Meteorology and Geographic Change

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Biol 417: Evolutionary Ecology

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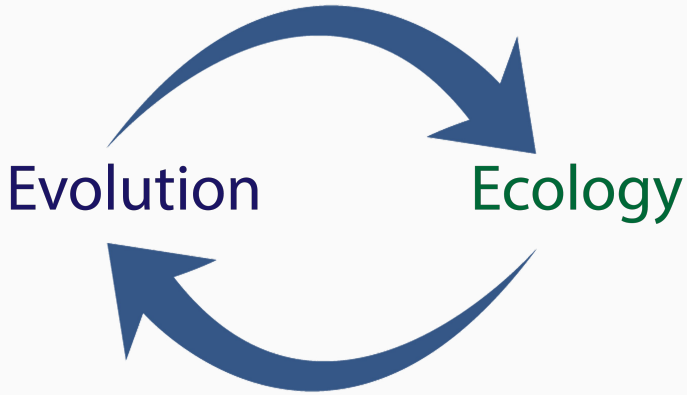
Review

Review



	Dynamic	Static
Proximate (How)	Ontogeny (development)	Mechanism (causation)
Ultimate (Why)	Phylogeny (evolution)	Function (adaptation)

Today's lecture

Today we will begin exploring the relationship between basic physics, the Earth's geography, and biogeography.

Library books

Library books

How would we answer the question of why Oxford's library has more books than UBC's?

UBC

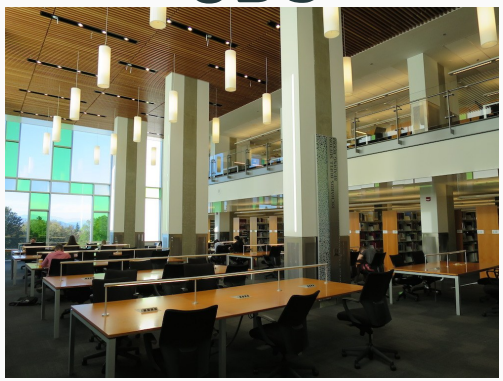
8.3 million items

Oxford

>12 million printed items

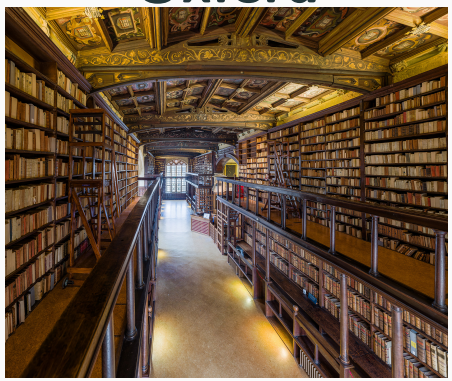
Library books cont.

UBC



8.3 million items

Oxford



>12 million printed items

To answer this we need to ask ourselves "Are both libraries full?"

- **Yes** – How do the physical properties of the two differ (e.g., number and height of shelves)?
- **No** – How does the age and rate of acquisition of the two differ (i.e., has one had more time to accumulate books?, is one acquiring books at a faster rate)?

Patterns of species diversity

If we were interested in patterns of species diversity instead of patterns in library books we would ask ourselves very similar questions:

"Are the habitats full?"

- **Yes** – How do the physical properties of the environments differ (temperature, solar energy, water availability)?
- **No** – How does the age of the two environments differ?

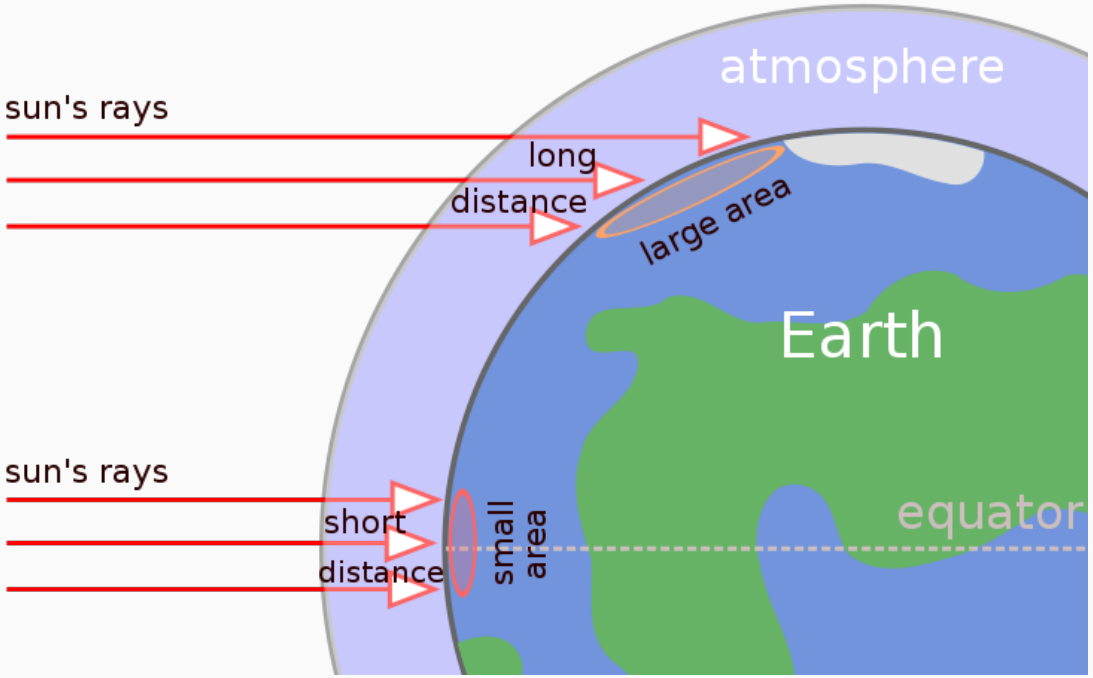
— MacArthur (1965)

