The Oil Drum: Europe
DISCUSSIONS ABOUT ENERGY AND OUR FUTURE

Dr James Hansen: Can We Still Avoid Dangerous Human-Made Climate Change?

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Topic: Environment/Sustainability
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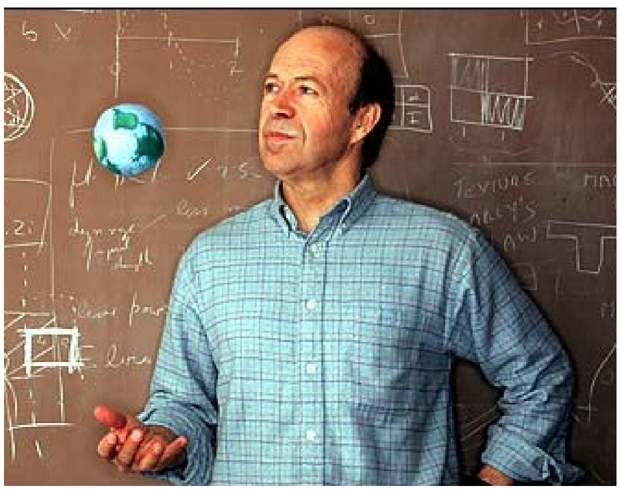
Dr James Hansen, physicist, adjunct professor: Earth and Environmental Sciences, Columbia University, director: NASA's Goddard Institute for Space Science and their lead climate scientist spoke to a packed lecture theatre at Bristol University on Friday (17Nov06). Outside the scientific community Hansen is probably best known for accusing the Bush administration of trying to silence him after he gave a lecture December 2005 calling for prompt reductions in emissions of greenhouse gases linked to global warming.

Hansen was speaking on climate change but I did have the opportunity to ask him about peak oil.



Dr James Hansen (image source NYT)

Hansen believes there is a huge gap between what is understood about global warming by the science community and what is known about it by the people who need to know, that is the public and policy makers. This belief has driven Hansen to communicate the science directly to the public as frequently and as clearly as he is able. Why is this important? Because we have just a decade to embark on a fundamentally different path regarding our use of fossil fuels if we are to avoid dangerous human-made climate change.

The world has experienced 0.8°C global average temperature rise over the last century with 0.6°C of that occurring over the last 30 years. Figure 1 illustrates the temperature anomalies of the 1st half decade of this century over the 1951-'80 average.

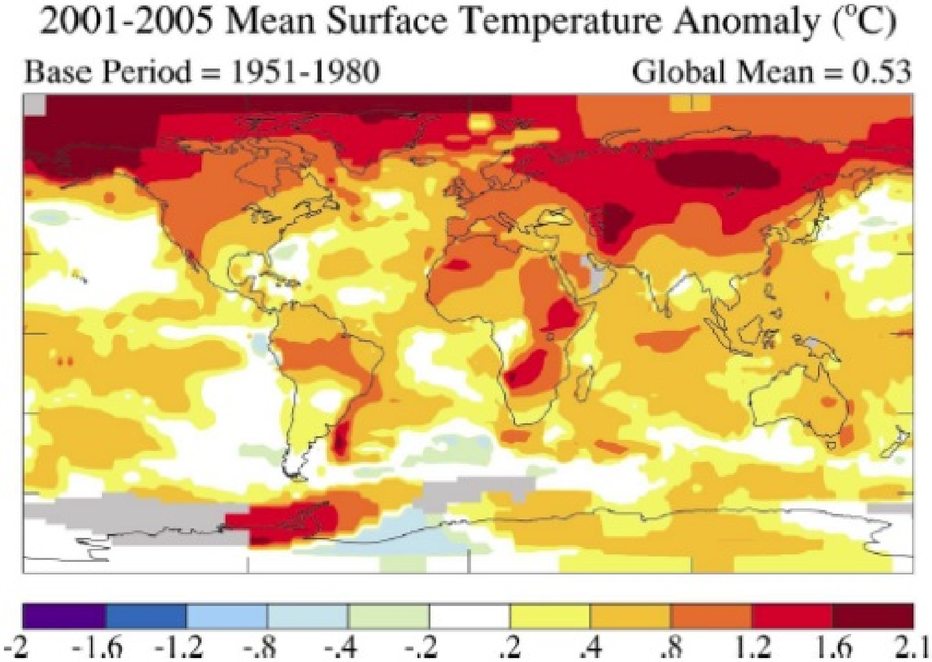


Figure 1

It is exactly what one would expect from forced climate change, the increase is larger over the land due to the thermal inertia of the oceans and it is larger at higher latitudes than low latitudes due to positive feedbacks.

