CLIMATE PREDICTION TO 2030:
Is it possible, what are the scientific issues, and how would
those predictions be used?
June 22-28, 2008
Aspen, Colorado

Musing about the
Future of Decadal Predictions

Keith W. Dixon

NOAA / OAR / Geophysical Fluid Dynamics Laboratory
Princeton, NJ

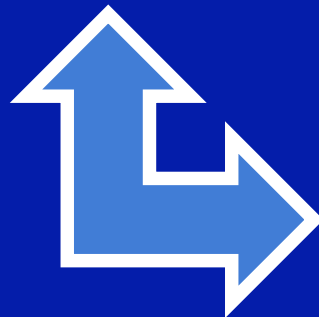**noaa research**
NOAA'S OFFICE OF OCEANIC AND ATMOSPHERIC RESEARCH

Climate Prediction to 2030:

- Is it possible?
- What are the scientific issues?
- How would those predictions be used?

Science for Science
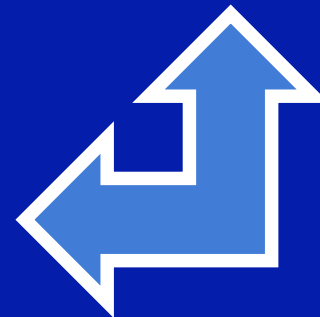
Decadal Predictability…
A really interesting problem!

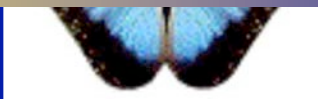A Goal: Improve our understanding of how the global climate system works.

Daily Weather Forecasts

Seasonal- ~1 yr Outlooks (T, Precip, ENSO Hurricanes)

Decadal Predictability

Multi-Decade to Century Projections
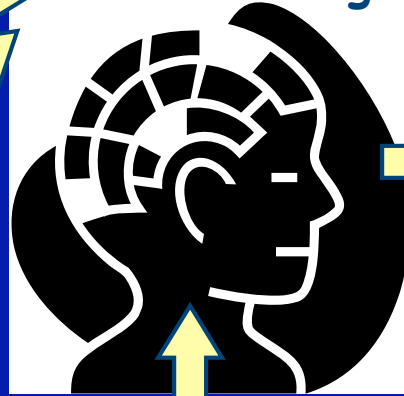
Initial value problem

Forced BC Problem

time scale

The Climate Model Knowledge Cycle

PHYSICAL LAWS & THEORY

OBSERVATIONS

Knowledge & Understanding
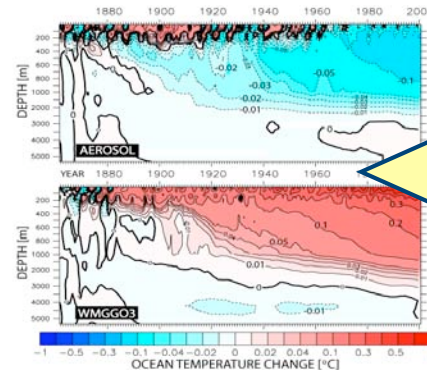
Model Development

```
if (diagts .and. eots) then
  do 1500 m=1,nt
    do 1490 k=1,km
      fx = cst(j)*dyt(j)*dzt(k)/(c2dtts*dtxcel(k))
      do 1480 i=2,imtm1
        boxfx          = fx*dxt(i)*fm(i,k,jc)
        sddt           = (ta(i,k,m)-t(i,k,jc,nm,m))*boxfx
        svar           = (ta(i,k,m)**2-t(i,k,jc,nm,m)**2)
                         *boxfx
        n              = 0
        termbt(k,1,m,n) = termbt(k,1,m,n) + sddt
        tvar(k,m,n)     = tvar(k,m,n)      + svar
        n              = nhreg*(mskvr(k)-1) + mskhr(i,j)
        if (n .gt. 0 .and. mskhr(i,j) .gt. 0) then
          termbt(k,1,m,n) = termbt(k,1,m,n) + sddt
          tvar(k,m,n)     = tvar(k,m,n)      + svar
```

Progress via a Synthesis of Theory, Observations, and Modeling

Analysis of Model Results

Well Designed Model Experiments

Climate change *attribution*

"Most of the observed increase in globally averaged temperatures since the mid-20th century is very likely* due to the observed increase in anthropogenic greenhouse gas concentrations."
(*very likely = 90-95% certainty)

- IPCC AR4 WG1 SPM, Feb 07

Climate Prediction to 2030:

- Is it possible?

