The application of meteorological ensembles in the SINAC decision support system

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June 4th 2019. Bruges, Belgium

Introduction

- CONFIDENCE Project :"Coping with uncertainties for improved modelling and decision making in nuclear emergencies"

- Objective of 1st Work Package

  - to quantify the uncertainties of atmospheric dispersion calculation

  - to investigate their effect on the result of a radiological release

  - explore methods for their reduction

- One of the tasks is producing recommendations for operational context:

  - For this task, we took the first step towards **developing an operational version of** our decision support system **SINAC using Hungarian ensemble meteorological data**
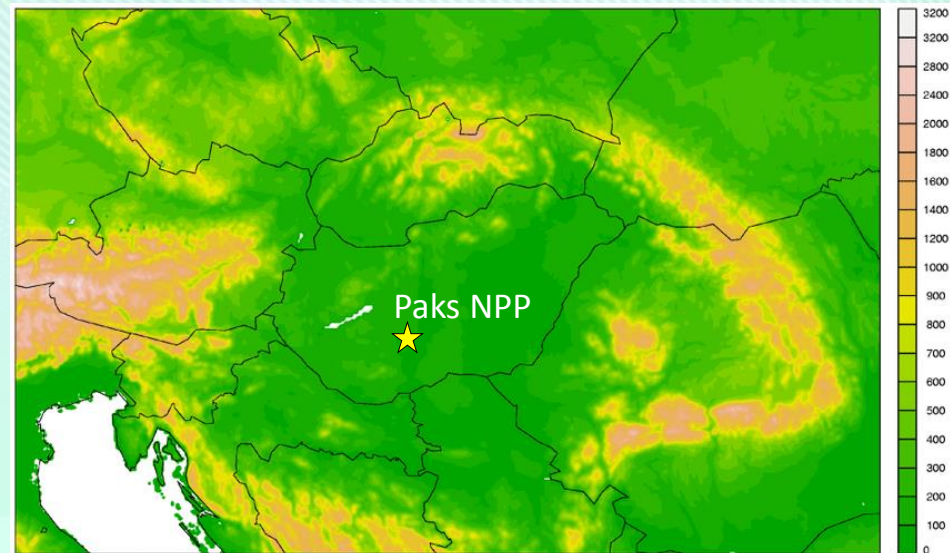
The model

- SINAC (**Si**mulator Software for Interactive Consequences of **N**uclear **Ac**cidents):
  - Decision Support System (DSS)
  - Developed by MTA-EK since the 1990's
  - Used in the Hungarian Atomic Energy Authority (HAEA) Centre for Emergency Response as a decision support system
  - Hungarian domain
- Atmospheric dispersion model
  - Gaussian puff model
- Output results:
  - Activity concentration (air, ground)
  - Dose rates and doses
  - Countermeasures: projected and avertable dose
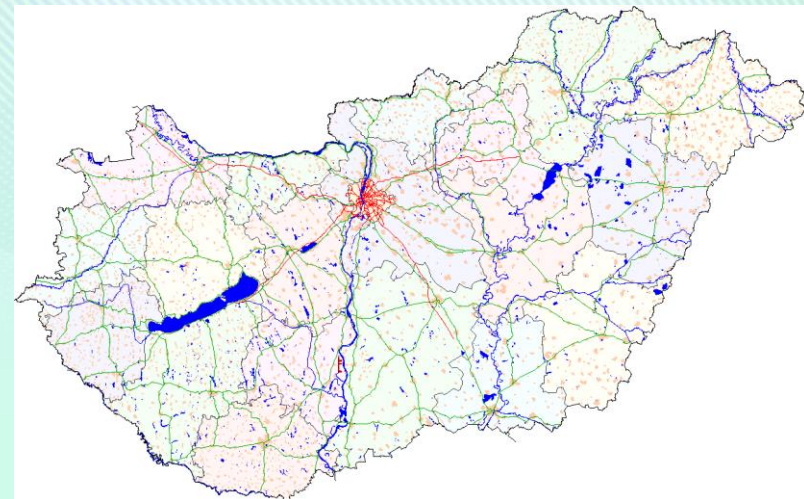
SINAC 1.2.0 version visualization (2013)

