AN EFFICIENT PARALLEL IMPLEMENTATION OF A CONTINUATION ALGORITHM BASED ON AN ASYMPTOTIC NUMERICAL METHOD

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This presentation aims to give an idea about the efficiency of continuation algorithms based on Asymptotic Numerical Method in comparison with classical ones in the framework of Rayleigh-Benard-Marangoni instabilities. Indeed, as many others instabilities problems, mixed buoyancy and surface-tension-driven convection are well known to be computationally time consuming, owing to strong non-linearities and multiple secondary bifurcations. Therefore, special attention has to been paid to look for the best compromise between the finite element formulation, the solution algorithm and the computer to be run, particularly if one intend to achieve high performance computations.

One assumes the problem is governed by the coupled incompressible Navier-Stokes and energy equations, in the Boussinesq approximation. However, to search for high performance computing, we have implemented separated finite element formulations and solution algorithms, depending on steady states or transient solutions are to be computed. The finite element model used in the computation of steady-state bifurcating branches of solution is built on a fully coupled primary variable approximation using a penalized formulation to address the incompressible constraint. The solution algorithm implements a refitting of the basic asymptotic numerical method [1-2], for coupled fluid flow and heat transfer problems in a high performance framework. It enables us to get both the threshold value and its associated pattern, or steady supercritical solutions together with subsequent bifurcations, in containers of various shapes. As an illustration, we compare several solution algorithms (Newton-Raphson + arc length control, standard and improved asymptotic numerical methods) and parameterizations for the computation of Rayleigh-Benard-Marangoni convection in a silicon oil layer (Pr = 880 at 25°C) of infinite horizontal extent. As far as multiple bifurcations have to be undertaken in the problem, Lopez 's parameterization [2] outperforms standard ones. Figure 1a presents the steady state branches of solution and the associated dominant patterns (hexagonal, mainly pentagonal and square), whereas in figure 2 the computation times are plotted for different solution algorithms versus the control parameter.

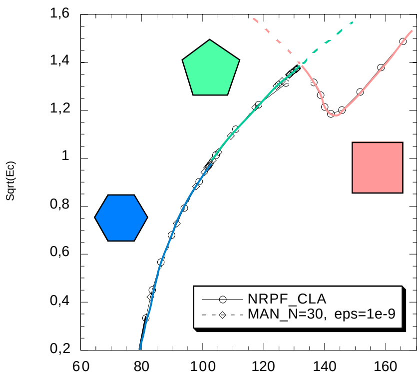

Figure 1: Steady-state branches of solutions

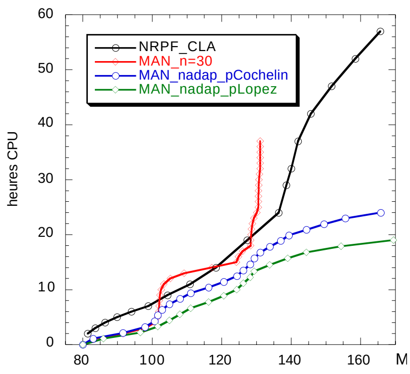

Figure 2: computing time of several solution algorithms

References

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