Land use and vegetation data in the IFS
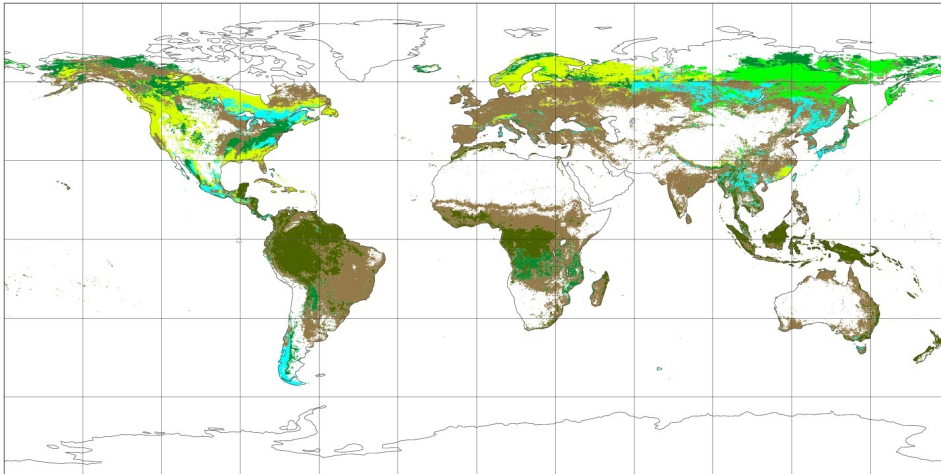
Souhail Boussetta, Gianpaolo Balsamo, Emanuel Dutra, Gabriele Arduini,

Margarita Choulga, Nils Wedi, Anna Agusti-Panareda, Joe McNorton

ECMWF

Current LU/LC status in the IFS

GLCC1.2 high veg type
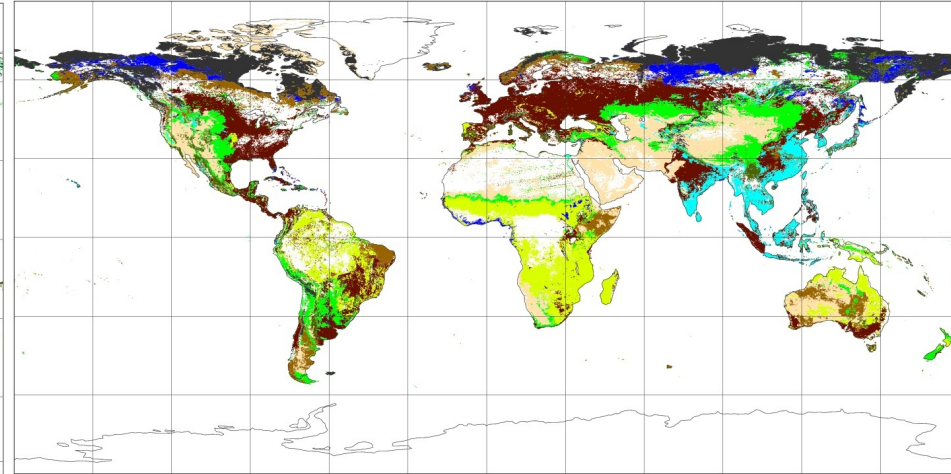Climate v015; High vegetation type; Tco1279

ever needle   deci needle   deci broad   evergr broad   mix forest   int forest

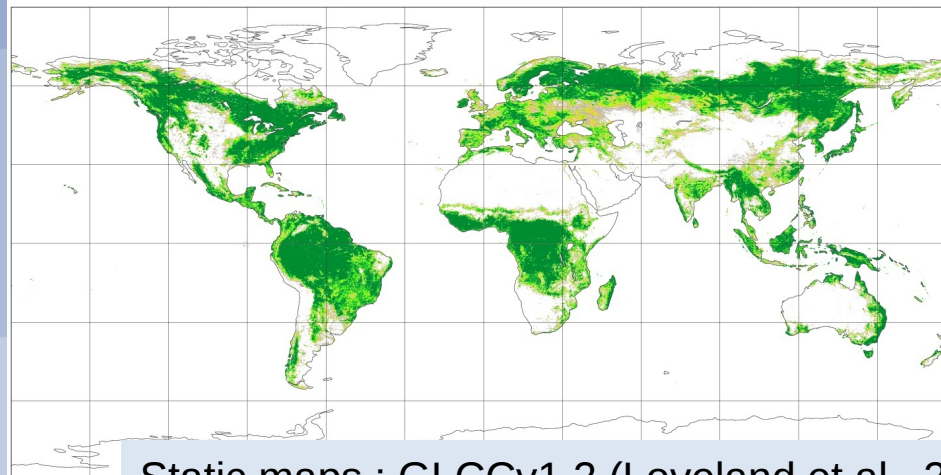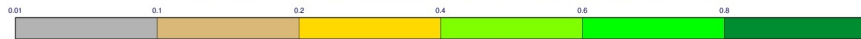### GLCC1.2 low veg type
Climate v015; Low vegetation type; Tco1279