Meteorological data

- Provided by the Hungarian Meteorological Service (OMSZ)

  – Operationally from AROME (Applications of Research to Operations at MEsoscale)

  – But as AROME-EPS is not operational yet, data was produced by ALADIN-EPS (Aire Limitée Adaptation Dynamique Développement International) converted to AROME grid

  – Resolution:

    • Horizontal: ~2.5 km

    • Vertical: 60 model levels

    • Temporal: 1 h

 – Forecast length: 36 h

  – Ensemble members: 9

Topography of the AROME model domain covering the Carpathian Basin (1200 x 750 km)

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Release scenario

- Newly developed module for Hungarian ensemble meteorological data

- Two fictional release cases:

| Parameters	Winter	Summer
Date	18:00 27th of January 2017.	18:00 14th of August 2018.
Duration of release	12 h	
Nuclides	Cs-137, Xe-133	
Activity	$1 \cdot 10^{16}$ Bq each	
# of puffs	360 puffs (puff release time resolution: 2 min)	
Effective release heigh	120 m	
Grid	600x600 km Cartesian-grid	
Release point	Paks NPP	
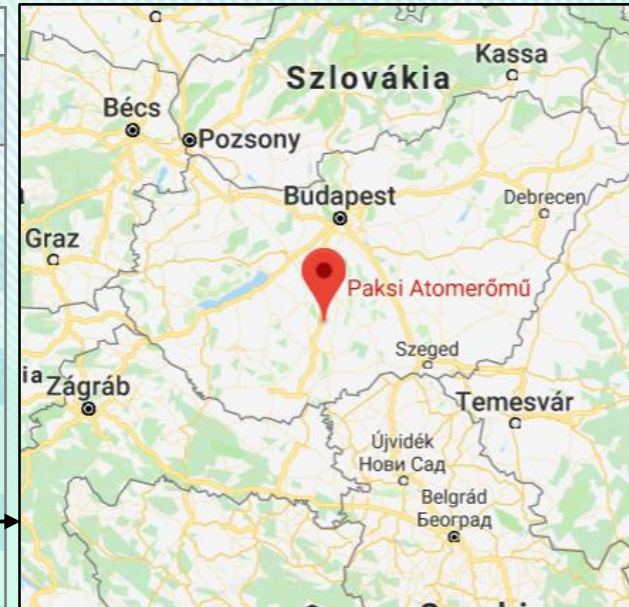
- Results:
  - Time integrated activity concentration in the air [Bq·s/m^3]
  - Deposited activity concentration on the ground [Bq/m^2]
  - Grid: 200x200 points, Resolution: 3 km, 1 h

