Application of Copernicus Global Land Service vegetation parameters and ESA soil moisture data to analyse changes in vegetation with respect to the CORINE database

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#shareEGU20, 6 May 2020, 14:00–15:45

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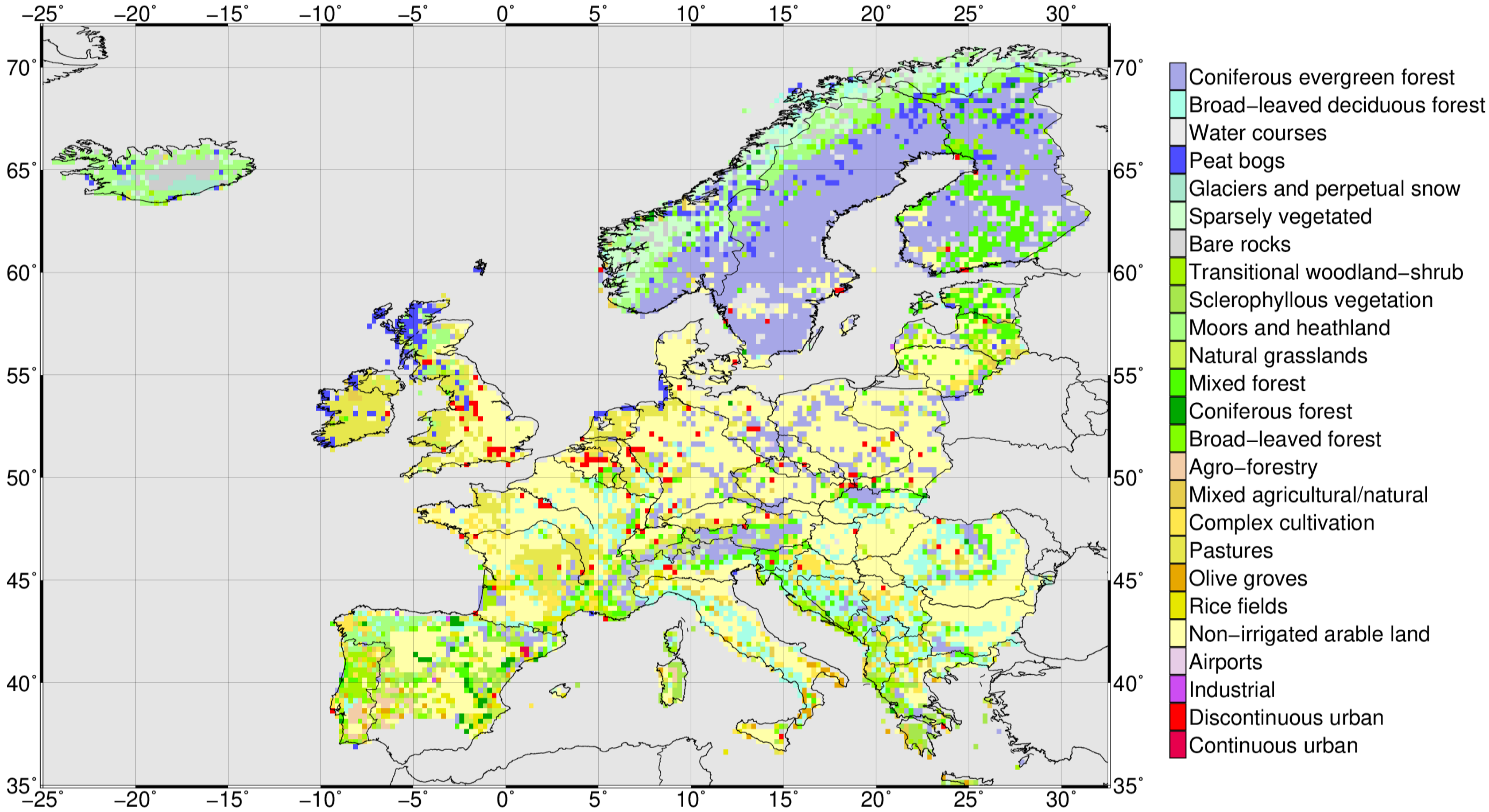
E·L·T·E KUTATÓEGYETEM

Nemzeti Kutatási, Fejlesztési és Innovációs Hivatal

ÚNKP Új Nemzeti Kiválóság Program

Data

- CORINE 2012 land cover
- Original 100 m resolution upscaled to 0.25° resolution
- Upscaling: most abundant land cover in 0.25°x 0.25° grid cell



Data

- ESA soil moisture v.4.4 (SMOIS) database (Gruber et al., 2017, 2019; Wagner et al., 2017)

