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

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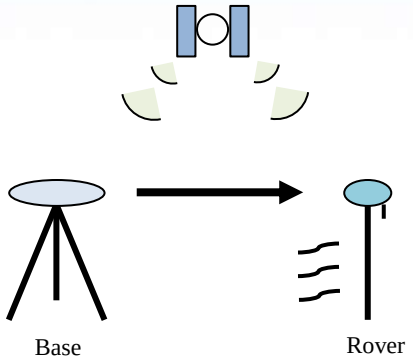
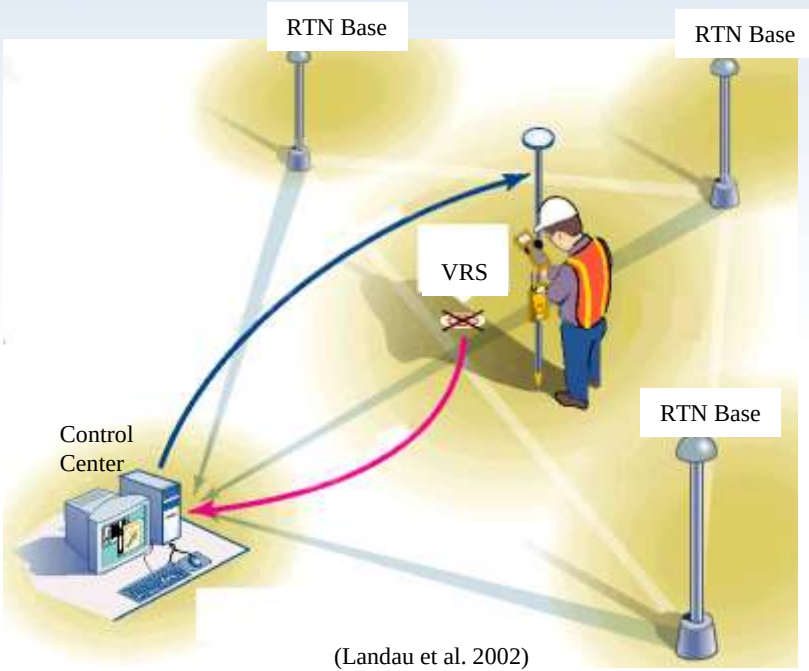
Real-Time Kinematic (RTK) Surveying

