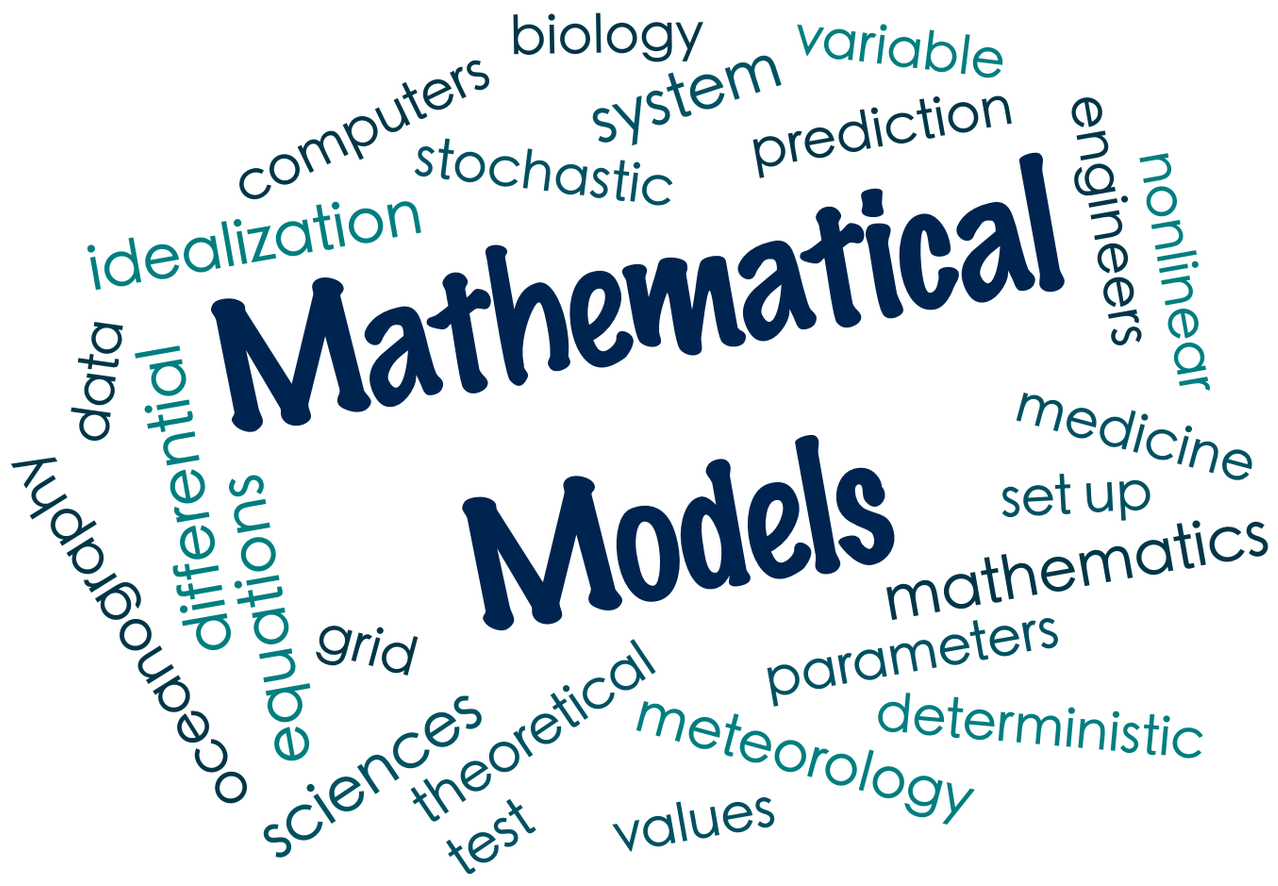
ALFRED-WEGENER-INSTITUT
HELMHOLTZ-ZENTRUM FÜR POLAR- UND MEERESFORSCHUNG

THE NIPPON FOUNDATION

Partnership for Observation of the Global Oceans

A Brief Introduction on



Natália T. Signorelli

Mathematical model

More than just numbers

What is it?

