

# Quantitative Assessment of Navigational Safety in Storm Surge Barrier Design

A Systematic Maneuvering-Based Approach for Early Evaluation of Alternative Configurations

Annex A: SHIPMA Output Plots

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# Quantitative Assessment of Navigational Safety in Storm Surge Barrier Design

A Systematic Maneuvering-Based Approach for  
Early Evaluation of Alternative Configurations

by

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in partial fulfillment of the requirements for the degree of  
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Cover: Greater Houston Port Region (photo by European Space Agency)

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# Nomenclature

## Abbreviations

<b>Abbreviation</b>	<b>Definition</b>
RoT	Rate of Turn
RPM	Revolutions Per Minute
S.C.	Simulation Case
SOG	Speed Over Ground

# 1

## Critical Positions Assessment Metrics Determination

All of the values in Table 1.1 were determined using the SHIPMA output plots presented in Chapter 2.

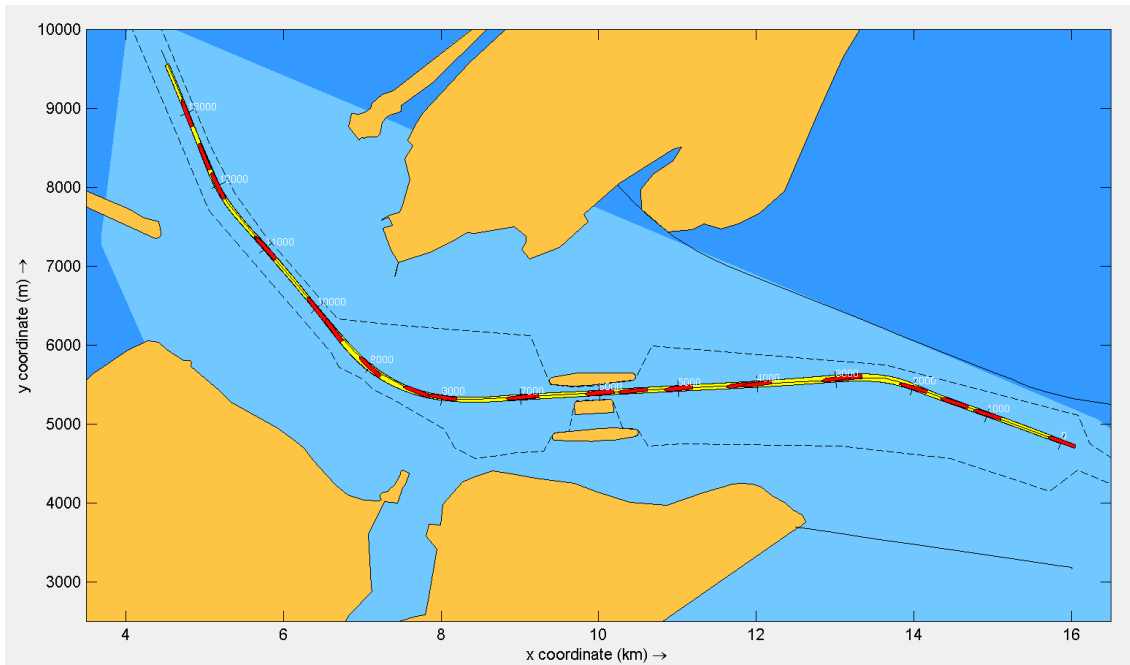
**Table 1.1:** Critical positions for determination of nautical safety assessment metrics, all simulation cases.

<b>S.C.</b>	<b>Finish Turn Before Barrier [m]</b>	<b>Entry Barrier [m]</b>	<b>Exit Barrier [m]</b>	<b>Start Turn After Barrier [m]</b>
1	3538	5529	6632	7114
2	3385	3943	5046	6911
3	3436	3908	4943	7873
4	3436	5494	6598	6911
5	7410	7460	8540	11100
6	7385	8983	10080	11075
7	6385	8862	9966	10925
8	7410	7437	8517	11075
9	3282	5529	6632	7190
10	3385	3943	5046	6987
11	3462	3908	4943	7925
12	3077	5494	6598	6937
13	7410	7460	8540	11190
14	7359	8983	10080	11165
15	6308	8862	9966	10987
16	7410	7437	8517	11139
17	3385	5529	6632	7291
18	3385	3943	5046	7089
19	2846	3908	4943	8025
20	3359	5494	6598	7063
21	7436	7460	8540	11291
22	7359	8983	10080	11241
23	6359	8862	9966	11089
24	7436	7437	8517	11241
25	3175	5531	6633	6816
26	2990	3949	5051	6837
27	2845	3847	4939	5959
28	3143	5500	6602	6828
29	5460	4327	5423	8255
30	5545	5888	6980	8235
31	6184	6224	7321	8485
32	5440	4337	5434	8235
33	3155	5531	6633	6714
34	3388	3949	5051	6727
35	2825	3847	4939	5857
36	3061	5500	6602	6720
37	4260	4327	5423	8118
38	4400	5888	6980	8118
39	5041	6224	7321	8380
40	4260	4337	5434	8118
41	3306	5531	6633	6633
42	3388	3949	5051	6640
43	3464	3847	4939	5758
44	3449	5500	6602	6620
45	4515	4327	5423	8059
46	4554	5888	6980	8039
47	5143	6224	7321	8303
48	4554	4337	5434	8039

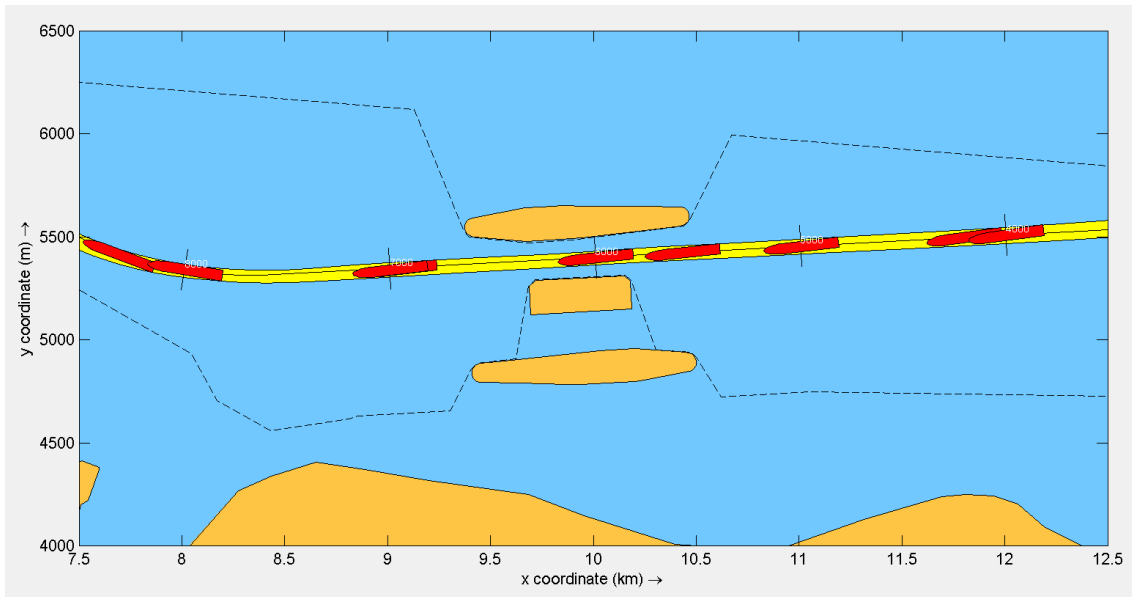
# 2

## SHIPMA Output Plots

### Simulation Case 1



**Figure 2.1:** S.C. 1: spatial overview plot.



**Figure 2.2:** S.C. 1: zoom-in of spatial overview plot, crossing segment.

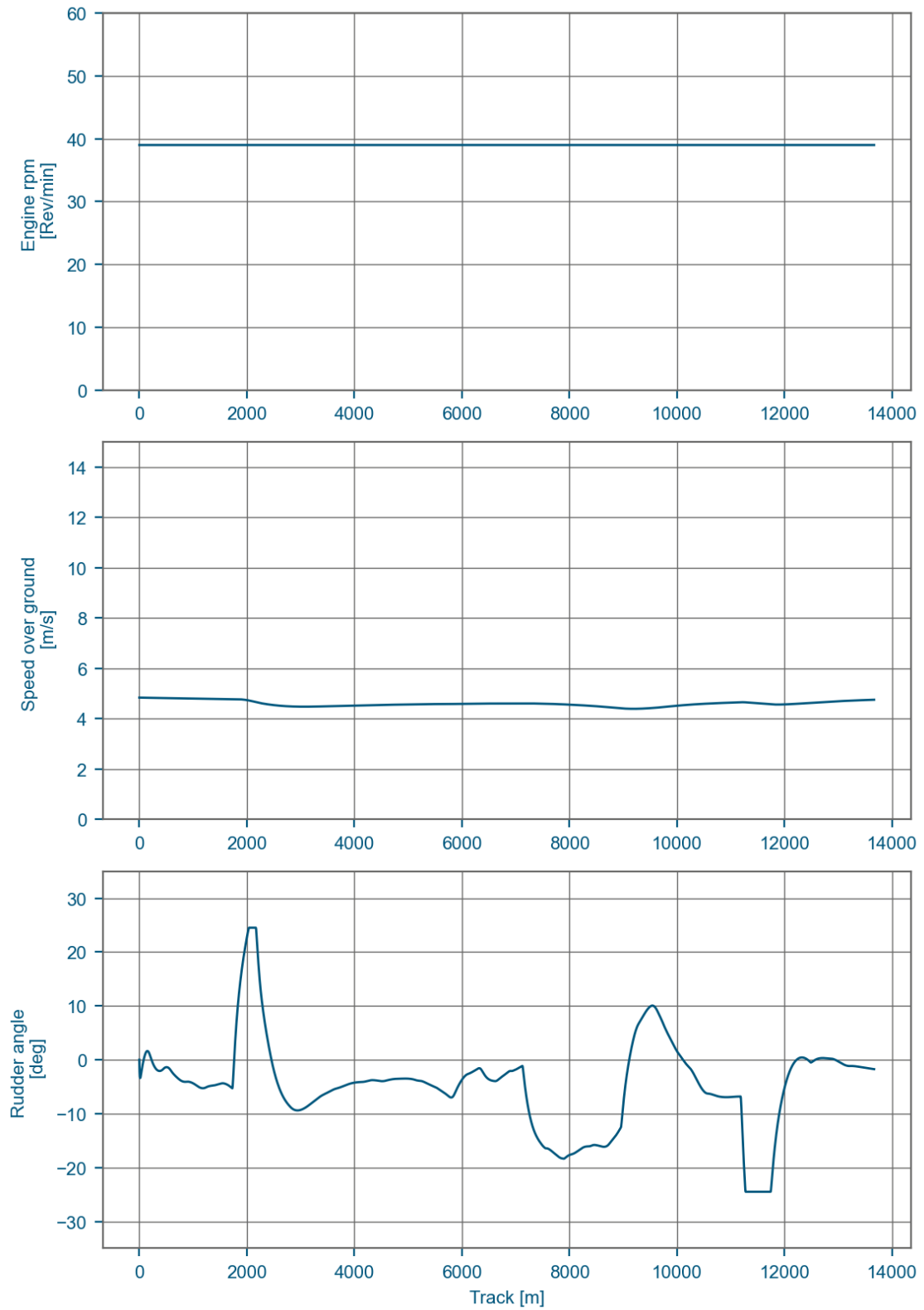
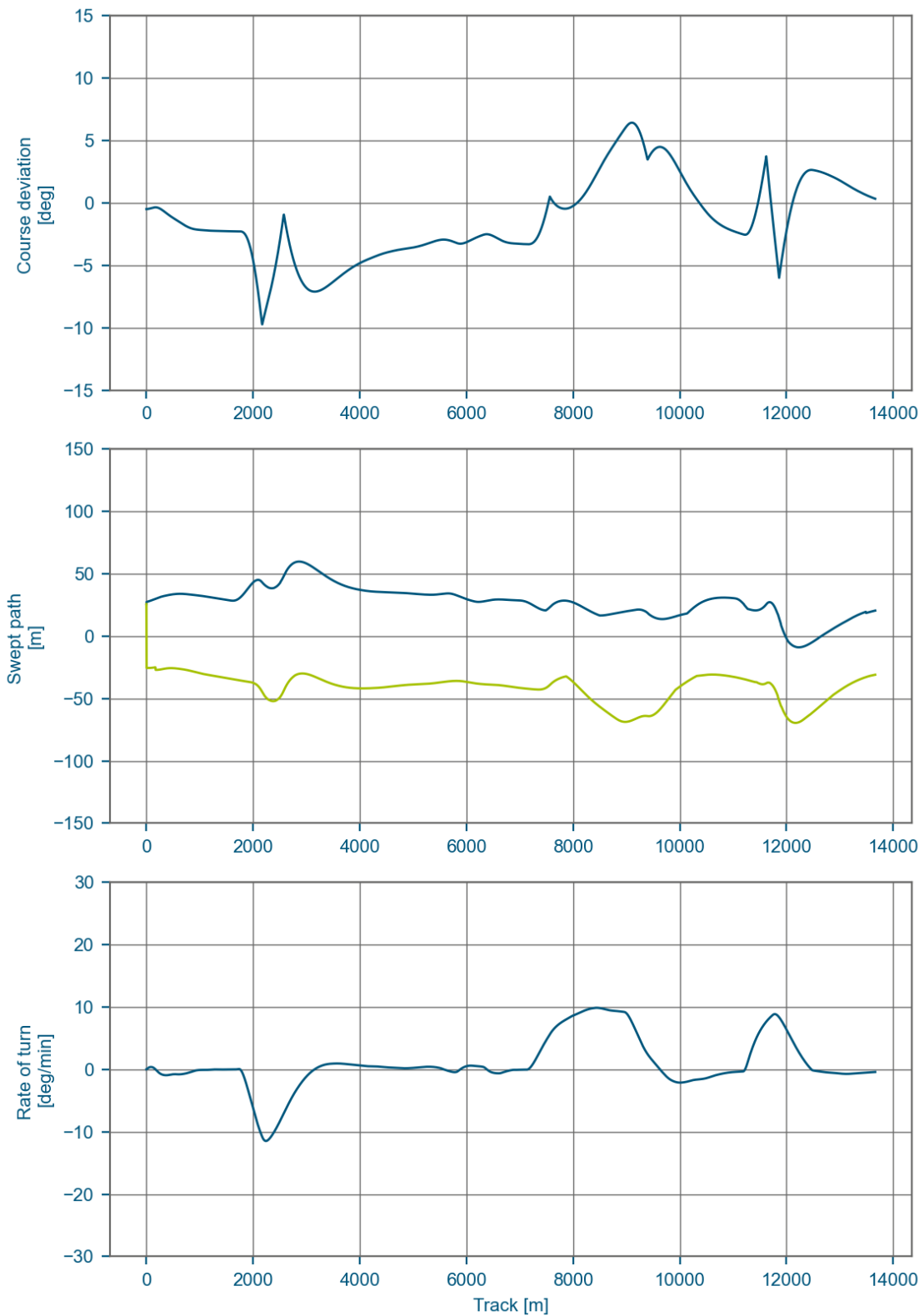


Figure 2.3: S.C. 1: engine RPM, SOG, rudder angle, vs. distance.



**Figure 2.4:** S.C. 1: course deviation (drift angle), swept path, RoT, vs. distance.

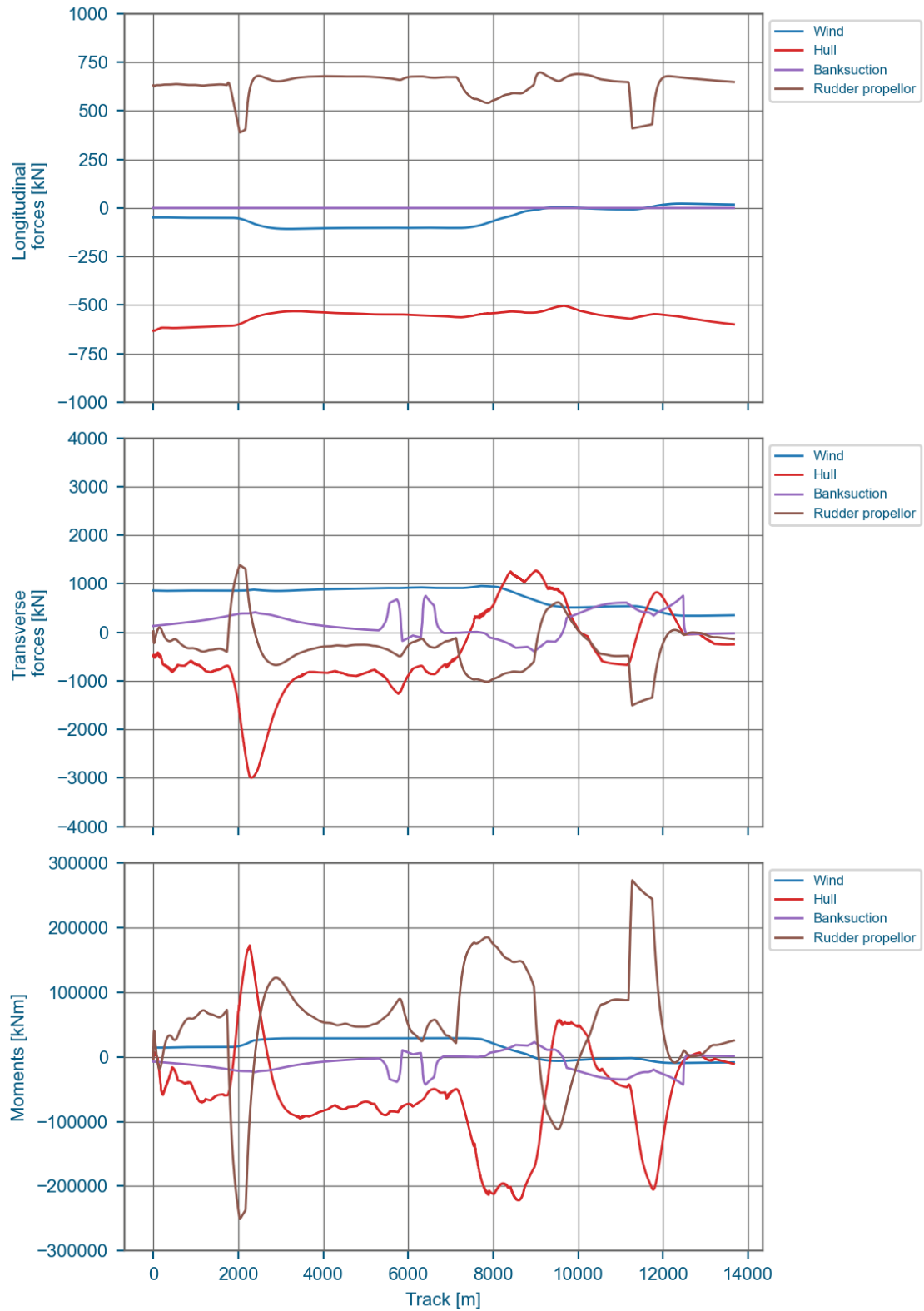


Figure 2.5: S.C. 1: forces, moments, vs. distance.

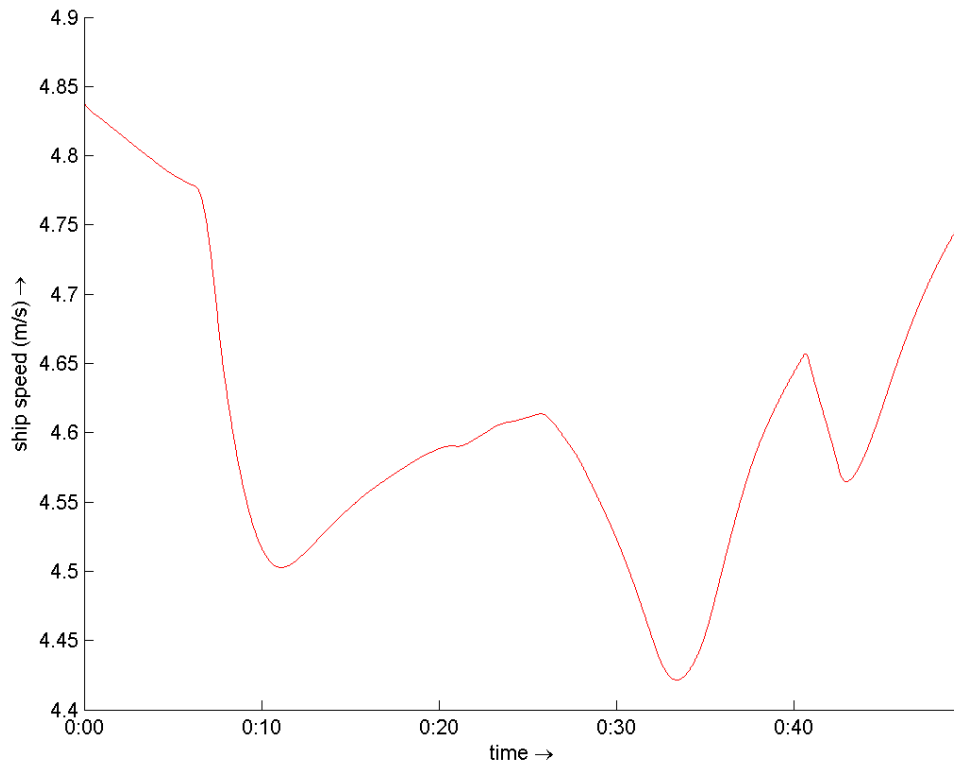


Figure 2.6: S.C. 1: SOG, vs. time.

