ASSESSMENT OF TEMPORAL VARIATIONS OF NATURAL RADIONUCLIDES BERYLLIUM-7 AND LEAD-212 IN SURFACE AIR IN TANAY, PHILIPPINES

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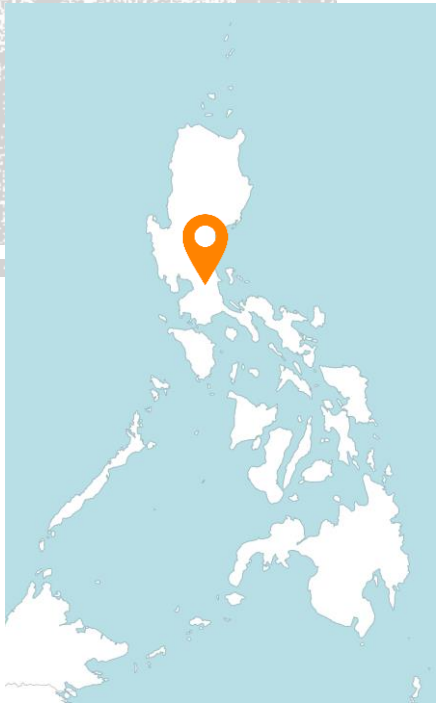
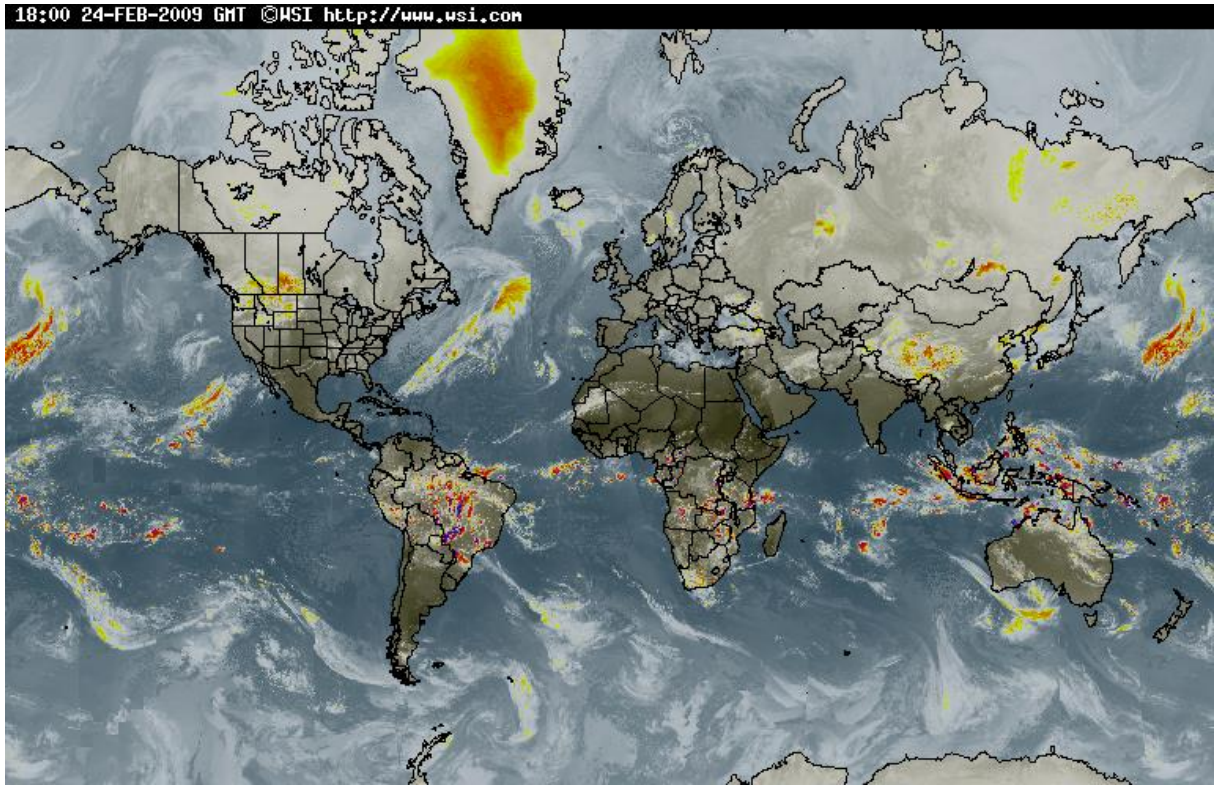


