# Impact of vegetation cover variability on surface energy and carbon fluxes

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*with the support and partnership of the EU FP7 project*




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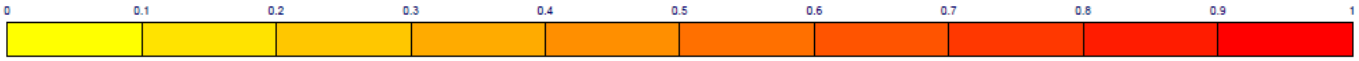
# Why vegetation state is important?

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

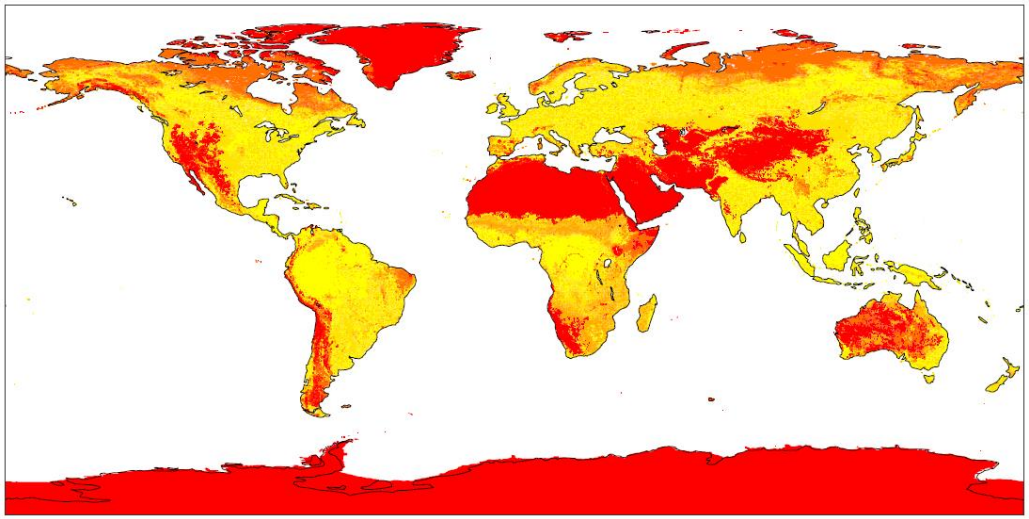
- **Earth System Models are evolving:**
  - ➔ **Higher resolution**
  - ➔ **Needs for higher physical complexity**
  - ➔ **Better representation of vegetation dynamic is needed**

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

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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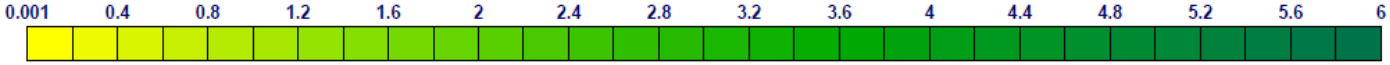
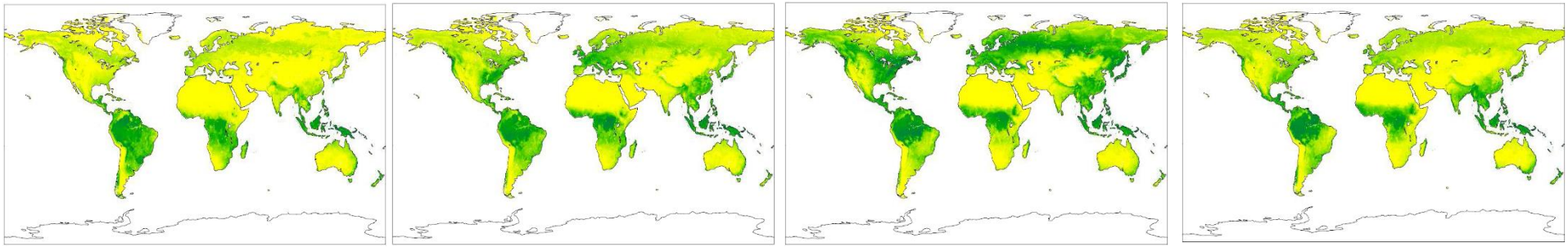
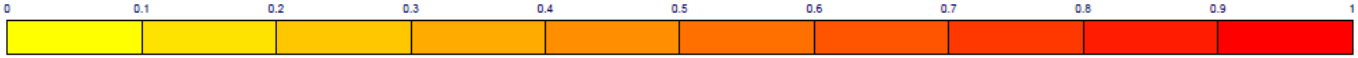
February May July October

