

NUSC Technical Document 8239
9 May 1988

AD-A196 925

Low Frequency Wind Generated Ambient Noise Source Levels

**Presented at the Australian Bicentennial
Conference on Ambient Noise,
27 January 1988, Sydney,
New South Wales, Australia**

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REPORT DOCUMENTATION PAGE

1a. REPORT SECURITY CLASSIFICATION UNCLASSIFIED			1b. RESTRICTIVE MARKINGS		
2a. SECURITY CLASSIFICATION AUTHORITY			3. DISTRIBUTION / AVAILABILITY OF REPORT Approved for public release; distribution is unlimited.		
2b. DECLASSIFICATION / DOWNGRADING SCHEDULE			5. MONITORING ORGANIZATION REPORT NUMBER(S)		
4. PERFORMING ORGANIZATION REPORT NUMBER(S) NUSC TD 8239			7a. NAME OF MONITORING ORGANIZATION		
6a. NAME OF PERFORMING ORGANIZATION Naval Underwater Systems Center		6b. OFFICE SYMBOL (if applicable) 304	7b. ADDRESS (City, State, and ZIP Code)		
6c. ADDRESS (City, State, and ZIP Code) New London Laboratory New London, CT 06320			9. PROCUREMENT INSTRUMENT IDENTIFICATION NUMBER		
8a. NAME OF FUNDING / SPONSORING ORGANIZATION Naval Underwater Sys. Center		8b. OFFICE SYMBOL (if applicable) 10	10. SOURCE OF FUNDING NUMBERS		
8c. ADDRESS (City, State, and ZIP Code) New London Laboratory New London, CT 06320		PROGRAM ELEMENT NO.	PROJECT NO. 710Y11	TASK NO.	WORK UNIT ACCESSION NO.
11. TITLE (Include Security Classification) LOW FREQUENCY WIND GENERATED AMBIENT NOISE SOURCE LEVELS					
12. PERSONAL AUTHOR(S) D. J. Kewley, D. G. Browning, W. M. Carey, and W. A. Von Winkle					
13a. TYPE OF REPORT		13b. TIME COVERED FROM TO		14. DATE OF REPORT (Year, Month, Day) 1988 May 09	
15. PAGE COUNT 10					
16. SUPPLEMENTARY NOTATION Presented at the Conference on Ambient Noise, 27 January 1988, Sydney. New South Wales, Australia					
17. COSATI CODES			18. SUBJECT TERMS (Continue on reverse if necessary and identify by block number)		
FIELD	GROUP	SUB-GROUP	Ambient Noise		
			Noise Models		
			Wind-Generated Noise		
19. ABSTRACT (Continue on reverse if necessary and identify by block number)					
Most of the wind-generated low frequency ambient noise data have been taken recently in the Southern Hemisphere Oceans. Burgess and Kewley have obtained corresponding source levels that have been implemented in the DUNES Ambient Noise Prediction Model. A survey is made of historical Northern Hemisphere ambient noise data to refine this estimation of source levels. These results are compared with other reported wind-generated noise source levels. (Work sponsored by the Naval Underwater Systems Center.)					
20. DISTRIBUTION / AVAILABILITY OF ABSTRACT ☐ UNCLASSIFIED/UNLIMITED ☒ SAME AS RPT. ☐ DTIC USERS			21. ABSTRACT SECURITY CLASSIFICATION UNCLASSIFIED		
22a. NAME OF RESPONSIBLE INDIVIDUAL David G. Browning			22b. TELEPHONE (Include Area Code) (203) 440-4173		22c. OFFICE SYMBOL 304

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LOW FREQUENCY WIND GENERATED AMBIENT NOISE SOURCE LEVELS

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W. M. CAREY, W. A. VonWINKLE**

