A&P at the IRSN in brief

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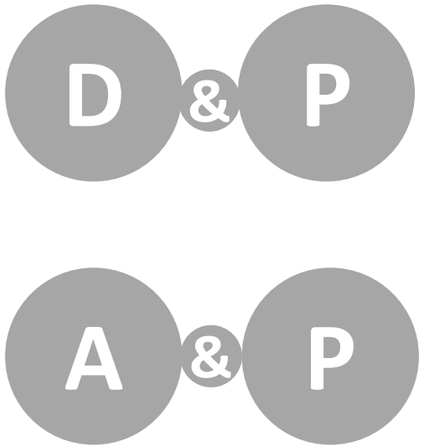
1 General considerations

A&P Method and Tools within the IRSN's response



- **IRSN's A&P method ("Diagnosis-Prognosis")**
  - In place for 30+y for French PWRs
  - Focuses on the states of the different containment barriers, functions and systems ensuring their integrity
  - Was progressively adapted to other French nuclear facilities and other kinds of NPPs
  - A&P for Consequences articulated with A&P for Facility
- **Main Benefits of A&P method**
  - **Factual** and stuck to the key topics of concerns: makes the situation readable
  - **Structuration & Rhythm** of the work of Emergency Assessment Teams
  - **Common language** and discussion material between Assessment Teams
  - **Anticipation** of the possible occurrence of significant releases, and of the related consequences → **Decision aiding for the protection of the people**
- **IAEA Assessment & Prognosis** is in-line with 3D/3P

A&P Method and Tools within the IRSN's response

- A&P implementation primarily rely on:
  - ✓ Facility Assessments Unit
  - ✓ Consequences Assessments Unit

- **A&P conduct on state of facilities and source terms**
- **A&P conduct on consequences for the environment & exposure of people**

- ✓ Data retrieving from the facility, met data, measurements…
- ✓ Iterative assessments combining modelling and measurements, specific operational assessment methods and tools
- ✓ Decision-aiding products

Technical Crisis Center

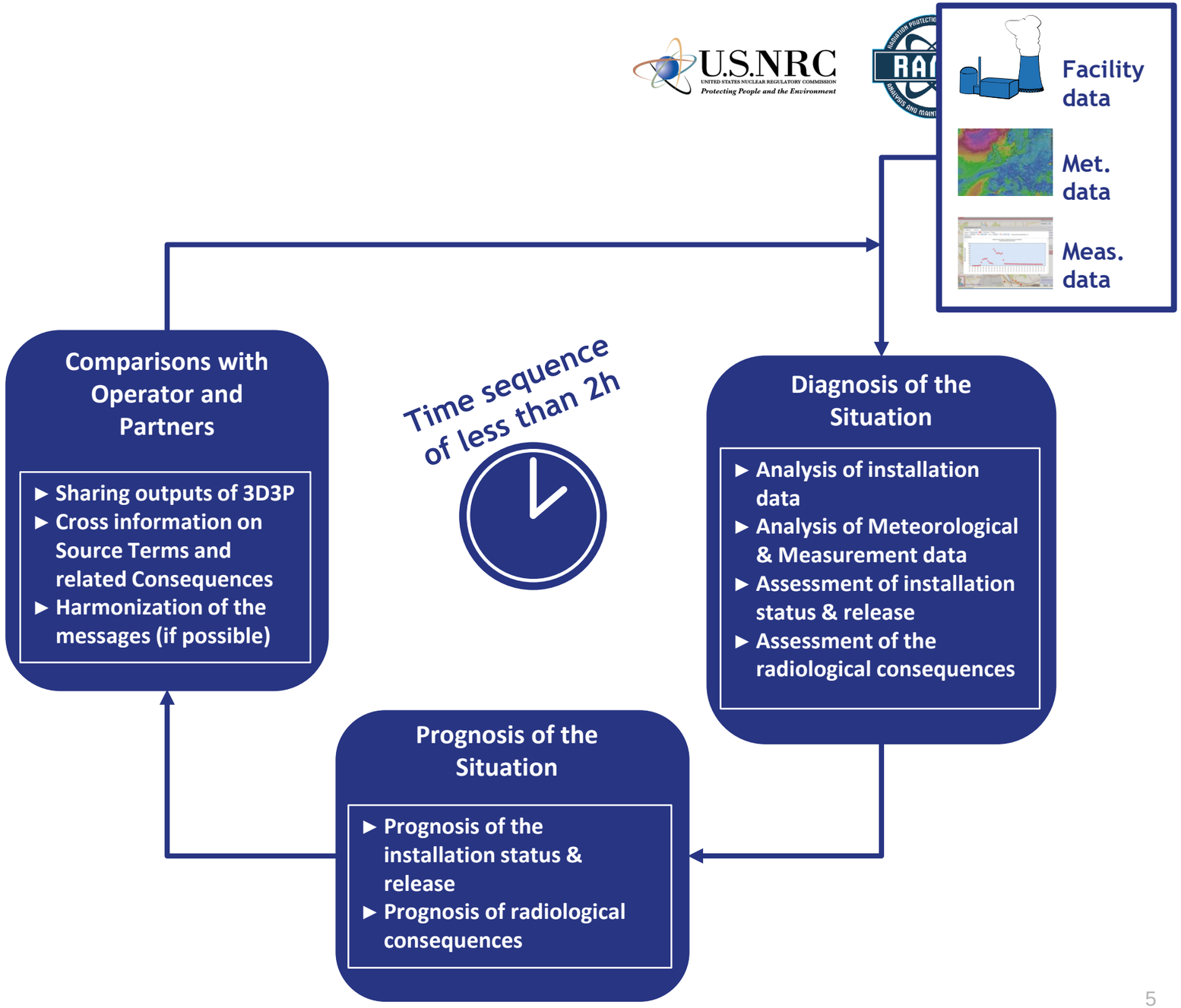
- **Sampling and measurement program conduct (local + French territory)**
- **Execution of measurements in the environment & on the people**

- ✓ Remote monitoring of environment networks (470+ stations)
- ✓ Mobile means projected on field
- ✓ Fixed Laboratories network
- ✓ Results centralized in specific databases