Winter release - contour

- Values exceeding zero

Member	Impacted area [km²]	
	12 h	24 h
00	14 643	31 590
01	16 767	24 966
02	14 607	28 485
03	15 192	**32 166**
04	**21 978**	27 756
05	15 948	24 831
06	13 554	31 158
07	17 595	26 604
08	7 398	21 708
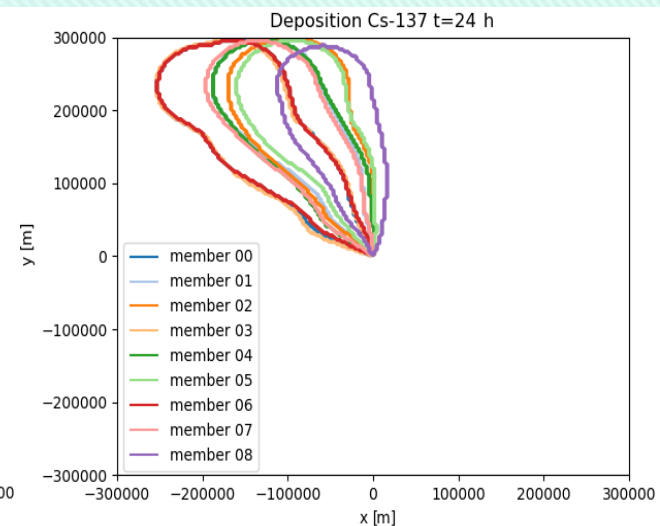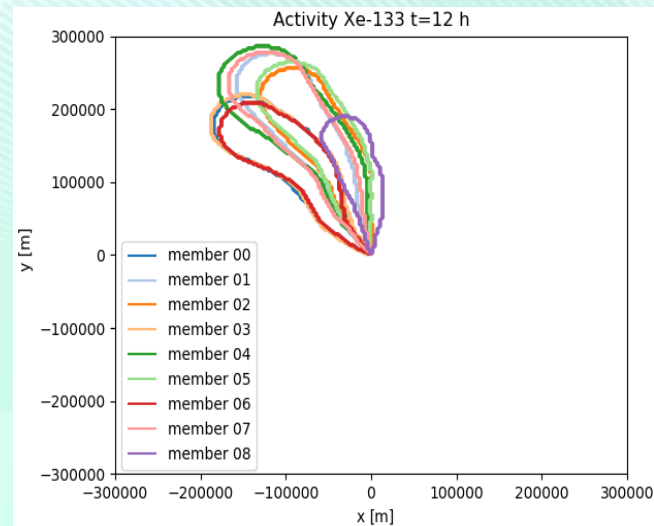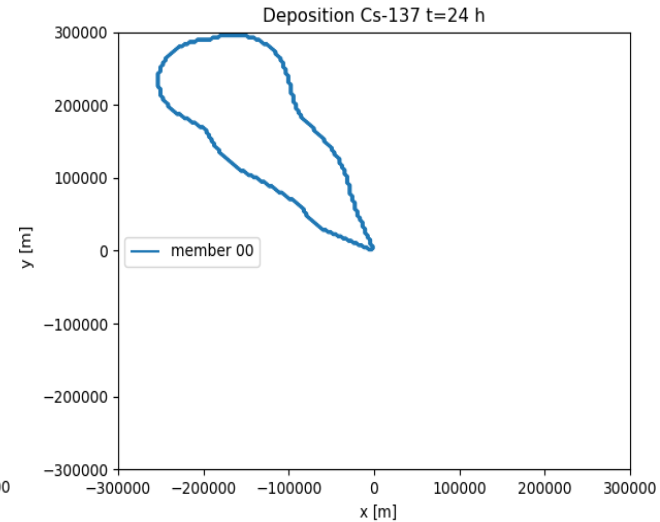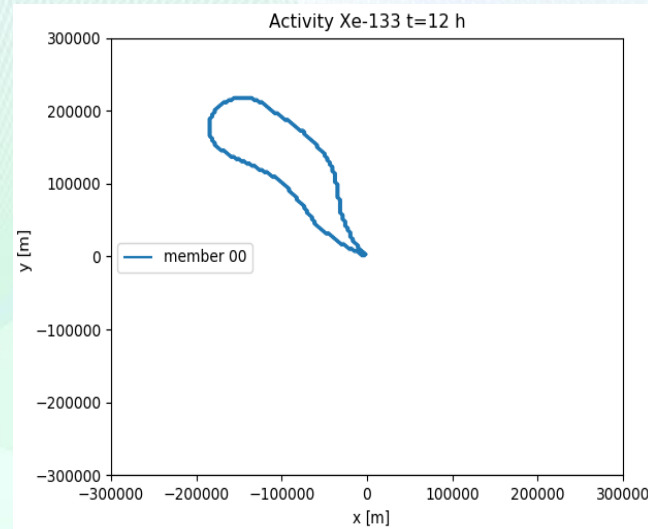
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Winter release - overlap

