

Course Syllabus: W21-INTLPOL 247
Seminar: Verification of 21st Century Arms Control Treaties
Rose Gottemoeller, Payne Distinguished Lecturer
Freeman-Spogli Institute, Center for International Security and Cooperation
Winter Quarter 2021

Course Overview:

- **Course Description:** Strong monitoring and verification are at the heart of an effective arms control treaty. The better we can monitor, the better we can verify that treaty obligations are met and nobody is cheating. Arms control monitoring is stuck in the past, however, with tools and methods unchanged from the first nuclear negotiations in the 1970s. Meanwhile, other international regimes have gone ahead, with environmental and resource management treaties making big strides in the use of ubiquitous sensing and other new technologies. This seminar course will explore how to bring these innovations to the arms control arena, to create treaties for the 21st century.
- **Course Requirements:** Students will have the opportunity to directly influence policy thinking in this area through research projects on the application of new technologies to monitoring and verification tasks. After introduction to the major regimes and the new challenges confronting them, students will be asked to scope out a research project focused on one of the regimes. Students may choose to work alone or in teams.
 1. Research Project Requirements:
 - February 17*, at mid-term: Proposals will be due for instructor review and approval. (20% of grade)
 - March 17-19*: Projects will be due for initial presentation and comment from instructor. (20% of grade)
 - March 19*: Final annotated briefings will be due on the last day of class. (40% of grade)
 - Class participation*: 20% of grade
 2. Course attendance:

I put a high premium on synchronous course attendance and active participation in discussions, which is why it is worth 20% of the grade that students will earn. For excused absences, time zone differences, and special accommodations see below, Asynchronous Accommodations.
 3. Grading Scheme:
 - A-F grading scheme;
 - S-U grading scheme with instructor's permission.
- **Course Eligibility:** Course is open to Masters students and upper level Undergraduates with instructor's permission. Although technical background is not a requirement, familiarity with monitoring, reconnaissance and remote sensing systems will be helpful, as well as methods of data analysis.
- **Instructor Contact Details:** Rose Gottemoeller, gottemoeller@stanford.edu.
- **Course Coordinator:** Dan Zhukov, dzhukov@stanford.edu.
- **Office Hours:** Wednesday and Friday, after each class, by appointment. Please email for additional options. I do answer emails ASAP.

Course Structure:

- The class will meet virtually on **Wednesdays and Fridays** from **10:00 to 11:20 PT** on Zoom.
- The course Canvas website <https://canvas.stanford.edu/courses/132683>, **Home Tab** lists the Zoom links and information for each class session.
- Please note that synchronous participation in the class lectures is the expectation for this course. However, all sessions will be recorded to accommodate any student's inability to participate synchronously due to technical issues or the exceptions noted below (see Asynchronous Accommodations).
- Please download Zoom and follow [these instructions](#) to help you get set up.

Class Zoom Etiquette:

- **Audio:** You should mute your audio and unmute only when speaking.
- **Video:** You should have your video turned on for the duration of the class. However, I do understand the need for brief turning off of the video due to bandwidth problems, home interruptions etc. If you have any concerns or issues with having your video on for the duration of the class, please contact me.
- **Discussion Protocol:** During the discussion, I ask that you use the chat box to let me know you'd like to speak, or the "raise hand" icon on the bottom of the Zoom participant panel. I will do my best to call on you in the order you raise your hand or post your request to speak.
- **Identification:** Use your real name and pronouns of choice to identify yourself on your Zoom screen.
- **Punctuality:** Arrive at your Zoom class and be ready to begin at the start of class.
- **Be Present:** It can be easy to get distracted during online meetings. So, we ask that you [try as best as you can to remain focused, present, and engaged during class](#). Avoid other on-screen distractions such as live-chat apps (Slack and Messenger groups), and close windows that you are not using during the session itself, such as games, email, news sites, and social media.
- I expect you to take an active role in your learning by coming to the virtual class meetings prepared and ready to participate. Class participation will be 20% of your grade.

