Climate Risk Management and Tailored Climate Forecasts

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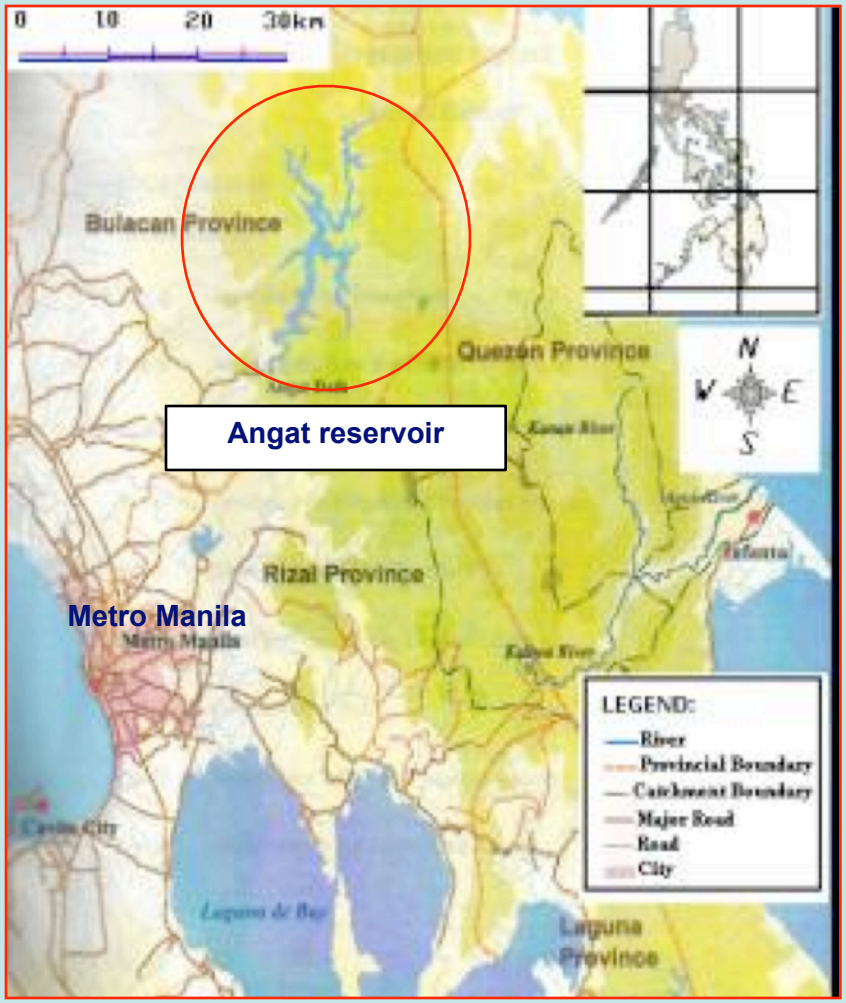
outline

- what is Climate Risk Management? – some examples
- statistical tailoring methods for seasonal forecasts

Climate Risk Management examples

- reservoir management in Manila
- malaria mapping and early warning in Africa

Angat Multipurpose Reservoir



- **The Angat watershed is 568 km^2**
- **Supplies about 97% of water for Metro Manila**
- **Irrigates about 30,000 hectares of farmlands**
- **Generates a maximum power of 246 MW**
- **Serves as flood control facility during rainy season**

IRI working partners (U. Phil., NWRB, PAGASA) on institutional landscaping, climate research & capacity building, and incorporation of seasonal fcsts in NWRB reservoir mgmt model.

Improved Decision Making in Reservoir Management

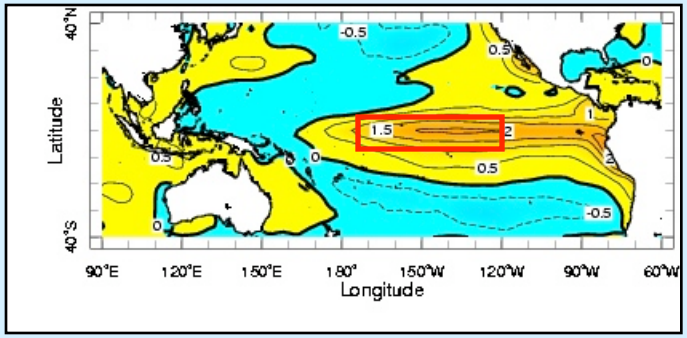
- Reservoirs operated without forecasts in risk averse mode
    - Anticipating drought of record in every year
    - Water is kept in the reservoir as a reserve for a drought, instead of being delivered to irrigators or being used for hydroelectricity production.
- Forecasts provide enhanced estimate of drought risk
    - Identifying opportunities in years when drought *risk* is low (eg La Niña)

- Decision Support System communicates forecast in relevant terms
    - Reservoir levels, reliability, water deliveries
    - allows a user to upload a climate forecast of reservoir inflows and projects the reservoir levels for the next 6 months based on the forecast. It also calculates reliability (relative to the existing rule curve) and allows the user to perform scenario analysis, adjusting water deliveries to each of the users until the desired reliability is reached
- Risks of forecast use must also be managed
    - Evaluating options for managing the low probability event
    - Forecasts are probabilistic, and low probability events (when forecasts are "wrong") could cause serious negative consequences for forecast users.
    - Thus, forecasts must be coupled with risk management strategies that guide the water system through the hard times (the drought that wasn't expected to occur). Otherwise, risk averse water managers are unlikely to utilize seasonal climate forecasts. In Manila, we have designed a conceptual risk management strategy that consists of option contracts between different user groups. If implemented, it would allow the stakeholders to exchange compensation for water in the drought years, so that an unexpected drought does not lead to a major water crisis.

Downscaling for Philippines Reservoir Inflow

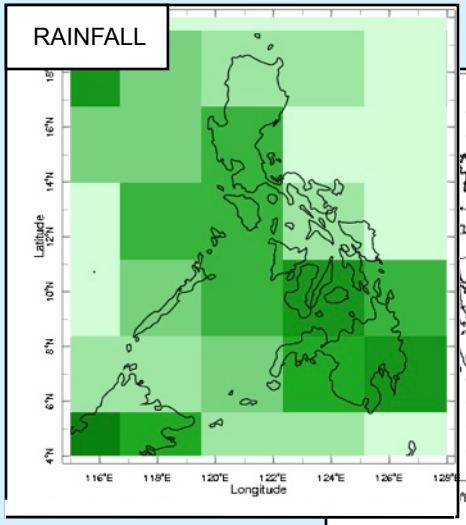
B. Lyon (IRI)
A. Lucero (PAGASA)

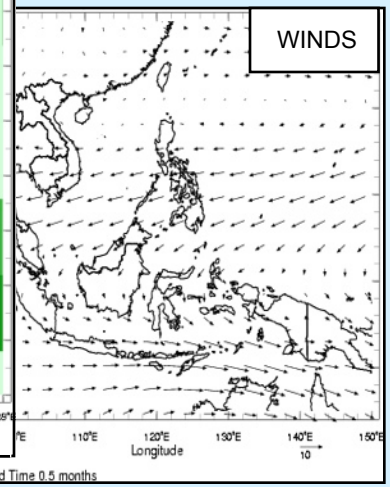
Sea Surface Temperatures



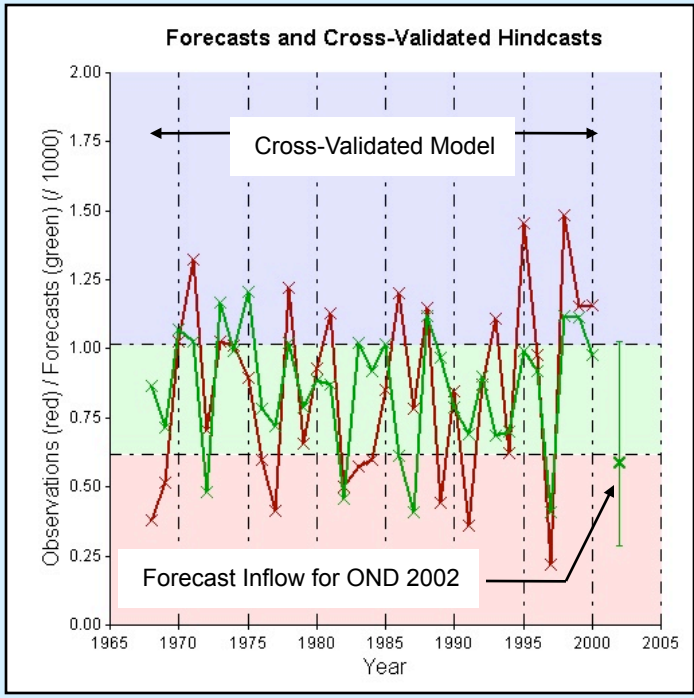
Historical Angat Inflow Observations

Global Climate Model





Statistical Model



IRI

Data Library

Africa

CSMT
Malaria
Meningitis
MEWS
RED

Malaria

Seasonal Transmission Suitability
EVI
MARA Distribution Model
Malaria Early Warning System
MODIS
NDVI
Rainfall Differences
Rainfall Percentages

Seasonal Transmission Suitability

Instructions

help@iri

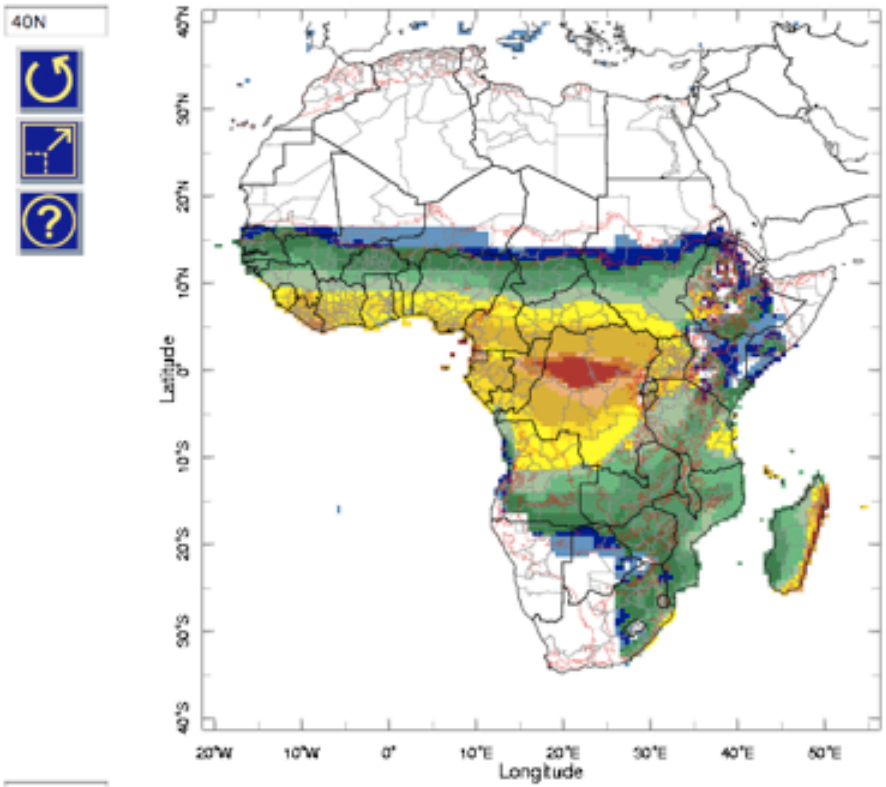
Printable Page

Seasonal Climatological Suitability for Malaria Transmission

Where malaria is not adequately controlled, the seasonality of climate greatly influences the seasonality of malaria transmission. Specifically, rainfall plays an important role in the distribution and maintenance of breeding sites for the mosquito vector (Anopheline species). Temperature regulates the development rate of both the mosquito larvae and the malaria parasite (Plasmodium species) within the mosquito host. Relative humidity and temperature play an important role in the survival and longevity of the mosquito vector.

