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Author(s):	Laird, Ian M.
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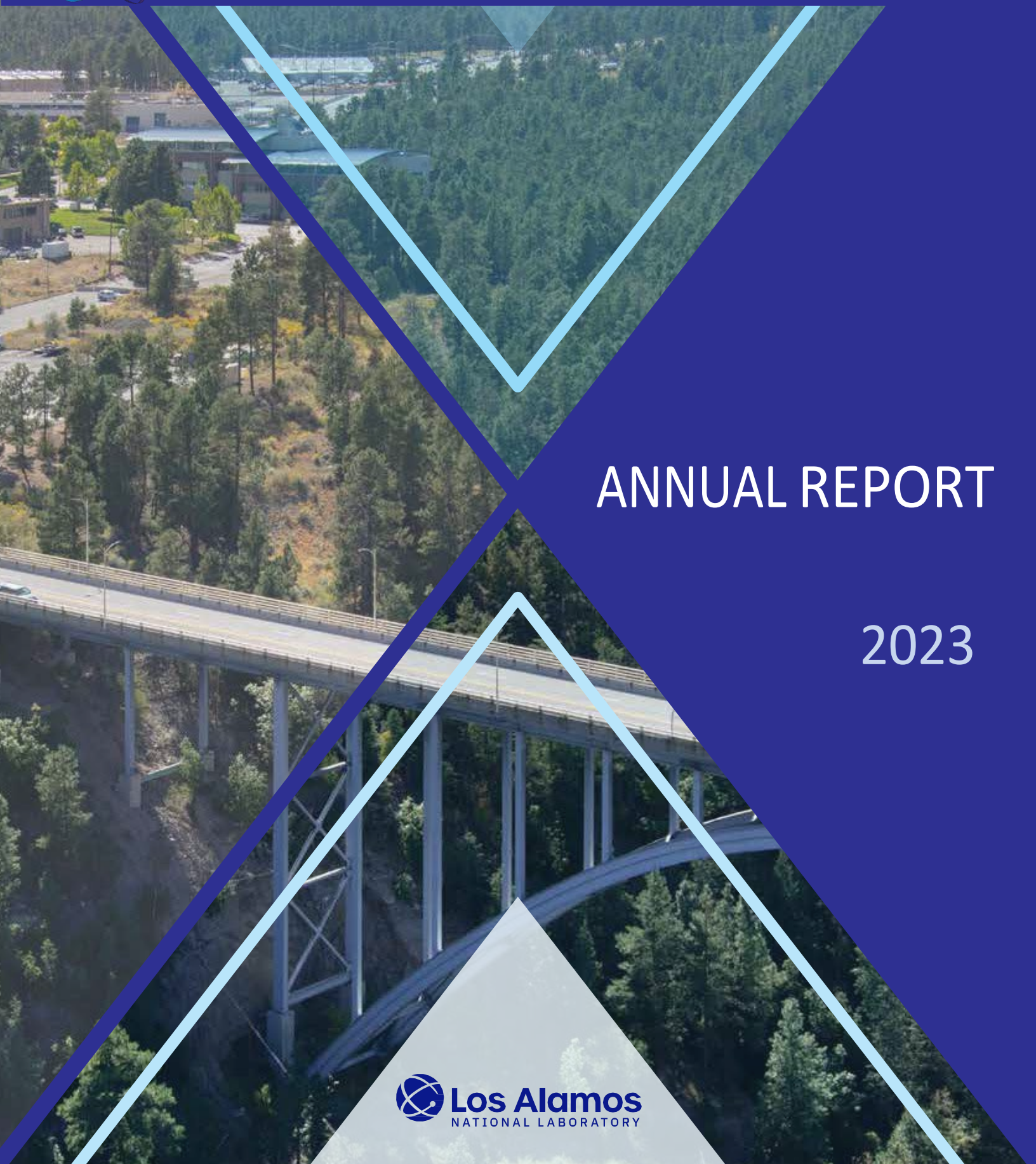
STRATEGIC ANALYSES AND ASSESSMENTS OFFICE

Decision-support information at the speed of relevance.



