Exploring the potential use of vegetation related satellite products within an NWP framework

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Why vegetation state is important?

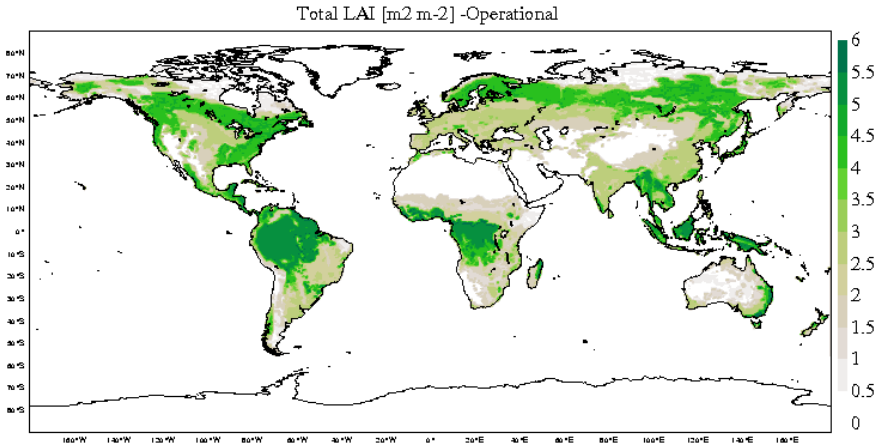
- **Because it affects**
  - ❖ **Evapotranspiration and energy partition**
  - ❖ **Boundary layer developement**
  - ❖ **Cloud and precipitation ...**
  - ❖ **the global carbon cycle and interact with climate change conditions**

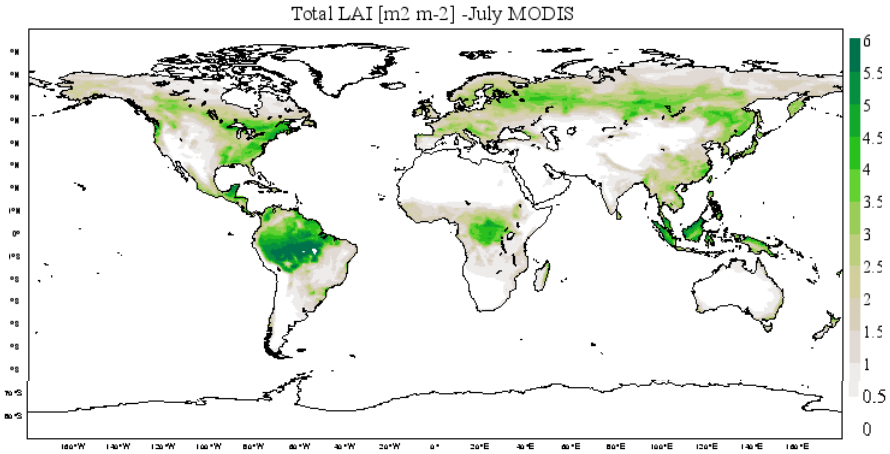
- **Earth System Models are evolving:**
  - ➔ **Higher resolution**
  - ➔ **Needs for higher physical complexity**
  - ➔ **Better representation of vegetation dynamic is needed**

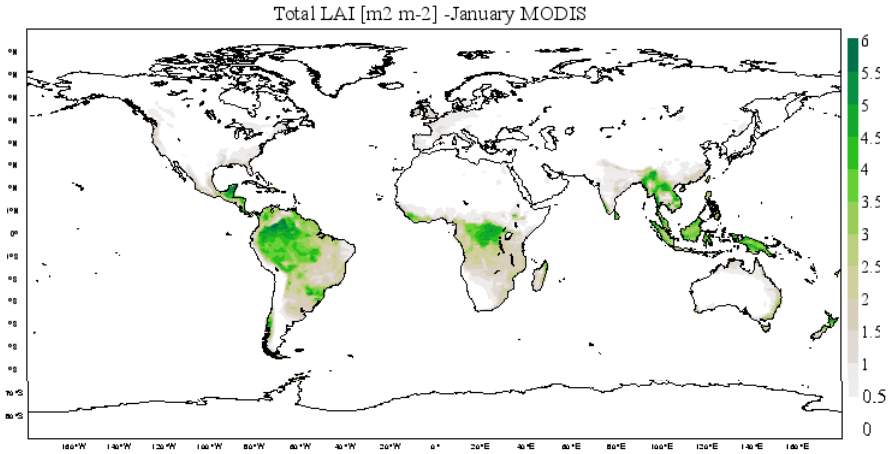
- **Satellite observations informative on the vegetation state are becoming more and more available and with higher accuracy & frequency**

More realistic vegetation cycle: From Static to Satellite-based monthly varying Leaf Area Index

Seasonal Varying Leaf Area Index







derived 8years (2000-2008) climatological time series from MODIS c5 products

Satellite-based LAI climatology introduce a more realistic seasonal variability of the vegetation state compared to the constant LAI map which used to overestimate LAI especially in winter and during the transition periods of spring and autumn

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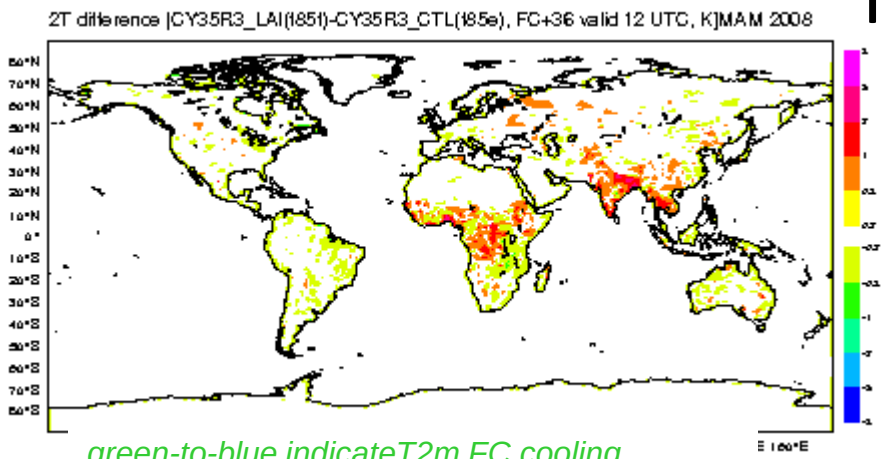
Coupled DA experiment with the monthly varying LAI

