We thank the two anonymous reviewers for their constructive comments and suggestions. In the pages below we respond to each of these in turn. Unless stated otherwise, we have incorporated these changes into the resubmitted version of the manuscript.

We have also included a version of the manuscript with mark ups of the changes made.

REFEREE #1

REFEREE COMMENT:

Kelleway et al present an interesting work on medium-term and short-term accretion and deposition dynamics in different vegetation communities of a salt-marsh site on the Australian East coast. By combining different methods for measuring short- and medium-term deposition and accretion, they were able to reveal that considerable differences exist between communities with regard to accretion and organic-matter source. The manuscript presents some novel aspects on sediment and organic matter dynamics within salt-marsh systems. Unfortunately, however, I cannot recommend the work for publication before several shortcomings, often with regard to the structure of the ms, have been considered. Overall, the connection between hypotheses/research questions and the rest of the ms is very weak. Thus, large parts of the discussion have not been sufficiently set up in the introduction and particularly not in the hypotheses. No doubt the study used interesting methodology and a wide array of tools; however, in most parts it does not become clear to the reader why certain analyses/methods were conducted or why they are necessary at all until one gets to the respective parts in the discussion of the ms. The authors need to make clear that this work is not simply about comparing different methods for assessing deposition, accumulation, and accretion dynamics. I will try to elaborate on this in the following:

RESPONSE: We have made minor changes to manuscript structure in order to clarify hypotheses and to link these to both methodology descriptions and discussion points. We have provided more detailed responses below regarding the specific comments raised by the referee.

REFEREE COMMENT: Title page: L1 The title could be more specific, but I don't have strong opinions on that. It seems that throughout the ms you rather use the terms deposition and accretion. So why is "accumulation" used in the title?

RESPONSE: We have modified the title to "Sediment and carbon deposition vary among vegetation assemblages in a coastal saltmarsh" in line with this comment and a similar comment from referee 2.

REFEREE COMMENT: L18 Please make clear that this is a case study, conducted in one marsh system only. "within 3 vegetation types common throughout Australia" could be misleading and can give the impression that this is a larger scale study which has been replicated in several systems. Please, also discuss implications of this missing replication.

RESPONSE: Text has been changed to improve clarity. Discussion of the implications and limitations of using a single study site has been added, in addition to text already included regarding the need for further research across a broader range of geographic settings

REFEREE COMMENT: Main part: L1+3 please be consistent in your wording coastal wetland <-> coastal saltmarsh, please use different terms only if you mean different things, otherwise that can be confusing..

RESPONSE: Terminology was updated to ensure consistency and avoid confusion.

REFEREE COMMENT: L13 give correct reference Kirwan instead if "Kirwin"

RESPONSE: Spelling updated

REFEREE COMMENT: L18 you use the term sediment for both, the suspended matter that can deposit on the marsh surface but also to that what others refer to the "soil" of the marsh. I know, that is hair-splitting, but please make sure that you don't confuse the reader too much. Especially when you are talking about organogenic systems (L15), you should not use the term sediment when actually referring to something like a peat soil. Please check out "Do marine rooted plants grow in sediment or soil? A critical appraisal on definitions, methodology and communication" (Kristensen and Rabenhorst 2015) for clarity.

RESPONSE: Thank you for pointing this out. Manuscript was updated to use both terms as relevant.

REFEREE COMMENT: L24-25 There is also work focused on other species (Schoenoplectus) by for instance Langley or Langley and Megonigal (PNAS or Nature) or by Rooth (2003) on Phragmites that could be mentioned here.

RESPONSE: Reference to these other species and relevant studies was added

REFEREE COMMENT: L39 I think this study of Kirwan et al (2013) was only on decay but not on the balance between OM inputs and decay. I think Mueller et al (2016; GCB) is more focused on the link between the two or Kirwan and Megonigal (2013; Nature) at least discusses both.

RESPONSE: Reference was updated to Mueller et al (2016; GCB).

REFEREE COMMENT: Page 3 L2 Hemminga and Buth 1991 give a nice citation here on litter-quality effects on decay

RESPONSE: Reference to this paper was made.

REFEREE COMMENT: Page3 L13-15 Please give expected directions of effects in your hypotheses instead of only expecting that they will "vary".

RESPONSE: Text was changed to: "We hypothesise that: 1) mineral deposition and accretion will be highest in lower elevation assemblages but organic deposition and accretion will be highest in the *Juncus* assemblage; and 2) the source and character of material deposited will vary temporally according to tidal inundation patterns, with a greater proportion of allochthonous material deposited during times of high inundation frequency."

REFEREE COMMENT: L15-18 It seems like the second aim of this study is a methods comparison. I see this as a major weakness of the manuscript. Like mentioned above, either justify why the application of the different methods was necessary to answer you research questions or save that for a very nice second manuscript. Otherwise it is hard to follow your structure.

RESPONSE: This experiment was not set up as a formal comparison of different methods. We acknowledge that the current wording of the manuscript may imply that, however, as both referees have raised this issue. In a revised manuscript, we hope to outline the rationale for using three different, but complimentary methods, and what insights we gain from the methods used. We believe this has largely been done in the manuscript already, but was clarified and expanded upon, while also improving the manuscript structure.

REFEREE COMMENT: Page4 L4,5 give range or st deviation for biomass values

RESPONSE: Range values were added to the existing text:

"*Juncus* mean = 1116 g m^{-2}, range = 51-4832 g m^{-2}), compared to that of the non-rush assemblages (*Sarcocornia* mean = 317 g m^{-2}, range = 52-1184 g m^{-2}; *Sporobolus* mean = 349 g m^{-2}, range = 148-852 g m^{-2})"

REFEREE COMMENT: L11 to what depths was biomass assessed here?

RESPONSE: Clarke and Jacoby 1994 report belowground biomass from the 0-20 cm depth interval. This information was added here.

REFEREE COMMENT: L23+L32 Briefly mention why those measurements were conducted and don't just list them. Well, an informed reader can probably guess why you measured elevation or deployed marker horizons; however, when it comes to 2.5(isotopes) or 2.7 (13CNMR) you need to give a rationale.

RESPONSE: The following sentences were added:

P4, L23: "Elevation was recorded to assess relationships between deposition dynamics and plot position within the tidal frame."

P4, L32: "The feldspar marker horizon (MH) technique was used to record the amount of accretion of bulk materials at each plot"

P6,L5: "Elemental C and N content was measured in order to quantify C deposition rates and infer biomass, litter and soil consumption 'quality' (C:N). $\delta^{13}C$ was analysed to infer the source of samples relative to reference sources material and literature values."

P6,L20: "Solid-state ^{13}C nuclear magnetic resonance (NMR) spectroscopy was used to quantify the contribution of C functional groups to live plant biomass, litter and residue samples. This was carried out to identify what compositional changes occurred between the different sample types, and to what extent this differed between vegetation assemblages and inundation periods."

REFEREE COMMENT: Page6 L21 which functional groups, why was this done?

RESPONSE: These functional groups (and their spectral regions) are detailed later in the paragraph:

"organic functional groupings found in natural organic materials: Alkyl C (0-45 ppm), N-Alkyl/Methoxyl (45-60 ppm), OAlkyl (60-95 ppm), Di-O-Alkyl (95-110 ppm), Aryl (110-145 ppm), O-Aryl (145-165 ppm), Amide/Carboxyl (165-190 ppm) and Ketone (190-215 ppm)."

This was carried out to identify what compositional changes occurred between the different sample types, and to what extent this differed between vegetation assemblages and inundation periods (see response above).

REFEREE COMMENT: Page7 L17 Is this method needed to better interpret isotope data?

RESPONSE: No, this method is not directly related to the interpretation of isotope data. It is instead used to inform differences in the molecular composition of samples and is used in interpreted in concert with ^{13}C NMR (the latter gives more detailed information regarding composition but was limited in its use due to practical constraints)

REFEREE COMMENT: L24 did you really assess net accretion or accumulation?

RESPONSE: 'Net accretion (i.e. vertical surface accumulation)' was recorded across the 19 month period for the *Juncus* assemblage. Wording of this sentence was changed to clarify this.

REFEREE COMMENT: Page10 L32 why are you using "organogenic" instead of "organic" deposition?

RESPONSE: Term was replaced with "organic"

REFEREE COMMENT: Page12 L28-34 I think this is a real highlight of your study. Try to better set up this whole redistribution thing in your intro. I guess there is relatively little known about these dynamics.

RESPONSE: We thank the reviewer for this suggestion. We updated the introduction to better highlight this as a focus of the study.

REFEREE COMMENT: Page13 L16-18 I don't buy that based on 13C natural abundance only! Did you consider that 13C-fractionation processes during of organic matter decay are inducing shifts in your signatures? Are differences between litter and fresh biomass large in your species? Can your other methods support/help here?

RESPONSE: Our data presented in Table 2 show that differences in $\delta^{13}C$ between fresh biomass and partially decomposed litter samples are small. That is, mean values are within 1‰ of one another, and $\delta^{13}C$ variability among replicate samples is typically low. Further, there is not a consistent direction of fractionation among the three species analysed (i.e. litter is less negative than biomass for *Sarcocornia*, but more negative for *Sporobolus* and *Juncus*).

In addition to the above, we note that a number of other studies have shown that there is little to no difference in $\delta^{13}C$ between fresh and decomposing leaves of estuarine plant species (e.g. Zieman et al., 1984;Fry and Ewel, 2003;Saintilan et al., 2013), though the literature record is very limited in terms of species analysed.

We cannot rule out the potential for ^{13}C-fractionation occurring in the decay from litter to residue samples. Unfortunately, no controlled experiments have been undertaken to assess this. We intend to highlight this as an uncertainty in our method and suggest the need for further research in this regard. While we recognise the uncertainty associated with isotope fractionation, the isotope method was just one of three lines of evidence used to support our conclusion of redistribution of surface materials (see section 4.2.3).

We have added text to reflect the above in the revised manuscript.

REFEREE COMMENT: Page14 L11 following: I think it goes too far to discuss sequestration rates based on the presented data. You studied processes on the marsh surface, which may affect C sequestration, but here you should really stick to "deposition". Also "surface C sequestration" sounds odd to me. I don't know if C sequestration can be determined at the surface if a more or less permanent process is meant. It needs to become clear that deposition, accumulation, and sequestration are different processes. Further down in the paragraph you are using accumulation again. Please be sure to be consistent in the use of terminology.

RESPONSE: The referee raises a good point here. We have clarified terminology here, modifying the discussion to focus upon short- to medium-term patterns of deposition and accumulation (for which we have data) and limiting discussion of 'sequestration' to literature that consider carbon sequestration processes over longer time frames. We have also changed the title of the manuscript to refer to the focus on 'deposition' patterns rather than accumulation or sequestration patterns.

REFEREE COMMENT: L26 and the whole paragraph: You don't have a hypothesis on decomposition. This needs to be linked!

RESPONSE: Thank you for raising this omission. We have added the following hypothesis to the introduction text:

"3) we hypothesise that there will be no difference in biomass-litter-sediment decay patterns among the vegetation assemblages".

We have updated the relevant discussion text to link directly to this hypothesis.

REFEREE COMMENT: Page15 L21 "Reddy and DeLaune 2008" is a nice textbook indeed, but I know there is a bunch of peer-reviewed primary research or even review articles out there that should be rather cited here!

RESPONSE: We have replaced this citation, with the following:

Sterner, R. W. and Hessen, D. O.: Algal nutrient limitation and the nutrition of aquatic herbivores, Annual review of ecology and systematics, 25, 1-29, 1994.

Hessen, D. O., Elser, J. J., Sterner, R. W., and Urabe, J.: Ecological stoichiometry: An elementary approach using basic principles, Limnology and Oceanography, 58, 2219-2236, 2013.

REFEREE #2

REFEREE COMMENT: Kelleway et al. present a study on the effect of different vegetation species on the trapping of mineral and organic deposits on a tidal marsh in southeast Australia. They use three different methods to assess deposition rates at the short (days) and medium term (months). Their study provides insights in the processes controlling both mineral sediment deposition and deposition of organic matter on a tidal marsh platform. Although their results make a substantial contribution to our knowledge of processes controlling tidal marsh growth and organic carbon dynamics in these environments, some issues need to be resolved before publication of the manuscript is possible, as I point out in my comments below.

General comments

REFEREE COMMENT: One of my main concerns is that the authors use short-term (days) deposition data measured only in December and January to draw conclusion on longer term carbon and sediment dynamics, since they express the accumulation rates on a per-year basis. I think the authors should limit the conclusions they draw based on these data to short-term deposition rates, instead of C sequestration.

RESPONSE: The referee raises a good point here. We have clarified terminology and focused upon short- to mid-term patterns of deposition and accumulation (for which we have data) and limited discussion of 'sequestration' to literature that consider carbon sequestration processes over longer time frames. We have changed the temporal reporting units and changed the title of the manuscript to refer to the focus on 'deposition' patterns rather than sequestration patterns.

REFEREE COMMENT: Another concern is that the authors calculate the annual sediment deposition rates using a linear regression line which does not pass through the origin to: this results in an overestimation which has to be corrected.

RESPONSE: We believe it is more appropriate to use the regression approach in the manuscript (i.e. one without forcing a y intercept of 0) than the approach the referee suggests. A detailed rationale for this is discussed in relation to the specific comment about this by the referee below

REFEREE COMMENT: Furthermore, the authors compare the results of measurements at different timescales (days – months) to draw conclusions about the processes controlling accretion rates in different vegetation assemblages. However, they do not address the issues this poses, e.g. the short-term methods were only employed in December and January, so no information from the rest of the year is collected using these methods. This will have an effect on the results, and should be thoroughly addressed.