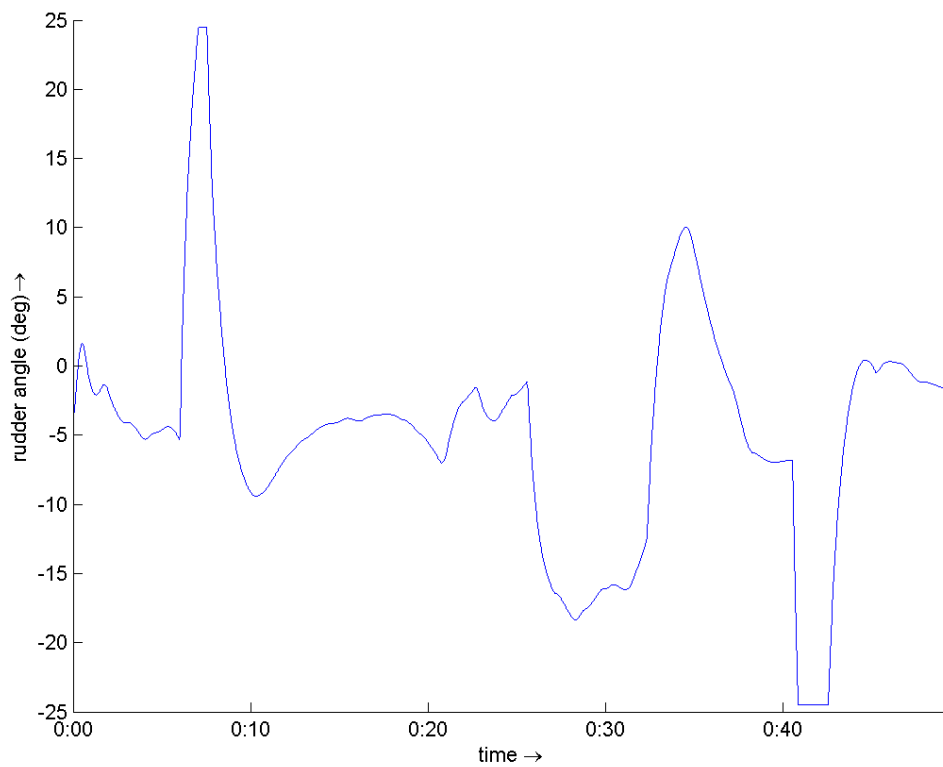


Figure 2.7: S.C. 1: rudder angle, vs. time.

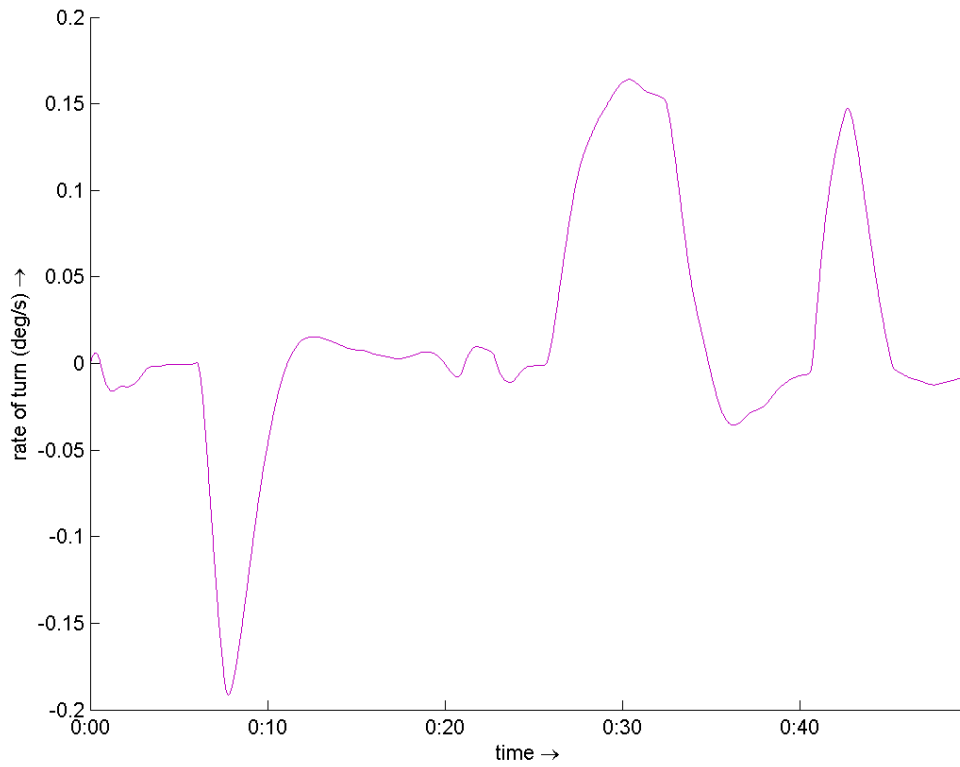


Figure 2.8: S.C. 1: RoT, vs. time.

## Simulation Case 2

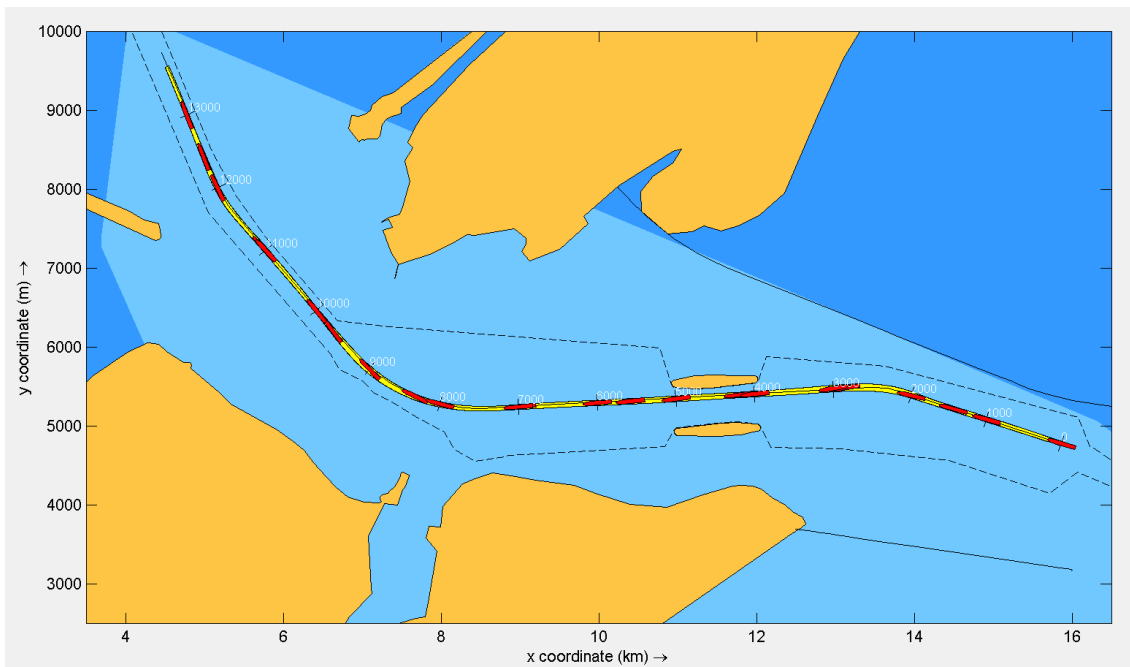
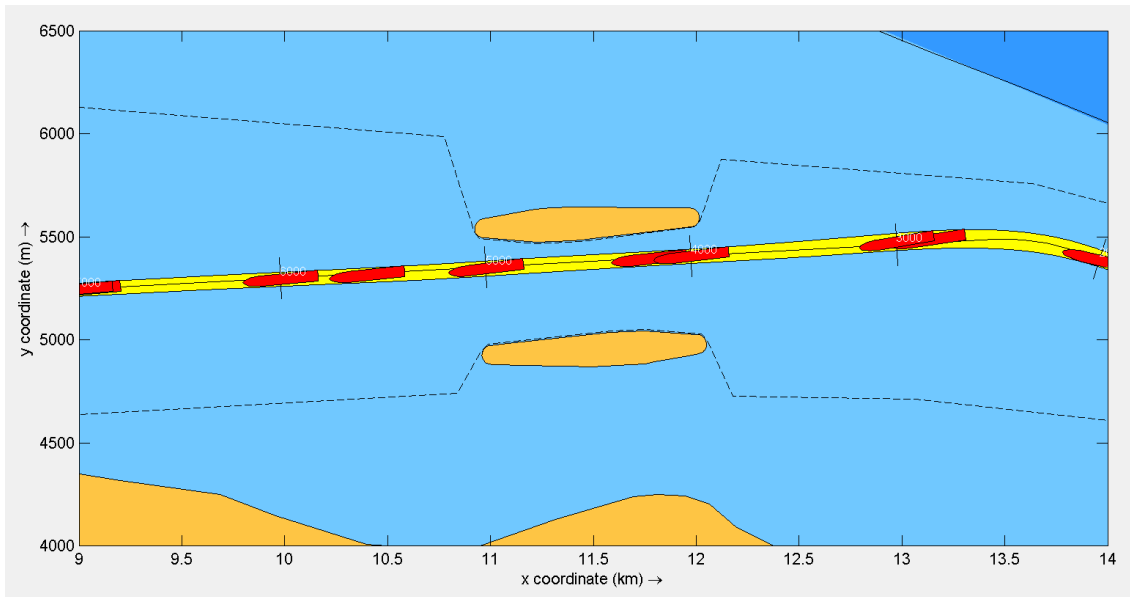
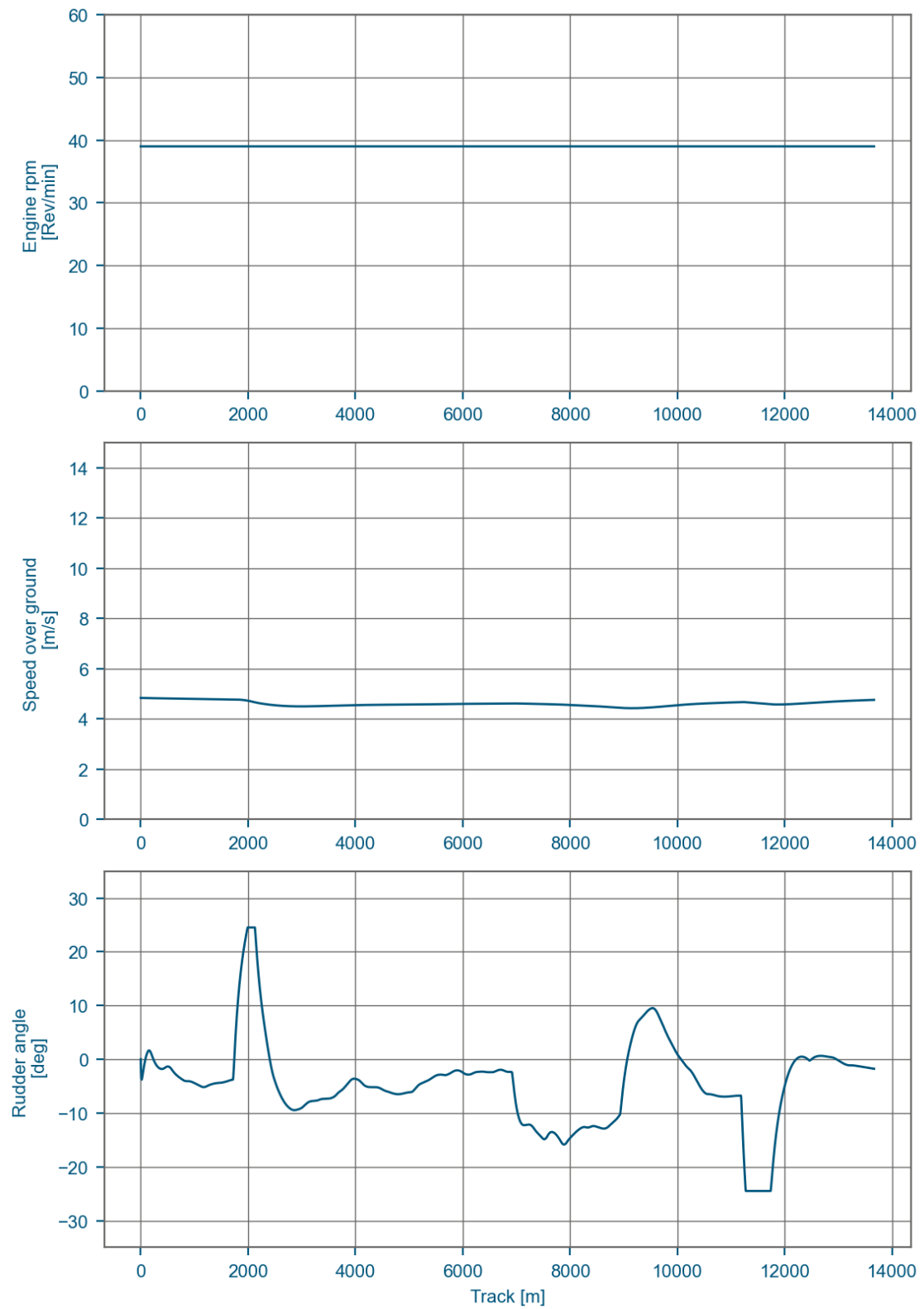


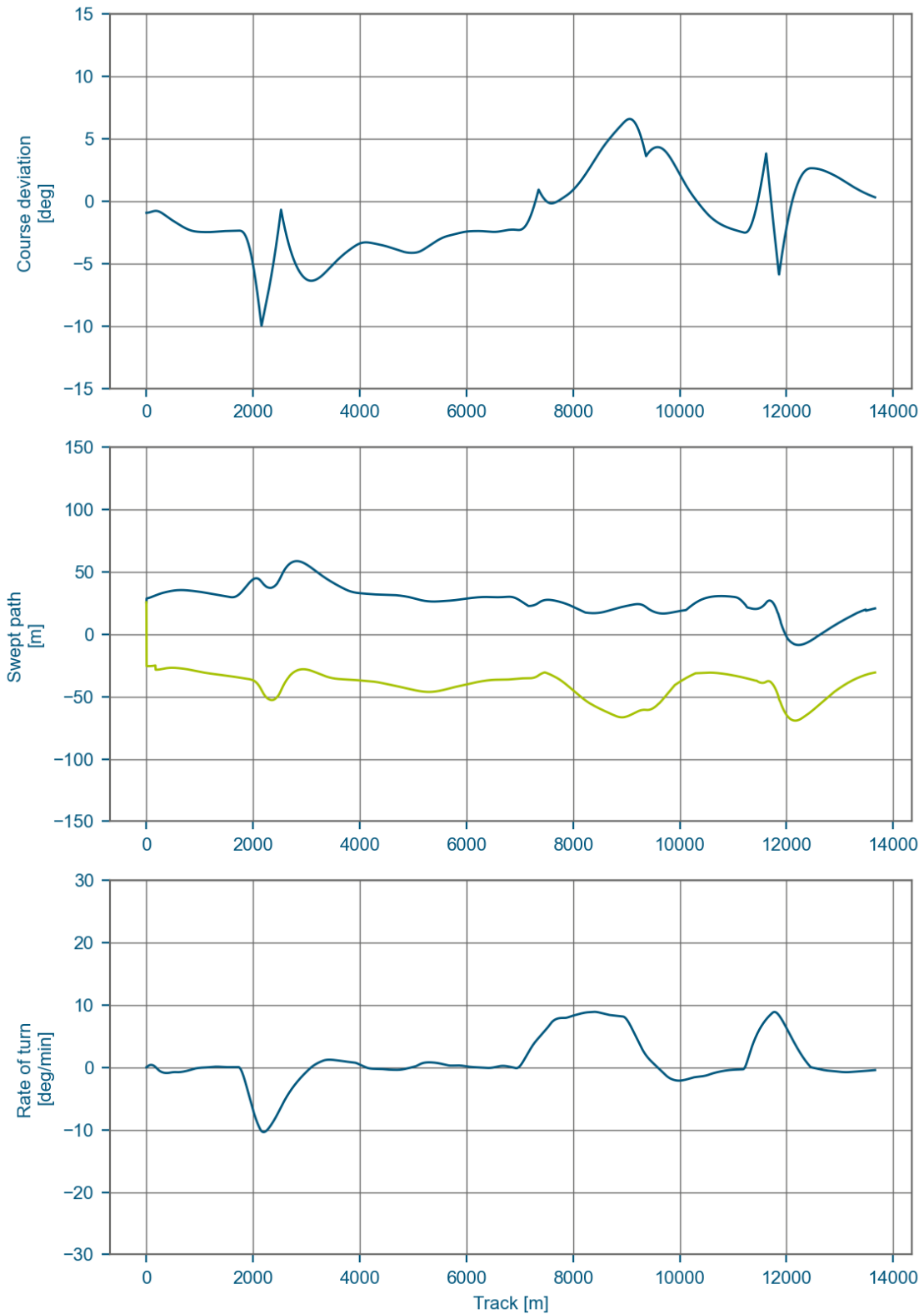
Figure 2.9: S.C. 2: spatial overview plot.



**Figure 2.10:** S.C. 2: zoom-in of spatial overview plot, crossing segment.



**Figure 2.11:** S.C. 2: engine RPM, SOG, rudder angle, vs. distance.



**Figure 2.12:** S.C. 2: course deviation (drift angle), swept path, RoT, vs. distance.

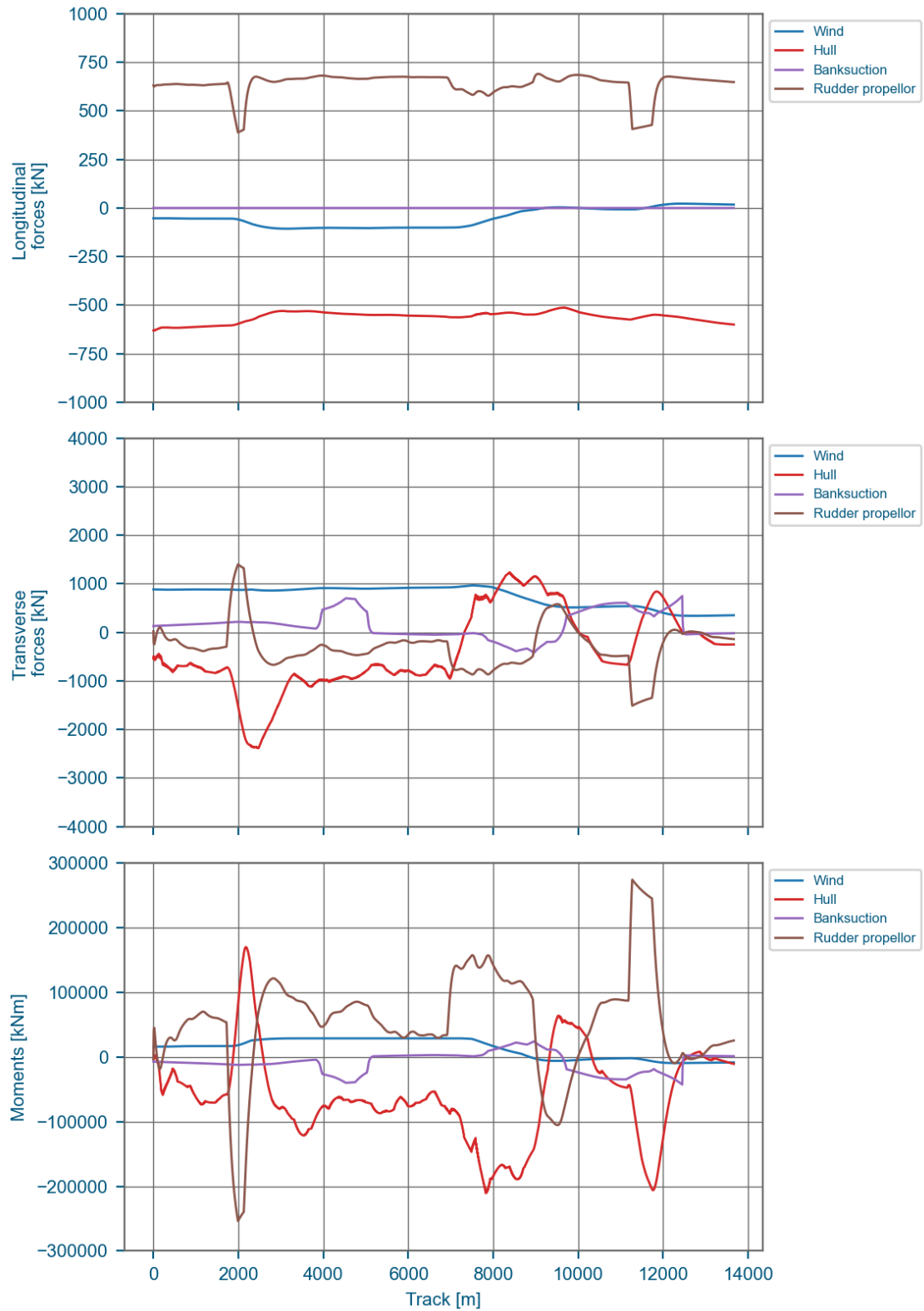


Figure 2.13: S.C. 2: forces, moments, vs. distance.

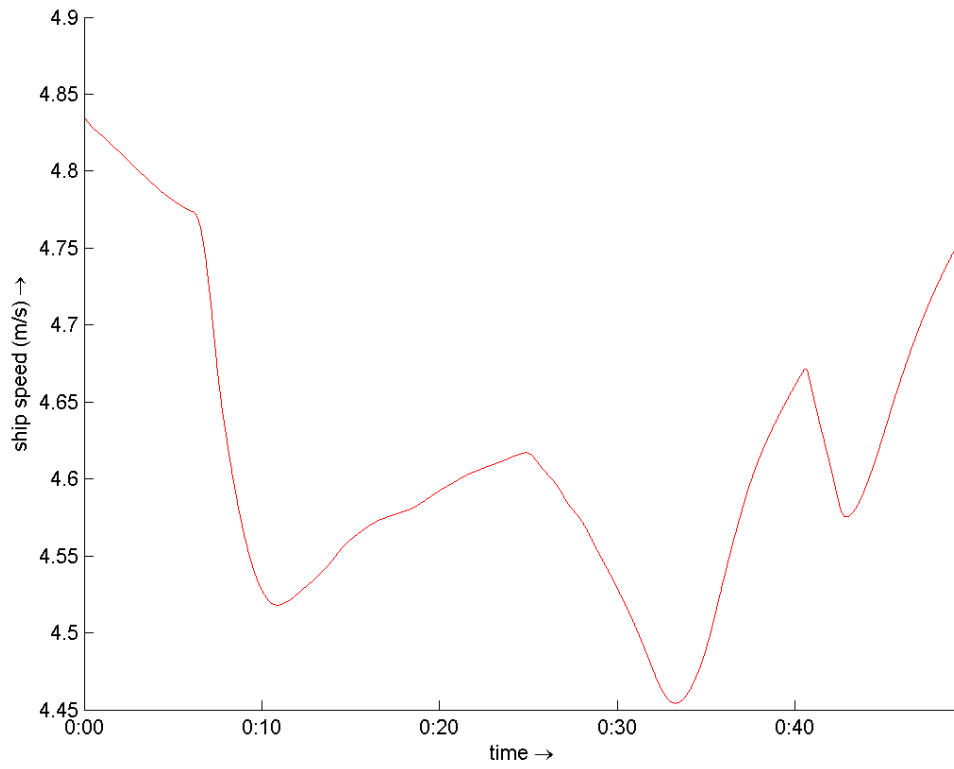


Figure 2.14: S.C. 2: SOG, vs. time.