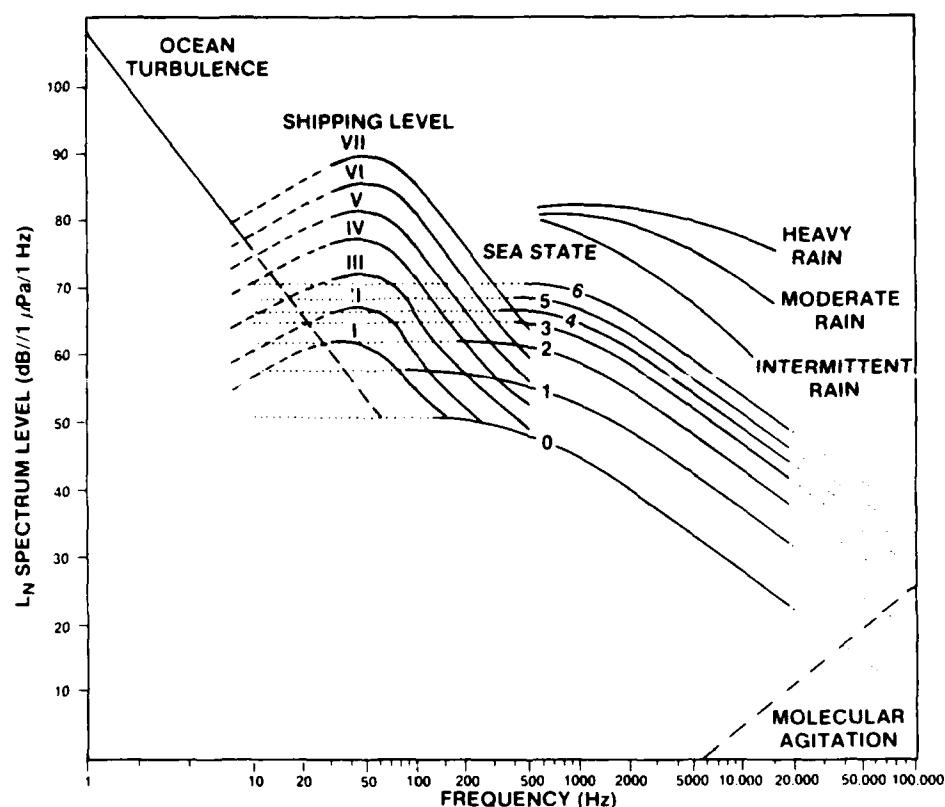
**NAVAL UNDERWATER SYSTEMS CENTER
NEW LONDON, CONNECTICUT 06320
U.S.A.**

VIEWGRAPH 1

We have been very fortunate to have Dr. Douglas Kewley visiting NUSC for the past eighteen months as a TTCP Exchange Scientist. He brought us up-to-date on the extensive measurements and state-of-the-art model developments that are taking place in Australia and New Zealand. Since we share a common interest in low frequency wind-generated ambient noise, it was a logical next step that we combine our thoughts (and data) to produce our best estimates of low frequency wind-generated ambient noise source levels for this meeting.



NUSC STANDARD NOISE CURVES



VIEWGRAPH 2

The present reality is that prediction models are becoming the dominant method to estimate system performance. To make meaningful comparisons, we must adopt standardized environmental inputs even when they may be only our best estimates. As a first step, we are using a standard set of ambient noise curves at NUSC.

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DUNES 2.2 OMNIDIRECTIONAL NOISE

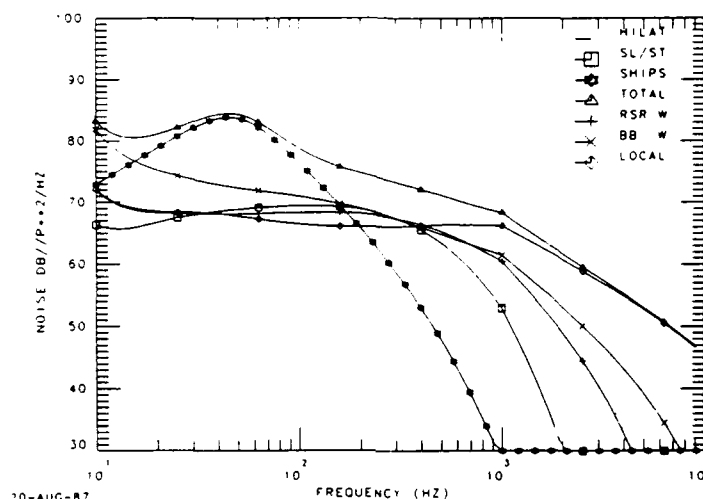
ATLANTIC OCEAN - FEBRUARY
 LATITUDE 65.0 DEGS
 WINDSPEED 40.0 KNOTS
 BOT LOSS GRADIENT 1.0
 VERTICAL BOT LOSS 2.0
 WINDLANE FRACTIONS
 3.0 (N) 0.0 (S)
 90 (M) 2590 DEPTH 5.00 KM