If the question is rephrased:

Do you expect properly initialized climate model simulations of 20 yrs duration soon will be able to consistently exhibit meaningful skill in forecasting surface climate variations at sub-continental scales over much of the globe?

SHOW OF HANDS PLEASE

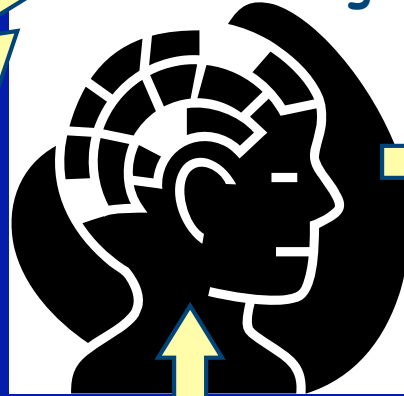Other metrics, modes of variability; 5 – 10 yr fcx; if not soon, ever?
On the other hand, "Anybody can run a model 20 years."

The Climate Model Knowledge Cycle

Knowledge & Understanding

PHYSICAL LAWS & THEORY

OBSERVATIONS

Model Development

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```
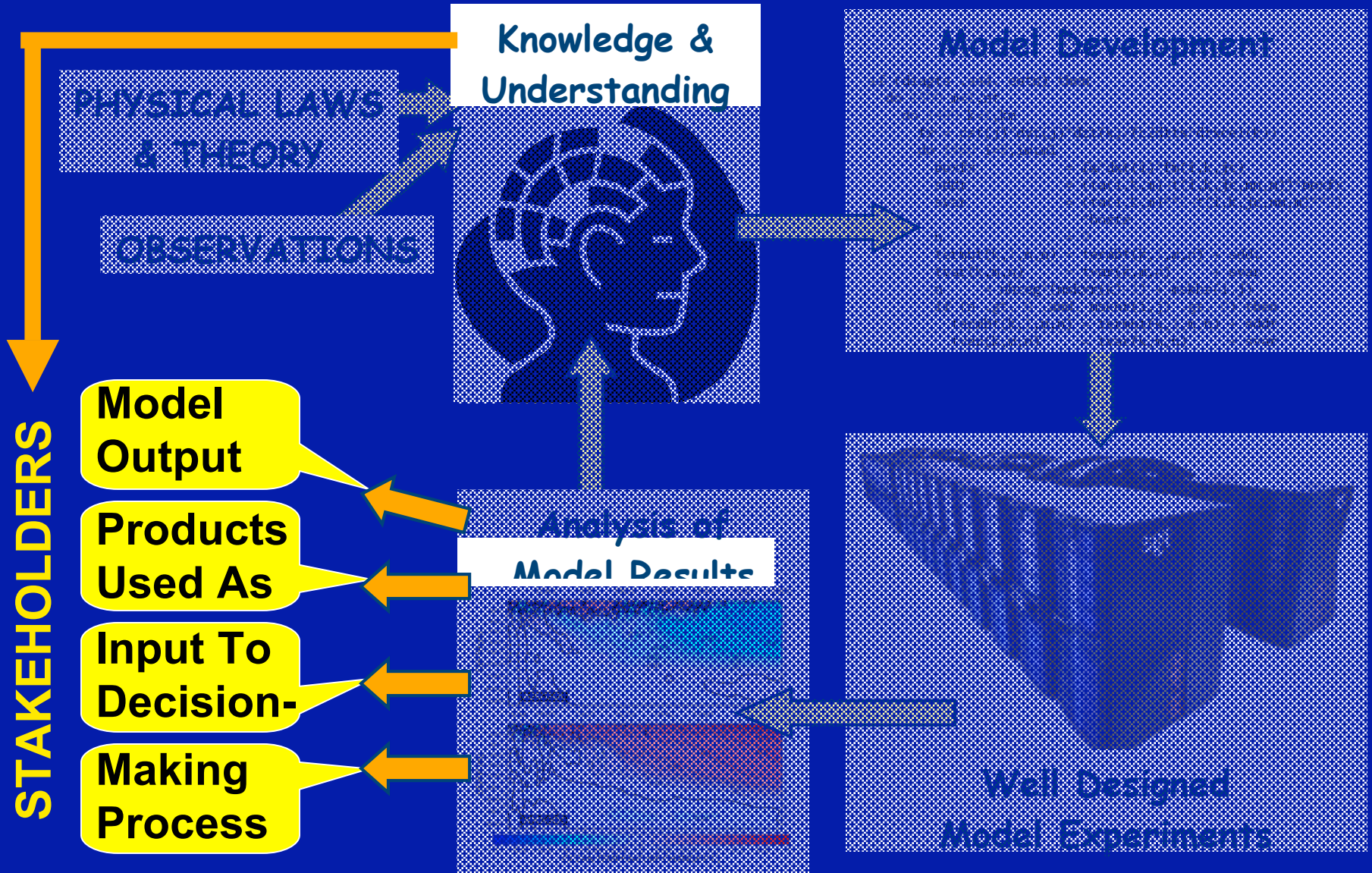
The hindcasts outlined in 1.1 and 1.2 of the Initial Value Decadal Predictions MIP Proposal developed here this week are designed to help address the question of **"Is it possible"** in a coordinated manner.
Science for Science

