# Large-scale mapping of shrublands in altitude pastures using the 20-m Sentinel-2 Normalized Anthocyanin Reflectance Index (NARI)

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*Bradley Z. Carlson, Centre de Recherche sur les Ecosystèmes d'Altitude (CREA)*
*Philippe Choler, Univ. Grenoble Alpes, Univ. Savoie Mont Blanc, CNRS, LECA*

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GLOBAL CHALLENGES IN MOUNTAIN AGROPASTORAL SYSTEMS
Scientific evidence on impacts, adaptation and policies

- **Remote sensing approaches has become pivotal to map land cover in mountains**

- **New computing platforms (GEE, Planetary Computer)**

- **Resulting in many products …**

- ESA World Cover
- S2-GLC
- Corine Land Cover
- OSO
- Dynamic World
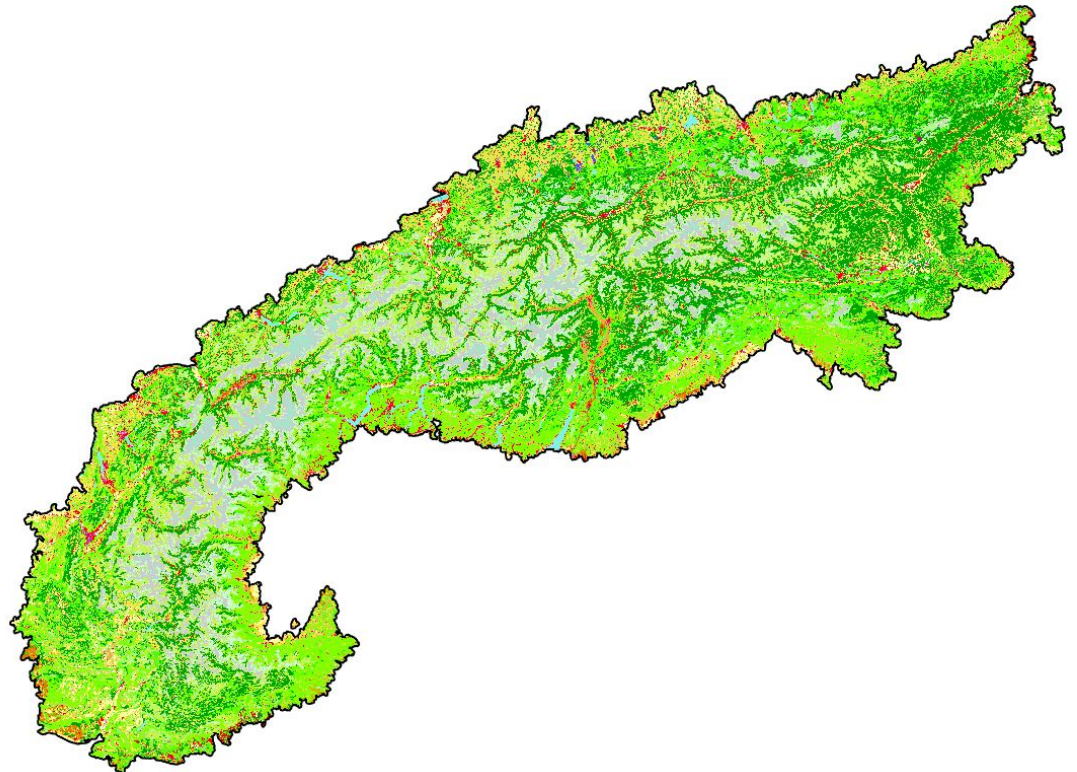


© Corine Land Cover

- **Mountain shrublands are notoriously difficult to map because of mixed reflectance signal with grasslands and forests**
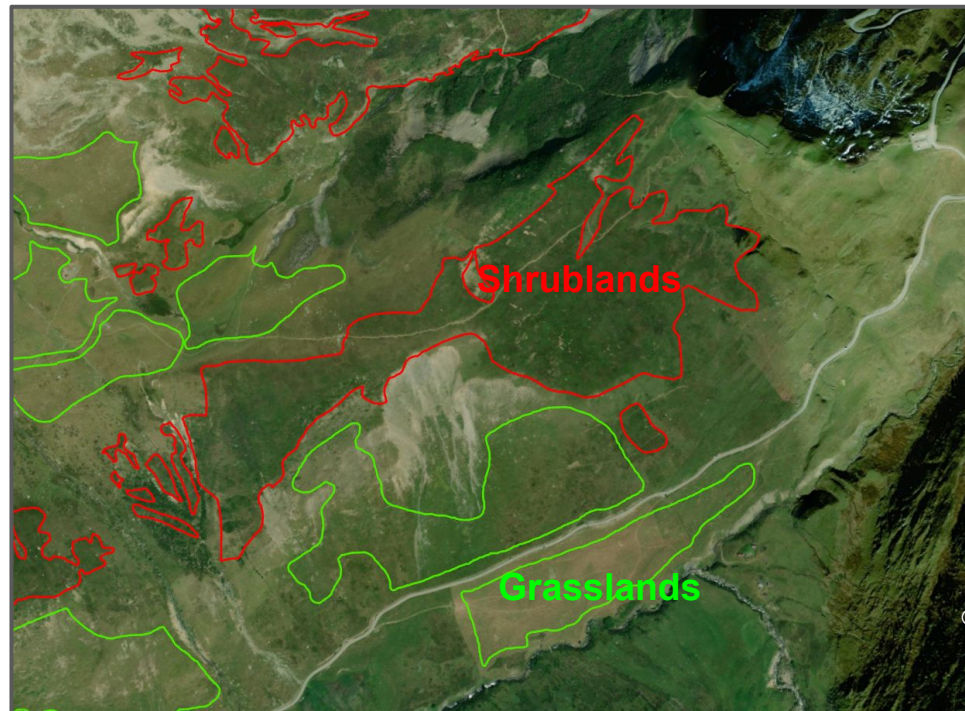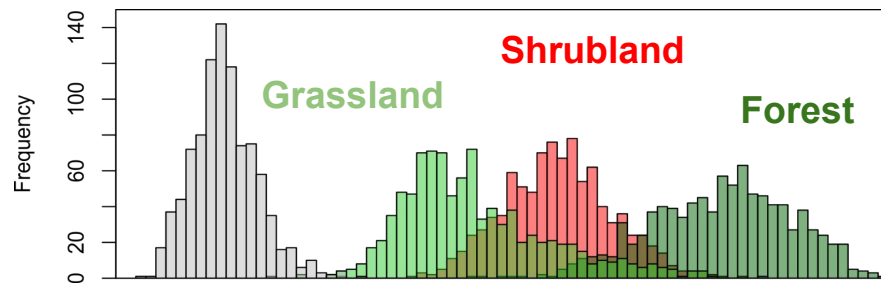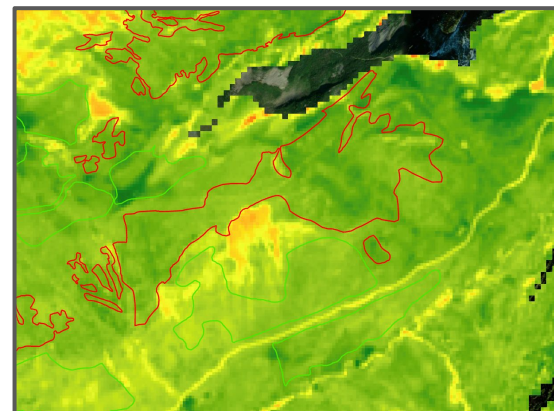


