TEXAS A&M UNIVERSITY

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Research Memo

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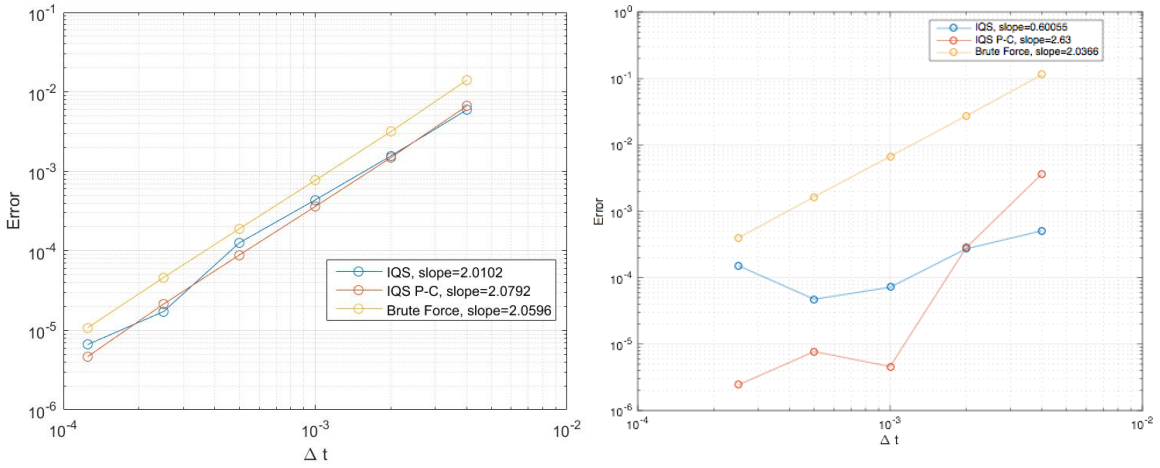
Subject: IQS with multiple PRKE Parameter Updates within Macro Steps

1 Initial Implementation of Multiple PRKE Parameter Updates

The purpose of this note is to describe how IQS updates the PRKE parameters within macro time steps and the results of the initial implementation. The impetus of this initiative was the underwhelming results from applying IQS to the LRA benchmark. It is strongly believed that the treatment of the coupling between temperature and the PRKE parameters were to blame for results. Figure 1(a) shows that IQS only improves the time step size by less than half at $t = 1.44$ s. This is the point where the power is at a max, so the temperatue is changing rapidly, but the shape is not changing significantly. Figure 1(b) shows the error at $t = 1.40$ s, where IQS performs significantly better. At this point, the temperature is not changing significantly. Therefore, IQS does not treat temperature with enough accuracy to see significant improvement over brute force.



(a) LRA convergence results at $t = 1.44s$ (b) LRA convergence results at $t = 1.40$

Figure 1: LRA convergence plots with only one temperature updated each macro step

Temperature has the most effect when calculating the PRKE parameters to solve for amplitude. So in order to more accurately capture the behavior of the flux, the PRKE parameters and temperature need to be evaluated multiple times within each macro step. To visualize this process the system is setup with three different time scales, as shown in Figures 2 and 3. Figures 4 and5 show the same processes in more detail. The occurrence that there are three updates in the figures is arbitrary, the number of temperature updates can be set by the user.

