

# **Assessing the effectiveness of radionuclide monitoring:**

## **a possible use for a natural airborne tracer**

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# Environmental monitoring 1.01

Major source of error and uncertainty

Sampling practice



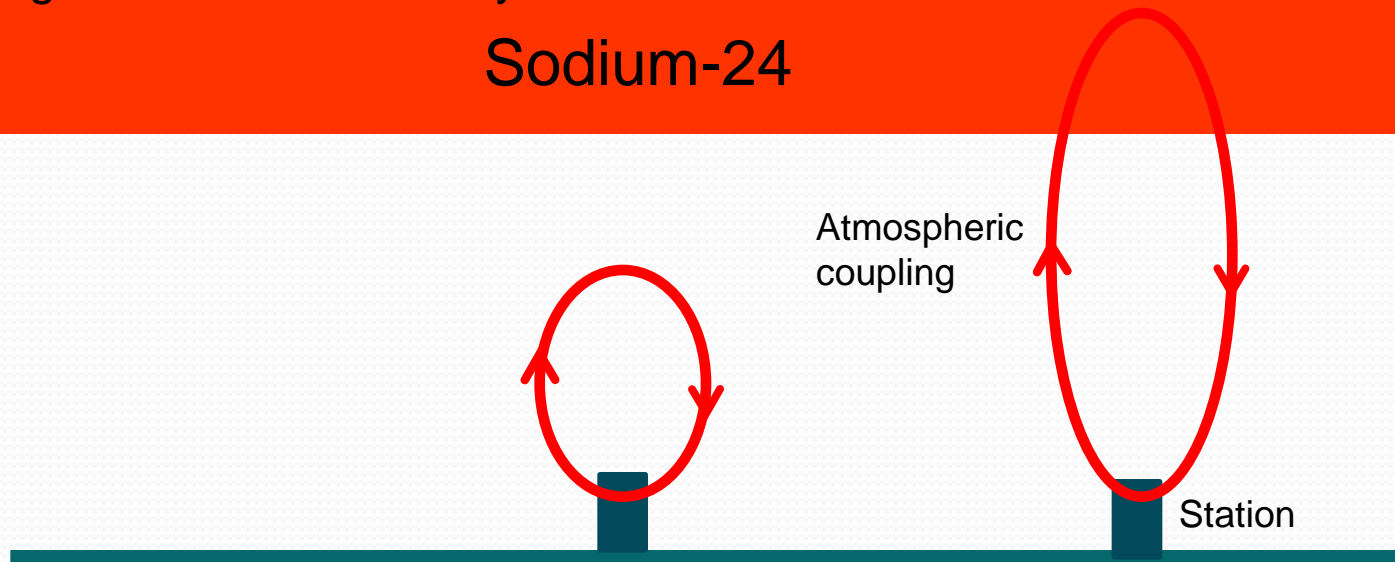
Laboratory precision