Here we present a clickable map interface that describes where, when and for how long the combination of climatic conditions may be suitable for malaria transmission in the Africa continent.

40N



40S

20W

55E

Optional Overlay Maps

Boundaries
- [ ] Coasts
- [x] Countries
- [x] States
- [ ] Districts

Epidemiological
- [x] Mask

Climatological Suitabilty for Malaria Transmission - Local Analysis

http://iridl.ldeo.columbia.edu/maproom/.Health/Local/csmt_history.html?states=on&cou

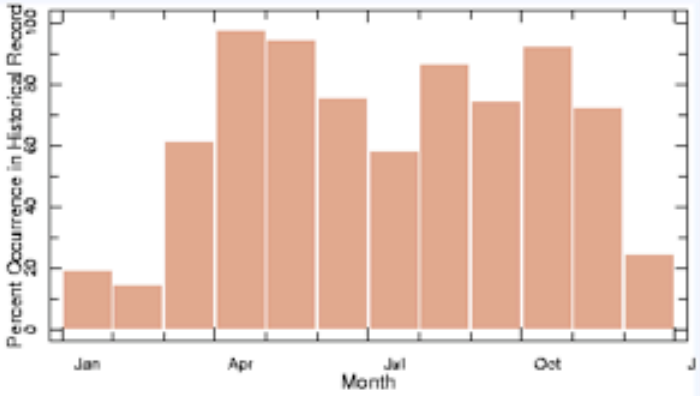
Google

Climatology for:
33.25E, 1.25N
- 55x55 km

33.25E 1.25N

View Climatology

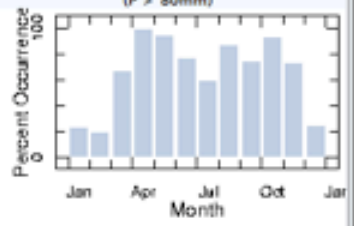
Percent Occurrence of Climate Conditions Suitable for Malaria Transmission



Longitude 33.25E Latitude 1.25N

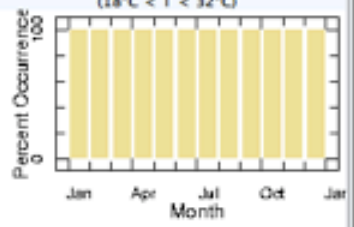
View animation

Precipitation
(P > 80mm)



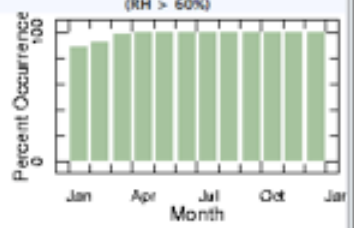
View animation

Temperature
(18°C < T < 32°C)



View animation

Relative Humidity
(RH > 60%)



View animation

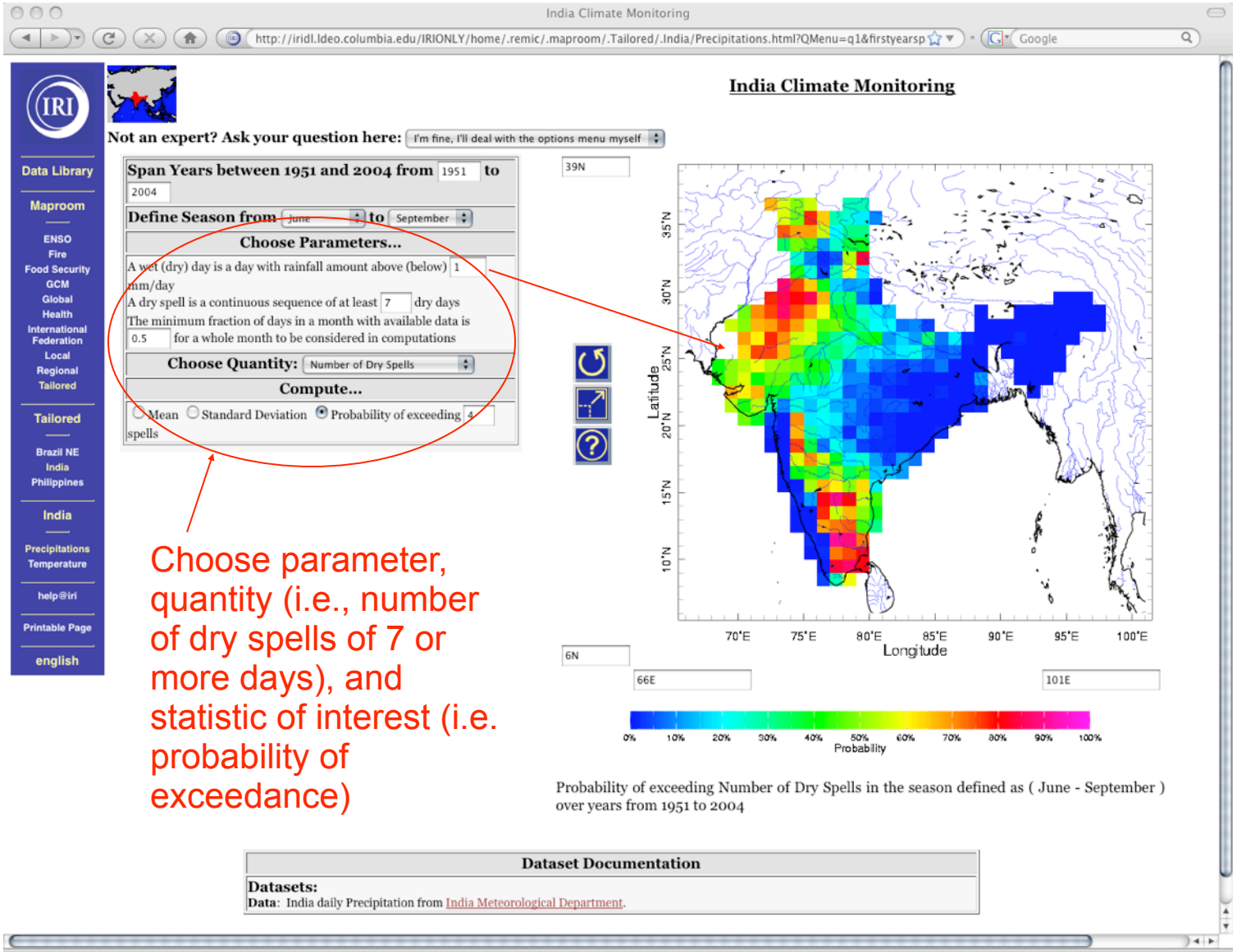
Description

The dominant species of malaria in Africa is Plasmodium falciparum. Its development rate is temperature dependent. The climatic conditions considered suitable for its development and transmission through the mosquito stage of its life cycle are temperatures within the range 18°C to 32°C. Below 18°C parasite development decreases significantly. Above 32°C the survival of the mosquito is compromised. Relative humidity greater than 60% is also considered as a requirement for the mosquito to survive long enough for the parasite to develop sufficiently to be transmitted to its human host stage. Rainfall and surface water is required for the egg laying and larval stages of the mosquito life cycle and monthly rainfall above 80mm is considered as a requirement.

The climate variables used here are derived on a macro-scale from historical records. We may use these variables to provide an illustration of where and when this combination of climatic conditions exist. However, we should also remember that mosquitoes will actively seek out micro-climatic conditions to maximize their chances of survival and this will have a significant bearing on actual transmission.

The main graph above shows how often all three conditions have concurrently been met at the point of enquiry for

Probability of exceeding a seasonal rainfall threshold



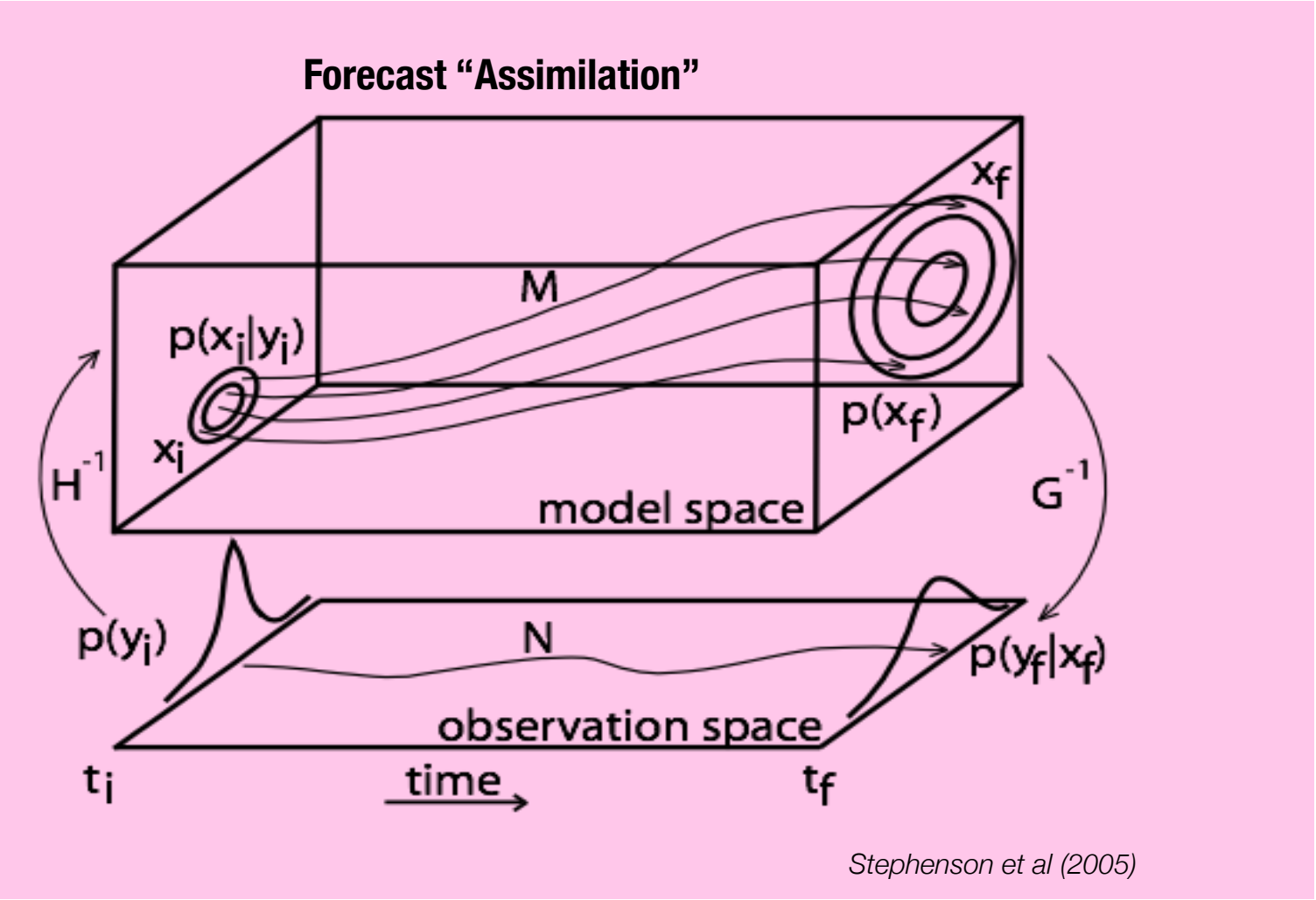
Choose parameter, quantity (i.e., number of dry spells of 7 or more days), and statistic of interest (i.e. probability of exceedance)

tailored seasonal forecasts

- for use as a risk management tool, forecasts need to be issued in a probability format
  - risk estimates (or “risk maps”) based on historical climate information can estimate *static* risk
  - make *dynamic* by updating according to the seasonal forecast
- forecasts need to be expressed in terms of the variable of interest
- forecasts should be flexible
  - probability of exceeding a *user-specified* threshold

