

Climate Change IV

in South-Eastern European Countries

■ **Adaptation
strategies for
economy &
society**



ClimateChange

Causes
Impacts
Solutions

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Incorporating Non-GHG Effects in the Climate Balance of Land-Use and Land-Use Change Options

DI Hannes Schwaiger, MSc Neil Bird
Zagreb, 19th – 20th October 2009

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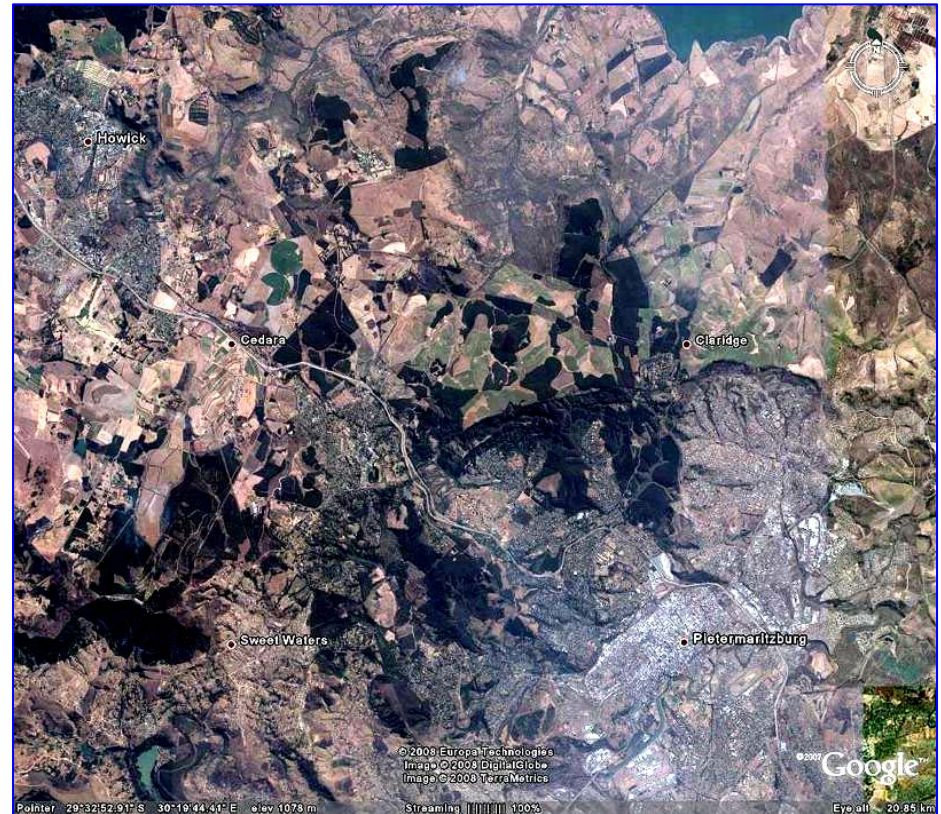
- ❖ Vegetation withdraws CO₂ via photosynthetic assimilation
- ❖ Climate change mitigation benefits via a positive NEP of land use
 - **LAND USE CHANGE:**
Conversion of non forest land into forest land
or avoiding deforestation (Kyoto Protocol Art.3.3, REDD)
- ❖ Albedo effects influence this balance depending on the colour and brightness of the land surface
 - **Cooling or warming effect on the climate**
- ❖ This has to be counterbalanced in a combined way:
 - ❖ carbon modelling (C stock change)
 - ❖ albedo change calculation (radiative forcing change)
 - ❖ combination of both on the same "unit"
- ❖ Applied on a case study area (Spain)



Introduction (2)



Coniferous forest in Austria



Pinus radiata plantations
in South Africa

Introduction (3)

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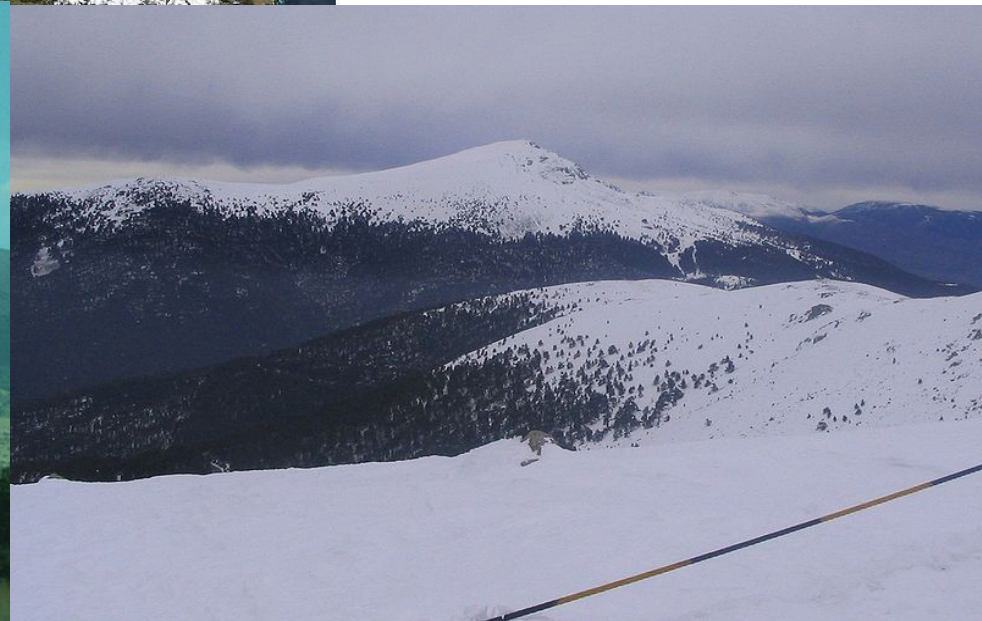
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Afforestation in the Highlands of Ecuador

