Comparison of the dispersion model in RODOS-LX & MM5-V3.7-FLEXPART(V6.2)

A case study for the NPP of Almaraz

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introduction

In case of a radioactive release a good early response and efficient management is needed.

RODOS -> real-time management of nuclear emergencies
(currently under revision and improvement within EURANOS)

The combination of high-resolution mesoscale meteorological modeling + atmospheric Lagrangian particle dispersion models may be advisable in places with complex orography, such as river valleys and seashore sites

(where NPP are located!)

increasing computer performance ✔

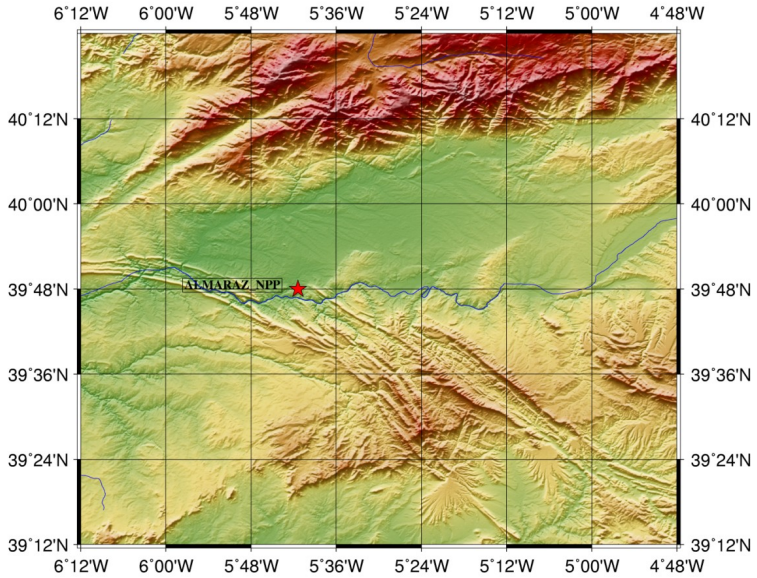
introduction

does it make a significant difference to use a Lagrangian particle dispersion model instead of the RODOS dispersion module as it is implemented in Spain by the CIEMAT and CSN?

Set-up and intercomparison study between RODOS-LX and MM5-V3.4-FLEXPART(V6.2)

site and release

- Almaraz NPP:
  - Located in inner Iberian Peninsula at the end of Arrocampo reservoir (Tajo river)
  - Complex topography -> river valley flanked by mountains
- Meteo basic features:
  - Dominant westerly flows -> chanelling through the valley expected
  - Possible thermally driven mesoscale circulations

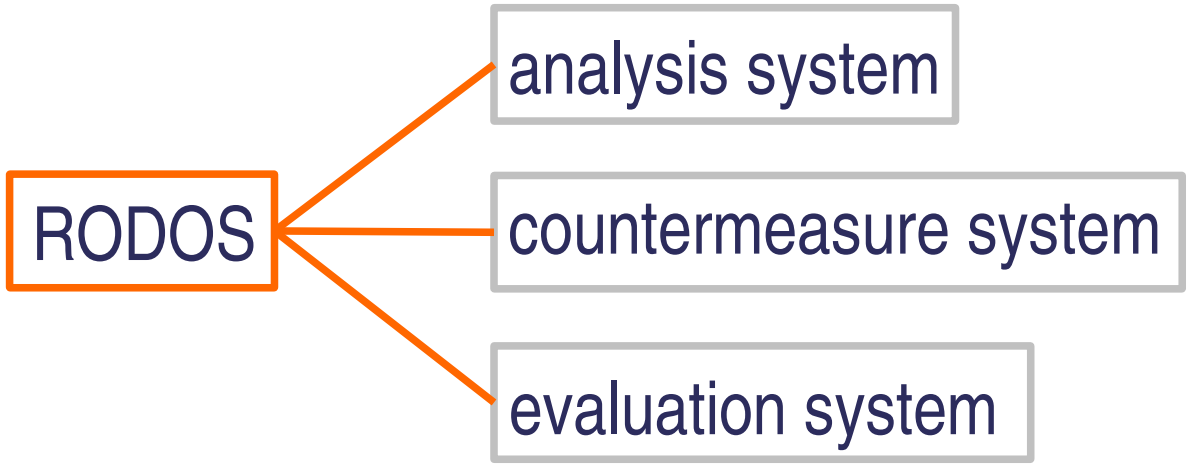


Release

2-hour ^{137}Cs $9.45 \cdot 10^{15}$ Bq at 40 m above ground beginning at 12:00 UTC -10th May 2007