NDVI



Photo-interpretation of shrublands ☐ and grasslands ☐

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- **Resulting in poor quality maps and/or lack of large-scale product**



**ESA World Cover**

**OSO**

Photo-interpretation of shrublands ☐ and grasslands ☐

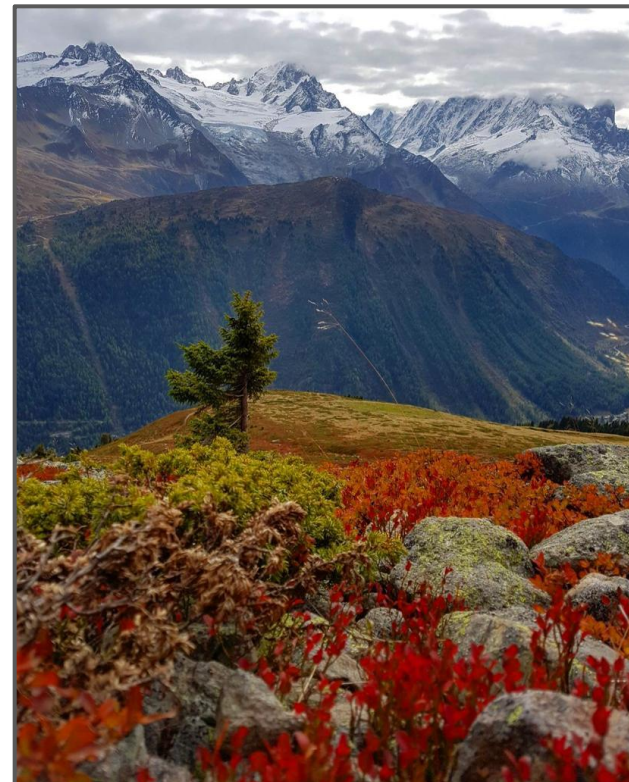■ Forests    ■ Grasslands    ■ Shrublands    ☐ Bare soil
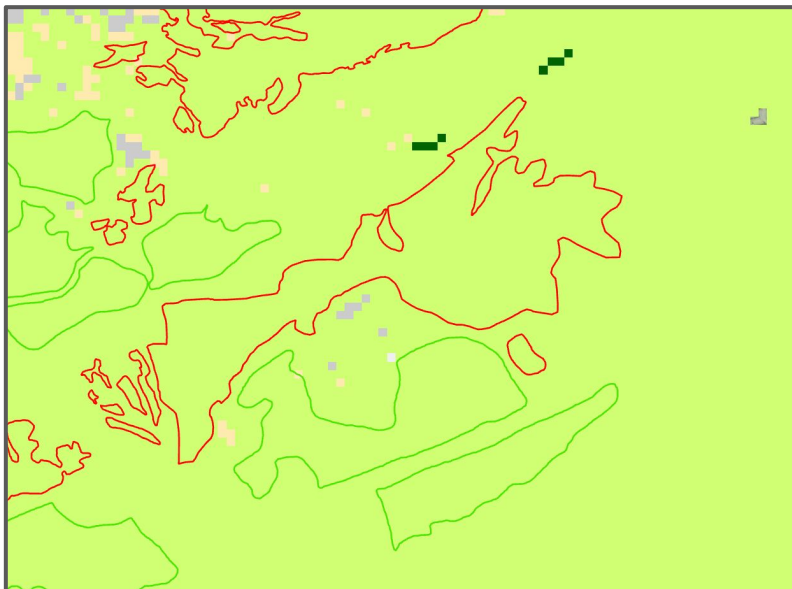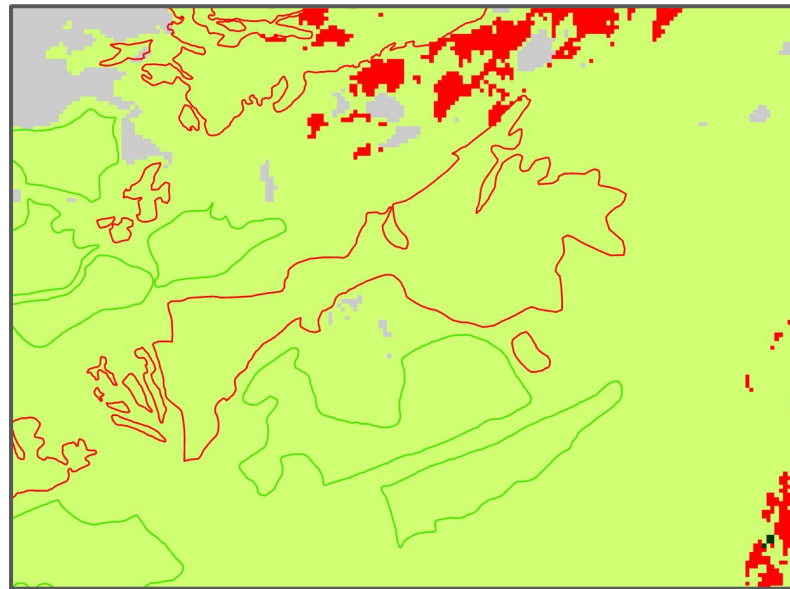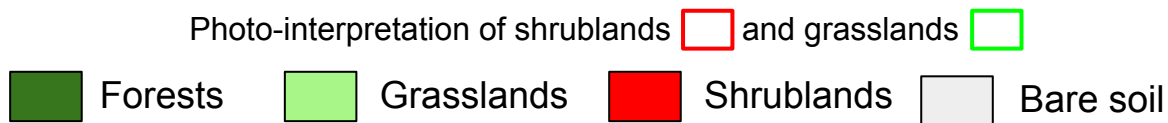
**In a recent study, we demonstrated the possibility to improve mountain shrublands mapping using a proxy of Anthocyanin concentration at fall.**