crops   sh grass   tall grass   tundra   irr crops   semi desert   bog/marsh   evergr shrub   deci shrub
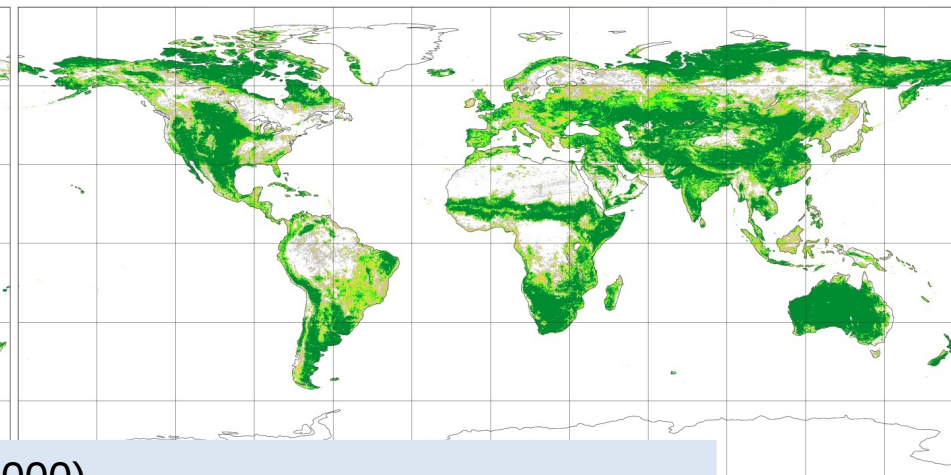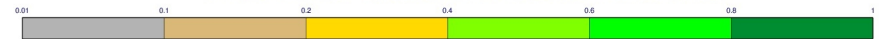
GLCC1.2 high veg cover
Climate v015; High vegetation cover; Tco1279 mean:0.33; max:1

0.01   0.1   0.2   0.4   0.6   0.8   1

GLCC1.2 low veg cover
Climate v015; Low vegetation cover; Tco1279 mean:0.43; max:1

0.01   0.1   0.2   0.4   0.6   0.8   1

Static maps : GLCCv1.2 (Loveland et al., 2000)
Mixed and Interrupted forest are not "pure" PFTs
Almost binary cover for low and high vegetation

New LU/LC planned for the IFS

ESA-CCI high veg type
ESA-CCI; High vegetation type; Tco399

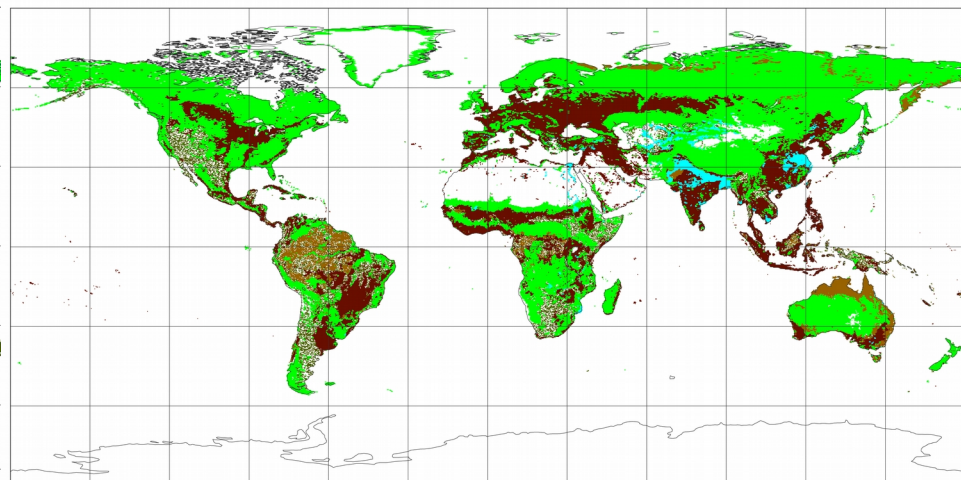Thursday 15 July 9999 00 UTC ecmf t+0 VT:Thursday 15 July 9999 00 UTC surface Type of high vegetation

ever needle | deci needle | deci broad | evergr broad | mix forest | int forest
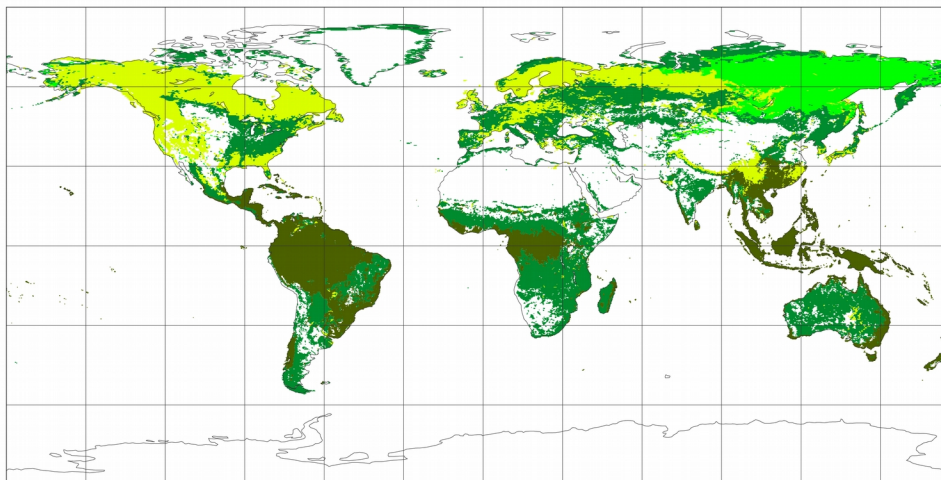
ESA-CCI low veg type
ESA-CCI; Low vegetation type; Tco399

