ENV101 – Earth Systems

Week 1: Unit Admin and Introduction

LECTURE OUTLINE

- Unit Outline
  - Topics
  - Assessments
  - Resources
- Learnline
- Introduction to Earth Systems and subsystems

INTRODUCTIONS

Dr Ian Leiper
Unit Coordinator and Lecturer

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Phone: 08 8946 7290
Room: Purple 12.2.27 (by appointment only)

Background:
Marine science, remote sensing, geographical information systems

INTRODUCTIONS

Dr Sofia Oliveira
Tutor

Practical session tutor and technical support

Background:
Fire ecology, modelling and remote sensing

INTRODUCTIONS

Other people involved

Lectures from research and industry

- Prof Wayne Erskine
- Dr Ian Hollingsworth
- Rohan Fisher
- Dr Mila Bristow
- Prof Andrew Campbell
- Dr Andrew Edwards
- Ian Lancaster
- Dr Ed Butler

Northern Territory Government

Australian Institute of Marine Science

Research Institute for the Environment and Livelihoods RIEL

UNIT AIMS

- To develop an understanding of the basics of the Earth as a system
- To introduce a wide variety of Earth Science related topics (e.g. Earth structure, atmosphere, oceans, climate…)
- To expose students to applications of spatial technologies (e.g. remote sensing and GIS)

UNIT OUTLINE

1. Unit admin and introduction to earth systems
2. Earth structure and earthquakes
3. Floods and extreme geophysical events
4. Soil and landscape concepts
5. Atmosphere/weather systems
6. Greenhouse gas exchange
7. Climate change and sustainability
8. Fire and responses to a changing climate
9. Surface and sub-surface water
10. Oceans and coastal processes
11. Natural Hazards
12. Unit summary

TEXT BOOK (REQUIRED)

- Zeeya Merali, Brian J. Skinner (2008) Visualizing Earth Science, 1st Edition John Wiley & Sons. ISBN: 978-0-471-74705-5
- Required textbooks can be ordered from the CDU Bookshop through their website at http://www.cdu.edu.au/bookshop
- A copy of the text is also available in the library (Casuarina Campus) on short term loan.
- Weekly readings shown in learning schedule of Unit Outline document
  - Read prior to lecture, to get the most out of lectures

PRACTICAL SESSIONS

- Designed to expand on lecture materials and provide 'hands on' learning
- Computer lab in Purple 12.3.17, Fridays 9am – 12pm

  Except, venue to be announced for:
  - week 4 (soil observation)
  - weeks 6 and 7 (ALLSP workshops)
- Software in use will be Google Earth, ArcMap
  - any Mac users?
- Individual practicals are not assessed, however final assessment item will include all aspects of work covered in practicals (and lectures and readings)

ASSESSMENT ITEMS

ASSESSMENT ITEM	FOCUS	VALUE	LENGTH	DUE DATE
1. On-line test	Lecture, text book readings, and practical topics covered in weeks 1- 5 inclusive	30%	Multiple choice and short answer questions	25 Aug 2015
2. Essay and discussion board posts	Discussion board posts and essay relating to climate change	30%	1500 - 2000 words	20 Sept 2015
3. Practical exercises workbook	Practical exercises covering entire unit	40%	Short answer	18 Oct 2015

1. ON-LINE TEST

- Content: lectures, pracs, and textbook readings from weeks 1 - 5 inclusive
- Due date: 25 August (week 6)
- Individual assessment
- 30% contribution to unit grade
- Format:
  - MCQ (1pt ea); T/F (1pt ea); Completion (1pt ea); Paragraph (5pt ea)
- 90 mins to complete
- Must be completed on first launch

2. ESSAY AND DISCUSSION BOARD POSTS

- Content – lectures, pracs, textbook, media, scientific literature
- Due date: 20 September (week 8)
- Individual assessment
- 30% contribution to unit grade
- Minimum three (3) Discussion Board contributions (at least 200 words)
- Essay format: 1500 – 2000 words
- ALLSP workshops (weeks 6 and 7)