*(Pigment produced in leaves to protect from light damage in the absence of chlorophyll, which gives the red colour at fall)*

# Improved Mapping of Mountain Shrublands Using the Sentinel-2 Red-Edge Band

Arthur Bayle [1,*], Bradley Z. Carlson [2], Vincent Thierion [3], Marc Isenmann [4] and Philippe Choler [1,5]



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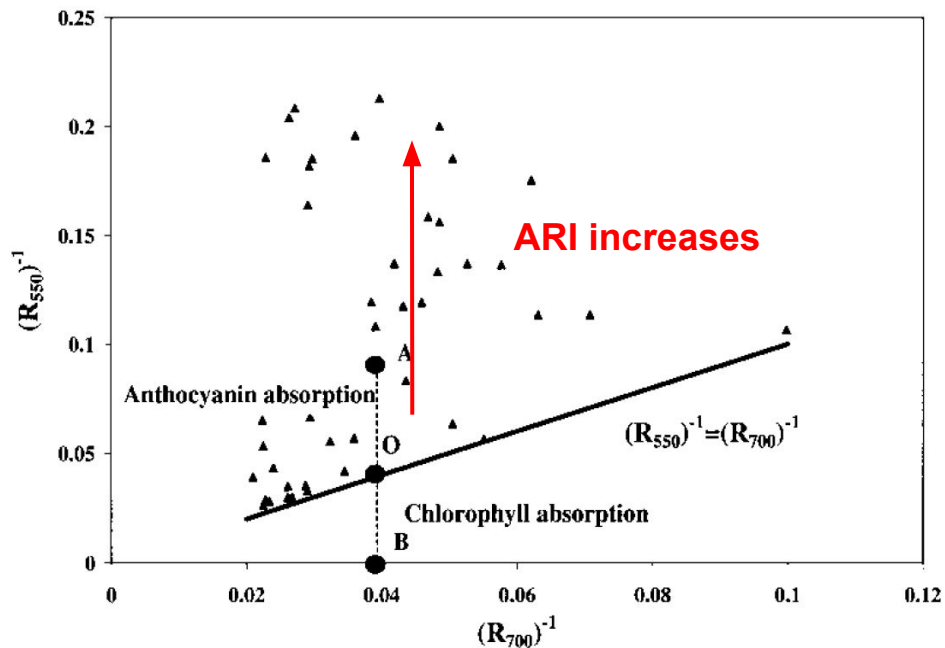
4

- **We used the Anthocyanin Reflectance Index (ARI) with Sentinel-2 bands (Green and Red-edge)**

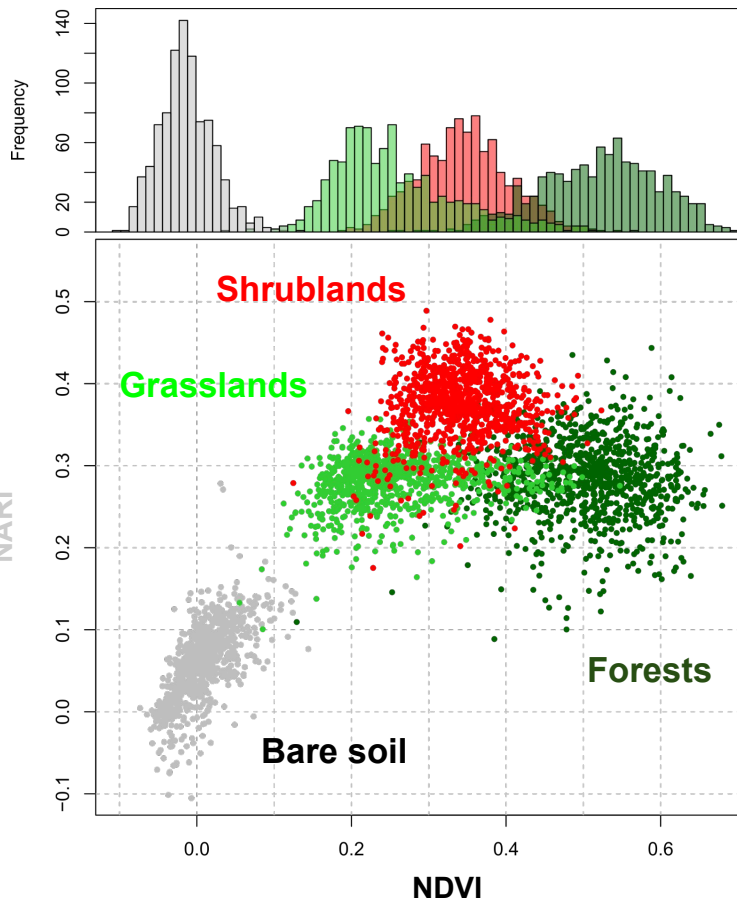$$ARI \propto (R_{550})^{-1} - (R_{700})^{-1}.$$

Anthocyanin Reflectance Index (ARI)

