Intra-ACP Climate Services and Related Applications Programme – ClimSA

WORKSHOP - SADC Region

WEFE NEXUS, Climate Variability, and Environmental Monitoring

South Africa, Johannesburg, June 10th – 13th 2024

Climate Variability module – Practical session

Estimation of CV indicators

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South Africa, Johannesburg, June 11th 2024

Joint Research Centre

Climate Variability module – Practical session

- **The following climate variability index can be calculated using E-Nexus tool – Climate Variability Module**

	TEMPORAL AGGREGATION	INDEX
PRECIPITATION	Daily [mm/d]	Drought
	Monthly Maximum[mm/d]	Return period (mm, yy, user defined)
	Monthly cumulative[mm/m]	Excess/Deficit (annual, monthly) SPI User defined Return periods
	Annual maximum[mm/d]	Annual return period
TEMPERATURE	Daily	HEAT WAVES
	Monthly maximum	Return period (monthly, annual, user defined)
	Annual maximum	Annual return period

Dry Spells

Dry Spells - definition and analysis

- **Dry spells** refer to temporary periods with little to no rainfall, lasting for a few days or weeks.
- Unlike full-fledged droughts, which persist for longer durations, dry spells are shorter but can still have significant consequences
- While dry spells may be mistaken for minor weather fluctuations, their impact **can accumulate over time**, affecting ecosystems, agriculture, and water availability. Understanding the difference between dry spells and droughts is crucial for effective water management and disaster preparedness.
- Droughts, on the other hand, are characterized by a protracted absence of precipitation—such as rain, snow, or sleet—resulting in significant water scarcity.

Dry Spells

Dry Spells - definition and analysis

- Dynamics of this phenomenon are of great interest for the organisation of sowing times at the start of the vegetation period, as crop growth is extremely sensitive to alternating dry and rainy periods (Gornall et al., 2010)

EXAMPLE OF IMPACTS

•**Crop Growth**: During dry spells, soil moisture decreases, affecting crop growth. Plants may experience water stress, leading to reduced yields.
•**Livestock**: Water scarcity affects livestock, as they rely on natural water sources. Reduced grazing areas and limited water availability impact livestock health.
•**Irrigation Challenges**: Dry spells strain irrigation systems. Farmers must manage water resources efficiently to sustain crops.
•**Pest and Disease Risk**: Dry conditions can increase pest and disease prevalence, as stressed plants become more susceptible.
•**Timing Matters**: Dry spells occurring during critical crop stages (e.g., flowering, fruiting) can have severe consequences.

IMPORTANTNCE OF UNDERSTANDING AND MANAGING DRY SPELLS

- **Water Conservation**: Understanding dry spells helps farmers plan irrigation schedules and conserve water.
- **Crop Selection**: Choosing drought-tolerant crops minimizes losses during dry spells.
- **Early Warning Systems**: Monitoring weather patterns and predicting dry spells allows timely interventions.
- **Soil Health**: Proper soil management (e.g., mulching, cover cropping) improves resilience during dry periods

Dry Spells

Dry Spells – E-Nexus CV Module implementation

- **Dry spells** can be defined as periods of **at least 3 consecutive days characterised by less than 1mm (precipitation threshold) of daily rainfall** (Ratan et al., 2013; Chaudhary et al., 2017; Masupha et al., 2016; Froidurot et al., 2017).
- **Dry spells** detection is performed using **functions developed in R** (Cordano, 2015)
- In order to summarise the general variability over recent years, **a set of statistical indices is evaluated during the crop growing months of each year**: in this way, the evolution of droughts is represented for the entire period covered by the input time series of daily precipitation.
- Once all the **dry spells** have been detected, the process produces a **synthetic characterisation in the form of numerical values displayed on spatial planes**. In particular, the results consist of a set of files (each corresponding to an index) containing values produced at annual frequency (number of droughts, average and maximum length, percentile values, etc.) and also grouped into factors such as average and deviation, including L-Moments.
- The **trends are obtained using the Mann-Kendall statistical tests** (Mann, 1945; Kendall, 1975) and the **Sen method** for magnitude of the trend (Sen, 1968), with a hypothesis of significance linked to a p-value of 0.05, and the general slope shows where the number of droughts may increase or decrease with the passage of years.

