

National Park Service
U.S. Department of the Interior
Alaska Regional Office



Centimeter Precision Mapping via GNSS Base Stations

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Alaska Regional Office
NPS

Outline

- Objectives of our Deployment
- Progress
- Accessing the Signal
- Future Plans

Our Objectives



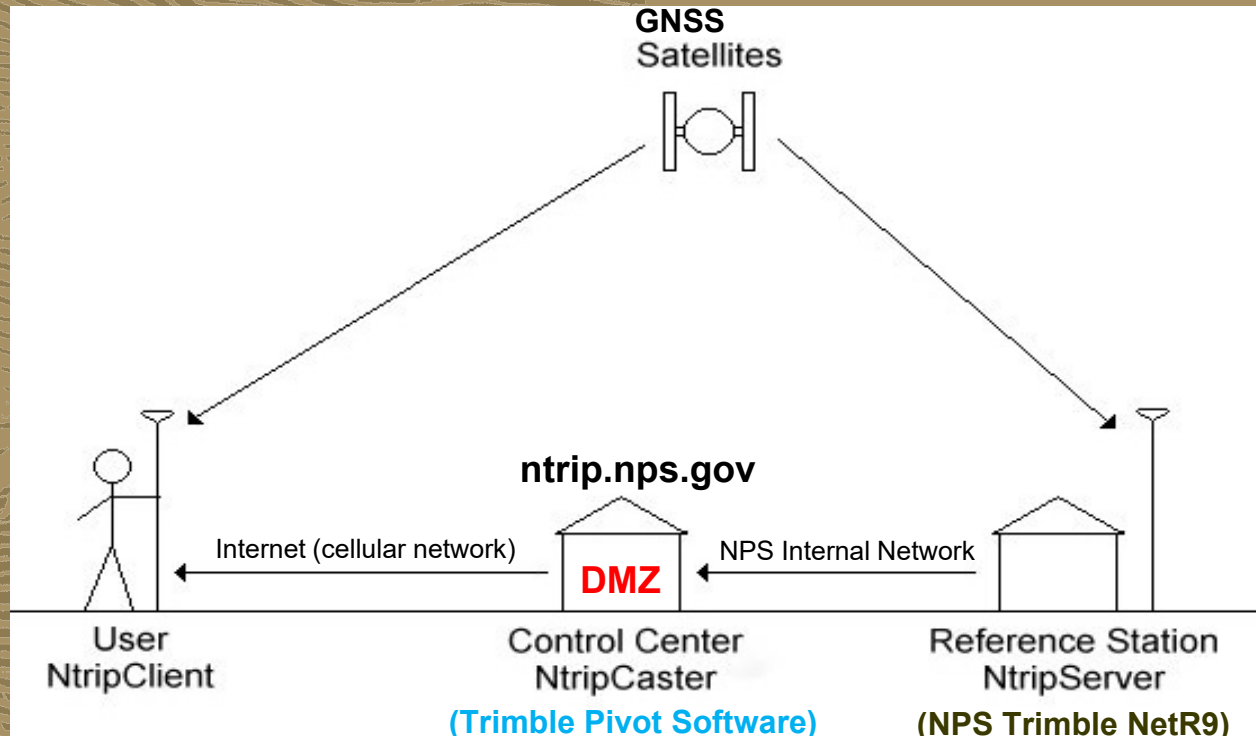
- Provide high precision GNSS data tied to NSRS for mapping and survey projects in Alaska Parks