SHIP LANE PARAMETERS

TYPE	LEN	RANG
LANE+	300	260
LANE+	200	290
LANE+	200	290
LANE	440	55
LANE	280	55

WIND LANE PARAMETERS

PEAK BEAR	TYPE	LEN	WIDTH	RANG	BEAR	WSPD
50 90	SLPE	300	90	260	90	40
50 210	SLPE	200	66	290	210	40
50 210	SLPE	200	74	350	260	40
50 90	SLPE	250	37	500	315	40
50 315	SLPE	500	74	730	358	40



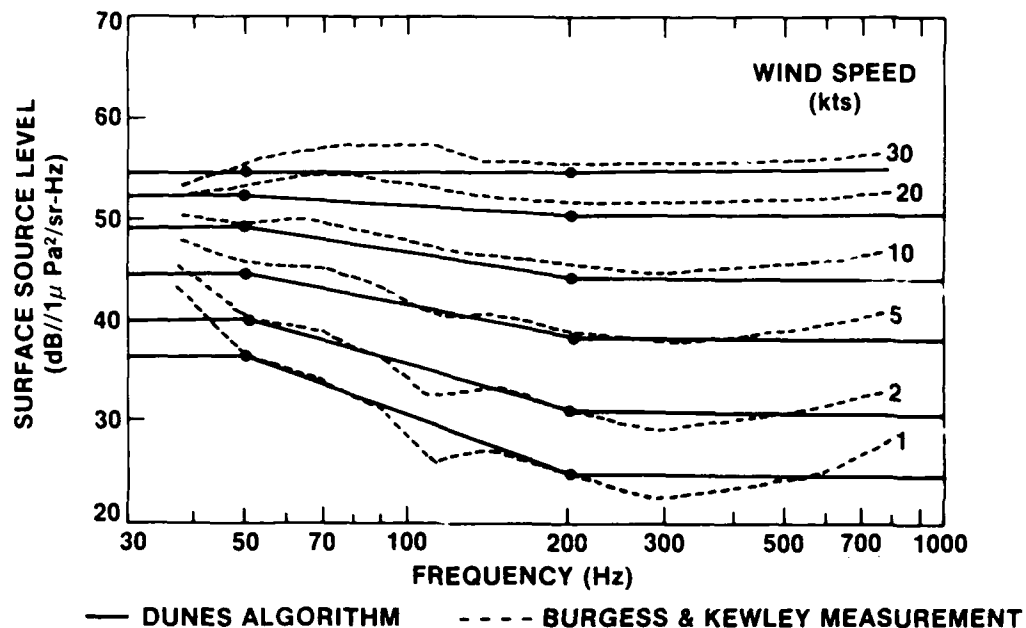
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VIEWGRAPH 3

We believe that excellent estimates of ambient noise will be obtained from a prediction model such as DUNES, which was developed by Dick Bannister at the New Zealand Defence Scientific Establishment and Allan Burgess and Douglas Kewley at Defense Science and Technology Organization (DSTO). By treating each acoustic source and propagation mode separately, the program will ultimately give very accurate predictions for any given site. It does require, as one of its key inputs, wind-generated noise source levels for the entire frequency range.



WIND GENERATED AMBIENT NOISE SOURCE LEVELS (FOR DUNES NOISE PREDICTION MODEL)



N0211-GA-88(L)-00243.04C

VIEWGRAPH 4

DUNES presently uses the source level curves shown here, which are based on the classic paper of Burgess and Kewley.* What we have done is add all the historical Northern Hemisphere data we could find to this Southern Hemisphere data base to further refine the wind speed dependency, and then compare our results with recently published data.

