



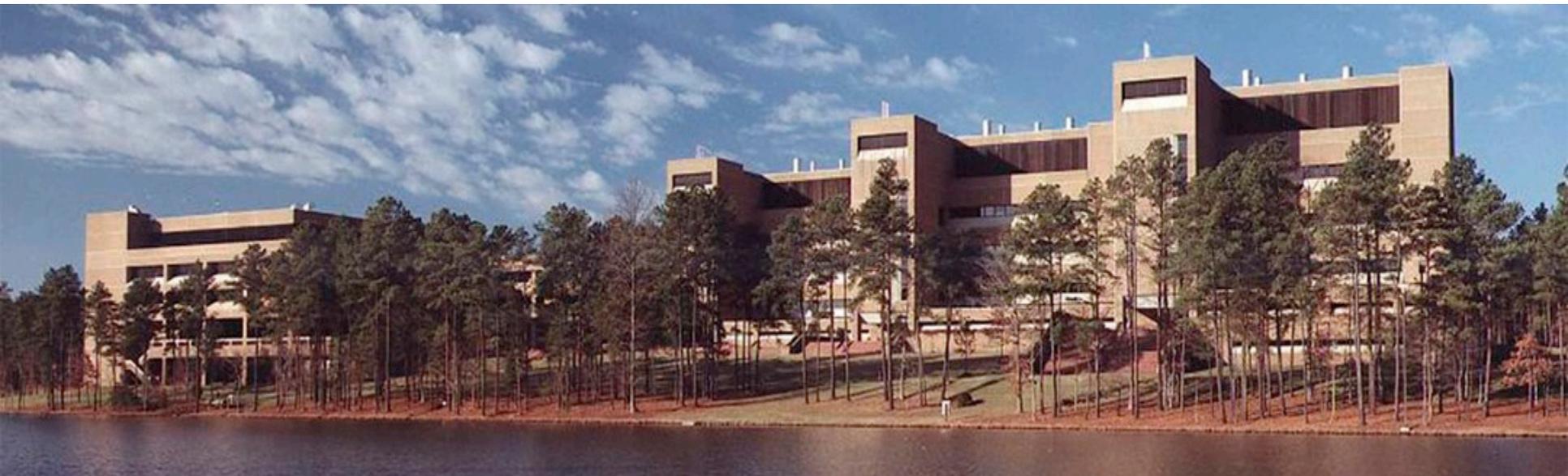
Environmental Monitoring for UOG

Exposure Monitoring for Human Health, Workers, & Community

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Data Data Data! > 52,000 Wells Across the U.S.

REPRESENTATIVE EXPOSURE DATA ??

