MOCAGE Accident : description and operational use

Météo-France
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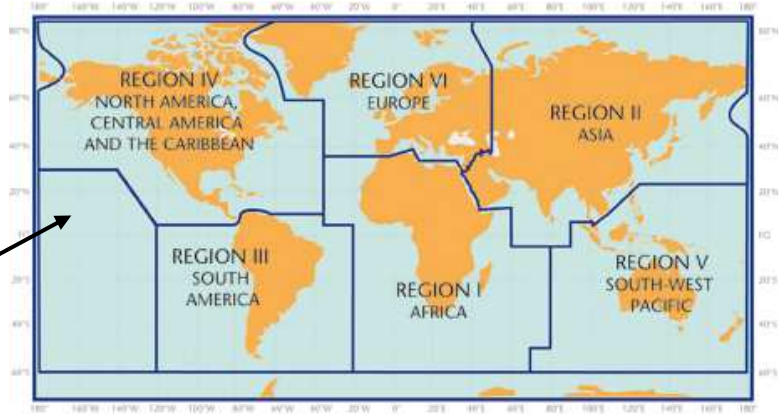
OUTLINE

- Meteo-France responsibilities
- MOCAGE-accident real-time context
- Use for volcanic eruptions :
  - Web-Interface
  - Validations
- New evolutions experiments
- VAACTRAJ tool

Responsibilities of Meteo-France in case of accidental release

- International :

- RSMC (Regional Specialised Meteorological Center) (6 regions) for WMO/IAEA (Exeter, Toulouse, Melbourne, Montreal, Washington, Beijing, Tokio, Obninsk) : NUCLEAR



- VAAC (Volcanic Ash Advisory Center) (9) for ICAO (Anchorage, Buenos Aires, Darwin, London, Montreal, Tokyo, Toulouse, Washington, Wellington): to track AIRBORNE ASHES in near real-time after an eruption

- National : Nuclear or chemical:
Intervention Particular Plan : an emergency meteorological cell is activated in order to provide the authority with information about pollutant transport.

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Model for long range dispersion tracking at CMC MOCAGE-Accident

- **MOCAGE-Accident is a version of MOCAGE model**

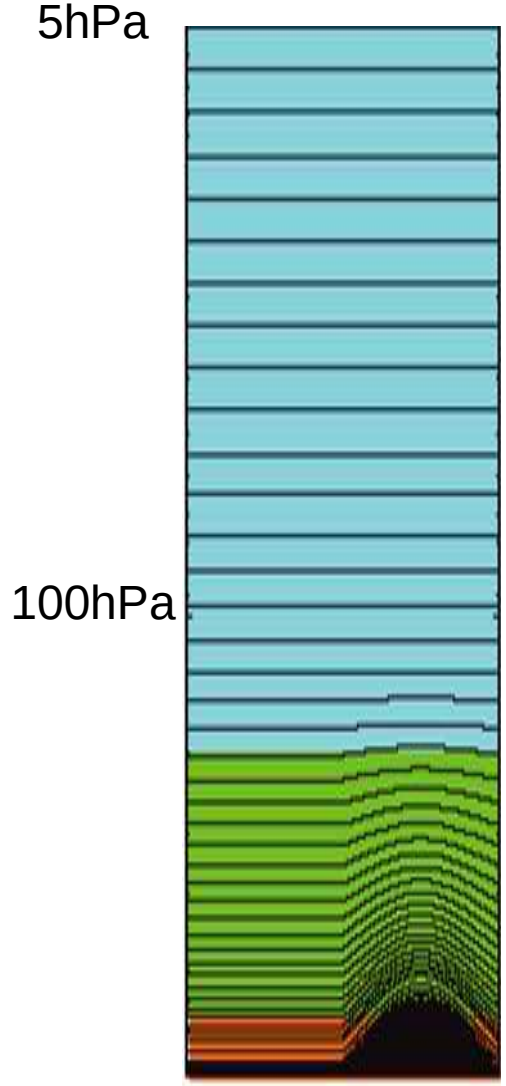
  - ✓ MOCAGE is a global 3D Chemical-Transport Model (CTM) developped at CNRM (Meteorological Research National Center). Dynamic core with physical and chemical optional parametrizations

  - ✓ Initialisation and coupling : ARPEGE(Meteo-France), ECMWF

  - ✓ Several versions of MOCAGE : operational uses « air quality »(2005), « accident » (2010), « backward-trajectories »(2012) and research uses « climate » , « chemical assimilation »,…

  - ✓ MOCAGE-Accident allows to specify several point sources anywhere over the world and takes into account deposits (dry and wet). Chemical parametrizations have been switched off. Polluants are considered as **passive tracers.**

MOCAGE-Accident operational configuration



- Horizontal resolution : 0.5°
- Vertical resolution : 47 levels from surface to 35km height (5hPa)
- Initialisation and 6-hourly coupling on 20 levels from surface to 10hPa
  - ARPEGE (Météo-France)
  - or IFS (CEPMMT).
- Parametrizations :
  - advection by a semi-lagrangien transport scheme de[Williamson and Rasch, 1989];
  - convection [Bechtold et al., 2000];
  - turbulence [Louis, 1979];
  - dry deposit (constant deposit velocities near the ground)
  - wet deposit (detailed 3D-scheme[Mari et al., 2000; Liu et al., 2001];
  - sedimentation for ashes f (size , density);
  - radioactive disintegration if radionuclides emission.

