SCIENCE OF CLIMATE CHANGE II

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Continuing on from last week: Let's start with some infrequently asked questions...

Would Karl Popper's contention still apply to the first law of thermodynamics?

Yes, although it's a physical law that is incredibly robust – i.e. in terms of IPCC language, you would stick to the "virtually certain" tag implying >99% confidence.

Is the strength of the model dependant on its ability to incorporate a greater wealth of different factors?

Yes and no. Let's focus on the word **strength** here. Whilst it's great that both the field of earth science as well as computational capabilities have improved remarkably, the **best** models need not be the ones with the most complicated algorithms.

The best models, quite frankly, are the ones that work closest to what is observed, and sometimes to get to that it's best to work with simpler set-ups.

Anyway... how do you know the model is the one that works closest to what is observed? Well, this is where we can get into the nuts and bolts of validating the models. It's this ability which allows scientists to apply a degree of "trust" on the data produced by such models.

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BEFORE we do that, let's clear up another thing.

Weather vs Climate

Climate is the average and variations of weather in a region over long periods of time.
Weather is the set of all extant phenomena in a given atmosphere at a given time.

This is important, because when folks talk about climate change prediction, they often get it mixed up with respect to predicting weather. i.e. if we suck at figuring out what the weather will be like in 3 days, how on earth can we figure out things 100 years from now.

Weather knowledge, because of its emphasis on the situation "at given time" is incredibly susceptible to chaos. This is where a minor perturbation can result in a major change down the timeline. Chaos is not necessarily a random event, and can to some degree be calculated, but in order to be accurate, you have to have perfect knowledge of initial conditions.

Climate, because it's looking at period of time (nominally 30 years +) is way less sensitive to such nuances. Therefore, the predictive data produced here should be more reliable.

Talking points. Heads and Tails analogy. Stanley Park storm.

THREE USUAL WAYS TO VALIDATE CLIMATE MODEL DATA.

“Firstly, it can be run for a number of years over simulated time and the climate generated by the model compared in detail to the current climate.”

Here, a valid model is one where average distribution and season variations of appropriate parameters such as surface pressure, temperature and rainfall compare well. As well, noted variability in the model should coincide well with variability in the observed situation as well.

“Secondly, models can be compared against simulations of past climates when distribution of key variables was substantially different than at present.”

An example would be about 9000 years ago, where the Earth’s orbit in relation to the sun was slightly different. The axis of rotation was basically tilted 24o rather than the current 23.5o. Enough, however, to obviously affect the distribution of solar energy to the surface of the planet. Now meteorological data is obviously weaker for those type of timescales but there is data that (ice core data, vegetation fossilization patterns, etc).

“Thirdly, a model can be validated by usage in predicting the effect of large perturbations on the climate.”

i.e. El Nino, large volcanic eruptions... (like mount Pinatubo 1991 / second largest eruption in 20th century).

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GAME (pictionary – arts vs science) Jewel. Newt, Meter. What.
Distance (m)
Time (s)
Velocity – speed (m/s)
Acceleration m/s2

Force (Newtons) (kgm/s2)
Energy (Joules) (kgm2/s2)
Power (Watt) kgm2/s3)

The Earths Climate is powered by the sun, so that seems to be as good as place as any. So let’s play pretend. Let’s pretend that we are all energy from the sun. This starts off as Hydrogen atoms fusing to become Helium, and with that comes a release of a whole load of energy, in the form of electromagnetic radiation initially gamma rays, but as it makes it way to the surface of the sun, it gets released primarily as visible light, and other higher energy/higher frequency radiation (like ultraviolet light).

Tshirt analogy (unicorn or coloblind test tshirt)

How much energy? Roughly 3.86×10^{26} Watts (BIG freaking number). Does this vary, yes – and this is where we can get into sunspot, sun flare stuff for instance - but not very much (estimates place it at around the $<0.5\%$ variation mark).

Energy in a vacuum will go along its merry way, but what if there’s “stuff” in the way. 4 possible events. (0) misses stuff – keeps going through vacuum, (1) Reflection, (2) Refraction or (3) Absorption.

Reflection -> bang on collision, energy bounces right back (no loss of energy)
Refraction -> going through something that doesn't change the amount of energy, just affects the speed at which that energy can go through (like through water, you see some of this).

Absorption -> some or all energy is taken up by the stuff. Allows the stuff to achieve a different state as determined by the quanta (amount) of energy it absorbs. Note that the stuff absorbing energy will inevitably need to re-emit (or else it will just keep collecting collecting and collecting energy). When it re-emits it inevitably does so as heat (thermal radiation) / radiation of longer wavelengths (less energetic).