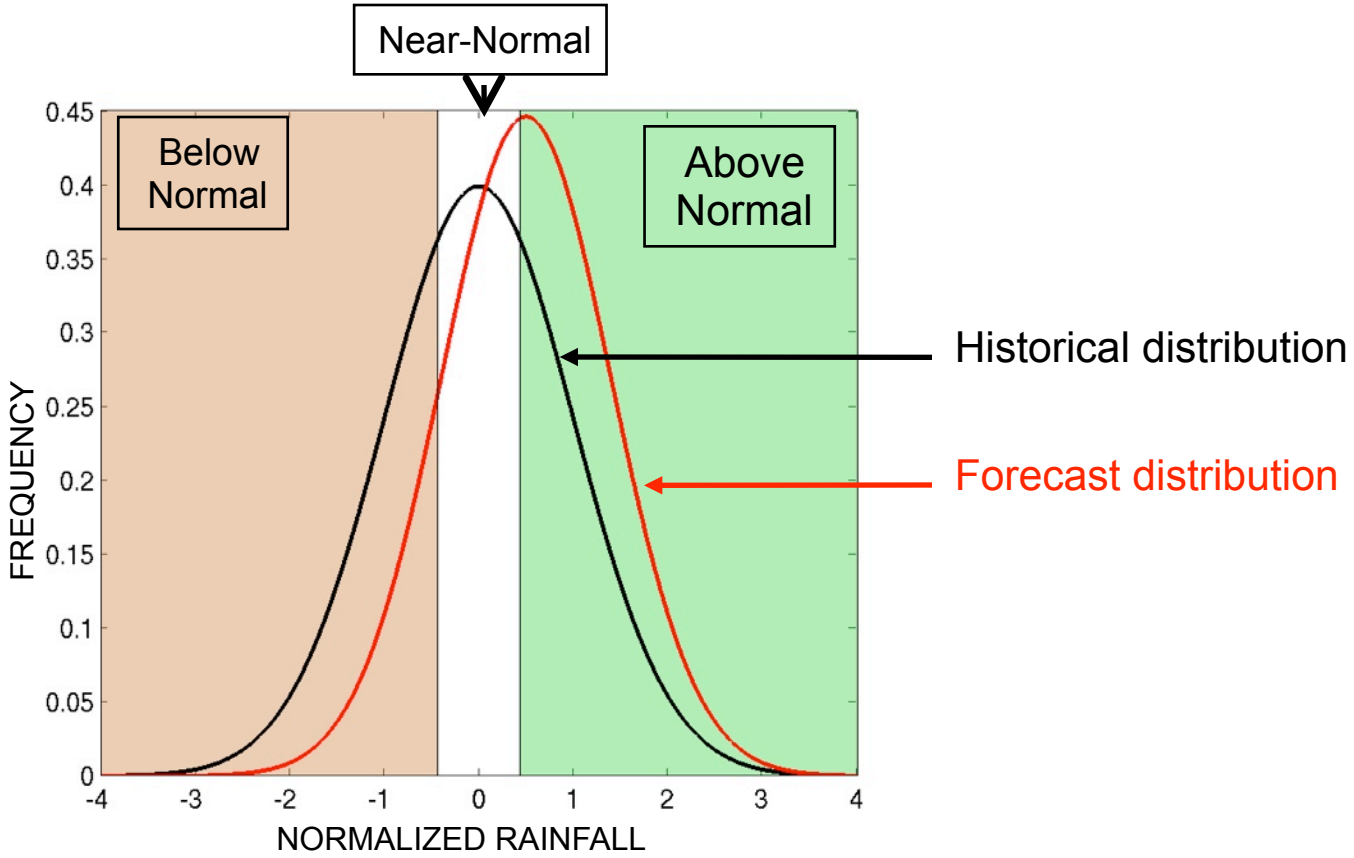
how to make tailored seasonal forecasts?

combining GCM forecasts and observational data



Stephenson et al (2005)

What probabilistic forecasts represent

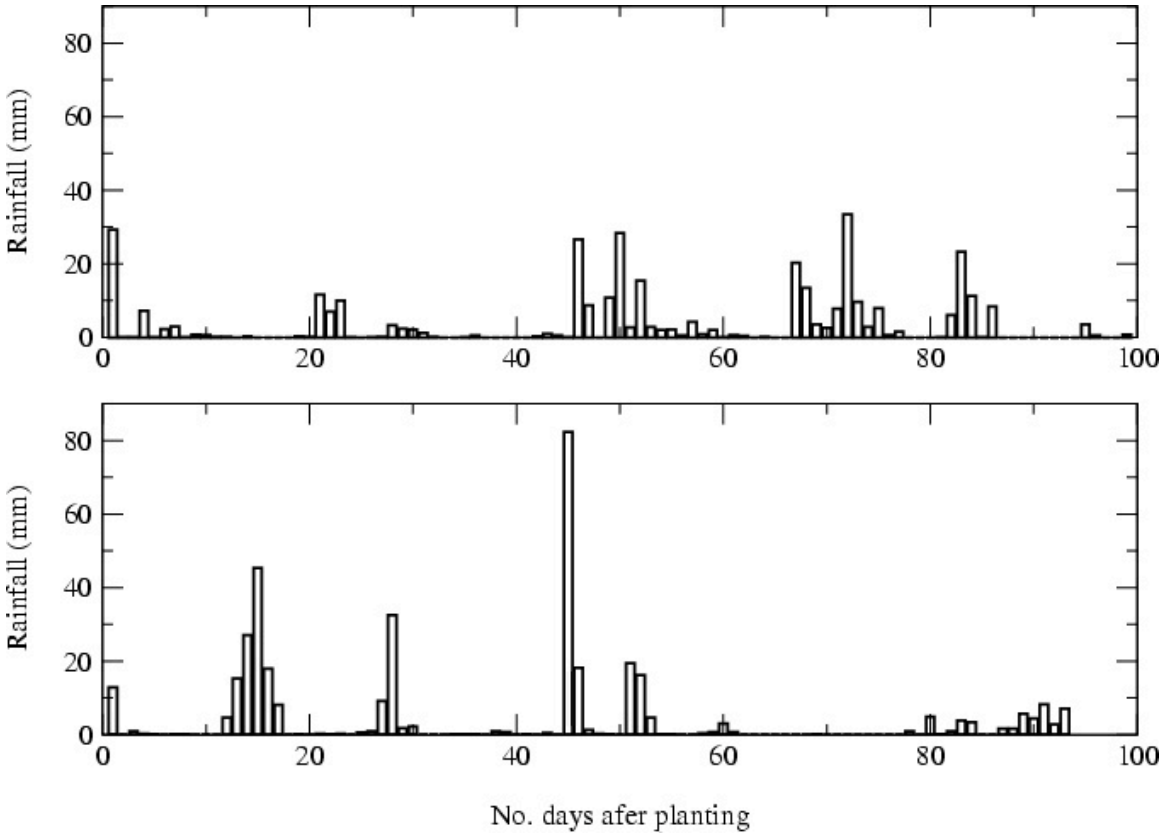


Historically, the probabilities of above and below are 0.33. Shifting the mean by half a standard-deviation and reducing the variance by 20% changes the probability of below to 0.15 and of above to 0.53.

(Courtesy Mike Tippett)

L. Goddard

relevant variables for agriculture?



Gujarat rainfall and groundnut yields

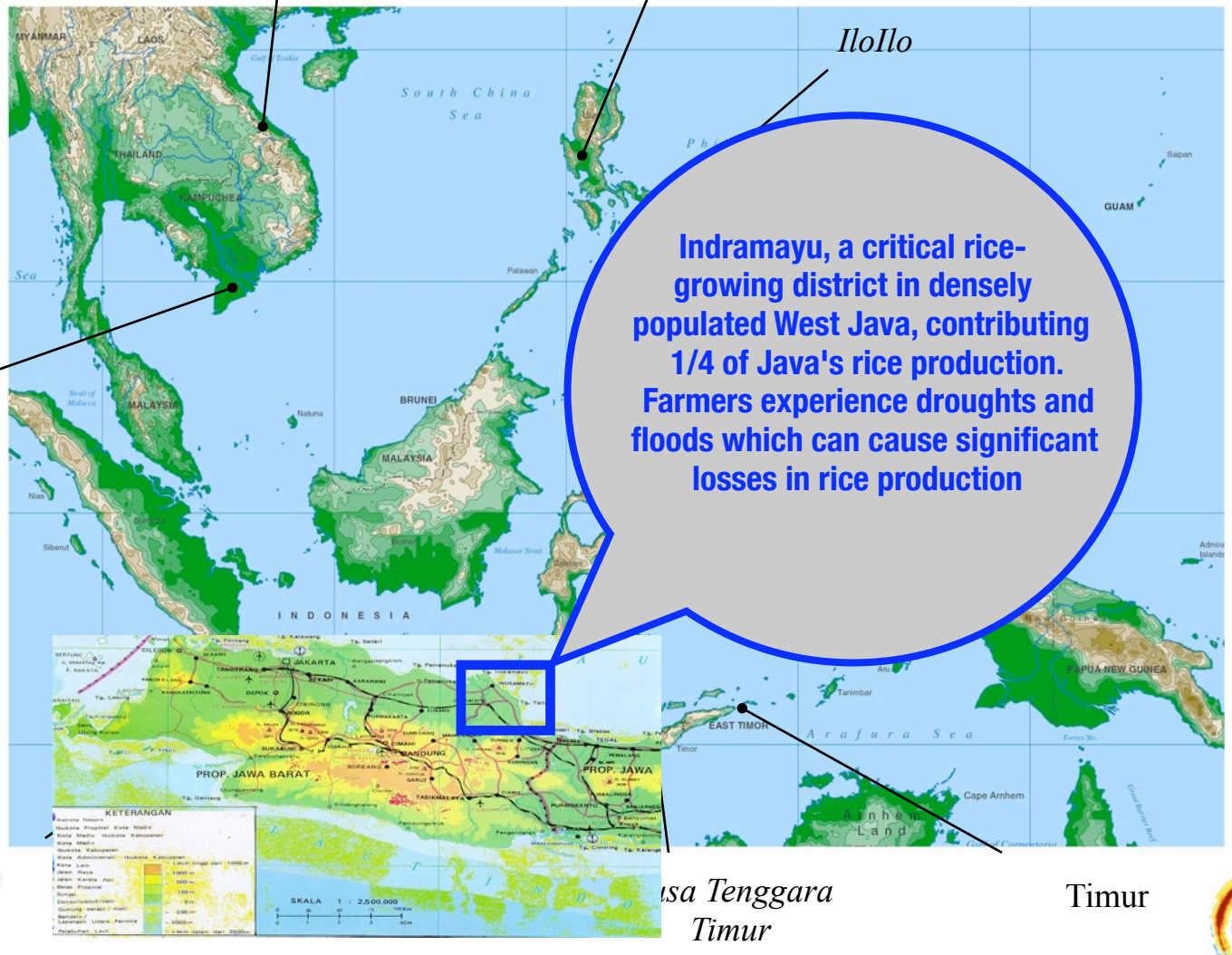
1975
Total rainfall: 394mm
Model: 1059 kg/ha
Obs: 1360 kg/ha

