Cloudiness variability and long-term decrease over Northeastern Argentina: Insights from Surface Observations and Satellite-Derived Data

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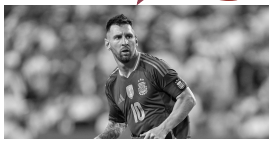
Cloud cover

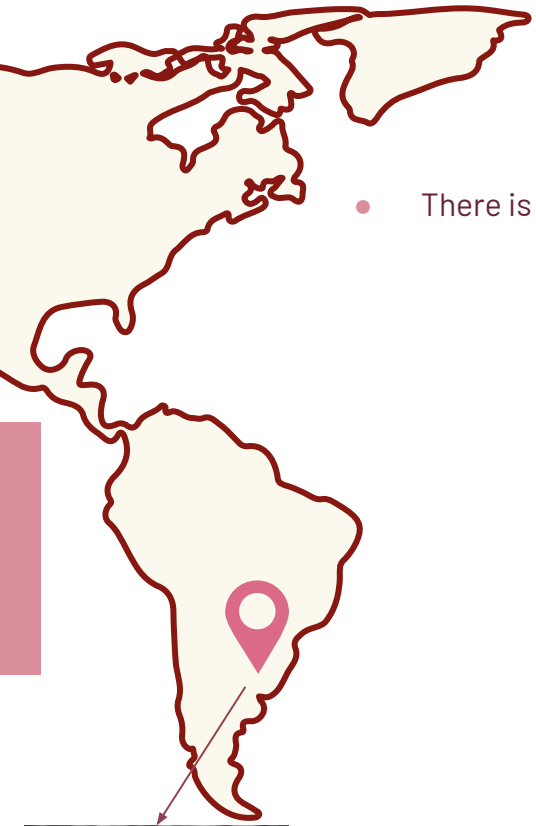
- Clouds cover roughly **two-thirds of the globe** (IPCC, 2013) and are a key element of the climate system.
- **Small changes in cloudiness** can exert a **powerful effect on the climate system** (IPCC, 2013)
- In the last decades **a slow but steady decrease in global cloud fraction amount was observed**, with most of the decrease emanating from mid-latitude regions (e.g., Karlsson et al., 2023; Karlsson & Devasthale, 2018; Norris et al., 2016).
- **Specific studies have explored TCC trends since the mid-20th century on smaller areas**. The direction and magnitude of observed TCC trends vary significantly depending on the region and time period under consideration (e.g., Sanchez-Lorenzo et al., 2017; Jovanovic et al., 2011; Sanchez-Lorenzo et al., 2012)



** Where Lionel Messi was born*

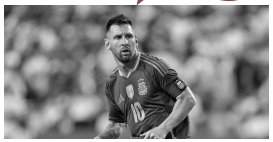
However, there are no studies exploring the particularities of those changes in

Northeastern Argentina (NEA)



Northeastern Argentina (NEA)

- There is **influence of large-scale climate patterns in the region**



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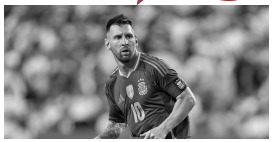
Northeastern Argentina (NEA)

- There is **influence of large-scale climate patterns in the region**
- It is **the largest rice and vegetable productive region in Argentina**



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Northeastern Argentina (NEA)

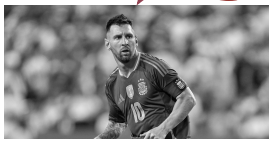
- It is **the largest rice and vegetable productive region in Argentina**
- There is **influence of large-scale climate patterns in the region**
- **We are in dialogue with producers:**

2016 - within a knowledge co-production process **horticultural producers from the NEA expressed that a sequence of 15 cloudy days had caused great losses in their production**

2023 - we started the dialogue with **rice producers in Corrientes and they also emphasized the role of cloud cover in modulating rice yields**

A variable rarely analyzed as an impact one by the scientific community, **can have great relevance for producers**:

Cloud cover modulates **solar radiation** reaching the surface and **environmental conditions** such as minimum and maximum temperature



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Objectives

1) Develop a methodology for the treatment of **cloudiness with ground-based (GB) observations**;
2) Conduct an **intercomparison of two different databases** of cloudiness in the region (GB observations and satellite estimations);
3) Contribute a **comprehensive understanding of total cloud cover long-term variations and variability over NEA**.