Real-time operations context

10 min

+20 min

Description of the source

+1D

+3,5D

6 12 18 24 6 12 18 24 6 12 18 24 6 12

meteorogical 3D-fields

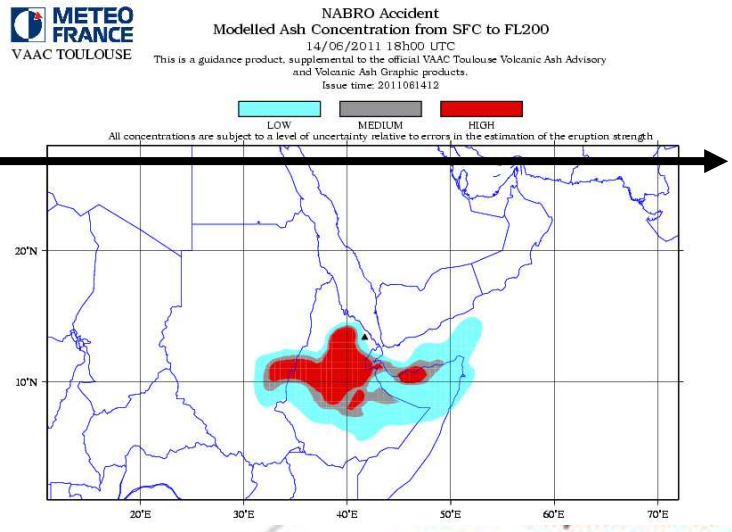
t0+84h

concentration 3D-fields

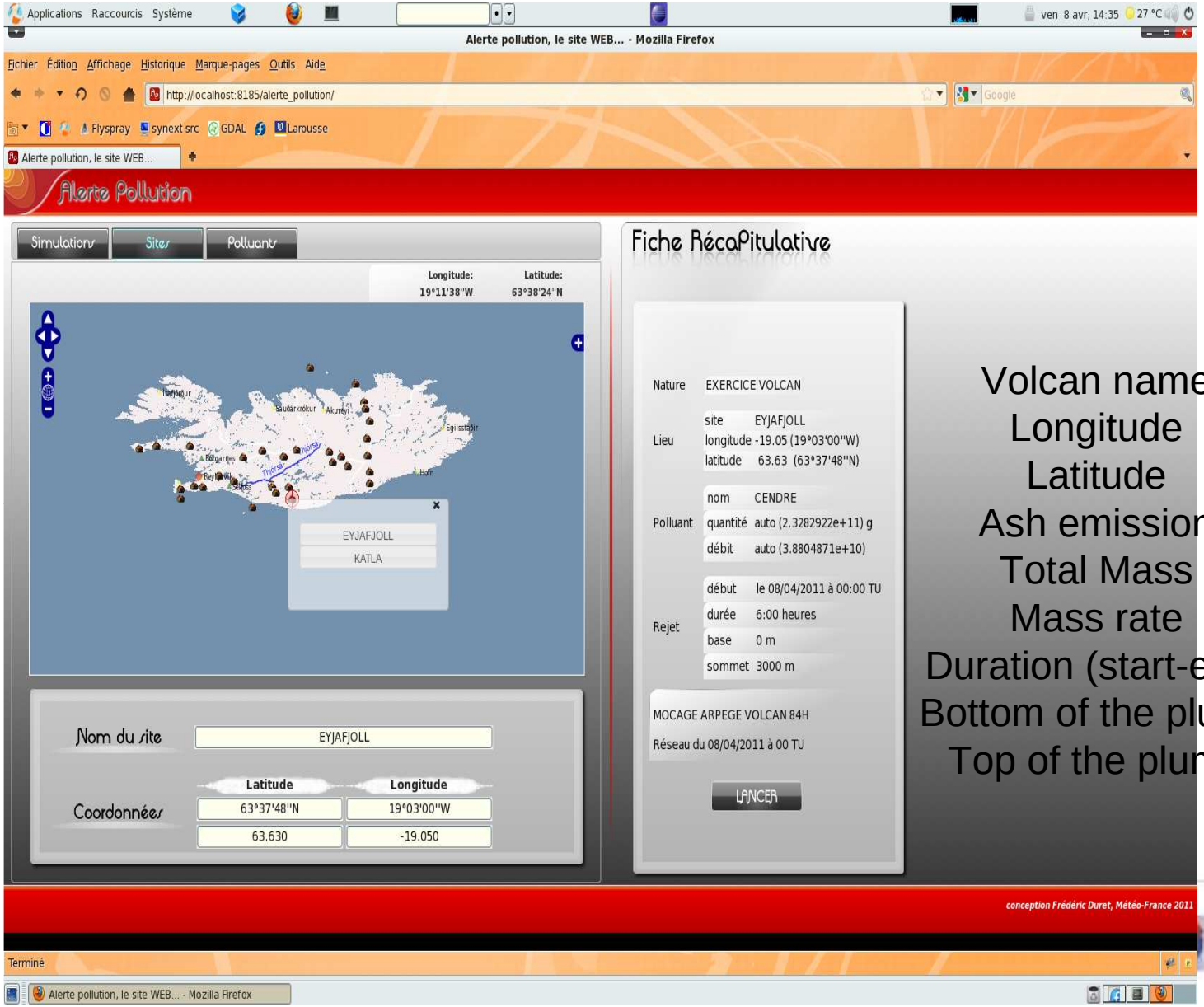
Long duration case

6-hourly output plots

New description of the source