The inverse in the "red-edge" is only correlated to the concentration in chlorophyll

The inverse of "Green" is directly correlated to the concentration in anthocyanin and chlorophyll
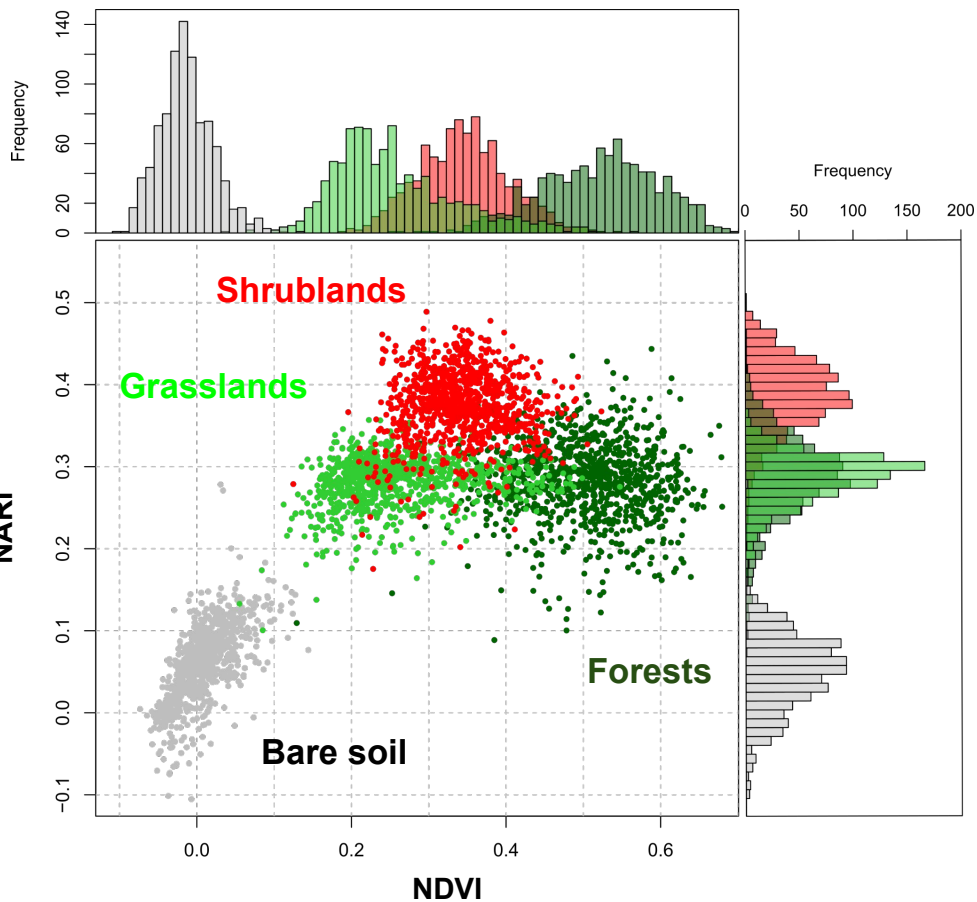


*From the work of Anatoly Gitelson et al (2001, 2004, 2006, 2009, 2018)*

**Only 2 predictive variables :**

- Normalized Anthocyanin Reflectance Index (NARI) at Fall
- Normalized Difference Vegetation Index (NDVI) at Fall

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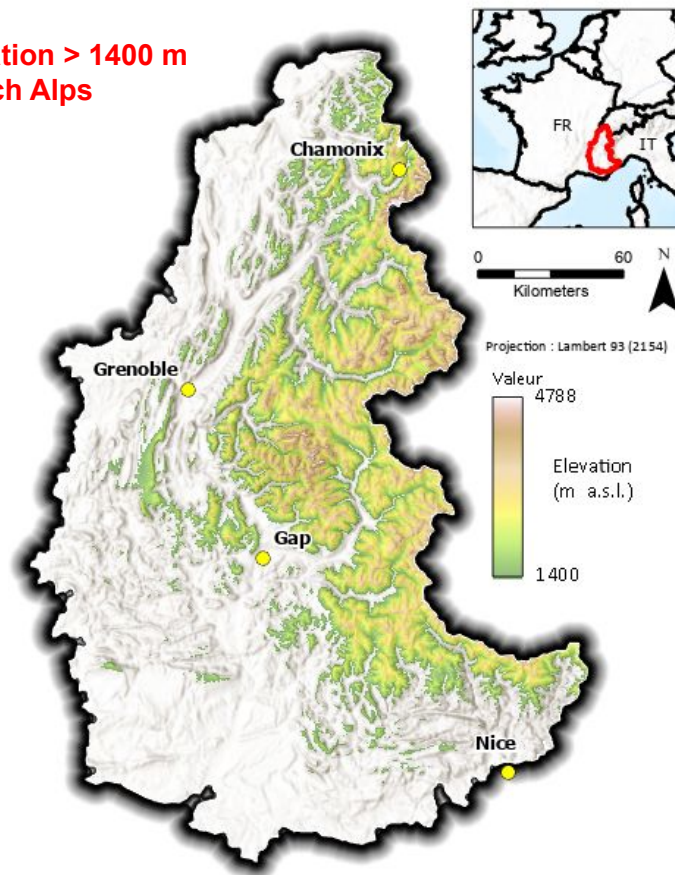- Normalized Difference Vegetation Index (NDVI) at Fall

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- We implemented the method at the scale of the French Alps using random forest classification informed by photo interpretation data

