Supplementary information for
High-resolution numerical modelling of seasonal volume, freshwater, and heat transport along the Indian coast

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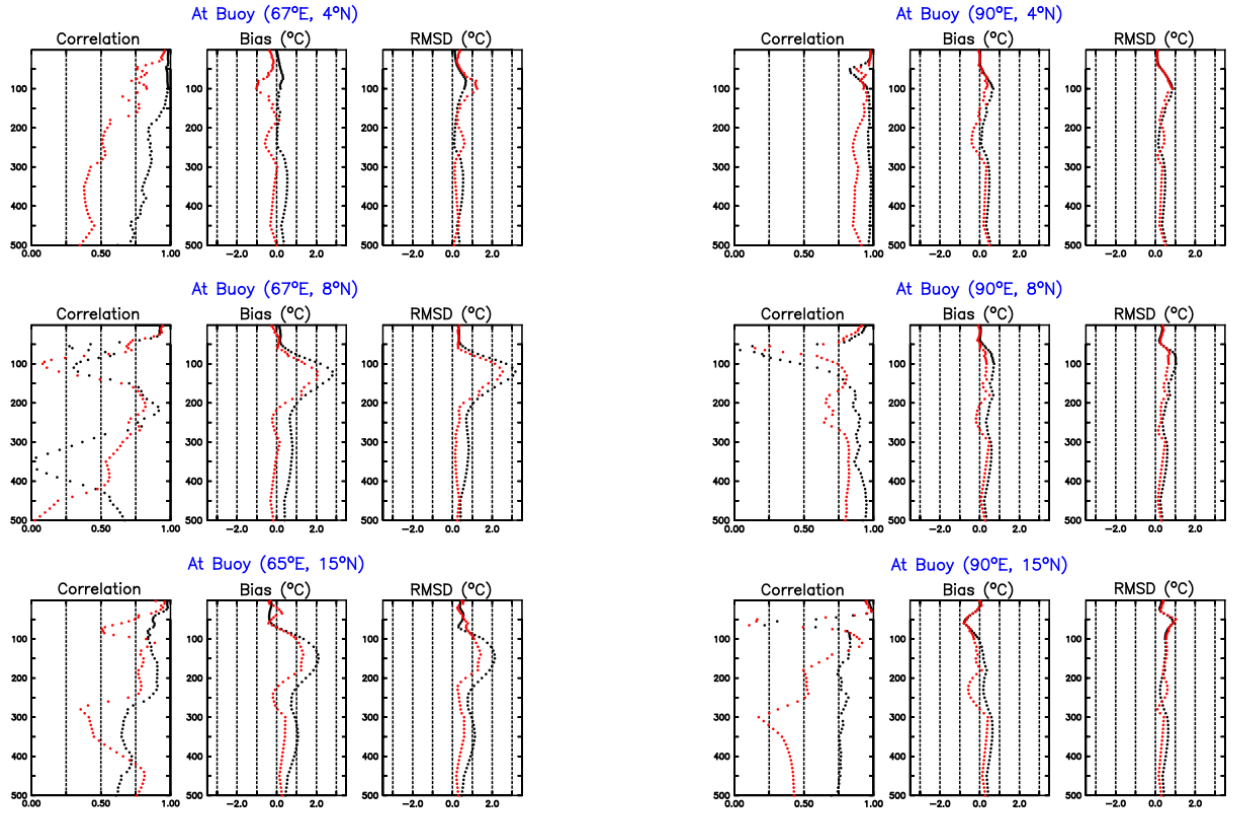
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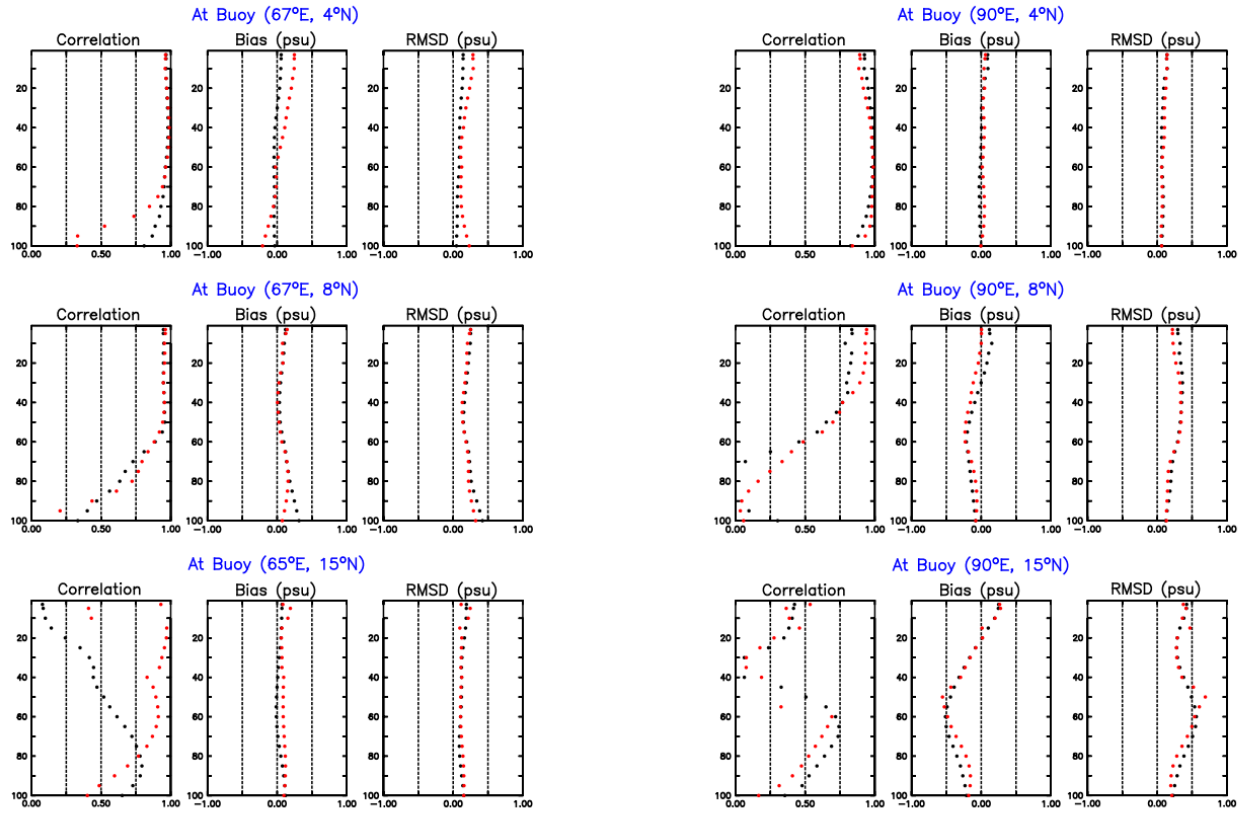
Text S1: Validation of ocean temperature