- Park HQ's are little cities

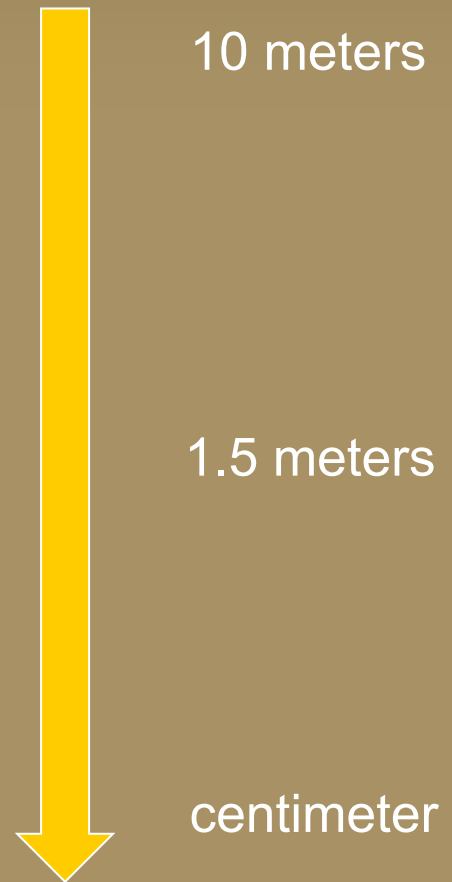
Our Stations use NTRIP Protocol

- Network Transfer of RTCM data over the internet



Satellite Errors Reduced by Differential Correction

- ✓ Ionosphere
- ✓ Troposphere
- ✓ Satellite Clock Errors
- ✓ Satellite Ephemeris Errors
- Multipath
- Receiver Noise



