Joint Agency Modelling:

A process to deliver emergency response national guidance for a radiological atmospheric release

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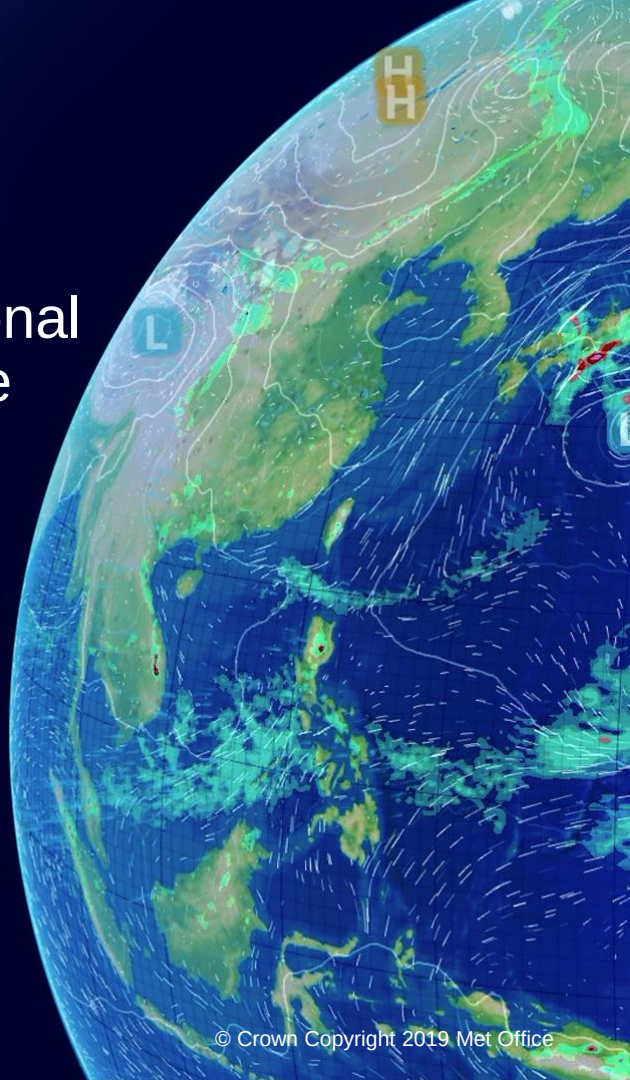

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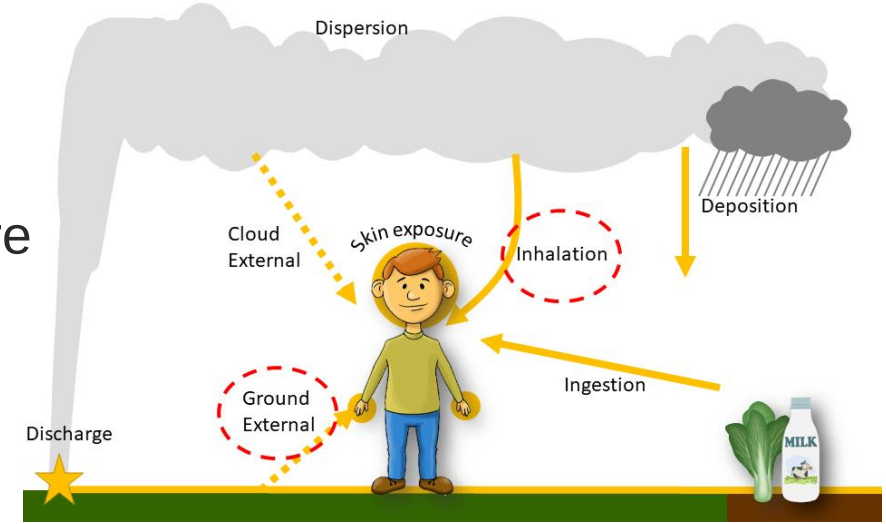
Purpose of JAM

- Radioactive material in the atmosphere can affect human health via:
  - Inhalation
  - External dose from deposited material
  - Ingestion of contaminated food & water

