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# Estimation of VGOS Station Coordinates

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# Structure

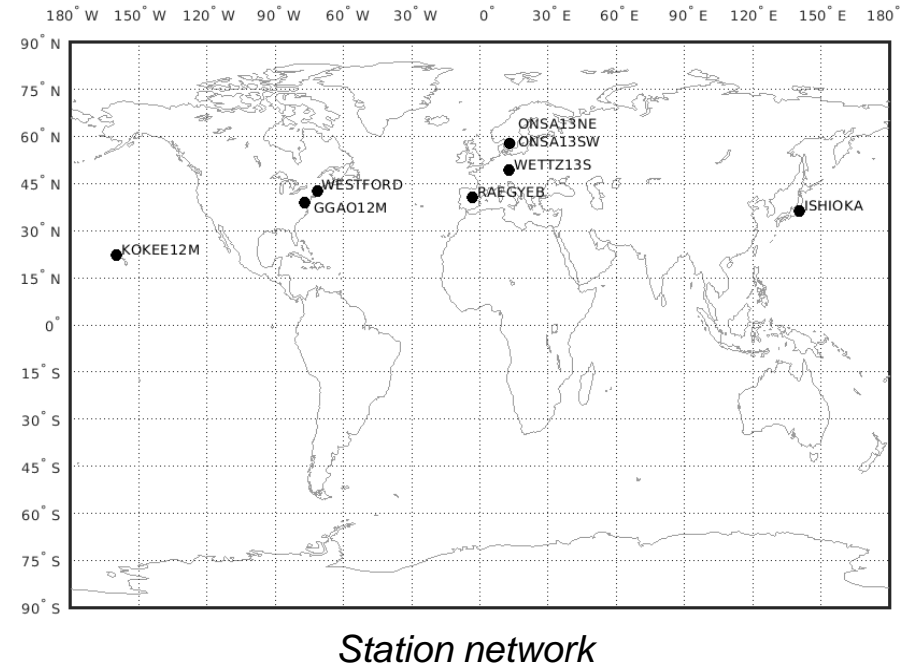
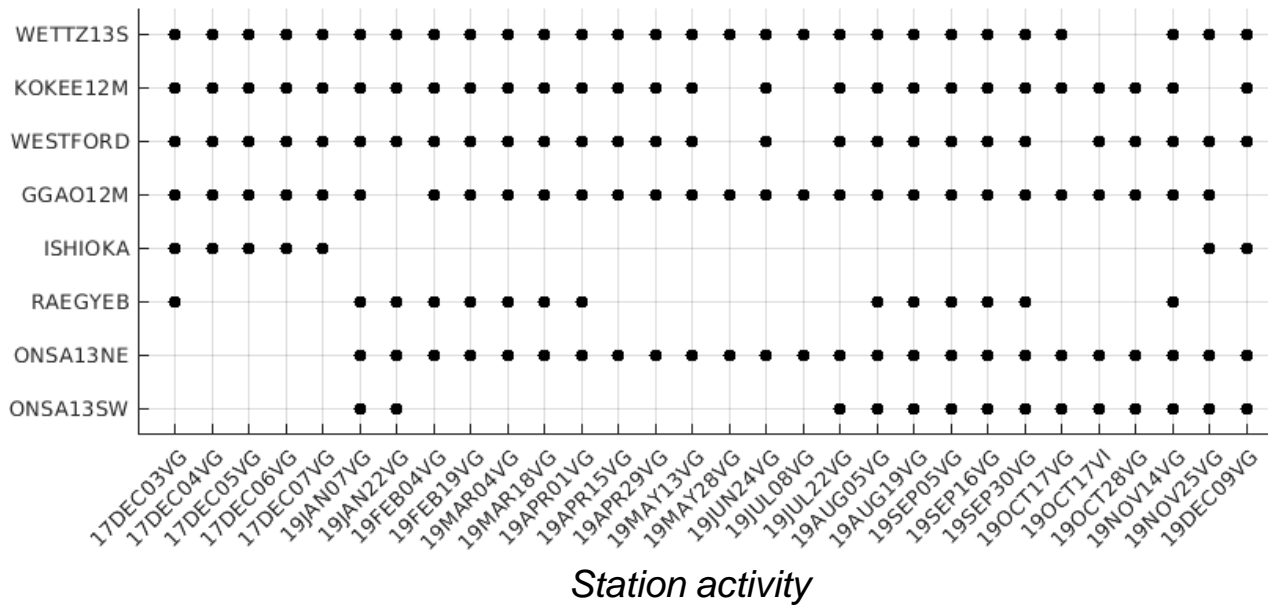
- Problem
- Data
- Geodetic datum definition in least square adjustment
- Global solution for VGOS network
- Results

