Applications of Seasonal Climate Forecast to Crop Yield: International & Domestic Collaborations

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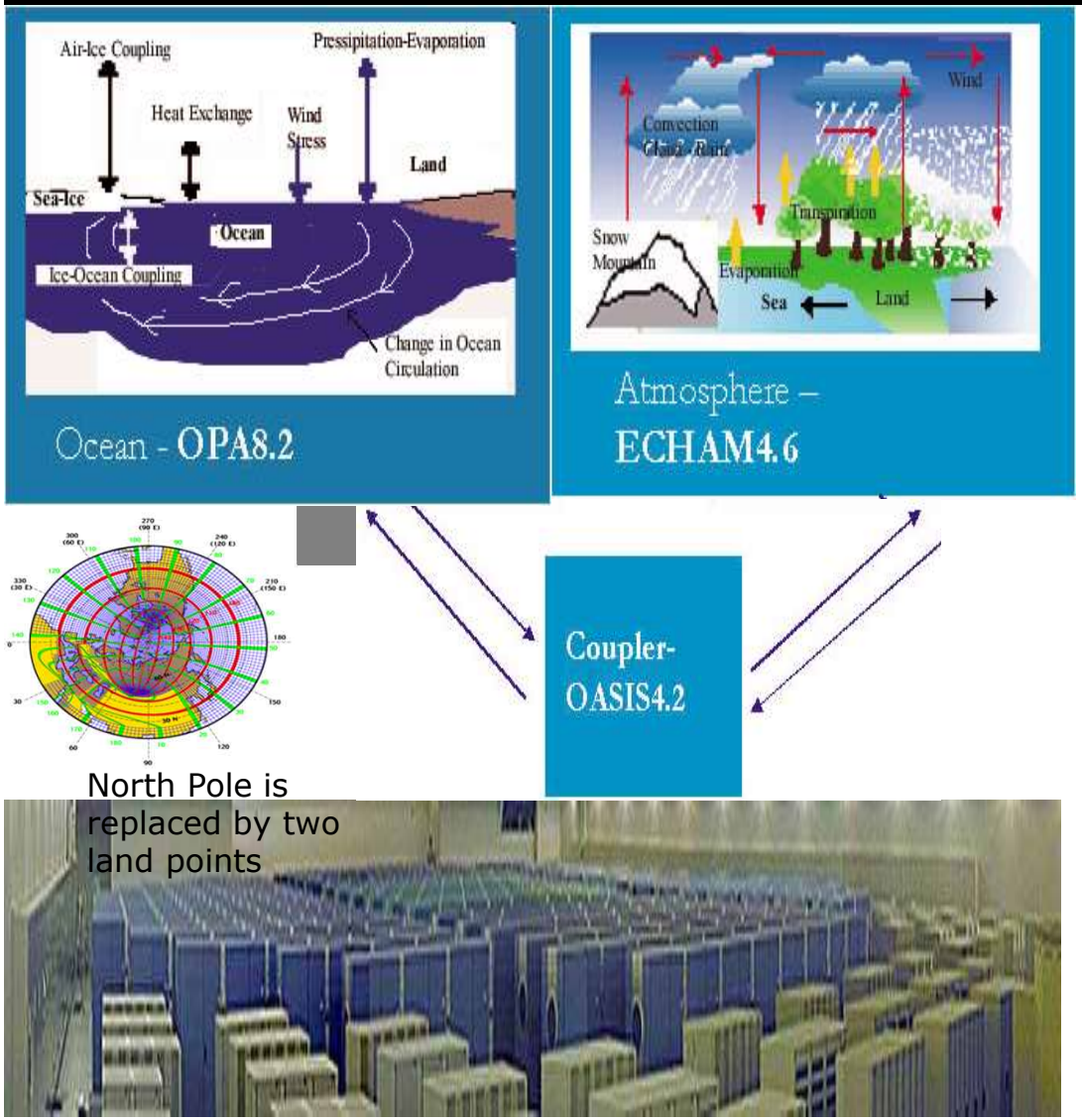
Outline

- **Brief overview on climate predictability activities using SINTEX-F1 coupled model.**
- **On agricultural collaborations.**
- **A new attempt of developing high performance bias correction scheme for short term climate predictions.**

EU-Japan Collaboration

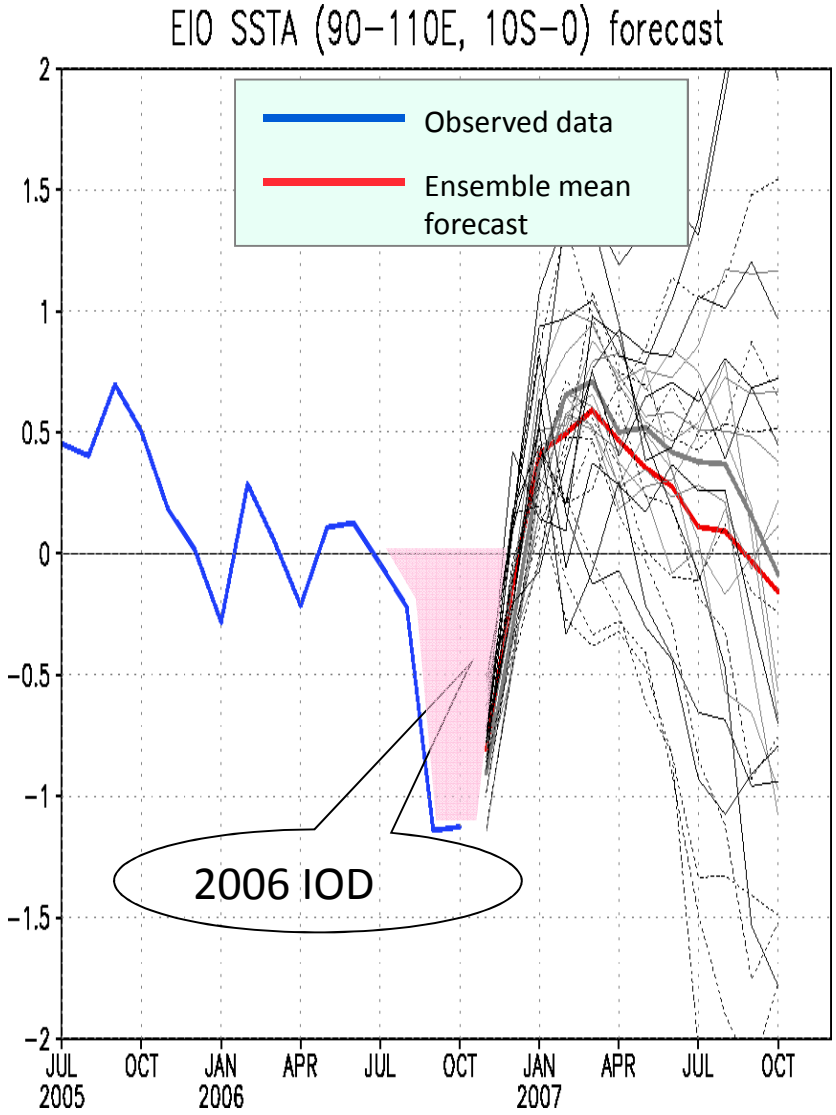
Schematic view of the present version of the SINTEX-F CGCM



