



Szén-dioxid fluxusok és vegetáció modellezése az ImagineS projekt keretében

Országos Meteorológiai Szolgálat

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Tartalom



- **ImagineS projekt alapja: Surfex talajmodell**
 - ISBA-A-gs séma a SURFEX-ben
 - Adat asszimiláció: Extended Kalman Filter
- **Eredmények, felhasználhatóság**
 - 1D (összevetés a hegyhátsáli adatokkal)
 - 2D (összevetés a műholdas adatokkal)
 - Mezőgazdasági felhasználhatóság
 - Szárazság-indukátorok
- **Honlapon elérhető információk**



OMSz feladata a projektben



- **OMSz talajmodellt futtat => kvázi valós idejű becslés**
 - biomassa növekedésére,
 - légkör-talaj (vegetáció) közötti áramok (hő, vízgőz és CO₂)
 - Aszályindexek
 - Termésbecslés (a modell képes bizonyos mezőgazdasági növényeket külön kezelni, pl. C3, C4 veg.)



Surfex modell



• SURFEX (SURface EXternalisée) 7.3: externalizált felszíni séma

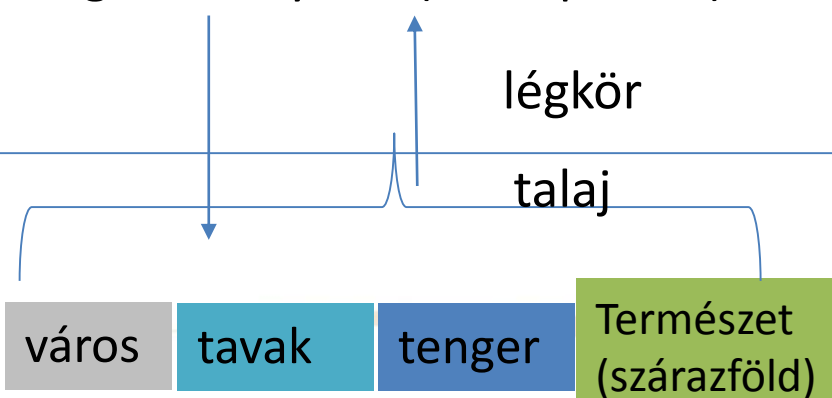
Surfex részei:

- TALAJ-VEGETÁCIÓ (ISBA)
- VÁROS
- TAVAK, TENGER, tengeri jég
- FELSZÍNI HATÁRRÉTEG

- Csak „természet” tile-on történik futtatás
- Természeti tile 12 patch-re van felosztva (fűfelszín, C3, C4 növények, lombhullató fák ... stb)
- Talajban lejátszódó folyamatok ún. ISBA sémával + fotoszintézis model - > ISBA-A-gs (3 rétegű Force-Restore séma)
- ISBA 3 rétegű talajmodell T, w (talajnedvesség) leírása prognosztikai egyenletekkel
- Növényzet fejlődését explicit módon írja le (fotoszintézis \leftrightarrow növényzet elhalása)

ECOCLIMAP II

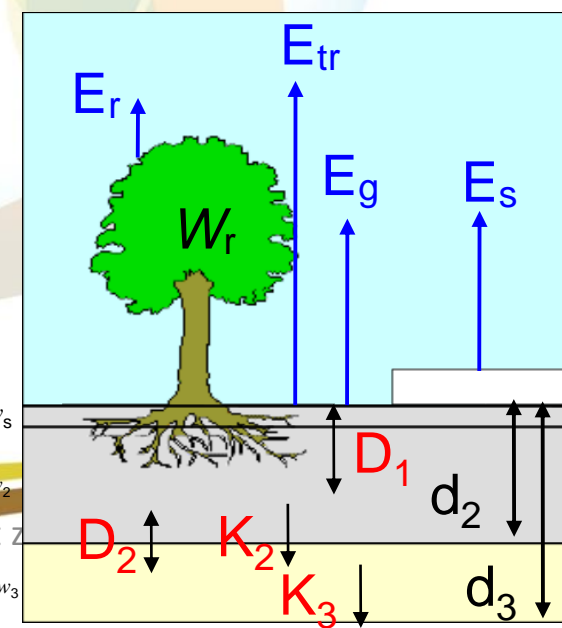
Légköri kényszer (u, v, T, q, P, rad)



ISBA Force (kényszer) – Restore (egyensúlyba visszaállás) séma:

Hőmérséklet változás=felszíni nettó sugárzás-látens és szenzibilis hő – rétegek közötti hőmérséklet kül.

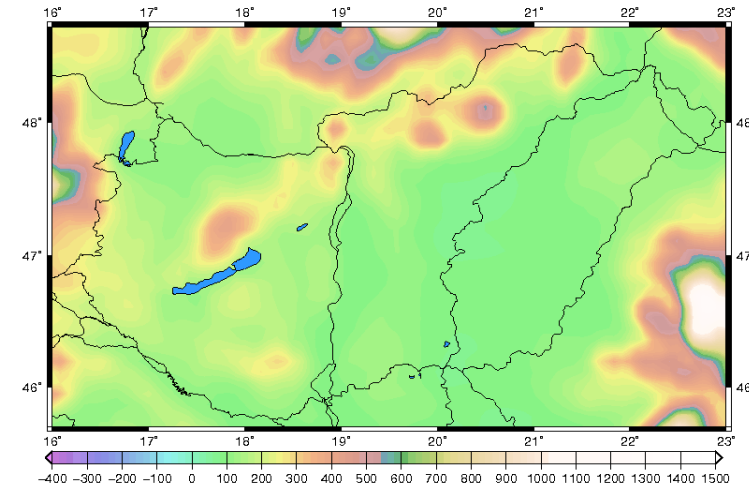
Talajnedvesség változás=csapadék-párolgás-rétegek közötti diffúzió-elfolyás



- A Surfex modellt magyarországi tartományra 8x8 km-es felbontáson futtattuk 24 órára előre, 6 órás output frekvenciával
- Asszimiláció: napi ciklussal
- A légköri bemenő adatokat az **ALADIN NWP** modell szolgáltatta (léghőmérséklet, légnedvesség, szélesség, csapadék) + **LandSAF** hosszú- és rövidhullámú **sugárzás**
- ún. offline módban futtattuk a modellt -> nincs hatás a légkörre

OUTPUT-ok:

- LAI (Növény felületi index)
- WG2 (gyökérzóna talajnedvessége)
- Szén-dioxid fluxusok: GPP (Gross Primary Product: fotoszintézis során elnyelt CO₂), NEE (Net Ecosystem Exchange: kilélegzett - fotoszintézis)
- Vízgőz fluxus: ETR (Evapotranspiráció: növényzet és a talaj párolgása), LE (Latens Hő Fluxus)



VALIDÁCIÓ:

- 1D (Hegyhátsáli mérésekkel)
- 2D (műhold adatokkal)
- Mezőgazdasági felhasználás: szimm. biomassza vs. KSH adatokkal, illetve WOFOST crop modell eredményeivel



Műhold adatok asszimilációja a SURFEX-ben



- **Cél a modell kezdeti feltételeinek pontosítása: LAI és Felszíni talajnedvesség műholdas adatok asszimilációja** (az adatokat a <http://land.copernicus.eu/> honlapról töltöttük le)
- **Eredeti terv: Sentinel-2 és 3 adatok, de ezek fellövése jelentősen késett**
 - LAI: SPOT-VEG (2014 májusáig) and PROBA-V (2014 májusától) 1km felb. 10 napos átlag. Jelenleg letölthető adatok V1:
 - Neurális hálót futtatnak Top-Of-Canopy (TOC) input adatokra a vörös, közeli-infravörös, és rövid hullámú infravörös tartományokban, normalizálják 30 napos időtartamra
 - A normalizáció során súlyfüggvényt alkalmaznak a legfrissebb napi megfigyelések felhasználásával
 - SWI (Soil Water Index) [0,1]: MetOp. ASCAT (Advanced SCATterometer) 10 km felb. 1 napos átlag. Jelenleg letölthető adatok V3, mi még a V2-t töltöttük le:
 - SWI számítás a MetOp/ASCAT szenzorok által mért (radar visszavert, hosszú hullámú, C-band) felszíni talajnedvességből a 2-rétegű water-balance modell felhasználásával
 - Talajtexturával nem számolnak
 - 8 SWI értéket számolnak ki különböző talajmélységek alapján
 - Rekurzív összefüggést alkalmaznak a számítások során.
 - Felszíni állapot Flaget használnak (SSF) (fagyott, nem fagyott, olvadt)
 - SSF alapján történik SSM kiszámítása nem-fagyott talaj esetén

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LAI

VPI

FAPAR

VCI

FCOVER

DMP

NDVI

Burnt Area

Leaf Area Index

The Leaf Area Index is defined as half the total area of green elements of the canopy per unit horizontal ground area. The satellite-derived value corresponds to the total green LAI of all the canopy layers, including the understory which may represent a very significant contribution, particularly for forests. Practically, the LAI

LAI Alerts

- Fix to LAI version 1, Apr-Dec 2013 period
Tue, 07 Jul 2015
LAI version 1 archive completed
Fri, 03 Jul 2015

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LAI is recognized as an Essential Climate Variable (ECV) by the Global Climate Observing System (GCOS).

LAI Alerts

- Fix to LAI version 1, Apr-Dec 2013 period
Tue, 07 Jul 2015
LAI version 1 archive completed
Fri, 03 Jul 2015
LAI version 1 resumes
Wed, 08 Apr 2015
LAI version 1 temporarily unavailable
Mon, 03 Nov 2014
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LAI characteristics

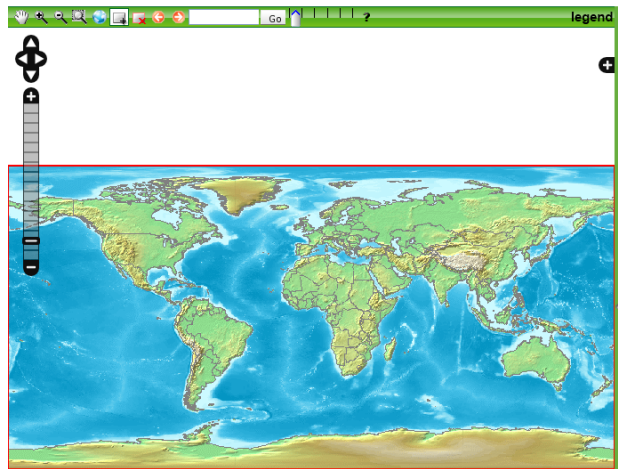
Product version	Access	Status	Sensor	Temporal coverage	Spatial information	Timeliness
3	Expected Q1 2016	In development	PROBA-V	May 2014 - present	Europe, 10°x10° tiles, continental tile, 1/3km	Within 3 days after end of synthesis period
2	Expected Q1 2016	In development	SPOT-VGT, PROBA-V	1999 - present	Global, 10°x10° tiles, continental tiles, 1km	Within 3 days after end of synthesis period
1	Product Portal	Pre-operational	PROBA-V	Jun 2014 - present	Global, 10°x10° tiles, continental tiles, 1km	Within 3 days after end of synthesis

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Vegetation Properties - LAI V1

- Help
- Collection
- Basic
 - Date: Start date 01/06/2014, End date 31/12/2020
 - ROI: 90, 180, -90
 - Coverage: BioPar_LAI_V1_Tiles, BioPar_LAI_V1_CONTINENTS
- Advanced

Search Reset

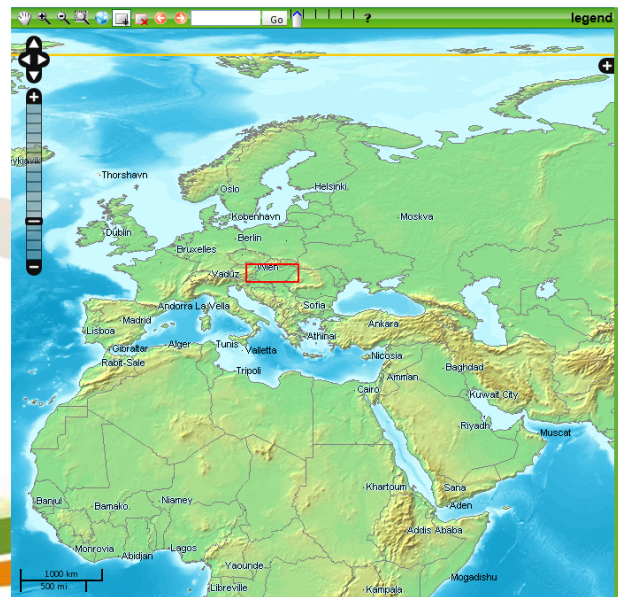
Number of results per page 100

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Vegetation Properties - LAI V1

0 products selected on a total of 3 100 Per << 1 of 1 >>

Select all 3 products

Download	Product ID	Start Date	End Date	Size	Thumbnail
<input type="checkbox"/>	LAI_201407240000_PROBAV_V1.4	06/07/2014	05/08/2014	364.9 MB	
<input type="checkbox"/>	LAI_201407130000_PROBAV_V1.4	25/06/2014	25/07/2014	367.3 MB	
<input type="checkbox"/>	LAI_201407030000_PROBAV_V1.4	15/06/2014	15/07/2014	366.1 MB	

Back to search Prepare custom order. Order now. Request perm...