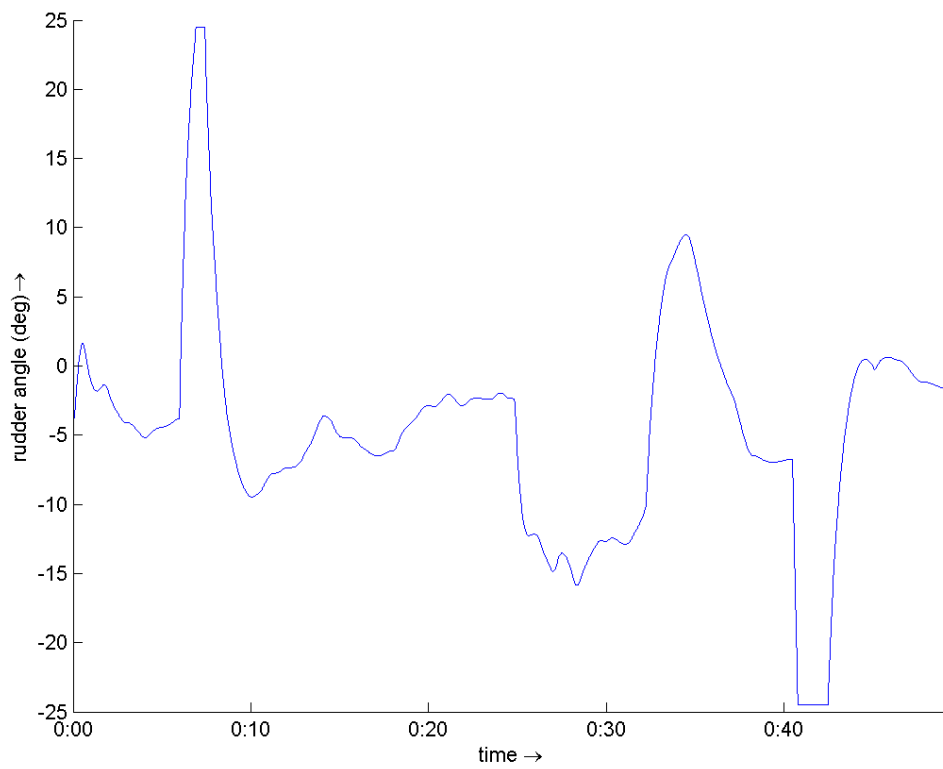


Figure 2.15: S.C. 2: rudder angle, vs. time.

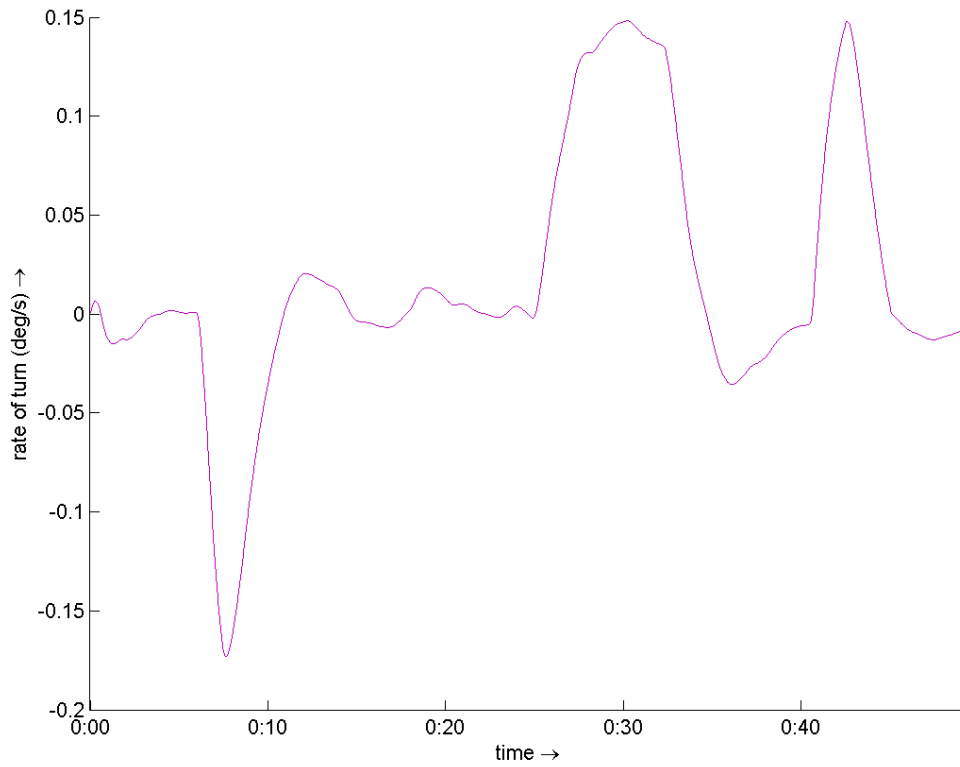


Figure 2.16: S.C. 2: RoT, vs. time.

### Simulation Case 3

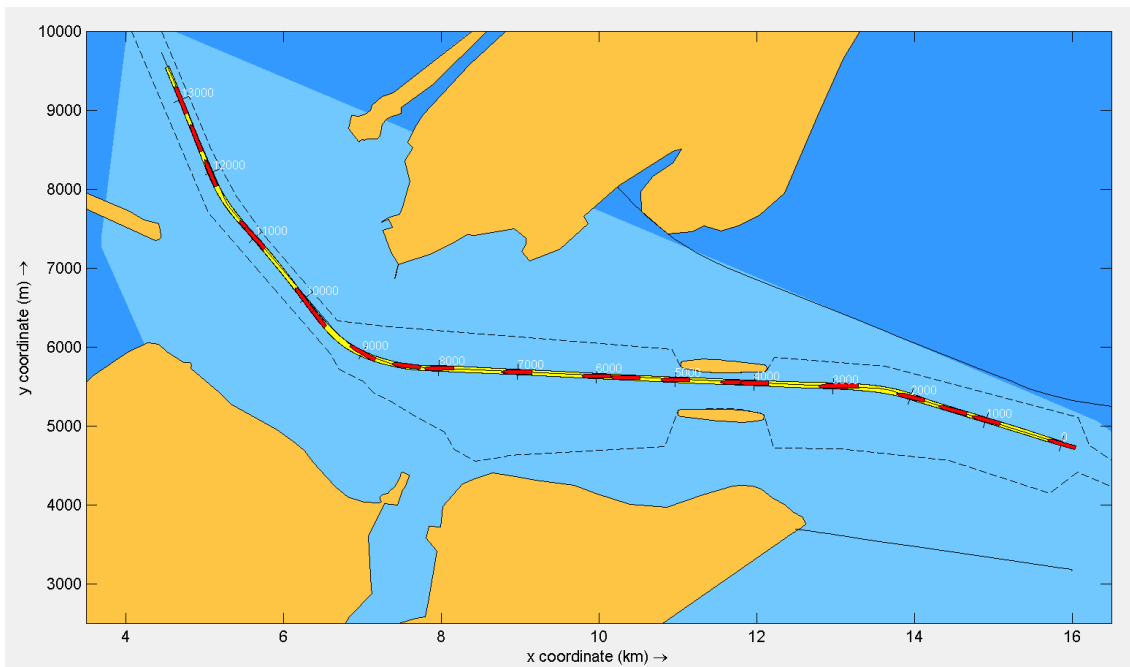
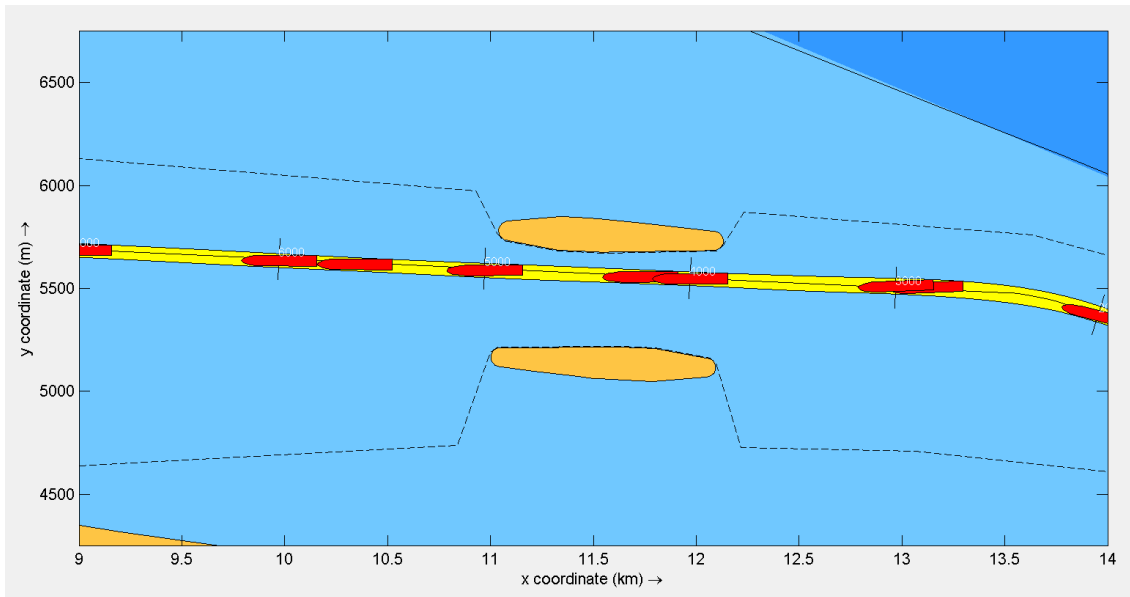
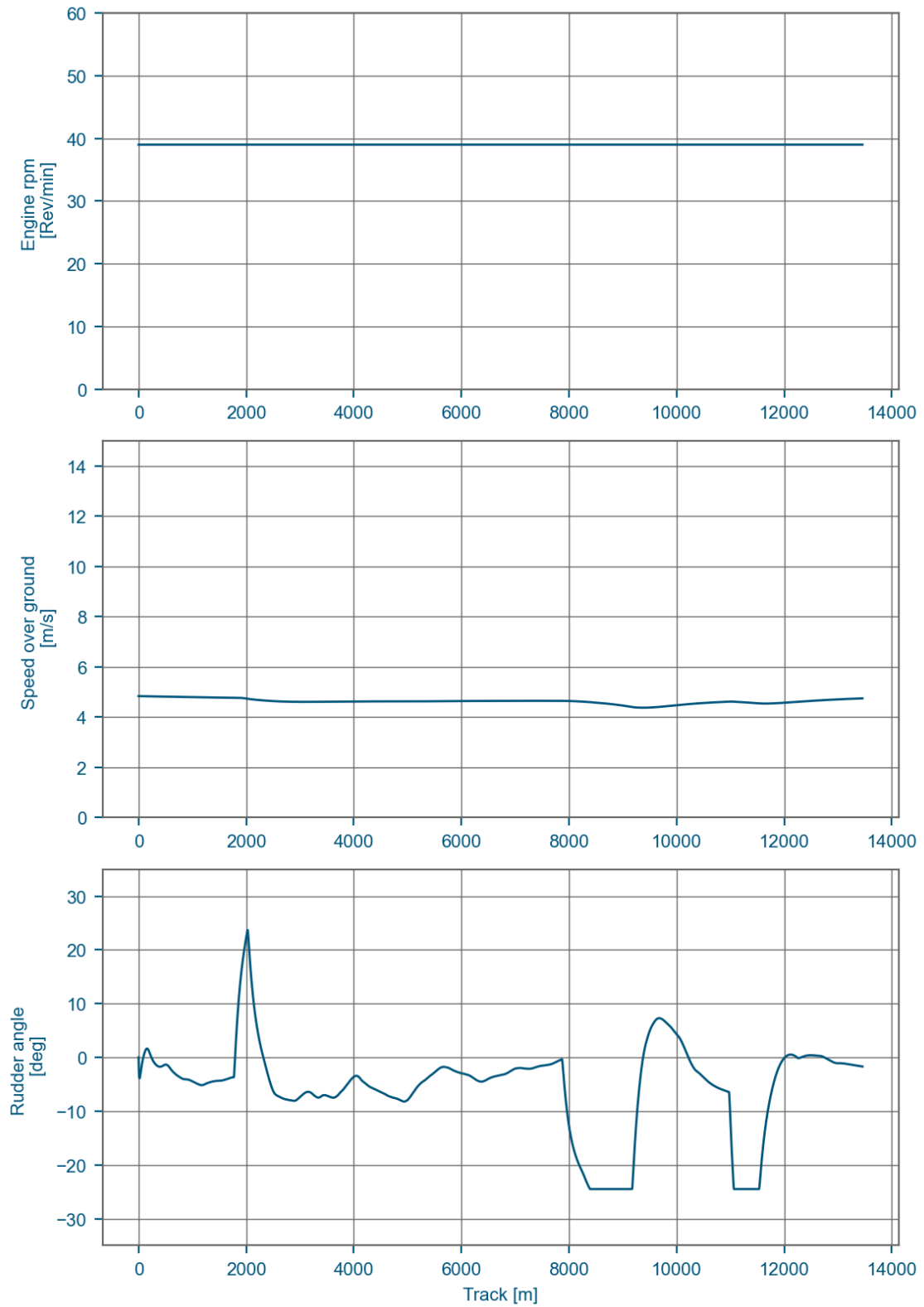


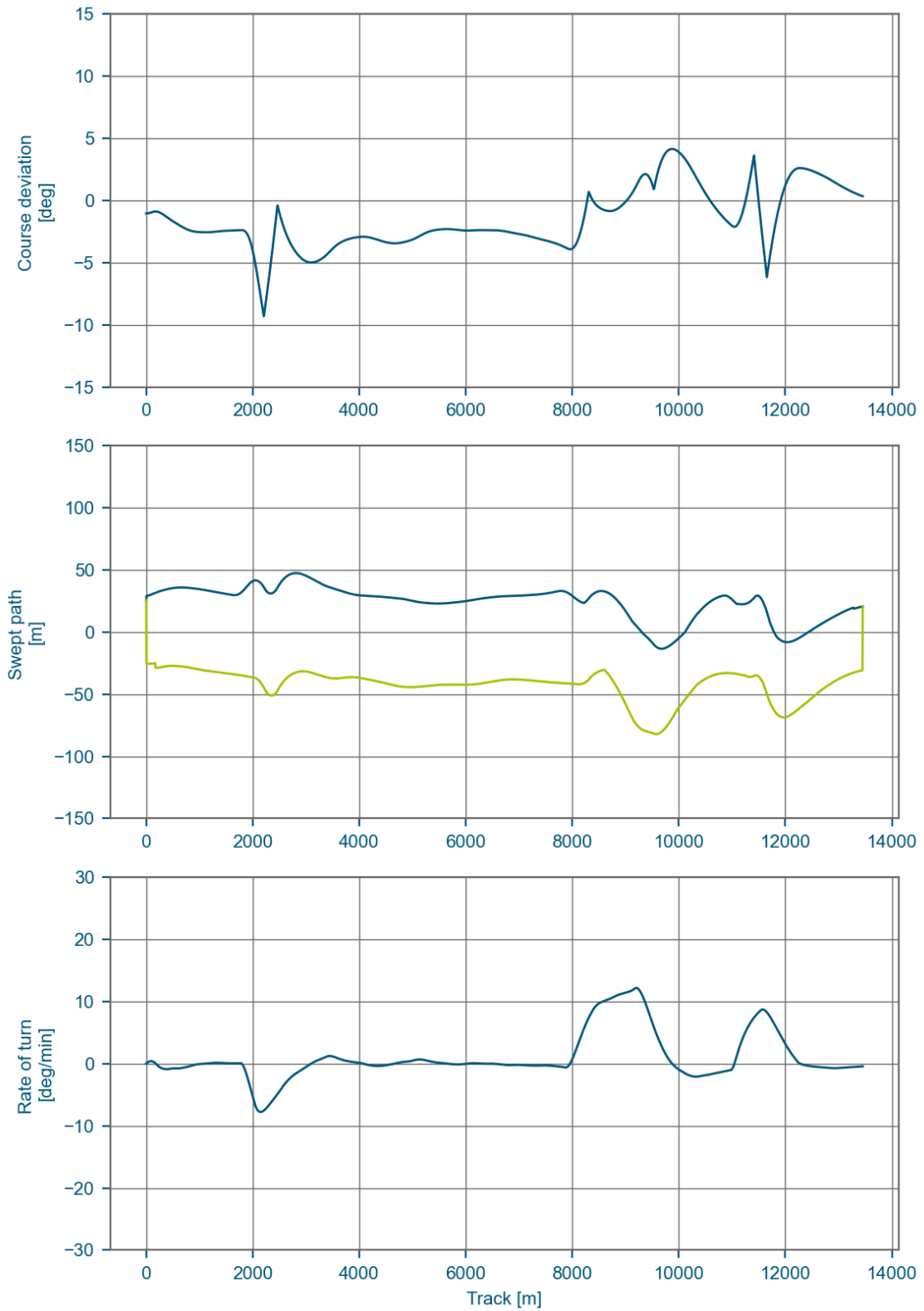
Figure 2.17: S.C. 3: spatial overview plot.



**Figure 2.18:** S.C. 3: zoom-in of spatial overview plot, crossing segment.



**Figure 2.19:** S.C. 3: engine RPM, SOG, rudder angle, vs. distance.



**Figure 2.20:** S.C. 3: course deviation (drift angle), swept path, RoT, vs. distance.

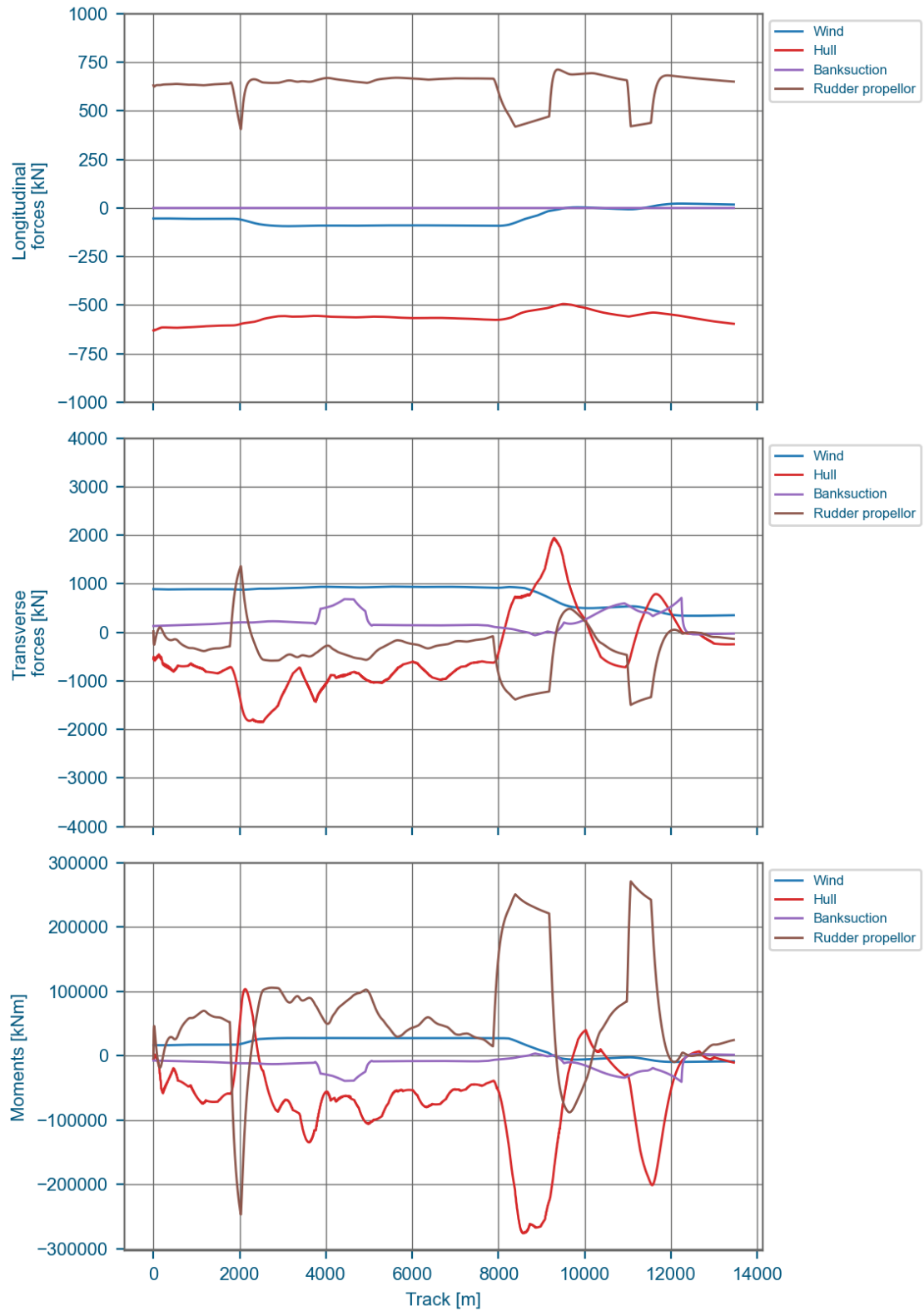


Figure 2.21: S.C. 3: forces, moments, vs. distance.