INTRODUCTION

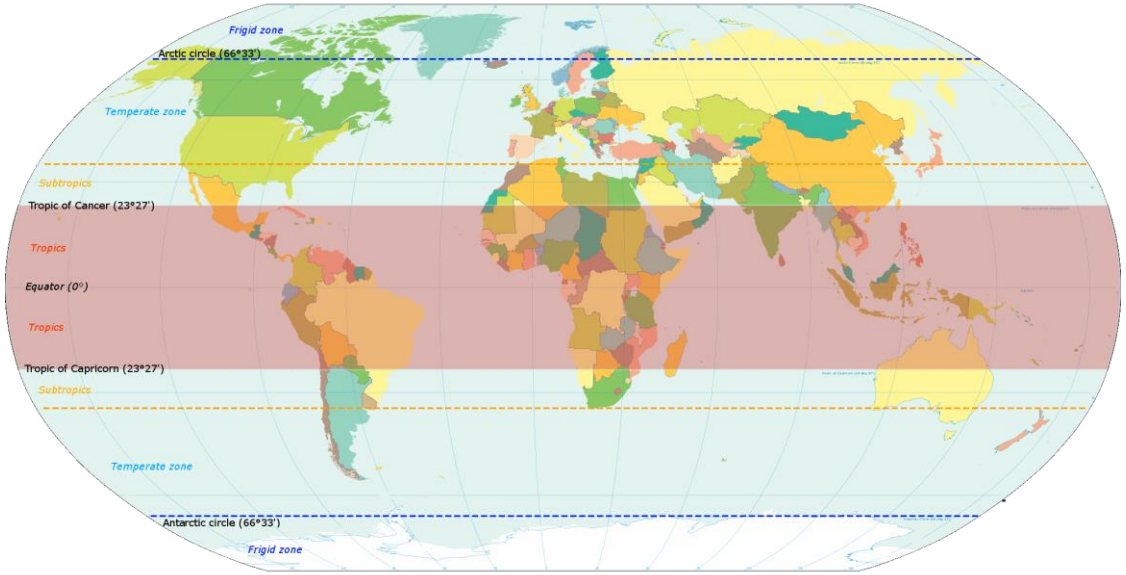
- Natural radionuclides such as ^{7}Be and ^{212}Pb are widely used as tracers for environmental processes.
- Understanding the behavior of radionuclides in aerosols and the atmospheric processes affecting radionuclide distribution is beneficial for an effective nuclear and radiological emergency preparedness and response system.



Weather gif n.d., image. Available from: https://media.giphy.com/media/deuCIIvRU8lGw/giphy.gif

INTRODUCTION

- Temporal variations of natural radionuclides in surface air in the tropics (0°-25° band) have been scarce in previous literatures
- In Southeast Asia, studies on the spatial and temporal variations of natural radionuclides in surface air are limited



Wikimedia Commons, *2013. World map indicating tropics and subtropics* n.d., image. Available from: https://commons.wikimedia.org/wiki/File:World_map_indicating_tropics_and_subtropics.png [24 May 2019].

INTERNATIONAL MONITORING SYSTEM

RADIONUCLIDE NETWORK - CERTIFIED STATIONS AND NON-CERTIFIED STATIONS

20 MAY 2019

CTBTO PREPARATORY COMMISSION | preparatory commission for the comprehensive nuclear-test-ban treaty organization

IMS Radionuclide Monitoring Station
RN52 (Station Code: PHP52)
14.581861 N, 121.369639 E

STATION STATUS

DATE	20 May 2019
TOTAL STATIONS	80
PLANNING	6
UNDER CONSTRUCTION	2
INSTALLED	0
CERTIFIED	70

SP Primary Seismic | SA Auxiliary Seismic | I Infrasound | H Hydroacoustic | R Radionuclide | RG Radionuclide w/ Noble Gas | RL Radionuclide Lab

WWW.CTBTO.ORG

PURPOSE OF THE STUDY

- To determine seasonal variations of Beryllium-7 and Lead-212 in surface air in Tanay, Philippines
- To identify the atmospheric conditions and processes affecting radionuclide concentrations in surface air
- To understand the atmospheric dynamics involved in the global distribution of radionuclides in the atmosphere
- To utilize CTBTO IMS data and IDC products for various civil and scientific applications

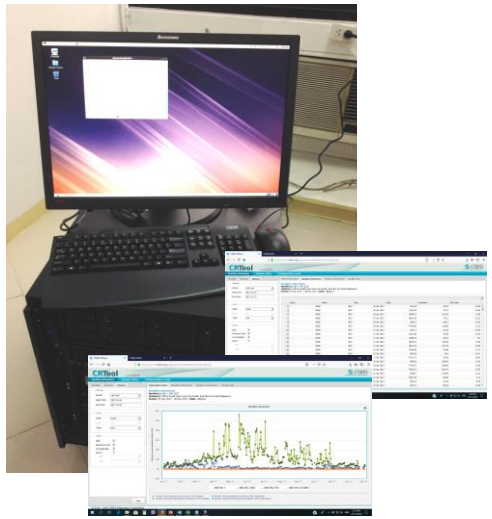
METHODOLOGY

SAMPLE COLLECTION AND ANALYSIS

Sample Collection (24 h)

