

Martin Beech

Terraforming: The Creating of Habitable Worlds

Table of Contents

1.	Prolog: The Big Guns of Kugluktuk	1
	Summer, the Year 2100	1
	Notes and References	4
2.	Introduction	7
	What's in a Word?.....	9
	Moving Forward.....	11
	The Anthropocene.....	12
	Future Worlds, Future Homes.....	13
	Economics.....	17
	Notes and References	18
3.	Life in the Solar System, and Beyond	19
	Mars: The Once and Future Abode of Life?	21
	Life Express.....	26
	The Miller–Urey Experiment.....	28
	Panspermia: The Bigger Picture	31
	Life and Death Clouds.....	35
	Vignette A: What Is Life?	37
	The Rights of Microbes	40
	Notes and References	41
4.	The Limits of the World.	45
	Home on the Range: A Brief History of the Solar System	46
	The Blue Marble	53
	Breathing Room	56
	A Magnetic Shield	59
	Humanity's Footprint.....	61
	We, the Tikopia	67
	The Aging Sun	68
	Back to the Present	74
	Vignette B: The Viking Landers	75
	Notes and References	79
5.	In the Right Place at the Right Time	81
	Planetary Temperatures	82
	Atmospheric Temperature and Pressure	88

x Contents

Phase Diagram of Water	93
The Habitable Zone	96
Atmospheric Retention	97
The Greenhouse Effect	101
The Tail Wagging the Dog	103
Feedback Cycles and Stability	105
The End of the Biosphere	110
The Formation of Terrestrial Planets	112
Super-Earths	118
Vignette C: Kepler's <i>Somnium</i>	119
Notes and References	122
 6. The Terraforming of Mars	125
The Measure of Mars	128
Whither the Water?	136
The Opening Salvo	138
Altered States: The Means of Terraforming Mars	142
Increased CO ₂ Abundance	146
The CO ₂ Runaway	147
Super-Greenhouse Gases	151
Albedo Change and Increased Insolation	154
The Phases of New Mars	157
The Times of Their Lives	162
Worldhouse	165
Near-Term Developments	165
Vignette D: Daisy World	167
Notes and References	171
 7. The Terraforming of Venus	175
The Moist Greenhouse Effect	182
Cloud Life	183
Perelandra Remade	185
Atmospheric Blow-off, Cooling, and Mining	186
Roman Blinds, Spin Up, and Spin Apart	191
Back to Basics	194
Getting CO ₂ Stoned	196
A Cold New Dawn	197
Surface Turnover	199
Flying High	201
A Distant Dawn	203
Vignette E: Back to the Moon	203
Notes and References	206
 8. An Abundance of Habitats	211
The Moon's a Balloon	212

Hot-Footed Hermes	216
A Fragmented Neighborhood	220
Life on a Dwarf Planet: Ceres World.....	222
Living in the Clouds	225
Supramundane Planets and Shell Worlds	226
O'Neill Colonies and Orbiting Cities	229
The Coming of a Second Sun	230
Earth Shift and a Synthetic Sun	235
Dyson Spheres and Jupiter	236
The Galilean Moons: Food for Thought	238
The Deeper, Darker, Colder Solar System	242
The Pull of More Distant Horizons	245
Other Worlds Abound	246
Future Prospects	248
Habitable Exoplanets and Biomarkers	251
Vignette F: The Mysterious Titius–Bode Law	254
Notes and References	257
 Epilogue	261
 Internet Resources.	265
 Glossary of Technical Terms	269
 Appendices.	273
A. Blackbody Radiators	273
B. Accounting for Greenhouse Gases	275
C. A Terraforming Simulator Model for Mars	277
D. Population Growth and Lily World.....	281
 Index.	289