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❖ Applications
Bringing It All Together

ASTRA Realtime Space Weather Operations

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ASTRA

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http://astraspace.net/news-2/cases-alaska/

ASTRA Space Weather Monitor

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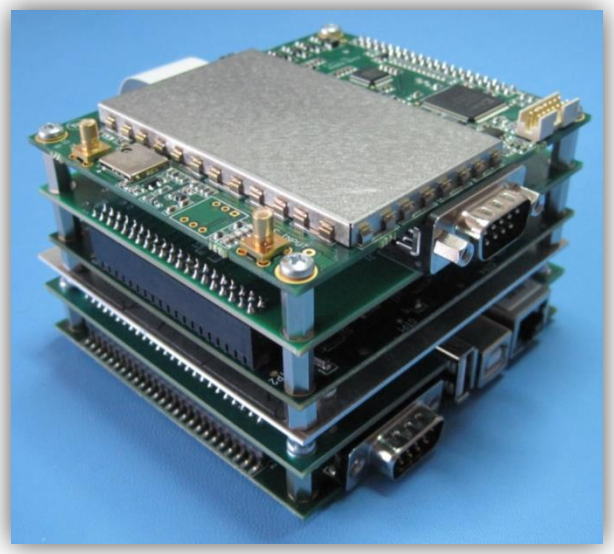
Monitoring Space Weather Effects on GPS



Two Form Factors

Standard Desktop Model
Dimensions: 9”x7”x1.75”
Power: 6W

Cubesat Model (10 cm x 10 cm x 8 cm)

‘CASES’ SM-211 GPS Receiver

ASTRA's Space Weather Monitor

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CASES On-Board Data Products

	Per Channel **High Rate**	Per Channel **Low Rate**	**Scintillation Params**	**Navigation Solution**
Default Rate	**100 Hz**	**1 Second**	**100 Second**	**1 Second**
Configurable Rate?	**Yes 50 or 100 Hz**	**Yes >= 1 Second**	**Yes**	**Yes >= 1 Second**
Parameters	I's, Q's, Integrated Carrier Phase	Pseudorange-based **TEC**	**S4, σ_Φ, T_0**	**Position Velocity**
		Phase-based **Delta-TEC**	Scint. Power Ratio	
		Integrated Carrier Phase		
		Pseudorange		
		Doppler Frequency		

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Receivers already deployed globally

SOUTH POLE ♥ ♥ ♥ ♥

Refresh

Connected CASES Receivers

Select All	Name	Last Updated (Min Ago)					WAN IP	LAN IP	Uptime (DDD:HH:MM)	L1 / L2	Lat	Lon	
		IP	LR Data	HR Data	LR Proc	HR Proc							
A:	GRID003	0	0	117	2	114	190.116.16.132	10.10.12.121	023:01:47	10 / 3	-11.952	-76.876	Details
B:	GRID004	2	0	N/A	2	536	71.211.160.47	192.168.50.104	023:01:47	7 / 2	40.002	-105.137	Details
C:	GRID007	8	0	N/A	2	1902	71.211.160.47	192.168.50.107	023:01:47	8 / 3	40.002	-105.137	Details
D:	GRID017	2	0	147	2	144	66.194.178.210	192.168.6.210	023:01:47	12 / 2	42.719	-73.752	Details

Upload DSP Image | Hard Reset | System Manager | Disconnect
Upload DSP Config | Soft Reset | Plot Manager
Upload SBC Config