Analysis of Model Results
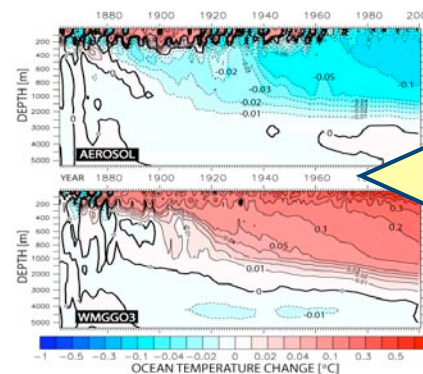
Well Designed Model Experiments

Science for Policy

Knowledge & Understanding

PHYSICAL LAWS & THEORY

OBSERVATIONS

Model Development

STAKEHOLDERS

Model Output

Products Used As

Input To Decision-

Making Process

Analysis of Model Results
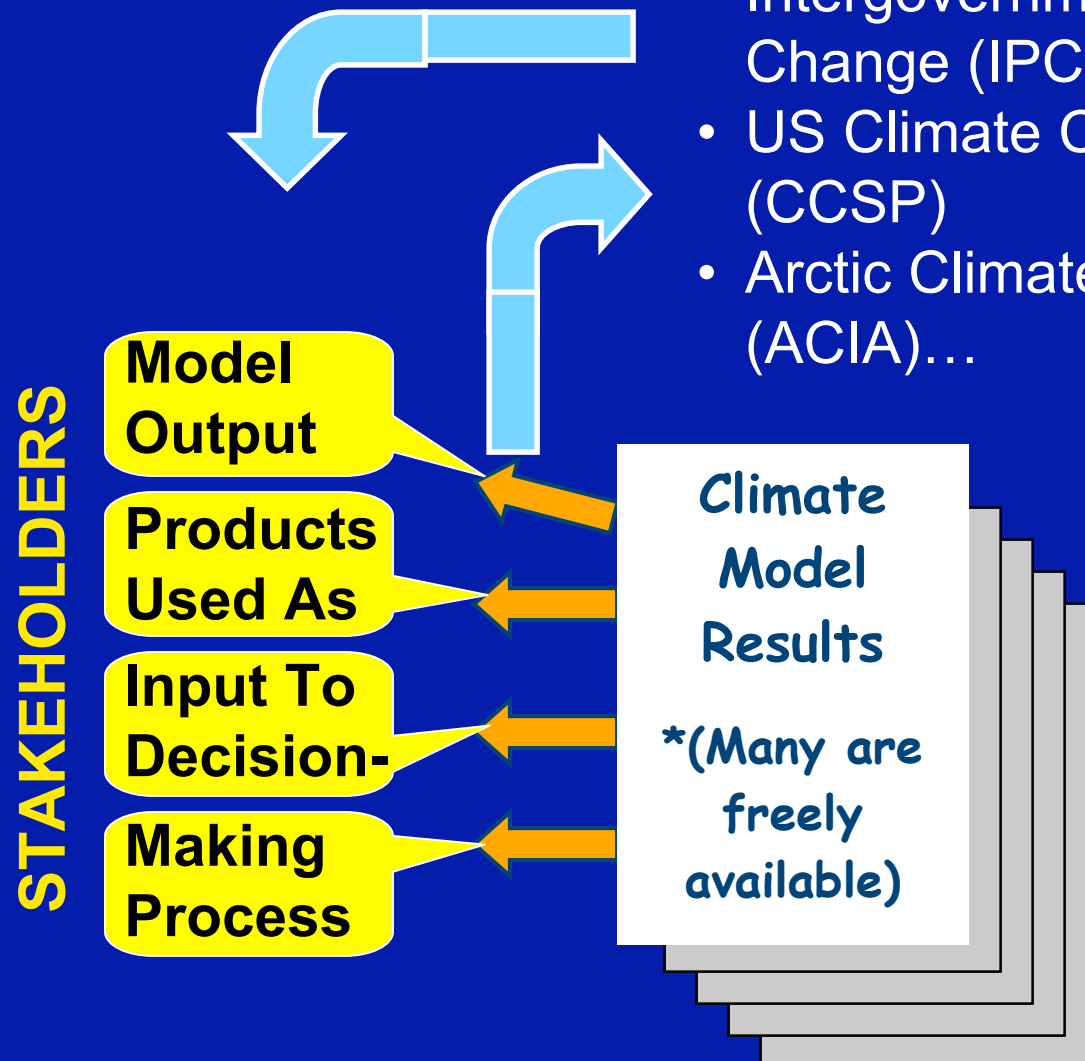
Well Designed Model Experiments

The Climate Model Knowledge Cycle

Big Scientific Assessments*

- Intergovernmental Panel on Climate Change (IPCC)
- US Climate Change Science Program (CCSP)
- Arctic Climate Impact Assessment (ACIA)…

* Climate modelers are among the authors of these big assessment reports

STAKEHOLDERS

Model Output

Products Used As

Input To Decision-

Making Process

Climate Model Results

*(Many are freely available)

The Climate Model Knowledge Cycle

Other Reports

PREDICTIONS OF CLIMATE CHANGE IMPACTS ON CALIFORNIA WATER RESOURCES USING CALSIM II: A TECHNICAL NOTE

A Report From:
California Climate Change Center
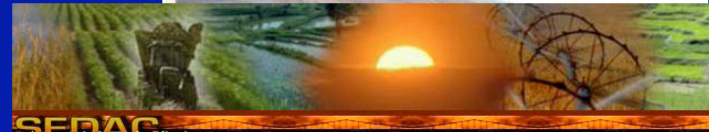
Arnold Schwarzenegger, Governor

Confronting Climate Change in the U.S. Northeast

SCIENCE, IMPACTS, AND SOLUTIONS

Impacts of Future Climate Change on California Perennial Crop Yields: Model Projections with Climate and Crop Uncertainties

MANAGING WATER RESOURCES IN THE WEST UNDER CONDITIONS OF CLIMATE UNCERTAINTY

SEDAC socioeconomic data and applications center
Introduction | Methodology | Data Limitations | The Scenarios | Query the Data | Web Resources | CIESIN home | SEDAC home

