

VU Research Portal

Integrating iceberg variability in the climate system using the iLOVECLIM climate model

Bügelmayer, M.

2016

document version

Publisher's PDF, also known as Version of record

[Link to publication in VU Research Portal](#)

citation for published version (APA)

Bügelmayer, M. (2016). *Integrating iceberg variability in the climate system using the iLOVECLIM climate model*.

General rights

Copyright and moral rights for the publications made accessible in the public portal are retained by the authors and/or other copyright owners and it is a condition of accessing publications that users recognise and abide by the legal requirements associated with these rights.

- Users may download and print one copy of any publication from the public portal for the purpose of private study or research.
- You may not further distribute the material or use it for any profit-making activity or commercial gain
- You may freely distribute the URL identifying the publication in the public portal ?

Take down policy

If you believe that this document breaches copyright please contact us providing details, and we will remove access to the work immediately and investigate your claim.

E-mail address:

vuresearchportal.ub@vu.nl

Table of Contents

Acknowledgements	ix
Abstract	xi
Samenvatting	xix
Table of Contents	xxv
List of Figures	xxxix
List of Tables	xxxiii
1 Introduction	1
1.1 The Present-Day Climate Perspective	1
1.1.1 Forcing and Feedback Mechanisms of the Climate System	2
1.2 The Paleoclimate Perspective	7
1.2.1 Proxy Data - Records of Past Climates	9
1.2.2 Climate Models: Tools to Understand Climate	10
1.2.3 The Last Glacial Period and the Occurrence of Heinrich Events	13
1.2.4 The Holocene	16
1.3 iLOVECLIM and Objectives	18
1.3.1 The iLOVECLIM climate model	18
1.3.2 The Atmospheric Model ECBilt	19
1.3.3 The Oceanic Component - CLIO	21
1.3.4 The Vegetation Model - VECODE	22
1.3.5 The Ice Sheet Model GRISLI	22
1.3.6 The Iceberg Model	23
1.3.7 The model performance	24
1.3.8 The model developments concerning this thesis	25
1.4 Objectives of my thesis	29

2	Impact of Icebergs on GrIS under PI conditions	33
2.1	Introduction	34
2.2	Methods	38
2.2.1	Atmosphere - ocean - vegetation model	38
2.2.2	GRISLI - ice sheet model	40
2.2.3	The iceberg module	41
2.2.4	The coupling method and experimental set-up	43
2.3	Results	46
2.3.1	Representation of icebergs compared to observations	49
2.3.2	Impact of icebergs on the pre-industrial climate and the Greenland ice sheet (cooling - freshening - distribution effect)	50
2.3.3	Parameterizing icebergs using freshwater fluxes - how well does it work?	52
2.4	Discussion	56
2.5	Conclusions	58
3	Representing icebergs in iLOVECLIM	61
3.1	Introduction	62
3.2	Methods	65
3.2.1	Atmosphere - ocean - vegetation model	66
3.2.2	GRISLI - ice sheet model	66
3.2.3	The iceberg module	67
3.2.4	Experimental set-up	68
3.2.5	Iceberg dynamical forcing	69
3.2.6	Initial iceberg size distribution	69
3.2.7	Radiative forcing	70
3.3	Results	70
3.3.1	Impact of dynamical forcing and initial iceberg size on the transport and lifetime of icebergs under pre-industrial conditions	70
3.3.2	Impact of dynamical forcing and initial iceberg size on pre-industrial climate	75
3.3.3	Impact of initial iceberg size under a changing cli- mate	76
3.4	Discussion	80
3.5	Conclusions	81
4	Enhanced IRD events during the Holocene	85
4.1	Introduction	86
4.2	Methods	90

4.2.1	Climate Model <i>i</i> LOVECLIM	90
4.2.2	Forcing Fields	91
4.2.3	Experimental set-up	93
4.3	Results	96
4.3.1	Modeled Holocene climate	96
4.3.2	The simulated iceberg melt flux	96
4.4	Discussion	105
4.5	Conclusions	108
5	Disentangling Oxygen - Isotope Signals during Heinrich Stadial 1	111
5.1	Introduction	112
5.2	Methods	115
5.2.1	The <i>i</i> LOVECLIM climate model	115
5.2.2	Experimental set-up	117
5.3	Results	118
5.3.1	Climate response to iceberg forcing	118
5.3.2	Minimum SST - its effect on the $\delta^{18}\text{O}_{\text{calcite}}$ evolution	124
5.3.3	Minimum $\delta^{18}\text{O}_{\text{seawater}}$ - its effect on the $\delta^{18}\text{O}_{\text{calcite}}$ evolution	127
5.3.4	How does the $\delta^{18}\text{O}_{\text{calcite}}$ evolution look in other regions?	128
5.4	Discussion	129
5.4.1	Can we use the modeled $\delta^{18}\text{O}_{\text{calcite}}$ evolution to better understand the $\delta^{18}\text{O}_{\text{calcite}}$ recorded in ma- rine sediment cores?	129
5.4.2	General discussion	133
5.5	Summary	134
6	Synthesis & Outlook	137
6.1	Summary of Main Findings	137
6.2	Outlook	143
	Supplementary Information A Representing icebergs in <i>i</i>LOVE- CLIM	147
	Supplementary Information B Enhanced IRD events dur- ing the Holocene	149

Bibliography

157