

USGS Geomagnetism Data Framework

IUGG, Montreal, Canada - 2019-07-12

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Geologic Hazards Science Center

- National Earthquake Information Center
 - Advanced National Seismic System (ANSS) National Operations Center
 - 24/7 earthquake monitoring and distribution of information
- National Landslide Hazards Program
- National Geomagnetism Program

National Geomagnetism Program

- Observatories
 - 14 INTERMAGNET observatories
- Research



Geomagnetism Data Framework

- Strategic plan for geomagnetism data
- Look at the big picture
- Revisit past design decisions

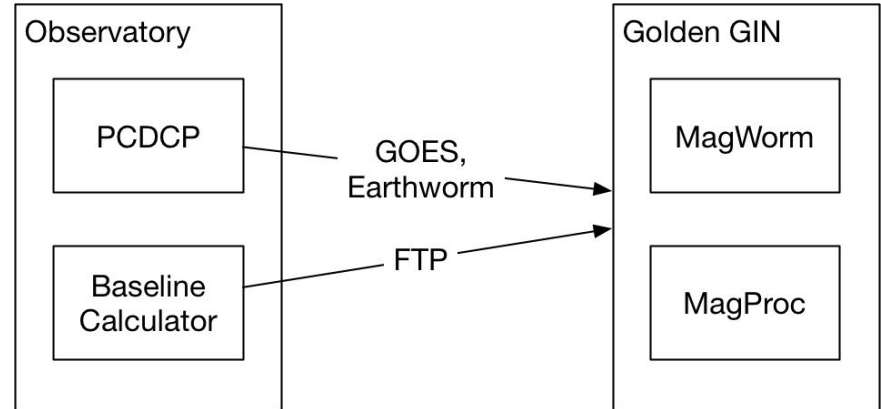
Instrumentation

- Narod 3-axis Ring-core Fluxgate
 - Bias (~ 500 nT/bin) 8-bit output
 - Voltage (~ 100 nT/V)
- GEM GSM-19 Overhauser
 - 1Hz Serial output



PC Data Collection Platform (PCDCP)

- Designed for 1 minute
- Lawson802 digitizer
 - Sample voltages at 100Hz, bins at 1Hz
- PC
 - Process to 1Hz, 1 minute
 - GOES Satellite, Earthworm



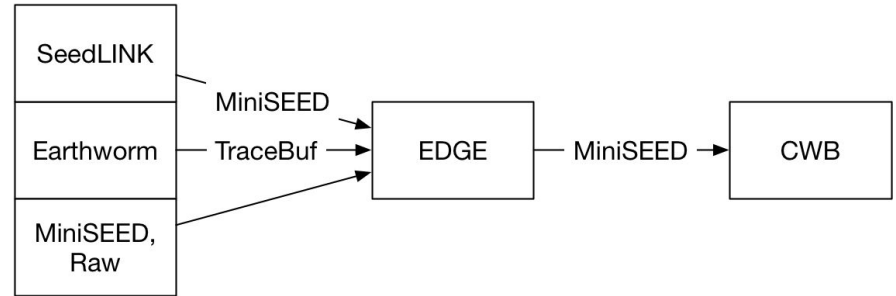
Edge/CWB

■ Seismic Acquisition System

- ~8k channels and 25gb per node

■ MiniSEED

- Binary time series format
- Fixed size blocks (512 b)
 - Channel Id
 - Starttime
 - Rate
 - Data



Web Absolutes

■ Replace Baseline Calculator

- Observations transferred using FTP
- Visual Basic
- Required Windows XP

■ Move to Web Application

- Central updates, storage
- Integrate with existing systems

USGS - Baseline Calculator - Version 1.0.0.0

HP Officejet 4500 G510n-z C:\Software\dev\Baseline Calculator\bin\Debug\Data\000\Baseline (ESC to Close)

Print This Print All Existing Files: [BOU\20080301449.ENM] Load Selected File

Set 1 Set 2 Set 3 Set 4 PCDCP Summary

Station: BOU Set No.: 1 Date: 4/13/2011
Instrument No.: 123456789 / 987654321 Pier: Main Year Day: 103
Save Observer: Eddie Temperature: unknown Mark: Main

