LexTech

AFGROW.NET

AFGROW Workshop 2018

Post processing AFGROW output – First Look

Alex Litvinov, Matthew Gross, James Lambert

LexTech, Inc .

LexTech

AFGROW.NET

Background

- Customers have requested the ability to generate reports that summarize the results of a life prediction analysis. For example:
  - *Allow an overlay of da/dN vs. DK values used in an analysis on the crack growth rate plot. This provides a visual reference of the portion of the total growth rate curve being used in the analysis.*
  - *Show damage accumulation data in a pie chart or histogram*
  - *Show damage by source for a given crack growth analysis*
- These reports can be generated either during a prediction by accumulating the necessary information, or all prediction information can be saved and then post processed.

LexTech

AFGROW.NET

Background

Post Processing

- Pros: The post-processing approach can allow unlimited number of reports be generated without modifying AFGROW. Users can generate report by themselves.
- Cons: The size of the output file

Generating reports during prediction

- Pros: Done in real time during the analysis
- Cons: Every new report will require modification of AFGROW. Users do not have opportunity to make any changes to the reports

What can be done by post processing AFGROW results

- Verify input data
- Promote a better understanding of the life prediction process
- Provide a detailed summary of the various elements of the analysis

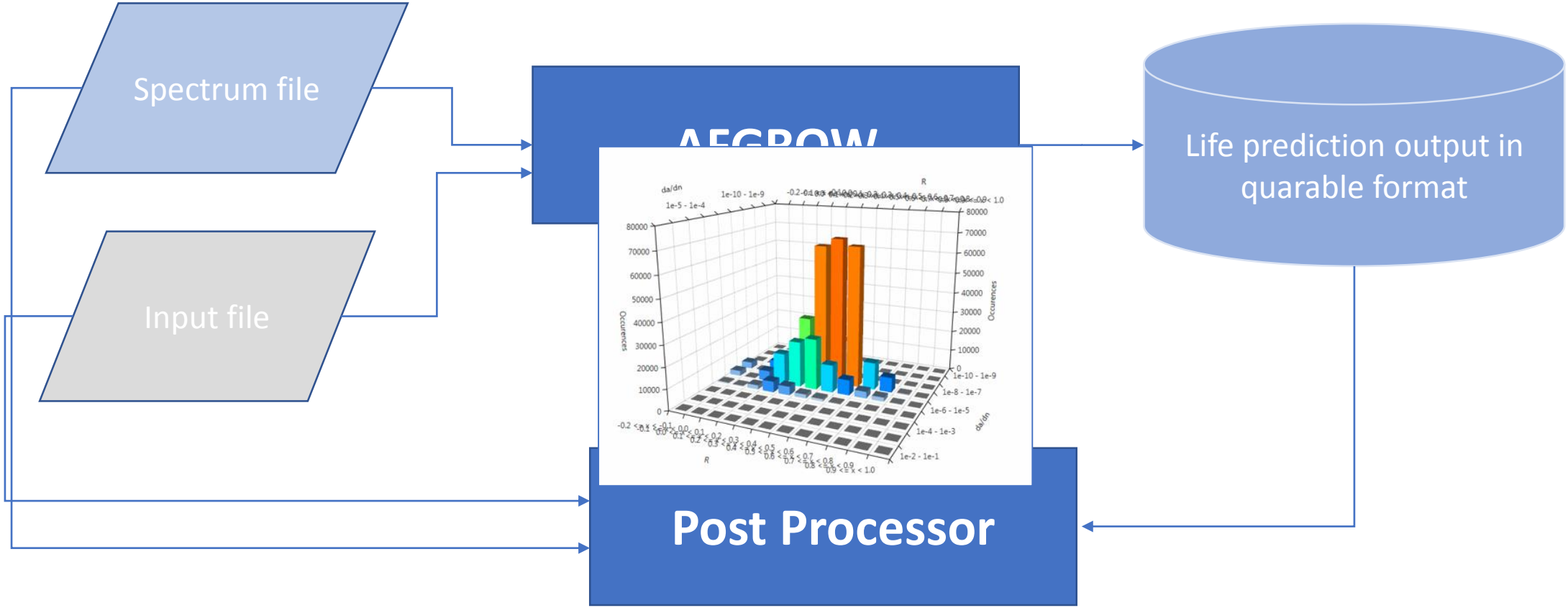
LexTech

AFGROW.NET

Approach to post processing

- Need to save all life prediction information
- Flat output files will be extremely large even for the most trivial analysis, need to use a database file.
- The database access should be as simple as possible. Output files need to be easily created, moved and deleted.
- The database should run in-process with the application which is hosting it.

