



Empirical Statistical Downscaling (ESD): Analog Method

**CORDEX Central America and South America
Training Workshop on Downscaling Techniques
La Paz, Bolivia, June 25-27 2018**

ESD Techniques

ESD methods can be classified according
the type of the Statistical Technique

Transfer Functions

Based on linear or nonlinear
regression models

Analogs and Weather Typing

Weather Generators

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Analogs and Weather Typing



The downscaling methods relate weather classes to local and regional weather conditions.

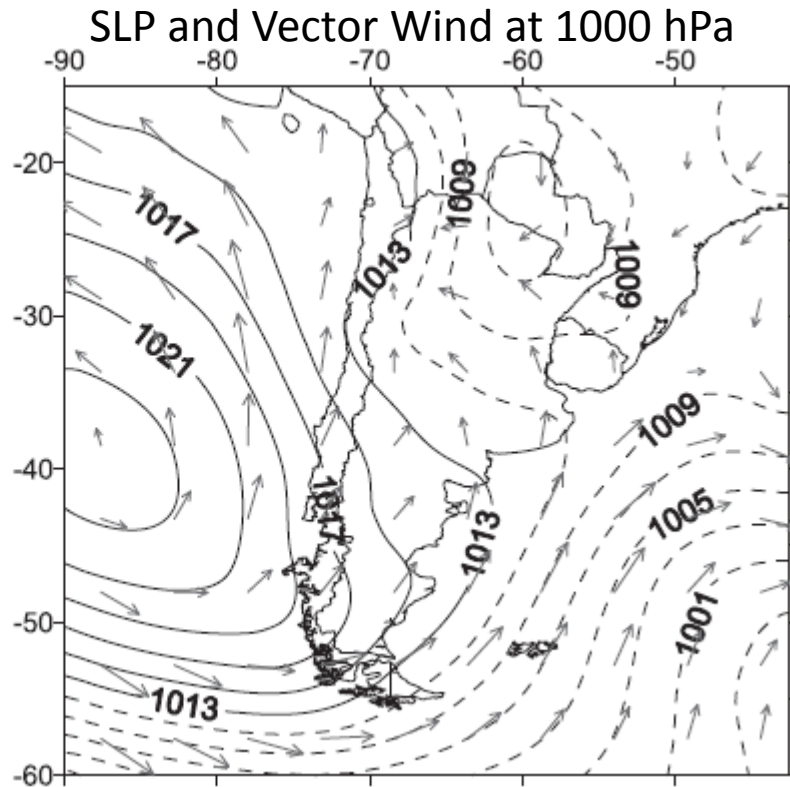
For instance

Analogs and Weather
Typing

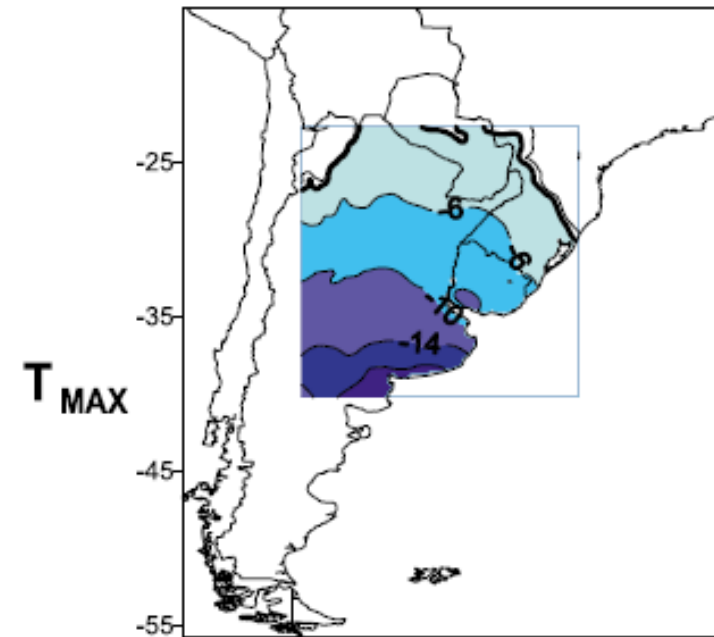


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CT1s



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Analog Method

In the analogue method, historical large-scale weather situations similar (according to a selected metric) to the large-scale weather situation on a given target day are identified.