# Problem

- Inherent geodetic datum defect in VLBI observations:  
VLBI observations define inner network geometry but not absolute position
- Not enough VGOS stations with precise ITRF2014 coordinates to define datum with NNR and NNT conditions → VGOS network is mostly independent of legacy S/X network and the ITRF2014
- Precise VGOS coordinates needed for
  - Calculation of dUT1 from VGOS intensive sessions
  - Comparison of analysis results such as Earth Orientation Parameters (EOP) to S/X
  - Combination with S/X data

# Data - VGOS

- 30 VGOS sessions used: 5 during CONT17, 25 during 2019
- Westford (Wf) is a ITRF2014 defining station that was converted into a VGOS station with a receiver change



# Geodetic datum definition: Unconstrained Adjustment

- Unconstrained Adjustment: some parameters fixed to a priori values
- → Definition with fixed Earth Orientation Parameters (EOP) and one Station
- Benefit: fewer/other precise a priori values necessary
- Drawbacks:
  - Fixed parameters not estimated and seen as the true values
  - Accuracy estimation for those parameters not possible
  - Cannot be done redundantly
- Common way in VLBI analysis: datum definition with a free adjustment where No-Net-Translation (NNT) and No-Net-Rotation (NNR) conditions are imposed on some/all stations **but at least three stations with precise coordinates needed**

# Global solution for VGOS network

- Global solution is a combination of VLBI sessions on normal equation level
- Datum defined by fixing
  - EOP (IERS EOP 14 C04 (IAU2000A))
  - Westford (ITRF2014 coordinates)
- Station velocities not estimated but taken from neighboring ITRF2014 stations
- Exception for Ishioka (Is) due to strong inconsistency with velocity from nearest station → Velocity for Is estimated using a global solution of R1 & R4 sessions from 2017-2019
- ZWD parametrization with 30 min interval and 1.5cm relative constraint accuracy
- Source coordinates fixed
- Calculated in VieVS

