The use of HYSPLIT by the Environmental Protection Agency to predict the transportation of smoke and Cs-137 from wildfires near the Chernobyl Nuclear Power Plant, April 2020.

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Background

On 3 April 2020, it was reported by the authorities in Ukraine that a wildfire had started in the forests and meadows west of the Chernobyl nuclear power plant (NPP) exclusion zone, a 30km limit established after the 1986 nuclear accident. Satellite images obtained from NASA's Fire Information for Resource Management System showed the evolution of fire hotspot locations between 3 - 24 April as strong westerly winds contributed to the fires moving to within 1km of the NPP at one stage (**Figure 1**). This was of particular concern as significant levels of radioactive contamination (150 - 1000 kBq/m^2 of Caesium-137) remain in the area following their release to the atmosphere in 1986. By the time the State Emergency Service of Ukraine had extinguished the fires, some 65km^2 of vegetation had been burned close to the Chernobyl NPP. The Environmental Protection Agency (EPA) of Ireland was one of several international organisations to use atmospheric dispersion models to estimate the transportation of Cs-137 re-suspended from the burned vegetation.

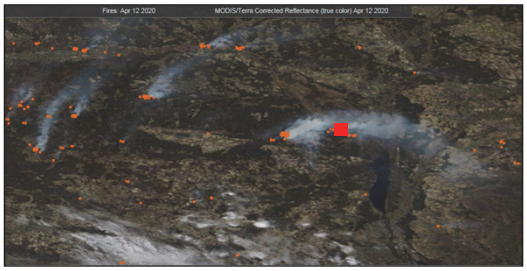

Figure 1 Satellite image showing the wildfire hotspots (orange squares) near the Chernobyl NPP (red square) on 12 April 2020.

EPA and the use of HYSPLIT

As per Ireland's National Plan for Nuclear and Radiological Emergency Exposures, the EPA (as the National Competent Authority for nuclear emergencies) operates a national monitoring network for the detection and measurement of radiation in the air and deposition of contamination on the ground. The EPA is also responsible for making a technical assessment of the radiological consequences of accidents with the potential to impact on Ireland. This is supported by HYSPLIT, one of a number of atmospheric dispersion models used by the EPA to visualise the transportation of radioactive contamination. The Hysplit (HYbrid Single-Particle Lagrangian Integrated Trajectory) model is used to compute air parcel trajectories and the spatial/temporal evolution of atmospheric releases using either puff or particle approaches.

HYSPLIT Modelling

On 6 April 2020, the EPA was informed through a network of European institutes involved with measuring ultra-low levels of radioactivity in the environment that there was a potential for increased airborne Cs-137 activity concentrations arising from the fires in the Chernobyl exclusion zone. The EPA used Global Forecast System weather data files to enable HYSPLIT to estimate the dispersion of particulate matter 2.5 microns (PM2.5) (**Figures 2 - 3**), the Cs-137 activity concentrations in air (**Figures 4 - 5**) and the trajectory of an air parcel (**Figure 6**), between 4-14 April 2020 (the fires were extinguished by 21 April). This required various input parameters to be selected such as the hourly PM2.5 emission rate and the hourly quantity of Cs-137 released. The former was calculated using the U.S. Fire Service's BlueSky smoke modelling framework while the latter was derived from the total Cs-137 released as determined by the Ukrainian Hydro-Meteorological Institute.

Conclusion

The results of HYSPLIT modelling by the EPA indicated that Ireland was not impacted by either PM2.5 or Cs-137 emissions from the Chernobyl exclusion zone, based on the meteorological conditions observed during the first three weeks of April 2020. Gamma spectrometric analysis of high-volume air filters collected from Dublin between 1 - 22 April provided further evidence that no elevated Cs-137 activity concentrations were observed in Ireland (**Figure 7**, orange dots). The dispersion of Cs-137 as determined by HYSPLIT strongly agreed with the modelling undertaken by other international organisations based in France, the Netherlands, Germany, Belgium and Norway.

References

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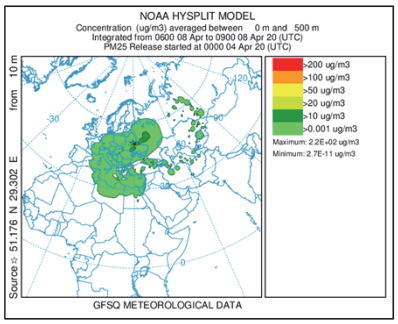

Figure 2 PM2.5 concentrations on 8 April 2020.

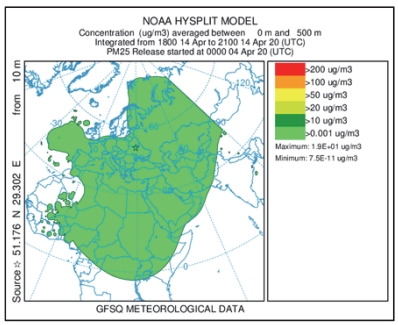

Figure 3 PM2.5 concentrations on 14 April 2020.

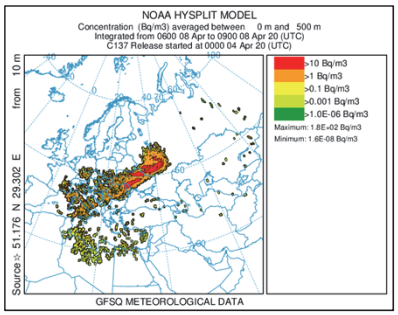

Figure 4 Cs-137 activity concentrations on 8 April 2020.

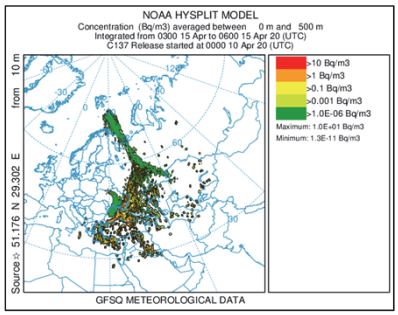

Figure 5 Cs-137 activity concentrations on 15 April 2020.

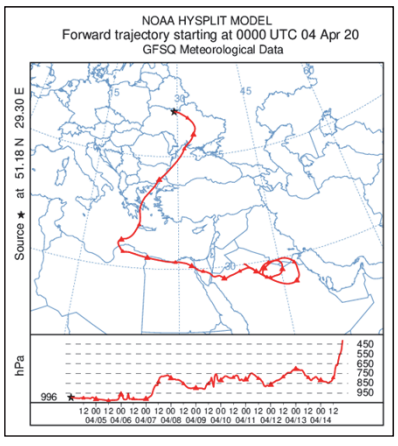

Figure 6 Forward trajectory of air parcel between 4 - 14 April 2020.

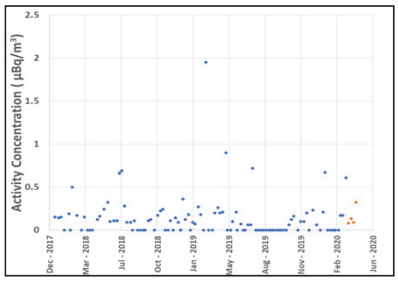

Figure 7 Weekly Cs-137 activity concentrations measured at Dublin between 2018 and 2020.

Acknowledgment

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