GGOS Focus Area Unified Height System: Status report, ongoing activities, outlook

Laura Sánchez

Deutsches Geodätisches Forschungsinstitut (DGFI-TUM)
Technische Universität München

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Introduction

The GGOS Focus Area Unified Height System (FA-UHS) presently concentrates on the implementation of the IAG Resolution 1, 2015: Establishment of the International Height Reference System (IHRS) and its realization, the International Height Reference Frame (IHRF).

1) Station selection for the IHRF reference network

2) Strategy for the determination of high-precise primary coordinates $\mathbf{X}_P$, $\dot{\mathbf{X}}_P$, W_P, $\dot{W}_P$ at the IHRF reference stations

3) Identification and preparation of standards and conventions to ensure consistency between the definition (IHRS) and the realization (IHRF).

IHRS coordinates according to the IAG Resolution No. 1, 2015
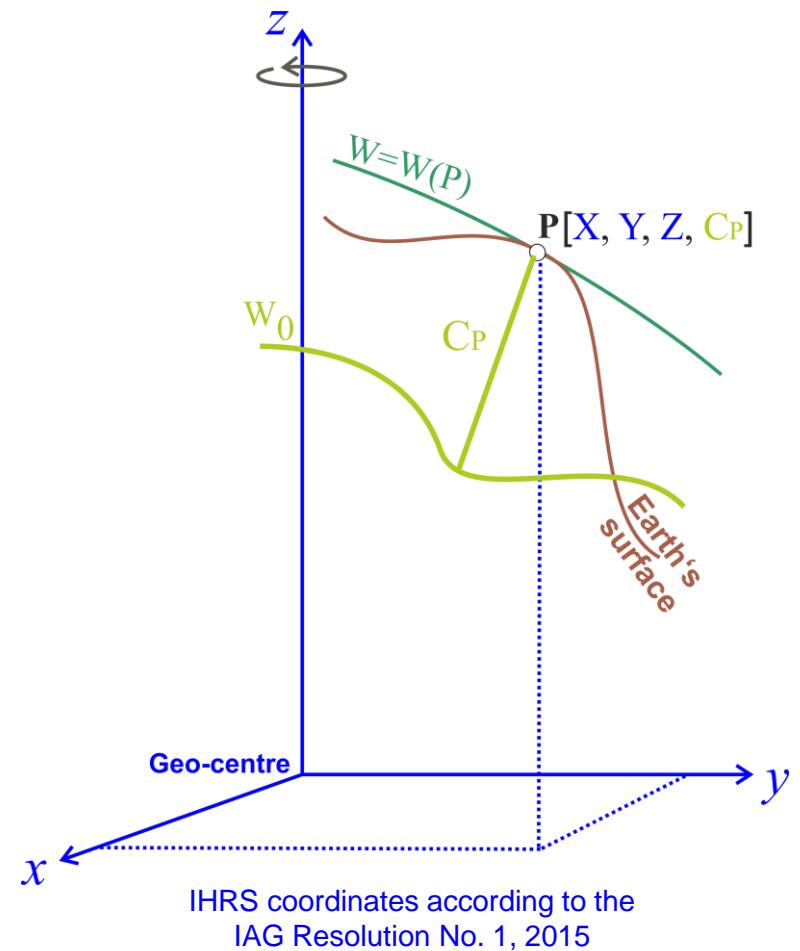
Proposal for the IHRF reference network presented at the GGOS Days 2018