**Elevation > 1400 m French Alps**

**Training samples**
- Shrublands (n = 935)
- Grasslands (n = 5244)
- Forests (n = 5510)
- Bare soil (n=5961)

**With excellent results !**

**Kappa** = 0.885
**F-score per class :**
- Bare soil = 0.99
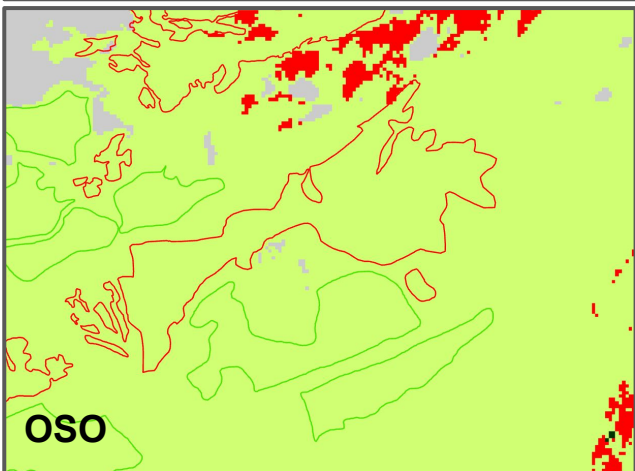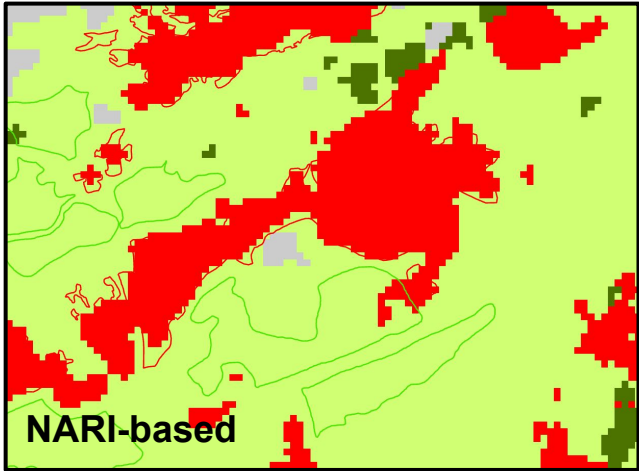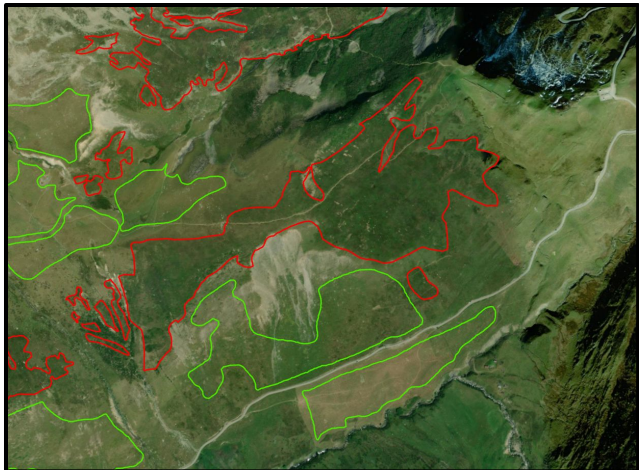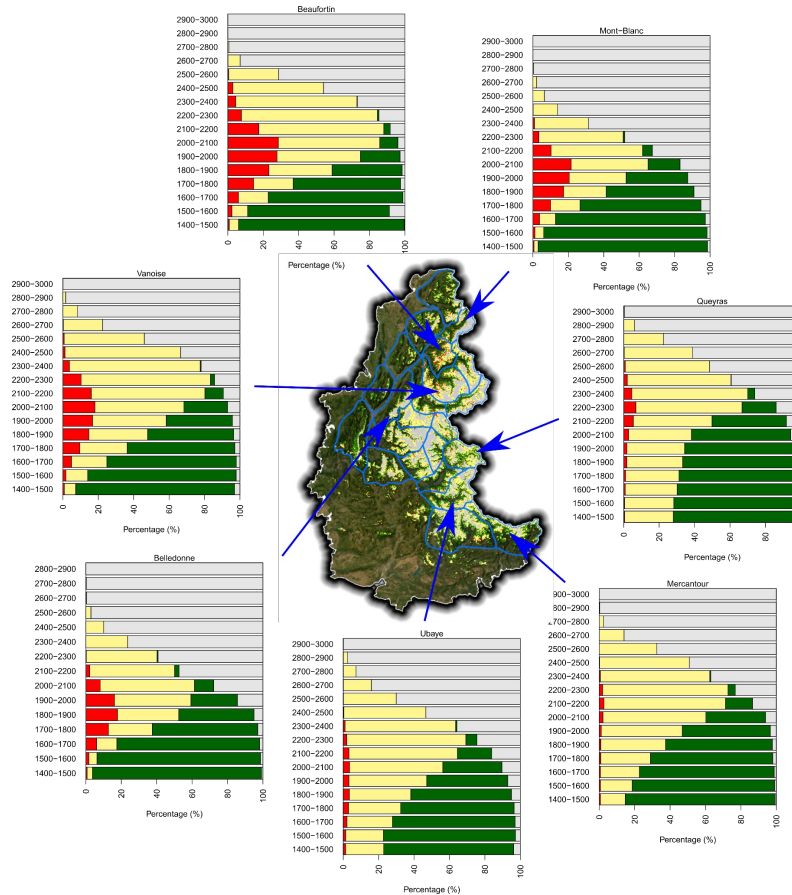- Forests = 0.89
- Grasslands = 0.87
- Shrublands = 0.88

Forests

Shrublands

Bare soil

Grasslands

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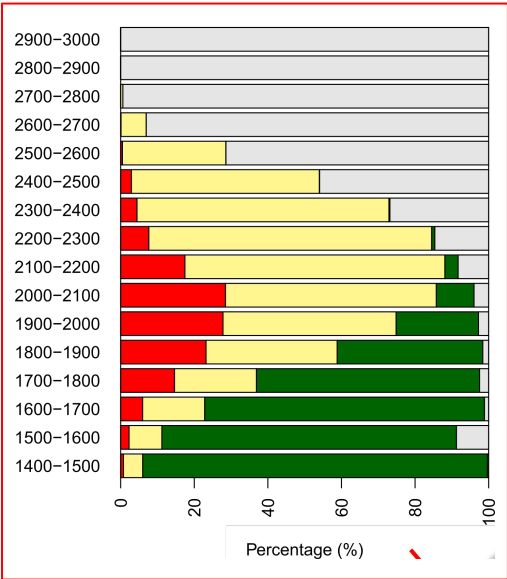- Forests = 0.89
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Forests

