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The Global Appearance of Cs137 in IMS Samples and the Major Sources for Repeating Observations at the Same Station

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INTRODUCTION

For more than two decades Radiocesium (Cs-137) has been detected in many IMS samples with varying concentration.
The global appearance of Cs-137 in IMS sample was assessed and the major sources for repeating observation in JPP 38, RUP 61, KWP 40, SEP 63 and MRP 43 were identified

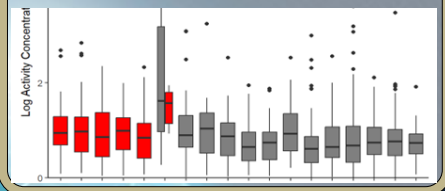
METHODS/DATA

IMS data for Cs 137 were retrieved from RNToolkit v.0.3.5. Statistical analysis were employed by using R-Programming tool. Atmospheric transport and dispersion modelling were performed.

START

RESULTS

Decreases in concentration of Cs-137 was observed at most IMS stations after Fukushima while having differences in number of occurrences.



CONCLUSION

The global appearance of Cs-137 in most stations is associated by resuspensions of Cs-137 to the atmosphere by different mechanisms like strong winds and forest fires from nuclear accidents including Chernobyl power plant accident , Fukushima as well as historic nuclear weapons tests.

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INTRODUCTION

- Large amounts of radionuclides including radiocesium Cs-137 (a main by-products of nuclear fission processes in nuclear reactors and nuclear weapons testing) released into the atmosphere, resulting in the contamination of terrestrial and marine environments.
- Radiocesium (Cs-137) is most frequently studied anthropogenic radionuclide that originates in nuclear fission, based on its radioecology importance, it is considered the most important radionuclide found in the environment due to its high fission yield, long physical half-life (30.07 years), high solubility and physicochemical properties similar to potassium.
- For more than two decades, Cs-137 has been detected in many IMS samples with varying concentrations. This study aims at assessing the global appearance of Cs-137 and identification of the major sources for repeating observations in selected stations located in Africa (MRN 43), Europe (SEP 63 & RUP 61) and Asia (KWP 40 & JPP 38).

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OBJECTIVES

The main objective of this study is to assess the global appearance of Cs-137 in IMS samples before and after Fukushima accident

Specific objectives:

- To ascertain trends of Cs-137 in IMS samples
- To compare number of occurrence of Cs-137 before and after Fukushima accident
- To identify the potential source region of the Cs-137 release

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METHODS/DATA

- IMS data of Cs-137 of almost two decades (20 years) retrieved from RNToolkit v.0.3.5.
- Median concentration of the monthly values were used in the analysis
- Statistical analysis were employed by using R-Programming tool.
- Atmospheric transport and dispersion modelling were performed. Backward trajectories were generated using the web-based Real-time Environmental Applications and Display sYstem (READY) environmental modelling software (Rolph et al., 2015).
- A backward trajectory model for a single source location was generated using archived Global Data Assimilation System (GDAS1) Meteorology data (gdas1.may13.w2; 1 degree, global, 2006-present).