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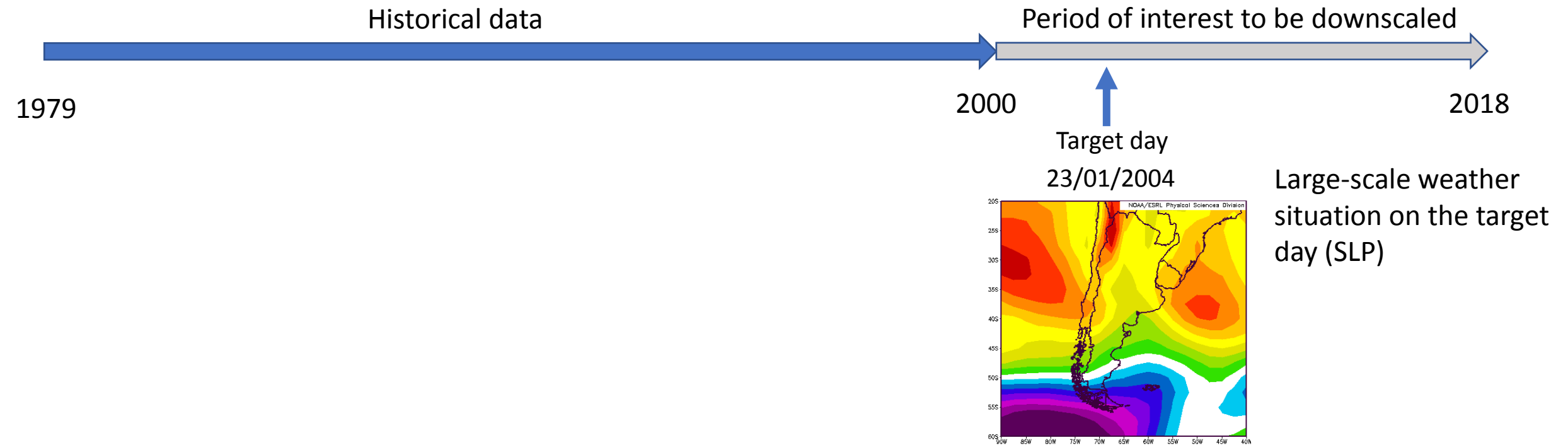
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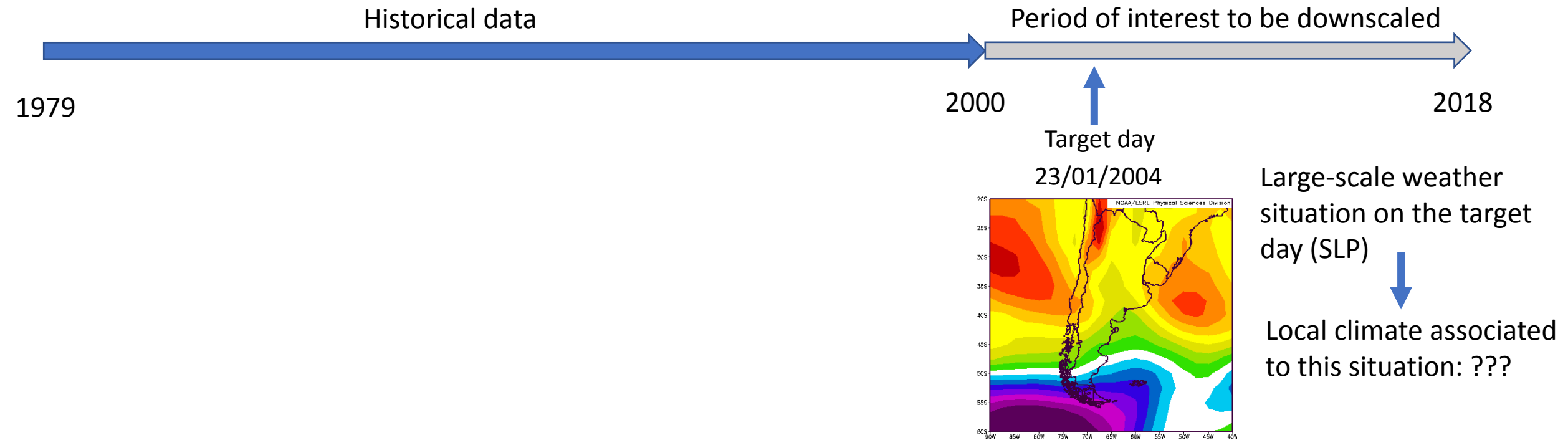
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