ITRF2008 at the epoch 2008.75 and the Nordic/Baltic ETRS89 realizations but preferably also the common NKG reference frame and any ITRFxx realization at arbitrary epochs in the same transformation procedure. Some potential approaches are identified in the Fig. 1 and discussed below.

Primary option would be to use the recommended *de facto* transformation by the EUREF [2] but it does not include correction for intraplate deformations and thus, is not applicable as such. We have added subsequent intraplate corrections between the epochs 2008.75 and 2000.0 to obtain coordinates aligned to the ETRF2000 at the epoch 2000.0, see approach 1 in the Fig. 1. Similarly, the coordinates in the national ETRS89 realizations need to be corrected to the same land uplift epoch 2000.0 before defining the transformation parameters. The steps of the approach 1 that are associated to the EUREF transformation are shown inside a grey-shaded box in the Fig. 1.

Another alternative would be to use existing NKG2003 transformation approach [14], see grey-shaded box of the approach 2a in the Fig. 1. This approach was developed for ITRF2000 coordinates and therefore it does not support other ITRF solutions. Consequently, a preceding transformation from ITRF2008 to ITRF2000 coordinates is necessary. This can be performed with the *de facto* transformation defined by the International Earth Rotation and Reference Systems Service, IERS [28]. In the first step of the NKG2003 transformation the ITRF2000 coordinates at the epoch 2008.75 are moved back to the epoch of the common reference frame NKG_RF03, 2003.75, by using velocities from the ITRF2000-PMM and $NKG\_RF03vel$. Together these simulate ITRF2000 velocities. Then the NKG_RF03 coordinates are intraplate corrected to the reference epoch of the national ETRS89 realizations. This corrects the internal geometry of the GNSS solution to agree with the situation at the epoch of the national ETRS89 realizations and any other systematic differences are accounted for in the subsequent Helmert transformation. According to this procedure, the NKG2003 approach could be used for transforming ITRF2008 coordinates to the national ETRS89 realizations but it does not support deriving the common frame aligned to the ETRF2000 at the common epoch 2000.0. Another drawback is that the NKG2003 transformation parameters were estimated only for Denmark, Finland, Norway and Sweden. Therefore it does not cover whole Nordic-Baltic region and national transformation parameters should be defined at least for the Baltic countries. Also NKG2003 parameters might need updating.

One possibility to define new transformation parameters is to follow the main principles of the NKG2003 transformation (epoch reductions with simulated/modelled velocities) and to adapt them to the ITRF2008 coordinates. Similarly to the NKG2003 approach, intraplate corrections could be applied to the NKG2008 coordinates and new transformation parameters would be defined from the in-

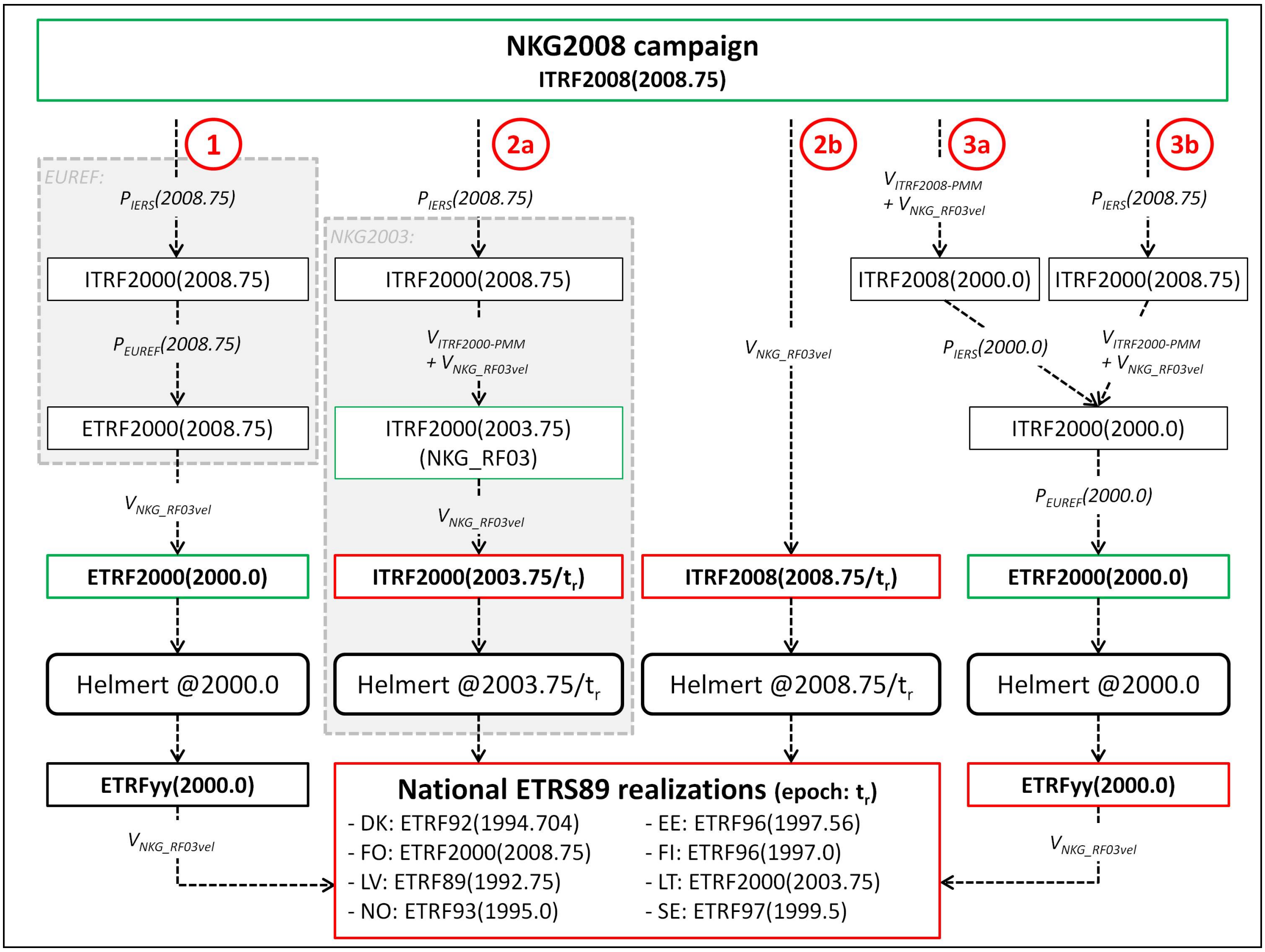

Figure 1: Some potential transformation alternatives. Options for the common frame are shown with green boxes while red boxes indicate input coordinates (that are not in a common frame) for defining the transformation parameters. Parts inside grey-shaded boxes indicate steps that are included either in the EUREF or in the NKG2003 transformations. $P_{IERS}(t)$ or $P_{EUREF}(t)$ refer to the transformation (parameters) recommended by either the IERS or the EUREF at the epoch t. $V_{ITRF200x-PMM}$ is a correction for the rigid plate motion according to corresponding ITRF200x plate motion model. $V_{NKG\_RF03vel}$ is a correction for intraplate deformations from the model $NKG\_RF03vel$. Helmert parameters are seven transformation parameters for the similarity transformation at the given epoch.

traplate corrected ITRF2008 coordinates to the national ETRS89 realizations, see approach 2b in the Fig. 1. But again, this approach would not support the common reference frame aligned to the ETRF2000(2000.0) and is thus not feasible for our case.

Two possibilities to realize the common reference frame utilizing both the principles of the NKG2003 approach and the parameters from the *de facto* IERS or EUREF transformations, are designated as the approaches 3a and 3b in the Fig. 1. In both approaches epoch reductions between 2008.75 and 2000.0 include rigid plate and intraplate corrections. The former approach utilizes the angular plate velocity of the Eurasian plate extracted from the ITRF2008 plate motion model, ITRF2008-PMM [29] and the latter the corresponding velocities from the ITRF2000-PMM. In both approaches intraplate motions would be estimated with the $NKG\_RF03vel$ model. The goal is that together these motions would simulate either ITRF2008 or ITRF2000 station velocities. Another difference is that transformations from the ITRF2008 to the ITRF2000 using IERS parameters are performed at different epochs. After these steps the resulting ITRF2000 coordinates at the epoch 2000.0 could be transformed to the ETRF2000 with the EUREF transformation. One issue with the approaches 3a and 3b is that IERS, EUREF or both transformations would be performed at different epochs than recommended central epoch of observations, see [2].

Another issue is related to the reference frame in which the corrections from the $NKG\_RF03vel$ model are applied to coordinates. The $NKG\_RF03vel$ was originally aligned to ITRF2000 GNSS station velocities reduced with rigid plate velocities from the ITRF2000-PMM. Rigorously, the $NKG\_RF03vel$ should be used only to simulate ETRF2000 velocities or together with the ITRF2000-PMM to simulate ITRF2000 velocities. In other cases the model should be transformed to the reference frame associated to the coordinates to be corrected for. More flexibly, one could ignore the reference frame of the model and consider and use it as a deformation model without a need for rigorous alignment to the reference frame of the coordinates. In such case its consistency has to be verified otherwise, *e.g.* with a comparison to observed station velocities in that given reference frame.

In the Fig. 1 all approaches except 2a include intraplate corrections from the $NKG\_RF03vel$ in some other reference frames than ETRF2000 or ITRF2000. In the approaches 1, 3a and 3b intraplate corrections are applied in an ETRFyy reference frame associated to the national ETRS89 realization. However, in these approaches any possible biases between the velocities of the $NKG\_RF03vel$ and the ETRFyy are taken into account in the defined transformation parameters. In the approaches 2b and 3a intraplate corrections are applied to ITRF2008 coordinates. In the 2b possible biases are also absorbed by the defined parameters but in the 3a where $NKG\_RF03vel$ is used together with the ITRF2008-PMM to simulate ITRF2008 velocities, any biases are propagated to the resulting coordinates. However, comparison of such simulated velocities with the observed station velocities in the ITRF2008 would, in fact, yield quite good consistency. But more importantly, according to the recommendation of the EUREF TWG and after the adoption of the ETRF2000 as the conventional frame of the ETRS89, one should not utilize post-ITRF2000 plate motion models in realization of ETRS89 coordinates from post-ITRF2000 coordinates [2]. For instance, use of the angular velocity of the Eurasian plate from the ITRF2008-PMM in the EUREF transformation would lead virtually to ETRF2008 which does not exist (neglecting translations in this hypothetical case).

Thus, also the approaches 3a and 3b would include some unorthodox choices and were therefore rejected. With all above considerations we concluded to use the approach 1 in order to be as consistent as possible with the standardized EUREF approach. The selected approach is explained in more details in the next section.

2.2 Selected approach

The selected transformation approach 1 includes all preset requirements: it can be used to transform between any ITRF solution at arbitrary epoch, Nordic/Baltic ETRS89 coordinates and the common NKG reference frame, see Fig. 2. The transformation can include only part of the chain or full path depending on source and target coordinates. The full step-by-step transformation from ITRFxx coordinates at an arbitrary epoch to the national ETRS89 coordinates (left-hand side path in the Fig. 2) can be simplified by combining (summing) transformation parameters and intraplate corrections (right-hand side path). In the figure the transformation is targeting coordinates in the national ETRS89 realizations but any step can be reversed to produce desired target coordinates.

The first step is a transformation from an ITRFxx to the ITRF2000 coordinates at an arbitrary epoch t_c (if necessary). This is performed according to Eq. (1) and parameters by the IERS [28].

$$\begin{bmatrix} X \\ Y \\ Z \end{bmatrix}^{ITRF2000}_{tc} = \begin{bmatrix} X \\ Y \\ Z \end{bmatrix}^{ITRFxx}_{tc} + \begin{bmatrix} T_1 \\ T_2 \\ T_3 \end{bmatrix} + D \cdot \begin{bmatrix} X \\ Y \\ Z \end{bmatrix}^{ITRFxx}_{tc} + \begin{bmatrix} 0 & -R_3 & R_2 \\ R_3 & 0 & -R_1 \\ -R_2 & R_1 & 0 \end{bmatrix} \cdot \begin{bmatrix} X \\ Y \\ Z \end{bmatrix}^{ITRFxx}_{tc} \quad (1)$$

Next, the coordinates are transformed to the ETRF2000 according to the EUREF recommendation using Eq. (2). The parameters can be found in the EUREF memo [2].

$$\begin{bmatrix} X \\ Y \\ Z \end{bmatrix}^{ETRF2000}_{tc} = \begin{bmatrix} X \\ Y \\ Z \end{bmatrix}^{ITRF2000}_{tc} + \begin{bmatrix} T_1 \\ T_2 \\ T_3 \end{bmatrix} + \begin{bmatrix} 0 & -\dot{R}_3 & \dot{R}_2 \\ \dot{R}_3 & 0 & -\dot{R}_1 \\ -\dot{R}_2 & \dot{R}_1 & 0 \end{bmatrix} \cdot \begin{bmatrix} X \\ Y \\ Z \end{bmatrix}^{ITRF2000}_{tc} \cdot (t_c - 1989.0) \quad (2)$$

These two steps are fully according to the EUREF recommendations. The first additional step is to reduce ETRF2000 coordinates from the epoch t_c to 2000.0 by applying intraplate corrections with the Eq. (3). One should observe that the corrections in this step are taken from a re-aligned $NKG\_RF03vel$ model. The original Nordic deformation model $NKG\_RF03vel$ was found out not being optimally aligned to the ETRF2000 and therefore it was re-aligned to the ETRF2000 velocities in this study; see more in sections 2.3 and 3.1. The re-aligned velocities, designated as $V_{NKG\_RF03vel\_ETRF2000}$ in Fig. 2, ensure that the resulting coordinates are accurately aligned to the ETRF2000 at the epoch 2000.0. The common NKG reference frame NKG_ETRF00 was realized with the transformation steps 1–3 from the NKG2008 solution, see more in section 3.2.

