Development of Sediment Classes—Informing Number of End Members

A careful balance between detail and imposed computational load were considered when evaluating the endmember results. Output (as Scree Plots) from the endmember unmixing analysis demonstrated that as the number of endmembers increased from *two* to *seven* that the overall R^2 goodness of fit metrics improved (Figure S1). To ensure that additional computational load did not hinder the purpose of this study (i.e., seabed complexity such that model failed to run in a reasonable block of time), we evaluated the Scree Plots (goodness-of-fit) to determine the lowest number of endmembers that would explain at least 90% of the data set variance (R^2). Based on these constraints, we chose four endmembers to represent the whole of our data in this study (see Fig. S.1). Inclusion of additional endmembers (five to seven endmembers) did increase the accuracy and precision of the resulting fits (i.e., R^2 improved by approximately 1.5 % per endmember), but with minimal improvement compared to jump from three to four endmembers (i.e., R^2 increased by 6.1%).
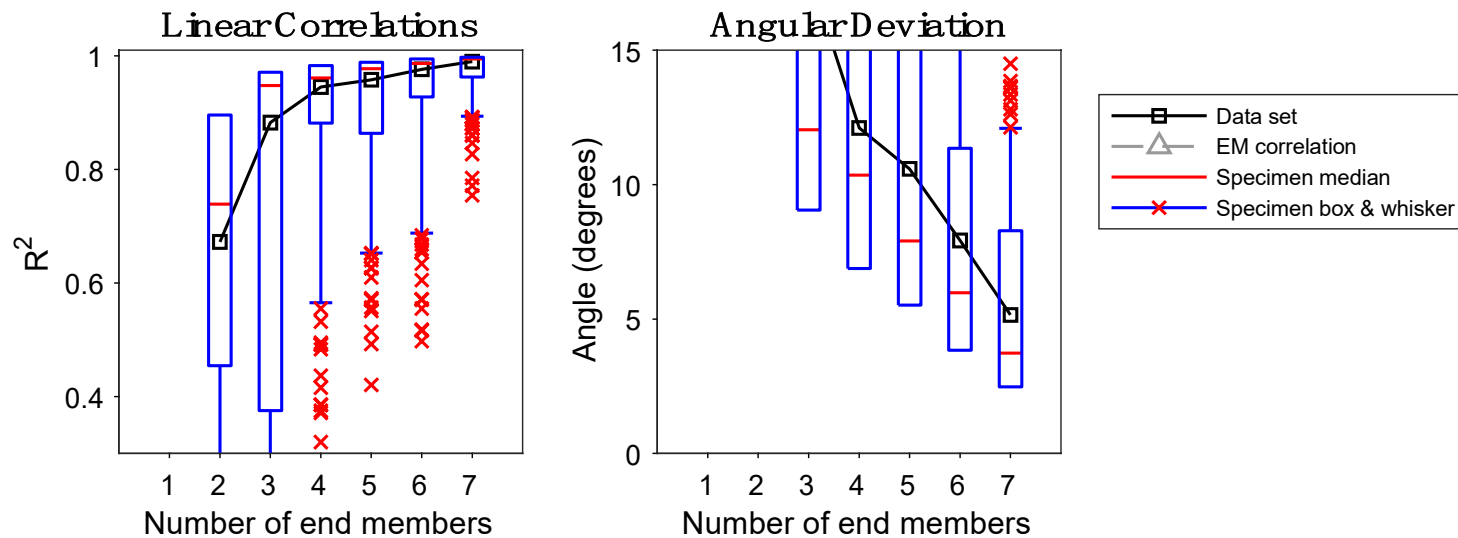

Figure S1. Scree-plot from AnalySize unmixing algorithm providing statistical goodness-of-fit metrics (R2 and angular deviation) for mixtures of between *two* to *seven* endmembers used to characterize all 240 samples.

Fluxes through a series of output cross-sections—Deterministic P-J Model

Time-series sediment fluxes are output at a series of model output transects. Delft3D directly outputs time series instantaneous sediment fluxes and time series cumulative sediment fluxes (CSF) through any number of user-defined and grid-following output transects for each sediment class, both as bed-load and suspended-load fluxes. CSF values are a simple running sum of the instantaneous flux time series. The final values of CSF, which is referred to as CSF_{final}, are output for each sediment class individually as well as for the combined bed-load (CSF_{final}^{bed}) (excluding the 6um sediment class; bed-load transport is not calculated for mud classes), combined suspended-load ($CSF_{final}^{susp.}$), the combined suspended load of just sand classes (CSF_{final}^{sand}), and finally the sum of CSF_{final}^{bed} and $CSF_{final}^{susp.}$, referred to as CSF_{final}^{total} which is the total sediment flux irrespective of type through a given transect over the course of a simulation in meters cubed (m^3).

Table S1, below, provides values of CSF_{final} produced by the P-J model during one-month deterministic simulations for each sensitivity configuration (Benchmark, Single-Layer Four Class (SL4C), and Under-Layer Four Class (UL4C)). The sensitivity configurations applied in the deterministic P-J runs are identical to those used in the decadal-scale P-J sensitivity cases.