Earth Simulator

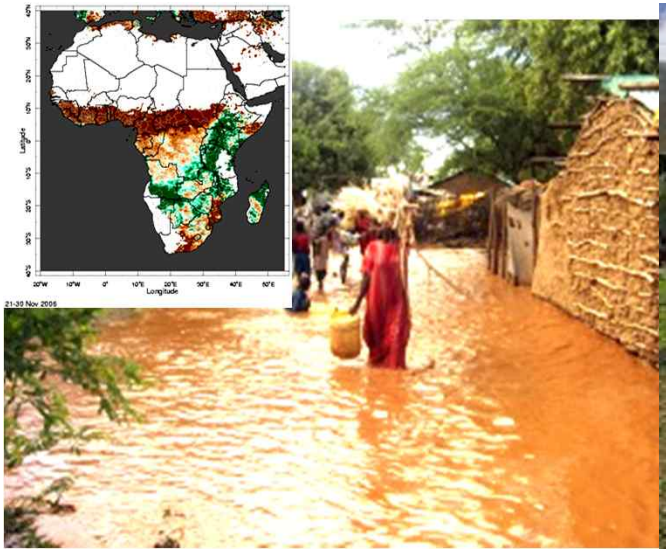
SST Forecast plumes

First successful prediction of IOD

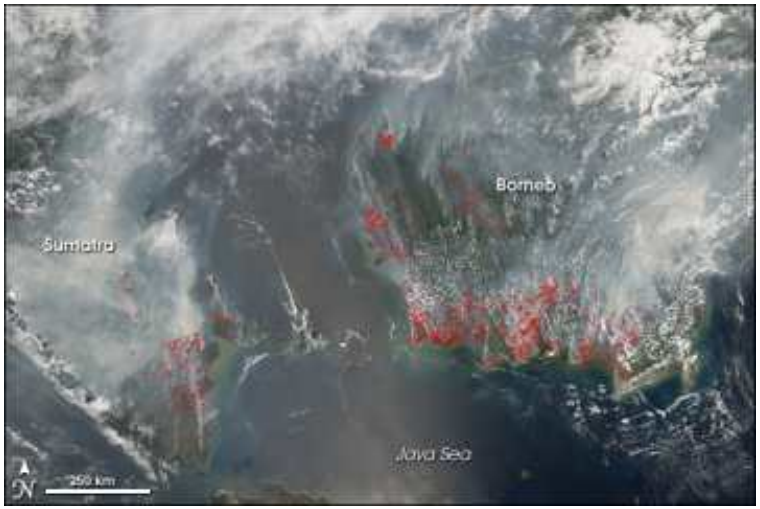


Extreme Weather Conditions Associated with 2006 IOD

East African Flood (more than 1 million have been uprooted in Kenya)



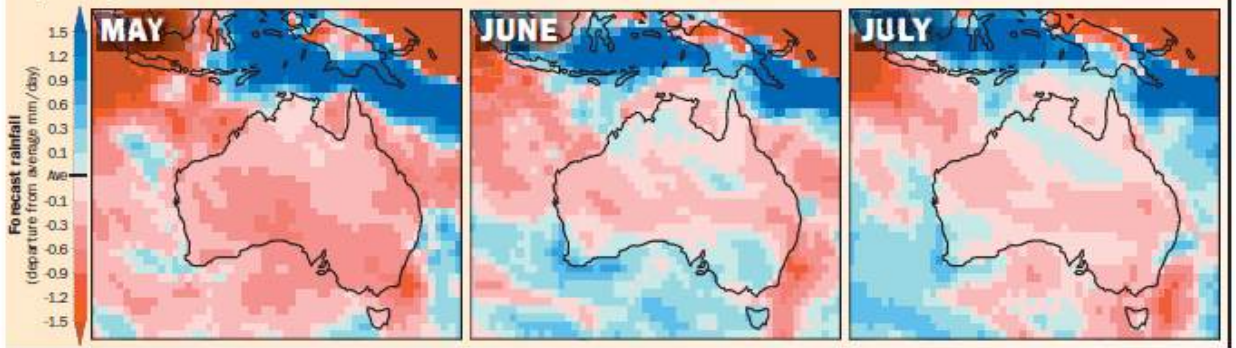
Indonesian Forest Fire



Australian Drought

DRY RUN AHEAD

Japanese predictions for the next three months



Weekly Times 23/4/2008 — Source: Earth Simulator SINTEX-F model

Rain hopes fading

Drought tip from box trees

By SIMONE DALTON

AS ANZAC Day draws near, and concerns about the autumn break intensify, weather watchers are looking to nature, patterns and history to work out what is in store.

Winds several weeks ago prompted hopeful memories of 1982 when a dust storm was followed weeks later by an early break which heralded a wet year.

Others are reporting rabbit breeding and mice on the run as a sign of approaching rain.

