Additional Materials for "Two-dimensional numerical experiments on mantle convection with stress-history-dependent rheology: Toward self-consistent reproduction of plate tectonics"

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Preprint submitted to *Earth, Planets and Space* on July 18, 2025

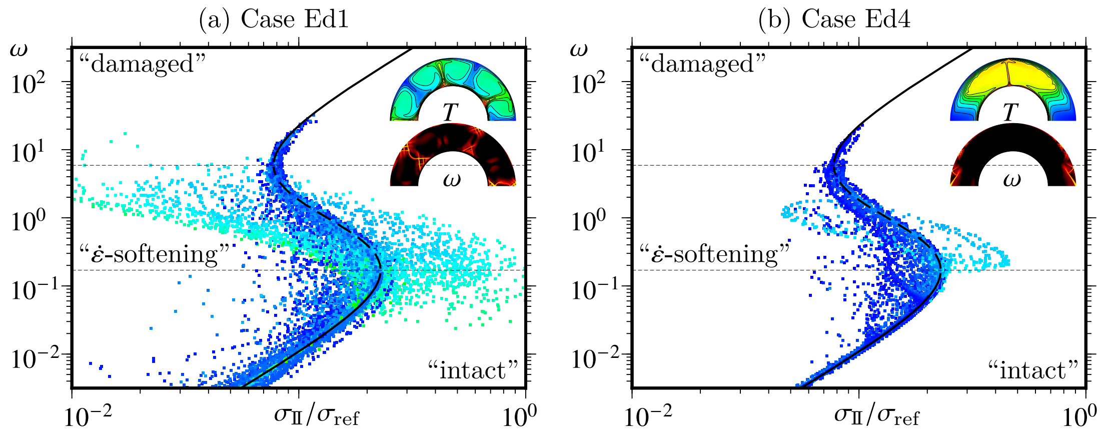

Figure S1. Plots against the stress σ_{II} applied to the fluid parcels of the values of their damage ω obtained for the cases where the viscosity is dependent on stress-history with $F = 8.06$. Plotted by the dots are the values of ω and σ_{II} obtained for the snapshots of Cases (a) Ed1 and (b) Ed4 indicated in the figure. The color indicates the temperature T of the parcels. Indicated by the black lines for comparison are the relationship between ω_s and σ_{II} given by (12) in the main text.

References

Ogawa M (2003) Plate-like regime of a numerically modeled thermal convection in a fluid with temperature-, pressure-, and stress-history-dependent viscosity. J Geophys Res 108(B2):2067, doi:10.1029/2000JB000069

