

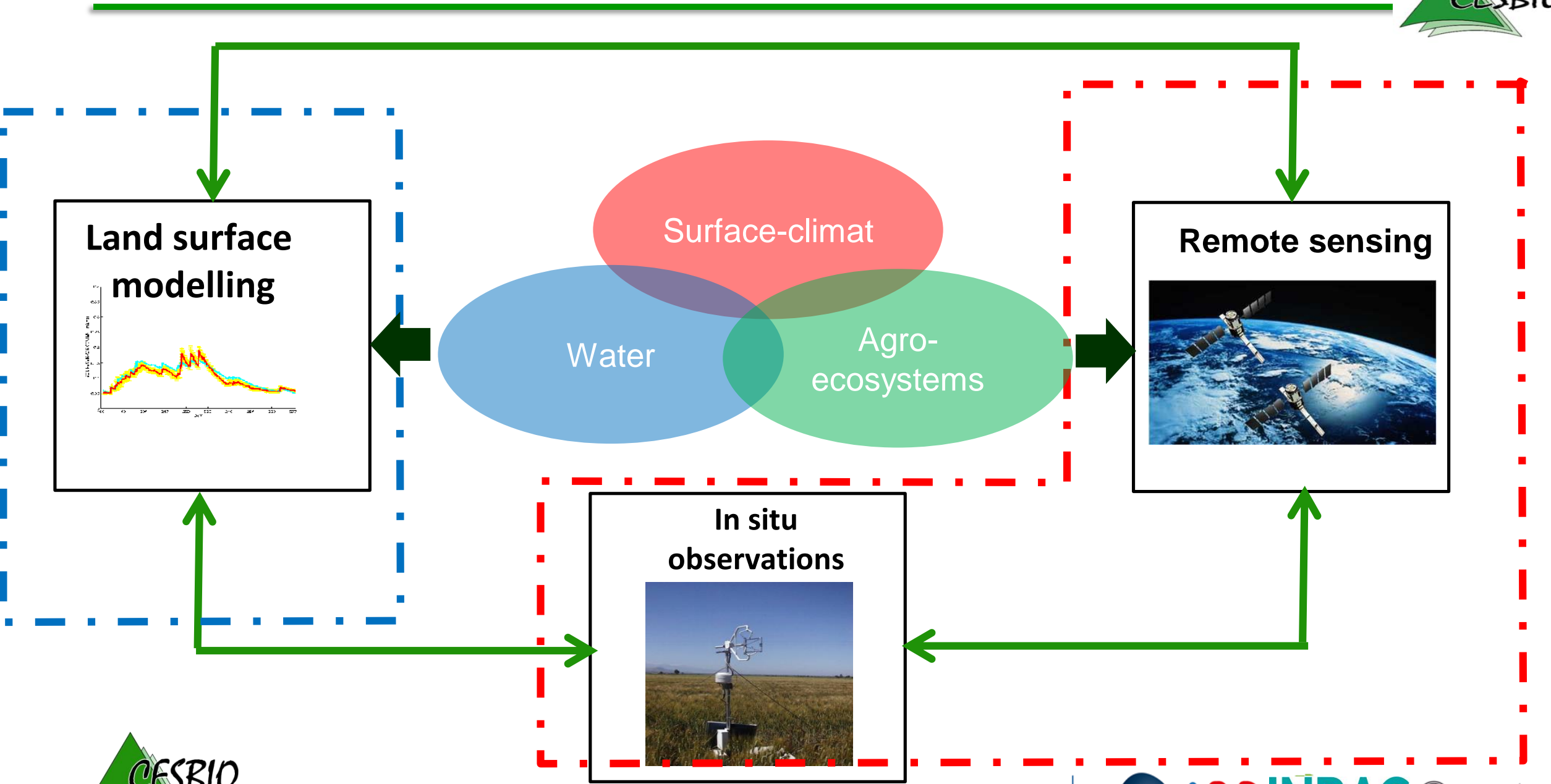
DROUGHE ESTIMATION AND MAPPING

Mehrez ZRIBI, Michel le page
CESBIO

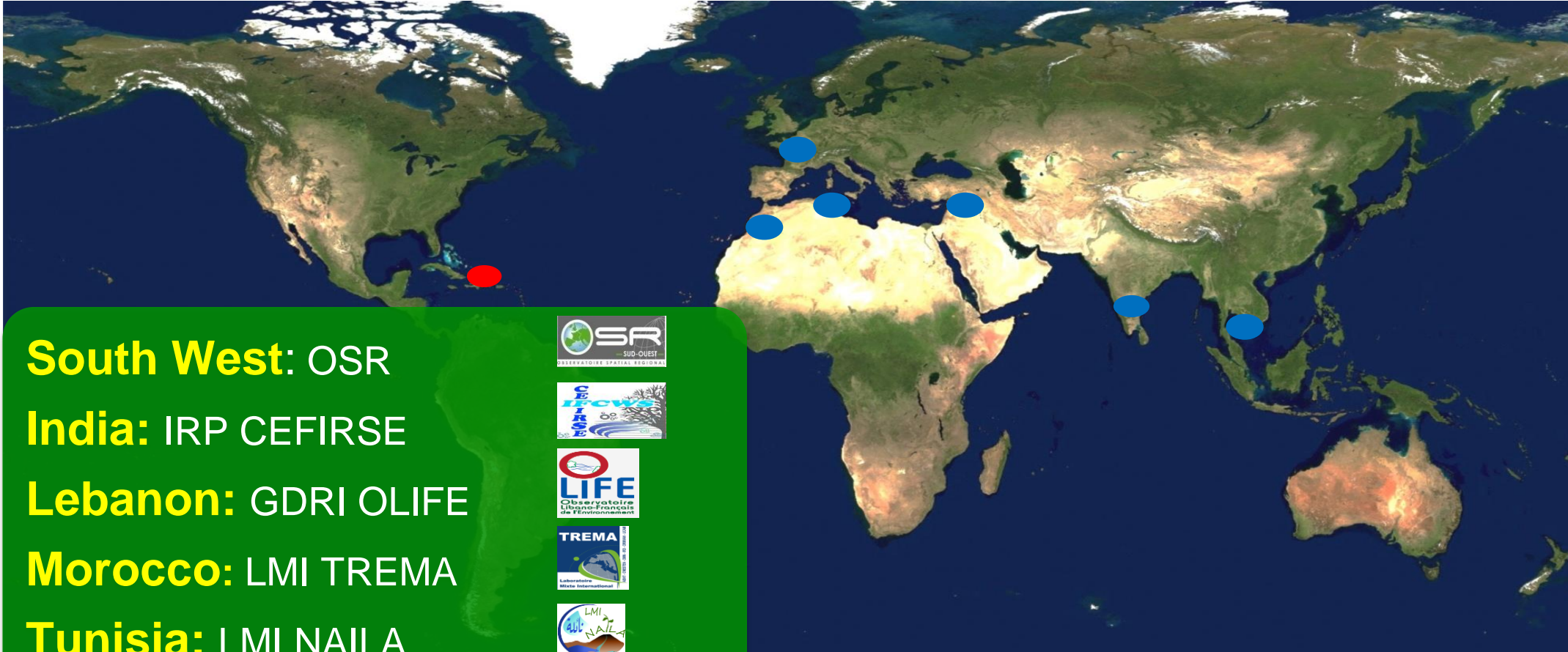
CESBIO/TOULOUSE



- Toulouse: second university city in France
- The world's largest higher education institution in aerospace engineering
- Strong presence of the aeronautics, space and high technology industry
- Toulouse III is 6th in the world in the Shanghai ranking in remote sensing
- The climate and weather are super pleasant



