Remotely sensed green-up trends in Europe (1989-2007)

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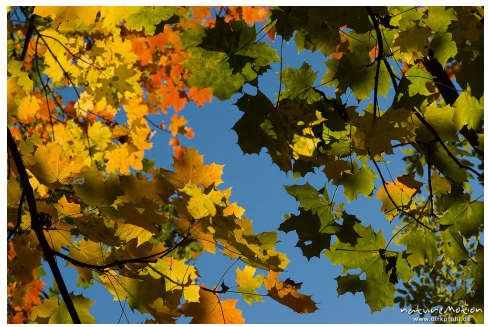
DGPF workshop, 30th of September 2016

What is phenology?

- Phenology is the study or recurring life cycle events such as bird migration, budburst of trees, flowering or fruit ripening.
- First observations related to cultural events. First scientific networks from 1882 in an agricultural context.

(a) Budburst

(b) Apple flowering

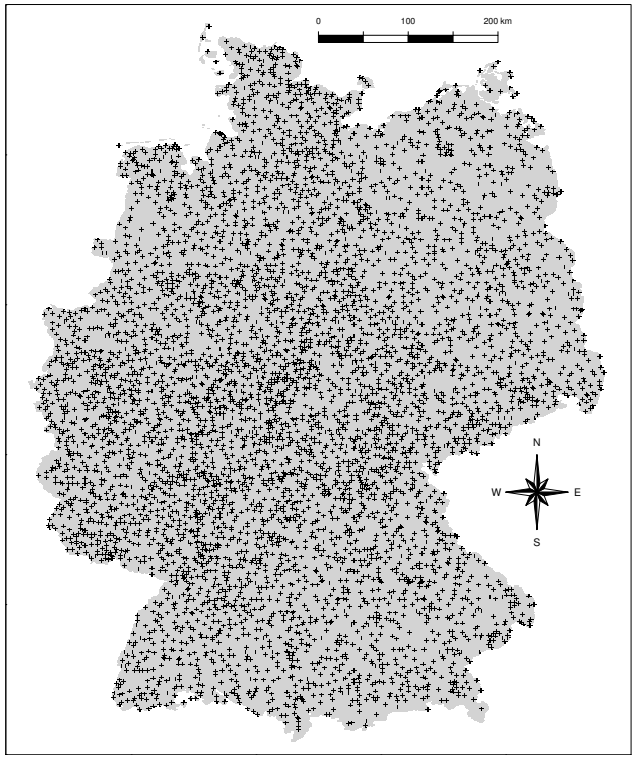


(c) Leaf colouring

- Strong indicator of climate change impact on e.g. vegetation and strong link to global carbon sequestration

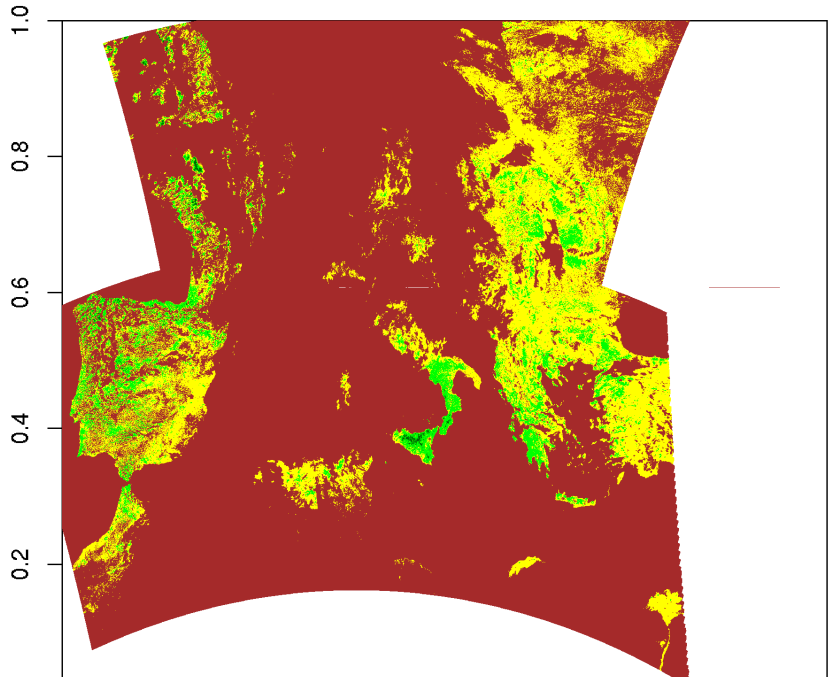
Phenology for ECV & EBV

- Identified as important variable for climate and biodiversity assessment, species traits
- Phenological monitoring done via ground networks and remotely sensed
- Long time series from ground networks, but large-scale and area-wide only remotely sensed