- Number of members exceeding zero values

Overlap [km²]	1	2	3	4	5	6	7	8	9
12 h	32 337	28 665	26 154	18 189	14 715	8 820	4 842	3 771	189
24 h	51 516	45 342	43 578	28 746	26 154	23 733	14 985	11 529	3 681
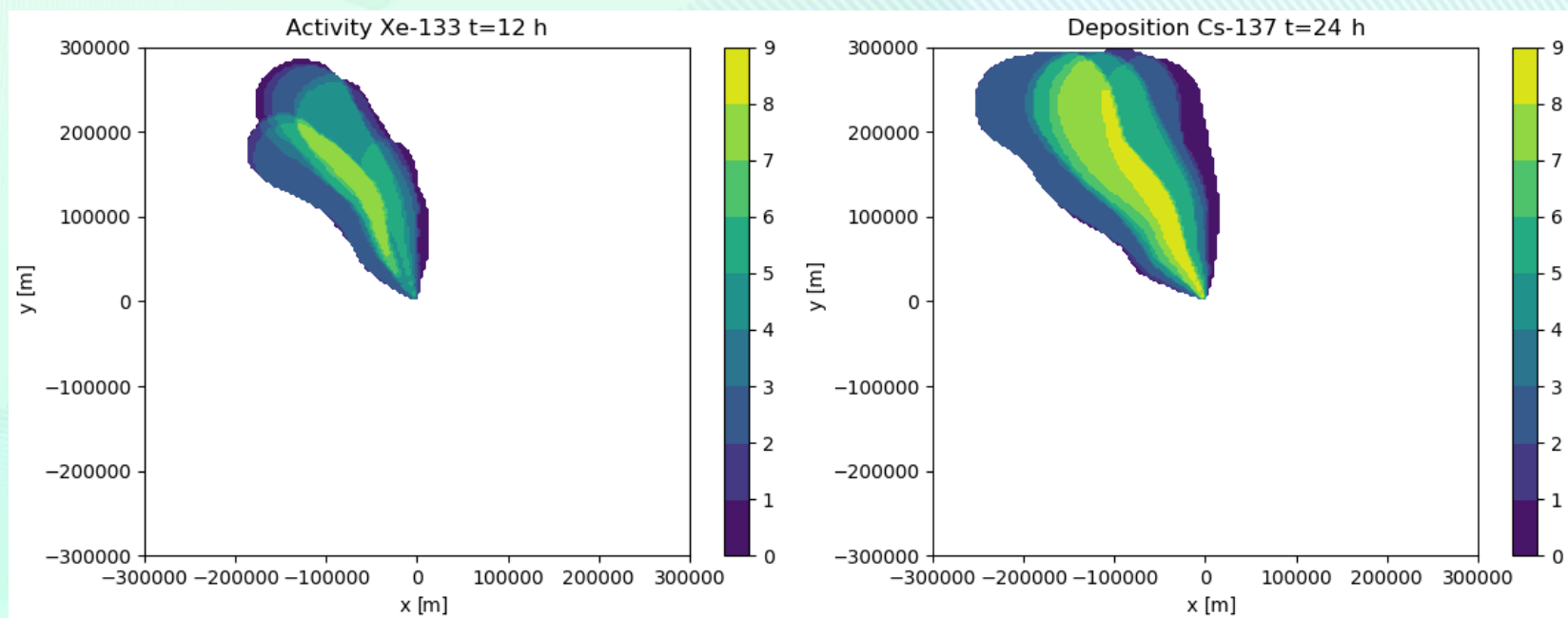
Activity Xe-133 t=12 h   Deposition Cs-137 t=24 h

