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Use of Lagrangian transport models and Sterilized High Volume Sampling to pinpoint the source region of Kawasaki disease and determine the etiologic agent

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Kawasaki disease (KD) is an acute, coronary artery vasculitis of young children, and still a medical mystery after more than 40 years. A former study [Rodó et al. 2011] demonstrated that certain patterns of winds in the troposphere above the earth's surface flowing from Asia were associated with the times of the annual peak in KD cases and with days having anomalously high numbers of KD patients.

In a later study [Rodó et al. 2014], we used residence times from an Air Transport Model to pinpoint the source region for KD. Simulations were generated from locations spanning Japan from days with either high or low KD incidence. In order to cope with stationarity of synoptic situations, only trajectories for the winter months, when there is the maximum in KD cases, were considered.

Trajectories traced back in time 10 days for each dataset and location were generated using the flexible particle Lagrangian dispersion model (FLEXPART Version 8.23 [Stohl et al. 2005]) run in backward mode. The particles modeled were air tracers, with 10,000 particles used on each model run. The model output used was residence time, with an output grid of 0.5° latitude × longitude and a time resolution of 3 h. The data input used for the FLEXPART model was gridded atmospheric wind velocity from the European Center for Medium-Range Weather Forecasts Re-Analysis (ERA–Interim at 1°).

Aggregates of winter period back-trajectories were calculated for three different regions of Japan. A common source of wind air masses was located for periods with High Kawasaki disease.

Knowing the trajectories of winds from the air transport models, a sampling methodology was developed in order to capture the possible etiological agent or other tracers that could have been released together. This methodology is based on the sterilized filtering of high volumes of the transported air at medium tropospheric levels by aircraft sampling and a later analyze these filters with adequate techniques. High purity quartz filters and sterilized polycarbonate membrane filters were used on sampling. Sterility conditions were required in all the processes from the preparation of the equipment, the sampling, and the later manipulation of the filter and instrumentation.

The methodology used to find the possible etiological agents sources for KD cases in Japan has been extrapolated to other regions worldwide as Catalonia. In Catalonia, in the last 10 years, an average of 40 cases of KD per year are detected. Taking in consideration that in Catalonia there is a lack of a predominant strong wind or synoptic situation with high energy associated, the possible source regions of etiological agents could be much more closer to the receptors than in Japan. Therefore we have used higher resolution models for the backward simulations and a different sampling methodology based on ground measurements.

References

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