Fabrice Ardhuin

born April 23, 1975

researcher at "Laboratoire d'Océanographie Physique et Spatiale" (LOPS),
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Education
- M. S., Fluid Dynamics & Geosciences, Ecole Polytechnique, France, 1997
- M S., Meteorology and Oceanography, Université Paul Sabatier, Toulouse, France, 1998
- PhD., Oceanography, Naval Postgraduate School, Monterey, CA, 2001

Professional experience
2014 - now   Senior researcher (DR2), CNRS, Brest, France

2010 - 2014   Senior researcher, Ifremer, Brest, France (on leave from the French DoD)

2001 - 2009   Researcher & program manager, Naval Hydrogr. & Oceanogr. Service (SHOM),
Brest, France.
(Ingénieur en Chef de l'Armement)

Honors
- **2009** prix Christian Le Provost Océanographe, French Academy of Sciences
- **2008** Fofonoff Award, American Meteorological Society, "for theoretical and observational research on the interaction of ocean surface waves with the sea floor and ocean currents, and developing accurate coastal wave prediction models."
- **2008** Journal of Physical Oceanography Editor's award

Research Interests
I have studied a wide range of phenomena associated to the upper ocean, in particular ocean waves, currents, sea ice and their interactions, helping in practical applications to marine meteorology. I have used and developed techniques for *in situ* observations, satellite remote sensing, the analysis of microseisms, and numerical modelling. I have been a very active co-developer of the WAVEWATCH III numerical model, contributing in particular physical parameterizations and numerical schemes on triangle-based grids, and methods for coupling to ice and ocean circulation models. I am particularly interested in understanding the patterns of extreme sea states in multi-decadal records obtained from satellite data and microseisms, and better understanding upper ocean dynamics, in particular the interaction of ocean waves and currents. This has led me to propose a new satellite mission "SKIM" for mapping ocean surface currents using a Doppler radar technique, and to be the "science lead" for the Essential Climate Variable "Sea state" in the European Space Agency "Climate Change Initiative" program (http://cci.esa.int).

Ph.D. Thesis Advisor for 10 graduated students: R. Magne, N. Rascle, V. Marieu, M. Delpey, JF Filipot, F. Leckler, A. Rawat, C. Peureux**,** P.V. Guimaraes, L. Pineau-Guillou, G. Boutin

Advisor for 2 students in progress: M. de Carlo, G. Marechal

Sponsor of 8 post-doctoral researchers: A.C. Bennis, A. Balanche, M. Obrebski, J. Pianezze, J. Stopa, N. Rascle, N. Suzuki, S. Brumer

Memberships
- AGU: since 1999, Life Member since 2015.
- American Meteorological Society: member since 2005.

Community service

Member of the Waves in Shallow Environment group (WISE) steering comitte since 2006.

Member of the French Ocean Remote Sensing advisory committee (CNES / TOSCA), (2010-2014).
Member of the Science Definition Team for the SWOT altimetry mission, since 2012.
Member of the LabexMer Cluster of Excellence Scientific Council since 2012.

Chairman of Laboratoire de Physique des Océans (2015) and Laboratoire d'Océanographie Physique et Spatiale (January 2016 – June 2019).

PUBLICATIONS

Publication statistics
- **over 115 peer-reviewed publications,**
- **WOS (2019/01/21): H-index 33, 3 highly cited papers, 3474 citations.**
- **Google Scholar (2019/03/28) : H-index 45, 7357 citations**

Book chapters
"Wind waves", in "New Frontiers in Operational Oceanography", GODAE Ocean View, 2018
" Physics of Ambient Noise Generation by Ocean Waves", in Seismic Ambient Noise, Cambridge University Press, 2019.

Peer-reviewed publications (in bold: F. Ardhuin or advised students & post-docs)

1. **Ardhuin, F**., J.-M. Pinot, and J. Tintoré, **1999**, Numerical study of the circulation in a steep canyon off the Catalan coast (western Mediterranean), *J. Geophys. Res.*, **104**(C5), 11115-11135.
2. **Ardhuin, F**., T. H. C. Herbers, and W. C. O'Reilly, **2001**, A hybrid Eulerian-Lagrangian model for spectral wave evolution with application to bottom friction on the continental shelf, *J. Phys. Oceanogr.*, **31**(6), 1498-1516.

