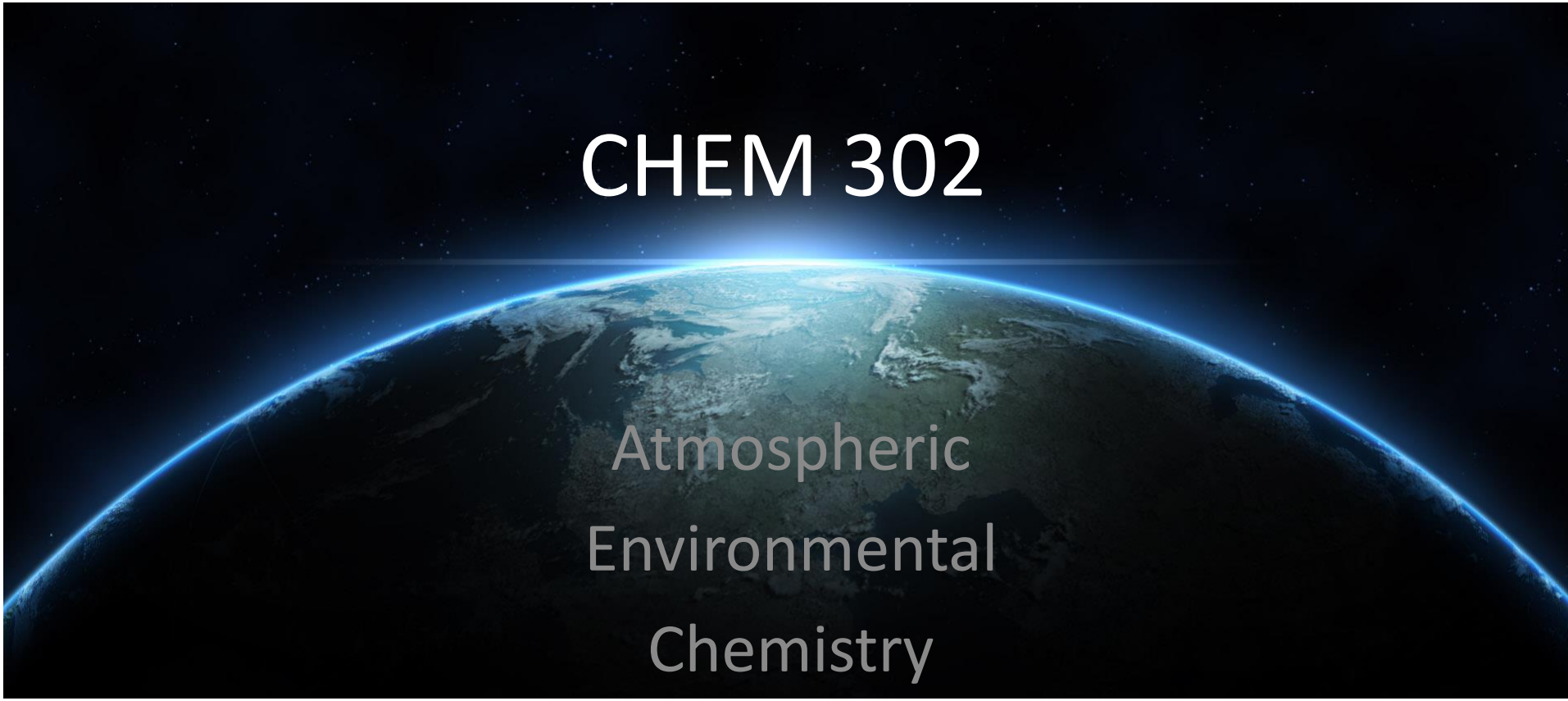


CHEM 302

Atmospheric Environmental Chemistry

Dr. Erik Krogh, P.Chem.
Chemistry &
Applied Environmental Research Laboratories

VANCOUVER ISLAND UNIVERSITY
EXPLORE. DISCOVER. EXCEL.