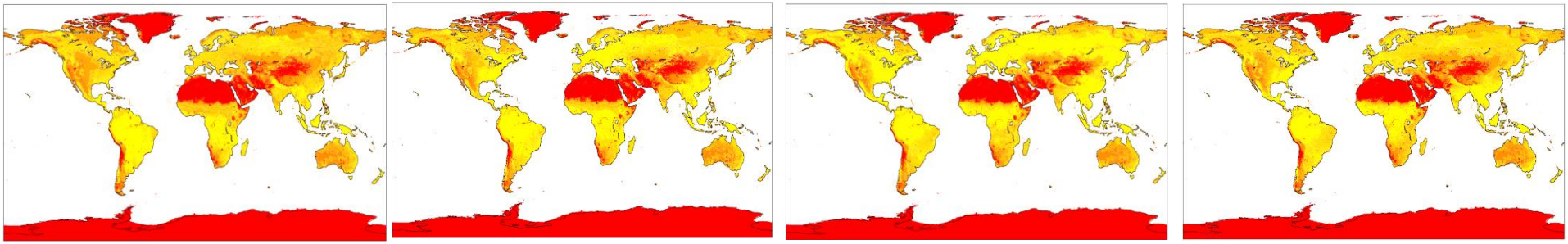



**LAI**






**(1- Vegetation fraction)**



➔ Physically-based seasonal variability of the vegetation cover



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# Which Impact on surface fluxes?

## *The surface-only simulation setup:*

To seek the impact of the variable vegetation cover two experiments are performed

**Period**: 1979 to 2013 **Coverage**: Global **Resolution**: 40km

**2 different experiments:**

- CTL: control simulation, Non variable prescribed Vegetation cover is used
- CVEG: Variable vegetation cover based on Beer-Lamber law + clumping

## *Results evaluated on surface fluxes:*

- Latent heat flux
- Sensible Heat flux
- Net Ecosystem Exchange of CO2

CTL

Difference (CVEG – CTL)

February

Latent heat flux

-250 -100 -70 -50 -20 0 -20 -10 -5 -3 -2 -1 0 0 1 2 3 5 8 10 15 20

Sensible heat flux

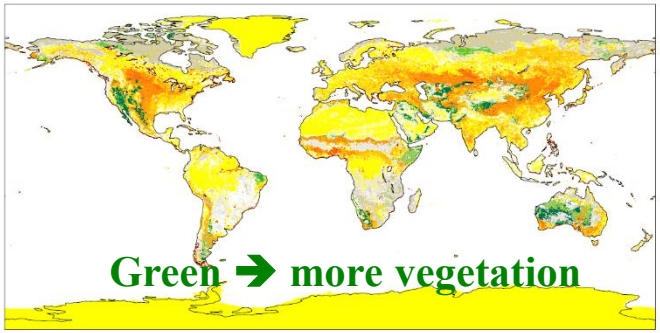
-250 -100 -70 -50 -20 0 -20 -10 -5 -3 -2 -1 0 0 1 2 3 5 8 10 15 20

Net Ecosystem exchange

-15 -7 -9 -5 -3 -1 0 0 1 3 5 7 9 12 15 -5 -3 -2 -1 -0.5 -0.1 0 0 0.1 0.5 1 2 3 5

CVEG - CTL

-0.5 -0.3 -0.15 -0.1 0 0 0.1 0.2 0.3 0.4 0.5




vegetated cover difference



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CTL

Difference (CVEG – CTL)

