Turbulent Rayleigh-Bénard convection in a strong vertical magnetic field
(supplemental materials)

R. Akhmedagaev[1], O. Zikanov[1]†, D. Krasnov[2] and J. Schumacher[2]

[1]University of Michigan - Dearborn, 4901 Evergreen Road, Dearborn, MI 48128-1491, USA
[2]Technische Universität Ilmenau, Postfach 100565, 98694 Ilmenau, Germany

This document summarizes the results of sections 2.4 *Grid sensitivity study* and 3.2 *Global transport properties* in the main article.

1. Grid sensitivity study

The results of the grid sensitivity study are presented in table below. The number of grid points inside the smallest thickness, which is δ_v for the cases with $Ha = 0$ and δ_{Ha} for the cases with $Ha > 0$ is shown as N_{BL}. Other definitions of the listed quantities can be found in the main article.

Run	*Ra*	*Ha*	$N_r \times N_z \times N_\theta$	A_z	N_{BL}	*Nu*	*Re*
1	10^7	0	$128 \times 128 \times 128$	3.0	8	10.52	7179
2	10^7	0	$192 \times 192 \times 192$	3.0	12	10.31	7075
3	10^8	0	$192 \times 192 \times 192$	3.0	8	19.68	20428
4	10^8	0	$256 \times 256 \times 256$	3.0	11	19.51	20408
5	10^9	0	$192 \times 192 \times 192$	3.0	5	40.47	59689
6	10^9	0	$256 \times 256 \times 256$	3.0	7	40.57	63434
7	10^9	0	$384 \times 384 \times 384$	3.0	11	40.85	58239
8	10^7	450	$192 \times 64 \times 192$	4.0	8	5.16	2513
9	10^7	450	$192 \times 96 \times 192$	3.5	8	5.43	2281
10	10^7	450	$192 \times 192 \times 192$	3.0	7	5.35	2202
11	10^7	650	$192 \times 64 \times 192$	4.0	6	3.86	1616
12	10^7	650	$192 \times 96 \times 192$	3.5	6	3.84	1690
13	10^7	650	$192 \times 192 \times 192$	3.0	7	3.63	1638
14	10^8	650	$192 \times 96 \times 192$	3.5	6	13.19	8366
15	10^8	650	$192 \times 192 \times 192$	3.0	7	12.76	8369
16	10^8	650	$256 \times 256 \times 256$	3.0	10	13.32	8311
17	10^8	850	$192 \times 64 \times 192$	4.0	6	10.76	7326
18	10^8	850	$192 \times 192 \times 192$	3.0	6	10.62	7476
19	10^8	850	$256 \times 256 \times 256$	3.0	7	10.65	6842
20	10^9	850	$192 \times 96 \times 192$	4.0	9	33.67	28204
21	10^9	850	$192 \times 192 \times 192$	3.0	6	32.60	24971
22	10^9	850	$256 \times 256 \times 256$	3.0	7	31.92	25239
23	10^9	1400	$192 \times 96 \times 192$	4.0	6	26.37	23348
24	10^9	1400	$192 \times 192 \times 192$	3.0	4	25.78	21034
25	10^9	1400	$256 \times 256 \times 256$	3.0	5	25.85	22547

† Email address for correspondence: zikanov@umich.edu

Although the comparison between the maximum grid step in the bulk with the estimates of the Kolmogorov length scale indicate that the non-magnetic flow at $Ra = 10^9$ is somewhat under-resolved, as already mentioned in the main article, the data convincingly shows that the regimes of the focus of this study (high Ra and Ha) are well-resolved.

2. Global transport properties

For each combination of Ha and Ra, the tables show the Nusselt Nu and Reynolds Re numbers, as well as the thickness of the thermal boundary layer δ_T defined in the main article. For the latter, the computed value δ_T^{DNS} and the theoretical value $\delta_T \approx 1/(2Nu)$ are listed.

Ha	Ra	Nu	Re	$\delta_T \times 10^2$	$\delta_T^{DNS} \times 10^2$
1400	7×10^7	5.60	4066	8.921	8.950
1400	9×10^7	6.58	5022	7.593	7.743
1400	10^8	6.97	5190	7.172	7.182
1400	3×10^8	13.36	10402	3.742	3.749
1400	5×10^8	17.49	15886	2.858	2.883
1400	7×10^8	21.89	17892	2.284	2.301
1400	9×10^8	24.86	19256	2.011	2.008
1400	10^9	25.85	22547	1.934	1.949

Ha	Ra	Nu	Re	$\delta_T \times 10^2$	$\delta_T^{DNS} \times 10^2$
850	10^7	2.93	1429	17.090	17.119
850	3×10^7	5.41	3188	9.242	9.272
850	5×10^7	7.39	4507	6.770	6.773
850	7×10^7	8.84	5240	5.654	5.645
850	9×10^7	10.30	6634	4.855	4.830
850	10^8	10.65	6842	4.695	4.724
850	3×10^8	18.78	13734	2.662	2.676
850	5×10^8	23.77	17749	2.103	2.118
850	7×10^8	27.26	21971	1.834	1.843
850	9×10^8	30.79	24724	1.624	1.632
850	10^9	31.92	25239	1.566	1.563

Ha	Ra	Nu	Re	$\delta_T \times 10^2$	$\delta_T^{DNS} \times 10^2$
650	10^7	3.84	1632	13.026	13.126
650	3×10^7	6.77	3805	7.389	7.439
650	5×10^7	9.06	5233	5.521	5.526
650	7×10^7	10.47	5946	4.776	4.812
650	9×10^7	11.84	7790	4.222	4.237
650	10^8	12.59	8549	3.971	4.001
650	3×10^8	21.31	14844	2.346	2.357
650	5×10^8	26.29	18958	1.902	1.925
650	7×10^8	30.48	23278	1.640	1.661
650	9×10^8	33.76	25829	1.481	1.498
650	10^9	35.15	27810	1.423	1.444

Ha	Ra	Nu	Re	$\delta_T \times 10^2$	$\delta_T^{DNS} \times 10^2$
450	10^7	5.24	2234	9.548	9.610
450	3×10^7	8.64	4583	5.785	5.801
450	5×10^7	11.04	6480	4.528	4.531
450	7×10^7	12.95	8100	3.862	3.898
450	9×10^7	14.94	8911	3.346	3.363
450	10^8	14.98	9711	3.337	3.326
450	3×10^8	23.88	18686	2.094	2.108
450	5×10^8	28.98	24096	1.725	1.745
450	7×10^8	32.88	29430	1.520	1.546
450	9×10^8	35.59	33187	1.405	1.439
450	10^9	36.98	33753	1.352	1.379

Ha	Ra	Nu	Re	$\delta_T \times 10^2$	$\delta_T^{DNS} \times 10^2$
0	10^7	10.31	7075	4.848	4.848
0	3×10^7	13.68	11929	3.655	3.650
0	5×10^7	16.09	13637	3.107	3.118
0	7×10^7	17.97	16768	2.783	2.785
0	9×10^7	18.67	19239	2.677	2.684
0	10^8	19.51	20408	2.562	2.547
0	3×10^8	27.16	34055	1.841	1.845
0	5×10^8	31.48	42203	1.588	1.588
0	7×10^8	34.94	47814	1.431	1.439
0	9×10^8	38.80	54015	1.289	1.295
0	10^9	40.85	58239	1.224	1.235