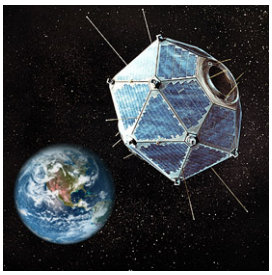
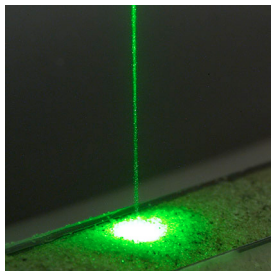
Los Alamos NATIONAL LABORATORY EST. 1943

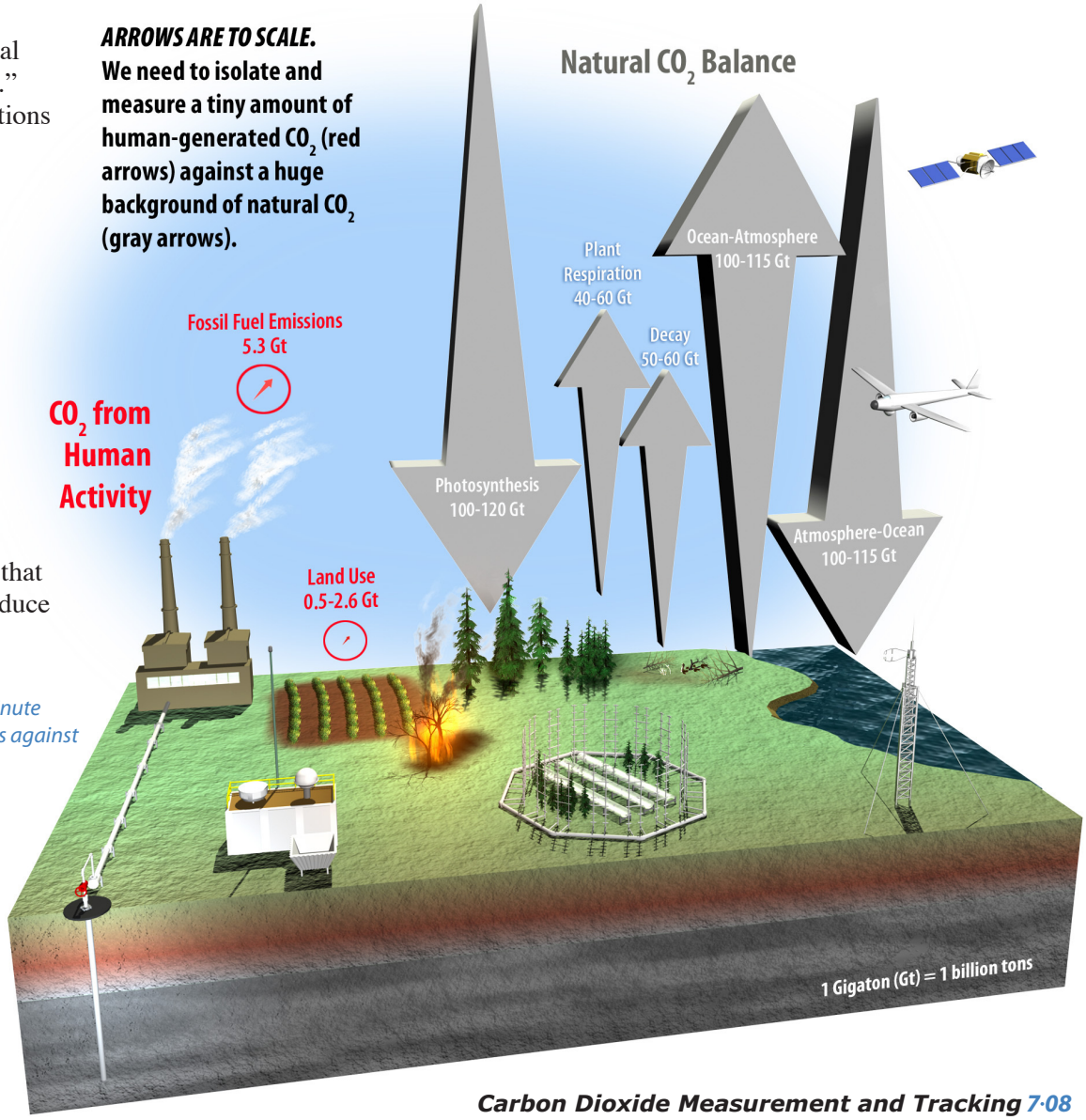





We are combining our expertise in remote sensing, measurement, experimentation, and modeling to track and quantify CO_2.

Carbon Dioxide Measurement and Tracking

Scientists and policy makers around the world now generally agree that the Earth's temperature is rising, largely as a result of human activities such as fossil fuel consumption and ineffective land use. The science academies of 11 countries, including the U.S., signed a joint statement confirming the human connection and imploring all nations to "identify cost-effective steps that they can take now, to contribute to substantial and long-term reduction in net global greenhouse gas emissions." Among the proposed solutions are carbon sequestration (storing carbon dioxide emissions in geologic, terrestrial, or oceanic reservoirs instead of releasing them into the atmosphere) and economic incentives to limit emissions, such as carbon credit trading sometimes called "cap and trade." Many countries are also pushing for an international treaty that legally binds nations to reduce their greenhouse gas emissions. But in implementing these solutions we face a common problem: how do we accurately measure and pinpoint the man-made emissions? ***Applications of advanced Los Alamos technologies in remote sensing, ground-based measurement, experimentation, and modeling are leading to effective ways to quantify these emissions and verify the results.***



Measuring and quantifying a minute amount of human CO_2 emissions against the huge background of natural CO_2 presents a difficult technical challenge but will be needed to monitor CO_2 sequestration operations, validate carbon cap and trade policies, and ensure compliance with future international treaties. Los Alamos has the expertise in ground-based, airborne, and satellite sensing and measurement to meet the challenge.

