ERM Symposium

Anticipating Black Swans

Alan D. Roth, Ph.D.
Chief Risk Officer,
Advanced Fusion Systems, LLC

What is a Black Swan?

- Nassim Nicholas Taleb defines a Black Swan Event as a rarity; has an extreme impact; and is retrospective.

  So when we look back at it, “human nature makes us concoct explanations for its occurrence.”* We are good at Monday morning quarterbacking.

*Taleb, The Black Swan: The Impact of the Highly Improbable, Second Edition, Prologue p. xxii, Random House, 2010.

In Today's World, are we really better off?

- Our modern lifestyle makes us much more vulnerable to Black Swan events.
- Our massive electric grid, dense cities, coastal development, mushrooming Internet, globalization could all come back and bite us.

There are positive Black Swans but, generally, we don’t like surprises.

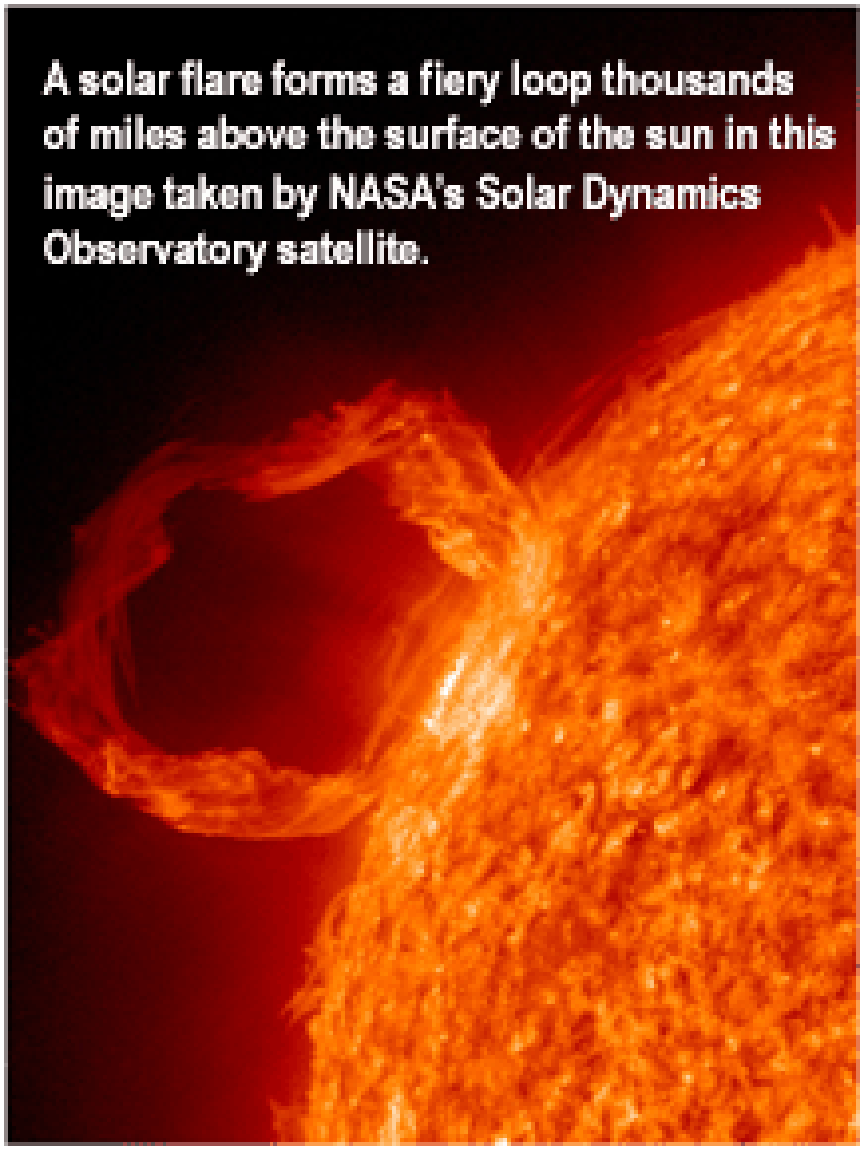
ELECTROMAGNETIC PULSE

Three main sources

- The Sun – almost certain
- A nuclear blast – high risk
- **A non-nuclear strike** – very high risk and near-term

Let’s take a look at the sun.

You don’t need to put on sunglasses for this.



A solar flare, the source of coronal mass ejections

Solar Flares

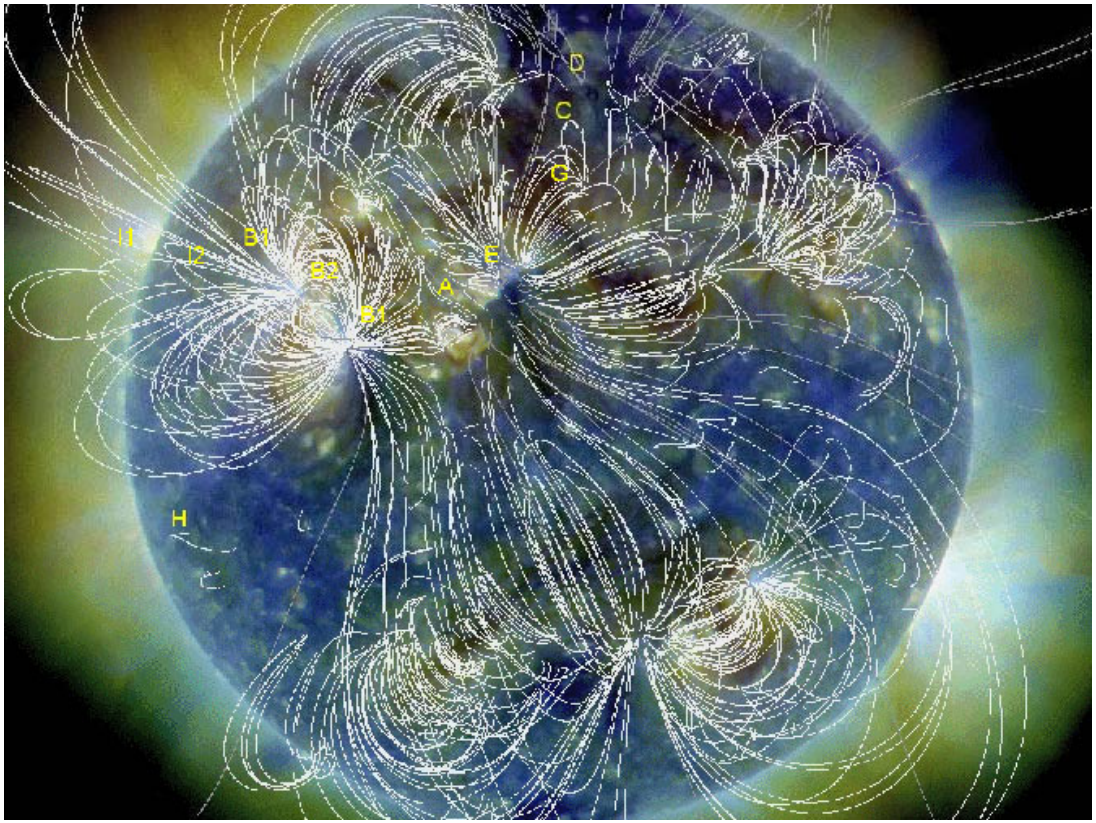
- Solar flares generate coronal mass ejections that are sometimes launched in our direction and cause geomagnetic storms also known as "**severe space weather**".
- The sun surface is most active when there are a lot of sun spots but coronal mass ejections can come at us **at almost any time**.
- The only exceptions are deep solar minimums.

These storms are dangerous events

- They cause damage to our electric grid resulting in blackouts.
- They cause damage to satellites interrupting communications and GPS services among other satellite functions.

We have become more and more vulnerable to solar activity

- As our electric grid technology improves to give us better, more efficient service, the grid becomes more vulnerable to geomagnetic storms.
- As we become more reliant on Internet and digital services, we become more vulnerable to the effects of blackouts and nuclear electro-magnetic pulse.



