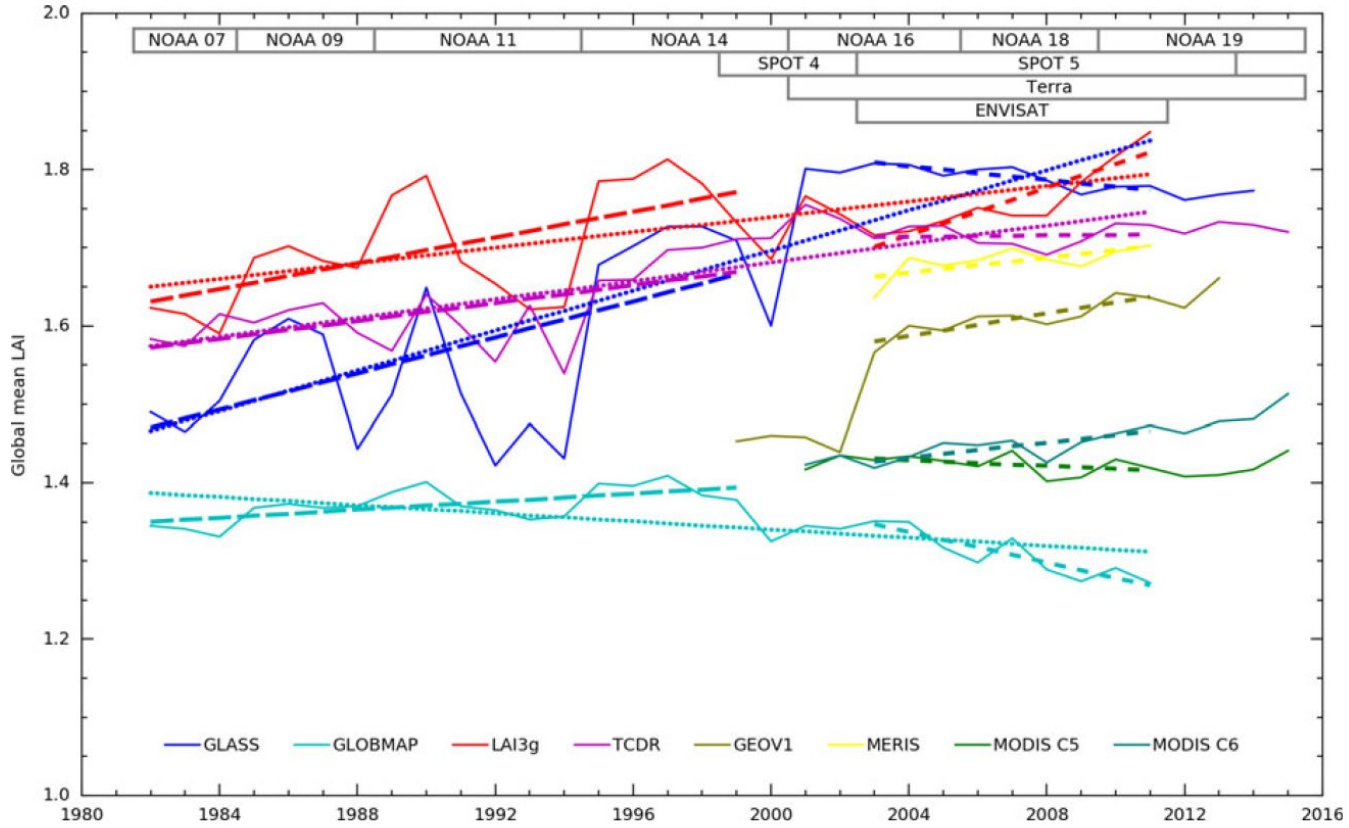
GEOV2-AVHRR long-term time series of global LAI, FAPAR and FCover since 1981: principles and validation based on the comparison with ground measurements and with GEOV2-CGLS, GIMMS3g, GLASS and C3S products

A. Verger, M. Weiss, T. Barroso, F. Baret

Background

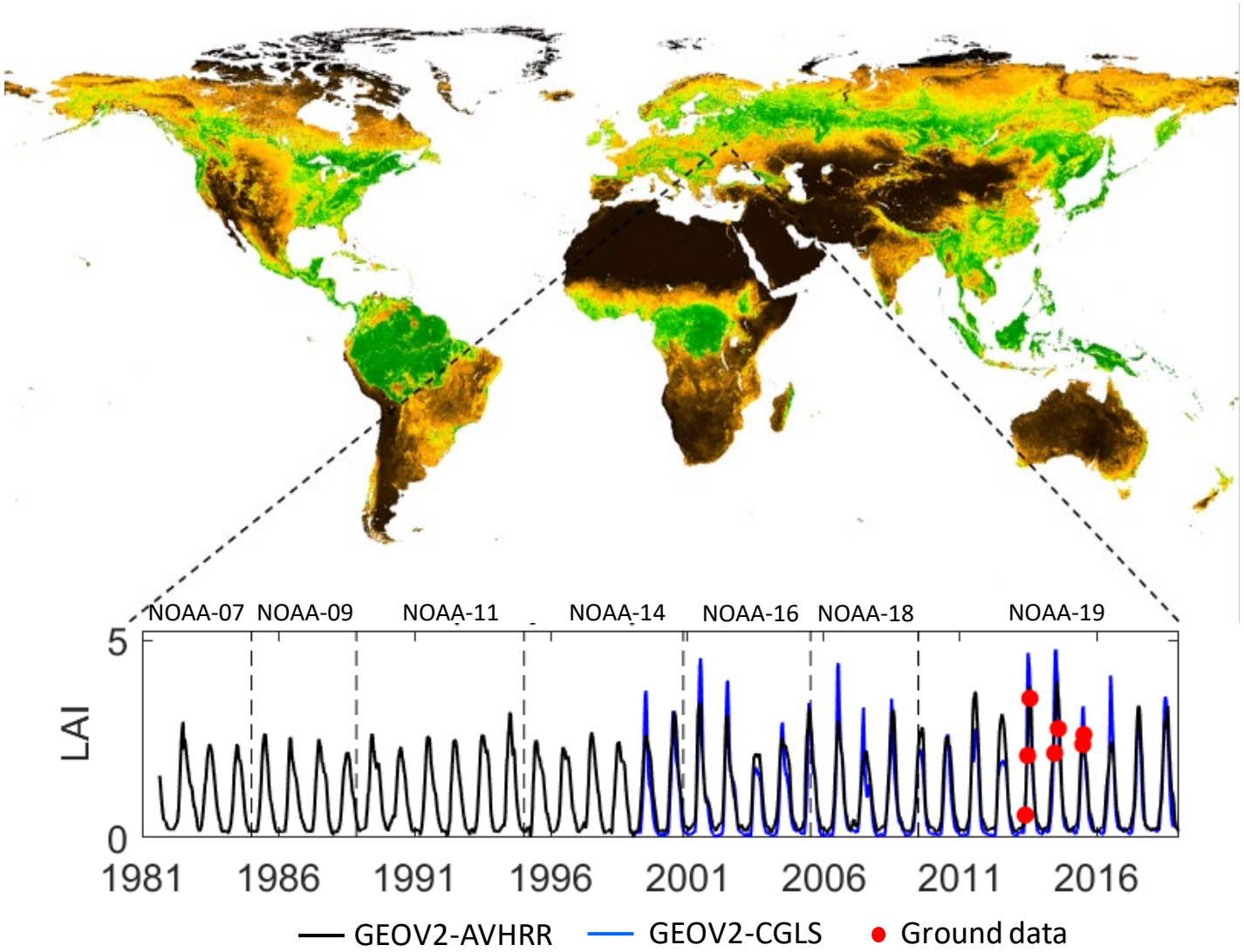
Need for biophysical variables ECVs LAI, fAPAR & fCover

- long, consistent, stable and continuous time series at the global scale
- Validated products with quantified uncertainties



Jiang et al. Global Change Biology 2017

GEOV2-AVHRR products

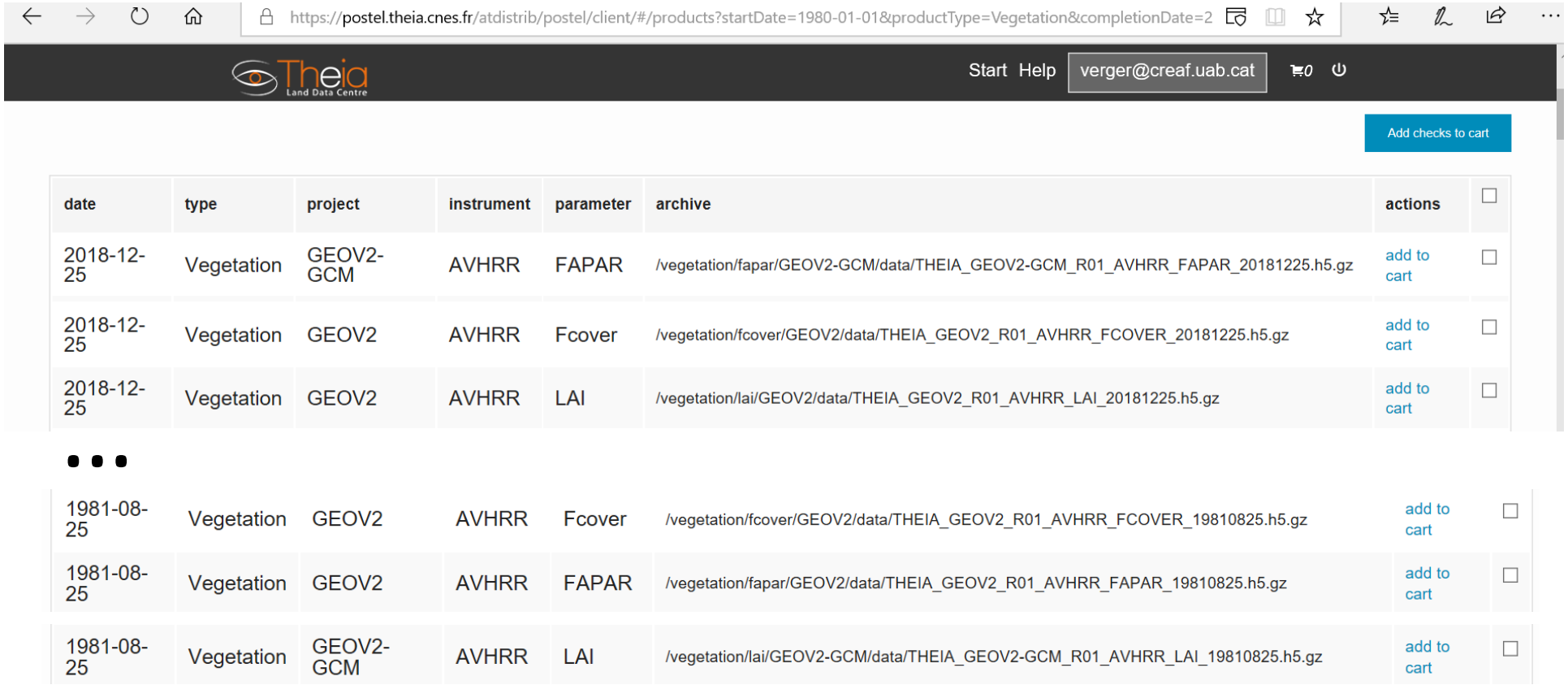


✓ 40+ years AVHRR

GEOV2-AVHRR products

Products available every 10-day at 5km resolution at

https://www.theia-land.fr



https://postel.theia.cnes.fr/atdistrib/postel/client/#/products?startDate=1980-01-01&productType=Vegetation&completionDate=2

Theia Land Data Centre — Start Help verger@creaf.uab.cat 0

Add checks to cart

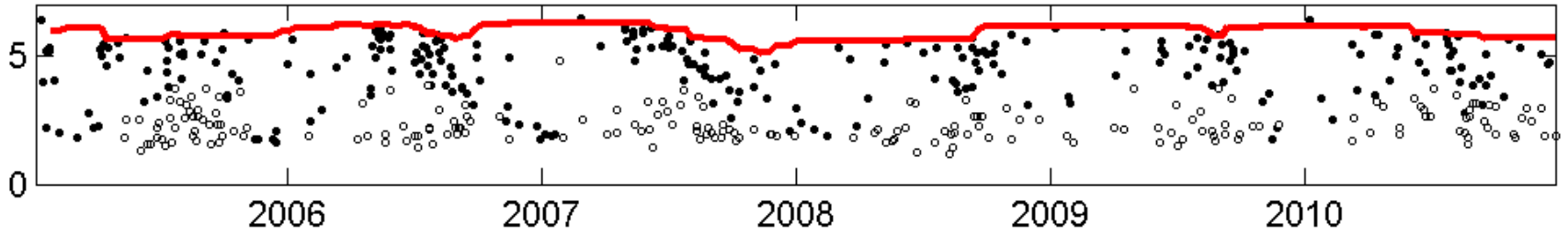
date	type	project	instrument	parameter	archive	actions
2018-12-25	Vegetation	GEOV2-GCM	AVHRR	FAPAR	/vegetation/fapar/GEOV2-GCM/data/THEIA_GEOV2-GCM_R01_AVHRR_FAPAR_20181225.h5.gz	add to cart
2018-12-25	Vegetation	GEOV2	AVHRR	Fcover	/vegetation/fcover/GEOV2/data/THEIA_GEOV2_R01_AVHRR_FCOVER_20181225.h5.gz	add to cart
2018-12-25	Vegetation	GEOV2	AVHRR	LAI	/vegetation/lai/GEOV2/data/THEIA_GEOV2_R01_AVHRR_LAI_20181225.h5.gz	add to cart
...						
1981-08-25	Vegetation	GEOV2	AVHRR	Fcover	/vegetation/fcover/GEOV2/data/THEIA_GEOV2_R01_AVHRR_FCOVER_19810825.h5.gz	add to cart
1981-08-25	Vegetation	GEOV2	AVHRR	FAPAR	/vegetation/fapar/GEOV2/data/THEIA_GEOV2_R01_AVHRR_FAPAR_19810825.h5.gz	add to cart
1981-08-25	Vegetation	GEOV2-GCM	AVHRR	LAI	/vegetation/lai/GEOV2-GCM/data/THEIA_GEOV2-GCM_R01_AVHRR_LAI_19810825.h5.gz	add to cart