Shrublands

Bare soil

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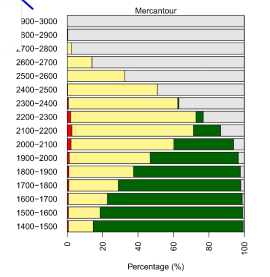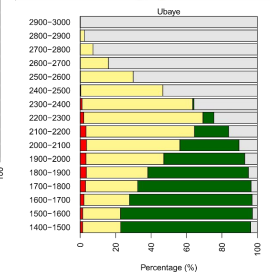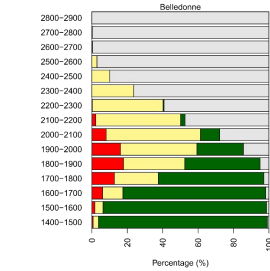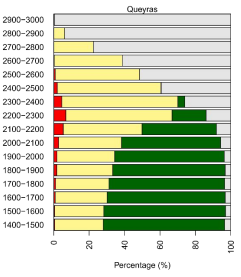ESA World Cover

NARI-based

OSO

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*Beaufortain*
*Northern French Alps*

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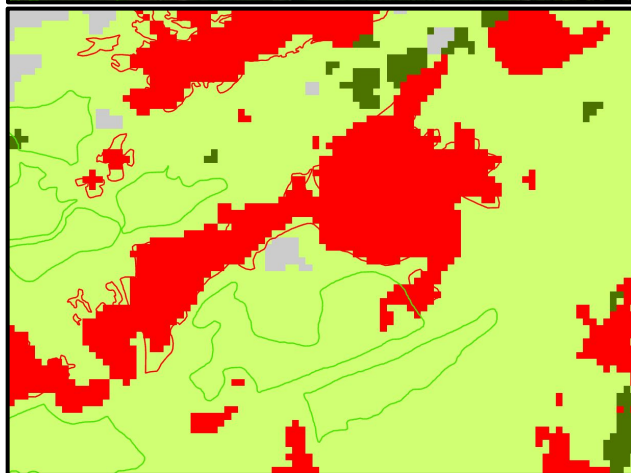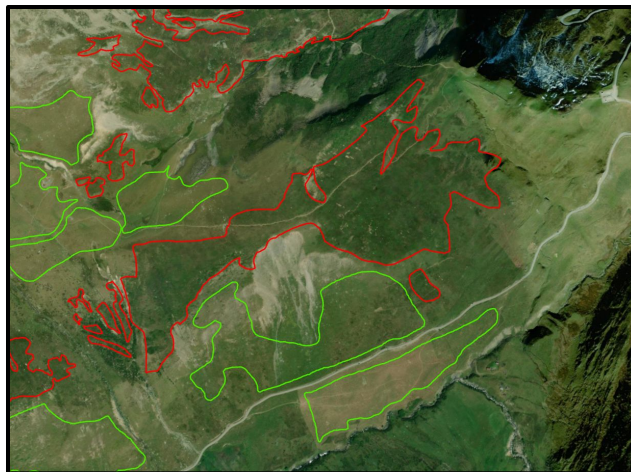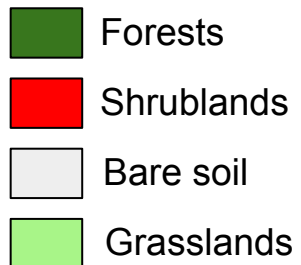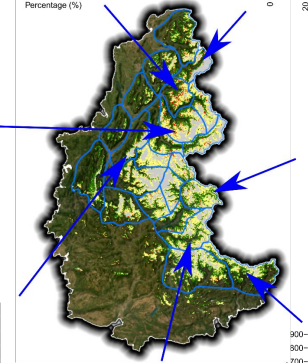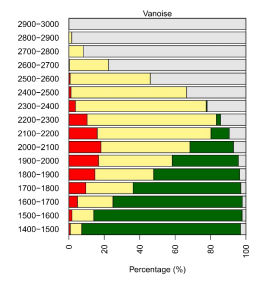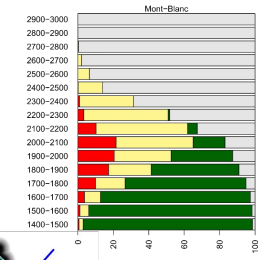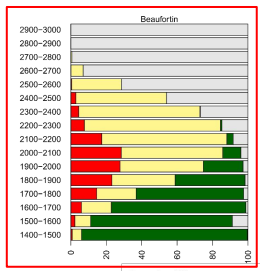
*Southern French Alps*
***Mercantour***
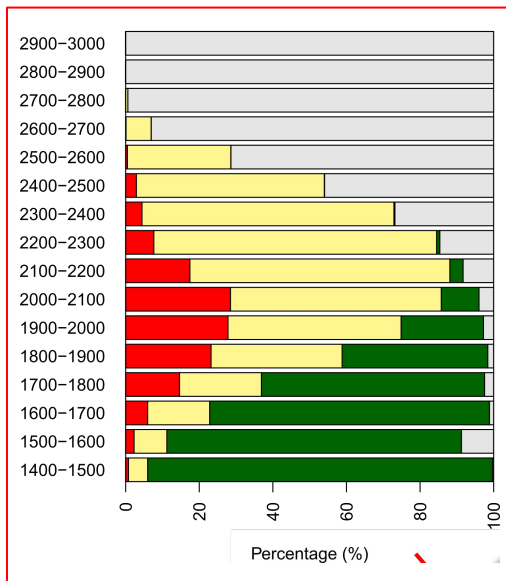
**Beaufortain**
*Northern French Alps*
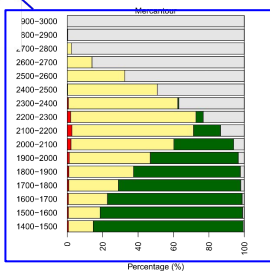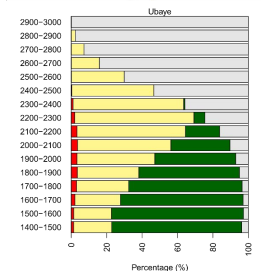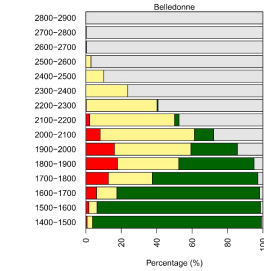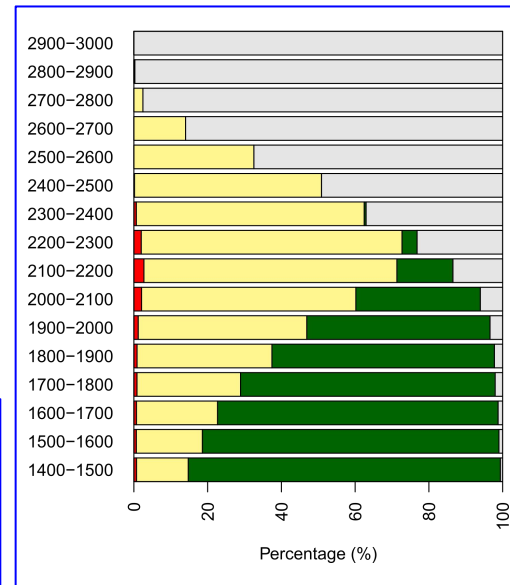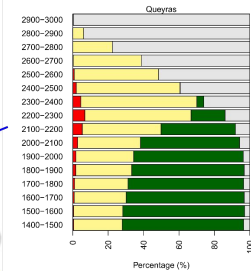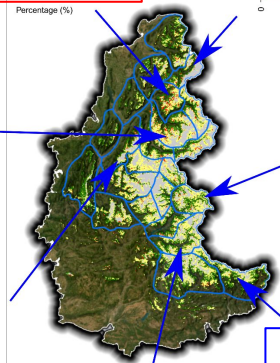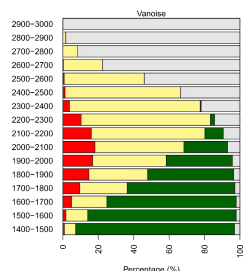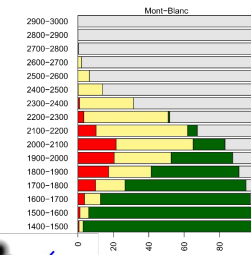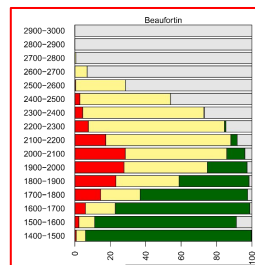
Shrublands in the Parc National des Ecrins (PNE)

