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EPSG plans for documenting national realizations of ETRS89

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EUREF symposium

Covilhã, Portugal, June 2025



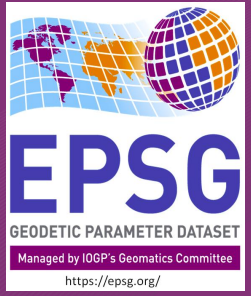
EPSG

GEODETTIC PARAMETER DATASET

Managed by IOGP's Geomatics Committee

<https://epsg.org/>

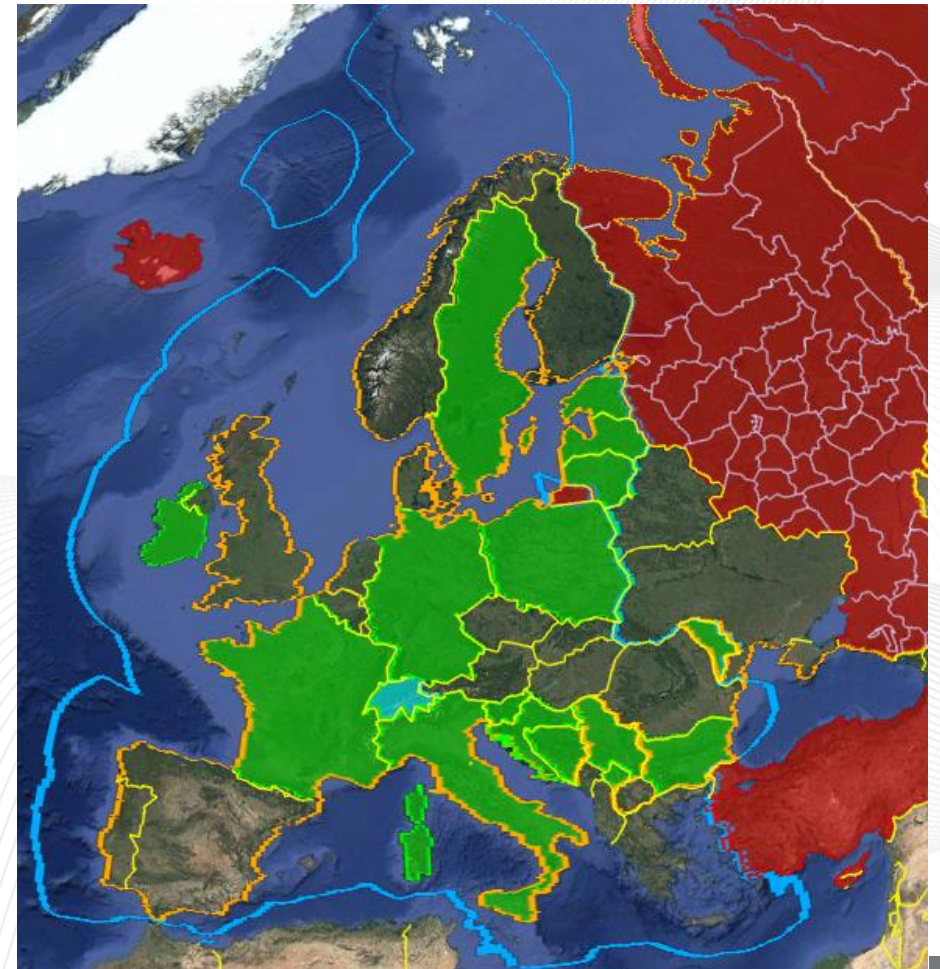
Catalyst for this presentation



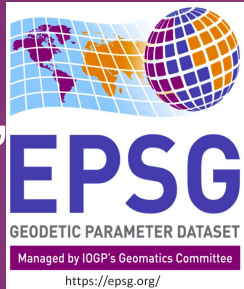
- Olav Vestøl presentation EUREF symposium Barcelona, June 2024
 - “EPSG codes – a blessing or a curse?”
 - Too many EPSG codes
 - Not enough EPSG codes
 - Hard to know if EPSG codes can be mixed
 - Olav’s summary:
 - idea of EPSG-codes is fine, but the realization can be better
 - EPSG-codes are a matter for EUREF
- Trimble request for EPSG to include epoch for national realizations of ETRS89
 - Similar request from commercial service suppliers

