CLIMAX WP1
Physical processes explaining climate variability in South America

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Addresses first objective of the project

"*to better understand the* ***combined role of remote and local drivers on South American climate variability*** *from sub-seasonal to decadal timescales, and its impact on the occurrence and intensity of* ***extreme events***"

- using historical data and model simulations.
- focus on the *effects of land use change from the Amazon to SSA and their impact on climate extremes.*
  - Impacts of tropical deforestation and degradation on changes of moisture transport and precipitation development in SSA
  - Emphasis on assessing the impacts of land-use and land cover change on the hydrological conditions of river basins in SSA, specifically droughts

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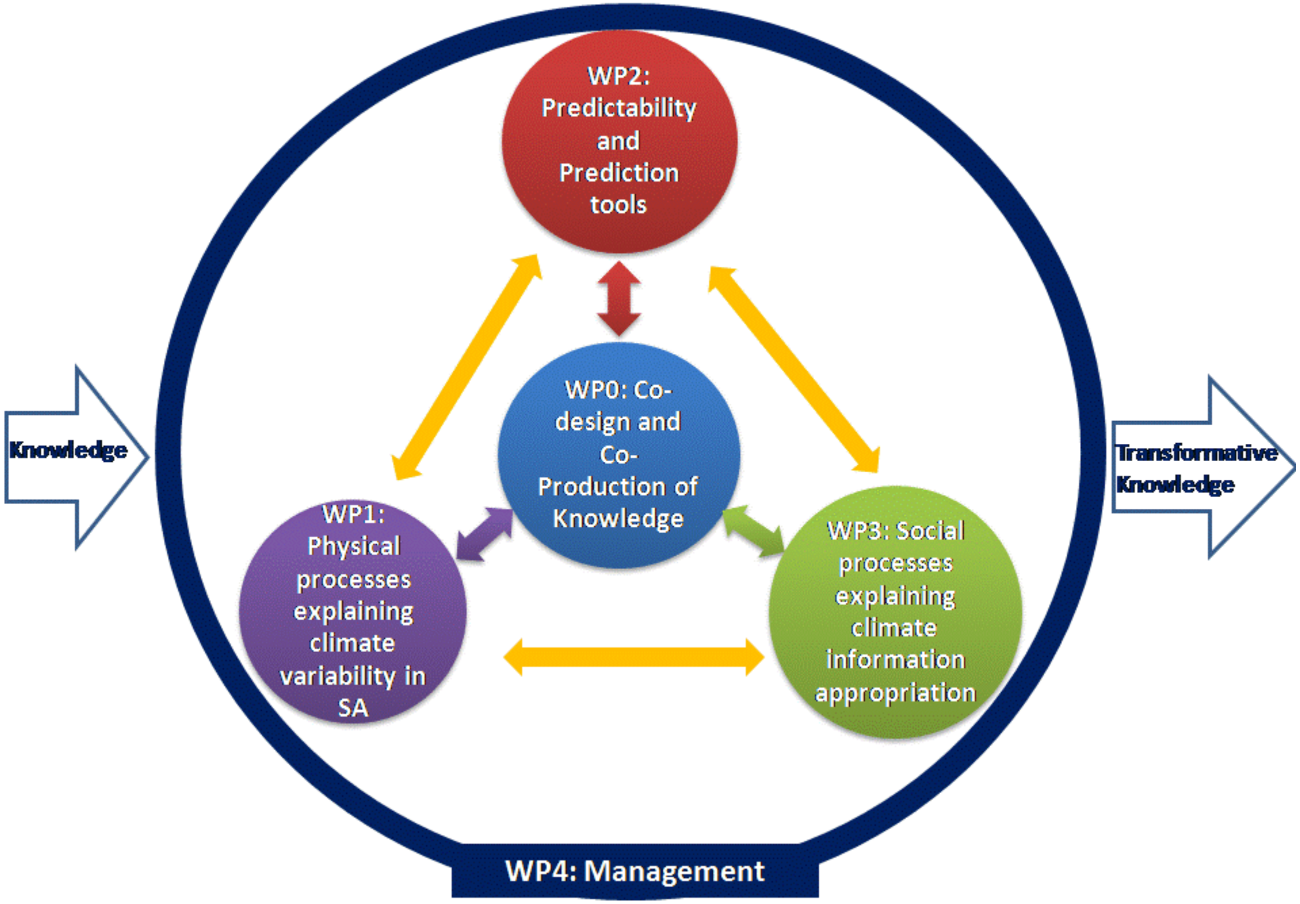
Position of WP1 in the CLIMAX project



WP1: 4 objectives

- **O1: How**
  - large-scale climate patterns (e.g. MJO, ENSO, SAM,PDO) through associated teleconnections
  - regional land surface conditions and
  - Remote and local sources of variability

  influence precipitation variability in SSA

- **O2: Identify the main (remote and local) physical mechanisms linked to extreme precipitation**
  - in selected areas of tropical and SSA and link them to the regions of highest climate predictability identified in WP2.
  - analysis of the combined influence on precipitation extremes over SSA by different climate phenomena (such as ENSO and MJO) occurring simultaneously.

