Physics/Global Studies 280

(Matthias Grosse Perdekamp, mgp@illinois.edu)

Module 1: Introduction to the Course

Physics/Global Studies 280 Goals

(1) To provide a basic understanding of the nature of nuclear weapons, the threat they pose to humankind, and possible ways to reduce and eventually eliminate this threat.

(2) To improve technical writing skills, as used in academia, government and business.

Physics/Global Studies 280 Goals

Goal for Writing in 280

(1) Study and review course related material.

(2) Develop writing skills in changing technical writing styles:
Scientific American, Congressional Research Service, National Counter Terrorism Center (NCTC) brief, a scientific journal.

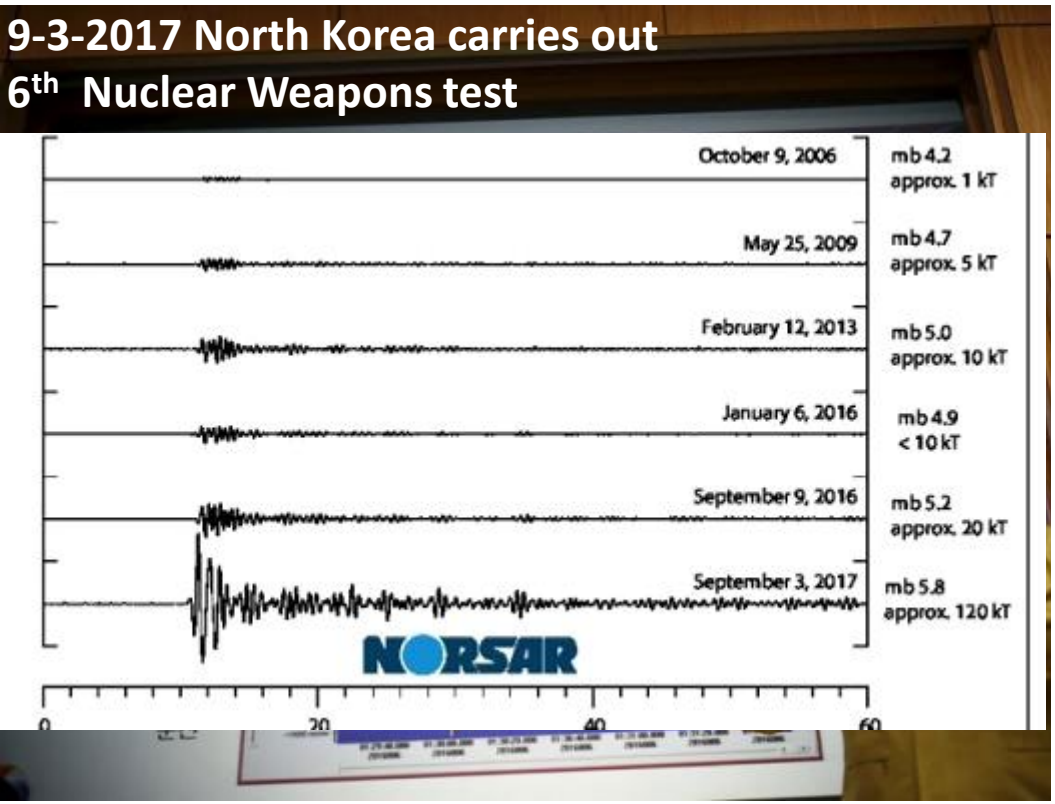
(3) Practice attention to detail that is necessary for successful professional writing.

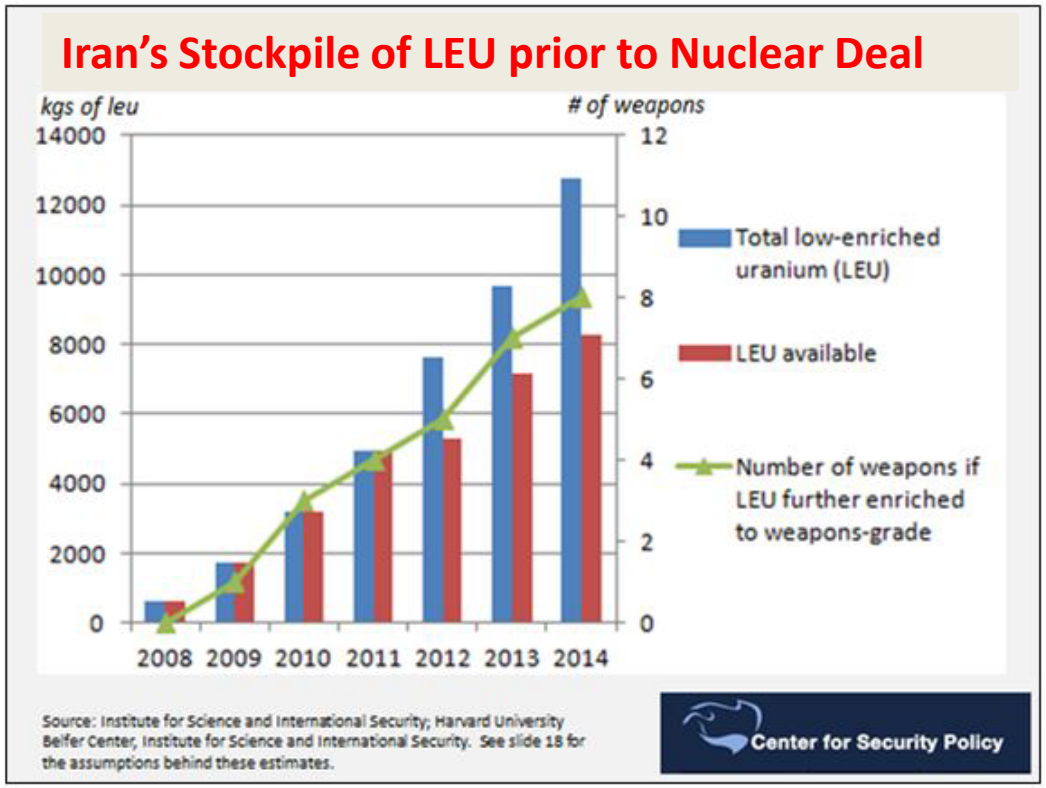
➔ Part of College of Engineering effort to improve technical writing skills. (alumni career surveys indicate that writing skills are highly important for professional success).

Physics/Global Studies 280: Motivation

What are current concerns with regards to nuclear weapons, 25 years after the end of the cold war?

