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Low-order modelling of unsteady flame behaviour in a spray combustor

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The effect of mass flow rate perturbations on the stability of a liquid-fulled annular aeroengine gas turbine is investigated using a three-dimensional uRANS code. The simulations are performed on a single sector of an idealised annular gas turbine geometry. A Lagrangian fuel spray description is used with a Monte Carlo solution of Williams' spray equation.
Broadband mass flow fluctuations are imposed at the combustor inlet and dilution ports, and the effect on heat release is quantifed using flame transfer functions. The excitation of inlet and dilution flows leads to signifcant unsteady combustion and the implications for self-excited oscillations are considered.
The numerical results are then compared to a low-order model which is developed to account for the different physical mechanisms responsible for unsteady heat release when the inlet and dilution port air mass flow rates are perturbed. The low-order model is used to predict the possibility of self-excited oscillations as well as to investigate the potential of altering the phase and relative magnitude of the inlet and dilution port excitation as a possible means of controlling thermoacoustic oscillations.