ANNUAL REPORT

2023

Los Alamos
NATIONAL LABORATORY

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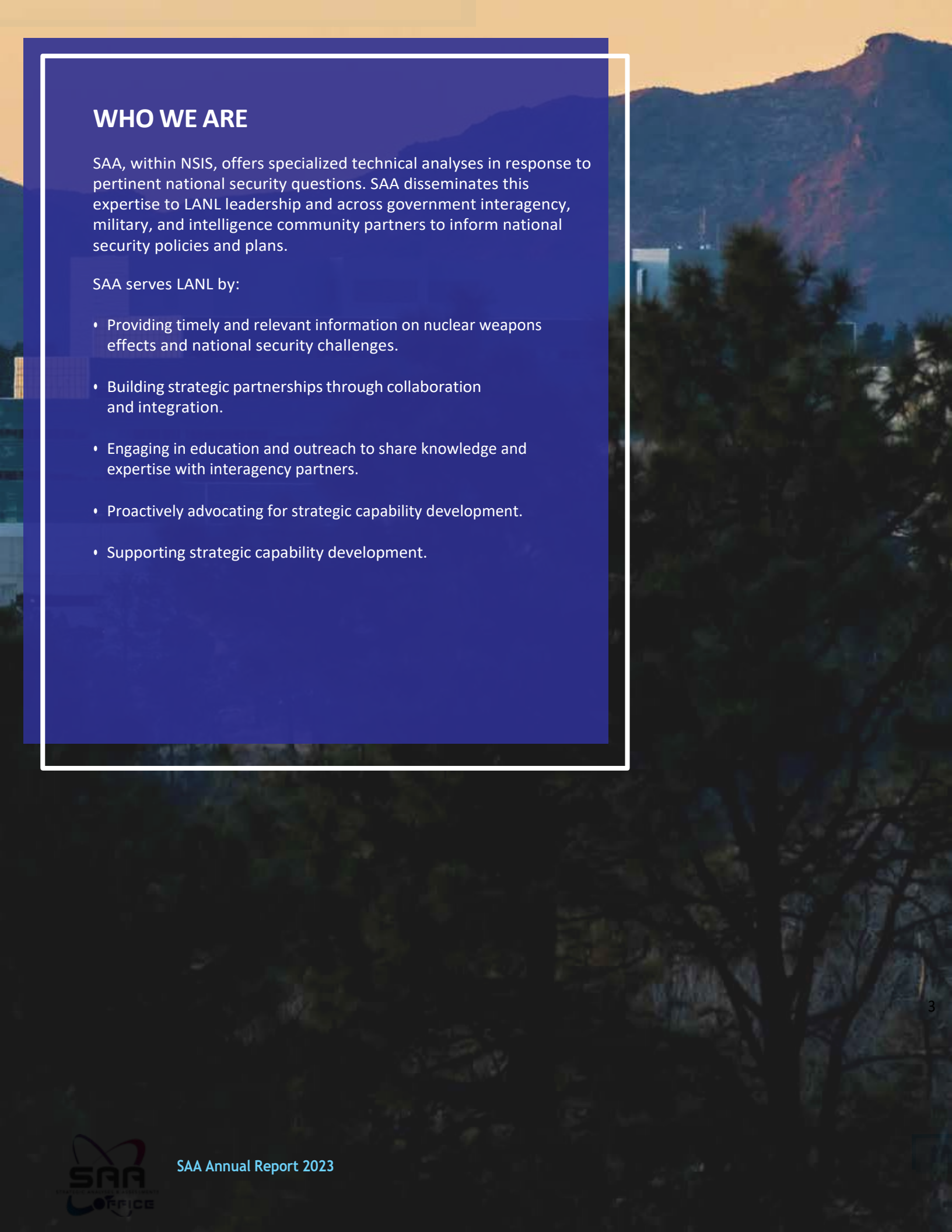
DIRECTOR'S OVERVIEW

The past year has seen a significant increase in focus on strategic issues with the continued aggression by Russia, the rapid expansion of China's military—particularly their nuclear capabilities, North Korea's rapid improvements in intercontinental ballistic missile (ICBM) technology, and the increase in Iranian fuel enrichment. The U.S. continues to modernize Nuclear Command Control and Communication and all three legs of its nuclear Triad—Columbia-class submarines, Sentinel ICBMs, and B-21 bombers—for the Department of Defense (DOD). At the same time, the National Nuclear Security Administration (NNSA) is updating its stockpile, producing the B61-12, the new B61-13, the W88 Alteration, the W87-1—with new pits, and the W80-4. This rework of the nuclear enterprise represents the most aggressive expansion of our capabilities and infrastructure in the modern era. At the same time, the Strategic Posture Commission completed its report to Congress and reported that the current modernization program, although clearly necessary, is insufficient to meet the threats that are emerging.

This emerging environment has provided the Strategic Analyses and Assessments Office (SAA) fertile ground on which to work with LANL leaders and interagency partners to understand the policy drivers, explore options, and provide insights and recommendations. As you will see in this report, we have been busy supporting many priorities across the spectrum of competition with a few noteworthy examples. First, we are leading the Net Assessment activities for LANL in support of the NNSA Administrator and to build a core capability here at LANL to support our senior leadership. Second, we continue to provide highly appreciated and visible support to major wargames and science boards—with Tim Goorley being awarded the Army Civilian service medal for his contributions. Third, we continue to deliver analytical products using LANL multidisciplinary teams in support of strategic issues like the sensing workshop in support of strategic survivability. Finally, we are responsive to leadership and policy by integrating Los Alamos, Sandia, and Livermore national laboratories' scientific efforts to support policy in understanding treaty objectives—this year focusing on the threat of nuclear winter. These examples are but a small sample of the work done this year; many more activities are described below.

To end this note, I want to take the opportunity to appreciate some of our key milestones and achievements for this year. We have increased our integration with technical organizations and programs at LANL and improved coordination with the Office of National Security and International Studies' (NSIS) Mission Integration office in support of integrated deterrence and strategic competition across LANL and think tank partners—a critical outcome for LANL. Tim Goorley was elevated to the Chief Scientist for Nuclear Weapon Effects at LANL after demonstrating the key importance of detailed weapon effects on mission drivers to LANL leadership. Tim is leading this effort and is proving to be the most effective advocate and communicator of these impacts. We added to our team Beth Hornbein, with her extensive knowledge and leadership experience in the intelligence and analytic tradecraft, to lead the Net Assessment efforts for LANL. Finally, we welcomed Josephine Kilde to our team—who is already helping in many ways to improve our communication and efficiency.

The last year has seen a flurry of activities, and we are excited about the coming year as the world remains unpredictable, and the opportunities to positively impact outcomes at LANL are only increasing.

