WCC-3: Parallel Session 3

WS-3 Seaonal-to-interannual climate variability

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Discussant-2

1 September 2009, 1:30 – 3:00 pm

LESSONS LEARNED FROM IPCC AR4

Scientific Developments Needed To Understand, Predict, And Respond To Climate Change

BY SARAH J. DOHERTY, STEPHAN BOJINSKI, ANN HENDERSON-SELLERS, KEVIN NOONE, DAVID GOODRICH, NATHANIEL L. BINDOFF, JOHN A. CHURCH, KATHY A. HIBBARD, THOMAS R. KARL, LUCKA KAJFEZ-BOGATAJ, AMANDA H. LYNCH, DAVID E. PARKER, I. COLIN PRENTICE, VENKATACHALAM RAMASWAMY, ROGER W. SAUNDERS, MARK STAFFORD SMITH, KONRAD STEFFEN, THOMAS F. STOCKER, PETER W. THORNE, KEVIN E. TRENBERTH, MICHEL M. VERSTRAETE, AND FRANCIS W. ZWIERS

Key research need #1: Efforts are needed to improve the ability of models to reproduce fundamental aspects of the climate system, such as circulation and precipitation patterns, El Niño, and seasonal variability, as well as to reproduce other impact-relevant variables such as extremes in temperature and precipitation.

(BAMS, 2009)

The State of the Art of Seasonal Prediction

Outcomes and Recommendations from the First World Climate Research Program Workshop on Seasonal Prediction

