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Supplement of

Long-range transport of black carbon to the Pacific Ocean and its dependence on aging timescale

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Table S1. Range of plausible aging timescales (units = hours) for 13 regions (For each HIPPO campaign, we assign a range of BC aging timescales for a region if the corresponding MNAE value is no larger than that of the optimized MNAE plus a small perturbation ΔE=0.01).

		CA	**SU**	**EU**	**MA**	**EA**	**ME**	**NA**	**SE**	**IN**	**AF**	**SA**	**AU**	**RR**
HIPPO1	Jan	12–200	4–200	90–120	4–200	4–8	4–60	160–200	4–4	4–8	4–4	4–160	4–60	90–120
HIPPO2	Nov	90–200	4–200	120–160	4–200	4–4	4–60	4–24	4–8	4–8	4–90	90–200	90–160	160–200
HIPPO3	Apr	4–200	60–200	200–200	4–200	38.4–48	160–200	4–60	27.6–48	4–48	18–90	18–60	4–27.6	200–200
HIPPO4	Jun	38.4–90	4–18	120–200	4–200	4–8	4–200	4–18	4–8	4–48	4–38.4	4–120	4–8	200–200
HIPPO5	Aug	90–120	4–4	4–38.4	4–120	4–4	4–60	4–4	4–4	4–12	60–90	60–60	48–160	4–4

Table S2. Optimized aging timescales (units = hours) for 13 regions using $MNAE_o = \frac{1}{N}\sum_{nlat}\sum_{nalt}\frac{Abs(BC_m(j,k)-BC_o(j,k))}{BC_o(j,k)}$

		CA	**SU**	**EU**	**MA**	**EA**	**ME**	**NA**	**SE**	**IN**	**AF**	**SA**	**AU**	**RR**
HIPPO1	Jan	60	60	120	60	4	12	4	4	4	4	4	4	4
HIPPO2	Nov	200	90	60	4	4	4	4	4	4	4	4	4	8
HIPPO3	Apr	120	200	200	200	38	4	4	18	4	12	12	12	27
HIPPO4	Jun	18	4	200	4	4	200	4	4	4	4	4	4	4
HIPPO5	Aug	8	4	4	4	4	4	4	4	4	4	4	4	4

Table S3. Optimized aging timescales (units = hours) for 13 regions using $MNAE_a = \frac{1}{N}\sum_{nlat}\sum_{nalt}\frac{Abs(BC_m(j,k)-BC_o(j,k))}{(BC_m(j,k)+BC_o(j,k))/2}$

		CA	SU	EU	MA	EA	ME	NA	SE	IN	AF	SA	AU	RR
HIPPO1	Jan	200	200	90	200	4	200	120	4	4	18	18	18	4
HIPPO2	Nov	200	200	48	200	4	4	4	4	4	90	90	90	160
HIPPO3	Apr	200	200	200	200	38	200	4	24	60	12	12	12	200
HIPPO4	Jun	18	8	200	200	4	160	4	4	4	4	4	4	160
HIPPO5	Aug	120	4	38	4	4	4	4	4	4	90	90	90	4