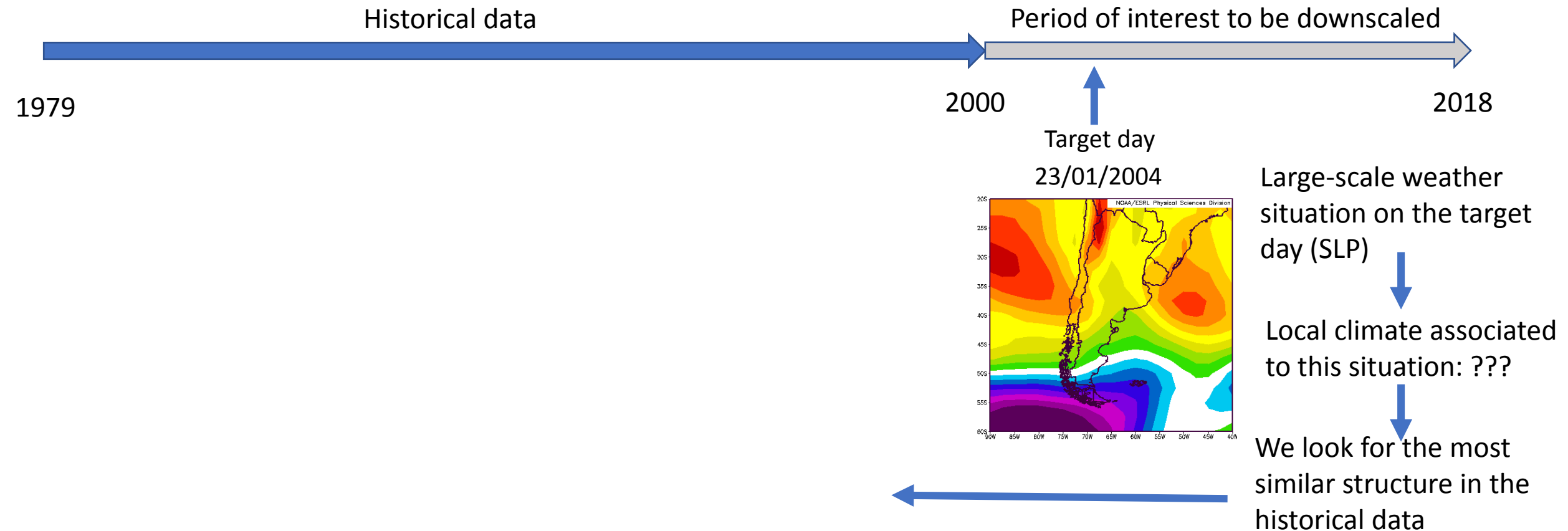
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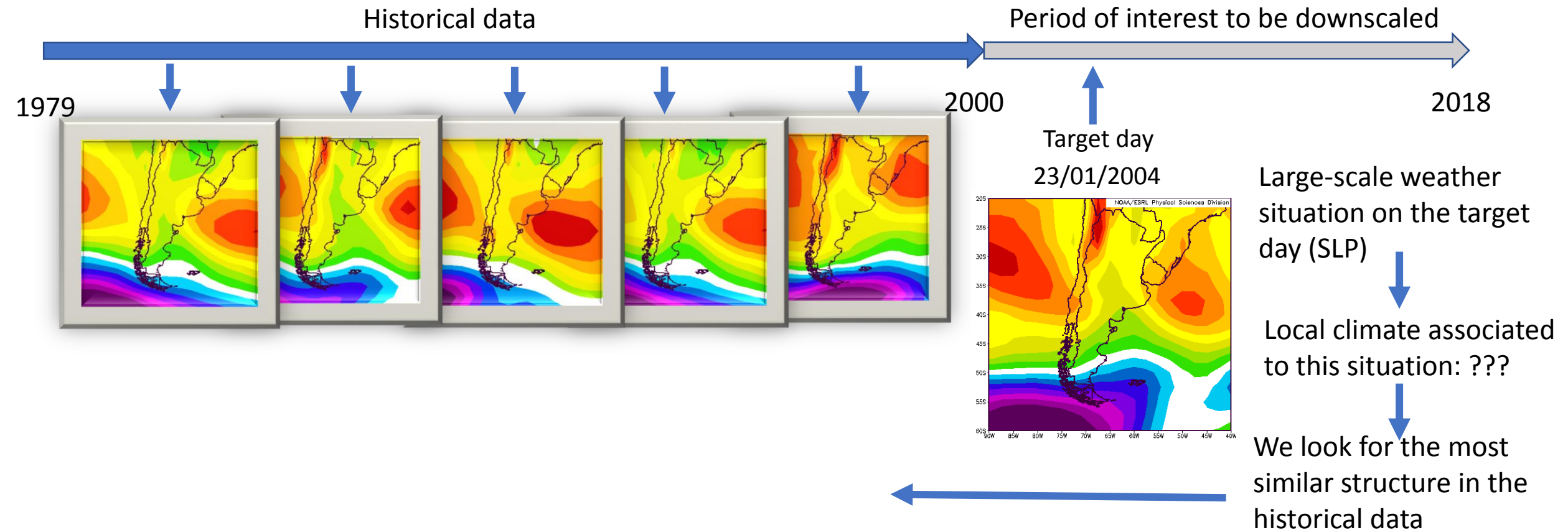
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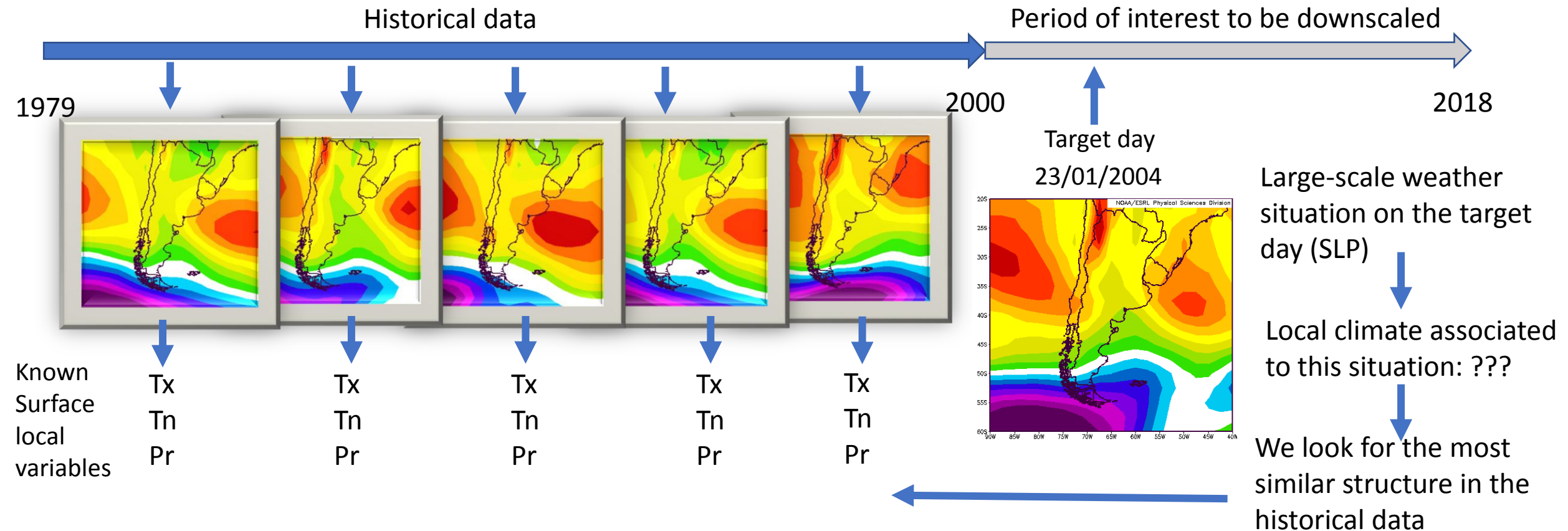
Analog Method