Measurements means

General A&P Process

- IRSN and operators share the A&P methodology
- IRSN and the operator implement A&P process independently
- Run Diagnosis, then run Prognosis
- A&P is executed periodically (update what is outdated!)
- IRSN and the operator compare their respective outputs before delivery to the decision-makers



General A&P Process

Reflex Expertise

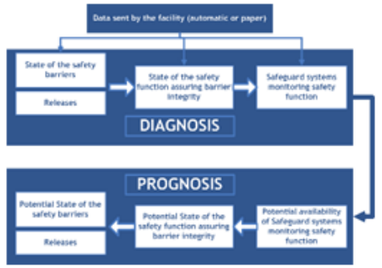
Specific / Tailored Expertise

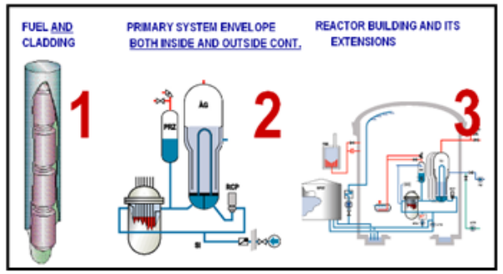
Use of Pre-Calculated Situations

–

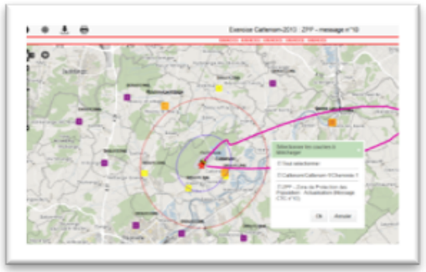
Typical Accident Sheets

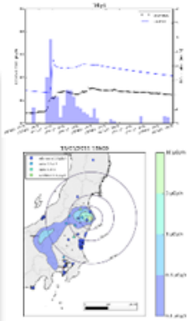
Periodical Assessment & Prognosis





1 hour





General A&P Methodology for the facility aspects

Facility data (automatic or paper)
Around 30 selected parameters is enough!

3D

State of the containment barriers → State of safety functions ensuring the barrier integrity → State of safeguard systems ensuring the safety function

RELEASES

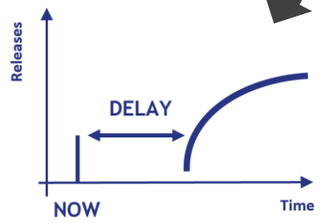
DIAGNOSIS (NOW)

PROGNOSIS (FUTURE)

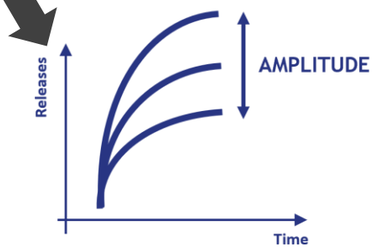
3P

Potential state of the containment barriers ← Potential state of safety functions ensuring the barrier integrity ← Potential state of safeguard systems ensuring the safety function