European data in the EPSG Dataset (as at October 2024)

- 'non-ETRS' national geodetic CRSs, projected CRSs and vertical CRSs [→ 100%]
 - National geoid models [~40% populated, **so ~60% missing** 😞]
- Includes EVRF 2000, 2007 and 2019
 - Transformations from national vertical CRS to EVRF2019 populated for ~55% of national vertical CRSs [so ~45% missing 😞]
- Includes ETRF89 ... ETRF2020
 - Geodetic CRSs XYZ, $\phi\lambda h$, and $\phi\lambda$ – no projected CRSs
 - Time-dependent transformations from ITRS from Memo and EUREF TN1
- National realizations of ETRS89 (densifications of ETRF)
 - Included when given local name (**green** on map) [~50% of national realizations]
 - Projected CRSs (UTM and national) based on these national realizations
 - **Missing 50% when national documentation uses 'EUREF' or 'ETRS89'** 😞
e.g. Norway, Netherlands, Spain, etc. (unshaded on map)
- Includes ETRS89 geodetic CRSs – based on datum ensemble
 - Includes projected CRSs based on this:
 - UTM – E,N and N,E
 - national projections for countries with missing national realization, e.g. Norway NTM zones
 - LCC and LAEA (extent extended to include Azores, Madeira, Canaries, Iceland, Cypress, Turkey)



EUREF wg document “Overview of national realizations”



Joachim Schwabe, Martina Sacher, Overview of national realizations of the integrated geodetic reference in Europe
Version 1.0a (2024-11-15) The information below has been compiled in the course of the [EUREF Working Group "European Unified Height Reference"](#).

Table 1 Overview of GNSS reference frames (national ETRS89 realizations) in Europe

Background colors: **Grey** No longer in use

EPSG codes refer to the according CRS code for 3D geographical coordinates (ellipsoidal longitude, latitude and heights)

CC	Country	Date of info	Valid from	Valid until	Name of realization	Target frame	Epoch [yr]	Tx [mm]	Ty [mm]	Tz [mm]	D [ppb]	Rx [mas]	Ry [mas]	Rz [mas]	Re- marks	EPSG
AL	Albania	2024-07-01	unknown	unknown	KRGJSH/ETRF2000(2008)	ETRF2000	2008.0									
	Albania	2024-07-01	unknown	unknown		ETRF2000	2014.177								[1]	
AT	Austria	2024-07-01	unknown	unknown	ETRS89 Austria 2002	ETRF2000	2002.56									
BA	Entity “Federation of Bosnia and Herzegovina” of	2024-09-02	unknown	unknown	BH_ETRS89	ETRF2000	2011.307									10327

Questions we asked ourselves

- Should we be using the EUREF 'Overview of national realizations document' to plug holes in the national realizations of ETRS89 missing from EPSG?
- How do (i) human and (ii) machine users of the EPSG Dataset discover what realizations of ETRS89 are available?
- How are these realizations related to each other?
- What data population do we need to have to ensure that both high accuracy and lower accuracy users can get appropriate information from the EPSG Dataset?

ETRS89 ensemble hub

Current

ETRF2014
(ITRF2014@1989.0)

Null transformations to ETRS89 ensemble

- SWE **SWEREF99** (ETRF97@1999.5)
- FIN **EUREF-FIN** (ETRF96@1997.0)
- EST **EST97** (ETRF96@1997.0)
- LTU **LKS94** (ETRF2000@2003.75)
- LVA **LKS92** (ETRF89@1992.75) / **LKS2020** (ETRF2020@2020.28)

- Explicit realization in EPSG (v12.005)
- National CRS is not a realization of ETRS89
- Old national CRS is not a realization of ETRS89

ETRF2020
(ITRF2020@1989.0)

ETRF2000
(ITRF2000@1989.0)

