**Supplementary Information (SI):**

Numerical investigations on the difference between aiding and opposing flows in the developing regime of laminar mixed convection in vertical tubes

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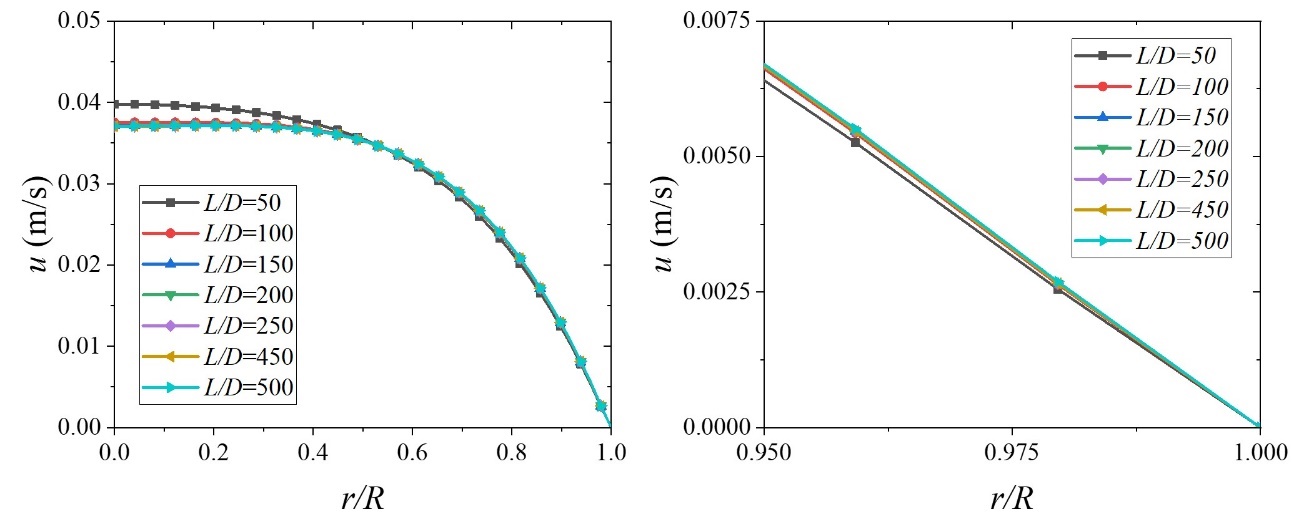
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Chart, scatter chart

Description automatically generated

(a) (b)

Fig. SI-1: Magnified view of (a) Fig. 5b and (b) Fig. 16b within region



(a) (b)

Fig. SI-2: (a) Velocity profile and (b) magnified velocity near the walls () at different axial length (for Fig. 5b at )

Chart

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(a) (b)

Fig. SI-3: Magnified view of (a) Fig. 5b and (b) Fig. 16b adjacent to the wall i.e., , based upon which the friction factor is defined

Chart, line chart, scatter chart

Description automatically generated

(a) (b)

Fig. SI-4: Wall temperature () and mean temperature () variation at different axial length (for Fig. 7b and 18b at ) for (a) assisting and (b) opposing flow

Chart

Description automatically generated

(a) (b)

Fig. SI-5: Magnified view of (a) Fig. 8b and (b) Fig. 19b

Chart, diagram, histogram

Description automatically generated

(a) (b)

Fig. SI-6: Magnified view of (a) Fig. 12b and (b) Fig. 23b

Chart, scatter chart

Description automatically generated

(a) (b)