RODOS-LX

- Real-time On-line De-cisiOn Support system for nuclear emergency management -> a comprehensive module-based system for assessing and evaluating the consequences of a nuclear accident at all scales including the effect of the possible countermeasures (www.rodos.fzk.de/rodos.html)



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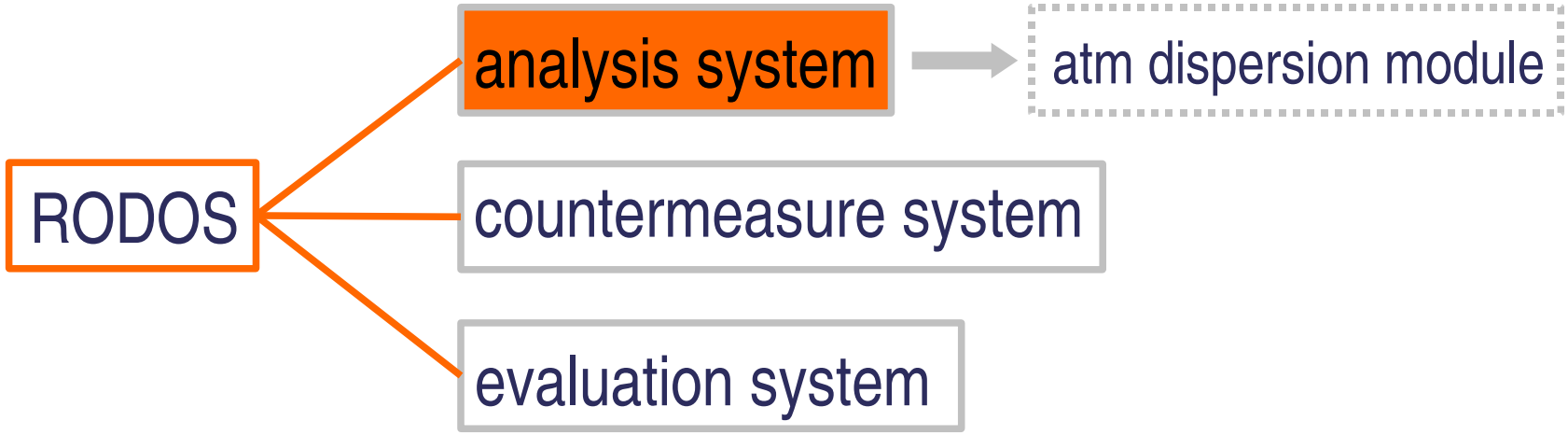

RODOS-LX

atm dispersion module

- MATCH -> long range
- ATSTEP -> simple elongated puff model
- **RIMPUFF -> lagrangian puff diffusion model**

meteorological fields:

- real-time measurements
- pre-calculated numerical weather forecasts

RODOS-LX

- Set-up of our case scenario
  - Meteo from HIRLAM (ECMWF lateral BC) provided by the Spanish National Institute of Meteorology (INM) ->hourly meteo fields with a forecasted length of 36 hours.

    160x160 grid cells with a grid size of 0.1deg

    15 vertical levels

    → pre-processed by the Local Scale Pre-processor LSP

  - RIMPUFF:
    - dynamic grid 4 domains down to 1km
    - hourly output
    - output: integrated gridded concentration, deposition and values at some receptors

Nest	RODOS-LX (RIMPUFF)		
	Number of cells	Grid size (km)	Domain size (km)
1	24	1	24
2	36	2	72
3	30	6	120
4	21	8	168

M5-V3.7-FLEXPART(V6.2)

- FLEXPART(V6.2) -> is a Lagrangian particle dispersion model which simulates the transport, diffusion, dry and wet deposition and radioactive decay of point, line, area or volume sources
(http://transport.nilu.no/flexpart)

FLEXPART newest versions

meteorological fields:

- ECMWF
- GFS
- WRF
- MM5-V3.7

M5-V3.7-FLEXPART(V6.2)

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FLEXPART newest versions

meteorological fields:

- ECMWF
- GFS
- WRF
- **MM5-V3.7->MM5-V3.7-FLEXPART(V6.2)**

→ coarser res.