Declination

| | Mark Up: | 10 | 6.8 | 0 | | | | | |
|------------|------------|-----|-----|-----|--------|--|--|--|--|
| | Mark Down: | 190 | 6.3 | 0 | | | | | |
| | Time | Deg | Min | Sec | Offset | | | | |
| West Down: | | 267 | 0 | 0 | 0 | | | | |
| East Down: | | 99 | 0 | 0 | 0 | | | | |
| West Up: | | 101 | 0 | 0 | 0 | | | | |
| East Up: | | 268 | 0 | 0 | 0 | | | | |
| Mark Up: | 10 | 6.8 | 0 | | | | | | |
| Mark Down: | 190 | 6.3 | 0 | | | | | | |

No Errors in Declination.

Magnetic S. Mer: 0 0 0
Offset Correction: 0
Corrected Mag S. Mer: 0 0 0
Mean Mark: 0
Mag. Az. of Mark: 0
True Az. of Mark: 176.6458
Magnetic Declination: 0 0 0
(WU - ED) * 60: 0 (EU - WD) * 60: 0
F mean: nT
Pier Correction: 7.4 nT
Corrected F: 7.40 nT

Inclination

| | Time | Deg | Min | Sec | Offset | | | | |
|-------------|------|-----|-----|-----|--------|--|--|--|--|
| South Down: | | 238 | 0 | 0 | 0 | | | | |
| North Up: | | 58 | 0 | 0 | 0 | | | | |
| South Up: | | 118 | 0 | 0 | 0 | | | | |
| North Down: | | 297 | 0 | 0 | 0 | | | | |


No Errors in Inclination.

Offset Correction (deg): 0
Inclination (deg): 0 0 0
Corrected Inclination (deg): 0 0 0
Horizontal Component (nT): 7.40
Vertical Component (nT): 0.00
(SD-SU-180) * 60: 0 (ND-SU-180) * 60: 0

PCDCP Magnetometer Ordinates

| | Mean Values | Scale Value | Computed Values | Obs. Declination: |
|----------|----------------|-------------|-----------------|--------------------------------|
| H (C1): | nT (Dead Vals) | | nT | 0.0 min |
| E (C2): | nT (Dead Vals) | 464.5604 | 0.00 min | Data Minutes Seconds |
| Z (C3): | nT (Dead Vals) | | nT | Calculate |
| F (C4): | nT (Dead Vals) | | nT | |
| Abs. D: | 0.00 min | D Baseline: | 0.00 min | 0.00 nT |
| Abs. H: | 7.40 nT | H Baseline: | 7.40 nT | |
| Abs. Z: | 0.00 nT | Z Baseline: | 0.00 nT | |
| Corr. F: | 7.40 nT | | | Transfer Values To Next Set -> |

Web Absolutes - Input



USGS
science for a changing world

National Geomagnetism Program

Web Absolutes v1.3.0

Dashboard

Observation Input

Baseline Plot

Administer Users

Logout

Observation Web Service

Monitoring

Data & Products

Research

Publications

Learn

Services

Partners & Customers

Observation Input v1.3.0

Date: 2019-02-15

Observatory: Boulder (BOU)

Julian Day: 46

Pier: MainPCDCP (-22 nT) 2016-01-01

Pier Temp: 21

Mark: AZ (199.1383°)

Observer: bworth

Electronics: 0110

Reviewer: bworth

Theodolite: 109648

Selected reviewer is not an admin user.