User Errors Reduced by Differential Correction

✓ DATUM

NAD83 (2011) 2010.0

The elusive cm
depends on the
datum

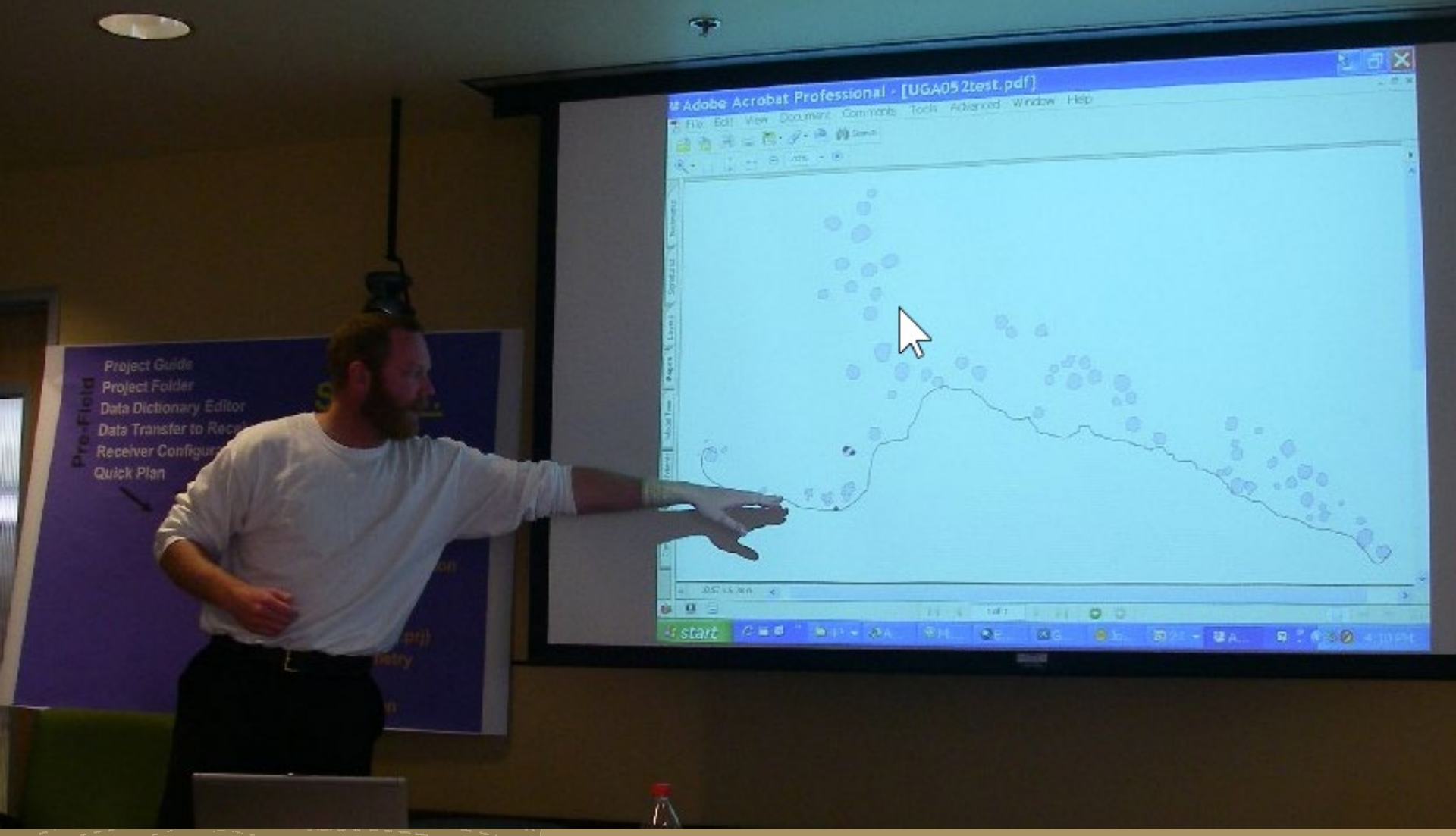


Nic Kinsman (AK NGS Advisor) ; Michael Dennis (NGS Geodesist);
Monica Youngman (former NGS GRAV-D Project Leader)

Alaskan Sized Issues!

- More important than ever Alaska GIS needs high precision to prepare for detecting change
- LiDAR, UAV's require highly accurate data from the ground (GCP's)
- Our data *must* be tied to NSRS
- Prepare for the new reference frames 2025

