Surveying the Alaskan Wilds: Geodetic Best Practices for Reliable Results

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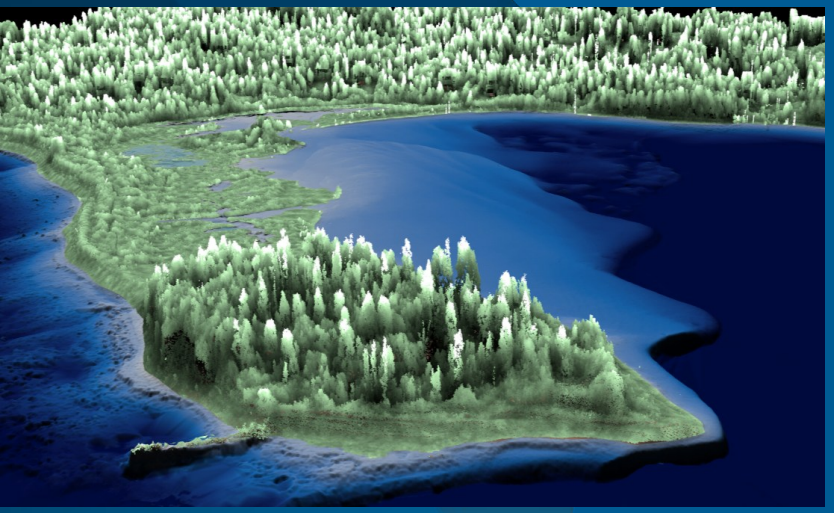
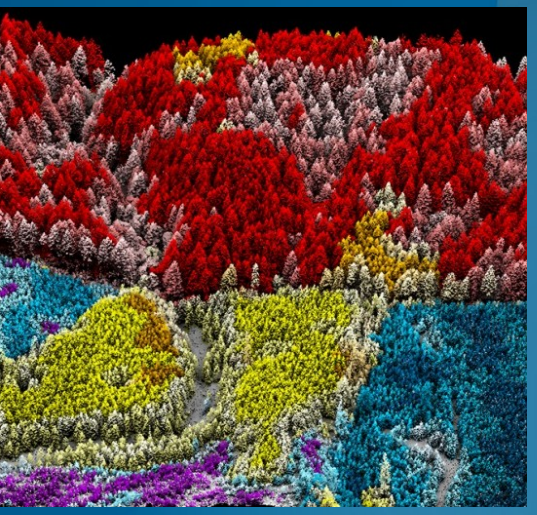
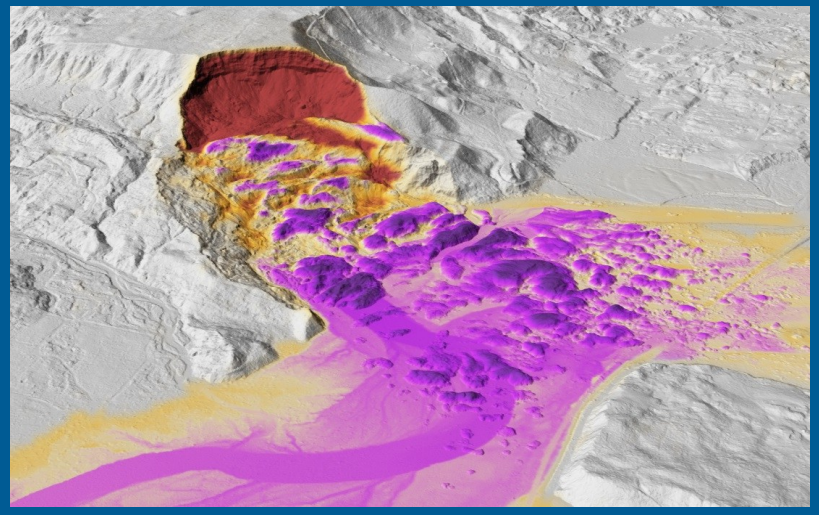
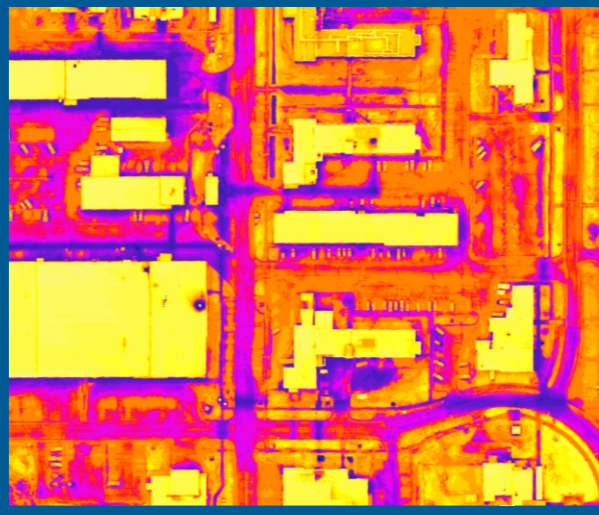