*A. S. Burgess and D. J. Kewley, "Wind-Generated Surface Noise Levels in Deep Water East of Australia," J. Acoust. Soc. Am., vol. 73, no. 1, pp. 201-210 (1983).

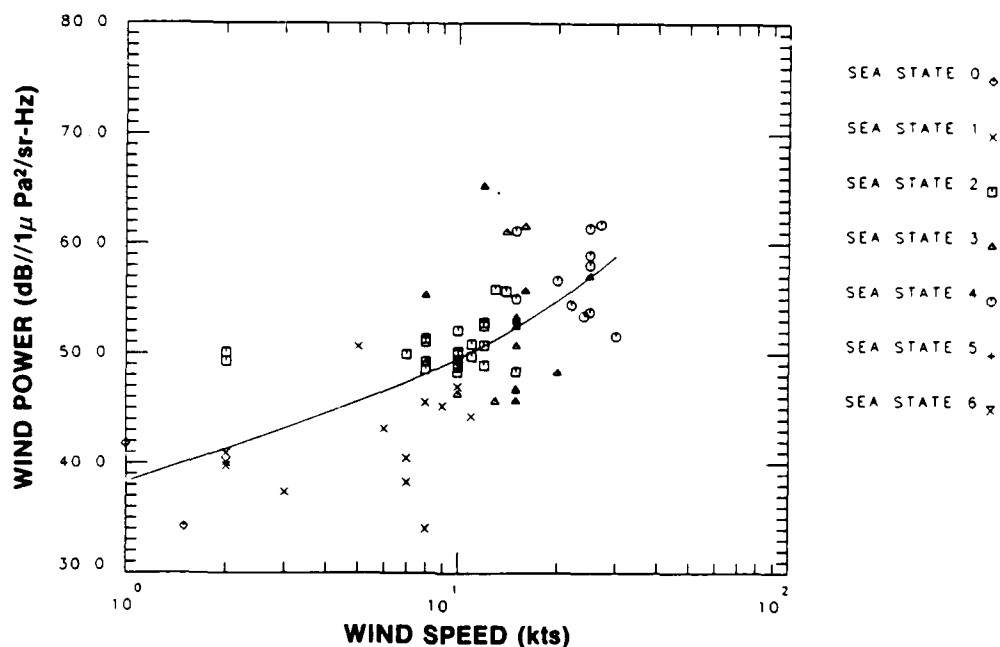


7-JAN-88 WINDFIT SPRIME CALC vs WS METH 1

M2F50 DAT
FREQ(HZ) = 50

ATF50 DAT
38 2670

SVF50 DAT
13 2744 SSO= 19 63



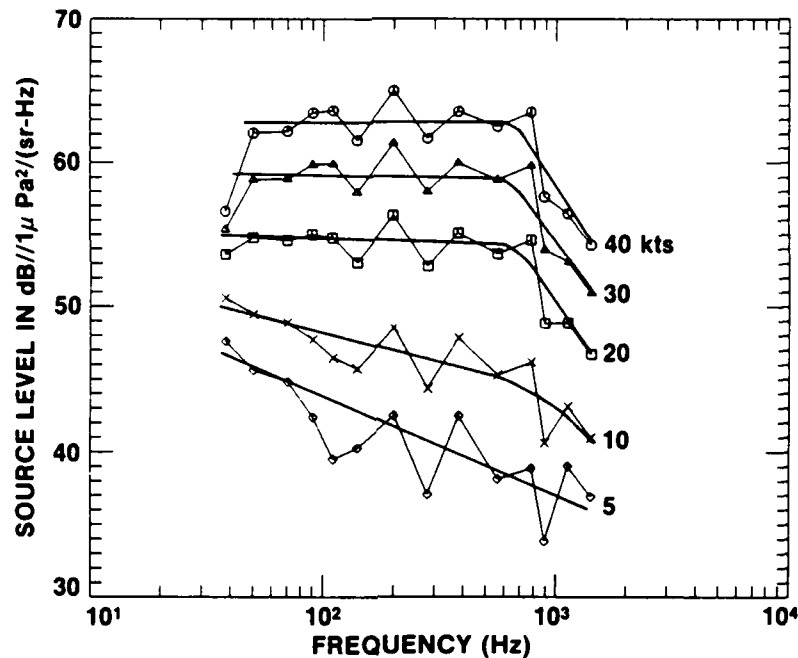
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VIEWGRAPH 5

A typical sample of the combined data base (50 Hz) with the corresponding fit is shown here. In general, we found an increase of the wind dependency at the higher wind speeds (above 20 knots) over what would be obtained from the Southern Hemisphere data alone.