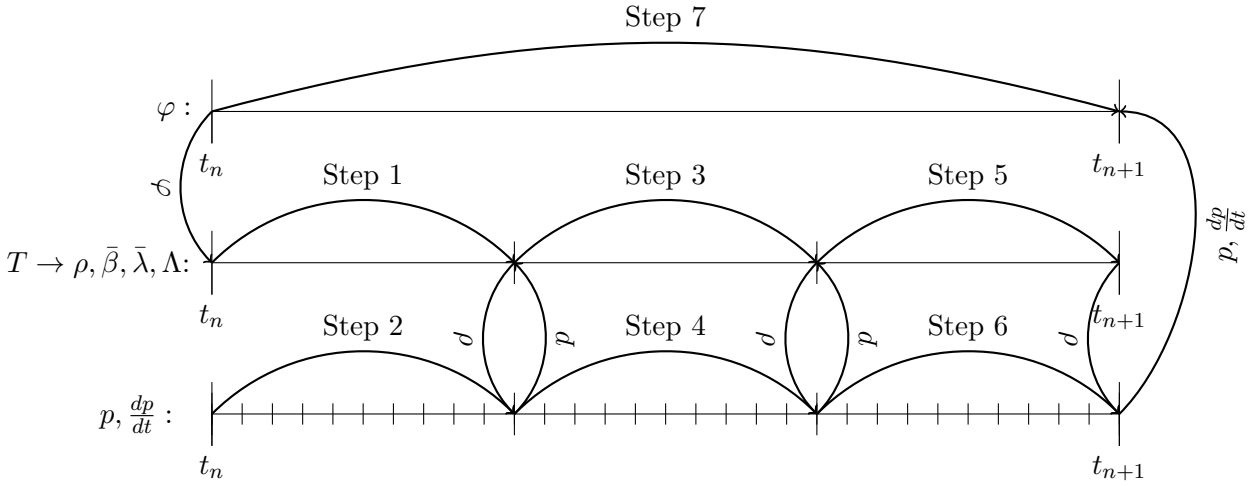


Figure 2: Time scales and process of regular IQS

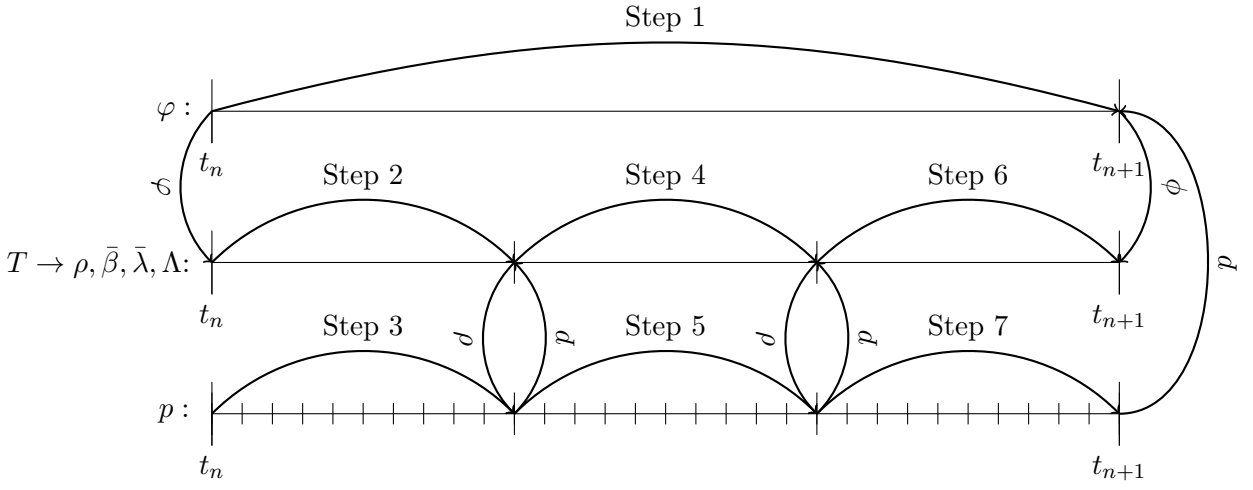