GEOVx algorithm principles

Same principles as for GEOV2-CGLS

NNT for achieving consistency with existing satellite products (CYCLOPES &MODIS) and temporal techniques to improve robustness and continuity

EBF



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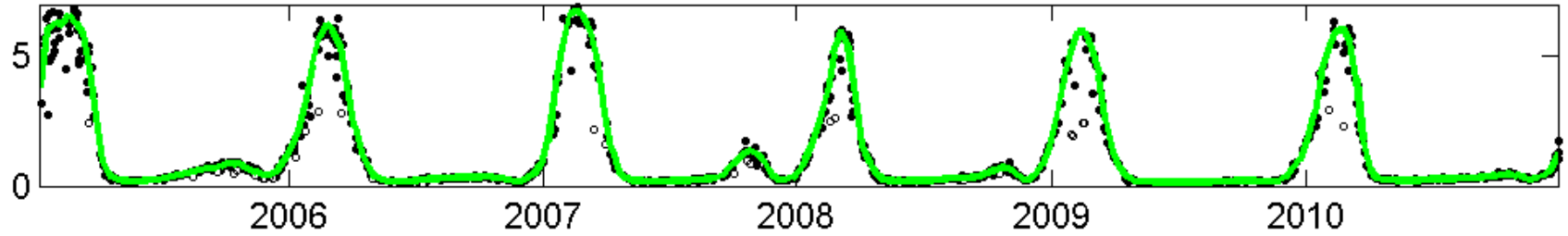


LAI, FAPAR and Fcover products

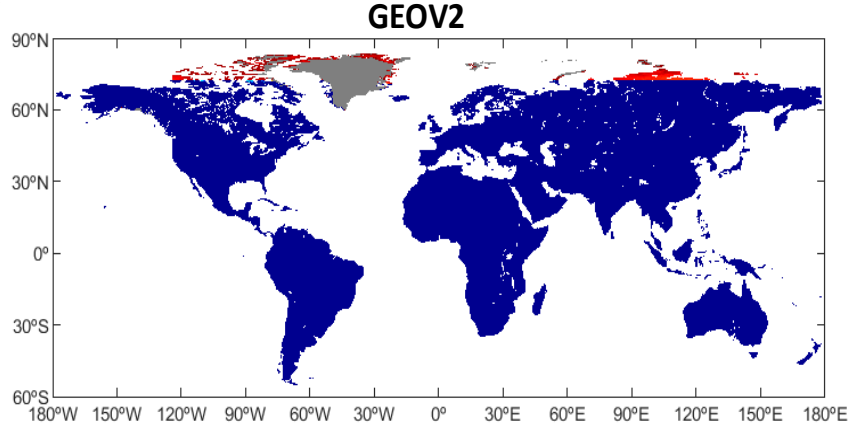
+ DIRECT2 ground data

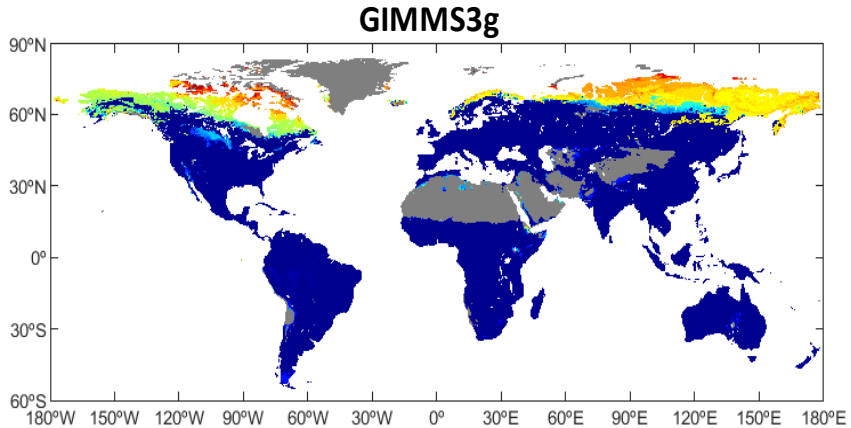
	GEOV2-AVHRR	GEOV2-CGLS	GIMMS3g	GLASSV4	C3SV3
Variable	LAI, FAPAR, FCover	LAI, FAPAR, FCover	LAI, FAPAR	LAI, FAPAR, FCover	Effetive LAI, White-sky FAPAR
Retrieval algorithm	NNT Smoothing and gap filling at output level	NNT Smoothing and gap filling at output level	NNT Maximum value NDVI composites	NNT / MARS Smoothing and gap filling at input level	TIP Smoothing and gap filling at input level
Input data	NTOC-r red and NIR, cos(SZA) LTDR v4	TOC-r red, NIR and SWIR, cos(SZA), cos(VZA), cos(RAA)	NDVI GIMMS3g	NTOC-r red and NIR LTDR v4, v5* *FCover	White-sky broadband albedos in the visible and NIR
Sensor **AVHRR (A)** **Vegetation (VGT)** **Satellite** **NOAA (N)** **SPOT (S)** **PROBA (P)** **Start date**	A2 N7 1981/06 A2 N9 1985/01 A2 N11 1988/11 A2 N14 1995/01 A3 N16 2000/11 A3 N18 2005/07 A3 N19 2009/06	VGT S 1999/01 VGT P 2014/01	A2 N7 1981/06 A2 N9 1985/03 A2 N11 1988/11 A2 N9 1994/09 A2 N14 1995/01 A3 N16 2000/11 A3 N17 2004/01 A3 N18 2009/01	A2 N7 1981/06 A2 N9 1985/01 A2 N11 1988/11 A2 N14 1995/01 A3 N16 2000/11 A3 N18 2005/07 A3 N19 2009/06	A2 N7 1981/09 A2 N9 1985/03 A2 N11 1988/11 A2 N14 1995/02 A3 N16 2001/03 A3 N17 2002/09 VGT S 2006/01 VGT P 2014/01
Spatial sampling	1/20°	1/112°	1/12°	1/20°	1/30° (AVHRR) 1/112° (VGT)
Temporal sampling	10 days	10 days	15 days	8 days	10 days
Time period	1981/06-2018/12	1999/01-2020/06	1981/06-2011/12	1981/06-2018/12 (LAI) 1982/01-2018/12 (FAPAR, FCover)	1981/09-2020/06
Reference	Verger et al. 2023	Verger et al. 2014	Zhu et al. 2013	Jia et al. 2019; Xiao et al. 2015; Xiao et al. 2016	Blessing and Giering, 2021; Pinty et al. 2006

Poster 31

Product completeness

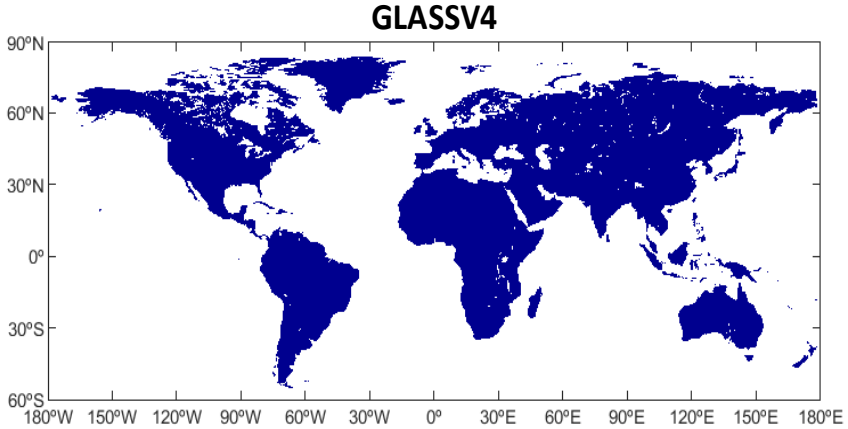
2% missing data

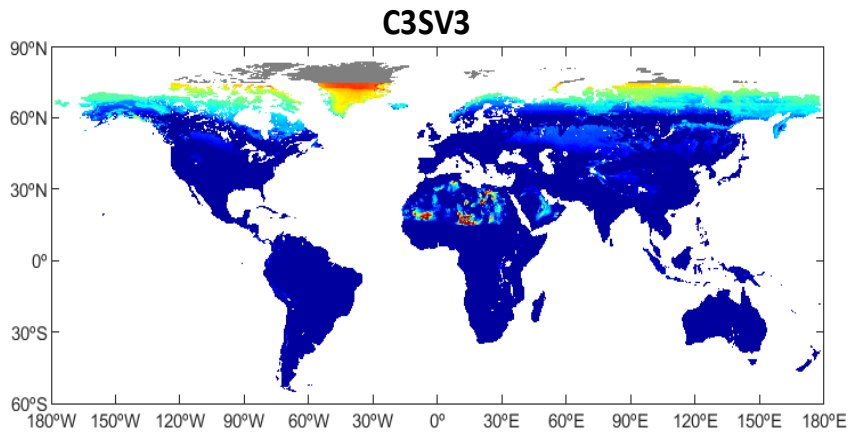




18% missing data
Bare areas not processed

No missing data





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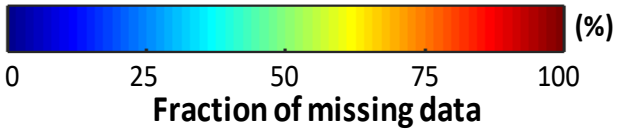
01/01/1995– 03/20/1985
09/20/1994 – 02/10/1995
not processed