Sensitivity

T 2m

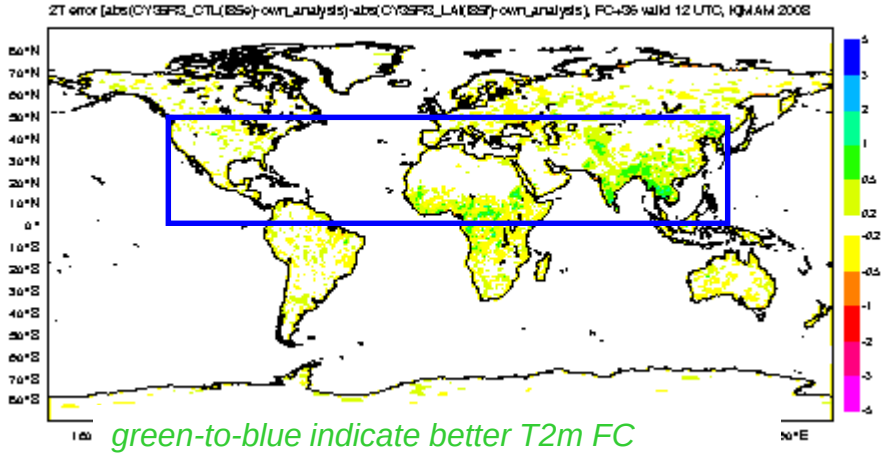


green-to-blue indicateT2m FC cooling

Setup:	T255 14/02/2008 -1/09/2008 Seasonal LAI vs fixed LAI

Sensitivity = CVEG - CTL ,
if >0 => Warming
if <0 => Cooling

Impact



green-to-blue indicate better T2m FC

Impact = |CTL – analysis| - |CVEG – analysis| ,
if >0 => relative error reduction from the analysis (positive impact)
if <0 => relative error increase from the analysis (negative impact)

The Satellite LAI introduces a consistent warming seen in FC36h (12UTC) due to reduction of LAI in spring, (increasing vegetation resistance to ET).

This has beneficial impact on near surface temperature forecast (green being positive impact in reducing t2m bias by ~0.5degree)

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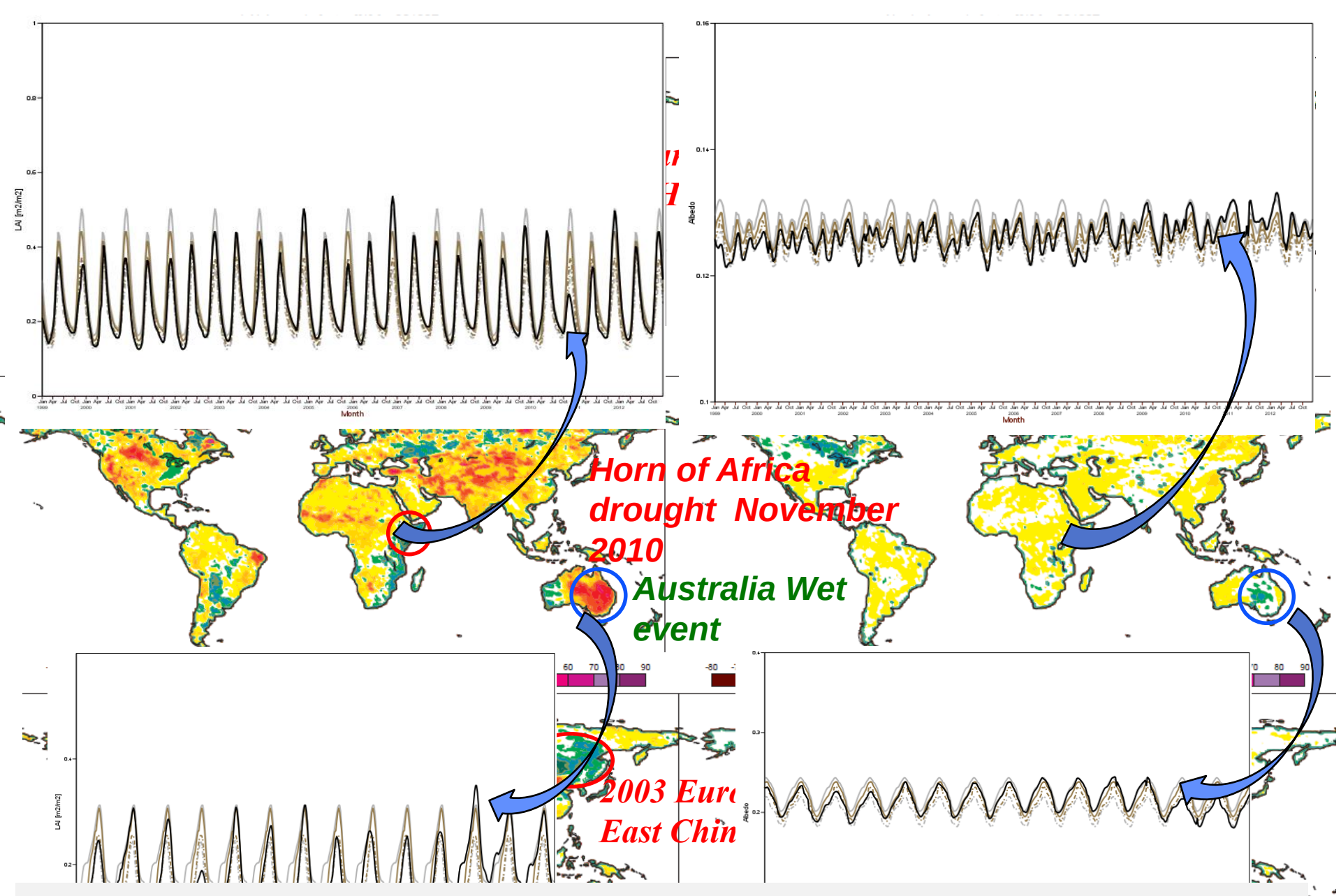
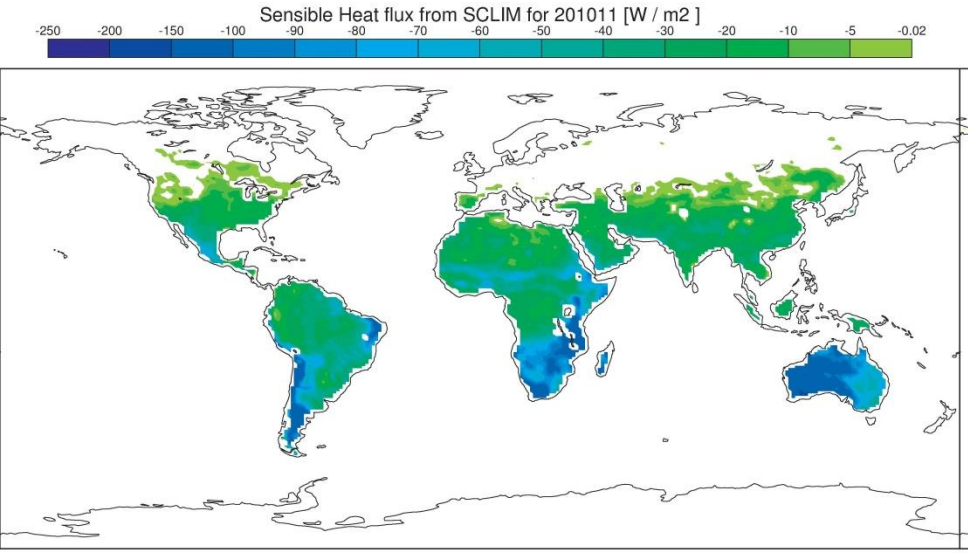
More and more realistic vegetation dynamic: Assimilation of Near Real Time LAI/Albedo