  + other pathways

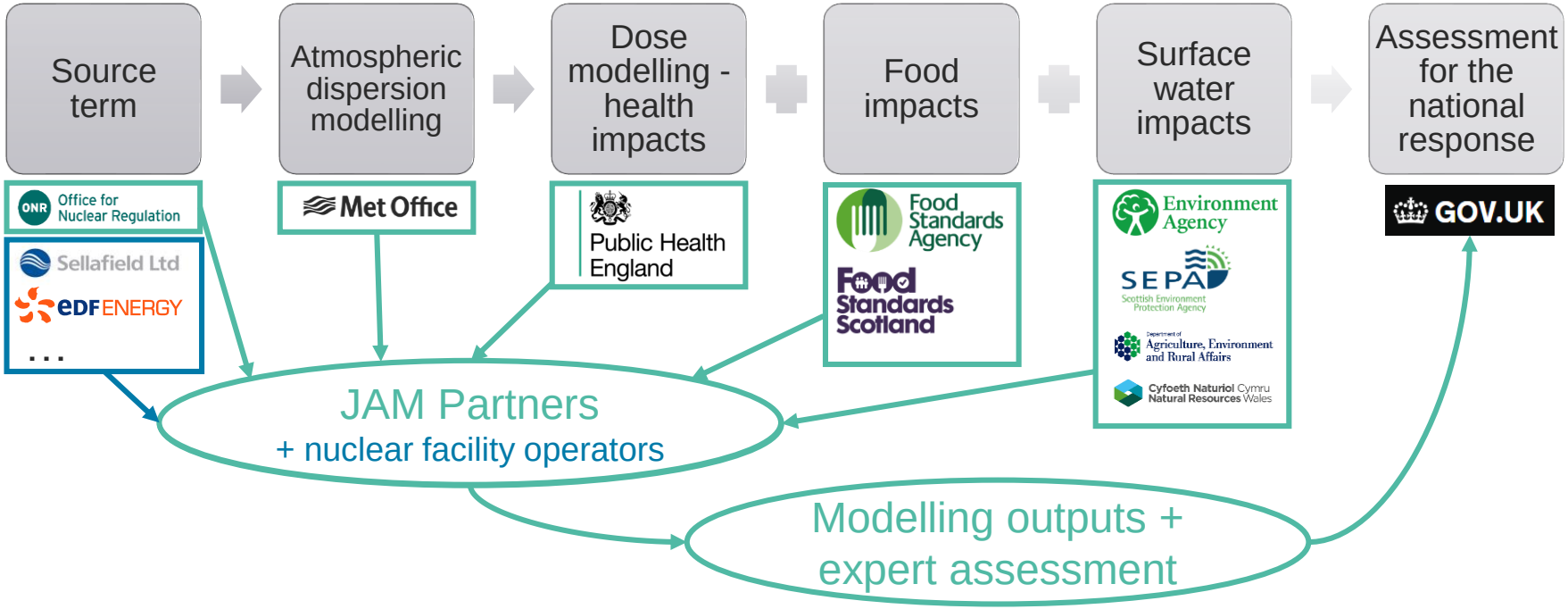
Exposure pathways



Keith Mortimer, Public Health England

- JAM provides:
  - **Assessments** of the impacts and potential areas for protective actions
  - based on **scenarios** of what's been released
  - to **central UK Government** to aid strategic decision-making during an emergency
  - by **modelling** AND reaching a **consensus** on the key points and uncertainties

The process and the partners



All modelling is run at the Met Office (other agencies will do additional modelling)

Source terms

- Sent by the Operator or ONR
- Information on:
  - Location
  - Radionuclides
  - Quantity
  - Time-varying
- Scenarios:
  - Already occurred
  - Most likely
  - Reasonable worst case

Part 3 - Estimate of the release that's already occurred (i.e. past only)

…

Part 4 - Estimate of the future most likely release (i.e. future only)