Dry Spells

PRACTICE WITH E-NEXUS

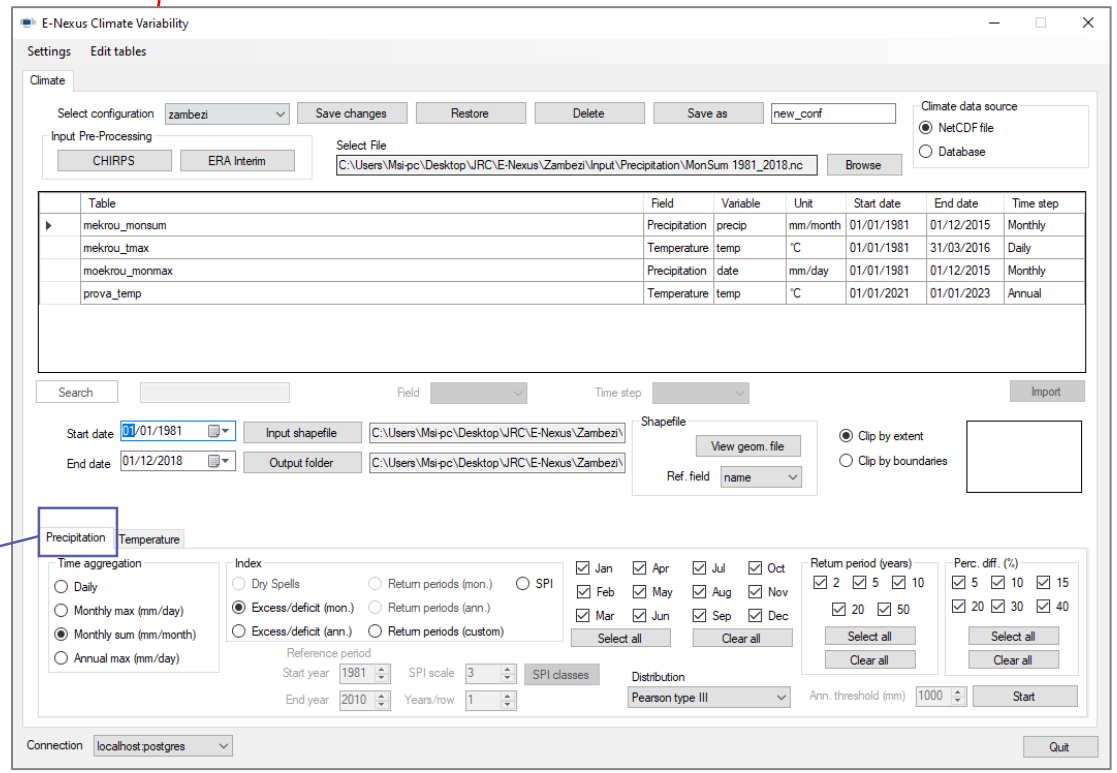
Precipitation indices

- The temporal aggregation of input data induces the types of indices that can be calculated.
- In case of monthly data, it is possible to choose particular months on which(s) to focus the process.
- The indices to calculate are Drought, Return Time, and Excess deficit (annual or monthly).

Specific Parameters

- Temporal aggregation of input values
- Index to calculate
- Month to choose for index evaluation
- Desired return time for index calculation
- Diff. Cent. (%) (excess/deficit percentages) desired for return period evaluation (excess/deficit indices)
- Statistical distribution for return period and SPI evaluation
- Ann. precipitation threshold desired for evaluation of custom return times

Input Setup



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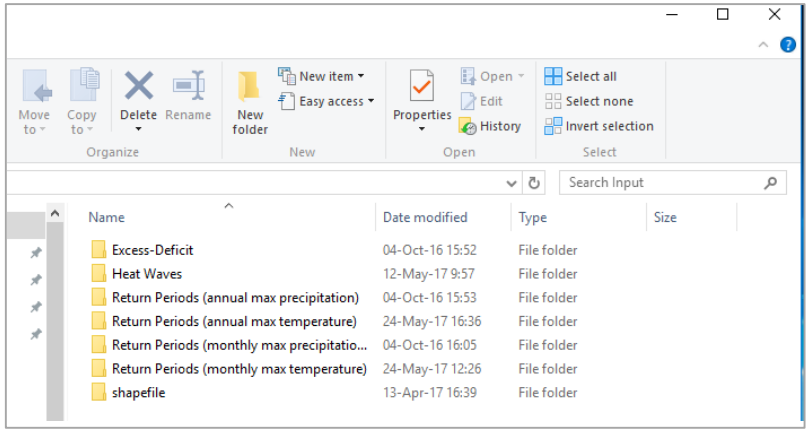
Dry Spells

Precipitation indices

All required input data are stored into ***Input*** folder. More in detail, inputs are located in folders named after the specific process to execute. ***Shapefile*** folder contains *.shp* files related to available geographical domains.