1981
Total rainfall 389mm
Model: 844 kg/ha
Obs: 901 kg/ha

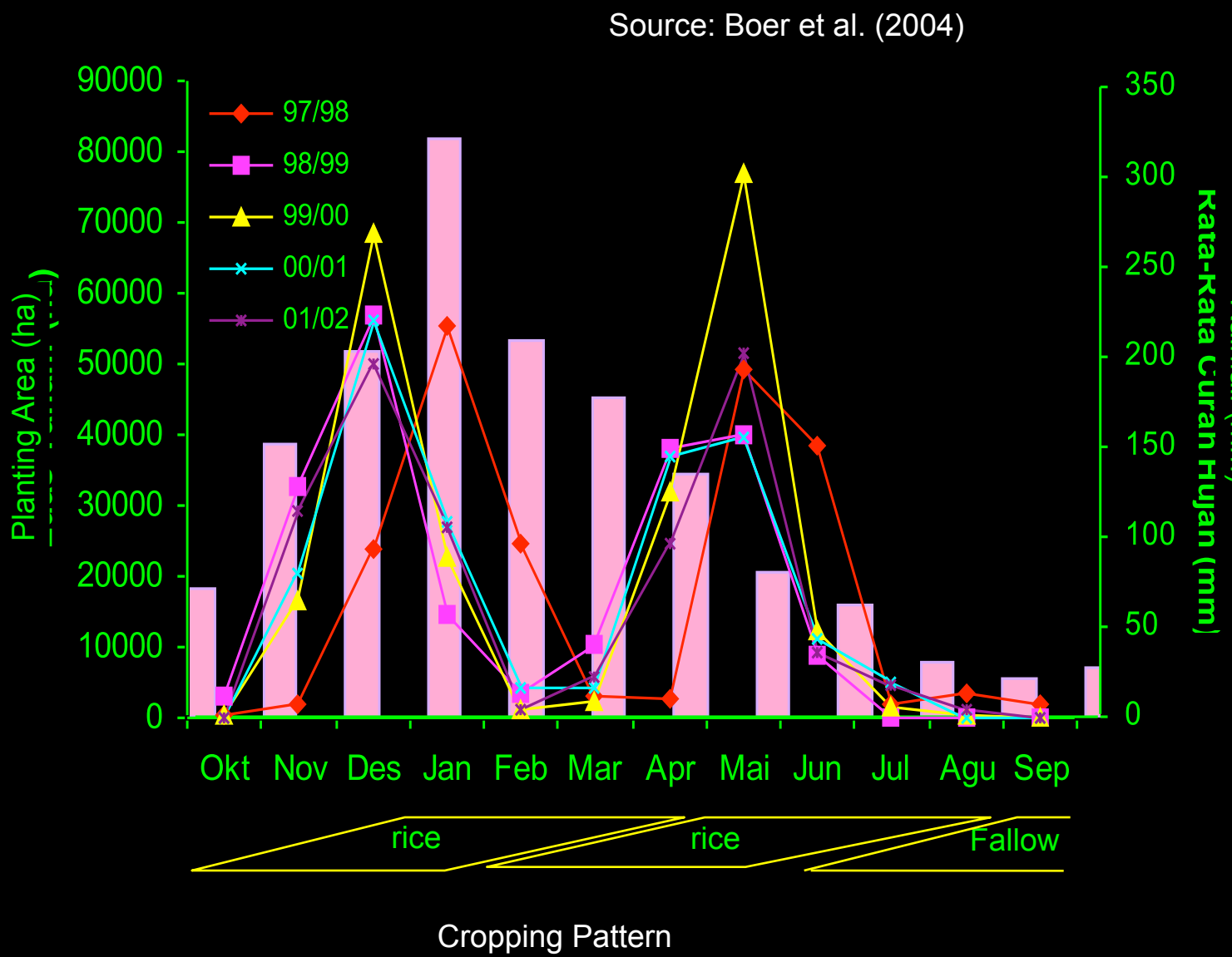
A. Challinor

Climate risk management: Demonstration sites in SE Asia

Diversity of climate hazards + socio-economic systems
Multi-scale partnerships

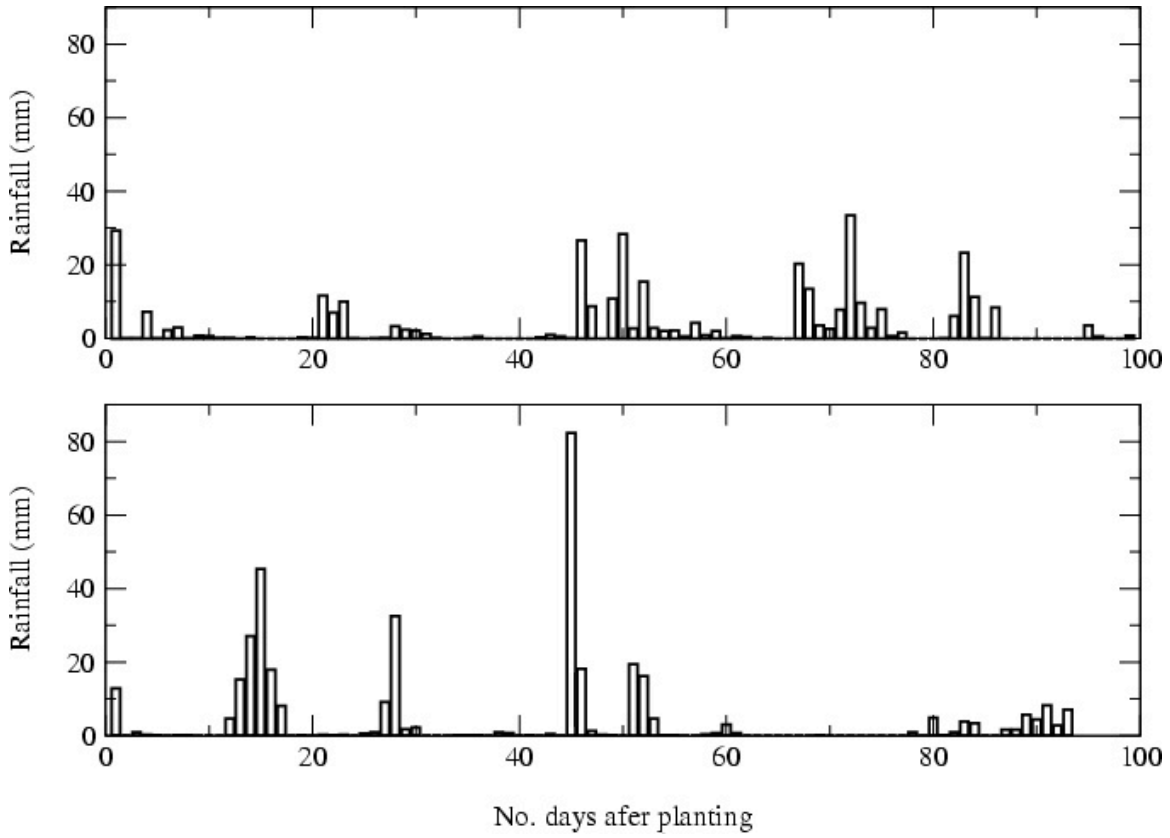


Rice-planting area in Indramayu, Java

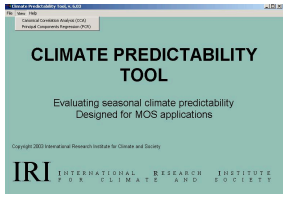


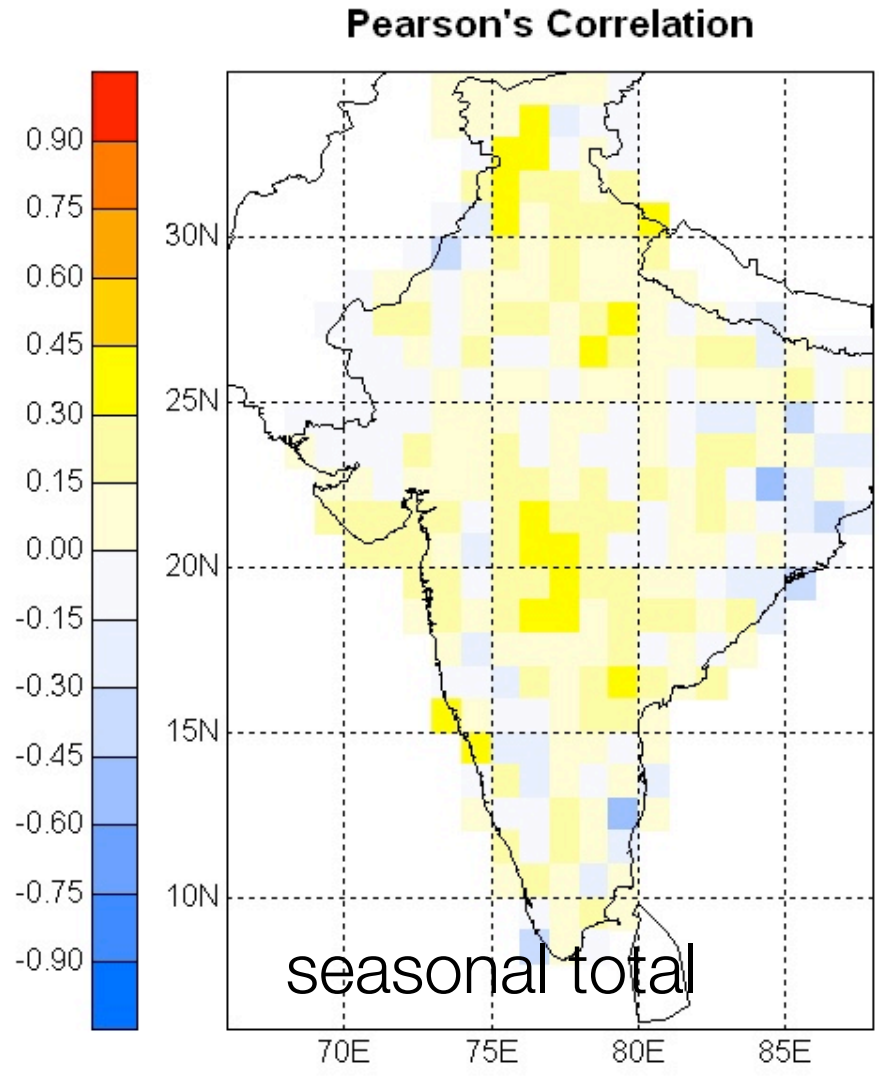
Start of planting changes from time to time, in planting season 97/98, start of planting delayed 1 month due to delay onset of rainfall, increasing drought risk for the second crop, except in La-Nina years

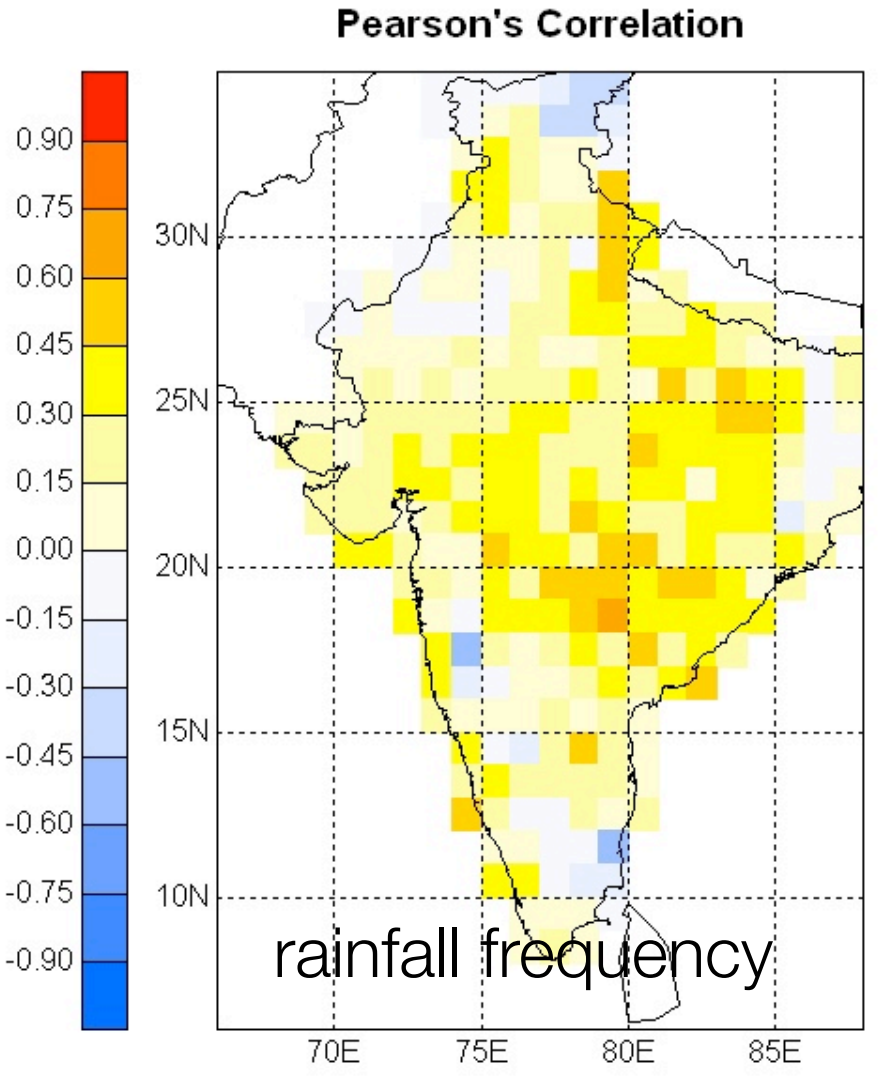
seasonal predictability of rainfall frequency and spells?