Case study area

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Summer

Winter

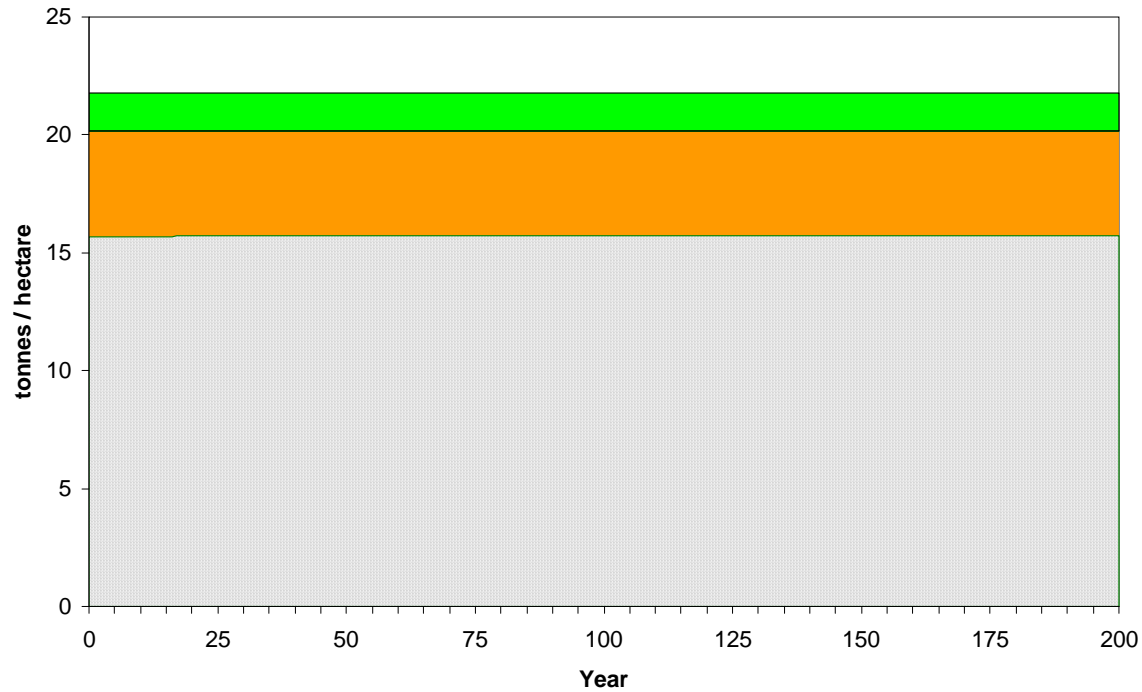


“Sierra Guadarrama” in central Spain

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Carbon accounting

Grassland



■ Soil ■ Dead Wood ■ Litter ■ Roots ■ Woody Vegetation ■ Non-woody Vegetation

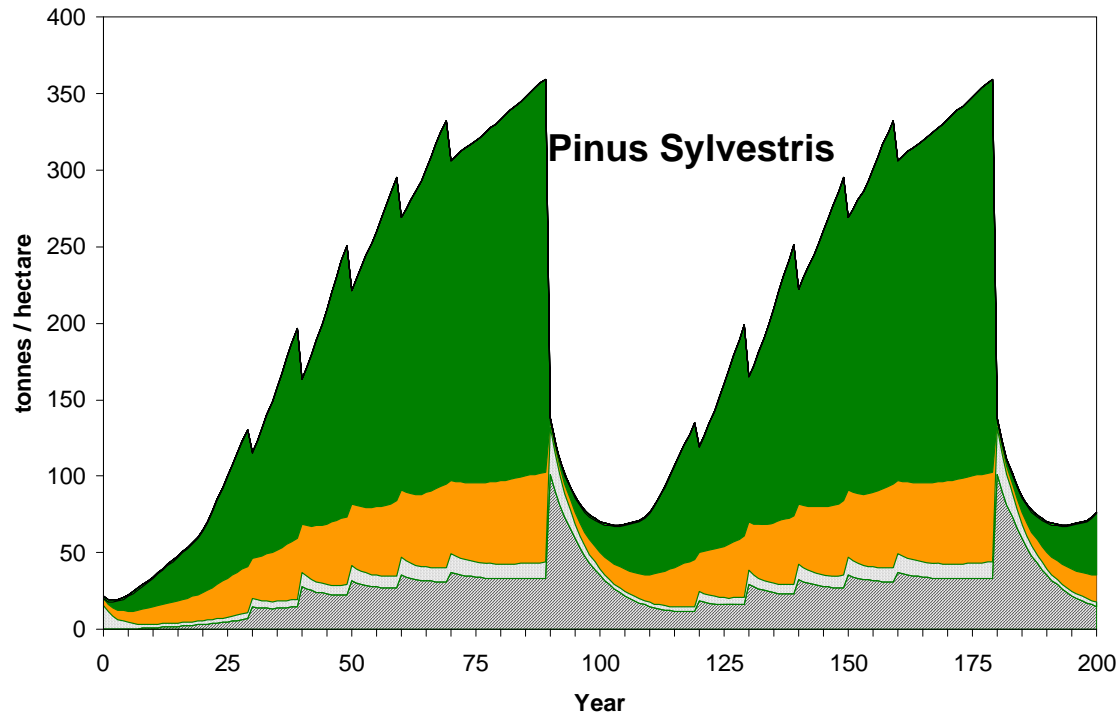
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Carbon accounting

Afforestation / Forest Land



- Soil
- Roots
- Dead Wood
- A/R Trees
- Litter

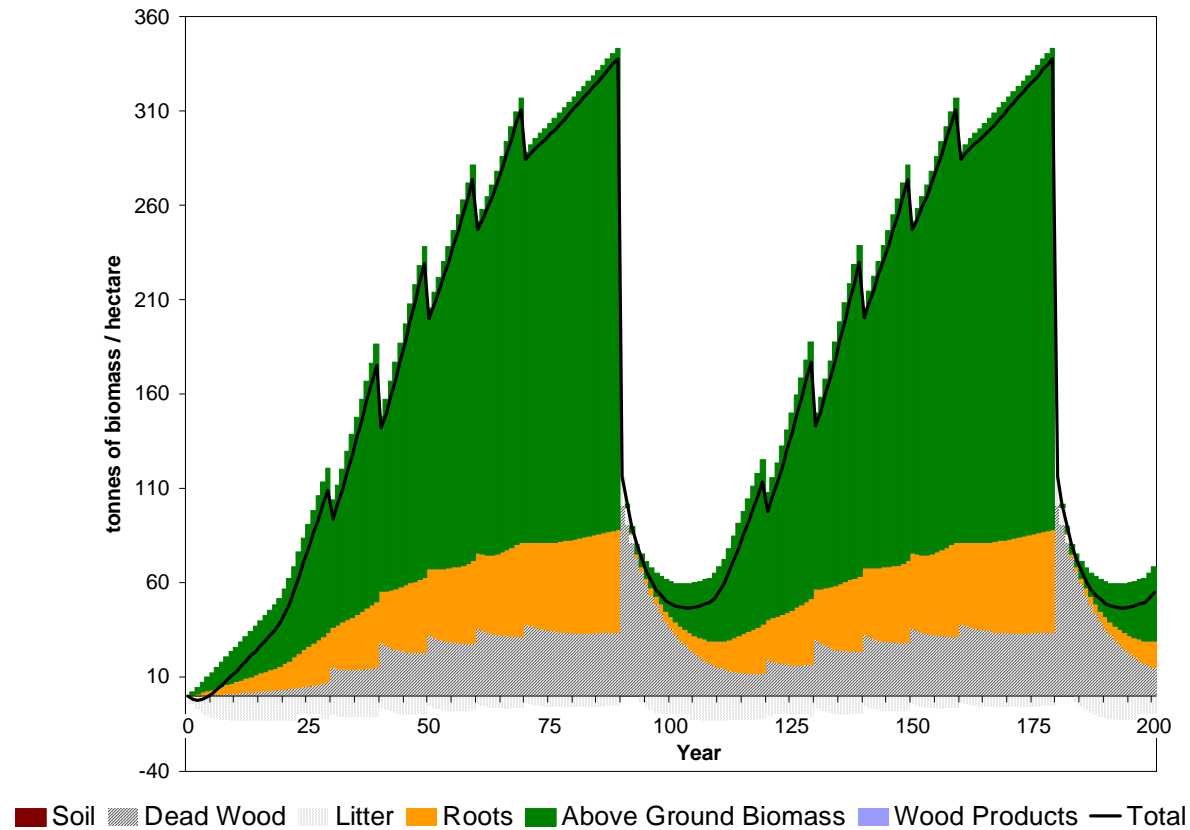
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Net biomass increase



ClimateChange ❖ Surface albedo data

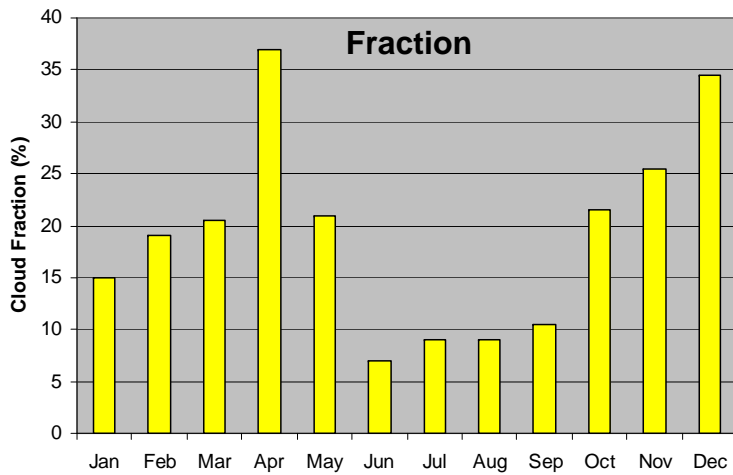
Land use type	<u>Pielke, 1984[1]</u>	Used in the combined model
Grassland (long – short)	0.16 – 0.30	0.20
Forest (pine, fir, oak)	0.10 – 0.15	0.10
Snow (dirty - fresh)	0.25 – 0.95	0.50