## The need for atmospheric coupling

High-altitude radioactivity

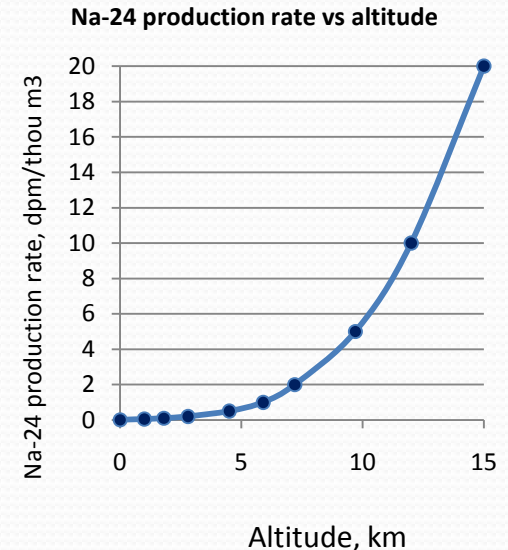
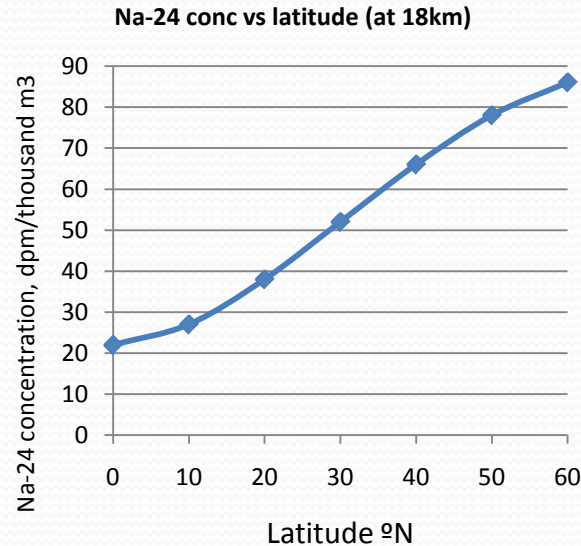
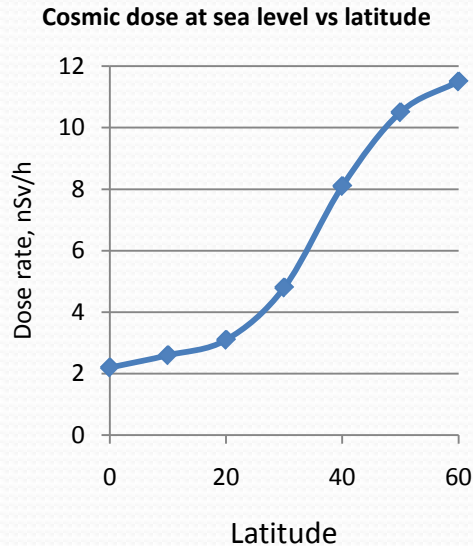
Sodium-24



Naturally occurring Na-24 may have application as a means of evaluating monitoring effectiveness

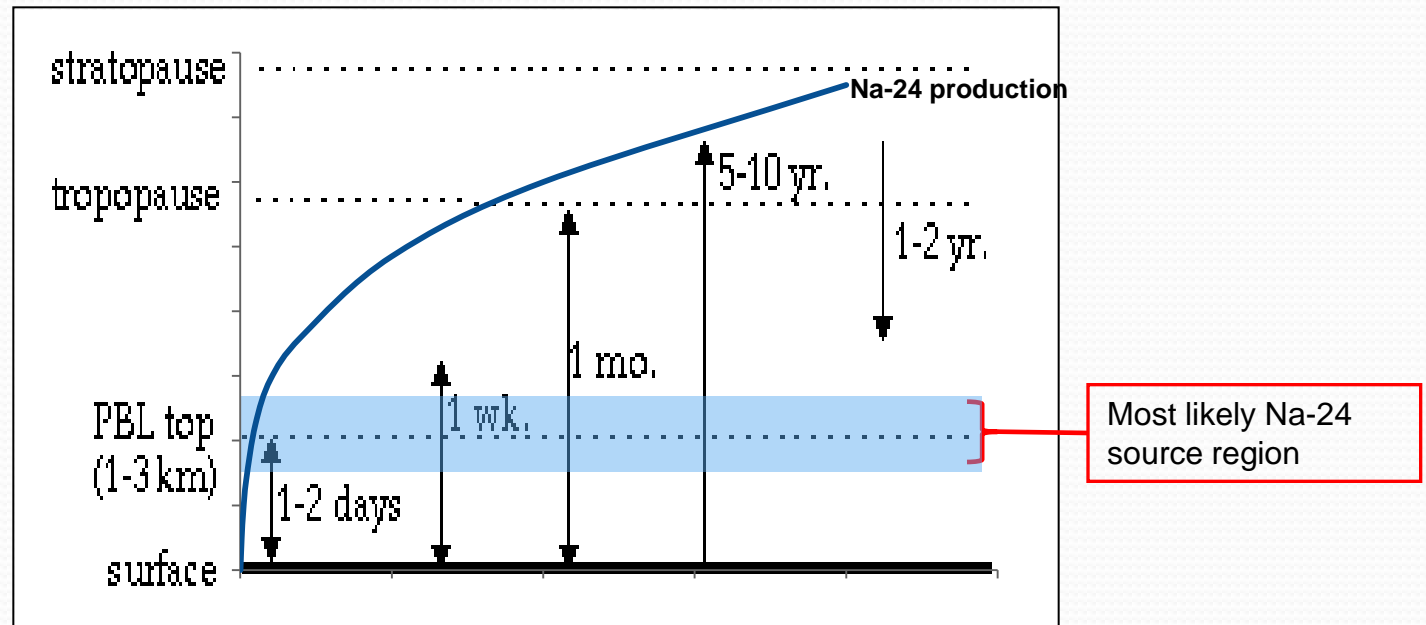
## What do we know about Na-24?

