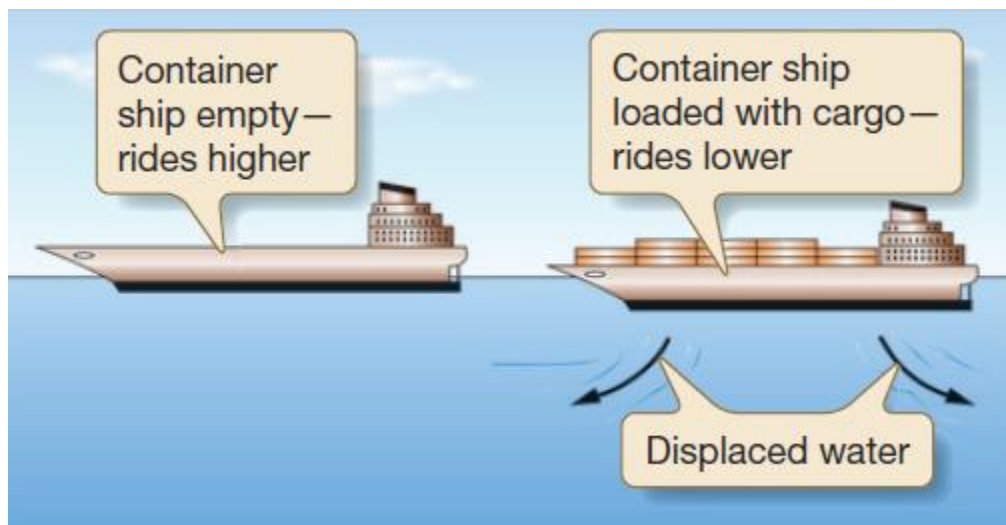


## Animation Storyboard Manuscript: Version 1/7/2013

### Isostatic Adjustment

**Summary:** This animation shows how a container ship experiences isostatic adjustment as cargo is loaded on/loaded off. It also shows how isostatic adjustment causes landmasses to exist at different elevations during and after continental glaciation.

**Base Art:** Trujillo and Thurman, *Essentials of Oceanography* 11E, Figure 1.19 (A container ship experiences isostatic adjustment). A similar figure exists as EO10E, Figure 1.17 (lacks the new balloons shown in the EO11 figure). Also include ancillary images: (1) maps of the Northern Hemisphere during/after the Pleistocene Ice Age and (2) a cross-section of Earth's outer structure (EO11 Figure 1.18: Internal structure of Earth), enlargement only.



**Motion Required:** The animation should show how the container ship being loaded with cargo and riding lower in the water. Then, as the cargo is unloaded, it should show the ship riding higher in the water. Ancillary images show the Northern Hemisphere Ice Age extent (during and after Ice Age) and the outermost structure of Earth.

**Labels:** The labels on the image are the same as shown in the reference figure.

**Slider/Buttons:** A slider is required to allow the user to control the animation.

**Length:** The animation should take about 40-45 seconds.

**Number of Pages:** Three. (1) The main image should show an empty ship being loaded with cargo, then the ship's cargo being removed; (2) A map showing the extent of Ice Age glaciers in the Northern Hemisphere, transitioning to today's view of Earth; and (3) a cross-sectional view of Earth's outmost structure.

---

## Detailed Description

This animation shows how a container ship experiences isostatic adjustment as cargo is loaded on/loaded off. It also shows how isostatic adjustment causes landmasses to exist at different elevations during and after continental glaciation.

### Modifications of Base Art:

- Show the left half of the image first, then transition to the right half, then back to the left half.
- The balloons should come on at the appropriate time to match the narration as indicated below.
- Include a map of Pleistocene Ice Age extent of the Northern Hemisphere, transitioning to today.
- Include a cross-section of the outmost part of Earth's structure, with labels modified as indicated below.

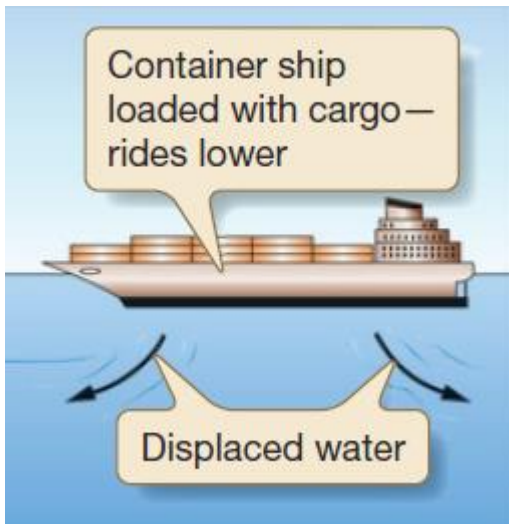
### Motion Needed:

The animation begins by showing its title "Isostatic Adjustment" while showing the left half of the first image: an empty cargo ship riding high in the water.