Thermal radiation is electromagnetic radiation emitted from the surface of an object which is due to the object's temperature. Infrared radiation from a common household radiator or electric heater is an example of thermal radiation, as is the light emitted by a glowing incandescent light bulb. Thermal radiation is generated when heat from the movement of charged particles within atoms is converted to electromagnetic radiation.

(Back to the tshirt thing) You, the minions of electromagnetic radiation, mostly high energy in visible range. Go through space. You see Mercury, Venuw and finally the earth is in site. Now why does the earth get less energy from the sun than say mercury? It's because of the inverse square law.

In physics, an inverse-square law is any physical law stating that some physical quantity or strength is inversely proportional to the square of the distance from the source of that physical quantity. This works here because energy is released from the sun in a radiant fashion – i.e. not like a laser following a single defined path. Therefore, the further out you are, the more the energy spreads out, the less you get.

Approaching the outer limits of the Earth's atmosphere (~2000km):

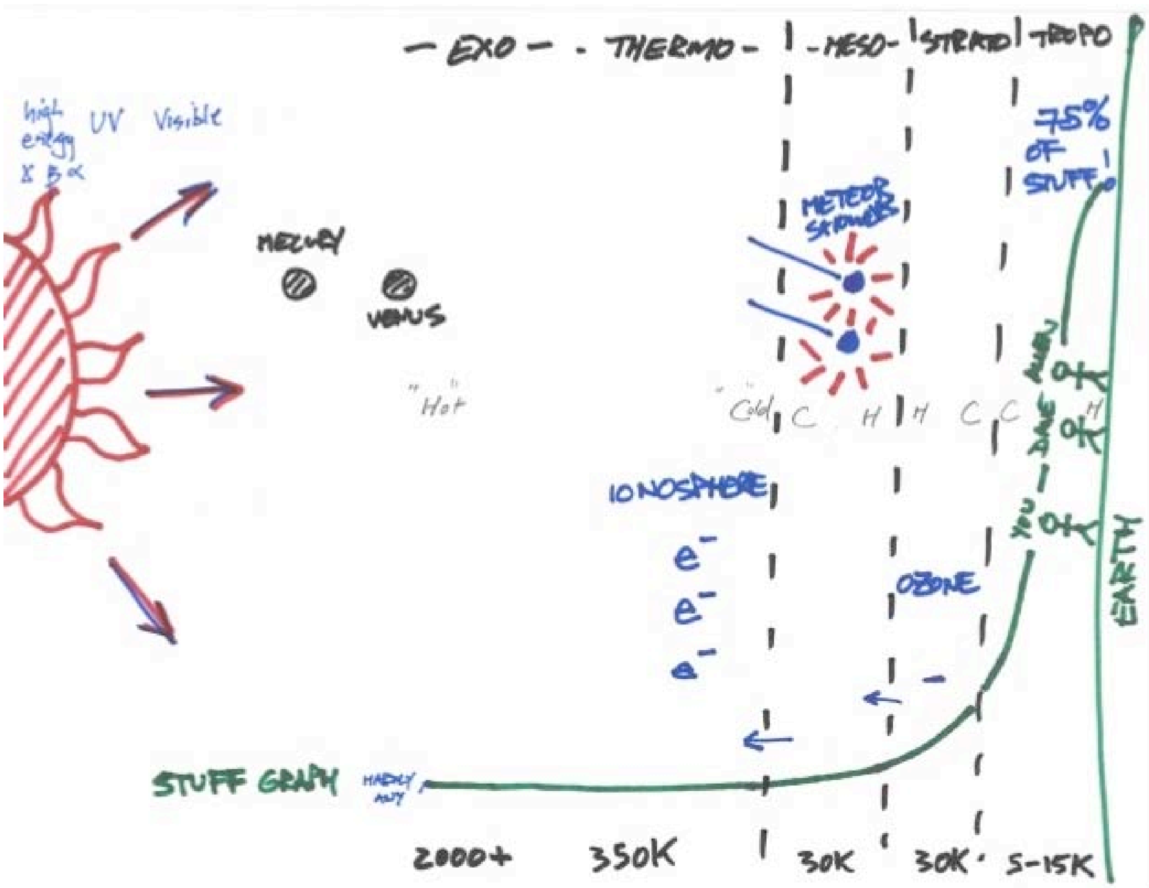
There are layers here, labeled due to temperature trends which are primarily determined by the stuff present and what it does with the incoming energy from the sun (remember it's a variety of different wavelengths in the ultraviolet and visible light ranges), as well as energy bouncing or re-emitted back from the earth. Where stuff settles is basically dependant on a number of different things.