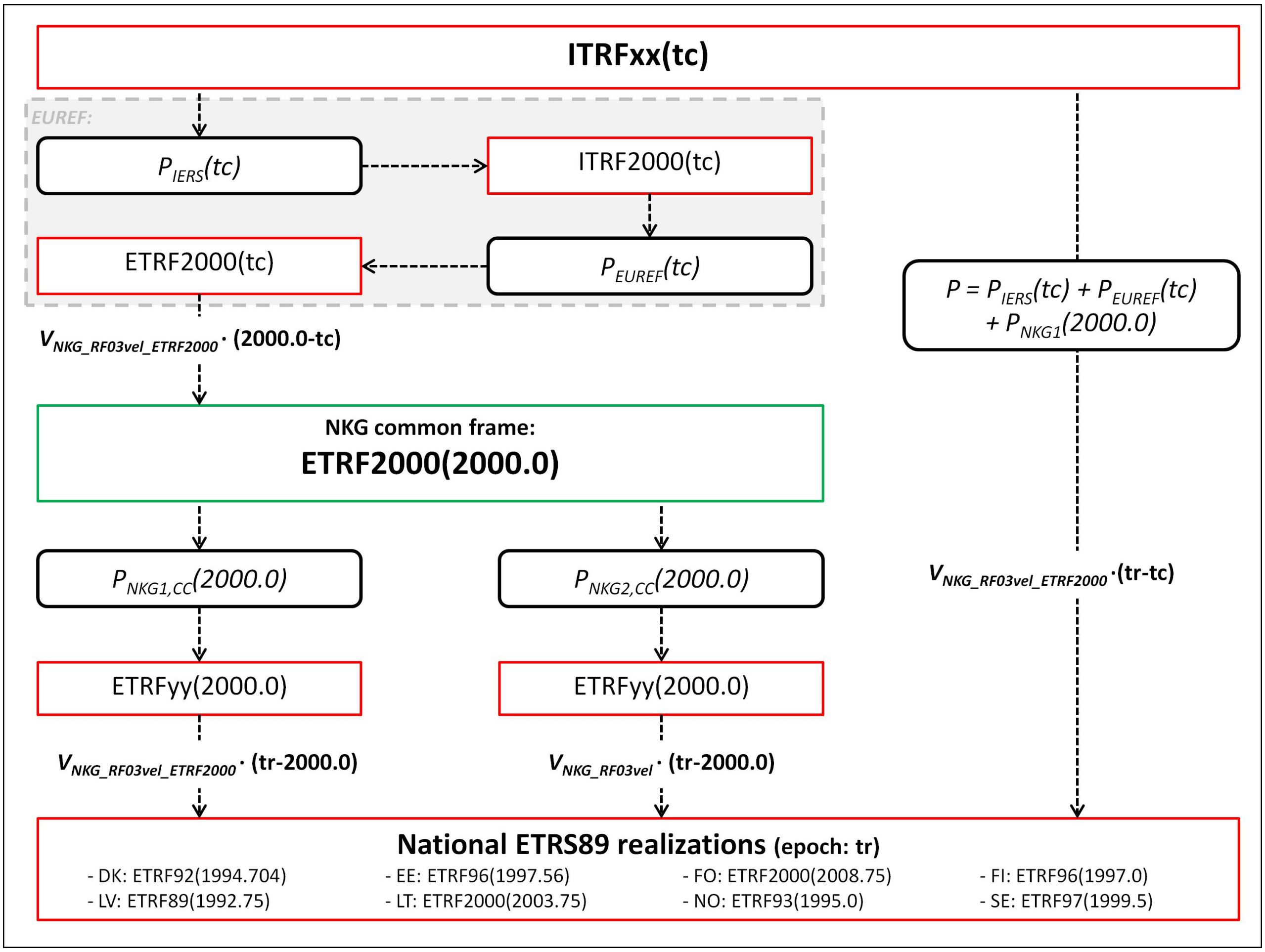

Figure 2: NKG2008 transformation from ITRFxx coordinates at an arbitrary epoch to the national ETRS89 realizations. Left-hand side path shows the step-by-step transformation and right-hand side the direct transformation with merged parameters and intraplate corrections. $V_{NKG\_RF03vel\_ETRF2000}$ is a correction for intraplate deformations from the re-aligned $NKG\_RF03vel$ model and $V_{NKG\_RF03vel}$ from the original NKG_RF03vel model. Helmert parameters P_{NKG1} and P_{NKG2} are seven parameters for the similarity (Helmert) transformation at the epoch 2000.0.

$$\begin{bmatrix} X \\ Y \\ Z \end{bmatrix}_{2000.0}^{ETRF2000} = \begin{bmatrix} X \\ Y \\ Z \end{bmatrix}_{tc}^{ETRF2000} + (2000.0 - t_c) \cdot \begin{bmatrix} V_{X,intra} \\ V_{Y,intra} \\ V_{Z,intra} \end{bmatrix}_{NKG\_RF03vel}^{ETRF2000} \tag{3}$$

Then the NKG_ETRF00 coordinates are transformed to the ETRFyy corresponding to the national ETRS89 realization at epoch 2000.0 with the 7-parameter Helmert transformation using the Eq. (4). From the Fig. 2 one can see that the NKG2008 transformation includes two separate transformation parameters for each country, denoted as $P_{NKG1,CC}$ and $P_{NKG2,CC}$ (cc = DK, EE, FI, FO, LT, LV, NO, SE). The reason is that one can use either the re-aligned or the original $NKG\_RF03vel$ model in the next step, see Eq. (5). In this step the ETRFyy coordinates at the common epoch 2000.0 are intraplate corrected to the reference epochs of the national ETRS89 realizations, t_r. The parameters P_{NKG1} are associated to the re-aligned velocities $V_{NKG\_RF03vel\_ETRF2000}$ in Eq. (5). Primarily, one should use the re-aligned velocities $V_{NKG\_RF03vel\_ETRF2000}$ and parameters P_{NKG1} in Eqs. (4–5). However, in some cases use of the original $NKG\_RF03vel$ model (velocities designated as $V_{NKG\_RF03vel}$ in the Fig. 2) may be necessary and justified in Eq. (5). In such case one should select the corresponding transformation parameters P_{NKG2} to be used in Eq. (4). The reader should observe that the use of the original $NKG\_RF03vel$ model is limited only to the transformations between the common frame and national ETRS89 realizations, *i.e.* Eq. (5). The reader should also note that we are using the IERS conventions for rotations in Eq. (4). Some geodetic software may use opposite signs for rotations.

$$\begin{bmatrix} X \\ Y \\ Z \end{bmatrix}^{ETRFyy}_{2000.0} = \begin{bmatrix} X \\ Y \\ Z \end{bmatrix}^{ETRF2000}_{2000.0} + \begin{bmatrix} T_X \\ T_Y \\ T_Z \end{bmatrix} + D \cdot \begin{bmatrix} X \\ Y \\ Z \end{bmatrix}^{ETRF2000}_{2000.0} + \begin{bmatrix} 0 & -R_Z & R_Y \\ R_Z & 0 & -R_X \\ -R_Y & R_X & 0 \end{bmatrix} \cdot \begin{bmatrix} X \\ Y \\ Z \end{bmatrix}^{ETRF2000}_{2000.0} \tag{4}$$

$$\begin{bmatrix} X \\ Y \\ Z \end{bmatrix}^{ETRFyy}_{tr} = \begin{bmatrix} X \\ Y \\ Z \end{bmatrix}^{ETRFyy}_{2000.0} + (t_r - 2000.0) \cdot \begin{bmatrix} V_{X,intra} \\ V_{Y,intra} \\ V_{Z,intra} \end{bmatrix}^{ETRF2000}_{NKG\_RF03vel} \tag{5}$$

If an inverse transformation in any step is needed, one can switch the places of source and target coordinates in the corresponding equation and, depending on the step, switch two epochs and/or give opposite signs for the transformation parameters.

2.3 Re-alignment of the *NKG_RF03vel* model

In the selected transformation the purpose of the *NKG_RF03vel* model is to correct for the intraplate deformations in the ETRF2000. On the other hand its purpose is to represent ETRF2000 velocities. In order to estimate the quality of the *NKG_RF03vel* model in the ETRF2000, we evaluated it with observed GNSS station velocities by using most recent cumulative solution from the EUREF Permanent Network (EPN). The EPN cumulative solutions are updated every 15 weeks and are available both in the latest ITRF (or corresponding IGS) realization and ETRF2000. We have used only stations that are categorized as class A stations meaning that they have high-quality coordinates and velocities [30, 31]. At the time of the study the most recent solution covered data up to GPS week 1785 [32], denoted hereafter as the EPNC1785.

As already pointed out in the previous section, we found out in this study that the *NKG_RF03vel* model is not optimally aligned to the ETRF2000. The vertical velocities of the *NKG_RF03vel* are biased compared to the ETRF2000 velocities from the EPNC1785; see more details in section 3.1. In the context of a common reference frame realization such biases are not acceptable. Therefore we have re-aligned the intraplate velocities of the *NKG_RF03vel* model to the ETRF2000 velocities of the EPNC1785 solution in this project. The velocities can be transformed or re-aligned with a general formula, see *e.g.* [28] that is adapted for the *NKG_RF03vel* below as the Eq. (6).

$$\begin{bmatrix} V_X \\ V_Y \\ V_Z \end{bmatrix}^{NKG\_RF03vel\_ETRF2000}_{X,Y,Z} = \begin{bmatrix} V_X \\ V_Y \\ V_Z \end{bmatrix}^{NKG\_RF03vel}_{X,Y,Z} + \left(\begin{bmatrix} \dot{T}_X \\ \dot{T}_Y \\ \dot{T}_Z \end{bmatrix} + \dot{D} \cdot \begin{bmatrix} X \\ Y \\ Z \end{bmatrix} + \begin{bmatrix} 0 & -\dot{R}_Z & \dot{R}_Y \\ \dot{R}_Z & 0 & -\dot{R}_X \\ -\dot{R}_Y & \dot{R}_X & 0 \end{bmatrix} \cdot \begin{bmatrix} X \\ Y \\ Z \end{bmatrix} \right) \tag{6}$$

A critical issue is to choose parameters that are present in the transformation. Typically scale rate should not be used in order not to introduce an artificial distortion to the resulting velocities. Furthermore, translation rates are usually to be avoided in small geographical areas because they are highly correlated with the rotation rates. Such transformation would become equivalent to the Euler pole determination. However, considering the implementation and alignment of the original *NKG_RF03vel* model, above general statements on choice of transformation parameters may not be completely valid or adequate. Moreover, we are not interested in making geophysical analysis or interpretation from the velocities but instead want our intraplate velocities to be expressed in the ETRF2000 as good as possible. Therefore and based on our evaluation, we have selected to use all seven parameters to re-align the *NKG_RF03vel* model.

3 Results

3.1 Velocities of the *NKG_RF03vel* model

The main purpose of the original *NKG_RF03vel* model has been to estimate internal deformations instead of rigorous alignment to any reference frame. However, when such a model is used to define final coordinates without further transformations, as is the case with the *NKG_ETRF00* and with the method described in section 2.2, it is crucial that the model is well-aligned to the corresponding reference frame. In such case any biases would propagate into the resulting coordinates. In the selected approach this reference frame is ETRF2000. While transforming between the common frame and national ETRS89 realizations, intraplate corrections are also applied to *ETRFyy* coordinates associated to the national ETRS89 realizations but in this case possible biases between *ETRFyy* and *NKG_RF03vel* velocities are absorbed in the defined

Helmert parameters and thus biases do not propagate to the coordinates.

We compared the velocities from the *NKG_RF03vel* model to the ETRF2000 station velocities of the EPNC1785 solution. The differences are summarized in Table 2. In the statistics, only stations in the land uplift area (meaning positive up velocity from the *NKG_RF03vel*) have been taken into account. Validity area of the *NKG_RF03vel* model is not explicitly given and therefore this constraint was applied to achieve more realistic statistics from the main usage area of the model. Outside the land uplift area the model may lack of geodetic data or experience far-field extrapolation or visualization related issues that have no physical meaning.

The standard deviation show that the precision of the *NKG_RF03vel* velocities is well below 0.5 mm/yr level in each velocity component (1σ). The accuracy of modelled velocities (rms of the differences) is 0.45/0.20/0.91 mm/yr in North, East and up components compared to the ETRF2000 velocities of the EPNC1785. This can be considered reasonably good result when speaking of modelled velocities. This also fulfils the criteria of 3 mm/yr for velocity quality given in [33] that however, would be far too much for our case.

However, it is evident that the *NKG_RF03vel* model has a bias in vertical velocities while horizontally it is well-fitted to the ETRF2000 velocities. Horizontally consistency is at the level 0.1–0.2 mm/yr but vertical velocities are biased about 0.8 mm/yr. The bias in up component is also visible in the Fig. 3 illustrating the velocity differences.

Some biases could be anticipated considering that the *NKG_RF03vel* model is actually a 2D+1D model constructed from observations of several geodetic techniques, includes a GIA model and has a global alignment through a GPS solution that was used to constrain the model. Furthermore, the GPS time series of this solution were much shorter compared to the up-to-date EPNC1785 solution. Obviously, these are the main reasons why the velocities of the *NKG_RF03vel* model do not fully agree with the up-to-date GNSS-derived ETRF2000 velocities of the EPNC1785 solution. However, considering the way it has been utilized in the past, it must be noted that this bias or inaccuracy has not had a degrading influence until now. The model has been considered to correct for the internal deformations in the Nordic area without a need for a rigorous alignment to any reference frame. Any possible systematic differences have been described in a subsequent Helmert transformation.

The results mean that the consistency could be improved by an additional fit of the velocity field. However, there are anticipations of a new NKG model in the near future, and therefore it is not meaningful to produce a new model with old data. Consequently, we have chosen to introduce only transformation parameters to re-align the *NKG_RF03vel* model to the ETRF2000 instead of publishing a new model (grid files, *etc.*).

A simple 1-parameter vertical fit would significantly improve the *NKG_RF03vel* velocities but in this case the

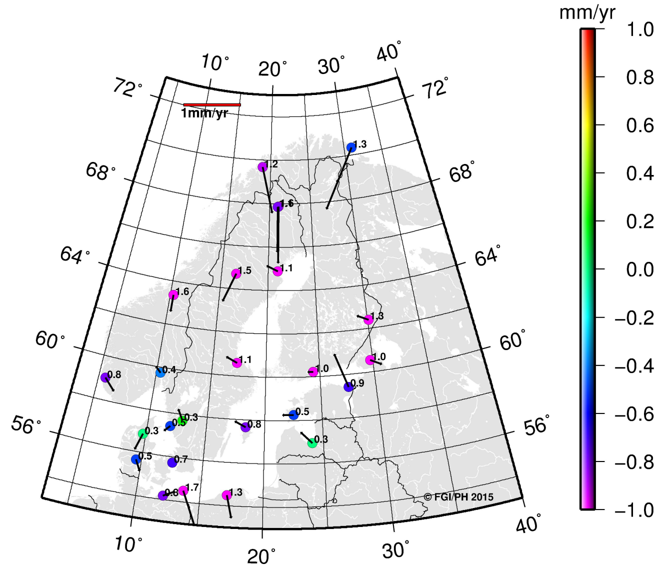

Figure 3: Observed ETRF2000 station velocities of the EPNC1785 minus *original NKG_RF03vel* intraplate velocities. Vectors show horizontal, coloured circles vertical and values next to the station 3D differences in mm/yr.