2. ESSAY AND DISCUSSION BOARD POSTS

- Your postings may include (but are not limited to):
  - Critical review of an article or video
  - Suggestions to classmates of other interesting materials
  - Thought provoking questions / answers
- Things to consider in your essay:
  - What is climate change?
  - What are some of the effects that are considered to be caused by climate change, and what is the evidence to support this?
  - What sorts of data are collected to monitor changes?
  - What are the accuracy or uncertainty levels in the data?
  - What is the 'evidence' for and against human induced climate change?
- Essay structure:
  - Introduction, main body, conclusions, and references.

3. PRACTICAL EXERCISES WORKBOOK

- Content – lectures, pracs, and textbook readings
- Due date: 18 October (week 12)
- Individual assessment
- 40% contribution to unit grade
- Format: short answer, practical assessment
- Assessment questions to be released following mid-semester break
  - Keep up-to-date with practical exercises

ASSESSMENT SUBMISSION

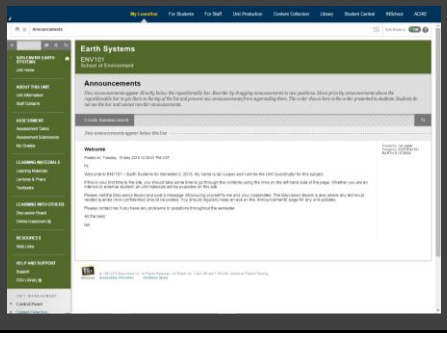
- All assessment items are compulsory
- Due by 11.59pm on the given date
- To be submitted via Learnline
- Late submissions: penalty of 5% per day may be applied
- Extensions
  - Granted on case by case basis
  - must be requested in writing a minimum of 48hrs prior to the due date
- Don't leave things until the last minute

FINAL INTRODUCTIONS

Your turn…

LEARNLINE

https://learnline.cdu.edu.au/



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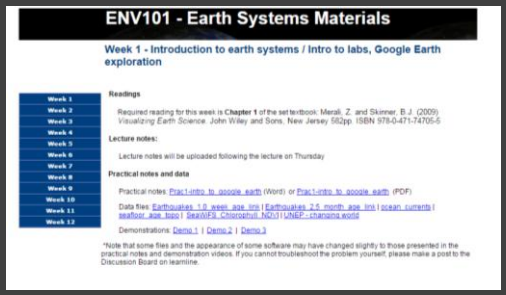
LEARNLINE ENV101 COMPANION SITE

http://learnline.cdu.edu.au/units/ses101/materials.htm



INTRODUCTION TO EARTH SYSTEMS

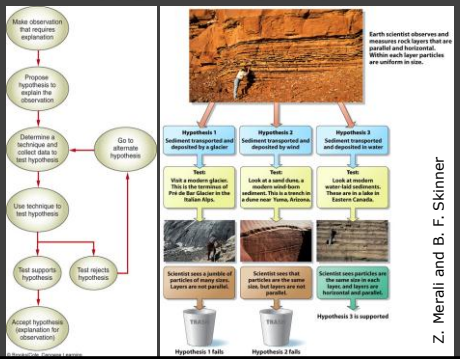
Resources

- Zeeya Merali, Brian J. Skinner (2008) Visualizing Earth Science, 1st Edition John Wiley & Sons. ISBN: 978-0-471-74705-5
  - Chapter 1
- Gabler, R.E., Petersen, J.E., Trapasso, L.M. and Sack, D. (2008) Physical Geography 9th Edition. Thomson-Brooks/Cole. Australia. ISBN 0495555061
  - Chapter 1

INTRODUCTION TO EARTH SYSTEMS

- Earth Science
  - The scientific study of all aspects of Earth (atmosphere, oceans, rocks, minerals, soils, mountains, and all living things).
- Earth Systems Science
  - Taking a portion of the Earth that can be separated from the rest for the purpose of observing changes that happen in it (without losing sight of connections between different pieces).