Software Architecture



Database Options

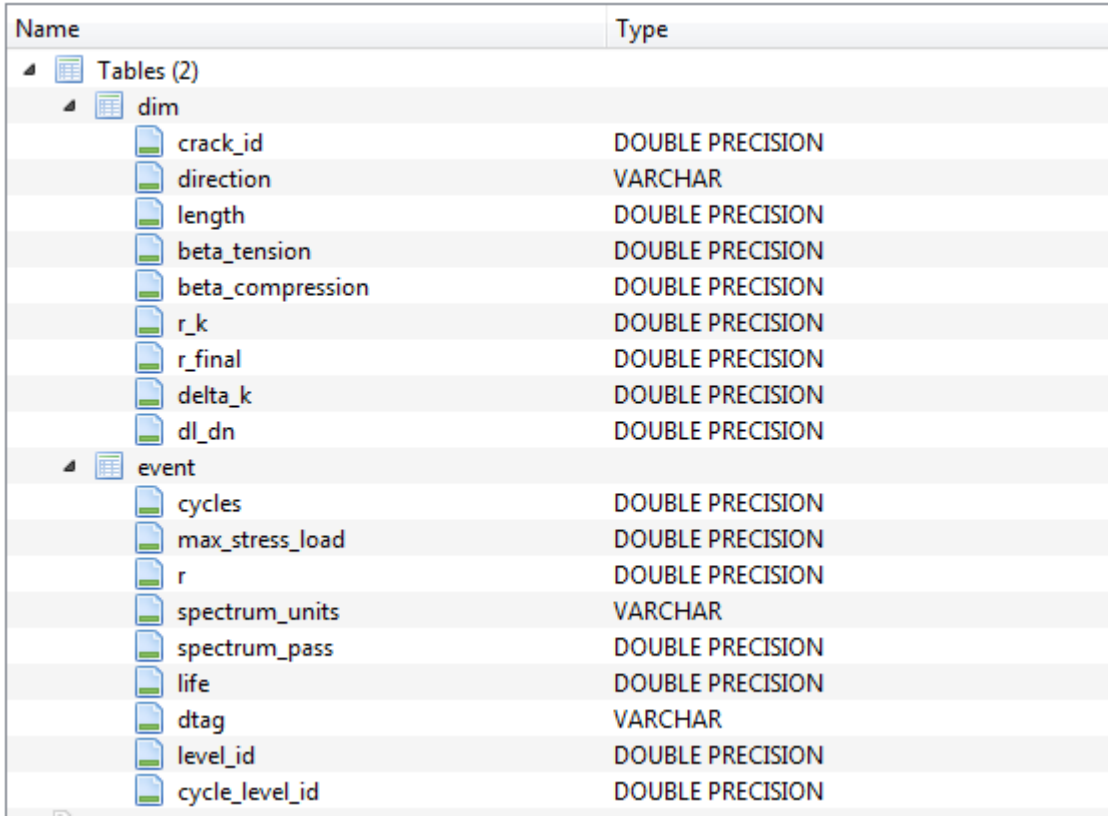
- SQLite - compact in-process database.
- SQL Server Compact Edition - compact in-process database, but support will end in July 2021.
- SQL Server Express – runs as the service. Standalone database server (often run on a dedicated machine) that communicates with client applications.

LexTech

AFGROW.NET

Database design

- 2 data tables, one for the loading information and another for direction information
- Similar to AFGROW XML output file format



Name	Type
Tables (2)	
dim	
crack_id	DOUBLE PRECISION
direction	VARCHAR
length	DOUBLE PRECISION
beta_tension	DOUBLE PRECISION
beta_compression	DOUBLE PRECISION
r_k	DOUBLE PRECISION
r_final	DOUBLE PRECISION
delta_k	DOUBLE PRECISION
dl_dn	DOUBLE PRECISION
event	
cycles	DOUBLE PRECISION
max_stress_load	DOUBLE PRECISION
r	DOUBLE PRECISION
spectrum_units	VARCHAR
spectrum_pass	DOUBLE PRECISION
life	DOUBLE PRECISION
dtag	VARCHAR
level_id	DOUBLE PRECISION
cycle_level_id	DOUBLE PRECISION