JJAS rainfall correlation skill
ECHAM4-CA: made from June 1

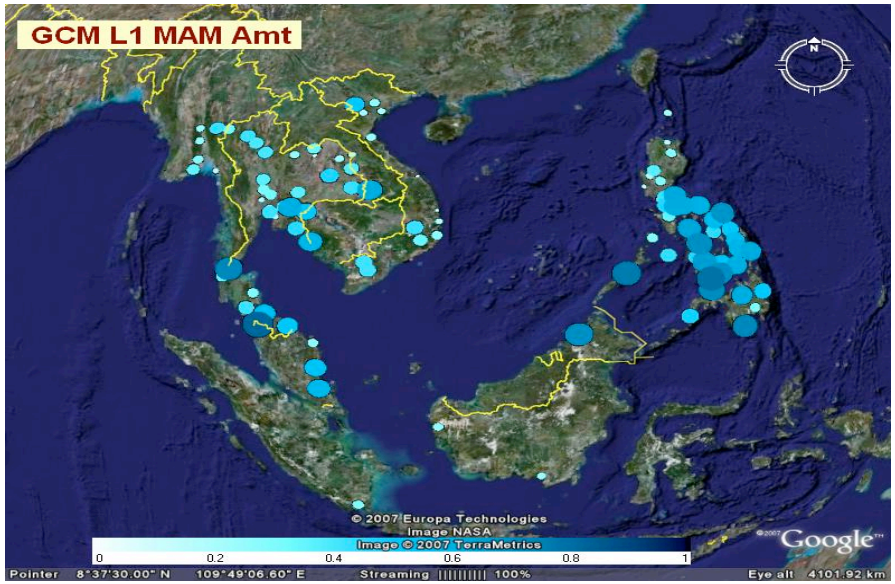




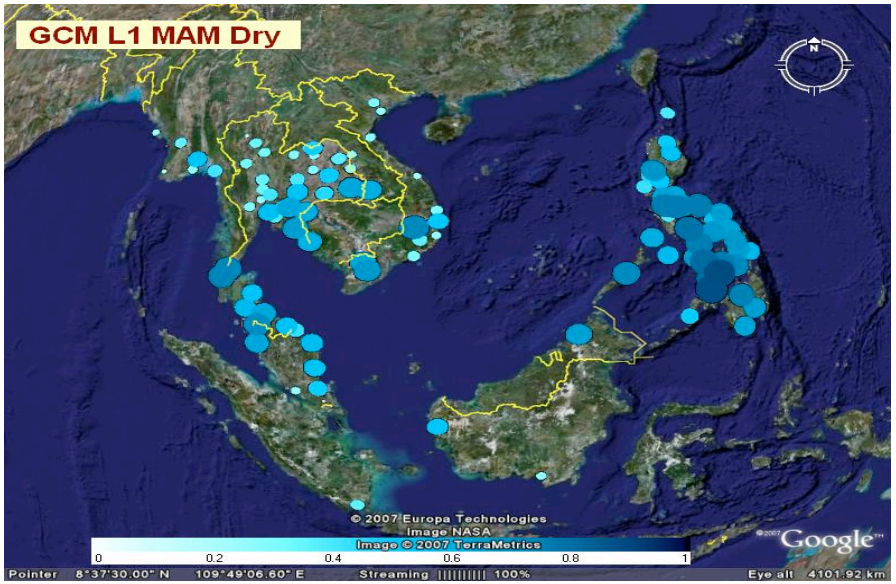


Example from recent ASEAN-IRI training workshop - anomaly correlation skill

seasonal rainfall total

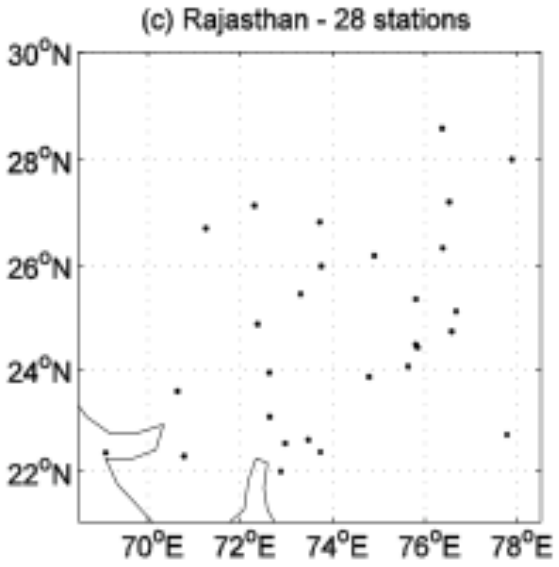


number of dry days per season



MAM rainfall from ECHAM-CA March 1st hindcasts

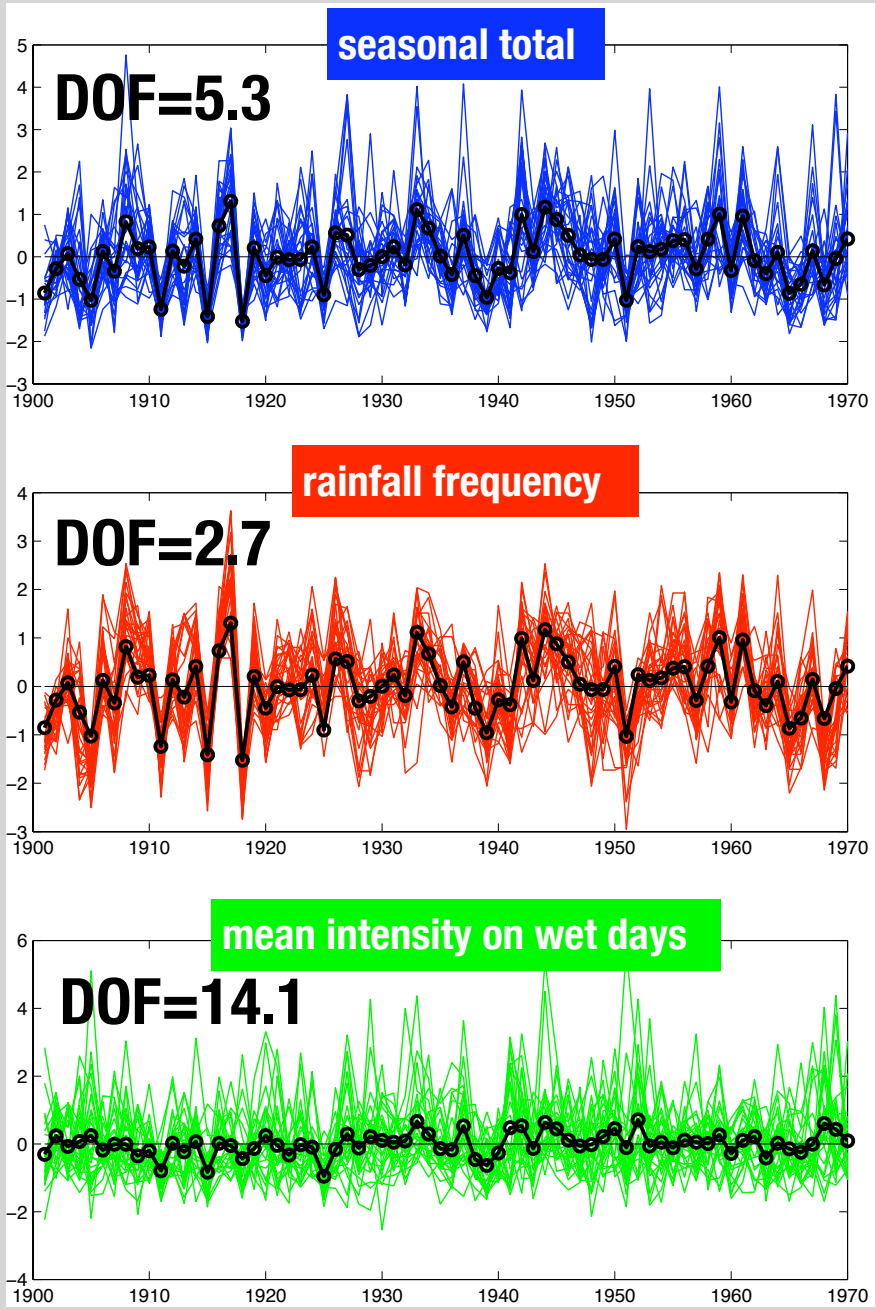
seasonal rainfall anomalies at individual stations



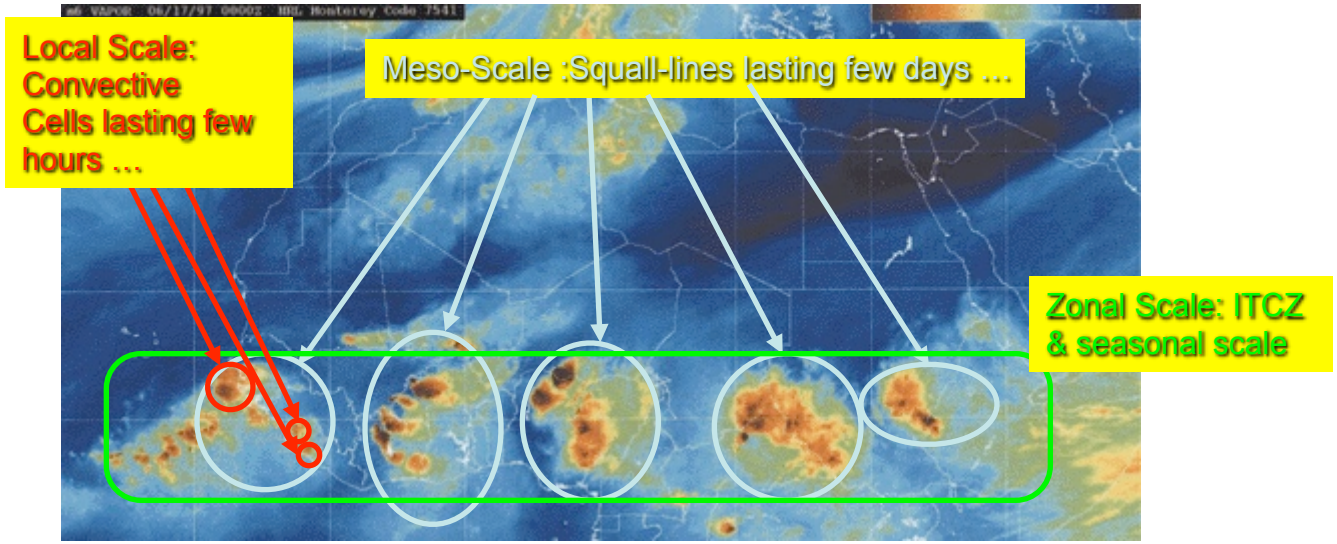
Jun–Sep
1900–70

seas. amount =
(no. of wet days) x (mean intensity on wet days)

Rainfall at individual stations and station-average



why are seasonal anomalies of rainfall frequency more coherent than intensity?