WP1 O1 and O2 are addressed in the first two tasks

- **T1: Analyses of precipitation variability and associated climate conditions at both large and regional spatial scales and from sub-seasonal to decadal timescales by applying empirical orthogonal functions (EOFs), correlations, composites and regressions analyses (INPE, CNRS/UMI3351)**

- **T2: Analyses of the variability of soil moisture at the surface and in the rooting zone in SSA using the Global Land Data Assimilation System (GLDAS) and climate model outputs (CHFP, CFSv2, ENSEMBLES), from subseasonal to decadal time scales. Explore their links with the climate patterns analyzed in WP1.T1. (CNRS/UMI3351, INPE)**

And its findings will be described in these two deliverables

- **WP1.D1: Scientific Articles/ Report about the regional variability of precipitation and soil moisture**
- **WP1.D2: Scientific Articles/Report on the impact of climate variability on forest fragmentation/degradation**

WP1 O3

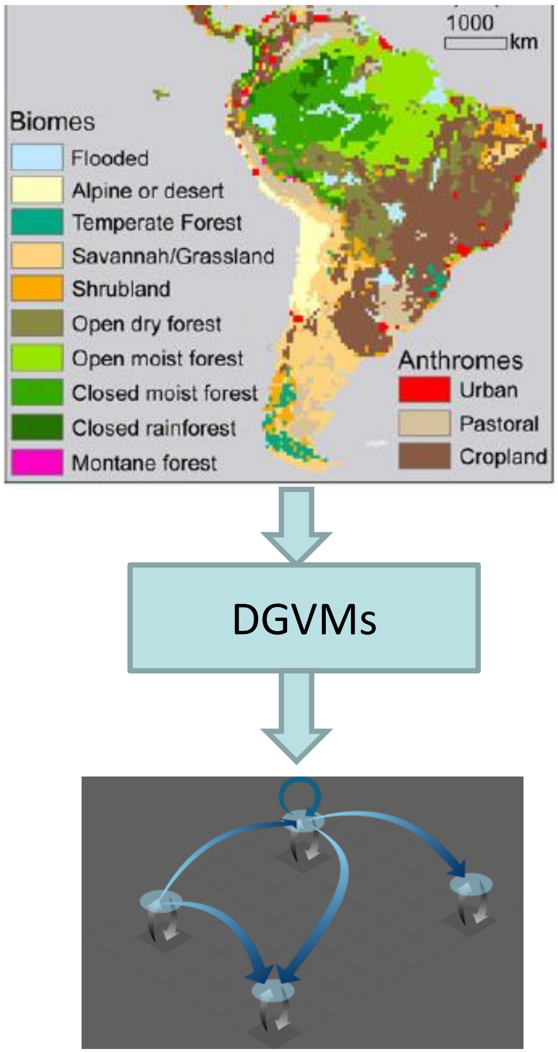
- **O3: how historical land-use and forest cover change in Amazon and southeastern Brazil influence continental moisture transport.**
  - **The influence of land-cover driven changes in moisture transport on climate variability in SSA will be particularly addressed.**
  - **Quantify impact of changes in moisture transport and of land-use change on river hydrology in Southeastern Brazil.**

WP1 O3 is addressed in Task3, 4 and 5

- **T3: Analyze the role of forest disturbance and land-use change on forest fragmentation and degradation using a moisture recycling network model, and the dynamic vegetation models, LPJmL, LPJmL-FIT and INLAND.**
  - **Investigate drought-induced changes in water conductivity in tropical trees and their impact on evapotranspiration and climate feedbacks in the Amazon and potential climate feedbacks (PIK, TUM, INPE)**
- **T4: Assessment of seasonal to decadal precipitation variability associated with the amount and direction of moisture transport and recycling in South America**
  - **apply CPTEC climate model and the moisture recycling network model which integrates drivers of climate and land-use change.**
  - **Effects of biodiversity, simulated by LPJmL-FIT (PIK), vs. effects of drought-related mortality in a gap model (LPJ-GUESS, TUM) on simulated evapotranspiration will be compared.**
  - **Investigate impacts of changes in Amazon land surface characteristics on rainfall variability in SSA using the CPTEC/INPE AGCM and INLAND dynamic vegetation model. (PIK, TUM, INPE)**

T3: What could that work in detail?

