



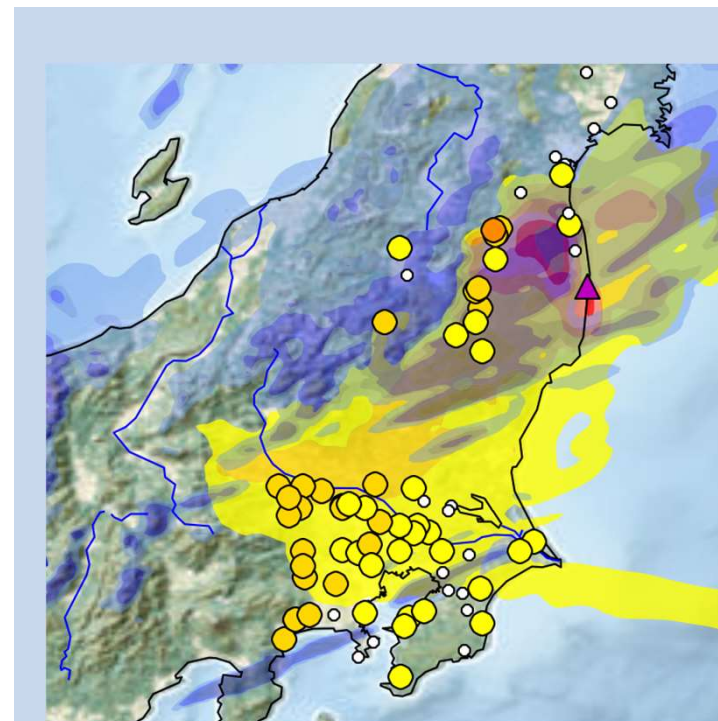
INSTITUT
DE RADIOPROTECTION
ET DE SÛRETÉ NUCLÉAIRE

Faire avancer la sûreté nucléaire

Data assimilation : objectives and needs regarding modelling and measurement issues

NERIS Workshop

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Plan

- Data assimilation objectives
- Model measurements combination basic principles
- Assimilation processes :
 - Measurement needs
 - Modelling issues

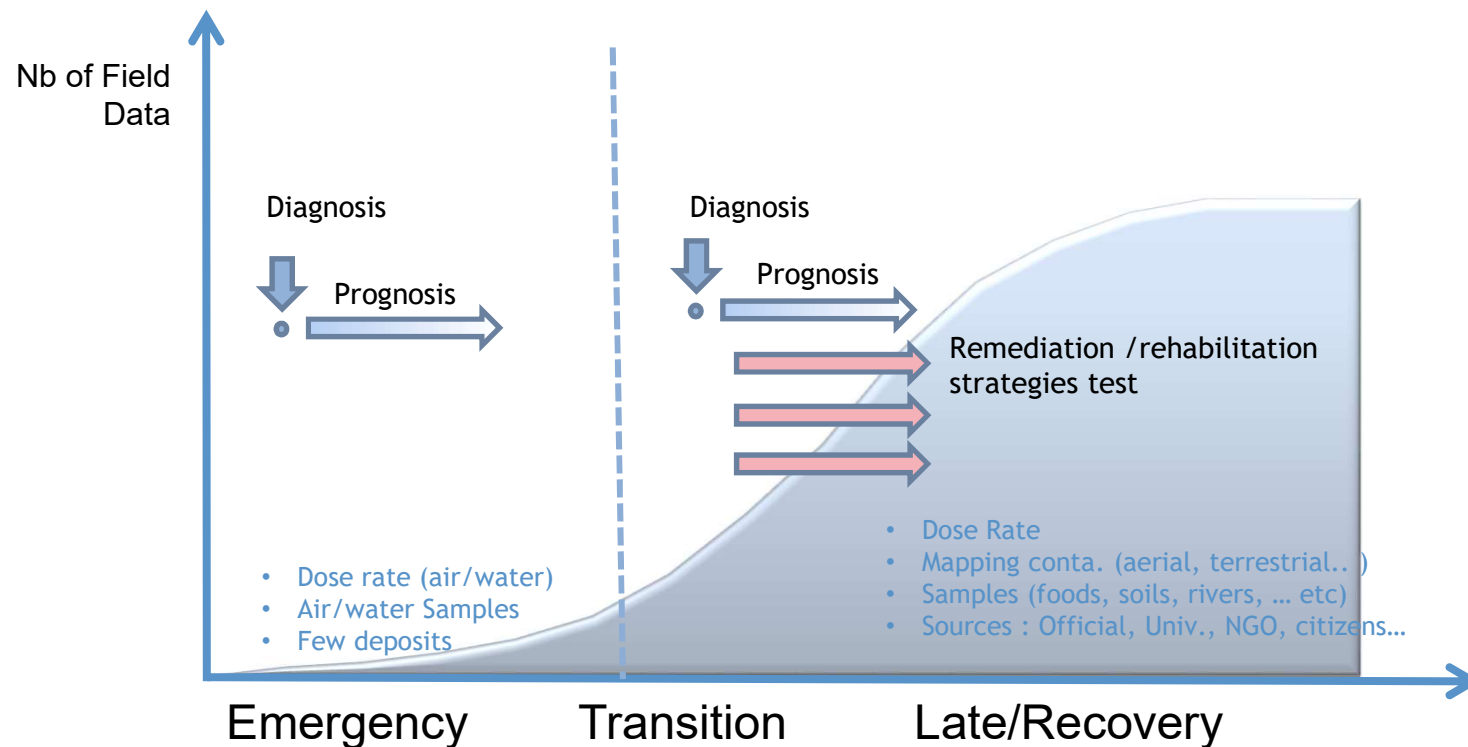
- Making Assessments of the impacts of an Accidental Release has the objective