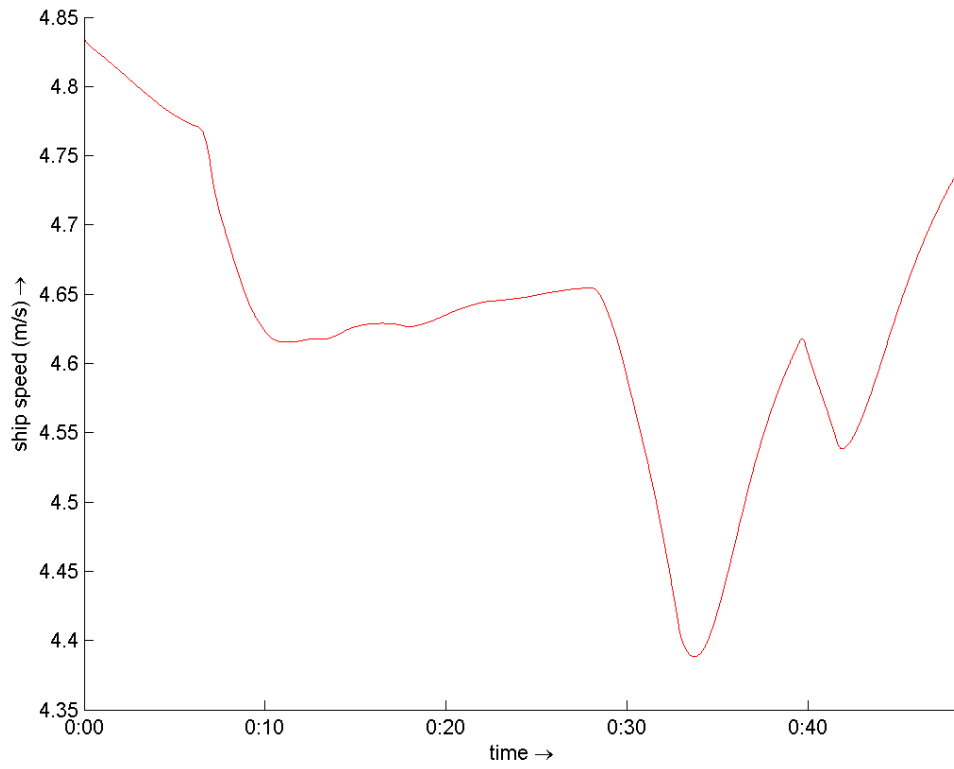


Figure 2.22: S.C. 3: SOG, vs. time.

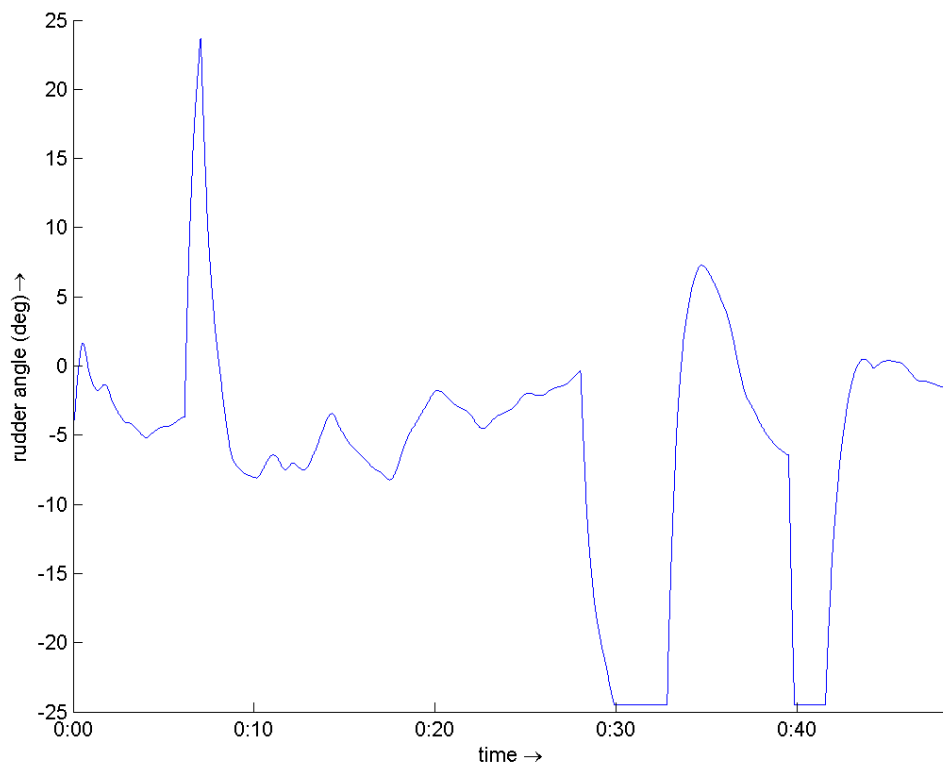


Figure 2.23: S.C. 3: rudder angle, vs. time.

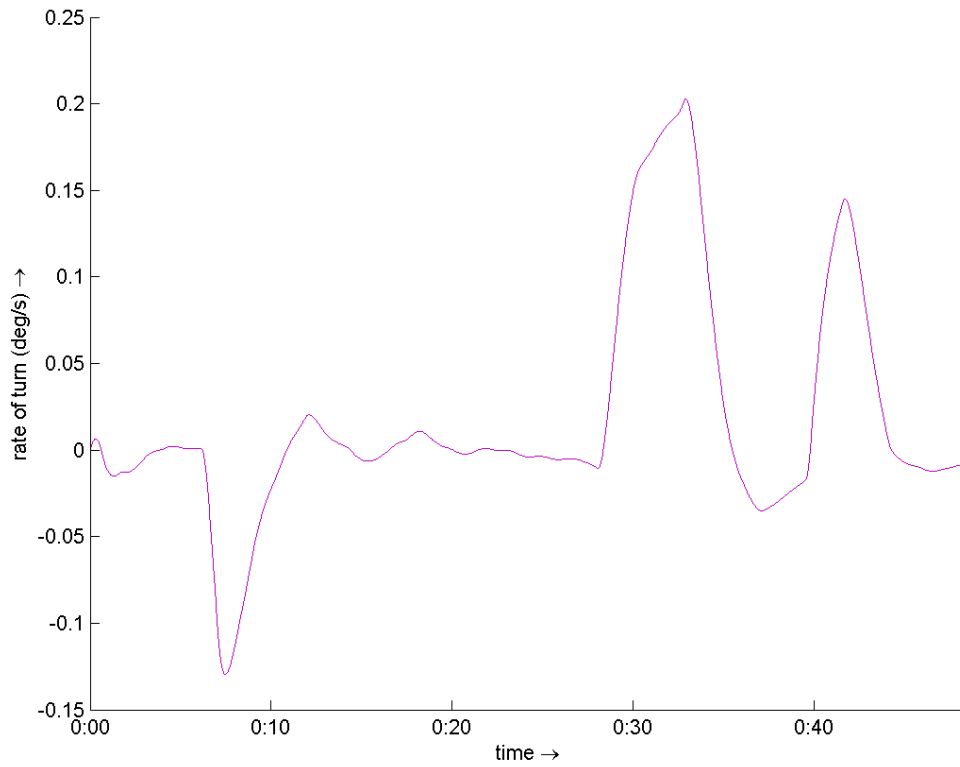


Figure 2.24: S.C. 3: RoT, vs. time.

#### Simulation Case 4

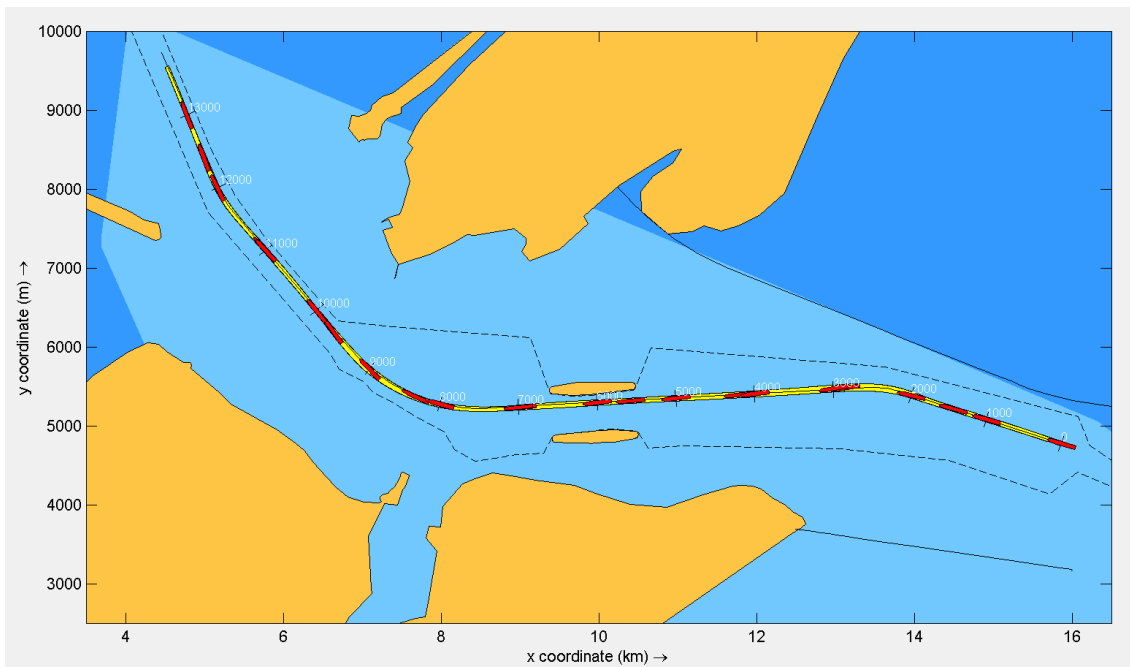
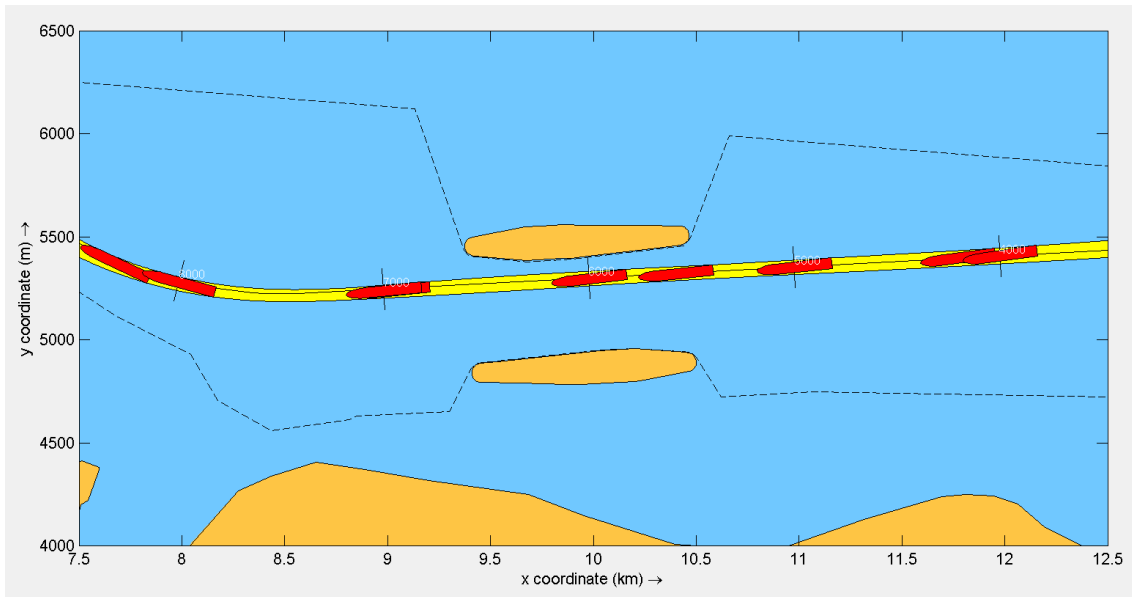


Figure 2.25: S.C. 4: spatial overview plot.



**Figure 2.26:** S.C. 4: zoom-in of spatial overview plot, crossing segment.

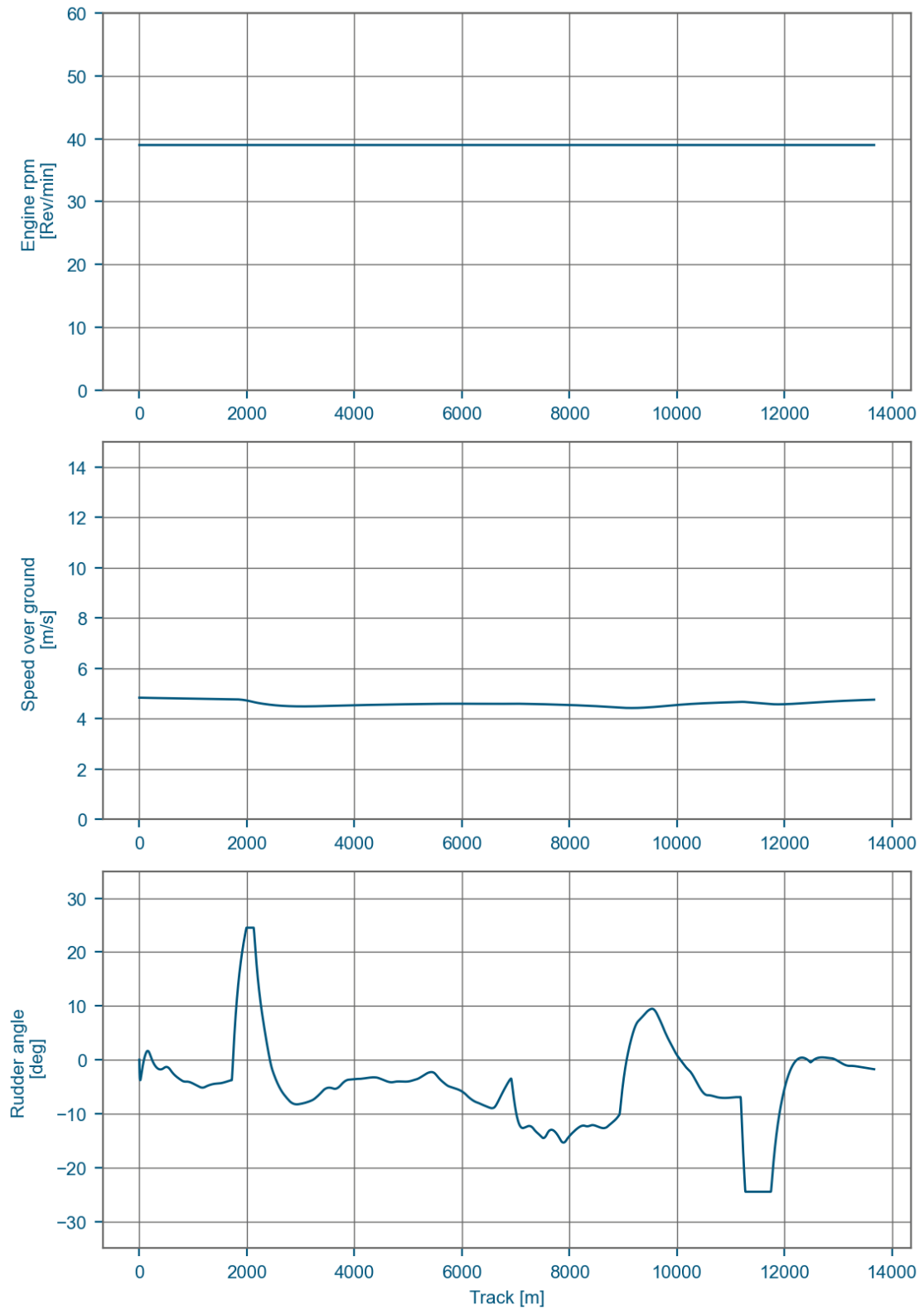
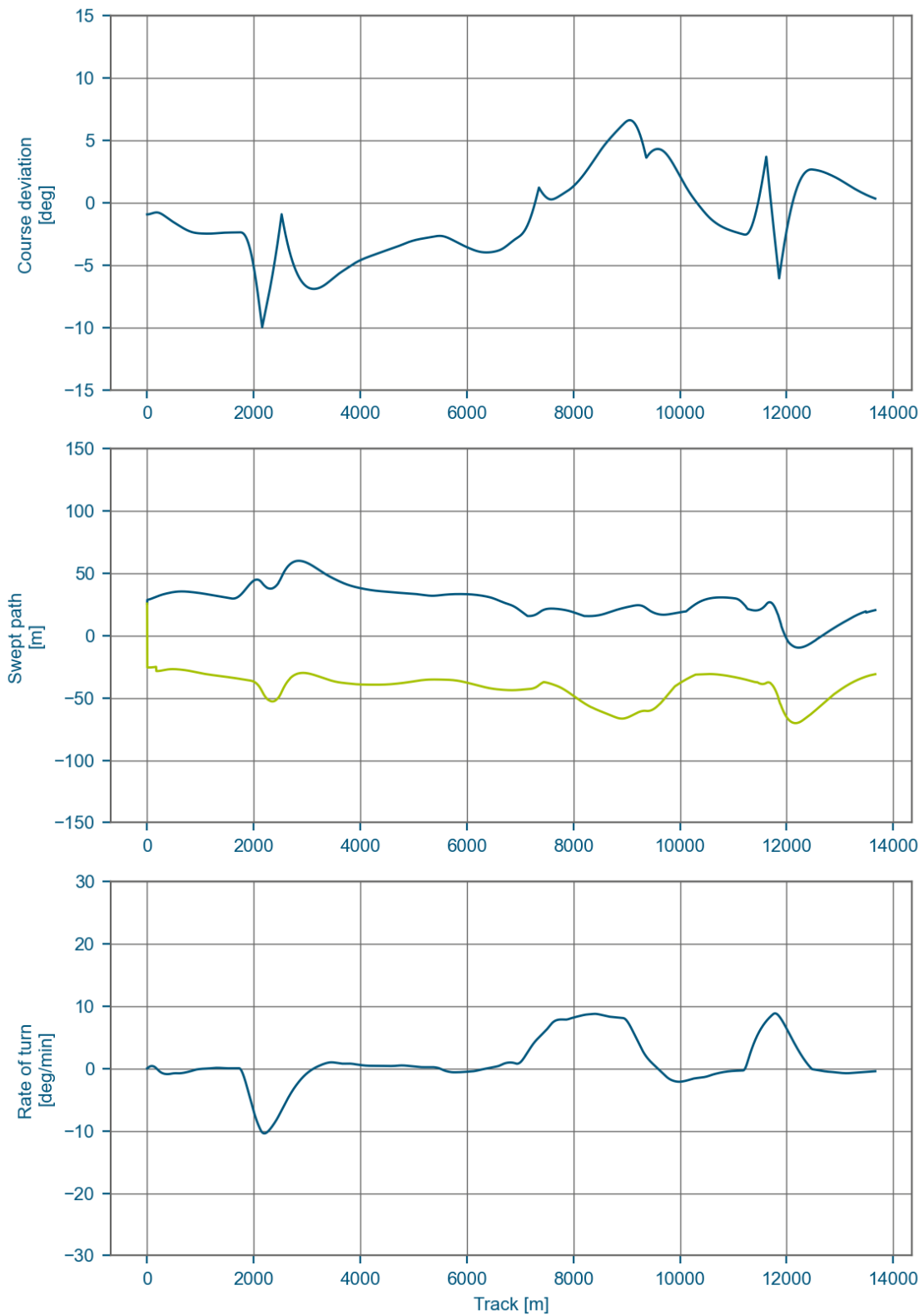


Figure 2.27: S.C. 4: engine RPM, SOG, rudder angle, vs. distance.



**Figure 2.28:** S.C. 4: course deviation (drift angle), swept path, RoT, vs. distance.

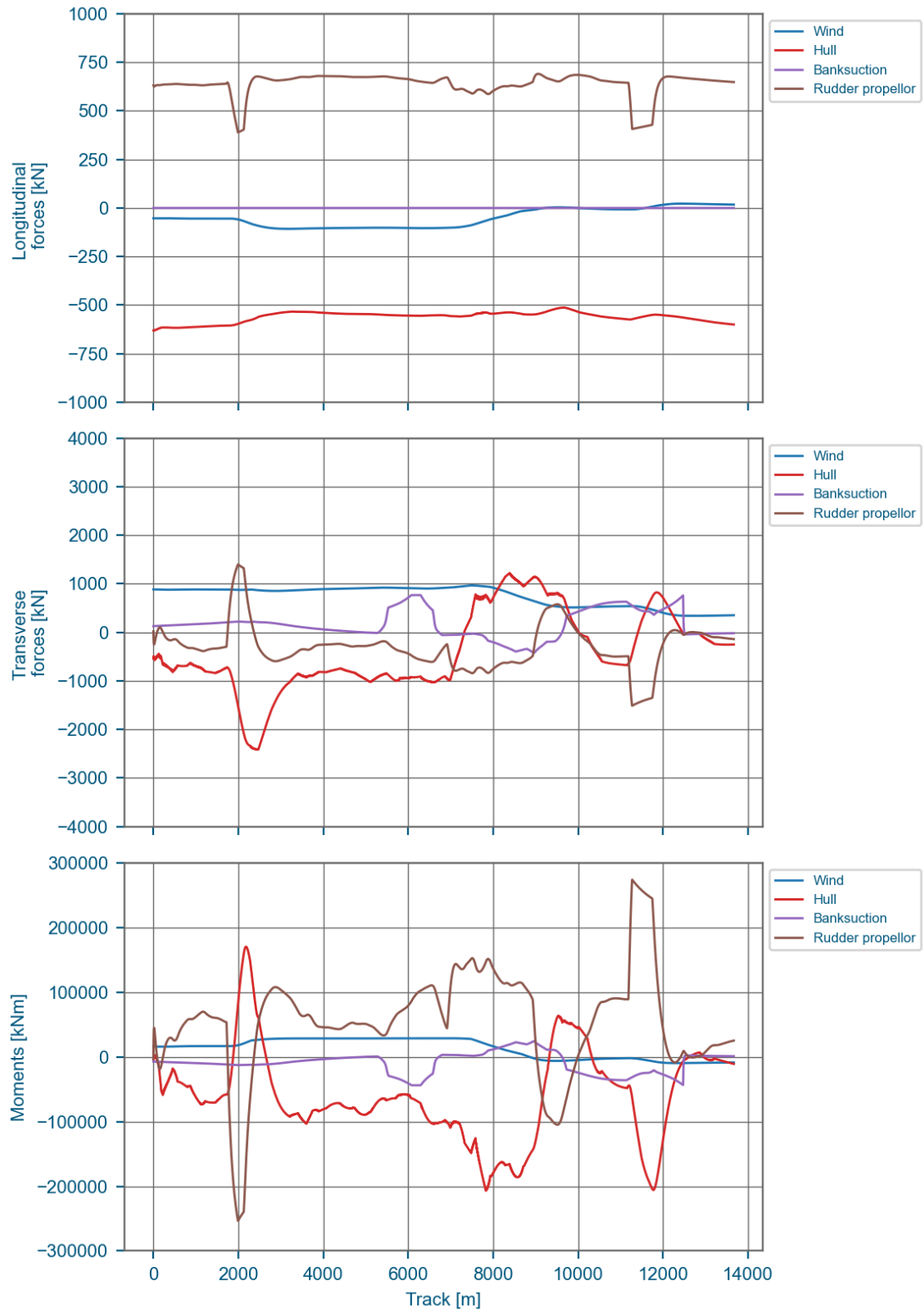


Figure 2.29: S.C. 4: forces, moments, vs. distance.