LexTech

AFGROW.NET

Output data example: damage information

	crack_id	direction	length	beta_tension	eta_compressio	r_k	r_final	delta_k	dl_dn
	Filter	Filter	Filter	Filter	Filter	Filter	Filter	Filter	Filter
1	0.0	C	0.15	1.231455518	1.231455518	-5.352331606	-0.2	0.408	0.0
2	0.0	C	0.15	1.231455518	1.231455518	4.804651163	4.804651163	0.0	0.0
3	0.0	C	0.15	1.231455518	1.231455518	0.382230624	0.382230624	3.45	1.17e-07
4	0.0	C	0.1500001	1.231455518	1.231455518	0.452146691	0.452146691	2.59	7.99e-08
5	0.0	C	0.1500006	1.231455518	1.231455518	0.382230624	0.382230624	3.45	1.17e-07
6	0.0	C	0.1500007	1.231455518	1.231455518	0.452146691	0.452146691	2.59	7.99e-08
7	0.0	C	0.1500009	1.231455518	1.231455518	0.409878683	0.409878683	4.32	1.87e-07
8	0.0	C	0.1500012	1.231455518	1.231455518	0.227599244	0.227599244	4.32	1.31e-07
9	0.0	C	0.1500014	1.231455518	1.231455518	0.329321663	0.329321663	2.59	6.04e-08
10	0.0	C	0.1500014	1.231455518	1.231455518	0.452146691	0.452146691	2.59	7.99e-08
11	0.0	C	0.1500016	1.231455518	1.231455518	0.536483932	0.536483932	2.59	1.01e-07
12	0.0	C	0.1500017	1.231455518	1.231455518	0.409878683	0.409878683	4.32	1.87e-07
13	0.0	C	0.1500019	1.231455518	1.231455518	0.536483932	0.536483932	2.59	1.01e-07
14	0.0	C	0.150002	1.231455518	1.231455518	0.528018486	0.528018486	3.45	1.67e-07
15	0.0	C	0.1500022	1.231455518	1.231455518	0.598559267	0.598559267	2.59	1.22e-07
16	0.0	C	0.1500023	1.231455518	1.231455518	0.29202773	0.29202773	5.18	2.09e-07
17	0.0	C	0.1500025	1.231455518	1.231455518	0.452146691	0.452146691	2.59	7.99e-08
18	0.0	C	0.1500026	1.231455518	1.231455518	0.382230624	0.382230624	3.45	1.17e-07
19	0.0	C	0.1500028	1.231455518	1.231455518	0.452146691	0.452146691	2.59	7.99e-08
20	0.0	C	0.1500028	1.231455518	1.231455518	0.409878683	0.409878683	4.32	1.87e-07
21	0.0	C	0.150003	1.231455518	1.231455518	0.536483932	0.536483932	2.59	1.01e-07
22	0.0	C	0.1500031	1.231455518	1.231455518	0.382230624	0.382230624	3.45	1.17e-07
23	0.0	C	0.1500032	1.231455518	1.231455518	0.452146691	0.452146691	2.59	7.99e-08

