EPSS 15: Blue Planet
Introduction to Oceanography

Santa Monica Bay Observatory mooring station
UCLA image

Four storms in the Pacific, Sept. 2 2015.
http://earthobservatory.nasa.gov/NaturalHazards/view.php?id=86532&eoce=image&eoce=morenth
GOES-15 Satellite, Public Domain

The Big Picture

Why does the Earth have oceans?
What happens in and around them?

How do the oceans affect our lives?
How do we affect the oceans?

Photo from Int’l Space Station, Jan. 17 2014
http://earthobservatory.nasa.gov/IOTD/view.php?id=83350
Public Domain
The Big Picture

• Oceans affect us, and we affect the oceans.

Introduction to Oceanography

• Earth, Planetary & Space Sciences 15 (EPSS15)

Webpages:
https://ccle.ucla.edu/course/view/17S-EPSSCI15-1
http://www2.ess.ucla.edu/~schauble/EPSS15_Oceanography

– This is the primary resource for course info!

Instructor: Professor Edwin Schauble
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Office Hours: Mon./Tues. 3-4pm (or appt.)
Teaching Assistants

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Lecture Format

• Lectures: Tues, Thurs 12:30pm - 1:45pm
• Location: MOORE 100
• Information
  – Lecture exams cover lectures AND textbook.
  – Some material will be covered only in the textbook or lab.
  – You are responsible for all material from lectures, labs & assigned reading.
Lecture Format

• Lecture slides will be put on the course webpage before class (usually)

Webcasts

http://www2.oid.ucla.edu/webcasts/courses/#E
Video and audio available

Group Work

• **Group Work Policy:**
• You are encouraged to work and study together on reading and lab exercises
• *Collaboration and copying are prohibited on all exams and lab quizzes. You must do your own work.*
• Using a cell phone as a calculator is OK for lab exercises, but not for quizzes or exams.
Prerequisites

• High school science background
  – **Math**: algebra & geometry, powers of 10, *graphs*
  – **Metric units**
  – **Geography**: *maps*, Earth’s major features, longitude & latitude
  – **Chemistry**: elements, atoms, molecules, chemical equations
  – **Physics**: matter, density, waves, velocity, energy, gravity
  – **Biology**: classification, metabolism, evolution

Textbook

• *Invitation to Oceanography*, (Pinet)

  7th Edition (2014) – 6th Ed. is good, too
QUESTIONS?

Grading Policy

• Weekly Lab Quiz: 8 checks & quizzes, worth 30%
• Lab Section Final Exam: 10%
• Two in-class exams: 35% total
  (First exam: 15%, 2nd: 20%)
• Final Exam: 25%
Laboratories

• Room 3820 Geology Bldg.

• All students must enroll in a lab section

• Lab attendance is required: You must attend SIX (6) or more labs to complete the course. All Lab quizzes count towards final grade.

• Reading for labs available on class website. Download, print and read before your section.

Laboratories

• Check completion of lab exercise with TA each week. “check” grade given for successful completion
• After first week, labs will begin with a short quiz based primarily on the previous week’s lab and reading material. chief grade for lab.
• Lab checks & quizzes: 30% of your total grade
• Each lab is worth about 4% of your final grade
• Working through the in-lab exercise each week is key to getting the best possible grade the next week’s quiz!

Attend a laboratory session next week! TA’s can issue PTE #’s. Permission to add or switch will be granted if lab section enrollments permit. Make sure your TA knows your status!
Grading Policy

• Curving: grades on exams are assigned relative to the class average.
  – Mean for each exam is adjusted to 77.5 (B–)
  – Standard deviation adjusted to 10%.
  – The curve will never lower your grade.
  – My.ucla.edu will report curved exam scores.

Grade Scale:
- A+ > 96; A > 92; A– > 88
- B+ > 85; B > 81; B– > 77
- C+ > 75; C > 72; C– > 69
- D+ > 66; D > 62; D– > 59
- F ≤ 59

Grading Policy

Lab scores usually are not curved (class average ≈ B). Every quiz counts!

Pass / No Pass:
- Pass = C and above
- No Pass = C– and below
Extra Credit

- Three movies (more or less) shown during term.
- Oceanography-related seminars are listed on class page.
- Write a brief (1-2 page) summary of either, get 0.5%.
- Email to instructor (schauble@ucla.edu)
- Maximum: 2% total from Seminar/Movie extra credits.
- Bigger projects/honors papers -- see instructor for approval.

QUESTIONS?
Ocean world(s?)
The Earth & Planets

• Earth in space
• Gross structure of the Earth
  – Crust
  – Mantle
  – Core
• Origins of Earth’s water
• Shapes of the ocean basins

Our Solar System (not to scale!)