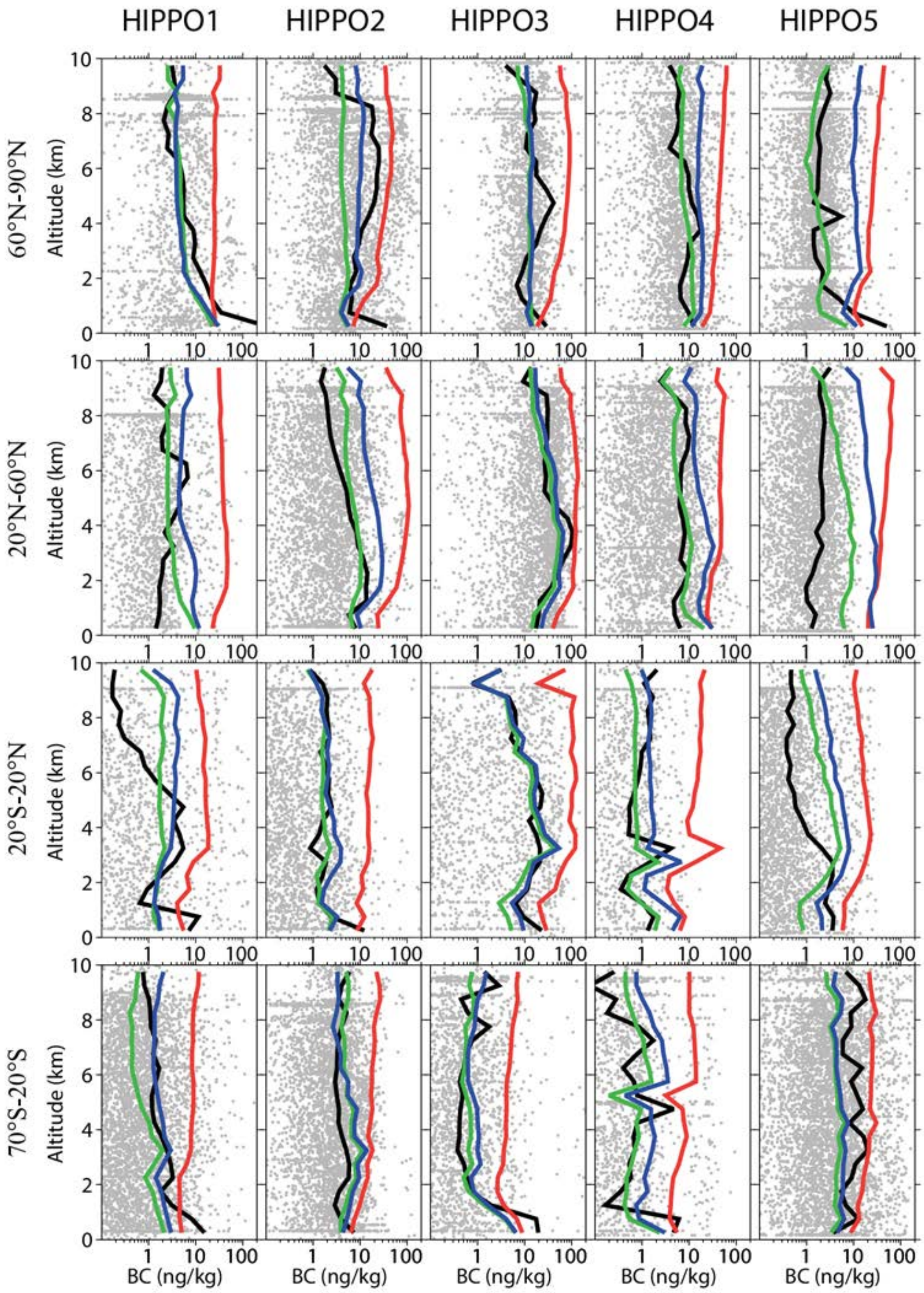

Figure S1. Vertical profiles of simulated and observed BC mass mixing ratios over 0.5 km altitude bins along the flight tracks of HIPPO 1-5 over the central Pacific Ocean (130ºW-160ºE). Data are shown separately as averaged over 70ºS-20°S, 20°S-20°N, 20°N-60°N, and 60°N-90°N. The black, red, green, and blue lines are mean values of BC mixing ratios from observations, default model, improved model with optimized region-specific aging timescale, and improved model using OH-dependent aging scheme respectively. The gray dots represent measured BC concentrations.

