

Introducing a daily updated Leaf Area Index in a mesoscale Numerical Weather Prediction model

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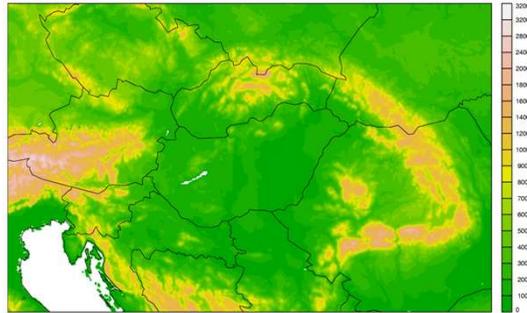


Why do we need dynamic LAI in a mesoscale NWP model?

- Hungary has a very large portion of non-irrigated croplands → severe droughts can cause large LAI anomalies
- Natural vegetation (forests, grasslands) can also produce LAI anomalies
- At the Hungarian Meteorological Service the AROME model is used for operational weather prediction
- Operational AROME uses a static climatological LAI external database → cannot reproduce LAI anomalies
- Motivation of the work: investigate to what extent these LAI anomalies can influence the weather forecasts
- Method: use prognostically computed LAI (ISBA-Ags) in AROME

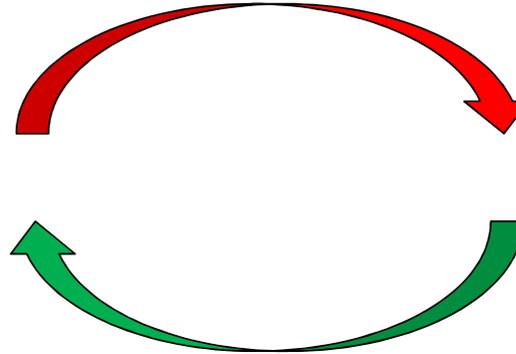
Modelling system

AROME NWP model



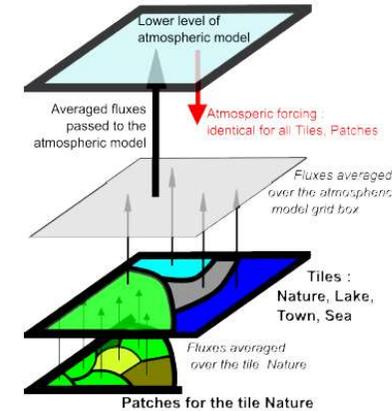
- 2.5 km horizontal resolution
- 60 vertical levels
- ECMWF-IFS boundary conditions
- Running 8 times a day out to +48h
- SURFEX land surface model (4 tiles, 1 patch over nature tile)
- 3DVAR upper-air assimilation
- SEKF surface assimilation using synop obs. (soil temp. and moisture)

Atmospheric forcing



Leaf Area Index

Offline SURFEX

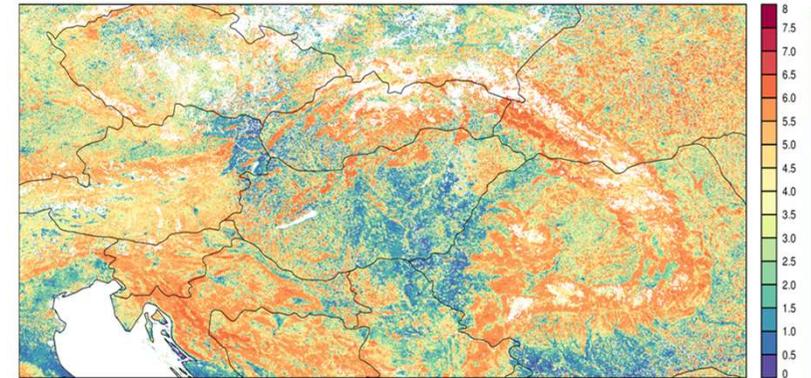


- Same domain as AROME
- 12 patch over nature tile
- ISBA-Ags scheme for prognostic vegetation
- Atmospheric forcing derived from AROME forecasts
- SEKF surface assimilation using satellite observed LAI
- LAI included in AROME once a day

