# The AGricultural Land AbandoNment and ClimatE change impacts on the water, energy and vegetation carbon cycles in the Mediterranean region (GLANCE)

GLANCE






GLANCE Team

March 2026

# Mechanisms of natural reforestation (after abandonment)


Since the 1990s, approximately **120 million hectares** of **land have been abandoned** in Europe (FAO), predominantly due to socio-economic factors such as rural migration towards regions offering new economic prospects. This process was particularly important in the **Mediterranean regions**.

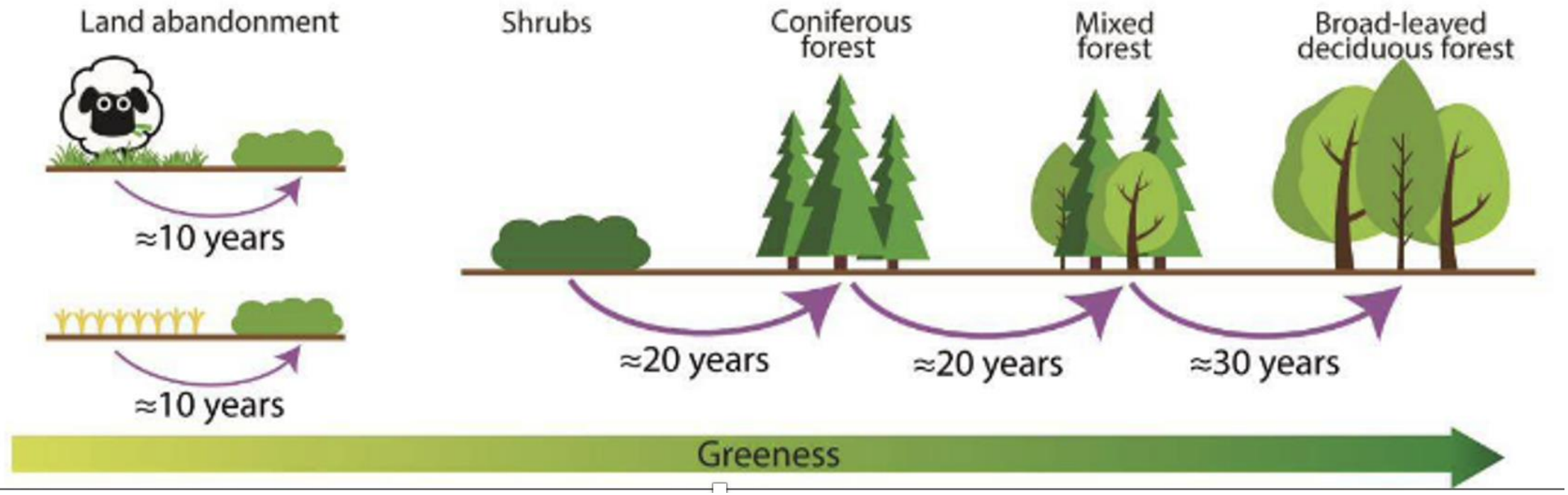
## What is land abandonment

*Cessation of management activities for at least four years (Levers et al. 2018), and it often occurs hand in hand with agricultural intensification in other regions, which at the same time further amplifies rural abandonment*.

# GLANCE: a socio-ecohydrological story

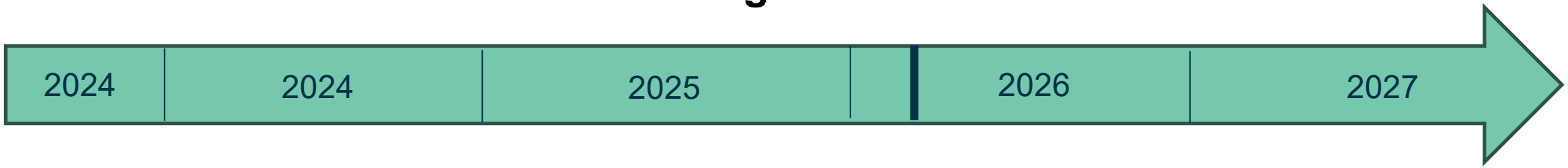
**Mechanisms**: Forest expansion through shrub colonization and seed dispersal.

**Factors:**. site characteristics, species traits, land-use history, landscape structure -> Shrub layers often facilitate tree establishment in Mediterranean ecosystems



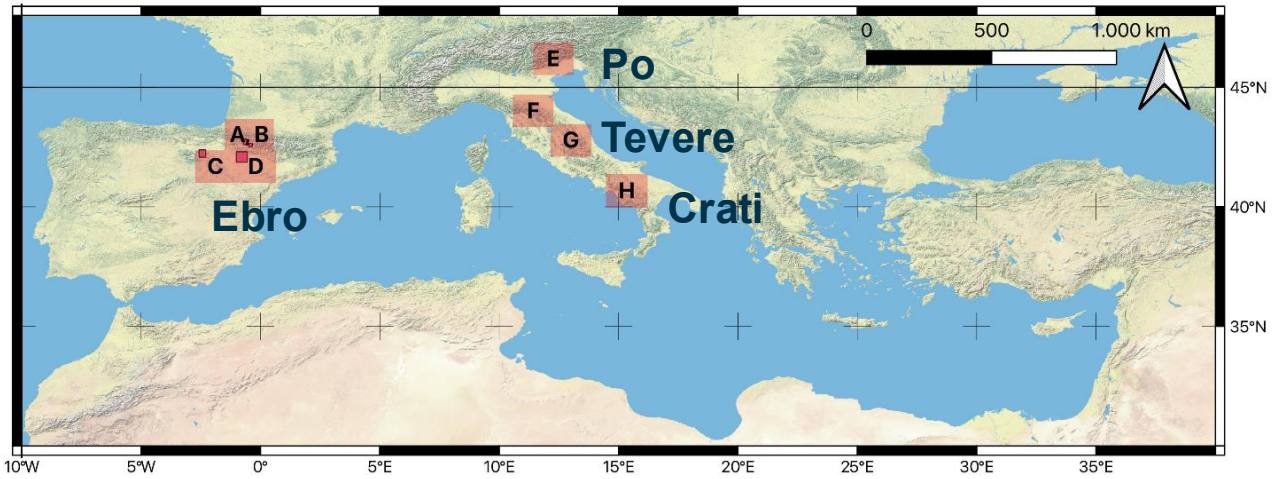
# GLANCE Objectives

**The main goal of GLANCE is to quantify the impacts of climate change and land abandonment on forest carbon dynamics, water and energy cycles in the Mediterranean using ESA CCI ECV datasets**