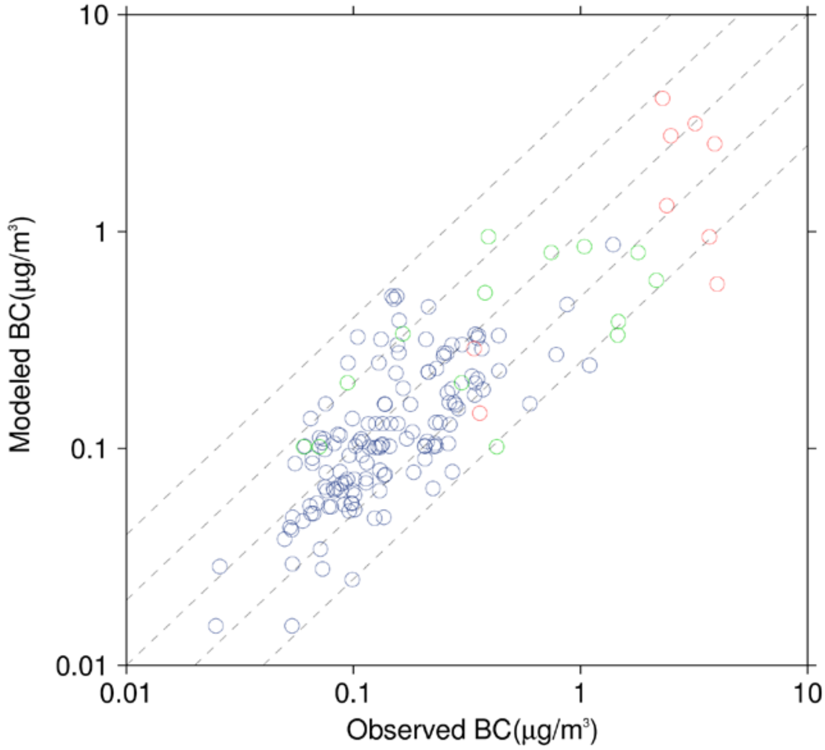

Figure S2. Modeled (employing OH-dependent aging scheme) versus observed surface annual mean concentration of BC at sites in IMPROVE (blue), EMEP (green), and China (red). Dash lines are 1 : 4, 1 : 2, 1 : 1, 2 : 1, and 4 : 1 ratio lines. BC observations in China are attained from Zhang et al. (2008).