ETRF2005
(ITRF2020@1989.0)

AdV non-null transformation

Null transformations to ETRS89 ensemble

Realizations aligned with ETRF2000

- DEU **ETRS89/DREF91/2016** (ETRF2000@2008.46)
- BIH **BH-ETRS89** (ETRF2000@2011.307)
- BGR **BGS2005** (ETRF2000@2005.0)
- FRA **RGF93 v2** (ETRF2000@2009.0)
- FRA **RGF93 v2b** (ETRF2000@2019.0)
- GRC **HTRS07** (ETRF2000@2007.83)
- ITA **RDN2008** (ETRF2000@2008.0)
- POL **ETRF2000-PL** (ETRF2000@2011.0)
- SRB **SRB-ETRS89** (ETRF2000@2010.63)

BIH **MGI 1901**

ITA **Monte Mario**

ETRF90
(ITRF90@1989.0)

ETRF91
(ITRF91@1989.0)

ETRF89
(ITRF89@1989.0)

Realizations aligned with ETRF89

- HRV **HTRS96** (ETRF89@1995.5)
- FRA **RGF93 v1** (ETRF89@1993.0)
- ITA **IGM95** (ETRF89@1996.0)

CZE **S-JTSK**

ETRF92
(ITRF92@1989.0)

ETRF93
(ITRF93@1989.0)

CHE **CHTRF93** (ETRF93@1993.0)

HUN **HD72**

LUREF 2020 parameters

RDNAPTRANS2018

- LUX **LUREF**
- NLD **Amersfoort**
- MKD **MGI 1901**
- ROU **Dealul Piscului**
- SVK **S-JTSK**

ETRF94
(ITRF94@1989.0)

ETRF96
(ITRF96@1989.0)

SVN **D96** (ETRF96@1995.5)

Null transformations to ETRS89 ensemble

Realizations aligned with ETRF97

- KOSOVAREF (ETRF97@2001.25)
- MDA **MOLDREF99** (ETRF97@1999.4)

OSTN15

GBR **OSGB36**

ETRF97
(ITRF97@1989.0)



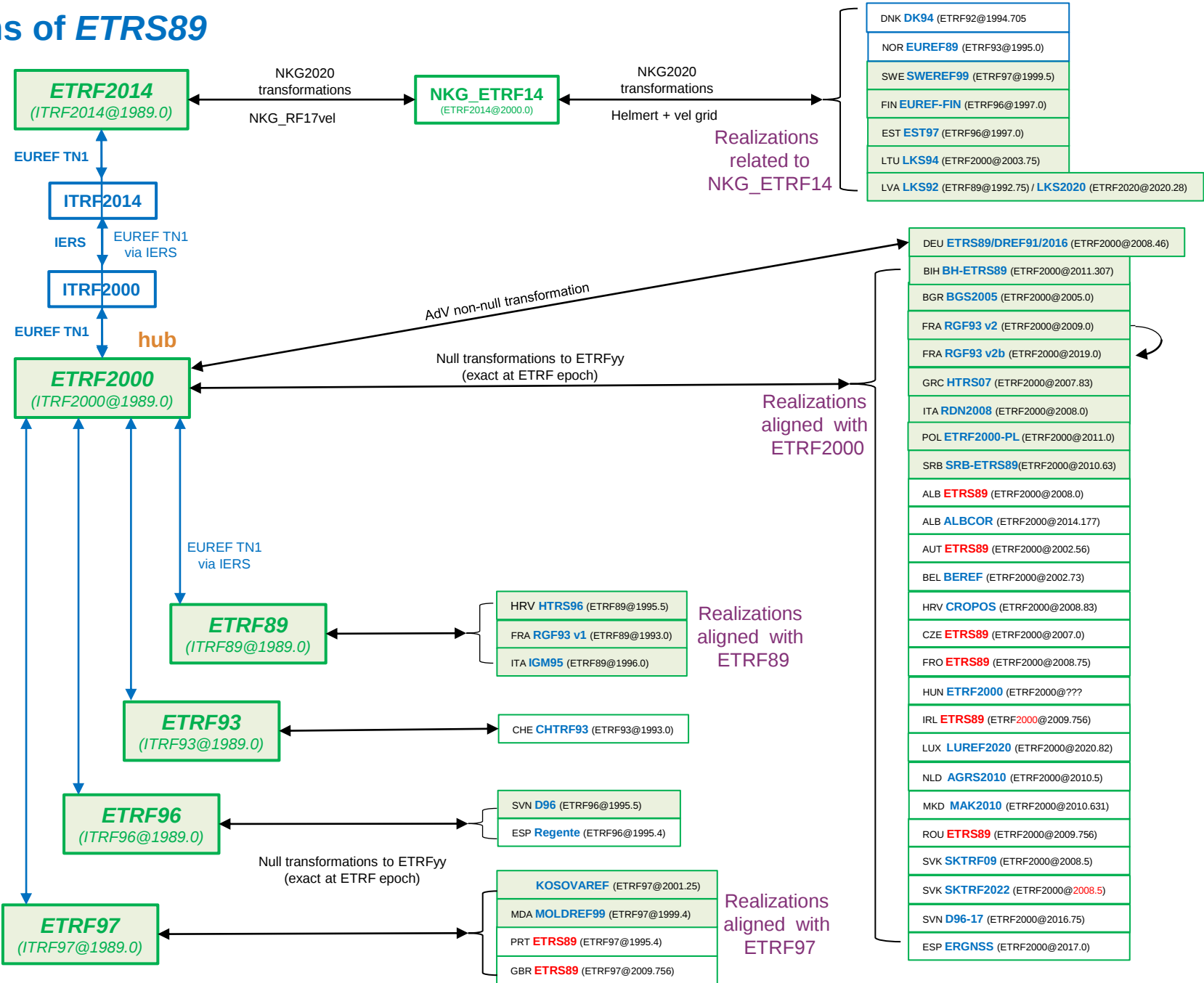
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Realizations of ETRS89

