

GFDL and the IPCC Special Report on Climate Change and Land

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Climate Change and Land

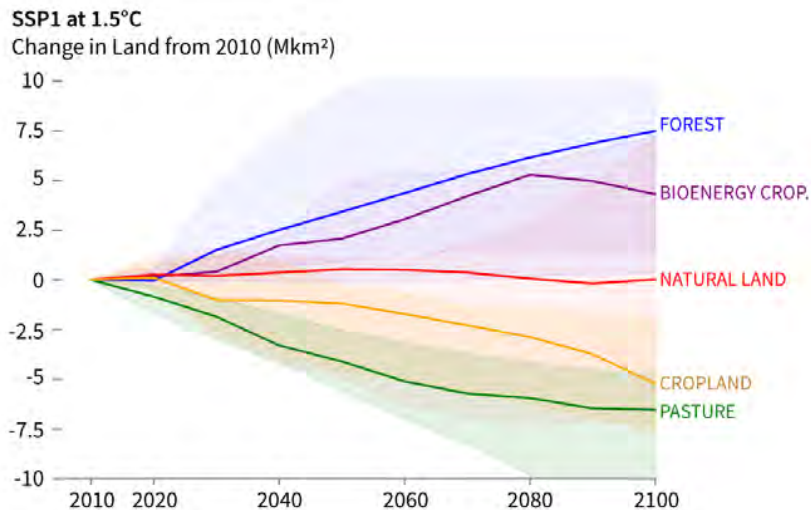
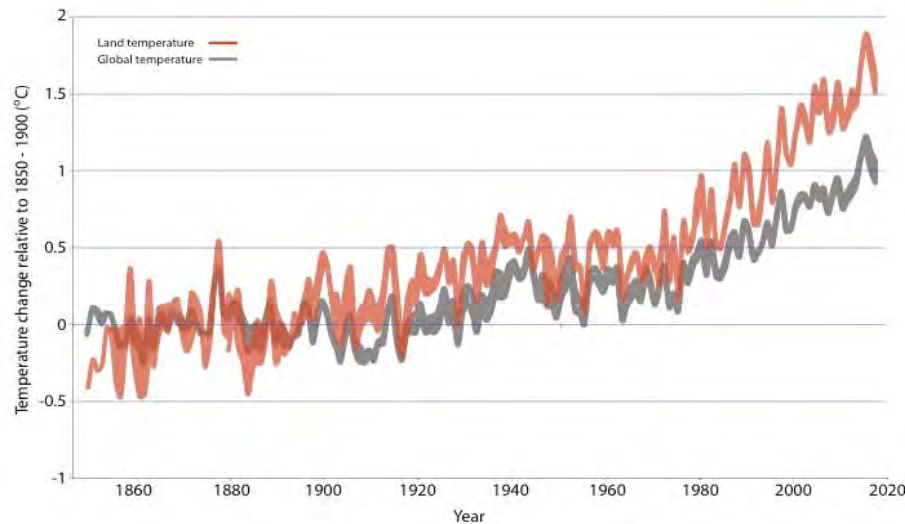
An IPCC Special Report on climate change, desertification, land degradation, sustainable land management, food security, and greenhouse gas fluxes in terrestrial ecosystems