In the analogue method, historical large-scale weather situations similar (**according to a selected metric**) to the large-scale weather situation on a given target day are identified.



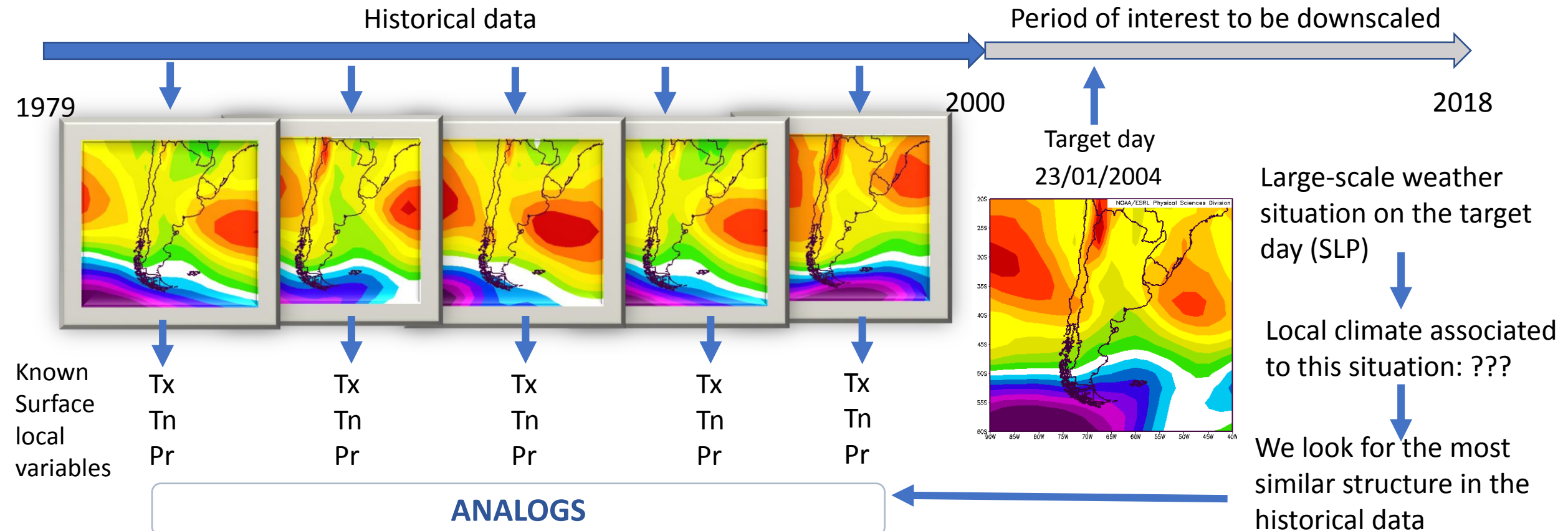
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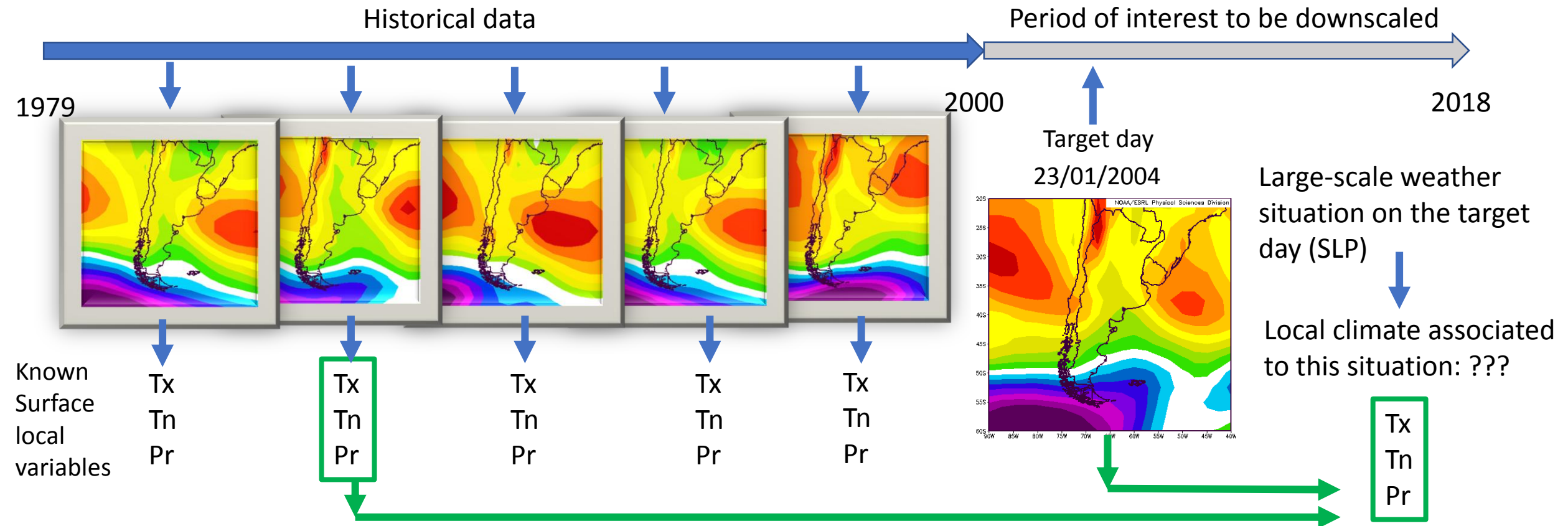
Analog Method

Then, the corresponding historical local weather conditions are used to **estimate** local weather conditions on the target day.