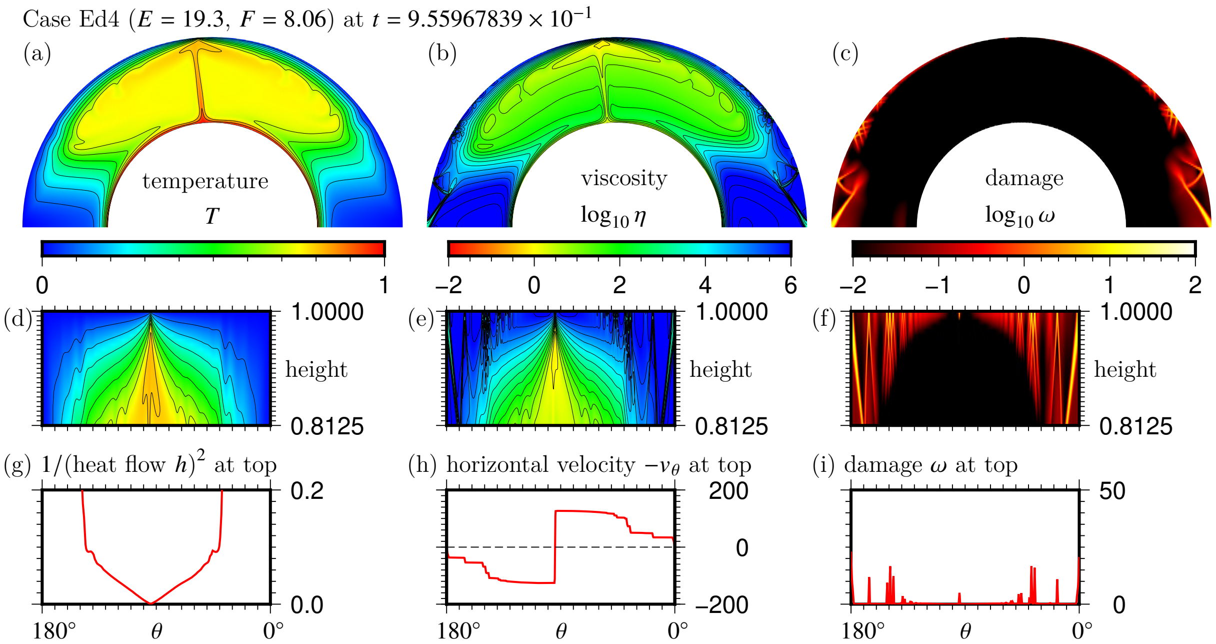

Figure S2. A snapshot of the convecting flow structure obtained for the calculation of Case Ed4 at the elapsed time of $t = 9.55968 \times 10^{-1}$. (a) The distribution of dimensionless temperature T in the entire domain. The contour interval is 0.1 and the color scale is shown in the figure. (b) The distribution of viscosity η in the entire domain. The color scale is shown in the figure. (c) The distribution of the damage ω in the entire domain. The color scale is shown in the figure. (d to f) Same as (a to c) but for the distributions in the uppermost part of the domain of dimensionless height $0.8125 \leq r - r_{\min} \leq 1$. (g) The plot against the horizontal coordinate θ of the inverse of the square of the dimensionless heat flow $1/h^2$, at the top surface boundary. (h) The plot against θ of the horizontal velocity v_θ at the top surface boundary. (i) The plot against θ of the damage ω at the top surface boundary.

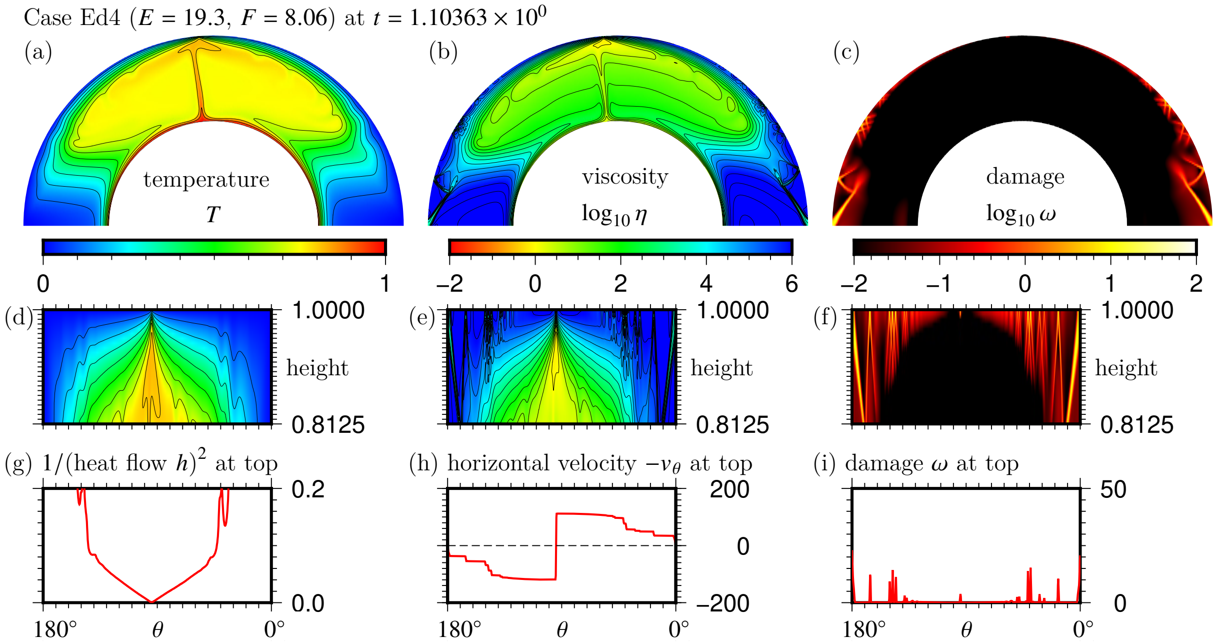

Figure S3. Same as Figure S2 but for the elapsed times at $t = 1.10363 \times 10^0$.