of determining **WHETHER, WHERE, WHEN** and **What Kind** of Protective/remediation Actions are Justified / Not Justified

- What kinds of protective actions are considered
 - **Human radiation protection** : evacuation, sheltering, iodine, ingestion restriction, decontamination, etc...
 - **Socio-economic measures** : preventive protective actions, marketing food/good restrictions, crops remediation, financial aids, educate them on radiation protection...

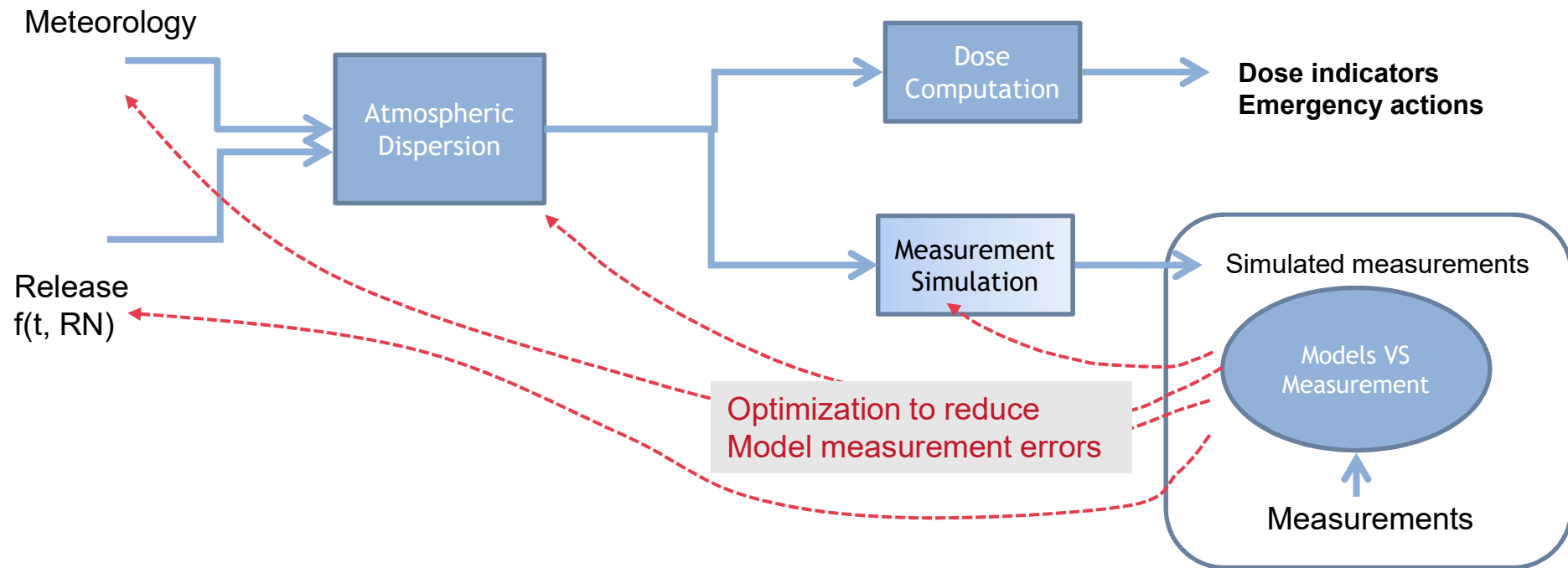
Decisions should be made based on an actual understanding of the situation which will rely first on the contamination state assessed via :