RESPONSE: We chose to base our sampling strategy upon expected tidal inundation patterns rather than to capture seasonal variability for several reasons. First, based on relevant literature (Rogers *et al.*, 2013) we expect tidal inundation patterns to be of primary importance to deposition and accretion dynamics. Second, we do not expect there to be substantial seasonal variability due to factors other than tidal pattern variation. That is, the study region does not experience high seasonal variability in rainfall (a point we failed to mention in the methods section, but intend to address), nor are there clear seasonal patterns in terms of biomass standing stock or senescence (Clarke and Jacoby, 1994).

We have added text to reflect the above in the revised manuscript.

REFEREE COMMENT: Also, as one of the aims of this paper is to compare different methods, I would like a discussion about the effect of the results obtained by these different methods on the conclusions they draw. The filter and vial methods result in C deposition rates that differ up to an order of magnitude: this is now not discussed in the manuscript and is a major shortcoming, and necessary if the authors want to use these results in order to draw conclusion based on these data.

RESPONSE: It was not our intention that this manuscript be seen as a formal methods comparison, though we acknowledge that both referees have taken this impression. As outlined in the introduction and methods sections, the methods chosen vary in their effectiveness of trapping and retaining different materials. For this reason, a combination of techniques was used to infer the relative importance of different physical and biotic influences on deposition and accretion. While the results from each method are informative in their own right, in most cases the results from these methods are not directly comparable (and may be expected to have an order of magnitude difference).

Our sentence “this study also presented an opportunity to compare wetland sedimentation methods” (and any others like it) was removed from the introduction. We hope that this removes any impression that a formal methods comparison is an aim of this manuscript.

In the revised manuscript, we have better outlined the rationale for using three different, but complimentary methods, and what insights we gain from the methods used.

REFEREE COMMENT: The authors should re-consider the title they use for this manuscript, e.g. based on the work they present, the word ‘deposition’ could replace the word ‘accumulation’.

RESPONSE: We changed the title to “Sediment and carbon deposition vary among vegetation assemblages in a coastal saltmarsh” in line with this comment and a similar comment from referee 1.

Specific comments

REFEREE COMMENT: P1 L24: you report the C deposition rates on a yr-1 basis, while you only measured during 2 cycles of spring and neap tide, which is misleading for the reader. I address this issue further in my comments.

RESPONSE: All deposition rates were changed to a d^{-1} (day) basis.

REFEREE COMMENT: P1 L33: By stating in the abstract that you have gained novel insights into processes responsible for regional differences, you suggest that you explicitly addressed these issues at a broader regional scale, which is not the case. Furthermore, by saying ‘…processes responsible for regional differences…’, you suggest that you have conclusive evidence that these processes are the most important one, which is also not the case (e.g. you didn’t took belowground biomass production or soil compaction into account). Therefore, I would change this sentence so that you make it clear you only performed these analyses for a single tidal marsh.

RESPONSE: Sentence was re-written to ensure it is clear this study was conducted in a single marsh. Wording regarding regional differences was softened to identify the processes we have measured and those we have not.

REFEREE COMMENT: P1 L34-36: I would formulate this more careful, as now you imply that it is possible that belowground processes are of minor importance. This contradicts with the finding of e.g Saintilan et al. (2013) that root OC is an important component of the total OC pool in SE Australian saltmarshes, and P2 L34 of this ms.

RESPONSE: This sentence was not intended to take that meaning. Sentence was revised to emphasise the fact that belowground processes can be important.

REFEREE COMMENT: P4 L22: I recommend to change this title to e.g. 'Surface elevation measurements'

RESPONSE: Agreed. Changed as suggested.

REFEREE COMMENT: P4 section 2.2: This method is of course characterised by substantial uncertainty. Are there e.g. no measurements of daily tidal height in the surroundings of the study area? That way you could calculate the difference between measured and predicted tidal height and use this to correct your measurements?

RESPONSE: There was an error in the wording here. The measured tidal height (at a nearby gauge shown in Figure 1), rather than the predicted tidal height was used to calculate plot surface elevation. Sentence was updated to "Depth of inundation above the saltmarsh surface was measured immediately after the tide receded and subtracted from the *measured* tide height to obtain an estimate of surface elevation."

REFEREE COMMENT: P5 L4: I propose you change this title to 'Sediment traps'

RESPONSE: Agreed. Changed as suggested.

REFEREE COMMENT: P5 L5-6: Here you state that the purpose is to quantify short-term deposition, while you report the measurement on a yr-1 basis. This should be addressed (see below).

RESPONSE: All deposition rates were changed to a d^{-1} (day) basis.

REFEREE COMMENT: P5 L14: please explain what you mean by 'resolution'

RESPONSE: This refers to the smallest accumulation increment detectable by a given method. Text was updated to describe this.

REFEREE COMMENT: P6 L2: The term ‘residual sediment’ is confusing, as this term is used to denote both residual sediments and organic matter, I propose to change this to e.g.; ‘residual deposits’.

RESPONSE: Agreed. Changed as suggested.

REFEREE COMMENT: P6 L6: Jaschinski et al. (2008) is not included in the reference list

RESPONSE: Reference was added. Citation is:

Jaschinski, S., Hansen, T., and Sommer, U.: Effects of acidification in multiple stable isotope analyses, Limnology and Oceanography: Methods, 6, 12-15, 2008.

REFEREE COMMENT: P6 L11: It’s very confusing that you say here that you used MIR spectroscopy to assess the composition of the listed materials, as this is not done in this ms. In some cases, MIR spectroscopy is used to assess characteristics of the analysed material (e.g. C content), based on a calibration dataset, but this is not done here. I think this sentence is confusing to the reader, as you use the MIR spectroscopy results only to perform a PCA to discriminate between different types of deposits. Therefore, I would limit the materials section about MIR spectroscopy to this aspect.

RESPONSE: We do not agree with the referee’s comment. MIR was used in conjunction with ^{13}C NMR to assess the composition of materials. That is, we use MIR primarily to assess the variability in spectra of all samples analysed in terms of their bulk composition (mineral plus organic components). We believe this variability in spectra is best presented by PCA. We then use the loadings plots of the PCA to assess what materials (e.g. quartz, kaolinite, water and OM-alkyl) are contributing to among sample variation based on diagnostic MIR spectral peaks. This is presented in section 3.4 and Figure 4B and C. We then use ^{13}C NMR to provide more specific information on the composition of the organic matter present in each of the samples.

We note that discussion of MIR results is limited to data that is already presented in the manuscript (i.e. the PCA and related loading plots in Figure 4). Individual MIR spectra can be presented as part of the supplementary information, if requested.

We believe the detail of MIR methods and rationale should be retained in the manuscript.

REFEREE COMMENT: P6 L14: if these procedures are important for the reader to replicate your measurements, please mention them.

RESPONSE: The central information (instrument, spectral range, resolution) required to replicate the method is already detailed in our manuscript. Reference to the cited paper is included for readers who wish to access further detail.

REFEREE COMMENT: P6 L15: the mid-infrared range of the electromagnetic spectrum is between 4000 – 400 cm^{-1}, so why did you measure between 8000 – 400 cm^{-1}? Please clarify.

RESPONSE: The infrared spectrometer has an operating range of 8000-400 cm^{-1}. All samples were scanned over this entire range.

Although the upper limit of the MIR region is 4000 cm^{-1}, we have included the signal between 6000 and 4000 cm^{-1} in our analysis for two reasons.

Firstly, in many samples significant signal intensity existed at 4000 cm^{-1}. If we had truncated our spectra to this wavenumber limit, the baseline offset transformation would not have worked correctly as real signal would have been lost differentially from the various samples. By extending our spectra to 6000cm^{-1}, a region devoid of signal intensity was present that could be used to appropriately apply the baseline offset spectral transformation uniformly across all spectra.

Secondly, the 6000-4000 cm^{-1} wavenumber region contains the first NIR overtones of the MIR spectra and thus may contain useful information that may aid in the development of predictive models.

The text was amended to include these justifications.

REFEREE COMMENT: P6 L15: Please clarify why the spectral range was adjusted to 6000 – 600 cm-1?

RESPONSE: The spectral range was limited because at wavenumbers >6000 cm^{-1} and <600 cm^{-1} noise in the acquired signal intensity was evident. At wavenumbers <450 cm^{-1} spikes in observed signal intensity were also evident for some samples. As a result, the spectra were truncated to 6000-600 cm^{-1}. The text was amended to indicate why the spectra were truncated to the 6000-600 cm^{-1} range.

REFEREE COMMENT: P6 L35-36: You say you test main and interactive effects of vegetation assemblages: please provide the effect on what exactly?

RESPONSE: Sentence was updated to "to test main and interactive effects of vegetation assemblage (*Sarcocornia, Sporobolus, Juncus*) and tidal event (repeated measures: December neap, December spring, January neap, January spring) on the amount of material retained at the end of a deployment period."

REFEREE COMMENT: P6 Section 2.8: please mention that you report the confidence on the mean of replicate measurements as standard error (as I assume this is what you mean with SE). Also state how this was done an why you didn't use standard deviation to report on the spread among different replicate measurements.

RESPONSE: We chose to report the standard error as this incorporates the number of samples contributing to the mean and its confidence. As mentioned elsewhere in the methods, for some measures a small number of samples were excluded from analyses – therefore we report standard error. We added this detail to Section 2.8.

REFEREE COMMENT: P6 Section 2.8 + P7 L24-29 + section 4.1: You use a simple linear regression, which you fit through the data points representing sedimentation rates above the MH's, to obtain annual rates of sediment deposition: this technique leads to an overestimation of sediment deposition rates! As you show in figure 2: the regression lines do no pass through the origin of the graph, which implies that after an infinitesimal timestep you have e.g. already 0.5mm accretion at the Sporobulus site. Likewise, when you use this regression line to calculate the amount of material that has been deposited after 12 months, you will overestimate this amount. This should be corrected: make sure you force your regression line to pass through the origin and calculate the deposition rates again.

RESPONSE: We believe it is more appropriate to use the regression approach in the manuscript (i.e. one without forcing a y intercept of 0) than the approach the referee suggests. While there would seem to be a logical argument for forcing the regression to pass through the origin in relation to the marker horizon (i.e. at time = 0 there was no accumulation above the marker horizon), forcing the intercept places undue importance on a nil accretion value at time = 0. This is misleading in terms of what is happening on the marsh surface at the time of marker horizon deployment - in reality there would have been some, unquantified accretion or erosion occurring at this time point.

The approach that we use is in fact the one which is more conservative overall and less likely to overestimate accretion dynamics. This is true of both the rates of accumulation and the strength of the linear relationships. To demonstrate this, we have tabulated the results of linear regression analyses using both our method (not forcing y-intercept = 0), and that suggested by the referee (forcing y-intercept = 0), here:

	Approach used: Not forcing y-intercept = 0		**Forcing y-intercept = 0**	
Vegetation assemblage	**Linear accretion rate (mm) ± SE**	**R^2; P-value**	**Linear accretion rate (mm y^{-1}) ± SE**	**R^2; P-value**
Sarcocornia	0.78 ± 0.18	R^2= 0.16; P<0.001	0.92 ± 0.09	R^2= 0.59; P<0.001
Sporobolus	0.88 ± 0.22	R^2= 0.14; P<0.001	1.30 ± 0.11	R^2= 0.65; P<0.001
Juncus	1.74 ± 0.13	R^2= 0.68; P<0.001	1.70 ± 0.06	R^2= 0.91; P<0.001

REFEREE COMMENT: P7 L9: Please explain what you mean by 'organic residue': are these the deposited macrolitter? Or all deposited materials combined? Or…?

RESPONSE: The 'organic residue' is inclusive of all the organic material which was leftover after macrolitter was removed. It is the material that could not be visually identified and accounted for in the physical sorting procedure. We have clarified this definition in an updated manuscript.

REFEREE COMMENT: P7 L18-19: please explain what you mean with 'composition'? It's confusing that you state that you will identify differences in composition, while you will only use PCA to plot the data on two PC's. Please better explain here how you used the PCA based on MIR spectra as an added value to standard lab analyses.

RESPONSE: As stated in a response above, we use MIR primarily to assess the variability in spectra of all samples analysed in terms of their bulk composition (mineral plus organic components). We believe this variability in spectra is best presented by PCA. We then use the loadings plots of the PCA to assess what materials (e.g. quartz, kaolinite, water and OM-alkyl) are contributing to among sample variation based on diagnostic MIR spectral peaks.

REFEREE COMMENT: P7 L24: I don't agree that 'consistent' accretion was measured for the Juncus plots, as e.g. replica 2 remains relatively stable after 11 months and replica 1 and 3 show negative erosion rates towards the end of the measurement period. I would formulate this more careful.

RESPONSE: Agreed. We have revised our wording here.

REFEREE COMMENT: P8 L12: F2,45.8: how can the degrees of freedom of variance within groups be 45.8?

RESPONSE: Non-integer degrees of freedom can occur in mixed models and are common in repeated measures analysis. This is because the denominator (or within groups) degrees of freedom are calculated based on the model and the estimated random effect and repeated measure matrices.

REFEREE COMMENT: P8 L24-25: please perform a statistic to show whether the differences between sporobolus and the other vegetation types is significant.

RESPONSE: We updated the text to include the pairwise comparison result for this comparison (not reported previously):

"Bulk deposition on filters varied among vegetation assemblages (F2, 30.85 = 48.82; P = 0.004), with significantly lower deposition in *Sporobolus* plots relative to both *Sarcocornia* (Bonferroni adjusted P-value = 0.010) and *Juncus* (Bonferroni adjusted P-value = 0.023) plots across all tidal events (Fig. 3; Table 1)."