- A gamma emitter:  $E_{\gamma} = 1.37 \text{ MeV}$ ; 100%; Half-life 15 h
- Produced in the atmosphere by cosmic radiation interaction with argon



*Cosmic radiation flux at a fixed latitude (and altitude) is ~constant; Ar content of atmosphere is constant; so Na-24 production rate is latitudinally ~constant.*

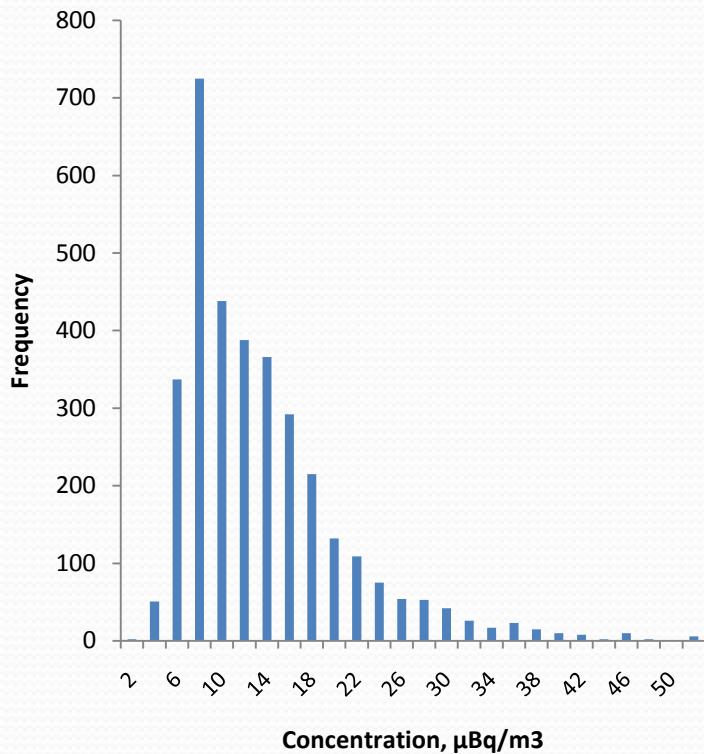
## Timescales for vertical transport



Detection of Na-24 is primarily dependent on vertical transport within the lower 5 km of the atmosphere.

