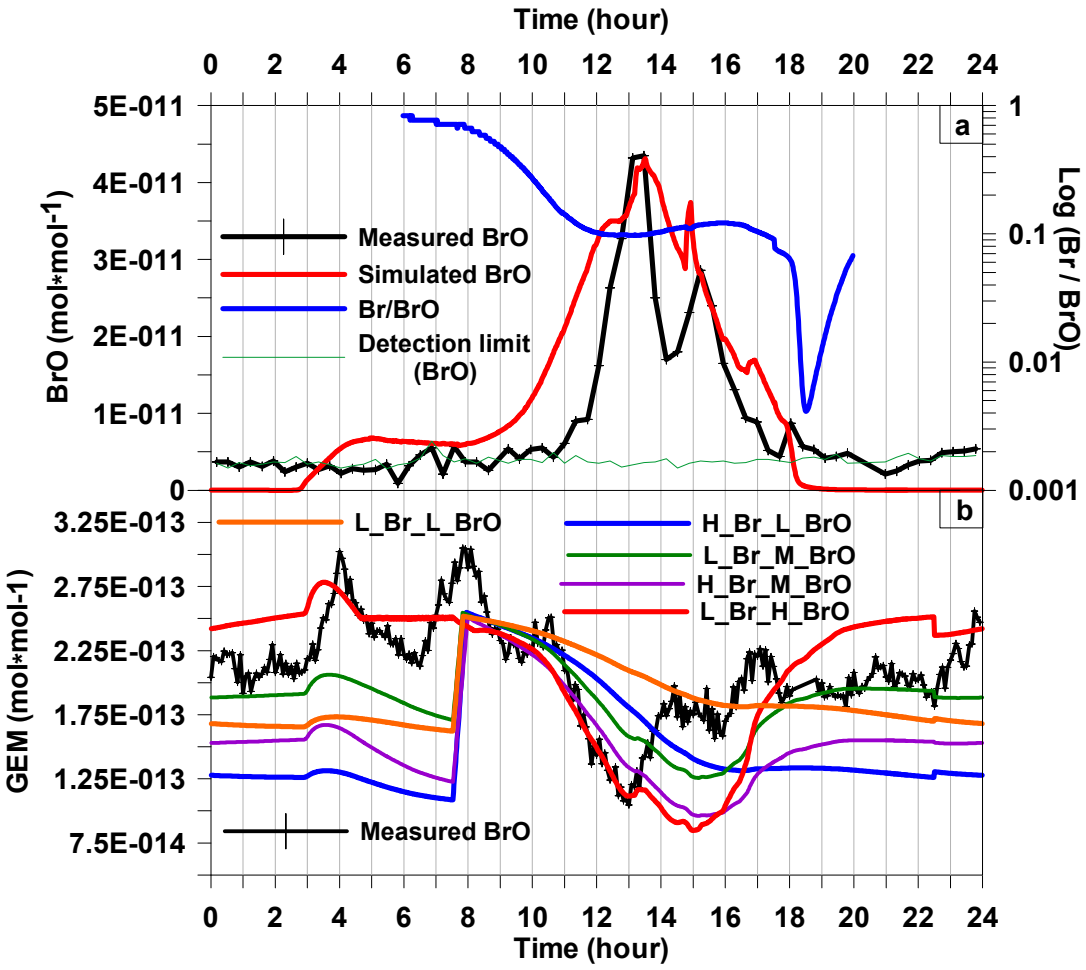
Supplementary Information



Supplementary Figure 1. Simulated vs. measured diurnal profiles of GEM and BrO. (a) Measured and simulated diurnal profiles of BrO as well as simulated diurnal profile of [Br]/[BrO] for Julian day 197. (b) Different combinations of values for $k_{\_Hg+BrO}$ and $k_{\_Hg+Br}$ were used to evaluate the simulated GEM diurnal profiles (Sect. 2.3).