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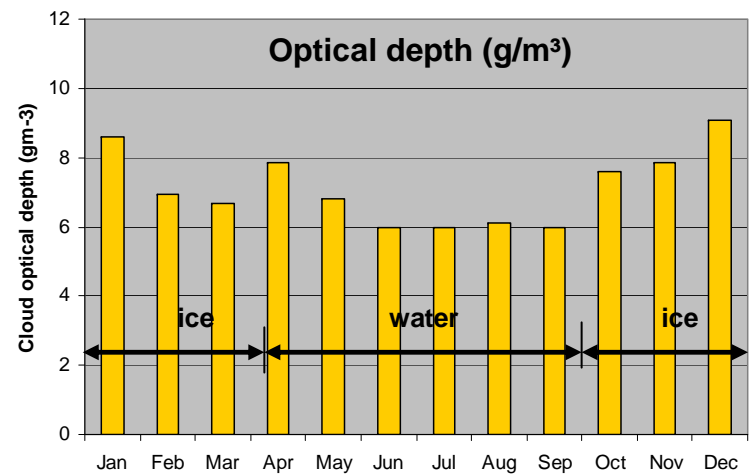
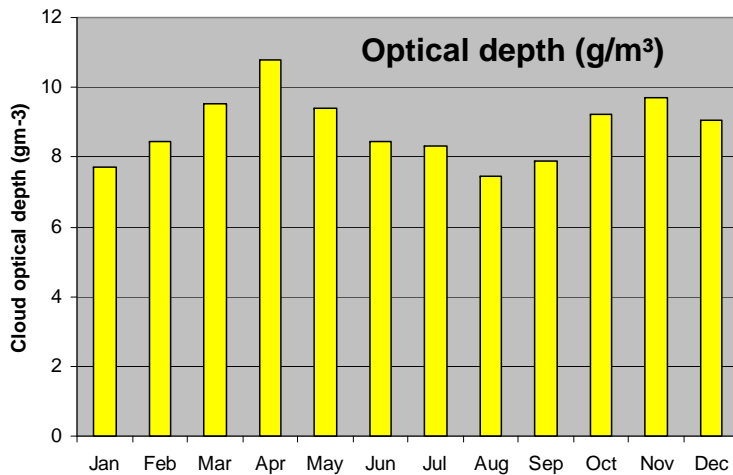
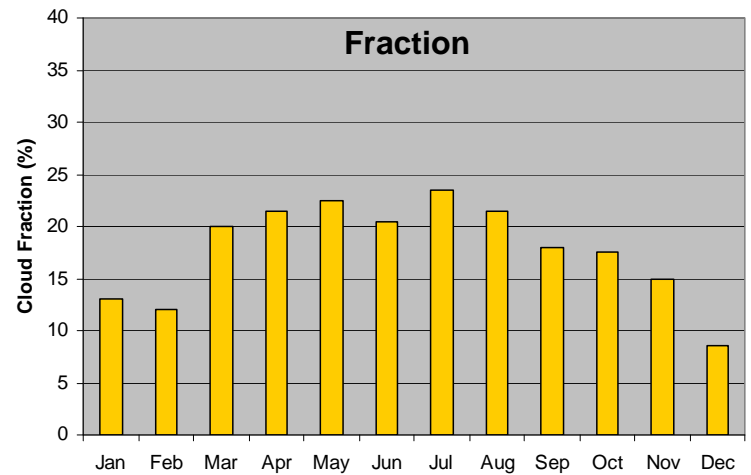
❖ Top of the Atmosphere (TOA) albedo data:

- ❖ Fu Liou Radiative Transfer Model
- ❖ Information on cloud cover per month in 2008
- ISCCP (International Satellite Cloud Climatology Project) data for 2 cloud levels (high/low)
- ✓ cloud fraction (%)
- ✓ cloud optical depth (gm^{-3})
- ✓ cloud top and bottom air pressure data (hPa)
- ✓ cloud phase (ice/water)

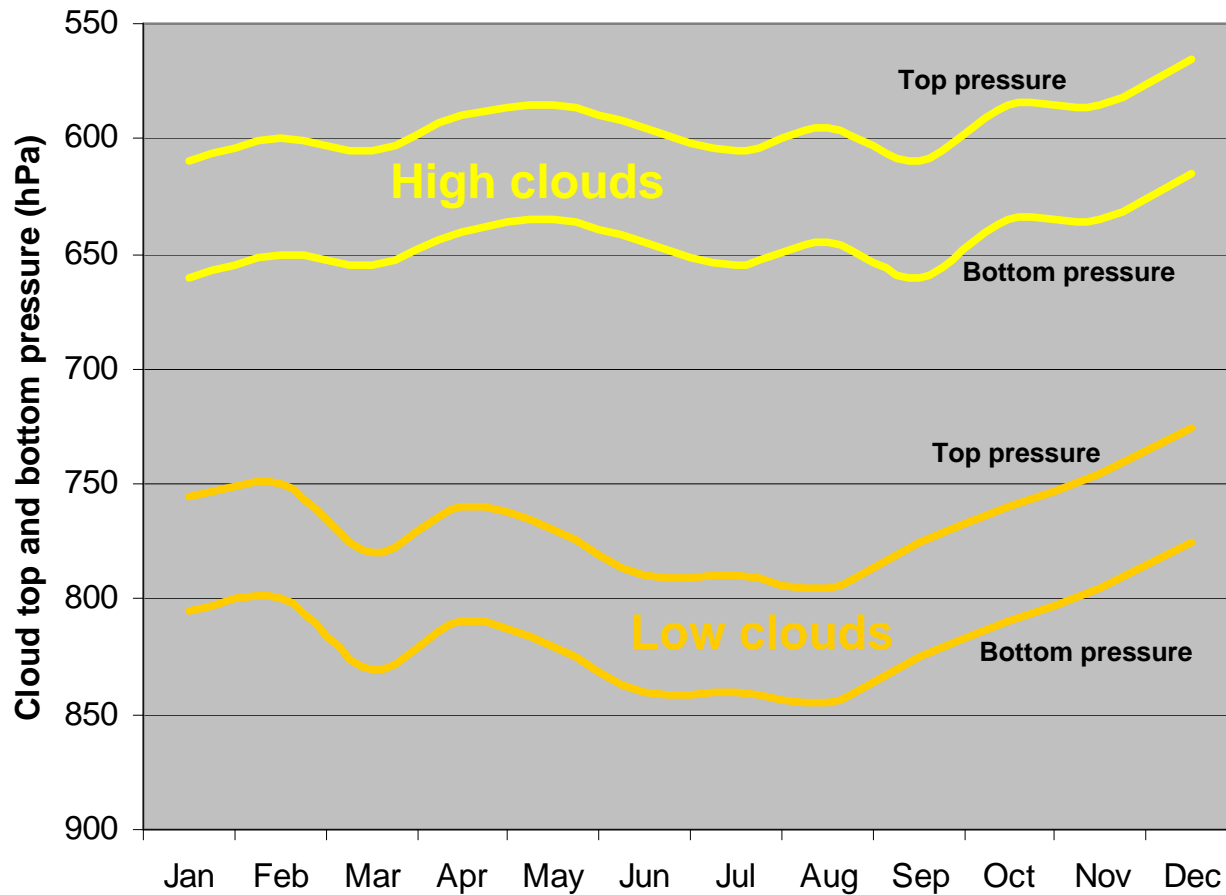
1st cloud layer (high)



2nd cloud layer (low)



