SandT-Pro

Sand Transport Process measurements under Breaking and Irregular waves

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Dataset description
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General remarks

The SandT-Pro experiments were conducted as part of the EC's 7th framework programme HydraLab IV (contract 261520).

When using this dataset, kindly cite the data as:

> Ribberink, J. S., Van der A, D. A., Van der Zanden, J., O'Donoghue, T., Hurther, D., Cáceres, I., & Thorne, P. D. (2014). *SandT-Pro: Sediment transport measurements under irregular and breaking waves*, 14 pp. Proceedings of the 34th International Conference on Coastal Engineering, Seoul, Korea. Doi 10.9753/icce.v34.sediment.1

About the experiments

The experiments were done in the CIEM wave flume at UPC, Barcelona, between November 2013 – January 2014. The primary objective of the experiment was the detailed investigation of sand transport processes under regular breaking and irregular non-breaking waves.

Measurements of hydrodynamic and sand concentration were obtained using a variety of instruments (see *Figure 1*) deployed from a mobile measuring frame. During the regular breaking wave experiments (from here on: 'RB' experiments), measurements were obtained at various cross-shore locations around an evolving breaker bar for two wave conditions, RB1 and RB2 (Table 1). The INB experiment involved five wave groups and three 'equivalent' monochromatic wave reference cases (Table 1). More details are found in the data report and in the ICCE paper by Ribberink *et al.* (2014) (see enclosed subfolder 1).

Table 1: Overview wave conditions. d_0 is the water depth at the wave paddle; T is the period of the short wave; H is the wave height with subscripts *rms*, *s* and *max* representing the root-mean-squared, significant, and maximum wave height of the wave group respectively; T_g is the period of the group; and n is the number of short waves per group.

Regular Breaking (RB)							
Run	***d0* (m)**	**Slope**	***T* (s)**	***H* (m)**	**# runs**	**Duration runs (min)**	**Remarks**
RB1	2.55	1:10	4.0	0.85	22	15 to 20	Plunging
RB2	2.65	1:20	4.0	0.95	26	20 to 30	Weakly plunging

Irregular Non-Breaking (INB), grouped waves									
Run	***d0* (m)**	**Slope**	***T* (s)**	H_{rms} **(m)**	H_s **(m)**	H_{max} **(m)**	T_g **(s)**	***n***	**Remarks**
IGB1	2.65	1:10	4.4	0.49	0.69	0.69	41.8	10	Bichromatic, fully modulated
IGB2	2.65	1:10	4.4	0.49	0.69	0.69	28.6	7	Bichromatic, fully modulated
IGB3	2.65	1:10	4.4	0.49	0.69	0.62	41.8	10	Bichromatic, partially modulated
IGM1	2.65	1:10	4.4	0.49	0.69	0.79	44.0	10	Waxing, fully modulated
IGM2	2.65	1:10	4.4	0.49	0.69	0.79	44.0	10	Waning, fully modulated

Irregular Non-Breaking (INB), monochromatic reference cases							
Run	***d0* (m)**	**Slope**	***T* (s)**	***H* (m)**	**# runs**	**Duration runs (min)**	**Remarks**
IM1	2.65	1:20	4.4	0.49	3	22	H equal to H_{rms} of groups
IM2	2.65	1:20	4.4	0.69	3	22	H equal to H_s of groups
IM3	2.65	1:20	4.4	0.79	2	22	H equal to H_{max} of IGM groups

The dataset has not been fully explored and processed. The RB dataset is potentially interesting, but within the SINBAD project the attention rapidly shifted to a follow-up experiment (SINBAD mobile bed experiment) that involved similar experimental objectives, conditions, and instrumentation.

The INB experiments were considered not fully successful due to the low velocities, leading to a rippled bed (while sheet flow conditions were targeted) and to poor data quality of the primary instrument, the ACVP (due to a lack of suspended particles). In addition, overall net transport rates were very low.

