Assessment of the JULES model surface soil moisture using in situ observations over the Brazilian North East semiarid region

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Cemaden
Centro Nacional de Monitoramento
e Alertas de Desastres Naturais

Outline

1. Site and measurements

2. Jules

3. Results
   - Jules evaluation
   - Modeled in situ soil moisture data

4. Conclusions

Objectives

- Compare superficial soil water from observations with Jules land surface model
- Derive relationships between model and measurements for applications on:
  - Generate modeled soil moisture data
  - Characterize long-term trends of soil water and drough events
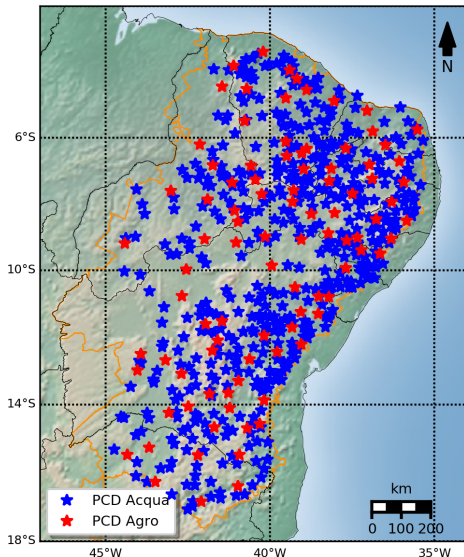

Soil Moisture
Standadized Anomaly
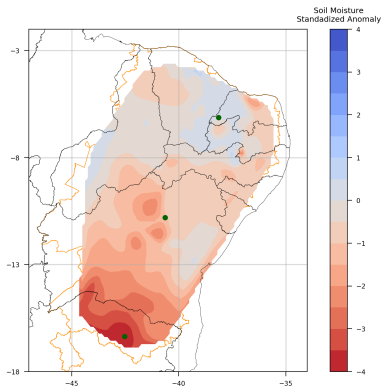
Brazilian Semiarid

- Covering 10 states
- 800,000 km^2 (10% Brazilian territory)
- 23 million inhabitants
- Caatinga (unique ecosystem with great biodiversity)
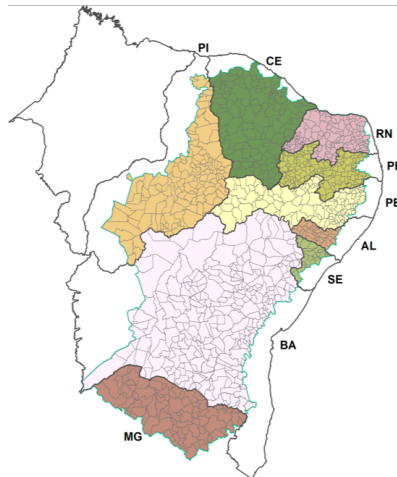
Cemaden's network

- Monitoring of rainfall and soil moisture at 595 stations (PCD Acqua, 10 and 20 cm)
- Four depths in 95 stations +
- Air temperature, relative humidity, wind speed, solar radiation (PCD Agro)
- Hourly data via cellular network
- "Rural network"

Database

- 360 stations
- Data coverage from 2015 to 2019
- 2 months to 4 years of data
- Physical consistency (other depths and rainfall)

Jules Land Surface Model

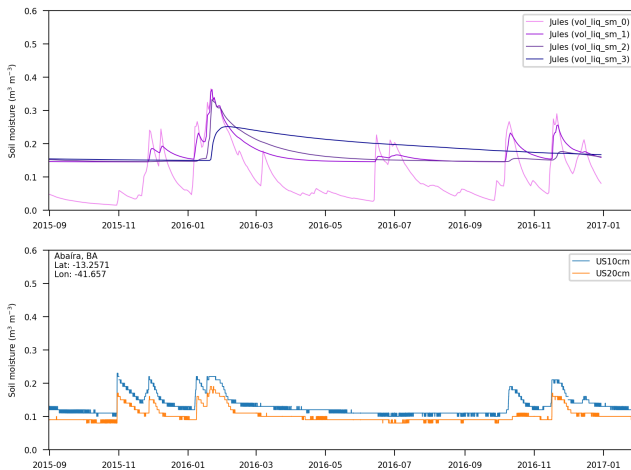- JULES Land Surface Model (the Joint UK Land Environment Simulator)

> **"Skillful seasonal prediction of key carbon cycle components: NPP and fire risk"**
>
> Philip Bett, Karina Williams, Chantelle Burton, Adam Scaife, Andrew Wiltshire, Richard Gilham
> https://eartharxiv.org/29ve5/

- Runs from 1979 to 2016
- Overlap with first full year of measurements

Original data

Outline

Index of agreement (d)