RELEASES



When they will occur

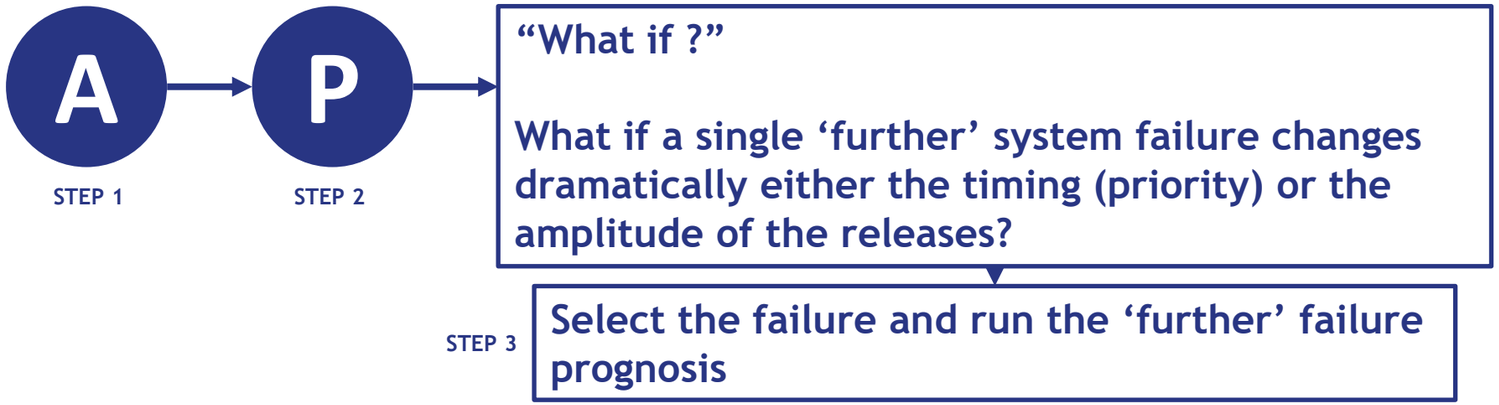


How big they will be

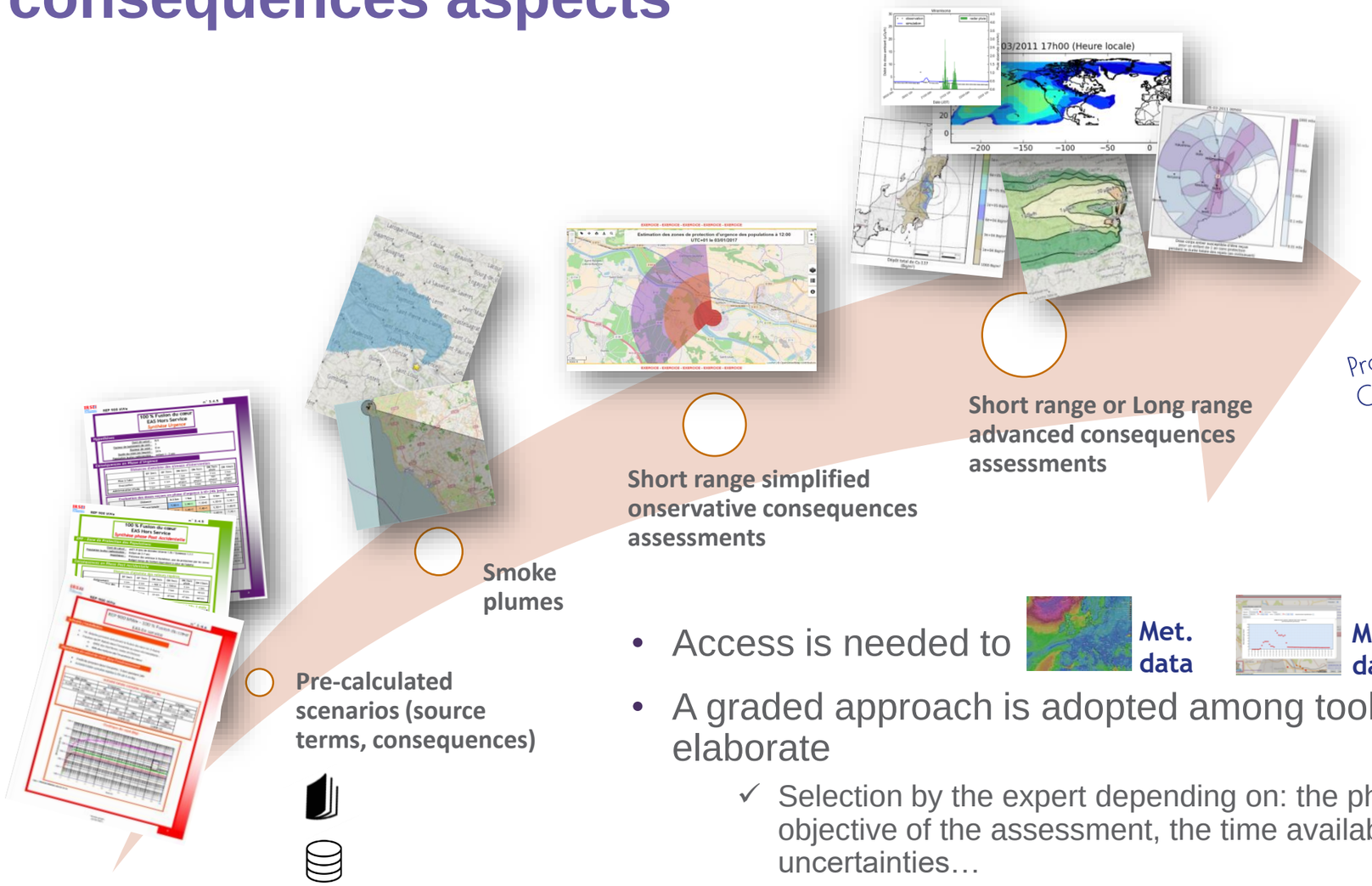
- Loss of a system may be due to
  - the depletion of water source (e.g. tank), of energy (e.g. batteries)…
  - the loss of a function required by the system under analysis
  - conditions beyond the equipment's qualification domain (temperature of fluids, humidity of filters…)
  - an operating procedure that will require for the system shutdown
  - …

General A&P Methodology for the facility aspects – Further failure Prognosis

- The aim of the method is to identify as early as possible situations leading to core melt and, more generally, to the release of activity into the environment which could justify emergency protective actions
- Case of a large break with safety injection provided by a single available pump: prognosis would not lead to PAR, but if lost, delay before significant releases would be too short to efficiently protect people…
- **Additional step : "further failure" prognosis**
  - Time before a significant release is a key topic to focus on
  - Amplitude of the prognosed release is also to be challenged

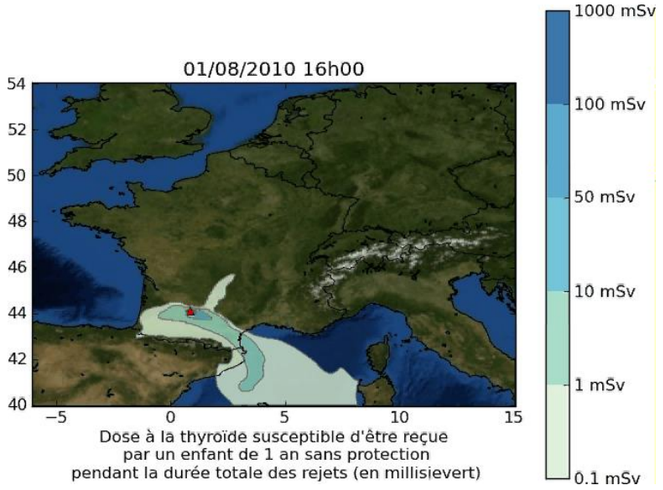


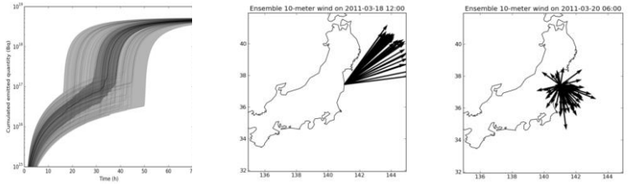
General A&P Methodology for the consequences aspects

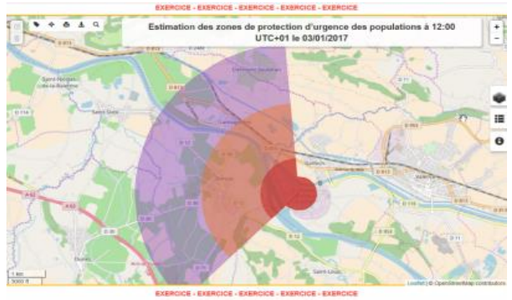


- Access is needed to **Met. data** **Meas. data**
- A graded approach is adopted among tools to use and products to elaborate
  - ✓ Selection by the expert depending on: the phase of accident, the recipient, the objective of the assessment, the time available, the data available, the level of uncertainties…
- A&P implies types of evaluation such as source term dispersion to dose, measurement-to-model comparison, measurements to dose, inverse modelling…