CESBIO and partners observatories



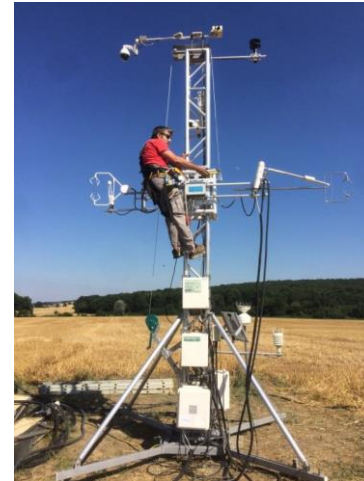
South West: OSR

India: IRP CEFIRSE

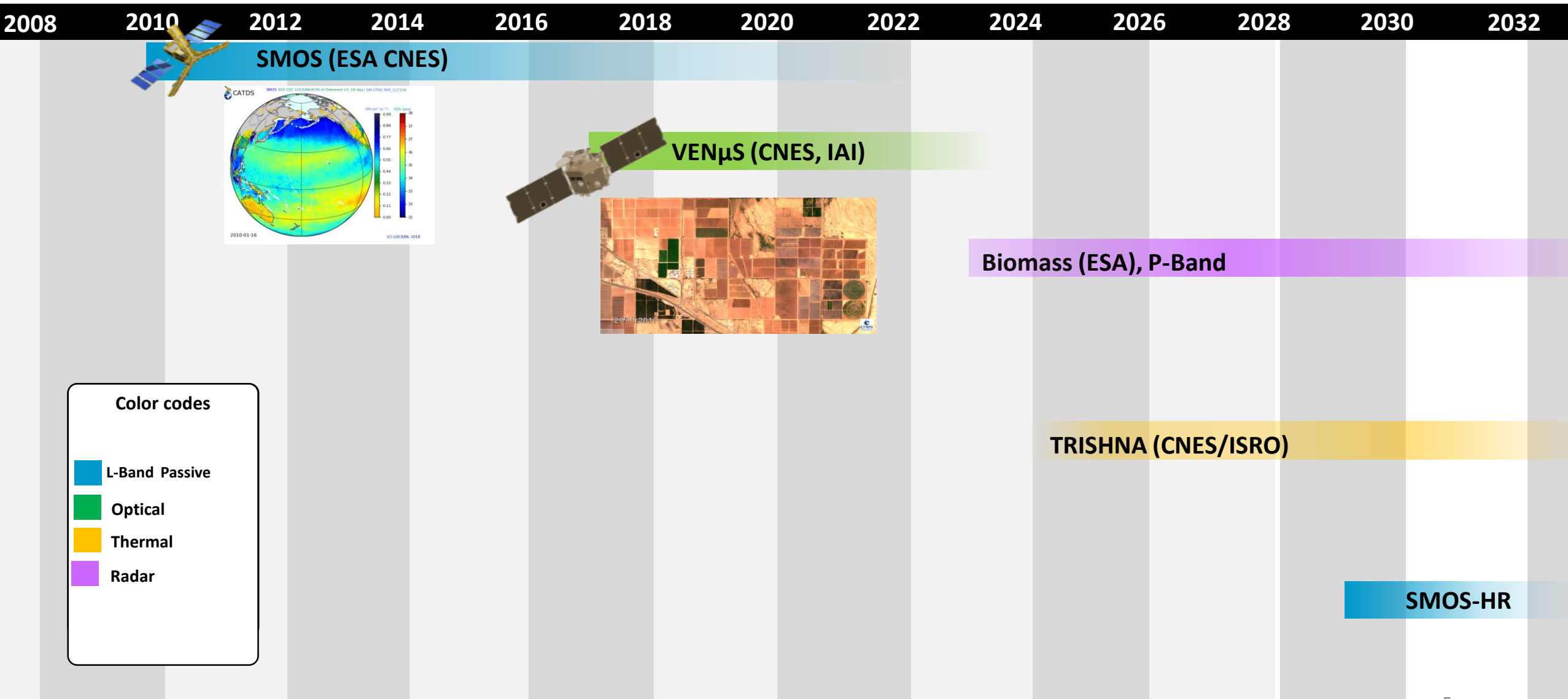
Lebanon: GDRI OLIFE

Morocco: LMI TREMA

Tunisia: LMI NAILA



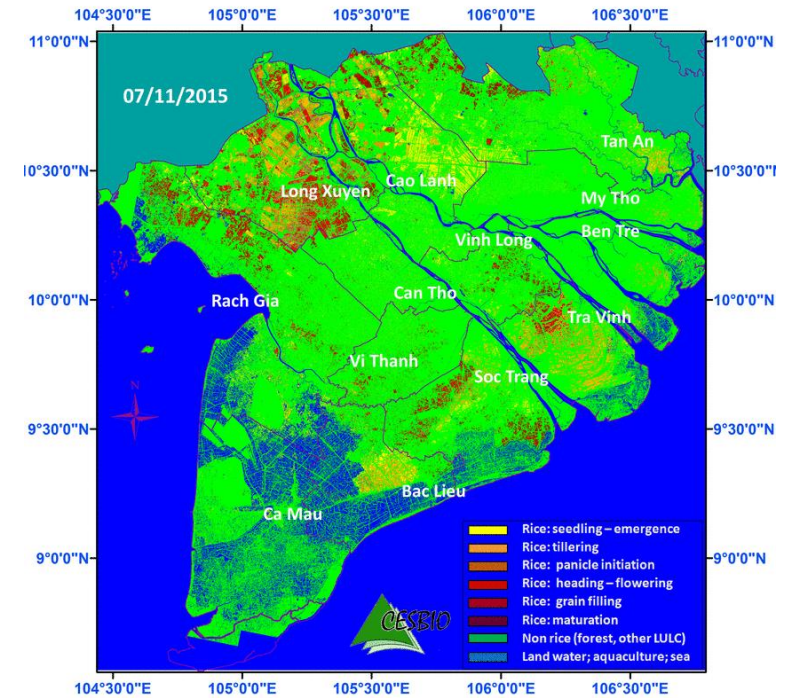
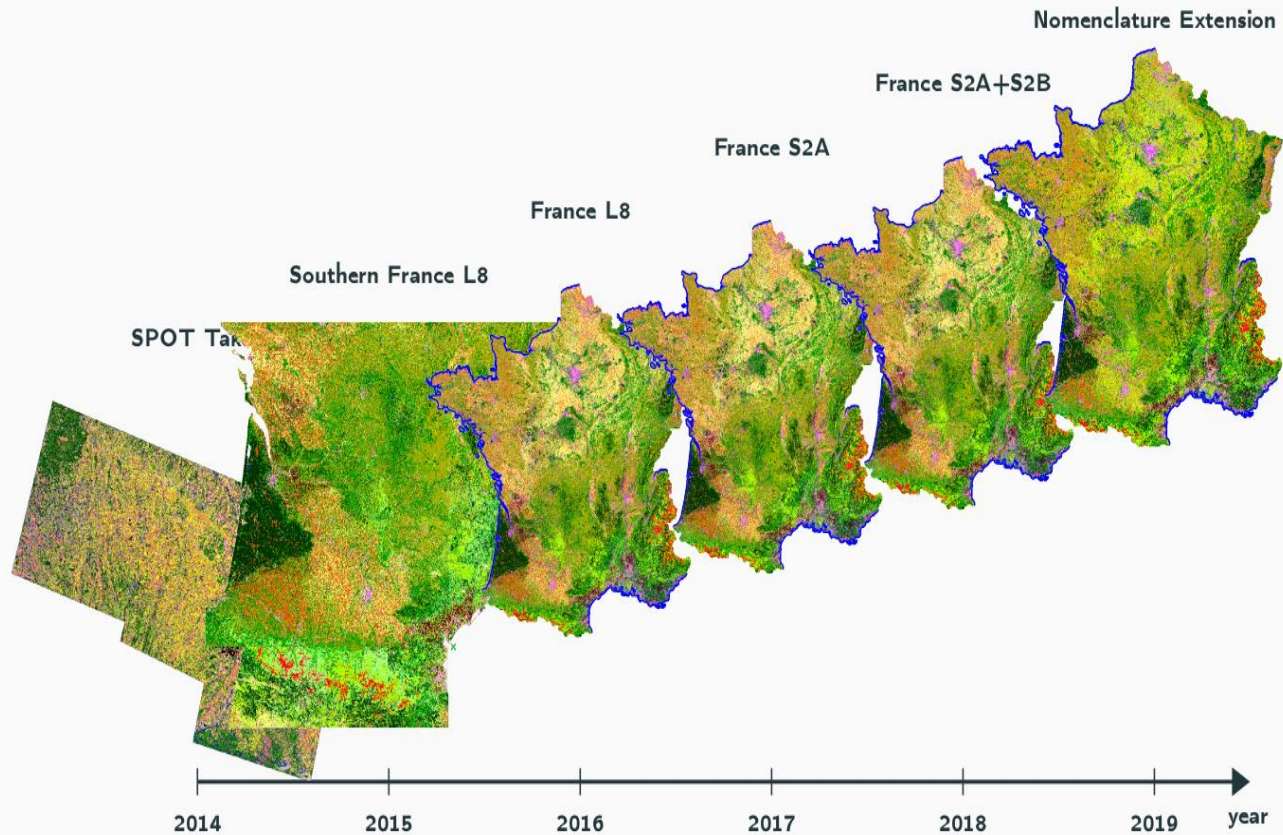
Satellite missions in CESBIO



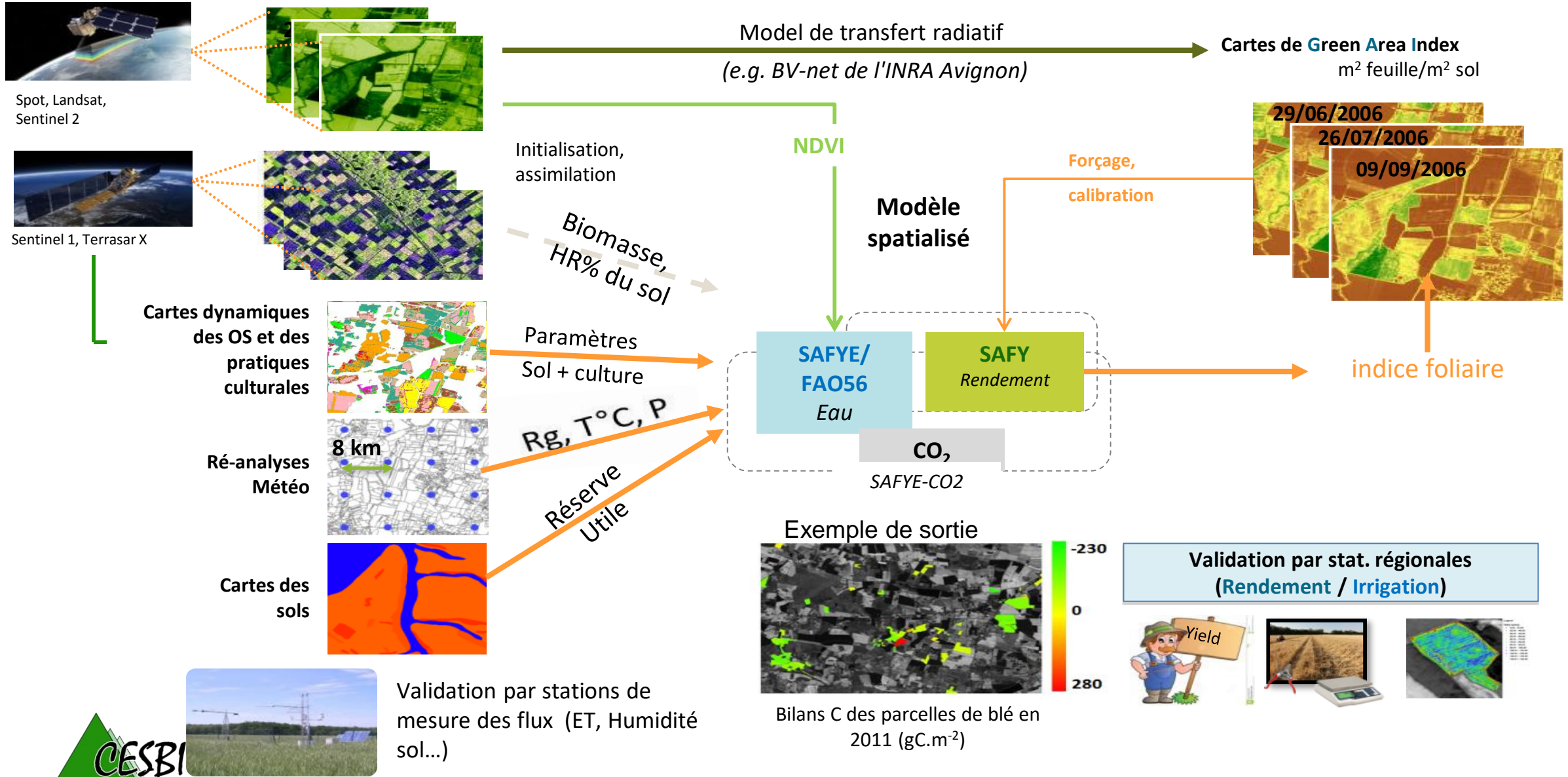
Color codes

- L-Band Passive
- Optical
- Thermal
- Radar

Satellite products



Spatialized platforms



Impacts of drought

- **Economic**
- **Social**
- **environmental**
- **Impacts increase in response to increasing vulnerability resulting from increased pressure on limited water resources, population growth and many other factors.**
- **Post-crash response increases vulnerability.**
- **The impacts differ from one country to another.**

Drought Characteristics

- Normal component of climate variability
 - No universal definition
 - Complex
 - Interdisciplinary
 - Impacts can be economic, social, environmental
 - Impacts can persist for years
- ❖ The beginning and end of the drought are difficult to determine
 - ❖ No precise and universally accepted definition of drought
 - ❖ Non-structural impacts and spread over a large geographical area

Agricultural Drought

- Meteorological drought affecting agriculture
- Usually, the first economic sector to be affected
- Shortage of precipitation, ET, soil moisture, etc.
- Demand for water from the plant in relation to available soil moisture

