Forest and albedo in ORCHIDEE

Juliane Otto
James Ryder
Kim Naudts
Matt McGrath
Sebastiaan Luyssaert

Forest and albedo in ORCHIDEE

Juliane Otto
James Ryder
Kim Naudts
Matt McGrath
Sebastiaan Luyssaert

The ***overall goal of DOFOCO*** is to quantify and understand the **role of forest management** in mitigating climate change. Specifically, the current focus on the carbon cycle and will be replaced with a **total climate impact approach**.

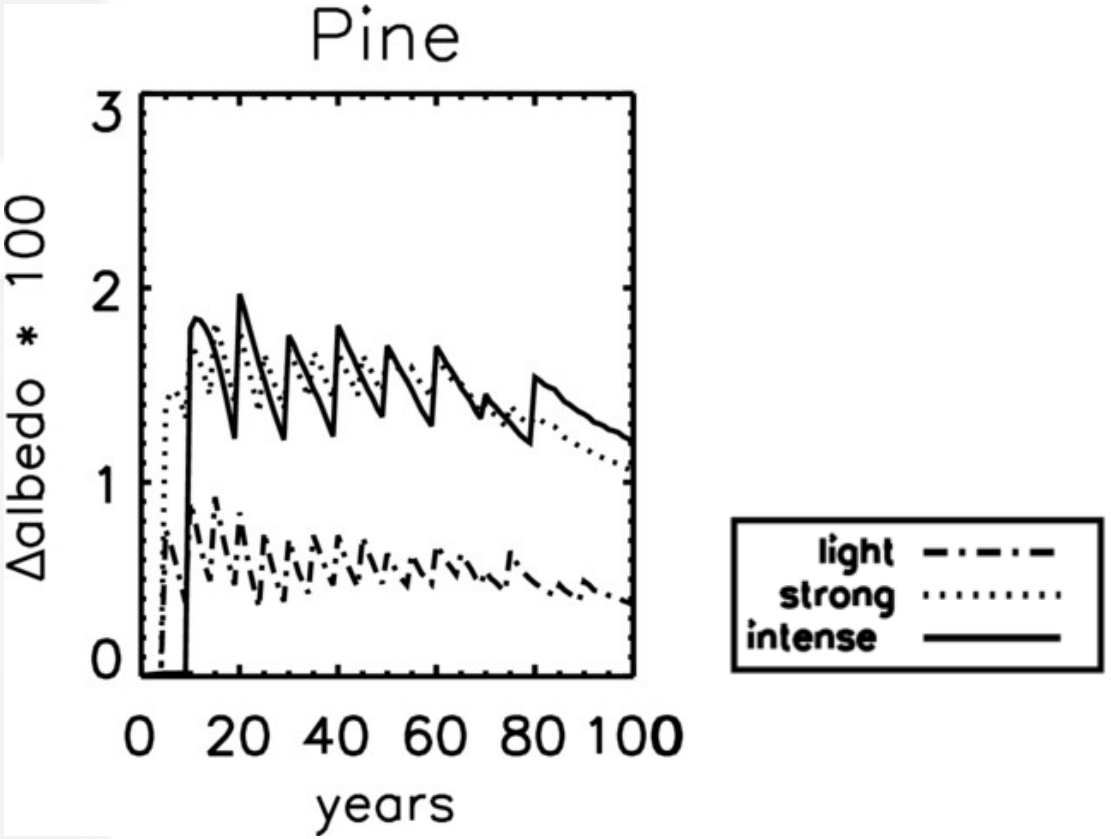
Forest and albedo in ORCHIDEE

Juliane Otto
James Ryder
Kim Naudts
Matt McGrath
Sebastiaan Luyssaert

The ***overall goal of DOFOCO*** is to quantify and understand the **role of forest management** in mitigating climate change. Specifically, the current focus on the carbon cycle and will be replaced with a **total climate impact approach**.