Single-base RTK

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

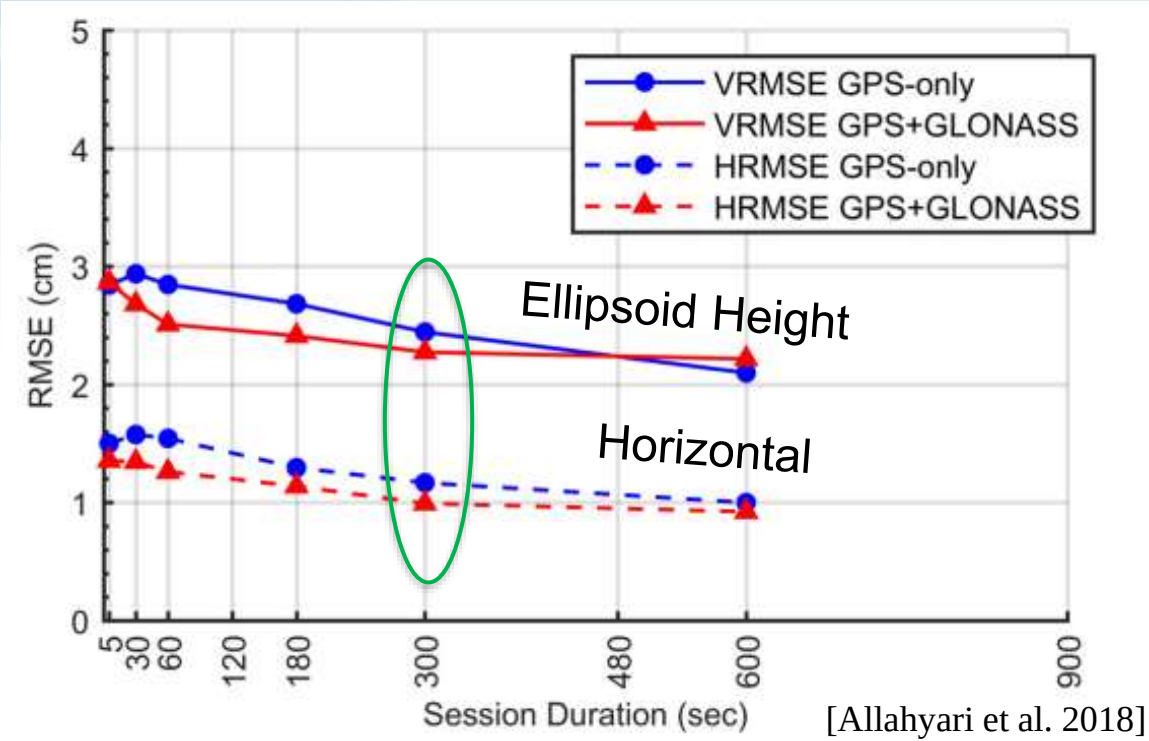


Network RTK



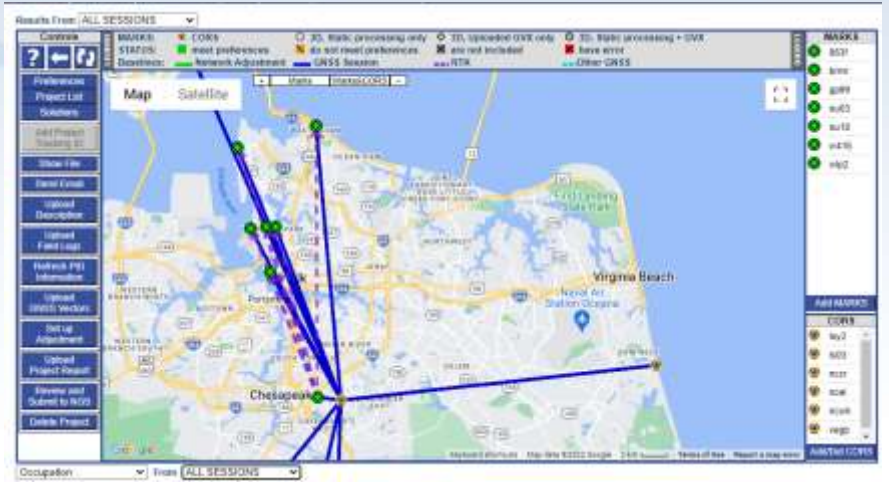
(Landau et al. 2002)

Empirical Evaluation of the Accuracy of Network RTK



[Allahyari et al. 2018]

What is OPUS-Projects?



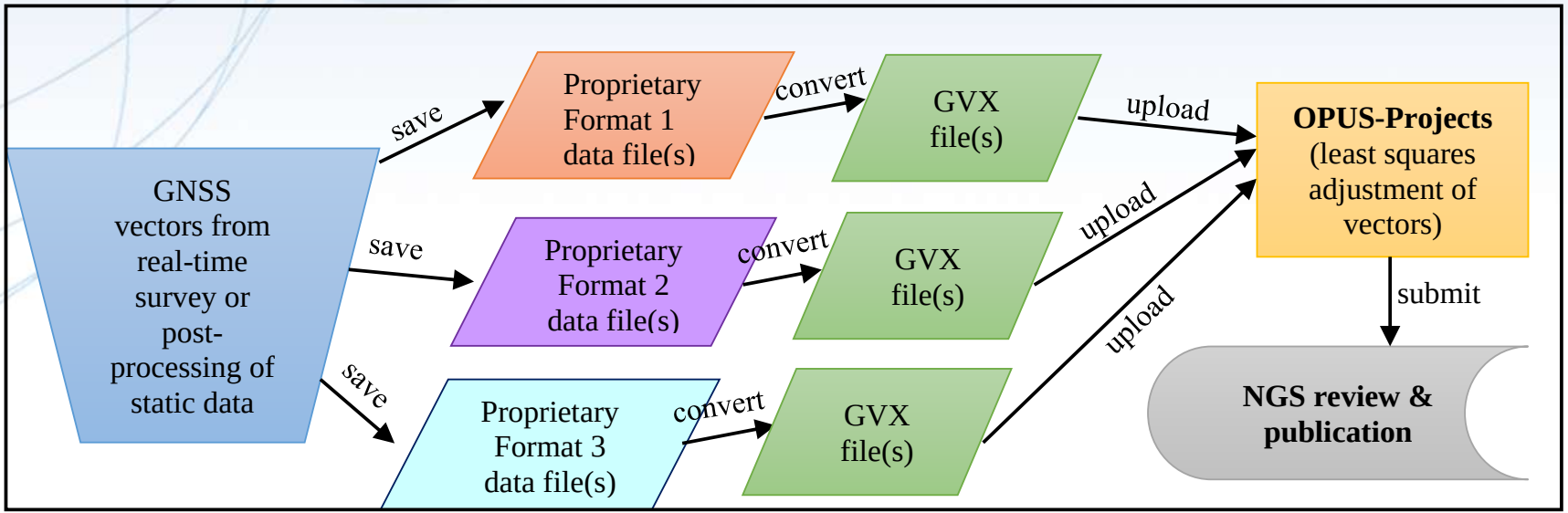
- Free, web-based application
- Upload static GPS data via OPUS-S
- Supports campaign-style surveys
- Custom survey network design
- Easy addition of CORS' data
- Data management and visualization aids
- Baseline processing using the PAGES engine
- Survey network adjustments
- Selection of reference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