The statistical validation of model ocean temperature has been done with RAMA and gridded ARGO datasets and correlation, bias and RMSD have been evaluated over monthly climatology. We have considered 3 locations each in the AS and BoB. The model shows a high positive correlation with both observations over the top 50 meters at all locations. It seems to perform quite well in the southern AS and BoB (4°N latitude). We observe that the model correlates well with ARGO than RAMA data. In the AS, RAMA buoy data is available for a shorter span (3-4 years) as compared to BoB. Thus, the climatology may not capture the long-term mean signal within this span. We observe the bias does not exceed ±1°C except over two locations in the AS. Similarly, the RMSD value is very low (two orders less) which is to be expected. This shows that the model is able to capture the mixing processes and net heat flux well to simulate ocean temperature.
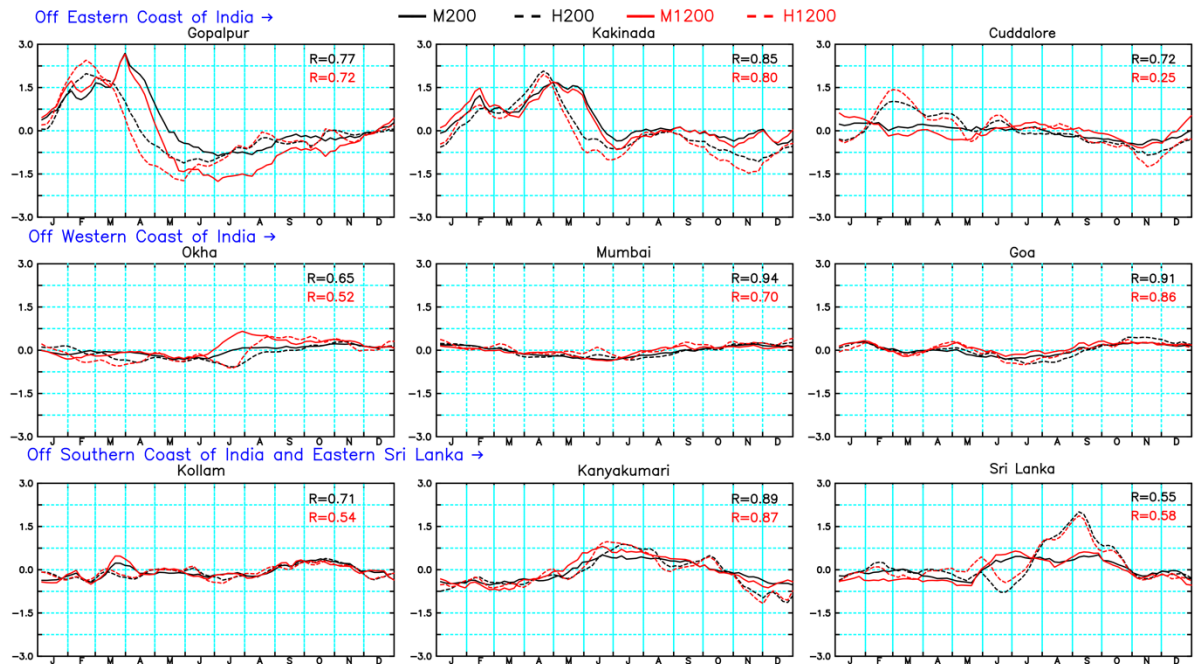
Text S2: Validation of ocean salinity