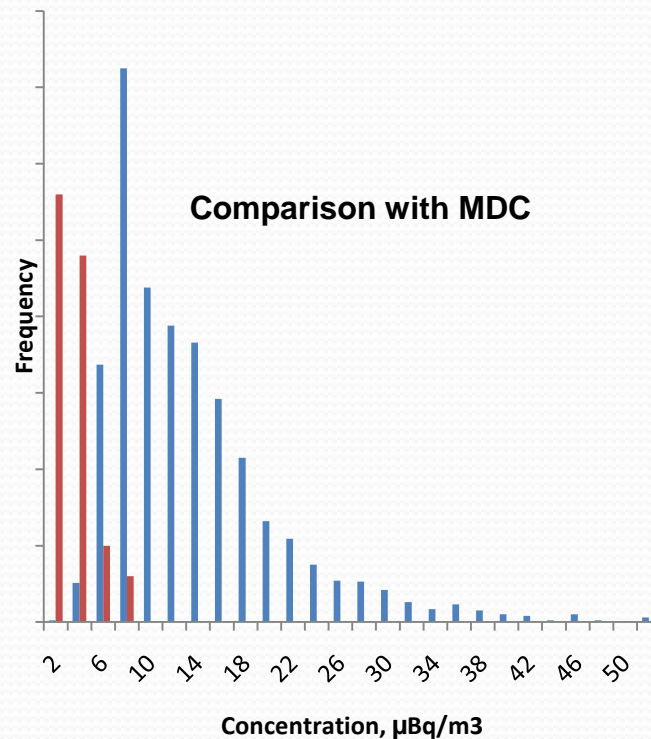
# Na-24 and the IMS: results of a >5y study

- Detected on >3000 occasions since 1 July 2005



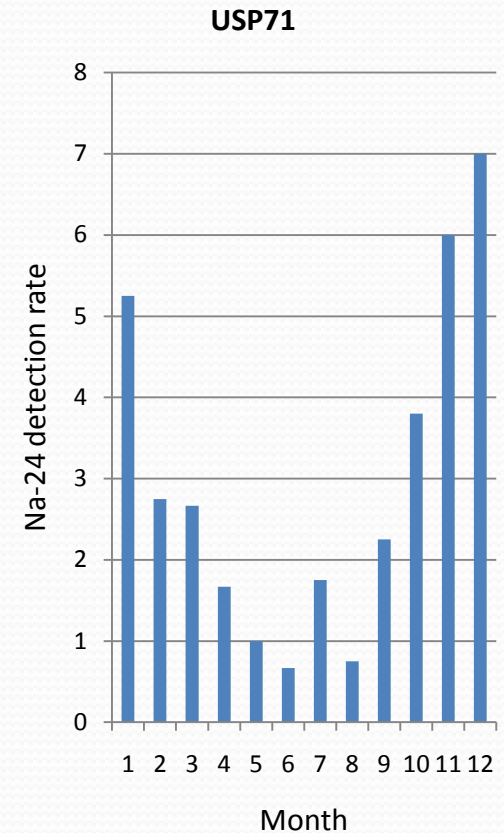
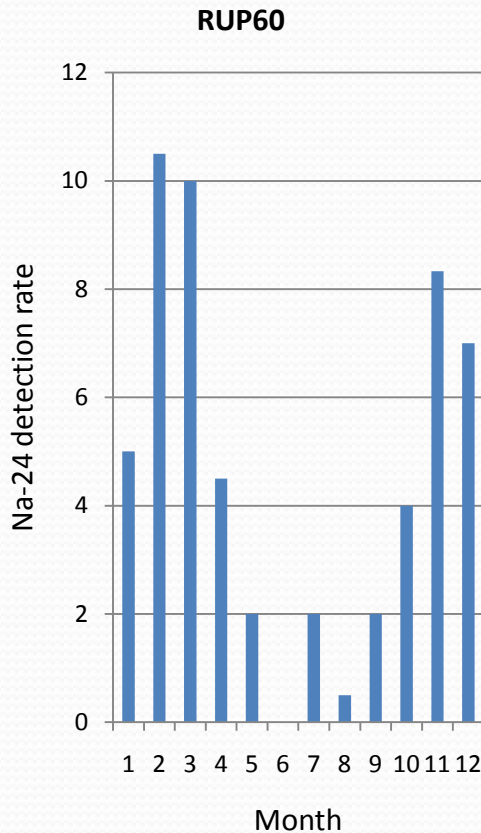
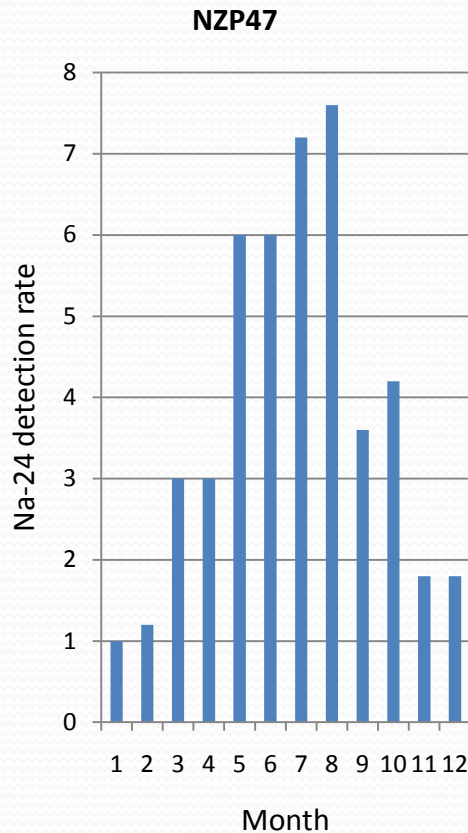
■ Na-24, All stations