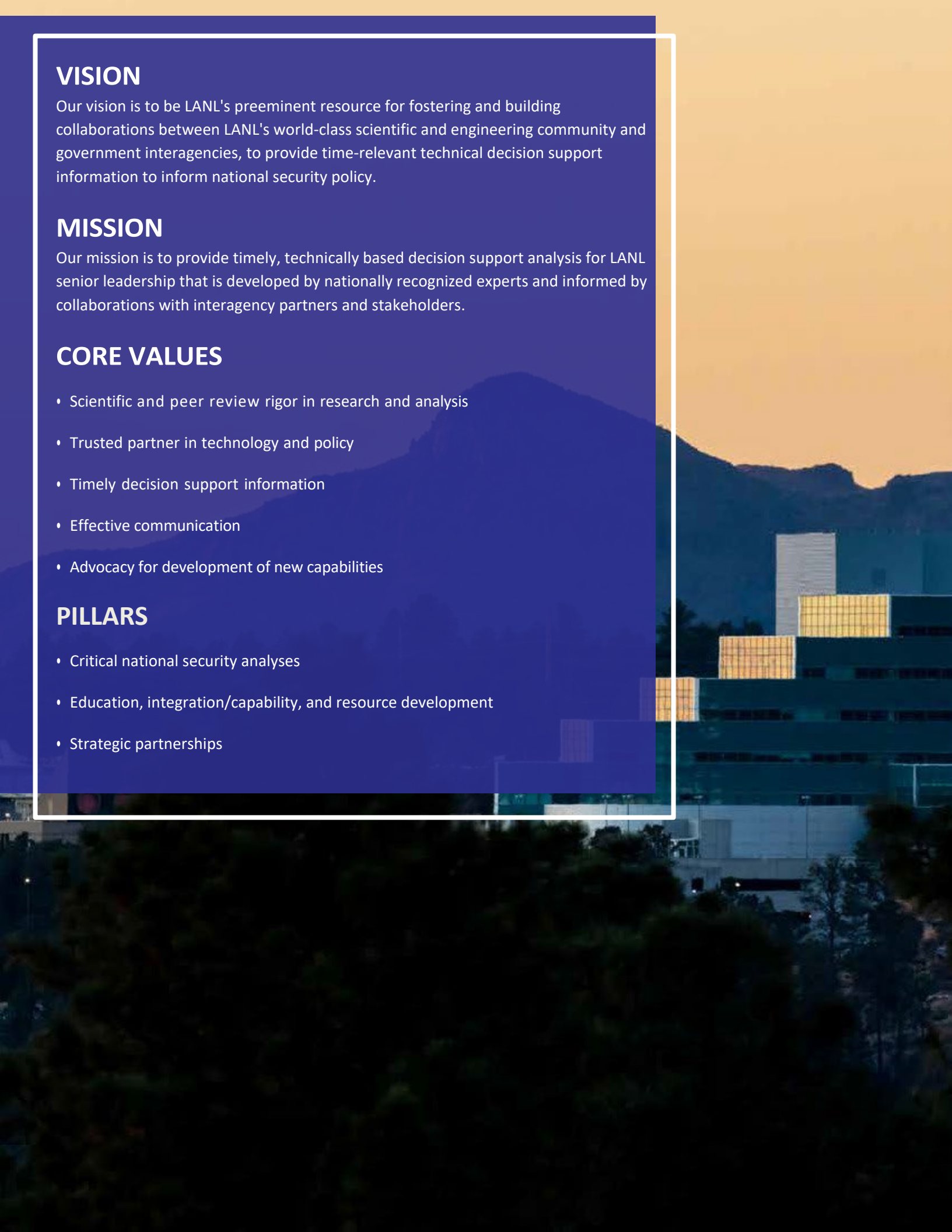


WHO WE ARE

SAA, within NSIS, offers specialized technical analyses in response to pertinent national security questions. SAA disseminates this expertise to LANL leadership and across government interagency, military, and intelligence community partners to inform national security policies and plans.

SAA serves LANL by:

- Providing timely and relevant information on nuclear weapons effects and national security challenges.
- Building strategic partnerships through collaboration and integration.
- Engaging in education and outreach to share knowledge and expertise with interagency partners.
- Proactively advocating for strategic capability development.
- Supporting strategic capability development.



VISION

Our vision is to be LANL's preeminent resource for fostering and building collaborations between LANL's world-class scientific and engineering community and government interagencies, to provide time-relevant technical decision support information to inform national security policy.

MISSION

Our mission is to provide timely, technically based decision support analysis for LANL senior leadership that is developed by nationally recognized experts and informed by collaborations with interagency partners and stakeholders.

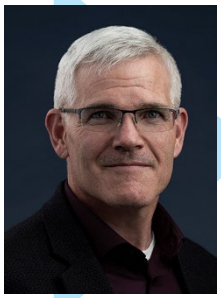
CORE VALUES

- Scientific and peer review rigor in research and analysis
- Trusted partner in technology and policy
- Timely decision support information
- Effective communication
- Advocacy for development of new capabilities

PILLARS

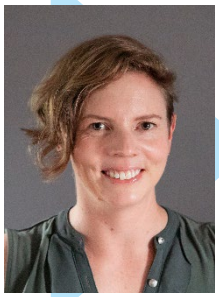
- Critical national security analyses
- Education, integration/capability, and resource development
- Strategic partnerships

JAMES COOLEY



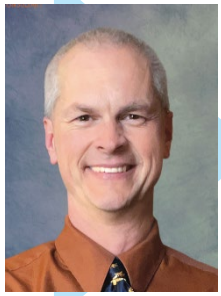
James Cooley is the office director for SAA in NSIS. He has been in this role since 2019. This role has provided him extensive exposure to the DOD partners at United States Strategic Command (USSTRATCOM) and in the Pentagon. Prior to this work he served as the leader for a group of computational physicists researching science in climate, astrophysics, and nuclear weapons physics. He began at Los Alamos as a weapon designer having experience in weapon physics related to weapons secondaries, weapons primaries, and counter terrorism. Jim started his career in the United States Navy finishing his tour as a lead engineer at Naval Reactors with responsibility for primary components, specifically heat exchangers and steam generators on submarines. Cooley has a PhD in plasma physics.