3. **Ardhuin, F.**, et T. H. C. Herbers, **2002**, Bragg scattering of random surface gravity waves by irregular sea bed topography, *JFM*, **451**, 1-33.

4. **Ardhuin, F.**, T. G. Drake et T. H. C. Herbers, **2002**, Observation of wave-generated vortex ripples on the North Carolina continental shelf, *J. Geophys. Res.*, **107** (C10), DOI:10.1029/2001JC000986.

5. **Ardhuin, F.**, W.C. O'Reilly, T.H.C. Herbers & P.F. Jessen, **2003**, Swell transformation across the continental shelf. Part I: Attenuation and directional broadening, *J. Phys. Oceanogr.*, **33**, 1921-1939.

6. **Ardhuin, F.**, T.H.C. Herbers, W.C. O'Reilly, & P.F. Jessen, **2003**, Swell transformation across the continental shelf. Part II: validation of a spectral energy balance equation, *J. Phys. Oceanogr.*, **33**, 1940—1953.

7. **Ardhuin, F.**, B. Chapron et T. Elfouhaily, **2004**, Waves and the air-sea momentum budget, implications for ocean circulation modelling, *J. Phys. Oceanogr.*, **34**, 1741—1755.

8. **Ardhuin, F.**, F. R. Martin-Lauzer, B. Chapron, P. Craneguy, F. Girard-Ardhuin et T. Elfouhaily, **2004**, dérive à la surface de l'océan sous l'effet des vagues, *Comptes Rendus Géosci.,* **336**, 1121—1130.

9. **Ardhuin, F.**, A. D. Jenkins, D. Hauser, A. Reniers et B. Chapron, **2005**, Waves and operational oceanography : Toward a Coherent Description of the Upper Ocean , *Eos*, **86** (4), 37—39.

10. **Ardhuin, F.**, et T.H.C. Herbers, **2005**, Numerical and physical diffusion: Can wave prediction models resolve directional spread? *J. Atmos. Ocean Tech.*, **22** (7), 883—892.

11. **Magne, R.**, **F. Ardhuin**, V. Rey et T. H. C. Herbers, **2005**, Topographical scattering of waves: a spectral approach, *J. Port Waterways Coastal Ocea, Engng*, **131**(6), 311—320.

12. Collard, F., **F. Ardhuin,** et B. Chapron, **2005**, Extraction of coastal ocean wave fields from SAR images, *IEEE-J. Ocean Engng*, **30**(3), 526—533.

13. Chapron, B., F. Collard et **F. Ardhuin**, **2005**, Direct measurements of ocean surface velocity from space: interpretation and validation, *J. Geophys. Res.*, **110**, C07008.

14. **Magne, R.**, V. Rey et **F. Ardhuin**, **2005**, Measurement of wave scattering by topography in presence of currents, *Physics of Fluids*, 17, 126601.

15. **Ardhuin, F.**, et A. D. Jenkins, **2006**, On the interaction of waves and upper ocean turbulence, *J. Phys. Oceanogr.*, 36(3), 551-557.

16. **Rascle, N.**, **F. Ardhuin**, et E. A. Terray, **2006**, Drift and mixing under the ocean surface. Part 1: a coherent one-dimensional description with application to unstratified conditions, *J. Geophys. Res.*, **111**, C03016, doi:10.1029/2005JC003004.

17. **Ardhuin, F.**, **2006**, On the momentum balance in shoaling gravity waves: a commentary of 'Shoaling surface gravity waves cause a force and a torque on the bottom' by K. E. Kenyon, *JO*, **62**, 917—922.

18. Cavaleri et al. , Wave modelling - The state of the art, PO, 75(4), 603-674, 2007.Guyonic, S, M. Mory, T. Wever, **F. Ardhuin** and T. Garlan, **2007**, Full scale mine burial experiments in wave and current environments, *IEEE-JOE*, 32(1), 119-132.

19. **Magne, R.**, K. Belibassakis, T. H. C. Herbers, **F. Ardhuin**, W. C. O'Reilly et V. Rey, **2007**, Evolution of surface gravity waves over a submarine canyon, *J. Geophys. Res.*, **112**(C1), C01002.