Thursday 15 July 9999 00 UTC ecmf t+0 VT:Thursday 15 July 9999 00 UTC surface Type of low vegetation
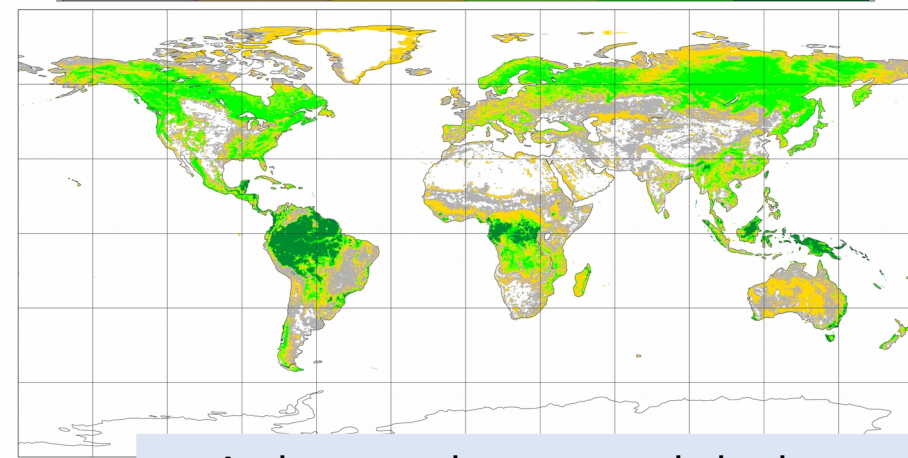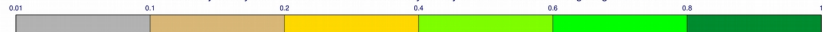
crops | sh grass | tall grass | tundra | irr crops | semi desert | bog/marsh | evergr shrub | deci shrub

ESA-CCI high veg cover
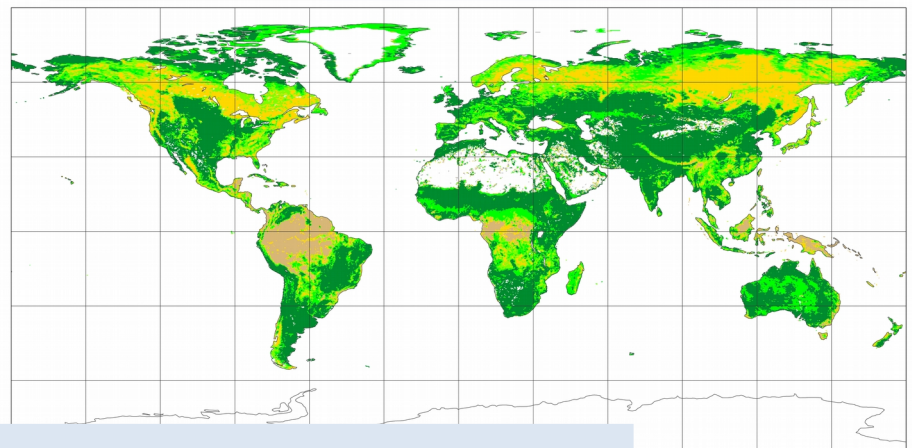ESA-CCI; High vegetation cover; Tco399 mean:0.25; max:0.9

Thursday 15 July 9999 00 UTC ecmf t+0 VT:Thursday 15 July 9999 00 UTC surface High vegetation cover

0.01 | 0.1 | 0.2 | 0.4 | 0.6 | 0.8 | 1

ESA-CCI low veg cover
ESA-CCI; Low vegetation cover; Tco399 mean:0.57; max:1

Thursday 15 July 9999 00 UTC ecmf t+0 VT:Thursday 15 July 9999 00 UTC surface Low vegetation cover

0.01 | 0.1 | 0.2 | 0.4 | 0.6 | 0.8 | 1
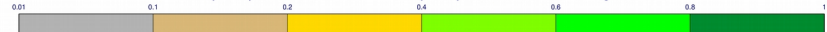
- An increase in grass and shrub types wrt to crops.
- An increase of low vegetation at the expense of the high vegetation in forest areas and a decrease of low vegetation favouring more bareground

3

Percentage of vegetated points at Tco399

| Index	Vegetation type	Percentage of land points ESA-CCI	GLCCv1.2
	Low vegetation		
1	crops	23.50%	18.00%
2	short grass	38.70%	9.00%
7	tall grass	0.00%	12.80%
9	tundra	0.70%	6.00%
10	irrigated crops	1.90%	3.90%
11	Semi desert	0.00%	11.60%
13	bog/marsh	0.00%	1.50%
16	evergreen shrub	5.10%	1.20%
17	deciduous shrub	4.70%	3.90%
	Remaining points	25.00%	31.40%
	High Vegetation		
3	evergreen needleleaf	11.70%	5.40%
4	deciduous needleleaf	4.70%	2.50%
5	deciduous broadleaf	29.50%	5.60%
6	evergreen broadleaf	18.20%	12.90%
18	mixed forest	0.00%	3.00%
19	interrupted forest	0.00%	24.70%
	Remaining points	35.60%	45.50%