NV5 – Full Service Geospatial
We've got the whole alphabet







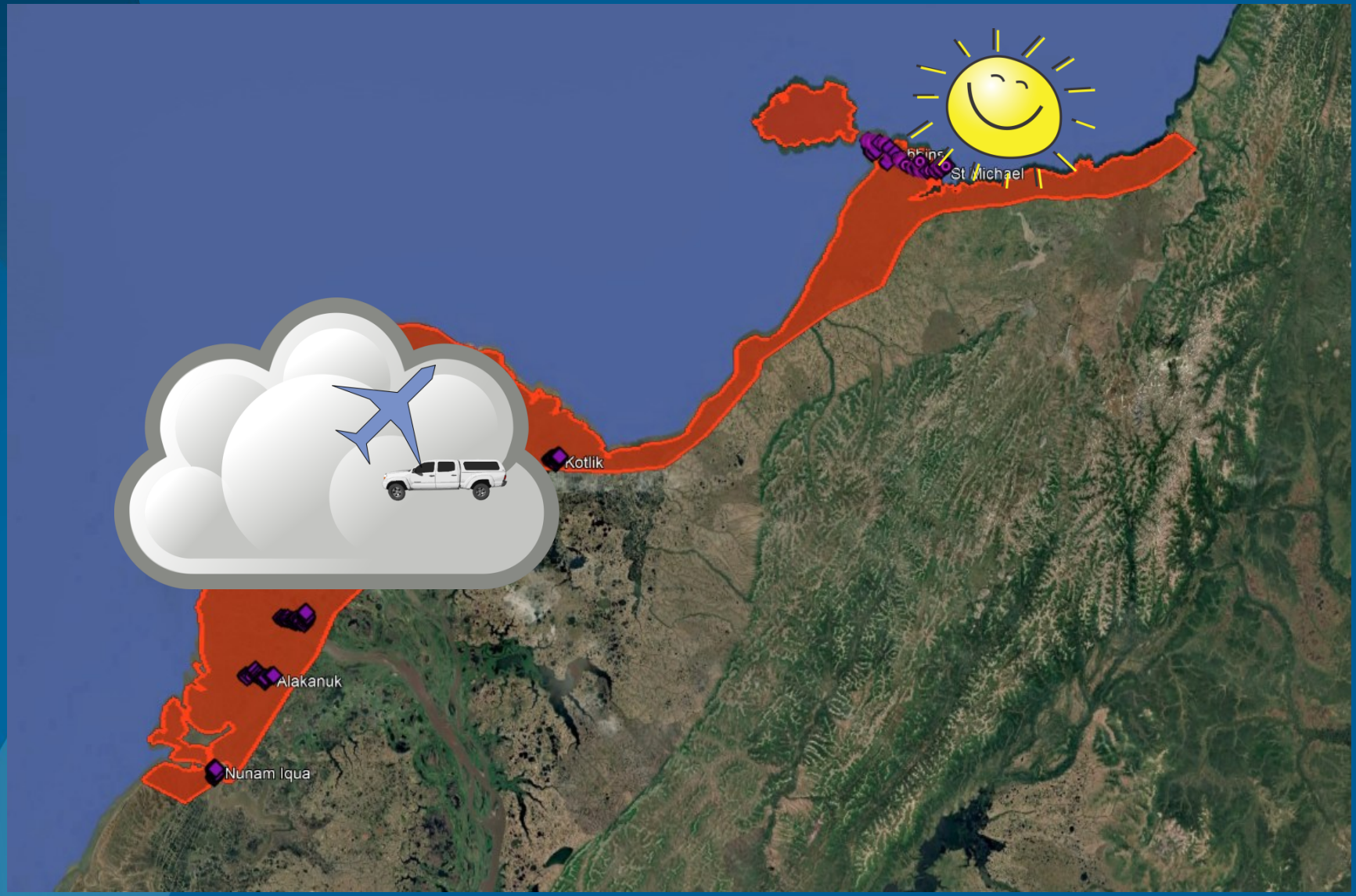
Overview

- Review study on viability of PPP SBET processing methods
- Lessons learned from flying without a base station
- The geodetic breadcrumb trail

