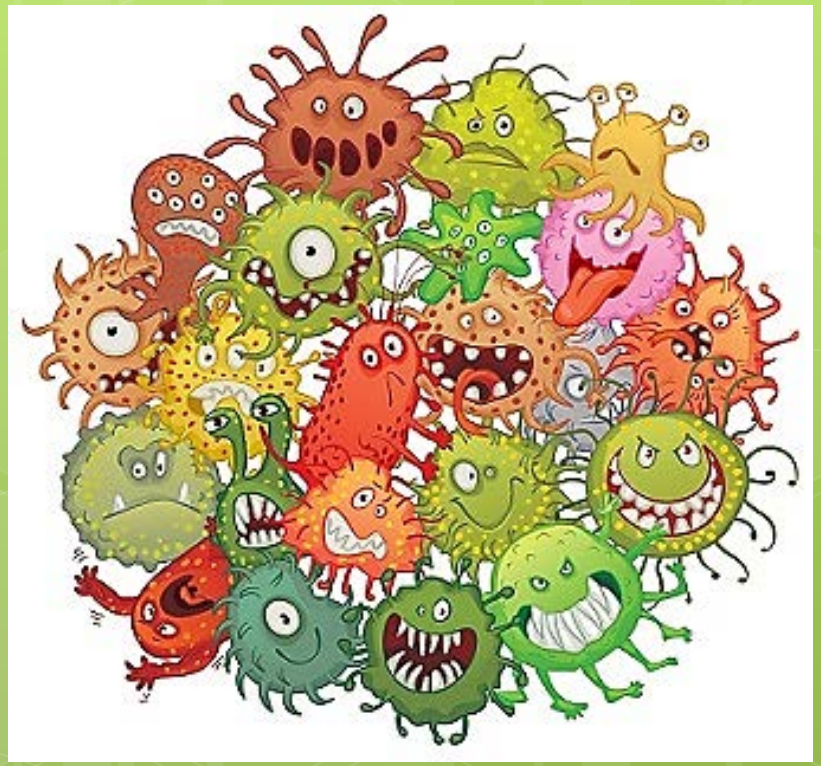

27febbraio 2019 Incontro del Gruppo di lavoro sui BIOFILM

Società dei Naturalisti in Napoli, via mezzocannone 8

Ore 9.30

UNIVERSITÀ DEGLI STUDI DI NAPOLI «*FEDERICO II*»

Dipartimento di Matematica e Applicazioni

Gruppo di lavoro sulla modellazione matematica di biofilm

Componenti:

- Prof. *Berardino D'Acunto*
- Dott. *Luigi Frunzo*
- Dott.ssa *Maria Rosaria Mattei*
- Dott. *Vincenzo Luongo*
- Dottorandi:
  - *Grazia Guerriero, Daniele Bernardo Panaro, Fabiana Russo, Alberto Tenore.*

Tematiche di interesse

- Modellazione Matematica di:
  - Cinetiche biologiche, meccanismi di **simbiosi e competizione** microbiche.
  - Ciclo di vita del biofilm, Ecologia:
    - Crescita: **Attachment**, **Invasione**, Maturazione di Biofilm multispecie
    - Perdita di Massa da Biofilm: **Dispersal** e Detachment, Decadimento.
  - Bioremediation e **Biosorption**
  - Processi **multiscala**: Reattori a Biofilm
  - Analisi Qualitativa e Quantitativa dei modelli proposti