- **Mathematical equations** representing the **reality**;

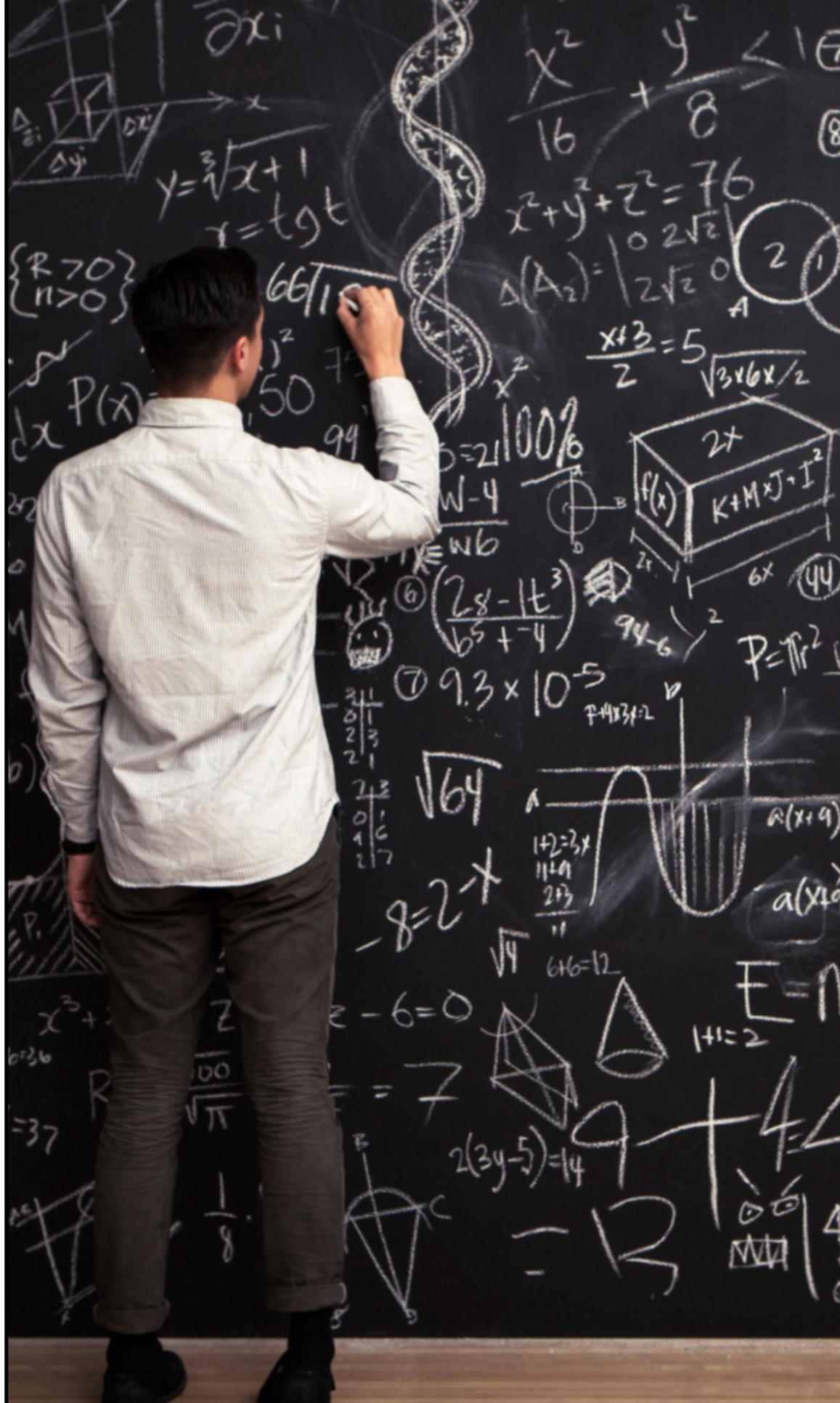
Who uses it?

- Mathematicians, Physicists, Chemists, Engineers, Biologists, Geneticists...

Why?