Pubmed

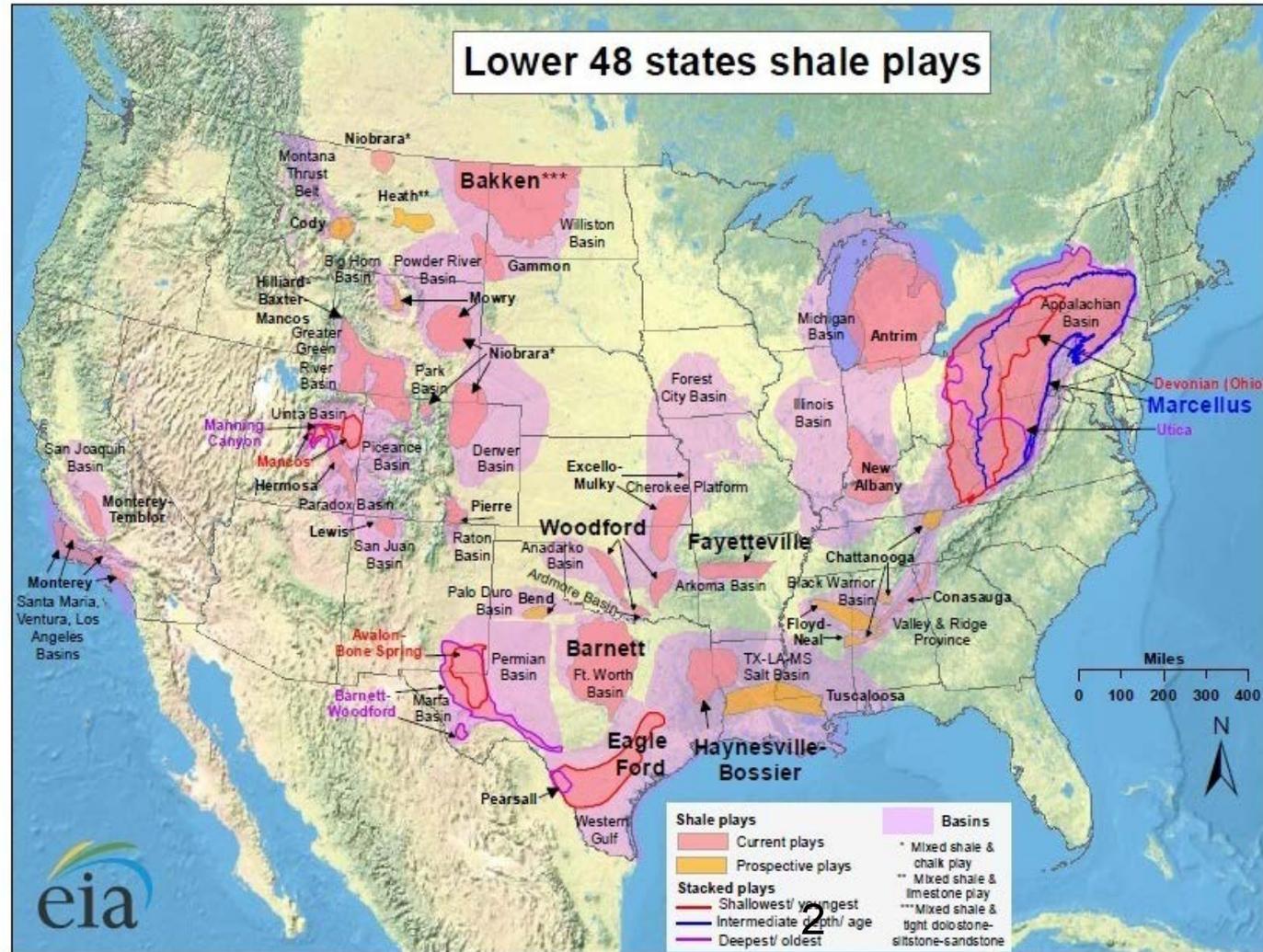
82 citations

27 health, exposure,
or risk related

(18/27 from 2013)

1 actual health data

4 exposure data



Source: Energy Information Administration based on data from various published studies.
Updated: May 9, 2011

What are the Health Risks ?