Range 1 – 65; Mean 14; Median 12  $\mu\text{Bq}/\text{m}^3$



■ Na-24, All stations ■ MDC

## Seasonal effects on Na-24 detection rate



Winter maxima; tropospheric source  
These stations are “in tune” with their environments

Detection rate = Mean number of days per month when Na-24 detected

## Summary so far

- Na-24 production rate increases with altitude and latitude
- Production rate ~ constant at fixed latitude and altitude
- IMS network provides a globally uniform detection platform
- Na-24 is readily detectable by the IMS
- Winter maxima confirm a tropospheric source
- Likely source region is within the lower 5km of atmosphere



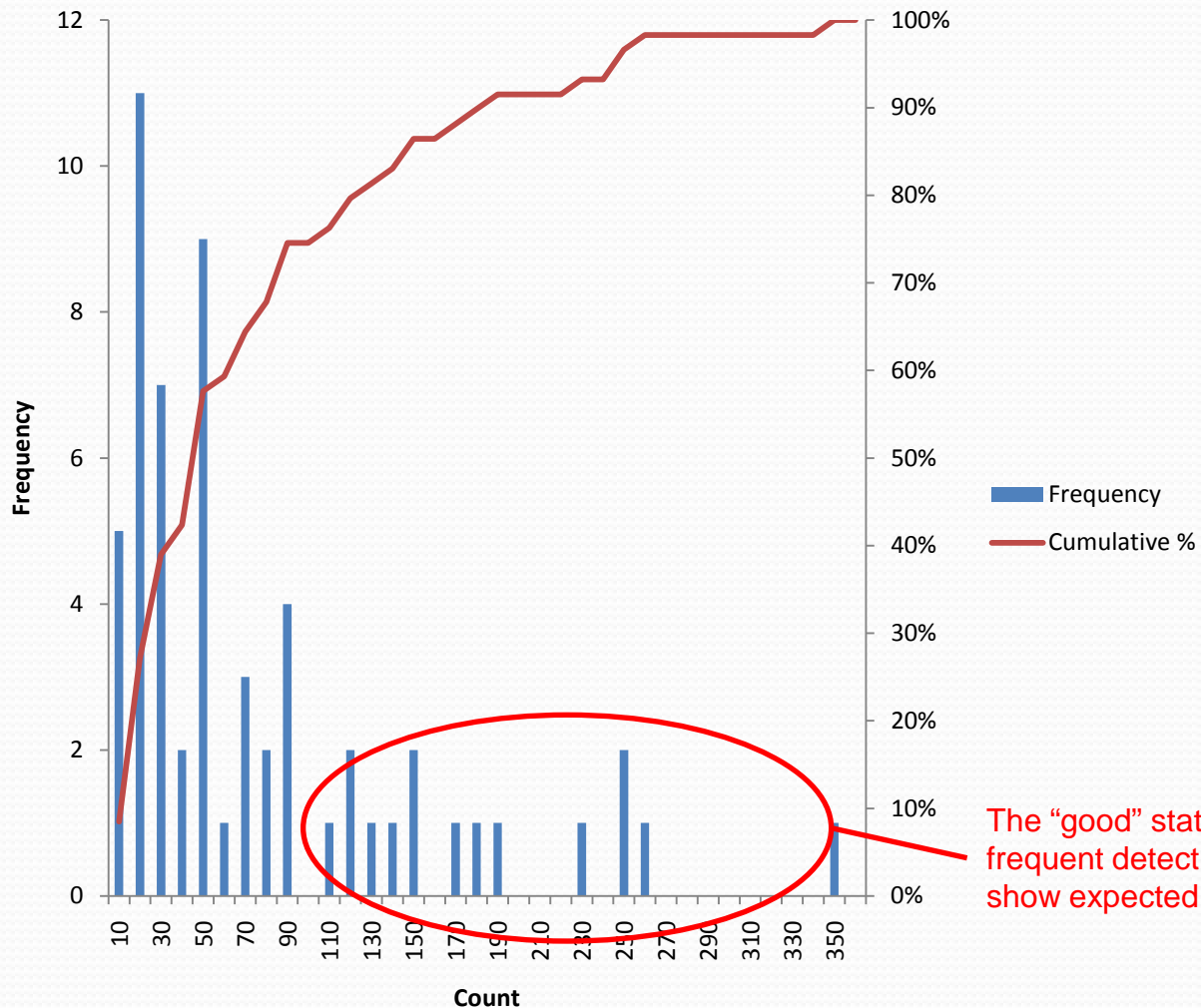
## Problem

Frequent detection and the display of seasonal variation is limited to 10 of the 60 stations currently in operation:

PAP 50:	Lat 8.9°N	Panama
FJP26:	Lat 18.0°S	Fiji
USP72:	Lat 28.3°N	Florida, USA
GBP68:	Lat 37.0°S	Tristan da Cunha
NZP47:	Lat 35.1°S	New Zealand
NZP46:	Lat 44.0°S	Chatham Island
RUP60:	Lat 53.1°N	Petropavlovsk, Russia
USP71:	Lat 55.2°N	Alaska
RUP61:	Lat 56.7°N	Dubna, Russia
USP76:	Lat 64.7°N	Alaska

*If transport within only the lower 5 km of atmosphere is involved, why are so many stations unable to detect Na-24 frequently?*

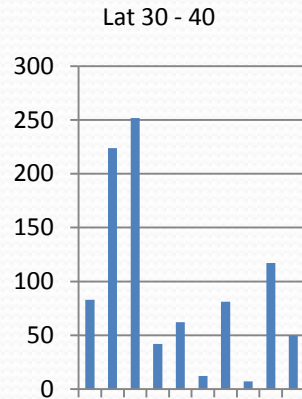
# Relative Na-24 detection rates



Detection count = No. detections since 1 July 2005, corrected for days off-line, multiplied by a scaling factor of 2000



# Exploring the differences (1)



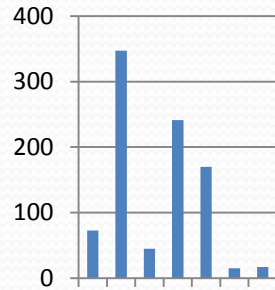
Station	Count
4	83
68	224
47	252
1	42
10	62
38	12
74	81
53	7
75	117
70	50