Forcings and the paleoclimate

Hansen's expertise lies partially in radiative transfer in planetary atmospheres, a large part of his lecture addressed climatic forcing. Looking back at paleoclimatic data enables an understanding of climatic forcing to be developed. Figure 2 shows the familiar Vostok ice core temperature data, illustrating the variation between the last ice age and the start of the Holocene, two periods when the planet was in radiation balance.

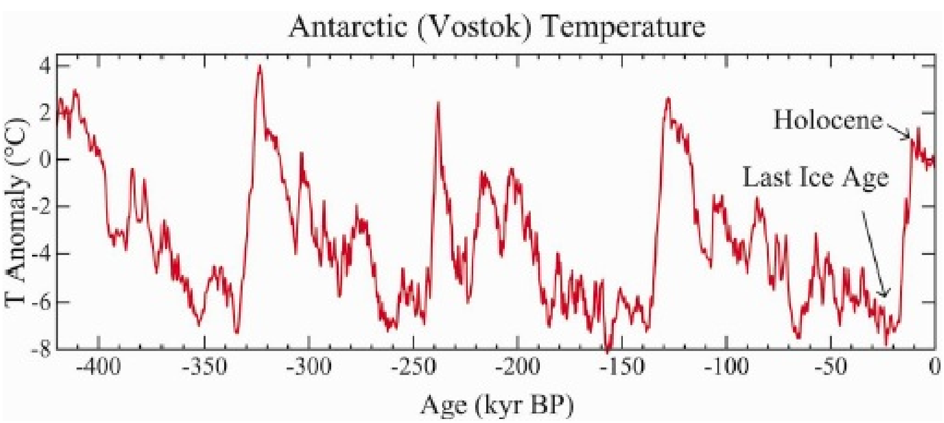


Figure 2

The reason for the temperature difference during these two periods? The climate forcing, mainly of increased ice sheets and reduced greenhouse gas concentrations. Figure 3 calculates the global equilibrium climatic sensitivity to climate forcing producing a result of ~3/4°C per W/m^2.

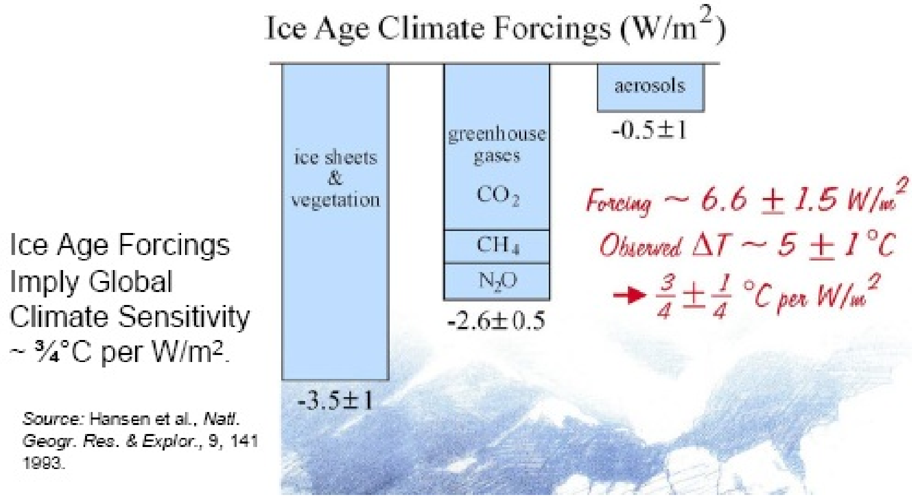


Figure 3

This result is easily checked back through time as we have pretty accurate (±12m on a variance of 100m) historic sea level data from which ice sheet area can be calculated and the ice cores provide historic greenhouse gas concentrations. He didn't mention it but I gather it is trivial to work out the forcing (W/m^2) from ice sheet area and greenhouse gas concentrations. Given these forcings and the previous results of 3/4°C per W/m^2, global temperatures can be calculated. Comparing this calculation with the observed temperatures from ice cores shows how just these two forcings account remarkably well for the temperature changes.

