

(with apologies to sam)

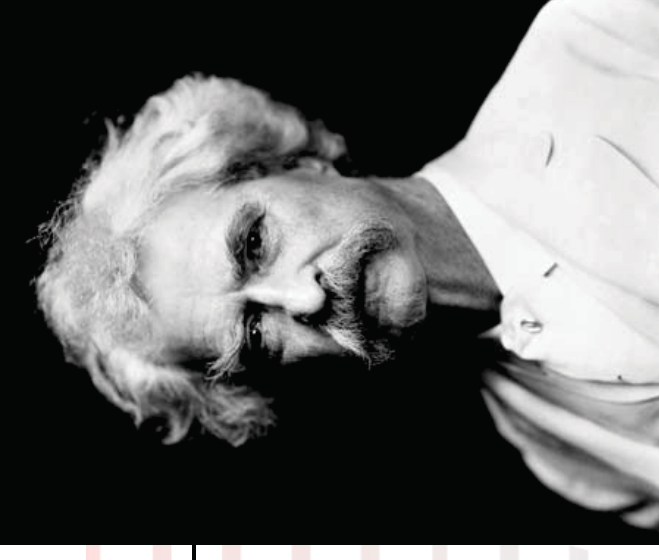
To the Physicist Sitting in Darkness

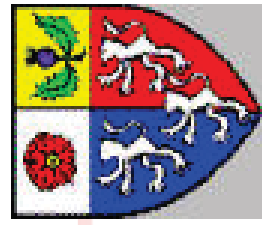
Probabilities are all well and good. And it is a fine thing to get in touch with your beliefs and feelings. Shall we bang ahead in our old-time, loud pious way, and commit new sciences to the game; or shall we sober up, sit down, and think it over first?

The Blessings-of-Subjective-Probability Trust, wisely and cautiously administered, is a Blue Chip. But Bayesians have been playing it badly of late, and must certainly suffer from it, in my opinion; they have been eager to solve every problem, especially the poorly posed ones, and

the Physicists who sit in Darkness have begun to notice it – they have noticed it and have begun to show alarm. They have become suspicious of posteriors on empirically vacuous reals, not to mention function spaces; they have begun to resist the kindly extraction of priors. More – they have begun to examine them! This is not well. The Blessings of Bayesianism are all right, and a good RC commercial property; there could not be better, in a dim light. In the right kind of light, and at the proper distance, with the goods a little out of focus, they are a desirable enticement to the Physicists who sit in darkness.

Probability theory eases the stress of decision making. And improves the outcome, but not if we adulterate it. For the Empirically Adequate and the Large Number Statistic, it is pie. But in cutting edge science, and in extrapolation, here the Physicist sitting in darkness is (almost) sure to say: “These is something curious about this – curious and unaccountable.” ... There have been lies yes, but told in a good cause, it might have worked; yet we have passed on a Shadow from one who hadn’t it to sell, and long term infrastructure investments are being made.





Doing Science in the Dark

Predictability & Understanding of Our Climate Risk: Approximations, Bugs and Insight

Leonard A. Smith
London School of Economics &
Pembroke College, Oxford

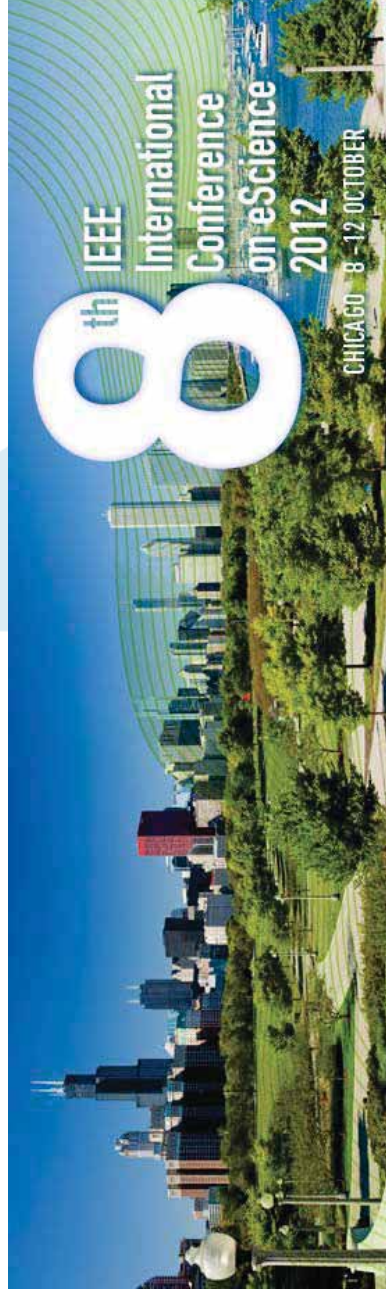
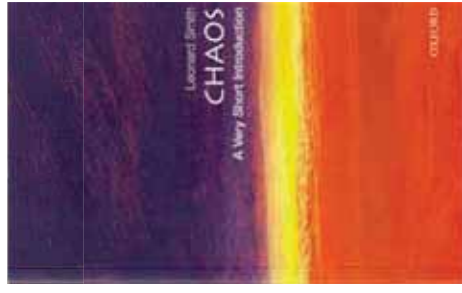
Not Possible without: H Du, A. Jarman, D Stainforth & E Suckling



Centre for
Climate Change
Economics and Policy
The Munich Re Programme: *Evaluating the Economics
of Climate Risks and Opportunities in the Insurance Sector*

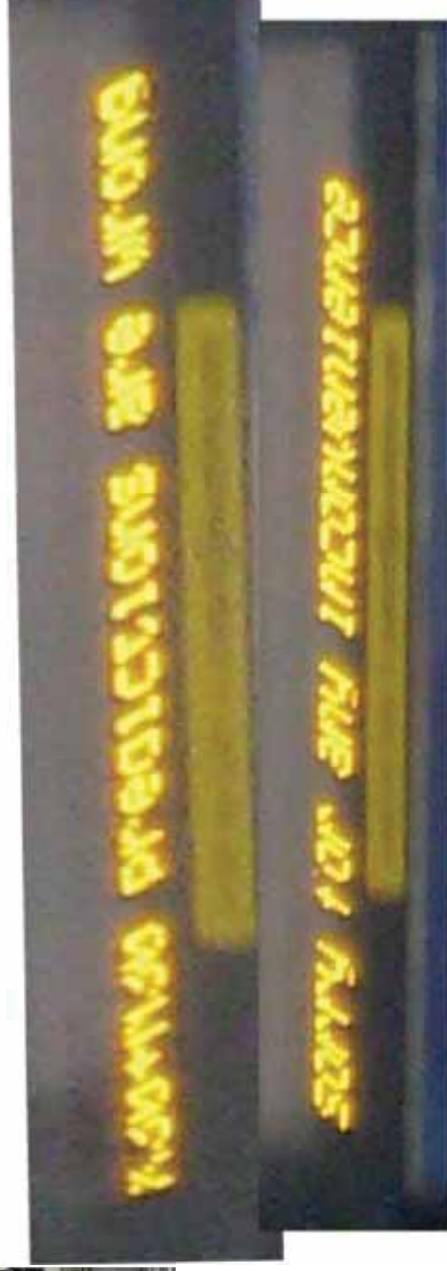


Grantham Research Institute on
Climate Change and
the Environment



What I wish to avoid

An Oxford Bus Stop in the summer of 2010:



X30+N30 predictions are wrong
Sorry for any inconvenience

Why do Predictions go wrong?

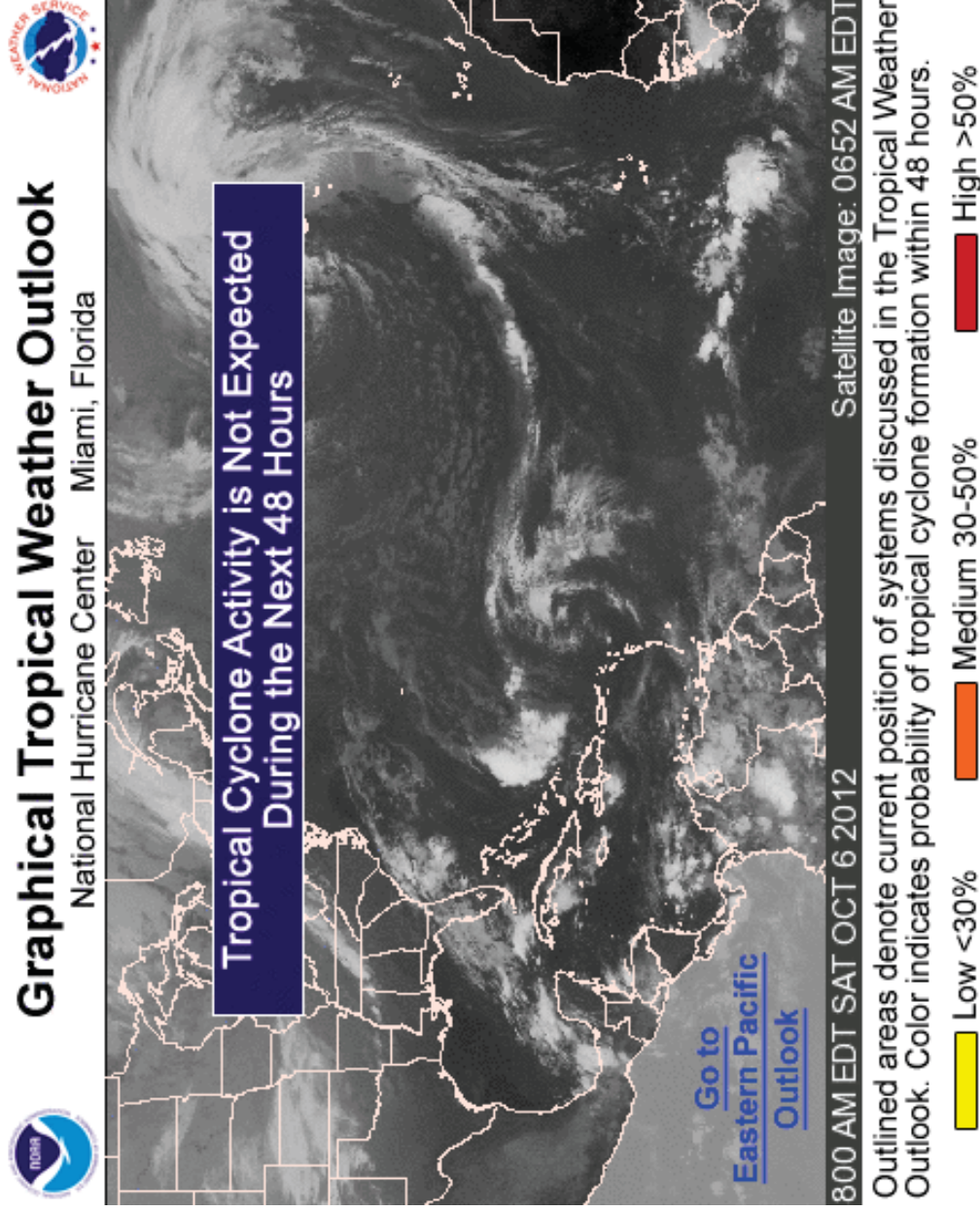
- a) Technology is Lacking
- b) Science is Lacking
- c) Political Shenanigans

(Should we hide this?)
(Can we know this?)
(Can we ignore this?)

Is it possible for Probabilistic Predictions to be “wrong”? (yes, sometimes)



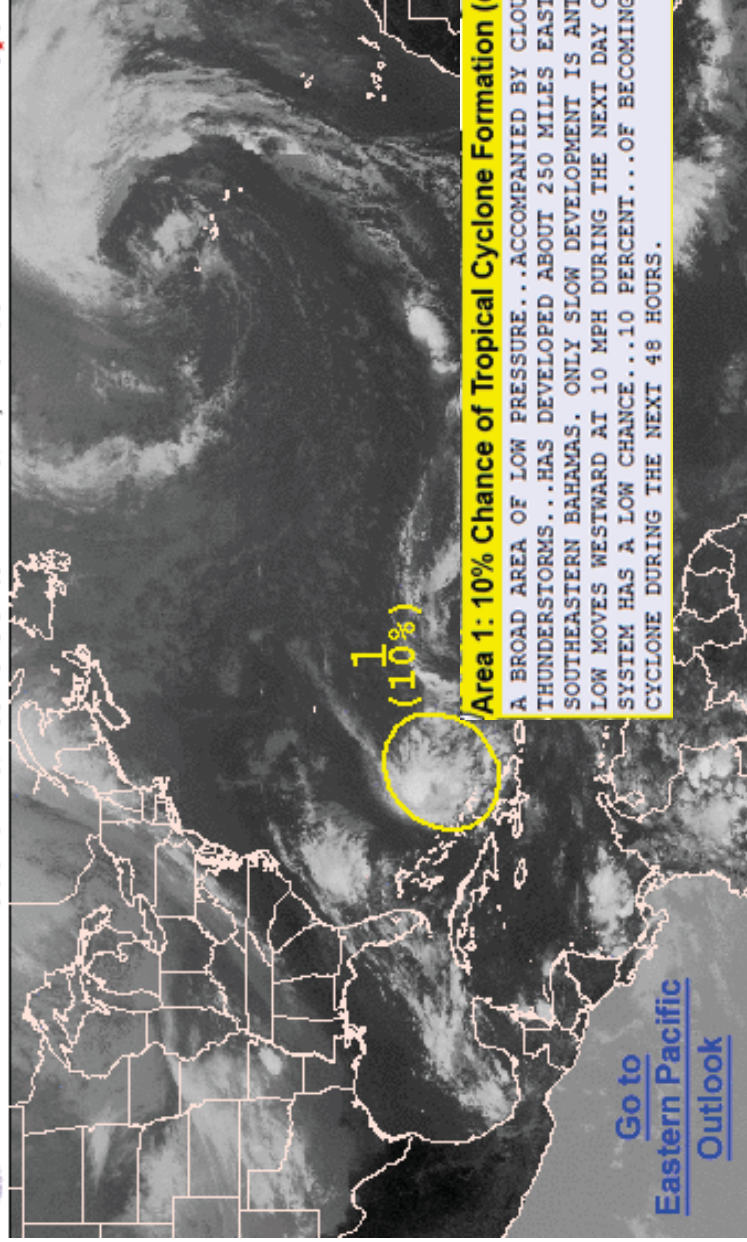
But first... a timely example for those of you flying south:





Graphical Tropical Weather Outlook

National Hurricane Center Miami, Florida



200 PM EDT SAT OCT 6 2012

Satellite Image: 1252 PM EDT

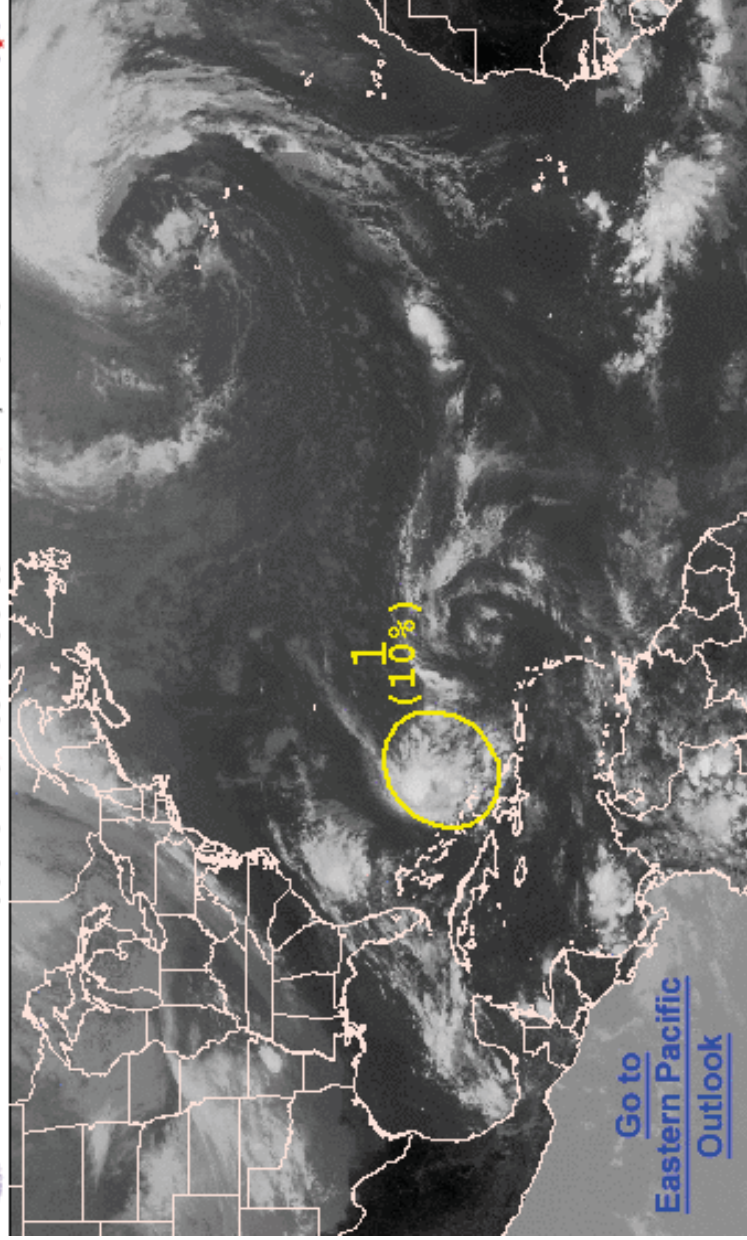
Outlined areas denote current position of systems discussed in the Tropical Weather Outlook. Color indicates probability of tropical cyclone formation within 48 hours.





Graphical Tropical Weather Outlook

National Hurricane Center Miami, Florida



200 PM EDT SAT OCT 6 2012

Satellite Image: 1252 PM EDT

Outlined areas denote current position of systems discussed in the Tropical Weather Outlook. Color indicates probability of tropical cyclone formation within 48 hours.

Low <30%

Medium 30-50%

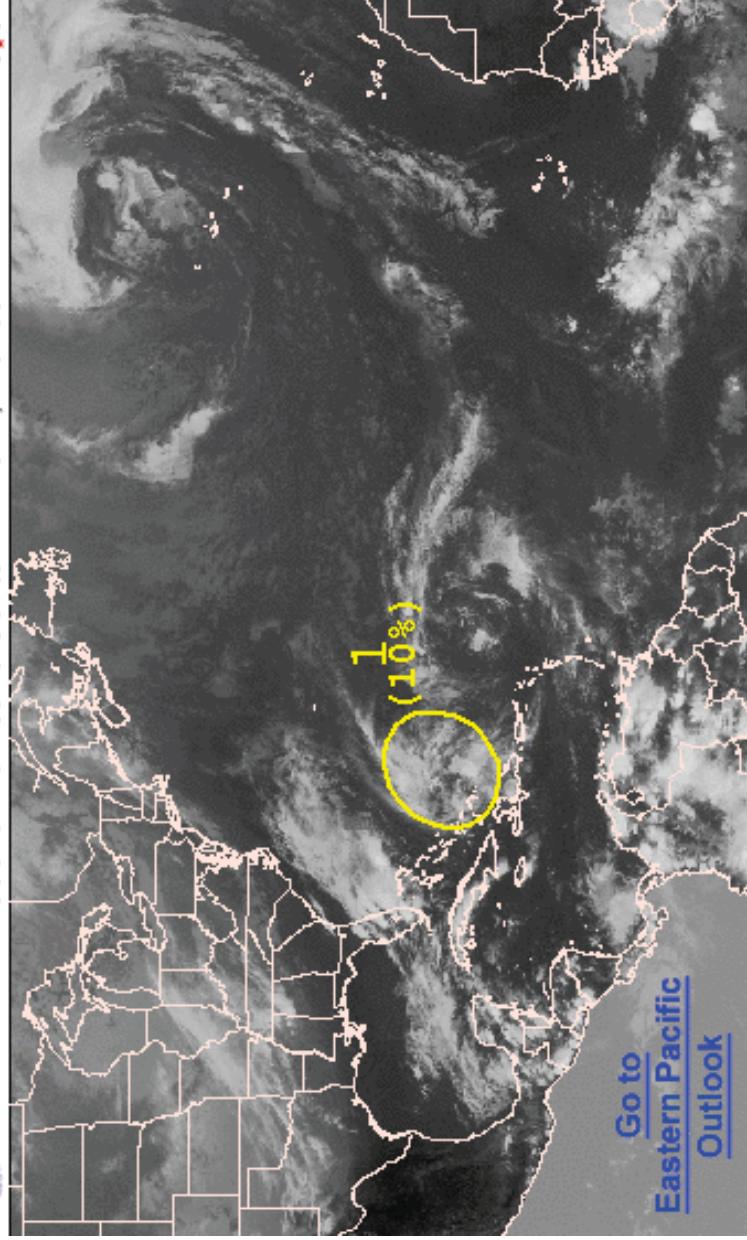
High >50%

[Go to
Eastern Pacific
Outlook](#)



Graphical Tropical Weather Outlook

National Hurricane Center Miami, Florida



800 PM EDT SAT OCT 6 2012

Satellite Image: 0652 PM EDT

Outlined areas denote current position of systems discussed in the Tropical Weather Outlook. Color indicates probability of tropical cyclone formation within 48 hours.

Low <30%

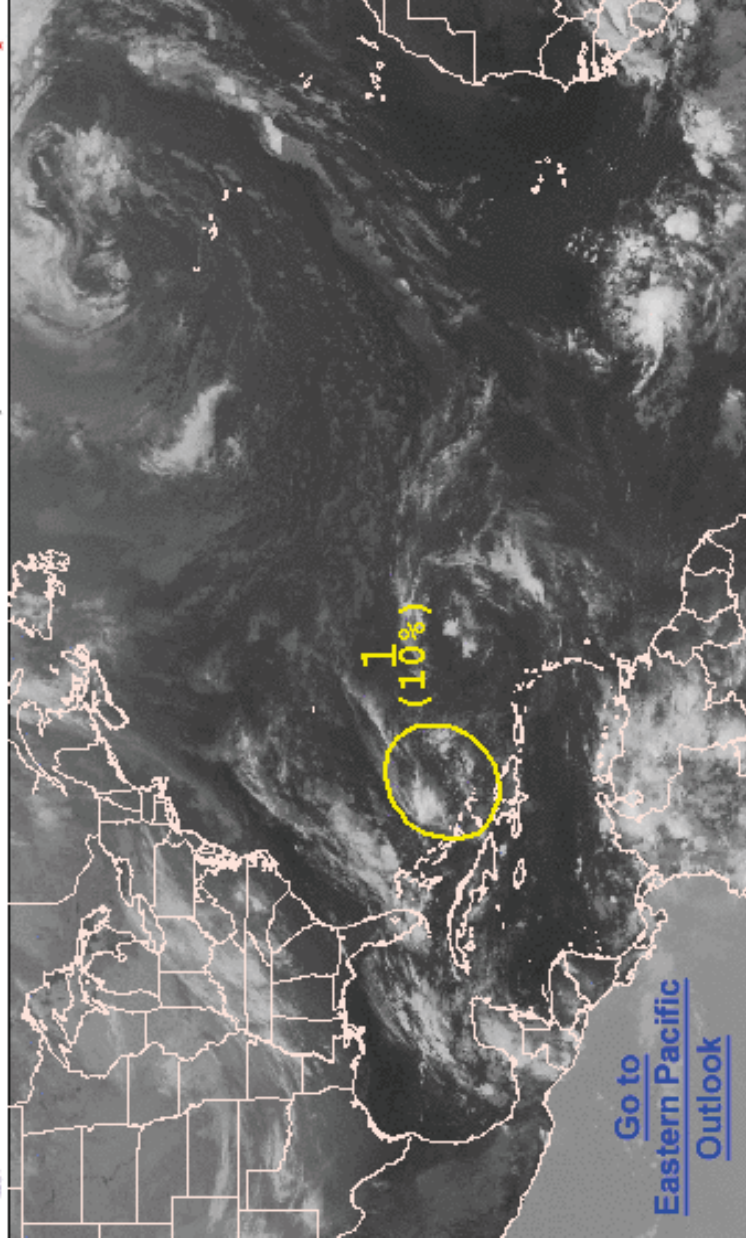
Medium 30-50%

High >50%



Graphical Tropical Weather Outlook

National Hurricane Center Miami, Florida



200 AM EDT SUN OCT 7 2012

Satellite Image: 1252 AM EDT

Outlined areas denote current position of systems discussed in the Tropical Weather Outlook. Color indicates probability of tropical cyclone formation within 48 hours.

Low <30%

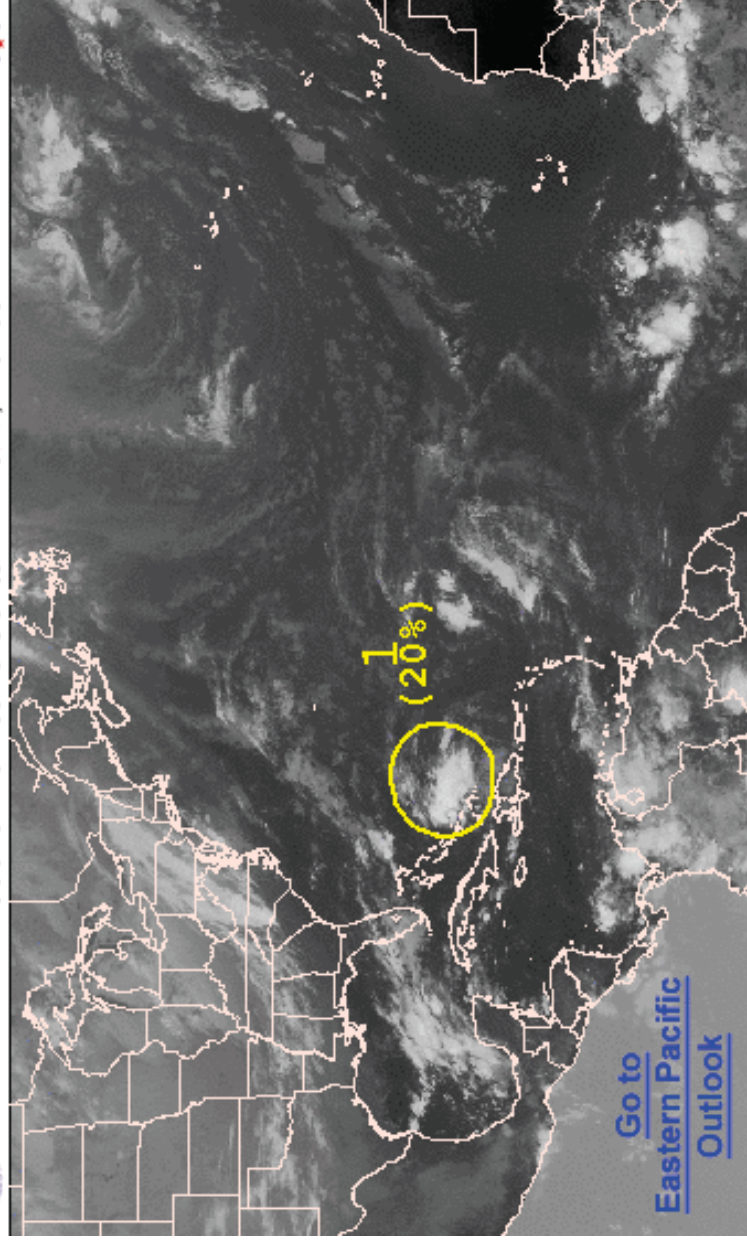
Medium 30-50%

High >50%



Graphical Tropical Weather Outlook

National Hurricane Center Miami, Florida



[Go to
Eastern Pacific
Outlook](#)

800 AM EDT SUN OCT 7 2012

Satellite Image: 0722 AM EDT

Outlined areas denote current position of systems discussed in the Tropical Weather Outlook. Color indicates probability of tropical cyclone formation within 48 hours.

 Low <30%

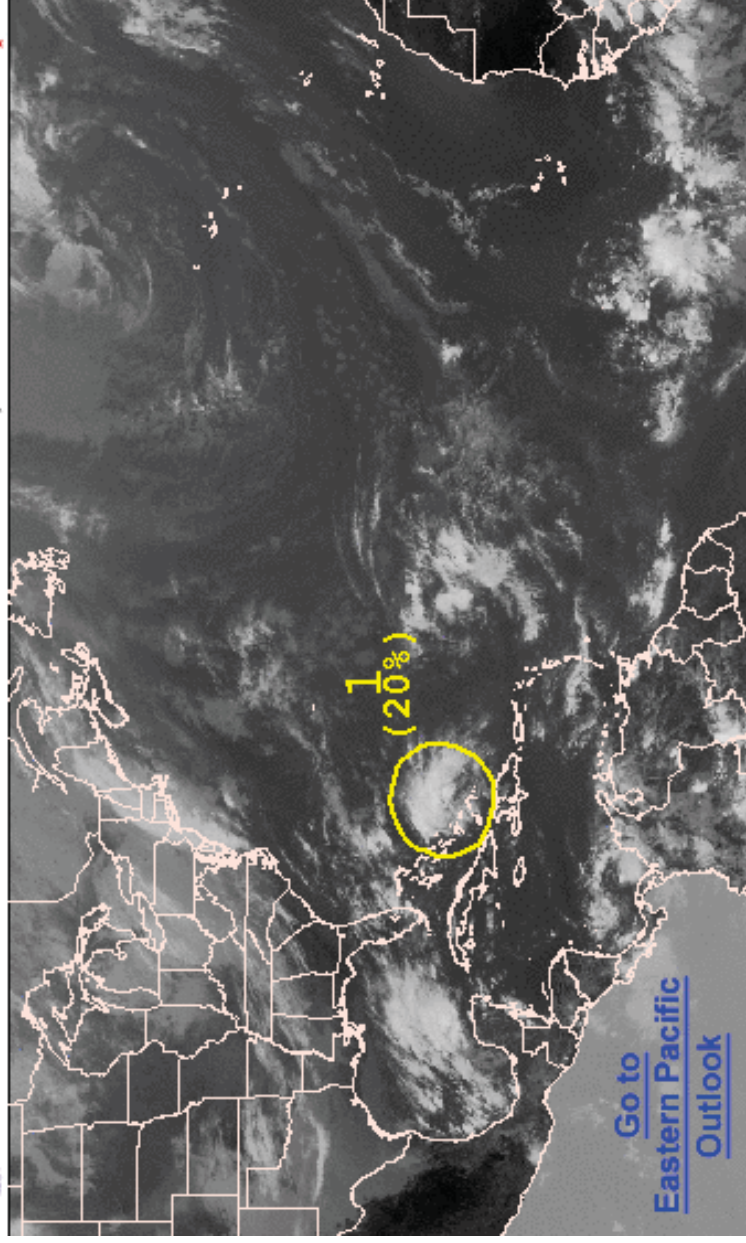
 Medium 30-50%

 High >50%



Graphical Tropical Weather Outlook

National Hurricane Center Miami, Florida



200 PM EDT SUN OCT 7 2012

Satellite Image: 0130 PM EDT

Outlined areas denote current position of systems discussed in the Tropical Weather Outlook. Color indicates probability of tropical cyclone formation within 48 hours.

Low <30%

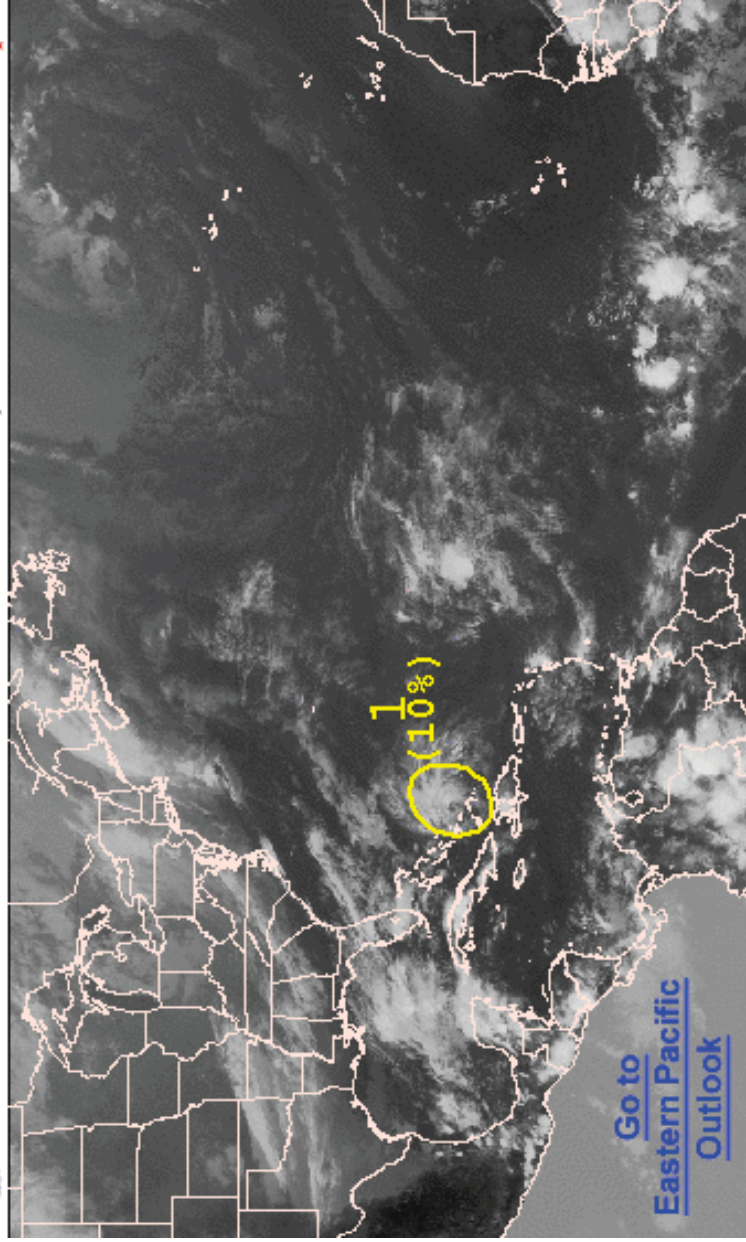
Medium 30-50%

High >50%



Graphical Tropical Weather Outlook

National Hurricane Center Miami, Florida



800 PM EDT SUN OCT 7 2012

Satellite Image: 0652 PM EDT

Outlined areas denote current position of systems discussed in the Tropical Weather Outlook. Color indicates probability of tropical cyclone formation within 48 hours.