20. **Ardhuin, F.**, L. Bertotti, J. Bidlot, L. Cavaleri, V. Filipetto, J.-M. Lefevre, P. Wittmann, **2007**, Comparison of wind and wave measurements and models in the Western Mediterranean Sea, *OE*, **34**, 526—541.

21. **Ardhuin, F.**, T. H. C. Herbers, G. Ph. van Vledder, K. P. Watts, R. Jensen et H. Graber, **2007**, Slanting fetch and swell effects on wind wave growth, *J. Phys. Oceanogr.*, **37** (4) , 908—931

22. **Ardhuin, F.**, et **Magne, R.**, **2007**, Current effects on scattering of surface gravity waves by bottom topography, *J. Fluid Mech.*, **576**, 235—264.

23. The WISE group, **2007**, Wave modelling – the state of the art, *Progress in Oceanogr.*, **75**, 603—674.

24. **Ardhuin, F.**, **N. Rascle** et K. A. Belibassakis, **2008**, Explicit wave-averaged primitive equations using a Generalized Lagrangian Mean, *Ocean Modelling*, **20**, 235—264.

25. Rascle, N., **F. Ardhuin**, P. Queffeulou, and D. Croizé-Fillon, **2008**, A global wave parameter database for geophysical applications. Part 1: Wave-current–turbulence interaction parameters for the open ocean based on traditional parameterizations, *Ocean Modelling*, **25,** 154—171 doi: 10.1016/j.ocemod.2007.07.001.

26. **Ardhuin, F.**, A. D. Jenkins et K. A. Belibassakis, **2008**, Commentary on `The Three-Dimensional Current and Surface Wave Equations' by George Mellor, *J. Phys. Oceanogr.*, **38,** 1340—1349

27. **Marieu, V.**, P. Bonneton, D. L. Foster, and **F. Ardhuin**, **2008**, Modeling of vortex ripple morphodynamics, *J. Geophys. Res.*, 113, C09007, doi:10.1029/2007JC004659.

28. **Rascle, N.**, **F. Ardhuin**, **2009**, Drift and mixing under the ocean surface. Part 2: Stratified conditions and model-data comparisons, *J. Geophys. Res.*, **114**, C02016, doi:10.1029/2007JC004466.

29. **Ardhuin, F.**, B. Chapron, and F. Collard, **2009**, Observation of swell dissipation across oceans, *Geophys. Res. Lett.*, **36**, L06607, doi:10.1029/2008GL037030.

30. Collard, F., **Ardhuin, F.**, B. Chapron, **2009**, "Routine monitoring and analysis of ocean swell fields using a spaceborne SAR," *J. Geophys. Res.,* 114, C07023.

31. Cariolet, J.-M., S. Costa, R. Caspar, **F. Ardhuin**, **R. Magne**, and G. Goasguen, "Atmospheric and marine aspects of the 10th of March 2008 storm in Atlantic and in the Channel," *Norois*, 215, **2010**.

32. Vandenbulcke, L.; Beckers, J. -M.; Lenartz, F., Barth, A Poulain, PM Aidonidis, M Meyrat, J, Ardhuin, F , Tonani, M,Fratianni, C, et al., Super-ensemble techniques: Application to surface drift prediction. ***Prog. Oceanogr.***, 82(3), 149-167, 2009, doi : 10.1016/j.pocean.2009.06.002.

33. **Ardhuin, F.,** L. Marié, N. Rascle, P. Forget, and A. Roland, **2009**, "Observation and estimation of Lagrangian, Stokes and Eulerian currents induced by wind and waves at the sea surface," ***J. Phys. Oceanogr.***, 39(11), 2820—2838.

34. **Magne**, R., F. Ardhuin, and A. Roland, "Prévisions et rejeux des états de mer du globe à la plage," *European Journal of Environmental and Civil Engineering*, 14, 149–162, **2010**.