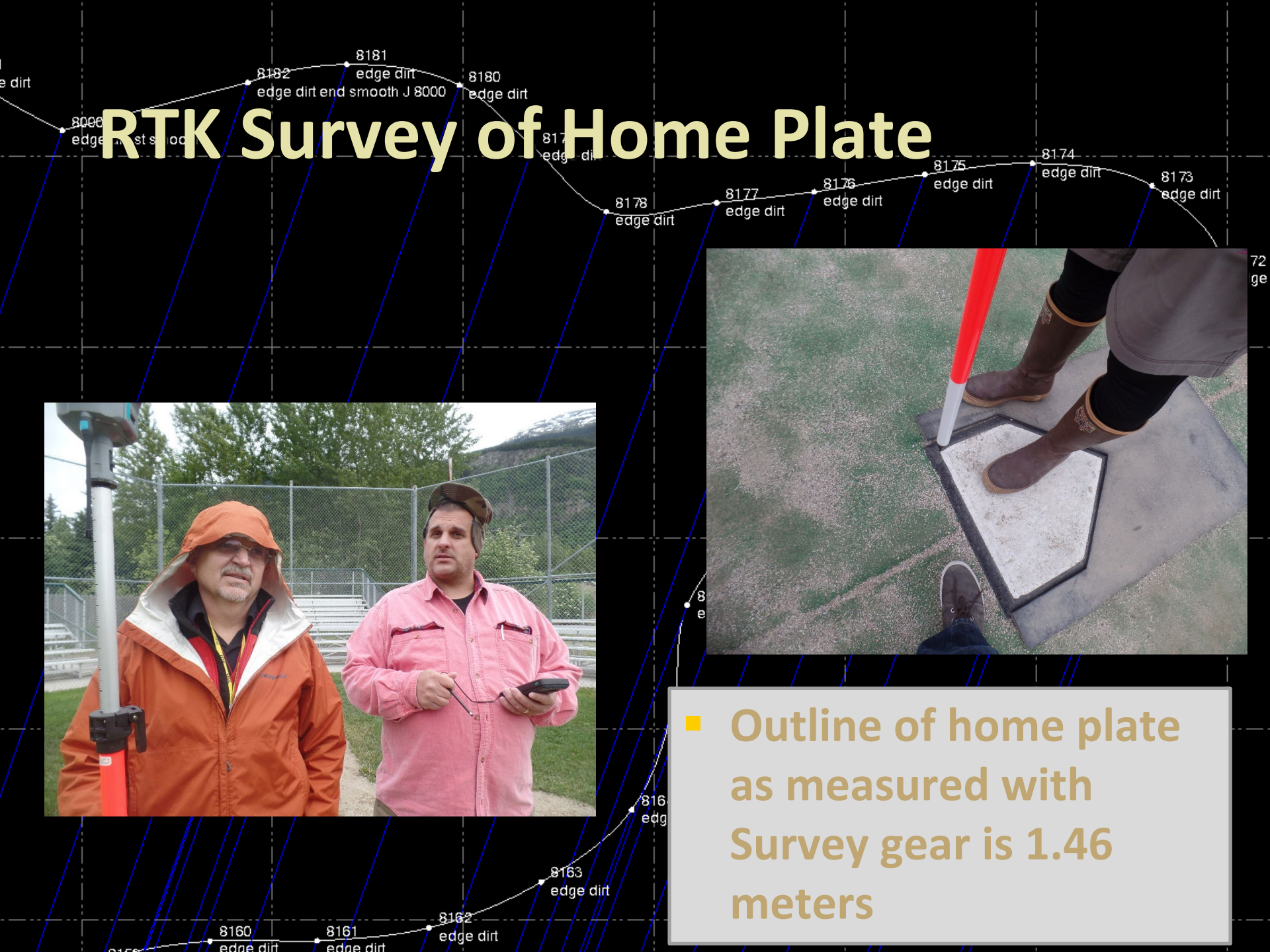
GIS User Community



RTK Survey of Home Plate



■ Outline of home plate as measured with Survey gear is 1.46 meters



Supports the NPS Mission

- Ties our field data to the National Spatial Reference System (CORS).
- Provides real time accuracy for park operations (facilities, engineering projects, coastal hazards).
- Reduces equipment costs.
- Reduces possibility of a very expensive equipment being stolen.
- Reduces costs by eliminating the need for costly UHF radios.
- Increases safety for NPS field personnel.
- Helps to assure that high-quality, standardized field data is collected.
- Supports reflectometry (water height measurement)
- UAS and other aerial platform support
- GNSS interference monitoring