7-JAN-88 SOURCE LEVEL



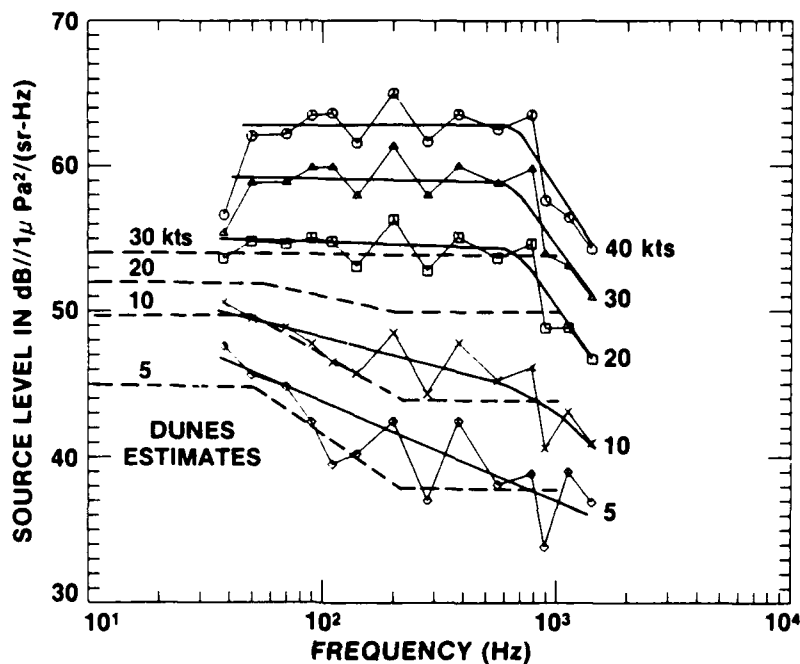
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VIEWGRAPH 6

The results of our analyses are given for wind speeds of 5, 10, 20, 30, and 40 knots, along with a hand fit through the data. You can see the change in the frequency dependence between 10 and 20 knots of wind speed, which may be attributed to the start of whitecap formation and gives credence to a two-mechanism explanation for wind noise generation.



7-JAN-88 SOURCE LEVEL (COMPARISON WITH DUNES ESTIMATES)



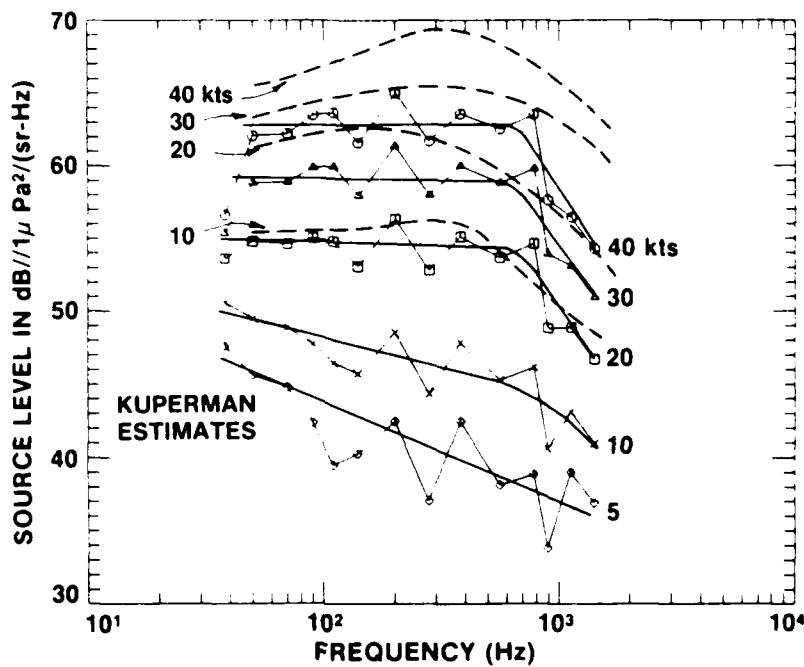
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VIEWGRAPH 7

If we now compare the approximate wind-generated noise source level curves presently used in the DUNES model (noted on the left), the agreement is good at the low (5 to 10 knots) wind speeds, but the data are higher at wind speeds above 10 knots.