Processing and Decay (24 h)

Analysis by Gamma Spectroscopy (24 h)

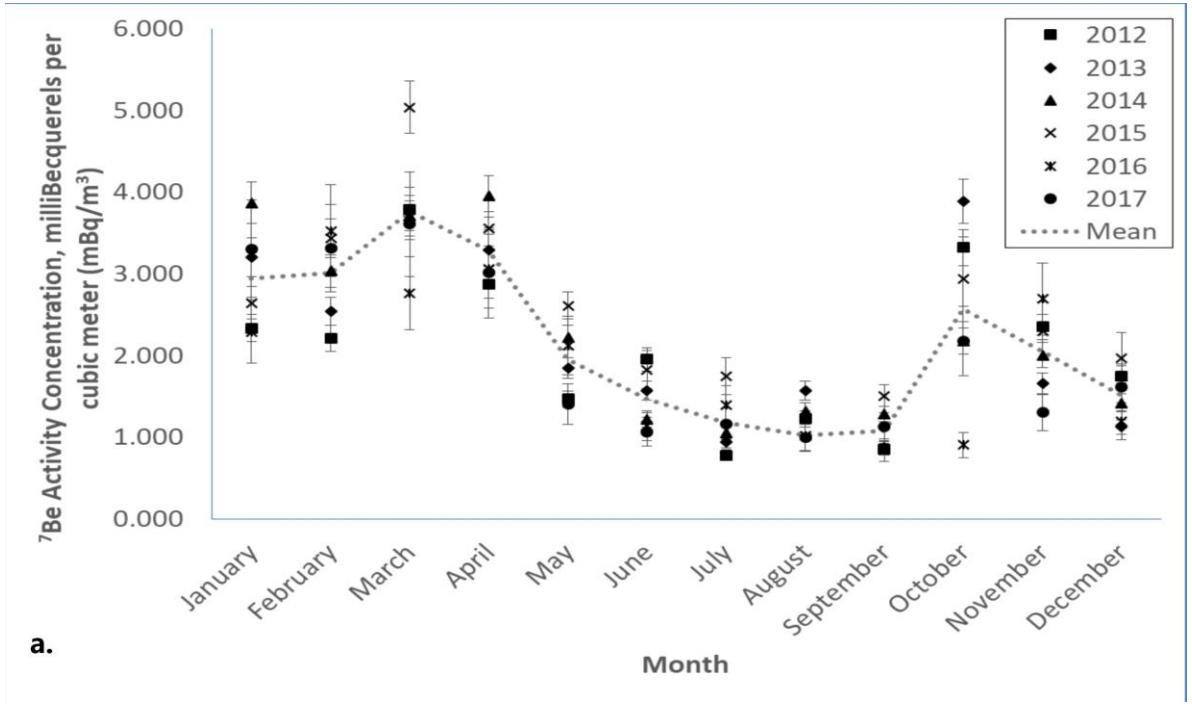


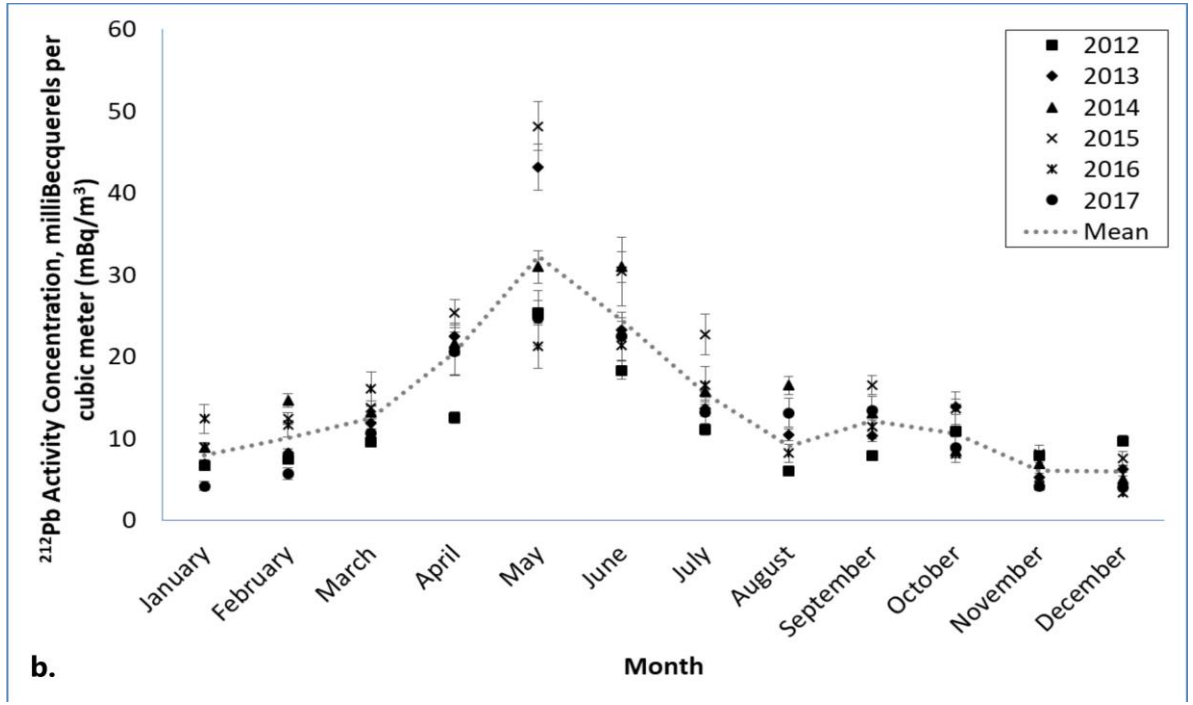