Introduction: albedo and forest management

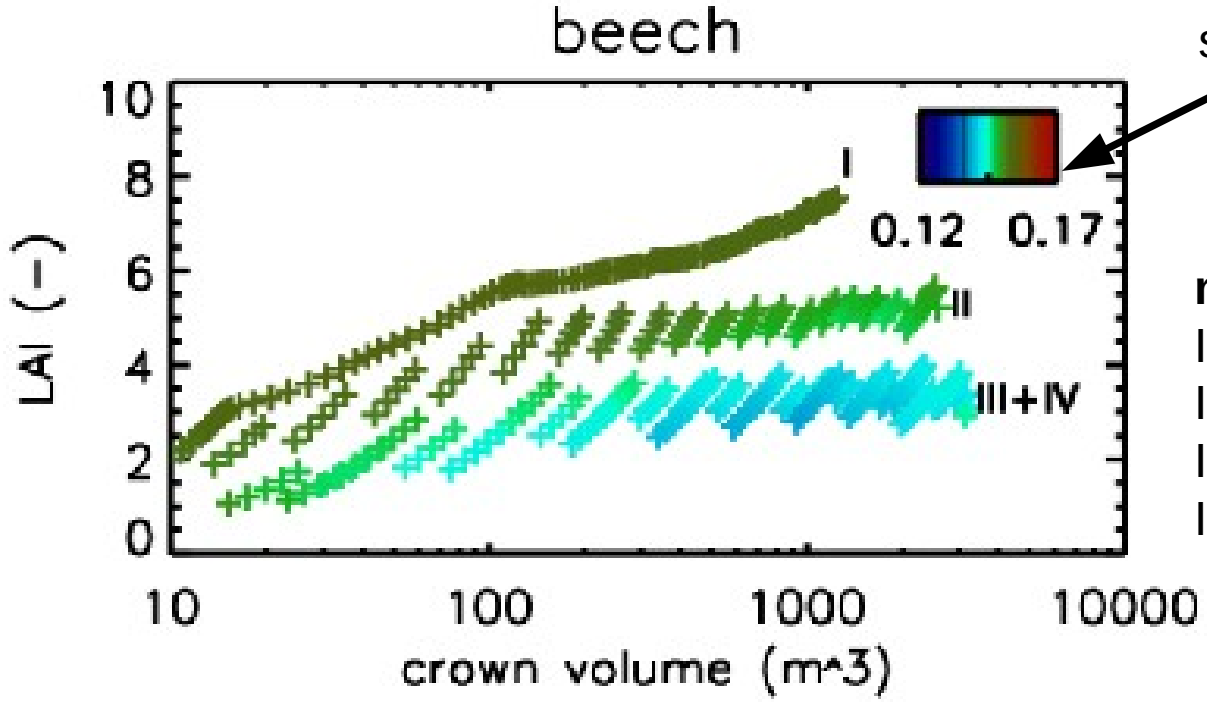
Change in shortwave albedo between unmanaged and managed forest



