Reference Frames and Datums: Improvements Planned for the Pacific

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Outline

• Height relationships
• GGRF and ITRS and WGS84
• NSRS 2022
• Western Pacific
• Summary
Height Relationships

\[ h = H + N \quad \text{or} \quad H = h - N \]

Geoid + TSS = LMSL

- \( h \): ellipsoid height
  - Above/below ellipsoid surface/datum
- \( H \): orthometric heights
  - Above geopotential datum (geoid)
  - Geoid ≈ Global MSL (MSL)
- \( N \): geoid height
  - Height from ellipsoid to geoid
- Local Mean Sea Level (LMSL)
  - Mean Sea Surface
- Topography of the Sea Surface (TSS)
  - Height from MSL(geoid) to LMSL(MSS)
Input for VDatum

VDATUM TRANSFORMATION ‘ROADMAP’

Each straight black line is a transformation.
Global Geodetic Reference Frame Roadmap

- NOAA CORS Network
- NWLON
- Absolute Gravity sites
- ISO/OGC Standards
- FGDC/FGCS Standards
- GDA

- Policies, Standards and Conventions
- Sustainable and Enhanced GGRF
- Appropriate Governance
- Outreach and Communication
- Geodetic Infrastructure
- Education, Training and Capacity building
## WGS84 versus ITRS

<table>
<thead>
<tr>
<th>Realization</th>
<th>Epoch, $t_D$</th>
<th>Implementation date</th>
<th>Nominally Aligned to</th>
<th>Accuracy (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Broadcast orbits</td>
<td>Precise ephemeris</td>
<td></td>
</tr>
<tr>
<td>WGS84 (G730)</td>
<td>1994.0</td>
<td>29 Jun 1994 (1994.49)</td>
<td>2 Jan 1994 (1994.00)</td>
<td>ITRF91</td>
</tr>
<tr>
<td>WGS84 (G873)</td>
<td>1997.0</td>
<td>20 Jan 1997 (1997.05)</td>
<td>29 Sep 1996 (1996.74)</td>
<td>ITRF94</td>
</tr>
<tr>
<td>WGS84 (G1150)</td>
<td>2001.0</td>
<td>20 Jan 2002 (2002.05)</td>
<td>20 Jan 2002 (2002.05)</td>
<td>ITRF2000</td>
</tr>
<tr>
<td>WGS84 (G1674)</td>
<td>2005.0</td>
<td>8 Feb 2012 (2012.10)</td>
<td>7 May 2012 (2012.35)</td>
<td>ITRF2008</td>
</tr>
<tr>
<td>WGS84 (G1762)</td>
<td>2005.0</td>
<td>16 Oct 2013 (2013.79)</td>
<td>16 Oct 2013 (2013.79)</td>
<td>ITRF2008</td>
</tr>
</tbody>
</table>

Kelly and Dennis, 2021 in preparation (in review)
Modernizing the NSRS
The “blueprint” documents: Your best source for information

Geometric:
Sep 2017
NOAA TR NOS NGS 62
32 pages

Geopotential:
Nov 2017
NOAA TR NOS NGS 64
41 pages

Working in the modernized NSRS:
April 2019
NOAA TR NOS NGS 67
77 pages
The old
- NAD 83 (2011)
- NAD 83 (PA11)
- NAD 83 (MA11)

The new
- NATRF
- CATRF
- PATRF
- MATRF
NAPGD2022 - The three gridded regions

“Guam/CNMI region”

“American Samoa region”

“North American region”
¼ of the Earth

Project Area
Western Pacific Geodesy

**Needs**
- Geometric Reference Frame
- GNSS access to the Frame
- Geoid model (h => H) GGM vs. regional
- Terrestrial & altimetric gravity data
- Tide gauges/TSS (MSL => LMSL)

**Possibilities**
- ITRF2014/ITRF2020/PATRF/MATRF
- NCN/APREF
- ICGEM/ISG/EGM2008/EGM2020
- NGA/BGI/PGSC
- Academia/PGSC/PSMSL
Stations in APREF are being added to the NCN to boost coverage and access in the West Pacific.
Geoid Models

- **Global Gravity Models at ICGEM**
  - Generally 5’ resolution or worse
  - 10-20 km resolution – omission error
  - Commission errors more significant

- **Regional geoid models**
  - Developed using GGM
  - R-C-R
  - Need additional terrestrial gravity
  - Altimetric anomalies
  - Still requires gravity data on islands

GGM derived from EIGEN-6c2 model
Provided on ICGEM website
PGSC Core Members

- Core members are national geospatial, hydrographic and surveying authorities of Pacific Island countries and territories
- Maintain GNSS receivers in region
- Ties: GA, LINZ, NGS, UN-GGIM, FIG, IAG
- Possibilities of having local gravity data, tide information, leveling
- Vision: Sustainable development in the Pacific enabled by world-class geospatial information and surveying services.

Cook Islands, Federated States of Micronesia, Fiji, Kiribati, Nauru, Niue, Republic of the Marshall Islands, Papua New Guinea, Palau, Samoa, Solomon Islands, Tonga, Tuvalu, Vanuatu
Summary

• VDatum requires considerable data/care
• GGRF requires all Nations to adopt ITRS
• WGS-84 is not sufficient for positioning
• For the West Pacific
  – ITRF2014 is available
  – NCN access limited but improving
  – NAPGD2022 will not cover region
  – EGM’s available but insufficient by themselves
  – Require regional geoid (R-C-R)
  – Altimetric anomalies available
  – Still lacking terrestrial gravity, TSS, tide gauge data
• PGSC may be able to help with data gaps
  – These are the Nations in the project area