Hansen made another point about the temperature changes and greenhouse gas concentration changes, specifically the temporal relationship between them. Data on both can be obtained from the same ice core with high relative temporal accuracy, with only a need to correct for the time it takes between fluffy snow falling and solid ice forming impervious bubbles (the air is younger than the ice, the temperature data comes from the ice and the gas data comes from the trapped air). Comparing the temperature change and gas concentrations Hansen said:

> The correlation is maximum when there is a 700 year lag, the temperature leads the greenhouse gas change. So the greenhouse gas changes are a feedback of the climate change.

That was news to me.

The conclusions from this part of the lecture were that greenhouse gases and ice area are the chief mechanisms for paleoclimatic changes, however they were "merely" feedbacks from the instigators of climate change which Hansen describes as orbital variations, other small forcings and chaos, stressing the fact that long term climate is very sensitive to very small forcings.

The system is different now though as humans have taken control of one of the main mechanisms through our emissions of greenhouse gases.

At this point Hansen criticised Al Gore's presentation in An Inconvenient Truth of current greenhouse gas concentrations in comparison to paleo concentrations. Saying Gore was wrong to suggest the temperature change we are likely to experience from current concentrations is proportional to that seen in the paleoclimate. Those paleoclimate changes were predominately driven by ice cover, which as long as Greenland and Antarctica stay roughly the same size isn't a major factor now and also aerosols which had scope to reduce their cooling contribution as climate changed from cold/dry=dusty to warm wet.

Dangerous Climate Change

So what is dangerous climate change? Surprisingly there doesn't seem to be very much research on this. Hansen suggested the following metrics to characterise climate change:

- Extermination of animal and plant species, specifically polar and alpine species and those suffering unsustainable migration rates.
- Ice sheet disintegration, leading to long term deviations from paleoclimate data and sea level rise.
- Regional changes including droughts and floods.

> For the last 30 years temperatures have risen by 0.2°C per decade. Over northern hemisphere land areas a given isotherm is moving forward at a rate of 50km per decade. A study of 1,700 species found that in the last half of the 20th century the average migration rate forward was about 6km per decade, much slower than the rate the isotherms were moving.

Hansen suggested a 3°C warming from where we are now would result in a likely species extinction rate of 50%. 3°C was described as the business as usual scenario. The "Alternative" scenario with falling CO_2 emissions and only 1°C temperature increase would result in a likely species extinction rate of 10%.

Greenland

Greenland received particular attention. Three points:

- The area of Greenland experiencing summer melting is increasing at around 0.7% per year with 2005 setting the record melt. This melt water serves as lubrication speeding up the transport of ice to the ocean.
- The GRACE satellite can measure the mass of Greenland ice sheet and is showing a reduction of $162\pm22 km^3/yr$ over recent years.
- The number of ice-quakes, similar to earthquakes and caused by ice sheets suddenly surging forward, has increased markedly. The seismic magnitudes are in the range 4.5 to 5.1 and they are located at the mouths of ice flows discharging ice into the ocean. See figure 4.

