XVII Congreso Internacional ALASA 2022

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Impactos reales del Cambio Climático en la Industria del Seguro Agropecuario

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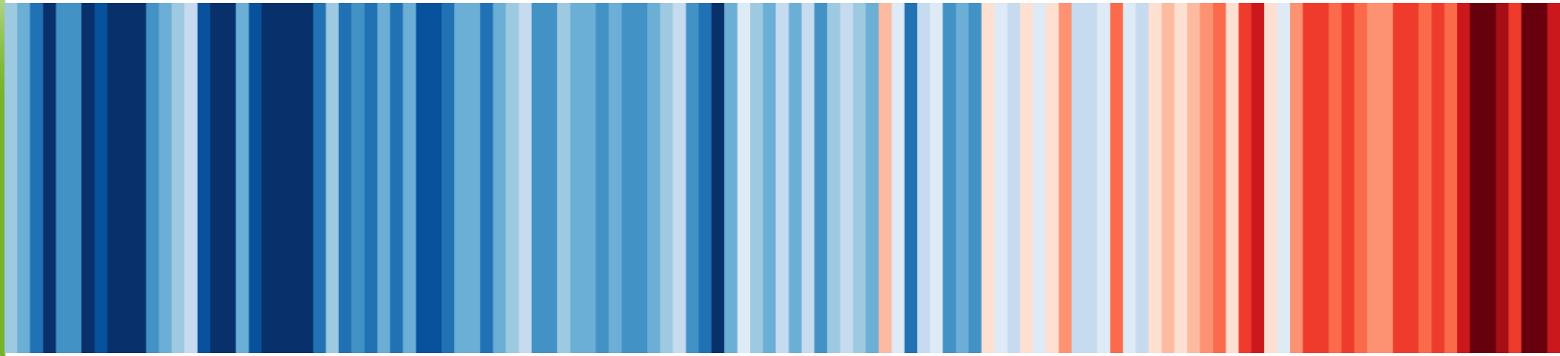
Climate Change Consultant at MunichRE



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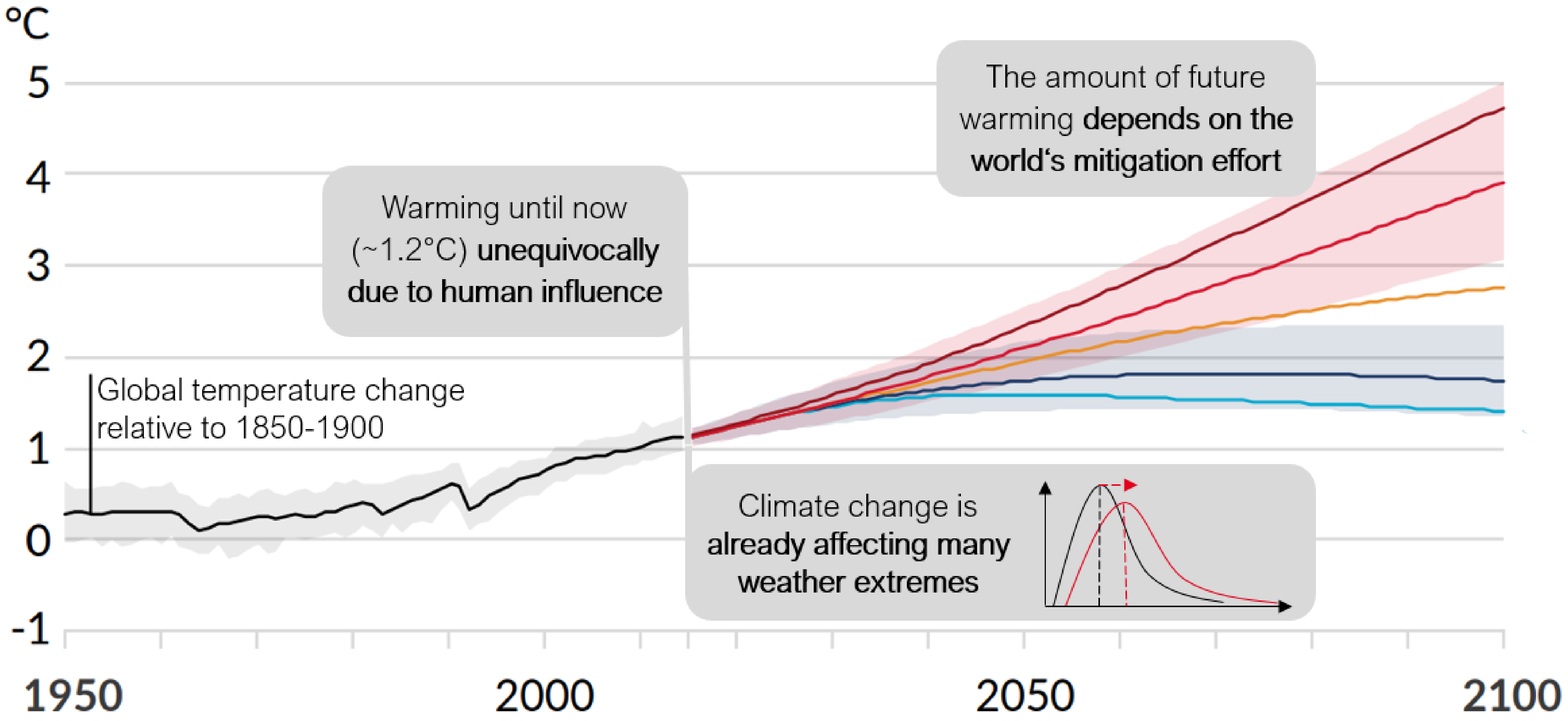
Climate Change in Past, Present & Future

Munich RE



based on Fig. SPM.8; IPCC AR6; modified

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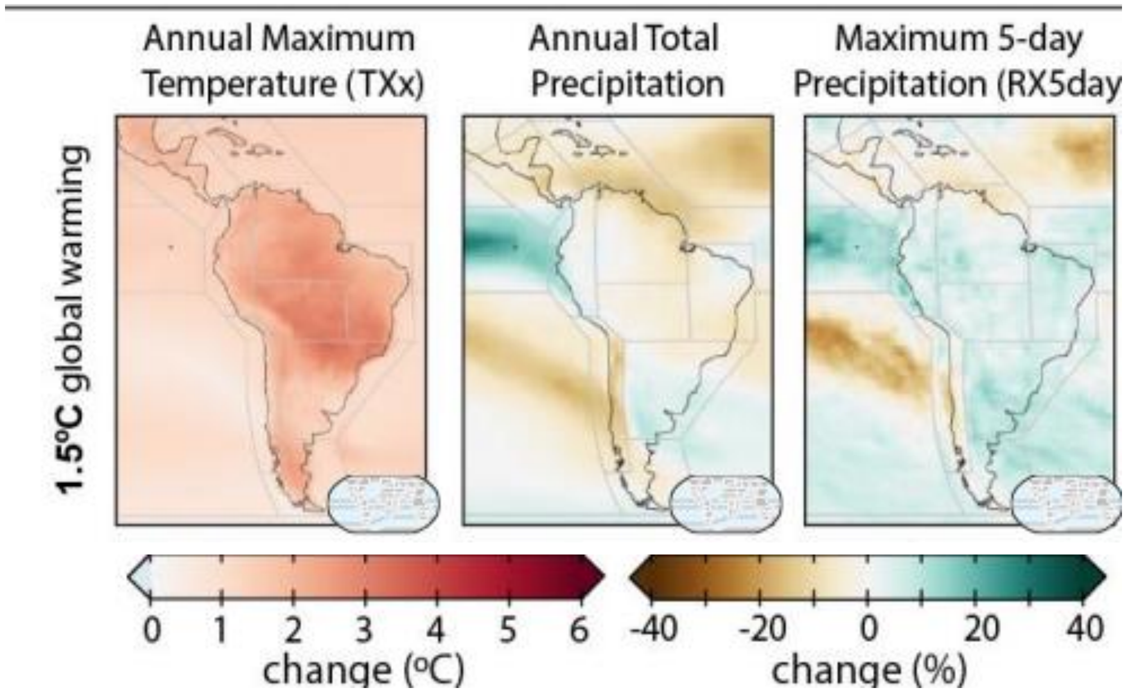
Climate Change in Latin America

Munich RE



"Changes in timing and magnitude of precipitation and extreme temperatures are impacting agricultural production (high confidence)."