Data retrieval

- nms_client
- autoDRM
- CRTool

RESULTS AND DISCUSSION

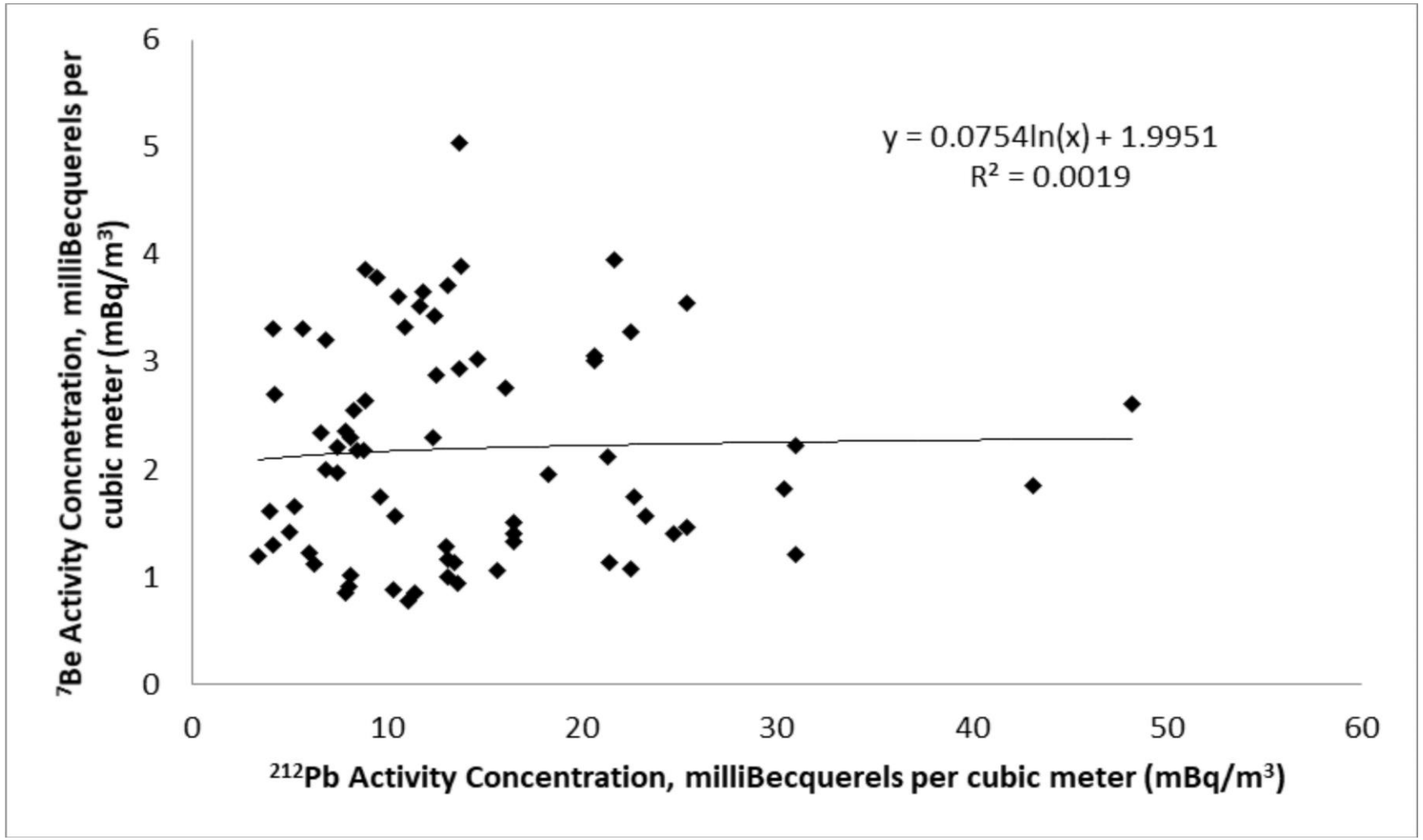
TEMPORAL VARIATIONS OF ^{7}BE AND ^{212}PB



