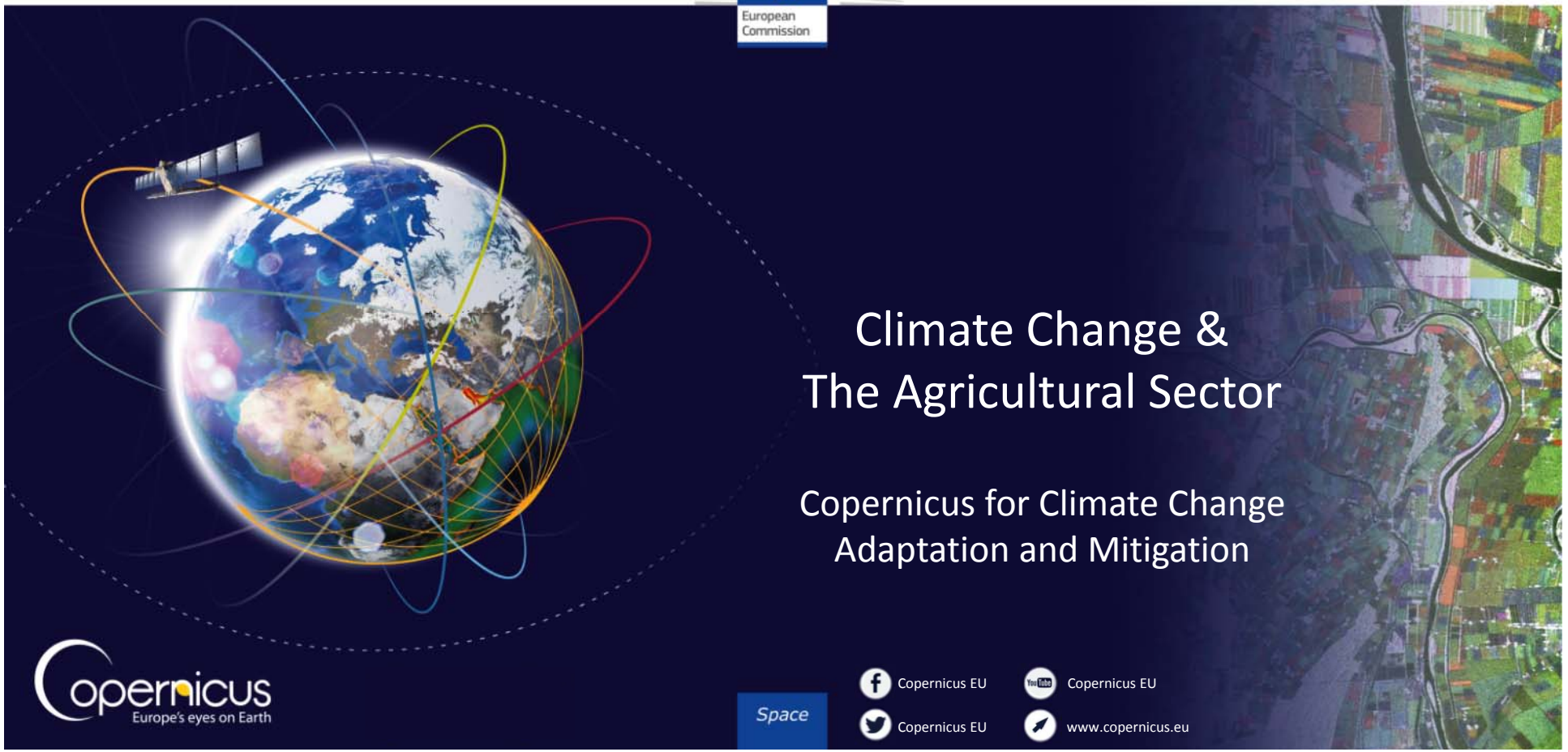
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Climate Change &
The Agricultural Sector
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WHY IS COPERNICUS NEEDED IN AGRICULTURAL SECTOR?

Climate change poses a direct challenge to agriculture.

Farmers across Europe are already experiencing effects of climate change including:

- **Climate induced stresses**
- **Pests and diseases**

A plan is essential for the agricultural sector to grow and adapt.