Low <30%

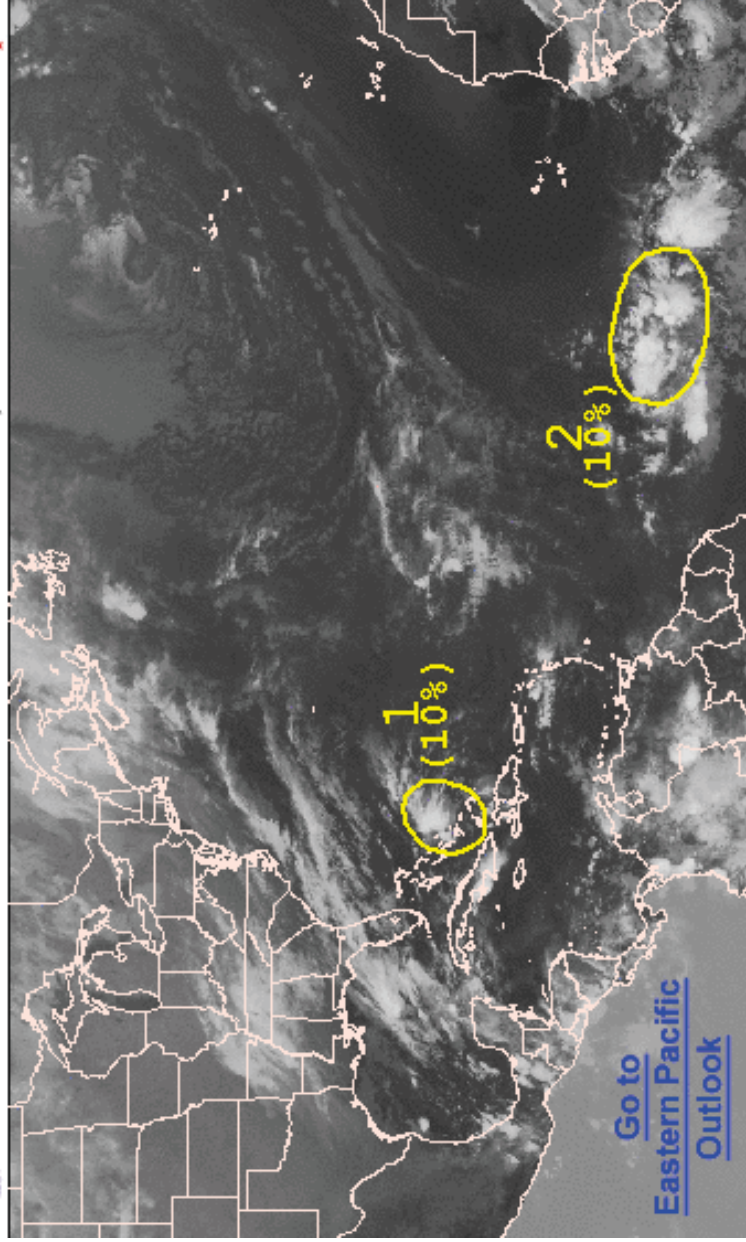
Medium 30-50%

High >50%



Graphical Tropical Weather Outlook

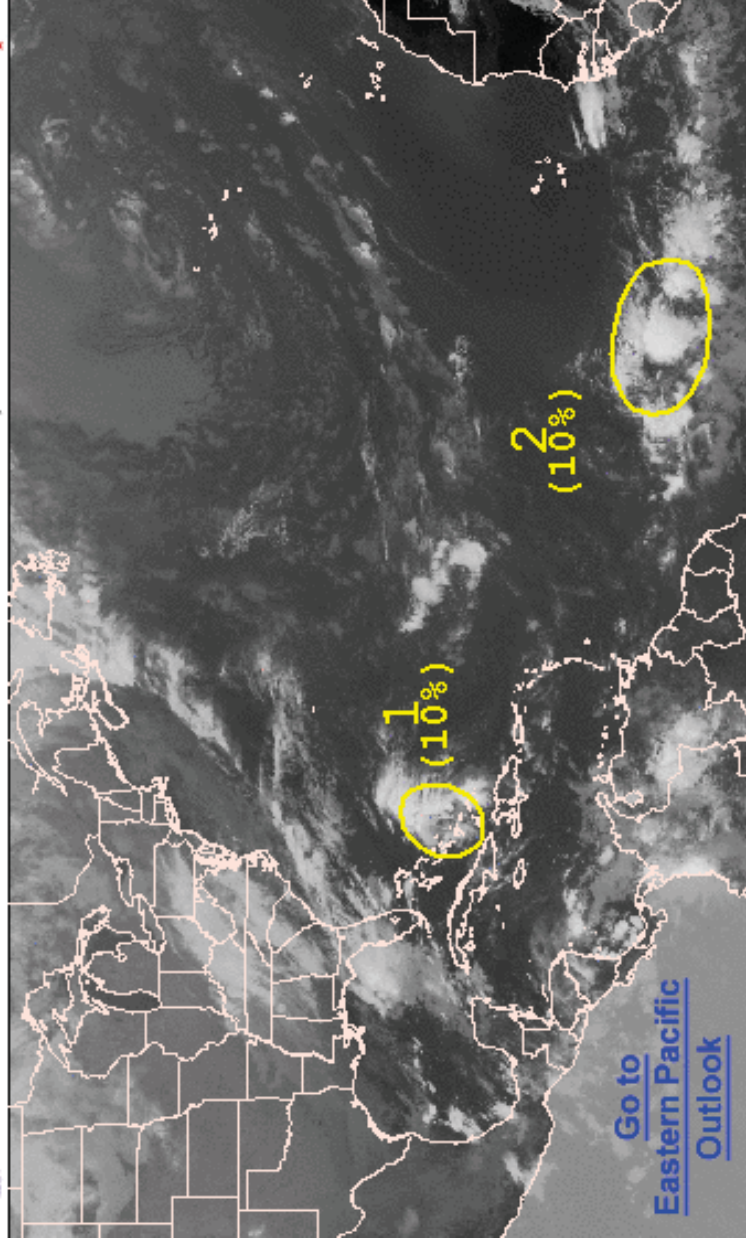
National Hurricane Center Miami, Florida





Graphical Tropical Weather Outlook

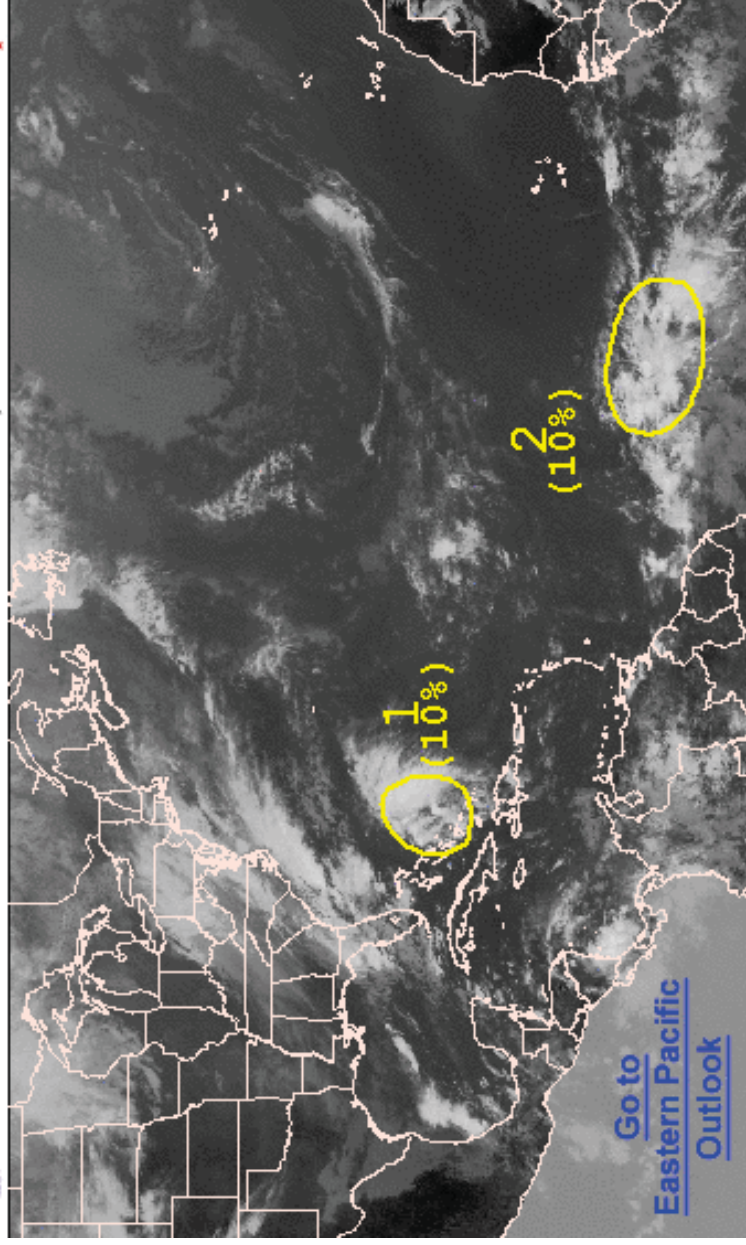
National Hurricane Center Miami, Florida





Graphical Tropical Weather Outlook

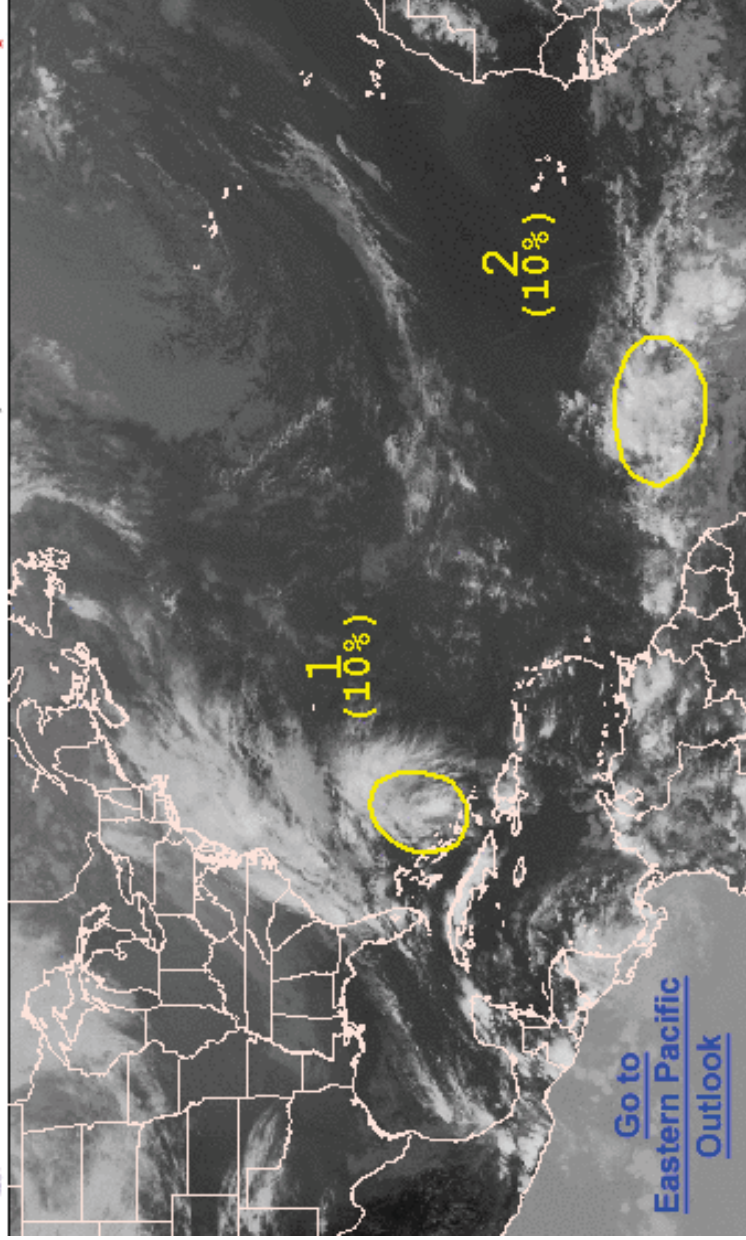
National Hurricane Center Miami, Florida





Graphical Tropical Weather Outlook

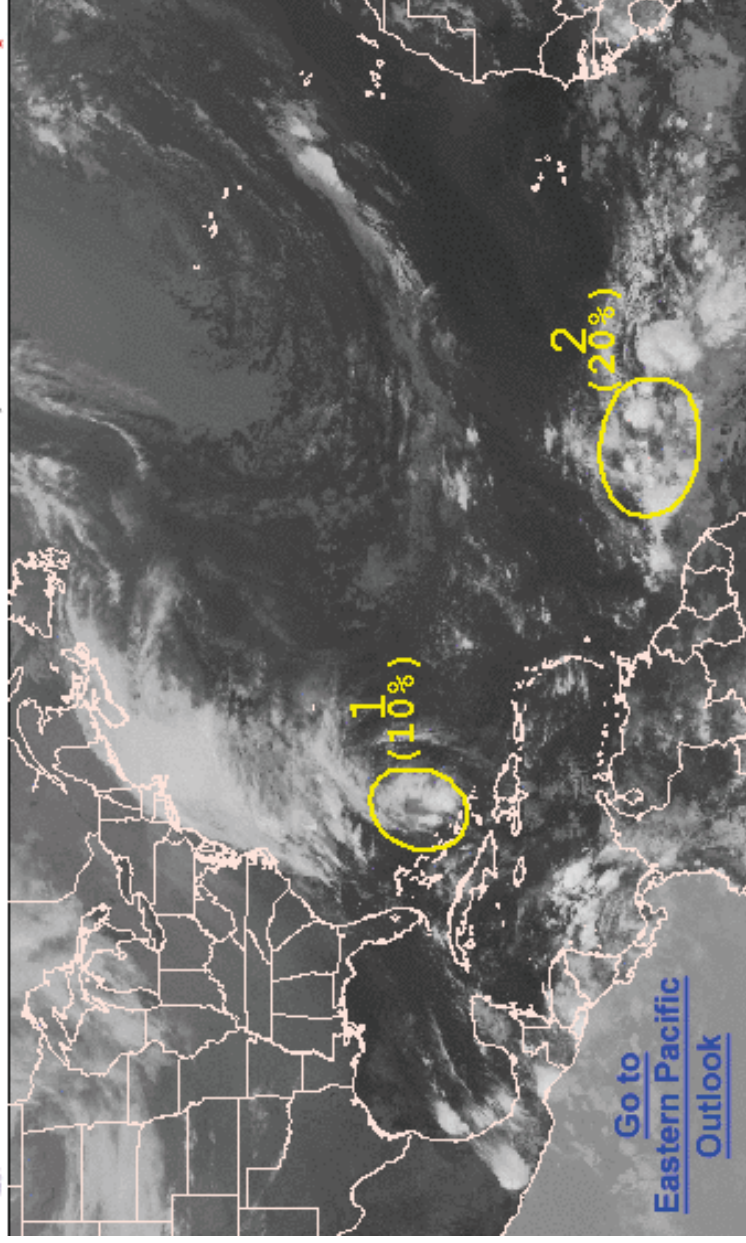
National Hurricane Center Miami, Florida





Graphical Tropical Weather Outlook

National Hurricane Center Miami, Florida



200 AM EDT TUE OCT 9 2012

Satellite Image: 0122 AM EDT

Outlined areas denote current position of systems discussed in the Tropical Weather Outlook. Color indicates probability of tropical cyclone formation within 48 hours.

Low <30%

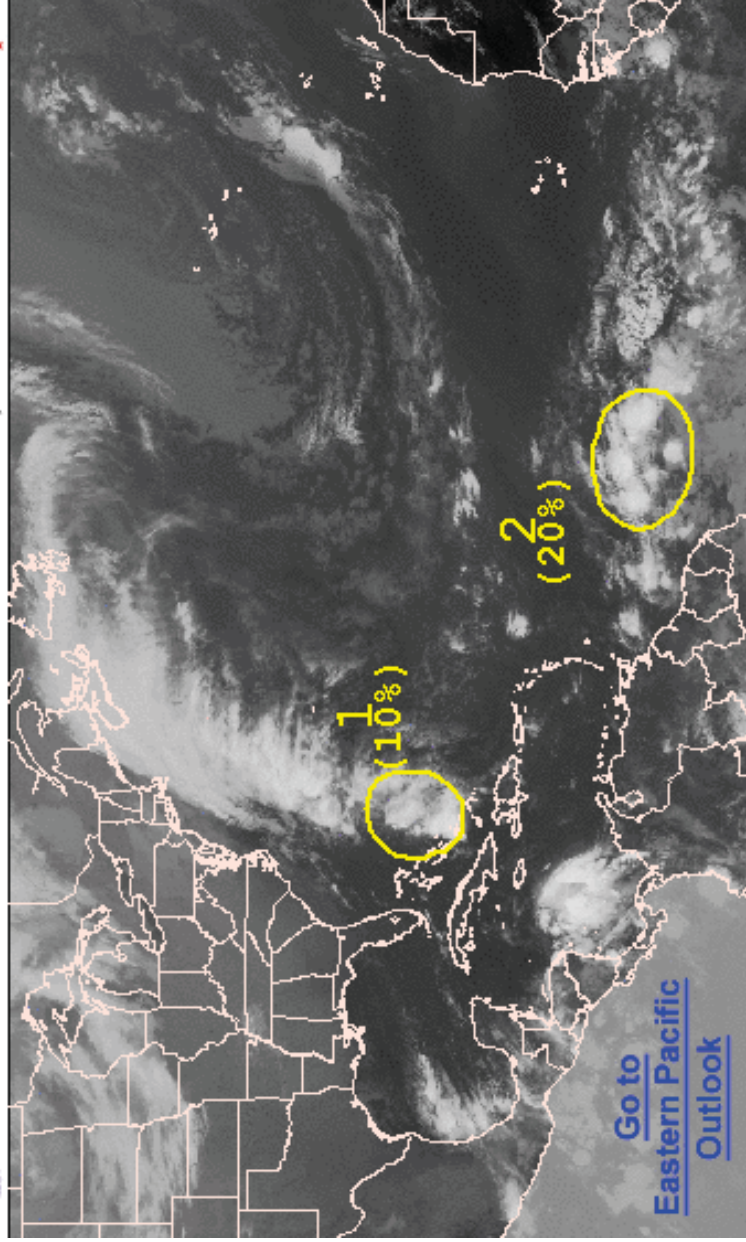
Medium 30-50%

High >50%



Graphical Tropical Weather Outlook

National Hurricane Center Miami, Florida



800 AM EDT TUE OCT 9 2012

Satellite Image: 0700 AM EDT

Outlined areas denote current position of systems discussed in the Tropical Weather Outlook. Color indicates probability of tropical cyclone formation within 48 hours.

Low <30%

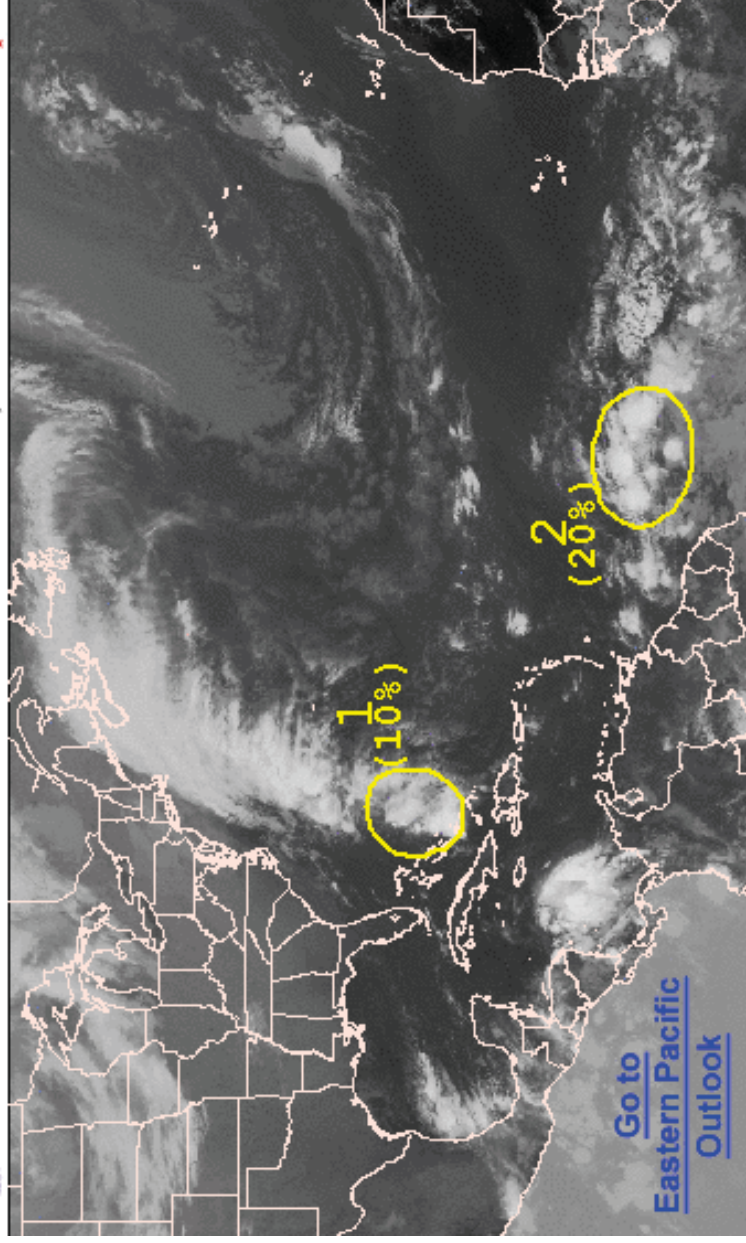
Medium 30-50%

High >50%



Graphical Tropical Weather Outlook

National Hurricane Center Miami, Florida



800 AM EDT TUE OCT 9 2012

Satellite Image: 0700 AM EDT

Outlined areas denote current position of systems discussed in the Tropical Weather Outlook. Color indicates probability of tropical cyclone formation within 48 hours.

Low <30%

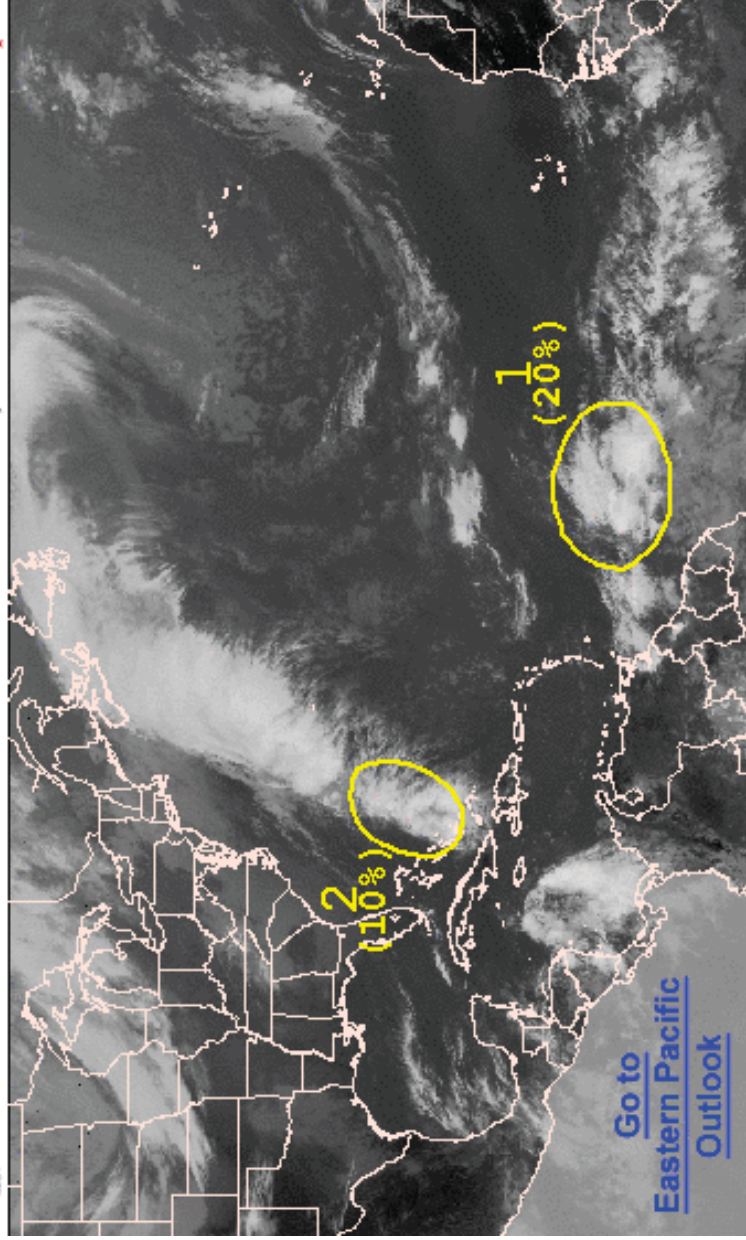
Medium 30-50%

High >50%



Graphical Tropical Weather Outlook

National Hurricane Center Miami, Florida



200 PM EDT TUE OCT 9 2012

Satellite Image: 1252 PM EDT

Outlined areas denote current position of systems discussed in the Tropical Weather Outlook. Color indicates probability of tropical cyclone formation within 48 hours.

Low <30%

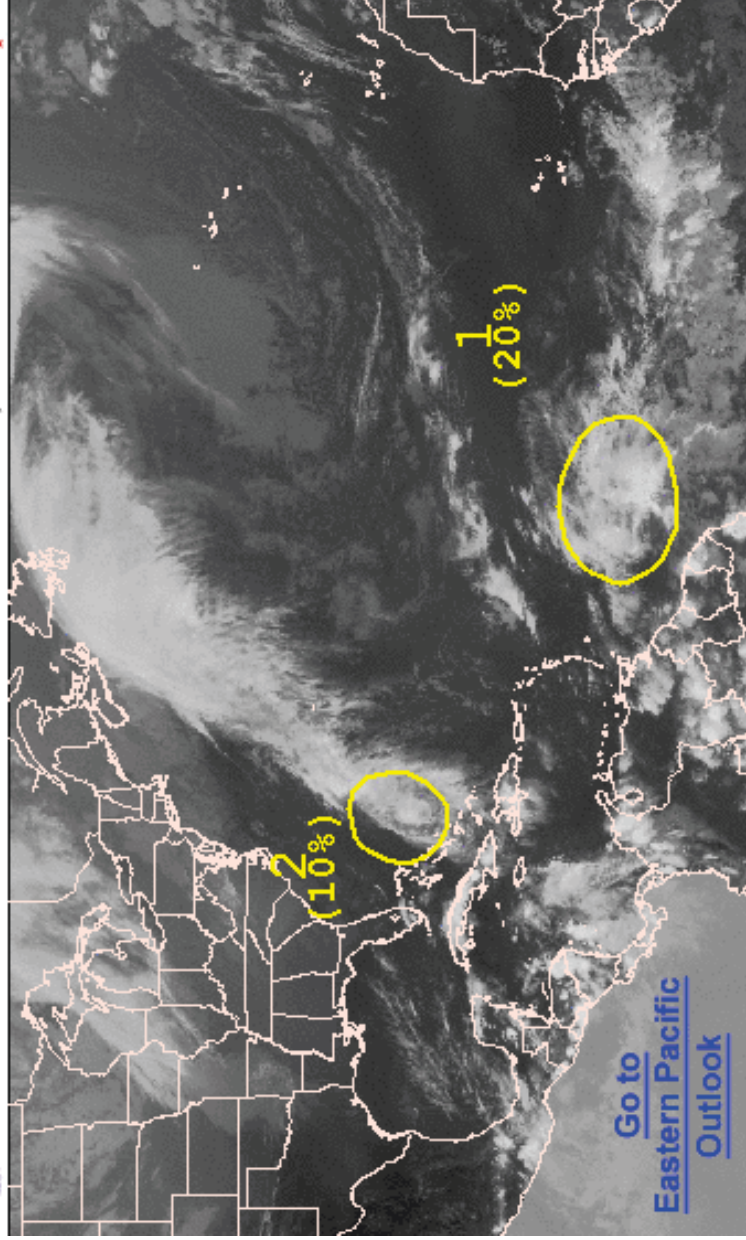
Medium 30-50%

High >50%



Graphical Tropical Weather Outlook

National Hurricane Center Miami, Florida



800 PM EDT TUE OCT 9 2012

Satellite Image: 0722 PM EDT

Outlined areas denote current position of systems discussed in the Tropical Weather Outlook. Color indicates probability of tropical cyclone formation within 48 hours.

Low <30%

Medium 30-50%

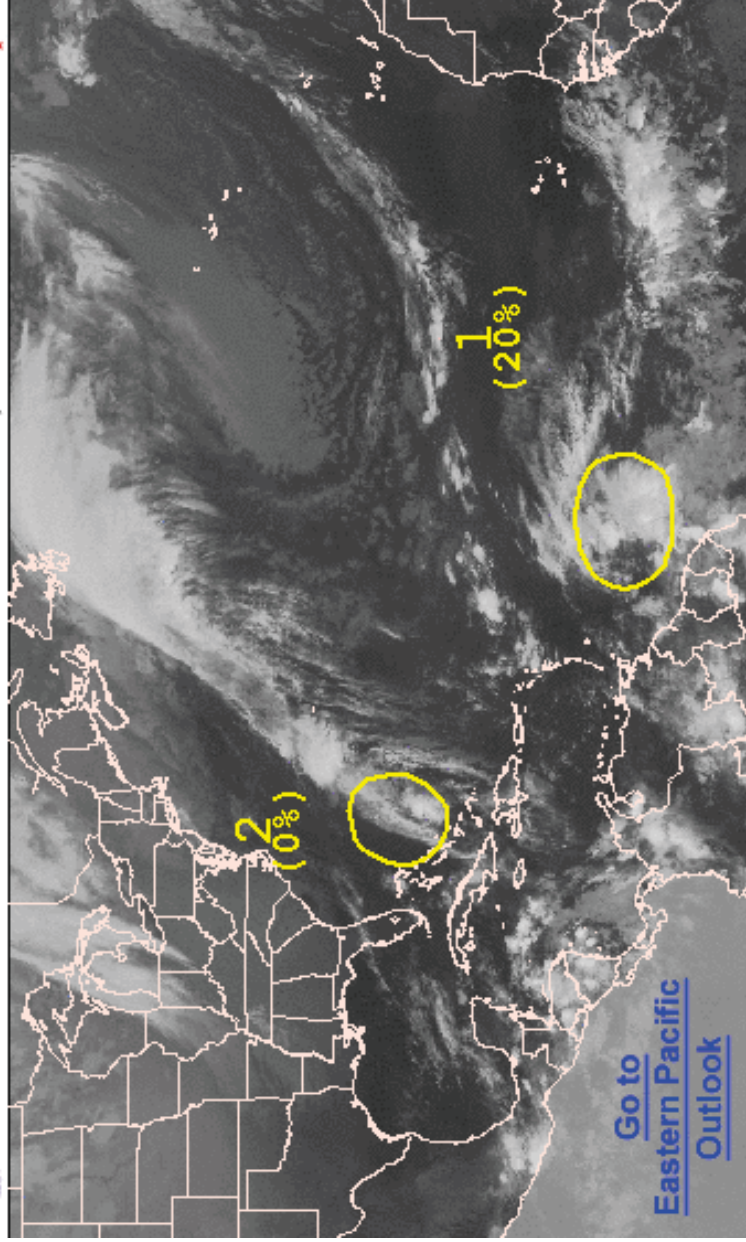
High >50%

[Go to
Eastern Pacific
Outlook](#)



Graphical Tropical Weather Outlook

National Hurricane Center Miami, Florida



200 AM EDT WED OCT 10 2012

Satellite Image: 1252 AM EDT

Outlined areas denote current position of systems discussed in the Tropical Weather Outlook. Color indicates probability of tropical cyclone formation within 48 hours.

 Low <30%

 Medium 30-50%

 High >50%

- Local forecast by "City, St" or "ZIP" Go
- Alternate Formats
 - Text | Mobile
 - Email | RSS
 - About Alternates
- Cyclone Forecasts
 - Latest Advisory
 - Past Advisories
 - Audio/Podcasts
 - About Advisories
- Marine Forecasts
 - Atlantic & E Pacific
 - Gridded Marine
 - About Marine
- Tools & Data
 - Satellite | Radar
 - Analysis Tools
 - Aircraft Recon
 - GIS Datasets
 - Data Archive
 - Development
 - Experimental
 - Research
 - Forecast Accuracy
 - Outreach & Education
 - Prepare
 - Storm Surge
 - About Cyclones
 - Cyclone Names
 - Wind Scale
 - Most Extreme
 - Forecast Models
 - Breakpoints

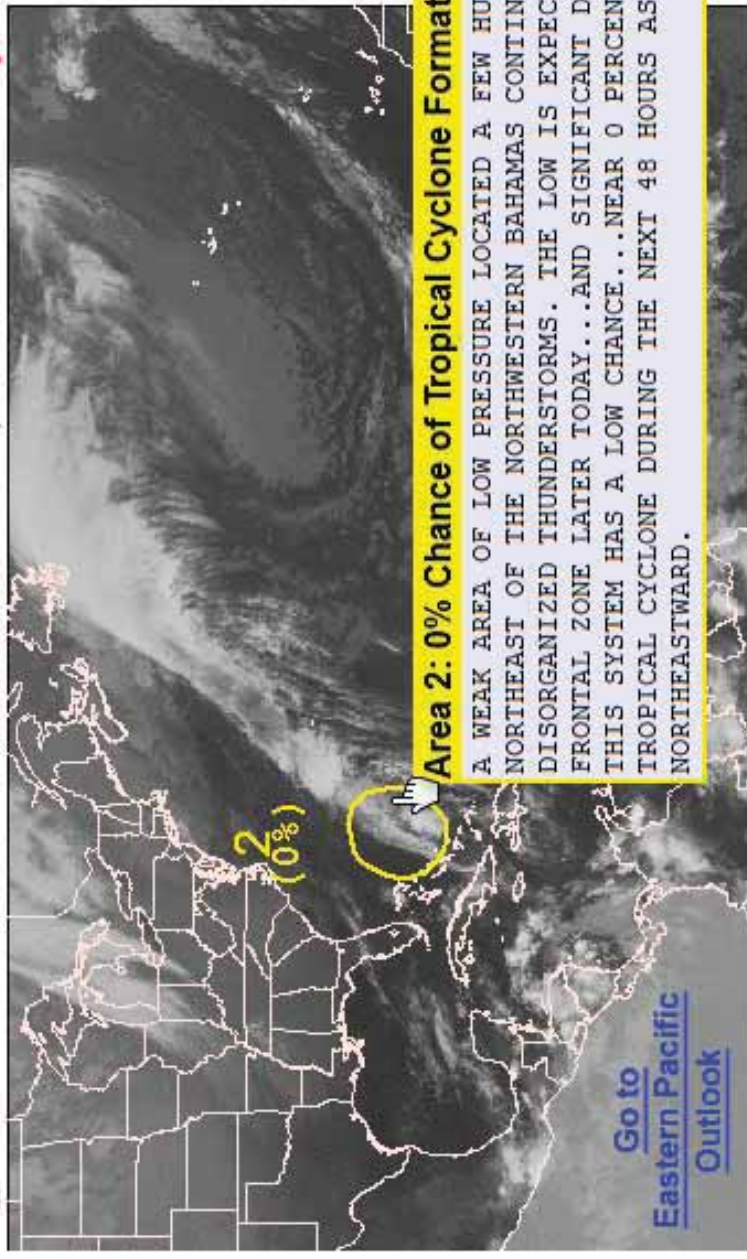
NHC Graphical Outlook Archive

« Earliest Available « Earlier Later » Latest Available »
Place your mouse cursor over areas of interest for more information



Graphical Tropical Weather Outlook

National Hurricane Center Miami, Florida



200 AM EDT WED OCT 10 2012

Satellite Image: 1252 AM EDT

Outlined areas denote current position of systems discussed in the Tropical Weather Outlook. Color indicates probability of tropical cyclone formation within 48 hours.

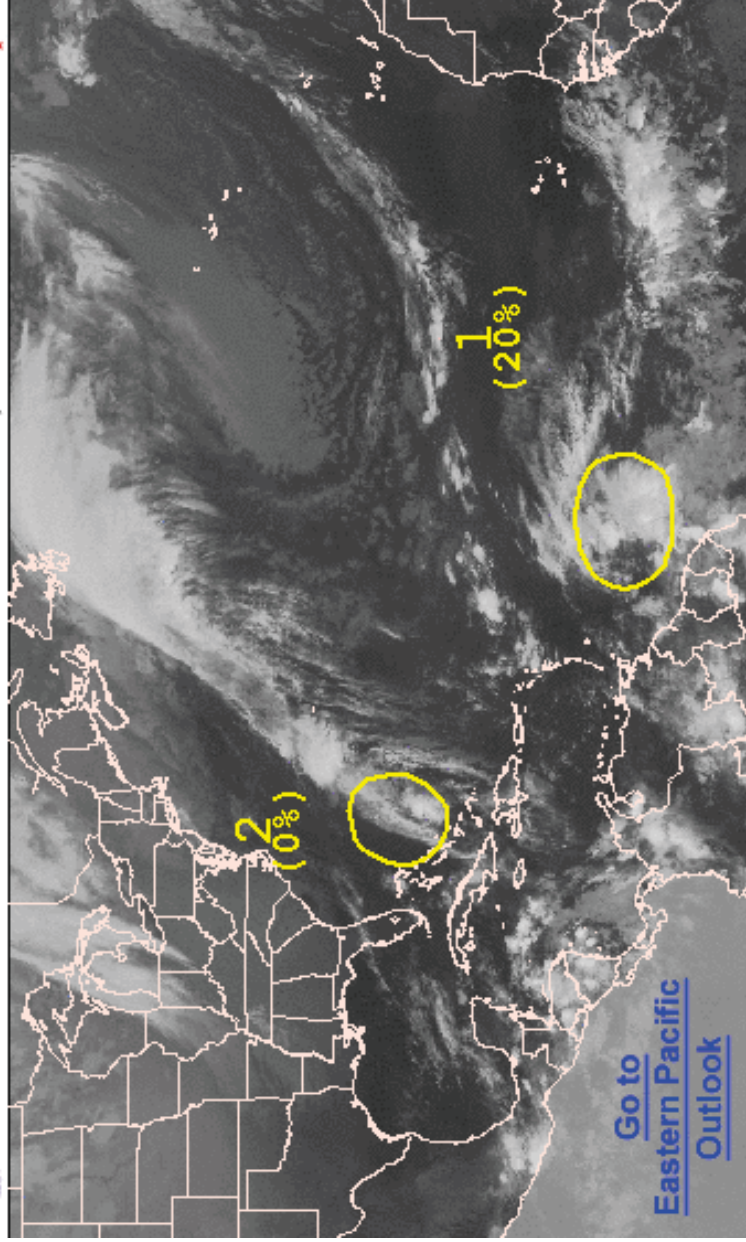
 Low <30%  Medium 30-50%  High >50%

GIS data: .shp



Graphical Tropical Weather Outlook

National Hurricane Center Miami, Florida




200 AM EDT WED OCT 10 2012

Satellite Image: 1252 AM EDT

Outlined areas denote current position of systems discussed in the Tropical Weather Outlook. Color indicates probability of tropical cyclone formation within 48 hours.