35. **Filipot, J.-F.**, F. Ardhuin, and A. Babanin, **2010**, "A unified deep-to-shallow-water spectral wave breaking dissipation formulation. Part 1. Breaking probability," ***J. Geophys. Res.***, 115, C04022. doi:10.1029/2009JC005448

36. **Ardhuin, F.**, E. Rogers, A. Babanin, J.-F. Filipot, R. Magne, A. Roland, A. van der Westhuysen, P. Queffeulou, J.-M. Lefevre, L. Aouf, and F. Collard, **2010**, "Semi-empirical dissipation source functions for wind-wave models: part I, definition, calibration and validation," *J. Phys. Oceanogr.*, 40, no. 9, 1917–1941.

37. **Delpey**, **M., F. Ardhuin**, F. Collard, and B. Chapron, "Space-time structure of long swell systems," *J. Geophys. Res.*, 115, p. C12037, **2010**.

38. **Ardhuin**, **F.,** J. Tournadre, P. Queffelou, and F. Girard-Ardhuin, "Observation and parameterization of small icebergs: drifting breakwaters in the southern ocean," *Ocean Modelling*, 39, 405–410, **2011**.

39. **Bennis, A.-C.**, **F. Ardhuin**, and F. Dumas, "On the coupling of wave and three-dimensional circulation models : Choice of theoretical framework, practical implementation and adiabatic tests," *Ocean Modelling*, 40, 260–272, **2011**.

40. Suanez, S., B. Fichaut, R. Magne, **F. Ardhuin**, D. Corman, P. Stéphan, and J.-M. Cariolet, "Morphological changes and sediment budget of trailing accumulations forming comet tails on the archipelago of Molène (Brittany, France)," 2, 187–204, Géomorphologie: relief, processus, environnement, **2011**.

41. Schimmel, M., E. Stutzmann, **F. Ardhuin**, and J. Gallart, "Polarized earth's ambient microseismic noise," ***Geochemistry Geophysics Geosystems***, 12, no. 7, p. Q07014, **2011**.

42. **Ardhuin, F.**, E. Stutzmann, M. Schimmel, and A. Mangeney, "Ocean wave sources of seismic noise," *J. Geophys. Res.*, 116, p. C09004, **2011**.

43. **Bennis, A.-C.**, and **F. Ardhuin**, "On the vertical structure of the wave forcing for the ocean circulation," *J. Phys. Oceanogr.*, 41, 2008–2012, **2011**.

44. Senechal, N., S. Abadie, **F. Ardhuin**, S. Bujan, S. Capo, R. Certain, G. Coco, E. Gallagher, T. Garlan, G. Masselink, J. MacMahan, H. Michallet, R. Pedreros, A. Reniers, V. Rey, B. Ruessink, P. Russell, and I. Turner, "The ECORS-Truc Vert 2008 field experiment: extreme storm conditions over a three-dimensional morphology system in a macro-tidal environment," *Ocean Dynamics*, 61, 2073–2098, **2011**.

45. Andrefouet, S.,Ardhuin, F., Queffeulou, P., R. Le Gendre, Island shadow effects and the wave climate of the Western Tuamotu Archipelago (French Polynesia) inferred from altimetry and numerical model data, *Marine Pol. Bull.*, 65(10-12), 415-424, **2012**, doi : 10.1016/j.marpolbul.2012.05.042

46. Michaud, H, P. Marsaleix, Y. Leredde, C. Estournel, F. Bourrin, F. Lyard, C. Mayet and **F. Ardhuin**, Three-dimensional modelling of wave-induced current from the surf zone to the inner shelf, *Ocean Science*, 8, 657—681, **2012**.

47. S. Suanez, J.-M. Cariolet, R. Cancouet, **F. Ardhuin**, and C. Delacourt, "Dune recovery after storm erosion on a high-energy beach: Vougot Beach, Brittany (France)," *Geomorphology*, 139, 16–33, **2012**.

48. Charles, E., D. Idier, J. Thiebot, G. L. Cozannet, R. Pedreros, **F. Ardhuin**, and S. Planton, "Present wave climate in the bay of biscay: Spatiotemporal variability and trends from 1958 to 2001," *Journal of Climate*, 25, no. 6, **2012**.

49. **J.-F. Filipot** and **F. Ardhuin**, "A unified spectral parameterization for wave breaking: from the deep ocean to the surf zone," ***J. Geophys. Res.***, 117, p. C00J08, **2012**.