Copernicus Climate Change Service (C3S), operated by ECMWF, can provide data and tools to help

- **understand climate change impacts**
- **inform policy and decision-making**
- **planning for mitigation and adaptation**
- **ensure resilience in the future**

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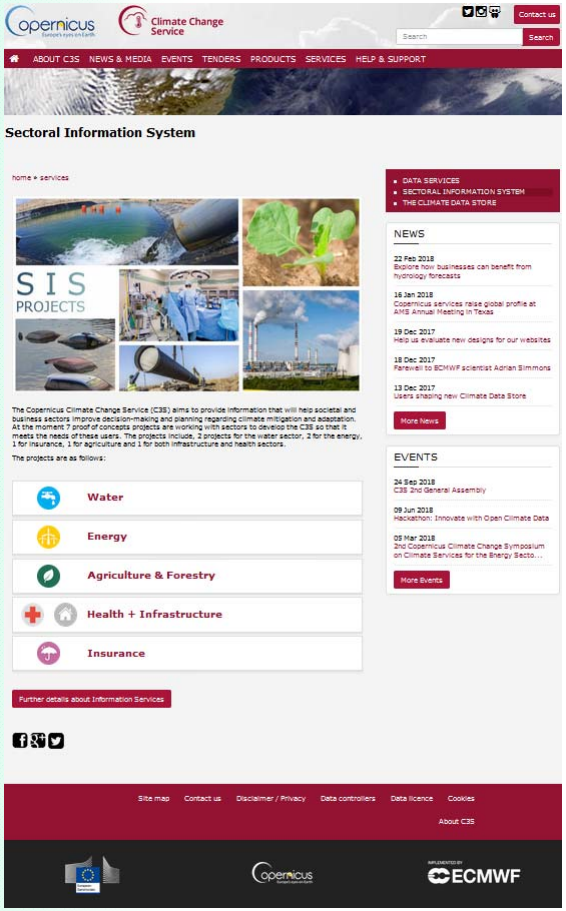
SECTORIAL INFORMATION SYSTEMS



https://climate.copernicus.eu/sectoral-information-system

In 2015, ECMWF commissioned 7 **proof of concept** projects, working with different sectors to develop the C3S:

- Water (x2)
- Energy (x2)
- **Agriculture**
- Health & Infrastructure
- Insurance

This presentation is based on the prototype Agriculture Sectoral Information System (SIS), also known as “AgriCLASS”.

CASE STUDIES

The Agriculture SIS is based on requirements from our local partners, working with end users, including growers and policy makers.

- Focus on 3 case studies: **vines, olives and forests**.
- These **woody perennial crops** can take >10 years to become established and productive, with an average productive life span of 50 years
- They can have **“climate memory”** and are responsive to cumulative change in climate conditions
- They are highly vulnerable to climate change and therefore require a long-term management strategy

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KEY CONCEPTS

For climate impact on agriculture, a key concept is **Phenology**:

1 : a branch of science dealing with the relations between climate and periodic biological phenomena (such as bird migration or plant flowering)

2 : periodic biological phenomena that are correlated with climatic conditions

(Merriam-Webster)

Examples from case studies:

- **Grape** vine growth advances with **accumulation of temperature** above 10°C, especially between April and September (different for each variety)
- **Olive** fruit fly pest activity increases with warmer winter **minimum temperature**
- **Forest** tree growth (ring width) decreases in **drought** years

Features of the climate that are relevant to agriculture and crop phenology can be represented as **Bioclimatic Indicators**.

VINES CASE STUDY

- **Viticulture** is a well developed agri-industry in more than 60 nations globally. The EU leads the global wine market with 45% of wine-growing areas, 65% of production by volume, 57% of global consumption and 70% of exports.

- **Grapevine phenology** is critical to the wine industry and is sensitive to climate change, shifting harvest dates, changing sugar/acid content, alcohol strength and flavour.

- A key bioclimatic indicator for vine development is the integration of temperature over time, commonly expressed in **Growing Degree Days**.

- Changes in this indicator directly affect the vine phenology, hence the wine quality, taste and yield.

- Harvest date can shift by several weeks, resulting in higher sugar content and affecting the wine typicality associated with the local region.

VINES CASE STUDY – LES VIGNERONS DE BUZET

Case Study Location: Buzet Appellation d'Origine Contrôlée (AOC), S.W. France.

Like other AOCs, it has strict a geographical boundary as well as compulsory technical specifications (allowed grape varieties, maximum yield, regulation of irrigation, control of alcohol content, etc.)

Climate change poses a real challenge to Buzet business…

"We are experiencing the impacts of climate change strongly – our wines contain more and more alcohol consequently we have to harvest earlier to keep this alcohol content low but in the meantime it is becoming now difficult to reach full grain maturity necessary to have a good wine quality. So the information provided by AgriCLASS is of high interest for us in order to select today the grape varieties suitable for the future climate conditions and to start adapting our production process."