- To reduce the complexity of reality;
- To understand and explain a phenomenon;
- To make predictions.

http://www.thecomputercoach.net/



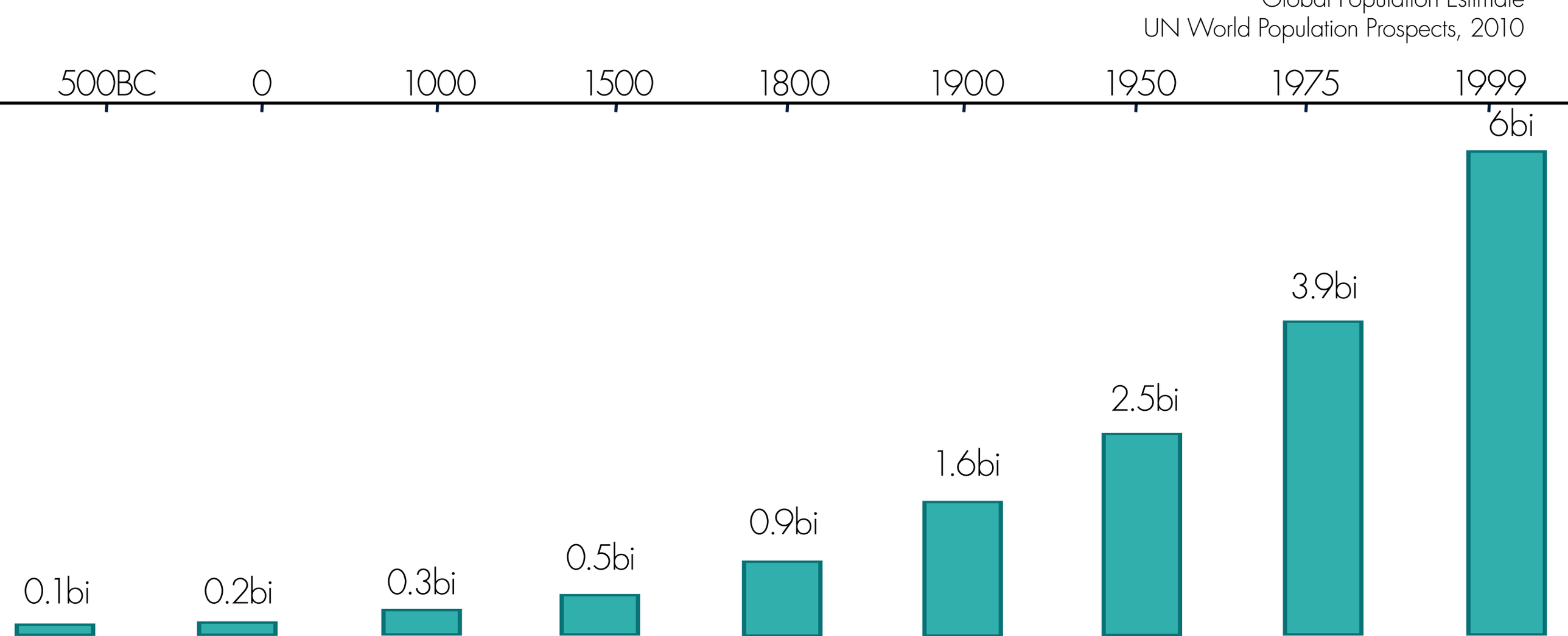
Mathematical model

How does it work?

What affects the population size?

- **Birth rate**;
- **Death rate**;