This solar event shows how active the sun can be during a relatively inactive period

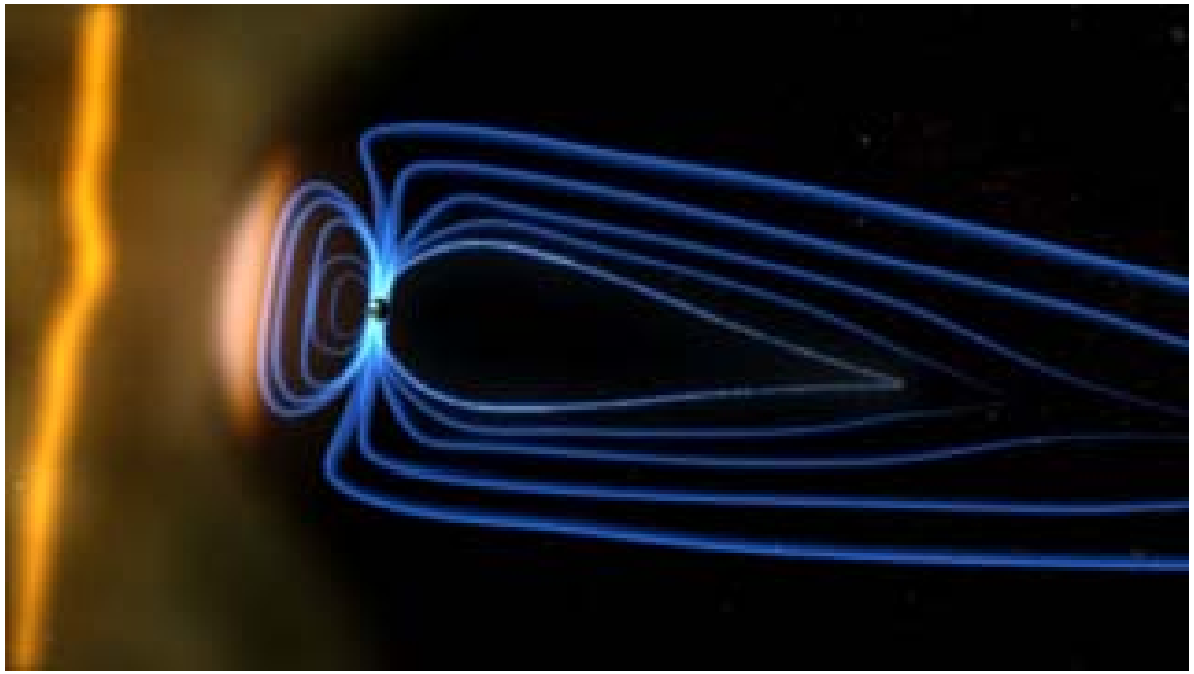
It was August 1, 2010 when the sun was just waking up from a very deep, long-lasting solar minimum. Drawing illustrates what could not be seen.

Fortunately, none of the flares were pointed at us.

http://www.nasa.gov/mission_pages/sunearth/news/global-eruption.html

Coronal Mass Ejection meeting the earth's geomagnetic field

The small dot in the light blue area is the earth. The blue lines represent the earth's geomagnetic field.



http://svs.gsfc.nasa.gov/vis/a010000/a010100/a010104/index.html

Aurora Borealis – Northern Lights

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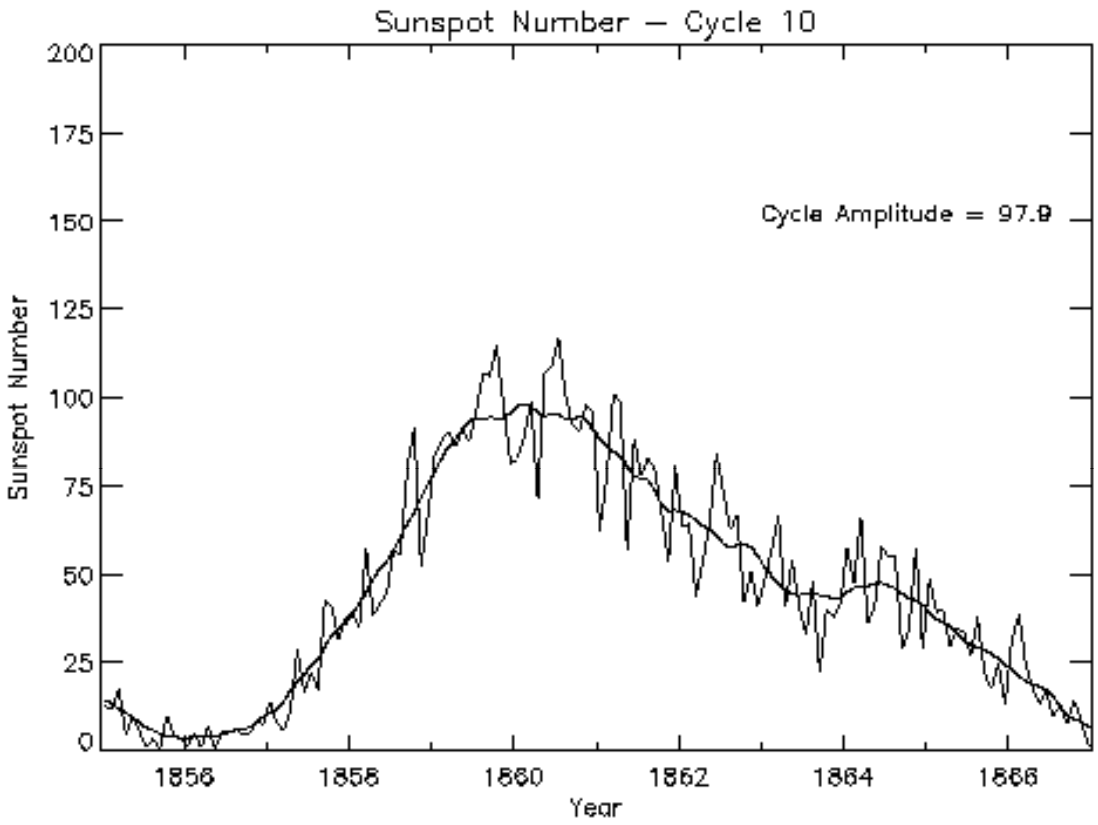
Photo: http://geology.com/nasa/aurora-borealis.shtml

Solar Cycles of about 11 years

- A cycle starts at a solar minimum – There are zero or close to zero sun spots at the minimum.