Asynchronous Accommodations:

- While synchronous student participation is expected for the course, it is possible that technical issues may impinge on synchronous participation. If you experience technical difficulties while attempting to join a session, please immediately inform Dan Zhukov, the course coordinator, via email (dzhukov@stanford.edu).
- There are a few exceptions that qualify for an excused student absence from synchronous participation. These are a health emergency accompanied by relevant documentation, death of an immediate family member, and documented disabilities. If you are requesting one of these exceptions, students must notify the instructor at gottemoeller@stanford.edu outlining the reason for the absence, and with accompanying documentation where relevant.

- If you need an asynchronous accommodation due to time-zone constraints please contact the instructor at gottemoeller@stanford.edu in **advance of the start of classes** for an exception to synchronous class participation.
- All students who are unable to synchronously participate in the speaker presentations for any of the reasons outlined above, are **required** to access and watch the video recordings of the presentations as soon as they are available, and also be fully present and engaged while viewing the recordings. Once the video has been watched, **please email a brief summary with three questions or comments** related to the lecture content to me and Dan Zhukov. All sessions in which you were unable to synchronously participate need to have been watched and summarized by March 19, the last day of class. Please discuss with the instructor at gottemoeller@stanford.edu for any extension of this deadline.

COVID-19 Resources:

For any questions or updates about COVID-19 and Stanford's response to the pandemic, be sure to visit <https://healthalerts.stanford.edu/covid-19/>. Remember to follow all the mandated guidelines and stay safe!

Regrade Policy:

I hope there will be no reason to contest a grade. If you strongly feel that your grade on an assignment does not reflect the quality of your work, you may appeal through the following procedure: Write a 1-2 page memo that explains, in as much detail as possible, why you think you should have received a different grade. Give the memo to the instructor, along with your graded assignment and a letter in which you formally request a re-grade. If you and the instructor cannot reach an agreement on your grade, she will pass the materials to another member of the teaching staff who will re-evaluate the work and assign a new grade, which may be higher, lower, or identical to the one you originally received. This new grade will be final.

Course Privacy Statement:

As noted in the University's [recording and broadcasting courses policy](#), students may not audio or video record class meetings without permission from the instructor and guest speakers. If the instructor grants permission or if the teaching team posts videos themselves, students may keep recordings only for personal use and may not post recordings on the Internet, or otherwise distribute them. These policies protect the privacy rights of instructors, guest speakers, and students, and the intellectual property and other rights of the university.

It is also important that you do not share the course Zoom links or meeting passwords with anyone outside of our course to protect the privacy of everyone in attendance.

The Honor Code:

Violating the Honor Code is a serious offense, even when the violation is unintentional. The Honor Code is available at: <https://communitystandards.stanford.edu/policies-and-guidance/honor-code>. You are responsible for understanding the University rules regarding academic integrity; you should familiarize yourself with the code if you have not already done

so. In brief, conduct prohibited by the Honor Code includes all forms of academic dishonesty, among them copying from another's exam, unpermitted collaboration and representing as one's own work the work of another. If you have any questions about these matters, please see me during office hours.

FERPA: Student Record Privacy Policy:

<http://studentaffairs.stanford.edu/registrar/students/ferpa>

Provost's Statement Concerning Students with Disabilities:

Students who may need an academic accommodation based on the impact of a disability must initiate the request with the Office of Accessible Education (OAE). Professional staff will evaluate the request with required documentation, recommend reasonable accommodations, and prepare an Accommodation Letter for faculty. Unless the student has a temporary disability, Accommodation letters are issued for the entire academic year. Students should contact the OAE as soon as possible since timely notice is needed to coordinate accommodations. The OAE is located at 563 Salvatierra Walk (phone: 723-1066, URL: <https://oae.stanford.edu/>).

Course Sessions*:

*If you are not on the Stanford network and cannot access any of the linked materials, please visit <https://library.stanford.edu/using/connect-e-resources> on instructions on how to obtain off-network access. Documents without corresponding links can be found on the Canvas site.

January 13: Introduction to course, "getting to know you," the basics. Readings:

1. Rose Gottemoeller, "[U.S.-Russian Nuclear Arms Control Negotiations: A Short History](#)," *The Foreign Service Journal*, May 2020;
2. Rose Gottemoeller, "[Rethinking U.S.-Russian Nuclear Arms Control](#)," *The Washington Quarterly*, September 2020;
3. Jane Vaynman, "Better Monitoring and Better Spying: The Implications of Emerging Technology for Arms Control," unpublished manuscript, last modified October 2020, on Canvas.