Course Syllabus

Required Textbook:
Environmental Chemistry: A Global Perspective (3rd Ed), **G.W. van Loon; S.J. Duffy**, 2011

Recommended Optional Texts:
Introduction to Atmospheric Chemistry, **P.V. Hobbs**, Cambridge Univ. Press, 2000
Elements of Environmental Chemistry, **R. Hites,** Wiley, 2007

Time and Location:

Lectures	10:00-11:20	**T Th**, B380-Rm202
Seminars	1:30-2:20	**F,** B355-Rm107

Course Evaluation:

Final Exam	40%
Mid-Terms	20%
Case Study/Participation	15%
Research Paper	13%
Assignments (4)	12%

1. Introduction & Review

Environmental Chemistry

Box Models and Residence Times

Properties of gases

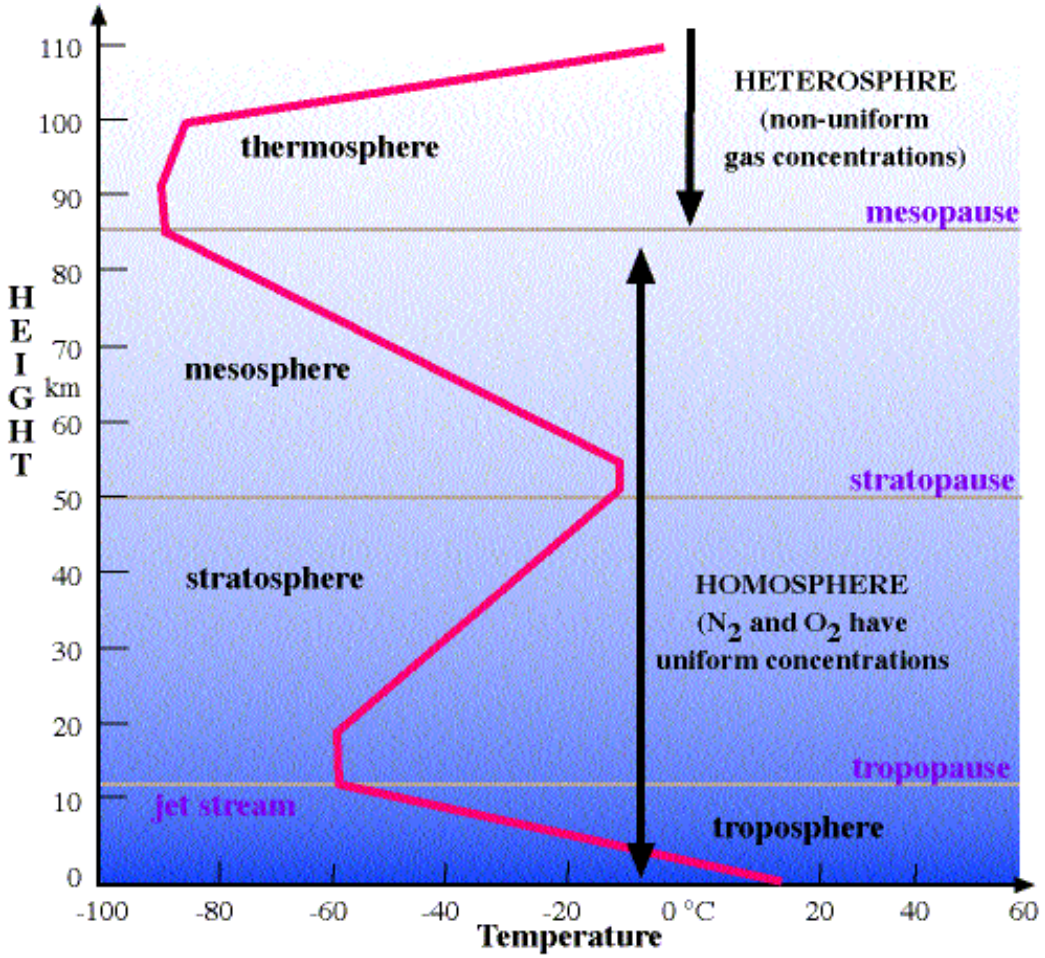
Units of Concentrations

Review of Oxidation states,

Thermodynamics and Kinetics

$$PV = nRT$$

2. Earths Atmosphere



Thermal structure and composition

Reactions and calculations in atmospheric chemistry

Chemical Kinetics

Biogeochemical cycling

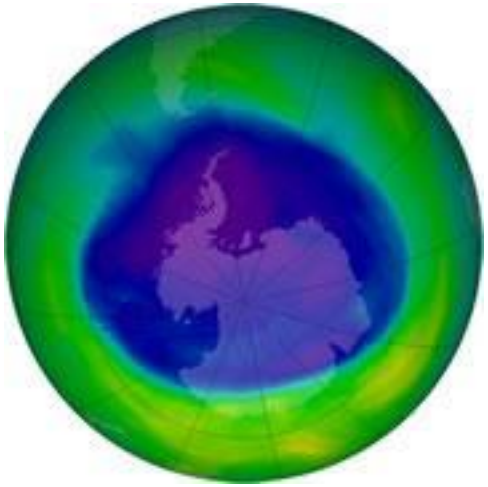
3. Stratospheric Chemistry - Ozone

The ozone layer and
Chapmann reactions