1. (Density) of stuff. (relates to the Earth's gravitational pull). This layering also creates strata of pressure (high at the bottom, and low at the top). The gravity of the moon also has a diurnal and lunar effect.
2. Temperature of stuff. (relates to energy as supplied from the sun coming in, as well as energy supplied by thermal radiation emitted from various parts of the earth/sky). Heat energy is capable of moving things, and can thus effect where certain things choose to settle.
3. And the movement of stuff in general will determine where things are going to settle – momentum from atmospheric tides, an effect from both the movement of the earth, as well as weather systems. Coriolis effect

(see image at http://commons.wikimedia.org/wiki/Image:Atmosphere_with_Ionosphere.svg)

Bottom line is that the stratification is quite severe. This stuff does tend to equilibriate to discernable layers. As far as terminology is concerned the common labeling of layers relates to temperature changes in the atmosphere.

Here's a diagram that goes with the below text:



Exosphere: stuff: hardly any, basically the cusp where things are escaping the gravitational pull of the earth.

Thermosphere: still hardly any stuff. Temperature gradient from hot (top) to cold (bottom), largely due to small amount of oxygen absorbing ultraviolet energy from the sun –near the top individual gas molecules can reach a temperature of 2000K. Still, you don't actually feel this because there's so little of it around. Some of the oxygen that gets smacked here from incoming UV light to the point, releases an electron to fly off. -> ionosphere (aurora).

Mesosphere: catching the tail end of atmospheric tides. Throws a bit of stuff into this region, such that you're starting to see that gradient of material (more closer to the earth, less further away from the earth). Consequently, you have a temperature gradient as seen due to more stuff able to absorb energy at the lower part of this layer. Enough material in this part of the atmosphere to create the friction necessary to burn out any falling object coming through to the earth (this is where meteor showers happen).

Stratosphere: Now we're seeing more of the stuff pluming up from below, but the stratosphere is notable because it is also where the vast majority of the atmosphere's ozone settles. Since ozone is a strong absorber of ultraviolet, this layer in particular takes in a lot of that energy. You see a reverse gradient here, because UV light essentially gets filtered out so that less and less makes it through to the lower levels to create that heat. (hence the temperature gradient from hot at the top to colder at the bottom).

Then we get into the troposphere.

What is the troposphere? In a nutshell, the troposphere is the lowest portion of Earth's atmosphere comprising about 75% of the total mass of the atmosphere. It's here that almost all of its water vapor and aerosols are present. The size varies between the poles and the equator, primarily due to this water vapor – i.e equator has a lot, the cold poles not so much. Therefore, the equator has a troposphere as large as 15 or so km. Whereas at the poles, it can be as small as about 5km in thickness.

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O.K. This part is important. The boundary of the troposphere and the stratosphere is called the TROPOPAUSE. It represents the place, where the temperature gradients do flip flop, since that seen from the stratosphere is due to the incoming solar (ultraviolet/visible) radiation from the sun, and that seen from the troposphere is due to the outgoing thermal radiation coming back from the earth. The idea here is that folks often say that if the earth had no greenhouse effect, in order for the energy to balance out (incoming solar = out going thermal), calculations suggest that the average temperature of the earth should be about –19C. Obviously, it's not (because of the greeenhouse effect). However, this 19C mark can be observed at the TROPOPAUSE – therefore it represents a place where that balance is seen.

Because thermodynamics principles decree that our bookkeeping is good, this boundary is a good place to work out a few things.

Which leads to the concept of radiative forcing.

"radiative forcing" - IPCC definition.

The radiative forcing of the surface-troposphere system due to the perturbation in or the introduction of an agent (say, a change in greenhouse gas concentrations) is the change in net irradiance (solar plus long-wave; in Wm^{-2}) at the tropopause AFTER allowing for stratospheric temperatures to readjust to radiative equilibrium, but with surface and tropospheric temperatures and state held fixed at the unperturbed values.