Why use OPUS-Projects?

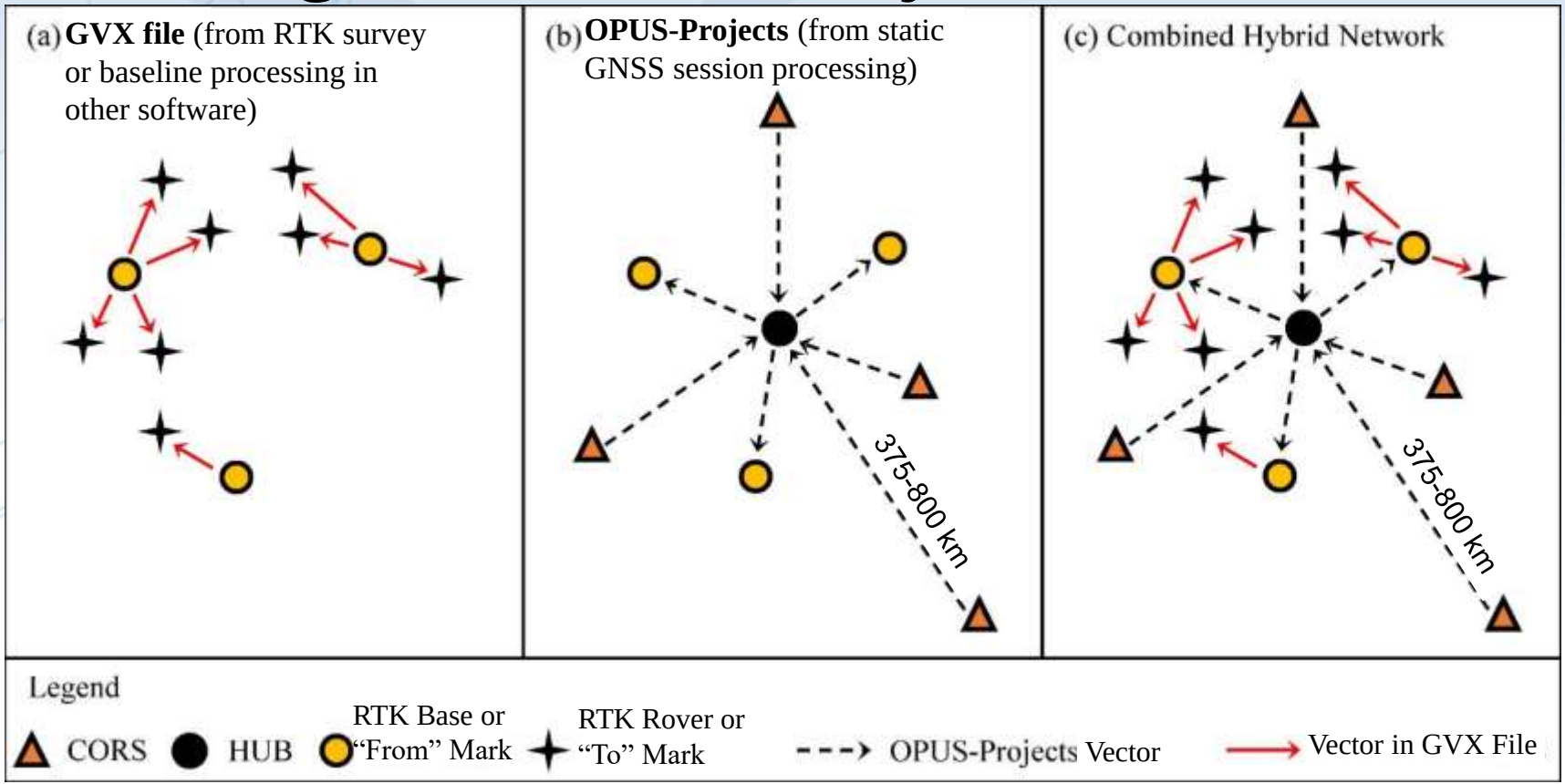
- **Organizes data** for multiple occupations on more than one mark
  - Campaign-style surveys for control
- Performs least squares **adjustments of control survey networks**
  - Estimate relative accuracy between marks
- Constrains NAVD 88 bench marks – **check/establish NAVD 88 heights**
- Ensures 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