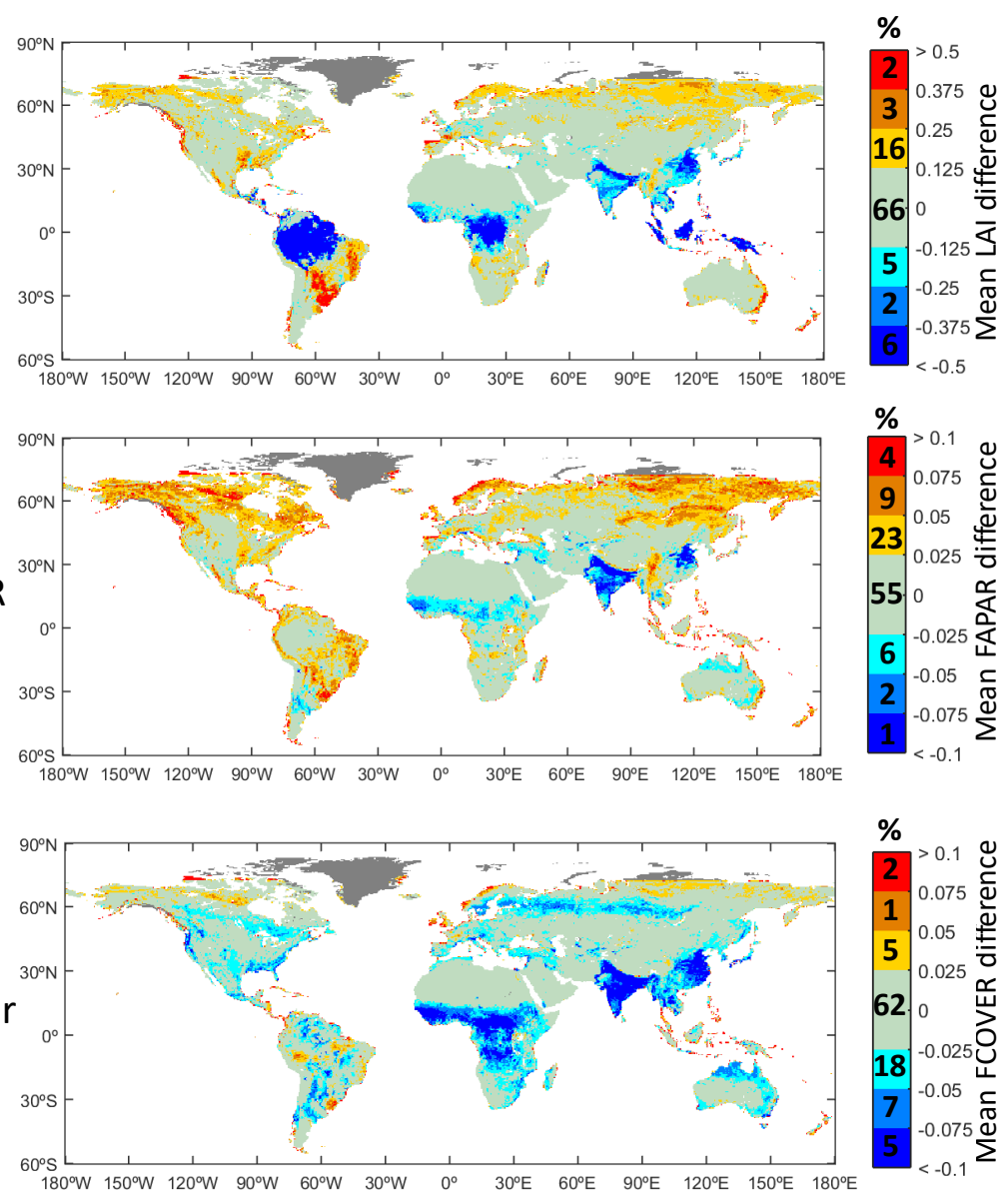


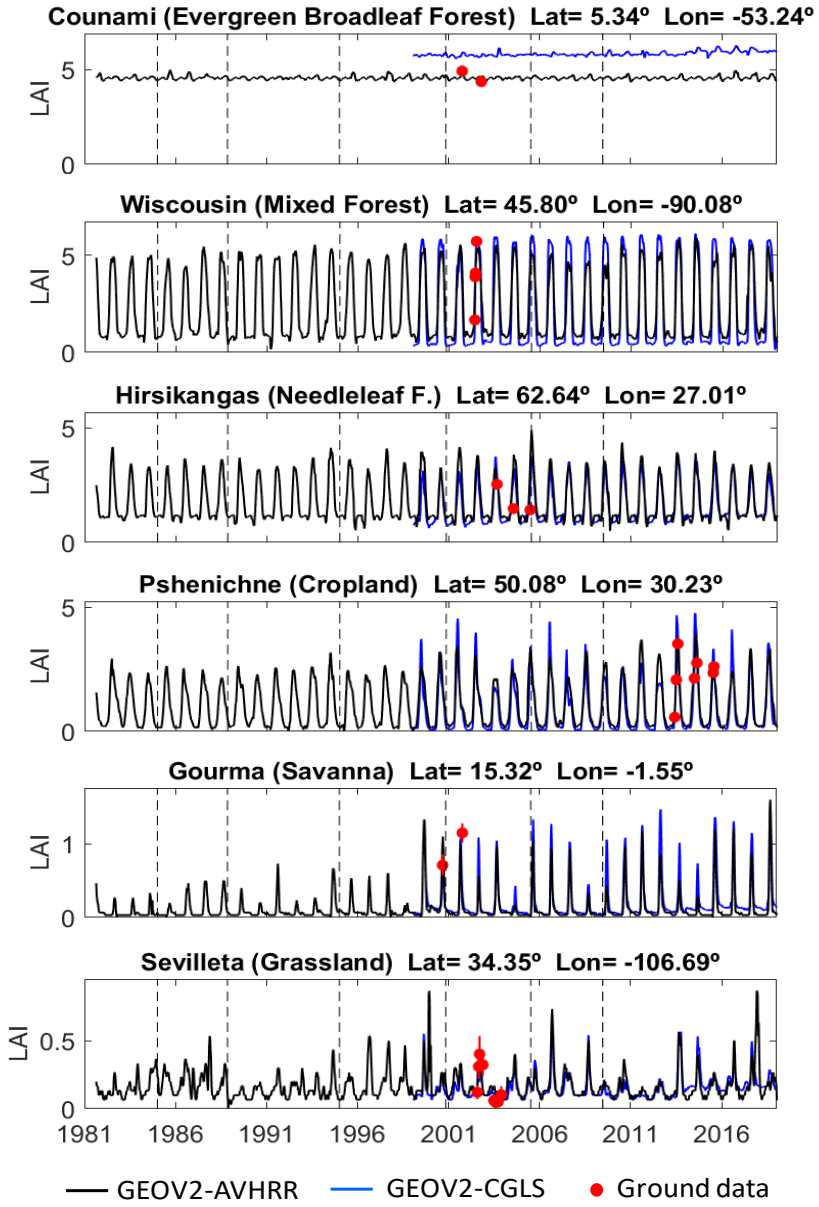
Consistency with GEOV2-CGLS

94% within ±0.5 LAI

85% within ±0.05 FAPAR

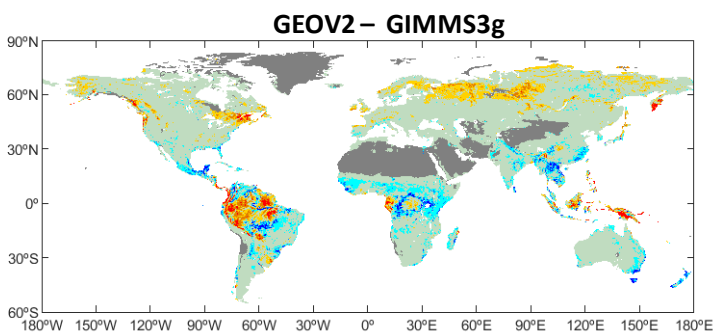
85% within ±0.05 FCover

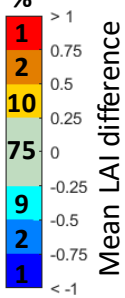




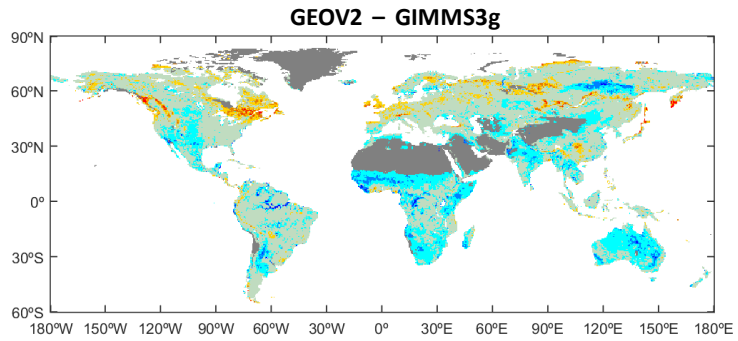
Consistency with existing AVHRR products