But retired farmer Mervyn Obst, from Jeparit, hopes he is wrong with his tip of a dry season ahead in northwest Victoria.

Mr Obst has been watching the box tree for weather signs after being taught by his uncle nearly half a century ago.

He watches when and how prolifically the trees flower from late spring to late summer, with a prolific flowering meaning a better season.

"The earlier the flowering the earlier the break, the later the flowering the later the break," he said.

This year the trees produced no flowers at all, similar to the situation before the 1982 drought. He said others near Swan Hill and Birchip had also no flowers on box trees.

Mr Obst said he was optimistic about some good falls next year.

Praying for rain: agents sold 8200 weaner calves at Cooma and Bombala in southern NSW last week.

Cattle hold the line

By JENNY KELLY

FARMERS are talking about the lack of autumn rain at saleyards — but not acting on it just yet.

Store cattle prices held their value at major markets last week as northern orders and lingering hopes of a season-changing rain kept people bidding.

Agents sold 8200 Angus and Hereford weaner calves at Cooma and Bombala in southern NSW last week for an average of $511 for steers and $400 for heifers.

Victorian Hereford breeder John McKeown, who received a top of $630 for 300 steers at Bombala, said the market was showing amazing resistance.

"When we booked them in several weeks ago we were just hoping for rain, but the fact it hasn't didn't seem to make much difference to the prices," he said.

In a trend that completely defied the odds, agents at Wodonga and Wangaratta last week quoted store cattle as dearer.

At Wodonga, Angus heifers with one-month-old calves sold to $1240, while Hereford weaner steers sold to $650 at 205c/kg liveweight.

Brian Unthank Rodwell auctioneer Michael Unthank said it was a surprise result in a week when most market watchers had expected prices to crumble.

"Yet there was a good field of buyers with higher than expected results for all grades of cattle," he said.

Selling on the AuctionsPlus computer network was also buoyant last week, with lightweight steers on northern NSW properties selling at 205c-217c/kg.

AuctionsPlus market commentator Dean Lemmich said he just hoped the season and export markets played out well for buyers.

"The confidence being shown at present is admirable and one hopes well-founded," he said.

• Northern buyers set a cracking pace, Pages 94-95

By PETER HUNT

FARMERS across south-east Australia may have to wait until spring for drought-breaking rain, according to Japanese long-range forecaster Toshio Yamagata.

"It is very unfortunate but our SINTEX-F model run by the Earth Simulator predicts rather dry conditions for at least the next three months," Prof Yamagata said.

"This is because the model, as an ensemble mean, predicts a weak positive IOD (Indian Ocean Dipole) again in this year."

A positive IOD is associated with a slump in the development of crucial northwest cloud bands that develop over the Indian Ocean and carry moisture across the continent to southeast Australia.

When the dipole is positive the sea surface temperature around Indonesia and northern Western Australia are cooler than average.

The cooler conditions reduce sea-surface evaporation and consequently the amount of moisture in the atmosphere.

Reduced atmospheric moisture levels lead to a slump in the formation of crucial northwest cloud bands that sweep across the continent to deliver rain to southeast Australia.

In May last year, Prof Yamagata, who is a lead scientist with the Japan Agency for Marine-Earth Science and technology, predicted southeast Australia's drought would continue into 2007-08.

In an email to *The Weekly Times* last week Prof Yamagata said: "I hope our (latest) prediction will be wrong."

Prof Yamagata's forecast will weigh heavily on grain growers' minds as they prepare to invest $180-$220 a hectare in the Mallee, or up to $300 in Victoria's southwest, sowing crops this autumn.

Horsham's Department of Primary Industries agronomist, Chris Sounness, said he encouraged farmers to look at as many climate models as possible.

"Don't make decisions based on just one," Mr Sounness said.

Northern irrigators are already contemplating carrying a large proportion of their unused water from this season into next to secure at least some supplies for 2008-09.

But while Prof Yamagata's forecast is frightening he does hint at some rainfall recovery in spring.

Prof Yamagata's forecast for September, October and November shows increased rainfall in southeast Australia.

More details on Professor Yamagata's research team's forecast can be found at www.jamstec.go.jp/frcgc/research/d1/iod/index.html, then take the link to seasonal prediction, then the link to rainfall prediction.

JAMSTEC による2008年4月からの予測結果

2008年4月23日にThe Weekly Timesに掲載

今年も異常気象予測

インド洋ダイポールモード現象 海洋機構 東南アの渇水など

海洋研究開発機構は十一月にかけてアフリカ東部を中心に大雨が降り、洪水が多発する可能性があるという。インド洋のダイポールモードは、インド洋の東部で海面水温が低下し、西部では上昇する現象。二〇〇六、〇七年の夏に続けて発生し、オーストラリアの干ばつやアフリカ東部の洪水を誘発するなどの影響が出た。

海洋機構では五月時点の大気や海洋の観測データをもとに計算。今夏に観測史上初となる三年連続のインド洋ダイポール現象が起きると予測した。インド洋での観測結果からは実際に水温変化の前兆がとらえられた。同現象による日本への影響は小さいとみている。研究チームは、アフリカや東南アジアで、洪水や渇水の事前対策が必要と分析している。

日本の新聞にも掲載

(MDF 2011)

CCARA approach (IRRI)

1. *Development of a seasonal (weather) prediction model* ***(JAMSTEC and IRRI)***

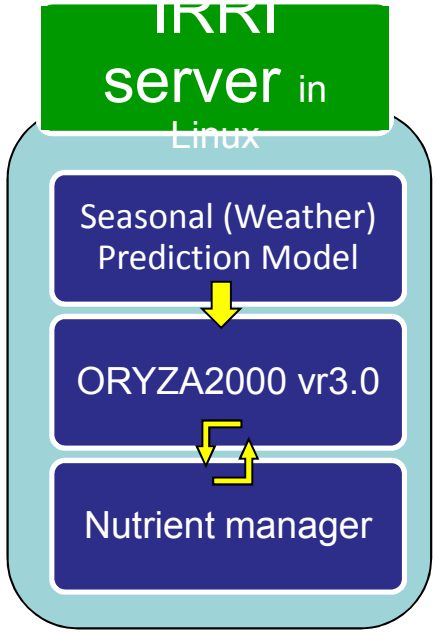
2. *Development of rice genotypes suitable for growing in abiotic stress conditions caused by climate change* ***(IRRI, NAFRI, AIAT, and IAERI)***

