Supporting Information

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SI Methods

Field Experiment Methods

Open-Top Chamber Design. The chamber design was modified from previous open-top chamber designs (1). The base was an octagonal frame made of aluminum angle stock inserted 10 cm into the ground. Mounted on the base was a hollow octagonal manifold (cross section: 30 cm high × 10 cm wide) consisting of an aluminum frame and transparent acrylic walls. The purpose of the manifold was to distribute air equally to the 8 sides of the chamber. Two hundred 1-cm diameter holes were drilled on the inside of the manifold so that air would flow equally from each side of the octagon. Ambient air was forced into the manifold with a blower mounted on a stand about 1.5 m above the marsh surface to avoid high tides. The blowers were placed at least 6 m away from each chamber and oriented to avoid shading the study area (Fig. S2). A 20-cm diameter duct carried air from the blower to the chamber manifold. On top of the manifold sat an octagonal prism (120 cm high) built from 2.5-cm PVC pipe. These PVC frames were placed into welded supports on the aluminum manifold to create an octagonal-prism chamber 1.5 m tall, 2 m in diameter, and with 1-m sides. Removable rectangular panels were made from aluminum, covered with IR-transparent film (Aclar 22A; Honeywell), and attached to the PVC frame with custom-fitted PVC snaps.

CO_2 Delivery and Sampling. CO_2 was delivered to each of the 10 elevated CO_2 chambers at a rate of $\approx$6 L min^{-1} to achieve a target concentration of 720 ppm. Each CO_2 delivery line was controlled with metered valves and fed into the intake chimney on the blower for each respective elevated chamber. Infusing the CO_2 upstream of the blower ensured sufficient mixing before air entered the chamber manifold.

Two sample lines continuously delivered air from each chamber: one line sampled manifold air, and the other sampled the chamber atmosphere. Gas flow from each of the 40 lines entered a separate solenoid valve (model 3V1; Sizto Tech Corporation) that could either direct the flow into a gas analyzer or exhaust it into the atmosphere. The system was programmed so that only 1 chamber at a time was being measured, with samples from the remaining chambers going to exhaust. The solenoids for 1 manifold line and 1 chamber line from a single chamber were activated simultaneously, feeding samples to a pair of IR gas analyzers. Each chamber was sampled at least once every 40 min.

We used the [CO_2] of the manifold line to monitor the amount of CO_2 delivered to each manifold. The chamber air sampling line was used to monitor the chamber atmosphere and to fine-tune the delivery rate to achieve our target concentration (ambient + 340 ppm). Average daily mean CO_2 during daylight hours in 2006 was 395 and 669 ppm in ambient and elevated chambers, respectively. Values improved to 394 and 707 ppm in 2007, which is a treatment difference of 313 ppm. SE among chambers was 1.2 and 6.0 ppm for ambient and elevated treatments, respectively. The SD among daily means for individual chambers averaged 21.9 and 59.0 ppm for individual ambient and elevated chambers, respectively.

Above-ground Biomass and Root Productivity. We estimated above-ground biomass by a combination of allometry and harvest subplots (2). At the end of July, 8 quadrats that were each 30 × 30 cm were placed in prescribed locations in each plot, 6 inside the chamber and 2 in an adjacent unchambered control plot. In the quadrats, each *S. americanus* stem was counted and nondestructively measured for total height, green height, and width at half-height. In the corner of each quadrat, we clipped and removed all vegetation and litter in a 5 × 5 cm area. Vegetation was sorted according to species. We measured the clipped *S. americanus* stems for total height and width. Clippings were dried for 72 h at 60 °C and weighed. To estimate total *S. americanus* mass, we developed an allometric relation using height and width to estimate dry mass of individual stems [$\text{mass} = (\text{height} \times \text{width} \times 0.0028) - 0.14, r^2 > 0.9$]. To estimate *S. patens* and *D. spicata* mass, we scaled up from mass in the clipped areas to total chamber area. To capture late-season growth, we repeated the above measurements using 4 quadrats in each chamber in October.