1 - 23 of 425170 Go to: 1

LexTech

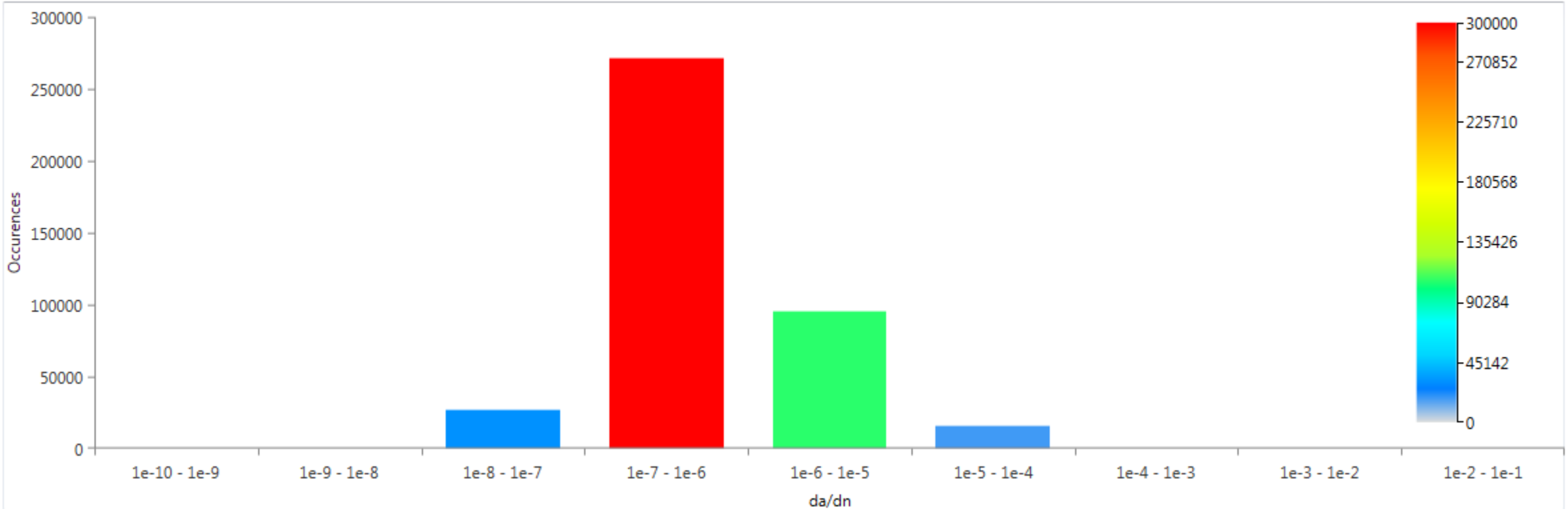
AFGROW.NET

Output data example – loading information

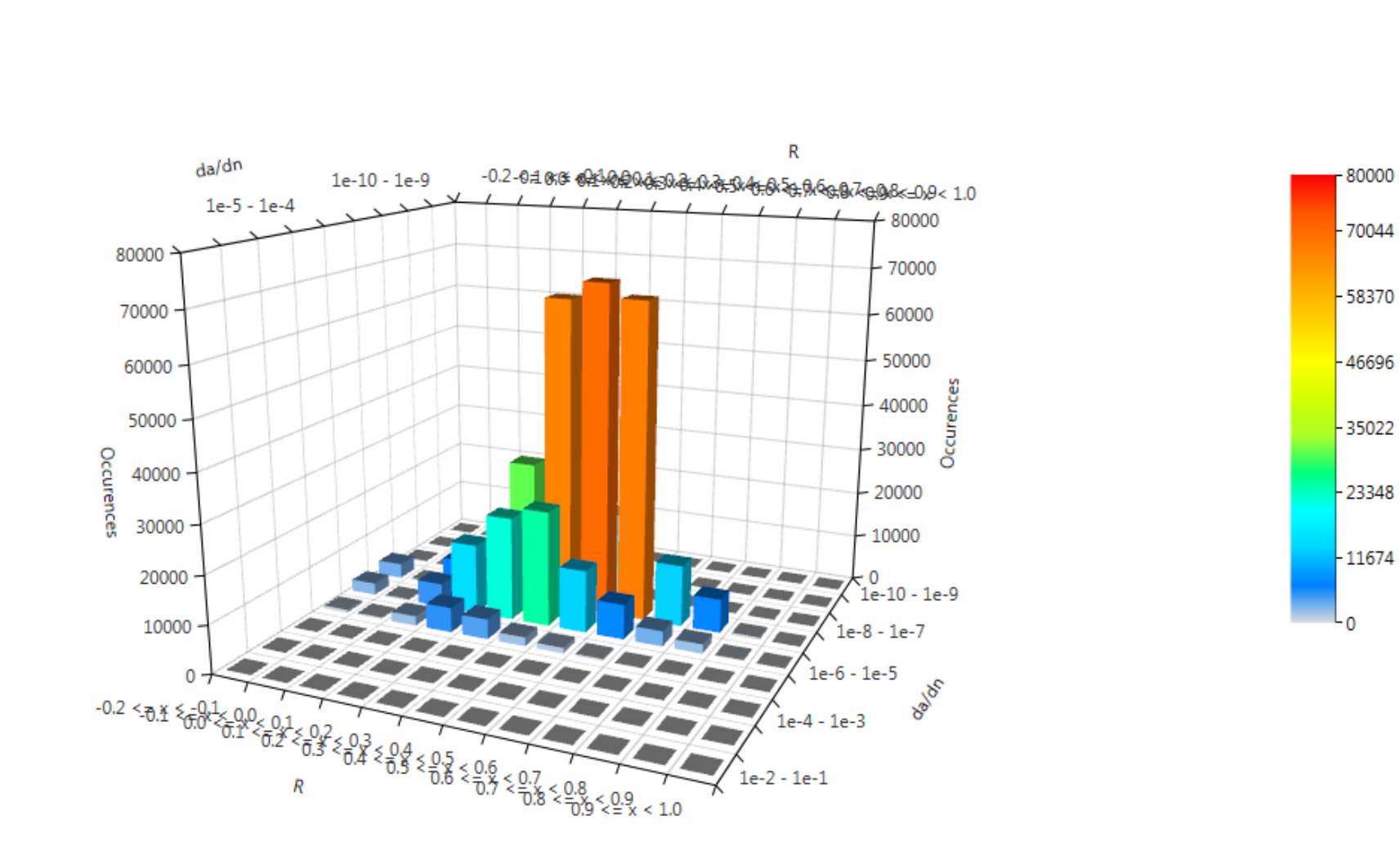
	cycles	max_stress_loac	r	spectrum_units	spectrum_pass	life	dtag	level_id	cycle_level_id
	Filter	Filter	Filter	Filter	Filter	Filter	Filter	Filter	Filter
1	0.0	0.4825	-5.35	0	1.0	0.0	Symmetric Pu...	0.0	0.0
2	1.0	-0.5375	4.8	0	1.0	1.0	Symmetric Pu...	0.0	0.0
3	2.0	6.6125	0.38	0	1.0	2.0	Symmetric Pu...	0.0	0.0
4	3.0	5.59	0.45	0	1.0	3.0	Symmetric Pu...	0.0	0.0
5	9.0	6.6125	0.38	0	1.0	9.0	Symmetric Pu...	0.0	0.0
6	10.0	5.59	0.45	0	1.0	10.0	Symmetric Pu...	0.0	0.0
7	12.0	8.655	0.41	0	1.0	12.0	Symmetric Pu...	0.0	0.0
8	14.0	6.6125	0.23	0	1.0	14.0	Symmetric Pu...	0.0	0.0
9	15.0	4.57	0.33	0	1.0	15.0	Symmetric Pu...	0.0	0.0
10	16.0	5.59	0.45	0	1.0	16.0	Symmetric Pu...	0.0	0.0
11	18.0	6.6125	0.54	0	1.0	18.0	Symmetric Pu...	0.0	0.0
12	19.0	8.655	0.41	0	1.0	19.0	Symmetric Pu...	0.0	0.0
13	20.0	6.6125	0.54	0	1.0	20.0	Symmetric Pu...	0.0	0.0
14	21.0	8.655	0.53	0	1.0	21.0	Symmetric Pu...	0.0	0.0
15	22.0	7.635	0.6	0	1.0	22.0	Symmetric Pu...	0.0	0.0