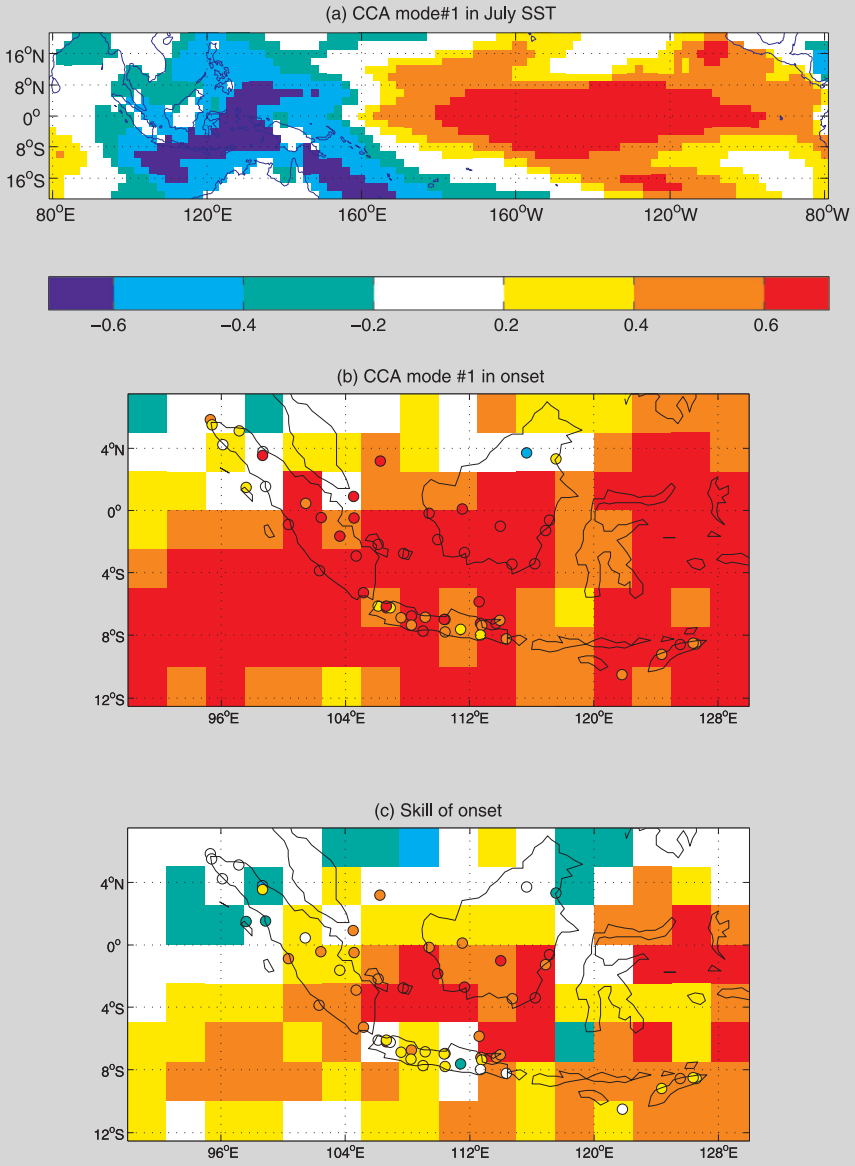
Water vapor image Canal June 17, 1997 at 00h (C.D. Thorncroft)

- intense convection is very fine scale: may hit or miss a raingauge
- organization of rainfall is larger scale
- climate forcings integrate across a season, preferentially acting on occurrence

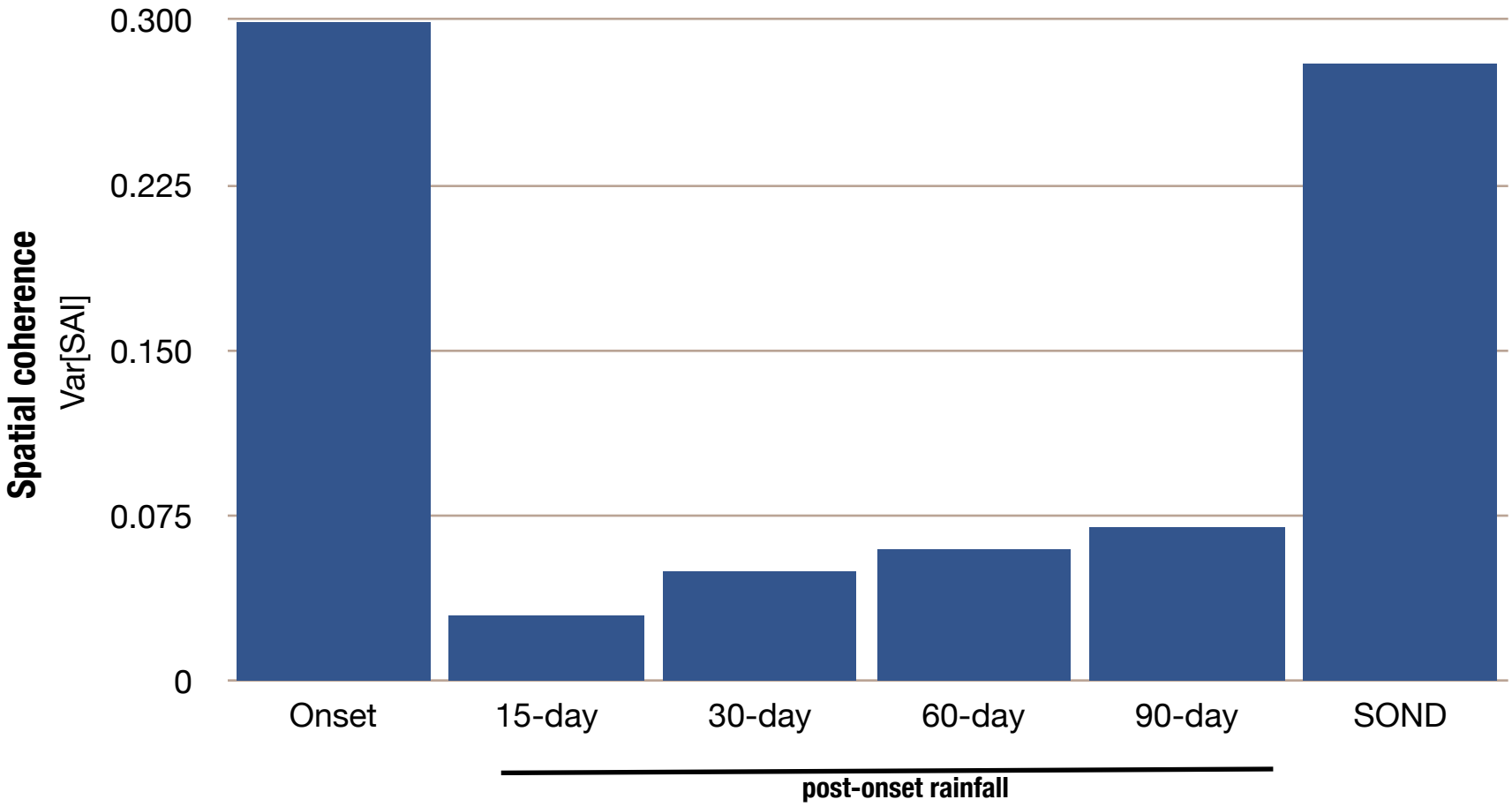
V. Moron

seasonal predictability of monsoon onset date?

prediction skill of Sept–Dec monsoon onset over Indonesia



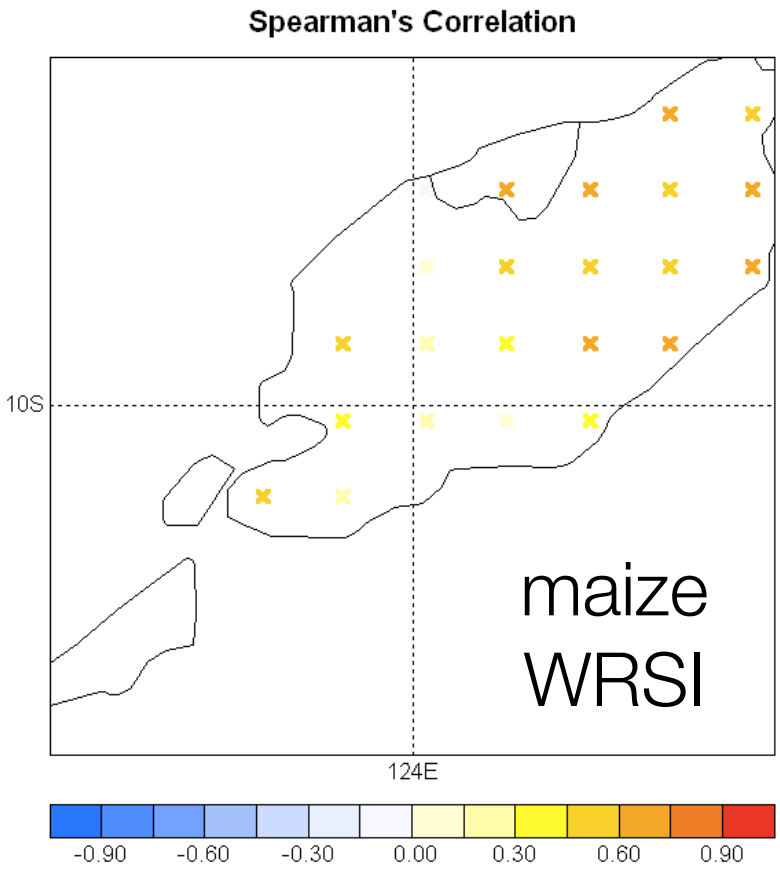
spatial coherence of onset-date & post-onset rainfall over Indonesia as a whole

