

---

## Contents

<i>List of Contributors</i>	<i>page</i> viii
<i>Preface</i>	ix
<b>1 Interfacial Fluid Dynamics</b>	
STEPHEN H. DAVIS	
1 Introduction	1
2 Interfacial regions	4
3 Thin films	8
4 Contact lines	31
5 Singularities, corners and cusps	42
6 Discussion	49
<b>2 Viscous Fingering as an Archetype for Growth Patterns</b>	
YVES COUDER	
1 Introduction	53
2 The basis of Saffman–Taylor viscous fingering instability	58
3 The basis of the instability of other physical systems	65
4 The existence of stable curved fronts	69
5 Fractal structures	84
6 Directional growth	93
7 Conclusions	98
<b>3 Blood Flow in Arteries and Veins</b>	
T. J. PEDLEY	
1 Introduction	105
2 Pulse propagation	108
3 Flow in veins and other collapsible tubes	119
4 Arterial wall shear stress and flow separation	137
5 Conclusion	153

**4 Open Shear Flow Instabilities**

PATRICK HUERRE

1	Introduction	159
2	Open shear flows: amplifiers versus oscillators	161
3	Absolute/convective instabilities in parallel flows	167
4	Global instability analyses	197
5	Absolute/convective and local/global instabilities in nonlinear systems	212
6	Epilogue	224

**5 Turbulence**

JAVIER JIMÉNEZ

1	Introduction	231
2	The small scales and the energy cascade	233
3	Inhomogeneity and anisotropy	245
4	Intermittency	249
5	Free-shear flows	255
6	Wall-bounded flows	265
7	Computing turbulence	276
8	Conclusions	283

**6 Convection in the Environment**

P. F. LINDEN

1	Introduction	289
2	Rayleigh–Bénard convection	294
3	Plumes and thermals	303
4	Double-diffusive convection	321
5	Katabatic flows and gravity currents	335
6	Effects of rotation	337

**7 Reflections on Magnetohydrodynamics**

H. K. MOFFATT

1	Introduction	347
2	Fundamental principles	349
3	The Lorentz force and the equation of motion	354
4	Electromagnetic shaping and stirring	356
5	Dynamo theory	367
6	Relaxation to magnetostatic equilibrium	379
7	Concluding remarks	388

**8 Solidification of Fluids**

M. G. WORSTER

1	Introduction	393
2	Some fundamentals of solidification	394
3	Convective heat transfer	401
4	Binary alloys	407
5	Morphological instability and flow	413

<i>Contents</i>		vii
6	Mushy layers	419
7	Solidification and convection in mushy layers	429
8	Concluding remarks	444
<b>9</b>	<b>Geological Fluid Mechanics</b>	
	HERBERT E. HUPPERT	
1	The Earth	447
2	Fluid processes in magma chambers	452
3	The propagation of magma through the crust	466
4	Fluid mechanics and thermodynamics of volcanic eruption columns	477
5	Gravity currents: pyroclastic flows, turbidity currents, lava domes	484
6	Extra topics	495
<b>10</b>	<b>The Dynamic Ocean</b>	
	CHRIS GARRETT	
1	Introduction	507
2	Ocean circulation	509
3	The parameterization of small-scale processes	521
4	Inference	527
5	Measurements	531
6	Processes	537
7	Other problems	551
8	Summary and outlook	553
<b>11</b>	<b>On Global-Scale Atmospheric Circulations</b>	
	MICHAEL E. MCINTYRE	
1	Introduction	557
2	Some fundamentals, including anti-friction	561
3	Wave propagation and gyroscopic pumping	564
4	Wave-induced momentum transport: experiment and theory	566
5	Wave breaking, wave filtering, and critical layers	570
6	The general definition of wave breaking	575
7	The Plumb–McEwan experiment and the refrigeration effect	577
8	Historical note: the Michelson–Morley principle	578
9	Material invariants and stratification surfaces	580
10	Stable stratification and balanced flow	586
11	Oscillations about balance: inertia–gravity wave dynamics	590
12	Balanced oscillations: PV inversion and Rossby wave dynamics	599
13	Rossby waves and anti-friction	606
14	The global-mean circulation of the middle atmosphere	613
15	The response to gyroscopic pumping	618
16	Postlude: the oceans, the troposphere, and climate feedback	619
	<i>Index</i>	625