Wiki also has a more layman description:

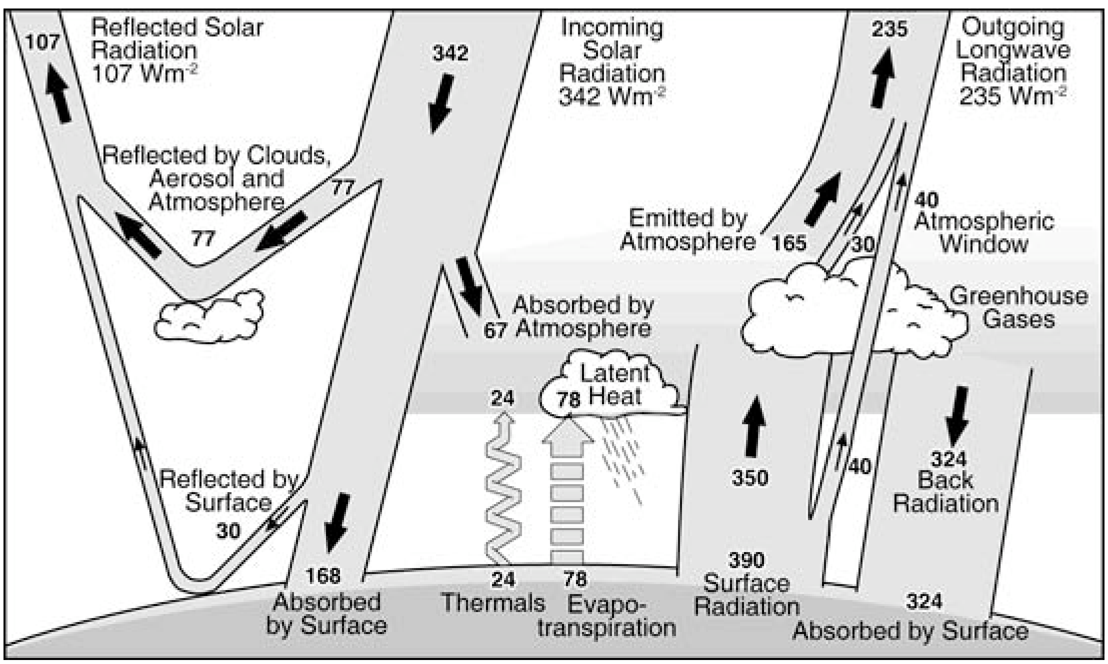
"radiative forcing is (loosely) defined as the change in net irradiance at the tropopause. "Net irradiance" is the difference between the incoming radiation energy and the outgoing radiation energy in a given climate system and is thus measured in Watts per square meter. The change is computed based on "unperturbed" values; the IPCC measures change relative to the year 1750. A positive forcing (more incoming energy) tends to warm the system, while a negative forcing (more outgoing energy) tends to cool it. Possible sources of radiative forcing are changes in insolation (incident solar radiation), or the effects of variations in the amount of radiatively active gases and aerosols present."

THIS is a good place to take stock of our tshirt analogy. (i.e. all you UV light tshirts are more or less gone, absorbed, reflected, generally not making your way into the troposphere).

Anyway, the net irradiance at this point, if measured, on the point of the earth closest and perpendicular to the sun, is about 1370 W/m2. However keeping in mind that the earth rotates (indeed, half the time it gets no irradiance), and as well, most places on the earth do not get this optimal amount because is afterall a sphere, it works out that on AVERAGE each square meter on the planet surface gets about 342 W/m2.

This is the number we'll work with. This is all you folks in "I love colour" tshirts getting through into the troposphere.

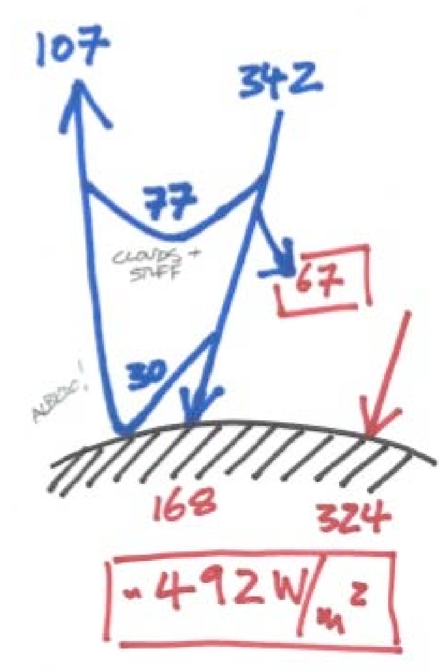
So what happens here? Well, a lot. This image taken from the IPCC report tries to summarize the major comings and goings of energy on the earth's surface and its troposphere.



This is where the numbers might get a little confusing, because its not like when energy is absorbed, it gets re-emitted back out past the tropopause instantly – rather it takes its time, it lingers, it loiters (this actually is the greenhouse effect).

O.K. maybe best to break "the figure" up into composite figures.

1. Incoming...



First up, many of you visible light energies will bounce off the atmosphere (gases that are suppose to be there as well as aerosols that aren't necessarily suppose to be there) and things like clouds, right back out. This reflection works out to about 77W/m2 returning to space (woohoo).