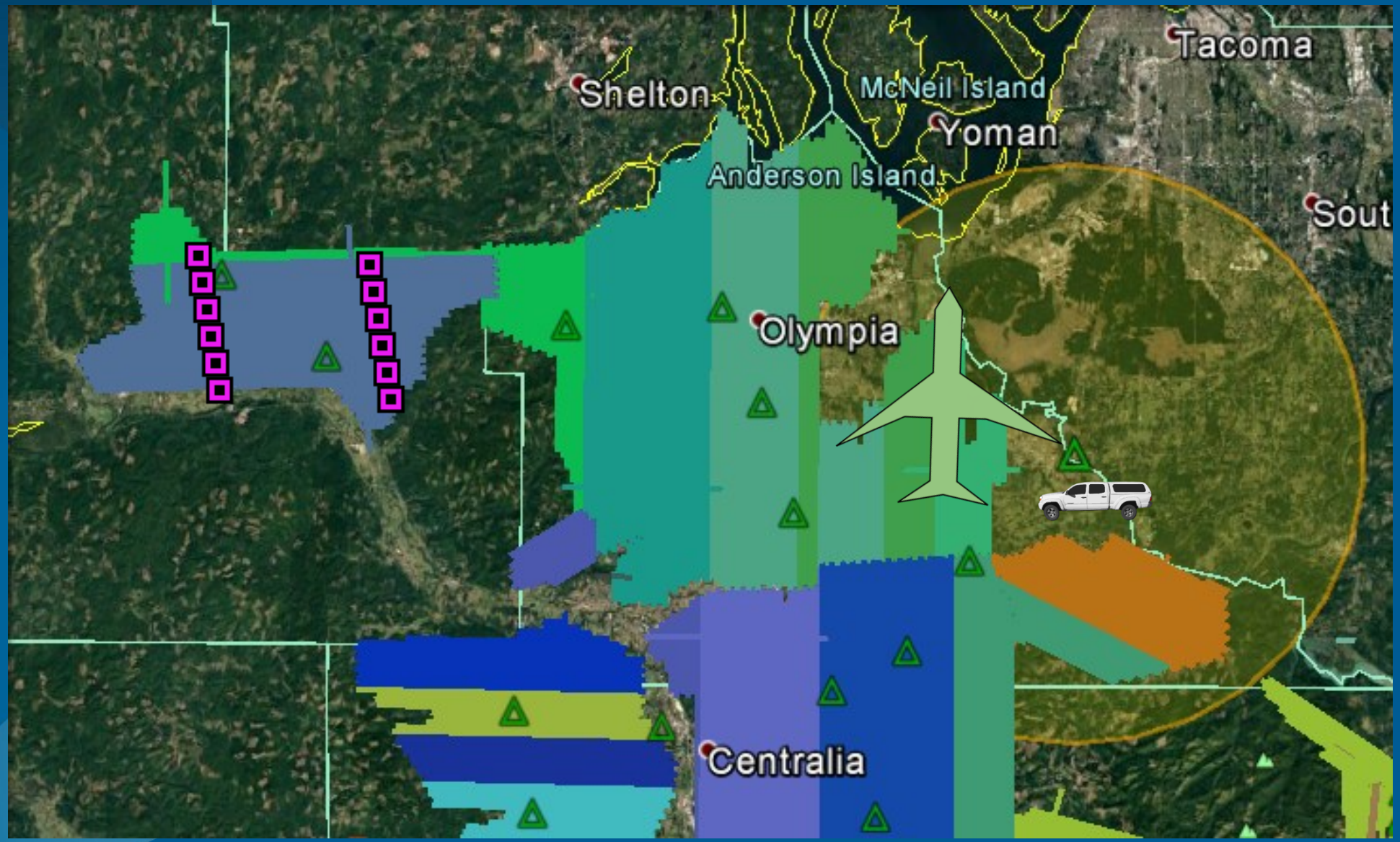
Precise Point Positioning (PPP) Processing Methods

Do they really work in Alaska?