Summary for Policymakers



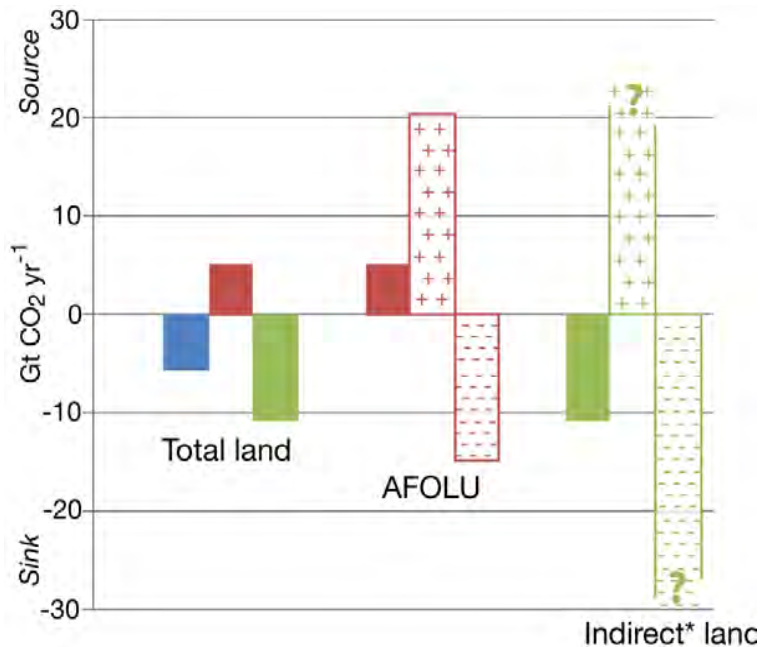
- 1: Framing and Context
- **2: Land-Climate Interactions**
- 3: Desertification
- 4: Land Degradation
- 5: Food Security
- 6: Interlinkages between desertification, land degradation, food security and GHG fluxes: Synergies, trade-offs and Integrated Response Options
- 7: Risk management and decision making in relation to sustainable development

Land-climate interactions



- Land temperatures increased nearly twice as much as the global mean
- The frequency and intensity of some extreme events have increased due to global warming. They will continue to increase
- **Limiting warming to 1.5 or 2°C would require conversion of large areas of land for afforestation/reforestation and bioenergy crops.**
- GFDL ESM capabilities enable comprehensive exploration of future regional climate changes under land-based mitigation scenarios and from global climate change

