# An Operational Meteorological Forecast System at Mesoscale for Radiological and Chemical Impact Assessment

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## I. Context and Objectives

In most cases, studies of radiological or chemical impact are carried out using average or simplified local weather conditions. This methodology is well appropriate to assess the health impact within a regulatory framework but may be inadequate in case of crisis such as real accidental atmospheric releases. In such situations, the objective is to determine accurately and as quickly as possible a potential danger zone. Taking into account too simplified weather conditions can lead to an underestimation of the consequences. In this context, the operational meteorological forecast system MEDICIS (French acronym for "meteorology at mesoscale dedicated to human health impact assessment") has been developed to provide realistic meteorological input conditions to radiological and chemical impact assessment models developed by the CEA (French Atomic Energy Commission).

## II. Modelling System

- The forecast system MEDICIS is designed to provide automatically forecasts at high resolution over the French territory (*Fig. 1*).
- The current version of the forecast system includes the mesoscale model MM5 [2].

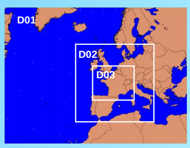



***Fig 1.** Calculation domains setup in MEDICIS: 81km (D01), 27km (D02) and 9km (D03)*

- Wind fields are calculated with a 1hr resolution for a total period of 5 days: initialization over a 24hr period using synoptic analysis input data and 4 days of forecast simulation.
- Calculations are started every 6 hours. An automatic controller synchronizes the start of MEDICIS processes with the availability on FTP servers of synoptic input data (*Fig. 2*).
- Calculated wind fields are automatically post-processed. Local data are extracted at the location of specified points (ex: CEA centres) and 3D wind fields are converted as input data for dispersion and impact assessment models.

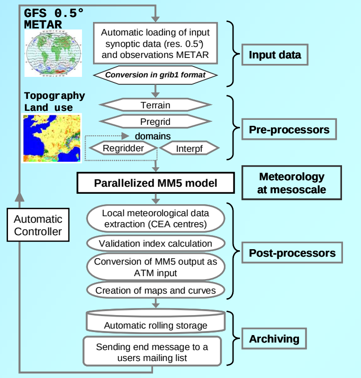



***Fig 2.** Detailed MEDICIS Flow Chart*

- Relevant processed data are made available for consultation at any moment to users through an interactive and ergonomic html bulletin (*Fig. 3*): maps (wind, temperature, rainfall fields, etc.), curves (local evolutions of wind direction and speed, etc.) and wind roses over calculated period.

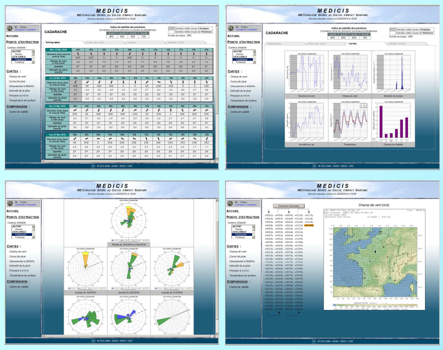


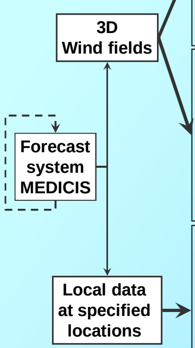
***Fig 3.** Example of pages of the automatic html MEDICIS bulletin*

## III. Coupling with dispersion and impact assessment models

POSTER

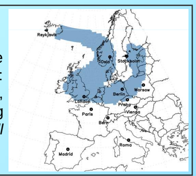
- 3D meteorological fields provided by the MEDICIS platform are post-processed and used as input data for dispersion models at mesoscale and urban scale wind field models and atmospheric dispersion such as MICRO-SWIFT-SPRAY [3] and SIRANERISK [1] (*Fig. 4*).
- Local forecast data extracted from 3D fields are input data for dispersion models such as the MITHRA puff gaussian model included in the CERES platform developed by the CEA and devoted to the radiological and chemical impact assessment [4].

