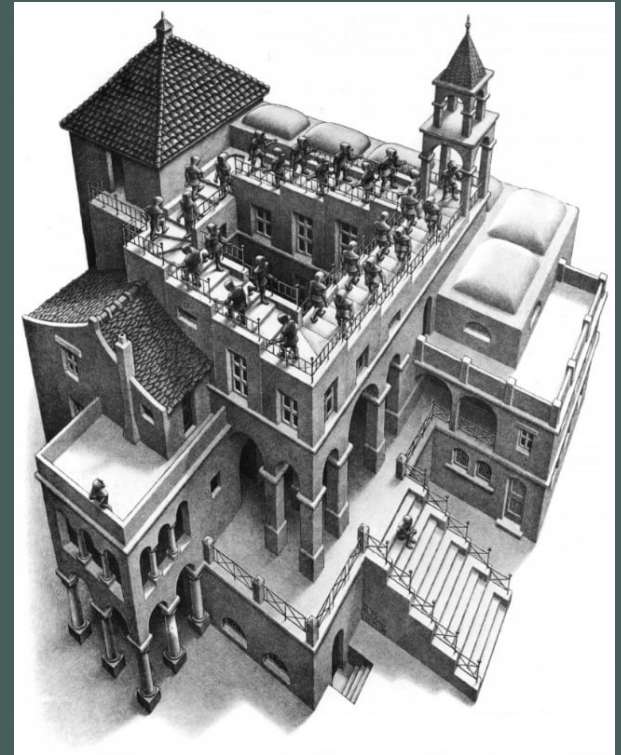


# 1.1 - Introduction to process-based forest modelling

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# Outline

1. Fundamental concepts
2. Modelling cycle
3. Overview of process-based forest models

# 1. Fundamental concepts

## Models

- *Model* - A simplification of reality constructed to gain insights into a set of attributes of a physical, biological, economic, or social system.
- *Conceptual model* - A hypothesis regarding the important factors that govern the behavior of an object or a process of interest.
- *Statistical model* - A model built using observations within a probabilistic framework.
- *Mechanistic (or process-based) model* - A model that explicitly represents the understanding of physical, chemical or biological processes.
- *Simulation model* - A model that represents the development of a solution by incremental steps through the model domain.

## Model components

- *Modules* - An independent or self-contained component of a model.
- *State variables* - The dependent variables calculated within a model, which often change over the simulation.

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- *Modules* - An independent or self-contained component of a model.
- *State variables* - The dependent variables calculated within a model, which often change over the simulation.

- *Parameters* - Terms in the model that are fixed during a model run or simulation but can be changed in different runs.
- *Constants* - Fixed values (e.g. the speed of light) representing known physical, biological or ecological activities.

## Model assessment

- *Verification* - Examination of the implementation to ascertain that they truly represents the conceptual model and there are no inherent numerical problems.
- *Qualitative assessment* - Uncertainty in model predictions that cannot be quantified (i.e. about the theory underlying the model or the model design).
- *Uncertainty analysis* - Investigation of the effects of lack of knowledge or potential errors on the model output.
- *Robustness* - The capacity of a model to perform well across the full range of environmental conditions for which it was designed.
- *Sensitivity* - The degree to which the model outputs are affected by changes in selected input parameters.
- *Transparency* - The clarity and completeness with which data, assumptions, and methods of analysis are documented.

# 2. Modelling cycle

## Modelling tasks

### 1. Problem formulation

- Definition of objectives
- Definition of the spatio-temporal physical domain

### 2. Model design and formulation

- Data availability
- Use of existing vs. new model
- Conceptual model
- Use of existing modules

### 3. Implementation

- Algorithmic design
- Model coding (e.g. C++)