< Set 1 Set 2 Set 3 Set 4 Summary >

< Set 1 Set 2 Set 3 Set 4 Summary >

Declination

| | Time | Deg | Min | Sec | E (nT) |
|-----------|----------|-----|-----|-----|---------|
| Mark Up | | 11 | 23 | 44 | |
| Mark Down | | 191 | 23 | 51 | |
| West Down | 18:30:45 | 270 | 43 | 56 | -56.981 |
| East Down | 18:32:28 | 90 | 25 | 15 | -57.426 |
| West Up | 18:34:12 | 90 | 35 | 44 | -57.728 |
| East Up | 18:35:58 | 270 | 57 | 57 | -58.076 |
| Mark Up | | 11 | 23 | 45 | |
| Mark Down | | 191 | 23 | 48 | |

Magnetic South Meridian: 180.679°
180° 40.717'

Mean Mark: 101.396°
10.718'

Magnetic Azimuth of Mark: 199.1383°
8.421'

True Azimuth of Mark: 199.1383°
8° 25.231'

Magnetic Declination: 8.421°
8° 25.231'

(WU - ED) * 60: 10.483'

(EU - WD) * 60: 14.017'

Inclination

| | Time | Deg | Min | Sec | H (nT) | Z (nT) | F (nT) |
|------------|----------|-----|-----|-----|-----------|-----------|-----------|
| South Down | 18:40:03 | 246 | 21 | 50 | 20811.582 | 46972.172 | 51897.798 |
| North Up | 18:41:04 | 66 | 21 | 17 | 20811.593 | 46971.971 | 51897.798 |
| South Up | 18:43:05 | 113 | 29 | 4 | 20811.080 | 46971.838 | 51897.798 |
| North Down | 18:43:57 | 293 | 29 | 56 | 20811.079 | 46971.676 | 51897.798 |

Copy to Next Set

Inclination: 66.434°
66° 26.029'

Horizontal Component: 20740.362 nT

Vertical Component: 47549.298 nT

(SD - NU - 180) * 60: 0.550'

(ND - SU - 180) * 60: 0.867'

Magnetometer Ordinates

| Channel | Ordinate Mean | Absolute | Baseline |
|---------|---------------|--------------|-------------|
| H | 20811.334 nT | 20740.362 nT | -70.971 nT |
| E | -57.553 nT | | 3105.677 nT |
| D | -9.539' | 505.231' | 514.771' |
| Z | 46971.914 nT | 47549.298 nT | 577.384 nT |
| F | 51897.798 nT | 51875.798 nT | |

Pier Correction -22 nT

Web Absolutes - Review

[<](#)
[Set 1](#)
[Set 2](#)
[Set 3](#)
[Set 4](#)
[Summary](#)

Declination

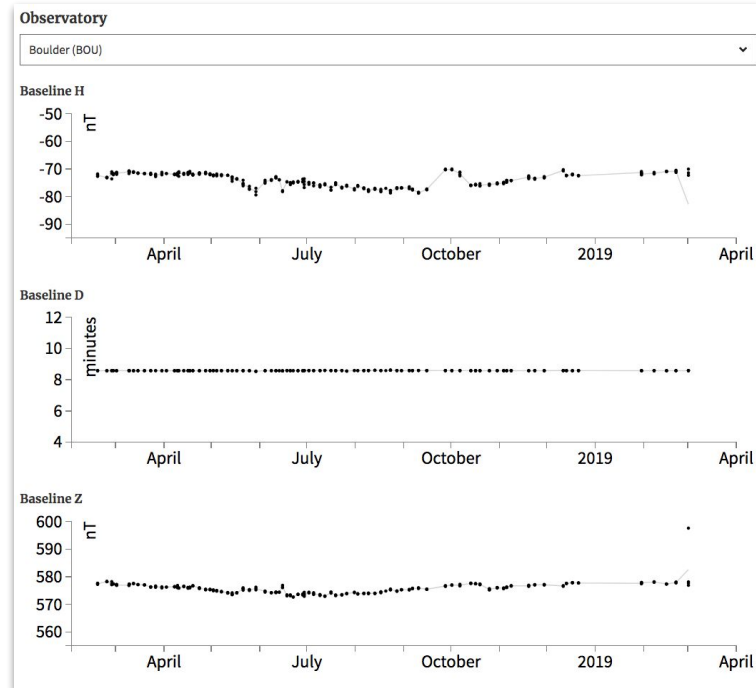
| Set | Valid | Start Time | End Time | Absolute | Ordinate | Baseline | Baseline | 180° Shift |
|---------------------------|-------------------------------------|------------|----------|------------|----------|----------|-------------|------------|
| 1 | <input checked="" type="checkbox"/> | 16:42:53 | 16:47:08 | 8° 29.310' | -5.777' | 515.087' | 3106.979 nT | 0 |
| 2 | <input checked="" type="checkbox"/> | 17:00:06 | 17:03:59 | 8° 27.590' | -7.198' | 514.788' | 3105.504 nT | 0 |
| 3 | <input type="checkbox"/> | 17:16:29 | 17:20:20 | 8° 28.336' | -9.095' | 517.430' | 3120.724 nT | 0 |
| 4 | <input checked="" type="checkbox"/> | 17:31:39 | 17:35:11 | 8° 23.923' | -10.888' | 514.811' | 3105.105 nT | 0 |
| Mean | | | | | | 514.896' | 3105.863 nT | |
| Range | | | | | | 0.299' | 1.874 nT | |
| Standard Deviation | | | | | | 0.136' | 0.806 nT | |