***Fig 4.** Coupling with dispersion models*

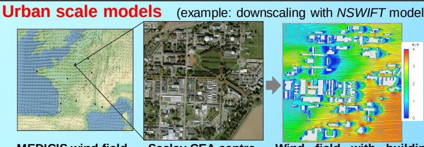



### Dispersion at mesoscale

Example of coupling with the FLEXPART lagrangian model: forecasted situation during April 16th, 2010 of the ashes plume resulting from the eruption of the *Eyjafjallajökull* volcano in Iceland (layer 0-5000 m).



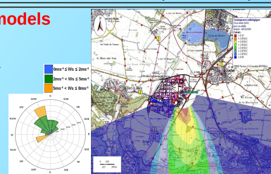
### Urban scale models (example: downscaling with *NSWIFT* model)



**MEDICIS wind field (9 km resolution)** | **Saclay CEA centre Dim.: 1050 m×1050 m** | **Wind field with building influence (3 m resolution)**

### Impact assessment models

Calculated radiological consequences for a fictitious accidental release from CEA Saclay.



Left: MEDICIS wind rose. Right: short term total dose from CERES (mSv)

## IV. Validation of the modelling system

Quality of simulations is assessed according two ways:

**1)** By comparing past simulations and observations at the location of 68 selected METAR stations: a score=100% is obtained if the simulated wind-rose represents the observed wind-rose. Score = 0% If there is no common class [5]. These criteria are cumulative and are updated at each new MEDICIS run. For a running period of one month, averaged criteria ranging from 70% ("analysis" part of runs) to 66% (4-days forecasts part). Results are quite satisfactory, showing that we can be confident in the forecasts produced by MEDICIS (fig. 5).

**2)** By calculating, a *Bravais-Pearson* correlation coefficient between the last forecast produced by MEDICIS and the previous one. Such a coefficient allows to estimate the quality of current forecast, for which no observation is yet available

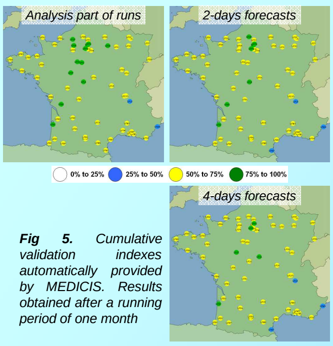



***Fig 5.** Cumulative validation indexes automatically provided by MEDICIS. Results obtained after a running period of one month*

## V. Future work

- Lowest validation scores are obtained in coastal or mountainous regions. It may result from the resolution of the finer grid (9 km) or from chosen physical parameterizations that may not be optimal in these regions. Tests are underway using spatial resolutions of 45 km, 15 km and 5 km (45 km is in better agreement with the resolution of 0.5° GFS input data). Preliminary tes ts seem to show an improvement of scores.
- Depending on computing time, an additional grid at a finer resolution (~1.5km) could be added on the south-eastern part of France where topography is complex (Alps).
- As MM5 is no more supported, tests will be conducted with the WRF mesoscale model in the possible purpose to integrate it into the modelling chain.

[1] Cierco, F.-X., L. Soulhac, P. Méjean, G. Lamaison, P. Salizzoni and P. Armand, 2010: Validation of the SIRANERISK model against a wind tunnel experiment of dispersion of a short release in an idealized urban street network. HARMO'13, 1-4 June, Paris (France).
[2] Dudhia, J., D. Gill, K. Manning, W. Wang and C. Bruyere, 2005: PSU/NCAR Mesoscale Modelling System Tutorial Class Notes and User's Guide. MM5 Modeling System Version 3 (release 3-7-4).
[3] Harris, T., C. Dougherty, J. Sontowski, J. Moussafir and J. Commanay, 2007: Micro-SWIFT-SPRAY presentation and validation cases. Chemical Biological Information Systems Conference and Exhibition. Austin, TX (USA), January 8-11.
[4] Monfort, M., L. Patryl and P. Armand, 2010: Presentation of the CERES platform used to evaluate the consequences of the emissions of radionuclides in the environment. HARMO'13, 1-4 June, Paris (France).
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