Catalytic decomposition
of ozone

Chlorofluorocarbon
chemistry

Polar hole formation



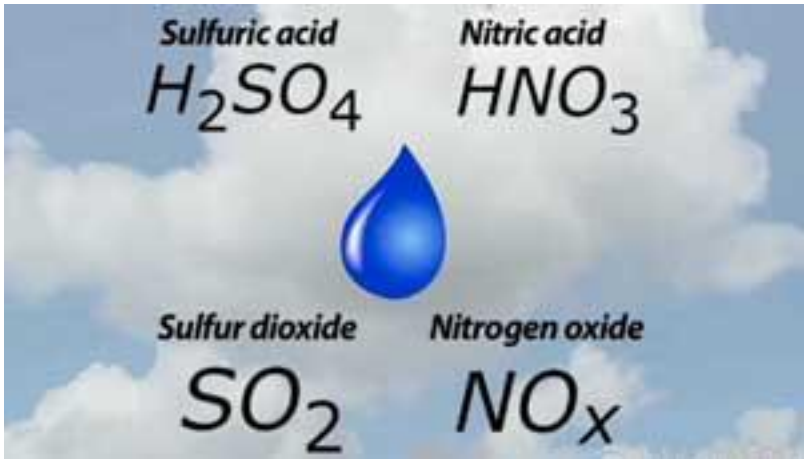
4. Tropospheric Chemistry - Smog

Photochemical smog formation

Hydroxyl radical chemistry

Internal combustion engine exhaust

5. Tropospheric Chemistry - Precipitation



Composition of rainwater
Atmospheric production of nitric and sulfuric acids
Rain, snow and fog chemistries
Short and long range acid transport
Control technologies for sulfur and nitrogen emissions

6. Atmospheric Aerosols

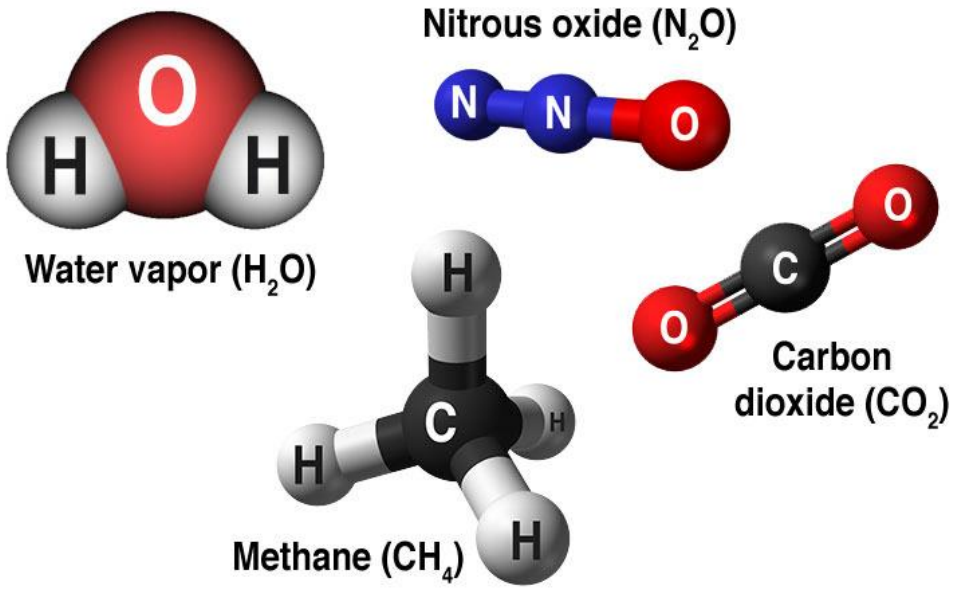
Sources, concentrations and atmospheric lifetimes
Abatement strategies for particulate emissions

7. Chemistry of Urban and Indoor Air

Pollutants in urban atmospheres

Indoor air quality, airborne contaminants and exposure

8. Chemistry of Global Climate



Thermal structures revisited and the solar energy balance
IR absorption spectra, greenhouse gases and aerosols
Relative importance of greenhouse gases
Carbon based fuels and alternative energy supplies