- Modelling transfers : powerful but uncertain
- Measurements : “true” but quite limited on their own.



➔ Model measurements combination is a critical process for safer recommendations

Model measurements combinations : The ATM case



➤ The best simulation will be obtained using assimilation processes

IRSN current approach for ATM

- Optimization of the **Source Term** considered as the most uncertain/sensitive parameters (variational approach).

μ	=	H	σ	+	ϵ
Vector of observations		Source receptor matrix computed with the forward ATM (Abida et al. 2011)	Estimator of the ST		Vector of errors Observations Model

$$J(\sigma) = \frac{1}{2}(\mu - H\sigma)^T R^{-1}(\mu - H\sigma) + \frac{1}{2}(\sigma - \sigma_b)^T B^{-1}(\sigma - \sigma_b)$$

■ Measurements used :

- Only **Air concentration** measurements (Winiarek et al. 2012, Saunier et al. 2016)
- Only **Dose rate** measurements (Saunier et al. 2013)
- Both **air concentration and deposition** measurements (Winiarek et al. 2014)

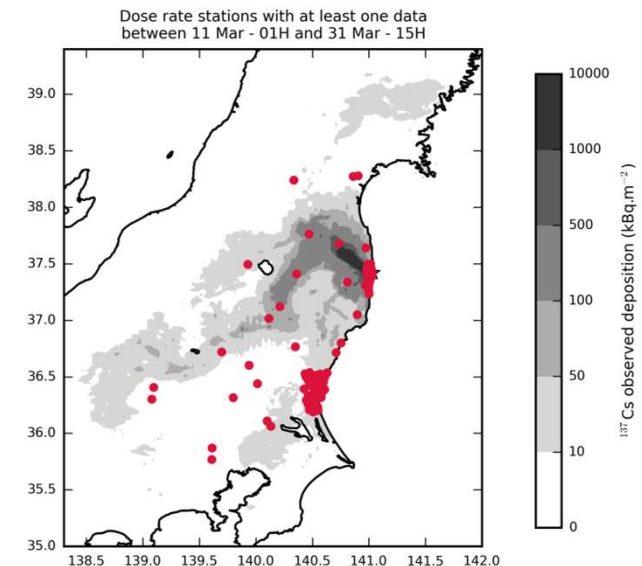
➤ The efficiency of the methods is limited by :

- **our capability of handling measurements**
- **modelling issues**

Measurement needs for assimilation

■ Need “good and enough data” → how to characterize these requirements ?

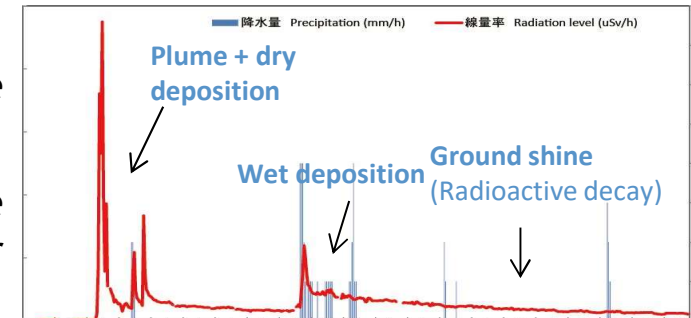
- Well distributed in space and time
 - Only detected contamination events can be assessed by assimilation
 - Too many measurements in the same area are useless and have to be processed to avoid bias in the assimilations process (over weighed zone, Ibaraki)
 - The quality of the ST time evolution is directly linked to time resolutions measurements
- Different types of measurements are needed to constrain the different kind of uncertainties
 - ST Composition → spectrometric information
 - Dynamic → high frequency measurements
 - Deposit process → deposit measurements
- How could we express these requirements in order to influence the measurement strategy (or network design) ?