→ albedo is sensitive to forest mangement

Introduction: albedo and forest management

albedo as a function of stand crown volume and stand LAI



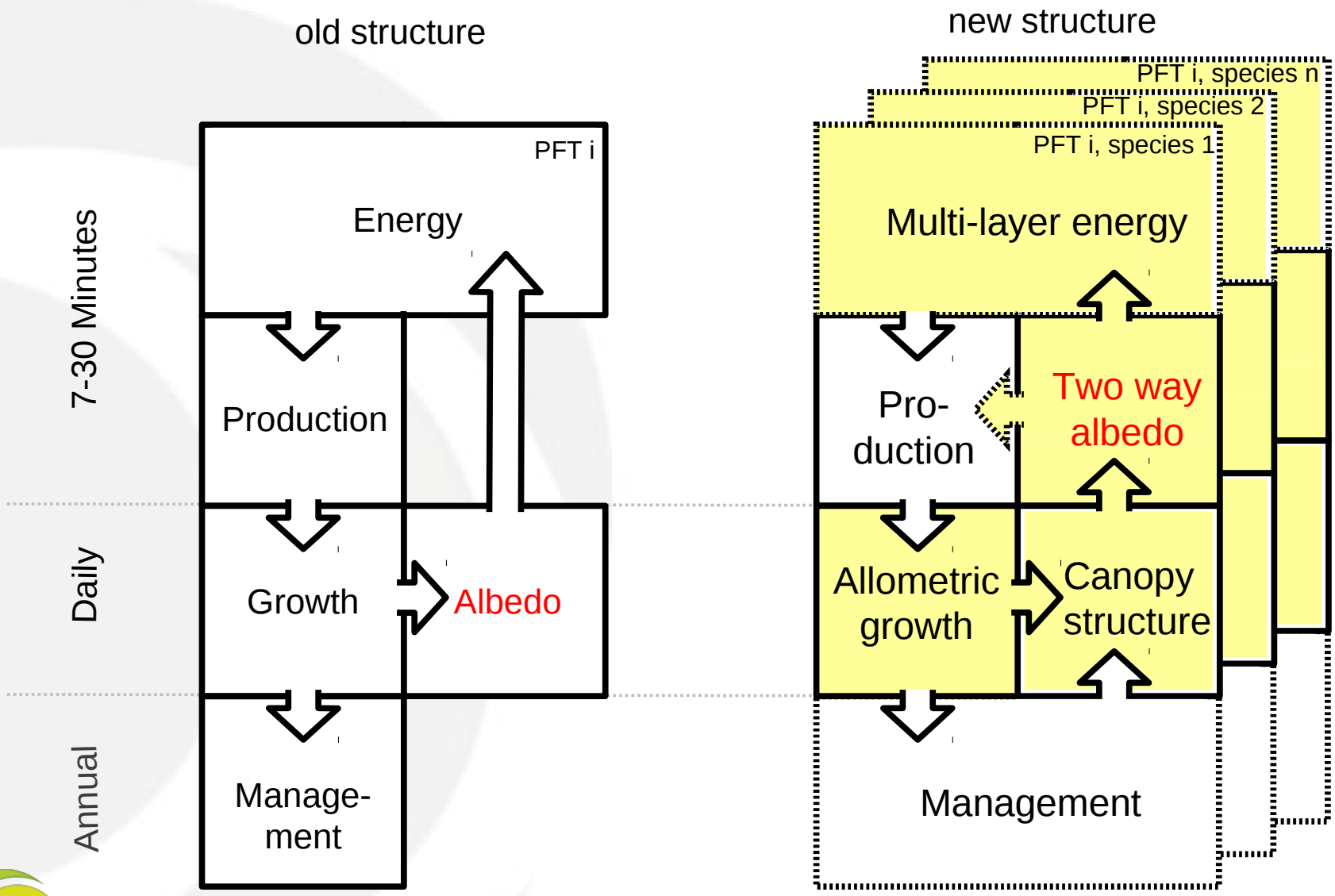
shortwave albedo

management strategies:

I unmanaged
II light thinning
III strong thinning
IV intense thinning

→ changes in LAI and crown volume drive the canopy albedo

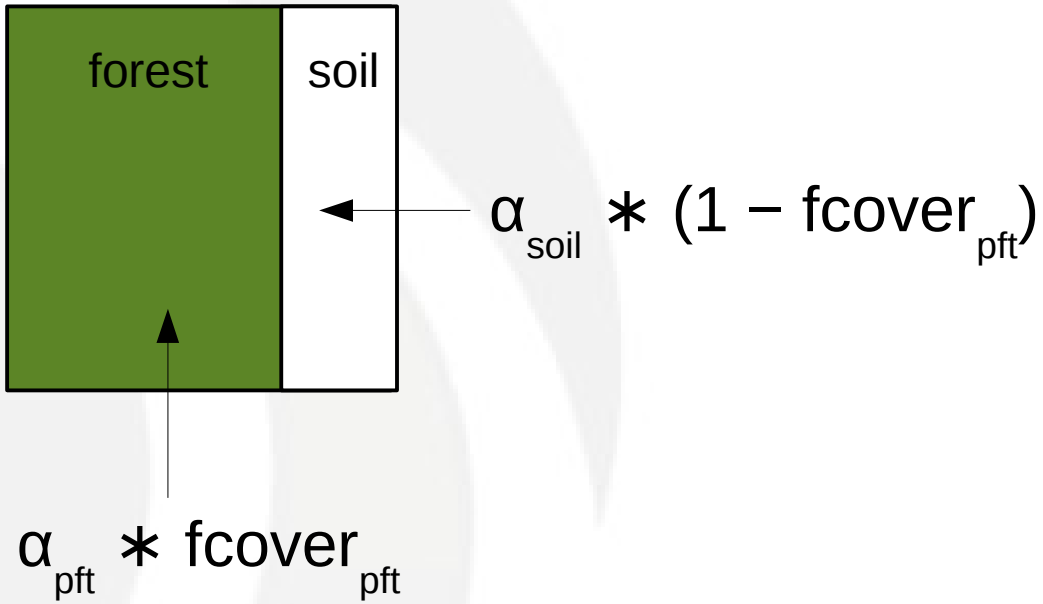
Model: ORCHIDEE



more information: http://labex.ipsl.fr/orchidee/

Model: Old albedo calculation in ORCHIDEE

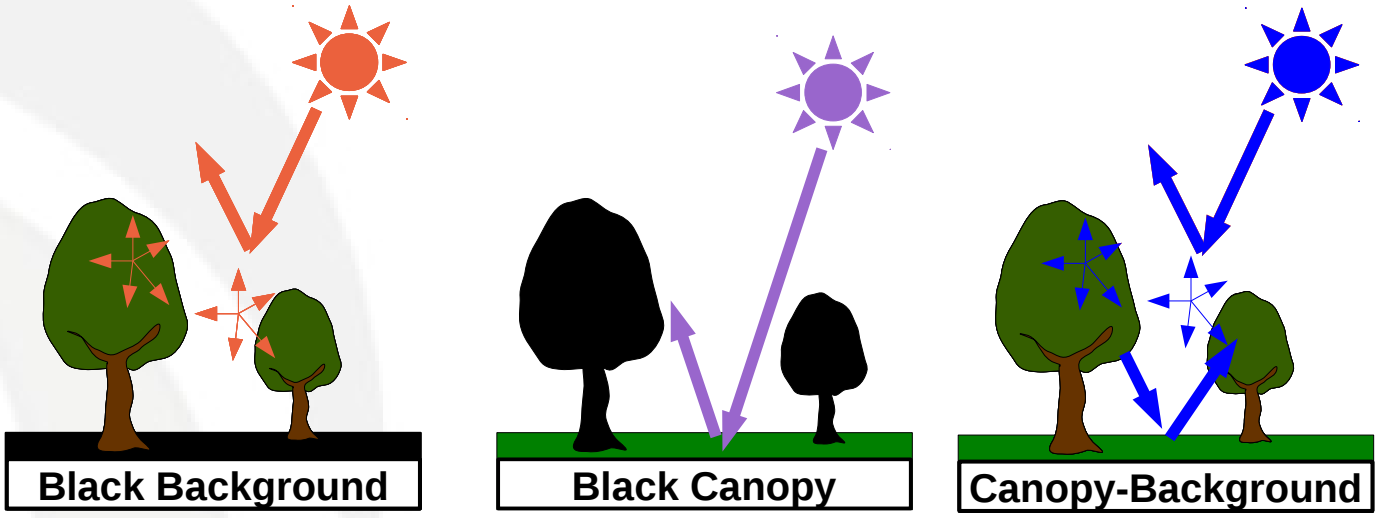
calculation of albedo used to depend only on LAI



New approach: transfer radiation scheme by Pinty et al.

$$R^{total}_{coupled}(z_{toc},\mu) = R^{Coll}_{veg}(z_{toc},\mu) + R^{UnColl}_{bgd}(z_{toc},\mu) + R^{Coll}_{bgd}(z_{toc},\mu)$$

μ = sun zenith angle
z_{toc} = top of canopy



Advantages:

- new: state-of-the-art code
- validated: successfully tested against 3D (effective values)
- consistent dataset: input parameters available from data package JRC-TIP

Pinty et al. (2006): Simplifying the interaction of land surfaces with radiation for relating remote sensing products to climate models. Journal of Geophysical Research.

New approach: input parameters

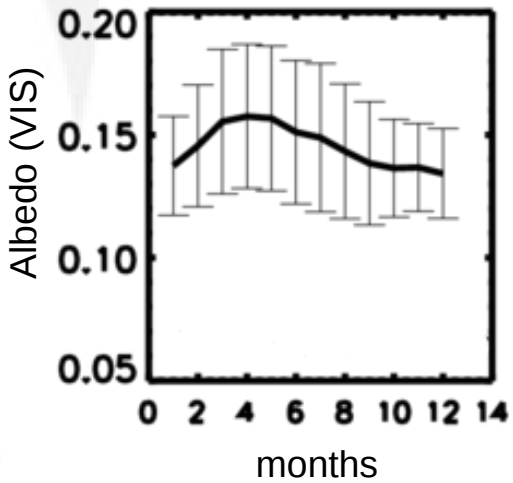
JRC-TIP (Joint Research Centre Two-stream Inversion Package) provides parameters which are required for radiation transfer scheme.