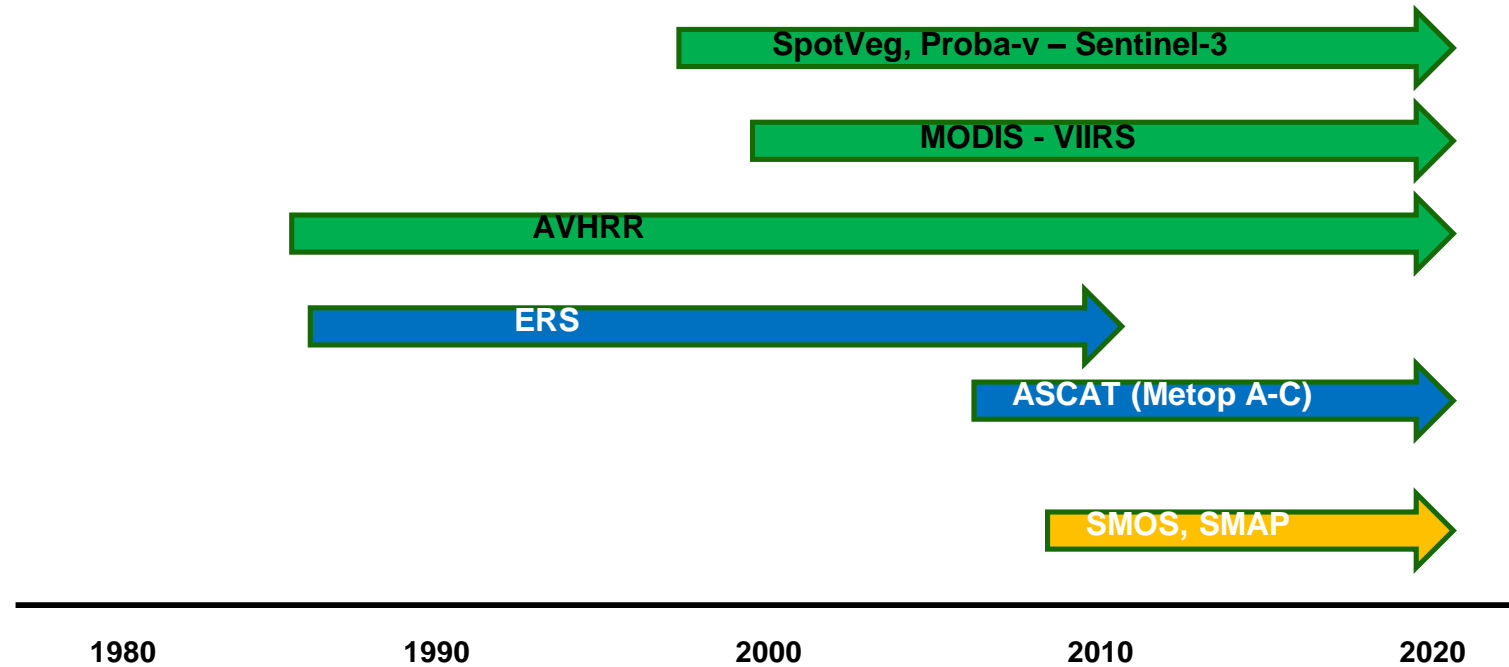


Monitoring of Drought

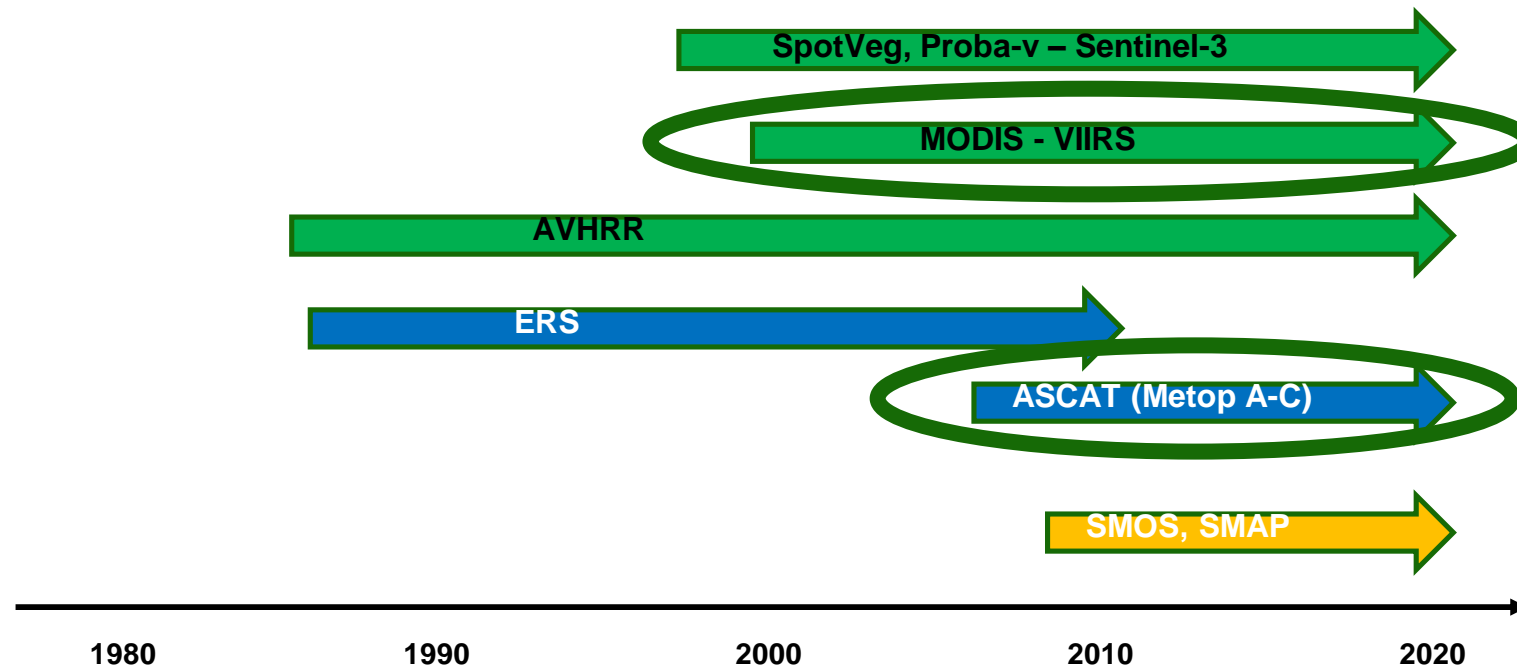
- **Importance of drought indices**
 - Simplify complex inter-relationships and provide a good communication tool for many audiences
 - Quantitative assessment of climatic conditions
 - Provide a historical perspective that can be used in planning and design applications

Data and Methods

Long multi-spectral and multi-resolution time series



Long multi-spectral and multi-resolution time series



Selected Indices

- **MODIS NDVI : Vegetation vigor**

$$NDVI = \frac{NIR - R}{NIR + R}$$

- **MODIS LST : Land Surface Temperature**

- **ASCAT SWI : Soil Moisture**

$$SWI(t) = \frac{\sum_i m_s(t_i) e^{-(t-t_i)/T}}{\sum_i e^{-(t-t_i)/T}} \quad \text{for } t_i \leq t$$

Normalization of Remote Sensing Obs.

VAI: Vegetation Anomaly Index

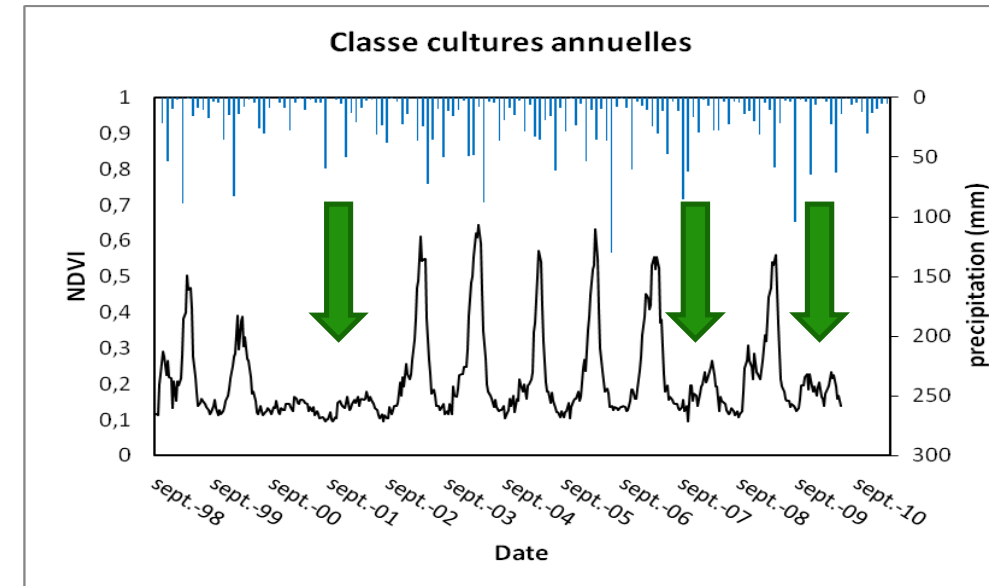
$$VAI = \frac{NDVI - NDVI_{mean}}{\sigma}$$

NDVI: NDVI at one date

NDVI_{mean}: mean of NDVI for a selected period

σ: standard deviation of NDVI

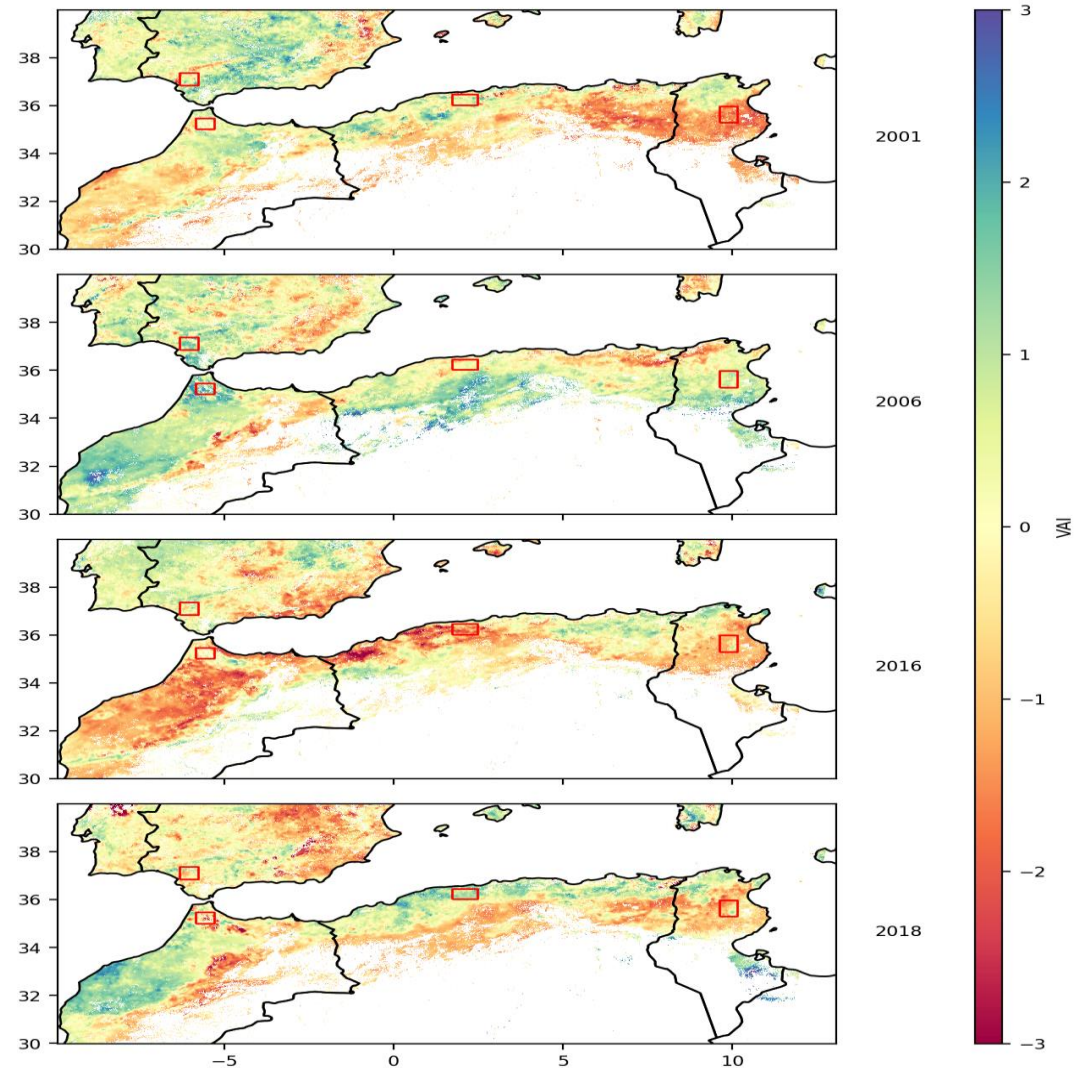
→ **The same normalization is applied to Soil Moisture (MAI) and Temperature (TAI)**