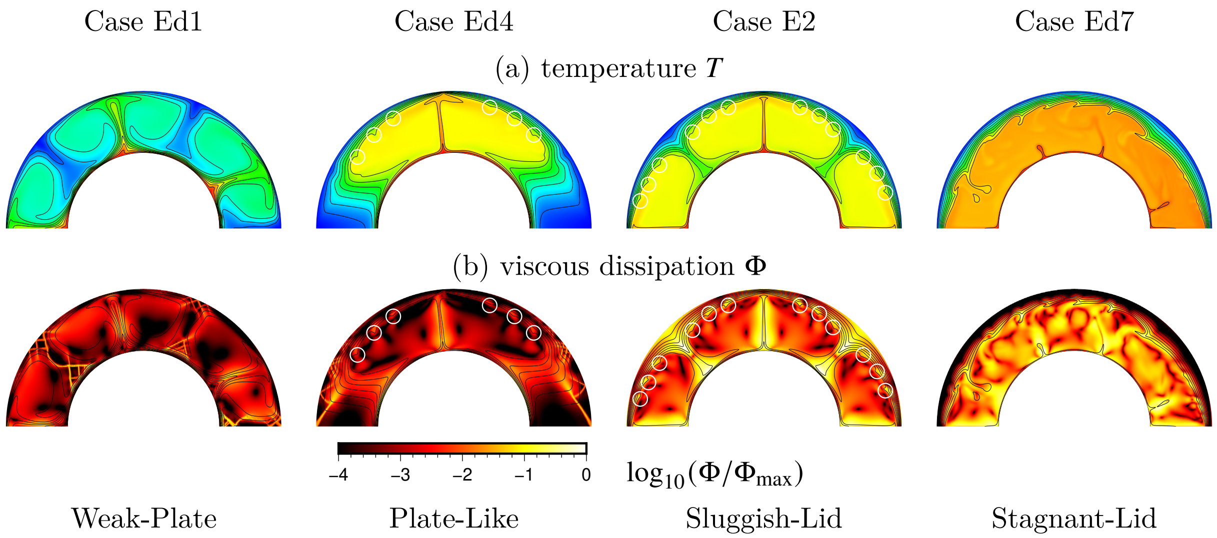

Figure S4. The comparison of the different modes of convecting flow structures obtained in this study. (a) The distribution of dimensionless temperature T in the entire domain. (b) The distribution of the ratio of the viscous dissipation Φ to its maximum value $\Phi_{\max}$ in the entire domain. The color scale is shown in the figure. Encircled by thin white lines in the distributions of T and $\Phi/\Phi_{\max}$ for the Cases Ed4 and E2 are the minor descending plumes occurring at the base of the cold TBLs.