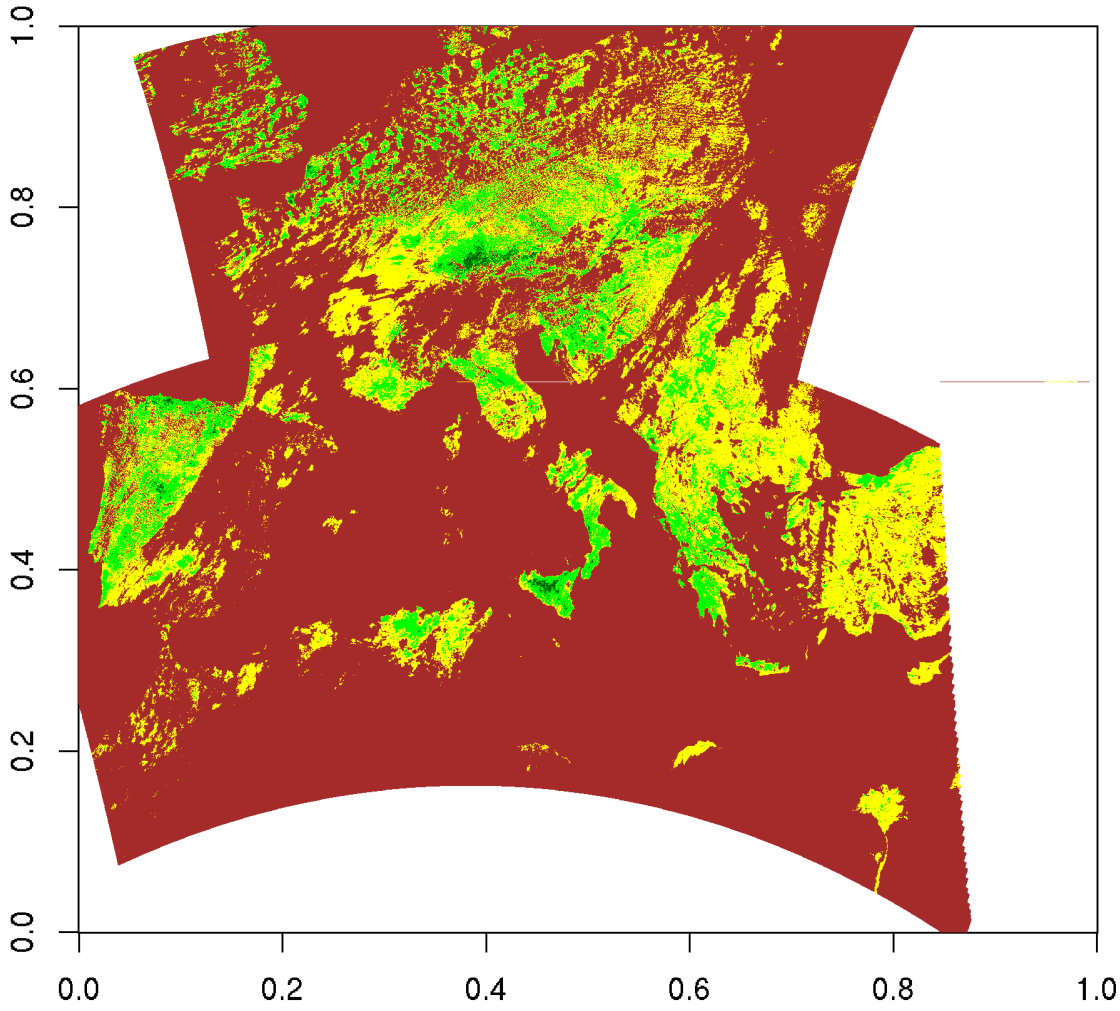


Remotely sensed data, the NDVI

- Daily observations of the Normalized Difference vegetation Index
- Influenced by clouds, atmospheric haze, viewing angle, sun position etc.
- Range of satellite products (Landsat, MODIS, Spot) with different space-time resolutions
- Long time series from NOAA AVHRR (since 1981)



NDVI over time



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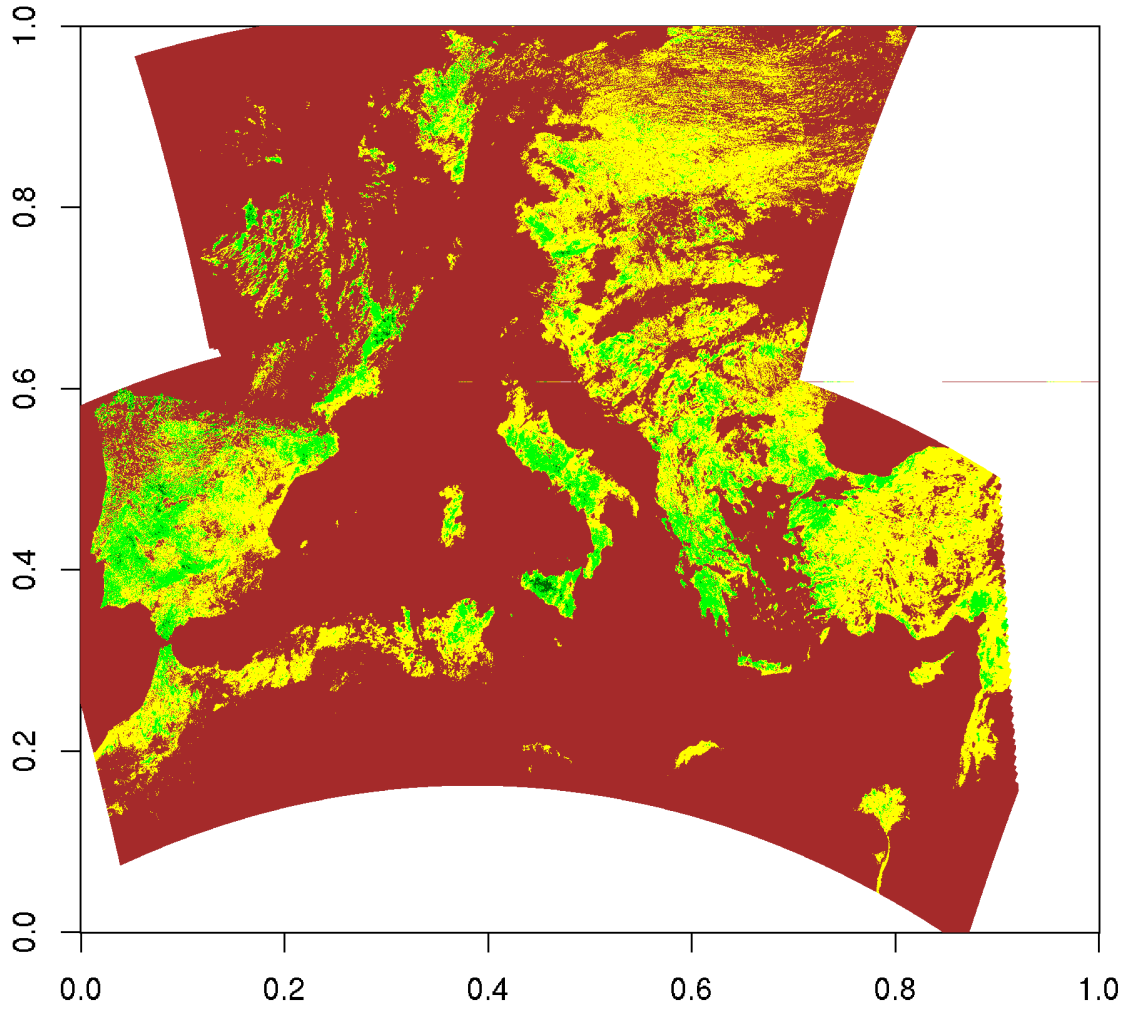