REJECT

Horizontal Intensity

| Set | Valid | Start Time | End Time | Absolute | Ordinate | Baseline |
|-----|-------------------------------------|------------|----------|--------------|--------------|------------|
| 1 | <input checked="" type="checkbox"/> | 16:52:48 | 16:57:14 | 20736.306 nT | 20809.168 nT | -72.862 nT |
| 2 | <input type="checkbox"/> | 17:09:00 | 17:13:28 | 20738.503 nT | 20808.404 nT | -69.901 nT |
| 3 | <input checked="" type="checkbox"/> | 17:25:02 | 17:28:58 | 20733.732 nT | 20807.015 nT | -73.283 nT |

REJECTED



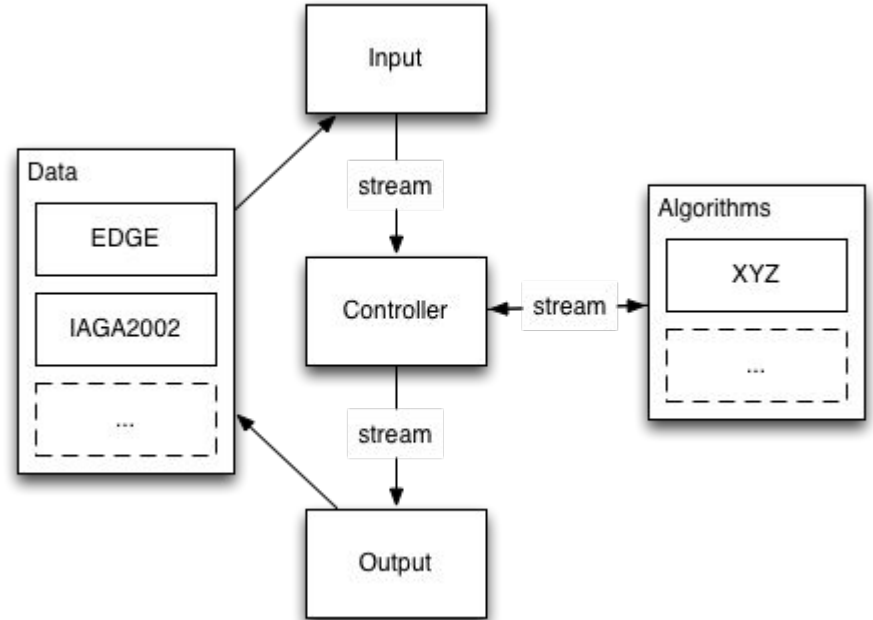
Geomag Algorithms

- Based on ObsPy
- Run every 5 minutes

```
import sys
import geomagio
from obspy.core import UTCDateTime

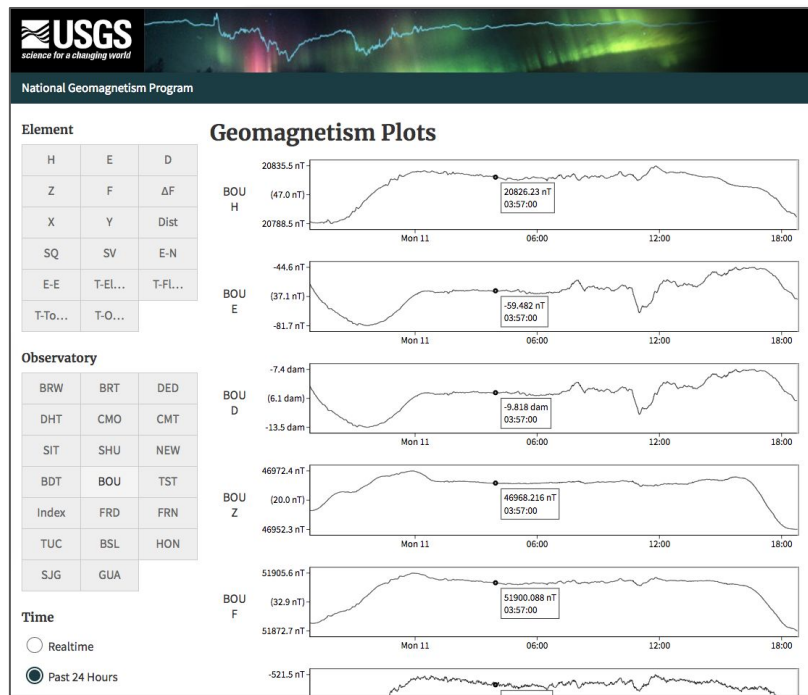
input_factory = geomagio.edge.EdgeFactory()
timeseries = input_factory.get_timeseries(
    observatory = 'BOU',
    channels = ('H', 'E', 'Z', 'F'),
    type = 'variation',
    interval = 'minute',
    starttime = UTCDateTime('2016-07-04T00:00:00Z'),
    endtime = UTCDateTime('2016-07-04T23:59:00Z'))

output_factory = geomagio.iaga2002.IAGA2002Factory()
output_factory.write_file(
    channels = ('H', 'E', 'Z', 'F'),
    fh = sys.stdout,
    timeseries = timeseries)
```



Interactive Plots

- Replace old image based plots, FTP
- Data from Web Service
 - Add IAGA-2002, IMAG-JSON



Definitive Processing

- MagProc
 - File based
 - Designed for 1 minute
- Evaluated MagPy
 - Added channel statistics
 - Added flagging tools



Ongoing Development

- Acquisition
- Processing
- Web Services

ObsRIO Acquisition

- National Instruments cRIO
 - PC + FPGA + Modules
 - Sample voltages and bins at 10kHz
 - Average timing error 3ms, corrected to ~1ms
- Output 10Hz
- MiniSEED + SEEDLink