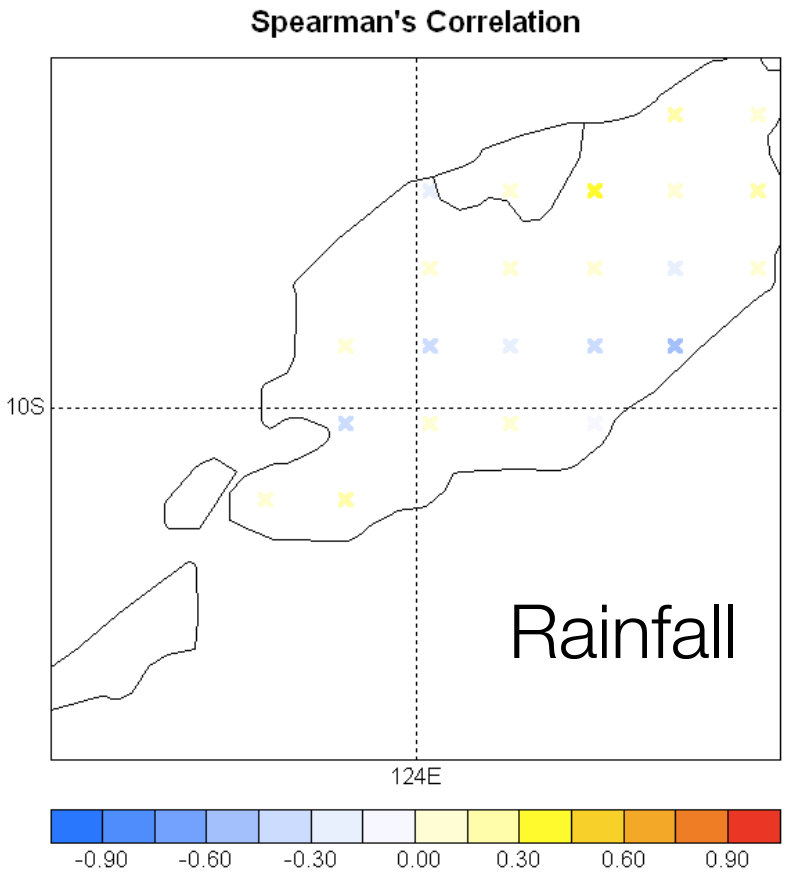


Moron et al. (2008)

skill of statistical downscaling over Indonesia:

water requirement satisfaction index for Maize vs seasonal rainfall total

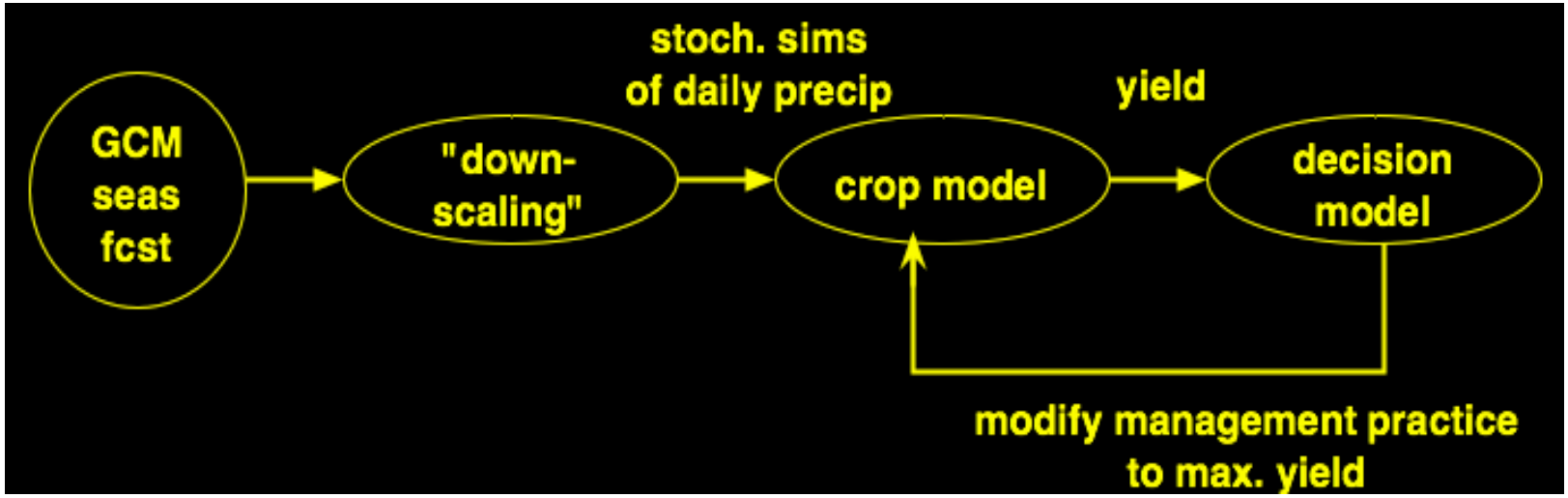




Nov–Feb season hindcasts made from Sept 1 (ECHAM-CA; 1974–02; NNRP-RegCM 25km rainfall)

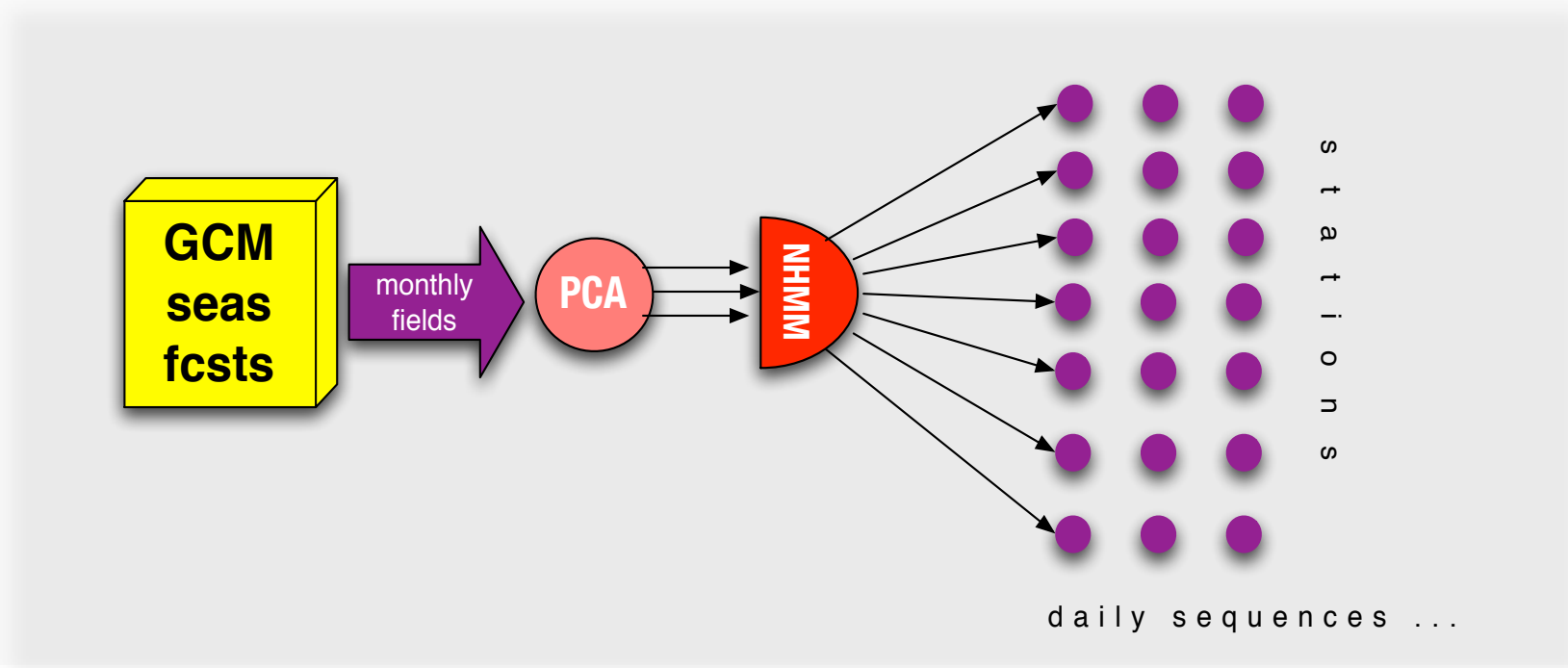
bridging **C**limate into **R**isk **M**anagement

.. crop models need daily time sequences

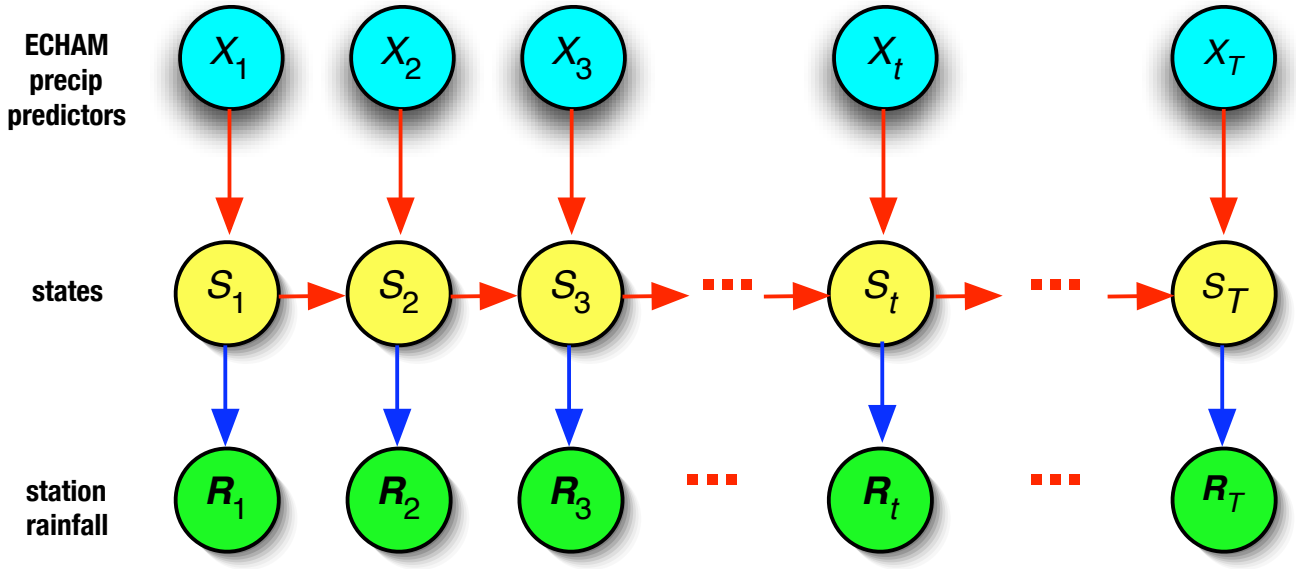


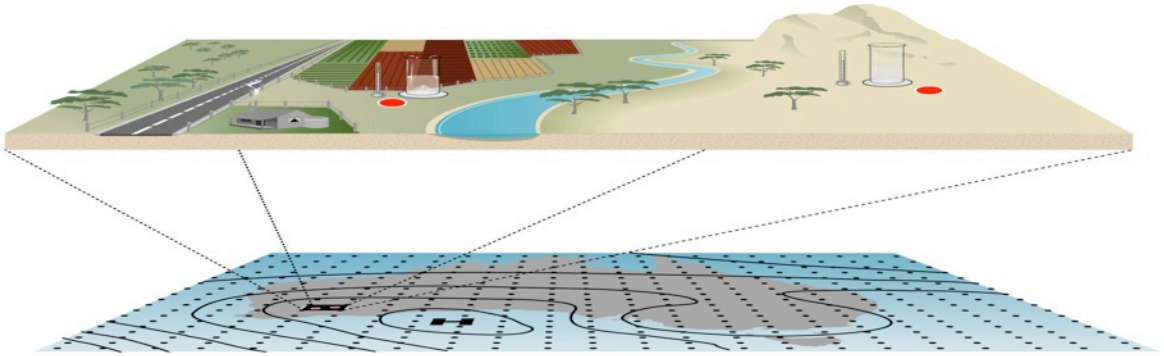
.. as do malaria models and hydrologic models

conditioning stochastic daily weather sequences on seasonal forecasts



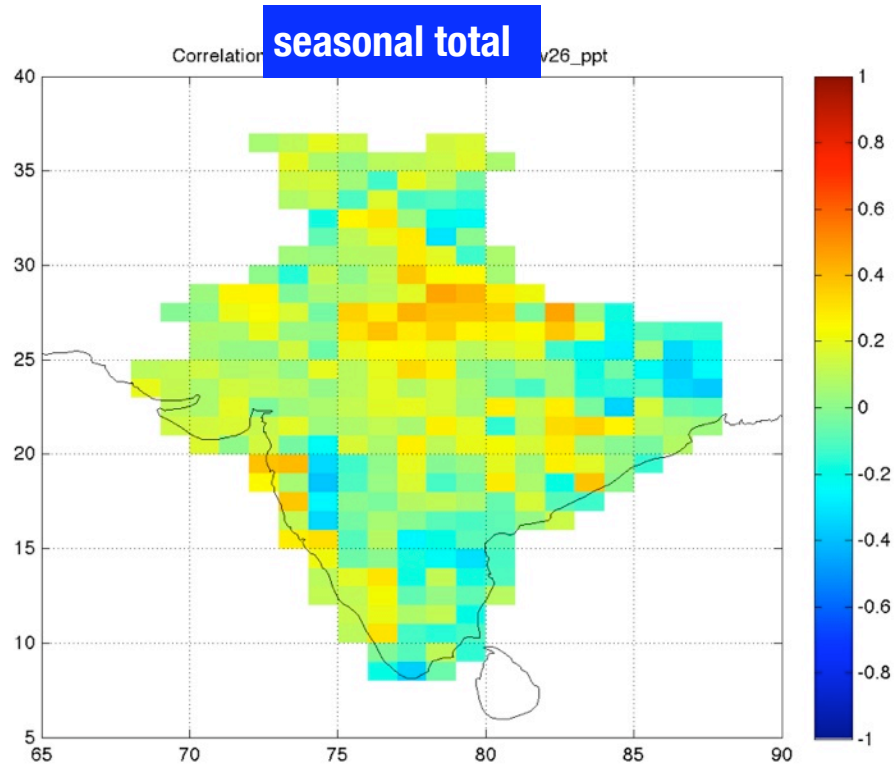
hidden Markov model (HMM)