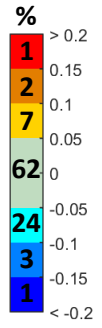
LAI 1981-2011



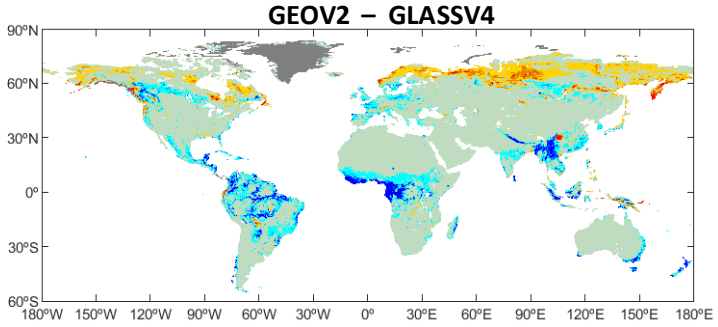


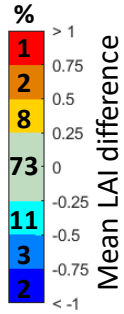
FAPAR 1982-2011

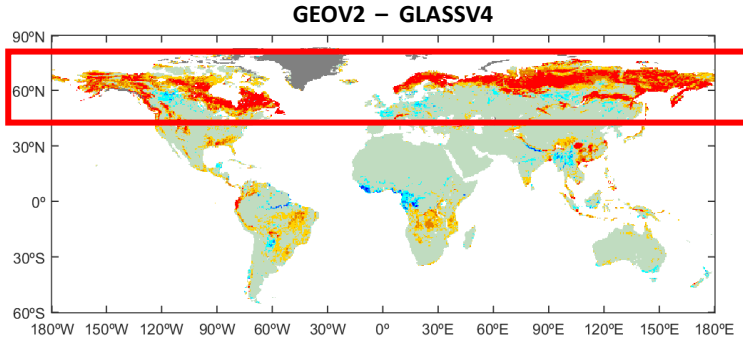


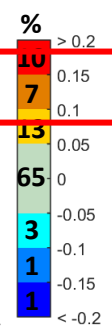


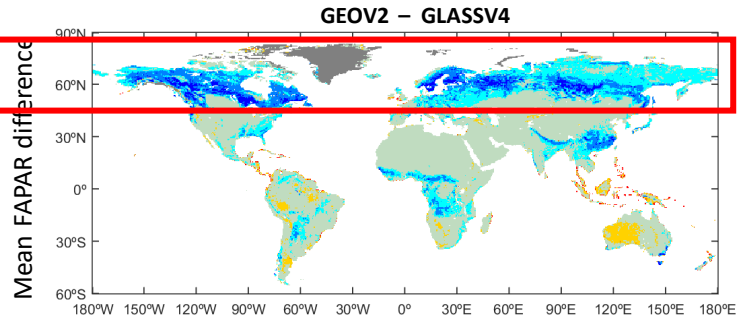
FCover 1982-2018

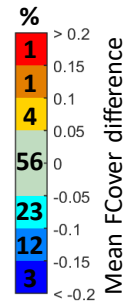


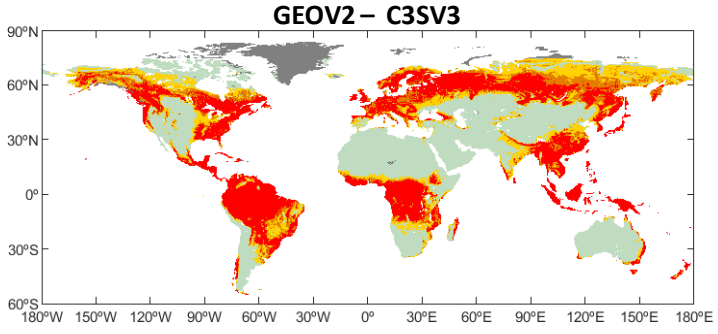


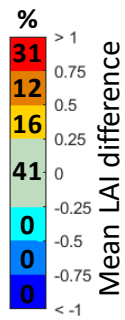


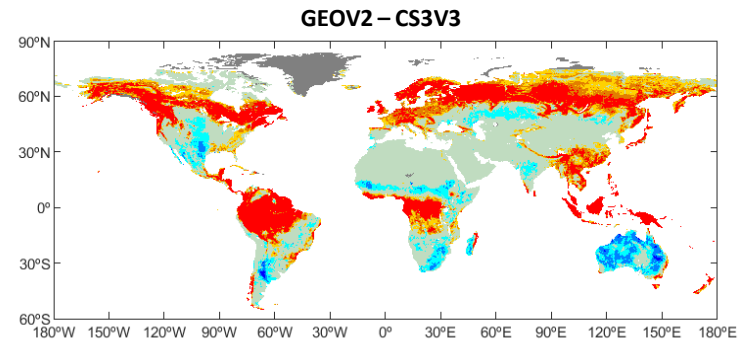


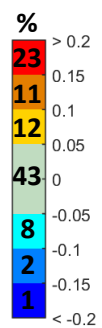










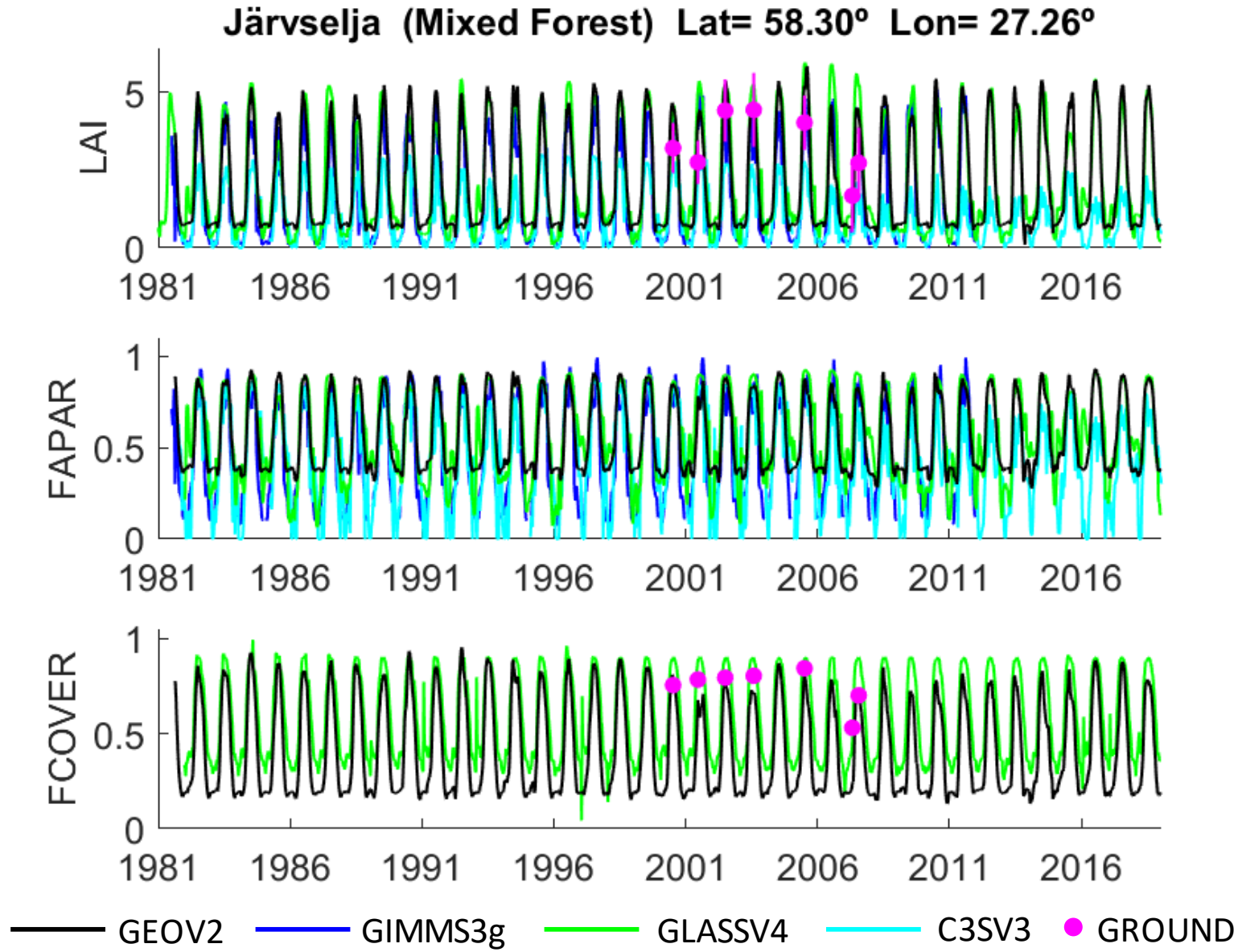


>90% within ±0.5 LAI

>60% within ±0.05 FAPAR

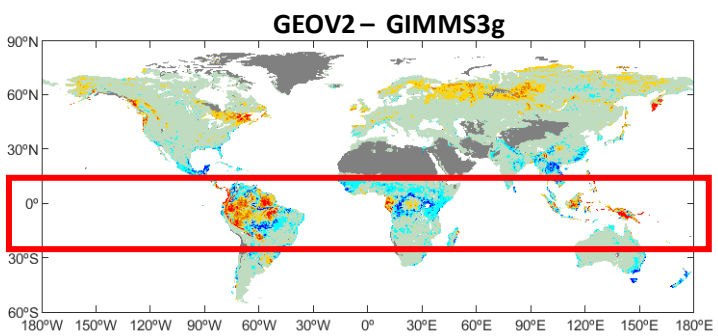
>50% within ±0.05 FCover

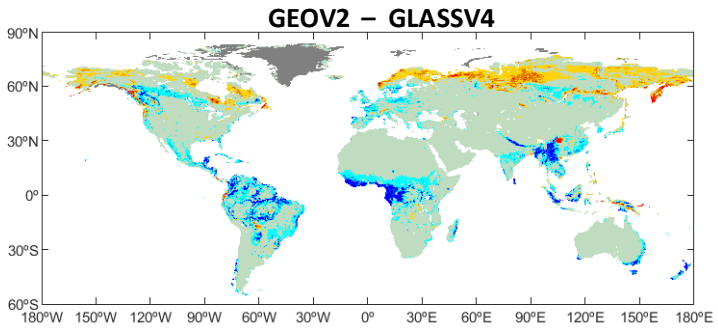
Temporal profiles

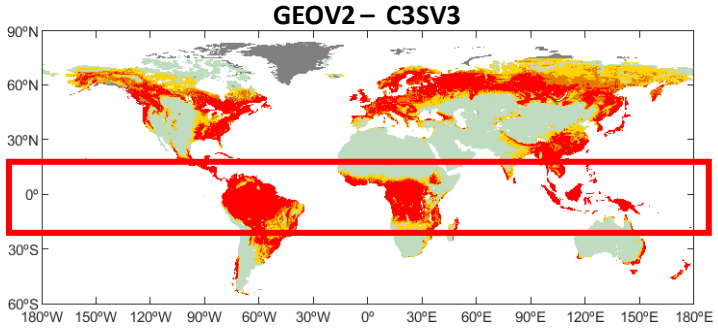