General A&P Methodology for the consequences aspects



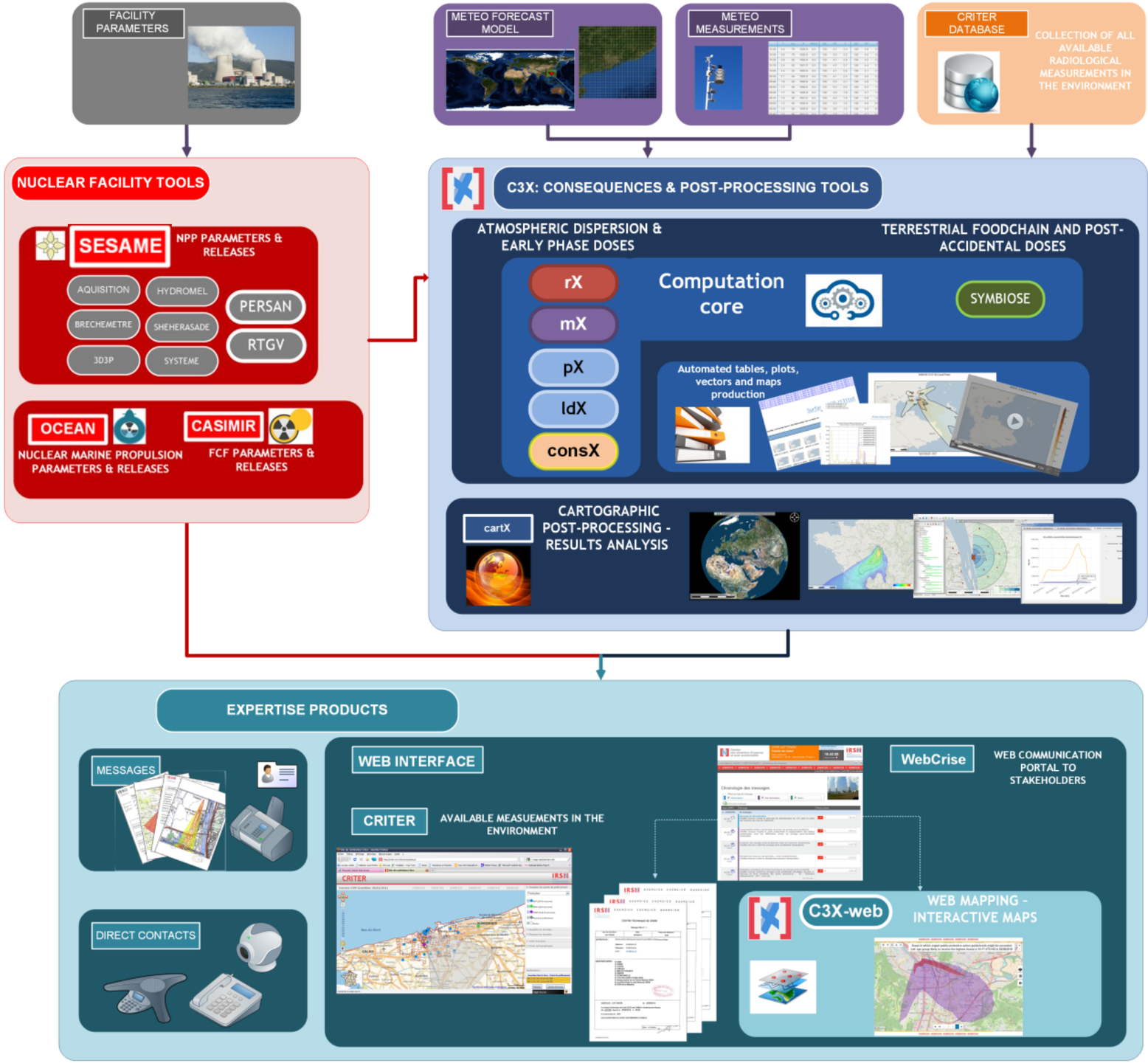




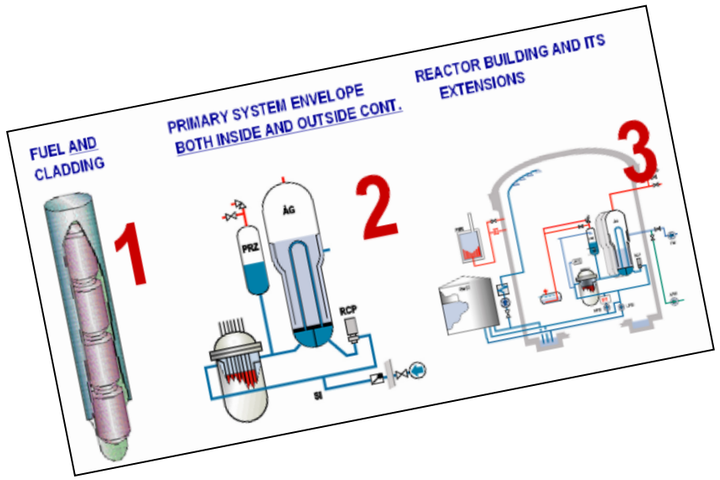
- Conservatism for ST assessment is generally delay-related… but this not necessarily lead to conservative consequences assessment!
- Meteorological conditions can change dramatically during the event and the consequences depend for a large part on this…
  - Planning as a starting point, decision shall be adapted/completed due to the accident progression, the meteorological conditions, the available measurements
- Expertise products should take uncertainties into account
  - Several sources of uncertainties in assessments, related to source term timing and amplitude, met. forecasts, cross-timing between ST and met. conditions, modelling and parametrization….
  - In case of several available assessments, which output to issue ?. E.g. The one leading to larger distance ? The one impacting the larger number of people ? etc.
  - Capabilities to obtain reasonably conservative results and to elaborate prudent assessment products is to be available

2 A few words about the tools

Tools to implement A&P in the Technical Crisis Center



3D/3P Grid – A common material for discussion



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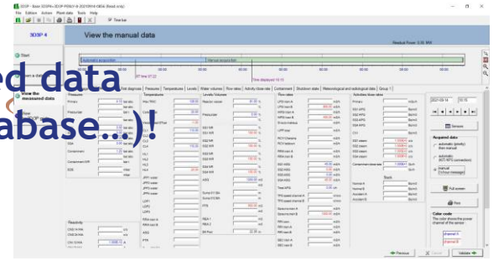
FORM "DIAGNOSIS-PROGNOSIS" — **INSTALLATION OPERATION** — #