SCIENTIFIC METHOD



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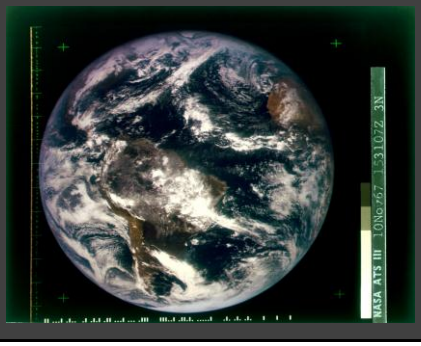
WHAT IS A SYSTEM?

- A combination of correlated parts forming a complex or unitary whole
- Examples of systems
  - Nervous, circulatory, respiratory, digestive
  - Solar
  - Computer
  - Railroad
  - Life Support
  - Ecological

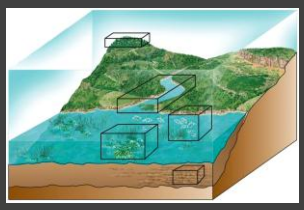
INTRODUCTION TO EARTH SYSTEMS



THE SYSTEMS APPROACH

- Deconstructs universe into interconnected elements or units
- Identifies processes and boundaries connecting and separating systems

THE SYSTEMS APPROACH



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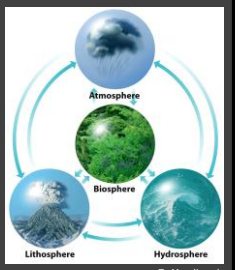
The systems approach is a helpful way to break down a large, complex problem into smaller pieces that are easier to study without losing sight of the connection between those pieces

Study the relationships within and between earth systems and how they affect the environment

EARTH SYSTEMS

- Four principle subsystems
  - Lithosphere
  - Hydrosphere
  - Atmosphere
  - Biosphere
- Anthroposphere
- Interactions within and between systems
  - Most intensely in the 'life zone'



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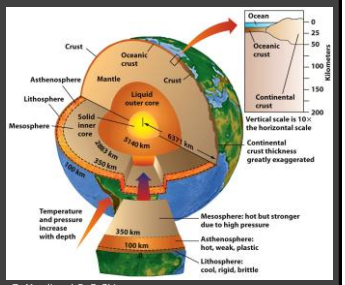
LITHOSPHERE

- Earth's outermost rocky layer
- Crust + upper mantle
- Approx 100km thick
- Strong but brittle, cool rock



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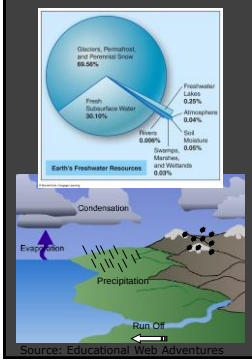
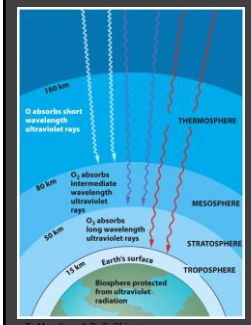
HYDROSPHERE (INCL CRYOSPHERE)



Source: Educational Web Adventures

- About 70% of Earth's surface is water covered
- Oceans
- Glacial ice
- Streams
- Groundwater
- Lakes
- Raindrops

ATMOSPHERE



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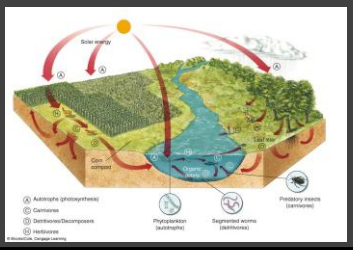
- Mostly nitrogen, oxygen and argon
- Water vapor – variable components
- Dry clean air and aerosols
- Small quantities of other gases
  - Nevertheless, trace gases have important properties
  - Absorption of radiation – protect and warm