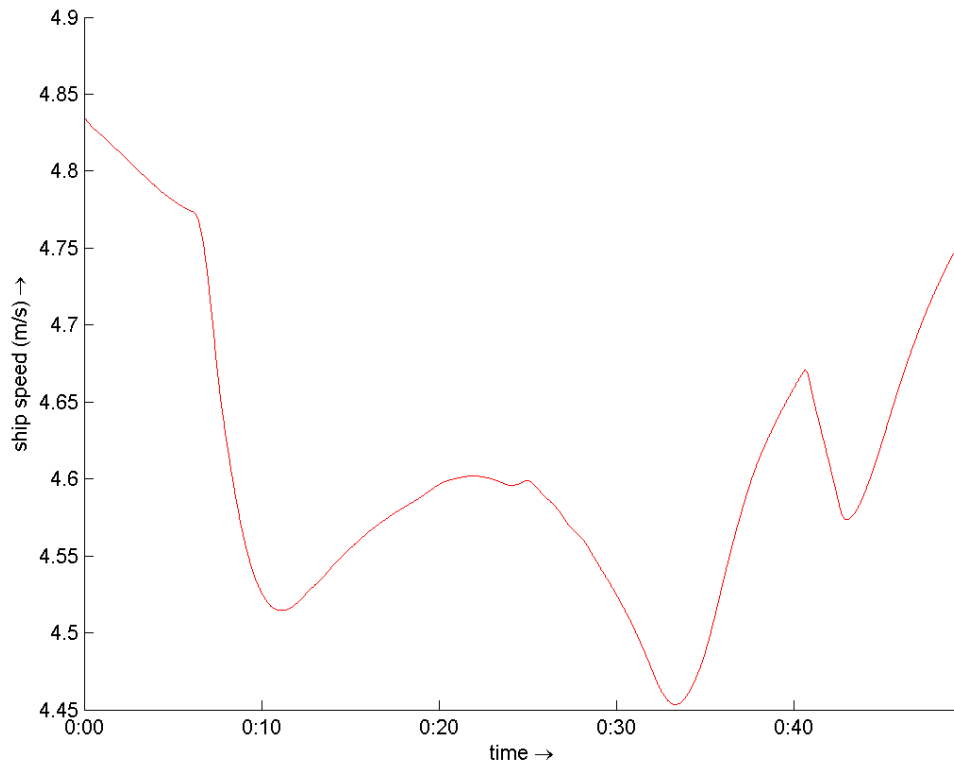


Figure 2.30: S.C. 4: SOG, vs. time.

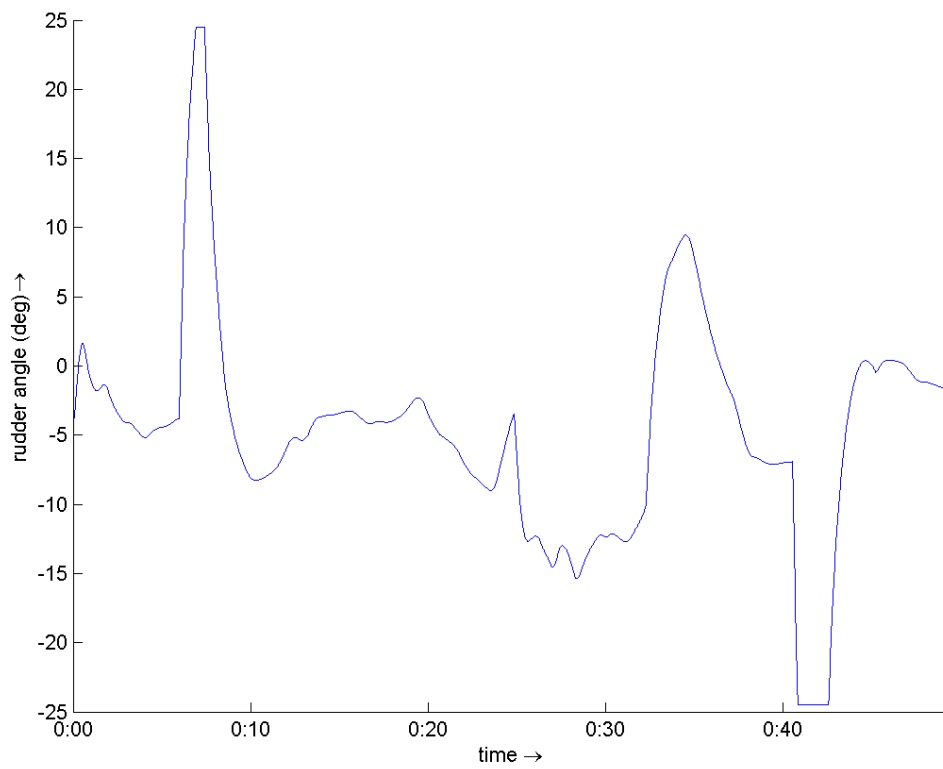


Figure 2.31: S.C. 4: rudder angle, vs. time.

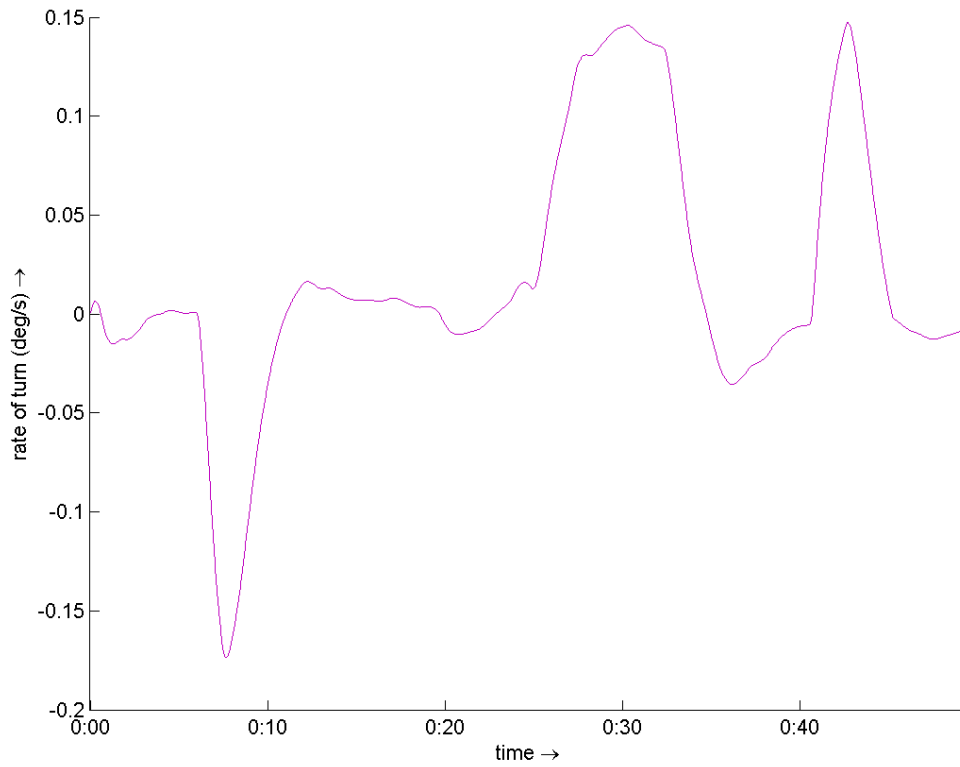


Figure 2.32: S.C. 4: RoT, vs. time.

## Simulation Case 5

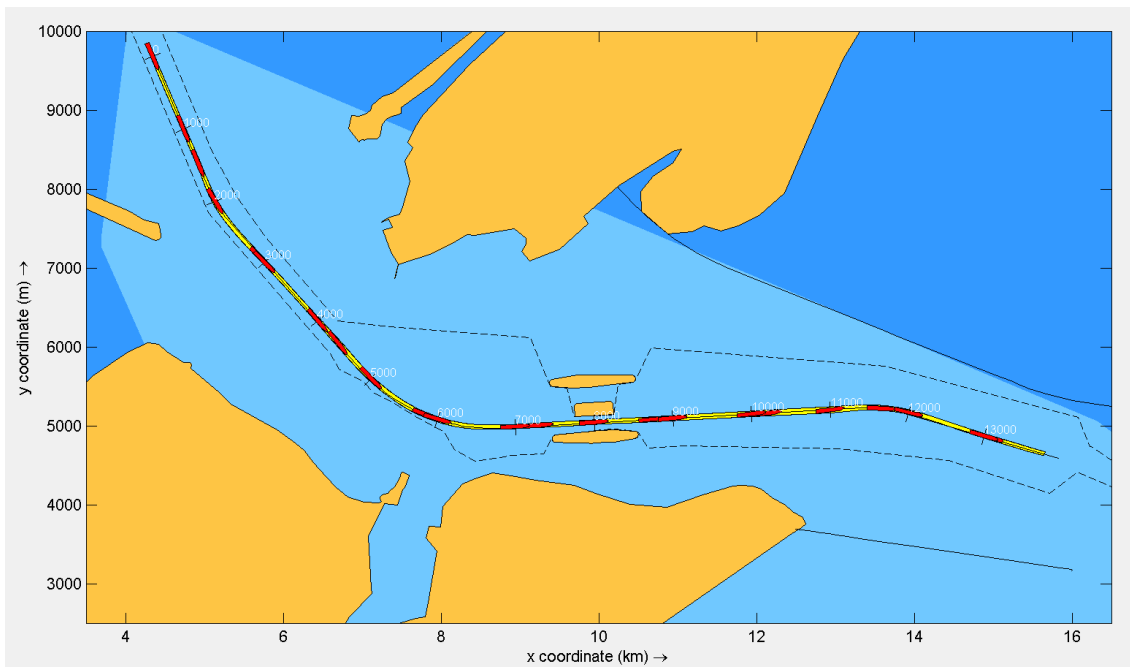
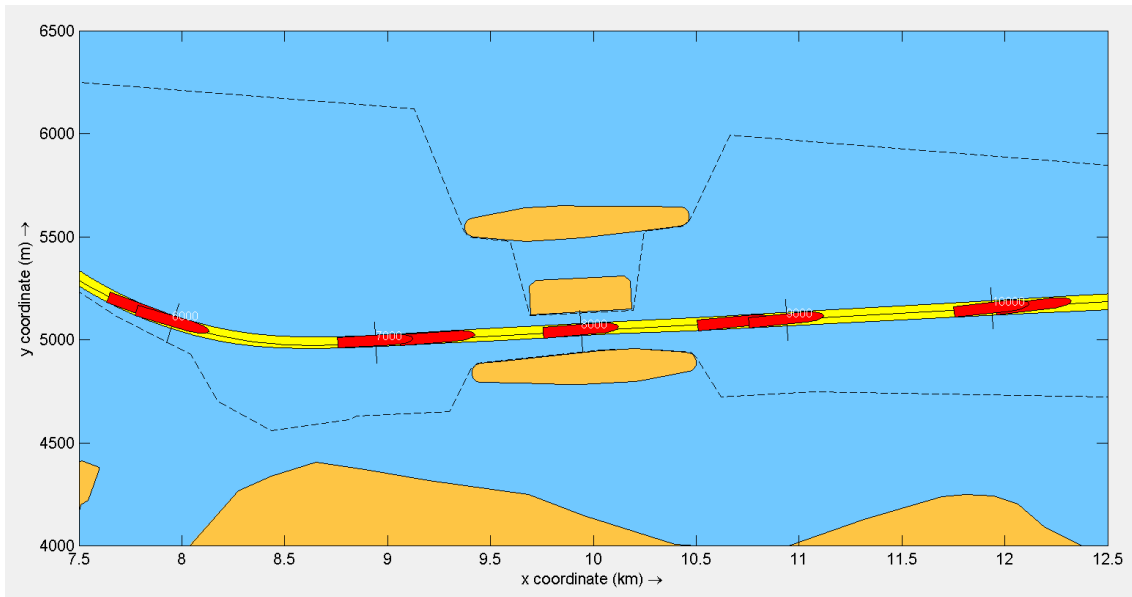
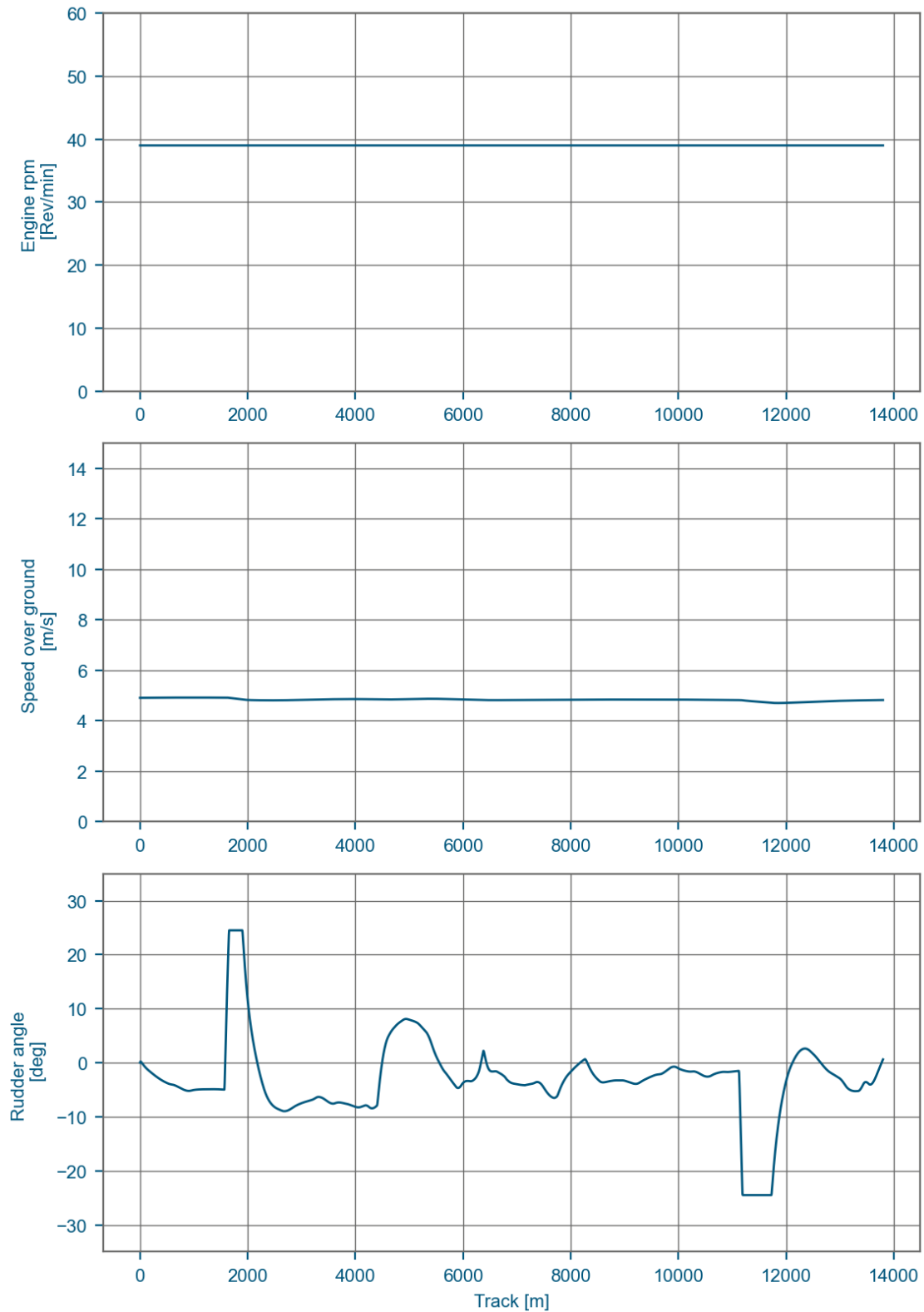


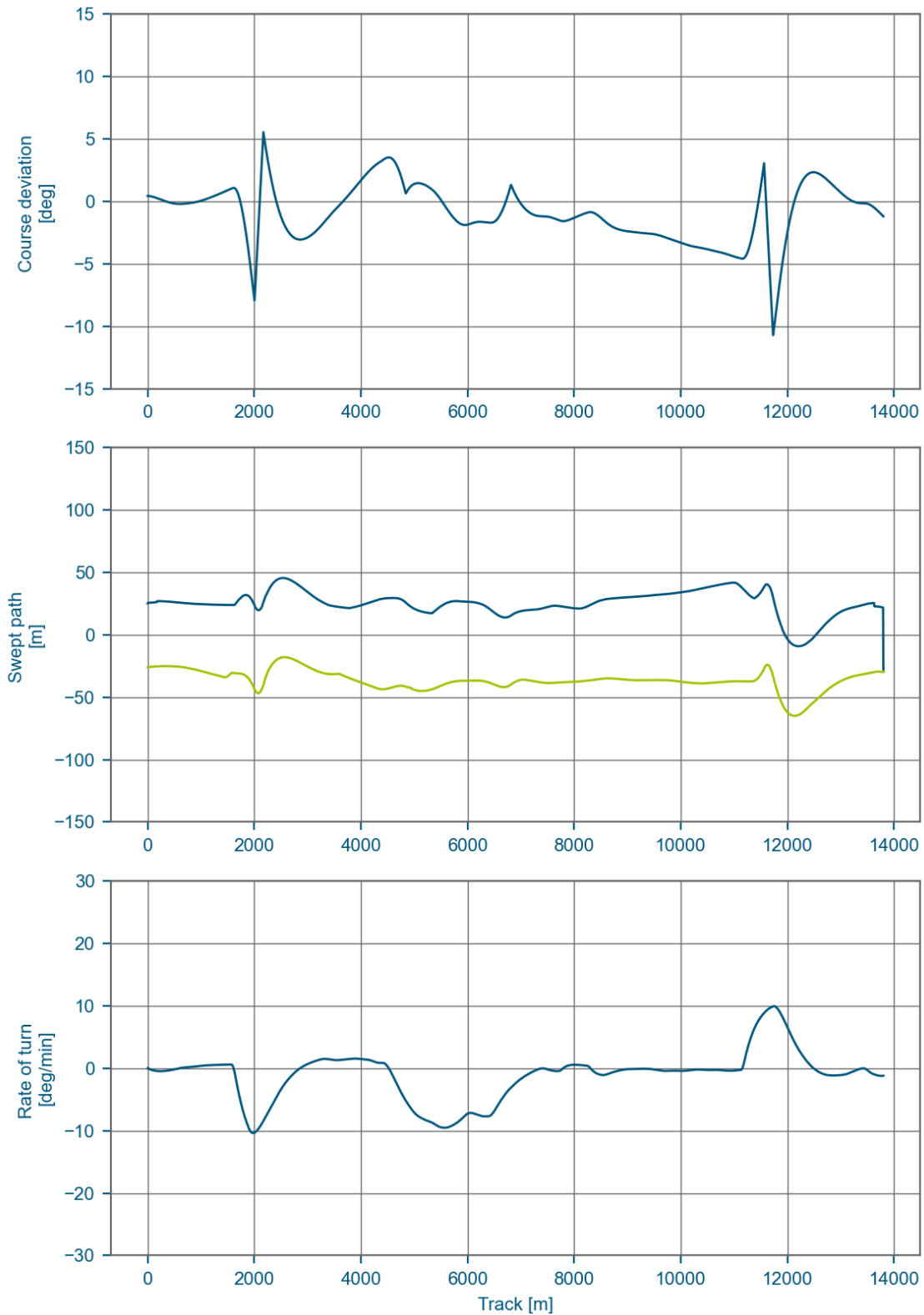
Figure 2.33: S.C. 5: spatial overview plot.