IPCC AR6, WG2

- Robust increase in **Maximum Temperature**
- Change in **total precipitation** dependent on region, but less certain
- Increase in **extreme precipitation** (≠ mean)
- Trends in T & P drive **drought** frequency, intensity & duration,
  but **T & ET** as **main driver** in many regions

Source: IPCC AR6, WG1 (2021)

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Changing Extreme Weather Events

Relevant questions

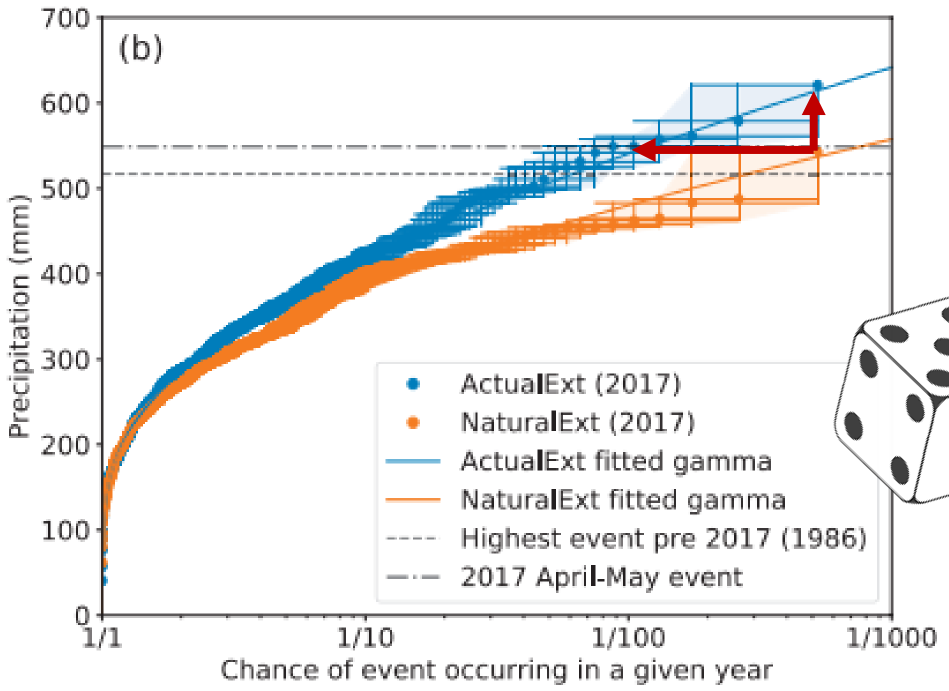
(1) Has a certain extreme event become more likely? If so, what has made it more likely?
(2) Will it become more likely in the future?

Challenge

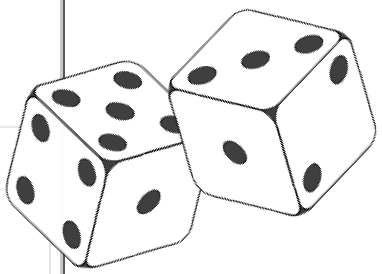
Climate world & NatCat world (-> different scales; time horizon; physics)

→ Information from both observations & climate model experiments necessary!

Event Attribution



De Abreu et al., 2019



Idea: Change in extreme value distribution of actual world (with GHG) and virtual world (only natural influences such as ENSO, solar, volc.)

→ Change in exceedance probability of certain event; **but NOT prove for individual event!**

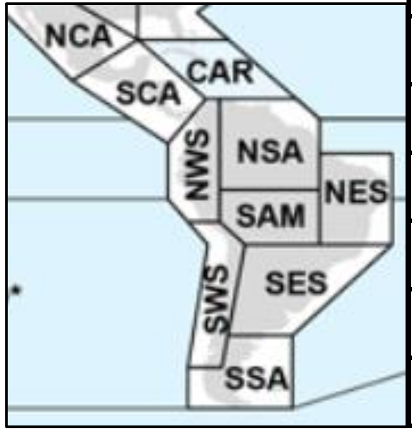
→ Can **identify loss drivers** which would not be detectable from statistics (rarity, variability)

Challenges:

- How to define event?
- Are models suited to simulate event type?

Drought – Observed Changes

- *Increased aridity, intense droughts and subsequent effects on agriculture are **already observed** for several regions in **Central & South America***



Subregion	Average change in the percentage of land area in drought in 2010-19 with respect to 1950-59		
	At least 1 month in drought	At least 3 months in drought	At least 6 months in drought
Central America (CA)	38.8%	17.6%	6.1%
Northwest South America (NWS)	51.8%	25.3%	7.0%
Northern South America (NSA)	52.5%	18.3%	2.5%
South America Monsoon (SAM)	48.0%	34.4%	12.2%
Northeast South America (NES)	64.5%	38.4%	12.0%
Southeast SouthAmerica (SES)	16.4%	6.7%	0.4%
Southwest South America (SWS)	20.5%	13.9%	7.5%
Southern South America (SSA)	-23.5%	-8.8%	--

IPCC AR6, WG2: Change in the percentage of land area affected by extreme drought using the Standardised Precipitation-Evapotranspiration Index (SPEI); extreme drought defined as SPEI ≤ -1.6. Data derived from *Romanello et al. (2021).*

Drought – Attribution to Climate Change

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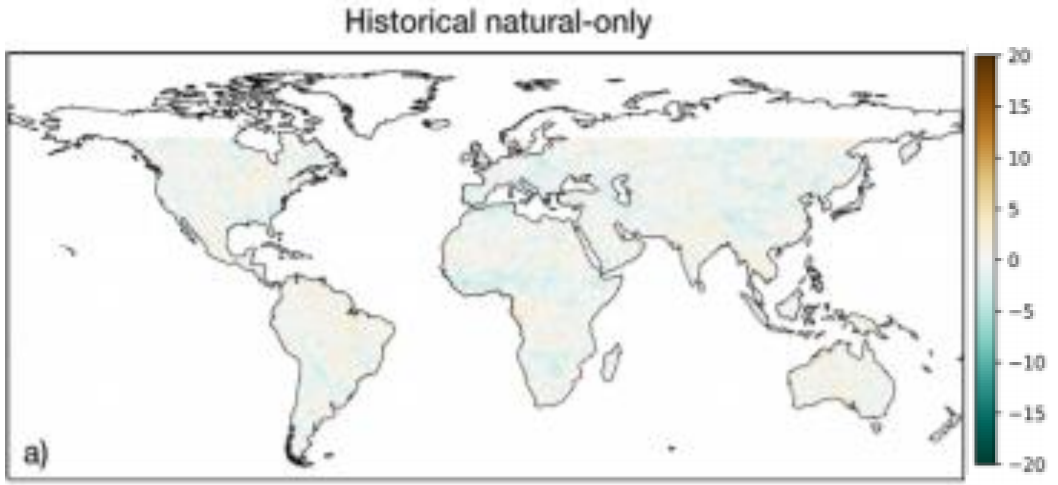
Global attribution study:

→ Anthropogenic forcing has increased …
- drought frequency
- maximum drought duration
- maximum drought intensity

