Evidence-based improvements to climate forecasting: Progress and Recommendations

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Global temperature forecasting

- Please forecast the missing years for the series shown on the two charts and pass to the end of the row for collection

Green, Armstrong, & Soon published climate forecasting contributions

2011	"Research on forecasting for the manmade global warming alarm"	Withdraw government funding from climate forecasting
2009	"Validity of climate change forecasting for public policy decision making"	Naïve forecast OK for policy and more accurate than warming
2008	"What is the appropriate public-policy response to uncertainty?"	Leave alone
2008	"Polar bear population forecasts: A public policy forecasting audit"	Forecasts of endangerment from warming unscientific; bears fine
2007	"Global warming: Forecasts by scientists versus scientific forecasts"	Dangerous warming scenarios not from scientific forecasting

Welcome new climate forecasting contribution from Robert Fildes & Nikolaos Kourentzes

2011 "Validation and forecasting accuracy in models of climate change"

Extrapolation models combined forecast .007°C p.a. declining to 2027

F&K followed evidence-based forecasting principles

1. Used simple methods for a complex and uncertain situation
2. Used reasonable alternative methods
3. Considered that different methods might be relevant for short-term than long-term forecasting
4. Combined forecasts from evidence-based methods
5. Conducted validation tests on data unknown to the models
6. Used valid and relevant error measures
7. Full disclosure including peer review, published commentary, and responses to questions about their research.

F&K trend forecasting methods sensible for short horizons

- Naïve makes no allowance for short term persistence
- F&K tested:
    1. Exp. smoothing: Single
    2. " Holt
    3. " Damped trend
    4. Autoregression: Up to 25 years
    5. Neural networks: Univariate
    6. " Multivariate

F&K validation tests

1. F&K selected models knowing they would be tested on data trending broadly upwards

2. F&K did not propose which of their 6 methods they expected to provide the most accurate forecasts

=> We (GAS2), therefore, compare the *average accuracy* of the F&K6 forecasts with that of naïve forecasts…

F&K results
(Average accuracy)

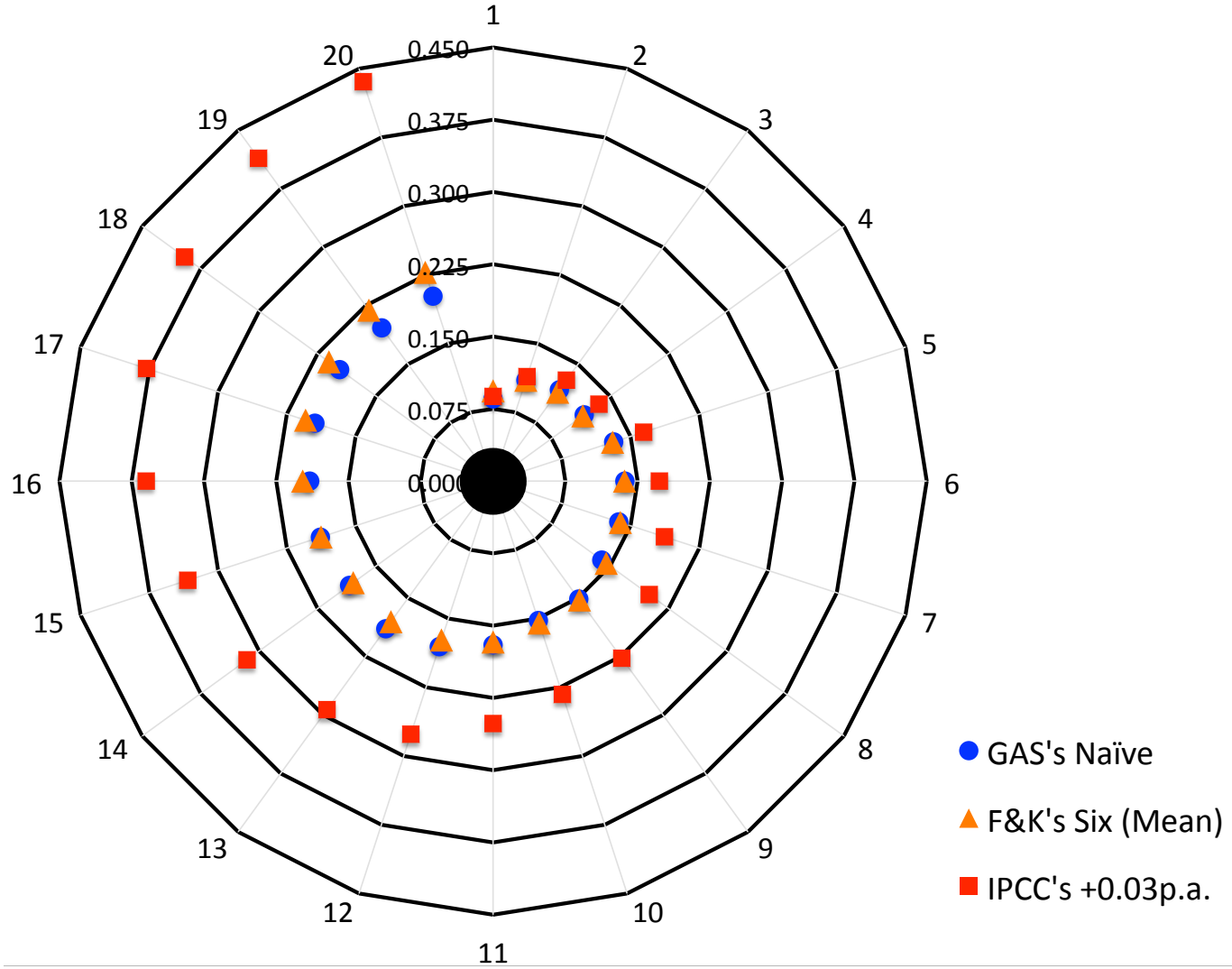
Horizon (years)	Forecasts per model	Improvement vs naïve
1–4, 10, & 20	176	-5%
1–20	1,190*	-2%
11–20	500*	-8%