Figure 3: Time scales and process of IQS P-C

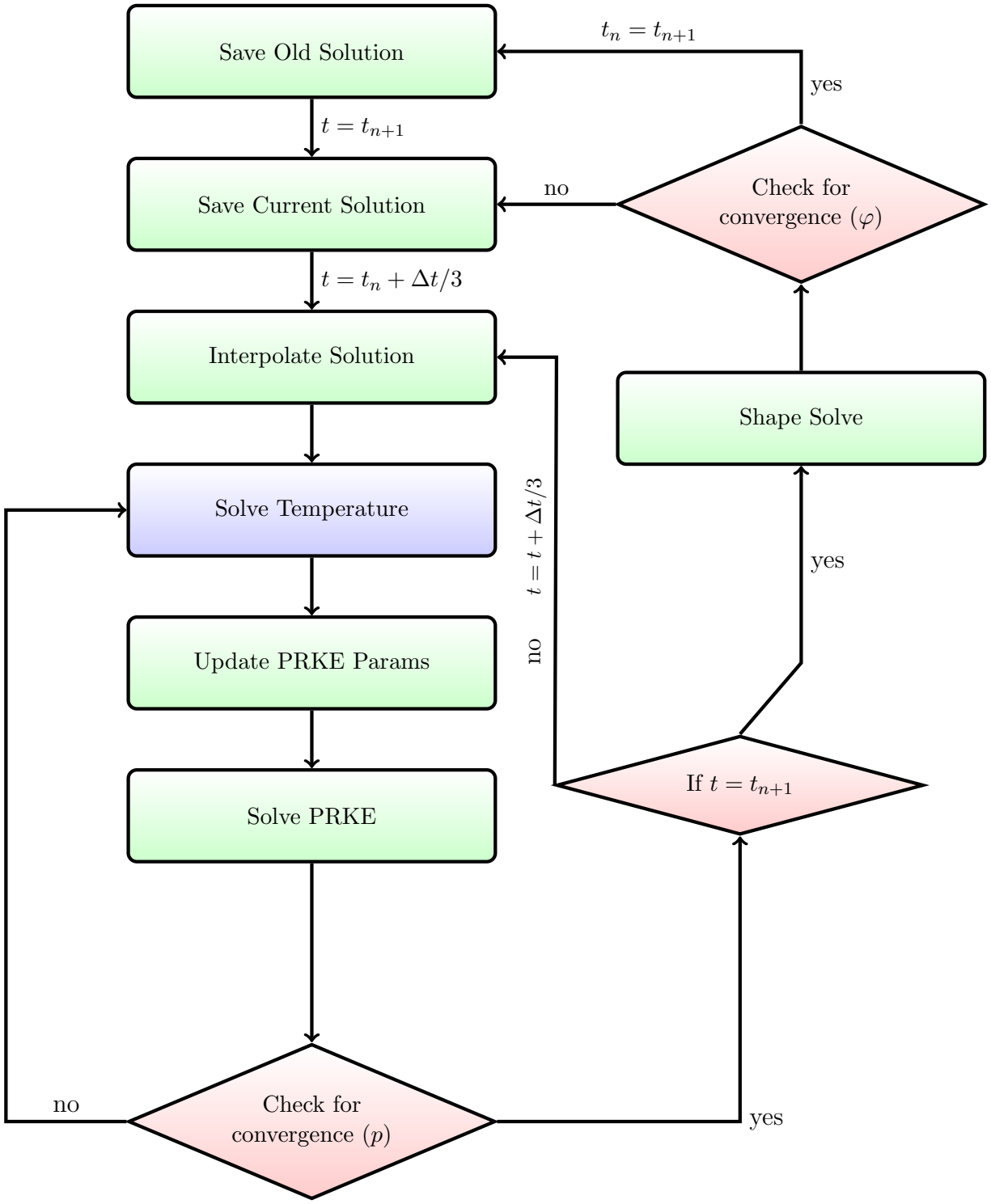


Figure 4: Visualization of Picard iteration and temperature update process for regular IQS