MICHELLE MOSBY



Michelle Mosby is the deputy director for SAA. Her current focus areas include managing projects related to integrated deterrence and LANL efforts in collaboration with USSTRATCOM. She also serves on the LANL rotation to USSTRATCOM where she engages with their War Plans Evaluation division. Mosby has a PhD in nuclear chemistry from Michigan State University and came to LANL as a postdoc in Chemistry division. Before joining the SAA, she spent several years as a weapon designer and is a graduate of Theoretical Institute for Thermonuclear and Nuclear Studies (TITANS).

TIM GOORLEY



Tim Goorley is the chief scientist for nuclear weapon effects at LANL, a role which guides and directs technical analyses, modeling and simulation capability development, and training. Ultimately, these efforts inform LANL senior leaders about mission effectiveness, survivability, consequences of execution, and 'the art of the possible'. For the past 23 years, Goorley has been applying his nuclear engineering expertise to various nuclear weapons detonation–related diagnostics, weapons effects, and forensics related missions. Goorley recently led a group in their successful support of nuclear weapons missions within the Weapons Physics Directorate at LANL. These missions include assessments of intrinsic radiation, modern and historic diagnostics, radiation shielding, nuclear forensics, criticality assessments, weapons effects, and the development of software used in these analyses.

BETH HORNBEIN

Beth Hornbein joined LANL in 2002 as a graduate student in the P-21 Biophysics Group, where she completed her dissertation in neurophysiology as part of the Retinal Prosthesis Project. Hornbein has spent most of her career in LANL's intelligence program, first as an intelligence analyst and later as a program manager for the Intelligence and Emerging Threats Program Office. She shifted to line management in 2018 and served as the group leader for A-1, Information Systems and Modeling. Hornbein currently provides analytic and facilitation support to LANL analysts and scientists and leads the net assessment program.

JOSEPHINE KILDE

Josephine Kilde is the administrative assistant for the SAA, and the broader NSIS office of which SAA is under. She joined LANL in 2015 as a graduate student in the High Performance Computing Division as part of the talent acquisition team. Her interests focus on the intersection between culture, technology, and policy. She joined SAA in 2023 as an administrative assistant to support SAA's coordination and communication efforts. Kilde graduated from University of Colorado Boulder with a PhD in information and communication technologies for development.

SAA PRIMARY PILLARS

SAA channels its work to support three primary capability pillars, critical national security analyses, education, integration/capability, and resource development, and strategic partnerships. These pillars help inform the way SAA engages with its work from start to finish. As such, the following summaries of analyses and exercises performed by SAA in the last year have been grouped by the primary pillar that the work contributed to, while the secondary pillars are also listed.

PRIMARY PILLAR: CRITICAL NATIONAL SECURITY ANALYSES

For work supporting critical national security analyses, SAA coordinates working teams to address the scope of the analytical need. This is done by evaluating the most effective processes to answering the posed questions and encouraging involvement from diverse, multidisciplinary analytical teams from across LANL or the Tri-Lab (LANL, Lawrence Livermore National Laboratory [LLNL], and Sandia National Laboratories [SNL]). The analyses and final products provide information directed toward specific actions or decisions that leadership can take. This means the analyses anticipate potential issues and next steps and take into account the surrounding context in the technological and political landscapes. The final products and reports are then peer reviewed, often by engaging external subject matter experts, before being delivered to senior leadership.

STRATEGIC STABILITY ANALYSIS

Secondary pillars: none

Strategic stability involves both the application of offensive weapon systems, which impose punishment on adversaries, and defensive systems, which increase the cost to the adversary through denial. The competition in a nuclear exchange between the offensive ballistic missiles and the ballistic missile defense provides opportunities to study this balance. There is a current expansion of both offensive and defensive capabilities being explored and developed by the U.S. and our adversaries, therefore we performed an updated quantitative analysis of the strategic stability with respect to these systems, both in terms of an arms race and crisis stability, using the following analysis approach.

In our analysis, we developed a simple model for the exchange of offensive nuclear weapons in the context of ballistic missile defense systems. This model is intended to contain minimal complexity while still retaining the richness required to explore differences in perceived risk and tolerance of national leadership. We applied this model to the case of peer nuclear powers in both strategic systems and ballistic missile defense capabilities and highlighted how each side perceives the crisis in terms of their individual risk framing and their belief in the capabilities of each other's systems.

Through this model, we demonstrated that even with perfect knowledge on both sides, the perceptions can sway the balance of strategic stability from stable to unstable leaving peer competitors with qualitatively different perceptions of the first strike stability in crisis. Through this analysis, we can understand how in this context U.S. and Russian perceptions of the stabilizing/destabilizing attributes for ballistic missile defensive systems can drive arms race instability. This understanding can then be used to avoid crisis stability issues.