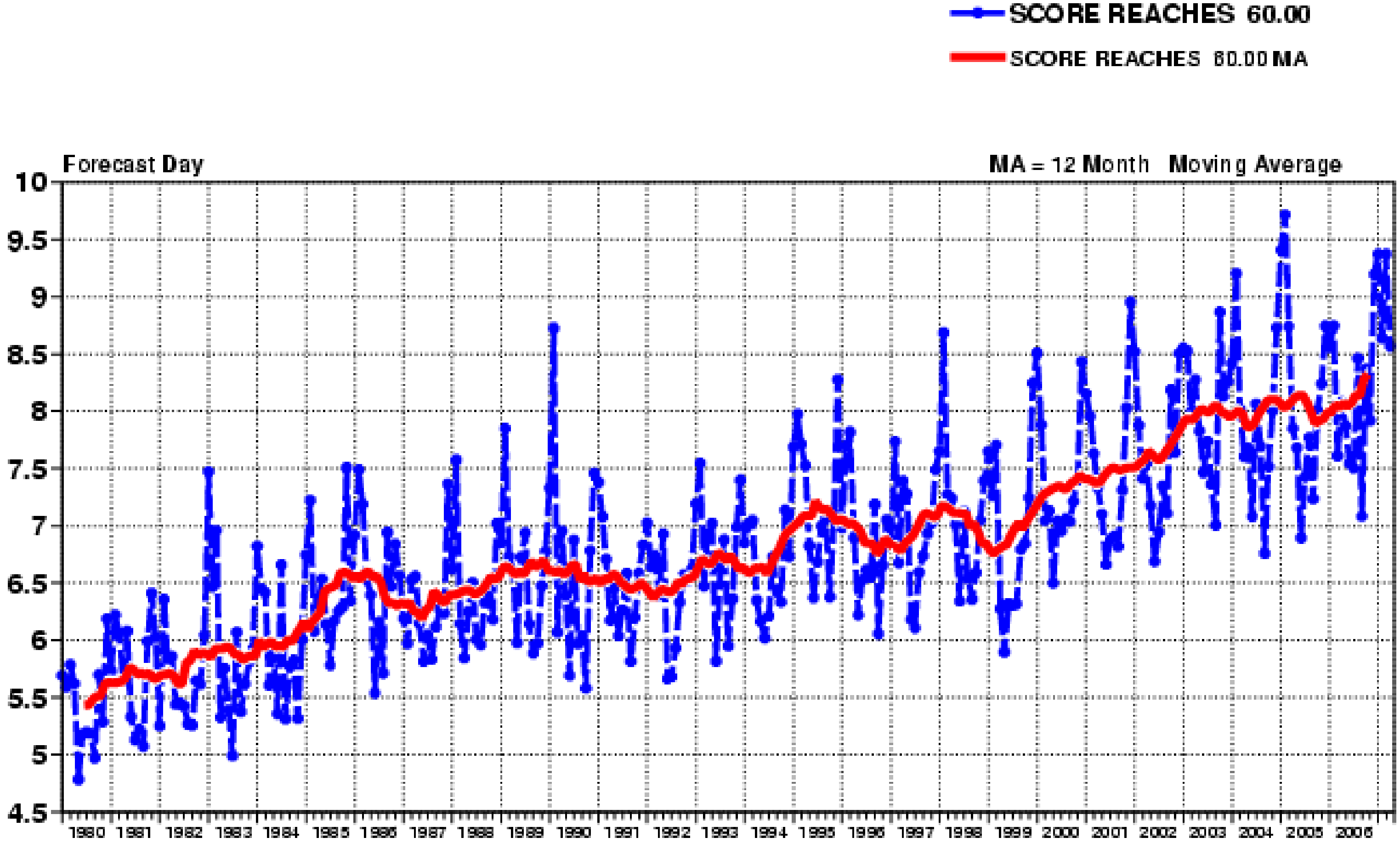
BY BEN KIRTMAN AND ANNA PIRANI

Overarching consensus statements on the state of seasonal prediction: The maximum predictability of the climate system has yet to be achieved in operational seasonal forecasting. Model error continues to limit forecasting skill and since not all interactions in the climate system-land-atmosphere interactions, for example-are currently fully resolved, there may still be untapped sources of predictability.

(BAMS, 2009)

ERA Forecast Verification

Anomaly Correlation of 500 hPa GPH, 20-90N



ERA Forecast Verification

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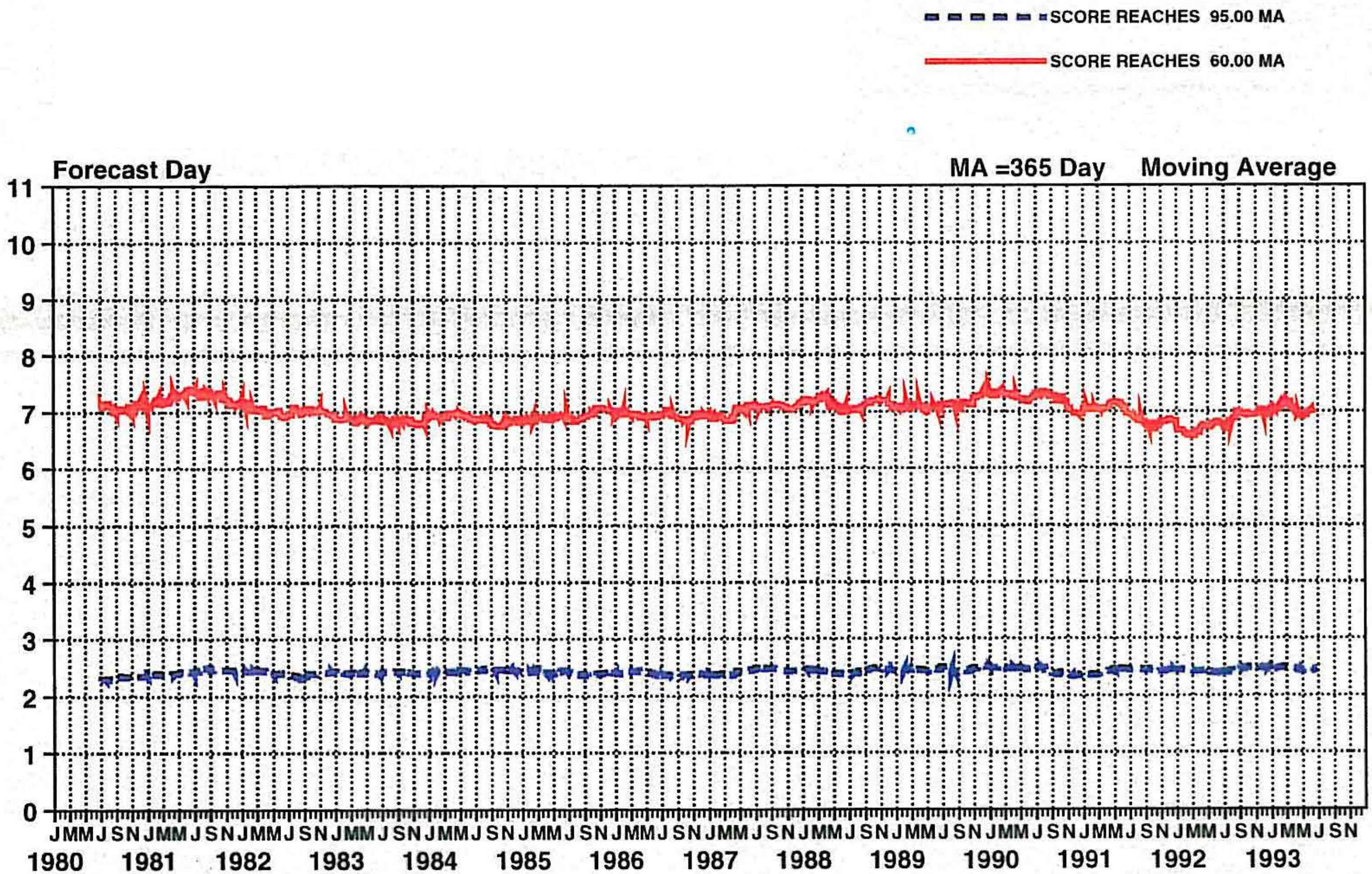