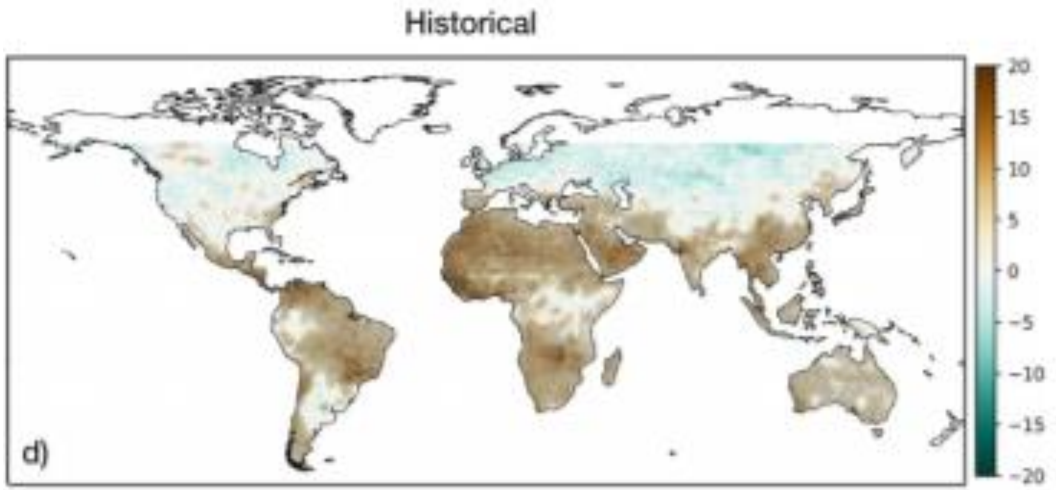
… in large parts of the Americas

Temperature & Evapotranspiration as main driver
(outweighs increases in mean precipitation in many regions)

Shifts in **SPEI drought frequency** between 1851-1900 & 1956-2005 for **natural-only** (no GHGs)



Shifts in **SPEI drought frequency** between 1851-1900 & 1956-2005 for **full historical** forcing (incl. GHGs)



Chiang et al. (2021): Evidence of anthropogenic impacts on global drought frequency, duration, and intensity. *Nature Comm.*

Mexico Drought 2020/2021

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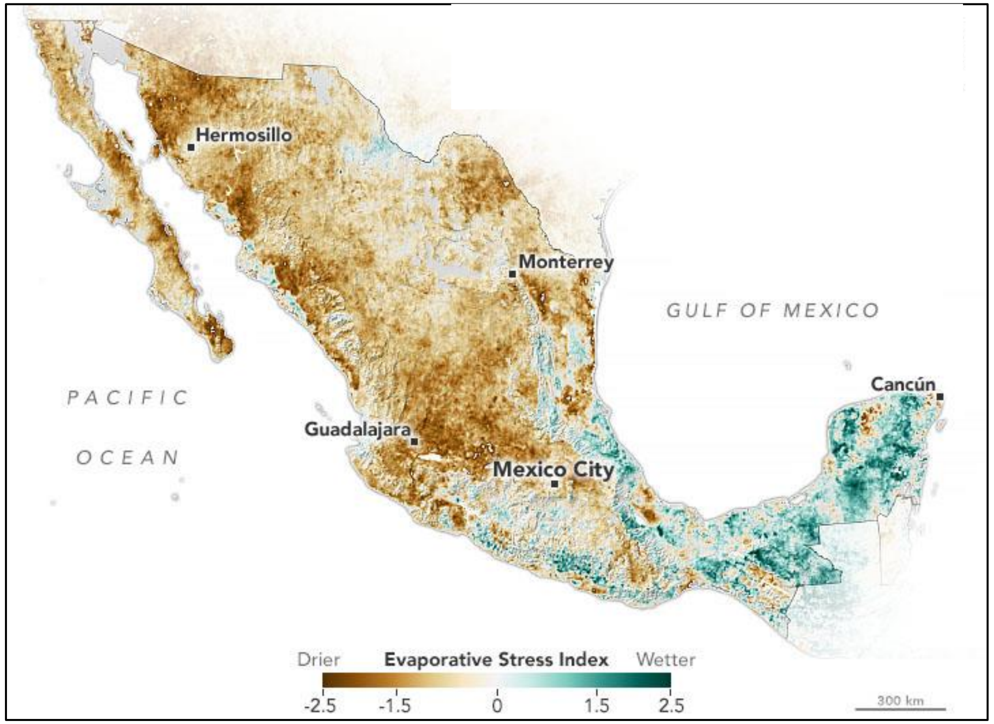
Evaporative Stress Index Oct 2021

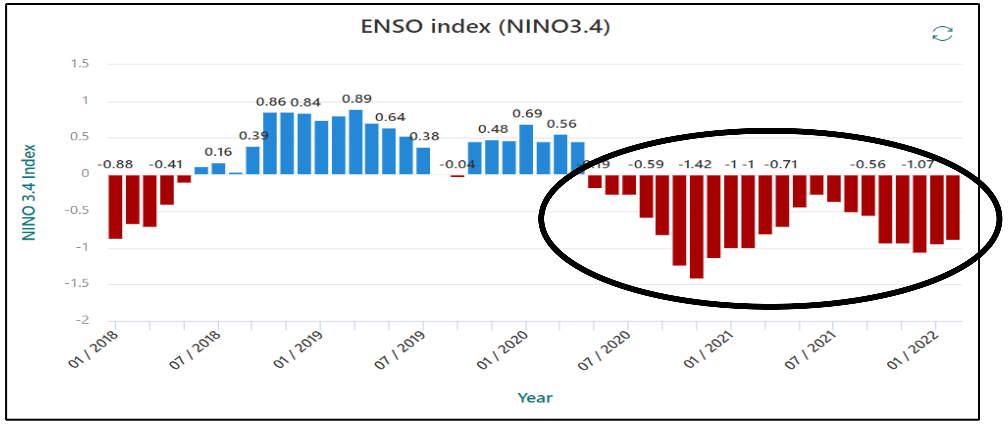


https://earthobservatory.nasa.gov/images/148270/widespread-drought-in-mexico

- ~20% less rainfall than normal during dry season (Oct 2020 - April 2021)
- Extreme temperatures above 35°C in many areas
- +2bn USD economic loss

Drivers:

- Rainfall deficit: **La Nina** (cold waters in eastern Pacific, inhibiting rain over Mexico
- Long-term **Climate Change** (-> hydrological drought)