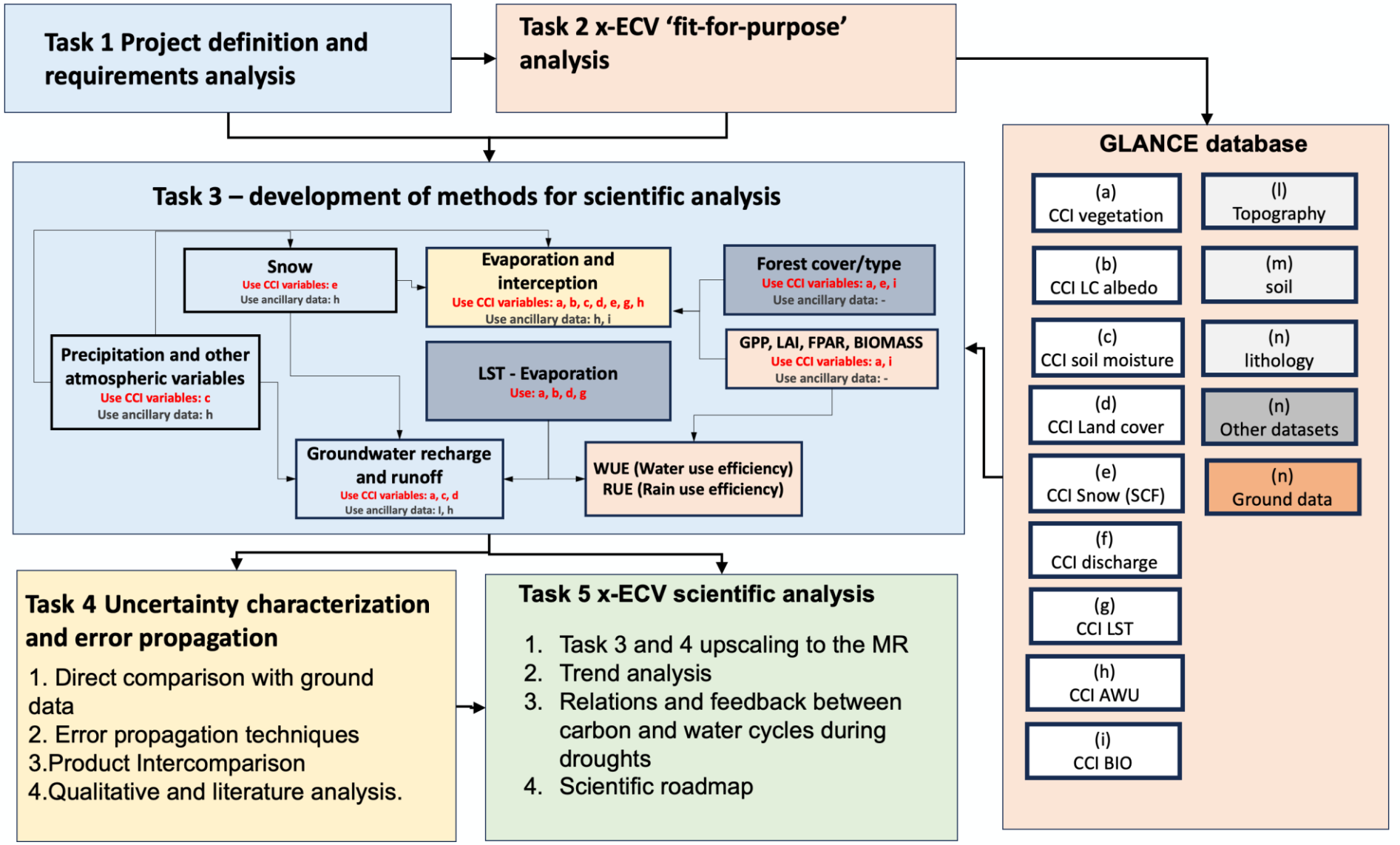



**Task 1** - Project definition requirements
**Task 2** - x-ECV 'fit-for-purpose' analysis
**Task 3** - Development of methods for scientific analysis
**Task 4** - Uncertainty characterization and error
**Task 5** - x-ECV scientific analysis
**Task 6** - Outreach and Communication