Consistency with existing AVHRR products

LAI 1981-2011

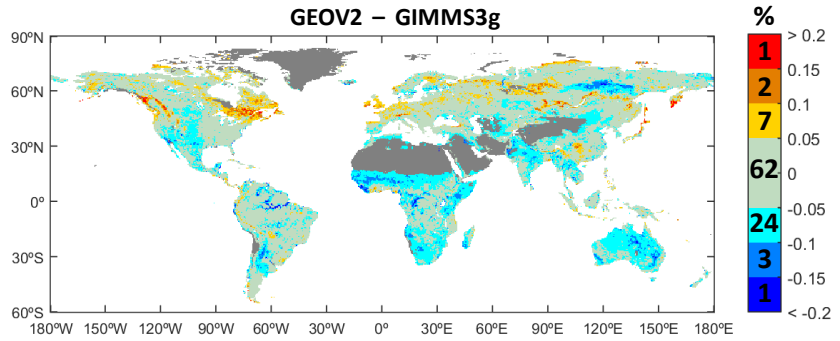


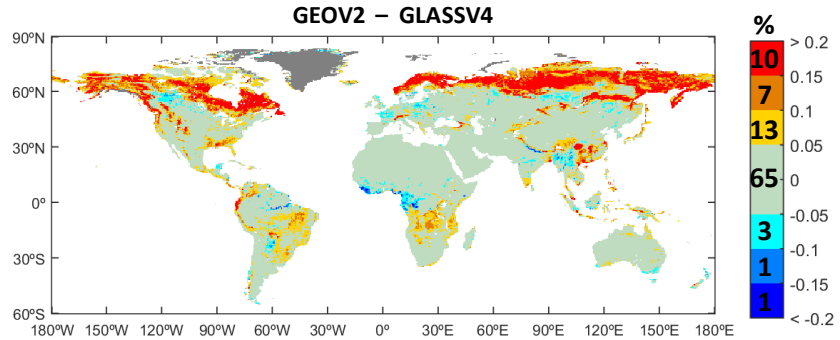


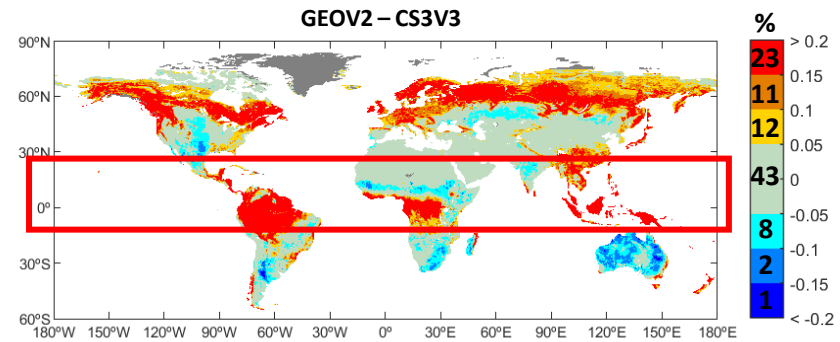


>90% within ±0.5 LAI

FAPAR 1982-2011

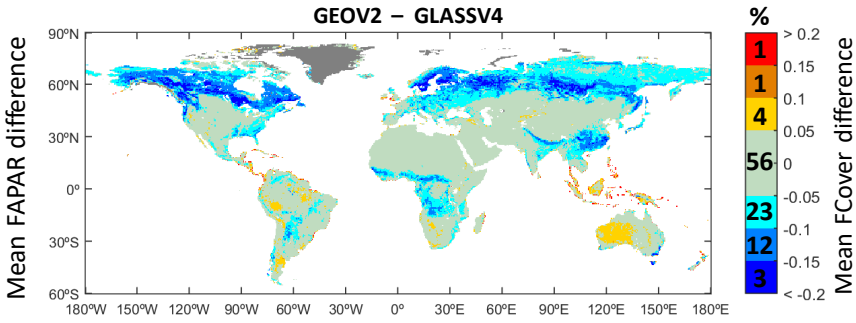






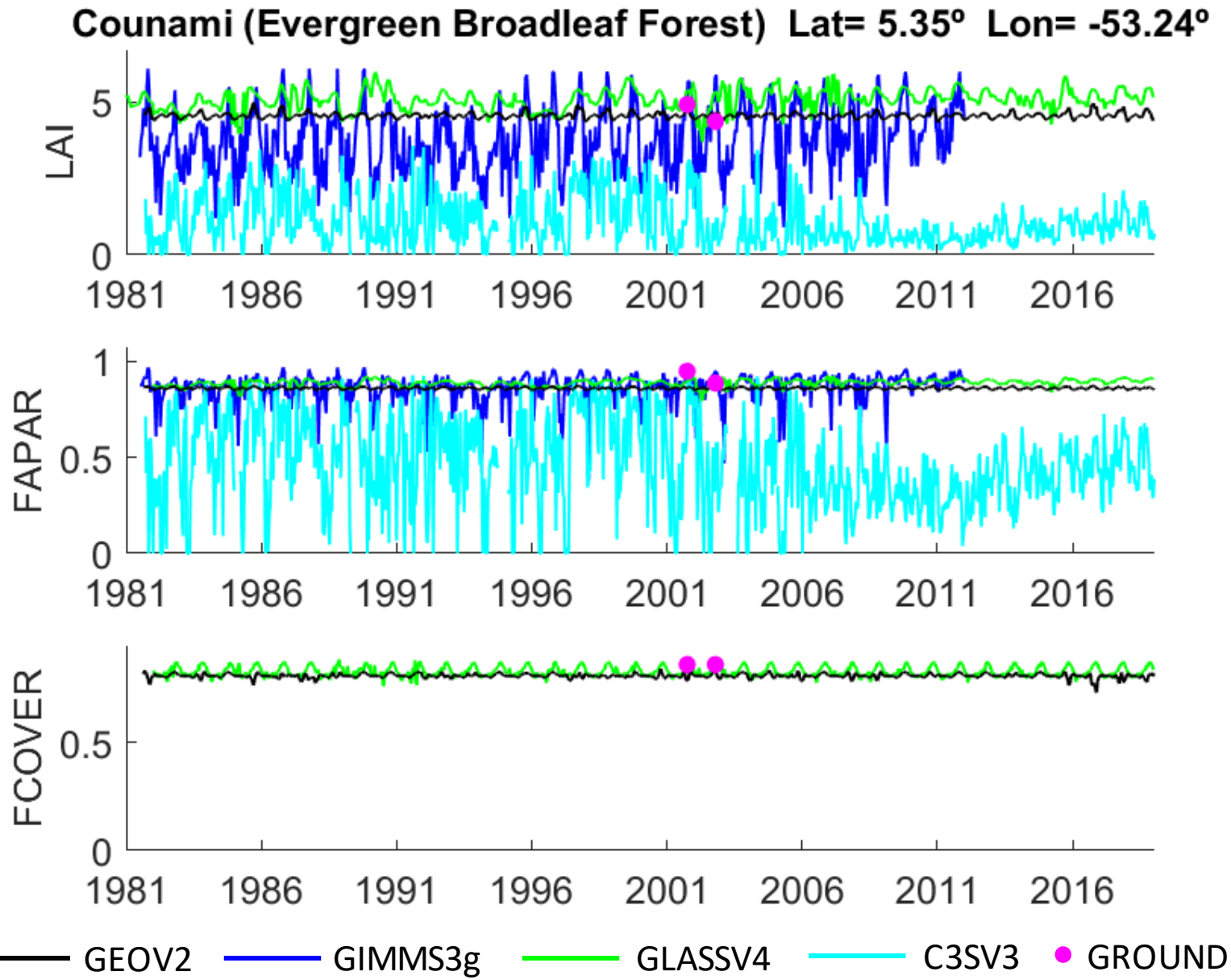
>60% within ±0.05 FAPAR

FCover 1982-2018



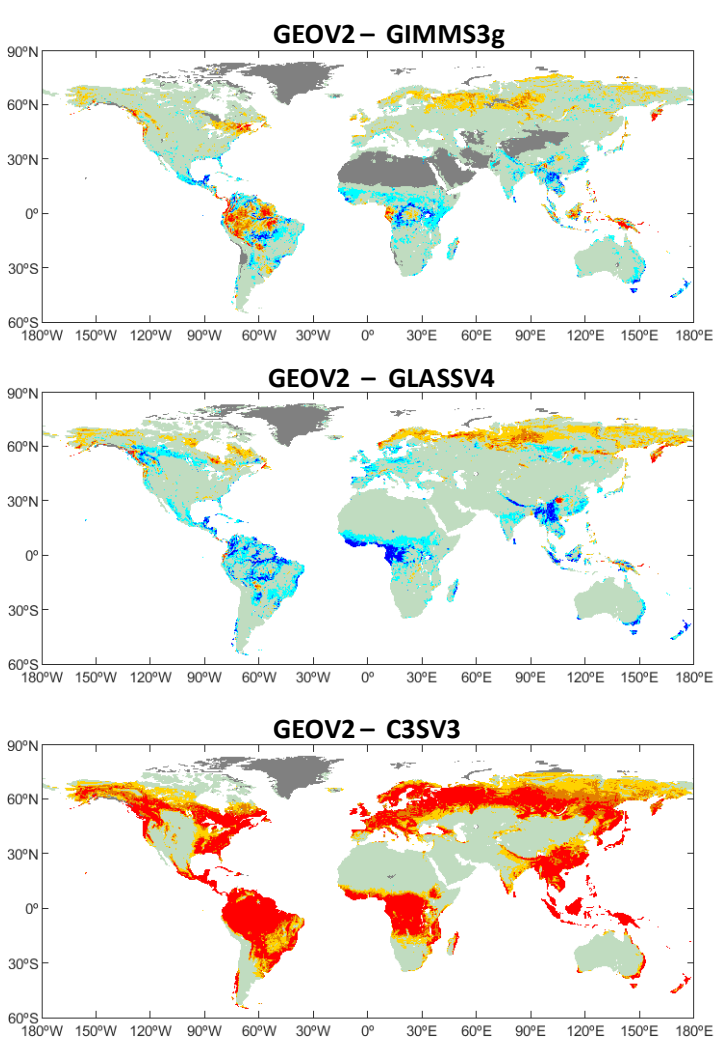
>50% within ±0.05 FCover

Temporal profiles

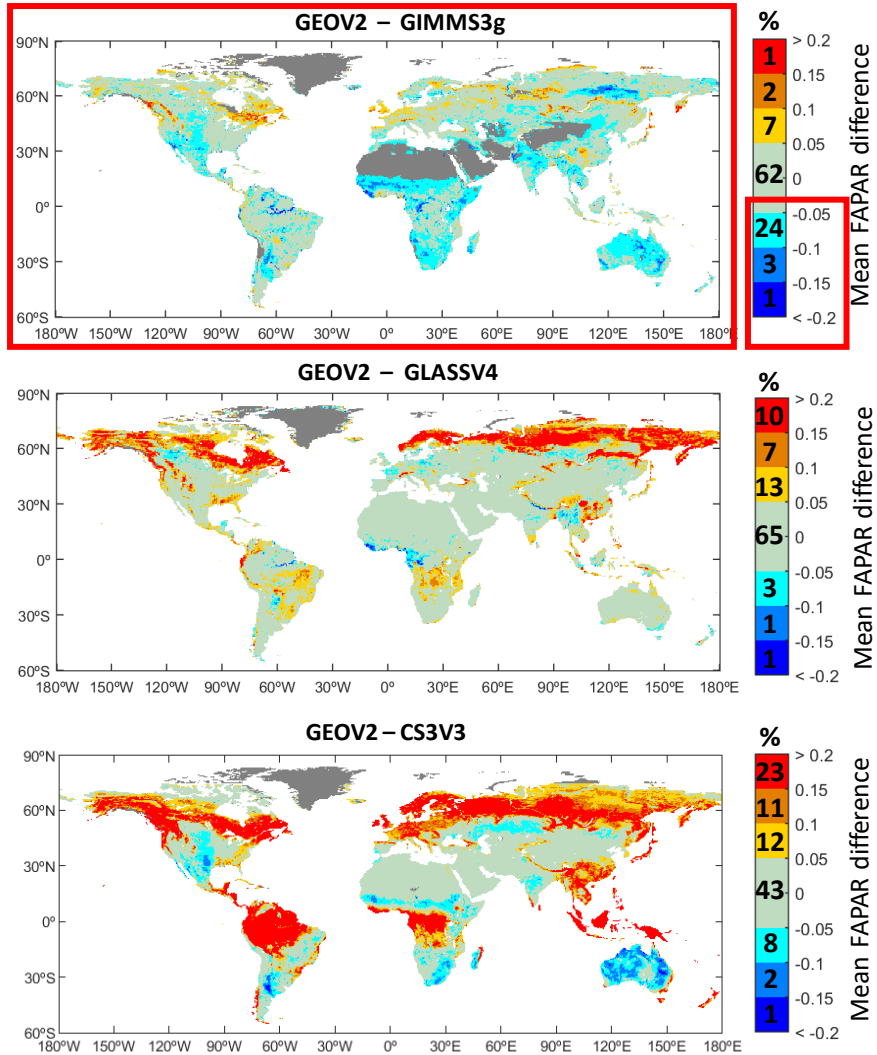


Consistency with existing AVHRR products

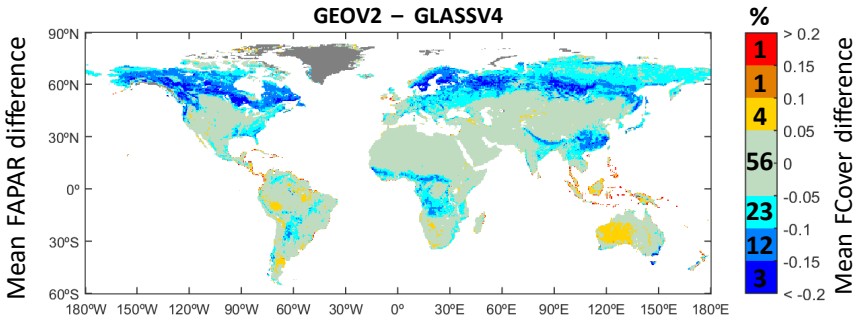
LAI 1981-2011



FAPAR 1982-2011



FCover 1982-2018



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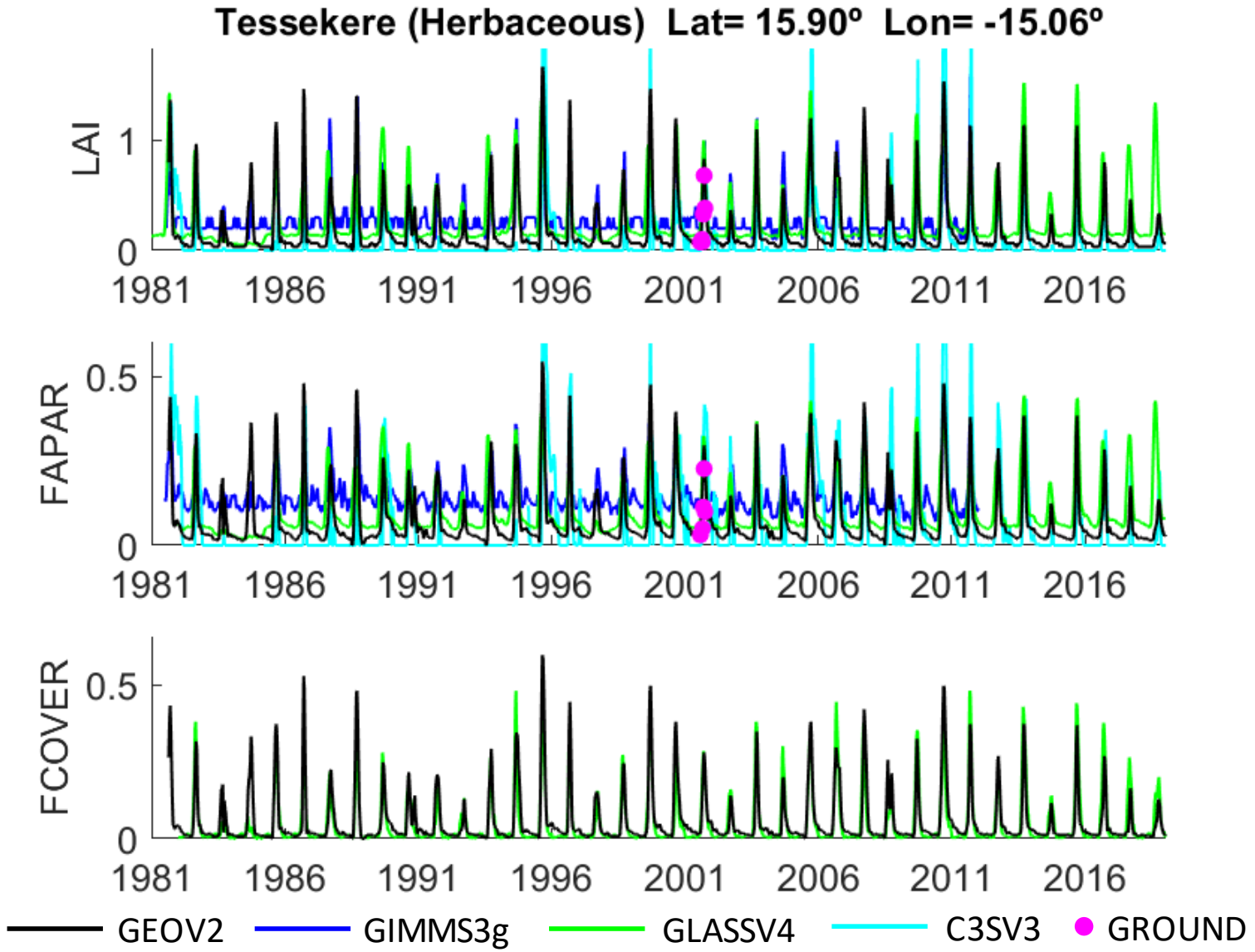
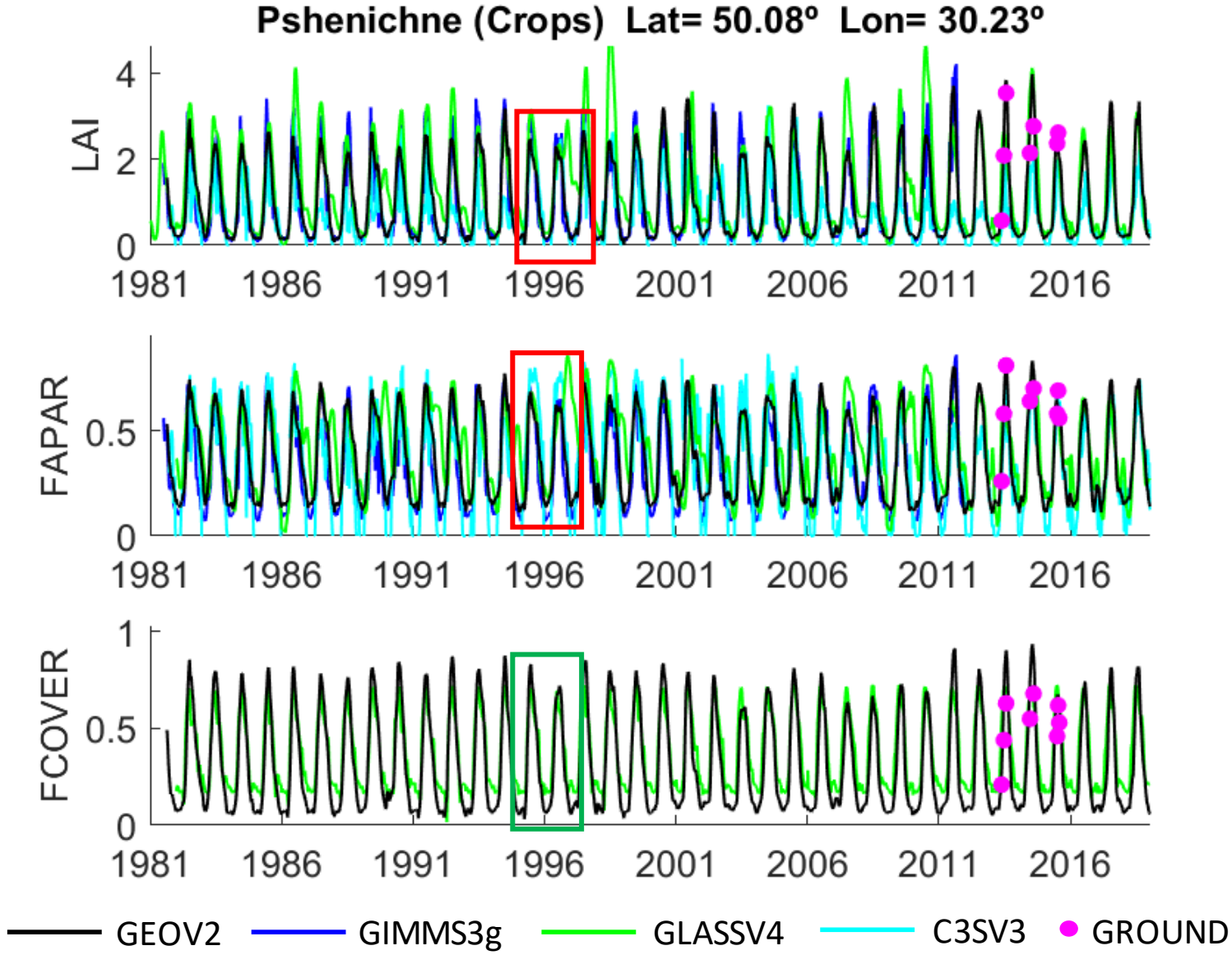
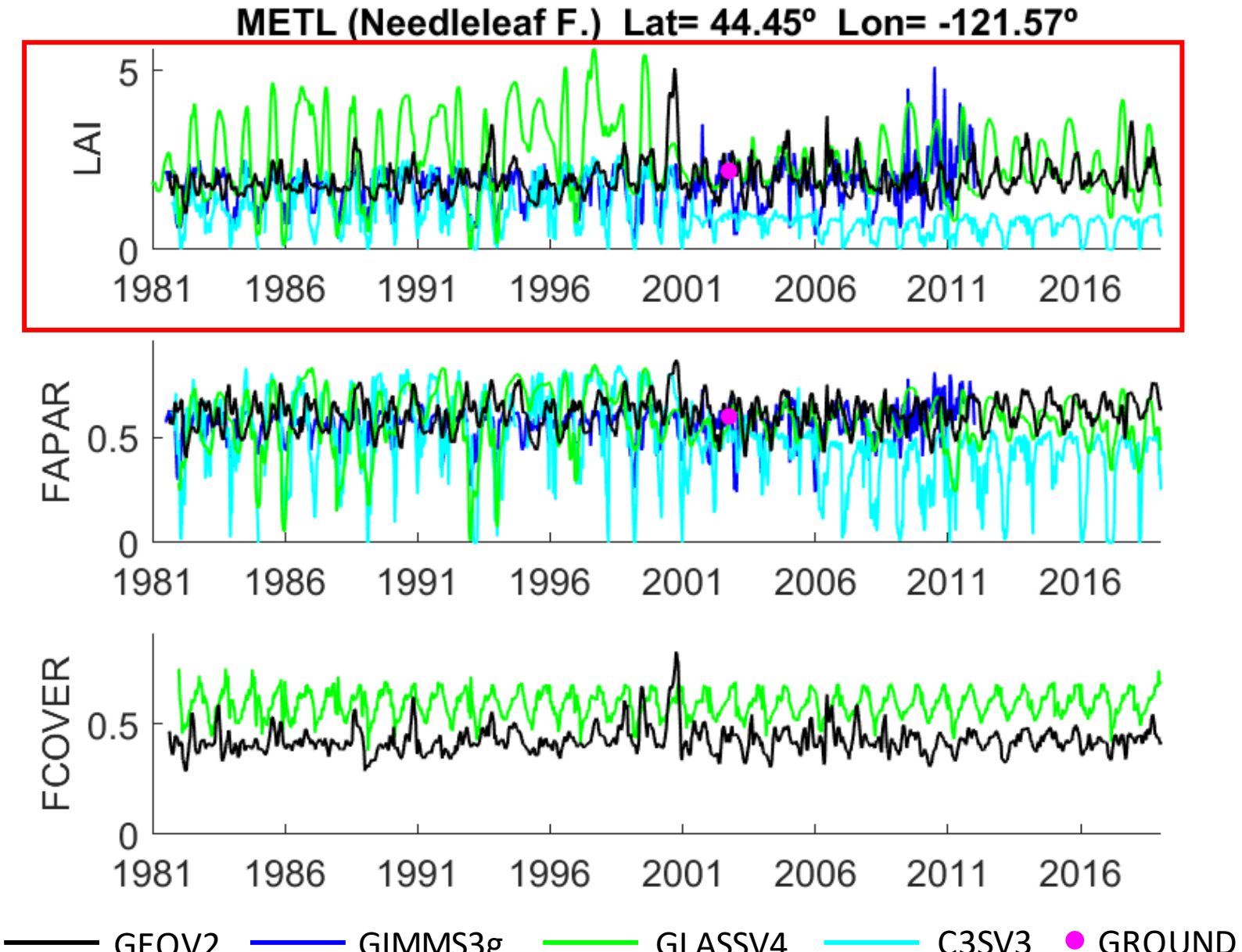
Temporal profiles