Pelican South, (PI), *Dauphin East*, (DE), and *Dauphin West* (DW) all give CSF_{final}^{total} on the order of roughly 150 m³ to 200 m³ with 1% to 10% of the total flux due to bed-load fluxes. *Pelican North* (PN) is the least active cross-section, with CSF_{final}^{total} 13.7 m³ southward, and is the only cross-section in case A where suspended-load and bed-load fluxes are in opposing directions, with bed-load fluxes making up 25% of the total signal, relative to a minimal suspended-load flux of 19.1 m^3. PI. DE, and DW are significantly less active, in terms of sediment flux, than *Main Pass* (MP) or *Pelican Offshore* (PO) across all sensitivity cases.

EM1 is introduced in SL4C and for each cross-section where EM1 is available as a significant percentage of the total sediment layer (i.e., PN, PS, DE, and DW), CSF_{final}^{total} and $CSF_{final}^{susp.}$ are dominated by EM1. Magnitudes of CSF_{final}^{total} at each of the four cross sections PN, PS, DE, and DW increased by several orders of magnitude when the highly-mobile, fine-silt, EM1 was introduced, and indicate, by a change in sign, a direction of flux opposite that of the Benchmark case. The same behavior of EM1 is present at transects PN, PS, DE, and DW in UL4C, with suspended fluxes of EM1 increasing relative to SL4C by roughly 30% to 40% on average and as much as 51% through DE.

Fluxes of EM2, which is present in all cases, are reduced in both case SL4C and UL4C relative to the Benchmark. There is a sensitivity as well to the additional sand fractions, with suspended and bedload fluxes for all sand fractions being less mobile in the sensitivity cases than EM2 alone is in the Benchmark. As was the case for EM1 across UL4C, sediments fluxes of EM2, EM3, and EM4 are increased relative to case SL4C.

Table S1. Cumulative sediment flux values in meters-cubed (m^3) through six observational output cross-sections as output during a one-month deterministic P-J model simulation of each model case (Benchmark, Single-Layer Four Class (SL4C), and Under-Layer Four Class (UL4C)).

		total	susp	bed.	susp. (sand)	susp. 6um	susp. 200um	susp. 350um	susp. 570um	bed. 200um	bed. 350um	bed. 570um
Main Pass	Benchmark	-23626	-21028	-2598	-21028	-	-21028	-	-	-2598	-	-
	SL4C	-23849	-20478	-3370	-22923	2444	-21890	-592	-440	-2052	-468	-850
	UL4C	-23340	-20026	-3315	-23254	3228	-22298	-552	-404	-2102	-437	-776
		total	susp	bed.	**susp. (sand)**	susp. 6um	susp. 200um	susp. 350um	susp. 570um	bed. 200um	bed. 350um	bed. 570um
Pelican North	Benchmark	-13.6	-19.0	5.4	-19.0	-	-19.0	-	-	5.4	-	-
	SL4C	-2469	-2475	6.6	-6.03	-2469	-4.1	-1.9	-0.00	0.8	4.9	0.8
	UL4C	-3406	-3413	6.3	-9.23	-3403	-7.2	-2.1	-0.01	1.4	4.2	0.7
		total	susp	bed.	susp. (sand)	susp. 6um	susp. 200um	susp. 350um	susp. 570um	bed. 200um	bed. 350um	bed. 570um
Pelican South	Benchmark	150.5	137.7	12.8	137.7	-	137.7	-	-	12.8	-	-
	SL4C	-5980	-5995	15.3	92.7	-6088	71.4	21.2	0.10	5.77	8.90	0.66
	UL4C	-8672	-8689	16.75	107.2	-8796	85.4	21.7	0.09	6.83	9.24	0.68
		total	susp	bed.	susp. (sand)	susp. 6um	susp. 200um	susp. 350um	susp. 570um	bed. 200um	bed. 350um	bed. 570um
Pelican Offshore	Benchmark	1490	1418	72.1	1418	-	1418	-	-	72.1	-	-
	SL4C	-1629	-1720	90.5	744.8	-2464	450.4	278.7	15.8	16.2	59.8	14.5
	UL4C	-2641	-2734	92.6	610.3	-3344	408	191.2	11.1	18.6	59.2	14.8
		total	susp	bed.	susp. (sand)	susp. 6um	susp. 200um	susp. 350um	susp. 570um	bed. 200um	bed. 350um	bed. 570um
Dauphin East	Benchmark	131.6	128.5	3.06	128.5	-	128.5	-	-	3.06	-	-
	SL4C	6942	6938	3.89	58.1	6880	40.9	15.4	1.79	0.86	1.69	1.34
	UL4C	10518	10515	3.29	68.8	10446	57.7	10.0	1.08	1.24	1.14	0.92
		total	susp	bed.	susp. (sand)	susp. 6um	susp. 200um	susp. 350um	susp. 570um	bed. 200um	bed. 350um	bed. 570um
Dauphin West	Benchmark	179.8	178	1.84	178	-	178	-	-	1.84	-	-
	SL4C	8894	8891	2.35	96.7	8795	75.2	19.1	2.40	0.64	0.90	0.81
	UL4C	12377	12374	2.17	106.3	12268	90.4	14.1	1.77	0.80	0.71	0.66