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Analog Method

In the whole process several decisions have to be made

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Historical data

Period of interest to be downscaled

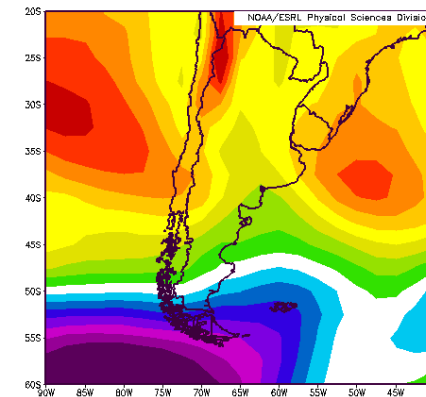
1979

2000

2018

Target day

23/01/2004

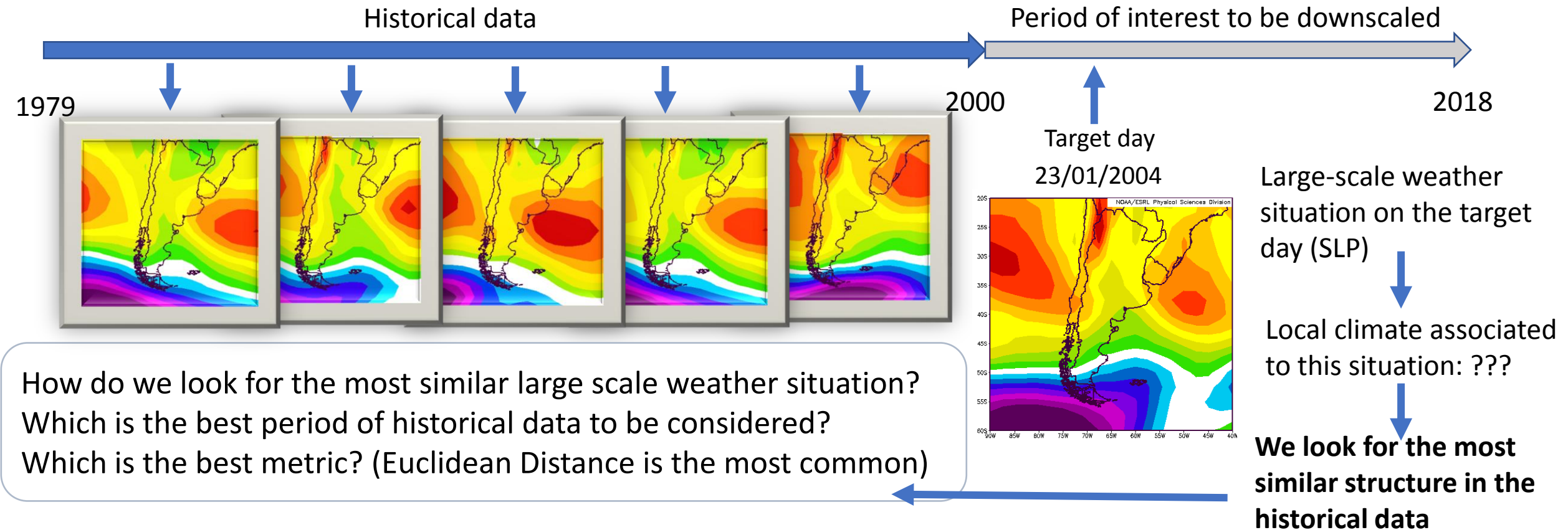


**Large-scale weather
situation on the target
day (SLP)**

- What large scale variables should be considered to define the large scale weather situation?
- Which is the best domain size for those variables?
- How do we get the information about those variables? Raw data? EOF?