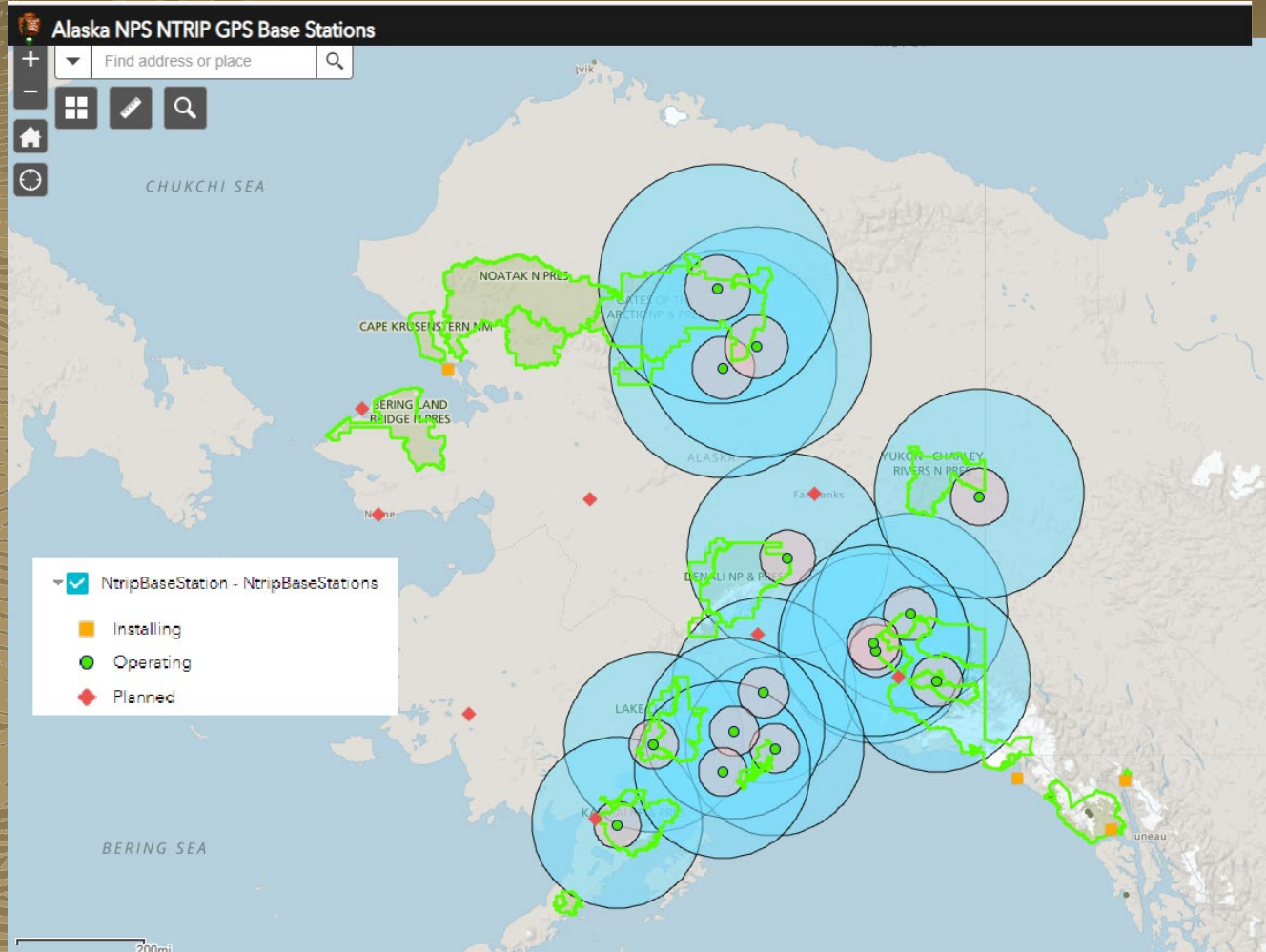


GNSS Base Stations

- NPS is deploying high accuracy base stations in Park / Refuge areas
- 16 operating
- 8 more planned



Map of Stations



[NPS NTRIP Base Stations \(arcgis.com\)](http://arcgis.com)

NPS Stations Details

- Single Base RTK Solutions
- 1 second stream
- MSM 4 message
- Address: ntrip.nps.gov
- Port 2101
- Username / PW – available on request

Base Station Identifiers

OPERATING AGENCY LEGEND

NPS

USFWS

CITY	PARK/REFUGE	ID	STATUS	Notes
Anaktuvak Pass	Gates of Arctic	GAA2	Operating	Summer only
Anchorage	Alaska Regional Office	AKRO	Operating	
Bettles	Gates of Arctic	GAAR	Operating	
Brooks Camp	Katmai	KATM	Operating	Summer only
Coldfoot	Gates of Arctic	GAA3	Operating	
Copper Center	Wrangell-St. Elias	WRST	Operating	
Denali Visitor Center	Denali	DVC1	Operating	
Eagle	Yukon-Charley	YUCH	Operating	
Gulkana	Wrangell-St. Elias	WRS3	Operating	
Gustavus	Glacier Bay	GLBX	Operating	
Homer	Alaska Maritime Refuge	AKMT	Operating	
McCarthy	Wrangell-St. Elias	WRS2	Operating	
Port Alsworth	Lake Clark	LACL	Operating	
Seward	Kenai Fjords	KEFJ	Operating	
Slana	Wrangell-St. Elias	WRS1	Operating	
Soldotna	Kenai National Wildlife Refuge	KNAI	Operating	

How Did We Get Here

- NPS acquired 122 Trimble NETR9 receivers from USCG (permanent loan)
- Intended to refurbish the now abandoned NDGPS system
- NPS received federal funding to upgrade receiver firmware software, update antennas and install kit



Homer Station – V. Error over Time



Graphs

Height 10-Second Positions [Hours]

Height: $\mu=40.271$, $\sigma=0.543$, $RMS=0.642$ [m]



Geodetics

- Can you trust the Base Station Coordinates?
 - Process 14-15 days of 24-hour files with OPUS
 - Calculate Average Lat/Long/Elevation with OPUS Accumulator (iGAGE)