The statistical validation (till 100 meters) of model ocean salinity has been done with RAMA and gridded ARGO datasets and correlation, bias and RMSD have been evaluated over monthly climatology. Comparison has been done at the same locations as that with temperature. Model salinity too performs very well at 4°N latitude with high positive correlation, and almost zero bias and RMSD. The model shows a high positive correlation with both observations over the top 50 meters. Overall, the bias and RMSD do not exceed ±0.5 psu. This shows that the model is able to capture the effects of evaporation, precipitation, and river runoff well to simulate ocean salinity.

Figure S1: Statistical validation (till 500 meters) of ocean temperature (in °C) with gridded ARGO (black dots) and RAMA buoy (red dots) locations in the Arabian Sea and the Bay of Bengal.

Figure S2: Statistical validation of ocean salinity (in psu) with gridded ARGO (black dots) and RAMA buoy (red dots) locations in the Arabian Sea and the Bay of Bengal.

Figure S3: AHT (in PW) of the model (solid lines: M200 / M1200) and INC-HYC (dashed lines: H200 / H1200). R represents the Pearson's correlation coefficient between the model and INC-HYC. Articles in black colour indicate transport integrated over 200 m depth and red colour

indicates transport integrated over 1200 m depth.

Table S1: Model and INC-HYC AVT (in Sv, monthly climatology).
*Gopa = Gopalpur, Kaki = Kakinada, Cudd = Cuddalore, KK = Kanyakumari, ESRL = Eastern Sri Lanka

Gopa*	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
M200	7.91	13.01	19.27	16.64	-0.66	-7.08	-8.82	-7.60	-2.28	-2.40	-2.34	0.93
H200	4.95	20.17	17.60	0.76	-9.98	-11.17	-7.39	-3.61	-3.83	-2.33	-0.74	-0.72
M1200	11.64	19.33	18.70	3.65	-24.04	-27.29	-29	-24.37	-14.89	-13.73	-7.33	2.53
H1200	12.59	32.22	14.84	-20.43	-27.44	-15.96	-7.30	-0.50	-1.69	-2.10	-6.15	0.75

Kaki*	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
M200	2.58	9.62	7.33	14.02	14.88	2.65	-2.01	0.19	0.06	-1.82	-1.58	-2.98
H200	-2.20	6.90	7.86	17.16	6.12	-5.23	-5.39	-0.85	-2.48	-6.29	-10	-8.01
M1200	9.34	15.49	4.77	10.23	10.35	-2.98	-7.88	-3.11	-0.09	-3.90	-5.72	0.57
H1200	3.52	10	1.71	11.33	-2.08	-16.05	-8.06	0.65	-4.75	-15.09	-21.53	-7.90

Cudd*	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
M200	3.50	2.22	1.32	1.35	0.42	0.56	0.81	-1.18	-2.24	-3.34	-3.90	-1.50
H200	-2.03	6.96	10.07	5.44	1.39	2.35	-1.04	-0.88	-3.04	-3.89	-8.14	-5.1
M1200	7.98	-0.94	-5.58	-6.88	-7.78	0.37	4.92	5.11	4.49	-0.66	-6.54	4.85
H1200	-2.82	12.04	16.20	1.56	-5.34	7.67	4.05	6.84	-1.52	-6.15	-15.93	-6.06

Okha	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
M200	-1.02	-0.92	-0.83	-1.37	-2.74	-2.67	-0.15	1.10	1.06	1.61	2.04	1.08
H200	1.17	-0.58	-2.23	-4.03	-3.25	-3.46	-5.38	-1.21	-0.04	1.91	2.60	1.16
M1200	-2.23	-3.94	-1.97	0.38	-1.21	-0.32	9.20	9.75	5.02	4.63	4.10	1.20
H1200	0.20	-7.01	-6.93	-3.77	-1.38	-0.80	-4.53	8.85	9.88	7.01	1.95	0.95

Mumbai	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
M200	1.74	1.05	-0.36	-1.77	-2.49	-3.03	-2.34	-1.16	-0.06	0.95	1.81	1.36
H200	2.19	0.89	-0.19	-2.66	-1.98	-1.82	-2.89	-2.01	0.01	0.74	2.42	2.25
M1200	-0.41	-0.98	-1.06	0.57	-0.80	-3.61	-0.56	2.37	2.13	0.63	0.33	0.05