Potential Impacts of Climate Change on World Food Supply Data Sets from a Major Crop Modeling Study

NATIONAL RESEARCH COUNCIL

STAKEHOLDERS

Model Output

Products Used As

Input To Decision-

Making Process

Climate Model Results

***(Many are freely available)**

CLIMATE MODEL RESULTS

MEDIA

ADVOCACY GROUPS

BLOGOSPHERE

PUBLIC

STAKEHOLDERS

Climate Model Results

*(Many are freely available)
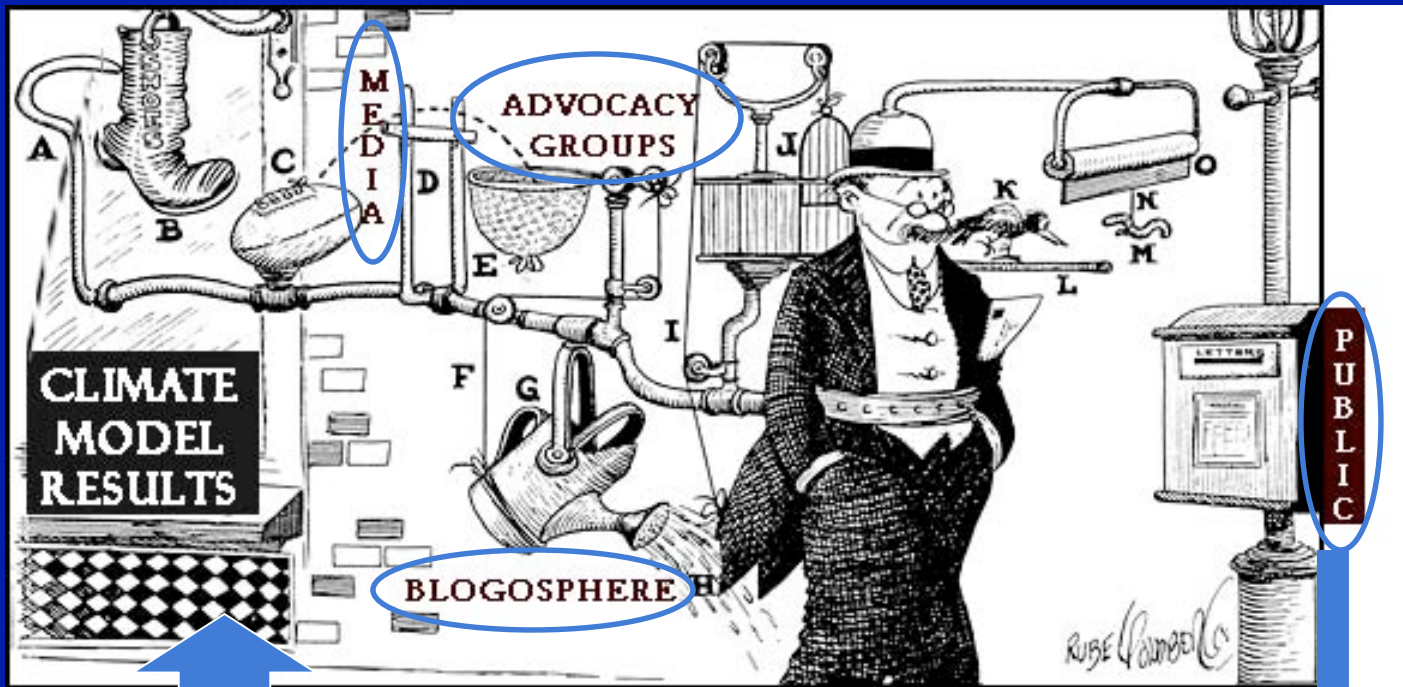
With apologies to RubeGoldberg.com

Science for Policy

While **Science for Science** may focus first on demonstrating decadal predictability via well designed hindcast experiments in conjunction with observations and theory…

…stakeholders interested in **Science for Policy** will look for forecasts of future conditions regardless of the relative roles of internal variability and forced signals.

