Supplementary Material for:

Preservation of terrestrial organic carbon in marine sediments offshore Taiwan: Mountain building and atmospheric carbon dioxide sequestration

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1 Mixing or organic carbon loss control on the variables

The linear relationship between $\Delta^{14}C_{org}$ and $\delta^{13}C_{org}$ (see Fig. 4a, P<0.0001) in marine sediments receiving fluvial sediments away from submarine canyons and direct hyperpycnal inputs (Okinawa Trough, Taiwan Strait, Gaoping Shelf) may be the result of mixing two end members with distinct isotopic compositions (see main text for discussion). The trend is consistent with mixture of the mean of the riverine particulate OC input (itself a mixture of non-fossil OC, $OC_{non\text{-}fossil}$, and fossil OC, OC_{fossil}) with marine OC (OC_{marine}). However, it may also result from preferential loss of terrestrial OC (or OC_{marine}), with the resulting composition moving toward that of OC_{marine} (or terrestrial OC). To distinguish between these hypotheses, we can use the C_{org}, as loss of OC will result in a lowering of C_{org} which is distinct from mixing (see Section 4.2 in the main text for a full discussion of the outputs).

1.1 End member mixing model

We define a binary mixing model resulting from terrestrial and marine end members (e.g. Komada et al., 2004; Leithold et al., 2006; Clark et al., 2013):

$$\delta_x = f_t \cdot \delta_t + f_m \cdot \delta_m \qquad \textbf{Equation S1}$$

$$\Delta_x = f_t \cdot \Delta_t + f_m \cdot \Delta_m \qquad \textbf{Equation S2}$$

$$f_t + f_m = 1 \qquad \textbf{Equation S3}$$

where δ_x and Δ_x are the measured stable isotopes and radiocarbon compositions (‰), respectively, and the equivalent for marine (*m*) and terrestrial (*t*) end members. f_t and f_m are the mass fractions of OC derived from each source, respectively, whose sum is 1 by definition of a binary mixture. The C_{org} for a sample (C_x, %) is then derived from the relative mass fraction of sediment contributed by terrestrial matter (RF_t) and marine matter (RF_m), with their corresponding C_{org} of C_t (%) and C_m (%), respectively:

$$C_x = \frac{RF_t}{(RF_t + RF_m)} \cdot C_t + \frac{RF_m}{(RF_t + RF_m)} \cdot C_m \qquad \textbf{Equation S4}$$

where:

$$RF_t = \frac{f_t}{C_t/100}$$ **Equation S5**

Equations S1-S5 can be used to model the predicted elemental and isotopic composition (C_x, δ_x and Δ_x) of a binary mixture of terrestrial OC and OC_{marine}.

For illustrative purposes we can define the δ_t, Δ_t and C_t of terrestrial OC using the linear trends through the data (Fig. 4a and 5a). These values (Table S5) are within the range permitted by the standard deviation on the mean riverine OC composition (see Fig. 4 and 5). It is important to note that we do not seek to quantify f_t and f_m, and instead seek to examine whether mixing or terrestrial OC loss is producing the trends in the data. The absolute values which are output from the mixing analysis of the marine sediments (Fig. 4) are therefore not used in any further analysis. The results are plotted on Figures 4b and 5b.

1.2 Terrestrial organic carbon loss

We model how the elemental and isotopic composition of OC in marine sediment may evolve due to instantaneous loss of terrestrial OC. Instantaneous loss is considered because progressive loss through time should alter the $\Delta^{14}C_{org}$ due to aging and result in a non-linear relationship between $\Delta^{14}C_{org}$ and $\delta^{13}C_{org}$ values, whereas the data show a linear trend (Fig. 4). To model OC loss, we consider the initial mass of carbon present in the sediment, m_o (g), comprised of terrestrial OC with a carbon mass, m_t, and OC_{marine} with a carbon mass, m_m:

$$m_o = m_m + m_t$$ **Equation S6**

Terrestrial OC loss is represented by loss percentage (L, %) so that the modified mass of carbon following loss, m_x:

$$m_x = m_m + m_t(1 - L/100)$$ **Equation S7**

The modification in C_x, δ_x and Δ_x can then be calculated for a unit of sediment mass using the Equations S1-S5.