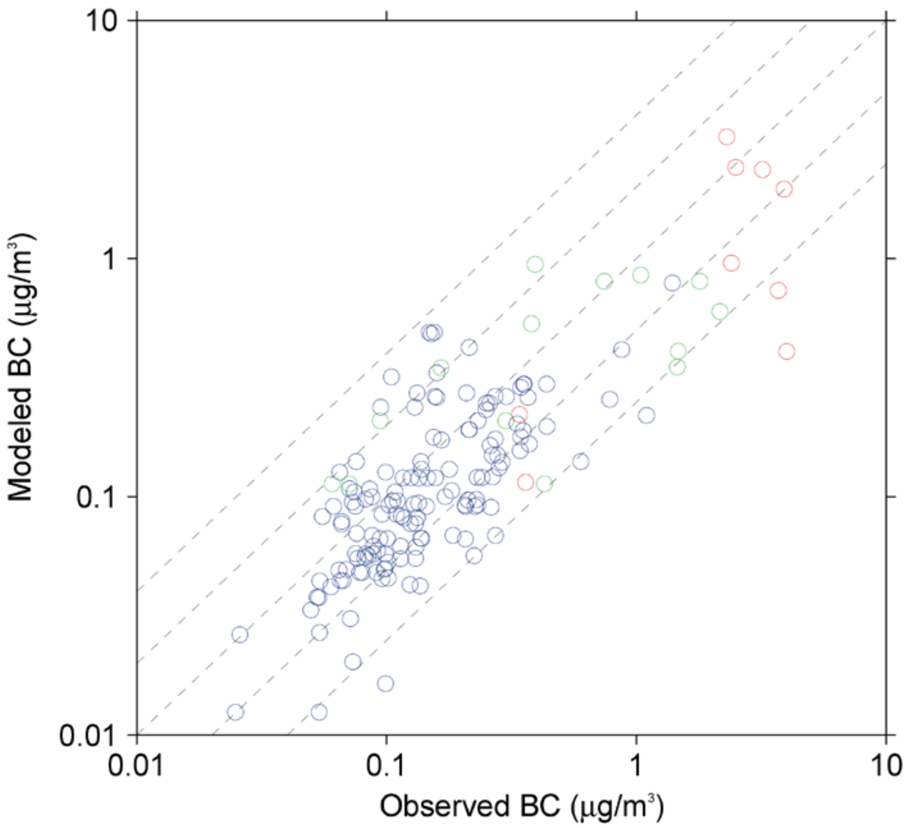

Figure S3. Modeled (employing optimized aging timescales) versus observed surface annual mean concentration of BC at sites in IMPROVE (blue), EMEP (green), and China (red). Dash lines are 1 : 4, 1 : 2, 1 : 1, 2 : 1, and 4 : 1 ratio lines. BC observations in China are attained from Zhang et al. (2008).