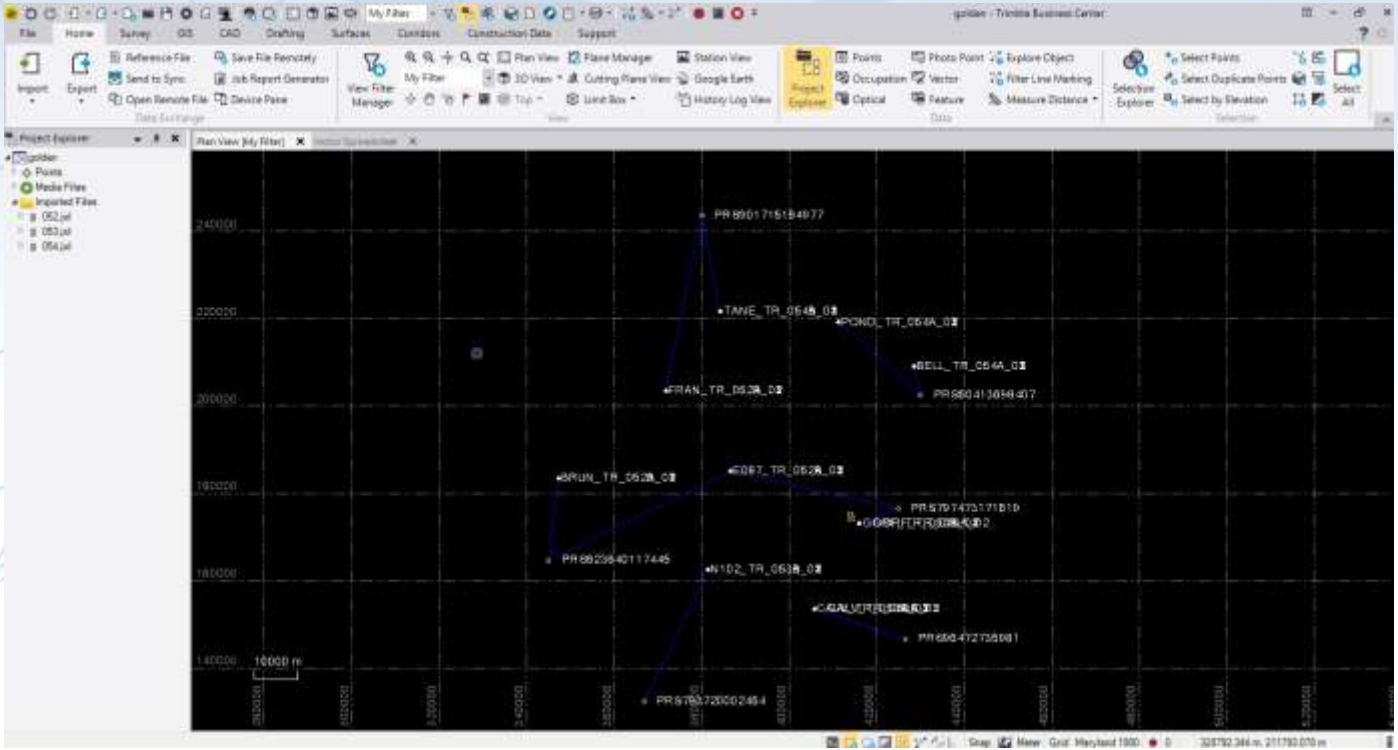


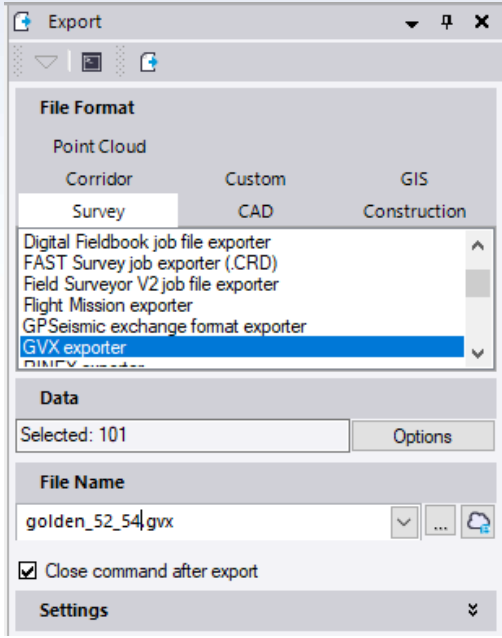
Design for OPUS-Projects and GVX



[Adapted from Weaver et al. 2018]

