

Supplementary information for

Evidence for the brown carbon absorption over the Bay of Bengal during the southwest monsoon season: a possible oceanic source

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“Environmental Science: Process and Impacts”

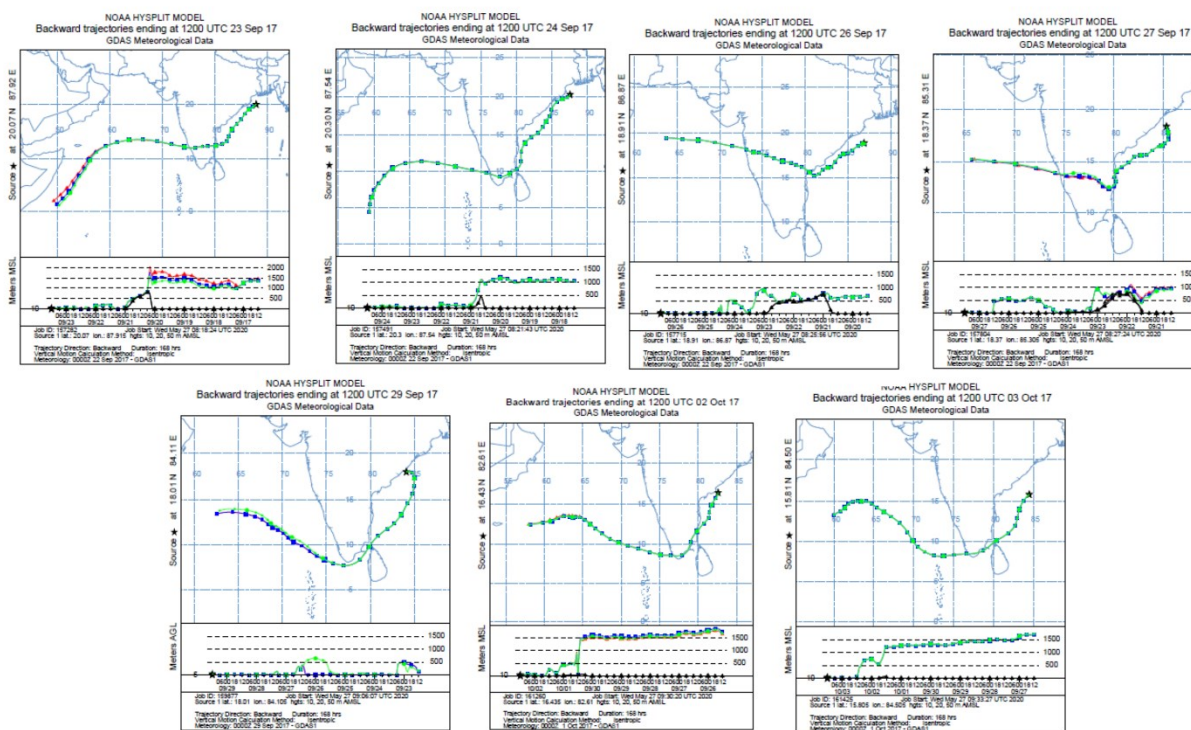


Figure S1: 7-day isentropic backward air mass trajectories over the BoB during SSK105 cruise (23 September – 3 October 2017).