**Figure 2.34:** S.C. 5: zoom-in of spatial overview plot, crossing segment.



**Figure 2.35:** S.C. 5: engine RPM, SOG, rudder angle, vs. distance.



**Figure 2.36:** S.C. 5: course deviation (drift angle), swept path, RoT, vs. distance.

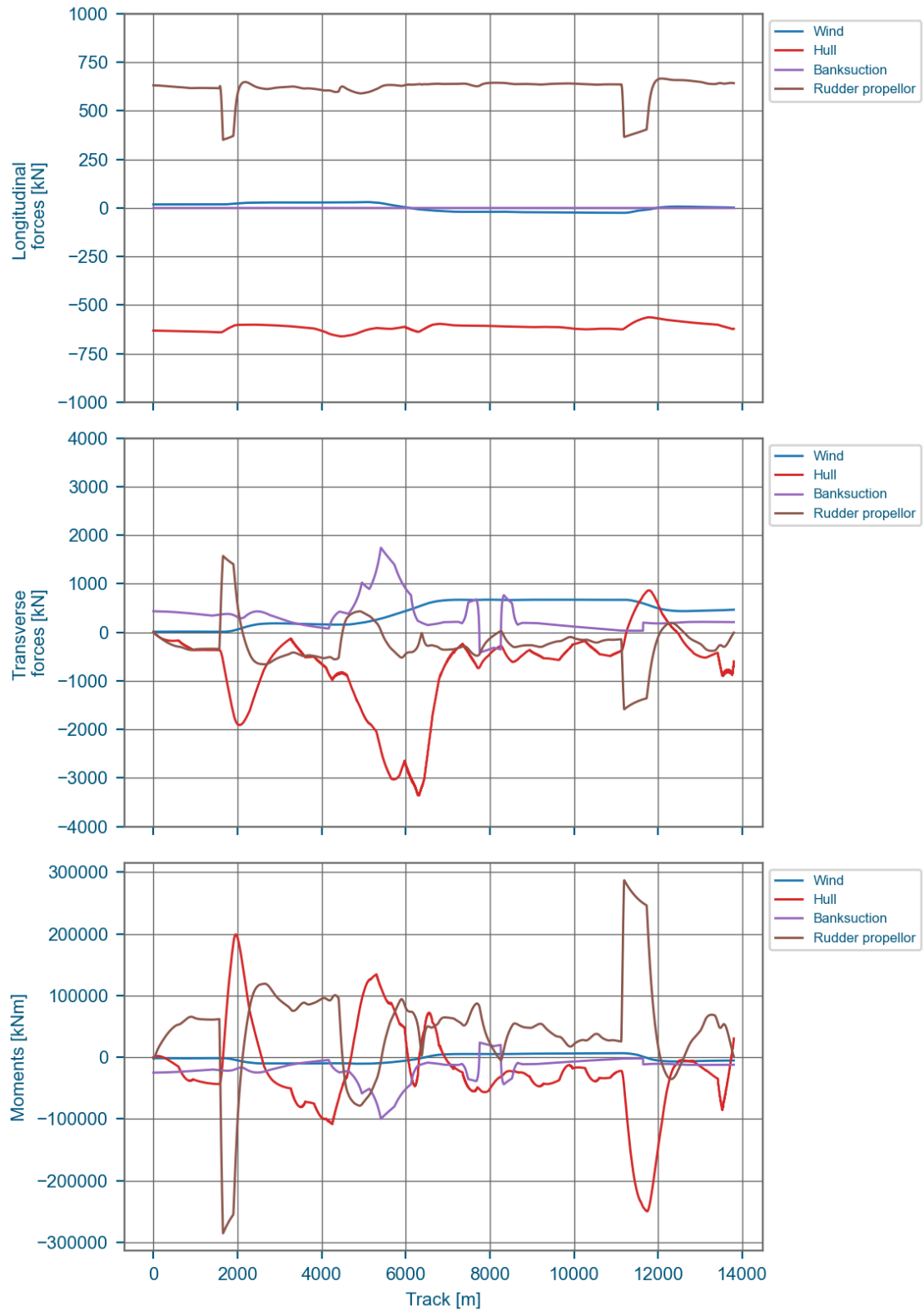


Figure 2.37: S.C. 5: forces, moments, vs. distance.

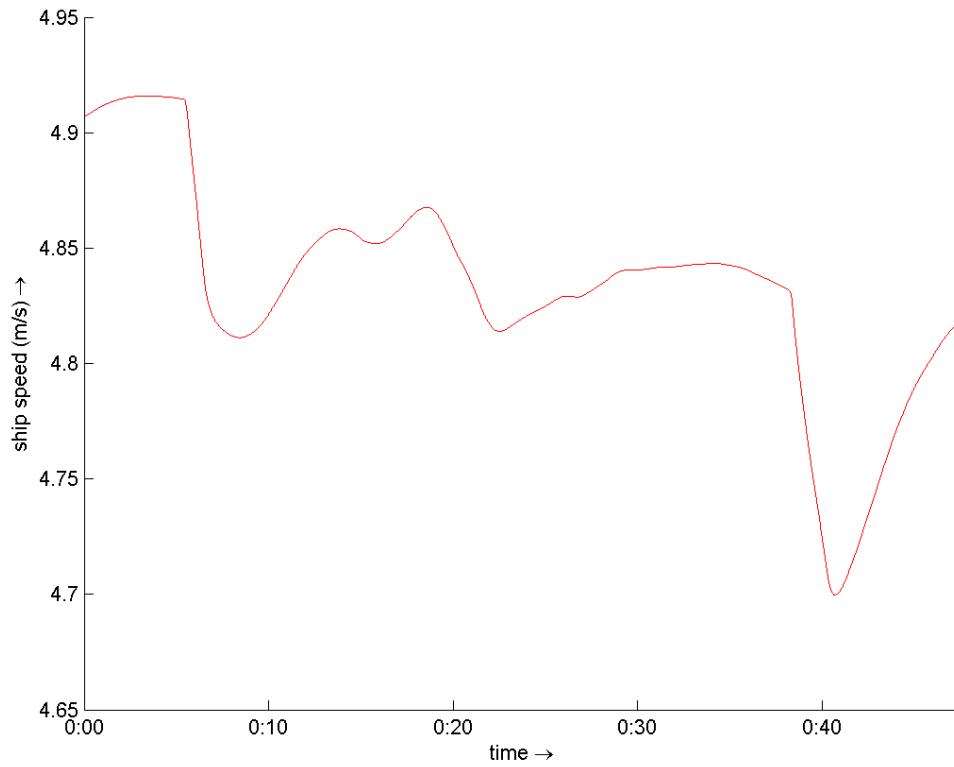


Figure 2.38: S.C. 5: SOG, vs. time.

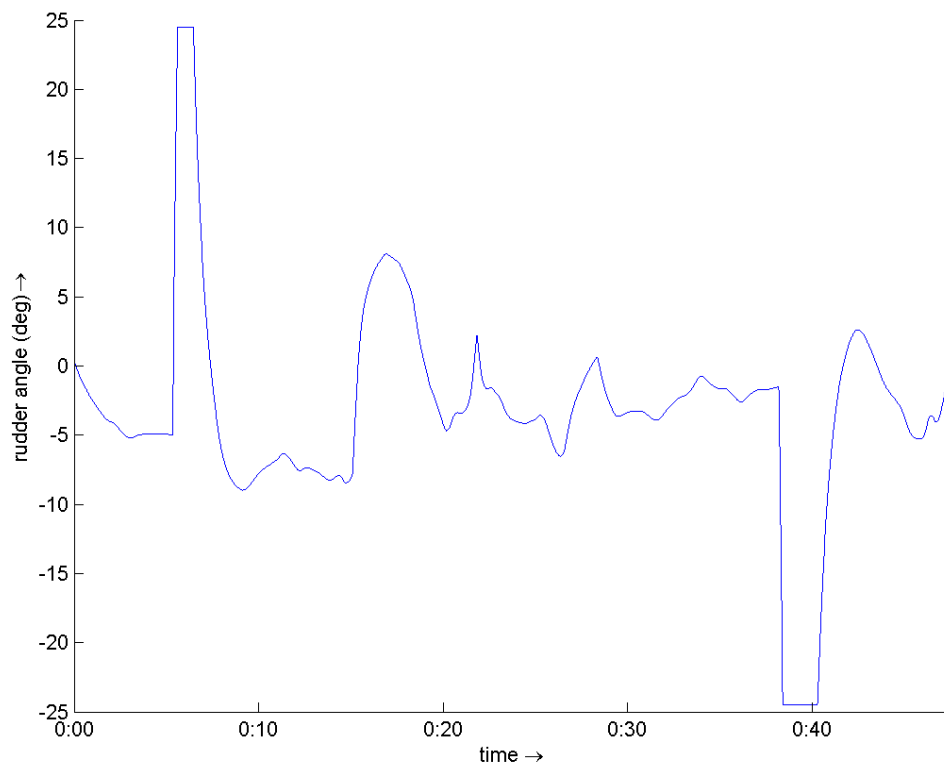


Figure 2.39: S.C. 5: rudder angle, vs. time.

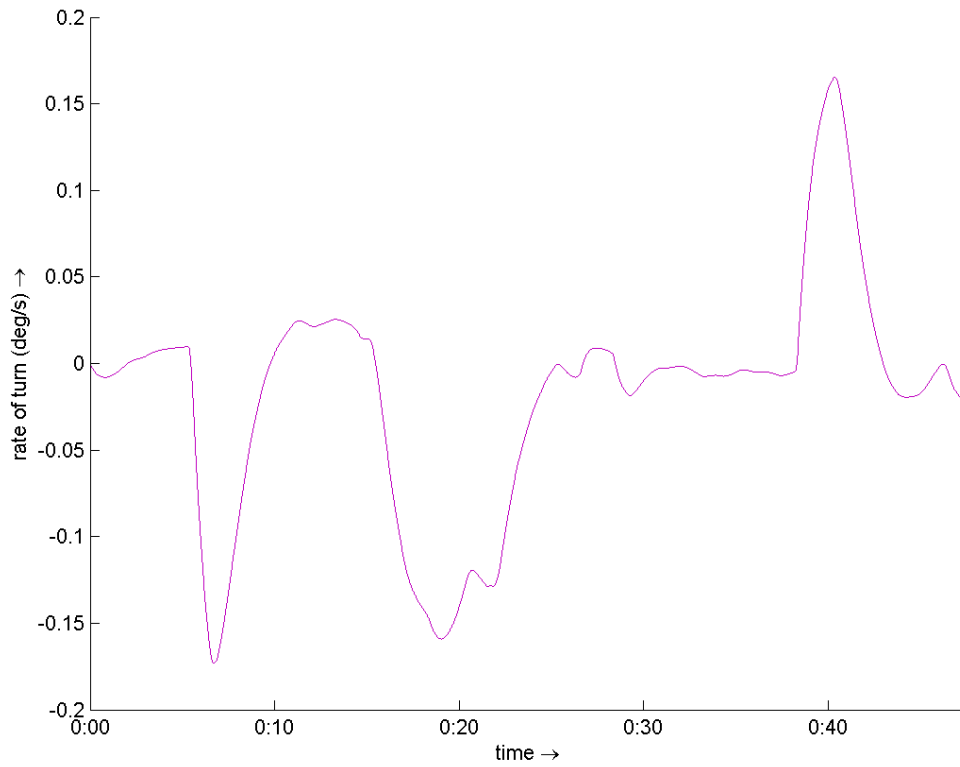


Figure 2.40: S.C. 5: RoT, vs. time.

## Simulation Case 6

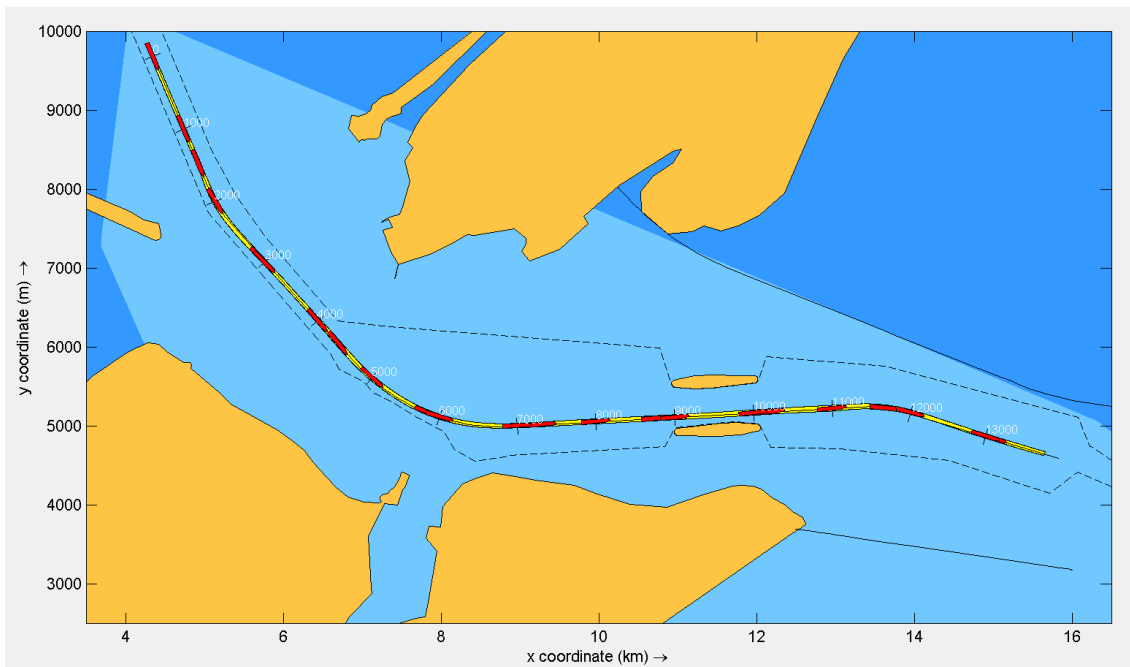
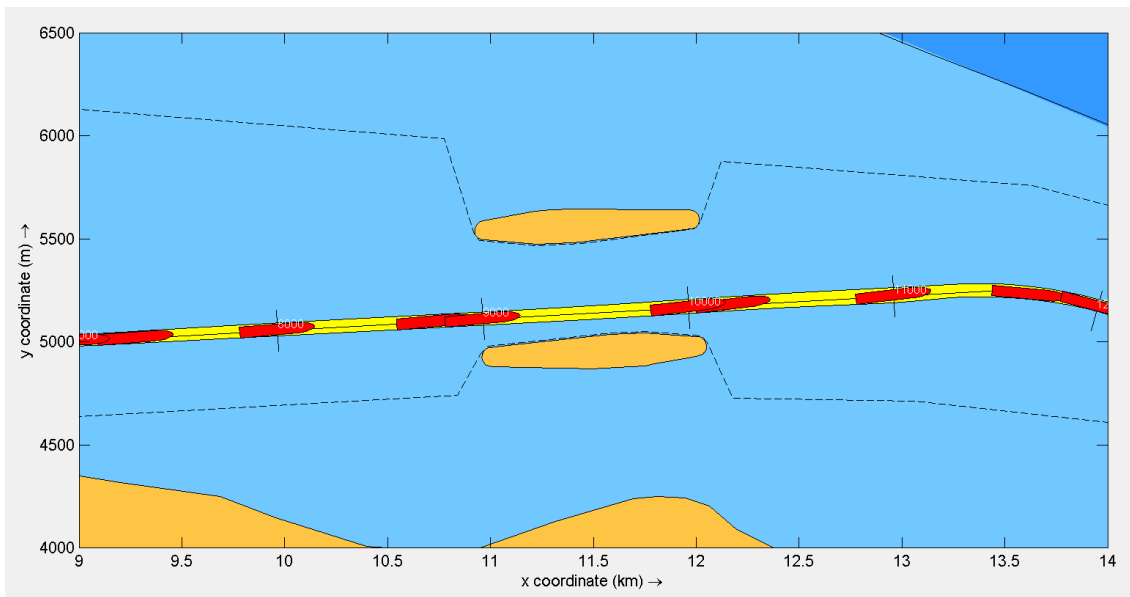


Figure 2.41: S.C. 6: spatial overview plot.



**Figure 2.42:** S.C. 6: zoom-in of spatial overview plot, crossing segment.

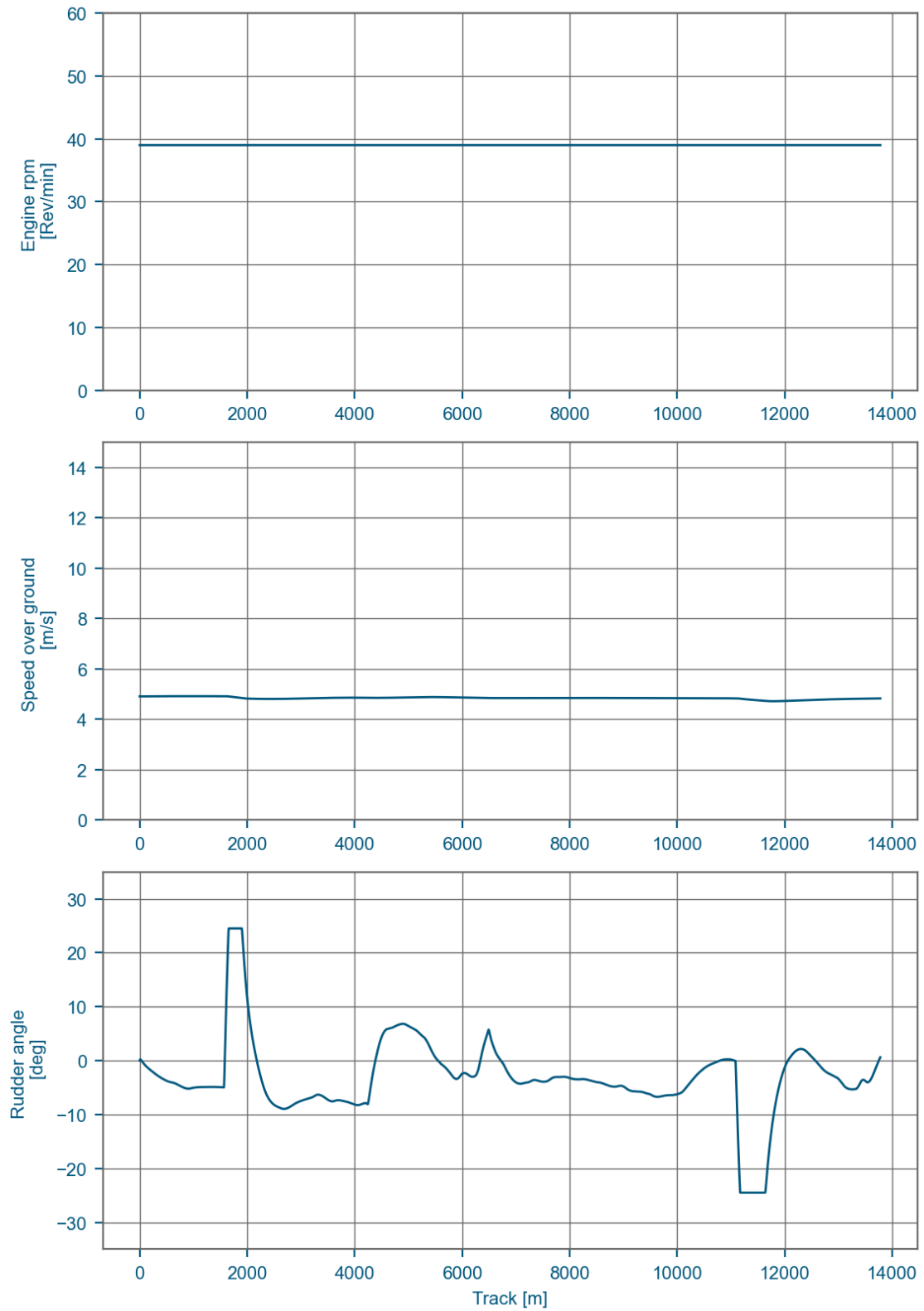
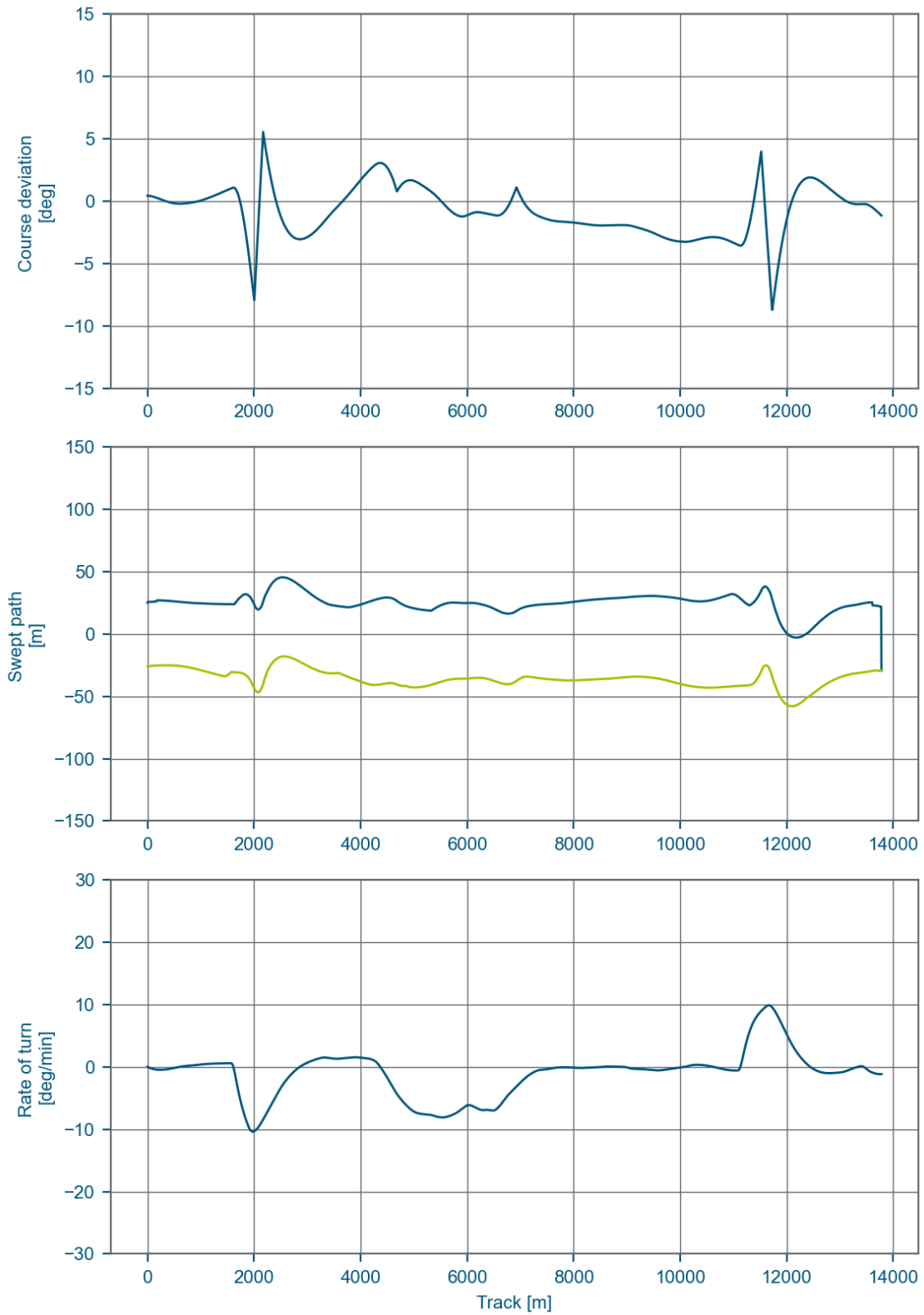


Figure 2.43: S.C. 6: engine RPM, SOG, rudder angle, vs. distance.