7-JAN-88 SOURCE LEVEL (COMPARISON WITH KUPERMAN SOURCE LEVELS)



VIEWGRAPH 8

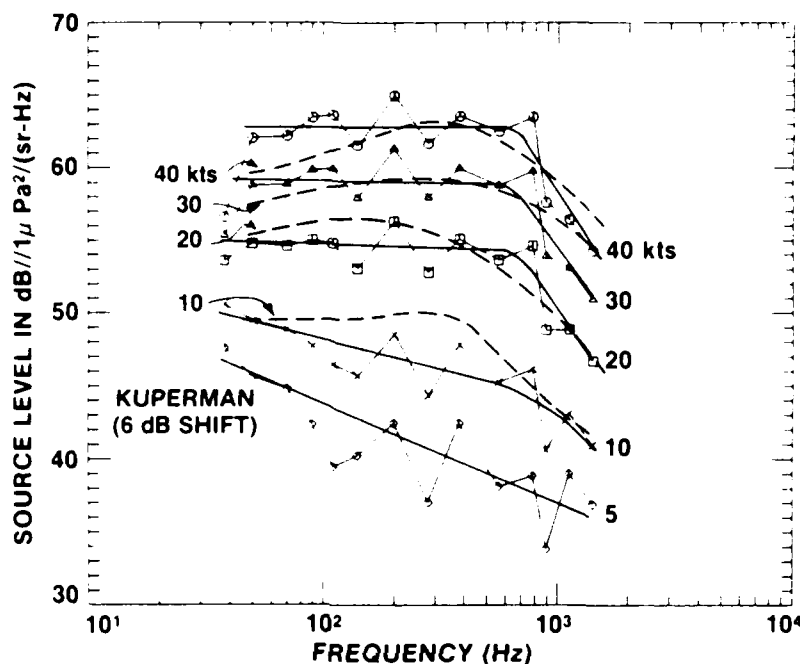
Kuperman* has recently published (and is presently publishing) several articles on wind-generated source levels based on shallow water propagation measurements. At low frequencies he merges with curves developed by Ross. An initial comparison with Kuperman's source levels as published does not show a good agreement; the shapes are similar but the levels are generally higher.

*W. A. Kuperman and M. C. Ferla, "A Shallow Water Experiment to Determine the Source Spectrum Level of Wind-Generated Noise," J. Acoust. Soc. Am., vol. 77, no. 6, pp. 2067-2073 (1985).



7-JAN-88 SOURCE LEVEL

(COMPARISON WITH KUPERMAN SOURCE LEVELS 6 dB SHIFT)



VIEWGRAPH 9

Looking for the cause of this difference, we dug back into the basic geometry involved. What we found was that, at least to date, everyone seems to be using either a different geometry or definition of source level -- sometimes even both! π , two π , four π , log of π , etc., are all floating around and it is obvious that we must have standard definitions before we can make meaningful comparisons. When we tried to sort these factors out, we got something like a 6 dB correction between our curves and Kuperman's. With this adjustment, the agreement is reasonably good.



LOW FREQUENCY AMBIENT NOISE SOURCE LEVELS CONCLUSIONS

- **CONSENSUS DEVELOPING**
- **REQUIRE STANDARD DEFINITIONS**
- **MORE DATA NEEDED**
- **REFINE TWO-MECHANISM MODEL**

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VIEWGRAPH 10

In conclusion, we can say the following: although we must get our definitions squared away, it does look like a consensus is developing on what the source levels should be. A two-mechanism model is suggested, but more data are needed to refine such a concept.

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