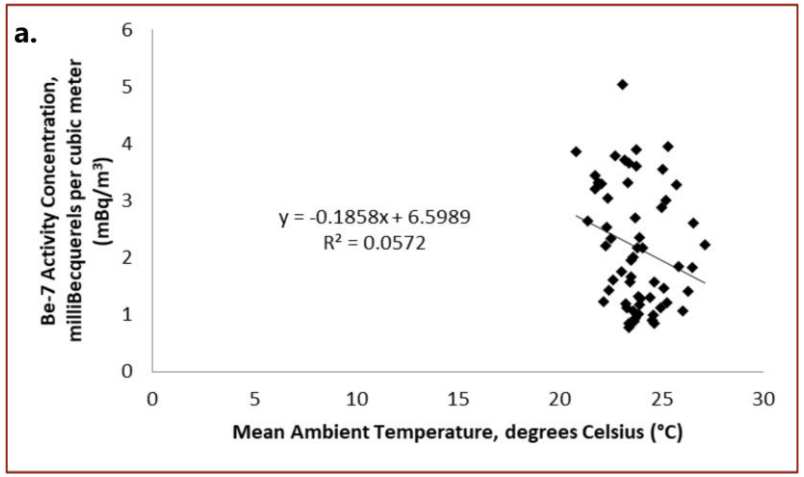


Be-7 Range: 0.00779±0.00188 – 11.2±0.116 mBq/m^3

Pb-212 Range: 1.371±0.036 – 106.6±1.075 mBq/m^3

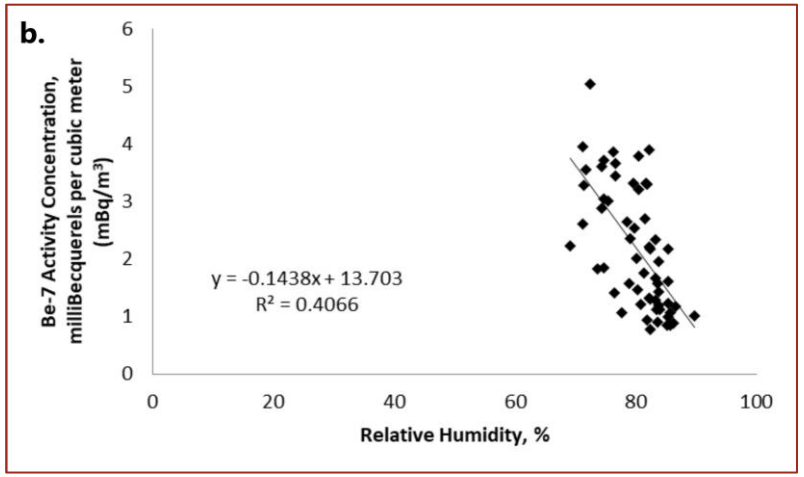

y = 0.0754ln(x) + 1.9951
R² = 0.0019
⁷Be Activity Concnetration, milliBecquerels per cubic meter (mBq/m³)
²¹²Pb Activity Concentration, milliBecquerels per cubic meter (mBq/m³)
0
1
2
3
4
5
6
0
10
20
30
40
50
60

^{7}Be vs Temperature (^{o}C)



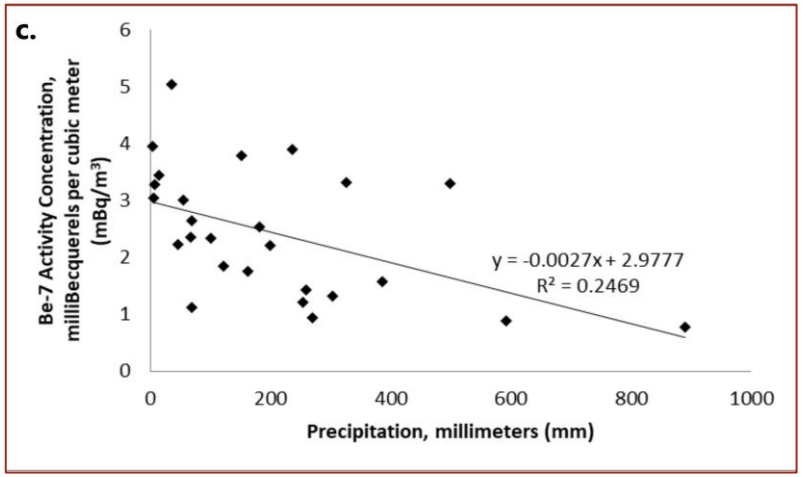
ρ = -0.23919, r^2 = 0.0572

^{7}Be vs Rel. Humidity (%)