Global Population Estimate
UN World Population Prospects, 2010



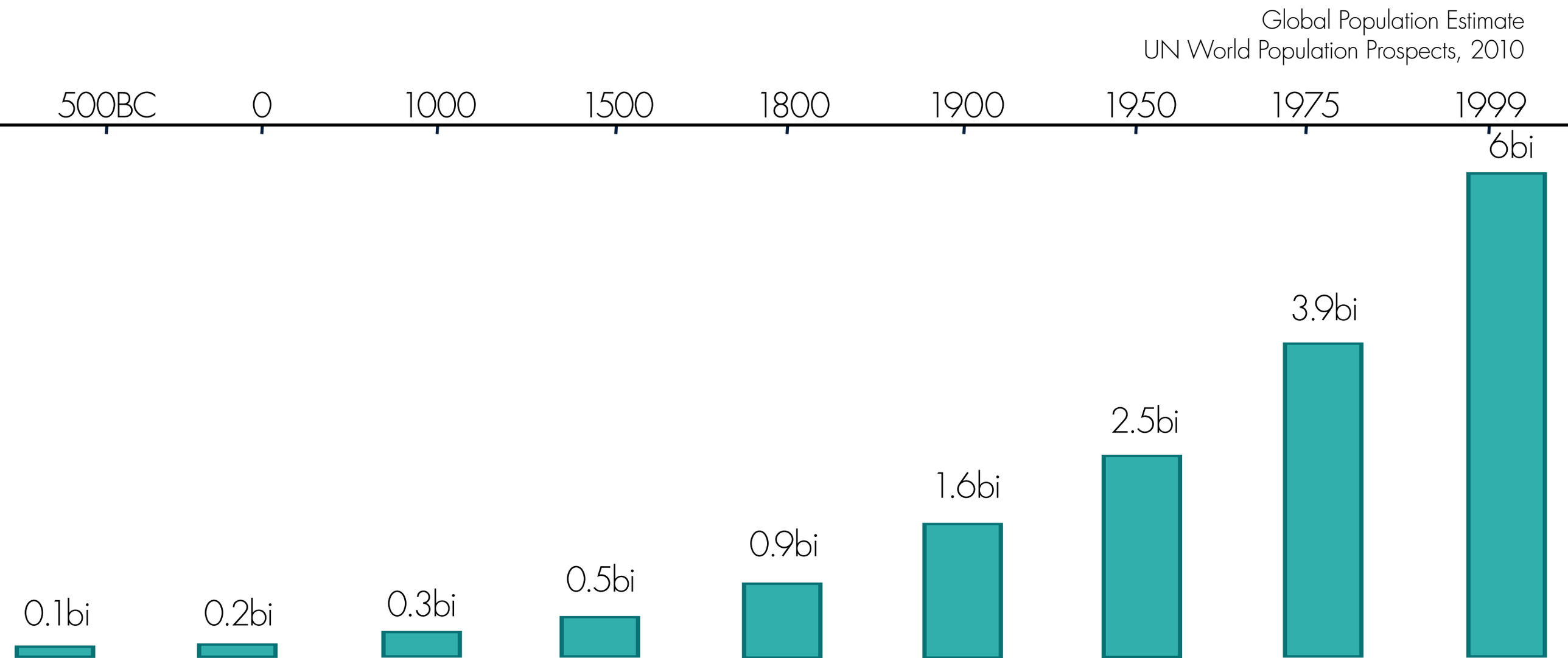
Mathematical model

Transforming words into numbers

Mathematical model:

- Transform observations into equations:

  Growth rate = Birth rate – Death rate



Mathematical model

Transforming words into numbers

Mathematical model:

- Transform observations into equations:

$$\textit{Growth rate} = \textit{Birth rate} - \textit{Death rate}$$

$$r = B - D$$

  - » exponential growth of the global population.

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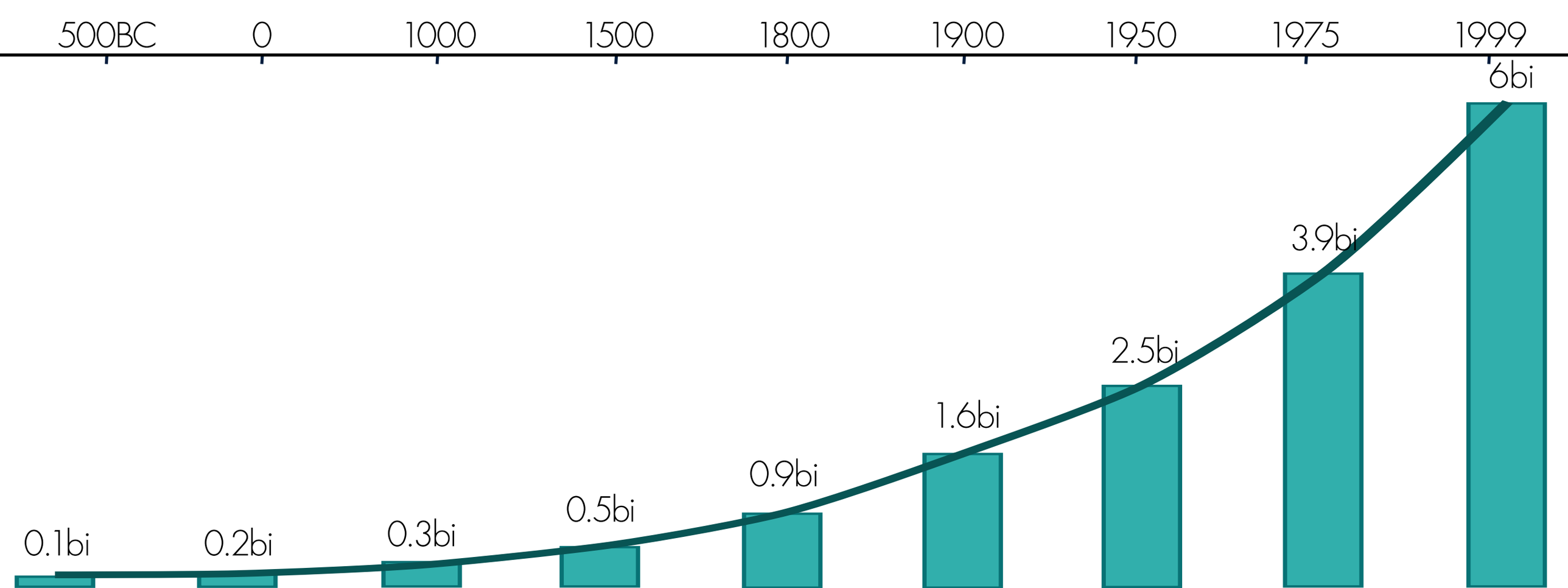