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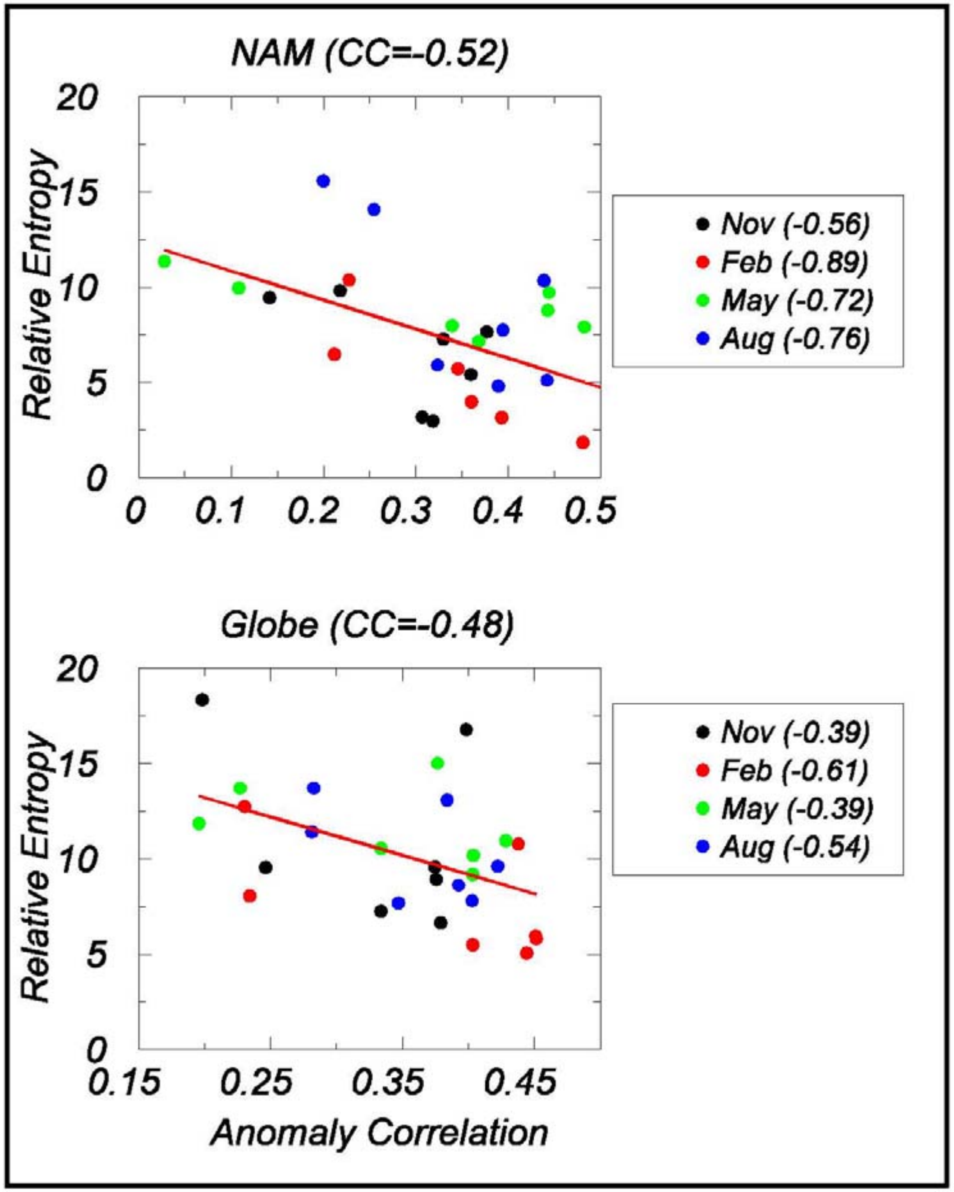
Fidelity vs. Skill

DEMETER 1980-2001 Seasonal Forecasts

DelSole and Shukla, 2009 (*J Climate, in review*)