Land-use change scenarios

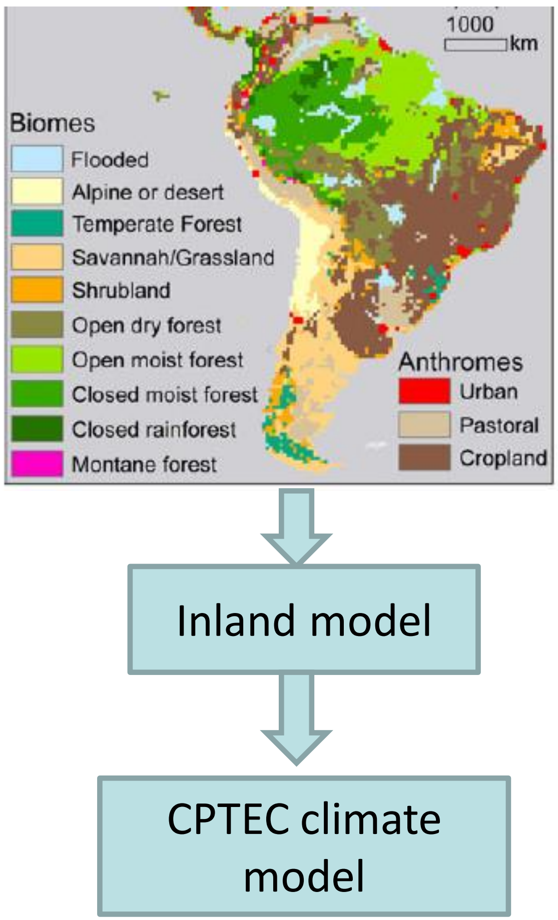


PIK, TUM and INPE collaborate on

- **The dynamic vegetation models (DGVMs) LPJ-GUESS, LPJmL-FIT and INLAND are driven by land-use change scenarios and either contemporary or near-future climate**
- **The models will be tested and improved to better represent drought-induced mortality (i.e. cavitation), plant traits representing water-use-efficiency of the forest → specific for each DGVM**
- **Simulated evapotranspiration is used as an input to the moisture recycling network model (cf. Zemp et al), respective changes on atmospheric moisture transport are mapped and compared to data-based approach**

→ We can identify the role of processes on moisture recycling

T4: how would that work in detail?



- **Apply improved INLAND model inside CPTEC climate model**
- **Use output from CPTEC model to build moisture recycling network to visualize changes in atmospheric moisture**

And its findings will be described in these 3 deliverables

- **WP1.D3: Scientific Articles/Report on the assessment of land use change on moisture transport and rainfall variability (PIK).**
- **WP1.D4: Scientific Articles/Report on the impact of land use change on the hydrological conditions in SSA basins**
- **WP1.D5: Scientific Articles/Report on the role of agroforestry on severe droughts in SSA.**

WP1 objective 4

- **O4: To co-design and co-develop new climate monitoring tools based on the knowledge resulted from achieving the previous WP1 objectives, for climate variability in SSA.**

WP1 Task 5 and 6 address Objective 1 & 4

- **T5: Evaluation of the relationship between local land use change and hydrological change in SSA.**
  - Study of the potential effects of agroforestry on severe drought events. Historical series of hydroclimatic variables will be correlated with climate variability indexes, land surface and vegetation properties to explore the hydrologic response through numerical experiments (INPE, CNRS/UMI3351).
- **T6: Development of regional climate indices to monitor climate variability in SSA at subseasonal and seasonal timescales by applying combined EOFs to sets of key variables identified in WP1.T1 and T2.**
  - Moreover, an index illustrating the importance of source and intermediate moisture transport regions and their influence on SSA will be developed, based on WP1.T3 results.
  - Variables that can be used as an early warning signal of critical climatic conditions will be co-designed and co-produced with the other WPs and coordinated by WP0, see section 11 (CNRS/UMI33513351, PIK, INPE).

PIK

WP1 Deliverable WP1.D6 summarizes findings from task 5 and 6

- **WP1.D6: Prototype of climate monitoring indexes and tools for the regions considered in the two WP0 case studies to be disseminated through the web portal developed in WP4.**