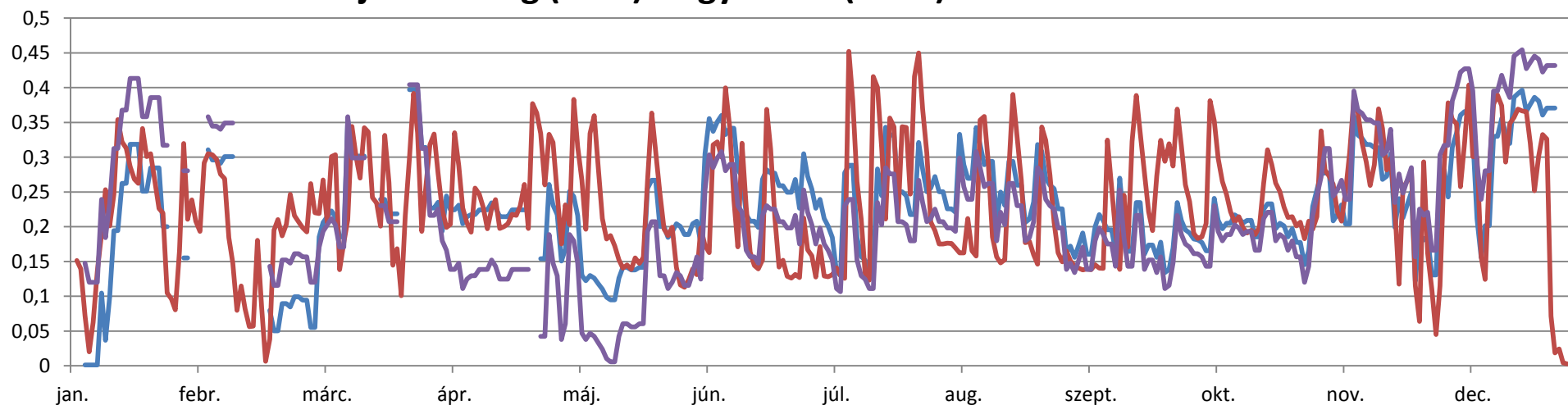
- A Surfex számára nem SWI, hanem tényleges talajnedvesség szükséges
- Talajnedvesség számolása SWI-ből: $SSM = SWI \cdot (w_{\max} - w_{\min}) + w_{\min}$
 w_{\max} és w_{\min} modellből számolt, több évre vonatkozó értékek
- ASCAT SSM és modellből előálló SSM BIAS-a és évszakos változékonysága különbözik => ASCAT SSM adatokat **CDF matching technikával** újra számítjuk (így távolítjuk el a műhold adatok és a modell adatai közötti különbséget => biztosítva van a modell és műhold közötti konzisztencia)

Linear matching:

$$SSM'_{sat} = p_1 + p_2 \cdot SSM_{sat} \quad \text{ahol} \quad p_1 = \overline{SSM_{mod}} - p_2 \cdot \overline{SSM_{sat}} \quad p_2 = \frac{stdev(SSM_{mod})}{stdev(SSM_{sat})}$$

p_1 és p_2 együtthatókat évszakos bontásban adjuk => évszakos lineáris matching

Felszíni talajnedvesség (SSM) Hegyhatsal (2008)

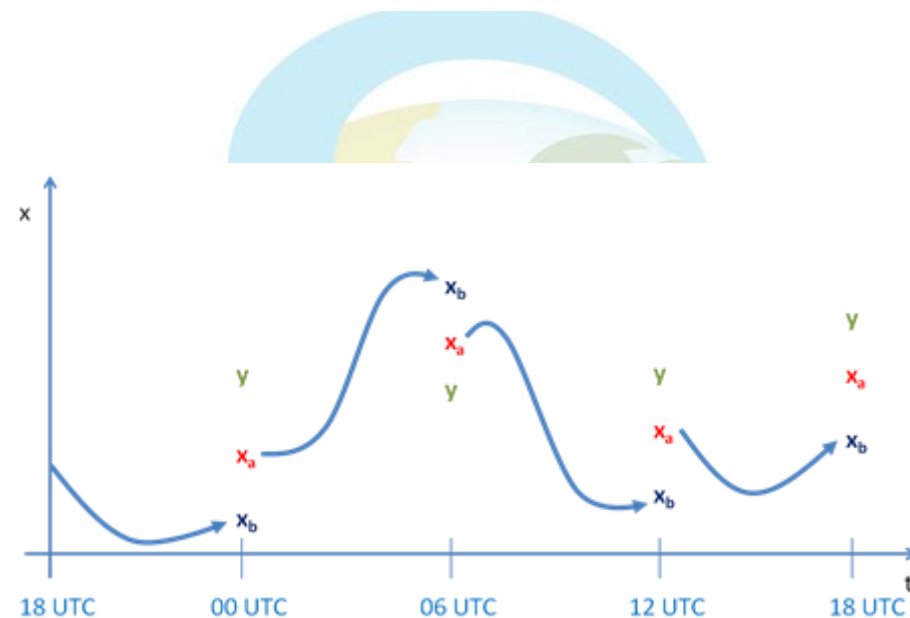




EKF asszimiláció



- Cél: kezdeti értékek minél pontosabb előállítása => Adatasszimiláció
- Modell számára rácsponti kezdeti mező előállítása a cél, az adatasszimiláció során figyelembe vesszük a méréseket (LAI, SSM) + háttér (korábbi előrejelzés) + légkör dinamikájának ismerete
- Analizált mezők (LAI, WG1, WG2) megadása a kezdeti időpillanatban, úgy, hogy az minél közelebb legyen a valósághoz



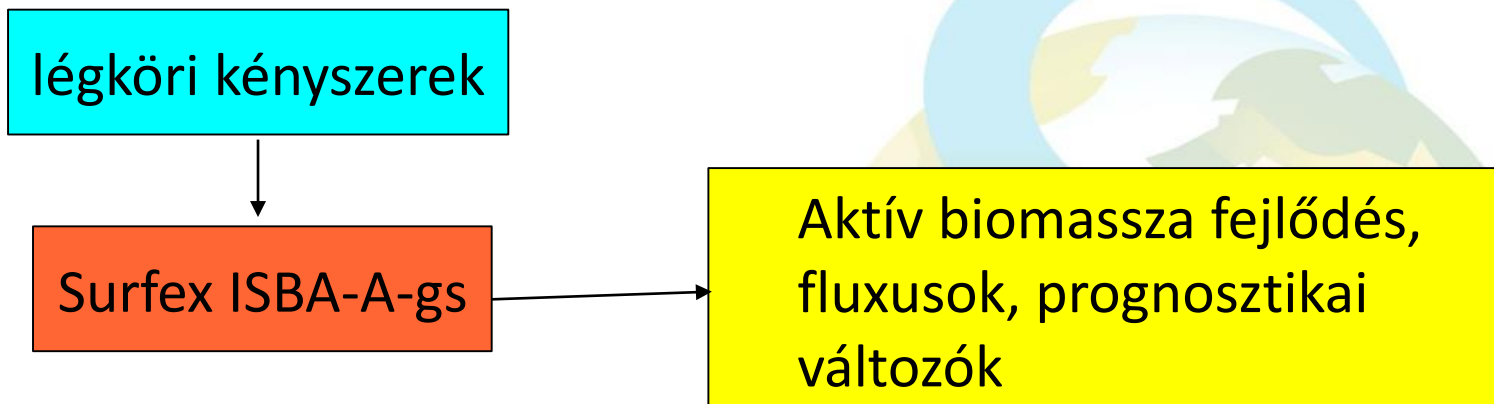
Asszimilációs technika: **Extended Kalman Filter (EKF)**



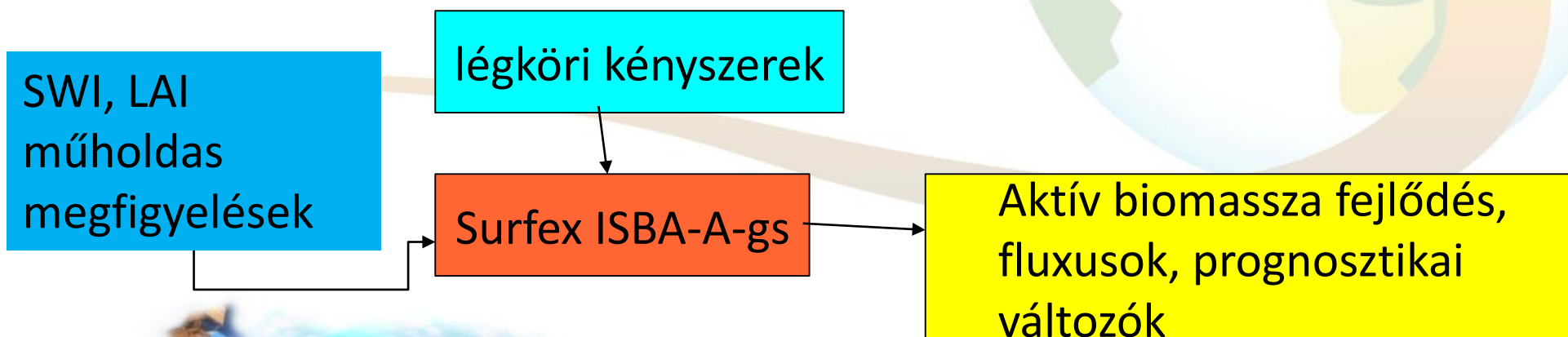
Modell futtatások



- **Surfex futtatás: 2008-2015 között (Openloop)**



- **Adatasszimilációs Surfex futtatás: 2008-2015 között**





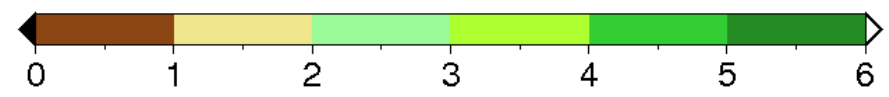
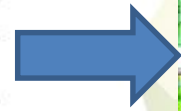
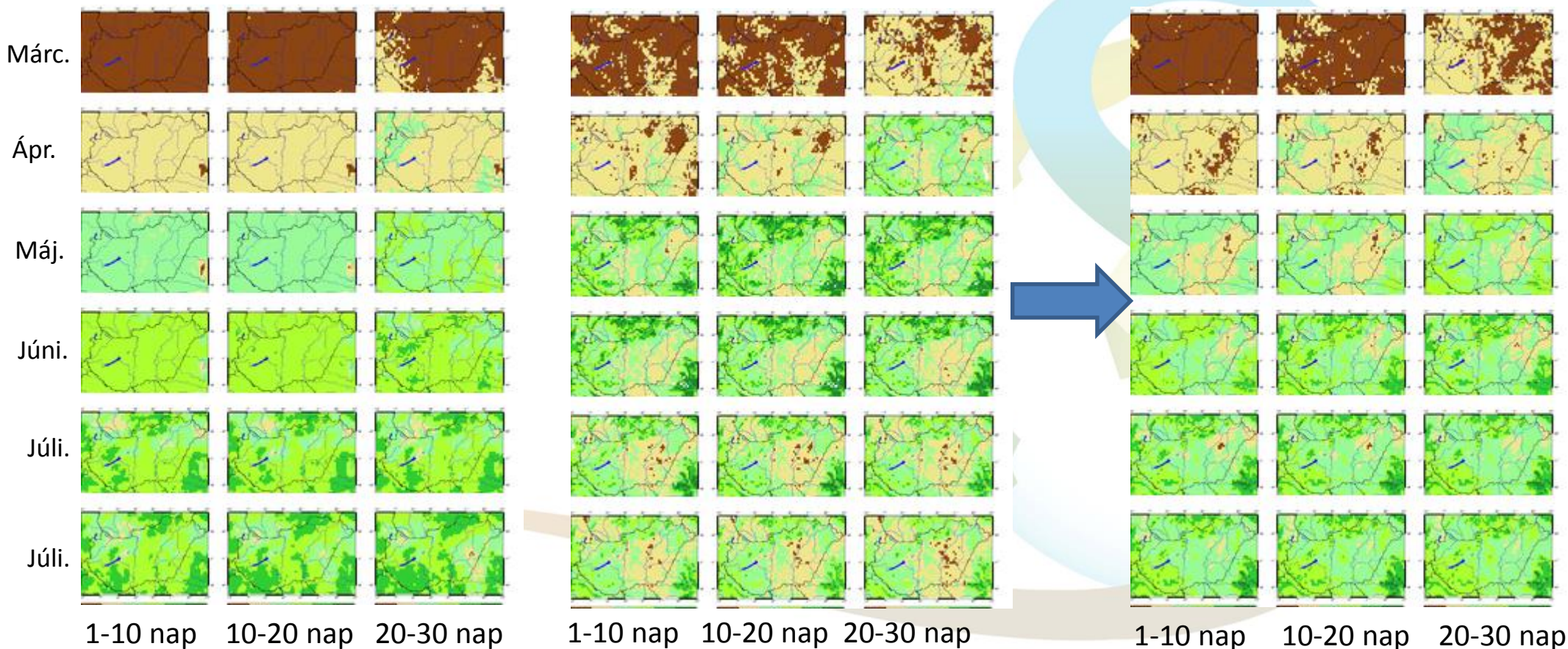
Asszimiláció hatása (2014, LAI m²/m²)



OP

SAT

ASS





Asszimiláció hatása (2014, SSM (m³/m³))



OP

SAT

ASS

Márc.