	STATUS AT __:__	DIAGNOSIS		PROGNOSIS		
	Barriers status	Safety functions status	Safety functions control systems	Forecast of systems availability	Forecast of safety functions status	Forecast of the barriers status
1	**CLAD - FUEL** **No clad failure** ☐ **Clads failures** ☐ **Core melt** ☐	Reactivity control Comfortable Low Not sufficient Doubtful	• Control rods • Boration: RIS, RCV, REA …		Reactivity control	**CLAD - FUEL** **No clad failure** ☐ **Clads failures at** __:__ ☐ **Core melt at** __:__ ☐
		RCS water inventory Satisfactory Degraded Dewatering Doubtful	• RIS, RCV … • Water reserves (PTR tank …)		RCS water inventory	
2	**PRIMARY SYSTEM** **Intact** ☐ **Doubtful** ☐ **Primary break** ☐ ☐inside containment ☐PZR relief lines ☐outside containment ☐SGTR	RCS heat removal Sufficient Not sufficient Doubtful Controlled Not controlled	• Steam generators • Break • RIS • Feed and Bleed • RRA • RRI/SEC • …		RCS heat removal	**PRIMARY SYSTEM** **Intact** ☐ **Doubtful** ☐ **Primary break** ☐ ☐inside containment ☐PZR relief lines op. at __:__ ☐outside containment ☐SGTR isolated at __:__
3	**CONTAINMENT** **Normal leak** ☐ **Doubtful** ☐ **Direct leak** ☐ ☐penetration ☐PTR tank ☐secondary systeme **Leak to aux. buildings** ☐ ☐penetration ☐connected system **U5 system On** ☐	Containment (isolation systems efficiency, atmosphere composition control) Safe Not assured Doubtful	• Containment isolation • H2 recombiners		Containment (isolation systems efficiency, atmosphere composition control)	**CONTAINMENT** **Normal leak** ☐ **Doubtful** ☐ **Direct leak** ☐ ☐penetration ☐PTR tank ☐sec. system isolated at __:__ **Leak to aux. buildings** ☐ ☐penetration ☐conn. sys. isolated at __:__ **U5 the**____-__-__**at** __:__ ☐
		RB heat removal Sufficient Not sufficient Doubtful	• EAS • RRI/SEC • Steam generators • U5		RB heat removal	

3D / 3P

1 2-3 4-5 6

3D/3P Software – An augmented 3D/3P grid



Organized data
(in a database…)!

E.g. Source term evaluation with PERSAN (Prognosis)

Sender:	Receiver:
	#

PROGNOSIS

bility	Forecast of safety functions status	Forecast of the barriers status
	Reactivity control Comfortable	**CLAD - FUEL** **No clad failure** ☐ **Clads failures at** ? ☒ **Core melt at** ? ☒
	RCS water inventory Dewatering	