May

Latent heat flux

-250 -100 -70 -50 -20 0 | -20 -10 -5 -3 -2 -1 0 | 0 1 2 3 5 8 10 15 20

Sensible heat flux

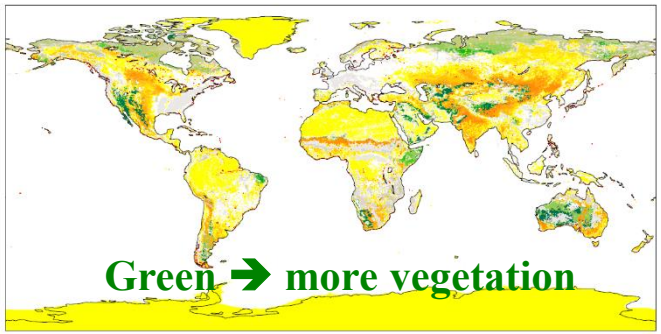
-250 -100 -70 -50 -20 0 | -20 -10 -5 -3 -2 -1 0 | 0 1 2 3 5 8 10 15 20

Net Ecosystem exchange

-15 -7 -9 -5 -3 -1 0 | 0 1 3 5 7 9 12 15 | -5 -3 -2 -1 -0.5 -0.1 0 | 0 0.1 0.5 1 2 3 5

CVEG - CTL

-0.5 -0.3 -0.15 -0.1 0 | 0 0.1 0.2 0.3 0.4 0.5




vegetated cover difference



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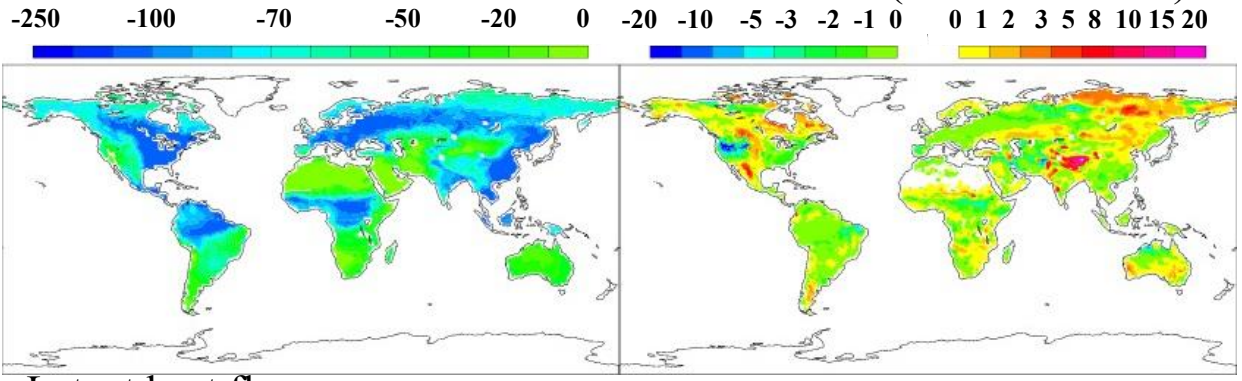
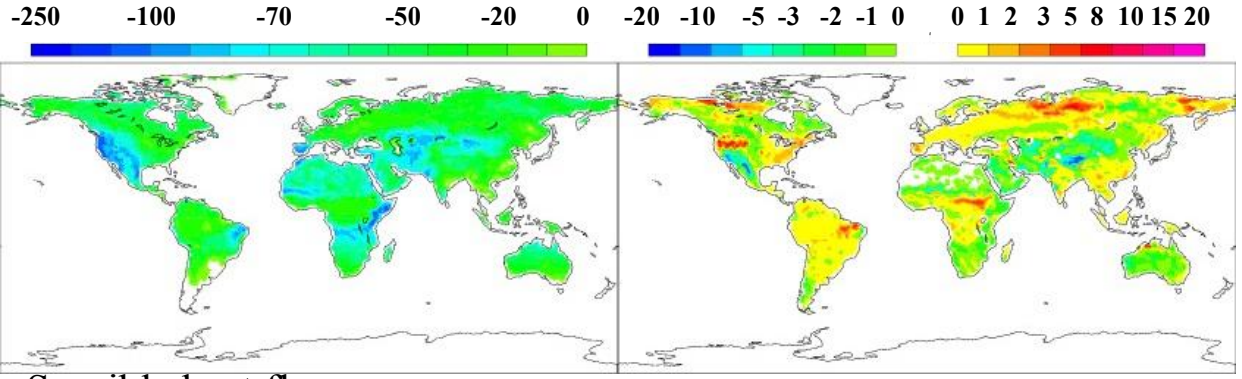
CTL

Difference (CVEG – CTL)