Data

Cloud Cover

Satellite estimates

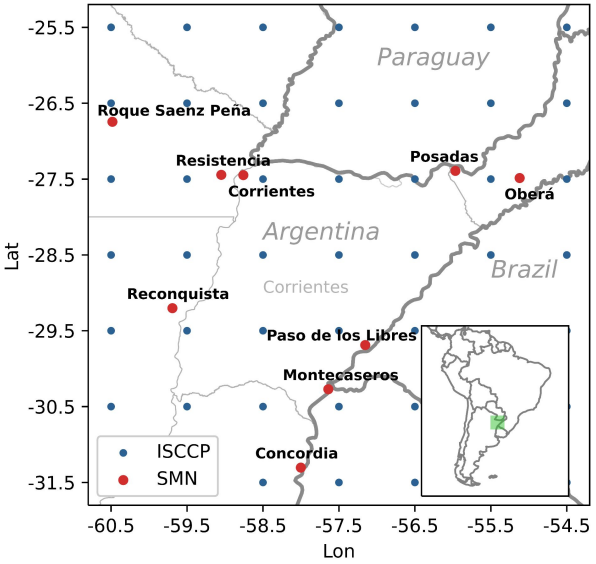
International Satellite Cloud Climatology Project (**ISCCP**) - H Series

Available: **July 1983 - June 2017**

Surface observations

National Weather Service Argentina

Available: **March 1961 to present**

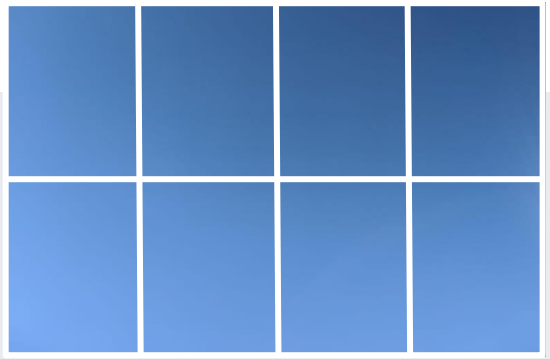


Surface observations

Surface visual-based observations conducted by experienced meteorological personnel:

- The sky is divided into eight parts (the entire visible sky).
- It is estimated how many oktas of sky are covered

These observations are made on a daily basis



0
OKTAS

8
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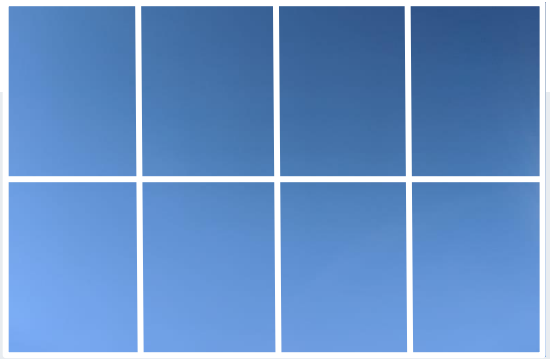

