SnT 2025 8 SEPTEMBER ONLINE DAY 9 TO 12 SEPTEMBER AT HOFBURG PALACE, VIENNA & ONLINE
CTBT: SCIENCE AND TECHNOLOGY CONFERENCE

P3.5-245

Event Location in the Geophysical Monitoring System (GMS)

N. McMahon, M. Harris, and K. Aur

Sandia National Laboratories

Sandia National Laboratories

INTRODUCTION AND MAIN RESULTS

LocOO3D (Object-Oriented 3-Dimensional Location Software) has been integrated with the event location service in the Geophysical Monitoring System (GMS) allowing analysts to adjust observations and location parameters as well as view details and history of location solutions.

This service is configured to use the traditional earth models and corrections used at the International Data Centre (IDC) but can also be extended to use advanced 3D earth models.

SAND2025-11142D

Sandia National Laboratories is a multimission laboratory managed and operated by National Technology and Engineering Solutions of Sandia LLC, a wholly owned subsidiary of Honeywell International Inc. for the U.S. Department of Energy's National Nuclear Security Administration under contract DE-NA0003525.

SnT 2025 CTBT: SCIENCE AND TECHNOLOGY CONFERENCE
8 SEPTEMBER ONLINE DAY
9 TO 12 SEPTEMBER AT HOFBURG PALACE, VIENNA & ONLINE

Event Location in the Geophysical Monitoring System (GMS)

N. McMahon, M. Harris, and K. Aur

P3.5-245

Introduction

GMS
Sandia National Laboratories is developing the Geophysical Monitoring System (GMS) for modernization of the United States National Data Center waveform processing system, now focused on development of the Interactive Analysis (IAN) capabilities. The United States provides open-source releases of GMS software to support the International Data Centre (IDC) Re-engineering.

LocOO3D
Sandia has integrated event location capabilities into GMS, including an event location service based on the LocOO3D (Object-Oriented 3-Dimensional Location Software) locator that is part of the openly available Salsa3D software package,

LocOO3D is used for locating and relocating single events using a variety of models and corrections via an iterative linear least squares inversion algorithm with Levenberg-Marquardt damping.

To maintain consistency with location solutions, GMS has also updated the feature prediction service to use LocOO3D to provide travel time, azimuth and slowness predictions.

GMS Event Location Service

The GMS Event Location Service is called by using the ”Locate” button in the Location Display.

When called, the Event Location Service will take in a variety of parameters to calculate an event location including:

- Associated signal detections, arrival time and phase
- Defining feature measurements (time, azimuth, slowness)
- Location restraints
- Models
- Correction definitions (e.g., elevation, LibCorr3D)
- LocOO3D configurable parameters
- Master Event (optional)

To support GMS requirements, LocOO3D has been recently updated to support phases beyond traditional seismic body phases, including:

- Seismic surface phases (reference period dependent)
- Hydroacoustic phases (seasonally dependent)
- Infrasonic phases (monthly dependent)

The Event Location service supports locating events using single or multiple phase types, models, and corrections.

Location Service Configuration

LocOO3D has a robust set of parameters that can be configured to produce the best location solution. Most of these parameters will be configured by GMS System Maintainers in processing configuration rather than directly by analysts. Examples of these parameters include:

- Phase-specific models
- Model-specific tuning parameters and locations
- Correction definitions and locations
- Overridable defining settings
- Uncertainty definitions
- Required location solutions

This service is configured to use the traditional earth models and corrections used at the International Data Centre (IDC) but can also be extended to use advanced 3D earth models and complex correction surfaces.

GMS Geophysical Monitoring System

Sandia National Laboratories

SnT 2025 8 SEPTEMBER ONLINE DAY 9 TO 12 SEPTEMBER AT HOFBURG PALACE, VIENNA & ONLINE
CTBT: SCIENCE AND TECHNOLOGY CONFERENCE

Event Location in the Geophysical Monitoring System (GMS)

N. McMahon, M. Harris, and K. Aur

P3.5-245

Location Display Interactivity

The Location Display (below) allows analysts to interactively set detection associations and phases, defining features (time, azimuth, slowness), and custom location restraints (latitude, longitude, depth, time).

Location Details and History

The Location Display (below) allows analysts to view location details and the history of computed location solutions. Computed location solutions and uncertainty ellipses are plotted on the Map Display (right).