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Winter release - overlap

- Cs-137 deposition, exceedence set to higher levels

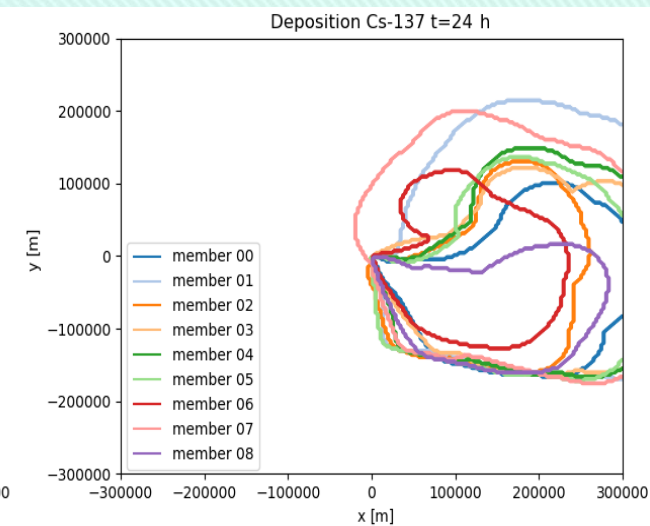| Overlap [km²]	1	2	3	4	5	6	7	8	9
>1 kBq/m²	31 779	25 911	24 138	13 410	12 105	5 805	2 547	936	0
>10 kBq/m²	25 686	20 295	17 289	7 875	6 273	1 314	477	99	0
