KATHOLIEKE UNIVERSITEIT LEUVEN
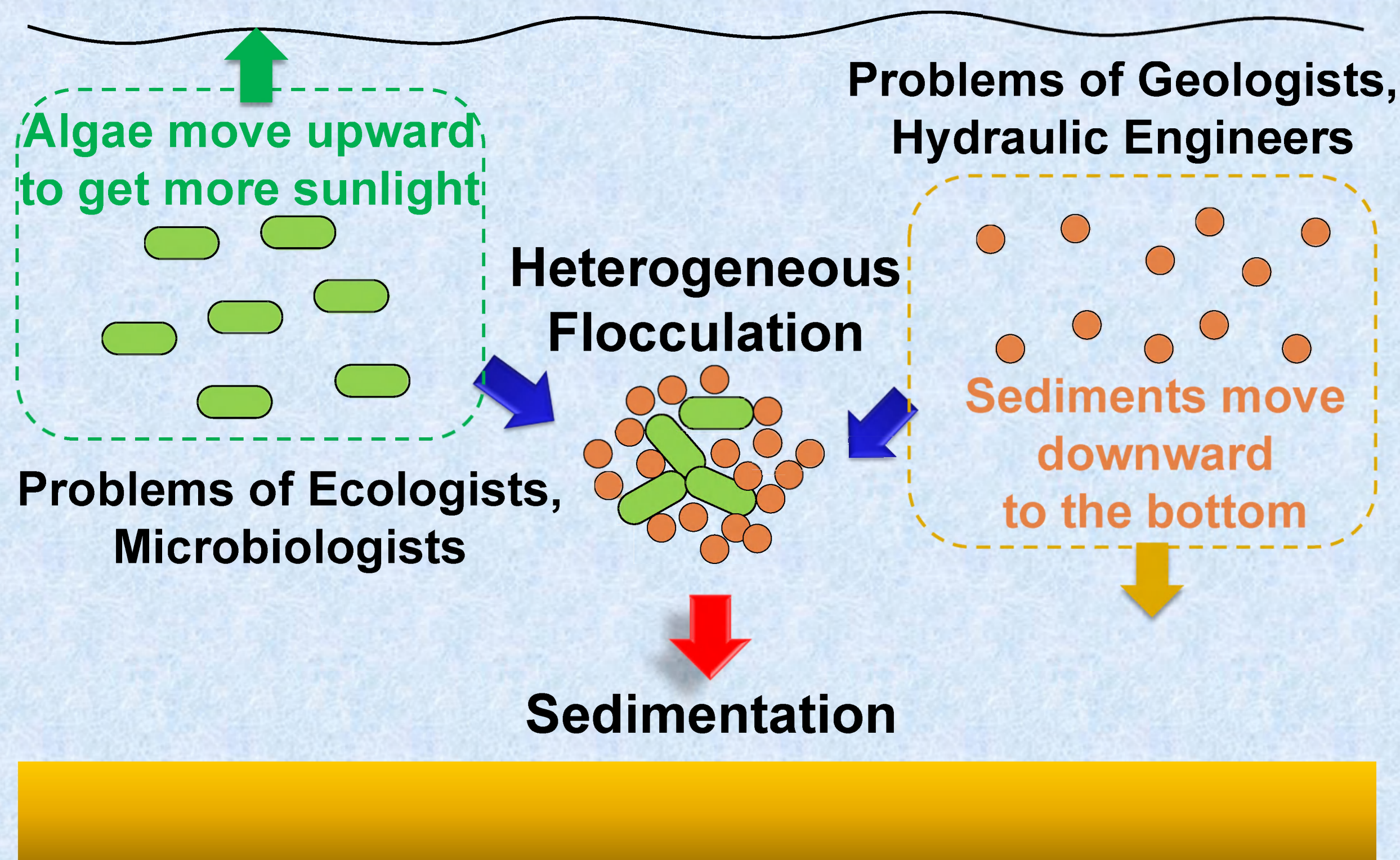
HYDRAULICS LABORATORY

Heterogeneous Flocculation Combining the Biological and Mineralogical Populations in a Marine and Coastal Environment

