

Terciles and probabilities in the context of seasonal forecasts

Caio Coelho

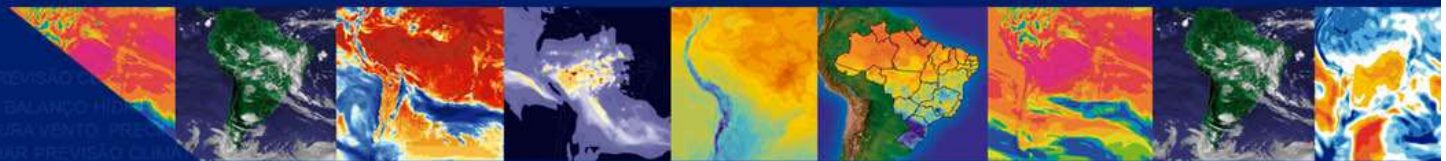
caio.coelho@cptec.inpe.br

CPTEC/INPE

Lecture plan

- 1) Introduction and interpretation of tercile probability rainfall seasonal forecasts
- 2) Brief conceptual review: definition of terciles and tercile categories
- 3) Empirical distribution, probabilities and aim of seasonal climate forecasting
- 4) Final remarks

**Ciência e
Tecnologia
a serviço
da sociedade**



MINISTÉRIO DA CIÊNCIA, TECNOLOGIA E INOVAÇÃO
INSTITUTO NACIONAL DE PESQUISAS ESPACIAIS

MedCOF Training Workshop on Verification of Operational
Seasonal Forecasts in the Mediterranean region. Rome, 15-18 Nov 2016

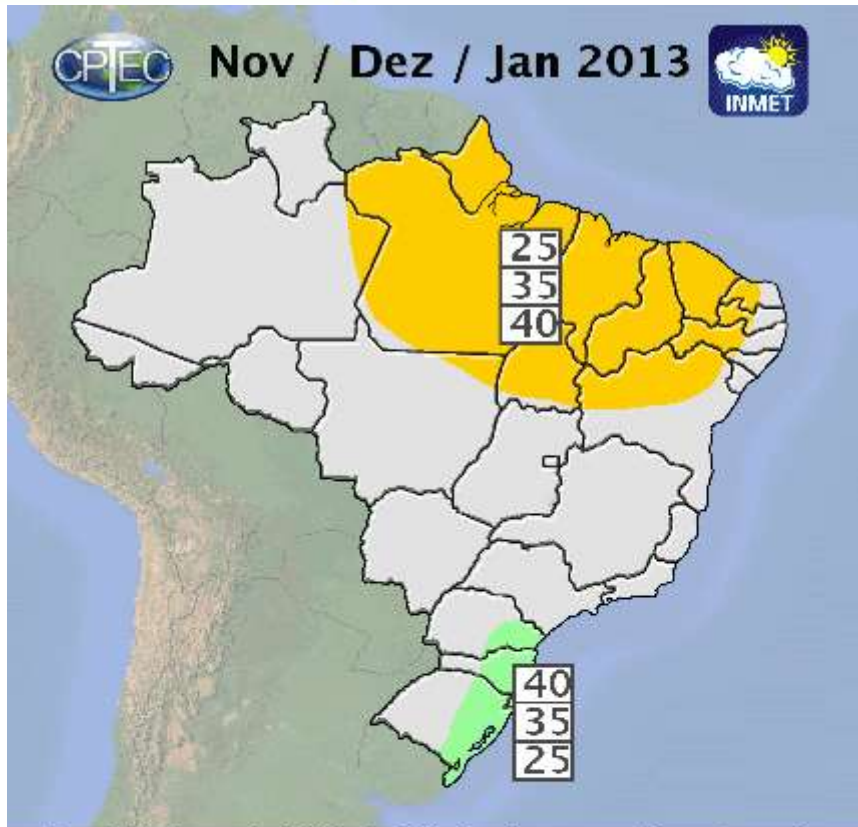
Ministério da
Ciência, Tecnologia
e Inovação





www.cptec.inpe.br

Example of tercile probability rainfall seasonal forecast for Brazil



Previsão de probabilidade (%) de chuva em três categorias
Abaixo da faixa normal Acima da faixa normal



Nota: As cores no mapa ilustram a maior probabilidade prevista nas categorias acima ou abaixo da normal climatológica

- Acima da normal
- Dentro da normal
- Abaixo da normal

ÁREA CINZA: O Prognóstico de Consenso indica comportamento climatológico (igual probabilidade para as três categorias)

- **Forecast probabilities** for the tercile categories (above normal, near normal and below normal) generally attributed subjectively through consensus agreement among climate experts
- This workshop is about **verification** of these **categorical forecasts** – (i.e. forecast goodness – particularly quality, not forecast production)

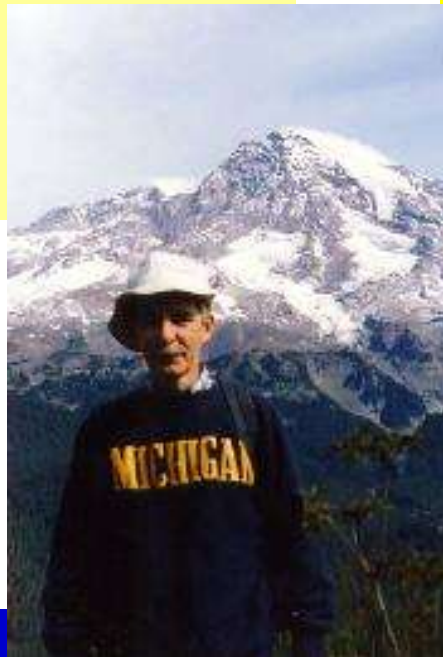
Some relevant questions:

- What do these forecasts mean?
- What are terciles?
- How are tercile categories defined?

What is a good forecast?

Good forecasts have:

- QUALITY
- VALUE/UTILITY
- CONSISTENCY



Attributes of quality:

- Reliability
- Resolution
- Accuracy
- Association

...

→ No single score can be used to summarize a set of forecasts.

A. H. Murphy 1993

“What is a good forecast ?

An essay on the nature of goodness in weather forecasting”

Weather and Forecasting, 8, 281-293.



Some definitions

- **Quality:** Measure of the association, though some form of mathematical relationship, between forecasts and the corresponding observations
- **Value:** Measure of benefit achieved (or loss incurred) through the use of forecasts
- **Consistency:** Correspondence between a forecast and the forecasters belief. If a forecast is consistent, it communicates what the forecaster thinks will happen, and will correctly indicate their level of uncertainty

Based on: Guidance on Verification of Operational Seasonal Climate Forecasts
By Simon J. Mason (IRI), prepared under the auspices of the World Meteorological Organization (WMO), Commission for Climatology XIV, Expert Team on CLIPS Operations, Verification and Application Service

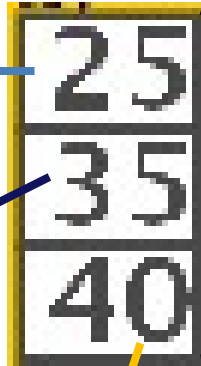


www.cptec.inpe.br

What do these forecasts mean?