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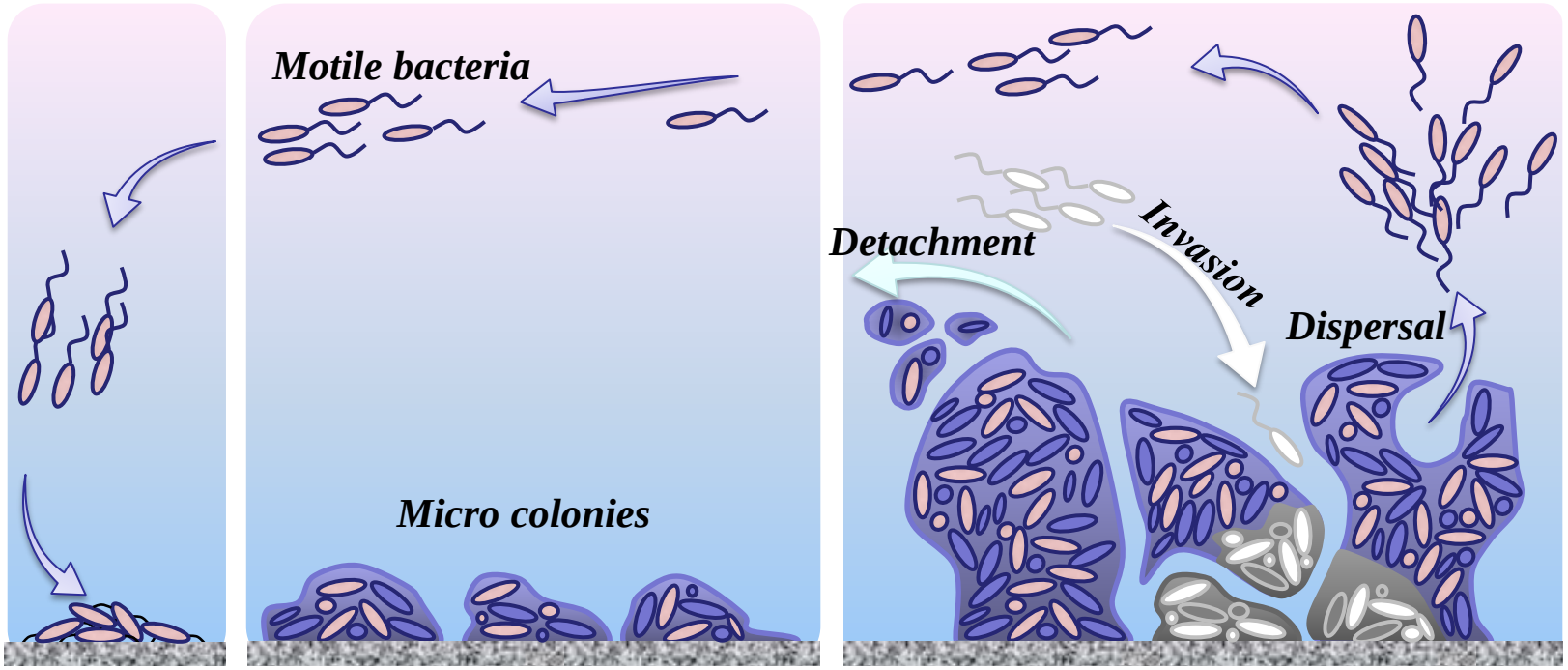
Mature biofilm development



Attachment (Primary colonization)