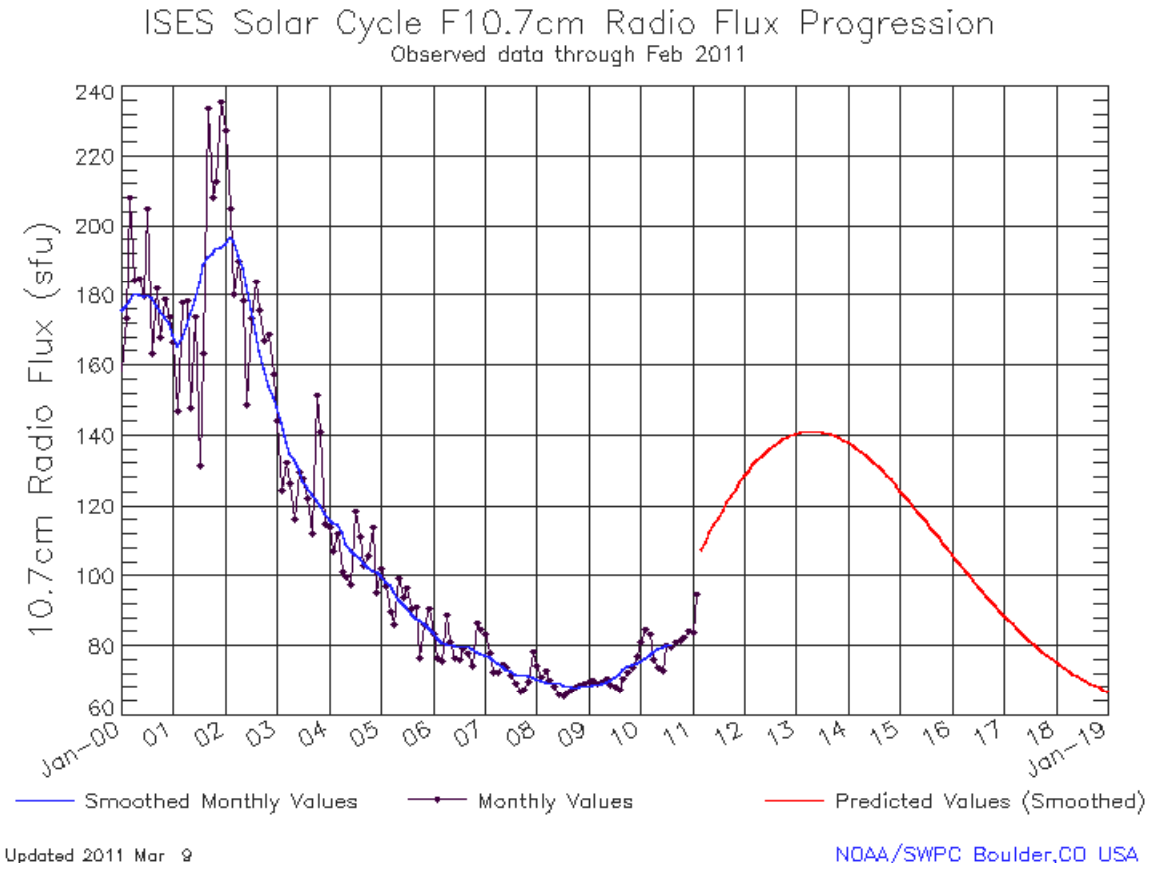
- Sun spot numbers increase until they reach a maximum number for that cycle before decreasing back to the minimum.



The Carrington Event of 1859 in Cycle 10

Not even 100 sun spots at peak that year

http://www.ips.gov.au/Educational/2/3/1

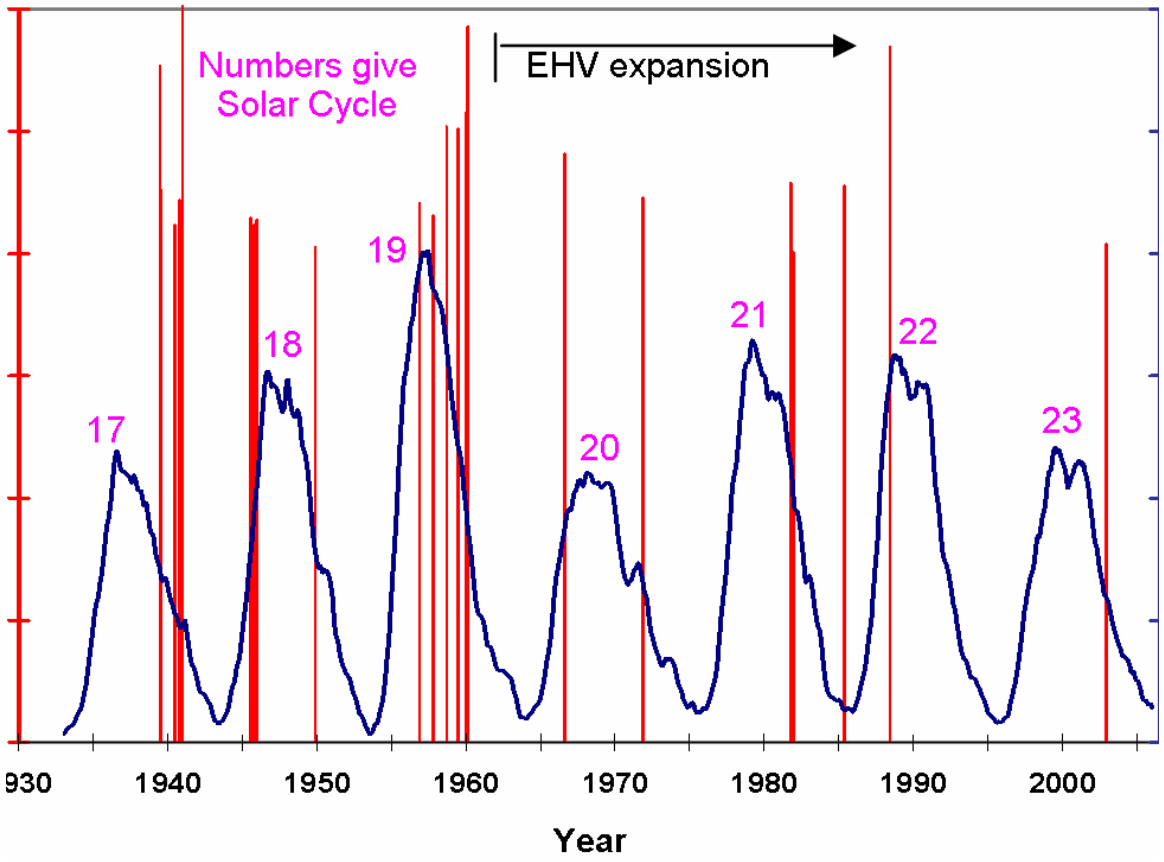


The recent long, deep solar minimum lasted almost two full years 2008-09
This last happened in 1912-14

http://www.swpc.noaa.gov/SolarCycle/

There have been many geomagnetic storms

- The online Operations Manual of the North American Electric Reliability Corporation (NERC) cites geomagnetic storms of **1957, 1958, 1968, 1970, 1972, 1974, 1979, 1982, and 1989** as causes of major power system disturbances.



Geomagnetic Storms during solar cycles

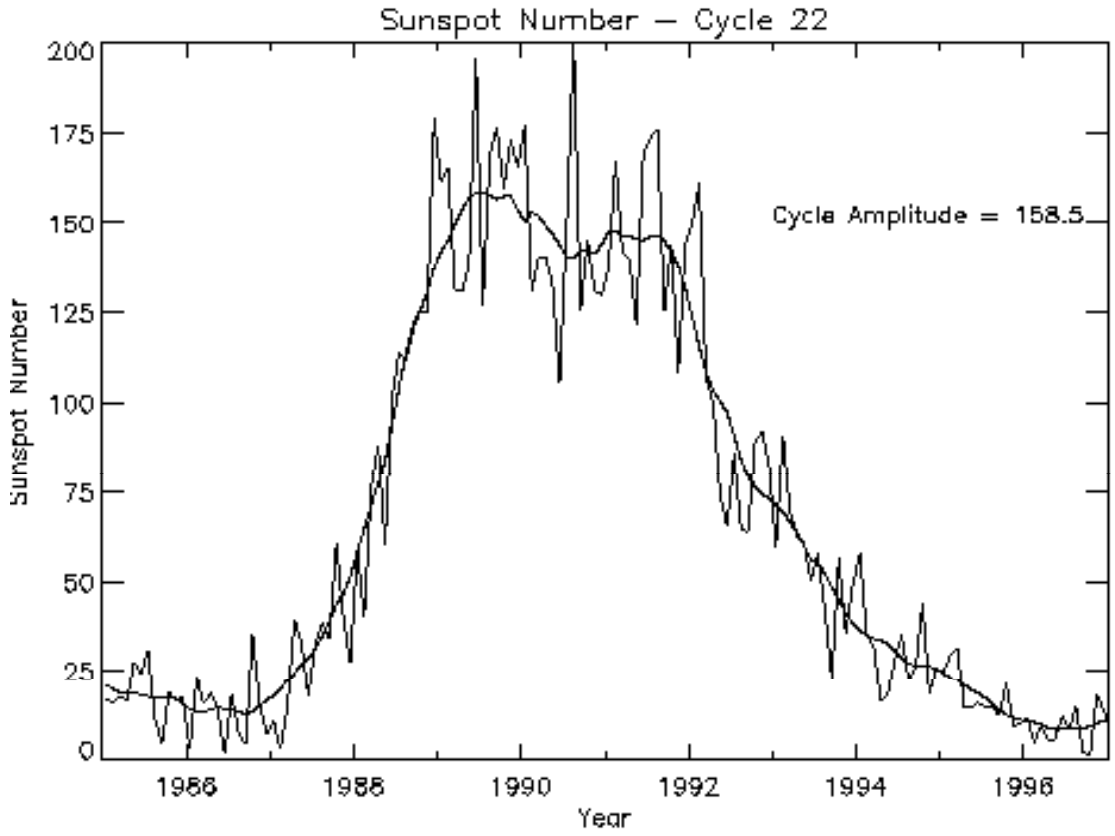
Vertical red lines show timing and intensity of storms.