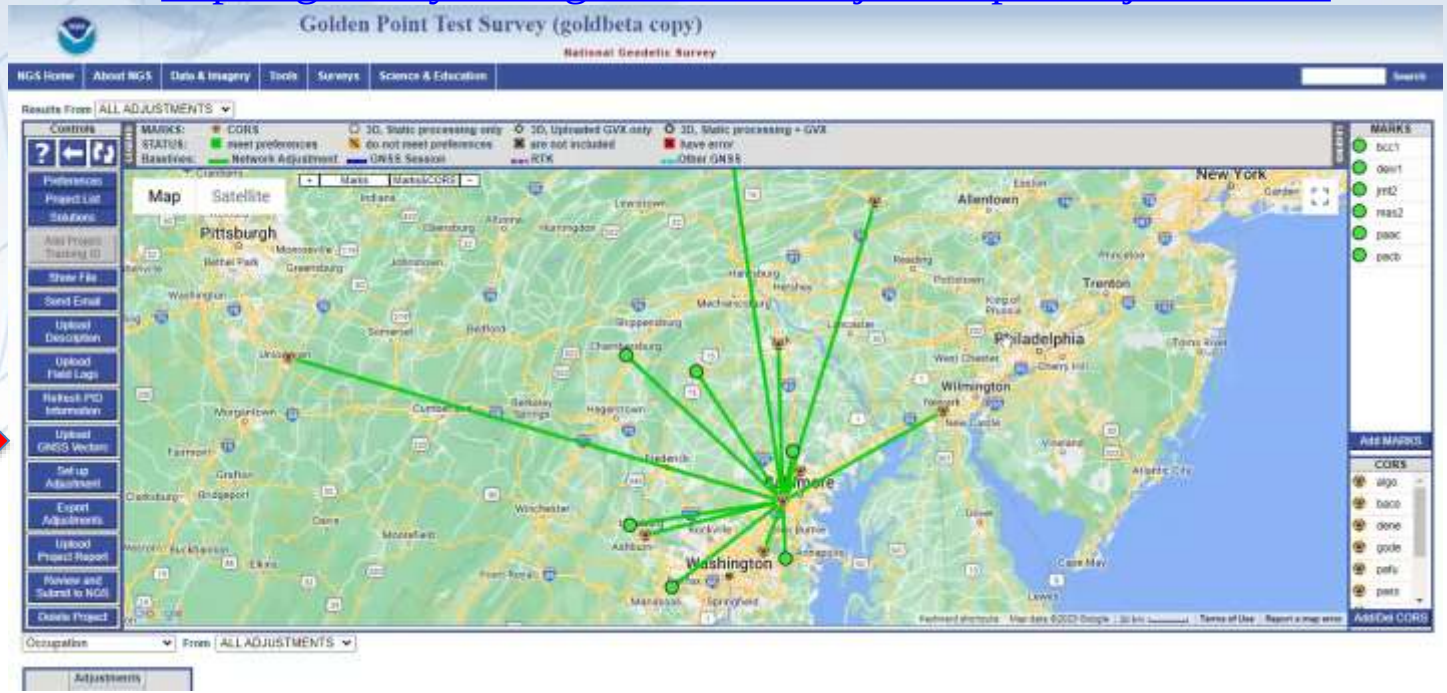
Example of GVX to OPUS-Projects





Example of GVX to OPUS-Projects (cont.)

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



Example of GVX to OPUS-Projects (cont.)

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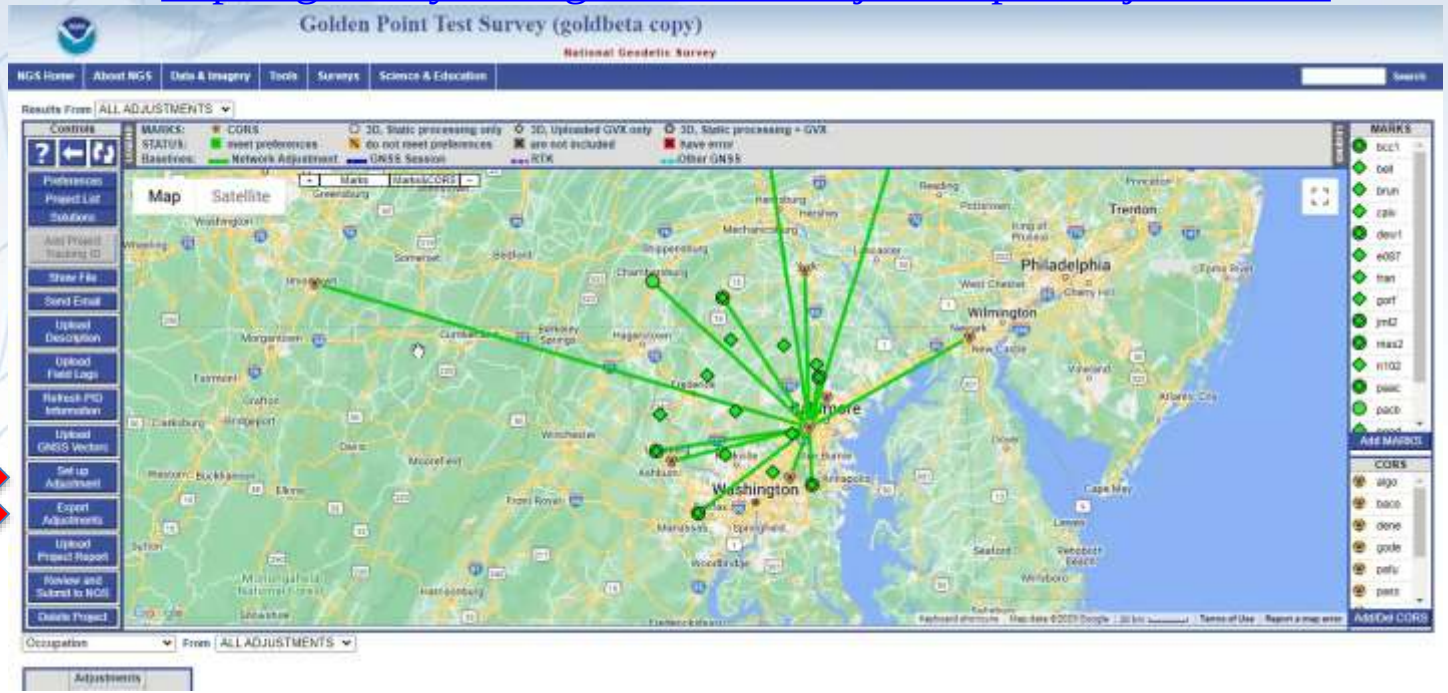