Effects of Space Weather on GPS

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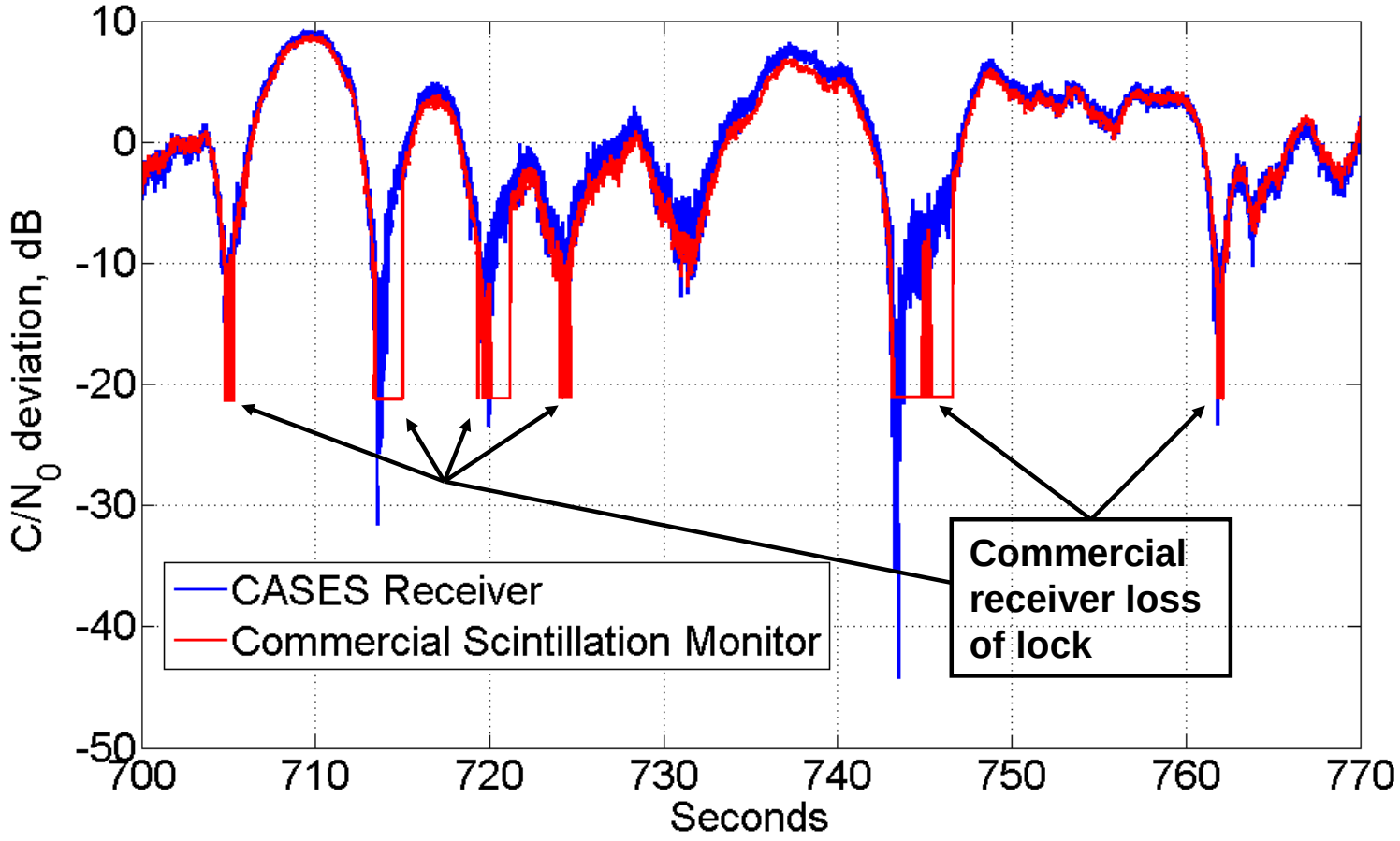
ASTRA's CASES Receiver Tracks Through Weak Signals better than Competitors



The CASES specialized tracking loop (blue trace) allows robust tracking during scintillations versus other receivers using fixed bandwidth PLL (red trace) which lose lock.

Data collected from Jicamarca, Peru at magnetic equator.