IHRF station selection, 2018−09−14
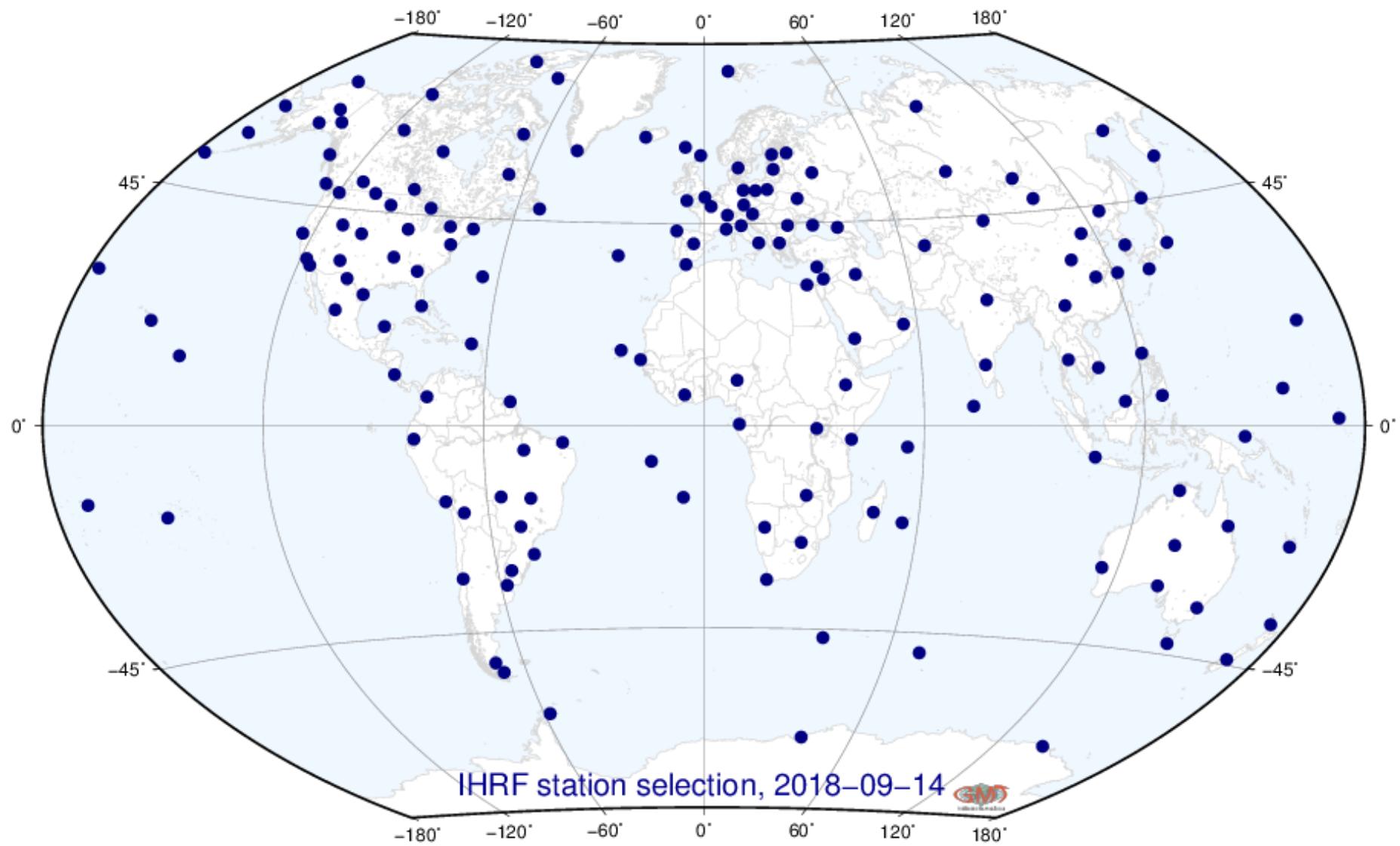
Recent changes in the selection of IHRF reference stations