BIOSPHERE

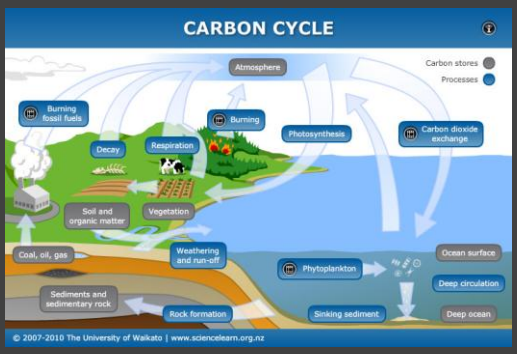
- Consists of all life, large or small, marine or terrestrial
- Driven by solar energy and photosynthesis



EARTH'S UNIQUE FEATURES

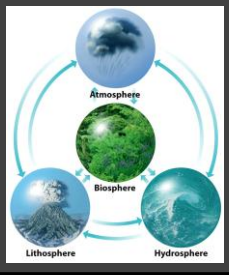
- Atmosphere – presence of Oxygen
- Hydrosphere – presence of Water
  - contains solid, liquid and gaseous water
- Biosphere
  - Contains all life on Earth
  - Interacts with surroundings and with itself
  - Changes and shapes its own environment
- Soil – layer of loose debris formed by weathering containing microscopic life
- Plate Tectonics
  - Continually reshapes the surface of the Earth

ANTHROPOSPHERE



GROUP ACTIVITY

- Investigate the four principle subsystems on earth, and record at least one interaction between each of the subsystems



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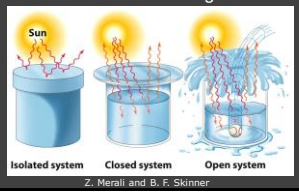
HOW DO EARTH'S MAJOR SYSTEMS INTERACT?

- Weathering of rocks (lithosphere) is accelerated by plants, microorganisms (biosphere) and water (hydrosphere)
- Plants (biosphere) regulate oxygen and carbon dioxide (atmosphere)
- Life forms (biosphere) utilise gases (atmosphere), water (hydrosphere), and nutrients (derived from lithosphere)
- Water (hydrosphere) is found within the lithosphere in soils and groundwater reservoirs, and in the atmosphere as water vapour, raindrops, and ice crystals
- Etc…

TYPES OF SYSTEMS

- Systems classified according to boundary interactions with the environment
  - Isolated: No energy or matter is exchanged
  - Closed: energy is exchanged but not matter
  - Open: energy and matter can be exchanged with environment



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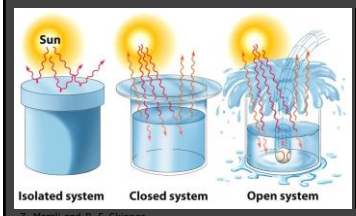
THE EARTH SYSTEM

- Isolated, closed, or open system?



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THE EARTH SYSTEM

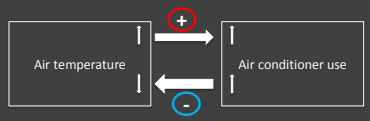
- A(n almost) closed system
- All resources are limited and finite
- Can't throw things 'away'
- Earth systems science
  - Treat Earth Science as a single field of study
  - Emphasis on studying interconnections between Earth subsystems
- Changing one part of the system will affect the other parts
  - E.g. Carbon

FEEDBACK MECHANISMS

- Feedback Mechanisms
  - System - Environment interaction cycles that change systems
  - Limit how much things can change in a system
  - Either change a system to a new state or return it to its original state
- Positive feedback
  - Enhances or amplifies change to a system, leading to imbalance
  - Not necessarily beneficial outcome
  - Push a system to a new state of equilibrium (or imbalance)
- Negative feedback
  - Reduces or dampens change to a system– leading to dynamic yet stable equilibrium
  - Not necessarily detrimental outcome
  - Push a system back to its original equilibrium position
- Thresholds
  - Condition within system that causes dramatic and often irreversible change to all variables in system

FEEDBACK MECHANISMS

- Positive coupling
  - Increase causes increase, decrease causes decrease
- Negative coupling
  - Increase causes decrease, decrease causes increase



- Negative feedback loop
  - push a system back to its original equilibrium and stable position

FEEDBACK MECHANISMS

Positive feedback mechanisms:

- push a system to a new state of equilibrium (or imbalance)

Imagine you are lost in the snow. As your body senses that it is cooling below 37ºC, mechanisms such as shivering help to raise your body temperature.