Meteorology

Solar energy and latitude

The amount of solar energy hitting the Earth's surface varies by latitude due to the angle the energy hits the Earth for 2 reasons:

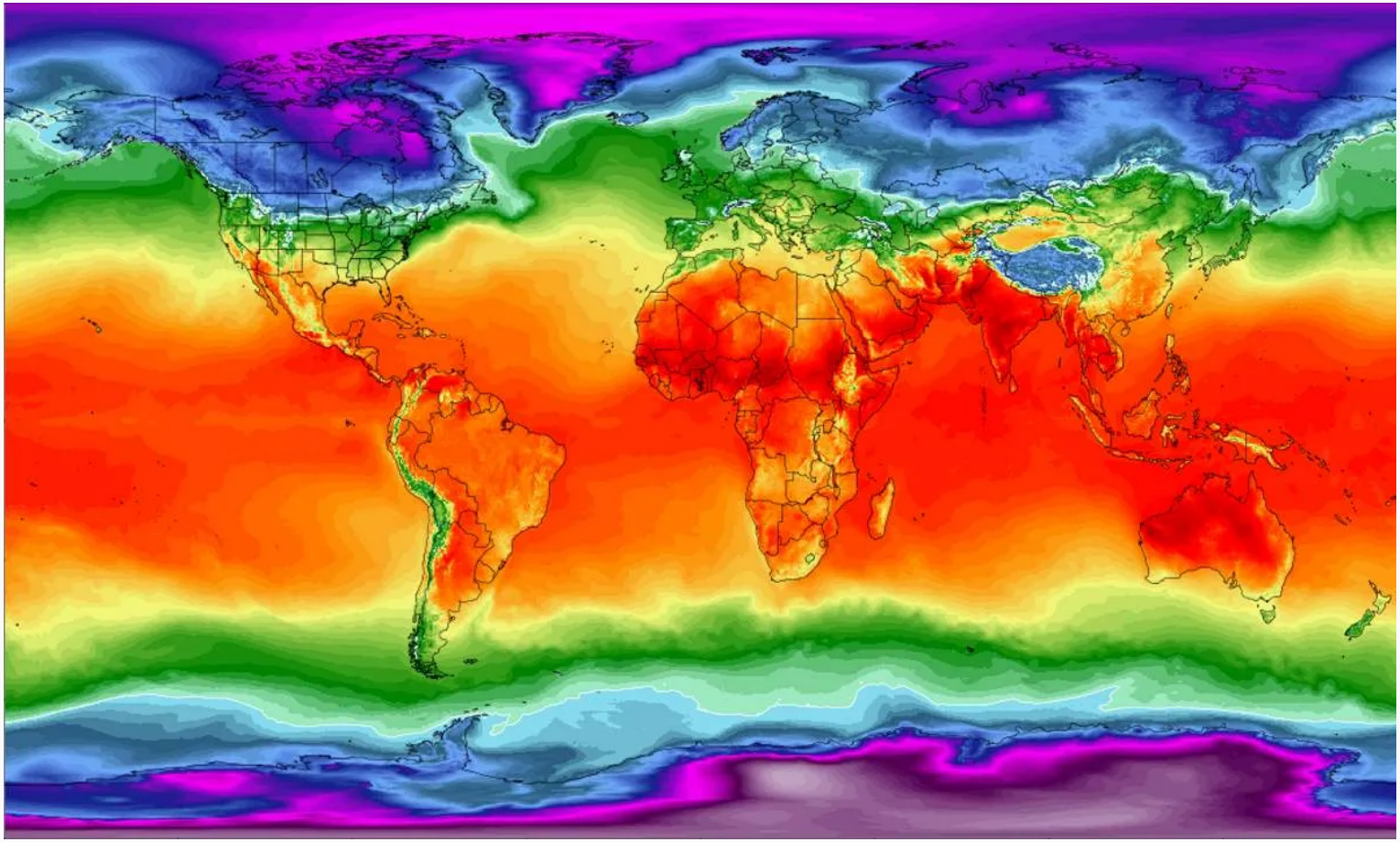
1. Amount of atmosphere penetrated.
2. Area of impact.



Source: Wikimedia Commons

Solar energy and latitude cont.