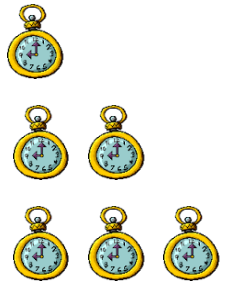


* Performances affected by hardware specifics

Precipitation source: CHIRPS
https://data.chc.ucsb.edu/products/CHIRPS-2.0/global_daily/netcdf/p05/

Temperature source : ERA5 re-analysis
https://cds.climate.copernicus.eu/cdsapp#!/dataset/reanalysis-era5-single-levels?tab=form

Process duration*



Short (<1 minute)

Average (5:10 minutes)

Long (>10 minutes)

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Dry Spells

Precipitation indices

A dry spell is defined as a prolonger period (>=3 consecutive days) characterised by the lack of significant daily precipitation (< 1 mm). This process produces a set of maps describing different aspects related to dry spells occurring in the analysed period (**1981-2023**), focusing on the seasonal window from November to March.

Duration: 

General parameters →

- **Folder**: *Input\.chirps_daily_19812023.nc*
- **Input Shapefile** : *Shapefiles\Gadm36_L4_SampleArea_Box1.shp*
- **Output folder**: free choice
- **Start time**: 01 Jan 1981
- **End time**: 31 Dec 2023

Specific parameters (tab **Precipitations**) →

- **Temporal aggregation:** daily
- **Index**: Dry spells
- **Month**: NOV-DEC-JAN-FEB-MAR