M5-V3.7-FLEXPART(V6.2)

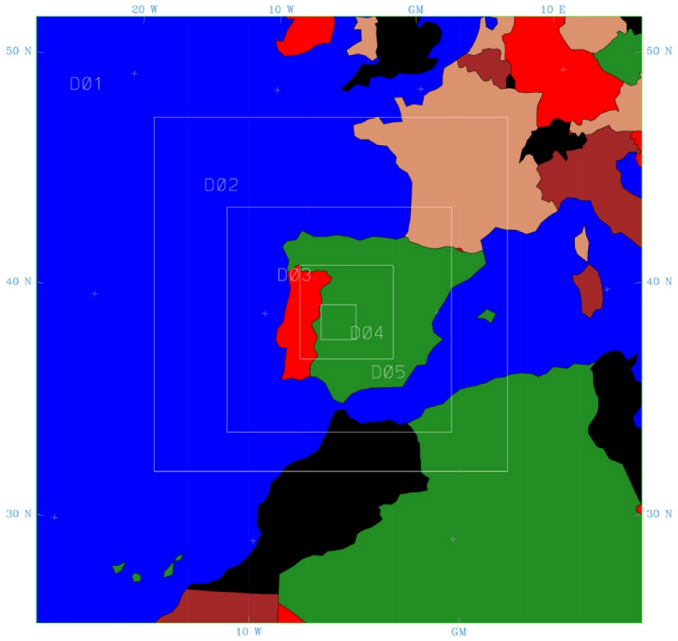
- Set-up of our case scenario
  - Meteo from MM5-V3.7

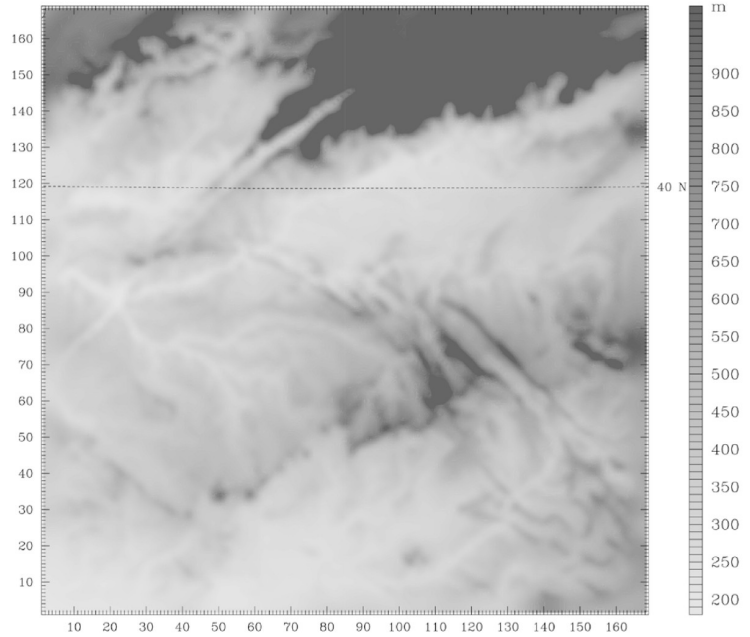
    5 domains down to 1km

    35 vertical levels

    fed by 6-hourly GFS data with 12-hours forecasted length

Nest	MM5-V3.7		
	Number of cells	Grid size (km)	Vertical levels
1	37x37	1	35
2	64x64	3	35
3	121x121	9	35
4	151x151	27	35
5	169x169	81	35





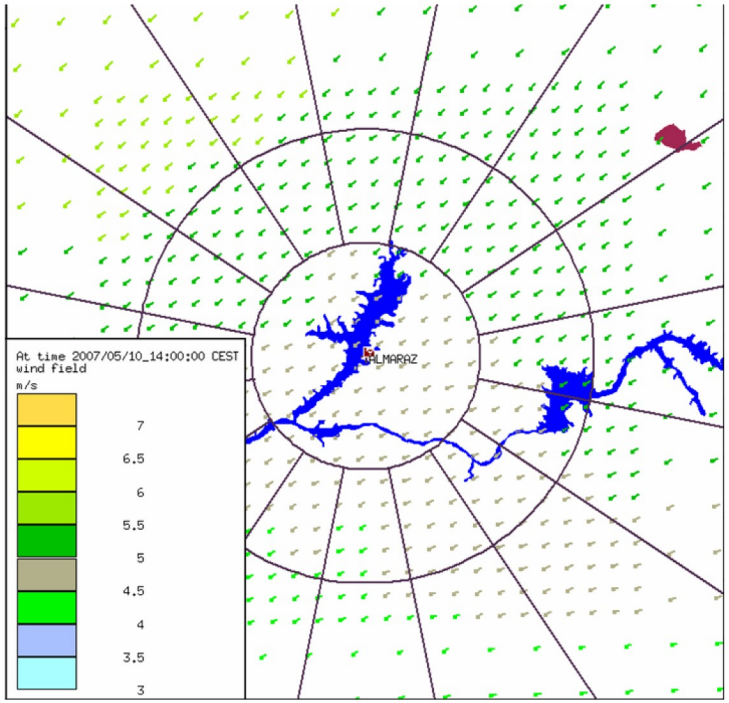
M5-V3.7-FLEXPART(V6.2)