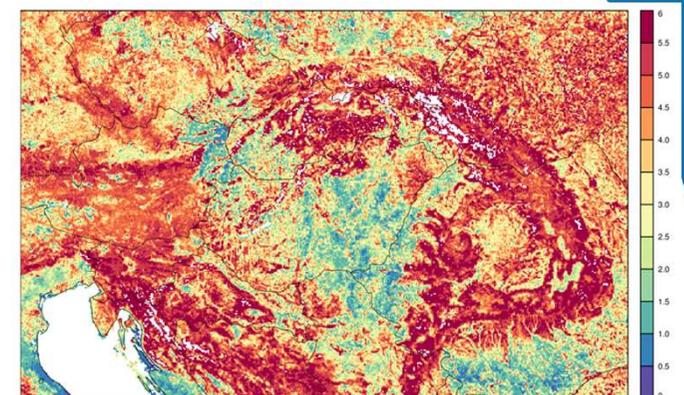
LAI observations

- Copernicus Global Land Service
- Sentinel-3 OLCI, available since July 2020
- (Proba-V between 2014 and 2020)
- 10 daily data, ~15 day latency
- Global 300m lat/lon files
- Apply quality filters (R program)
- Interpolate onto AROME Lambert grid (cdo)

Sentinel-3 LAI (300 m), 2021-07-20



Sentinel-3 LAI (2.5 km), 2021-07-20



Analysis of LAI from offline LDAS

T - 15 days

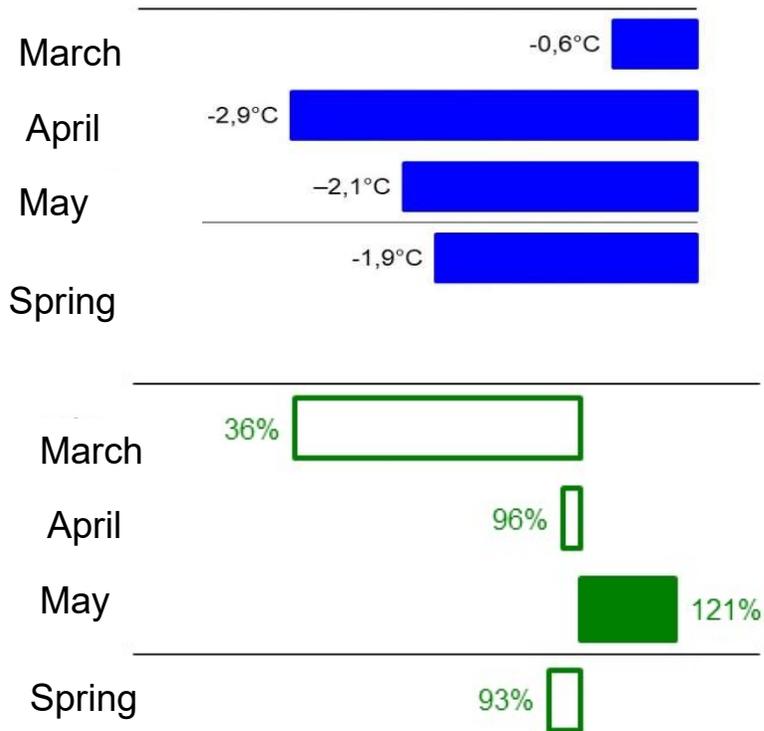