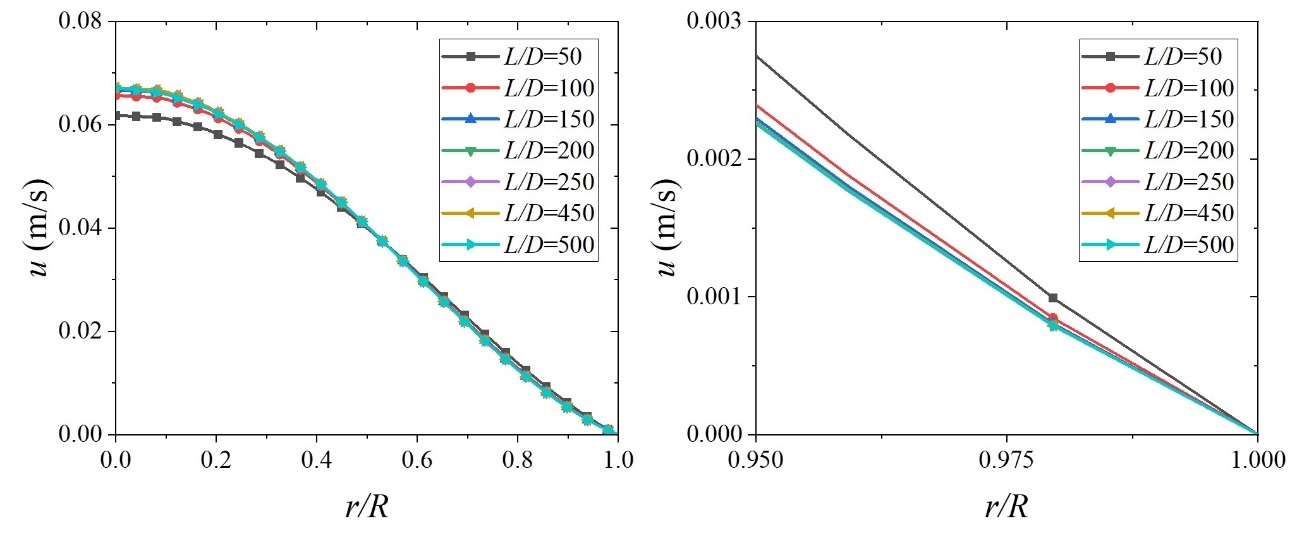
Fig. SI-7: Magnified view of (a) Fig. 14 and (b) Fig. 25

Chart

Description automatically generated with medium confidence

(a) (b)

Fig. SI-8: Enlarged view of (a) Fig. 15b and (b) Fig. 26b



(a) (b)

Fig. SI-9: (a) Velocity profile and (b) magnified velocity near the walls () at different axial length (for Fig. 16b at )