Mexico Drought 2020/2021

Data: 1950-2017, from CRUv4.02

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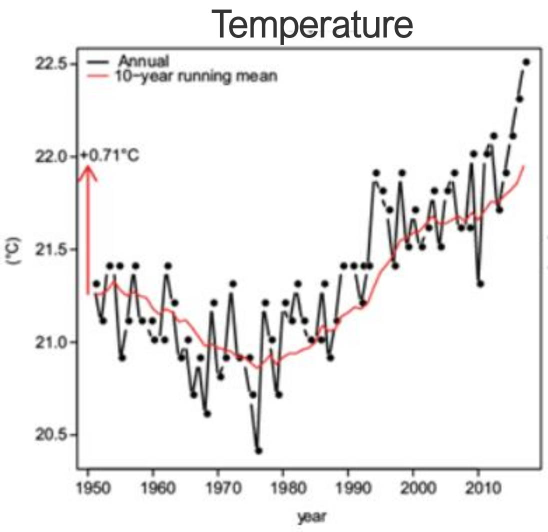
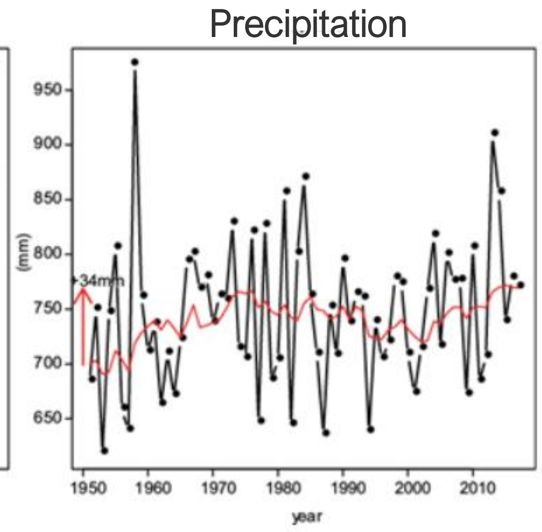
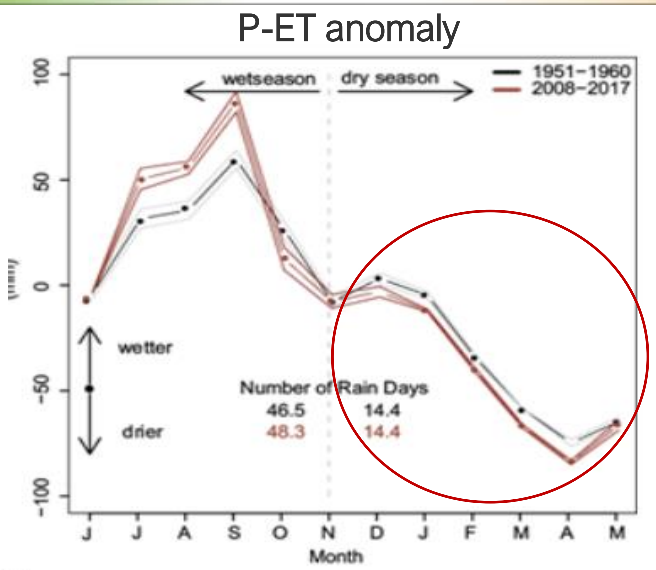
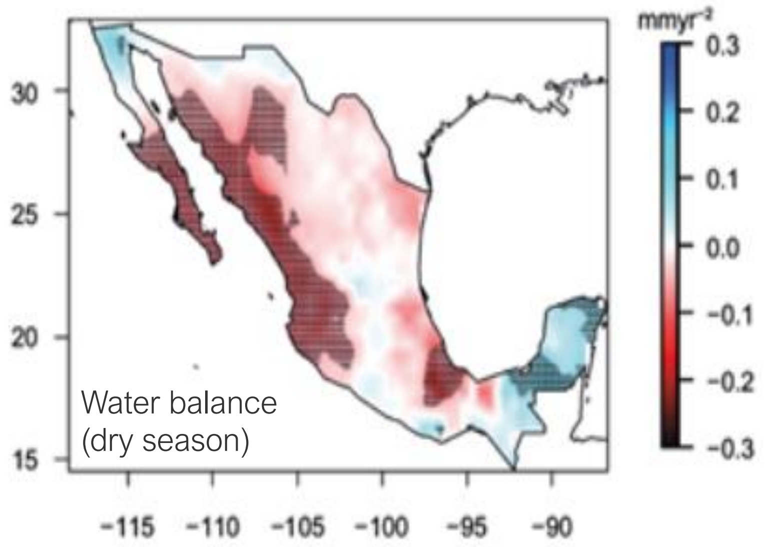
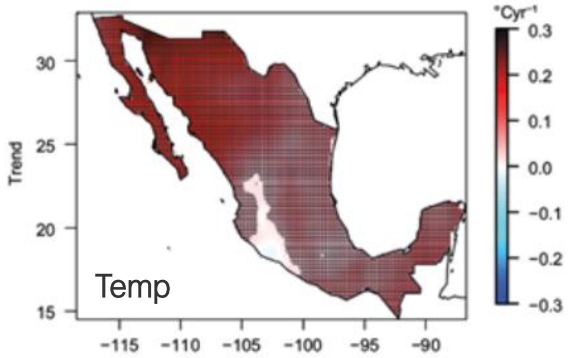
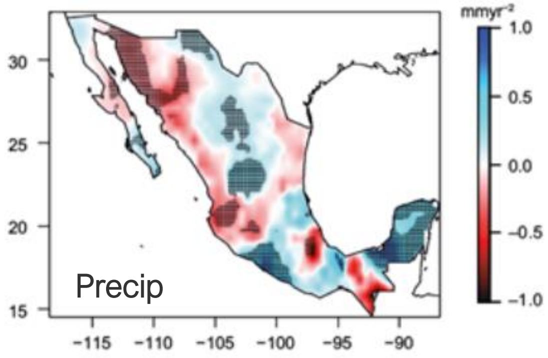












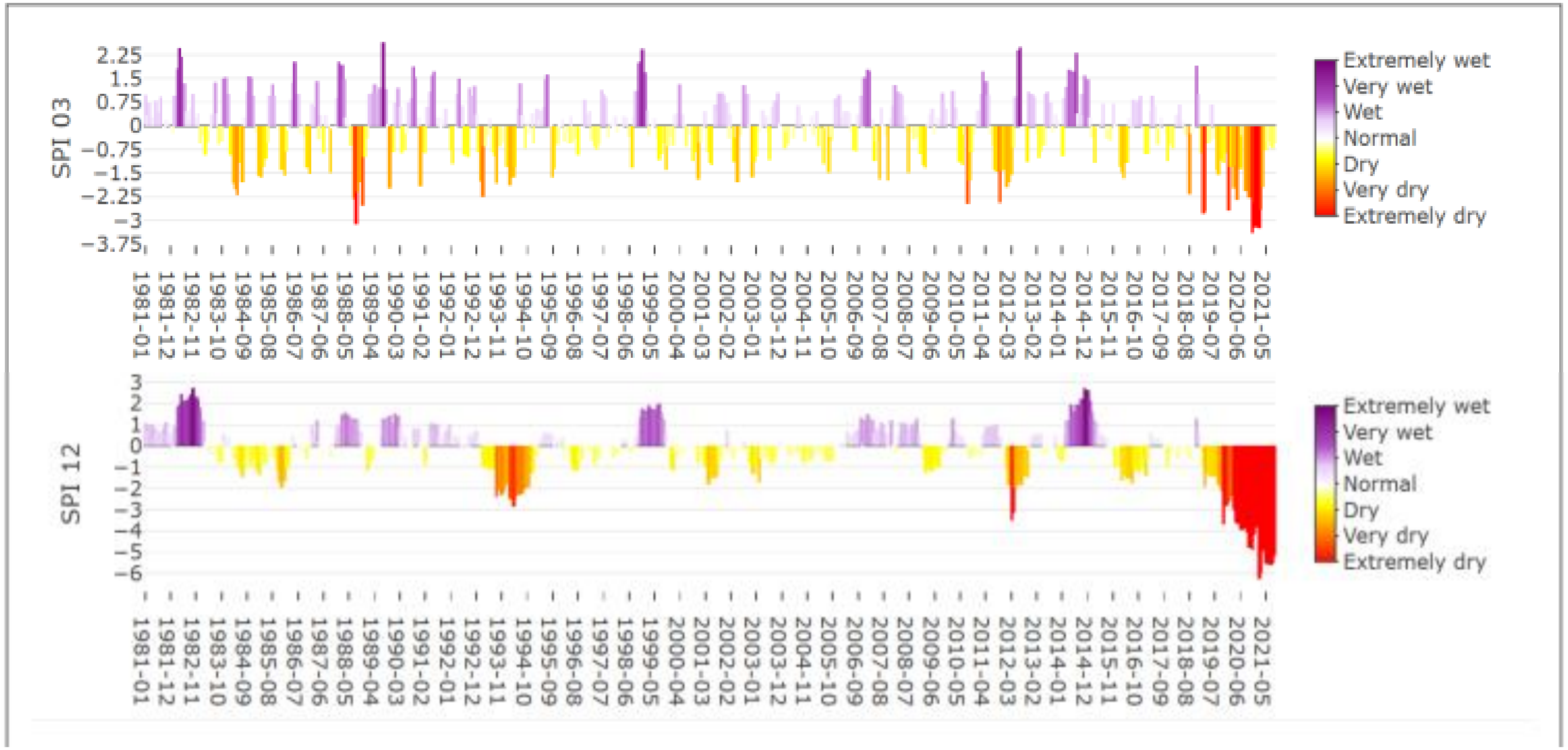
Long-term climate change:

- no trend in P (but expected to weaken in future).
- But: Water balance (P-ET): **Dry season got drier**

→ Attribution study (*Williams et al., 2021*): **19% of drought severity attributable** to man-made climate change

Source: Murray-Tortarolo, 2021. Atmosfera

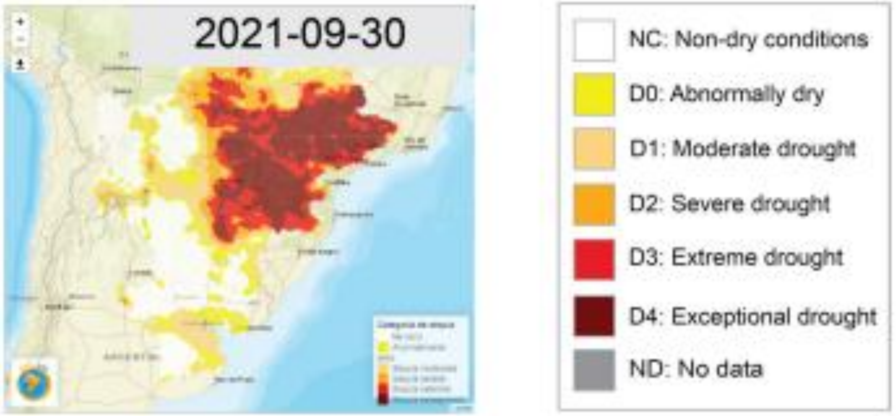
2019-2022 La Plata Basin Drought



Standard Precipitation Index for 3 and 12 months in Mato Grosso

2019-2022: **Prolonged drought**

- 3 years with lower-than-normal precip
- severe water deficit
- Paraná River with lowest levels in 77y
- Affected winter (corn, wheat, coffee) & summer crops (soybean)



Source: Pascale et al. (2021): Natural variability vs forced signal in the 2015–2019 Central American drought. *Climatic Change*

2019-2022 La Plata Basin Drought

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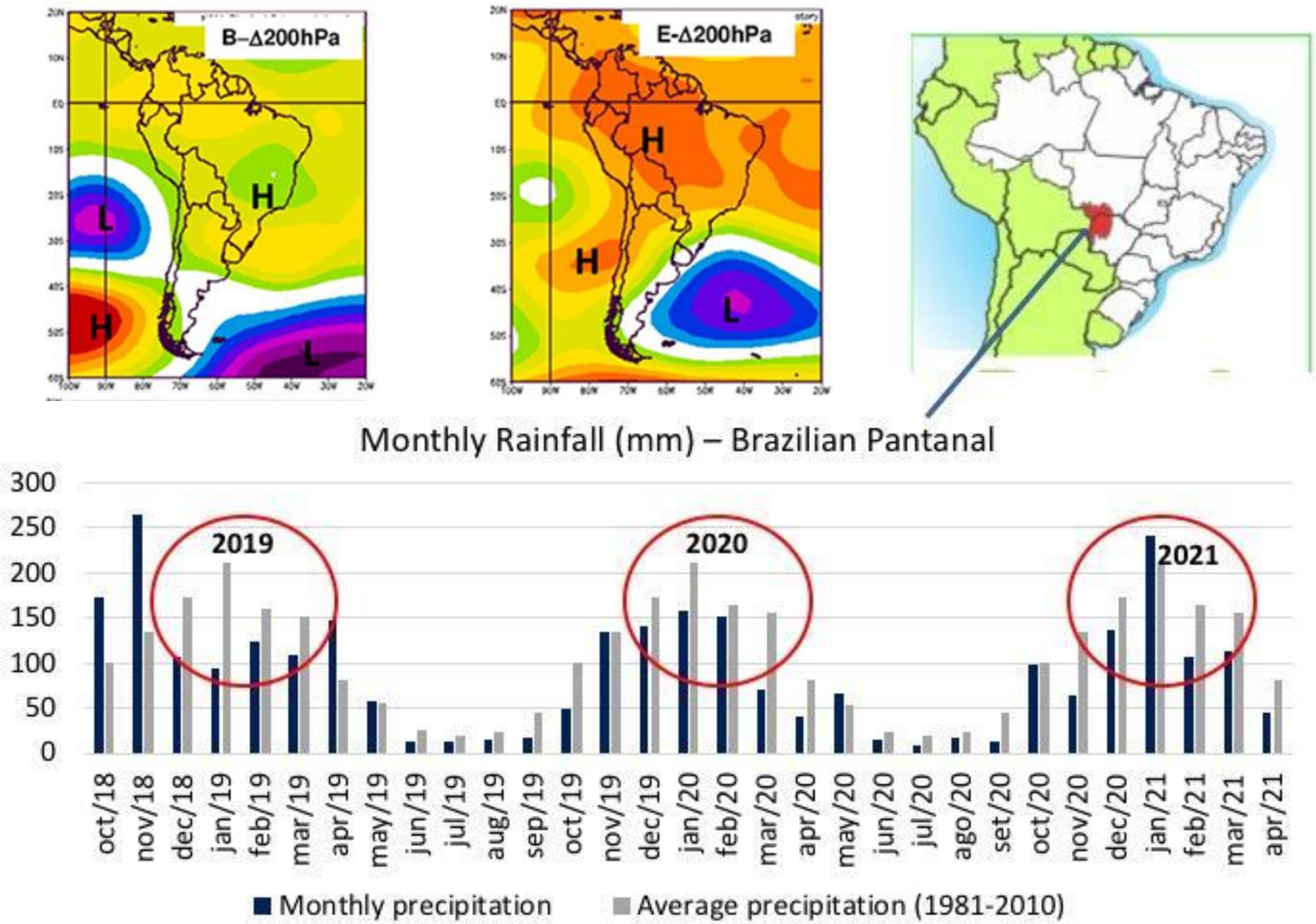

Source: Marengo et al. (2021): Extreme Drought in the Brazilian Pantanal in 2019–2020. *Frontiers in Water*

Suite of drivers:

- **Meteorological** situation:
  Stationary High **("Atmospheric blocking")** led to reduced moisture flux from Amazon + extreme **heat wave** Jan 2022
- **Climatological** situation:
  2 consecutive La Nina-summers (associated with lower mean rainfall)
- **Deforestation & disruption of water cycle:**
  Rainforests with higher capacity for evapotranspiration (ET)
  → Deforestation affects local energy balance & reduces rainfall in adjacent regions