| **H1200** | 2.48 | 0.09 | 3.00 | 0.53 | 0.98 | 2.13 | -1.29 | 2.61 | 4.96 | 2.73 | 2.65 | 2.83 |

Goa	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
M200	2.00	1.03	-0.58	-0.23	-1.19	-2.20	-2	-1.31	0.99	2.05	2.30	1.30
H200	1.43	0.77	-0.91	-0.11	-0.18	-1.67	-3.80	-3.26	0.08	3.04	4.34	2.75
M1200	3.10	1.88	-1.56	3.51	5.00	1.21	1.59	1.39	4.28	3.37	2.62	2.66
H1200	-1.24	2.23	-2.16	2.53	3.41	-3.31	-3.84	1.30	1.92	1.78	-0.002	0.76
Kollam	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
M200	-3.23	-2.50	-0.26	-0.56	-0.53	-1.31	-0.98	-1.37	2.10	3.30	1.18	-1.65
H200	-2.11	-3.46	-1.44	-1.84	0.34	0.19	-2.47	-1.10	2.21	3.36	1.34	-3.29
M1200	-4.76	-2.87	2.90	-0.82	1.43	-3.06	-1.54	-1.72	3.26	1.30	-0.87	-0.83
H1200	-2.35	-2.33	1.02	-0.81	-0.45	-1.93	-3.37	2.19	0.60	1.48	0.55	-2.55
KK*	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
M200	-4.35	-4.30	-4.09	-3.66	-0.84	3.65	3.88	3.41	2.19	-0.16	-1.57	-4.18
H200	-5.49	-3.14	-4.37	-3.50	-2.36	3.65	7.99	3.97	1.57	2.15	-5.45	-8.91
M1200	-5.62	-7.65	-8.90	-1.53	4.40	9.78	8.03	4.91	2.06	-1.89	-5.89	-5.27
H1200	-3.10	-5.47	-6.12	-3.05	-1.02	12.55	7.36	-1.93	-1.79	-0.68	-8.88	-8.83
ESRL*	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
M200	-1.63	-1.10	-1.02	-3.54	-3.71	3.18	5.00	3.66	5.04	2.34	-1.23	-1.37
H200	-2.05	2.06	-1.06	-0.48	-2.07	-5.28	2.01	13.96	16.18	6.27	-1.91	-0.56
M1200	-7.39	-10.10	-9.72	-5.94	-5.00	6.7	5.11	0.48	5.75	-1.69	-4.38	-6.63
H1200	-2.58	-2.95	-7.21	-0.06	8.20	8.54	5.63	9.92	9.86	3.16	-2.79	-4.78

Table S2: Model and INC-HYC AFT (in Sv, monthly climatology).
*Gopa = Gopalpur, Kaki = Kakinada, Cudd = Cuddalore, KK = Kanyakumari, ESRL = Eastern Sri Lanka

Gopa*	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
M200	0.238	0.371	0.386	0.241	0.016	-0.102	-0.162	-0.199	-0.131	-0.222	-0.200	-0.074
H200	0.182	0.675	0.574	0.159	-0.129	-0.318	-0.303	-0.243	-0.314	-0.241	-0.066	-0.018
M1200	0.221	0.340	0.379	0.290	0.118	-0.006	-0.067	-0.122	-0.076	-0.168	-0.170	-0.075
H1200	0.15	0.616	0.578	0.252	-0.044	-0.288	-0.299	-0.256	-0.324	-0.244	-0.041	-0.020

Kaki*	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
M200	0.033	0.219	0.088	0.136	0.202	0.039	-0.017	0.009	-0.009	-0.101	-0.165	-0.108
H200	-0.089	0.189	0.202	0.345	0.164	-0.073	-0.126	-0.059	-0.128	-0.230	-0.318	-0.257
M1200	0.003	0.189	0.095	0.146	0.213	0.064	0.008	0.022	-0.011	-0.094	-0.147	-0.121
H1200	-0.111	0.173	0.227	0.372	0.204	-0.021	-0.111	-0.065	-0.119	-0.189	-0.261	-0.254

Cudd*	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
M200	-0.040	-0.002	0.005	0.011	0.007	0.003	-0.001	-0.021	-0.041	-0.080	-0.162	-0.118
H200	-0.082	0.079	0.089	0.086	0.054	0.062	-0.017	-0.026	-0.105	-0.120	-0.229	-0.193
M1200	-0.082	0.004	0.035	0.05	0.047	0.005	-0.020	-0.048	-0.072	-0.094	-0.150	-0.150
H1200	-0.082	0.050	0.053	0.102	0.090	0.044	-0.038	-0.061	-0.113	-0.111	-0.191	-0.189

