



Celebrating **175** yrs  
Célébrons **175** ans



NATURAL RESOURCES CANADA - INVENTIVE BY NATURE

# Canadian Hazards Information Service Earthquake Monitoring (CHIS/EQCan)

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for IRIS QA Workshop



Natural Resources  
Canada

Ressources naturelles  
Canada

Canada

# Organizational Structure and Activities

- Natural Resources Canada (NRCCan)
  - Geological Survey of Canada (GSC)
    - **Canadian Hazard Information Service (CHIS)**
      - **Earthquakes Canada**
- CHIS has an *operational focus* (e.g. operate networks)
  - Meet Emergency Management Obligations
  - Sister group PSG in Sidney has Scientific/Research focus
- CHIS Activities
  - **Earthquake Monitoring**
  - Nuclear Explosion Monitoring, Tsunamis
  - Geomagnetic Monitoring, Space Weather Forecasting
  - Landslides, Nuclear Emergency Response
  - Volcanic Eruptions, Emergency Mapping

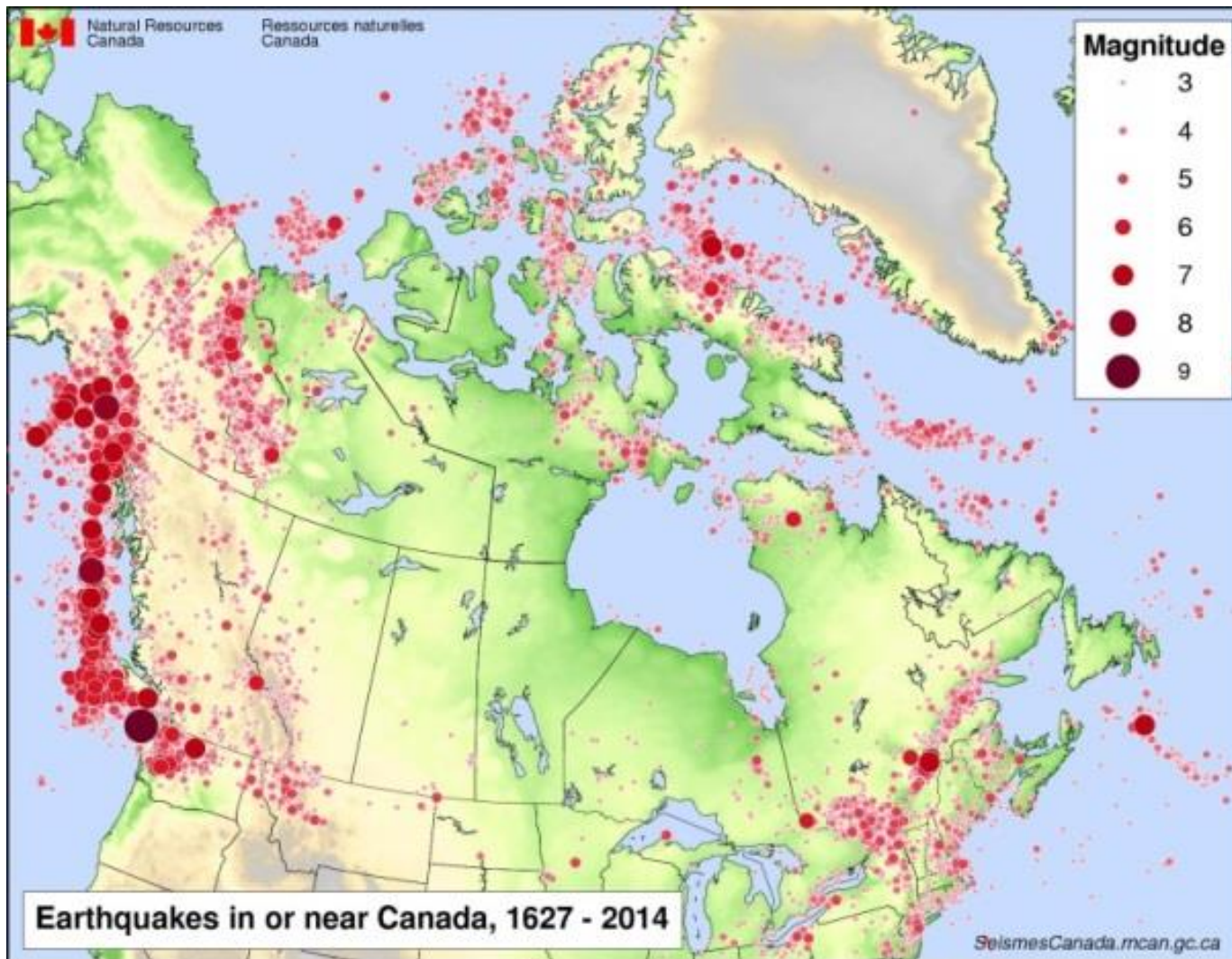


# Earthquake Monitoring

- Mandate from: Emergency Management Act