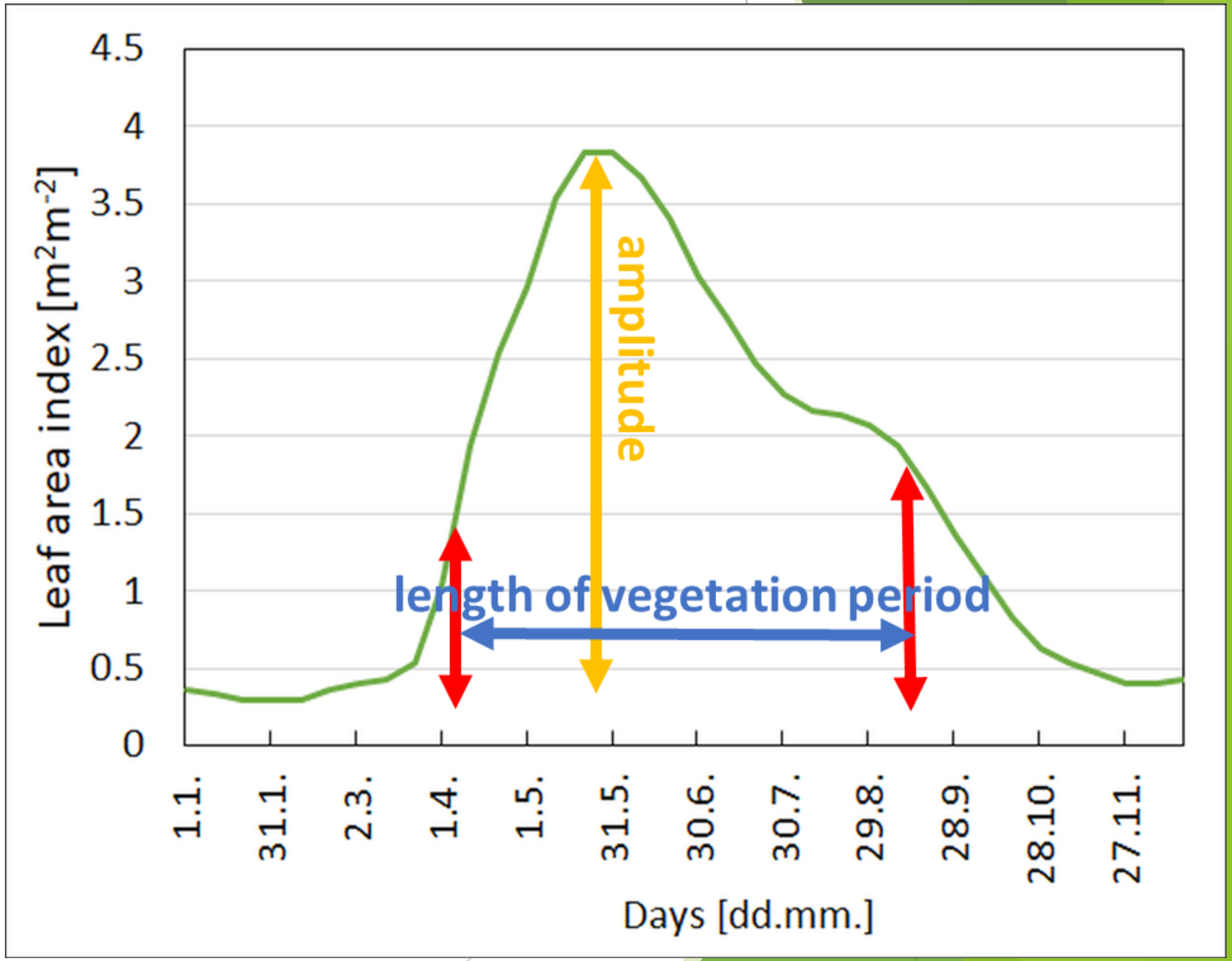
- Active and passive sensor combined satellite data
- 0.25° resolution
- Upper soil layer (2-4 cm) moisture
- Availabale period: Nov. 1978 to June 2018
- Used period: 2000-2018 => to be able to combine it with satellite vegetation indices
- Daily data => monthly averages

Data

- COPERNICUS Global Land Service database
  - SPOT-VGT and PROBA-V satellite sensors
  - Leaf area index (LAI) and gross dry matter productivity (GDMP)
  - 1 km resolution interpolated to 0.25° resolution (second-order conservative mapping)
  - Period: 2000–2018, every 10 days

Method – vegetation period

- Verger et al. (2016)
- Based on annual amplitude (A) variaton
  - start of season (SOS): $A \cdot 0.3 + \min(LAI)$
  - end of season (EOS): $A \cdot 0.4 + \min(LAI)$