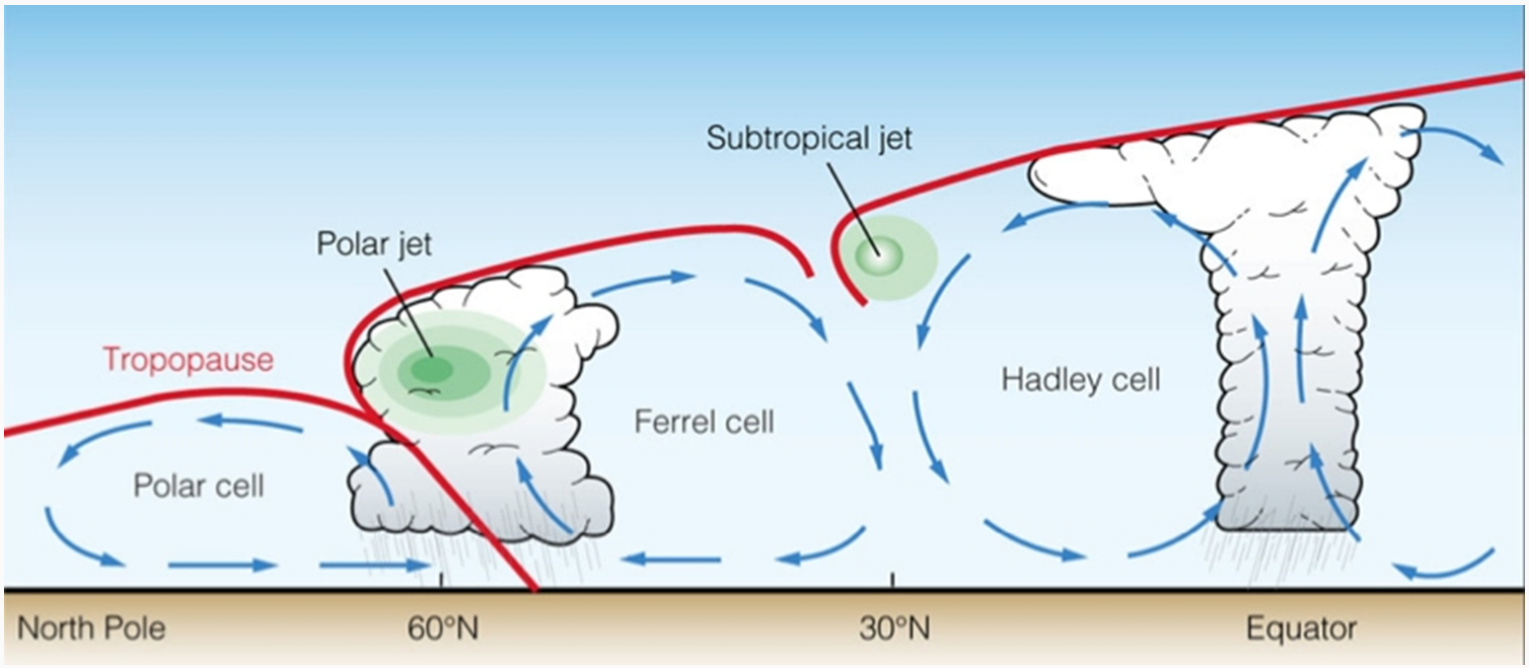
This drives a latitudinal pattern in temperatures



Source: Our Planet

Hot air rises

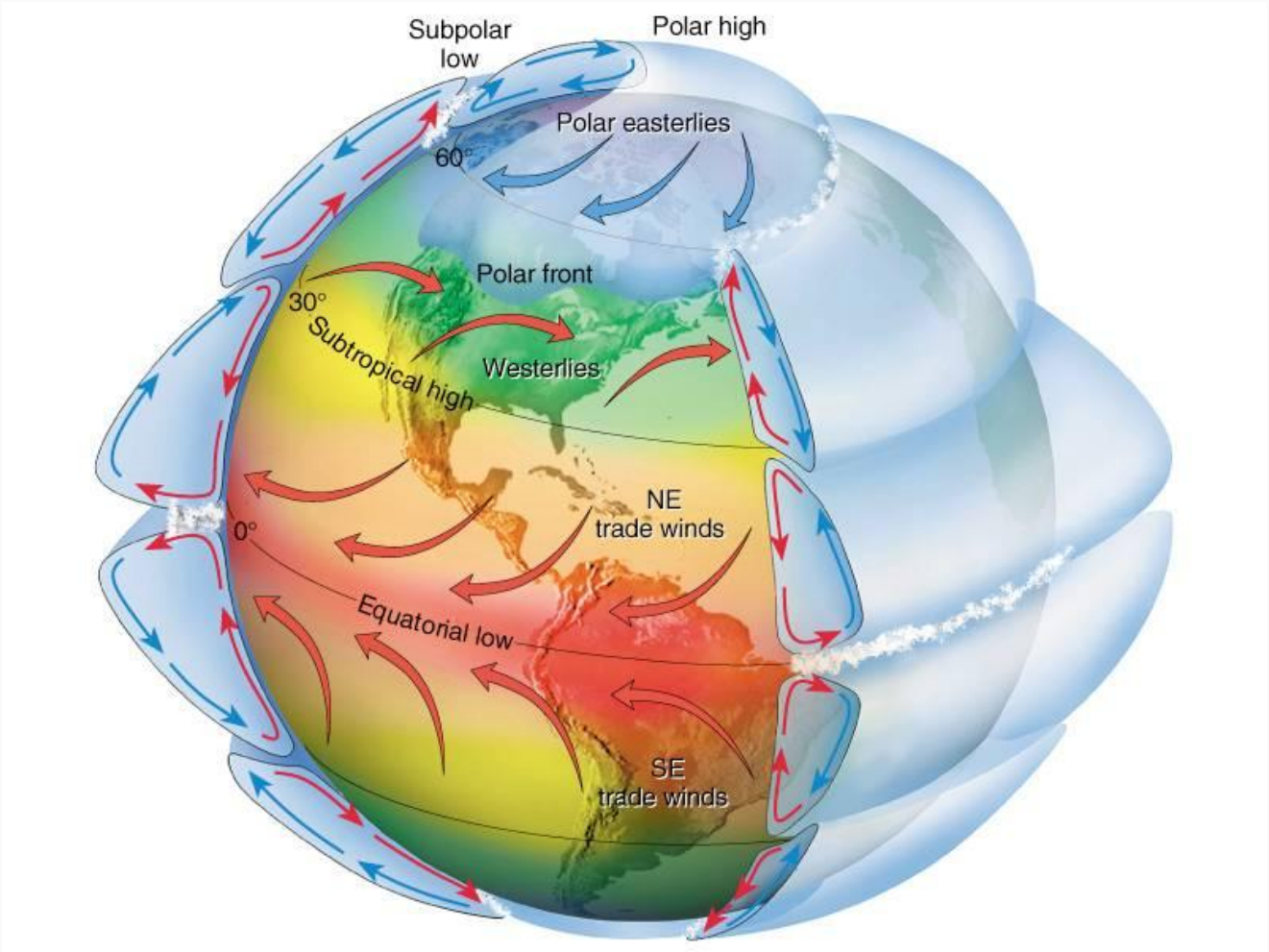
Hot air rises and Earth is a ∼closed system so cold air rushes into the gaps, generating latitudinal cells.