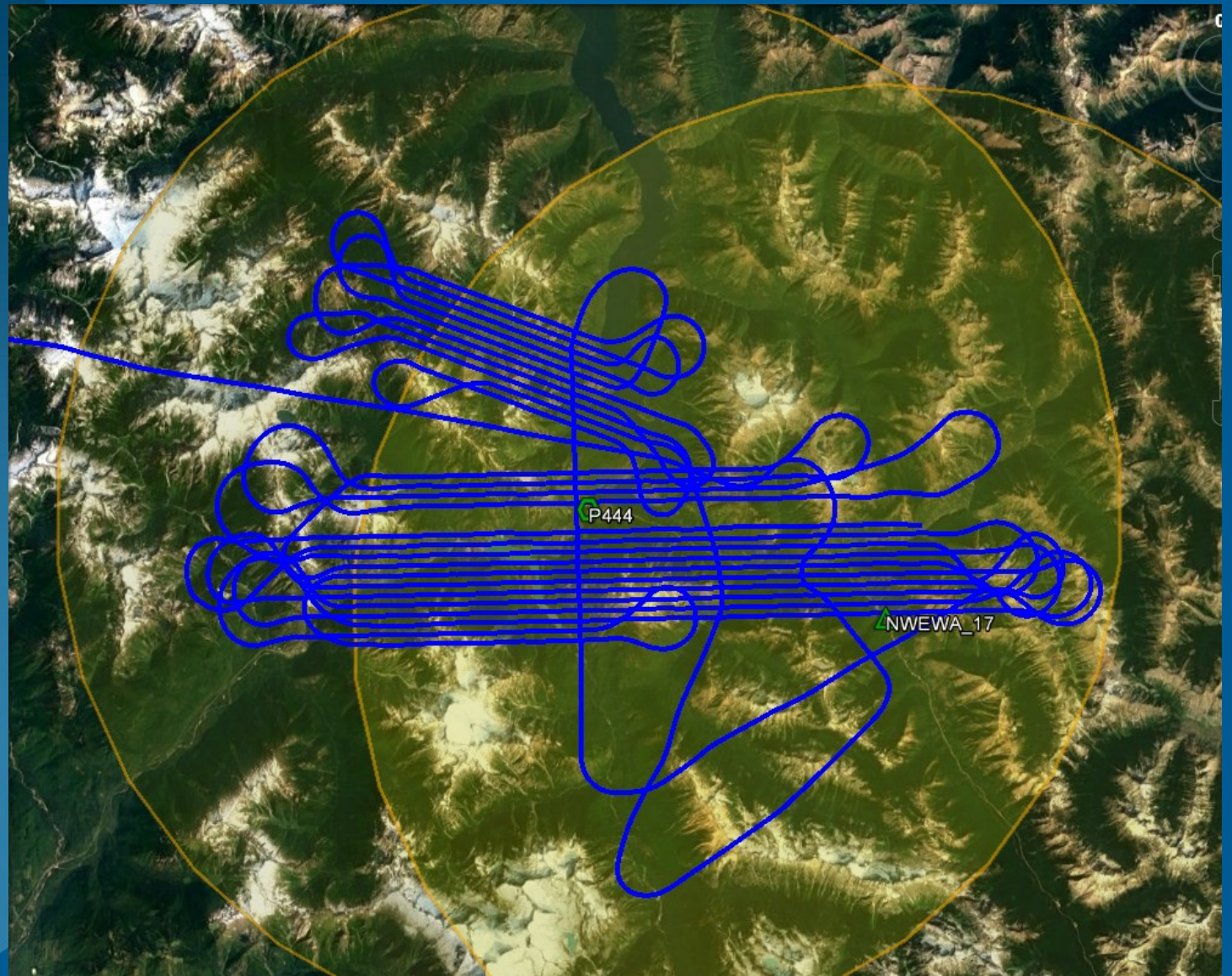
Agility decouples ground survey from airborne ops



