We learned some things about the water cycle in the lecture on 10/5/2010 that will help us think about a claim that is sometimes put forward by climate contrarians. The claim runs something like this: it is water vapor, not CO₂, that is the most important greenhouse gas, and since humans emit lots of water vapor, then one of two things must be true: either we should be equally or more concerned about human emissions of water vapor as we are about emissions of CO₂ and other non-water greenhouse gases, or, alternatively, if water vapor emissions are not something to worry about, than neither are emissions of CO₂. (e.g., see [http://www.geocraft.com/WVFossils/greenhouse_data.html](http://www.geocraft.com/WVFossils/greenhouse_data.html) or [http://www.ecoenquirer.com/EPA-water-vapor.htm](http://www.ecoenquirer.com/EPA-water-vapor.htm)).

Here are two possible responses to this contrarian claim. Are these accurate responses, or not? Explain why or why not.

1. "The contrarian claim is just wrong. Water vapor is not the most important greenhouse gas by a long shot."

2. "The contrarian claim is not directly false, just highly misleading. We don't worry about anthropogenic water vapor emissions as much as we do about CO₂ because humans just don't emit a flux of water vapor that is anywhere close to the flux of CO₂ we emit." (hint: a simplified formula for combustion of fossil fuel is: \( \text{C}_6\text{H}_{12}\text{O}_6 + 6 \text{O}_2 = 6 \text{CO}_2 + 6 \text{H}_2\text{O} + \text{energy} \))

3. Let's consider a third possible response.

   a. Use the facts given on the slide summarizing the global water cycle to answer the question: What is the residence time of water vapor in the atmosphere? How does this compare to the residence time of CO₂ or other greenhouse gases?

   **Hint:** for a pool or stock of size \( S \) that, like water vapor, is in steady state with its sources and sinks (i.e. where the inflow from its sources = outflow to its sinks), and those flows are each of size \( F \), the average amount of time (residence time, \( \tau \)) that each molecule spends in the pool is equal to \( S / F \). This makes sense unit-wise, because dividing \( S \) (in gazillions of stuff) by \( F \) (units of gazillions of stuff per year) gives an answer in years.

   b. What is the flow of water from combustion sources (calculable from knowledge of the total emission of CO₂ and from information in b)? How does this flow compare to natural background flows of water from precipitation or evapotranspiration?

   c. Using the answers to (a) and (b), together with the stock-flow relation defined there \( (S = F \cdot \tau) \), calculate the new steady state stock \( S_{\text{new}} \) for atmospheric water vapor given the "new" extra emission \( \Delta F \) of water from combustion (and
assuming the residence time does not change). What fractional increase is this over the original (pre-anthropogenic) steady-state stock of atmospheric water vapor?

d. In light of these calculations, write a third possible response to the contrarian's claim. Imagine that your audience is the general public, and explain the elements of your response as if you are writing an op-ed for a newspaper.