IHRF station selection, 2019−04−02

Decommissioned
New station
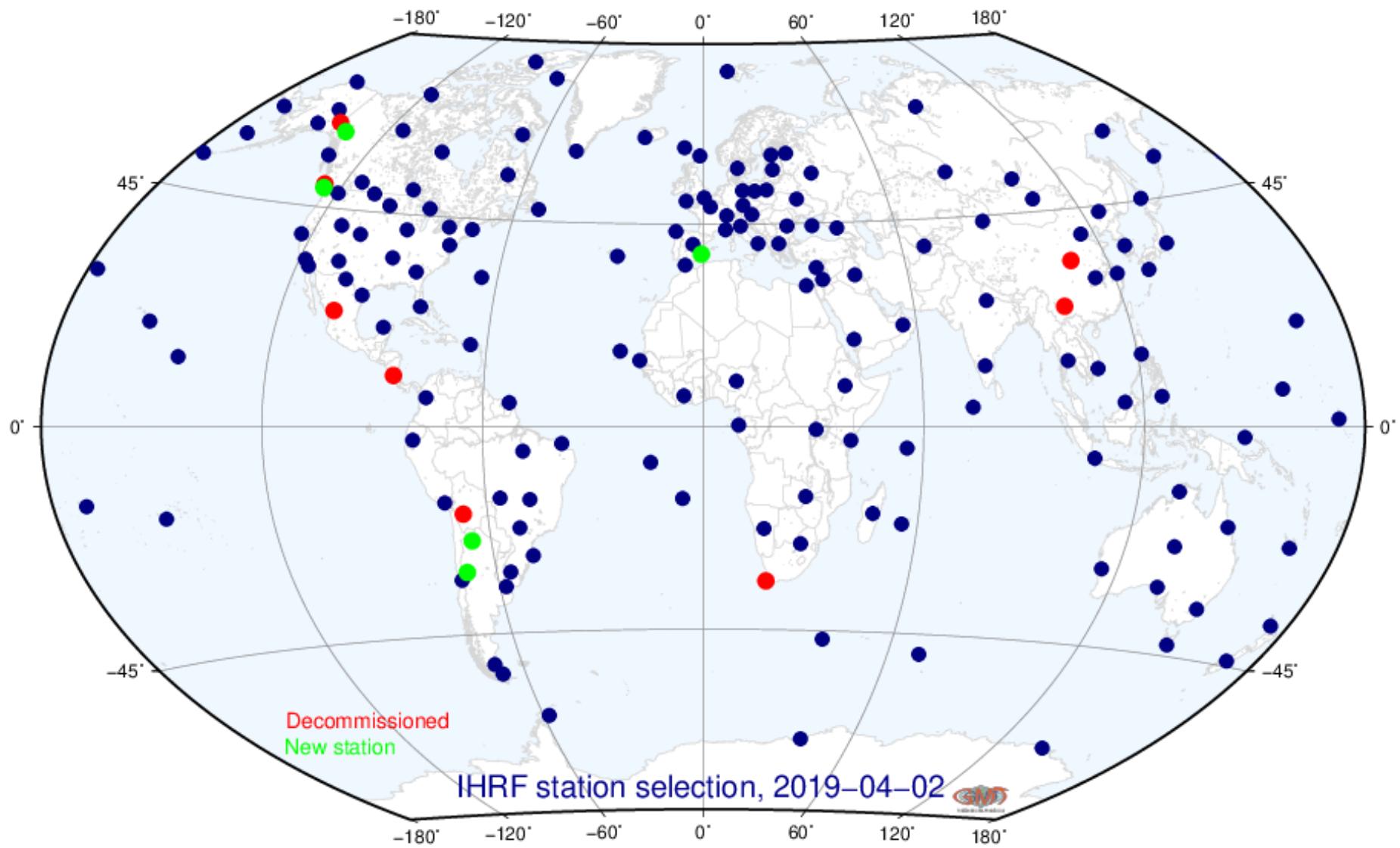
IHRF coordinates

- Basic definition: $W(P) = W(\mathbf{X})$, with $\mathbf{X} = [X,Y,Z]_{ITRF}$

- IHRS is based on the combination of

  1) a geometric component given by $\mathbf{X}$ and
  2) a physical component given by the determination of W at $\mathbf{X}$.

- $\mathbf{X}$ is to be determined in the ITRS/ITRF and consequently, it follows the IERS standards and conventions.

- The potential values $W(P)$ may be determined using different approaches, which produce different results.

- It is necessary, to ascertain the magnitude of the disagreement between the approaches.