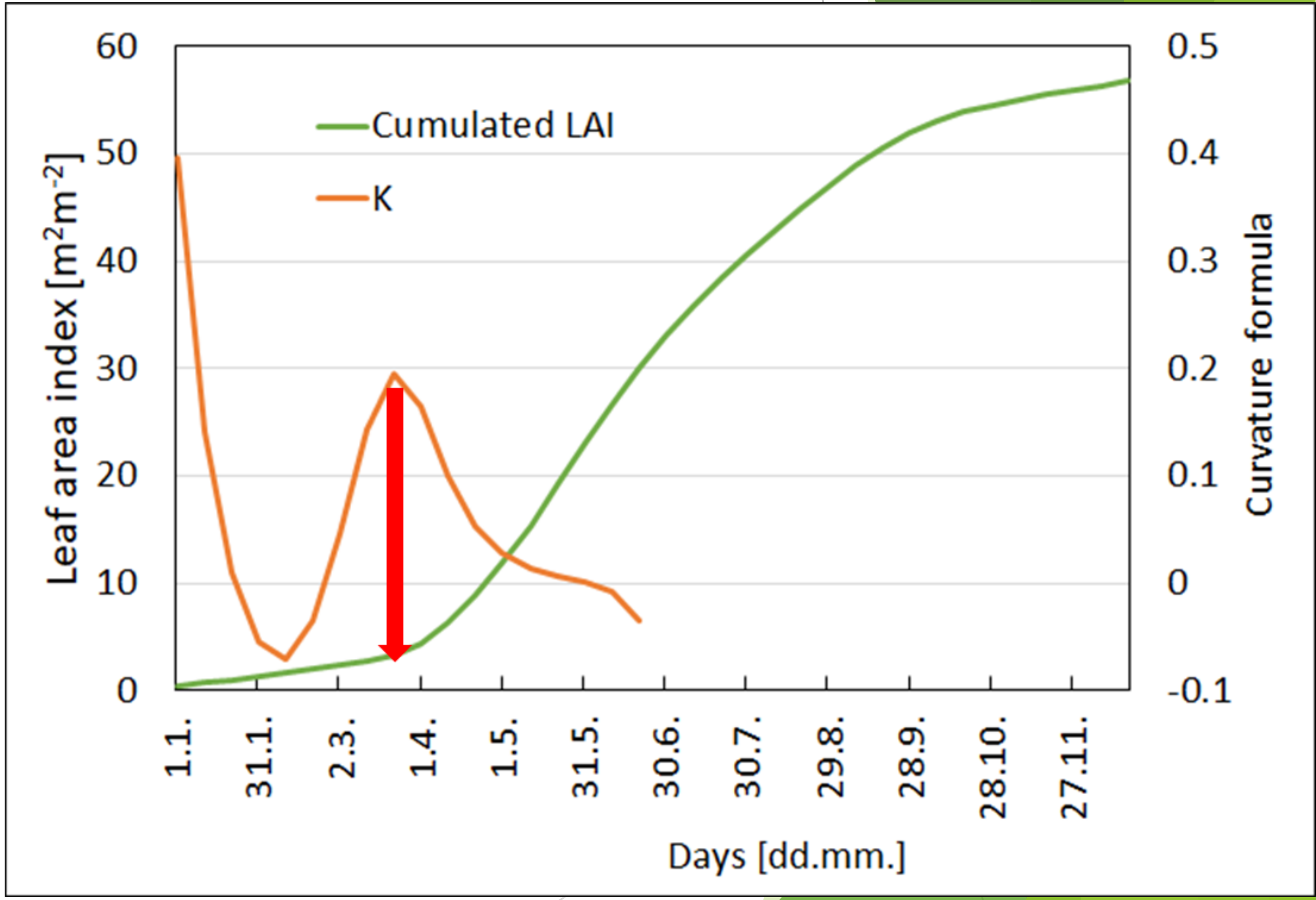


Method – vegetation period

- Wang et al. (2017)
- Originally developed for NDVI data for wheat
- Based on cumulated NDVI gradient
- Instead of NDVI LAI is used (cLAI)
  - y: 6th-order fitted polynomial function of cLAI
  - SOS: max(K), K – curvature of y
  - EOS (Verger et al., 2016):

