Verification of Green House Gas emissions

To keep the global surface temperature rise within +2C (3.6 F) of pre-industrial conditions, scientists have developed future decadal targets of global atmospheric CO_2 concentrations. Today's value is 400 ppm; the 2030 target is 435 ppm. To achieve this nations submitted their "Intended Nationally Determined Contributions" (INDCs) ahead of the COP21 meeting in Paris. INDC's are their future expected Green House Gas (GHG = CO_2 & CH_4) emissions. China, the world's largest emitter, has pledged to reduce its 2030 CO_2 emissions per unit of GDP (carbon intensity) by 60% below 2005 levels. Using economic forecasts, analysts estimate 2030 emissions between 13.8 to 16.5 Gigatons (GT) of equivalent CO_2 (combined radiative effects of CO_2 and CH_4) per year. China's 2010 reported emissions were 9.4 GT equivalent CO_2; for perspective the US emitted 6.0 GT. Although these are targets, and not part of an international climate treaty, we still need to monitor the actual year-to-year emissions of the top global CO_2 emitters. Currently, a nation' s CO_2 emissions rely on 'bottom-up' accounting. For example, US facilities with significant emissions are required to annually report them to EPA.

Although scientists closely monitor concentrations of CO_2 by satellite and ground based instruments, we are unable to detect (<15%) changes in regional emissions. The fear is that by 2030 the equivalent CO_2 emissions *reported* by each nation will be within their INDC target but the global atmospheric concentration will be much higher than 435 ppm – meaning we will be on a trajectory of more than +2C warming. With our current global monitoring network we will be unable to detect which nations misreported.

Scientists use a technique termed 'inverse modeling' to translate CO_2 concentration measurements to CO_2 emission values. Estimating the emission for a geographic region requires lots of CO2 concentration measurements nearby – the more measurements the better the emission estimate. But even with NASA's new Orbiting Carbon Observatory (OCO-2) instrument and the Japan Space Agency GOSAT instrument, we still don't have enough individual concentration measurements to closely monitor the annual national targets for the largest emitters. One reason is that the OCO-2 and GOSAT instruments revisit the same geographic location once every 3 to 8 days – this is not enough for national emission monitoring. Worse, they are unable to take precise measurements over clouds so measurements over perpetually cloudy/hazy locations are scarce. We need more measurements - lots more!

New instruments. 1) NASA has developed laser technology that can measure CO_2 when broken clouds are present (ASCENDS), but this technology continues to be in the 'research phase' due to insufficient funding for earth science. 2) A proposed instrument that would significantly increase the number of individual measurements is GeoCARB. It measures CO_2 and CH_4 using reflected sunlight and would be launched on a geostationary satellite positioned to 'stare' at a geographic region of interest. In cloud-free conditions it could measure the same location several times a day! We would need 5 of these satellites to monitor all the significant anthropogenic source regions. 3) The OCO-3, similar to OCO-2, is scheduled to fly on the International Space Stations in 2017. OCO-3 has an additional capability to point to specific regions, but it is still a sampling mission, and measures just a limited region each day.

These new instruments give us a fighting chance of detecting emission changes on the national level, but we will not know the CO_2 emission uncertainty until they are deployed.

Recommendations

1. If the US is serious about reducing global levels of CO_2 we need to make sure that the best available technology is deployed to monitor the concentrations / emissions of the largest emitters: US, China, Japan, the EU and India. An international agreement to limit CO2 without verification is only as good as each nation's reported emissions levels. Gullibly accepting the reported emission levels from other top emitters sets us all up for (Volkswagen)[2]

2. Perform simulation studies to find what combination of the different satellite technologies are needed to detect small changes in CO_2 and CH_4 emissions. Evaluate whether additional strategically placed NOAA ground-based measurement stations would further reduce the uncertainty.

3. The current appropriation for US earth-science is already committed to equally important scientific questions. For example, NOAA is maintaining an array of ocean instruments designed to observe the El Nino / La Nina cycle – a natural warming and cooling of Pacific Ocean temperatures that impacts the weather of almost every US state. So we need to augment the NASA/NOAA earth science Congressional appropriation or create a separate appropriation under 'carbon monitoring' to fund the most cost-effective combination of satellite and ground-based instruments.

Most are aware that even if the US implements policies to significantly reduce GHG emissions they will not be effective at moderating global temperatures, unless China and India reduce their emissions trajectory too. Without verification a US policy of carbon tax could be detrimental to our economy and ineffective to boot. Playing by the rules, our goods and services would include higher energy costs. But other major emitters that did not follow their emissions schedule would enjoy the economic advantage of lower energy costs from fossil fuels.

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