Offline ISBA-A-gs run

AROME run with "normal" ISBA

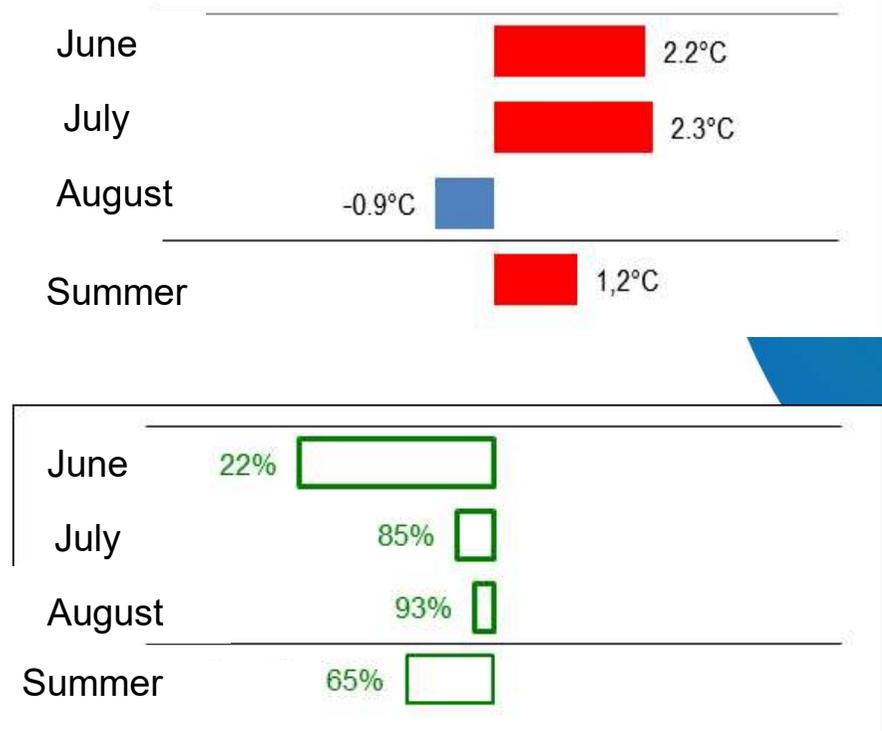
Case study: summer of 2021

- Cold spring followed by very hot and dry summer → severe drought over Southern Hungary and Northern Serbia, mainly affecting maize

Spring 2021



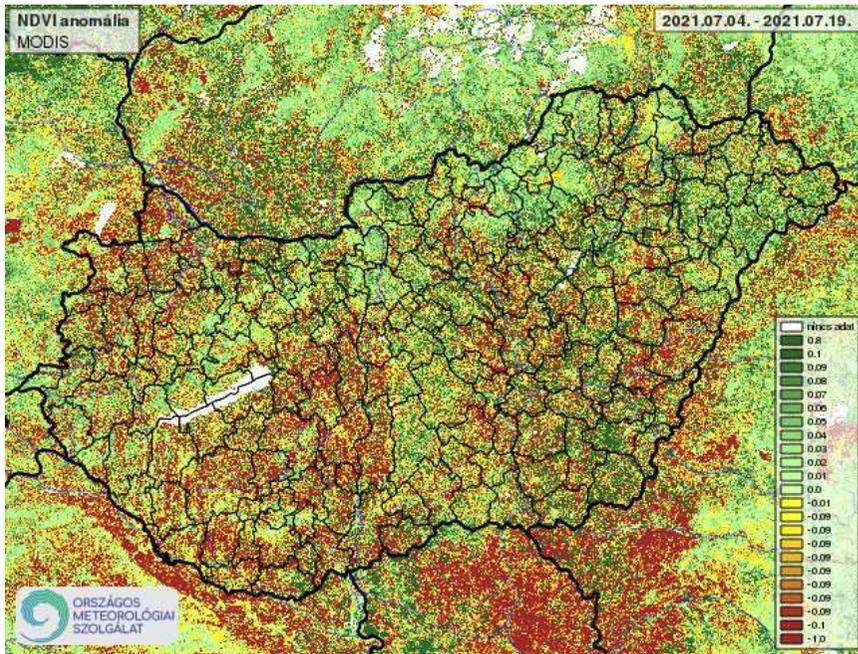
Summer 2021



Case study: summer of 2021

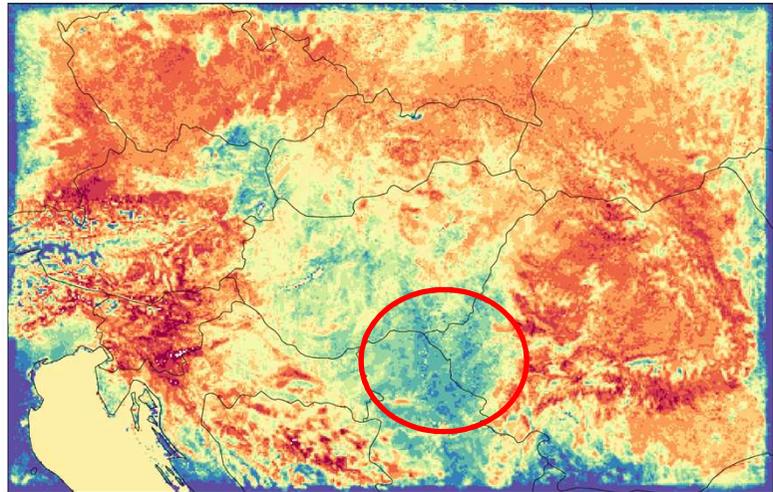
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NDVI anomaly