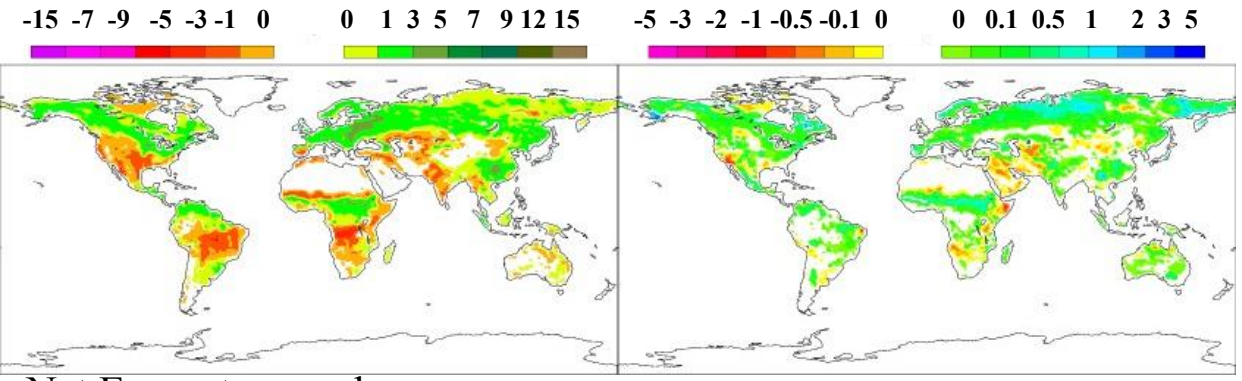
July




Latent heat flux

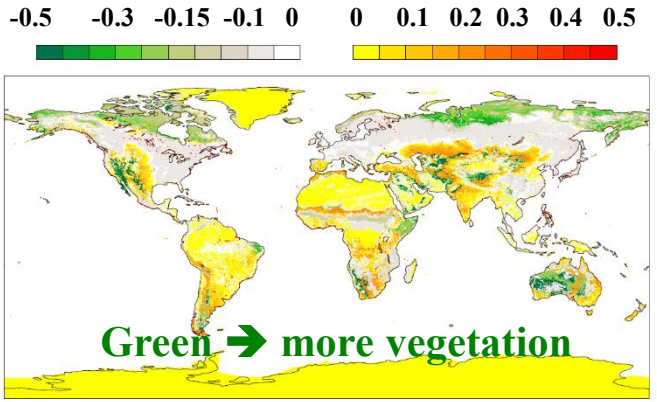



Sensible heat flux




Net Ecosystem exchange

CVEG - CTL




vegetated cover difference



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CTL

Difference (CVEG – CTL)

-250 -100 -70 -50 -20 0 -20 -10 -5 -3 -2 -1 0 0 1 2 3 5 8 10 15 20

Latent heat flux

-250 -100 -70 -50 -20 0 -20 -10 -5 -3 -2 -1 0 0 1 2 3 5 8 10 15 20

Sensible heat flux

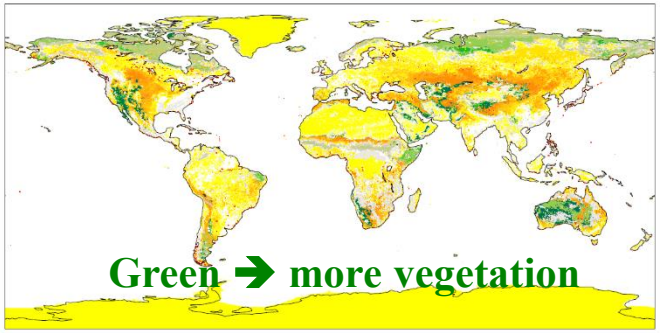
-15 -7 -9 -5 -3 -1 0 0 1 3 5 7 9 12 15 -5 -3 -2 -1 -0.5 -0.1 0 0 0.1 0.5 1 2 3 5

Net Ecosystem exchange

October

CVEG - CTL

-0.5 -0.3 -0.15 -0.1 0 0 0.1 0.2 0.3 0.4 0.5




vegetated cover difference



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# Impact in weather forecast mode

## *The atmospheric coupled simulation setup:*

To seek the impact of the variable vegetation cover on NWP two coupled experiments of a spring 2015 case study are performed