Workers



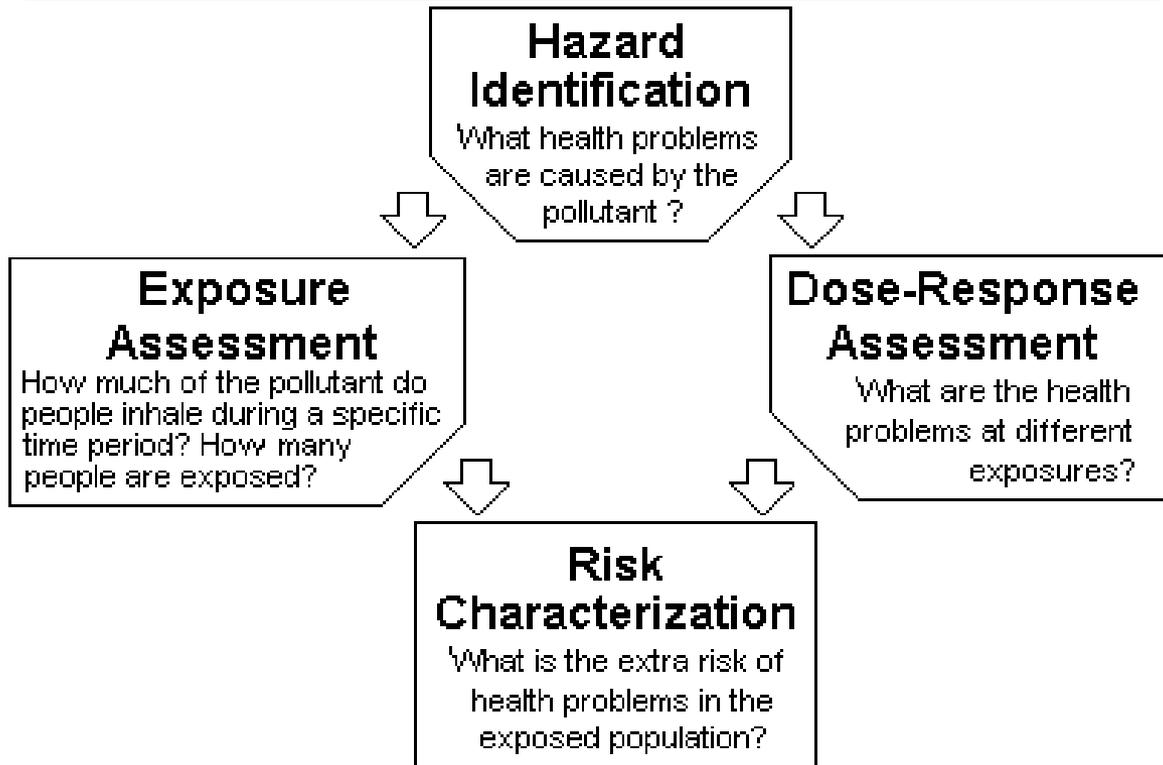
Community

Ground

Water

Air

The 4-Step Risk Assessment Process



> 1000 Chemicals Used

Lubricants

Acids

Solvents & Emulsifiers

Biocides

Gelling Agents

Anti-corrosives

Scale inhibitors

Clay Stabilizers

Diesel fuels ?

Chemical Reporting Issues

Nondisclosure “trade secret”

Low penalties for wrong info or not reporting

Timelines for reporting vary

- **Potential Health Effects can include:**
 - **Cancers** (benzene, PAH's, metals, diesel fume, NORMs)
 - **Neurologic & neurobehavioral** (metals, VOCs)
 - **Respiratory** upper & lower (acids, PM, PAH)
 - **Pregnancy & development** (endocrine disruptors)
 - **Explosive/flammability** (methane)
 - **Skin, eyes, nose, throat** (irritants, sensitizers)

Flow Back Waters: adds metals, salts, naturally occurring radioactive materials

Cancers, Respiratory & Cardiovascular Disease

Exposure Data (limited & variable)

Sites Exposure Assessments

- **Diesel** Fumes
- **Ozone** elevations
- **VOC's & PAH's**
 - Benzene, Ethylbenzene, Toluene, Xylene (BTEX)
- **Particulate: Silica**, road dust, **PM₁₀ & PM_{2.5}**
- **H₂S, NOx**
- **Methane**
 - 190 sites in U.S. ranged from 0.01-17Mg (Allen, PNAS Oct 2013)
 - US EPA Studies 2011 had higher estimates



Process Concerns:

- Drilling & Wells
- Pipe leaks
- Spills
- Retention Ponds
- Proppant -Sand (silica)
- Engines & Vehicles

- **Community Health Impacts Assessments & Surveys**
 - **Noise** & light pollution
 - Safety Hazards
 - Traffic & road dust
 - Impact on **Resources** (boom & bust): (community & hospital records)
 - medical & emergency services, housing, public infrastructure, labor market
 - **Crime, substance abuse, mental health, STD's, & psychosocial impacts**



Road Dust in Kildeer, ND

Hazardous **Erionite** mineral fibers also present in road gravel.



Exposure & Health Issues

- **Concentration & Duration**
- **Intensity & frequency:** peaks & averages
- **Route of Exposure:** air, water/ingestion, dermal
- **Mixtures & Cumulative Effects**
- **Sampling**
 - Regulatory vs Health Research
- **Acute vs. Chronic Effects**
- **Susceptibility :** low dose effects?
 - Fetus, children, elderly
 - Pre-existing conditions
 - Asthma, allergies



NIEHS Gulf Oil Spill Response



- **>32,000 adults involved in oil spill clean-up: Enrolled**
- **Home Visits:** 11,210 from Gulf States
 - **Questionnaires:** including family, work, mental health, diet
 - **Medical:** blood pressure, height/weight, lung function,
 - **Biospecimens:** blood, hair, toenails
 - **Environmental:** house dust
- **BTEX Study** (n ~1000)
 - Blood levels of VOC's & metals
 - 200 with personal air monitoring for VOC's
- **Comprehensive Clinical Exam** (n ~4000) –Jan. 2014

- **Baselines Not Available:**

- **Exposure:** what are background levels
- **Health:** symptoms, lung function, biospecimens
 - **Biomarkers of exposure & effect**
 - Metals, VOC's, PAH's
 - Genotoxic, inflammatory markers (e.g., blood, urine; exhaled breath?)