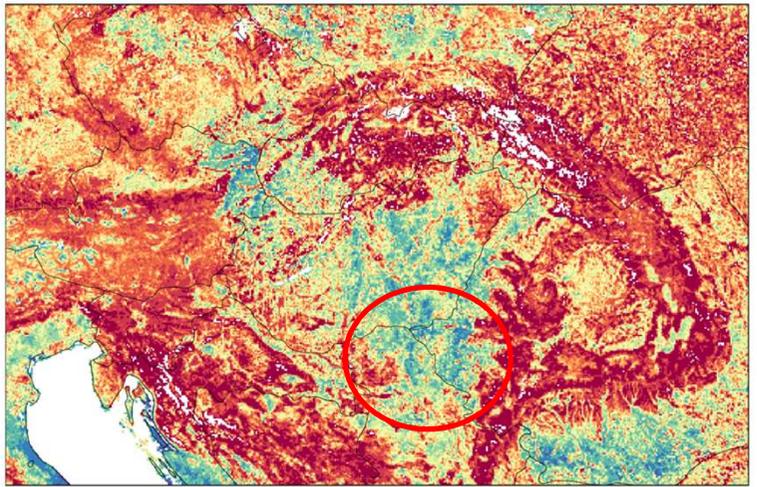
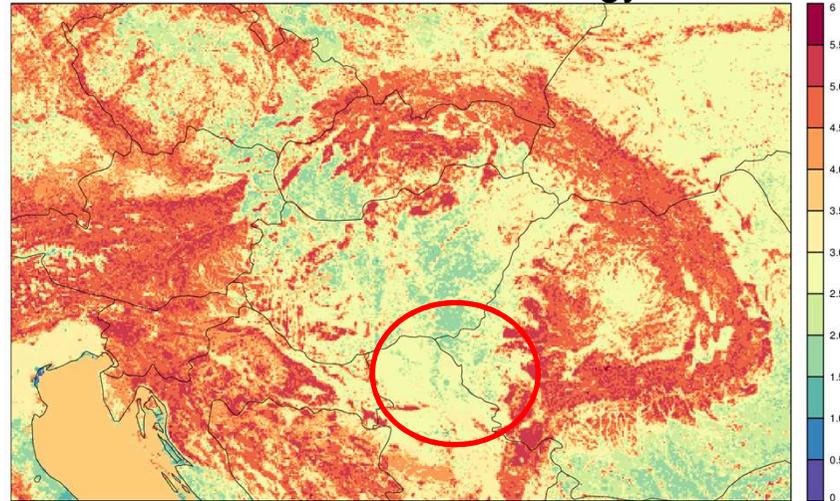


LAI values on 15th July 2021

ISBA-Ags



AROME-climatology

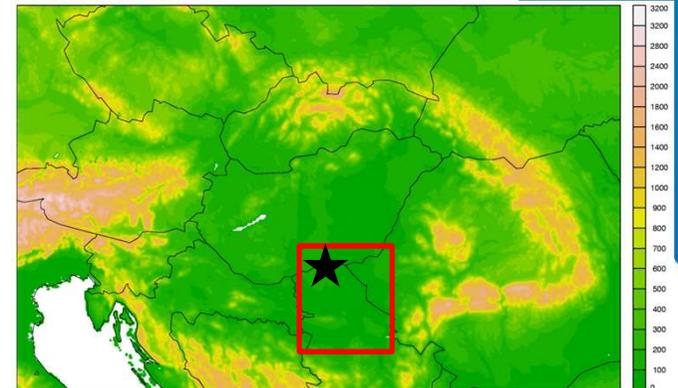


Sentinel-3 LAI product

- Negative LAI anomaly over Northern Serbia is well simulated
- Strange LAI values over Czech Republic and Ukraine
- Problems in high mountains (needleleaf forests)

