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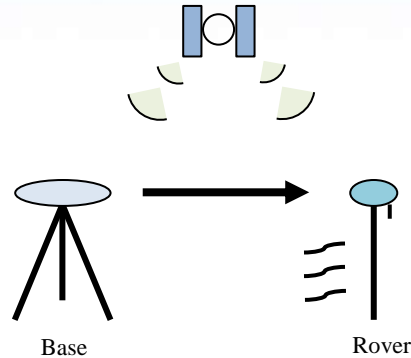
OPUS Projects 5: Supporting Real-Time Kinematic Measurements for Establishment of Geodetic Control

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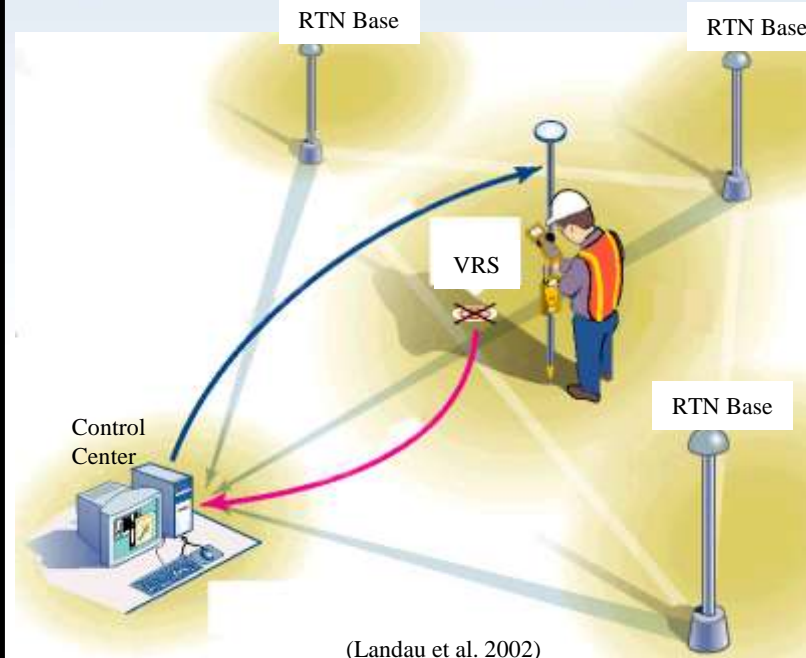
Real-Time Kinematic (RTK) Surveying

Single-base RTK

- Stationary single “base” station
- Transmits precise coordinates and GNSS observables to moving “rover”
- < 10-20 km baseline length