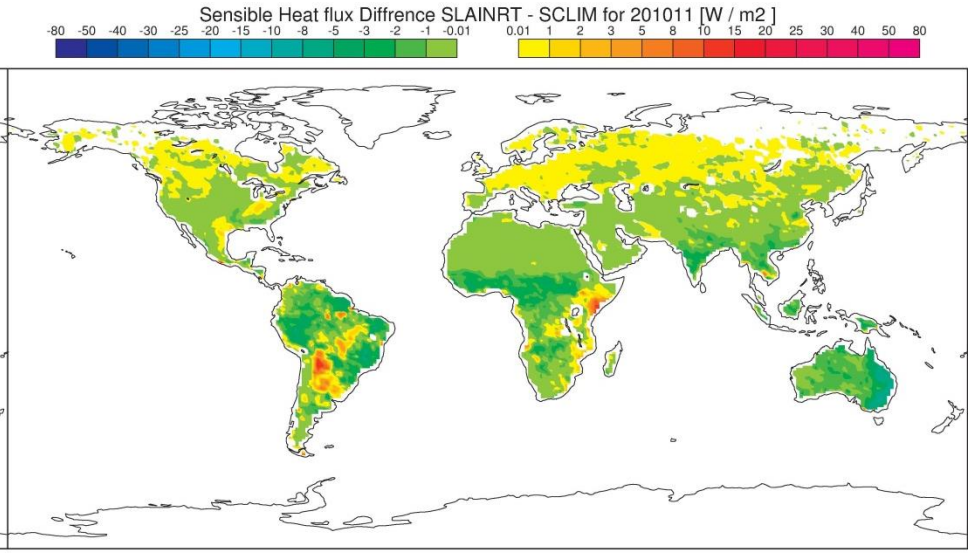
➔ NRT analysed LAI is able to fairly detect/monitor anomalous year

➔ The analysed LAI and albedo signal can be covariant mainly during wet year.