## Is the climate modeling community ready to move from "projections" to initialized "decadal predictions"?

On the "YES" side…

• "Recent papers have provided promising evidence it is possible."

• "Observations (e.g., ARGO, satellites) have improved, as have models and assimilation techniques, making us more ready."

• "People are already using AR4 projections for this purpose, so unless the initialized runs do worse there's no harm."

Is the climate modeling community ready to move from "projections" to initialized "decadal predictions"?

On the "NO" side…

• "Don't put the cart ahead of the horse. A better case can be made for coordinated decadal predictability experiments than for coordinated decadal prediction experiments."

• "The community needs to be aggressive, but also careful ... if there is a rush of decadal predictions made that are not based on very solid grounds, the community risks losing credibility."

• "A bad forecast is worse than no forecast at all."

• "Concerns about analyzing drift."
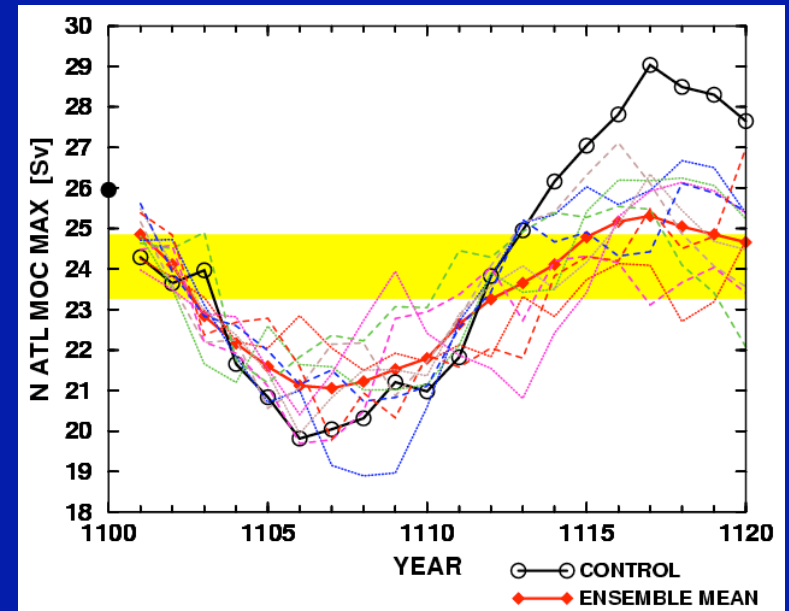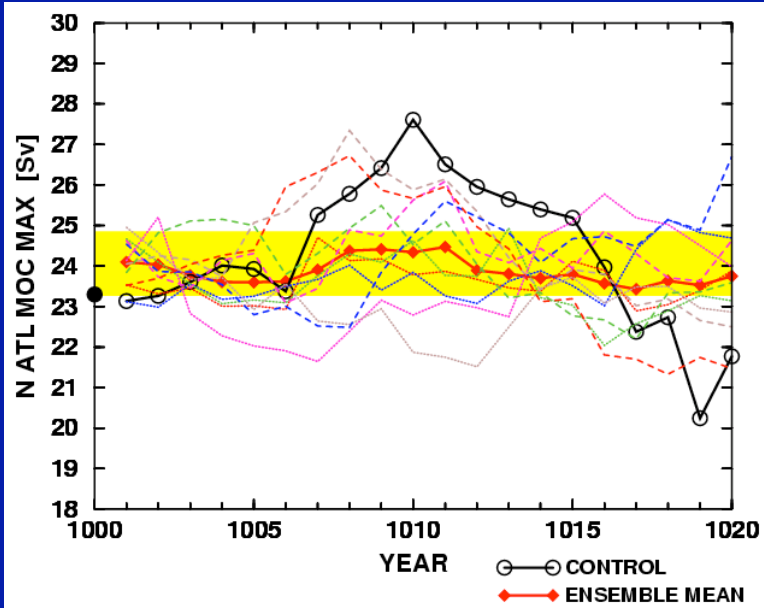
IPCC "BRAND"
decadal skill

Low
Just more ensemble members

High
Great new tool

IMPORTANCE OF COMMUNICATIONS.