Five Examples: (I) Further proliferation of Nuclear Weapons
Challenges to Nuclear Non-Proliferation Regime





Russian War on Ukraine:
Failure of Nuclear Arms Control
First war in country with extensive civilian nuclear industries

1991: Ukraine inherits ~5000 nuclear warheads from the disintegrating Soviet Union

1992: Lisbon Protocol – Russia assumes nuclear arsenals of the Soviet Union (START)

1994: Budapest Memorandum – Russia, UK and USA provide security guarantees for Ukraine

2014: Annexation of Crimea by Russia

2022: All out Russian assault on Ukraine – open threats with nuclear deterrent from Putin

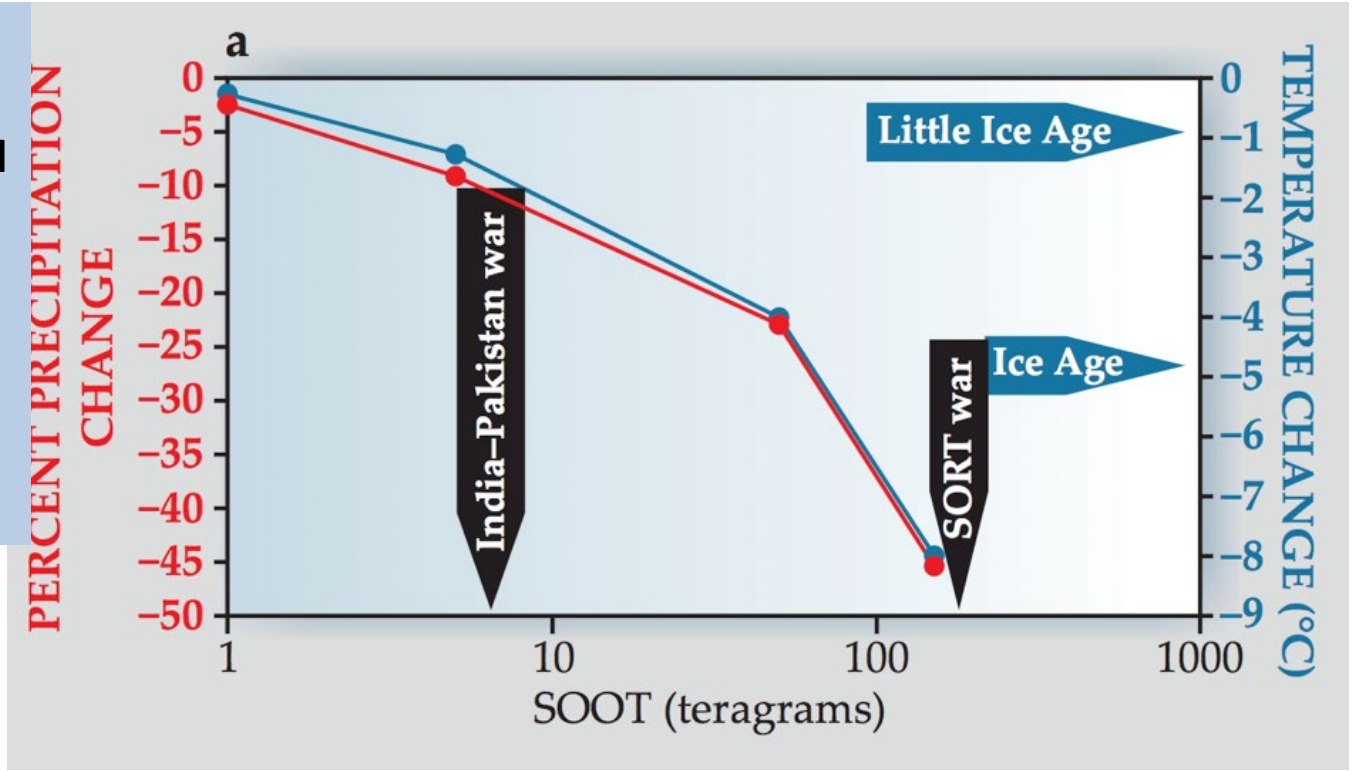
Ukraine gave up nuclear deterrent in exchange for security guarantees.

Physics/Global Studies 280

(II) “Limited scale” nuclear conflict appear possible:
current concerns are the situation in Ukraine, on the Korean Peninsula and the tensions between Pakistan and India. Possible future concerns include the middle east.

Temperature change from soot ejected into the atmosphere would lead to a temperature decrease:

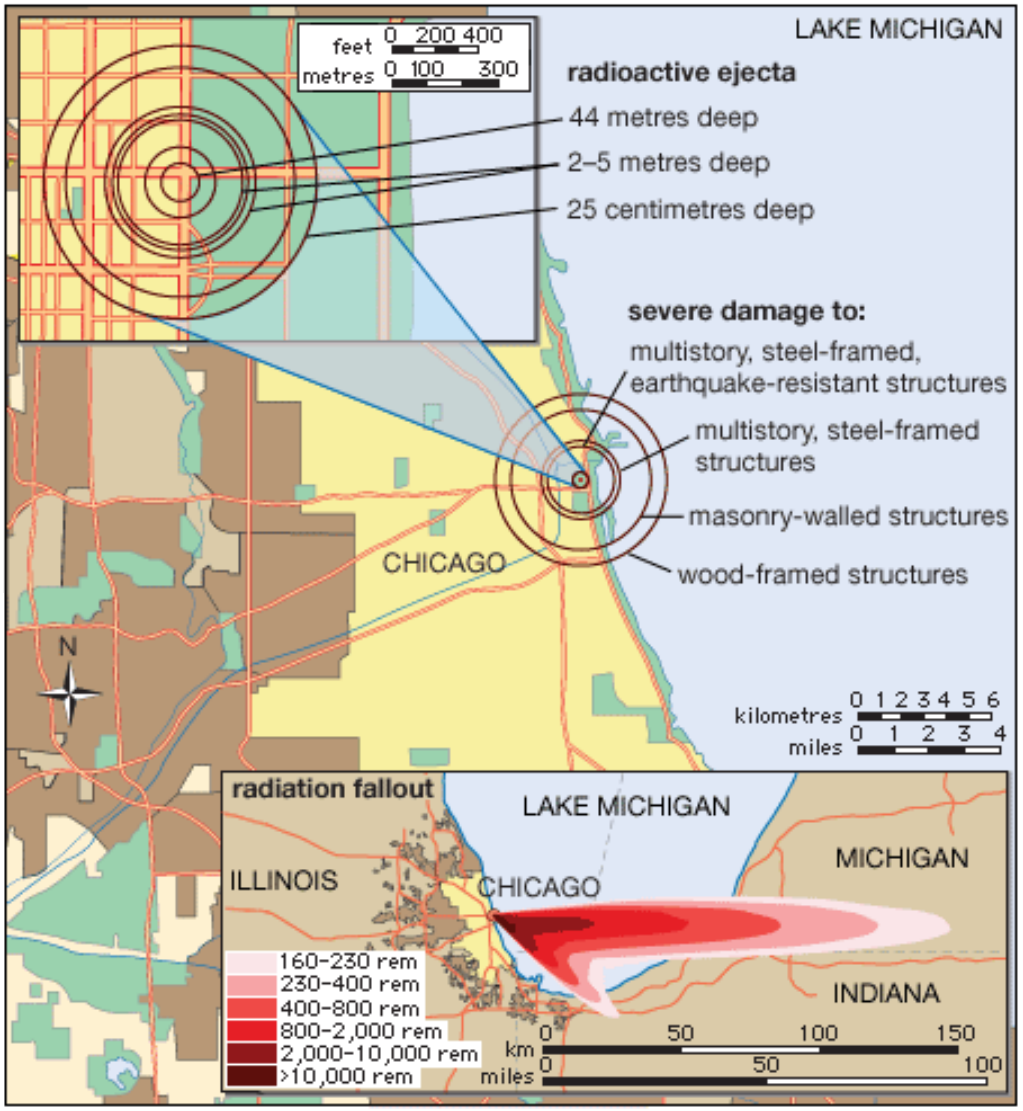
“Nuclear Winter”