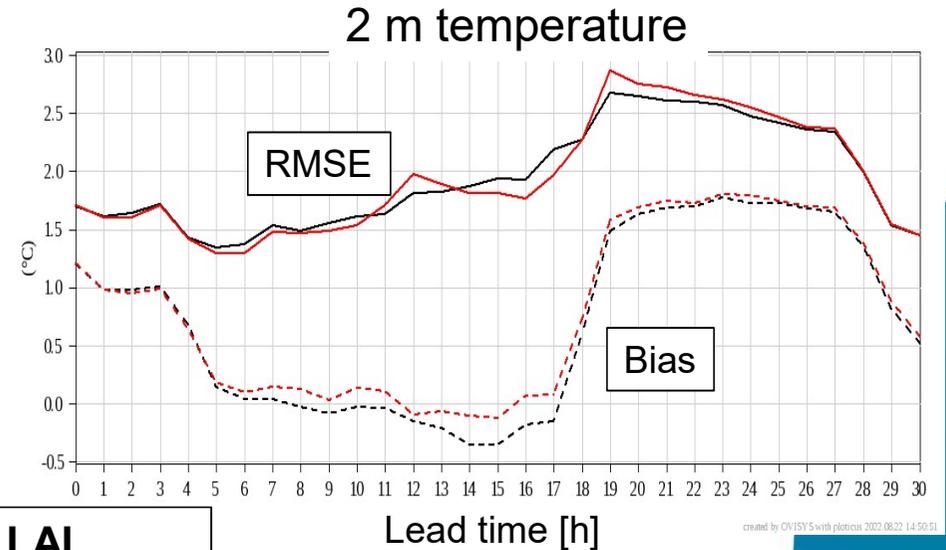
Model verification

- Verification period: 2021-06-28 – 2021-07-28
- Two weeks spin-up
- Reference: AROME run using climatological LAI
- Experiment: LAI taken from SURFEX-offline (ISBA-Ags) once a day
- Both reference and experiment run own assimilation cycle (surface and upper-air)
- Pointwise verification on the whole model domain showed no impact of modified LAI
- Certain differences can be detected if verification domain is reduced to the area affected by severe drought

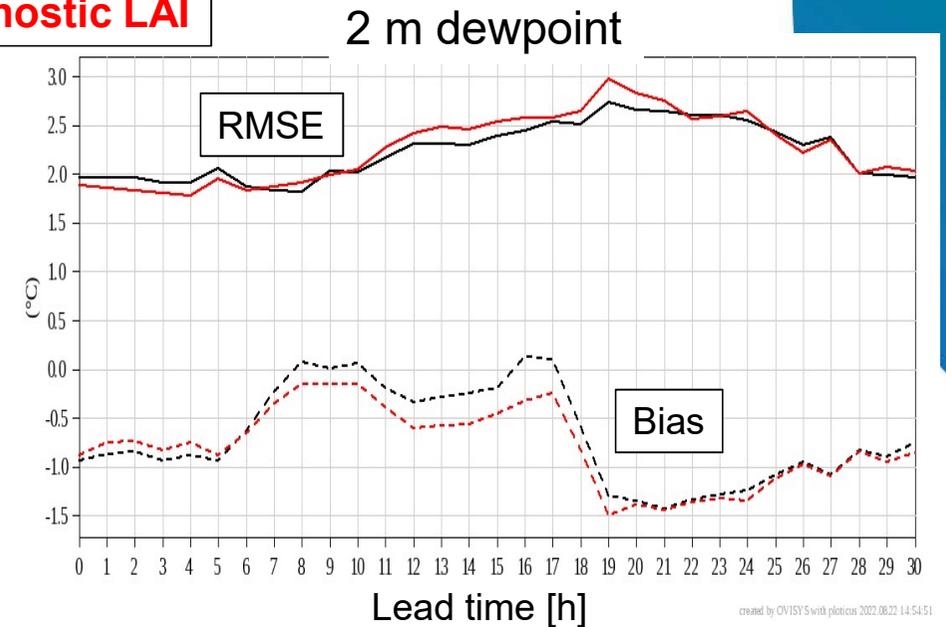
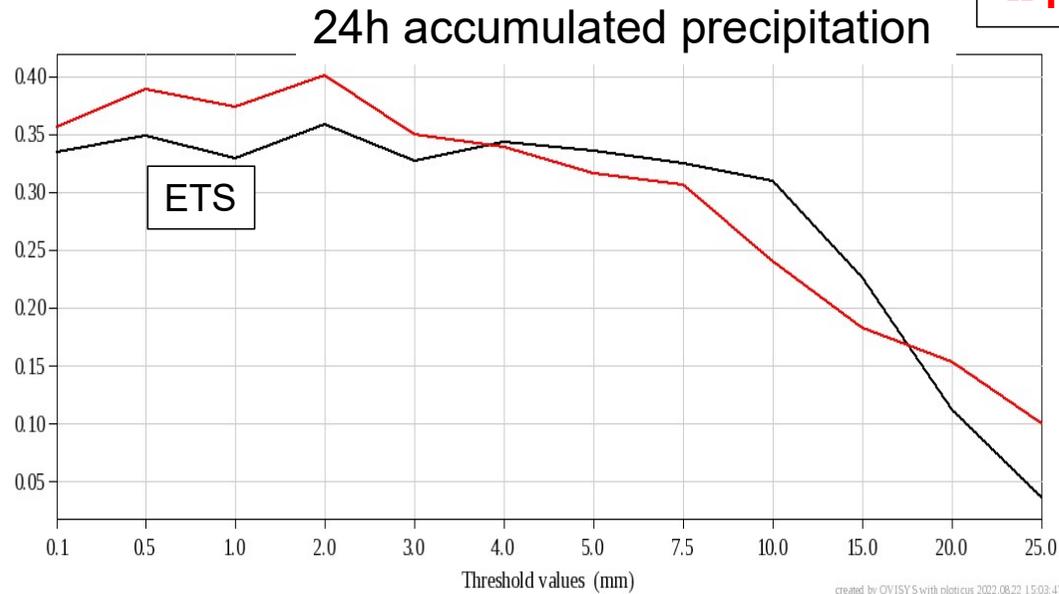