Fermenting Froth vs. Scientific Consensus

The ideas contained in individual papers are bits of the "fabulous fermenting froth*" of scientific investigation.

The assessment reports serve to distill the information and communicate the policy relevant bits that stand up.

(*paraphrase of Richard Alley during Congressional Hearing of 8 Feb 2007)

WHEN AR5 IS WRITTEN, WILL DECADAL PREDICTIONS BE "FERMENTING FROTH" OR RESULTS THAT "STAND UP"???

Uncertainties In Climate Change Projections – Long Term (2100)

Two broad types of uncertainties:

1) Imperfect models

2) Uncertainties in future forcing agent levels

Uncertainties In Climate Change Projections – Short Term (5 – 10 – 20 yrs)

Three broad types of uncertainties:

1) Imperfect models

2) Imperfect observations   (1+2 assimilation)

3) Uncertainties in limits of predictability

April 30, 2008

Global Cooling Consistent With Global Warming

Posted to Author: Pielke Jr., R. | Climate Change | Prediction and Forecasting

For a while now I've been asking climate scientists to tell me what could be observed in the real world that would be inconsistent with forecasts (predictions, projections, etc.) of climate models, such as those that are used by the IPCC. I've long suspected that the answer is "nothing" and the public silence from those in the outspoken climate science community would seem to back this up. Now a paper in Nature today (PDF) suggests that cooling in the world's oceans could~~that the world may cool over the next 20 years~~ few decades , according to Richard Woods who comments on the paper in the same issue, "temporarily offset the longer-term warming trend from increasing levels of greenhouse gases in the atmosphere", and this would not be inconsistent with predictions of longer-term global warming.

I am sure that this is an excellent paper by world class scientists. But when I look at the broader significance of the paper what I see is that *there is in fact nothing that can be observed in the climate system that would be inconsistent with climate model predictions*. If global cooling over the next few decades is consistent with model predictions, then so too is pretty much anything and everything under the sun.

This means that from a practical standpoint climate models are of no practical use beyond providing some intellectual authority in the promotional battle over global climate policy. I am sure that some model somewhere has foretold how the next 20 years will evolve (and please ask me in 20 years which one!). And if none get it right, it won't mean that any were actually wrong. If there is no future over the next few decades that models rule out, then anything is possible. And of course, no one needed a model to know that.

…there is in fact nothing that can be observed in the climate system that would be inconsistent with climate model projections.

…if global cooling over the next few decades is consistent with model predictions, then so too is pretty much anything and everything under the sun.

…from a practical standpoint climate models are of no practical use beyond providing some intellectual authority in the promotional battle over global climate policy.

I explained to her that James Annan, a modest, constructive, and respectful colleague of mine who happened to be a climate modeler ("Cool" she said), had explained that the best way to compare these datasets was to look at the normal distribution associated with the data (N(0.19, 0.21) and plot on that distribution the outlying value from the smaller dataset.