Okha	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
M200	0.056	0.049	0.047	0.069	0.138	0.132	0.017	-0.045	-0.048	-0.077	-0.101	-0.056
H200	-0.051	0.022	0.099	0.178	0.149	0.160	0.254	0.066	0.007	-0.079	-0.109	-0.051

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
M1200	0.081	0.129	0.095	0.056	0.115	0.086	-0.212	-0.266	-0.149	-0.157	-0.160	-0.055
H1200	-0.027	0.189	0.230	0.199	0.117	0.111	0.253	-0.170	-0.221	-0.189	-0.091	-0.041
Mumbai	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
M200	-0.088	-0.049	0.023	0.091	0.124	0.153	0.125	0.066	0.007	-0.046	-0.090	-0.071
H200	-0.082	-0.036	0.007	0.106	0.083	0.082	0.132	0.097	0.007	-0.026	-0.094	-0.089
M1200	-0.052	-0.011	0.044	0.046	0.088	0.170	0.097	-0.010	-0.052	-0.052	-0.068	-0.045
H1200	-0.088	-0.013	-0.056	0.050	0.029	-0.008	0.099	-0.001	-0.107	-0.077	-0.108	-0.103
Goa	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
M200	-0.052	-0.017	0.047	0.028	0.045	0.085	0.085	0.053	-0.038	-0.072	-0.075	-0.035
H200	-0.020	-0.006	0.034	0.013	0.002	0.045	0.121	0.114	0.010	-0.072	-0.101	-0.061
M1200	-0.050	-0.014	0.085	-0.002	-0.037	0.040	0.039	0.017	-0.081	-0.089	-0.072	-0.045
H1200	0.028	-0.027	0.063	-0.023	-0.059	0.068	0.124	0.040	-0.022	-0.055	-0.031	-0.025
Kollam	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
M200	0.094	0.017	0.009	0.009	-0.001	0.023	0.013	0.027	-0.035	-0.078	-0.036	0.056
H200	0.032	0.027	0.010	0.002	-0.015	-0.013	0.012	0.001	-0.021	-0.041	-0.007	0.060
M1200	0.107	0.016	-0.021	0.008	-0.024	0.037	0.016	0.031	-0.048	-0.061	-0.011	0.051
H1200	0.034	0.019	-0.007	-0.007	-0.014	-0.001	0.023	0.022	-0.006	-0.023	0.008	0.061
KK*	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
M200	-0.105	-0.032	-0.019	-0.014	-0.006	-0.014	-0.032	-0.045	-0.041	-0.004	-0.015	-0.079
H200	-0.075	-0.035	-0.036	-0.015	-0.001	-0.006	-0.026	-0.035	-0.013	-0.034	-0.035	-0.115

M1200	-0.105	-0.018	0.011	-0.037	-0.054	-0.076	-0.080	-0.068	-0.053	0.003	0.006	-0.079
H1200	-0.091	-0.026	-0.023	-0.021	-0.008	-0.062	-0.032	-0.004	-0.002	0.029	-0.021	-0.115

ESRL*	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
M200	-0.039	0.011	0.013	0.000	-0.019	-0.038	-0.044	-0.037	-0.040	-0.022	-0.098	-0.101
H200	-0.064	0.019	0.005	0.013	-0.034	-0.144	-0.068	0.004	0.057	0.023	-0.125	-0.098
M1200	-0.016	0.047	0.046	0.005	-0.008	-0.067	-0.062	-0.036	-0.066	-0.020	-0.094	-0.080
H1200	-0.060	0.040	0.032	0.014	-0.075	-0.206	-0.092	0.011	0.078	0.038	-0.118	-0.080

Table S3: Quantification of freshwater advection due to WBC and EICC from Model and INC-HYC simulation

	MAM (WBC)	JJAS (EICC)	ON (EICC)	DJF (NMC)
Model	2.096%	6.030%	4.857%	2.827%
INC-HYC	3.617%	8.390%	5.135%	2.628%