



NGA Update

Todd Kawakami, Research Directorate

September 25, 2018

NATIONAL GEOSPATIAL **NGA** INTELLIGENCE AGENCY

Outline

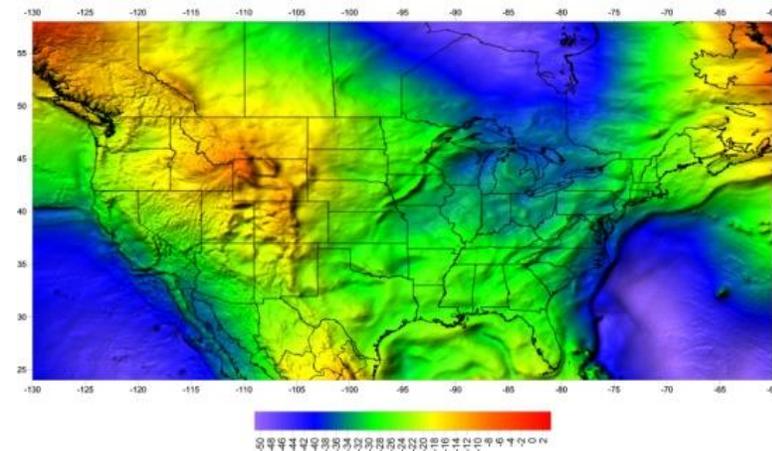
- NGA Mission
- Current GPS Operations
- NGA Support to the GPS Enterprise
- WGS 84
- NGA Contribution to IGS
- EGM2020
- Satellite Laser Ranging Reflectors

NGA Mission

NGA's mission is to provide timely, relevant and accurate geospatial intelligence in support of national security objectives

■ NGA's Mission Set

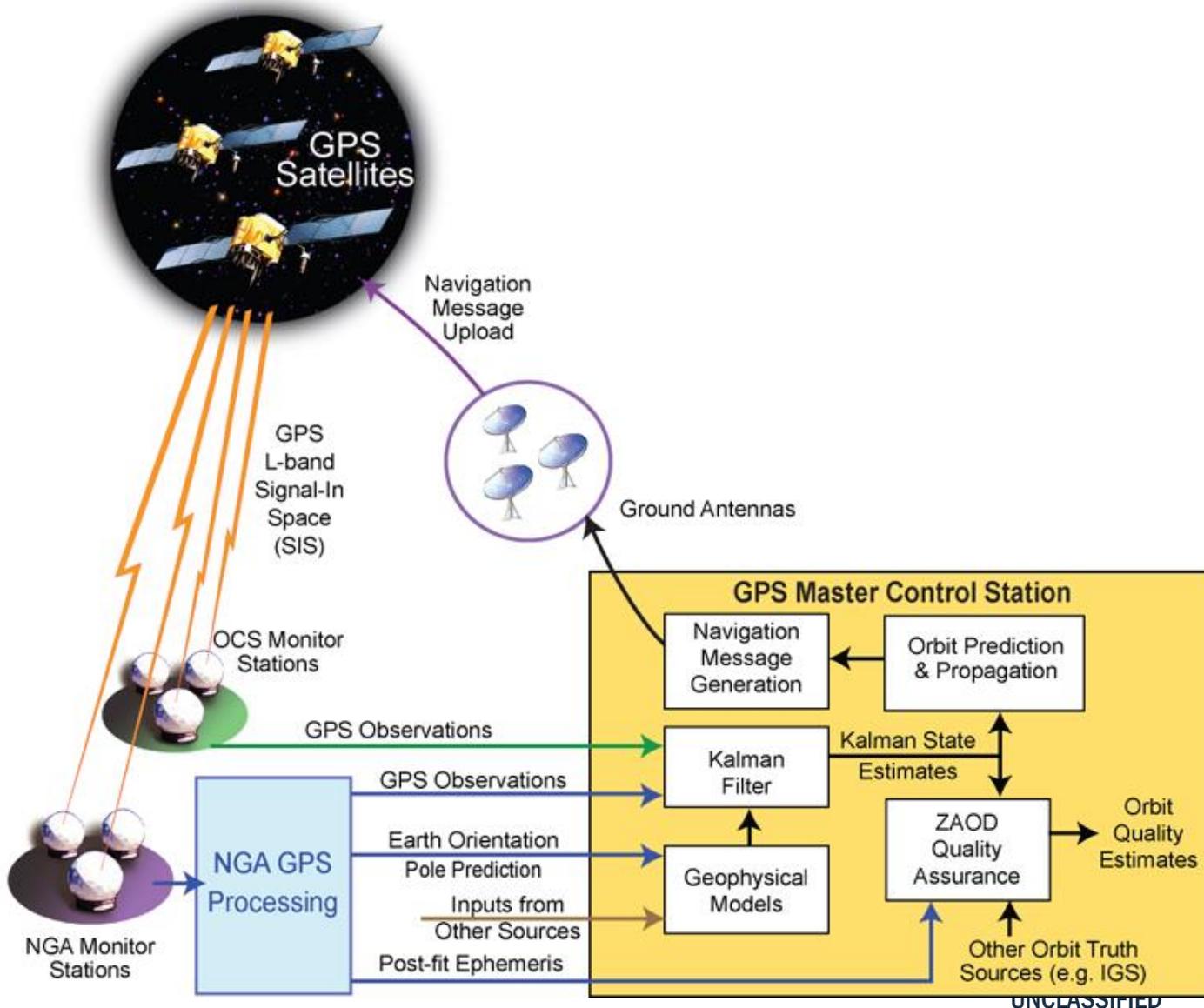
- ▶ Warfighter Support
- ▶ Strategic Intelligence
- ▶ Counterterrorism
- ▶ Cyber Warfare
- ▶ Homeland Security
- ▶ Foundation Data
- ▶ Humanitarian Relief
- ▶ Safety of Navigation