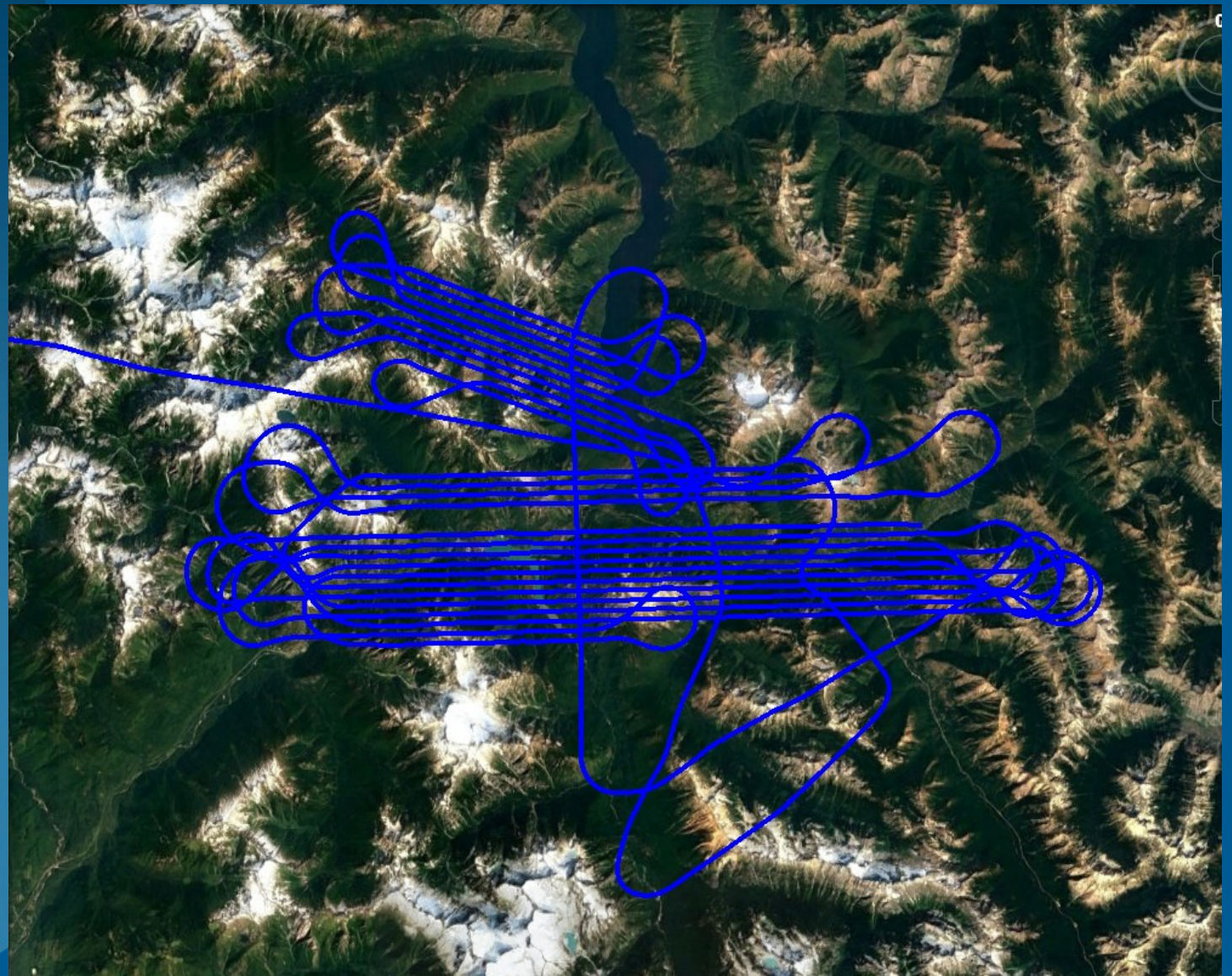
Flexibility means you can work where the work is