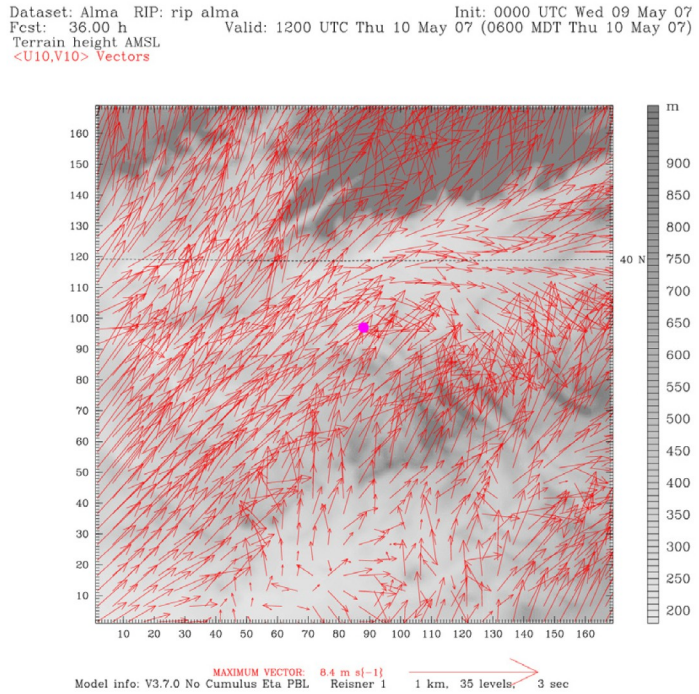
- Set-up of our case scenario
  - FLEXPART (V6.2)
    - 1 domains with 1km horizontal resolution
    - 6 vertical levels (lowest at 25 m a.g.l)
    - 10-minute output
    - output: integrated gridded concentration, deposition and values at some receptors

Number of particles released	$3 \cdot 10^6$
Total mass/activity released with the particles	$9.45 \cdot 10^{15}$ Bq
Height above ground level	from 40 to 40.5 m a.g.l.
Output interval	10 min
Outgrid dimensions	225 x 225 x 6
Horizontal resolution	1 km
Height of the first vertical level	25 m
Minimum mixing height	10 m
Length of the simulation	1 day