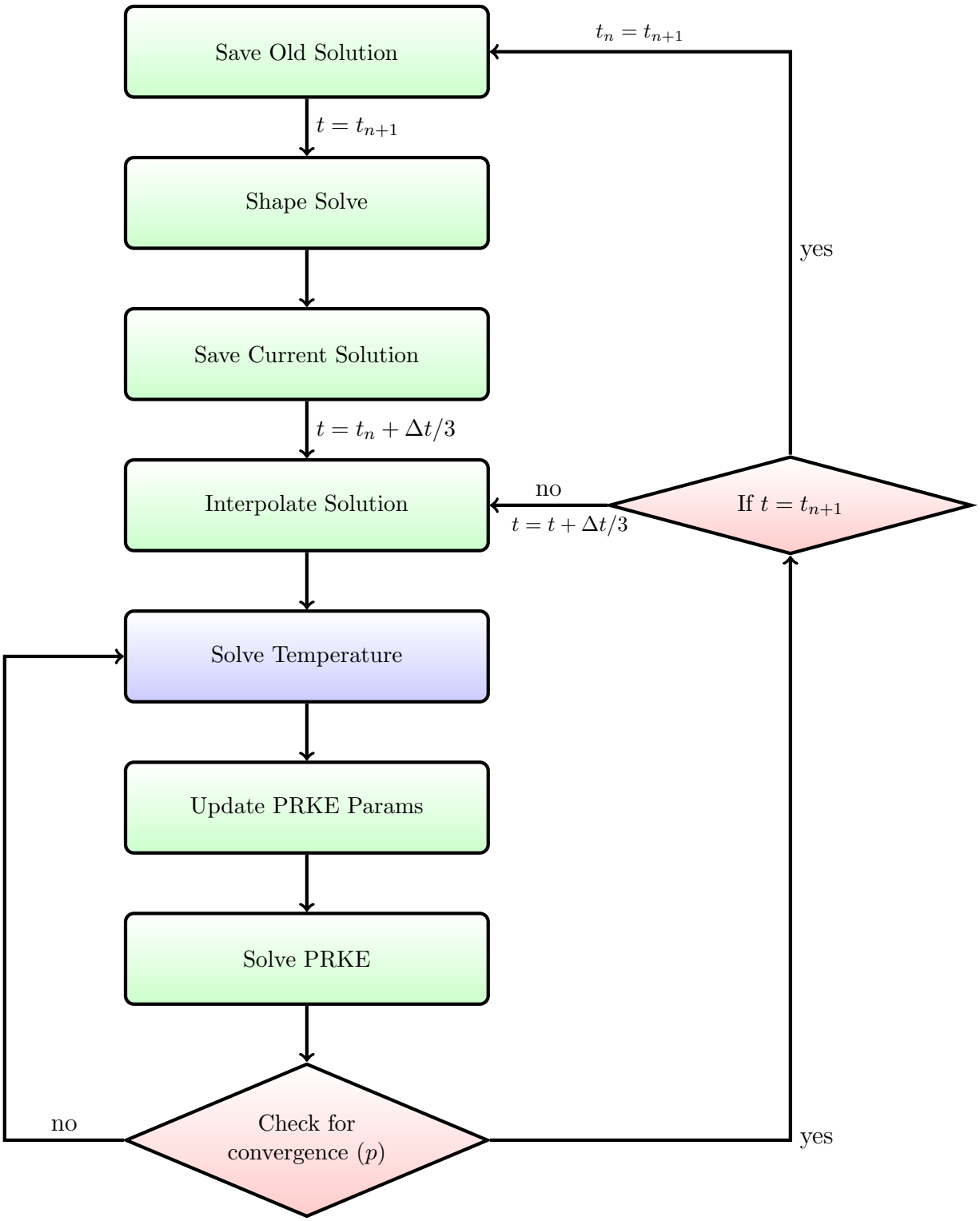


Figure 5: Visualization of Picard iteration and temperature update process for IQS P-C

2 Results

This section describes the results of this implementation of temperature updates with the LRA benchmark. Figure 6 shows the error convergence with 5 temperature updates per macro step. It shows that with this amount of updates, IQS needs approximately a fourth of the time steps. Figure 7 shows how various number of temperature updates affect the error with the same macro step size.