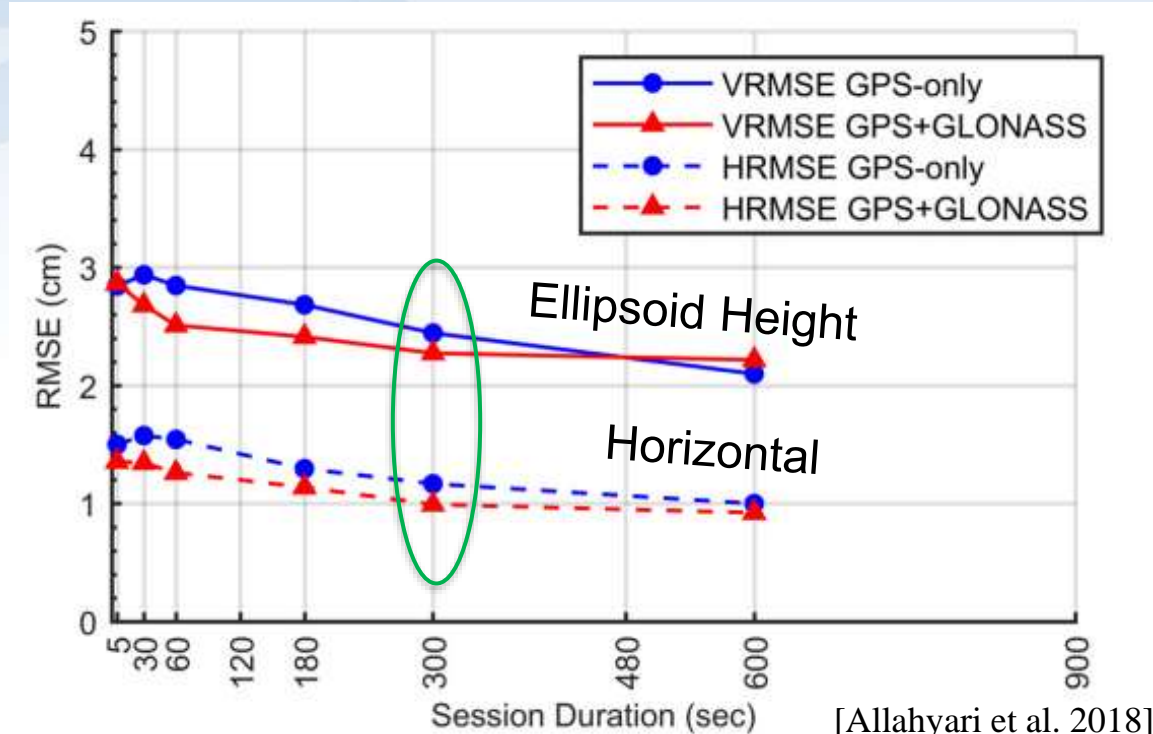


Network RTK



(Landau et al. 2002)

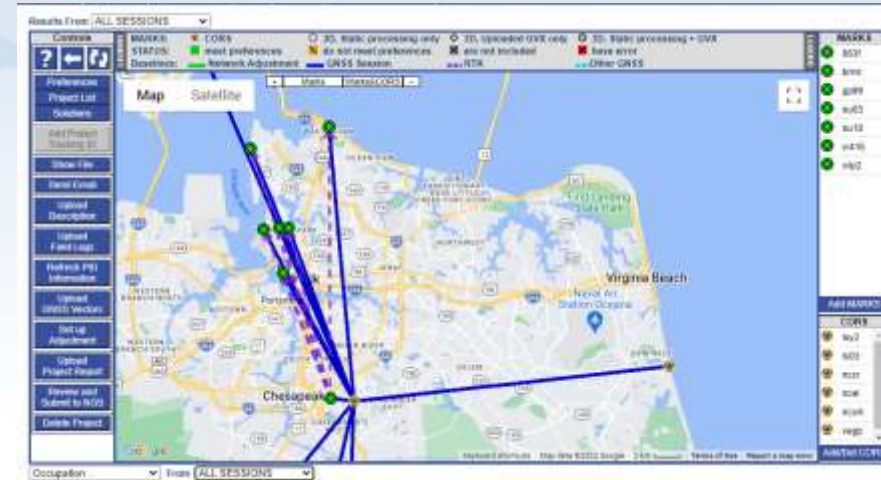
Empirical Evaluation of the Accuracy of Network RTK



[Allahyari et al. 2018]

What is OPUS-Projects?

- Free, web-based application
- Upload static GPS data via OPUS-S
- Supports campaign-style surveys
- Custom survey network design
- Easy addition of CORS' data
- Data management and visualization aids
- Baseline processing using the PAGES engine
- Survey network adjustments
- Selection of reference frames , geoid models, State Plane Coordinates, etc.