**GLANCE domain**



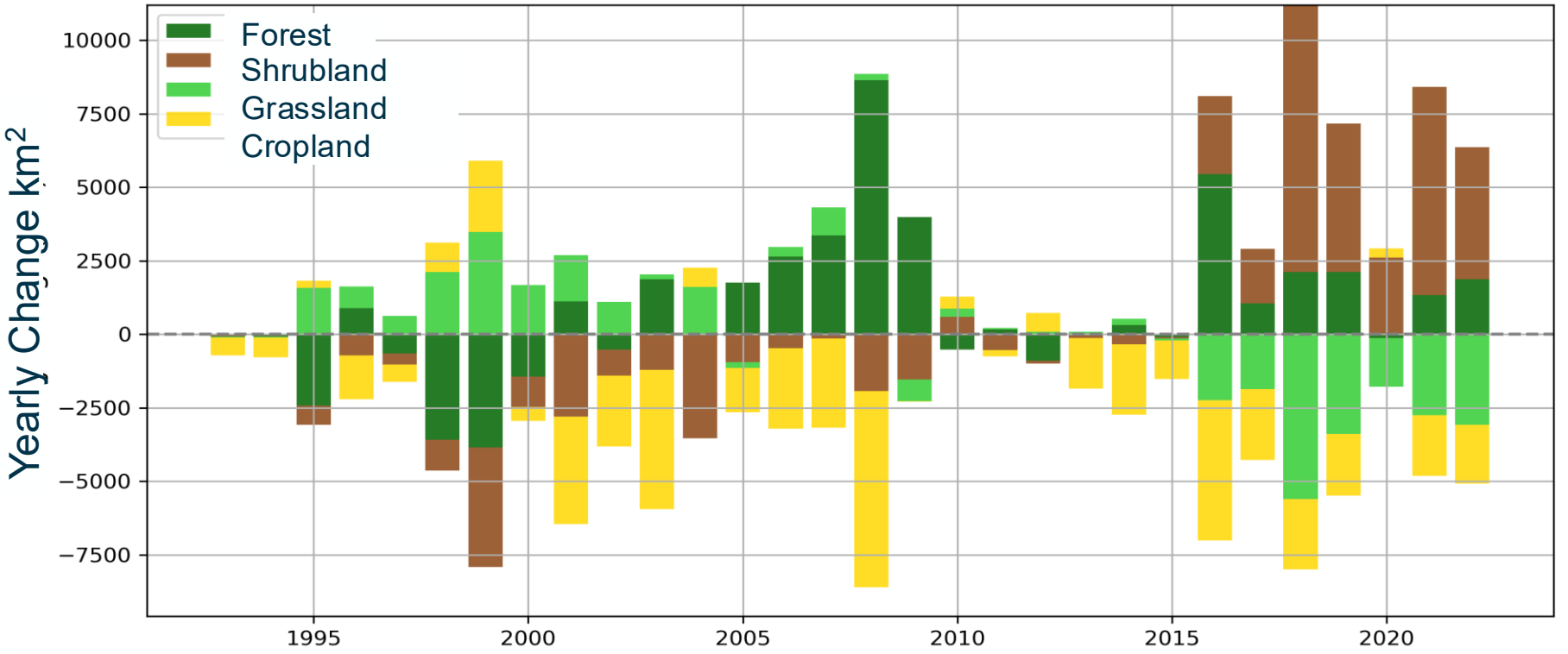
# GLANCE at “glance” & ECVs being used



# Land cover transition using ESA CCI LC

**ESA CCI LC** (*300m; 1995-2022; MERIS-AVHRR-SPOT-VGT-PROBA-V-Sentinel-3)*. UN-FAO LCCS compatible legends harmonised to a common 10-class schema (MOLCA) derived from the HR_LandCover_CCI project

**ESA CCI LC (300m)**



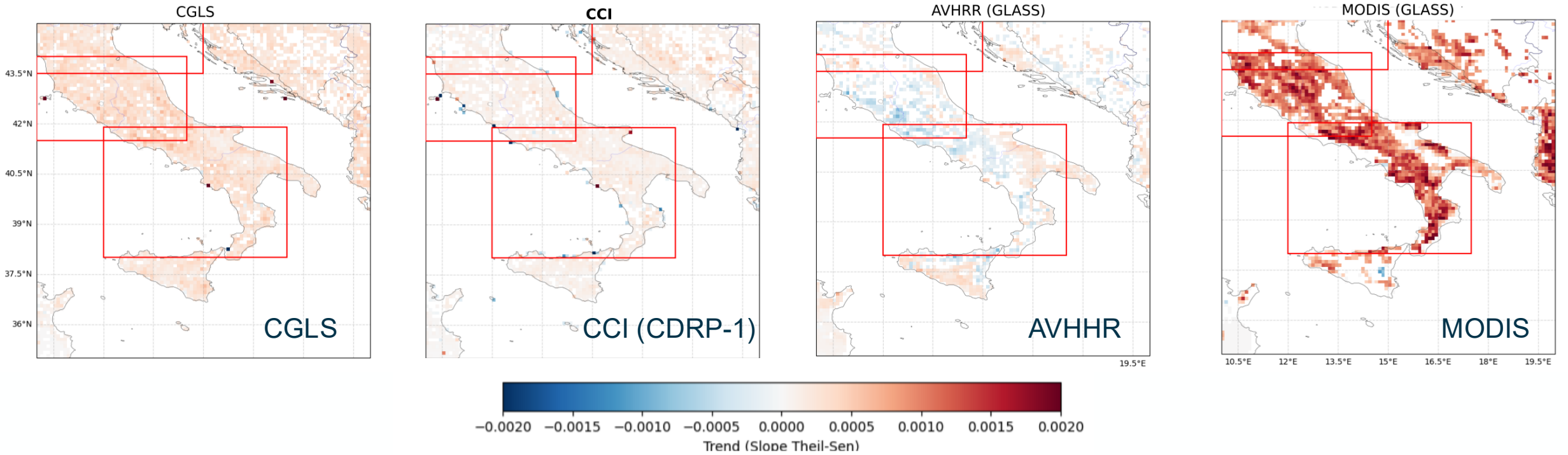

- Cropland **−50,000 km²**
- Forest **+40,000 km²**
- Shrubland **+10,000 km²**
- High interannual variability

**We observed significant discrepancies in cropland and forest transition with respect to GLC-FCS30!**

# Vegetation parameters: LAI

- **CCI (CRDP-1):** ESA CCI effective LAI, 1 km, 2000–2020.
- **CGLS:** Copernicus global LAI, 300 m, neural-network retrieval.
- **GLASS MODIS:** Global MODIS-based LAI, 8-day, 2000–present.
- **GLASS AVHRR:** Long-term AVHRR LAI record, 15-day, 1995–present.

