Comparison of Long-Range Transport and dry and wet deposition of selected $C_3 - C_6$ Chlorinated Organic Compounds on two different climatic regions of Europe

Palau, J.L.[1*]; Sales, M.J.[2*]; Rovira, F.[1]; Knowles, S.[3]

[1] **Fundación CEAM.** C/ Charles Darwin-14. 46980 Paterna (Valencia). Spain. www.ceam.es

[2] **MODELIZA**. Parque Científico Universitat València. C/ Catedrático Agustín Escardino, nº 9, 46980 Paterna (Valencia). Spain. www.modeliza.eu

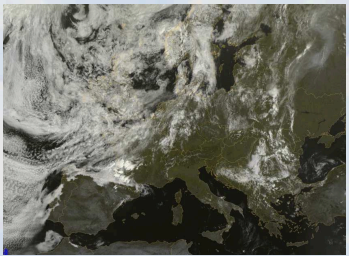
[3] **Dow AgroSciences Ltd.**, 3 Milton Park. Abingdon, Oxon, OX14 4RN. UK www.dowagro.com

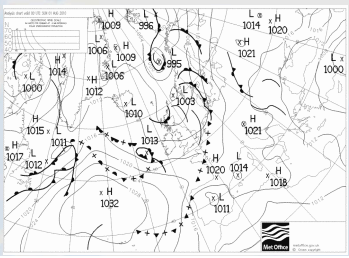
[*] joseluis@ceam.es ; mjsales@modeliza.com

INTRODUCTION

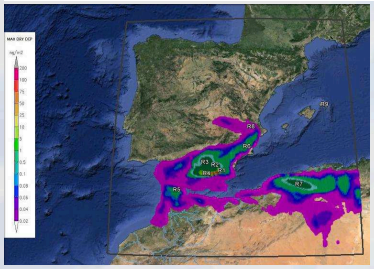
In this study results are presented from **numerical simulations** of the atmospheric dispersion and fate **of five chlorinated organic compounds** released into the atmosphere as a result of agricultural activity **in two different climatic areas**; one located in **Almería** region (Southeast of Spain) and the other in **Cherbourg** Peninsula region (North of France). All five impurities were modelled with the same initial concentration at ground level (250 g/ha) and are released into the atmosphere linearly during the first 24 hours after the application of the agrochemical on a rectangular area of 10 ha. **The Lagrangian Particle Dispersion Model, FLEXPART,** was used in both regions to simulate, over a 10-day period and with meteorological vertical levels extending from the surface to 0.26 hPa, the Long-Range and Mesoscale Transport, diffusion, dry and wet deposition of chemicals released into the atmosphere. The simulated days were chosen accordingly to the agronomic practices in each area (June in Cherbourg and August in Almería). Results show both the strong dependency of the LRT and the dilution of these chlorinated organic compounds on typical summer meteorological conditions in the geographical areas studied, and the quantitative differences of dry/wet depositions simulated on these different climatic regions.

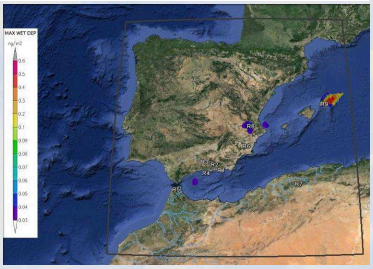
Almería Case:



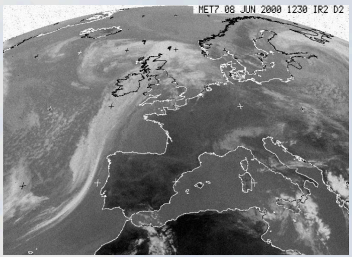


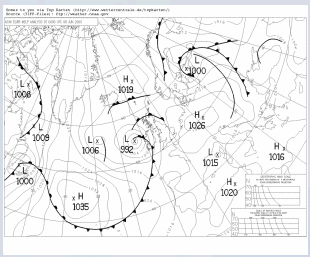
Anticyclone conditions with a low pressure gradient at the Iberian Peninsula scale favors the activation of well-developed sea-breezes all along the coastline. Temperatures show marked daily cycles with maximum values peaking 28-32 ºC. METEOSAT satellite images show clear skies predominated over the Southeastern side of Spain. Regarding precipitation, slight precipitation was only recorded over the Balearic Island region.