7 models, 4 initial conditions

Lead Time = 0 months

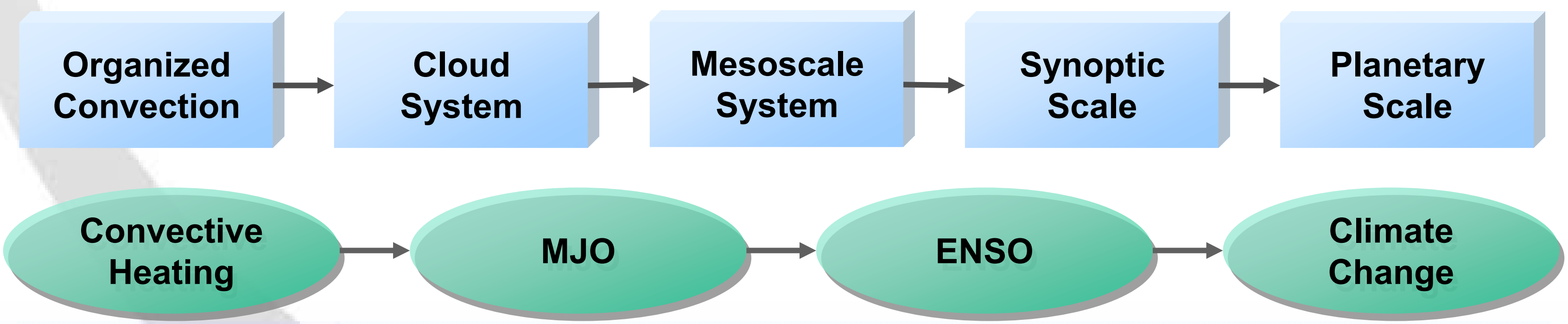
Fidelity and Skill are related

- **Models with poor climatology tend to have poor skill.**
- **Models with better climatology tend to have better skill.**

Seamless Prediction of Weather and Climate

From Cyclone Resolving Global Models to Cloud System Resolving Global Models

1. Planetary Scale Resolving Models (1970~): Δx~500Km
2. Cyclone Resolving Models (1980~): Δx~100-300Km
3. Mesoscale Resolving Models (1990~): Δx~10-30Km
4. Cloud System Resolving Models (2000 ~): Δx~3-5Km



