Albedo effects of biomass production: a review

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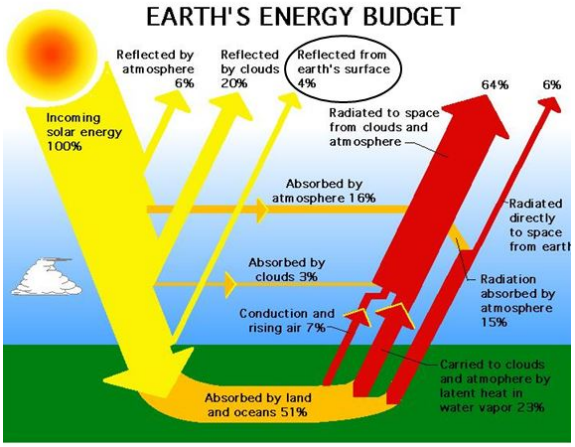
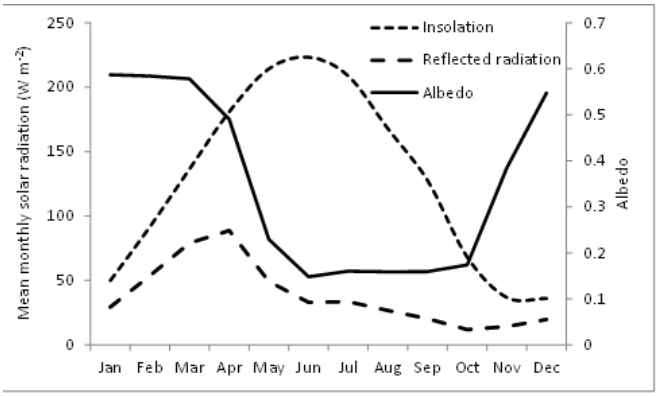
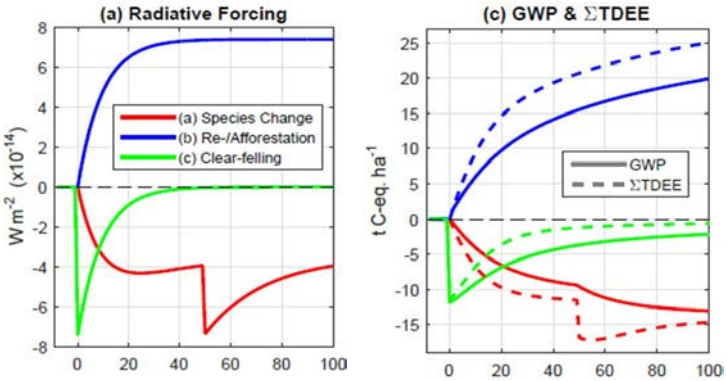
- Changes in albedo and increased atmospheric concentrations of non-condensing GHG are the only drivers of global climate change.
- Deforestation since 1750 has resulted in a global radiative forcing (RF) of -0.15 ± 0.1 W m^{-2}
- Surface albedo is a direct land cover property and is affected by vegetation type and density, and in cold climates, by the presence or absence of snow cover.

Land cover type	Snow-free	Max, with snow
Evergreen needleleaf forests	0.09	0.24
Deciduous needleleaf forests	0.11	0.36
Deciduous broadleaf forests	0.14	N/A
Mixed forests	0.12	0.26
Open shrublands	0.18	0.70
Woody savannas	0.11	0.37
Grasslands	0.18	0.71
Croplands	0.17	0.65



- Differences in the seasonal patterns of radiation flux and albedo generate asymmetries in the RF potential
- On inter-annual time scales, RF potential following disturbance is influenced by the life-cycle (growth rate) of the rotation biomass system
- In cold climates, spring snow has a disproportionate impact on albedo-driven RF.
- RF estimates must account for albedo changes across both seasonal and inter-annual time scales





- Recent metrics of the climate impact of mitigation actions incorporate a measure of effect over time.
- Different metrics may yield different results as to the impact of albedo RF relative to GHG balance within a project.
- Largest albedo effects are associated with a local to regional land cover change