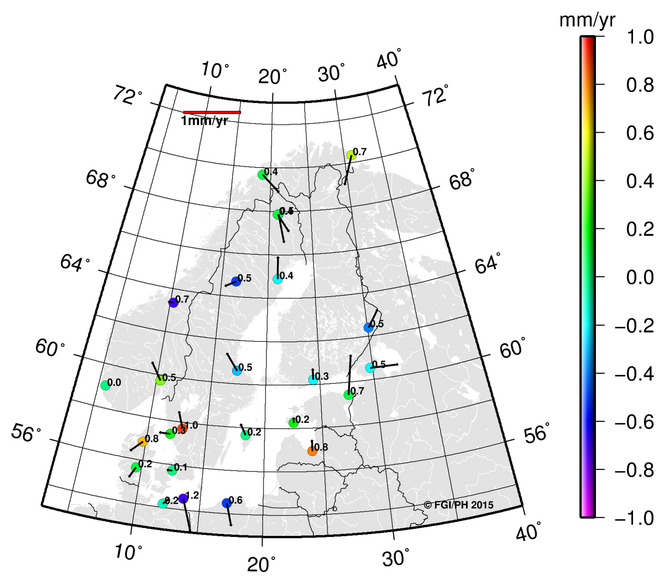

Figure 4: Observed ETRF2000 station velocities of the EPNC1785 minus *re-aligned NKG_RF03vel* intraplate velocities (*NKG_RF03vel_ETRF2000*), *i.e.* residuals of the re-alignment. Vectors show horizontal, coloured circles vertical and values next to the station 3D differences in mm/yr.

Table 2: Statistics of the velocity differences: ETRF2000 velocities of the EPNC1785 minus $NKG\_RF03vel$ and $NKG\_RF03vel\_ETRF2000$ (only stations in land uplift area considered in the statistics).

	$NKG\_RF03vel$			$NKG\_RF03vel\_ETRF2000$		
n = 25	N [mm/yr]	E [mm/yr]	U [mm/yr]	N [mm/yr]	E [mm/yr]	U [mm/yr]
Min	−1.01	−0.55	−1.59	−0.88	−0.24	−0.75
Max	0.56	0.41	0.16	0.67	0.49	0.88
Mean	−0.20	−0.05	−0.79	−0.01	0.00	0.00
Std	0.41	0.20	0.45	0.35	0.19	0.43
Rms	0.45	0.20	0.91	0.34	0.18	0.42
95%	0.94	0.38	1.40	0.64	0.33	0.76

Table 3: Transformation parameters to estimate a correction to the velocities of the $NKG\_RF03vel$ model in order to re-align the velocities to the ETRF2000.

Par.	Value	Unit
$\dot{T}_X$	0.00211	[m/yr]
$\dot{T}_Y$	0.00056	[m/yr]
$\dot{T}_Z$	0.00127	[m/yr]
$\dot{D}$	−0.465	[ppb/yr]
$\dot{R}_X$	0.01612	[mas/yr]
$\dot{R}_Y$	−0.03066	[mas/yr]
$\dot{R}_Z$	0.01435	[mas/yr]

transformation should be done in a local system. The transformation parameters should preferably be given in geocentric cartesian system. Otherwise the re-alignment can be difficult to implement to user applications. The parameters could be converted from local to geocentric system but there is no real reason to restrict to a vertical fit. Therefore, we defined all seven transformation parameters in geocentric system to describe the difference between the velocity fields. The re-aligned $NKG\_RF03vel$ velocities can be computed with Eq. (6) and parameters given in Table 3. The transformation parameters define a correction to the velocities of the $NKG\_RF03vel$ so that they agree better with the ETRF2000 velocities of the EPNC1785.

The 7-parameter fit with available 25 fiducial (EPN) stations yields to rms of differences 0.34/0.18/0.42 mm/yr in North, East and up respectively. The statistics of the differences between the re-aligned $NKG\_RF03vel$ and ETRF2000 (of the EPNC1785) velocities are summarized in Table 2 and illustrated in the Fig. 4. Indicated by the precision (standard deviation) and the accuracy (rms), the model is now well-aligned to the ETRF2000 velocities and possible deficiencies are mostly due to the original model itself. Some identified limitations in the $NKG\_RF03vel$ model are *e.g.* missing levelling data in Denmark and Baltic countries, weaknesses in the underlying GIA model and short time series at some GPS stations. Some of the larger velocity differences may be attributed to these reasons. However, below 0.5 mm/yr uncertainty level in modelled velocities is a very good result and proves that the $NKG\_RF03vel$ model is still performing mostly well.

3.2 Common NKG reference frame NKG_ETRF00

The NKG2008 solution was aligned to the ITRF2008 at the epoch 2008.75 with a 4-parameter Helmert fit (translations and scale). The accuracy of the solution, by means of post-fit rms of fiducial sites, is 1, 1 and 3 mm in North, East and up components respectively. The resulting NKG2008 campaign coordinates were transformed with the three-step transformation (equations (1–3) shown in top-left corner in the Fig. 2 to realize the common NKG reference frame aligned to the ETRF2000 at the epoch 2000.0, NKG_ETRF00. In the transformation we used the re-aligned velocities from the $NKG\_RF03vel$ model ($V_{NKG\_RF03vel\_ETRF2000}$) to reduce the epoch of the coordinates. We estimated the accuracy of the NKG_ETRF00 by comparing the resulting coordinates with the EPNC1785 solution. We use this as a measure of the accuracy of the realized NKG_ETRF00 reference frame. It is important that the resulting reference frame is well-aligned to the official solution because it is a key factor to the access and sharing of data, *i.e.* reproducibility of the coordinates, in that frame. If the difference between the reference frame realization and official solution is large, the realized coordinates are only approximately aligned to the desired reference frame, which in turn may mean that the coordinates cannot be reproduced within certain accuracy in the future and thus the realized frame may become useless.

Table 4 summarizes the statistics of the differences between the NKG_ETRF00 and EPNC1785 solutions. The accuracy of the NKG_ETRF00, by means of the rms of the co-

Table 4: Statistics of the common reference frame realization (coordinate differences to the EPNC1785 solution). Only stations in the land uplift area taken into account in the statistics.

	*NKG_ETRF*00 minus EPNC1785 (ETRF2000 coordinates @2000.0)		
n = 25	N [mm]	E [mm]	U [mm]
Min	−9.60	−4.00	−9.40
Max	5.70	4.90	12.30
Mean	−0.88	−0.17	−1.40
Std	3.45	2.44	5.30
Rms	3.49	2.40	5.38
95%	7.38	3.92	9.24

ordinate differences, is 3.5/2.4/5.4 mm in North, East and up components. Consequently, the accuracy of the solution is not significantly degraded during the transformation and the result can be considered very good. There are no suitable existing criteria for our common reference frame realization but in order to weigh our result, we have used EPN guidelines [33] as a point of comparison. The EPN guidelines state that the estimated coordinates of the reference stations, after a minimum constraint alignment to the EPN cumulative solution in IGb08, should agree better than 10 mm for positions with the values of the EPN cumulative solution. This measure is not directly comparable to our case because it would refer to the initial alignment of the NKG2008 solution to the ITRF2008 solution which fulfils the criterion. Since our common frame is a result of the additional transformation to the ETRF2000 and the additional epoch correction and, as roughly 95% of our coordinates fulfil the criterion, it is arguable that our approach is suitable for the purpose. Figure 5 illustrate coordinate differences of the common reference frame realization.

Our goal was to have the common reference frame to be close to the national ETRS89 realizations. Table 5 shows the differences of the *NKG_ETRF*00 and national ETRS89 coordinates. The difference is by means of averages varying up to 4 cm in coordinate components. The difference is usually very systematic for each country. One reason for this is intraplate deformations between the common epoch and reference epochs of the national ETRS89 realizations. Another reason is caused by small differences in different ETRFyy realizations. Figure 6 illustrates the coordinate differences. The difference is quite small but it tells that the consistency between the Nordic/Baltic ETRS89 realizations is in the order of some centimetres. In cases where better consistency is needed, the national coordinates should be transformed to the common reference frame *NKG_ETRF*00.

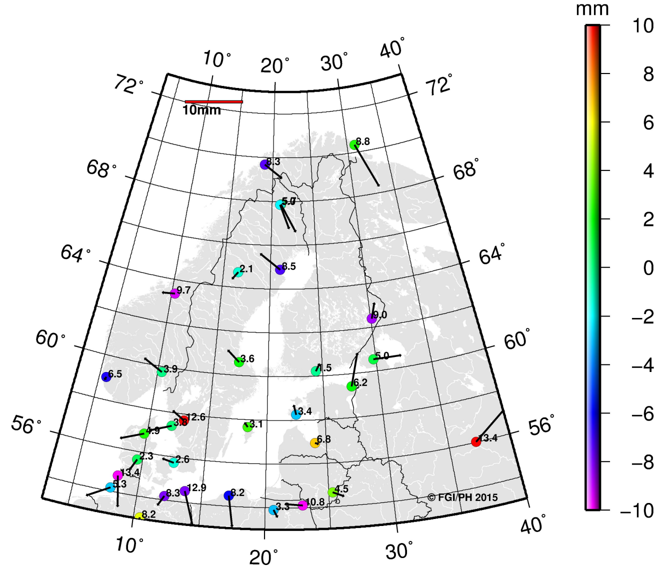

Figure 5: Coordinate differences *NKG_ETRF*00 minus EPNC1785 (expressed in ETRF2000 at the epoch 2000.0). Vectors show horizontal, coloured circles vertical and values next to the station 3D differences in mm. Most of the largest differences can be found outside the land uplift area (*i.e.* subsidence area) or close to it where the *NKG_RF*03*vel* model has its weakest points.

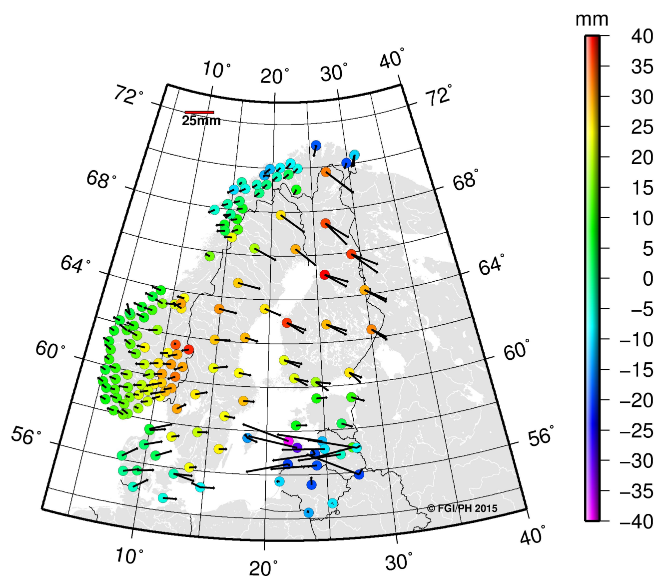

Figure 6: Coordinate difference *NKG_ETRF*00 minus national ETRS89 coordinates.

We have also estimated the long-term quality of the NKG2008 transformation by means of common frame realization from ITRF2008 coordinates given in different epochs. For this we have again used EPNC1785 solution. We propagated the IGb08 (ITRF2008) coordinates of the EPNC1785 to epochs 1990, 2000, 2010, 2020, 2030 and 2040 and then transformed these coordinates to the

Table 5: Averages of the coordinate differences *NKG_ETRF*00 minus national ETRS89 coordinates.

	N [mm]	E [mm]	U [mm]
Denmark	3.70	14.65	−0.05
Estonia	−1.78	10.21	7.48
Faroe Islands	1.16	−0.02	−1.83
Finland	−8.38	16.82	29.89
Latvia	4.19	−39.24	−21.56
Lithuania	2.65	−0.81	−14.10
Norway	−0.88	−5.72	10.44
Sweden	−6.12	13.63	24.92

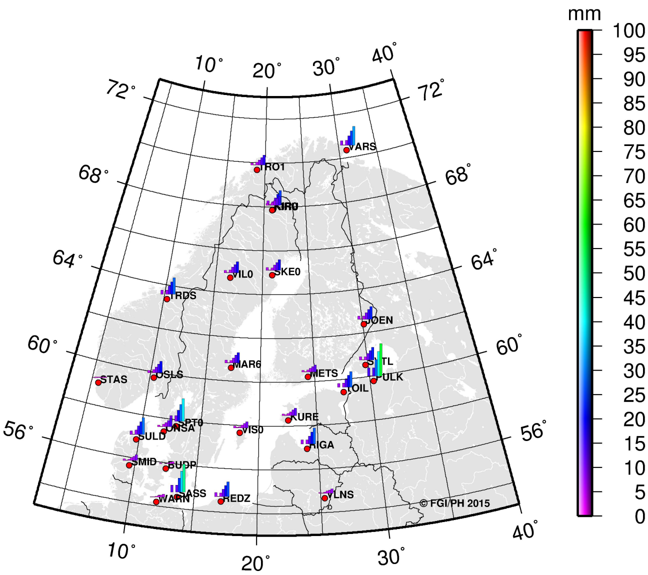

Figure 7: Coordinate difference *NKG_ETRF*00 minus EPNC1785 in ETRF2000 at the epoch 2000.0 when IGb08 coordinates of the EPNC1785 are first converted with the station velocities to epochs 1990, 2000, 2010, 2020, 2030 and 2040 and then transformed with the NKG2008 transformation to the *NKG_ETRF*00. Error bars from left to right show the difference for epochs 1990–2040.

*NKG_ETRF*00 (steps 1–3). The resulting coordinates were compared to the ETRF2000 coordinates of the EPNC1785 at the epoch 2000.0. Rms of differences (Table 6) show that the selected transformation is able to produce better than roughly 2 cm-level accurate coordinates (rms) during the whole 50-year period. Some of the largest differences can be found outside the land uplift area where the *NKG_RF03vel* model has some limitations, (*e.g.* station SASS) or be attributed to worse velocity due to shorter time series (*e.g.* PULK), see Fig. 7.