50. **Ardhuin, F.**, A. Balanche, E. Stutzmann, and M. Obrebski, "From seismic noise to ocean wave parameters: general methods and validation," ***J. Geophys. Res.***, 117, C05002, **2012.**

51. **Obrebski**, **M., F. Ardhuin**, E. Stutzmann, and M. Schimmel, "How moderate sea states can generate loud seismic noise in the deep ocean, ***Geophys. Res. Lett.***, 39, p. L11601, **2012**.

52. **Ardhuin, F.**, and A. Roland, Coastal wave reflection, directional spreading, and seismo-acoustic noise sources, *J. Geophys. Res.*, 117, p. C00J20, **2012**.

53. Husson, R, **F. Ardhuin**, B. Chapron, F. Collard, and **A. Balanche**, "Swells throughout the Pacific: a combined view using the global seismic network and Envisat's wave mode asar data," ***Geophys. Res. Lett.***, 39, p. L15609, **2012**.

54. Stutzmann, E., M. Schimmel, and **F. Ardhuin**, "Modeling long-term seismic noise in various environments, *Geophys. J. Int.* , 191, 707-722. **2012**.

55. **Hanafin, J.**, Y. Quilfen, **F. Ardhuin**, D. Vandemark, B. Chapron, H. Feng, J. Sienkiewicz, P. Queffeulou, M. Obrebski, B. Chapron, N. Reul, F. Collard, D. Cormand, E. B. de Azevedo, D. Vandemark, and E. Stutzmann, "Phenomenal sea states and swell radiation: a comprehensive analysis of the 12-16 February 2011 North Atlantic storms," *Bull. Amer. Met. Soc.*, 93, 12, 1825-1832, **2012**.

56. **Ardhuin, F.** , F. Dumas, A.-C. Bennis, A. Roland, A. Sentchev, P. Forget, J. Wolf, F. Girard, P. Osuna, and M. Benoit, "Numerical wave modeling in conditions with strong currents: dissipation, refraction and relative wind," *J. Phys. Oceanogr.*, 42, 2101—2120, **2012**.

57. **Ardhuin, F.,** and T. H. C. Herbers, "Noise generation in the solid Earth, oceans and atmosphere, from nonlinear interacting surface gravity waves in finite depth", *J. Fluid Mech*, 716, 316—348, **2013**. doi: 10.1017/jfm.2012.548

58. Gualtieri, L., E. Stutzmann, Y. Capdeville, **F. Ardhuin**, M. Schimmel, A. Mangenay A. Morell, "Modeling secondary microseismic noise by normal mode summation", *GJI*, 193(3), 1732-1745, **2013**.

59. Aucan, J., and **F. Ardhuin,** "Infragravity waves in the deep ocean : An upward revision", *Geophys. Res. Lett.*, 40, 3435-3439, **2013**.

60. **Obrebski, M.**, **F. Ardhuin**, E. Stutzmann, and M. Schimmel, "Detection of microseismic compressional (P) body waves aided by numerical modeling of oceanic noise sources", *J. Geophys. Res.* (solid-Earth), 118, 4312-4324, **2013**.

61. **Rascle, N**, B. Chapron, **F. Ardhuin** and A. Soloviev, "A note on the direct injection of turbulence by breaking waves", *Ocean Modelling*, 70, 145-151, **2013**.

62. **Rascle, N** and **F. Ardhuin**, "A global wave parameter database for geophysical applications. Part 2: model validation with improved source term parameterization", *Ocean Modelling*, 70, 174-188, **2013**.

63. Fedele, F., A. Benetazzo, G. Gallego, P.-C. Shih, A. Yezzi, **F. Ardhuin** and F. Barbariol, "Space-time measurements of oceanic sea states", *Ocean Modelling*, 70, 103-115, **2013.**

64. **Leckler, F**, **F. Ardhuin,** J-F. Filipot and A. Mironov, "Dissipation Source Terms and Whitecap Statistics", *Ocean Modelling*, 70, 62-74, **2013.**

65. **Ardhuin, F., T. Lavanant, M. Obrebski**, L. Marié, J.-Y. Royer, J.-F. D'Eu, B. M. Howe, R. Lukas and J. Aucan, "A numerical model for ocean ultra-low frequency noise: Wave-generated acoustic-gravity and Rayleigh modes", *J. Acoust. Soc. Amer.*, 134 (4), 3242-3259, **2013**.