 Low <30%

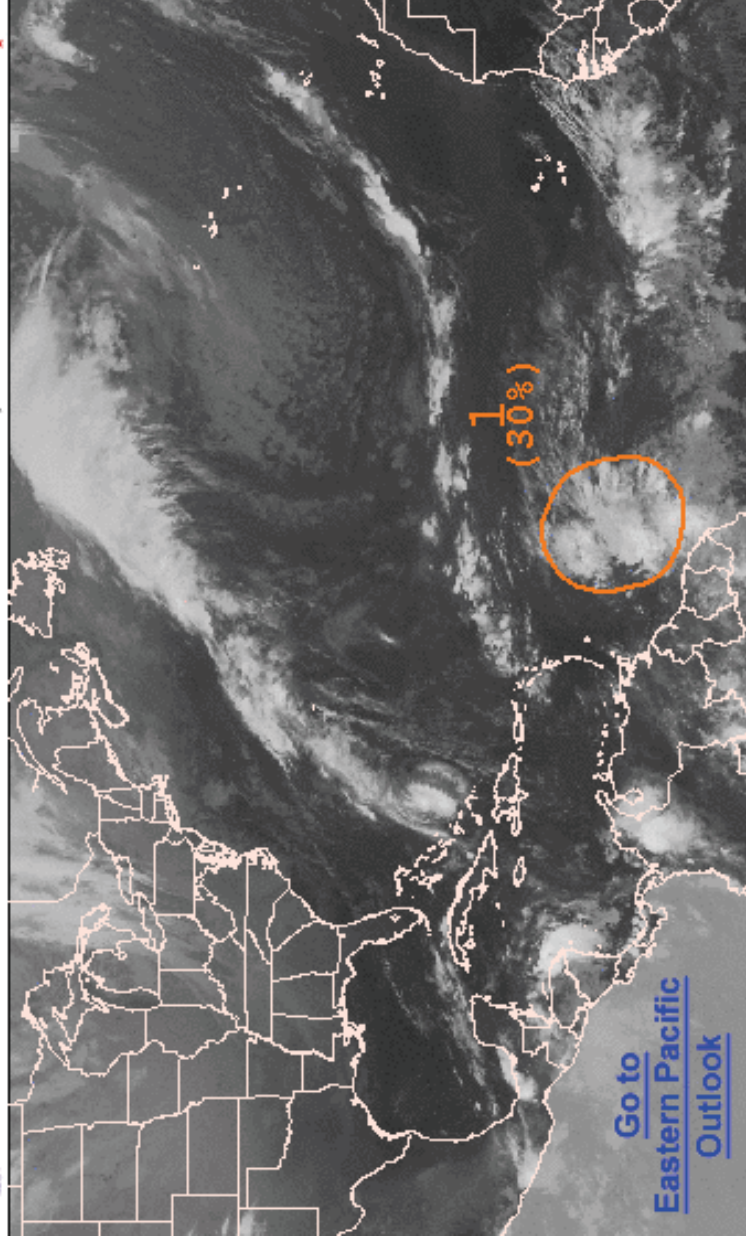
 Medium 30-50%

 High >50%



Graphical Tropical Weather Outlook

National Hurricane Center Miami, Florida



800 AM EDT WED OCT 10 2012

Satellite Image: 0652 AM EDT

Outlined areas denote current position of systems discussed in the Tropical Weather Outlook. Color indicates probability of tropical cyclone formation within 48 hours.

Low <30%

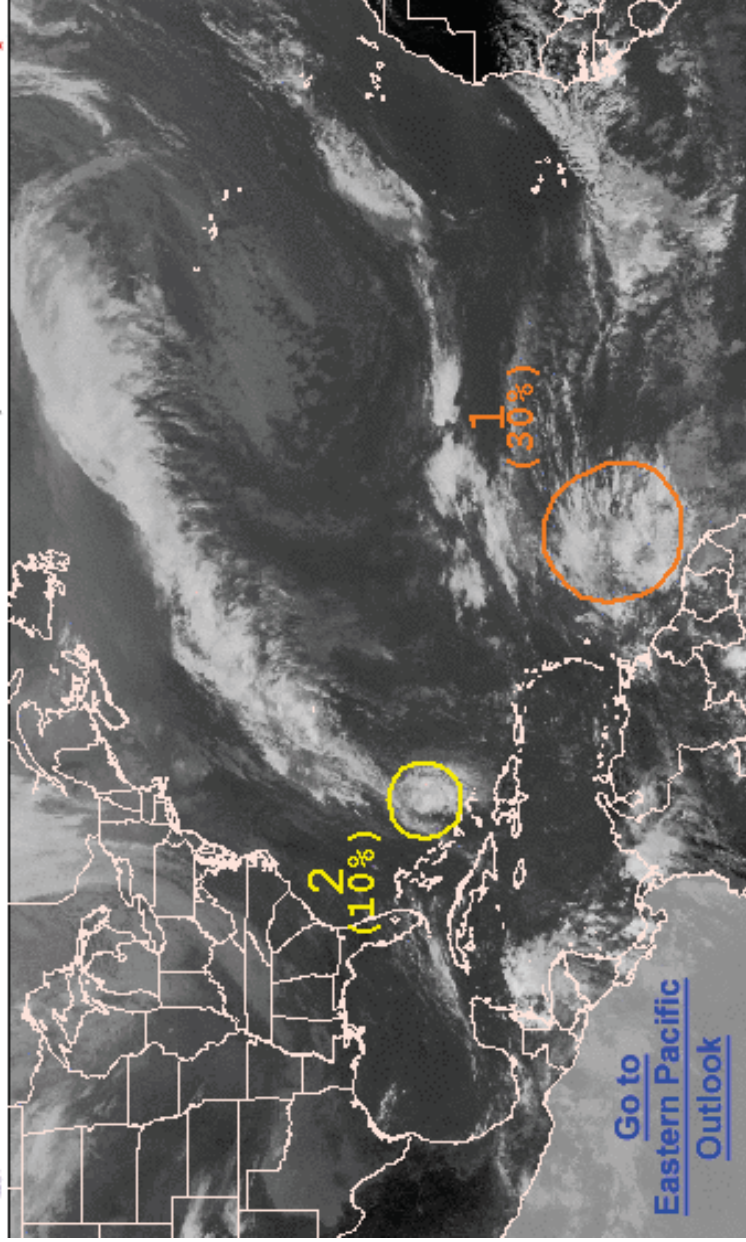
Medium 30-50%

High >50%



Graphical Tropical Weather Outlook

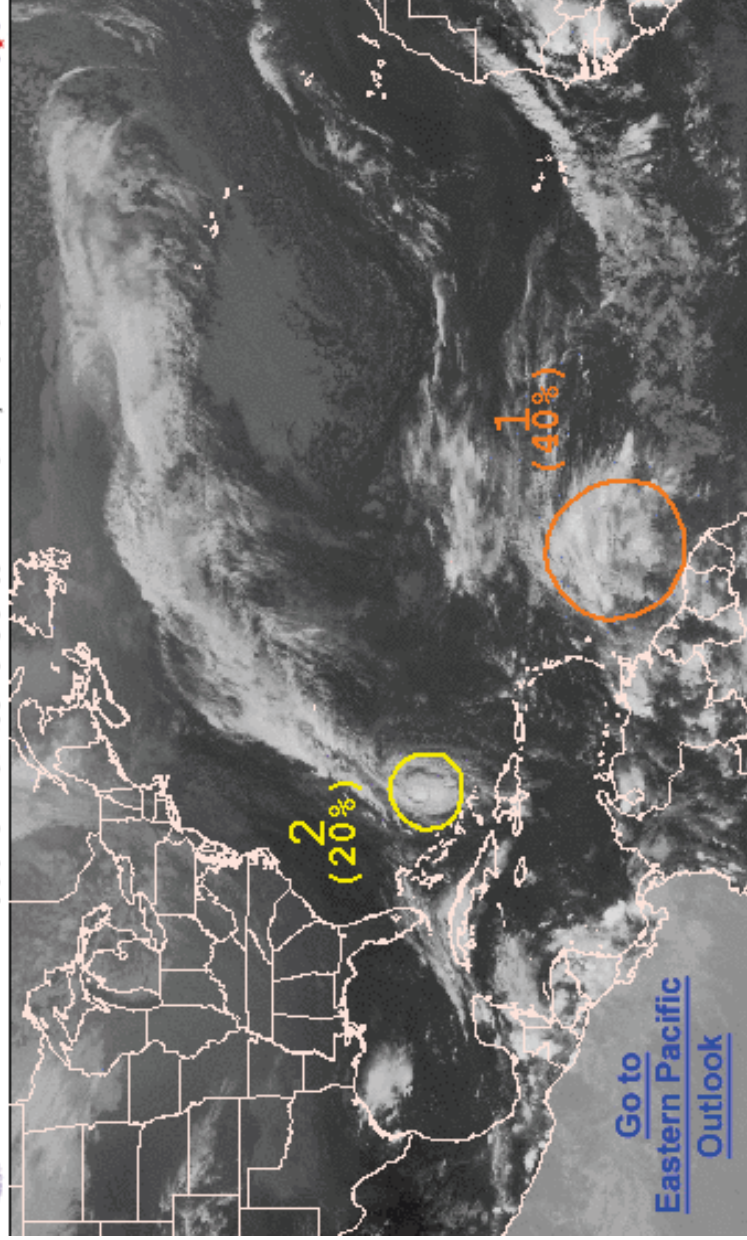
National Hurricane Center Miami, Florida





Graphical Tropical Weather Outlook

National Hurricane Center Miami, Florida



800 PM EDT WED OCT 10 2012

Satellite Image: 0722 PM EDT

Outlined areas denote current position of systems discussed in the Tropical Weather Outlook. Color indicates probability of tropical cyclone formation within 48 hours.

Low <30%

Medium 30-50%

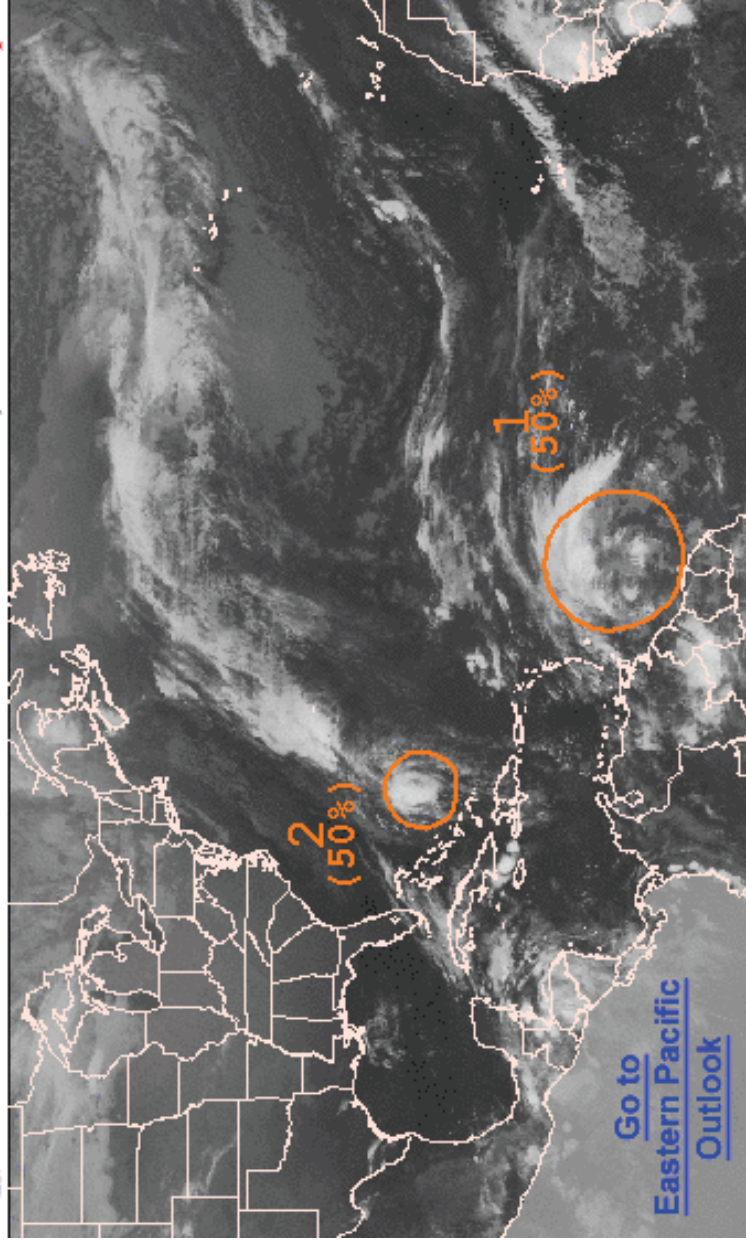
High >50%

[Go to
Eastern Pacific
Outlook](#)



Graphical Tropical Weather Outlook

National Hurricane Center Miami, Florida



200 AM EDT THU OCT 11 2012

Satellite Image: 1252 AM EDT

Outlined areas denote current position of systems discussed in the Tropical Weather Outlook. Color indicates probability of tropical cyclone formation within 48 hours.

Low <30%

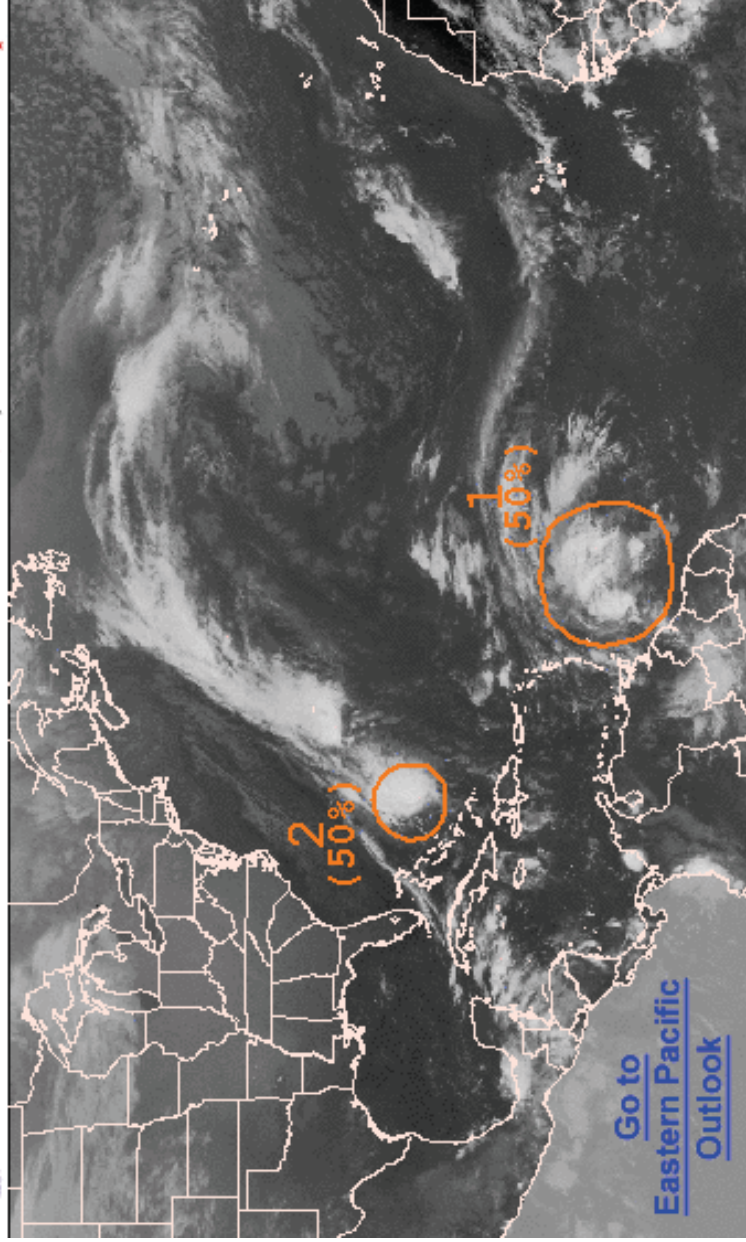
Medium 30-50%

High >50%



Graphical Tropical Weather Outlook

National Hurricane Center Miami, Florida



800 AM EDT THU OCT 11 2012

Satellite Image: 0652 AM EDT

Outlined areas denote current position of systems discussed in the Tropical Weather Outlook. Color indicates probability of tropical cyclone formation within 48 hours.

Low <30%

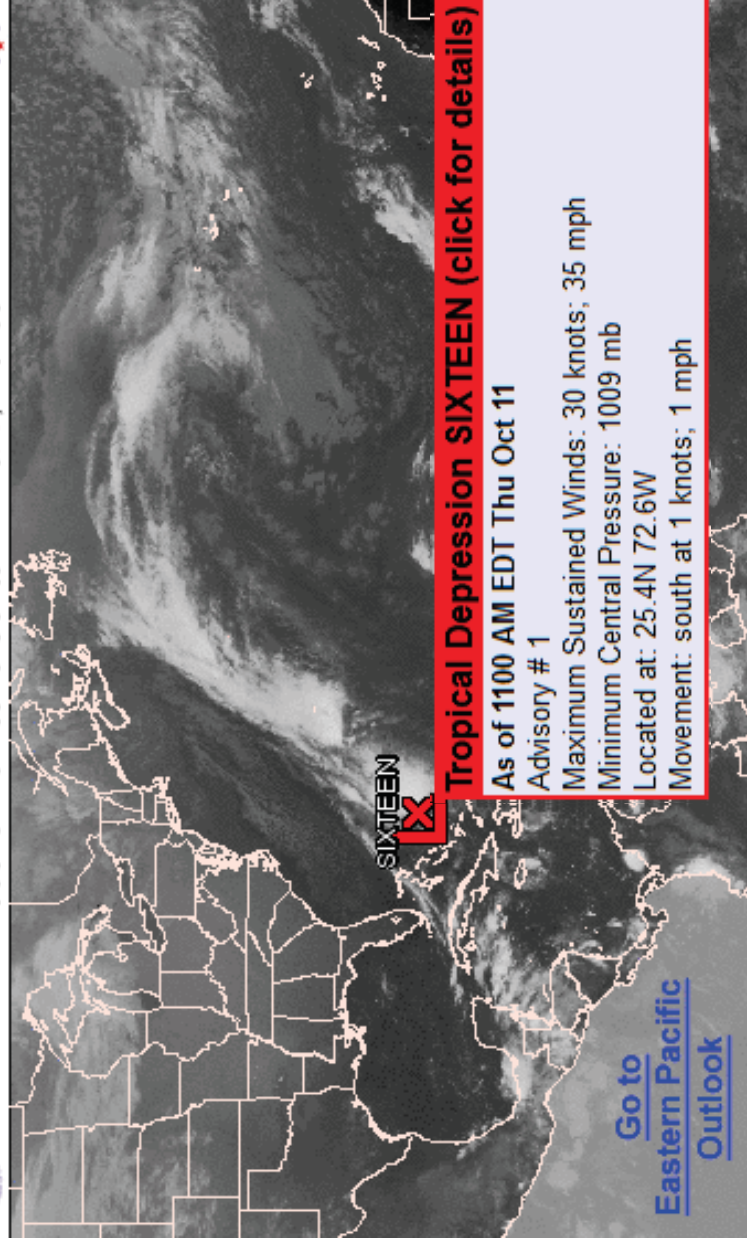
Medium 30-50%

High >50%



Graphical Tropical Weather Outlook

National Hurricane Center Miami, Florida



800 AM EDT THU OCT 11 2012

Satellite Image: 0652 AM EDT

Outlined areas denote current position of systems discussed in the Tropical Weather Outlook. Color indicates probability of tropical cyclone formation within 48 hours.

Low <30%

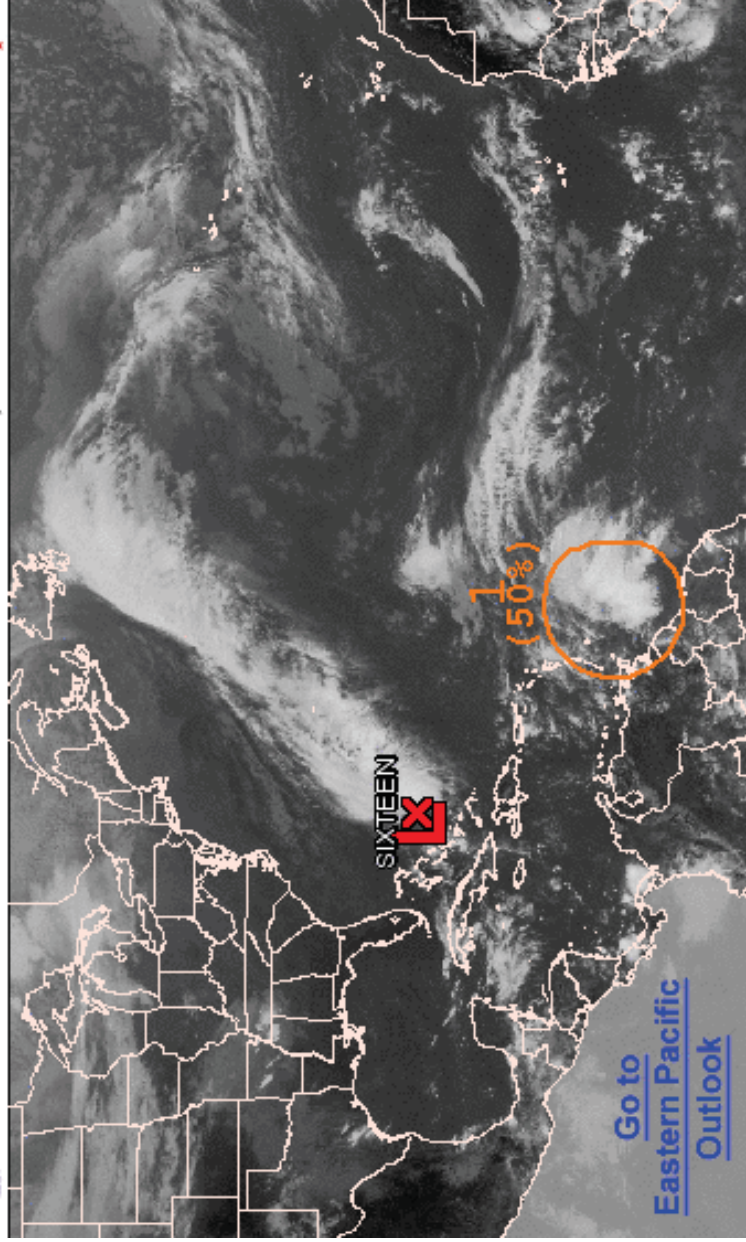
Medium 30-50%

High >50%



Graphical Tropical Weather Outlook

National Hurricane Center Miami, Florida



200 PM EDT THU OCT 11 2012

Satellite Image: 0122 PM EDT

Outlined areas denote current position of systems discussed in the Tropical Weather Outlook. Color indicates probability of tropical cyclone formation within 48 hours.

Low <30%

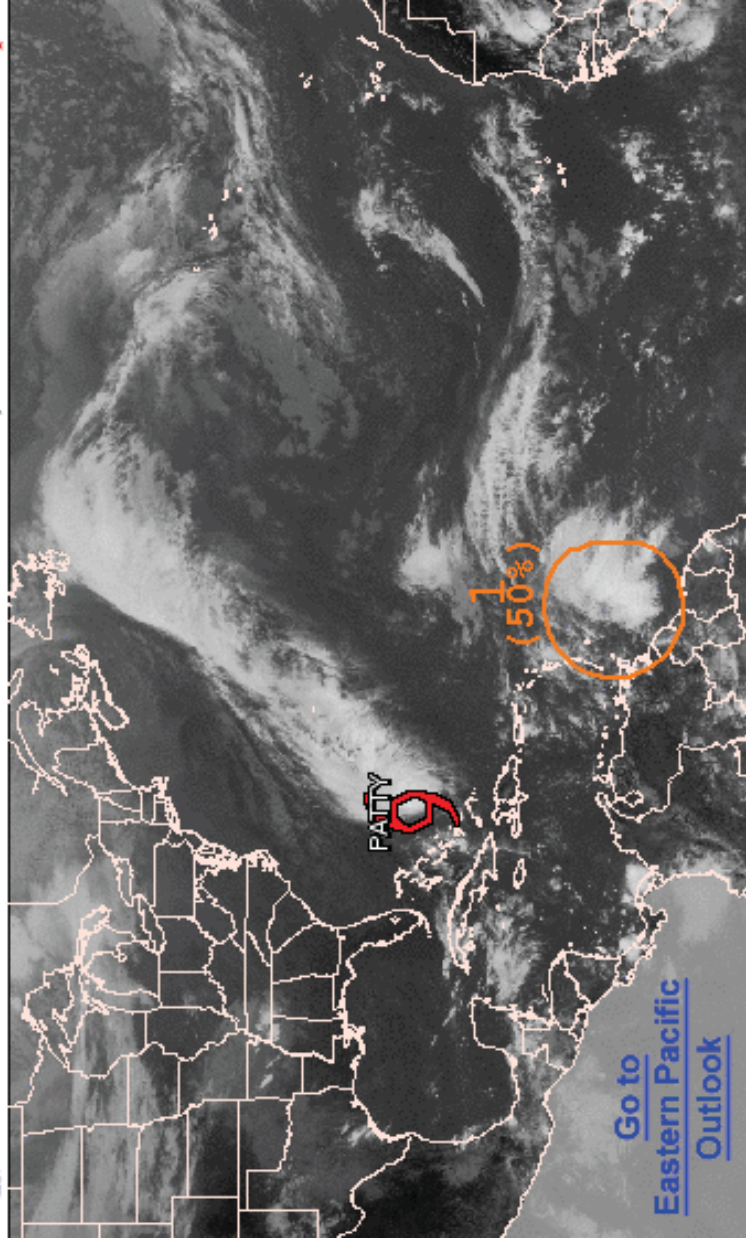
Medium 30-50%

High >50%



Graphical Tropical Weather Outlook

National Hurricane Center Miami, Florida



200 PM EDT THU OCT 11 2012

Outlined areas denote current position of systems discussed in the Tropical Weather Outlook. Color indicates probability of tropical cyclone formation within 48 hours.

Low <30%

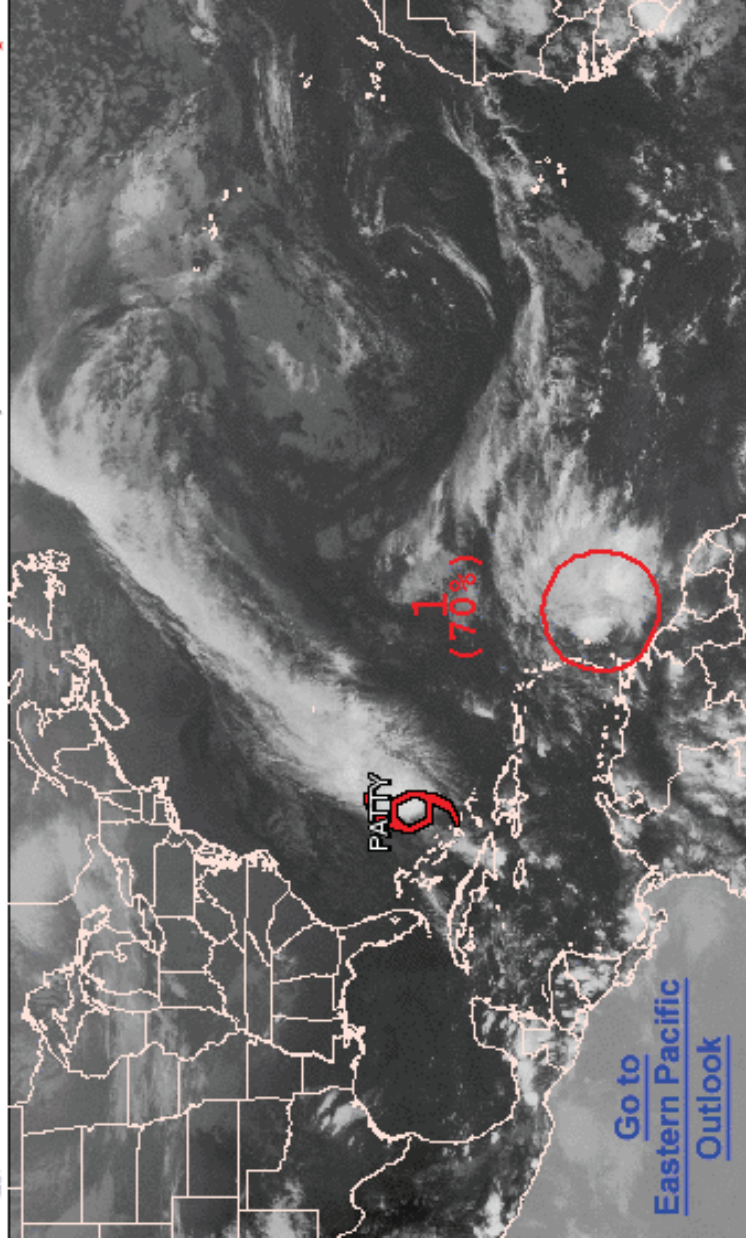
Medium 30-50%

High >50%



Graphical Tropical Weather Outlook

National Hurricane Center Miami, Florida



800 PM EDT THU OCT 11 2012

Satellite Image: 0652 PM EDT

Outlined areas denote current position of systems discussed in the Tropical Weather Outlook. Color indicates probability of tropical cyclone formation within 48 hours.

Low <30%

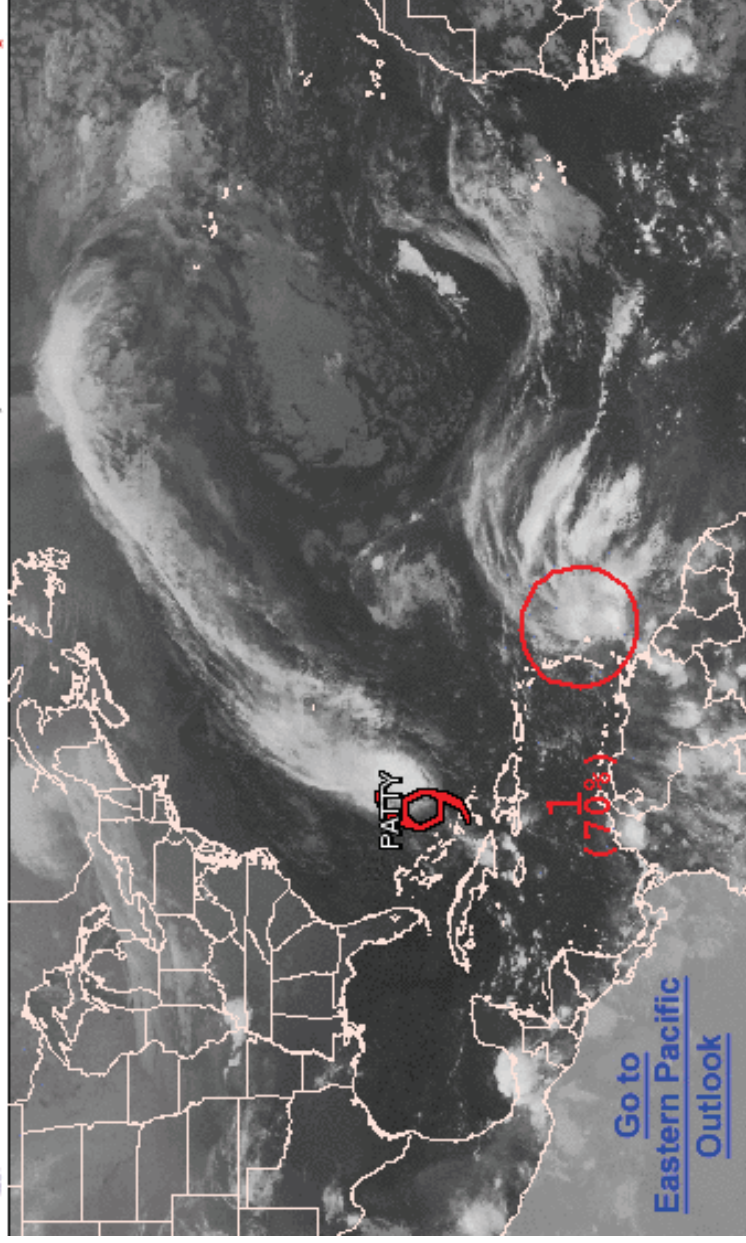
Medium 30-50%

High >50%



Graphical Tropical Weather Outlook

National Hurricane Center Miami, Florida



200 AM EDT FRI OCT 12 2012

Satellite Image: 0122 AM EDT

Outlined areas denote current position of systems discussed in the Tropical Weather Outlook. Color indicates probability of tropical cyclone formation within 48 hours.

Low <30%

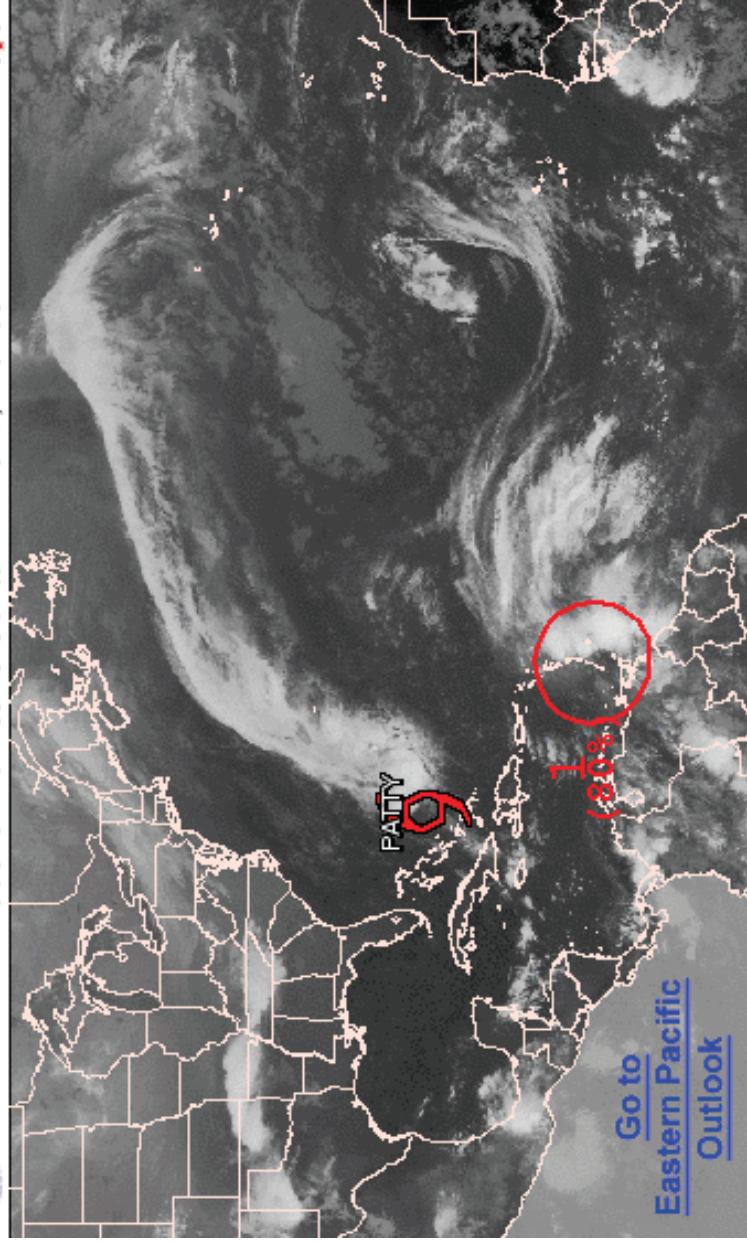
Medium 30-50%

High >50%



Graphical Tropical Weather Outlook

National Hurricane Center Miami, Florida



Probability Forecasting “in the Light”

Collect all the forecasts of 10% probability of an event, and compute the fraction of them in which the event occurred!

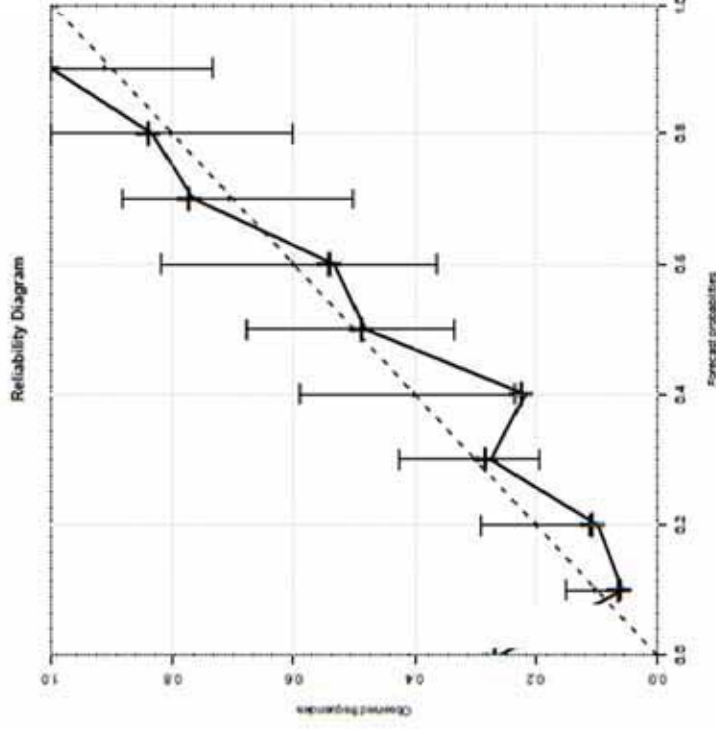


Figure 1: Reliability diagram for NOAA 2012 hurricane forecasts (48 hours lead time) with 5% - 95% consistency bars. The bin boundaries are taken as [0.05, 0.15, 0.25, 0.35, 0.45, 0.55, 0.65, 0.75, 0.85, 0.95].

This science is **in the light** not because the forecasts tend to be consistent: but merely because they can be evaluated with relevant observations!

The constants they are a chang'n (in the light)

Several of the 2006 values change by more than one would expect given the uncertainties stated in 2006...

2010

2006 CODATA RECOMMENDED VALUES OF THE FUNDAMENTAL CONSTANTS OF PHYSICS AND CHEMISTRY NIST SP 959 ~~1000-2006~~ **UPDATE**

Values from: P. J. Mohr, B. N. Taylor, and D. B. Newell, *Rev. Mod. Phys.* ~~80:463-1003~~ **79:1201-1264** (2007) and *J. Phys. Chem. Ref. Data* ~~37:1201-1264~~ **39:1201-1264** (2010). The number in parentheses is the one-sigma (1 σ) uncertainty in the last two digits of the given value.