Cloud pressure



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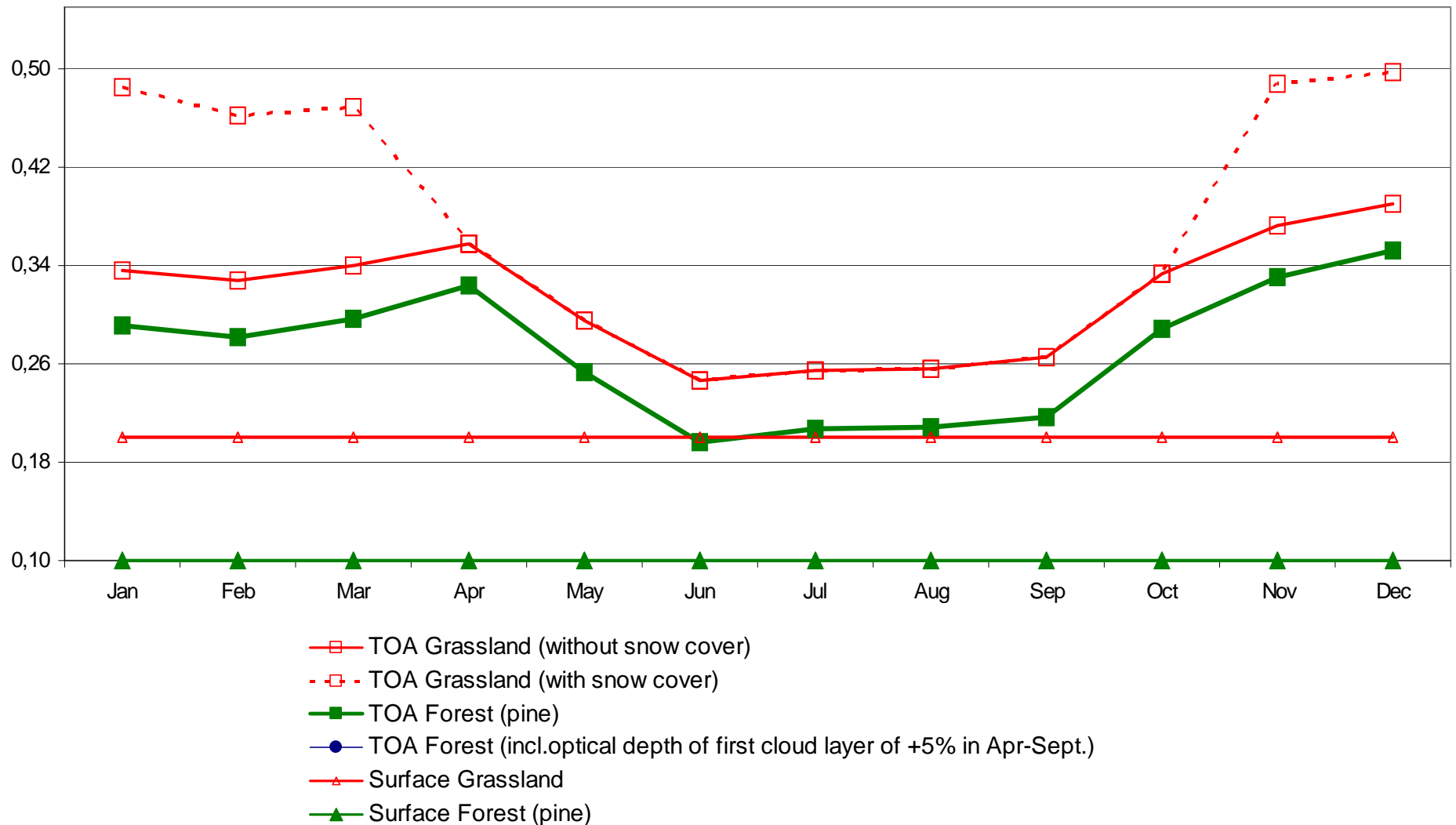
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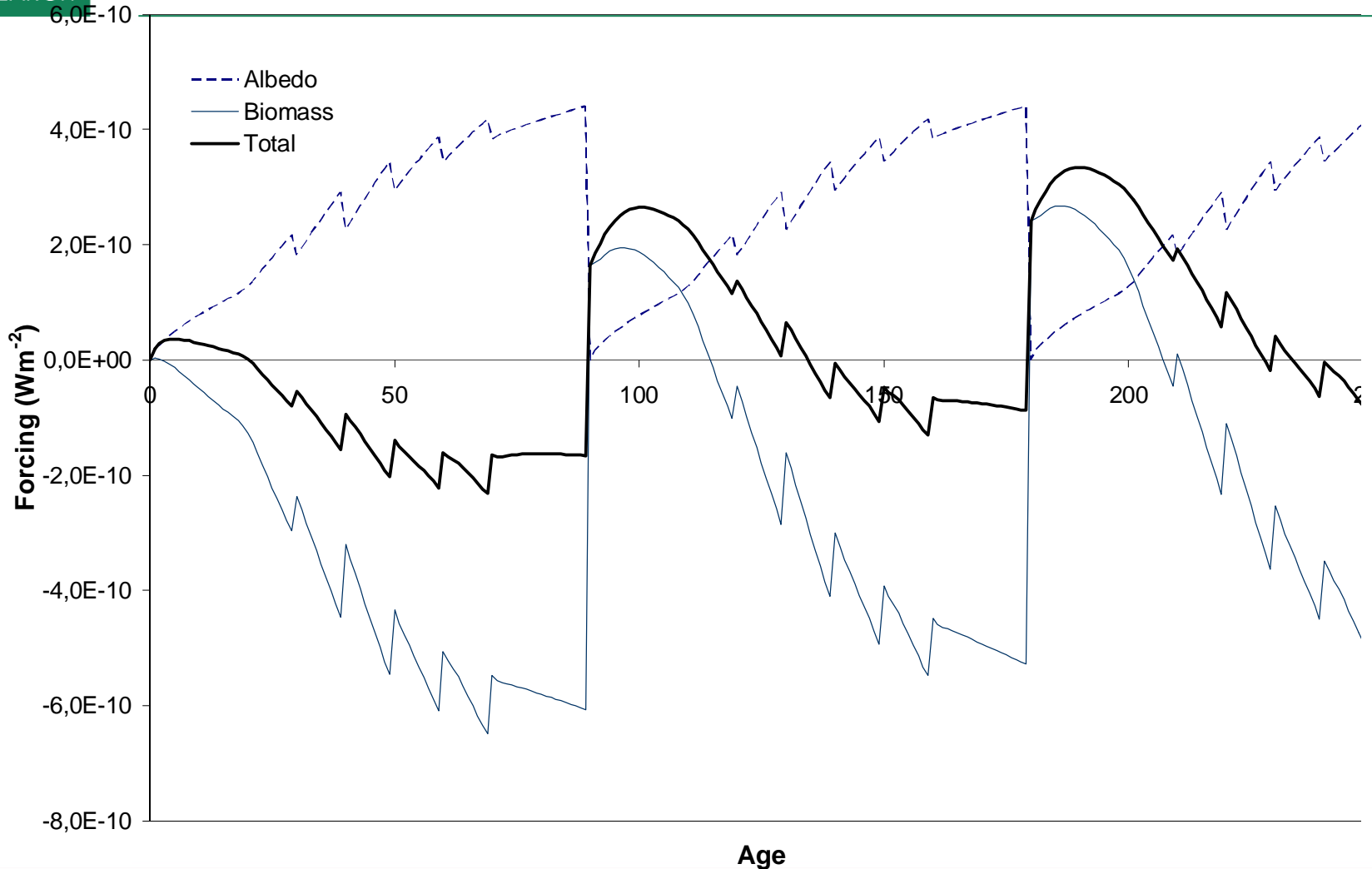
Fu-Liou Online 200507 (Diurnal Simulation)

Input Controls			
<input type="button" value="-->"/> <input type="button" value="Compute"/> <input type="button" value="<--"/>		<input type="button" value="RESET"/>	
Output @ <input type="text" value="TOA"/>	Output Parameter: SW Downwelling SW Upwelling SW NET ALBEDO Direct (sfc) Diffuse (sfc)	Output Type: <input type="radio"/> 24Hr_avg <input type="radio"/> Daylight_avg <input type="radio"/> 3Hr_avgs <input type="radio"/> Instantaneous <input checked="" type="radio"/> All of Above	Atmosphere <input type="text" value="MidLatSummer"/> Atmosphere EDIT <input checked="" type="radio"/> No <input type="radio"/> Simple <input type="radio"/> Detail
Solar Astronomy			
Latitude <input type="text" value="40.48"/> Longitude <input type="text" value="-4.05"/>	Year <input type="text" value="2008"/> Julian Day <input type="text" value="135"/> (1-366) ?JD?	Diurnal Resolution # Calc per day <input type="text" value="24=1Hr"/>	
Cosine View Zenith <input type="text" value="1.0"/>	#Streams <input type="radio"/> 2 <input checked="" type="radio"/> GW TSA <input type="radio"/> 4	Surface Albedo <input type="text" value="0.2"/> Spectral IGBP <input type="text" value="10 Grassland"/>	Foam <input checked="" type="radio"/> ON <input type="radio"/> OFF Wind Speed <input type="text" value="5.0"/> Chlorophyll <input type="text" value="0.1"/>
CO2(ppmv) <input type="text" value="360.0"/> lw only	LW Continuum <input type="text" value="2.4_ckd"/>	Surface Elevation (meters) <input type="text" value="0.0"/>	
Cloud1			
Fraction <input type="text" value="0.21"/>	Optical Depth <input type="text" value="9.38"/>	Pressure(hPa) Top <input type="text" value="585."/> Bot <input type="text" value="635."/>	Phase <input type="radio"/> WATER <input type="radio"/> ICE Size um <input type="text" value="60"/> Inhomgeniety (GW TSA) <input type="text" value="100"/>
Cloud2			
Fraction <input type="text" value="0.225"/>	Optical Depth <input type="text" value="6.82"/>	Pressure(hPa) Top <input type="text" value="770."/> Bot <input type="text" value="820."/>	Phase <input checked="" type="radio"/> WATER <input type="radio"/> ICE Size um <input type="text" value="20"/> Inhomgeniety (GW TSA) <input type="text" value="100"/>
Overlap Fraction(1&2) <input type="text" value="0.0"/>			
Aerosols			
Optical Depth 1 <input type="text" value="0.20"/>	Type <input type="text" value="continental"/>	Scale Hgtkm <input type="text" value="4"/>	
Optical Depth 2 <input type="text" value="0.00"/>	Type <input type="text" value="0.5_dust_I2004"/>	Scale Hgtkm <input type="text" value="1"/>	

