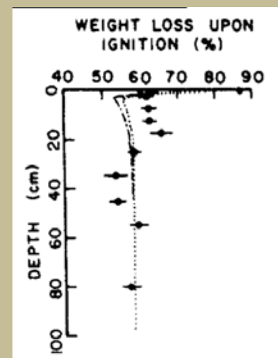
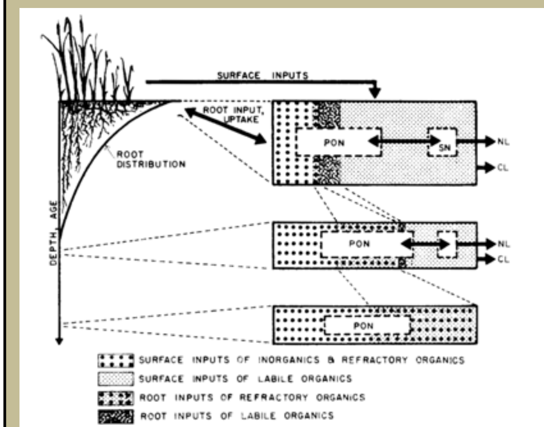
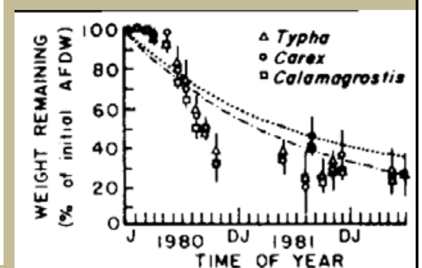
From Morris and Bowden 1986:

A model that follows 'cohorts' of sediment inputs through time.







Chen and Twilley, 1999. Biogeochemistry 44:93-118.

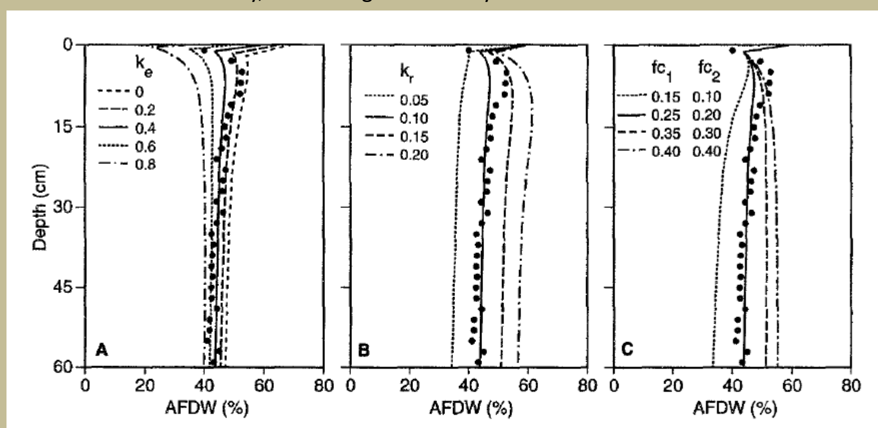
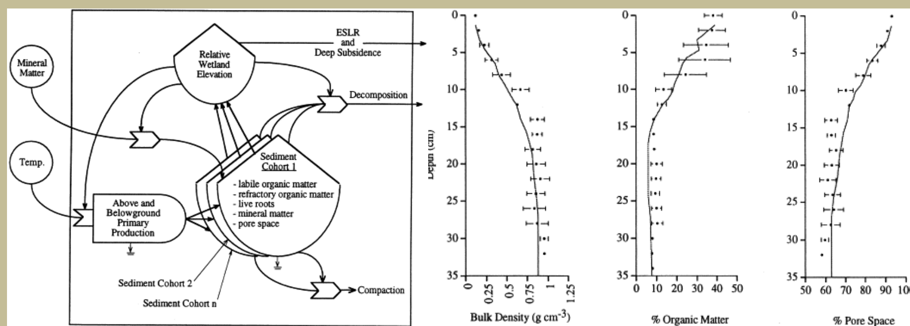


Figure 2. Sensitivity analysis of model input parameters. Dots represent the observed results. A) Litter export (k_e); B) Fine root turnover rate (k_r); C) Fraction of organic matter which is in refractory organic matter in fine roots (fc_1) and main roots (fc_2). Parameters $k_e = 0.4$, $k_r = 0.10$, $fc_1 = 0.25$ and $fc_2 = 0.2$ were set if they were not tested parameters.

Rybczyk, Callaway, and Day. 1998. Ecological Modelling. 112: 23-44.



***Spartina* stems trap sediment.**
The amount of sediment trapped is proportional to the biomass density (B) of plants and the depth (D) of the marsh surface below MHW.