About the dataset

The present dataset stores the primary processed RB data:

1. Bed profile evolution
2. Wave heights
3. Time-averaged velocities (undertow)
4. Time-averaged suspended sediment concentrations
5. Grain size measurements

The dataset further stores the following raw data (for both the RB and the INB experiments):

- Water surface level time series
- Dynamic pressure time series
- Velocity time series
- Suspended sediment concentration time series

The data storage reports and the Excel logbooks can be used to explore the raw data files. Raw data files of other instruments (ACVP, Vectrino Profiler, CCM+, ABS, Sand Ripple Profiler) are available on request.

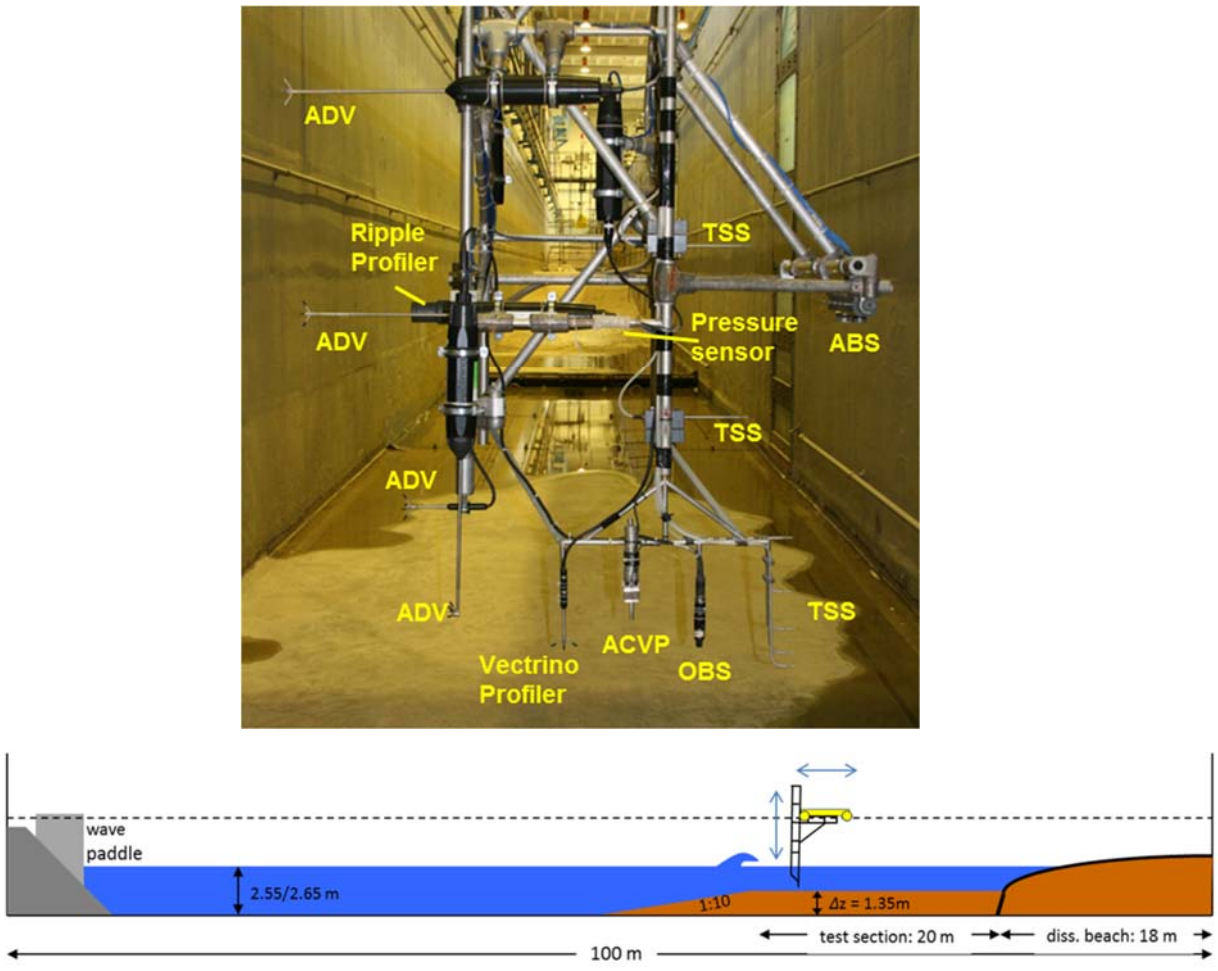

Figure 1. Mobile frame instrumentation (upper) and experimental set-up (lower).