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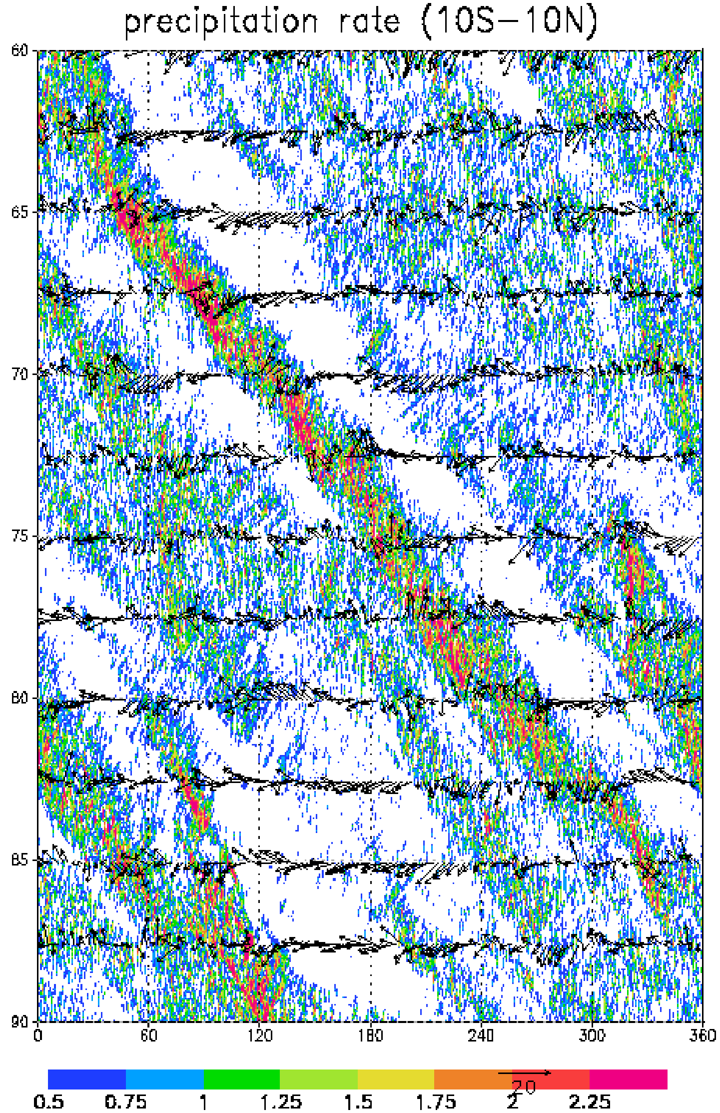
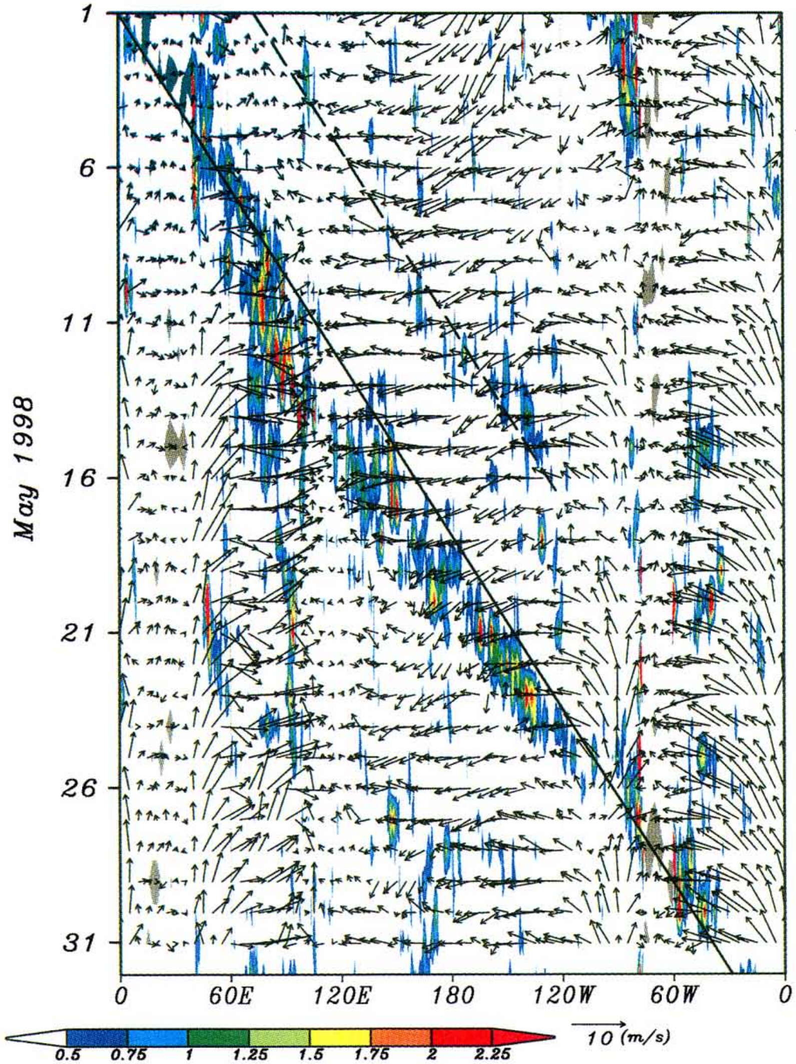
NICAM (7-km)