Original Articles

ON THE VALIDATION OF MODELS

Cort J. Willmott

Pages 184-194 | Published online: 15 May 2013

🔖 Download citation   🔗 https://doi.org/10.1080/02723646.1981.10642213

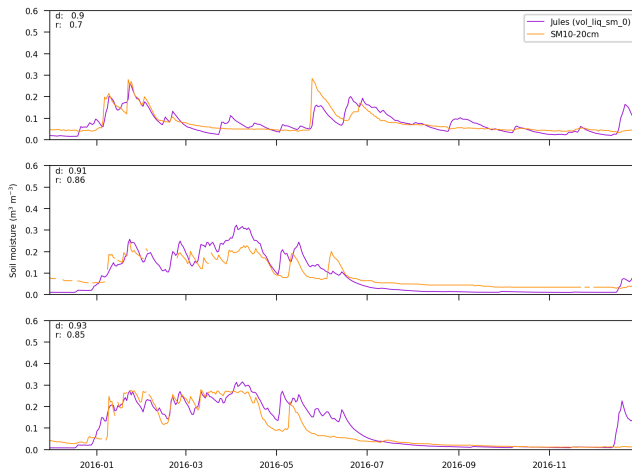## 3.   Brief history of the index of agreement

The original form of Willmott's index of agreement (Willmott and Wicks, 1980; Willmott, 1981) was a specification of Equation (1). Willmott and Wicks used d to represent the index (rather than ρ) and we will follow their convention here. It (d) was a sums-of-squares-based measure, within which δ was the sum of the squared errors while μ was the overall sum of the squares of sums of the absolute values of two partial differences from the observed mean, $|P_i - \bar{O}|$ and $|O_i - \bar{O}|$. Thus, the form of the original index was

$$d = 1 - \frac{\sum_{i=1}^{n} |(P_i - \bar{O}) - (O_i - \bar{O})|^2}{\sum_{i=1}^{n} (|P_i - \bar{O}| + |O_i - \bar{O}|)^2} \qquad (2a)$$
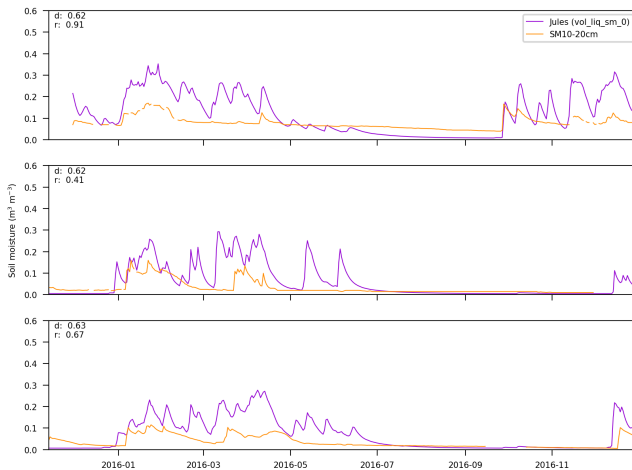
which simplifies to and is commonly written as

$$d = 1 - \frac{\sum_{i=1}^{n} (P_i - O_i)^2}{\sum_{i=1}^{n} (|P_i - \bar{O}| + |O_i - \bar{O}|)^2} \qquad (2b)$$
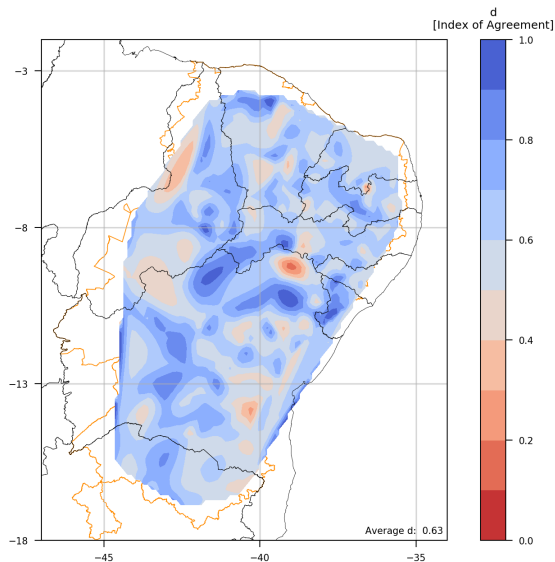
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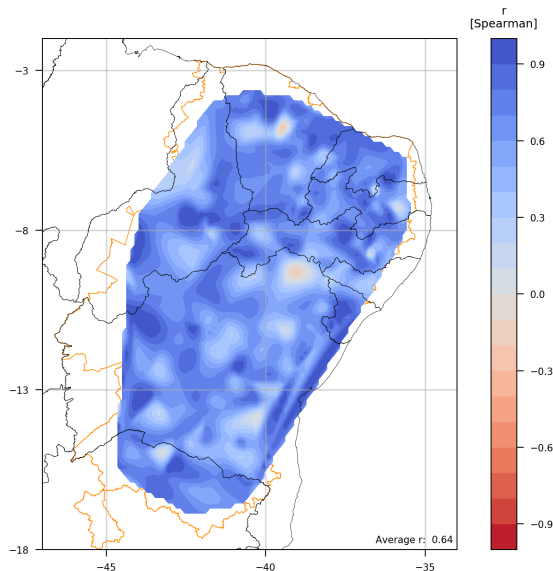
Jules and stations