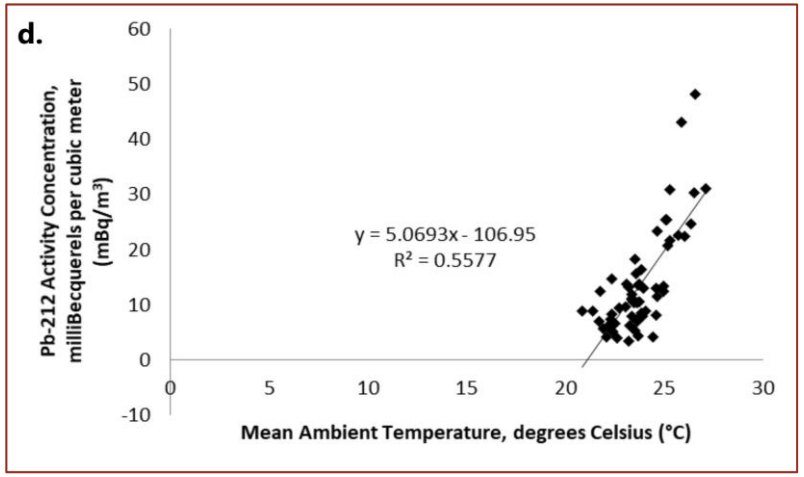
ρ = -0.63769, r^2 = 0.4066

^{7}Be vs Precipitation (mm)



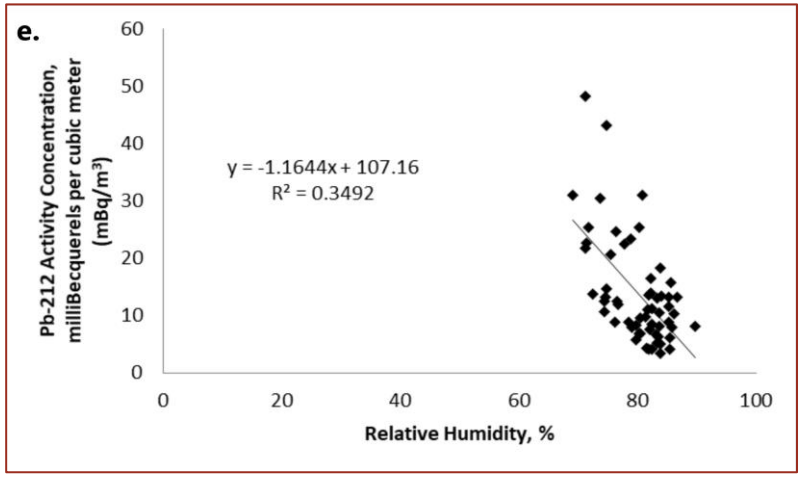
ρ = -0.49690, r^2 = 0.2469

^{212}Pb vs Temperature (^{o}C)



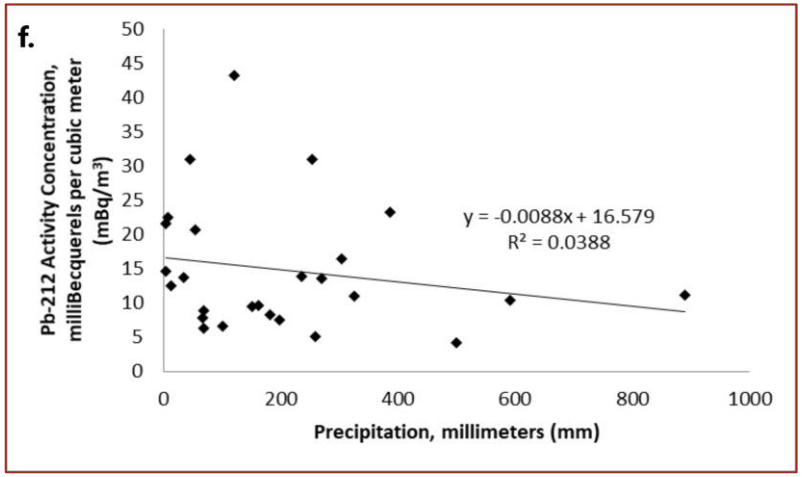
ρ = 0.74681, r^2 = 0.5577

^{212}Pb vs Rel. Humidity (%)



ρ = -0.59096, r^2 = 0.3492

^{212}Pb vs Precipitation (mm)



