
Memo

To: Whom it may concern
From: Fugro Norway AS
Ref No.: C75433
Subject: The MEM spectrum file format

Introduction

The MEM spectrum files have been added to the dataset for Ten noorden van de Waddeneilanden – TNW data set. This Memo describes the file format.

MEM Spectrum file

MEMspec file format

The file contains the 2-dimensional directional spectral density $S(f, \Theta)$ in addition to other spectral parameters. The directional spectrum is estimated from the directional Fourier components using the Burg Maximum Entropy method (MEM).¹

The MEMspec data file is a sequential text file containing a sequence of records for each recorded wave time series:

1. ISSUE TIME: The date and time when the analysis was produced.
2. START TIME: The time of the first measurement in the time series of Heave, Pitch, Roll and Compass heading data
3. END TIME: The time of the end of the time series of Heave, Pitch, Roll and Compass heading data
4. LOCATION: Text identifying the location and buoy.
5. direction: Unit for direction data.
6. frequency: Unit for frequency
7. matrix rows: Number of rows (frequencies) in the spectrum matrix.
8. Hm0 m: Spectral estimate of significant wave height in meters for this time series.
9. Tp s: Peak period = $1/f_{\text{Peak}}$ where f_{Peak} is the frequency of the maximum spectral energy density within the (omni-directional) wave spectrum $S(f)$.
10. Mdir deg: Mean wave direction in degrees for this time series.
11. spectral density: Unit for spectral density ($\text{m}^2 \text{s} = \text{m}^2 \text{Hz}^{-1}$).
12. a1: $a_1(f)$ = Fourier coefficients a_1 of the directional distribution at frequency $f = f_{\text{min}}, \dots, f_{\text{max}}$.
13. b1: $b_1(f)$ = Fourier coefficients b_1 of the directional distribution at frequency $f = f_{\text{min}}, \dots, f_{\text{max}}$.

¹ A. Lygre and H. E. Krogstad. Maximum entropy estimation of the directional distribution in ocean wave spectra. *J. Phys. Oceanogr.*, 16, 1986.

14. a_2 : $a_2(f)$ = Fourier coefficients a_2 of the directional distribution at frequency $f = f_{\min}, \dots, f_{\max}$.
15. b_2 : $b_2(f)$ = Fourier coefficients b_2 of the directional distribution at frequency $f = f_{\min}, \dots, f_{\max}$.
16. hspec: Omnidirectional spectral energy density $S(f)$ for each frequency f .
17. Directions in degrees for each column in the following directional spectrum matrix.
18. - 18 + <matrix rows> -1: The directional wave spectrum. There is one record for each frequency, f , of the directional spectrum, containing f and then $S(f, \Theta)$, for $\Theta = \Delta\Theta, \dots, 360^\circ$.

Then follows the next spectrum data block beginning with "ISSUE TIME:"

This shows an example of the beginning of a file (data records are truncated rather than wrapped for better readability):

```

ISSUE TIME:      2020-04-28T11:07:21 UTC
START TIME:      2019-11-24T08:00:00Z
END TIME:        2019-11-24T08:17:04Z
LOCATION:          Hollandse Kust (west) HKWA - WS187
direction:       degrees
frequency:       Hz
matrix rows:     47
Hm0 m:           0.889935
Tp s:            6.90541
Mdir deg:        43.8949
spectral density: m^2/Hz
a1: 3.343140e-01 -2.610406e-02 -8.412030e-01 -8.561417e-01 -6.685495e-01 -4.134838e-01 ...
b1: -1.864170e-01 -5.296924e-01 -4.253628e-01 -1.040059e-01 1.368127e-01 2.330087e-01 ...
a2: -4.217079e-02 -4.548931e-01 5.896031e-01 6.633129e-01 6.627326e-01 3.612899e-01 ...
b2: -8.923932e-01 5.746614e-01 7.289080e-01 2.295494e-01 1.246986e-02 -5.979325e-01 ...
hspec: 1.420225e-02 9.146353e-03 6.205127e-03 5.714705e-03 3.591919e-03 6.694930e-03 ...
10.000      20.000      30.000      40.000      50.000      60.000 ... (Directions)
0.040 0.000000e+00 0.000000e+00 0.000000e+00 0.000000e+00 0.000000e+00 ... (f S(f,Θ1) S(f,Θ2) ...)
0.050 6.032181e-04 4.255230e-03 3.961375e-04 1.130246e-04 0.000000e+00
0.060 0.000000e+00 0.000000e+00 0.000000e+00 0.000000e+00 0.000000e+00

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Some spectral parameters are described in the table below:

Parameter	Unit	Description
f	Hz	Frequency
$S(f) = Hspec(f)$	$m^2 \text{ Hz}^{-1} = m^2 \text{ s}$	Omni-directional spectral density at frequency f
$S(f, \Theta)$	$m^2 \text{ s deg}^{-1}$	Directional wave energy density spectrum
a_1	-	Directional Fourier coefficient a_1
a_2	-	Directional Fourier coefficient a_2
b_1	-	Directional Fourier coefficient b_1
b_2	-	Directional Fourier coefficient b_2
MDIR1(f)	deg	Direction of frequency band: $MDIR1(f) = \arctan(b_1(f), a_1(f))$
SPR1	deg	Wave spreading based on 1st order Fourier coefficients: $SPR1(f) = \sqrt{2 - 2\sqrt{a_1^2 + b_1^2}}$