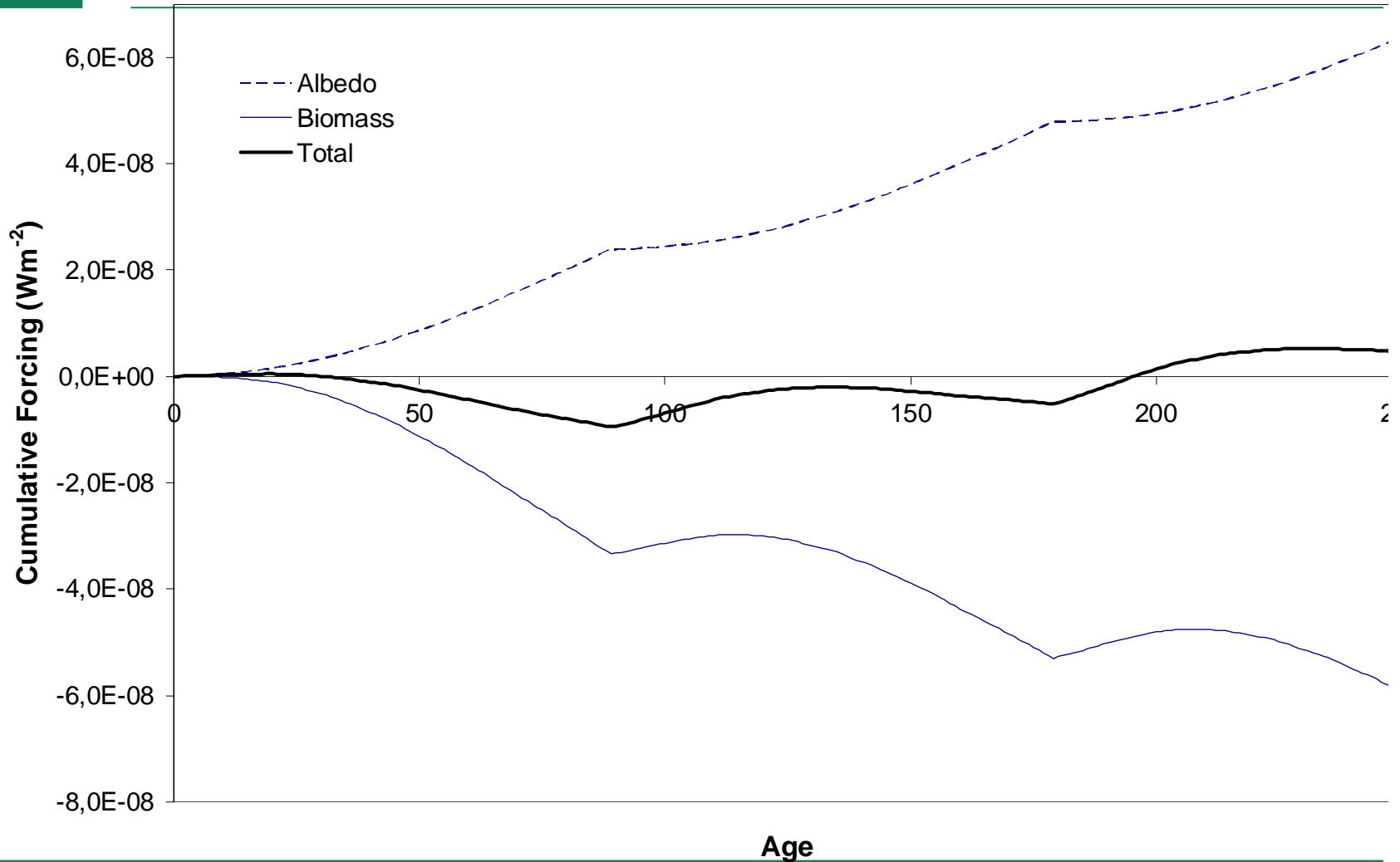
Albedo results



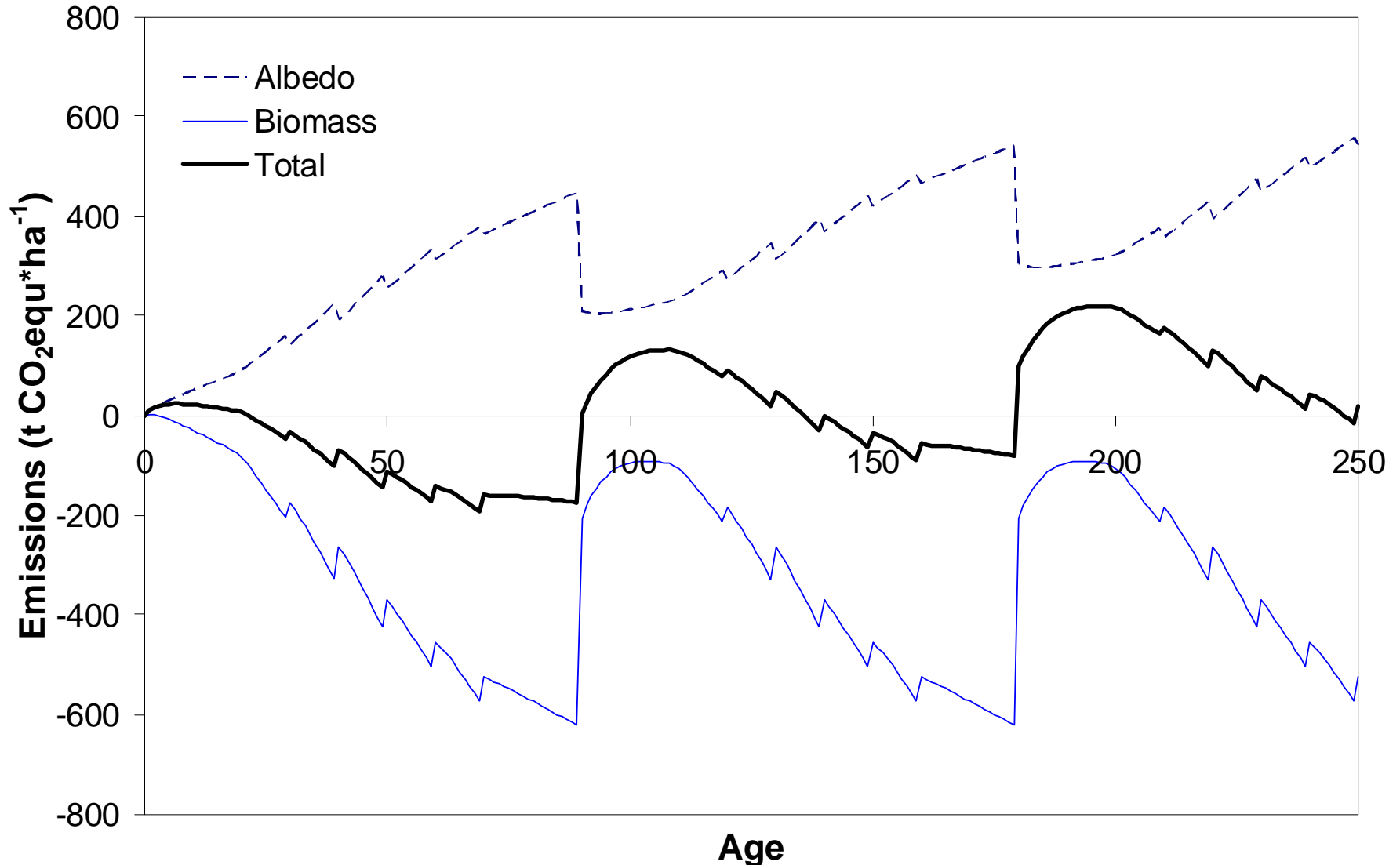
Combination of carbon accounting and Albedo (Forcing)