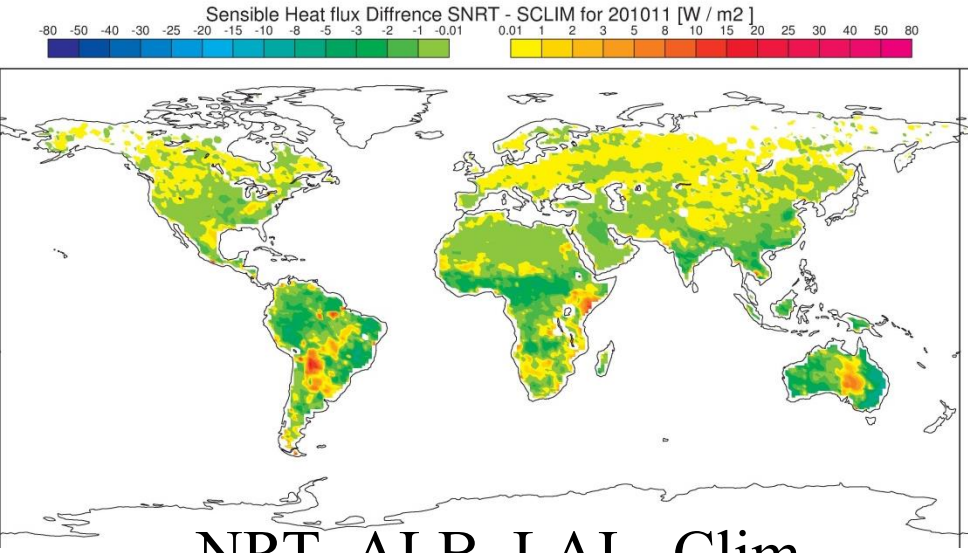
Sensible Heat flux



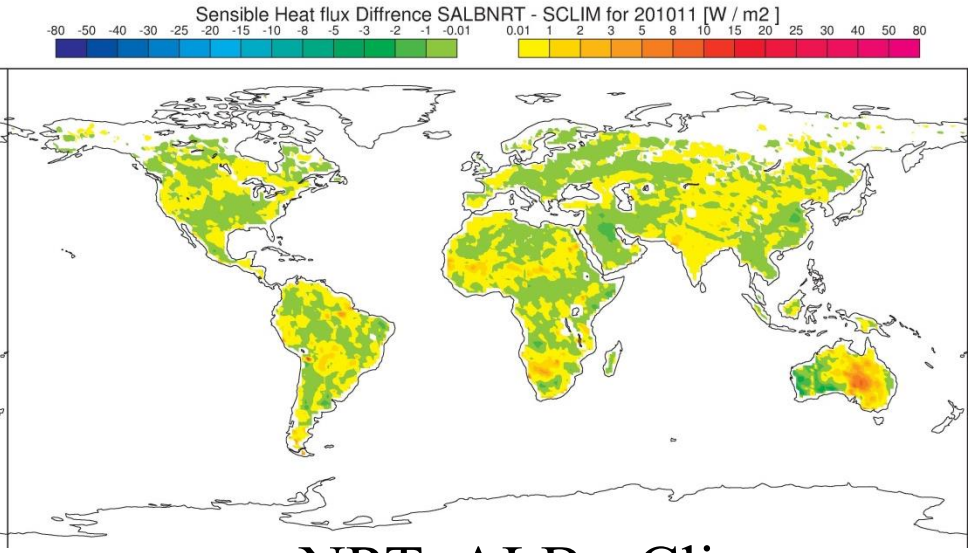
Clim



NRT_LAI - Clim



NRT_ALB_LAI - Clim



NRT_ALB - Clim

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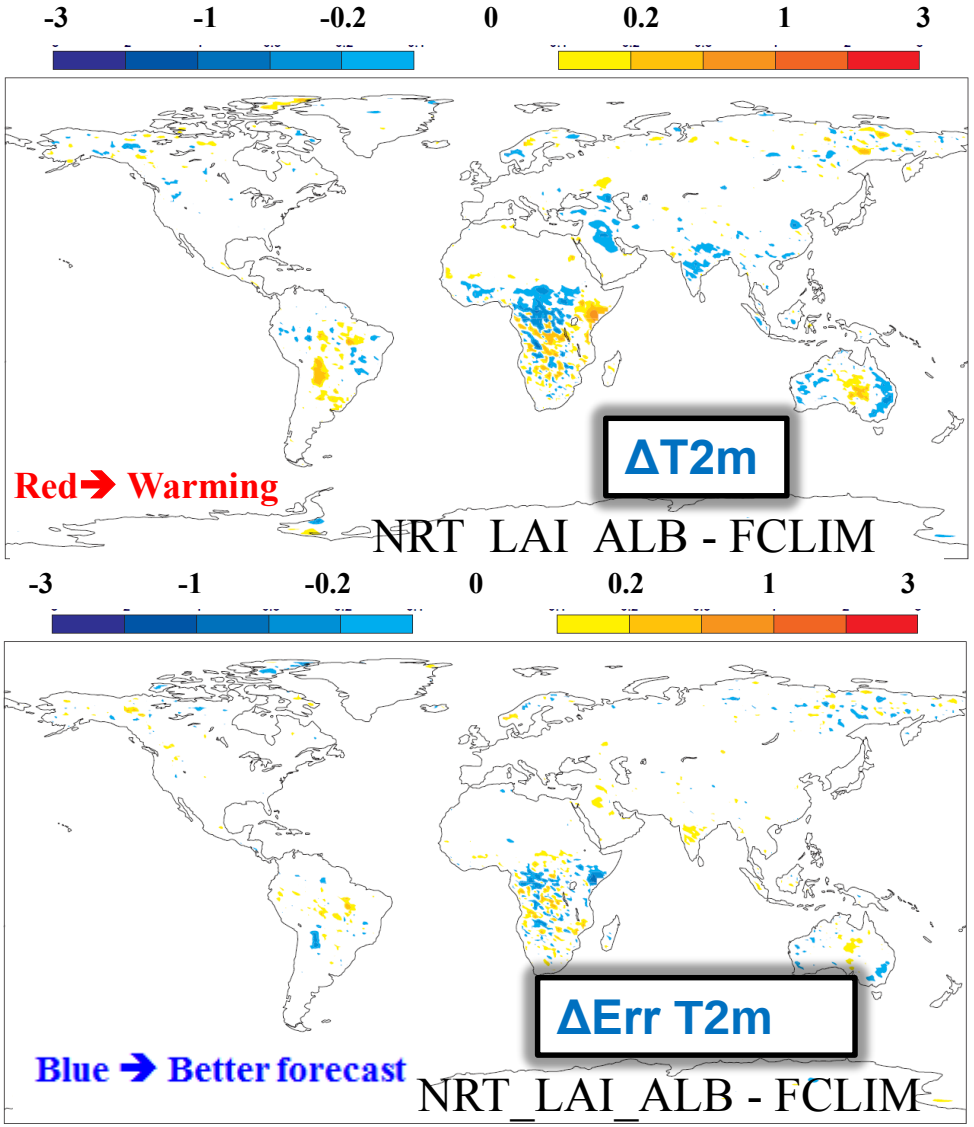
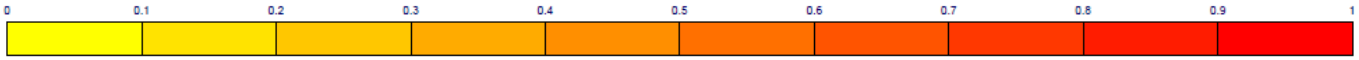
2m temperature sensitivity in coupled run