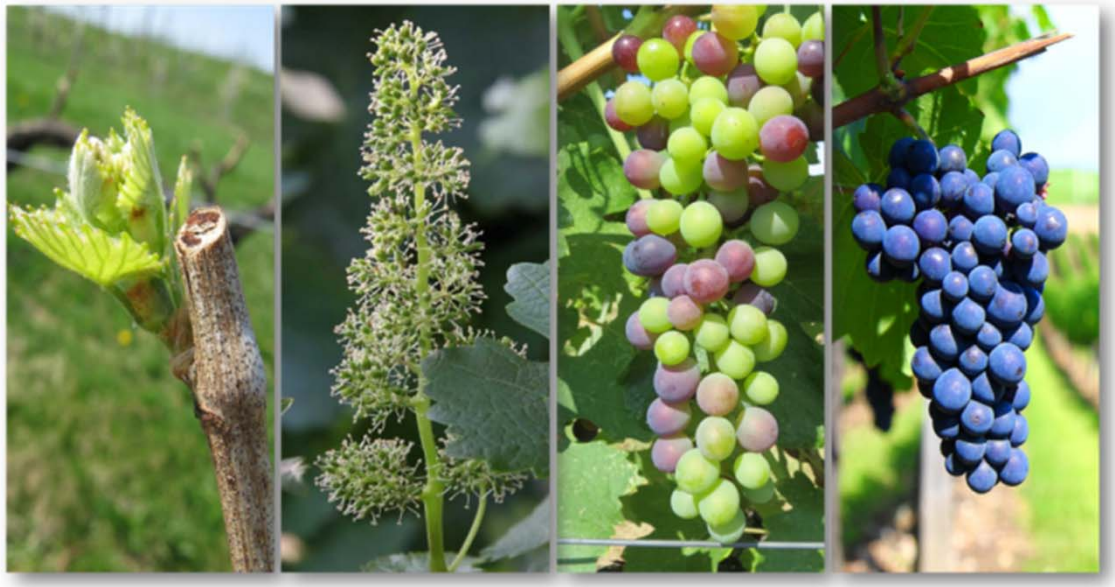
Sébastien Labails
Viticulture Innovation at the Cave des Vignerons de Buzet

LES VIGNERONS DE BUZET
S'engager autrement !

VINES CASE STUDY – PHENOLOGICAL MODEL

The case study considered 4 key stages in grape vine phenology:

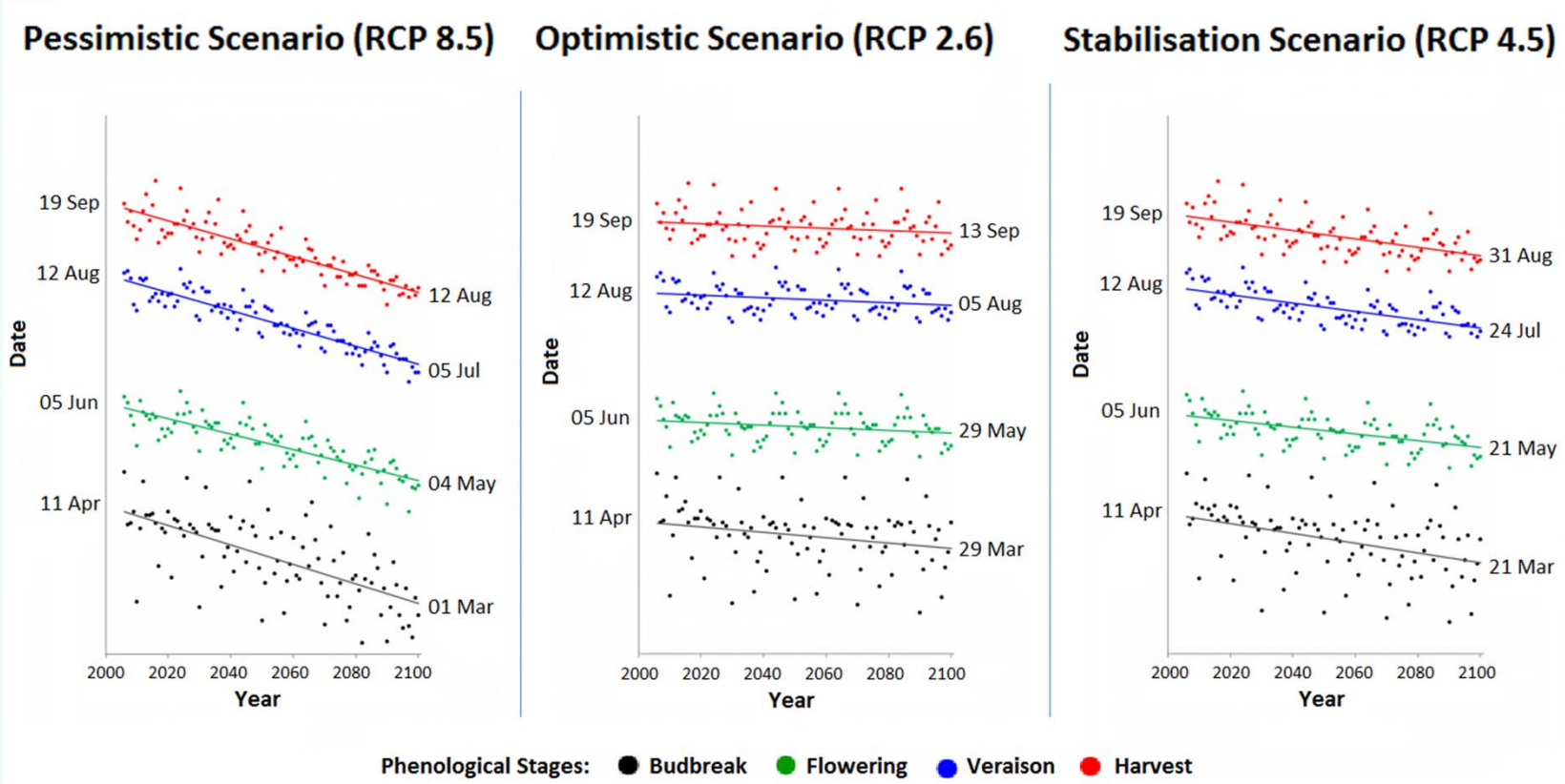
1. **Bud Break**
2. **Flowering**
3. **Veraison**
4. **Maturity**