REFEREE COMMENT: P8 L 31: indicate if the 66% and 78% are mass percentages or some other measure?

RESPONSE: Yes, these are mass percentages. Text was updated to reflect this.

REFEREE COMMENT: P8 L32-37: Sarcocornia and Sporobolus plots were located on the low marsh, which are generally subject to higher water flow velocities compared to the high Juncus marsh. This can partly contribute to the lower amount of litter retained at the low marsh. Please discuss this briefly.

RESPONSE: We added a brief discussion of this point to section 4.2.3, which already discusses expected differences in hydrodynamic energy across the marsh elevation profile.

REFEREE COMMENT: P10 L9: Indicate that you analysed the types of materials deposited for the short term

RESPONSE: Text was updated as per comment.

REFEREE COMMENT: P10 L22: how about the effect of sediment removal through erosion?

RESPONSE: Erosion was added as a potential cause of this variability.

REFEREE COMMENT: Section 4.1: here you discuss that sedimentation rates are higher for the high marsh compared to the low marsh, which is the opposite of what is normally observed. Discuss this briefly, or refer to where you discuss this (section 4.2.2)

RESPONSE: We included reference to section 4.2.2, where this is discussed in detail.

REFEREE COMMENT: P10 L29: Section 4.2 has a confusing structure: in sections 4.2, 4.2.2 and 4.2.3 you describe the results from the short-term methods, while in section 4.2.1 you describe results from the long-term methods. Please indicate this e.g. in the titles of the different subsections, as this in very confusing for the reader.

RESPONSE: The intent of section 4.2 is to discuss both the short-term and medium-term results as indicated by both the first and last sentences of the introductory paragraph of Section 4.2 (i.e. P10,L30-31 and P11,L8-10). For example, Section 4.2.1 describes results from both short-term and medium-term methods, and infers that results from the short-term measures may partly explain the results obtained from medium-term measures.

We updated terminology such as 'short-term filter', 'short-term vial' and 'medium-term marker horizon' (as opposed to just 'filter', 'vial', 'marker horizon') throughout this section to clarify the temporal resolution of results being discussed.

REFEREE COMMENT: P11 L6: you state here that during the January neap there was no inundation of the Sporobolus plots for the vials, but in table 2 you report deposition rates for JN in vials for Sporobolus plots. Please explain.

RESPONSE: In the neap tide periods, some deposition and retention of materials was recorded during periods where no tidal inundation is expected to have occurred (based on plot elevations and nearby tidal height measurements). In these instances, non-tidal processes such as rain- or wind-driven sedimentation and/or bioturbation are the most likely causes. Although filters with visible crab-excavated sediment (n = 23/180) were excluded from analysis, such clear identification was not able to be determined for sediments deposited in vials.

REFEREE COMMENT: P11 L8-10: please better explain which 'scale differences' you mean and shorten this sentence (or split into two sentences).

RESPONSE: We re-wrote this sentence as:

"In the following sections we interpret the influence of biological, physical and interactive processes on saltmarsh surface dynamics. We do so by assessing the response of different surface deposition measures (2 short-term; 1 medium term) among the three vegetation assemblages studied. "

REFEREE COMMENT: P11 L11: please use a more specific title, so the reader know what this section is about

RESPONSE: We replaced this with "The influence of vegetation on saltmarsh surface deposition"

REFEREE COMMENT: P11 L14: please better specify that with ‘direct organic sedimentation’ you mean contributions of litter fall to increases in marsh elevation. The fact that local vegetation has a high biomass production does not necessarily mean that this litter will contribute to long-term accretion rates, so this should be nuanced.

RESPONSE: Yes, we are referring to litter fall here and updated the sentence to clarify this. We accept that biomass production does not necessarily equate to higher accretion rates. We also discuss, however, our results of relatively high litter retention in the *Juncus* assemblage relative to other assemblages (Section 4.2.3), while our spectrometric techniques revealed a high contribution of plant-derived C to benthos in the *Juncus* assemblage (Section 4.3.2)

REFEREE COMMENT: P11 section 4.2.1 In my opinion, the conclusions drawn in this section are too much based on speculations. The only evidence you present that vegetation has an effect on sedimentation rates is that Juncus has a higher standing biomass (while no measures of biomass have been carried out on the studied marsh), without putting forward evidence that e.g. indeed more autochthonous plant material is being retained on the longer term. Moreover, if measurements would have been carried out over e.g. 11 months, the conclusions would have been different and the Sporobolus plots would have collected most sediment. Therefore, I would like the authors to formulate these conclusion more careful and include some discussion about the effect of the duration on their measurements on their results.

RESPONSE:

We updated this section with reference to:

- variation among the three vegetation assemblages in terms of the contribution of autochthonous litter to short-term deposition (Figure 3), corresponding to literature (and visually observed) biomass patterns and plant structural differences;

- reference to section 4.3.2 which details variation in the contribution of plant-derived C to short-term benthos among the three vegetation assemblages, as revealed by our spectrometric methods;

- discussion of limitations of our approach for determining the long-term contribution of plants to marsh accretion (including discussion of the effect of measurement duration in our study).

REFEREE COMMENT: P11 L30: please use a more specific title, so the reader knows what this section is about

RESPONSE: We replaced this with “The influence of physical factors on saltmarsh surface deposition”

REFEREE COMMENT: P11 L34-36: You can add ‘3) flooding frequency is higher at lower elevations’ to this list.

RESPONSE: Agreed. Thank you.

REFEREE COMMENT: P12 L28 – P13 L5: Here you compare the results from the short-term methods with the long-term methods in order to draw conclusion about the redistribution of surface materials. However, the data obtained with the short-term methods has only been collected in December and January, neglecting potential intra-annual variability in the composition of deposits. This is a major concern of mine, as I don't agree the results obtained in these two months can be directly compared to the results obtained over a 19 months period without addressing this issue thoroughly: please do this.

RESPONSE: We chose to base our sampling strategy upon expected tidal inundation patterns rather than to capture seasonal variability for several reasons. First, based on relevant literature (Rogers *et al.*, 2013) we expect tidal inundation patterns to be of primary importance to deposition and accretion dynamics. Second, we do not expect there to be substantial seasonal variability due to factors other than tidal pattern variation. That is, the study region does not experience high seasonal variability in rainfall (a point we failed to mention in the methods section, but intend to address), nor are there clear seasonal patterns in terms of biomass standing stock or senescence (Clarke and Jacoby, 1994).

We have now more clearly stated why we expect little seasonal variation in deposition, and to apply caution in comparing results between different timescales.

In addition, we updated terminology such as 'short-term filter', 'short-term vial' and 'medium-term marker horizon' (as opposed to just 'filter', 'vial', 'marker horizon') throughout the manuscript to clarify the temporal resolution of methods being discussed. Also, all deposition rates were changed to a d^{-1} (day) basis.

REFEREE COMMENT: P13 L28: How about the effect of kinetic fractionation of stable carbon isotopes on the results of your analysis.

RESPONSE: Our data presented in Table 2 show that differences in $\delta^{13}C$ between fresh biomass and partially decomposed litter samples are small. That is, mean values are within 1‰ of one another, and $\delta^{13}C$ variability among replicate samples is typically low. Further, there is not a consistent direction of fractionation among the three species analysed (i.e. litter is less negative than biomass for *Sarcocornia*, but more negative for *Sporobolus* and *Juncus*).

In addition to the above, we note that a number of other studies have shown that there is little to no difference in $\delta^{13}C$ between fresh and decomposing leaves of estuarine plant species (e.g. Zieman et al., 1984;Fry and Ewel, 2003;Saintilan et al., 2013), though the literature record is very limited in terms of species analysed.

We cannot rule out the potential for ^{13}C-fractionation occurring in the decay from litter to residue samples. Unfortunately, no controlled experiments have been undertaken to assess this. We highlight this as an uncertainty in our method and suggest the need for further research in this regard. While we recognise the uncertainty associated with isotope fractionation, the isotope method was just one of three lines of evidence used to support our conclusion of substantial redistribution of surface materials (see section 4.2.3).

Manuscript has been updated to reflect the text above.

REFEREE COMMENT: P13 L38: In my opinion, I don't agree that the evidence presented allows to draw definite conclusions about the mobilisation of litter on the tidal marsh. Therefore I propose that these results are formulated in terms of hypothesis instead of conclusions.

RESPONSE: We replaced reference to ‘conclusions’ with ‘hypotheses’

REFEREE COMMENT: P13 L40 – P14 L1: ‘Autochthonous sedimentation’ is a strange term, as sedimentation refers to sediment deposition. This could be changed with ‘autochthonous litter’

RESPONSE: We changed this simply to ‘autochthonous materials’

REFEREE COMMENT: P14 L5: Please change to e.g. ‘Implications for wetland functioning’

RESPONSE: Agreed

REFEREE COMMENT: P14 L10: Since you didn’t measure long-term C sequestration, remove ‘sequestration’ from the title of this section

RESPONSE: The referee raises a good point here. We clarified terminology here, modified the discussion to focus upon short- to medium-term patterns of deposition and accumulation (for which we have data) and limited discussion of ‘sequestration’ to literature that consider carbon sequestration processes over longer time frames. We changed the title of the manuscript to refer to the focus on ‘deposition’ patterns rather than accumulation or sequestration patterns.

REFEREE COMMENT: P14 L12-14: Since C deposition was only measured 4 events in December and January, I don’t agree to calculate annual C deposition rates based on this data, as this way 1) you ignore intra-annual variations in C deposition and 2) the reader might think that you measured C deposition over a whole year. Also, you don’t discuss the effectiveness of the method you use to calculate these number (filters) in trapping deposits. I suggest the annual C deposition rates are removed, or a detailed discussion on the effect of intra-annual C deposition dynamics on the calculations is included.

RESPONSE: We chose to base our sampling strategy upon expected tidal inundation patterns rather than to capture seasonal variability for several reasons. First, based on relevant literature (Rogers *et al.*, 2013) we expect tidal inundation patterns to be of primary importance to deposition and accretion dynamics. Second, we do not expect there to be substantial seasonal variability due to factors other than tidal pattern variation. That is, the study region does not experience high seasonal variability in rainfall (a point we failed to mention in the methods section, but intend to address), nor are there clear seasonal patterns in terms of biomass standing stock or senescence (Clarke and Jacoby, 1994).

We have now stated why we expect little seasonal variation in deposition, and to applied caution in comparing results between different timescales.

In addition, all deposition rates were changed to a d^{-1} (day) basis.

REFEREE COMMENT: Moreover, you use the results from the filters to calculate these annual C deposition rates, while the amount of deposits measured with the filters (fig. S2) are an order of magnitude smaller compared to the amount of deposits measured with the vials (fig. S3). Please explain why you used the filter results to make these calculations, and not the vial results?

RESPONSE: As outline in section 2.4, we expect different results from the two methods, with vials having several biases in terms of the materials (and quantities) they accumulate. The filter method was used to calculate C deposition rates as it is considered a 'passive' technique (see section 2.4), and is less likely to overestimate C deposition on a natural saltmarsh surface.

REFEREE COMMENT: As one of the goals of your study is to compare both the filter and vial method, please provide a more in-depth discussion of the effect of the order of magnitude difference between the results from both methods on the calculations you make and the conclusion you draw based on this data.

RESPONSE: As outlined in responses above, it is not our intent that the manuscript undertakes a formal comparison of different methods. We have now clarified this in the text. We believe that sufficient discussion of the differences between filter and vial results has been made in the manuscript (particularly in sections 3.2 and 4.2.2). Use of vial-derived deposition rates for calculating C deposition would represent a substantial overestimate of actual C deposition, as it is an 'active' sedimentation method. As there is no rationale or intent to use the vial method to calculate C deposition rates, we do not see a reason for extending the discussion of the two methods here.

REFEREE COMMENT: P14 L26: By using the title 'Decomposition of organic matter…' you suggest that you have effectively measured OM decomposition, which is not the case. Please change the title so that this is more clear. E.g. 'Chemical structure of deposits varies among…'

RESPONSE: Agreed. We have changed this title as suggested.

REFEREE COMMENT: P14 L28-31: Please reformulate this sentence: by saying '… these analyses have revealed insights in to fate of aboveground OM and the likelihood of their contribution to…' you suggest that you have done measurements that directly allow you to say something about the different contributions of OM in these different vegetation assemblages to long-term C sequestration. This is however not the case, as you use chemical measurements to make suggestions about these processes.

RESPONSE: We have deleted this sentence, in light of the referee's comment.

REFEREE COMMENT: P15 L8: Based on which data do you calculate the 'retention of plant-derived C'? Please explain.

RESPONSE: The paragraphs preceding this statement, discuss the data upon which we come to this conclusion. That is:

"Importantly, cellulose also appears to be a factor in the separation of residues from the three different saltmarsh assemblages along PC2 (Fig. 4c), suggesting higher content in the two *Juncus* samples, followed by *Sporobolus* and then *Sarcocornia* samples. This finding was confirmed by 13C NMR data, which showed greater proportions of plant compounds (carbohydrates more broadly, as well as lignin) were retained within the *Juncus* litter and residue relative to the other species (Table 2). In contrast, the higher proportions of alkyl–C and amide/carboxyl–C within *Sarcocornia* and *Sporobolus* residues were indicative of higher protein and lipid contents, consistent with bacterial biomass and marine algae signatures (Dickens et al., 2006). However, they may also be partly explained by the selective retention of resistant plant waxes, such as suberin and cutan."

REFEREE COMMENT: P15 L17: 'The selective sorption of N by a plant…': how does this explain that Juncus litter is enriched in N compared to the original biomass?