  - “the provision of information on the actual or probable occurrence and intensity of earthquakes”.
- About 20-25 staff in seismology group
  - Analysts, researchers, field techs, IT ops & dev
- Located in 4 offices in 3 locations
  - Ottawa, Sidney, Yellowknife



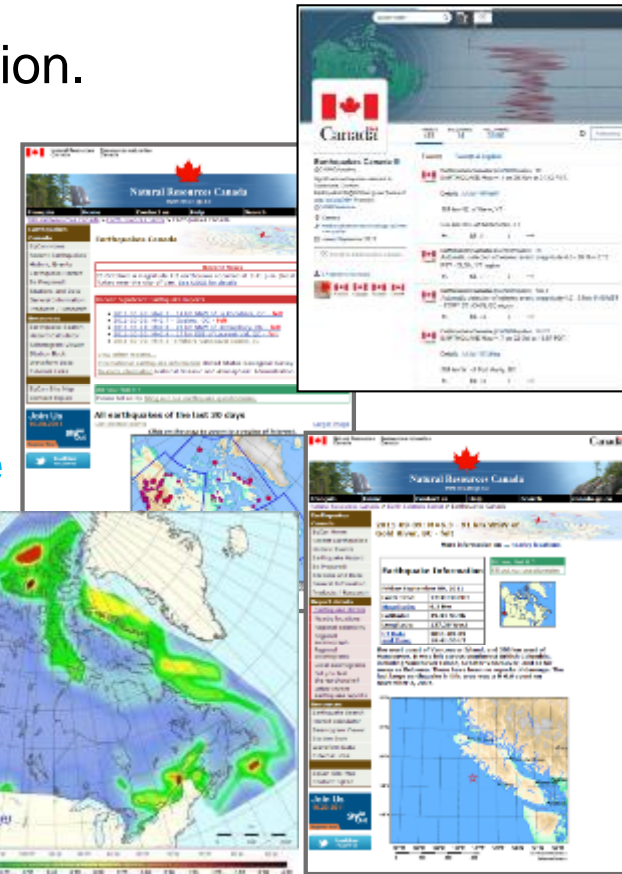
# Earthquakes in Canada



- > 4000 earthquakes/year
- ~ 50 - 100 / year felt by the public
- ~ 40 significantly damaging earthquakes in 350 years
- Largest recent EQ Oct 2012: M=7.8 offshore Haida Gwaii

# Earthquake Monitoring Activities

- Operate Seismic Monitoring Network
- Collaboration with many other agencies
  - Data exchange
- Rapid Response to Earthquakes
  - Automatic and manual. Alerting and notification.
  - On-call staff
  - Create and maintain EQ catalogue
- Providing Public Information
  - Web: [www.earthquakescanada.nrcan.gc.ca](http://www.earthquakescanada.nrcan.gc.ca)
  - Twitter: [@CanadaQuakes](https://twitter.com/CanadaQuakes) [@CanadaSéisme](https://twitter.com/CanadaSéisme)
- Earthquake Hazard Assessment
  - Hazard maps feed into building codes
- Other projects