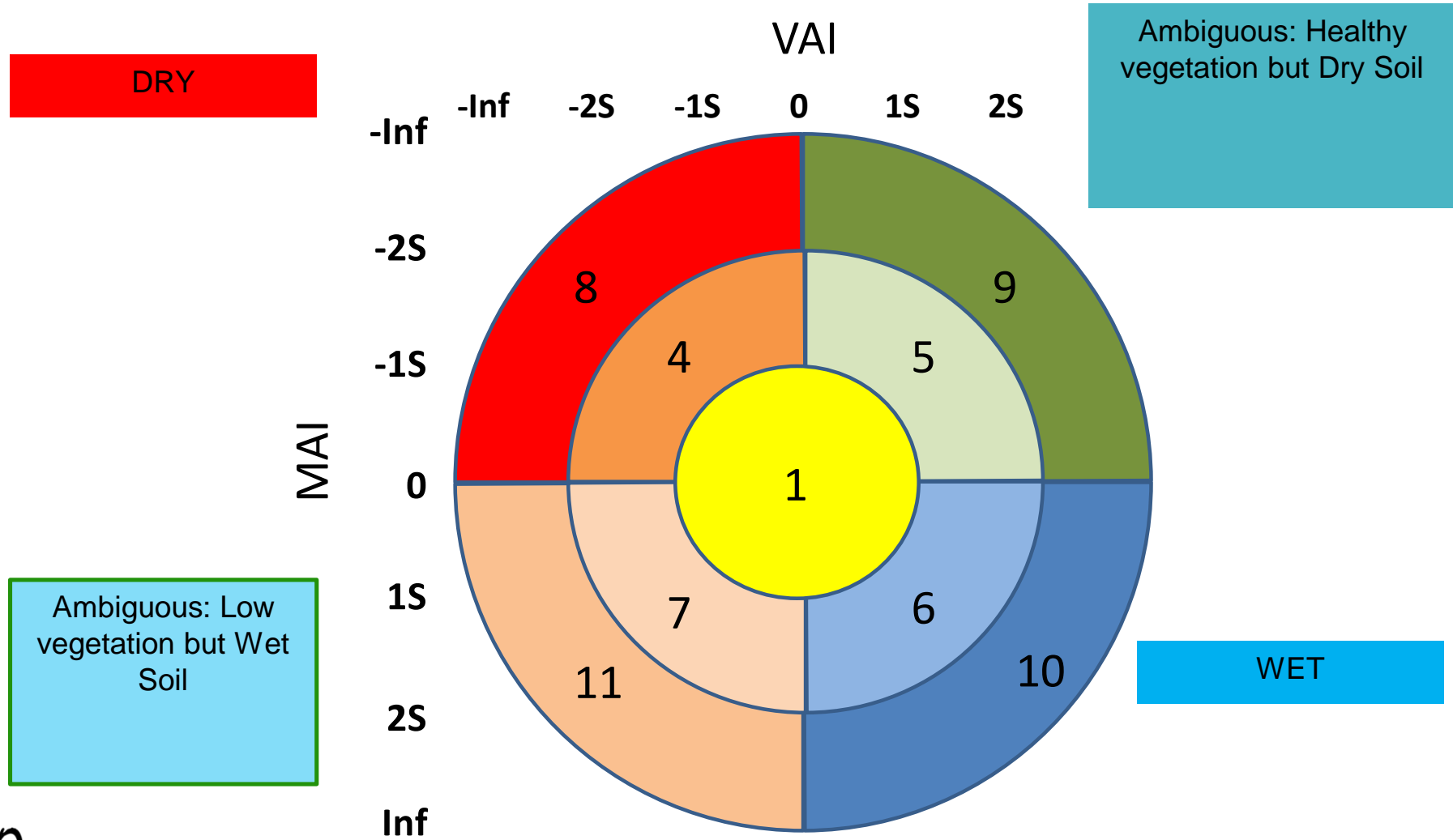
Mixed indices

$$\text{Ind}_i = \alpha_i \text{VAI}_i + \beta_i \text{MAI}_i$$

$$\text{GDI}_i = \frac{\text{Ind}_i - (\text{Ind}_i)_{\text{mean}}}{\sigma_{\text{Ind},i}}$$



Classify drought on two dimensions



Search for similar years using a drought vector

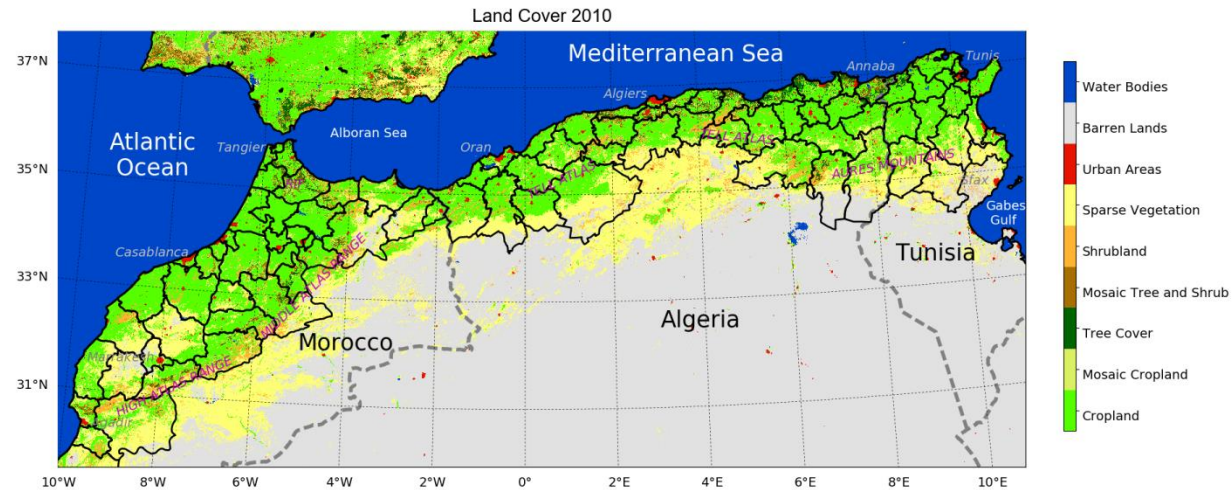
$$VD = \begin{bmatrix} VAI \\ MAI \\ TAI \end{bmatrix}$$

$$VD_i = \begin{bmatrix} VAI_i \\ MAI_i \\ TAI_i \end{bmatrix} \Rightarrow VD'_i = [VAI_i \quad MAI_i \quad TAI_i]$$

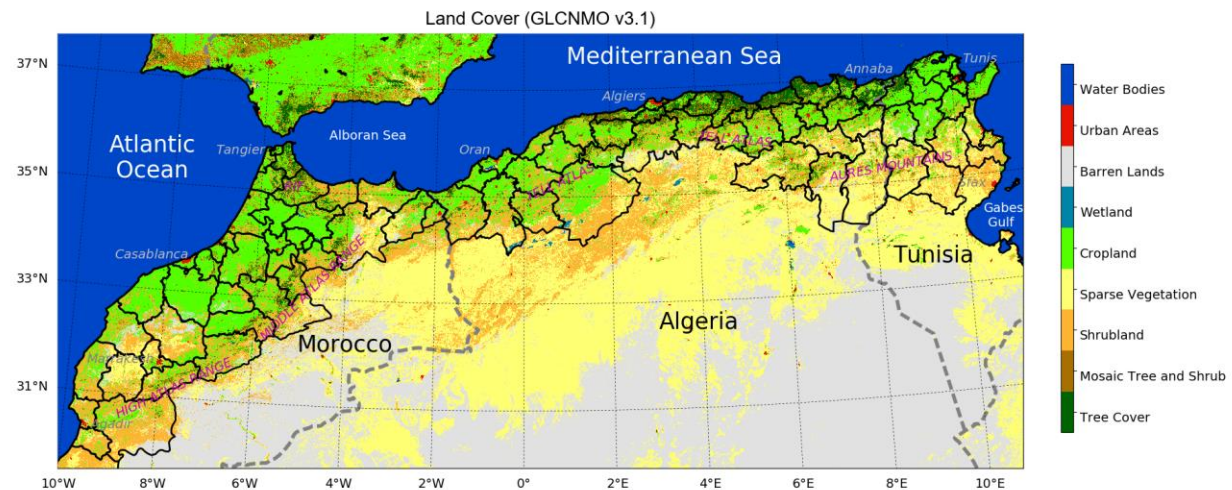
$$d(VD', VD'') = \sqrt{\sum_{i=1}^n (VD'_i - VD''_i)^2}$$