### 4. Parameterization and calibration

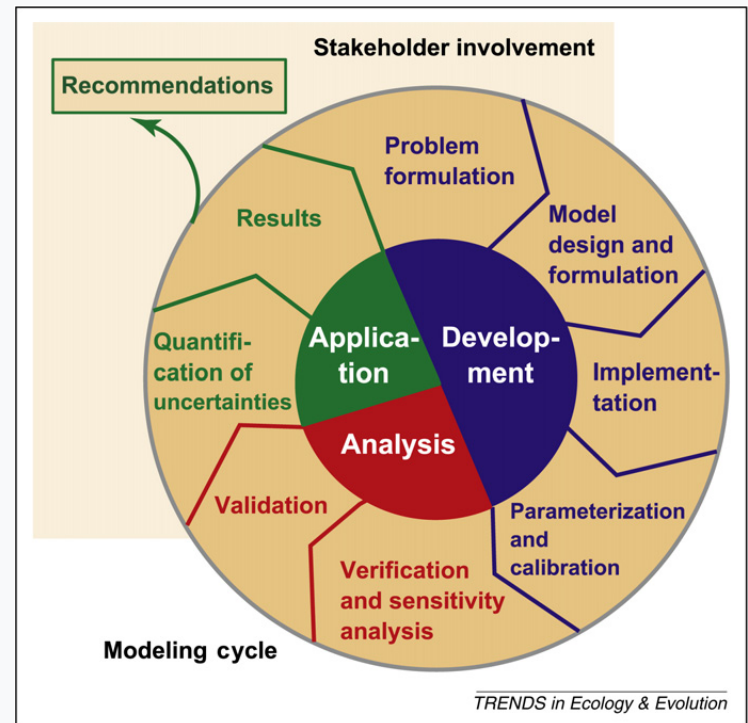
- Sources for direct parameter estimation
- Sources for parameter calibration

### 5. Model assessment

- Verification and qualitative assessment
- Sensitivity/uncertainty analysis
- Formal evaluation (validation)