3. *Development of fertilizer management technologies to mitigate stresses caused by climate change* ***(IRRI, NAFRI, IAERI)***

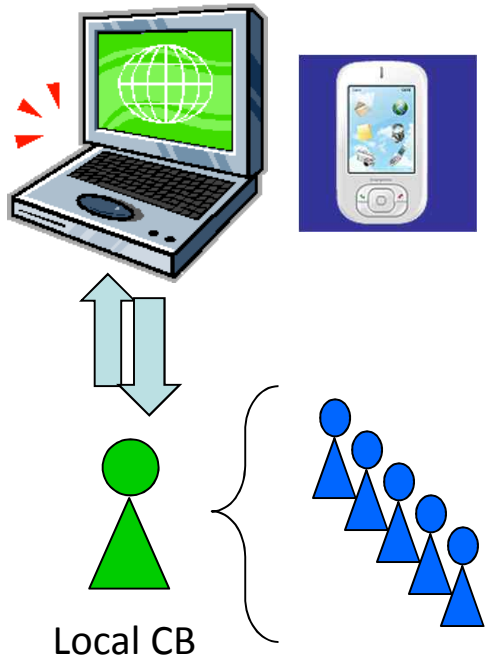
4. *Development of an integrated decision support system* ***(IRRI, NAFRI, IAERI)***

CCARA design
Information process and delivery

RA with JAMSTEC



Internal collaboration



Implications for crop prediction

TABLE 1. RPS skill scores, % [Eq. (2)], for the IRI temperature forecasts.

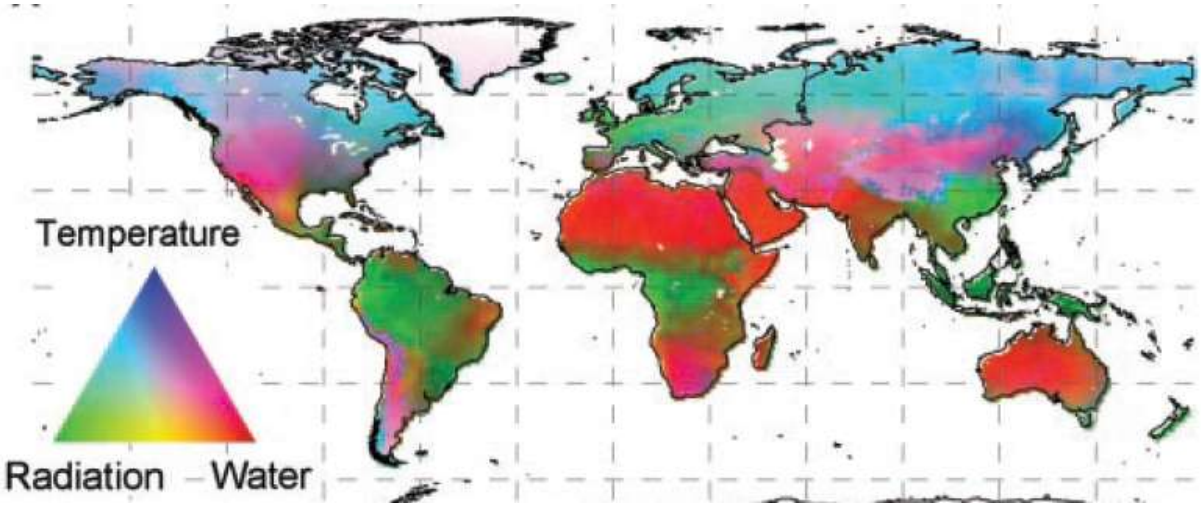
	0-month lead (JFM 1998–OND 2000)	3-month lead (AMJ 1998–OND 2000)
Global	8.9	4.2
Low latitudes ($\|\phi\| < 30°$)	17.8	10.5
High latitudes ($\|\phi\| > 30°$)	2.7	−0.3
Africa	25.6	9.1
Asia	1.1	1.3
Australia/west Pacific	19.8	13.0
Europe	5.0	2.7
North America	2.6	−1.3
South America	5.9	7.0

TABLE 2. RPS skill scores, % [Eq. (2)], for the IRI precipitation forecasts.

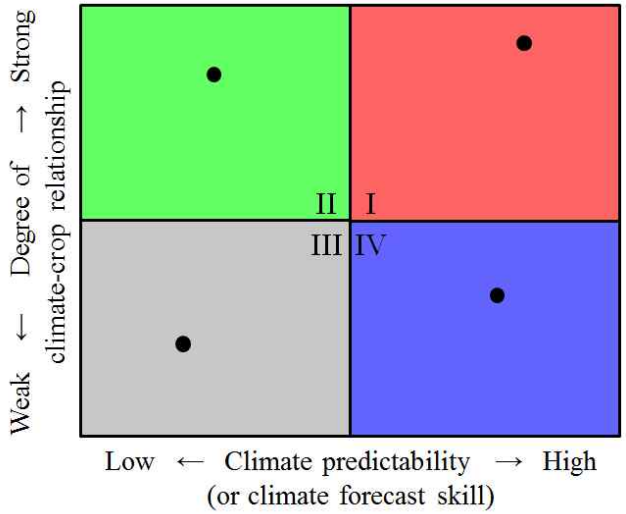
	0-month lead (OND 1997–OND 2000)	3-month lead (JFM 1998–OND 2000)
Global	1.8	1.0
Low latitudes ($\|\phi\| < 30°$)	4.8	3.0
High latitudes ($\|\phi\| > 30°$)	−0.6	−0.6
Africa	3.2	0.8
Asia	−0.8	−0.1
Australia/west Pacific	6.7	5.8
Europe	−0.8	−1.2
North America	0.0	−0.7
South America	4.8	2.5