Reaction		k [$cm^3 molecule^{-1} s^{-1}$] or s^{-1}	Reference
G1	$Hg+O_3 \rightarrow HgO+O_2$	$8.43E-17 \times \exp(-1407K/T)$	A
G2	$Hg+OH \rightarrow HgO+H$	$3.55E-14 \times \exp(294K/T)$	A
G3	$Hg+NO_3 \rightarrow HgO+NO_2$	$4.0E-15$	B
G4	$Hg + Br \rightarrow HgBr$	$2.7E-13$	C
G5	$HgBr \rightarrow Hg + Br$	$1.2 \times E10 \times \exp(-8357/T)\ s^{-1}$	D
G6	$HgBr + BrO \rightarrow BrHgOBr$	$3.0E-12$	E
G7	$Hg + BrO \rightarrow HgO + Br$	$1.5E-13$	F
G8	$Hg+H_2O_2 \rightarrow HgO+H_2O$	$8.5E-19$	G
G9	$Hg + H_2O_2 \rightarrow Hg(OH)_2$	$6.1E-19$	H
G10	$Hg + Br_2 \rightarrow HgBr_2$	$9.0E-17$	I
G11	$HgBr \rightarrow Hg + Br$	$6.09E-4$	F
G23	$HgBr + Br \rightarrow HgBr_2$	$3.0E-12$	J
G13	$HgBr+Cl \rightarrow ClHgBr$	$3.0E-12$	*
G14	$HgCl+Br \rightarrow ClHgBr$	$3.0E-12$	*
G15	$Hg + HCl \rightarrow \rightarrow HgCl_2$	$1.0E-19$	K
G16	$Hg + Cl \rightarrow HgCl$	$1.0E-11$	I
G17	$Hg + Cl_2 \rightarrow HgCl_2$	$2.6E-18$	I
G18	$Hg + ClO \rightarrow HgOCl$	$1.9E-14$	L
G19	$Hg + I_2 \rightarrow HgI2$	1.27E-19	M
G20	$Hg + I \rightarrow HgI$	$4.0E-13 \times (T/298K)^{-2.38}$	D

Supplementary Table 1. Gas phase reactions. A. Pal and Ariya (2004); B. Sommar et al. (1997); C. Donohoue et al. (2006); D. Goodsite et al. (2004); E. Shon et al. (2005); F. Raofie and Ariya (2003); G. Tokos et al. (1998); H. Xie et al. (2008); I. Ariya et al. (2002); J. Hedgecock et al. (2005); J. Calvert and Lindberg (2003). K. Hall and Bloom (1993) .L. Byun et al. (2010); M. Raofie et al. (2008).

* Since the kinetics of these reactions have is not known, we have used the value k(HgBr+Br) as assumed by Calvert and Lindberg (2003)(see Xie et al., 2008).

Reaction No.		K ($M^{-1}s^{-1}$) / s^{-1}	Reference
A1	$Hg+O_3 \rightarrow HgO+O_2$	$4.7E7$	A
A2	$HgO+H^+ \rightarrow Hg^{2+}+OH^-$	$1.0E10$	B
A3	$Hg+OH \rightarrow Hg^{+}+OH^-$	$2.0E9$	C
A4	$Hg^{+}+OH \rightarrow Hg^{++}+OH^-$	$1.0E10$	C
A5	$Hg^{2+}+HO_2 \rightarrow Hg^{+}+O_2+H^+$	$1.1E4$	D
A6	$Hg^{+}+HO_2 \rightarrow Hg+O_2+H^+$	$1.0E10$	E
A7	$Hg+HOCl \rightarrow Hg^{2+}+Cl^-+OH^-$	$2.09E6$	F
A8	$Hg+ClO^- +H^+ \rightarrow Hg^{2+}+Cl^-+OH^-$	$1.99E6$	F
A9	$Hg+HOBr^- \rightarrow Hg_2^{+}+Br^-+OH^-$	0.279	G
A10	$Hg^{++}+O_2^- \rightarrow Hg^{+}+O_2$	$1.1E4$	D
A11	$Hg+Br_2 \rightarrow Hg^{2+}+2Br^-$	0.196	G
A12	$HgSO_3+H2O \rightarrow Hg+HSO_4^- +H^+$	0.0106	H
A13	$Hg(OH)_2 \xrightarrow{h\nu} Hg+2\ OH$	$3E-7\ s^{-1}$	I