The Regimes and Their New Challenges

January 15: New START and "traditional" nuclear arms control. New challenge: Non-Strategic Nuclear Warhead (NSNW) limitation, control and elimination. Guest lecturer: Corey Hinderstein, Vice-President, Nuclear Threat Initiative. Readings:

1. International Partnership for Nuclear Disarmament Verification, "[Phase II Summary Report](#)," December 2019;
2. Katlyn Turner, "[New ways to detect nuclear misbehavior](#)," *Bulletin of the Atomic Scientists*, 2018 Vol 70, No. 1, 2-6.

January 20: The Non-Proliferation Treaty regime. New challenge: Actually getting to zero. How to monitor zero indefinitely. Role of ubiquitous sensing. NTM enhancement. Guest lecturer: James Fuller, Pacific Northwest National Laboratory (ret.). Readings:

1. James Fuller, "[Verification on the Road to Zero](#)," *Arms Control Today*, December 2010;

2. Michael P. Gleason and Luc H. Riesbeck, "[Noninterference with National Technical Means: The Status Quo Will Not Survive](#)," Center for Space Policy and Strategy, Aerospace Corporation, January 2020.

January 22: Chemical Weapons Convention. New challenge: restoring the regime. Guest lecturer: Ambassador Kenneth Ward, U.S. Department of State. Readings:

1. Harald John, et. al., "[Fatal Sarin Poisoning in Syria 2013: forensic verification within an international laboratory network](#)," *Forensic Toxicology* (2018) 36:61-71.
2. John Hart and Ralf Trapp, "[Collateral Damage? The Chemical Weapons Convention in the Wake of the Syrian Civil War](#)," *Arms Control Today*, April 2018;
3. Julia Masterson, "[Russia Disputes OPCW Findings](#)," *Arms Control Today*, March 2020.

January 27: Biological Weapons Convention. New challenge: forensics in the midst of pandemic. Guest lecturer: Christopher Park, U.S. Department of State. Readings:

1. "Convention on the Prohibition of the Development, Production and Stockpiling of Bacteriological (Biological) and Toxin Weapons and on Their Destruction," [on Canvas](#);
2. Gunnar Jeremias and Mirko Himmel, "[Can everyone help verify the bioweapons convention? Perhaps, via open source monitoring](#)," *Bulletin of the Atomic Scientists*, 2016 Vol 72, No. 6, 412-417;
3. John C. Kelly, "[The Trilateral Agreement: lessons for biological weapons verification](#)," *Disarmament Yearbook 2002*, Chapter 6, pp. 93-108;
4. Kolja Brockmann, et. al., "[New Developments in Biotechnology](#)," *Capturing New Technology, Rethinking Arms Control: Conference Reader*, Stockholm International Peace Research Institute, March 15, 2019, pp. 25-31.

January 29: Comprehensive Test Ban Treaty. New challenge: monitoring zero. What is meaningful zero? Guest lecturer: Dr. Sig Hecker, Stanford University. Readings:

1. Edward Ifft, "The New Threat to the Test Ban Treaty," *Survival* (2020) 62:5, 55-64, [on Canvas](#).
2. Keith D. Koper, "[The Importance of Regional Seismic Networks in Monitoring Nuclear Test-Ban Treaties](#)," *Seismological Research Letters*, Vol. 91, No. 2a, March 2020;
3. "[The Comprehensive Nuclear Test Ban Treaty: Technical Issues for the United States](#)," Executive Summary, Washington, DC: The National Academies Press 2012;
4. Anna Peczeli and Bruce Goodwin, "[Technical Issues in the Comprehensive Test Ban Treaty \(CTBT\) Ratification Debate](#)," Center for Global Security Research Lawrence Livermore National Laboratory, September 2020;
5. Siegfried Hecker, "A winning gambit: Nuclear armed States stand to gain more than they lose from CTBT ratification," *CTBTO Spectrum* (19), September 2012, [on Canvas](#).

