

# The first soil moisture reconstruction in the Mediterranean Chilean Andes region developed by tree rings and satellite observations to inform climate change impacts in South America

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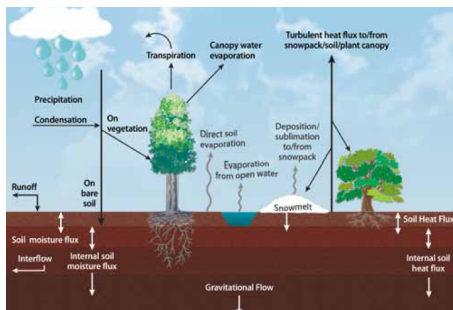


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# What is the relevance to understand spatiotemporal soil moisture variability?

The soil moisture is a crucial variable to produce heat and water interchange between the earth's surface and the atmosphere.

**It is vital to create meteorological patterns such as precipitation mainly in extra-tropical regions of the world**



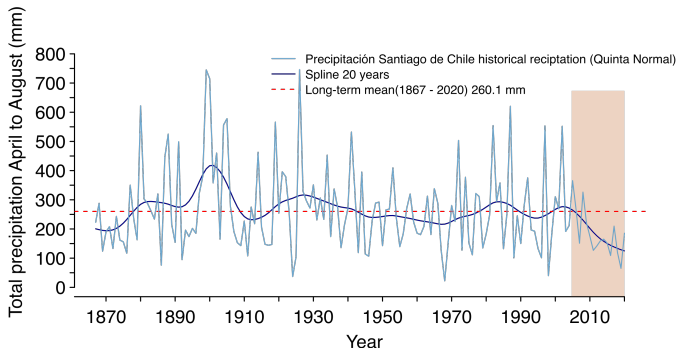
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# The mediterranean andes of Argentina and Chile MA; South America

- MA ( $30^{\circ}$ - $37^{\circ}$ S; densely populated with  $\geq 10$  millions inhabitants). Big cities are located into MA (*Santiago de Chile, Valparaíso, Mendoza in Argentina*)
- Economical activities on the MA regions are highly demanded of water resources (*i.e., agriculture and minning*)
- Nowadays, the MA region present a worse and extended drought since 2010 without past replicates recorder on the last millennium (Garreaud et al., 2017).



## A worse precipitation decline is recorder in the MA region since 2006



Historical precipitation of Santiago de Chile (Quinta Normal Station) since 1867

# Soil Moisture (SM)

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**Despite to relevance of this variable, exist scarce studies in Chile about the spatiotemporal variation of SM. Moreover, studies that find understand past changes using natural proxies such as tree rings.**

# Motivations to reconstruct SM variability

-Tree rings of several species have showed strong potential to reconstruct different variables of the hydrological cycle (i.e., Precipitation and Streamflow), reconstructing past hydroclimatic variations using tree-ring growth of (i.e., *Austrocedrus chilensis* or Ciprés de la Cordillera)

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- To date, exist a unique article published by Muñoz et al., 2013, reporting linkages between soil moisture inferred by remote sensing (i.e., European Space Agency ESA; ESA-CCI product) and ancient conifers as *Araucaria araucana* (*Araucaria*). However, there is an enormous gap between SM and tree-growth relationships of multiple species living in the MA region.

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This research is part of a national research project funding (ANID/PAI/77190101), which seeks to know the changes in spatiotemporal soil moisture variability in the AM and South-Central Chile during the last 500 years.

# Soil Moisture data

ESA | CCI | Aerosol | Cloud | CMUG | Fire | GHG | Glaciers | Ice Sheets | Land Cover | Ocean Colour | Ozone | Sea Ice | Sea Level


## Soil Moisture CCI



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### Consortium



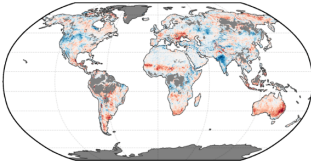
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## Overview

Submitted by Tracy Scanlon on Fri, 2019-10-25 08:28


The important role of soil moisture for the environment and climate system is well known. Soil moisture influences hydrological and agricultural processes, runoff generation, drought development and many other processes. It also impacts on the climate system through atmospheric feedbacks. Soil moisture is a source of water for evapotranspiration over the continents, and is involved in both the water and the energy cycles. Soil moisture was recognised as an Essential Climate Variable (ECV) in 2010.

2019-09



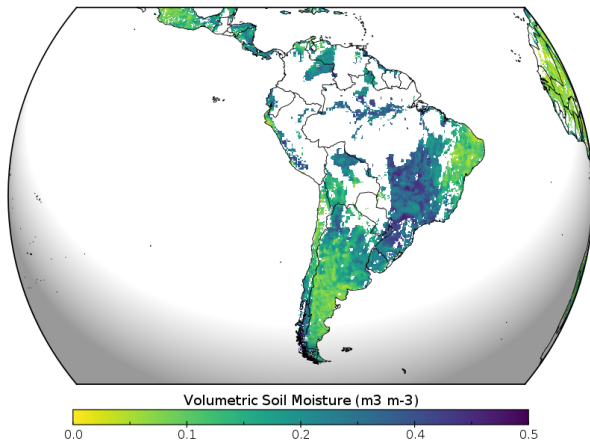
Soil moisture anomalies for the year 2019 derived from the ESA CCI COMBINED v05.2 product.