Thermal-hydraulic expert

BRECHEMETRE
Calculation of the Break size

SHEHERASADE
Calculation of the Dewatering time

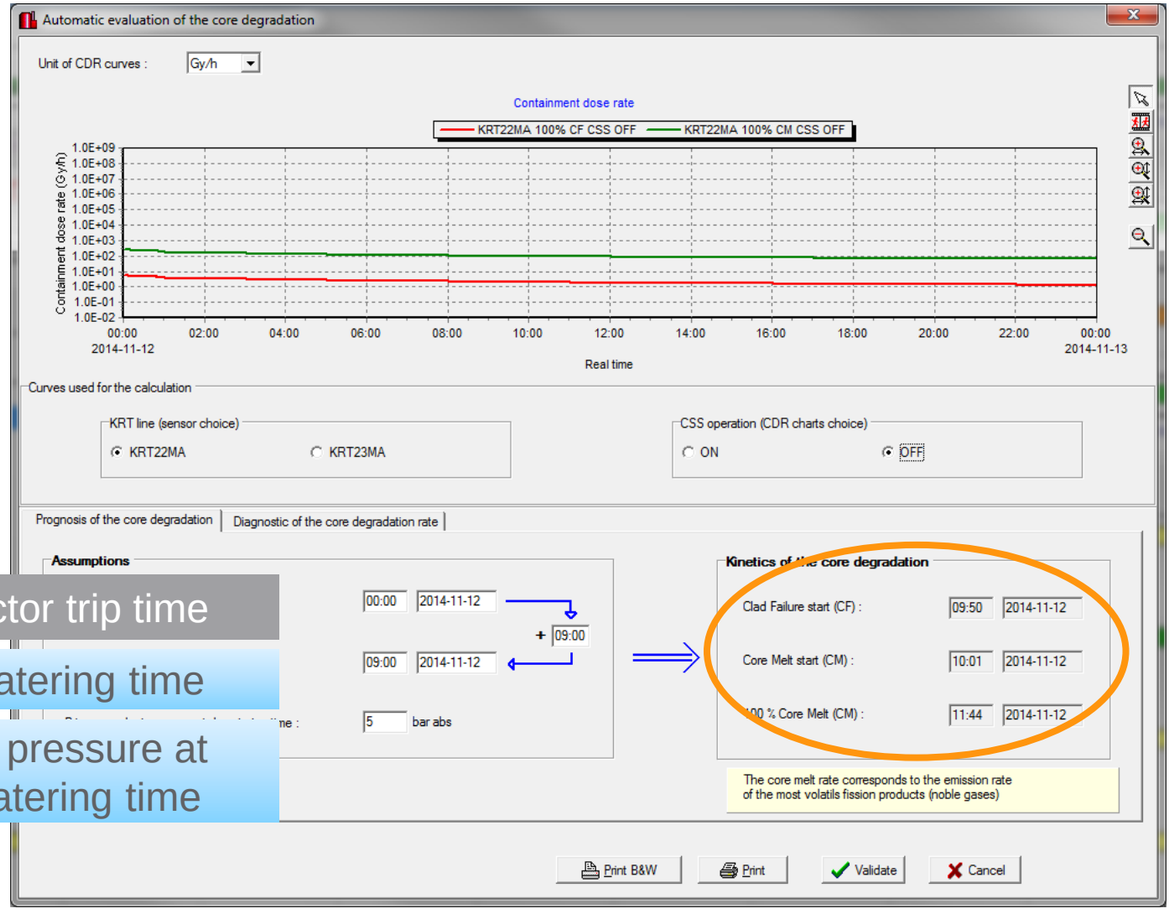
Containment expert

PERSAN
Calculation of core degradation

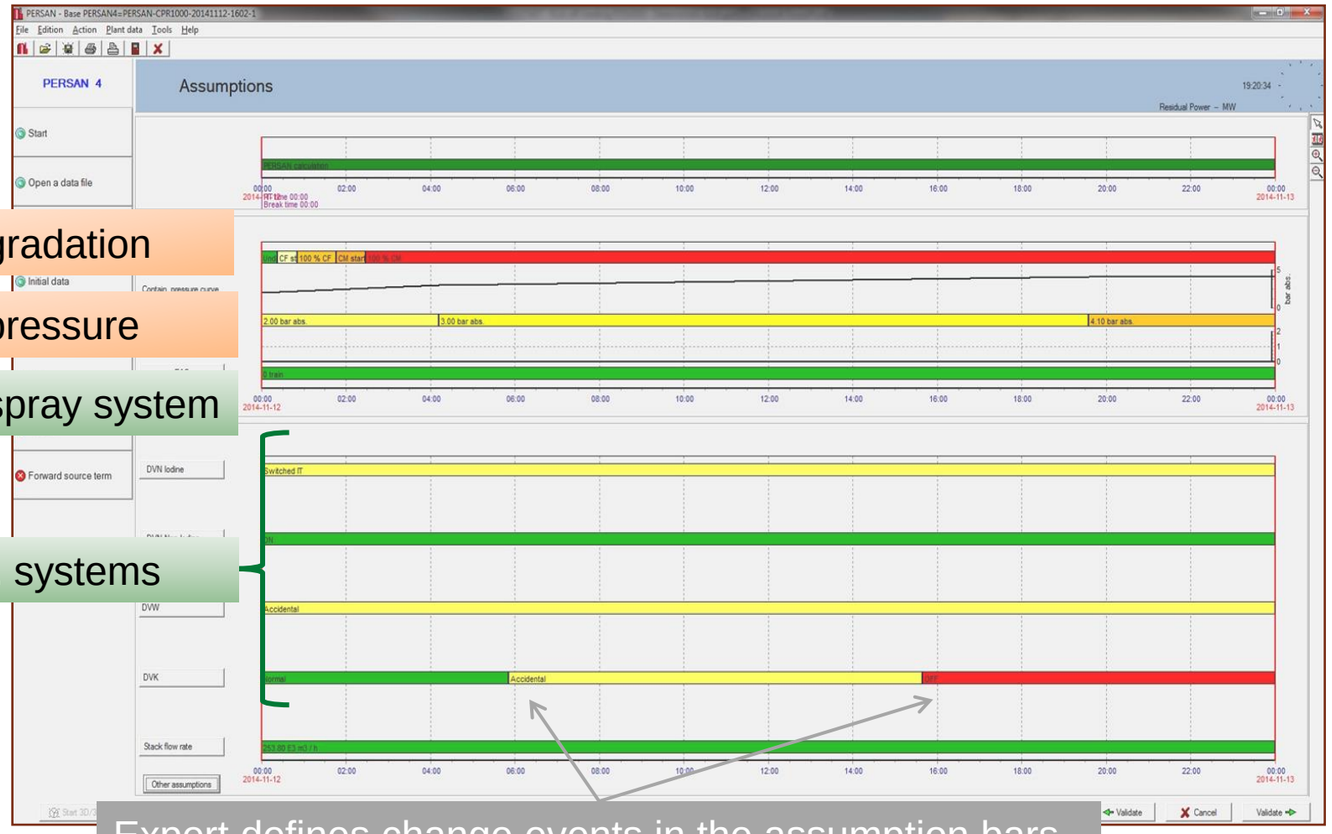
Reactor trip time

Dewatering time

RCS pressure at dewatering time



E.g. Source term evaluation with PERSAN (Prognosis)