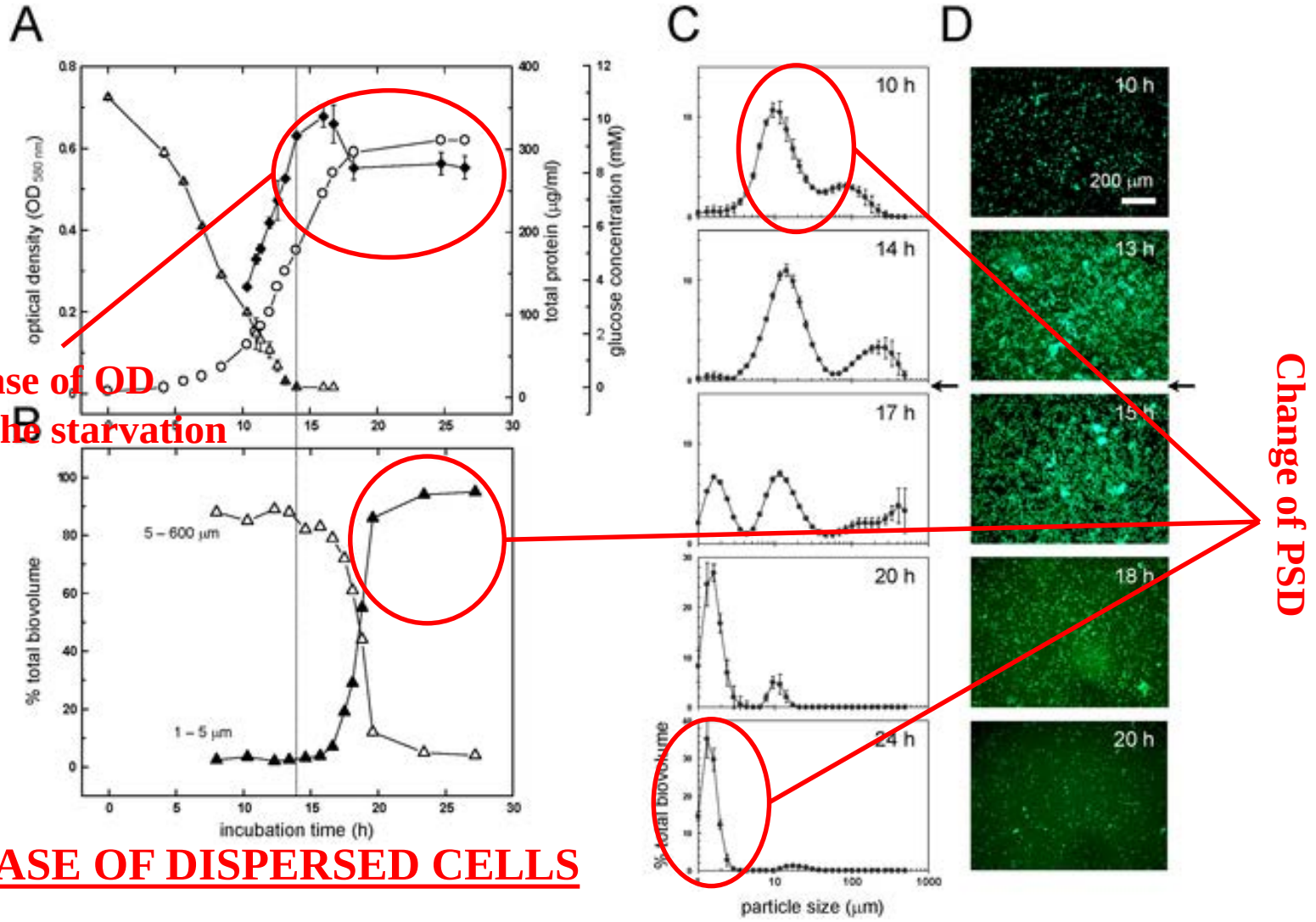
Initial growth (Micro-colony development; EPS production)

Mature biofilm (Invasion of other microbial species; Passive and active dispersal)

DISPERSAL as active regulated response.

CAUSE: stress as a result of habitat decay (e.g resource depletion)

