# The 26 September 2006 mesoscale storm over the western Mediterranean Sea: satellite observations and numerical simulations

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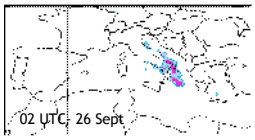
## 1 MOTIVATION AND OBJECTIVES

On 26 September 2006, a strong mesoscale storm, with some resemblance to a polar low, hit south-eastern Italy. Intense precipitation was detected by AMSU satellite observations at 02 UTC 26 Sept.
This event is investigated from a numerical point of view. We aim at:
• demonstrating the ability of the high-resolution PV advection model MIMOSA to characterize stratospheric intrusions at very fine scale, and reaching well below the 350K isentropic level.
• assessing the ability of ARPEGE to produce realistic precipitation fields for intense and localized precipitating events with the improved description of the stratospheric intrusion given by MIMOSA.




Detection of convection and precipitation by AMSU
In purple : deep convective clouds
In blue : areas with moderate precipitation

## 2 MODELS' DESCRIPTION

### 2.1 MIMOSA

- MIMOSA, « Modélisation Isentrope du transport Méso-échelle de l'Ozone Stratosphérique par Advection », is a high-resolution advection model of potential vorticity (PV), running on isentropic surfaces, covering latitudes between 10°S and 90°N. ( Hauchecorne et al. [2002] ).
- The model was initially designed to interpret the observations of ozone laminae in lidar profiles, especially at Observatoire de Haute-Provence (OHP, 44°N, 5.7°E), and to support the planning of an ozone lidar onboard an aircraft.
- The size of an elementary grid cell is either of 37 x 37 km (used in the simulations presented here) or 18.5 x 18.5 km.
- Initial conditions are taken from ECMWF PV fields at 1.125° resolution, interpolated to MIMOSA orthogonal grid. PV is then advected using ECMWF winds*.
  * Note: Advected PV is not the true dynamical PV, but in fact a « quasi-passive PV » which correlates well with the concentration of ozone and other long-lived trace species in the lower stratosphere.
- MIMOSA has been extensively validated in the 350K to 675K isentropic range but not at lower levels.

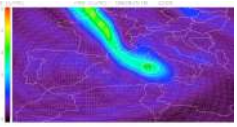
### 2.2 ARPEGE

- ARPEGE is the operational global model of Météo-France.
- The horizontal truncation is T358, which corresponds to a spatial resolution of 23 Km over France.
- 46 vertical levels (from 18 m above the ground up to 1hPa) are considered.
- The validation of the results is performed on the cyclone and the rainfall forecast.

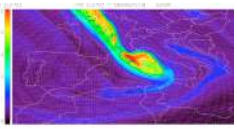
## 3 DESCRIPTION OF THE INTRUSION

• MIMOSA simulations are initialized on 24 Sept 00 UTC on isentropic levels between 320 K and 350 K.
• PV fields for 18 UTC 25 Sept obtained by MIMOSA at 320K ( b ) provide more details than the corresponding original ECMWF fields for the same level( a ). In particular, note the relatively high PV values ( ~ 2.5 PVU ) on the western coast of Italy, compared to the ECMWF field ( ~ 1 PVU ).
•MIMOSA results are validated by comparison with MSG water vapor channel ( c ). As a matter of fact, in dynamically active zones associated with baroclinic areas, high brightness temperatures (BT) in the water vapour image correspond to dry stratospheric air with large PV values, and the highest features are often associated with cyclonically curved PV contours. Such features are frequently identified as dry intrusions associated with rapid cyclogenesis. Hence, in the baroclinic zones there is a strong relationship between high and low values of brightness temperature and the upper level PV field.
Concerning the shape of the PV field west of Italy, MIMOSA PV fields are in rather fair agreement with MSG for which high BT are observed.

