Parallelisation of the discrete transfer radiation model

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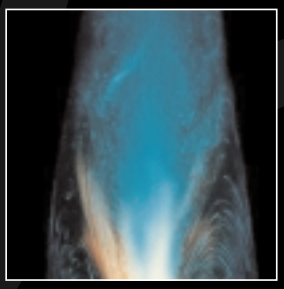
Thermal radiation is a critical component of heat transfer in a range of combustion systems.

But the complexity of thermal radiation demands high computational cost when included in the simulation of combusting flows.



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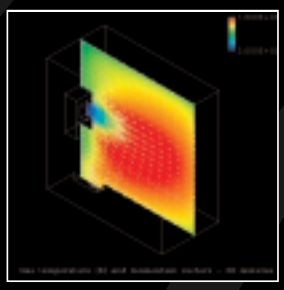
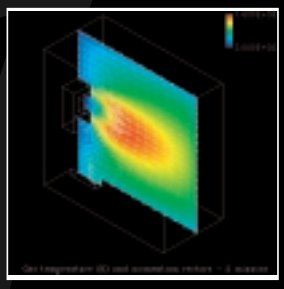
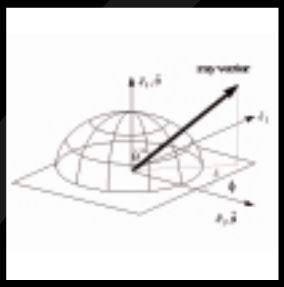


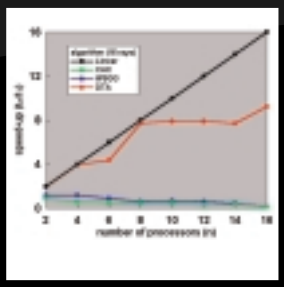
Therefore, parallelisation of radiation algorithms is particularly attractive for improving the turn around time of computational fluid dynamics simulation of combustion systems.



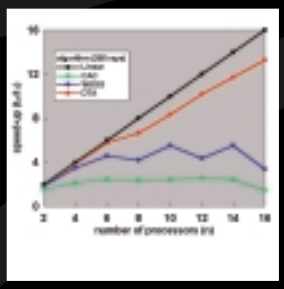
The discrete transfer radiation model solves the radiative transfer equation throughout a domain by a method of ray tracing from surface elements on its boundaries. Solutions of increasing complexity and accuracy produce different responses to variation in the number of processors employed to parallelise the ray tracing algorithms.

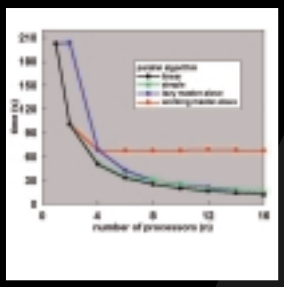


Three solutions are compared for the volumetric flux between infinite parallel walls. Constant absorption coefficient (CAC); Weighted sum of gray gases (WSGG); Differential total absorptivity (DTA)



Parallelisation techniques (a) loop splitting; (b) lazy master-slave; (c) working master-slave. Speed up depends on:
(a) algorithm-processor loading (granularity and detail)
(b) relative cost of communications and computation
(c) algorithm expansion due to parallelism complexity.
Good scalability is possible with a more complex (and accurate) algorithm.





Different parallelisation algorithms coupled to the DTA solution using 256 rays per surface.
All calculations were performed on the IBM SP2 at Southampton University using the message passing interface (MPI).

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