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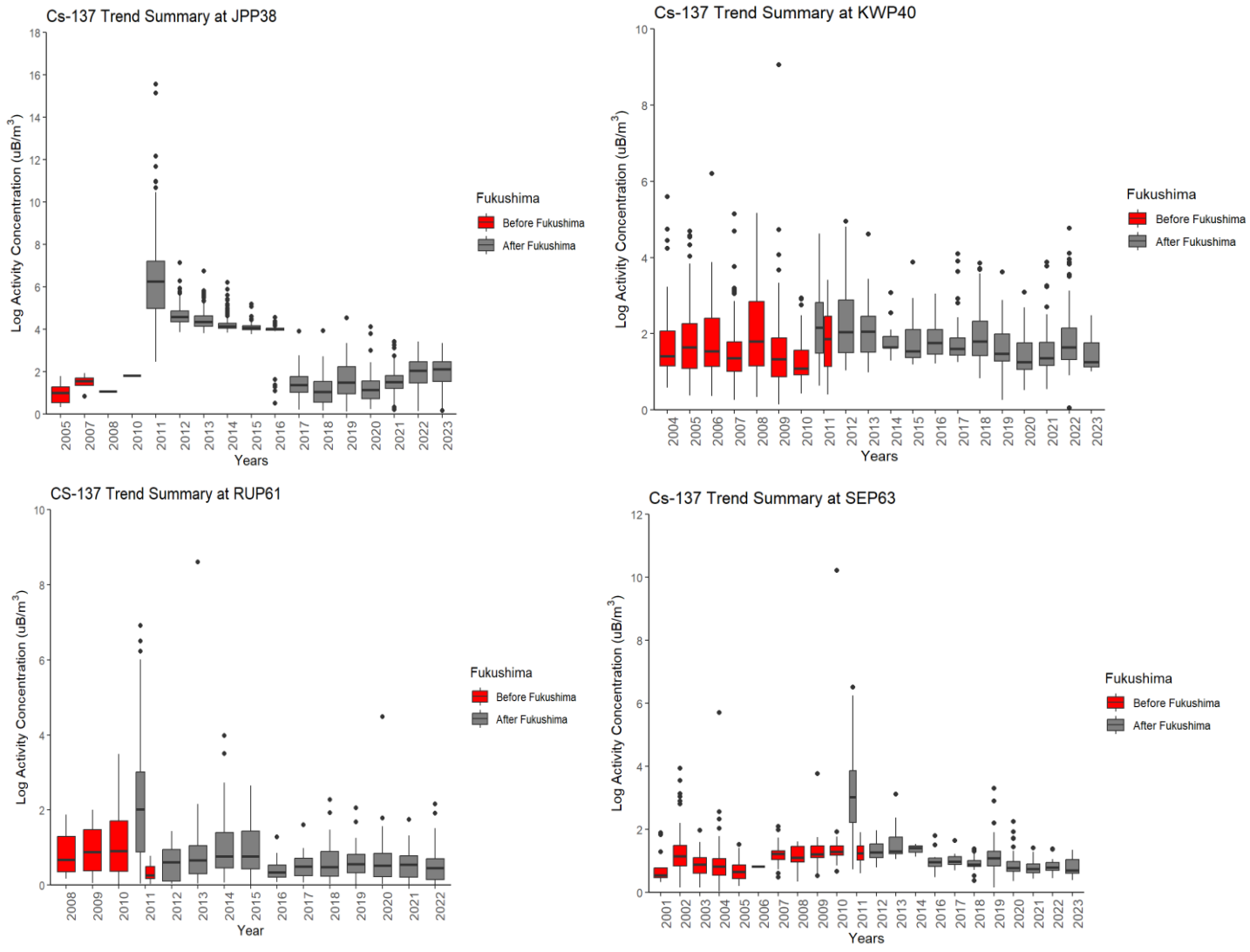

Fig 1: Variations of the monthly values of Cs 137 in Mauritania, Kuwait, Japan, Russia and Sweden from 2001-2023 and between 2004-2023

Cs-137 Trends from 2001-2023

Out of five stations, the highest activity concentrations of Cs-137 and largest range of concentrations before Fukushima accident were observed at the Kuwait (KWP40) in 2008 with total number of occurrence 214 followed by Sweden though Sweden detects Cs-137 since 2001. The jump of concentrations in 2016 at JPP38 indicates that there may have been a detector contamination that was cleaned up.

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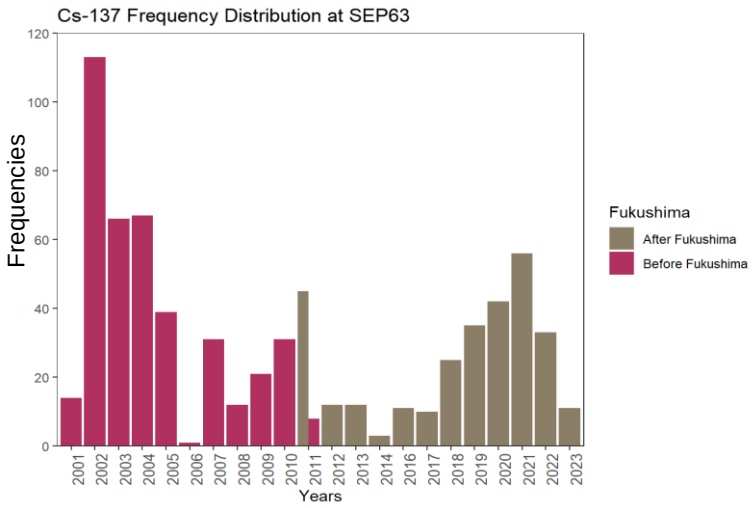