>37 kBq/m²	19 251	14 508	10 656	3 105	2 277	414	90	18	0
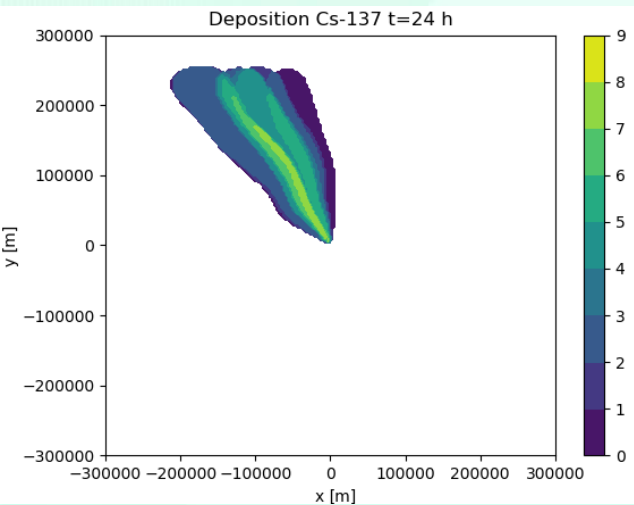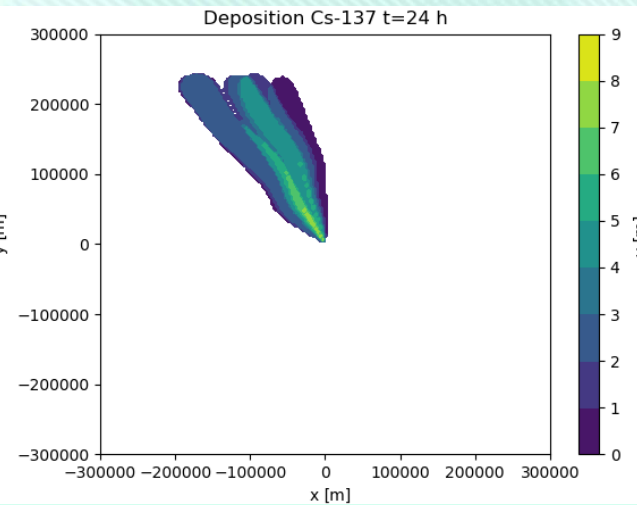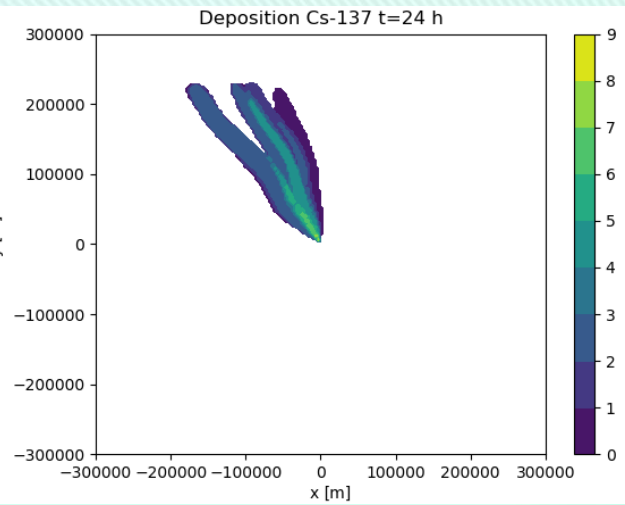
>1 kBq/m²   >10 kBq/m²   >37 kBq/m²
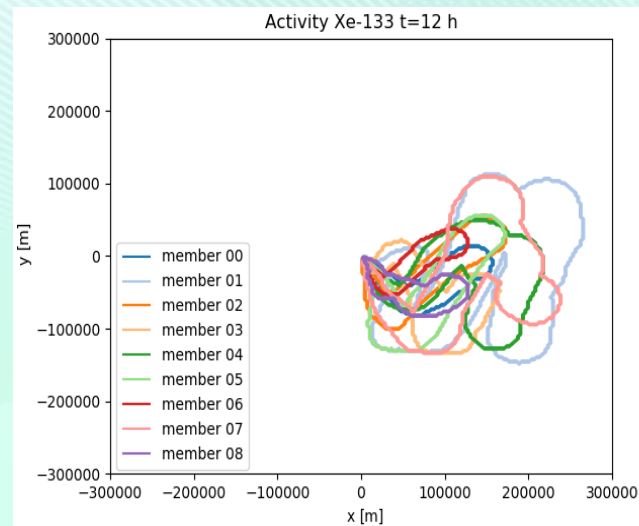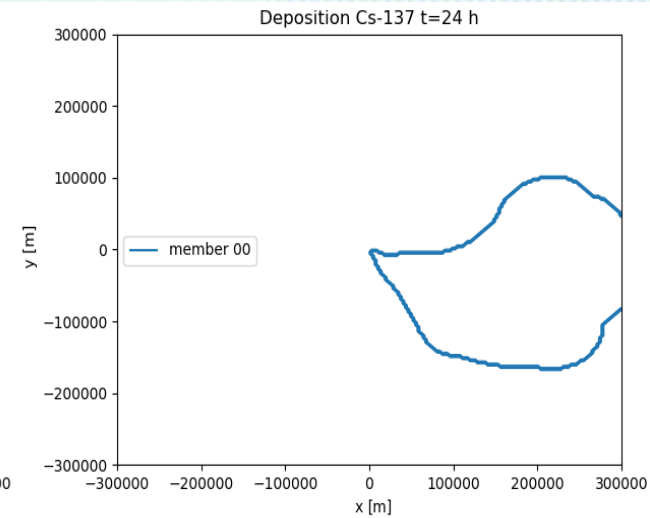
Summer release - contour

