Forest Warming Paradox
Table 2. Annual mean values (6 years) of radiation fluxes, albedo, and surface (skin) temperature in the semi-arid forest (Yatir) and in the shrubland background.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Forest</th>
<th>Shrubland</th>
</tr>
</thead>
<tbody>
<tr>
<td>Global radiation ($E_g$, W m${}^{-2}$)</td>
<td>238</td>
<td>238</td>
</tr>
<tr>
<td>Albedo (unit-less)</td>
<td>0.11</td>
<td>0.21</td>
</tr>
<tr>
<td>Net solar radiation ($S_n$, W m${}^{-2}$)</td>
<td>212</td>
<td>188</td>
</tr>
<tr>
<td>Net longwave radiation ($L_n$, W m${}^{-2}$)</td>
<td>-96</td>
<td>-121</td>
</tr>
<tr>
<td>Net radiation ($R_n = S_n + L_n$, W m${}^{-2}$)</td>
<td>115</td>
<td>67</td>
</tr>
<tr>
<td>Skin temperature (°C)</td>
<td>19</td>
<td>24*</td>
</tr>
</tbody>
</table>

*Source: Rotenberg*
Paradoxes and questions

• The forest is cooler despite more radiation loading than the shrub land.
• A cooler surface leads to a warmer climate system.
• Is longwave radiation a forcing term or part of a feedback mechanism?
• Are surface processes and CO$_2$ radiative forcing two additive quantities?
The enhanced greenhouse effect without and with feedbacks

(a) S 240 L 240 W/m²  
(b) S 240 L 236  
(c) S 240 L 240  
(d) S 240 L 240

CO₂×2  
CO₂×2  
CO₂×2 + Feedbacks

top of atmosphere

$T_S = 15°C$  
$T_S = 15°C$  
$T_S = 15 + 1.2°C$  
$T_S = 15 + 2.5°C$

Earth’s surface
Basic versus apparent climate sensitivity

Basic or intrinsic sensitivity

\[ \Delta T_o = \lambda_o \Delta Q \quad \lambda_o = \frac{1}{4\sigma T^3} \]

Apparent sensitivity

\[ \Delta T_a = \frac{\lambda_o \Delta Q}{1 - \sum g_i} \]
FluxNet

Source: http://www.fluxnet.ornl.gov/fluxnet/graphics.cfm
Blame the trees for global warming

Source: alaska-in-pictures.com