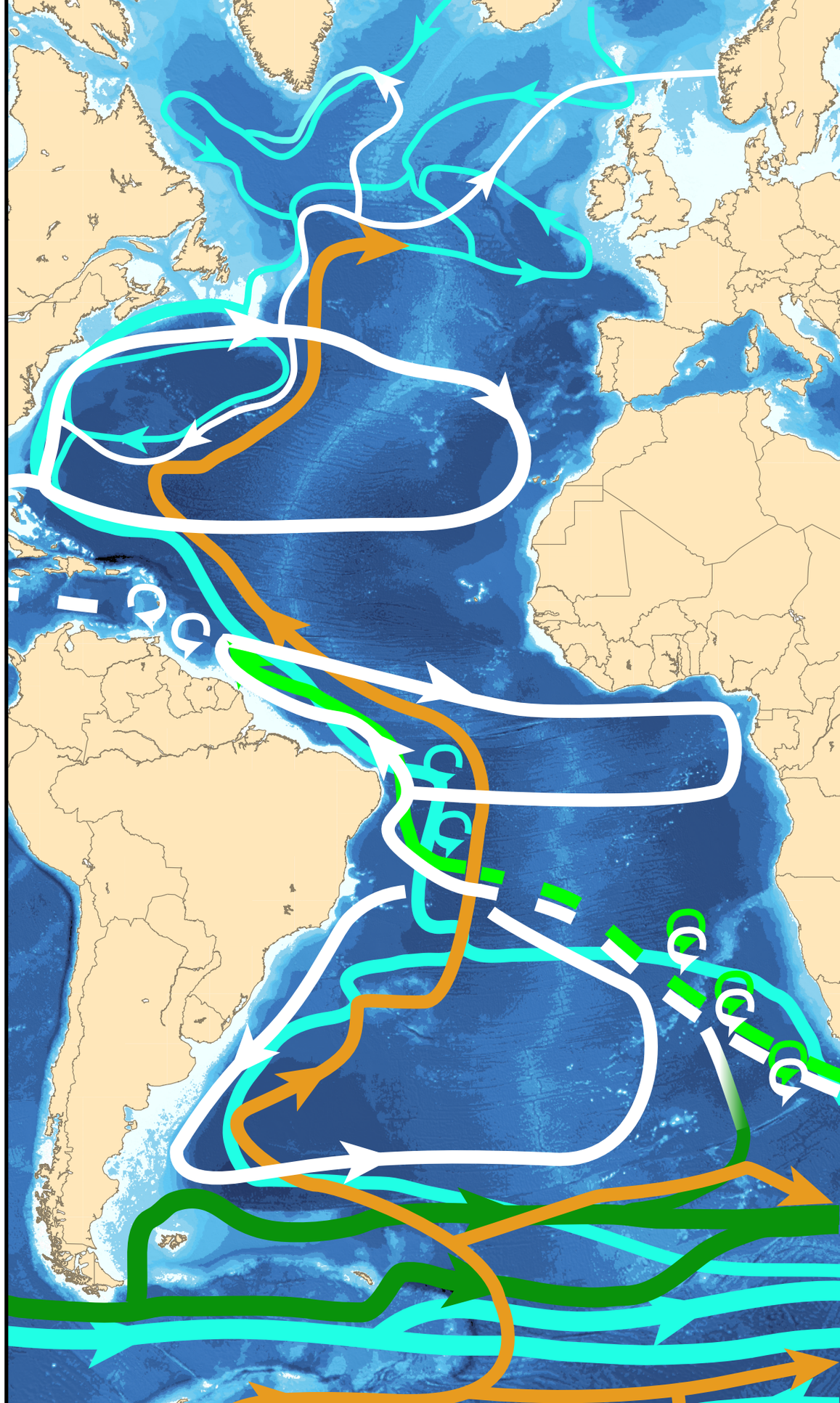
Mathematical model

And about Oceanography?