Source: Geophile pages

Earth's rotation

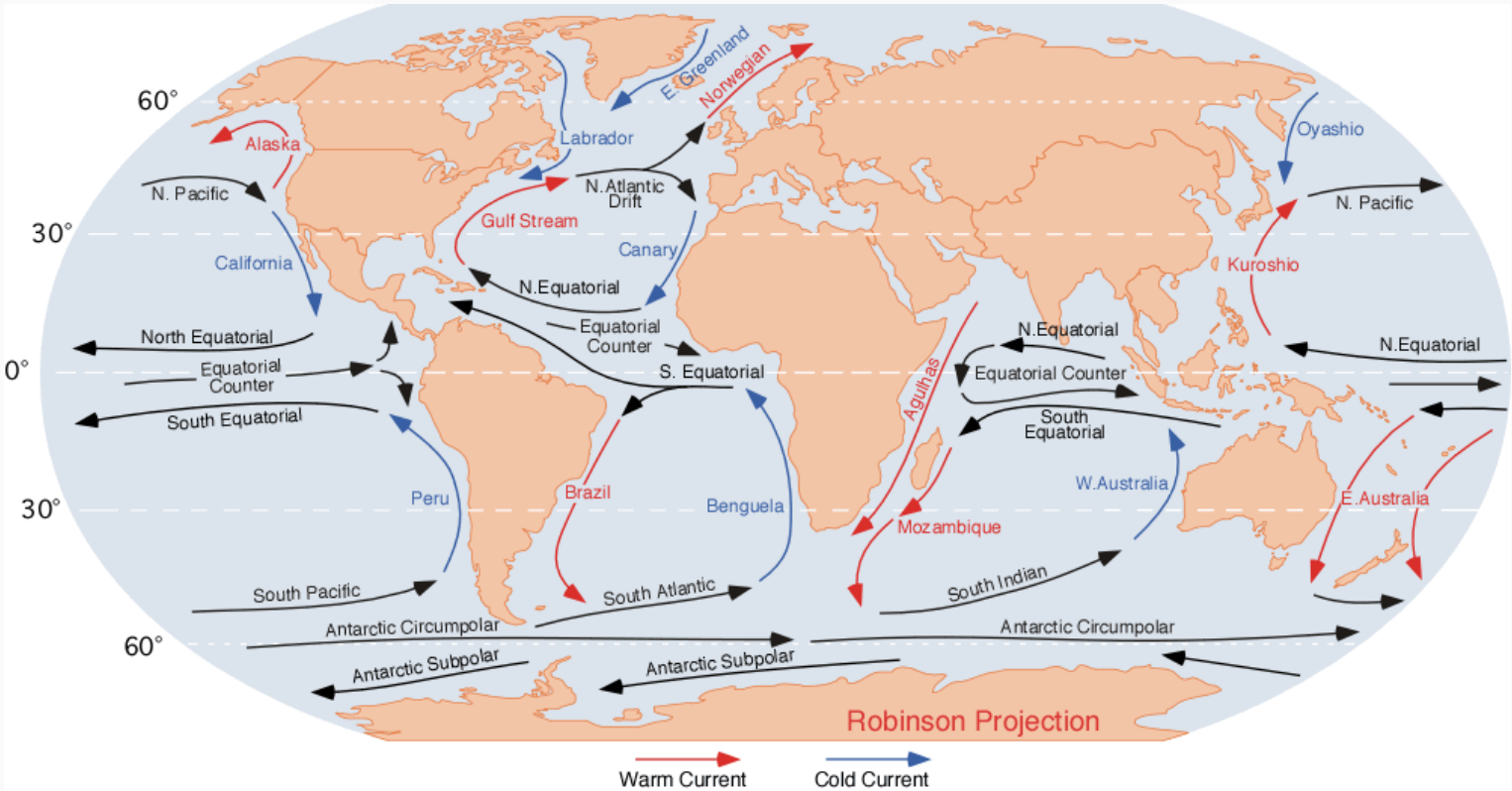
The Earth's rotation adds east/west patterns via the Coriolis effect.