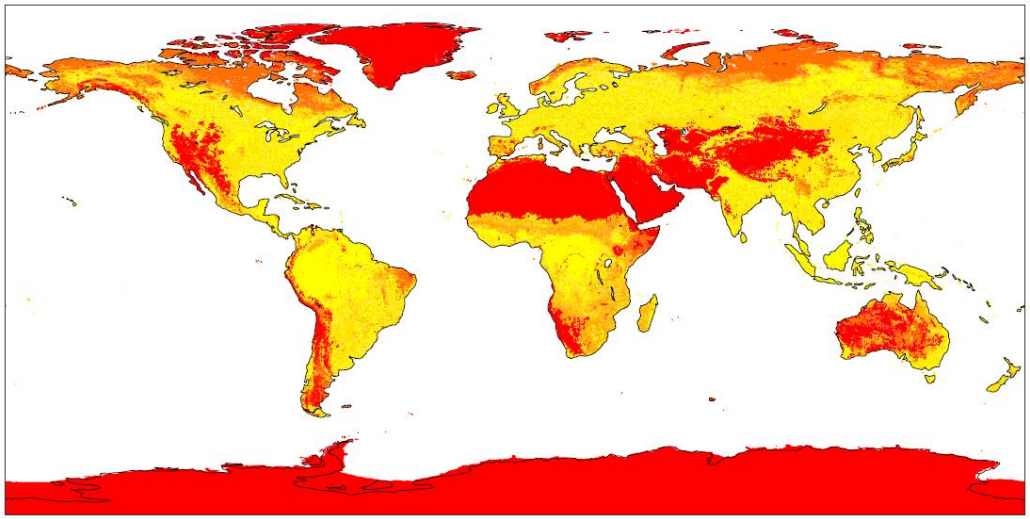


Even more realistic vegetation dynamic: Satellite derived variable vegetation cover

February May July October



(1- Vegetation fraction)



Bare-ground/snow cover
(1- Vegetation fraction)

➔ vegetation cover variation based on satellite observation of Leaf Area Index according to a modified Beer-Lamber law with clumping

$$C_{veg} = 1 - e^{0.5\omega LAI}$$

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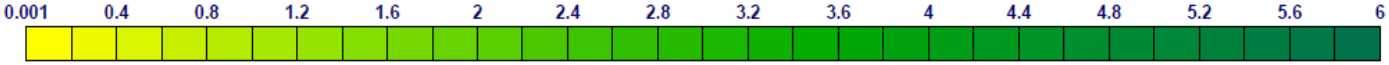
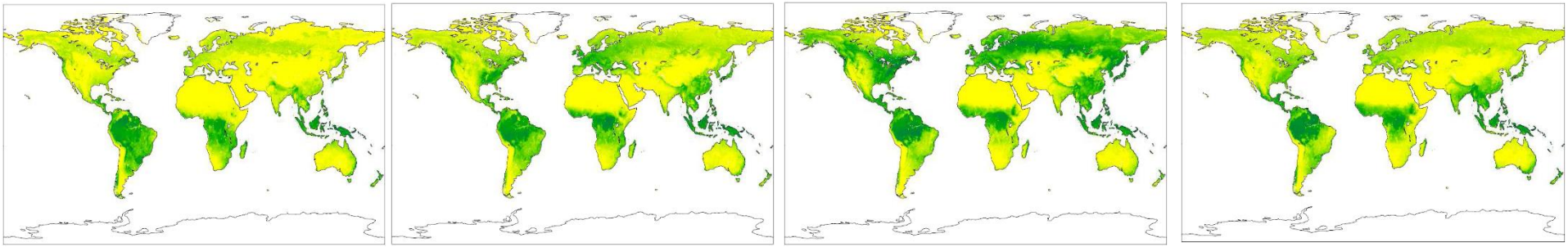
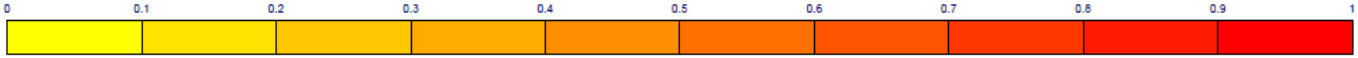
February May July October