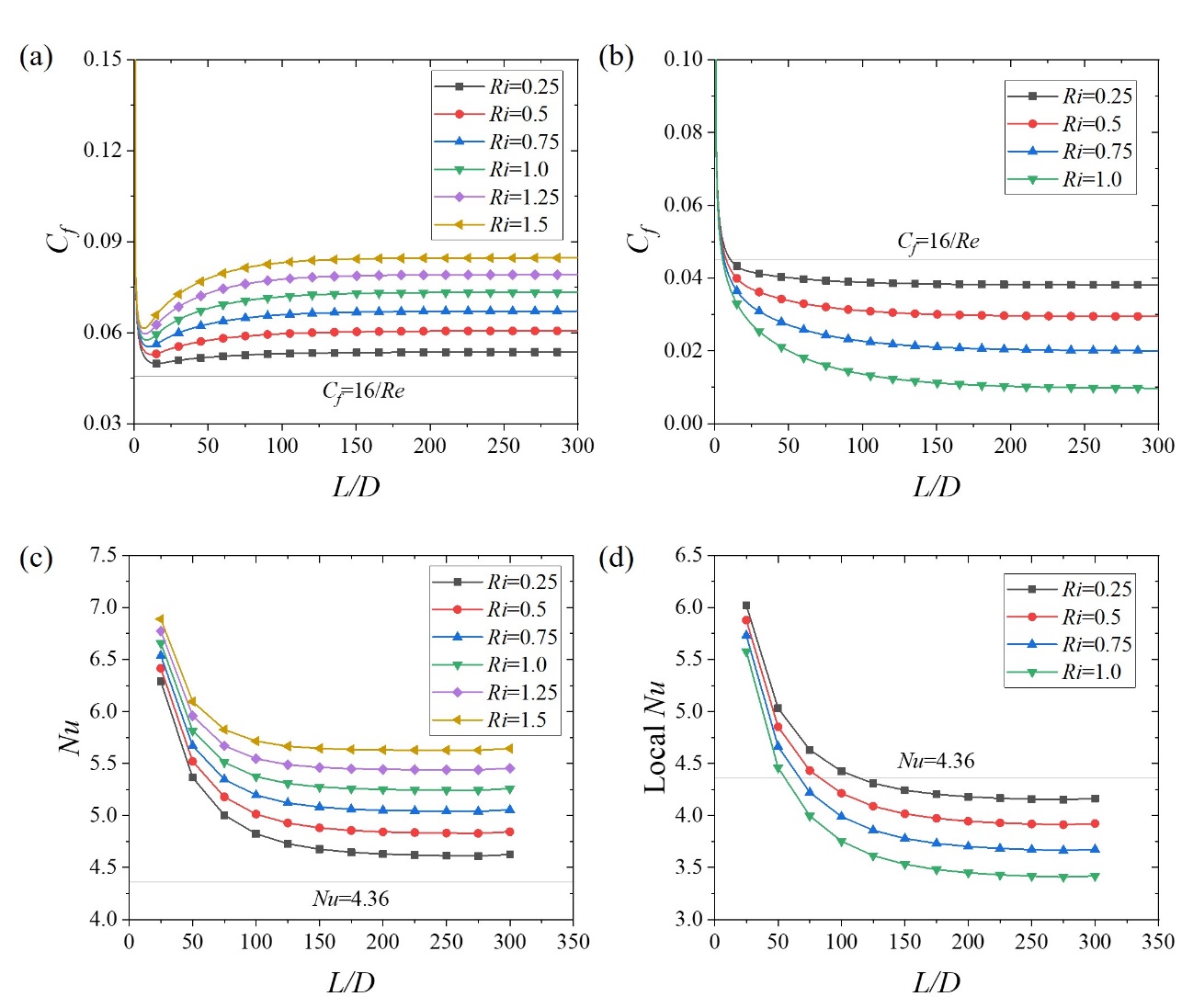


Fig. SI-10: Local and plot corresponding to different at for (a, c) assisting and (b, d) opposing flow (numerical instability observed after )