The Soil Moisture CCI project is part of the ESA Programme on Global Monitoring of Essential Climate Variables (ECV), better known as the Climate Change Initiative (CCI), initiated in 2010 and producing an updated soil moisture product every year. The ESA CCI Soil moisture product has contributed to hundreds of hydrological and climatological studies worldwide, as well as the annual BAMS "State of the Climate" reports.



**ESA CCI Soil Moisture v05.2 Download**

Daily combined SM data since 1979 to date.  $0.25^\circ \times 0.25^\circ$  longitude and latitude.



## Relationships between SM and tree species

We selected two native tree species from the Mediterranean Sclerophyllous forest to explore potential relationships between volumetric SM variations and tree-ring growth.



Belloto del Norte (*Beilschmiedia miersii*)



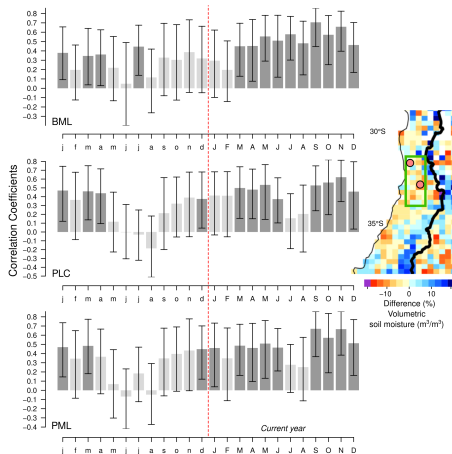
Peumo (*Cryptocarya alba*)

We explore potential relationships based in a SM spatial domain average (**green rectangle**).

-We evaluated possible relationships performing Pearson correlations. Also we use BootRes climate and tree-ring growth response Package developed in R software by Zang and Biondi (2013).

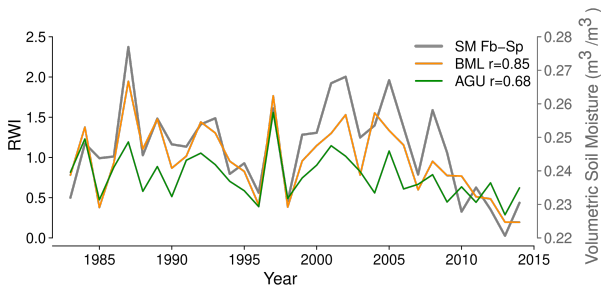
-To reconstruct, we implemented the Dave Meko routine developed to Matlab, that combine Principal Component Analysis PCA and tree-ring chronologies using lags ( $\pm 1$  and 2 years).

# Belloto del Norte (BML), Peumo (PLC and PML) and SM

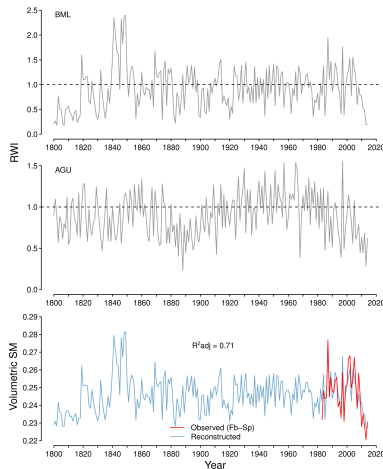


Peumo and Belloto del Norte shows significant relationships ( $p < 0.05$ ) with monthly Soil Moisture average during previous and current year.

## Significant correlations between Belloto del Norte and SM variations from February to September



# Reconstructing the SM during last 200 years using Belloto del Norte



Both chronologies (BML and AGU) are based on 70 cores in total.  $EPS > 0.85$  since 1800

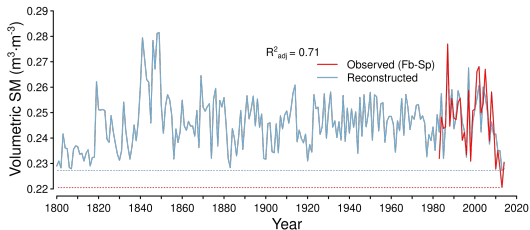
## Discussion and some conclusions

Belloto del Norte (*Beilschmiedia miersii*) y Peumo (*Cryptocarya alba*) recorder a high sensitivity to Soil Moisture, mainly during february to September (Fb-Sp).

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Tree-ring chronologies of Belloto del Norte (BML) shows an strong potential to reconstruct the Soil Moisture variation in a subregion of the MA, at least, since 1800s.



**Reconstructed SM variations during Fb-Sp reveal unprecedented values during recent years and respect to the past two centuries**

## Browning: potential effect of SM changes in the MA region



September 2020

## Next steps

- Refine the SM reconstruction and extend back in time tree-ring chronologies of Belloto del Norte, at least, since 1700s.
- Perform new SM reconstructions based on others statistical methods (i.e., Point by Point Regression performed by Ed. Cook)

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A lot of work to do !

# Muchas gracias

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