142 cm NAVD88 @ 141 days

111 cm NAVD88 @141 days

Sedimentation rate is proportional to the length of time that the surface is inundated (*D/T*), the concentration of suspended sediment (*m*) times the depth, and the settling velocity (*q*):

$$dS/dt \propto mqD^2/T$$

22 cm NAVD88 @ 43 days

The Third Leg: The Plant Response to Relative Elevation

Plum Island

South Carolina

Bioassay in Miss. R. delta

The 2002 Marsh Equilibrium Model – An early Picasso

Inorganic + organic

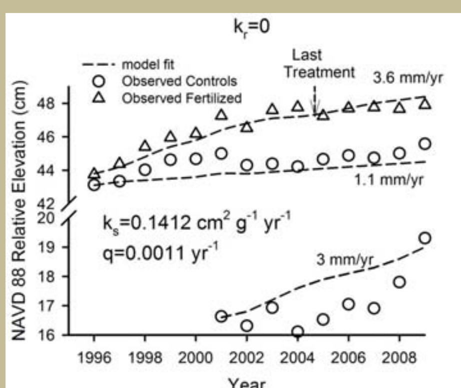
Accretion rate: $$\frac{dZ}{dt} = (q + k_s B_s)D$$

Aboveground biomass: $$B_s = aD + bD^2 + c$$

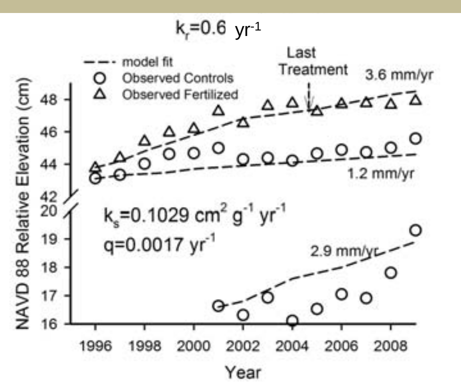
After substituting and dividing by sediment bulk density, the change in surface elevation may be computed as: $dZ/dt = D(c\ ks + a\ D\ ks + b\ D^2\ ks + q)$

In equilibrium, $\partial Z / \partial t = r$ (r = rate of SLR)

Original Model



With explicit organic matter accretion



D = depth below MHW (cm)
B_s = standing biomass (g/cm^2)
k_s = trapping coefficient (cm^2 g^{-1} yr^{-1})
q = settling velocity (yr^{-1})
k_r = preserved fraction of biomass (cm^3 g^{-1} yr^{-1})

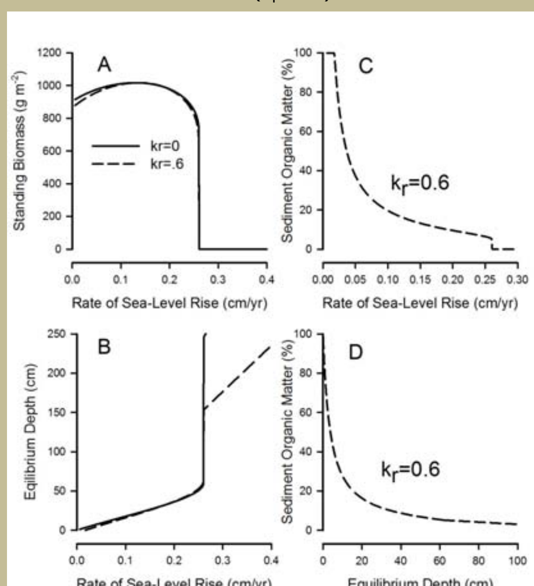
$$\frac{dZ}{dt} = D(k_s B_s + q) + k_r B_s$$

North Inlet Data

Time Span	Accretion Rate (cm/yr)
1996-1999	0.52
1997-2000	0.46
1998-2001	0.30
1999-2002	-0.06
2000-2003	-0.16
2001-2004	-0.23
2002-2005	0.09
2003-2006	0.19
2004-2007	0.18
2005-2008	0.09
2006-2009	0.11
all data	0.12

Accretion rate was negative in 3 of 11 periods. Hence, there was a 27% chance of calling the wrong trend. The range of accretion rates was -0.23 to 0.52 cm/yr. MODELS CAN HELP RESOLVE THE CONFUSION.