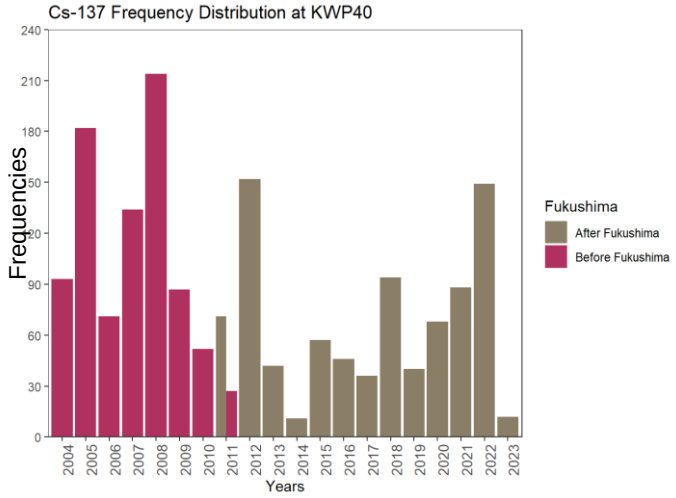

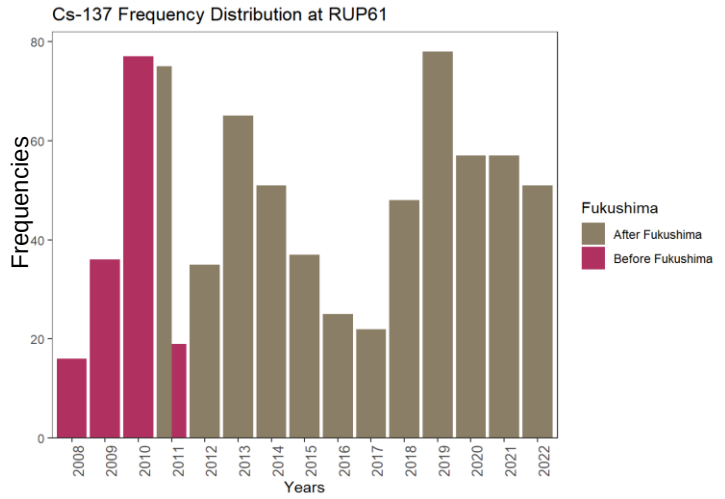

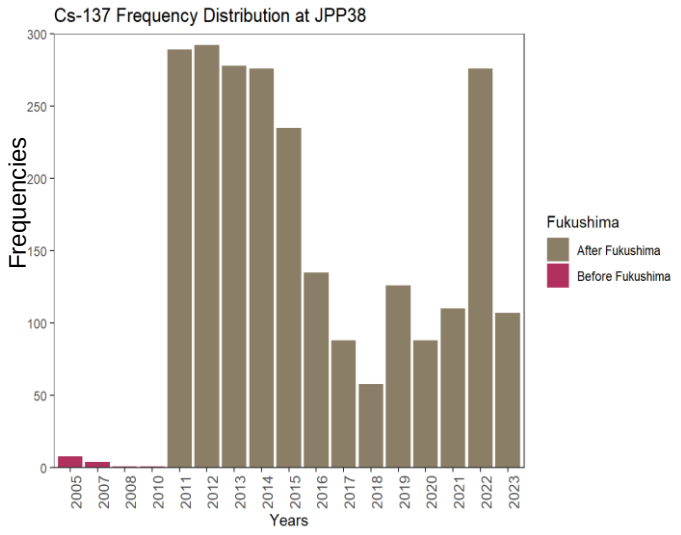

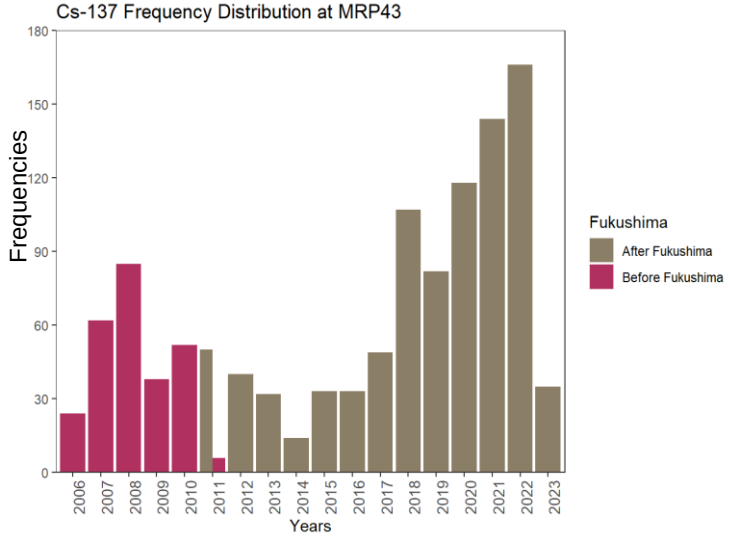

Fig 2: Occurrence of Cs 137 in Mauritania, Kuwait, Japan, Russia and Sweden from 2001-2023 and between 2004-2023

Frequency comparison before and after Fukushima accident

In addition to observing decrease in trend of Cs-137 concentration in many stations, variation of its occurrence before and after Fukushima accident were observed.

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Cs-137 occurrence before and after Fukushima accident

Sweden (SEP63) depicted 113 as the highest number of occurrence of Cs-137 in 2002 while in Mauritania (MRP43) it was 166 in 2022. The maximum activity concentration of Cs-137 MRP43 (264µB m^{-3}) was observed two weeks after Fukushima Accident (30th of March 2011).

Kuwait (KWP40) on the other hand depicted 214 as the maximum number of occurrence in 2008, Russia (RUP61) 77 in 2010. The decrease in Cs-137 activity concentration were observed at SEP63, MRP43 and KWP40 from 2011 to 2022. Meanwhile the number of occurrence of Cs-137 in JPP38 increased to 276 in 2022, with maximum activity concentration in 22.51µBm^{-3} on 7th of March 2022.