Study Area: North-West Africa

ESA CCI-LC
V2.0.7

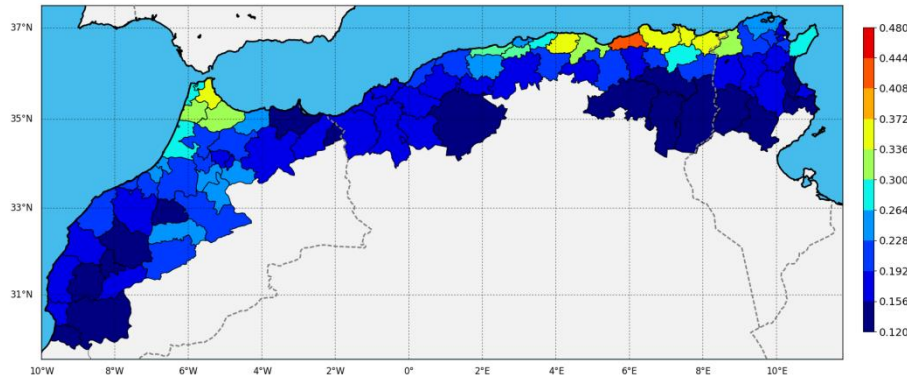


GLCNMO V3.1

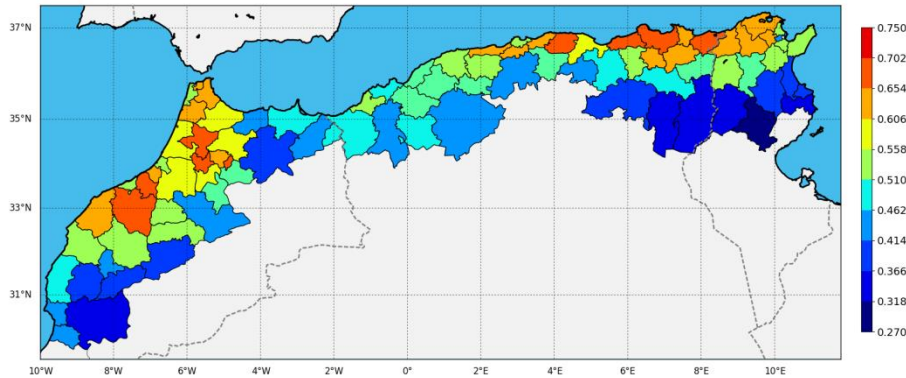


Characterization of agricultural calendars

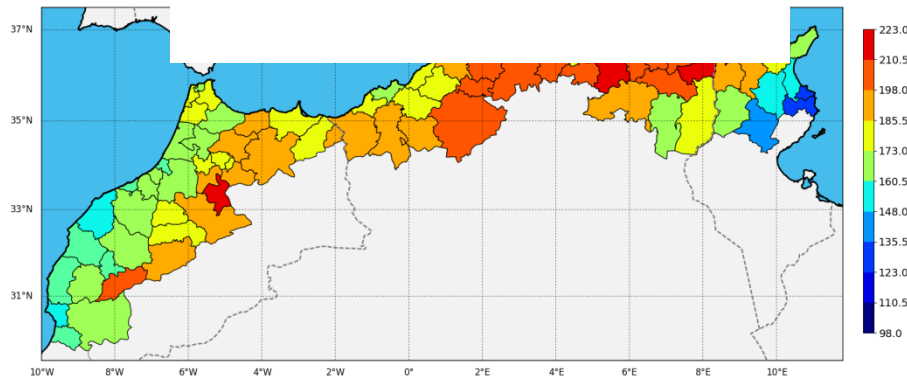
Minimum of NDVI



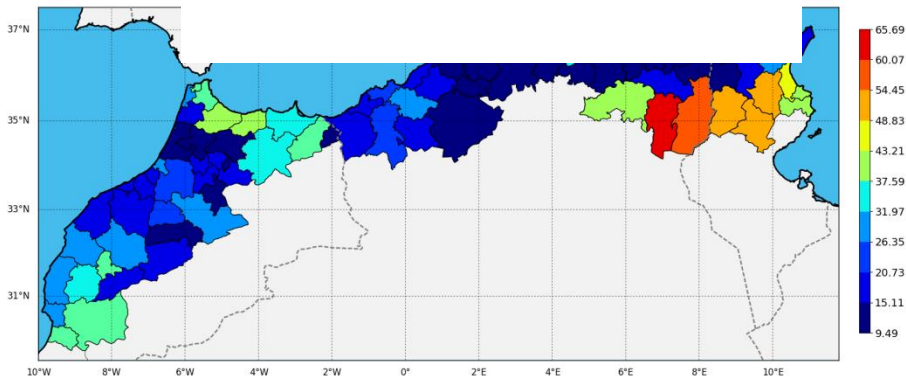
Maximum of NDVI



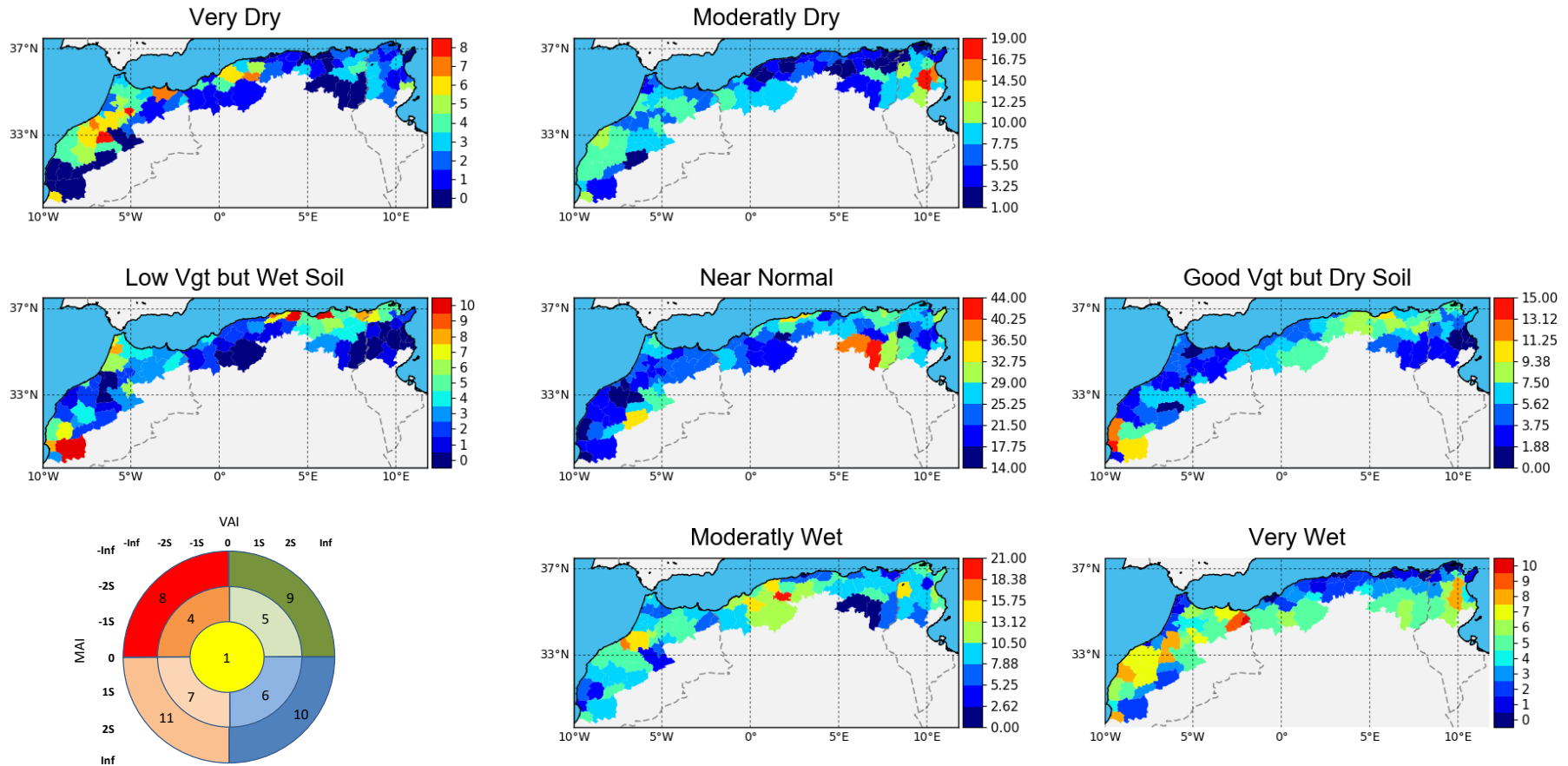
Average Date of maxNDVI



Stdev of Date of maxNDVI

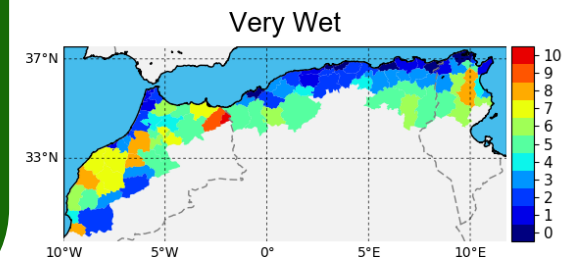
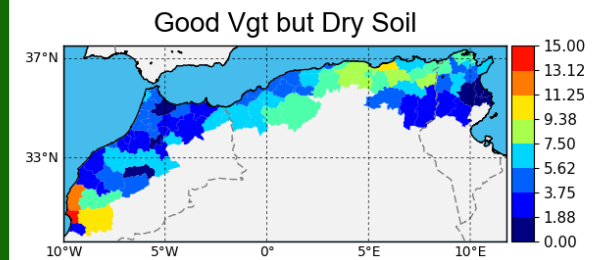
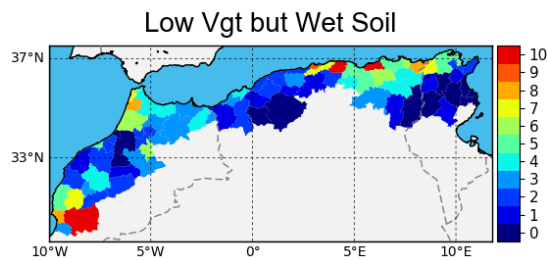
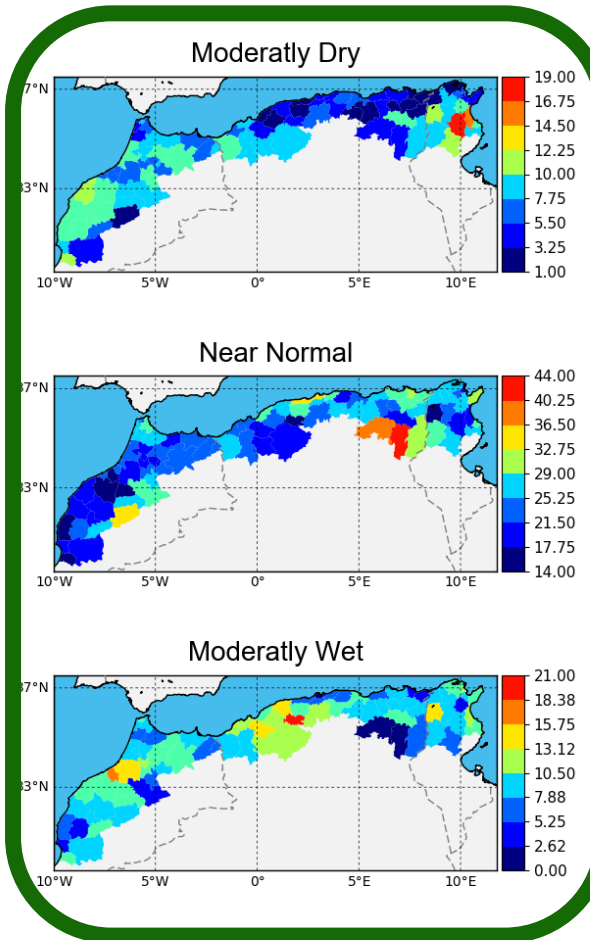
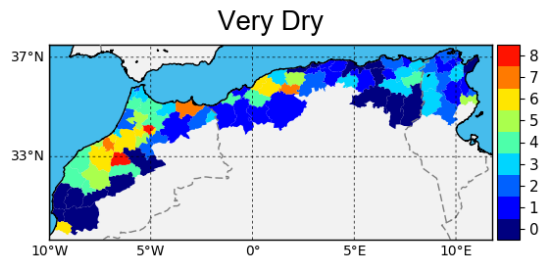