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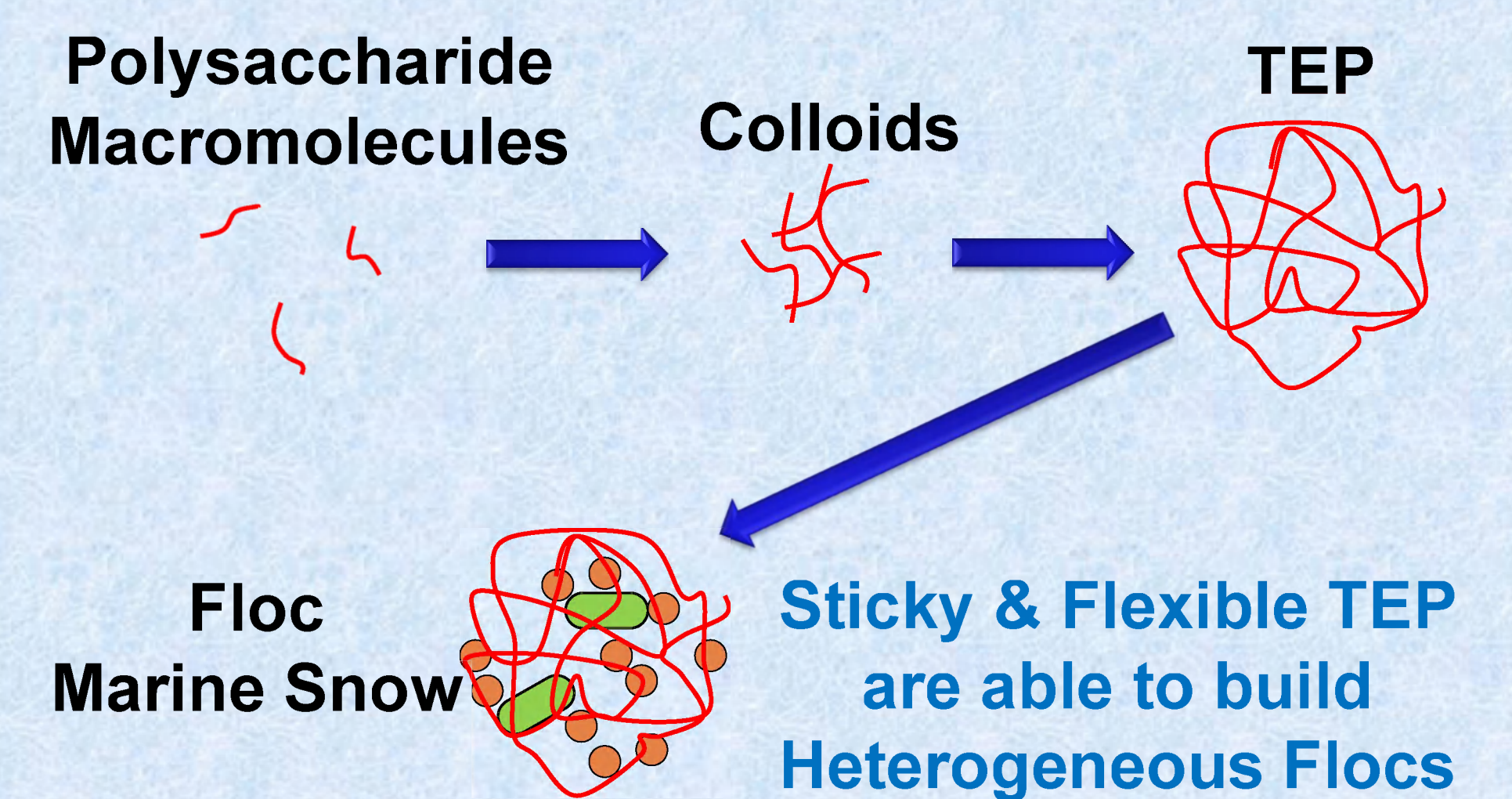## 1 Heterogeneous Flocculation