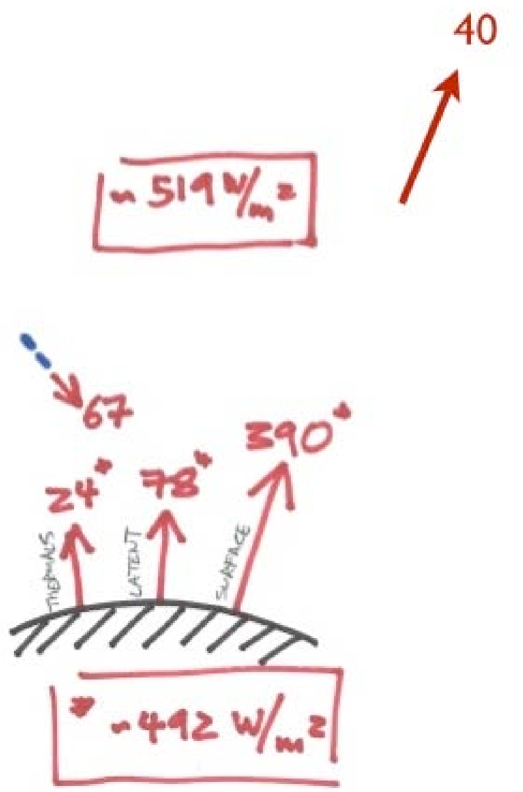
Some of you visible energy dudes will make it to the surface, but depending on the reflective properties of that surface (cue in fancy word albedo), some of you will also bounce right back into space here (on AVERAGE about 30W/m2).

Now the rest of you get absorbed. Two main places where that happens – (1) the atmosphere itself (and by atmosphere, we mean the big old 7 to 15 km layer of stuff) at about 67W/m2 and (2) the surface: here on AVERAGE you have about 168W/m2 being absorbed.

Wow. That adds up.

However, due to the greenhouse effect, an additional 324W/m2 is absorbed into the surface (this however is in the form of thermal radiation). Which means that a net amount of 492W/m2 of energy is smoking the surface of the earth.

2. Outgoing from surface. (+ the incoming to the atmosphere)



Now what? Well on AVERAGE, about 390W/m2 gets to be reemitted back into the atmosphere (the key here is that all of this is thermal radiation). As well, heat energy can move from the surface in two other ways:

Latent heat. Basically the evaporation of water. It takes energy to get liquid water to evaporate, whereby this gaseous water form hangs out in places like clouds. This is latent heat, because when that water reverts back to liquid (i.e. in the form of rain), the heat energy will be re-emitted. About 78W/m2 can be accounted for here.

Thermals: When a pool of warmer air accumulates, it expands and becomes lighter (less dense) than the surrounding air mass. The mass of lighter air will then rise, but as it does so it will cool due to expansion. This process will continue until at some height the pool of air will have cooled to the same temperature as the surrounding air, at this stage the air will stop rising.

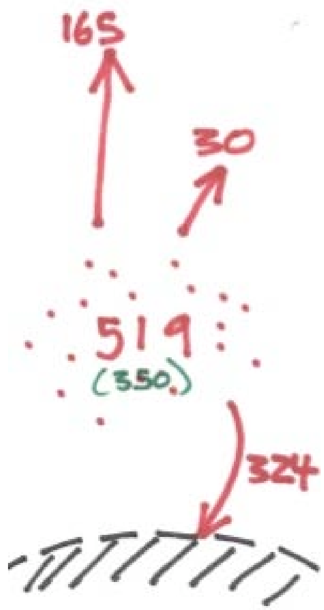
Net going from surface is 492W/m2 (good)
If you include the 67W/m2 from incoming, that gives you a total of 559W/m2

3. Thermal radiation that goes directly out.

So the troposphere gets this 559W/m2 of thermal radiation, of which about **40W/m2** beelines it past the tropopause. That leaves about 519W/m2 being absorbed by the "atmosphere" itself.

NOTE that some of the absorption is from the incoming solar radiation, but the vast majority is from the thermal radiation coming off the surface.

4. That which is absorbed by the "atmosphere" and re-emitted.



From that 519W/m2 that is absorbed in the troposphere, 195W/m2 gets remitted out (30 of which due specifically to cloud formations), and the remaining 324W/m2 gets remitted back in.
AND BTW, greenhouse gases are responsible for about 75% of the thermal radiation absorption in the atmosphere (~350W/m2). And it's this that we seem to be mucking around most with. Carbon Dioxide, water, methane, nitrous oxide, ozone.