All datasets resampled to a 10 km grid (area-weighted resampling), time period: 2000-2018

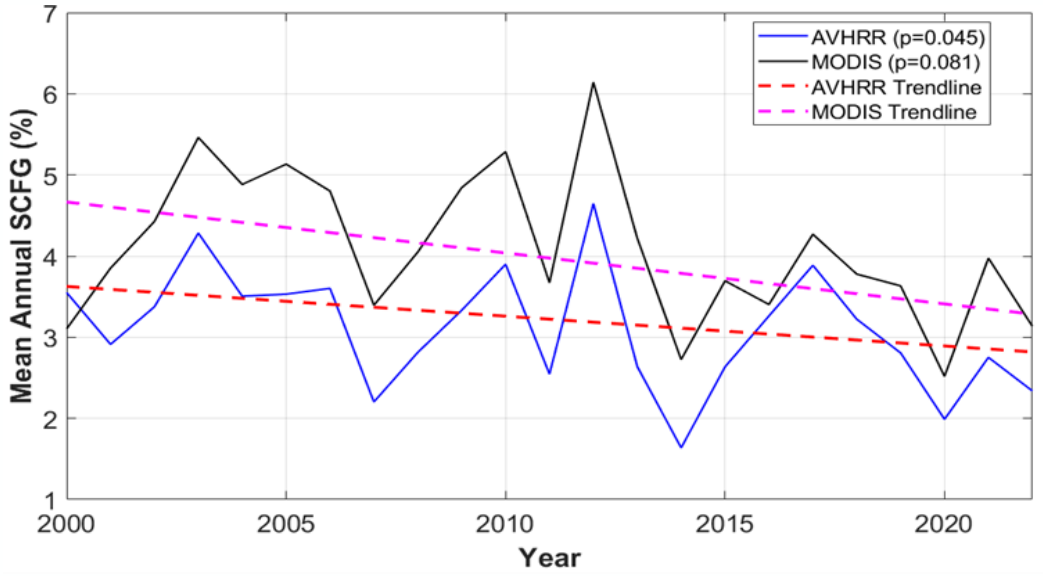


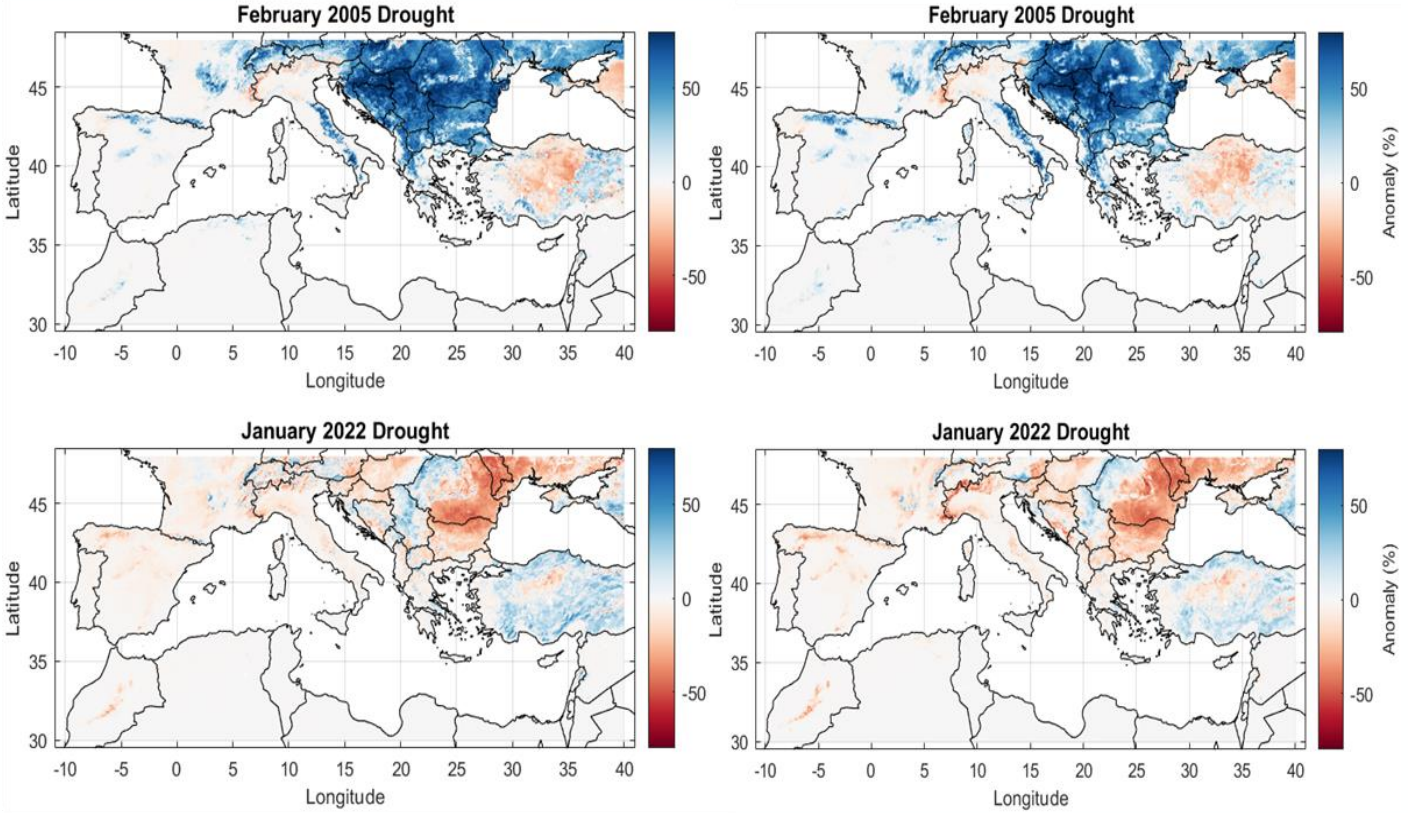
# Snow cover fraction

- **CCI-AVHRR** (~0.05˚ , 1980-2022, Daily)
- **CCI-MODIS** (~0.01˚ , 2000-2023, Daily)
- **Variable:** SCFG (Snow Cover Fraction Ground)
- **Version:** 3.0
- **CCI-MODIS** is regridded at ~0.05˚

## Trends & Performance

- **Mediterranean-wide :** Significant declining trend (AVHRR) | **2000 to 2022:** MODIS and AVHRR strongly correlated (R ≈ 0.91, RMSE ≈ 2.7; Po Basin = 7.3) with POD > 99 % and limited false alarms (≤ 0.27 in Crati).