NGA's Role in GPS

- 40+ years of satellite tracking
- Signatory (as DMA) on the 1975 GPS JPO Charter
- GPS Monitor Station Network established 1985
- Generation and distribution of GPS precise ephemerides and GPS clock solutions
- WGS 84 – NGA defines and maintains the DoD reference frame
 - ▶ Station position accuracy ≈ 1 cm
 - ▶ GPS contributes to the determination of WGS

Current GPS Operations and NGA



- NGA GPS observations
 - ▶ 10 NGA vs 6 USAF GPS monitor stations
 - ▶ Directly improve GPS Broadcast Accuracy
 - ▶ Directly improve GPS Integrity Monitoring
 - ▶ L2C/L5 global monitoring (~2014) supports USAF CNAV verification and enabled pre-operational use of CNAV
- NGA GPS Precise Ephemeris
 - ▶ DoD Standard
 - ▶ Quality control for GPS operations

NGA & USAF GPS Monitor Stations - 2018



NGA and USAF have separate, but complimentary, missions in GPS

- NGA and USAF stations operated and maintained independently
- NGA and USAF receivers and antennas are different

NGA & USAF GPS Monitor Stations - OCX



NGA and USAF have separate, but complimentary, missions in GPS

- **NGA and USAF equipment collocated at each monitor station**
- **All 17 stations will have a USAF OCX receiver and antenna**

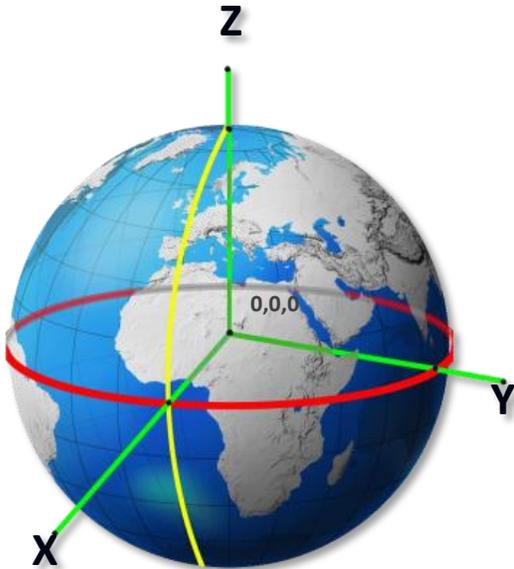
NGA Support to the GPS Enterprise

- NGA support for on-orbit checkout of GPS III SV01
 - ▶ Monitor station data
 - ▶ Ephemeris products

- NGA will continue to determine monitor station positions as required by Master PNT Plan
 - ▶ Compute ocean loading coefficients for each station in support of OCX