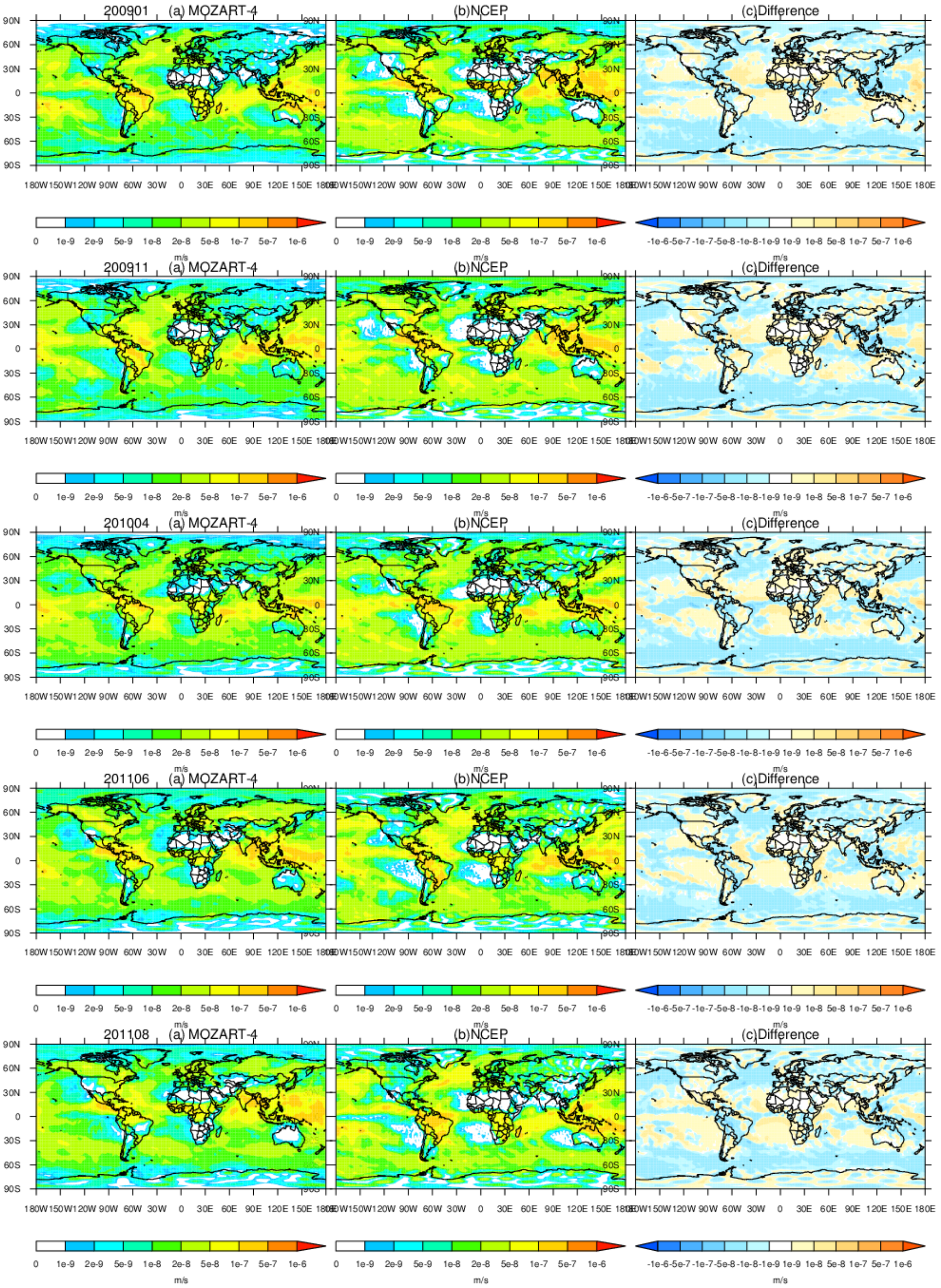

Figure S4. Average precipitation of MOZART-4 model, NCEP reanalysis meteorology, and their difference (MOZART-4 minus NCEP) during HIPPO I (January, 2009), HIPPO II (November, 2009), HIPPO III (April, 2010), HIPPO IV (June, 2011), and HIPPO V (August, 2011).