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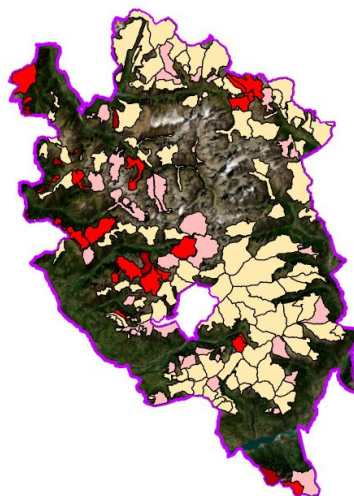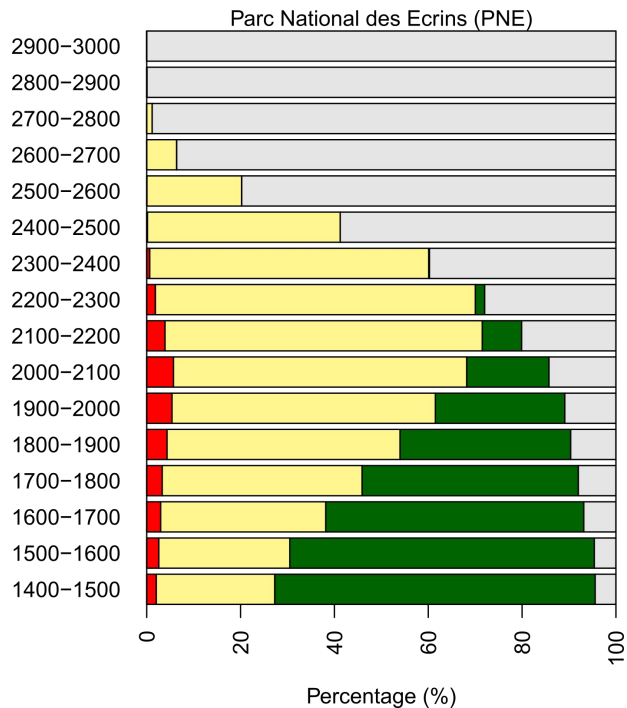
Proportion of shrublands in Pastoral Unit (%)

- < 1 %
- < 10 %
- < 20 %
- < 50 %

A spatially exhaustive product of shrublands distribution at large-scale to …

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A spatially exhaustive product of shrublands distribution at large-scale to …