2019-2022 La Plata Basin Drought

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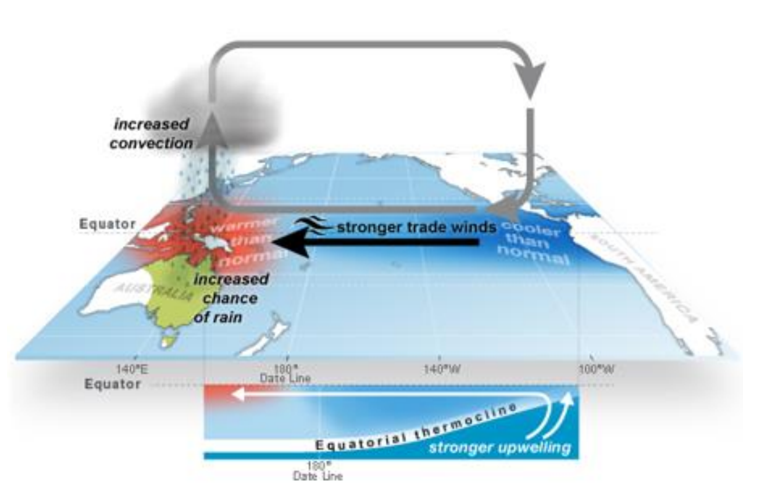
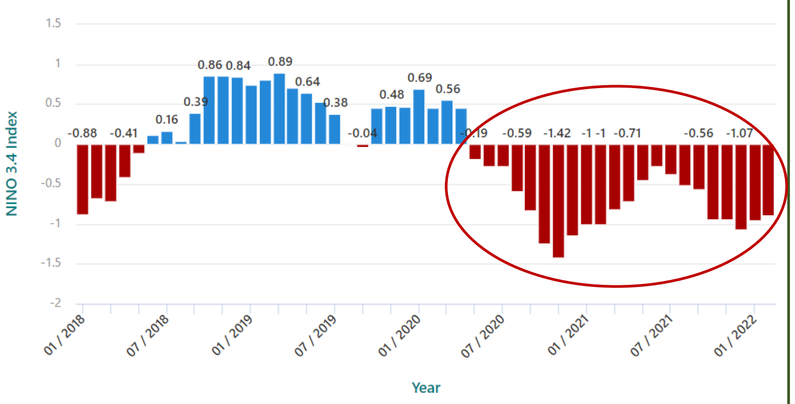
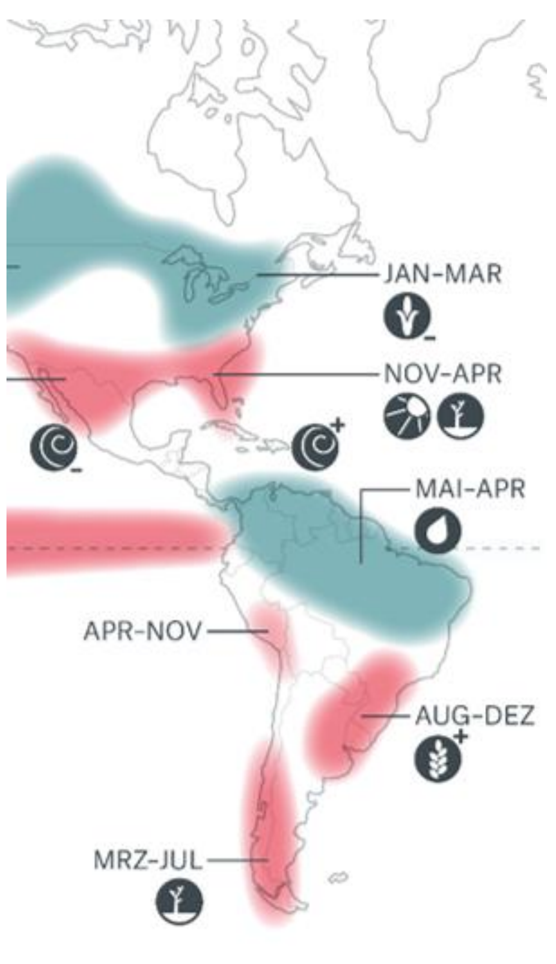


El Niño-Southern Oscillation (ENSO): **La Niña**

ENSO index (NINO3.4)





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2019-2022 La Plata Basin Drought

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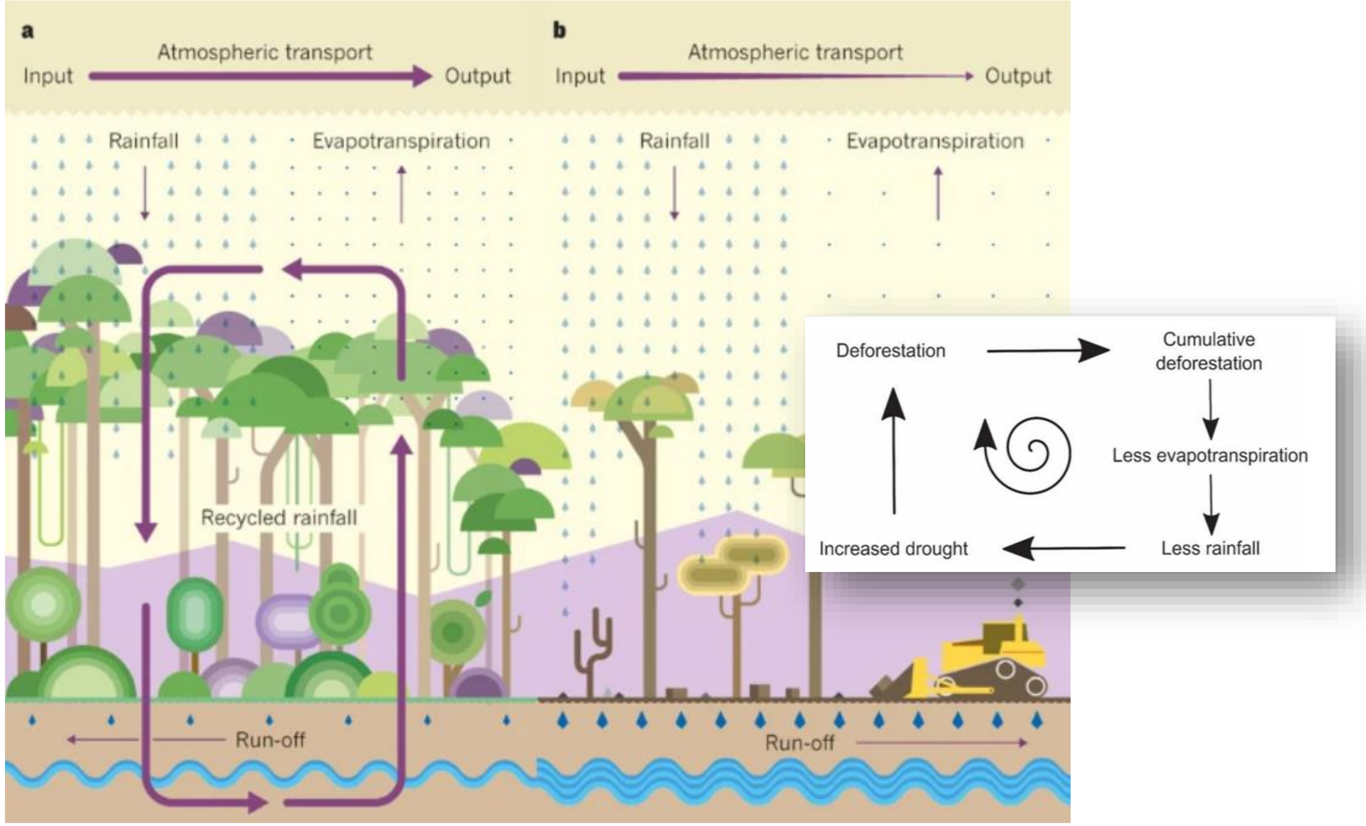

Sources:
Aragao et al. (2013): The rainforest's water pump. *Nature*
Staal et al. (2020): Feedback between drought and deforestation in the Amazon Arie. *Env. Res. Letters*

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2019-2022 La Plata Basin Drought

+ Long-term climate change:

- **Exacerbating droughts** due to increased temperatures & evaporation rates
- **Increasing likelihood** of other drivers

Suite of drivers:

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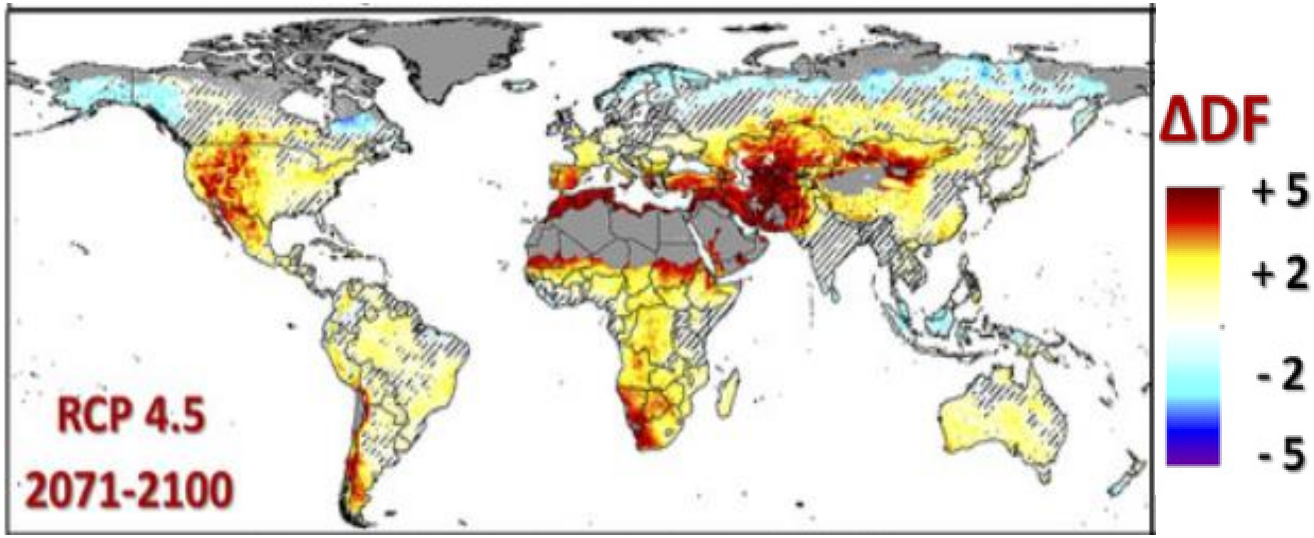
Drought – Future Projections



Differences in **drought frequency** (events/decade) in terms **SPEI** between 2071–2100 and 1981–2010 under RCP4.5

Source: Spinoni et al. (2020); based on large ensemble of RCMs

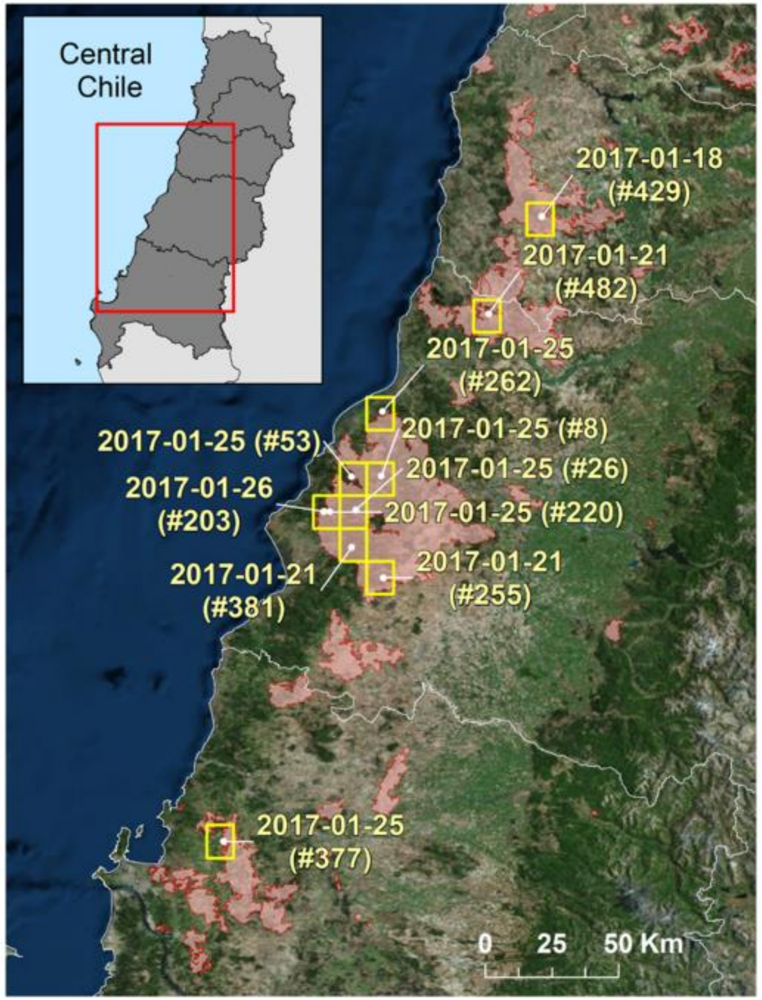
- **Increased drought risk** (frequency, intensity and length) for many regions of the world

- Most affected: **Subtropics** (here both ET & P driving)
- Hadley cell expansion works to expand dry subtropics poleward

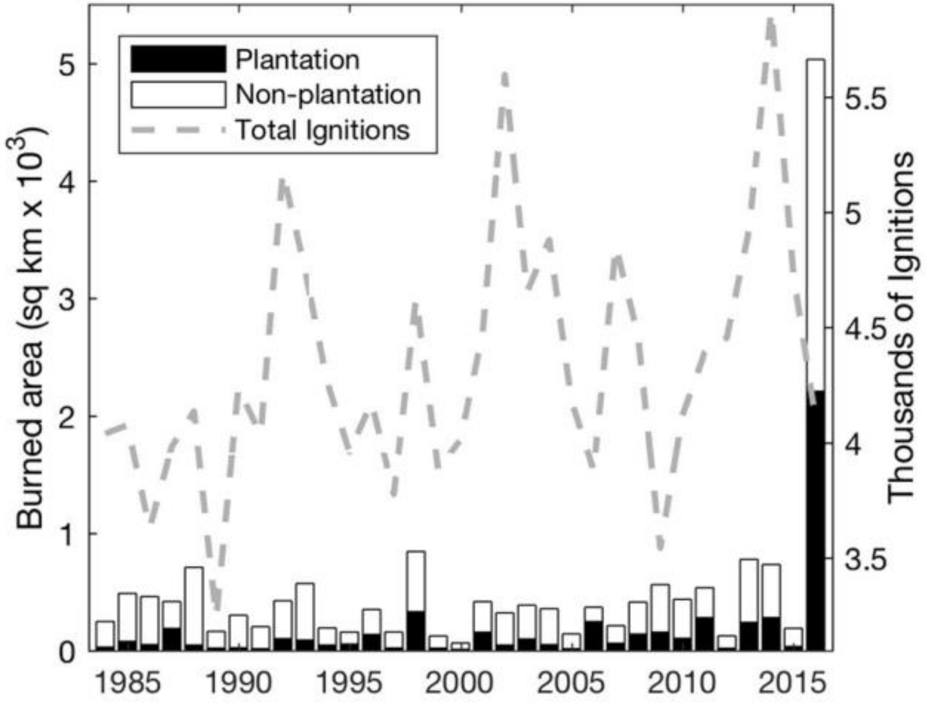
- **Temperature & Evapotranspiration as main driver** in many regions (often outweighs increases in mean precipitation)

Wildfire season 2016/2017 in Chile

- Chile's worst wildfires on record
- Affected an area of > 5000 km²
- Loss of forest plantations, olive orchards, vineyards, …



Location, date & rank (2002-2017) of the 2017 fires



Trends in area burned & number of ignitions for Central Chile.