Physics/Global Studies 280

III) Nuclear Terrorism

If terrorists could gain access to nuclear weapons they could target events such as the NATO summit that took place in Chicago in May of 2012 with all NATO heads of state present.



chicagotribune.com

Trial to begin of three charged with planning attacks at NATO summit

Mary Wisniewski

Reuters

7:31 AM CST, January 21, 2014

CHICAGO (Reuters) - Opening statements are due to begin on Tuesday in the trial of three men accused of plotting to attack high-profile targets, including President Barack Obama's re-election campaign headquarters, during the 2012 NATO summit in Chicago.

Brent Betterly, 25, Brian Church, 25, and Jared Chase, 29, are being prosecuted under an Illinois anti-terrorism law adopted after the September 11, 2001 al Qaeda attacks.

Physics/Global Studies 280

IV) The challenge to safeguard nuclear materials long-term:

U.S.

ELDERLY NUN SENTENCED TO NEARLY THREE YEARS FOR TENNESSEE NUCLEAR BREAK-IN

BY REUTERS AND BIZU.TV ON 2/19/14 AT 12:43 PM

In 2012 Sister Megan Rice, Michael Walli and Greg Boertje-Obed advanced through several fences reaching a storage facility for nuclear material at the Y-12 nuclear facility in Oakridge.

➔ If such incident can happen in the US: what are the standards for nuclear safeguards in other countries?

Physics/Global Studies 280

V) Challenge to sustain high quality nuclear forces under "hair trigger alert" long-term:

The New York Times http://nyti.ms/1iX3ZG8

POLITICS

Cheating Accusations Among Officers Overseeing Nuclear Arms

By HELENE COOPER JAN. 15, 2014

WASHINGTON — The Air Force said on Wednesday that 34 officers responsible for launching the nation's nuclear missiles had been suspended, and their security clearances revoked, for cheating on monthly proficiency tests that assess their knowledge of how to operate the warheads.

Defense experts say that the end of the Cold War and the elevation of counterterrorism in the American military has led to low morale among the men and women, known as missileers, who live and work within a hair trigger of the country's 450 nuclear missiles. The missileers have increasingly come to view their mission as a backwater, with little chance of advancement to the top ranks of the Air Force.

➔ What are the standards for military nuclear operations elsewhere?

Dual Use of Nuclear Energy: Civilian vs Military Uses

(1) Benefits of peaceful use of nuclear energy including applications in electricity production, medicine, agriculture, propulsion etc. should be available to all!

(2) At the same time want to prevent access to devastating nuclear weapons! (Materials, technology and manpower for weapons program can be re-directed from civilian nuclear efforts.)

Current solution emerged from President Eisenhower's initiative: "Atoms for Peace"

Civilian use of Nuclear Energy monitored by the International Atomic Energy Agency (IAEA) + treaty to stop proliferation of nuclear weapons!

Example: Meeting Increasing Energy Consumption will use mix of Fossil + Renewables + Nuclear Power

Environmental Science & Technology

Article

pubs.acs.org/est

Burden of Disease from Rising Coal-Fired Power Plant Emissions in Southeast Asia

Shannon N. Koplitz,[*,†] Daniel J. Jacob,[‡] Melissa P. Sulprizio,[‡] Lauri Myllyvirta,[§] and Colleen Reid[∥]

[†]Department of Earth and Planetary Sciences, Harvard University, Cambridge, Massachusetts 02138 United States

[‡]John A. Paulson School of Engineering and Applied Sciences, Harvard University, Cambridge, Massachusetts 02138 United States

[§]Greenpeace International, 1066 AZ Amsterdam, The Netherlands

[∥]Department of Geography, University of Colorado, Boulder, Colorado 80309 United States

Example: Meeting Increasing Energy Consumption will use mix of Fossil + Renewables + Nuclear Power

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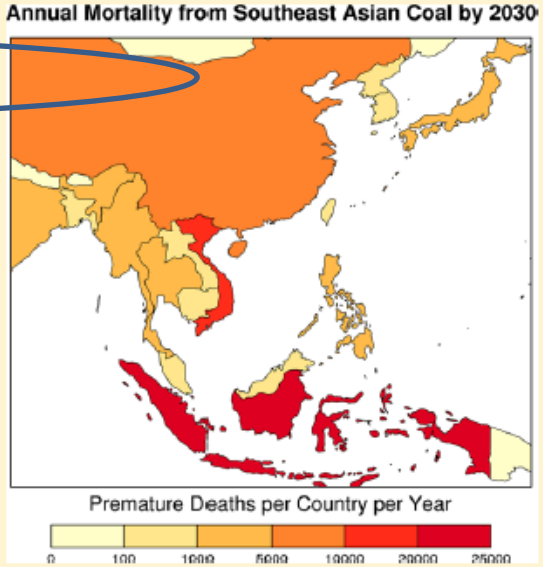
Burden of Disease from Rising Coal-Fired Power Plant Emissions in Southeast Asia

ABSTRACT: Southeast Asia has a very high population density and is on a fast track to economic development, with most of the growth in electricity demand currently projected to be met by coal. From a detailed analysis of coal-fired power plants presently planned or under construction in Southeast Asia, we project in a business-as-usual scenario that emissions from coal in the region will triple to 2.6 Tg a^{-1} SO_2 and 2.6 Tg a^{-1} NO_x by 2030, with the largest increases occurring in Indonesia and Vietnam. Simulations with the GEOS-Chem chemical transport model show large resulting increases in surface air pollution, up to 11 $\mu g\ m^{-3}$ for annual mean fine particulate matter ($PM_{2.5}$) in northern Vietnam and up to 15 ppb for seasonal maximum 1 h ozone in Indonesia. We estimate 19 880 (11 400−28 400) excess deaths per year from Southeast Asian coal emissions at present, increasing to 69 660 (40 080−126 710) by 2030. 9000 of these excess deaths in 2030 are in China. As Chinese emissions from coal decline in coming decades, transboundary pollution influence from rising coal emissions in Southeast Asia may become an increasing issue.