**Period**: March 2015 **Coverage**: Global **Resolution**: 16km

*72-hour forecast range from the 13 March 2013, Focus on Scandinavia.*

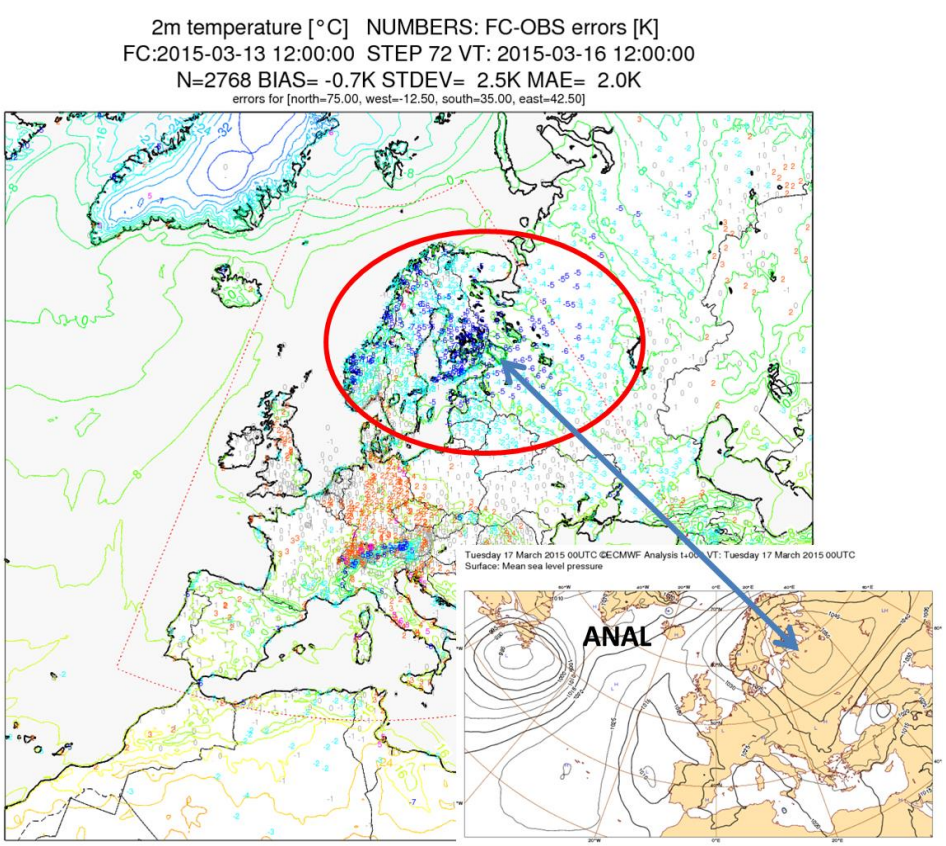
**2 different experiments:**

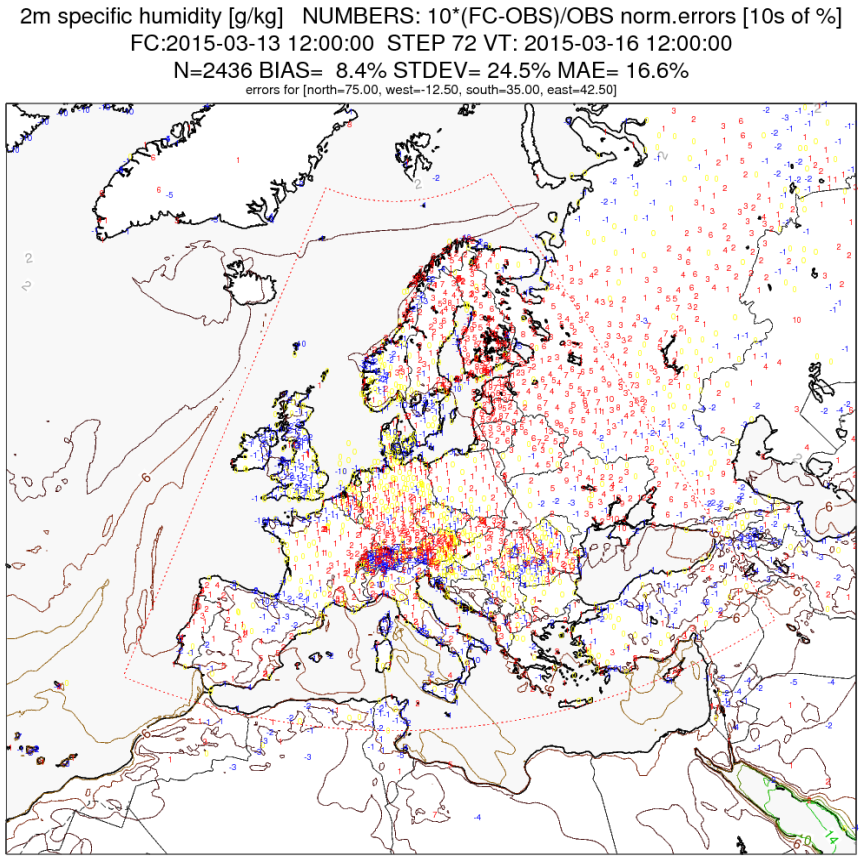
- CTL: control simulation, Non variable prescribed Vegetation cover is used
- CVEG: Variable vegetation cover based on Beer-Lamber law + clumping