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OKTAS

8
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2
OKTAS

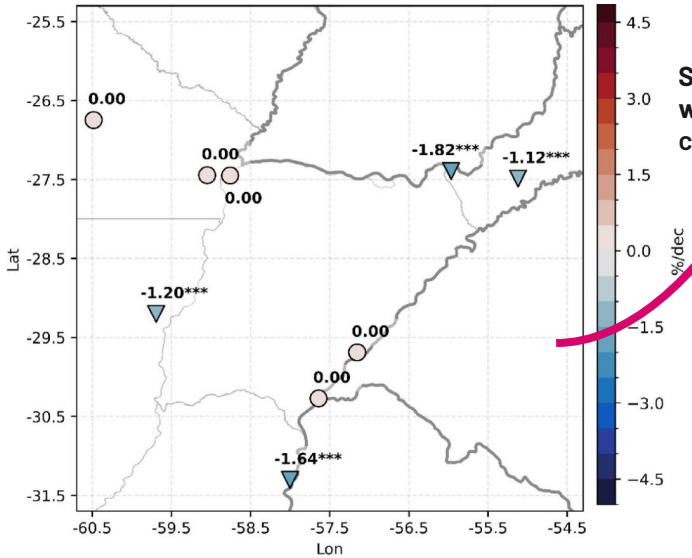
Cloud Index (%)

$$CI = 50 + 50\,(N_8 + N_7 + N_6 - N_2 - N_1 - N_0) / N_{tot}$$

N_i = number of days with octa i
N_{tot} = number of days of the month

¿How is cloud cover changing in NEA?
Surface observations

Cloud Index Theil-Sen trends (1961 - 2021)



Significant decrease at 4 weather stations (99% confidence)

+ The **regional mean** of cloud index **decreases 0.66% per decade between 1961-2021** (significant with 99% of confidence)

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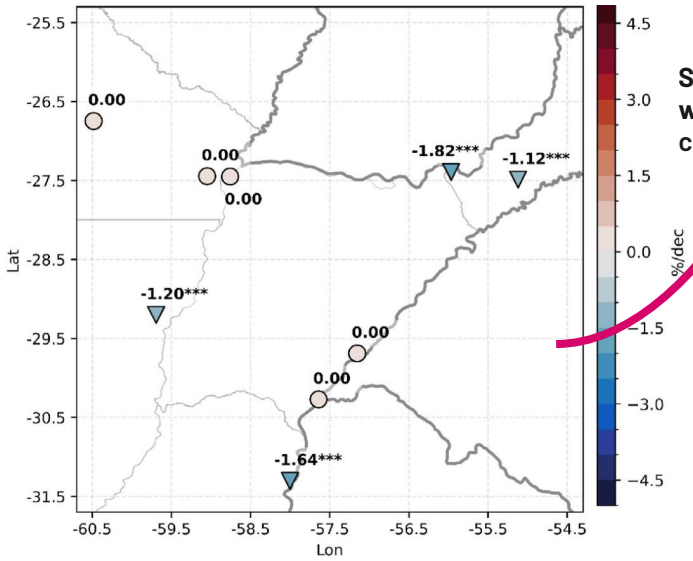
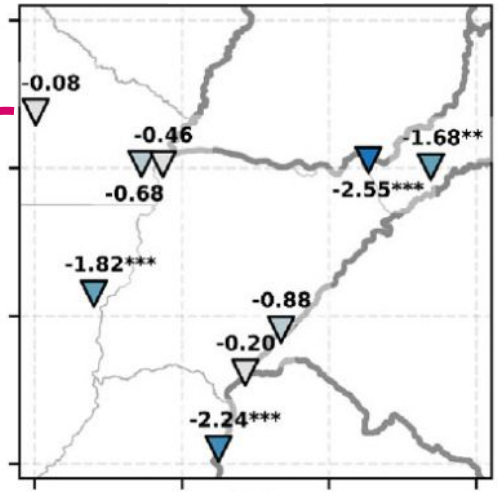


+ The **regional mean** of cloud index **decreases 0.66% per decade between 1961-2021** (significant with 99% of confidence)

Significant decrease at 4 weather stations (99% confidence)