RESPONSE: The point here is that the *Juncus* litter is <u>depleted</u> in N compared to the original biomass. This then gets reflected in a higher C:N ratio in the litter, relative to the live biomass

REFEREE COMMENT: P15 L23: How does table 2 show that the bacterial biomass increases for Sacocornia and Sporobolus?

RESPONSE: Table 2 does not show this directly. Instead this increase in bacterial derived C is inferred earlier in section 4.3.2:

"In contrast, the higher proportions of alkyl–C and amide/carboxyl–C within *Sarcocornia* and *Sporobolus* residues were indicative of higher protein and lipid contents, consistent with bacterial biomass and marine algae signatures (Dickens et al., 2006)."

It is for this reason that we refer to the 'increases suggested for *Sarcocornia* and *Sporobolus* assemblages'. We have added another citation of Dickens et al. 2006 as required.

REFEREE COMMENT: P15 L24-27: This seems highly speculative and you don't use any data or references to prove this: I suggest you remove this.

RESPONSE: Agreed. We have removed this sentence.

REFEREE COMMENT: P15 L30-31: you only measured C deposition on a very short timescale (averaged over 2 months), so I would refrain from any suggestions or conclusion of your observations for long-term C sequestration.

RESPONSE: We have modified this sentence to reflect the short-term nature of our measure, and be more circumspect in its suggestion:

"…highlight short-term processes which may contribute to the high capacity of *Juncus* to accumulate C stocks…"

<u>Technical corrections</u>

RESPONSE: The technical corrections below were incorporated in the revised manuscript. We thank the referee for taking the time to provide a comprehensive list of technical corrections.

P1 L15: remove ‘surface’

P1 L21: Replace ‘Accretion was…’ by ‘Accretions rates were…’

P1 L23: change ‘(6d)’ to ‘(6 days)’

P1 L28: change ‘mid infrared’ to ‘mid-infrared’ (also in the rest of the ms)

P2 L5: change ‘broad’ to ‘general’

P2 L8: change ‘exceptional productivity’ to ‘exceptionally high productivity’

P2 L12: Change ‘Surface elevation and sedimentation dynamics are central…’ to ‘Sedimentation dynamics partially determine the survival of coastal wetlands under rising…’

P2 L14-16: This is a strange sentence: first you define minerogenic as ‘dominated by mineral inputs’, by which you imply that there is also other (organic) material present. Next you say that most saltmarsh sediments contain both organic and mineral fractions, repeating what you first said. You can simply only say that most saltmarsh sediments are a mixture of organic and mineral materials, to avoid confusion.

P2 L18: change ‘sediment’ to ‘sediments’

P2 L19-20: change ‘…); as well as the tidal range of a site and position…’ to ‘…), the tidal range of a site and the position…’

P2 L25: change ‘Broadly’ to ‘Generally’

P2 L26: change ‘helping to trap mineral sediments’ into ‘facilitating sediment tapping’

P2 L27-30: Change to: ‘Findings of comparative studies of the effect of vegetation composition on sediment deposition rates, however, vary from no difference among different vegetation species () to substantial differences among…’

P2 L32: I would change this sentence to: ‘Average global rates of carbon accumulation in saltmarshes are extremely high, relative to…’

P2 L33: state that SE is the standard error

P2 L39: change ‘their’ to ‘its’

P3 L1: change ‘soil pools’ to ‘soils’

P3 L9: You can change this sentence to ‘Because methods vary…, a combination of …’

P3 L15: change ‘presented’ to ‘presents’

P3 L15-16: I would reformulate this sentence and state that another aim of your study was to compare different methods that are used to measure sedimentation rates on tidal marshes (otherwise it is not clear to the reader whether or not you made the comparison).

P3 L24-25: put ‘(Fig. 1)’ at the end of the sentence

P3 L 25-26: ‘mangrove species Avicennia…’

P3 L27: ‘the upslope limit of saltmarshes…’

P3 L28: ‘but for the most part saltmarshes are bordered…’

P3 L29-30: '… with ranges in elevation and tidal extent.'

P3 L31: 'Salmarshes within this site comprise…'

P3 L31: '… communities. The lower and middle marsh is characterized by an association of … pathway). The upper marsh …'

P3 L36: 'Fifteen plots were selected on the basis…'

P4 L5: is this g dry weight per m-2? If so, mention this, also in the next sentence.

P4 L6: '… 350 g m-2). Moreover, there do not'

P4 L12-15: Move these sentence to the beginning of the study area section: they provide general information about SE Australian saltmarshes.

P5 L5: Change 'sedimentation traps' to 'sediment traps'

P5 L35: Change to '… the supernatant decanted and the vial was placed…'

P7 L14-16: Please explain the symbols more clearly: e.g. 'where δ13C denotes the isotopic signal of different sources of OC: Cresidue (…), CC4 (…) and CC3 (…).

P8 L16: please mention the units of '100 ± 32.73'

P8 L19: better to give the range in R^2 instead of saying '$R^2 > 0.35$); I wouldn't call these relationships significant as long as you didn't test them statistically.

P10 L 15-16: change to '… and deposition measured with short-term sediment traps…'

Section 4.1: use the re-calculated accretion rates (see my comments above)

P11 L14: change 'massive' to 'large'

P12 L7: 'the physical position'

P14 L6: This sentence is not correct: change to e.g. '… surface dynamic is critical to predict the survival…'

P14 L11: Please rephrase 'organogenic and minerogenic assemblages' to e.g. 'organogenic and minerogenic deposits'

P14 L28: Replace 'MIR' by 'MIR spectroscopy'

P15 L38: remove 'then'

Figure 1

- Heading: change '…location of nearest…' in '…location of the nearest …'

Figure 2

- Heading: is 'SE' the standard error? Is this the same as standard deviation? Please clarify.

- Change the axes so that the 0 marker of the y-axis is at the same height of the x-axis (since you don't plot negative accretion)

- You should make it more clear that what you show is the height of deposited sediments above the marker horizon. Now the reader can interpret it as accretion rates measured at different time periods. I would change the y axis label to something like ‘Height of deposited sediments (mm)’

Figure 3

- Heading: write ‘6d’ as ‘6 days’

- As you have standard deviations on this data the quality of the figure would improve if the differences between the different vegetation species are significantly different, e.g. with letters above the bars.

Figure 4

- The letters written within the symbols of A) are very difficult to read: place them next to the symbols

- Also the letters next to the symbols in A) are difficult to read: enlarge them and increase the space between the symbol and the letters

Figure S1

- Heading: replace ‘scatterplots’ with ‘plots’; explain what ‘AHD’ is; put ‘regression line’ in plural; explain that DW (on the y-axis) means dry weight; explain what ‘bulk material’ is.

- Y-axis: change units to ‘g DW m-2’

- Plot D should be January ‘spring’ instead of ‘neap’?

Figure S2

- Heading: same remarks as for fig. S1

- Replace the y-axis label as for fig. S1

- Remove ‘no linear fits’ from the legend: this is already explained in the heading

- Plot D should be January ‘spring’ instead of ‘neap’?

Tables

Table 1

- Heading: change ‘Summary of sediment measure techniques…’ to ‘Summary of sedimentation measurement techniques’; Change ‘C’ to ‘OC’, since you measure only organic carbon

- Under Parameter, change ‘Measure’ into ‘Measurement’

- Under ‘Filter + isotopic analyses’: clarify what ‘sediment residue’ is. This should be clear to the reader without reading the whole manuscript.

- Under ‘Filter + MIR & 13C NMR’: change ‘Character of …’ to ‘Characteristics of …’

- In the ‘Filter + elemental analysis’ section: C deposition rate is expressed in ‘yr-1’ while you only measured for a short period in summer. This should be changed (see my previous comments)

- In the notes (a): change ‘%C’ to ‘%OC’, since you measured organic carbon

- For the filter method – ‘Filter + isotopic analysis’: it should be clear what ‘sediment residue’ is, please clarify in the heading.

Table 2

- Heading: change ‘assemblage’ to plural; change ‘… plant assemblages, plus other…’ to ‘plant assemblages and other potential sources’; change ‘… for each of biomass…’ to ‘…for each of the biomass…’

- Explain what ‘n/a’ stands for in the heading

Table S1

- Place ‘Number of tides exceeding mean plot elevation’ above the names of the neap and spring events to increase readability

Table S2

- Are these values based on 1 measurement or are these average values from multiple replicates? If so, provide the standard deviation

ADDITIONAL REFERENCES

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Sediment and carbon ~~accumulation~~ deposition vary among vegetation assemblages in a coastal saltmarsh

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Abstract. Coastal saltmarshes are dynamic, intertidal ecosystems which are increasingly being recognised for their contributions to ecosystem services, including carbon (C) accumulation and storage. The survival of saltmarshes and their capacity to store C under rising sea levels, however, is partially reliant upon ~~surface~~ sedimentation rates and influenced by a combination of physical and biological factors. In this study, we use several complementary methods to assess short-term (days) deposition and medium-term (months) accretion dynamics within a single marsh which contains three saltmarsh vegetation types common throughout southeast (SE) Australia.

We found that surface accretion varies among vegetation assemblages, with medium-term (19 month) bulk accretion rates in the upper marsh rush (*Juncus*) assemblage (1.74 ± 0.13 mm y^{-1}) consistently in excess of estimated local sea level rise (1.15 mm y^{-1}). Accretion rates were~~r~~~~was~~ lower and less consistent in both the succulent (*Sarcocornia*) (0.78 ± 0.18 mm y^{-1}) and grass (*Sporobolus*) (0.88 ± 0.22 mm y^{-1}) assemblages located lower in the tidal frame. Short-term (6 days) experiments showed deposition within *Juncus* plots to be dominated by autochthonous organic inputs with C deposition rates ranging from 1.14~~0.41~~ ± 0.~~15~~41 mg C cm^{-2} d~~y~~$^{-1}$ (neap tidal period) to ~~0.87~~2.37 ± 0.~~16~~44 mg C cm^{-2} d~~y~~$^{-1}$ (spring tidal period), while minerogenic inputs and lower C deposition dominated *Sarcocornia* (0.~~03~~ 10 ± 0.0~~1~~2 to 0.62~~23~~ ± 0.~~03~~08 mg C cm^{-2} d~~y~~$^{-1}$) and *Sporobolus* (0.~~06~~17 ± 0.0~~1~~4 to 0.40~~15~~ ± 0.0~~3~~7 mg C cm^{-2} d~~y~~$^{-1}$) assemblages.

Elemental (C:N), isotopic ($\delta^{13}C$), mid-infrared (MIR) and ^{13}C NMR analyses revealed little difference in either the source or character of materials being deposited among neap versus spring tidal periods. Instead, these analyses point to substantial redistribution of materials within the *Sarcocornia* and *Sporobolus* assemblages, compared to high retention and preservation of organic inputs in the *Juncus* assemblage. By combining medium-term accretion quantification with short-term deposition measurements and chemical analyses we have gained novel insights into aboveground biophysical processes ~~responsible for~~that may explain previously observed regional differences in surface dynamics among key saltmarsh vegetation assemblages. Our results suggest that ~~unless belowground processes (e.g. root production) make substantial contributions to surface elevation gain, then~~ *Sarcocornia* and *Sporobolus* assemblages may be particularly susceptible to changes in sea level, ~~with implications for the future structure and function of these saltmarsh areas~~though quantification of belowground processes (e.g. root production, compaction) is needed to confirm this.

1 Introduction

1.1 Coastal **wetlandssaltmarshes**

Coastal saltmarshes are dynamic ecosystems, vegetated by herbs, grasses and rushes that are found in a range of sedimentary settings along low-energy coastlines. Globally, vegetation type and floristic assemblage have been used to classify broad general types of saltmarsh (Adam, 1990; Adam, 2002). At the local scale, vegetation zonation is one of the most striking ecological features of many saltmarshes, reflecting the elevation requirements of a small number of dominant species, although mosaics of species within a zone are also common (Adam, 2002; Hickey and Bruce, 2010). Whilst the biodiversity values and exceptionally high productivity of coastal wetlandssaltmarshes have been long recognised, increasing attention is now being focused upon ecosystem services such as carbon (C) accumulation and storage (Chmura et al., 2003; Duarte et al., 2013), and the response of these coastal ecosystems to changes in climate (Kirwan and Mudd, 2012) and sea level (Rogers et al., 2013). Surface elevation and sSedimentation dynamics partially determine the survival of are central to both coastal wetlandsaltmarshes survival under rising sea level (Baustian et al., 2012; Kirwan and Megonigal, 2013; Kirwin Kirwan et al., 2016) and to the delivery and storage of organic matter (OM) (Duarte et al., 2013; Lovelock et al., 2013). Saltmarsh sediments soils may be minerogenic (dominated by mineral inputs) or organogenic (dominated by biomass and litter production and/or allochthonous OM inputs), although most sediments comprise both mineral and organic fractions (Adam, 2002; Baustian et al., 2012). Consequently, sediment soil properties and surface dynamics may be influenced by both physicochemical and biological factors. Physical drivers of accretion (the vertical accumulation of sediments) in intertidal wetlands include the suspended sediment supply of inundating waters (Zhou et al., 2007); as well as the tidal range of a site and position within the tidal range (Ouyang and Lee, 2014; Saintilan et al., 2013; van Proosdij et al., 2006). High tides may play an important role in importing sediment into saltmarshes (Rosencranz et al., 2015), while low-tide rainfall may act to redistribute or export materials, including particulate organic carbon (Chen et al., 2015).