To examine selective loss of terrestrial non-fossil OC from the sediments, we can modify the above equations (S1-S7) to define a three component system where m_t is comprised of non-fossil OC (m_{nf}) and fossil OC (m_f). This allows us to assess the impact of pervasive terrestrial OC loss (using m_t) and selective terrestrial OC loss (only m_{nf}). For consistency, we model these trends using the end member compositions used with the mixing model. The loss from a sample with and initial $f_t = 0.8$ is shown for illustrative purposes in Figures 4b and 5b. The values of C_{nf}, C_f, δ_{nf}, δ_f, Δ_{nf}, and Δ_f (of the non-fossil and fossil terrestrial end-members) are selected based on the terrestrial mixing domain (Fig. 2a) and published data (Kao and Liu, 2000; Hilton et al., 2010) (Table S5). Again, these values are for illustrative purposes and their range can be altered within the known bounds with no impact on the conclusions of the mixing and modeled loss analysis. Only the values of Δ_{nf}, and Δ_f which are well constrained in Taiwan and relatively invariant (Hilton et al., 2008) are used in a quantitative analysis (see Section 4.1 of the main text).

Table S1: Radiocarbon and stable isotopic composition ($\Delta^{14}C_{org}$ and $\delta^{13}C_{org}$) of fluvial sediments from Taiwan in order of which they were collected. Water discharge (Q_w), suspended sediment concentration (SSC) and OC concentration (C_{org}, %) are provided.

River	**Latitude**	**Longitude**	**Q_w (m^3 s^{-1})**	**SSC (g L^{-1})**	**C_{org} (%)**	**$\delta^{13}C_{org}$ (‰)**	**$\Delta^{14}C_{org}$ (‰)**	**Lab Code**
Suspended sediments collected during Typhoon Tim (1994), eastern flank								
Langyang	24.715	121.772	1195	7.7	0.68	–25.1	–802	NZA-4392
			2550	24.5	0.71	–25.4	–714	NZA-10292
			453	11.4	0.58	–25.0	–434	NZA-5055
			1560	6.7	0.62	–25.3	–297	NZA-5051
			444	9.8	0.58	–25.6	–241	NZA-5056
			642	5.3	0.58	–25.7	–227	NZA-5053
			59	0.4	1.03	–26.1	55	NZA-5048
			64	0.4	1.08	–25.6	–	–
			112	0.7	0.92	–25.4	–	–
			938	5.6	0.66	–25.1	–	–
			526	12.8	0.58	–25.0	–	–
Suspended sediments collected during Typhoon Doug (1994), western flank								
Jhuoshuei	23.810	120.469		6.5	0.66	–24.5	–760	NZA-10315

Zengwun	23.108	120.205		12.9	0.49	–24.9	–622	NZA-10302
Wu	24.154	120.522		3.9	0.68	–24.7	–441	NZA-10317
Fonshan	24.851	121.015		0.5	0.67	–25.3	–407	NZA-10290
Gaoping	22.770	120.454		3.6	0.58	–25.4	–9	NZA-10316
Daan	24.366	120.664		4.3	0.58	–25.1	–	–
Dahan	24.958	121.536		3.2	0.62	–25.5	–	–
Toucian	24.760	121.075		1.4	0.44	–25.9	–	–
Suspended sediments collected in the Jhuoshuei watershed during Typhoon Mindulle (2004), western flank								
J16r	23.785	120.636	3200	199.0	0.23	–26.6	–808	OS-70920
J18r	23.785	120.636	2520	87.9	0.25	–25.4	–674	OS-71071
J26r	23.785	120.636	6390	11.6	0.45	–25.6	–487	OS-71072
C16	23.772	120.652	639	133.9	0.30	–26.2	–697	OS-70921
C18	23.772	120.652	970	134.2	0.25	–26.7	–872	OS-71094
C26	23.772	120.652	1292	132.3	0.20	–26.4	–879	OS-70922
R003	23.784	120.885	313	62.8	0.63	–26.2	–849	OS-71073
R010	23.784	120.885	976	41.4	0.37	–26.0	–869	OS-71074
R025	23.784	120.885	2655	36.6	0.32	–25.6	–756	OS-71095