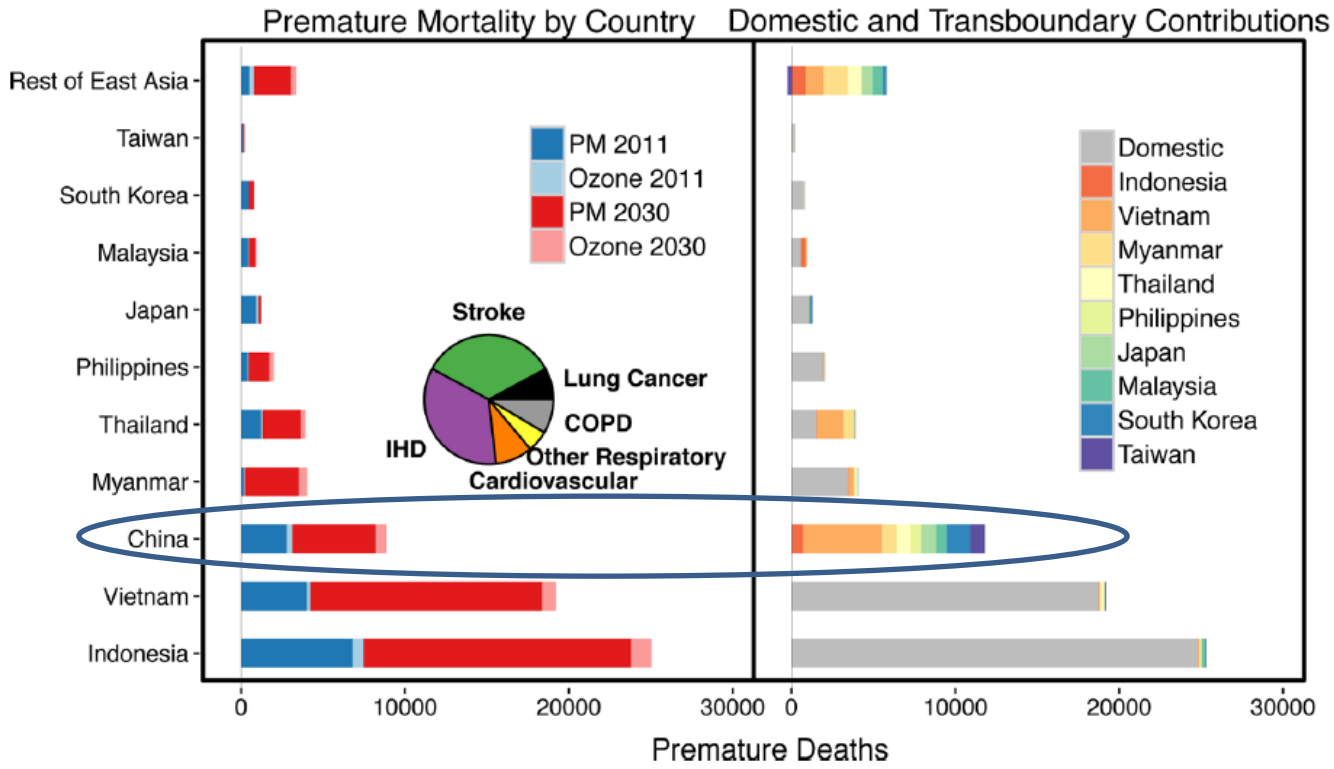


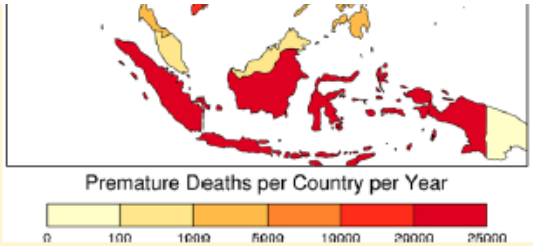
Example: Meeting Increasing Energy Consumption will use mix of Fossil + Renewables + Nuclear Power

Environmental Science & Technology

Burden of Disease from Southeast Asia

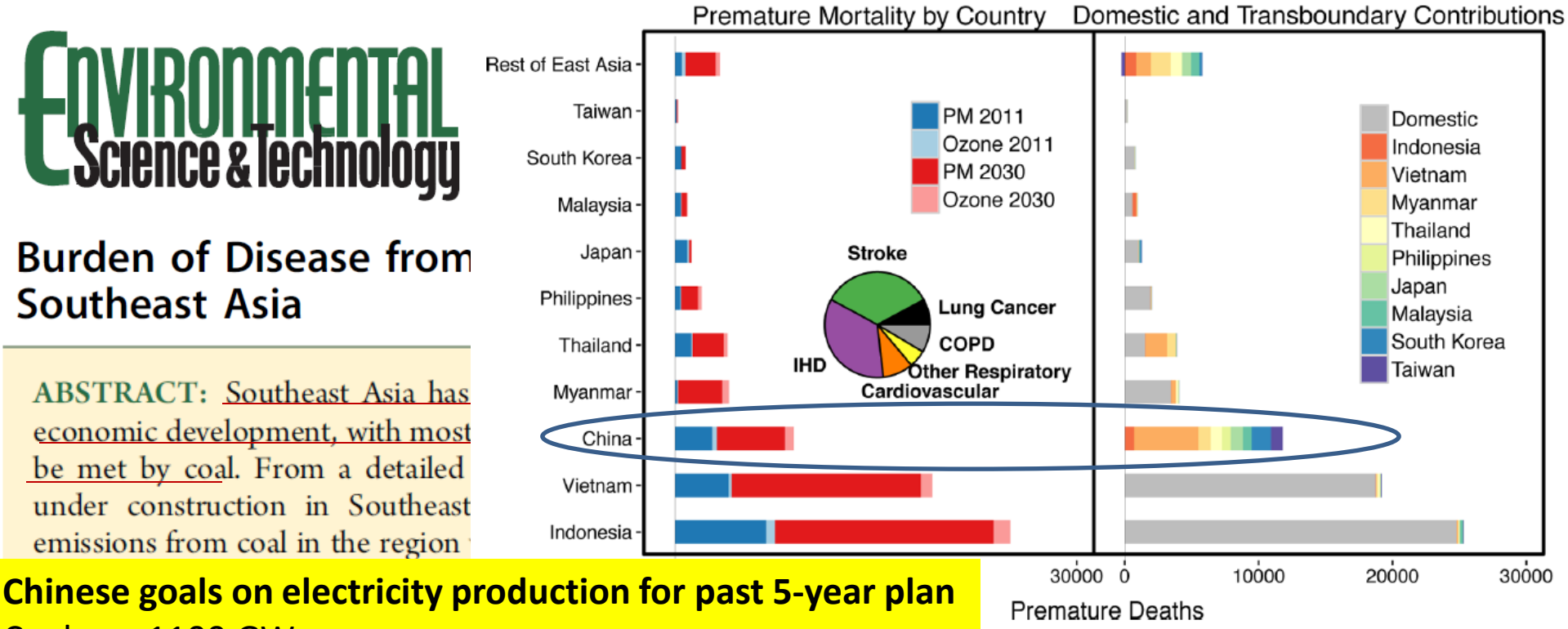
ABSTRACT: Southeast Asia has economic development, with most be met by coal. From a detailed under construction in Southeast emissions from coal in the region with the largest increases occurrin Chem chemical transport model s 11 $\mu g\ m^{-3}$ for annual mean fine particulate matter ($PM_{2.5}$) in northern Vietnam and up to 15 ppb for seasonal maximum 1 h ozone in Indonesia. We estimate 19 880 (11 400–28 400) excess deaths per year from Southeast Asian coal emissions at present, increasing to 69 660 (40 080–126 710) by 2030. 9000 of these excess deaths in 2030 are in China. As Chinese emissions from coal decline in coming decades, transboundary pollution influence from rising coal emissions in Southeast Asia may become an increasing issue.