- Hybrid vegetation types (interrupted or mixed forest) disappear.
- Classification depends also on cross-walking table choices
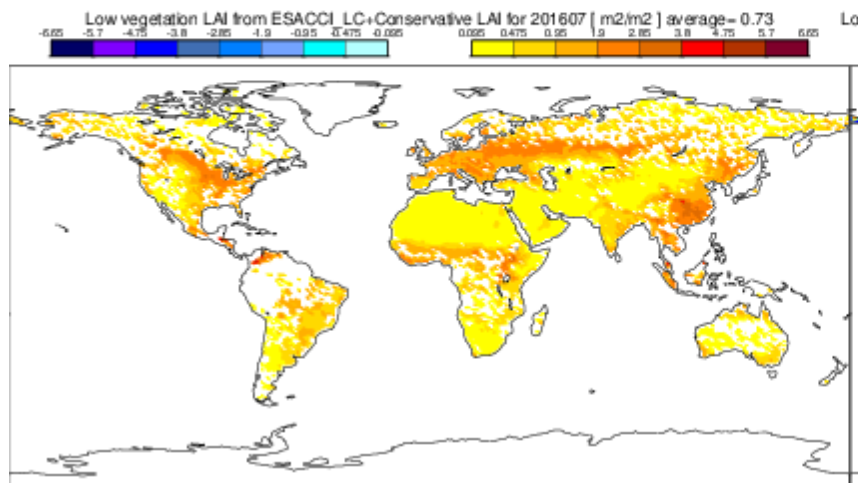
Leaf Area Index disaggregation operator
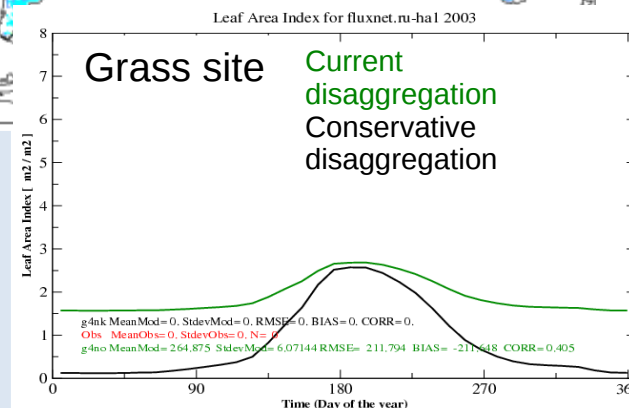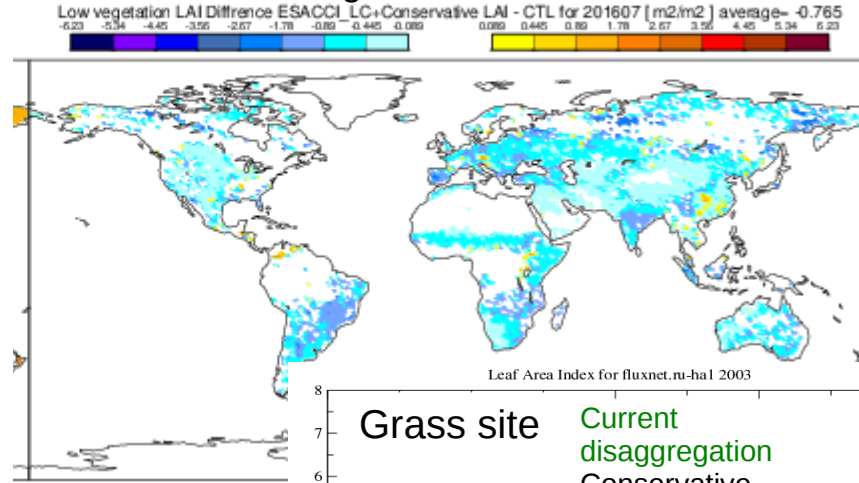
High veg LAI conservative
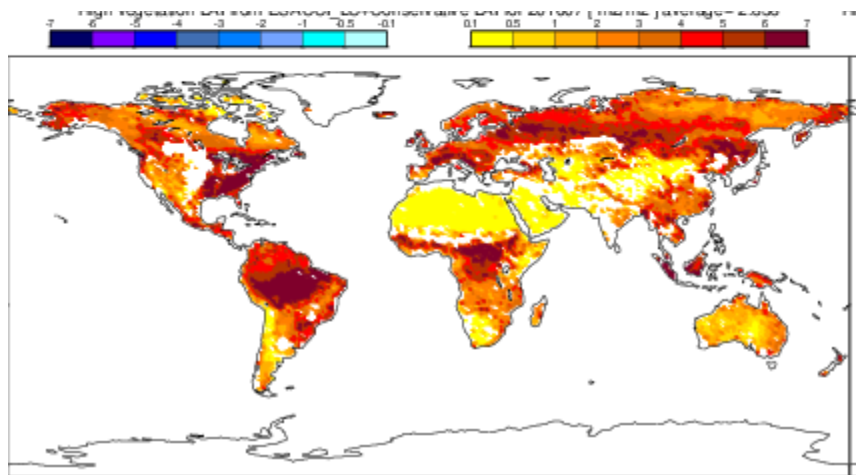
High veg LAI conservative - ctl
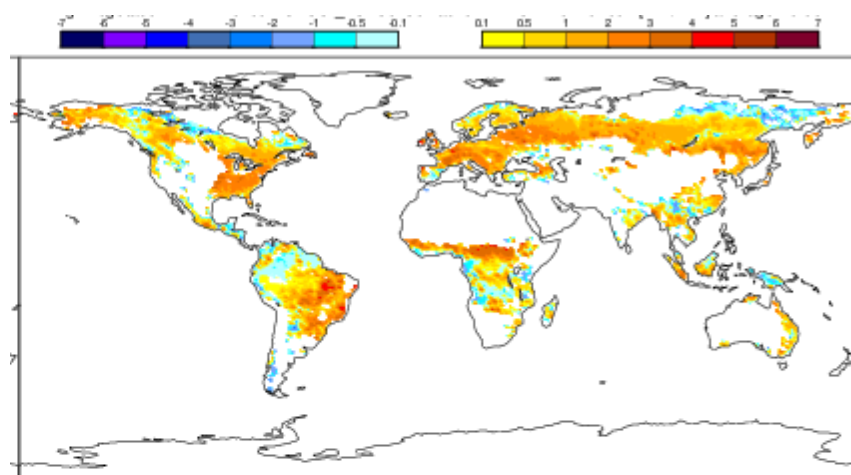
Low veg LAI conservative