Wilks & Godfrey (2002) *J Clim*

$$SS_{RPS} = \frac{RPS - RPS_{clim}}{0 - RPS_{clim}} \times 100\%,$$

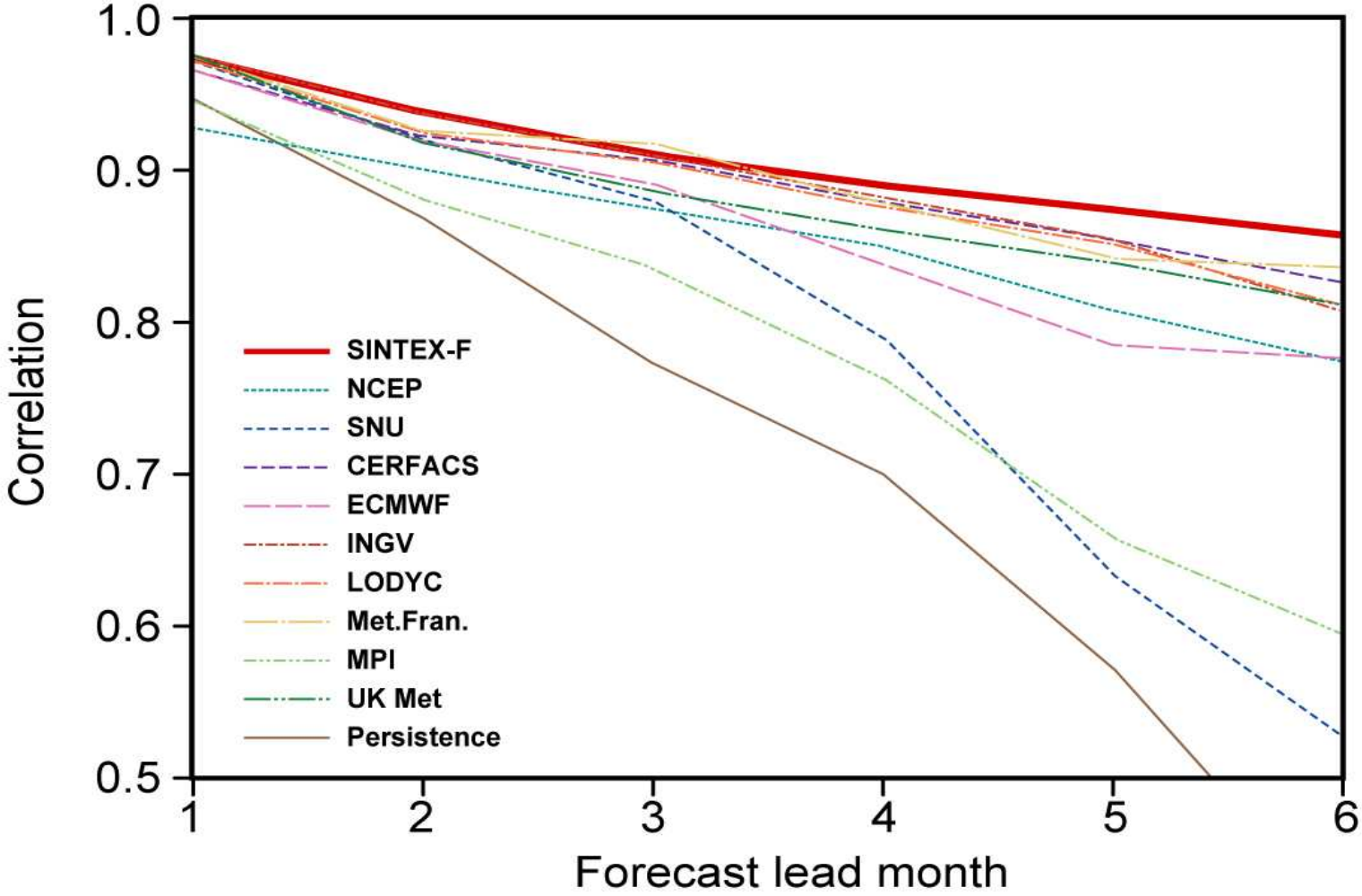


Nemani et al. (1997) *Science*

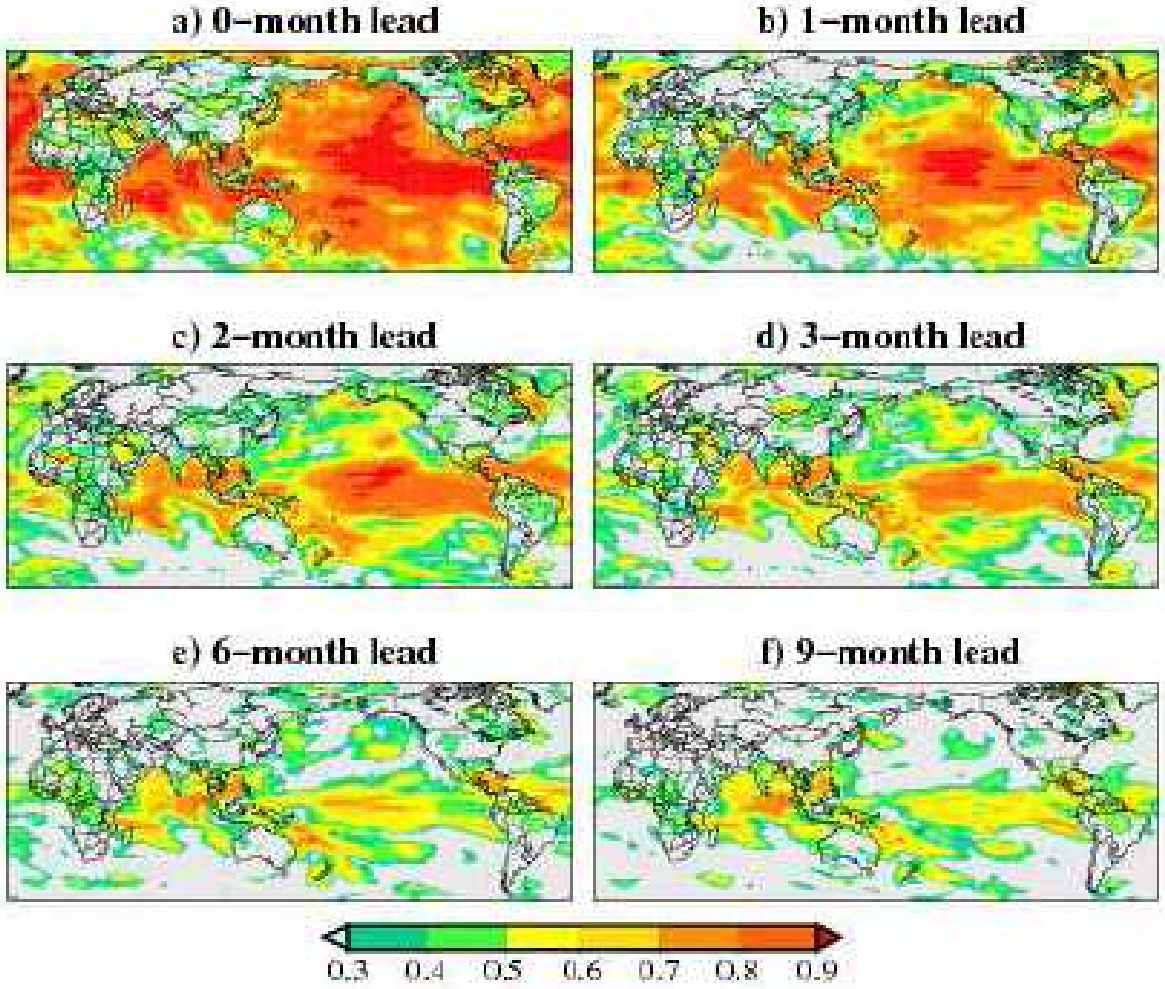


Iizumi et al. (in preparation)

ENSO prediction skill of 10 top models



Correlation b/w 3-month mean values of JRA25 reanalysis and SINTEX-F forecast at various lead times (sample size 28: 1983-2010). T_{ave}–JJA



New attempt of bias correction (1)

- **Miscellany of several methods, some of them are based on our subjective judgments.**

  ⇒ Generic method without ad hoc assumptions.

- **The basic idea of prevailing methods is called quantile(Q)-matching:**

  Observational data **Model Output**