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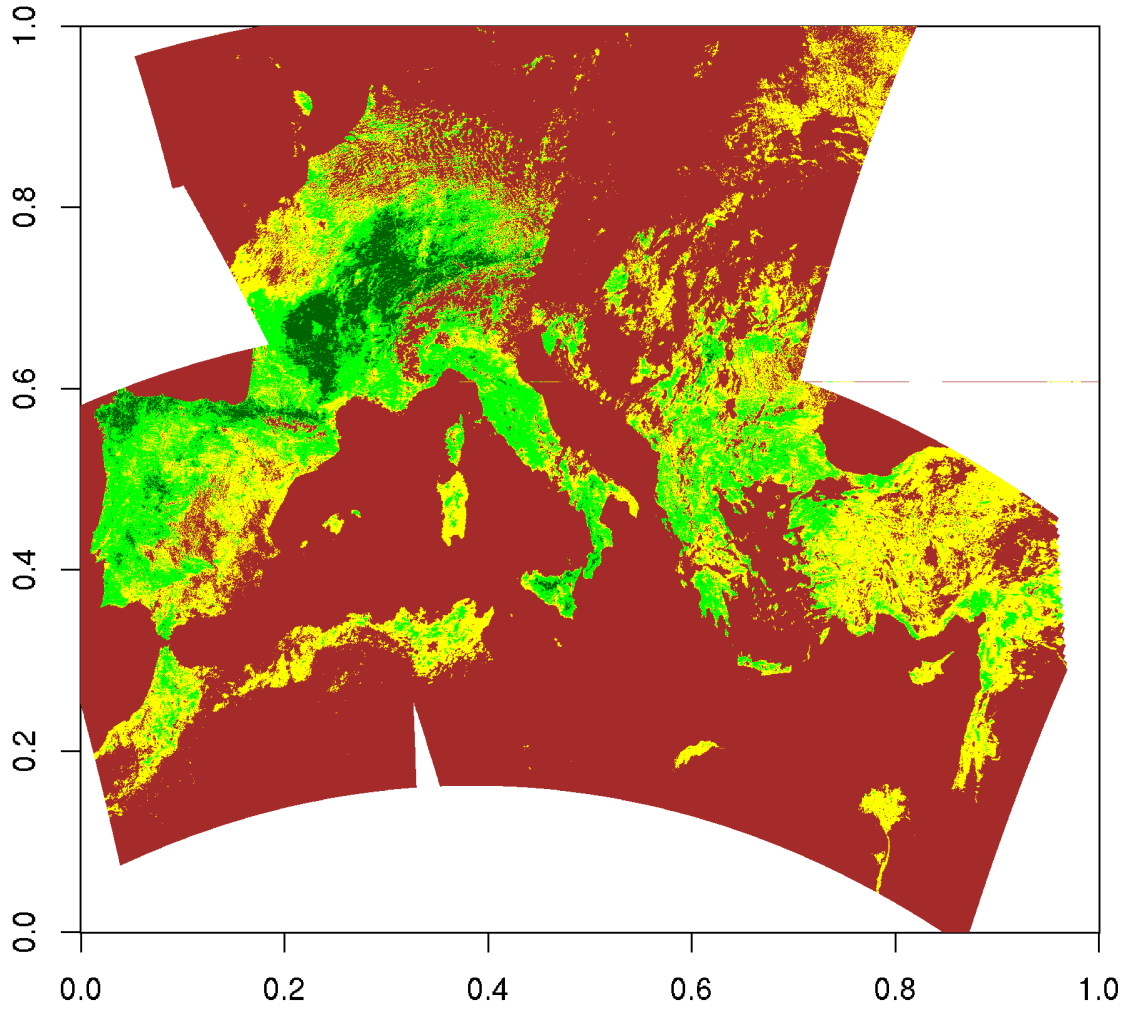