*Forecasts provided by the authors in response to our request.

F&K vs Naïve average errors in °C for 1 to 20 year horizons (n=69 to 50 per model)

Horizon	GAS's Naïve	F&K's Six (Mean)	IPCC's +0.03p.a.
1	0.09	0.09	0.09
2	0.11	0.11	0.11
3	0.12	0.11	0.13
4	0.12	0.12	0.14
5	0.13	0.13	0.16
6	0.14	0.14	0.17
7	0.14	0.14	0.19
8	0.14	0.15	0.20
9	0.15	0.15	0.23
10	0.15	0.15	0.23
11	0.17	0.17	0.25
12	0.18	0.17	0.28
13	0.19	0.18	0.29
14	0.18	0.18	0.32
15	0.19	0.19	0.33
16	0.19	0.20	0.36
17	0.19	0.20	0.38
18	0.20	0.21	0.40
19	0.20	0.22	0.41
20	0.20	0.23	0.44

Visual of F&K vs Naïve average errors in °C for 1 to 20 year horizons (n=69 to 50 per model)



Suggestions for improving long-term climate forecasting

1. Consider causal forces
2. Validate methods with long-term forecasts
3. Adjust validation data for known biases
4. Use alternative validation data
5. Increase the number of forecasts in validation samples, and
6. Damp trends strongly due to complexity and uncertainty.

We take some first steps…

Consider causal forces*

Uncertainty over nature and extent of causes

+

Difficult to forecast causal variables

=

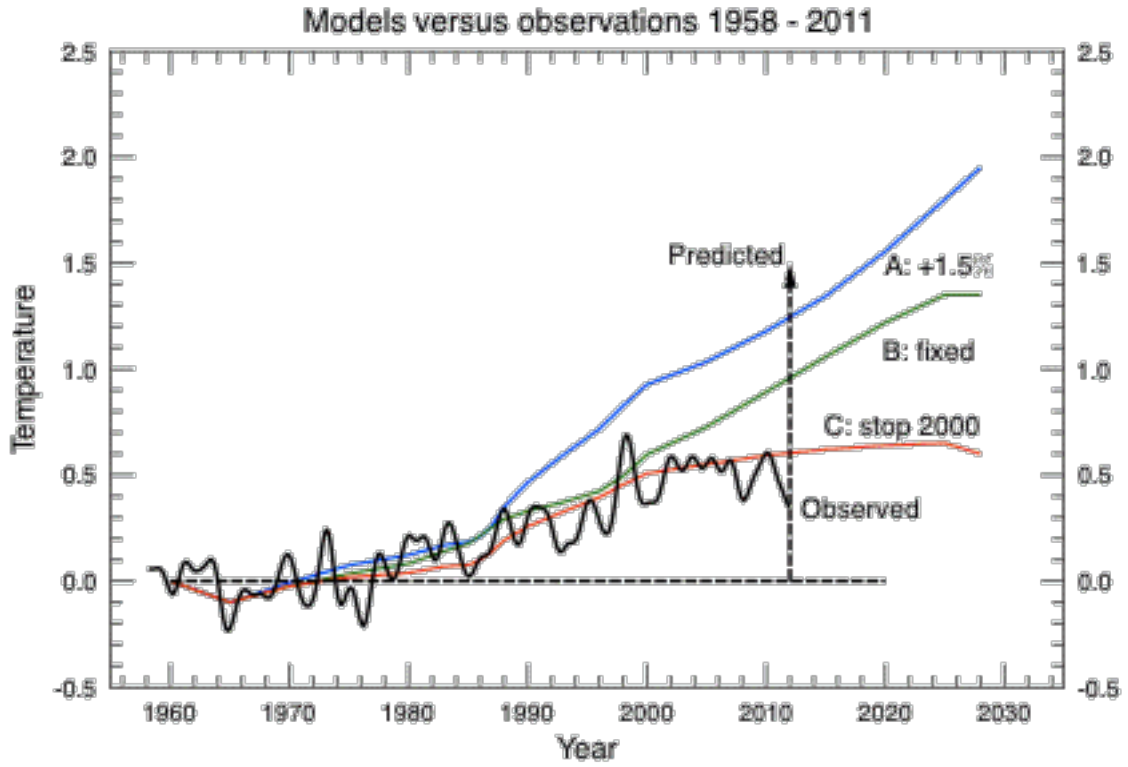
Conservative + Simple + Transparent implementations