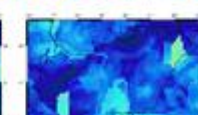
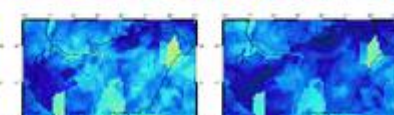
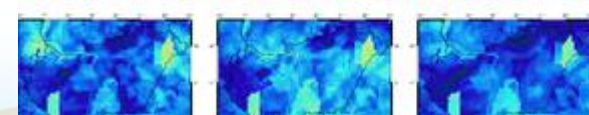
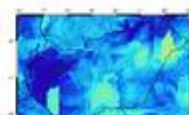
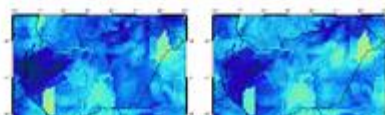
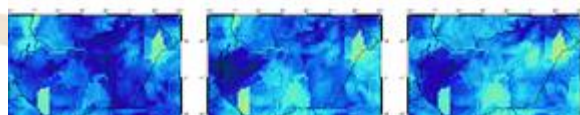
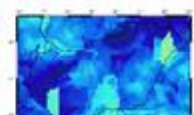
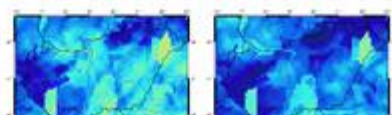
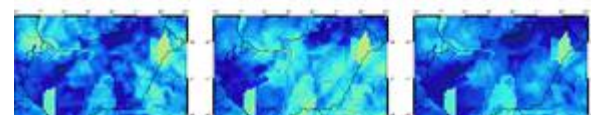
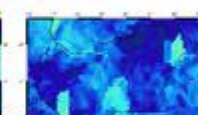
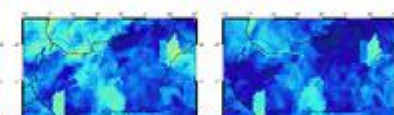
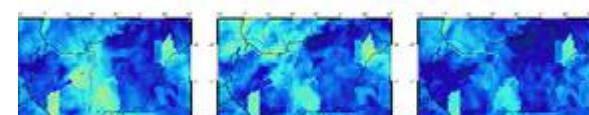
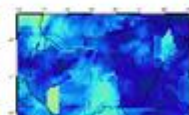
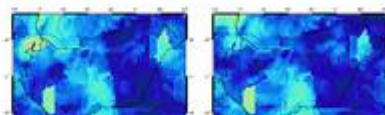
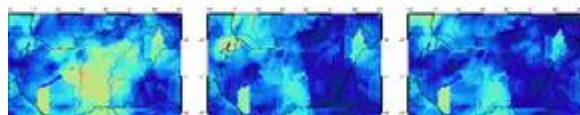
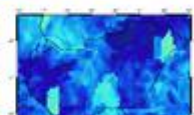
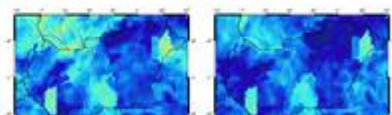
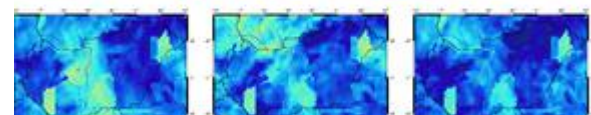
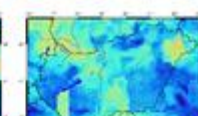
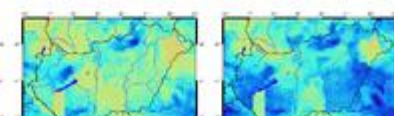
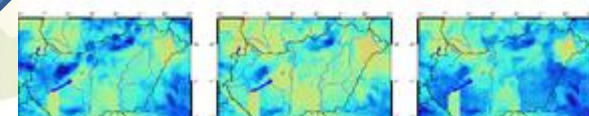
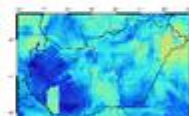
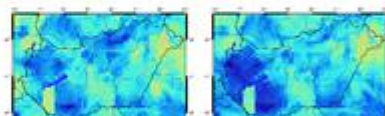
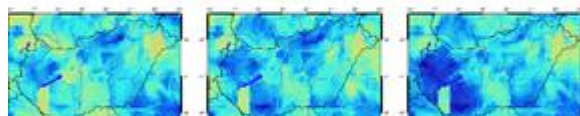
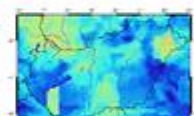
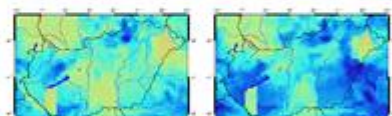
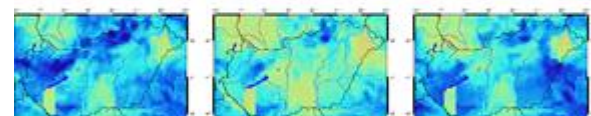
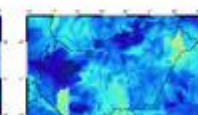
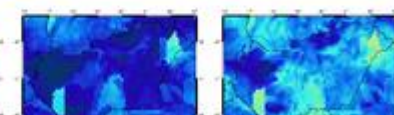
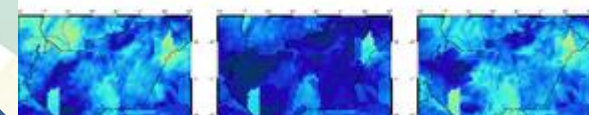
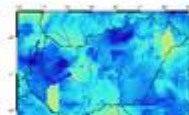
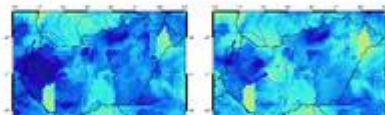
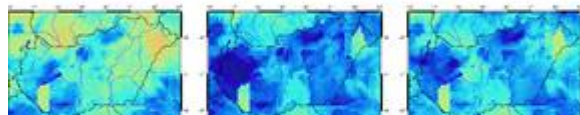
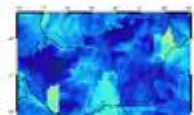
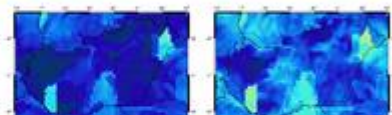
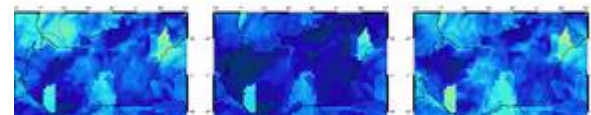
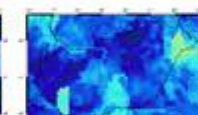
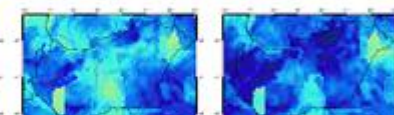
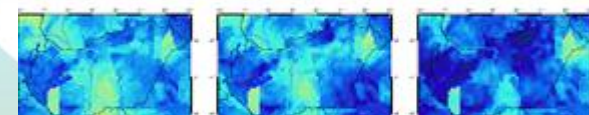
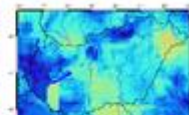
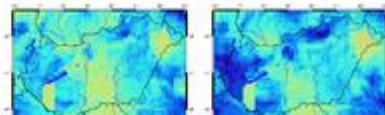
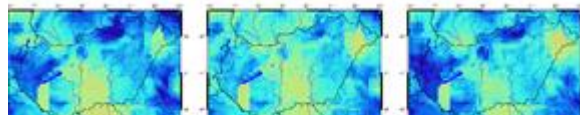
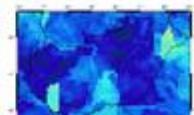
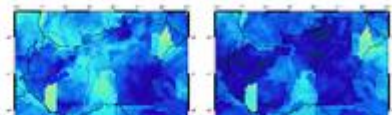
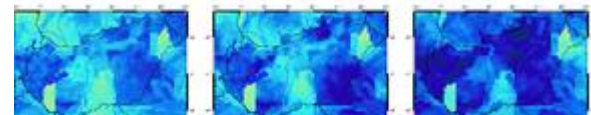
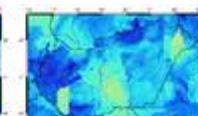
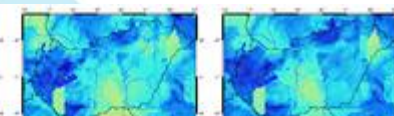
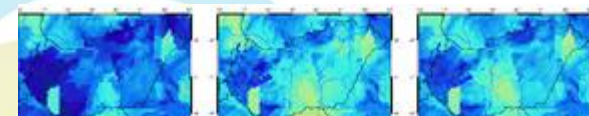
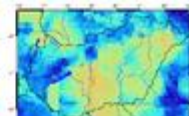
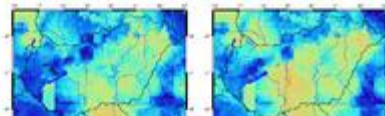
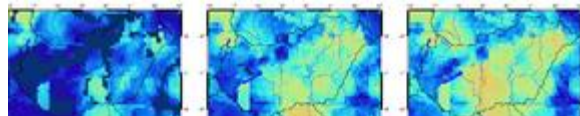
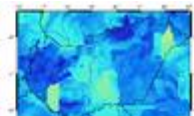
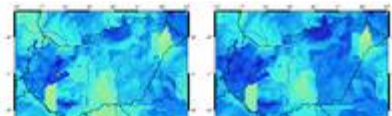
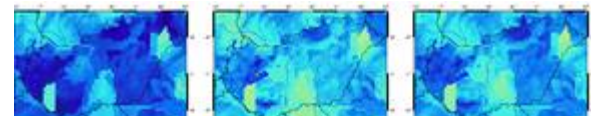
Ápr.

Máj.

Júni.

Júli.

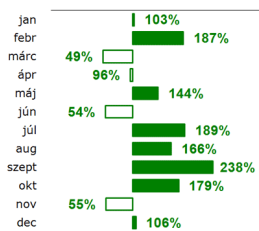
Júli.



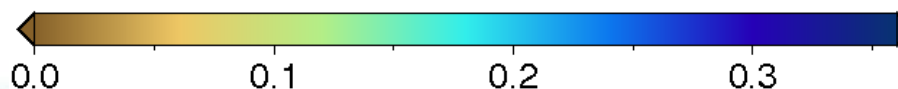
1-10 nap 10-20 nap 20-30 nap

1-10 nap 10-20 nap 20-30 nap

1-10 nap 10-20 nap 20-30 nap

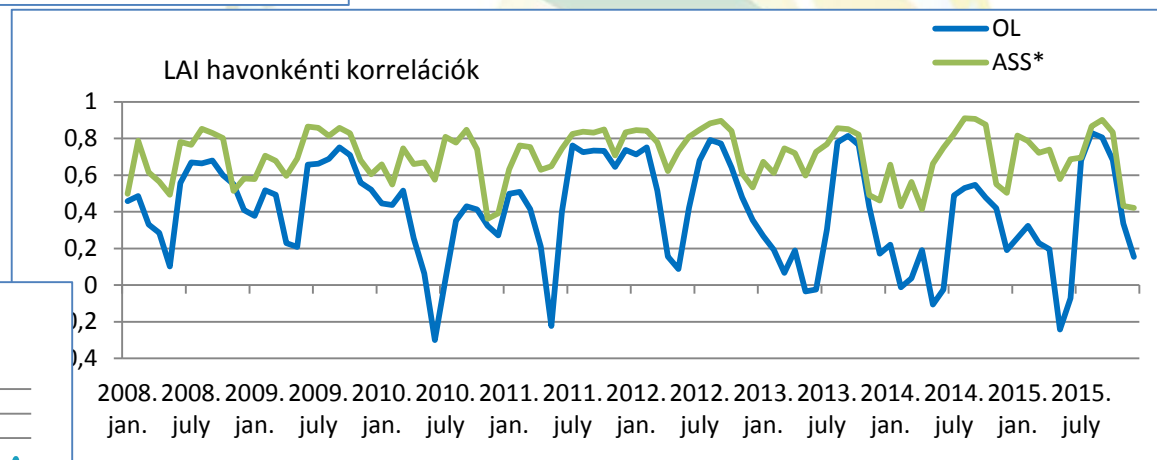
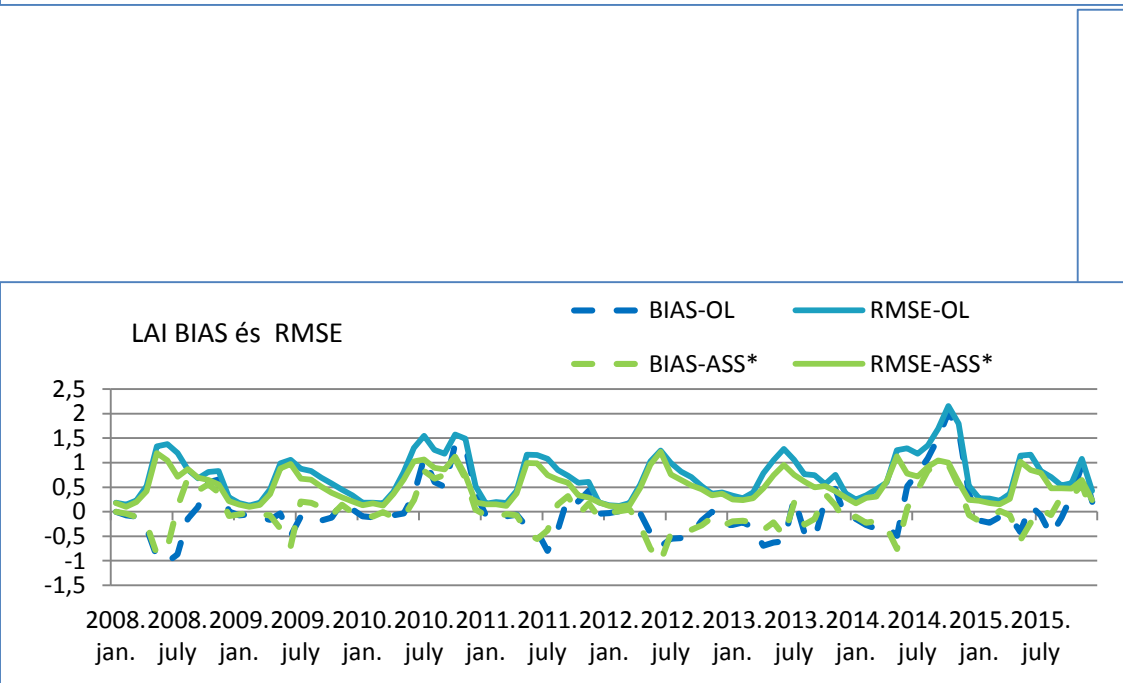
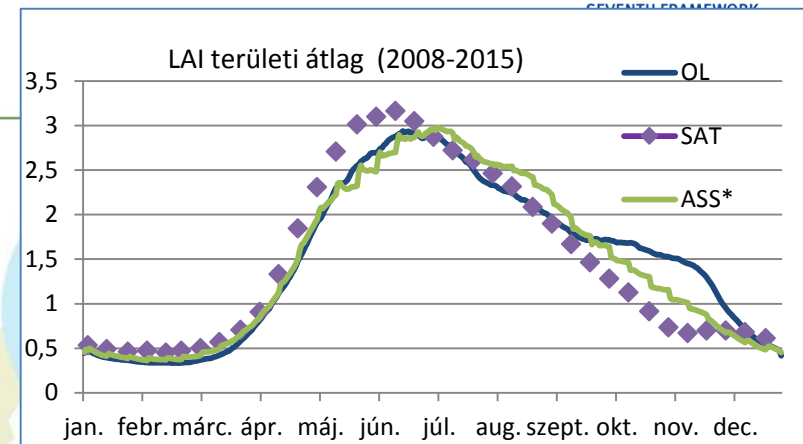
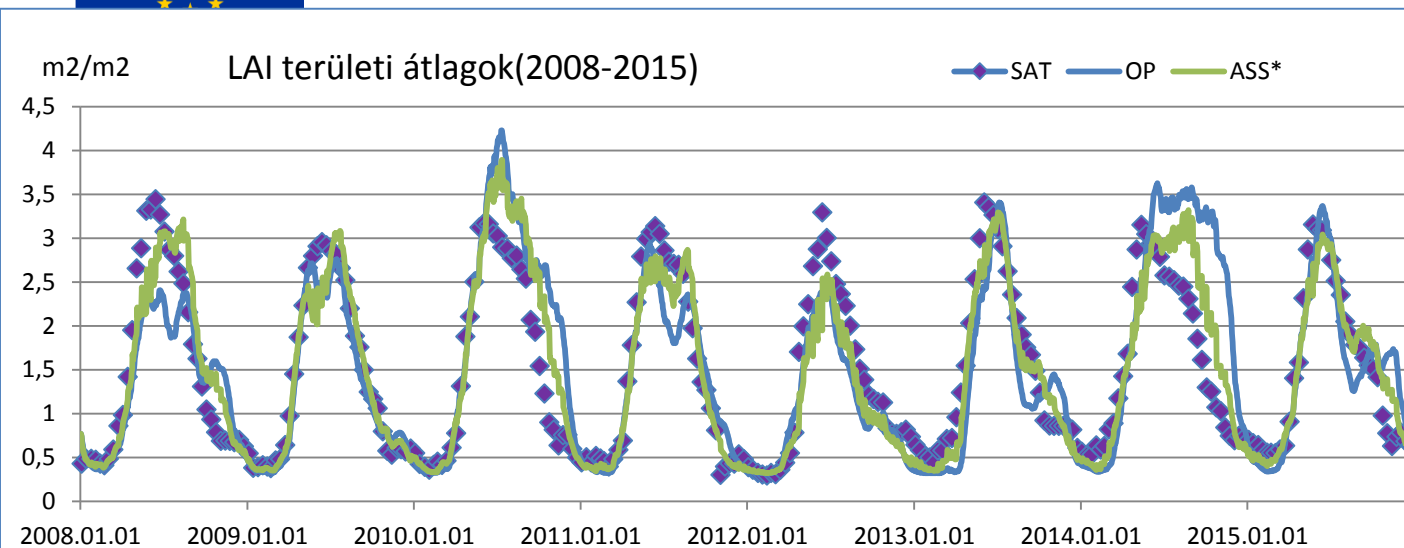