The net effect of this series of flowcharts is to realize that there specific places where this energy moves to and from. If we affect any part of it, that change will feedback on the entire system. For instance, say our greenhouse gases are increased, this will unduly affect the net absorption of thermal radiation in the atmosphere, which in turn can be emitted back down to the surface – overall this creates an effect where the overall presence of thermal radiation in either the troposphere or the surface is increased (i.e. it lingers, loiters, even longer – net average temperature goes up – global warming).

Likewise, think about what would happen if cloud formation is altered due to the conditions of the atmosphere. Think of what would happen to this system if land albedo changes. Think of what may happen if you have an ozone hole over the stratosphere (which means more UV light can get to the troposphere – more energy, and also energy that can affect the make up of the troposphere). In all, everything is connected to everything else, so trying to project changes is having the models take these things into account.

I also highlighted the word AVERAGE a couple times, because the other point is that the troposphere, the earth's surface and how the solar irradiance hits the earth's surface, varies greatly depending on where on the earth, you're talking about.

i.e. in the Northern Poles – thinner troposphere, less water vapor, less solar irradiance coming in, high albedo.

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Climate modeling takes everything I've mentioned so far into consideration – it tries to provide a mathematical way to connect all of those dots. IPCC reports look at different scenarios, and from those scenarios it effectively determines things like CO_2 amounts in the atmosphere. This in turn leads to a radiative forcing (the energy values in all of those flowcharts get tweaked). That tweaking often looks at specific feedback systems.

Such as:

1. Water vapour feedback – temp goes up, more water vapour, water is itself a greenhouse gas -> keeps more heat in -> more heat results in more water vapour, etc.
2. Cloud radiation feedback – depending on the temperature is stratified, what the water content is, how wind patterns are, cloud formation can vary. Since clouds are capable of affecting radiative forcing in a number of ways, some models attempt to take that into account.
3. Ocean Circulation feedback – the ocean is strongly coupled to atmosphere, the ocean has a lot of heat capacity, and how that heat is taken up can also be influenced by circulation patterns, mixing, etc.
4. Ice-Albedo feedback

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What are the net effects of this radiative forcing?

Well, weather can be affected. Weather is primarily dependant on temperature differences from one locale vs another. For example, surface temperature differences are responsible for pressure differences (i.e. hot air wants to expand therefore lowering air pressure). The resulting pressure difference between adjacent spots accelerates the air from high to low pressure (air rushes in to even it out) – this creates wind. The Earth's rotation in turn, can cause this wind to bend (Coriolis effect).

For water, a good general example of how this stuff gets moved around is to look at the concept of thermohaline circulation.

(from http://www.pik-potsdam.de/~stefan/thc_fact_sheet.html)
"As opposed to wind-driven currents and tides (which are due to the gravity of moon and sun), the thermohaline circulation is that part of the ocean circulation which is driven by density differences. Sea water density depends on temperature and salinity, hence the name thermo-haline. The salinity and temperature differences arise from heating/cooling at the sea surface and from the surface freshwater fluxes (evaporation and sea ice formation enhance salinity; precipitation, runoff and ice-melt decrease salinity). Heat sources at the ocean bottom play a minor role."

Other effects of climate change can relate to more physical changes in the geography of the earth. Things like sea level rise, ice melting.

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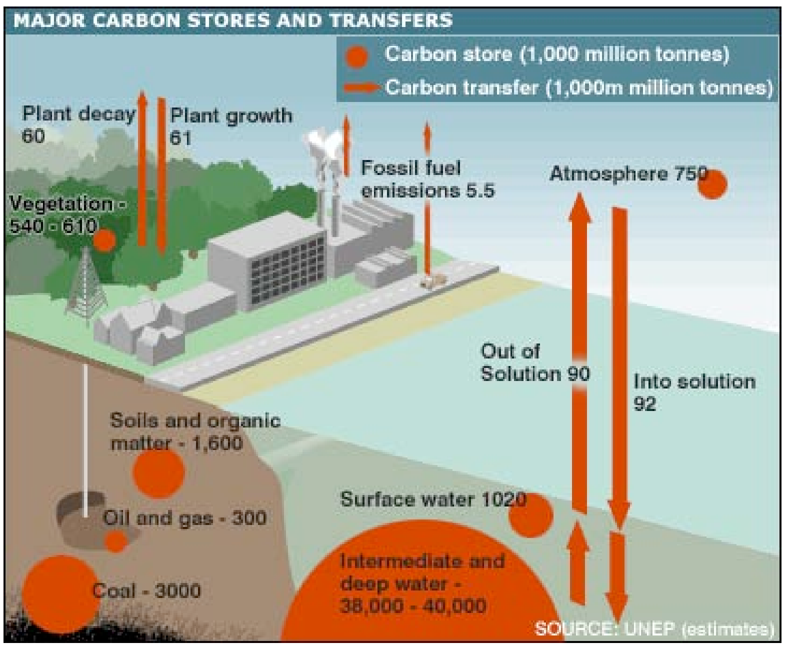
So what are the greenhouse gases? Basically, they are things in the atmosphere capable of absorbing the radiation being emitted from the earth's surface or the earth's atmosphere. Since this is generally in the form of thermal radiation particularly at the infrared range, this is what these molecules are good at taking up. There are a number of them (water, CO2, methane, ozone, nitrous oxide), but let's just focus on Carbon Dioxide, which is the one getting the most attention.