Source description 1/2



Volcan name
Longitude
Latitude
Ash emission
Total Mass
Mass rate
Duration (start-end)
Bottom of the plume
Top of the plume

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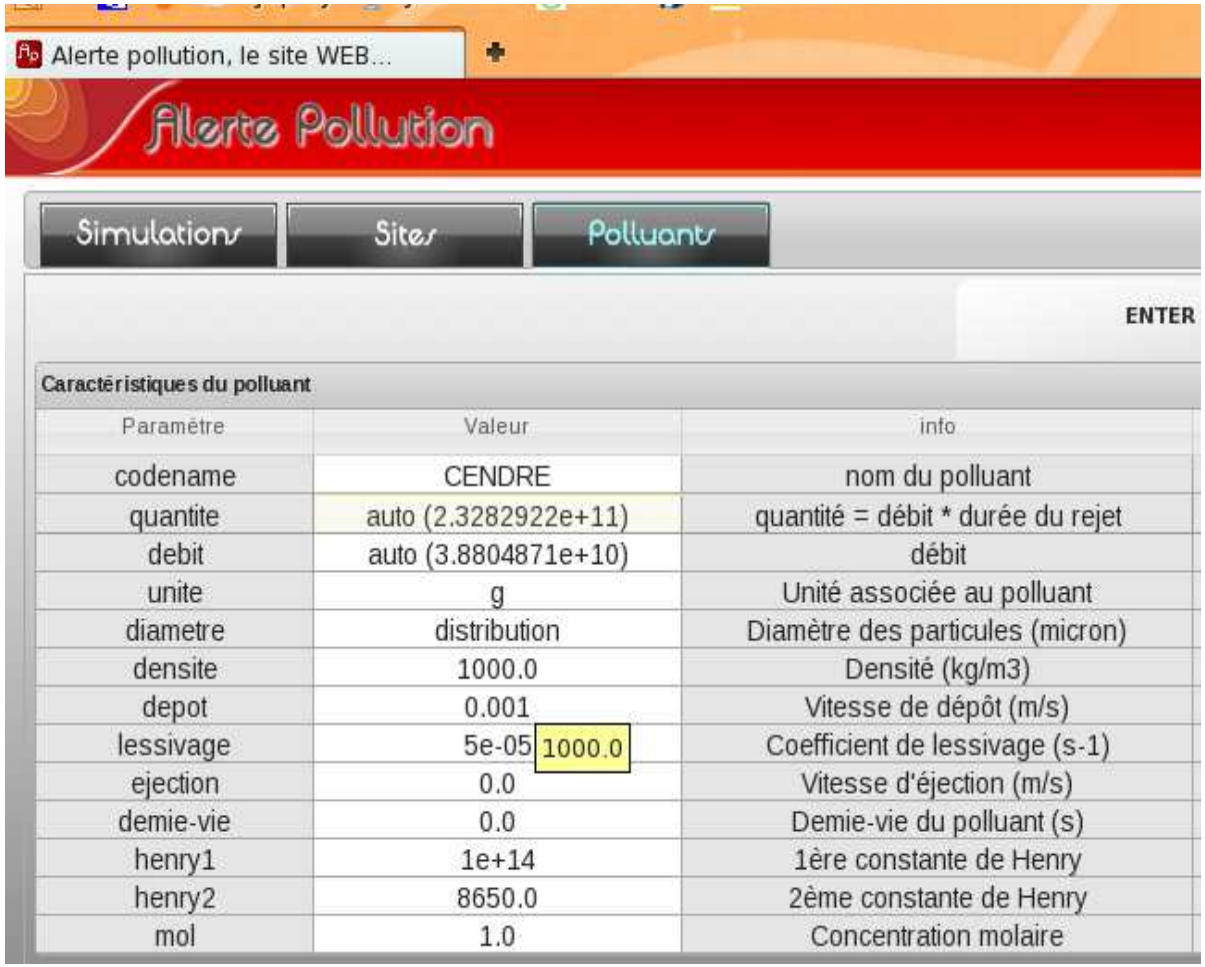
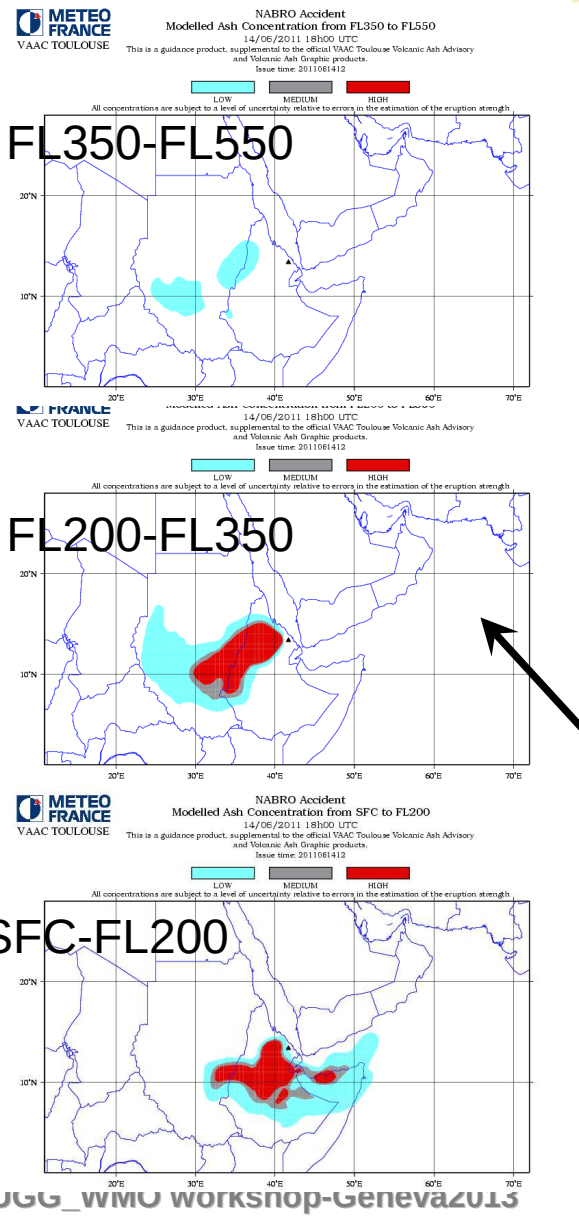
Source description 2/2