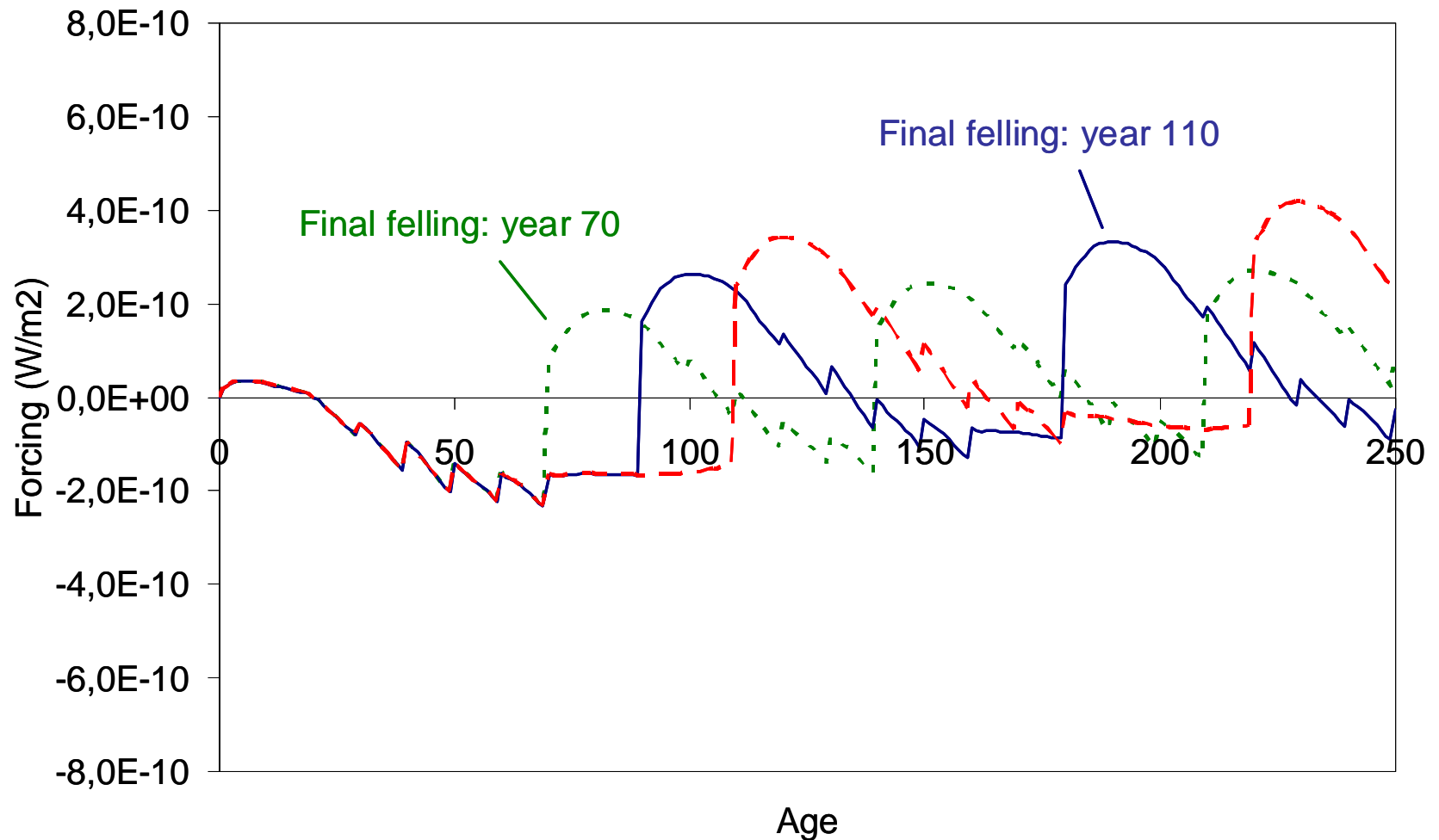
Combination of carbon accounting and Albedo (Forcing)



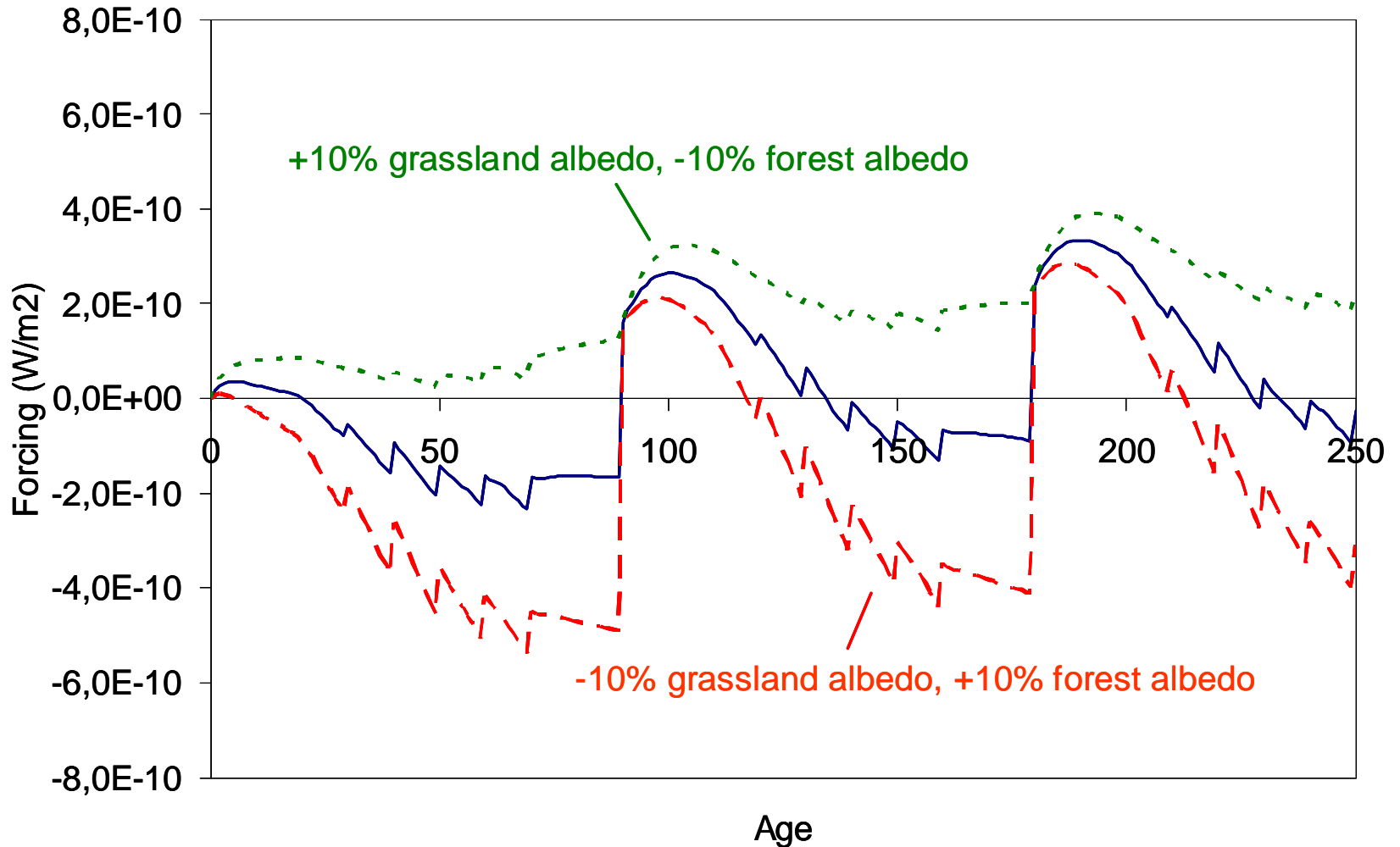
Combination of carbon accounting and Albedo (GHG Emissions)