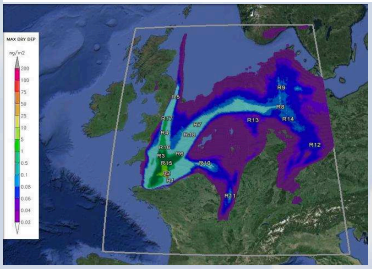


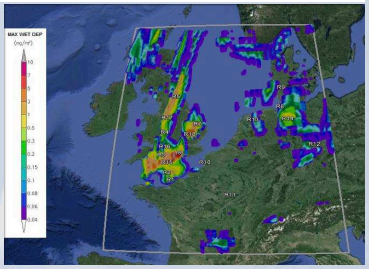
Cherbourg Case:





Minimum anomalies of some meteorological variables (Mean, maximum and minimum temperatures, wind speed and direction, and surface pressure) are used in order to find some climatologically representative conditions (period 1997-2011) for 10-consecutive days of June. As a result, we got the "typical" synoptic conditions for summer season (in June) with temperatures ranging between 17,5 and 12,1 ºC.



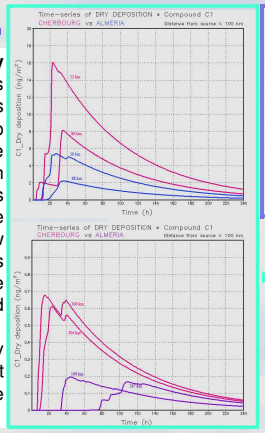


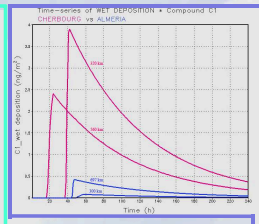
Regarding dry deposition, maximum simulated values ranging between 100 and 200 ng/m2 are found at **distances <100 km** in the Almería case and at distances **<35 km** in the Cherbourg case. Concentrations ranging between 1 and 5 ng/m2 have been simulated up to distances of 500 km from the emission area in the Almería case (due to LRT aloft and over the Mediterranean Sea towards Algiers) and up to 200 km in the Cherbourg case. **Regarding wet deposition,** maximum simulated concentrations are very much lower than those related with dry deposition in both areas; furthermore, on Cherbourg area wet deposition is much higher than in Almería region. On the Western Mediterranean region, maximum values of 0.5 ng/m2 were recorded over Mahon island (700 km from the emission area). On the Iberia Peninsula, maximum values range between 0.07 and 0.08 ng/m2 at 300 km from the emission source. On the Southern UK, maximum values of 10 ng/m2 were simulated from the emissions on the Cherbourg area. Values ranging between 0.1 and 0.25 ng/m2 were simulated at distances >1000 km from the emission area.

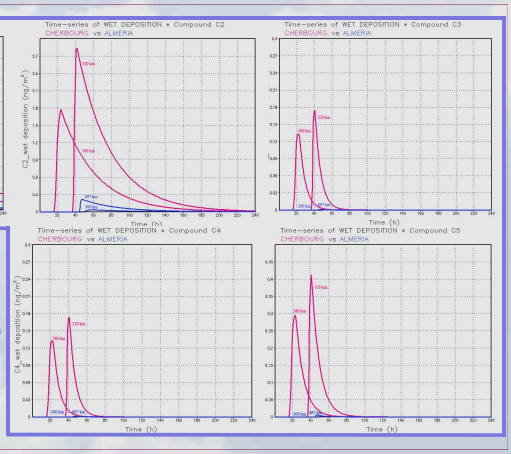
Comparison:

We have obtained the **time evolution of maximum values of dry and wet deposition concentrations at different sites**. Receptors have been selected according to the criterion of similar distances to the source in both simulations. Differences can be attributed to different atmospheric conditions: **convective turbulence** over the Iberian Peninsula (much higher than on Northern Europe), driven by the strong insolation in Almería latitudes, which enhances atmospheric dilution of pollutants; and, in both regions, some pollutants can be **transported long distances** with low atmospheric dilution. Maximum values of dry and wet depositions were obtained earlier in the Cherbourg simulation than in the Almería simulation. Maximum simulated concentrations on land were higher around Cherbourg than around Almería.

Furthermore, the deposited material may experience a secondary volatilisation process ("hopping") with further subsequent dispersion and dilution (hopping was not considered in these simulations).







Cherbourg vs Almeria

Dry Deposition

Wet Deposition

CONCLUSIONS

Further studies will quantify **the environmental impact** of simulated values from both wet and dry deposition for all compounds (e.g., leaching to groundwater). Although there are uncertainties from the simulation of atmospheric dry and wet depositions due to the physical processes involved, the subsequent behaviour of deposited chemicals may reveal the importance of variables like pluviometry, ground porosity, isolation, accumulation of deposition, etc. These variables are **highly different** between North and South Europe and, beyond the absolute values of deposited chemicals on the ground, they can be a key issue in relation to the establishing overall environmental impact. A priori, it might seem reasonable to think that simulated values in these two numerical exercises may be low (minimum dilutions found are of the order of 100.000 to 1.000.000 times at distances lower than 150 km) to constitute a concern with respect to groundwater thresholds (the Groundwater Directive 2006/118/EC established a threshold of 0.1 µg/L for pesticides at 1m soil depth).

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