Low veg LAI conservative - ctl

Leaf Area Index for fluxnet.ru-ha1 2003

Grass site

Current disaggregation
Conservative disaggregation

An update of the LAI disaggregation operator

- More consistent and conservative of the observed total LAI.
- Increase of the high vegetation LAI and an decrease of the low vegetation LAI when using the ESA-CCI land cover.
- CGLS LAI to be used for prospective assimilation.

LAI high/low vegetation disaggregation operator

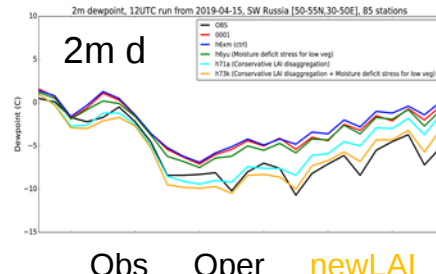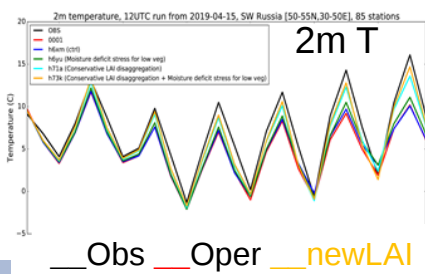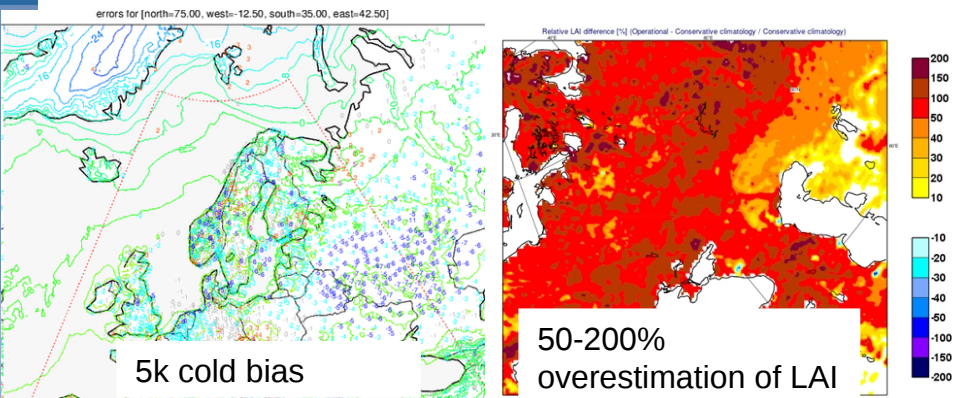**April 2019 SW Russia case**

errors for [north=75.00, west=-12.50, south=35.00, east=42.50]

5k cold bias

Relative LAI difference [%] (Operational - Conservative climatology / Conservative climatology)

50-200% overestimation of LAI

2m T

2m d

___Obs ___Oper ___newLAI   ___Obs ___Oper ___newLAI

T+36   DJF   T+48

MAM

JJA

SON
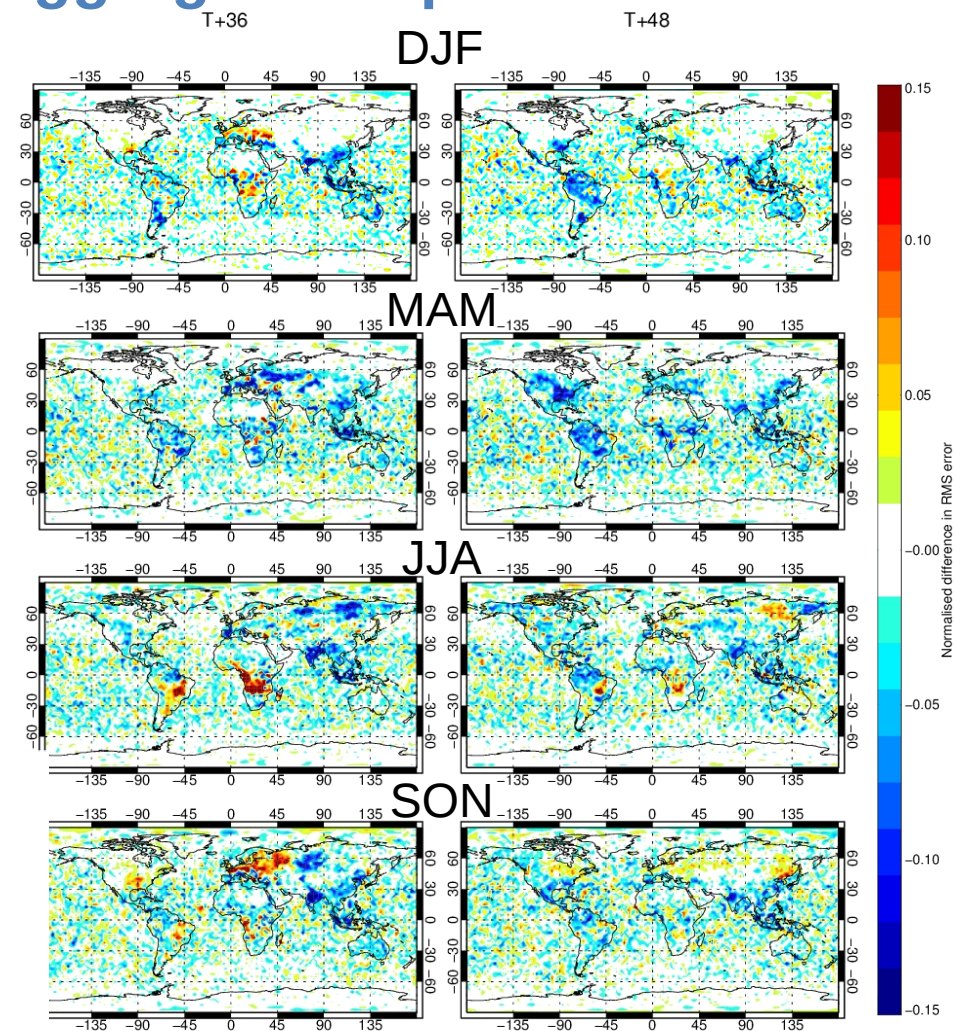
Change in RMSE error of the 2m temperature