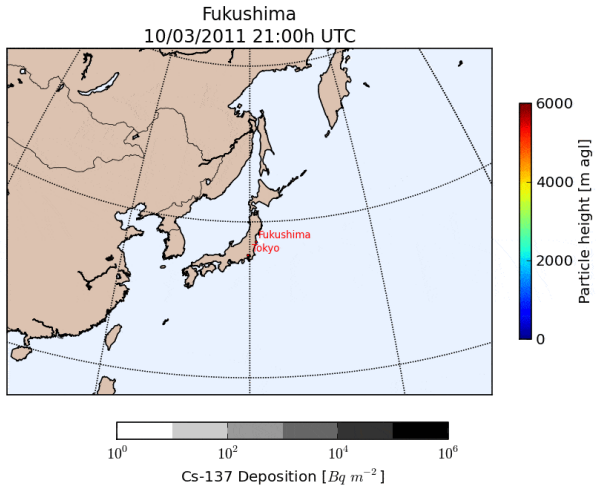
Part 4: column start date (dd/mm/yyyy)				20/03/2019		
Part 4: column start time (hh:mm Local Time)				11:00		
Part 4: column end date (dd/mm/yyyy)				20/03/2019		
Part 4: column end time (hh:mm Local Time)				14:00		
Height of release: e.g. stack or building height (m agl)				0		
Optional: Estimated height of the top of the plume (if visible) above the release point (m agl)						
Nature of release: i.e. leak; fire; explosion				Fire		
	Chemical symbol e.g. Cs-137	***Optional: Gas or Particulate (g/p)*** *(leave blank if unknown)*	***Optional: Depositing? (y/n)*** *(leave blank if unknown)*	**Activity * (Bq)**	**Activity * (Bq)**	**Activity * (Bq)**
Radionuclide 1	I-131			4.1E+16		
Radionuclide 2	Cs-137			5.5E+15		
Radionuclide 3						
Radionuclide 4						
Radionuclide 5						

Part 5 - Estimate of the future release if mechanisms to control the release fail (i.e. future only)

…

Atmospheric dispersion modelling

- NAME (Numerical Atmospheric-dispersion Modelling Environment)
  https://www.metoffice.gov.uk/research/modelling-systems/dispersion-model
- Developed by Met Office, UK
- Lagrangian off-line dispersion model
- Represents advection, diffusion, chemical transformations, deposition, gravitational settling, radioactive decay, plume rise, resuspension,…
- Many uses, e.g. chemical, biological, volcanic ash, dust, air quality, disease spread, and radioactive releases.



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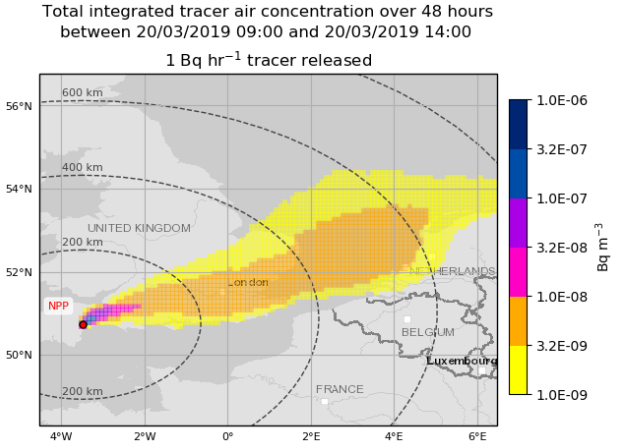
Atmospheric dispersion modelling

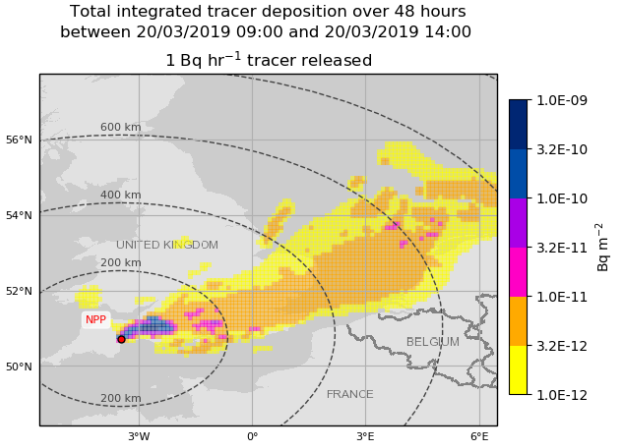
- Inputs:
  - Source term from a UK operator or ONR
  - Meteorological data:
    - Global data at 10 km
    - UK data at 1.5 km
    - ECMWF data

  } Horizontal spatial resolution (approx.)