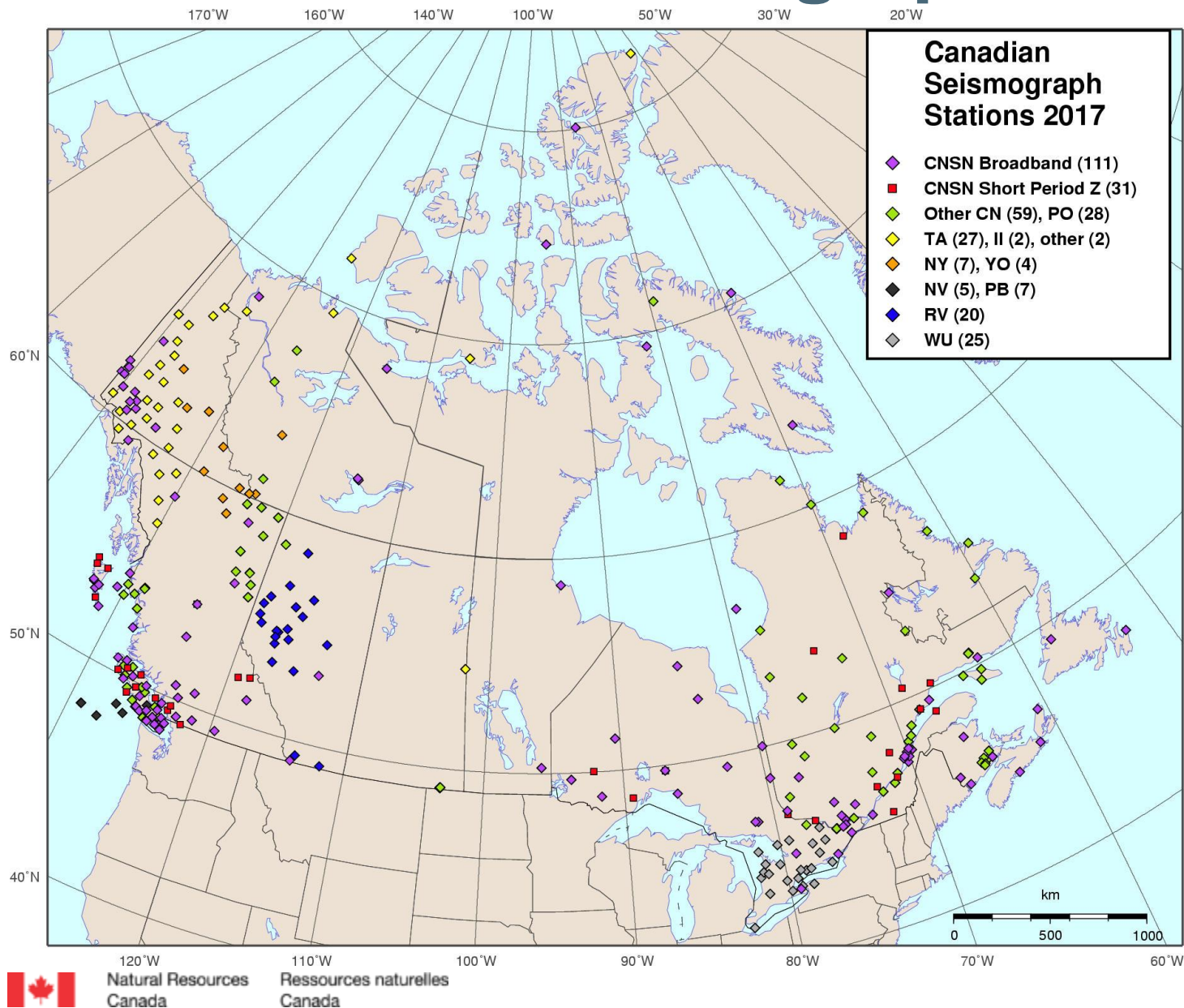


# Monitoring Network

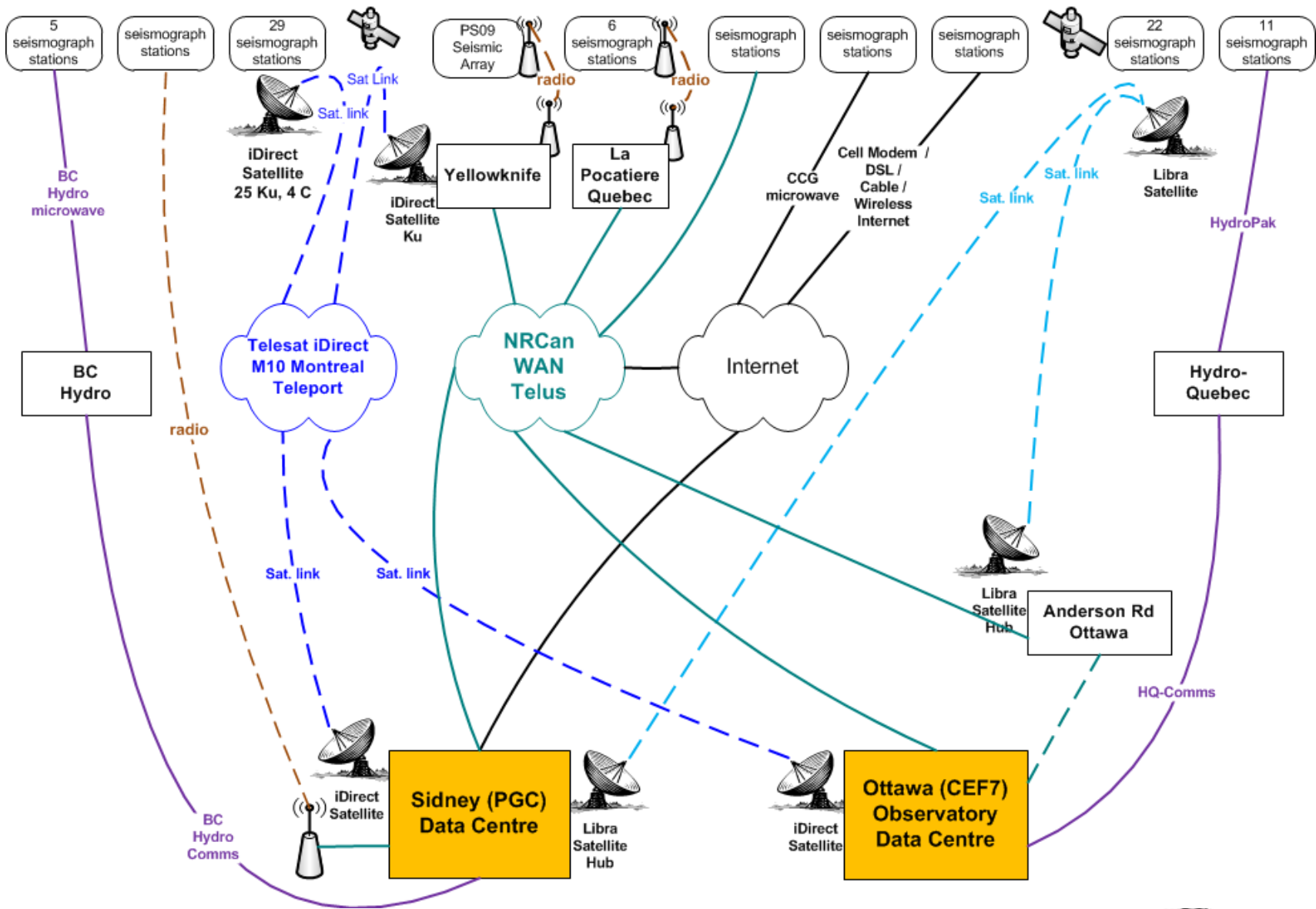
- Operate 11 stations for CTBTO as part of the International Monitoring System: 3 primary and 6 auxiliary seismic, 1 infrasound, and 1 hydroacoustic
- Operate the **Canadian National Seismograph Network (CNSN)**
  - ~ 150+ weak motion seismographs
  - ~ 120 strong motion accelerographs
- Operate other temporary seismograph stations and/or networks
  - On behalf of other Canadian research groups



# Weak Motion Seismograph Station Map



# Telecommunications for Stations





# Two Data Centres: Ottawa, Sidney

- Parallel/Independent Operation
- Redundant Systems
- Redundant Communication Links



- Acquire, process and archive over 6 GB/day (~2.5 TB/year) of raw data from ~300+ stations
- ~30 TB of waveform data in archive (decades of data)
- National Earthquake DataBase (EQ catalogue) has events from 1627 – present day.