- Values exceeding zero
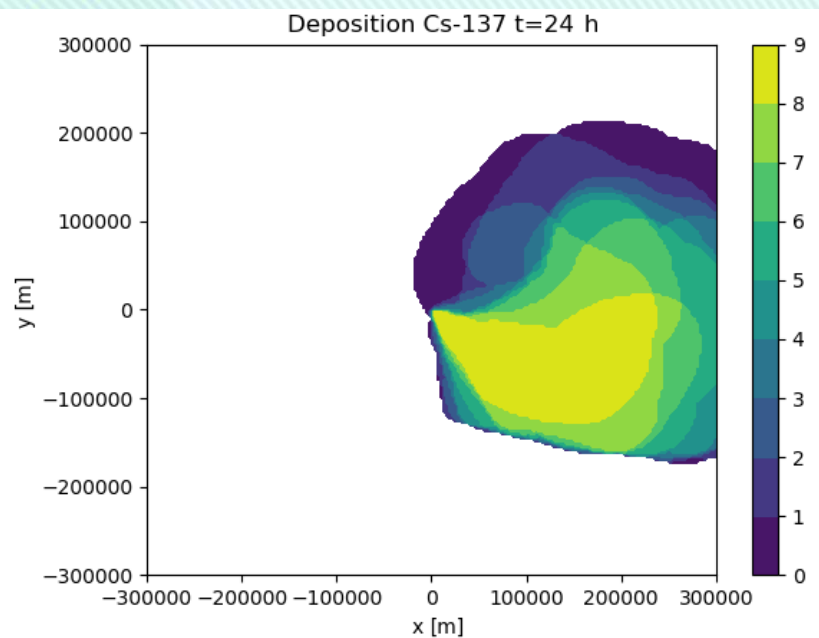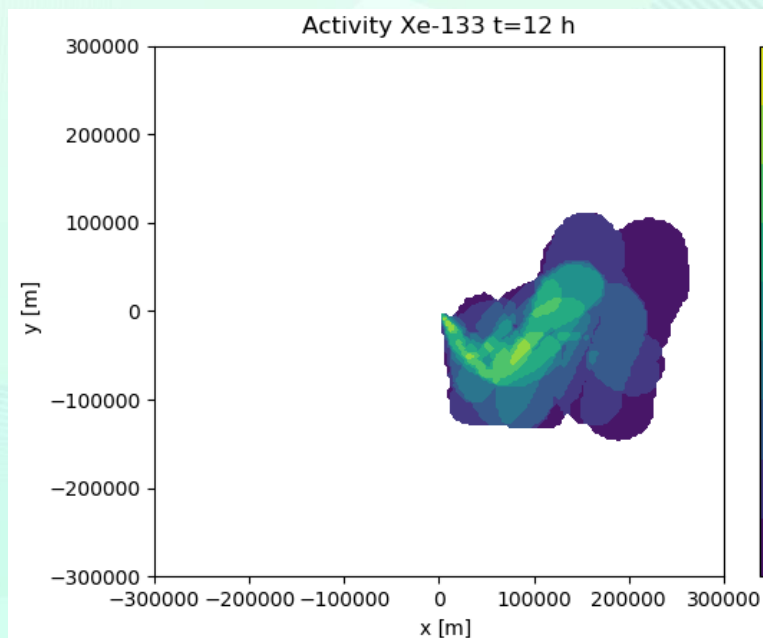
Member	Impacted area [km²]	
	12 h	24 h
00	8 280	52 182
01	**46 098**	92 502
02	12 042	49 914
03	14 895	62 802
04	22 887	68 346
05	17 028	67 761
06	5 544	39 348
07	31 860	**94 419**
08	6 480	35 469
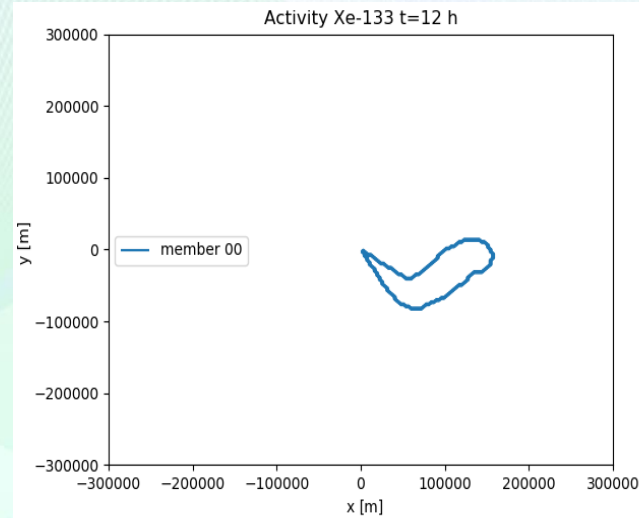
Summer release - overlap