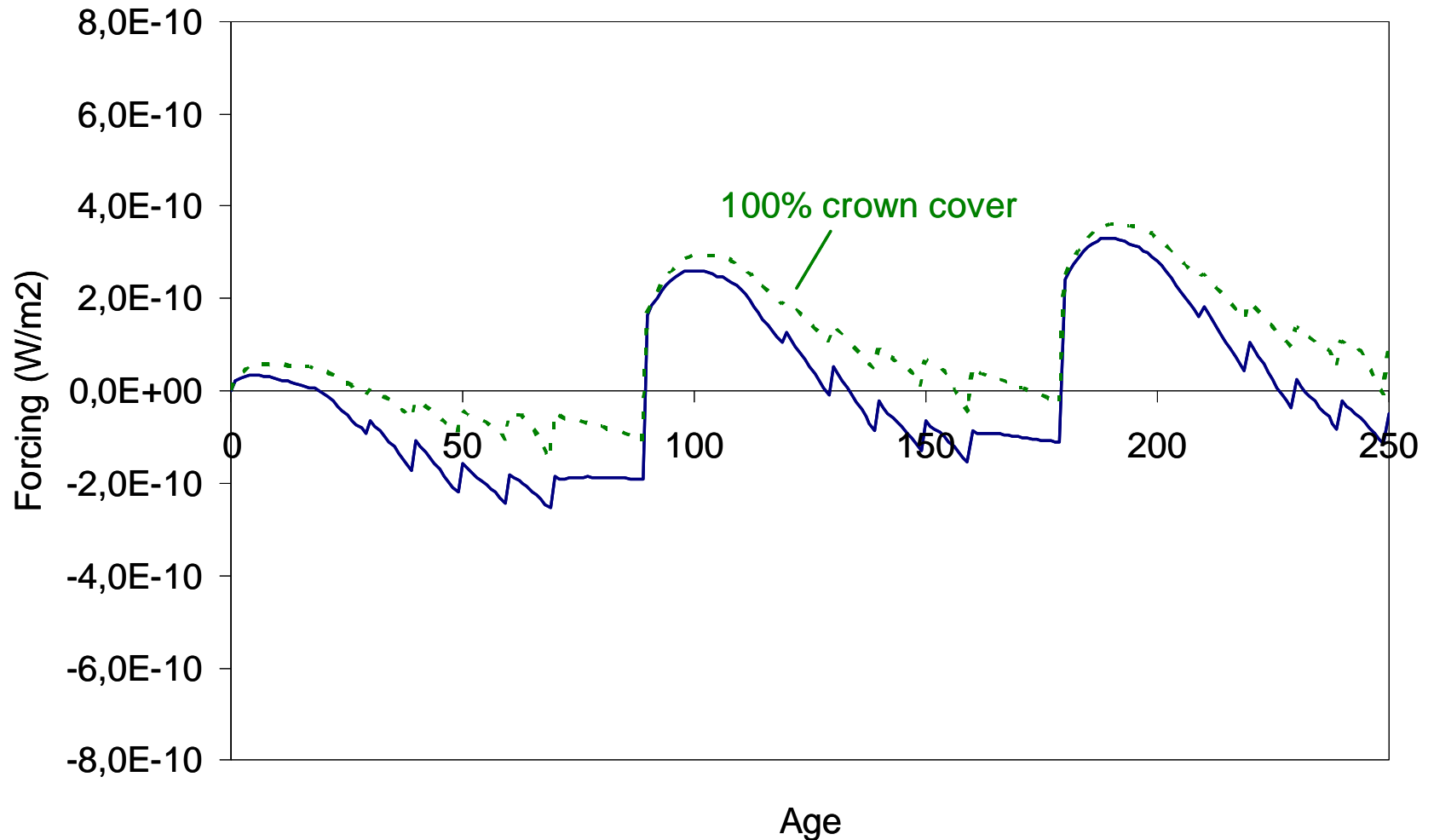
Sensitivity Analysis (1)



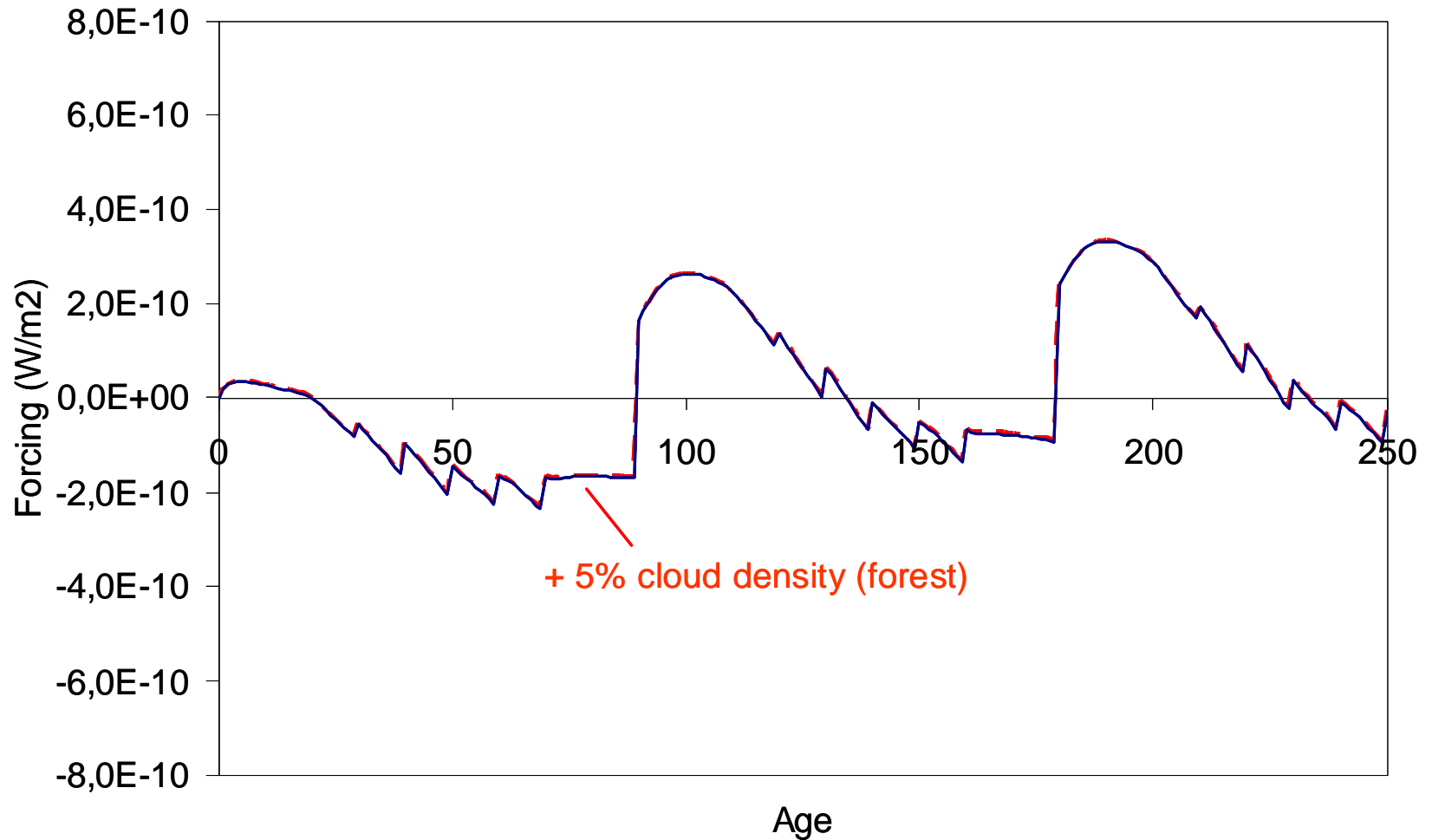
Sensitivity Analysis (2)