- Outputs:
  - Time-average and integrated air concentration
  - Wet, dry & total deposition

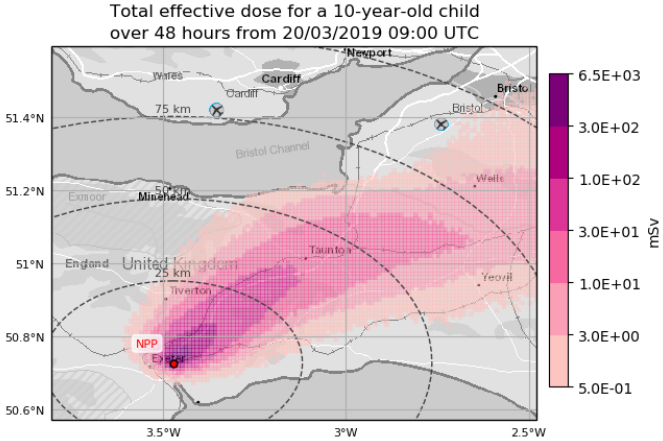
  } For each radionuclide (in source term + daughters)

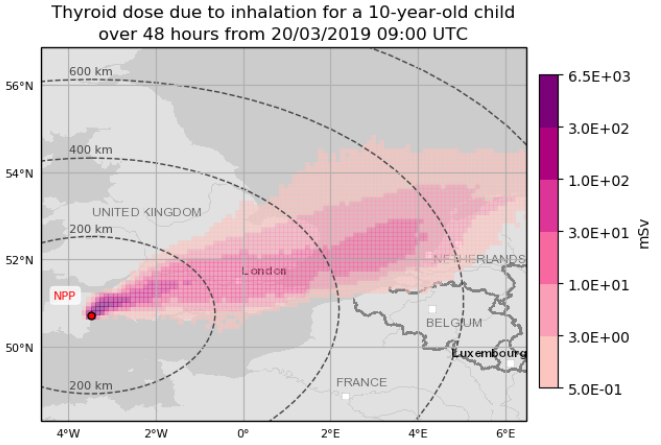




Dose modelling

- Public Health England supply code and data
- Time-integrated air concentrations and deposition → indicative dose quantities:
  - Total effective dose
    (committed effective dose + external effective dose)
  - Thyroid dose (inhalation)
- Dose is calculated for an infant, 10-year old or adult





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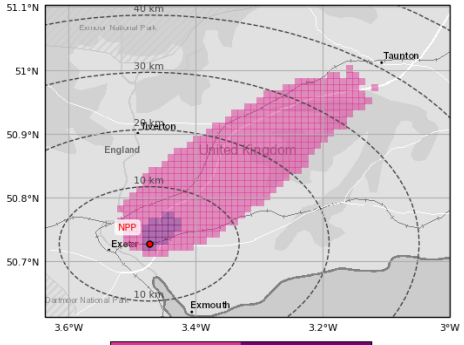
Dose modelling

- Dose calculations → potential areas for protective actions to reduce early health impacts
- Emergency Reference Levels (ERL) are used as thresholds

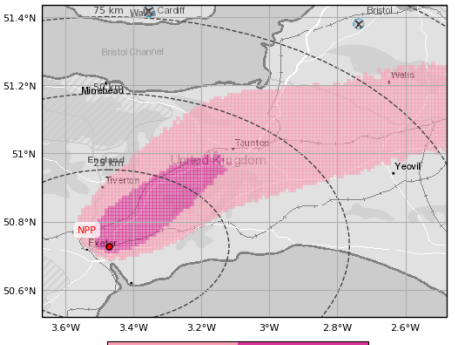
Protective action	Averted dose (mSv)	
	Lower ERL	Upper ERL
Evacuation	30	300
Sheltering	3	30
Stable iodine	30	300

Potential evacuation area
based on a 10-year-old child's total effective dose
over 48 hours from 20/03/2019 09:00 UTC



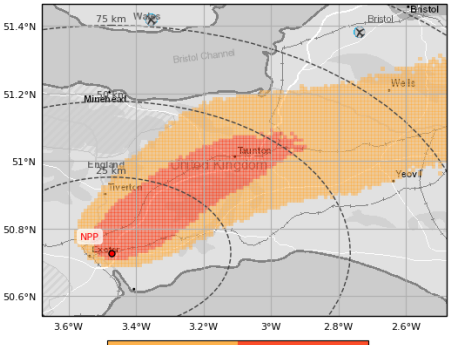
Above LOWER ERL (30.0 mSv) | Above UPPER ERL (300.0 mSv)
(maximum area for evacuation) (minimum area for evacuation)