## *Results evaluated on weather forecasts for next day :*

- 2m temperature
- 2m dew point temperature
- Forecast Albedo

# Motivation for the experiment




Cold bias on 2m Temperature 4K on average

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



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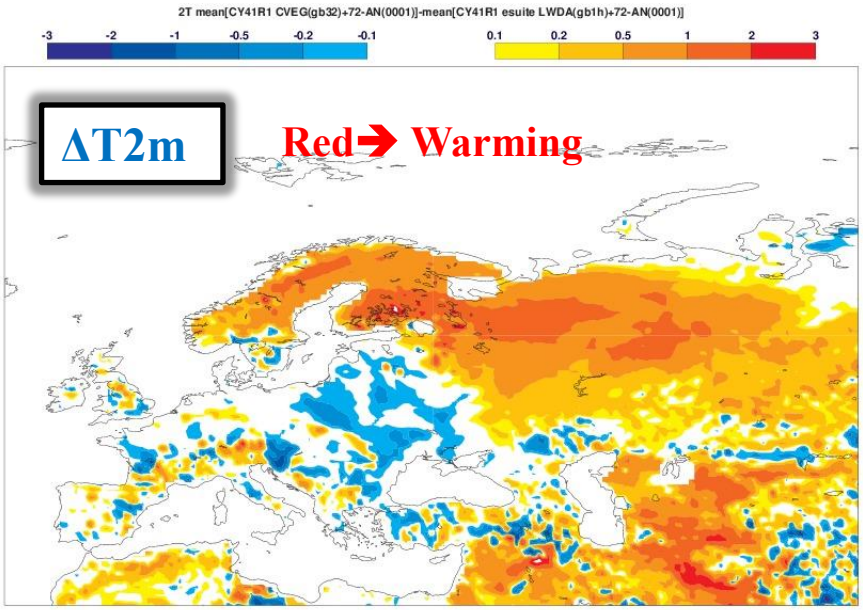
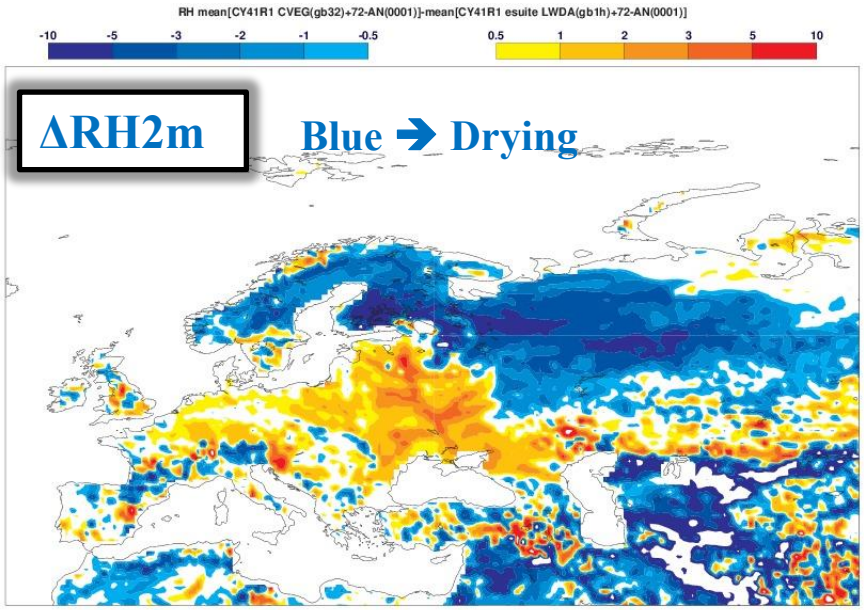
# Weather forecasts sensitivity