  PDF(o) ⇒ CDF(o) **PDF(m) ⇒ CDF(m)**

  There exists

CDF(o) ← (one to one correspondence) → CDF(m)

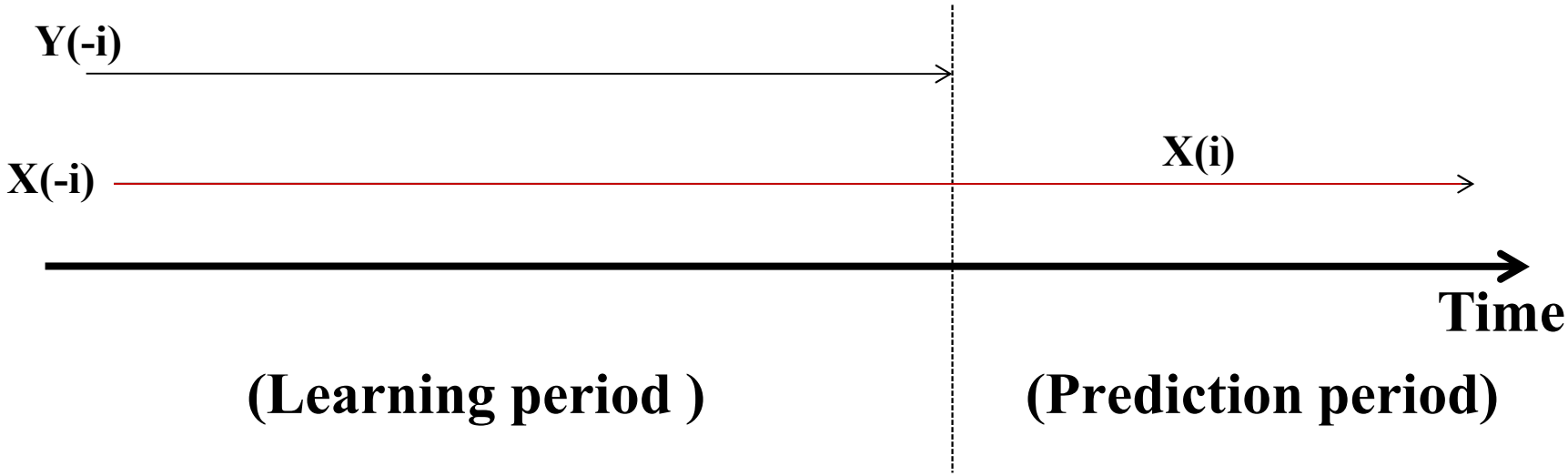
since CDF is a monotonous function.

New attempt in bias correction (2)

- **Conventional Q-matching is purely statistical approach in which the picture of time evolution of events is totally missing, while it is important in short-term climate variability prediction.**
- **This motivates us to look into *the time dependent bias time series* defined as the difference between observational value and model output with the same spatio-temporal mean.**

New attempt in bias correction (3)

Y(i): Obs.; X(i): Model outputs (hindcast & prediction)



Time dependent model bias:

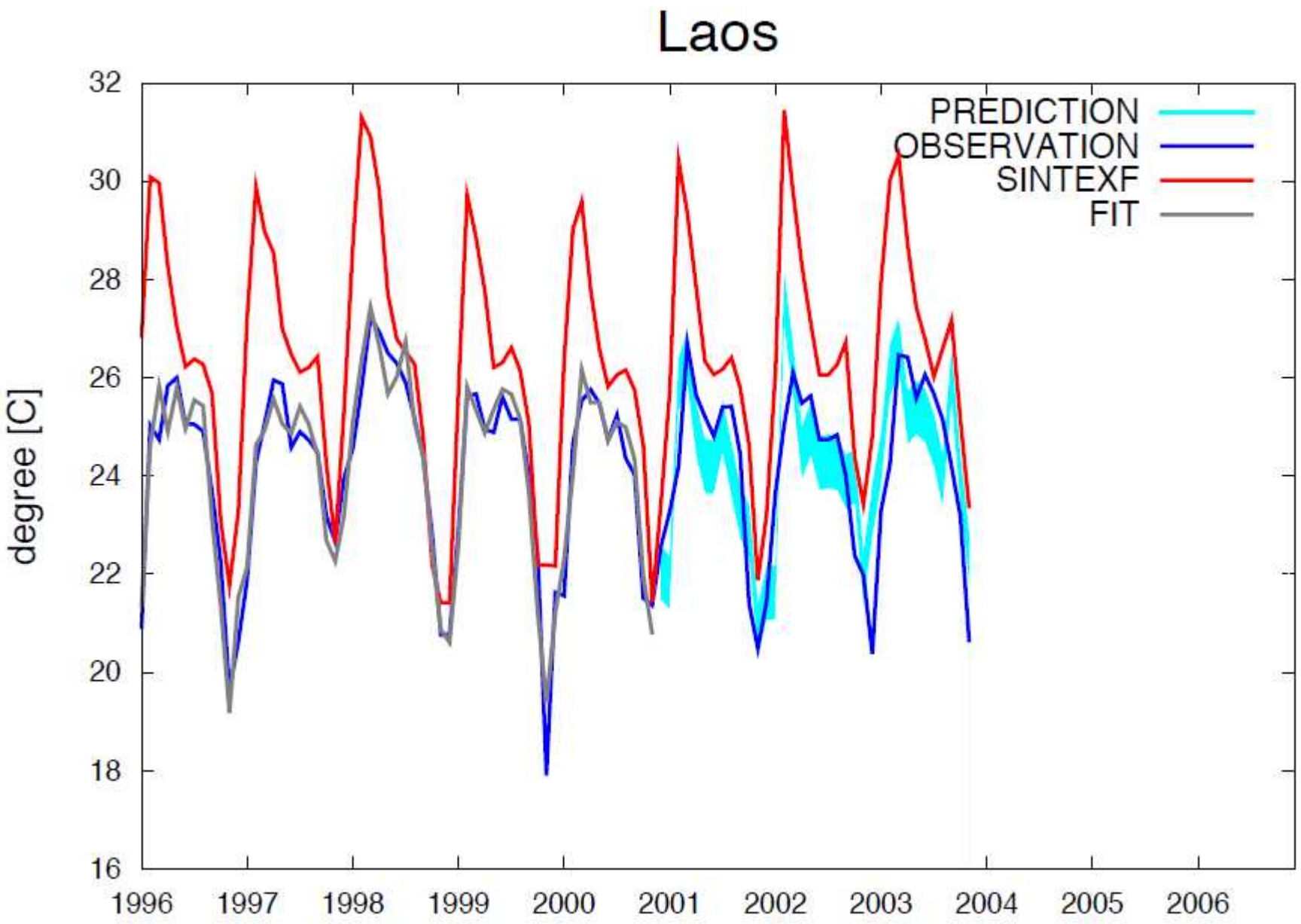
$$Z(-i) = Y(-i) - X(-i)$$

New attempt in bias correction (4)

- **Mathematically, we cannot determine power spectrum of a given data with finite length.**
- **Maximum Entropy Method provides a measure to cope with the lack of information.**
- **A numerically improved code of MEM is now available.**

i) High resolution analysis is justified beyond Akaike Information type criteria valid for AR process but not necessarily so for MEM.

