

Cambridge University Press

978-0-521-14245-8 - Sound Transmission through a Fluctuating Ocean

Edited by Stanley M. Flatte, Roger Dashen, Walter H. Munk, Kenneth M. Watson and

Fredrik Zachariassen

Table of Contents

[More information](#)

CONTENTS

	<i>Sketch by Leonardo da Vinci</i>	<i>Frontispiece</i>
	<i>Preface</i>	xi
	<i>Acknowledgements</i>	xiv
	<i>Introduction</i>	xv
	PART I. The ocean environment	1
1	Ocean structure	3
1.1	Scales	3
1.2	Water masses	10
1.3	Finestructure and microstructure	14
1.4	Circulation	19
1.5	The surface mixed layer	30
1.6	The canonical sound structure	31
2	Planetary waves and eddies	34
2.1	Planetary waves	35
2.2	Mesoscale	40
2.3	Geostrophic turbulence	42
3	Linear internal waves	44
3.1	Observed ocean fluctuations	44
3.2	Equations for internal-wave motion	46
3.3	Approximation to the wavefunctions $W(k, j, z)$	53
3.4	The spectrum of internal waves	54
3.5	Equivalent spectra	57
3.6	The sound-speed correlation function	59
	PART II. Introduction to sound transmission in the ocean	63
4	The ocean sound channel	65
4.1	Rays in the sound channel	65
4.2	Angle–depth diagrams	69
5	The wave equation	74
5.1	Fundamental approximations	74
5.2	The reduced wave equation and the parabolic approximation	76

Cambridge University Press

978-0-521-14245-8 - Sound Transmission through a Fluctuating Ocean

Edited by Stanley M. Flatte, Roger Dashen, Walter H. Munk, Kenneth M. Watson and

Fredrik Zachariassen

Table of Contents

[More information](#)

viii

CONTENTS

5.3	Introduction to the path-integral formulation	78
5.4	Rays	82
	PART III. Sound transmission through a fluctuating ocean	85
6	Transmission through a homogeneous, isotropic medium	87
6.1	Correlation functions and spectral functions	87
6.2	Parameters and regimes; Λ - Φ space	90
6.3	Geometrical optics	94
6.4	Other parameter regimes	99
7	The ocean medium	100
7.1	Fresnel zones and ray tubes	101
7.2	Definitions of the strength and diffraction parameters, Φ and Λ	106
7.3	The phase-structure function, D	108
7.4	Internal-wave dominance for Φ and Λ	110
7.5	Evaluation of the phase-structure function	117
8	Statistics of acoustic signals	120
8.1	Signal statistics and variables	120
8.2	Regimes in Λ - Φ space	126
8.3	One-point functions	130
8.4	Time separations	135
8.5	Spatial separations	139
8.6	Frequency separations	140
8.7	Pulse propagation	144
9	Multipath effects and n-point Gaussian statistics	150
9.1	Statistics of a wavefunction obeying n -point Gaussian statistics	150
9.2	Cartesian statistics	152
9.3	Intensity and phase statistics	154
9.4	n -point Gaussian statistics	158
	PART IV. Theory of sound transmission	163
10	Supereikonal, or Rytov approximation	165
10.1	Isotropic ocean	165
10.2	Anisotropic ocean	170
10.3	Channeled ocean	174
10.4	Internal-wave dominance	175
10.5	Comparison with numerical experiments	185
11	Propagation through a single upper turning point	189
11.1	Setting up the problem	189
11.2	Regions in Λ - Φ space	193

Cambridge University Press

978-0-521-14245-8 - Sound Transmission through a Fluctuating Ocean

Edited by Stanley M. Flatte, Roger Dashen, Walter H. Munk, Kenneth M. Watson and

Fredrik Zachariassen

Table of Contents

[More information](#)

CONTENTS	ix
11.3 Sound fluctuations in the presence of micromultipath	197
11.4 A better method of calculating sound fluctuations in the presence of micromultipath	200
11.5 Correlations in frequency	204
12 Path integrals and propagation in saturated regimes	207
12.1 The path integral	208
12.2 Signal statistics in the fully saturated regime	209
12.3 The Markov approximation	212
12.4 The partially saturated regime	217
13 The transport equation in sound scattering	220
13.1 The energy flux	221
13.2 The transport equation for acoustic intensity	222
13.3 The diffusion approximation	225
13.4 Scattering from internal waves	228
13.5 Scattering from the microstructure fluctuations	234
PART V. Experimental observations of acoustic fluctuations	237
14 Eleuthera–Bermuda	239
14.1 Treatment of data	239
14.2 Cartesian spectra	243
14.3 Phase and intensity statistics	248
14.4 Conclusions	248
14.5 The Williams and Battestin resolved experiment	250
15 Cobb seamount	252
15.1 Phase and intensity variances	252
15.2 Spectra	254
16 Azores	256
16.1 Environmental data	256
16.2 CW measurements	260
16.3 Pulse measurements	265
Epilog	269
Appendix A: Calculation of $K(\alpha)$	273
Appendix B: Calculation of $Q(\alpha)$	274
Appendix C: Calculation of γ	276
<i>Bibliography</i>	277
<i>Glossary of terms</i>	285
<i>Units, dimensions and glossary of symbols</i>	289
<i>Index</i>	295