Marked differences at similar latitudes and small separation



# Exploring the differences (2)

Lat 50 - 60



Station	Count
18	73
60	347
59	45
71	241
61	170
54	15
63	17



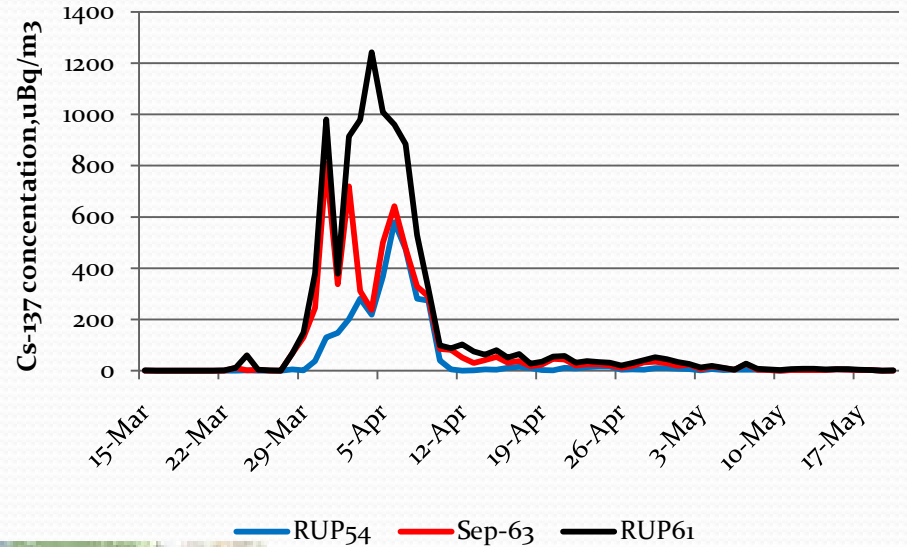
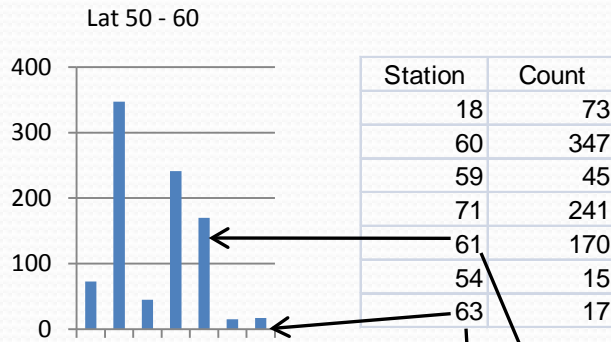
## Implication

Some monitoring stations are clearly “better” at detecting Na-24 than others.

Given the existence of Na-24 as a uniform high-altitude source of natural tracer and the uniformity of station specifications, the implication is that:

The disparity in Na-24 detection rates might indicate less-than-optimum atmospheric coupling below ~ 5km altitude at many (most?) stations

# Possible recent effect



Station 63  
(Stockholm) stopped  
detecting Fukushima  
on 8 May

Station RUP61  
(Dubna) reported  
detections until 20  
May



Detections at RUP54 continued till  
18 May;  
*Concentrations were, on average,  
25-30% below RUP61.*

## Conclusions

- Na-24 is available in the atmosphere for use as a tracer of vertical transport
- The IMS provides a stable global monitoring platform well able to detect Na-24
- Detections rely mainly on vertical transport within 0 - 5km altitude
- Only 17% of monitoring stations regularly detect Na-24
- There are wide variations in detection frequency, even between close stations at similar latitudes
- Relative sensitivities to vertical transport (atmospheric coupling) may be a factor



## Important note

None of the above should be construed as a being a criticism of the IMS or any particular station in it.

The reality is that perfect atmospheric coupling is probably not consistently attainable in global monitoring.

With any environmental monitoring, it is vital that the system is understood in terms of how it interfaces with the environment being monitored.

***Sodium-24 may be trying to tell us something***

## Further work

- Continued study of Na-24 detection rates
- Atmospheric transport modelling



### References

UNSCEAR 2000

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