S004	23.695	120.852	43	0.8	0.32	–24.3	–747	OS-71096
S010	23.695	120.852	61	67.5	0.29	–24.4	–759	OS-70914
S019	23.695	120.852	247	83.6	0.35	–25.1	–338	OS-71131
Suspended sediments collected during Typhoon Mindulle & Aere (2004), eastern flank								
Liwu	24.179	121.492	37	2.5	0.41	–23.0	–593	SUERC-15280
			126	13.1	0.27	–21.8	–897	SUERC-13675
			403	64.2	0.38	–23.2	–572	SUERC-13678
			195	24.4	0.34	–23.7	–917	SUERC-13679
			173	17.6	0.39	–24.1	–926	SUERC-15281
			44	7.7	0.42	–24.4	–948	SUERC-13680
			35	5.8	0.37	–24.3	–956	SUERC-13681
			87	30.6	0.16	–22.5	–826	SUERC-13682
			72	17.7	0.28	–23.2	–872	SUERC-13683
Suspended sediments collected during Typhoon Morakot (2009), eastern flank								
Liwu	24.156	121.622		59.5	0.17	–24.1	–604	OS-76535
					0.12	–	–698	OS-76536

	83.6	0.19	–23.8	–644	OS-76537
	65.1	0.15	–24.0	–746	OS-76538
	43.6	0.13	–24.0	–698	OS-76539
	53.0	0.20	–23.5	–729	OS-76540
	34.3	0.20	–23.9	–888	OS-76541
	39.6	0.30	–24.7	–861	OS-76409
	30.3	0.30	–24.7	–914	OS-76410

Table S2: Average composition of fluvial OC in rivers draining the eastern and western flanks of Taiwan (Table S1) and the average input assuming approximately equal input of sediment from both sides of the mountain range (Dadson et al., 2003; Kao and Milliman, 2008).

	n	**C_{org} (%)**	**S.D.**	**$\delta^{13}C_{org}$ (‰)**	**S.D.**	**$\Delta^{14}C_{org}$ (‰)**	**S.D.**
Average West	20	0.43	0.16	–25.5	0.7	–646	237
Average East	28	0.45	0.27	–24.4	1.1	–677	271
Average	48	0.44	0.22	–24.9	0.9	–661	254

Table S3: Radiocarbon and stable isotopic composition ($\Delta^{14}C_{org}$ and $\delta^{13}C_{org}$) of marine sediments, Gaoping Canyon.

Station	**Depth (m)**	**Latitude**	**Longitude**	**Year**	$\mathbf{C_{org}}$ **(%)**	$\mathbf{\delta^{13}C_{org}}$ **(‰)**	$\mathbf{\Delta^{14}C_{org}}$ **(‰)**	**Lab code**
T7-KP-b-13-14	Trap	22.354	120.274	2008	0.65	–24.5	–558	NZA37397
T7-KP-3	Trap	22.354	120.274	2008	0.55	–25.5	–551	OS-76305
T7-KP-5	Trap	22.354	120.274	2008	0.42	–25.3	–624	OS-76306
T7-KP-10	Trap	22.354	120.274	2008	0.40	–24.8	–643	OS-76307
T7-KP-14	Trap	22.354	120.274	2008	0.33	–25.6	–630	OS-76308
T7-KP-22	Trap	22.354	120.274	2008	0.41	–25.7	–605	OS-76309
T7-KP-31	Trap	22.354	120.274	2008	0.35	–25.7	–612	OS-76478
T7-KP-32	Trap	22.354	120.274	2008	1.58	–25.8	–112	OS-76479
T7KP-33	Trap	22.354	120.274	2008	0.43	–25.5	–548	OS-76480
T7-KP-43	Trap	22.354	120.274	2008	0.20	–25.7	–870	OS-76481
T7-KP-49	Trap	22.354	120.274	2008	0.37	–25.3	–758	OS-76534
T7-KP-50	Trap	22.354	120.274	2008	0.56	–24.6	–622	OS-76408
K1-0	Surface	22.458	120.415	2009	0.70	–24.6	–794	UCIT22740
K1-19	0.19	22.458	120.415	2009	0.54	–24.1	–753	UCIT22741
K1-41	0.41	22.458	120.415	2009	1.33	–25.9	–644	UCIT22742

Table S4: Radiocarbon and stable isotopic composition ($\Delta^{14}C_{org}$ and $\delta^{13}C_{org}$) of marine sediments collected from the Okinawa Trough (OT), Taiwan Strait (TS) and Gaoping Shelf (GP).