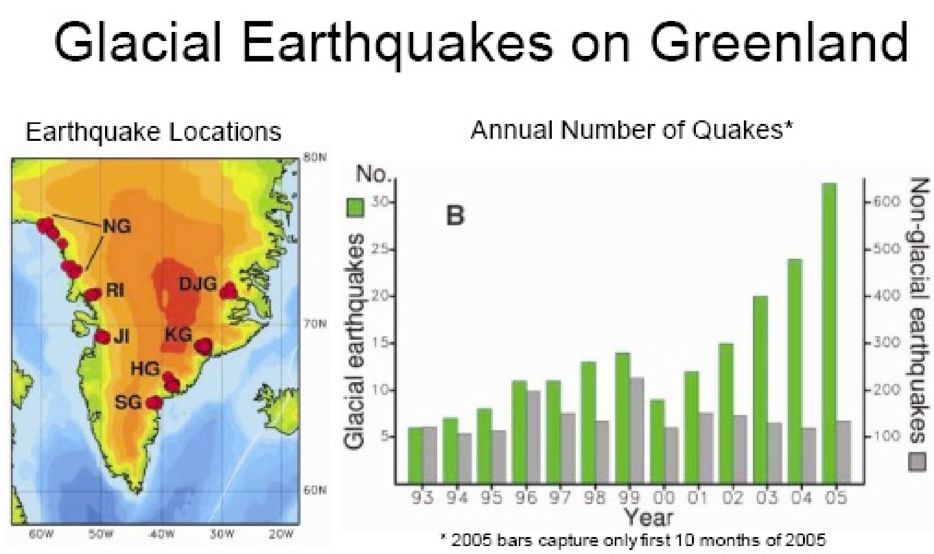


Figure 4

Hansen believes the IPCC are conservative with their estimations for sea level rise as they only consider thermal expansion and alpine glacier melt, believing the major ice sheets to be in approximate mass equilibrium and taking millennia to respond. He suggested ice sheet disintegration may start slowly but multiple positive feedbacks can lead to rapid non-linear collapse, noting the equilibrium sea level rise for 3°C warming is 25±10m.

Fossil Fuel

The dominant forcing now at work is human CO_2 emissions from the burning of fossil fuels. Figure 5 shows historic CO_2 emissions from fossil fuels which we are familiar with.

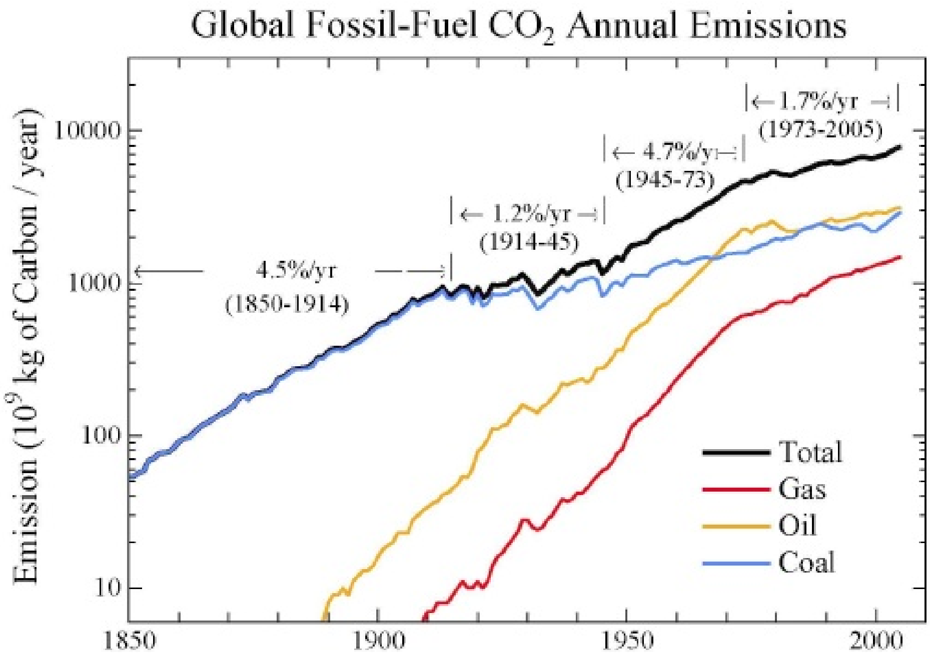
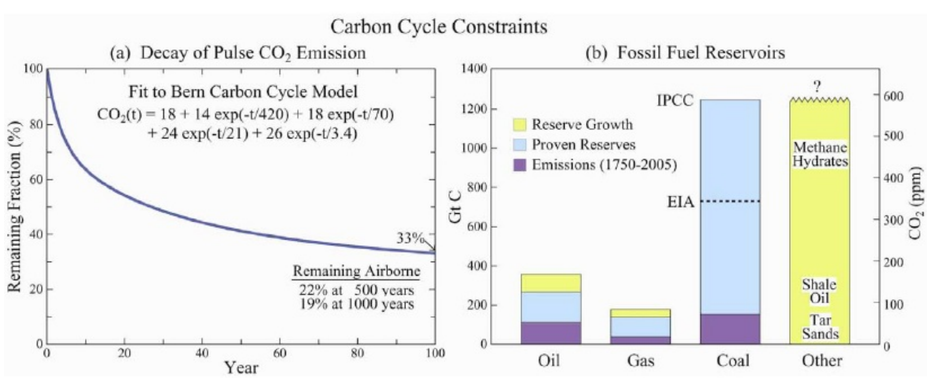