# Multi-year NRCan project to upgrade CNSN Network in progress

- Stations
  - A total of 150 stations will be upgraded.
  - 75 stations have been upgraded to date.
  - About 100 stations will record 3 weak motion and 3 strong motion channels
  - About 50 stations will record 3 weak motion channels
- New equipment includes:
  - Nanometrics Centaur 6 channel digitizers
  - Nanometrics Trillium 120QA seismometers
  - Nanometrics Titan accelerometers
  - new power management & SOH monitoring systems
- New civil works where needed
- Data centre acquisition and processing will move to SeiscomP3 soon
- FDSN web services will be publically available by end of project
- Separate from the CNSN upgrade, a contract for prototype Earthquake Early Warning System in B.C. awarded to Ocean Networks Canada from B.C. Gov.
- NRCan working with ONC on this project



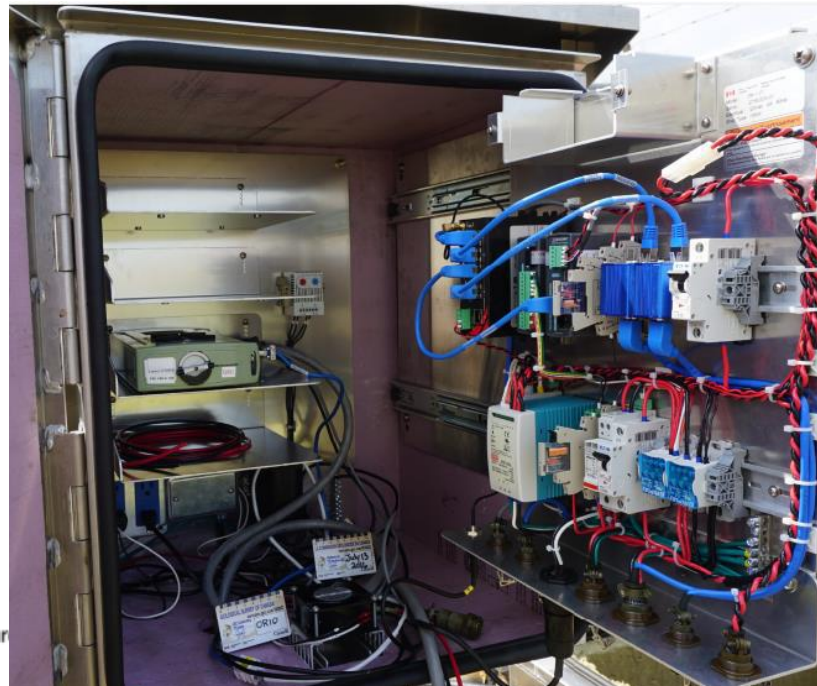
# New Station Infrastructure

- New vaults, where needed



# New Station Infrastructure

- New power management, networking and SOH systems
  - Remote power control
  - State of Health – query or streaming



# New Station Infrastructure

At DC  
powered  
stations

- Kiosks
- Solar panels
- DC power managers



# New Data Centre Software

- Data acquisition and processing
  - SeisComP3
- Data quality evaluation
  - SQLX
- Station State-Of-Health (SOH) monitoring
  - Nagios with custom extensions
- Ticket-based problem tracking
  - Jira Service Desk
- Station information document repository / Wiki
  - Confluence
- Asset management
  - WASP or Confluence add-ons