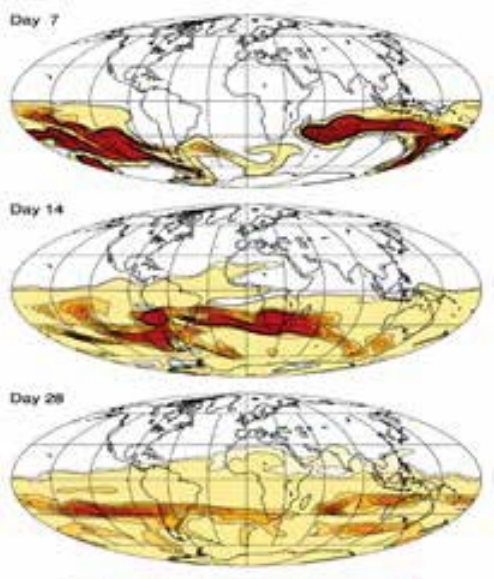
NUCLEAR WINTER

Secondary pillars: education, integration/capability, and resource development and strategic partnerships

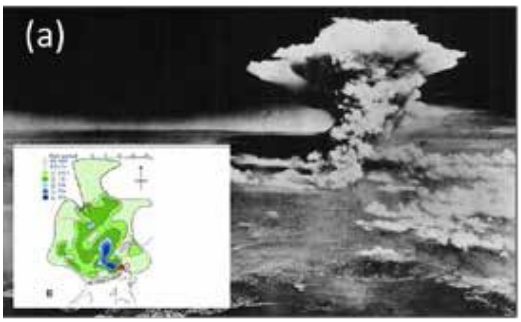
The threat of nuclear winter—a term used to describe the global cooling and drying in response to the lofting of particles into the atmosphere following an exchange of nuclear weapons—had been investigated in previous analyses of regional nuclear exchanges, but predictions for nuclear winter were reliant on software and models that were dated in their ability to produce high-accuracy, high-confidence results.

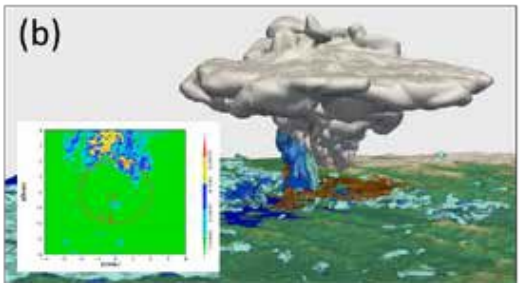
SAA, in partnership with SNL and LLNL, undertook the mission of providing a more accurate analysis of the likelihood of an exchange leading to nuclear winter, using much more powerful modeling tools than had previously been used. This analysis included end-to-end modeling from initial fire start and spread to lofting, which is a capability unique to NNSA labs. The findings of the analysis countered conventional knowledge of a high likelihood of nuclear winter in a regional conflict, like one between India and Pakistan as used in this analysis study. The analysis instead found that a more likely scenario would be a "nuclear autumn" where there are minor climate effects regionally or even globally, but nowhere near extensive enough to produce the significant cooling predicted in a nuclear winter scenario.

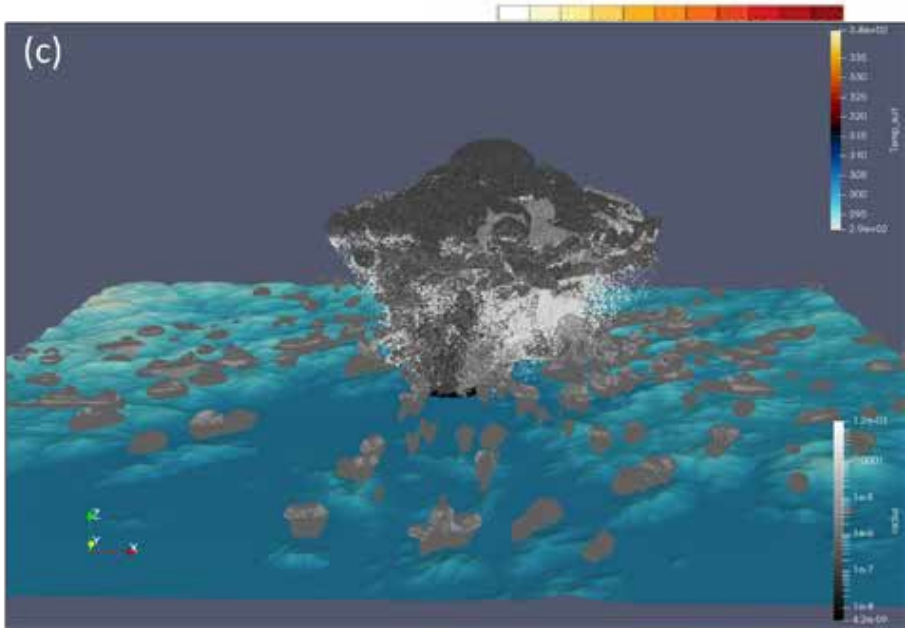
Along with using cutting-edge models and simulations to reset the academic narrative around nuclear winter, the team also identified data gaps where improvements could be made to provide more accurate, higher-confidence results. Overall, the analysis provided the most extensive report on nuclear winter scenarios in years. It gave leadership greater understanding of what has previously been an area of uncertainty, while identifying a pathway forward for further research.



To evaluate the likelihood of nuclear winter scenarios, the SAA team had to pair data on modern building materials with known historical events where large volumes of ash and smoke were lofted into the atmosphere. To do so, the team used models of urban environments and materials (bottom) to determine how the layout and composition of a city might affect black carbon and ash production. That was then connected to weather data from the 2019–2020 Australian bush fires (right) to understand how the resulting black carbon and ash might be transported regionally and globally.