Each country will determine its own mix of fossil, renewables and nuclear power production.
Eg. past 5-year plan in China called for increase from 58 nuclear power plants to 88.
China intends to export nuclear reactor technology: **Dual use challenge of nuclear power is bound to stay!**

Example: Meeting Increasing Energy Consumption will use mix of Fossil + Renewables + Nuclear Power



ENVIRONMENTAL Science & Technology

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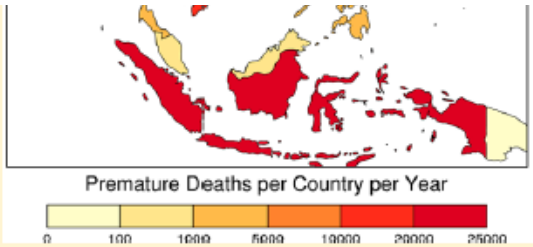


Chinese goals on electricity production for past 5-year plan

Coal - 1100 GW
Gas - 110 GW
Hydro - 340 GW
Wind – 210 GW
Solar – 110 GW

Nuclear – 58 GW (corresponding to 88 power plants)

Each country will determine its own mix of fossil, renewables and nuclear power production.
Eg. current 5-year plan in China calls for increase from 58 nuclear power plants to 88 by 2021.
China intends to export nuclear reactor technology: **Dual use challenge of nuclear power is bound to stay!**

History of Physics 280

- First offered in Spring 1982
  - —At the height of the nuclear arms race during the cold war
  - —Motivated by concern about the growing threat of nuclear weapons and nuclear war
  - —Professors Fred Lamb and Jeremiah Sullivan who developed and taught the course were active contributors to ACDIS at UIUC and arms control related work in the US
- Has been taught every spring semester, since to 2000+ students
  - —Integrated in ACDIS, many ACDIS students continue to take the class (ACDIS -> campus program for Arms Control and Domestic and International Security)
  - —Has served as model for courses elsewhere

Physics 280 Topics

- Introduction
- Nuclear weapons
- Effects of nuclear explosions
- Terrorism and the possibility of Nuclear Terrorism
- Military systems for delivering nuclear weapons
- Arsenals of “nuclear weapon” states
- Defenses against nuclear attack
- Nuclear arms control
- Current events including Iran and North Korea
- Future directions

Interdisciplinary Subject:
280 Students from Diverse Set of Fields

The class subject is multidisciplinary and so are the backgrounds of the students and TAs in class.

Good opportunity to practice, how to learn from each other and how to communicate with others (experts in different fields)!

Physics	11
Computer Science (+X)	8
Psychology	7
Political Science	5
Molecular and Cellular Biology	4
Agr & Consumer Economics	3
Computer Engineering	3
Mathematics	3
18 other majors	1-2

Introduction of Physics 280 Staff

Dr. Matthias Grosse Perdekamp, Course Director
Physics

Nico Daiyega, TA
Physics

Chieh Hsu, TA
Physics

David Lundquist, TA
Statistics

Simran Rathod, TA
Advanced Clinical Social Work

Dr. Kelly Searsmith, Technical Research Writer
Physics

Introduction of Physics 280 Staff

Nico Daiyega, TA
Physics

Nico a PHD Candidate in Nuclear Physics at UIUC. Nico studied Physics and Japanese studies in undergrad, focusing on atomic culture from the impact of living in areas that were targeted with nuclear weapons. He has visited Hiroshima and Nagasaki as well as met with political leadership to discuss radiation safety and environmental hazards. Nico works at Argonne National Laboratory, developing methods to decontaminate areas effected by radioactive fallout and currently is writing his dissertation on the understanding of resuspended radioactive particles in emergency phase situations.

Simran Rathod, TA
Advanced Clinical Social Work

Simran is pursuing a medical master's in social work with a minor in college teaching. Her bachelor's was in technical/scientific writing with a minor in business administration. She is currently working on organizing food security and cancer research within the Center for Social and Behavioral Sciences.

Introduction of Physics 280 Staff

David Lundquist, TA
Statistics

David is a fourth-year PhD student in Statistics, studying time series data and financial shocks. David has an MA in Chinese Studies from Michigan, for which he did on-location research in China regarding human flows along the North Korean border.

Chieh Hsu, TA
Physics

Chieh is a senior in Engineering Physics with a minor in Global Studies. He has carried out research on Quantum Information Theory with Professor Roy Araiza in the department of Mathematics at UIUC and worked on artificial intelligence for medical diagnosis at the China Medial University Hospital in Taichung City, Taiwan.

Writing Lab Assignments and Office Hours

Writing Laboratories – start 1-23: Mondays in Campus Instructional Facility

L11 10-10.50am	in CIF 4036	Simran Rathod
L12 11-11.50am	in CIF 4036	Simran Rathod
L13 12-12.50pm	in CIF 4036	Chieh Hsu
L14 1-1.50pm	in CIF 4036	Nico Daiyega
L15 2-2.50pm	in CIF 4036	Nico Daiyega
L16 3-3:50pm	in CIF 4036	David Lundquist
L17 4-4:50pm	in CIF 4036	David Lundquist

Office Hours – start 1-25:

Tuesday (Loomis 428)

3.30 pm Nico Daiyega

Wednesday (Grainger Library 4th floor)

