

# science

## 1 THE CLIMATE SYSTEM

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### 1.1 WHAT IS A SYSTEM?

A system is a way of compartmentalising complicated processes. The terminology related with systems are:

- Inputs – what is being put into a system
- Outputs – what comes out of a system
- Components – parts of a system, sometimes a subsystem
- Couplings – interactions between components
  - o Couplings can be positive or negative
    - A positive coupling means that an increase in one component leads to an increase in another component
      - A positive coupling is represented through  $\longrightarrow$
    - A negative coupling means that an increase in one component leads to a decrease in another component
      - A negative coupling is represented through  $\longleftarrow$
  - o When couplings are mutual they create feedback loops
    - A negative feedback loop is stable meaning that overall no significant change occurs and a positive feedback is unstable meaning that changes can have runaway effects.
      - The way to tell if a system is negative or positive is to count the number of negative couplings. When a system has an even (or zero) number of negative couplings the system is positive, when a system has an odd number of couplings the system is negative.

### 1.2 WHAT EFFECTS THE CLIMATE SYSTEM?

#### 1.2.1 WHAT IS A PERTURBATION?

A perturbation is a temporary causer of change in the climate system. Examples of a perturbation include volcanoes.

#### 1.2.2 WHAT IS A FORCING?

A forcing is something which has a permanent effect on the climate system. An example of a forcing (the most significant forcing) is the sun.

### 1.3 WHAT ARE THE IMPORTANT FORMS OF ENERGY IN THE CLIMATE SYSTEM?

Energy Type	Definition	Example
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# SCI1300 – CLIMATE CHANGE: FROM SCIENCE TO SOCIETY

Kinetic Energy	Movement Energy	Movement of particles
Potential Energy	Stored Energy	Thermal (temperature), Chemical (water vapour), Mechanical (pressure), Gravitational (gravity)
Radiant Energy	Emission and absorption of electromagnetic waves	Light

## 1.3.1 WHERE DOES THE ENERGY THAT DRIVES CLIMATE COME FROM?

The major source of energy for the climate system is radiation from the sun.

## 1.3.2 WHAT IS RADIATION?

There is two definitions for radiation. Radiation can either be viewed as:

1. A stream of particles called photons which carry energy but do not have mass, in this definition higher frequency = more energy per photon.
2. The interplay of electric and magnetic fields where is self-perpetuating wave, meaning that it is able to travel through a vacuum.

The definition used for radiation is dependent on the situation. Generally, whichever definition makes the action of the radiation easier to understand is the one which is applied.

### 1.3.2.1 WHAT DOES RADIATION DO?

Radiation is a form of energy and is most significantly responsible for heating (when radiation is absorbed) and cooling (when radiation is emitted).

### 1.3.2.2 WHAT IS FLUX?

Flux is the amount of energy (or material) that passes through a given area per unit time (usually per m per second).

In the climate system, fluxes are measured in watts per metre squared ( $W/m^2$ )

#### 1.3.2.2.1 WHY IS FLUX SIGNIFICANT?

Flux causes the Earth's seasons due to the tilt of the Earth.

## 1.4 WHAT LAWS EFFECT THE CLIMATE SYSTEM?

### 1.4.1 PLANCK'S LAW

Planck's law allows the description of wavelength emitted based on temperature.

### 1.4.2 WIEN'S DISPLACEMENT LAW

Wein's law explains he maximum energy of radiation emitted.

### 1.4.3 STEFAN-BOLTZMANN LAW

The Stefan-Boltzmann law relates the total energy emitted to temperature.