Case Studies – Friday Seminar Series

Student seminar presentations and discussion on a current environmental issue related to atmospheric chemistry

- Overview of environmental atmospheric topic
- Review relevant chemistry and reinforce core concepts and connections to course
- Critically evaluate mainstream media representations of scientific topics
- Comment on the economic, political and/or social context of the topic
- Stimulate interest and discussion

TRANSPORTATION

ENVIRONMENTAL PROTECTION » AIR POLLUTION

The high cost of blowing smoke on the high seas

Canada and the United States want ships to burn cleaner fuel when approaching the continent to reduce smog-related deaths

BY MARTIN MITTELSTAEDT
ENVIRONMENT REPORTER

Canada and the United States are telling ocean shippers to clean up their acts.

The two governments want to set up a zone around the coastline of most of North America, from which they would bar all large ocean-going vessels that create too much air pollution. They would also stop cruise ships.

The proposal was made public on Monday by the U.S. Environmental Protection Agency, which said the move could save up to 8,300 lives annually in the two countries because of the large number of premature deaths caused by smog and other air contaminants from ships.

Ocean vessels are an often overlooked and major source of air pollution, particularly in port cities. Critics view them as floating factory smokestacks that up to now have escaped the same kind of stringent regulation that has cleaned up emissions from cars, railway locomotives and trucks.

Ships are big polluters because they burn a low quality, asphalt-like fuel laced with impurities such as sulphur left over from the refining process after cleaner items, such as gasoline, are produced. "It's basically garbage that's being sold as fuel," said Beatrice Olivastri, chief executive officer of Friends of the Earth Canada. The shippers are "using our atmosphere as a free garbage can," she said.

The use of ship fuel leads to large emissions of smog-causing nitrogen oxides, sulphur dioxides, which create acid rain, and small soot particles.

Marine shipping accounted for about two-thirds of sulphur dioxide emissions from the transportation sector in 2002, and in the absence of control measures the figure would rise to 98 per cent by 2020, according to federal government figures.

The Canadian area most affected by marine pollution is Vancouver and lower B.C., the location of the country's largest port and gateway to burgeoning trade with Asia, but there are also sizable emissions along the St. Lawrence Seaway and the Great Lakes and in Atlantic ports, such as Halifax and Saint John.

Air pollutants from ships don't stay in port areas, and are blown hundreds of kilometres inland, affecting millions.

For a major announcement affecting both the environment and public health, the proposal hasn't received much formal notice by Ottawa. News only emerged because the EPA unveiled the action, and mentioned that Ottawa backed it.

The details were released by EPA administrator Lisa Jackson – the equivalent of a Canadian cabinet minister – at a New Jersey port.

Ms. Olivastri said she was "astonished" and "aghast" that the federal government didn't join the United States in jointly unveiling the proposal. She said the lack of information from Ottawa has meant her group had to rely on details provided by the EPA.

Environment Canada referred queries to Transport Canada, which was unable to immediately answer questions about it.

According to the EPA, the two governments are proposing an "emission control area" that would extend about 375 kilometres from the coastline of most areas, except in the Arctic.

Countries can't unilaterally establish shipping restrictions, and Canada and the United States have jointly submitted their proposal for consideration later this year by the International Maritime Organization, the UN agency responsible for shipping.

The governments are going to try to clean up shipping by having freighters burn cleaner f
Starting in 2015, large ocean
going vessels will have to m
sulphur-dioxide emission re
ductions equivalent to burn
fuel with less than 0.1 per ce
sulphur – a 96 per cent drop
Freighters approaching Nort
America would have extra f
tanks storing the cleaner fue
which they would use when
near the continent.

Vessels built in 2016 and la
will have to cut nitrogen-oxi
emissions by 80 per cent.

According to the EPA, the
measure will cost the indust
about $3.2-billion (U.S.), but
the increase per shipping co
tainer will be a modest $18.

The Chamber of Shipping
British Columbia and GSL
Group Inc. of Montreal, one
the country's largest shipper
did not return phone calls
seeking comment.

A bulk carrier is the first ship through the St. Lambert locks as the St. Lawrence Seaway opens yesterday for its 50th season. In Canada, marine pollution chiefly affects Vancouv and lower British Columbia, but there are also sizable emissions along the St. Lawrence Seaway and the Great Lakes. RYAN REMIORZ/THE CANADIAN PRESS

SHIPPING'S DIRTY SECRET

Shipping is raising a stink because it uses some of the dirtiest fuel going.