Simple Model: (F&K6_trend_models + Naïve) / 2

Finding: 10% error reduction vs F&K6

*Dick Lindzen will discuss state of knowledge re causal forces.

Immoderate, complex, & opaque causal modeling results*



*Hansen *et al.* (1988) NASA GISS forecasts vs actual (5-year rolling average) from http://www.kaltesonne.de/?p=4006

Validate with LT forecasts

Problem: Rational decision makers need valid LT forecasts before making costly changes.

Solution: Test F&K's AR models*, from their 69 origins, forward to 2011 and back to 1850.

Findings

Horizon	Error vs naïve	Forecasts per model
1-20 years	−24%	2,589
21-50 years	−35%	2,745

*"Conservative trend" models; average trend forecast of +.0037°C p.a. going forward in time.

Alternative validation data

Problem: Hadley data used by F&K and GAS obscure and apparently biased toward warming

Solution: Test annual change in F&K forecasts vs naïve against UAH* changes for 1980 to 2007

Findings

Horizon	Error vs naïve	Forecasts per model
2-10 years	–0.9%	532
11-20 years	+0.5%	190

*University of Alabama at Huntsville satellite measurement of global lower troposphere temperatures (Christy *et al*. 2012).

Damp trends strongly

Problems:

- Long term climate is complex
- Knowledge is modest and uncertain
- Naïve (100% damped) more accurate than F&K6 for longer (10 & 20 year) forecasts.

Solution: Test progressive damping of F&K6 forecasts for 11 to 20 years out…

$$F_m \; damped = F_m + \; [(F_N - F_m) \,/\, (21 - h)]^*$$

Findings**

Horizon	Error vs F&K6	Forecasts per model
1-20 years	−3%	1,190

* F_m = forecast from F&K model m; F_N = forecast from naïve model; h = horizon.
**No attempt was made to optimize the damping algorithm.

Our analysis supports F&K's conclusion

"the structural weaknesses in the GCM identified here suggest that a reliance on the policy implications from the general circulation models, and in particular the primary emphasis on controlling global carbon dioxide (CO_2) emissions, is misguided" (F&K, p. 992)

Global warming policies and the 3-legged stool

Rational policies require accurate forecasts from validated evidence-based methods that:

1. Long-term global warming will occur
2. Substantial net harm will result from warming
3. Cost-effective policies will reduce net harm.

All three are necessary.

To date, there is not a single scientific forecast to provide any of the three legs.