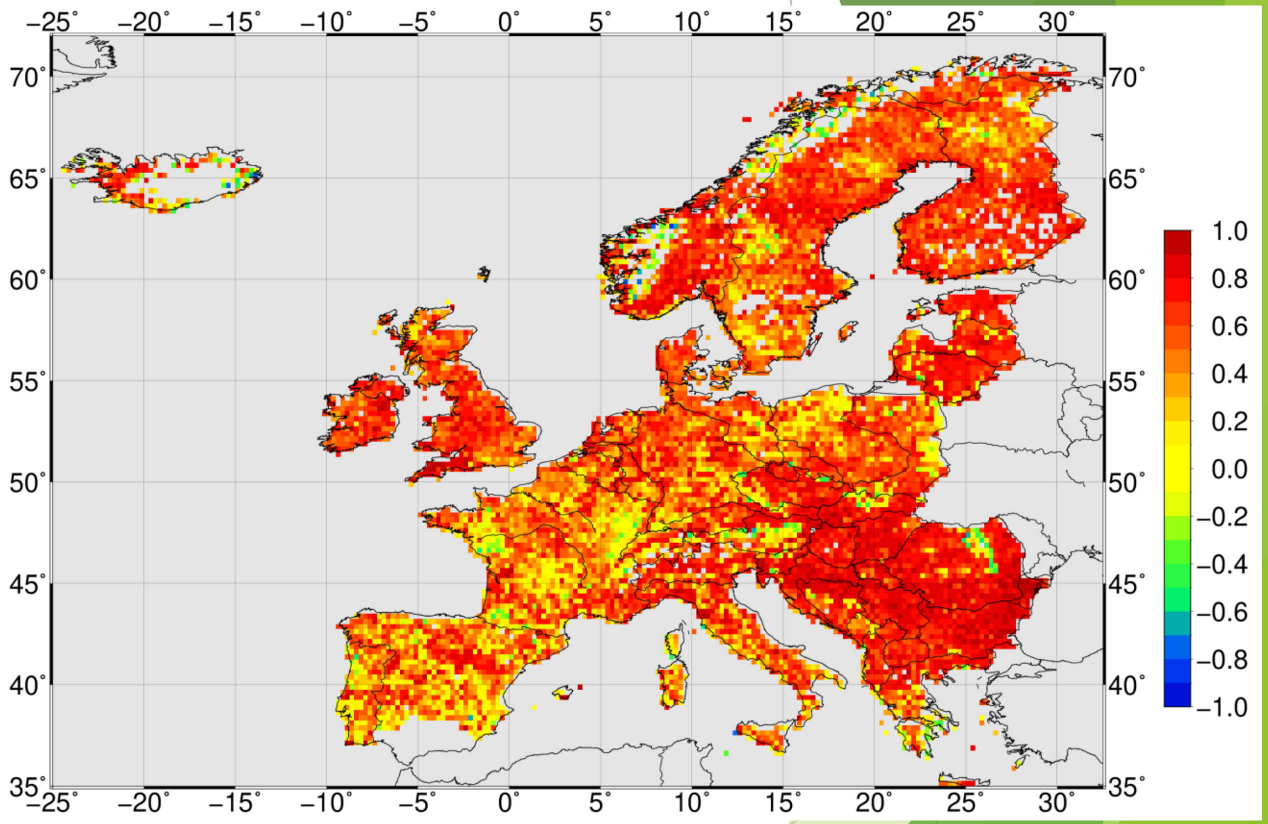
    A·0.4 + min(LAI)

$$K = \frac{y''}{\sqrt{(1 + y'^2)^3}}$$



Difference in start of season methods

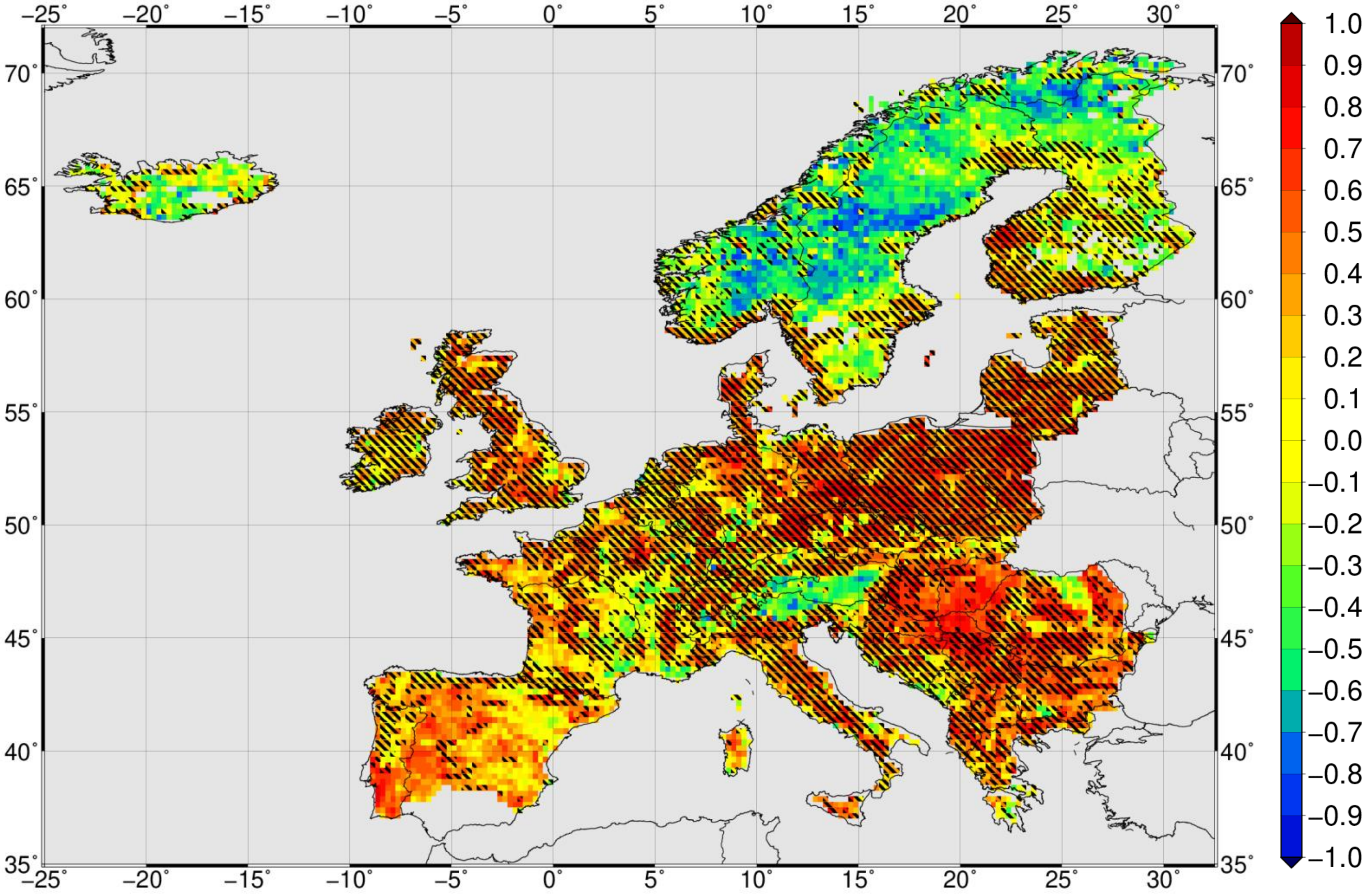
- Correlation of the two method is high, but there are exceptions.
- When:
  - the intra-annual variation of LAI is low (e.g. coniferous forests in mid-latitudes)
  - there are variations in LAI in winter (DJF) months
  - there are two green-up phases, one around February and one in March/April