Numerous studies have investigated the interactions between vegetation and marsh surface dynamics (Langley et al., 2009; Rooth et al., 2003), although the majority of these studies have focussed on the genus *Spartina* (e.g. Baustian et al., 2012; Mudd et al., 2010; Mudd et al., 2009; Nyman et al., 2006). BroadlyGenerally, these studies have shown that the presence of vegetation may have a significant positive influence on surface accretion through: 1) accumulating organic matter; and 2) helping facilitating sediment trapping to trap mineral sediments (Morris et al., 2002; Mudd et al., 2010; Nyman et al., 2006). Findings of Ccomparative studies of the effect of vegetation composition onin deposition rates the intertidal zone, however, vary from no difference in accretion among different vegetation species in the wetland (e.g. Culberson et al., 2004) to substantial sizeable differences among mangroves and different saltmarsh species (e.g. Saintilan et al., 2013). Little is known about the extent to which surface materials are re-distributed among neighbouring saltmarsh species assemblages, though stable isotope approaches have been used to demonstrate the small-scale (i.e. a few metres) movement of organic matter at mangrove – saltmarsh interfaces (Guest et al., 2004; Guest et., 2006).

1.2 C storage

Average globalGlobally, the rates of sediment soil carbon accumulation is extremely high in saltmarshes, relative to most terrestrial and most coastal ecosystems, with a mean ± standard error (SE) accumulation rate of 0.024 ± 0.003 g C cm^{-2} y^{-1} (Ouyang and Lee, 2014). While much of this C is produced belowground by roots and rhizomes, contributions from aboveground sources may be significant (Boschker et al., 1999; Zhou et al., 2006). Sources of aboveground C may include both autochthonous (produced within the community) and allochthonous (deposited from outside the community) OM, although their relative contributions may vary within and among saltmarsh settings (Kelleway et al., 2016a). The contribution of C re-distributed within the community (i.e. within and among different species assemblages) to surface deposition and ~~longer term~~longer-term C accumulation remains unquantified, and may vary with vegetation structure and geomorphic position.

Regardless of OM source, the capacity of ~~coastal wetland~~saltmarshes to store carbon in the long-term remains dependent upon the balance between OM inputs and ~~their~~ its decay ~~(Kirwan et al., 2013)~~ (Mueller et al., 2016). While there is considerable debate as to which factors most influence the long-term retention of C in soils~~ pools~~, litter quality has long been identified as a key driver of decay rates (Cleveland et al., 2014; Enríquez et al., 1993; Hemminga and Buth, 1991; Josselyn and Mathieson, 1980; Kristensen, 1994) and is of particular relevance to C stock accumulation ~~on~~ in ~~the sediment~~ surface soils.

1.3 Measuring surface deposition and accretion

A variety of methods have been developed for measuring and monitoring surface dynamics in tidal wetlands (for reviews see Nolte et al., 2013; Thomas and Ridd, 2004). These include techniques relevant to short-term *deposition* events (of sediments and plant litter) through to medium- and long-term measures of *accretion* or *accumulation* (the net effect of multiple deposition and removal events) as well as *surface-elevation change*. ~~Methods~~ Because methods ~~also~~ vary in their effectiveness of trapping and retaining different materials, ~~meaning~~ a combination of techniques may be required to identify the different physical and biotic influences on deposition and accretion (Nolte et al., 2013). In this study, we ~~use~~ combine several methods to assess short-term (days) deposition and medium-term (months) accretion dynamics within three saltmarsh vegetation assemblages common throughout southeast (SE) Australia. Our aim is to use three different measurement methods to identify the role of vegetation and physical factors in surface deposition and/or accretion. We hypothesise that: 1) mineral deposition and accretion will be highest in lower elevation assemblages but organic deposition and accretion will be highest in the *Juncus* assemblage; 2) the source and character of material deposited will vary temporally according to tidal inundation patterns, with a greater proportion of allochthonous material deposited during times of high inundation frequency; and 3) there will be no difference in biomass-litter-sediment decay patterns among the vegetation assemblages~~We hypothesise that: 1) deposition and accretion will vary among assemblages, in accordance with differences in vegetation structure and location within the saltmarsh; and 2) the source and character of material deposited will vary temporally according to tidal inundation patterns~~. ~~This study also presented an opportunity to compare wetland sedimentation methods~~. Together, we expect this information will improve our understanding of how materials (including C) are deposited and accumulate in coastal wetlands and how these ecosystems might respond under rising sea level.

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2 Methods

2.1 Study setting

~~More b~~Broadly, the saltmarshes of southeast (SE) Australia have been classified within the temperate group of saltmarshes which also includes those of Europe, the Pacific coast of North America, Japan and South Africa

(Adam, 1990). These are distinct from the well-studied *Spartina*-dominated marshes of North America's Atlantic coast. Towra Point Nature Reserve is located within the oceanic embayment Botany Bay, approximately 16 km south of central Sydney, Australia's largest city. The intertidal estuarine wetland complex at this site is the largest remaining within the Sydney region and is listed as a Ramsar Wetland of International Importance. Within the site, a large saltmarsh area adjacent to Weeney Bay was chosen as a study site (Fig. 1) as this area exhibits vegetation zonation typical of SE Australian saltmarshes (Fig. 1). The lower saltmarsh is bordered by the mangrove species *Avicennia marina*, beyond which seagrass meadows (including *Posidonia australis*) occur within the subtidal zone. In some areas the upslope limit of saltmarsh extends into small patches of the supratidal trees *Casuarina glauca* and *Melaleuca ericifolia,* but for the most part is saltmarsh is bordered by a levee which was constructed between 1947 and 1951. Previous investigation has revealed vegetation zonation across the site coinciding with ranges in elevation measurements and tidal extent modelling (Hickey and Bruce, 2010).

Saltmarsh within this site comprises two broad vegetation communities. The lower and middle marsh is characterised by – an association of the perennial succulent *Sarcocornia quinqueflora* (C3 photosynthetic pathway) and the perennial grass *Sporobolus virginicus* (C4 photosynthetic pathway), mostly intermixed across the lower and middle marsh. The upper marsh assemblage is dominated by the rush *Juncus kraussii* (C3), with *S. virginicus* (C4) ubiquitous as a sub-dominant lower stratum across this assemblage.

Fifteen plots were selected for study on the basis of saltmarsh vegetation zonation – five plots randomly chosen within the *Juncus*-dominated assemblage, and 10 plots strategically selected within the *Sarcocornia*-*Sporobolus* association (five plots vegetated exclusively by *Sarcocornia,* and five vegetated exclusively by *Sporobolus*). Hereafter, these three assemblages are referred to by genus (*Sarcocornia; Sporobolus; Juncus*), while reference to the plant species themselves involves the species name (*S. quinqueflora; S. virginicus; J. kraussii*).

Data previously collected within the study region showed a substantial difference in aboveground biomass of the rush assemblage (*Juncus* mean = 1116 g DW m^{-2}; range = 51-4832 g DW m^{-2}), compared to that of the non-rush assemblages (*Sarcocornia* mean = 320 g DW m^{-2}, range = 52-1184 g DW m^{-2}; *Sporobolus* mean = 350 g DW m^{-2}, range = 148-852 g DW m^{-2}). Moreover – importantly, there do not appear to be distinct seasonal patterns of biomass stock for any of these species (Clarke and Jacoby, 1994). Both *Sarcocornia* and *Sporobolus* are perennial species, while *J. kraussii* culms undergo initiation and senescence throughout the year, but with peak culm initiation before and after summer flowering and fruiting (Clarke and Jacoby, 1994). Belowground biomass data are rare, though on the basis of 0-20cm depth data presented by Clarke and Jacoby (1994) we have calculated a mean aboveground : belowground biomass ratio of 1.5 for *Juncus*. No belowground data have been reported for either *Sarcocornia* and *Sporobolus*. More broadly, the saltmarshes of southeast (SE) Australia have been classified within the temperate group of saltmarshes which also includes those of Europe, the Pacific coast of North America, Japan and South Africa (Adam, 1990). These are distinct from the well-studied *Spartina*-dominated marshes of North America's Atlantic coast.

Tides along the New South Wales coast are semidiurnal (two flood and two ebb periods each lunar day) with a maximum spring tidal range of 2.0 m (Roy et al., 2001). Astronomical (i.e. predicted) maxima occur during the new moon in summer and during the full moon in winter (spring tides). Tidal inundation to and recession from the study area occurs via Weeney Bay, with the causeway acting as a barrier to surface water exchange with the western section of the Nature Reserve and Woolooware Bay. The linear rate of sea level rise in Botany Bay since

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local records commenced in 1981 is 1.15 mm y^{-1} (Kelleway et al., 2016b). Rainfall in the region is spread throughout the year, with annual rainfall of 1084 mm y^{-1} in Botany Bay (Bureau of Meteorology, 2016).

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2.2 ~~Elevation~~ Surface elevation measurements

Plot elevation was recorded to assess relationships between deposition dynamics and plot position within the tidal frame. ~~Within each plot, e~~Elevation was measured using a modified version of the tidal inundation method described by English et al. (1994), whereby three vertical rods marked with water-soluble dye were inserted into the ground immediately prior to a summer spring tide (23/01/2015; measured tidal height of 1.897 m above lowest astronomical tide (LAT) datum at nearest tidal gauge). Depth of inundation above the saltmarsh surface was measured immediately after the tide receded and subtracted from the ~~predicted~~ measured tide height to obtain an estimate of surface elevation. Care was taken during the measurement procedure and in the selection of a calm day (to minimise wind and waves effects) to minimise discrepancies between measurements at different plots. Comparison of three replicate rods revealed a standard error of the mean < 1.3 cm for each plot.

2.3 Feldspar marker horizons

The feldspar marker horizon (MH) technique (Cahoon and Turner, 1989) has been proposed as a suitable method to investigate the effects of aboveground vegetation structure on the accretion (vertical accumulation) of material on the marsh surface over the medium-term (Nolte et al., 2013). The feldspar MH technique was used to record the amount of accretion of bulk materials at each plot at the temporal scale of multiple months. A total of 45 feldspar MHs were installed across the study site on 23 January 2014, comprising three replicates in each of the 15 study plots. Accretion was determined at later dates as the height difference between the marsh surface and the feldspar (i.e., the material accumulated above the MH), and was recorded as the mean of three replicate measurements from within the marker horizon at each sampling event. Measurements were taken 11, 13, 15, 17 and 19 months after installation. During the later sampling events many MHs in *Sarcocornia* and *Sporobolus* plots became increasingly difficult to discern within the ~~sediment~~soil, probably due to bioturbation and mixing of sediments (Cahoon and Turner, 1989; Krauss et al., 2003). Consequently, monitoring of all plots was terminated after 19 months.

2.4 Sediment~~ation~~ traps

Two complementary types of sediment~~ation~~ trap were installed concurrently for the purpose of quantifying short-term (days) deposition of materials among the three vegetation assemblages. These types of traps were selected on the basis of the types of materials which they are most likely to collect, with the aim of providing insights on the processes driving deposition among assemblages. First, pre-weighed, 50 mL centrifuge vials (30 mm mouth diameter; 115 mm depth) were placed into the ground, so that the 'lip' of each tube was 10 mm above the ground surface. This vial method has a bias towards the collection of non-buoyant materials washing over the mouth of the tube (i.e. mineral matter) and a bias against collection of coarse and/or buoyant materials, including large fragments of plant litter. Second, a modified version of the filter paper method described by Reed (1989) and Adame et al. (2010) was used to quantify 'passive' sedimentation and litter accretion on the saltmarsh surface. Pre-weighed 90 mm hydrophilic nylon filters (pore size 0.45μm) were placed over 90 mm upturned plastic Petri dishes, and attached to the ~~sediment~~ saltmarsh surface by two small staples, so that the nylon filter lay level with the sediment surface. The resolution of this method (i.e. the smallest accumulation increment detectable), using a 90 mm filter has been calculated as 0.0015 mg cm^{-2} (Thomas and Ridd, 2004).

Three replicates of each short-term trap were installed at the centre of each of the study areas described above during the summer of 2014/15. We chose to base our sampling strategy upon expected tidal inundation patterns rather than to capture seasonal variability for several reasons. First, based on relevant literature (Rogers et al., 2013) we expect tidal inundation patterns to be of primary importance to deposition and accretion dynamics. Second, we do not expect there to be substantial seasonal variability due to factors other than tidal pattern variation. That is, the study region does not experience high seasonal variability in rainfall, nor are there clear seasonal patterns in terms of biomass standing stock or senescence (Clarke and Jacoby, 1994).

Short-term Ttraps were deployed for 6 d (12 high tides) periods on four instances, on the basis of tide chart predictions. Two neap ('December neap' and 'January neap') periods were selected to reflect periods when high tides were at their lowest. While these neap periods were intended to measure periods without any inundation, higher than predicted tides occurred in both neap periods. Although unconfirmed, inundation of some plots within lower elevation zones of the study area were expected to have occurred at least once during the December neap (up to 80% of *Sarcocornia* plots and 100% of *Sporobolus* plots) and/or the January neap (up to 60% of *Sarcocornia* plots only) (Table S1). Two other periods ('December spring' and 'January spring') were selected as maximum saltmarsh inundation events with between five and ten high tides inundating each plot in each period (Table S1). Although unintended, the fact that a small number of inundations were likely captured during neap tides more accurately reflects the differences in tidal behaviour that naturally occurs among the three vegetation assemblages (i.e. lower elevation assemblages are subject to a greater number of high tides throughout the year than higher elevation assemblages). Consequently, all results from short-term measures were considered in the context of these varied inundation patterns.

Great care was taken not to disturb sediments or litter collected on, or surrounding the removable traps during their installation and collection. Filters with visible crab-excavated sediment (n = 23/180) or physically upturned during inundation (n = 3 January spring inundation only) were excluded from analysis, although all plant (autochthonous and allochthonous) materials were retained for analysis as we considered these to be largely unaffected by crab excavation.