**Figure 2.44:** S.C. 6: course deviation (drift angle), swept path, RoT, vs. distance.

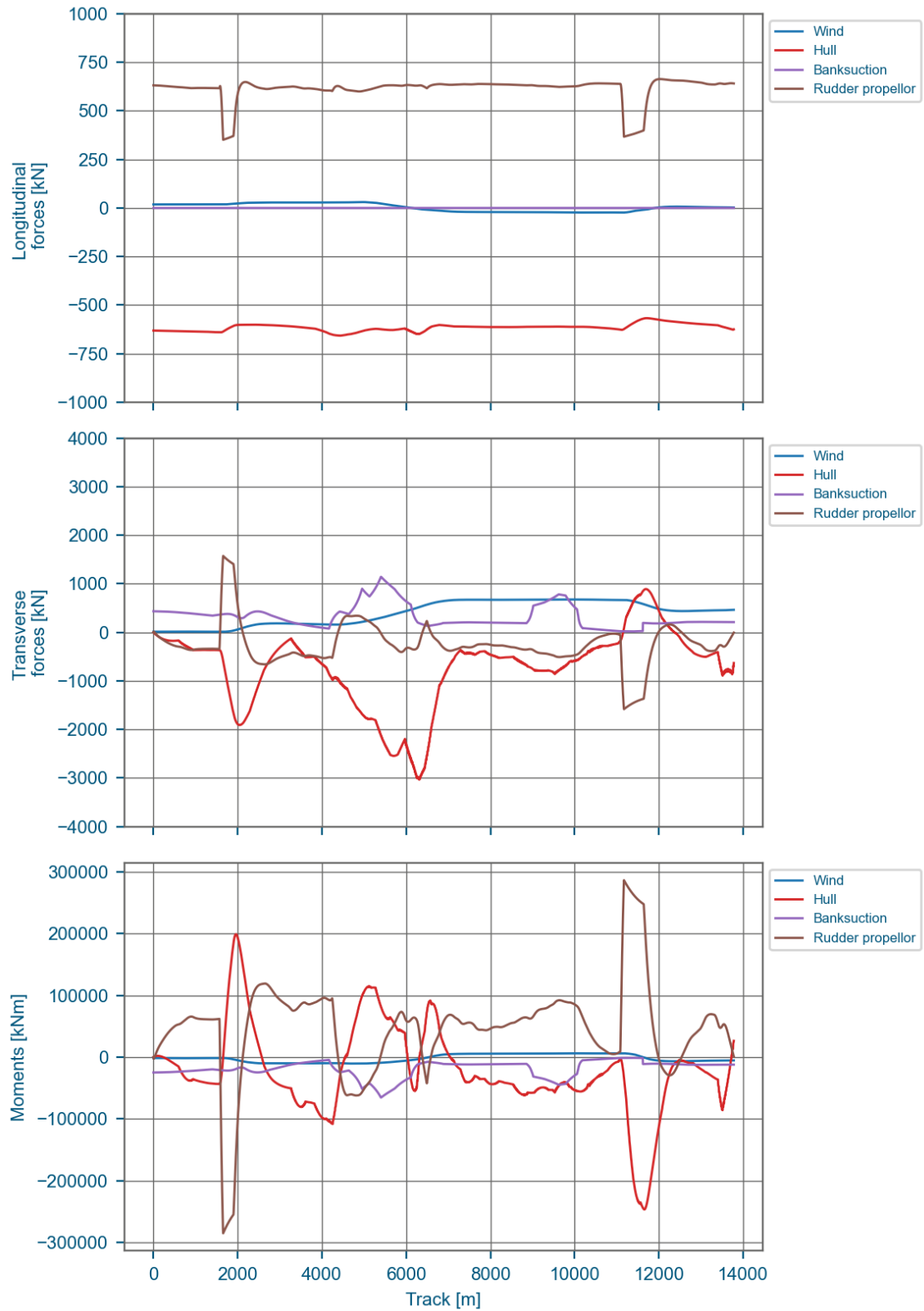


Figure 2.45: S.C. 6: forces, moments, vs. distance.

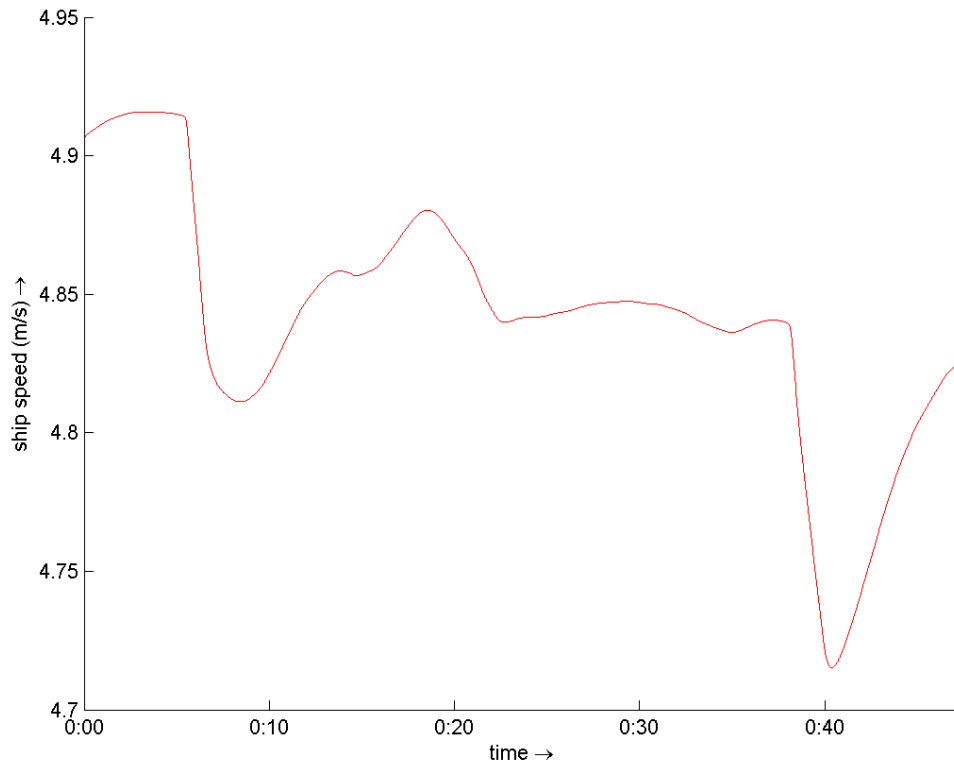


Figure 2.46: S.C. 6: SOG, vs. time.

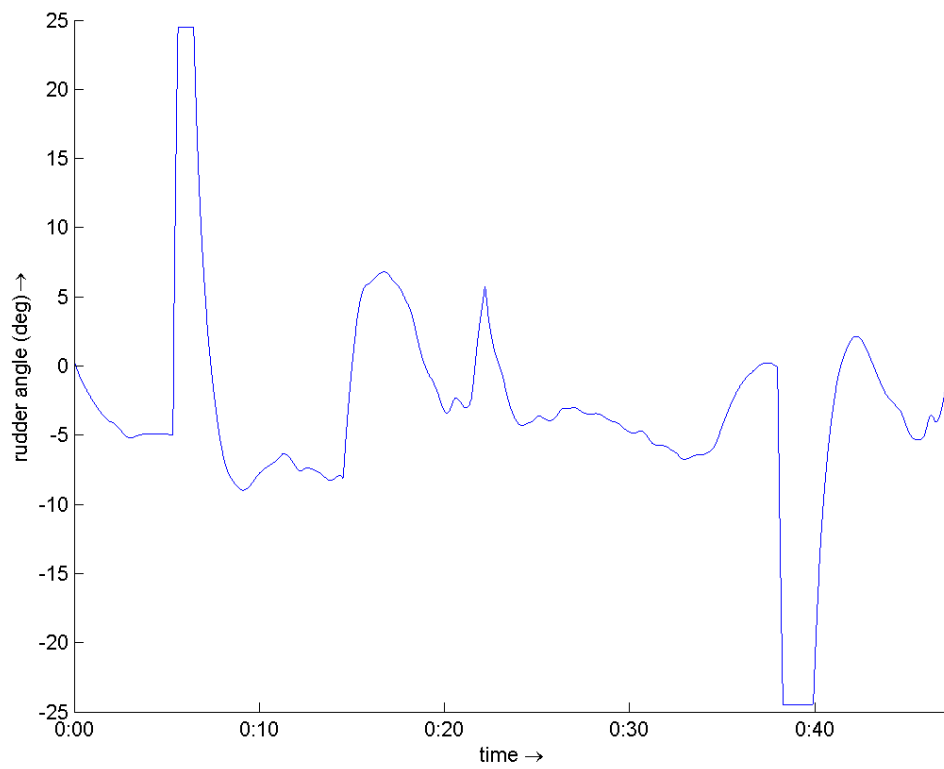


Figure 2.47: S.C. 6: rudder angle, vs. time.

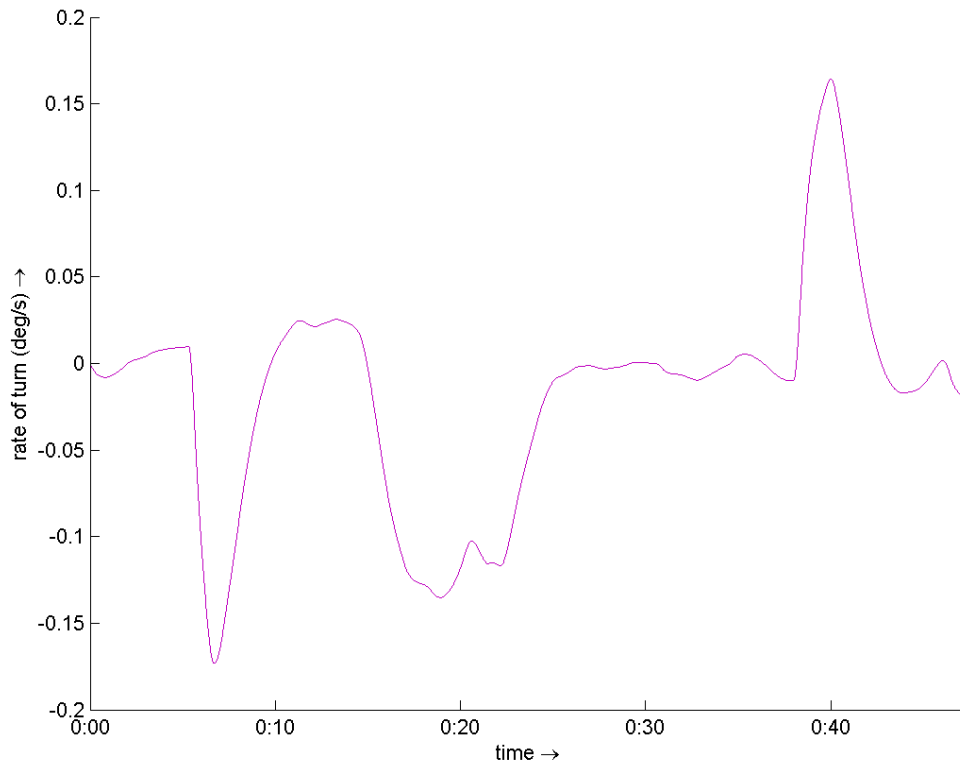


Figure 2.48: S.C. 6: RoT, vs. time.

## Simulation Case 7

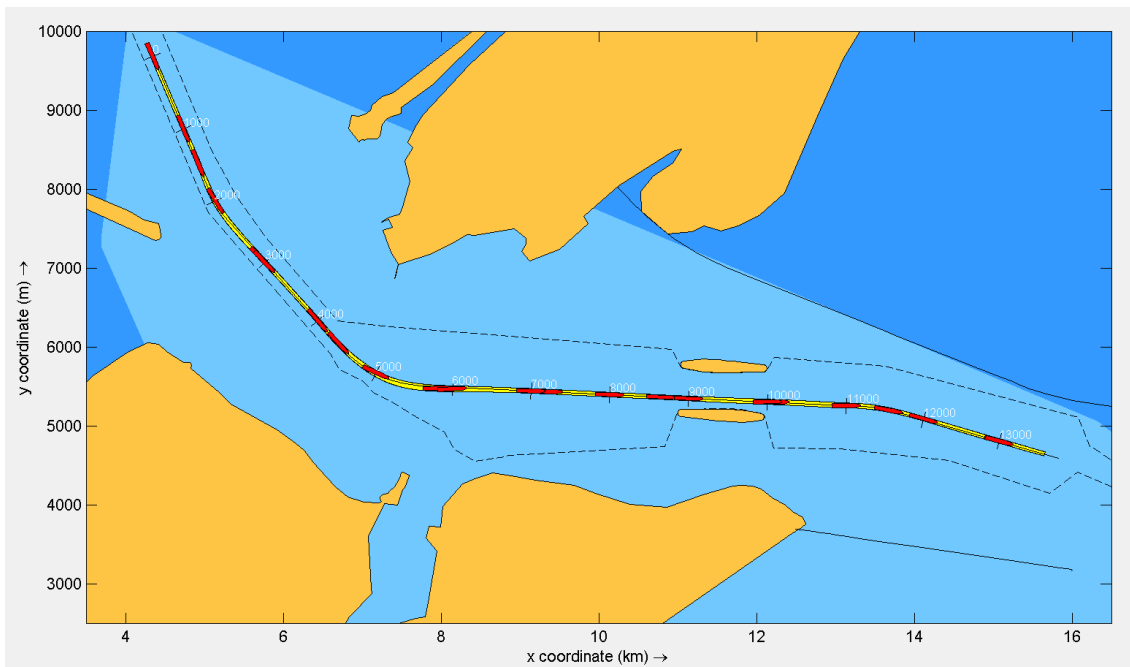
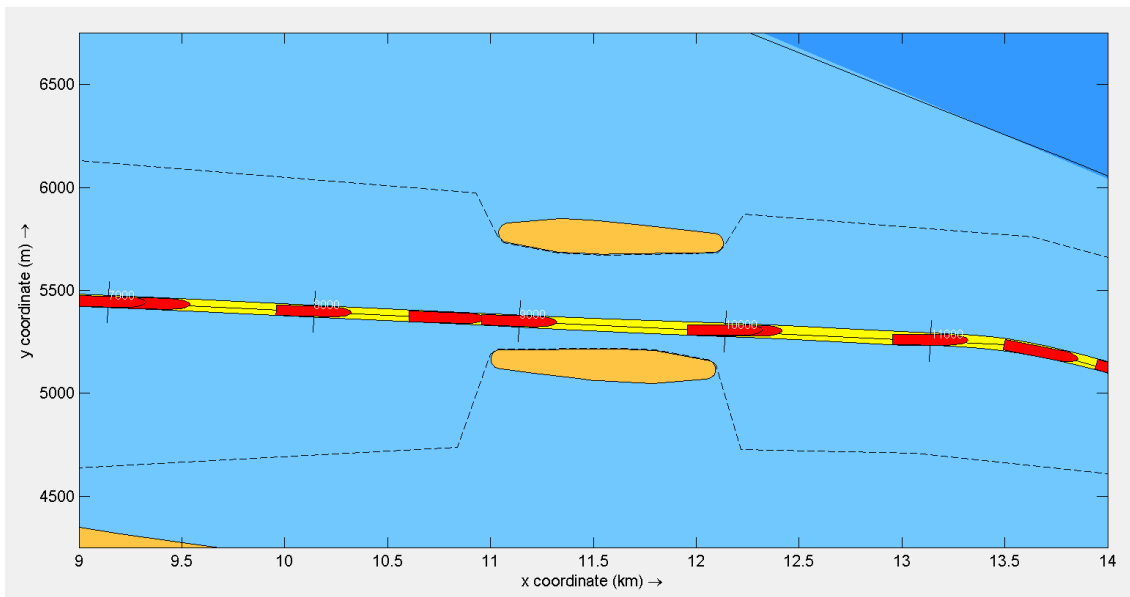
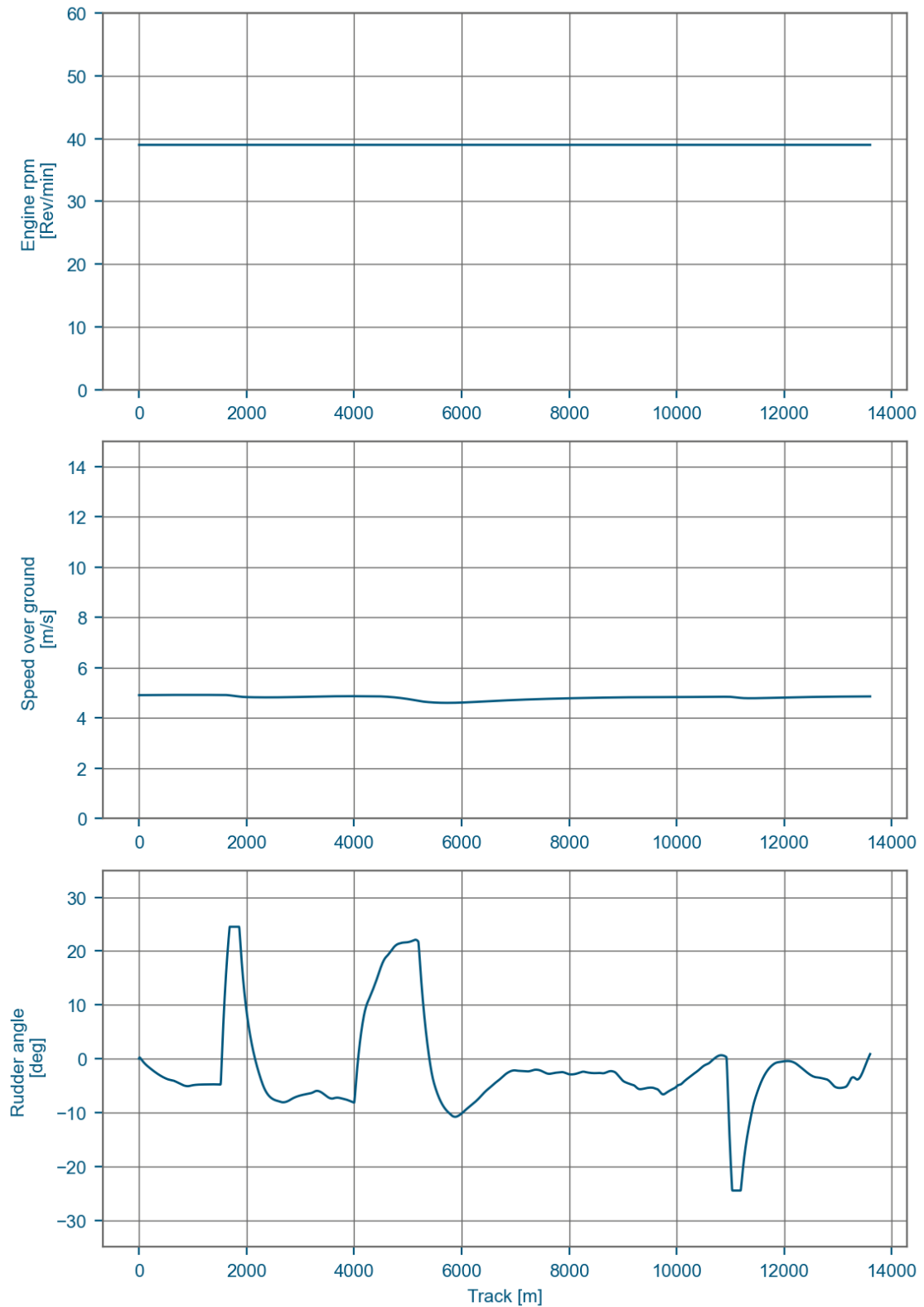


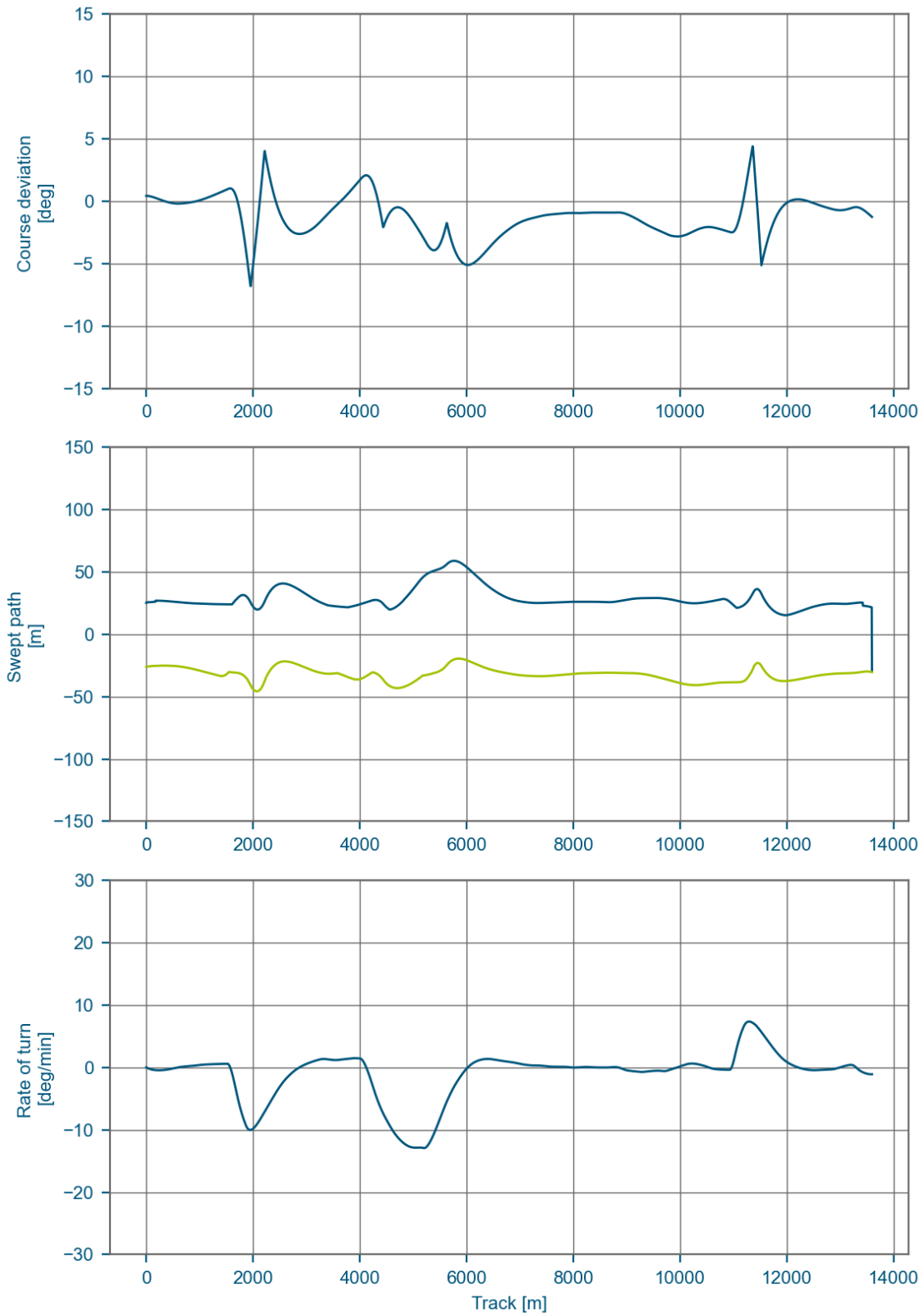
Figure 2.49: S.C. 7: spatial overview plot.