NUCLEAR WEAPONS LARGE EXCHANGE

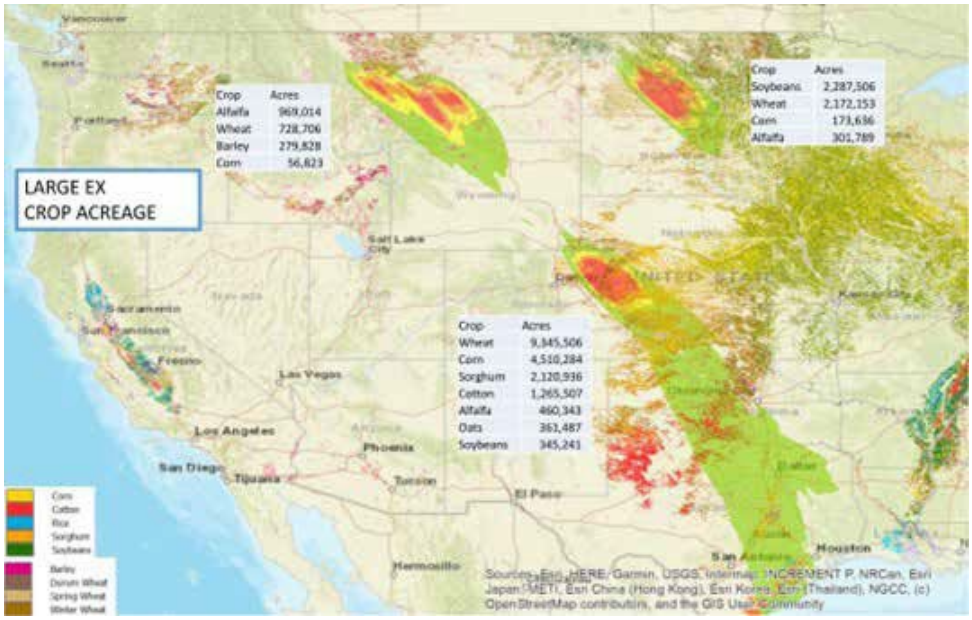
Secondary pillars: education, integration/capability, and resource development

In a large-scale nuclear exchange, it is likely that adversaries would target the United States' ICBM silos in an attempt to render second-strike capabilities less effective. To date, modern analyses of such an exchange and the resulting effects on the surrounding area have been somewhat limited due to the multiscale elements required for a full analysis. As a result, there is little understanding of what such an exchange would mean economically and socially for the United States.

To fill this gap, in 2021, an analysis of a large-scale nuclear exchange was undertaken to investigate the results and aftermath of an opposition strike against the nation's ground-based deterrent. In this analysis, a simulation was produced to model what might happen if all the ICBM silos operated by the U.S. were hit by multiple warheads. A summary of the analysis was published earlier this year, giving leadership and stakeholders a better understanding of potential threats and responses associated with such an exchange. This study was designed to explore high-fidelity capabilities at LANL and to identify potential gaps where strategic investment in development might occur.

The team responsible for the study leveraged multiple coupled software to accurately predict fire, ash, and fallout generation. This information was then entered into climate models to predict how weather patterns might affect things like fallout transport. Resulting models were used to estimate what potential effects to resources like agriculture, water sources, and power generation could look like. This study not only provided leadership with quantitative data to help develop future nuclear weapons strategy, but also demonstrated the high-quality, powerful modeling capabilities at LANL's disposal.

The large exchange analysis used a combination of coupled modeling software. A multi-disciplinary team analyzed the potential economic and human impacts of a large-scale strike on the nation's ICBM silos. Pictured are high-fidelity graphics of the effect such a strike would have on U.S. agriculture.



NET ASSESSMENTS

Secondary pillars: education, integration/capability, and resource development and strategic partnerships

With the acceleration of competition and the rapid developments of capabilities of other nations, understanding the net competitiveness of the United States in relationship to others is even more critical today. This is particularly true as the U.S. undergoes a complete modernization of the nuclear enterprise at significant expense.

At the request of the NNSA administrator, Jill Hruby, LANL (along with LLNL and SNL) is developing a net assessment capability to conduct comprehensive, competitive analyses of the U.S.' and adversaries' military capabilities, especially as they relate to NNSA competencies. LANL's approach to net assessment will be informed by the work of Andrew Marshall, who served as director of the DOD office of Net Assessment for nearly 40 years and developed this analytical approach. In FY23 LANL worked with the other two NNSA laboratories to perform a comparative analysis of the three peer nations and assess the advantages and disadvantages of each within the nuclear enterprise.

In FY24 we are inviting several of Marshall's protégées, including Tom Mahnken and Steve Rosen, to LANL to provide workshops and mentoring for the team. To ensure that our assessments go beyond technical comparisons, the team has a wide range of expertise, including policy, intelligence, modeling, and weapons science. The team is currently completing work on the initial round of questions, which were related to testing, and pit production, and will begin work on a topic related to integrated deterrence and strategic culture.