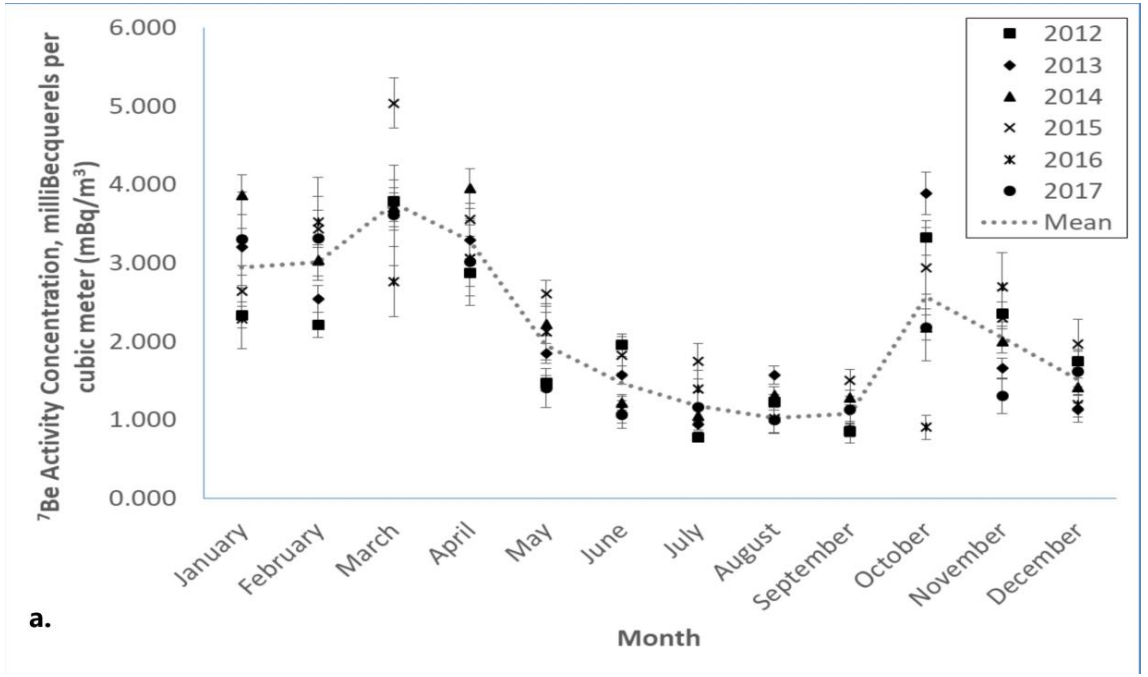
ρ = -0.19709, r^2 = 0.0388

Table 1. Pearson's correlation coefficient (ρ) and coefficient of determination (r^2) values between activity concentrations and atmospheric parameters

Radionuclide	Ambient Temperature		Relative Humidity		Precipitation	
	ρ	r^2	ρ	r^2	ρ	r^2
^{7}Be	-0.23919	0.0572	-0.63769	0.4066	-0.49690	0.2469
^{212}Pb	0.74681	0.5577	-0.59096	0.3492	-0.19709	0.0388