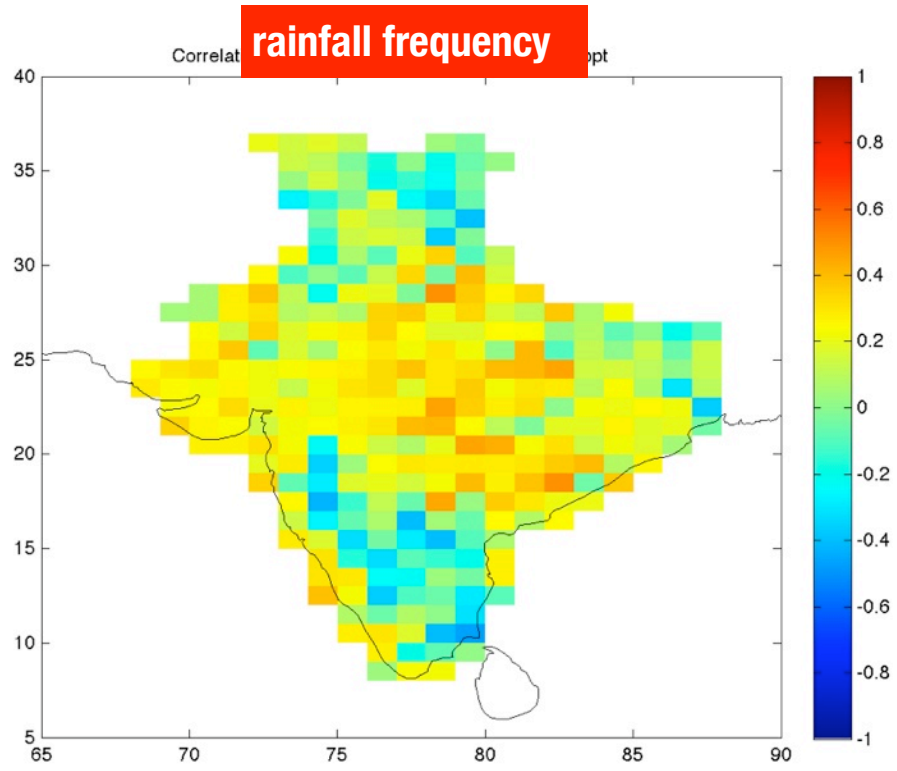




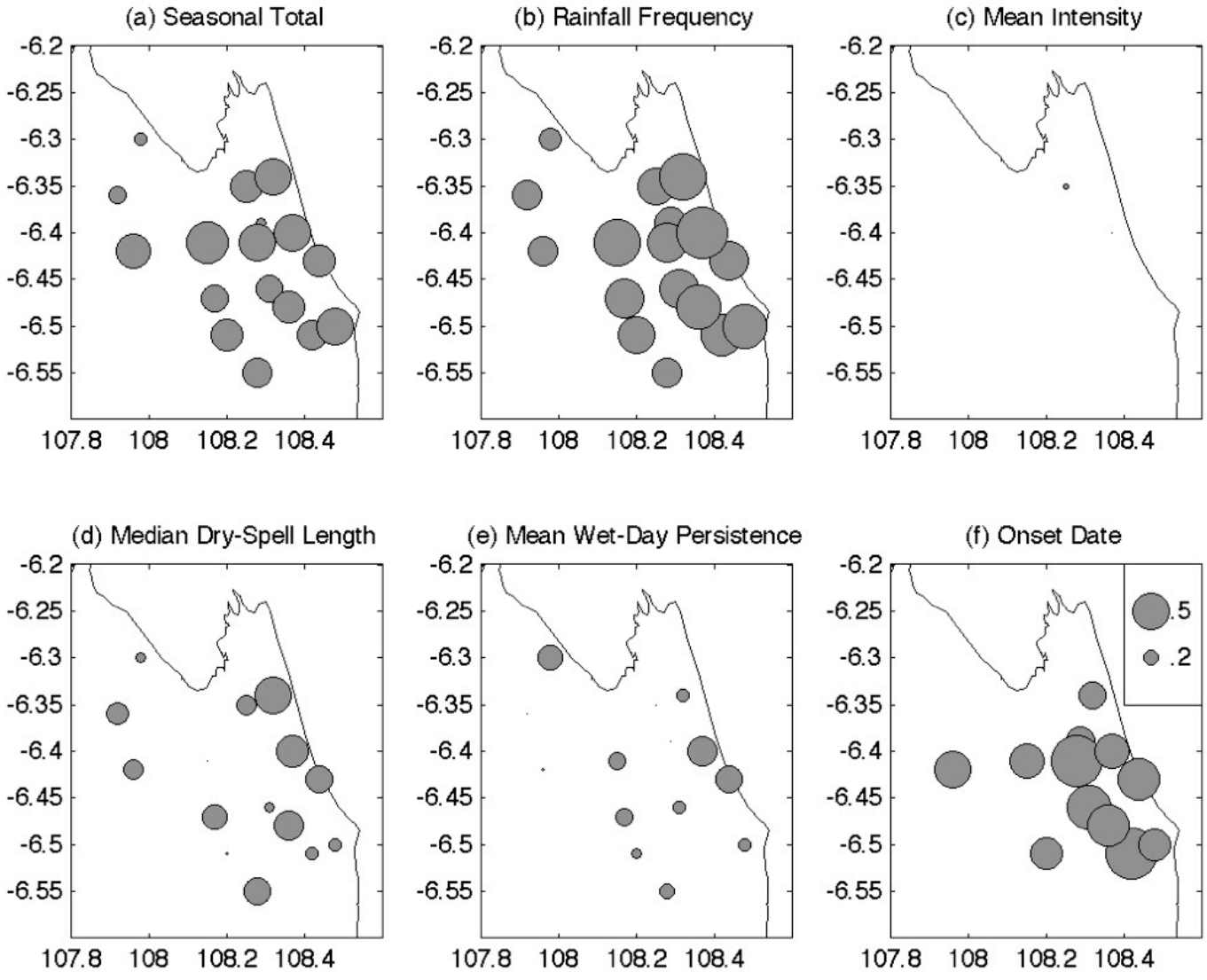
Jun–Sep anomaly correlation skill:

NHMM[ECHAM4 precip (65E-200E, 5N-35N) , IMD]





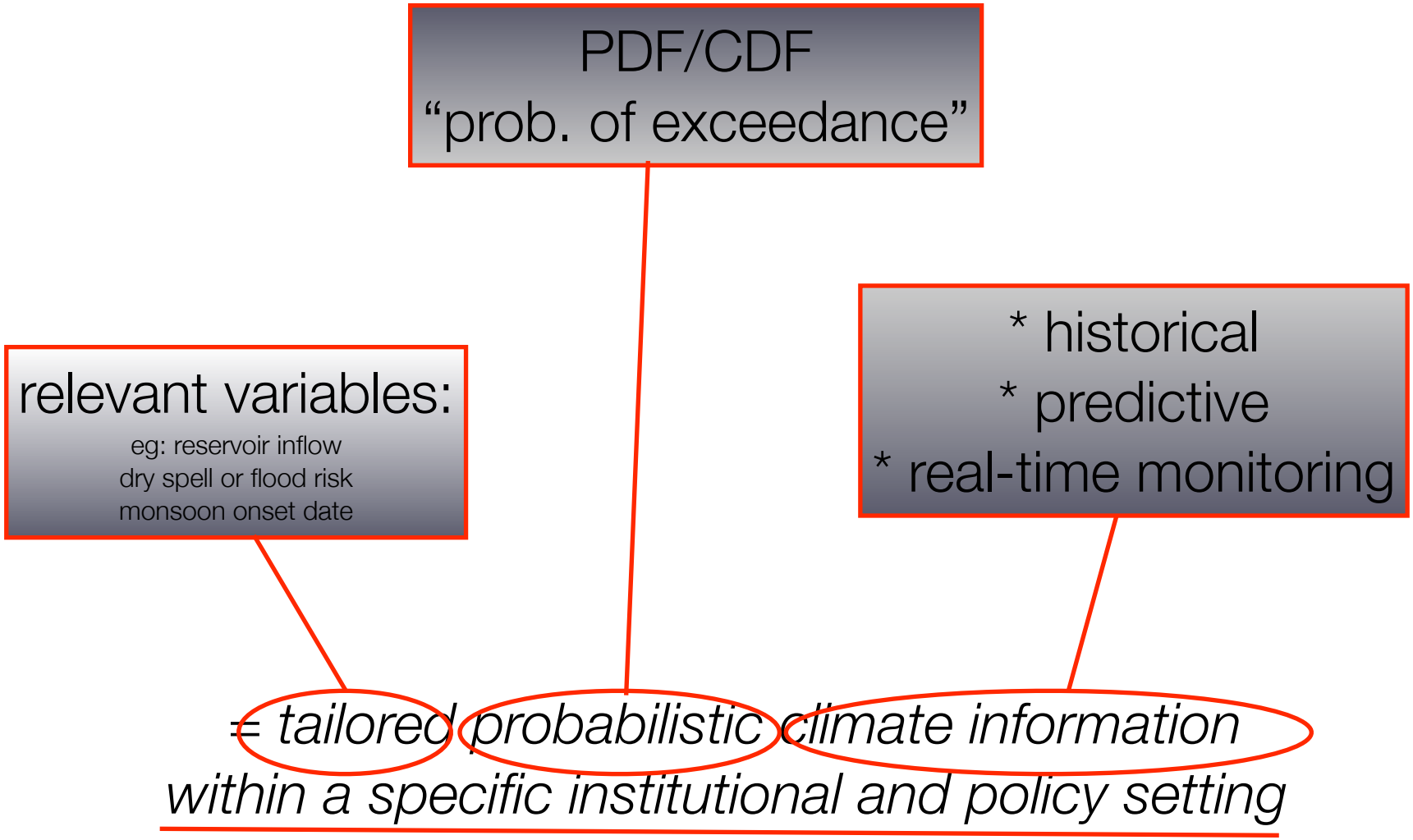
skill of statistical downscaling over Indramayu province, Indonesia



Sep–Dec season hindcasts made from Aug 1 (ECHAM-CA; 1979–02; station rainfall; NHMM)

Robertson et al. (2008)

summary: Climate Risk Management



summary: “tailored” seasonal forecasts

- correction of various biases (aka calibration, fcst assimilation)
- spatial “downscaling” of seasonal averages
  - local stations
  - administrative units, e.g. districts, to match user needs & ag. data
- user-relevant meteorological “events” (eg dry-spell probability)
- coupling to a sectoral (e.g. crop) model using “temporal downscaling”
- probability format: want a “CDF” conditioned reliably on fcst