- Colorado experiment: to compute geoid, quasi-geoid and potential values using exactly the same input data, a set of basic standards, and the own methodologies (software) of colleagues involved in the gravity field modelling.
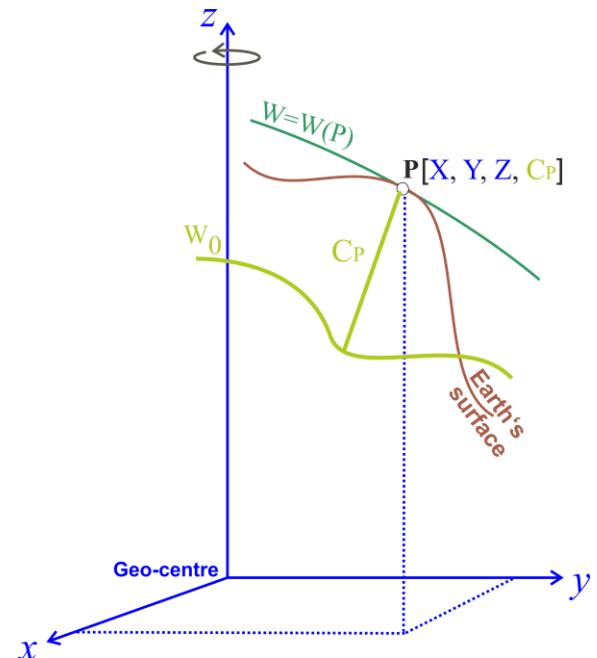
Colorado data
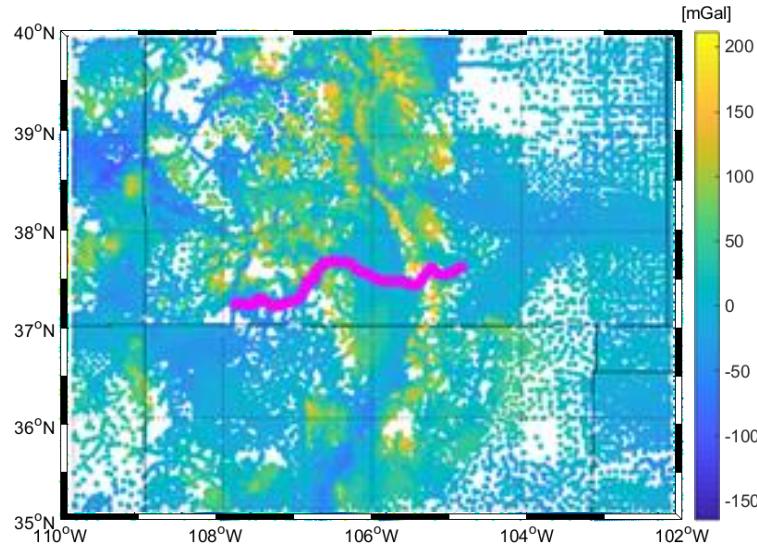
Surface gravity data (59,303 points)
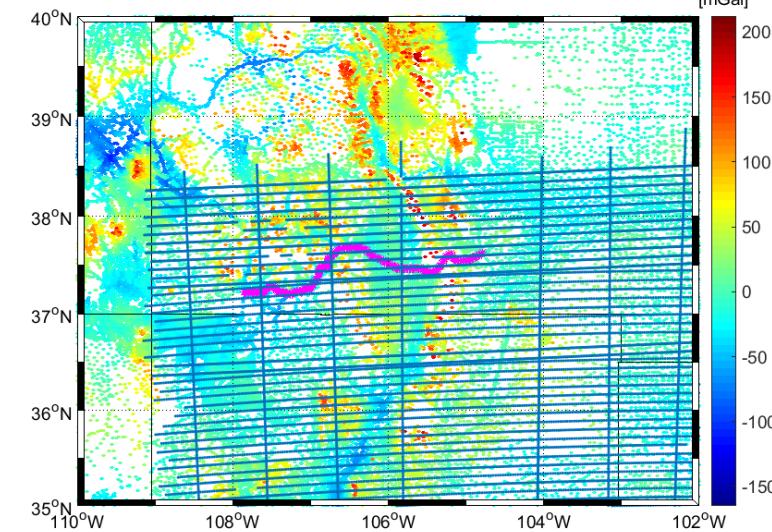