- mass eruption rate (constant through the simulation) possibly calculated from eruption height
- the vertical distribution (bottom->top) is uniform
- one size of particle (choosen by the forecaster) or a distribution of sizes

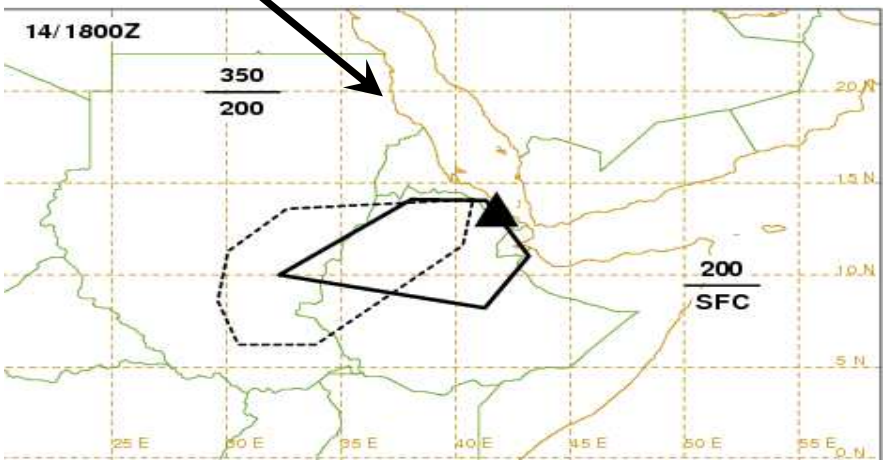
Mass fraction	Diameter µm
0.1%	0.2
0.5%	0.7
5%	2
20%	7
70%	20
4.4%	70



6-hourly output products



- Instantaneous concentrations for synoptic hours on each standard pressure level to support the forecasters expertise in official ICAO VAA and VAG productions :



- + mean concentration integrated on 3 layers Surface→FL200, FL200→FL350 , FL350→FL550
- Corresponding to 3 contamination levels :

Low	Medium	High

based on 3 thresholds

provided during the Eyjafjöll crisis (200µg/m3, 2mg/m3 and 4mg/m3)