Proposal

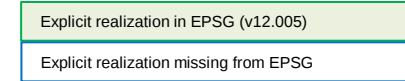
Explicit realization in EPSG (v12.005)
Explicit realization missing from EPSG

ETRF2014 to ETRF2000	
tX (mm)	53.7
tY (mm)	51.2
tZ (mm)	-55.1
dS (ppb)	1.02
rX (mas)	-0.044
rY (mas)	-0.451
rZ (mas)	-0.242
δtX (mm/yr)	0.1
δtY (mm/yr)	0.1
δtZ (mm/yr)	-1.9
δdS (ppb/yr)	0.11
δrX (mas/yr)	-0.004
δrY (mas/yr)	-0.041
δrZ (mas/yr)	-0.022
param ref epoch	2000.0



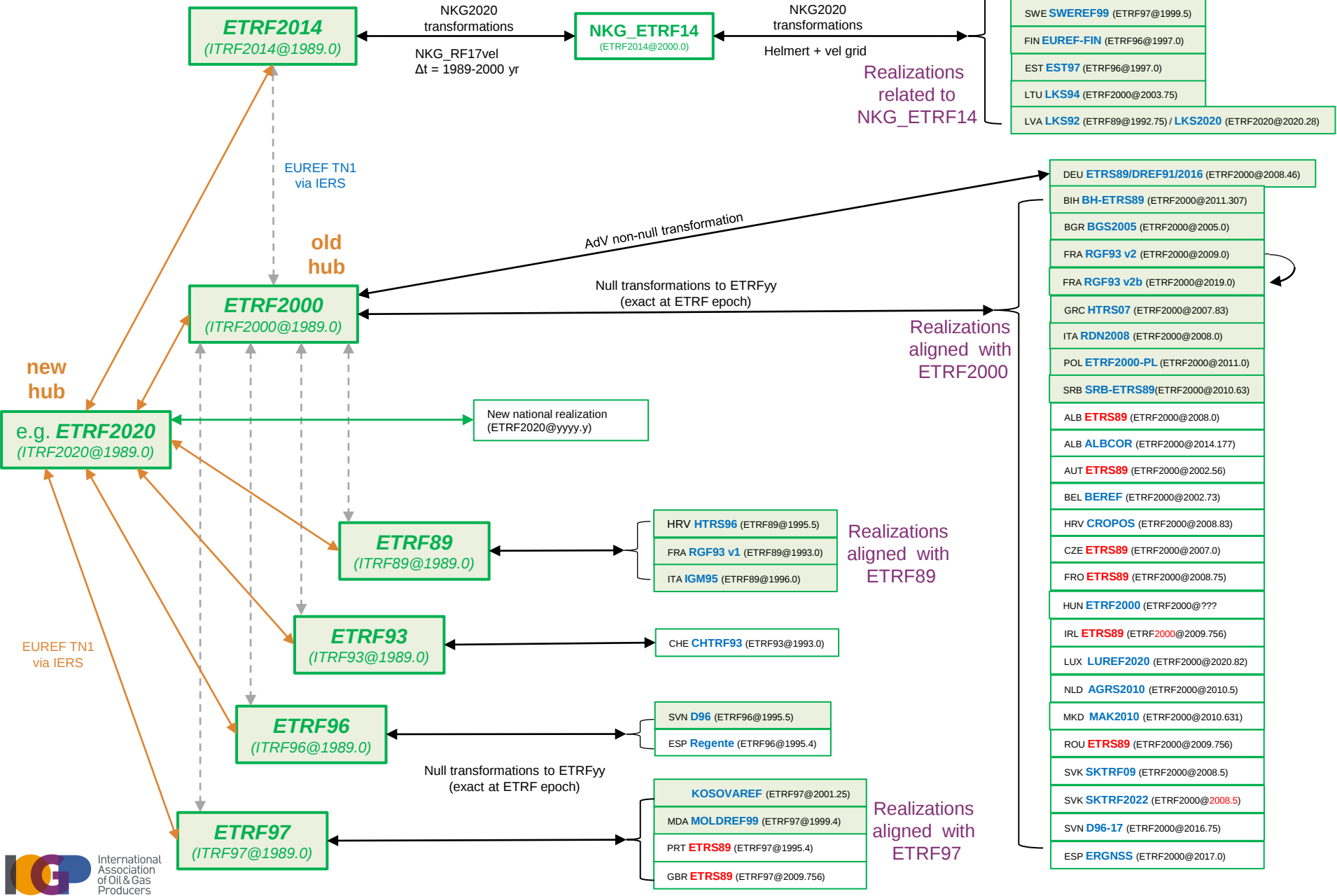
1. Add the missing national realizations.
2. Add transformations to relevant ETRFyy.
- default is null.
- accuracy: ??
3. For existing CTs national → ensemble, change to relevant ETRFyy
4. Add ETRFyy to ETRF2000 transformations.