16	23.0	8.655	0.29	0	1.0	23.0	Symmetric Pu...	0.0	0.0
17	24.0	5.59	0.45	0	1.0	24.0	Symmetric Pu...	0.0	0.0
18	26.0	6.6125	0.38	0	1.0	26.0	Symmetric Pu...	0.0	0.0
19	27.0	5.59	0.45	0	1.0	27.0	Symmetric Pu...	0.0	0.0
20	28.0	8.655	0.41	0	1.0	28.0	Symmetric Pu...	0.0	0.0
21	29.0	6.6125	0.54	0	1.0	29.0	Symmetric Pu...	0.0	0.0
22	30.0	6.6125	0.38	0	1.0	30.0	Symmetric Pu...	0.0	0.0
23	31.0	5.59	0.45	0	1.0	31.0	Symmetric Pu...	0.0	0.0

1 - 23 of 425170 Go to: 1

da/dN occurrences



da/dN occurrences vs. R



LexTech

AFGROW.NET

Damage accumulation per sub spectra

Subspectra	Accumulated Damage
130	0.02361149460
197	0.02002495479
32	0.01897933443
129	0.0183204835
193	0.01785394520
36	0.01664393429
46	0.01346913180
139	0.0134016639
87	0.0132056772
136	0.01286146640
125	0.0124577707
37	0.01221966739
89	0.0120433538
126	0.0116214965
30	0.0114470514
195	0.0105882331
40	0.0105053393
182	0.0100139449
26	0.00875278440
122	0.0083622315
185	0.00835523180

Damage accumulation per spectrum tag

Damage Tag	Accumulated Damage
Symmetric Pull Up	0.0167839055
3G Gust	0.38153865585
Limit Load	0.25889194676
GAG Cycle	0.13000287863

LexTech

AFGROW.NET

Questions