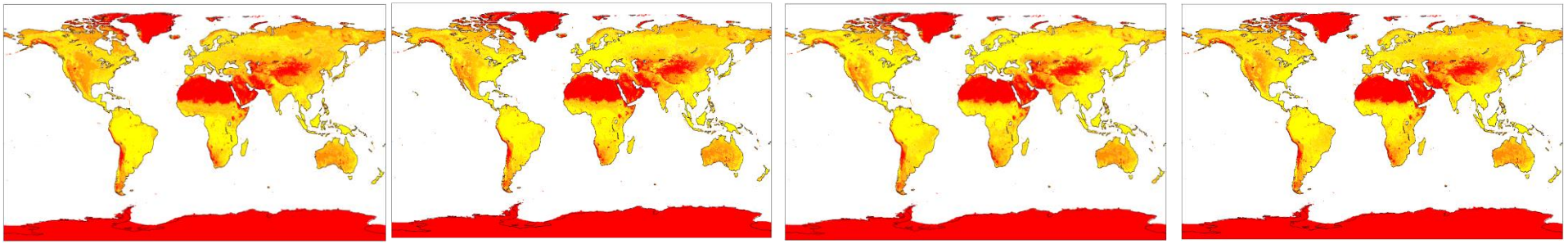


LAI



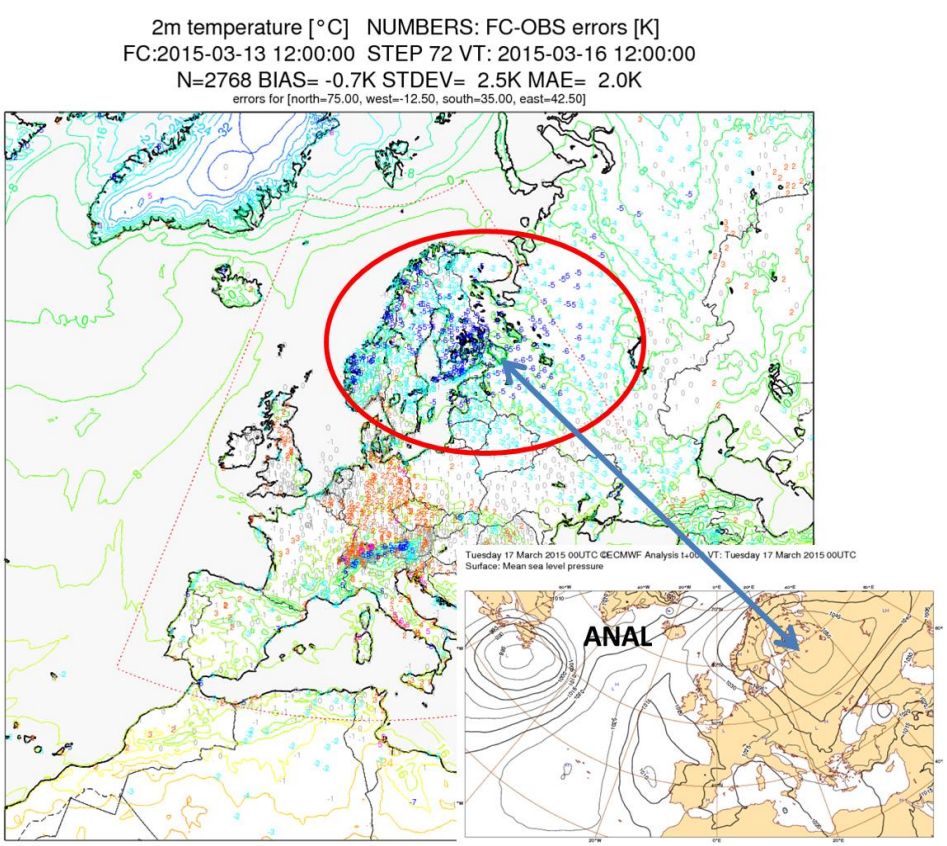


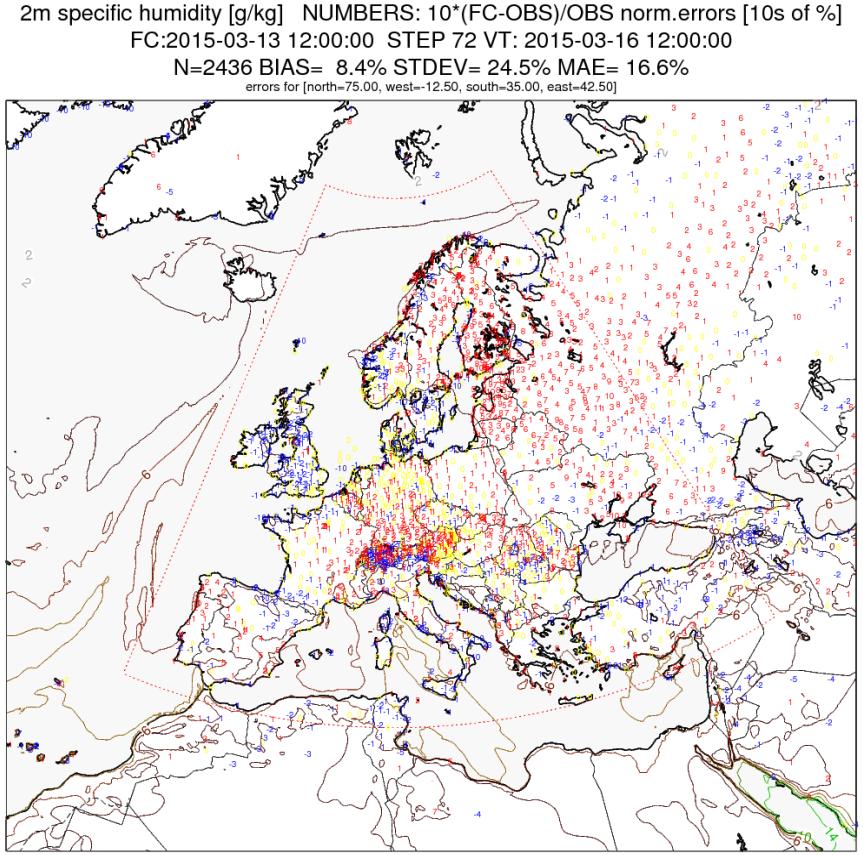
(1- Vegetation fraction)



➔ Physically-based seasonal variability of the vegetation cover

A Spring 2015 2m Temperature bias case





Cold bias on 2m Temperature
4K on average

Moist bias on 2m specific humidity 1g/kg on average

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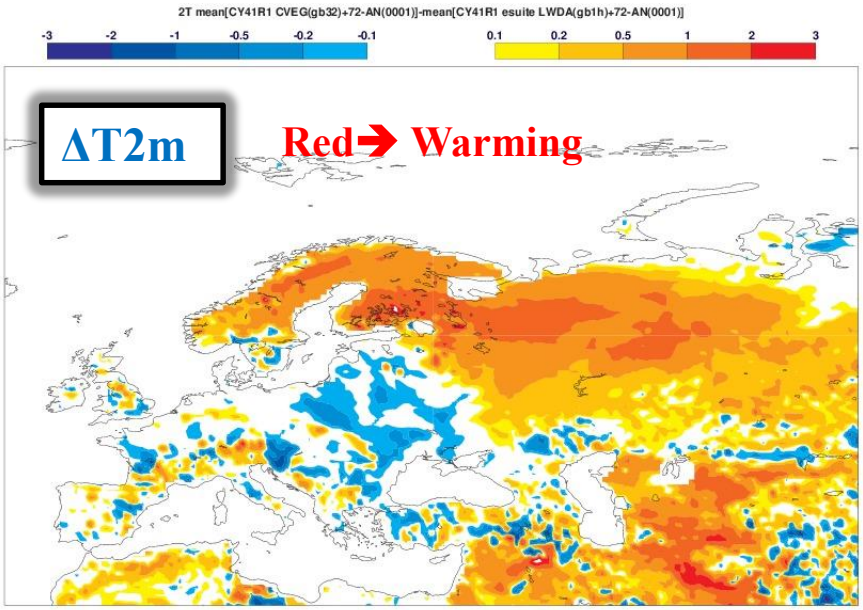
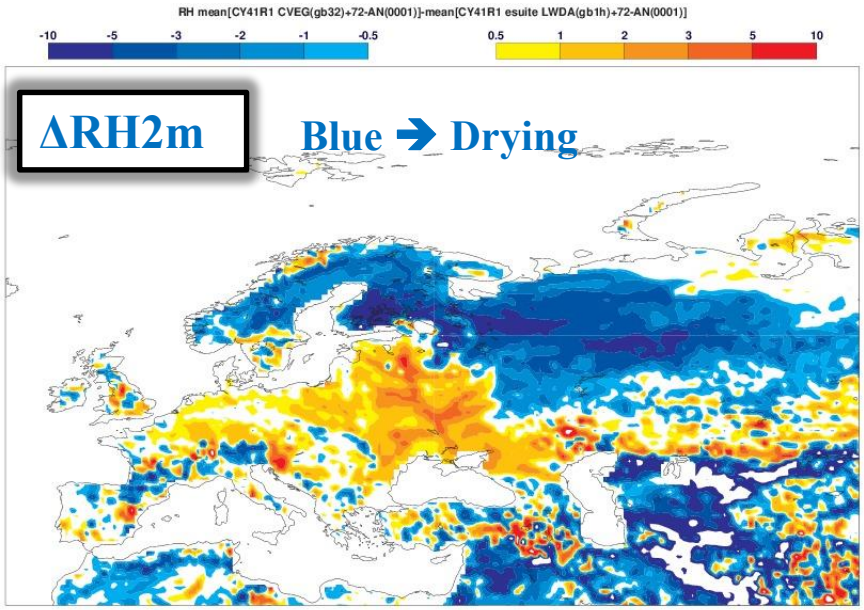
Weather forecasts sensitivity