Quantity	Symbol	Numerical value	Unit
speed of light in vacuum	c , c_0	299 792 458 (exact)	m s^{-1}
magnetic constant	μ_0	$4\pi \times 10^{-7}$ (exact)	N A^{-2}
electric constant $1/\mu_0 c^2$	ϵ_0	$8.854 187 817 \dots \times 10^{-12}$	F m^{-1}
Newtonian constant of gravitation	G	$6.674 08(42) \times 10^{-11}$	$\text{m}^3 \text{kg}^{-1} \text{s}^{-2}$
Planck constant	h	$6.626 068 96(30) \times 10^{-34}$	J s
$h/2\pi$	\hbar	$1.054 571 828(47) \times 10^{-34}$	J s
elementary charge	e	$1.602 176 432(40) \times 10^{-19}$	C
fine-structure constant $\alpha^2/4\pi\epsilon_0\hbar c$	α^{-1}	$7.297 352 569(89) \times 10^{-3}$	m^{-1}
inverse fine-structure constant	α	$137.035 999 074(44)$	m^{-1}
Rydberg constant $\alpha^2 m_e c/2\hbar$	R_∞	$10 973 731.568 539(66)$	m^{-1}
Bohr radius $\alpha/4\pi R_\infty$	a_0	$0.529 177 235 461(46) \times 10^{-10}$	m
Bohr magneton $eh/2m_e$	μ_B	$9.27 400 944(40) \times 10^{-26}$	J T^{-1}

Handwritten updates:

- μ_0 : ~~$4\pi \times 10^{-7}$~~ **$1.256 637 061(2) \times 10^{-6}$**
- ϵ_0 : ~~$8.854 187 817 \dots$~~ **$8.854 187 817(28) \times 10^{-12}$**
- G : ~~$6.674 08(42)$~~ **$6.674 08(42)$**
- h : ~~$6.626 068 96(30)$~~ **$6.626 070(50)$**
- \hbar : ~~$1.054 571 828(47)$~~ **$1.054 571 817(47)$**
- e : ~~$1.602 176 432(40)$~~ **$1.602 176 634(94)$**
- α^{-1} : ~~$7.297 352 569(89)$~~ **$7.297 352 569(29)$**
- α : ~~$137.035 999 074(44)$~~ **$137.035 999 074(44)$**
- R_∞ : ~~$10 973 731.568 539(66)$~~ **$10 973 731.568 539(66)$**
- a_0 : ~~$0.529 177 235 461(46)$~~ **$0.529 177 235 461(46)$**
- μ_B : ~~$9.27 400 944(40)$~~ **$9.27 400 944(40)$**

Science often underestimates its own uncertainty. Whether this is due to carelessness to intellectual phase locking, science **in the light** can advance when new evidence contradicts old belief.

Science in the Dark does not imply scientists have gone over to the dark side



Scientists are forced to “violate” traditional best practice guidance if such violations are imposed by the nature of the question being addressed.

One cannot wait 50 years for out-of-sample observations.

It is a brute fact that a climate model’s lifetime is less than its forecast lead-time!
The physics underlying CO₂ induced warming remains as solid as science gets.

Cast of Characters



Fitzroy



Le Verrier



Galton



Einstein



Richardson



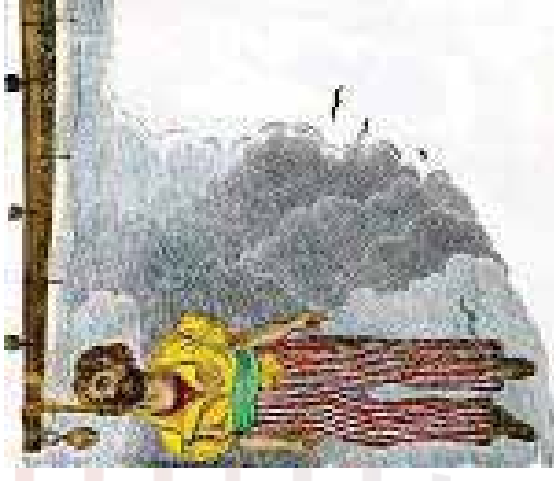
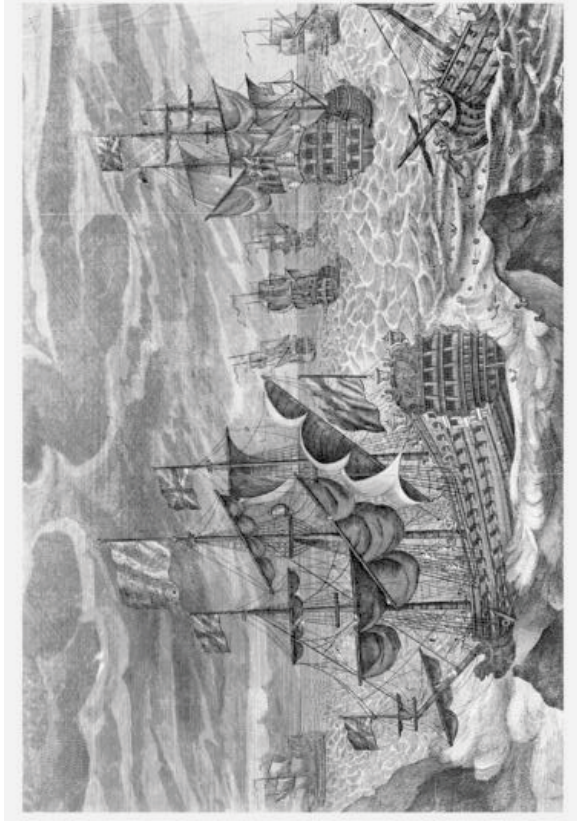
Lorenz



Whitehead

It was a dark and stormy night...

...in 1707, when a dispute broke out between Sir Cloudesley Shovell, the master of HMS Association and his navigator regarding where they were and when they would reach land. Legend has it the sailor was hung, but no record survives, in part because...



...on the Oct 22 the ships hit “unexpected” rocks; four ships and 1400 sailors were lost, including Sir Shovell, and the Association.

Dangers of Forecasting (c)
Political Shenanigans: The forecaster may be vulnerable

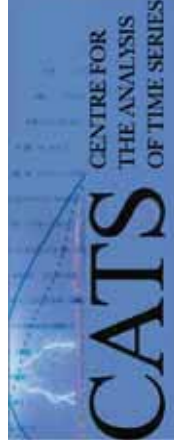
Fast-forward to 1859

In October 1859, the steam clipper *Royal Charter* foundered in a violent storm off the coast of Anglesey in North Wales with the loss of over 450 lives. As a direct result of this disaster, FitzRoy introduced the first British storm warning service for shipping in February 1861, making use of the electric telegraph. FitzRoy was the main influence in the early development of the Met Office, which was then primarily intended to improve safety at sea.



Fitzroy exploited **new technology**, the telegraph, to provide information on current meteorological conditions, but he was not allowed to “foretell” the future. (He coined the word “forecast” but was not allowed to issue them!)

He partnered with Le Verrier in France, who was famous for predicting the location (and existence) of the planet Neptune.
Fitzroy met resistance in the UK.

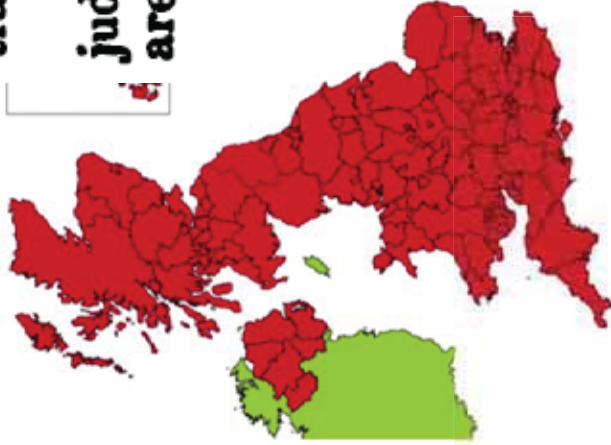




UK: severe weather

Weather	Latest/recent			Forecast		
	Sun	Mon	Tue	Wed	Thu	Fri
Rainfall						
Pressure						
Cloud						
Wind						
Temperature						

ALL WARNINGS: Sun 12 to Thu 15



Region
No flash
Early w
These are
Risk of
RISK OF

Objection has been taken to such forecasts, because they cannot be always exactly correct,—for all places in one district. It is, however, considered by most persons that general, comprehensive expressions, in aid of local observers, who can form independent judgments from the tables and *their own instruments*, respecting their immediate vicinity, *though not so well for distant places*, may be very useful, as well as interesting: while to an unprovided or otherwise uninformed person, an idea of the kind of weather thought *probable* cannot be otherwise than acceptable, provided that he is in no way *bound to act* in accordance with any such views, against his own judgment.

Like the storm signals, such notices should be merely *cautionary*—to denote anticipated disturbance *somewhere* over these islands,—without being in the least degree compulsory, or interfering arbitrarily with the movements of vessels or individuals.

Certain it is, that although our conclusions may be incorrect—our judgment erroneous—the laws of nature, and the signs afforded to man, are invariably true. Accurate interpretation is the real deficiency.

Fitzroy, 1862

Fitzroy aimed to provide decision makers with more information: not orders or decisions made.



Fitzroy



Le Verrier



Galton



Einstein



Richardson

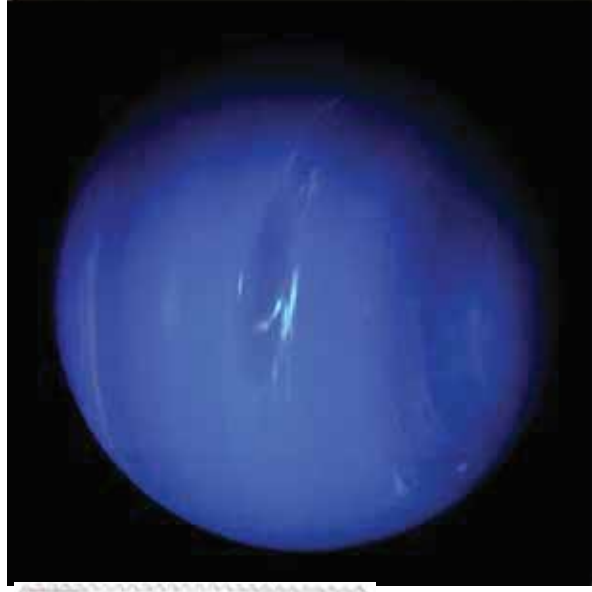


Lorenz



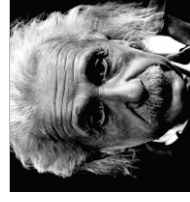
Whitehead

Le Verrier & the “Discovery” of Neptune and Vulcan



Le Verrier found discrepancies between the observations of Uranus and the workings of Newton’s Laws; he knew these must be caused by a previously unknown planet, and in 1846 predicted where that planet should be, leading to the discovery of “Neptune”.

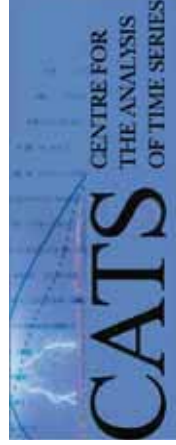
In 1859 Le Verrier found discrepancies between the observations of Mercury and the workings of Newton’s Laws; he knew these must be caused by a previously unknown planet, and predicted another new planet. This led to the discovery of “Vulcan” by Lescarbault on 26 March 1859. Lescarbault was awarded the Légion d’honneur.



**Danger of Forecasting (b)
Science is Lacking**



**There is no planet Vulcan!
Newton’s Laws fail near
the sun.**





Fitzroy



Le Verrier



Galton



Einstein



Whitehead



Lorenz



Richardson

Fallacy of Misplaced Concreteness

“The advantage of confining attention to a definite group of abstractions, is that you confine your thoughts to clear-cut definite things, with clear-cut definite relations. ... The disadvantage of exclusive attention to a group of abstractions, however well-founded, is that, by the nature of the case, you have abstracted from the remainder of things.

... it is of the utmost importance to be vigilant in critically revising your *modes* of abstraction.

Sometimes it happens that the service rendered by philosophy is entirely obscured by the astonishing success of a scheme of abstractions in expressing the dominant interests of an epoch.”

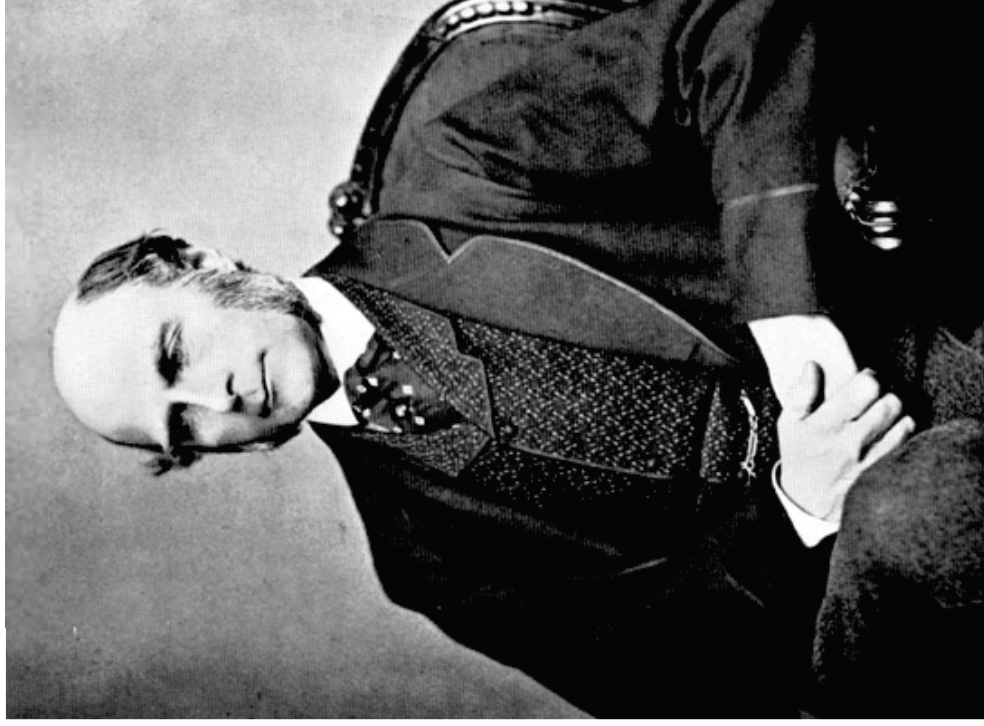
A N Whitehead. Science and the Modern World. Pg 58/9



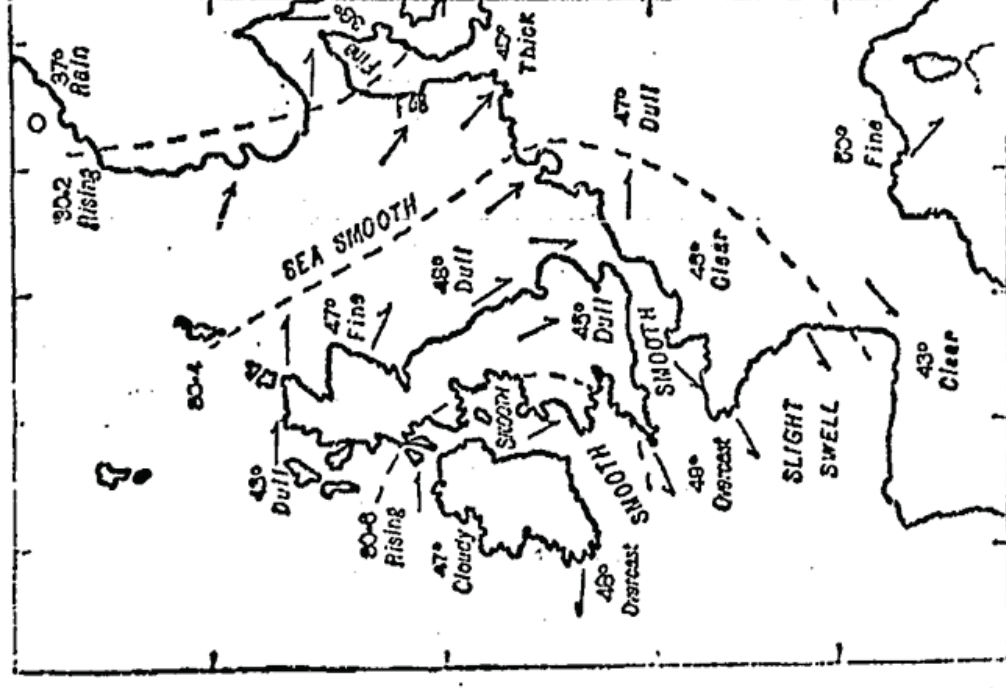
Whitehead was criticising straightjacket of Newtonian science; I will suggest that computer simulation may impede more than just the progress of science.

But first, lets bring in Galton...

Back to Galton



WEATHER CHART, MARCH 31, 1875.



The dotted lines indicate the gradations of barometric pressure. The variations of the temperature are marked by figures, the state of the sea and sky by descriptive words, and the direction of the wind by arrows—barbed and feathered according to its force. ☉ denotes calm.

Sir Francis Galton FRS (16 February 1822 – 17 January 1911), cousin of Douglas Strutt Galton, **cousin of Charles Darwin**, was an English Victorian polymath: anthropologist, eugenicist, tropical explorer, geographer, inventor, meteorologist, proto-geneticist, psychometrician, and statistician. He was knighted in 1909.
<http://galton.org/meteorologist.html>



Fitzroy



Le Verrier



Galton



Einstein



Richardson



Lorenz



Whitehead

The Galton Board

(Galton 1889)

(quincunx)

FIG . 7.

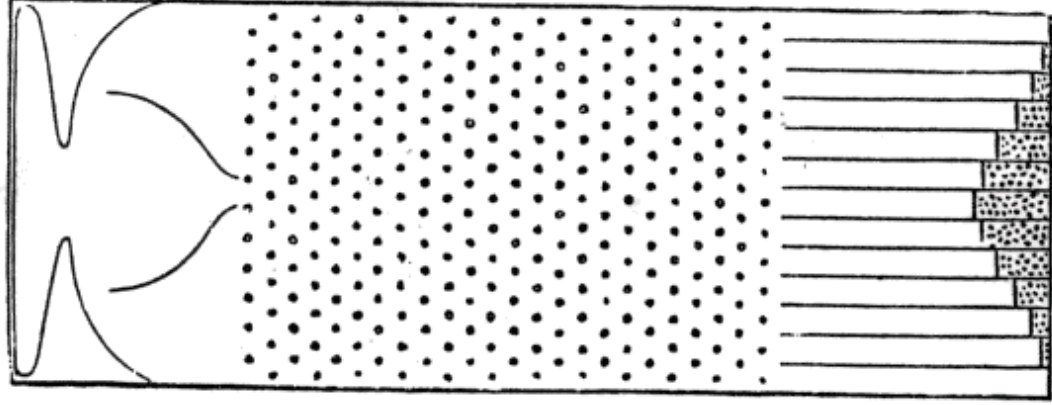


FIG . 8.

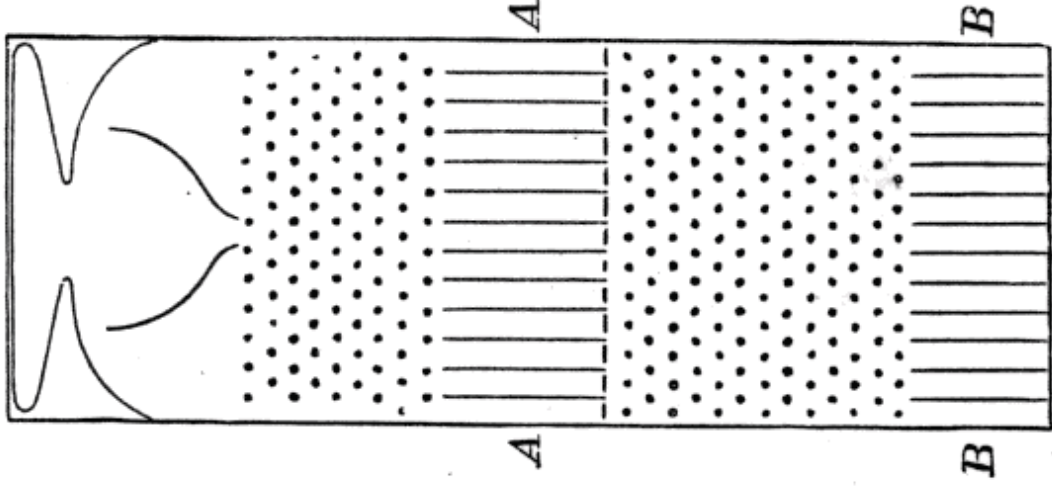
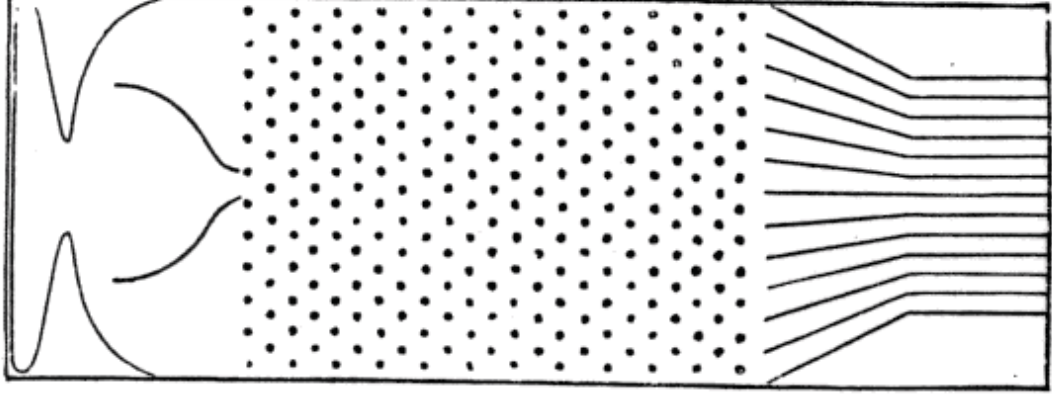


FIG . 9.



Each pellet has a 50/50 chance of going to the right (left) of each nail.

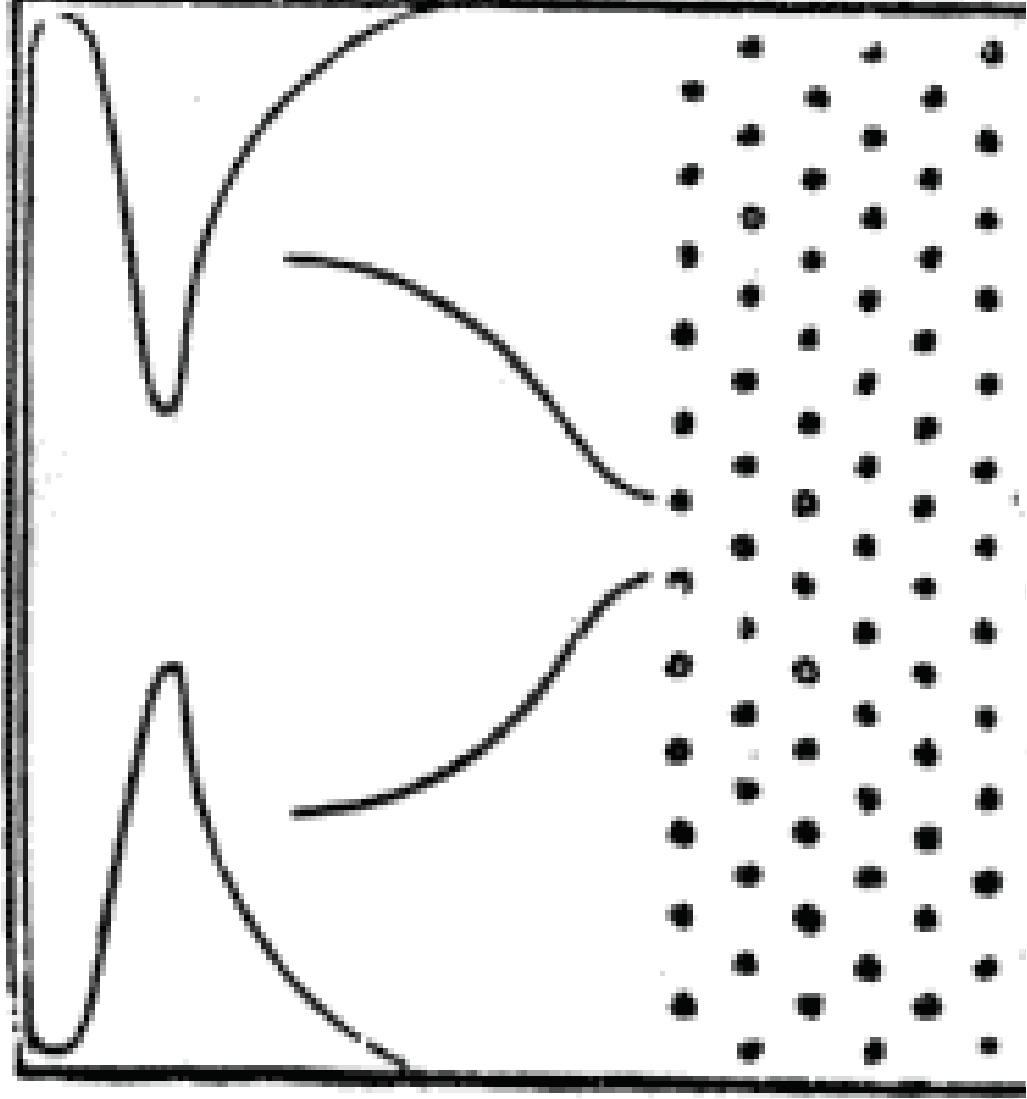
A mathematical result which is easier to match if you pour the shot in all at the same time...

The Galton Board

(Galton 1889)

(quincunx)

FIG. 7.



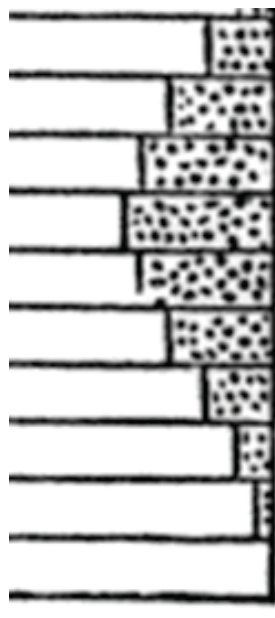
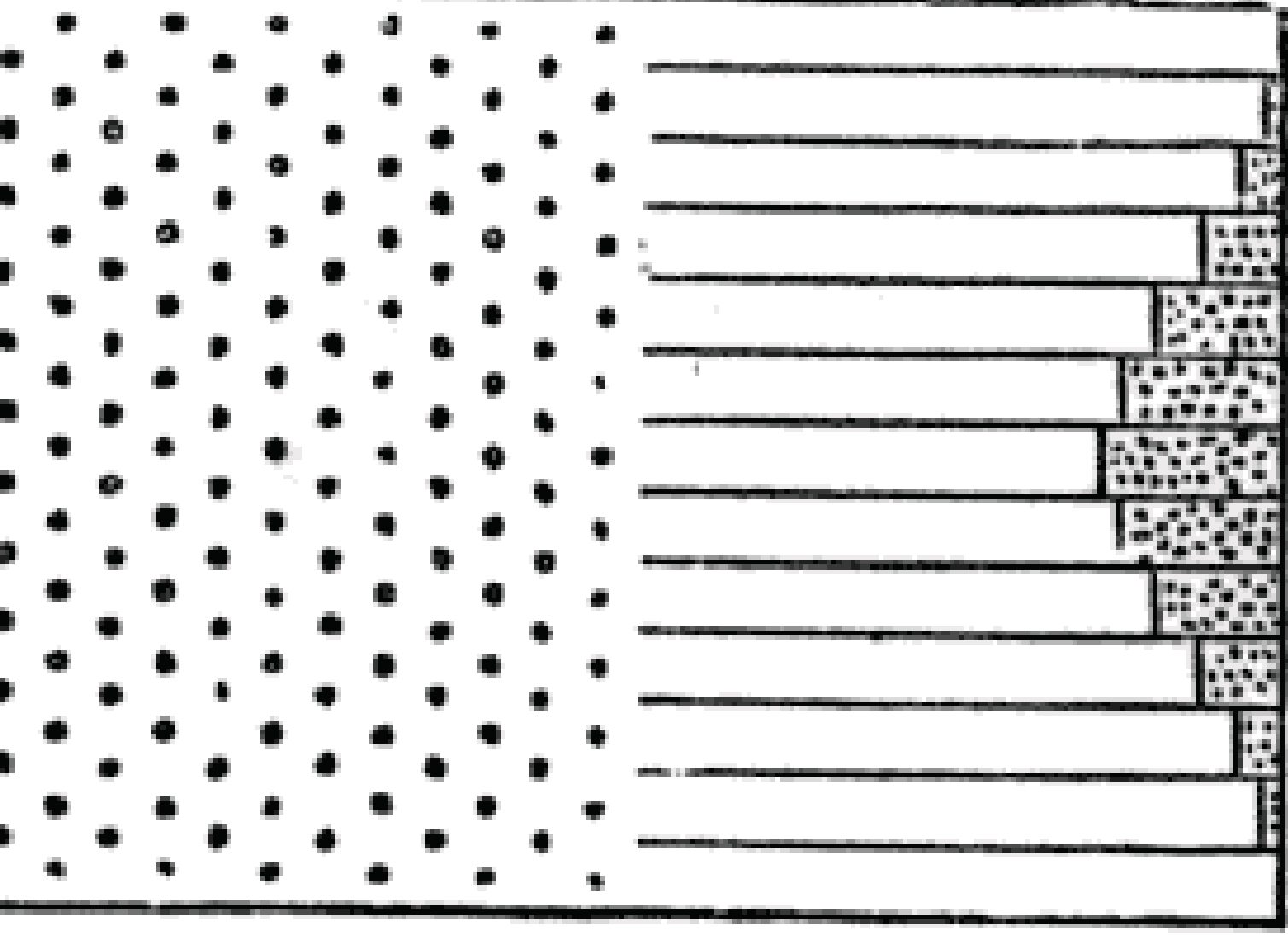
Each pellet has a 50/50 chance of going to the right (left) of each nail.

A mathematical result which is easier to match if you pour the shot in all at the same time...

Each pellet has a 50/50 chance of going to the right (left) of each nail.

A mathematical result which is easier to match if you pour the shot in all at the same time...

But would any randomness remain if we knew exactly where each pellet started?





Laplace's Demon (1814)

- 1) Perfect Equations of Motion (PMS)
- 2) Perfect noise-free observations
- 3) Unlimited computational power



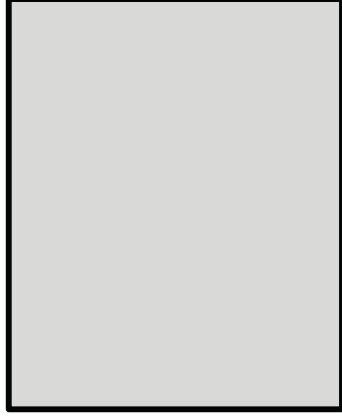
Demon's Apprentice (2007)

- 1) Perfect Equations of Motion (PMS)
- 2) ~~Perfect noise-free observations~~
- 3) Unlimited computational power



Apprentice's Novice (2012)

- 1) ~~Perfect Equations of Motion (PMS)~~
- 2) ~~Perfect noise-free observations~~
- 3) Unlimited computational power



Lewis Fry Richardson's Successful Failure (in the light)

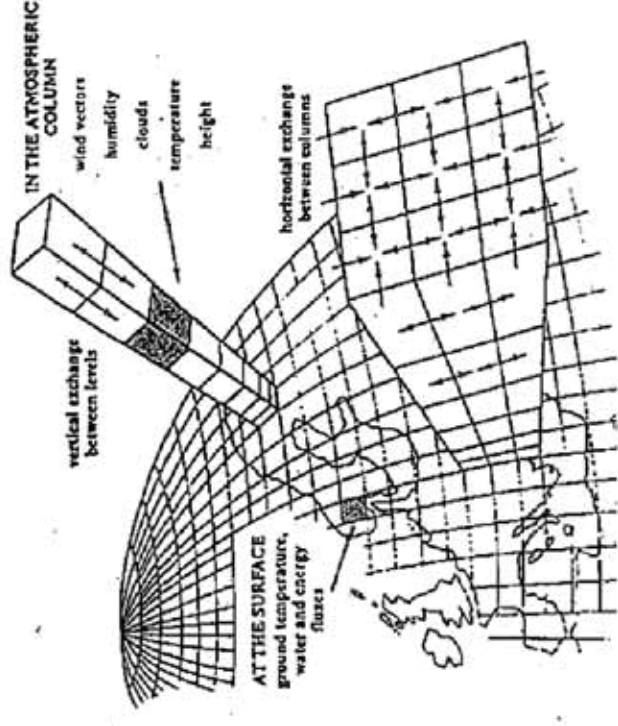
Given the equations and an initial condition, one can compute a forecast.

Richardson made the first numerical weather forecast for 20 May 1910. He did this by hand, while working as an ambulance driver in WWI.

While the forecast was wildly inaccurate, comparison with what actually had happened, it allowed progress leading to modern systems.

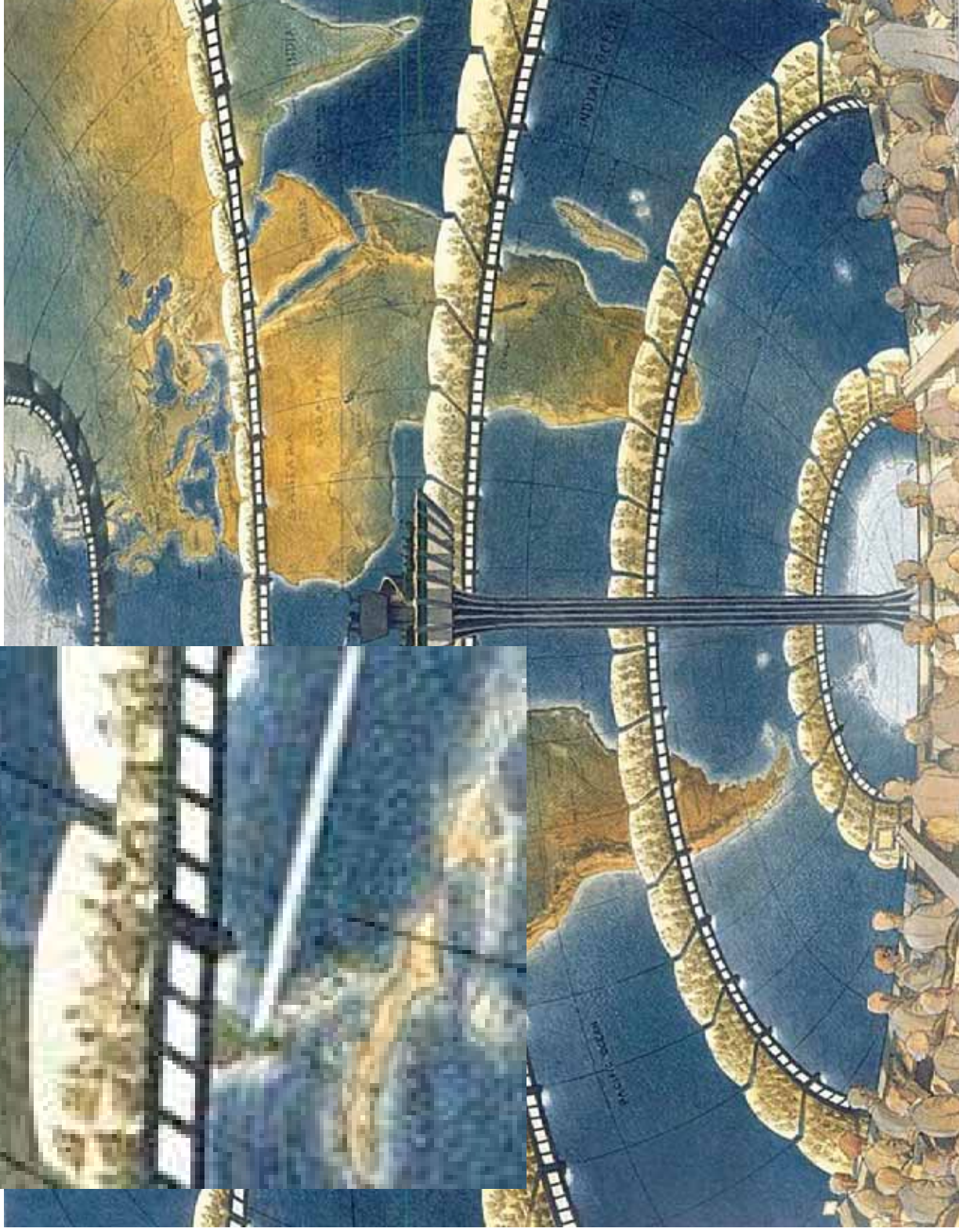
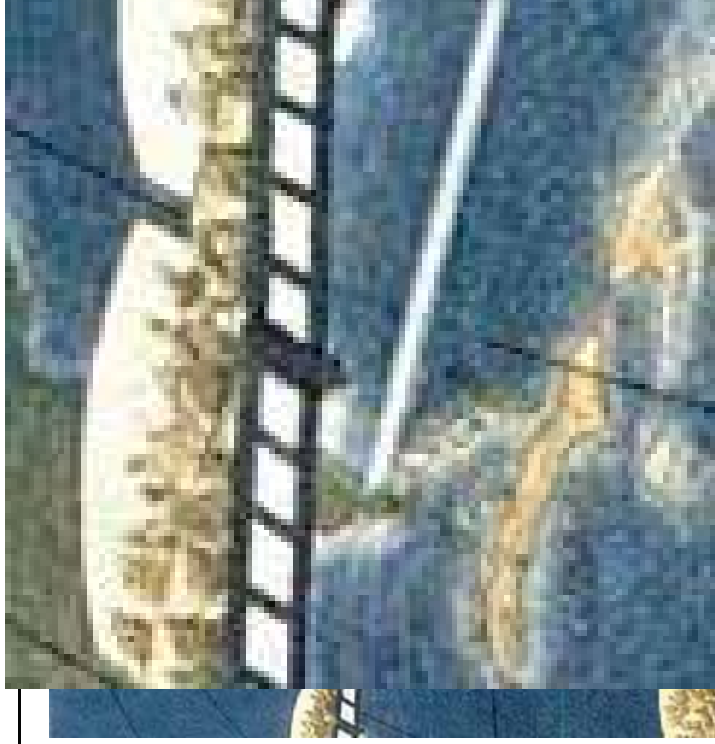
Of course, even today's best models do not resolve everything we see from space.