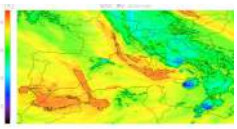
25 Sept18 UTC



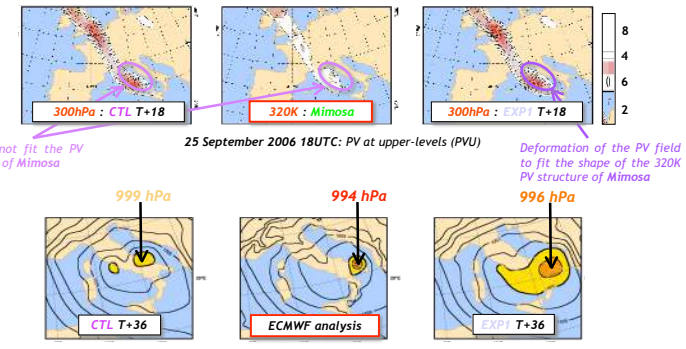
( a ) ECMWF PV at 320K



( b )MIMOSA PV at 320K



( c ) MSG water vapor channel

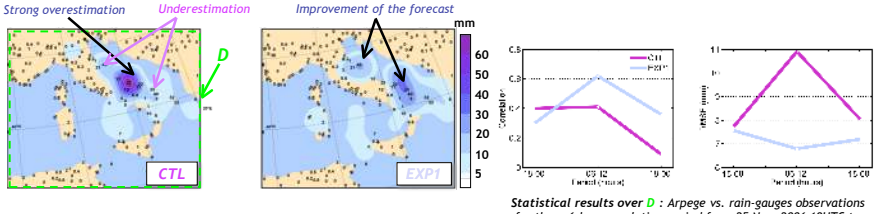



*25 September 2006 18UTC: PV at upper-levels (PVU)*

*26 September 2006 12UTC: Mean sea level pressure (hPa, coloured under 1000 hPa)*

## 4 INVESTIGATING THE ROLE OF FINE SCALE PV STRUCTURES USING ARPEGE

In this study, an attempt has been made to assess the realism and the influence of mesoscale PV structures produced by **MIMOSA**. At first, a numerical forecast using the French global model ARPEGE was initialized on 25 September 2006 at 00UTC and integrated over 48-h (**CTL** experiment). After 18 hours (or **T+18**), **CTL** did not fit the small upper-level PV structure produced by MIMOSA east of Corsica.
We used the PV inversion method proposed by Arbogast *et al.* (2008) to directly incorporate PV modifications in the **CTL** run. These PV modifications mainly consisted of improving the correspondence between the upper-level PV field of **CTL** at **T+18** with that of MIMOSA. The realism of the modifications was controlled by checking the new PV field against MSG observations available in the water vapour channel (not shown). The numerical rerun based on the new dynamical fields (called **EXP1**) clearly provides a substantial improvement of both the cyclone and the precipitation forecasts.




*Statistical results over D : Arpege vs. rain-gauges observations for three 6-h accumulation period from 25 Nov. 2006 18UTC to 27 Nov. 2006 00UTC*

## 5 CONCLUSIONS AND PERSPECTIVES

• MIMOSA provides PV fields around the tropopause that are in fair agreement with the MSG water vapour imagery.
• Modifications of PV between 400 and 100 hPa in ARPEGE provide improved rain fields ( both in location and intensity).

**For the future:**
•MIMOSA simulations will soon be available with a better numerical resolution (18.5 km x 18.5 km) on isobaric or isentropic levels.
•The realism of fine scale PV structures provided by MIMOSA will be further assessed using kilometer-scale MESO-NH simulations. The quality of the experiments will be evaluated through comparisons with rain-gauge as well as MSG infrared observations.
• Experiments which assimilate AIRS (Atmospheric InfraRed Sounder) satellite data in Météo-France ARPEGE global model are presently conducted. Benefits of assimilating cloudy infrared data in addition to clear data, instead of assimilating only clear data, will be investigated.

## REFERENCES

•Arbogast P, Maynard K and Crépin F. 2008. Ertel potential vorticity inversion using a digital filter initialization method. QJRMS, in press.
•Hauchecorne, A., S. Godin, M. Marchand, B. Hesse, and C. Souprayen, Quantification of the transport of chemical constituents from the polar vortex to midlatitudes in the lower stratosphere using the high-resolution advection model MIMOSA and effective diffusivity, J. Geophys. Res., 107 (D20), 8289, doi :10.1029/2001JD000491, 2002.