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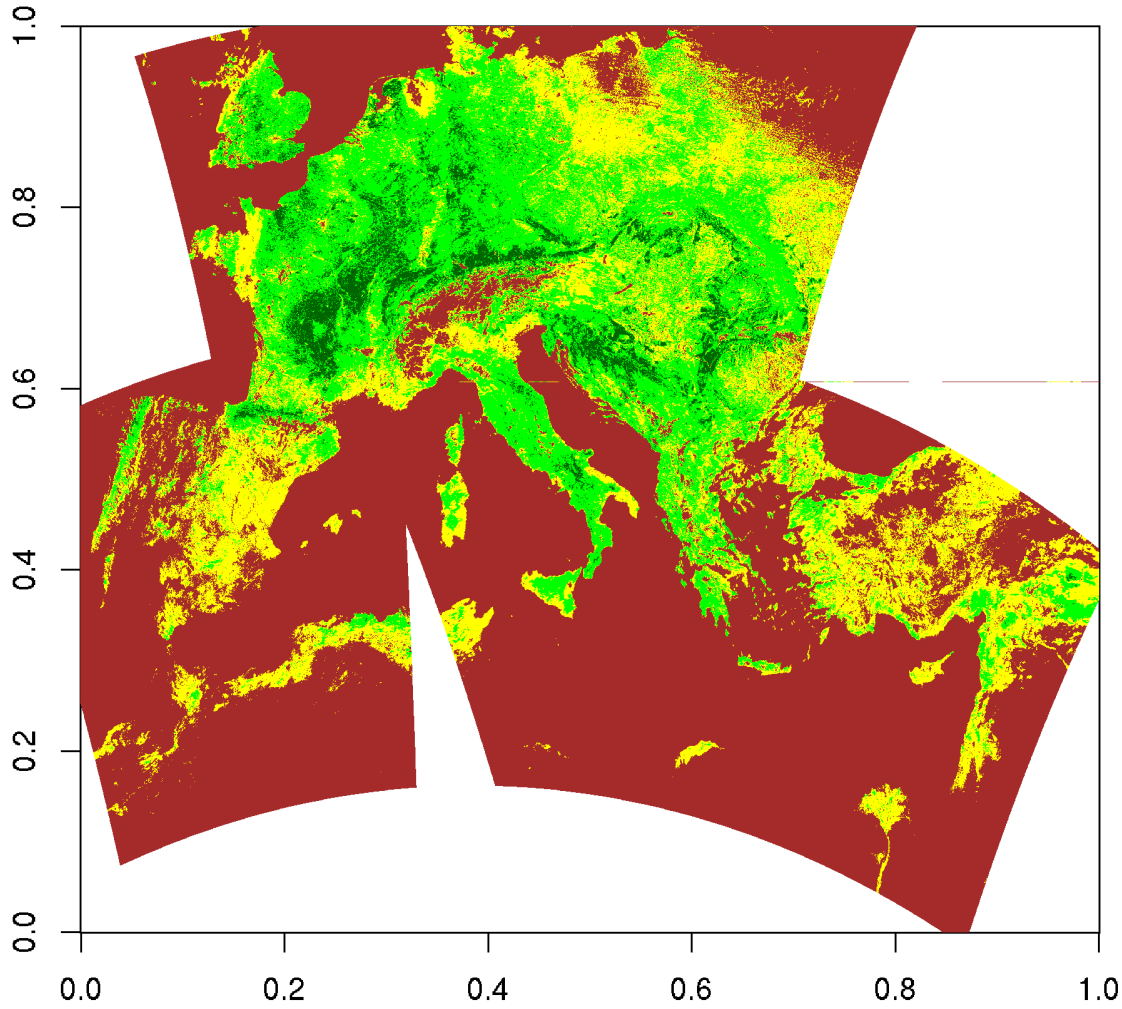
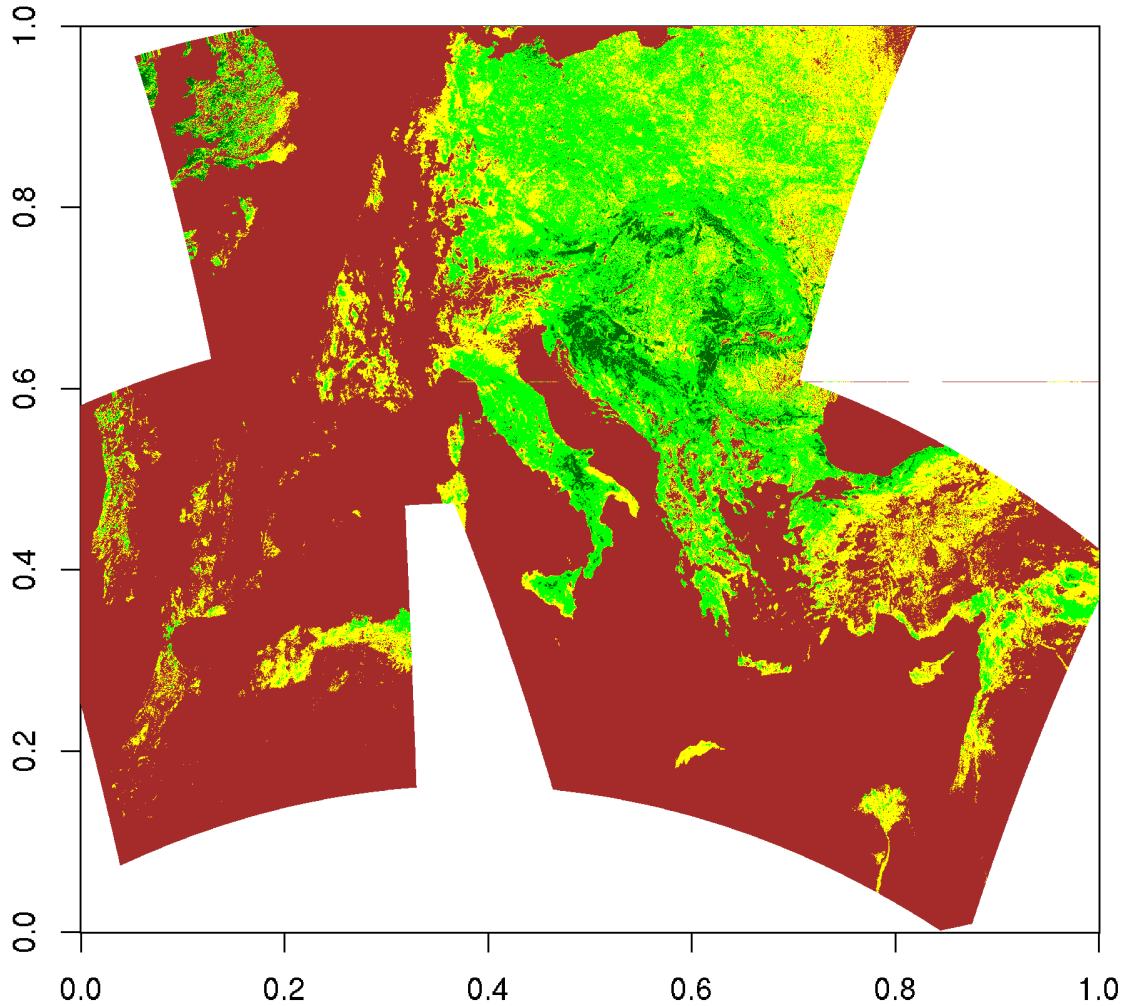
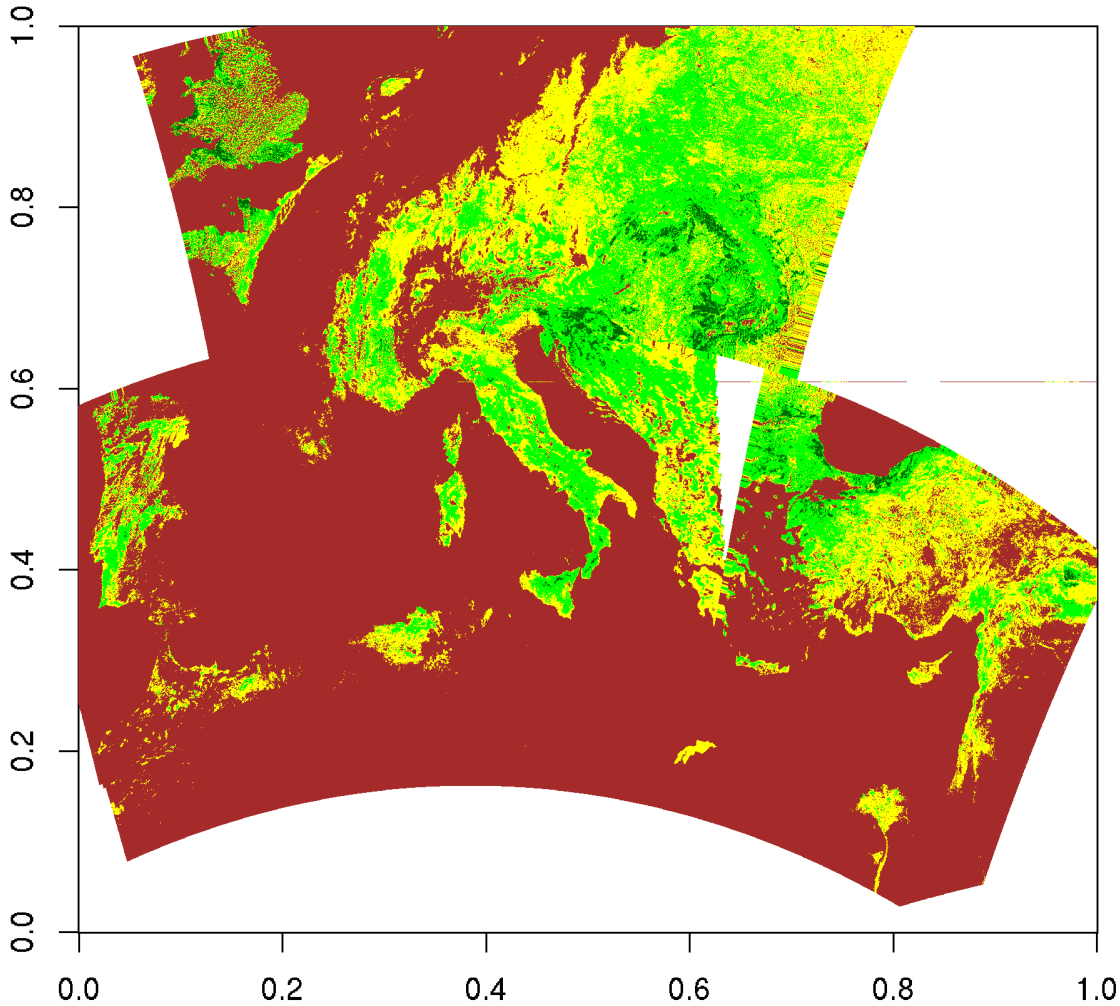