- SW Russia case shows that using new LAI disaggregation correct for an overestimation of the LAI that lead to a cold/wet bias.
- Overall beneficial for the scores of near surface atmosphere (although some adjustment of the vegetation parameters might be necessary to overcome the autumn bad scores over Europe)
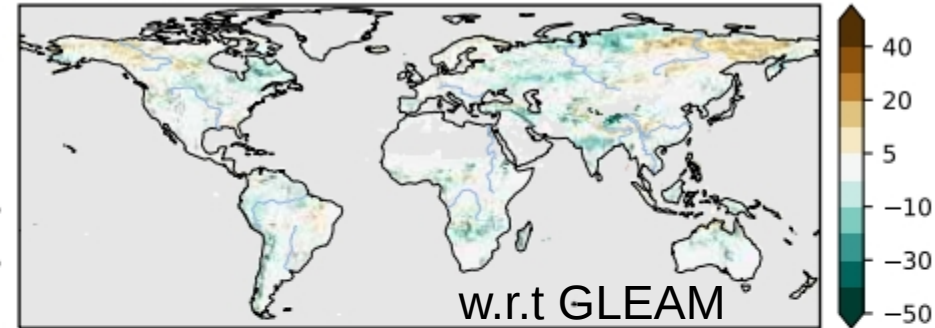
Impact on Surface flux (Offline simulations, ESA-CCI LU + LAI)

Annual mean evapotranspiration
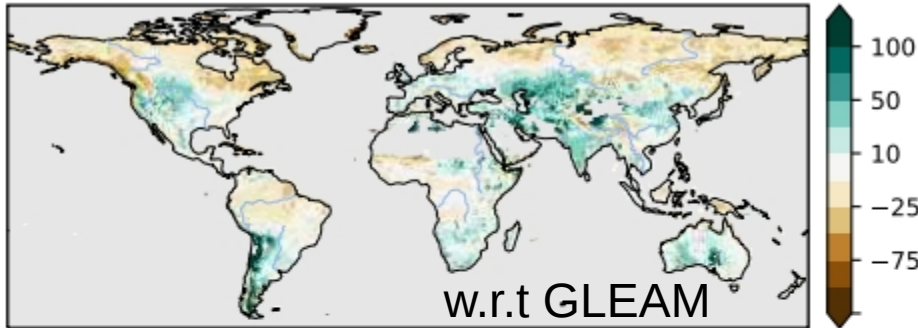
a) CTR pbias ET (vs GL3b)
b) |CLAI|-|CTR| pbias ET (vs GL3b)
c) CTR pbias ET (vs FCRS)
d) |CLAI|-|CTR| pbias ET (vs FCRS)

w.r.t GLEAM

w.r.t GLEAM

w.r.t FluxCom

w.r.t FluxCom
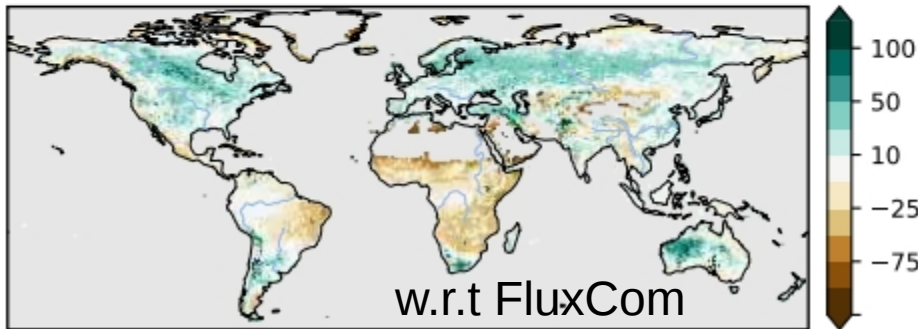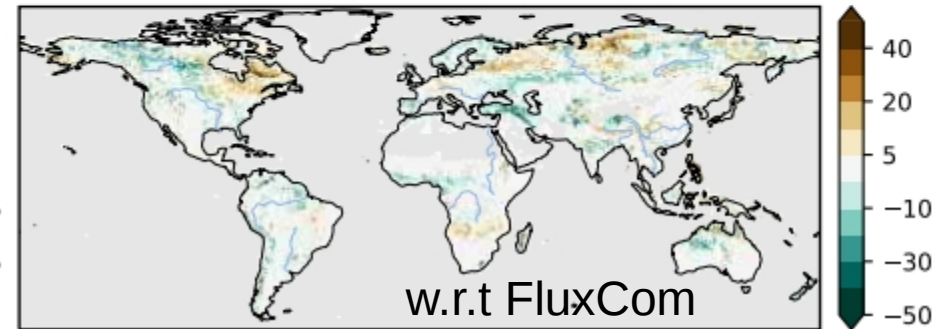
Percentage bias