As a comparison, we made the same test but now using the standard EUREF transformation (steps 1–2, *i.e.* no intraplate corrections). Rms of differences is summarized in the Table 6. The results show very clearly the effect of the

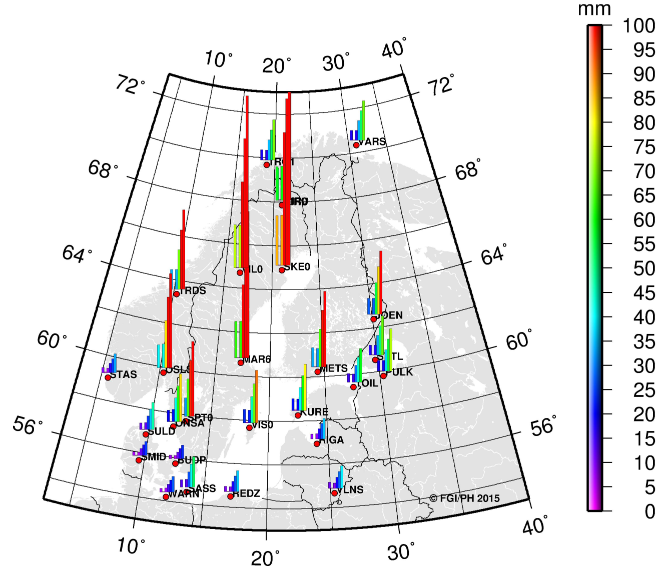

Figure 8: Coordinate difference ETRF2000(t) minus EPNC1785 in ETRF2000 at the epoch 2000.0 when IGb08 coordinates of the EPNC1785 are first converted with the station velocities to epochs 1990, 2000, 2010, 2020, 2030 and 2040 and then transformed with the standard EUREF transformation to the ETRF2000. Error bars from left to right show the difference for epochs 1990–2040.

PGR as significantly larger rms values compared to the results of the NKG2008 transformation. The results are also varying a lot in the Nordic-Baltic area, see Fig. 8. This example again describes the necessity to correct for the intraplate deformations in Fennoscandian area.

3.3 Transformations to national ETRS89 realizations

The NKG2008 transformation is performed country-wise and therefore transformation residuals can be used as an accuracy measure for accessing the national ETRS89 realizations from ITRF coordinates, *i.e.* national transformations. In case of the NKG2008 transformation the residuals reflect consistency of the input coordinates (both NKG2008 solution and national ETRS89 coordinates) and the intraplate model that is used to take care of the internal deformations (except for Faroe Islands that is outside the validity area of the *NKG_RF03vel* model and therefore intraplate corrections have not been applied in the transformations). While the intraplate model *NKG_RF03vel* was shown to have an overall precision of 0.5 mm/yr level, most of the larger residuals should imply inconsistencies between the input coordinates.

Transformation residuals are summarized in Table 7 and all residuals station-by-station are given in the Ap-

Table 6: RMS of coordinate differences: NKG_ETRF00 (aligned to the ETRF2000@2000.0) and ETRF2000(t) (no intraplate correction, eqs. 1-2) minus ETRF2000 coordinates of the EPNC1785 at the epoch 2000.0. The IGb08 coordinates of the EPNC1785 were first converted to the epochs 1990-2040 with IGb08 station velocities and then transformed to the NKG_ETRF00 or ETRF2000(t) and compared to the ETRF2000 coordinates of the EPNC1785 solution.

	NKG_ETRF00 minus EPNC1785			ETRF2000(t) minus EPNC1785		
Epoch (t)	N [mm]	E [mm]	U [mm]	N [mm]	E [mm]	U [mm]
1990	3.70	1.91	4.50	5.84	5.86	33.78
2000	0.38	0.47	0.32	0.38	0.47	0.32
2010	3.65	2.16	4.57	5.64	5.87	33.86
2020	7.30	4.11	9.09	11.37	11.70	67.67
2030	10.95	6.08	13.61	17.10	17.54	101.49
2040	14.61	8.06	18.13	22.83	23.38	135.31

Table 7: Rms of transformation residuals for Nordic-Baltic countries.

Country	# Points	N [mm]	E [mm]	U [mm]
Denmark (DK)	12	2.67	1.94	3.60
Estonia (EE)	4	0.89	0.94	1.64
Faroe Islands (FO)	5	0.52	0.29	0.80
Finland (FI)	12	2.37	2.35	3.40
Latvia (LV)	11	8.95	2.75	13.44
Lithuania (LT)	10	3.07	1.92	4.56
Norway (NO)	92	1.53	1.62	2.94
Sweden (SE)	31	2.58	2.08	3.71

pendix 1. The rms of transformation residuals is some millimetres for most countries. This again proves that the $NKG\_RF03vel$ model is sufficient for correcting the intraplate deformations in the selected transformation approach. The residuals are slightly larger for Latvia compared to the other countries which can be mostly attributed to the national ETRS89 coordinates. Latvian ETRS89 coordinates are based on EUREF.BAL'92 campaign that has an estimated accuracy of +/−2 cm [8]. In fact, similar residuals would be obtained also for Lithuania if the coordinates of the older national realization, based on the same EUREF.BAL'92 campaign, were used as input coordinates. However, in this project we have used coordinates of the newer Lithuanian ETRS89 realization EUREF-NKG-2003 instead [9].

The national transformation parameters $P_{NKG1,CC}$ for Nordic/Baltic countries are given in the Table 8 and parameters $P_{NKG2,CC}$ in the Table 9.

The coordinates for the fiducial points of the transformation in the common Nordic reference frame NKG_ETRF00 together with the transformation residuals are given in the Appendix 1. The coordinates of the NKG2008 solution aligned to the ITRF2008(2008.75), designated as the NKG_RF08, together with the re-aligned $NKG\_RF03vel$ intraplate velocities ($V_{NKG\_RF03vel\_ETRF2000}$) for all stations are given in the Appendix 2.

4 Conclusions

We have developed a transformation procedure to access the Nordic/Baltic ETRS89 realizations from any ITRF solution at an arbitrary epoch. The transformation makes use of the *de facto* transformation by the EUREF with necessary additional steps. The procedure includes a new common NKG reference frame as well. The common frame was aligned to the ETRF2000 at the epoch 2000.0, named as the NKG_ETRF00. While NKG_ETRF00, as a realization of the ETRS89, is fixed to the Eurasian plate, one may use the NKG2008 solution aligned to ITRF2008(2008.75) as the common frame in the Arctic (outside the Eurasian plate). We have named this NKG2008 solution as the NKG_RF08 (similarly to NKG2003 campaign solution, NKG_RF03).

Selection of the ETRF2000 as the underlying reference frame for the NKG_ETRF00 follows the recommendation of the EUREF TWG and with this choice the resulting common frame is close to the national ETRS89 coordinates as well. Even if the Nordic/Baltic ETRS89 realizations are close to each other, 1–4 cm compared to the NKG_ETRF00, there might be applications requiring better consistency. The NKG_ETRF00 is useful in such applications. Secondly, the epoch 2000.0 is congruent with the national height systems (most of them being implementations of the EVRF2007), meaning the same "land uplift" epoch as the orthometric or normal heights in most Nordic/Baltic countries. These choices mean that the common frame can be used *e.g.* in the Nordic geoid project.

With the common epoch and the selected procedure, we have compromised that the intraplate corrections are

Table 8: Transformation parameters $P_{NKG1,CC}$ from the common NKG reference frame NKG_ETRF00 to national ETRS89 realizations at the epoch 2000.0, ETRFyy(2000.0). Transformation is defined and parameters given at the epoch 2000.0. Parameters $P_{NKG1,CC}$ are associated and should be used only with intraplate corrections from the re-aligned $NKG\_RF03vel$ model ($NKG\_RF03vel\_ETRF2000$), see Fig. 2 for more details.

Country	T_X [m]	T_Y [m]	T_Z [m]	D [ppb]	R_X [mas]	R_Y [mas]	R_Z [mas]
Denmark	0.03863	0.14700	0.02776	−9.420	6.17753	0.05064	0.04729
Estonia	0.12194	0.02225	−0.03541	−5.626	2.27196	−3.23934	2.47008
Faroe Islands	−0.10947	0.23500	0.09432	−2.626	7.34019	4.54595	−2.53141
Finland	0.07251	−0.13019	−0.11323	13.012	−1.57399	−3.08833	4.10332
Latvia	0.41812	−0.78105	−0.01335	0.757	−21.64360	−11.51840	17.19911
Lithuania	0.05692	0.11549	−0.00078	−6.182	3.14291	−1.47975	−1.34758
Norway	−0.13116	−0.02817	0.02036	6.569	−0.38674	4.08947	1.03588
Sweden	−0.01642	−0.00064	−0.03050	1.861	1.87431	0.46382	2.28487

Table 9: Transformation parameters $P_{NKG2,CC}$ from the common NKG reference frame NKG_ETRF00 to national ETRS89 realizations at the epoch 2000.0, ETRFyy(2000.0). Transformation is defined and parameters given at the epoch 2000.0. Parameters $P_{NKG2,CC}$ are associated and should be used only with intraplate corrections from the original $NKG\_RF03vel$ model, see Fig. 2 for more details.

Country	T_X [m]	T_Y [m]	T_Z [m]	D [ppb]	R_X [mas]	R_Y [mas]	R_Z [mas]
Denmark	0.02746	0.14404	0.02104	−6.958	6.09221	0.21292	−0.02866
Estonia	0.11680	0.02088	−0.03851	−4.492	2.23263	−3.16453	2.43507
Faroe Islands	−0.10947	0.23500	0.09432	−2.626	7.34019	4.54595	−2.53141
Finland	0.06618	−0.13187	−0.11704	14.407	−1.62235	−2.99635	4.06027
Latvia	0.40283	−0.78511	−0.02256	4.128	−21.76047	−11.29611	17.09507
Lithuania	0.06483	0.11759	0.00398	−7.925	3.20336	−1.59472	−1.29376
Norway	−0.14171	−0.03097	0.01401	8.894	−0.46734	4.24277	0.96413
Sweden	−0.01748	−0.00092	−0.03114	2.093	1.86625	0.47915	2.27769

applied to ETRS89 coordinates. In principle ETRS89, while being fixed to the stable part of the Eurasian plate, has zero velocities. However, in practice instability of the Eurasian plate can be seen *e.g.* as non-zero ETRF2000 velocities in the EPN solutions. Intraplate deformations are under discussion within the EUREF working group of deformation models but currently, there is no standardized way to correct the deformations. Consequently, the official recommendation is not to apply any corrections at the moment. With this example from the Nordic/Baltic area, we present the methodology for transformation between current ITRF realization at arbitrary epochs and national realizations of the ETRS89, including the parameters for the transformation and the model for crustal deformations. Since the coordinates of the national realizations have a clear epoch of validity, they are by definition static over time (no velocities in the national realizations). By applying this kind of methodology, we believe that the sustainability of the ETRS89 realizations at national level can be extended substantially, to the benefit for both end users as well as authorities responsible of the national geodetic reference frames.

We have defined and introduced transformation parameters to align the velocities of the $NKG\_RF03vel$ model accurately to the ETRF2000 velocities. The intraplate corrections to be applied in the transformation should be taken from the re-aligned $NKG\_RF03vel$ model. However, we have not introduced nor published a corresponding new model (*e.g.* grid files) from the old $NKG\_RF03vel$ model since a new model with amended geodetic data is in plans of the Nordic Geodetic Commission in the near future.

The transformation was defined to go via the common frame (using it as the transformation hub) to the national ETRS89 realizations. This includes several transformation steps but the procedure can be simplified by combining transformation parameters and intraplate corrections from the different steps.

The transformations between ITRF2008 and national ETRS89 coordinates can be performed at a few millimetre level (1σ) for most of the Nordic/Baltic countries. The procedure seems to work quite well for several decades ahead as well.

Acknowledgement: We thank all the members of the NKG Working Group of Reference Frames and other contributors for participating to this project. We also appreciate valuable comments and suggestions from the reviewers that helped us to improve our methodology and the manuscript.

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Appendix 1: coordinates in NKG_ETRF00 (in ETRF2000, epoch 2000.0) and transformation residuals for the fiducial points of the transformation

		*NKG_ETRF*00: ETRF2000(2000.0)			Residuals		
Country	Station	X	Y	Z	dX	dY	dZ
DK	BUDD	3513649.6263	778954.5561	5248201.7746	0.0011	−0.0030	0.0095
DK	MYGD	3379477.8469	598261.4336	5358170.3666	−0.0022	0.0020	−0.0011
DK	STAG	3629048.3290	603765.4879	5192855.6491	0.0025	0.0004	−0.0008
DK	HVIG	3523228.8990	502878.6867	5275212.9219	−0.0006	0.0005	−0.0035
DK	TYVH	3471138.6742	665488.3681	5291632.3100	0.0016	0.0022	−0.0029
DK	BORR	3523675.1999	928375.7787	5217378.5595	−0.0025	0.0032	−0.0078
DK	SMID	3557911.5231	599176.4818	5242066.2584	−0.0033	−0.0018	−0.0004
DK	SULD	3446394.4992	591712.9535	5316383.2707	0.0013	−0.0002	0.0006
DK	BUDP	3513638.5553	778956.1997	5248216.2456	0.0012	−0.0009	0.0022
DK	GESR	3625387.6129	765503.9378	5174102.5088	−0.0002	0.0010	0.0024
DK	HIRS	3374903.3202	593115.3869	5361509.3105	0.0040	−0.0018	0.0002
DK	ESBC	3582105.2910	532589.7421	5232754.8097	−0.0029	−0.0014	0.0017
EE	SUUR	2959056.7145	1341058.3585	5470427.1226	0.0014	0.0022	0.0008
EE	KURE	3107617.7529	1287856.3390	5400807.1129	−0.0003	−0.0014	−0.0012
EE	TORA	3010571.9073	1498759.2509	5401441.1026	0.0003	−0.0002	0.0016
EE	TOIL	2884257.5798	1503793.9005	5468067.7851	−0.0014	−0.0006	−0.0012
FI	JOEN	2564139.4361	1486149.6204	5628951.2871	0.0007	−0.0005	−0.0047
FI	KEVO	1972158.5139	1005174.3797	5961798.6658	−0.0059	−0.0019	−0.0017
FI	KIVE	2632277.5023	1266957.2886	5651027.5464	0.0029	−0.0001	0.0023
FI	KUUS	2282711.8010	1267071.7498	5800215.6974	0.0048	−0.0025	0.0014
FI	METS	2892571.1246	1311843.2786	5512633.9669	0.0011	0.0011	0.0005
FI	OLKI	2863210.2923	1126271.3828	5568267.2206	−0.0001	0.0014	0.0040
FI	OULU	2423778.7756	1176553.7062	5761860.8610	0.0019	−0.0005	−0.0024
FI	ROMU	2410839.5022	1388069.4786	5720515.1513	0.0062	−0.0011	0.0044
FI	SODA	2200147.0169	1091638.2259	5866870.6305	−0.0020	0.0012	0.0025
FI	TUOR	2917811.0819	1205222.5493	5523549.9437	−0.0031	0.0025	−0.0003
FI	VAAS	2699864.6519	1078263.8494	5658064.7007	−0.0043	0.0009	−0.0015
FI	VIRO	2788248.5148	1454873.3191	5530280.0295	−0.0022	−0.0006	−0.0044
FO	KLAK	2960778.0851	−342299.7927	5620225.3573	−0.0005	−0.0001	0.0002
FO	SORV	2971445.1797	−379959.4073	5612155.7982	−0.0001	−0.0002	−0.0000