Only occasionally do they coincide with solar maximums.

The Carrington Event of 1859 and the Geomagnetic Storm of 1921 are considered 100-year events.

NASA scientists tell us the next big one is due.

The question is not "if" but "when".



The Geomagnetic Storm of 1989 in Cycle 22

Around 175 sun spots at peak that year

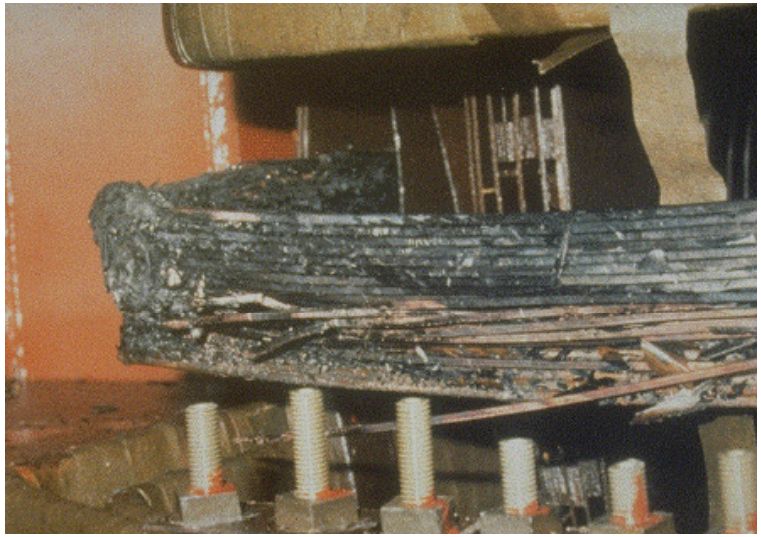
http://www.ips.gov.au/Educational/2/3/1

Impact of the 1989 storm

- Coronal mass ejection was launched on March 9, 1989. It reached earth **3 ½ days** later.
- It was manifested by a ground induced current (GIC) that coupled with transmission lines.
- The greatest impact was the outage of the Quebec Province electric grid for 9 hours.
- One large transformer was destroyed (cooked) at the Salem nuclear plant in New Jersey.

Damage from 1989 storm

Part of the cooked transformer



Kappenman, Geomagnetic Storms and Their Impacts on the U.S. Power Grid
Prepared for Oak Ridge National Laboratory, January 2010, p. 2-29

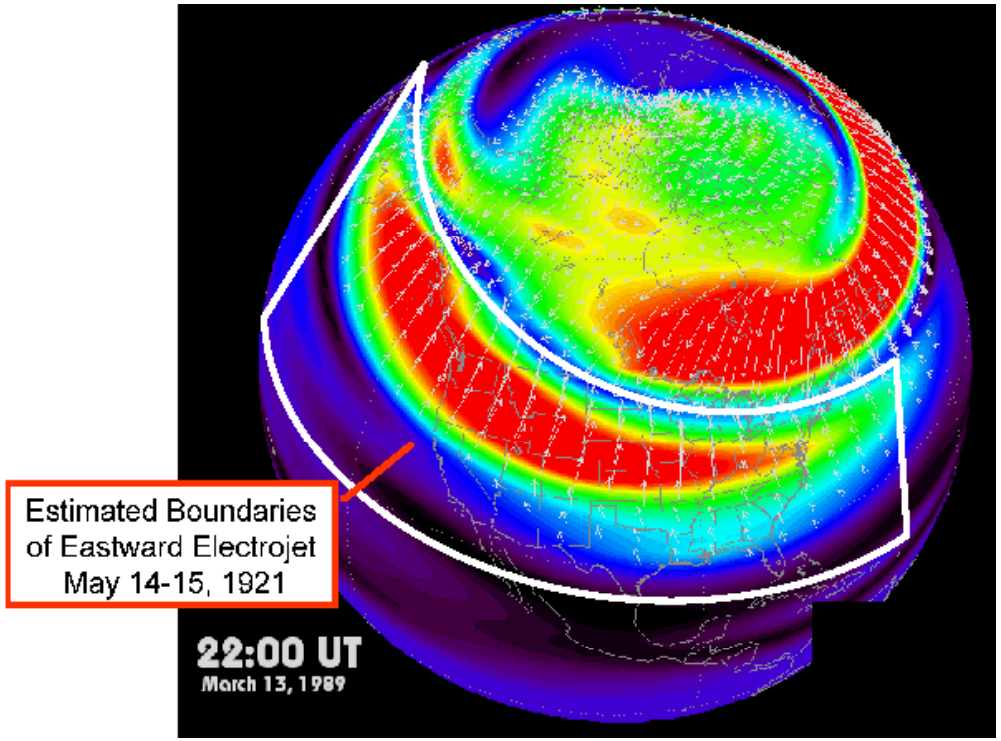
Damage from 1989 storm cont'd

Within 2 years after the March '89 exposure, 11 nuclear plants noted failures of their large transformers, in addition to the Salem failure.

Great Geomagnetic Storms

- **Comparison of March 1989 Storm & May 1921 Storm**

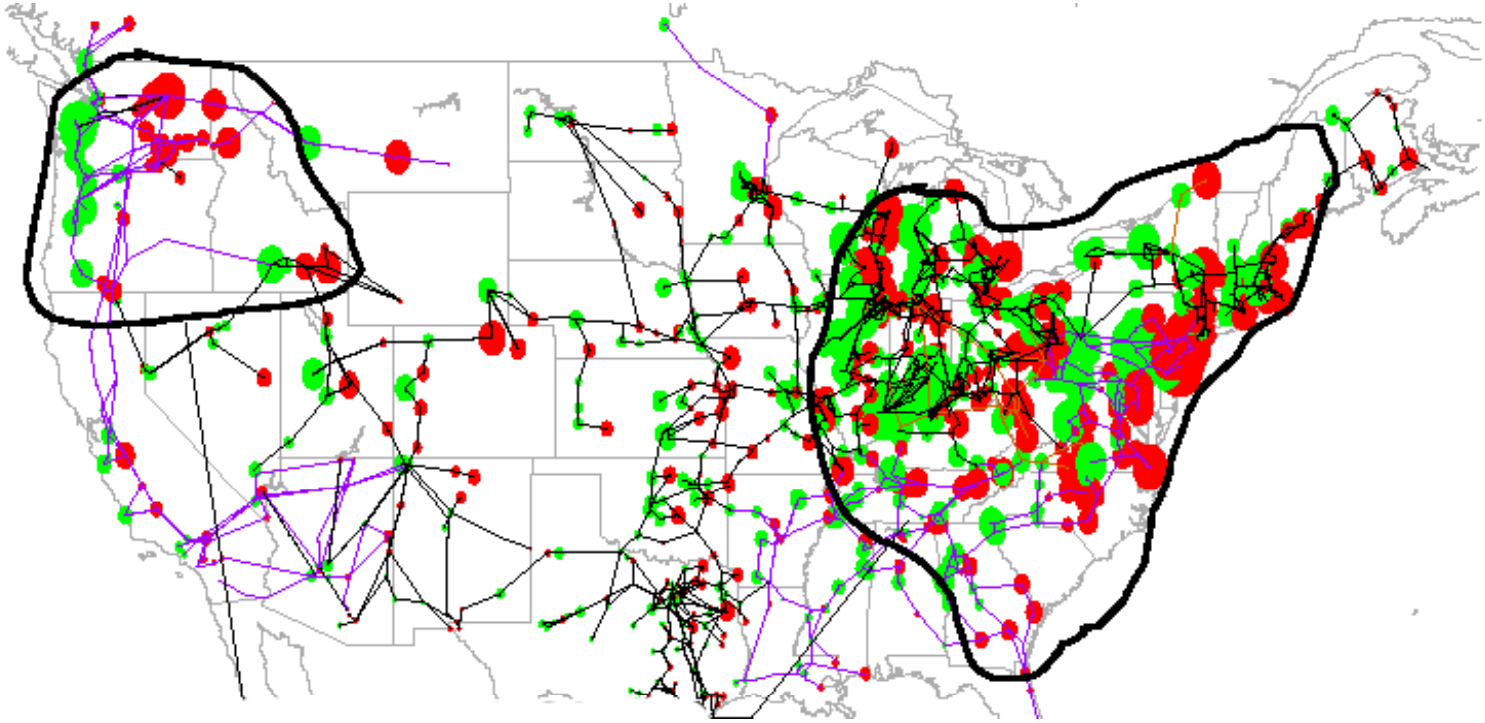
  The latter estimated to be largest storm of 20th Century – 10x stronger than '89 - extended further south