Model verification

- Verification period: 2021-06-28 – 2021-07-28
- Pointwise verification performed with in-house software OVISYS
- Small verification domain (affected by drought)
- 24 stations

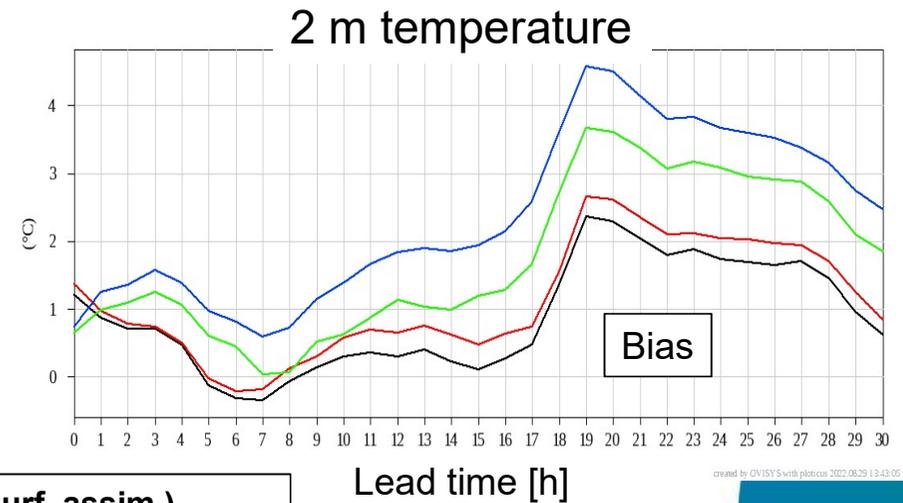


-- Clim. LAI
 -- Prognostic LAI

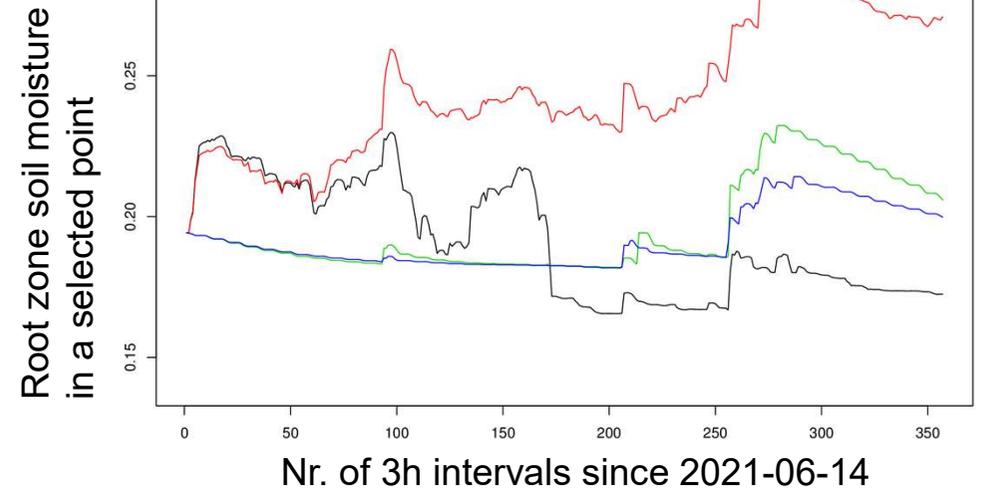
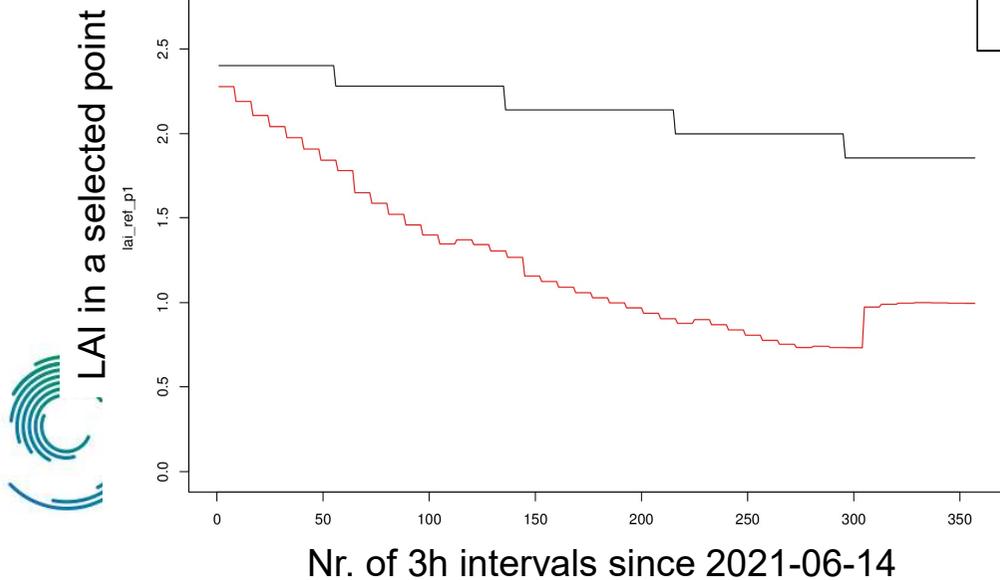


Impact of surface assimilation (preliminary results)

- Verification period: 2021-07-22 – 2021-07-28 (extremely warm period, no precipitation)
- Surface assimilation compensates for the errors in LAI (LAI overestimation in reference)
- Larger impact of LAI change if no surface assimilation is applied (free surface runs)



-- Clim. LAI (surf. assim.)
 -- Prognostic LAI (surf. assim.)