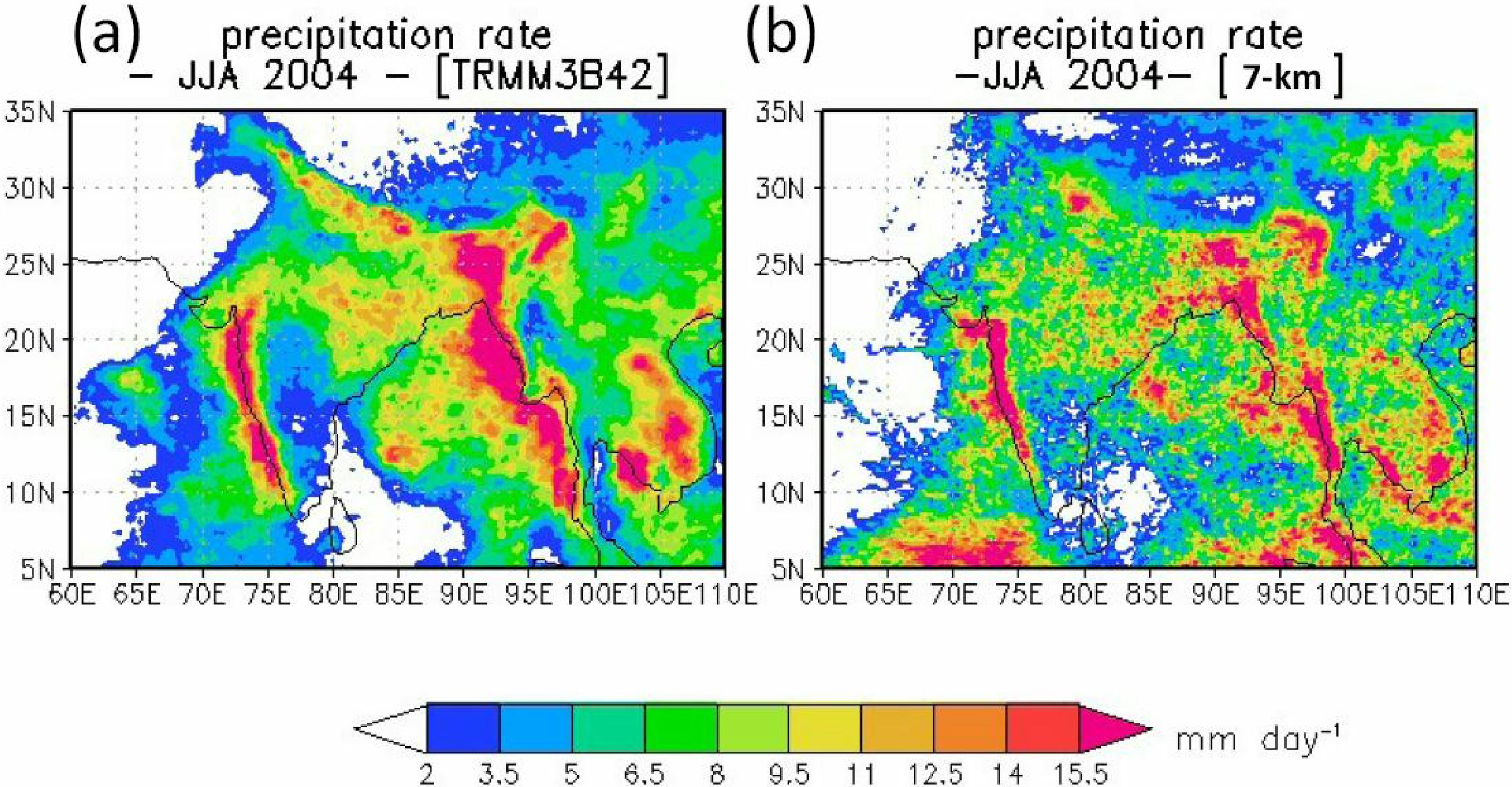


Obs. (Takayabu et al. 1999)



Matsuno (AMS, 2007)

Monsoon Rainfall in High Resolution Model



***Oouchi et al. 2009*: (a) Observed and (b) simulated precipitation rate over the Indo-China monsoon region as June-July-August average (in units of mm day -1). The observed precipitation is from TRMM_3B42, and the simulation is for 7km-mesh run.**

Fundamental barriers to advancing weather and climate diagnosis and prediction on timescales from days to years are (partly) (almost entirely?) attributable to gaps in knowledge and the limited capability of contemporary operational and research numerical prediction systems to represent precipitating convection and its multi-scale organization, particularly in the tropics.

(Moncrieff, Shapiro, Slingo, Molteni, 2007)

A Conjecture

- The largest obstacles in realizing the potential predictability of weather and climate are inaccurate models and insufficient observations, rather than an intrinsic limit of predictability.
  - In the last 30 years, most improvements in weather forecast skill have arisen due to improvements in models and assimilation techniques
- The next big challenge is to build a hypothetical "perfect" model which can replicate the statistical properties of past observed climate (means, variances, covariances and patterns of covariability), and use this model to estimate the limits of weather and climate predictability
  - The model must represent ALL relevant phenomena, including ocean, atmosphere, and land surface processes and the interactions among them

International Research and Computational Facilities to Revolutionize Climate Prediction

1. Computational Requirement:

- Sustained Capability of 2 Petaflops by 2011
- Sustained Capability of 10 Petaflops by 2015