Comparing Climate Model Predictions With Observations

8-Year Temperature Distibution in the Models
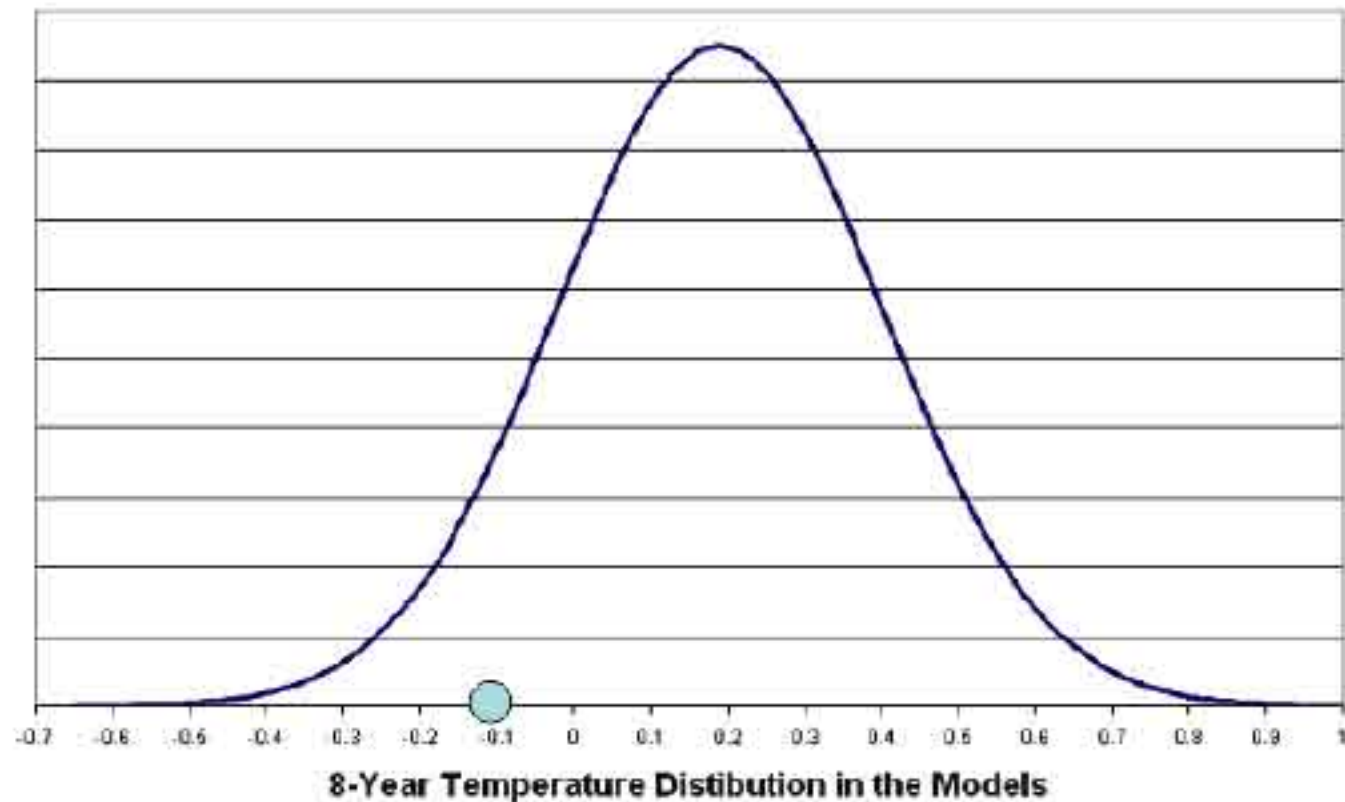
Since the outlying value of the observations fell well within the distribution of the estimates, James told us, the two dataset could not be claimed to be different -- case closed, anyone saying anything different must be an ignorant climate denying lunatic.

Is the climate modeling community ready to move from "projections" to initialized "decadal predictions"?

??? To what extent, if any, is the demand for decadal predictions influencing judgments about our readiness to provide meaningful initialized decadal climate forecasts that will capture both internal variability and forced climate signals?

Policy for Science

Gov't support & demands for elements related to decadal climate predictability/prediction efforts.

- Varies by nation…
- Support and enhancement of
  *observational network
  * modeling resources
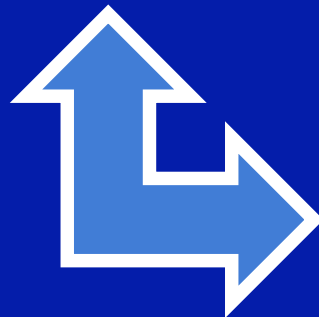 * research -> operations -> applications efforts