Follow-up

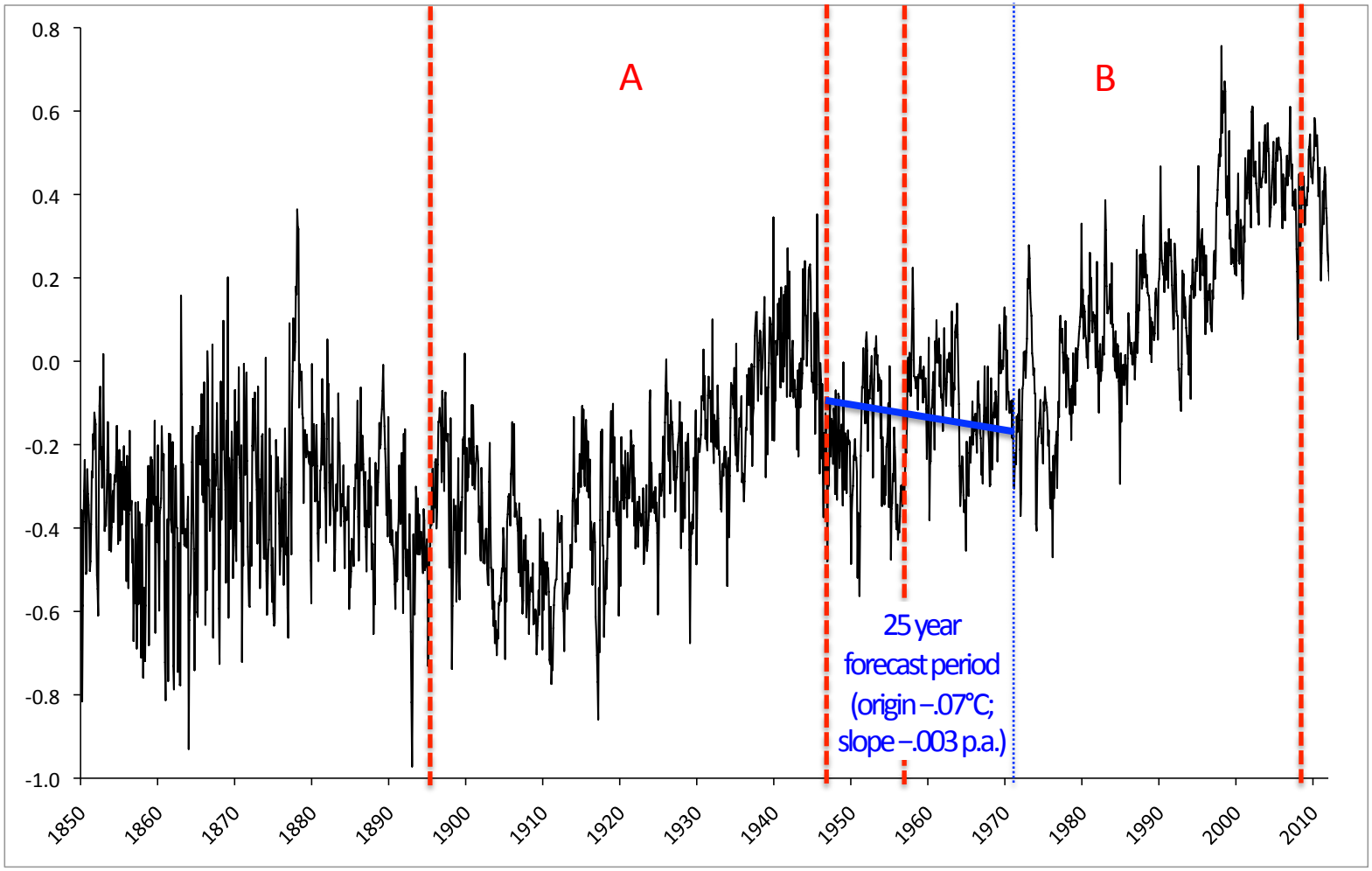
For a rough draft of our paper, supporting materials, and information on the mystery charts, go to…

"Evidence-based Improvements to Climate Forecasting: Progress and Recommendations", at

http://tinyurl.com/Climate-Forecasting

We seek peer review, especially with empirical evidence that might refute our findings.

Hadley global mean °C temperature anomalies showing selected half-centuries



http://tinyurl.com/Climate-Forecasting

Joy of Spring continues through May for Mr Gore's bet
(Temperature deviation from 1981-2010 average, in degrees C*)

Year		Anomaly*	Armstrong	Gore
	6	-0.01	0.170	0.229
	7	0.36	0.170	0.231
	8	0.17	0.170	0.234
	9	0.38	0.170	0.236
	10	0.25	0.170	0.239
	11	0.39	0.170	0.241
	12	0.21	0.170	0.244
2010	1	0.55	0.170	0.246
	2	0.52	0.170	0.249
	3	0.55	0.170	0.251
	4	0.40	0.170	0.254
	5	0.46	0.170	0.256
	6	0.39	0.170	0.259
	7	0.42	0.170	0.261
	8	0.44	0.170	0.264
	9	0.48	0.170	0.266
	10	0.31	0.170	0.269
	11	0.27	0.170	0.271
	12	0.18	0.170	0.274
2011	1	0.00	0.170	0.276
	2	-0.01	0.170	0.279
	3	-0.10	0.170	0.281
	4	0.12	0.170	0.284
	5	0.14	0.170	0.286
	6	0.32	0.170	0.289
	7	0.38	0.170	0.291
	8	0.33	0.170	0.294
	9	0.29	0.170	0.296
	10	0.12	0.170	0.299
	11	0.13	0.170	0.301
	12	0.13	0.170	0.304
2012	1	-0.08	0.170	0.306
	2	-0.11	0.170	0.309
	3	0.11	0.170	0.311
	4	0.30	0.170	0.314
	5	0.29	0.170	0.316

*http://vortex.nsstc.uah.edu/data/msu/t2lt/uahncdc.lt
Updated 5 June 2012
See latest "readme" discussion at http://vortex.nsstc.uah.edu/data/msu/t2lt/