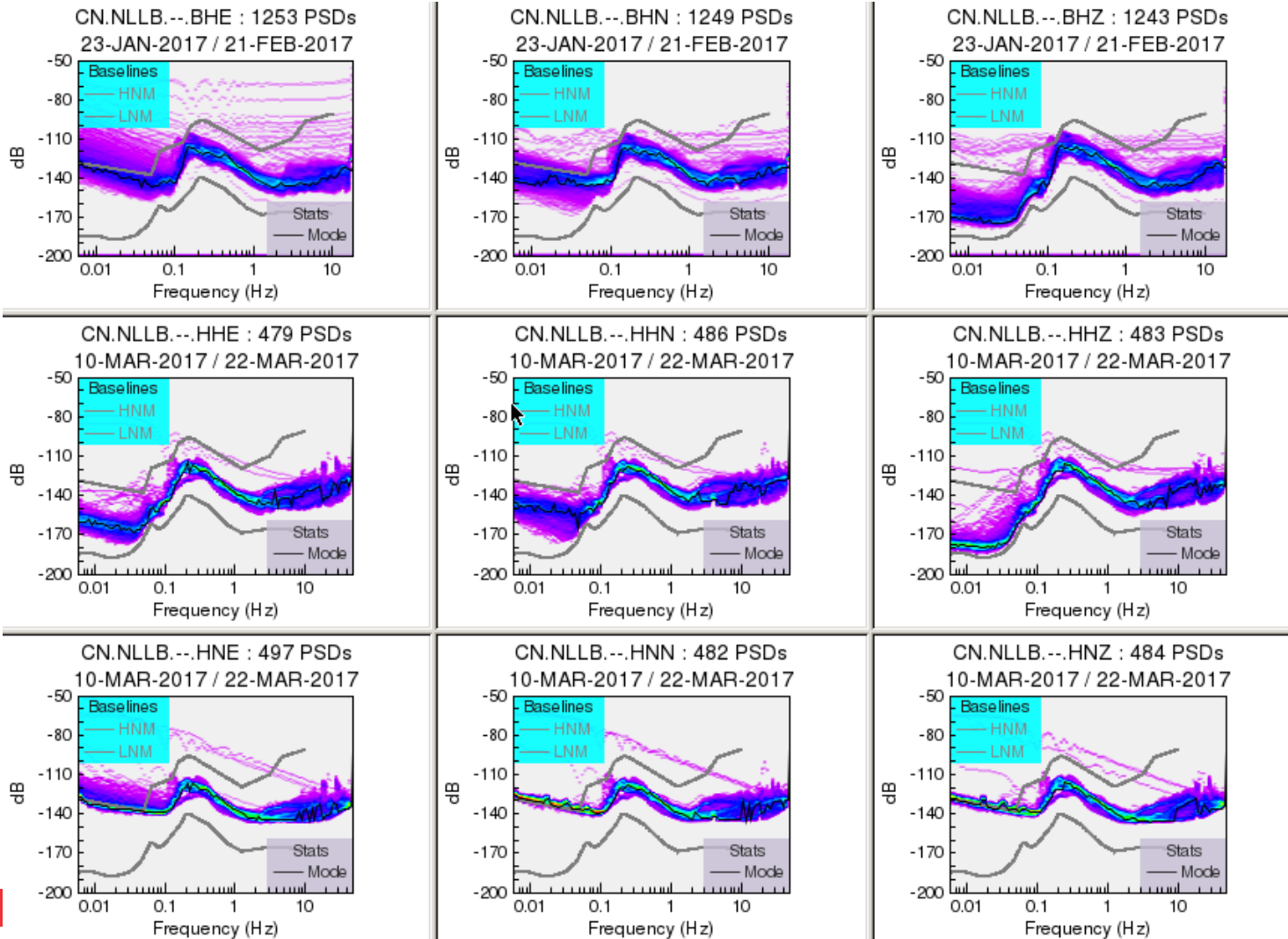
# New Quality Control and Quality Assurance Procedures

- Standardized procedures and/or checklists needed for all aspects of network operation
  - Equipment testing
  - Building station kits
  - Equipment configuration
  - Installing and verifying stations
  - Hand off from field techs to data centre ops group
  - Validating data flow and station response
  - Modifying processing software