- First, using data from historical observations, a mathematical model was developed to correlate the Day of Year (DOY) reaching each stage, with the accumulated temperature, measured in Growing Degree Days.

- Then, using simulated future daily weather from climate projections, it was possible to predict how the DOY of each stage might change in future.

VINES CASE STUDY – RESULTS



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PROOF OF CONCEPT SIS – PRODUCTS

18 annual **Bioclimatic Indicators** were computed for 1950-2100 on a 25 km grid.

Growing Degree Days (base 10°C)
Many organisms respond to the accumulation of growing degree days. If the target amount to reach a particular phenological stage is known, then it is possible to predict the Day of Year (DOY) when this will occur.

Specialised Indicators

- Huglin Index (Viticulture)
- Spring Flight (Olive pest)
- Standardised Precipitation-Evapotranspiration Index (Drought)

Monthly Weather Features

- Mean T_{max}
- Max T_{max}
- Min T_{max}
- Mean T_{min}
- Max T_{min}
- Min T_{min}
- Mean DTR (T_{max}-T_{min})
- Mean Temp (estimated)
- Frost Days ($T_{min} < 0°C$)
- Ice Days ($T_{max} < 0°C$)
- Hot Days ($T_{max} > 30°C$)
- Rain Days (precip >= 0.2mm)
- Wet Days (precip >= 1.0mm)
- Total Precip (mm)

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PROOF OF CONCEPT SIS – METHODOLOGY AND APPLICATIONS

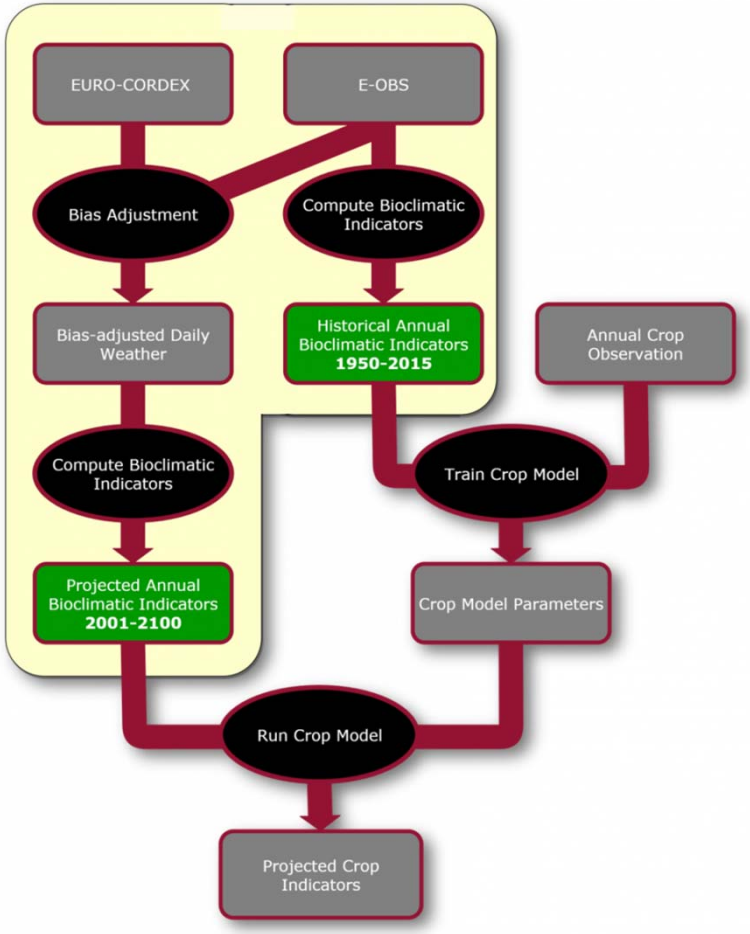
Bioclimatic Indicators can be used to model the impact of climate change on agricultural crops.