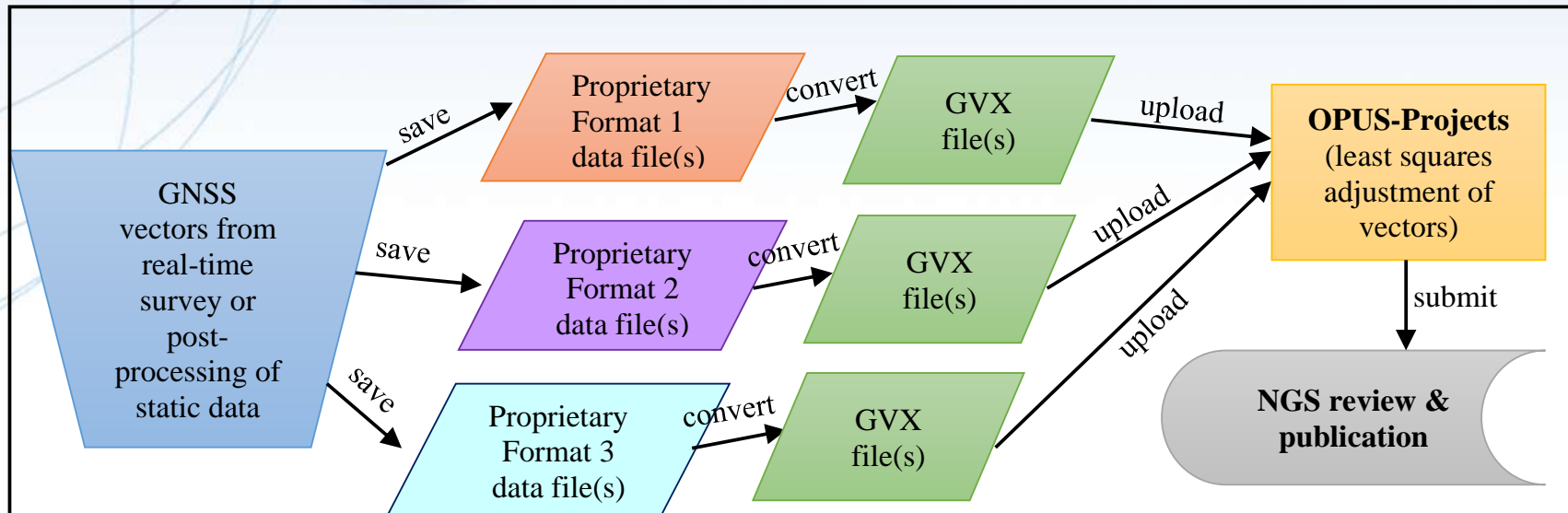


Why use OPUS-Projects?

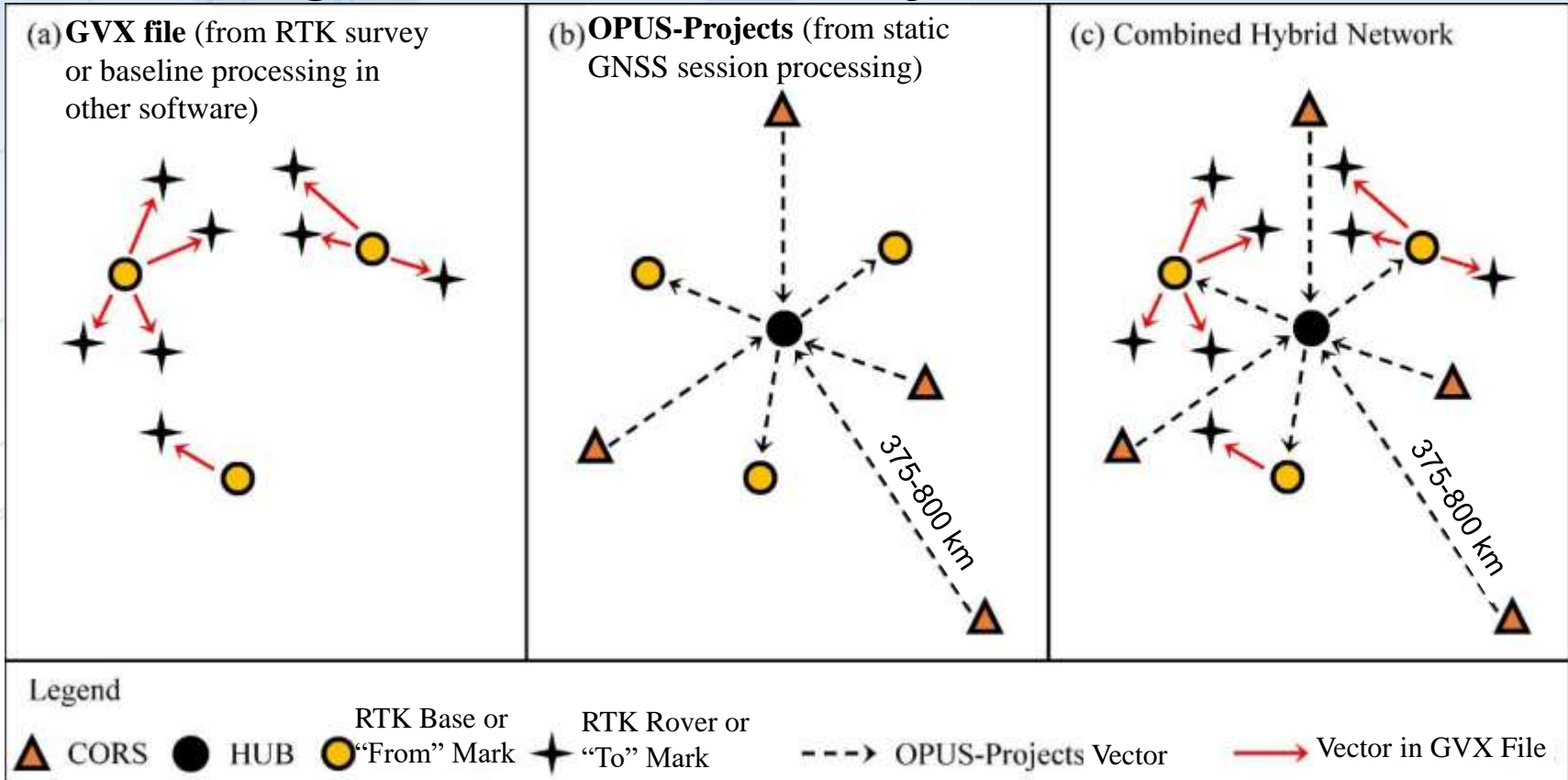
- **Organizes data** for multiple occupations on more than one mark
 - Campaign-style surveys for control
- Performs least squares **adjustments of control survey networks**
 - Estimate relative accuracy between marks
- Constrains NAVD 88 bench marks – **check/establish NAVD 88 heights**
- Ensures survey is **tied to the National Spatial Reference System (NSRS)**
 - CORS data and published coordinates/heights
 - Official models (HTDP, GEOID18)
- Submits survey to NGS for review, loading in database, and **publication** on datasheets
 - Establishment of geodetic control
 - NGS will use data for making models (e.g., future transformation model for the new datums)