In the laboratory, vials were centrifuged, the supernatant decanted and the vial was placed in an oven for drying. All samples and vessels (filters and centrifuge vials) were dried at 60°C until constant weight was achieved (≤ 72 h) and subtracted from initial vessel mass to obtain the dry weight of material collected. In addition, all identifiable litter was removed from each filter, identified to the species level and weighed. Litter samples of the main saltmarsh species encountered (*S. quinqueflora, S. virginicus* and *J. kraussii*), wrack of the seagrass *Posidonia australis* and macroalga *Hormosira banksii*, fresh leaves of the mangrove *Avicennia marina*, as well as composite samples of all residual sediment deposits (mineral component and unidentified organic matter; referred hereafter as 'residues') from filters were also prepared for chemical analyses.

2.5 Elemental and isotopic analysis

Elemental C and N content was measured in order to quantify C deposition rates and infer biomass, litter and soil consumption 'quality' (C:N). $\delta^{13}C$ was analysed to infer the source of samples relative to reference sources material and literature values. Dried aboveground plant biomass, litter and residues were homogenised and ground

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into a fine powder using a ball mill. The 'Champagne test' (Jaschinski et al., 2008) was used to determine that no residue samples contained inorganic C. Consequently, acidification of samples was deemed unnecessary. Organic %C, %N, and $\delta^{13}C$ were measured for all samples using an Isotope Ratio Mass Spectrometry – Elemental Analyzer (Thermo DeltaV) at University of Hawaii (HILO).

2.6 MIR

Diffuse reflectance mid-infrared (MIR) spectroscopy was used to assess the composition of biomass, litter and residue samples. MIR spectroscopy characterises the bulk composition and is therefore inclusive of both mineral and organic components. Spectra were acquired using a Nicolet 6700 FTIR spectrometer (Thermo Fisher Scientific Inc., Waltham, MA, USA) following the specifications and procedures outlined by Baldock et al. (2013a). Spectra were acquired over 8000–400 cm^{-1} with a resolution of 8 cm^{-1}, but were truncated to 6000–600 cm^{-1}. This spectral range was chosen to include significant signal intensity (including the first near-infrared overtones of the MIR spectra) in the range 4000–6000 cm^{-1} and allow appropriate baseline-correction, but also to exclude noise in the acquired signal intensity outside the selected spectral range. Spectra were baseline-corrected using a baseline-offset transformation and then mean-centred using the Unscrambler 10.2 software (CAMO Software AS, Oslo, Norway) before conducting principal component analysis (PCA).

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2.7 ^{13}C NMR

Solid-state ^{13}C nuclear magnetic resonance (NMR) spectroscopy was used to quantify the contribution of C functional groups to live plant biomass, litter and residue samples. This was carried out to identify what compositional changes occurred between the different sample types, and to what extent this differed between vegetation assemblages and inundation periods. Residue samples were treated with 2% hydrofluoric acid (HF) according to the method of Skjemstad et al. (1994) to remove paramagnetic materials and concentrate organic C for ^{13}C NMR analyses. Cross-polarization ^{13}C NMR spectra were acquired using a 200 MHz Avance spectrometer (Bruker Corporation, Billerica, MA, USA) following the instrument specifications, experimental procedures and spectral processing outlined by Baldock et al. (2013b). ^{13}C NMR data are presented as the proportion of integral area under each of eight chemical shift regions corresponding to main types of organic functional groupings found in natural organic materials: Alkyl C (0-45 ppm), *N*-Alkyl/Methoxyl (45-60 ppm), *O*-Alkyl (60-95 ppm), Di-*O*-Alkyl (95-110 ppm), Aryl (110-145 ppm), *O*-Aryl (145-165 ppm), Amide/Carboxyl (165-190 ppm) and Ketone (190-215 ppm) (Baldock and Smernik, 2002).

2.8 Statistical analyses

Separate simple linear regression analyses were conducted using all feldspar MH measurements for each of the three vegetation assemblages for the purpose of obtaining accumulation rates over 19 months and to assess the strength of linear fits for these data. Bulk short-term deposition variables (bulk material collected in vials; bulk material collected on filters) were log-transformed to achieve normality and analysed with separate linear mixed models, to test main and interactive effects of vegetation assemblage (*Sarcocornia*, *Sporobolus*, *Juncus*) and tidal event (repeated measures: December neap, December spring, January neap, January spring) on the amount of material retained at the end of a deployment period. Elevation was included as a covariate for each of these analyses. Covariance structure was selected for each model through comparison of Akaike's Information Criterion

(AIC) of four covariance structures (unstructured, compound symmetry, diagonal, scaled identity). Where main effects presented significance differences (P < 0.05), post hoc tests (with conservative Bonferroni adjustment) were used to determine difference among levels of vegetation and tidal event factors. Data are presented as the mean ± standard error (SE) as there was some minor variation in samples numbers among assemblages and events (as described above). Statistical analyses were performed using SPSS v19 (IBM, USA), Origin Pro 2015 (OriginLab, USA) and PRIMER v6 (PRIMER-E, UK).

2.8.1 Isotope mixing model

A two-source, single isotope mixing model (Phillips, 2012) was used to estimate the proportion of C3 (f_1 in equation (1)) and C4 (f_2 in equation (2)) plants to the unidentified organic residue (i.e. the material leftover after macrolitter was removed):

$$f_1 = \frac{\delta^{13}C_{residue} - \delta^{13}C_{C4}}{\delta^{13}C_{C3} - \delta^{13}C_{C4}} \quad (1)$$

$$f_2 = 1 - f_1 \quad (2)$$

where $\delta^{13}C$ denotes the isotopic signal of different sources of organic C: $C_{residue}$ ~~denotes (~~the residue organic C); ~~,~~ C_{C3} ~~denotes the $\delta^{13}C$ of the (~~relevant C3 plants - ~~(~~*S. quinqueflora* litter for *Sarcocornia*-*Sporobolus* association residues or *J. kraussii* litter for *Juncus* assemblage residues); and C_{C4} ~~denotes $\delta^{13}C$ of (~~litter of the C4 species ~~(~~*S. virginicus*).

2.8.2 MIR analysis

Principal components analysis (PCA) was performed using the transformed MIR spectra to: 1) identify differences in composition among samples due to sample type and vegetation assemblage; and 2) define the MIR spectral components most important to differentiating the samples. Loadings were plotted for the first two principal components to assist in the latter and to guide interpretation of differences in composition among samples.

3 Results

3.1 Feldspar MHs

Net accretion (i.e. vertical surface accumulation) ~~Positive and consistent accretion~~ was measured among *Juncus* plots throughout the entire 19 months, reflected in the moderate-strong linear fit (R^2 = 0.68; P <0.001) and a mean accumulation rate with relatively low variance (1.74 ± 0.13 mm y^{-1}). In contrast, accumulation above the feldspar MHs was more varied and slower overall in the *Sarcocornia* (R^2 = 0.16; P <0.001; 0.76 ± 0.18 mm y^{-1}) and *Sporobolus* plots (R^2 = 0.14; P <0.001; 0.88 ± 0.22 mm y^{-1}) (Figure 2). Accretion varied both spatially and temporally within the *Sarcocornia* and *Sporobolus* assemblages. Across *Sporobolus* plots, there was relatively high accretion recorded at the 11-month interval, followed by multiple peaks and troughs in the amount of height of material measured above MHs, with some similarity among replicate plots in the timing of these (Fig 2b). After modest gains at the 11-month interval, *Sarcocornia* accretion diverged among plots with two plots (*Sarcocornia*

2 and 5) experiencing continued accretion, whilst *Sarcocornia* 3 and 4 appeared to lose surface material through the remainder of the study. The pattern of accumulation and loss observed between 13-19 months at *Sarcocornia* 1 was mirrored in the nearby *Sporobolus* 1 plot.

3.2 Short-term deposition

3.2.1 Vials

Mean bulk material deposition rates as determined by vials were higher than filter bulk deposition rates across all sampling events and vegetation assemblages (Table 1). Observations of materials retained within vials suggested a dominance of mineral matter and unidentified detritus, except in *Juncus* plots where *Juncus kraussii* fragments were the dominant material.

Deposition varied significantly among tidal events ($F_{6, 42} = 10.01$; $P < 0.001$), with post-hoc tests revealing each event as significantly different to the others. Despite large differences in mean deposition among the three vegetation assemblages during December spring, January neap and January spring events (Table 1), vegetation assemblage was not a significant factor when elevation was included as a covariate ($F_{2, 45.8} = 1.06$; $P = 0.36$). There was, however, a significant event × assemblage interaction ($F_{6, 42} = 10.01$; $P < 0.001$), with deposition in *Sarcocornia* vials higher during January neap relative to December spring for *Sarcocornia* plots, but not so for *Sporobolus* and *Juncus* vials (Table 1). Deposition into vials was lowest for all three assemblages during December neap (Table 1) and was highest overall in *Sarcocornia* vials during January spring (275.93~~100.78~~ ± 89.62~~32.73~~ mg cm^{-2} d^{-1}).

Regression of the log (mass of material retained within vials) versus plot surface elevation revealed no clear relationship between the two variables during the December neap period (Fig. S1a), but ~~significant~~ negative relationships ($P<0.001$, R^2 ~~>~~= 0.35 to 0.59) existed for all other time periods (Fig. S1b-d). That is, there were broad trends of higher sedimentation at lower elevation plots than higher elevation plots during these periods.

3.2.2 Filters

Retention of bulk materials on filters also varied among all four tidal periods ($F_{3, 109.3} = 48.82$; $P < 0.001$), with overall deposition highest in January spring, followed by December spring (Table 1, Fig. 3). Bulk deposition on filters varied among vegetation assemblages ($F_{2, 30.85} = 48.82$; $P = 0.004$), with significantly lower deposition in *Sporobolus* plots relative to both *Sarcocornia* (Bonferroni adjusted P-value = 0.010) and *Juncus* (Bonferroni adjusted P-value = 0.023) plots across all tidal events (Fig. 3; Table 1). In contrast to the vials, there was no clear relationship between bulk material retained on filter papers and plot surface elevation during either of the neap or spring tidal events (Fig. S2).

Although the mass of bulk material retained on filters was similar across *Sarcocornia* and *Juncus* plots, Fig. 3 demonstrates that different materials were contributing to surface accumulation among the two vegetation assemblages. In *Juncus* plots, autochthonous plant litter (that is, from the dominant species *Juncus* kraussii and the sub-dominant species *Sporobolus* virginicus) contributed between 66% (December neap) and 78% (both December spring and January neap) of all deposited material mass. In contrast, litter contributions were low (≤ 12% of all deposited material) in both *Sarcocornia* and *Sporobolus* assemblages, regardless of tidal period. Contributions from identifiable allochthonous materials were low in all cases, with negligible quantities of *Posidonia australis* litter (recorded in five out of all 60 *Sporobolus* filters) and a single large piece of *Hormosira*

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banksii deposited on a *Sporobolus* filter during December spring – the latter was considered an outlier and was therefore excluded from Fig 3.

Chemical analysis of the unidentified portion of material deposited on filters also highlights differences between the vegetation assemblages. The organic content (%C, %N) of unidentified material pooled across *Juncus* plots was much higher than for the other assemblages (Table S2), with this difference also apparent in the disparity between C accumulation rates in *Juncus* versus *Sarcocornia* and *Sporobolus* assemblages (Table 1).

3.3 Elemental and isotopic ratios

Elemental C:N ratios and $\delta^{13}C$ values of plant biomass, litter and unidentified residues are presented in Table 2. The biomass and litter samples of the C4 grass *Sporobolus* were more enriched in ^{13}C relative to those of the C3 species *Sarcocornia* and *Juncus* (Table 2). This distinction, however, was not as great for the unidentified residue samples, with $\delta^{13}C$ values from all assemblages sitting between the $\delta^{13}C$ values of the C3 and C4 saltmarsh plants. Outputs from the isotope mixing model (Table 1) highlighted differences in source contribution among the vegetation assemblages. *Sarcocornia* residues showed a higher contribution of C3 plant material during spring tides relative to the neap tides. Further, similar contribution from the host plant (i.e. C3 in *Sarcocornia* and C4 in *Sporobolus*) to residues was apparent for all tidal periods except January neap, when the C4 contribution to *Sporobolus* residue was higher. Overall, contributions of the host plant ranged from 59.6 – 77.5 % in *Sarcocornia* plots and 61.7 - 80.1% in *Sporobolus* plots.

Source contributions across the four tidal periods were most consistent in the *Juncus* assemblage, where estimates ranged between 78.8% and 84.6% for C3 plant material and 15.4 - 21.2% for C4 plant material. These contributions aligned well with visual observations of plant cover across plots (where the C3 plant *J. kraussii* is dominant over the C4 plant *S. virginicus* in approximately an 80:20% biomass mix). Quantification of litter fall onto filters, however, highlighted a skew towards *J. kraussii* litter (85.9 – 97.0%) over *S. virginicus* litter (3.0 – 14.1%) across the *Juncus* assemblage. Residue C:N ratios were also highest for *Juncus*, followed by *Sporobolus* then *Sarcocornia*. While *Juncus* litter samples had a higher C:N, relative to all other *Juncus* biomass (Table 2), this difference was not noted for *Sarcocornia* nor *Sporobolus*.

3.4 MIR and ^{13}C NMR

Together, the first two principal components explained 96.4% of the variation in MIR spectra of all samples assessed. A clear separation of residue samples from litter and biomass is apparent along PC1 (Fig 4A) with inspection of the loadings plot (Fig 4B) highlighting variation in the range 600-2000 cm^{-1} (quartz), and distinct troughs at 3400 cm^{-1} (water) and 2900 cm^{-1} (OM-alkyl). Residue samples are separated along PC2, with differentiation among vegetation assemblages, regardless of tidal event. The loadings plot for PC2 (Fig 4C) also exhibits variation in the range 600-2000 cm^{-1} (quartz), a peak at 2900 cm^{-1} (OM-alkyl) and also 3600-3700 cm^{-1} (kaolinite).