Government regulations have led to cleaner fuel standards for cars, trucks, construction equipment and locomotives. With higher quality fuels, these vehicles have had a sharp fall in harmful emissions.

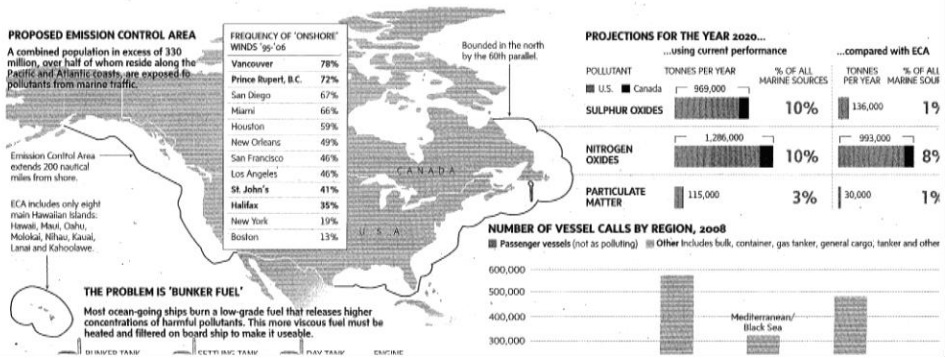
Ocean shipping is one of the only businesses allowed to continue burning fuel with extremely high levels of impurities that cause air quality problems.

The accepted measure of the cleanliness of a fuel is its sulphur content. By this yardstick, ships are in a league of their own, with each litre of their fuel carrying up to hundreds of times the pollution punch as a litre of gasoline.

Ships can burn fuel containing up 45,000 parts per million sulphur under international standards. Under the U.S.-Canada proposal, the concentration would fall to 1,000 ppm in 2015.

Gasoline for cars, by contrast, is limited to 80 ppm. Diesel for locomotives, trucks, and off-road vehicles, such as road graders, has to be even cleaner, at 15 ppm, with various implement dates.

» Source: *Environment and Transport Canada*



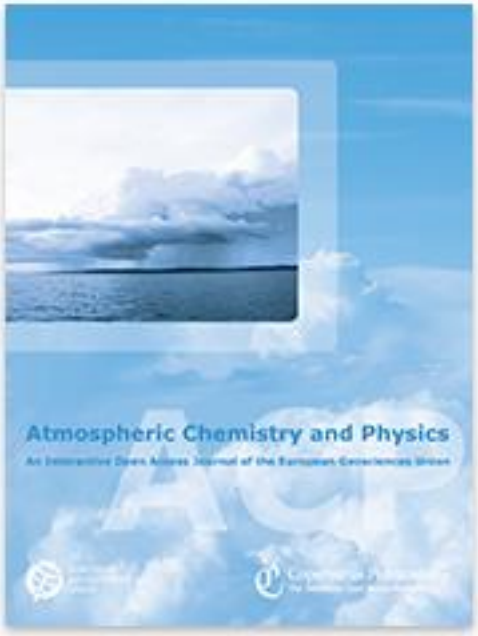
Topics in 2011

Global Atmospheric transport/distribution (arctic POP's)
The Goldilocks Effect – Atmospheres on Venus and Mars
Chlorofluorocarbons, Alternatives and the Montreal protocol
Urban air quality – sources, sinks and health impacts
Atmospheric Nitrogen Imbalance
No Seminar
Acid Rain – The good, the bad and the ugly
Natural emissions - Volcanoes Natural emissions - Forest Fires
Radioactivity –Indoor Radon and Outdoor Fallout (Fukishima)
Natural emissions – BVOCs Municipal waste incineration
Energy and Power – Coal, Biodisel and Beyond
Global Climate Change

Research Paper

4 Page summary of peer reviewed paper involving atmospheric chemistry

Seasonal characteristics of tropical marine boundary layer air measured at the Cape Verde Atmospheric Observatory
L. J. Carpenter et al.
J Atmos, Chem., **2010**, 67(2), pp 87-140



Diesel-related hydrocarbons can dominate gas phase reactive carbon in megacities
R. E. Dunmore et al,
Atmos. Chem. Phys., 15, 9983-9996, **2015**

Environmental Science & Technology

Aqueous Organic Chemistry in the Atmosphere: Sources and Chemical Processing of Organic Aerosols
V. Faye McNeill
Environ. Sci. Technol., **2015**, *49* (3), pp 1237-1244