Much more complicated equations:

- Navier-Stokes equation:

$$\frac{\partial \vec{v}}{\partial t} + \vec{v} \cdot \nabla \vec{v} = -\frac{1}{\rho} \nabla P + 2\Omega \times \vec{v} + g + \nu \nabla^2 \vec{v}$$



Atlantic Meridional Overturning Circulation
Speich (2009) after Lumpkin (2003)
http://www.aoml.noaa.gov/

Mathematical model

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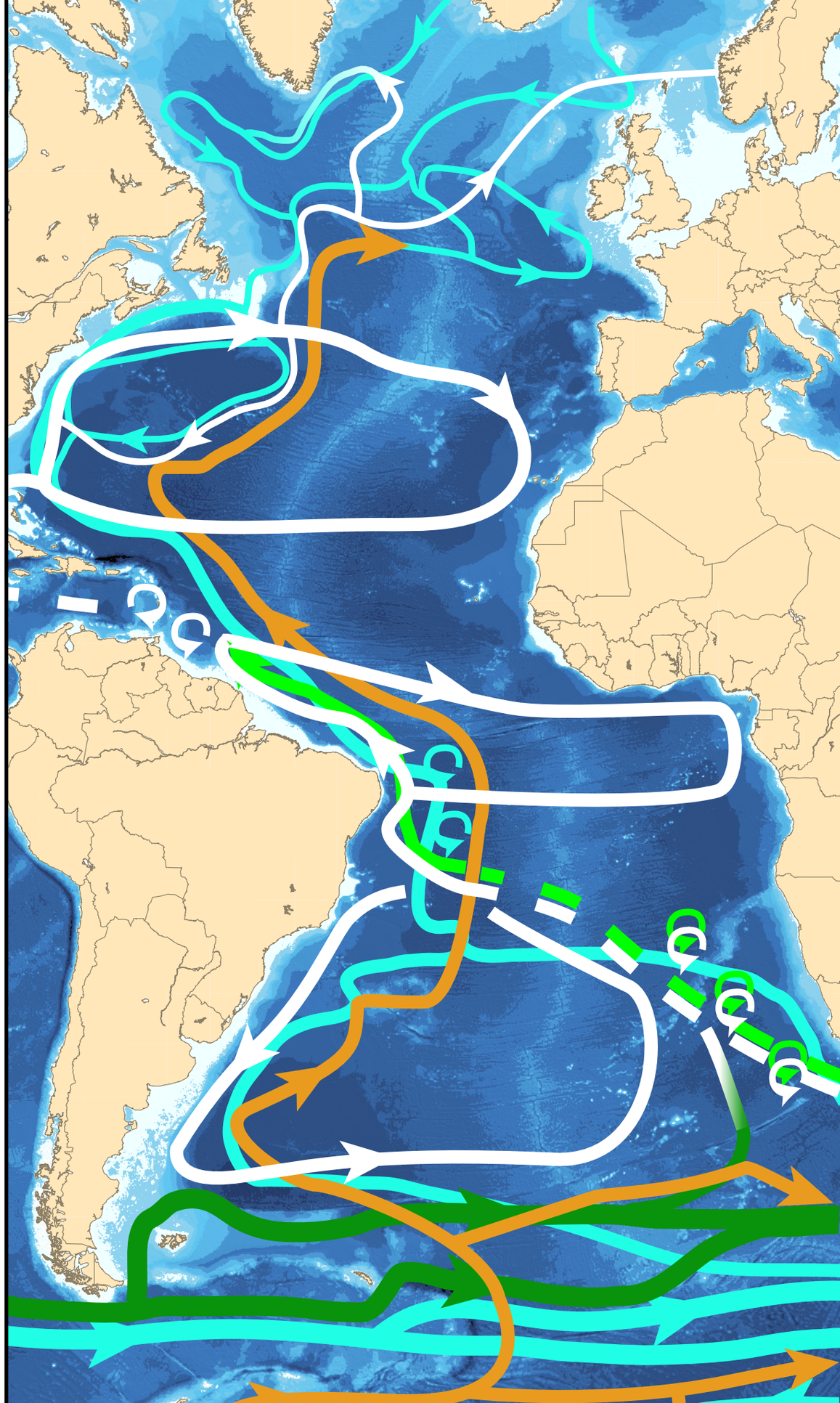
Changes on time	Changes on space	Pressure gradients	Earth rotation	Gravity	Wind