Experimental evidence



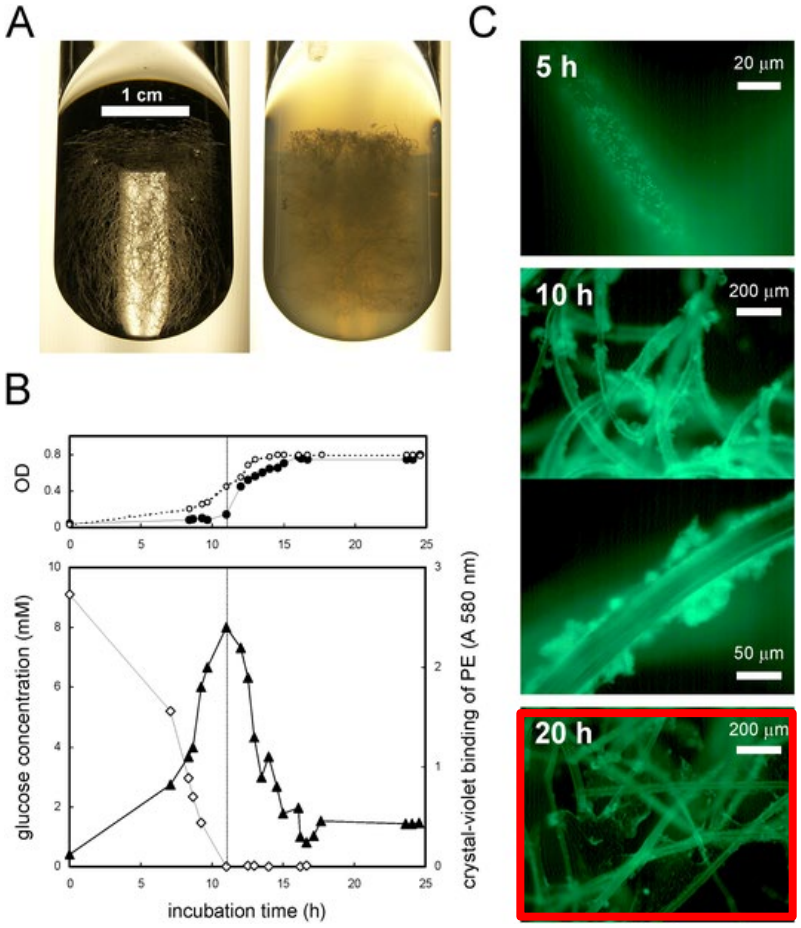
Increase of OD after the starvation

Change of PSD

RELEASE OF DISPERSED CELLS

Schleheck D, Barraud N, Klebensberger J, Webb JS, McDougald D, et al. (2009)

Experimental evidence



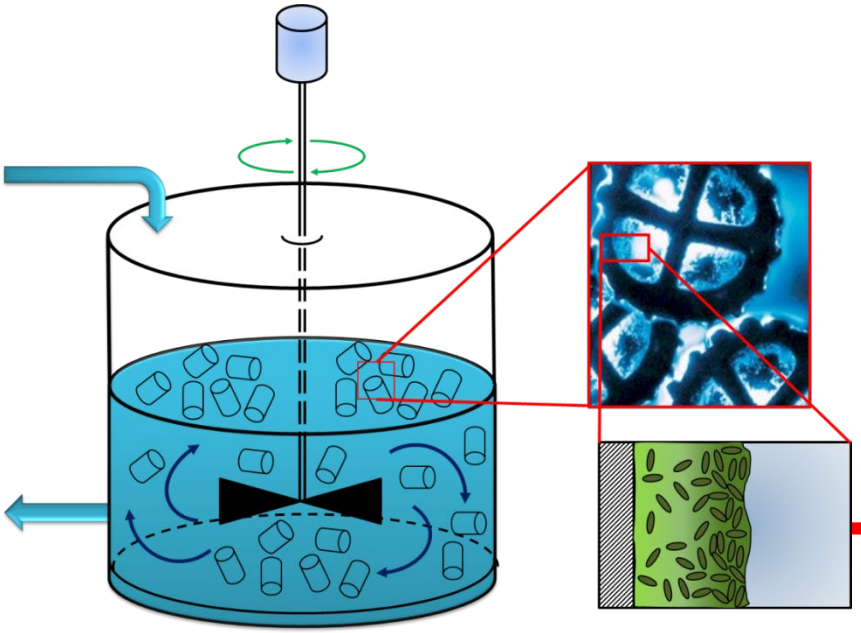
Microscopic appearance of biomass (SYTO 9-stain) attached to PE in the early growth phase (after 5 h), during the late-exponential growth phase (after 10 h), and in the stationary phase (after 20 h), respectively (panel C)

The beginning of the dispersal phase coincides with the **formation of necrosis zones**, where the active biomass, constituted by active cell, is hydrolyzed leading to the formation of dispersed cells which will released in the biofilm and further in the bulk liquid. The **release of dispersed cells** determine the **formation of voids** resulting in an increase of biofilm porosity.

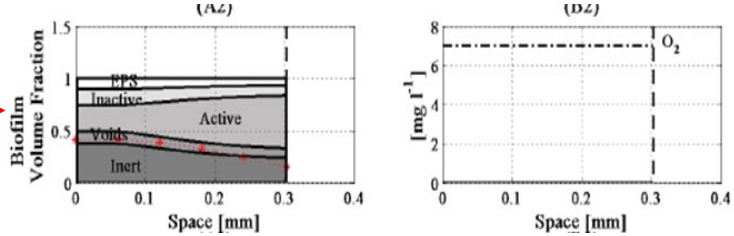
Formation of Voids → POROSITY INCREASE
Biofilm appears
lack of viable cells → INERT FORMATION

Schleheck D, Barraud N, Klebensberger J, Webb JS, McDougald D, et al. (2009)