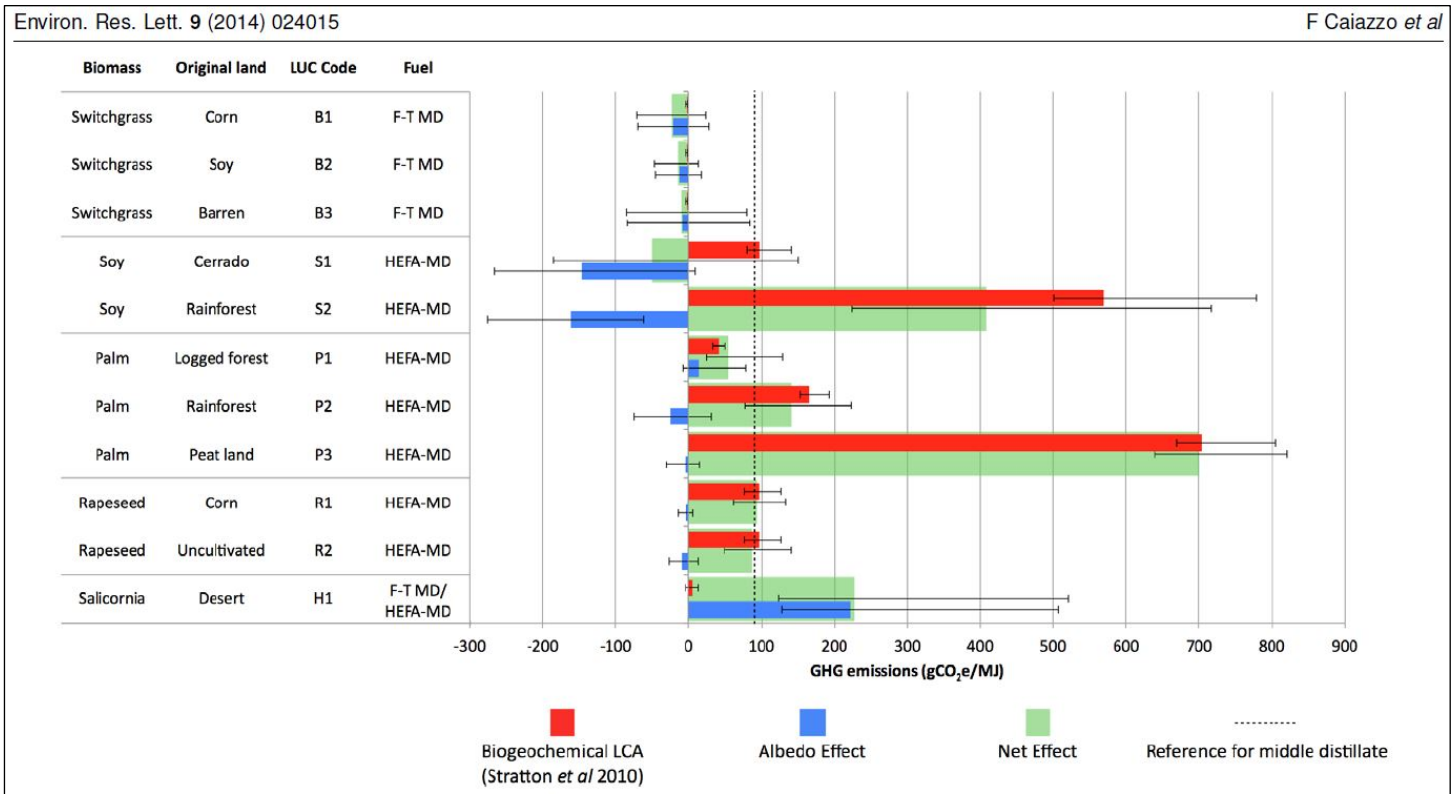


Figure 1. Climate impacts of biofuel production and use for different LUC scenarios.

Project	Baseline	Snow cover	Climate effect	Source
Harvest of green trees	Trees left on site	yes	---	Singh et al, 2014; Cherubini et al, 2012
Conversion of conifer to deciduous	No conversion	yes	---	Zhao and Jackson, 2014, Bright et al, 2014
Soy	Cerrado	no	--	Caiazzo et al, 2014
Soy	Rainforest	no	--	Caiazzo et al, 2014
Palm	Logged forest	no	-	Caiazzo et al, 2014
Swicthgrass, miscanthus	Corn or soy	yes	+ or -	Miller et al, 2014; Caiazzo et al, 2014
Conifer plantation / afforestation	Land left open	no	+	Bala et al, 2007; Arora and Montenegro, 2011
Deciduous plantation/afforestation	Land left open	yes	+	Cai et al, 2011; Jassal et al, 2013
Palm	Rainforest	no	+	Caiazzo et al, 2014
Salicornia	Desert	no	++	Caiazzo et al, 2014
Conifer plantation / afforestation	Land left open	yes	+++	Bala et al, 2007; Arora and Montenegro, 2011

Some take-home messages:

- Evaluations of greenhouse gas mitigation potential of projects that involved land conversions must include the effect of albedo changes
- Albedo RF effects are a function of the local environment and land management practices, and can have either a waring or a cooling effect
- The permanence or duration of the change in albedo, either at the site level or at the project level, will largely control this effect.
- It is the combination of albedo change and incoming solar radiation that determines the albedo effect of a given project.