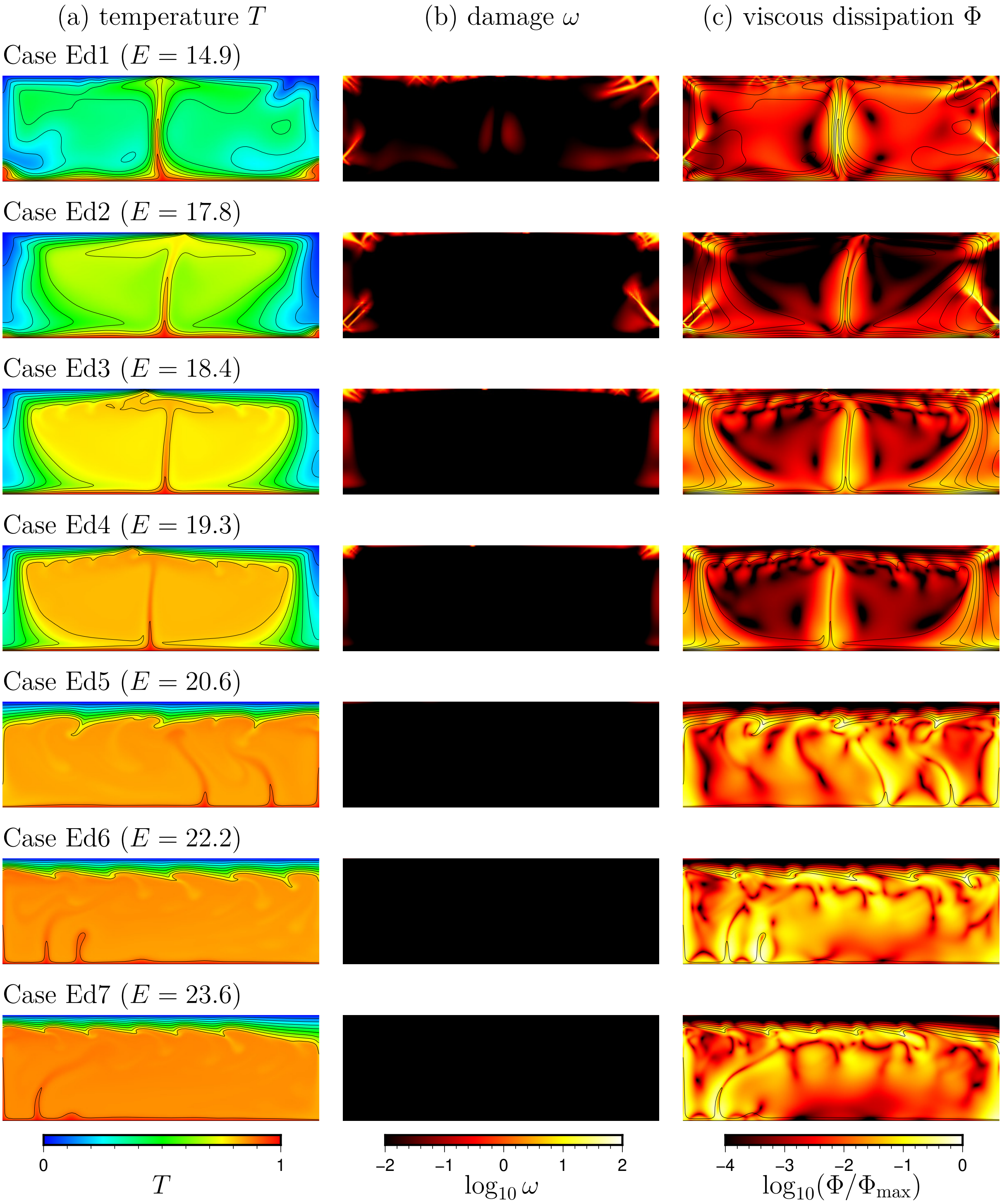

Figure S5. Snapshots of overall structures of the thermal convection in two-dimensional Cartesian box of aspect ratio (width/height) 3 similar to the earlier work by Ogawa (2003). (a) The distribution of temperature T. The contour interval is 0.1. The color scale is indicated at the bottom of the figure. (b) The distribution of damage ω. The color scale is indicated at the bottom of the figure. (c) The distribution of viscous dissipation Φ. Plotted are the values of Φ divided by its maximum value $\Phi_{\max}$ for the given snapshot. The color scale is indicated at the bottom of the figure.