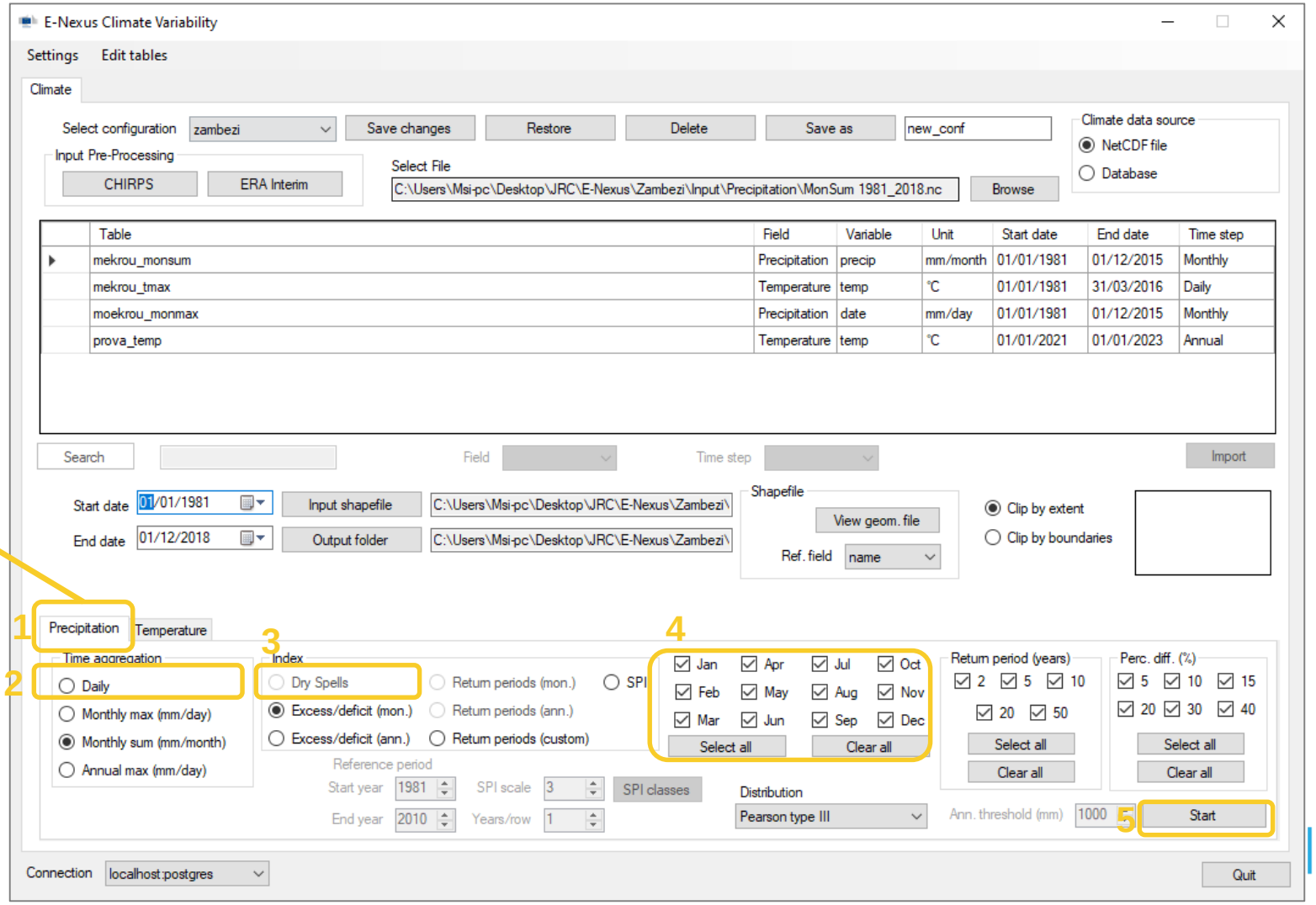
→ **Run** ←

Dry Spells

Precipitation indices

Specific parameters
(tab **Precipitations**)

1. Variable = Precipitation
2. Aggregation = Daily
3. Index = Dry Spells
4. Months = NOV, DEC, JAN, FEB, MAR
5. Start the tool

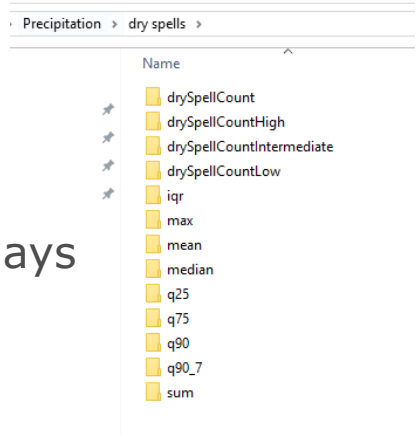


Dry Spells - OUTPUTS

*In order to summarise the general variability over recent years, **a set of statistical indices is evaluated during the crop growing months of each year**: in this way, the evolution of droughts is represented for the entire period covered by the input time series of daily precipitation.*

Precipitation indices

All created files will be placed in the following folders:



- ***drySpellCountLow***: number of dry spells with duration between 3-10 days
- ***drySpellCountIntermediate***: number of dry spells with duration between 11-21 days
- ***drySpellCountHigh***: number of dry spells with duration over 21 days
- ***drySpellCount***: total number of dry spells
- ***median***: 50th percentile of dry spells duration
- ***max***: maximum of dry spells duration
- ***q25***, ***q75***, ***q90***: 25th , 75th and 90th percentiles of dry spells duration
- ***mean***: average duration of dry spells
- ***q90_7***: 90th percentile of dry spells duration (only 7+ days dry spells)
- ***iqr***: difference between 75 and 25 percentiles of dry spells duration (**I**nter**Q**uartile **R**ange)
- ***sum***: total duration of dry spells

Along annual data for every index, the process also provides **L-Moments and statistical evaluation with results obtained by Mann-Kendall statistical testing and significance** assumption related to a p-value of 0.1, along with the values of dry spells overall slope showing their trend over the years.