In summer (DJF) cloudiness decreases in all weather seasons

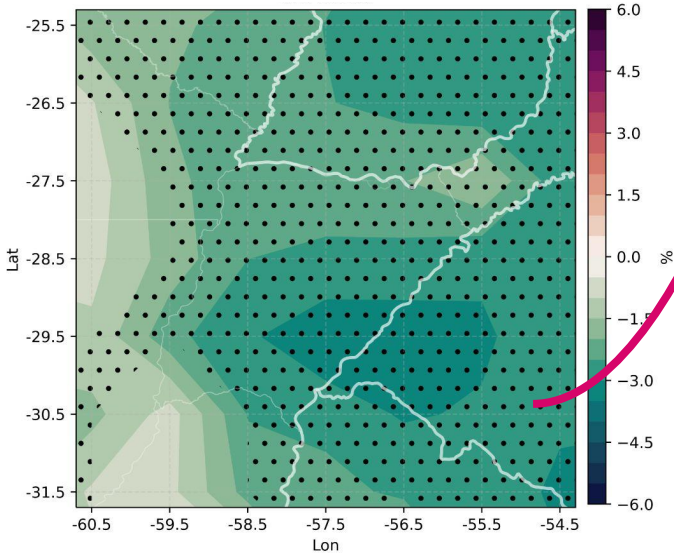
DJF



The regional mean of cloud index **decreases 1.09% per decade between 1961-2021 in DJF** (significant with 95% of confidence)

¿How is cloud cover changing in NEA? Satellite estimates

ISCCP-H Cloud Amount Theil-Sen trends (1983 - 2016)

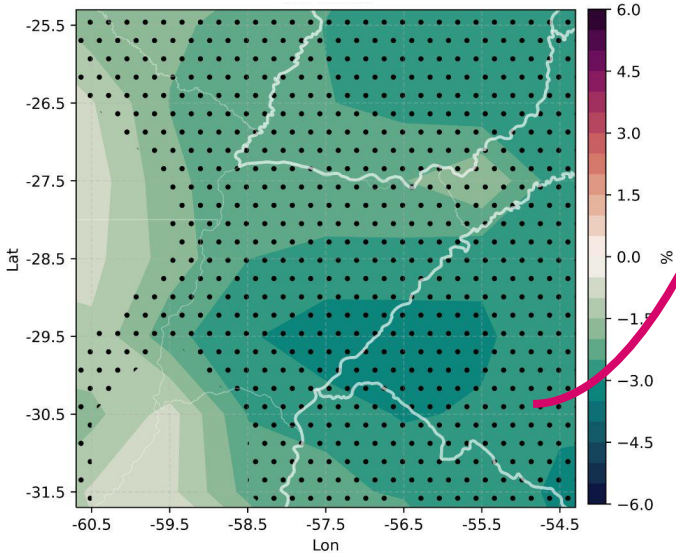


Significant decrease (95% of confidence) Annually (and in all seasons except JJA)

The regional mean of **ISCCP Cloud Amount decreases 2.22% per decade between 1983-2016** (significant with 99% of confidence). **In DJF it decrease is 2.44% per decade.**

¿How is cloud cover changing in NEA? Satellite estimates

ISCCP-H Cloud Amount Theil-Sen trends (1983 - 2016)



Significant decrease (95% of confidence) Annually (and in all seasons except JJA)

The Cloud Amount regional mean presents **similar variability** than the Cloud Index annually and for all seasons -**stronger in DJF**- (significant with 99% of confidence)