The case study methodology was based on **statistical correlation** of **bioclimatic indicators** with **observed crop behaviour**.

Machine Learning techniques included Principle Component Analysis and Generalised Linear Regression. A similar approach can be applied to many other agricultural crops and pests.

For further information please visit:

https://agriclass.climate.copernicus.eu



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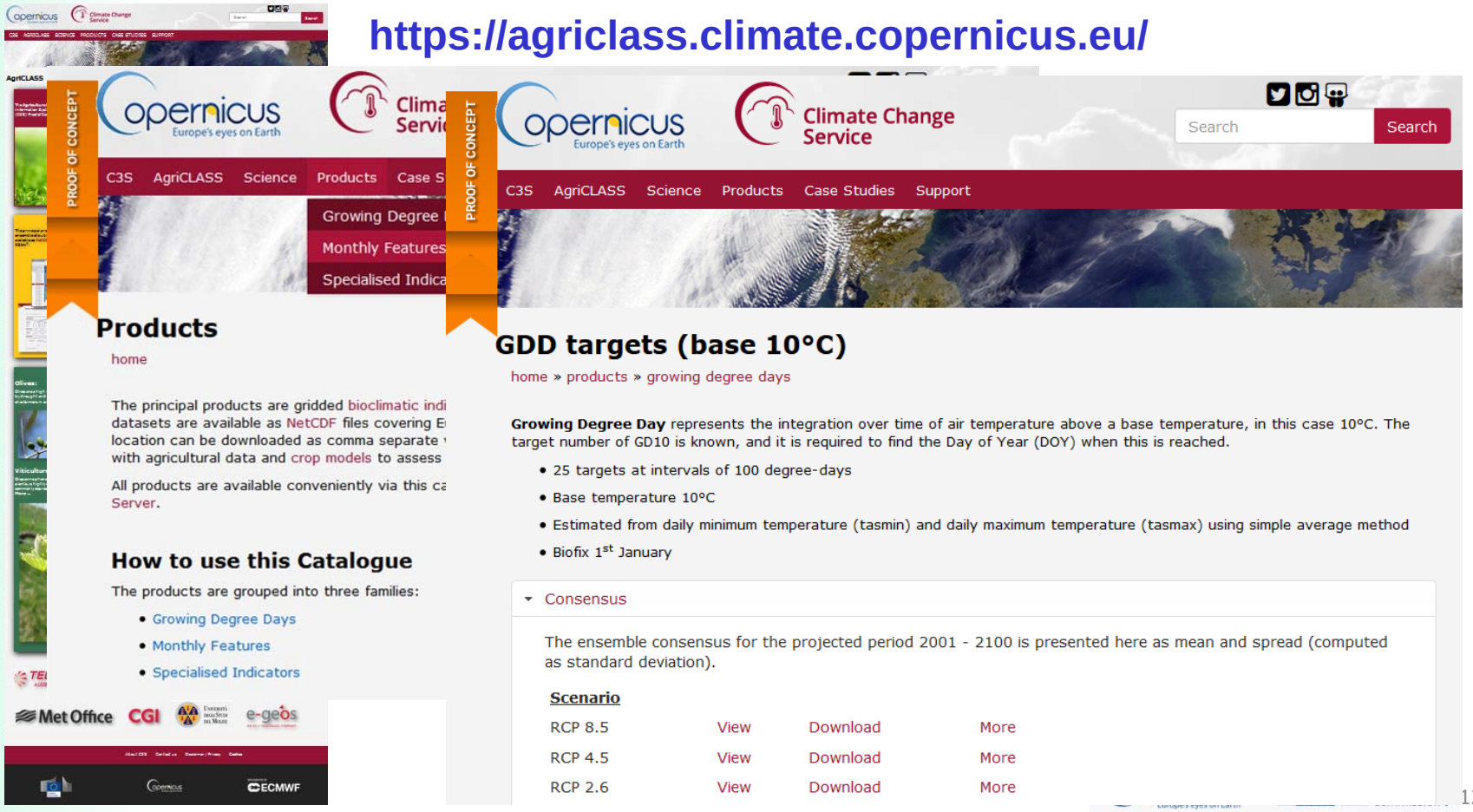
PROOF OF CONCEPT SIS DEMO – PRODUCTS

