GEOS 24705 / ENST 24705
Problem set #1
Due: Friday April 3

## Estimating the sun's energy flow

Finish the estimation we started in class, of the sun's energy flux reaching the Earth's surface (energy per time per area, in units of $W/m^2$). You need (and should use) no information other than the precipitation map on the last slide of today's lecture. *Please do not Google anything.* You will be graded on having a reasonable approach to estimation, not on the exact value of your answer. With these "order of magnitude" estimates, you can almost always get within a factor of 10 of the right answer. With this problem I expect most of the class to get to within a factor of two.

## Problem

In class you were shown a map of annual precipitation – the amount of water (in units of depth of water) that falls on the Earth's surface per year. Your goal is to use that information to estimate the flux of radiation energy from the sun. The problems below walk you through that estimation.

*First, calculate the flux of energy that goes to evaporating water:*

A. By eyeballing the map, estimate the average annual precipitation on the Earth's surface (in meters).

B. Convert that into a precipitation flux: volume of water per area of the Earth's surface per year.

C. Now estimate the amount of energy required to evaporate a volume of water (in units of, for example, Joules/liter).

   You can do this by visualizing the situation where you put some container of hot water in a microwave whose power consumption you know. (The class said 1000 W is a reasonable number). Microwaves are very efficient, so it's OK to assume that 1000 W of power goes into the water. You need to imagine your water nearly boiling when you start your scenario, because you're assuming that the energy from the microwave doesn't go to heating up the water. It only serves to turn the liquid water into steam. So imagine: put your hot water in the microwave and walk away. How long before it evaporates? That time tells you the total energy required to evaporate the water. *Don't just give a value here, explain how you estimated it.*

D. Now, combine your answers in B and C to give the flux of energy that goes to evaporating water. Convert from $J/(m^2*year)$ to $J/(m^2*second)$, i.e. $W/m^2$.

*Then, consider the total energy flux from the sun:*

E. In class we decided that of the sunlight that reached the surface, some part was reflected and some part was absorbed. Of the part that was absorbed, some part went to evaporating water and some part was absorbed as heat. Draw a diagram showing what fraction of incoming radiation you assign to each flux.

F. Now, back out the total flux of energy from the sun reaching the Earth's surface (in $W/m^2$)