Figure 5

When looking forward things became interesting, Hansen suggesting it is feasible to contain CO_2 emissions, chiefly because the reservoirs of oil and gas are limited. Figure 6 indicates the potential carbon contributions from oil and gas. This, coupled with the decay of CO_2 emissions means that the combustion of remaining oil and gas aren't critical to climate change.



Source: "Dangerous human-made interference with climate: A GISS modelE study", submitted

Figure 6, Click to enlarge.

The problem lies squarely with Coal. Hansen's plan for dealing with coal?

- Sequester CO_2 at new coal power plants after 2012/2022 in developed/developing countries
- Bulldoze Coal Power Plants without sequestration during 2025-2050

- Stretch oil/gas via slowly increasing carbon tax, avoiding use of non-conventional fossil fuels, permitting time to develop non-CO_2 technologies

Figure 7 illustrates the source of future atmospheric CO_2 under such a plan. Interestingly this seems to indicate oil and gas peak around 2030 (the point where the gradient of the oil and gas lines dips below 1, but it's not really clear) although it could be sooner that this if one considers falling EROI leading to increased CO_2 per barrel post peak more than offsetting the reduced extraction.

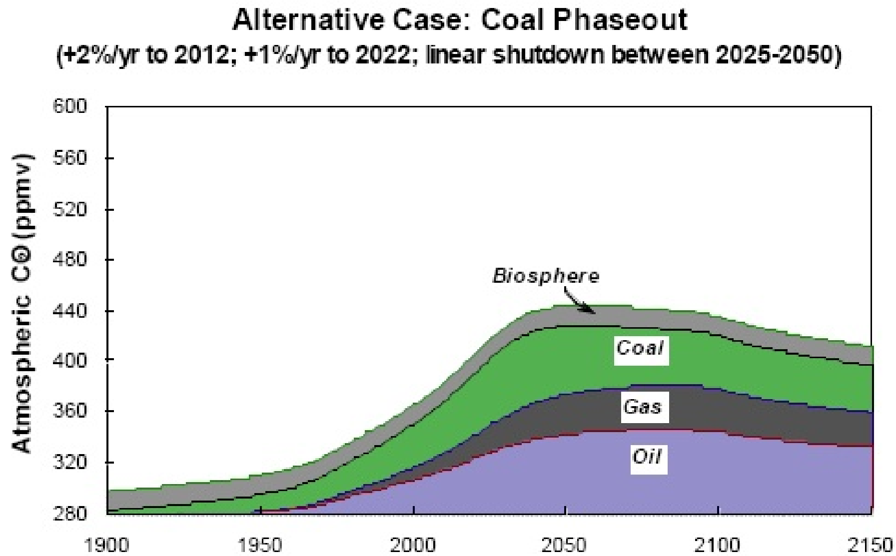


Figure 7

Contrast this with the business as usual (figure 8) scenario, noting the assumed 2% decline after 50% depletion.