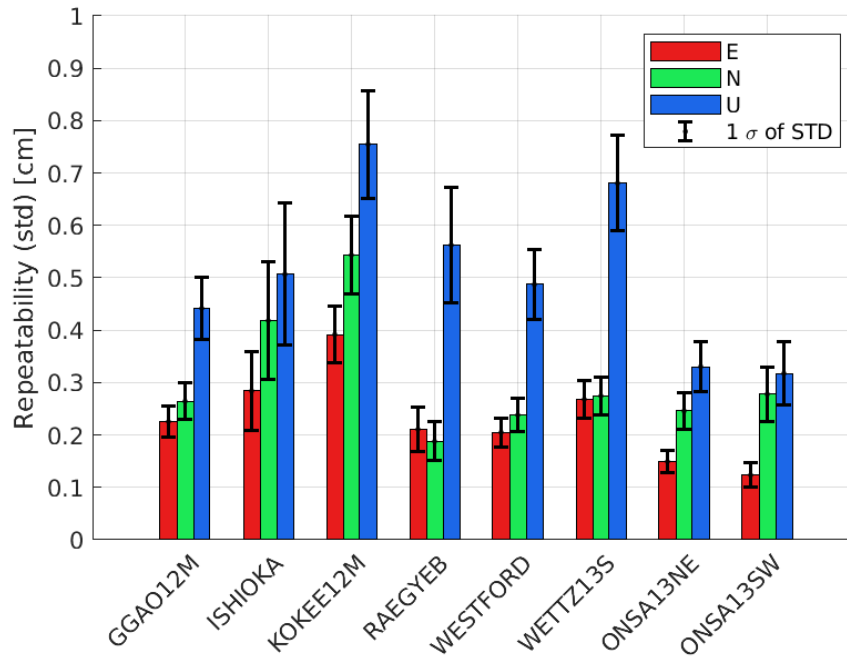
# Resulting Coordinates

Station	Coordinates [m]			Formal Errors [mm]			Velocities [cm/y]			Epoch
	x	y	z	x	y	z	vx	vy	vz	
GGAO12M	1130729,8900	-4831245,9513	3994228,2859	0,13	0,27	0,28	-1,50	-0,11	0,23	2019.0
ISHIOKA	-3959636,1638	3296825,4801	3747042,5997	0,64	0,52	0,87	-2,29	-0,08	-0,65	2019.0
KOKEE12M	-5543831,7443	-2054585,6766	2387828,9139	0,65	0,50	0,57	-0,93	6,29	3,23	2019.0
ONSA13NE	3370889,1670	711571,3336	5349692,1358	0,27	0,26	0,46	-1,44	1,45	1,04	2019.0
ONSA13SW	3370946,6467	711534,6414	5349661,0127	0,30	0,27	0,51	-1,44	1,45	1,04	2019.0
RAEGYEB	4848831,0419	-261629,4098	4122976,5472	0,40	0,28	0,48	-0,49	1,90	1,65	2019.0
WETTZ13S	4075658,8759	931824,8823	4801516,2886	0,27	0,25	0,42	-1,61	1,70	1,00	2019.0
WESTFORD	1492206,3859	-4458130,5272	4296015,5872	-	-	-	-1,56	-0,13	0,41	2010.0

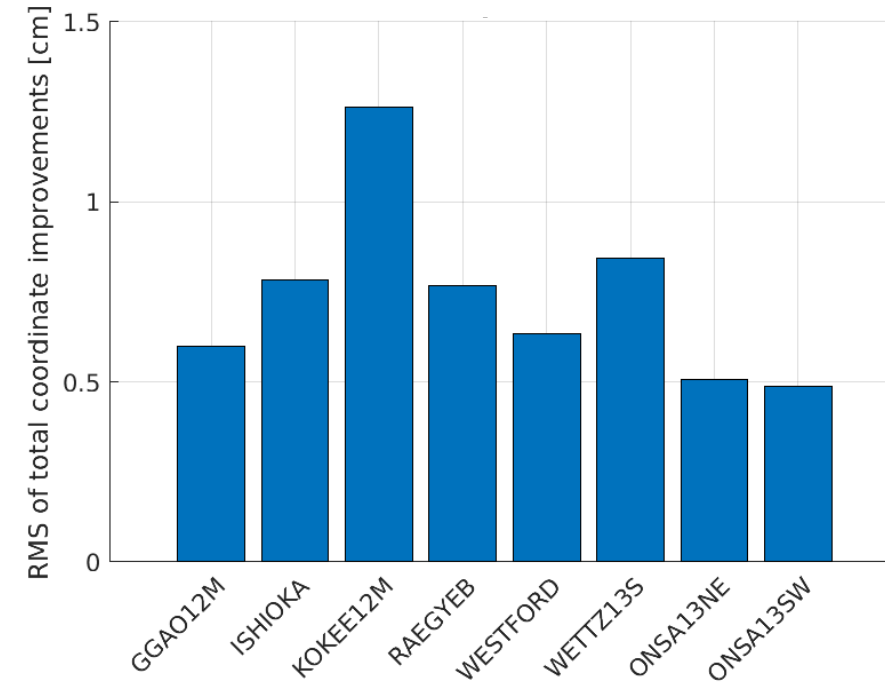
*VGOS coordinates resulting from global solution*

# VGOS station repeatability

Station repeatability in single session analysis of the VGOS sessions using the estimated coordinates



Station repeatability as the standard deviation of coordinate improvements in East, North & Up along with one sigma uncertainty based on single analysis of 30 VGOS sessions



Root-mean-square of estimated total station position improvements based on single analysis of 30 VGOS sessions

$$\sqrt{\frac{1}{n} \sum_i^n \Delta x_i^2 + \Delta y_i^2 + \Delta z_i^2}$$