2014. év 130%



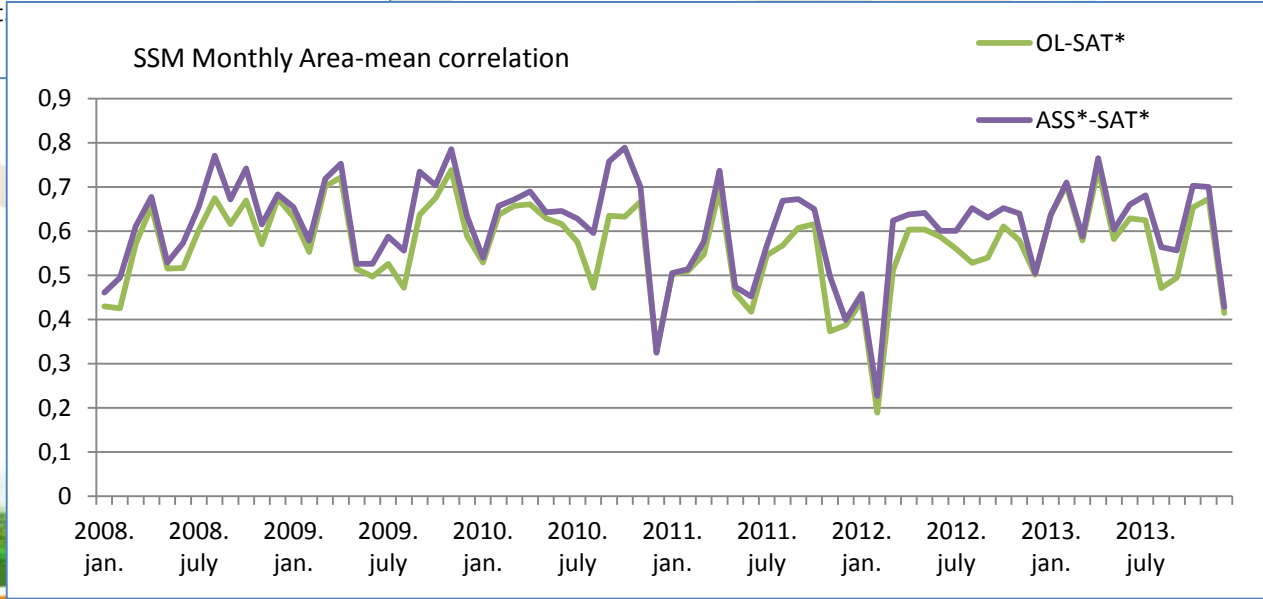
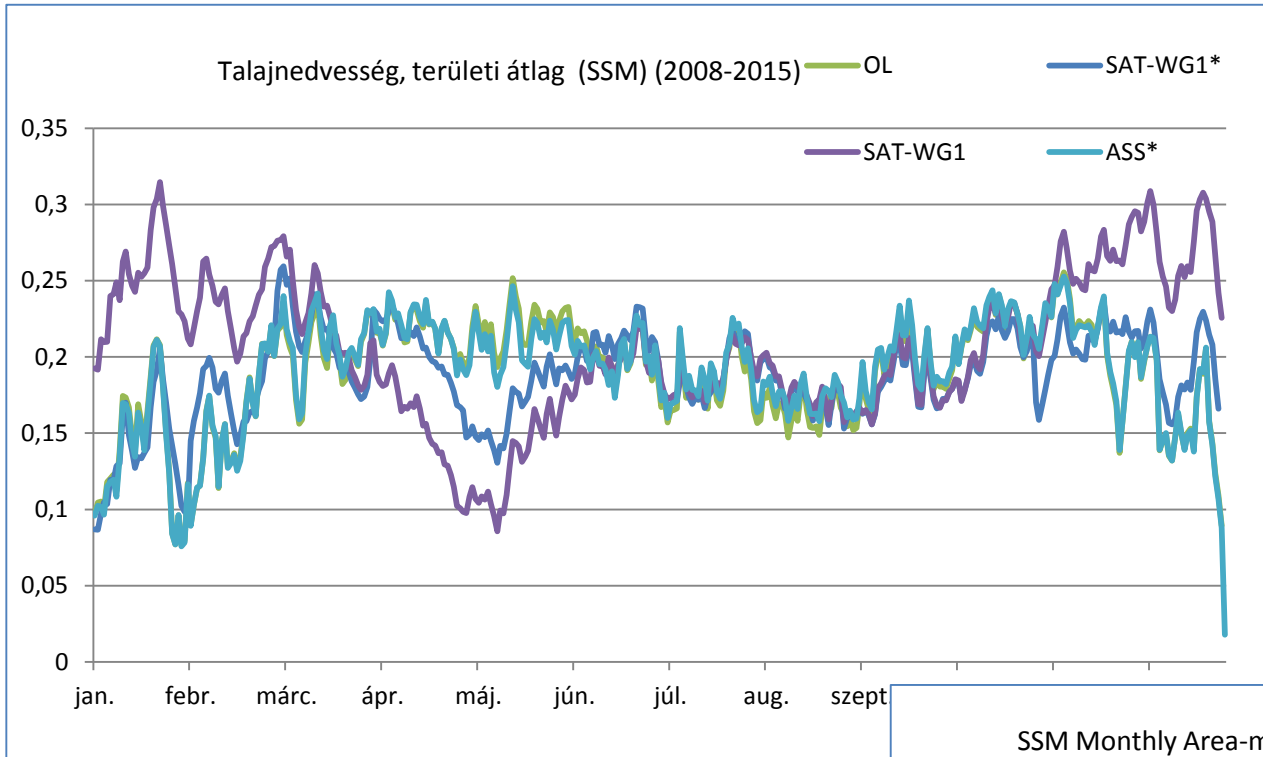


Statisztikák (LAI)





Statisztikák (Felszíni Talajnedvesség – Surface Soil Moisture)





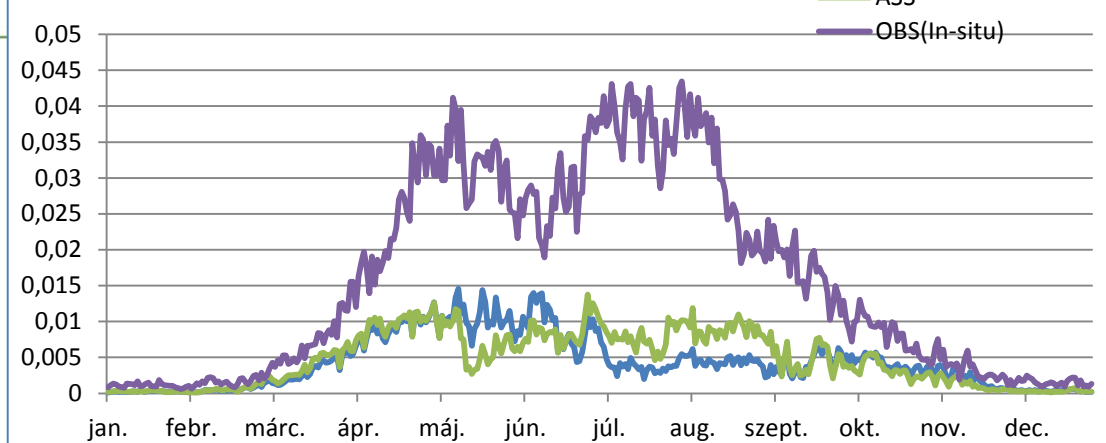
Eredmények (1D)



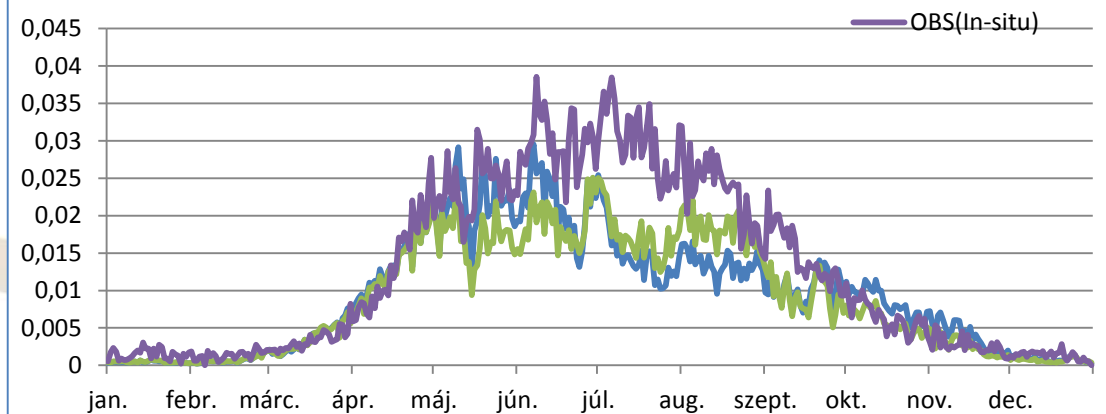
Hegyhátsági mérések: az adatok 2 magasságból származnak:

- LAI (heti), fűfelszín fölött (tenyészedőszakban)
- Talajnedvesség (napi) (10-30 cm mélységből)
- 3 m-ről füves terület fölött (a modellből csak a fűfelszínre vonatkozó eredményekkel hasonlítjuk össze):
 - Szén-fluxusok: GPP, Reco and NEE (napi)
 - Víz-fluxus: Latens hő (LE) (napi)
- 82 m-es magasságból (teljes rácspontra vonatkoztatjuk):
 - Szén-fluxusok: GPP and NEE (napi)
 - Víz-fluxus: LE (napi)

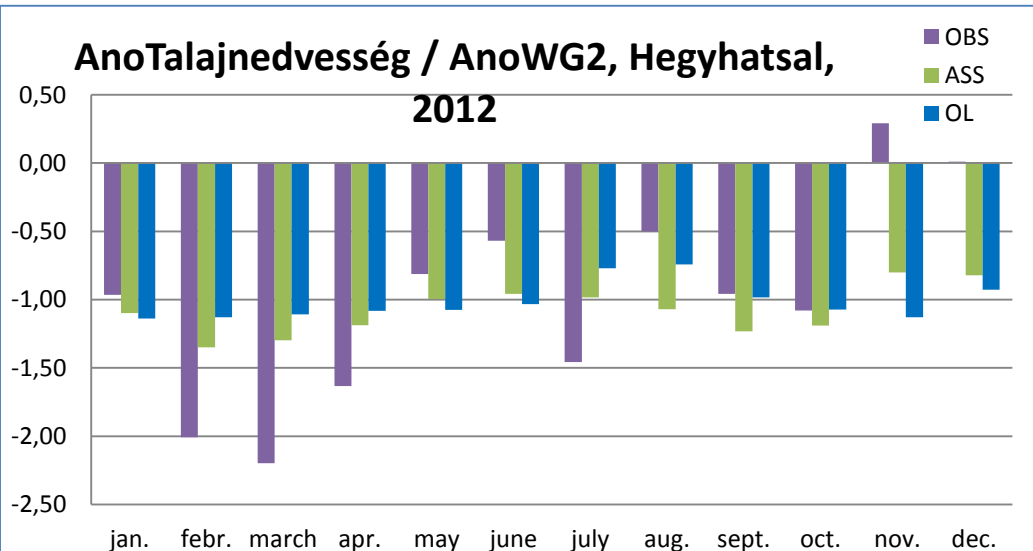
Átlagos GPP 3m Hegyhatsal (2008-2015)



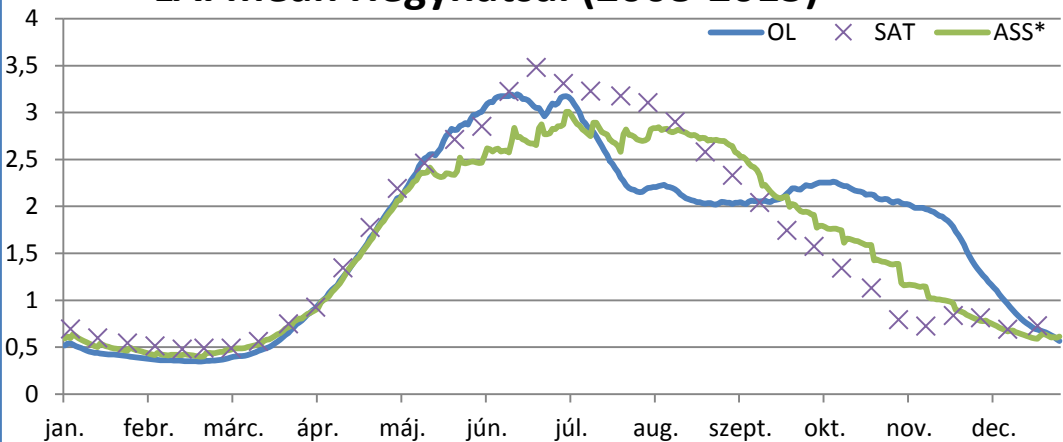
Átlagos GPP 82m Hegyhatsal (2008-2015)