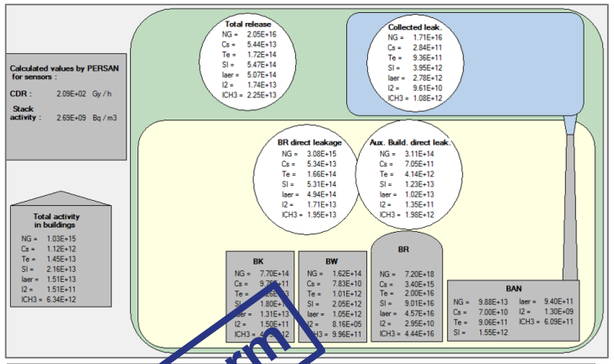
Core degradation

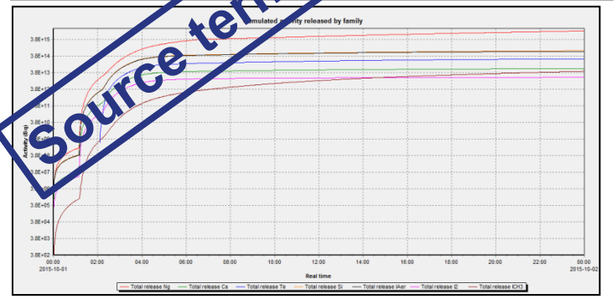
Containment pressure

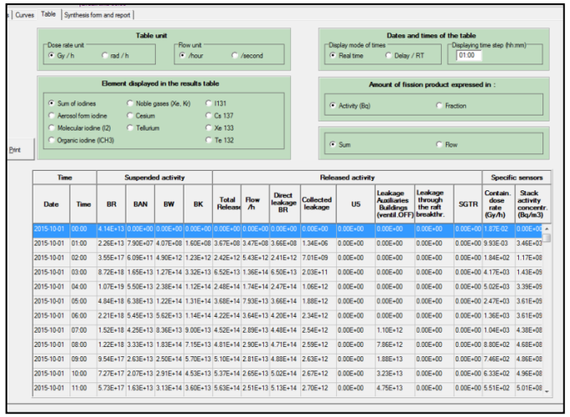
Containment spray system

Ventil. systems

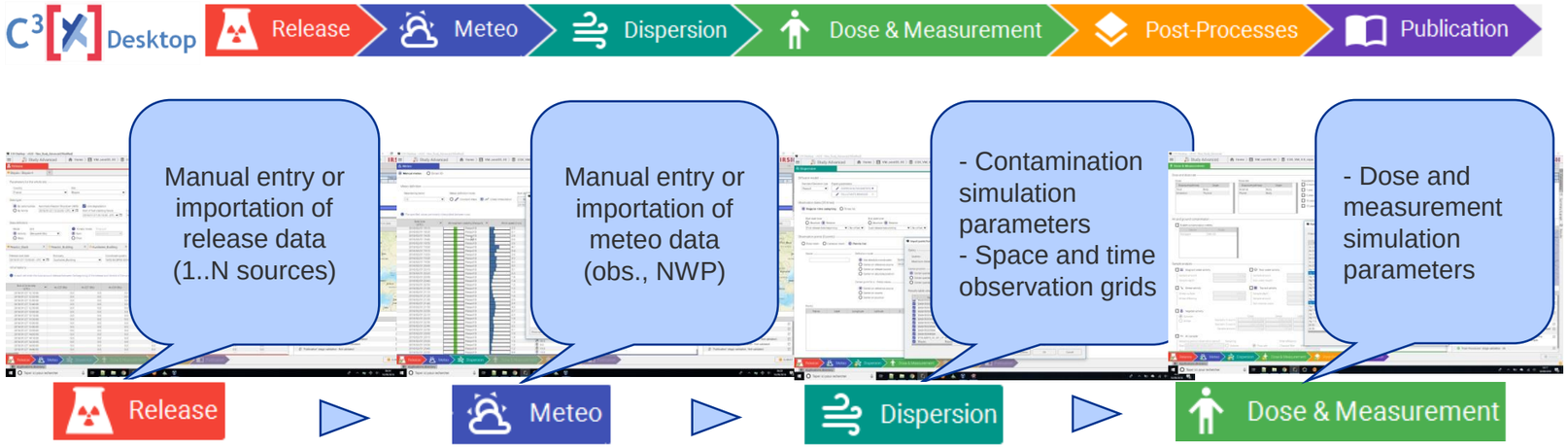
Expert defines change events in the assumption bars

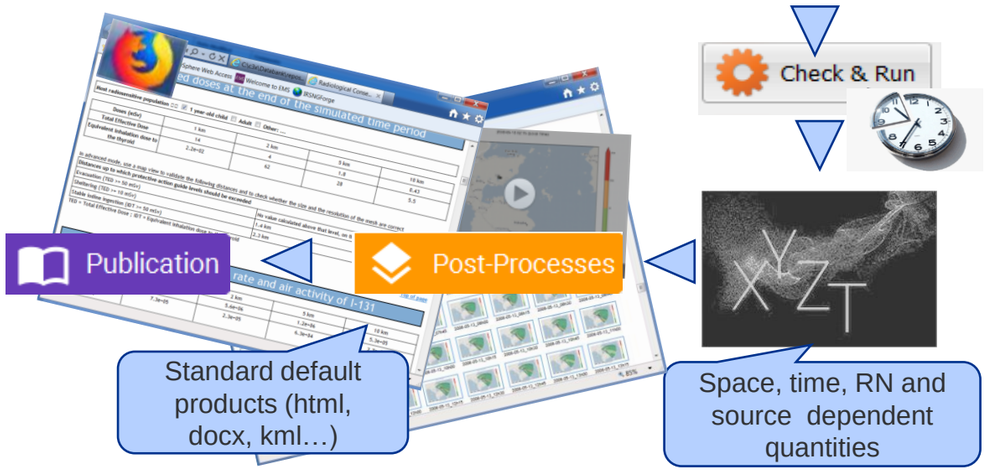






E.g. Consequences assessments with C3X

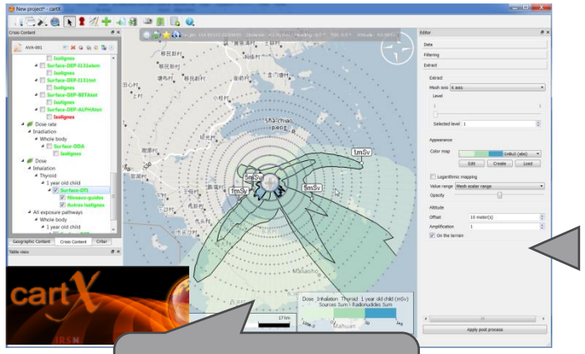




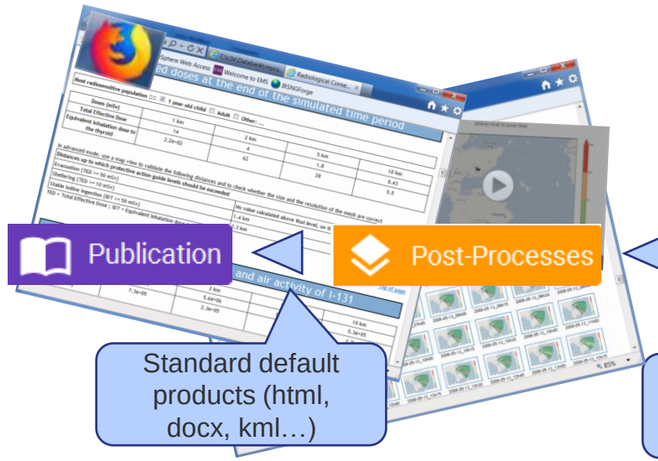
- Assessing Indicators, and whether/where/when PAGs might be exceeded
- Importance of prepared interoperability (source-term inputs, met. Inputs, consequences outputs…)