This mathematical model:

- **Can not** be solved analytically;
- We need computers calculating the equations results:
  - » **numerical models**.



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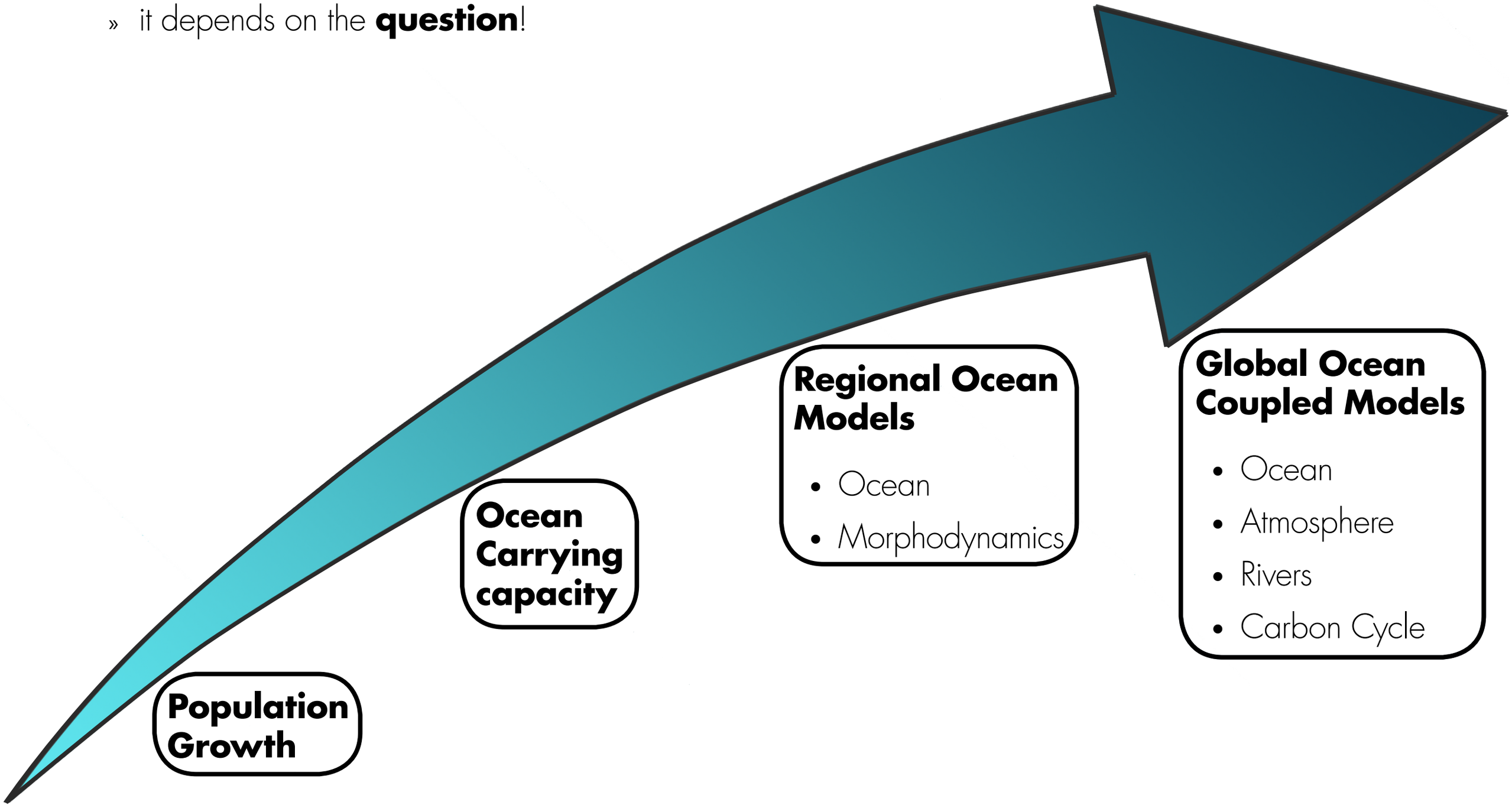
Mathematical models

Application in Oceanography

In Oceanography:

- Models of different complexity can be applied:
  - » it depends on the **question**!



