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GGOS Bearing Essential Fruit: Globally-Consistent Land Motion and Integrated Water Vapor from >17,000 Sites

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The IAG's Global Geodetic Observing System (GGOS) has begun to mature, and is approaching a turning point. After decades of development in hardware, networks, models, algorithms, estimation methods, and software, we are starting to reap an abundance of global data products essential to multi-disciplinary geosciences. With the adoption of international conventions and reference frames, together with calibrations, formats, and data processing standards recommended by the IAG Services, such products are well-documented and reproducible in a well-defined system. Such consistency enables rigorous intercomparison between analysis centers, between techniques, and with geophysical models, enabling scientific interpretation.

The above IAG/GGOS machinery now allows us to convert all the world's geodetic GPS data into data products that are globally consistent, with applications to a wide variety of scientific applications, including Earth rotation, tectonics, earthquakes, volcanology, atmospheric science, sea level, mass redistribution, and terrestrial water storage. This leveraging would not be possible without IAG-coordinated efforts that enable any investigator to gain accurate, practical access to GGOS, effectively expanding GGOS coverage by orders of magnitude. "If I have seen further, it is by standing on the shoulders of Giants" (Newton, 1676).

Following this philosophy, we at Nevada Geodetic Laboratory (NGL; http://geodesy.unr.edu) produce and make publicly available data products from over 17,000 GNSS sites going back over two decades. Here we report on progress toward our latest products that, for the first time, use "Repro 3.0" products and the GipsyX software from JPL's IGS Analysis Center, including GPS orbits, clocks, and daily transformations into reference frame ITRF2014. For land motion, NGL estimates site positions every 24 hours as well as every 5 minutes to capture sub-daily deformations such as co-seismic displacements. For the first time, NGL now produces integrated water vapor (IWV) every 5 minutes from all sites. The conversion of total zenith delay to IWV uses products from TU Vienna, including the ECMWF data-driven Vienna Mapping Function, hydrostatic delay and weighted mean tropospheric temperature. Such IWV time series are self-consistent with vertical land motion (VLM, which anti-correlates with IWV), and should be inherently stable over decades, suitable for climate change studies. Initial results show improved resolution in VLM over our previous generation of products.

In conclusion, NGL geodetic products, including essential variables VLM and IWV, leverage core GGOS products by expanding global coverage by orders of magnitude. Products are generated in a way that is self-consistent over decades, a prerequisite for global change studies. Consistency between NGL and GGOS is maintained thanks to maturation of space geodetic technology and the adherence to practices developed under the IAG umbrella. We propose that products such as NGL's will be needed by GGOS to provide adequate, globally-consistent coverage of essential geodetic variables. That being the case, GGOS would need to become "the home" for such extended products.