Analog Method

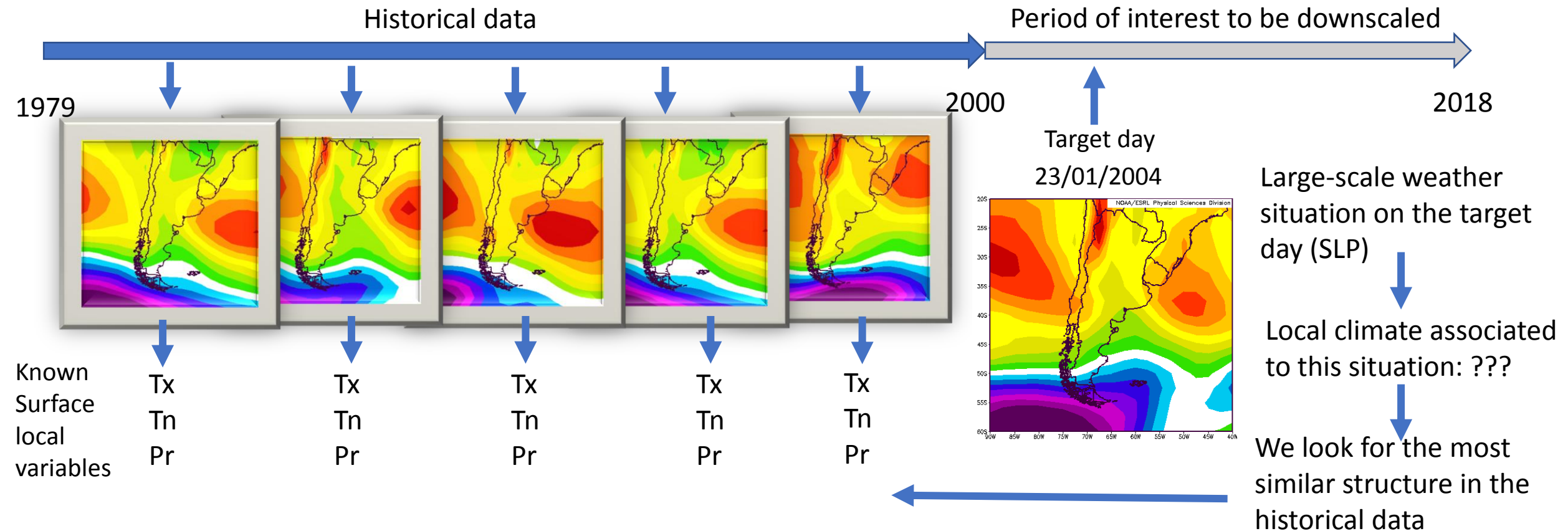
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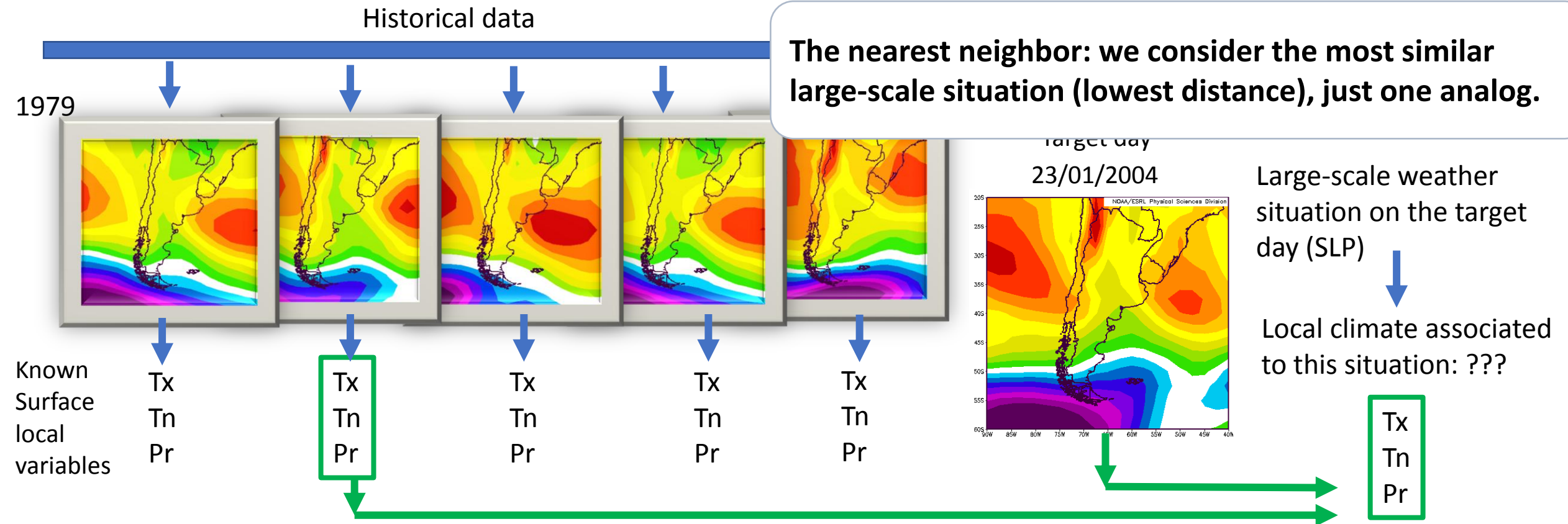
How do we estimate local weather conditions using the analogs?



Analog Method

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How do we estimate local weather conditions using the analogs?



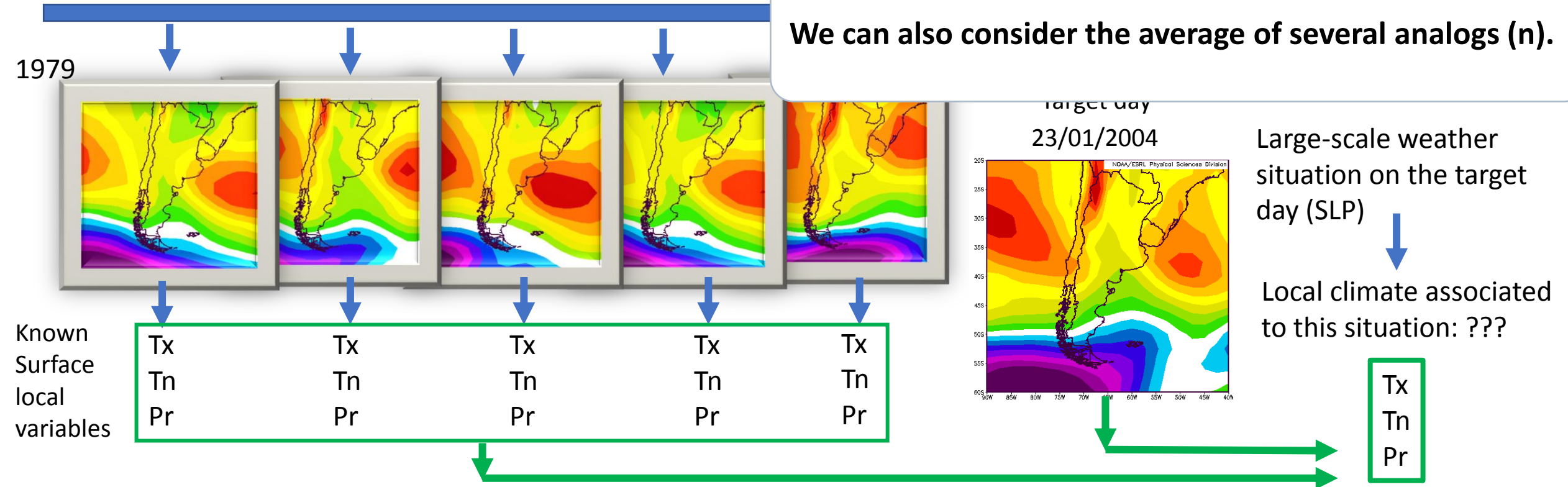
Analog Method

In the whole process several decisions have to be made

How do we estimate local weather conditions using the analogs?

