Potential Impact of vegetation on the land-atmosphere within an NWP framework

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Why vegetation matters?

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 information on the vegetation state are becoming more and more available and with higher accuracy & frequency
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.
Impact on near surface atmosphere with forecast/analysis experiments

Impact on near surface atmosphere with forecast/analysis experiments

**Sensitivity**

\[ \text{Sensitivity} = \text{MLAI} - \text{CTL} \]

- if $>0$ => Warming
- if $<0$ => Cooling

**Impact**

\[ \text{Impact} = |\text{CTL} - \text{analysis}| - |\text{MLAI} - \text{analysis}| \]

- 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 due to reduction of LAI in spring, (with increased vegetation resistance to ET).

- beneficial impact on near surface temperature forecast (green being positive impact in reducing t2m bias by $\sim 0.5$ degree)
What about Inter-annual variability, does it matter?

Anomalous years could be fairly monitored/detected using the LAI IAV information.

NRT LAI and albedo signal can be covariant mainly during wet year.
LAI and albedo inter-annual variabilities affects the sensible heat flux and in general the energy partition on the surface in a considerable way.
The impact of the LAI and albedo IAV on the sensible heat flux results in an enhancement of the near surface temperature forecast w.r.t the operational analysis.
Vegetation cover variation based on satellite observation of Leaf Area Index according to a modified Beer-Lamber law with clumping:

$$C_{\text{veg}} = 1 - e^{-0.5 \omega \text{LAI}}$$
Consistent and Physically-based seasonal variability of the vegetation cover
Testing on a forecast bias case

Cold bias on 2m
Temperature 4K on average

After applying the vegetation cover change

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

\[ \text{Impact} = |\text{CTL} - \text{analysis}| - |\text{CVEG} - \text{analysis}|, \]
if >0 => relative error reduction from the analysis (positive impact)
if <0 => relative error increase from the analysis (negative impact)
Change in forest albedo under snow conditions

The change is be attributed to the change in the forest albedo in presence of snow which itself is linked to the vegetation cover change
Vegetation: few thoughts

Taking into account realistic vegetation dynamics is important for accurate representation of surface fluxes and eventually better atmospheric predictability.

Enhanced connections between albedo, LAI, vegetation cover (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
- 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 G. Balsamo presentation on Thursday S13)
- CO2/evapo-transpiration coupled processes and satellite fluorescence observation
Thank you for your attention

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