# Station Validation – Checking Data Quality

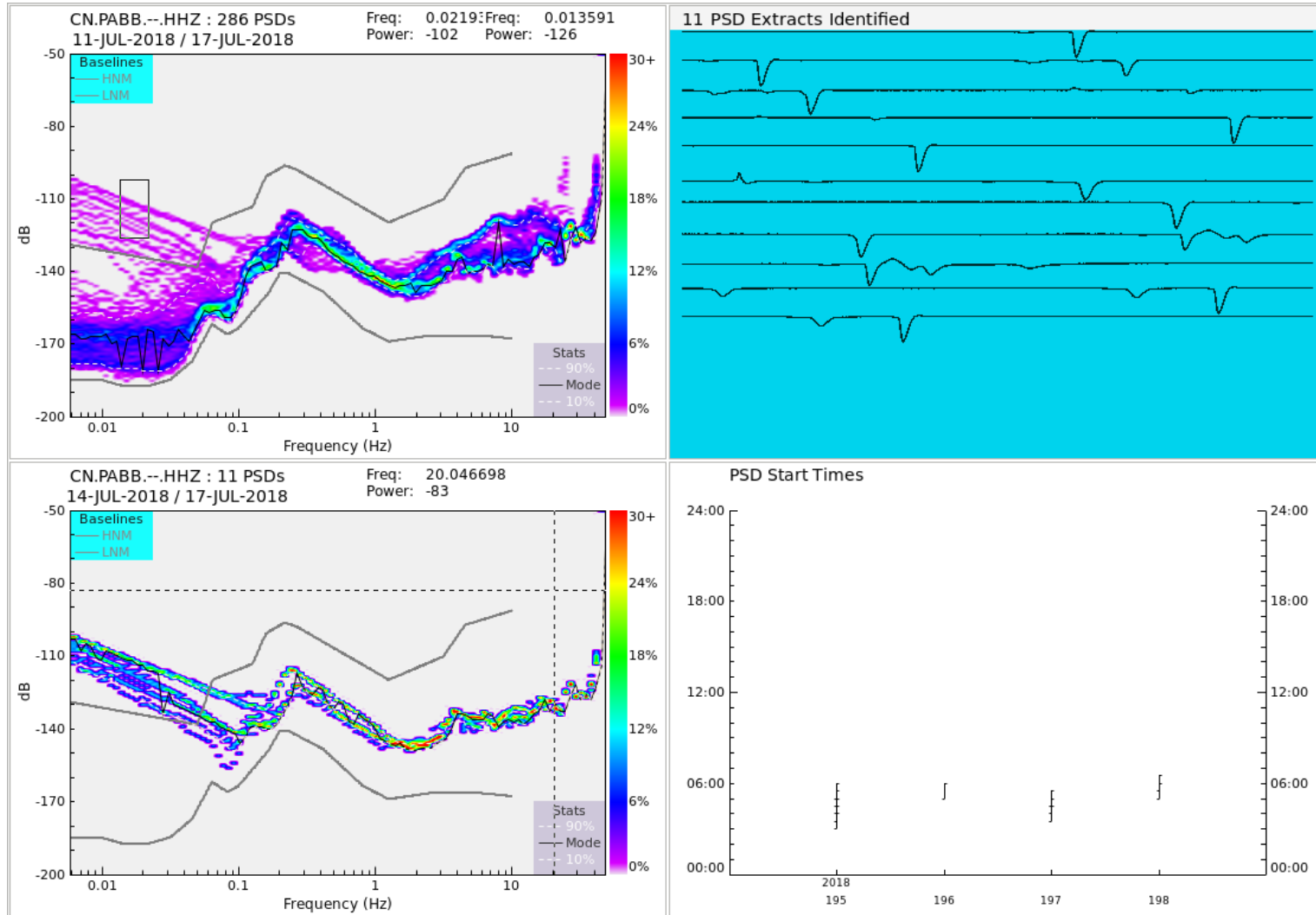
- Checking noise before and after upgrade





