MAR 110 Lecture #36
REVIEW Section 2

MAR 110
Natural Hazards & the Ocean

Final Examination Format

Wednesday December 17, 2008
DION Room 110

PART 1 - Term/Definition Matching (20 points)

PART 2 – Multiple Choice (50 points)

PART 3 – Short Answers (30 points)

FINAL EXAM STUDY GUIDELINES

1. Know correct answers to ALL previous exams!

2. Know the “Essential” definitions;  

2. Focus on Review Session material;

3. Understand the details of the “Underlying Principles”;

4. Know which “Underlying Principles” apply to each of the Review Session “HAZARDS” and why.
**Ocean-Related Hazards**

**Subtropical Storms**
Northeasterns
Blizzards

**Tropical Storms**
Hurricanes
Typhoons
Cyclones

**Flooding**
Storm Surge

**Underlying Principles**

Energy Considerations

Earth Rotation

Atmospheric Winds

Air-Sea Interaction

Ocean Currents
Energy Considerations

Earth’s Basic Heat Budget

Equal amounts of incoming solar radiation

Solar Energy
short wave

IN

Infrared Energy
long wave

OUT

Atmospheric & Oceanic Circulation

..moves tropical surplus heat to polar regions of heat deficit

Net loss
Net gain

Annual outgoing radiation

Annual incoming radiation
Climatic Zones

Global Winds

Polar
Subpolar
Subtropics
Tropics
Subtropics
Subpolar
Polar

Winds (and ocean currents) affected by Earth Rotation

Coriolis Force Alone in the NH

..explains SMALL-SCALE water parcel trajectory curvature – a circle

Air or Water Parcel
initially moving northward

CF
FORCE BALANCE

Geostrophic Wind & Ocean Flows

LARGE-SCALE “Straight-Line” Flow

Pressure Gradient Force

PGF = CF

<-- Coriolis Force

NORTHERN HEMISPHERE

The Polar Jet Stream
- An Global Geostrophic Wind Feature
  ‘..guides pathways of weather systems’
Wind-Driven Ekman Transport: NH

Coastal Upwelling

A NH Subtropical Ocean Basin

Zonal Winds & Ekman Transport

set up a

Geostrophic Gyre Flow

(Same Physics as Geostrophic Winds)
Atlantic Ocean Basin Gyre Circulation

- Gulf Stream
- St. John’s Current
- Gulf of Mexico Current
- Sargasso Sea
- Canary Current

Global Winds

Ocean Gyre

Gulf Stream

a
Western Boundary Current
HAZARD - Subtropical Ocean Storm
Winter Nor’easters → BLIZZARD of 1978

HAZARD - Tropical Ocean Storms
The Extreme Ones - Hurricanes & Typhoons
Hurricane Cloud & Geostrophic Wind Structure
- A Bird’s Eye View -

HAZARD - Storm Surge
“Raises the Platform” Enabling Flooding & Coastal Wave Destruction

The worst flooding of New Orleans was shown in this aerial view taken by New York Times photographer Vincent Laforet on Tuesday, August 30, a day after Katrina passed through the region. Vincent Laforet/AP
HAZARD - Storm Surge

Wave-Related Hazards

Waves
- rogue
- rip current
- episodic storm erosion
- long-term erosion

Tides
- extreme
Underlying Principles

Energy Considerations

Wave Types

Wind-Wave Generation

Wave Currents

Wave Shoaling

Wave Energy Alternates Forms - as it “progresses”
..between Potential Energy (PE) and Kinetic Energy (KE)
Wave Principles Review

**Deep Water Waves**

Speed Depends on **Wavelength** - L

\[ C_p (\text{ft/s}) = 2.26 \sqrt{L} (\text{ft}) \]

\[ C_g = \frac{1}{2} C_p \]

**Shallow Water Waves**

Speed Depends on **Water Depth** - D

\[ C_g = C_p = \sqrt{gD} = 5.67 \sqrt{D} \]

\[ C_g = C_p \]

Deep Water Wave Propagation – Pacific Ocean - Summer

- **WAVE PROPAGATION ZONE**
  - “Longer Waves Outtrace Shorter Waves”

- **STORM WAVE GENERATION ZONE**
  - “Waves of ALL Wavelengths”
HAZARD – Open Ocean Rogue Waves

The Shoaling of Shallow Water Waves

Wave Currents Erode Sand

The water is moving shoreward in the surf zone
HAZARD — Wave-Induced Rip Currents

HAZARD — Episodic Coastal Storm Wave Erosion
HAZARD Long-Term Coastal Erosion

HAZARD – Extreme Tides
Raises the Sea Level Platform - Enabling Coastal Wave Destruction

50 ft Tidal Range!