Proposal



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ETRS89 ensemble



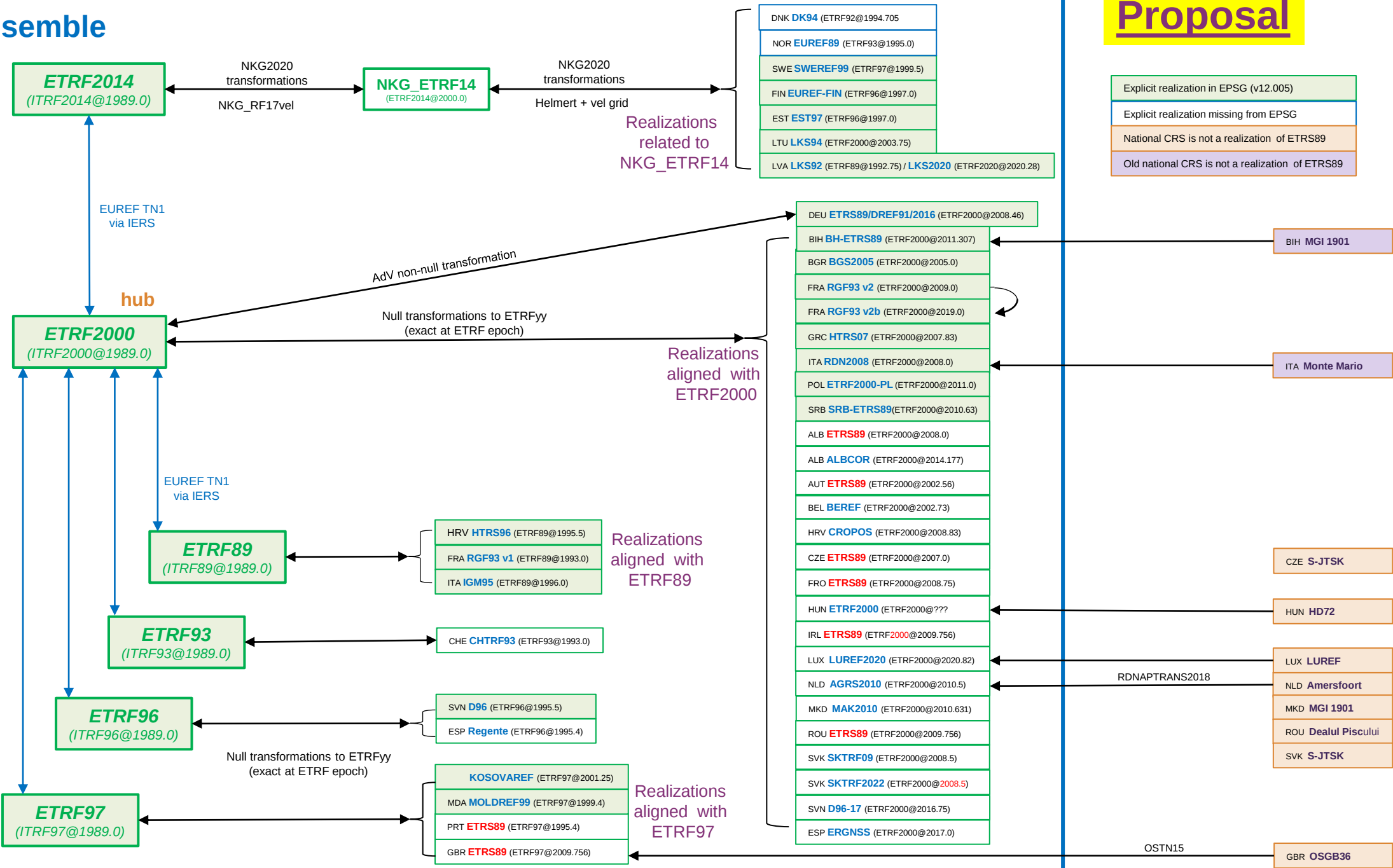
Proposal

Explicit realization in EPSG (v12.005)

Explicit realization missing from EPSG

ETRS89 ensemble

Proposal



Names for national realizations

- No common syntax for existing names
 - AGRS2010, OSNet v2009, RGF93 v2b, ETRF2000-PL, SRB-ETRS89, ETRS89 Austria 2002
- For end users, most have no obvious connection with ETRS89
- Key element for assisting (human) users – name should include (begin with) “ETRS89”
 - Also include ‘well-known’ local name.
- Possibilities for common syntax:
 - full name: “ETRS89-GBR (OSNet v2009)”
 - local name (alias): “OSNet v2009”
 - metadata: “ITRF97 at epoch 2009.756 aligned to ETRS97 following the EUREF conventions”
- EUREF resolution recommending syntax for name of national realization?

Geoid models

- In EPSG Dataset as a transformation from a geometric CRS to national vertical (physical) CRS
 - Usually using EPSG ensemble, e.g. EPSG:9283 “ETRS89 to NAP height”
- But model should be based on national realization
- Change source CRS from ETRS89 ensemble to local
 - e.g. EPSG:9283 “ETRS89 to NAP height” → “ETRS89-NLD (AGRS2010) to NAP height”
 - old name (“ETRS89 to NAP height”) becomes an alias so not lost
 - code remains EPSG:9283
- In principle would add EUREF height wg Table 2 missing models, but missing information
 - file name and accuracy

Table 2 Overview of national height reference surfaces (geoid models) for transformation between ellipsoidal heights and leveling heights. For more details on the GNSS realizations, please refer to Table 1.