Potential sheltering area
based on a 10-year-old child's total effective dose
over 48 hours from 20/03/2019 09:00 UTC



Above LOWER ERL (3.0 mSv) | Above UPPER ERL (30.0 mSv)
(maximum area for sheltering) (minimum area for sheltering)

Potential stable iodine distribution area
based on a 10-year-old child's thyroid dose
over 48 hours from 20/03/2019 09:00 UTC

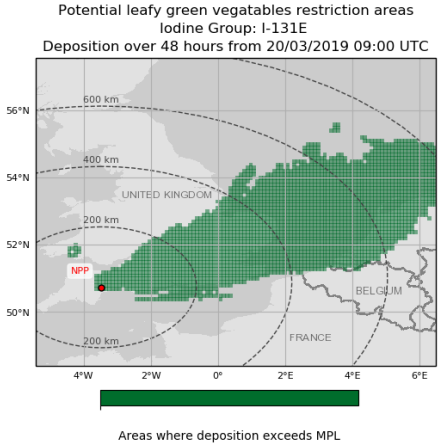


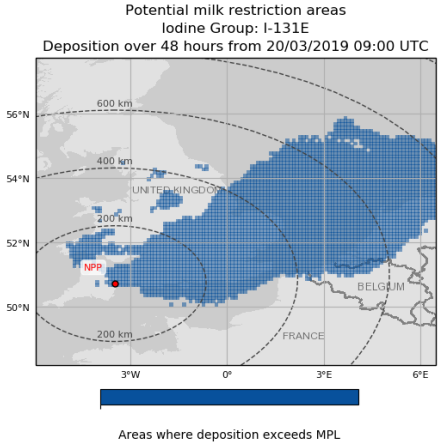
Above LOWER ERL (30.0 mSv) | Above UPPER ERL (300.0 mSv)
(maximum area for stable iodine) (minimum area for stable iodine)

Note: Other factors are considered in decision making and thus actions taken.

Food impact modelling

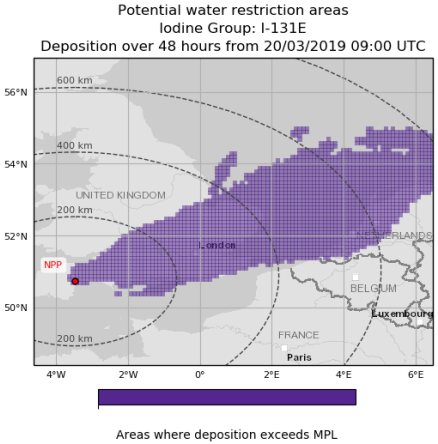
- Maximum Permitted Level (MPL) for each radionuclide permitted in foodstuffs (European Council Regulation)
- Food Standards Agency model the transport of radionuclides in food chains → deposited activity level equating to the MPL (→ static threshold table)
- Sum deposited activity in 4 groups:
  - Strontium isotopes
  - Iodine isotopes
  - Alpha-emitting isotopes of plutonium and trans-plutonium
  - All other radionuclides (half-life > 10 days)