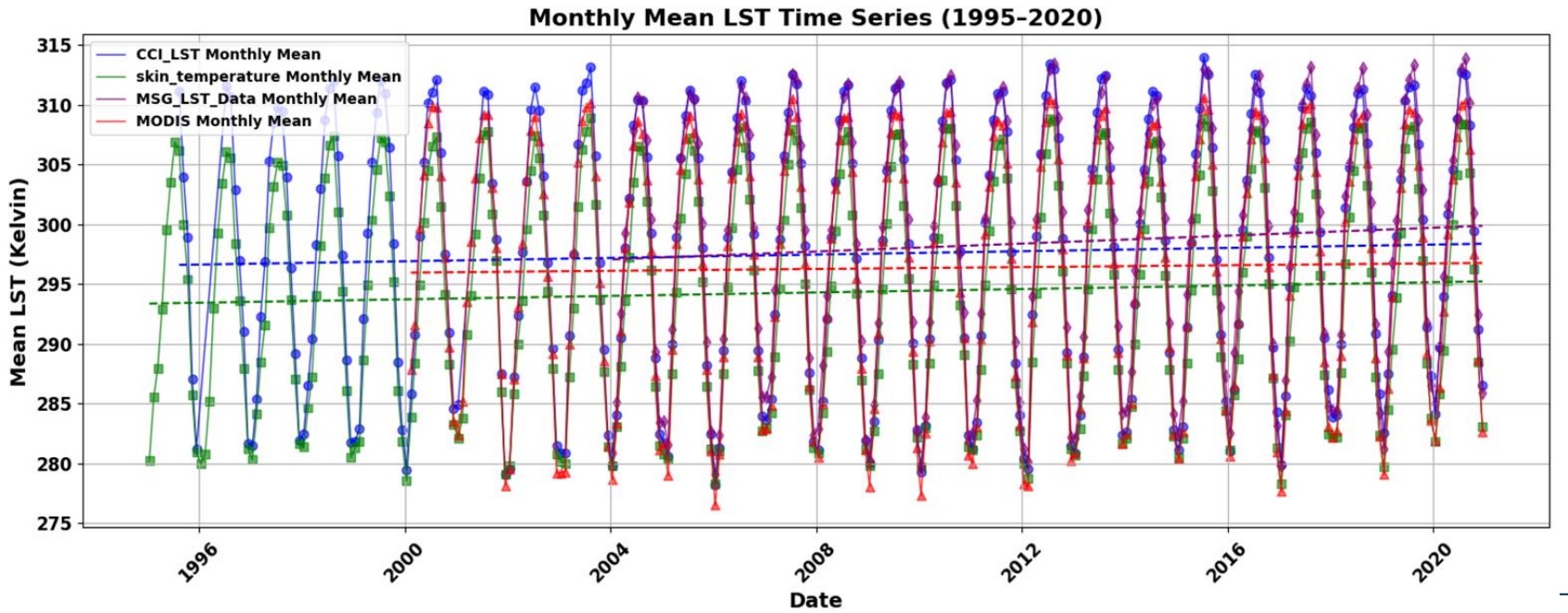




Overall, the datasets show a consistent depiction of snow dynamics across the Mediterranean, with MODIS and AVHRR closely aligned

# Land surface temperature

- **CCI LST:** ESA CCI land surface temperature, 1 km, multi-satellite, 1995–2020.
- **MODIS LST (MOD11 / MYD11):** MODIS satellite LST product, 1 km daily observations, 2000–2025.
- **MSG LSA-SAF LST:** Geostationary MSG satellite LST, high-frequency (15 min), 2004–2025.

**Results**: CCI LST small bias with MSG LST (+0.63 K), MSG LST hotter than CCI LST, MODIS slightly colder than CCI LST, ERA5-Land shows the lowest temperatures and lower correlation, higher differences due to topography




## Trends over the GLANCE domain

- CCI LST and ERA have a similar trend
- MODIS a smaller one
- MSG has the shortest time series, highest LST increase

# Results & relevance to the CCI community

## Preliminary results

- Overall good consistency between CCI ECVs and independent datasets across the Mediterranean region.
- Expected physical relationships are preserved, e.g. decreasing LST with increasing soil moisture.
- Some discrepancies identified, particularly in land cover transitions and LST magnitude.

## Relevance for the CCI programme

- Highlights regions where CCI datasets diverge most, requiring attention from developers and users
- Identifies potential algorithm or sensor-related sources of inconsistencies.
- Provides feedback to CCI developers to improve dataset harmonisation and uncertainty characterization.
- Supports integrated use of multiple ECVs for climate impact studies.

# Dissemination activities

## Conferences presentations

- 3rd Carbon cluster coordination meeting in the third session on 17th November. The presentation focused on the results related to the estimate GPP for the purpose of assessing the impact of land abandonment (Wouter Dorigo, Ruxandra-Maria Zotta)
- “Do Earth Observation Essential Climate Variables (ECVs) provide a consistent picture of land surface dynamics? Insights from a multi-variable analysis over the Mediterranean region “, Pierre Laluet, Chiara Corbari, Christian Massari, Luca Ciabatta, Odunayo David Adeniyi, Mohsin Tariq, Daniele Oxoli, Maria Antonia Brovelli, Andreas Wappis, Sophie Hebden, and Wouter Dorigo”, to EGU – European Geoscience Union 2026
- “Multi-Sensor Snow Cover Assessment over the Mediterranean Region”, Mohsin Tariq, Christian Massari, at the conference Open-Earth-Monitor Global Workshop 2025, Perugia-Italy (17–19 September 2025)
- “Integrated Satellite-Based Monitoring of Snow Cover Variability in the Mediterranean Region”, Mohsin Tariq, Christian Massari, at the SnowHydro Conference, Jaca-Spain (2–6 February 2026)
- “Multidecadal Snow Water Equivalent Reconstruction in Central Italy Using the Multiple Snow Data Assimilation System”, Mohsin Tariq, Christian Massari, submitted to EGU – European Geoscience Union 2026
- VODCA2GPP: High Resolution GPP Estimation in the Mediterranean basin from Vegetation Optical Depth Using Machine Learning, Moritz Müller, Ruxandra Zotta, Pierre Laluet, and Wouter Dorigo – European Geoscience Union 2026
- An improved machine learning approach to estimate global long-term VOD2GGP”, Wouter Dorigo, Ruxandra-Maria Zotta, ICOS conference 2026