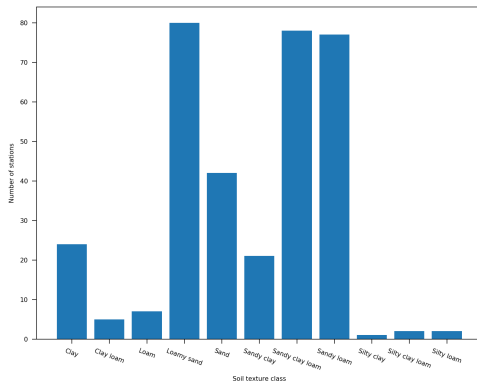## Jules and stations

Index of agreement (d)

Correlation coefficient (r)
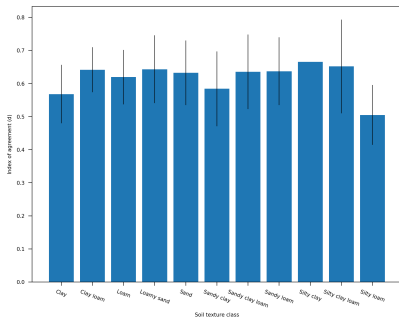
Statistics and soil texture class

- Fractions of sand, silt and clay
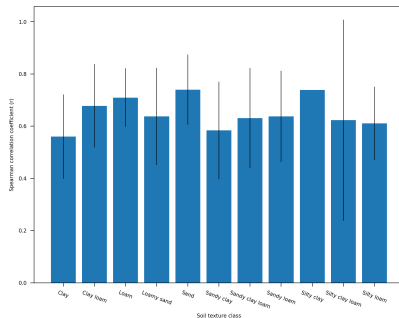- USDA soil classification

Statistics and soil texture class

Good agreement and correlation between measurements and model for different soil texture classes

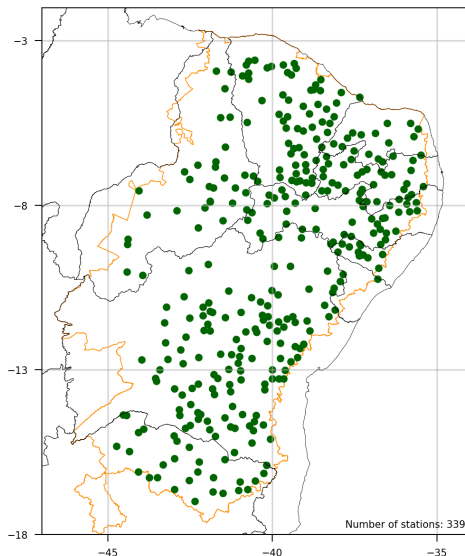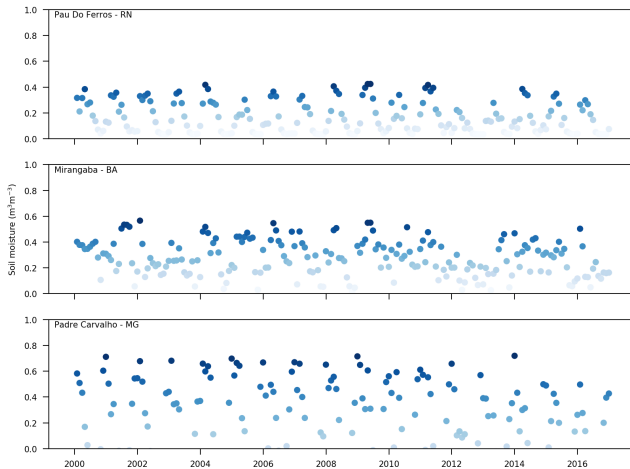## Index of agreement