- Source John G. Kappenman,
  Storm Analysis Consultants, Oct 2010

Power Grids should expect Storms 4 to 10 Times More Intense than the March 1989 Storm

Power System Disturbance and Outage Scenario of Unprecedented Scale



Areas of Probable Power System Collapse

Impacted Regions involve population of >130 Million

John G. Kappenman, Storm Analysis Consultants, October 2010

THE NUCLEAR BLAST

High Altitude (Nuclear) EMP = HEMP

- First example of **HEMP** was 9 July 1962 – Starfish Prime
- The nuclear pulse reached Honolulu 898 miles from the detonation point. Burned out 300 street lights and triggered many burglar alarms. Some hotels had “Rainbow Parties” watching the aurora.
- Today’s nuclear devices are x times more powerful.

Other nuclear attacks

- A low altitude or ground level nuclear explosion emits the same EMP. It reaches a smaller geographical area but closer proximity makes it more powerful.
- Nuclear causes a very low frequency GIC like a solar geomagnetic storm but also has other frequencies that can destroy electronic equipment.

NON-NUCLEAR EMP (NNEMP)

NNEMP is the greatest most immediate threat.

- An EMP generator can fit inside a van and can destroy an electrical substation from the road.
- It is not difficult to get parts for it and make it.
- It can be **5 times stronger** than a nuclear blast.
- The van then drives to other substations unnoticed. We wouldn’t know what hit us.

So what does this mean?

If the solar GIC or the nuclear or non-nuclear EMP is strong enough, **our civilization is destroyed.** We do not have defenses in place to stop it.

We lose potable water, food, sanitation, HVAC, communications, transportation, medical services, law enforcement, government, financial services and the list continues….

Nuclear plants may spread radioactivity.

It would take **years** to recover.

But less destruction is more likely

We can recover from a moderate or indirect hit. But we may need to get through some weeks or some months. Those who prepare will be the most likely to regain operations.

Tasks that are needed <u>now</u>

- Educate your BOD and C level about this and the need for priority attention. Then educate others.
- Determine what is needed to manage a week or more and then a month or more without electricity. This is not easy.
- Plan what to do when satellite malfunction causes a loss of communications or GPS service.
- Water, food, medical supplies, and other basics can be stored. Plan for this and start storing.
- Steuben Foods in Elma, NY provides an example. www.steubenfoods.com

More tasks

- Back-up generators and fuel need to be in place.
- Speak with your utilities to see what their plans are. Work with them.
- Investigate preparations at all of your locations and along your supply chains.
- Plan strong protection for storage depots.
- Insurers need to consider what risks can be transferred. Actuaries will struggle.

Solutions are coming

Devices to counter the EMP pulse at key locations are on the drawing board and may start to be available as early as the end of this year.

Websites of value:

www.empactamerica.org

www.empcoalition.org

www.empcommission.org

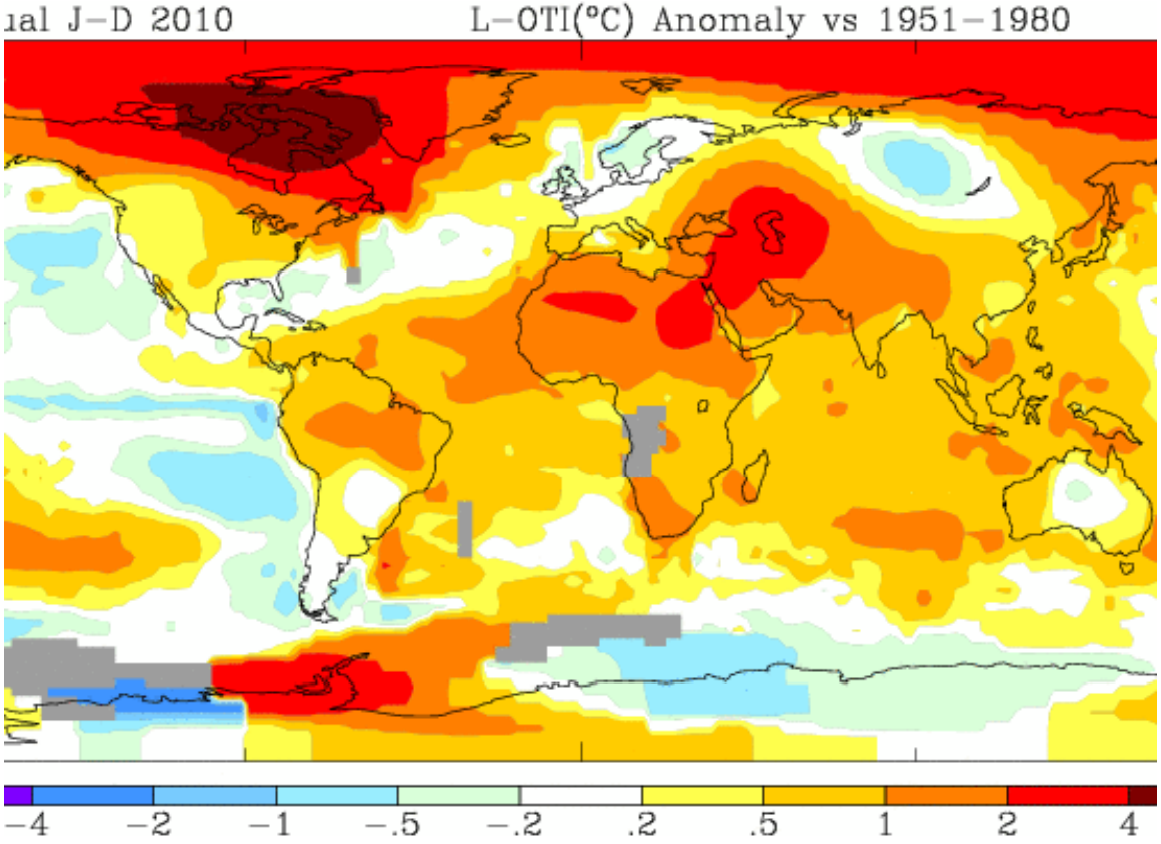
CLIMATE CHANGE

Climate change is a challenge!

- Causes are not well understood – even controversial
- The impact is not clear – even confusing
- Little agreement about what we can do about it – even serious doubt that anything can be done.

The temperature is rising!