3 pm Chieh Hsu

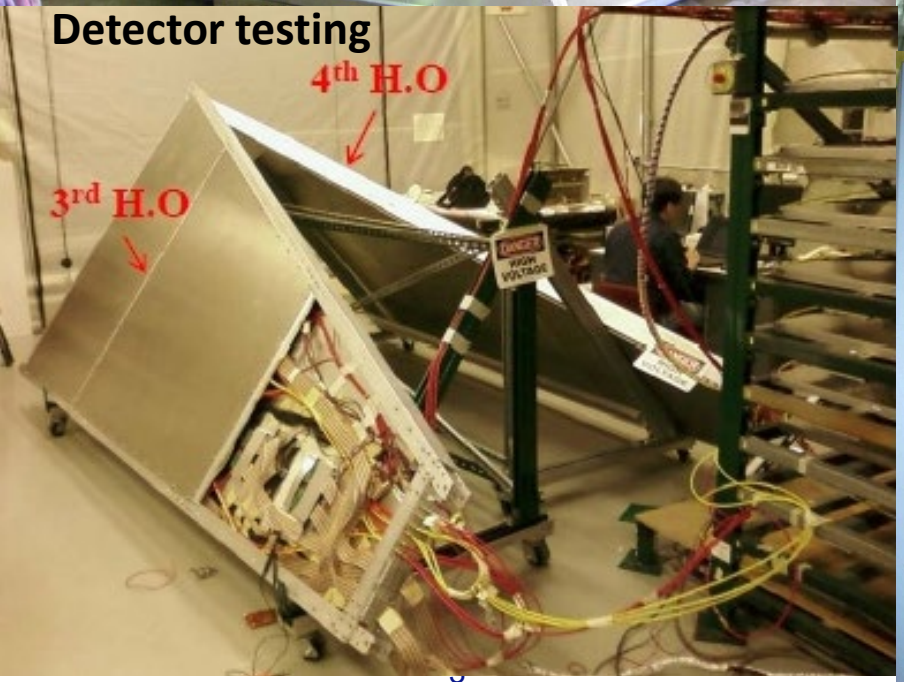
4 pm Simran Rathod

5 pm David LUn

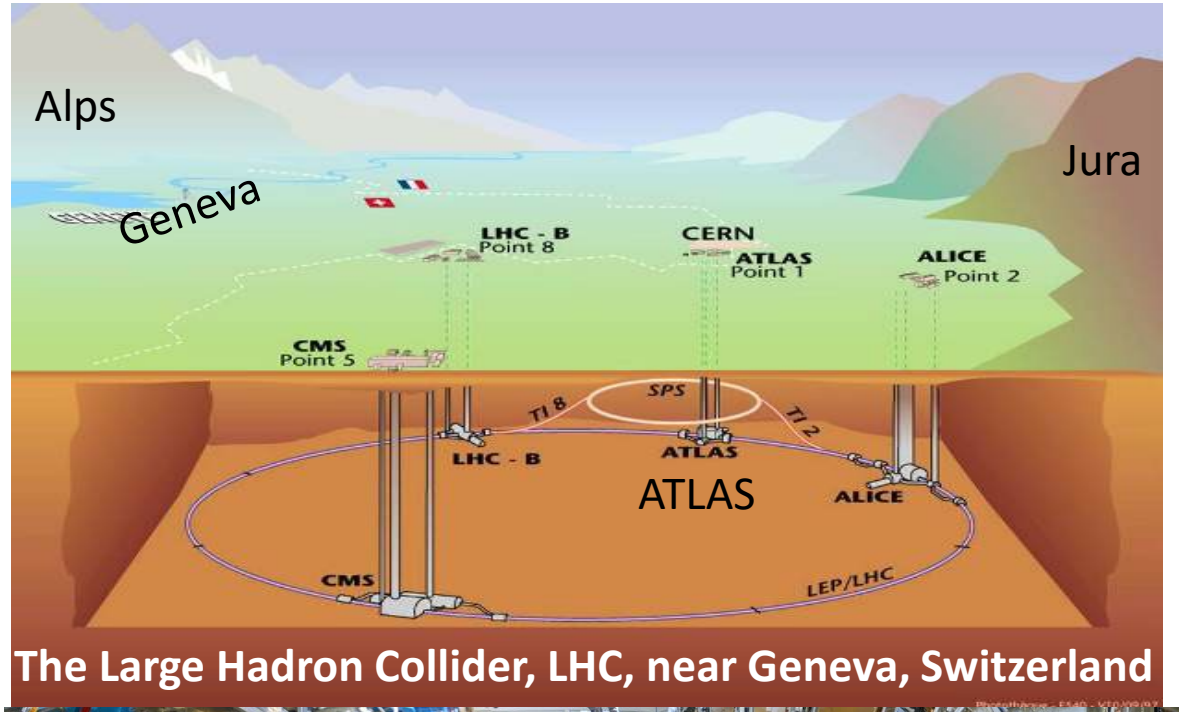
My Research: Nuclear Physics + Instrumentation

- Structure of nuclear matter using accelerators.
  - Quark and gluon sub-structure of protons and neutrons
  - nuclear effects in proton and neutron structure
  - Transition of quarks to nuclear matter observed in nature
- Instrumentation for experiments at particle accelerators :
  - PHENIX at Brookhaven National Laboratory, Long Island
  - COMPASS at CERN, Geneva, Switzerland
  - ATLAS at CERN, Geneva, Switzerland
- Instrumentation development for the detection of fissile materials.

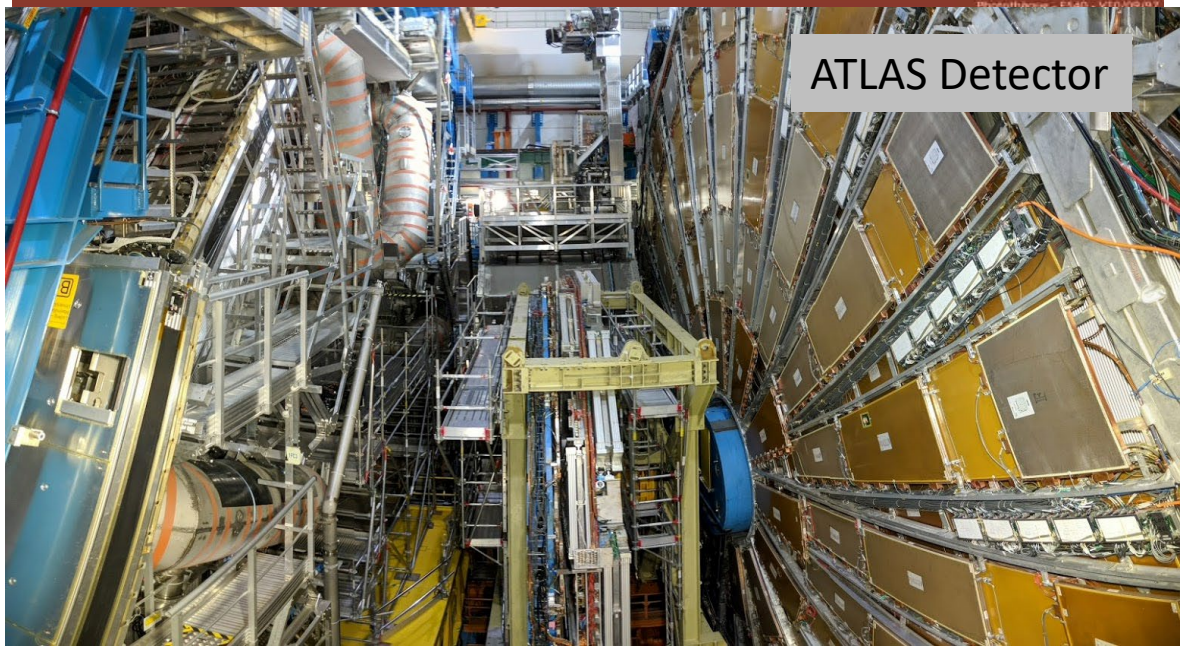
Instrumentation to Measure Quark and Anti-Quark Substructure of the Proton with the PHENIX Detectors