- **Exposure Reconstruction**

- **Data:** Over 25 million measurements
- **Various methods & analyses**
 - Limits of Detection (**reanalysis:** total hydrocarbons increased from 40 to 80%)

Hydrofracking Opportunities for Needed Research

- **Baseline** measures of **Exposure & Health** status & **Biospecimens**
 - **New Study**: Researchers & volunteers collecting ongoing baseline water samples from 50+ streams in upstate New York. (Penningroth et al, New Solutions 2013)
- **Epidemiology**: health studies in various locations & assessing HF approaches
 - **Acute**: *respiratory function, eye/nose/ throat/skin, constitutional symptoms*
 - **Longer-term**: *neurobehavioral, reproductive & developmental, cardiovascular, lung disease, cancers*
 - **Community Impacts**: *Health Impact Assessments & psychosocial stressors*

Community based participatory research !

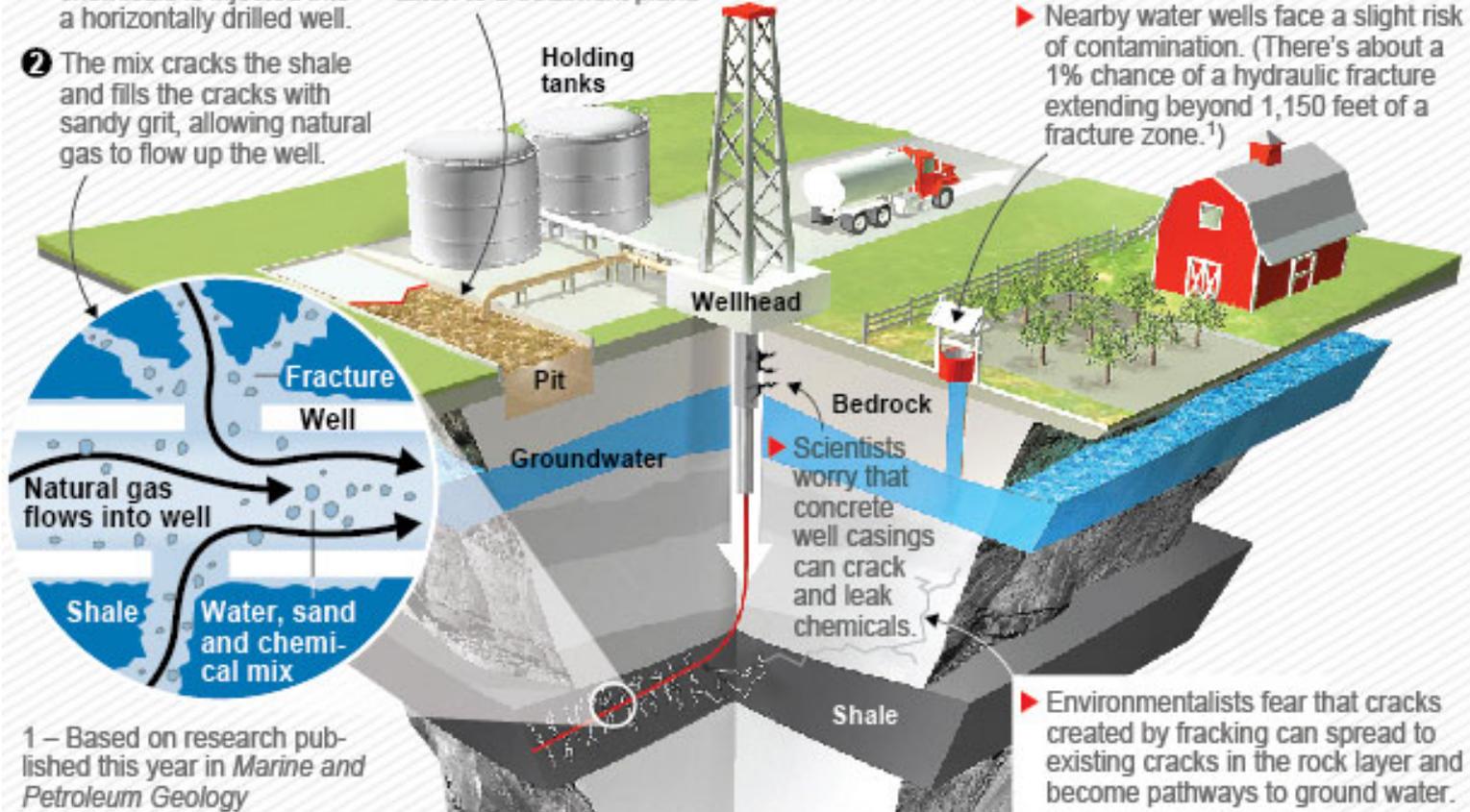
- **Toxicology**: studies looking at **fracking fluids & complex mixtures**
 - In-vitro assays (**Tox21**) & animal models (genetic diversity)
 - **Archive Samples for characterization**