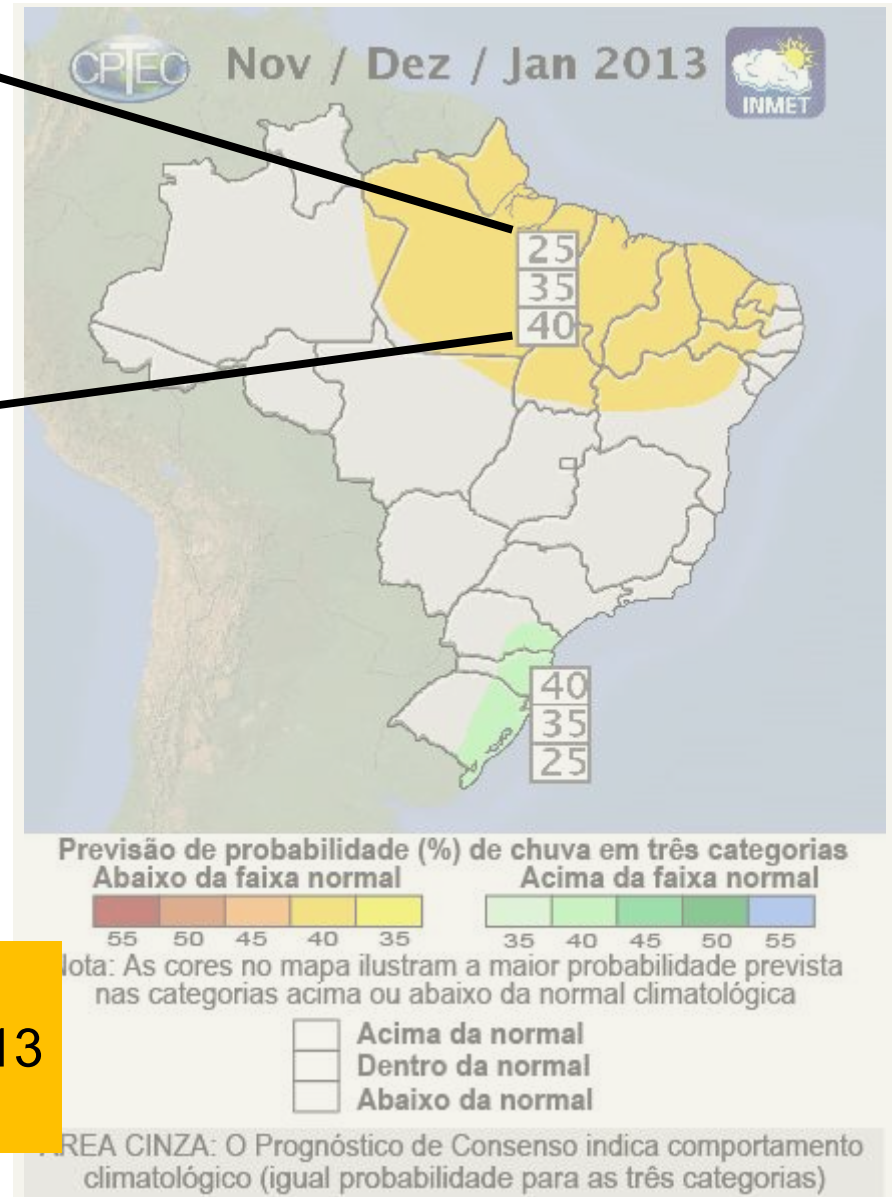
Interpretation of tercile probability seasonal forecasts

25% chance (probability) for occurrence of excess rainfall during the NDJ 2012/2013 season



35% chance (probability) for occurrence of rainfall within a pattern considered normal during the NDJ 2012/2013 season

40% chance (probability) for occurrence of deficit rainfall during the NDJ 2012/2013 season





www.cptec.inpe.br

How to identify excess and deficit rainfall?

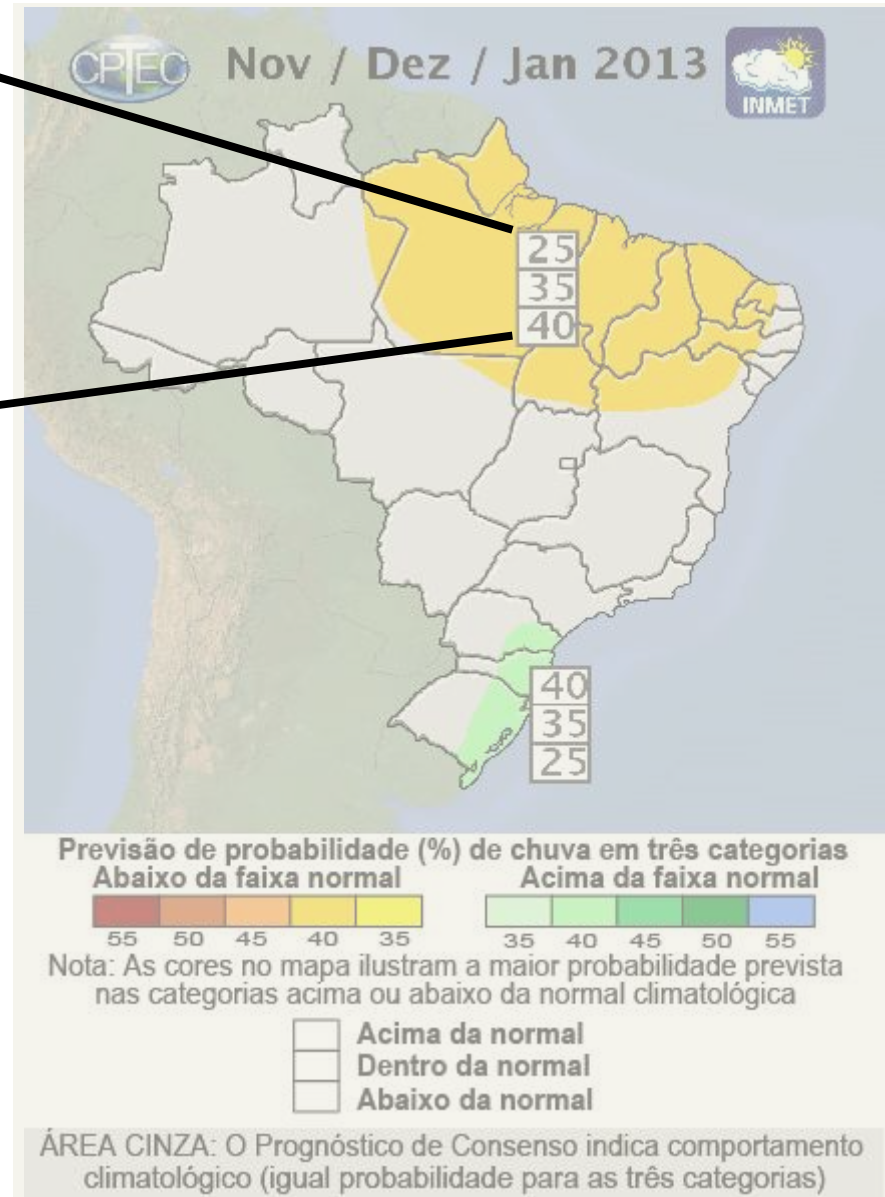
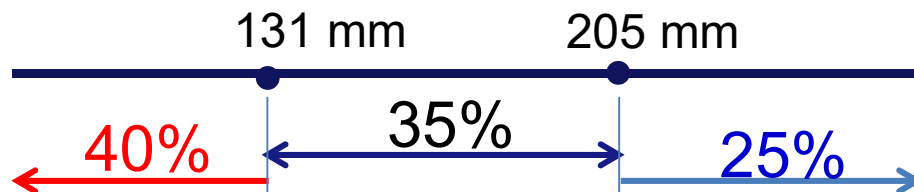
Example for a particular location within the orange area