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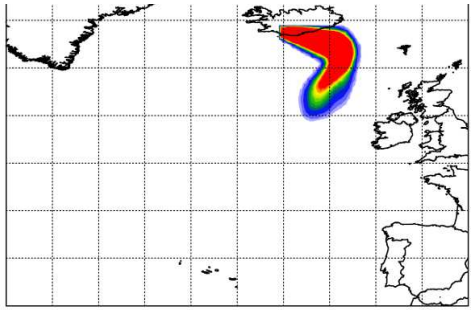
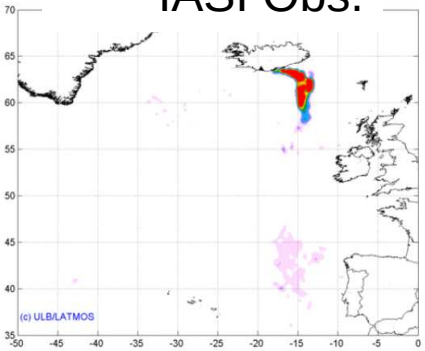
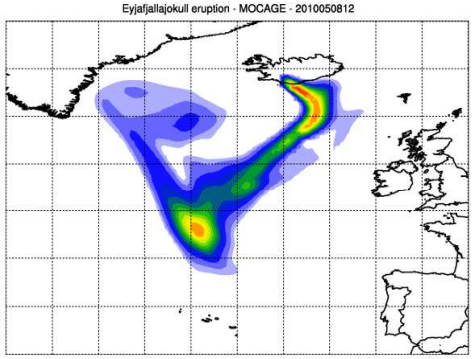
EYJAFJÖLL eruption by MOCAGE-ACCIDENT

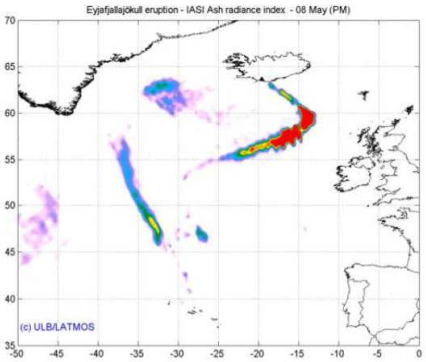
Mocage-acc simul.

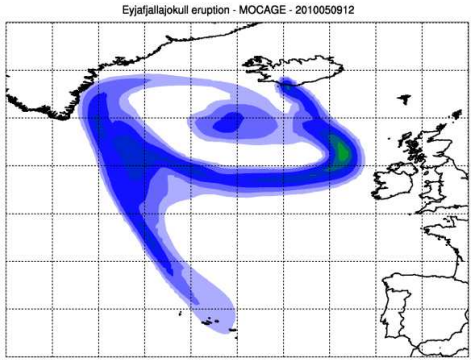
IASI Obs.

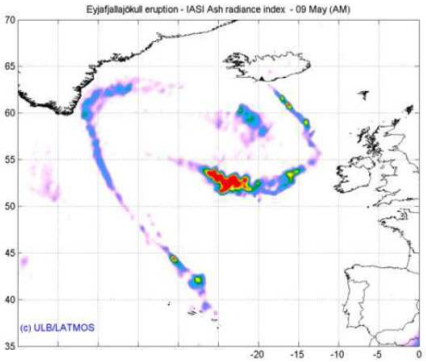












source : CNRM/GMME/CARMA

May 2010 eruption, comparaison between Mocage-Accident simulation (total column ash) and IASI (radiance indice) (LATMOS/ULB).

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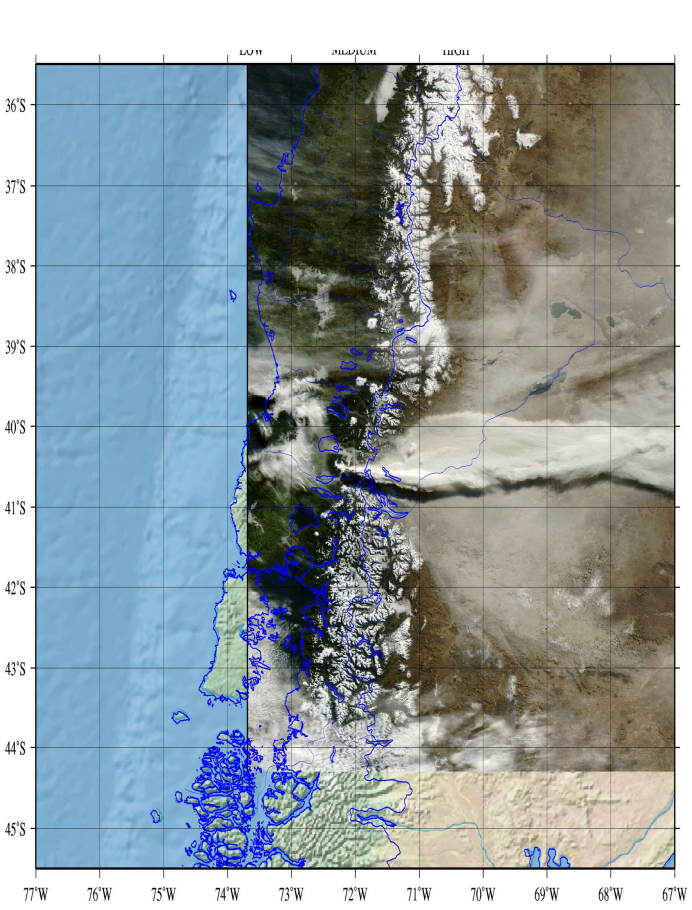
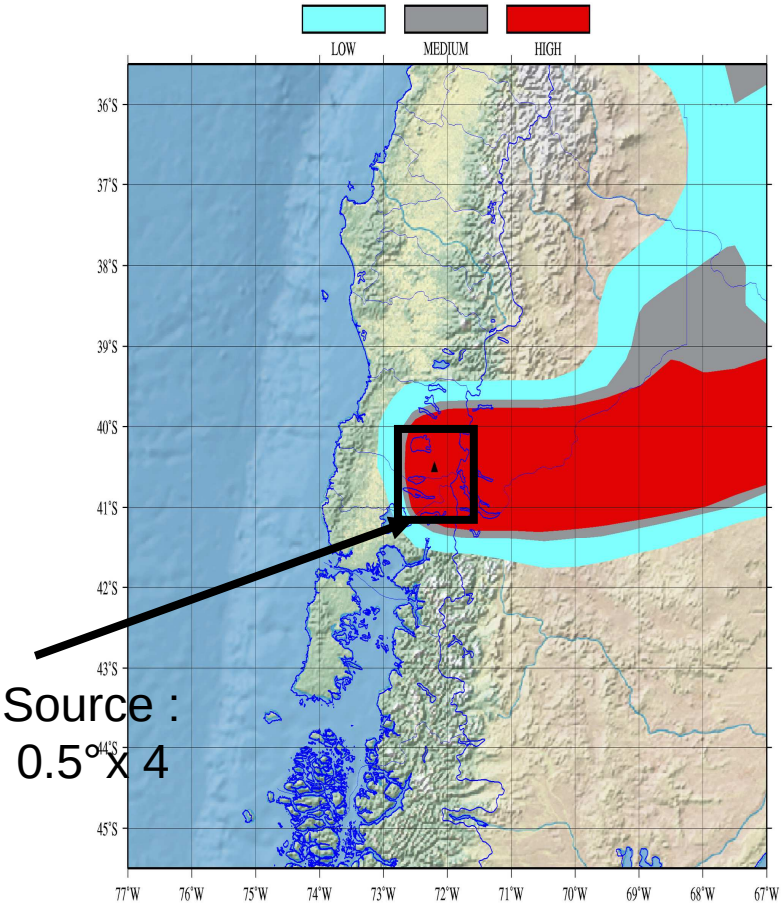
Real case : Cordon Caulle eruption (June 2011)