 -- Clim. LAI (free surface)
 -- Prognostic LAI (free surface)



Conclusions and plans

- Climatological LAI (used in most operational NWP models) cannot represent anomalies of vegetation
- SURFEX ISBA-Ags is able to reproduce LAI anomalies
- LAI anomalies can influence weather forecasts
- Surface assimilation can compensate for LAI errors, but this could result in unrealistic soil moisture

- Plans:
 - Compute more periods (summer 2022: extreme drought)
 - Compare with in-situ observations (LAI, WG2)
 - The system described in this study is planned to be implemented in the operational NWP chain of the Hungarian Meteorological Service

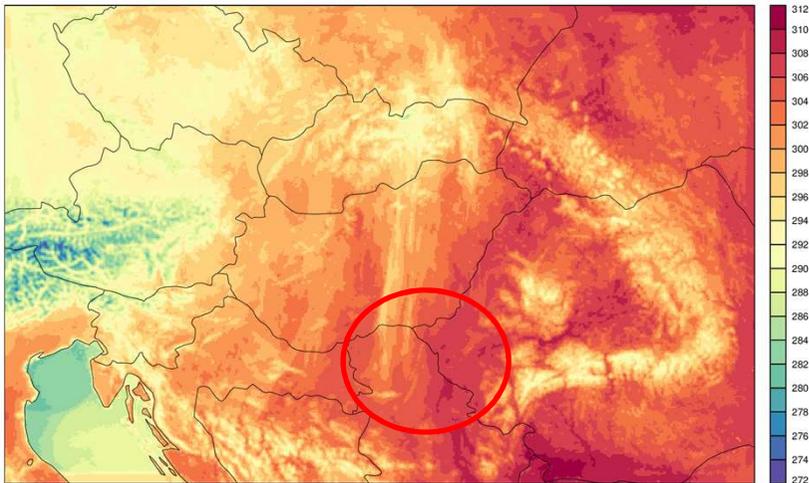
Thank you for your attention!