https://agriclass.climate.copernicus.eu/



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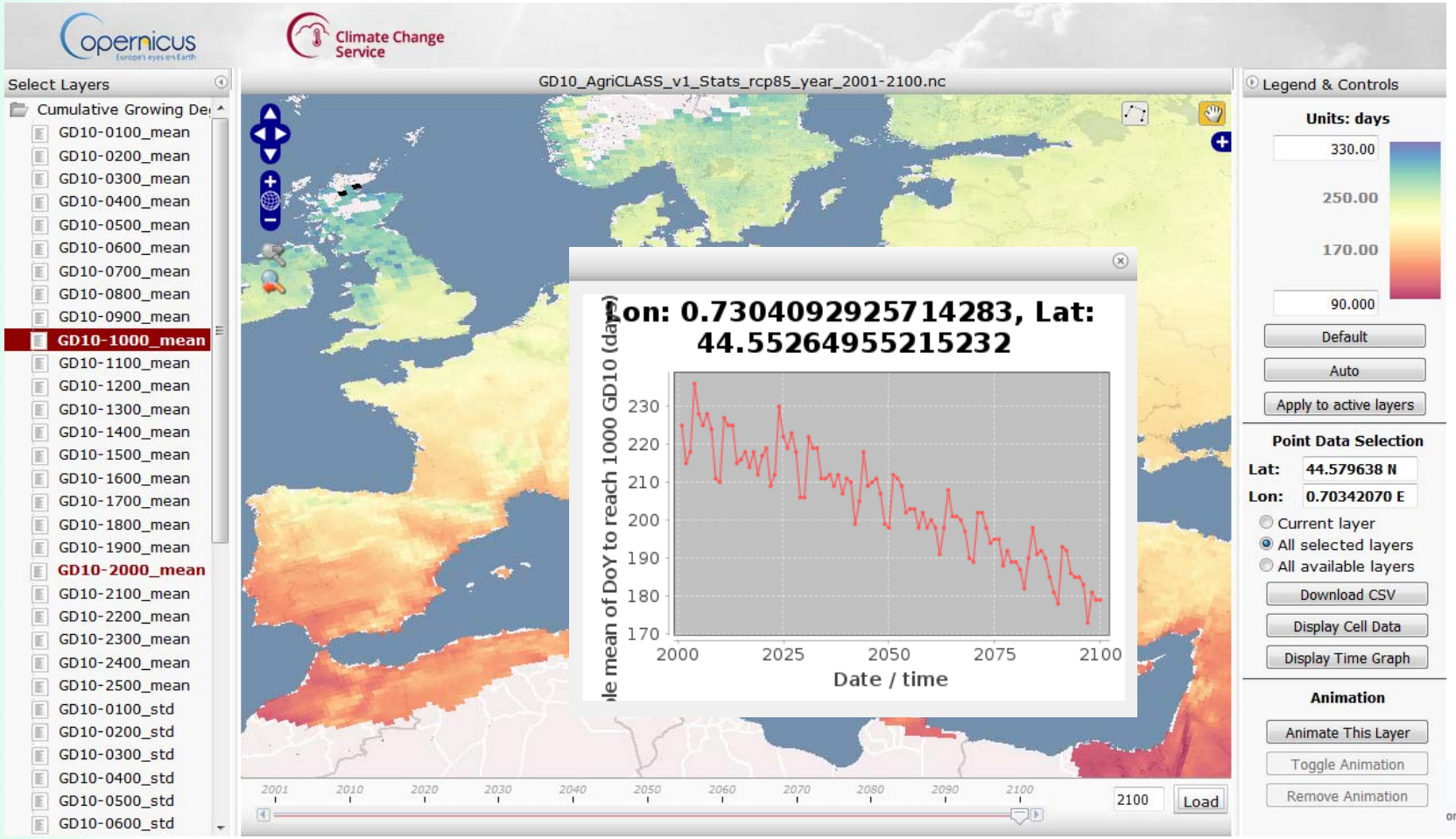
PROOF OF CONCEPT SIS DEMO – DAY OF YEAR / DEGREE DAYS