CASES ALASKA CHAIN

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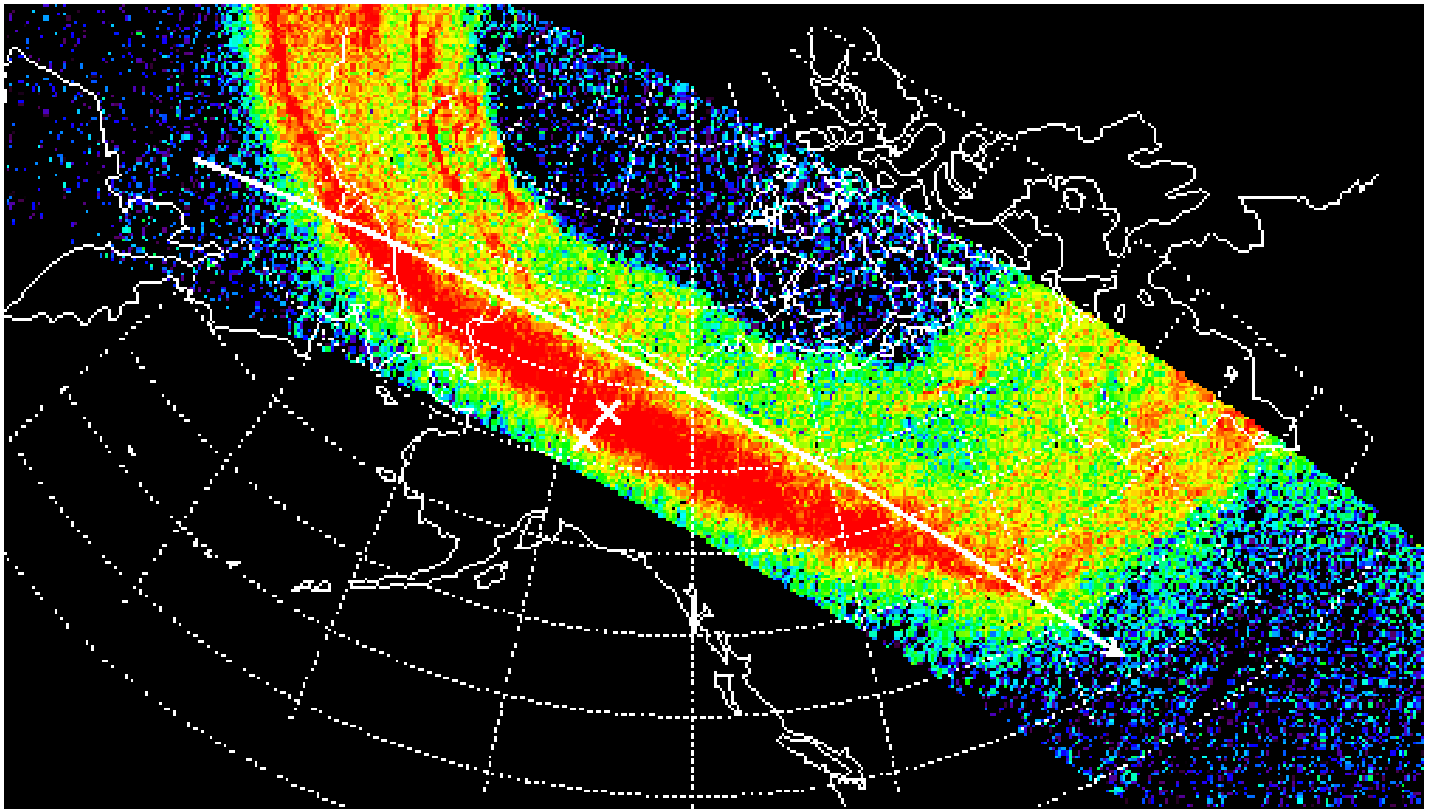
- CASES SM-211 dual frequency (L1/L2C) GPS receivers