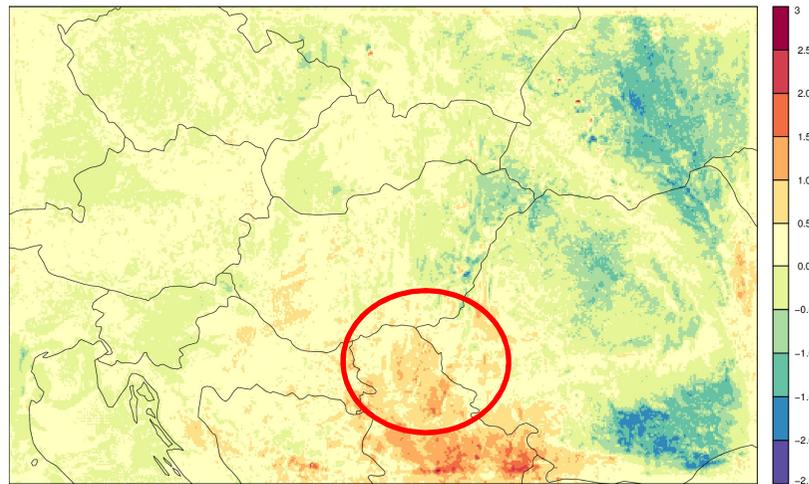
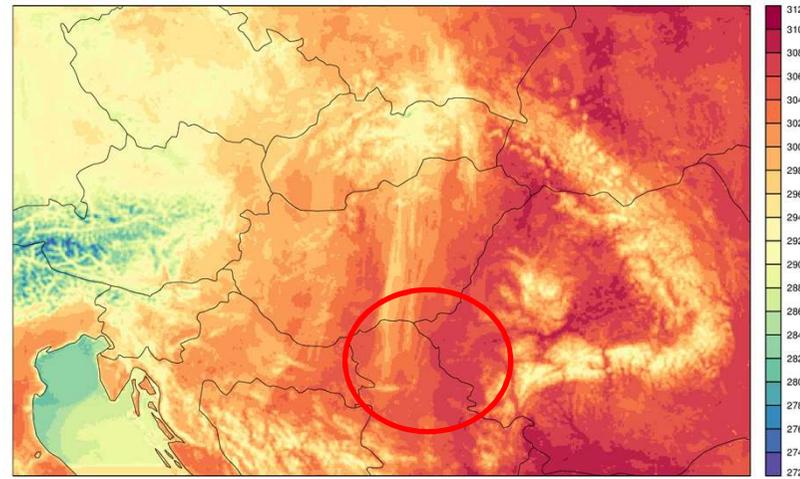
Spare slides

Case study 2021-07-15 : T2m at 12 UTC (+12h forecast)

AROME/ISBA-Ags



AROME-oper

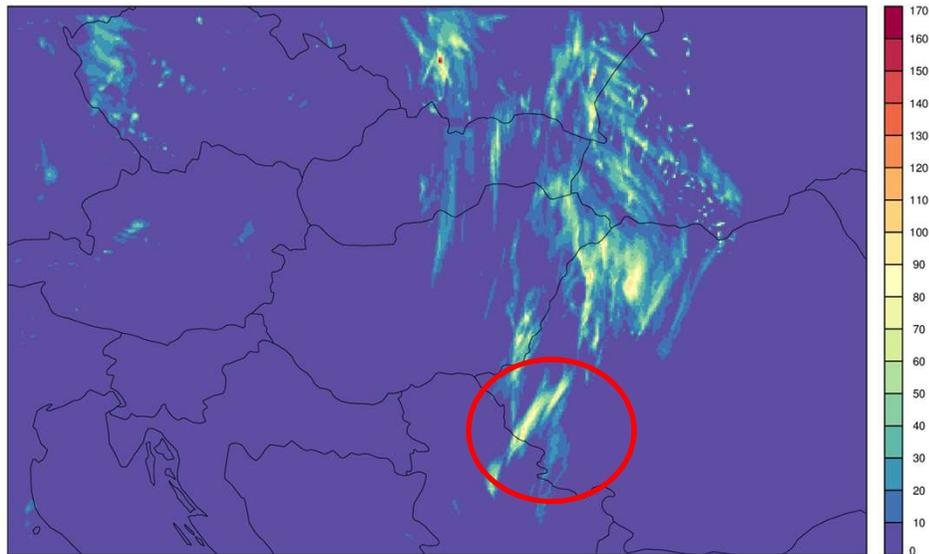


AROME/ISBA-Ags – AROME-oper

- Negative LAI anomaly over Northern Serbia causes 1-2 degrees higher temperatures

Case study 2021-07-15 : +30h accumulated precipitation

AROME/ISBA-Ags



AROME-oper