results & discussion

- meteorological modeling



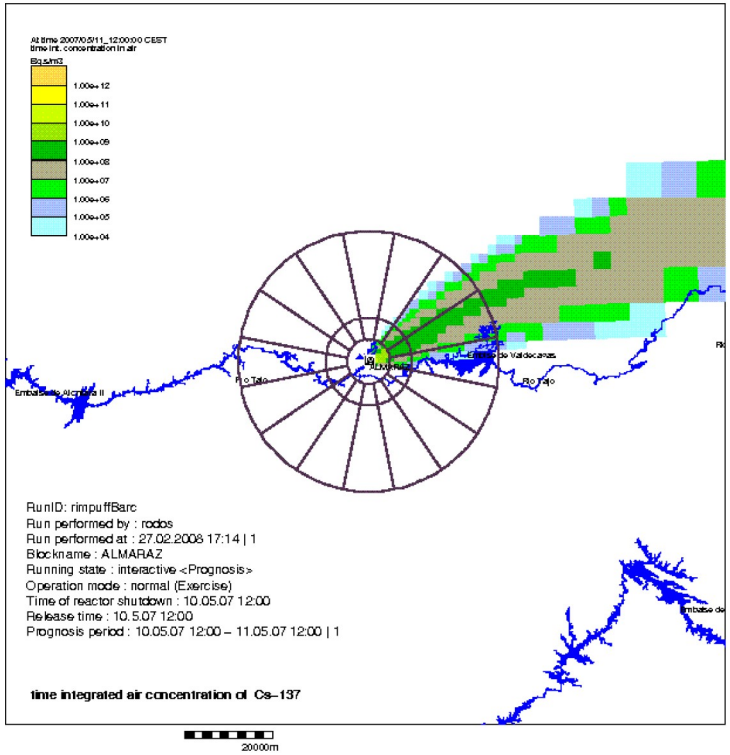


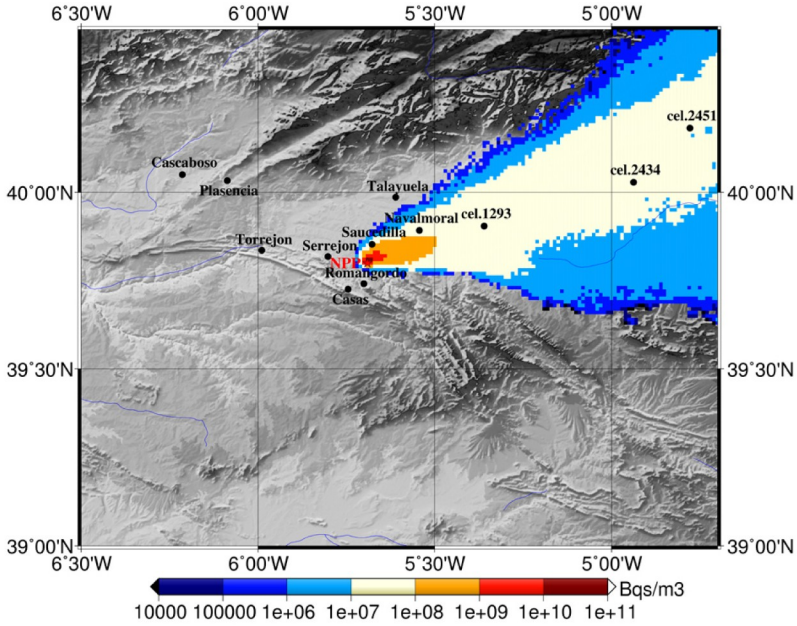
- south-westerly flows appear in both models.
- HIRLAM is rather homogeneous!
- MM5 reproduce better orographic influences!

results & discussion

- dispersion modeling

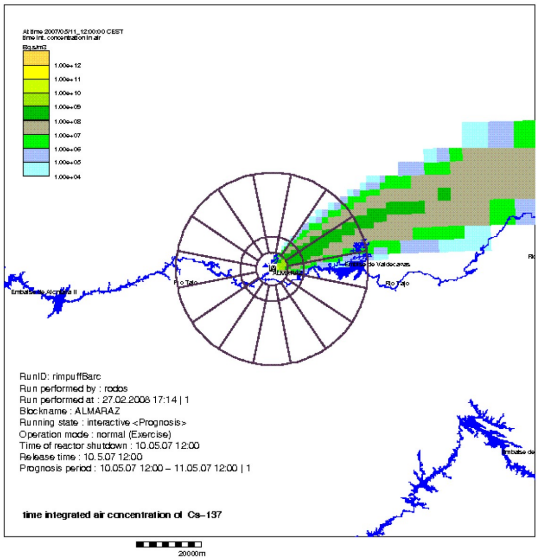
1-day integrated ^{137}Cs air concentration (Bq·s·m-3) with RODOS-LX (left) and MM5 - FLEXPART (right)

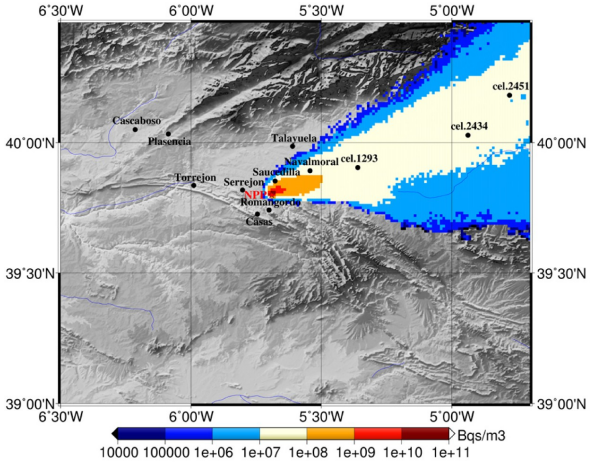




- main transport direction and spreading within the valley are similar.
- FLEXPART simulates a more complex plume and orographic features are better followed.
- highest concentration plume-center is longer in RODOS.

