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## Comment on os-2020-121

David Pugh (Referee)

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Referee comment on "Preface: Developments in the science and history of tides" by Philip L. Woodworth et al., Ocean Sci. Discuss., <https://doi.org/10.5194/os-2020-121-RC2>, 2021

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Review of the Preface to "Developments in the science and history of tides"

By Woodworth, Green, Ray and Huthnance.

Emerson wrote that an Institution is the lengthened shadow of one man. For the Liverpool Tidal Institute, make that two: Joseph Proudman and Arthur Doodson. When the LTI was formed in 1919, they were Director and Secretary respectively. Gradually the importance of the Institute increased through a combination of scientific excellence, and the demands from shipping for reliable tidal predictions. Today as part of the UK National Oceanographic Centre the work on sea level and tides, recently focussed on climate change studies and flooding risks, remains world class.

This Special Edition celebrates the 100<sup>th</sup> anniversary of the LTI with a collection of 25 papers, accreted since 2019, by a worldwide array of authors, on the general theme of tidal research, following in the 1919 tradition. Many Special Editions fail because the editors neglect to sustain a coherent narrative justifying and connect the contributions. Here the four editors provide their cohering preface. The challenge is to chronicle the development of the LTI, and to relate the component chapters in the Edition to the

development of tidal science more generally. This is a difficult balance to achieve in a brief preface: they succeed admirably.

The structure of their overview has three components. The first describes the establishment of the LTI in 1919, and the leading roles of Proudman and Doodson. It could have maybe recognised the way in which David Cartwright's time as Director sustainably boosted the academic excellence of the laboratory: another shadow, for the future.

The second part looks at the development of tidal science historically, as reflected in the Special Edition chapters, focussing on the boosts given to tidal, as of course all science, by technology breakthroughs. For tides these are: measurement technology, both *in situ* and later, satellite altimetry; and the advent of computers capable of numerically modelling ocean dynamics with high spatial resolution. The LTI, then called the Institute of Oceanographic Sciences, played an important role in the *in situ* instrument development , and in building numerical models for flood warnings and for more esoteric tidal scientific topics such as third-diurnal tides. This is neatly covered in the preface, and indeed in the Special Edition chapters. Other aspects include earth tides, and the use of GNSS coordinates to integrate sea- and earth-tidal observations. This section then takes a different cut at the themes in the 26 papers, relating many to wider developments in tidal science. The integration of a wide range of topics is conceptually difficult and challenging, but it works well in this Preface. Overall the message is that tidal science has an expanding diversity of applications across other disciplines...one of the principal reasons for having this EGU Copernicus Special Edition.

The final, brief though encouraging, section is a short look to the future of tidal science. More understanding of tides in coastal waters, especially with more focussed altimetry, and better understanding of paleotides...linking to geological sciences , are presaged. Tides have always impacted on a wide spectrum of earth sciences, and will continue to do so. Another promising area of investigation is the role of vertical ocean mixing and heat transfer influenced by tidal energy dissipation, on past and future climates. The editors might have added biological tidal interactions.

Overall, this Preface is very well done. It justifies the Special Volume and its contents, while enlightening both the expert and casual reader about an important century in scientific tidal studies. In presenting it as a "snapshot of present activity", it is important to emphasise that the subject is as actively pursued now as at any time previously. Emerson's shadows are multiple and still very mobile!

No significant changes are needed or suggested, though for balance and emphasis the authors might consider the following small amendments.

Line 182 "around the coast of the *United Kingdom*, and control of the Thames Barrier."

Line 207 "called. Cartwright's contribution to tidal science in the latter half of the 20C was immense, and he raised the intellectual level of the Institute's contribution enormously. The team..".

Line 268 This points to an almost inevitable detailed historical publication on the evolution of tidal science and the contributions of the LTI and its successors. This Preface is a good starting point. Schoffield (2006) is a delightful publication dealing with the people rather than the science.

Line 301 The main component of seasonal sea level variations is the steric effect of ocean warming and cooling. This is missing here.

Line 370 this paragraph should mention the important role of ocean internal tides in tidal energy dissipation, in vertical heat transfer, and hence climate variations.

Line 385 It would be nice, and a cyclical balance here to add: " By a neat coincidence, these biological drifters were deployed in the same area of the Irish Sea investigated by the Doodson and Proudman summer scientific cruises in the 1930s. Figure 2."

Line 409 replace "constituents" with "processes". Constituents just represent the shallow-water complexities, which are fundamentally the physical processes.

Line 432 "...in the history of tidal *science*. The work *advanced* at the LTI.." Tidal science was a major 19C part of the work of the BAAS and other organisations. It didn't *start* in 1919.

Line 434 "snapshot of the dynamic present-day spectrum of tidal research." More shadows for the future? *Snapshot* is good, but unqualified, could imply stagnation.

Does Special Issue mean a hard copy book publication? As a milestone in recording the progress of tidal science, it would be an appropriate and tangible permanent marker.