Height types: NH Normal heights, NOH Normal-orthometric heights, OH Orthometric heights (Helmert heights not precluded), OH(H) Helmert orthometric heights (confirmed), U Uncorrected for gravity

Background colors: **Yellow** CRS of grid is not ETRS89 or WGS84 geographic (longitude, latitude) → projected coordinates and/or other datum, **Grey** No longer in use

Standard CRS of interpolation grids: “ETRS89 geographic” (i.e., any ETRFxxxx) assumed as EPSG:4258, “WGS84 geographic” (i.e., any ITRFxxxx) assumed as EPSG:4326

CC	Country	Subregion	HRS grid	Valid from	Valid until	CRS of grid	GNSS realization of ellipsoidal height	ETRS89 datum?	Ell. height linked to	Height realization	Height datum	Height type	Re- marks	Link
AL	Albania		ALBAGEO03 (software only)	2008		ETRS89 geographic	KRGJSH	yes	ETRF2000 (2008.00)	ALB86	Durrës	OH(H)		
AT	Austria		Austrian Geoid 2008 (GRS80) (EPSG:9276)	2008-01-01		ETRS89 geographic	ETRS89 with GRS80 ellipsoid (EPSG:4937)	yes	ETRF2000 (2002.56)	EVRF2000 Austria (EPSG:9274)	Amsterdam/NAP	OH	[1] [2]	Info Info ZIP

How does this help users?

- No national realizations of ETRS89 missing from EPSG Dataset
- Removes inconsistent treatment of transformations
- Reference Frame for national CORS identified (meets Trimble request)
- Clear transformation pathway between countries
 - e.g. Lithuania LKS94 → ETRF2014 → ETRF2000 → Poland ETRF2000-PL
 - preferable to LKS94 → WGS 84 (EPSG:4326) → ETRF2000-PL
- ETRS89 ensemble acts as look-up table listing all realizations
- No change in existing EPSG code values



For more information please contact:

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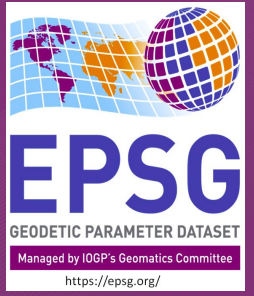
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Back-up slides

National transformations

- Transformations from historic systems
 - To be consistent with treatment of geoid models, also change ETRS89 ensemble to national CRS
 - e.g. EPSG:10098 “KKJ to ETRS89” → “KKJ to EUREF-FIN” with old name as alias and EPSG code retained
 - but only if transformation clearly derived from currently national realization of ETRS89
 - e.g. EPSG:1638 “KKJ to ETRS89” derived from realization pre-dating EUREF-FIN (ETRF97 @ 1997.0), so remains unchanged

Projected CRSs



- Pan-European projections based on the ETRS89 ensemble EPSG:4258
 - ETRS89 / UTM, ETRS89 / LCC, and ETRS89 / LEAE
 - to remain unchanged
- ETRS89 / local projections
 - Change base geodetic CRS from ETRS89 ensemble to national realization
 - projCRS name changes to incorporate national base CRS
 - old name added as alias
 - Example (EPSG:3880): ETRS89 / GK26FIN → EUREF-FIN / GK26FIN with alias ETRS89 / GK26FIN
 - EPSG codes for these projected CRSs unchanged
- Projected CRSs for UTM zones based on national realization: new record

What is EPSG?