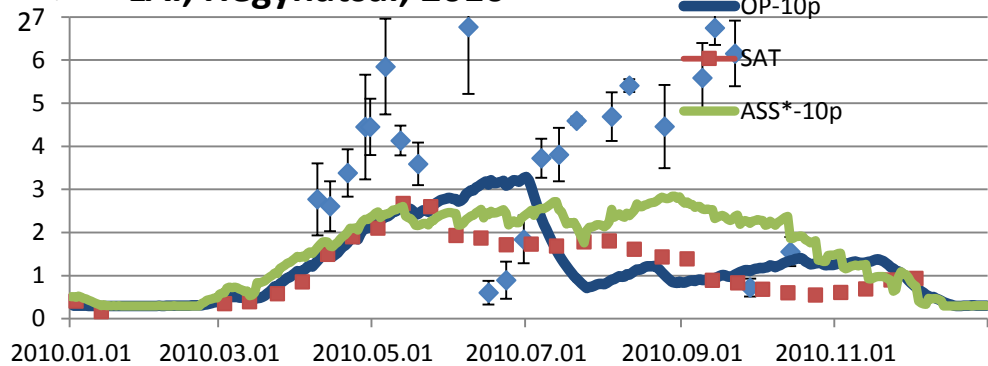
AnoTalajnedvesség / AnoWG2, Hegyhatsal, 2012



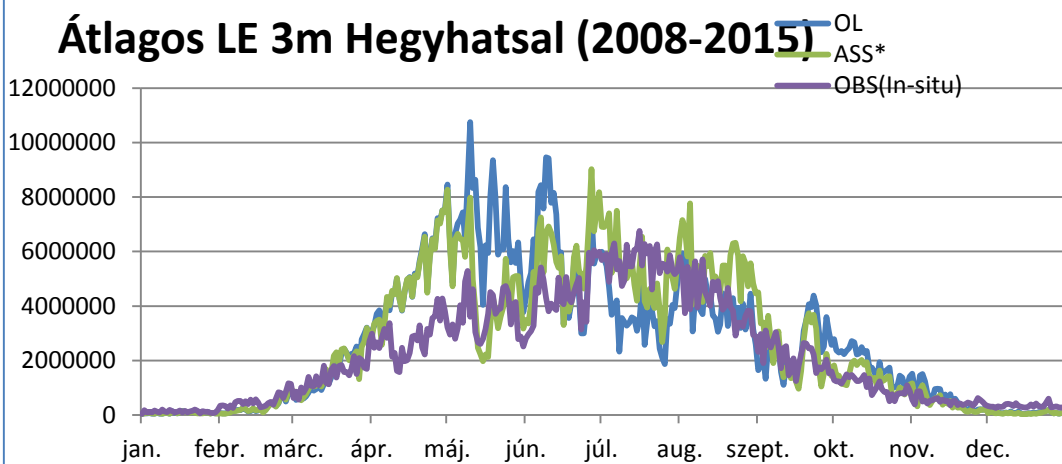
LAI mean Hegyhatsal (2008-2015)



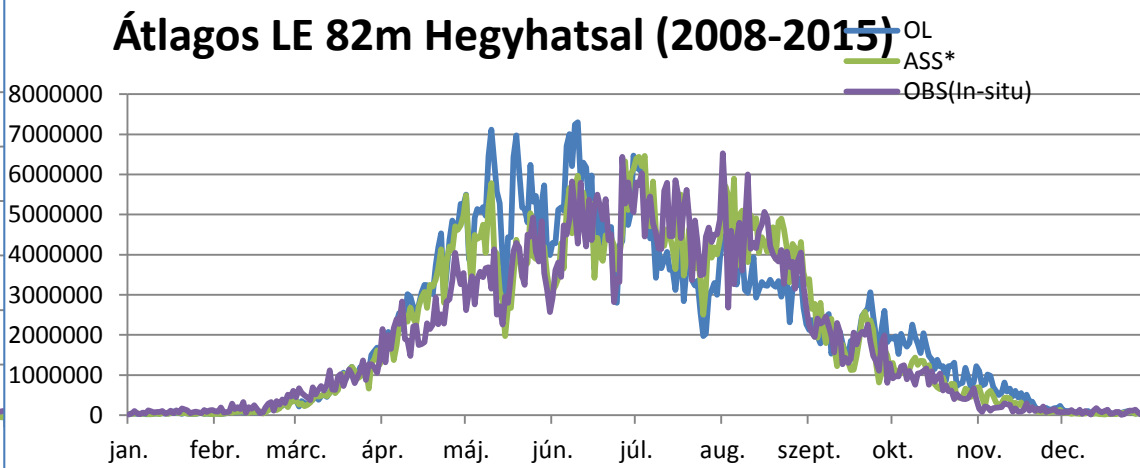
LAI, Hegyhatsal, 2010



Átlagos LE 3m Hegyhatsal (2008-2015)

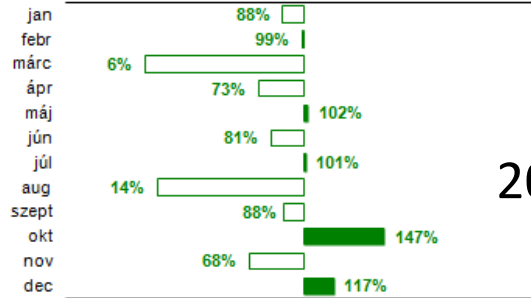


Átlagos LE 82m Hegyhatsal (2008-2015)





2012 aszály monitorozása, anomália térképek (AnoLAI)



2012. csap.

$$AnoX = \frac{X - \langle X \rangle}{stddev(X)}$$

Máj.

Júni.

Júli.

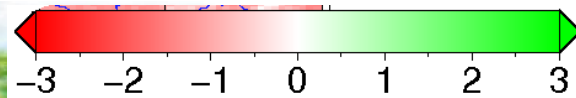
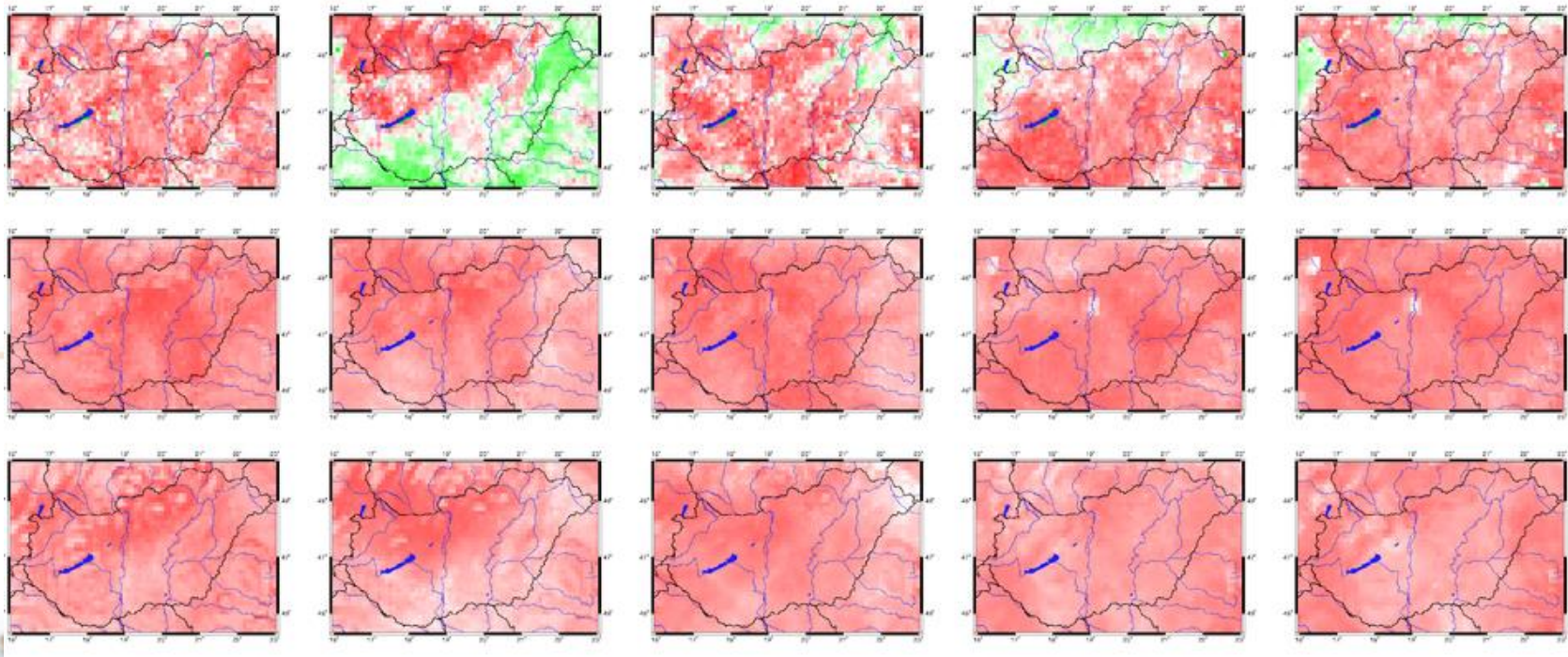
Aug.

Szept.

SAT

ASS

OP





Gyökér-zóna talajnedvesség évszakos változékonysága 2012-ben (AnoWG2 (modellekből) és AnoSWI10 (műhold))



Máj.

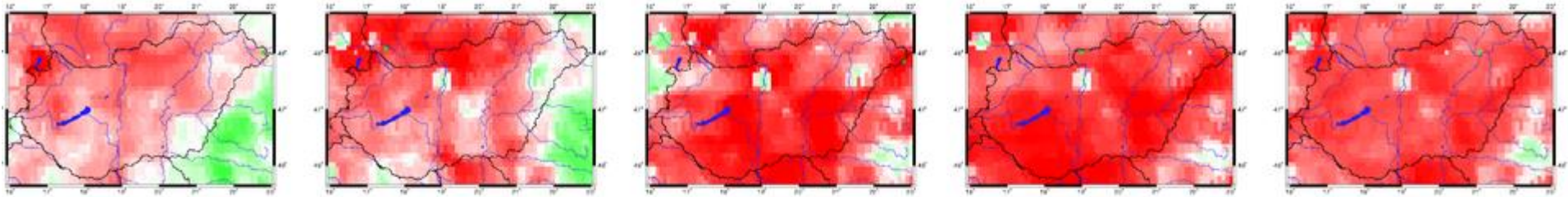
Júni.

Júli.

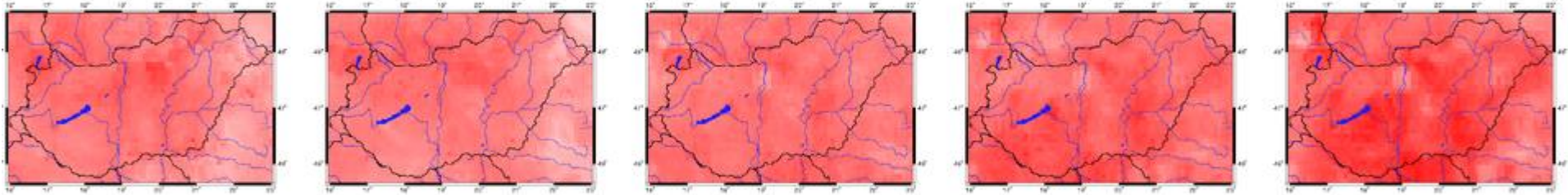
Aug.

Szept.

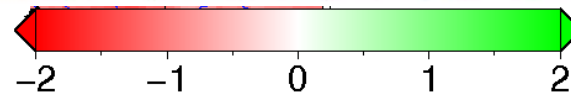
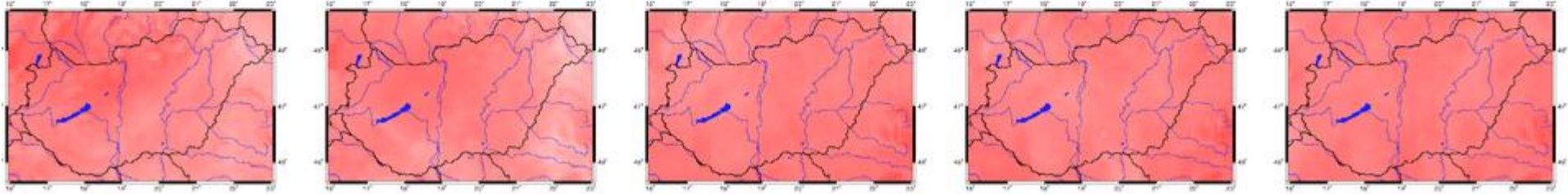
SAT



ASS



OP



LAI és Talajnedvesség évszakos változékonysága 2014-ben (extrém csapadékos nyár)



Máj.

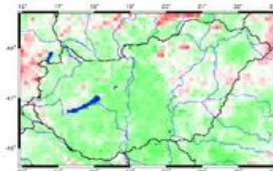
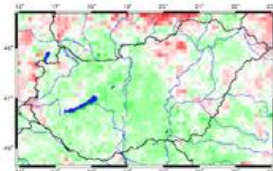
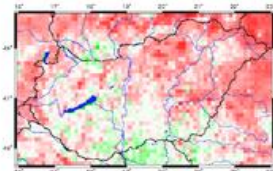
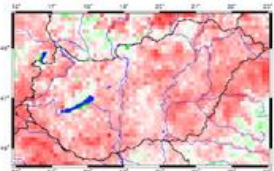
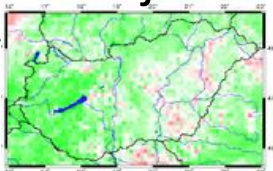
Júni.