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		*NKG_ETRF*00: ETRF2000(2000.0)			Residuals		
Country	Station	X	Y	Z	dX	dY	dZ
FO	TORH	2980573.6411	−353744.5004	5608956.9018	−0.0007	0.0000	−0.0010
FO	TVOR	3026017.3717	−360952.0511	5584332.1750	−0.0003	−0.0001	0.0001
FO	ARGI	2981490.0687	−354651.8091	5608474.7834	0.0015	0.0004	0.0007
LT	ARAJ	3277266.8919	1309685.6627	5295146.5840	0.0003	−0.0039	0.0082
LT	BORR	3523675.1999	928375.7787	5217378.5595	−0.0005	0.0034	−0.0022
LT	INDR	3177703.8474	1662049.9514	5257080.2144	0.0047	0.0013	0.0017
LT	KANG	3078175.2992	1608797.6140	5331767.4993	−0.0049	−0.0046	−0.0052
LT	KLPD	3359228.4748	1297490.2914	5246690.1721	−0.0034	−0.0002	−0.0007
LT	L408	3311606.9399	1453968.6450	5236111.1069	0.0070	0.0027	0.0014
LT	L409	3425868.2072	1482315.5412	5154672.3089	0.0010	0.0016	−0.0015
LT	RIGA	3183899.5403	1421478.3132	5322810.6301	0.0016	0.0026	0.0036
LT	VIS0	3246470.5735	1077900.3267	5365277.9208	−0.0030	−0.0021	−0.0007
LT	VLNS	3343600.9728	1580417.5580	5179337.1237	−0.0028	−0.0007	−0.0046
LV	BALV	3084535.0822	1589675.9009	5333791.7097	−0.0133	−0.0121	−0.0062
LV	BAUS	3226815.0033	1449250.1405	5289639.3604	−0.0102	−0.0040	−0.0054
LV	LIMB	3119682.9135	1435782.6510	5356755.0689	−0.0006	0.0008	−0.0083
LV	MADO	3136049.8595	1544577.0743	5317122.7308	−0.0085	−0.0061	−0.0018
LV	OJAR	3185444.6339	1423322.9511	5321411.1763	−0.0056	−0.0042	0.0037
LV	SIGU	3145951.7611	1459815.0794	5335020.9504	−0.0067	−0.0045	−0.0073
LV	TALS	3193687.6599	1328546.4989	5340896.9827	0.0017	0.0047	−0.0096
LV	IRBE	3183614.9127	1276707.5116	5359315.0105	0.0136	0.0071	−0.0001
LV	KANG	3078175.2992	1608797.6140	5331767.4993	0.0190	0.0132	0.0253
LV	ARAJ	3277266.8919	1309685.6627	5295146.5840	0.0014	−0.0038	0.0175
LV	INDR	3177703.8474	1662049.9514	5257080.2144	0.0093	0.0089	−0.0079
NO	AKRC	3254758.8529	295601.4495	5458918.6786	0.0003	0.0009	0.0006
NO	ALES	2938027.6175	319096.2073	5633413.8041	−0.0010	−0.0003	−0.0056
NO	ALTC	2011819.9907	866267.8202	5970245.0547	0.0005	0.0014	0.0001
NO	ANDO	2175766.2017	624248.1032	5943417.6464	−0.0017	−0.0019	−0.0059
NO	AREC	3310416.1459	507077.7076	5410027.8176	0.0017	−0.0026	−0.0005
NO	ARNC	3121908.4450	633906.6275	5507319.2689	−0.0010	−0.0007	−0.0012
NO	BALC	2140934.4252	746664.0817	5941587.0658	−0.0010	−0.0005	−0.0005
NO	BARC	2189670.4947	726323.8651	5926495.7467	−0.0006	−0.0001	0.0031
NO	BJAC	2197254.1598	653578.0231	5932029.4678	−0.0004	0.0011	0.0022
NO	BOD3	2391774.5495	615614.9026	5860965.8220	−0.0012	0.0010	−0.0003

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Country	Station	*NKG_ETRF*00: ETRF2000(2000.0)			Residuals		
		X	Y	Z	dX	dY	dZ
NO	BOMC	3202528.6267	289431.6412	5489898.0187	0.0016	−0.0001	0.0036
NO	BRGS	3155871.4197	290902.7117	5516573.3891	−0.0001	−0.0007	−0.0003
NO	BYGC	3278594.6282	449040.8152	5434527.7137	0.0012	−0.0023	0.0007
NO	DAGS	3122524.6191	466764.0524	5524286.3753	−0.0006	0.0011	0.0009
NO	DOMS	2957496.5928	474476.5662	5612992.2724	−0.0010	0.0007	0.0031
NO	FINC	2157475.3687	700471.4235	5941222.3511	−0.0004	0.0003	0.0011
NO	FLIC	3069140.8167	653054.4006	5534533.7210	0.0011	0.0005	0.0034
NO	FLOC	3029753.1639	267083.0844	5587514.8618	−0.0007	−0.0006	0.0001
NO	FROC	2785000.4160	424190.1469	5703190.4194	−0.0004	0.0012	−0.0011
NO	GJEC	3013863.1321	384200.9865	5589512.0006	−0.0001	0.0022	−0.0029
NO	GLOC	3007511.3387	326280.0878	5596312.0825	0.0008	0.0013	−0.0018
NO	HANC	2064009.4983	736022.1735	5969866.8311	−0.0003	0.0019	0.0021
NO	HARC	3081816.0270	260952.1332	5559464.0059	−0.0005	0.0007	0.0003
NO	HAUC	3190242.3327	402823.7058	5490993.5084	−0.0012	−0.0002	−0.0012
NO	HEDC	3093504.0661	531189.8508	5534341.4265	−0.0003	0.0003	0.0007
NO	HELC	2977963.4231	353232.1643	5610785.3075	0.0001	0.0005	0.0009
NO	HEMC	2838350.5728	453607.5507	5674729.8997	−0.0001	−0.0005	−0.0040
NO	HFSS	3132537.6032	566401.8225	5508615.0231	−0.0008	0.0002	−0.0021
NO	HOLC	2779581.2650	549368.6045	5695298.6673	−0.0006	−0.0015	−0.0027
NO	HONS	1874722.6280	912942.9870	6007499.5640	−0.0018	−0.0001	0.0011
NO	HUSC	2884086.1150	361222.6490	5658395.4905	−0.0001	0.0015	−0.0001
NO	INNC	2927523.9584	387862.1090	5634412.9309	0.0023	0.0005	0.0039
NO	KAUS	2107889.5114	895603.2114	5933242.3232	−0.0012	−0.0013	−0.0015
NO	KJOC	2289009.7827	673144.0608	5895302.1761	−0.0000	0.0001	−0.0011
NO	KOBC	2346368.9259	667943.8714	5873445.4597	0.0000	0.0002	0.0006
NO	KRSS	3348186.1197	465040.8598	5390738.1071	0.0023	0.0002	−0.0012
NO	KVAC	2054886.8118	832604.9354	5960372.1580	−0.0025	0.0008	−0.0059
NO	LEIC	3060419.9145	367986.2413	5565177.6985	0.0014	−0.0003	−0.0011
NO	LILC	3035802.5370	559312.8004	5562956.4006	0.0015	−0.0001	0.0029
NO	LINC	3113386.5740	281350.8040	5541022.2879	−0.0001	0.0008	−0.0019
NO	LISC	3356519.0058	393644.8864	5391129.0536	−0.0008	0.0008	0.0009
NO	LODC	2262517.8877	648164.3554	5908272.3501	−0.0010	0.0003	−0.0013
NO	LOFS	2345766.9436	543139.0609	5886461.4292	−0.0025	−0.0002	0.0002
NO	LONC	2434929.1711	673600.9527	5837390.0720	−0.0022	−0.0001	−0.0062

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Country	Station	*NKG_ETRF*00: ETRF2000(2000.0)			Residuals		
		X	Y	Z	dX	dY	dZ
NO	LOPC	2000371.6462	822394.0128	5980168.5284	−0.0010	0.0014	−0.0007
NO	LYSC	3269684.2076	366420.4425	5446037.4087	−0.0002	−0.0014	0.0015
NO	MEBC	2827601.6551	551358.5673	5671662.3456	0.0025	0.0010	−0.0042
NO	MOLC	2418106.0395	628665.8576	5848777.9035	0.0014	0.0012	0.0049
NO	MYRC	2221995.2730	598999.1184	5928613.8172	−0.0014	0.0013	0.0016
NO	MYSC	3175705.1658	636305.7228	5476421.0757	0.0003	−0.0002	−0.0011
NO	OLDC	2087738.2726	782002.0941	5955837.5921	−0.0007	0.0006	0.0005
NO	OSLS	3169982.1604	579956.5919	5485936.4859	−0.0011	0.0010	0.0003
NO	OSTC	3090542.1953	407157.6438	5546820.5835	0.0008	0.0003	0.0021
NO	PORC	3267085.0810	542580.8339	5432706.0861	−0.0004	−0.0006	−0.0000
NO	PREC	3227088.9295	353649.6615	5471909.7403	0.0007	0.0003	0.0017
NO	RENC	3026038.1688	608374.3272	5563169.1734	−0.0001	0.0010	0.0017
NO	ROSC	3181052.0925	335027.4366	5499661.2724	0.0001	0.0001	0.0023
NO	SELC	3209902.9302	487409.3405	5471751.9583	−0.0000	0.0004	0.0013
NO	SIRC	3323397.6701	336993.5330	5415277.8443	0.0009	0.0005	0.0026
NO	SKJC	2039577.8278	781938.4970	5972404.5072	−0.0001	0.0008	−0.0008
NO	SKOC	3187460.4067	543918.8600	5479515.9030	−0.0010	−0.0006	0.0003
NO	SKRC	3077326.5284	594183.4627	5536602.9571	0.0011	0.0003	−0.0011
NO	SMOC	2824689.6124	394744.3301	5685842.5299	0.0004	0.0002	0.0005
NO	STAC	2977626.8019	277105.4337	5614791.3314	−0.0014	0.0009	0.0000
NO	STAS	3275753.9112	321110.8595	5445041.8921	0.0021	−0.0002	0.0033
NO	STEC	2336698.1838	626806.3853	5881754.7292	−0.0002	0.0007	0.0017
NO	SULC	2389748.1352	688764.1166	5853814.5214	−0.0000	−0.0008	0.0027
NO	SVEC	3313865.9478	434268.8974	5414427.0671	0.0003	−0.0004	0.0003
NO	SVOC	2295994.0222	596438.3291	5900792.8061	−0.0009	0.0001	−0.0003
NO	TGDE	3358081.1927	445364.7238	5386152.7490	0.0003	0.0003	−0.0019
NO	TINC	2882293.8538	415691.9810	5655579.1226	−0.0009	0.0003	−0.0001
NO	TJMC	3227106.4058	592239.8919	5451311.0498	−0.0004	−0.0001	0.0012
NO	TONC	3301576.6228	389092.9383	5425120.7459	0.0010	0.0008	0.0025
NO	TRDS	2820171.1164	513485.8960	5678935.7621	−0.0022	−0.0002	−0.0021
NO	TREC	3255039.9314	487706.1519	5445319.2475	−0.0012	−0.0019	−0.0025
NO	TRO1	2102928.8041	721619.3423	5958196.1048	0.0034	−0.0012	0.0033
NO	TRYS	2987994.1389	655946.0608	5578690.0462	−0.0014	−0.0007	−0.0037
NO	TYIC	3050967.4986	441448.7104	5566379.6186	−0.0031	−0.0004	−0.0051

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Country	Station	*NKG_ETRF00*: ETRF2000(2000.0)			Residuals		
		X	Y	Z	dX	dY	dZ
NO	ULEC	3223773.6430	527002.6570	5459933.6322	−0.0006	0.0002	0.0013
NO	VALC	3241304.2320	425413.0577	5458869.3122	−0.0002	0.0020	0.0018
NO	VARD	1839676.3994	1109939.3174	5985244.4885	−0.0023	−0.0016	−0.0036
NO	VARS	1844607.6490	1109719.1134	5983936.0257	−0.0018	0.0004	−0.0013
NO	VEGC	3152743.8630	508812.8352	5502859.2304	0.0017	−0.0011	0.0056
NO	MR02	2931040.4141	312062.4441	5637266.4119	0.0058	−0.0010	−0.0014
NO	OE01	3199408.1250	611115.7337	5465433.7621	−0.0033	0.0054	−0.0003
NO	FI16	1871721.2814	911636.1306	6008644.3811	0.0057	0.0014	−0.0013
NO	HE06	2988391.7883	583378.9975	5586113.1226	0.0007	−0.0060	−0.0068
NO	NO08	2554643.7085	599751.0708	5793992.6455	0.0026	−0.0026	−0.0008
NO	NO17	2336651.2463	626667.8091	5881804.2585	−0.0007	−0.0011	0.0054
NO	TR02	2102022.3714	719850.7486	5958615.0016	0.0070	−0.0065	0.0042
NO	NT04	2807246.5310	541526.1152	5682404.1012	−0.0063	−0.0032	−0.0062
NO	FI12	1892320.5237	1085003.0200	5973509.5222	0.0054	0.0029	0.0086
SE	ARJE	2441775.4466	799268.0601	5818729.1844	−0.0006	0.0014	0.0080
SE	HASS	3464655.8515	845749.9564	5270271.5170	−0.0022	−0.0007	0.0011
SE	JOEN	2564139.4361	1486149.6204	5628951.2871	0.0008	−0.0023	−0.0109
SE	JONK	3309991.8531	828932.0876	5370882.2815	0.0007	0.0000	0.0035
SE	KARL	3160763.3682	759160.1512	5469345.5182	0.0009	0.0013	−0.0011
SE	KEVO	1972158.5139	1005174.3797	5961798.6658	−0.0052	−0.0026	−0.0038
SE	KIR0	2248123.5183	865686.5607	5886425.6125	−0.0053	−0.0006	0.0013
SE	KIVE	2632277.5023	1266957.2886	5651027.5464	0.0047	−0.0023	0.0023
SE	KUUS	2282711.8010	1267071.7498	5800215.6974	0.0014	−0.0049	0.0037
SE	LEKS	3022573.1938	802945.6511	5540683.9762	0.0037	0.0020	0.0013
SE	LOVO	3104219.4642	998383.9958	5463290.5320	0.0002	0.0004	−0.0039
SE	MAR6	2998189.7225	931451.6028	5533398.4938	0.0014	0.0023	0.0008
SE	METS	2892571.1246	1311843.2786	5512633.9669	0.0028	−0.0003	0.0017
SE	NORR	3199093.3319	932231.2998	5420322.5049	0.0002	0.0004	0.0009
SE	OLKI	2863210.2923	1126271.3828	5568267.2206	0.0049	0.0002	0.0059
SE	ONSA	3370658.8409	711876.9478	5349786.7655	−0.0024	0.0014	0.0017
SE	OSKA	3341340.1981	957912.3118	5330003.2360	−0.0009	−0.0002	−0.0011
SE	OSTE	2763885.5276	733247.3495	5682653.3695	−0.0030	0.0010	−0.0036
SE	OULU	2423778.7756	1176553.7062	5761860.8610	0.0027	−0.0010	0.0006
SE	OVER	2368885.0434	994492.1988	5818478.2018	−0.0051	−0.0002	−0.0011