Typical kind of available measurements : +/-

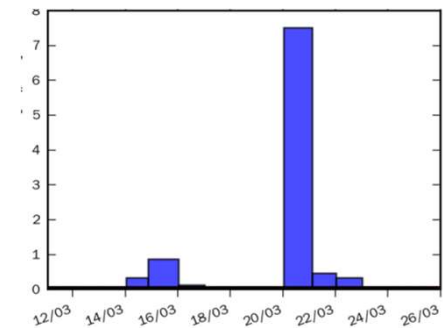
Gamma dose rate measurements

- ☺ High temporal resolution, dense spatial coverage, available in real time.
- ☹ No access to the isotopic composition of the ST and to the respective share of the plume and the deposit. Available for major release events only (high detection level).



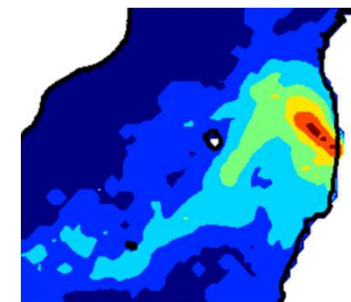
Air concentration & daily deposition measurements

- ☺ Provide information on the isotopic composition of the release (aerosols part at least). Available for major + minor release events: low detection level.
- ☹ Coarse spatial coverage. Time averaged data (often 24 h). Time series not always available. Delays in making data available.



Total deposit

- ☺ Dense spatial coverage (in PA phase). Provide information on the isotopic composition of the release.
- ☹ No information on the temporal evolution of the deposit during the release period. Delays in making data available.



Measurements needs for assimilation

■ Need Quality measurements

- Well documented (value, time, location, detection limits, etc..)
- Measurement trueness/precision : same kind of measurement should be comparable (share measurement protocols)
- Representivness of measurements
 - Space/time : Not too influenced by very local effects which are not modeled
 - Sensitivity of the environment around the DR Stations (trees, building, height, artificial ground...)

➤ **Develop a measurements ranking system (as it's the case in meteorology) could be a great improvement for assimilation processes**

■ **Need proper access to measurements** : dealing with thousands or millions of measurements implies a reliable well formatted IT process which should take into account the assimilations needs (national, European, world !)