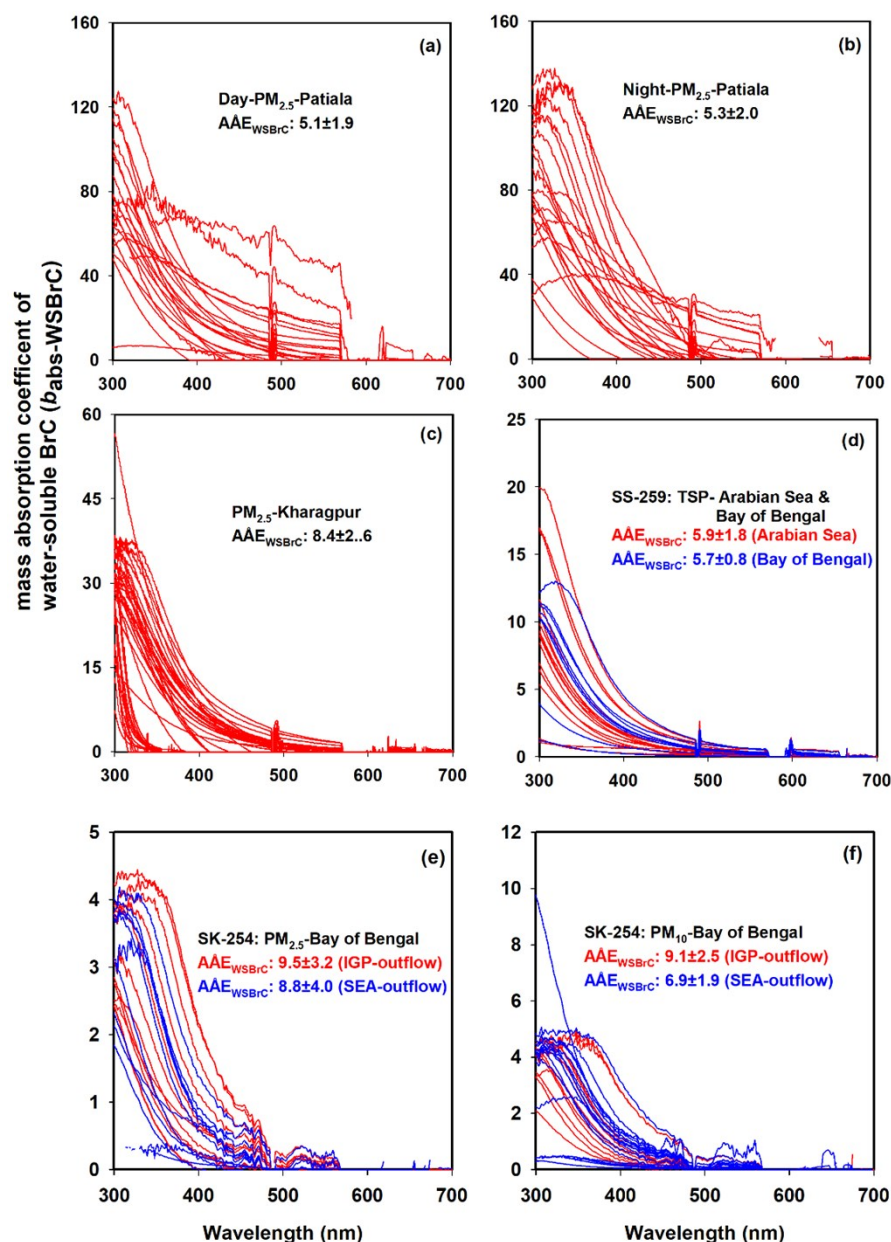


Figure S2. Typical wavelength-dependent mass absorption coefficient of water-soluble BrC ($b_{\text{abs-H}_2\text{O-BrC}}$ or $b_{\text{abs-ws-BrC}}$) in the wintertime aerosols from the Indo-Gangetic Plain (IGP) and its outflow to the Bay of Bengal, adopted from Bikkina and Sarin, ESPI, 2019¹. Here, (a-b) $b_{\text{abs-H}_2\text{O-BrC}}$ in PM_{2.5} collected over Patiala (panel. a: day time and panel. b: Night time), (c) PM_{2.5} over Kharagpur, (d) TSP over Arabian Sea and Bay of Bengal during SS-259 cruise, (e and f) PM_{2.5} and PM₁₀ over the Bay of Bengal during SK-254. In Panel d, “red” and “blue” colours indicate TSP collected over the Arabian Sea and Bay of Bengal, respectively. Here, PM_{2.5} and PM₁₀ refer to particles with an aerodynamic diameter of less than 2.5 and 10, respectively. TSP is the total suspended particulate matter.