Flocculation: is a reversible floc-size growth and decay process, due to particle aggregation and breakage.
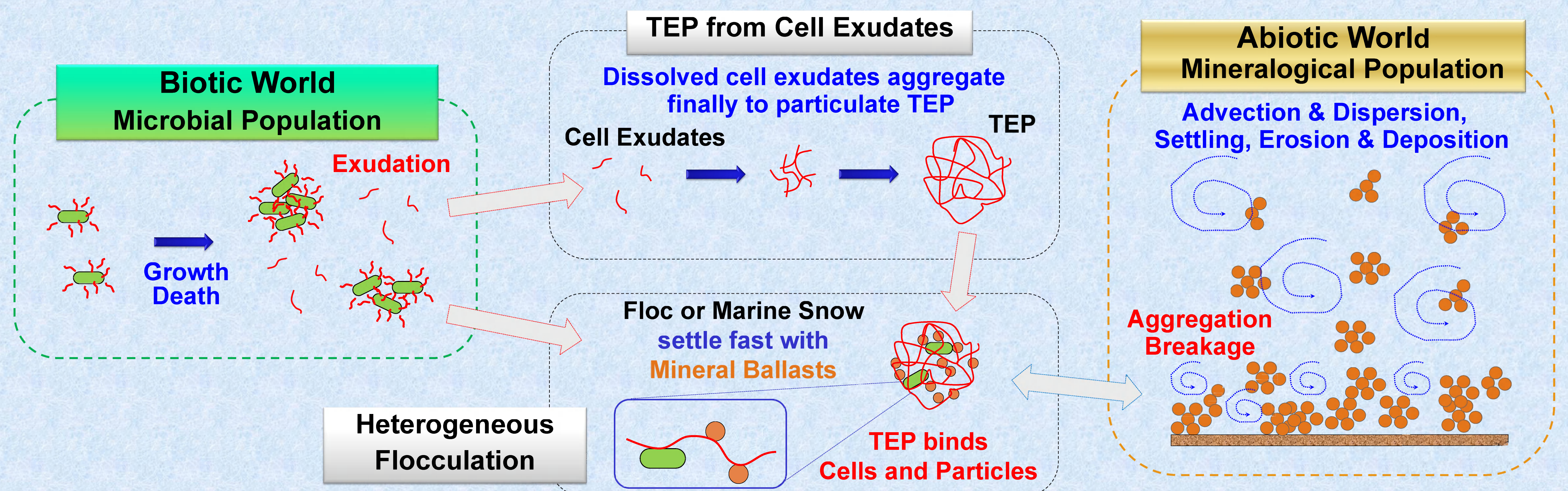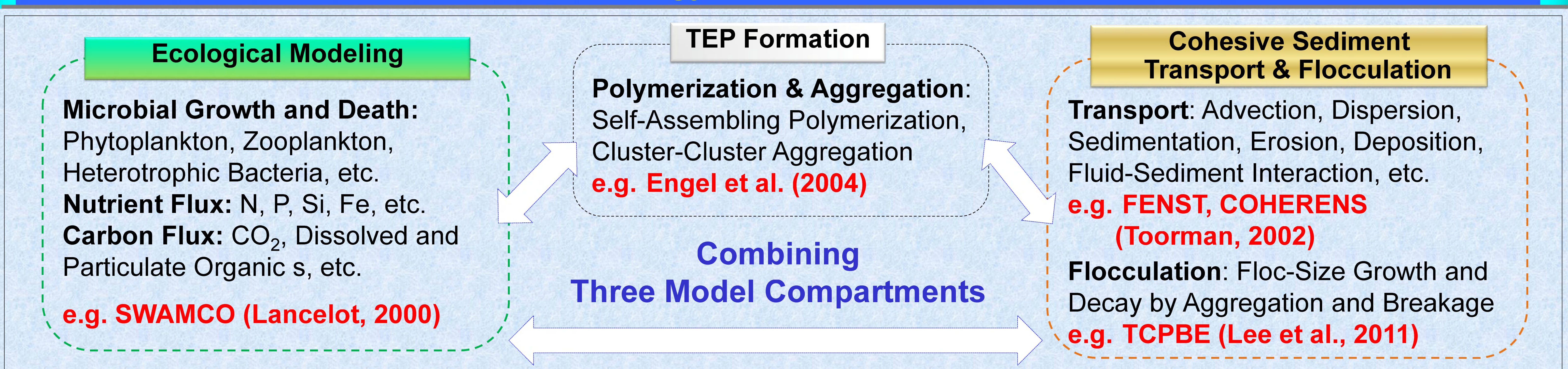
Heterogeneous Flocculation: is flocculation combining heterogeneous fractions of the biological and mineralogical populations into a bio-mineral floc, thereby bridging the biological and mineralogical worlds.

Algae move upward to get more sunlight

Problems of Ecologists, Microbiologists

Heterogeneous Flocculation

Problems of Geologists, Hydraulic Engineers

Sediments move downward to the bottom

Sedimentation

2 Transparent Exopolymer Particles (TEP)

TEP is an organic particles formed by aggregation of polysaccharides excreted by microorganisms (Alldredge et al., 1993).

Polysaccharide Macromolecules → Colloids → TEP

Floc Marine Snow

Sticky & Flexible TEP are able to build Heterogeneous Flocs

3 Conceptual Model: TEP-Mediated Heterogeneous Flocculation

TEP combines the Biological and Mineralogical Populations into a Heterogeneous Floc.

Biotic World Microbial Population

Exudation

Growth Death

TEP from Cell Exudates

Dissolved cell exudates aggregate finally to particulate TEP

Cell Exudates → TEP

Abiotic World Mineralogical Population

Advection & Dispersion, Settling, Erosion & Deposition

Aggregation Breakage

Floc or Marine Snow settle fast with **Mineral Ballasts**

Heterogeneous Flocculation

TEP binds Cells and Particles

4 Mathematical Model: Initiative Strategy

Ecological Modeling

Microbial Growth and Death: Phytoplankton, Zooplankton, Heterotrophic Bacteria, etc.
Nutrient Flux: N, P, Si, Fe, etc.
Carbon Flux: CO_2, Dissolved and Particulate Organic s, etc.

e.g. SWAMCO (Lancelot, 2000)

TEP Formation

Polymerization & Aggregation: Self-Assembling Polymerization, Cluster-Cluster Aggregation
e.g. Engel et al. (2004)

Combining Three Model Compartments

Cohesive Sediment Transport & Flocculation

Transport: Advection, Dispersion, Sedimentation, Erosion, Deposition, Fluid-Sediment Interaction, etc.
e.g. FENST, COHERENS (Toorman, 2002)

Flocculation: Floc-Size Growth and Decay by Aggregation and Breakage
e.g. TCPBE (Lee et al., 2011)

5 Multi-disciplinary Collaboration Required

Ecological Engineer
Developing Ecological Models of Microbial Population Dynamics

Microbiologists
Physiology of Microbial Species, e.g. Finding EPS-Producing Species

Hydraulic Engineer
Large-scale Simulation of Sediment Transport and Ecological Models

Process Engineer
Developing Biological and Physicochemical Process Models
This is me …

Marine Geologist
Mineralogical and Geomorphological Investigation
and more …

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