Concepts of Operation for the National Center for Atmospheric Research (NCAR)

This document addresses NSF's request (NSF 26-203) for concepts regarding operation of NCAR's space weather capabilities, weather modeling and observing capabilities, and its Mesa Laboratory. Because these capabilities and facilities are closely connected, this document addresses all three collectively.

The importance of NCAR's capabilities for national security and prosperity

NCAR is a vital source for environmental intelligence: critical information, together with analytical and forecasting capabilities, concerning weather and other geophysical processes that profoundly influence our economy, prosperity, and national security. Weather impacts nearly every sector of the economy. Agriculture, aviation, shipping, insurance: all depend directly on weather—and those effects ripple downstream to banking, tech, health care, manufacturing, and beyond. A healthy economy requires the best possible environmental intelligence.

National security also relies critically on environmental intelligence. Successful environmental intelligence can contribute to success on the ground, as in the famous example of the weather forecasts that led to a prudent one-day postponement of the 1944 D-Day landings. Likewise, failure of environmental intelligence can spell operational disaster, as with Operation Eagle Claw in 1980, when an unforeseen dust storm wrecked the daring attempt to rescue American hostages in Tehran.

Environmental intelligence extends well beyond short-term weather forecasting. For example, the soil moisture that our agriculture industry relies on depends on regional and global weather patterns that develop over months to years. Similarly, when the insurance industry needs to price risk, their calculations rely on critical information about the causes and consequences of drought and wildfire. Further, entities that assess and manage flood risk, both private and public, require detailed spatial intelligence on the relative likelihood of flood inundation in different locations.

Weather extends above earth's atmosphere, where radiation and particle storms from the sun can degrade the operational capabilities of satellite systems. Geomagnetic storms can also threaten aircraft navigation, power grids, and telecommunications networks. Because of these threats, intelligence on the near-space and geomagnetic environments is vital for national security and prosperity. For example, if a geomagnetic storm on the scale of the 1859 "Carrington Event" were to occur today, it would wreak havoc—unless sufficient advance warning were available to prepare grid infrastructure, alert air traffic, and take other mitigation measures.

Why NCAR is unique, and uniquely effective

NCAR was founded in 1960, just ten years after NSF itself. NCAR has enabled the United States to dominate atmospheric science and applications for the past six decades. This dominance is not

accidental, but rather reflects the power of America's unique approach to science and technology that was deployed in the aftermath of the Second World War.

NSF (along with NIH) was established on the principle that a relatively modest government investment in fundamental research will yield huge scientific and economic dividends over time. This principle—that public-sector investment in science generates returns far in excess of the initial investment, yielding a net profit to the US Treasury—has been borne out in study after study. Alongside this economic benefit, US postwar science policy has given the nation a huge advantage in technological innovation. Before the Second World War, the United States was more or less a backwater in research. After 1950, America quickly rose to global dominance: a fact reflected, among other things, in America's disproportionate share of major prizes and top university rankings. Spinoffs from basic research into successful industries are not hard to find; one oft-cited example is NSF's support for developing the algorithms that ultimately launched Google. There are plenty of examples, and their lesson is clear: America's dominance in scientific discovery and technological innovation is a direct consequence of our highly effective national research policy.

Universities form a key element of America's prominence in science and technology. Support for basic research in universities has two powerful benefits. First, by situating research inside universities, US science policy takes advantage of the fact that universities act as hubs of expertise, idea generation, and youthful ambition—and where the scope of research extends well beyond the purview of any single sector or industry—creating a dynamic that forges new ideas and discoveries. Second, university-based research places technical innovation side-by-side with education, thereby generating a highly skilled workforce that funnels the very latest ideas into industry. As a result, America's universities are the envy of the world, attracting the best and brightest talent.