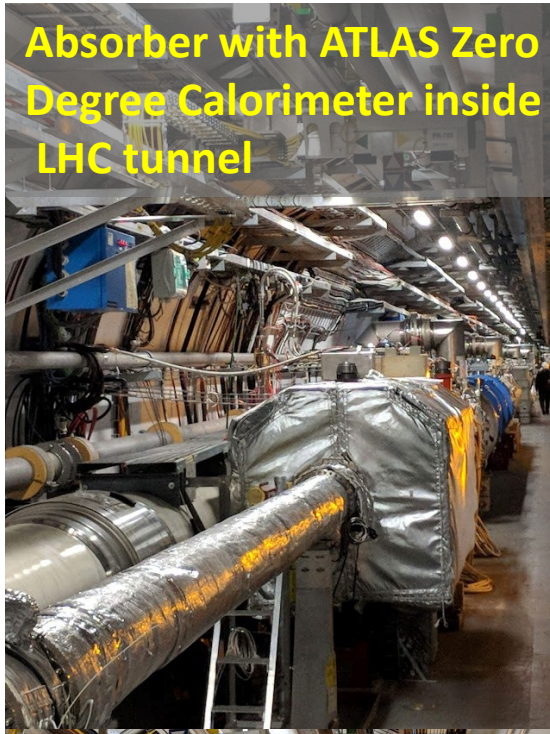


Instrumentation to Characterize Nuclear Pb-Pb Collisions at the LHC for the Study of the Quark Gluon Plasma



The Large Hadron Collider, LHC, near Geneva, Switzerland





Absorber with ATLAS Zero Degree Calorimeter inside LHC tunnel

Michael Murray, Riccardo Longo and MGP at the ATLAS ZDC

The Physics 280 Web Site

The Physics 280 web site is the “Information Center” for this course
A first writing assignment, RE1 has been posted.

http://courses.physics.illinois.edu/phys280/sp2023/index.html

➔ ***instructions related to essay writing and submission will be followed very closely to emulate rules for technical writing.***

PHYS/GLBL 280 Subject ID for Email

If you send **e-mail: please start the subject line with**

23p280

This sorts 280 e-mail in my 280 folder and will allow me to respond promptly.

280 Lectures, Writing Labs, Office Hours

- Lectures: Tuesdays and Thursdays, 2:00-3.20pm
  - —Lectures slides posted on TopHat
  - —Videos, demos, Q&A, discussions of readings and current events
- Writing Labs: Mondays, starting 1-23.
  - —Explanation of the writing assignments
  - —Instruction and guidance on how to write for the course
  - —Writing exercises, discussion of readings and current events, assessments
  - —Help in revising first versions of assignment
- Office Hours: Tue 3.30-4.30pm in Loomis 428 and
  Wed 3 pm to 6 pm in Grainger
  starting 1-25, next week.

280 – Required Reading

Required Textbooks

- *What Terrorists Want,* by Louise Richardson (paperback)

Required Online Readings

- Selections from *The Day After Midnight: The Effects of Nuclear War*
  (available as a PDF file on the P280 'Documents' page)
- *Preventing Catastrophic Nuclear Terrorism*, by Charles Ferguson
  (available as a PDF file on the P280 'Documents' page)
- *The Gravest Danger*, by Sidney D. Drell and James E. Goodby
  (available as a PDF file on the P280 'Documents' page)

280 – Recommended Reading

Recommended texts:

(1) Alred, Gerald J., Oliu, Walter E., and Brusaw, Charles T. *The Handbook of Technical Writing*, 12th edition. New York: Bedford/St. Martin's, 2018.
e-book ISBN: 9781319107345
6-month e-book rental: $34.99 (or purchase: $50.99) direct from publisher:
https://www.macmillanlearning.com/college/us/product/Handbook-of-Technical-Writing/p/1319058523.

(2) Booth, Wayne C., Colomb, Gregory G., Williams, Joseph M., Bizup, Joseph, and FitzGerald, William T. *The Craft of Research*, 4th edition. Chicago: University of Chicago Press, 2016.
e-book ISBN: 9780226239873
available direct from publisher:
$18.00: https://www.press.uchicago.edu/ucp/books/book/chicago/C/bo23521678.html.

3) John A. Lynn II *Another Kind of War, The Nature and History of Terrorism,*
Yale University Press
ISBN 978-0-300-18881-3

Follow the News related to Nuclear Arms and Arms Control !

- Follow the news media with regards to topics related to the course (eg. North Korea, Iran Nuclear Deal etc.)
- *Bring questions and interesting articles to class to share!*
- *We will start class by briefly presenting and discussing current related news.*

280 Writing Assignments - 1

280 is an Advanced Composition Course

- Previous credit for a Composition course is a prerequisite

280 has three types of Required Writings

- Required essays
- Research paper proposal
- Research paper
- Writing assignments will be due electronically by 10pm on Wednesdays. The first essay, required essay 1 (RE1), will be due next week on Wednesday, 1-25 at 10 pm. A paper copy will be due at the beginning of class on Thursdays.

The late deadline will be Friday at 4.00 pm electronically, (paper copy to be deposited in the yellow 280 homework box in the “interpass” between Loomis and MRL).

280 Writing Assignments - 2

- We strictly enforce the UI's rules on academic integrity
  - — All writing assignments are scanned using plagiarism detection software We use Turnitin including a library of all PHYS/GLBL 280 essays submitted in the past.
- Four Required Essays, RE1, RE2v1, RE2v2, …, RE4v2
  - — Essays 2-4 will be revised and re-submitted
  - — Peer review v1 essays of your co-students
  - — Both versions count equally
  - — There are penalties for late submissions

280 Writing Assignments -3

- *Research Paper Proposal (2 pages)*
  - —The topic will be chosen in consultation with your TA
  - — Your proposal must be approved in advance by your TA
  - —Your paper must address both technical and policy aspects of some issue (but the weights need not be 50–50)
  - — Your scores on the first and second versions count equally
- *Research Paper (7–10 pages)*
  - — Scores on the first and second versions count equally
- *Optional Extra Credit Essay (about 1.5 pages)*
- *Writing Lab participation counts 6% of your writing grade*

Timeline for Physics/Global Studies 280

The Timeline is available on course webpage:

https://courses.physics.illinois.edu/phys280/sp2023/schedule.html

280 – Midterm + Final

- Mid-Term Exam: 2:00–3:20 p.m., (March 23rd)
  - Location TBD (*it will not be in Loomis 144)*
  - Closed book
  - Tests factual knowledge and understanding
  - Includes essay question
- Final Exam: (time TBD)
  - Location TBD (*it will not be in this room)*
  - Closed book
  - Tests factual knowledge and understanding
  - Includes essay question
  - The final exam will emphasize material presented after the mid-term exam

Top Hat for Slides and Lecture Questions

We will post lecture question

- to encourage and facilitate discussion and interaction
- to poll you about your experiences and opinions
- to monitor attendance

Grading of lecture questions (for extra credit)

- 50% for participation and 50% for correct answer

TopHat will send out invitations!