GNSS Vector Exchange (GVX) Flow Chart:

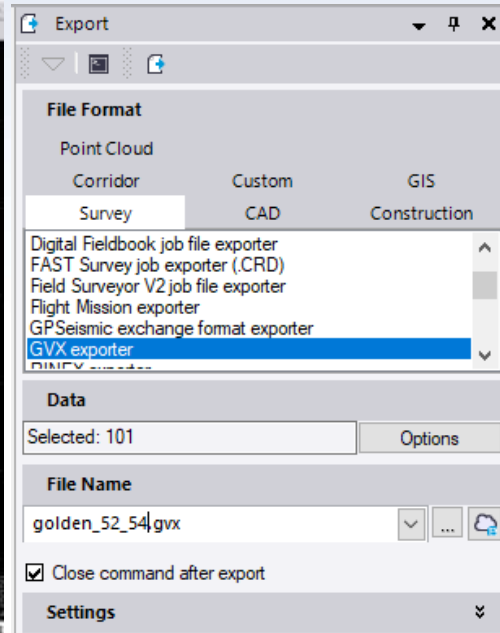
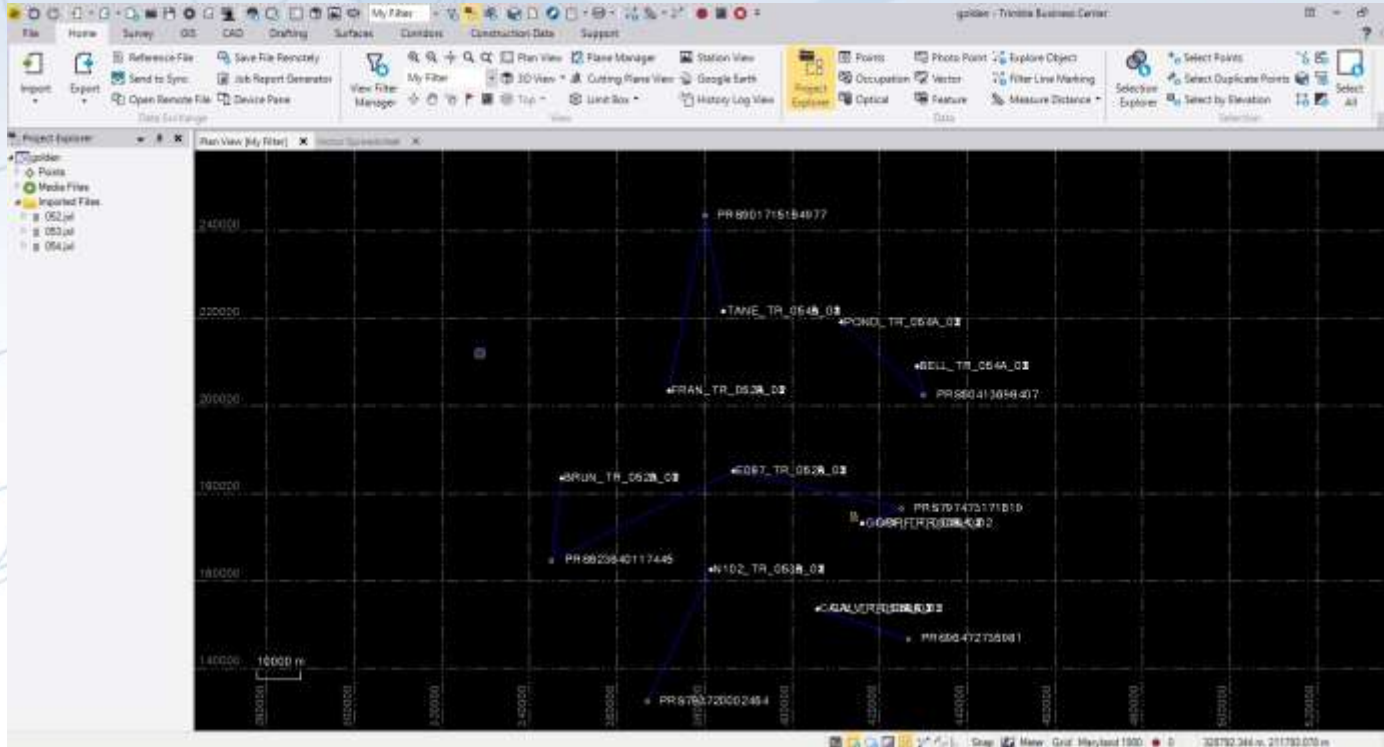
<https://www.ngs.noaa.gov/data/formats/GVX/index.shtml>



Design for OPUS-Projects and GVX



Example of GVX to OPUS-Projects



Example of GVX to OPUS-Projects (cont.)

<https://geodesy.noaa.gov/OPUS-Projects/OpusProjects.shtml>

The screenshot displays the NOAA National Geodetic Survey (NGS) OPUS web interface. The title bar reads "Golden Point Test Survey (goldbeta copy)" and "National Geodetic Survey". The interface includes a navigation menu with options like "NGS Home", "About NGS", "Data & Imagery", "Tools", "Surveys", and "Science & Education". A search bar is located in the top right corner. The main content area features a map of the Northeast United States, centered on Baltimore, Maryland. Several green lines radiate from Baltimore to other locations, including Pittsburgh, Washington, and Philadelphia, representing GNSS stations. The interface also includes a "MARKS" list on the right side, showing stations like BOLL, OPI1, JPL2, PAS2, PAS1, and PAS0. A red arrow points to the "Upload GNSS Vectors" button in the left-hand navigation menu.

Example of GVX to OPUS-Projects (cont.)

<https://geodesy.noaa.gov/OPUS-Projects/OpusProjects.shtml>

The screenshot displays the NOAA National Geodetic Survey website interface for the "Golden Point Test Survey (goldbeta copy)". The page features a navigation menu with options like "NGS Home", "About NGS", "Data & Imagery", "Tools", "Surveys", and "Science & Education". The main content area shows a map of the Philadelphia region with several green dots representing adjustment points and lines connecting them to a central point. The interface includes a sidebar with project management tools such as "Preferences", "Project List", "Add Project", "Share File", "Send Email", "Upload Description", "Upload Field Logs", "Refresh PID Information", "Upload GNSS Workfile", "Set up Adjustment", "Expert Adjustments", "Upload Project Report", "Review and Submit to NGS", and "Delete Project". The bottom of the page shows a "Occupation" dropdown menu set to "Free" and a "Adjustments" button. On the left side of the image, two red arrows point towards the sidebar area.

