ELECTRONIC SUPPLEMENT

Partially non-ergodic ground motion model for the Bucaramanga seismic nest in Northern South America (NoSAm Nest GMM).

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ABSTRACT

The Bucaramanga seismic nest has the highest concentration of seismic events with magnitudes over 4.8 worldwide. Despite the nest depth, these events play a crucial role in the seismic hazard assessment for several cities in northern South America (NoSAm), particularly those situated close to their epicenters. Moreover, these earthquakes are widely felt across the country, even hundreds of kilometers away from the nest. This paper assesses the performance of commonly used subduction intra-slab Ground Motion Models (GMMs) in predicting the updated nest database gathered and processed by the Colombian Geological Survey. This analysis confirms the necessity of a partially non-ergodic ground motion model for estimating the spectral acceleration produced by Bucaramanga nest earthquakes in northern South America. The GMM presented herein is the first model developed specifically for seismic nests in the region and is conceived as a regionalization of the recent NGA-Sub Abrahamson and Gülerce (2022) GMM. Additionally, we provide estimates of the variance components at both the earthquake and station levels and compare the developed GMM with the spectral accelerations recorded for typical earthquakes, for the highest magnitude earthquake in the database, and for the most recent Bucaramanga nest earthquake having a moment magnitude over 5.

Keywords: ground motion model - GMM; seismic nest; Northern South America; Colombia; period-based site characterization; intermediate seismicity; deep earthquakes.

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Table E 1 Database of Bucaramanga nest earthquakes selected for the GMM development.

EQID Code	Date (dd/mm/Yiyi)	Time UTC (HH: mm:ss)	Epicenter Latitude [°]	Epicenter Longitude [°]	Magnitude [Mw]	Hypocenter Depth [km]	No. of Records
CO_19950520221900	20/05/1995	22:19:00	5.508	-73.811	5.25	146.8	5
CO_19970101043553	01/01/1997	4:35:53	6.742	-72.933	5.29	160.9	11
CO_20011119210124	19/11/2001	21:01:24	6.731	-72.904	5.27	161.0	3
CO_20050225064124	25/02/2005	6:41:24	6.712	-73.013	5.32	158.7	8
CO_20060110031441	10/01/2006	3:14:41	6.683	-72.937	5.02	156.5	6
CO_20060508150739	08/05/2006	15:07:39	6.732	-72.982	4.91	164.4	7
CO_20070506044714	06/05/2007	4:47:14	6.725	-72.961	5.37	161.3	14
CO_20080217211502	17/02/2008	21:15:02	6.725	-72.983	5.37	156.0	13
CO_20090420085402	20/04/2009	8:54:02	7.682	-73.388	5.09	123.7	6
CO_20091027162553	27/10/2009	16:25:53	6.706	-72.949	5.14	159.4	13
CO_20120224134317	24/02/2012	13:43:17	6.646	-73.005	5.09	164.1	7
CO_20120901050945	01/09/2012	5:09:45	6.652	-72.980	5.09	163.4	5
CO_20130725120926	25/07/2013	12:09:26	6.677	-73.085	4.96	157.3	5
CO_20140207203711	07/02/2014	20:37:11	6.792	-73.067	5.27	158.3	12
CO_20141125202015	25/11/2014	20:20:15	6.826	-73.096	5.02	158.8	15
CO_20141214014930	14/12/2014	1:49:30	5.447	-73.704	4.84	149.4	13
CO_20150310205544	10/03/2015	20:55:44	6.780	-72.990	6.25	155.0	23
CO_20150322222737	22/03/2015	22:27:37	6.800	-73.150	4.90	154.6	18
CO_20151014074719	14/10/2015	7:47:19	7.650	-73.300	5.13	125.7	13
CO_20160211071437	11/02/2016	7:14:37	6.820	-73.140	4.50	154.0	13
CO_20160309062717	09/03/2016	6:27:17	6.840	-73.150	4.70	148.0	12
CO_20160922104217	22/09/2016	10:42:17	6.770	-72.970	4.80	151.5	15
CO_20170201001826	01/02/2017	0:18:26	6.770	-73.160	4.70	149.0	14
CO_20170224105415	24/02/2017	10:54:15	6.800	-73.170	4.50	150.0	10
CO_20170321103019	21/03/2017	10:30:19	7.150	-73.920	4.60	100.0	17
CO_20170414221607	14/04/2017	22:16:07	8.320	-72.960	4.80	186.0	12
CO_20170417074924	17/04/2017	7:49:24	6.790	-73.140	4.60	145.0	16
CO_20170527121548	27/05/2017	12:15:48	6.820	-73.140	4.60	154.0	14
CO_20170913030703	13/09/2017	3:07:03	9.600	-73.190	4.70	132.0	6
CO_20170929225203	29/09/2017	22:52:03	6.840	-73.150	4.70	155.0	18
CO_20171001013525	01/10/2017	1:35:25	7.530	-73.150	5.18	128.6	26
CO_20180108125827	08/01/2018	12:58:27	6.790	-72.980	4.99	153.4	16