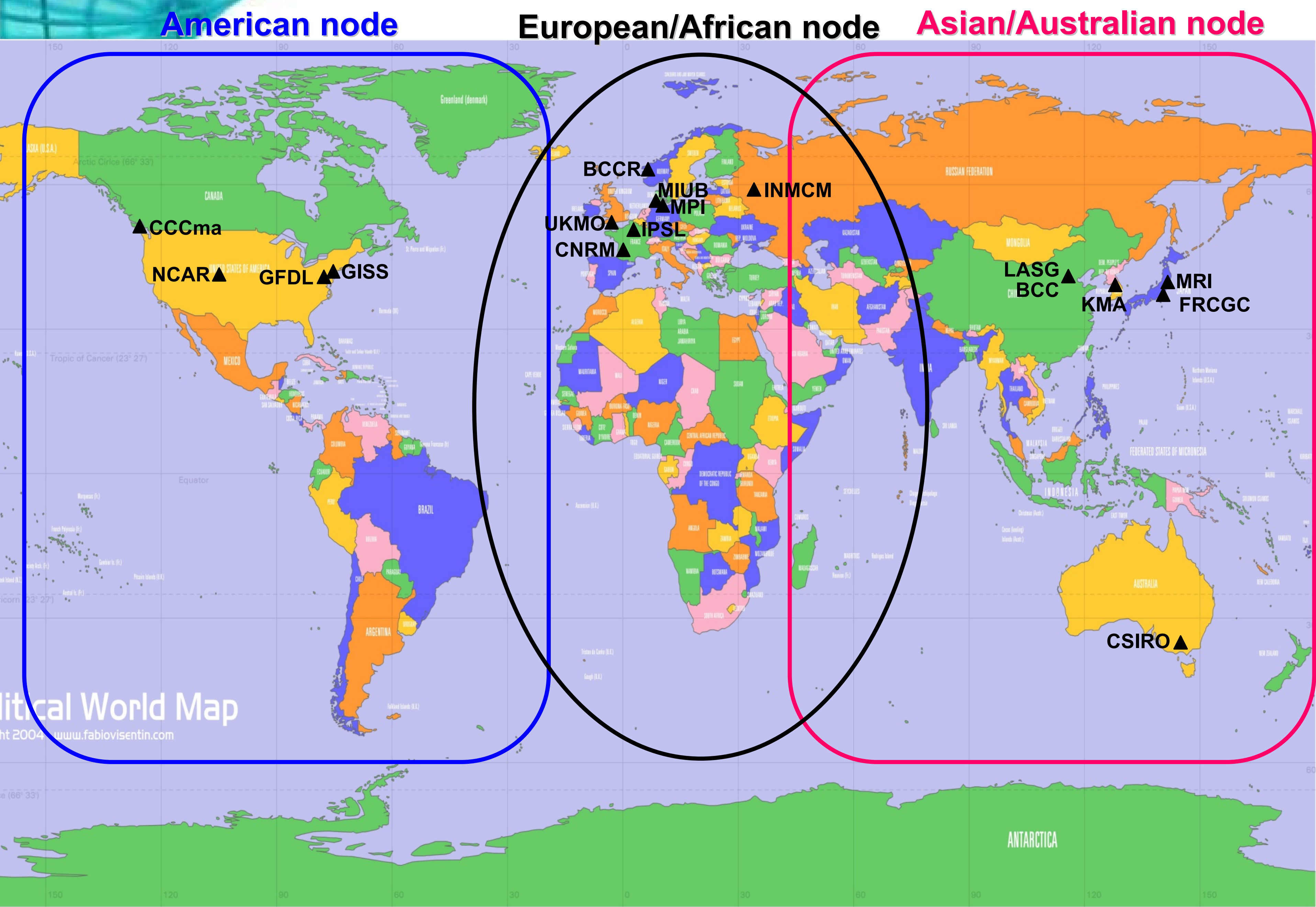
Earth Simulator (sustained 7.5 Teraflops) takes 6 hours for 1 day forecast using 3.5 km global atmosphere model; ECMWF (sustained 2 Teraflops) takes 20 minutes for 10 day forecast using 24 km global model

2. Scientific Staff Requirement:

- Team of 200 scientists to develop next generation climate model
- Distributed team of 500 scientists (diagnostics, experiments)

A computing capability of sustained 2 Petaflops will enable 100 years of integration of coupled ocean-atmosphere model of 5 km resolution in 1 month of real time

Scientific/Political Domains of Climate Modeling Facilities



Summary

- The most dominant obstacle in realizing the potential predictability of intraseasonal and seasonal variations is inaccurate models, rather than an intrinsic limit of predictability.

- Our inability to improve climate simulations using ultra-high resolution models is not primarily limited by lack of knowledge of science, but lack of powerful computers and a critical mass of scientific staff.

THANK YOU!

ANY QUESTIONS?