Lewis Fry Richardson in *Weather Prediction by Numerical Process*, 1922.



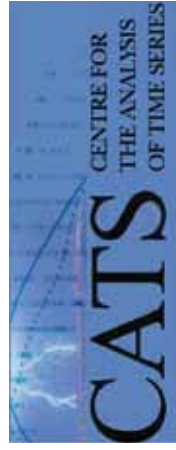


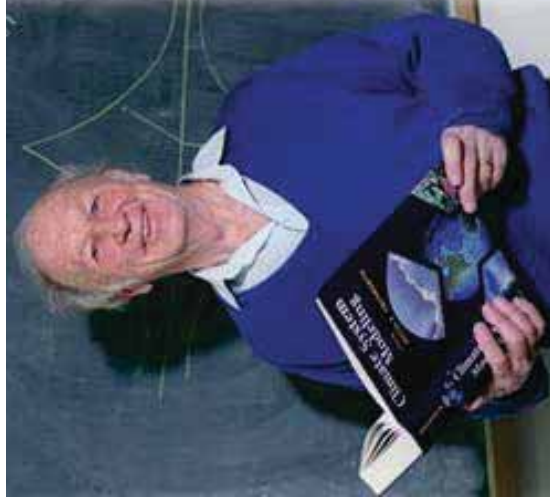
Richardson's Dream (1922)



Richardson realised that his algorithm could be run in parallel by a large number of “computers” sitting in a theatre...

He suggested that 64,000 computers could forecast the weather in real time.

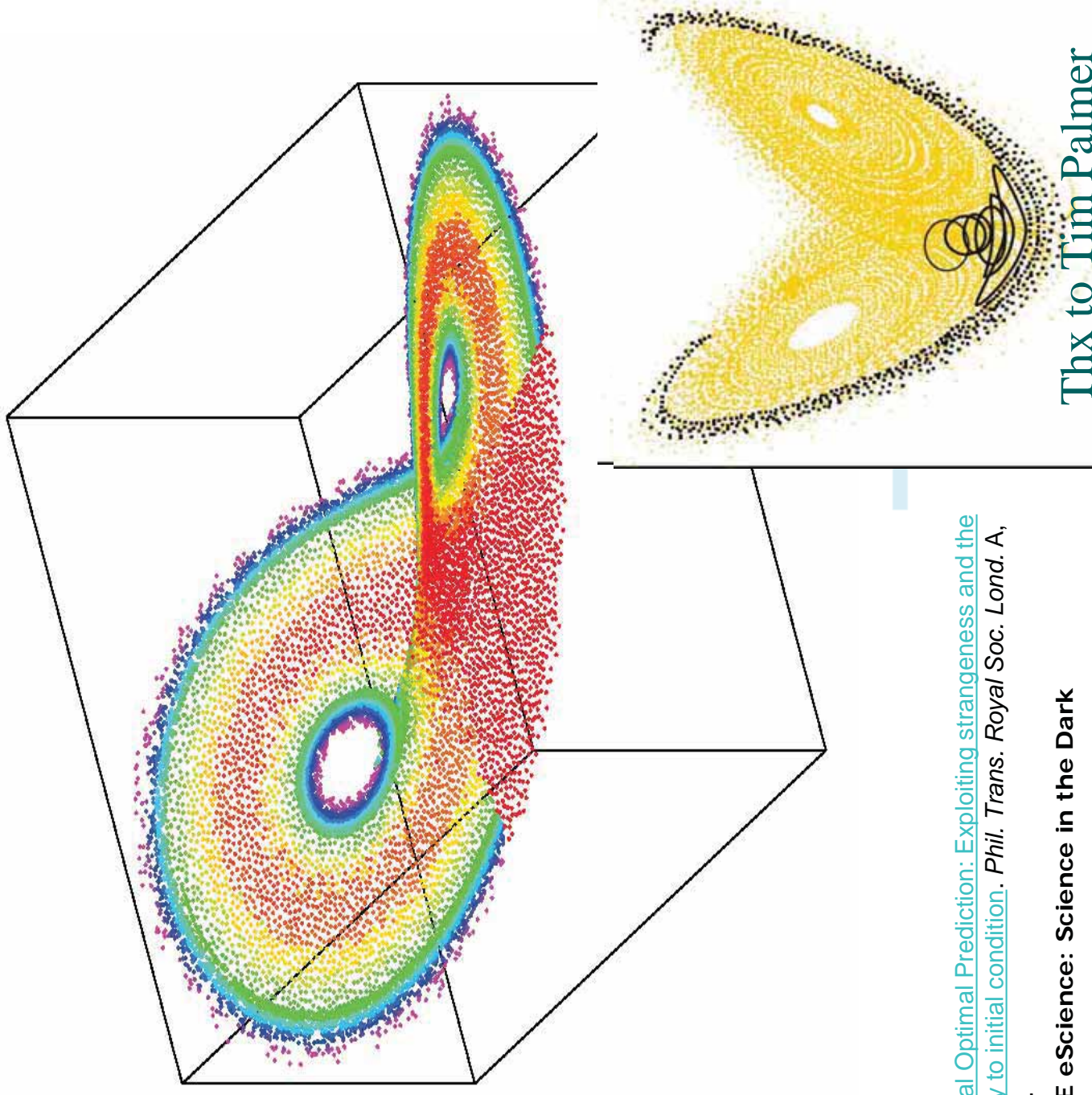




Ed Lorenz: Weather and Chaos (and Error)

Lorenz realised that even for the Apprentice, small uncertainties could grow exponentially fast, leading to “chaos.”

He was also very concerned about the role of model error, which is much harder to solve than that of mere chaos.



LA Smith (1994) [Local Optimal Prediction: Exploiting strangeness and the variation of sensitivity to initial condition](#). *Phil. Trans. Royal Soc. Lond. A*, 348 (1688): 371-381.

Oct 2012

IEEE eScience: Science in the Dark

Thx to Tim Palmer

Probability Forecasts: Chaos

The evolution of this probability distribution for the chaotic Lorenz 1963 system tells us all we can know of the future, given what we know now.

It allows prudent quantitative risk management (by brain-dead risk managers)

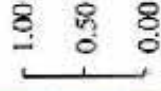
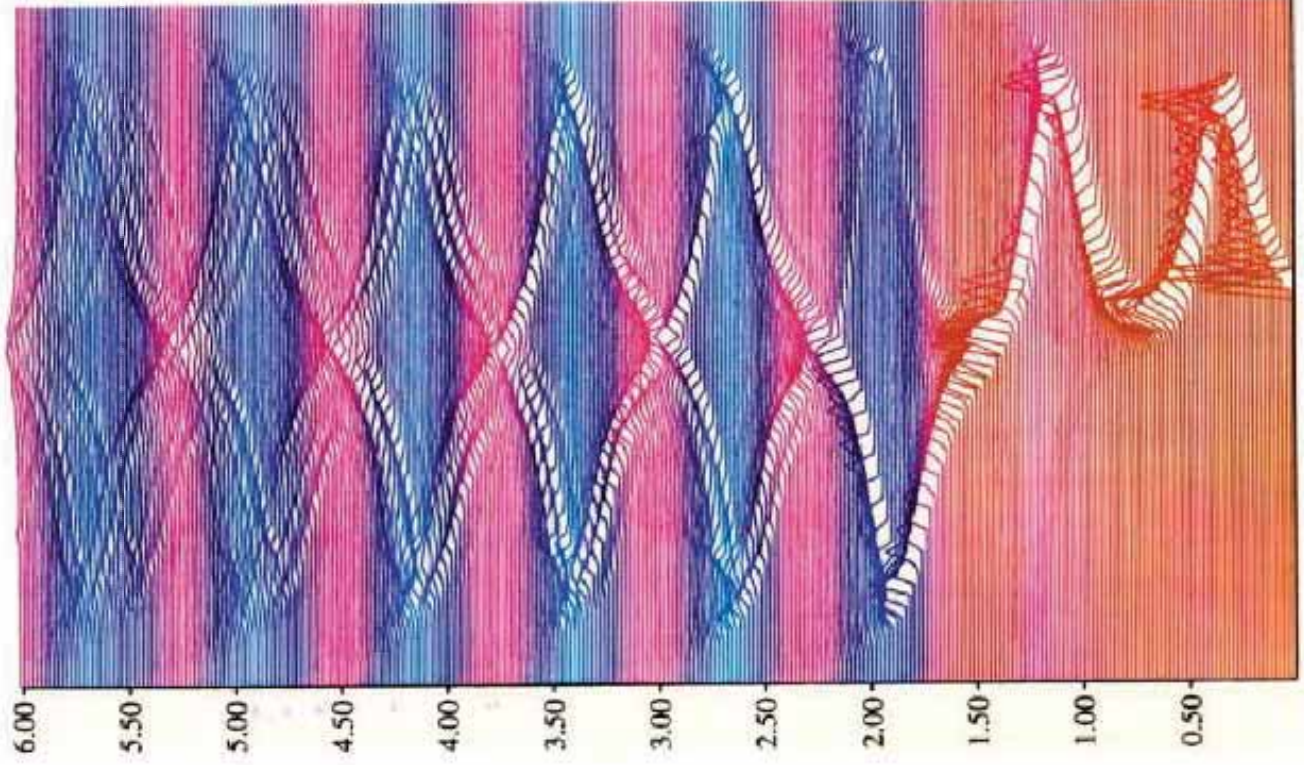


And sensible resource allocation.

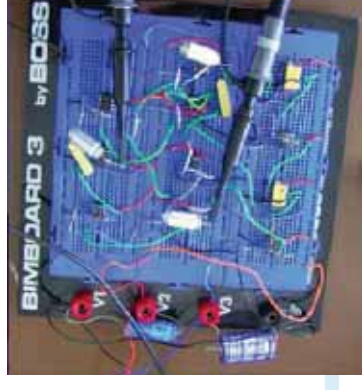
We can manage uncertainty for chaotic systems (given a perfect model).

But how well do we manage uncertainty in the real world? For GDP? Weather? Climate?

Do we have a single example of a nontrivial system where anyone has succeeded (and willing to offer odds given their model-based PDFs?)



Smith (2002) Chaos and Predictability in *Encyc Atmos Sci*





Einstein



Whitehead



Lorenz



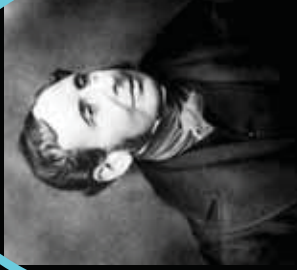
Richardson



Galton

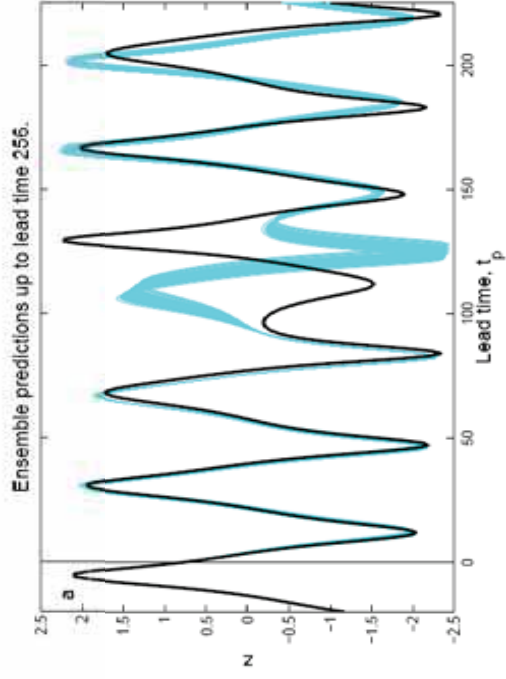


Le Verrier

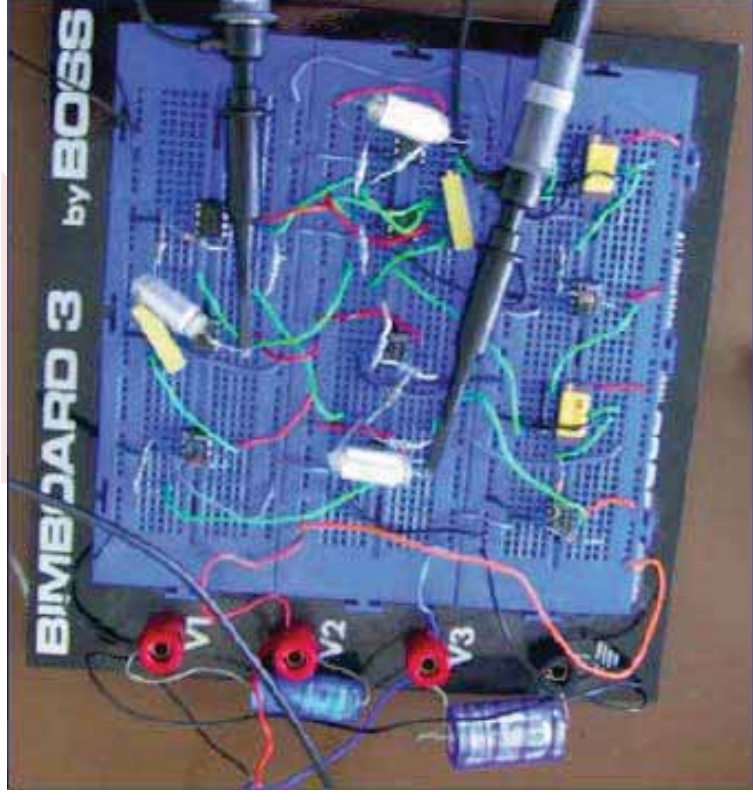


Fitzroy

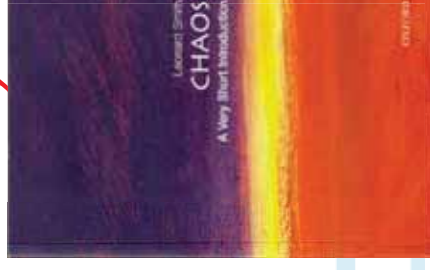
Probability Forecasts: “Simple” “chaotic” Physical System



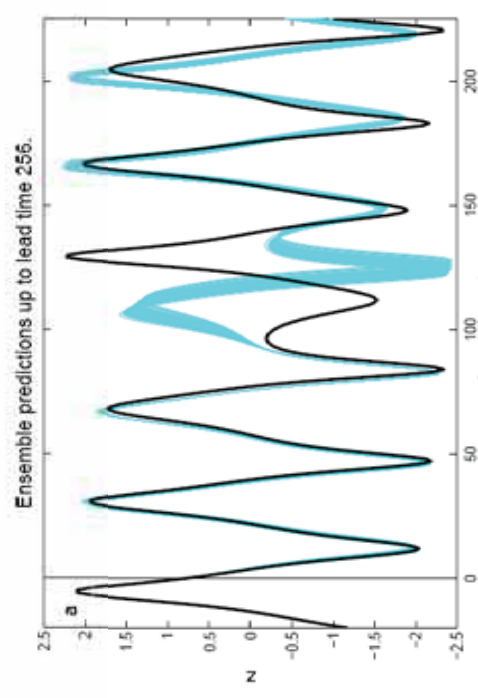
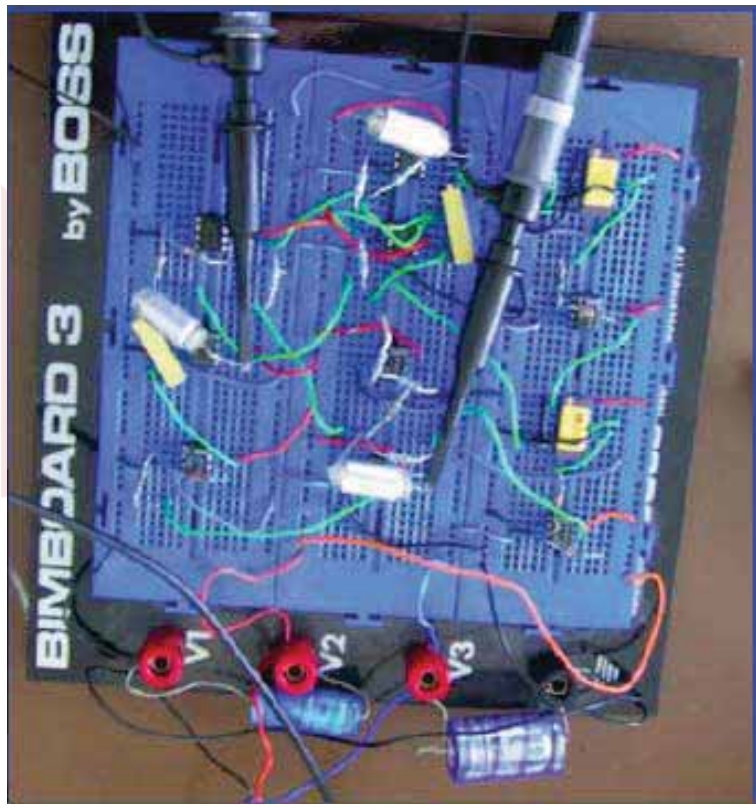
Model 1



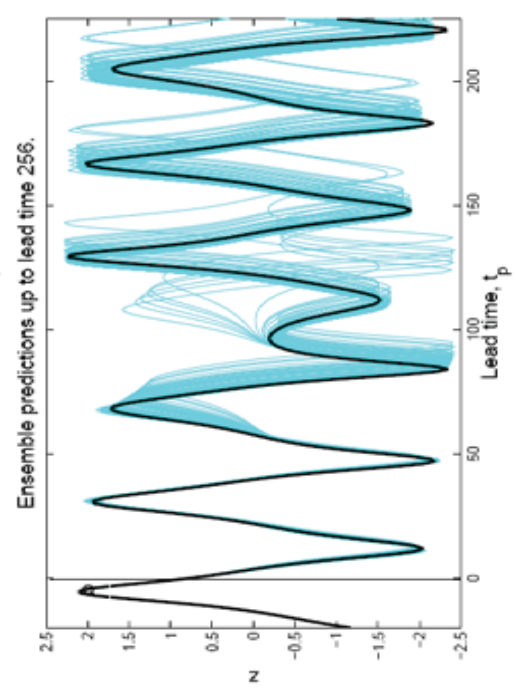
A Big Surprise in the Moore-Spiegel Circuit (by Reason Machette)



Probability Forecasts: “Simple” “chaotic” Physical System

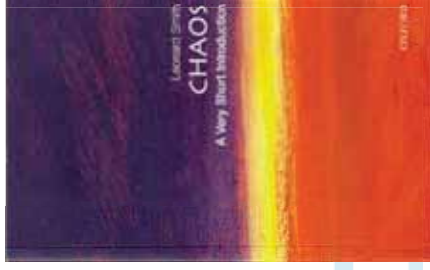


Model 1



Model 2

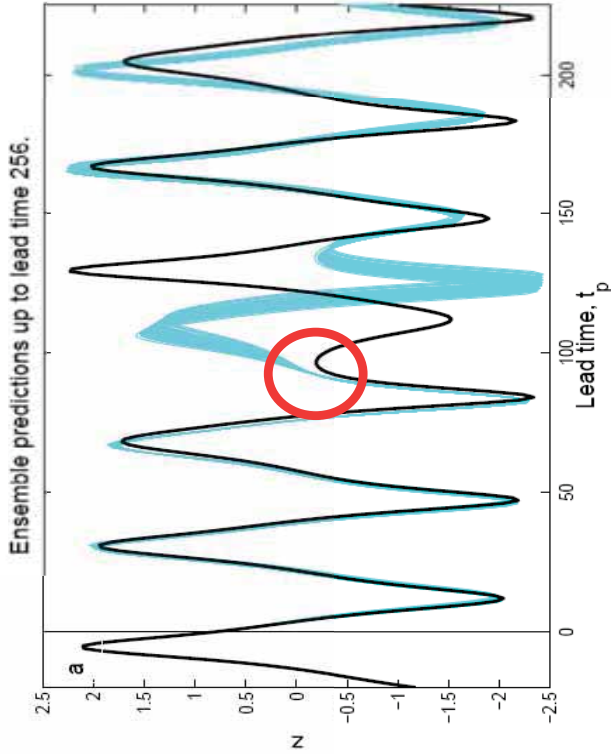
Figure 7: Ensemble predictions using (a) model 1 and (b) model 2. The



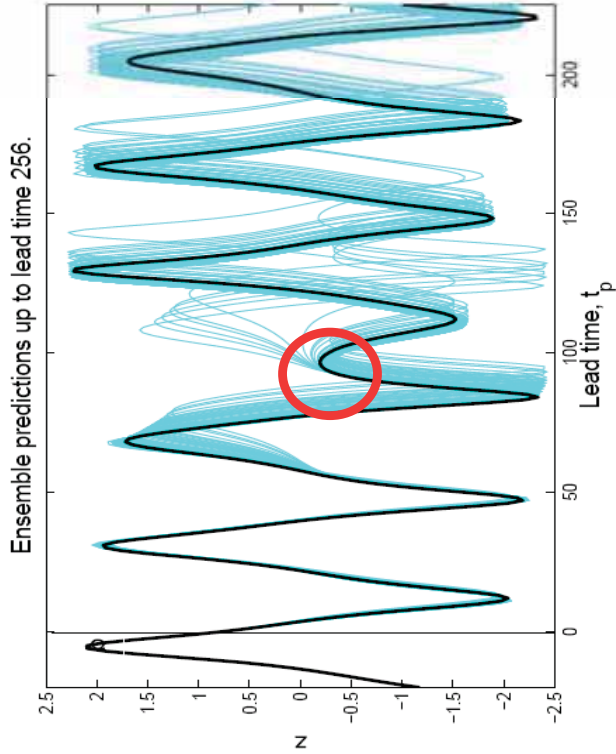
Leonard Smith

Big Surprise in the Moore-Spiegel Circuit (by Reason Machette)

One Initial State



Model 1



Model 2

Another Initial State

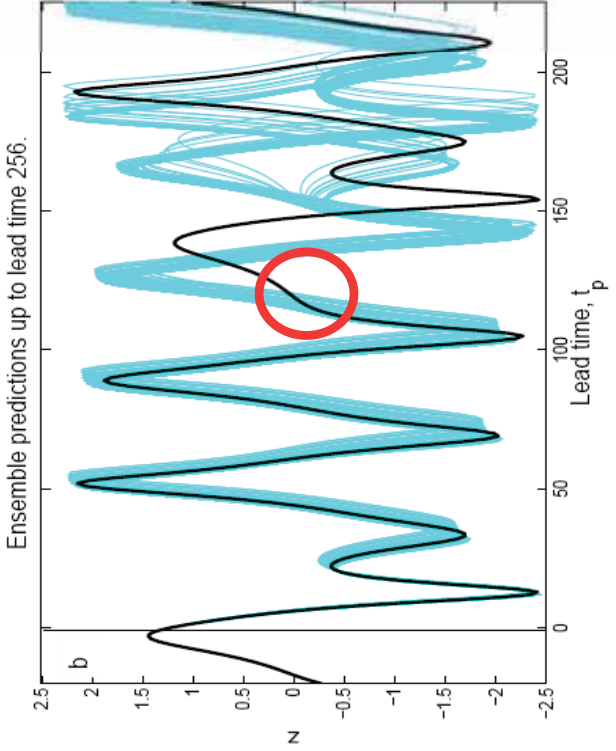
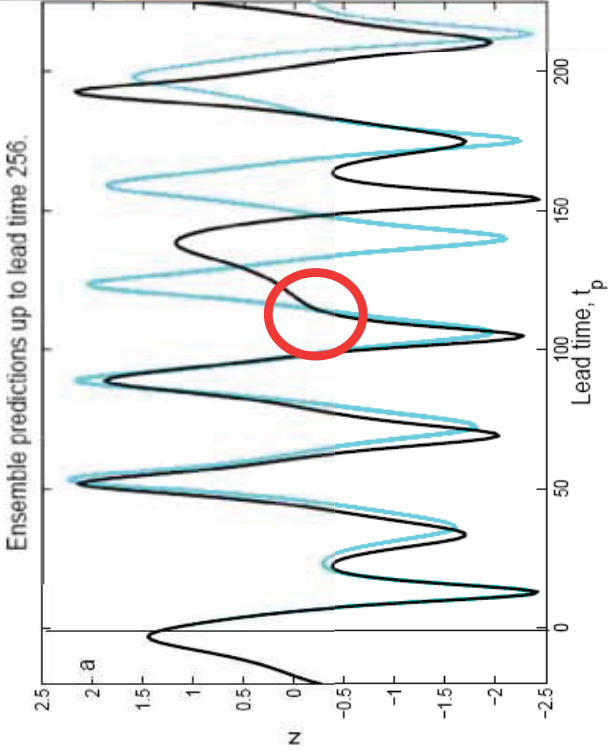
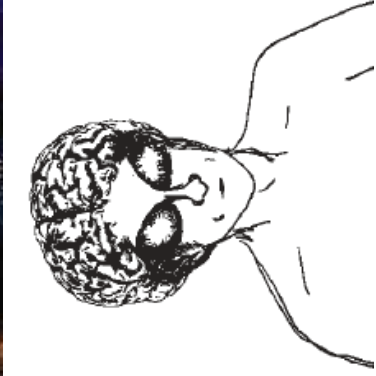


Figure 7: Ensemble predictions using (a) model 1 and (b) model 2. The 2: Ensemble predictions using (a) model 1 and (b) model 2. T



Laplace's Demon (1814)

- 1) Perfect Equations of Motion (PMS)
- 2) Perfect noise-free observations
- 3) Unlimited computational power

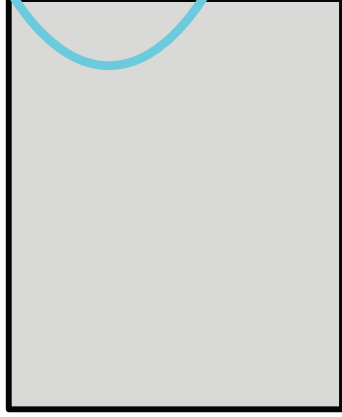


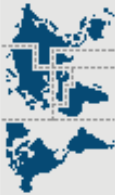
Demon's Apprentice (2007)

- 1) Perfect Equations of Motion (PMS)
- 2) ~~Perfect noise-free observations~~
- 3) Unlimited computational power

Apprentice's Novice (2012)

- 1) ~~Perfect Equations of Motion (PMS)~~
- 2) ~~Perfect noise-free observations~~
- 3) Unlimited computational power



News Front Page

Africa
Americas
Asia-Pacific
Europe
Middle East
South Asia
UK
England
Northern Ireland
Scotland
Wales
UK Politics
Education
Magazine
Business
Health
Science & Environment
Technology
...

Page last updated at 11:04 GMT, Friday, 5 March 2010

☒ E-mail this to a friend

 Printable version

Met Office seasonal forecasts to be scrapped

The Met Office is to stop publishing seasonal forecasts, after it came in for criticism for failing to predict extreme weather.

It was berated for not foreseeing that the UK would suffer this cold winter or the last three wet summers in its seasonal forecasts.

The forecasts, four times a year, will be replaced by monthly predictions.

The Met Office said it decided to change its forecasting approach after carrying out customer research.

Explaining its decision, the Met Office released a statement which said: "By their nature, forecasts become less accurate the further out we look.



The Met Office says its short-term forecasts are "extremely accurate"

SEE ALSO
► Met Office rethink on forecasts

http://news.bbc.co.uk/2/hi/uk_news/8551416.stm

Met Office document shows it only renamed its seasonal forecasts

Published 01/02/2011 Uncategorized 21 Comments

Tags: Abuse of Power, Dishonesty, Incompetence, Met Office, Our Tax Es, Spin, Weather



A Freedom of Information request submitted to the Met Office by Autonomous Mind reveals the Met Office did not tell the truth when it said it had scrapped its seasonal forecast.

Despite repeatedly trailing the line that the Met Office no longer issues seasonal forecasts because the public says they are not of use (a separate blog post on that public view later today, with some new information that has come to light... *Update: part two can now be [read here](#)*), the reality is that the department's Chief Executive, John Hirst, engaged in a smoke and mirrors exercise in an attempt at reputation management.

At a Board meeting of the Met Office on 26 January 2010, (original Minutes extract received under FOI: 0012014 AM Attachment) a recommendation was tabled by Hirst to *rename* the forecasts and locate them in a different part of the department's website, and that Hirst:

<http://autonomousmind.wordpress.com/2011/02/01/met-office-document-shows-it-only-renamed-its-seasonal-forecasts/>

These forecasts are not quite in the dark.

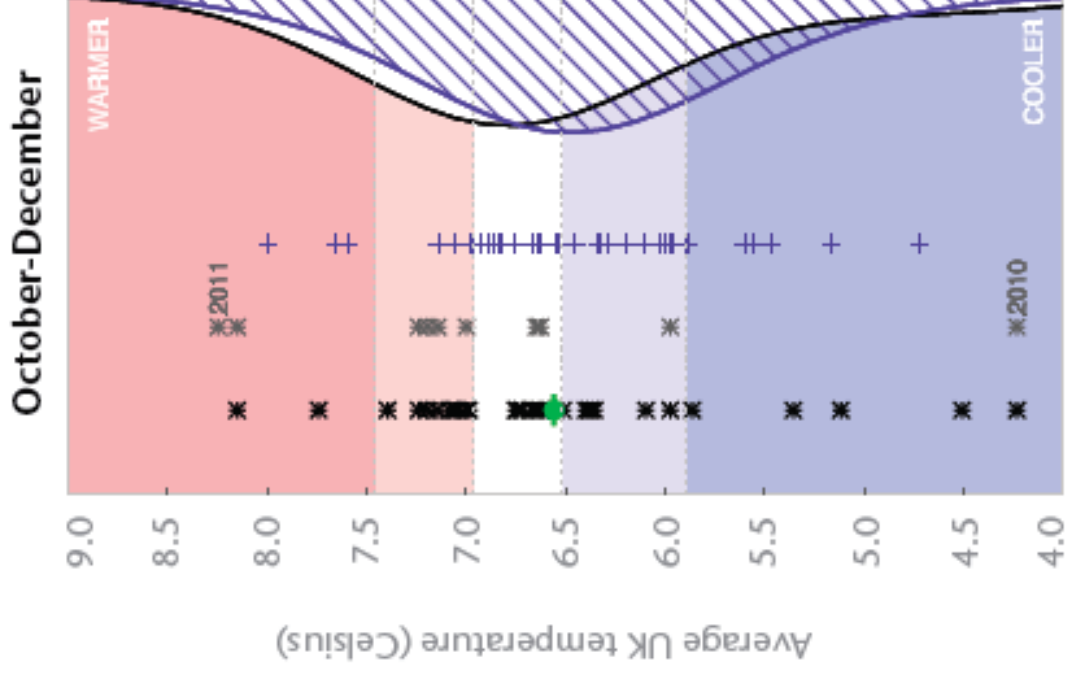
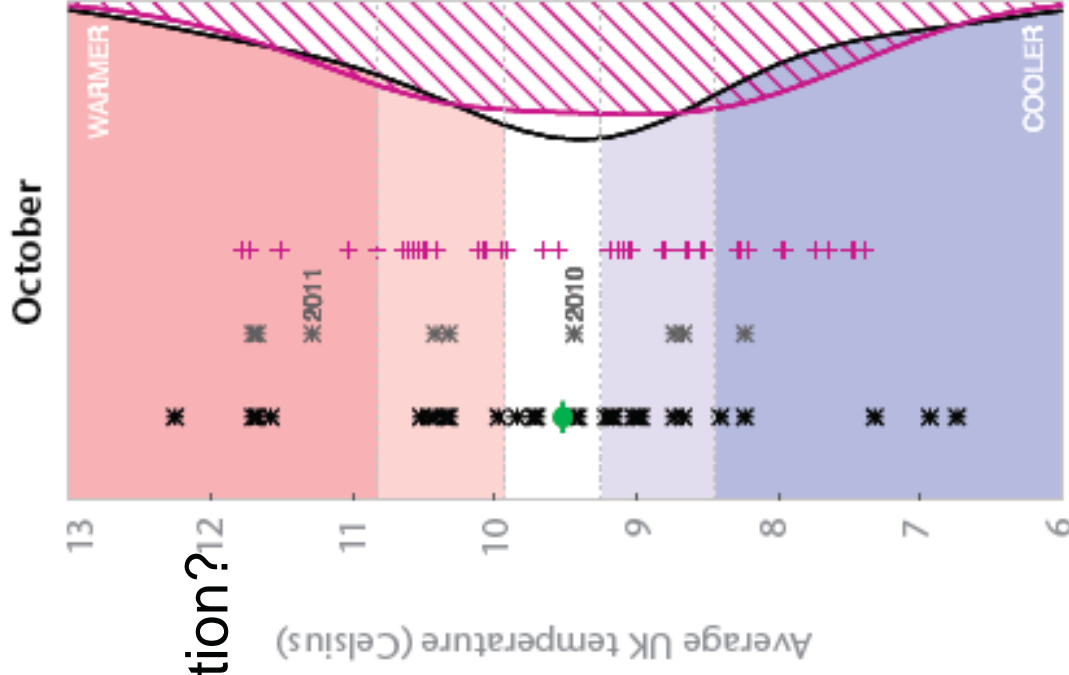
Skill?

Value?

Expectation?

Time to

Value?



✱ Observations 1981-2010

● 1981-2010 Average

✱ Observations 2002-2011

2012 outlook: + Oct + Oct-Dec



Can we disentangle these “uncertainties”?



Demon's Apprentice (2007)

- 1) Perfect Equations of Motion (PMS)
- 2) ~~Perfect noise-free observations~~
- 3) Unlimited computational power

Apprentice's Novice (2012)

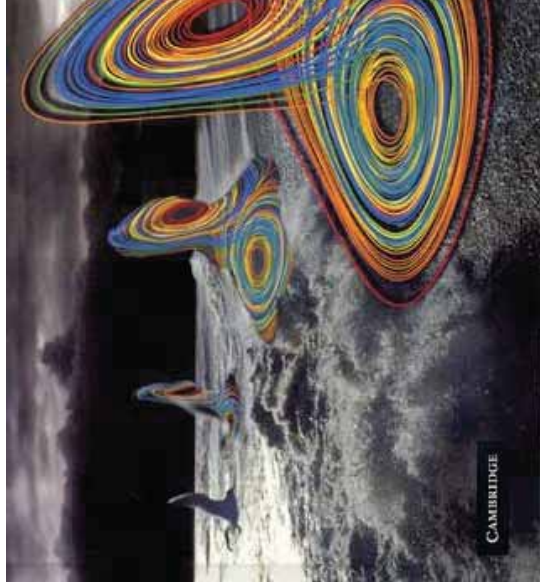
- 1) ~~Perfect Equations of Motion (PMS)~~
- 2) ~~Perfect noise-free observations~~
- 3) Unlimited computational power



Enter the NAG Board

The NAG Board

(Not A Galton Board 2000)
150th Birthday of RMS



Enter Ensembles



How might ensembles help us understand uncertainty?

Consider the Not A Galton (NAG) Board.

In the NAG board, probability forecasting corresponds to predicting with a collection (ensemble) of golf balls...

Ensembles inform us of uncertainty growth within our model!
(Telling us about the next golf ball.)