Equilibrium Solutions: Original model (k_r=0) and with explicit organic matter accumulation (k_r=0.6)



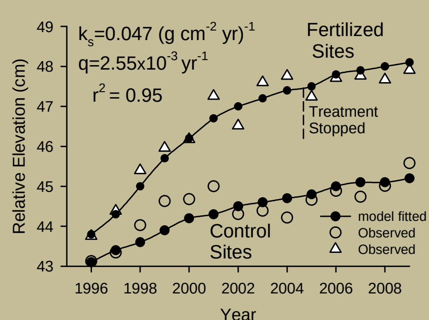
MEM II – A Matisse

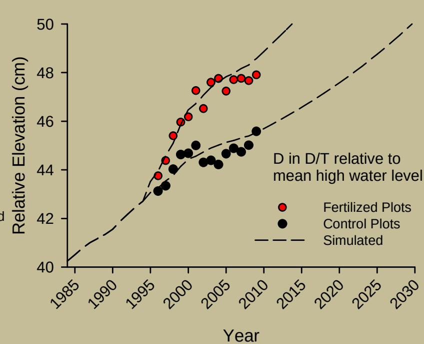
Now the concentration of suspended sediment (*m*) and tide range (*T*) are included. The time that a site is inundated is proportional to its depth below MHW (*D*) divided by the tide range (*T*).

$$\frac{dS}{dt} = \frac{D^2 m(\mathrm{B_s k_s} + q)}{T} + \mathrm{k_r B_s}$$

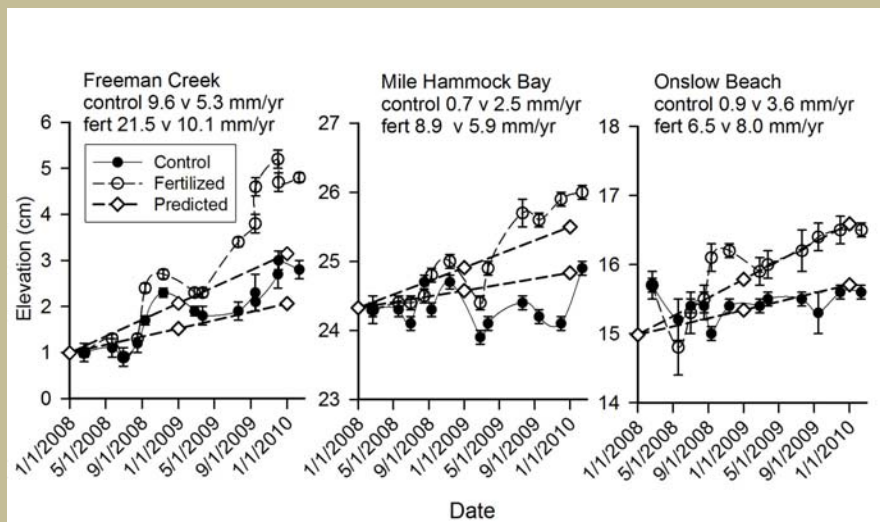
dS/dt is the rate of accumulation of sediment. The change in elevation (*dZ/dt*) is obtained by dividing *dS/dt* by sediment bulk density (sediment weight/sediment volume):

$$\frac{dZ}{dt} = \frac{(\mathrm{B_s} D^2 \mathrm{k_s} m + D^2 mq + \mathrm{B_s k_r} T)^2}{T(D^2 mq\alpha + \mathrm{B_s}(D\mathrm{k_s} m\alpha + \mathrm{k_r} T(\alpha - \beta)))}$$





Camp Lejeune, NC Results, with m=7 mg/l



From Mudd et al. 2009: **The numerical model expands upon the analytical model by including belowground processes such as compaction and root growth, and by explicitly tracking the evolution of aboveground biomass and its effect on sedimentation rates.** 210Pb accretion rates are generally determined by the slope of the relationship between the logarithm of the 210Pb activity and depth . Thus, organic decay affects the accretion rate as estimated by 210Pb not only by enriching the concentration of 210Pb in a given layer, as described by Appleby and Oldfield (1992), but also by influencing a layer's depth below the surface as a function of its age. The decay of carbon, through both of the above mechanisms, leads to overestimation of the accretion rate when using 210Pb and 137Cs.

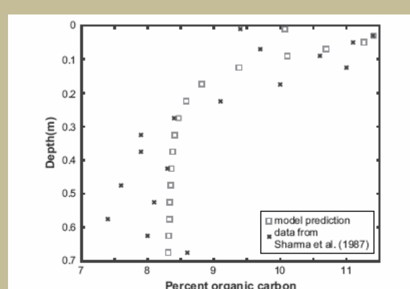


Fig. 5. Best-fit prediction of % organic matter as a function of depth (grey squares) using the OIMAS-N model plotted with data collected by Sharma et al. (1987) at Bread and Butter Creek, North Inlet, SC (black crosses). The *RMSE* of the organic carbon % is 0.68.

'Fast' , 'slow' and refractory pools of organic matter are accounted for in the OIMAS-A model. The total mass supply rate per unit area at which organic material is added to the marsh (Rorg) is:
Rorg = Rref + Rlsl + Rlfa;