• The Sun
• Planets and Moons
• Dwarf Planets, Minor Planets, Meteoroids, Comets
How do solar systems form?

Large clouds of gas between stars can collapse under their own gravity, especially when disturbed, for instance by a supernova explosion.

The collapse is a runaway process, leading to high-density clumps that become stars and solar systems.

~ 1.2 light years
82,500 times the Earth-Sun distance
1.1 x 10^{16} meters

Computer simulation by Matthew Bate, UK Astrophysical Fluids Facility, Non-profit use allowed, http://www.ukaff.ac.uk/starcluster/

Units! Scientific Notation!

• 1.1 x 10^{16} meters!
• What does that mean?
  Today: Meters (our unit of length)
• Units define the meaning of a quantity, in this case length.
  How tall are you? Just under 2.2.
  You’re short! No.
Always understand the units.
Always include units with a quantity.

You’re Kareem Abdul Jabbar.

2.18 meters

UNITS!

Inches

Centimeters

A common system of units makes discussions much easier to understand!
Scientists use METRIC (S.I.) units
SI Units

LENGTH, meters

- 1 meter = 100 centimeters (cm) = 1000 millimeters (mm)
- 1000 m = 1 kilometer (km)

Compared to British Units:

- 2.54 cm = 1 inch
- 1 meter = 39.4” = 3.3 feet (= 1.1 yards)
SI Units

Compared to “British” (American) Units:

1 km = 3281 feet
1 km = 0.62 miles
   (about 2/3 of a mile!)
10 km = 6.2 miles
Mean Ocean Depth: ~ 3.7 km = 3700 m

$10^{16}$ meters is a very large distance

$10,000,000,000,000,000$ m

Birth of a solar system

After collapse, each new star may have an associated disc of leftover material trapped in its gravity. Some condenses to make planets.

We can see new solar systems forming today!

Proplyd *(protoplanetary disk)* around star HL Tau

Our Solar System at the same scale


More proplyds in the Orion Nebula

Other Planetary Bodies with Oceans?

- Probably water oceans on
  Europa, Ganymede & Callisto (moons of Jupiter)
  Enceladus and Titan (moons of Saturn)
  Subsurface briny oceans with solid icy “crust” -- thin
- Lakes on Titan (largest moon of Saturn)
  - Liquid methane/hydrocarbon pools, *not* water!
- Ancient Mars?
  - Flood channels & deep, flat N. hemisphere
- **Definitely Earth**

What Planetary Bodies have Oceans?

**Europa** – a moon of Jupiter.
  Bright, icy surface lacking craters – evidence of recent resurfacing.
  Geophysical and magnetic evidence of salty liquid water at depth.
  Salt water is also likely present at depth inside Ganymede, another moon of Jupiter.

“All these worlds are yours, except Europa. Attempt no landings there.” (2010: Odyssey Two, Arthur C. Clarke)
What Planetary Bodies have Oceans?

**Enceladus** – a moon of Saturn.
Also has few craters
It is spewing water into space!
Geysers may tap deep ocean.

What Planetary Bodies have Oceans?

Titan -- largest moon of Saturn.
Persistent radar “dark spots” near North & South Poles
Consistent with liquid methane/ethane
What Planetary Bodies have Oceans?

- Early Mars: Northern oceans?
- Water ice found in soil!
- Hydrous salts over “seeps”

Liquid water on Mars today?

Seasonal streaking inside Newton Crater, Mars
McEwen et al. 2011 (Science) - Ohja et al. 2015 (Nature Geoscience). Images NASA/JPL-Caltech/Univ. of Arizona
Extrasolar Planets

- Evidence for planets around other stars
  - 3607 confirmed, 610 systems with multiple planets, as of April 1, 2017 (+many unconfirmed, mostly from Kepler spacecraft)

Image of HR8799, a solar system 129 light years away from Earth. By Ben Zuckerman, UCLA using the Keck Observatory telescope

See also http://www.nytimes.com/interactive/science/space/keplers-tally-of-planets.html?_r=0 for a continuously updated animation of planetary systems.
Most planets found so far are closer to their stars than Earth is to the Sun, and probably are too hot to have familiar oceans.

Water vapor has been found in the atmospheres of some of these: including HD189733b (2007) HAT-P-11b (2014)

12 “habitable zone” extrasolar planets now known (July, 2015) → liquid water may be stable at or near the surface.

What Planetary Bodies have Oceans?

• Definitely Earth!
Where does Earth’s water come from?

Most water probably came from water-bearing minerals in accreted planetesimals and comets. Such minerals are common in meteorites found today.

Where does the ocean’s water come from?

- Outgassing theory:
  Earth incorporates meteorites containing water
  Early volcanism releases H₂O vapor to the air

Pu’u O’o gas piston events, Kilauea, Hawaii