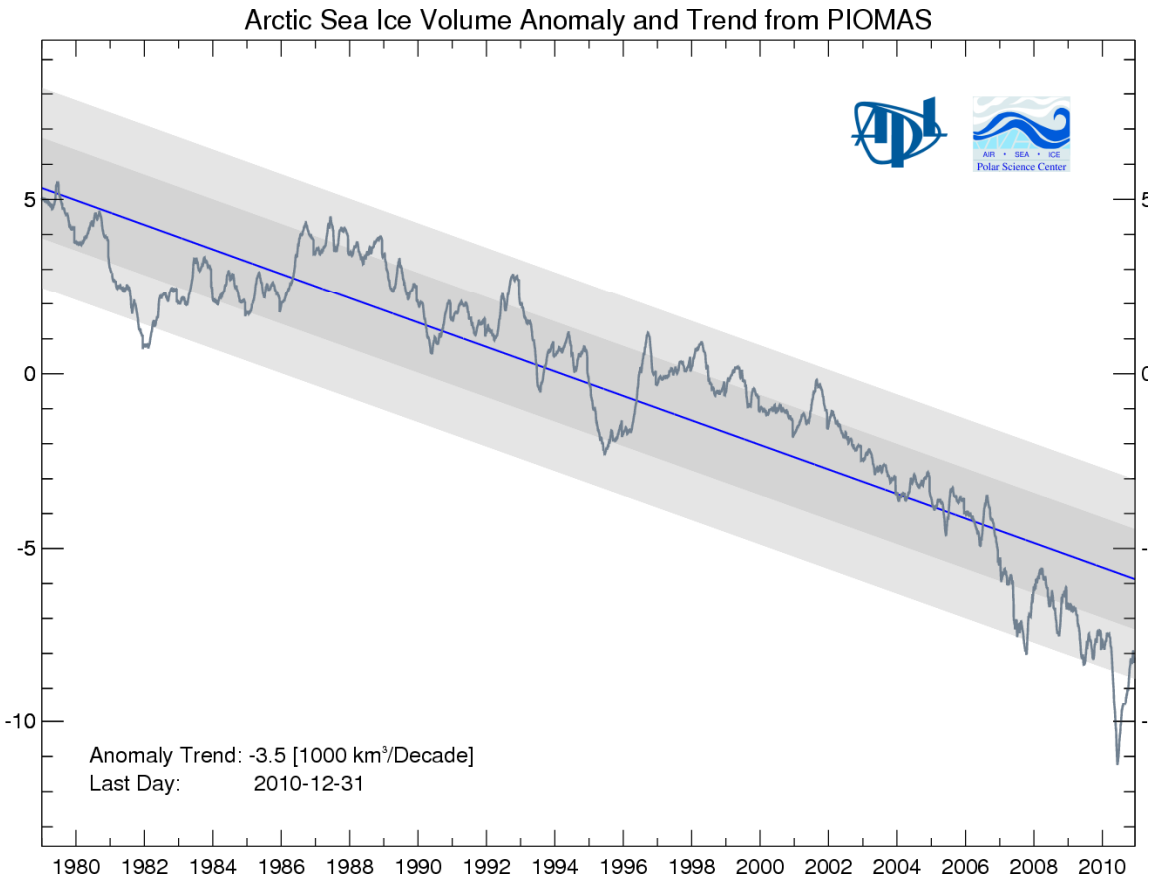
- While some say it is getting colder, the evidence is clear that it is getting warmer.
- 2010 tied with 2005 as the warmest year in recorded history.



2010 Temperature Anomalies Compared with a Base Period of 1951-1980

Source: Map generated from National Aeronautics and Space Administration, Goddard Institute for Space Studies, "GISS Surface Temperature Analysis: Global Maps from GHCN Data," at data.giss.nasa.gov/gistemp/maps/, viewed 12 January 2011.

Arctic sea ice is melting fast!!



Arctic Sea Ice Volume Anomaly

Arctic Sea Ice Volume Anomaly from PIOMAS and the NASA ICESat satellite in November for each year relative to the 2003-2007 mean ice volume. ICEsat Ice volume is from Kwok et al. 2009.

Dynamics of loss of sea ice

- Reflection of the sun's thermal energy is reduced. Ice normally reflects about 85% of the sun's energy.
- The open ocean absorbs about 85% of the sun's energy.
- The result is rapid warming of the Arctic Ocean.
- This thermal energy in the ocean then keeps the Arctic region warmer.

What is so bad about a warmer Arctic?

- It speeds the melting of Greenland's massive sheet of ice. Greater risk of **sea level rise.**
- It affects lower latitudes in surprising and disruptive ways. e.g. Massive snow fall
- It speeds the thawing of Permafrost. Greater risk of **methane emissions**.

Something few people know:

In the last 100,000 years, the earth has experienced abrupt climate change **23 times!**

We've learned this from the ice core samples taken from the Greenland ice sheets.

How abrupt? 14 to 18 degrees F over an average period of ten years!!*

Can it happen again?

*Richard B. Alley, The Two-Mile Time Machine, Princeton University Press, 2000.

Here is one possible scenario

i.e. one potential Black Swan

The threat of methane

- Methane is 25 times more powerful a greenhouse gas than CO_2 over 100 years. (IPCC 4th Assessment Report)
- Methane's life in the atmosphere is only 12 years.
- Methane's strength is 100 times that of CO_2 when first emitted and it stays close to that for the first few years.[1]
- There are an estimated 1 trillion tons of carbon in the top 3 meters of the Permafrost, much of it waiting to be converted to methane as it thaws.[2]
- Scientists suggest that 90% of the top 3 meters of the Permafrost may thaw this century.[3]
- Just 1 billion tons of one thousand billion is already equivalent to 3 times the CO_2 we are now emitting.

1. Interview: Daniel Lashof, Director, Climate Center, National Resources Development Council, 2007.

2. Edward A.G. Schuur et. al., Vulnerability of Permafrost Carbon to Climate Change: Implications for the Global Carbon Cycle, BioScience 58(8):701-714. 2008

3.

Methane and the open Arctic Ocean

- The combination of increased thermal energy from the Arctic Ocean and the increased thermal radiation from methane speed the thawing of permafrost, causing more rapid global warming.
- The combined effect can cascade.
- Not probable, just possible.

As a risk manager,

your major concern is more

near-term than long-term

Extreme Weather is NOW!

- Extreme weather events worldwide have increased dramatically.
- No one event can be tied to climate change.
- The pattern across events strongly suggests that rising temperatures are responsible.
- Higher temperature increases the amount of water vapor the atmosphere can hold.
- Combined they cause both flooding and droughts.

Risk Management and Climate Change

- There need not be concern over the cause but there should be agreement that major climate changes are happening.
- The U.S. Government is hard at work providing their best estimates of impact.
- Their output should be used for planning.
- There will be carbon-related regulations such as in Calif. that will require compliance.

Unsure Carbon and CO_2 Policies

- These disrupt strategic planning and operations.
- Federal and state legislation and regulation have little consistency and conflict reigns.
- Scientists are not communicating well and many politicians are making unfounded scientific judgments.
- Risk managers need to stick to the science, not the politics.

ENERGY ISSUES ARE PARAMOUNT

Among them:

- Fuel demand is increasing while supply is not, causing prices to rise.
- Environmental issues cloud new coal and nuclear power plants needed for anticipated increase in demand for electricity.
- Power from wind, solar, etc. can help some but it does not meet base load requirement (24/7).

More Energy Issues

- Biofuels have limitations because of high cost of production and conflict with food production.
- Next generation biofuels are not ready. They will still produce carbon dioxide emissions.
- Wind and solar energy have high capital cost and only intermittent power. They may be a good source of power if the grid goes down.
- Electric vehicles have potential but are expensive and the grid cannot handle large numbers of them.

Energy Solutions

- Best current strategy is energy conservation to lower demand.
- Being Green through conservation, recycling and more, helps the bottom line and generates customer/client satisfaction.
- Increasing fuel cost will provide opportunities for development of new technologies and services.
- We need to look to science.

How to judge science from science fiction.

- This is not easy. There is too much conflicting information esp. regarding climate change.
- Scientists are reluctant to get involved in politics and stay silent. Climate scientists believe in climate change (98% of them).
- Look if information comes from peer-reviewed journals. Don’t accept absolutes. Scientists will express some doubt. Risk management is about probabilities.