Visible satellite Image

MOCAGE-ACC 0.5°
total column concentration





Source :
0.5°x 4

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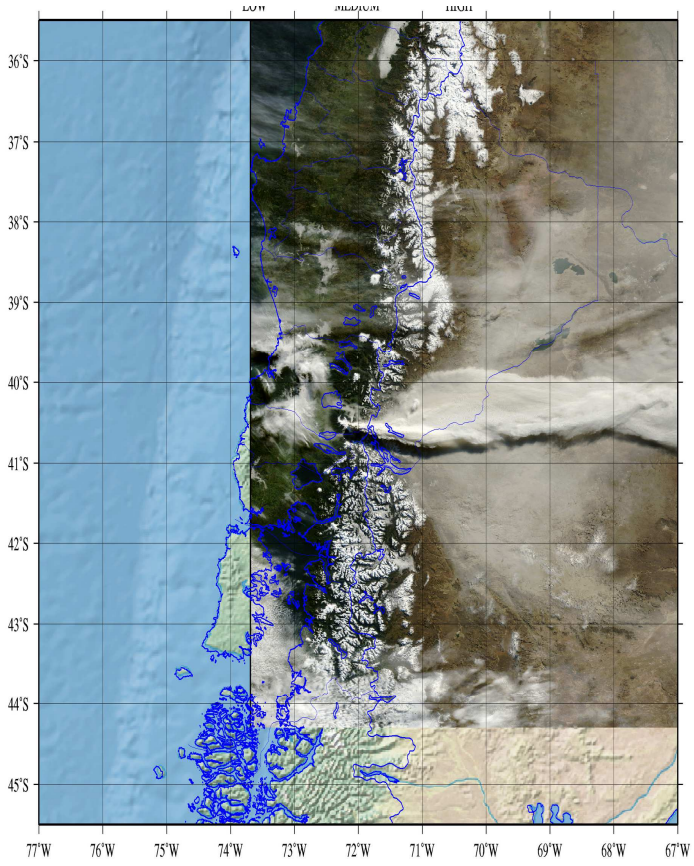
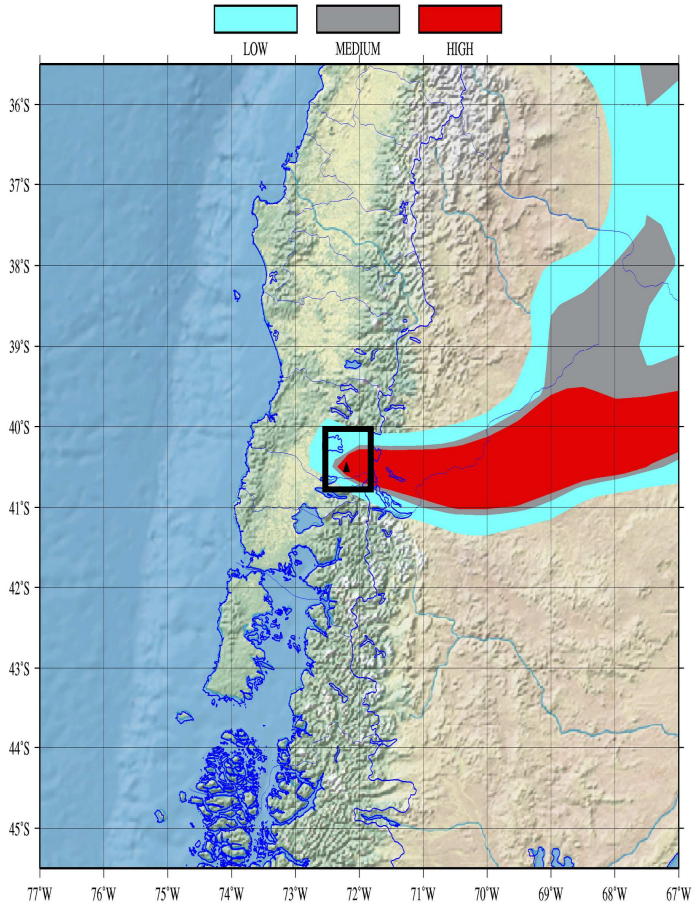
Perspectives for MOCAGE Accident : increase the horizontal resolution near the source