Diversity is not Uncertainty



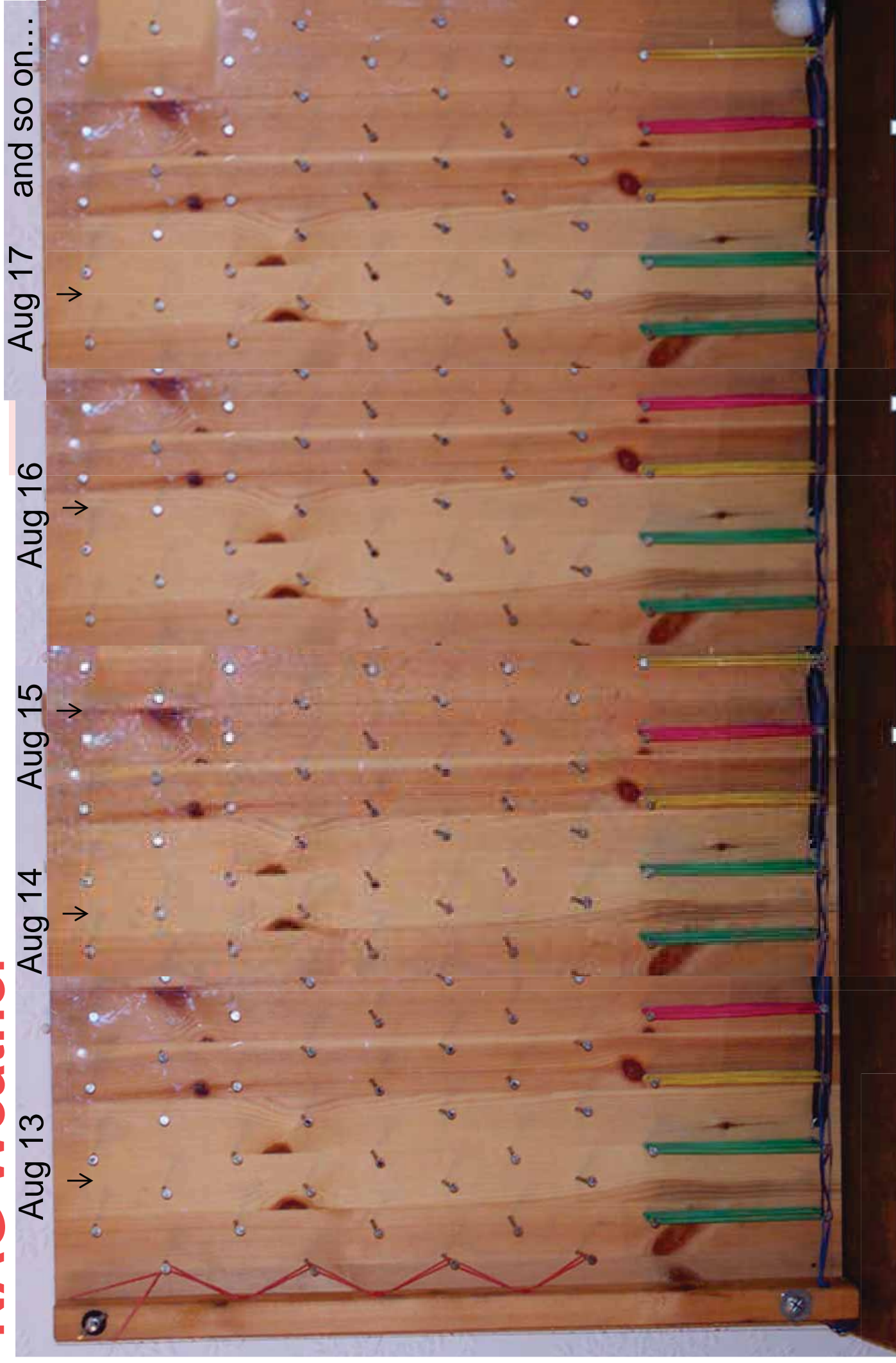
Ensembles inform us of uncertainty growth within our model(s)!

But **reality** is not a golf ball...

... **reality** is a red rubber ball.

What exactly does the distribution of 1024 golf balls tell us about the one (and only) red rubber ball?

While we never see similar initial states, we can still learn from our mistakes!(in this weather-like case)



Science can anticipate surprises beyond model-land

Interpreting even **weather-like** distributions is a challenge!

Climate predictions require extrapolating out of the observed archive: into the known-to-be-different (?fluid?) unknown.

Scientific insight can help.

But the best we can hope for is sensible, consistency **in distribution** between our models (“the details do not matter”).

And to anticipate “Big Surprises” (things are models cannot do)



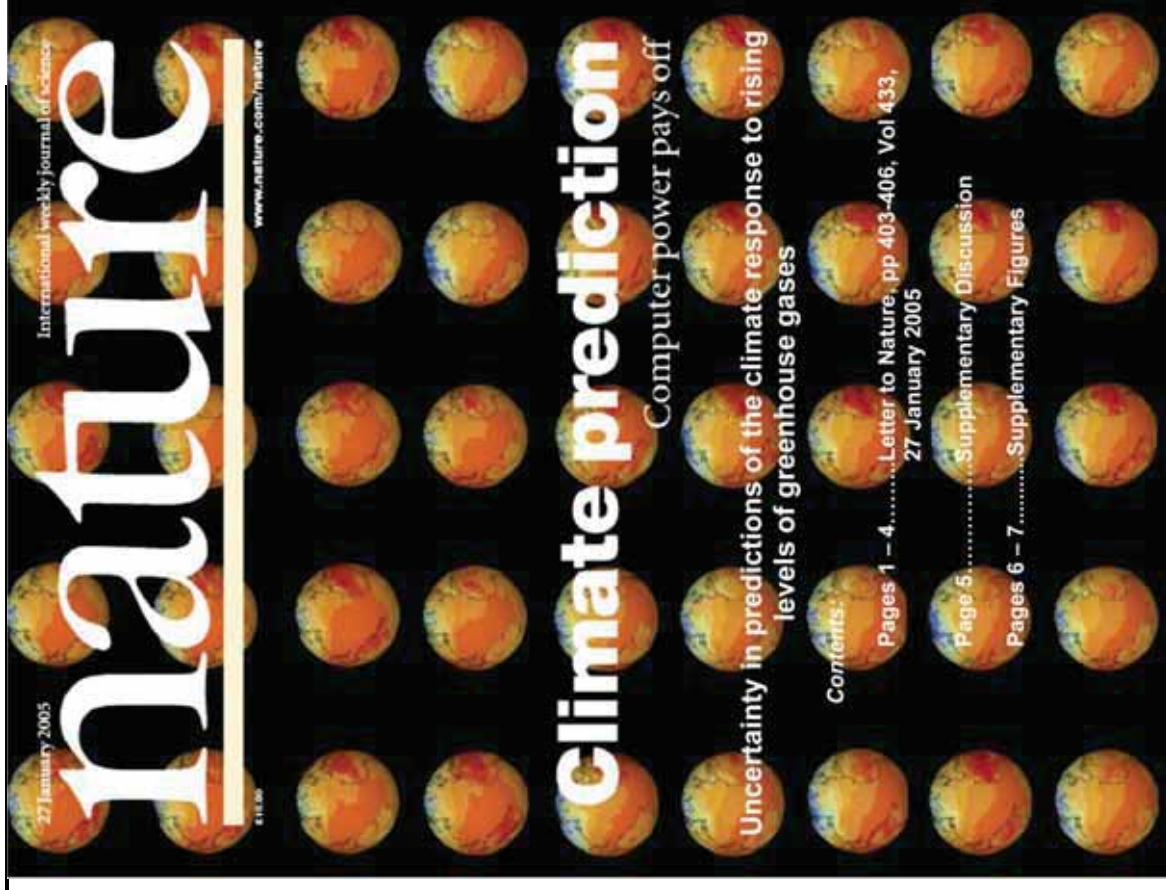
What is the aim of Climate Modelling?

It would be interesting to trace how the idea that climate models could provided quantitative insight came about.

Weather models are simplified climate models: you need not turn on ocean currents in the first few days, or ice in the first few weeks, or forest in the first few years...

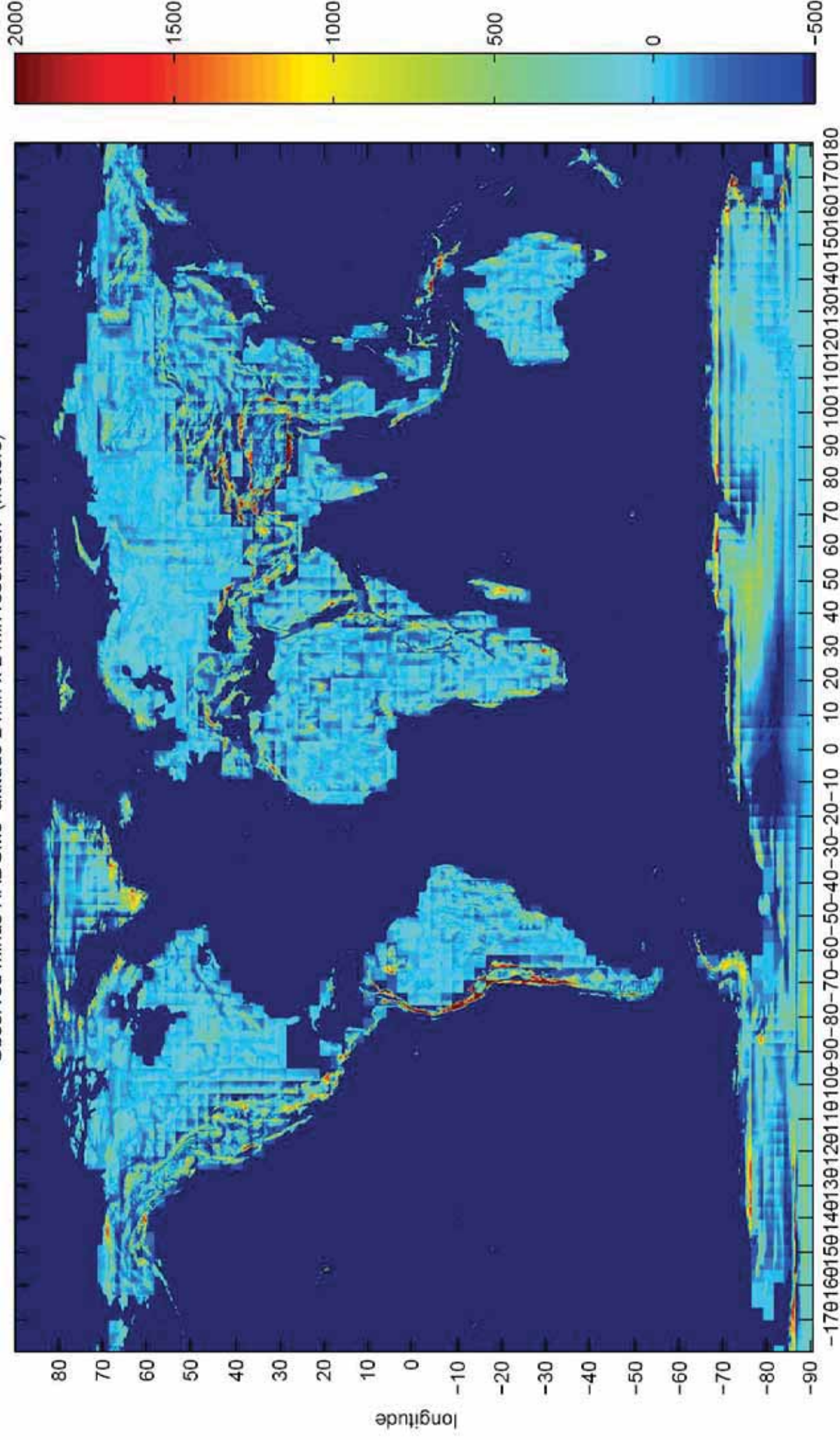
But climate models must run faster than real-time, and so are simplified in implementation: do we have the technology to run high fidelity climate models?

Why do we hide behind clouds when we cannot realistically simulate rock?

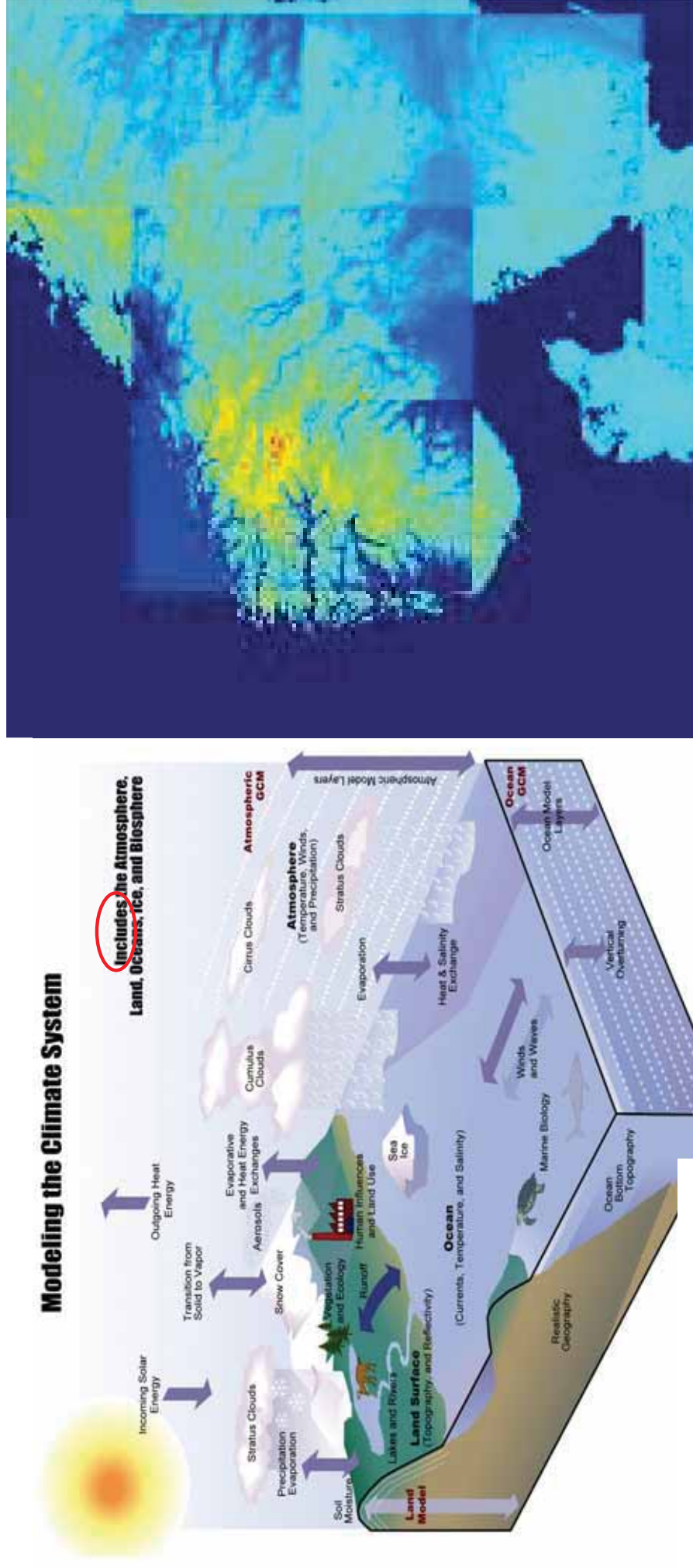


DA Stainforth, T Aina, C Christensen, M Collins, DJ Frame, JA Kettleborough, S Knight, A Martin, J Murphy, C Piani, D Sexton, L Smith, RA Spicer, AJ Thorpe, M.J Webb, MR Allen (2005) Uncertainty in the Predictions of the Climate Response to Rising Levels of Greenhouse Gases *Nature* 433 (7024): 403-406.

Observed minus HADCM3 altitude 2 min x 2 min resolution (meters)



Climate Models: “Included” vs “realistically simulated”



Karl and Trenberth 2003

A very schematic reflecting phenomena the model “includes”.
(Note the turtle)

The detail you see above is what is *missing* in HadCM3: the large squares reflect model grid resolution, the detail reflects the difference between the observed surface height and the model surface height, “constant” within a grid point,

Probabilistic Forecasts: IPCC Sixty-Forty Rule

MULTI-MODEL AVERAGES AND ASSESSED RANGES FOR SURFACE WARMING

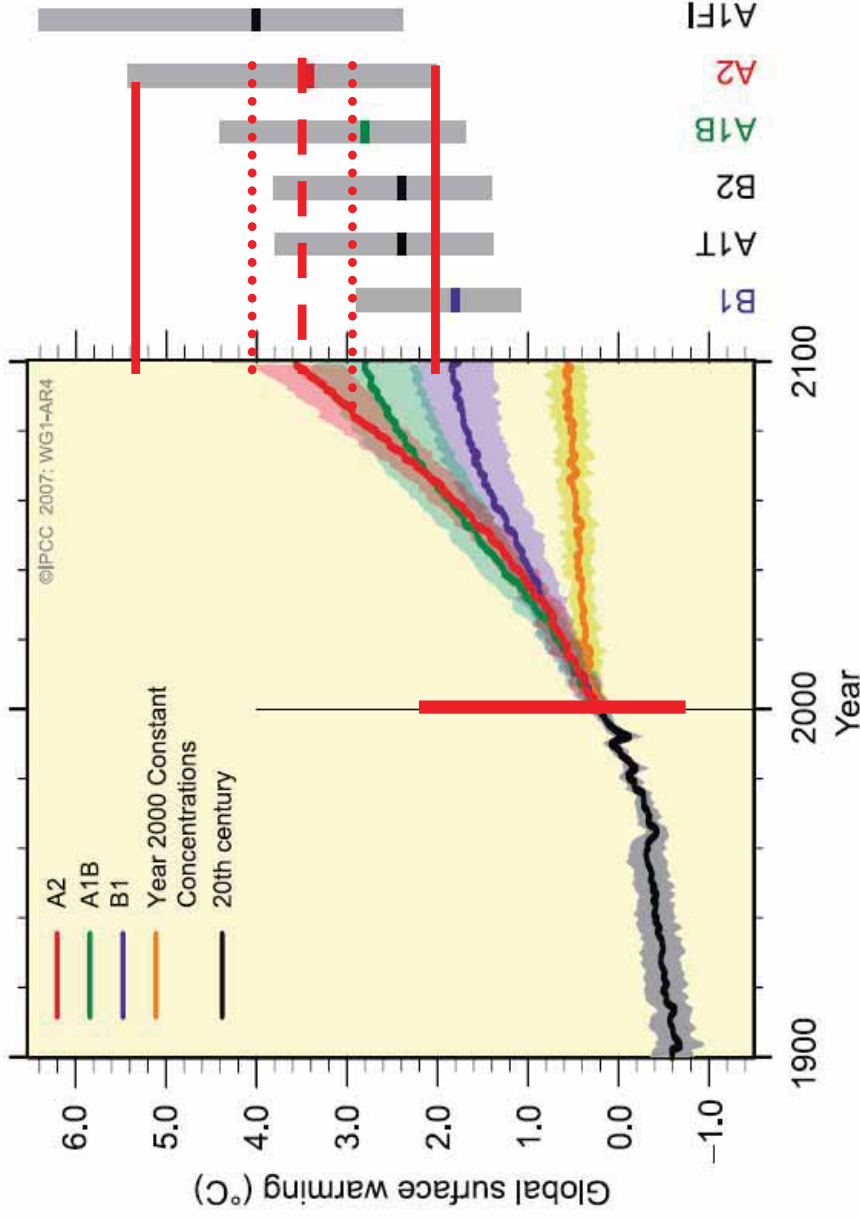
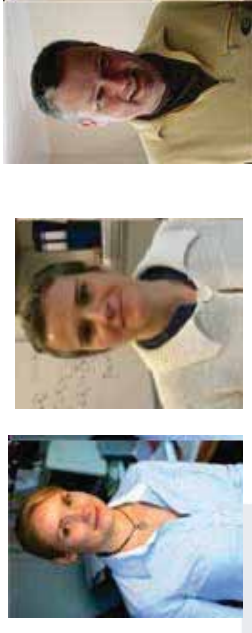


Figure SPM.5. Solid lines are multi-model global averages of surface warming (relative to 1980–1999) for the scenarios A2, A1B and B1, shown as continuations of the 20th century simulations. Shading denotes the ± 1 standard deviation range of individual model annual averages. The orange line is for the experiment where concentrations were held constant at year 2000 values. The grey bars at right indicate the best estimate (solid line within each bar) and the likely range assessed for the six SRES marker scenarios. The assessment of the best estimate and likely ranges in the grey bars includes the AOGCMs in the left part of the figure, as well as results from a hierarchy of independent models and observational constraints. (Figures 10.4 and 10.29)

- The conditional forecasts (projections) are the grey bars (right); they differ from the ensemble distributions left and centre.



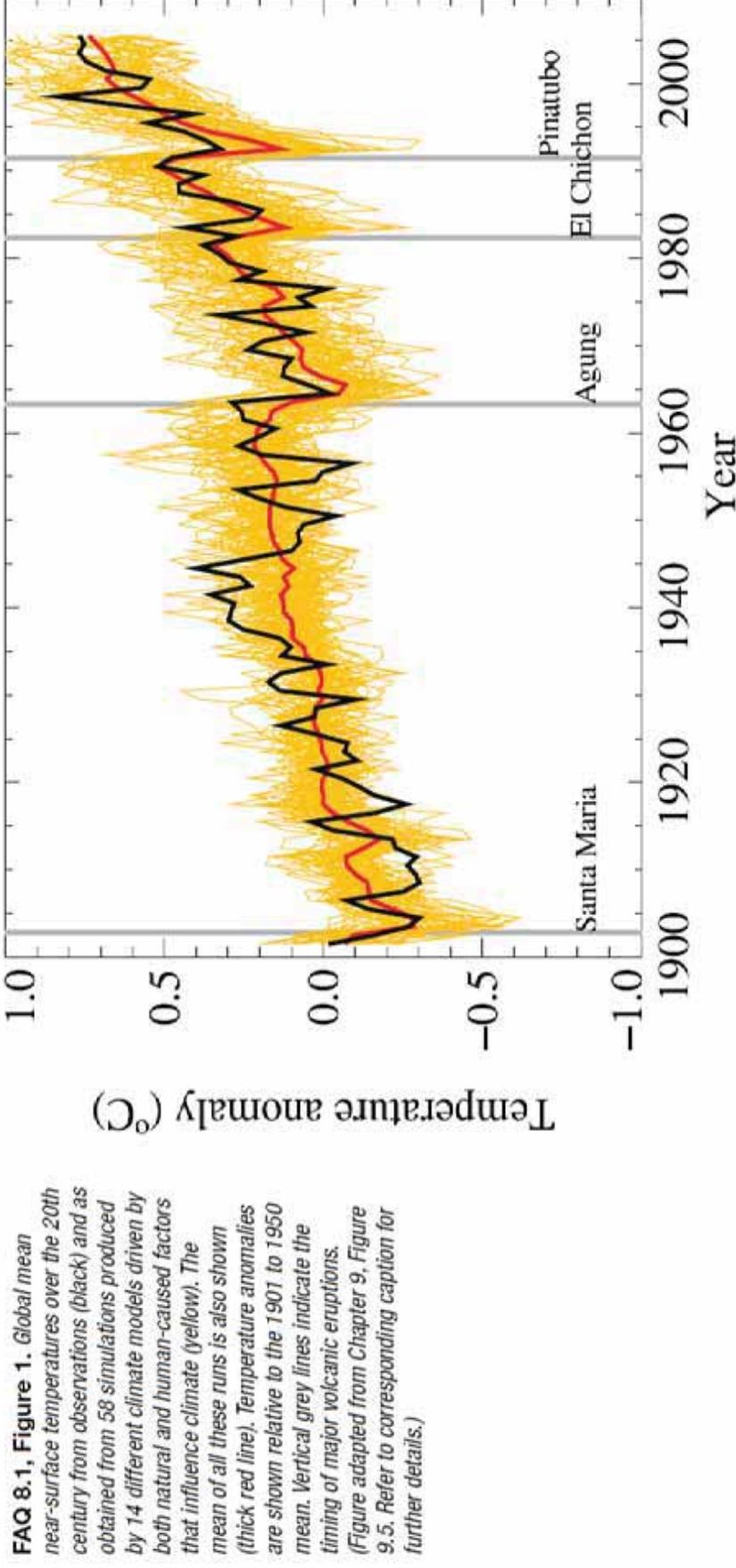
The real concern is that an adequately parameterised process might significantly shift the range.

Discussions of broadening imply confidence in the location. Do we have that confidence?

The IPCC rejects the diversity of ensembles directly reflecting the pdf of GMT, it follows that “downscaling” cannot provide local probabilities.

Climate in Practice: In-sample examples.

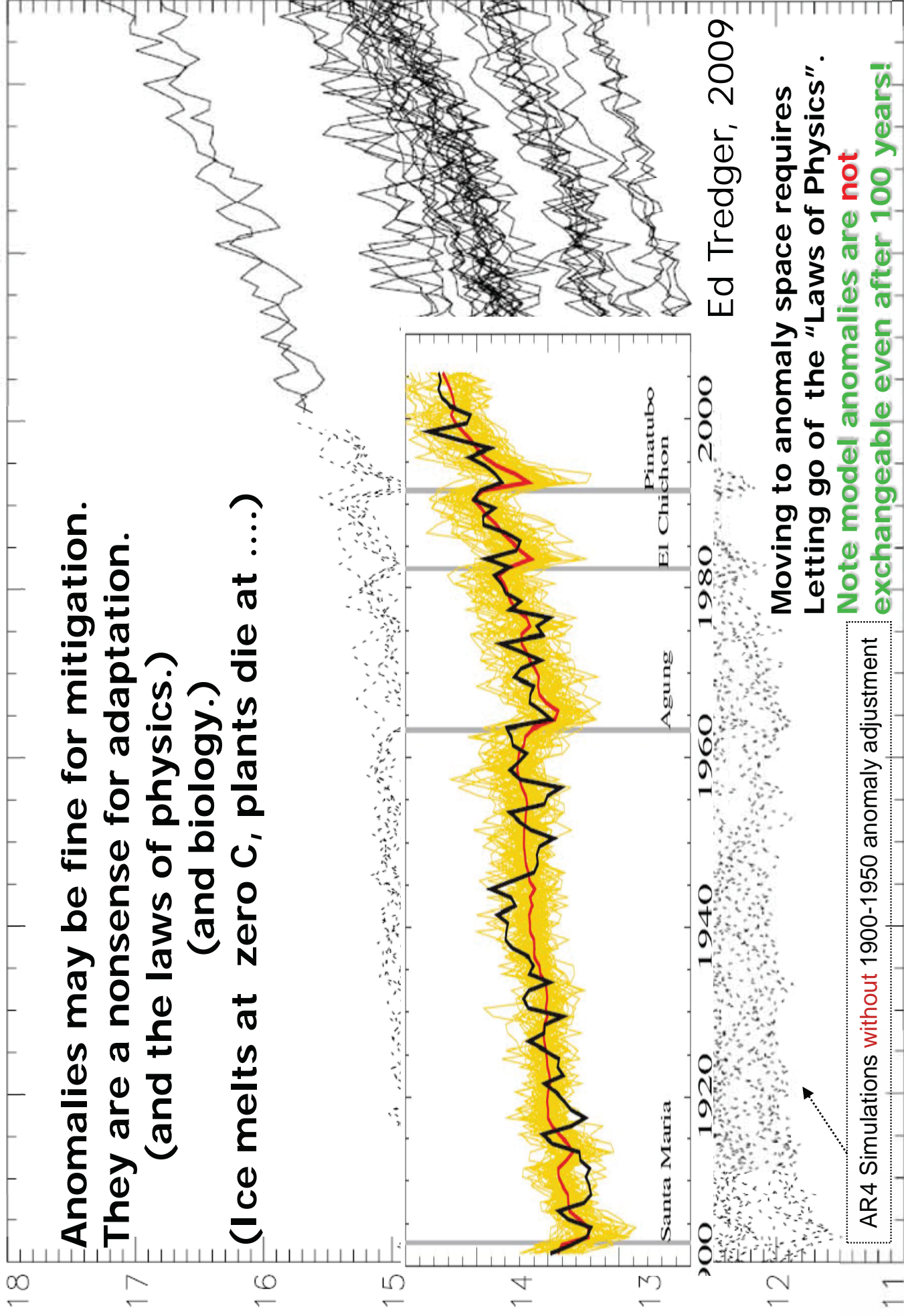
This graph tends to leave the impression GCMs do rather well.



While systematic errors are larger than the observed effect

Hindcasts and Forecasts of Global Mean Temperature

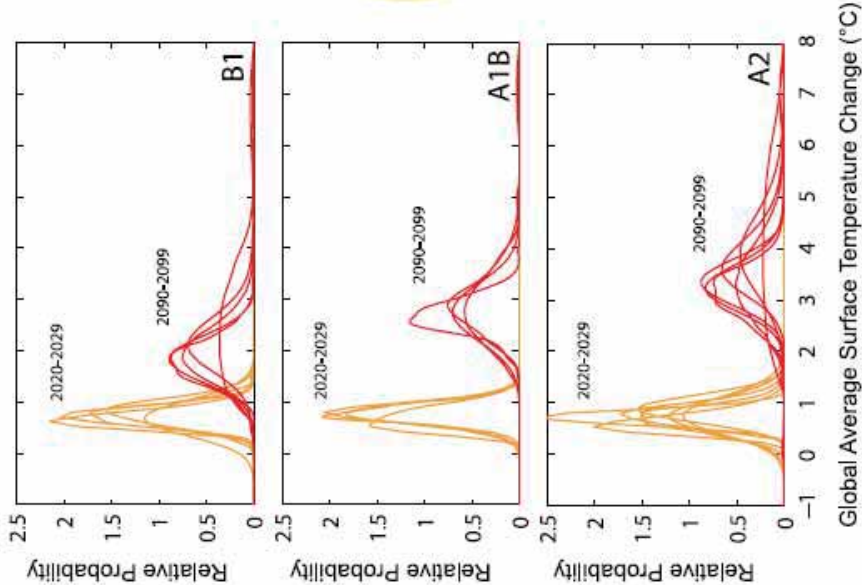
**Anomalies may be fine for mitigation.
They are a nonsense for adaptation.
(and the laws of physics.)
(and biology.)
(Ice melts at zero C, plants die at)**



Ed Tredger, 2009

**Moving to anomaly space requires
Letting go of the "Laws of Physics".
Note model anomalies are not
exchangeable even after 100 years!**

PROJECTIONS OF SURFACE TEMPERATURES



10

Global Climate Projections

The effects of uncertainty in the knowledge of Earth system processes can be partially quantified by constructing ensembles of models that sample different parametrizations of these processes. However, some processes may be missing from the set of available models, and alternative parametrizations of other processes may share common systematic biases. Such limitations imply that distributions of future climate responses from ensemble simulations are themselves subject to uncertainty (Smith, 2002), and would be wider were uncertainty due to structural model errors accounted for.

797

Figure SPM.6. Projected surface temperature changes for the early and late 21st century relative to the period 1980–1999. The central and right panels show the AOGCM multi-model average projections for the B1 (top), A1B (middle) and A2 (bottom) SRES scenarios averaged over probabilities of studies for the Therefore the {Figures 10.8.4

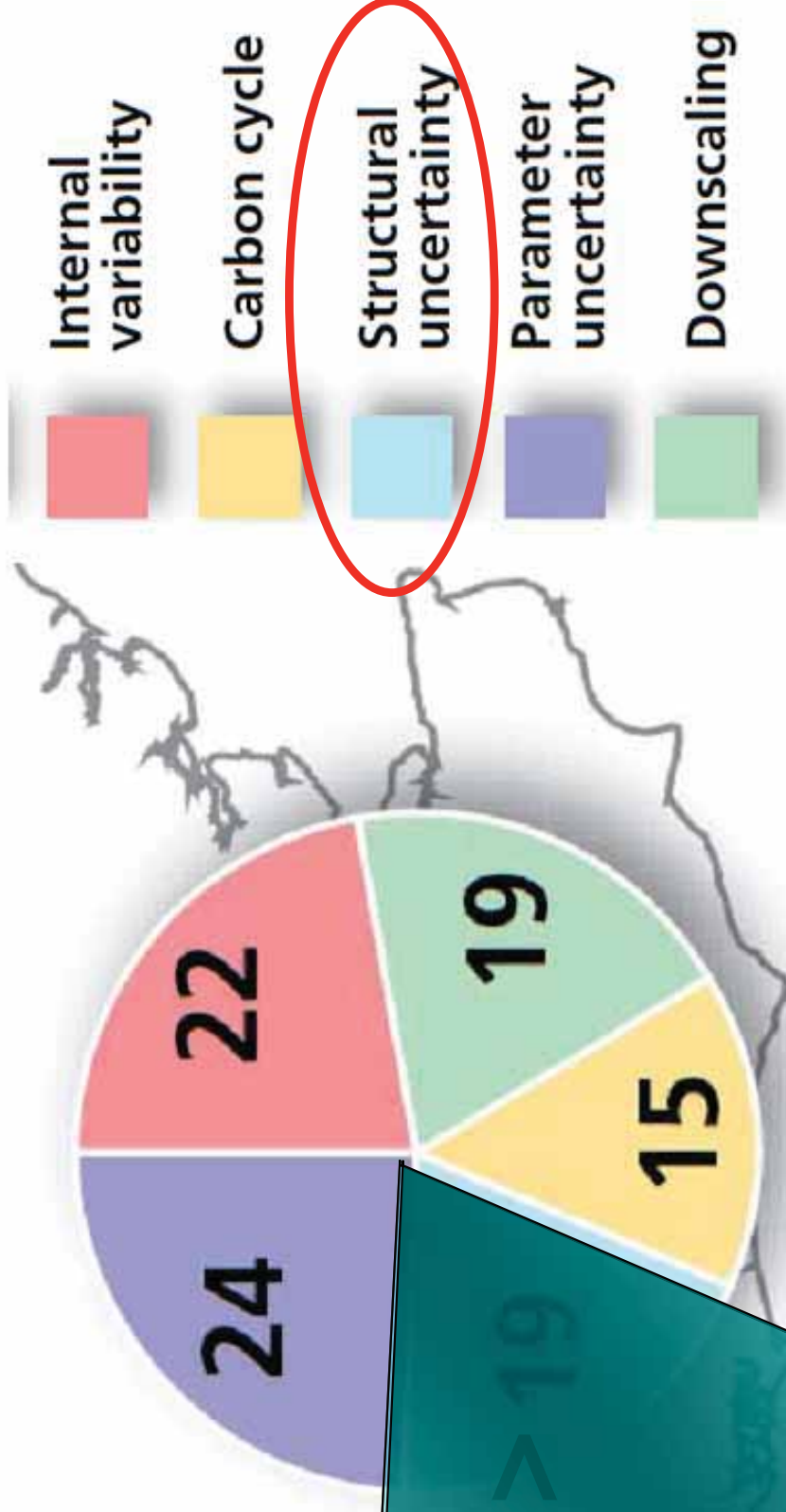
Not necessarily wider: they may narrow and shift under better models...

The IPCC itself might say this a bit louder/earlier: What space-time scales are realistic as a function of lead-time? (Focus on robust, but discuss inappropriate use.)

How important are different sources of uncertainty?

Dangers in the Dark: The value of qualitative insight is at risk of being discarded in favour of quantitative mis-information.

- Varies, but typically no single source dominates.



How might we avoid miscommunication in this case?

Uncertainties in winter precipitation changes for the 2080s relative to 1961-90, at a 25km box in SE England

How can we know our simulation models are inadequate?

Science is more than simulations



When does
"Sit and Think" trump
"Simulate and Count"?

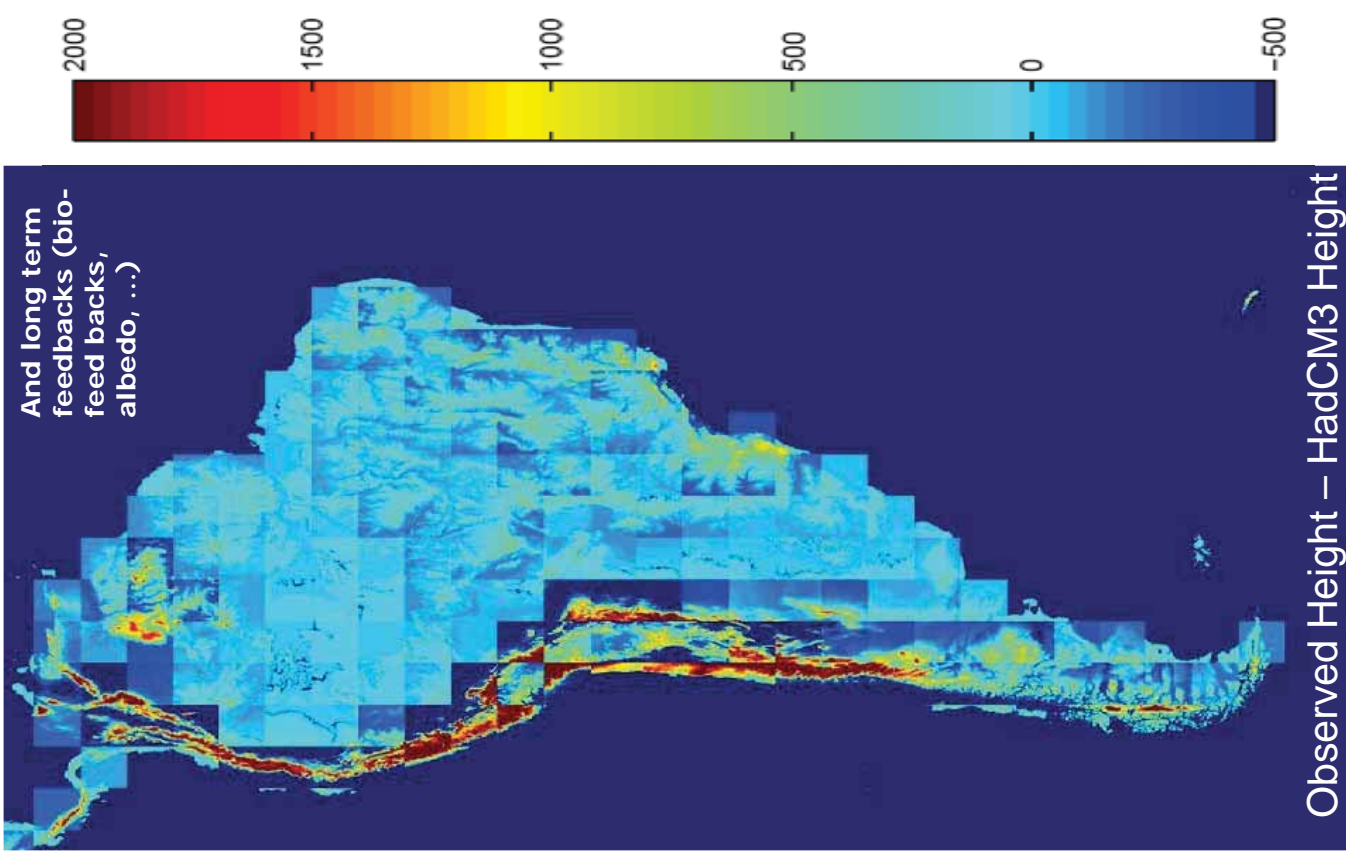
Example: When we
know moist air must go
over or around in (and
only in) the real world!

