Testimony for the Record  
Hearing:  *Driving Innovation Through Federal Investments*  
Submitted to the  
Committee on Appropriations  
United States Senate  
by  
Thomas J. Bogdan, President  
University Corporation for Atmospheric Research  
April 29, 2014

On behalf of the University Corporation for Atmospheric Research (UCAR), I am pleased to submit this testimony to the Senate Appropriations Committee in support of the hearing entitled *Driving Innovation through Federal Investments*. UCAR is a consortium of over 100 research institutions, including 77 doctoral degree granting universities, which manages and operates the National Center for Atmospheric Research (NCAR) on behalf of the National Science Foundation (NSF).

On February 6, 2014, the National Science Board (NSB) released its latest report entitled *Science and Engineering Indicators 2014*. The biennial report makes it increasingly clear that the United States’ predominance in science and technology (S&T) eroded further during the last decade, as several Asian nations--particularly China and South Korea--rapidly increased their innovation capacities. According to the NSB report, the major Asian economies taken together now perform a larger share of global research and development (R&D) than the U.S., and China performs nearly as much of the world’s high-tech manufacturing as the U.S.

The NSB report makes it increasingly clear that the U.S. no longer monopolizes the global R&D arena. Since 2001, the share of the world’s R&D performed in the U.S. and Europe has decreased, respectively, from 37 percent to 30 percent and from 26 percent to 22 percent. In this same time period, the share of worldwide R&D performed by Asian countries grew from 25 percent to 34 percent. China led the Asian expansion, with its global share growing from just 4 percent to 15 percent during this period. Recognition on the part of national leaders that S&T innovation contributes to national competitiveness, improves living standards, and furthers social welfare has driven the rapid growth in R&D in many countries.
China and South Korea have catalyzed their domestic R&D by making significant investments in the S&T research enterprise and enhancing S&T training at universities. China tripled its number of researchers between 1995 and 2008, whereas South Korea doubled its number between 1995 and 2006. And there are indications that students from these nations may be finding more opportunities for advanced education in science and employment in their home countries.

In addition to investing in their research and teaching enterprises, these countries have focused their attention on crucial sectors of the global economy, including high-tech manufacturing and clean energy. The size of China's high-tech manufacturing industry increased nearly six-fold between 2003 and 2012, raising China's global share of high-tech manufacturing from eight percent to 24 percent during that decade, closing in on the U.S. share of 27 percent. In addition, emerging economies now invest more in clean energy—a critical 21st century industry—than advanced economies do. In 2012, emerging economies invested nearly $100 billion in clean energy, primarily wind and solar, with China serving as the "primary driver of investment" with $61 billion. China's investment is more than double the $29 billion spent in the U.S.

One of the most notable S&T trends of the last decade has been the increased innovation capacity of emerging economies as they narrowed many gaps with the West. However, the U.S. S&T enterprise remains the global leader. For example, the U.S. invests twice as much as any other single nation in R&D, despite slipping to tenth in world ranking of the percentage of its GDP it devotes to R&D. In 2011, the U.S. spent $429 billion on R&D, compared to China's $208 billion and Japan's $146 billion. Among other S&T metrics, the U.S. leads in high quality research publications, patents, and income from intellectual property exports.

While the U.S. remains the world's leader in science and technology, there are numerous indicators showing how rapidly the world is changing and how other nations are challenging our predominance. As other countries focus on increasing their innovation capacities, we can ill afford to stand still. We now face a competitive environment undreamt of just a generation ago as indicated in the chart entitled R&D Expenditures as a Share of Economic Output for Selected Countries/Economies: 1996-2011.
The federal government has a critical role in funding R&D. To a large extent, the federal government devotes resources to R&D to fund projects that, despite their potential for improving economic growth and people’s well-being, would be unattractive for businesses to pursue. Businesses tend to underinvest in R&D because the returns from their investment are often smaller than the returns to the economy as a whole.

The knowledge generated from a basic research project can often be used—without compensation—by other firms within and outside their industry. To make up for this underinvestment, the federal government has played a major role in funding R&D. Federal support for basic research is particularly crucial because the lack of direct commercial applications from basic research projects—as well as the uncertainty of project success—can deter businesses from performing basic research even though some studies have shown that it is this form of R&D that generates the greatest economy-wide returns.

Economists studying the link between science funding and economic growth have found that innovation through R&D is the primary driver of growth over the long run. Nobel prize winning MIT economist Robert Solow found that over half of increases in economic productivity can be attributed to new innovations and technologies. Another similar study that attempted to quantify the impact of R&D on economic growth found that increases in the level of research intensity in the U.S. and four other developed countries may have accounted for close to 50 percent of U.S. economic growth between 1950 and 1993.

The return on investments in the atmospheric sciences exemplifies how federal R&D drives economic growth. The commercial weather industry leverages U.S. investments in weather observation, atmospheric research, and computer modeling to produce tailored products for a wide variety of clients, including the general public. There are now more than 350 U.S. commercial weather companies, and they are estimated to generate nearly $3 billion in annual revenues. The growth rate of this industry is estimated to be about 10 percent per year.

This entire commercial weather industry is directly dependent on the federal scientific infrastructure, and most of its tools and technologies were developed in universities and laboratories with federal R&D dollars. In fact, a nationwide survey indicates that the U.S. public obtains several hundred billion forecasts each year, generating $31.5 billion in benefits compared to costs of $5.1 billion, a 6 to 1 direct return on investment.

Even though federal support for research—particularly basic research—is inextricably linked with long term economic growth, federal funding for basic research has dropped
since 2004. In real dollars, the federal government spends less on non-defense R&D than it did ten years ago, even as Asian R&D investments have ballooned. R&D is no longer prioritized in the federal budget as it once was. As a percent of GDP, U.S. federal R&D has been cut by over one third from 1.3% to 0.8% since 1976. Many of these cuts have fallen on the atmospheric and geospace sciences, and universities and laboratories including NCAR have been forced in recent years into difficult layoffs of researchers and other staff. This comes at a steep cost to our future.

For all of these reasons – though confronted by extreme constraints in overall spending – it is vitally important for the future national and economic health and well-being of our citizens that the Congress do all it can to support this Committee’s ability to fully fund the Federal R&D portfolio. The University Corporation for Atmospheric Research and its more than 100 member institutions respectfully urge the Committee to maintain its strong priority commitment for research and education as it moves to develop its FY 2015 appropriations recommendations.

We appreciate very much the opportunity to provide these views and stand ready to provide whatever assistance we can to the Committee and its members.

Thank you.