Historical data

We can also consider the average of several analogs (n).



Analog Method

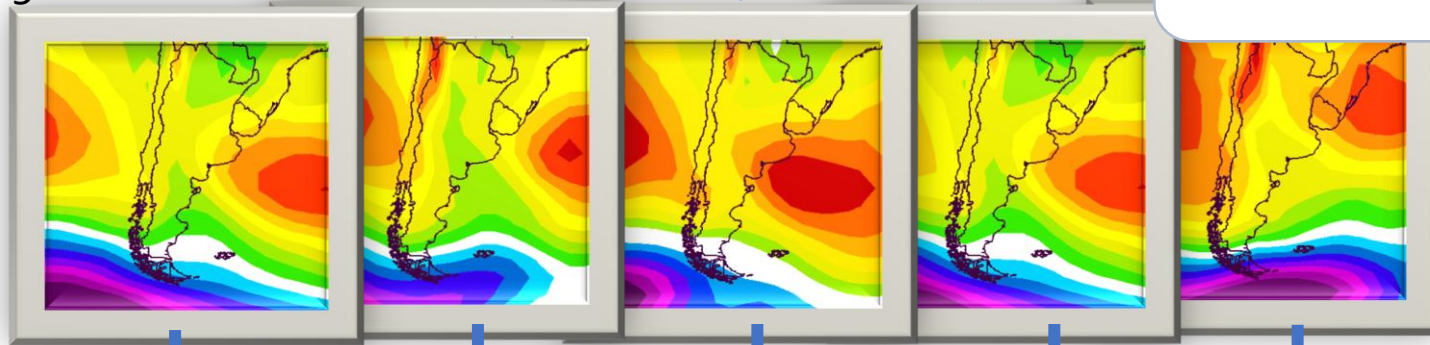
In the whole process several decisions have to be made

How do we estimate local weather conditions using the analogs?

Historical data

Or we just can pick a random analog among the n analogs

1979



Known
Surface
local
variables

Tx
Tn
Pr

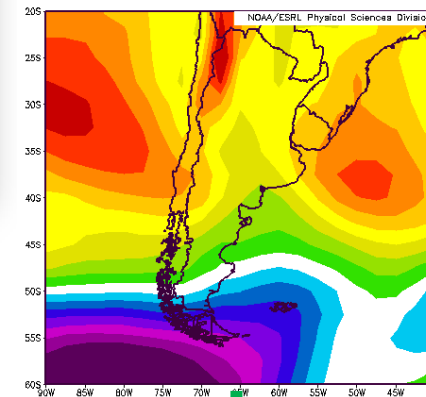
Tx
Tn
Pr

Tx
Tn
Pr

Tx
Tn
Pr

Tx
Tn
Pr

target day
23/01/2004



Large-scale weather
situation on the target
day (SLP)

Local climate associated
to this situation: ???

Tx
Tn
Pr

Analog Method

With a relatively **simple design**, the analog method has shown to perform as **well** as more complicated methods.

It is able to be applied to both **normally and non-normally variables** such as local temperatures and precipitation.