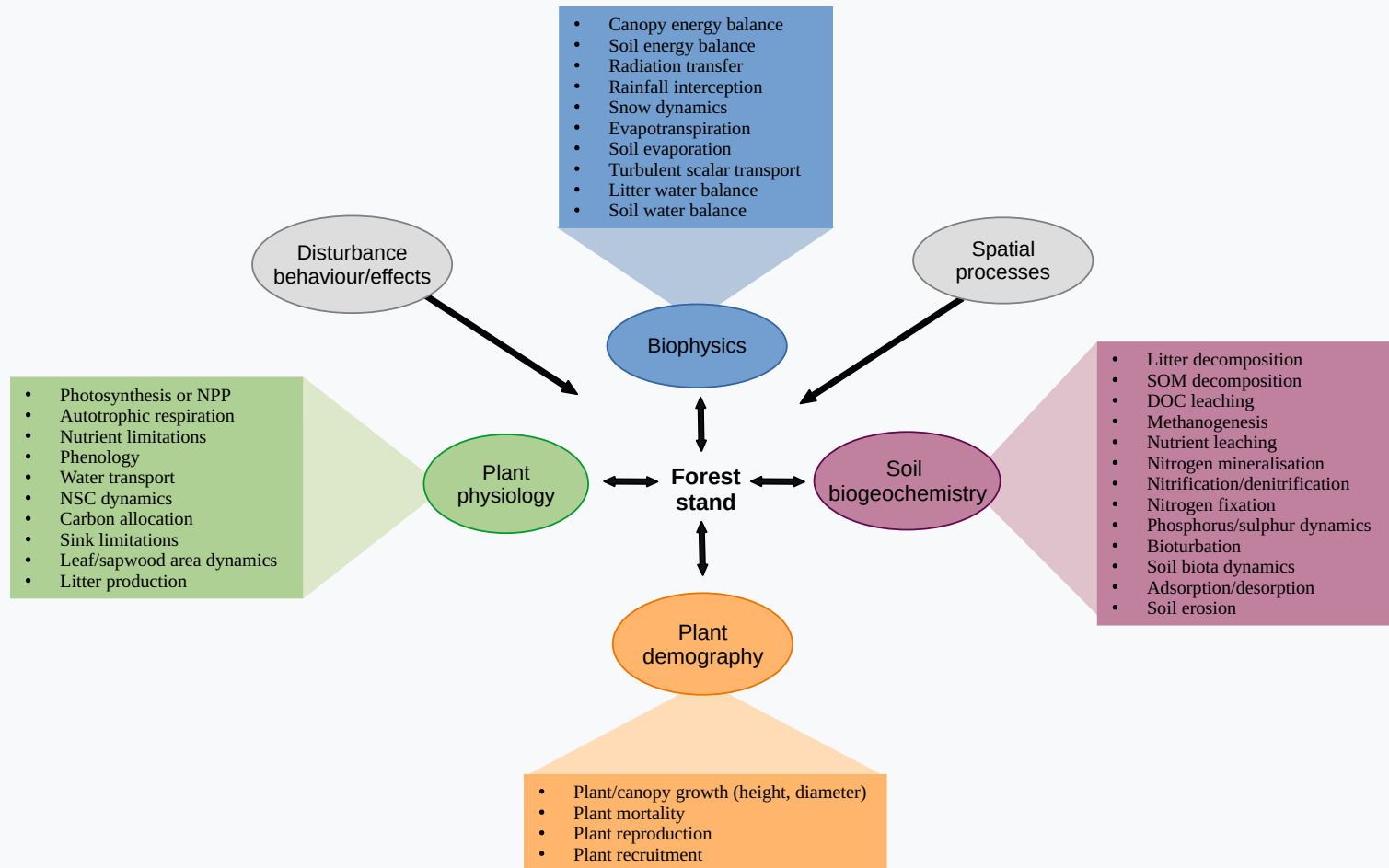
### 6. Model application

- Simulation and documentation
- Quantifying uncertainty
- Evidence for decision



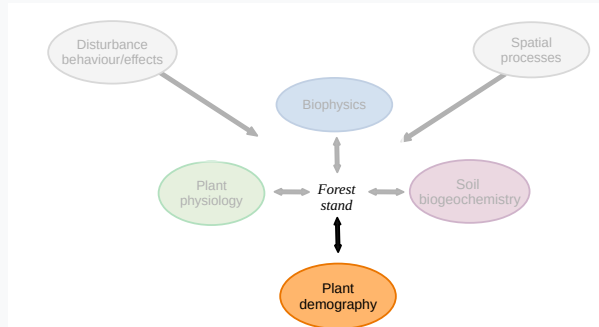
# 3. Overview of process-based forest models

## A typology of forest processes



# 3. Overview of process-based forest models

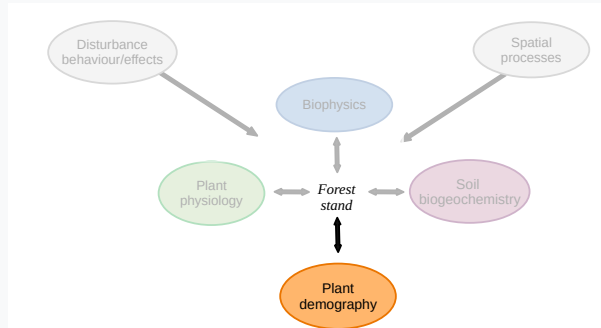
## Forest gap models



e.g., FORCLIM, FORCEEPS, GREFOS

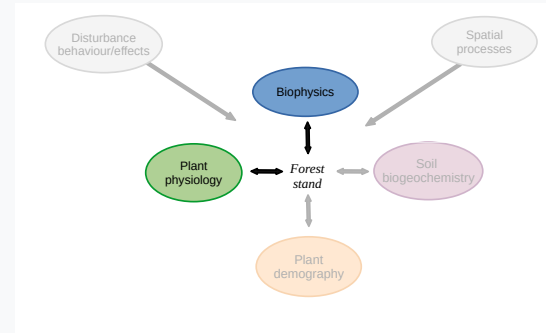
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## Soil-vegetation-atmosphere transfer model