Table 9.2. Heidke skill score of CPC temperature seasonal forecasts for JFM95–FMA2002. All 102 climate divisions, starting times and leads are combined. The, CCA and OCN methods were unchanged during this period, while the dynamical method (predecessor of current CFS) changed several times

	SS_1	SS_2	Coverage (%)
OFF	22.7	9.4	41.4 (13 leads)
CCA	25.1	6.4	25.5
OCN	22.2	8.3	37.4
Dynamical	7.6	2.5	32.7 (First four leads only)

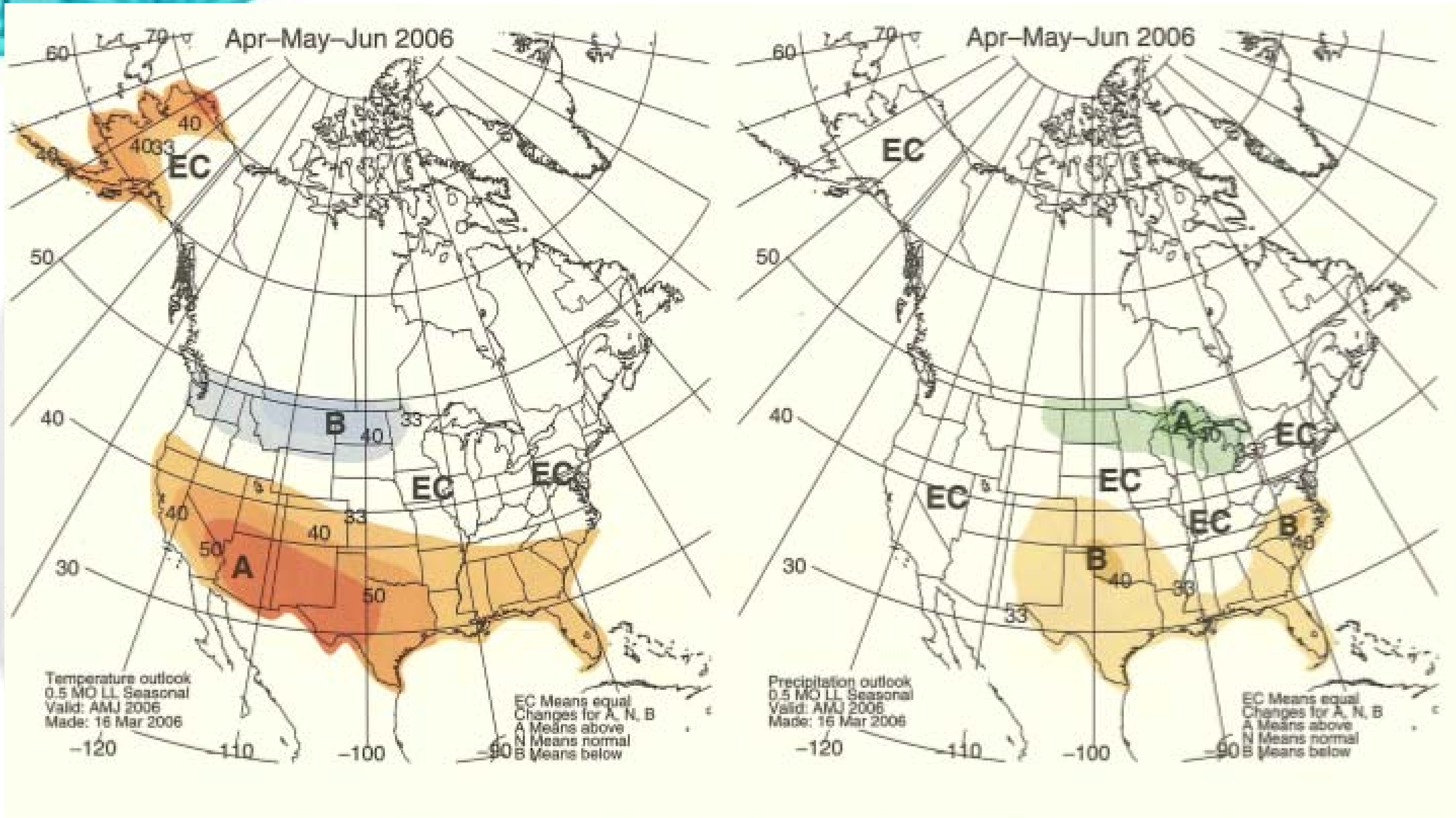


Plate 11 (corresponds to Fig 9.4): An example of a recently released forecasts for AMJ 2006, *T* on the left and *P* on the right. Contours are absolute probabilities at 33%, 40, 50 and 60%. The color and the letters A or B indicate the shift in probability towards Above (A, T red, P green) or Below (B, T blue, P brown). White areas labeled EC have climatological probabilities for all three classes.