Three soil cores (30 cm in depth × 5 cm in diameter) were taken from a prescribed location in each plot. Cylindrical ingrowth bags were constructed (30 cm in height × 5 cm in diameter) from 1-cm pore-size mesh and filled with milled moistened peat to achieve the bulk density of in situ peat, 0.12 g cm^{-3}. Bags were implanted in winter and removed in November the following year. Contents were washed over a 1-mm sieve. Larger organic fragments were picked out by hand. Root mass was separated into fine (<2 mm in diameter) and coarse (>2 mm in diameter) categories, dried for 72 h at 60 °C, and weighed. Results of plant biomass and productivity measurements are given in Table 1.

Elevation Measurements. Measurements of soil elevation at each plot were made with a SET (3) (Fig. S1 and Fig. S2) modified to accommodate plot dimensions. Outside each experimental chamber, a posthole was dug roughly 15 cm in diameter and 20 cm deep. A 30-cm segment of PVC pipe (15 cm in diameter) was placed into the hole. In the center of the PVC pipe, a series of attachable stainless steel rods was driven with an electric hammer through the entire profile of organic matter (4–5 m) until the point of refusal (6–7 m); at that point, the PVC pipe was anchored in a mineral deposit underlying the marsh. Concrete was poured into the PVC pipe, securing the top of the SET rod.

To isolate the influence of root zone processes on elevation, we implanted "shallow benchmarks" to a depth of 30 cm. The vertical movement of these benchmarks results from processes that occur below a depth of 30 cm. The benchmarks were made of aluminum pipe (5 cm in diameter × 40 cm long). Several 1-cm diameter holes were drilled into the sides of the lower 10 cm of the pipes so that roots would grow through and anchor the benchmarks in place. Six benchmarks were implanted to a depth of 30 cm under the path of the SET arm in each chamber, 3 inside the chamber and 3 outside. After placement, solid caps were placed on the top of the pipes. All these perturbations as well as boardwalks to service each plot were completed in the summer of 2005, at least 9 months before the beginning of the experiment.

At intervals ranging from 1 to 3 months, a modified horizontal aluminum SET arm (4 m long compared with <0.5 m long for the original rod SET design) was attached to the top of the SET rod, leveled precisely, and affixed to an aluminum support post at the other end. The arm provided a horizontal reference of known elevation across the soil surface; changes in the distance from this reference surface to the soil surface are a sensitive measure of changes in soil elevation. Fiberglass pins (0.5 cm in diameter), all exactly 91.0 cm in length, were placed through precision-drilled holes in the SET arm at 4-cm increments. In each chamber, ≈40 individual measurements were made, and in each adjacent unchambered reference plot, 40 individual measurements were made. Each pin was carefully lowered to the soil surface and gently placed so that no litter or live plant material lay between the pin and the soil surface. The height from the SET arm to the top of each pin was measured to the nearest millimeter, providing a measurement of change in total elevation.

Changes in total elevation were partitioned into either the root zone (top 30 cm of soil) or the deep zone (below 30 cm of soil). To measure changes in the thickness of the deep zone, we lowered 2–4 pins to the surface of each of the 6 shallow benchmarks (3 inside and 3 outside each chamber) and measured height in the same manner. Elevation measurements were performed by the same person to minimize sampling error. We calculated the change in elevation resulting from processes occurring in the root zone, ΔE_R, from the 2 measured variables following the equation $\Delta E_R = \Delta E_T - \Delta E_D$, where ΔE_T represents the change in total elevation and ΔE_D represents elevation change attributable to change in thickness of the deep zone. Surface accretion was measured using feldspar marker horizons in each plot (4). Because roots that grew above soil accumulated above the marker horizon, this surface horizon was not functionally distinct from the root zone. Therefore, surface accretion was not mathematically separated from root zone dynamics in the present study.