➔Check the T 2m and RH on short term forecast fc+72 valid 12 UTC, March 2015





Sensitivity = CVEG - CTL ,

if >0 => Warming / adding moisture

if <0 => Cooling / removing moisture

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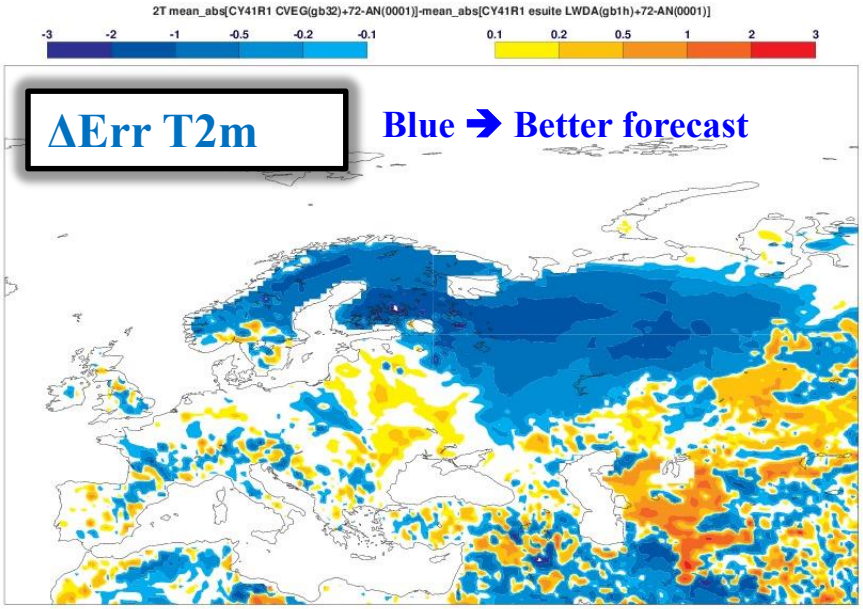
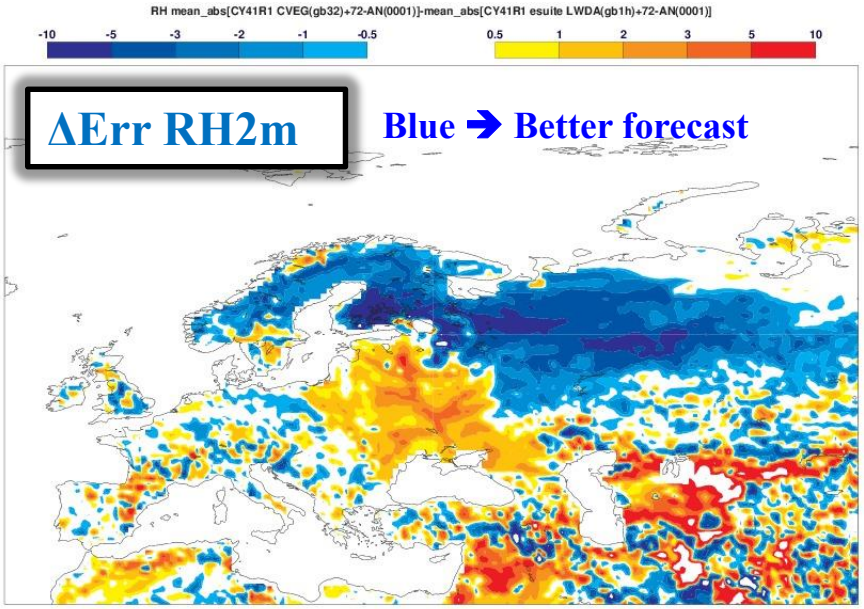
Weather forecasts impact