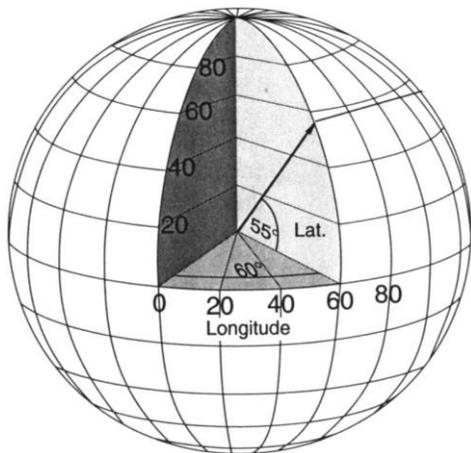
- NGA Precise Ephemeris will continue to be the DoD Standard

World Geodetic System 1984 (WGS 84)



Origin for ALL modern Geospatial Data is at Earth's Center of Mass

Known in 3-D with uncertainty smaller than the size of a postage Stamp



Recent WGS 84 Frame Realizations

Realization	Absolute Accuracy	Date
Original (TRANSIT)	1-2 m	Jan 1987
G730	10 cm	Jun 1994
G873	5 cm	Jun 1997
G1150	2 cm	Jan 2002
G1674	1 cm	Feb 2012
G1762*	1 cm	Oct 2013
GXXXX **	1 cm	Oct 2018

WGS 84 defined in NGA.STND.0036

* Aligned to ITRF08

** Aligned to ITRF14

NGA Predecessor Agencies – Developed the First (1958) Global Reference Frame and Geophysical Models for Modern Geospatial Information including WGS 60, 66, 72



NGA GPS Tracking Data Contribution to IGS

- NGA has been providing daily 30-sec RINEX files since November 2015
- NGA data has been used since January 2016 as part of daily position estimates for the International Terrestrial Reference Frame
- NGA plans to continue to provide GPS tracking data post transition to OCX

Satellite Laser Ranging (SLR) Reflectors on GPS IIF



- SLR is a key component of NASA's Space Geodesy Program
- Stakeholders: NASA, NRL and NGA
- Improvements to the reference frame and models
 - ▶ Separate clock errors from other orbital errors
 - ▶ Detect and analyze unmodeled systematic effects
- Maintain close alignment of WGS 84 & ITRF
- Ensure interoperability of GPS with other GNSS through a common, independent measurement

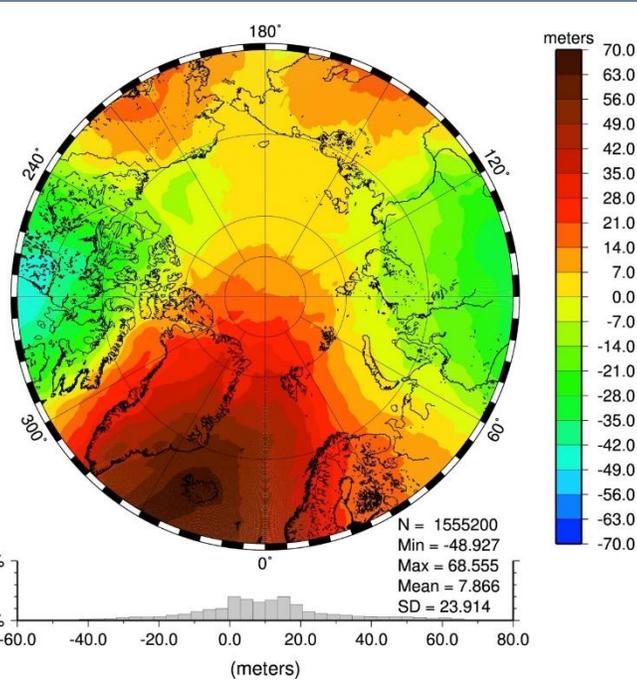
EGM2020

- Last EGM release 2008
- Keep WGS 84 State-of-the-Art
- Enhanced EGM recipe will improve NGA products as well as civilian products
- Provide a more accurate determination of Mean Sea Level
- Numerous new data sources available