Visible satellite Image



MOCAGE-ACC 0.1°
total column concentration



+8%

computer cost

source : M. Martet

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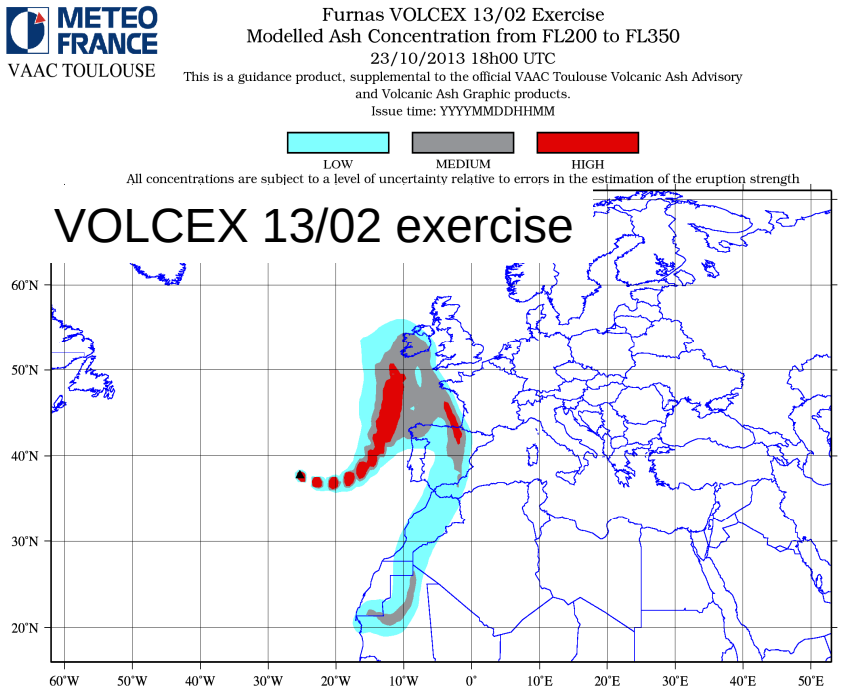
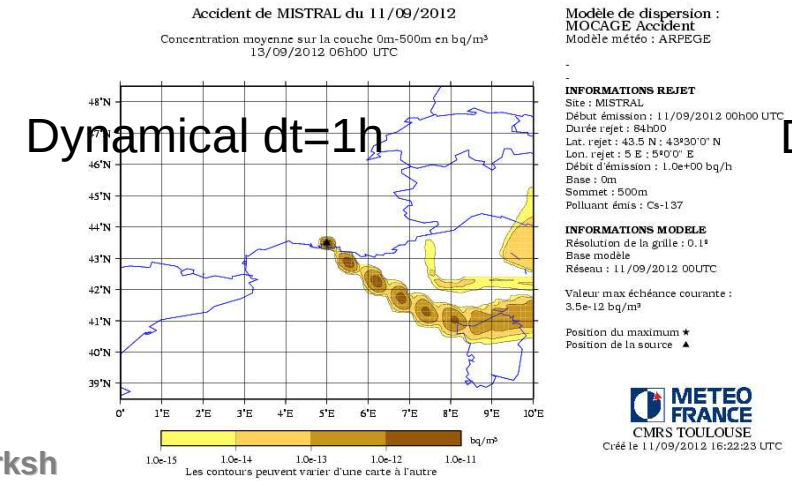
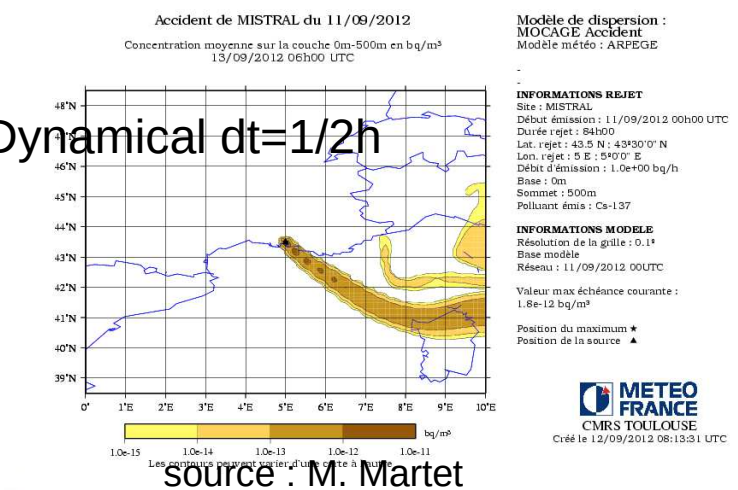
Mocage-ACC & transport scheme