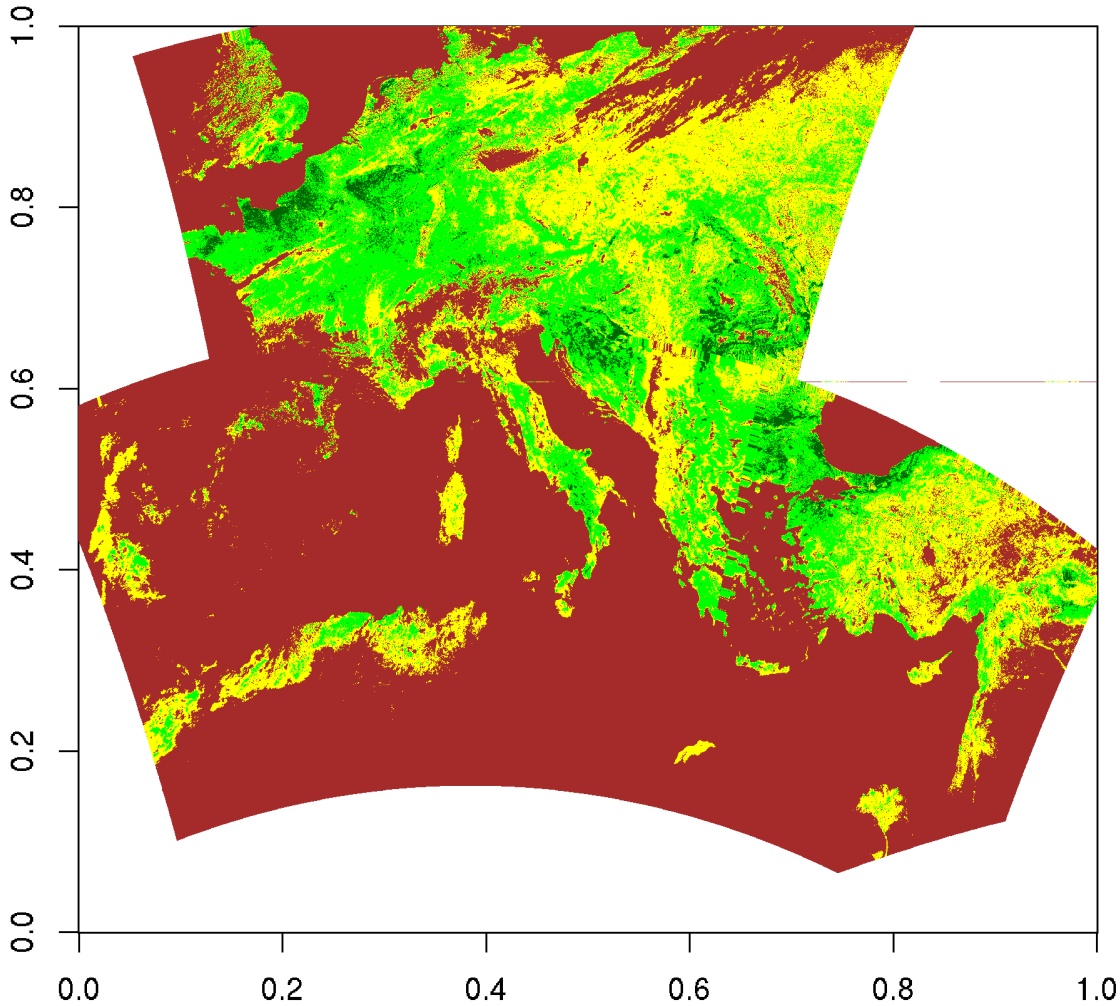
NDVI over time



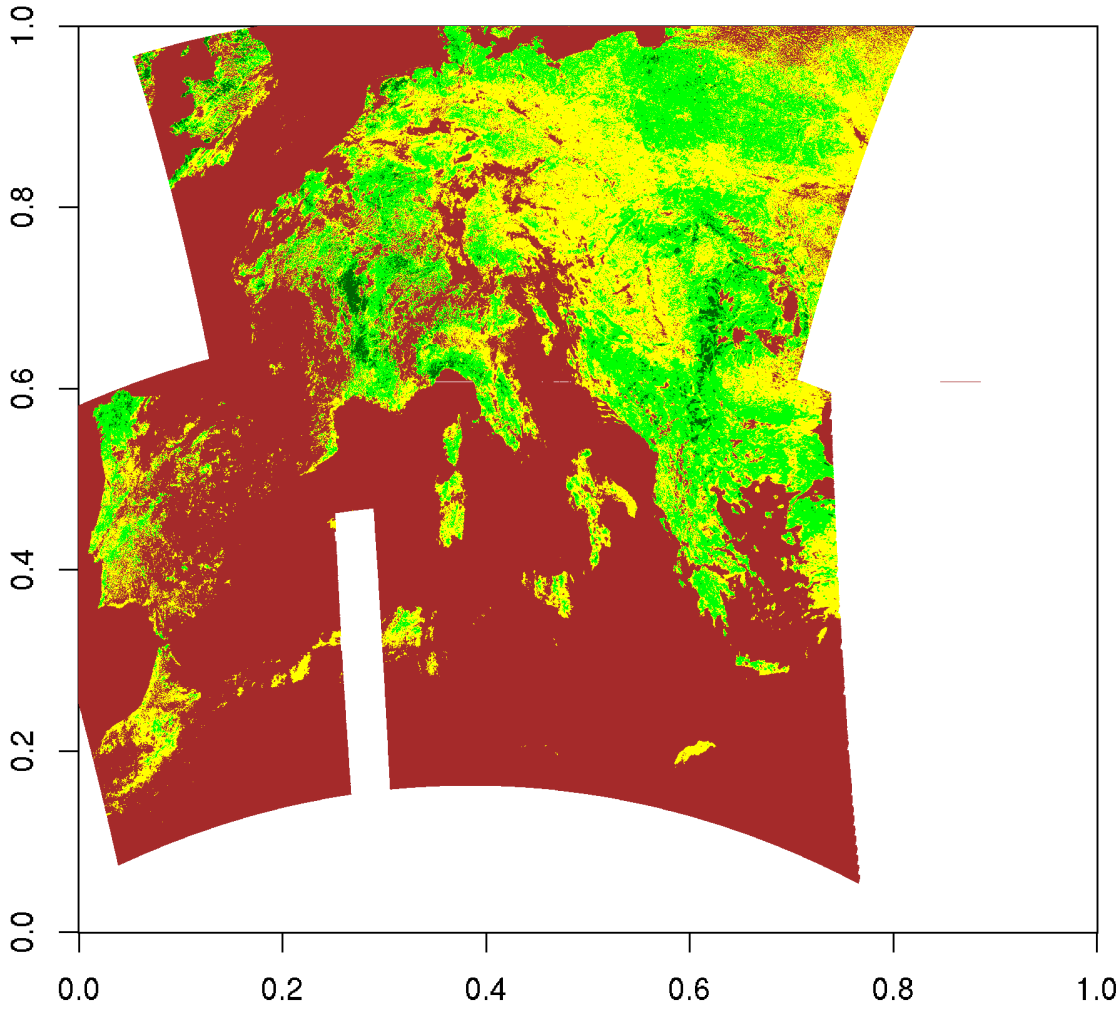
NDVI over time



NDVI over time



NDVI over time

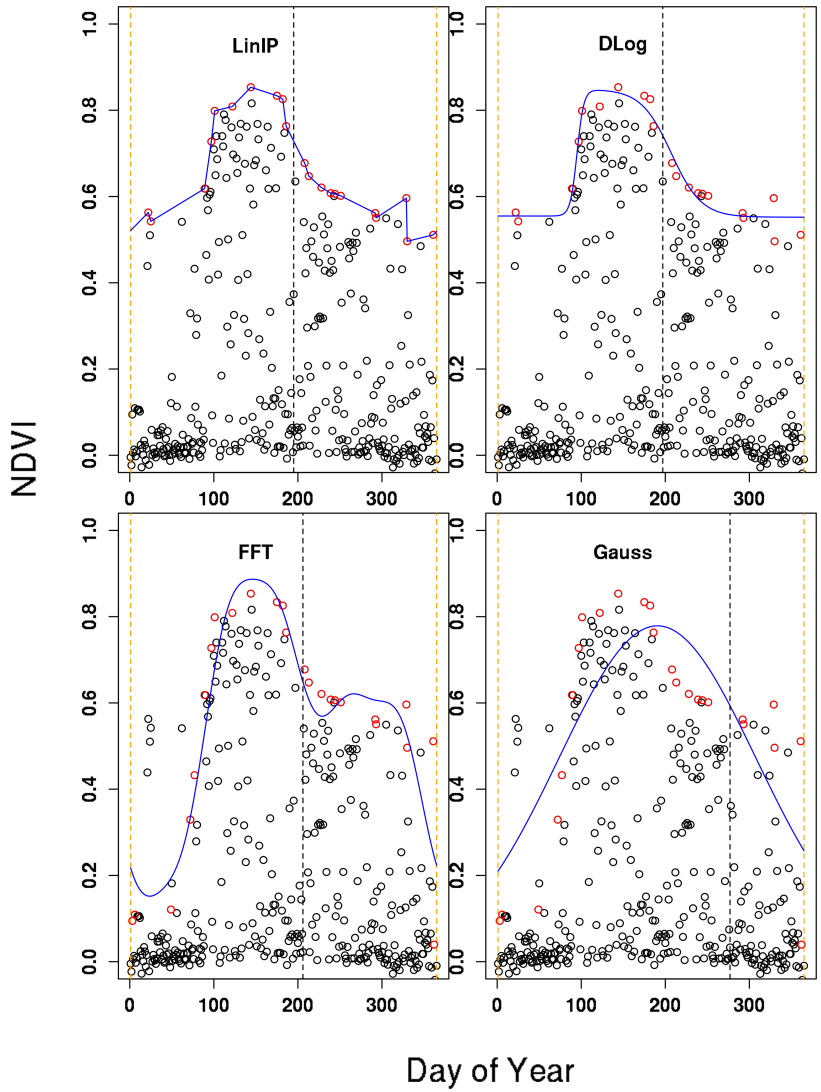


Problem statement

- No universally accepted method for extracting phenological metrics
- Use of different observation sets / NDVI products
- Incoherent validation against ground observations
- $=>$ Does this effect phenological trend estimates ?