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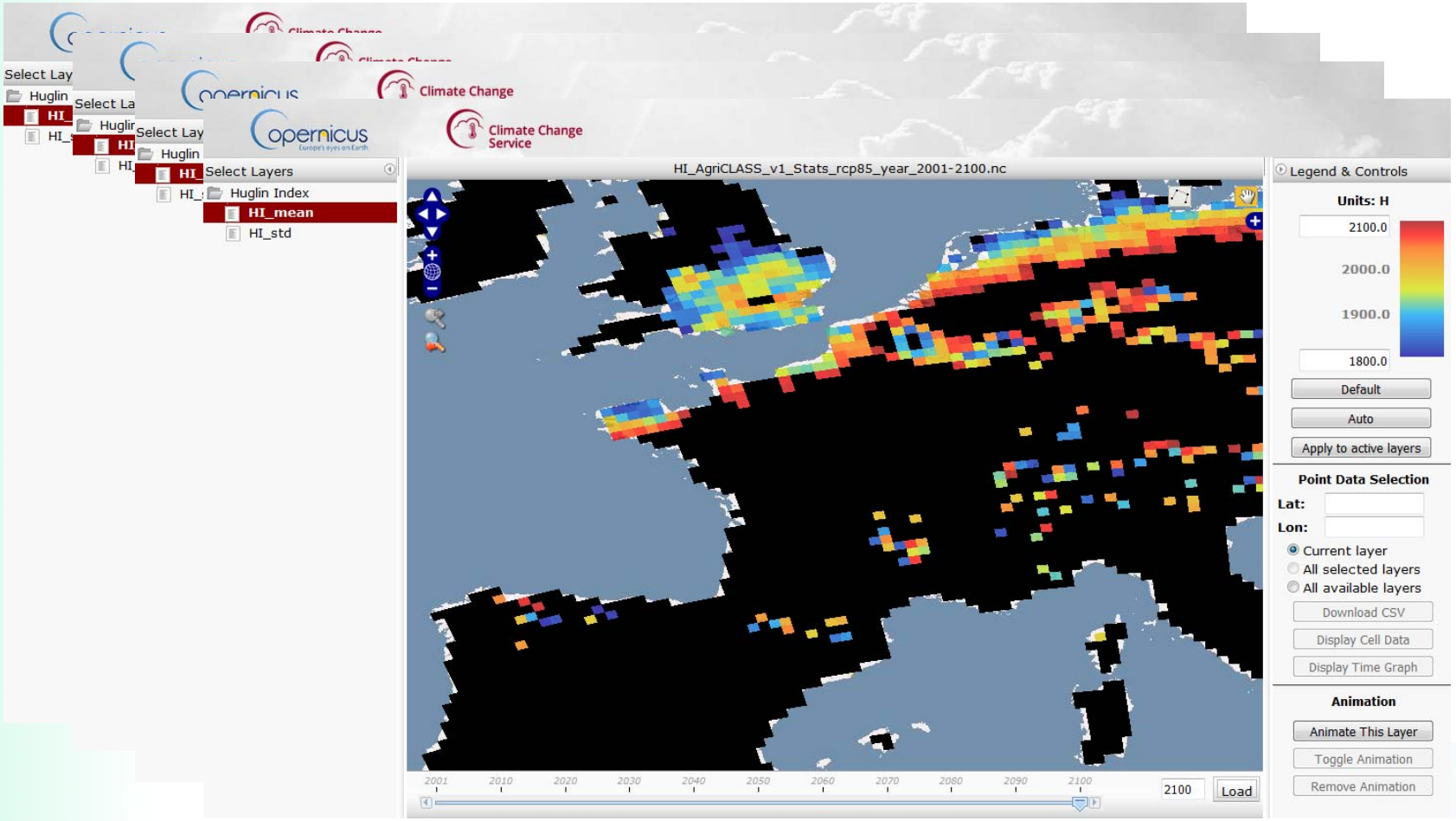
PROOF OF CONCEPT SIS DEMO – HUGLIN INDEX



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C3S AGRICULTURE SERVICES

There are now two projects addressing the Agricultural Sector:

Proof of Concept SIS

- ECMWF contract in 2015 with Telespazio Vega UK Ltd
- 18 Bioclimatic Indicators as gridded datasets over Europe
- 3 case studies on woody perennials: vines, olives and beech forests
- Completed and **currently available** via C3S web site
- Caveat: no quality control!