PRIMARY PILLAR: EDUCATION, INTEGRATION/CAPABILITY, AND RESOURCE DEVELOPMENT

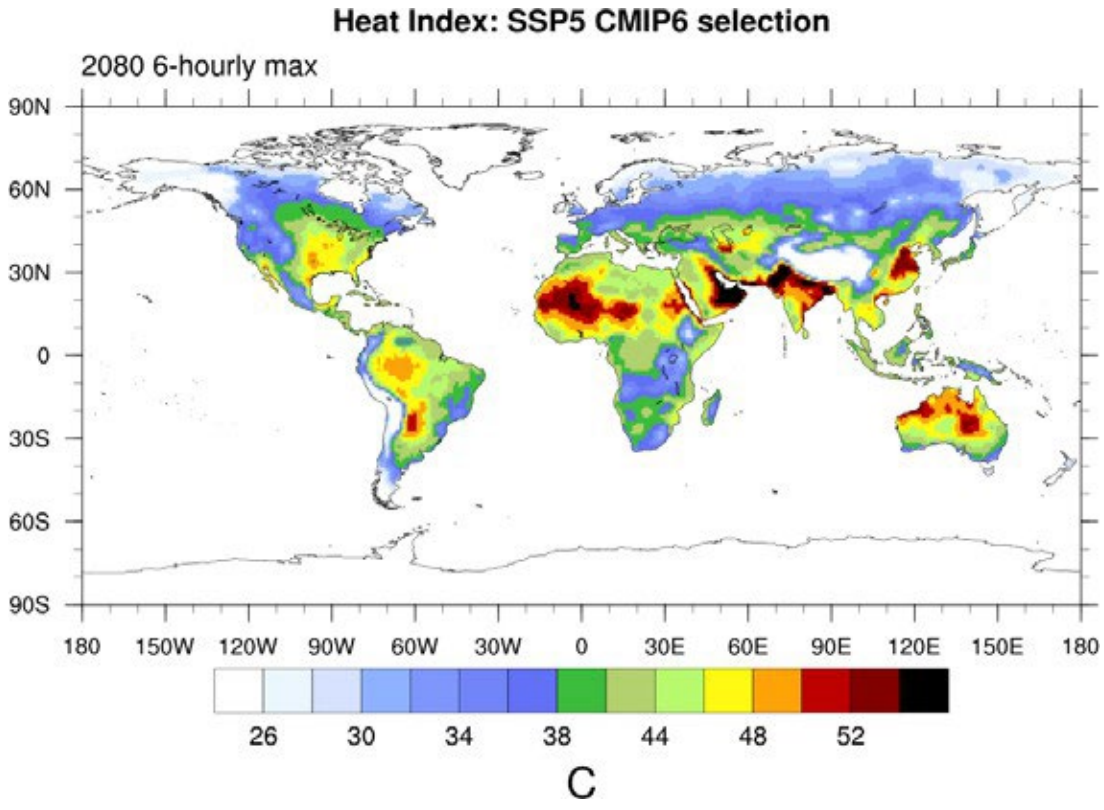
For work supporting education, integration/capability, and resource development, SAA focuses on equities that are unique to LANL. This means amplifying the pursuits of LANL scientists and engineers when appropriate and not duplicating the capabilities that exist in the interagency unless doing so with the aim to provide peer review. Education and capability development take a long time to implement, so effective implementation and development of these resources require planning and regular re-evaluation to ensure we are capable of meeting the interagency needs. This means engaging with interagency partners and accounting for the breadth of relevant capabilities currently held by LANL to leverage and build upon current capabilities.

CLIMATE DRIVEN DISRUPTORS

Secondary pillars: critical national security analyses

The realities and effects of climate change are becoming increasingly prevalent in our daily lives, whether it be more frequent and more potent natural disasters or the rapid warming of large portions of the planet. To help prepare for a future where climate holds a more disruptive role in the world a multidisciplinary team led by SAA is attempting to model the long-term effects climate change could have on global stability.

This effort to support evaluation of future strategic environments began at the end of FY23 and uses existing data from various climate models to attempt to visualize the consequences of climate change. The effort will initially focus on easily extracted quantities such as maximum temperature and sea level, leveraging high performance computing capabilities and visualization expertise that exist at LANL. The intention is to provide a context map of physical characteristics that can be used by SAA or others to better explore potential instability due to migration, food insecurity, and new sources for conflict. This work is expected to be the beginning of the process, with further work building on this initial analysis to explore implications for higher order impacts such as migrations, food and water security, and ultimately, demographic stability.



As part of the Climate Driven Disruptors analysis, the SAA team is developing models to show the effects climate change could have in the future. This graphic represents the maximum heat index areas of the world might experience in 2080.

The heat index is measure of heat stress on the body. The heat index depends on air temperature and relative humidity in the shade and without wind. The following table is provided by the National Weather Service (see also https://www.weather.gov/ffc/hichart):

Heat Index		
deg C	**deg F**	**Notes**
27-32	80-91	Caution: fatigue & cramps possible with prolonged exposure and activity.
32-41	90-105	Extreme caution: cramps, heat exhaustion & heat stroke
41-54	105-130	Danger: cramps, heat exhaustion are likely; heat stroke is probable
54+	130+	Extreme danger: heat stroke is imminent.

CISLUNAR TABLETOP EXERCISE AND ANALYSIS

Secondary pillars: strategic partnerships

As technology advances and near-Earth orbital zones become more crowded through the proliferation of public and private satellite systems, countries will increasingly look to explore what is known as the cislunar space. Cislunar space refers to the 240,000 miles of space and orbital zones between the Earth and moon. Exploration and control of this area is of major interest to the U.S., our allies, and our adversaries for economic, scientific, strategic, and military motivations. Securing footholds in the cislunar space would provide launch points for deeper exploration to places like Mars and beyond. It would also allow nations to return to the moon in the search of non-renewable resources like rare earth minerals that are becoming scarce on our planet.

As attention turns to this area of space, there has been an increased awareness in the international community for the need for cooperation and governing regulations. Current regulations are adequate for the former space landscape, but the increasing scope of governable space is rendering some treaties ineffective in addressing some of the potential threats.