ii) Code satisfies Parseval's theorem within allowable limits of numerical error.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SINTEXF
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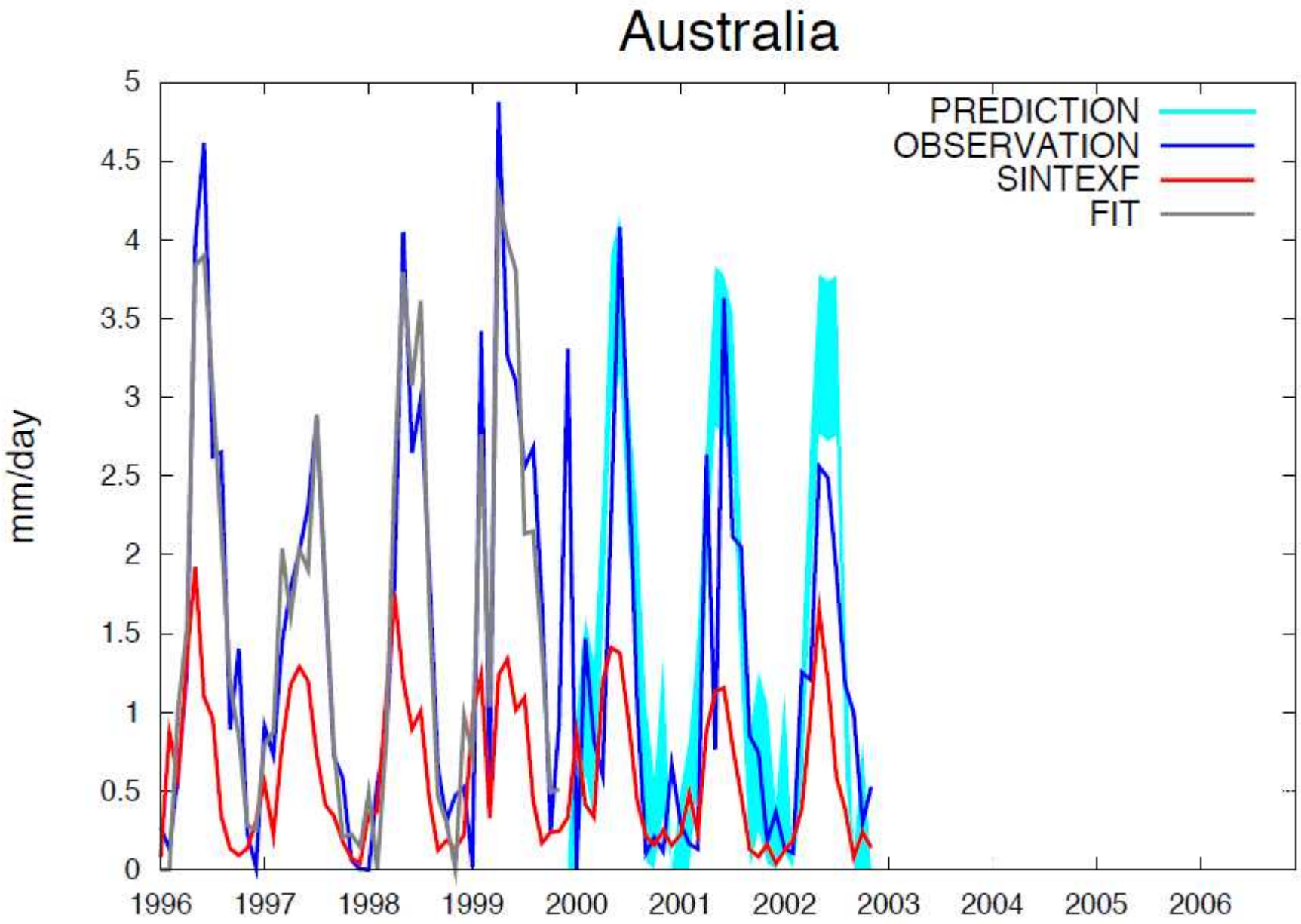
Australia
PREDICTION
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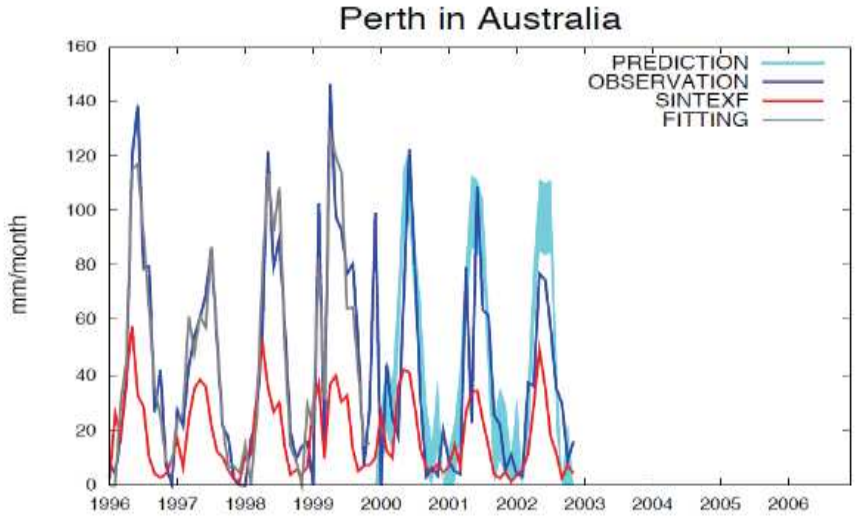


Fig. 3

BEFORE YEAR 2000

(OBS-SINTEX)^2/OBS^2 = 0.693^2

(OBS-FITTING)^2/OBS^2 = 0.220^2

AFTER YEAR 2000

0.646^2

0.400^2

1 year

BEFORE YEAR 2000

(OBS-SINTEX)^2/OBS^2 = 0.693^2

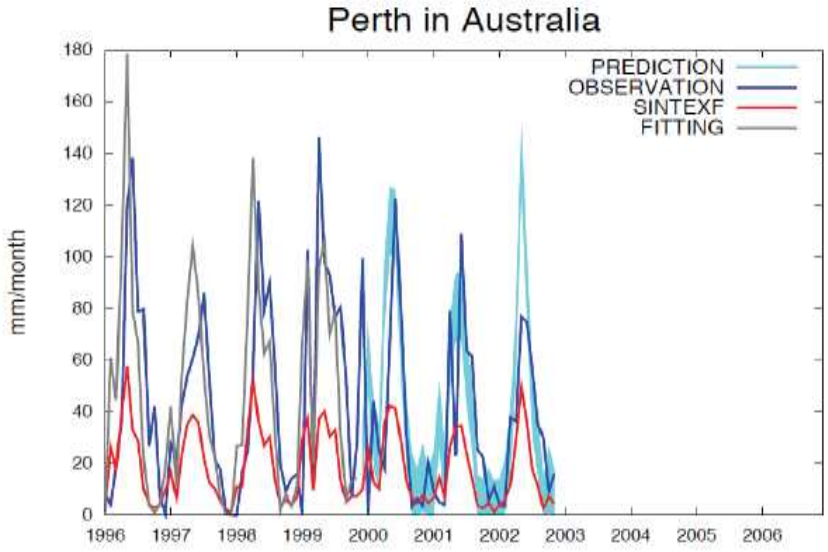
(OBS_FITTING)^2/OBS^2 = 0.560^2

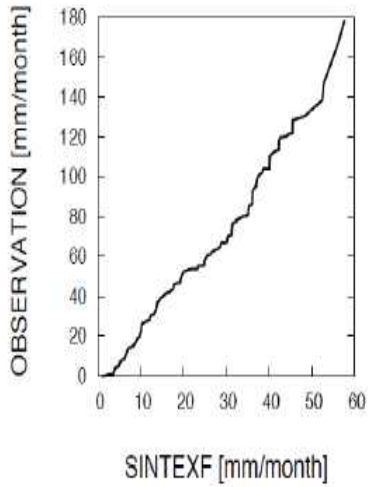
AFTER YEAR 2000

0.646^2

0.626^2

1 year





Summary

- **A high-performance bias correction method exclusively for short-term seasonal climate prediction has been developed.**

- **Next challenge is bias correction for sub-seasonal or shorter time scale phenomena important for agricultural applications.**