➔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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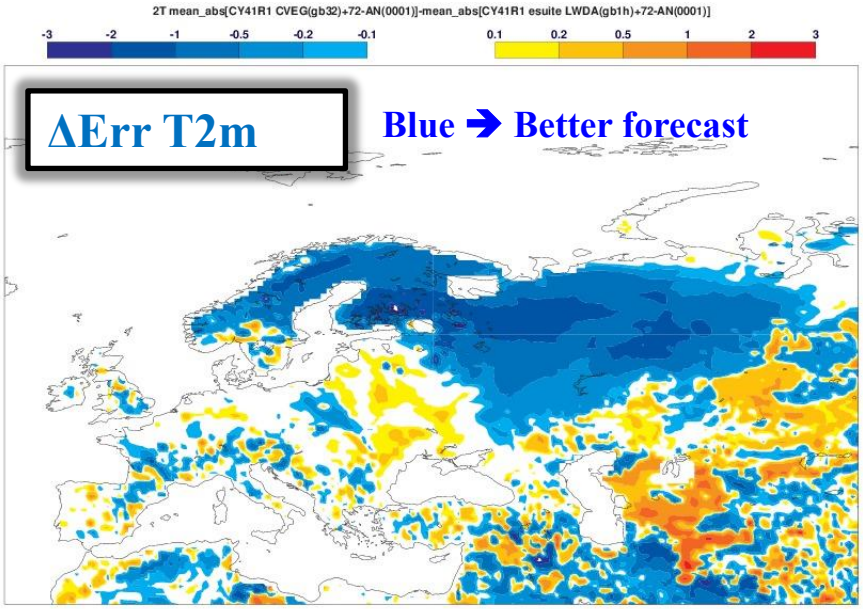
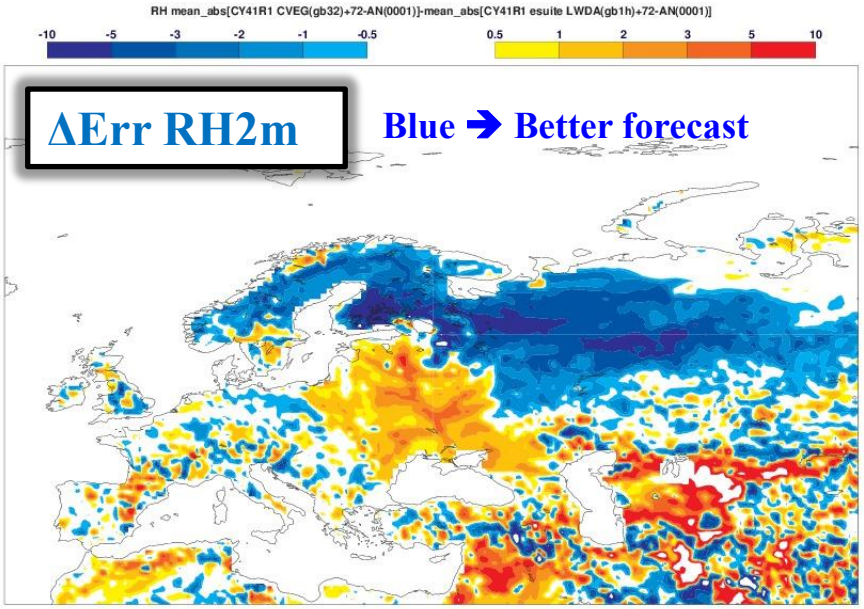
# Weather forecasts impact




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

if >0 => relative error reduction from the analysis (positive impact )

if <0 => relative error increase from the analysis (negative impact)