	CA and CI R2 (1983-2016)
ANNUAL	0.567 ***
DJF	0.729 ***
MAM	0.676 ***
JJA	0.342 ***
SON	0.561 ***

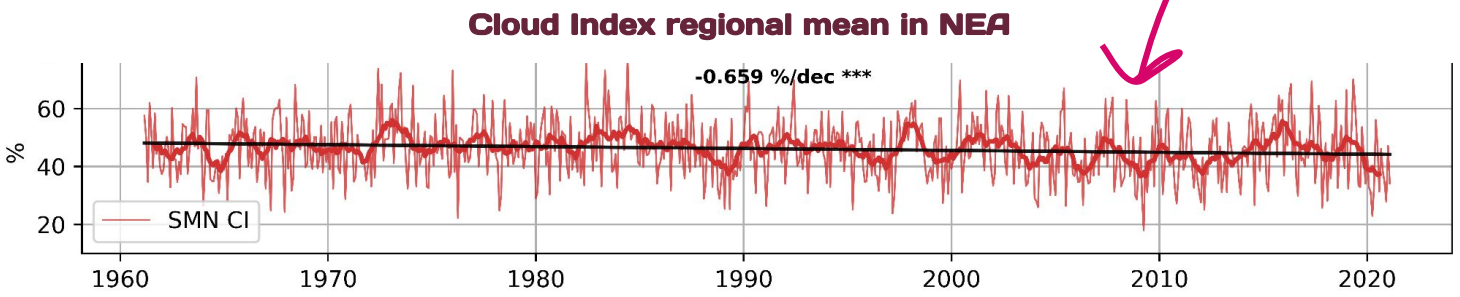
The regional mean of **ISCCP Cloud Amount decreases 2.22% per decade between 1983-2016** (significant with 99% of confidence). **In DJF it decrease is 2.44% per decade.**

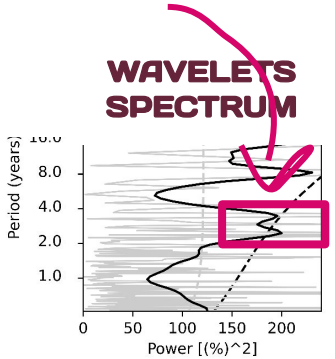
Nadia, T., Robledo, F. A., & Díaz, L. B. (2024). Climatology and trends of cloudiness in a productive rice and vegetable region of South-Eastern South America. International Journal of Climatology, 44(5), 1339–1354. https://doi.org/10.1002/joc.8385

These findings are detailed in this paper:

Cloud Cover variability

CI shows a variability of 3 to 5 years





Cloud Cover variability

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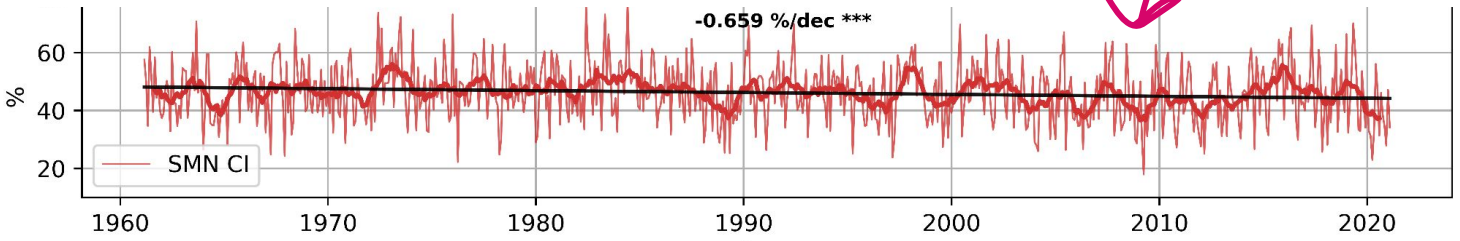
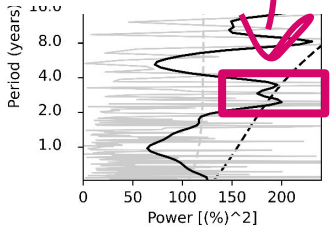
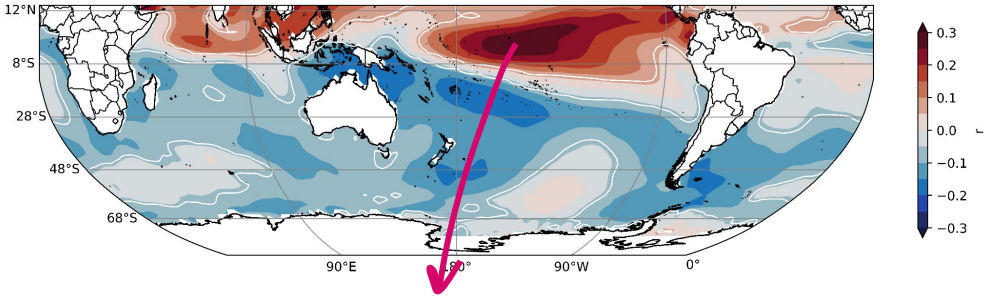
Cloud Index regional mean in NEA