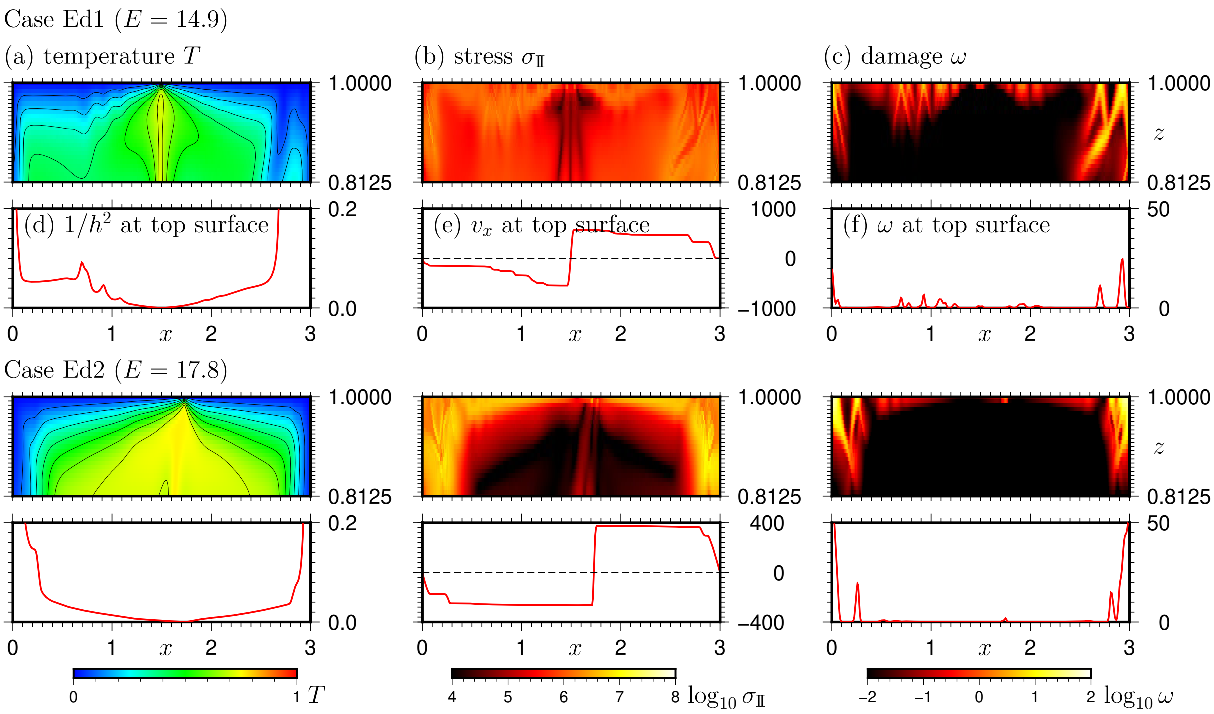

Figure S6. Snapshots of overall structures of the thermal convection in the uppermost part of the box two-dimensional Cartesian box obtained for Cases Ed1 and Ed2. (a) The distribution of temperature T from the top surface (dimensionless height $z = 1$) down to $z = 0.8125$. The contour interval is 0.1. (b) The distribution of second invariant of stress tensor σ_{II} for $0.8125 \leq z \leq 1$. (c) The distribution of damage ω for $0.8125 \leq z \leq 1$. (d) The plot against horizontal coordinate x of the inverse square of heat flux h at the top surface ($z = 1$). (e) The plot against x of the horizontal velocity v_x at $z = 1$. (f) The plot against x of the damage ω at $z = 1$. For (a) to (c), the color scales are indicated at the bottom of the figure.

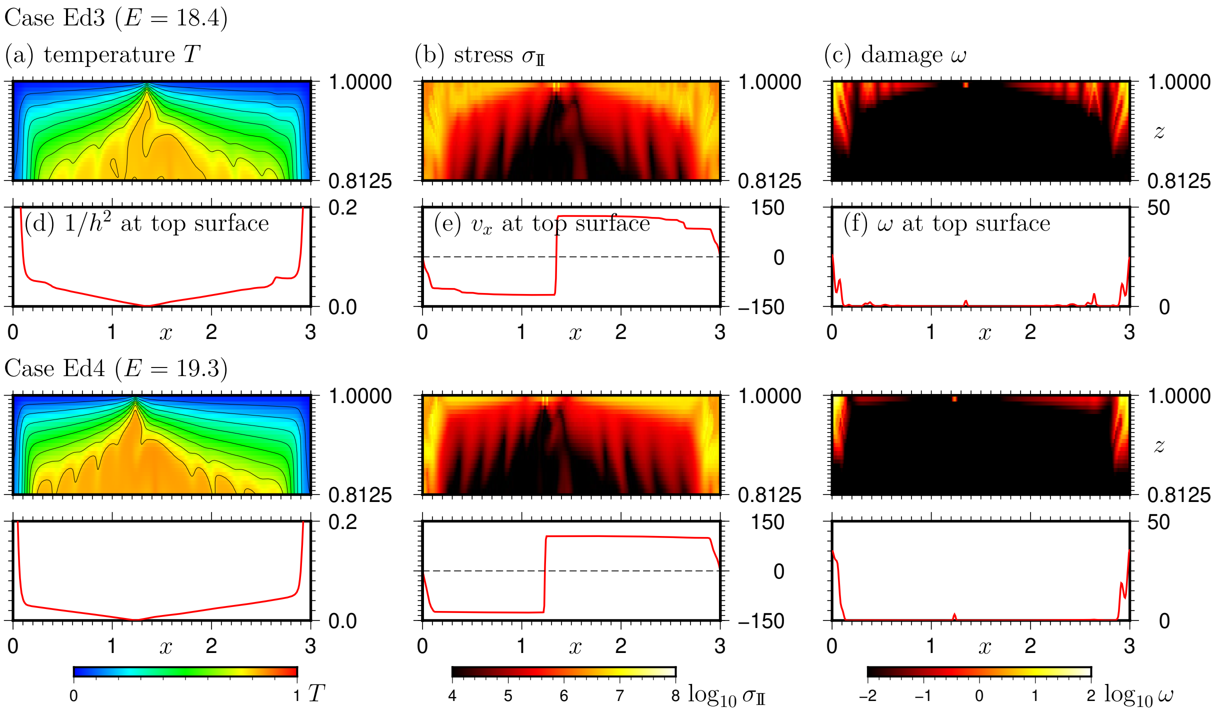

Figure S7. Same as Figure S6 but for Cases Ed3 and Ed4.