If our models cannot reproduce today's driving meteorological phenomena, can we expect them to get second order feedbacks "well enough"?

At what lead times do inadequacies in downstream flow (or precipitation) result in feedbacks with beyond local impacts? alter extremes? &c?

Can we provide Prob(Big Surprise) with lead time?

Missing 2km tall walls of rock!



Model-based probability forecasts are incomplete without a quantitative measure of the likelihood of model irrelevance.

If precip over the Amazon (or Okefenokee) is badly simulated, the biomass will be badly simulated, this missing/extra feedback may lead to model irrelevance... First local, then global.

Timescales for such things may be sound science!

Prob(Big Surprise)

Target
Lead-time

Spatial
Scales

metres

km

1000km

hours

weeks

years

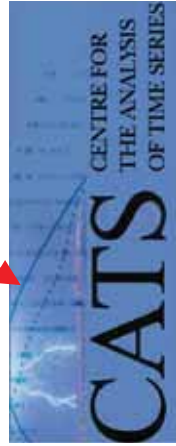
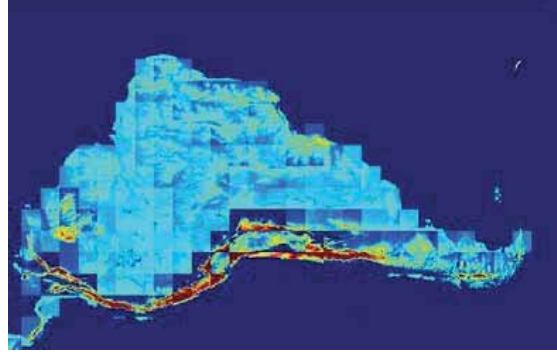
decades

centuries

weeks

day

Temporal
Average
Scale



Oct 2012

IEEE eScience: Science in the Dark

Leonard Smith



A genuine expert can always foretell a thing that is
500 years away easier than he can a thing that's only
500 seconds off.
- *A Connecticut Yankee in King Arthur's Court*

What is a “Big Surprise”?

Big Surprises arise when something our simulation models cannot mimic turns out to have important implications for us.

Often we can identify cases where we are “leaking probability” when a fraction of our model runs explore conditions which we know they cannot simulate realistically. (Science can warn of “known unknowns” even when the magnitude remains unknown)

Big Surprises invalidate (not update) model-based probability forecasts, the I in $P(x|I)$. (Arguably “Bayes” does not apply: this is not a question of probability theory.)

In weather forecasting, we can see when are models become silly, but in climate forecasting we are in the dark.

If our models agreed (in distribution) we would we have more confidence?

Services provided at: **Science & Technology Facilities Council, Rutherford Appleton Laboratory.**

Data Data Everywhere, and Not a Bit to Bank On

It seems we are surrounded by model output... but we know that the models are unlikely to be adequate to inform the questions we must answer.

What is the rational path forward when the best available model is known not to be adequate for purpose?



The basic insight here is not new

When in doubt, distrusting the indications, or inferences from them (duly considered on purely scientific principles, and checked by experience), the words “Uncertain,” or “Doubtful,” may be used, without hesitation.

Fitzroy, 1862

Dr. Platzman

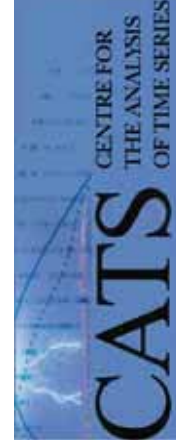
I may add to this another point mentioned by Dr. Charney, a somewhat philosophical comment concerning model experiments. I think that I agree with Dr. Charney's suggestion that machines are suitable for replacing model experiments. But I think it is also necessary to remember that there are in general two types of physical systems which one can think of modeling. In one type of system one has a fairly good understanding of the dynamical workings of the system, involved. Under those conditions the machine modeling is not only practical but probably is more economical in a long run. Typical examples of this kind, I think, are problems where you are concerned, let's say, with wave action in harbors, in general a whole class of engineering problems of that kind. But there is another class of problem where we are still far from a good understanding of the dynamical properties of the system. In that case laboratory models, I think, are very effective and have a very important place in the scheme of things.

PROCEEDINGS
OF
THE INTERNATIONAL SYMPOSIUM
ON NUMERICAL WEATHER
PREDICTION IN TOKYO ✓

NOVEMBER 7-13, 1960 ✓

Because of the various simplifications of the model described above, it is not advisable to take too seriously the quantitative aspect of the results obtained in this study. Nevertheless, it is hoped that this study not only emphasizes some of the important mechanisms which control the response of the climate to the change of carbon dioxide, but also identifies the various requirements that have to be satisfied for the study of climate sensitivity with a general circulation model.

The Effects of Doubling the CO₂ Concentration on the Climate of a General Circulation Model¹



SYUKURO MANABE AND RICHARD T. WETHERALD

Geophysical Fluid Dynamics Laboratory/NOAA, Princeton University, Princeton, N.J. 08540

(Manuscript received 6 June 1974, in revised form 8 August 1974)

ans

Senator Inhofe's List

U. S. Senate Report Over 400 Prominent Scientists Disputed Man-Made Global Warming Claims in 2007 Scientists Debunk "Consensus"



cyclopedia

nhofe (/ ˈɪnhɒf/; born
senior United States
and a member of the
ected to the Senate in

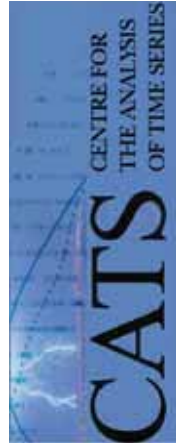
in Environment
ivities cause
nce, Chris
the science of

Jim Inhofe



United States Senator
from Oklahoma

Statistician Lenny Smith of the London School of Economics, who co-authored a study on the uncertainties of climate models for the Tyndall Centre for Climate Change Research in Oxford, dubbed climate modeling "naive realism." "Our models are being over-interpreted and misinterpreted," Smith said, according to a New Scientist article from August 16, 2007. "They are getting better; I don't want to trash them per se. But as we change our predictions, how do we maintain the credibility of the science?" Smith explained. "We need to drop the pretence that they are nearly perfect," he added. The article noted that Smith believes that the "over-interpretation of models is already leading to poor financial decision-making." The article continued: "[Smith] singled out for criticism the British government's UK Climate Impacts Programme and Met Office. He accused both of making detailed climate projections for regions of the UK when global climate models disagree strongly about how climate change will affect the British Isles." (LINK)



Derailing Science Ourselves: The Penguin Effect

The challenge of climate change will be with us for some time.

Can we maintain parallel streams: pure research to apply in 2050, and applied research to improve the modelling position we are in when we get there?

When selecting a thesis problem: do you suggest something important, like understanding cloud dynamics (better)?

Or to be the first person in the world to include the penguin effect in a global model? (and thereby all but assured a job at a rival modelling centre?)

(Similar effects plague economics and statistics)

THERE IS NO PENGUIN EFFECT

(My prior on this effect is zero)

**It is a joke regarding climate,
but sadly not career paths!**



Science in the Dark does not imply scientists have gone over to the dark side

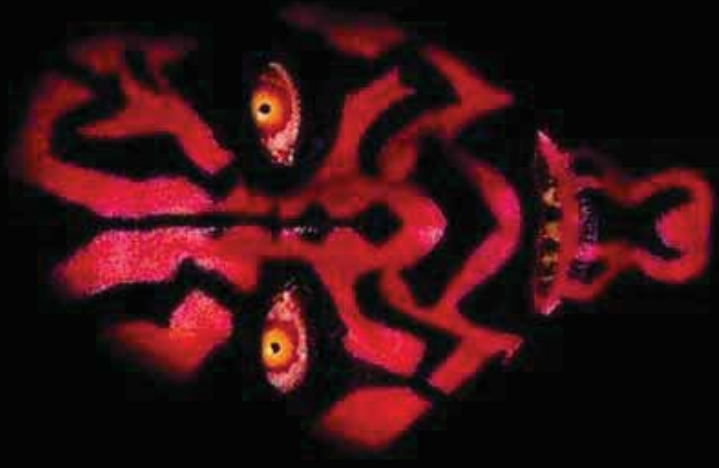


Scientists must “violate” traditional best practice guidance if such violations are imposed by the nature of the question being addressed.

One cannot wait 50 years for out-of-sample observations.

It is a brute fact that a climate model’s lifetime is less than its forecast leadtime!
The physics underlying CO₂ induced warming is as solid as science gets.

Science in the Dark does not imply scientists have gone over to the dark side



But science done without the benefit of out-of-sample evaluation cannot call on the unreasonable effectiveness of science done in the light.

Science which cannot be falsified without risking catastrophe needs to communicate clearly the limits of its (current) insights, or it risks the credibility of all science.

When the best available model is not adequate for purpose

Accept (for a moment) that **Model Inadequacy** may make probability forecasting irrelevant in just the same way that **chaos** made the RMS/least-squares error of point forecasts irrelevant.

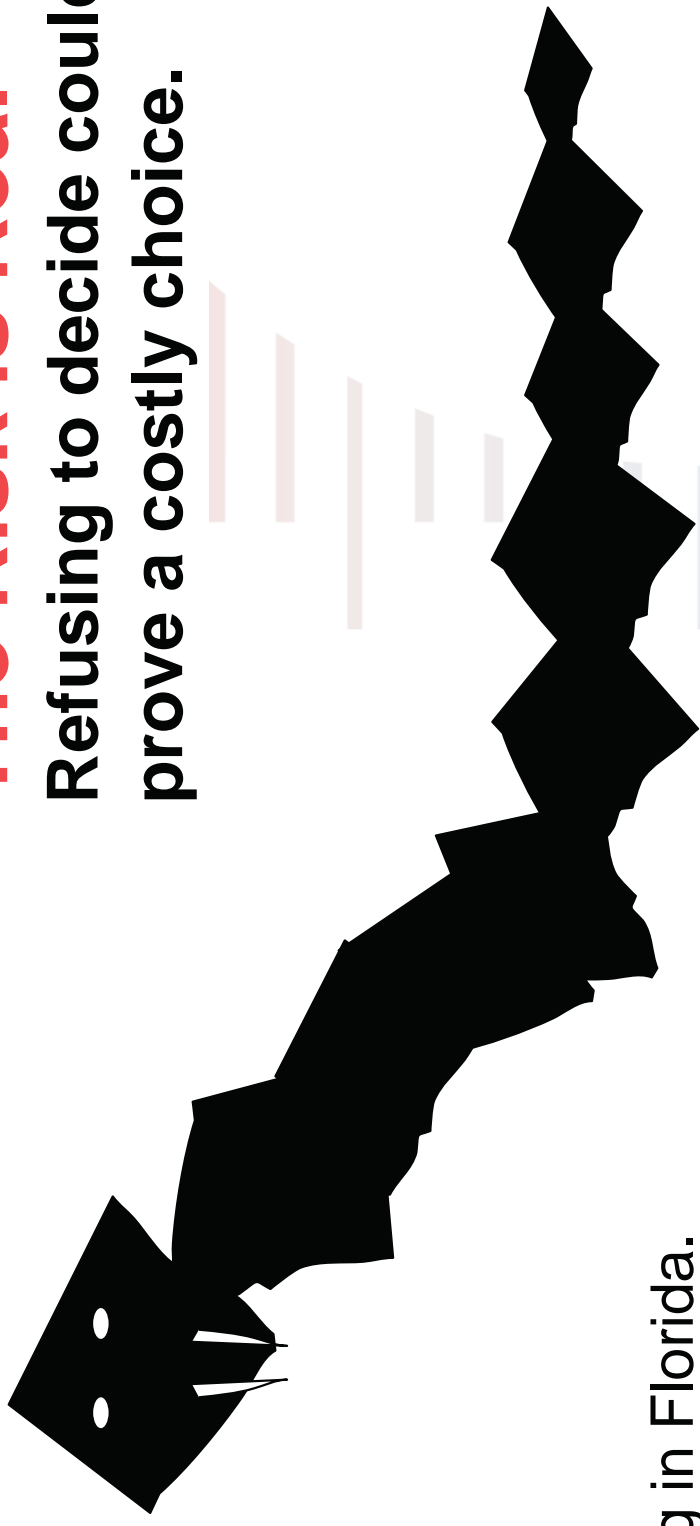
When the best model we have is not adequate from quantitative prediction: What is the role of quantitative modelling & simulation in decision support? In explanation?

How can we better extract insight and information from big models and ensemble forecasts without taking them too seriously?

Might this lead to better decision making?

The Risk is Real

Refusing to decide could prove a costly choice.



We are walking in Florida.

You find you have just been bitten on the hand by a snake.

We did not see the snake.

If it was the deadly carbonblack snake, the bite will kill you in a painful way, unless you cut off your hand within 15 secs.

I have a hatchet.

You have 5 seconds left.

Did you cut off your hand?

How would a society learn to make such decisions?

Luckily with climate change we have more than 15 seconds.

How can eScience help?

















You are here - [Welcome to LSE](#) > [CATS](#) > [Publications](#)

Publications http://www2.lse.ac.uk/CATS/publications/Publications_Smith.aspx

LA Smith, (2002) [What Might We Learn from Climate Forecasts?](#) *Proc. National Acad. Sci. USA* 4 (99): 2487-2492.

Smith, LA and Stern, N (2011) [Uncertainty in science and its role in climate policy](#) *Phil. Trans. R. Soc. A* (2011), **369**, 1-24

K Bevan, W Buytaert & LA Smith (2012) [On virtual observatories and modelled realities](#) *Hydrol. Process.*, 26: 1905-1908

R Hagedorn and LA Smith (2009) [Communicating the value of probabilistic forecasts with weather roulette](#). *Meteorological Appl* 16 (2): 143-155.

K Judd, CA Reynolds, LA Smith & TE Rosmond (2008) [The Geometry of Model Error](#). *Journal of Atmospheric Sciences* 65 (6), 1749-1772.

J Bröcker & LA Smith (2008) [From Ensemble Forecasts to Predictive Distribution Functions](#) *Tellus A* 60(4): 663. [Abstract](#)

DA Stainforth, MR Allen, ER Tredger & LA Smith (2007) [Confidence, uncertainty and decision-support relevance in climate predictions](#), *Phil. Trans. R. Soc. A*, **365**, 2145-2161. [Abstract](#)

LA Smith (2006) [Predictability past predictability present](#). MS Roulston, J Ellepola & LA Smith (2005) [Forecasting Wave Height Probabilities with Numerical Weather Prediction Models](#), *Ocean Engineering* **32** (14-15), 1841-1863. [Abstract](#)

[DA Stainforth, T Aina, C Christensen, M Collins, DJ Frame, JA Kettleborough, S Knight, A Martin, J Murphy, C Pianì, D Sexton, L Smith, RA Spicer, AJ Thorpe, M.J Webb, MR Allen \(2005\) Uncertainty in the Predictions of the Climate Response to Rising Levels of Greenhouse Gases](#) *Nature* **433** (7024): 403-406.

A Weisheimer, LA Smith & K Judd (2005) [A New View of Forecast Skill: Bounding Boxes from Seasonal Forecasts](#), *Tellus* **57** (3) 265-279 MAY.

K Judd & LA Smith (2004) [Indistinguishable States II: The Imperfect Model Scenario](#). *Physica D* **196**: 224-242.

MG Altalo & LA Smith (2004) [Using ensemble weather forecasts to manage utilities risk](#), *Environmental Finance* October 2004, 20: 8-9.

MS Roulston & LA Smith (2004) [The Boy Who Cried Wolf Revisited: The Impact of False Alarm Intolerance on Cost-Loss Scenarios](#), *Weather and Forecasting* 19 (2): 391-397.

LA Smith (2003) [Predictability Past Predictability Present](#). In 2002 ECMWF Seminar on Predictability. pg 219-242. ECMWF, Reading, UK.

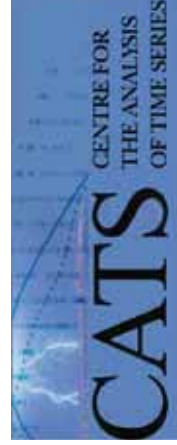
also now: Chapter 9 of [Predictability of Weather and Climate](#) (eds T. Palmer and R Hagedorn). Cambridge, UK. Cambridge University Press.

MS Roulston, DT Kaplan, J Hardenberg & LA Smith (2003) [Using Medium Range Weather Forecasts to Improve the Value of Wind Energy Production](#), *Renewable Energy* 29 (4) April 585-602.

MS Roulston and LA Smith (2002) 'Weather and Seasonal Forecasting' in *Climate Risk and the Weather Market* pg 115-126. Risk Books, London.

MS Roulston & LA Smith (2002) [Evaluating probabilistic forecasts using information theory](#), *Monthly Weather Review* 130 6: 1653-1660.

D Orrell, LA Smith, T Palmer & J Barkmeijer (2001) [Model Error in Weather Forecasting](#), *Nonlinear Processes in Geophysics* 8: 357-371.





Thank you














You are here - [Welcome to LSE](#) > [CATS](#) > [Publications](#)

Publications http://www2.lse.ac.uk/CATS/publications/Publications_Smith.aspx

LA Smith, (2002) [What Might We Learn from Climate Forecasts?](#) *Proc. National Acad. Sci. USA* 4 (99): 2487-2492.

Smith, LA and Stern, N (2011) [Uncertainty in science and its role in climate policy](#) *Phil. Trans. R. Soc. A* (2011), **369**, 1-24

K Bevan, W Buytaert & LA Smith (2012) [On virtual observatories and modelled realities](#) *Hydrol. Process.*, 26: 1905-1908

R Hagedorn and LA Smith (2009) [Communicating the value of probabilistic forecasts with weather roulette](#). *Meteorological Appl* 16 (2): 143-155.

K Judd, CA Reynolds, LA Smith & TE Rosmond (2008) [The Geometry of Model Error](#). *Journal of Atmospheric Sciences* 65 (6), 1749-1772.

J Bröcker & LA Smith (2008) [From Ensemble Forecasts to Predictive Distribution Functions](#) *Tellus A* 60(4): 663. [Abstract](#)

DA Stainforth, MR Allen, ER Tredger & LA Smith (2007) [Confidence, uncertainty and decision-support relevance in climate predictions](#), *Phil. Trans. R. Soc. A*, **365**, 2145-2161. [Abstract](#)

LA Smith (2006) [Predictability past predictability present](#). MS Roulston, J Ellepola & LA Smith (2005) [Forecasting Wave Height Probabilities with Numerical Weather Prediction Models](#), *Ocean Engineering* **32** (14-15), 1841-1863. [Abstract](#)

[DA Stainforth, T Aina, C Christensen, M Collins, DJ Frame, JA Kettleborough, S Knight, A Martin, J Murphy, C Pianì, D Sexton, L Smith, RA Spicer, AJ Thorpe, M.J Webb, MR Allen \(2005\) Uncertainty in the Predictions of the Climate Response to Rising Levels of Greenhouse Gases](#) *Nature* **433** (7024): 403-406.

A Weisheimer, LA Smith & K Judd (2005) [A New View of Forecast Skill: Bounding Boxes from Seasonal Forecasts](#), *Tellus* **57** (3) 265-279 MAY.

K Judd & LA Smith (2004) [Indistinguishable States II: The Imperfect Model Scenario](#). *Physica D* **196**: 224-242.

MG Altalo & LA Smith (2004) [Using ensemble weather forecasts to manage utilities risk](#), *Environmental Finance* October 2004, 20: 8-9.

MS Roulston & LA Smith (2004) [The Boy Who Cried Wolf Revisited: The Impact of False Alarm Intolerance on Cost-Loss Scenarios](#), *Weather and Forecasting* 19 (2): 391-397.

LA Smith (2003) [Predictability Past Predictability Present](#). In 2002 ECMWF Seminar on Predictability. pg 219-242. ECMWF, Reading, UK.

also now: Chapter 9 of *Predictability of Weather and Climate* (eds T. Palmer and R Hagedorn). Cambridge, UK. Cambridge University Press.

MS Roulston, DT Kaplan, J Hardenberg & LA Smith (2003) [Using Medium Range Weather Forecasts to Improve the Value of Wind Energy Production](#), *Renewable Energy* 29 (4) April 585-602.

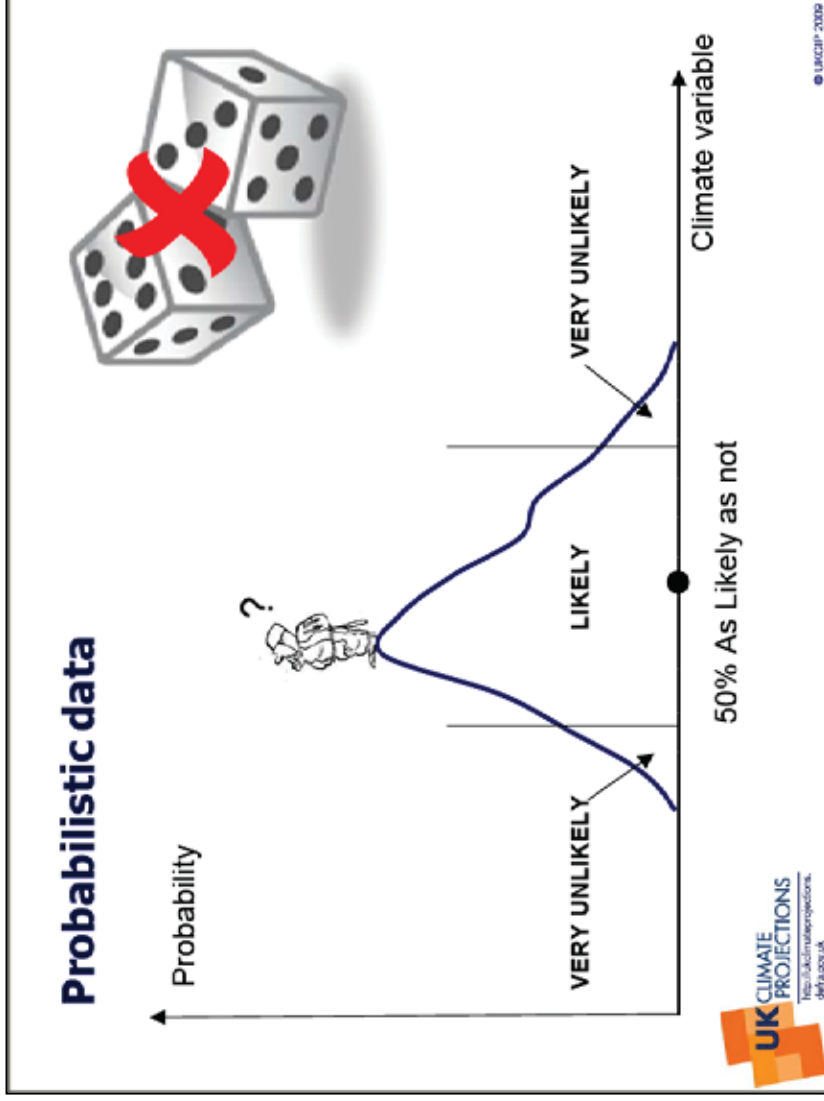
MS Roulston and LA Smith (2002) 'Weather and Seasonal Forecasting' in *Climate Risk and the Weather Market* pg 115-126. Risk Books, London.

MS Roulston & LA Smith (2002) [Evaluating probabilistic forecasts using information theory](#), *Monthly Weather Review* 130 6: 1653-1660.

D Orrell, LA Smith, T Palmer & J Barkmeijer (2001) [Model Error in Weather Forecasting](#), *Nonlinear Processes in Geophysics* 8: 357-371.

So what about UKCP probabilities?

What is the chance of falling above the 90% line of UKCP PDFs?



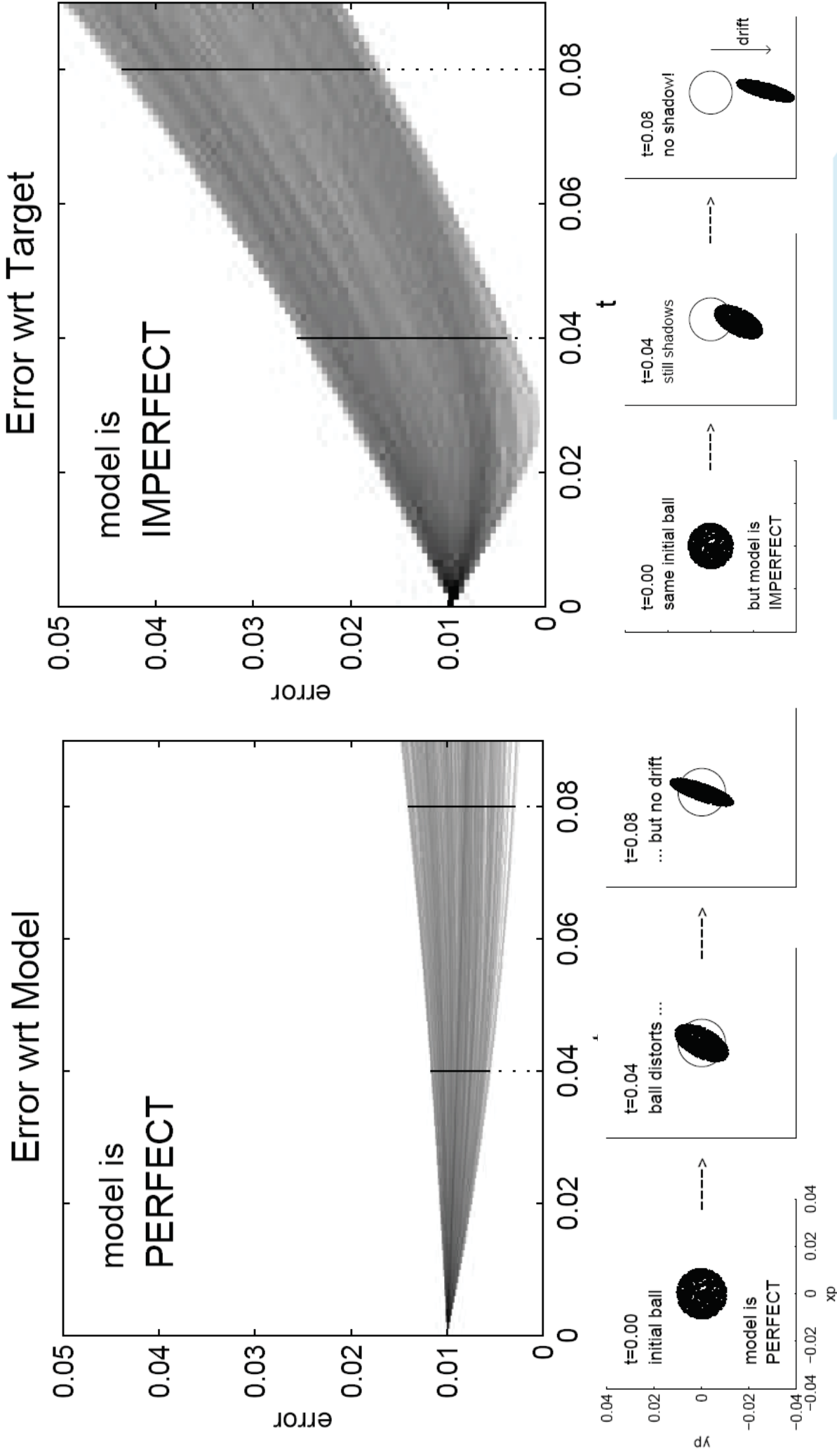
The probability of the real world falling above the 90% line of the UKCP PDF can be much **much** greater than 10%.

The shortcoming of climate models are more clearly acknowledged in the peer reviewed literature than in the UKCP user guidance.

It is important to stress that our approach to the specification of discrepancy can only be expected to capture a subset of possible structural modelling errors and should be regarded as a lower bound. This is because models tend to share certain common systematic biases, which can be found in diverse elements of climate including multiannual means of basic quantities such as surface temperature,

Model Imperfections

D Orrell, LA Smith, T Palmer & J Barkmeijer
(2001) [Model Error in Weather Forecasting](#),
Nonlinear Processes in Geophysics 8: 357-371.



Moving Forward:

Plausible Planets or Implausible Earths?

How can we best develop our models as the available computational power increases?

A) Simulate potentially real planets that get more and more Earth-like while omitting any Earth-relevant process for which the model cannot provide coherent physical drivers on Earth-like scales. (no suggestion of linear superposition intended!)

Does water vapour come after mountains?

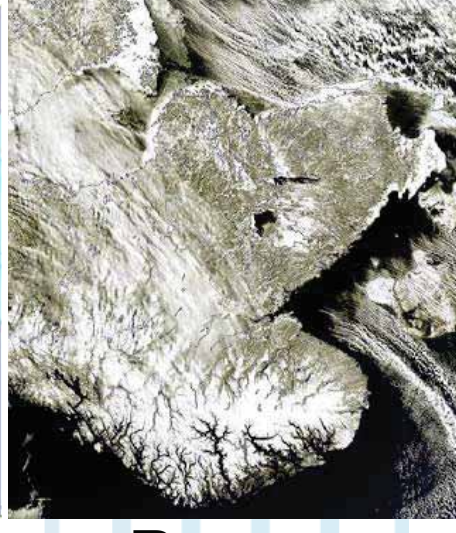
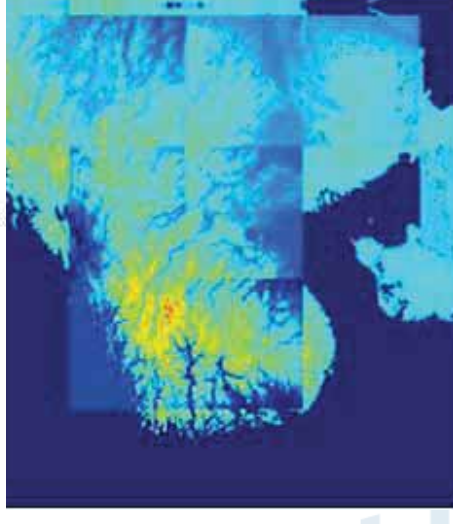
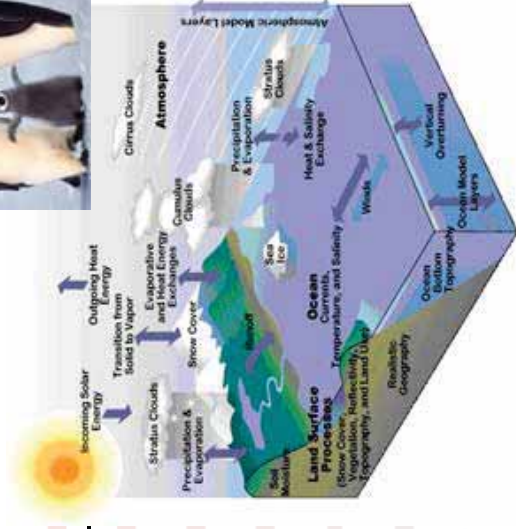
Does vegetation come after water vapour?

Do we avoid the penguin effect? (until it is simulated realistically)



B) Via an hodgepodge of unphysical/unbiological simulations resembling no planet that could possibly exist, but “including” every phenomena we can think of that might be important (including penguins), and hoping the simulated planets will suddenly become Earth-like at some resolution in an ill-defined higgledy-piggledy way.

One might argue physical intuition is more effective in evaluating plausible planets, as there is physics to intuit in that case. (and at least a few examples.)





Fitzroy



Le Verrier



Galton



Einstein



Whitehead



Lorenz



Richardson

Take home questions

How might we **better communicate model diversity** given the possibility that we cannot get probabilities useful as such!

Do we have a single example of a nontrivial system where anyone has succeeded (and **willing to bet** on their model-based probabilities?)

At what lead times do inadequacies drive (or fail to drive) feedbacks yielding local impacts? **global impacts?**

How far to one go with a simulation model (when to stop: in time? space?)

How can we best deal with models behaving badly?

What prevents the provision of **Prob(Big Surprise)** with lead time?

How can we improve the communication of insights from simulations without falling afoul of **forecasting good practice**?

How to distinguish the value of improvement from the utility of prediction?

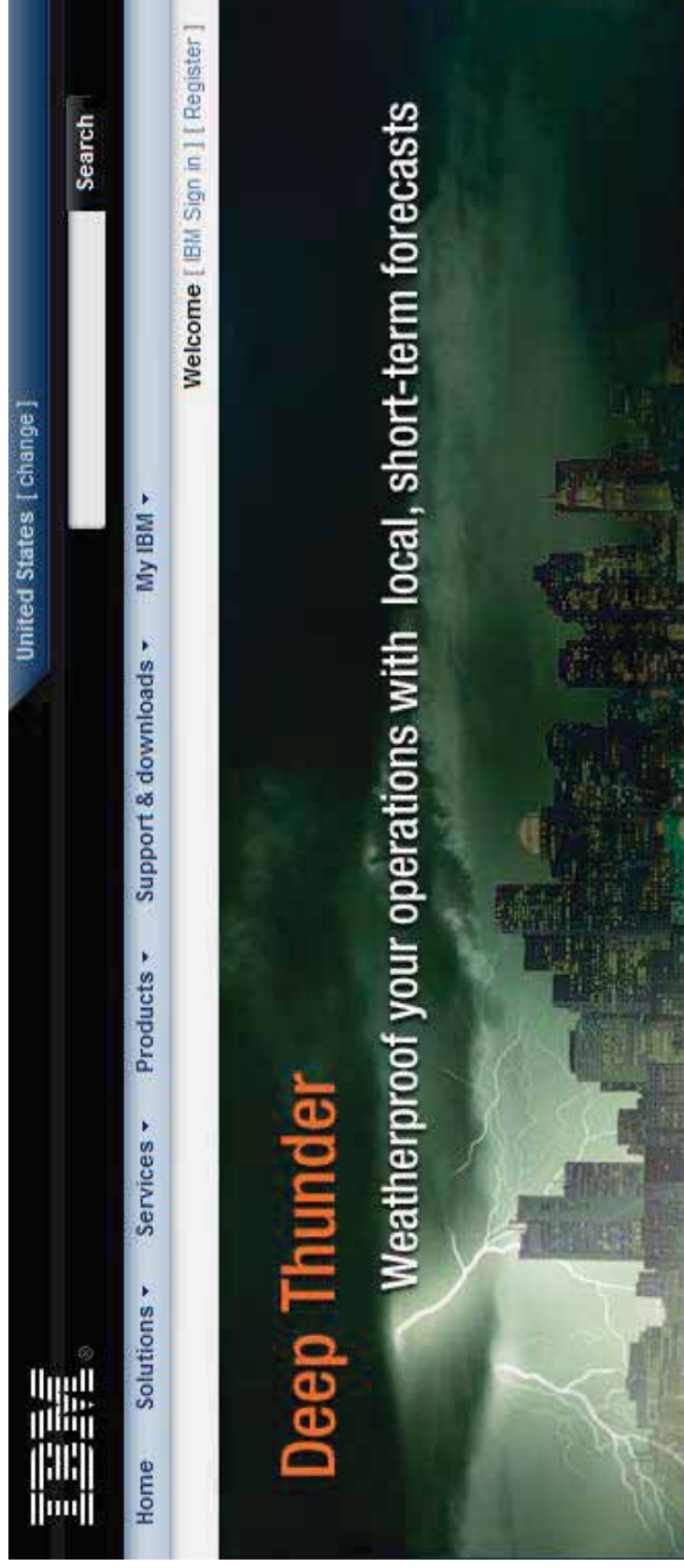
Might the provision of probability be maladaptive?

How might we better **communicate** the inadequacy as well as imprecision

Is the **value of qualitative insight** at risk of being discarded in favour of quantitative mis-information?



Precision or Early Warning an Event is Likely?




Smoothing out the highs and lows of running a business

As in daily life, one of the unruliest factors in running a business can be the weather. It can bring a highly functioning organization to a dead stop in a matter of seconds. Rack up billions in costs, in the blink of an eye. It's completely uncontrollable. And relentless. It is not, however, unpredictable.

Increasingly, precise, short-term, extremely local forecasts can help companies sidestep major disasters as well as plan for the more routine weather events that haemorrhage energy and resources.

<http://www.ibm.com/ibm/ideasfromibm/science/092506/>



science for a changing world

Earthquake Hazards Program

USGS Home
Contact USGS
Search USGS

Search

Home About Us Contact Us

EARTHQUAKES

HAZARDS

LEARN

PREPARE

MONITORING

RESEARCH

Did You Feel It?

- Home
- Archives
- Background
- Comment
- FAQ
- Disclaimer

Did You Feel It?