One thing that is important to note is that the carbon dioxide gets around. This is important, because its presence in the atmosphere is not only determined by what is released into the atmosphere, but also determined by how much of it can be sequestered in other place (like the ocean, the ground, etc).

Here, take a look at the Carbon Cycle.



(from http://news.bbc.co.uk/2/shared/spl/hi/sci_nat/04/climate_change/html/carbon.stm)

This figure shows a simple diagram of the way that carbon cycles between various places. It shows that movement of carbon between carbon into and out of the atmosphere is quite large (from the ocean, from combustion, respiration).

Also shows that the big reservoirs (i.e. the water and the land) do take up a corresponding amount that quite closely balances it out. In fact, it would appear tat there was a relative state of equilibrium before the human disturbances became a significant disturbance.

The other key thing here, is that is rate of movement of carbon from one locale to another exists in variety of different timescales. (i.e. mixing between surface and deep ocean can take hundreds or even thousands of years). Models have been created to mimic this (use of radioactive isotopes of Carbon from nuclear testing in the 1950's to validate these models).

Not quite though, especially with the small amount produced by fossil fuel burning (~ the 5 to 6 Gt/year). If you do the math, this results in a net accumulation in the atmosphere works out to about 3 or so Gt/year. (http://www.esrl.noaa.gov/gmd/ccgg/trends/)

This is where our future output can correspond to the various Special Emissions Report Scenarios (SRES).

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GAME: Let's look at some papers (partly for fun, but also partly to illustrate some of the research lingo involved in this particular arena of science).

WHICH ONE IS FALSE?

1. Climate modeling papers have suggested a "tipping point" of only 1^{o}C of warming as being subjectively "dangerous" to the planet. (Note that BAU models tend to project a mean increase of 3^{o}C by 2100).

2. The majority of the debate surrounding the famous "hockey stick graph" was due to a peer reviewed paper published by a former mining executive and an economics professor.

3. If we were to assume that Spongebob Squarepants is real, various ocean models suggest that he would be in serious trouble in about 50 years or so.

4. A paper correlating the albedo effects of the vast sheep population in New Zealand has been previously published. In this paper, it noted the sharp decline in sheep numbers correlated strongly with noticeably lowered reflection measurements.

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1. Hansen paper. Full on modeling paper, that attempts to show significant effects (such as sea level rise) even with a minor amount of radiative forcing (enough to just alter the temperature by 1^{o}C). The paper gives you a taste of some of the parameters involved in model construction, as well as figures that demonstrate validity by comparing against data collected from the 1850s on. **("Dangerous human-made interference with climate: a GISS modelE study" Atmos. Chem Phys., 7, 2287-2312, 2007)**

2. Stephen McIntyre and Ross McKitrick paper.
These two published a paper that critiqued the statistical methodology used by Mann and Jones when they produced their famous hockey stick graph. This graph - two versions of it, one over a 1000 year timeline (1998), and a more recent paper over a 2000 year timeline(2004) – amalgamated various collections of "proxy" (i.e. indirect) data used to access relative temperatures to relative atmospheric CO2 amounts. Examples include tree ring data (the space between tree rings is indicative of growth patterns indicative of environmental conditions), ice bore data (the relative proportion of certain types of carbon, and analysis of trapped air). In all, the Mann and Jones paper looked at about 15 such data sets from all different parts of the world, and also compared it to more recent data where hard measurements have been taken.

The statistics are pretty sophisticated, because you have to take into affect that you are not necessarily obtaining a value (i.e. so many degrees celcius, tons of carbon), but rather a relative trend. Then, you have to compensate for the fact that the proxy data comes from distinct parts of the world. Therefore the actual process of overlapping them is not as easy as it sounds.