Correlation between Verger et al. (2016) and Wang et al. (2017) start of season estimations

Results – correlation between soil moisture and vegetation

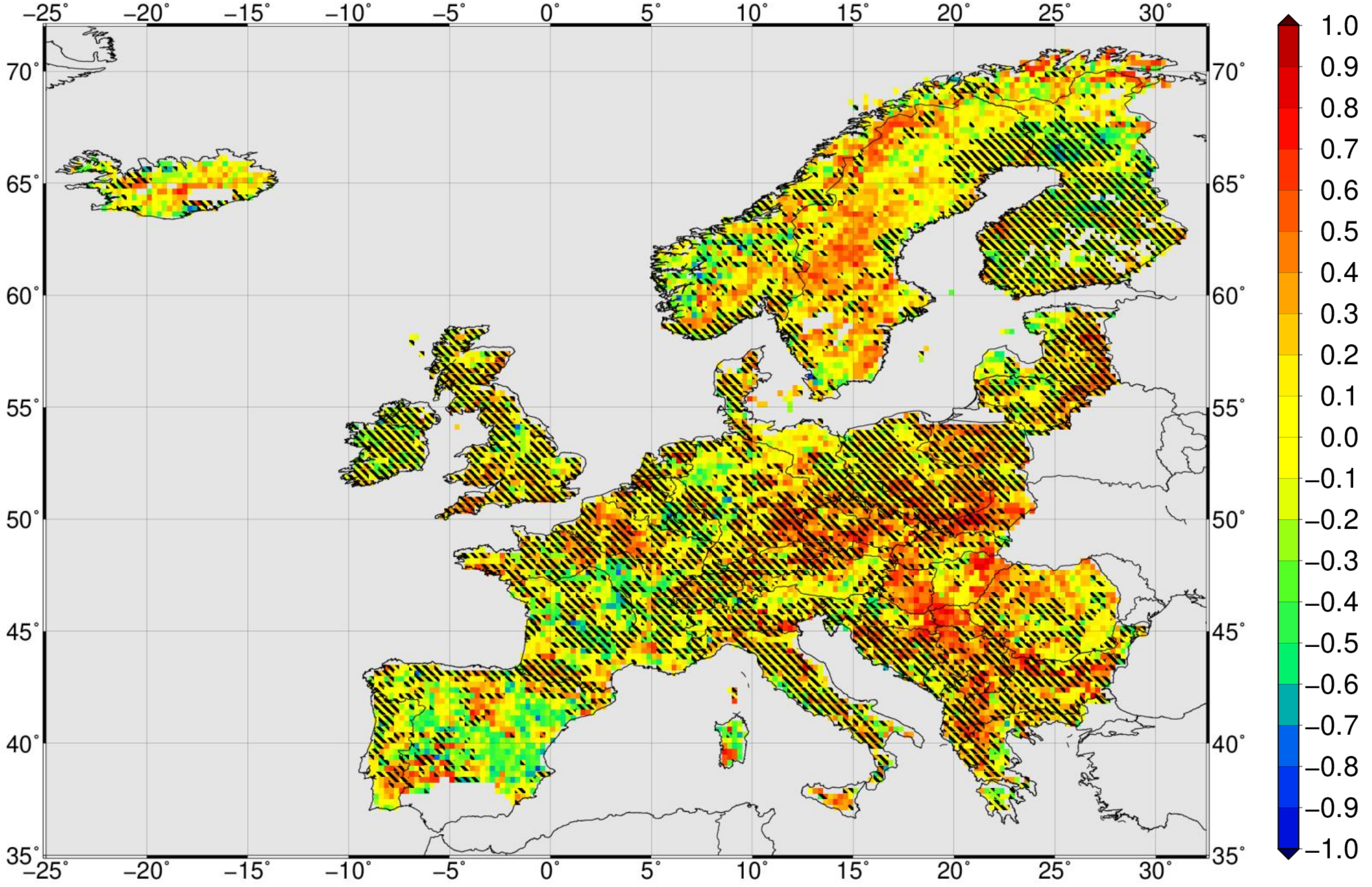
- LAI and GDMP trends are mostly positive in Europe
- Soil moisture decreases in the Alps, in the Carpathian Mountains, in the Iberian Peninsula and in Scandinavia
- In Eastern Europe soil moisture changes drive the vegetation greenness (also true for Iberian Peninsula, but correlations are not high)
- In cold climates decreasing soil moisture effect is superseded with temperature increase effect