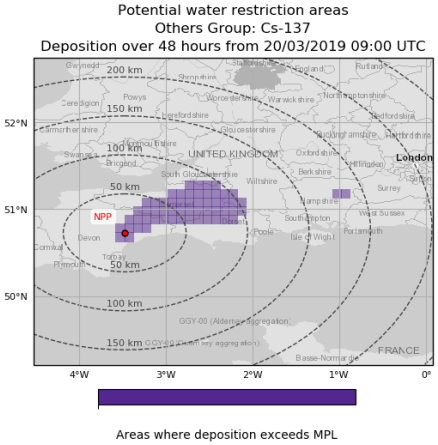




Surface water modelling

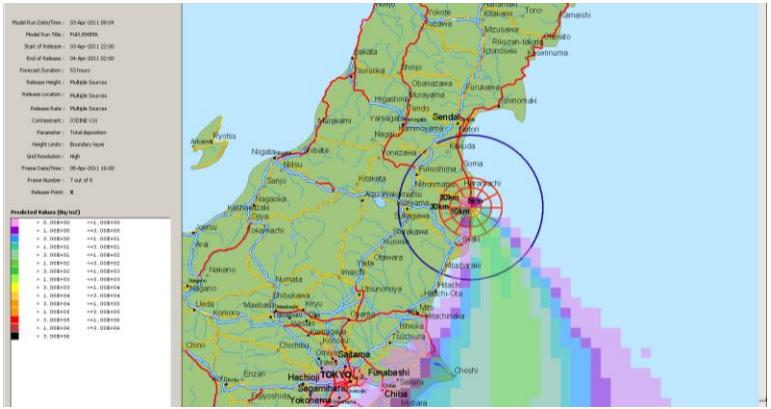
- Similar methodology as for food impacts
- Environment Agency calculates the activity per litre permitted in surface water supplies → static threshold table
- For each radionuclide group: compare deposition with thresholds to highlight areas when deposited activity is too high for surface water supplies
- Select the radionuclide group with the largest impact area

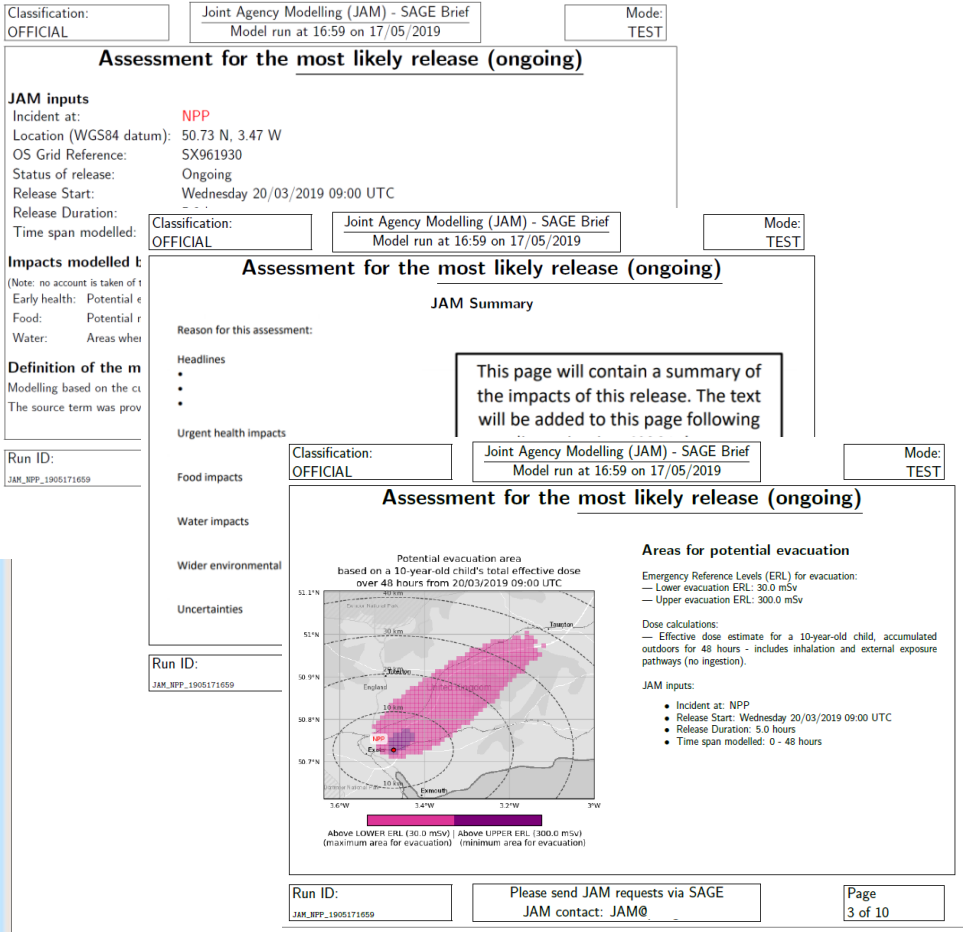




JAM outputs

- JAM modelling outputs
  - ➢ JAM SAGE Brief
  - ➢ Data onto a national mapping platform (RIMNET/RREMS)





Classification: OFFICIAL | Joint Agency Modelling (JAM) - SAGE Brief Model run at 16:59 on 17/05/2019 | Mode: TEST