- Number of members exceeding zero values

Overlap [km²]	1	2	3	4	5	6	7	8	9
12 h	49 086	36 603	26 505	17 649	12 906	9 702	6 336	4 356	1 971
24 h	104 454	87 147	77 202	68 454	63 657	58 527	46 800	35 001	21 501

Summer release - overlap

- Cs-137 deposition, exceedence set to higher levels

Overlap [km²]	1	2	3	4	5	6	7	8	9
>1 kBq/m²	71 154	54 918	43 902	39 573	35 073	28 971	21 321	16 416	8 640
>10 kBq/m²	54 360	35 163	22 752	16 263	12 915	9 720	5 814	3 222	1 791
>37 kBq/m²	34 209	11 214	5 067	2 880	1 944	1 305	936	702	279
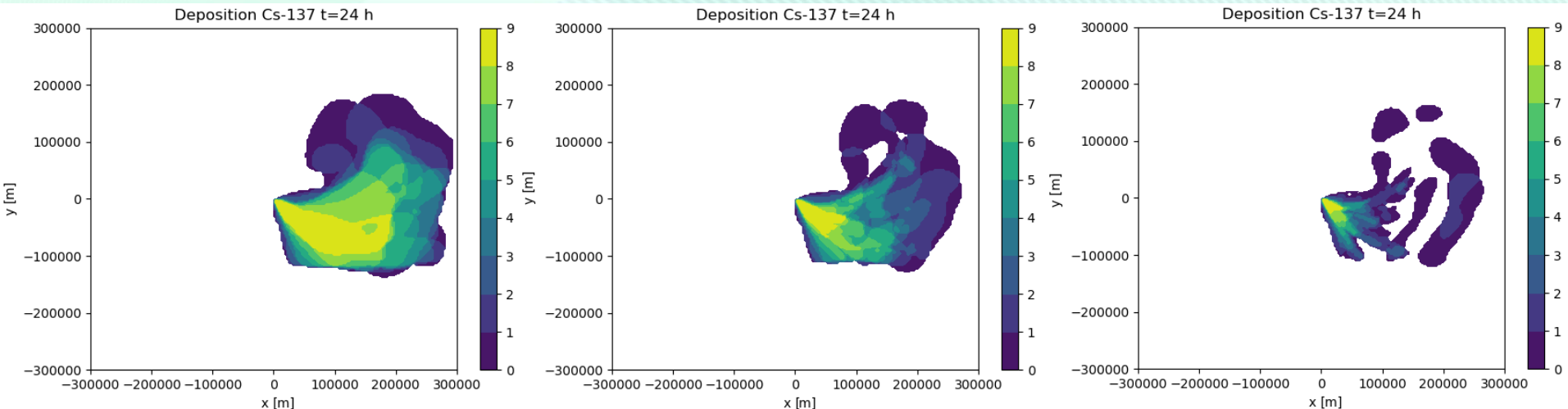
>1 kBq/m²

>10 kBq/m²

>37 kBq/m²

Conclusions

- Application of new module, using meteorological ensembles from ALADIN-EPS provided by Hungarian Meteorological Services.

- Two scenarios for 9 ensemble meteorological members:
  - Winter, calm, foggy (27th of January)
  - Summer, convective, dynamic (14th of August)

- Results shown in contour and overlap plots of exceedence (set to different values)

- Overlap of number of results member → corresponding to percentile values
  - Only the effect of different meteorological members was examined
  - Release height and release timing was not investigated

- Results show that in the summer case more significant change in wind speed and wind direction results in bigger spread of the impacted area.

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Thank you for your attention!

Any questions?

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