- **European Petroleum Survey Group**
 - Founded in 1985.
 - Meeting of the Geomatics leaders of several European multinational oil majors to discuss issues of mutual interest.
 - Short summary of history at <https://epsg.org/history.html>
- Compiled a database of CRS definitions – the EPSG Geodetic Parameter Dataset
 - Database made public in 1994.
 - Adopted by GeoTIFF format and the Open Geospatial Consortium (OGC).
- European Petroleum Survey Group disbanded in 2005
 - **EPSG as an organisation no longer exists**



<https://epsg.org>



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- **EPSG continues, but only as the brand name for the Dataset.**
 - Maintenance now the responsibility of the **IOGP Geomatics committee**.
 - Content managed by the Geomatics committee's Geodesy Subcommittee.

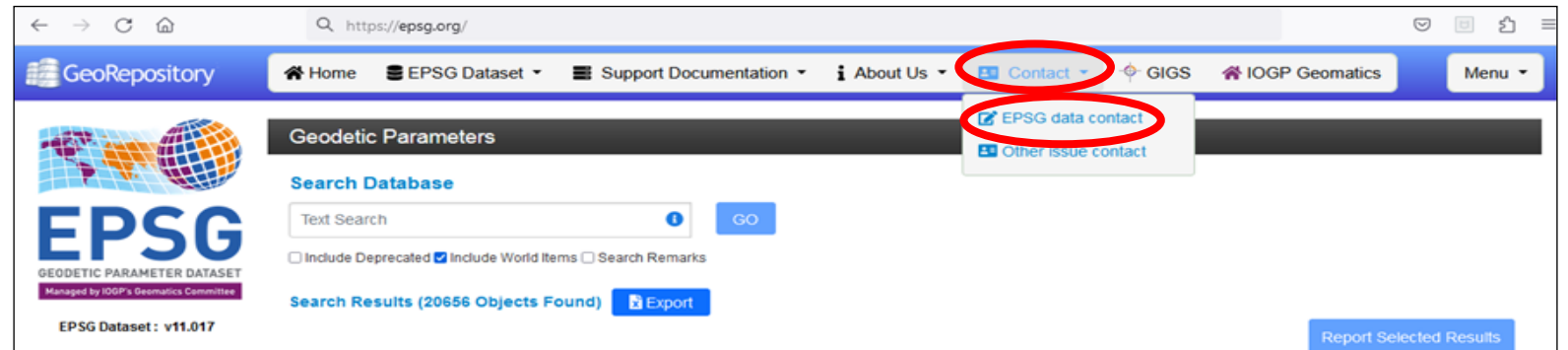
What are EPSG codes?

- Integer identifier of a data record – every record has a code. It is permanent.
 - In principle, EPSG code values are within range 1024 to 32766
 - Data is never deleted from the EPSG Dataset, although minor corrections may be made (no code change).
 - Anything with significant error will be deprecated and replaced with a new record with a new code.
 - The deprecated record remains in the Dataset.
- EPSG codes are unique within each table (record type) of the data model
 - But same code value may be used in different tables
 - Exception: codes are unique across union of **CRS** and **coordinate operation** tables. **
- To be unique, EPSG code and table (or entity type) should be cited:
 - e.g. “EPSG extent 1234” (= ‘Tonga – onshore and offshore’).
 - “EPSG transformation 1234” (= a transformation applying to Uruguay).
 - Code 1234 is also used in two other tables, datum and scope.
 - No CRS has EPSG code1234, because it is used as a transformation (see ** above).
- By default, an EPSG code without table name / record type is a code for a **CRS**
 - e.g. “EPSG:5678” (= a projected CRS for Germany)

There is no EPSG **coordinate operation** 5678, because 5678 is used as a CRS code (see ** above)

Population of the EPSG Dataset

- We do not actively look for data – we react to requests.
- Requests can be made by anyone – see <https://epsg.org/dataset-change-requests.html> and [EPSG Guidance Note 7-1](#).



- Procedure for accepting requests described in [EPSG Guidance Note 7-6](#). In summary:
 - Data must be in public use.
 - Information about the data must be in the public domain.
 - Parameters are included in the EPSG Dataset.
 - Grid data files are cited by name, but the grid file itself is not in the EPSG Dataset (or held by IOGP).
 - Data embedded in applications but not otherwise available is not included.
- So if you feel that some data is missing, submit a request !