Source: World Building Pasta

Ocean currents

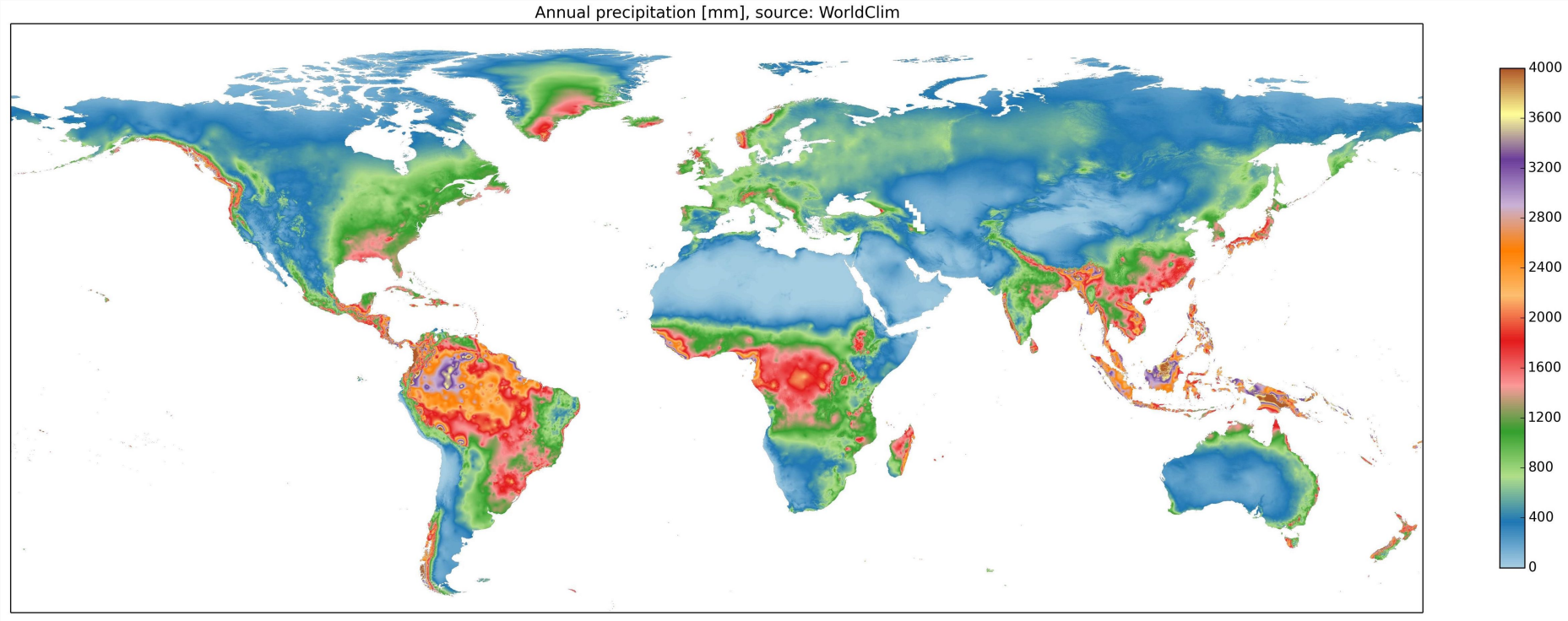
These same forces influence water, driving the world's oceanic currents (but oceanic currents are impeded by land masses)



Source: Wikipedia

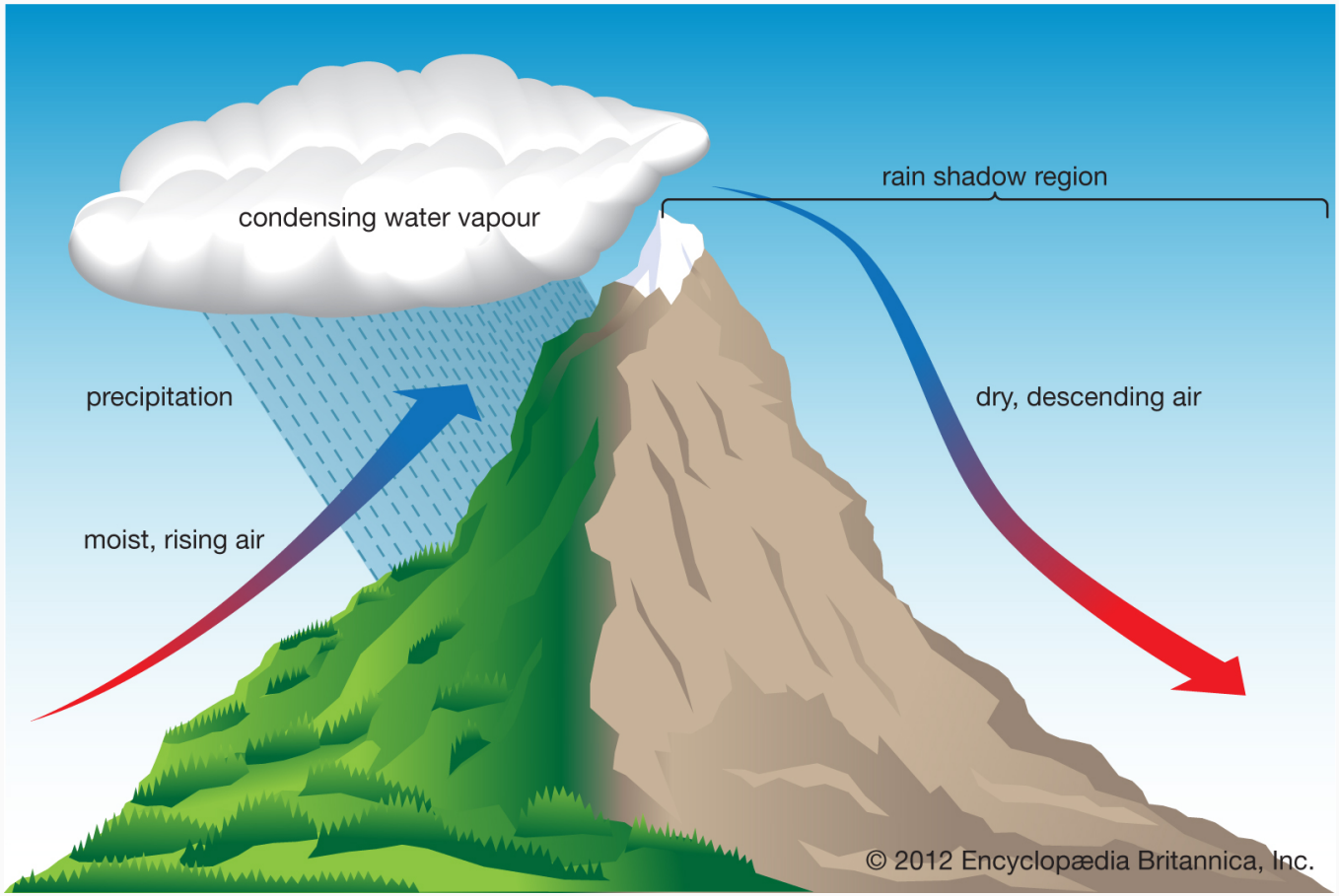
Latitudinal precipitation

Warm air can store more water vapour than cold air, driving north/south patterns in rainfall.