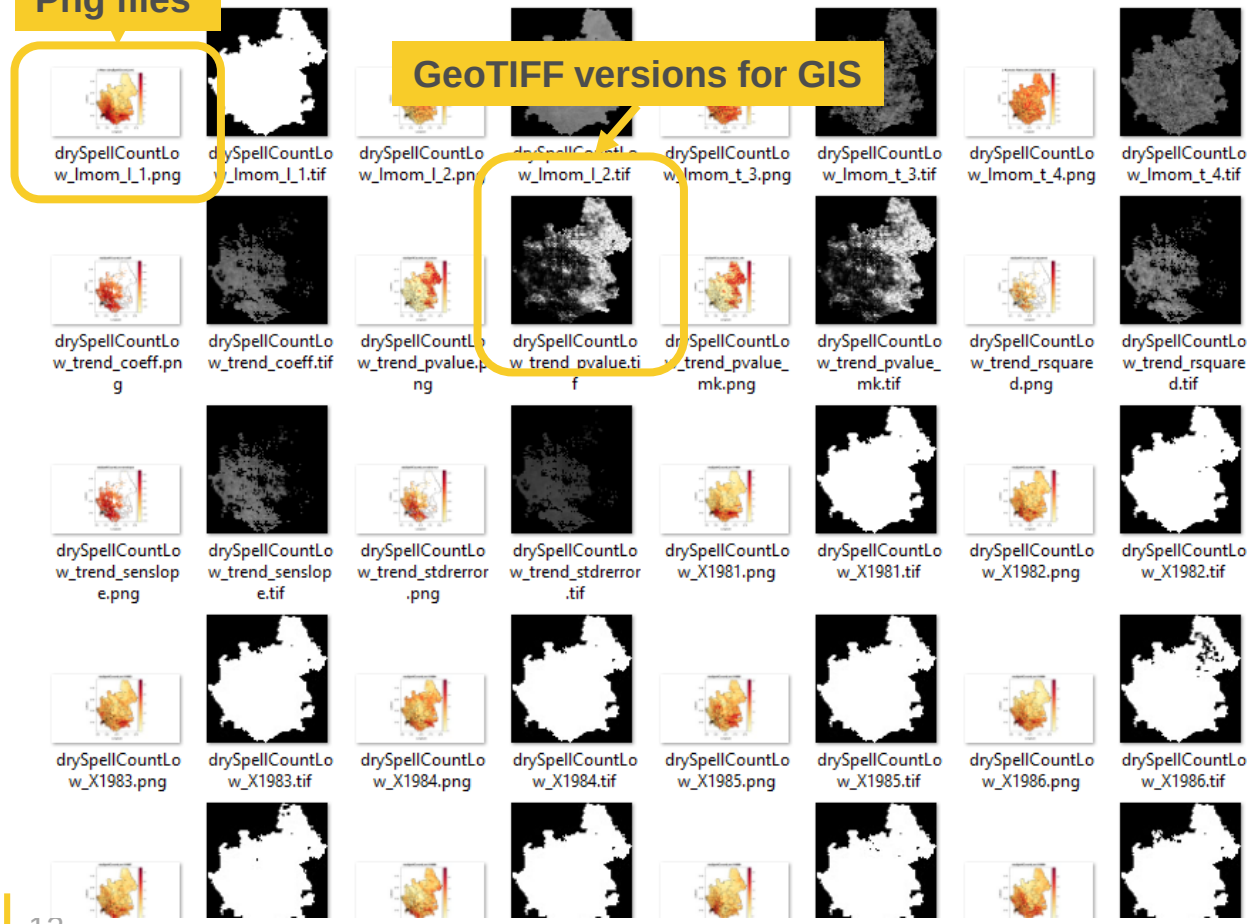
Dry Spells - OUTPUTS

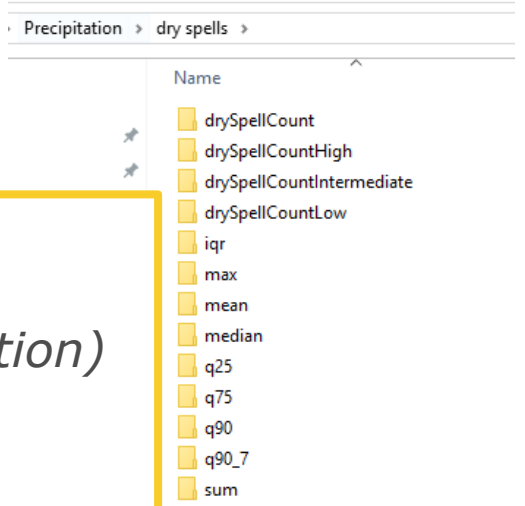
SAMPLE FOLDER CONTENT

Precipitation indices

Png files

GeoTIFF versions for GIS





Index list

L-Moments

1 mean
2 L-CV (standard deviation)