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		*NKG_ETRF*00: ETRF2000(2000.0)			Residuals		
Country	Station	X	Y	Z	dX	dY	dZ
SE	ROMU	2410839.5022	1388069.4786	5720515.1513	0.0064	−0.0017	0.0012
SE	SODA	2200147.0169	1091638.2259	5866870.6305	−0.0042	0.0005	0.0063
SE	SUND	2838909.9445	903822.0613	5620660.2274	−0.0009	0.0031	−0.0021
SE	SVEG	2902495.1150	761455.8054	5609859.7063	0.0002	0.0017	−0.0020
SE	TUOR	2917811.0819	1205222.5493	5523549.9437	0.0022	−0.0000	0.0012
SE	UMEA	2682407.9334	950395.9033	5688993.1351	0.0007	0.0025	0.0008
SE	VAAS	2699864.6519	1078263.8494	5658064.7007	−0.0023	−0.0008	−0.0028
SE	VANE	3249408.3013	692757.9271	5426396.9597	−0.0022	0.0028	−0.0054
SE	VIL0	2620258.8999	779138.0032	5743799.2992	0.0001	−0.0012	−0.0008
SE	VIRO	2788248.5148	1454873.3191	5530280.0295	0.0010	−0.0005	−0.0042
SE	VIS0	3246470.5735	1077900.3267	5365277.9208	−0.0010	−0.0018	0.0004

Concluded

Appendix 2: NKG2008 coordinates (in ITRF2008, epoch 2008.75) and re-aligned NKG_RF03vel velocities (stations outside Eurasian plate and beyond Ural excluded)

Station	ITRF2008(2008.75) (= *NKG_RF08*)			*NKG_RF03vel_ETRF2000*		
	X [m]	Y [m]	Z [m]	VX [m]	VY [m]	VZ [m]
AHTM	2894579.0708	1501319.9684	5463361.6538	0.0013	0.0008	0.0006
AIZK	3183144.8000	1501282.5841	5301551.7447	0.0003	−0.0001	−0.0005
AKRC	3254758.5152	295601.6805	5458918.8928	0.0000	−0.0008	0.0001
ALES	2938027.2696	319096.4112	5633414.0110	−0.0001	−0.0013	0.0010
ALFT	2946813.1387	848598.3848	5573978.6368	0.0040	0.0008	0.0062
ALMU	3051686.8496	995723.7508	5493063.0511	0.0035	0.0012	0.0043
ALTC	2011819.5866	866267.9625	5970245.2234	−0.0001	−0.0005	0.0022
ALVD	2985826.6647	746502.5433	5568019.5307	0.0036	0.0002	0.0055
ALVS	2459581.1238	944476.4103	5789143.9459	0.0031	0.0008	0.0079
ALYT	3398976.5283	1516145.3152	5162464.0136	−0.0003	−0.0005	−0.0009
AMMA	2502400.4113	727285.2602	5802472.1302	0.0022	−0.0006	0.0064
ANDE	2169480.8168	627616.9180	5944952.2566	−0.0004	−0.0011	0.0011
ANDO	2175765.8143	624248.2529	5943417.8154	−0.0004	−0.0011	0.0011
ANEB	3290692.6974	870337.7679	5376156.9789	0.0022	0.0003	0.0019
ANGE	2840959.9294	796398.3006	5635959.5518	0.0038	0.0004	0.0068
ANTS	3045502.2355	1520523.2684	5375905.0311	0.0007	0.0003	−0.0001
ARAJ	3277266.4893	1309685.9003	5295146.7895	0.0006	0.0001	−0.0002
AREC	3310415.8041	507077.9441	5410028.0400	0.0012	−0.0006	0.0009
ARGI	2981489.7734	−354651.5890	5608474.9888	0.0000	0.0000	0.0000
ARH1	3033348.8334	1051896.3106	5492738.4009	0.0033	0.0013	0.0040
ARJE	2441775.0747	799268.2369	5818729.4148	0.0022	−0.0002	0.0068
ARJT	2471780.9043	795582.7319	5806615.0393	0.0024	−0.0002	0.0069
ARNC	3121908.1044	633906.8533	5507319.5069	0.0029	−0.0002	0.0038
ARVI	2496440.4871	868007.5460	5785745.2638	0.0030	0.0004	0.0077
ASAK	3286466.3813	723964.4327	5400051.7829	0.0021	−0.0000	0.0018
ASAR	2846989.2746	729482.0350	5642136.8409	0.0034	−0.0000	0.0063
ASEL	2660696.3074	831586.6204	5717878.9005	0.0036	0.0004	0.0077
ATRA	3382553.9852	777774.9111	5333332.8975	0.0015	−0.0001	0.0010
AUDR	3051130.0555	1378514.9560	5410561.2652	0.0013	0.0007	0.0007
BAGA	3339599.3374	710996.2323	5369302.6087	0.0017	−0.0001	0.0013

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Station	ITRF2008(2008.75) (= *NKG_RF08*)			*NKG_RF03vel_ETRF2000*		
	X [m]	Y [m]	Z [m]	VX [m]	VY [m]	VZ [m]
BALC	2140934.0328	746664.2312	5941587.2468	0.0000	−0.0008	0.0028
BALV	3084534.6557	1589676.1225	5333791.9014	0.0004	−0.0000	−0.0005
BARC	2189670.1061	726324.0178	5926495.9344	0.0002	−0.0009	0.0033
BAST	2559130.8857	933302.8439	5748152.9564	0.0036	0.0010	0.0080
BAUS	3226814.5885	1449250.3726	5289639.5602	0.0003	−0.0001	−0.0004
BELF	3685257.9468	−382909.0137	5174311.0350	0.0000	0.0000	0.0000
BIE_	3154144.1931	917058.9216	5449043.1751	0.0032	0.0008	0.0035
BIRZ	3229446.6864	1489359.3759	5277001.4255	0.0002	−0.0001	−0.0005
BJAC	2197253.7727	653578.1745	5932029.6445	−0.0002	−0.0011	0.0019
BJOR	3169460.2732	805521.5325	5457845.9243	0.0031	0.0004	0.0035
BJUC	2785002.8883	481751.1059	5698729.6466	0.0008	−0.0014	0.0028
BJUR	2562312.6836	1013194.2246	5733061.7017	0.0037	0.0014	0.0078
BLAN	3286234.4844	974376.5637	5360886.1207	0.0020	0.0004	0.0016
BOD3	2391774.1733	615615.0666	5860966.0181	0.0004	−0.0013	0.0030
BODA	3306742.5165	1014675.4198	5340866.7759	0.0017	0.0004	0.0012
BOMC	3202528.2887	289431.8676	5489898.2326	0.0001	−0.0009	0.0003
BOR1	3738358.3895	1148173.7681	5021815.8058	0.0000	0.0000	0.0000
BORR	3523674.8276	928376.0322	5217378.7816	0.0004	−0.0002	0.0000
BRGS	3155871.0813	290902.9340	5516573.6037	0.0002	−0.0010	0.0007
BRUS	4027893.6940	307045.8871	4919475.1574	0.0000	0.0000	0.0000
BUDD	3513649.2648	778954.8089	5248201.9980	0.0004	−0.0003	0.0001
BUDP	3513638.1938	778956.4525	5248216.4690	0.0004	−0.0003	0.0001
BURT	2574747.1250	970794.0660	5734870.1713	0.0037	0.0012	0.0080
BYGC	3278594.2886	449041.0485	5434527.9353	0.0010	−0.0007	0.0009
CHAR	3134776.2845	683718.1793	5494106.3151	0.0030	−0.0000	0.0038
DAGS	3122524.2794	466764.2730	5524286.6024	0.0016	−0.0009	0.0024
DANG	3404669.2242	922054.2422	5296402.8273	0.0012	0.0000	0.0007
DARE	3811965.3067	−175799.7714	5093615.7455	0.0000	0.0000	0.0000
DAUG	3209659.3759	1601282.4782	5256434.0210	0.0001	−0.0003	−0.0007
DEGE	2994012.1491	1112559.8315	5502272.0102	0.0031	0.0014	0.0038
DKST	3243939.6261	1604583.1909	5234563.9298	−0.0000	−0.0004	−0.0008
DOBE	3230386.7563	1389950.7823	5303282.9908	0.0005	0.0001	−0.0003
DOMS	2957496.2465	474476.7727	5612992.4968	0.0014	−0.0012	0.0030
DORO	2664074.4671	784911.9501	5722866.0374	0.0033	0.0001	0.0073

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Station	ITRF2008(2008.75) (= *NKG_RF08*)			*NKG_RF03vel_ETRF2000*		
	X [m]	Y [m]	Z [m]	VX [m]	VY [m]	VZ [m]
EDAN	3152095.1745	717041.2702	5479946.5202	0.0030	0.0001	0.0036
EKET	3404422.7167	1007063.0989	5280999.5047	0.0010	0.0001	0.0005
ELKT	3351170.1243	1537439.5909	5187197.8649	−0.0002	−0.0005	−0.0008
ESBC	3582104.9400	532589.9989	5232755.0316	−0.0005	−0.0005	−0.0006
ESBH	3585278.9297	531971.2096	5230646.5540	−0.0006	−0.0005	−0.0007
FALK	3278189.6024	790418.6119	5395964.8560	0.0023	0.0002	0.0021
FARO	3208031.0104	1113333.8295	5380981.9757	0.0019	0.0007	0.0014
FBER	3408401.2250	755024.6179	5320097.1972	0.0012	−0.0002	0.0007
FI06	2107818.8863	896943.7905	5933012.6644	0.0004	−0.0003	0.0039
FI12	1892320.1033	1085003.1566	5973509.6801	−0.0001	−0.0001	0.0018
FI16	1871720.8698	911636.2625	6008644.5269	−0.0004	−0.0005	0.0004
FINC	2157474.9786	700471.5732	5941222.5291	−0.0001	−0.0010	0.0023
FLIC	3069140.4750	653054.6231	5534533.9614	0.0031	−0.0002	0.0044
FLOC	3029752.8214	267083.2963	5587515.0708	−0.0001	−0.0012	0.0007
FRED	2652982.7831	882670.1256	5713799.3760	0.0038	0.0008	0.0080
FROC	2785000.0588	424190.3380	5703190.6235	0.0001	−0.0015	0.0016
FROV	3132396.4209	860615.5330	5470596.9628	0.0033	0.0007	0.0039
FUNA	2880169.6960	643850.9413	5636020.6914	0.0027	−0.0005	0.0053
FURD	2976754.3029	805544.7934	5564636.1490	0.0038	0.0006	0.0058
GADD	2669718.1390	672511.1241	5734476.2159	0.0023	−0.0007	0.0058
GALL	2809659.3811	765285.9880	5655934.6242	0.0035	0.0002	0.0068
GAV4	2993588.5929	922760.3119	5537296.0026	0.0039	0.0011	0.0054
GAVL	2993586.6250	922761.8044	5537295.9210	0.0039	0.0011	0.0054
GESR	3625387.2499	765504.1975	5174102.7350	−0.0002	−0.0004	−0.0002
GJEC	3013862.7879	384201.1965	5589512.2180	0.0007	−0.0013	0.0018
GLOC	3007510.9949	326280.2973	5596312.2954	0.0003	−0.0013	0.0013
GRAF	2813762.4699	699874.4252	5662613.9838	0.0031	−0.0003	0.0062
GRAN	3081967.3223	824652.1664	5504761.7926	0.0036	0.0006	0.0046
GROV	2927622.8623	639248.9889	5612310.9406	0.0028	−0.0005	0.0052
GRYT	3226575.6054	974213.1131	5396772.1247	0.0024	0.0006	0.0022
GULB	3094907.0413	1560384.3681	5336432.3235	0.0005	0.0000	−0.0004
GUNN	2407199.9054	962834.9866	5807976.1041	0.0027	0.0008	0.0076
HAGF	3102843.8908	756558.2806	5502658.1038	0.0034	0.0003	0.0043
HALE	3115217.5847	806835.9000	5488628.1917	0.0034	0.0005	0.0042

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	ITRF2008(2008.75) (= *NKG_RF08*)			*NKG_RF03vel_ETRF2000*		
Station	X [m]	Y [m]	Z [m]	VX [m]	VY [m]	VZ [m]
HALV	3456798.6317	906264.2650	5265352.9943	0.0008	−0.0001	0.0004
HAMR	2932847.1542	785884.1470	5590803.4655	0.0037	0.0004	0.0061
HANC	2064009.1017	736022.3169	5969866.9956	−0.0004	−0.0009	0.0013
HAPA	2390141.6880	1070747.6280	5796167.9680	0.0028	0.0014	0.0074
HARA	3414099.9591	880515.0240	5297435.7902	0.0012	−0.0000	0.0007
HARC	3081815.6861	260952.3494	5559464.2158	−0.0001	−0.0011	0.0005
HASS	3464655.4871	845750.2066	5270271.7398	0.0008	−0.0002	0.0004
HAUC	3190241.9939	402823.9312	5490993.7297	0.0010	−0.0009	0.0013
HE06	2988391.4444	583379.2103	5586113.3586	0.0025	−0.0007	0.0043
HEDC	3093503.7262	531190.0707	5534341.6594	0.0022	−0.0007	0.0033
HEDE	2879086.0990	691909.5429	5630727.6190	0.0031	−0.0002	0.0058
HELC	2977963.0775	353232.3713	5610785.5210	0.0004	−0.0013	0.0016
HELG	3706067.1275	513803.9287	5148174.5006	−0.0010	−0.0004	−0.0006
HEMA	2529751.3931	681679.3251	5796246.5131	0.0018	−0.0008	0.0056
HEMC	2838350.2195	453607.7466	5674730.1134	0.0007	−0.0014	0.0024
HERS	4033470.0570	23672.9522	4924301.3492	0.0000	0.0000	0.0000
HFSS	3132537.2637	566402.0467	5508615.2575	0.0024	−0.0005	0.0033
HILL	3351528.4107	828634.4307	5345223.4373	0.0017	0.0001	0.0013
HIRS	3374902.9726	593115.6291	5361509.5315	0.0010	−0.0004	0.0005
HISI	3338919.3724	708876.4117	5369936.3605	0.0017	−0.0001	0.0013
HJO_	3255728.1007	829058.6530	5403567.1832	0.0025	0.0003	0.0023
HOB0	3315706.8354	1087011.2980	5321221.0265	0.0013	0.0003	0.0007
HOBU	3778219.7366	698635.4949	5074054.2649	−0.0011	−0.0005	−0.0007
HOE2	3650022.6206	532050.6092	5185984.5258	−0.0009	−0.0005	−0.0008
HOFN	2679689.9621	−727951.1660	5722789.3674	0.0000	0.0000	0.0000
HOFS	2679698.0431	−727953.0041	5722785.4503	0.0000	0.0000	0.0000
HOLC	2779580.9109	549368.7978	5695298.8915	0.0015	−0.0012	0.0040
HOLJ	3030937.6358	674414.3976	5553001.5310	0.0032	−0.0001	0.0048
HONS	1874722.2164	912943.1192	6007499.7105	−0.0004	−0.0005	0.0004
HOS0	2658636.1224	988138.4718	5693663.5610	0.0040	0.0015	0.0079
HOTA	2721007.2793	686844.4629	5708763.5137	0.0027	−0.0005	0.0062
HROR	3219412.1605	798973.1264	5429569.7021	0.0028	0.0003	0.0028
HSSA	2865276.3881	860260.9061	5614325.7971	0.0041	0.0009	0.0069
HUDI	2894696.7810	892723.5437	5594123.1864	0.0041	0.0010	0.0066

