# FACTORES DE LA VARIABILIDAD ESTACIONAL DE LAS PRECIPITACIONES EN LAS MESETAS DE ANGOLA Y NAMIBIA

## *DRIVERS OF SEASONAL RAINFALL VARIABILITY OVER THE ANGOLAN AND NAMIBIAN PLATEAUS*

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*SUMMARY*

*Most of southwestern African economies rely on rudimentary agriculture, highly dependent on precipitation, due to the lack of a better land management and technology these regions are deeply vulnerable to climate variability and change. This work focused on using reanalysis, mixed ground and satellite-based rainfall products and observations from local weather-stations to perform a climatological analysis focussing on atmospheric circulation, moisture transport and their relationship with rainfall anomalies over the Angolan and Namibian Plateaus. Results show a stronger (weaker) Zambezi low level jet (LLJ) magnitudes associated with above (below) normal rainfalls over the region. The Angola Low in its tropical phase is associated with deeper moisture convergence, leading to higher amounts of precipitable water within the air column, enhancing precipitation. The major moisture source of rainfall is the Indian Ocean, advected to the region mostly via the Zambezi LLJ.*

Austral summer rainfall occurring across SW Africa originates in low-level transport of water vapour, mainly from three sources: Atlantic Ocean, Indian Ocean, and equatorial Africa (Barimalala et al., 2021; Munday & Washington, 2017; Rapolaki et al., 2020). Over the Indian Ocean, easterly low-level moisture fluxes are generally influenced by the Mascarene anticyclone. From the Atlantic Ocean, westerly humidity fluxes onto southern Africa are related to a semipermanent low-pressure system centred near the Angola-Namibian border (named Angola Low, or AL) and St. Helena high pressure (Figure 1). The convergence of Indian and Atlantic Ocean low-level moisture fluxes enhances convective processes associated with the ITCZ over the subcontinent, which is placed south of the equator during this time of year, promoting cloud formation and precipitation (Barimalala et al., 2018, 2021; Barry & Chorley, 2003; Huntley et al., 2019). The predominance of an easterly wind regime over the subcontinent allows moisture transport towards continental southern Africa. However, by dynamical adjustments, Madagascar island topographic barriers shift this easterly flow southwards, generating a cyclonic feature over the Mozambique Channel, named Mozambique Channel Trough (or MCT). This cyclonic system occurs mostly in austral summer and is usually placed south of the Mozambique Channel (Barimalala et al., 2020).

This work focused on using reanalysis, mixed ground and satellite-based rainfall products and in-situ observations focussing on a climatological analysis on atmospheric circulation, moisture transport and their relationship with rainfall anomalies over the Angolan and Namibian Plateaus. Results clearly show that a stronger (weaker) Zambezi low level jet (LLJ) magnitudes associated with above (below) normal rainfalls over the main Angolan and Namibian plateaus. The Zambezi LLJ fluxes are moderately controlled by Mozambique Chanel Trough and Angola Low intensities, while the Limpopo LLJ intensities have very low influence from the MCT and AL, respectively. The AL in its tropical phase is associated with deeper moisture convergence and stronger vertical velocities, enhancing precipitation over the region. Given the current lack of observations and projected climate change, further research and investments are

urgently needed in the region regarding the expansion of the surface data network. EU-funded projects such as FRESAN (Strengthening of the Nutricional Resilience and Food Security in Angola) aims to improve the lack of in-situ observations by installing weather stations, rain gauges and other facilities to develop agriculture and food production over regions severely affected by humanitarian crisis (Carvalho et al., 2017; Lourenco et al., 2023).

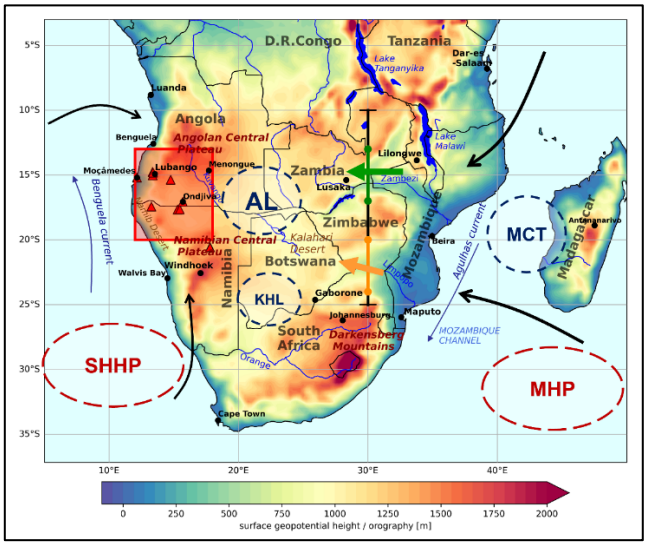


**Figure 1 - Surface geopotential height (or orography) over southern African subcontinent (shading colours), retrieved from ERA5. Red triangles located in SW Africa represent the exact location of 10 SASSCAL weather stations. Values of zonal IVT for Z-LLJ and L-LLJ were retrieved with respect to green [13-17ºS] and orange [20-24ºS] sections, respectively. Green and orange arrows Thick black arrows represent the main routes of water vapour transport towards the subcontinent. Important synoptic and mesoscale features are represented with the acronyms AL (Angola Low), MCT (Mozambique Channel Trough), KHL (Kalahari Heat Low), SHHP (St. Helena High Pressure) and MHP (Mascarene High Pressure).**

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