Excess limit: 205 mm
[25% chance (probability) that rainfall occurrence will be larger than 205 mm]

Deficit limit: 131 mm
[40% chance (probability) that rainfall occurrence will be less than 131 mm]

35% chance (probability) that rainfall occurrence will be bwt 131 and 205 mm

Historical mean: 186 mm





www.cptec.inpe.br

Brief conceptual review

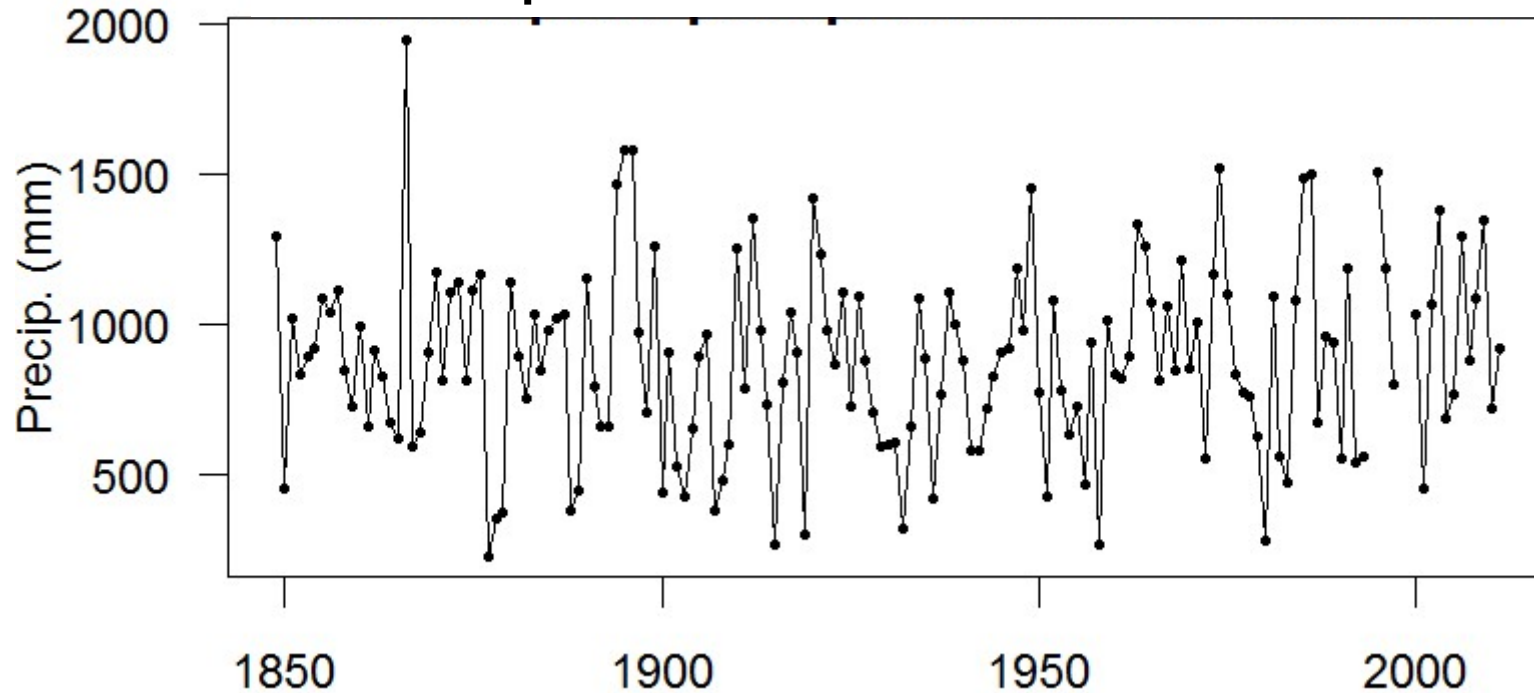
- **Definition of terciles**
- **Finding tercile values (i.e. excess and deficit limits)**
- **Definition of tercile categories**



www.cptec.inpe.br

Fortaleza MAM historical precipitation record

Precipitation time series: MAM 1849-2011



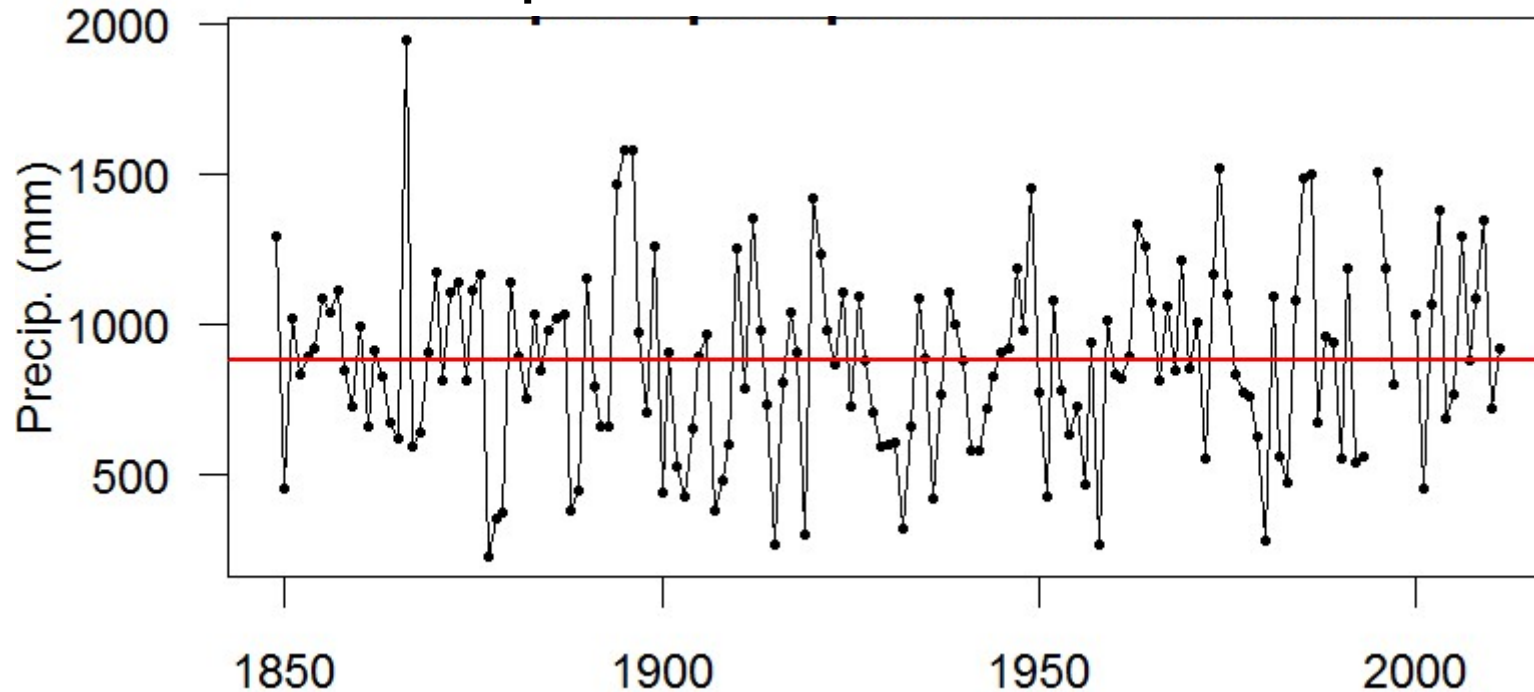
n = 160 years of observed data in Fortaleza