Júli.

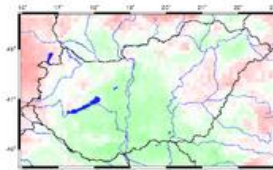
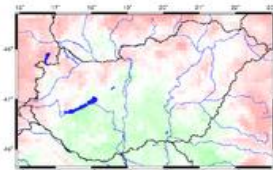
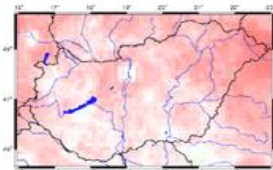
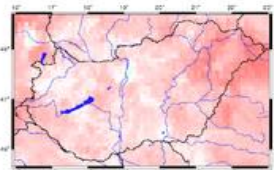
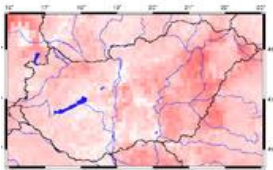
Aug.

Szept.

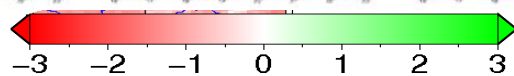
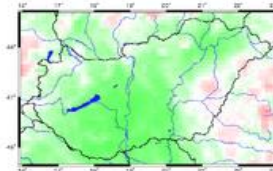
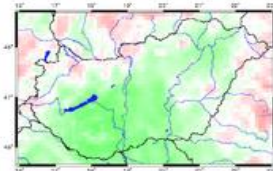
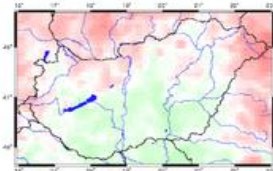
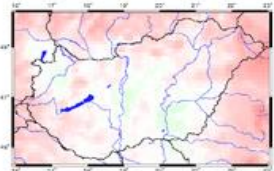
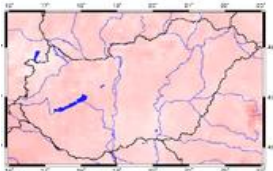
SAT



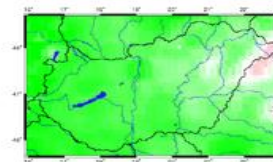
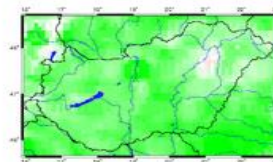
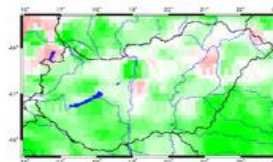
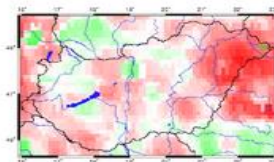
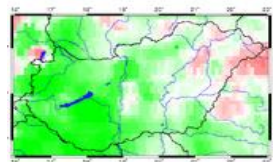
ASS



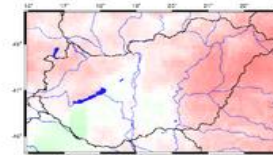
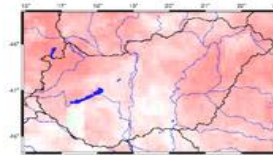
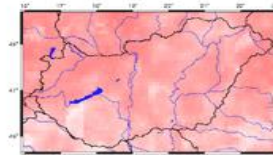
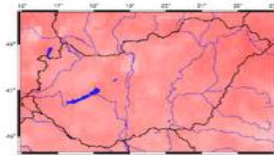
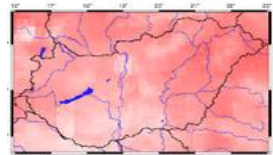
OP



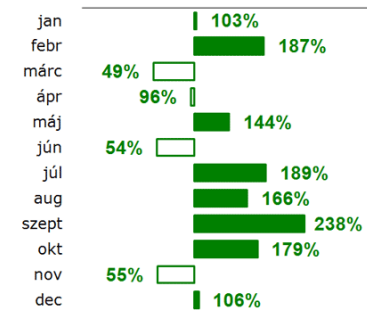
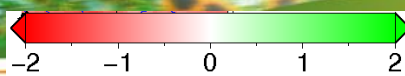
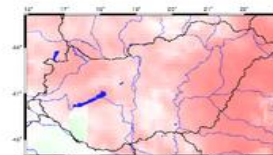
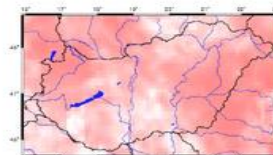
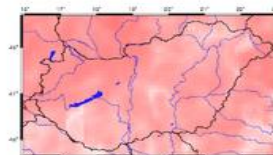
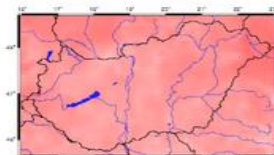
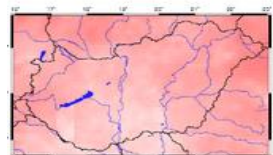
SAT



ASS



OP

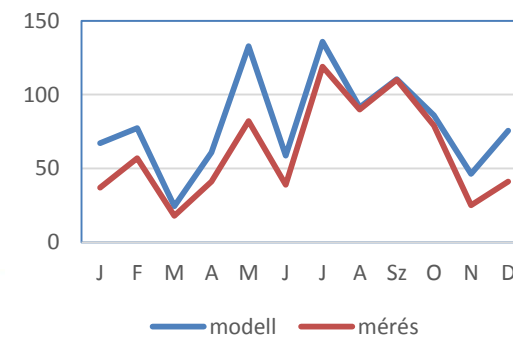


2014. év 130%

AnoLAI

AnoSWI10 /
AnoWG2

2014. csapadék



magnes projekt



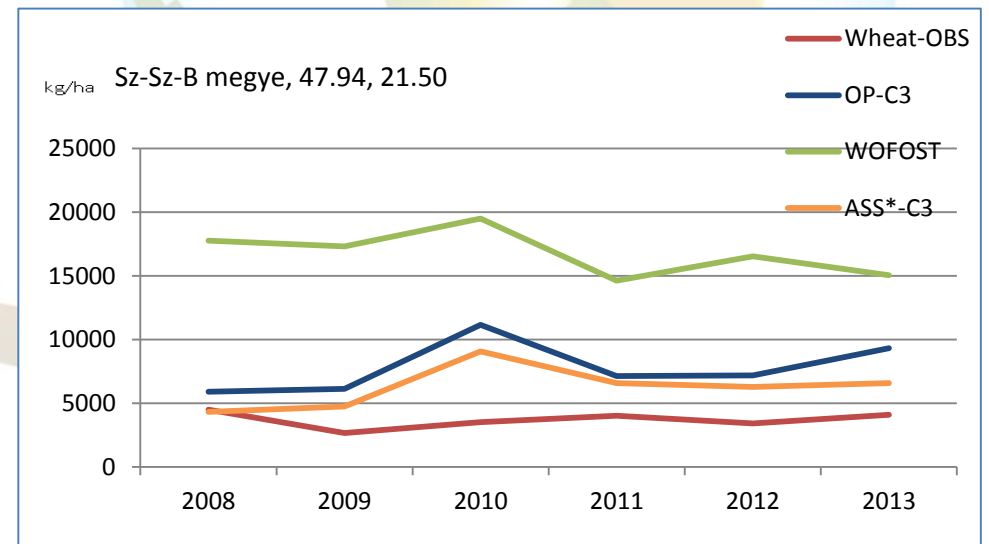
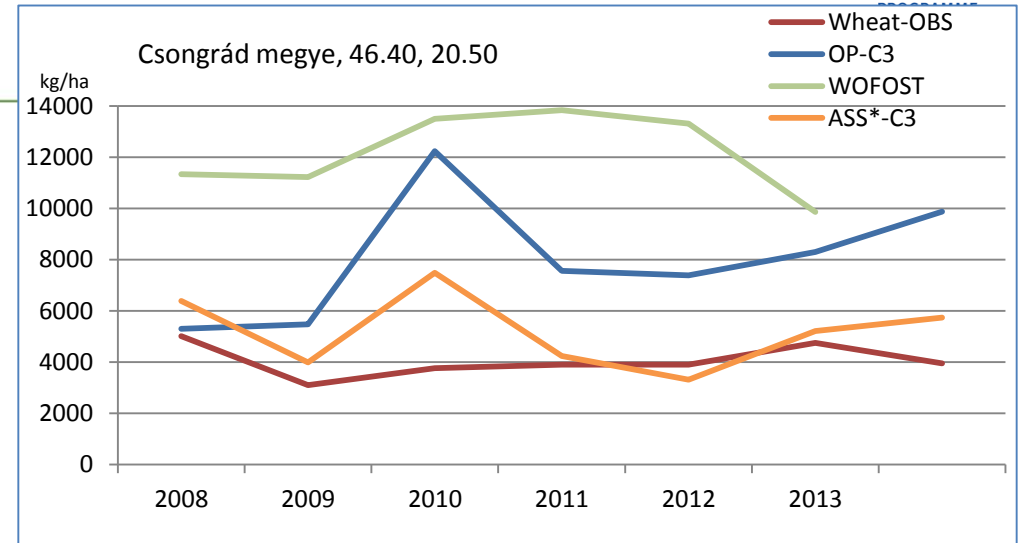
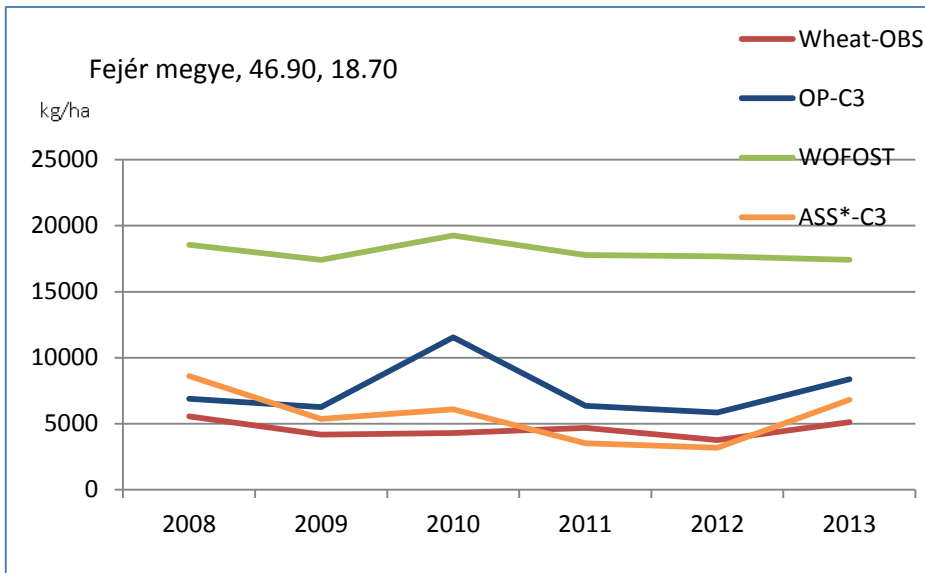
Hegyhátsál	Átlagos WG2 ill SWI10 aug.	AnoWG2/ AnoSWI10 2014 aug.	WG2 / SWI10 (2014. aug.)
ASS	0.34	-0.50	<p>ASS* WG2</p>
SWI-10 műhold	0.43	1.03	<p>SWI10</p>



Termésbecslés



Modellezett C3 BIOMASS ZA vs. Mért hozam és vs. WOFOST eredményekkel 2008-2013-as időszakra



Nagyon jó egyezés az LDAS BIOMASSZA és a mért hozam között, kivéve 2010-re (extrém nedves év)

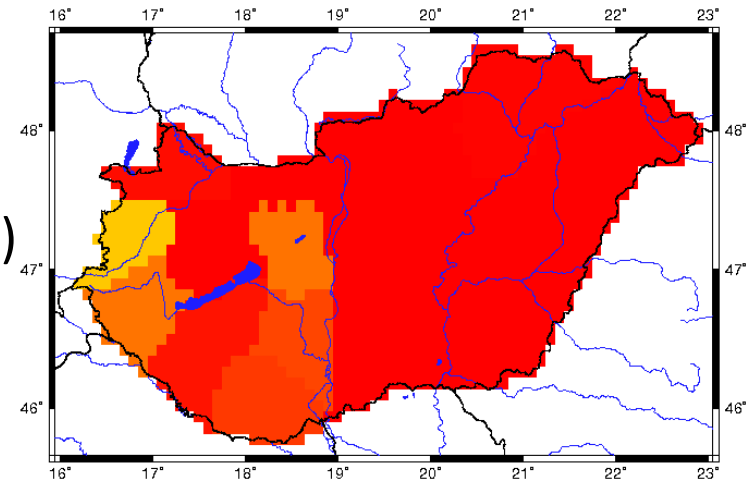
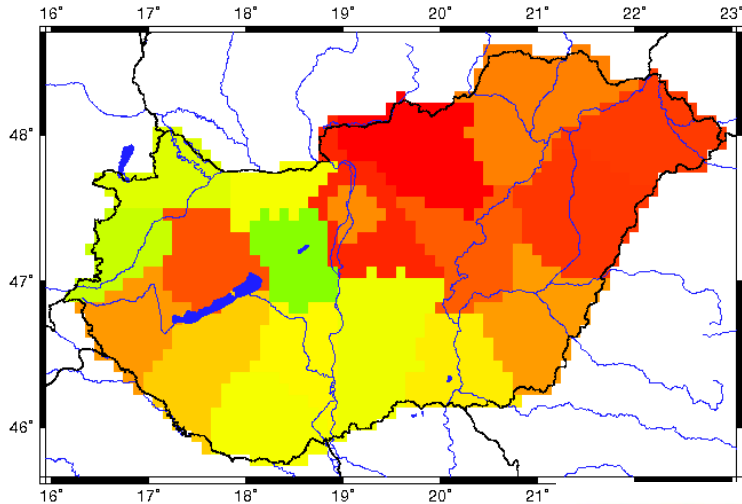


Természetlag relatív anomália térképek ((sim-obs)/obs)