The contention in McIntyres and McKitrick's paper is that (1) the stats used in the Mann paper is not great, in that by default, regardless of the proxy data used, you will always solve to a hockey stick shape. (2) that the validity of some of these Proxy data sets is suspect.

Anyway, the problem arose because the IPCC made a relatively big deal of the hockey stick graph, and then this paper goes to show that maybe it's not such a great paper afterall. Mann and Jones (and actually most of the scientific community) rebuttal, but the debate was created and soon entered the political arena.

So much so that the US Congress and the National Research Council had to convene to generally consider such reconstructions. Via congressman Joe Barton, a panel of three statisticians went on to do an independent investigation of the paper and its results.

Although the scientific community has generally decreed that Mann and Jones were redeemed by this investigation, this particular piece of data still has a central role in many of the skeptics arguments against the reality of global warming.
("Hockey Sticks, principal components and spurious significance" Geophy. Res. Letters 32, L03710, 2005)
("Global surface temperatures over the past two millenia" Geophys. Res. Letters 30, 1820, 2003)

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3) Orr paper. So basically things aren't looking too good for Spongebob Squarepants and his buddies. The reason being that, all of this carbon dioxide we're pumping into the air is doing some serious shit to the oceans. However in this case, it's less to do with the usual greenhouse effects, but more to do with the ocean's role as a carbon sink. Anyway, it's an interesting and important sidebar to the CO_2 equation, and one that I've looked into a bit more lately as I prep myself for potential topics of discussion in a new course I'm working on.

In essense, the oceans of the world have been changing slowly, not only from a temperature and salinity point of view, but also from a pH point of view. In fact, between the mid 1700s (roughly when the Industrial Revolution started) to present day, the approximate mean ocean pH values have been decreased from 8.25 to 8.14. This is why you hear the term "ocean acidification", although to be technical, the ocean is not actually "acidic" (needs to be less than pH 7.0 for that proper label).

This change might not sound like a lot, but when you consider that the pH scale is a log scale, that .11 difference is akin to a startling 29% increase in H^+ ions. And how the pH is altered by CO_2 is nicely explained at wikipedia:

When CO_2 dissolves, it reacts with water to form a balance of ionic and non-ionic chemical species : dissolved free carbon dioxide (CO_2 (aq)), carbonic acid (H_2CO_3), bicarbonate (HCO_3^-) and carbonate (CO_3^{2-}). The ratio of these species depends on factors such as seawater temperature and alkalinity.

The overall effect, of course, is that all of this dissolving CO_2 will increase H^+ concentration in the ocean, leading to the aforementioned change in pH. And although, the irony is that this might actually be a good thing in the greenhouse context, it's not so good for the calcifying organisms that inhabit the waters.

Hmm... "calcifying organisms?" Probably not a term you come across everyday (try working in, "So hows'about them calcifying organisms" into your next dinner conversation), but this basically includes organisms like Spongebob, whose delicate structure is primarily made of calcium carbonate and is essentially viable under conditions where the carbonate ion is supersaturated in the water.

However, under the more acidic conditions, chemical equilibrium pushes the oceanic carbonate amounts down, which can result in chemistry that essentially goes: "Hey, where did all the carbonate go in the water? Let's put it back into the water by dissolving the stuff from our shells and skeletons. I'm such a good sponge!"

Obviously, this causes a serious breakdown of these aforementioned structures. In fact, one of the more notable outcomes of this is the current bleaching of coral reefs, which is why we have the silly graphic at the top of the page.

In any event, it's certainly something that merits cause for concern, especially when you consider that the most recent peered reviewed papers suggest a potential drop of a further 0.3 to 0.4 units by 2100 - alarming because this is indicative of a net 100% to 250% increase in H+ ions.

As Spongebob once said, "Good people don't rip other people's arms off." - there's a metaphor in there somewhere.
("Anthropogenic ocean acidification over the twenty-first century and its impact on calcifying organisms" Nature 437, p681, 2005)

4) THIS ONE IS FALSE, although it was presented as an april fools joke on a well known climate science website
Graversen paper. This paper basically suggests that the amplified warming occuring in the North Pole is due to atmospheric phenomenons as opposed to albedo ice effects. The paper is interesting primarily because of the way a few sentences are worded, which in effect have launch some media scrutiny on the validity of some of the IPCC statements.

Here's the statement: what do you think?

""Our results do not imply that studies based on models forced by anticipated future CO_2 levels are misleading when they point to the importance of the snow and ice feedbacks. …. Much of the present warming, however, appears to be linked to other processes, such as atmospheric energy transports.""

("Vertical structure of recent Artic warming" Nature 541, p53, 2008)