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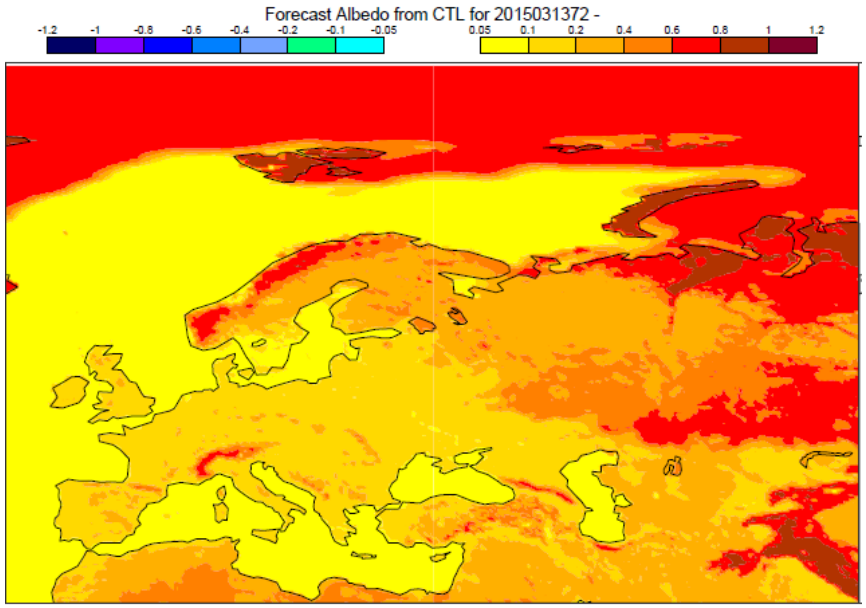
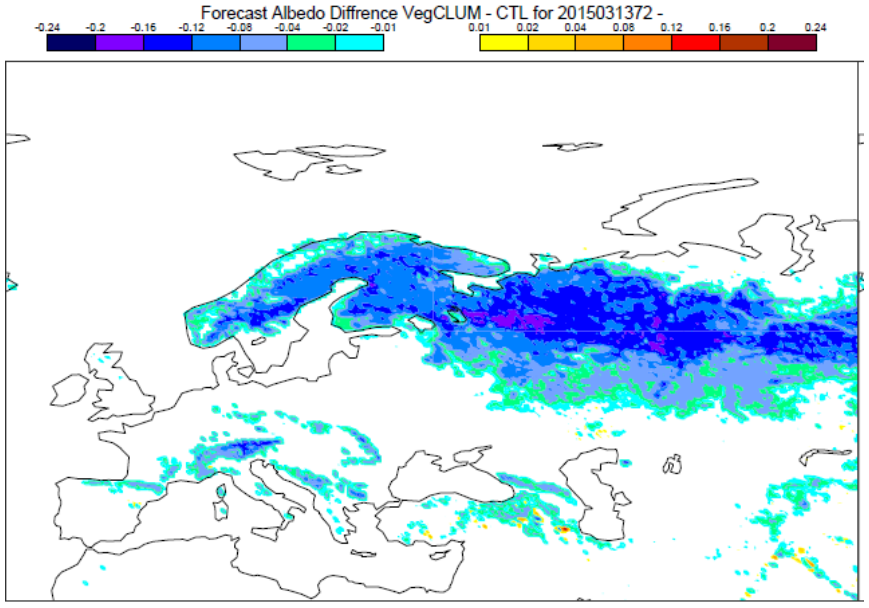
# Behind the scene




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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# Conclusions & Outlook

- Taking into account vegetation cover variability is important for accurate representation of surface fluxes
- Variable vegetation cover not only affect the Latent and sensible heat partition but also affect the partition of the fluxes between bare-ground and vegetation.
- Land surface carbon flux is slightly affected with the vegetation cover variability and tend to increase the sink during the growing season and the source in autmn.
- Introducing variable vegetation cover in coupled runs is physically justified and has an overall positive impact on forecasted weather parameters, with the cover signal being linked with the albedo signal. (Results should be generalised to others cases)
- In future work, enhanced connections between albedo, LAI (and roughness) in Earth System Models will most likely increase the sensitivity to vegetation dynamics.
- With increased resolution ESM will have to take into account an additional layer of physical complexity such as interaction with snow/frozen soil and better vegetation dynamics.



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***Thank you for your attention***


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