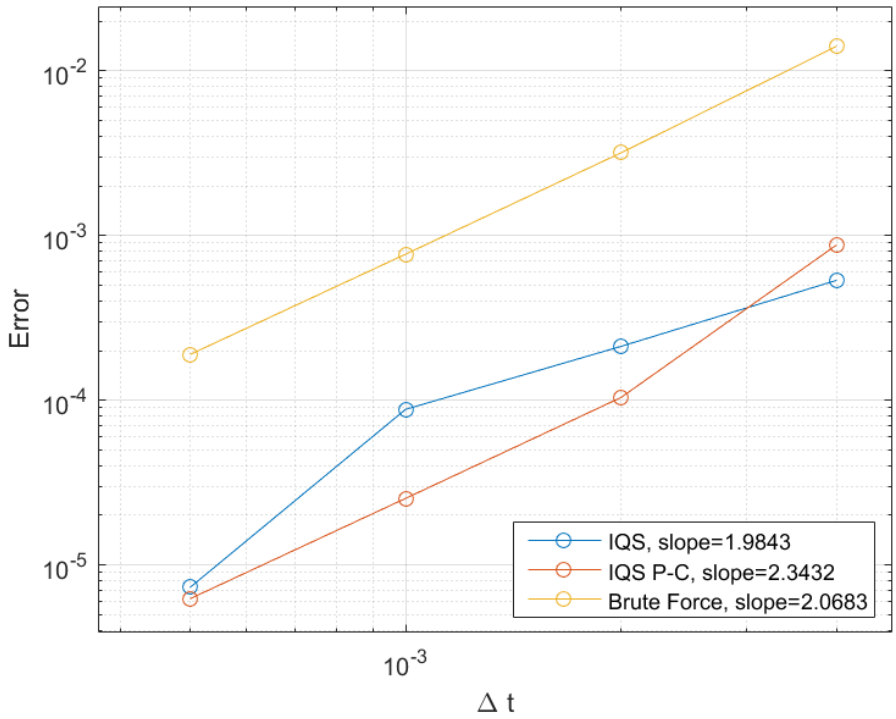


Figure 6: Error convergence plot with 5 temperature updates per macro step

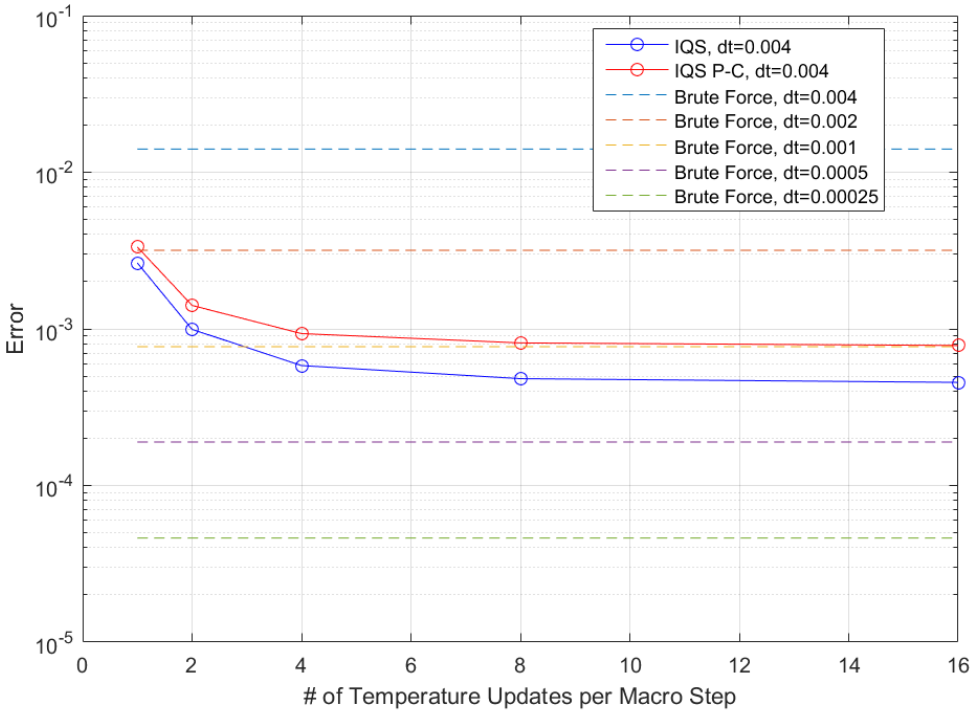


Figure 7: Error plot with various temperature updates per macro step