Tools

February 3: Reassurance and queuing. Ubiquitous sensing. High-coverage and multispectral satellite constellations. Role of open source analysis. Utility of social media. NTM enhancement. Readings:

1. Allison Puccioni, Sulgiye Park, "[Remote Sensing for Environmental Security in North Korea](#)," Stanford University, January 27, 2021;

2. Josef S. Koller, "[The Future of Ubiquitous, Realtime Intelligence: A GEOINT Singularity](#)," Center for Space Policy and Strategy, The Aerospace Corporation, August 2019;
3. Elaine Okanyene Nsoesie, Benjamin Rader, Yiyao L. Barnoon, Lauren Goodwin, and John S. Brownstein. [Analysis of hospital traffic and search engine data in Wuhan China indicates early disease activity in the Fall of 2019](#) (2020).

February 5: Tools for inspectors. Geolocation, virtual reality, blockchain, robotics. Guest lecturers: Ben Loehrke, Stanton Center for Peace and Security and Sarah Frazar, Pacific Northwest National Laboratory. Readings:

1. World Bank Group, FinTech Note 1, "[Distributed Ledger Technology \(DLT\) and Blockchain](#)," 2017, first twenty pages only;
2. Sarah Frazar, C. Joslyn, R. Singh, A. Sayre, "Evaluating Safeguards Use Cases for Blockchain Applications," Pacific Northwest National Laboratory, October 2018, on Canvas;
3. Morgan Peck, "[Nuclear Policy Takes a Deep Dive Into Blockchain](#)," Stanley Center for Peace and Security, November 2018;
4. Dylan Anderson et. al., "[Using Unmanned Aerial Systems to Collect Hyperspectral Imagery and Digital Elevation Models at a Legacy Underground Nuclear Explosion Test Site](#)," *Proceedings of SPIE* Vol. 10656 1065605-1;
5. Tamara Patton, Bernadette Cogswell, Moritz Kuett, and Alexander Glaser, "[Refining New Concepts in Nuclear Arms-Control Verification Through Full-Motion Virtual Reality](#)," *57th Annual INMM Meeting*, July 24-28, 2016, Atlanta, Georgia;
6. Sarah Frazar, Ben Loehrke, "Onboarding Materials - Assessing the Utility of DLT for the JASI Treaty," 2021, on Canvas.

February 10: Crowdsourcing. Guest lecturer: Dr. Moriba Jah, University of Texas Austin. Readings:

1. For an example of crowdsourcing satellite data in Low Earth Orbit, see ASTRIAGraph: <http://bit.ly/astrigraph>, <http://astria.tacc.utexas.edu/compliance>, <http://astriacss03.tacc.utexas.edu/ui/min.html>;
2. Esteva, M., Xu, W., Simone, N., Gupta, A., Jah, M., "[Modeling Data Curation to Scientific Inquiry: A Case for Multimodal Data Integration](#)," Proceedings of the 2020 IEEE Joint Conference on Digital Libraries (JCDL2020), Xi'an, China, August 1-5, 2020;
3. Jennifer Chu, "[Searching for balloons in a social network](#)," MIT News Office, October 28, 2011;
4. Mark Harris, "[How a Lone Hacker Shredded the Myth of Crowdsourcing](#)," *Backchannel*, February 9, 2015.

February 12: Data Fusion. Guest lecturer: Melissa Hanham, James Martin Center for Nonproliferation Studies. Readings:

1. Rachel Becker, "[The Detonation Detectives: How to decipher a North Korean missile test in just 72 hours](#)," *The Verge*, March 24, 2017;
2. Ned Beaman, "[How to Conduct an Open-Source Investigation, According to the Founder of Bellingcat](#)," *The New Yorker*, August 30, 2018.