Changes in total soil elevation were strongly related to innate spatial and temporal variability in deep zone dynamics. Specifically, the thickness of the deep zone changed directly in response to mean monthly sea level through time, and distance from the bank predicted the amplitude of that oscillation. To isolate treatment effects on soil elevation, we accounted for variation by referencing within-chamber SET measurements to SET measurements in the adjacent unchambered plots. Individual linear trends were estimated for individual plots. All treatment comparisons, including those of plant response, were made using two-way ANOVA ($CO_2 \times N$, $n = 5$).

1. Drake BG, Leadley PW, Arp WJ, Nassiry D, Curtis PS (1989) An open top chamber for field studies of elevated atmospheric CO_2 concentration on saltmarsh vegetation. *Funct Ecol* 3:363–371.
2. Erickson JE, Megonigal JP, Peresta G, Drake BG (2007) Salinity and sea level mediate elevated CO_2 effects on C-3-C-4 plant interactions and tissue nitrogen in a Chesapeake Bay tidal wetland. *Global Change Biol* 13:202–215.
3. Cahoon DR, et al. (2002) High-precision measurements of wetland sediment elevation: II. The rod surface elevation table. *Journal of Sedimentary Research* 72:734–739.
4. Cahoon DR, Reed DJ, Day JW (1995) Estimating shallow subsidence in microtidal salt marshes of the southeastern United States—Kaye and Barghoorn revisited. *Mar Geol* 128:1–9.

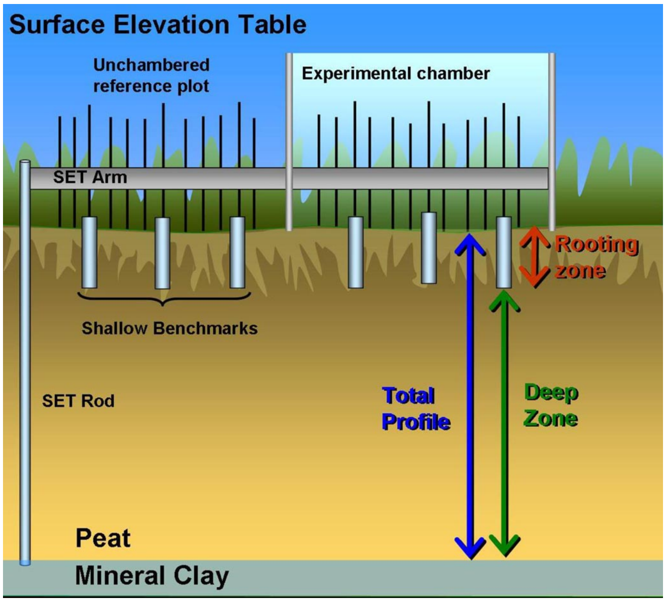

Fig. S1. A schematic of the SET in the field experiment (not drawn to scale).

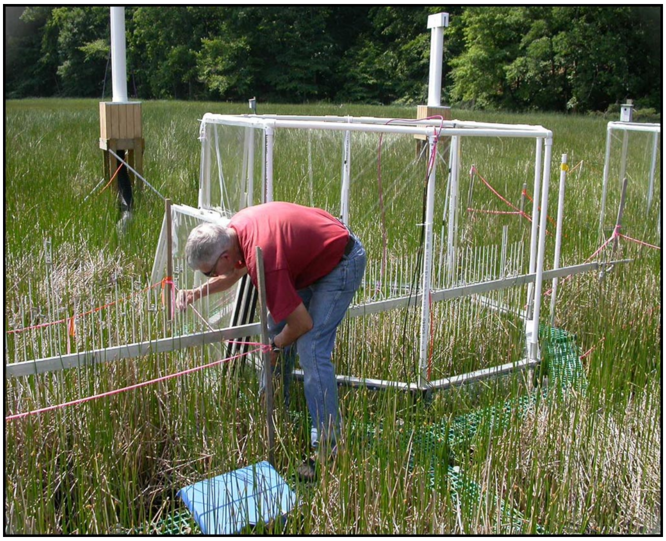

Fig. S2. SET measurements on an experimental chamber and the adjacent reference plot. Note that the blower shown in the background is located ≈6 m from the plot. (Photograph by M. Sigrist.)