66. **Boudiere E**, Maisondieu C., **Ardhuin F.**, Accensi M., Pineau-Guillou L., Lepesqueur J., A suitable metocean hindcast database for the design of Marine energy converters. *Int. J. of Mar. Energy,* 3-4, e40–e52, **2013**.

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68. **Delpey M.**, **F. Ardhuin**, P. Otheguy, A. Jouon, "Effects of waves on coastal water dispersion in a small estuarine bay", *J. Geophys. Res.,* 119, 70-80, **2014**.

69. Sheremet, A, T. Staples, **F. Ardhuin**, S. Suanez, and B. Fichaut, "Observations of large infragravity wave runup at Banneg Island, France, *Geophys. Res. Lett.*, 41, **2014**. doi:10.1002/2013GL058880

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71. **Ardhuin F.,** A. Rawat and J. Aucan, "A numerical model for free infragravity waves: definition and validation at regional and global scales", *Ocean Modelling,* **2014.** doi: 10.1016/j.ocemod.2014.02.006

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73. Bennis, A.C., F. Dumas, F. Ardhuin and B. Blanke, *Ocean Engng*, Mixing parameterization: Impacts on rip currents and wave set-up, 84, 213, **2014**.

74. Rascle, N., B. Chapron, A Ponte, F. Ardhuin and P. Klein, "Surface Roughness Imaging of Currents Shows Divergence and Strain in the Wind Direction", *J. Phys. Oceanogr.*, 44, 2153, **2014.**

75. Perignon, Y, **F. Ardhuin**, M. Cathelain and M. Robert, Swell dissipation by induced atmospheric shear stress, *J. Geophys. Res.,* 119, 6622-6630, **2014.**

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79. **Ardhuin, F.**, Collard, F., Chapron, B., Girard-Ardhuin, F., Guitton, G., Mouche, A., and **Stopa, J.**, "Estimates of ocean wave heights and attenuation in sea ice using the sar wave mode on sentinel-1a," *Geophys. Res. Lett.*,42(7), 2317-2325, 2015.

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Funded research projects at CNRS

Lead Scientist: Fabrice Ardhuin
duration : 01/01/2015 – 31/12/2019
Amount of support: € 200,000

Funded research projects at Ifremer

Project title: **DRIFT4SKIM** (demonstration field experiment for SKIM)
Sponsor: European Space Agency
Lead Scientist: Louis Marié
duration : 01/08/2018 – 31/12/2019
Amount of support for Ifremer (PI L. Marié): € 380,000

Project title: **Microseism Modelling for Oceanographic and Seismic Applications** (MIMOSA)
Sponsor: Agence Nationale de la Recherche
Lead Scientist: Eleonore Stutzmann (IPGP, Paris, France)
duration : 01/01/2015 – 31/12/2019
Amount of support for Ifremer (PI F. Ardhuin): € 200,000

Project title: **Ships and Waves Reaching the Arctic** (SWARP)
Sponsor: European Union (FP7 program)
Lead Scientist: Laurent Bertino (NERSC, Bergen, Norway)
duration : 01/01/2014 – 31/12/2016
Amount of support for Ifremer (PI F. Ardhuin): € 400,000

Project title: **Integrated Ocean Waves for Geophysical and other Applications** (IOWAGA)
Sponsor: **European Research Council**
Lead Scientist: F. Ardhuin
duration : 01/01/2010 – 31/12/2013
Amount of support for Ifremer : € 1,200,000

Project title: **wave dissipation and energy balance** (WAVE-DB)
Sponsor: **U.S. National Ocean Partnership Program (via ONR)**
Lead Scientist: F. Ardhuin
duration : 01/01/2010 – 31/12/2015
Amount of support for Ifremer : USD 720,000

Project title: **Infragravity waves for satellite altimetry** (IGALTI)
Sponsor: **CNES**
Lead Scientist: F. Ardhuin
duration : 01/01/2012 – 31/12/2015
Amount of support for Ifremer : € 300,000

Funded research projects at SHOM
2007-2010: PI for the ECORS-wave modelling program funded by the French DoD, including the analysis of swell dissipation from SAR data and the parameterization of breaking waves. 500 k€.