Supplementary Table 2. Aqueous phase reactions. A. Munthe (1992); B. Pleijel and Munthe (1995); C. Lin and Pehkonen (1997); D. Pehkonen and Lin (1997); E. Xie et al. (2008); F. Lin and Pehkonen (1999); G. Wang and Pehkonen (2004); H. van Loon et al. (2000); I. Xiao et al. (1994).

Reaction		K [M^{-1}]	Reference
EQ1	$Hg(II)+OH^- \leftrightarrow Hg(OH)^+$	3.9*E*10	A
EQ2	$Hg(OH)^+ + OH^- \leftrightarrow Hg(OH)2$	1.6*E*11	A
EQ3	$Hg^{2+} + SO_3^{2-} \leftrightarrow HgSO_3$	2.1*E*13	B
EQ4	$HgSO_3 + SO_3^{2-} \leftrightarrow Hg(SO_3)2^{2-}$	1.0*E*10	B
EQ5	$Hg(OH)^+ + Cl^- \leftrightarrow HgOHCl$	2.7*E*7	A
EQ6	$Hg(II)+Cl^- \leftrightarrow HgCl^+$	2.0*E*7	C
EQ7	$HgCl^+ + Cl^- \leftrightarrow HgCl_2$	2.5*E*6	A
EQ8	$HgCl_2 + Cl^- \leftrightarrow HgCl_3^-$	6.7*E*0	D
EQ9	$HgCl_3 - + Cl^- \leftrightarrow HgCl4_2^-$	1.3*E*1	D
EQ10	$Hg(II)+Br^- \leftrightarrow HgBr^+$	1.1*E*9	D
EQ11	$HgBr^+ + Br^- \leftrightarrow HgBr_2$	2.5*E*8	D
EQ12	$HgBr_2 + Br^- \leftrightarrow HgBr_3^-$	1.5*E*2	D
EQ13	$HgBr_3^- + Br^- \leftrightarrow HgBr_4^{2-}$	2.3*E*1	D

Supplementary Table 3. Aqueous-phase equilibria. A. Pleijel and Munthe (1995); B. van Loon et al. (2001); C. Smith and Martell (1976); D. Clever et al. (1985).

Reference		K_H[M/atm]	Reference
H1	$Hg \rightarrow Hg_{(aq)}$	$3.2E-1$	A
H2	$HgO_{(g)} \rightarrow HgO_{(aq)}$	$2.69E12$	B
H3	$HgCl_2 \rightarrow$ HgCl2(aq)	$2.75E6$	C
H4	$HgBr_2 \rightarrow HgBr_2(aq)$	$2.75E6$	D
H5	$Hg(OH)_2 \rightarrow Hg(OH)_{2(aq)}$	$1.2E4$	E
H6	$(CH3)_2Hg \rightarrow (CH_3)_2Hg_{(aq)}$	$1.3E-1$	E
H7	$CH_3HgCl \rightarrow CH_3HgCl_{(aq)}$	$2.2E3$	E
H8	$CH_3HgOH \rightarrow CH_3HgOH_{(aq)}$	$1.5E5$	F
H9	$BrHGOBr \rightarrow BrHgOBr_{(aq)}$	$2.75E6$	G

Supplementary Table 4. Heterogeneous Reactions. A. Schroeder et al. (1991); B. Schroeder and Munthe (1998); C. Hedgecock et al. (2005); D. Hedgecock and Pirrone. (2004); E. Seigneur (1994); F. Petersen (1998). G. K_H assumed to be as $HgCl_2$ (Xie et al., 2008).