280 – Grading Scheme

Writing Component – 70%

Required essays (7 essays)	34%
Research paper proposals and research papers	30%
Writing Lab participation	6%
Extra credit essay	2%

Exam Component – 30%

Midterm exam	12.5%
Final exam	17.5%
Lecture quizzes (extra credit)	5.0%

280 – Grade Boundaries

A+	95-100
A	90-94
A-	85-89
B+	80-84
B	75-79
B-	70-74
C+	65-69
C	60-64
C-	55-59
D	<55

The Beginning of The Atomic Age

Please Watch the PBS Documentary:

"Atomic Bomb" (PBS), The Bomb 2015

PBS Documentary HD – YouTube

(https://www.youtube.com/watch?v=3AfNpIzoIoQ)

Next class will be Thursday 1-19 at 2pm in 144 Loomis

280: Announcements

First Writing Lab Sessions: Monday, January-23

First office hours: Wednesday

January-25th – Grainger Library

Course news available on course web-page

Beginnings: PBS Documentary “The Atomic Bomb”

Discussion

Which issues related to nuclear weapons do you consider most important? Answers not limited to but may include:

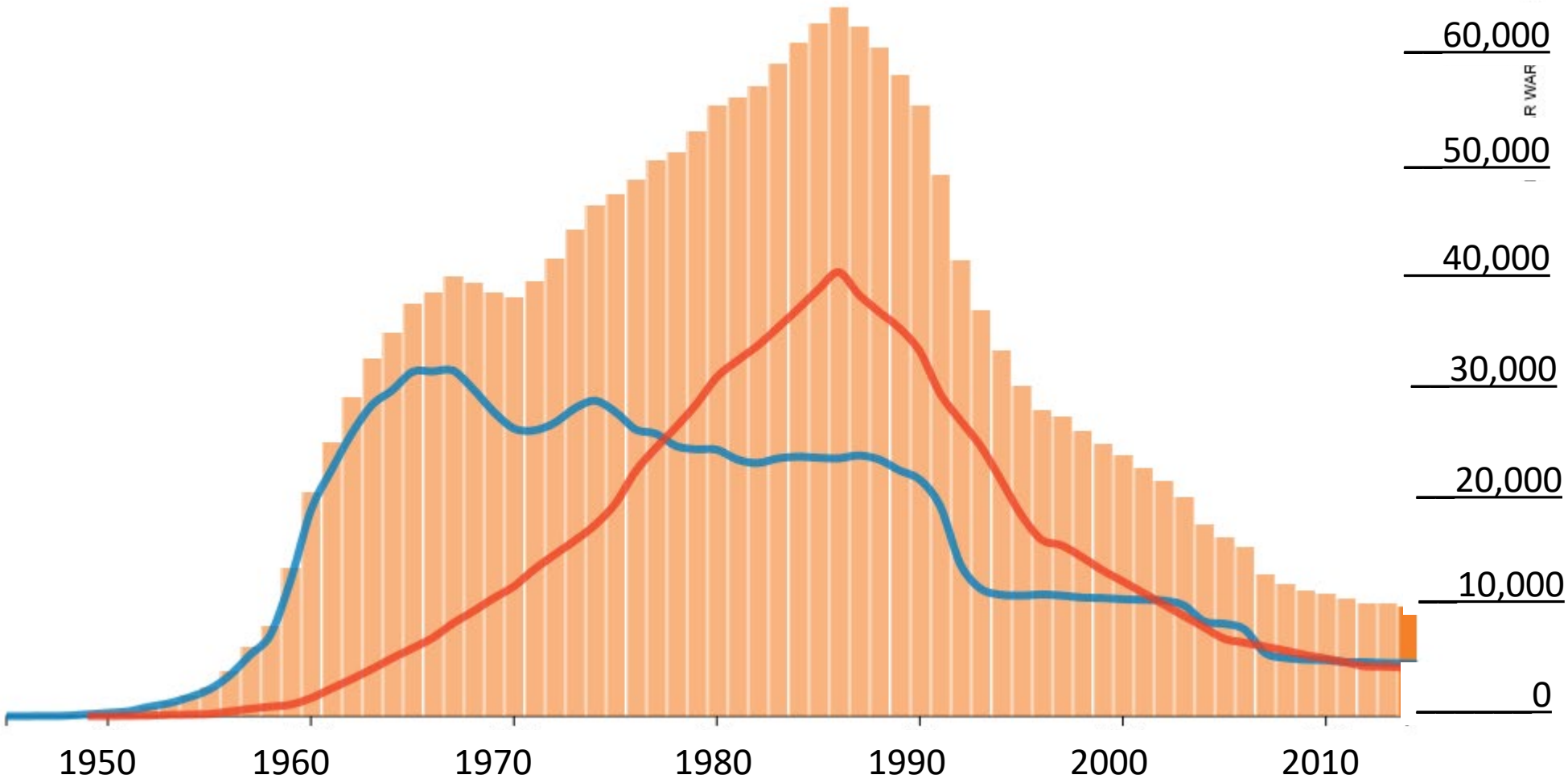
o risk of accidental nuclear war between major nuclear powers
o threat from nuclear armed North Korea
o nuclear program in Iran
o US nuclear armament insufficient for effective deterrence
o proliferation to additional countries (eg. South Korea, Saudi Arabia)
o theft of nuclear materials by terrorist groups/nuclear terrorism
o need for modernization of nuclear armament
o cost of operating and modernizing nuclear arsenals
o environmental impact of nuclear arms production

Nuclear Powers: First Weapon Tests

The year each declared nuclear weapon state first tested a nuclear device:

United States:	1945
Soviet Union:	1949
United Kingdom:	1952
France:	1960
China:	1964
India:	1974 (1998)
Pakistan:	1998
North Korea:	2006

World Nuclear Weapon Stockpiles 1945–2014



Source: *The Bulletin of Atomic Scientists'* Nuclear Notebook, written by Hans M. Kristensen and Robert S. Norris, Federation of American Scientists
http://thebulleting.org/nuclear-notebook-nultimedia

End of Introduction to Physics 280