Status of GVX Exporters

Available Now



- Trimble Business Center (TBC) 5.80



- Carlson SurvCE7



- Topcon MAGNET Field v. 7.3



- Leica Infinity 4.0.0



- JAVAD in Triumph-LS device

Coming Soon



- i-Gage X-PAD



- Reachview 3

OPUS-Projects 5.1

- Supports static GPS baseline processing & network adjustments
- Uploader for GVX files
 - RTK vectors; vectors from post-processing
- Automatically “weights” uploaded vectors in a network least squares adjustment
- Builds all necessary files for publication on datasheets



The screenshot shows the OPUS Projects 5.1 website. The header includes the NOAA logo and the text "OPUS Projects 5.1" and "National Geodetic Survey". A navigation menu contains links for "NGS Home", "About NGS", "Data & Imagery", "Tools", "Surveys", "Science & Education", and a search bar. The main content area features a description of OPUS Projects as a management and processing tool, with bullet points listing advantages like customizable data processing, visualization aids, and adjustments to the National Spatial Reference System. A "Learn More" section includes links to a video, training videos, a user guide, a WebDesc tutorial video, and GPS for GPS/BIM2023. Below this is a "NEWS v5.1 UPGRADE COMPLETE" section with bullet points about uploading real-time (RTK) and post-processed vectors via GVX format and exporting adjustments to various formats. A "Workflow Recommendations" section provides instructions for users submitting projects to NGS. At the bottom, there are sections for "Create a new project" (restricted to trained managers) and "Configure, edit, and process individual network sessions" with input fields for Project Identifier, Session Keyword, and Your Email.

More Help with OPUS-Projects and GNSS Surveying

Completed Work:

- New digital user guide
- New web content for GPSONBM using network RTK and OPUS-Projects 5.1

Ongoing Work:

- New GNSS surveying standards & specifications—NGS-92
- Training videos to support independent learning
- Tutorial lesson with example data

OPUS Projects User Guide

- Abstract
 - Revision History
 - Acknowledgements
 - Conventions Used Throughout the Document
 - Disclaimer
 - List of Figures
 - Quick Start Guide
-
1. Introduction
 2. NGS Survey Proposal
 3. Create Your Project in OP
 4. Review and Edit Project Preferences
 5. Naming Files Correctly for Best Results in OP
 6. Loading GNSS Observation Files
 7. Walking Through OP Visualizations
 8. Selecting CORS
 9. Upload GVX Vectors
 10. Mark Descriptions
 11. Session Processing
 12. Network Adjustments

NGS 92: New Standards for GNSS Surveying

Description	Primary	Secondary	Local
Ellipsoid height (cm)	2 cm	3 cm	5 cm
Horizontal (cm)	1 cm	1.5 cm	2.5 cm
Orthometric height (cm)	3 cm	4 cm	6 cm

All accuracies are at 95% confidence; network & local

Requirement for Network RTK method	Primary	Secondary	Local
Repeat number & duration of occupations	(6) 5 min.	(3) 5 min.	(3) 5 min.
Longest allowable vector	40 km	40 km	40 km
Precision of repeat vectors	N/E: 3 cm Up: 6 cm	N/E: 4 cm Up: 8 cm	N/E: 5 cm Up: 10 cm
Maximum vector residuals (observed minus adjusted)	N/E: 1.5 cm Up: 3.0 cm	N/E: 2.0 cm Up: 4.0 cm	N/E: 2.5 cm Up: 5.0 cm

Key Takeaways

- Software developers are adopting GVX as a standard file format for GNSS vectors
- GVX facilitates uploading GNSS vectors to OPUS-Projects 5 for quality control, adjustment, and (optionally) submission to NGS for publication
- OPUS-Projects 5.1 is now live and freely available for use

Questions?

Please feel free to contact me with any questions.

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