Assessment for the most likely release (ongoing)

JAM inputs

Incident at:	NPP
Location (WGS84 datum):	50.73 N, 3.47 W
OS Grid Reference:	SX961930
Status of release:	Ongoing
Release Start:	Wednesday 20/03/2019 09:00 UTC
Release Duration:	
Time span modelled:	

Impacts modelled b

(Note: no account is taken of t

Early health: Potential e

Food: Potential r

Water: Areas whe

Definition of the m

Modelling based on the cu

The source term was prov

Run ID: JAM_NPP_1905171659

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Assessment for the most likely release (ongoing)

JAM Summary

Reason for this assessment:

Headlines

-
-
-

Urgent health impacts

Food impacts

Water impacts

Wider environmental

Uncertainties

This page will contain a summary of the impacts of this release. The text will be added to this page following

Run ID: JAM_NPP_1905171659

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Assessment for the most likely release (ongoing)

Potential evacuation area
based on a 10-year-old child's total effective dose
over 48 hours from 20/03/2019 09:00 UTC

Above LOWER ERL (30.0 mSv) (maximum area for evacuation) | Above UPPER ERL (300.0 mSv) (minimum area for evacuation)

Areas for potential evacuation

Emergency Reference Levels (ERL) for evacuation:
— Lower evacuation ERL: 30.0 mSv
— Upper evacuation ERL: 300.0 mSv

Dose calculations:
— Effective dose estimate for a 10-year-old child, accumulated outdoors for 48 hours - includes inhalation and external exposure pathways (no ingestion).

JAM inputs:

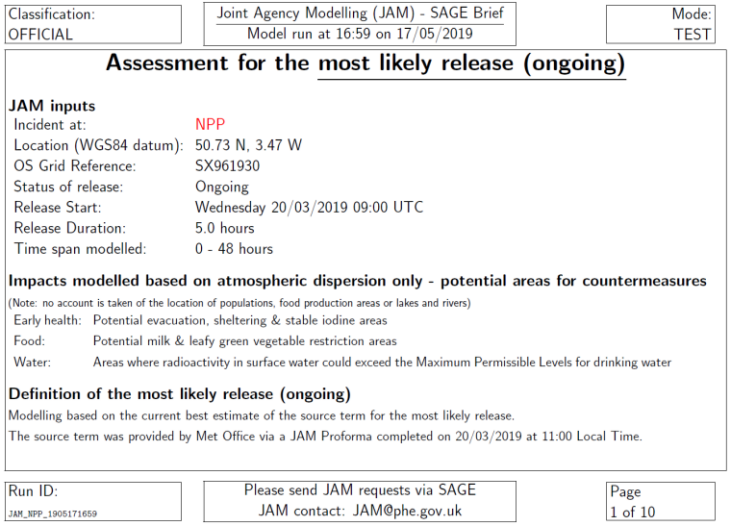
- Incident at: NPP
- Release Start: Wednesday 20/03/2019 09:00 UTC
- Release Duration: 5.0 hours
- Time span modelled: 0 - 48 hours

Run ID: JAM_NPP_1905171659 | Please send JAM requests via SAGE JAM contact: JAM@ | Page 3 of 10

Source term → ADM → Dose Modelling → Food & water → SAGE

Scientific Advisory Group for Emergencies (SAGE)

- JAM SAGE Brief → SAGE attendees (Government Chief Scientists, high-level reps from government agencies, industry and academia)
- JAM assessment considered alongside other information
- SAGE provides scientific advice to national government during an emergency (e.g. Government Chief Scientific Advisor → Prime Minister)



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Joint Agency Modelling (JAM) - SAGE Brief
Model run at 16:59 on 17/05/2019

Mode: TEST

Assessment for the most likely release (ongoing)

JAM inputs

Incident at:	NPP
Location (WGS84 datum):	50.73 N, 3.47 W
OS Grid Reference:	SX961930
Status of release:	Ongoing
Release Start:	Wednesday 20/03/2019 09:00 UTC
Release Duration:	5.0 hours
Time span modelled:	0 - 48 hours

Impacts modelled based on atmospheric dispersion only - potential areas for countermeasures

(Note: no account is taken of the location of populations, food production areas or lakes and rivers)

Early health:	Potential evacuation, sheltering & stable iodine areas
Food:	Potential milk & leafy green vegetable restriction areas
Water:	Areas where radioactivity in surface water could exceed the Maximum Permissible Levels for drinking water

Definition of the most likely release (ongoing)

Modelling based on the current best estimate of the source term for the most likely release.