Percentage bias difference CLAI - CTR

- ◆ An overall reduction of the bias with regards to GLEAM and FluxCom products.
- ◆ The bias change of CLAI with respect to CTR are reasonably small when compared with the differences the differences between the obs-based products.

Impact on 2m Temperature (Fc simulations, ESA-CCI LU + LAI)

2m temperature normalised rmse difference
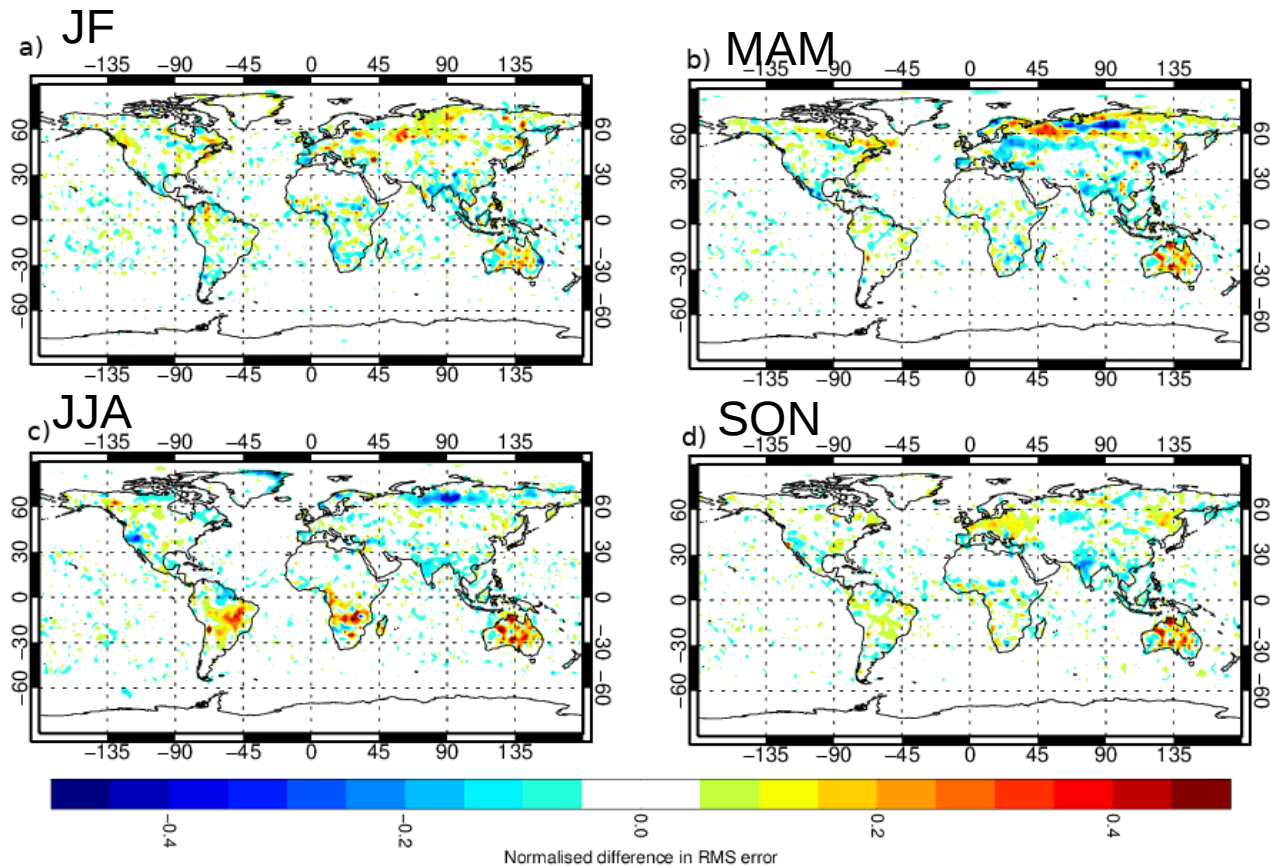
- Mixed signal in different areas with a marked reduction of the 2m temperature rmse in the northern hemisphere during MAM and JJA
- Some areas still show degradation pointing to the need for additional investigations and a parameter optimization .

