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Multi-level modeling of the stochastic spatio-temporal dynamics of phototrophic biofilms

Phototrophic biofilms are complex microbial communities encased in an extracellular polymeric matrix and fueled by a significantly present photosynthesizing fraction (e.g. cyanobacteria) existing in symbiosis with heterotrophic bacteria [1]. In the present work we present our ongoing work on the development of several integrated, quantitative approaches to modeling the spatio-temporal dynamics of the biofilm life cycle. In particular an SDE model predicting the deterministic development of biofilm biomass as well as the frequency and size of abrupt biomass detachments, the so-called sloughing events, is discussed [2]. We furthermore analyze a kinetic flux-balance based PDE model for the spatio-temporal distributions of 16 particulate and solute biofilm components [3], which has originally been developed for the modeling framework AQUASIM [4]. Here, we report on our efforts to reduce the complexity of this model in terms of variables and parameters, in order to obtain a minimal model for the spatio-temporal dynamics of phototrophic biofilms, and achieve integration with generic PDE-modeling approaches to biofilms [5]. Our final aim is to connect both models in a coherent fashion, and furthermore adjust them with evidence from experimental data of biofilm physiology and morphology, obtained within a European project on phototrophic biofilms (http://www.photobiofilms.org).

References

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