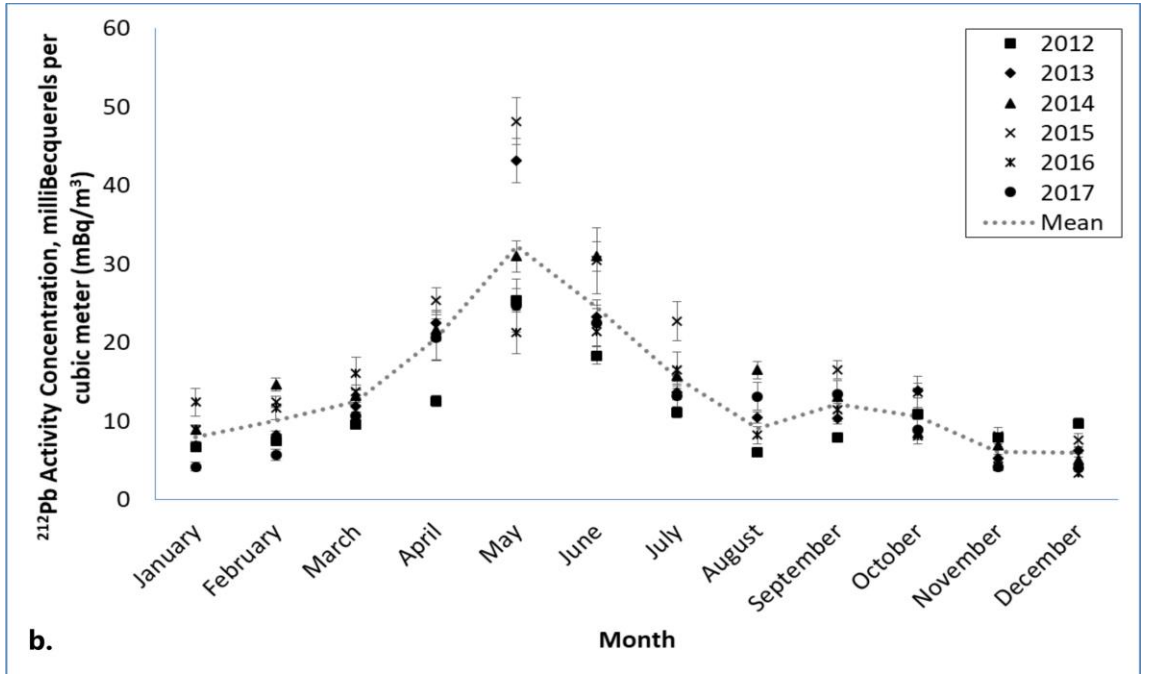
TEMPORAL VARIATIONS OF ^{7}BE

- Overall annual trend of ^{7}Be concentrations is similar to that observed in Shanghai, China (Du et al., 2015)
- ^{7}Be increase can be associated with large-scale subsidence of ^{7}Be-rich winds from the stratosphere and upper troposphere (Lal and Peters, 1967; Du et al., 2015; Heinrich & Pilon, 2013)



TEMPORAL VARIATIONS OF ^{212}PB

- Surface air concentrations of terrestrial radionuclides such as ^{212}Pb are dependent on the emanation rate of their parent noble gas (^{220}Rn for ^{212}Pb)
- Higher temperatures experienced during the months of March to May result to warmer and drier soils (Villarin et al., 2016), increasing thoron release into the surface air.



CONCLUSIONS

- Atmospheric conditions and processes affect surface air ^{7}Be and ^{212}Pb concentrations in Tanay, Philippines independently
- Surface air ^{212}Pb in Tanay, Philippines increase with warmer ambient temperatures
- Strong stratosphere-troposphere exchange of air masses increases surface air ^{7}Be in Tanay, Philippines

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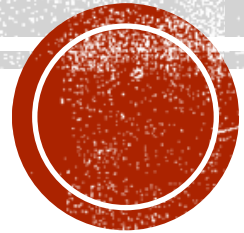

Table 3. Concentrations of ^{7}Be and ^{212}Pb in surface air at different locations.

Location	Coordinates	Altitude (m.a.s.l.)	Study Duration	^{7}Be Activity Concentration Range (mBq/m^3)	^{212}Pb Activity Concentration Range (mBq/m^3)	Reference
Tanay (Philippines)	14.581861 N, 121.369639 E	640	2012 - 2017	0.00779 ± 0.00188 - 11.2 ± 0.116	1.371 ± 0.036 - 106.6 ± 1.075	This study
Sao Paulo (Brazil)	23°33'58.27"S, 46 44'14.82"W	760	April 2011 – June 2013	0.31 ± 0.07 – 2.44 ± 0.15	--	Damatto et al., 2013
Kawasaki (Japan)	35°36'N, 139°31' E		2000 - 2003	--	20 – 50	Koike et al., 2005
Barcelona (Spain)	41°23'05.8"N, 2°07'02.3"E		2001-2005	3.6 ± 1.1 (mean)	2.1 ± 1.1 $\mu Bq/m^3$ (mean)	Vallés et al., 2009
Yamagata (Japan)	38.25° N, 140.35° E	168.33	2000-2008	3.97 ± 2.66 (mean)	--	Kikuchi et al., 2009
Puy de Dôme (France)	45°46'20" N, 2°57'57" E	1465	2006-2008	3.64 ± 0.41 - 10.7 ± 1.0	--	Bourcier et al., 2011
Opme (France)	45°43'00" N, 3°5'30" E	660	2006-2008	1.73 ± 0.50 - 7.73 ± 2.13	--	Bourcier et al., 2011
Kanazawa University (Japan)	36°26' N, 136° 32' E	40	2004	0.77 – 6.28	9.04 – 189	Abe et al., 2010
Shishiku Plateau, Ishikawa (Japan)	36°27' N, 136°39' E	640	2004	0.72 – 7.44	6.57 – 23.2	Abe et al., 2010
Hegura Island (Japan)	37°51' N, 136°55' E	10	2004	0.72 – 6.81	3.58 – 44.0	Abe et al., 2010
Milan (Italy)			2000	--	13.0 - 333	Marcazzan et al., 2003
Panama City (Panama)	9.0° N, 79.5° W	90	2009-2015	2.307 ± 1.403 (annual mean)	--	Kuśmierczyk-Michulec & Bourgouin, 2018
Nouakchott (Mauritania)	18.1° N, 15.9° W	20	2009-2015	5.755 ± 1.807 (annual mean)	--	Kuśmierczyk-Michulec & Bourgouin, 2018
Kuwait City (Kuwait)	29.3° N, 47.9^{0} E	1	2009-2015	7.759 ± 3.230 (annual mean)	--	Kuśmierczyk-Michulec & Bourgouin, 2018