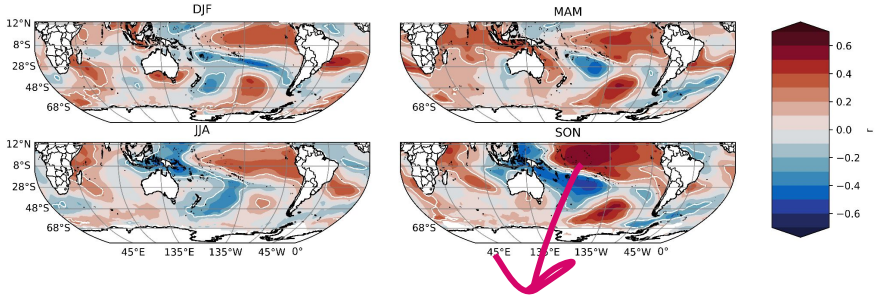
WAVELETS SPECTRUM



SST AND NEA CI CORRELATION (1961-2021)

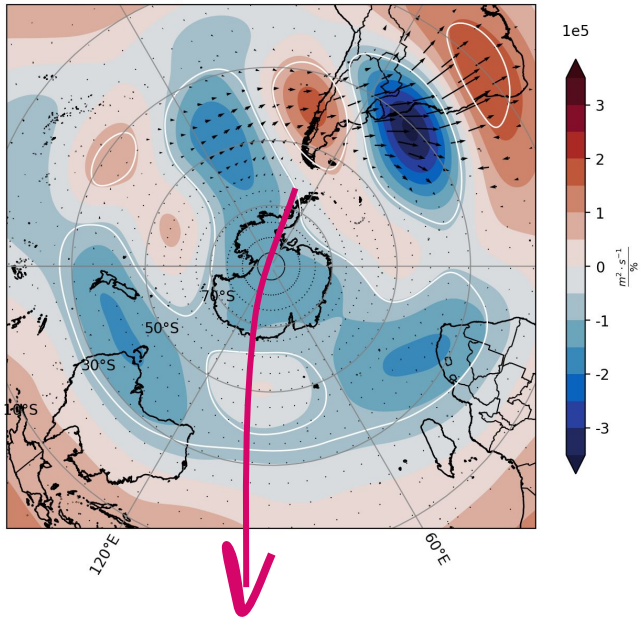


Pattern similar to ENSO SST anomalies pattern



Stronger in Spring (SON)

STREAMFUNCTION (200 hPa) UPON NEA CI (1961-2021) AND WAVE ACTIVITY FLUX



Rossby Wave with Indo-Pacific source forces atmospheric circulation over South America