better predict their long-term dynamic in response to climate change and …
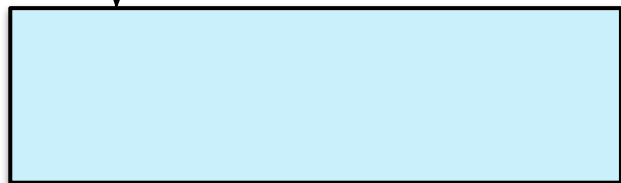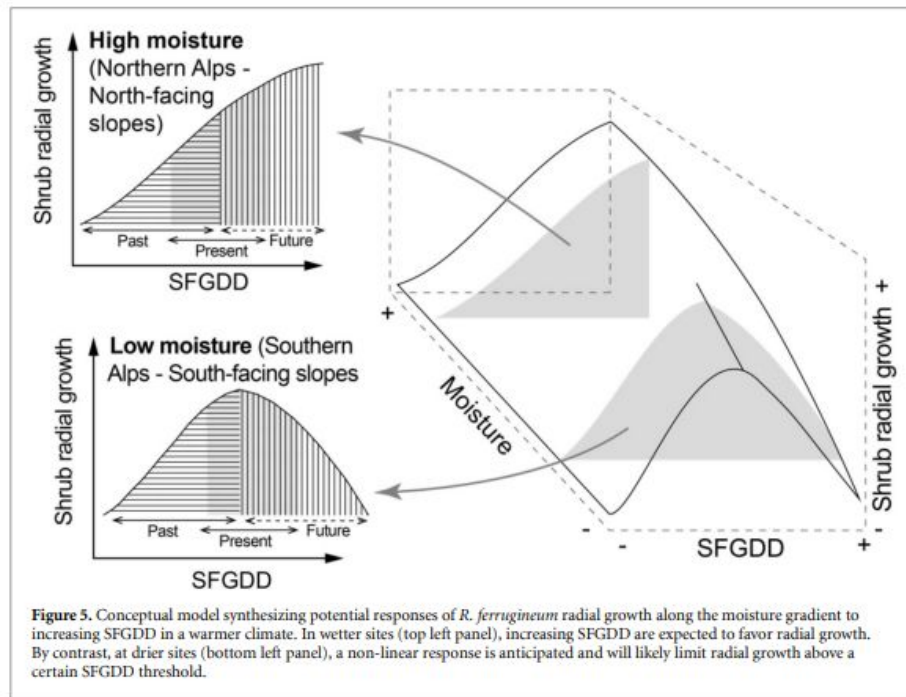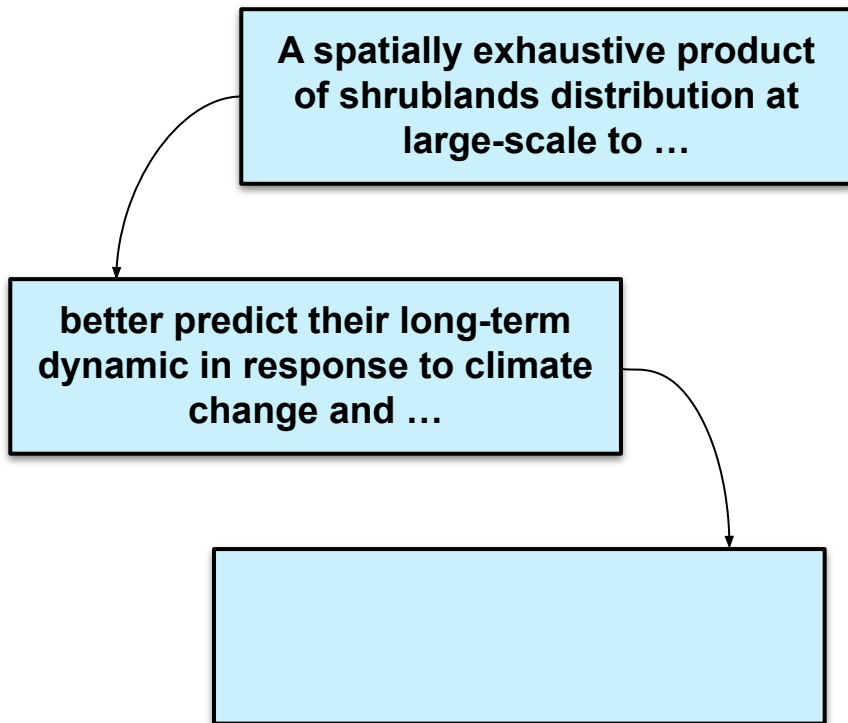


**Figure 5.** Conceptual model synthesizing potential responses of *R. ferrugineum* radial growth along the moisture gradient to increasing SFGDD in a warmer climate. In wetter sites (top le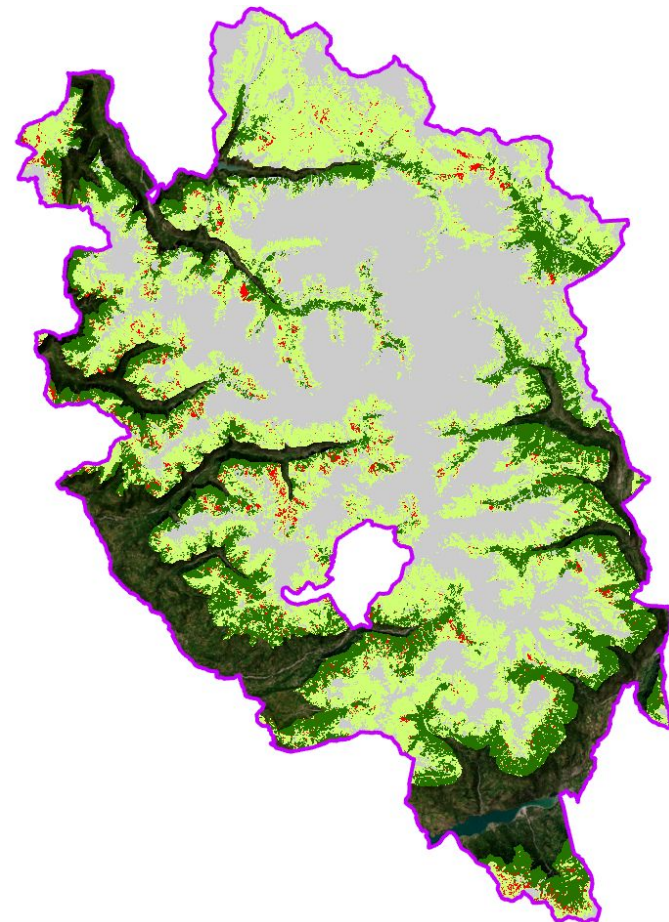ft panel), increasing SFGDD are expected to favor radial growth. By contrast, at drier sites (bottom left panel), a non-linear response is anticipated and will likely limit radial growth above a certain SFGDD threshold.

Shown with authorisation : Loïc Francon et al. (2021) Shrub growth in the Alps diverges from air temperature since the 1990s. *Environmental Research Letters*

A spatially exhaustive product of shrublands distribution at large-scale to …

better predict their long-term dynamic in response to climate change and …

the potential consequences on mountain pastoral activities at biogeographical scale

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Thanks for listening
Any question ?

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