Problems

February 17: Institutional acceptance and negotiability. Guest lecturer: Dimitri Finker, International Atomic Energy Agency (IAEA). Impact of emerging technologies on nuclear safeguards field work. Project proposals due from teams or individuals. Readings:

1. Sasha Henriques, "[A day in the life of a safeguards inspector](#)," *IAEA Bulletin*, June 2016;
2. Vincent Fournier, "[What's in an inspector's luggage?](#)" *IAEA Bulletin*, June 2016;
3. Margot Dubertrand, "[Robotics in Nuclear Verification: Sparking Innovation Through Crowdsourcing](#)," IAEA Office of Public Information and Communication, September 19, 2018;
4. Adem Mutluer, "[Robotics Challenge Winning Design Helps Speed up Spent Fuel Verification](#)," IAEA Department of Safeguards, March 18, 2019;
5. "[Emerging Technologies for Nuclear Safeguards](#)," IAEA, January 29, 2020;
6. "[IAEA Completes 3-Year Project to Modernize Safeguards IT System](#)," IAEA, May 16, 2018;
7. Sarah E. Kreps, "[The Institutional Design of Arms Control Agreements](#)," *Foreign Policy Analysis* (2018) 14, 127-147.

February 19: Quality control and legitimacy. Guest lecturer: Dr. Amy Zegart, Stanford University. Readings:

1. Amy Zegart and Michael Morell, "[Spies, Lies, and Algorithms: Why U.S. Intelligence Agencies Must Adapt or Fail](#)," *Foreign Affairs*, May/June 2019;
2. Melissa Hanham and Jaewoo Shin, "[Ethics in the Age of OSINT Innocence](#)," Stanley Center for Peace and Security, May 2020;
3. Alberto Fittarelli, "[Ghost in the Machine: From Chad, a Case Study on Why You Shouldn't Blindly Trust Tech](#)," Bellingcat, July 17, 2020.

February 24: Privacy protection and confidentiality in crowd-sourcing. Guest lecturer: Ross Chanin, Co-founder and CEO at Artifact, and Paul Arnaudo, Kinsa. Readings:

1. Fred H. Cate, Peter Cullen, Viktor Mayer-Schonberger, "[Data Protection Principles for the 21st Century](#)," *Books by Maurer Faculty*, 2013;
2. Zoe N. Gastelum, Kari Sentz, Meili C. Swanson, and Cristina Rinaudo, "[Power of the People: A Technical, Ethical and Experimental Examination of the Use of Crowdsourcing to Support International Nuclear Safeguards Verification](#)," Sandia National Laboratories, October 2017;
3. Agnieszka Onuchowska, Gert-Jan de Vreede, "[Disruption and Deception in Crowdsourcing: Towards a Crowdsourcing Risk Framework](#)," Proceedings of the 51st Hawaii International Conference on System Sciences, 2018.

Real-world examples

February 26: What makes for good open-source analysis. Guest lecturer: Frank Pabian, Los Alamos National Laboratory Fellow and Stanford University CISAC Affiliate. Readings:

1. Frank Pabian, "[Commercial Satellite Imagery as an Evolving Open-Source Verification Technology: Emerging Trends and Their Impact for Nuclear Nonproliferation Analysis](#)," Joint Research Centre, European Commission, 2015;

2. David Albright, Sarah Burkhard, and Frank Pabian, "[The Amad Plan Pilot Uranium Conversion Site, Which Iran Denies Ever Existed](#)," Institute for Science and International Security, November 9, 2020;
3. Frank V. Pabian, Guido Renda, Giacomo G.M. Cojazzi, "[Open Source Analysis in support to the identification of possible undeclared nuclear activities in a State](#)," ESARDA Bulletin, No. 57, December 2018 pp. 20-39;
4. "[OSINT at Home – Tutorials on Digital Research](#)," YouTube;
5. [Tearline Project](#), National Geospatial-Intelligence Agency;
6. For two quick summary tutorials on "open source GEOINT" and "detecting disinformation," please see: "[Open Sources of Aerial Imagery](#)" and "[Detecting Disinformation in Imagery](#)", Open Aerial Imagery Association.

March 3: What makes for good open-source analysis, con't. Dr. Jeffrey Lewis, James Martin Center for Nonproliferation Studies. Readings:

1. Jeffrey Lewis, "[Wollo-ri Nuclear Facility](#)," Arms Control Wonk, July 8, 2020.

March 5: Negotiability. Lessons from the New START Treaty.

March 10: What makes for good open-source analysis, pt. 3. Allison Puccioni, Armillary, and Scott Herman, BlackSky.

March 12: TBD

Final presentations

March 17: Final project presentations, Day 1.

March 19: Final project presentations, Day 2. Final annotated briefings due.