Occurrences of Situations



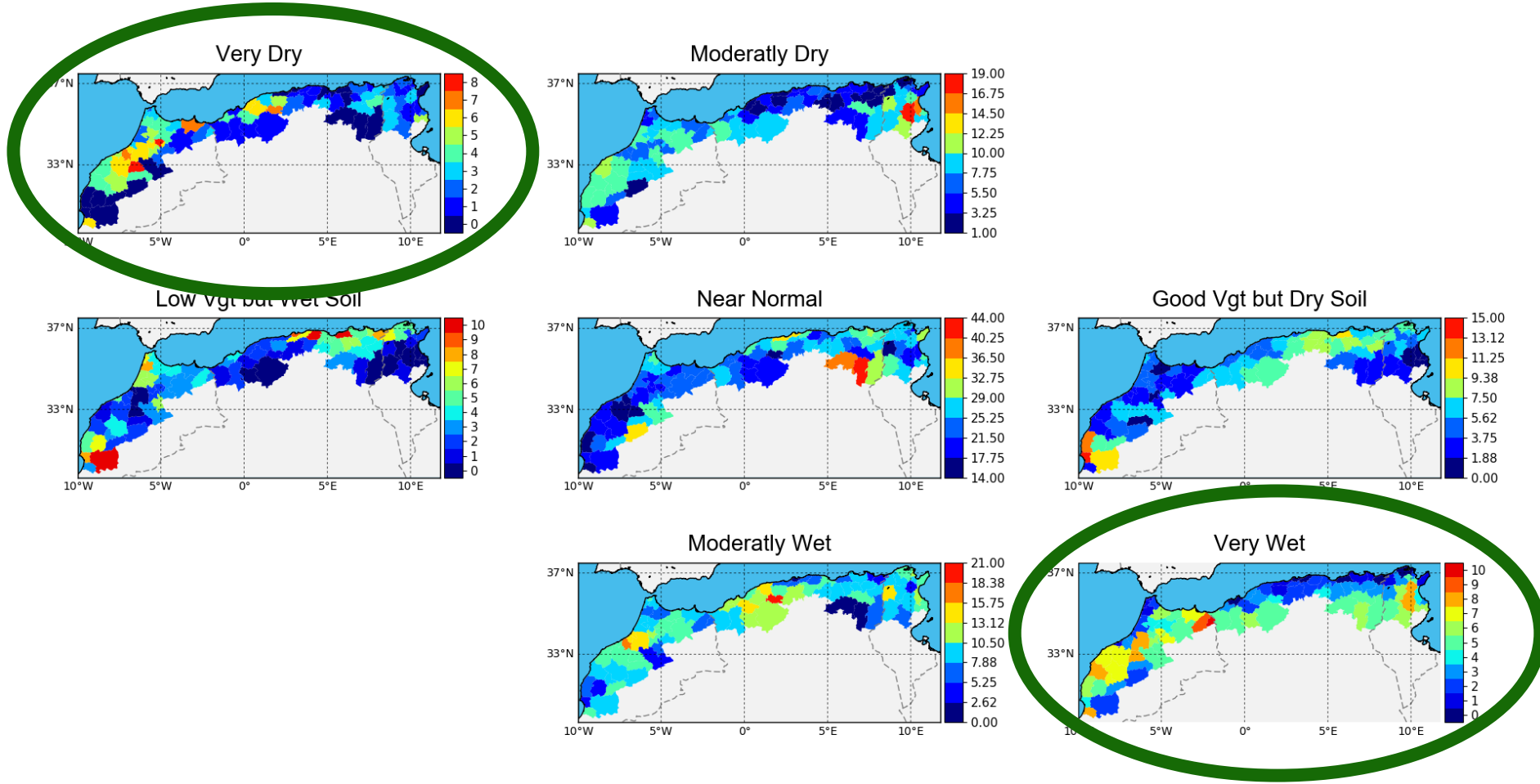
2007 to 2018, November to April

Occurrences of Situations: Normal and moderate



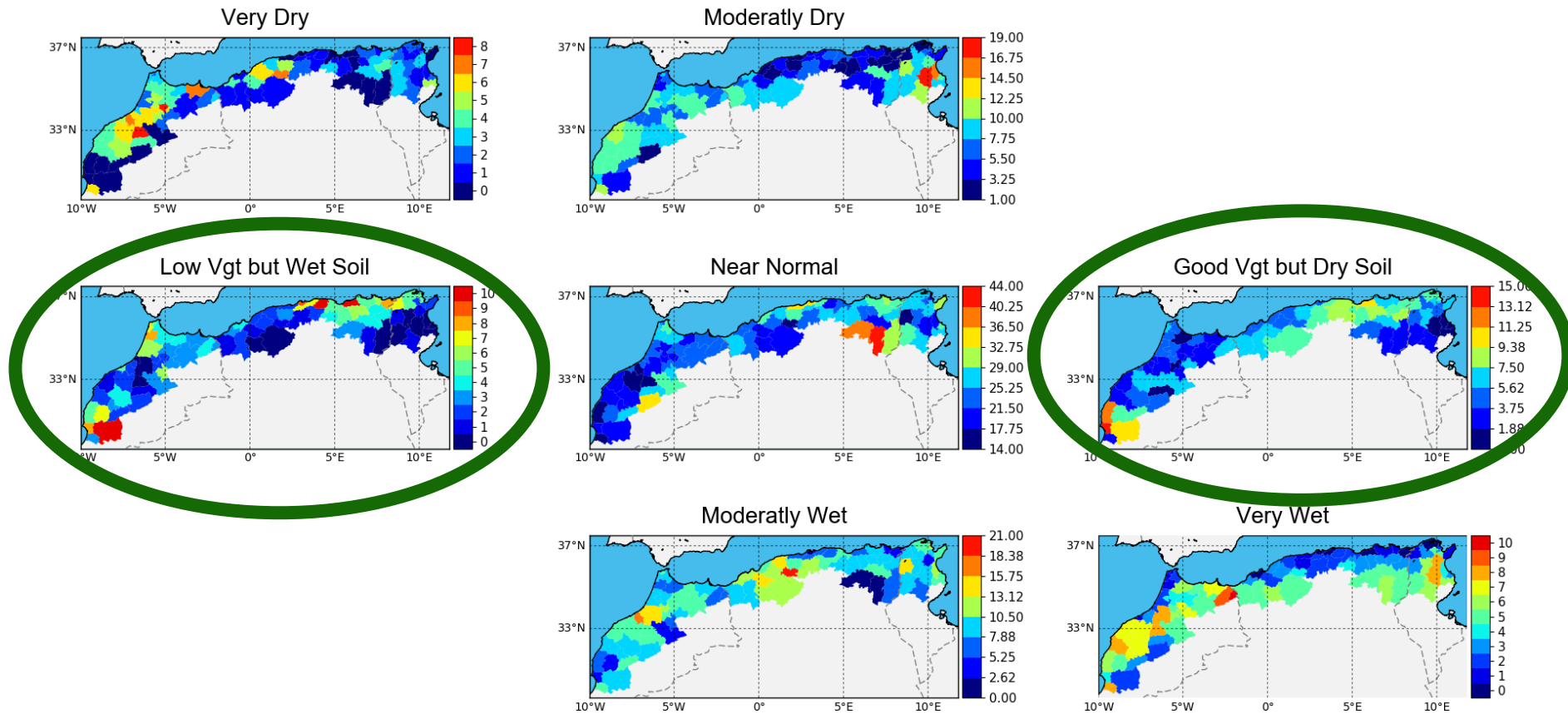
2007 to 2018, November to April

Occurrences of Situations: Extremes



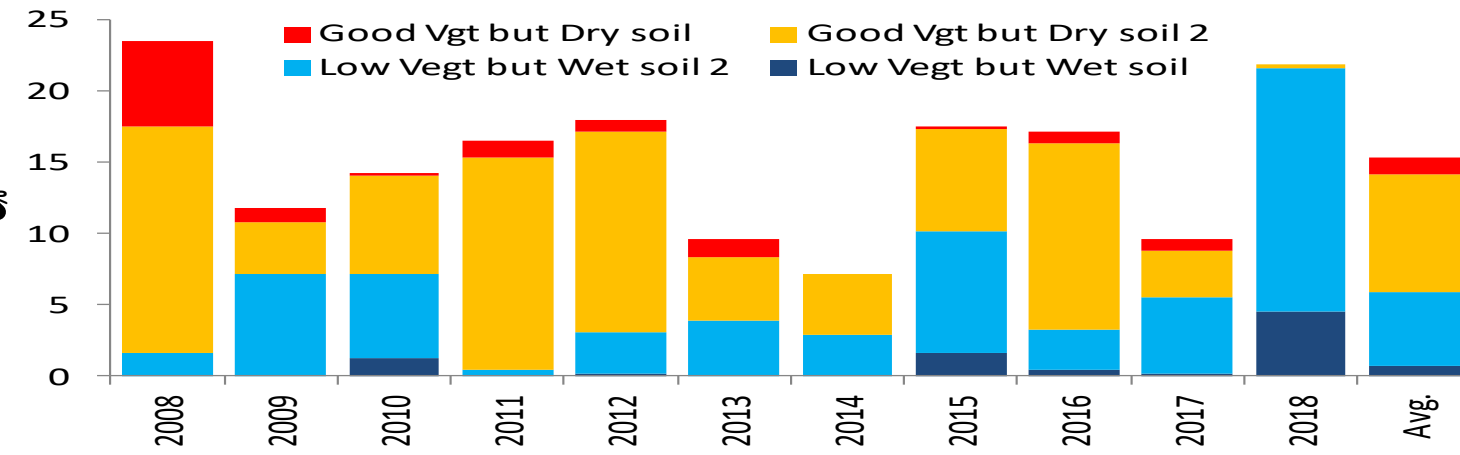
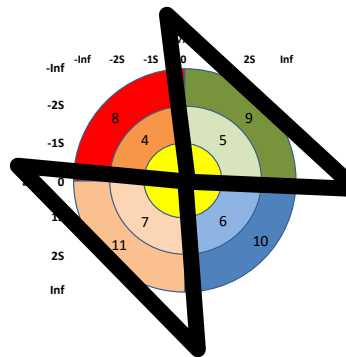
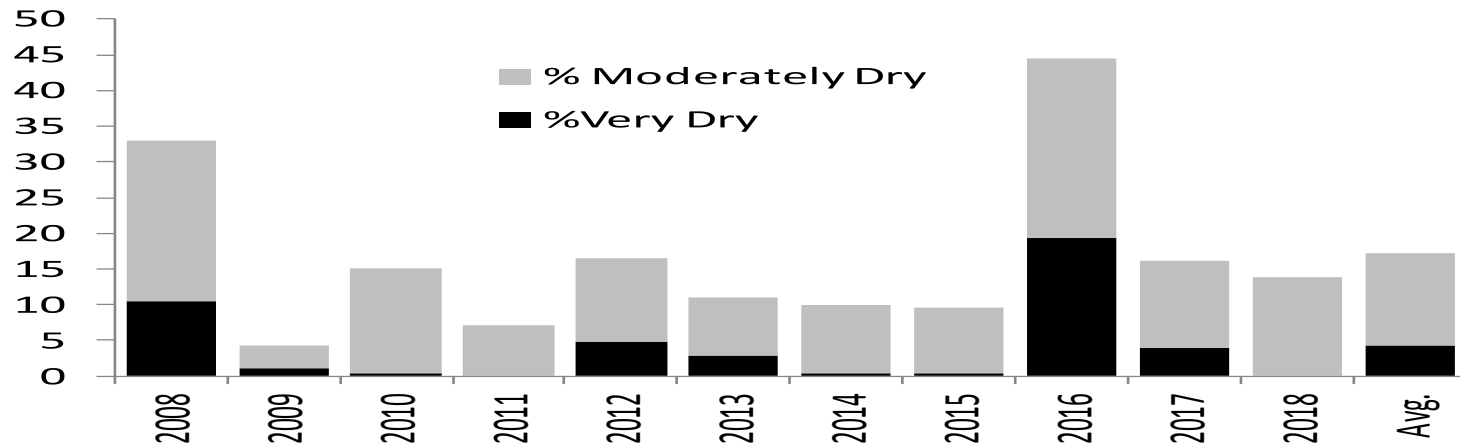
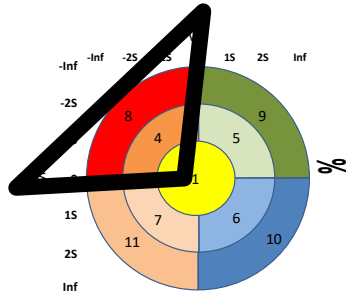
2007 to 2018, November to April