RINEX_FN	RINEX_FN2	OverAll_RMS	OBS_Used	FIXED_AMB	LAT1_RMS	LON1_RMS	EL1_HGT	EL1_RMS
knai308a.21o	knai308a.21o	0.021	87%	74%	0.017	0.008	98.948	0.021
knai3120.21o	knai3120.21o	0.012	94%	94%	0.013	0.008	98.89	0.014
knai313a.21o	knai313a.21o	0.012	94%	92%	0.011	0.006	98.894	0.016
knai3140.21o	knai3140.21o	0.011	94%	85%	0.013	0.008	98.891	0.011
knai3150.21o	knai3150.21o	0.011	95%	93%	0.014	0.007	98.891	0.009
knai3210.21o	knai3210.21o	0.011	94%	87%	0.012	0.007	98.897	0.013
knai3230.21o	knai3230.21o	0.011	95%	95%	0.012	0.006	98.897	0.013
knai324a.21o	knai324a.21o	0.011	94%	86%	0.012	0.007	98.896	0.014
knai3250.21o	knai3250.21o	0.011	94%	85%	0.012	0.007	98.893	0.008

Avg: Overall RMS 0.0118
StdDev: 0.0026

Avg: Elevation RMS 0.0141
StdDev: 0.0037

How to Access the Data

- Realtime in the Field
- Post Processing

What you need for Real-time

- A dual frequency hi-precision receiver
 - E.g. Trimble R series, EOS Arrow series, Leica GG04, Topcon etc
- Cellular connection (a mobile hotspot)
 - Mifi – 2GIG monthly data plan
- Username/PW to lock on signal
 - Contact joel_cusick@nps.gov



Example: Trimble R series

- Internet
 - Sim Card or Mobile Hotspot

☰ Edit GNSS contact

Network connection Corrections

GNSS contact name

Contact type
Internet rover ▼

Network connection
Controller Internet ▶

☰ Edit GNSS contact

Network connection Corrections

NTRIP Configuration

Use RTX (Internet)
 No

Use NTRIP v1.0

Connect directly to Mountpoint
 No

NTRIP password

Use NTRIP
 Yes

Use proxy server
 No

NTRIP username

IP Address

IP Port



What you need for Post-Processing

- No Internet? No problem...Post Process!
 - Postprocess using files stored on UAF's Geophysical Institute servers
 - <ftp://gps.alaska.edu/pub/gpsdata/CoopCORS/2022/>
- Trimble Post Processing Pathways
 - Pathfinder Office
 - Trimble Positions
 - Trimble Business Center
 - Manual download

Example: Post Processing

- Trimble GeoExplorer
 - TerraSync
- Pathfinder Office
 - Stations begin with NPS



Base Station	L2	G	Distance	
NBACS, Woodstock		□	8338 km	^
NPS, (AKRO), Alaska Regional Office, Anchorage, AK		□	4637 km	
NPS, (DENA), Denali Visitor Center, Denali Park, AK		□	4921 km	
NPS, (GAAR), Bettles VC/Ranger Stn, Bettles, AK		□	5257 km	
NPS, (HALE), Haleakal VC/HQ, Makawao, HI		□	122 km	
NPS, (KAHO), Kaloko-Honokohau HQ, Kailua-Kona, HI		□	25 m	
NPS, (KATM), Main Maintenance Bldg, Brooks Camp, AK		□	4314 km	
NPS, (KEFJ), Kenai Fjords Visitor Center, Seward, AK		□	4520 km	
NPS, (LACL), Main Maintenance Bldg, Port Alsworth, AK		□	4500 km	
NPS, (PUHE), Pu'ukohola Heiau Visitor Center, Kawaihae, HI		□	43 km	▼

Example: Post Processing

■ Trimble Business Center



Add Predefined Reference Station Provider

Select one or more providers and press OK.