Vast amounts of natural CO_2 continuously cycle through the atmosphere, plants, soils, and oceans, and these natural fluxes have remained in balance. Human-generated CO_2 emissions are small compared to natural fluxes but they are significant enough to upset the balance and cause climate change. Detecting, isolating, and quantifying the human contribution from a large natural background requires extremely clever science, sophisticated instrumentation, and innovative data integration. Los Alamos National Laboratory is uniquely positioned to provide the tools and expertise to address these requirements.

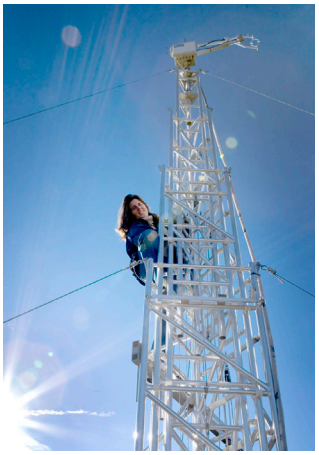
Remote Sensing

Los Alamos developed the ability to detect minute seismic and atmospheric disturbances from nuclear tests and explosions using a network of satellites and ground-based sensors; this ability has been a key part of the Los Alamos mission for over half a century. Tracing human-generated contaminants in rocks, soils, and water has also been perfected by Los Alamos researchers. Similar methods can be used to distinguish human and industrial sources of CO_2 from the large natural background signal from space and on the ground. These capabilities provide the framework to monitor the important variables of climate change.

Los Alamos deploys the world's first 3-laser photoacoustic instrument to measure Arctic aerosols and pollution.

In Situ Measurement

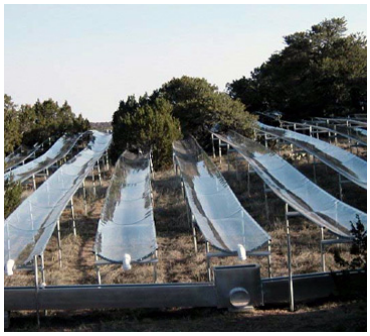
Advanced measurement systems have been another key part of the Los Alamos mission for decades; application of new measurement methods on the ground and from the air, specifically for CO_2 monitoring, has improved detection of carbon in soils and ecosystems dramatically. Application of these advanced measurement systems is critical to validating remote sensing information and evaluating changes in carbon concentrations over time and in different places.



A Los Alamos scientist on an eddy covariance tower used to measure CO_2 flux at the land-atmosphere interface.

Experimental Manipulations

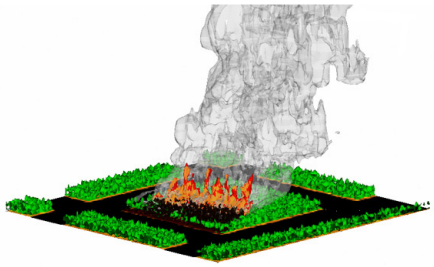
The observational data obtained from remote and *in-situ* measurements are critical, but to better understand the factors influencing the carbon cycle, those factors must be actively manipulated through laboratory and field experiments. Los Alamos researchers conduct studies to understand how the carbon cycle responds to various influences such as cloud formation and solar radiation, forest fires, vegetation death and replacement, and combinations of factors such as rainfall, temperature and type of vegetation. The results of these studies help to inform, improve, and validate predictive models.



Tree mortality experiment, a manipulation to understand impacts of climate change.

Climate and Carbon Cycle Models

Making sense of all the gathered data requires advanced models that can characterize the interaction between the atmosphere and Earth's surface. Los Alamos has proven expertise in just this kind of modeling, which has been used to successfully predict wildfires, wind fields, and the dispersion of contaminants in plumes in urban areas. Los Alamos also partners with the National Center for Atmospheric Research (NCAR) to develop global climate change models. As part of this effort, Los Alamos provided the ocean and sea ice models underpinning the recent climate assessment by the Intergovernmental Panel on Climate Change (IPCC), which earned a 2007 Nobel Peace Prize. Modeling with real-time observational measurements will be a key part in developing a global monitoring and verification network that will parallel the efforts of the Cold War in nuclear test monitoring.



Simulation of wildfire and smoke plumes with FIRETEC.

Bringing It All Together

Since World War II, the nation has looked to Los Alamos to provide scientific solutions to its most urgent national security priorities. That investment has nurtured the capabilities needed to face the newest priority—monitoring and modeling climate change. The Laboratory's combined expertise in remote sensing, *in-situ* measurement, experimentation, and advanced modeling are what the nation needs to ensure effective carbon sequestration, emissions cap and trade measurements, and greenhouse gas treaty verification.

For more information:

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