# Backup slides

# Review of the state of art research: Potential problems with satellite spatial resolution

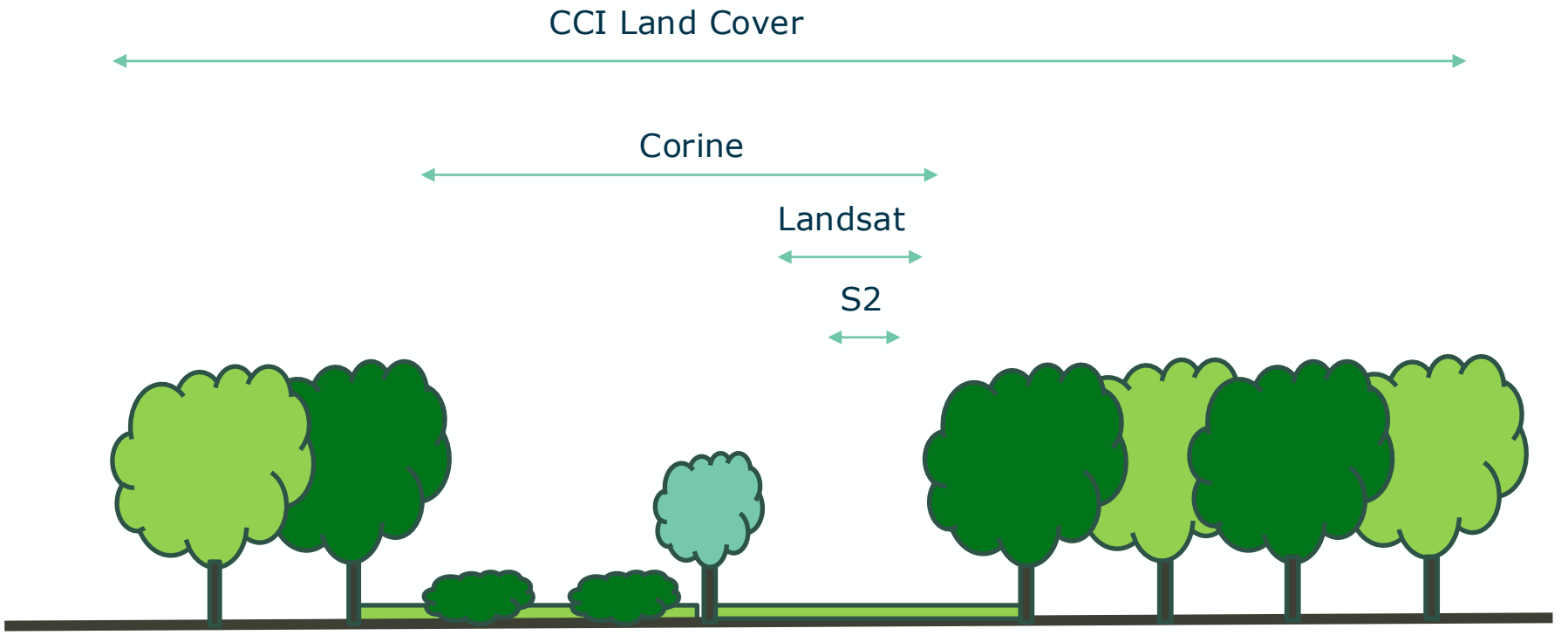




Photo: Christian Massari

Thanks to Recapp 2.0 we will have 30m forest map since 1980. For now NDVI and EVI2 will be shared.

# Consistency Analysis

**For each CCI variable:**

1. CCI Land cover
2. CCI Precipitation
3. CCI LST
4. CCI Vegetation Param. (LAI, fAPAR)
5. CCI Biomass
6. CCI Soil Moisture
7. CCI Snow

**1. Select 2/3 state-of-the-art reference datasets**
***(e.g., for CCI Soil moisture analysis: ERA5-Land, GLEAM, and SMAP)***

**2. Process all datasets to the common GLANCE 0.1° grid**

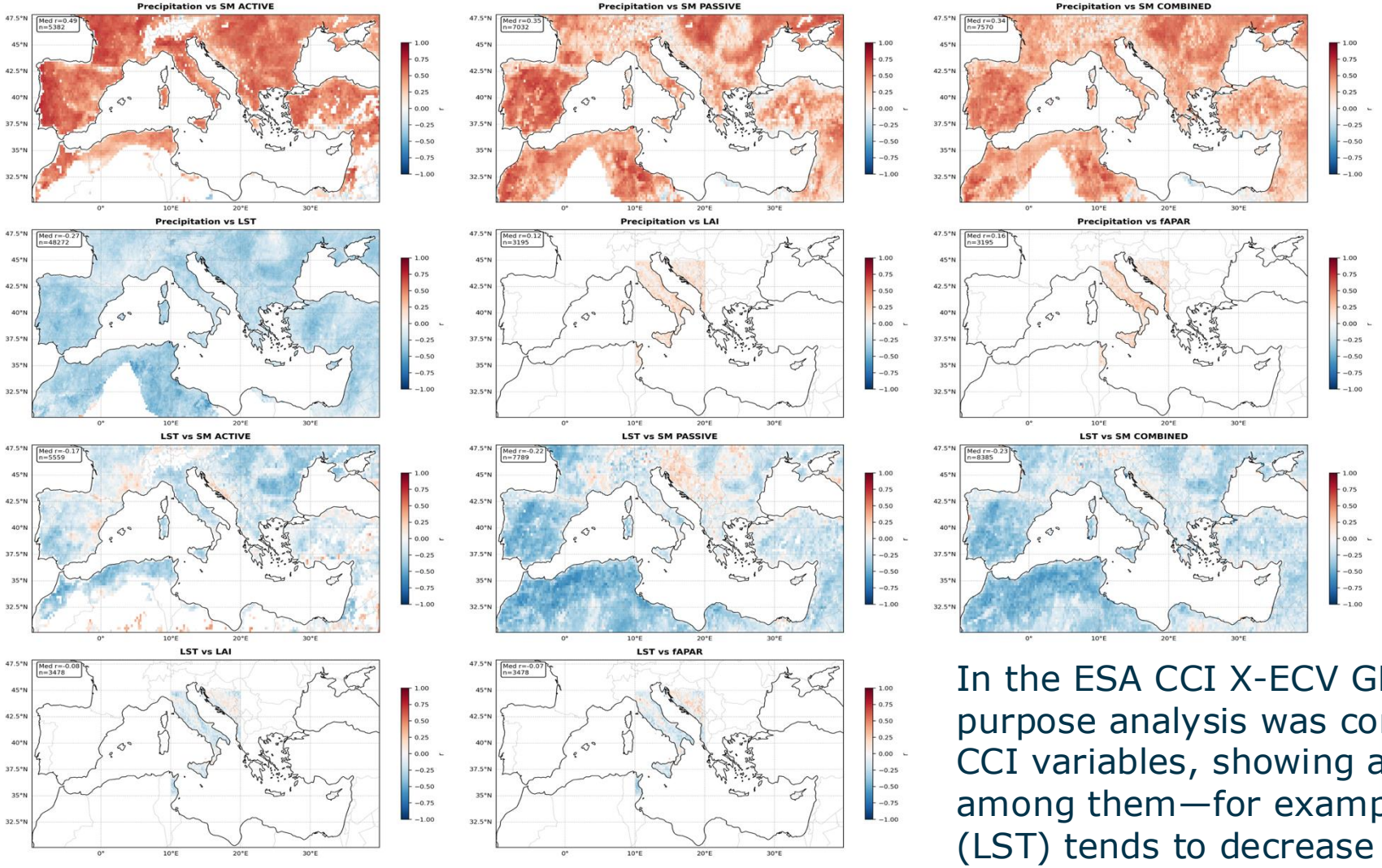
**3. Compare spatial and temporal pattern between CCI ECVs variable and reference datasets**
***(e.g., CCI Biomass vs. GEDI Biomass vs. Xu et al. (2021) Biomass)***