Provider	Code	Location	Public	Distance
NPS, (WRS3), NPS Hangar,	wrs3	Gulkana AK	<input checked="" type="checkbox"/>	0.5 KM
▶ NPS, (WRST), Park HQ, Co	wrst	Copper Center AK	<input checked="" type="checkbox"/>	16.0 KM
SOPAC, HAARP Daily	haar	Gakona AK	<input checked="" type="checkbox"/>	32.1 KM
SOPAC, Sourdough_AK200	ac77	Meiers Lake AK	<input checked="" type="checkbox"/>	59.4 KM
UNAVCO, Meiers Lake, AK	ac77	Meiers Lake AK	<input checked="" type="checkbox"/>	59.4 KM
SOPAC, MtnDrumVP_AK20	ac64	Chistochina AK	<input checked="" type="checkbox"/>	86.2 KM
UNAVCO, N/A, Alaska (ac6	ac64	Chistochina AK	<input checked="" type="checkbox"/>	86.2 KM
NPS, (WRS4), Ranger Stati	wrs4	Slana AK	<input checked="" type="checkbox"/>	98.1 KM
CORS, DenliHwy32AK2004	ac62	Paxson AK	<input checked="" type="checkbox"/>	112.4 KM
SOPAC, DenliHwy32AK200	ac62	Paxson AK	<input checked="" type="checkbox"/>	112.4 KM
UNAVCO, Paxson, Alaska (ac62	Paxson AK	<input checked="" type="checkbox"/>	112.4 KM
UNAVCO, Chickaloon, AK (ac11	Chickaloon AK	<input checked="" type="checkbox"/>	155.6 KM