RB experiment: some remarks

Waves were breaking at the crest of the breaker bar. Condition RB1 resulted in a plunging breaker. Note that this condition was later also used during a follow-up campaign (SINBAD experiment). The intention was to generate a spilling breaker with condition RB2 (through a milder offshore slope), but the breaking wave also ended up to be of a (weakly) plunging type.

Measurement procedures are fully explained in the data report. Runs were 15 to 30 min. Total number of runs: 22 (for RB1) and 26 (for RB2). Measurements were taken at various locations while the breaker bar developed (see Figures 2 and 3).

The measurement program in the data report (from p.29 onwards) is a useful reference. **Column 2** in this table lists the runs. Runs 1-22 are condition RB1; runs 57-82 are condition RB2.

Data processing steps are consistent with descriptions in Van der Zanden (2016) for the accompanying SINBAD experiment.

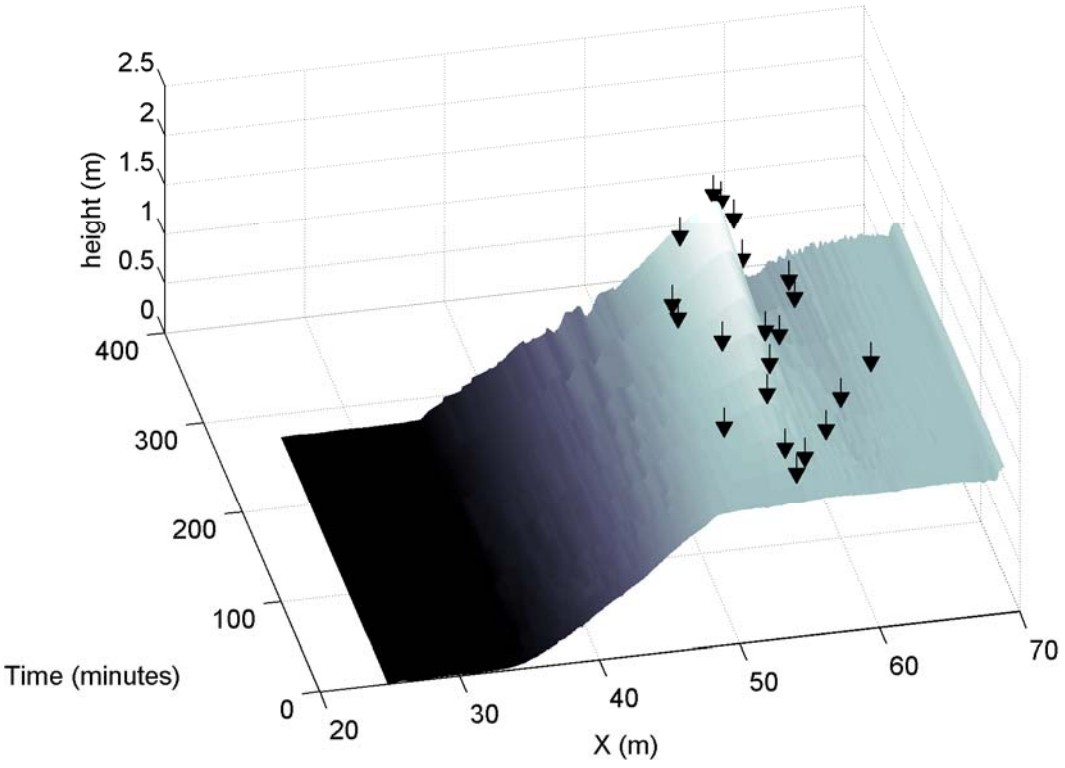

Figure 2. Profile evolution and measurement locations for condition RB1

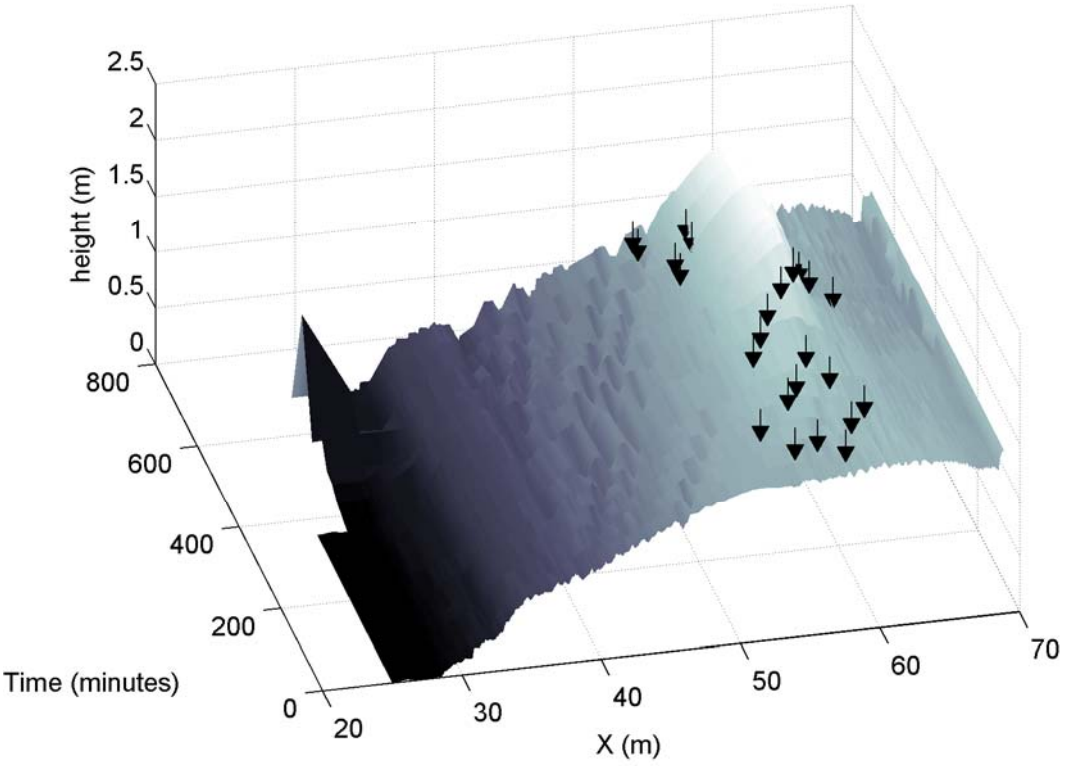

Figure 3. Profile evolution and measurement locations for condition RB2

Description processed data files:

1. Profile measurements

Data were collected along two transects using echo sounders. The data were cleaned and data gaps were then linearly interpolated.

Each file is a profile measurement, the time reference is found in the measurement program. Each file contains three columns: column 1 = x position in m, columns 2 and 3 are bed profile measurements of each sensor in m, with vertical datum at the flume's floor.