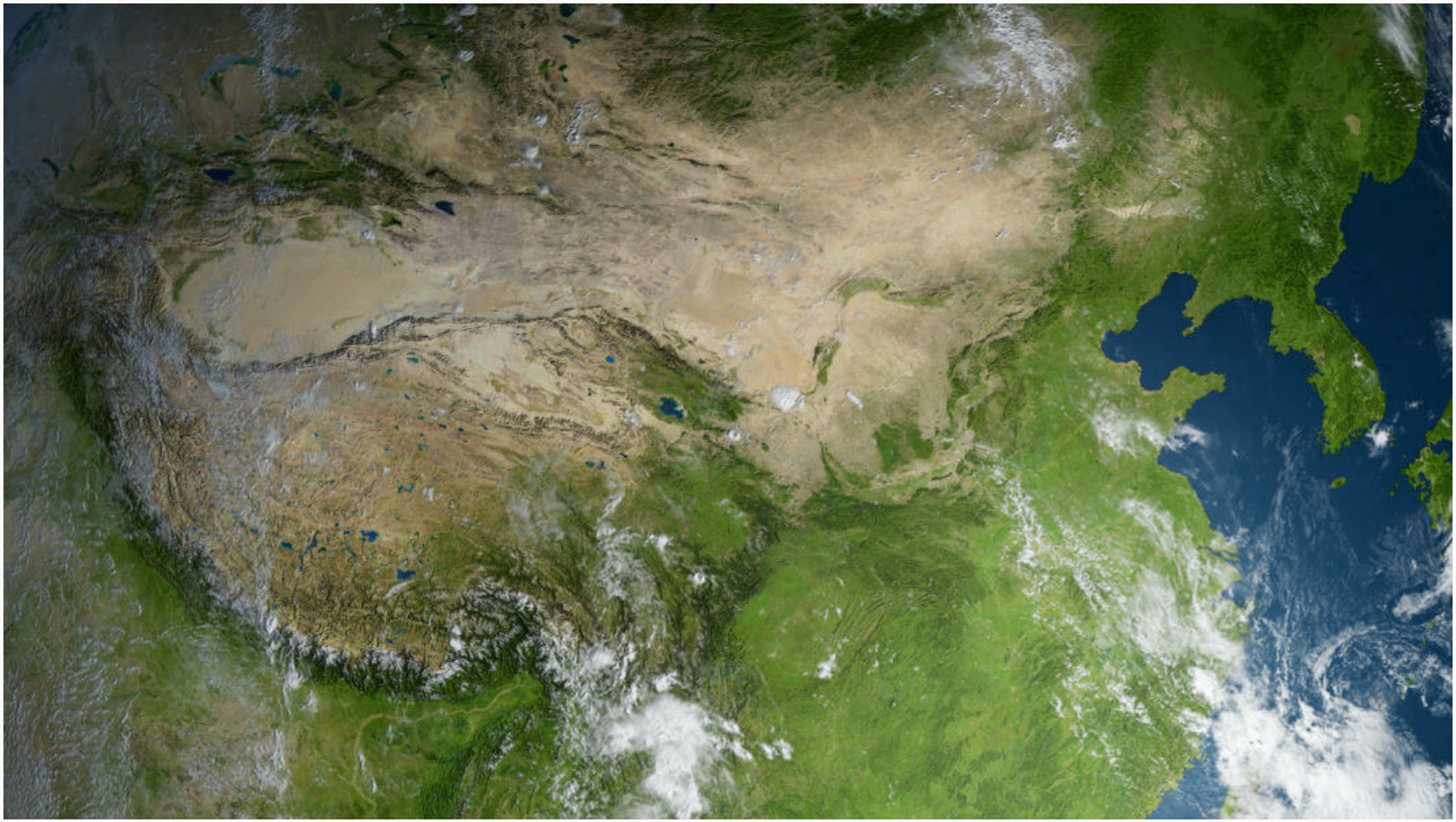
Mountains and precipitation

Warm rising air cools and loses water, cold falling air warms and soaks up water, generating predictable patterns near mountains



Mountains and precipitation cont.

Large mountain ranges generate deserts.