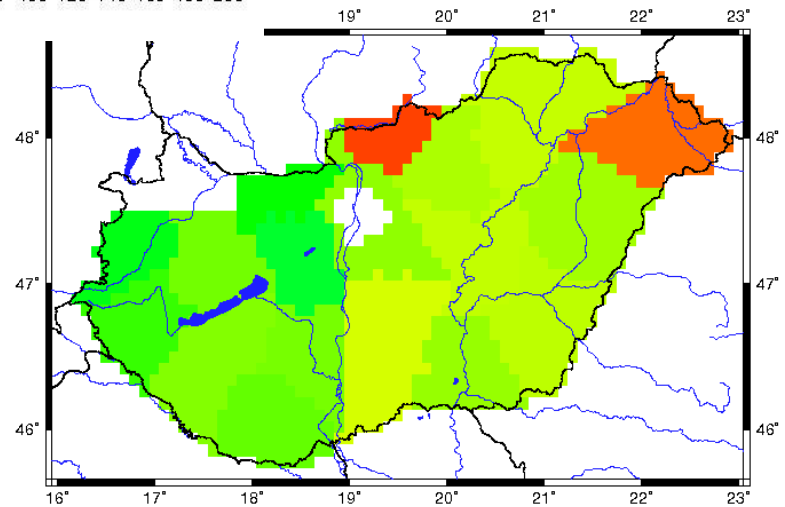
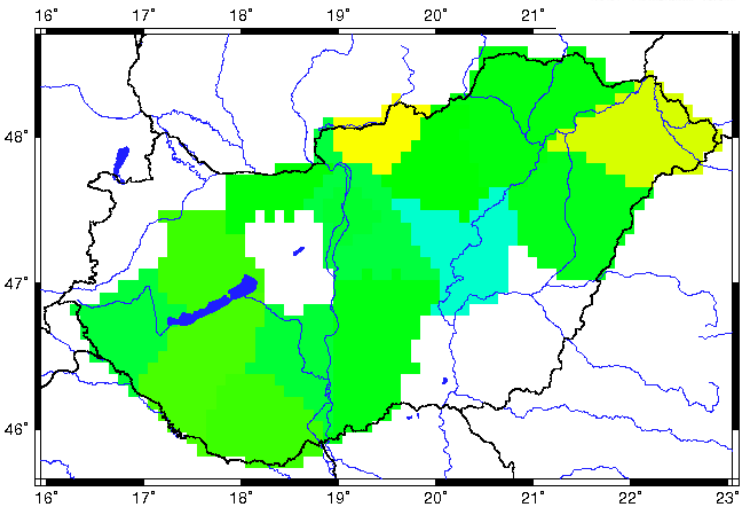
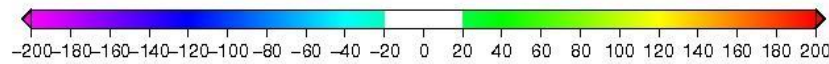


ASS

OP



2010 (csapadékos)



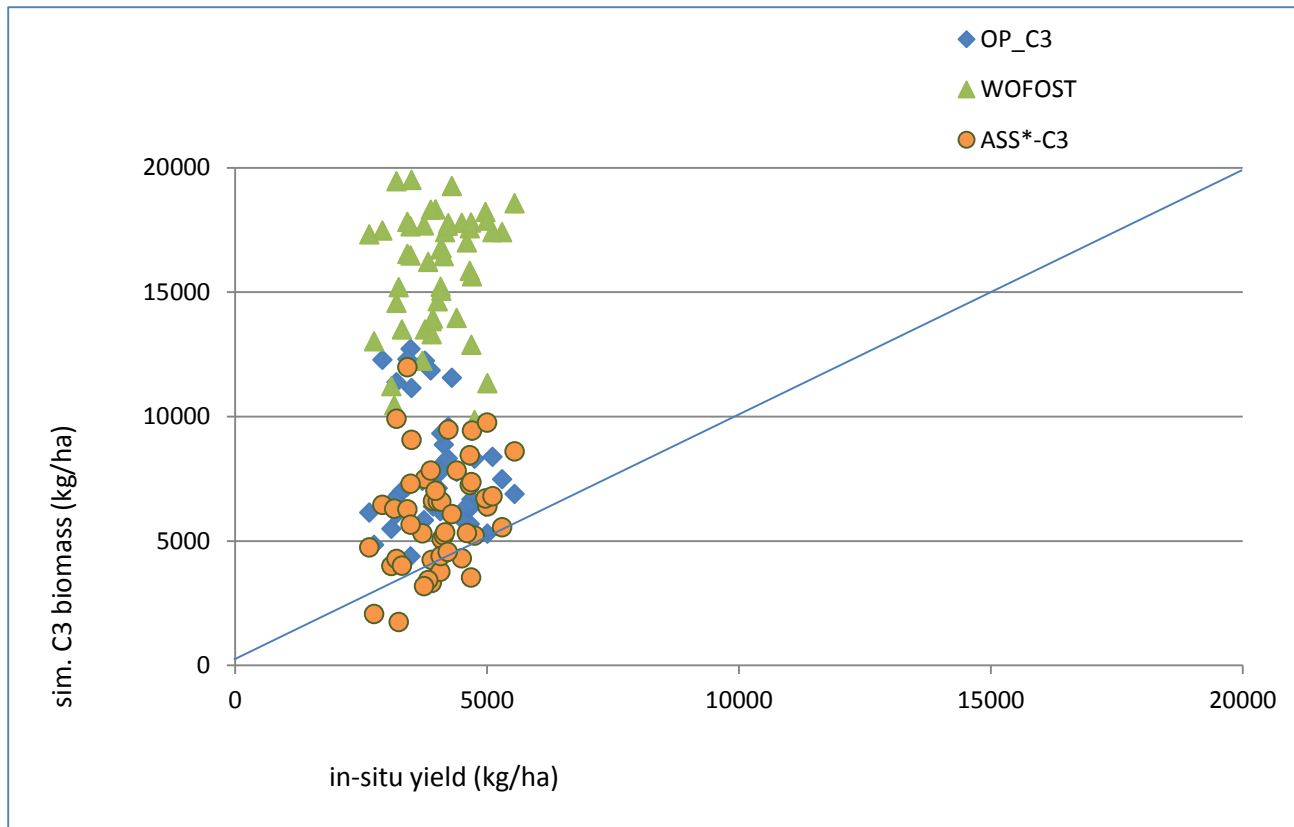
2012 (aszály)



Felülbecslés! ASS pontosabb



Scatter-plott a 2008-2013-as időszakra

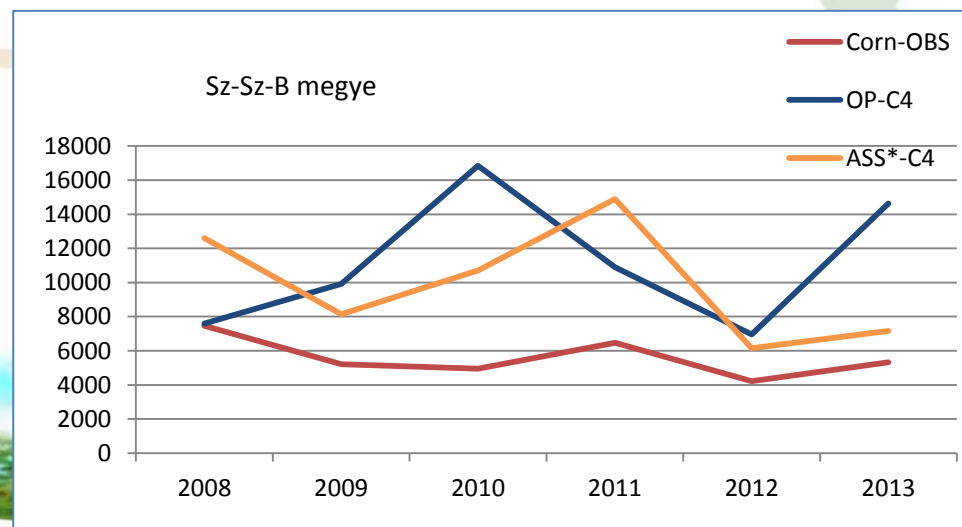
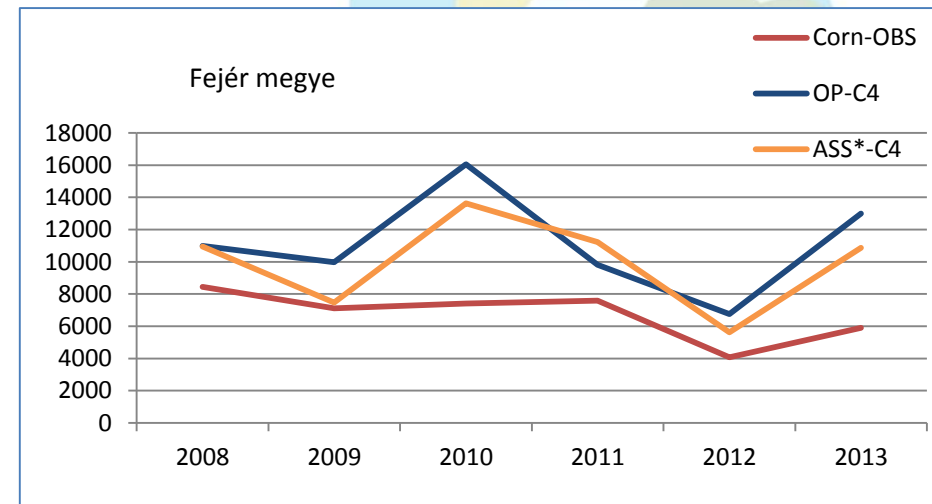
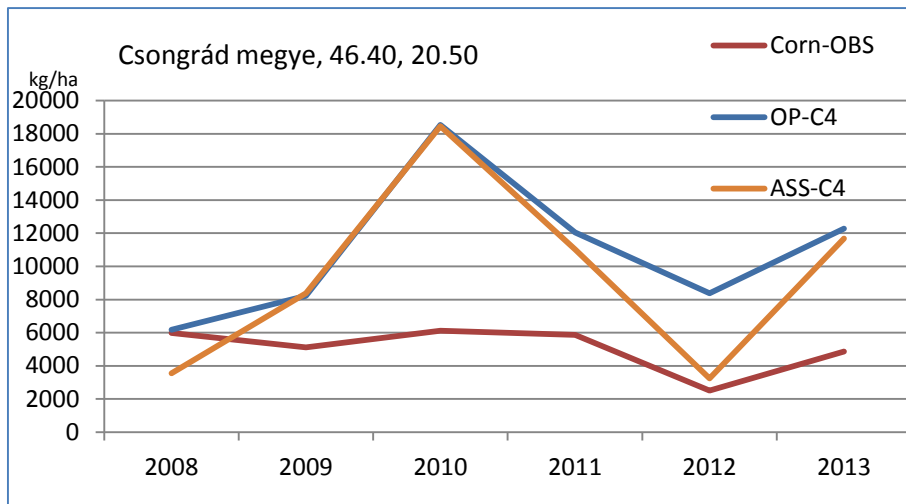


Korrelációk:

- **OP: -0.13 (2010-es adat nélkül: 0.28)**
- **ASS*: 0.25 (2010 nélkül: 0.56)**
- **WO: 0.15 (2010 nélkül: 0.32)**

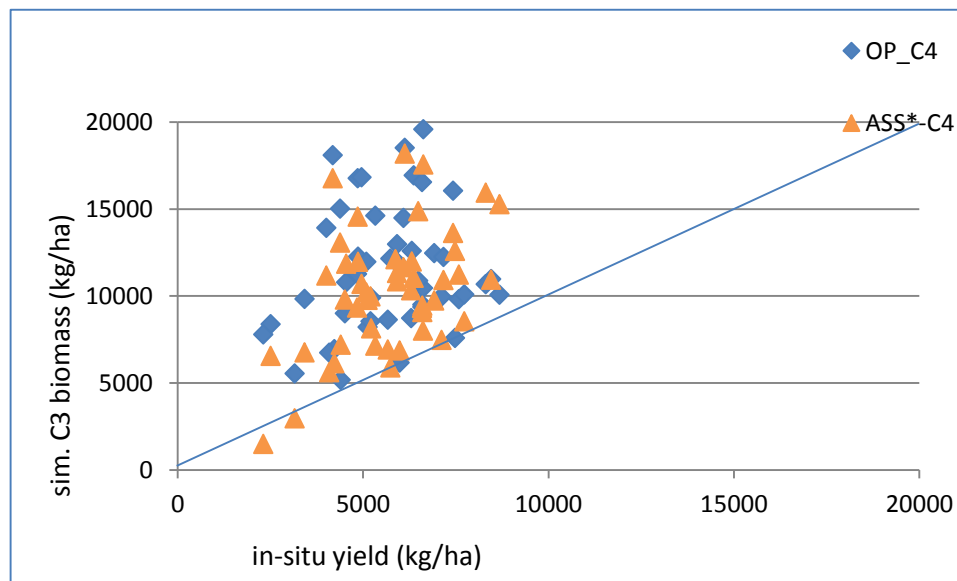


- **Hasonló vizsgálatok kukoricára**
– **Durvább felülbecslés!**





- **Scatter-plott a 2008-2013-as időszakra**



Korrelációk:

- **OP: 0.17**
- **ASS: 0.32**



<http://fp7-imagines.eu>



The screenshot shows a web browser window displaying the homepage of the fp7-imagines.eu project. The browser's address bar shows the URL 'fp7-imagines.eu'. The website features a navigation menu with links for Home, Objectives, Services and Products, Documents, News and Events, Links, Contact, and Registration. The main content area is divided into two columns. The left column, titled 'HOME', contains a paragraph about the adaptation of decametric reflectances for Sentinel-2 data and a table of demonstration sites. The right column, titled 'LATEST NEWS', lists recent updates with dates and brief descriptions, each followed by a 'read more' link. At the bottom of the browser window, a terminal window is visible with the command 'tothh@pc2429:~ - Shell - Konsole <5>'.