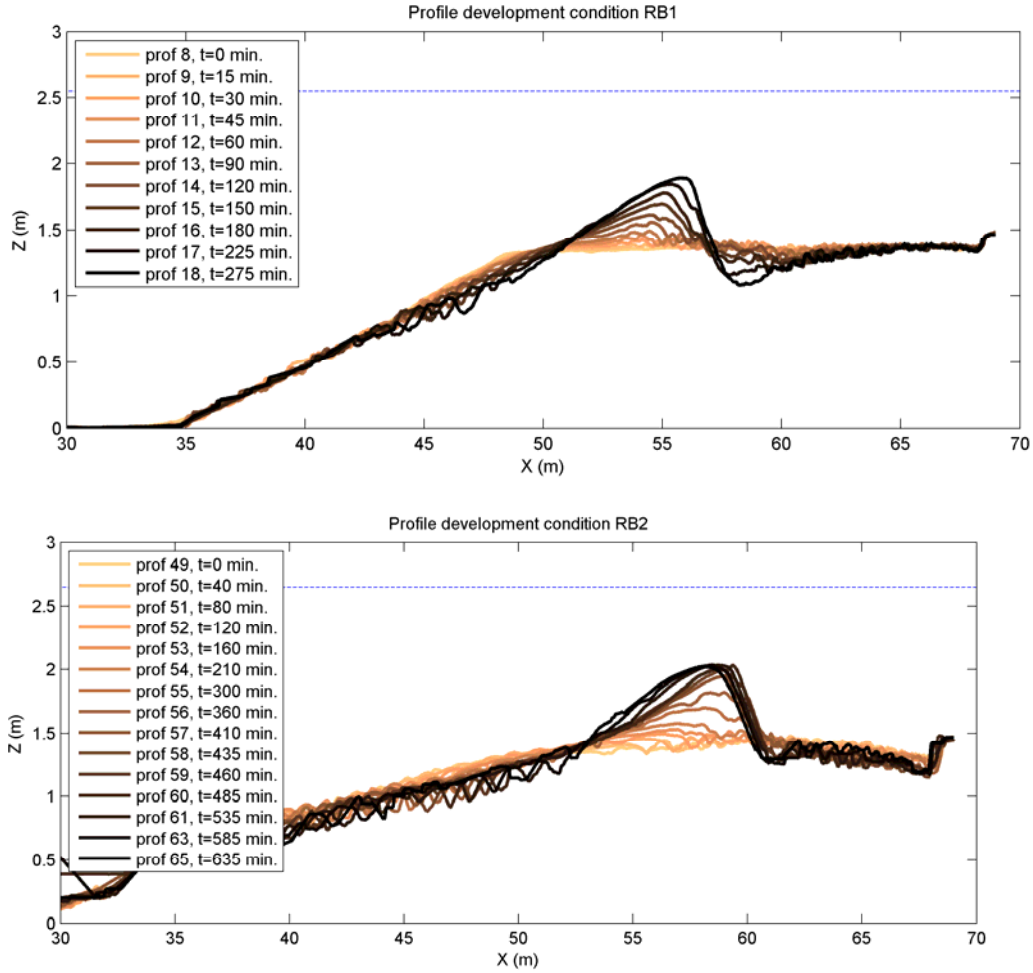

Figure 4. Bed profile evolution

2. Wave heights

Wave heights were obtained using resistive wave gauges (RWGs) and pressure transducers (PTs). The latter measurements of dynamic pressure were converted to water surface elevation through linear wave theory. Note that this underestimates the actual wave height with about 10%. The PTs also cannot capture the top of the water surface of the overturning breaking wave.

The RWGs did not always give good data due to several issues. Particularly in the surf zone the RWG measurements were contaminated with noise, as the splash up of the breaking wave affected the measurements. Poor measurements were identified and removed.

Filename: SandTPro_waveheight.txt

- First column is run number

- First row is header (RWG and PPT)
- Second row is *x* location in m
- From row 3: wave height in m