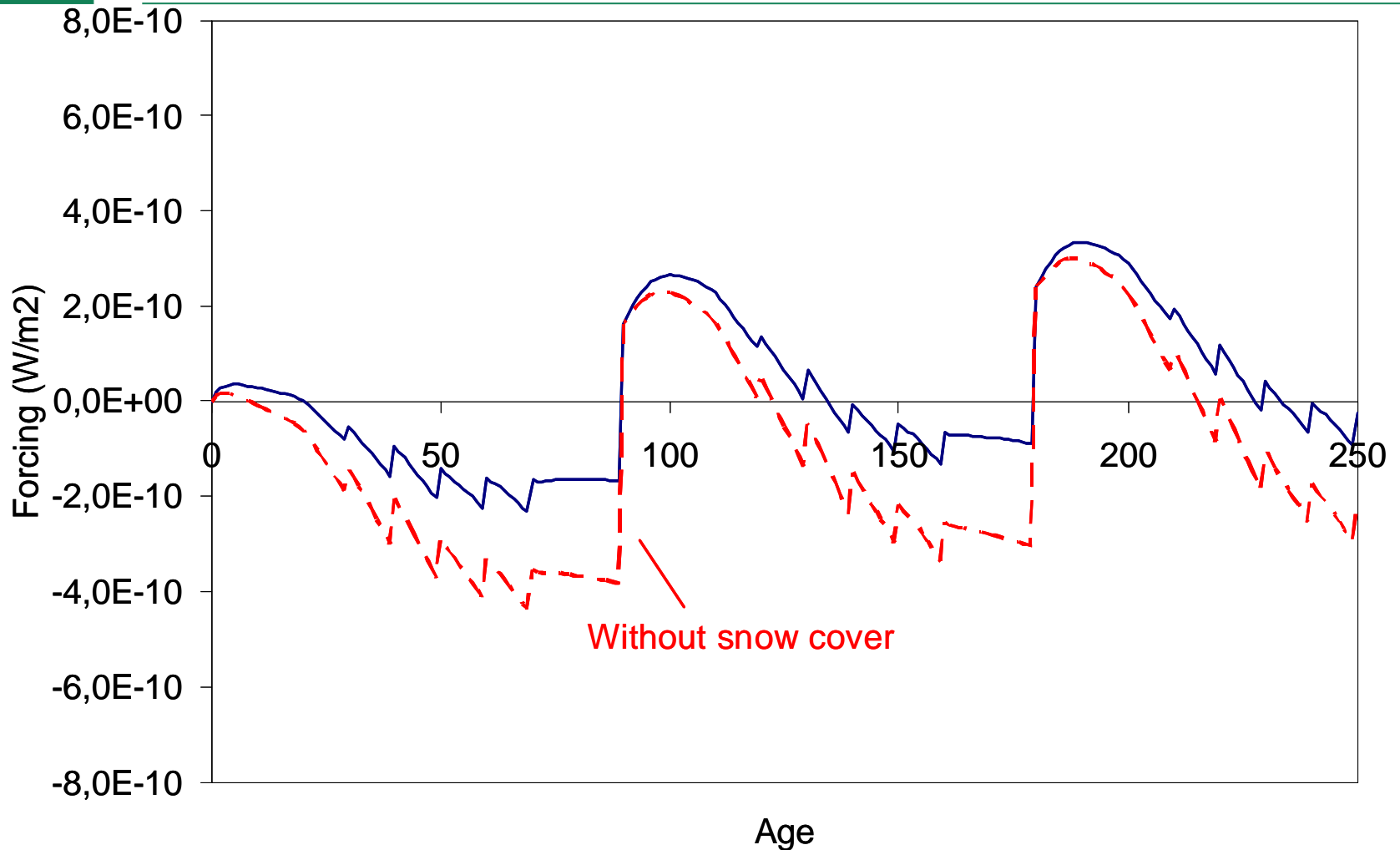
Sensitivity Analysis (3)



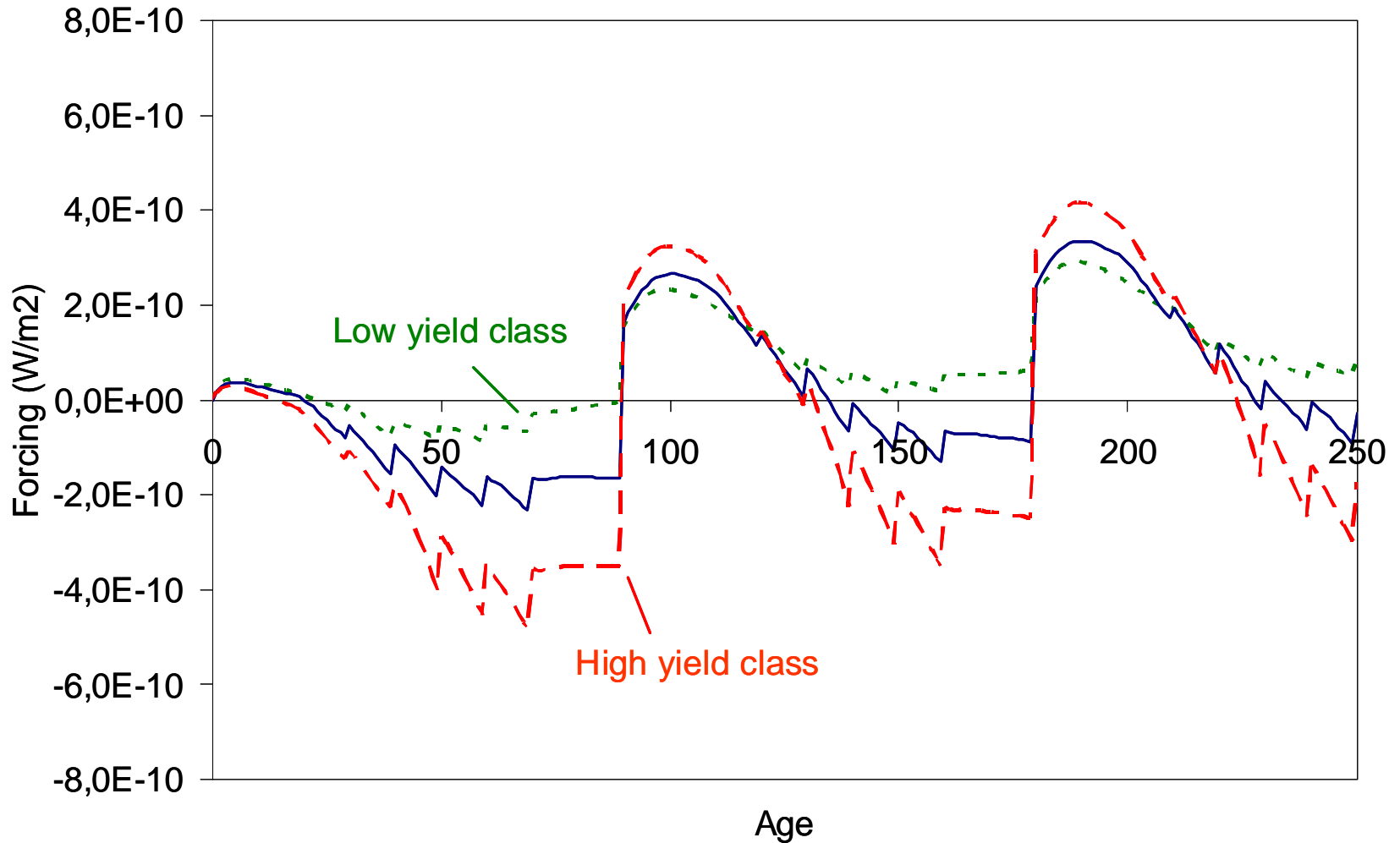
Sensitivity Analysis (4)



Sensitivity Analysis (5)



Sensitivity Analysis (6)



- ❖ Inclusion of albedo effects has to be taken into account when speaking about LUC (direct + indirect)
- ❖ Carbon sequestration due to forest growth and albedo change may compensate for each other, tending towards a net warming effect
- ❖ Sensitivity analysis: model results are highly sensitive to both, surface and TOA albedo as well as forest growth
- ❖ LCA: Albedo impacts should be included (e.g. in the sustainability discussion of liquid biofuel production out of second generation feedstock)
- ❖ Afforestation / Reforestation according to KP Art. 3.3. cannot simply be viewed as a positive activity to mitigate climate change (consideration also in JI, CDM, REDD projects)
- ❖ Further research is needed:
 - ❖ inclusion of MODIS satellite image data
 - ❖ effects of topography
 - ❖ forest inventory data instead of yield tables
 - ❖ influence of evapotranspiration changes (not considered here)
 - ❖ Inclusion of SOC and wood products may influence the results “positively”