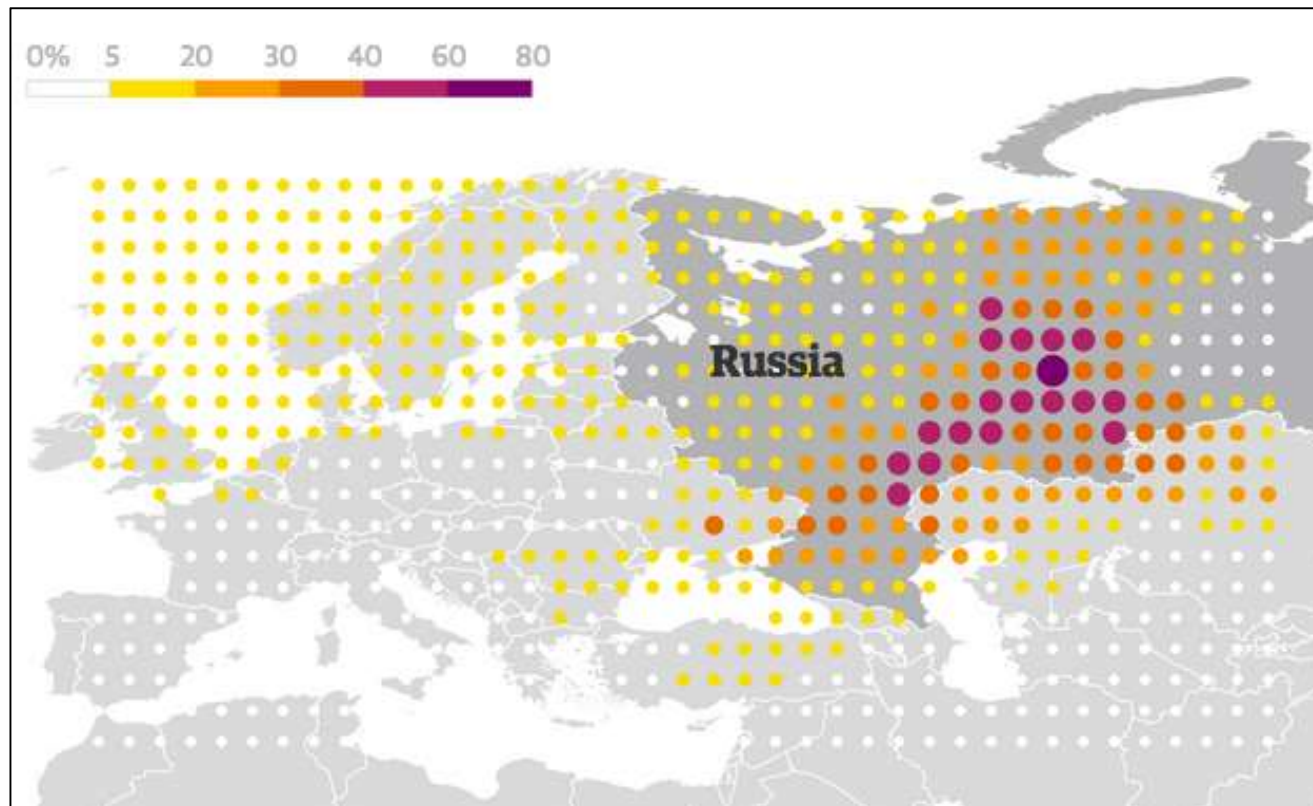
Modelling issues for assimilation

- How to deal with other uncertainties ?
 - How to sort out the true error information from the margins of uncertainty?
 - Error modelling
 - Meteorological error : Use of met ensemble information ?
 - Measurements errors : Work on modelling measurements and representivness (quality criteria)
- How to combine the different kind of measurements to constrain simultaneously air, deposit contamination and the RN composition ?
- How to deal with big range of values (μBq to Bq) : How to better take into account the lowest values ?
- How to deal with significantly different detection limits (critical when observed values are closed to the Detection Limits) ?
- How to improve the assessment of the simulations relevance and define operational criteria to judge it (scores issues) ?

A recent case : Ruthenium contamination

- Specific objective : where is coming from ?
- Application of the method taking into account heterogeneous sampling periods and source localization issues.
- Huge differences between measurement parameters
 - Air sampling durations vary from 11 hours to 2 months !
 - Detection limits (when available) vary from 0,1 $\mu\text{Bq}/\text{m}^3$ to 4 mBq/m^3 !
- Outdated measurements exchange system
 - Phone, pdf(AIEA), mail, xls... => many errors
 - Missing information : start and end collection time, UTC or local, location coord. ...
 - Confusion between Beta total and Ru activities...

→ Extremely time consuming tasks to build, clean, sort and maintain a database to finally feed assimilation algorithm (and we had almost only air sampling measurements...)



- *Best FAC2 score obtained for each release candidate point.*
- *The overall best score indicated the most likely release zone.*

- 400 measurements
- 100 to 300 TBq between Volga and Oural region
- ~24h duration
- 48h computation time - 24 processors, 600 Go of data

Conclusions : topics to be developed

- Assimilation is a key approach to improve assessment of contamination event : it will provide the best simulation.
- Several measurement needs have been expressed to improve the assimilation process : efficient IT access and measurements ranking system
- Several assimilation issues have to be studied : modelling errors!
- Similar issues can be raised regarding other compartments (river, marine, ...) the overall assimilation process should be very similar.



Thank you for your attention