WATER SCARCITY

Water scarcity is upon us

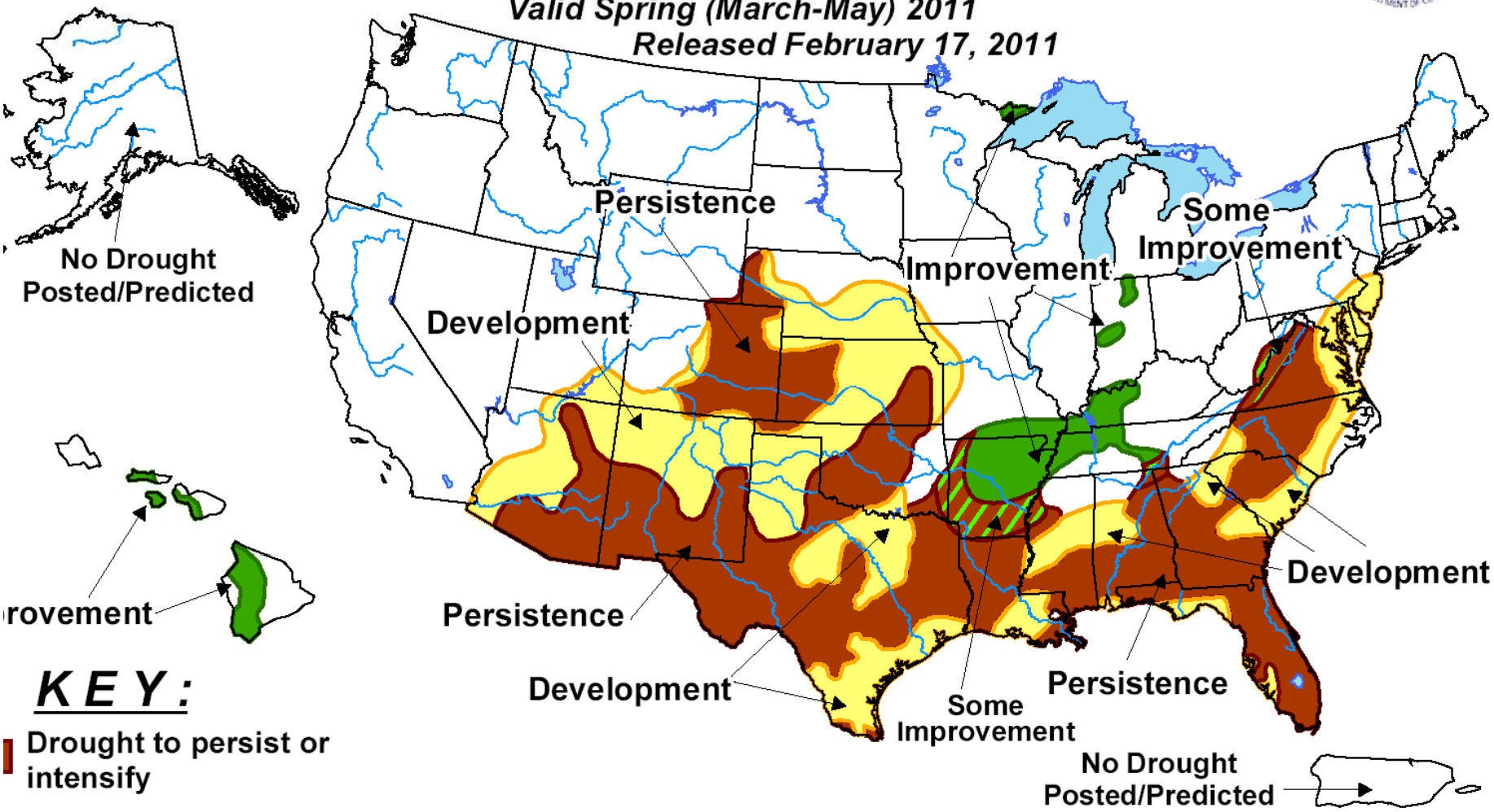
- This is already a critical problem. As the planet warms, droughts become more prevalent.
- Population growth is partly responsible.
- Water issues are arising in parts of the U.S.

U.S. Seasonal Drought Outlook

Drought Tendency During the Valid Period

Valid Spring (March-May) 2011

Released February 17, 2011

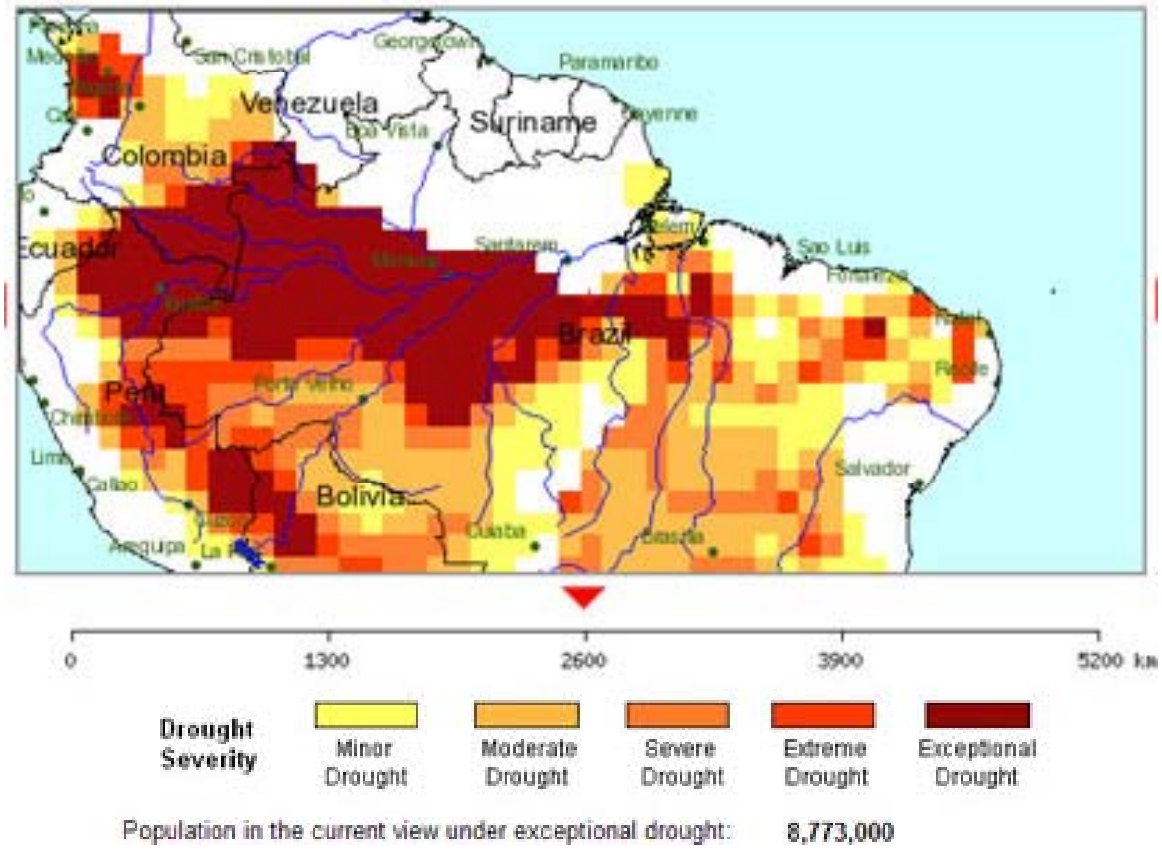


K E Y :

- **Drought to persist or intensify**
- **Drought ongoing, some improvement**
- **Drought likely to improve, impacts ease**
- **Drought development likely**

Depicts large-scale trends based on subjectively derived probabilities guided by short- and long-range statistical and dynamical forecasts. Short-term events -- such as individual storms -- cannot be accurately forecast more than a few days in advance. Use caution for applications -- such as crops -- that can be affected by such events. "Ongoing" drought areas are approximated from the Drought Monitor (D1 to D4 intensity). For weekly drought updates, see the latest U.S. Drought Monitor. NOTE: the green improvement areas imply at least a 1-category improvement in the Drought Monitor intensity levels, but do not necessarily imply drought elimination

Extreme Drought in the Amazon



Water Scarcity cont'd

This is a worldwide phenomenon that has already begun and threatens to create severe challenges. Here are some recent headlines in science magazines:

"…The Amazon's 3 'hundred-year droughts' in the last 15 years."