Core	**Site**	**Depth (m)**	**Foram age (ka)**	**Latitude**	**Longitude**	**Year**	**C_{org} (%)**	**$\delta^{13}C_{org}$ (‰)**	**$\Delta^{14}C_{org}$ (‰)**	**Lab code**
NE441w	OT	surface	–	24.707	121.912	1995	0.52	–23.4	–711	OS-70886
431y	OT	surface	–	24.576	121.932	1995	0.49	–24.1	–703	OS-70887
5021	OT	surface	–	25.004	122.352	1995	0.56	–23.5	–682	OS-70889
5123	OT	surface	–	25.369	122.364	1995	0.68	–22.1	–586	OS-70890
MD012403[a]	OT	0.26-0.27	0.0	25.283	123.160	2001	0.72	–22.6	–543	NZA25459
MD012403[a]	OT	2.41-2.42	3.0	25.283	123.160	2001	0.68	–22.5	–632	NZA25404
MD012403[a]	OT	4.91-4.92	6.6	25.283	123.160	2001	0.55	–22.6	–602	NZA25405
MD012403[a]	OT	9.51-9.52	10.4	25.283	123.160	2001	0.74	–22.9	–434	NZA25406
T5/3-11	OT-trap	trap	–	25.108	122.501	1994	0.90	–21.8	–268	OS-70919
T5/4-7	OT-trap	trap	–	25.108	122.501	1994	1.33	–21.4	–256	OS-70915
T5/4-8	OT-trap	trap	–	25.108	122.501	1994	1.04	–21.8	–338	OS-70916
T5/4-11	OT-trap	trap	–	25.108	122.501	1994	0.85	–22.3	–423	OS-70917
T5/4-12	OT-trap	trap	–	25.108	122.501	1994	0.87	–22.0	–423	OS-70918

TS-12	TS	surface	–	23.999	119.500	2006	0.35	–23.7	–552	OS-71097
TS-21	TS	surface	–	25.000	120.666	2006	0.71	–22.8	–379	OS-71100
KP-3B	GP	surface	–	22.337	120.085	2009	0.70	–23.0	–622	OS-76300
KP-6B	GP	surface	–	22.330	120.167	2009	0.58	–23.1	–651	OS-76301
KP-05-B	GP	surface	–	22.417	120.252	2009	0.47	–23.3	–669	OS-76302
KP-B-9	GP	surface	–	22.082	119.916	2009	0.90	–23.0	–501	OS-76303
KP-5A	GP	surface	–	22.374	120.207	2009	0.49	–23.3	–676	OS-76304
L9-5	GP	0.05	–	22.184	120.361	2009	0.73	–23.8	–555	UCIT22747
L9-25	GP	0.25	–	22.184	120.361	2009	0.73	–23.0	–544	UCIT22748
L9-30	GP	0.3	–	22.184	120.361	2009	0.92	–23.9	–734	UCIT22749
K11A-0	GP	surface	–	22.253	120.176	2009	0.69	-23.3	-637	UCIT22743
K11A-5	GP	0.05	–	22.253	120.176	2009	0.53	-22.9	-708	UCIT22744
K11A-30	GP	0.30	–	22.253	120.176	2009	0.63	-22.5	-655	UCIT22745

[a]IMAGES core where $\Delta^{14}C_{org}$ was estimated at time of deposition using co-deposited foraminifera (*Globigerinoides ruber*, *Globigerinoides sacculifer*, *Globigerinoides conglobatus*, *Globigerina ququilateralis* and *Orbulina universa*) ^{14}C-ages (Kao et al., 2008)

Table S5: Compositions used in the mixing and terrestrial OC loss models

	$\Delta^{14}C_{org}$ (‰)	$\delta^{13}C_{org}$ (‰)	C_{org} (%)
OC_{marine}	–59[a]	–19.5	30
River OC	–753[b]	–24.2[b]	0.48[b]
River OC_{fossil}	-1000	-23.5[b]	-
River $OC_{non\text{-}fossil}$	0	-26.0[b]	-

[a]from open marine surface trap samples (Hsu et al., 2006)

[b]indicative values used to examine the nature of trends in the data (Fig. 4b and 5b) informed by the measured compositions (Fig. 2a, 4a and 5a).