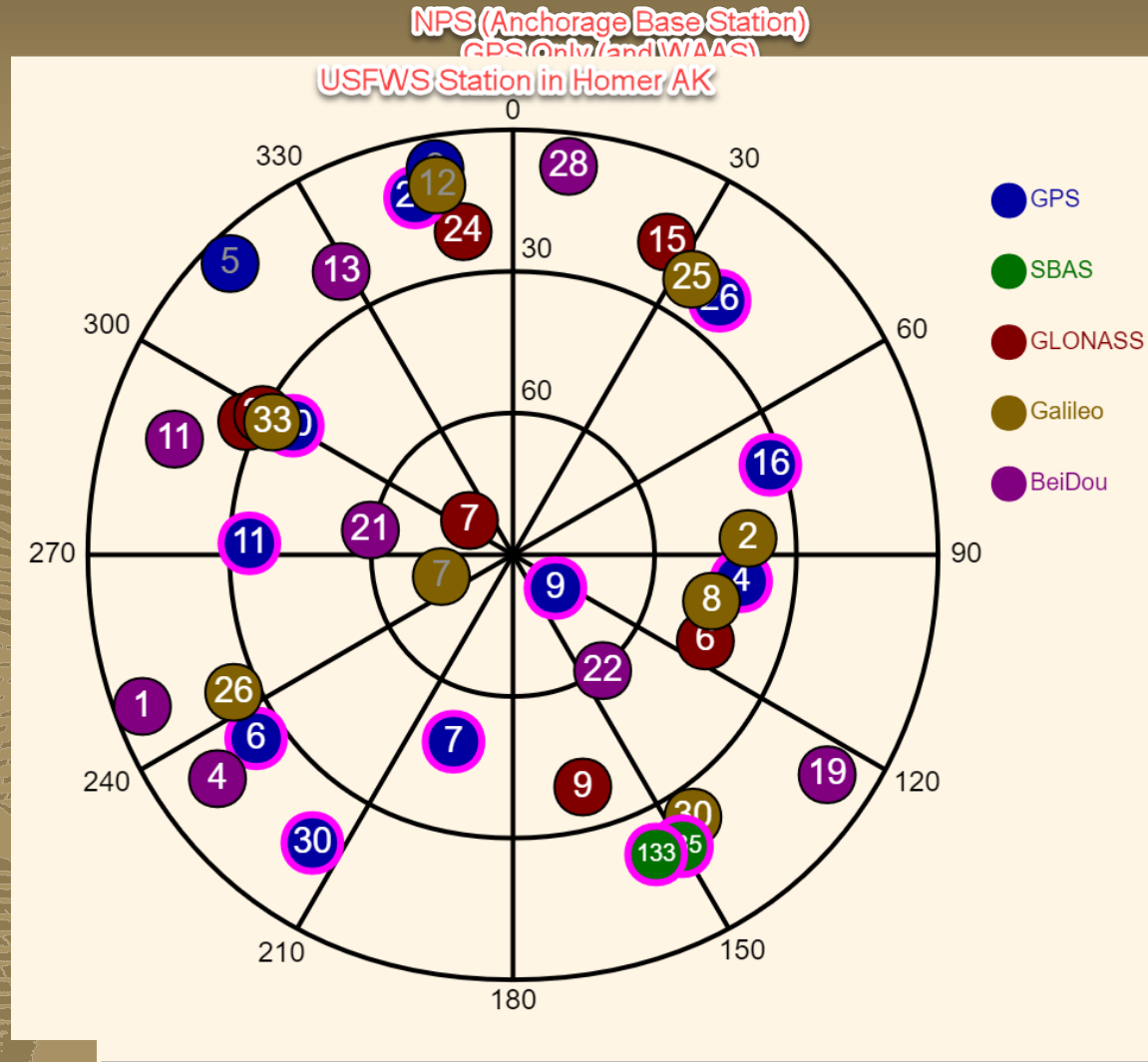
OK Cancel

Steps You Can Do Now

- Lock on to our station and evaluate
- Modernize Your Receiver
- Put the Antenna on a POLE!
- Occupy a Survey Mark in NAD83 (2011) and evaluate your workflow
- Precisely define your GIS features NOW!
 - Defining as “NAD83” is not right
 - You haven’t been in “NAD83” since 1986!

Modernize Your Receivers

- GPS only – old school
- ~32 Satellites in View
- Modernize your “GPS” fleet



Two Alaska Base Stations Satellite Views, 1:30pm Local time, 11/10/2022

Planned Installations 2023

OPERATING AGENCY LEGEND

NPS

USFWS

- 8 More Sites Across Alaska
- DOI partners preferred

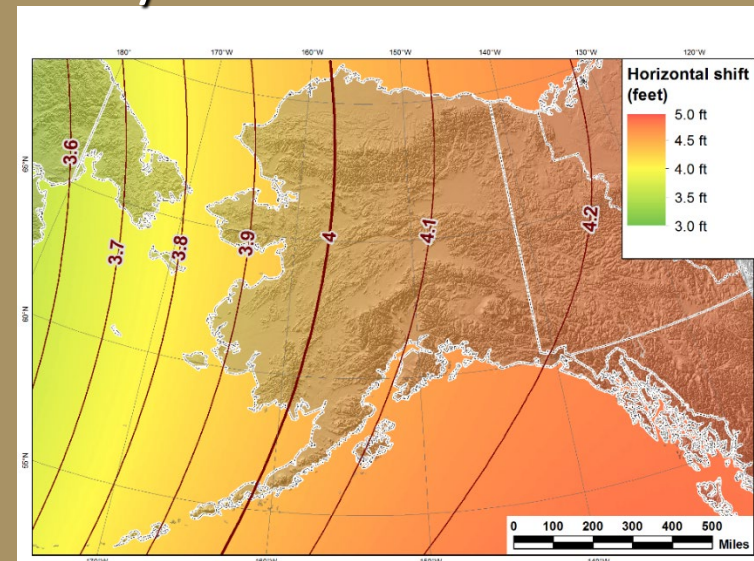
CITY	PARK/REFUGE	ID	STATUS
Bethel	Yukon Delta Refuge		Planned
Galena	Koyukuk National Wildlife Refuge		Planned
Kodiak	Kodiak Wildlife Refuge		Planned
Kotzebue	Western Arctic Parklands		Planned
Nome	Bering Land Bridge		Planned
Skagway	Klondike Gold Rush		Planned
Yakutat	Glacier Bay		Planned
Talkeetna	Denali		Planned

- Shishmaref Partner?

Summary

- Base Station deployments serve the National Park Service Mission for high precision mapping/surveying projects in and around NPS facilities
- Signal in real-time does require internet in the field
- Planning today for better internet in the future
- Using our stations is good practice for tying into ACORN
- Data is tied to the National Spatial Reference System NAD83(2011) today
- Prepare today for the new datum (2025)

Datum Shift Coming in 2025



Questions



EXPERIENCE YOUR AMERICA