Correlation between annual average SMOIS and LAI, positive SMOIS trends are noted with diagonal hachures

Results – correlation between soil moisture and vegetation

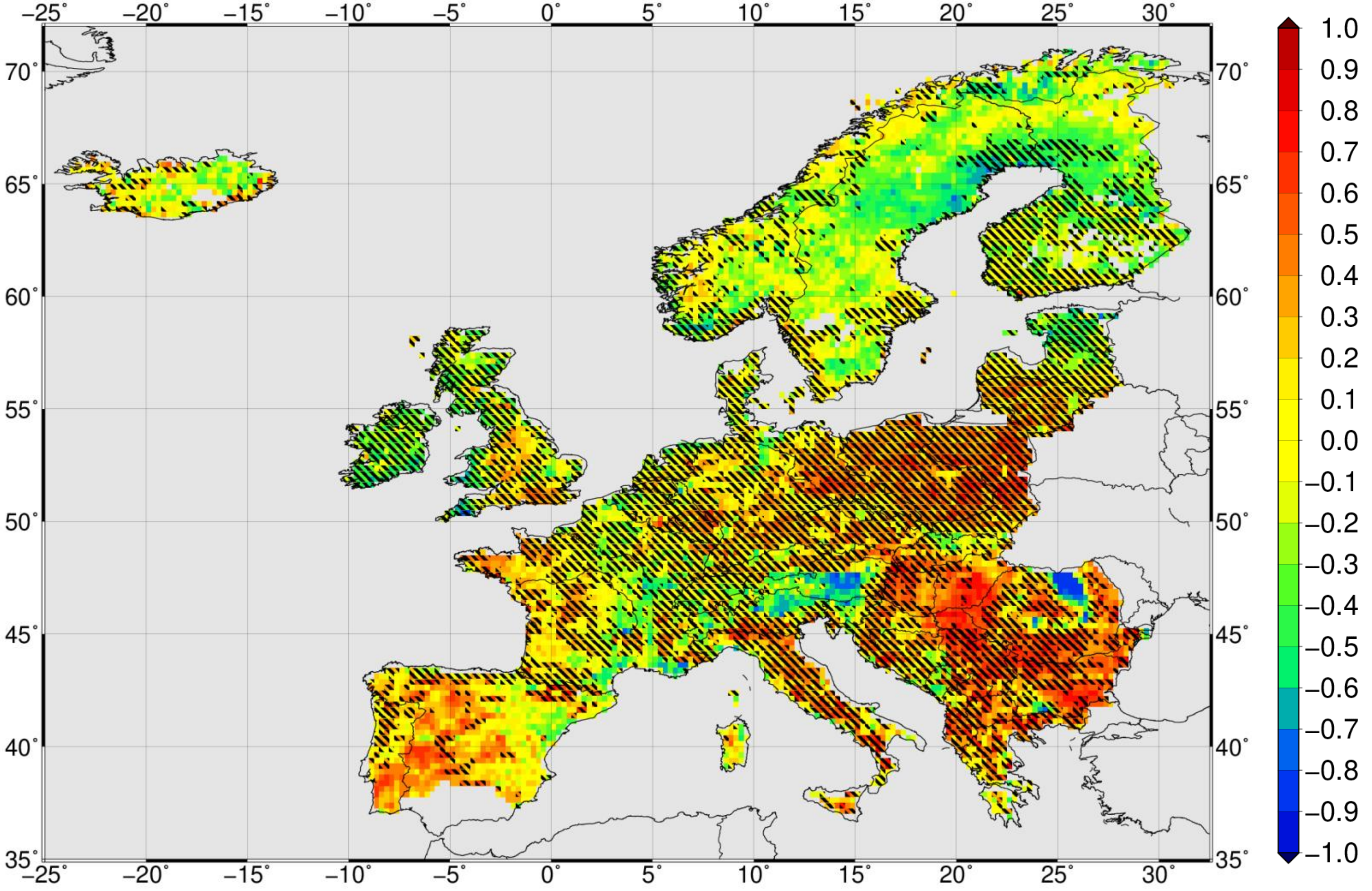
- End of season increases in Germany, Poland, most of Great Britain, eastern Iberian Peninsula.
- End of season decreases in Scandinavia, in the Carpathian region, in western France and in western Iberian Peninsula.
- Increasing summer soil moisture is most likely to extend the vegetation period.
- Despite the increase of LAI in Scandinavia the vegetation period decreases due to lower soil moisture availability.