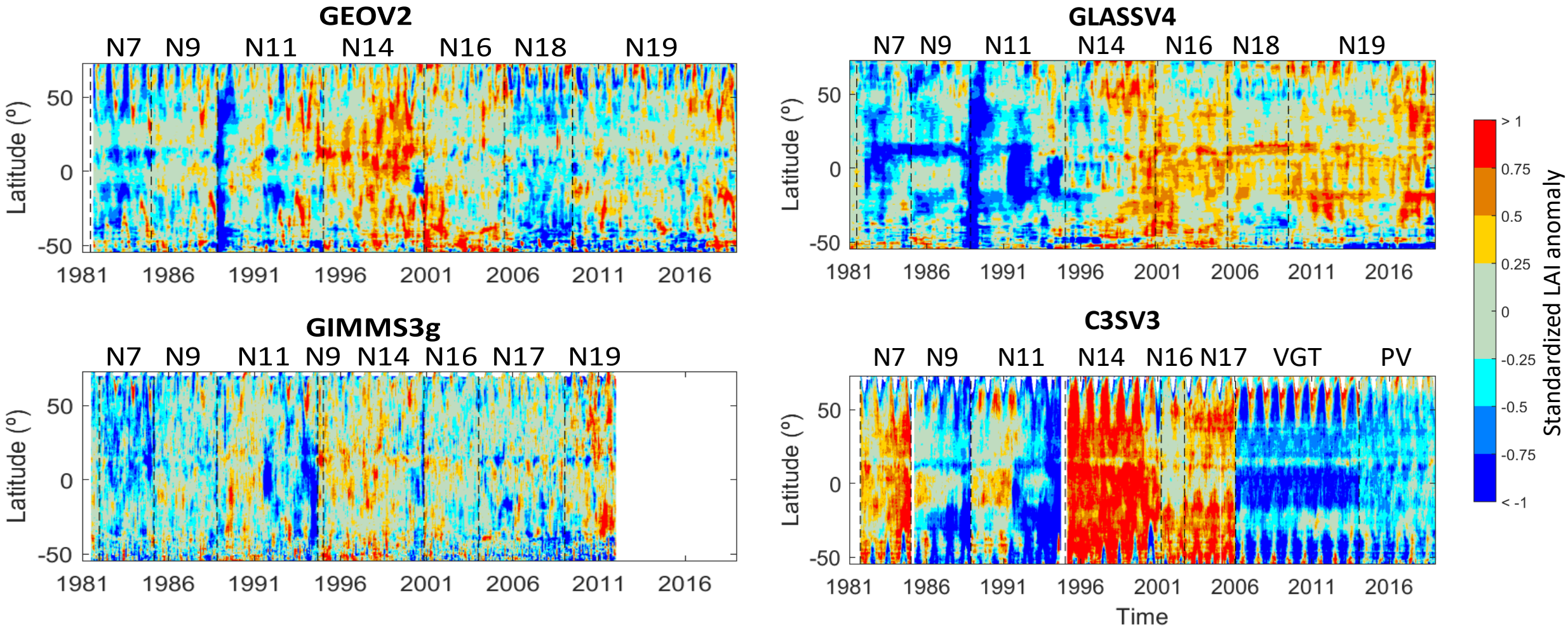
Temporal profiles



Temporal profiles



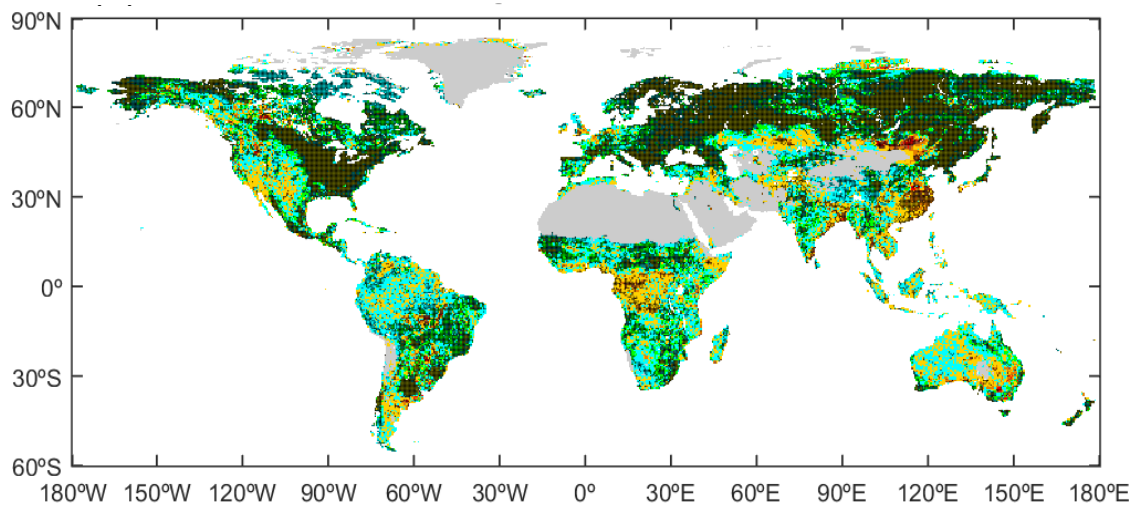
Temporal anomalies



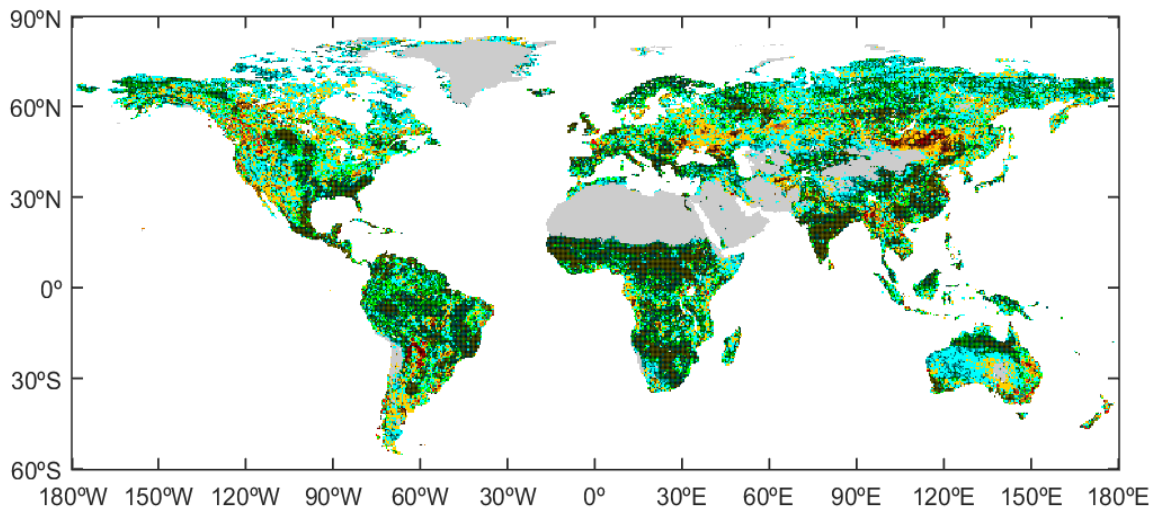
Temporal trends

(1981-2011)