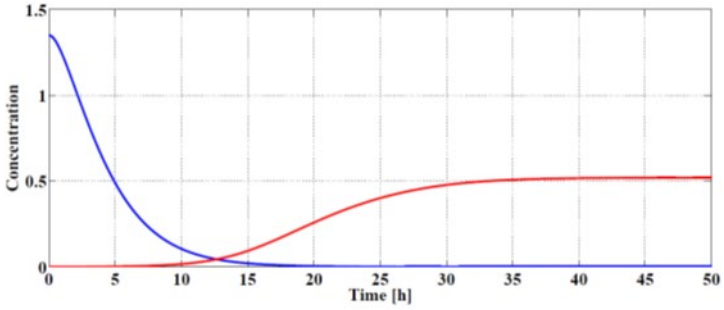
Model Output



Model Output at biofilm scale



Model Output at Reactor Scale

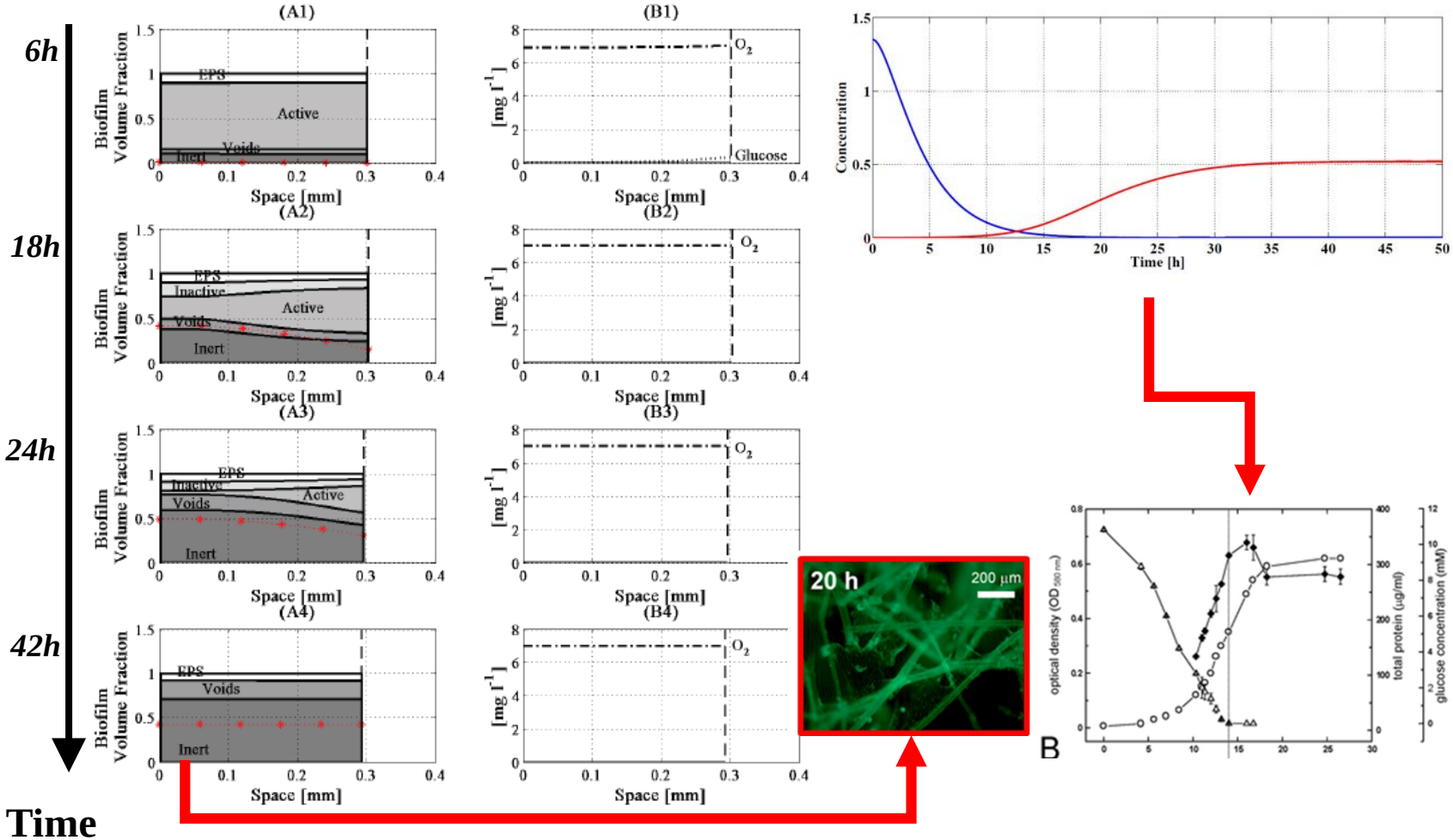