Status of GVX Exporters

Available Now

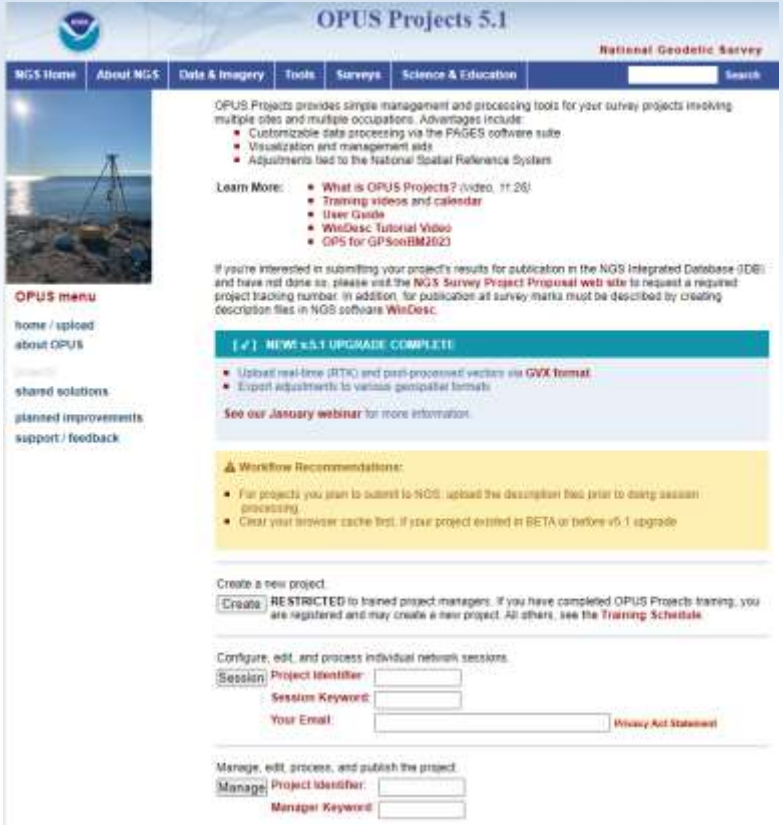
- Trimble Business Center (TBC) 5.80
- Carlson SurvCE7
- Topcon MAGNET Field v. 7.3
- Leica Infinity 4.0.0
- JAVAD in Triumph-LS device

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



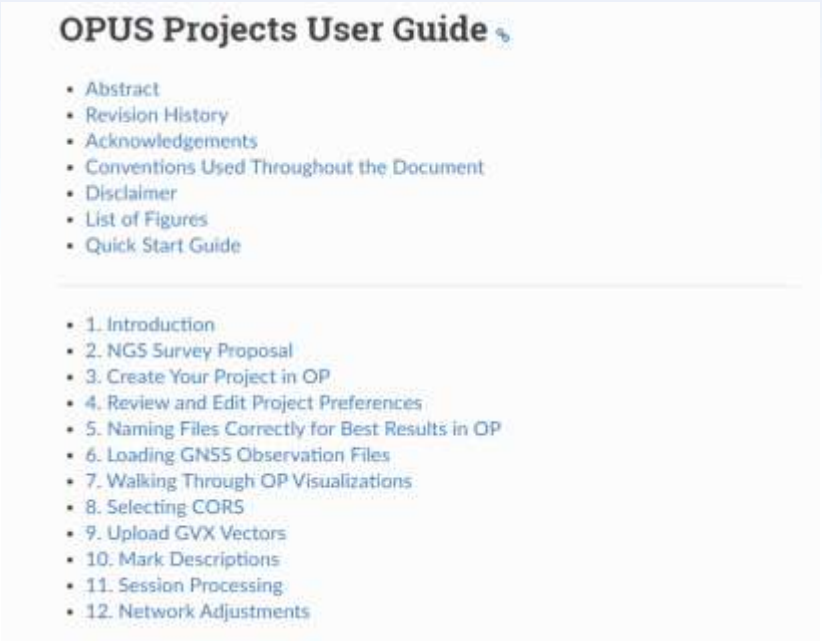
More Help with OPUS-Projects and GNSS Surveying

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



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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