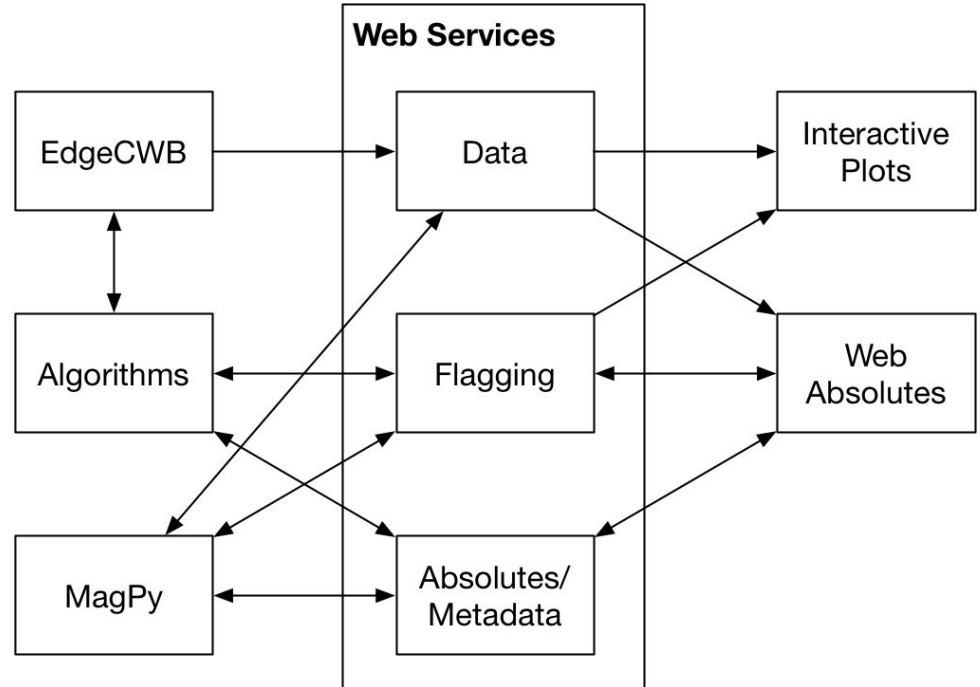


Processing

- Process raw digitized output
- SEEDLink
 - Streaming data processing
 - Integrate with existing Algorithms
- Developing Baseline based on Adjusted Algorithm
 - 4x4 transform matrix

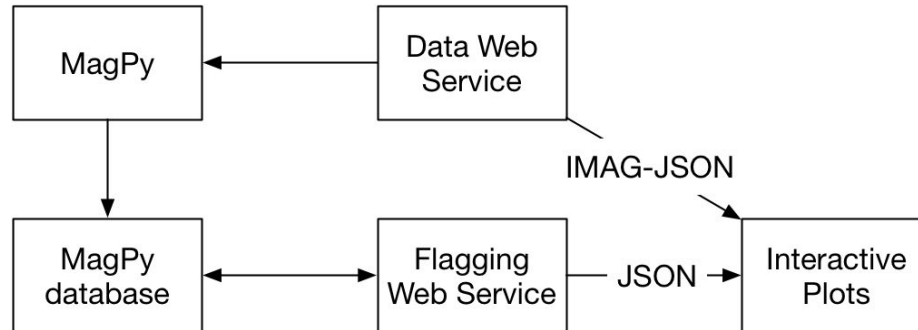
Web Services

- Data format exists
- Develop new standard formats



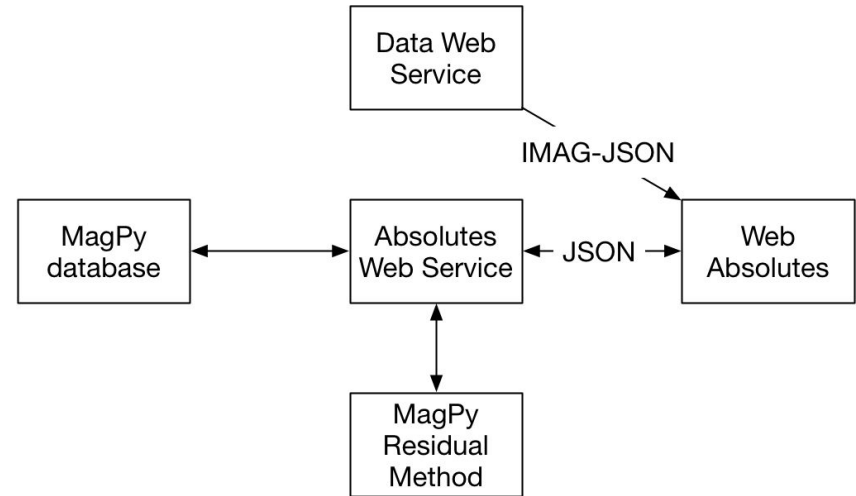
Flagging Service

- Add MagPy style flags to USGS workflow
- Integrate with plots



Absolutes Service

- Integrate residual method
- Updated interface
 - Better metadata tools
 - Flagging?



Thank You

Jeremy Fee <jmfee@usgs.gov>

<https://github.com/geomagpy/magpy/issues/95>