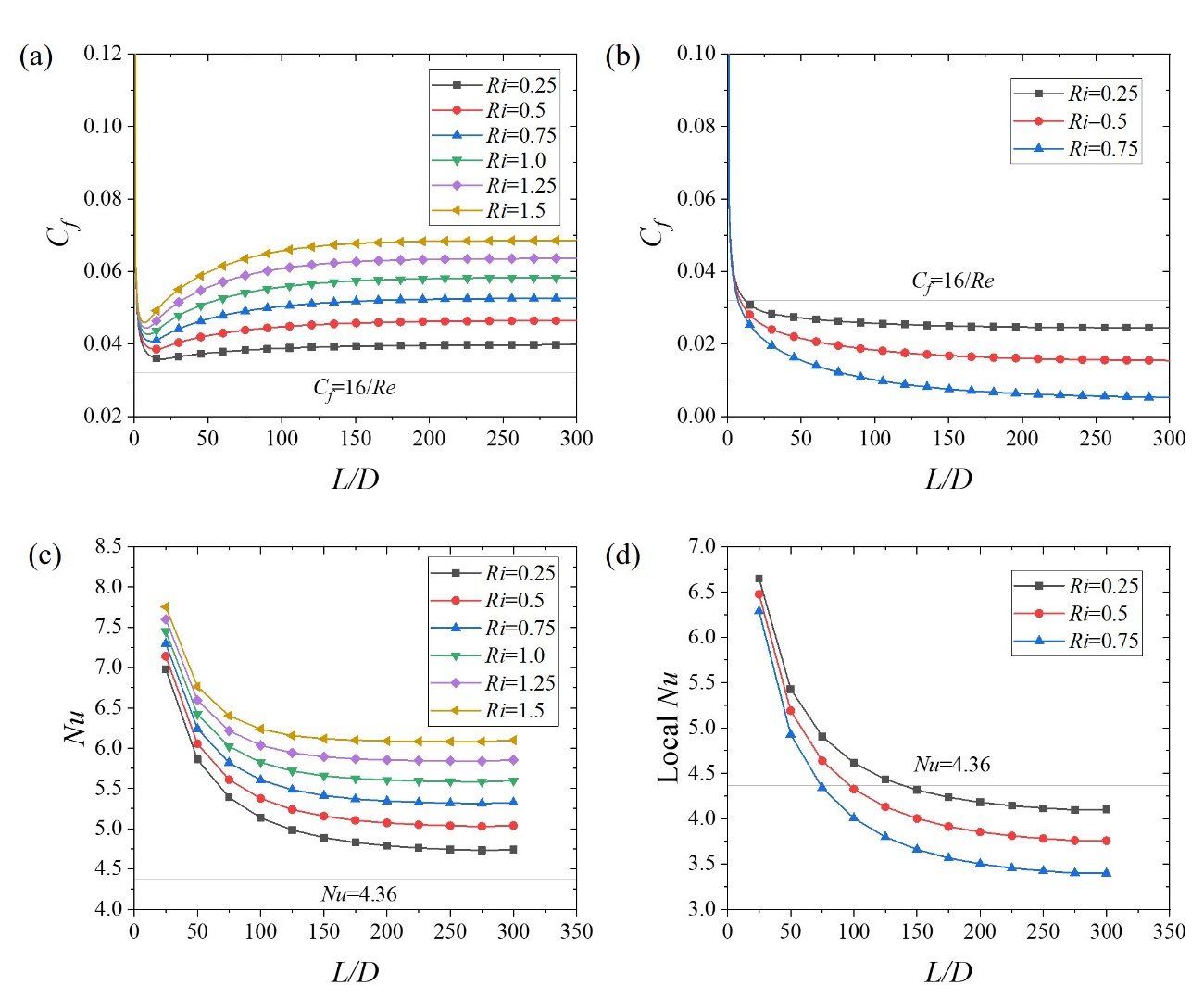


Fig. SI-11: Local and plot corresponding to different at for (a, c) assisting and (b, d) opposing flow (numerical instability observed after )

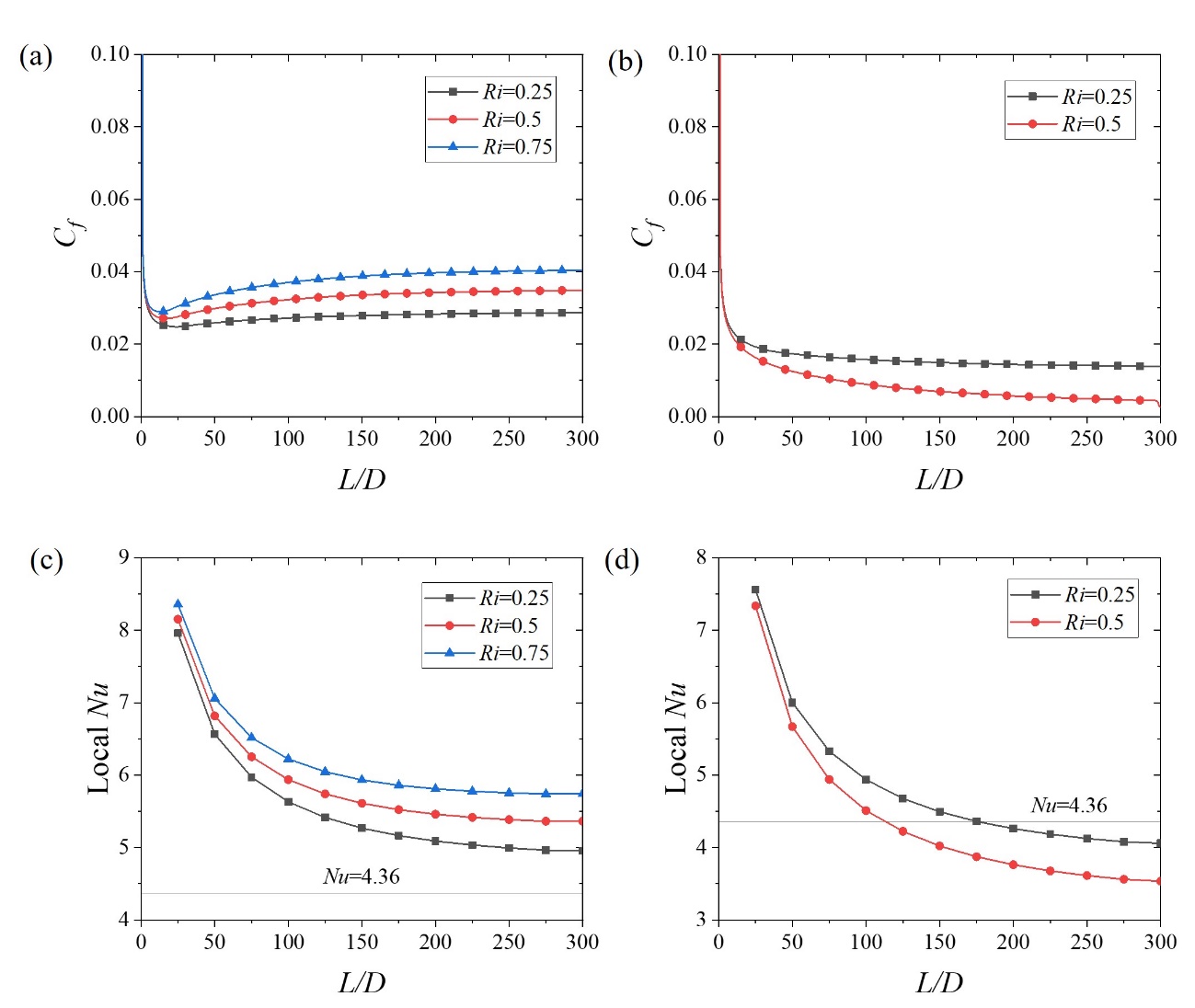


Fig. SI-12: Local and plot corresponding to different at for (a, c) assisting and (b, d) opposing flow (numerical instability observed after )