GHGs Emissions and Land

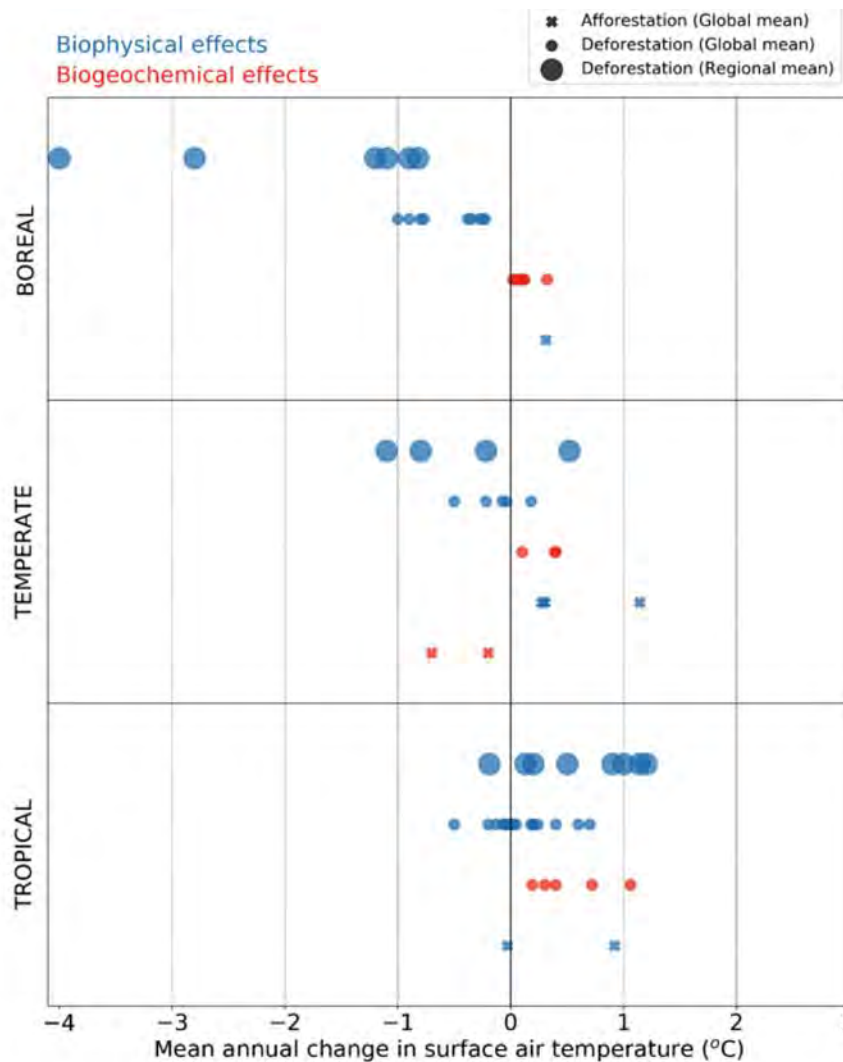


- Net land flux
- Net AFOLU flux
- Net indirect flux on land
- ++ Gross AFOLU emissions
- Gross AFOLU removals
- ++ Gross indirect emissions on land
- Gross indirect removals on land

* indirect effects due to environmental changes on managed and unmanaged lands.

- Agriculture, Forestry and Other Land Use (AFOLU) results in both emissions and removals of CO₂, CH₄, and N₂O to and from the atmosphere.
 - *contributing about 22% of anthropogenic emissions.*
- Gross fluxes on managed and unmanaged lands are uncertain
- Land accounts for **61% of anthropogenic CH₄** emissions.
- **50% of the nitrogen applied** to agricultural land **not taken up** by the crop, resulting in N₂O emissions.
- In the last decade, land very likely provided a net CO₂ removal from the atmosphere -11.2±2.6 GtCO₂/yr
- **GFDL ESM4 land allows to evaluate contribution of anthropogenic and climate change effects on global carbon budget, with no missing sinks.**

Land Feedbacks and Climate



- Changes in land conditions from human use or climate change **in turn affect regional and global climate.**
- Regional climate change can be dampened or enhanced by changes in local land cover and land use.
- **Combined BGC and BP land-use feedbacks are poorly constrained**

Table 2.4 | Change in mean global annual surface air temperature resulting from anthropogenic land cover change over the historical period. This historical period varies from one simulation to another (middle column).

Reference of the study	Time period	Mean global annual change in surface air temperature (°C)
Simmons and Matthews (2016)	1750–2000	-0.02
Shevliakova et al. (2013)	1861–2005	+0.17
Pongratz et al. (2010)	1900–2000	+0.14
Matthews et al. (2004)	1700–2000	+0.15
Brovkin et al. (2004)	1850–2000	-0.05
Mean ± standard deviation		0.078 ± 0.093

Special Reports, AR6, and Paris Agreement

from SCOPING OF THE IPCC SIXTH ASSESSMENT REPORT (AR6) Background, Cross Cutting Issues and the AR6 Synthesis Report , http://bit.ly/p46_doc6

- 1. Global Stocktake”: ...the state and trends of the climate system, observed impacts, and human fingerprint; ... relevant for tracking **progress towards achieving the purpose of the Paris Agreement and its long-term goals**, which could include mitigation and adaptation...
- 2. Interaction among emissions, climate, risks and development pathways: characteristics of mitigation pathways; remaining carbon budget consistent with long-term temperature limits, **including 1.5°C and 2°C**; non-CO₂ and short-lived climate forcers,..., climate impacts and risks arising from climate change and extremes at various spatial and temporal scales, ..., rate of change and how it varies through time; irreducible uncertainties at local and regional scales...
- **Challenge: limited CMIP6 focus on ambitious SSPs and their implications for regional climate and carbon cycle**



Summary & Future Challenges

- Understanding of land climate change, including extremes, requires quantification of regional biogeochemical and biophysical feedbacks.
- GFDL ESM capabilities enable comprehensive exploration of historical and future regional climate changes under land-based mitigation scenarios and from global climate change and implications of such changes for carbon cycle.

Emerging challenges/opportunities:

- CMIP6 has a limited number of MIPs/scenarios to explore implication of land-based mitigation for global and regional climate and carbon stocks changes
- Potential for novel designs and collaborations on specific regions (e.g. North America climate, tropical or boreal)