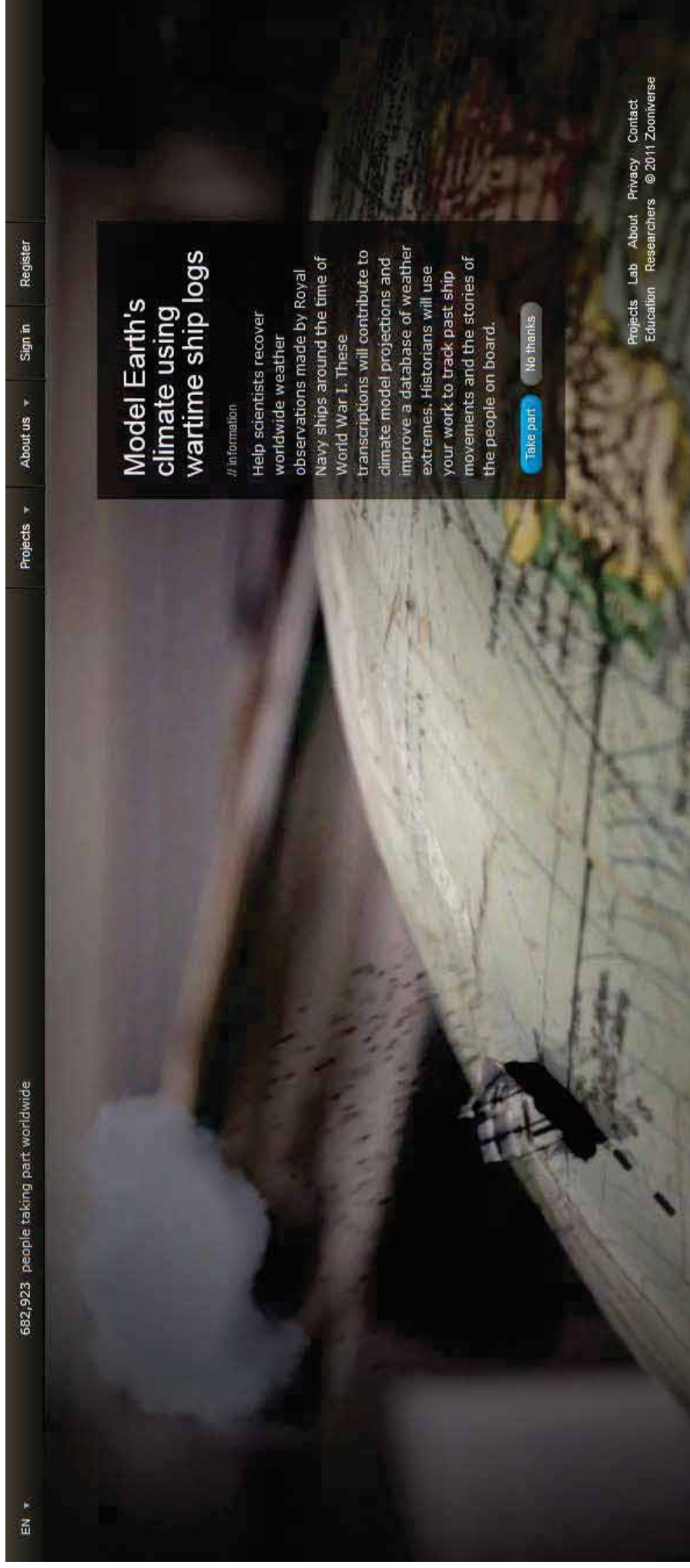
Report Unknown Event

View Archives

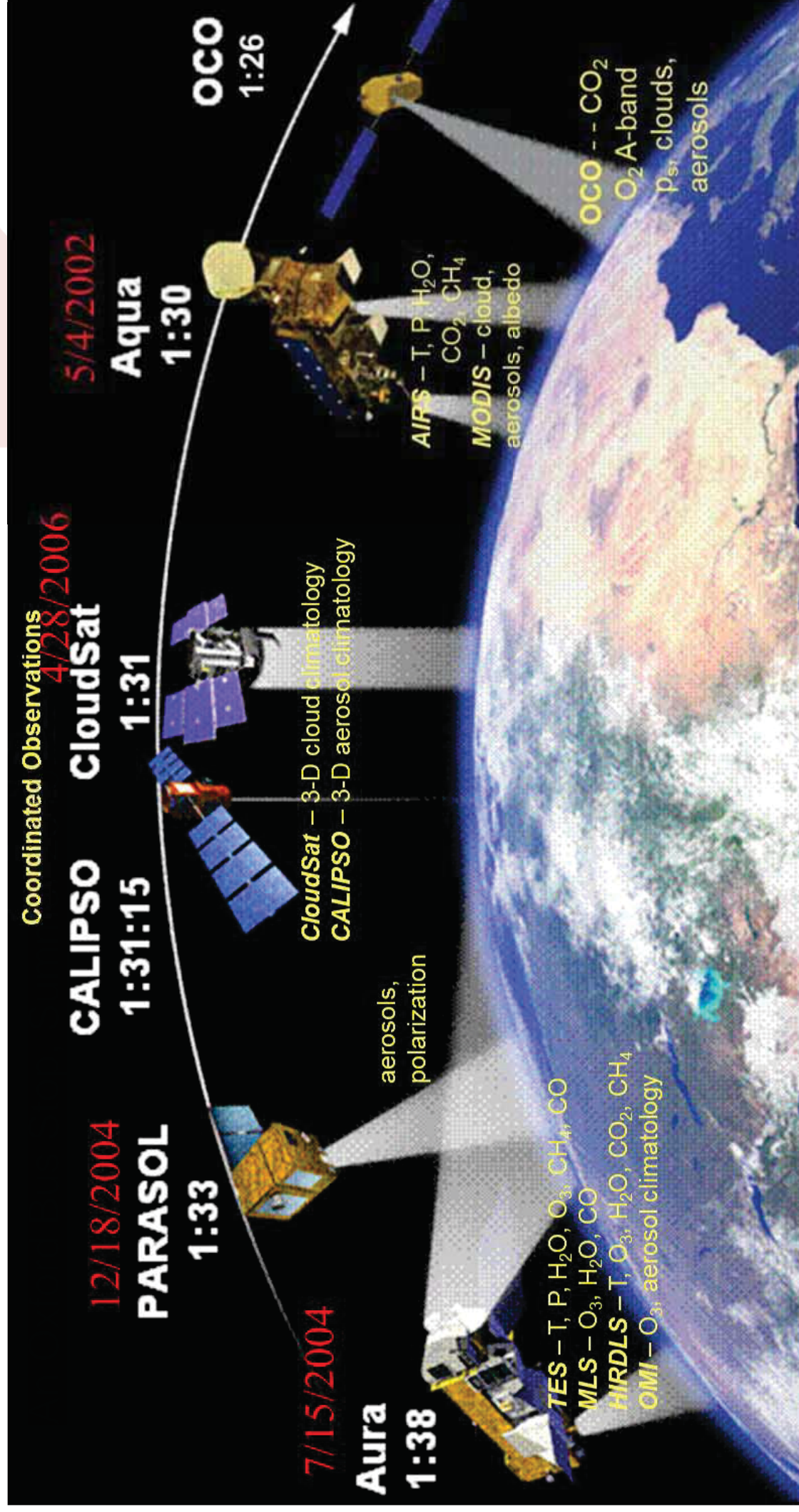
Found 12 matching results Events - Last 24 Hours



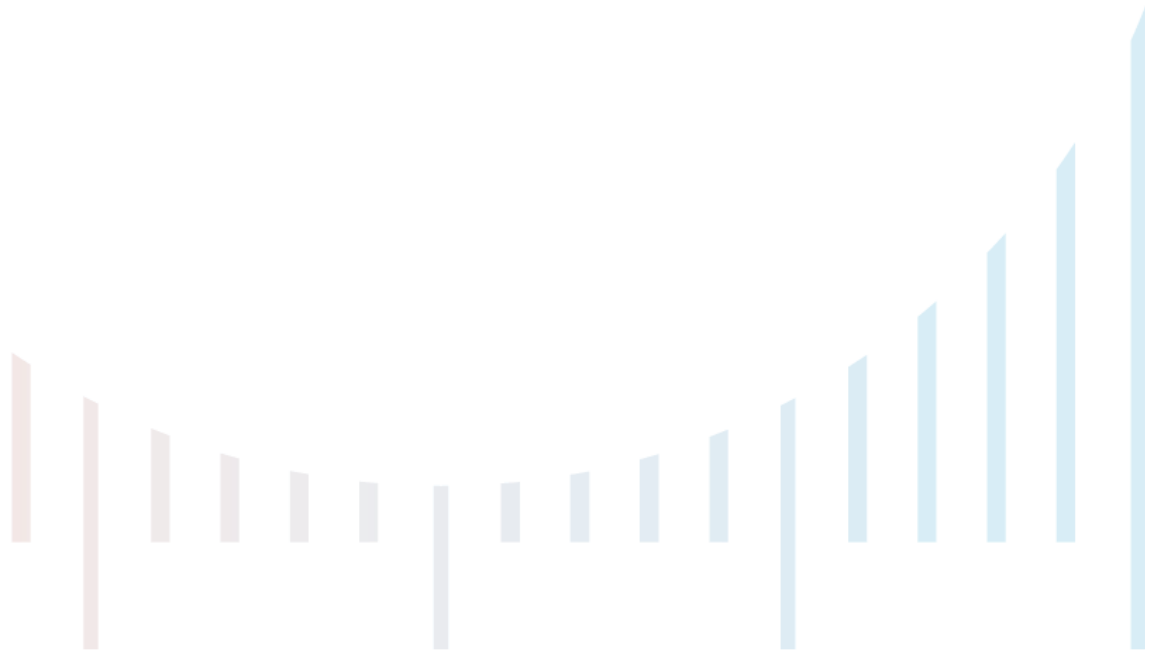
Where Might Climate Science Better Use eScience?



Better Handling of Data Streams



An Oxford Bus Stop, Summer 2010:



How did we get to zipcode PDFs from here?

(It would be interesting to trace how the idea that climate models could provided quantitative insight came about.)

Because of the various simplifications of the model described above, it is not advisable to take too seriously the quantitative aspect of the results obtained in this study. Nevertheless, it is hoped that this study not only emphasizes some of the important mechanisms which control the response of the climate to the change of carbon dioxide,

The Effects of Doubling the CO₂ Concentration on the Climate
of a General Circulation Model¹

SYUKURO MANABE AND RICHARD T. WETHERALD

Geophysical Fluid Dynamics Laboratory/NOAA, Princeton University, Princeton, N.J. 08540

(Manuscript received 6 June 1974, in revised form 8 August 1974)

It is important to stress that our approach to the specification of discrepancy can only be expected to capture a subset of possible structural modelling errors and should be regarded as a lower bound. This is because models tend to share certain common systematic biases, which can be found in diverse elements of climate including multiannual means of basic quantities such as surface temperature,

Why do these words get lost in the graphics?

What is climate?

Climate is what you expect, Weather is what you get.

Robert Heinlein (1973)

The climate system is a complex, interactive system consisting of the atmosphere, land surface, snow and ice, oceans and other bodies of water, and living things. The atmospheric component of the climate system most obviously characterises climate; climate is often defined as 'average weather'. Climate is usually described in terms of the mean and variability of temperature, precipitation and wind over a period of time, ranging from months to millions of years (the classical period is 30 years).

climate—"The synthesis of the weather" (C. S. Durst); the long-term manifestations of **weather**, however they may be expressed. More rigorously, the climate of a specified area is represented by the statistical collective of its weather conditions during a specified interval of time (usually several decades).

Climate is a distribution of multivariate time series!

(It's not just a number or two)

And for policy and (most) decision support:

“All Climate is Local”

[illegible]

GLOSSARY
OF
METEOROLOGY

Edited by
RALPH E. HUSCHKE

Sponsored by
U. S. Department of Commerce
Weather Bureau

U. S. Air Force
Air Weather Service, MAIS
Geophysics Research Directorate
AFSC, AFMPC

U. S. Army
Signal Corps

U. S. Navy
Office of Naval Research



AMERICAN METEOROLOGICAL SOCIETY
Boston, Massachusetts
1959



CATS
CENTRE FOR
THE ANALYSIS
OF TIME SERIES

The Advantage of being Local

While there is a common desire for non-locality, I know of no examples where a nonlocal score can be expected to have any advantages in probability forecasting.



“Should” this probability forecast score more highly for the red verification than the green (because there is more probability mass “near” the red verification)?

Is this not merely a case of trying to evaluate a single probability forecast in isolation?

Is there an example where this can happen repeatedly, which is not a case where smoothing the forecast pdf and using a local score would be advantageous?

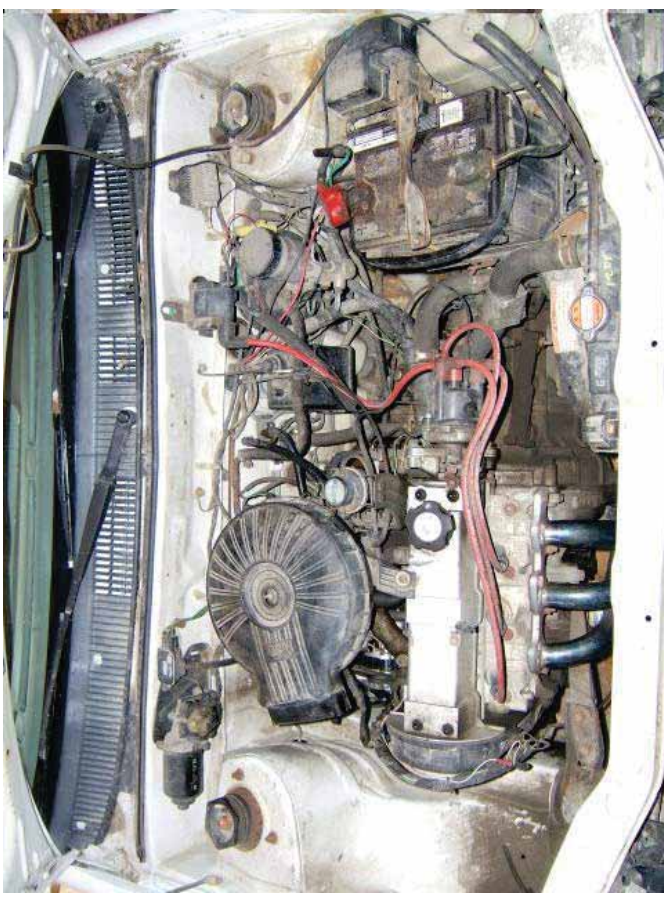
Parameter Estimation via Probability Forecasts

Consider parameter estimation in the case of the logistic map $F(x) = a \times (1-x)$

We can evaluate the skill of our entire ensemble prediction system as a whole by examining the skill of out forecast as a function of a .

Unless the prediction system is perfect, this need not return the true value of a .

If the model is structurally in error, there is no True value of a .



Where should decision makers draw the line?

Climate models are based on well-established physical principles and have been demonstrated to reproduce observed features of recent climate (see Chapters 8 and 9) and past climate changes (see Chapter 6). There is considerable confidence that Atmosphere-Ocean General Circulation Models (AOGCMs) provide credible quantitative estimates of future climate change, particularly at continental and larger scales. Confidence in these estimates is higher for some climate variables (e.g., temperature) than for others (e.g., precipitation). This summary highlights areas of progress since the TAR:

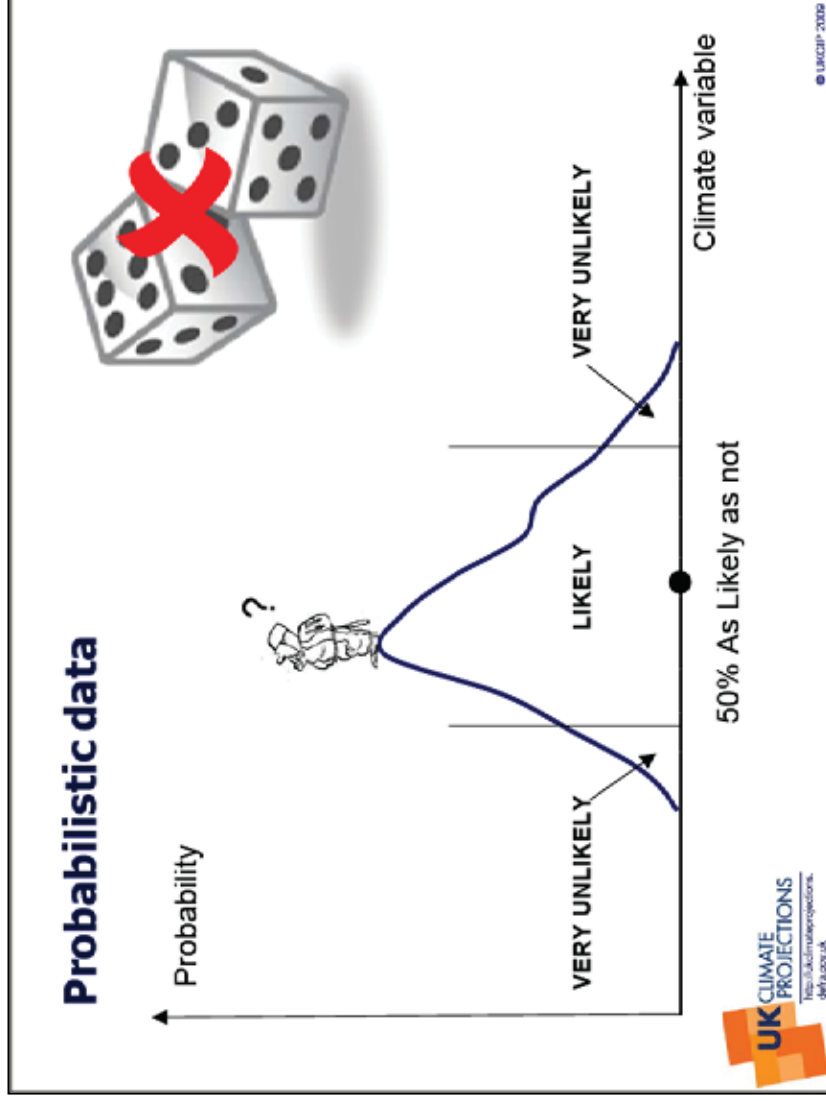
Page 591

A report of Working Group I of the
Intergovernmental Panel on Climate Change

Clear, plain spoken discussion of what today's models cannot capture quantitatively would be of great value.

So what about UKCP probabilities?

What is the chance of falling above the 90% line of UKCP PDFs?



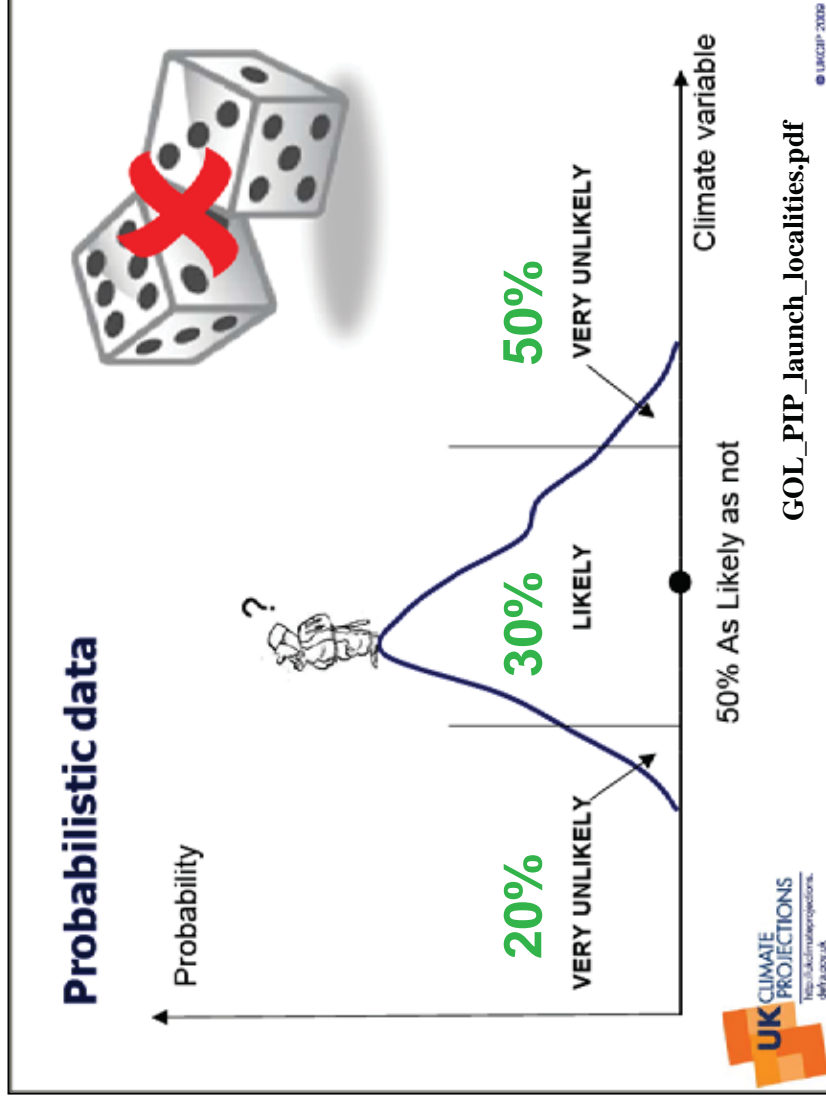
The probability of the real world falling above the 90% line of the UKCP PDF can be much **much** greater than 10%.

The shortcoming of climate models are more clearly acknowledged in the peer reviewed literature than in the UKCP user guidance.

It is important to stress that our approach to the specification of discrepancy can only be expected to capture a subset of possible structural modelling errors and should be regarded as a lower bound. This is because models tend to share certain common systematic biases, which can be found in diverse elements of climate including multiannual means of basic quantities such as surface temperature,

So what about UKCP probabilities?

What is the chance of falling above the 90% line of UKCP PDFs?

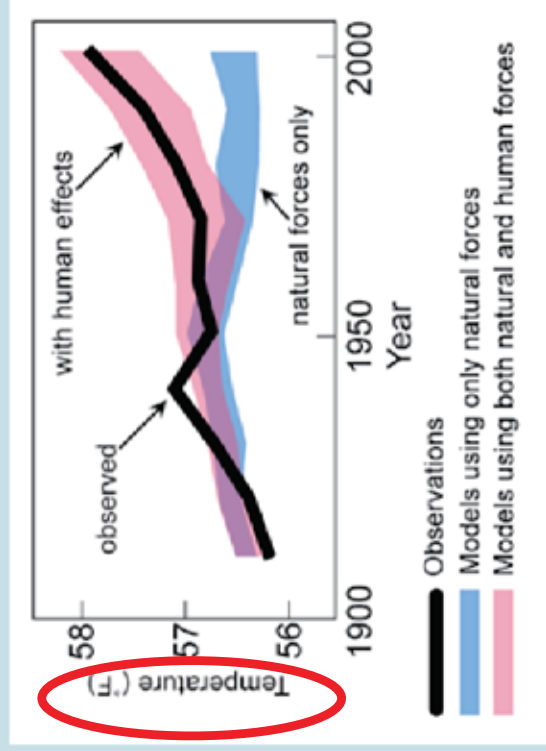


The probability of the real world falling above the 90% line of the UKCP PDF can be much **much** greater than 10%.

The shortcoming of climate models are more clearly acknowledged in the peer reviewed literature than in the UKCP user guidance.

It is important to stress that our approach to the specification of discrepancy can only be expected to capture a subset of possible structural modelling errors and should be regarded as a lower bound. This is because models tend to share certain common systematic biases, which can be found in diverse elements of climate including multiannual means of basic quantities such as surface temperature,

Separating Human and Natural Influences on Climate



As the blue band indicates, without human influences, global average temperature would actually have cooled slightly over recent decades. With human influences, it has risen strongly (black line), consistent with expectations from climate models (pink band).

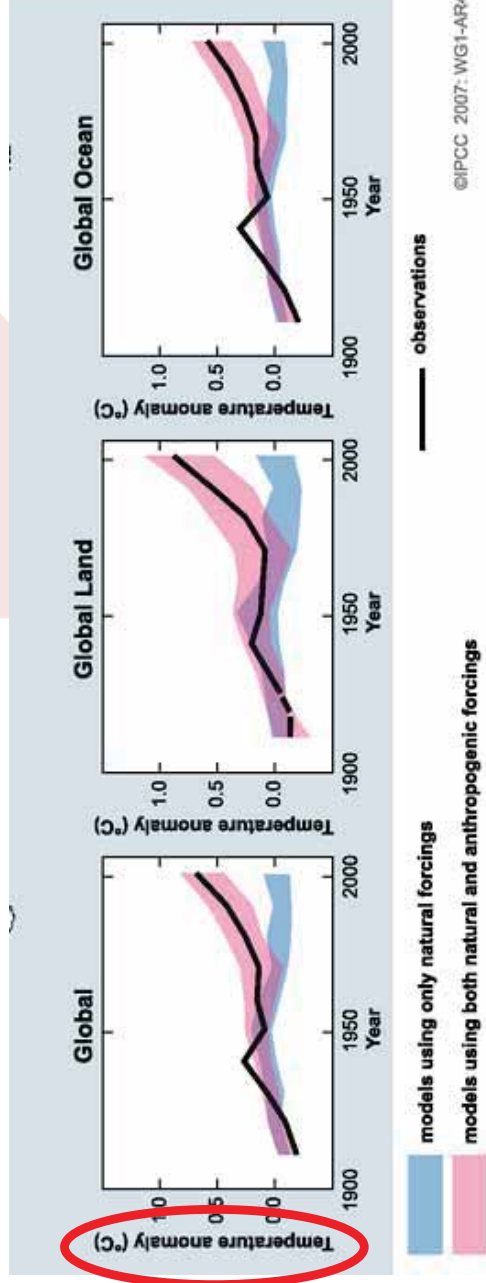


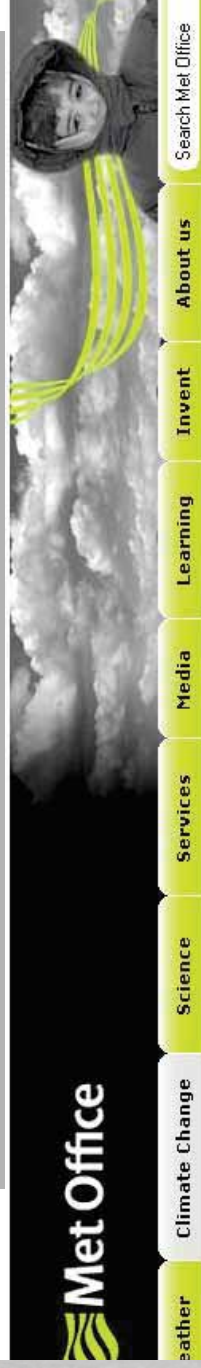
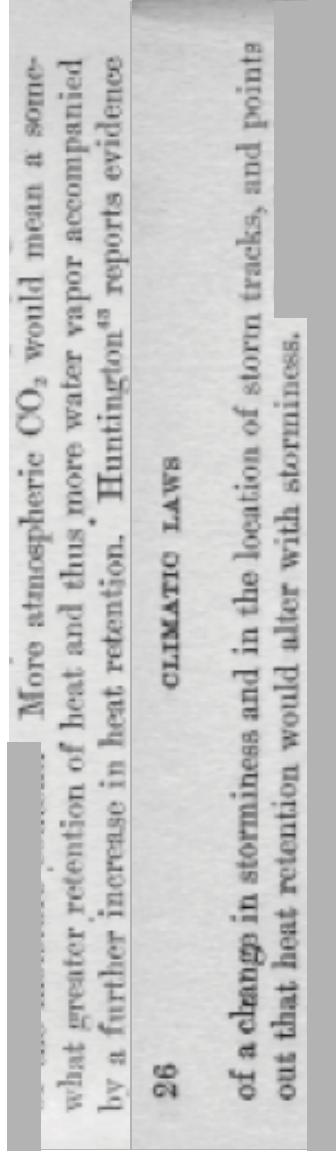
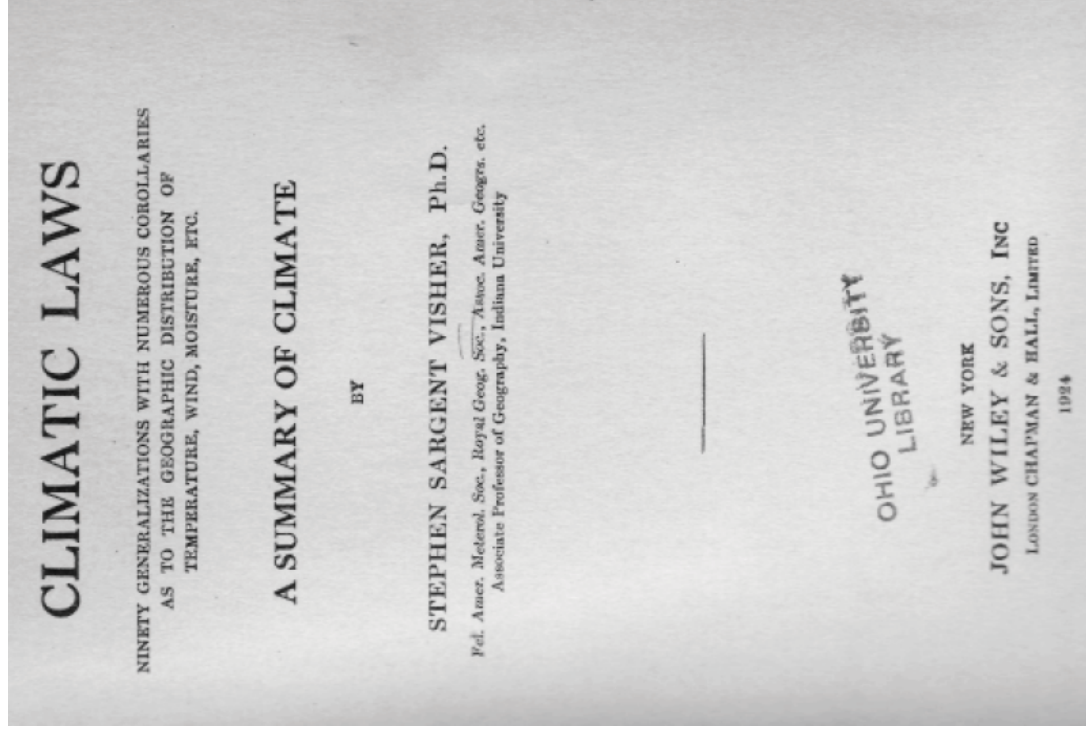
Figure SPM 4. Comparison of observed continental- and global-scale changes in surface temperature with results simulated by climate models using natural and anthropogenic forcings. Decadal averages of observations are shown for the period 1906 to 2005 (black line) plotted against the centre of the decade and relative to the corresponding average for 1901–1950. Lines are dashed where spatial coverage is less than 50%. Blue shaded bands show the 5–95% range for 19 simulations from five climate models using only the natural forcings due to solar activity and volcanoes. Red shaded bands show the 5–95% range for 58 simulations from 14 climate models using both natural and anthropogenic forcings. {FAQ 9.2 Figure 1}

http://www.ipcc.ch/publications_and_data/ar4/wg1/en/figure-spm-4.html

<http://www.globalchange.gov/images/cir/pdf/20page-highlights-brochure.pdf>

Statistical post-processing: These are anomalies, **not temperatures.**
Parameterization of cloud formation is a bit of a distraction when we are missing two kilometre tall walls of rock...

Does a big model add?



me Climate change Guide

bookmarks What you can do

s and events

ate change e

The UK faces hotter, drier summers and warmer, wetter winters as a result of climate change. Cooling your home without air conditioning and being prepared for a flood are just two of the ways to get ready.

Why should I make changes?



climate change

Within this century average summer temperatures in the UK are expected to rise between three and four degrees. Heatwaves, torrential rain and floods are likely to become more common; summers will get drier and winters wetter.

You can help to tackle climate change by saving water and energy, and reducing your carbon footprint.

There are also many things you can do at home to be ready for changes in the



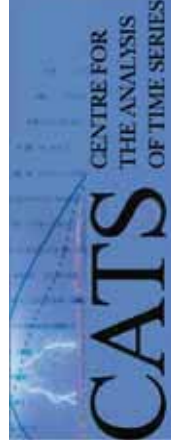
1924

?Confidence?

?Insight?

?Numbers?

<http://www.metoffice.gov.uk/climatechange/guide/what/>



Oct 2012

IEEE eScience: Science in the Dark

Leonard Smith

Probability and Weather-like Simulations

Here we usually have a “unconditioned distribution” called “climatology”

$$P_{\text{clim}}(x | \text{archive})$$

It is “unconditioned” inasmuch as it does not take into account our knowledge of the current state of the system.

In addition we have a number of model simulations that are conditioned on current observations, s , and of course on the model used.

$$P_i(x | s, M_i)$$

the subscript i denotes the model used

Given that we know the model is inadequate, this notation is already odd...

But in the weather case, we use the forecast-verification archive to determine when the model has less skill than climatology, and thereby cope with model inadequacy.

Probability in Climate-like Simulations

Here the problem is one of extrapolation, we have no relevant forecast-verification archive and we do not know the climatology (that being our aim!)

Arguably, the best we can hope for is agreement between our models (in distribution) which suggests the details do not (better: did not) matter.

LA Smith, (2002) [What might we learn from climate forecasts?](#) *Proc. National Acad. Sci. USA* 4 (99): 2487

We do not have that sort of agreement today, even for the planet's temperature.

And we have a hodge-podge of various types of “uncertainties” mixed together and shown to policy makers on the same graph:

Reference: Probability level

Probability level

Describes the strength of evidence associated with a given value within a **probabilistic climate projection**. Probabilistic climate projections fall under subjective probability as the probabilities are a measure of the degree to which a particular level of future climate change is consistent with the evidence considered. In the case of UKCP09, the evidence comes from observations and outputs from a number of climate models, all with their associated uncertainties.

In detail

One of the main advances associated with UKCP09 is that it provides probabilistic climate projections. This means that different future climate outcomes described by a probabilistic projection have different strengths of evidence associated with them. As such, probability levels associated with a given change should be interpreted as indicating the relative likelihood of the projected change being at or less than the given change.

For example, if a projected temperature change of +4.5°C is associated with the 90% at a particular [location](#) in the 2080s for the UKCP09 medium [emission scenario](#), this should be interpreted as it is projected that there is a 90% likelihood that temperatures at that location will be up to and including 4.5°C warmer than temperatures in the 1961–90 [baseline period](#). Conversely, there is a 10% likelihood that those temperatures will be at or greater than 4.5°C warmer than the baseline period.

Misleading argument 5: 'Global warming computer models which predict the future climate are unreliable'

CLIMATE CHANGE **controversies** a simple guide

Computer models which predict the future climate are unreliable and based on a series of assumptions

What does the science say?

Modern climate models have become increasingly accurate in reproducing how the real climate 'works'. They are based on our understanding of basic scientific principles, observations of the climate and our understanding of how it functions.

By creating computer simulations of how different components of the climate system - clouds, the Sun, oceans, the living world, pollutants in the atmosphere and so on - behave and interact, scientists have been able to reproduce the overall course of the climate in the last century. Using this understanding of the climate system, scientists are then able to project what is likely to happen in the future, based on various assumptions about human activities.

It is important to note that computer models cannot exactly predict the future, since there are so many unknowns concerning what might happen. Scientists model a range of future possible climates using different scenarios of what the world will 'look like'. Each scenario makes different assumptions about important factors such as how the world's population may increase, what policies might be introduced to deal with climate change and how much carbon dioxide and other greenhouse gases humans will pump into the atmosphere. The resulting projection of the future climate for each scenario, gives various possibilities for the temperature but within a defined range.

While climate models are now able to reproduce past and present changes in the global climate rather well, they are not, as yet, sufficiently well-developed to project accurately all the detail of the impacts we might see at regional or local levels. They do, however, give us a reliable guide to the direction of future climate change. The reliability also continues to be improved through the use of new techniques and technologies.

The Bayesian Way

Bayesian probability calculus

[edit]

Main article: Bayes' Theorem

Given some data and some hypothesis, the posterior probability that the hypothesis is true is proportional to the product of the *likelihood* multiplied by the *prior probability*. For simplicity, the "prior probability" is often abbreviated as the "*prior*" and the "posterior probability" as the "*posterior*". The likelihood brings in the effect of the data, while the prior specifies the belief in the hypothesis before the data was observed.

More formally, Bayesian inference uses Bayes' formula for conditional probability:

$$P(H|D) = \frac{P(D|H) P(H)}{P(D)}$$

where

- H is a hypothesis, and D is the data.
- $P(H)$ is the *prior probability* of H : the probability that H is correct before the data D was seen.
- $P(D|H)$ is the conditional probability of seeing the data D given that the hypothesis H is true. $P(D|H)$ is called the *likelihood*.
- $P(D)$ is the marginal probability of D .
- $P(H|D)$ is the *posterior probability*: the probability that the hypothesis is true, given the data and the previous state of belief about the hypothesis.

$P(D)$ is the prior probability of witnessing the data D under all possible hypotheses. Given any *exhaustive* set of *mutually exclusive* hypotheses H_i , we have:

$$P(D) = \sum_i P(D, H_i) = \sum_i P(D|H_i)P(H_i).$$

We can consider i here to index alternative worlds, of which there is exactly one which we inhabit, and H_i is the hypothesis that we are in the world i . $P(D, H_i)$ is then the probability that we are in the world i and witness the data. Since the set of alternative worlds was assumed to be mutually exclusive and exhaustive, the above formula is a case of the *law of total probability*.

$P(D)$ is the normalizing constant, which in many cases need not be evaluated. As a result, Bayes' formula is often simplified to:

$$P(H|D) \propto P(D|H) P(H)$$

where \propto denotes proportionality.