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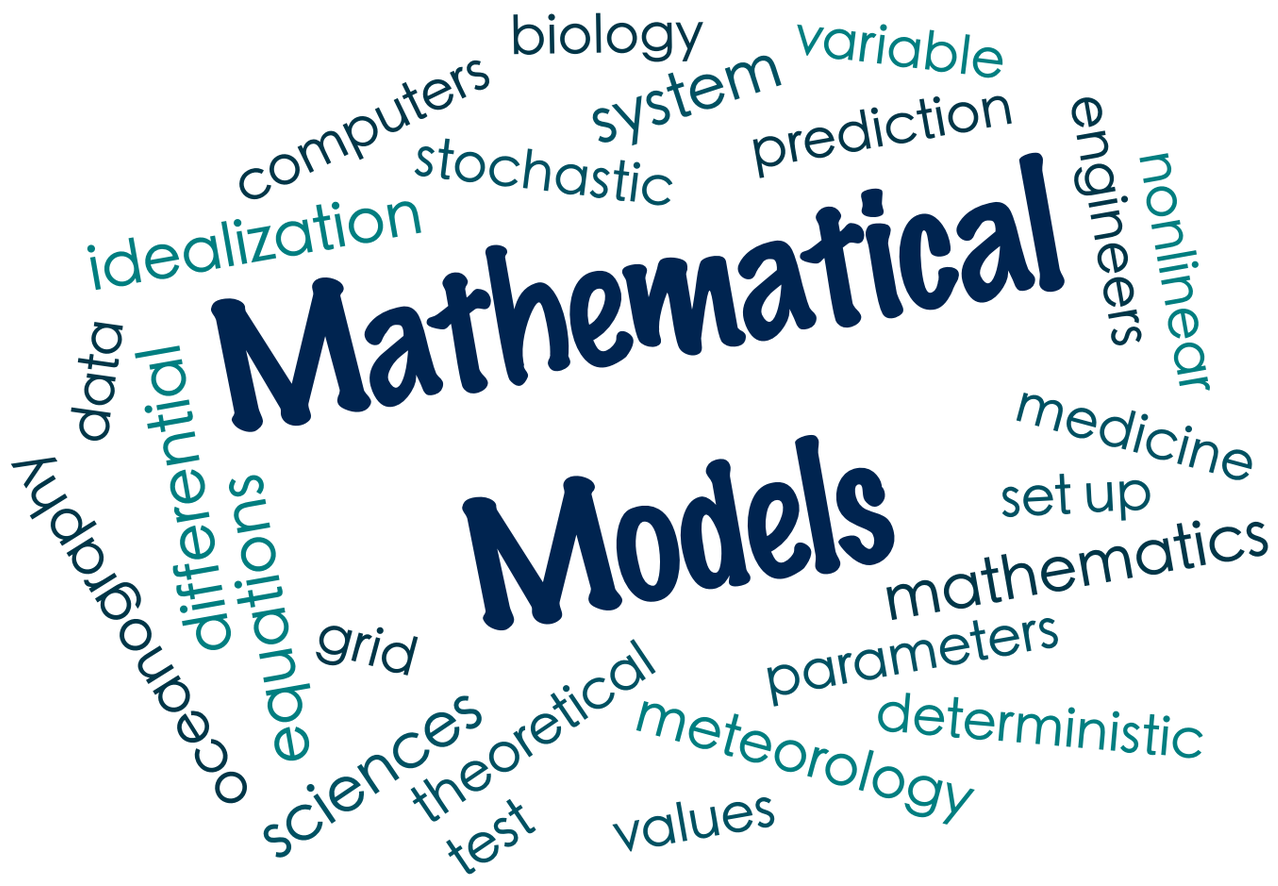

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