The proportions of C within each of eight organic functional groupings for each sample analysed with ^{13}C NMR are presented in Table 2. For all samples O-Alkyl C was the most abundant. O-Alkyl C content was higher in live plant biomass than litter for both *Sarcocornia*, but less so for *Sporobolus* and essentially unchanged for *Juncus*. Generally, residues were higher in Alkyl C, and Amide/Carboxyl C, and lower in O-Alkyl, Di-O-Alkyl and aromatics relative to litter and biomass samples. There were differences in residue C composition according to which vegetation assemblage they were collected from –aromatics (higher in *Juncus* and *Sporobolus*), Alkyl C and Amide/Carboxyl (higher in *Sarcocornia*). There was high similarity between residues collected under the two different tides, however, for both the *Sarcocornia* and *Sporobolus* assemblages. These similarities among tides are mirrored in the similarity of the residue C:N values. There was insufficient residue material available for analysis from *Juncus* neap tide, even though samples were pooled across a large number of filters, further highlighting the small contribution of unidentifiable sedimentary components within this assembla ge.

4 Discussion

In this study we have compared sediment and C accretion dynamics among three vegetation assemblages within a single ~~n~~ intertidal wetland complex. Our findings, across a range of methods, showed that there were substantial differences among assemblages in: 1) the types of materials deposited on the marsh surface in the short term (days); and 2) the quantities of material accumulated over the medium-term (19 months). Here, we first consider the accumulation differences among assemblages over the medium~~-~~ term, and then discuss the interactions among vegetation, physical and degradation processes which are likely driving ~~these~~ short-term and medium-term differences among assemblages. We conclude with an assessment of the implications for C accumulation ~~and storage~~, and response to relative sea level rise (RSLR).

4.1 Accretion varies among vegetation assemblages

Surface accretion above feldspar MHs over a period of 19 months and deposition ~~within~~ measured with short-term sediment~~ation~~ traps provide evidence of the multiple ways in which deposition and accretion dynamics differ between saltmarsh vegetation assemblages. First, feldspar MHs highlight a record of continued and consistent accretion across the upper marsh *Juncus* assemblage, amounting to a reliable ($R^2 = 0.68$) accretion rate of 1.74 ± 0.13 mm y^{-1} (Fig. 2). This value is remarkably similar to the mean accretion rate measured over 10 years above feldspar MHs of 1.76 mm y^{-1} by Saintilan et al. (2013) for *Juncus* saltmarshes across a range of sites in SE Australia. In contrast, accretion above MHs in *Sarcocornia* and *Sporobolus* assemblages varied substantially– both spatially and temporally – in our study (Fig. 2), possibly due in part to the influence of erosion, bioturbation and sediment mixing above MHs (Cahoon and Turner, 1989; Krauss et al., 2003). While our mean accretion estimates for both *Sarcocornia* and *Sporobolus* are lower than the regional estimate for *Sarcocornia*/*Sporobolus* associations (1.11 ± 0.08 mm y^{-1}; ~~) (~~Saintilan et al., 2013), this regional mean is within the 95% confidence interval for both species at Towra Point (Table 1). Critically, medium-term accretion rates in the *Juncus* assemblage consistently exceed contemporary rates of sea level rise within Botany Bay (1.15 mm y^{-1}), while mean accretion rates for both *Sarcocornia* and *Sporobolus* (~~and even~~including the upper 95% confidence interval of *Sarcocornia)* are below the contemporary rate of sea level rise. These patterns of high marsh versus lower marsh accretion are also atypical of results reported outside of the study region (see section 4.2.2), and while in general agreement within previous data from our region, would benefit from validation across a broader network of sites.

4.2 Processes driving spatial variability in deposition and accretion

One of the key strengths of using short-term ~~accumulation~~ deposition methods is the ability to identify and quantify the composition of inputs which may be contributing to differences observed over the medium-term. In this study, a distinction was observed between the organ~~ogen~~ic deposition which dominated the *Juncus* assemblage (where medium-term accretion rates were consistently high) and the minerogenic deposition of the *Sarcocornia* and *Sporobolus* assemblages (where medium-term accretion rates were generally lower but ~~and~~ more varied). This distinction was best exemplified by the results of the short-term filter method (Fig 3.), where differences in the contributions of autochthonous litter and the residual sediment (comprising mineral and organic residue components) were stark. There was further evidence of this in the short-term vial results, where mineral-biased deposition was high in the lower elevation, non-rush assemblages, and low in the higher elevation *Juncus* assemblage during multiple experimental periods (Table 1; Fig. S1). Although higher than predicted tides likely influenced some short-term traps during neap experimental periods (Table S1), the fact that deposition into vials was lower during December neap (when up to 80% of *Sarcocornia* plots and 100% of *Sporobolus* plots would have been subjected to at least one tidal inundation) relative to January neap (up to 60% of *Sarcocornia* plots; no inundation of *Sporobolus* plots), suggests that this had a small impact relative to other influences. Non-tidal processes, such as rain- or wind-driven sedimentation and/or bioturbation are the most likely factors behind sedimentation when inundation was absent. Although filters with visible crab-excavated sediment (n = 23/180) were excluded from analysis, such clear identification was not able to be determined for sediments deposited in vials.

In the following sections we interpret the influence of biological, physical and interactive processes on saltmarsh surface dynamics at the sub-site scale. We do so by assessing the response of different surface deposition measures (~~2~~two short-term; one~~1~~ medium term) among the three vegetation assemblages studied.~~Together, the vegetation assemblage scale differences in short-term deposition and longer-term accumulation patterns observed in this study suggest further consideration of the biological, physical and interactive processes which are most responsible for the dynamics of saltmarsh surface materials is warranted~~.

4.2.1 The influence of vegetation on saltmarsh surface deposition~~The role of vegetation~~

The results of this study partially support our first hypothesis. That is, there were broad differences among the vegetation assemblages regarding the amount and type of materials deposited in the short-term and rates of accretion in the medium-term. The high spatial and temporal variability of marker horizon measurements across *Sarcocornia* and *Sporobolus* plots (Table 1; Fig 2A,B) limit interpretation of medium-term processes between these two assemblages. In contrast, the relative stability of medium-term accretion patterns in *Juncus* plots (Fig 2B) and unique short-term deposition results from *Juncus* plots (Table 1; Fig. 3; plus section 4.3.2) allow some interpretation of the potential role of vegetation structure on surface dynamics.

There are fundamental differences in vegetation structure and function which can at least partly account for the variations in the quantity and type of materials being retained in rush (*Juncus*) versus non-rush (*Sarcocornia* and *Sporobolus*) assemblages. First, *Juncus* assemblages have ~~massive~~ large potential for ~~direct organic sedimentation~~litter production through the annual replacement of their significant aboveground biomass (1116 g m^{-2}) (Clarke and Jacoby, 1994). No clear patterns of annual turnover have been observed in *Sarcocornia* and

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Sporobolus assemblages, where standing biomass is only about one-third that of the *Juncus* assemblage (Clarke and Jacoby, 1994).

There may also be indirect vegetation effects on the deposition and accumulation of surface materials. For instance, the tall (~1 m), dense structure of the *Juncus* assemblage is likely to enhance: 1) the retention of autochthonous litter (Fig. 3) which may have otherwise been exported during tidal recession, and 2) the capture of mineral particles on plant stems (Morris et al., 2002; Mudd et al., 2004). Dense saltmarsh vegetation also has the capacity to enhance sedimentation by reducing the turbulent energy of inundating waters, with Mudd et al. (2010) demonstrating that this phenomenon was responsible for virtually all of the sedimentation increase observed when standing plant biomass of *Spartina alterniflora* was artificially increased. The high short-term litter deposition rates we observed during neap tides (Fig. 3a,c) and the increased contribution of both mineral and litter components during spring tides (Fig 3b,d) suggested that each of these direct and indirect plant-mechanisms may be ~~operating and~~ contributing to the relatively high medium-term accretion rates observed within *Juncus* assemblages. ~~This supported the first element of our first hypothesis - that assemblage differences can be (at least partly) explained by differences in vegetation structure.~~

4.2.2 The influence of physical factors on saltmarsh surface deposition~~The role of physical factors~~

Differences in suspended sediment supply and tidal flooding characteristics (tidal range, position within the tidal prism) have been identified as key physical drivers of saltmarsh accretion (Chmura and Hung, 2004; Rogers et al., 2014). Generally, lower elevation within the tidal frame and closer proximity to the source of tidal inundation result in higher sedimentation rates. This is because: (1) greater flooding depth allows for greater suspended sediment volume and higher sedimentation;~~, and~~ (2) the increase in flooding duration increases the time for sediment deposition to occur;~~,~~ and (3) flooding frequency is higher at lower elevations (Baustian et al., 2012; Harter and Mitsch, 2003; Morris, 2007; Oenema and DeLaune, 1988). If these processes were operating in our site, we would have expected to observe higher sedimentation rates in the *Sarcocornia* and *Sporobolus* assemblages, which were generally both lower in the tidal frame (Table S1) and nearer to tidal sources (Fig. 1). Indeed, when measurements relevant to the mineral component were considered, our results appeared to be consistent with this. First, overall mineral retention on filters (Fig. 3) was highest in the *Sarcocornia* and *Sporobolus* assemblages. Second, mineral-biased deposition into short-term vials was shown to have a significant log-linear relationship with elevation during the periods of greatest tidal inundation (December spring, January spring), and during January neap when significant rainfall (Fig. S3) as well as some inundation of low elevation sites likely occurred (Table S2). Further, observations made during the first measurement of feldspar MHs at 11 months suggested a high mineral contribution in all *Sporobolus* and *Sarcocornia* plots, though it is unclear why this accretion trend reversed in many plots after this sampling event. Overall, ~~These~~ mineral-specific deposition results are largely ~~were therefore~~ supportive of the role of the physical position within the saltmarsh towards differences among assemblages ~~(i.e. part two of our first hypothesis)~~.

Importantly, ~~however,~~ the deposition-elevation relationship expressed by the mineral component, did not apply when bulk results of the passive short-term filter method were considered. With the mineral bias effectively removed, no clear relationship between elevation and bulk deposition was observed across any of the tidal periods (see Fig. S2). Instead, total deposition was similar between the minerogenic, lower elevation *Sarcocornia/Sporobolus* plots, and the organogenic, higher elevation *Juncus* plots.

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The lack of an elevation relationship in terms of bulk material deposition is somewhat contrary to spatial patterns expected on the basis of physical sedimentary processes in the tidal zone. This disparity extended to medium-term accretion results, where lower marsh (*Sarcocornia* and *Sporobolus*) assemblages accrete at a slower rate than upper marsh (*Juncus*), both in our study, and regionally (Saintilan et al., 2013). This relationship doesn't necessarily downplay the importance of tidal influence on surface dynamics in SE Australian saltmarshes. An alternative explanation is that these physical processes, in interaction with biological factors, are instead remobilising and redistributing materials across the lower marsh assemblages, rather than depositing significant amounts of 'new' allochthonous material.

4.2.3 Redistribution of surface materials

The second hypothesis of our study was that the source and character of materials deposited would vary temporally with tidal inundation patterns. For the most part, however, this was not observed, with high degrees of within-assemblage similarity for neap and spring tide samples across the various analyses undertaken (Table 2; Fig. 4). Instead, our results provide multiple lines of evidence that ~~point~~ suggest a ~~to the~~ redistribution of surface materials across the saltmarsh, mediated by a range of biological, physical and interactive processes.

The first indication of redistribution of surface materials was the mismatch between rates of short-term bulk deposition and patterns of medium-term accretion among vegetation assemblages. This was best exhibited in the *Sarcocornia* plots, where short-term measures showed deposition to be as high or higher in *Sarcocornia* plots relative to the other assemblages (Table 1; Fig. 3), while medium-term accretion was actually lowest here (Fig. 2). This suggests that short-term measures in this assemblage were capturing materials which were being moved or redistributed across the saltmarsh, but not necessarily retained in a given location over longer time periods (i.e. months). While the short- versus medium-term discrepancy was not as large for the *Sporobolus* assemblage, the temporal variability in medium-term feldspar MH measurements (i.e. multiple peaks and troughs across the 19 month period for most plots) also suggested significant redistribution of materials over time in this assemblage. Such movement of materials within the *Sarcocornia* and *Sporobolus* assemblages also fits with the expectation that hydrodynamic energy, and therefore potential for sediment redistribution, would be highest in the saltmarsh zones lower in the tidal frame and located closer to tidal sources (Fig. 1, Table S1). We also attribute the fading of feldspar horizons in many *Sarcocornia* and *Sporobolus* plots over time to mixing of sediments (Cahoon and Turner, 1989) in this active zone, with assistance from bioturbation (Cahoon and Turner, 1989; Krauss et al., 2003). In contrast, these temporal discrepancies and variations (including fading of MHs) were not observed in the *Juncus* assemblage, where hydrodynamic energy is expected to be greatly reduced as a result of both its position within the marsh and the influences of plant biomass (see discussion ~~above~~in 4.2.2).