What is fracking?

Hydraulic fracturing, or fracking, is a method of forcing natural gas or oil from rock layer deep below the Earth's surface.

How fracking works ...

- 1 A pressurized mixture of sand, water and chemicals is injected into a horizontally drilled well.
- 2 The mix cracks the shale and fills the cracks with sandy grit, allowing natural gas to flow up the well.
- 3 The recovered water is stored in lined pits or taken to a treatment plant.



... and why it's controversial

Much of the water used in fracking is collected from the well and processed, but some communities have raised concerns that potentially carcinogenic chemicals can escape into drinking water.

- ▶ Nearby water wells face a slight risk of contamination. (There's about a 1% chance of a hydraulic fracture extending beyond 1,150 feet of a fracture zone.¹)

▶ Scientists worry that concrete well casings can crack and leak chemicals.

- ▶ Environmentalists fear that cracks created by fracking can spread to existing cracks in the rock layer and become pathways to groundwater.

1 – Based on research published this year in *Marine and Petroleum Geology*

Hydrofracking Opportunities for Needed Research cont.

– Air

- VOC's (active & passive samplers, personal & stationary monitors)
- Particulate: silica (at certain locations), diesel
- Methane, CO2, NOx

– Water

- **Assays:** Chemicals, Metals, Radiation, Gases (fingerprinting)
- **Locations:** Wells, holding ponds, aquifers,