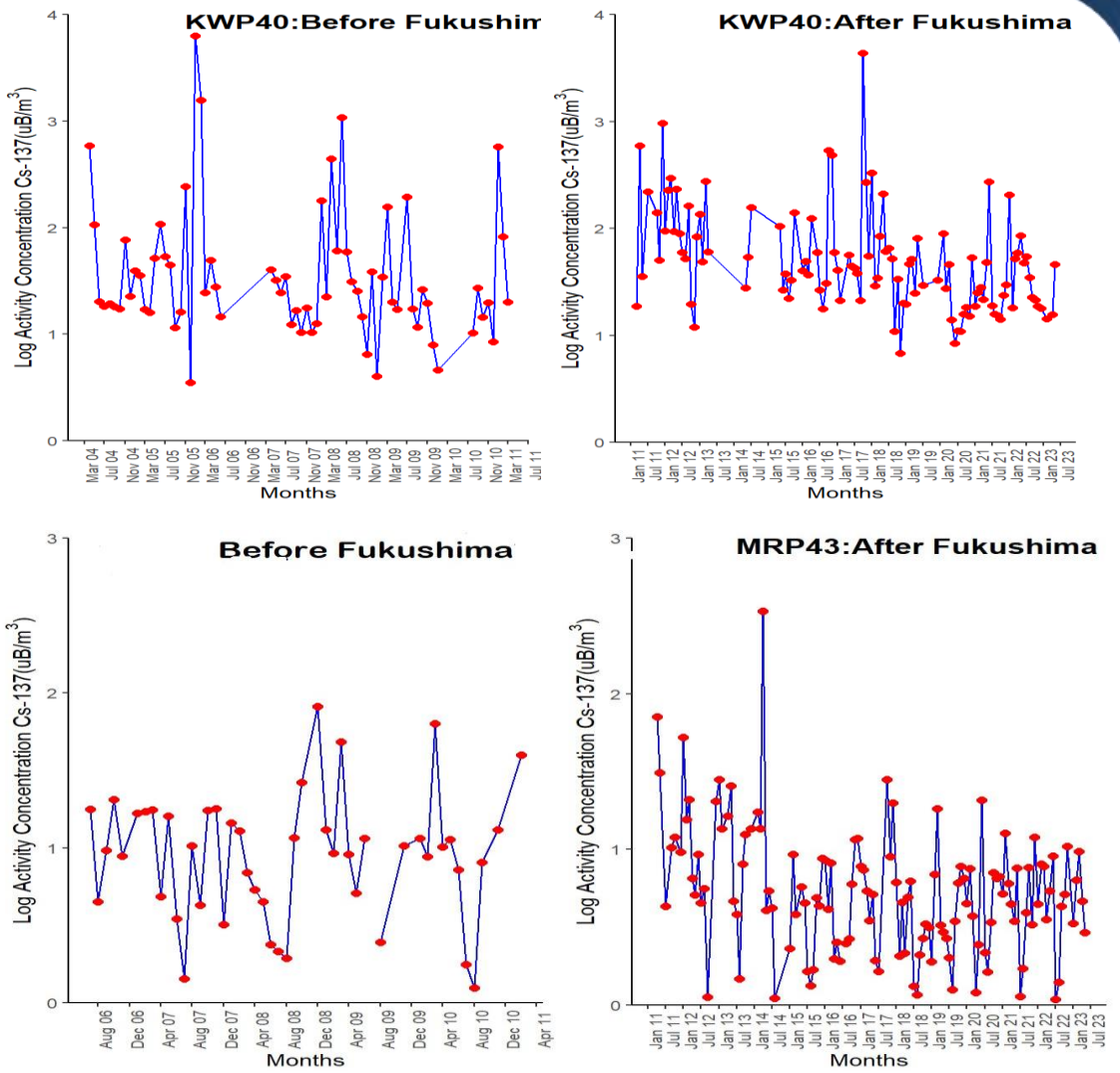

Fig 3: Variation of Cs-137 in KWP40 and MRP43 before and after Fukushima accident

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Source Identification

Based on measured activity concentrations of Cs-137 (25.36μB m^{-3}) recorded on 11th May 2022 in Japan (JPP38), (7.00μB m^{-3}) in Mauritania on 24th June 2022, (60.95μBm^{-3}) 17th May 2022 in Kuwait.

Seven days HYSPLIT backward trajectories from 11th - 4th of May 2022 for JPP38, 24th - 17th June 2022 for Mauritania and from 17th - 10th of May 2022 for KWP40 were performed.