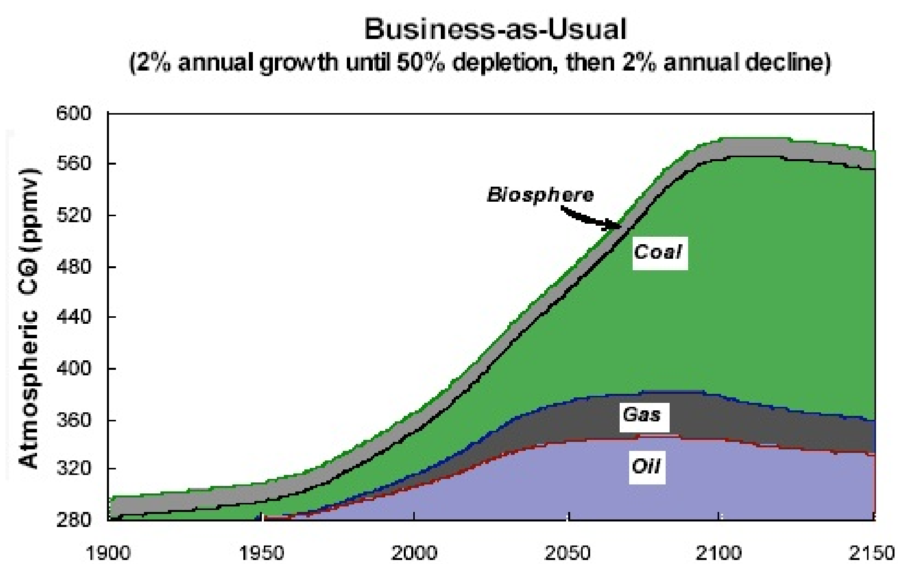


Figure 8

What Hansen is saying is that the remaining oil and gas can be burnt whilst limiting atmospheric CO_2 to ~450ppm and incremental temperature increase to only 1°C, which really should be the limit unless we want to live on a very different planet. The challenge is that the oil and gas combustion use most of the 450ppm limit, the key therefore is CO_2 sequestration or abstinence from coal and unconventional fossil fuels.

This was confirmed in the Q&A session. I asked Hansen his opinion on oil peak within a decade and impacts of peak oil on climate change. He replied that he expects to see oil peak within 20 years as we would have passed the 50% point by then adding, in that case we can probably live with the CO_2 emissions from oil without hitting 450ppm. However he did stress the point that we have to start emphasising conservation and efficiency by taxing emissions otherwise we will start squeezing oil/gas from unconventional sources such as shale oil and tar sands. That is something we absolutely can not afford to do.

Someone else asked about aviation growth to which Hansen again replied the climate could probably afford a **few more decades** of aviation growth, given we address power plants and vehicles.

So where do these views leave us with respect to peak oil and climate change. Perhaps Hansen is right. We can (and I expect will) burn all the oil and gas we can get our hands on, as fast as possible without condemning ourselves to dangerous climate change, ***if*** and it's an incredibly big if, we can get away from coal (and unconventional oil), or at least the CO_2 emissions. In some ways this is encouraging as coal is used virtually exclusively for electricity and it is electricity where we have a wealth of potential alternatives: coal with sequestration, wind, hydro, wave, tidal, nuclear fission, solar etc. If we accept that it is physically impossible (maybe unconventional oil will never amount to more than 5mbpd?) to burn enough oil and gas to cause dangerous climate change then the climate change debate needs to be refocused away from SUVs and cheap flights and onto electricity demand, clean coal and other non-CO_2 sources of electricity. Can we just let peak oil take care of oil and gas emissions and only pro-actively address coal?

Of course this is only emissions, there are other reasons to try as hard as we can to reduce our reliance on oil and gas. Chiefly due to peak oil and gas inevitably reducing supply and it being easier to *choose* reduced consumption than to be forced to consume less.

The slides (not for this specific lecture) but for virtually the same lecture given recently are available on Hansen's Columbia University page.

Additional

This view that there isn't enough oil and gas to cause dangerous climate change is in line with what Anders Sivertsson, Kjell Aleklett and Colin Campbell of Uppsala University published in New Scientist (Oct 2003): 'Too little' oil for global warming

> Although estimates of oil and gas reserves vary widely, the researchers are part of a growing group of experts who believe that oil supplies will peak as soon as 2010, and gas soon after (New Scientist print edition, 2 August 2003).
>
> Their analysis suggests that oil and gas reserves combined amount to the equivalent of about 3500 billion barrels of oil - considerably less than the 5000 billion barrels estimated in the most optimistic model envisaged by the IPCC.
>
> The worst-case scenario sees 18,000 billion barrels of oil and gas being burnt - five times the amount the researchers believe is left. "That's completely unrealistic," says Aleklett. Even the average forecast of about 8000 billion barrels is more than twice the Swedish estimate of the world's remaining reserves.