Could the private sector do a better job of fundamental research than the current model of university-based, government-funded science? Economists have provided a clear answer to this question: no! There are many domains in which the private sector excels, but fundamental research is not one of them. The private sector has little incentive to undertake high-risk, high-reward research in fundamental topics where the fruits might end up well outside their core business. Moreover, the demands of trade secrecy impede the discovery process. The "golden eggs" of fundamental research require openness and transparency—the same values that the current administration has highlighted as key elements of its vision for "gold-standard science." The rewards of basic research are by nature unpredictable, yet the ultimate yields are enormous (Albert Einstein, for example, did not set out to invent global positioning systems, yet that >$100 billion industry is just one of many unforeseen spinoffs from the theory of relativity).

Universities, however, do have limitations, and part of NCAR's genius is to overcome those limitations while retaining the best advantages of university research. Innovation in environmental intelligence requires big hardware, including fleets of aircraft and state-of-the-art supercomputers. Such instrumentation is beyond the scope of any one university. The beauty of NCAR's design lies in marrying the innovative power of university research with the large-scale infrastructure needed to understand and forecast the natural world. As an efficient partnership among many universities, NCAR is able to take advantage of resources that only a consortium approach can provide.

Operating concepts

Has this marriage of infrastructure and discovery worked? Absolutely and unambiguously. The scientific and economic value of the National Center for Atmospheric Research (NCAR) is enormous. NCAR's products have helped accelerate research in countless labs across the nation, including my own (which happens to work in geology and geophysics). My students have benefited directly from internships and training programs offered by NCAR, and I have seen firsthand how these

experiences catapult productive careers in science and engineering that contribute to national productivity. The broader public has also benefitted tremendously from NCAR's 66-year track record of excellence and innovation in atmospheric science. NCAR has, for example, dramatically improved weather forecasting, including forecasting of extreme events such as storms, floods, and droughts. It continues to pioneer the use of advanced computing for solving scientific and societal problems. NCAR's work has also has driven major improvements in aviation safety. These are just a few of its many accomplishments. As a professional research scientist and research-team leader, I have witnessed and greatly admired the effective management of NCAR by the University Corporation for Atmospheric Research (UCAR). They have made NCAR a highly efficient and productive institution, and one that all Americans should be proud of. Among all possible governance models, continued management by UCAR is by far the best option. **Simply put, NCAR is a crown jewel of American innovation. It is not broken, and there is no need to fix it.**

What will happen if NCAR is dismantled?

The risks of capability loss that would accompany dismantling NCAR, selling off its assets, and dispersing its activities, are enormous. Other nations have seen plainly how successful NCAR has been, and they have tried to develop similar capabilities of their own. Notable in this space are China and Europe. If NCAR is dismantled or diminished, it is virtually guaranteed that the Chinese and others will quickly surpass the United States in environmental intelligence capabilities. Countries like China are not afraid to make national investments in the interests of their own national security and long-term economic growth. American aviation, transport, agricultural, insurance, and other industries will suffer as a result. These industries will be forced to make an unpleasant choice: buy the best-available products from Beijing (those that they're willing to release), or rely on increasingly poor home-grown intelligence. Voluntarily surrendering America's position as the world leader in environmental intelligence will harm us, and it will be our own fault.

What are alternatives?

NSF's unique charter requires it, as a matter of law, to seek guidance from the scientific community in implementing its programs. If there was ever a time to seek community guidance and gather the requisite data before taking drastic action, surely this is it. One of America's best scientific assets is the US National Academy of Science. If NSF is serious about rethinking its approach to facilities for weather research, there is a much better pathway than the legally dubious one outlined in NSF 26-203. The National Academy should be commissioned to do a thorough study of the strengths, weaknesses, opportunities, and threats related to America's environmental intelligence research portfolio, including NCAR. Such an evaluation process should be conducted on a wholly non-partisan basis, applying the best principles of "gold-standard science," and assessing the topic fully, honestly, and transparently. Above all, such a process must adhere to the applicable laws and to NSF's founding principles. Only under these circumstances will the process be likely to produce an outcome that advances the nation's security and prosperity.

(Submitted by Gregory E. Tucker, Professor of Earth Science, Fellow of AGU; Univ. of CO, Mar 2026)