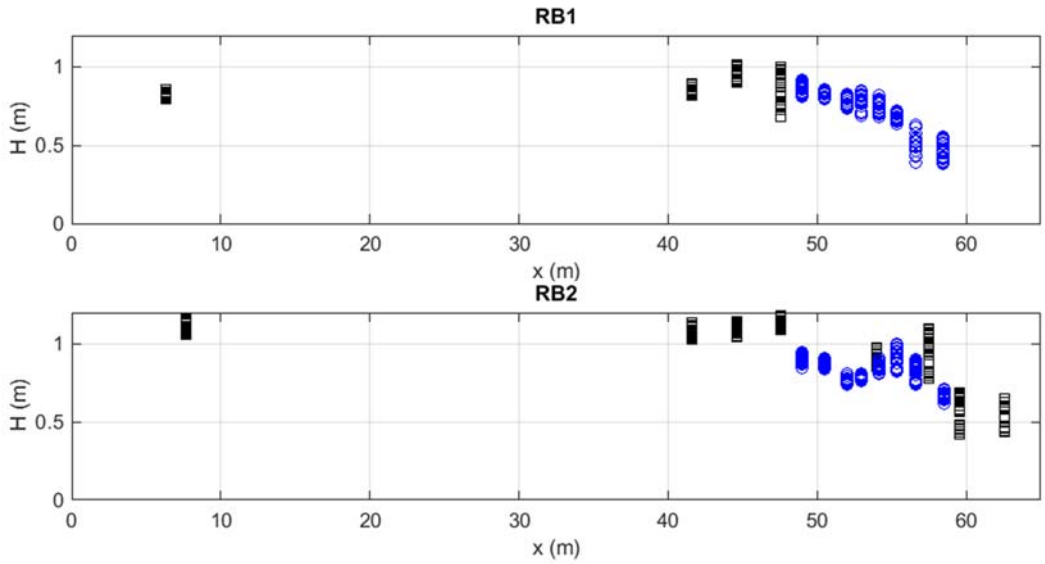

Figure 5. Wave heights for all runs; RWG (squares) and PT (circles)

3. Velocity measurements

Velocities were measured by ADVs deployed from the mobile measuring frame. The processed data folder contains the time-averaged velocities for each instrument, for each run. Data were de-spiked and phase-averaged before calculating the time-averaged velocity. Note that the mean is calculated over the 'wet period', that is, the fraction of the wave cycle where the ADV probe is in the air is not considered ('nanmean').

Data are contained in two files:

- umean_RB1.txt
- umean_RB2.txt

Each file contains the run number (column 1), the x location in m (column 2), the z location w.r.t. the bottom of the wave flume in m (column 3), the time-averaged horizontal velocity in m/s (column 4) and the time-averaged vertical velocity in m/s (column 5).

4. Concentration measurements

Transverse suction system (TSS) measurements of time-averaged concentrations. Because the collection of these samples was time-consuming, measurements were only taken for about half of the runs.

Data are contained in two files:

* TSS_RB1.txt
* TSS_RB2.txt

For each file:

- Column 1 is the run number
- Column 2 is the x location in m
- Columns 3 to 9 are the concentration measurements (kg/m^3)
- Columns 10 to 16 are the relative elevations w.r.t. the local bed level (in m)

The relative elevation was obtained by measuring the local bed level using an Aquascat ABS. The elevations are time-averaged over the run. There is a variability of +/- 3 cm in terms of relative elevation between the different runs (due to uncertainties in repositioning, due to bed evolution, and long-shore wave flume asymmetries for instance due to bedforms). This also explains the occasional 'negative' elevation.

Note that for condition RB2 the elevations of the suction nozzles were changed at some stages, in order to be able to lift the frame over the breaker bar (see also p.27 in data report).