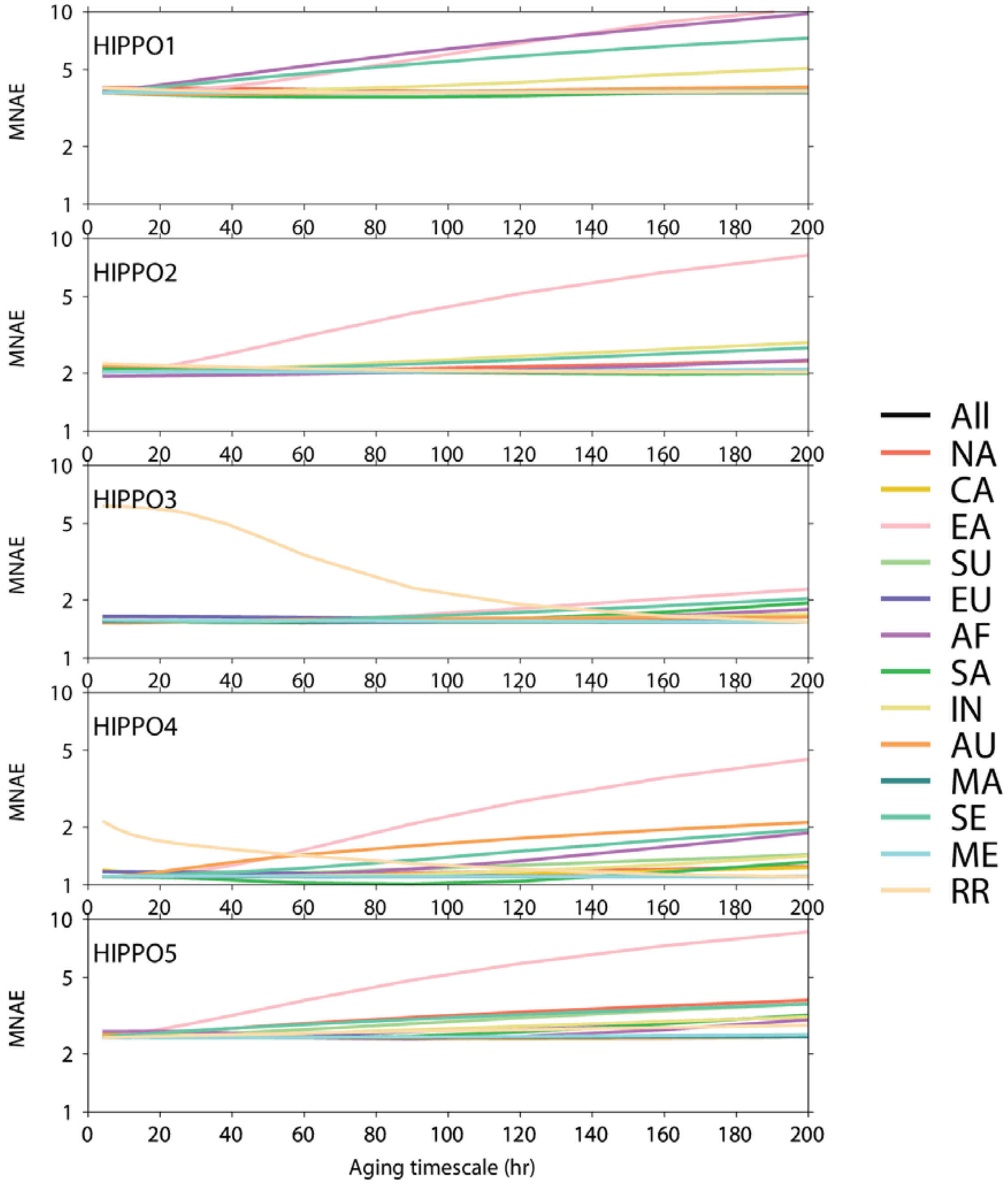

Figure S5. For HIPPO 1-5, mean normalized absolute error (MNAE) as a function of varying aging timescale for each region while keeping the aging timescale of other regions as optimized.

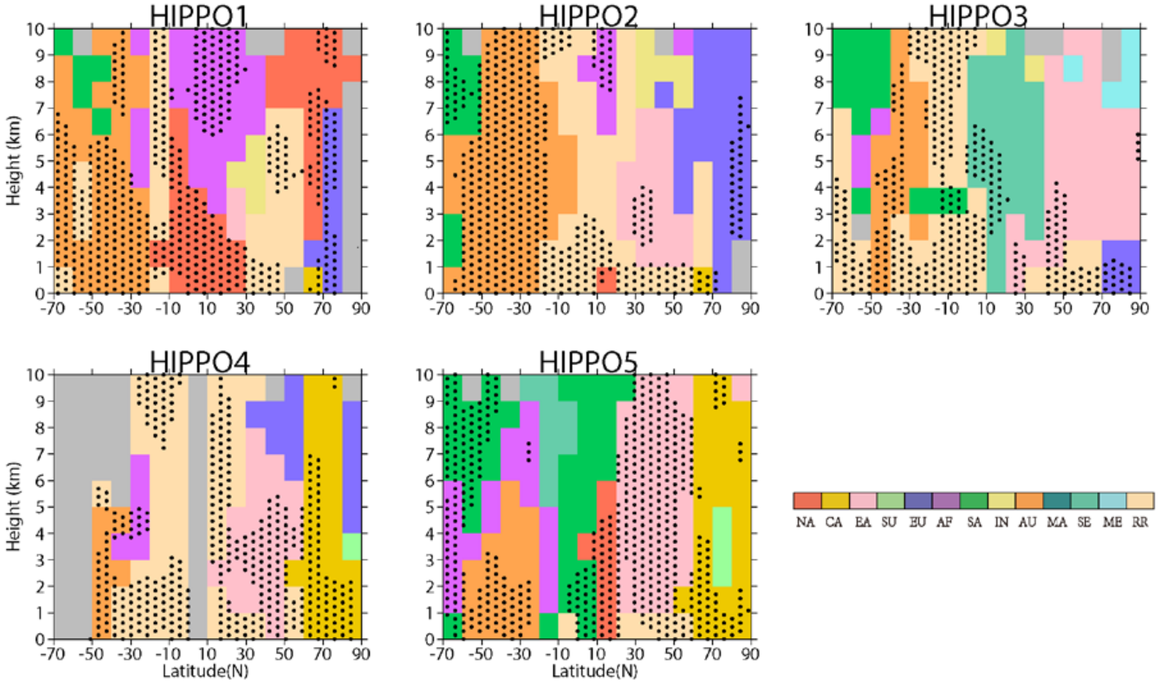

Figure S6. The most significant regional contributors to BC mass mixing ratios along the trajectories of five HIPPO campaigns, averaged over 1 km altitude and 10° latitude bins. Dotted areas represent where the most significant contributor accounts for more than 50% of the total BC mixing ratio.

References

Zhang, X. Y., Wang, Y. Q., Zhang, X. C., Guo, W., and Gong, S. L.: Carbonaceous aerosol composition over various regions of China during 2006, Journal of Geophysical Research-Atmospheres, 113, Artn D14111 Doi 10.1029/2007jd009525, 2008.