Next, it was not expected that tidal inundation would substantially increase saltmarsh plant litter production. We therefore interpret the increased concentration of autochthonous litter in *Juncus* plots during spring tides relative to neap tides (Fig. 3) as evidence of the redistribution and trapping of autochthonous material within this assemblage. That is, the 'extra' spring tide litter was material that had been remobilised by inundating water and redistributed within the same community, resulting in a larger amount of material being caught on the *Juncus* filters. The fact that no identifiable *Juncus* litter was collected on any of the *Sporobolus* short-term filters, despite their position being within the expected path of receding tides (Fig. 1), further highlights the retaining capacity within the *Juncus* assemblage. While it is not known over what scale the litter redistribution is occurring in the

Juncus assemblage, we expect it to be highly localised, given the dense structure of standing vegetation here and its capacity to impede movement of coarse litter particles.

Finally, by placing our *Sarcocornia* and *Sporobolus* plots within small patches vegetated exclusively by either the C3 species (*S. quinqueflora*) or the C4 species (*S. virginicus*), we are able to estimate the contribution of each resident plant to the short-term residue collected from within its assemblage. While the dominance of resident plant signatures suggested a strong autochthonous contribution in all instances (see mixing model results in Table 1), residue signatures across all tidal periods reveal a mixture of sources both present (i.e. the resident plant) or neighbouring (i.e. the other co-dominant plant in the association) to the plots. The fact that contributions of sources other than the resident plant were in the order of 20 – 40% (Table 1) during the neap tides suggest significant mixing across scales greater than the monospecific patches (i.e. several metres or more). While some of this movement of materials may have been due to the creep of the highest neap period tides into the lower elevation plots (though this appears small - see section 4.2), non-tidal agents such as redistribution by rainfall (Chen et al., 2015) and faunal activity (Guest et al., 2004) may have also contributed.

It should be noted that our isotopic mixing model does not account for any degradation-related kinetic fractionation from plants to litter and sediments. Data in Table 2 suggest little to no fractionation between fresh biomass and partially decomposed litter samples, consistent with other studies comparing δ^{13}C between fresh and decomposing leaves of estuarine plant species (e.g. Zieman et al. 1984; Fry and Ewel, 2003; Saintilan et al. 2013). We cannot rule out the potential for isotopic fractionation occurring in the decay from litter to residue samples, however, and we recommend this as an area of future research.

A two source (C3 plant v C4 plant) mixing model probably presents an overly simplified estimate of source matter contributions. This is because it does not account for other potential sources which have δ^{13}C values within or near the range of saltmarsh plant sources prescribed in the mixing model. These include mangroves (-28.7 ± 0.3 ‰), seagrass (-12.3 ‰), macroalgae (-17.7 ‰) and benthic algae (-15.0 ± 0.4 ‰). Of these, benthic algae would have the greatest potential to contribute to *Sarcocornia* residue, as vegetation is sparsest here (and therefore light penetration to benthos the greatest), while the MIR PC plot (Fig. 4) also points to a similarity in chemical composition between the two. However, the fact that *Sporobolus* residues are consistently depleted in ^{13}C, relative to both the resident plant (*S. virginicus*) and benthic algae, show that our interpretation of mixing between both C3 and C4 sources is warranted at least in that assemblage. In contrast, the constancy of isotope signatures and their overall similarity with the mix of C3- and C4-derived biomass in the *Juncus* plots provide further evidence of the autochthonous nature and trapping capacity of this assemblage.

Together, these findings allow several ~~conclusions~~ hypotheses to be made about redistribution of surface materials. First, short-term deposition measures may capture a significant proportion of within-marsh redistribution and therefore may not necessarily equate with longer term accretion. Second, the capacity of vegetation to retain autochthonous ~~sedimentation~~ materials appears to vary substantially among species assemblages. Third, redistribution is likely to be greatest in more exposed, lower-biomass assemblages. These findings also highlight the importance of considering redistributed materials in quantifications of wetland surface dynamics, and likely shortcomings for studies which attempt to assess surface dynamics using only short-term methods.

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4.3 Implications for wetland functioning

Understanding the biological and physical feedbacks which affect surface dynamics is critical to predict the survival of intertidal wetlands and their associated ecosystem services, under changing environmental conditions (Kirwan and Megonigal, 2013). To this end, the data collected as part of this study reveal patterns of how C ~~sequestration capacity~~deposition and accumulation, organic matter decomposition and vulnerability to sea level rise vary among saltmarsh assemblages.

4.3.1 C deposition and ~~sequestration~~ accumulation rates

The distinction between organogenic and minerogenic ~~assemblages~~deposits, and their respective locations within the tidal frame, has important implications for surface C ~~sequestration~~ deposition and accumulation rates. Here we estimate mean C deposition rates ranging from 0.10 to 0.62 ~~0.03 to 0.23~~ mg C cm^{-2} d~~y~~$^{-1}$ across the four tidal periods for the minerogenic *Sarcocornia* and *Sporobolus* assemblages and 1.14~~0.41~~ to ~~0.87~~2.37 mg C cm^{-2} d~~y~~$^{-1}$ for the organogenic *Juncus* assemblage (Table 1). It should be noted that such short-term C deposition rates inclusive of plant litter will likely represent a massive overestimation of C that is retained and sequestered over longer timescales, due to diagenesis of deposited OM (Duarte and Cebrian, 1996), and the potential for materials to be redistributed or even exported by tidal and non-tidal processes (see section 4.2.3). Therefore, these deposition rates are not directly comparable to C accumulation rates determined by medium-term (e.g. feldspar MH) or longer term (e.g. radiometric dating) techniques. Notwithstanding this, the magnitude of the differences we report among assemblages above fit broadly with differences in regional estimates of C accumulation over the medium-term (10 y MH experiments) which have been estimated as 4.5 times higher in *Juncus* relative to *Sarcocornia-Sporobolus* saltmarsh (Saintilan et al., 2013). Similarly, our results are also in agreement with findings further north in Moreton Bay, where Lovelock et al. (2013) reported much higher C sequestration rates on oligotrophic sand island marshes dominated by *J. kraussii*, than *S. quinqueflora* dominated marshes on the western side of that bay.

4.3.2 Chemical composition of deposits ~~Decomposition of organic matter~~ varies among assemblages

We have assessed the chemistry of aboveground biomass, litter and unidentified residues through elemental (C:N) and spectrometric (MIR spectroscopy, ^{13}C NMR) methods. ~~Together, these analyses have revealed insights into the fate of aboveground organic matter and the likelihood of their contribution to longer-term sedimentary carbon stocks.~~ Most importantly, our results highlight ~~among~~ assemblage differences in the transformation of OM along the biomass-litter-~~sediment~~ soil decay continuum.

Shifts in the bulk composition of materials was best seen in the principal components plots of MIR spectra, where biomass, litter and ~~sediment~~ soil residue samples varied across PC1 (Fig. 4a). Broadly, the separation of residues from litter and biomass was primarily due to the addition of mineral components in the residues, however, there was also evidence of a shift in alkyl OM. Specifically, the presence of a single peak at ~2900 cm^{-1} in the loadings plot (Fig. 4b) was indicative of a declining cellulose content across PC1, that is, in the general order live biomass – litter – residue. Importantly, cellulose also appears to be a factor in the separation of residues from the three different saltmarsh assemblages along PC2 (Fig. 4c), suggesting higher content in the two *Juncus* samples, followed by *Sporobolus* and then *Sarcocornia* samples. This finding was confirmed by ^{13}C NMR data, which showed greater proportions of plant compounds (carbohydrates more broadly, as well as lignin) were retained within the *Juncus* litter and residue relative to the other species (Table 2). In contrast, the higher proportions of alkyl–C and amide/carboxyl–C within *Sarcocornia* and *Sporobolus* residues were indicative of higher protein and lipid contents, consistent with bacterial biomass and marine algae signatures (Dickens et al., 2006). However, they may also be partly explained by the selective retention of resistant plant waxes, such as suberin and cutan. We therefore reject our third hypothesis that decay patterns would show no differences among the vegetation assemblages.

There are multiple mechanisms which may explain the greater retention of plant-derived C along the biomass-litter-residue pathway for *Juncus*, relative to the other assemblages. The simplest explanation is that a high turnover of *Juncus* biomass (and its exclusion of other sources through shading and/or structural impedance) ensures ample supply of plant-derived C to the benthos. Our data, however, reveal an important biomass-to-litter transformation in *Juncus* that was not observed in either the *Sarcocornia* or *Sporobolus* assemblage. That is, the C:N of *Juncus* litter increased substantially relative to live biomass. Such an increase is commonly observed in terrestrial (McGroddy et al., 2004) and marine (Stapel and Hemminga, 1997) plants and may be explained by the selective resorption of nutrients (but not carbon) by the plant prior to, or during, senescence (McGroddy et al., 2004; Stapel and Hemminga, 1997). Such a mechanism was supported by the constancy of molecular C composition between *Juncus* biomass and litter (Table 2). The selective resorption of N by a plant has important implications for the fate and processing of the resulting litter and residue, as tissue C:N is considered a primary determinant on saltmarsh organic matter decomposition (Minden and Kleyer, 2015). By retaining nutrients within the living tissues, the plant effectively decreases the lability of resulting litter and residual sediments soils and makes them less attractive to the microbial decomposer community (Hessen et al., 2013; Sterner and Hessen, 1994)(Reddy and DeLaune, 2008). This will have the effect of lowering OM remineralisation rates in *Juncus* relative to other assemblages, a result which also coincides with the bacterial and/or marine algae signatures (Dickens et al, 2006)biomass increases suggested inferred for *Sarcocornia* and *Sporobolus*, but not apparent within the more recalcitrant *Juncus* residues (Table 2). Finally, there may also be an element of physical protection, with the closed structure of the *Juncus* assemblage potentially offering increased protection against decomposition with lower, more stable temperatures expected at ground level, relative to the more exposed *Sarcocornia* and *Sporobolus* assemblages.

Together, these data from SE Australia contribute to a broader pattern of plant assemblage differences in saltmarsh surface dynamics and C sequestration potential (Minden and Kleyer, 2015; Saintilan et al., 2013; Wang et al., 2003). They also highlight the likelyshort-term processes which may contribute tobehind the high capacity of *Juncus* saltmarshes to accumulate significant C stocks globally (0.034 g C cm^{-2} y^{-1}, or 0.093 mg C cm^{-2} d^{-1}), relative to most other saltmarsh genera (mean C accumulation rate = 0.024 g C cm^{-2} y^{-1} or 0.066 mg C cm^{-2} d^{-1}) (Ouyang and Lee, 2013).

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4.3.3 Vulnerability to sea level rise

There is growing evidence of the capacity of coastal wetlands to maintain surface elevation with relative sea level rise (RSLR), in certain situations, by increasing surface elevation through belowground production, enhanced trapping of sediments, or a combination of the two (Baustian et al., 2012; Kelleway et al., 2016b; McKee et al., 2007). Where wetland assemblages are unable to maintain a suitable elevation relative to inundating water levels, then vegetation shifts may occur, including the loss of marsh vegetation (Day Jr et al., 1999; Day Jr et al., 2011;

Rogers et al., 2006). While wetland surface elevation is a function of multiple factors, including belowground production and decomposition, groundwater dynamics and sedimentary and regional subsidence (Cahoon et al., 1999; Rogers and Saintilan, 2008), the retention of aboveground inputs play a critical role in wetland survival under changing hydrological conditions (Day et al., 2011).

With this in mind, ~~our~~ medium-term accretion data suggest that *Sporobolus* and *Sarcocornia* assemblages at our study site may be particularly vulnerable to current RSLR. That is, ~~with~~ mean surface accretion rates were either lower (*Sarcocornia* = 0.92 mm y^{-1}) or only marginally higher (*Sporobolus* = 1.30 mm y^{-1}) than contemporary rates of local sea level rise within Botany Bay (1.15 mm y^{-1}). ~~In fact, there is already evidence of this a~~Across much of the Towra Point Nature Reserve (~~,~~ as well as elsewhere in the region)~~,~~ ~~where~~ upslope encroachment of mangrove shrubs into *Sarcocornia*-*Sporobolus* association is occurring, possibly in response to sea-level rise (Kelleway et al., 2016b). In contrast, vegetation change (either in the form of mangrove encroachment or dieback) has not been widely reported for *Juncus* assemblages across SE Australia over recent decades, suggesting relative stability during a time of changing sea levels. While belowground biomass production likely plays a role, average *Juncus* surface accretion rates (1.70 mm y^{-1} in this study; 1.76 mm y^{-1} regionally) in excess of local RSLR suggest a potential role of aboveground inputs towards maintaining surface elevation. Dependence upon organogenic inputs for accretion, however, also means the response of *Juncus* assemblages to RSLR may vary with shifts in productivity or decomposition dynamics (e.g. changes in climate and/or nutrient status). Under present conditions, at least, our analyses have shown these organic inputs to be relatively resistant to early decomposition. In all, our findings are also supportive of recent research which suggests organic ~~sediment~~ accretion may be of critical importance in marsh survival under RSLR, particularly in areas most removed from inorganic sediment delivery (D'Alpaos and Marani, 2015). Whether belowground organic matter production makes substantial contributions to Australian saltmarsh surface elevation dynamics and vulnerability to sea level rise remains unknown, and represent an important area for further research. Better understanding of the temporal dynamics of organic and mineral contributions to elevation maintenance is also required, including in relation to expected non-linear increases in sea level.

By combining medium-term accretion quantification with short-term deposition measurements and chemical analyses we have gained insights into the various processes behind observed differences in accretion among saltmarsh vegetation assemblages. While our study highlights assemblage~~-~~-scale differences in potential response to RSLR, it represents only a small part of the information needed to accurately predict the future of SE Australian saltmarsh assemblages. Further measures of short-term deposition and medium-term accretion across a broader range of sites and geographical settings, longer-term studies of ~~soil~~ surface elevation change among assemblages and modelling of vegetation response thresholds are all required.

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