Airborne gravity data
(41 lines E-W, 7 lines N-S)
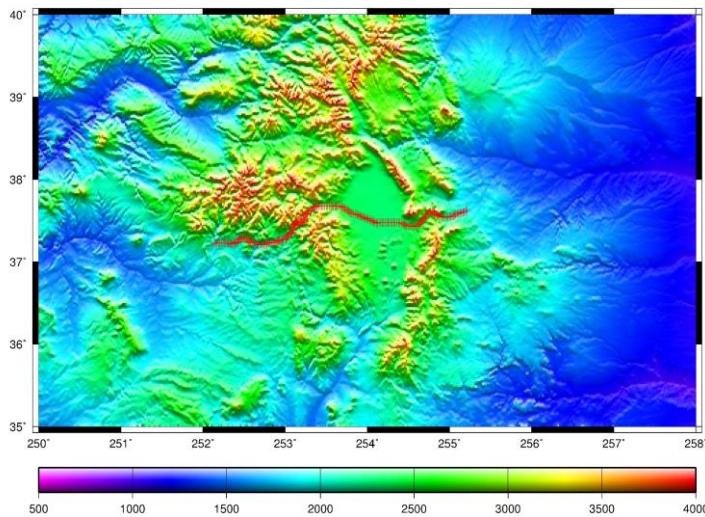
Terrain model: SMRT V4.1
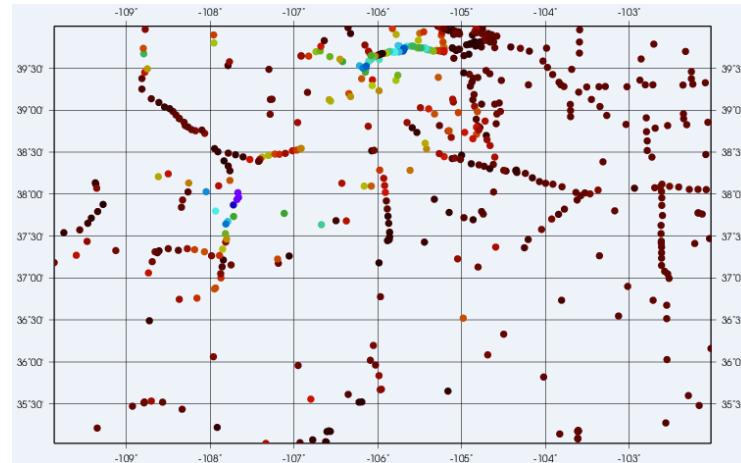

NGS *historical* GPS/levelling (510 points)

Colorado experiment

1) Aug 2017: Initiated in Kobe (IAG General Assembly) by
   - GGOS JWG: Strategy for the realisation of the IHRS (chair: L Sánchez)
   - IAG JWG 2.2.2: The 1 cm geoid experiment (chair: YM Wang)
   - IAG SC 2.2: Methodology for geoid and physical height systems (chair: J Ågren)
   - ICCT JSG 0.15: Regional geoid/quasi-geoid modelling - Theoretical framework for the sub-centimetre accuracy (chair: J Huang)

2) Dec 2017 - Jan 2018: Preparation of a set of basic (minimum) standards for the data processing (L Sánchez, J Ågren, J Huang, YM Wang, R Forsberg)

3) Feb 2018: Distribution of the Colorado data (YM Wang, NGS-NOAA)

4) Feb - Aug 2018: First computations with 10 contributing groups

5) Sep 2018: Comparison of the results at the GGHS2019 Symposium (Copenhagen)

6) Nov - Dec 2018: Refinement of the basic standards for the data processing (L Sánchez, J. Ågren, J. Huang, YM Wang, R. Forsberg)

7) Jan - Apr 2019: Refined computations for the Colorado experiment with 14 contributing groups

8) Since Mar 2019: Comparison of results to identify sources of discrepancy between the delivered solutions

Solutions contributing to the first computation

Faculty of Engineering, Minia University, Egypt

İstanbul Teknik Üniversitesi, Istambul, Turkey

Department of Geodesy and Surveying, Aristotle University of Thessaloniki, Thessaloniki, Greece
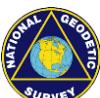
National Geodetic Survey, USA

Natural Resources Canada, Canada

Lantmäteriet, Swedish mapping, cadastral and land registration authority, Sweden
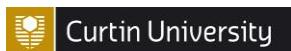
School of Earth and Planetary Sciences and The Institute for Geoscience Research, Curtin University, Australia

Universidade Federal do Parana, Brazil

Escola Politécnica, Universidade de São Paulo; Centro de Estudos de Geodesia, Brazil

Deutsches Geodätisches Forschungsinstitut, Technische Universität München, Germany

Solutions contributing to the second (refined) computation

Faculty of Engineering, Minia University, Egypt

İstanbul Teknik Üniversitesi, Istambul, Turkey

Department of Geodesy and Surveying, Aristotle University of Thessaloniki, Thessaloniki, Greece

National Geodetic Survey, USA

Natural Resources Canada, Canada

Lantmäteriet, Swedish mapping, cadastral and land registration authority, Sweden

School of Earth and Planetary Sciences and The Institute for Geoscience Research, Curtin University, Australia

Escola Politécnica, Universidade de São Paulo; Centro de Estudos de Geodesia, Brazil

Deutsches Geodätisches Forschungsinstitut, Technische Universität München, Germany