Model Output

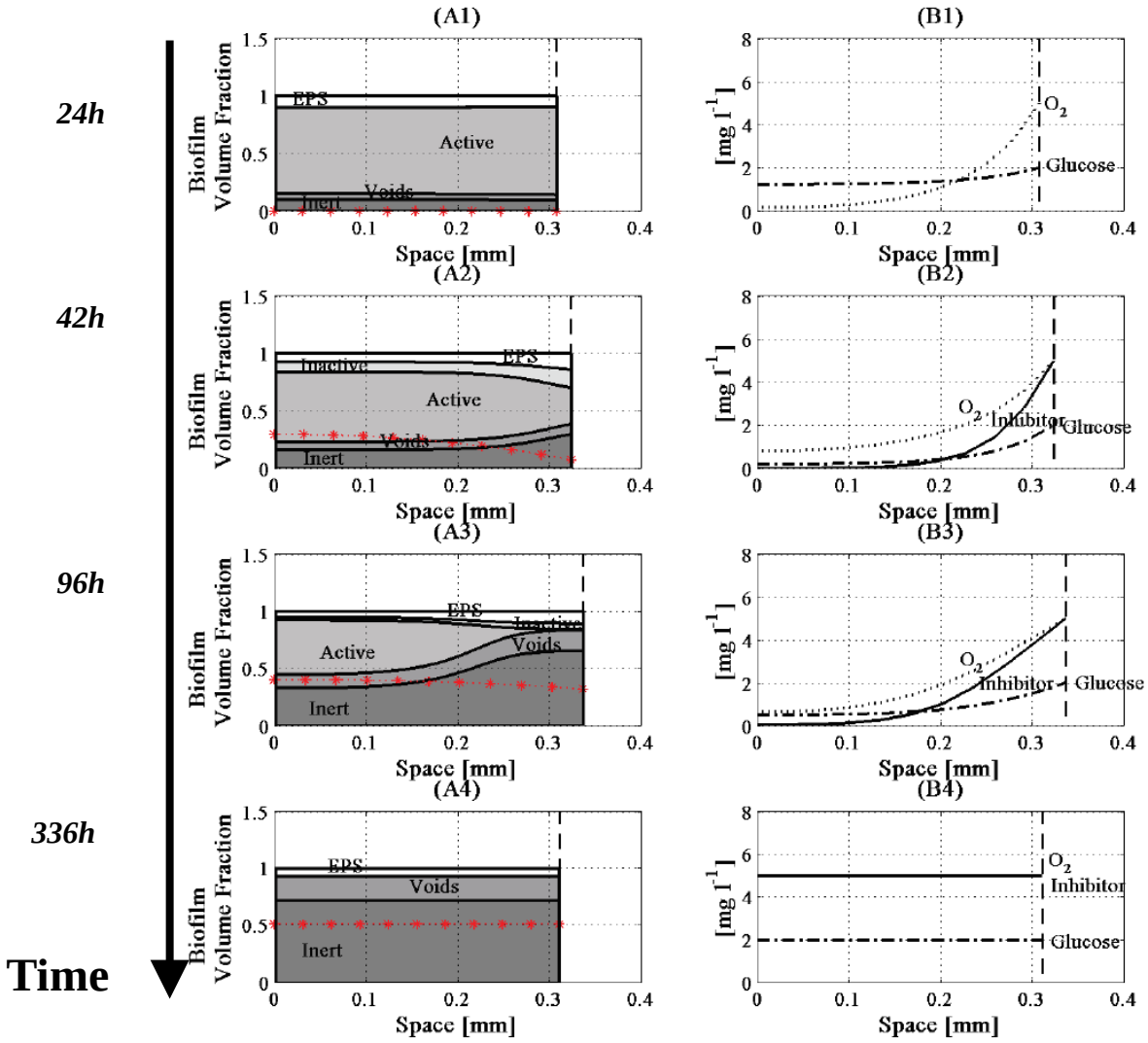
Model application_1 Pseudomonas aeruginosa dispersal upon starvation