SALIENT FEATURES

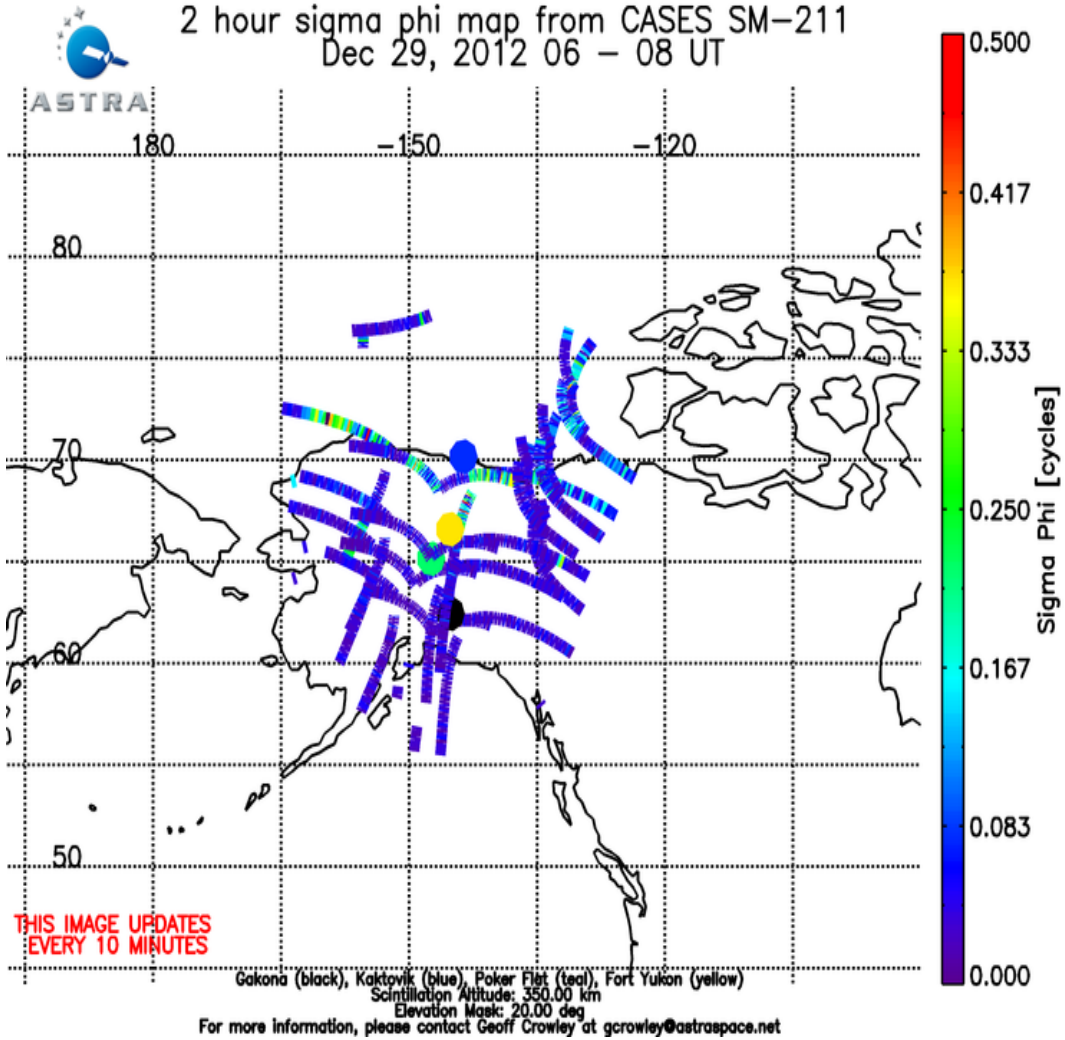
- Software radio architecture for remote configurability
- Innovative algorithms that can track through scintillations
- Specialized tracking loops for operation in weak signal conditions and scintillating environment
- Flexible communications interfaces
- Low cost

Ionospheric Space Weather: High-latitudes

- Aurora – caused by particles entering the ionosphere
- UV Remote Sensing from GUVI instrument
- Effect: OTH Radar, GPS Nav