One true variable:
(1) background albedo

Three effective variables:
(1) single scattering albedo, including leaves and branches
(2) preferential forward or backward direction of scattering
(3) leaf area index (not taken from JRC-TIP)

Example:

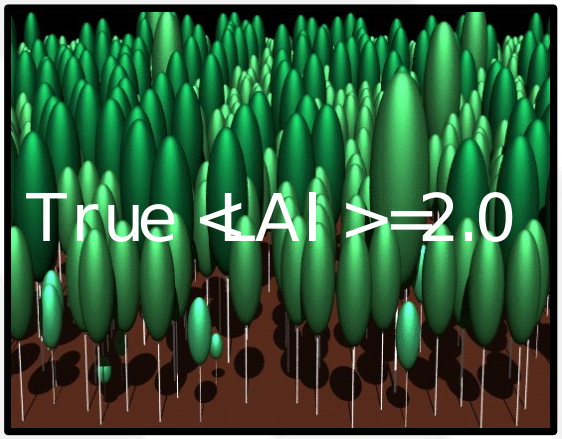
Single scattering albedo of pine



Pinty et al. (2011): Exploiting the MODIS albedos with the Two-stream Inversion Package (JRC-TIP): 1. Effective leaf area index, vegetation, and soil properties. Journal of Geophysical Research.

New approach: What does “effective” LAI mean?

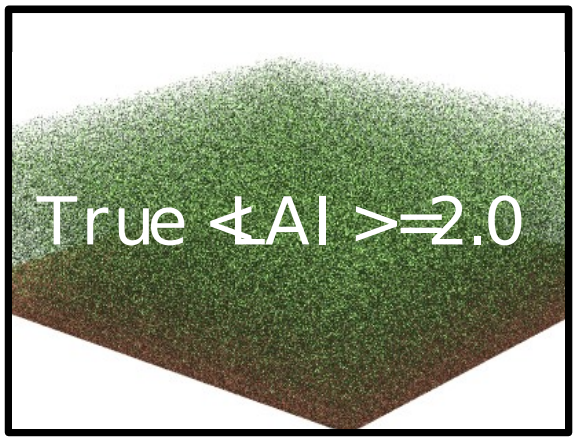
3-D heterogeneous



direct transmission at 30° solar zenith angle

$T_{3\text{-}D}(<LAI>)=0.596$

1-D heterogeneous



direct transmission at 30° solar zenith angle

$T_{1\text{-}D}(<LAI>)=0.312$

$$\rightarrow \quad \widetilde{LAI}(\theta) = -2.0 * \cos(\theta) * \log P_{\text{gap}}(\theta)$$

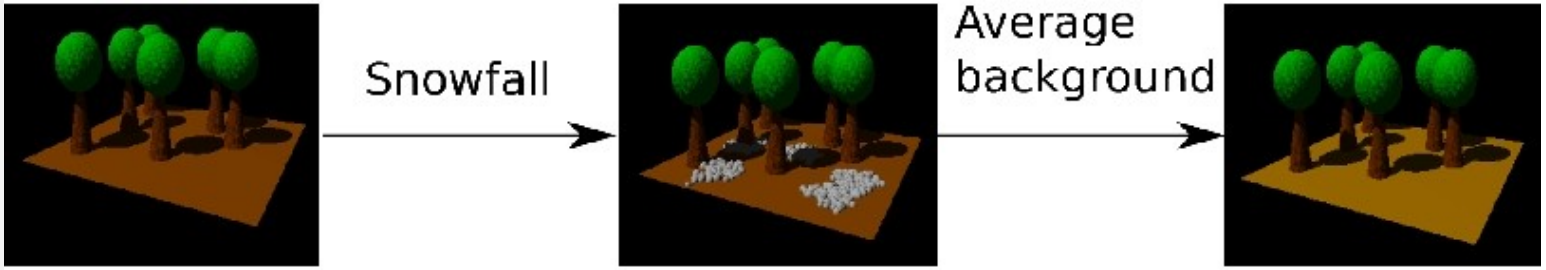
Haverd et al. (2012): The Canopy Semi-analytic Pgap And Radiative Transfer (CanSPART) model: Formulation and application. *Agricultural and Forest Meteorology.*

New approach: how do we treat snow?

current version:

visible and near-infrared snow albedo are taken from *Dickinson et al. 1993* and snow aging from *Chalita and Treut 1994*

no snow on canopies



Summary

Albedo and management:
- forest management decreases canopy albedo

New albedo scheme:
- a full representation of the radiation transfer processes in the biosphere
- diurnal cycle
- direct/diffuse albedo

On-going changes in ORCHIDEE:
- allocation scheme: more realistic growth model
- energy budget: multi layers including hydraulic architecture of plants