Understanding Aggregate Dynamics in Turbulent Shallow Waters using a New Modelling Approach

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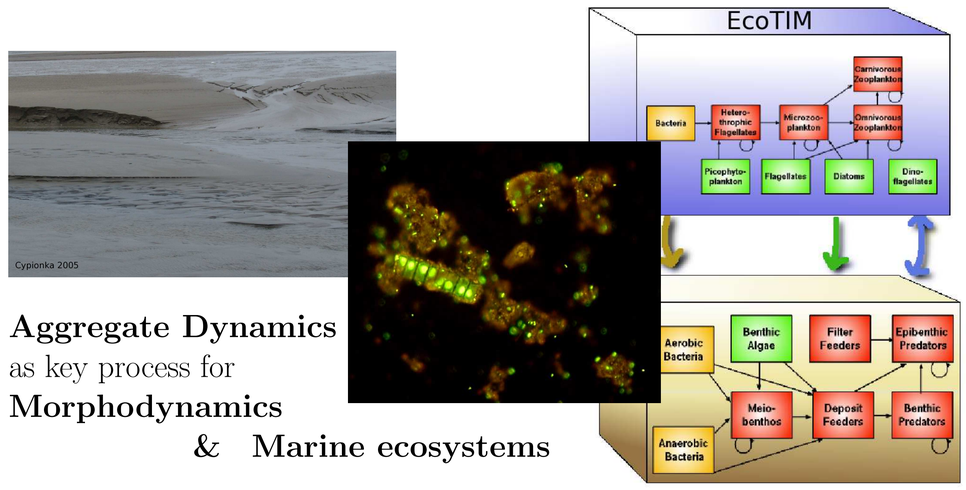
Aims and Motivation

- Aggregate dynamics in coastal waters play an important role in marine biogeochemical cycling as well as for morphodynamics
- Throughout the year, **S**uspended **P**articulate **M**atter (**SPM**) dynamics are changing due to **physical, biological and chemical environmental conditions** and their **complex interplay on various timescales**
- **Aim** of the study is to develop a **distribution based model** for **turbulent shallow waters** like the tidal backbarrier of the island of Spiekeroog (Germany) to **quantify** the relative importance of different processes
- Resolving a variable particle distribution, the model should be simple enough to be coupled to state-of-the-art hydrodynamic and/or ecosystem models



Aggregate Dynamics as key process for **Morphodynamics** & **Marine ecosystems**

Approach & Model

The model follows the approach of **E**ffective **V**ariable **A**pproximation (**EVA**) by Wirtz & Eckhardt (1996):

$$\frac{d}{dt}\langle r\rangle = \delta r^2 \cdot \frac{\partial RGR}{\partial r}(\langle r\rangle)$$

δr^2	variance
RGR	relative growth rate
$\langle r\rangle$	average radius of aggregate concentration distribution

- Average radius of aggregate concentration distribution is introduced as effective variable

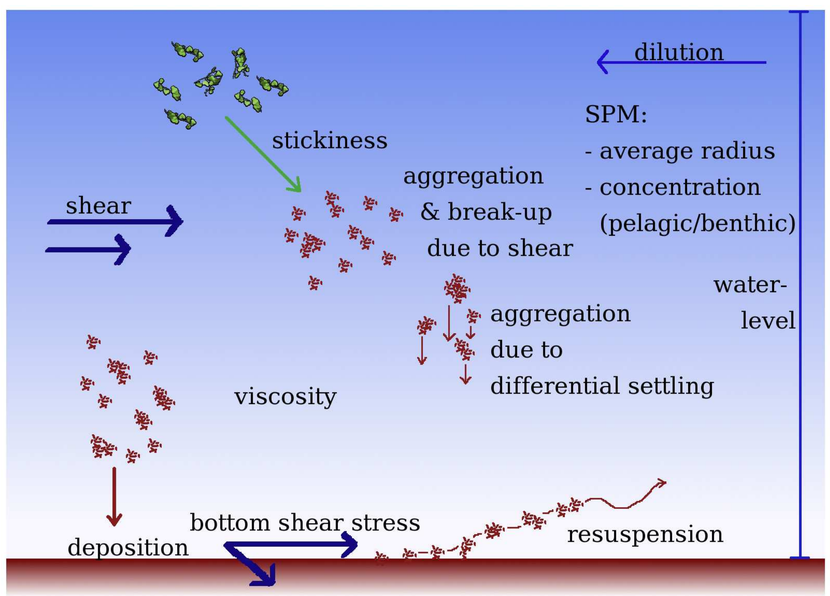


FIG. 1: Processes and forcings in the model

- Process descriptions, e. g. aggregation, are **directly** derived from traditional size-class models (e. g. Jackson 1990)
- Receiving **one** differential equation for the average radius (no size classes!)
- Simple SPM-concentration model is coupled
- Zero dimensional model