**4. Cross-check with other CCI ECVs variables and/or auxiliary datasets**
***(e.g., SM vs. drought indices, Biomass vs. CCI Land cover)***

**5. Assess if the CCI ECV dataset is more or less consistent/fit-for-purpose in comparison with the reference state-of-the-art datasets**
*→ Identify potential causes (e.g., algorithm, sensors, mask)*
*→ Provide recommendations to CCI developers*

# How consistent are CCI variables with each other across the Mediterranean?

Selected Spatial Patterns of temporal co-variability (2000-2018). Pixel-wise monthly correlations

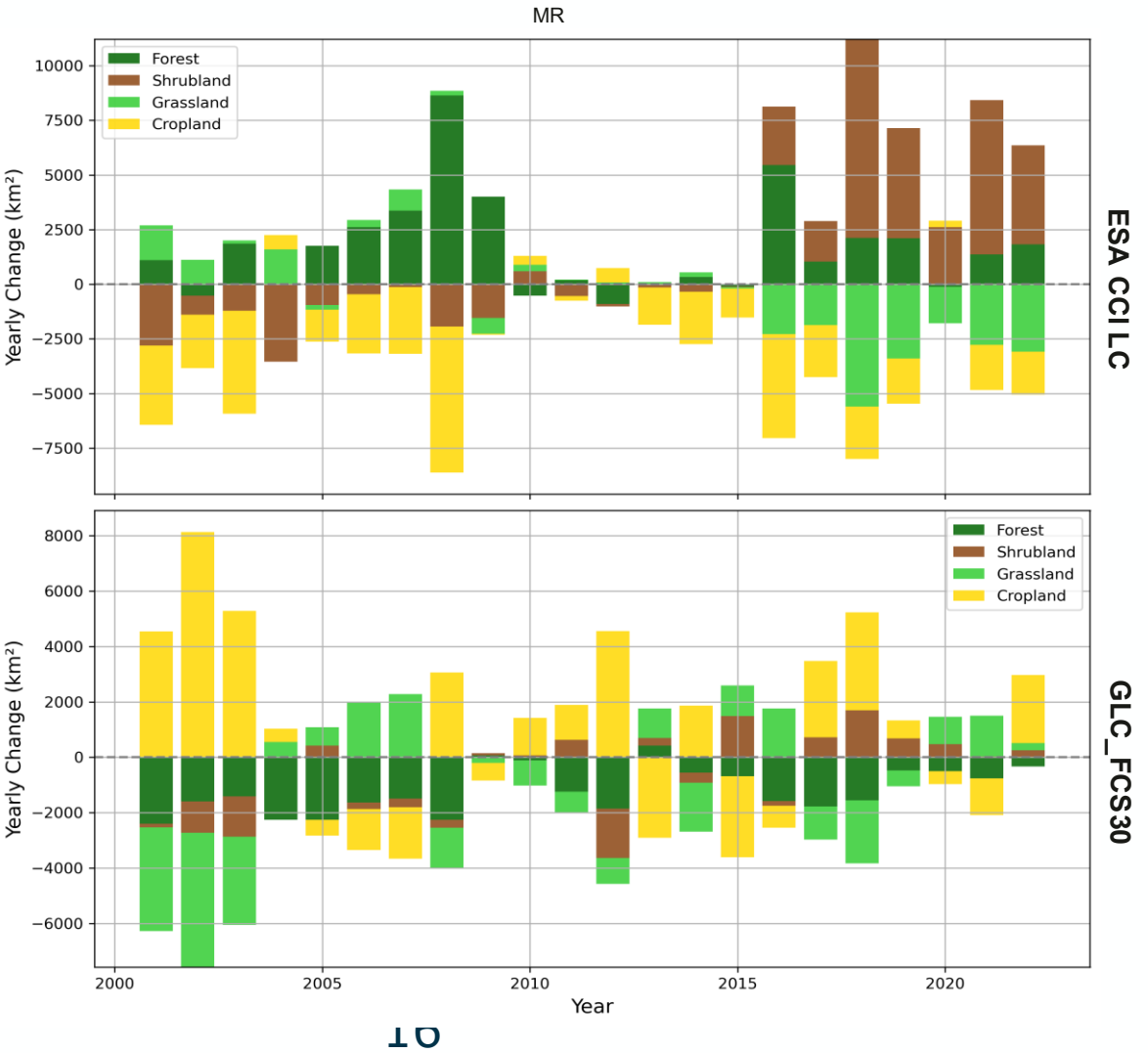



In the ESA CCI X-ECV GLANCE project, a fit-for-purpose analysis was conducted for both CCI and non-CCI variables, showing a good level of consistency among them—for example, land surface temperature (LST) tends to decrease when soil moisture increases.

