How to make a splash: from high speed drop impact to a new methodology for calculating water collection on aircraft surfaces

The rich structures arising from the impingement dynamics of water drops onto solid substrates at high velocities are investigated from a multi-scale perspective. Current methodologies in the aircraft industry for estimating water collection are based on particle trajectory calculations and empirical extensions thereof in order to approximate the complex fluid-structure interactions. The approach to be presented incorporates the detailed fluid dynamical processes often ignored in this setting, such as the drop interaction with the surrounding air flow, drop deformation, rupture and coalescence, as well as the motion of the ejected microdrops in the computational domain. One-to-one comparisons are made with experimental data available in the pre-impact stage[1], while the early stages of the impact are validated using the analytical framework provided by Wagner theory, context in which recent developments are also presented. The main body of results is created using parameters relevant to flight conditions with droplet sizes in the range from tens to several hundreds of microns[2]. New morphological features in regimes below the splashing threshold in the modelled conditions are identified. The variation in the number and distribution of ejected microdrops as a function of the impacting drop size and angle of incidence beyond this threshold is then expanded on[3]. The direction then shifts towards quantifying useful information on the liquid movement on longer timescales. The analysis shows a high degree of flexibility and can be used efficiently when considering changes in geometry (aircraft design), flow conditions and cloud characteristics.

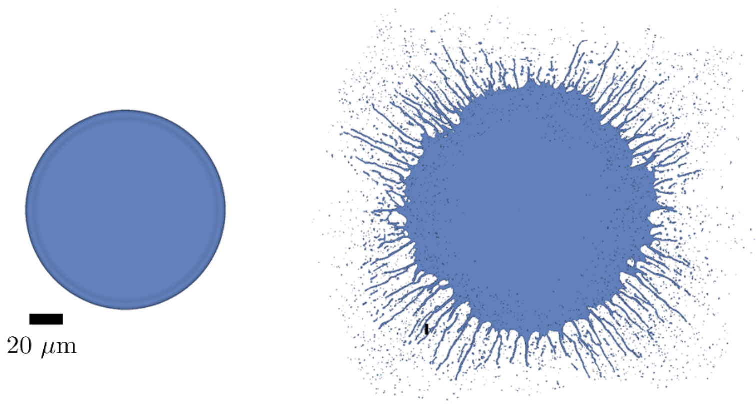

Figure 1: Top view summary of post-impact behaviour after impingement at an incident angle of 90° for drops described by initial dimensional diameters $D = 20$ μm (left, spreading dynamics) and $D = 236$ μm (right, splashing dynamics).

[1] Sor and García-Magariño, *J. Aircraft.* **52**(6), 1838 (2015).
[2] Papadakis et al., *AIAA* **565**, 1 (2004).
[3] Cimpeanu and Papageorgiou, *Int. J. Multiphase Flow*, under review, arXiv:1711.06208.