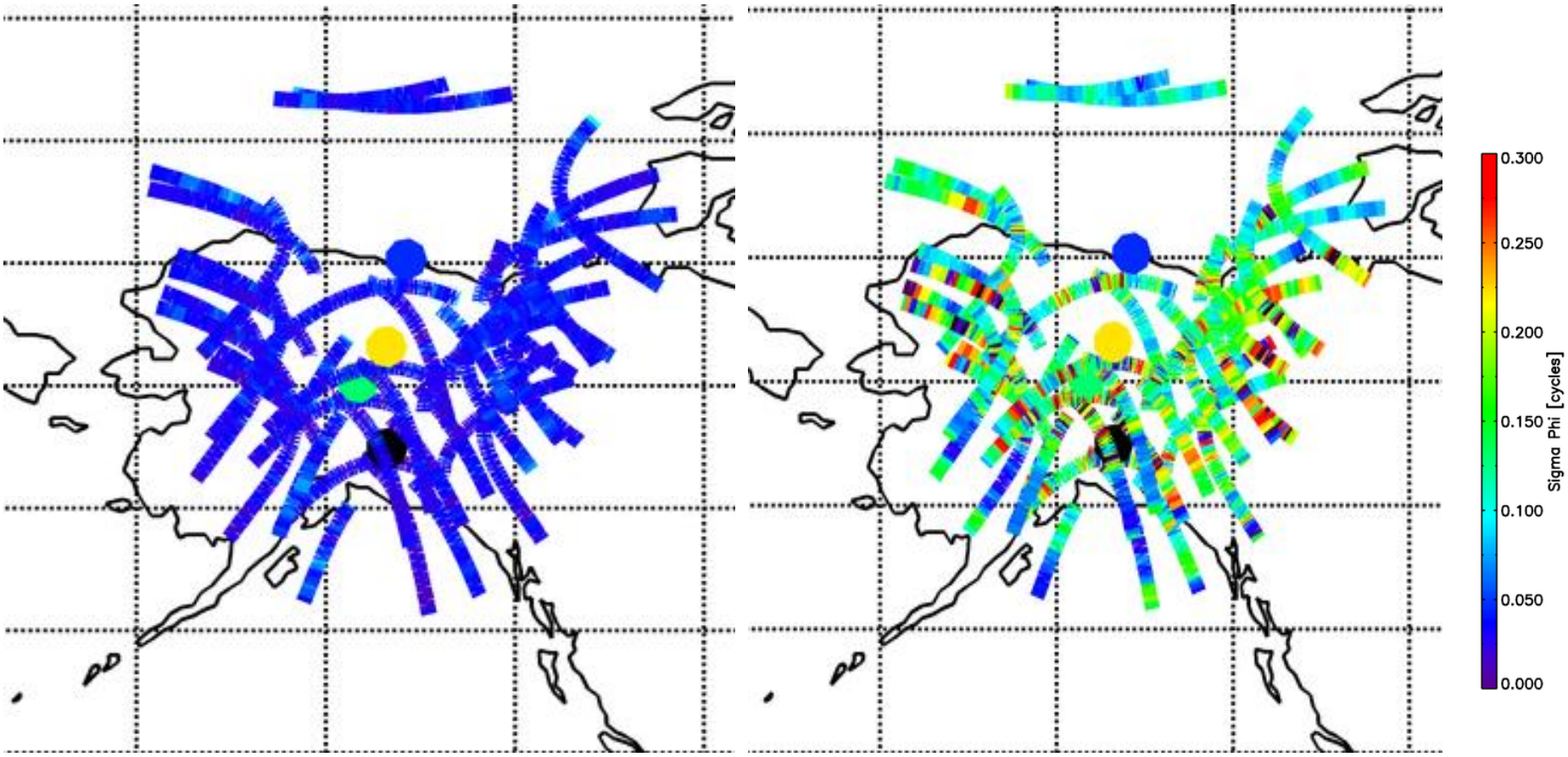


Alaskan Scintillation Monitoring in Realtime



We are now providing the Alaskan scintillation monitoring service in realtime at our website: http://astraspace.net/news-2/cases-alaska/

Alaskan Scintillation Monitoring in Realtime



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Phase Scintillation Nov. 14, 2012