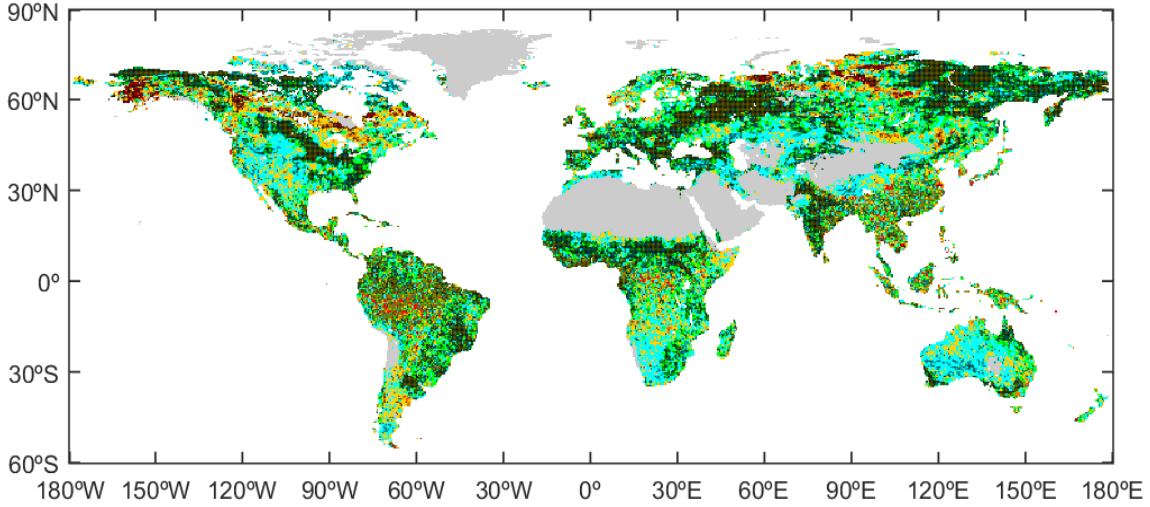
GEOV2



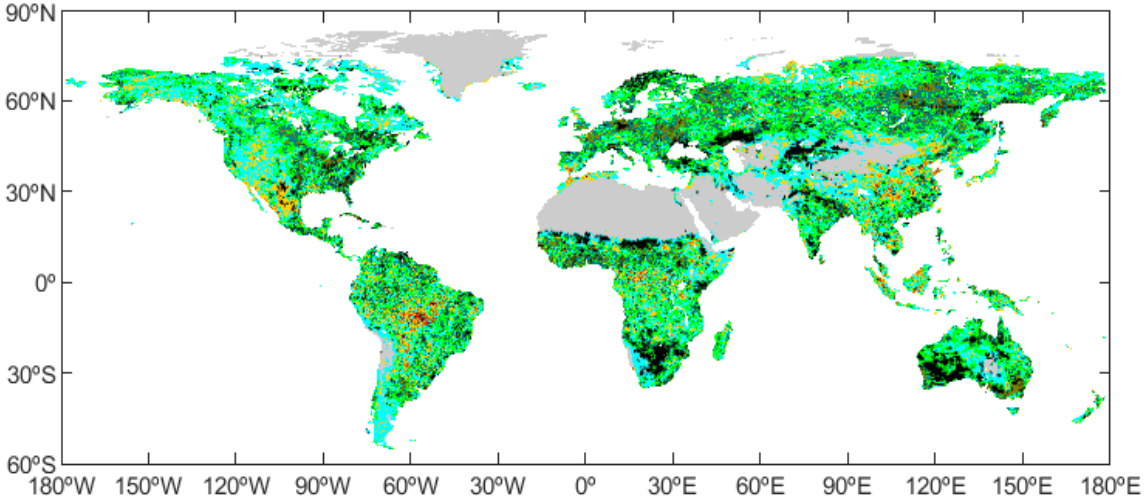
GLASSV4



GIMMS3g

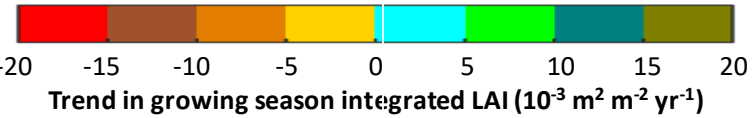


C3SV3



85% agreement

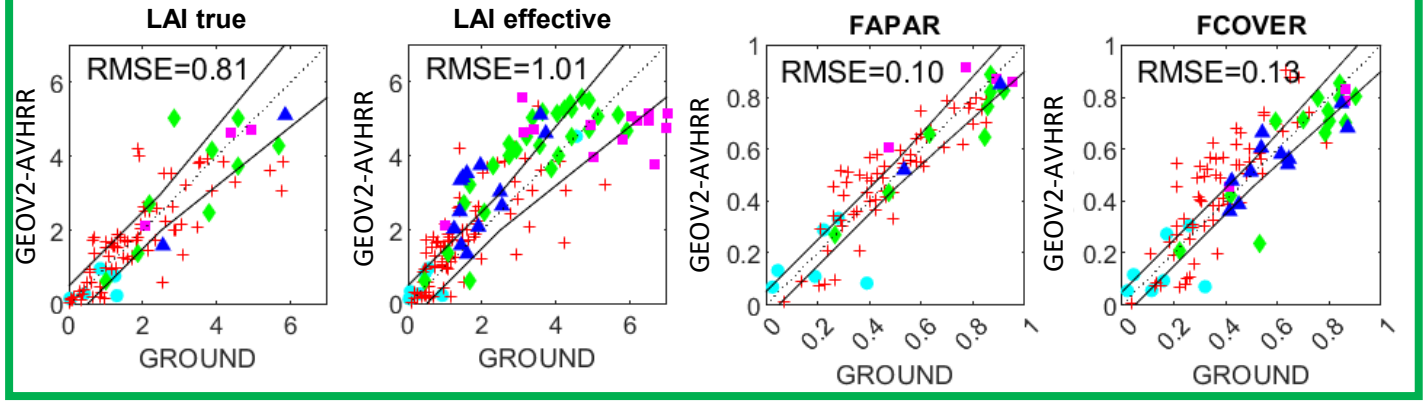
20% browning



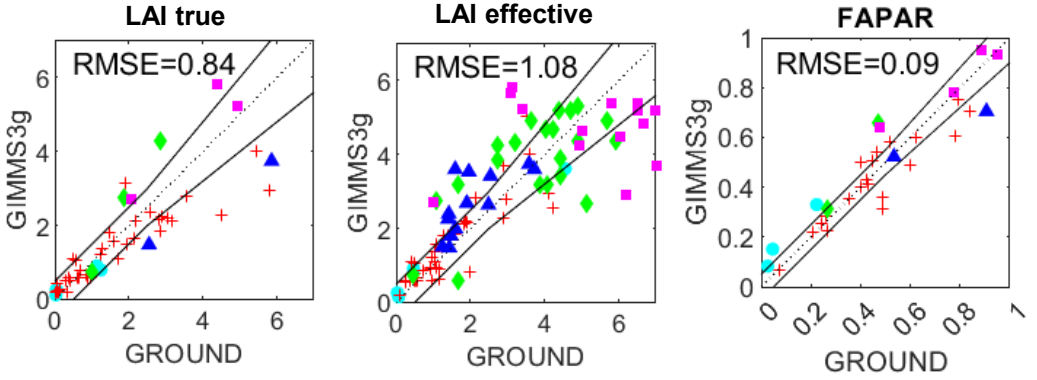
80% greening

Accuracy assessment over DIRECT2.0

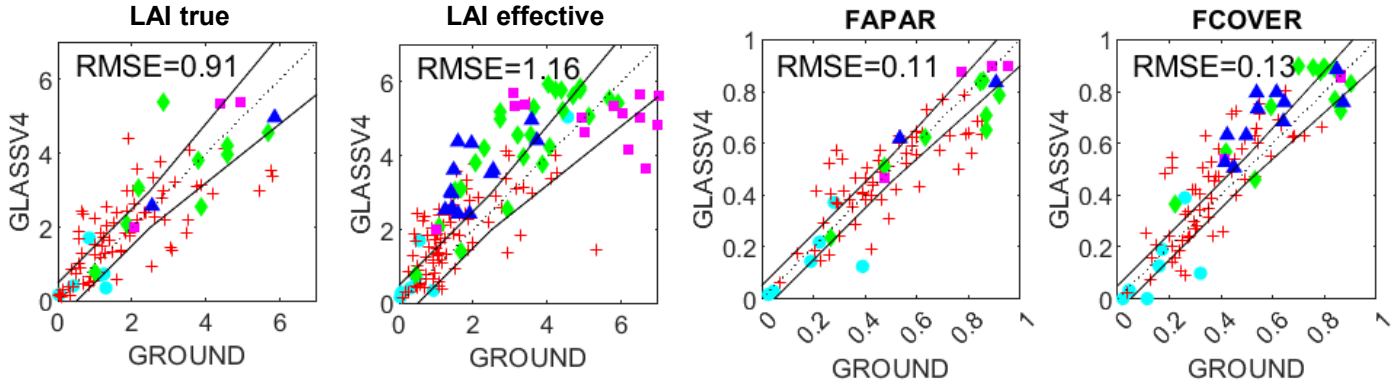
GEOV2-AVHRR



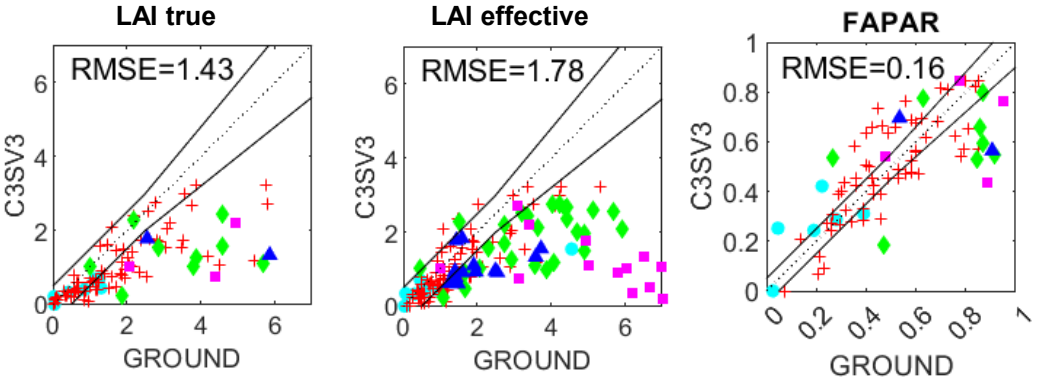
GIMMS3g

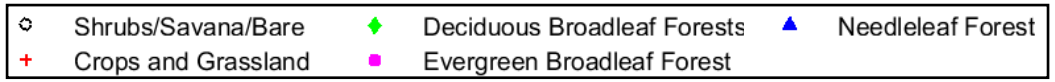


GLASS V4



C3S V3



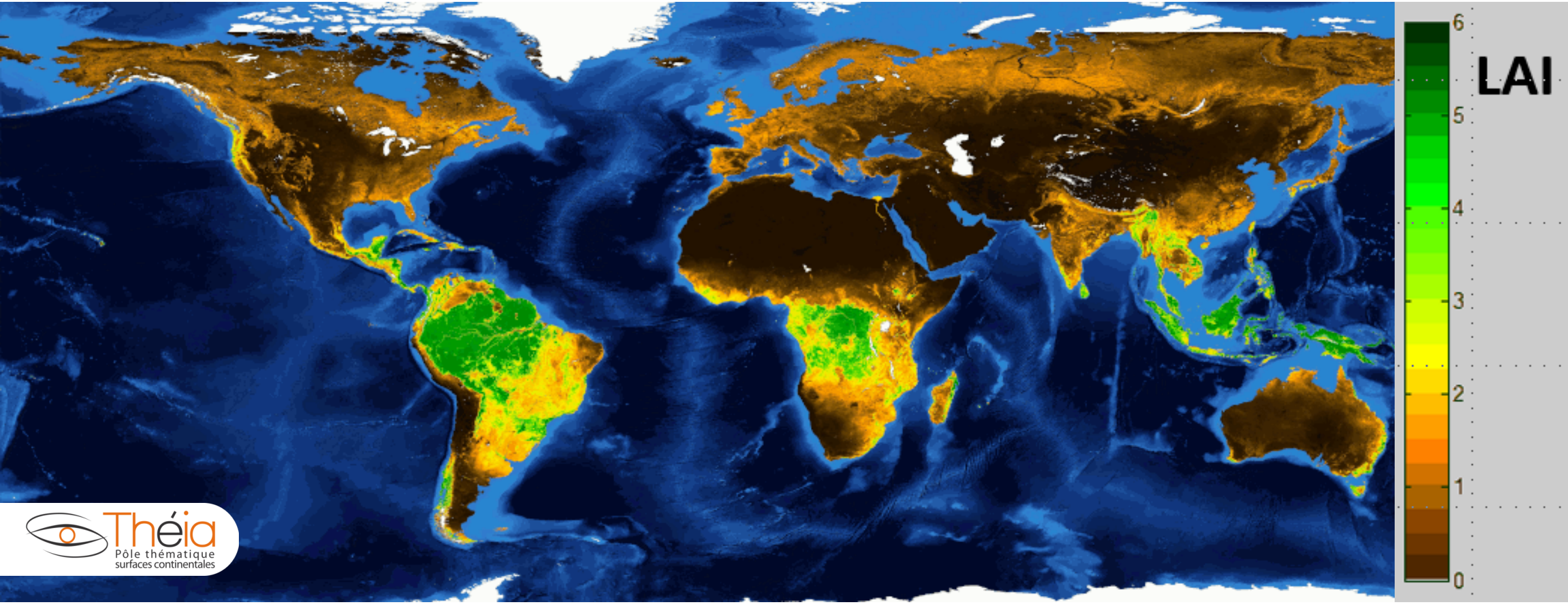


Conclusions

- GEOV2-AVHRR LAI, FAPAR and FCOVER 5km, 10d time series (**1981-2018**) at the global scale
- Associated with **quality flags and quality indicators**
- **Same principles as for GEOV2-CGLS** 1999-2019: ~90% of land pixels within ±0.5 LAI and ±0.05 FAPAR/FCover
- **GEOV2-AVHRR agrees with GIMMS3g and GLASSV4** products within ±0.5 LAI and ±0.05 FAPAR/FCOVER in >90% of land pixels for LAI and >50% for FAPAR and FCOVER
- GEOV2-AVHRR is **an intermediate solution** between GIMMS3g and GLASSV4 in terms of the magnitude of products, temporal **smoothness**, and spatio-temporal **continuity** (5% of missing data for GEOV2-AVHRR)
- High **temporal consistency** of GEOV2-AVHRR with no artifacts from the transition between NOAA satellites
- The **temporal trends** in GEOV2-AVHRR LAI agrees with GIMMS3g and/or GLASSV4 in 85% of land pixels
- **GEOV2-AVHRR agrees the best with ground measurements**: uncertainty of 0.81 LAI, 0.10 FAPAR and 0.13 FCOVER
- **C3SV3** shows temporal discontinuities, **inconsistencies and artifacts** from the transition between sensors as well as important discrepancies with other products and ground data both for LAI and FAPAR
- GEOV2-AVHRR (1981-2018) time series will be updated to present using **MetOp** data

Thank you!

Time series of LAI, FAPAR and FCOVER every 10-day since 1981



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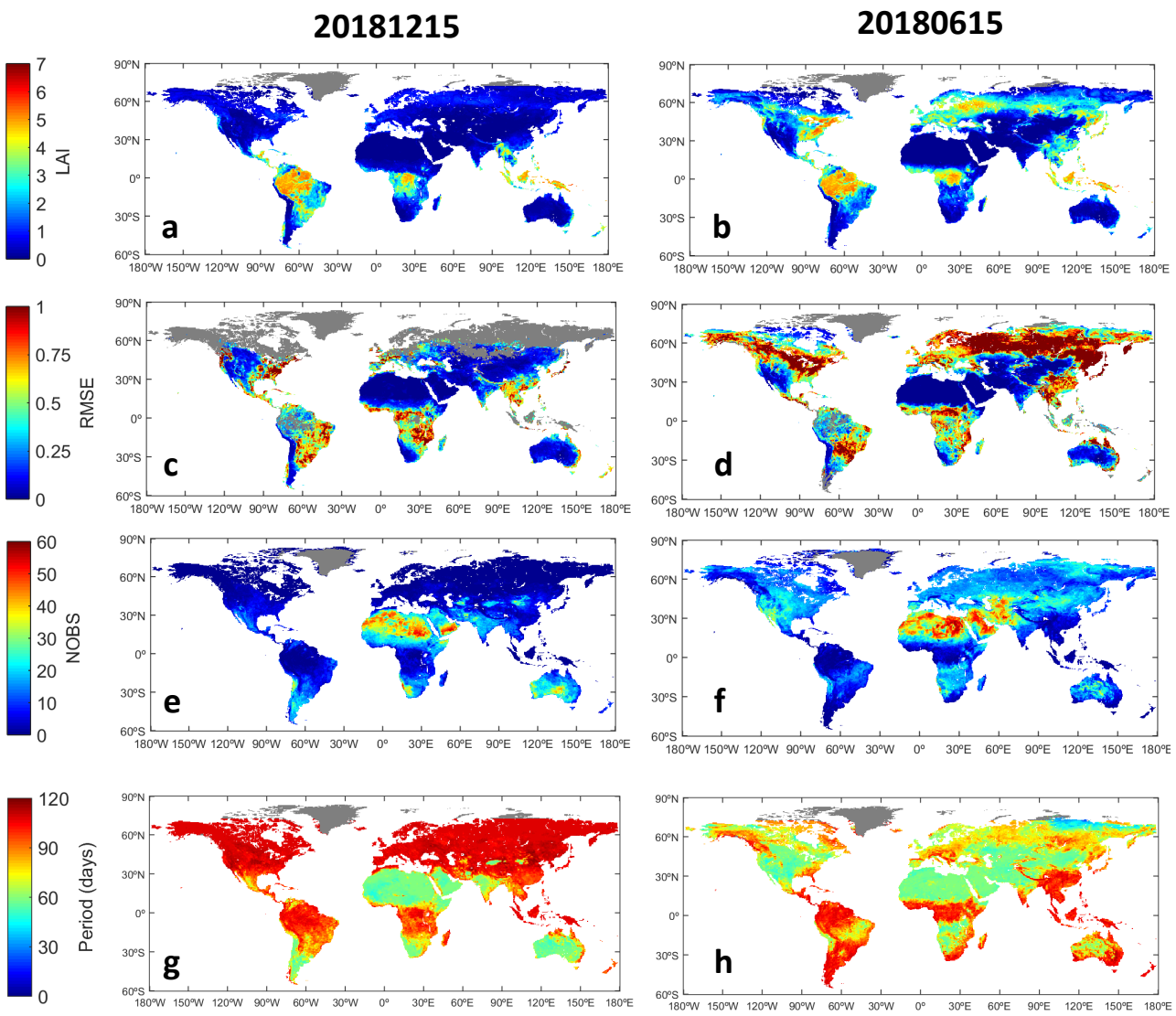
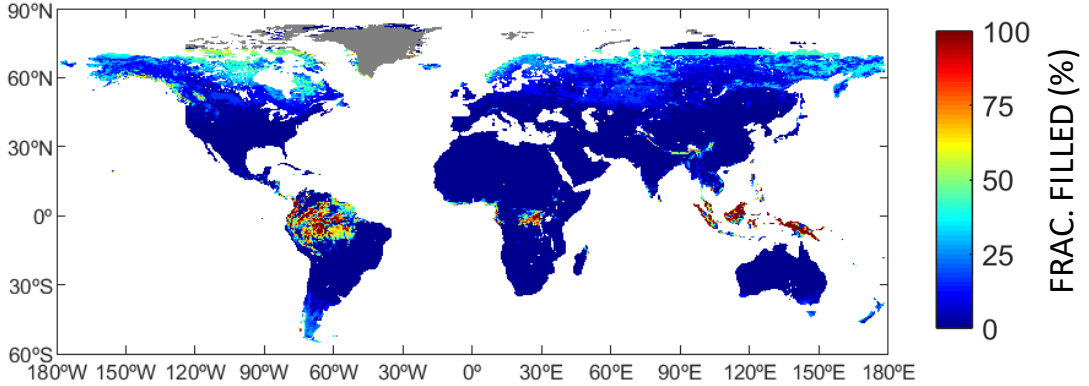
Quality flags and quality indicators