Correlation between summer (Mar.-Aug.) average SMOIS and end of season dates, positive SMOIS trends are noted with diagonal hachures

Results – correlation between soil moisture and vegetation

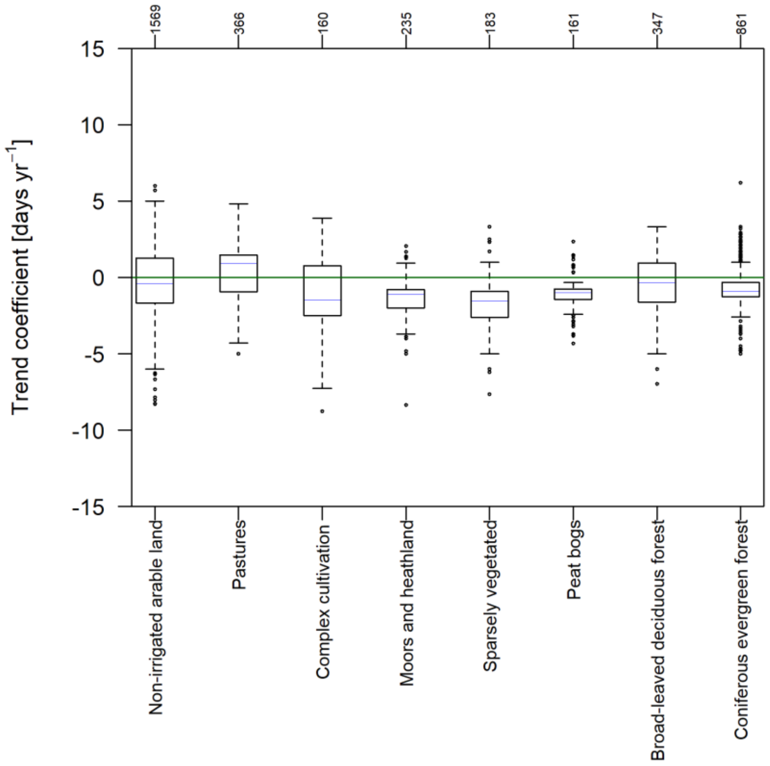
- Soil moisture and GDMP correlations are generally lower than LAI-soil moisture
- Soil moisture decrease in the eastern Carpathian ranges and in the Alps show stronger negative correlation than LAI
- In the British Isles there is a correlation sign change compared to the LAI correlations



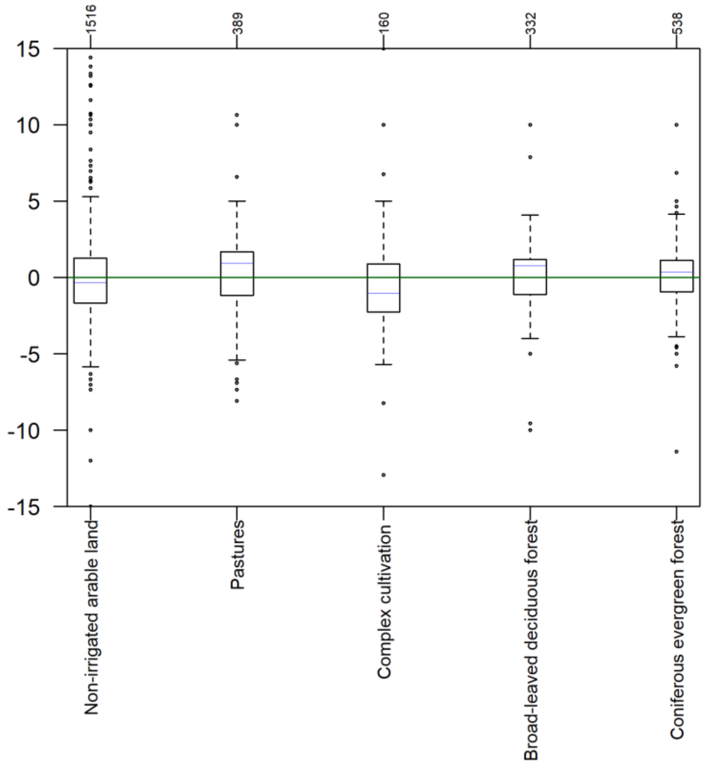
Correlation between annual average SMOIS and summer (Mar.-Aug.) GDMP, positive SMOIS trends are noted with diagonal hachures

Results – trends and land cover

- Length of season (LOS) changes:
  - Though LAI and GDMP increases in every season, and SOS shows a small decrease the end of season (EOS) decreases
  - Differences in LOS stem from the two SOS determination methods are a combination of decreasing EOS and SOS days
  - In case of Wang et al. (2017) more gridpoints have 0 slope, resulting in lower land cover types.