- The 1 hour time step for the advection with a strong mean wind could lead to a «strange» plume. This will be emphasized at higher resolution.

➔ Tests with a timestep =1/2h on a chemical accident run





source : M. Martet

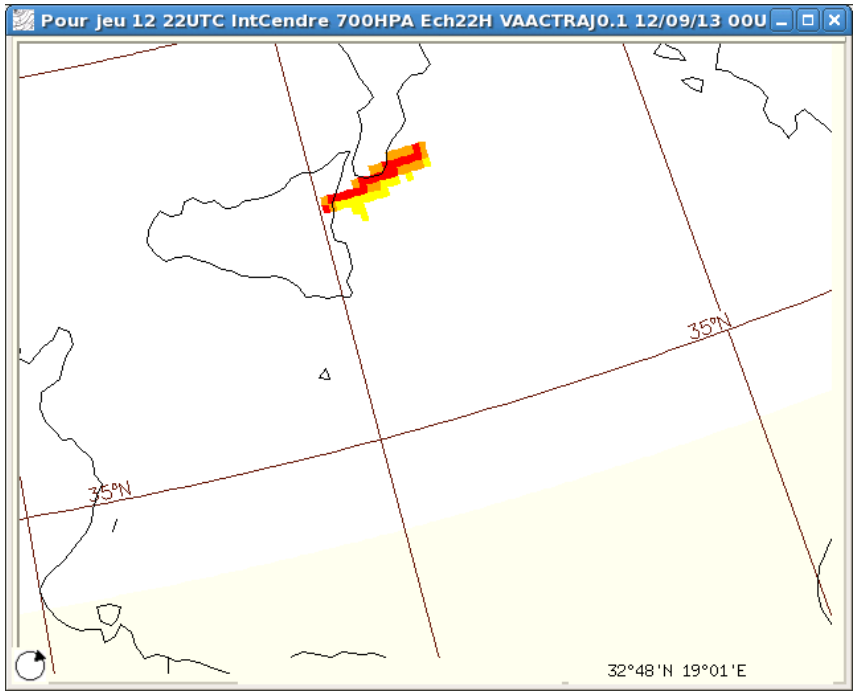
Evolutions summary

- Higher horizontal resolution near the source :
  - With a source represented by a square of 4 x 4 grid, better capture of the plume for the first time steps.
- Dynamical time step : higher frequency
  - Better representation of the plume but the puff-shape still remains
- Meteorological fields
  - The frequency of meteorological fields would be increased as well to 3-hourly This high frequency could help in capturing wind shift and the mid-afternoon convection (15UTC). Wet deposition improvement is expected
- But ….
  - Computing time increases of 8% for higher horizontal resolution
  - Computing time increases of 20% for increasing dynamical time step
  - Computing time increases again for higher frequency of meteorological fields

  The new computer will allow to apply the two last evolutions within the operational time constraints

  Nevertheless the forecast close to the source will be not enough accurate ➔ New tool : VAACTRAJ

Local scale : tool VAACTRAJ



Quartile 30 / total in the whole domain

Between 30 and 70

Quartile 70 / total in the whole domain

source : M. Bouzom

- Trajectories off-line tool based on ARPEGE / ECMWF 6-hourly meteorological fields
- 8000 trajectories/min at the location of the eruption
- Parameterizations :
  - Dynamical time step along the mean wind = 5 minutes
  - Sedimentation is applied
  - No convection, no turbulence, no wet scavenging
- Source description :
  - Volcano, localisation,
  - Start and duration of the eruption
  - Bottom and top of the plume
  - 4 particles size classes
  - Vertical distribution : homogeneous from bottom to top / 2 layers one with 10% and a second with 90%
- Available within 15min
- Area covered : <150km-300km around the source
- Hourly outputs on one day
- 3 scales (not quantitative)

CONCLUSIONS

- The performances of MOCAGE-ACCIDENT model must include the real-time operations constraints.
- This model has been validated on several cases (real cases and international exercises) : the regional (> 300km from the source) to global scale is better represented.
- Some improvements have been experimented.
- The new computer in Meteo-France will allow new evolutions within the real-time operations time constraints.
- The local scale is covered with the new VAACTRAJ tool.

THE END

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