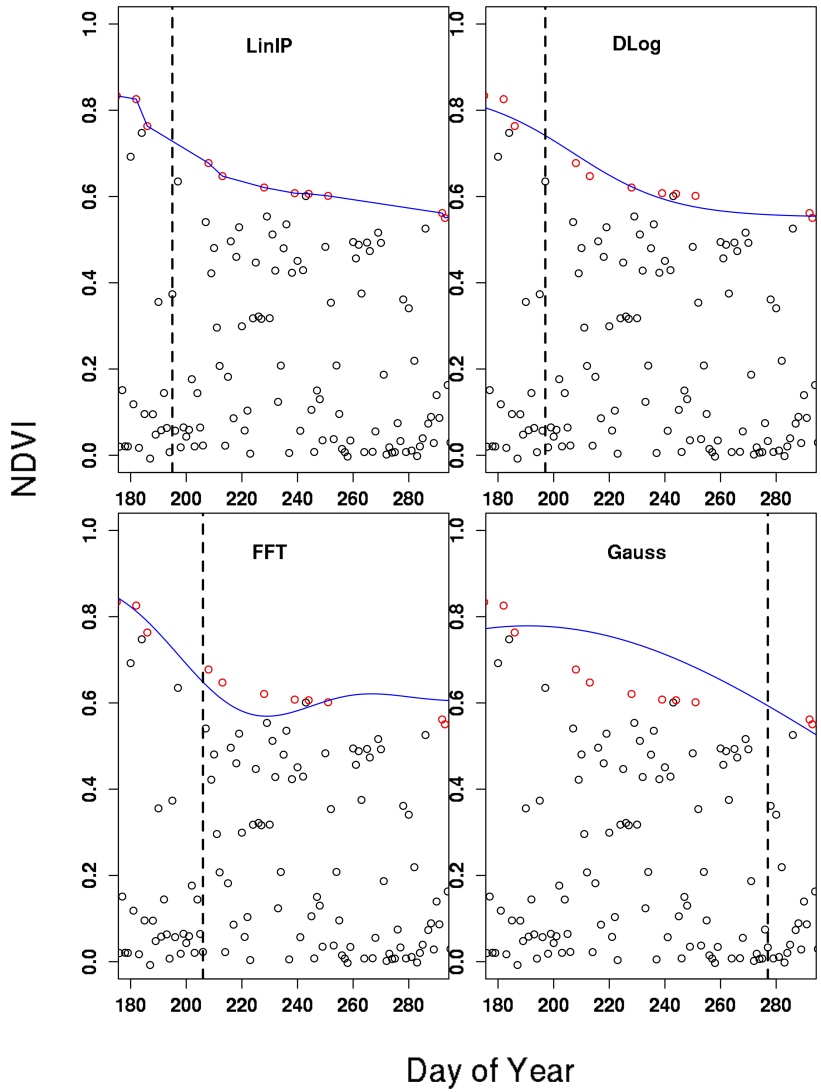
Methods

- Dynamic filtering, approximating and interpolating methods



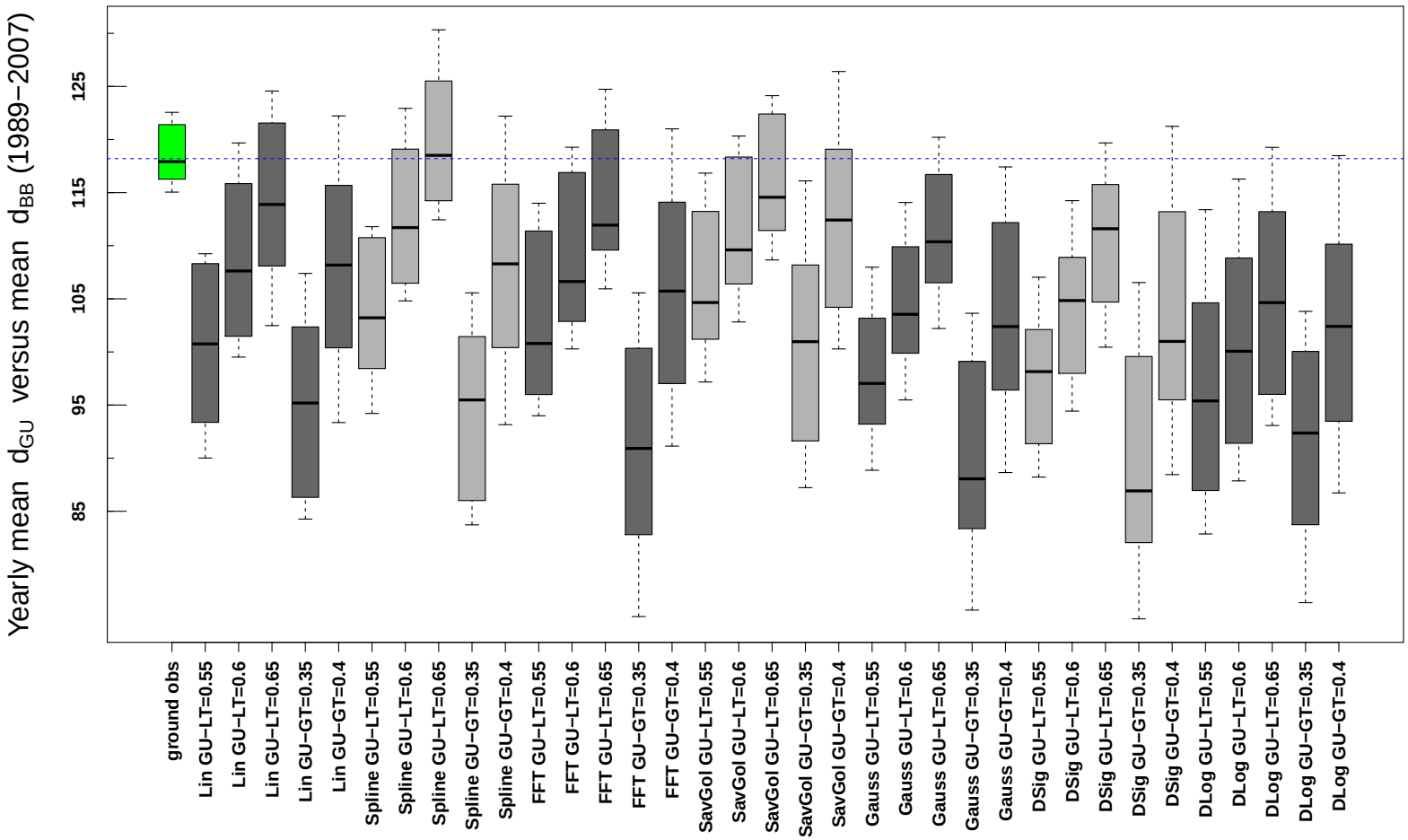
Methods

- Substantial differences between methods extracting phenological metrics



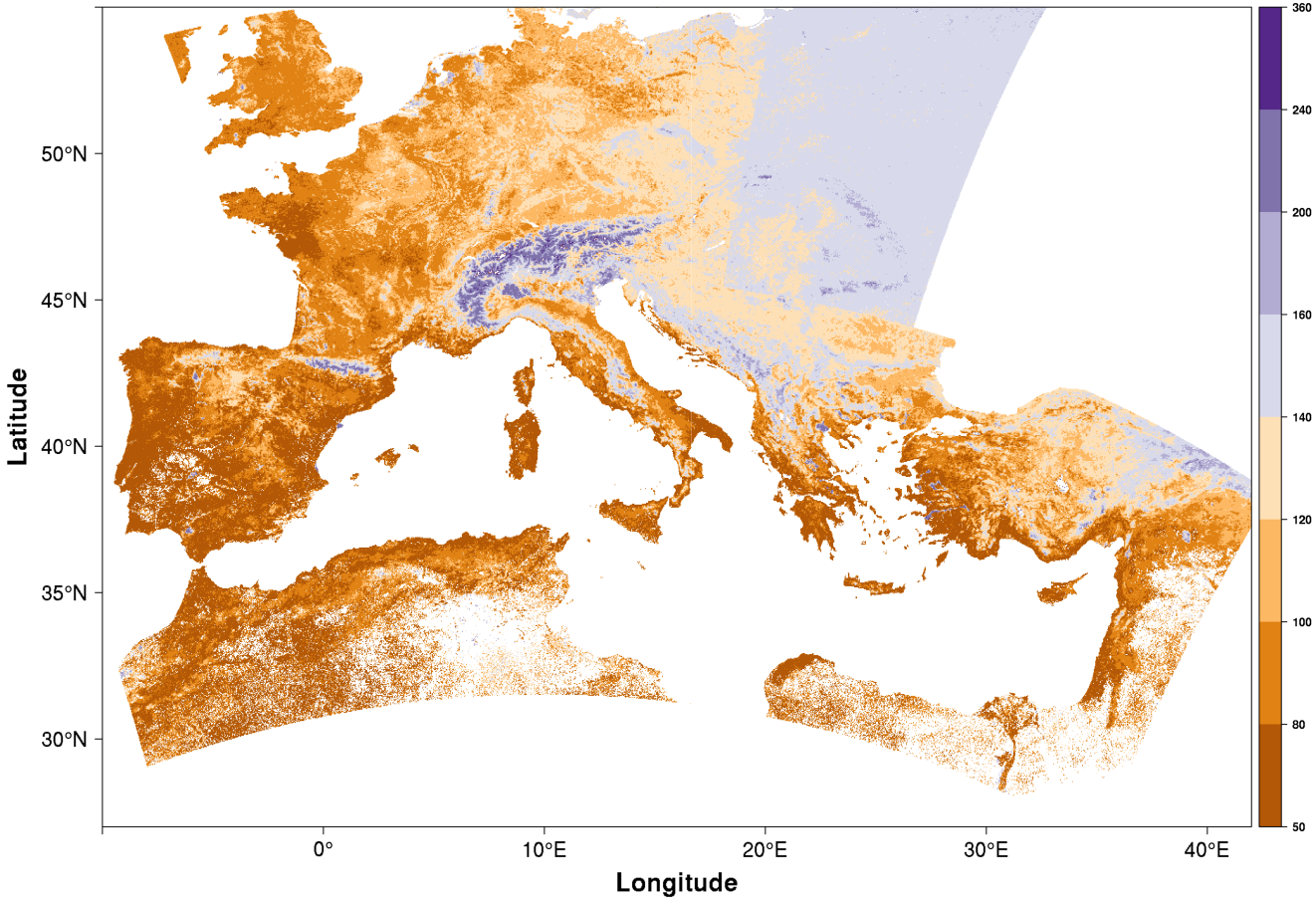
Metrics compared to ground observations

- Remotely sensed metrics in line with ground observations