Site	Coordinate	Period	Number of Images
25deMayo, Argentina	37° 54' S 67° 44' W	Nov 2013 - Nov 2014	17
La Albufera, Spain	39° 16' N 0° 19' W	Nov 2013 - Oct 2014	22
Barrax, Spain	39° 02' N 2° 04' W	Oct 2013 - Oct 2014	24
Ottawa, Canada	45° 18' N 75° 45' W	April 2013 - Nov 2014	24
Pshenichne, Ukraine	50° 04' N 30° 06' E	April 2013 - Nov 2014	39
Rosasco, Italy	45° 15' N 8° 33' E	Nov 2013 - Nov 2014	13
SouthWest, France	43° 29' N 1° 16' E	April 2013 - Nov 2014	46
Tana, Kenya	0° 55' N 36° 47' E	July 2013 - Dec 2014	92

FAPAR over Pshenichne, October 2014

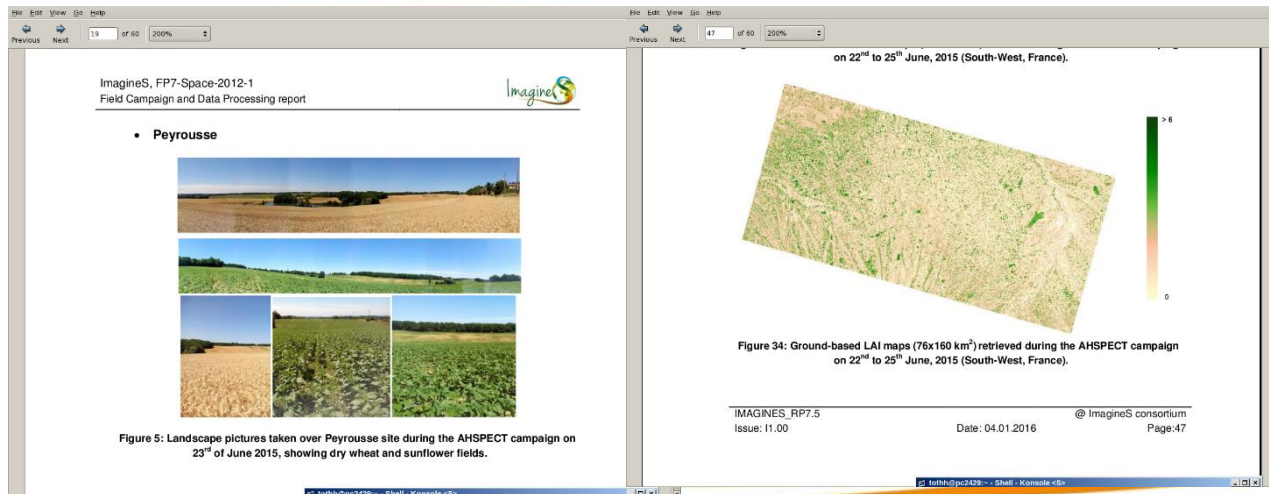


Milyen adatok tölthetők le a honlapról?



1. Talaj-felszín (kampány) mérések:

- 15 helyről szerte a világból
- Pl. AHSPECT kampány, 2015. júni. 22-25 DNY Franciaország (Toulouse-tól NY-ra az Atlanti-óceán irányába) 75x160 km-es terület. Mért elemek:
 - LAI
 - FCOVER (zöld növényzet aránya)
 - FAPAR (elnyelt fotoszintetikusan aktív sugárzás aránya)



2. Landsat-8 biofizikai produktumok:

- 30 m-es felbontásban LAI, FAPAR és FCOVER idősorok 8 demonstrációs területen 2013-2014 időszakra vonatkozóan.
- Az eredményeket a demonstrációs területeken mért értékekkel vetették össze



LANDSAT-8 BIOPHYSICAL PRODUCTS

ImagineS provides biophysical variables (LAI, FAPAR and FCOVER) at 30m resolution derived from Landsat-8 time series of surface reflectances over 8 ImagineS demonstration sites (SouthWest in France, Barrax and La Albufera in Spain, Tana in Kenya, Ottawa in Canada, 25deMayo in Argentina, Rosasco in Italy and Pshenichne in Ukraine). The variables are estimated using artificial neural networks trained on PROSAIL model simulations. The retrieval methodology, set-up by [INRA](#), is described in details in the [ATBD](#).

The Landsat-8 products are available after [registration](#). A [Product User Manual](#) describes their technical characteristics, and presents the results of the quality assessment.

Maps of Landsat-8 FCOVER over SouthWest of France site

The high resolution Landsat-8 biophysical products are provided in multi-band GEOTIFF files which contain the variable (LAI, or Black-Sky FAPAR, or White-Sky FAPAR, or FCOVER), its associated uncertainty and a quality flag. The length of the time series depends on the demonstration site but it covers, at least, one growing season during the 2013-2014 period. The products are evaluated against the [in-situ measurements](#) collected over the demonstration sites.

Comparison of Landsat-8 products with ground measurements collected over 25deMayo site (Argentina)

Variable	N	R ²	Bias	RMSE	Equation
Ground LAI	41	0.89	0.13	0.47	$y = 0.85x + 0.241$
Ground black-sky FAPAR	41	0.89	0	0.1	$y = 0.89x + 0.042$
Ground white-sky FAPAR	40	0.91	0	0.1	$y = 0.91x + 0.022$
Ground FCOVER	41	0.92	0.02	0.13	$y = 1.023x + 0.013$

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toth@pc2429:~ - Shell - Konsole <5>

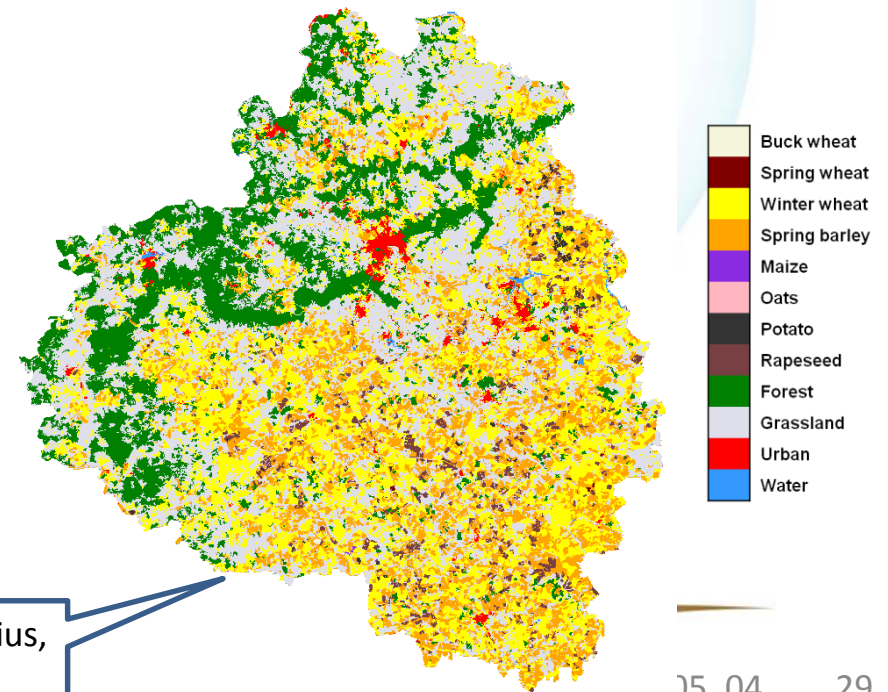
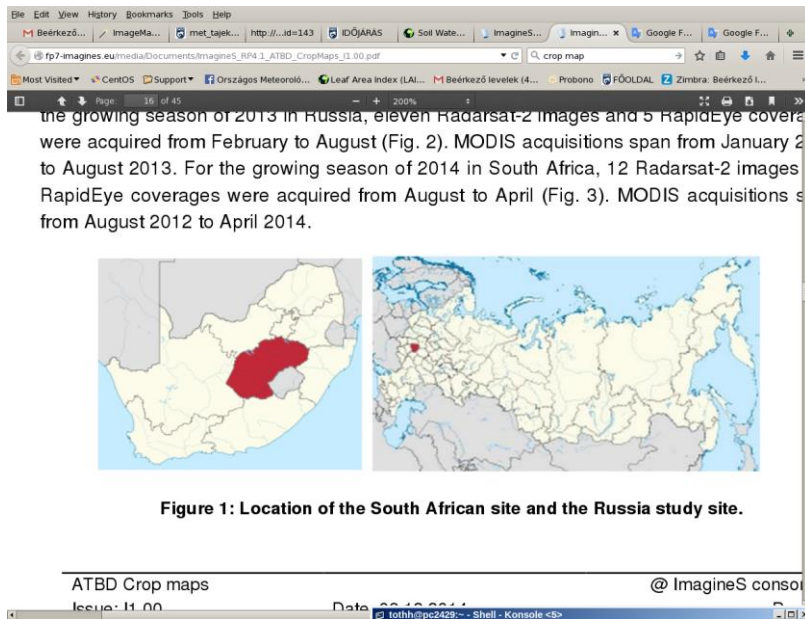
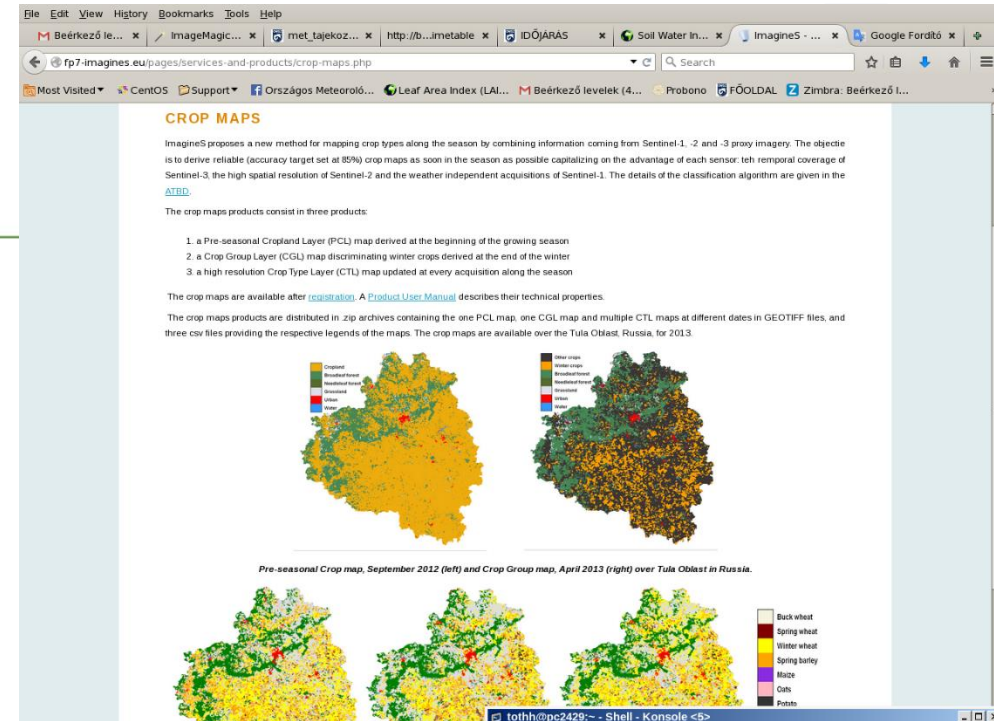
3. Termésbecslésel kapcsolatos térképek, Tula (Oroszország területére, 2013-as időszakra).

Felhasznált műhold adatok:

Sentinel-1 és 2 valamint proxy 3 adatok

Térképek:

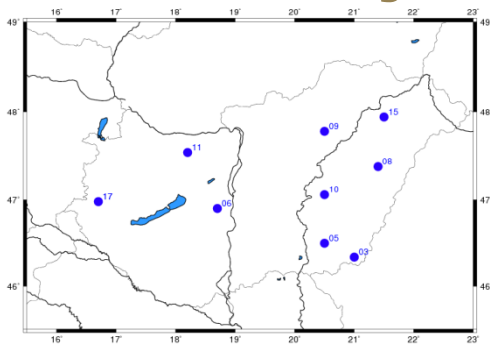
- Tenyésztési időszak elején cropland layer (PCL) térképek (250m-es felb.)
- crop group layer (CGL) térképek a téli időszak végén (250-10 m)
- Nagy felbontású Crop Type Layer (CTL) térképek a tenyésztési időszakban (10 m, 15 napos időbeli felb.)



CTL 2013. június, Tula

4. LDAS adatok

- **Meteo France (Franciaországi területre: 45 gabonával és 48 fűvel borított rácspont**
- **OMSZ Magyarországra: 9 gabonával borított magyarországi pont**
- **ECMWF teljes Földre: 85 pont**



LDAS PRODUCTS

ImagineS provides products derived from the regional LDAS operated over France by [Meteo-France](#) and over Hungary by [OMSZ](#), and the global LDAS, operated by [ECMWF](#) over the globe. They are presented in the [ATBD](#), and are provided in ASCII csv format files. All practical information are given in the [Product User Manual](#). They are all freely accessible after [registration](#).

The **global LDAS products** are calculated over 85 sites of crops and grassland scattered around the globe. They include a set of variables derived from the analysis is the land surface model simulation after the assimilation of satellite-derived products. For each site, the daily and the 10-daily products are sets of 21 files corresponding to:

- 7 variables: Leaf Area Index (LAI), root zone soil moisture, surface soil moisture, evapotranspiration, Net Ecosystem Exchange (NEE), Gross Primary Production (GPP), and Above Ground Biomass (AGB)
- 3 product types: time series, drought indicator and anomaly index.

The **regional LDAS products** are calculated for 45 straw cereal sites and 48 grassland sites in France, and for 9 straw cereal sites in Hungary. They include:

- daily time series of Leaf Area Index (LAI), root zone soil moisture (SWI), evapotranspiration, Net Ecosystem Exchange (NEE), Gross Primary Production (GPP), and Above Ground Biomass (AGB) anomaly (% difference w.r.t. the 2008-2013 mean at the same date)
- 10-daily time series of drought indicators. A drought indicator is a scaled anomaly index of a variable for a particular 10-day period (from January to December) with regard to its standard deviation over the 2008-2013 period. The variables are the LAI, the SWI and the AGB.

The added value of the assimilation of satellite products on vegetation biomass simulations is evaluated over France using reference agricultural yearly statistics of fodder production and straw cereal yields ([Agreste](#)), and compared to the output of the [WOFOST](#) model implemented currently within the [MARS_Crop_Growth_Monitoring_System](#) of JRC. The assimilation of LAI triggers a dramatic improvement of the correlation between the simulated biomass and the observations, and the ImagineS regional LDAS outperforms the WOFOST model. Further details are given in the [Validation Report over France](#). Similar comparisons have been performed over Hungary. The results are given in the [Validation](#)

Szabadon letölthető adatok .csv formátumban 2008-2013-ra:

- Napi adatok: GPP, LAI, Párolgás, NEE, SWI, felszín feletti növényzet anomália (AGB)
- 10 napra vonatkozó szárazság indikátorok: AnoLAI, AnoSWI and AnoAGB