www.cptec.inpe.br

Fortaleza MAM historical precipitation record

Precipitation time series: MAM 1849-2011



$n = 160$

Mean:

$$\bar{y} = \frac{1}{n} \sum_{i=1}^n y_i = 880 \text{ mm}$$

Standard deviation:

$$s_y = \sqrt{\frac{1}{n} \sum_{i=1}^n (y_i - \bar{y})^2} = 311.9 \text{ mm}$$



Definition of terciles

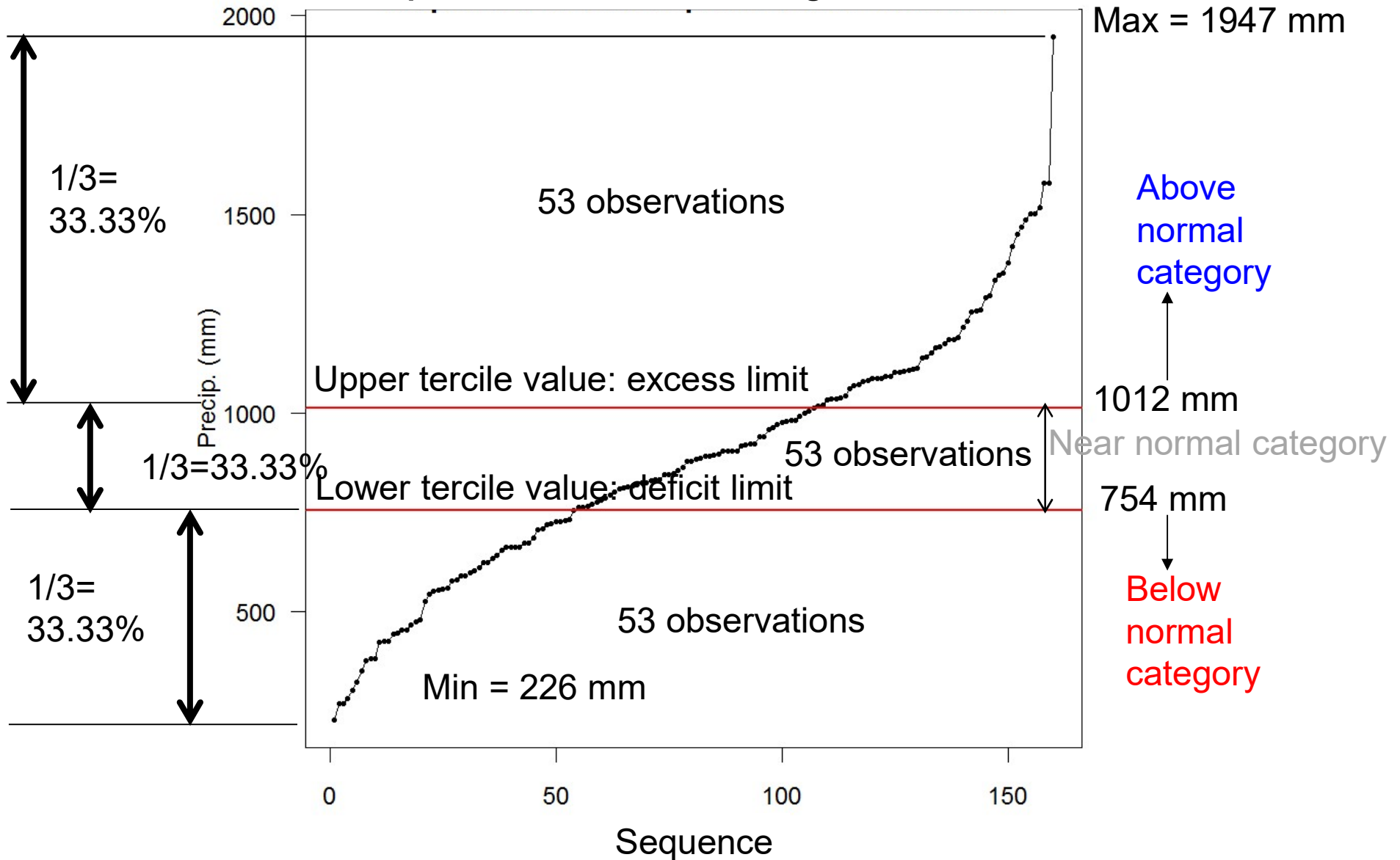
- **Terciles are the 2 values** that divide the historical time series record in three parts leaving $1/3$ of the values below **the so-called lower tercile value**, $1/3$ of the values above **the so-called upper tercile value** and $1/3$ of the values between the lower and upper tercile values