Biofilm scale

Reactor Scale



Model Output



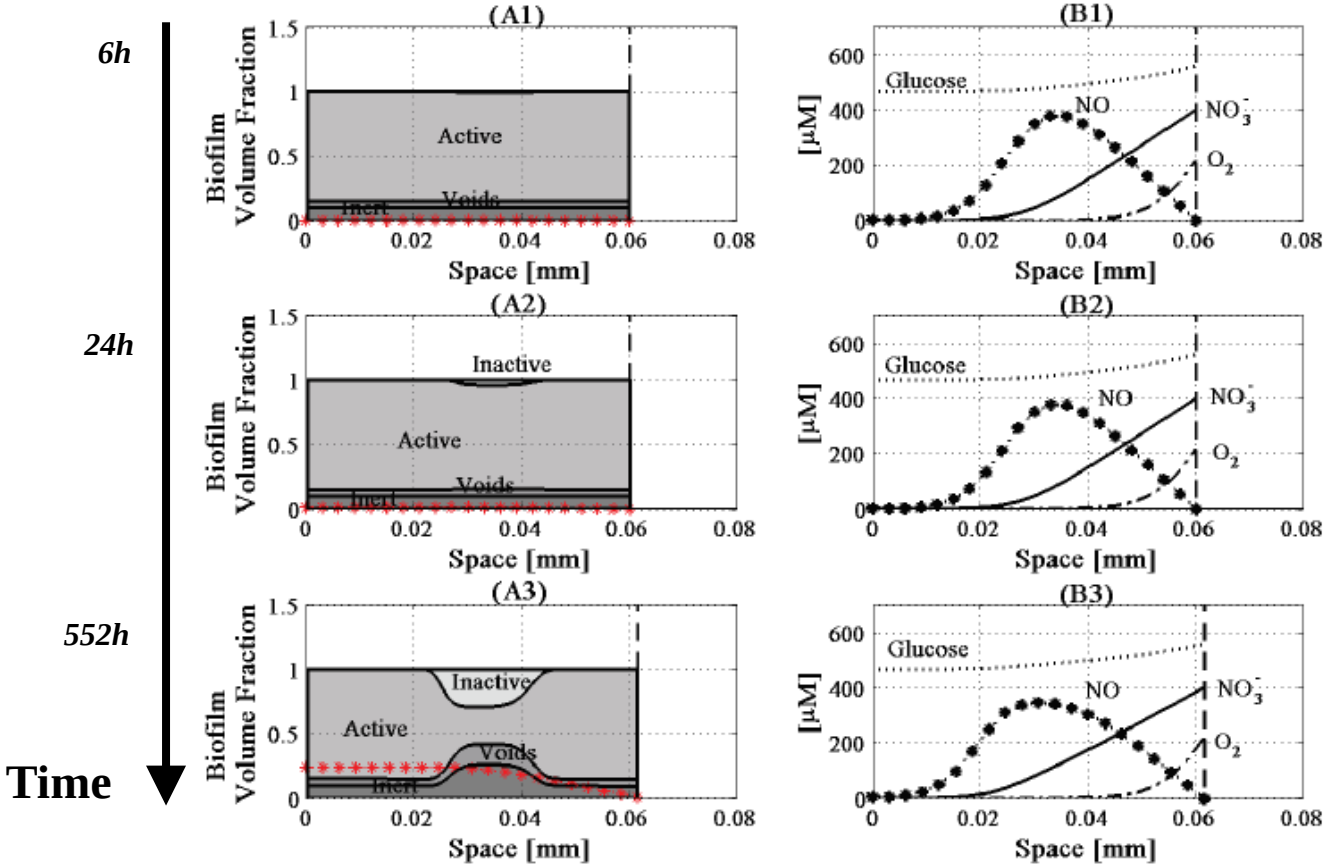
Model application_2

Modeling dispersal induced by a sub-lethal antibiofilm agent

Dispersal phenomenon induced by a diffusion of an **antibiofilm agent** in sub-lethal concentration: bacterial volume fractions, $\psi 1$ profile (dotted-starred red line) and substrate concentration profiles after 24 (A1,B1), 42 (A2,B2), 96 (A3,B3), 336 (A4,B4) hours.

Model Output

Model application_3 - Modeling dispersal induced by a self-produced biocide agent



Effect of dispersal phenomenon induced by a **self-produced biocide (NO)** on bacterial volume fractions, ψ1 profile (dotted-starred red line) and substrate concentration profiles in a batch system after 6 (A1,B1), 24 (A2,B2), 552 (A3,B3) hours (**NO concentration is multiplied by 100 and Glucose is divided by 10**).

Gruppo di lavoro sui BIOFILM

Napoli 27 Febbraio 2019