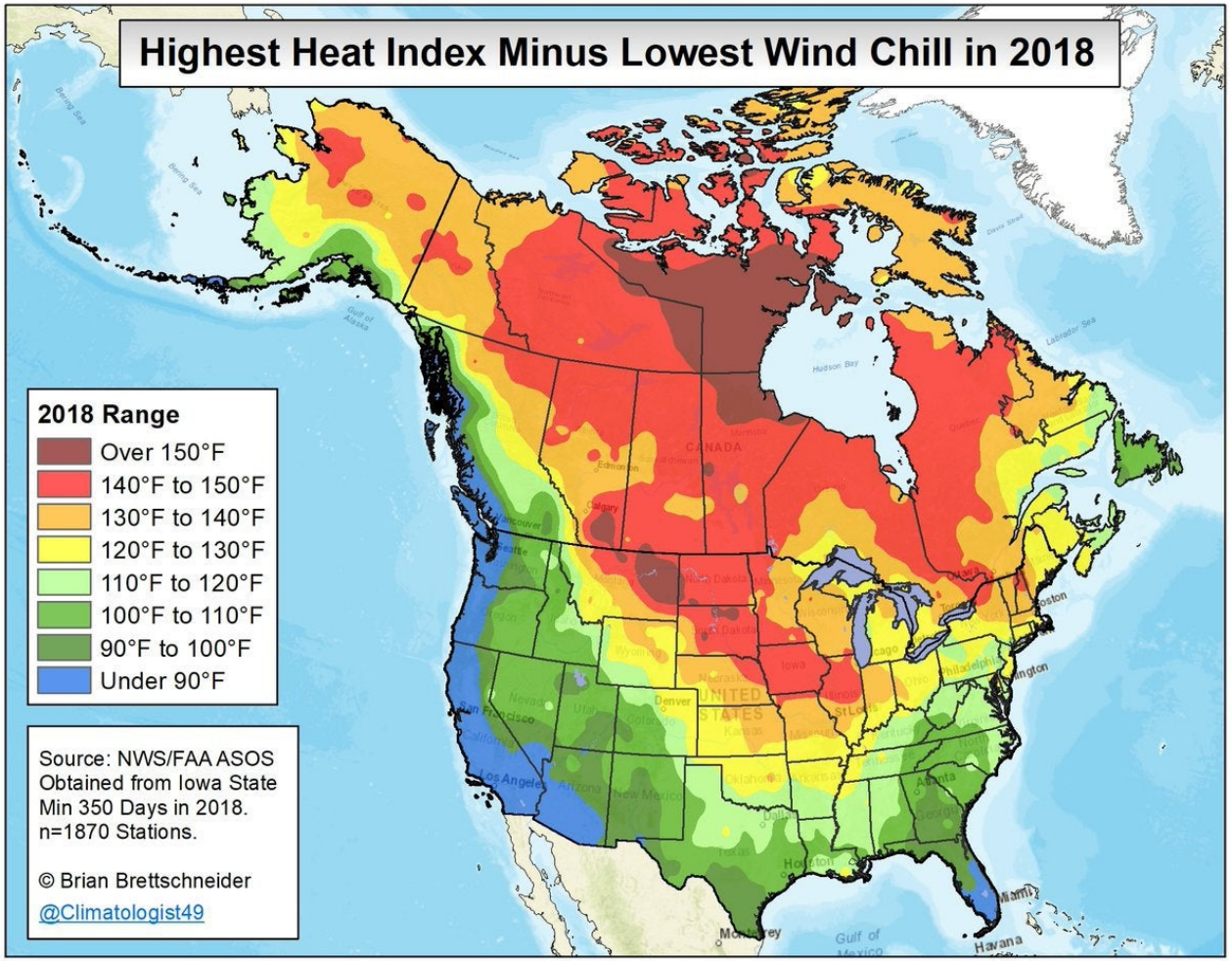
Mountains and precipitation cont.

Large mountain ranges generate deserts.

Notice anything different about deserts in NA vs. SA?