Aurora is Well Correlated with GPS Scintillation

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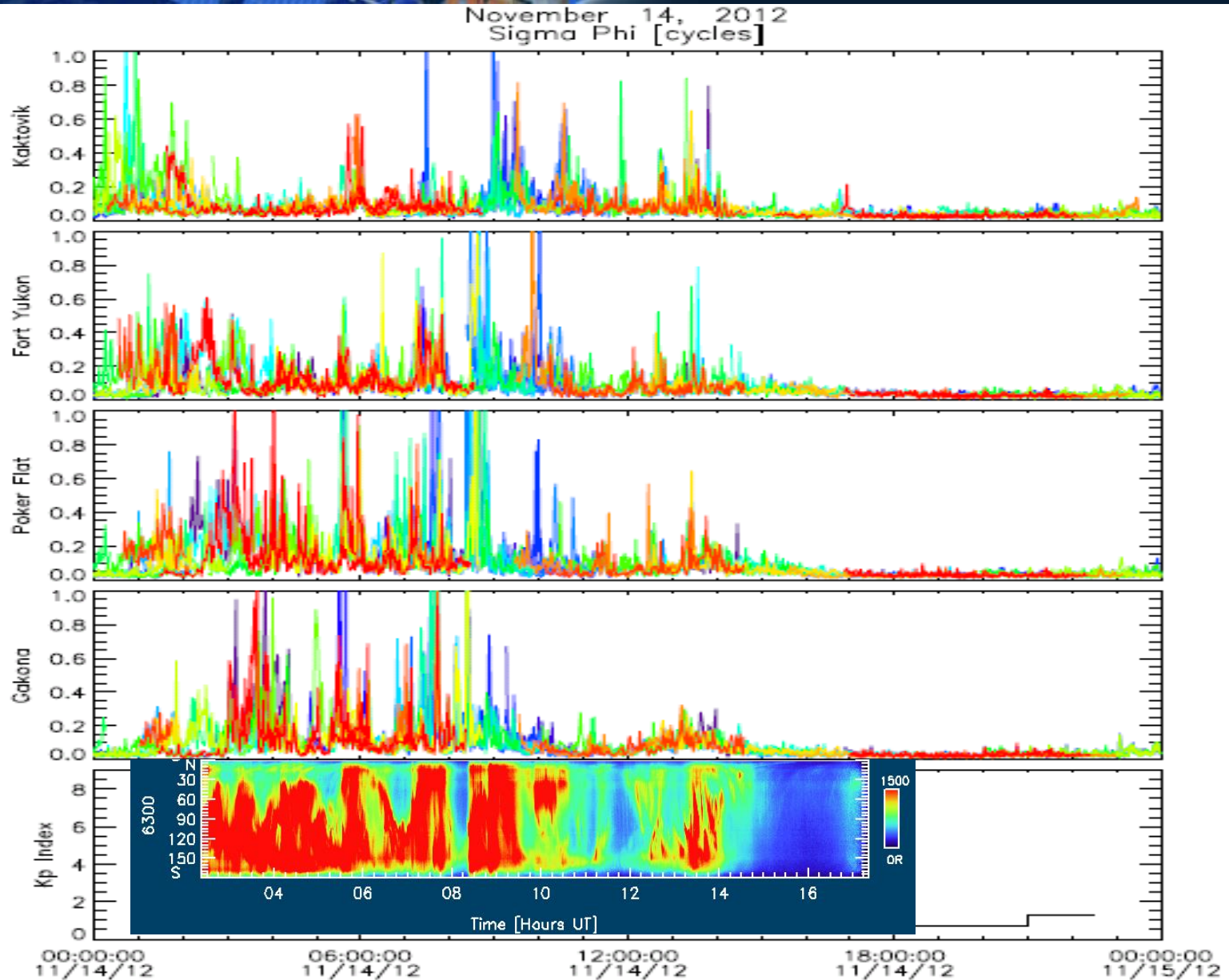
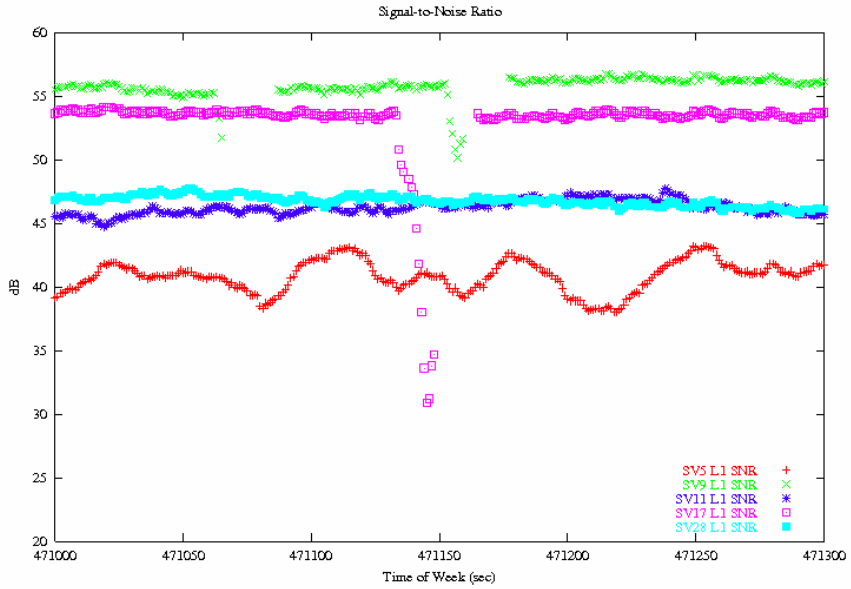
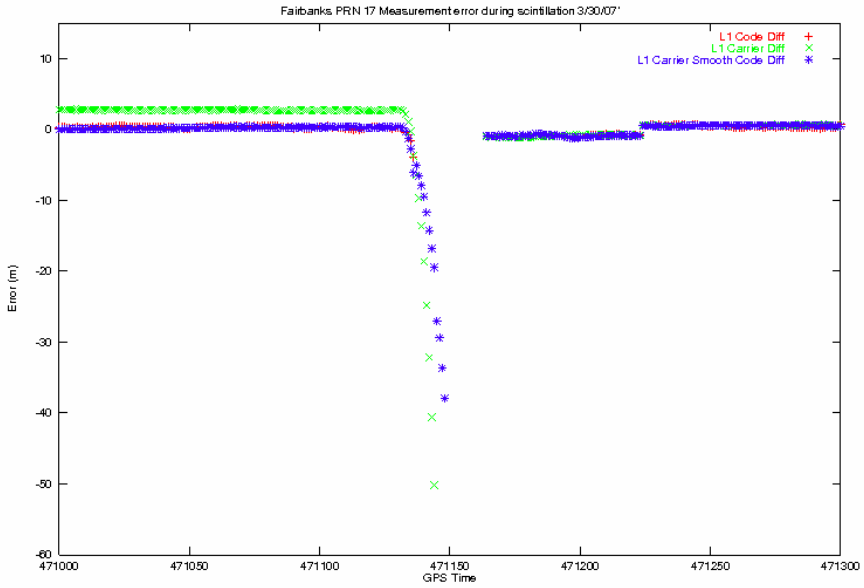