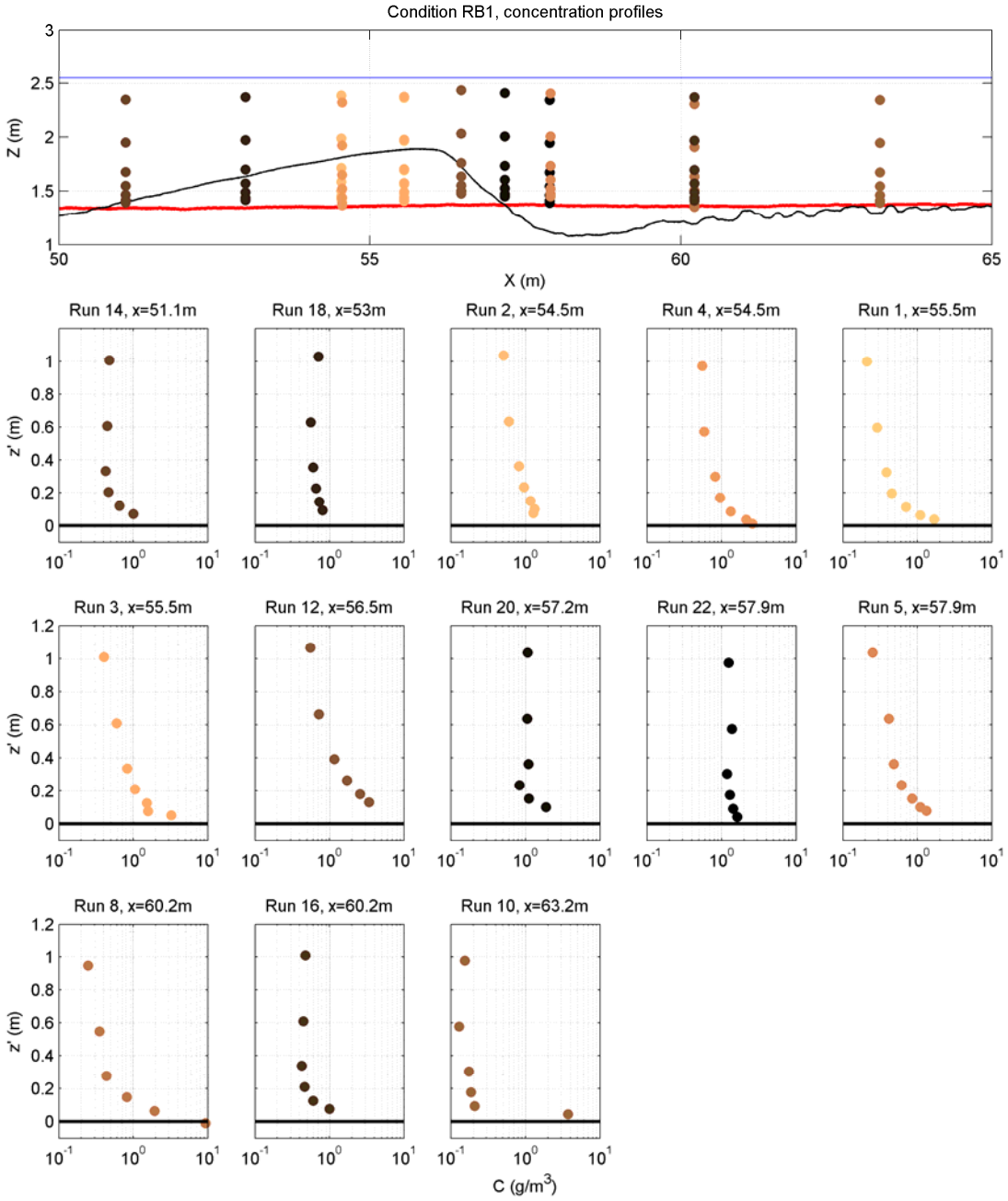

Figure 6. Concentration profiles condition RB1

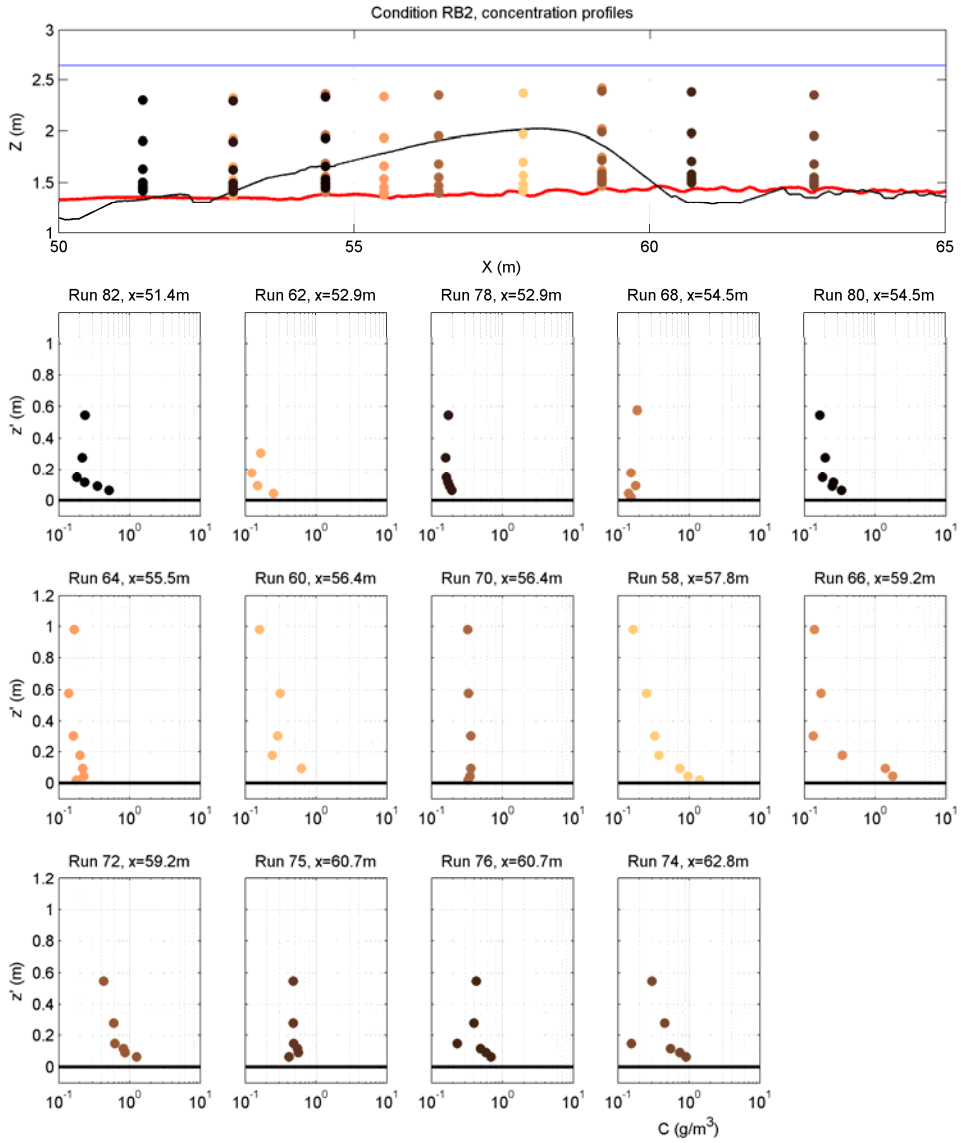

Figure 7. Concentration profiles condition RB2

5. Grain size measurements

Grain diameters of bed samples and of suspended sediment samples were analyzed using a Malvern laser-diffraction particle sizer. More information is found in the technical report 'Grain Size Analysis' of Sjoerd van Til, contained in subfolder 1.

The Excel file 'Grain size summary.xls' contains an overview of D_{50} measurements for each sample.

The original grain size data files, i.e. the written output of the particle sizer, contain the full grain size distribution for each sample. These data are contained in the Raw Data subfolder.

References

Ribberink, J. S., Van der A, D. A., Van der Zanden, J., O'Donoghue, T., Hurther, D., Cáceres, I., & Thorne, P. D. (2014). *SandT-Pro: Sediment transport measurements under irregular and breaking waves*, 14 pp. Proceedings of the 34th International Conference on Coastal Engineering, Seoul, Korea. Doi 10.9753/icce.v34.sediment.1

Van der Zanden (2016). *Sand Transport Processes in the Surf and Swash Zones*. Ph.D. thesis, University of Twente, Netherlands, 202 pp. doi: 10.3990/1.9789036542456