Occurrences of Situations: Ambiguous

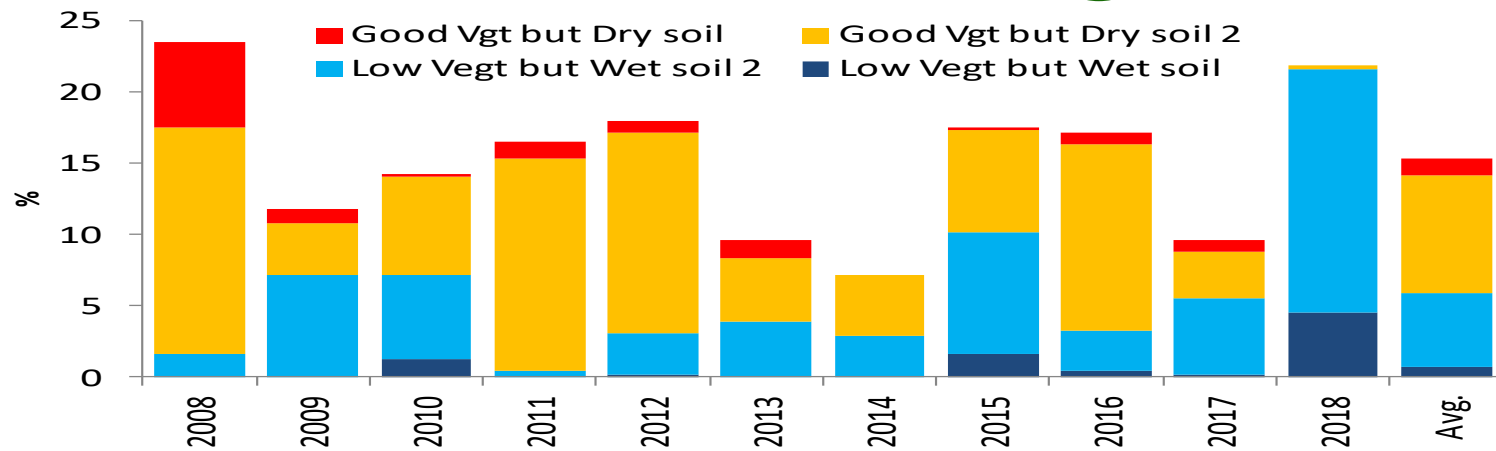
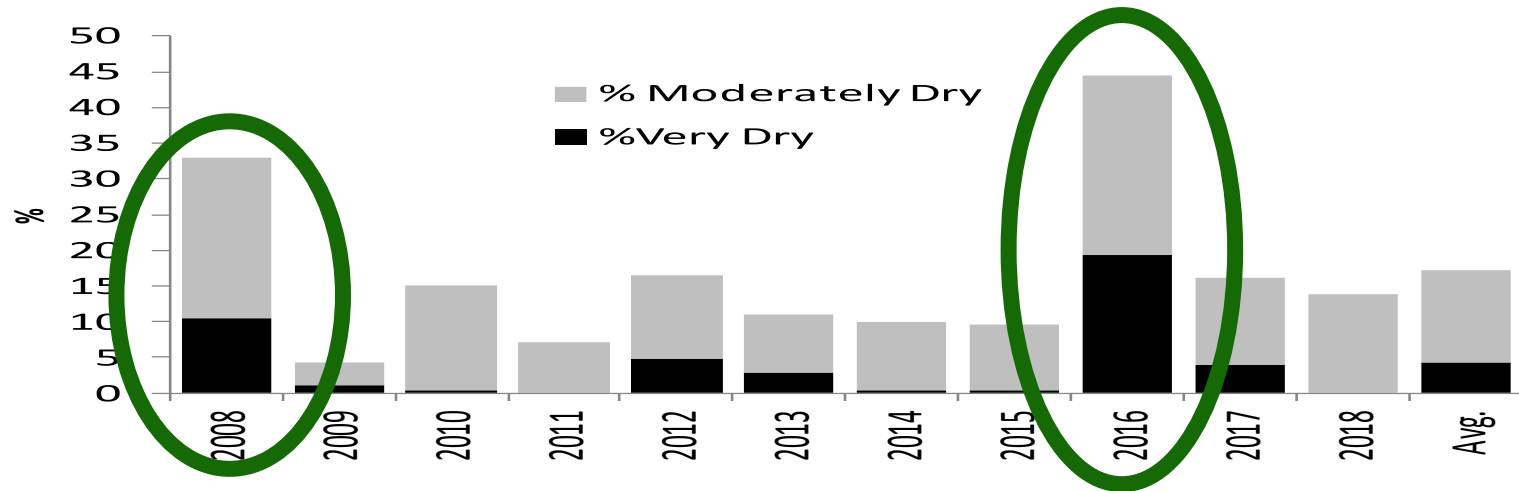


2007 to 2018, November to April

Drought qualification for the study area

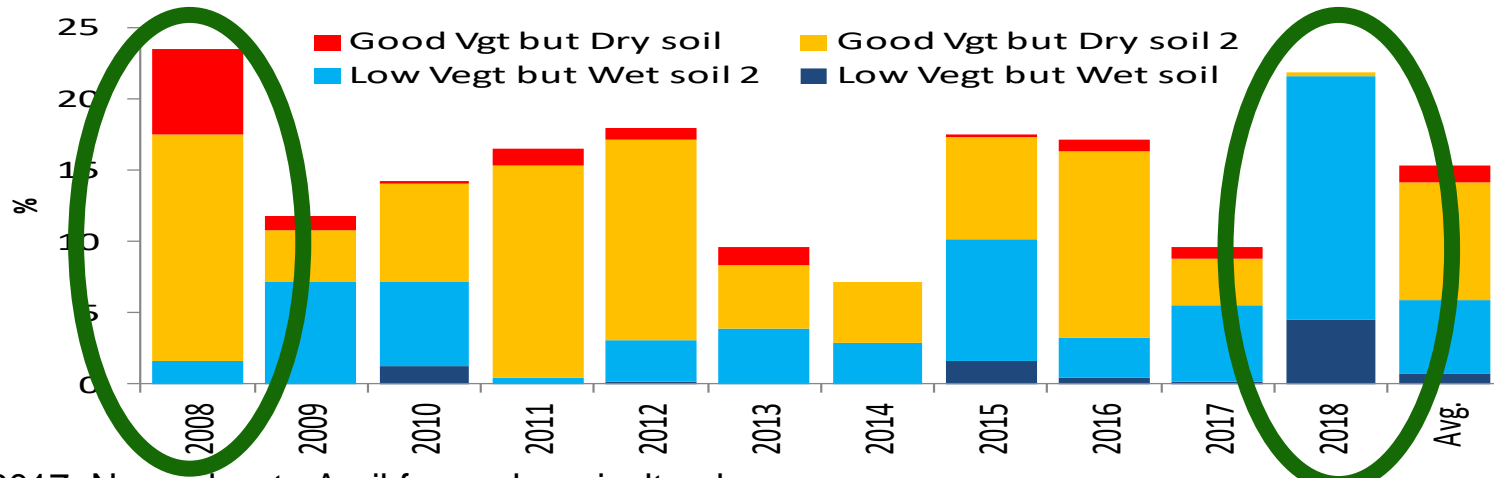
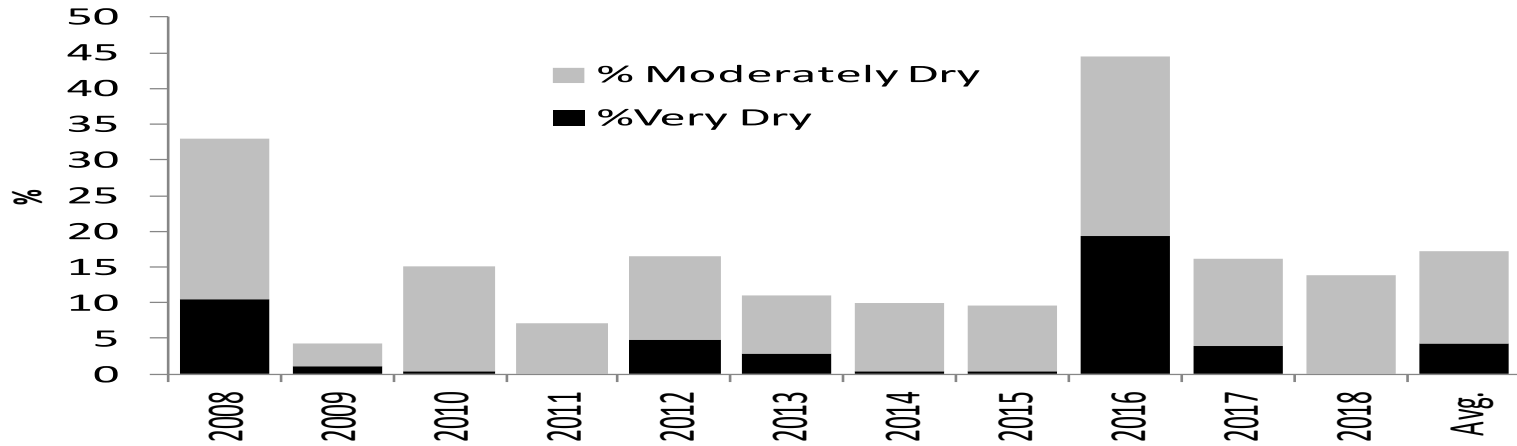


Drought qualification for the study area



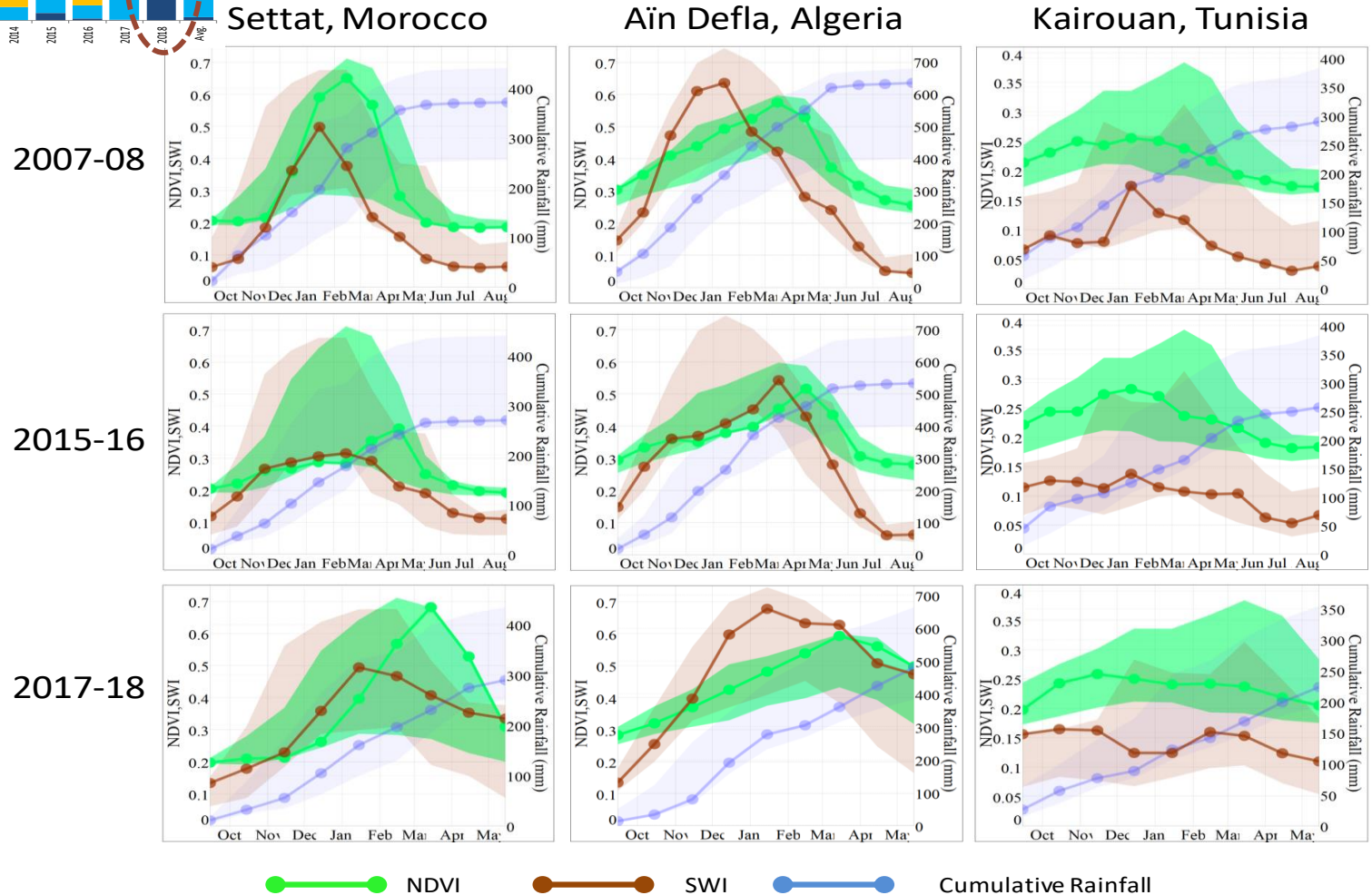
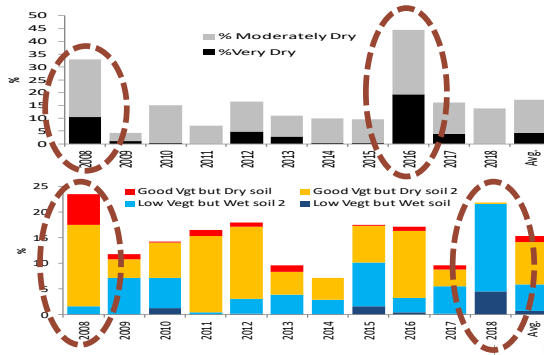
2007 to 2017, November to April for each agricultural year