To address LANL's role in this evolving space, an analysis was conducted to assess how the LANL's strategy in contributing to research in this area could align with national policy goals while identifying challenges and questions around national security that LANL is already working to answer outside of the cislunar space. SAA also conducted a tabletop exercise (TTX) to work out how to address concerns surrounding scenarios like the launch of special nuclear material for power and propulsion into the cislunar space and how to address the lack of stable orbits in cislunar space and what that could mean for the interaction between different vehicle orbit paths. As this is still an emerging area, there are still plenty of questions and areas to explore, and understanding of the opportunities and challenges associated with operating in cislunar space will continue to evolve.

PRIMARY PILLAR: STRATEGIC PARTNERSHIPS

SAA work supporting strategic partnerships often takes three forms. The first of which is providing informational briefings to interagency partners. This involves getting LANL leadership endorsement for the sharing of information, and coordination with relevant stakeholders to establish how and where the information will be shared. The information shared with interagency partners leverages the unique capabilities of LANL and SAA, showcasing competencies in strategic areas. The second way SAA supports strategic partnerships is by engaging stakeholder meetings to facilitate the exchange of information and ideas. This requires planning to get all relevant stakeholders and parties together, documentation of the meeting and future actions, and communication of the documentation and results with relevant stakeholders. Lastly, SAA communicates questions and points of interest from interagency partners with relevant LANL stakeholders to ensure a two-way dialogue remains open and to allow LANL stakeholders to modify messaging and capabilities to address the questions and interests of the interagency partners in subsequent meetings.

SENSING WORKSHOP

Secondary pillars: education, integration/capability, and resource development

Recent years have seen an explosive growth in technology used for geophysical sensing and instrumentation for laboratory sciences along with big data and artificial intelligence. These advances in seemingly dispersant fields might result in a confluence of new capability that could be revolutionary in both the scientific disciples and in national security spaces.

SAA hosted a workshop in February 2023 with the goal of building a multidisciplinary perspective on emerging and future opportunities and threats in the LANL science of signatures strategic pillar. The team brought together subject matter expertise from across LANL alongside invested internal global security partners to discuss new measurement, sensing, and data fusion capabilities and outlooks for emerging technologies. Specifically, experiments in geophysics, chemistry, biology, space sensing, and data fusion were integrated in discussions related to sensing environments and novel signatures that could be combined to extract desirable signals.

The goals of the workshop were, first, to facilitate introductions and collaborations between experts in various disciplines at LANL. Second, was to obtain useful and potentially actionable information about scenarios of interest. SAA deputy director Michelle Mosby produced an internal classified report summarizing the outcomes of the discussion. The discussions were not complete enough to be actionable, but the ideas generated during the workshop can be developed and explored in the future. We will hold a follow-on workshop early in FY24, where the subject matter experts will be able to do more detailed thinking on the ideas presented at the initial workshop.

The science of signatures is one of six primary pillars LANL. A signature refers to a unique and recognizable piece of information that is representative of a pattern or authenticity. LANL works to identify new signatures, revolutionize the measurement of signatures, and engineer and deploy advanced signature-related technologies. LANL is a leader in the science of biological, energy, nuclear and radiological, climate, chemical and materials, and space signatures.

WARGAME REPORT

Secondary pillars: critical national security analyses

FY22 and FY23 have seen growth in the number and quality of LANL staff in the DOD wargames. More nuclear wargames are being conducted in the DOD, and there is a definite trend to start the games with a nuclear detonation, rather than end with the nuclear detonation. More military officers are advocating for more nuclear weapons options. LANL has increasing requests to attend wargames and to provide weapons effects briefings. LANL has partnered and is funded by the Defense Threat Reduction Agency (DTRA) Nuclear Technology Assessments (NTA) to participate and lead their nuclear wargaming efforts, especially for events that occur in the Midwest U.S. and for USSTRATCOM sponsored wargames.

One of the ways LANL supports the DOD wargames is to provide scenario analyses of nuclear detonations, frequently to set the stage for the start of the game, but also as a pre-generated list of possible options for the players to choose from during the wargame. SAA also provides information materials such posters (e.g., At Sea Detonations, Nagasaki: Nuclear Detonations) and weapon effects pamphlets to help educate the wargaming audiences on nuclear weapons detonations and impacts. Weapons effects analysis tools such as: Strategic Mission Assurance Data System (SMADS), DTRA tools (like Hazard Prediction and Assessment Capability—Nuclear (HPAC-N) and Integrated Weapons of Mass Destruction Toolset (IWMDT) have been introduced into the wargames per the recommendations of LANL.

SAA's primary objectives in leading and participating in wargames are: (1) Advise LANL senior leaders about current and future (DOD perceived) nuclear weapons needs; (2) Inform DOD about the 'art of the possible' for nuclear weapon design, effects, and infrastructure impacts; (3) Correct misperceptions about nuclear weapon effects; (4) Develop and maintain stronger ties with DOD stakeholders; (5) Energize LANL staff.

INTO THE FUTURE

In 2024, SAA will continue to support LANL leadership and external partners through cutting-edge research and analysis. We are excited to see weapon effects recognized as a critical activity at LANL and look forward to developing integrated deterrence and net assessments into a similarly vibrate effort. With another year of experience under our belt and more time to work on integrating our capabilities with the rest of LANL, SAA is equipped to have an even greater impact at LANL. After a successful 2023, in which the office further cemented its status as an asset for senior leaders, SAA looks forward to what 2024 will bring.

SAA Contact:
Email: saa_office@lanl.gov
Phone: (505) 819-9342
Website: lanl.gov/saa

STAFF

James Cooley, Director

Michelle Mosby, Deputy Director

Tim Goorley, Chief Scientist for Nuclear Weapons Effects

Beth Hornbein, Senior Analyst for Net Assessments

Josephine Kilde, Administrative Assistant

Ian Laird, Technical Editor

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