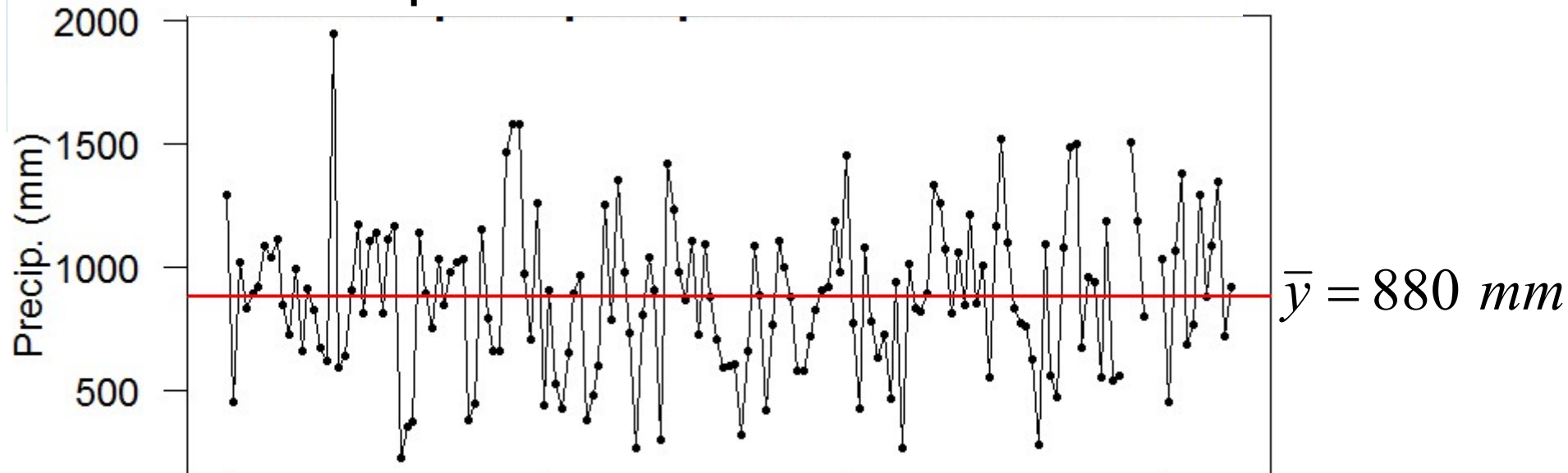
www.cptec.inpe.br

Finding tercile values and defining tercile categories

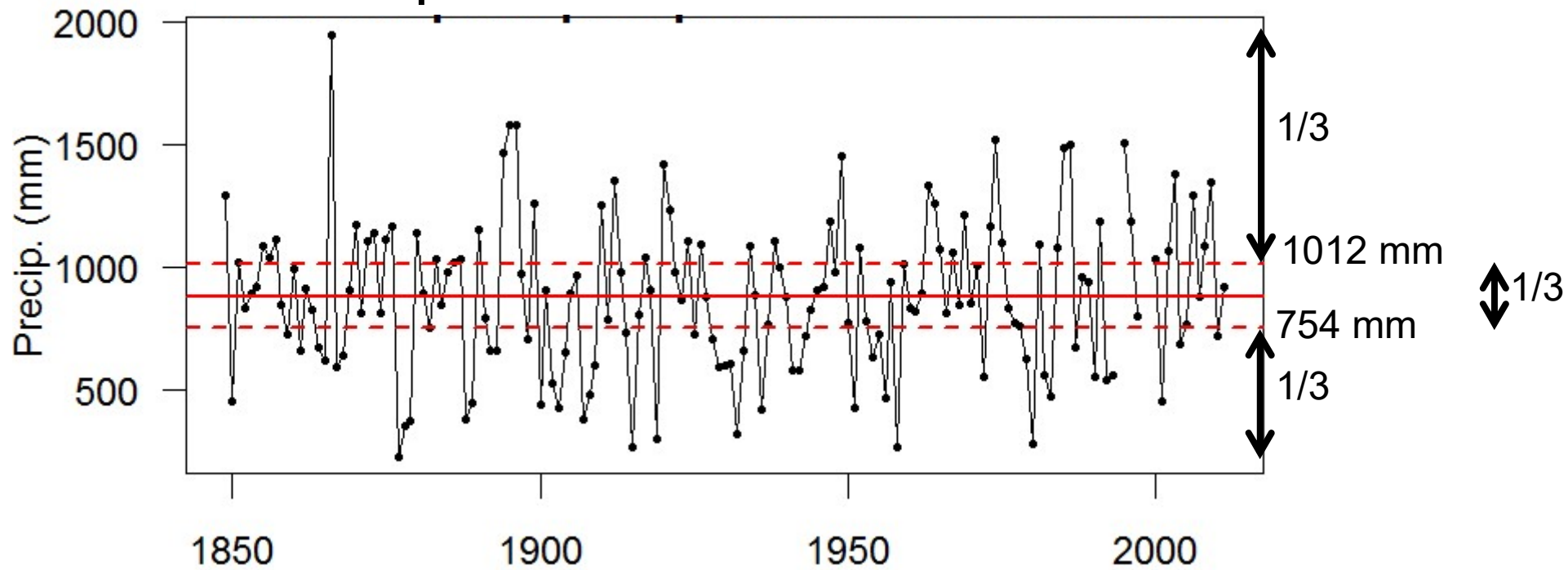
Sequence from smallest to largest obs value