E.g. Consequences assessments with C3X

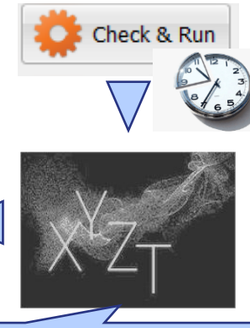
- Elaborating products and messaging



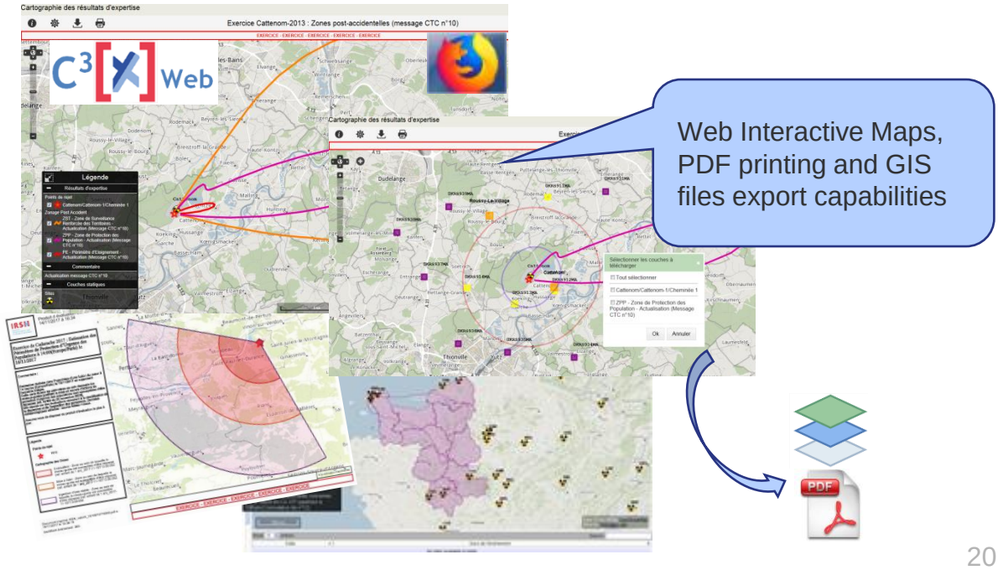
Custom post-processes



Standard default products (html, docx, kml…)



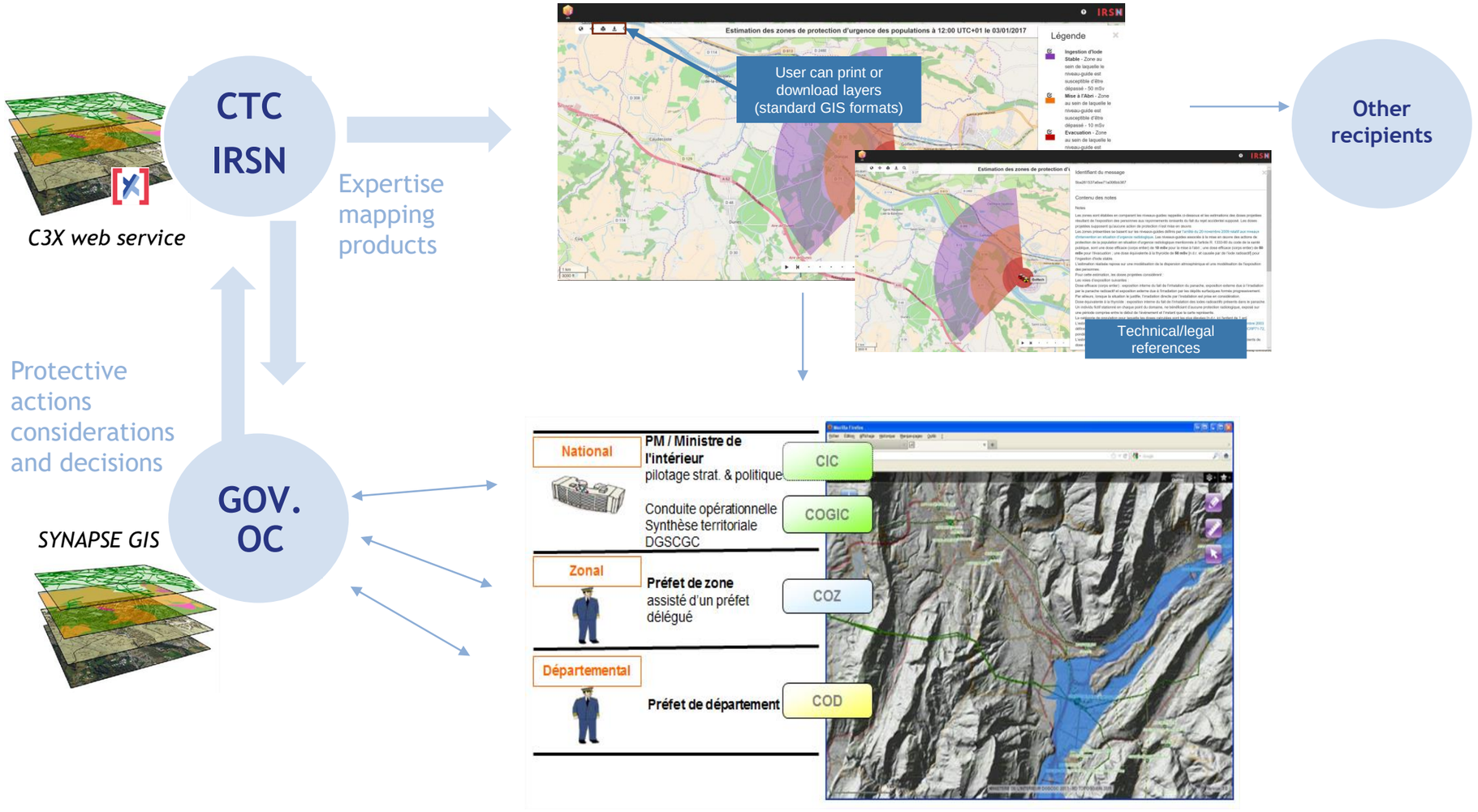
Space, time, RN and source dependent quantities



Web Interactive Maps, PDF printing and GIS files export capabilities

E.g. Consequences assessments with C3X

- Provinding expertise map results

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