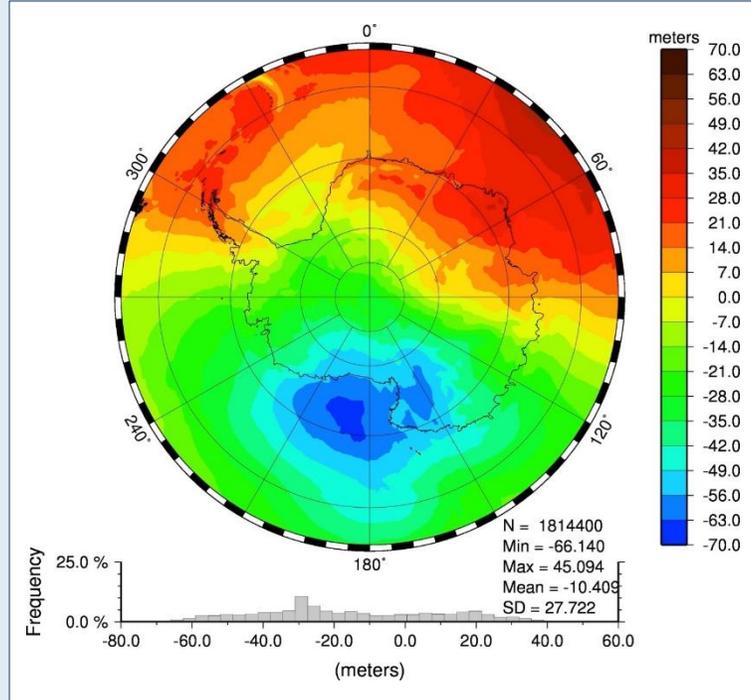
- Projected Release Date December 2019
 - ▶ Provides clients the time to schedule new model assimilation

- Same structure as EGM2008
 - ▶ 5' x 5' resolution is consistent with the customers needs
 - ▶ Ellipsoidal harmonic model up to degree (n) and order (m) 2159
 - ▶ Spherical harmonic model to degree 2190 and order 2159

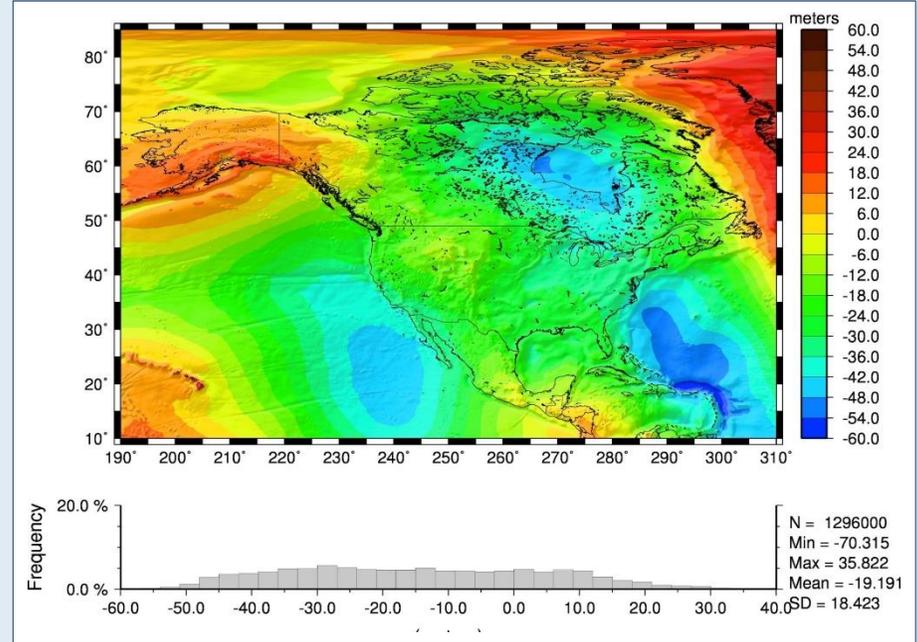
EGM2020



Geoid Ht: North Polar Region



Geoid Ht: Antarctica



Geoid Ht: CONUS



Image Sources:

- Slide #3 Photo of Tank and Aircraft Carrier taken by US DoD photographer available in open source; gravity model image produce by NGA in 2015. Similar to image on Slide #13 that was approved for public release, 17-404.
- Slide #5 NGS/SFN public release approval 06-230.
- Slide #6 & #7 Created by Applied Research Laboratory: The University of Texas at Austin (ARL:UT) for NGA under a NGA contract.
- Slide #9 Updated NGA/SFN slide public release approval 16-603, Update adds additional row to table for GXXXX to be released in Oct. 2018.
- Slide #11, All images are from NASA briefing to International Satellite Ranging (SLR) Jamboree (Conference) and available open source via International laser ranging service website hosted by NASA Goddard Space Flight Center. NASA has approved these images for public release. Image of SLR package for GPS 35/36 in NASA presentation, is actual a picture taken by the Naval Research Laboratory that was approved for public release.
- Slide#13, NGA/SFN image, public release approval 17-404.