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	ITRF2008(2008.75) (= *NKG_RF08*)			*NKG_RF03vel_ETRF2000*		
Station	X [m]	Y [m]	Z [m]	VX [m]	VY [m]	VZ [m]
HUSC	2884085.7635	361222.8482	5658395.6963	0.0000	−0.0014	0.0012
HVIG	3523228.5485	502878.9389	5275213.1384	−0.0005	−0.0005	−0.0010
HYBO	2902251.4149	843669.6099	5597931.4506	0.0040	0.0008	0.0066
INDR	3177703.4154	1662050.1761	5257080.4071	0.0000	−0.0004	−0.0008
INNC	2927523.6101	387862.3118	5634413.1445	0.0005	−0.0014	0.0019
INVE	3427172.0958	−252834.0684	5355255.7554	0.0000	0.0000	0.0000
IRBE	3183614.5147	1276707.7460	5359315.2169	0.0011	0.0005	0.0004
JANE	2946746.7849	1417457.0573	5457910.4548	0.0015	0.0009	0.0010
JARP	2789756.5093	667140.2603	5678055.2938	0.0027	−0.0005	0.0059
JAVR	2500466.5366	984257.1702	5765093.9669	0.0034	0.0012	0.0079
JEKA	3174744.3349	1539672.1702	5295615.0298	0.0003	−0.0001	−0.0005
JNSK	3254950.6720	1423244.4620	5279545.8259	0.0003	−0.0001	−0.0005
JOEN	2564139.0177	1486149.8184	5628951.4773	0.0019	0.0015	0.0021
JOKK	2389199.6381	861690.0147	5831334.9232	0.0023	0.0001	0.0072
JONK	3309991.4967	828932.3298	5370882.5088	0.0021	0.0002	0.0017
JONS	3467026.4230	779817.0295	5278744.8723	0.0008	−0.0002	0.0003
JOZE	3664940.0957	1409153.9217	5009571.4223	0.0000	0.0000	0.0000
JUNS	2712015.1554	823350.7969	5694939.0640	0.0037	0.0005	0.0076
KABD	2430673.2021	884173.0413	5811030.1708	0.0027	0.0004	0.0075
KALL	3237443.2701	758888.6495	5424621.0158	0.0026	0.0001	0.0025
KANG	3078174.8711	1608797.8348	5331767.6902	0.0004	−0.0001	−0.0005
KARD	3038082.1702	1272076.6132	5443646.4897	0.0019	0.0010	0.0015
KARL	3160763.0215	759160.3838	5469345.7548	0.0031	0.0003	0.0036
KASE	2761499.4607	635454.0584	5695427.1155	0.0024	−0.0008	0.0055
KATT	3257720.1027	1111411.6930	5351668.1127	0.0016	0.0005	0.0010
KAUN	3358006.9008	1493647.1938	5195474.6726	−0.0002	−0.0004	−0.0008
KAUS	2107889.1114	895603.3628	5933242.5117	0.0004	−0.0003	0.0039
KEDN	3328307.4847	1481452.6657	5217851.1987	−0.0001	−0.0004	−0.0007
KEHT	2994090.0972	1387774.2946	5439846.7323	0.0015	0.0008	0.0010
KELM	3323954.1443	1406190.9442	5241339.7285	0.0001	−0.0002	−0.0006
KEVO	1972158.1009	1005174.5219	5961798.8349	−0.0000	−0.0002	0.0025
KIR0	2248123.1294	865686.7235	5886425.8225	0.0012	−0.0002	0.0056
KIRU	2251420.7303	862817.2600	5885476.7487	0.0012	−0.0002	0.0056
KIVE	2632277.1098	1266957.4965	5651027.7653	0.0031	0.0020	0.0049

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Station	ITRF2008(2008.75) (= *NKG_RF08*)			*NKG_RF03vel_ETRF2000*		
	X [m]	Y [m]	Z [m]	VX [m]	VY [m]	VZ [m]
KJOC	2289009.4011	673144.2193	5895302.3710	0.0004	−0.0011	0.0035
KLAK	2960777.7884	−342299.5741	5620225.5617	0.0000	0.0000	0.0000
KLIN	3273234.1752	1076938.6957	5349249.8942	0.0016	0.0005	0.0011
KLPD	3359228.0726	1297490.5331	5246690.3798	0.0003	−0.0001	−0.0004
KNAR	3431762.4994	812400.3414	5296793.0973	0.0011	−0.0001	0.0006
KOBC	2346368.5477	667944.0339	5873445.6609	0.0007	−0.0011	0.0039
KOSG	3899225.0745	396732.0004	5015078.4621	0.0000	0.0000	0.0000
KRAM	2774197.3490	897521.1699	5653796.7306	0.0041	0.0010	0.0075
KRSS	3348185.7777	465041.0988	5390738.3264	0.0007	−0.0006	0.0003
KRTN	3341534.8186	1299158.7440	5257522.2374	0.0003	−0.0001	−0.0003
KUIV	3059850.0967	1323500.5415	5419306.6575	0.0015	0.0008	0.0010
KULD	3232099.2123	1303197.1373	5324069.2450	0.0008	0.0003	0.0000
KUNG	3434083.2719	958104.9375	5270953.0432	0.0009	−0.0000	0.0005
KURE	3107617.3552	1287856.5701	5400807.3195	0.0015	0.0007	0.0009
KUUS	2282711.3947	1267071.9297	5800215.9059	0.0022	0.0017	0.0056
KVAC	2054886.4112	832605.0804	5960372.3317	−0.0001	−0.0006	0.0025
KYRC	3067893.6878	317075.4598	5564217.2289	0.0004	−0.0012	0.0012
L311	3376642.9029	1352770.0213	5221718.8972	0.0001	−0.0002	−0.0006
L312	3320253.9133	1570665.2695	5197158.2316	−0.0002	−0.0005	−0.0008
L408	3311606.5246	1453968.8813	5236111.3090	0.0000	−0.0003	−0.0006
L409	3425867.7899	1482315.7830	5154672.5143	−0.0003	−0.0005	−0.0009
LAMA	3524522.8580	1329693.6842	5129846.3878	−0.0004	−0.0005	−0.0007
LANG	3030339.8137	870622.5370	5525927.4773	0.0038	0.0009	0.0052
LANT	2498276.1524	926081.4023	5775933.4274	0.0032	0.0008	0.0079
LASE	2758145.0118	846688.3219	5669350.7030	0.0039	0.0007	0.0076
LEIC	3060419.5723	367986.4552	5565177.9160	0.0007	−0.0012	0.0016
LEKS	3022572.8466	802945.8764	5540684.2216	0.0037	0.0006	0.0054
LENN	3192279.9688	673626.9751	5462331.1488	0.0027	−0.0001	0.0030
LIDE	2808298.4710	847704.8138	5644689.5573	0.0040	0.0007	0.0073
LIEP	3293151.2523	1264543.8994	5296068.3616	0.0006	0.0001	−0.0001
LILC	3035802.1949	559313.0163	5562956.6351	0.0023	−0.0007	0.0038
LIMB	3119682.5006	1435782.8785	5356755.2672	0.0008	0.0003	−0.0000
LINC	3113386.2344	281351.0228	5541022.5009	0.0001	−0.0011	0.0007
LIND	3064281.6428	794270.9937	5518918.1070	0.0036	0.0005	0.0049

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	ITRF2008(2008.75) (= NKG_RF08)			$NKG\_RF03vel\_ETRF2000$		
Station	X [m]	Y [m]	Z [m]	VX [m]	VY [m]	VZ [m]
LISC	3356518.6647	393645.1258	5391129.2694	0.0002	−0.0007	−0.0002
LJUN	3394252.4980	842398.5798	5316209.5802	0.0014	−0.0000	0.0009
LODC	2262517.5043	648164.5112	5908272.5359	0.0001	−0.0012	0.0026
LODD	3504242.3581	808744.2412	5249935.0042	0.0005	−0.0003	0.0002
LOF0	2909702.5102	686509.5638	5616173.6511	0.0031	−0.0002	0.0056
LOFS	2345766.5654	543139.2207	5886461.6076	−0.0003	−0.0014	0.0012
LONC	2434928.7989	673601.1223	5837390.2852	0.0012	−0.0010	0.0048
LOPC	2000371.2439	822394.1534	5980168.6922	−0.0003	−0.0006	0.0016
LOVO	3104219.1007	998384.2305	5463290.7645	0.0032	0.0010	0.0036
LULE	2450271.2321	1000701.4542	5783646.6612	0.0031	0.0012	0.0078
LYCK	2599892.2829	880169.4324	5738277.3433	0.0036	0.0007	0.0080
LYSC	3269683.8696	366420.6746	5446037.6273	0.0006	−0.0008	0.0006
MADO	3136049.4368	1544577.2997	5317122.9253	0.0004	−0.0000	−0.0005
MALA	2541510.0383	863152.6220	5766870.1135	0.0032	0.0005	0.0078
MALU	3041410.4874	742848.4279	5538623.6765	0.0035	0.0003	0.0050
MAR6	2998189.3669	931451.8308	5533398.7366	0.0039	0.0011	0.0053
MARE	3323905.6828	708463.1656	5379277.4513	0.0018	−0.0001	0.0014
MARI	3121535.1144	967771.4501	5458911.7638	0.0032	0.0010	0.0036
MAZK	3280421.4357	1345974.2024	5284026.6667	0.0004	0.0000	−0.0003
MDVJ	2845456.0006	2160954.2923	5265993.2573	−0.0001	−0.0010	−0.0014
MEBC	2827601.3036	551358.7649	5671662.5732	0.0017	−0.0011	0.0042
METS	2892570.7273	1311843.4998	5512634.1762	0.0023	0.0014	0.0024
MJOL	3241110.5113	876033.0692	5404956.9214	0.0026	0.0004	0.0025
MOLC	2418105.6654	628666.0240	5848778.1060	0.0007	−0.0012	0.0036
MORP	3645667.7870	−107277.1771	5215053.5617	0.0000	0.0000	0.0000
MR02	2931040.0656	312062.6475	5637266.6170	−0.0002	−0.0013	0.0008
MRJM	3401531.5974	1469808.8191	5174067.3488	−0.0002	−0.0005	−0.0008
MUST	2955319.1440	1359137.5618	5467954.0267	0.0018	0.0010	0.0014
MVEE	2946882.6585	1498402.5028	5436249.0847	0.0011	0.0006	0.0004
MYGD	3379477.4989	598261.6762	5358170.5876	0.0010	−0.0004	0.0004
MYRC	2221994.8878	598999.2707	5928613.9876	−0.0005	−0.0012	0.0010
MYSC	3175704.8244	636305.9525	5476421.3104	0.0027	−0.0002	0.0032
NARC	2242853.7581	704058.3275	5909359.6869	0.0004	−0.0009	0.0037
NIKK	2396284.2362	1062626.6178	5795119.9898	0.0029	0.0014	0.0074

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	ITRF2008(2008.75) (= *NKG_RF*08)			*NKG_RF*03*vel_ETRF*2000		
Station	X [m]	Y [m]	Z [m]	VX [m]	VY [m]	VZ [m]
NO08	2554643.3429	599751.2471	5793992.8589	0.0011	−0.0013	0.0041
NO17	2336650.8673	626667.9696	5881804.4506	0.0003	−0.0012	0.0029
NOBA	2602872.7043	829615.4110	5744673.3867	0.0033	0.0003	0.0077
NORB	3068753.7650	875354.2993	5504108.9441	0.0037	0.0008	0.0047
NORR	3199092.9719	932231.5380	5420322.7355	0.0028	0.0006	0.0028
NRRA	2658396.7791	741825.4461	5731135.1418	0.0030	−0.0002	0.0069
NT04	2807246.1783	541526.3107	5682404.3264	0.0016	−0.0012	0.0040
NYBO	2410777.4632	1031768.1243	5794689.7642	0.0029	0.0012	0.0076
NYLI	2685695.3185	898443.4772	5696063.4779	0.0040	0.0010	0.0080
NYNA	3141747.3099	1017436.0569	5438418.4061	0.0029	0.0009	0.0030
OE01	3199407.7836	611115.9643	5465433.9942	0.0024	−0.0003	0.0027
OJAR	3185444.2216	1423323.1819	5321411.3759	0.0005	0.0001	−0.0002
OLDC	2087737.8759	782002.2404	5955837.7674	−0.0001	−0.0007	0.0024
OLKI	2863209.9179	1126271.6064	5568267.4537	0.0036	0.0018	0.0051
OLUS	3008949.7975	1439051.6480	5418438.2662	0.0012	0.0006	0.0005
ONSA	3370658.4889	711877.1916	5349786.9900	0.0015	−0.0002	0.0010
OPPE	3256897.2692	922031.9300	5387884.4782	0.0024	0.0005	0.0021
ORNS	2722463.0066	922447.4018	5674646.6110	0.0041	0.0012	0.0079
ORSJ	3378112.5692	952900.4336	5307836.5500	0.0013	0.0001	0.0009
OSKA	3341339.8298	957912.5564	5330003.4588	0.0016	0.0002	0.0012
OSLS	3169981.8204	579956.8194	5485936.7188	0.0024	−0.0005	0.0029
OSTC	3090541.8541	407157.8606	5546820.8048	0.0010	−0.0011	0.0019
OSTE	2763885.1749	733247.5506	5682653.6145	0.0032	−0.0001	0.0067
OSTM	3091485.2688	699969.1200	5516360.9672	0.0032	0.0000	0.0044
OSV2	3037695.9294	938853.0095	5510714.2547	0.0037	0.0011	0.0048
OULU	2423778.3844	1176553.8984	5761861.0867	0.0030	0.0019	0.0067
OVER	2368884.6598	994492.3796	5818478.4328	0.0026	0.0009	0.0075
OVET	2346841.1414	1028174.6111	5821401.9351	0.0025	0.0011	0.0073
OXEL	3177394.3000	977921.7307	5425008.4656	0.0028	0.0008	0.0028
PAUL	3313197.6763	919489.3350	5354180.4884	0.0019	0.0003	0.0015
PNVZ	3280106.5701	1481464.3742	5248074.8788	0.0001	−0.0002	−0.0006
PORC	3267084.7393	542581.0676	5432706.3111	0.0016	−0.0006	0.0015
POTS	3800689.5752	882077.4454	5028791.3536	0.0000	0.0000	0.0000
PREC	3227088.5915	353649.8899	5471909.9584	0.0006	−0.0009	0.0007