Global Agriculture Service

- ECMWF contract in 2017 with Wageningen Environmental Research (NL)
- 4 data streams: indicators based on Climate Data, Earth Observation and Water; forcing data for agricultural impact models
- Planned ongoing operational service via the **Climate Data Store (CDS)**
- In development, **coming soon**…

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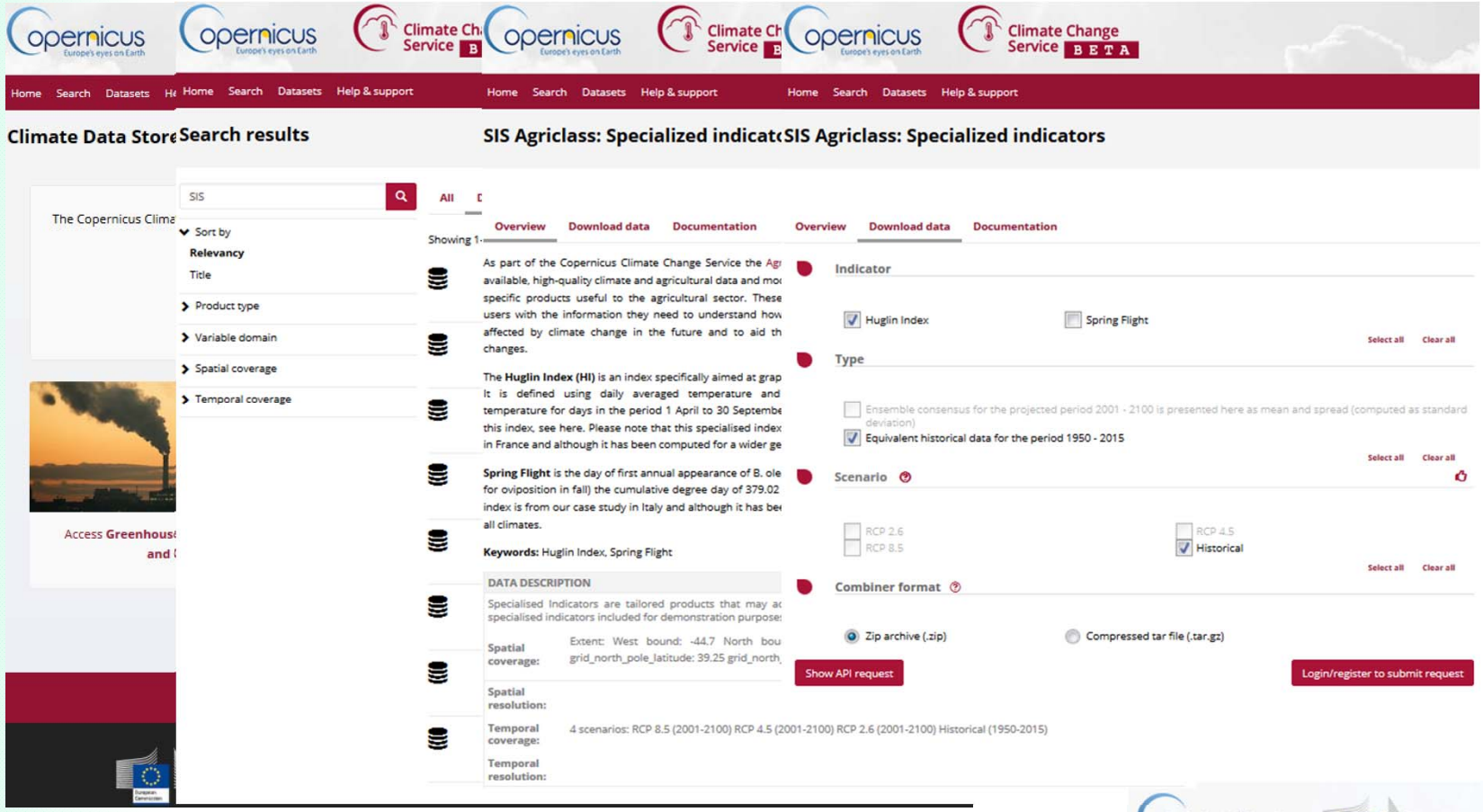
CLIMATE DATA STORE (BETA)



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SUMMARY

- Climate change is likely to have a **major impact** on agri-businesses, therefore it is important to assess climate change impacts to ensure future sustainability
- **Copernicus Climate Change Service (C3S)** is addressing the Agricultural Sector, providing information for adaption and mitigation
- A **proof of concept SIS** has been developed and is available via the C3S website
- A suite of **18 bioclimatic indicators** is available as gridded data sets at 25 km resolution from 1950 to 2100
- **3 case studies**, including viticulture in SW France, demonstrate how these data can be used to project climate impact on agriculture
- An operational **Global Service for Agriculture** is in development, and will be built on the new C3S Climate Data Store (CDS)