Ingenieurinstitut für Astronomische und Physikalische Geodäsie, Technische Universität München, Germany

Chinese Academy of Surveying and Mapping, China

Politecnico de Milano, Italy

Faculty of Geodesy, University of Zagreb, Croatia - Research Institute of Geodesy, Topography and Cartography, Czech Republic

National Space Institute, Technical University of Denmark, Denmark

Geography and Crustal Dynamics Research Center, Geospatial Information Authority of Japan, Japan

Outlook

1) Regarding the Colorado experiment
   - to decide if a new iteration is necessary
   - to present the results at the IUGG 2019 General Assembly (Montreal)
   - to publish methods and results in a Journal of Geodesy special issue.

2) The first version of "the IHRS standards and conventions" should be ready for discussion before the next IUGG General Assembly in Montreal, July, 2019

3) A first (static) solution for the IHRF will be presented at the IUGG General Assembly: it should be preliminary and it is to identify drawbacks and required improvements

4) For the next term 2019-2023, a joint working group of the GGOS FA-UHS, IAG Commission 2 and the IGFS should investigate the best way to establish an 'IHRS/IHRF element' within the IGFS to ensure the maintenance and availability of the IHRF:
   - Regular updates of the IHRF$yyyy$ to take account for:
     - new stations;
     - coordinate changes with time $\dot{\mathbf{X}}$, $\dot{W}$;
     - improvements in the estimation of $\mathbf{X}$ and W (more observations, better standards, better models, better computation algorithms, etc.)
   - Geodetic products associated to the IHRF (description and metadata).
   - Organizational and operational infrastructure to ensure the IHRF sustainability.

International workshop for the implementation of the Global Geodetic Reference Frame (GGRF) in Latin America
Buenos Aires, Argentina, September 16 – 20, 2019
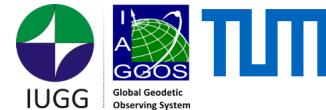
1) Initiative of the GGOS Focus Area Unified Height System (L Sánchez) and the Argentine-German Geodetic Observatory - AGGO (C Brunini)

2) It is sponsored by the IUGG and led by the IAG and IASPEI within the project "Implementation of the United Nations' Resolution on the Global Geodetic Reference Frame (UN-GGRF) for Sustainable Development in Latin America", granted by the IUGG in 2019.

3) Objectives:
   - To present the definition of the GGRF and the roadmap for its implementation
   - To give a complete overview of the different international organizations contributing to and supporting the implementation of the GGRF to promote a more active participation of the Latin American countries in global and regional related initiatives.
   - To identify possibilities of improvement in the existing Latin American geodetic infrastructure and to show how fundamental geodetic observatories operate.
   - To provide the SIRGAS colleagues with scientific and political arguments to convince policy makers about the necessity of investing in geodetic and geophysical infrastructure.

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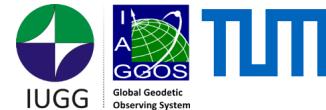
	Sep 16	Sep 17	Sep 18	Sep 19	Sep 20
08:30 – 10:00	Opening	Global cooperation framework	Group on Earth Observation (GEO)	IAG Services	Argentine-German Geodetic Observatory (AGGO)
10:00 – 10:30	Coffee break				
10:30 – 12:00	GGRF definition and organization	Global cooperation framework	Group on Earth Observation (GEO)	IAG Services	Round table discussion, conclusions, outcomes
12:00 – 14:00	Lunch time				
14:00 – 15:30	GGRF definition and organization	Regional cooperation framework	Global geodetic reference systems and frames	GGOS	Visit to AGGO
15:30 – 16:00	Coffee break				
16:00 – 17:30	Panel on GGRF	Regional cooperation framework	Global geodetic reference systems and frames	GGOS / Panel on geodetic infrastructure	Visit to AGGO

Speakers: Z. Altamimi, G. Johnston, H. Schuh, R. Gross, A. Ismail-Zadeh, J. Schweitzer, H. Drewes, M. Assumpção, A. Craddock, R. Heinkelmann, M. Pearlman, L. Soudarin, F. Lemoine, L. Sánchez, J. Boumann, C. Brunini, T. Schüler, H. Hase, M. Lilje [tbc], P. Merodio-Gómez [tbc], D. Taller [tbc], H. Wziontek [tbc], still missing GEO, IGFS, PAIGH.