# Station Validation – Sensor Verification

## ■ Checking for faulty instruments

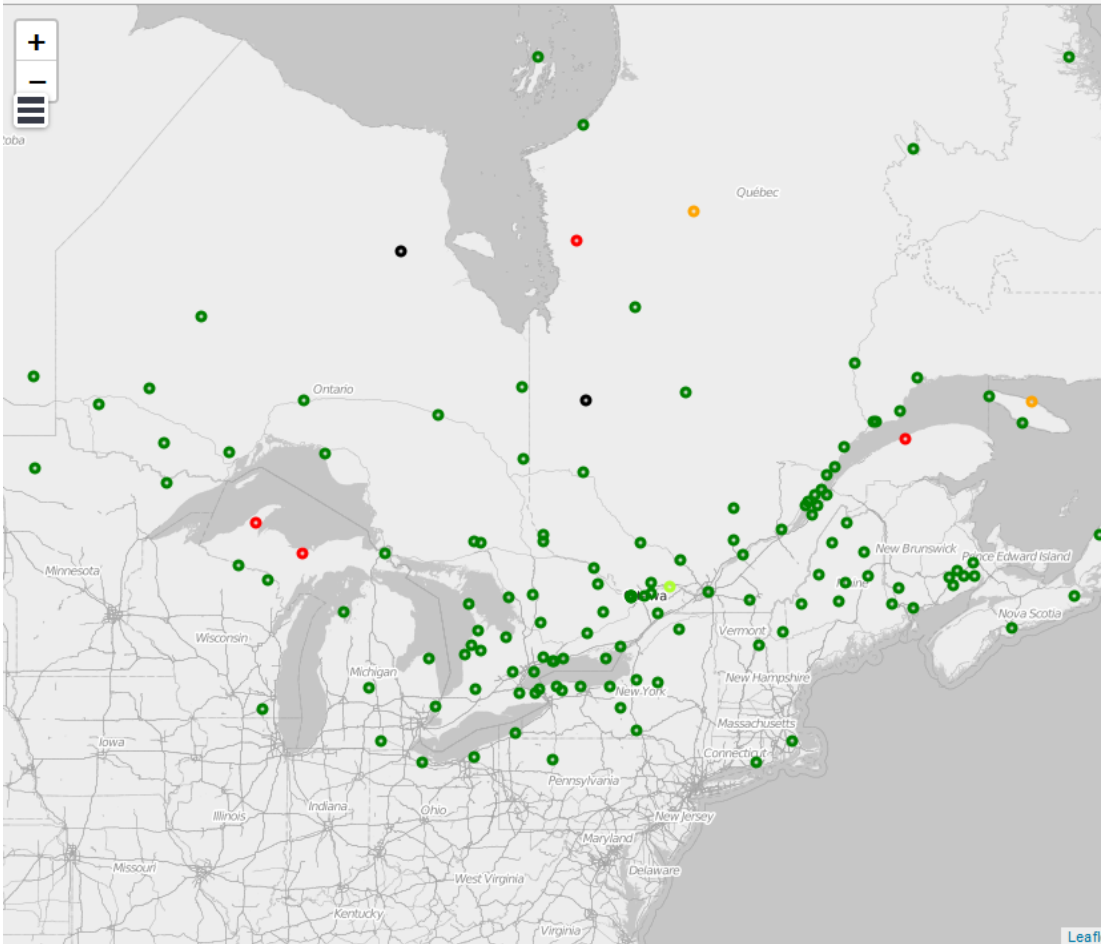


# Station Operations – Monitoring Data

Status Orb Channels Data Flow Maps Data Availability Data Growth Compare Archives

Server **antarc-01** Filter **seed network** station location HZ

Delay	CN	N4	PO	US	WU	Total
< 5 min	62	28	12	8	22	132
< 30 min	0	0	1	0	0	1
< 1 day	2	0	0	0	0	2
< 14 days	1	2	1	0	0	4
> 14 days	1	0	1	0	0	2
<b>Total</b>	<b>66</b>	<b>30</b>	<b>15</b>	<b>8</b>	<b>22</b>	



Net (1)↑	Sta (2)↑	Loc	Chan	Outage	Latency
CN	BSCQ		HHZ	2.688s	5.20
CN	CHEG		HHZ	2.57s	5.03
CN	CNQ		EHZ	2.652s	12.00
CN	CRLO		EHZ	2.158s	12.49
CN	DPQ		HHZ	4.1s	4.85
CN	EEO		EHZ	3.753s	10.90
CN	EFO		HHZ	1.409s	5.99
CN	ELNB		HHZ	2.491s	6.27
CN	EPLO		HHZ	2.625s	7.35
CN	FORQ		HHZ	3.942s	5.15
CN	GAAQ		HHZ	0.897s	7.25
CN	GAC		BHZ	3.23s	12.40
CN	GAC		HHZ	3.89s	5.39
CN	GBN		HHZ	1.525s	8.32
CN	GGN		HHZ	1.87s	6.09
CN	GRQ		HHZ	1.649s	4.88
CN	GSQ		EHZ	1d 4h 29m 16s	29.32
CN	GTO		EHZ	1.117s	13.54
CN	HAL		HHZ	0.843s	2.88
CN	HKNB		HHZ	4.143s	6.49
CN	ICQ		HHZ	1.574s	5.09
CN	KAPO		HHZ	1.411s	5.98
CN	KGNO		HHZ	0.948s	2.82
CN	KILO		HHZ	4.901s	5.38
CN	KIPQ		HHZ	3.541s	4.90
CN	LESQ		HHZ	2.687s	6.10
CN	LG4Q		EHZ	16h 52m 11s	-103.41
CN	LMN		HHZ	3.217s	5.26
CN	LMQ		HHZ	3.608s	5.46
CN	MALO		HHZ	4.111s	8.82
CN	MCNB		HHZ	3.693s	4.90
CN	MNQ		EHZ	2.56s	12.09
CN	MNTQ		HHZ	2.022s	4.76
CN	MOQ		EHZ	2.144s	12.51
CN	ORIO		HHZ	0.896s	4.96
CN	OTT		HHZ	1.177s	2.87
CN	PCAQ		HHZ	2h 42m 42s	13.95
Leaflet	PKLO		HHZ	1.315s	4.87