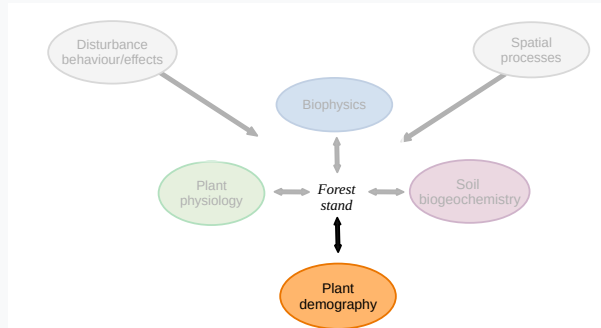


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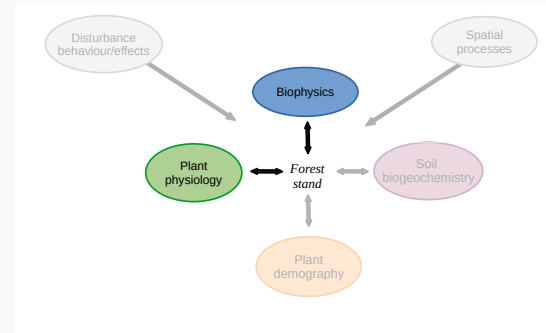
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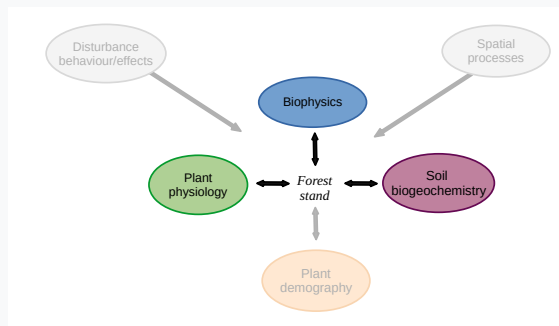
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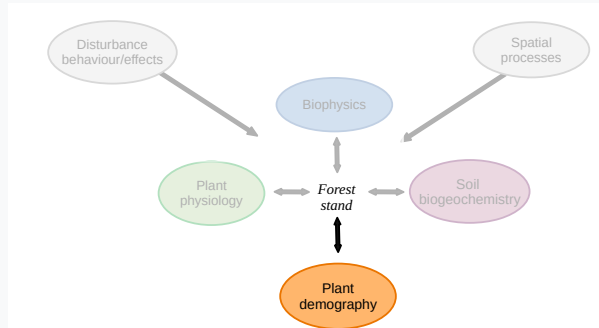
## Forest biochemical model



e.g., CASTANEA, GOTILWA+, FOREST-BGC

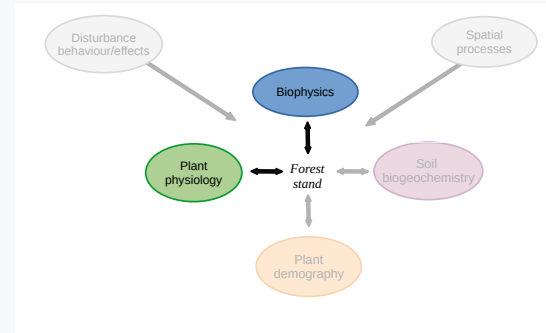
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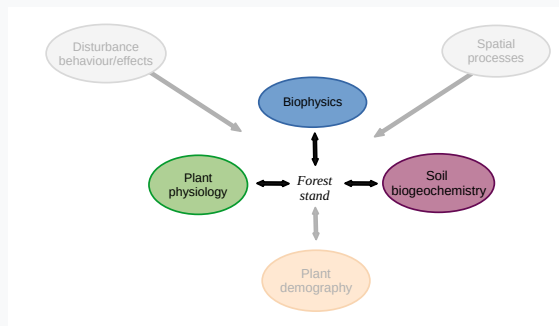
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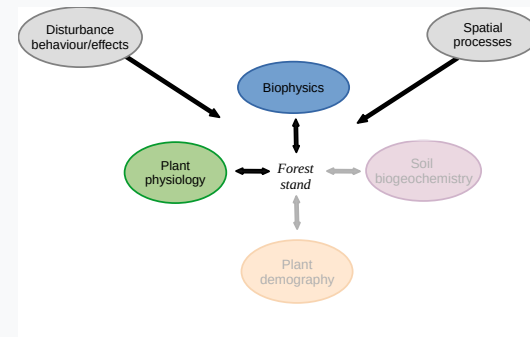
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## Forest biochemical model



e.g., CASTANEA, GOTILWA+, FOREST-BGC

## Watershed ecohydrological model



e.g., RHESYS, ECH2O, Tethys-Chloris

# M.C. Escher - Ascending and Descending, 1960