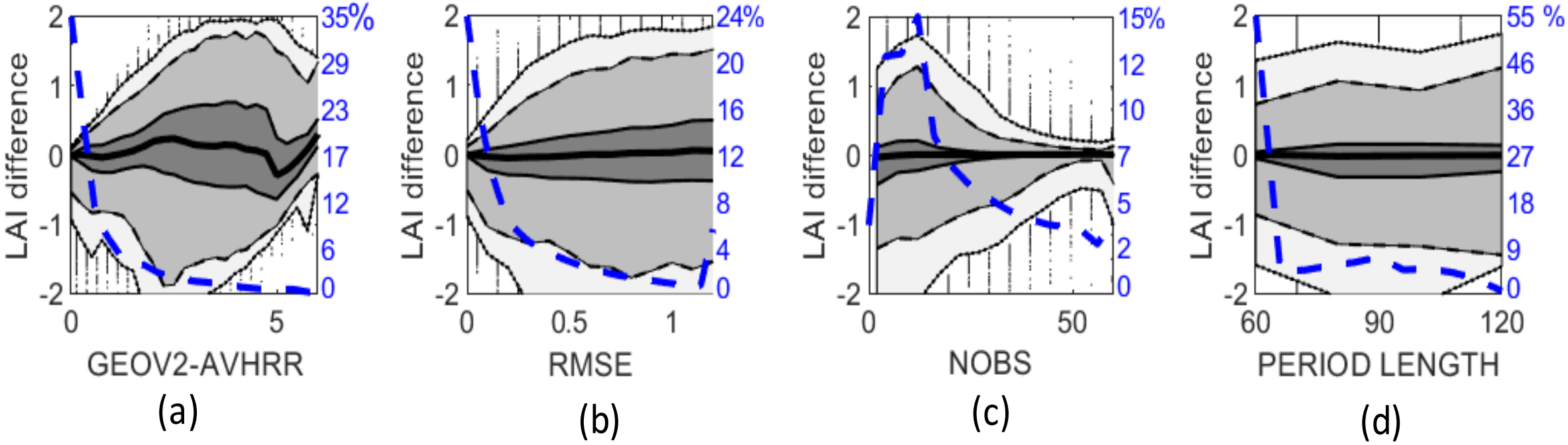


Fraction of dekads with no valid daily estimates



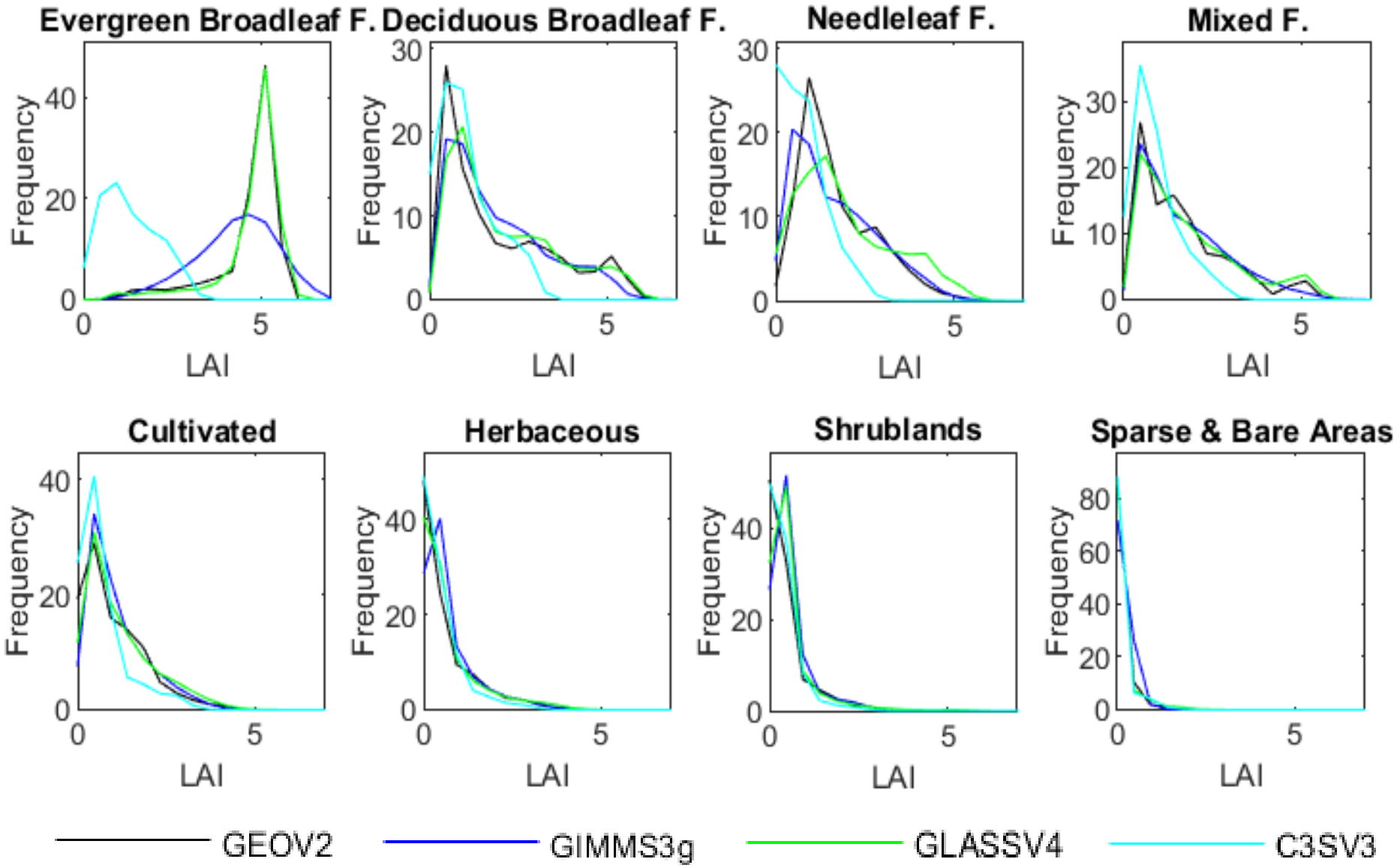
Consistency with GEOV2-CGLS

GEOV2-AVHRR – GEOV2-CGLS (1999-2018)



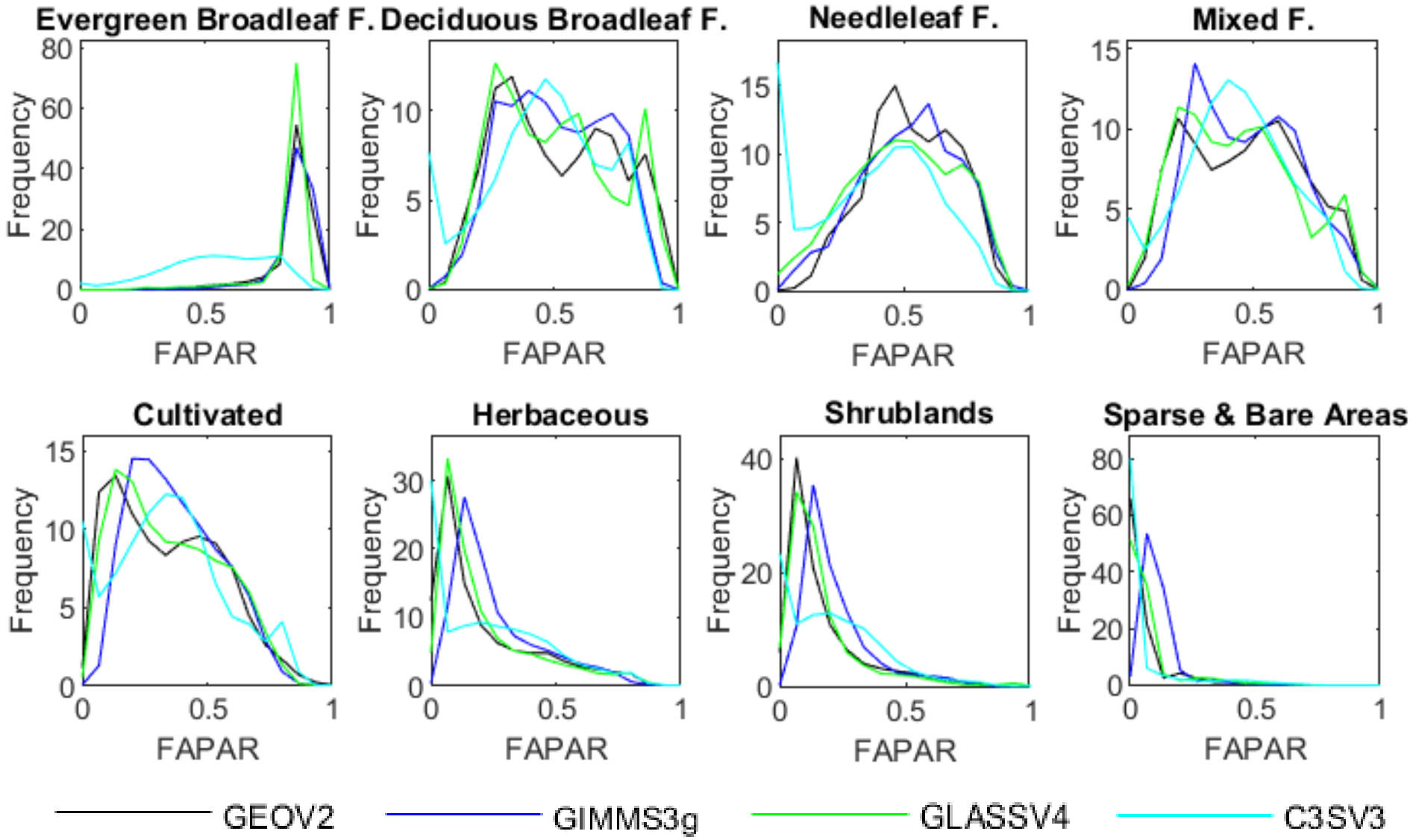
Statistical analysis

LAI



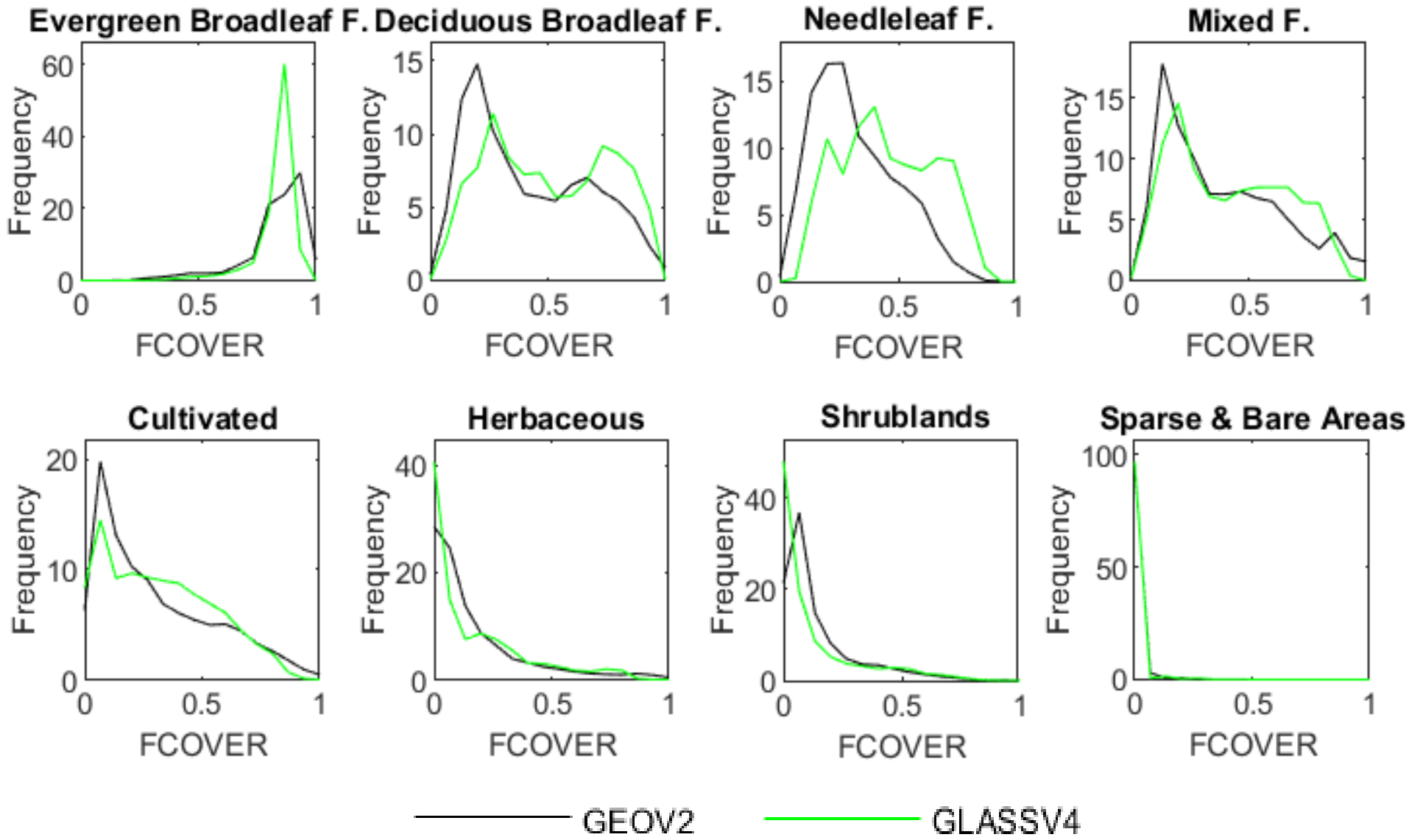
Statistical analysis

FAPAR

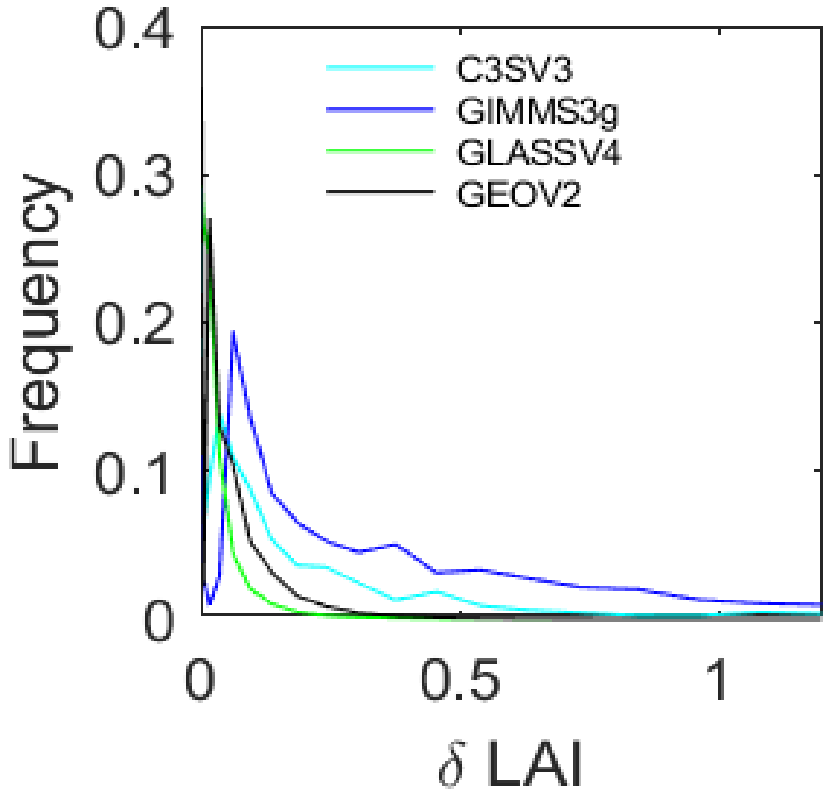


Statistical analysis

FCover



Temporal smoothness



FAPAR-FCover consistency