Results & Discussion

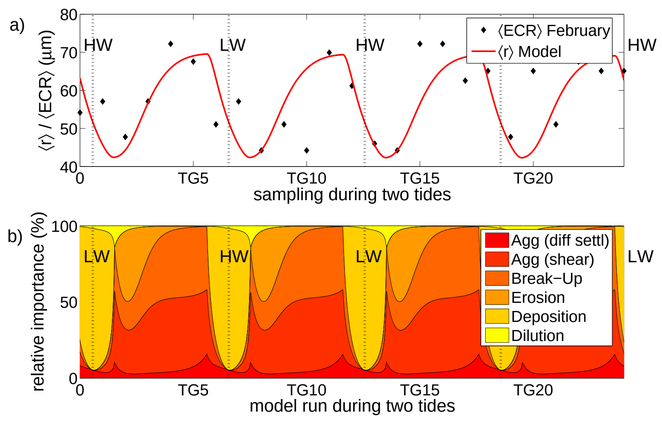


FIG. 2: a) Average radius in model and observed data in February (backbarrier tidal flat of Spiekeroog island, Germany provided by M. Lunau, ICBM)
b) Relative importance of processes in the model
ECR: equal circle radius LW: low water HW: high water TG: sample number

Model forced by sinusoidal approximation of real physical conditions

	February	**July**
Collision efficiency	low	high
Porosity	low	high
Aggregate density	high	low
Water temperature	low	high
Resuspended flocs	small	big

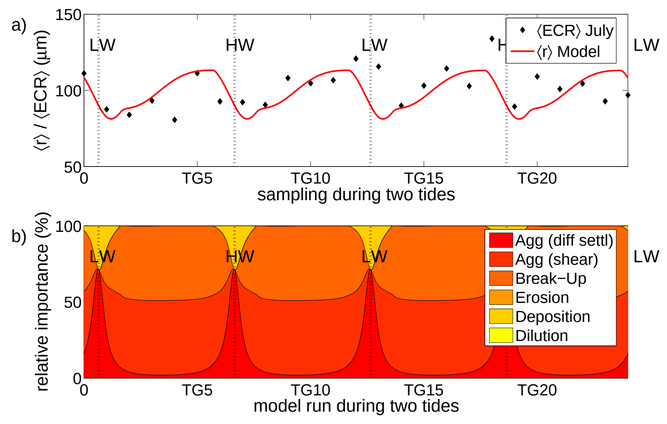


FIG. 3: a) Average radius in model and observed data in July (backbarrier tidal flat of Spiekeroog island, Germany provided by M. Lunau, ICBM)
b) Relative importance of processes in the model
ECR: equal circle radius LW: low water HW: high water TG: sample number

- Due to high aggregate density and low stickiness deposition determines the system dynamics during tidal time intervals of low turbulence.
- Benthic interactions due to resuspension and deposition have great relevance in the winter situation.
- Low aggregate density leads to small sinking velocities so that aggregates are kept in suspension. Relative importance of resuspension is very small.
- Processes in the water column (aggregation and break-up) determine the aggregate dynamics in the summer situation.

Conclusion

Thanks
M. Lunau for providing data and helpful discussions

Related Links
www.icbm.de/watt

- Model results show good agreement with observed aggregate dynamics.
- Different importance of processes is identified for winter and summer situation.
- Model provides better insights into aggregate dynamics.
- Different impacts on aggregate dynamics can easily be tested e. g. changes of collision frequency due to shifts in phytoplankton diversity.
- Parameterization and computation costs are low.

Literature

Jackson, G. A. 1990: *A model of the formation of marine algal flocs by physical coagulation processes.* Deep-Sea Res. 37. No. 8. 1197 - 1211
Wirtz, K. W. and Eckhardt, B. 1996: *Effective variables in ecosystem models with an application to phytoplankton succession.* Ecological Modelling 92. 33 - 53

For further information see the talk of **M. Lunau** (Thursday, 3.45 pm)