The balloon can come on for a few beats as the narration states, "Because of buoyancy, even very heavy objects are able to float on water. For example, this container ship is able to float because it displaces an equivalent amount of water beneath it. Because the ship is empty and lightweight, it rides high in the water." The balloon fades off.

The animation then shows various containers being loaded onto the ship and it transitions to a loaded ship (the left half of the image).



The animation should gradually show containers being added to the ship, taking several seconds. The narration states, “Now let’s add some cargo to the ship. As the weight is added, notice how the ship gets heavier, so it displaces more water and the ship rides lower in the water.” Show the ship gradually riding lower in the water. At the appropriate time to match the narration, the balloons and arrows come on for a few beats and then both balloons and arrows fade off. The containers should be smaller and look more multi-colored, maybe like this pix (use to make containers look realistic):



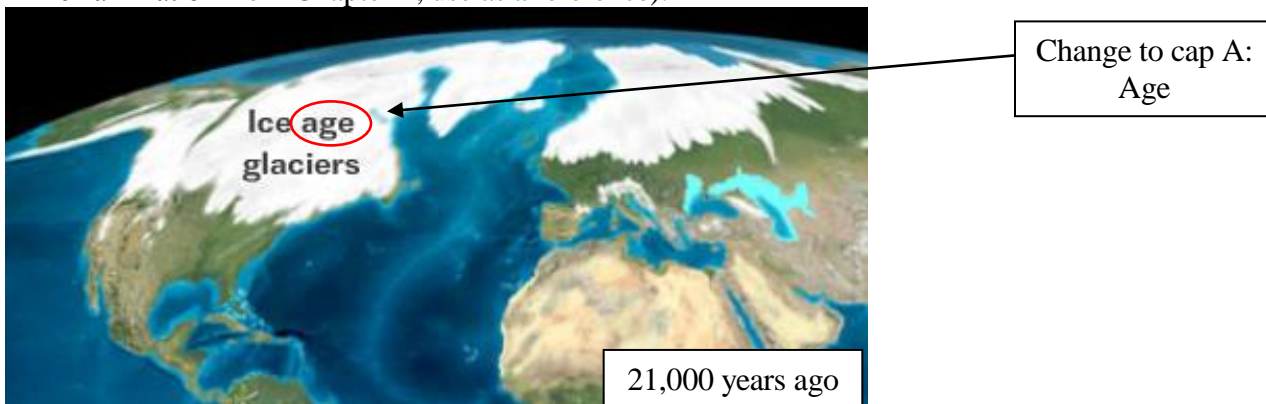
Ref: <http://www.shipspotting.com/gallery/photo.php?lid=1690683>

Then the animation shows cargo being removed from the ship and returns to its initial view:



The narration can state, “As the cargo is removed, the ship once again rides higher.” The containers should be removed for a few seconds, showing the ship rising. Toward the end, the balloon can come back on and then fade off after a beat. The narration can continue by stating, “A container ship riding higher or lower in the water depending on its weight illustrates the principle of **isostatic adjustment**” as a banner with a new label comes on that says, “Isostatic adjustment.”

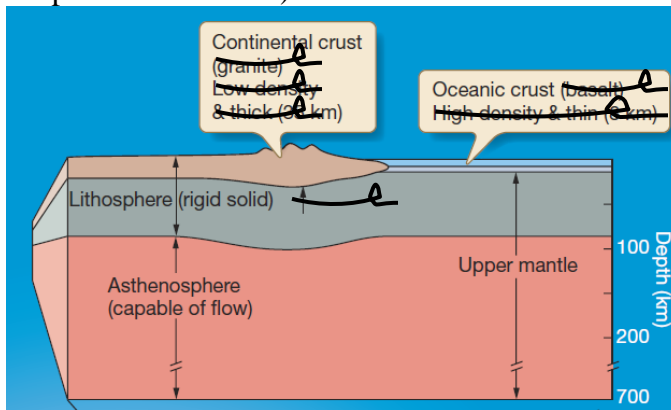
Now the animation transitions to an Ice Age map of the world (taken from the “Plate Motions Through Time” animation from Chapter 2; use as a reference):



The narration states, “Landmasses also experience isostatic adjustment as weight is added or removed. For example, northern land areas that were covered by a thick ice sheet during the last Ice Age were pushed down because of the additional weight. After the ice melted, landmasses began to slowly rise back up and this process even continues today.” This is accompanied by a transition to the “Today” view:



The animation can then transition to the enlargement from the top part of EO11 Figure 1.16 (with simplifications shown):



The narration can continue by stating, “This suggests that lithospheric plates are in essence “floating” on the plastic asthenosphere below. Since continents move vertically by isostatic adjustment, it would make sense that they are also able to slowly drift horizontally from place to place across the globe. This is exactly what is happening on Earth today because of plate tectonics.”

The animation ends here and the user can replay the animation by moving the slider.

#### Other Considerations/Simplifications:

- When I initially thought about this animation, I considered having the user add/remove weight to the ship to see the effect, but I think the loading/unloading of the cargo should just be shown automatically.
- There are probably many ways to show the loading of containers onto/off of the ship.