Seasonal vegetation cover
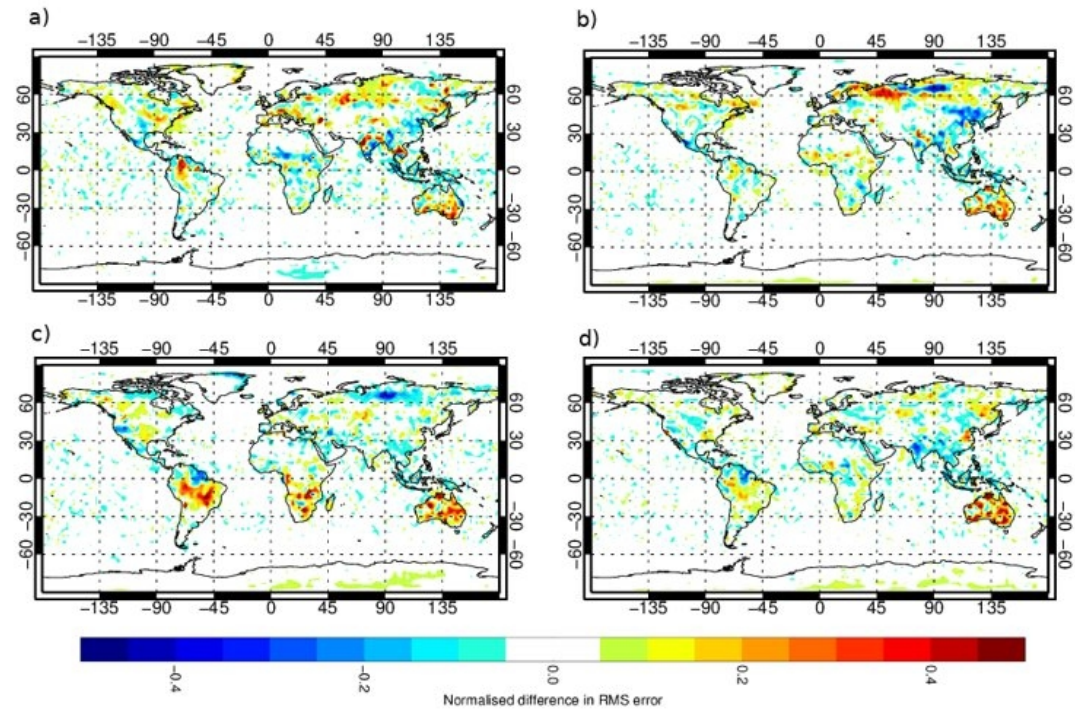

a) Bareground fraction diffrence seasonal - fixed for July

b) Seasonal amplitude of the bareground fraction July-January
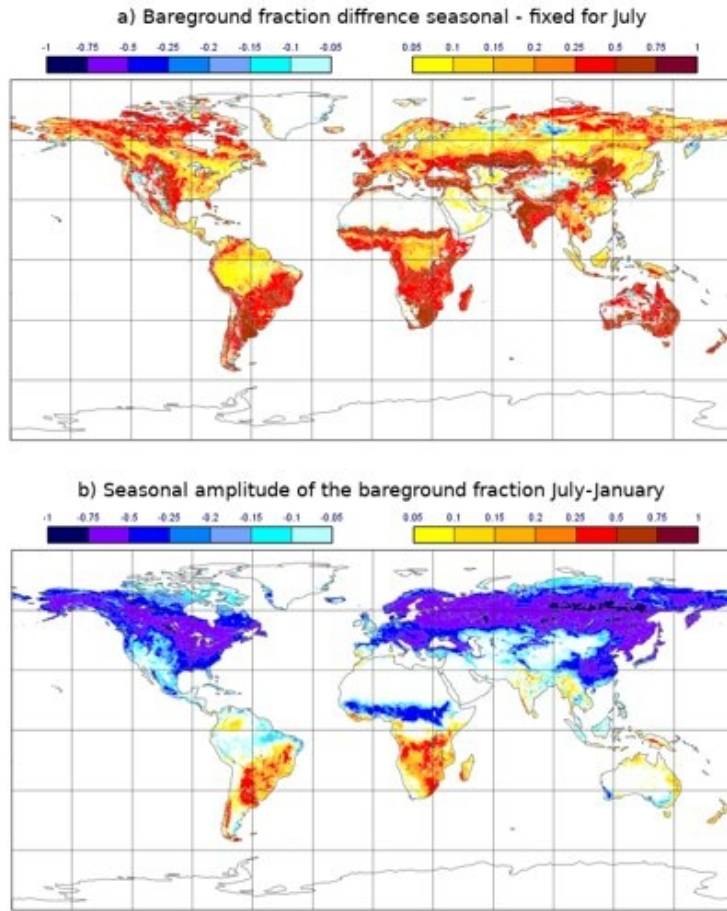
Same as previous slide: Although there is a substantial difference in the bareground fraction, most signal is coming from the LU map change

Vegetation cover based on LAI seasonality following Lambert-Beer law

Summary

- An update of the vegetation status in the ECMWF model is being explored by introducing:

    - ESA-CCI/C3S LC/LU maps

    - Conservative disaggregation operator for the LAI

    - Vegetation cover seasonality based on clumping

- Introducing ESA-CCI LU/LC results in an increase in low vegetation cover at the expense of the high vegetation cover and allow removing "non pure" vegetation types.

- Combining the ESA-CCI LU/LC with the new LAI disaggregation results in modification of the surface fluxes which is strengthen when introducing the seasonal land cover variation. And forecast simulations show mixed scores which suggests that parameters related to L-A interaction would need optimisation/tuning.

Perspectives

- Confirm Cross-walking table choices

- Include climate zones information (Köppen-Geiger)

- Introduce C3/C4 sub-classification (C. Still et al)

- Tight links with CONFESS and CoCO2 projects

ECMWF European Centre for Medium-Range Weather Forecasts

Discussion questions

- Cross-walking table choices and sub-classifications

- Change of vegetation cover associated with fires not taken into account

- How to include uncertainty of land cover map in LSM simulations?

- Managed land?

- Wet land (CAMS41)

ECMWF **European Centre for Medium-Range Weather Forecasts**