Precipitation time series: MAM 1849-2011



Precipitation time series: MAM 1849-2011

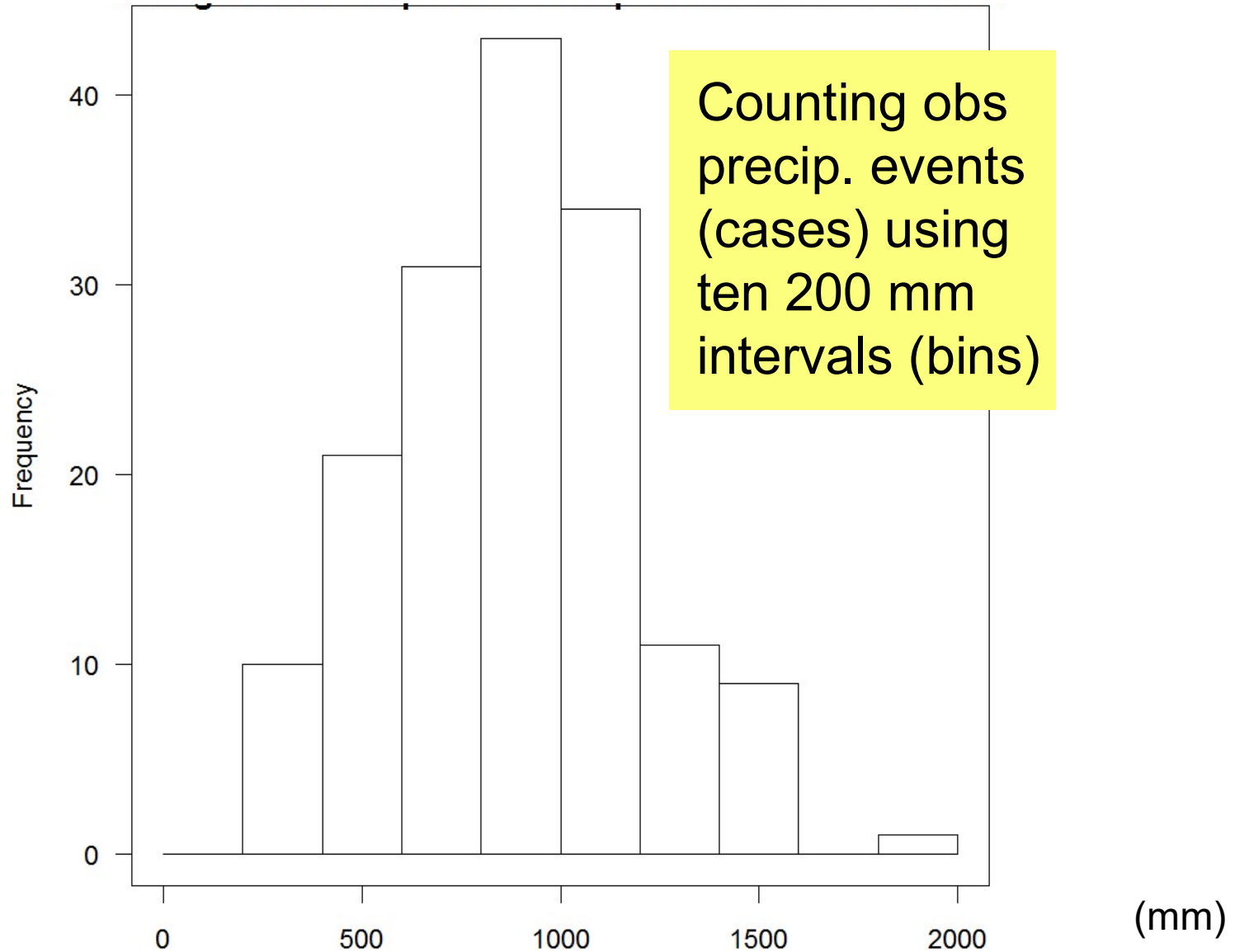




www.cptec.inpe.br

Empirical historical distribution

Frequency histogram: Precipitation MAM 1849-2011

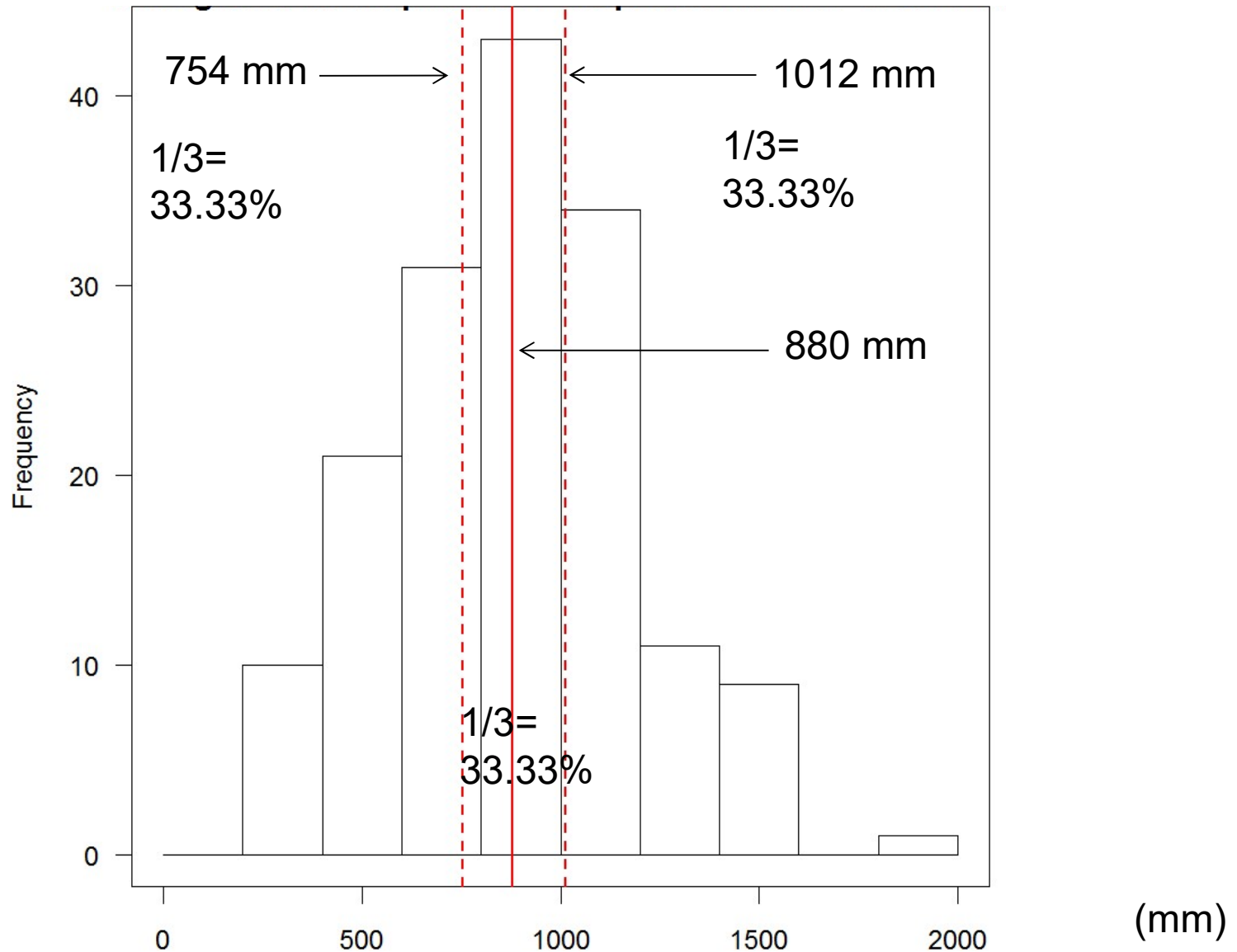




www.cptec.inpe.br

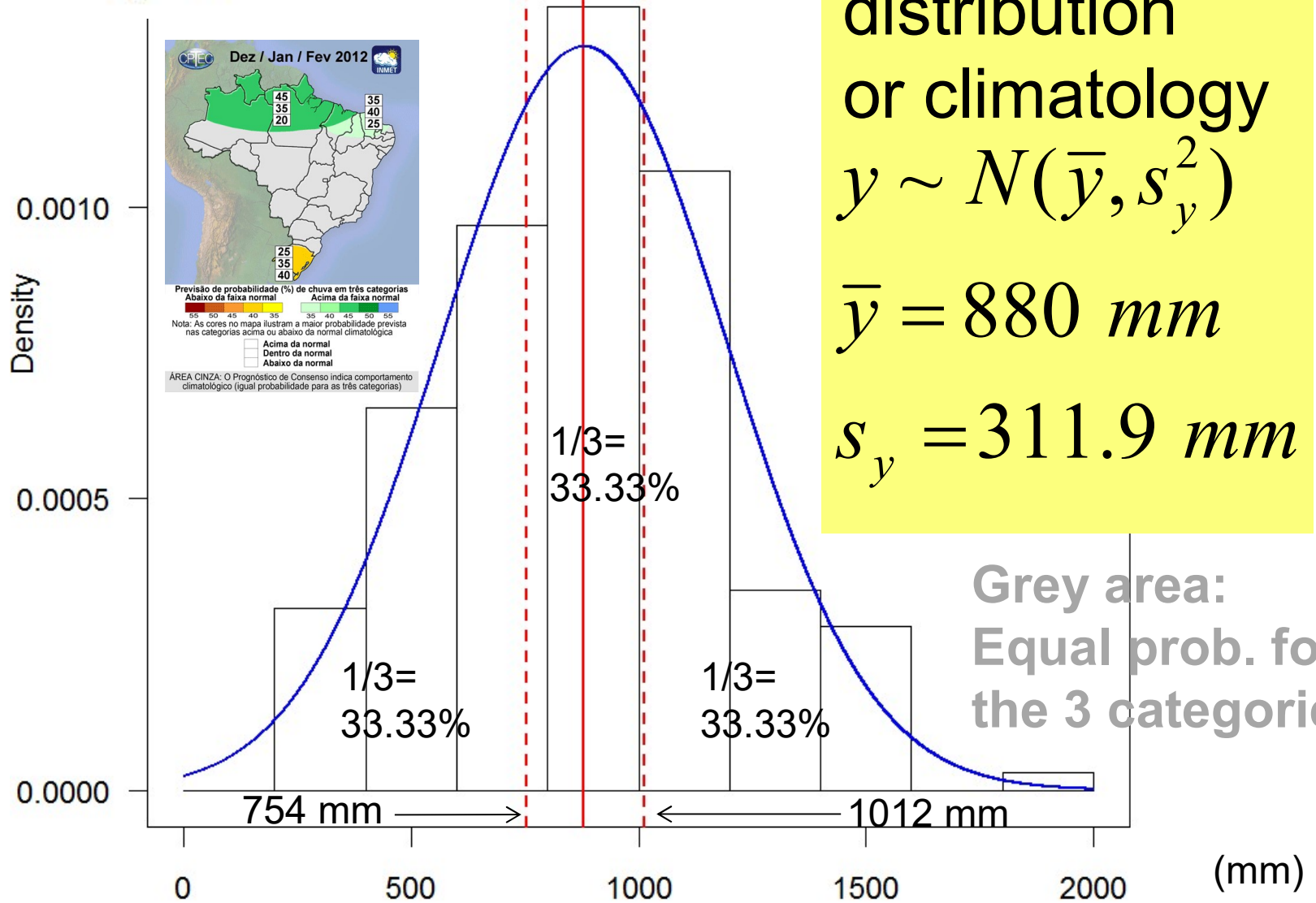
Empirical historical distribution

Frequency histogram: Precipitation MAM 1849-2011



Density histogram: Precipitation MAM 1849-2011

$$f(x) = \frac{1}{\sqrt{2\pi\sigma^2}} e^{-\frac{(x-\mu)^2}{2\sigma^2}}$$





Historically (i.e. from the climatological distribution of available observed data values) we have:

- 33% chance (probability) for rainfall to be below 754 mm
