

## TSUNAMIS, TIDES AND OTHER LONG WAVES

### Storm surges

- Caused by winds and low atmospheric pressure associated with large storms
- Can raise sea surface by up to 25 ft, bottom contours magnify effect
- Not a progressive wave as only has one crest, does not break
- Comes ashore like a tide -- sometimes called a storm tide
- Main cause of loss of life and property in low lying areas when hurricanes come ashore

**Seiche:** Wave that resonates (sloshes) in a basin like a lake after a storm or change in atmospheric pressure

### Tsunami (are not tidal waves)

- Caused by displacement, usually of the seabed during seismic events
- Are progressive waves with wavelength ~200 km (125 miles)
- Act as shallow water waves, velocity 472 mph in Pacific
- Period ~ 16-20 minutes, height ~ 1-2 ft in the open ocean, too small to see
- When reaches shallow water velocity drops, period stays the same, wave height increases
- Rushes on shore as a flood of water, not a breaking wave
- 1946 Aleutian tsunami was 30 ft high at Hilo, was >118 ft high at point of origin in Alaska
- May have been big local tsunamis from island landslides
- Network of seabed pressure sensors give warning of approaching tsunamis
- Half the time the trough of the tsunami arrives first, curiosity draws people to investigate exposed shoreline, following crest (~8 minutes later) drowns them

### Tides

- Are waves -- the real tidal waves!
- Caused by the gravitational attraction of the Moon and the Sun
- Unlike wind waves, tides are constantly under the influence of their disturbing force
- Wavelength up to 12,000 miles

### Tide creating forces

1. Inertia: The tendency of a body in motion to keep going in the same direction
2. Gravity: The mutual attraction of two bodies, is proportional to the mass of the bodies but inversely proportional to distance between them
3. **Effect of the Moon:**
  - Earth and Moon orbit around common centre of mass is ~1,000 miles below the surface of Earth
  - Inertia and gravity balanced on planetary scale; not balanced though at every point on the Earth's surface
  - Force of inertia is away from moon and equal everywhere on Earth
  - Force of gravity is towards moon and decreases with distance away from moon
  - On the moon-side of Earth net force is towards moon, gravity>inertia
  - On far side of Earth net force is away from moon, inertia>gravity
  - Net forces raise ocean water into a high tide, one each on the near and far side of the Earth
  - Water drawn for bulge of high tide causes troughs (low tide) in other regions
  - Heights of tide (bulge) small ~ 2 metres (6 ft)
  - Wavelength ~12,000 miles, tries to travel at ~ 1,000 mph to keep up with the moon, usually fails
  - Solar day is 24 hrs, lunar day is 24h 51 minutes so high tides are 51 minutes later each day

- Moon's monthly cycle from 28°N to 28°S of the equator affects height of high and low tides

#### 4. **Effect of the Sun:**

- Sun is 27 million times larger than the moon but is also 368 times further away
- Gravitational pull of the Sun raises tides, is ~ 46% strength of that of the moon
- Sun has an annual cycle from 23° N to 23° S

#### 5. **Sun and Moon together:**

- Sun and moon on the same side or opposite side of the Earth, forces add up get high, high tides, and low, low tides get Spring Tides
- When Sun and Moon are at right angles to each other forces cancel get low high tides etc. get Neap Tides
- Complete cycle takes 28 days (lunar month)
- Are other factors affecting tidal height such as Earth- Sun distance
- Altogether 150 factors affect tides, 7 have most effect
- Amplitude (height) of tide corresponds closely to Moon phases

### **Real tidal patterns**

- Expect two high and two low tides per lunar day (Semidiurnal tide)
- Tide is a very large wave, its progression is affected by shapes of ocean basins and presence of continents
- Get constructive and destructive interference of tidal waves
- Local tides affected by these factors

### **Tide types**

1. Semidiurnal: 2 high and 2 low tides per day
2. Diurnal: 1 high and 1 low tide per day
3. Mixed tide: 2 high and 2 low tides per day but of unequal height

Tidal heights are zero at Amphidromic points (points of destructive interference)

Bay of Fundy (Canada) tides are up to 50 ft

Honolulu has a mixed tide which is ~ 6 ft or less

### **Effect of tides on day length**

- Gravitational energy causing tides is dissipated as friction this is slowing the rotation of the Earth
- Day length is increasing, but number of days per year is decreasing
- 350 million years ago 22 hrs/day ~405 days per year
- 350 million years from now ~ 26 hrs/day ~ 320 days per year
- With fewer days we will have to make OCN 201 classes longer! Graduate early!