EQID Code	Date (dd/mm/Yiyi)	Time UTC (HH: mm:ss)	Epicenter Latitude [°]	Epicenter Longitude [°]	Magnitude [Mw]	Hypocenter Depth [km]	No. of Records
CO_20180531030210	31/05/2018	3:02:10	6.760	-72.934	4.61	160.3	16
CO_20180807155359	07/08/2018	15:53:59	6.790	-72.990	5.38	148.8	16
CO_20181129053156	29/11/2018	5:31:56	6.840	-73.150	4.50	148.0	18
CO_20190525151337	25/05/2019	15:13:37	6.810	-73.120	4.80	145.0	15
CO_20190609194318	09/06/2019	19:43:18	6.810	-73.170	4.60	152.0	19
CO_20190616161836	16/06/2019	16:18:36	6.820	-73.150	4.60	143.0	17
CO_20190713023903	13/07/2019	2:39:03	10.180	-73.130	4.90	126.0	9
CO_20200114175709	14/01/2020	17:57:09	6.820	-73.150	4.60	150.0	18

Table E 2. Database of stations selected for the GMMs development.

Station ID	**Station Latitude [°]**	**Station Longitude [°]**	**Predominant Period [s]**	**P***	**No. of Records**
RNAC_3	9.858	-74.246	0.44	1.78	9
RNAC_5	6.592	-73.184	0.44	4.04	19
RNAC_8	6.973	-73.744	0.20	3.42	5
RNAC_14	5.261	-75.813	0.12	5.83	4
RNAC_22	4.250	-74.434	0.24	1.73	4
RNAC_35	7.107	-73.712	0.18	6.10	10
RNAC_43	7.072	-73.074	0.18	3.25	6
RNAC_47	6.998	-73.069	0.10	2.67	4
RNAC_49	7.071	-73.073	0.25	4.65	4
RNAC_72	4.569	-73.705	0.34	1.79	6
RNAC_81	7.898	-72.487	0.34	3.49	12
RNAC_82	7.871	-72.504	0.32	2.39	19
RNAC_94	5.467	-73.735	0.32	7.46	17
RNAC_97	7.018	-73.134	0.25	4.68	10
RNAC_100	5.065	-74.590	0.38	3.91	14
RNAC_138	7.379	-72.637	0.34	2.41	4
RNAC_146	5.391	-75.158	0.34	8.91	6
RNAC_150	4.600	-74.922	0.68	3.06	5
RNAC_152	6.290	-74.939	0.32	1.95	8
RNAC_171	4.634	-74.088	0.38	2.97	6
RNAC_183	8.056	-72.795	0.30	2.78	7
RNAC_187	5.999	-74.939	0.62	2.48	3
RNAC_190	5.678	-75.329	0.20	2.89	4
RNAC_212	5.554	-73.358	0.20	3.09	13
RNAC_228	5.032	-75.120	0.48	1.51	13
RNAC_230	4.177	-73.639	0.26	1.91	5
RNAC_242	7.017	-76.210	0.16	1.37	16
RNAC_243	9.607	-73.523	0.46	1.70	9
RNAC_248	5.226	-75.383	0.92	1.96	14
RNAC_253	5.072	-75.524	0.56	4.66	22
RNAC_257	6.276	-75.589	0.30	2.45	14
RNAC_273	5.058	-75.471	0.24	1.35	10
RNAC_274	5.564	-74.869	0.15	2.70	26
RNAC_275	8.239	-73.320	0.28	1.94	15
RNAC_278	7.340	-72.700	0.26	1.46	23
RNAC_281	6.992	-73.064	0.25	3.44	6
RNAC_290	6.540	-74.456	0.09	2.07	17
RNAC_313	4.960	-75.353	0.22	4.66	16
RNAC_317	4.845	-74.321	0.80	2.57	21
RNAC_319	9.897	-75.180	0.14	2.00	5
RNAC_320	11.164	-74.225	0.12	1.56	3
RNAC_323	5.652	-74.072	0.12	2.42	12
RNAC_324	6.435	-71.791	0.46	2.01	19
RNAC_328	7.752	-75.533	0.25	7.64	14
RNAC_331	10.509	-73.258	0.02	1.99	5
RNAC_332	4.111	-73.693	1.00	6.20	17
RNAC_334	5.397	-72.380	0.50	2.83	13

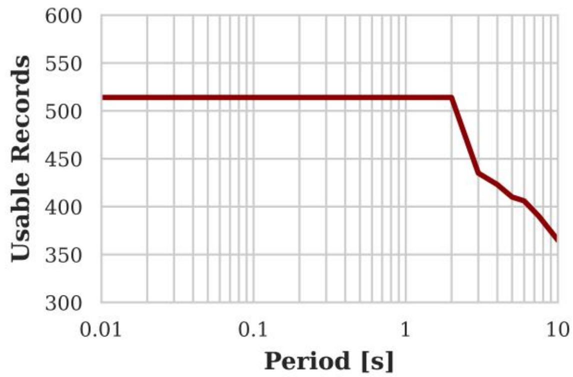

Figure E 1. Number of usable records per spectral period