# Land cover transition: ESA CCI LC vs GLC-FCS30

- Main **discrepancies concern cropland and forest**: ESA CCI LC shows cropland loss and forest gain in accordance with literature evidence and vegetation parameters, while GLC-FCS30 shows the opposite, with the strongest divergence before 2010 and after 2017.

- Overall, both datasets capture the main transition flows among Cropland, Forest, Shrubland, and Grassland within comparable ranges of area change; however, **class trends are sometimes completely divergent.**



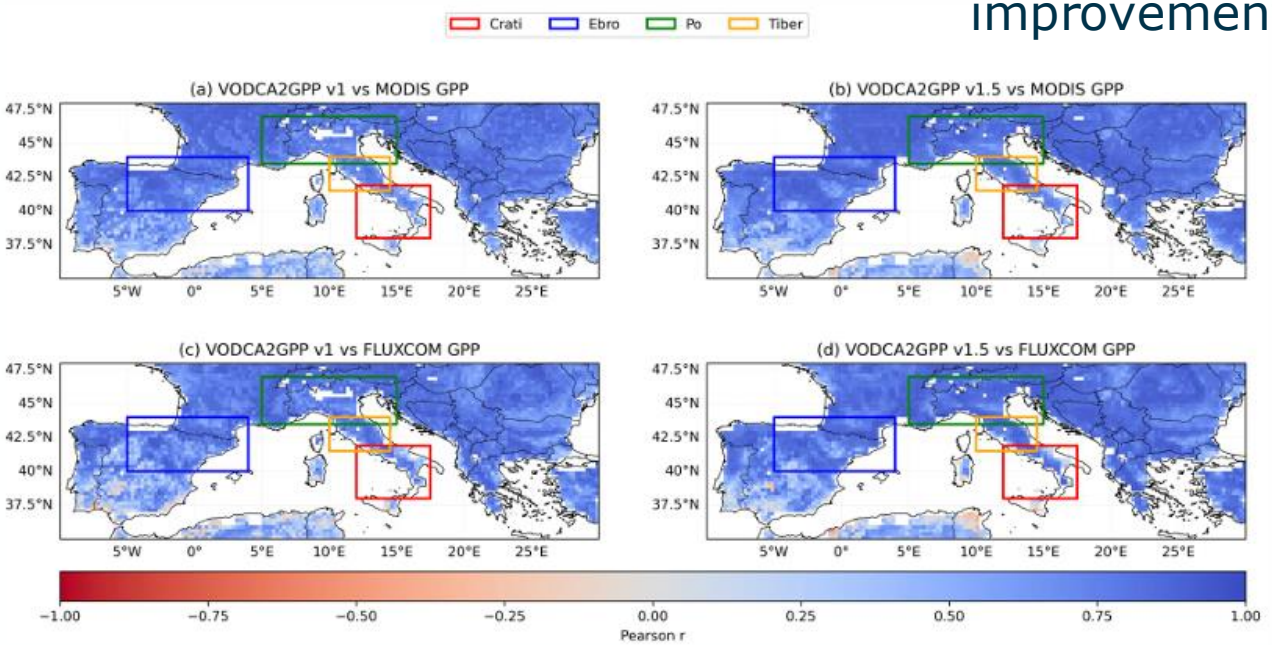
# New VODCA2GPP estimates available soon

GPP ESTIMATES FROM VODCA2GPP

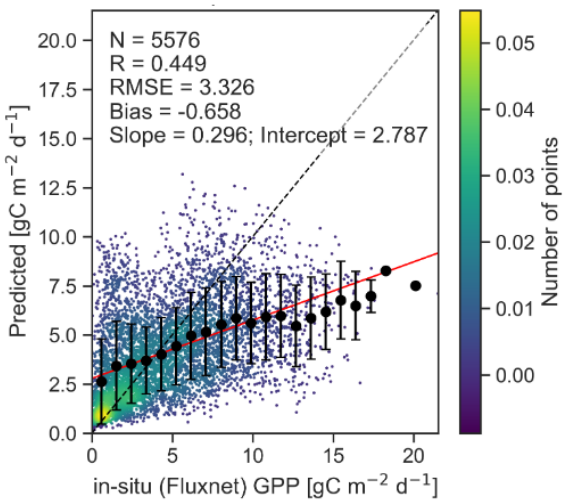
Long-term (1988-2020)

8-daily, 0.25°

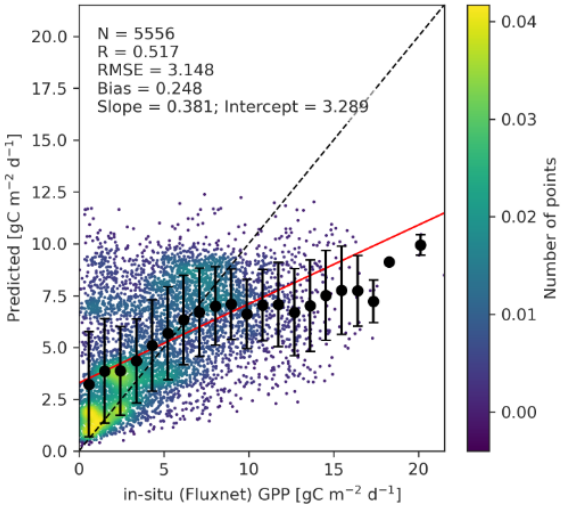
Within GLANCE, work is underway to develop a new Version 2.0 product at 10-km resolution for the Mediterranean region. In addition, the intermediate Version 1.5 of VODCA2GPP (0.25°), developed specifically for GLANCE, already shows clear improvements compared to the global (Version 1) product.




Correlation between 8-daily VODCA2GPP (v1 - (a); v1.5 (b)) and MODIS GPP and between VODCA2GPP (v1 - (c); v1.5 (d)) and FLUXCOM GPP.




(a) VODCA2GPP v1




(a) VODCA2GPP v1.5