3 L-Skewness
4 L-Kurtosis

Statistics

Trend
Slope
R-squared
Sen slope
Standard error

Annual values

From 1981 to 2023

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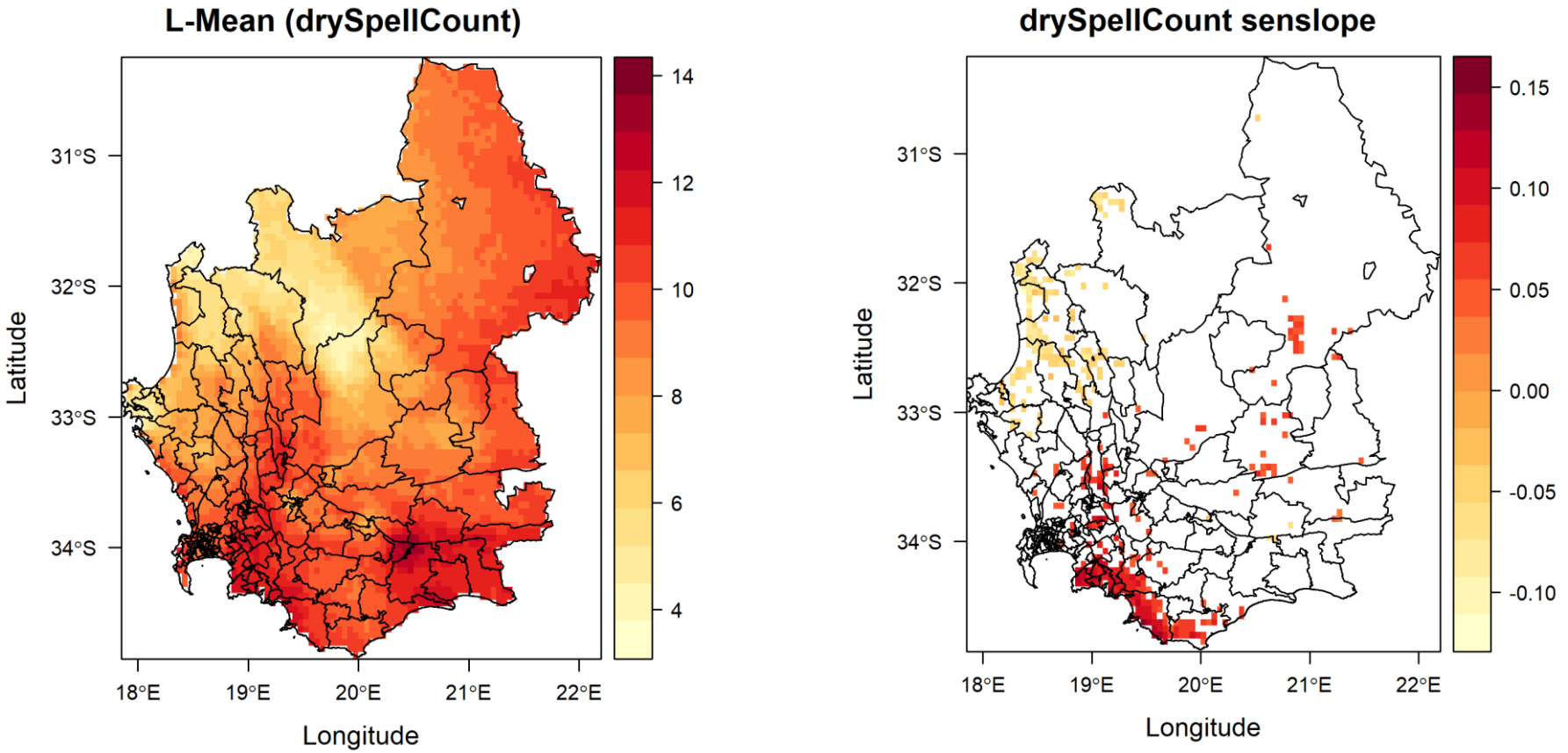
Dry Spells - OUTPUTS