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	ITRF2008(2008.75) (= *NKG_RF08*)			*NKG_RF03vel_ETRF2000*		
Station	X [m]	Y [m]	Z [m]	VX [m]	VY [m]	VZ [m]
PREI	3169093.6917	1595616.4733	5282561.0531	0.0002	−0.0002	−0.0007
RAMS	2873732.2719	805038.8608	5618251.4580	0.0038	0.0005	0.0067
RATA	2620557.9272	1000461.7512	5709038.9031	0.0039	0.0015	0.0079
REDZ	3550066.5389	1093332.0493	5167562.1729	−0.0000	−0.0003	−0.0003
RENC	3026037.8264	608374.5442	5563169.4118	0.0027	−0.0005	0.0044
REZE	3132776.4319	1620591.1984	5296521.7934	0.0002	−0.0002	−0.0006
RIET	3339385.8175	1344366.9258	5247685.3375	0.0002	−0.0001	−0.0005
RIGA	3183899.1282	1421478.5440	5322810.8298	0.0006	0.0001	−0.0002
RIST	3007253.8001	1342805.1624	5443821.8100	0.0016	0.0009	0.0012
RKSK	3227842.8586	1545633.9701	5261963.4056	0.0001	−0.0003	−0.0007
RO04	3279043.7253	338684.5482	5441978.9656	0.0003	−0.0008	0.0003
ROMU	2410839.0916	1388069.6692	5720515.3531	0.0024	0.0019	0.0042
RORO	3339312.1160	686422.8992	5372576.0810	0.0017	−0.0002	0.0012
ROSC	3181051.7543	335027.6610	5499661.4898	0.0005	−0.0010	0.0009
ROTT	3363093.2517	894250.2818	5327489.4598	0.0016	0.0001	0.0011
RUNS	3362288.7864	1008254.0786	5307534.2014	0.0013	0.0002	0.0008
SAFF	3196936.3128	734232.9030	5451814.3396	0.0028	0.0001	0.0031
SAKI	3377976.6919	1437266.9150	5198395.2978	−0.0001	−0.0004	−0.0007
SALD	3245132.2207	1342447.4393	5306566.9470	0.0006	0.0001	−0.0002
SALE	3002947.5270	707990.1925	5564002.5863	0.0034	0.0000	0.0052
SAN0	2937425.9425	906696.7954	5569710.1624	0.0040	0.0011	0.0061
SANG	2399031.4280	1042830.3502	5797568.0001	0.0029	0.0013	0.0075
SARN	2953011.3632	689808.9558	5592841.4685	0.0032	−0.0001	0.0054
SASS	3606146.0207	875303.4023	5170193.9850	−0.0001	−0.0004	−0.0002
SAUL	3286703.8045	1416460.8878	5261850.9089	0.0002	−0.0001	−0.0005
SAXN	2609571.7765	716221.8349	5756943.0450	0.0025	−0.0005	0.0065
SELC	3209902.5911	487409.5688	5471752.1845	0.0016	−0.0007	0.0019
SIGU	3145951.3458	1459815.3074	5335021.1481	0.0006	0.0001	−0.0002
SILT	3383189.3298	1330395.4098	5223162.1312	0.0001	−0.0002	−0.0005
SIRC	3323397.3314	336993.7698	5415278.0597	0.0001	−0.0007	−0.0001
SKAN	3537800.5183	807532.0193	5227707.8283	0.0003	−0.0003	0.0000
SKE0	2534030.8385	975174.6157	5752078.6075	0.0035	0.0012	0.0080
SKIL	3511254.5846	893660.6030	5231575.3805	0.0005	−0.0002	0.0001
SKJC	2039577.4285	781938.6396	5972404.6729	−0.0003	−0.0008	0.0016

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Station	ITRF2008(2008.75) (= *NKG_RF08*)			*NKG_RF03vel_ETRF2000*		
	X [m]	Y [m]	Z [m]	VX [m]	VY [m]	VZ [m]
SKOC	3187460.0670	543919.0878	5479516.1331	0.0021	−0.0006	0.0025
SKOR	2727333.7798	880044.6402	5679171.4235	0.0040	0.0009	0.0079
SKRC	3077326.1875	594183.6834	5536603.1941	0.0027	−0.0005	0.0039
SLCN	3368884.0496	1598568.0601	5157449.6681	−0.0004	−0.0006	−0.0010
SLUS	2553258.5656	743986.0484	5778252.0977	0.0026	−0.0004	0.0068
SMID	3557911.1696	599176.7368	5242066.4805	−0.0002	−0.0005	−0.0004
SMOC	2824689.2569	394744.5243	5685842.7331	−0.0000	−0.0015	0.0013
SMOG	3290543.4806	652615.2761	5406535.6235	0.0019	−0.0002	0.0016
SMYG	3536512.2086	840549.8825	5223404.0584	0.0003	−0.0003	0.0000
SNAS	2776353.4670	788762.0879	5668973.6381	0.0036	0.0003	0.0071
SODA	2200146.6153	1091638.3936	5866870.8392	0.0016	0.0009	0.0059
SODE	2993266.3207	996674.0979	5524712.0929	0.0037	0.0013	0.0049
SORS	2525762.2561	798304.2574	5783033.4582	0.0027	−0.0001	0.0072
SORV	2971444.8862	−379959.1878	5612156.0034	0.0000	0.0000	0.0000
SPT0	3328984.4792	761910.3198	5369033.7368	0.0019	−0.0000	0.0015
STAC	2977626.4564	277105.6412	5614791.5372	−0.0002	−0.0013	0.0006
STAG	3629047.9736	603765.7478	5192855.8730	−0.0006	−0.0005	−0.0006
STAS	3275753.5736	321111.0923	5445042.1081	0.0002	−0.0008	0.0002
STAV	3091410.5840	1045979.4398	5461608.3550	0.0030	0.0011	0.0033
STEC	2336697.8048	626806.5458	5881754.9214	0.0003	−0.0012	0.0029
STHO	3102638.5855	1009508.9825	5462127.0317	0.0031	0.0011	0.0035
STLI	2809572.7106	603439.8814	5675775.6528	0.0022	−0.0009	0.0050
STOC	3341196.3546	869986.4499	5345184.5674	0.0018	0.0001	0.0013
STOR	2574618.9057	792308.8829	5762427.6454	0.0030	0.0000	0.0074
STRO	3236555.7455	639759.6375	5440363.4929	0.0023	−0.0002	0.0023
STSU	2715197.5931	756115.7457	5702787.6825	0.0033	−0.0000	0.0070
SULC	2389747.7597	688764.2832	5853814.7311	0.0011	−0.0010	0.0046
SULD	3446394.1484	591713.2005	5316383.4898	0.0004	−0.0005	−0.0002
SUND	2838909.5896	903822.2777	5620660.4782	0.0041	0.0011	0.0071
SURT	3329458.8357	708746.2229	5375813.8949	0.0018	−0.0001	0.0014
SUUR	2959056.3133	1341058.5819	5470427.3279	0.0019	0.0011	0.0016
SVAR	2986231.4667	864201.8375	5550929.0283	0.0039	0.0009	0.0057
SVEC	3313865.6079	434269.1335	5414427.2873	0.0008	−0.0007	0.0006
SVEG	2902494.7666	761456.0196	5609859.9536	0.0036	0.0003	0.0062

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Station	ITRF2008(2008.75) (= NKG_RF08)			NKG_RF03vel_ETRF2000		
	X [m]	Y [m]	Z [m]	VX [m]	VY [m]	VZ [m]
SVNL	3282372.7091	1600631.8139	5211914.6881	−0.0001	−0.0005	−0.0008
SVOC	2295993.6411	596438.4862	5900792.9877	−0.0002	−0.0013	0.0019
SVTL	2730155.2782	1562364.7827	5529989.2975	0.0013	0.0009	0.0008
SWKI	3452304.4455	1460314.8433	5143362.6186	−0.0004	−0.0006	−0.0009
TALS	3193687.2565	1328546.7324	5340897.1864	0.0008	0.0003	0.0001
TAUR	3371431.4828	1381753.3981	5217506.7317	0.0000	−0.0003	−0.0006
TELS	3310227.3214	1353644.4472	5263670.0605	0.0003	−0.0001	−0.0004
TGDE	3358080.8506	445364.9634	5386152.9671	0.0005	−0.0007	0.0001
TINC	2882293.5026	415692.1802	5655579.3351	0.0005	−0.0014	0.0020
TJMC	3227106.0641	592240.1239	5451311.2792	0.0021	−0.0004	0.0022
TJUR	3315932.6668	711610.7861	5383700.3466	0.0019	−0.0001	0.0015
TOIL	2884257.1617	1503794.1151	5468067.9776	0.0013	0.0008	0.0007
TONC	3301576.2841	389093.1732	5425120.9649	0.0006	−0.0008	0.0004
TORA	3010571.4892	1498759.4716	5401441.2968	0.0009	0.0004	0.0002
TORH	2980573.3457	−353744.2803	5608957.1072	0.0000	0.0000	0.0000
TR02	2102021.9774	719850.8945	5958615.1713	−0.0003	−0.0009	0.0017
TRDS	2820170.7639	513486.0917	5678935.9842	0.0013	−0.0013	0.0036
TREC	3255039.5913	487706.3837	5445319.4713	0.0014	−0.0007	0.0013
TRO1	2102928.4101	721619.4883	5958196.2749	−0.0003	−0.0009	0.0017
TROM	2102940.1315	721569.4938	5958192.1966	−0.0003	−0.0009	0.0017
TRYS	2987993.7950	655946.2768	5578690.2879	0.0030	−0.0003	0.0050
TUOR	2917810.6974	1205222.7746	5523550.1647	0.0029	0.0016	0.0035
TVOR	3026017.0779	−360951.8278	5584332.3826	0.0000	0.0000	0.0000
TYIC	3050967.1561	441448.9243	5566379.8424	0.0013	−0.0011	0.0024
TYVH	3471138.3195	665488.6174	5291632.5308	0.0005	−0.0004	−0.0000
ULEC	3223773.3030	527002.8872	5459933.8596	0.0018	−0.0006	0.0020
UMEA	2682407.5717	950396.1100	5688993.3859	0.0041	0.0013	0.0080
UPPS	3060037.6290	970123.0745	5492999.4736	0.0035	0.0011	0.0043
UTEN	3264089.7022	1566185.3656	5233638.9395	−0.0000	−0.0004	−0.0008
VAAS	2699864.2808	1078264.0621	5658064.9425	0.0040	0.0019	0.0070
VAEG	3612854.8988	763382.5170	5183133.8613	−0.0002	−0.0004	−0.0002
VALC	3241303.8928	425413.2876	5458869.5333	0.0010	−0.0008	0.0010
VALM	3099939.4838	1472346.5319	5358234.2501	0.0007	0.0002	−0.0001
VANE	3249407.9549	692758.1632	5426397.1895	0.0023	−0.0001	0.0022

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Station	ITRF2008(2008.75) (= *NKG_RF08*)			*NKG_RF03vel_ETRF2000*		
	X [m]	Y [m]	Z [m]	VX [m]	VY [m]	VZ [m]
VARD	1839675.9762	1109939.4498	5985244.6388	−0.0002	−0.0001	0.0012
VARN	3398712.2157	1555724.9546	5150966.9120	−0.0004	−0.0006	−0.0009
VARS	1844607.2259	1109719.2462	5983936.1770	−0.0002	−0.0001	0.0013
VAST	3097214.6416	921046.1994	5480693.6478	0.0035	0.0009	0.0042
VEGC	3152743.5240	508813.0593	5502859.4603	0.0020	−0.0007	0.0026
VEIS	3432563.7750	1507108.0067	5143018.2148	−0.0004	−0.0006	−0.0009
VENT	3204595.6590	1265427.0193	5349535.3291	0.0011	0.0004	0.0003
VGTU	3336888.5201	1580025.2532	5183706.7050	−0.0003	−0.0005	−0.0009
VIL0	2620258.5400	779138.1946	5743799.5423	0.0031	−0.0000	0.0073
VIND	2620256.3104	938912.5216	5719758.2494	0.0039	0.0011	0.0081
VIRO	2788248.1016	1454873.5304	5530280.2249	0.0017	0.0012	0.0015
VIS0	3246470.1964	1077900.5670	5365278.1399	0.0018	0.0006	0.0013
VLNS	3343600.5477	1580417.7935	5179337.3241	−0.0003	−0.0006	−0.0009
VOLL	3498677.9495	858203.8003	5245923.0426	0.0006	−0.0002	0.0002
VORU	3032183.7003	1545143.7223	5376385.2495	0.0007	0.0002	−0.0001
VOSC	3116663.1438	350851.6501	5535247.2814	0.0007	−0.0011	0.0013
WARN	3658785.7410	784470.9322	5147870.6272	−0.0004	−0.0004	−0.0002
WROC	3835751.2421	1177250.0226	4941605.2860	0.0000	0.0000	0.0000
WSRT	3828735.8039	443305.0154	5064884.7455	0.0000	0.0000	0.0000
WTZR	4075580.4957	931853.8613	4801568.1752	0.0000	0.0000	0.0000
ZINK	3196313.2092	861751.7762	5433743.4354	0.0030	0.0005	0.0031

Concluded