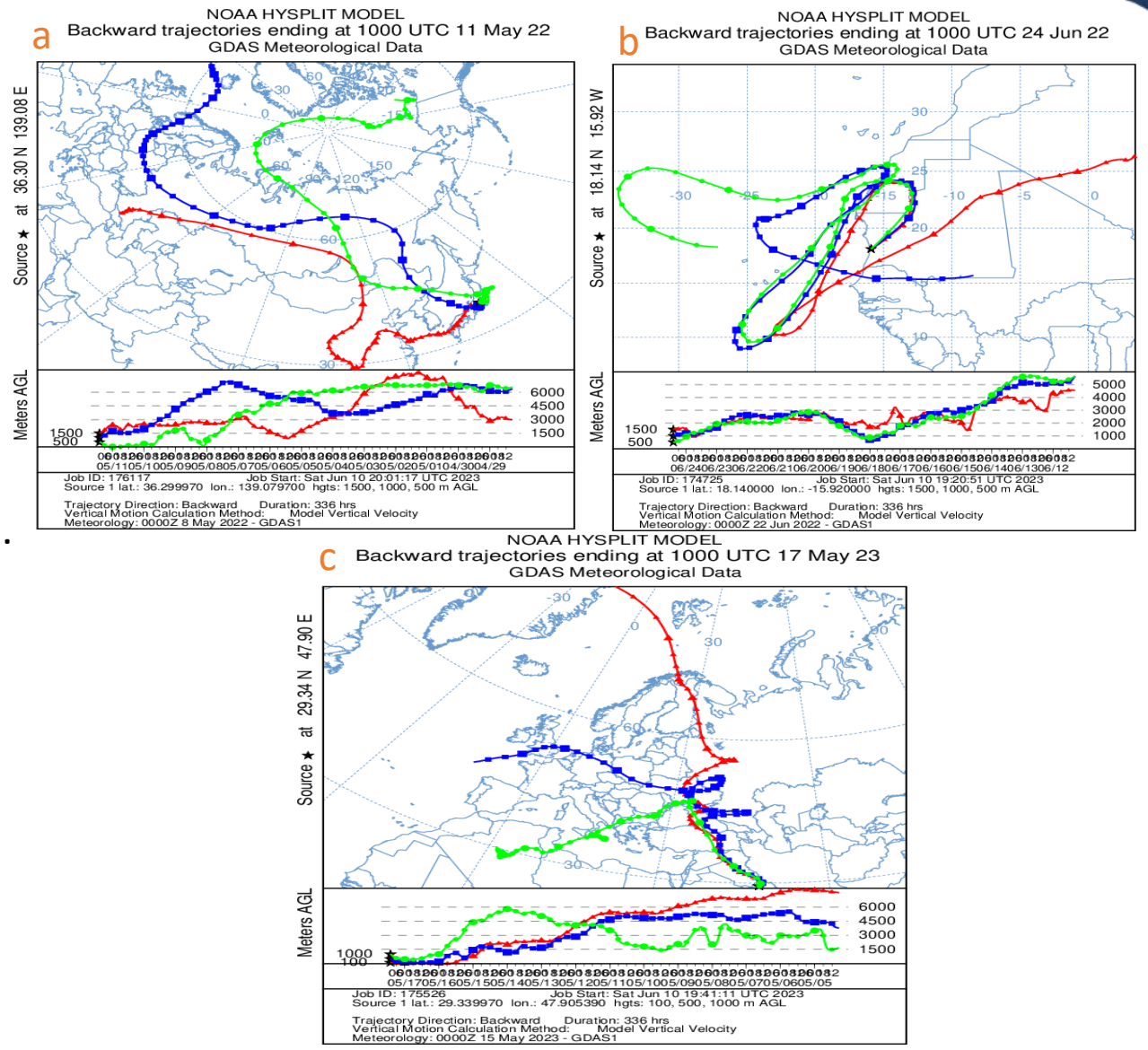

Fig 4: Backward trajectories for JPP38 (Fig 4a), MRP43(Fig 4b) and KWP40 (Fig 4c) in 2022

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- Based on trajectories in Kuwait (KWP40) Winds were from North Africa (Algeria) and some European countries. This implies that, Cs 137 in Kuwait can be associated with bomb test experiments in the Northern Hemisphere,, Fukushima and with a minor contribution from Chernobyl accident.
- For the case of JPP 38, The dust was transported across the East Asian continent and some parts of the Northern Hemisphere. The possible source could be re-suspension processes of the dust from the East Asian continent.
- Based on trajectories the air masses with Cs 137 in MRP43 were coming from the North Eastern part of Mauritania and possible Saharan dust as well as Mongolia dust which might be contaminated.
- Also trajectories were observed to come from the Atlantic Ocean, Cs 137 might be from JPP38.

Generally, based on the results it is evidently that the measured Cs-137 in IMS samples were resuspended into the atmosphere as remaining's from Past nuclear test and accidents. Cs-137 originating from Fukushima deposited on the ground surface and to a large extend still remains on the soil surface as a potential source of atmospheric Cs-137 in IMS samples.

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- Due to the long half-life of Cs-137, a significant portion of radiocesium released from past nuclear tests and reactor accidents is still present in the soil and can be resuspended into the atmosphere.
- The study demonstrate that there is a decrease in trend of Cs-137 activity concentration as observed in IMS samples after Fukushima.
- Detected Cs137 in IMS samples were transported by winds from geographic regions with possibly high background levels.
- This study provides preliminary results. Further research will be conducted based on identification and discrimination of emission sources of Cs-137 by using isotopic ratio with Cs-134 and other techniques.

REFERENCE

Stein AF, Draxler RR, Rolph GD, Stunder BJB, Cohen M (2015) NOAA's HYSPLIT atmospheric transport and dispersion modelling system.

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