results & discussion



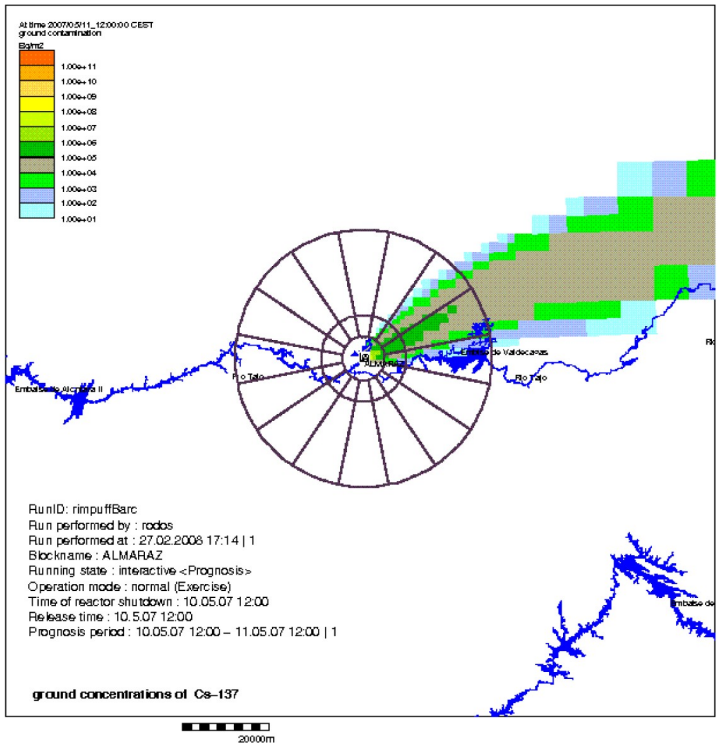


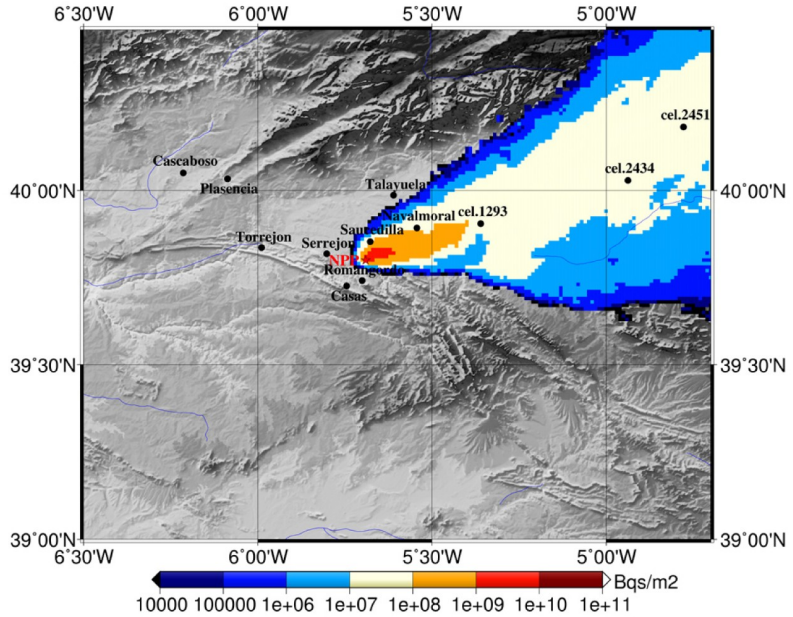
Cel. Number	1293	2434	2451
LON/LAT	(-5.2603/39.9045)	(-4.9370/40.0282)	(-4.7781/40.1814)
RODOS-LX	80.6	86.8	5.0
MM5-V3.7-FLEXPART(V6.2)	33.3	16.5	13.7

- receptors at the center of the plume give higher concentrations in RODOS.
- according to FLEXPART an area in the SE of the NPP would be affected while not in RODOS.

results & discussion

^{137}Cs deposition (Bq·m-2) with RODOS-LX (left) and MM5 - FLEXPART (right)





- deposition fields also show differences mainly in the SE direction as well as in the complexity of the plume structure.

conclusions & outlook

- Both models show similar behaviour under an advective SW situation and a diurnal release.
- However, FLEXPART shows a more complex structure which may be important under non-advective conditions.
- Point-to-point differences are up to one order of magnitude.
- Differences are not big in this case but may be important in practice.

- Further studies under other meteo conditions such as nocturnal stable situations and under well-developed mesoscale circulations are currently being done in the framework of a Spanish Researh Project