The source term was provided by Met Office via a JAM Proforma completed on 20/03/2019 at 11:00 Local Time.

Run ID: JAM_NPP_1905171659

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JAM contact: JAM@phe.gov.uk

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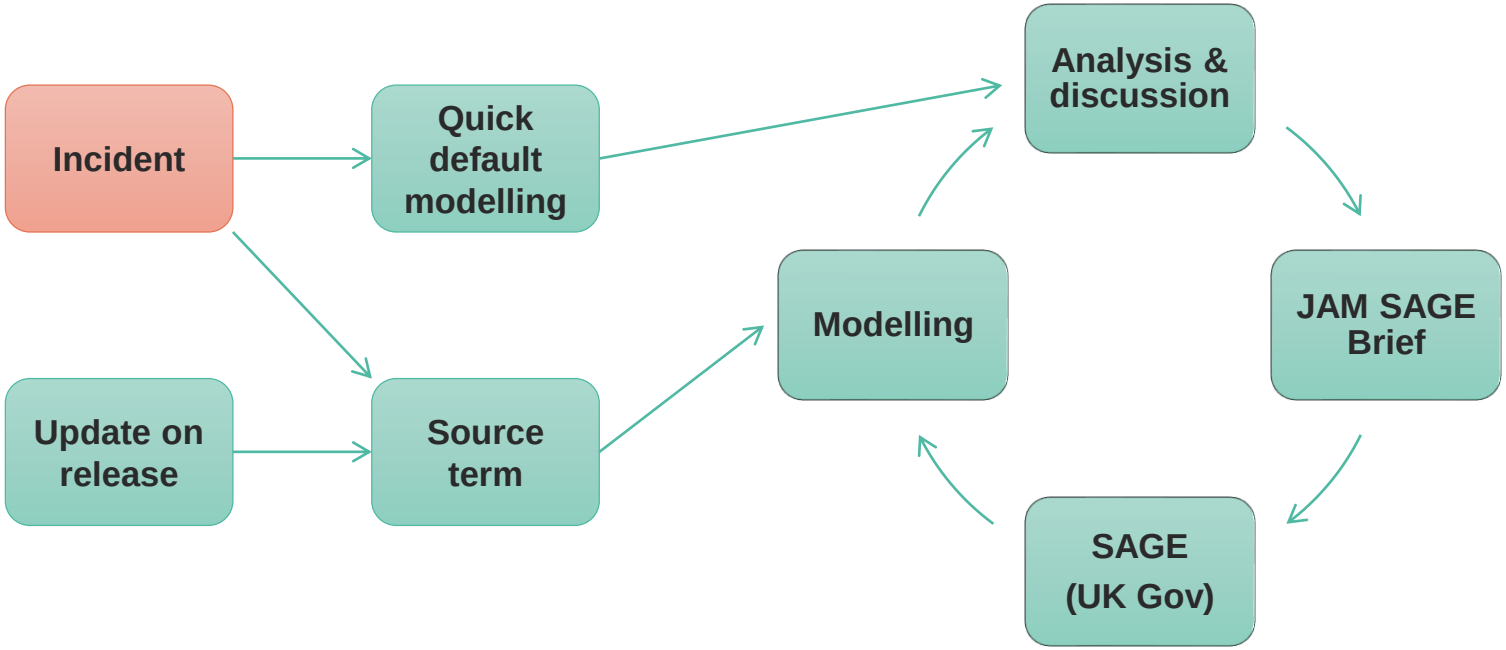
A cyclical process



Joint Agency Modelling (JAM) – a summary

- Born out of the response to the Fukushima Daiichi accident
- A multi-agency response to provide assessments to UK Government on the potential impacts and protective actions following a radiological release anywhere in the world
- Includes scenarios and uncertainties
- Developed over many years and ready to be operational
- Successfully tested during a recent national exercise

Met Office

Thank you for your attention

Any questions?

Contact: sarah.millington@metoffice.gov.uk

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