Dear Editor,

We take pleasure in submitting this manuscript, “**Global monitoring data shows grain size controls turbidity current structure”** for publication in *Geophysical Research Letters*.

This manuscript is the first paper to use a compilation of direct monitoring measurements from many locations worldwide to show fundamental controls on the velocity structure of turbidity currents. It will be of widespread interest because turbidity currents play a key role in sediment and nutrient transfer to the deep sea, and form the largest sediment accumulations on Earth. These seabed sediment flows affect global geochemical cycles, including the transfer and burial of organic carbon. They threaten critical seafloor infrastructure, and break seabed cables that carry > 99% of global data, underpinning global communications. Despite their importance, fundamental questions regarding the controlling factors on the structure of these flows remain open.

Turbidity currents are very challenging to measure directly. This is due to their proven ability to damage seafloor sensors placed in their path, as well as their hard to access deep-sea location, and relatively unpredictable occurrence. However, despite these major challenges, the last decade has seen a revolution in direct monitoring of turbidity currents. These individual case studies have led to a series of new models for what determines internal structure and behaviour of these submarine flows. To date, there has been no broad comparison of velocity measurements between multiple different sites, which is needed to determine underlying general patterns and controls.

Here, we take advantage of the recent availability of detailed turbidity current monitoring datasets at sites worldwide. We synthesise measurements from multiple systems to test previously-proposed theories for the first time. Previous debate has centred on whether flow structure is determined mainly by how flows are triggered, grain-size, or physiographic setting. We demonstrate that grain size is the most fundamental control on flow structure; not the setting or initial trigger.

This study is novel because we analyse detailed turbidity current monitoring data from multiple (seven) systems worldwide, that span a wide range of environments. These environments include fjord-head delta systems, river-fed deep-sea canyons, and deep-sea canyons fed by littoral cells. This is the first such global and cross-site comparison of monitored turbidity current structure, allowing us to systematically investigate the diversity of turbidity current behaviour.

For the first time using full-scale field data, we then demonstrate that two end member types of flow structure exist. These end member flow types have distinctly different implications for hazards to seafloor structures and sediment and organic carbon transport. For example, muddy systems generate very prolonged flows with a velocity plateau, whilst sandy systems form much shorter-lived flows whose velocity decelerates rapidly after an initial abrupt peak.

The manuscript will be of interest to a broad range of geologists and geoscientists interested in hazard prediction and mitigation, sediment transport, global transport and burial of particles such as organic carbon and pollutants, including microplastics. As such, we consider this manuscript suitable for the broad readership of *Geophysical Research Letters*.

The abstract, text and captions contain 3734 words, which is equivalent to 7.5 publication units. There are 3 figures that accompany the manuscript, which brings the total number publication units to 10.5. We agree to pay for a colour submission of this manuscript.

We recommend the following reviewers:

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Thank you for your time in considering this submission.

Yours faithfully,

Daniela Vendettuoli on behalf of all co-authors