Mitigation of Space Weather Effects on GPS

DR#52: Ionospheric Scintillation caused High Position Errors at Fairbanks
GPS Week/Day: Week 1420 Day 5 (March 30, 2007)
Discussion: On March 30, 2007 (GPS Week 1420 Day 5), large vertical position errors (VPE) were observed at Fairbanks WAAS reference receiver thread A (WRE-A).





Effects of Space Weather on GPS

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DR#52: Ionospheric Scintillation caused High Position Errors at Fairbanks

GPS Week/Day: Week 1420 Day 5 (March 30, 2007)

Discussion: On March 30, 2007 (GPS Week 1420 Day 5), large vertical position errors (VPE) were observed at Fairbanks WAAS reference receiver thread A (WRE-A). The vertical errors occurred when WAAS vertical protection levels (VPL) were less than 50 meters, which would allow LPV operations. The maximum vertical error during the event that lasted five seconds was 22.492 meters at 471158 GPS time of week (GMT 10:52:38) and is shown as the red trace on Figure 1. It should be noted that the VPE did not exceed the VPL at any period. The horizontal errors were unaffected during the event reaching a maximum error 1.879 meters. The ratio of the vertical position error (VPE) divided by the VPL was also high (0.669) indicating the VPL (blue trace in figure 1) did not increase at the time of the event. The VPL increased when satellite measurements were rejected from the navigation solution or dropped from receiver tracking.

More study is planned since this effect has been observed on other occasions. The focus of the study will be the evaluation of data from a certified avionics receiver installed at a location in Alaska to see the tracking performance in this type of environment.

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SUMMARY

Possibility of monitoring TEC and scintillation in realtime
Clearly TEC gradients and GPS scintillation at low and high latitudes

Customers want to know when GPS is reliable in realtime
Customers want to know why their system was affected