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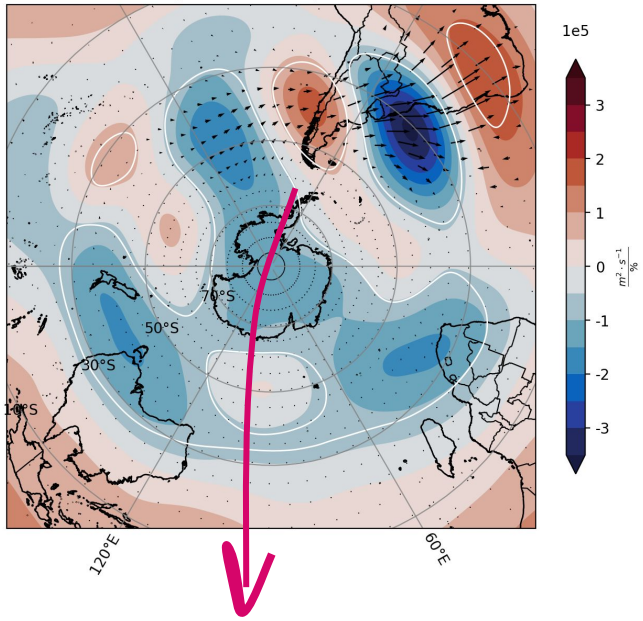
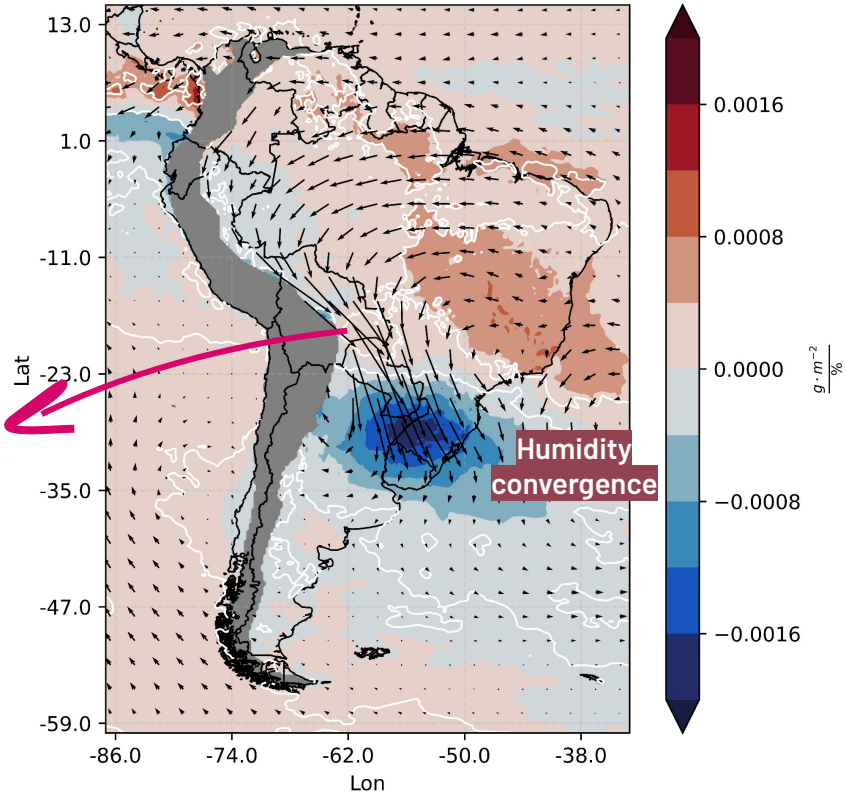


Rossby Wave with Indo-Pacific source forces atmospheric circulation over South America

Characterised by moisture flows from central-eastern Brazil towards NEA: favours cloud cover in this region

HUMIDITY FLUX 850 hPa (arrows), HUMIDITY DIVERGENCE (CONTOURS) UPON NEA CI (1961-2021)



Conclusions

- A **first characterisation** of the **long-term changes and variability of cloud cover in the NEA** was carried out motivated by the dialogue with agricultural producers
- **Cloud cover in the NEA is decreasing** (consistent with two independent sources of information)
- **Cloud cover variability in the NEA is characterised by 3-5 year frequencies, influenced by large-scale circulation patterns such as ENSO**

References

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Questions?

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