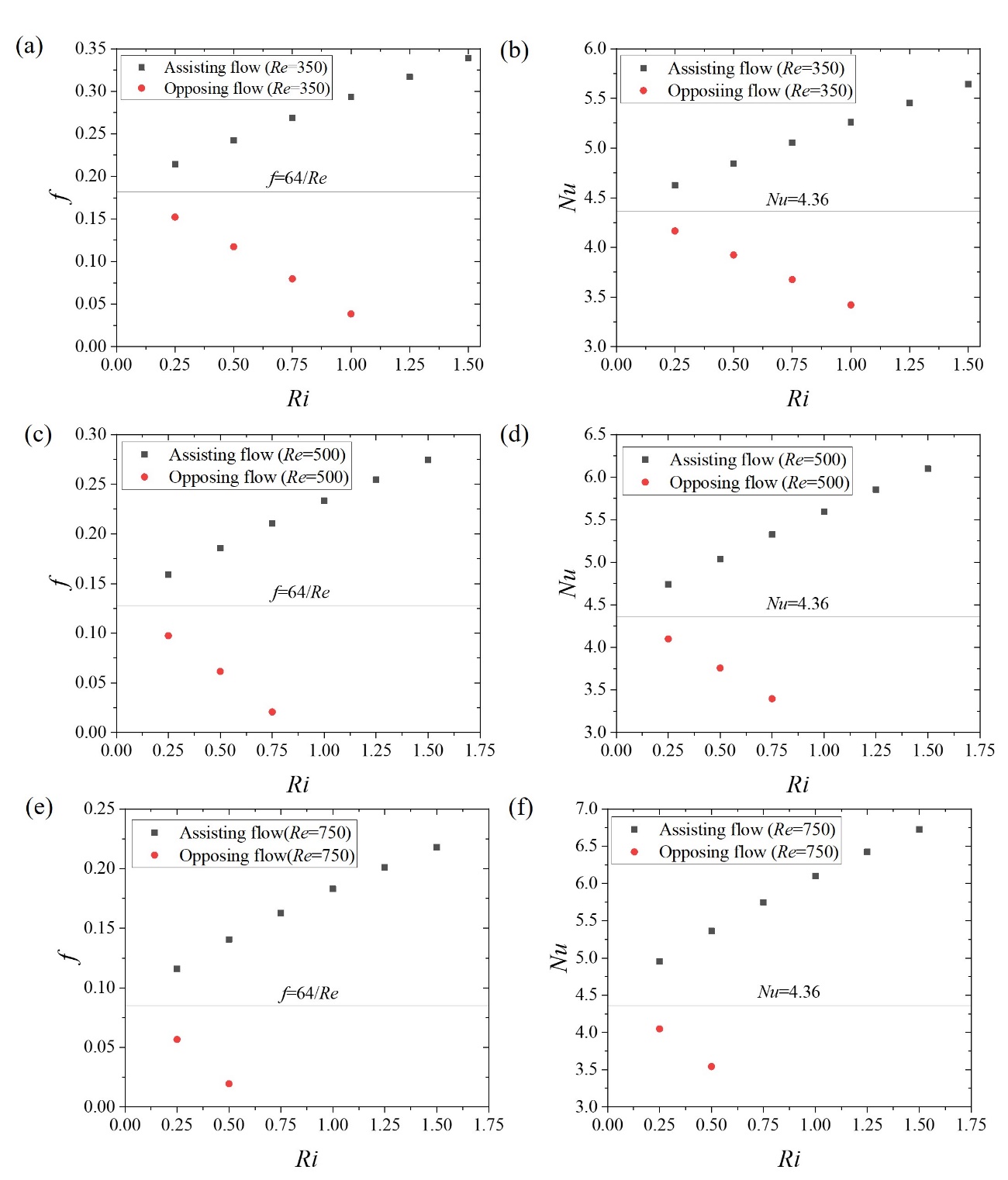


Fig. SI-13: Fully developed Vs and Vs plots corresponding to (a, b) (c, d) and (e, f) for assisting and opposing flow (numerical instability observed after for , after for and after for