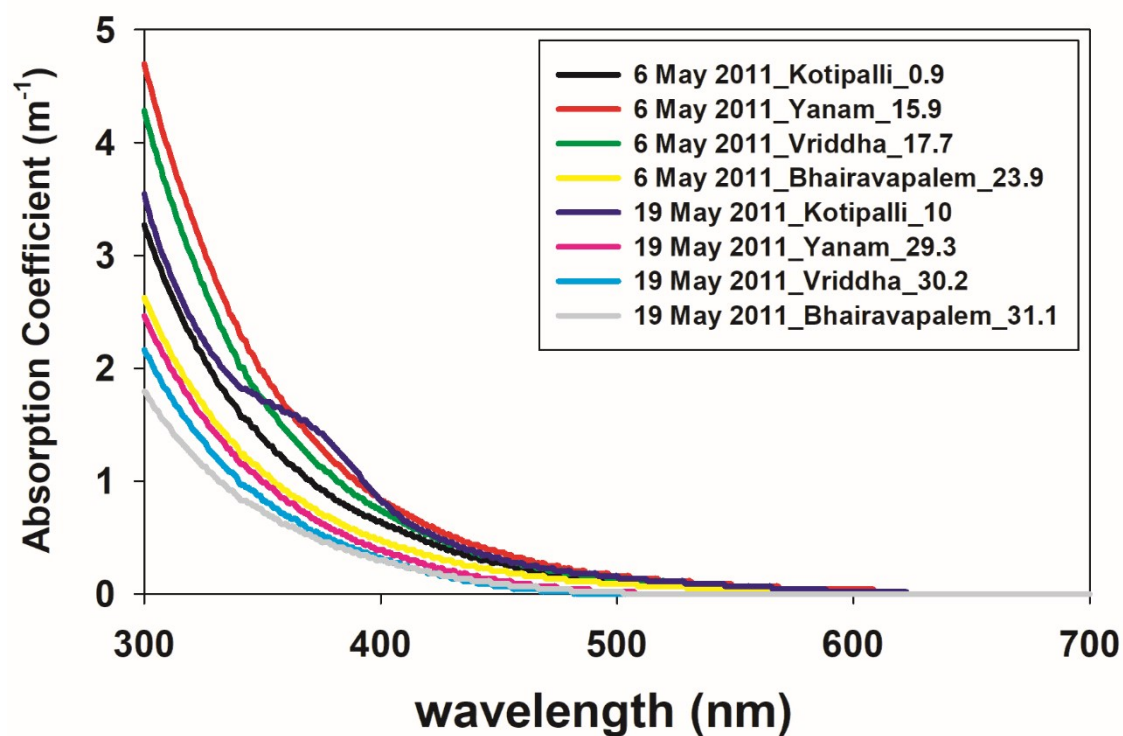


Figure S3. Absorption coefficient of colour dissolved organic matter (CDOM) measured in the surface waters collected from the Gautami-Godavari estuary draining into the Bay of Bengal during the southwest monsoon. Here, the absorption coefficient is estimated as The absorption coefficient of CDOM ($b_{\text{abs-CDOM}}$, expressed in m^{-1}) is calculated as “ $A(\lambda) \times \ln(10)/l$ ”, where $A(\lambda)$ is the absorbance at given wavelength and l is the path length of cuvette used for absorption measurement².

Table S1. Sampling details of PM₁₀ during the SSK105 cruise.

Sample codes	Start date (DD-MM-YYYY)	Start time	Starting coordinate		Stop date (DD-MM-YYYY)	Stop time	Stop coordinates		air volume (m ³)
			Lat (°N)	Lon (°E)			Lat (°N)	Lon (°E)	
23 Sept 2017	23-09-2017	6:50 AM	19.65	87.99	24-09-2017	11:00 AM	20.49	87.84	2110
24 Sept 2017	24-09-2017	1:30 PM	20.49	87.84	25-09-2017	12:00 AM	20.11	87.24	2286
25 Sept 2017	25-09-2017	12:00 AM	20.11	87.24	26-09-2017	9:30 AM	19.75	87.49	2126
26 Sept 2017	26-09-2017	12:30 PM	19.35	87.77	27-09-2017	9:30 AM	18.47	85.97	2228
27 Sept 2017	27-09-2017	1:30 PM	18.52	85.87	29-09-2017	2:00 AM	18.22	84.74	2670
29 Sept 2017	29-09-2017	9:15 AM	18.22	84.74	01-10-2017	7:50 PM	17.80	83.47	1884
2 Oct 2017	02-10-2017	12:00 PM	16.49	82.39	03-10-2017	9:00 AM	16.38	82.61	2197
3 Oct 2017	03-10-2017	1:15 PM	15.81	84.51	04-10-2017	9:00 AM	15.80	84.50	1964

Table S2. Sampling details of PM₁₀ collected over Visakhapatnam.

Sample codes	Start date (DD-MM-YYYY)	Start time	Stop date (DD-MM-YYYY)	Stop time	air volume (m ³)
16 May 2018	16-05-2018	09:59 AM	17-05-2018	10:00 AM	2391
18 May 2018	18-05-2018	09:20 AM	18-05-2018	17:25 PM	808
21 May 2018	21-05-2018	18:16 PM	22-05-2018	05:55 AM	1163
22 May 2018	22-05-2018	18:05 PM	23-05-2018	05:48 AM	1173
24 May 2018	24-05-2018	18:06 PM	25-05-2018	05:47 AM	1166
28 May 2018	28-05-2018	18:02 PM	29-05-2018	05:59 AM	1195
29 May 2018	29-05-2018	17:57 PM	30-05-2018	11:50 AM	1787
30 May 2018	30-05-2018	17:57 PM	31-05-2018	05:50 AM	1185
4 June 2018	04-06-2018	18:15 PM	05-06-2018	05:47 AM	1151

Lat: 17.72; lon: 83.22

Table S3. Monte Carlo error propagation (MCEP)-based estimates of absorption coefficient ($b_{\text{abs-H2O/MeOH-BrC-365 nm}}$), mass absorption efficiency ($\text{MAE}_{\text{H2O/MeOH-BrC-365nm}}$) and imaginary refractive index ($k_{\text{H2O/MeOH-BrC-365 nm}}$) of BrC from the water and methanol extracts of PM_{10} collected over the Bay of Bengal and Visakhapatnam.