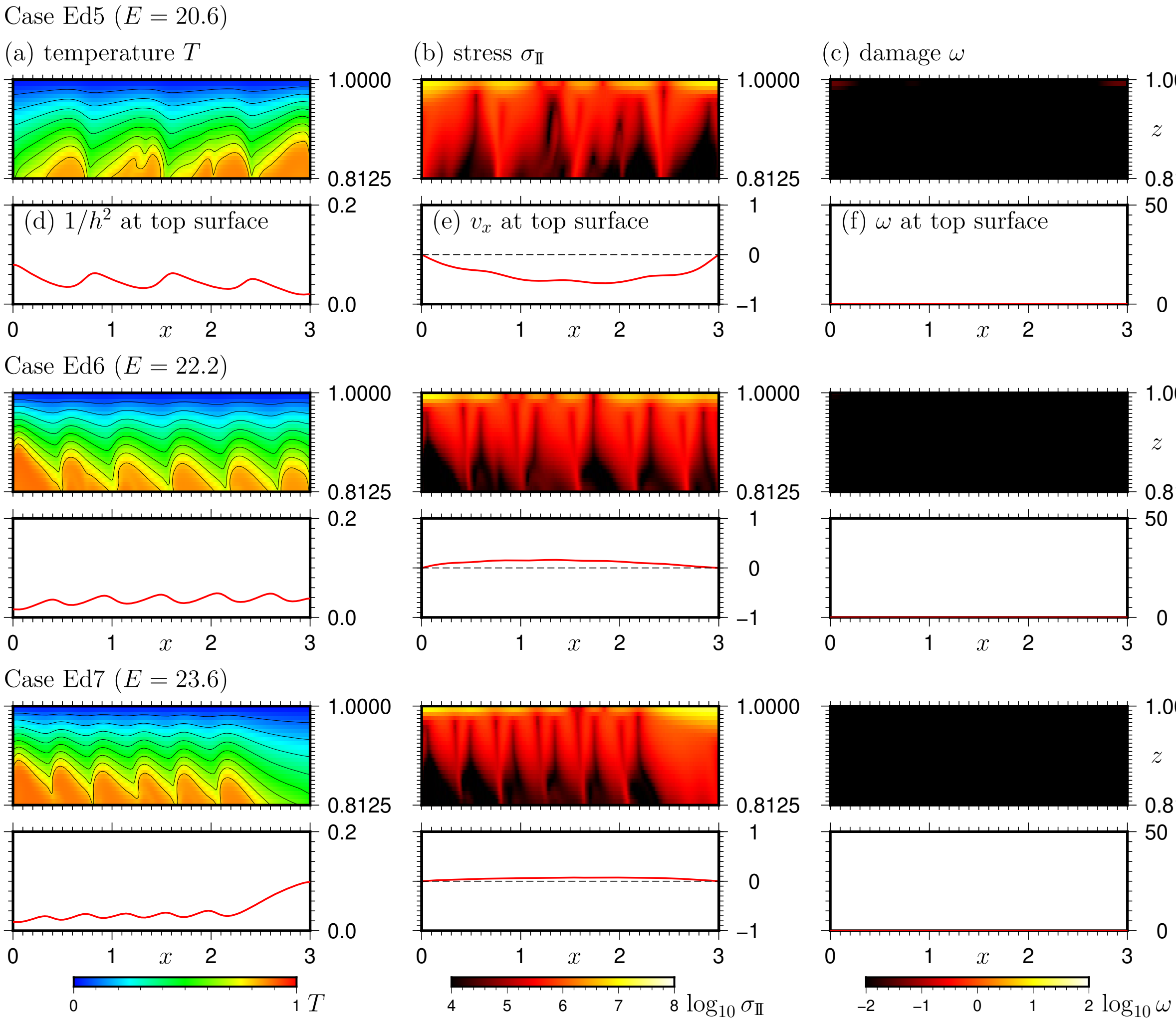

Figure S8. Same as Figure S6 but for Cases Ed5 to Ed7.