Base support has limited range



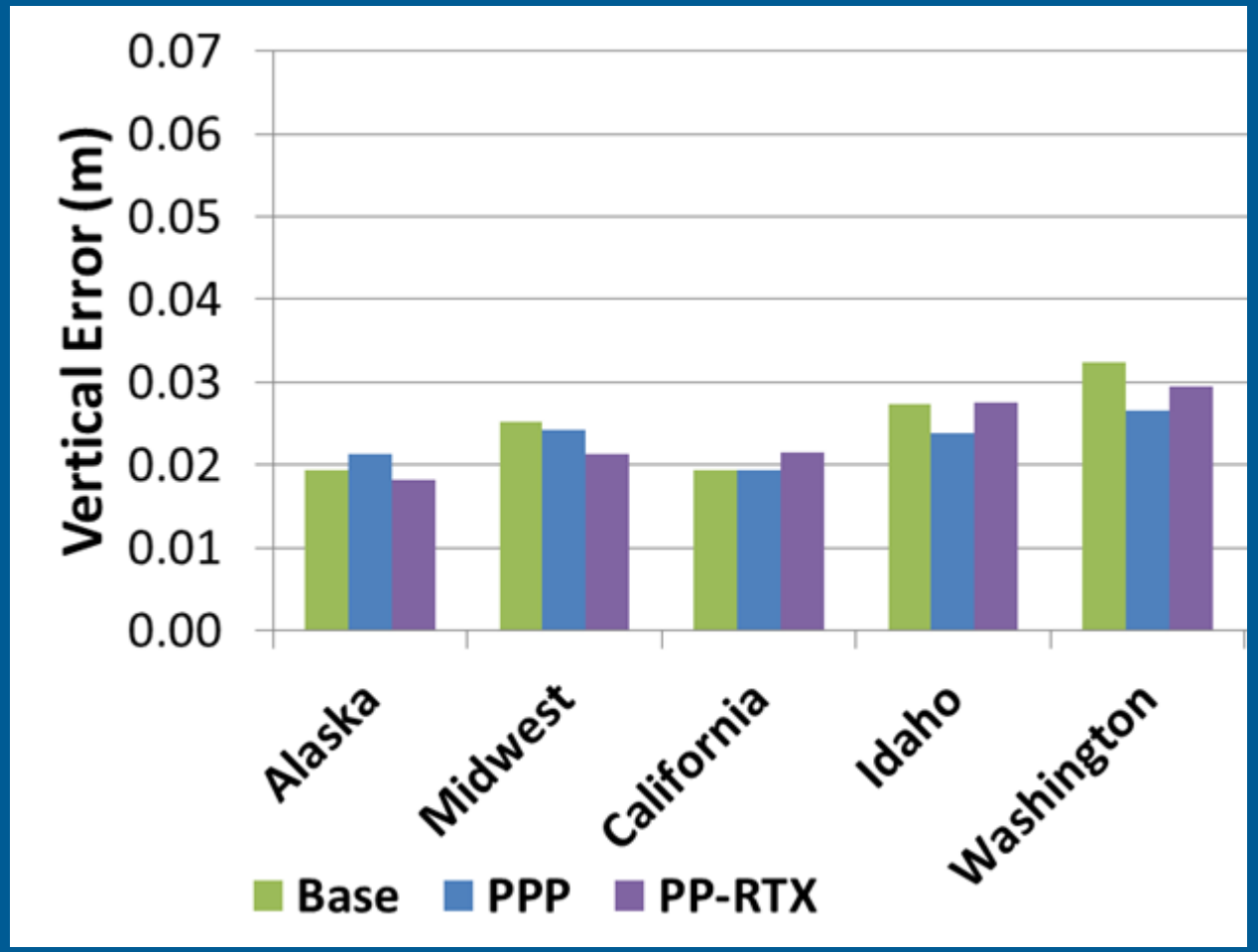
PPP has no such boundaries



Logistical Comparison

	Base Station (Multi/Single)	PP-RTX
Recommended Flight Time	20+ minutes	20-40+ minutes >5 minutes req'd
Claimed SBET Accuracy	3-10cm	3-15cm
Processing Delay	12-36 hours	1 hour
Availability	No restriction	2013+
Restrictions	30-100km range <20° bank angles if >30km	Uninterrupted GNSS <20° bank angles POSPac Only
Constellations	GPS, GLONASS, BEIDOU, QZSS	GPS, GLONASS, BEIDOU, QZSS

Accuracy By Region (1σ)