Total number of annual dry spells, mean (left) and trend slope (right) for years 1981-2023

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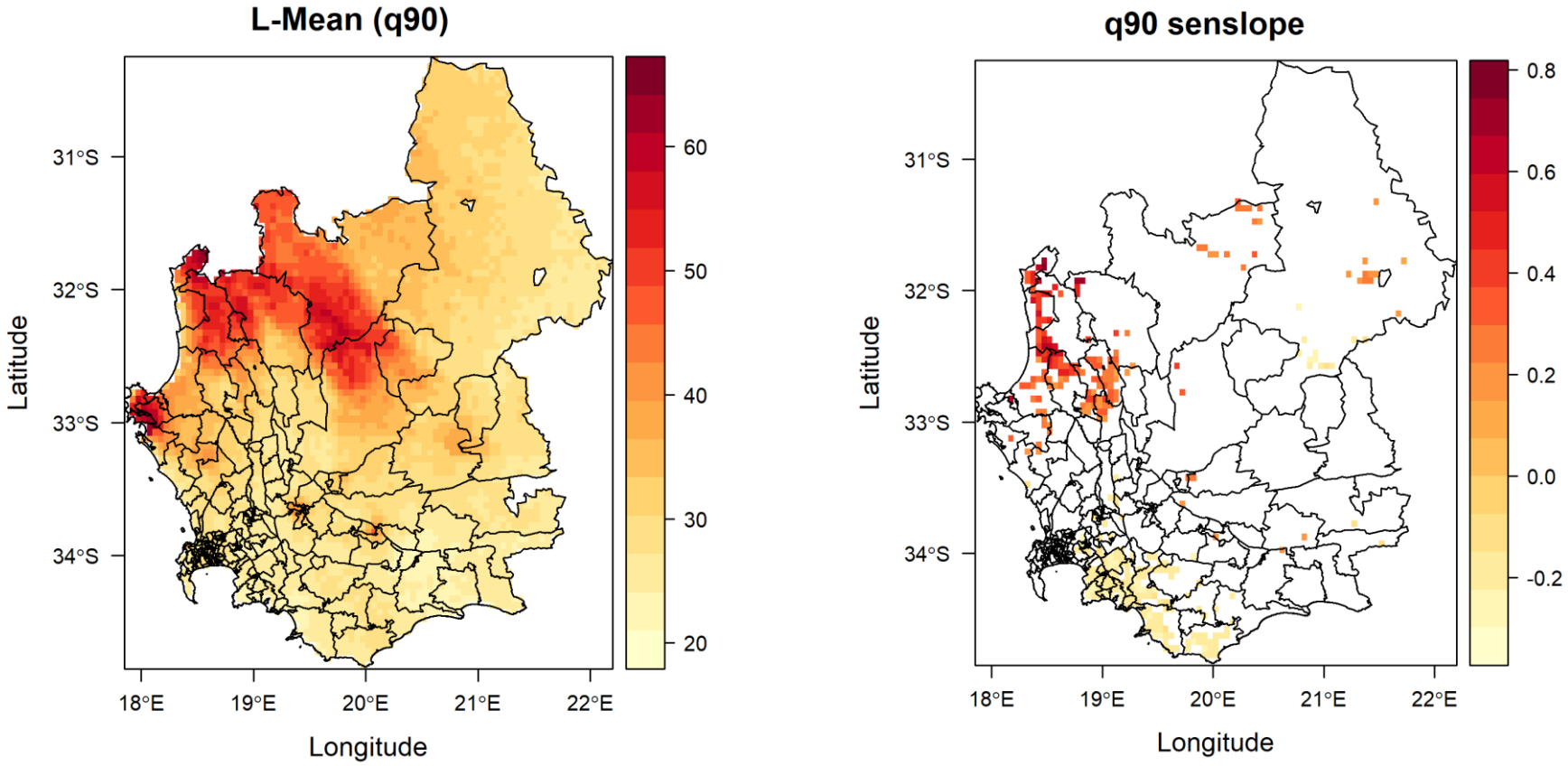
Dry Spells - OUTPUTS



Annual 90th percentile of dry spells duration, mean (left) and trend slope (right) for years 1981-2023

Thank you

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