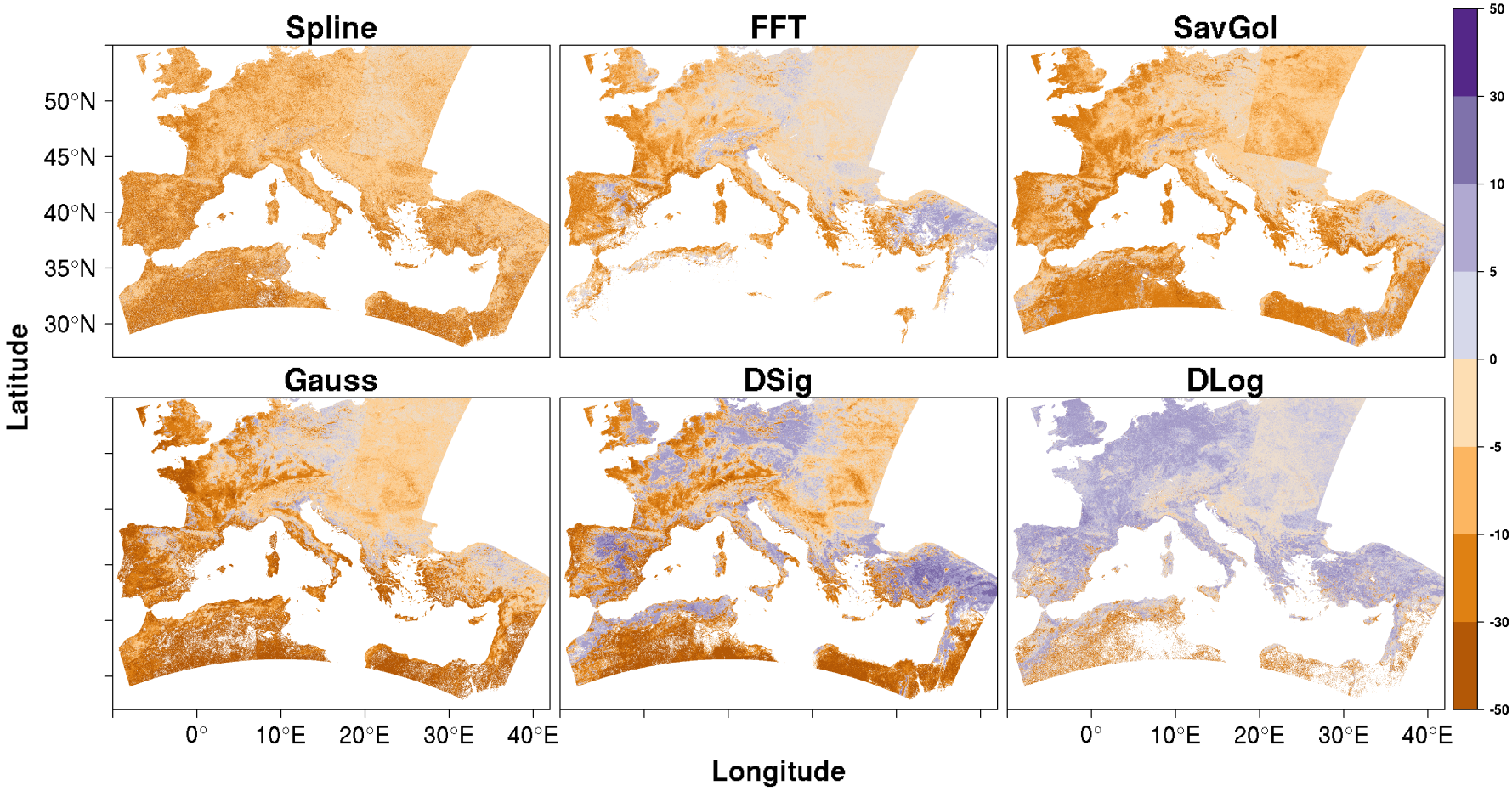
Mean phenological metrics

- Mean e.g. green-up dates vary spatially according to climatic factors



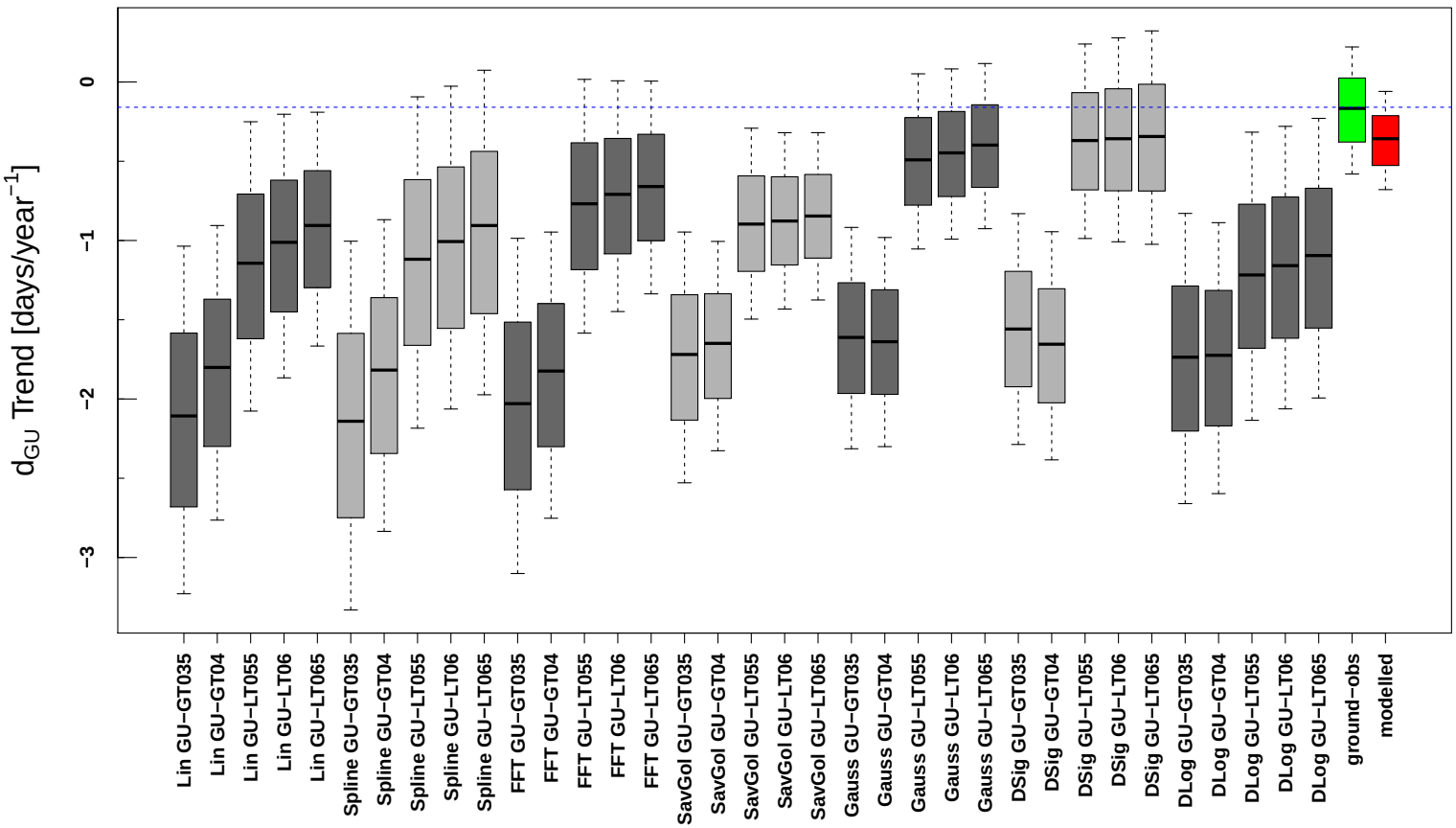
Mean metrics methods

- Substantial variance between methods and between land-cover



Trends of green-up dates

- Trend towards earlier green-up over all methods
- Trend differences between methods minor



Conclusions

- Metrics between methods differ substantially for single years
- Metrics between methods differ substantially for land-cover classes
- Trend estimates are more affected by threshold rather than methods
- Spatial resolution has a considerable effect on derived green-up trends