Location

Locate | Custom Restraint | No Custom Restraint | Full History: | Show Columns

Preferred		Time	Time std dev (s)	Lat (°)	Lon (°)	Depth (km)	Depth std dev ...	Restraint	# Associated	# Defining	Sdobs	Event notification
●		2019-01-05 18:27:08.801	12.313	-6.278	129.828	118.672	127.585	Unrestrained	12	5	0.220	
★ ○		2019-01-05 18:26:53.524	2.886	-5.164	131.156	0.000		Fixed At Surface	12	5	1.752	
○		2019-01-05 18:27:01.159	2.735	-5.696	130.422	50.000		Fixed At Depth	12	5	0.709	
☆ ✓		2019-01-05 18:27:06.996		-6.495	129.538	105.967		Unrestrained	12	5	1.061	

Defining: Allow all stations | Set to prev location | Set to defaults | Show Columns

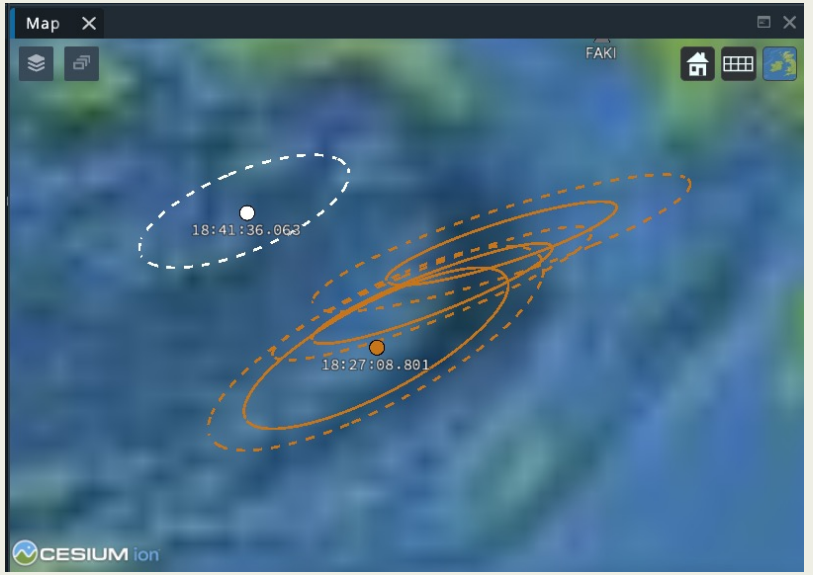
Associated Signal Detections							Time					Azimuth				
			Station	Channel	Ph... 1	Di... 2	Az (°)	Observed (s)	Std dev (s)	Residual (s)	Used	Def	Observed (°)	Std dev (°)	Residual ...	Used	Def
			ASAR	ASAR.be...	P	17.843	167.718	2019-01-05 18:31:06.100	0.685	-0.097	✓	✓	340.816	1.637	-5.763	✓	✓
			CMAR	CMAR.b...	P	39.282	309.663	2019-01-05 18:34:25.200	1.708	0.451	✓	✓	127.924	10.638	1.862	✓	✓
			MKAR	MKAR.b...	P	67.764	326.910	2019-01-05 18:37:51.850	0.889	-0.140	✓	✓	114.232	7.581	-13.244	✓	✓
			KURK	KURK.be...	P	72.036	328.619	2019-01-05 18:38:17.725	1.252	-0.105	✓	✓	126.286	4.621	1.032	✓	✓
			WRA	WRA.be...	Pn	14.362	162.644	2019-01-05 18:30:21.150	0.685	-0.028	✓	✓	342.301	0.952	0.791	✓	✓
			WRA	WRA.be...	Sx	14.362	162.644	2019-01-05 18:33:03.850	1.449				336.733	1.468			
			WRA	WRA.be...	Sx	14.362	162.644	2019-01-05 18:33:12.425	1.589				332.185	1.578			
			WRA	WRA.be...	Sx	14.362	162.644	2019-01-05 18:32:55.050	1.581				331.523	1.060			
			ASAR	ASAR.be...	Sx	17.843	167.718	2019-01-05 18:34:15.000	1.231				343.633	2.807			
			ASAR	ASAR.be...	tx	17.843	167.718	2019-01-05 18:31:37.450	1.684				353.885	6.816			
			ASAR	ASAR.be...	tx	17.843	167.718	2019-01-05 18:31:30.600	1.678				333.159	3.779			
			MKAR	MKAR.b...	tx	67.764	326.910	2019-01-05 18:37:59.400	1.709				107.080	14.569			

Loading Complete | Sdobs: 0.220 | Current Phase: P | Rows: 0 | Stations: 0 | Channels: 0 | Waveforms: 0 | Events: 0 | Signal Detections: 0 | 18:17 UTC

LocOO3D Validation Efforts

Validation of the new functionality included in LocOO3D, e.g., infrasonic phase predictions, and comparisons of the LocOO3D-produced locations against the IDC's LocSAT-produced Late Event Bulletin (LEB) locations are underway with promising initial results.

The primary difficulty arises in ensuring that LocOO3D is tuned exactly the same as LocSAT. Strong communications between the IDC and Sandia National Laboratories have helped progress validation efforts.



Sandia National Laboratories