Drought qualification for the study area



2007 to 2017, November to April for each agricultural year

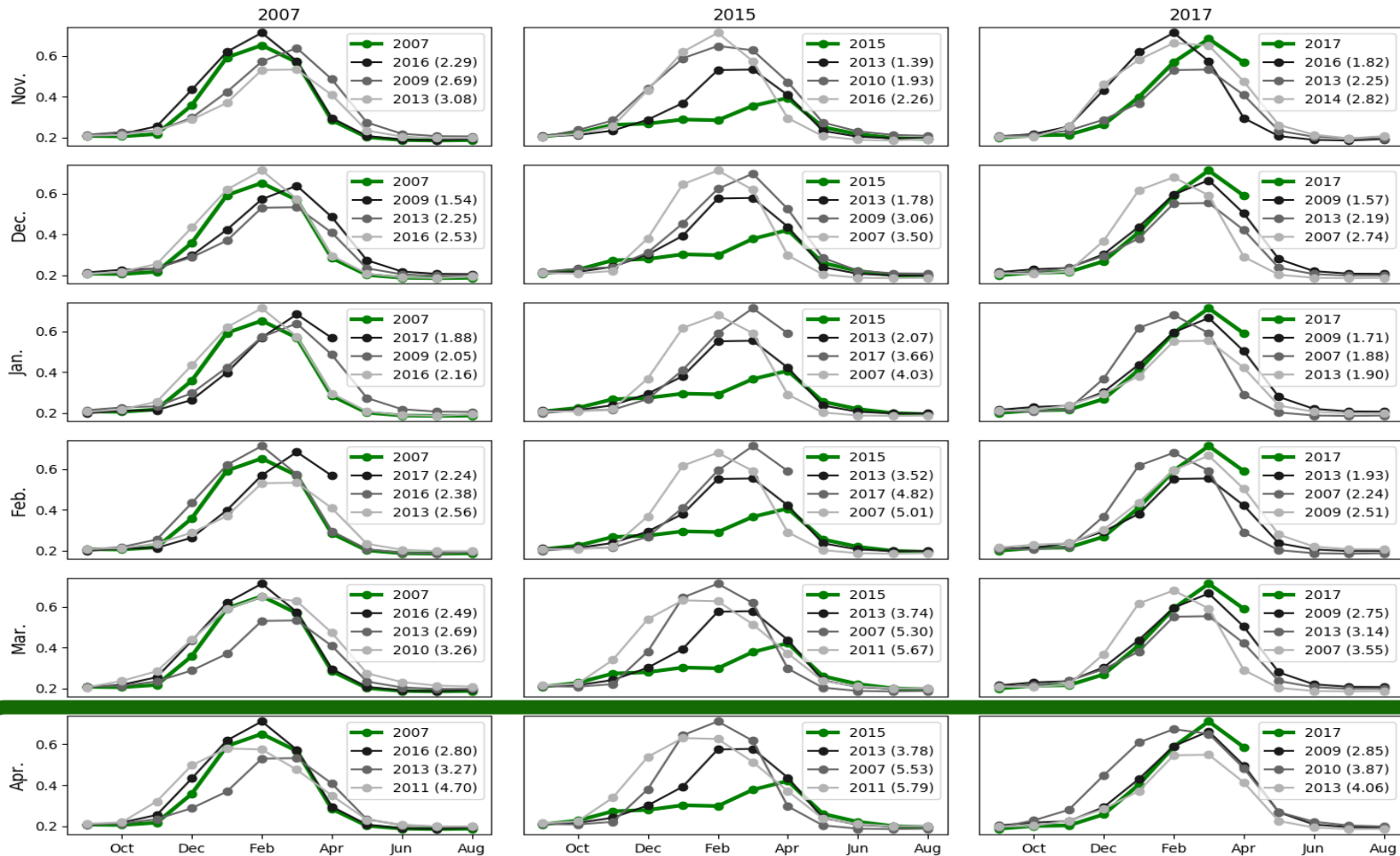
Use cases for the peculiar years



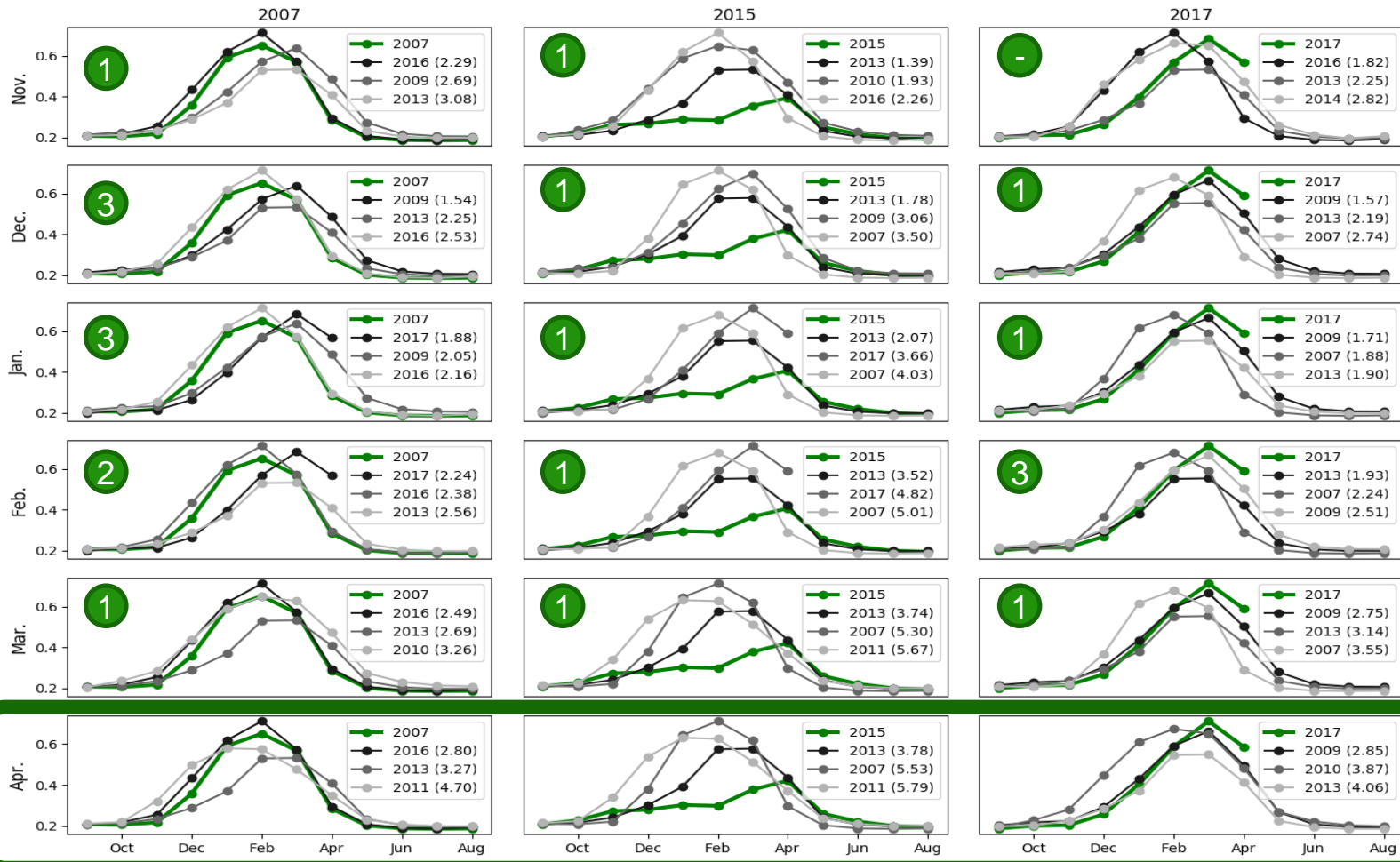
Performance of the forecast

	Percentage of First Analog	Percentage of First or Second Analog	Average Rank
November	21.2	38.4	4.09
December	32.6	53.0	3.12
January	47.5	72.4	2.46
February	57.3	80.0	2.03
March	71.4	91.7	1.51
April	100	100	1

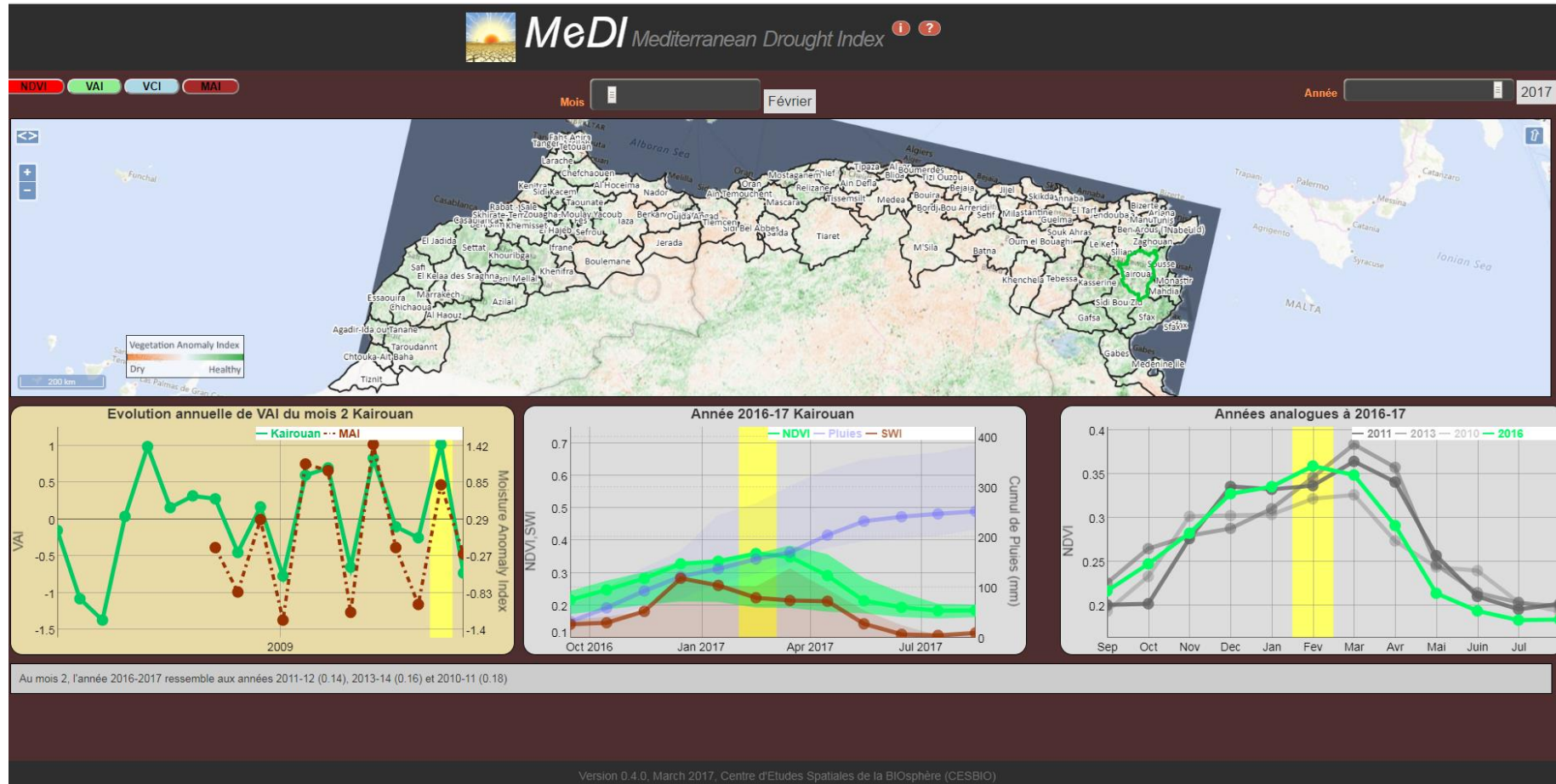
Use Case: Settat, Morocco



Use Case: Settat, Morocco



A Webapp with monthly updates



Thank you for your attention