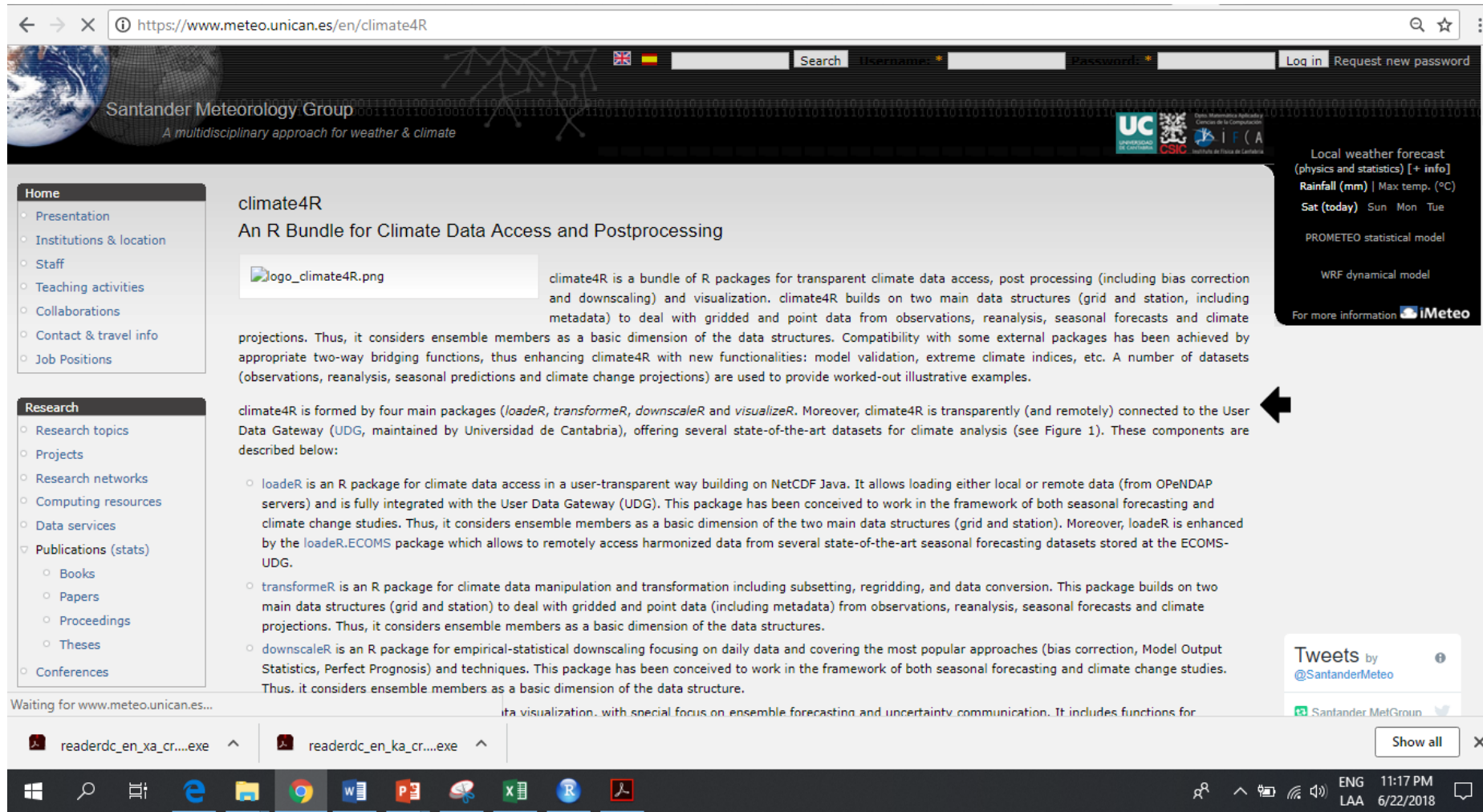
However, it is **incapable of predicting new values** that are outside the range of the historical data.

Our training is on Analogs

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Analog Method

We will use the Climate4R tool developed by the Santander Meteorology Group
<https://www.meteo.unican.es/en/climate4R>



The screenshot shows the website <https://www.meteo.unican.es/en/climate4R> in a web browser. The page features a header with the Santander Meteorology Group logo and navigation links. A sidebar on the left contains a 'Home' menu with links to Presentation, Institutions & location, Staff, Teaching activities, Collaborations, Contact & travel info, and Job Positions. Below this is a 'Research' menu with links to Research topics, Projects, Research networks, Computing resources, Data services, and Publications (stats). The main content area is titled 'climate4R' and 'An R Bundle for Climate Data Access and Postprocessing'. It includes a description of the tool as a bundle of R packages for transparent climate data access, post processing, and visualization. A list of four main packages is provided: *loaderR*, *transformerR*, *downscaleR*, and *visualizeR*. A black arrow points to the text 'climate4R is transparently (and remotely) connected to the User Data Gateway (UDG, maintained by Universidad de Cantabria)'. The bottom of the page shows a Windows taskbar with various application icons and a system clock indicating 11:17 PM on 6/22/2018.

climate4R
An R Bundle for Climate Data Access and Postprocessing

climate4R is a bundle of R packages for transparent climate data access, post processing (including bias correction and downscaling) and visualization. climate4R builds on two main data structures (grid and station, including metadata) to deal with gridded and point data from observations, reanalysis, seasonal forecasts and climate projections. Thus, it considers ensemble members as a basic dimension of the data structures. Compatibility with some external packages has been achieved by appropriate two-way bridging functions, thus enhancing climate4R with new functionalities: model validation, extreme climate indices, etc. A number of datasets (observations, reanalysis, seasonal predictions and climate change projections) are used to provide worked-out illustrative examples.

climate4R is formed by four main packages (*loaderR*, *transformerR*, *downscaleR* and *visualizeR*). Moreover, climate4R is transparently (and remotely) connected to the User Data Gateway (UDG, maintained by Universidad de Cantabria), offering several state-of-the-art datasets for climate analysis (see Figure 1). These components are described below:

- loaderR* is an R package for climate data access in a user-transparent way building on NetCDF Java. It allows loading either local or remote data (from OPeNDAP servers) and is fully integrated with the User Data Gateway (UDG). This package has been conceived to work in the framework of both seasonal forecasting and climate change studies. Thus, it considers ensemble members as a basic dimension of the two main data structures (grid and station). Moreover, *loaderR* is enhanced by the *loaderR.ECOMS* package which allows to remotely access harmonized data from several state-of-the-art seasonal forecasting datasets stored at the ECOMS-UDG.
- transformerR* is an R package for climate data manipulation and transformation including subsetting, regridding, and data conversion. This package builds on two main data structures (grid and station) to deal with gridded and point data (including metadata) from observations, reanalysis, seasonal forecasts and climate projections. Thus, it considers ensemble members as a basic dimension of the data structures.
- downscaleR* is an R package for empirical-statistical downscaling focusing on daily data and covering the most popular approaches (bias correction, Model Output Statistics, Perfect Prognosis) and techniques. This package has been conceived to work in the framework of both seasonal forecasting and climate change studies. Thus, it considers ensemble members as a basic dimension of the data structure.

data visualization, with special focus on ensemble forecasting and uncertainty communication. It includes functions for