***Impact* = |*CTL – analysis*| - |*CVEG – analysis*|** ,

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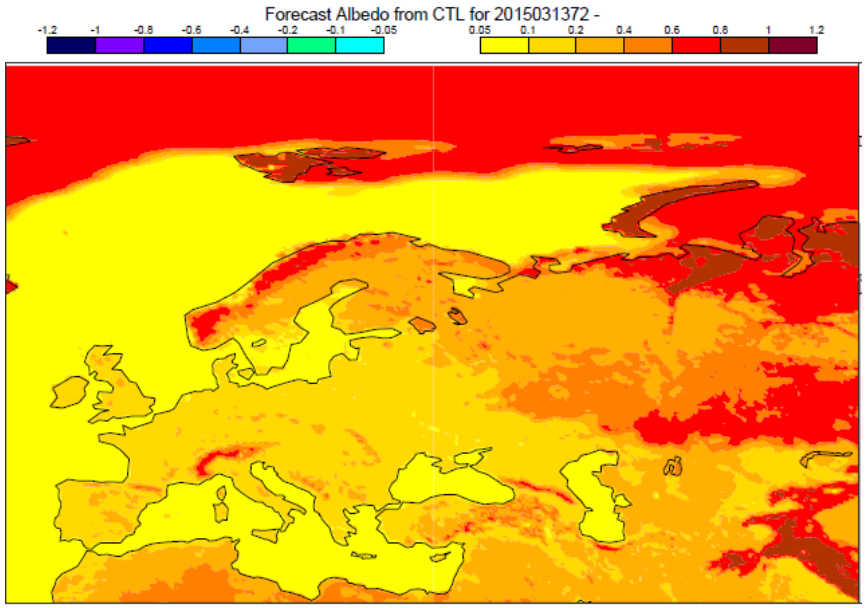
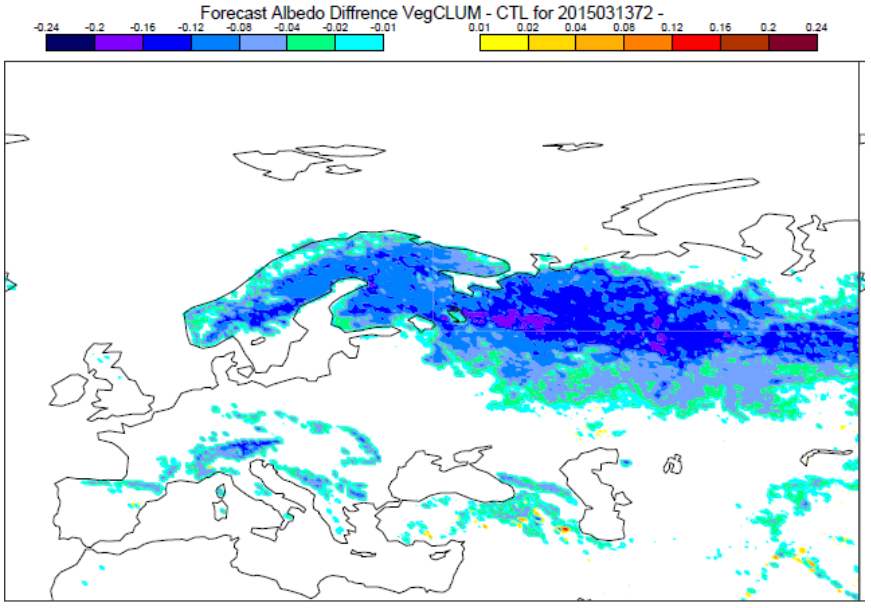
Behind the scene



Forecast Albedo for CTL



CVEG albedo – CTL albedo

➔ Change in the vegetation cover is linked with a change in the forest albedo in presence of snow (in this case)

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Outlooks & Perspectives

- Taking into account realistic vegetation dynamics is important for accurate representation of surface fluxes and eventually better atmospheric predictability.
- Enhanced connections between albedo, LAI (and roughness) in Earth System Models (ESMs) will most likely increase the sensitivity to vegetation dynamics.
- With increased surface related satellite observation products there is potential for further improvements of NWP systems linked with land surface.

➔better initialisation (& DA, see C. Albergel presentation)
➔better process description
➔possibility to better tune non-observable model parameters.

- With increased resolution ESMs will have to take into account additional layer of physical complexity such as
  - vegetation interaction with snow/frozen soil,
  - surface- atmosphere coupling and the link with satellite LST (see I. Trigo presentation)
  - CO2/evapo-transpiration coupled processes and satellite fluorescence observation

Thank you for your attention

http://fp7-imagines.eu/

Contact: souhail.boussetta@ecmwf.int

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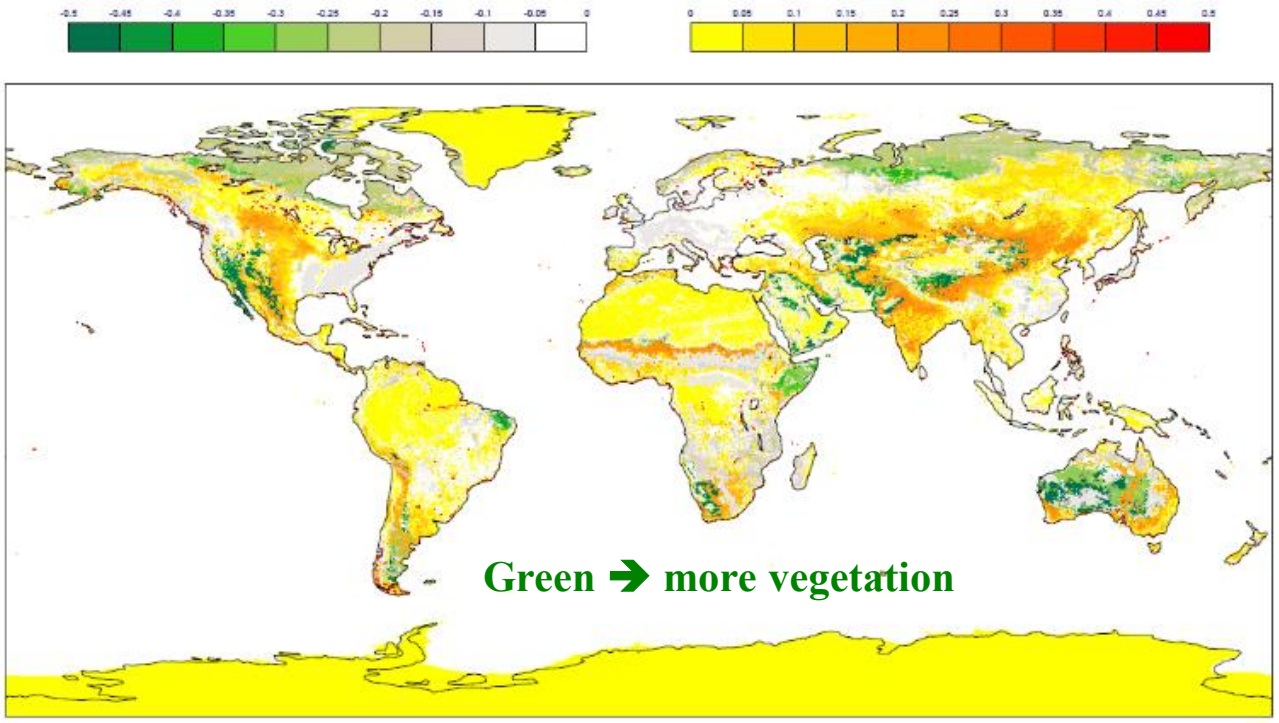
CVEG - CTL



vegetated cover difference