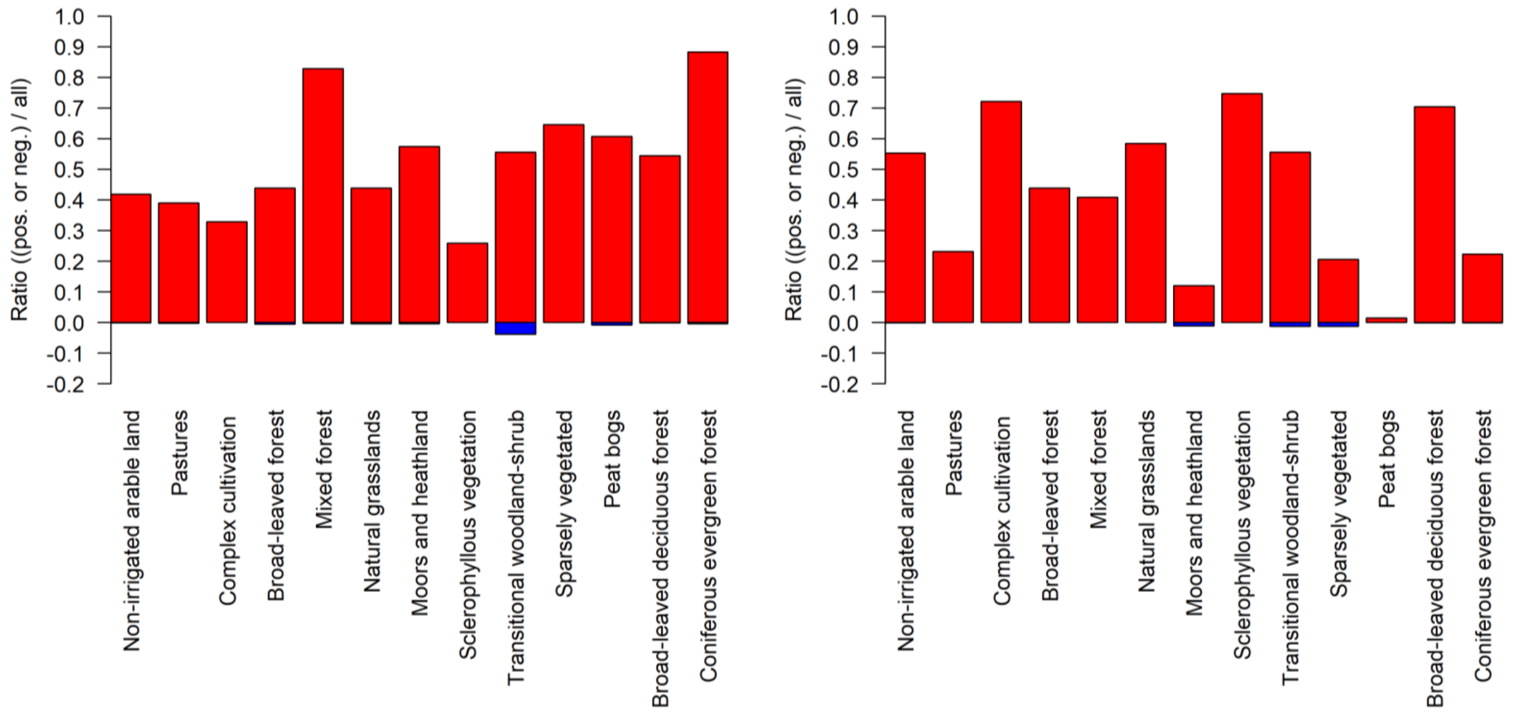
Trend of the length of vegetation period (Verger et al., 2016) [only land use types with over 150 grid points are shown]



Trend of the length of vegetation period (Wang et al., 2017) [only land use types with over 150 grid points are shown]

Results – trends and land cover

- Strength of trends
  - LAI and GDMP trends show a significantly increasing trend
  - Significant LAI changes are observed for almost 90% of coniferous and mixed forests.
  - GDMP trend variation between land cover types is larger than for LAI.
  - Peat bogs and moors show almost no significant trends.
  - Despite lower LAI changes GDMP mostly increases for complex cultivation, for deciduous forests and for sclerophyllous vegetation.



Ratio of significant ($p<0.05$) and all gridpoints for annual LAI trend [only land use types with over 150 grid points are shown]

Ratio of significant ($p<0.05$) and all gridpoints for summer (Mar.-Aug.) GDMP trend [only land use types with over 150 grid points are shown]

References

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Acknowledgement

- Hajnalka Breuer’s work was supported by the János Bolyai Research Scholarship of the Hungarian Academy of Sciences and by the ÚNKP-19-4 New National Excellence Program of the Ministry for Innovation and Technology

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