Source: Bowman et al., 2019

Wildfire season 2016/2017 in Chile

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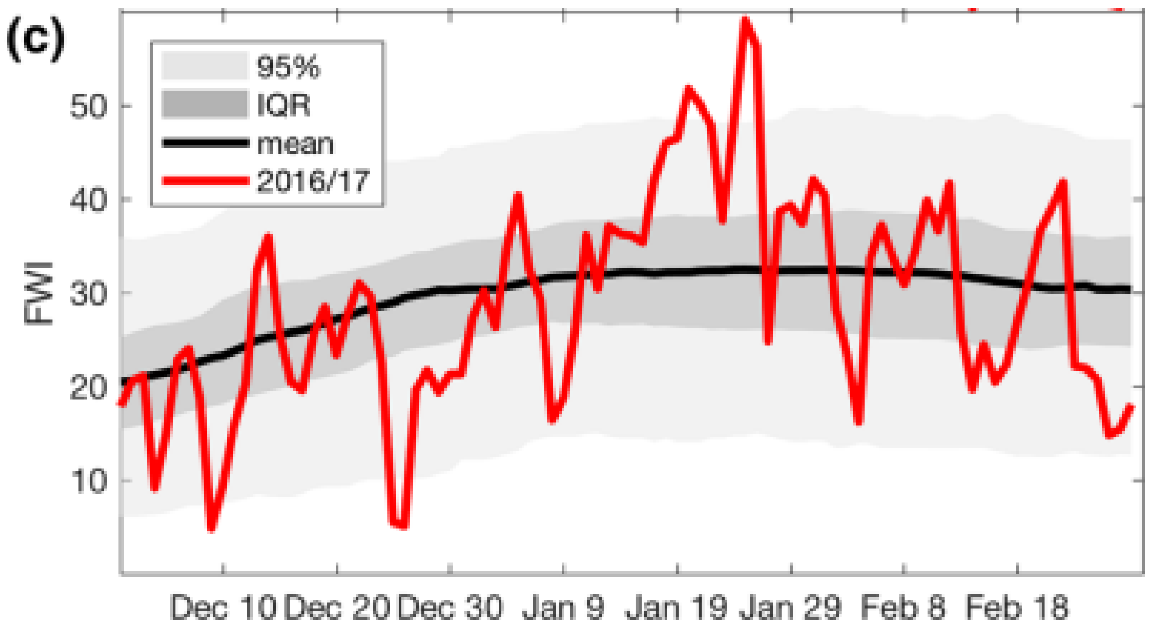

Fire Weather Index for Dec 2016–Feb 2017 over central Chile.
Black line: daily average (1981–2010)

Source: Bowman et al., 2019

Meteorological drivers:

- extended period of extreme heat in Dec (up to 45°C, all-time temperature record)
- Elevated Wind speeds (-> spread)
  → enhanced Fire Weather Index (FWI)

Non-climatic drivers:

- Land cover modification (<20% of native vegetation remaining)
- Extensive plantations of highly flammable species (e.g., Eucalyptus)

Wildfire season 2016/2017 in Chile

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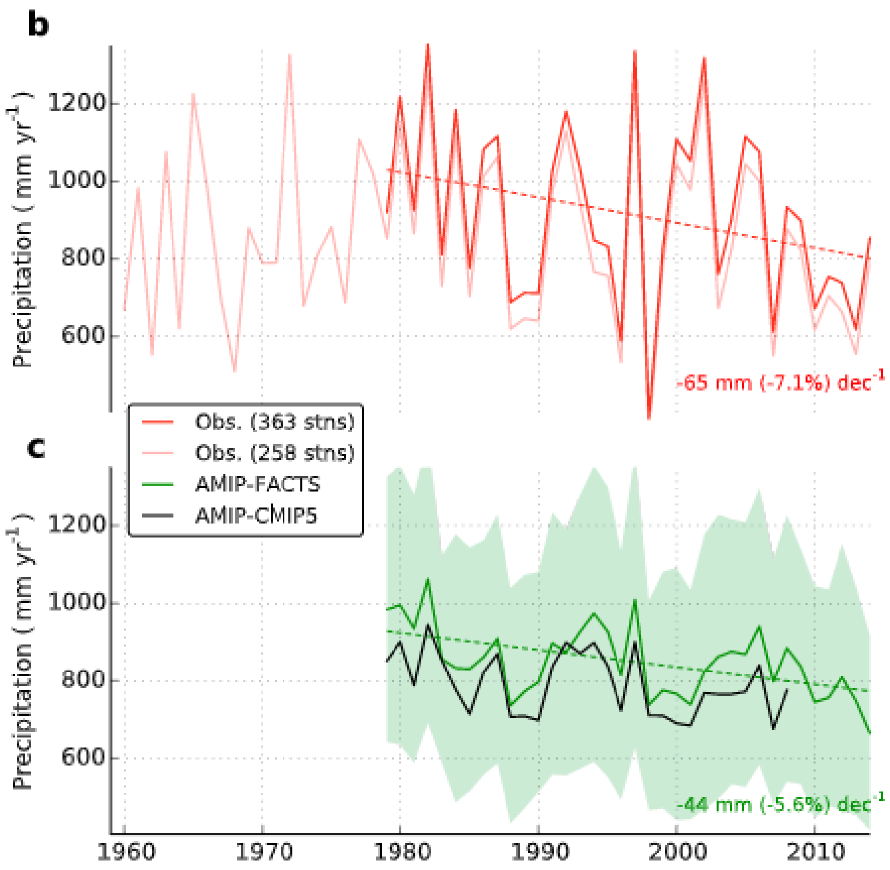

Annual precipitation trends since 1979 from **b** observations and **c** climate models.

Source: Boisier et al., 2016

Climatological drivers:

- **Long-term drying tendency** over most of central Chile, esp. since 2010
- Rainfall decline both due to
  - **climate change**
  - **natural variability**
    Pacific Decadal Oscillation
    -> southward position of storm tracks
- Fire Weather Index has been shown to have increased globally due to CC

Conclusions

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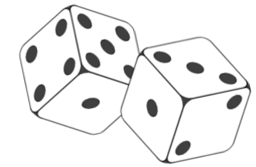
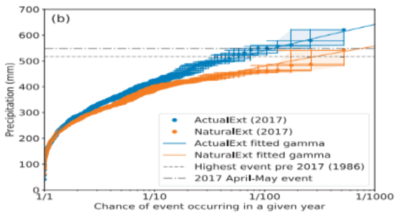
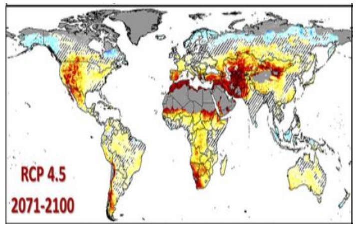
- Singular **events** largely driven by **weather & natural variability**, but **likelihoods** have already been affected by changes in the **background climate** due to **global warming**



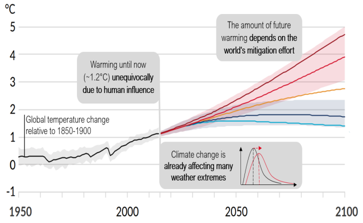
- Specifically, climate change has **already led to more frequent & extended periods of drought, enhanced wildfire weather and increased frequency of heavy precipitation**



- In the **future**, these trends are **expected to continue**.
  Additional drivers: **land use change, deforestation, ENSO changes** (uncertain)



➢ Slow climate system:
Some impacts **in near-term unavoidable** (→ relevance of **adaptation**); but **emission pathways** govern risks for **mid/long-term** (→relevance of **near-term mitigation**)



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