SSK105 cruise:- Monte Carlo Error Propagation (MCEP)-based BrC absorption properties												
Sampling date	$b_{\text{abs-H2O-BrC-365 nm}}$ (Mm^{-1})		$\text{MAE}_{\text{H2O-BrC-365 nm}}$ ($\text{m}^2 \text{g}^{-1}$)		$b_{\text{abs-MeOH-BrC-365 nm}}$ (M m^{-1})		$\text{MAE}_{\text{MeOH-BrC-365 nm}}$ ($\text{m}^2 \text{g}^{-1}$)		$k_{\text{H2O-BrC-365 nm}}$		$k_{\text{MeOH-BrC-365 nm}}$	
	av.	sd.	av.	sd.	av.	sd.	av.	sd.	av.	sd.	av.	sd.
23-Sep-17	0.4	0.1	0.63	0.16					0.0258	0.0276		
24-Sep-17	0.56	0.13	0.61	0.16	0.44	0.45	0.07	0.018	0.0249	0.0266	0.0028	0.0031
25-Sep-17	0.3	0.07	0.34	0.09	0.11	0.11	0.015	0.004	0.0140	0.0149	0.0006	0.0007
26-Sep-17	0.12	0.03	0.16	0.04	0.29	0.29	0.038	0.01	0.0065	0.0070	0.0015	0.0017
27-Sep-17	0.4	0.1	0.63	0.17	0.36	0.36	0.049	0.013	0.0256	0.0275	0.0020	0.0022
29-Sep-17	0.51	0.12	0.63	0.17	0.22	0.22	0.03	0.008	0.0256	0.0275	0.0012	0.0013
02-Oct-17	0.39	0.09	0.54	0.14	0.28	0.28	0.037	0.01	0.0219	0.0234	0.0015	0.0016
03-Oct-17	0.98	0.23	1.48	0.39	0.18	0.18	0.029	0.008	0.0605	0.0648	0.0012	0.0013
Visakhapatnam:- Monte Carlo Error Propagation (MCEP)-based BrC absorption properties												
Sampling date	$b_{\text{abs-H2O-BrC-365 nm}}$ (Mm^{-1})		$\text{MAE}_{\text{H2O-BrC-365 nm}}$ ($\text{m}^2 \text{g}^{-1}$)		$b_{\text{abs-MeOH-BrC-365 nm}}$ (M m^{-1})		$\text{MAE}_{\text{MeOH-BrC-365 nm}}$ ($\text{m}^2 \text{g}^{-1}$)		$k_{\text{H2O-BrC-365 nm}}$		$k_{\text{MeOH-BrC-365 nm}}$	
	av.	sd.	av.	sd.	av.	sd.	av.	sd.	av.	sd.	av.	sd.
16-May-18	2.73	0.65	3.10	0.81	0.13	0.14	1.44	1.44	0.3098	0.0964	0.1129	0.1212
18-May-18	2.14	0.61	1.31	0.40	0.05	0.06	1.18	1.19	0.2132	0.0563	0.0087	0.0093
21-May-18	1.32	0.26	1.48	0.33	0.06	0.06	7.38	7.45	2.8826	0.5431	0.1166	0.1222
22-May-18	1.63	0.42	1.37	0.38	0.06	0.06	1.79	1.81	0.3392	0.0846	0.0137	0.0146
24-May-18	2.02	0.45	1.50	0.37	0.06	0.06	0.98	0.99	0.1742	0.0415	0.0071	0.0075
28-May-18	1.81	0.44	1.46	0.39	0.06	0.06	2.23	2.26	0.4499	0.1228	0.0182	0.0197
29-May-18	4.31	1.01	3.23	0.83	0.13	0.14	2.03	2.05	0.5777	0.1570	0.0236	0.0253
30-May-18	1.84	0.44	1.80	0.47	0.07	0.08	7.08	7.15	2.7751	0.7425	0.1133	0.1211
04-Jun-18	2.41	0.64	1.11	0.32	0.05	0.05	4.64	4.69	0.4812	0.1319	0.0196	0.0211

References

1. S. Bikkina and M. Sarin, Brown Carbon in the continental outflow to the North Indian Ocean, *Environmental Science: Processes & Impacts*, 2019, doi: 10.1039/C9EM00089E.
2. S. R. Pandi, R. Kiran, N. S. Sarma, A. S. Srikanth, V. V. S. S. Sarma, M. S. Krishna, D. Bandyopadhyay, V. R. Prasad, T. Acharyya and K. G. Reddy, Contrasting phytoplankton community structure and associated light absorption characteristics of the western Bay of Bengal, *Ocean Dynamics*, 2014, **64**, 89-101.