- 33% chance (probability) for rainfall to be above 1012 mm
- 33% chance (probability) for rainfall to be between 754 mm and 1012 mm



Aim of seasonal climate forecasting

www.cptec.inpe.br

- Signalize shifts (to the right or left) on the climatological distribution
- Indicate the degree of uncertainty associated to the forecast distribution (width/spread)

Need to determine two parameters:

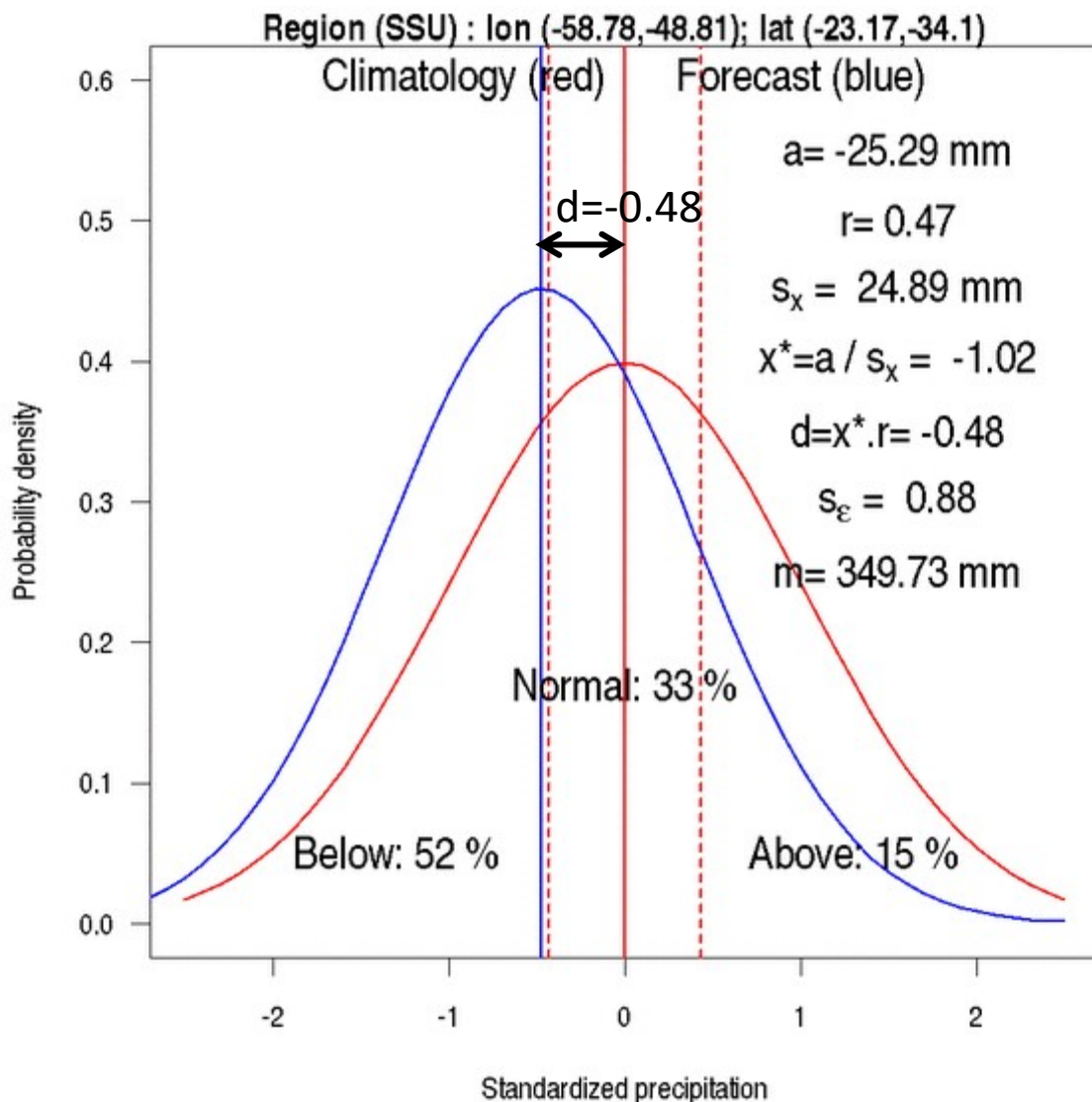
Displacement: Predicted signal (e.g. forecast anomaly)

Width of forecast distribution (uncert.): Function of historical (retrospective) forecast skill produced for past years (e.g. correlation between past forecasts and past observations)