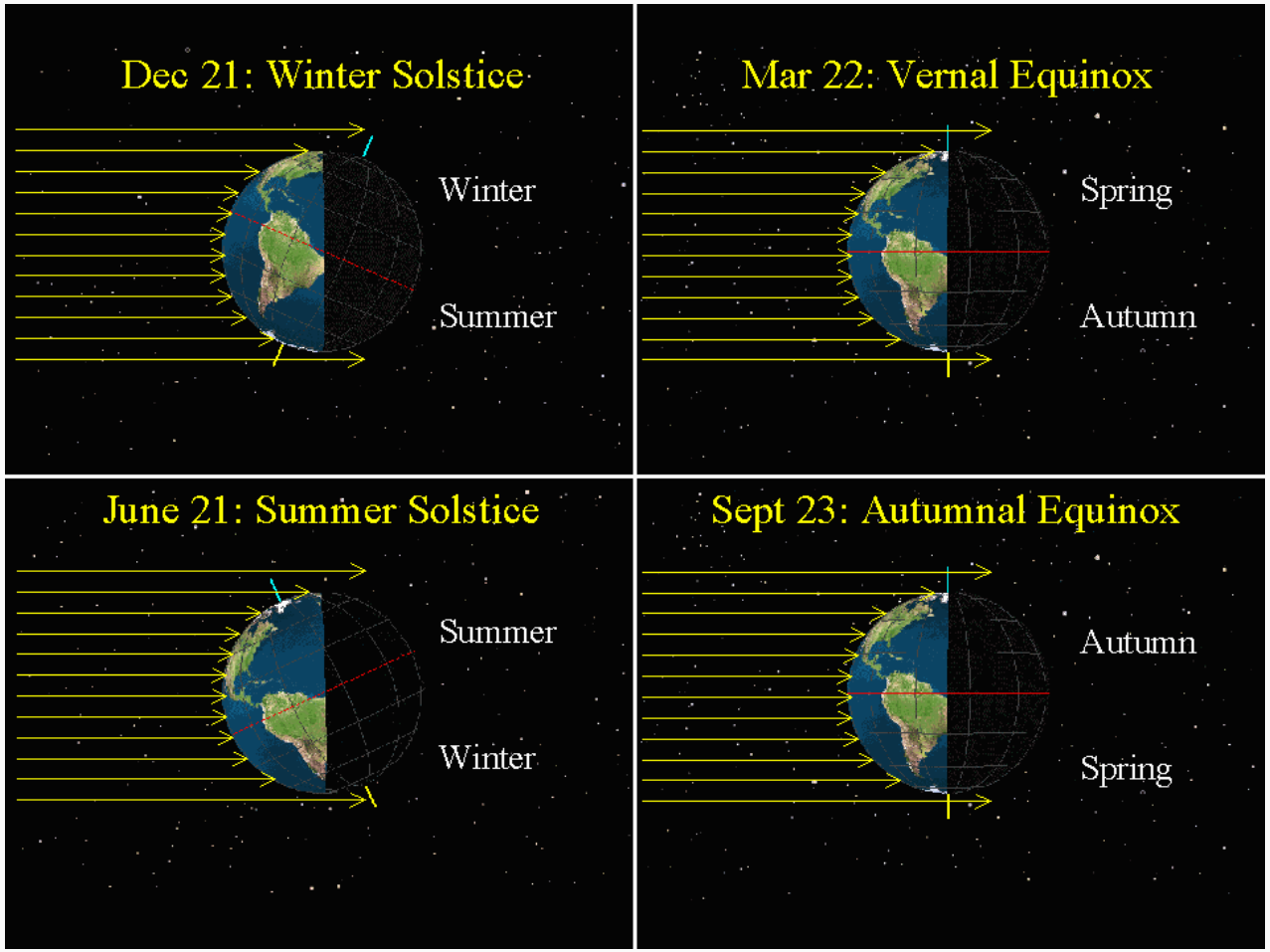
Lakes as thermal buffers

Water has a high specific heat capacity. This means large bodies of water can buffer against large swings in temperature



Seasonal changes

The Earth's annual rotation results in changes to the amount of solar energy hitting the surface.



Short term changes

Cloud cover also influences how much solar energy hits the surface over short timescales.

Summary

The amount of solar energy hitting the Earth is not uniform in space or time.

The fundamental, physical properties of heat and energy transfer, combined with the non-uniform distribution of energy across the Earth's surface, drive changes in the amount of energy, heat, and water available to organisms living in different regions across the planet.

I.e., some fairly simple rules can generate a substantial amount of climatic variation that life must contend with.

History – A Planet in Flux

Geography and meteorology

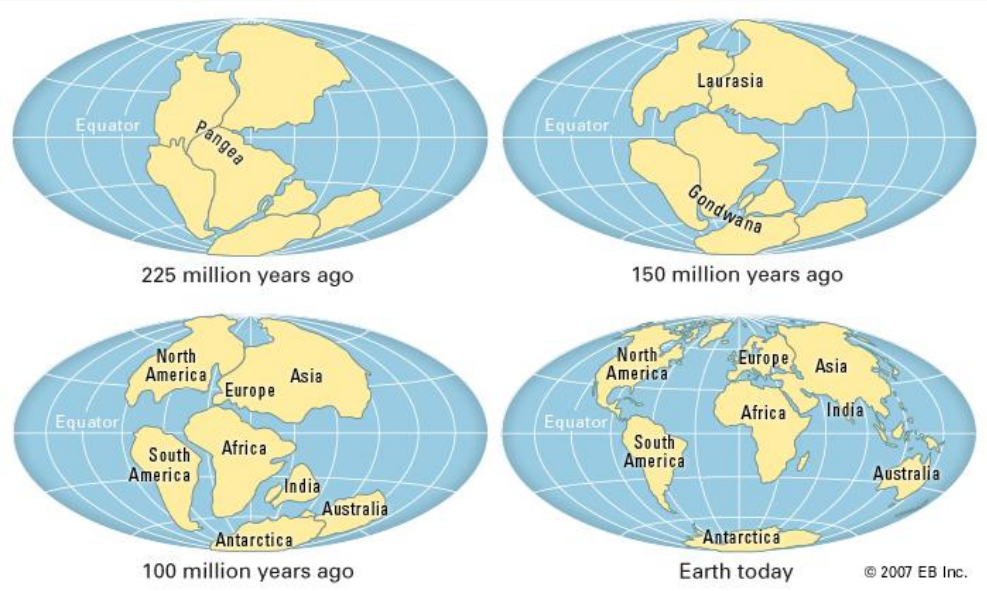
Basic physics, combined with the Earth's geographic structure work to govern meteorological patterns.

In turn, this governs what conditions a species in any given place can be expected to experience.

...but the earth hasn't always looked as it does now, and won't continue to look as it does now in the future.

Continental Drift

Plate tectonics shift the Earth's continents around in space.



The Indian continent changed from south temperate to tropical to north temperate, Australia became arid as it drifted north, but will become wetter and more tropical in the future.

Imagine the impact this can have on plants and animals!

Mediterranean drying

Around 5-6 million years ago a land bridge formed at the straight of Gibraltar, cutting off the influx of water from the Atlantic Ocean.

The sea dried out over 100s of thousands of years and became uninhabitable to the species previously there. Eventually the straight opened up again and within 2 years(!) the sea was back.

Volcanic islands

Volcanic activity creates islands that start as blank slates for life.

Source: BBC

Changing ocean levels

Changes in ocean levels can submerge or expose islands, transforming the type of life that can be supported.

Source: ABC News

Take home message

Basic physics, combined with the Earth's geographic structure work to govern meteorological patterns.

The Earth's geographic structure, and therefore meteorology, is in constant flux. New habitats are constantly being created, old ones are being changed.

There is no place on Earth can be expected to have constant conditions in the long run.

Inter-specific interactions can drive speciation, but spatio-temporal variation in physical conditions necessitates variety among organisms from one place/time to the next and is the primary reason why there are so many species.

Next Lecture

Next lecture we will focus on the relationship between environmental conditions and physiology, given what we have covered today.

References

MacArthur, R.H. (1965). Patterns of species diversity. *Biological reviews*, 40, 510–533.

Pianka, E. (2000). Evolutionary Ecology, Chapters 3-4.