However, if this fails to restore your normal body temperature, your metabolic processes start to slow down because your body temperature is low.

Because of this, you start becoming lethargic and sleepy, and move around even less, and your body becomes even cooler..

Your body is continually being pushed to a new state of equilibrium (or imbalance). Unless rescued you will die of hypothermia.

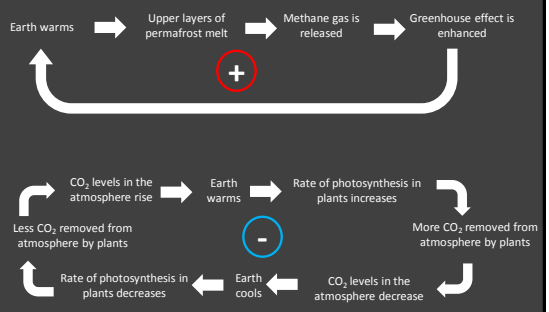
FEEDBACK MECHANISMS

- Negative feedback mechanisms
  - push a system back to its original equilibrium position

Imagine you set out for a walk early in the morning. As you are walking the sun rises higher in the sky and the air temperature increases. Your body senses that its internal temperature is rising above 37ºC and you begin to sweat.

This reduces your body temperature by evaporating water from your skin, and your body temperature is pushed back to normal.

FEEDBACK LOOPS



MOTIVATION FOR THE STUDY OF EARTH SYSTEMS SCIENCE

- Understanding the Earth system
  - Provides an appreciation of the Earth System as a closed system
    - All material resources are limited
    - Sustaining resources requires
      - understanding processes and
      - understanding time-scales
  - Provides an understanding of
    - Geological features
    - Phenomena and
    - Natural hazards
    - Things you see and experience every day

AREAS OF SCIENTIFIC INTEREST

- Changes in interactions within and between systems and their impacts
  - Natural hazards – earthquakes, volcanic eruptions, landslides, flooding, severe storms, tsunami…
  - Sea level rise / fall
  - Climate change
  - Human impacts, population pressures
  - Etc…

EARTH SCIENCE PROFESSIONS

- Meteorologists
- Climatologists
- Geomorphology
- Biogeographers
- Soil Scientists
- Hydrologists
- Oceanographers
- Glaciologists
- Volcanologists
- Geologists

Photo: Laura Wallace

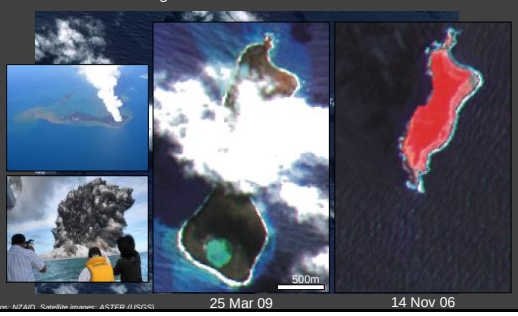
NATURAL SYSTEMS

- What processes could further affect this island causing environmental change?

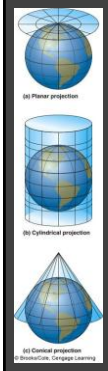
Photos: NZAID, Satellite images: ASTER (USGS)

NATURAL SYSTEMS

- What processes could further affect this island causing environmental change?



Photos: NZAID, Satellite images: ASTER (USGS)



COMING UP

- No on-campus practical session this week (public holiday).
  - Software required is Google Earth which can be downloaded online for free
- Next week lecture – Earth structure and earthquakes (Prof. Wayne Erskine)
- Next week prac – map projections and intro to GIS software