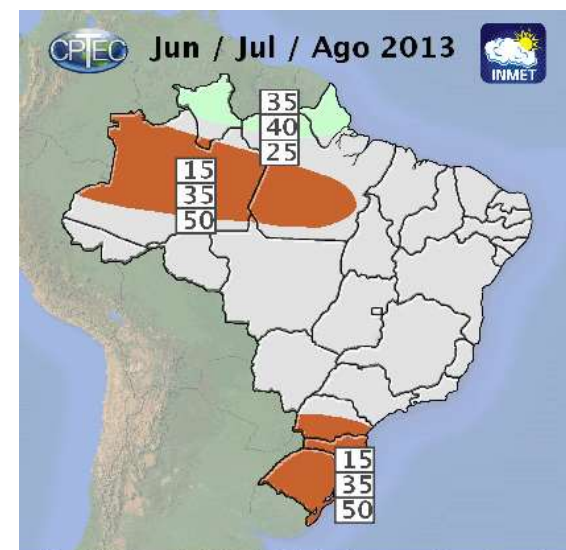


www.cptec.inpe.br

Example of tercile probability rainfall seasonal forecast for South Brazil



Forecast for South Brazil: JJA 2013



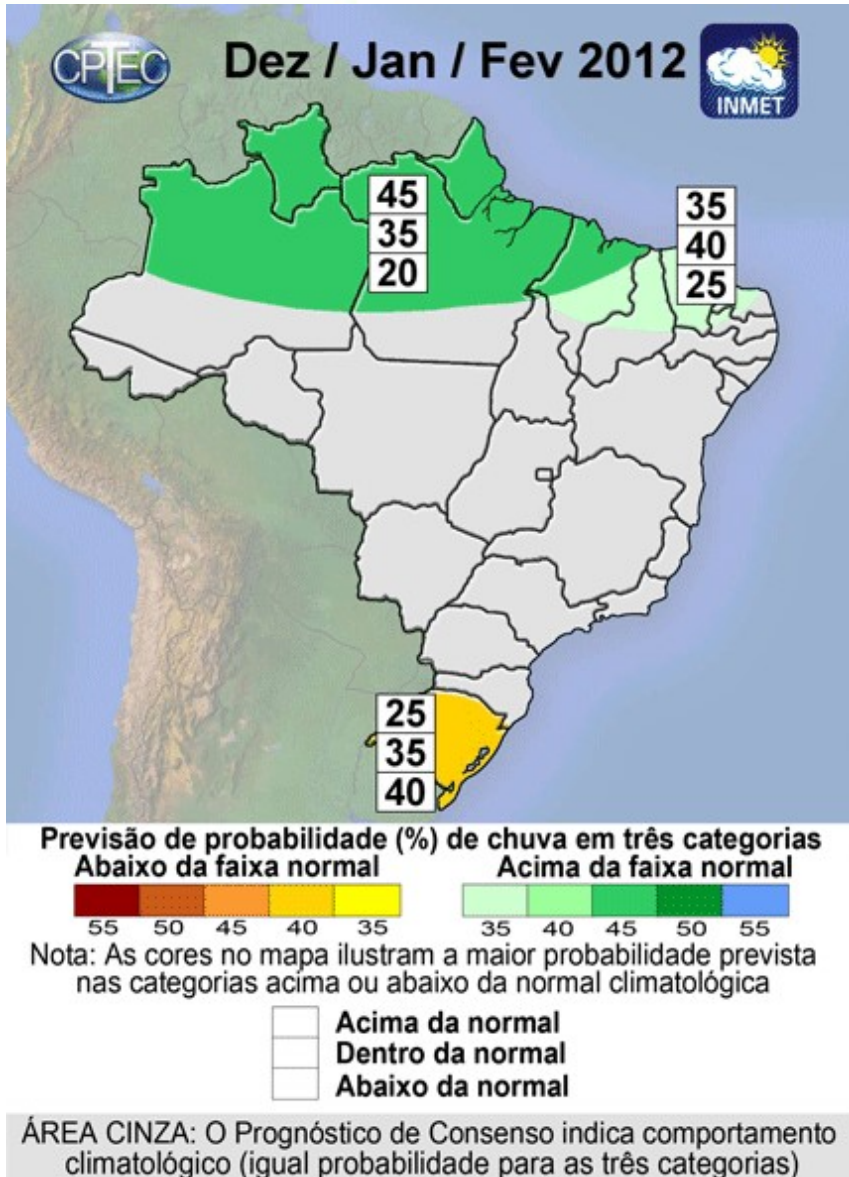
Previsão de probabilidade (%) de chuva em três categorias

Abaixo da faixa normal					Acima da faixa normal				
55	50	45	40	35	35	40	45	50	55

Nota: As cores no mapa ilustram a maior probabilidade prevista nas categorias acima ou abaixo da normal climatológica

- Acima da normal
- Dentro da normal
- Abaixo da normal

ÁREA CINZA: O Prognóstico de Consenso indica comportamento climatológico (igual probabilidade para as três categorias)



- Tercile-based seasonal forecasts do not indicate perspectives for conditions above or below the historical mean value
- Tercile-based seasonal forecast indicate **forecast probabilities for three categories**: Below normal, near normal and above normal



Previsão de probabilidade (%) de chuva em três categorias
 Abaixo da faixa normal Acima da faixa normal



Nota: As cores no mapa ilustram a maior probabilidade prevista nas categorias acima ou abaixo da normal climatológica

- Acima da normal
- Dentro da normal
- Abaixo da normal

ÁREA CINZA: O Prognóstico de Consenso indica comportamento climatológico (igual probabilidade para as três categorias)

- Grey area do not indicate higher probability for the near normal category

- Grey area indicates equal probabilities for the three categories (climatological conditions)



Final remarks

- Important to understand precisely what is communicated in these tercile probability seasonal rainfall forecasts
- Same procedures are valid for temperature seasonal forecasts
- Special forecasts (e.g. storm counts, onset and cessation dates) might need alternative procedures different from tercile probability forecasts



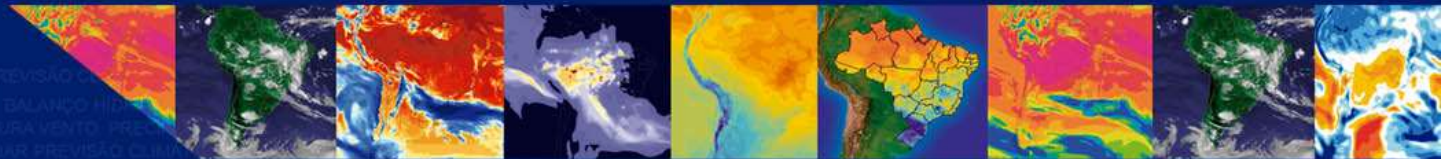
Centro de Previsão de
Tempo e Estudos Climáticos

CPTEC / INPE

www.cptec.inpe.br

Thank you for your attention !

Ciência e
Tecnologia
a serviço
da sociedade



MINISTÉRIO DA CIÊNCIA, TECNOLOGIA E INOVAÇÃO
INSTITUTO NACIONAL DE PESQUISAS ESPACIAIS

Ministério da
Ciência, Tecnologia
e Inovação

