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

Souhail Boussetta, Gianpaolo Balsamo, Emanuel Dutra, Anton Beljaars, Clement Albergel, Patricia De Rosnay, and Joaquin Munoz-Sabater



LSA SAF, Reading 9 June 2015 S. Boussetta





Why vegetation state is important?

Because it affects

- Evapotranspiration and energy partition
- Boundary layer development
- 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



Coupled DA experiment with the monthly varying LAI



```
    Setup:
    T255

    14/02/2008 -1/09/2008

    Seasonal LAI vs fixed LAI
```

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

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)

LSA SAF, Reading 9 June 2015 S. Boussetta



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





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

Sensible Heat flux



Clim

NRT_LAI - Clim



2m temperature sensitivity in coupled run



LSA SAF, Reading 9 June 2015 S. Boussetta



9

Even more realistic vegetation dynamic: Satellite derived variable vegetation cover











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





0.1 0.2 0.3 0.5 0.4 0.6 07 0.9 (1- Vegetation fraction)



→ Physically-based seasonal variability of the vegetation cover

LSA SAF, Reading 9 June 2015 S. Boussetta



A Spring 2015 2m Temperature bias case

2m temperature [°C] NUMBERS: FC-OBS errors [K] FC:2015-03-13 12:00:00 STEP 72 VT: 2015-03-16 12:00:00 N=2768 BIAS= -0.7K STDEV= 2.5K MAE= 2.0K errors for [north=75.00, west=-12:50, south=35.00, east=42.50]



Cold bias on 2m Temperature 4K on average 2m specific humidity [g/kg] NUMBERS: 10*(FC-OBS)/OBS norm.errors [10s of %] FC:2015-03-13 12:00:00 STEP 72 VT: 2015-03-16 12:00:00 N=2436 BIAS= 8.4% STDEV= 24.5% MAE= 16.6% errors for [north-75.00, west=12.50]



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

Slide 13



ECMWF

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



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)





Behind the scene



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

LSA SAF, Reading 9 June 2015 S. Boussetta





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





CVEG - CTL



vegetated cover difference