– Surface Soil contamination around sites

– Homes

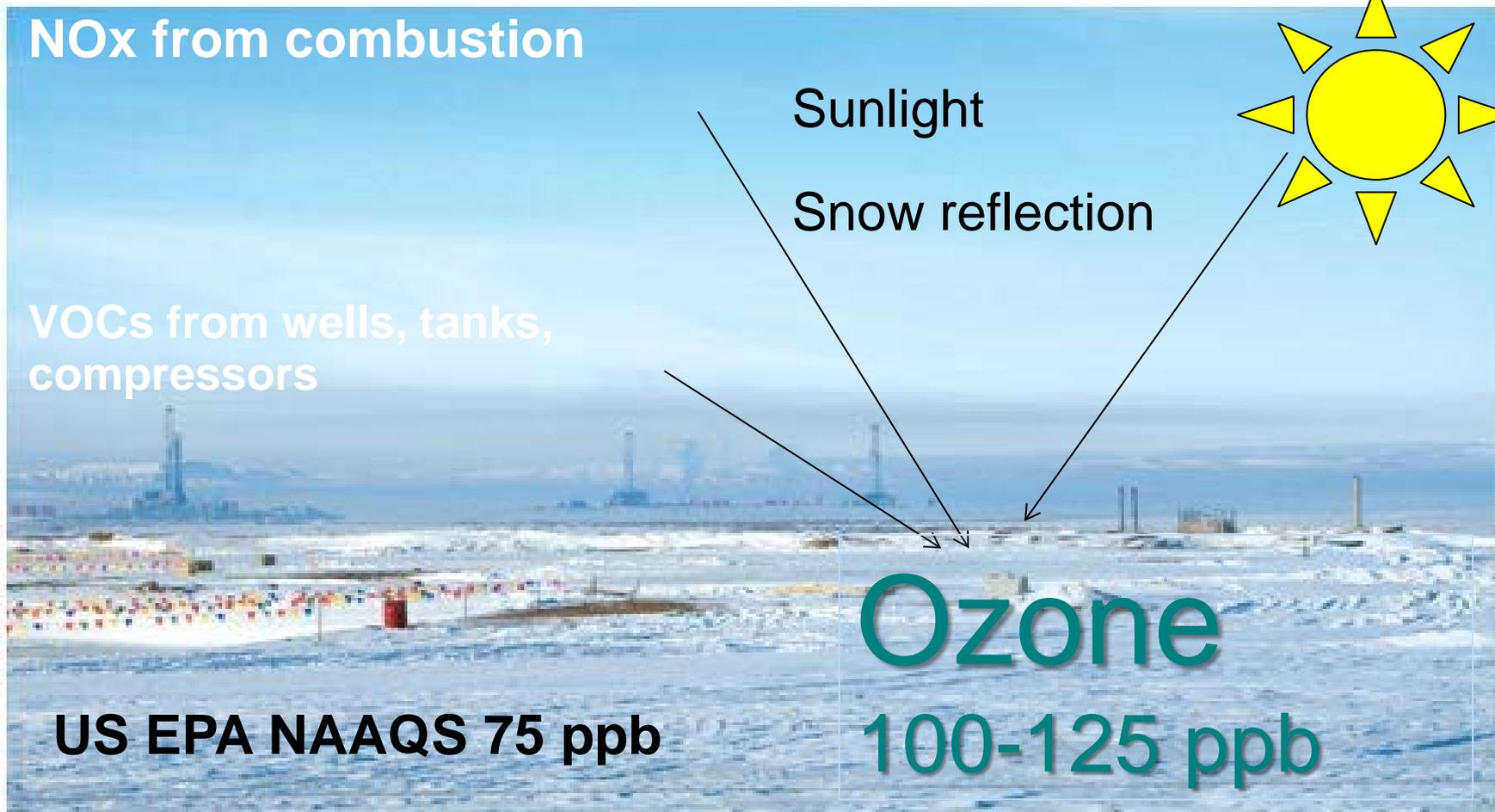
- Dust, surface wipes, tap water

– Need for

- Standardized Sampling Protocols
- Regulatory vs. Research (e.g., lower limits of detection and differing analytes)



Regional Wintertime Ozone Wyoming, Utah Schnell, 2009 Nature Geoscience



JENNIFER FRAZIER

Citizen Science !

<http://deq.state.wy.us/aqd/Ozone%20Main.asp>
http://www.denverpost.com/business/ci_20042330

US Government Health Research Activities

- **Multi-Agency Collaboration on Unconventional Oil & Gas Res.** (2012)

US EPA

US Geologic Survey

US Dept. of Energy

- **Research Plan** to address the highest priority research questions associated with safely and prudently developing unconventional shale gas and tight oil resources. (under review)

Executive Order –

Supporting Safe and Responsible Development of Unconventional Domestic Natural Gas Resources

“ . . . it is vital that we take full advantage of our natural gas resources, while giving American families and communities confidence that natural and cultural resources, air and water quality, and public health and safety will not be compromised.”

-- President Obama

US Government Health Research Activities

- **NIH/ NIEHS**

Promotion of Health Research

- National Toxicology Program (NTP)
 - H₂S
 - PAHs
- Environmental Health Science Core Centers
- Funding to the Research Community
 - Risk perception about HF in the Eastern US
 - Airborne exposures (VOCs) associated with HF in Ohio
 - Health record evaluations in counties with and without HF in NY & PA
 - Silica Exposures during sand mining in IA
 - HARVARD WORLD MAP : **FrackMap** <http://worldmap.harvard.edu/maps/FrackMap>

Thank you!



US Government Health Research Activities (cont.)

Centers for Disease Control & Prevention (CDC)

– National Institute for Occupational Safety & Health (NIOSH)

- <http://www.cdc.gov/niosh/programs/oilgas/default.html>
- **Focus on Worker Exposures, Health, & Safety: Silica & Chemical Exposures**

– Agency for Toxic Substances & Disease Registry (ATSDR)

Health Consultations

- **Water quality:** LeRoy, PA; Pavilion, WY; **Dimock, PA**; Posey County, IN
- **Air quality:** Garfield County, CO, Washington County, PA
- **Explosive hazards:** Medina, OH; Posey County, IN; Dimock, PA

*“CDC and ATSDR **do not have enough information** to say with certainty whether natural gas extraction and production activities including hydraulic fracturing pose a **threat to public health**. We believe that **further study is warranted** to fully understand potential public health impacts.” May 2012*