Correlation coefficient

Outline

Modeled in situ soil moisture data

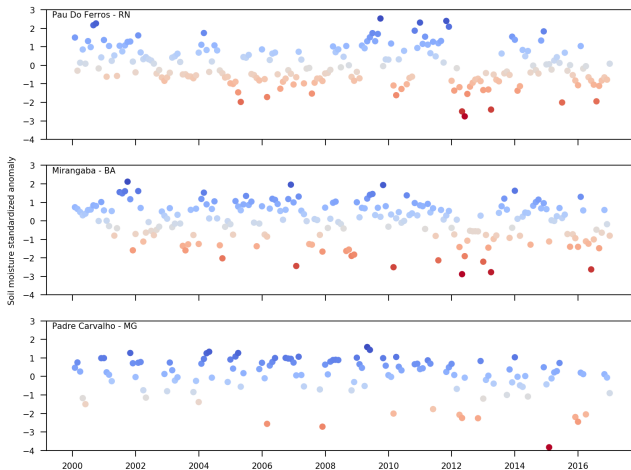- Generate 1979-2016 soil moisture data
- Locations criteria:
  - Significant correlation (p-value)
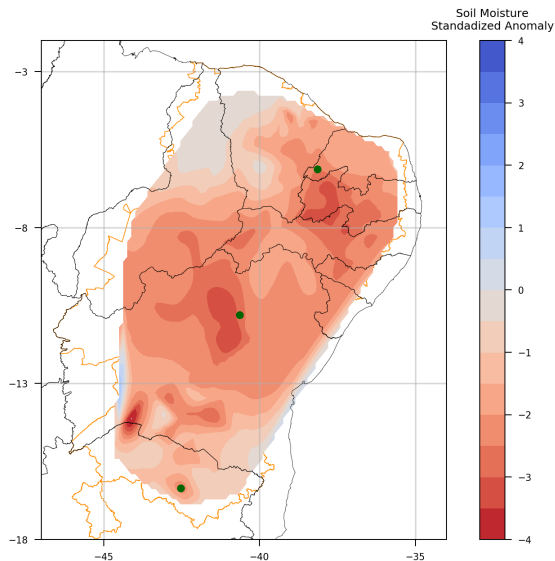 - Correlation higher than 0.6

Number of stations: 339
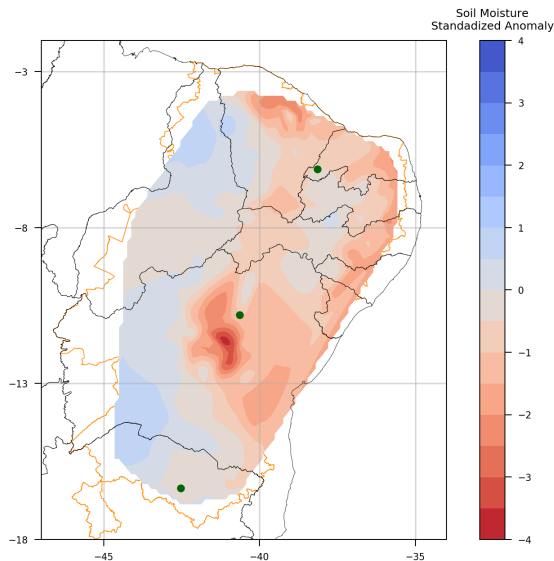
Soil moisture 2000-2016

Soil moisture 2000-2016 - Standardized anomaly

Standardized anomaly - April 2012

Standardized anomaly - April 2013

Soil Moisture
Standardized Anomaly

Standardized anomaly - January 2015

Soil Moisture
Standardized Anomaly
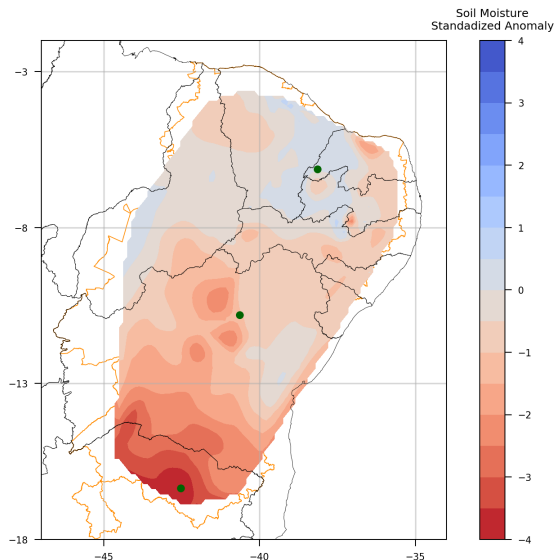
Conclusions

- Good correlation between Jules superficial soil water and measurements
- Modeling of in situ data from 1979 to 2016
- Standardized soil moisture anomaly
  - Correct identification of drought events

Future steps

- Comparison with other metrics (SPI, NDVI)
- Integration with other metrics in a combined drought index

Obrigado!

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[2] Umbuzeiro tree (*Spondias tuberosa L.*)

Picture: Cláudio Rogério Pontes