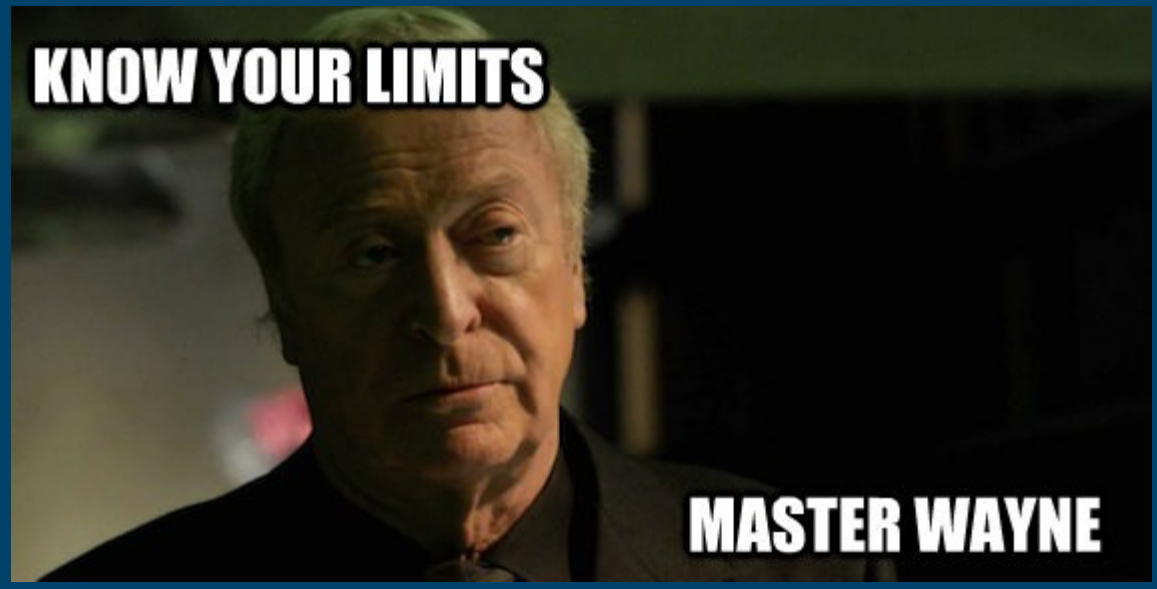


The Bottom Line

- PPP and PP-RTX CAN be viable options for tightly-coupled SBET processing
- PP-RTX was even slightly better in our tests
- PP-RTX results are more consistent than base support with long baselines
- PP-RTX much easier to automate, drastically reducing user error

Lessons learned from flying without a base station for the past 8 years

…MOST of the time…



Practical Limitations and Lessons Learned

- Know your datums
- Sensitivity to interruptions
- Availability at extreme latitudes
- Constellations and PDOP

Know your datums

- PPP methods typically output in WGS84, ITRF2000, ITRF2014, ITRF2020…
  - None of these datums are NAD83(2011)(2010.00)
  - Many WGS84/ITRF → NAD83 transformations in GIS software are no-op transformations
    - (multiply everything by 1)
  - Differences ~0.5-2.0m vertically, 1-3m horizontally in Alaska. At Dena'ina:
    - ΔX = +1.608m
    - ΔY = +0.301m
    - ΔZ = -0.347m
    - ITRF2000(4/9/2025, Epoch2025.27) → NAD83(2011)(2010.00) using HTDP

- Vertical control CAN correct this
- What about horizontal control? Nonexistent?
- What if you don't have control?