"Water Shortages Loom as Northern China's Aquifers Are Sucked Dry"

"Drought turns southern China into arid plain"

"Russia counts the cost of drought and wildfires"

"Severe drought threatens millions in Somalia"

'Yemen's capital 'will run out of water by 2025'

"Drought May Threaten Much of Globe Within Decades"

"Land 'evapotranspiration' taking unexpected turn: Huge parts of world are drying up"

"80 Percent of Global Water Supplies at Risk"

"Groundwater depletion rate accelerating worldwide"

Water Scarcity cont'd

- Risk Managers needs to look at future plans (and even current operations) in regard to water availability. This will affect supply chains.
- Water also affects energy supply. Many power plants depend on water for cooling.
- Water scarcity will affect agriculture, food availability and food prices.
- Water scarcity will cause major conflicts.

PANDEMICS

Pandemics

- H1N1 virus reached pandemic levels in 2009.
- It was less virulent than expected but it infected about 55 million Americans with as many as 16,000 deaths and more than 360,000 hospitalizations, said the CDC.[1]
- A study by Mercer LLC of 1,000 employers across the U.S., Latin America, Canada, Asia and Europe found that only 25% have integrated contingency plans in the event of an outbreak.[2]

1. Reuters, Jan 15, 2010
2. http://www.businessinsurance.com/apps/pbcs.dll/article?AID=/20091221/NEWS/912219994#.

Pandemics cont'd

- Mercer found that 94% of employers with a plan distributed hand sanitizers, 64% started more frequent or intensive office cleaning and 54% started providing more H1N1 educational sessions.*

- Only one-third of organizations worldwide have issued guidance to their employees about the message that should be given to clients and suppliers should business be affected by the spread of the virus. (also Mercer)

*http://www.businessinsurance.com/apps/pbcs.dll/article?AID=/20091221/NEWS/912219994#

Pandemic Insurance Coverage

- The principal liability exposure will be alleged negligence (failing to protect against exposure to the virus).
- Business interruption coverage may not cover losses. Check policies and investigate options.
- It pays to do small things that have a big payback in employee health.

Some small things for employee health

- Sunshine makes a big difference. Facilitate access outdoors during mid-day when there is sun and comfortable temperature. The H1N1 pandemic was seasonal when people were mostly indoors. Sunshine provides needed vitamin D. Many studies support this. Visit www.vitaminDcouncil.org.

- Vitamin D3 capsules are small, easy to swallow, very cheap and strongly protective.

More small things for employee health

- Use the Vitamin D Council recommendation for dose, backed by hundreds of scientific studies, not government recommended levels set by committees that appear to have industry bias.
- You will be amazed at all of the illnesses that vitamin D can help avoid. Make vitamin D available to employees regularly, not just for pandemics.
- Set up hand sanitizer stations throughout the workplace.

For the next pandemic

- Review plans to operate with diminished personnel and a drop in supplier capability.
- Review telecommunications capability for many people to work from home. Smart phones can help.
- Review how travel, meetings and conferences will be affected.
- Work with public health and other public services.

Resources for Pandemics

- http://global.marsh.com/risk/pandemic/index.php#Resources
- http://www.pandemicflu.gov/
- http://www.flu.gov/
- http://www.cdc.gov/flu/tools/fluaid/
- http://www.cdc.gov/h1n1flu/
- http://www.rims.org/RESOURCES/BUSINESSCONTINUITYANDPANDEMICS/Pages/default.aspx
- http://www.osha.gov/Publications/influenza_pandemic.html
- http://bioethics.iu.edu/reference-center/pandemic-influenza/
- http://nnlm.gov/ep/disaster-plan-templates/pandemic-planning/
- http://www.hhs.gov/pandemicflu/plan/appendixj.html
- http://www.lrc.fema.gov/path_pandemic.html

CYBER SECURITY

- **Cybercrime is rampant.** In 2010, McAfee detected an average of 60,000 new pieces of malware each day.*
- There is a vast array of professional services to help you secure your systems.
- There is a big push now to move companies to the “cloud”. It appears to have value. There is higher efficiency and the cloud service companies assure adequate security.

*http://www.mcafee.com/us/resources/reports/rp-good-decade-for-cybercrime.pdf

Cyber Security cont'd

- The Internet is a fabulous innovation. We accomplish so much with it. So much more business can be done. We now have our social networking and smart phones to enhance our personal lives. How wonderful! **Not!**
- We have given our enemies the means to cause us **grave harm**. We are so dependent on the Internet that its loss would be **catastrophic.**

Cyber Security cont'd

- The Stuxnet worm that damaged Iranian nuclear development operations was just a start.
- "A malicious computer attack that appears to target Iran's nuclear plants can be modified to wreak havoc on industrial control systems around the world, and represents the most dire cyberthreat known to industry, government officials and experts said."*

*Senate Homeland and Government Affairs Committee, Nov. 17, 2010

Cyber Security cont'd

While White House cybersecurity czar Howard Schmidt tried to quell fears by saying "**Cyber war is a terrible metaphor. Don't make it something it's not**," Others at the RSA security conference in San Francisco on Feb 15, 2011, **did not agree.**

Bruce Schneir of BT Group said, "We haven't seen offensive cyber weapons companies, but they are coming. Big defense contractors are working on this; you know they would be dumb not to."

Deputy Secretary of Defense William Lynn said in a keynote address to the gathering, "**The threat is moving up a ladder of escalation, from exploitation to disruption to destruction**."

"Perhaps the greatest concern in our judgment is a terrorist group that gains the level of disruptive and destructive capability currently possessed by nation-states," Lynn said.

Cyber Security cont'd

- If the Internet goes down for an hour, a day, a week, **what will you do? What will you lose?**
- Clearly, cyber security has improved and cyber security companies sound confident, but Homeland Security and Defense Dept. officials have a different take on it.
- Is there a Black Swan waiting in the background?
- Risk managers need to ask a lot of questions.

THE FINANCIAL CRISIS

- Did you foresee the bursting of the housing bubble? Did you do anything about that?
- Too many kept playing. The bubble was ignored for too long.
- Did you see the subprime mortgage market weaknesses? Why worry? The credit rating agencies gave the mortgage backed securities triple A ratings.

The Financial Crisis cont'd

- Did you see that bets were made using credit default swaps and synthetic CDOs against the MBS's? Those were also getting triple A ratings.
- **So much was hidden.** The credit rating agencies didn't look inside these toxic securities. They needed to please the issuers. Everybody was making money…lots of money.

The Financial Crisis cont'd

- When it all fell apart, everybody asked, "**Where were the risk managers?**" "Why didn't they see the problem and save us?"
- Of course we know why. Nobody wanted to hear the truth. "**Shut up!**" "**We need to make hay while the sun shines**." But then the sun went down and it got **real dark.**
- But now it's a windfall for risk managers. Every company wants to enhance its risk management. It's even being mandated.

The Financial Crisis cont'd

- What about those credit rating agencies (the NRSROs)? We can't trust them. They led us astray. But we need them. Risk managers need to rely on them. Can we?

- They have confessed their sins. They are avoiding conflicts of interest. They are being transparent. They seem to be playing straight.

- Legislation has changed the rules. The regulators are getting tough. Now what?

- Can there be any more surprises?

Review of potential Black Swans:

- Electromagnetic pulse
- Severe weather events
- Other climate change impacts
- Water Scarcity
- Pandemics
- Cyber Security
- Financial Crisis

Other potential Black Swans and some solutions

I'll be available after the presentation today and I'll be available here tomorrow. I'll be glad to speak with you more in depth about the risks that were covered and other risks, such as earthquakes, terrorists, volcanoes.

I can also tell you about important work that is underway to protect the electric grid and large industrial/commercial facilities from EMP.

Also, you can reach me at aroth@advfusion.com and 301 928-6314.