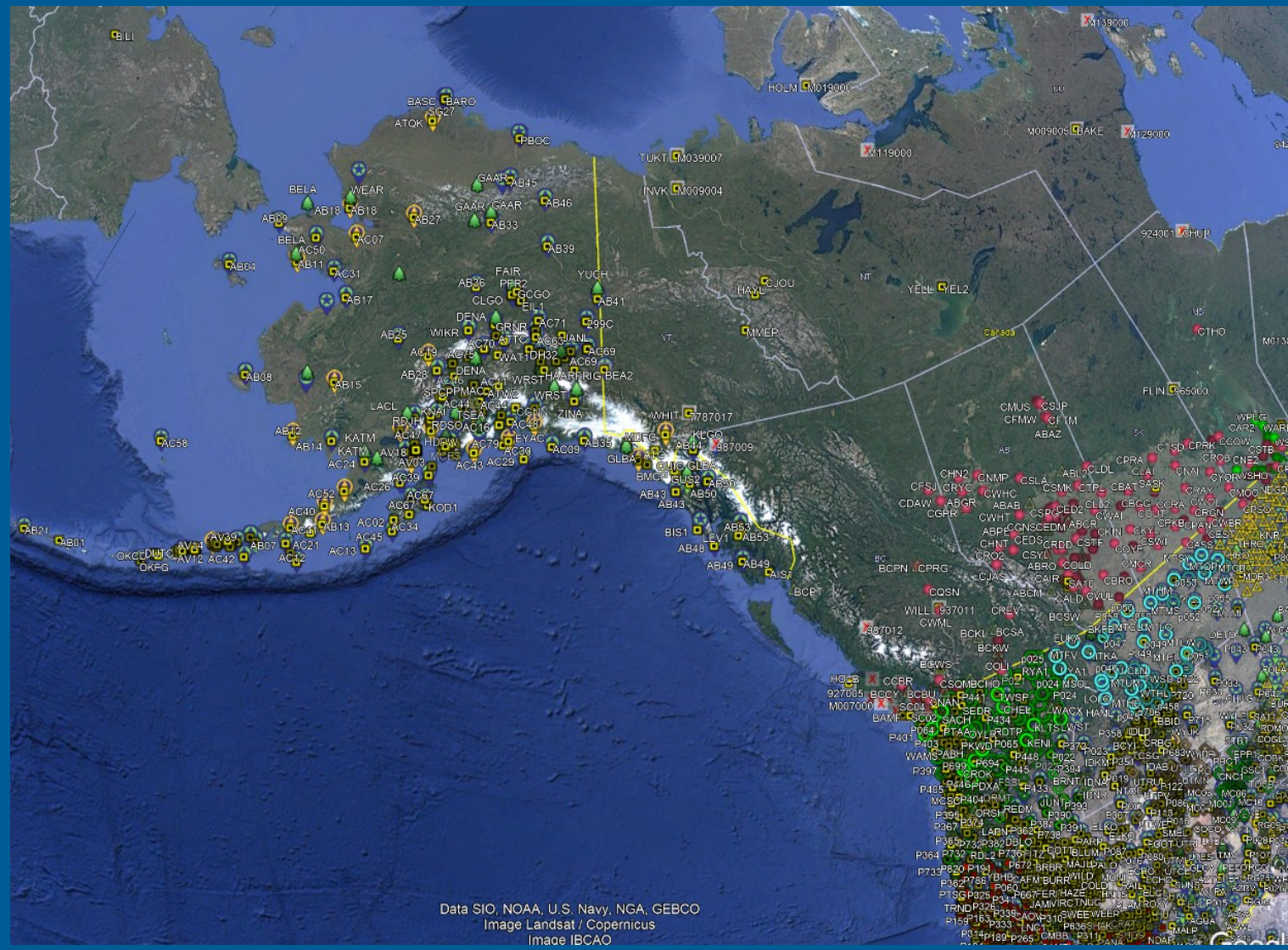
Sensitivity to interruptions

- PP-RTX had noticeably worse separation plots at northern latitudes above CONUS
  - Not equipment: the same aircraft and the same systems
  - Not crew: the same crew in a similar time period
  - Not execution: the same protocols and similar RPY plots
  - Not constellation: similar PDOP and sat-count
  - What's going on????

- The cause:
  - Uniquely challenging in northern latitudes, where satellites are lower on the horizon
  - Published restriction to PP-RTX is 20° max roll, but you can get away with 30° in Florida
  - They really mean it in Alaska → STRICT 20-25° max roll
- Other sources of interruptions
  - GNSS jamming tests near military bases → check FAA notices
  - Rare constellation issues → use Trimble Planning and/or base support for high-stakes collections

Other lessons learned

- PPP methods simply aren't always available
  - Maintain a map of CORS and RTNs worldwide
  - Worldwide networks save money
  - Engage local governments to discover new networks, especially internationally
  - Coverage often limited or nonexistent at extreme latitudes or remote countries
  - Learn about other nations' PPP services, such as Canada
- The Feds won't always be there… … … …will they?



The Geodetic Breadcrumb Trail

Designing datasets to prioritize repeatability, consistency, and maintainability

Datums

- Use modern, standard NGS datums to always align with NSRS
  - Future-proof against new datums, like NATRF2022/NAPGD2022
  - Align with future datasets
  - Standardized transformations
  - Standard techniques
  - Transform to local systems at the very end

- Avoid NAD83(HARN) specifically → use NAD83(CORS96) instead
  - Localized adjustments within HARN result in weird distortions for wide area projects
  - Documented instances of NCAT unexpectedly introducing 0.5’ vertical errors when transforming HARN to/from NAD83(2011)

- Avoid WGS84
  - Which one?
  - No two people mean the same thing when they say WGS84
  - Standard transformations in GIS are identity transformations

Ground surveying practices for large mapping efforts

- Planned redundancy
  - No one point becomes too important
  - Golden survey
- Never VRS: always tie to a base station so that you can document and defend datum differences relative to NSRS
  - This is especially important when using PPP methods for airborne processing
  - Can RTX be an exception?
- State-managed RTNs are your best friend
  - Let tying to the NSRS be their problem
  - Everyone in a region does their survey the same way
  - Federal instability
- Reduce opportunity for mistakes
  - Fixed-height rods
  - Geodetic-grade equipment
  - RTNs, not base stations

When surveys disagree

- When two surveys disagree… get a third survey
  - Lidar, ground survey, both?
  - No lidar survey is done until you revisit
  - Local vs regional accuracy

- What is a survey?
  - RTN network itself
  - Each lidar flightline
  - Ground survey
  - Multiple lidar collections over several years

- Is ground survey more reliable than lidar?

Thank you!

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