**Figure 2.50:** S.C. 7: zoom-in of spatial overview plot, crossing segment.



**Figure 2.51:** S.C. 7: engine RPM, SOG, rudder angle, vs. distance.



**Figure 2.52:** S.C. 7: course deviation (drift angle), swept path, RoT, vs. distance.

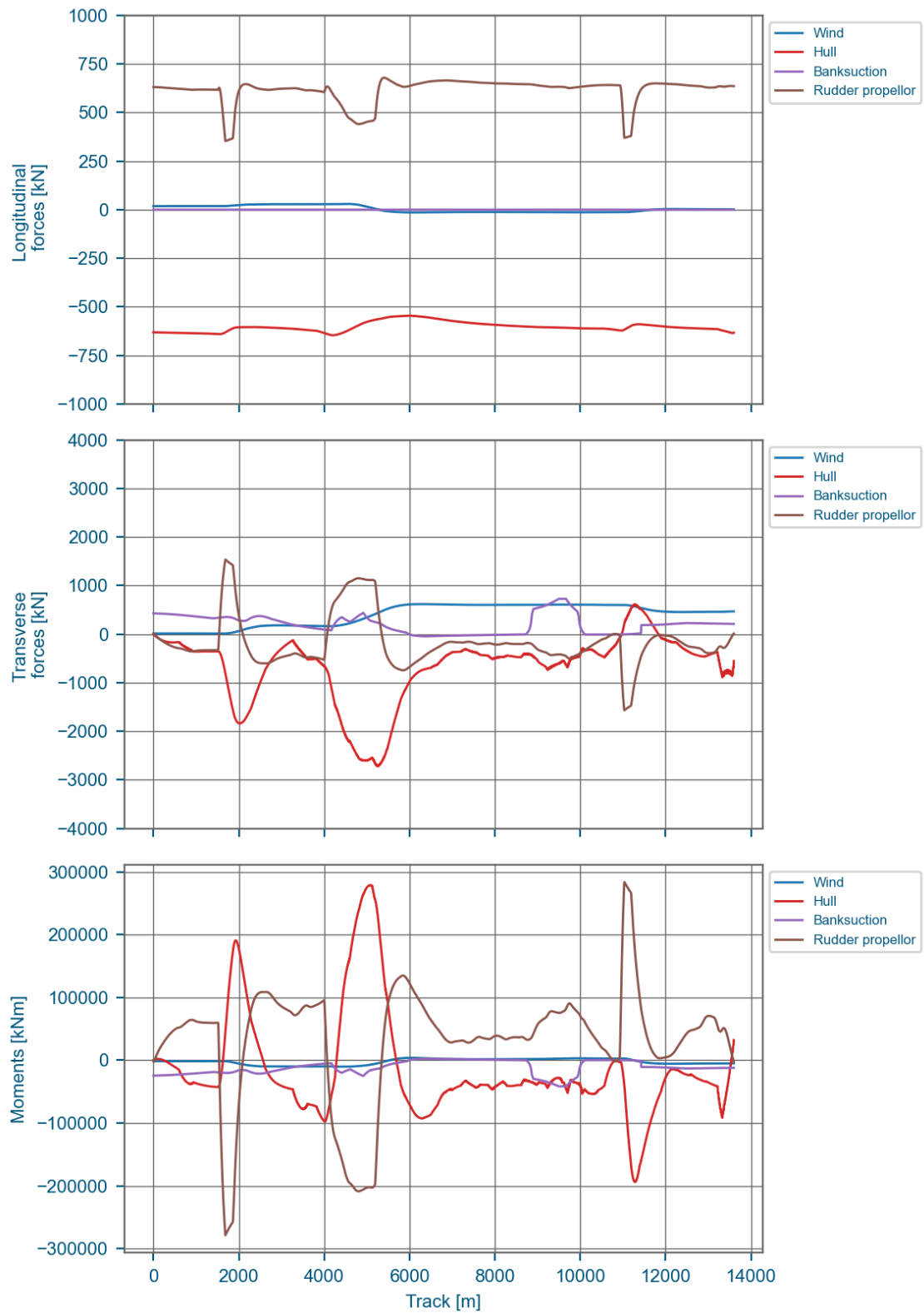


Figure 2.53: S.C. 7: forces, moments, vs. distance.

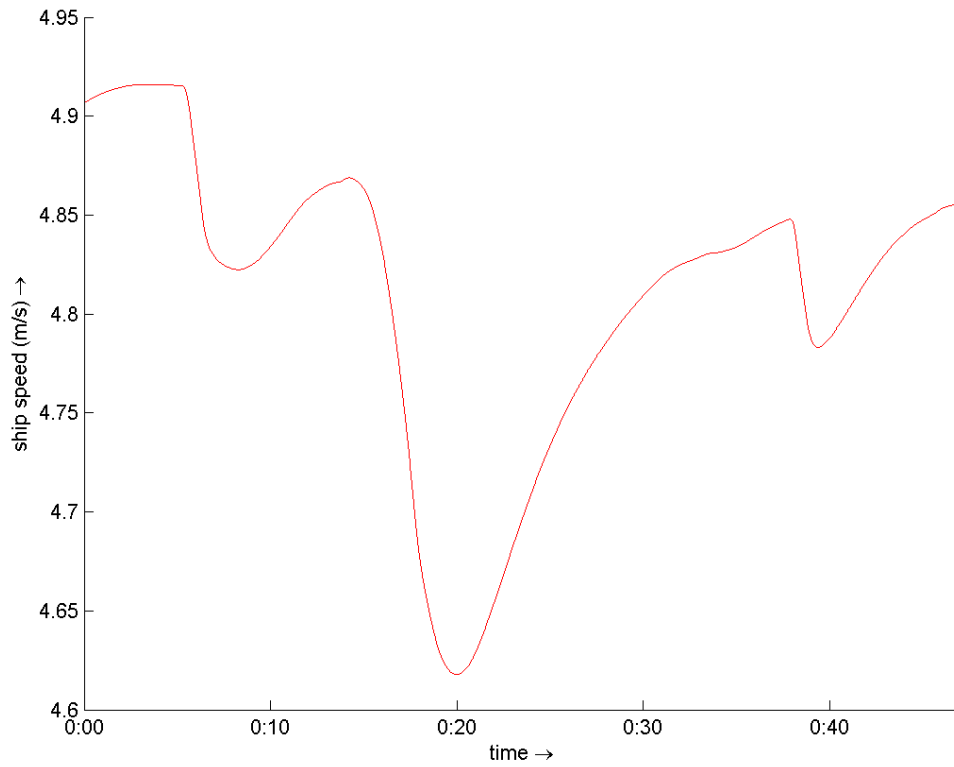


Figure 2.54: S.C. 7: SOG, vs. time.

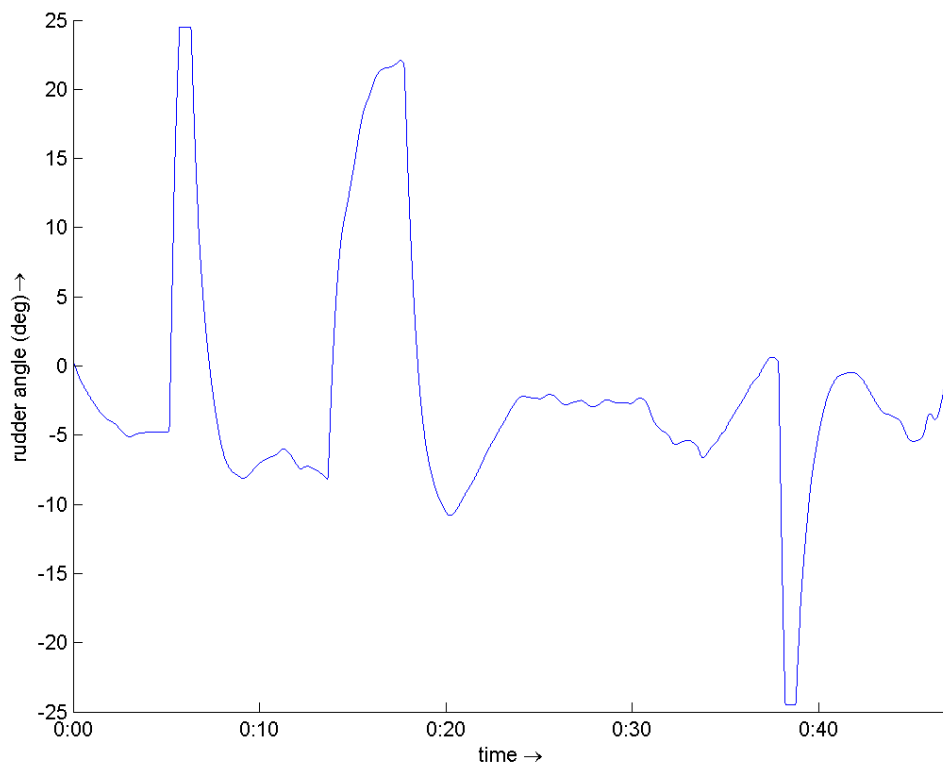


Figure 2.55: S.C. 7: rudder angle, vs. time.

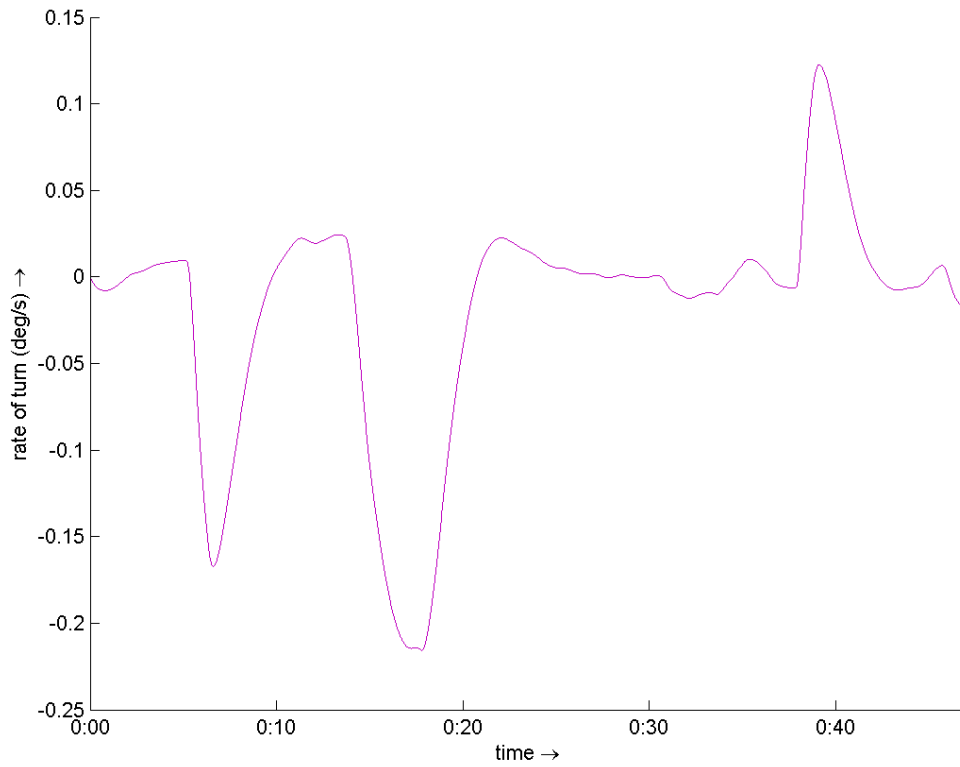


Figure 2.56: S.C. 7: RoT, vs. time.

## Simulation Case 8

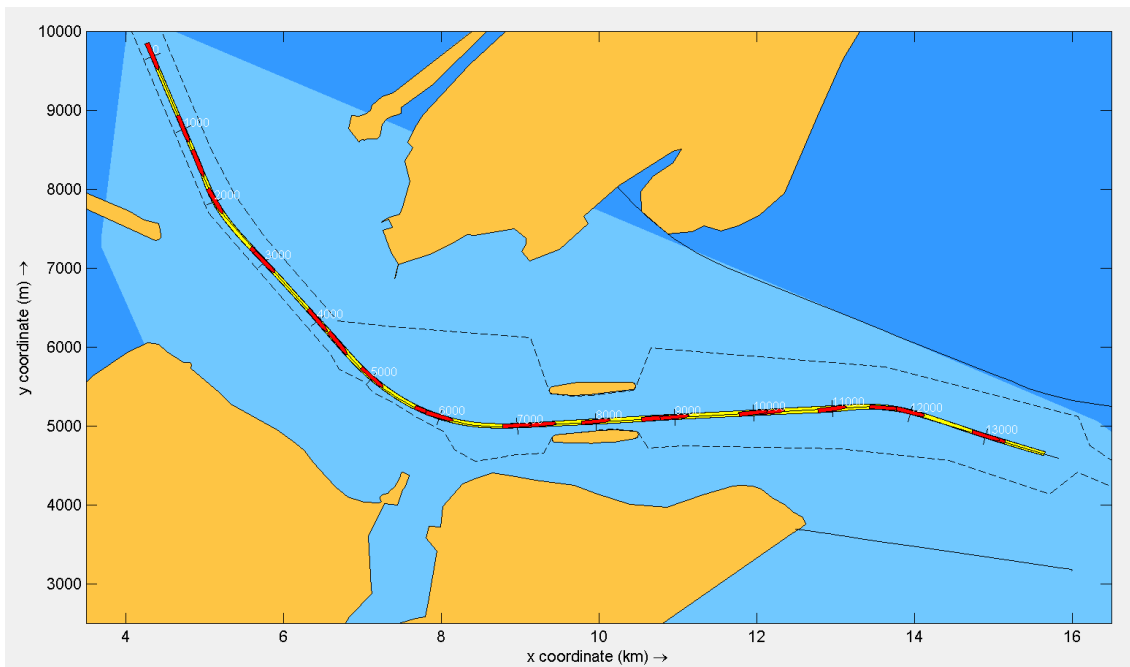
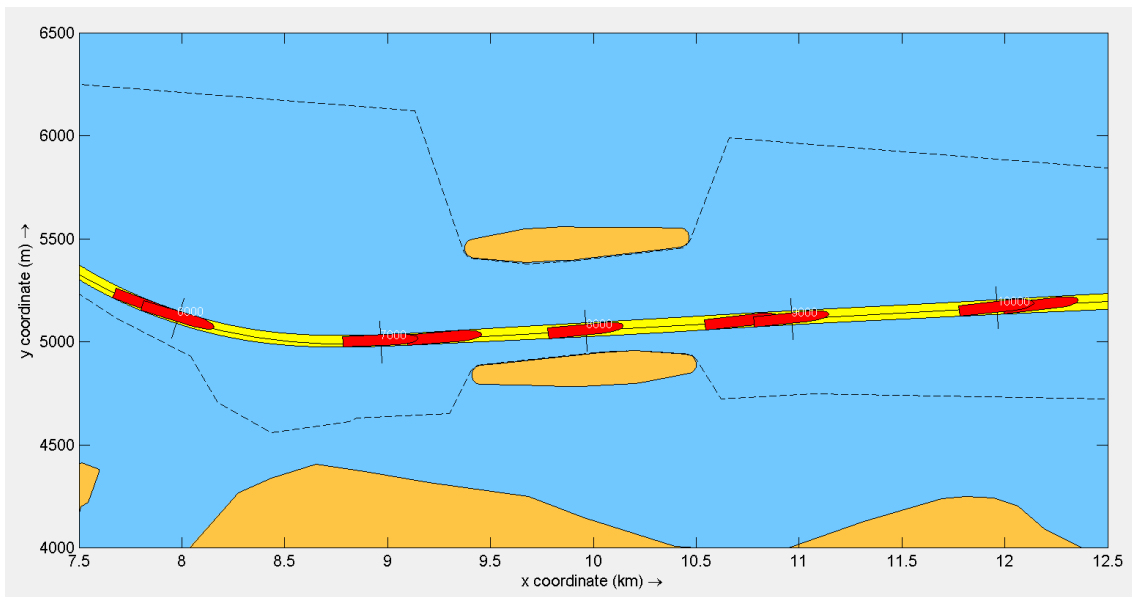
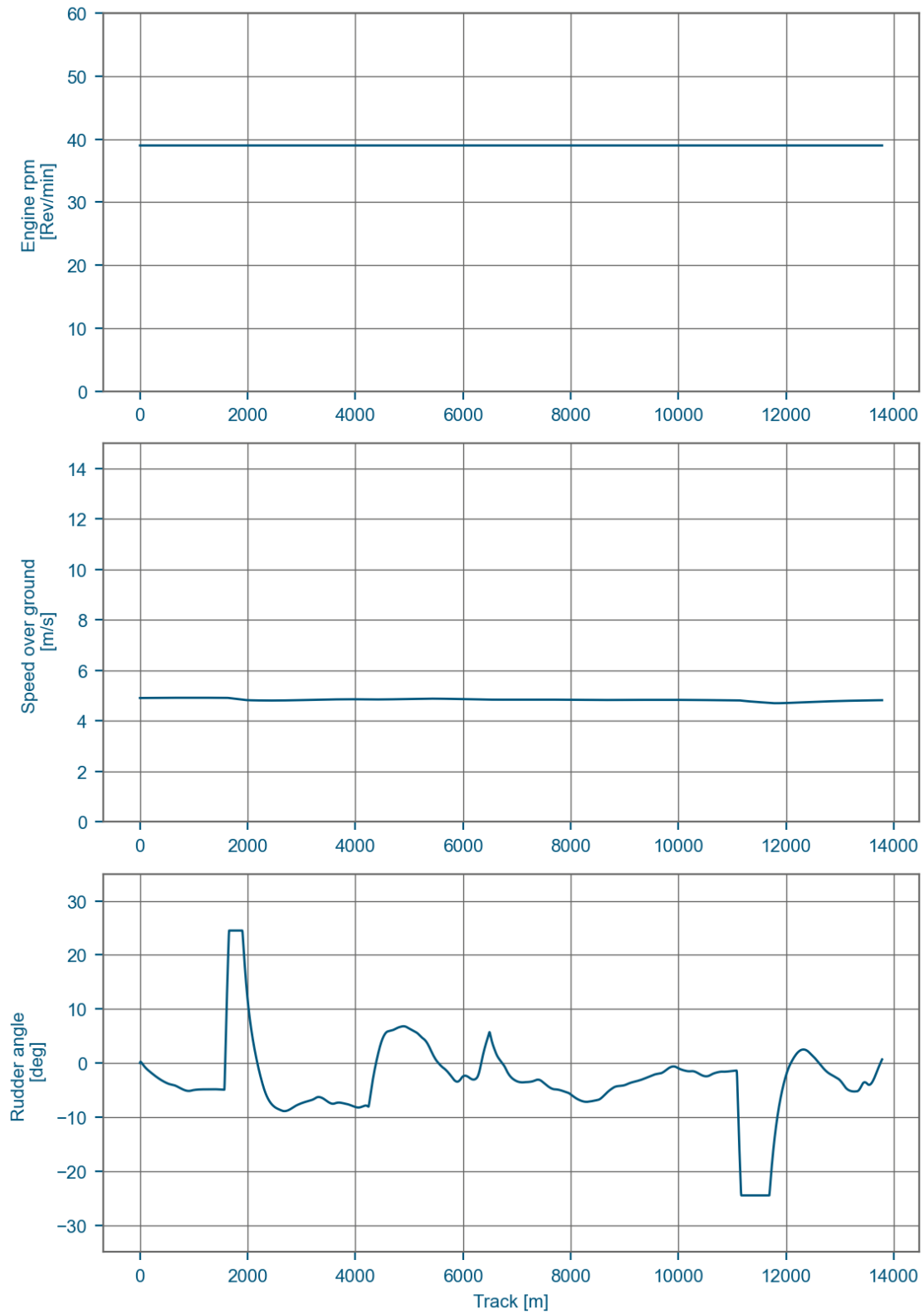


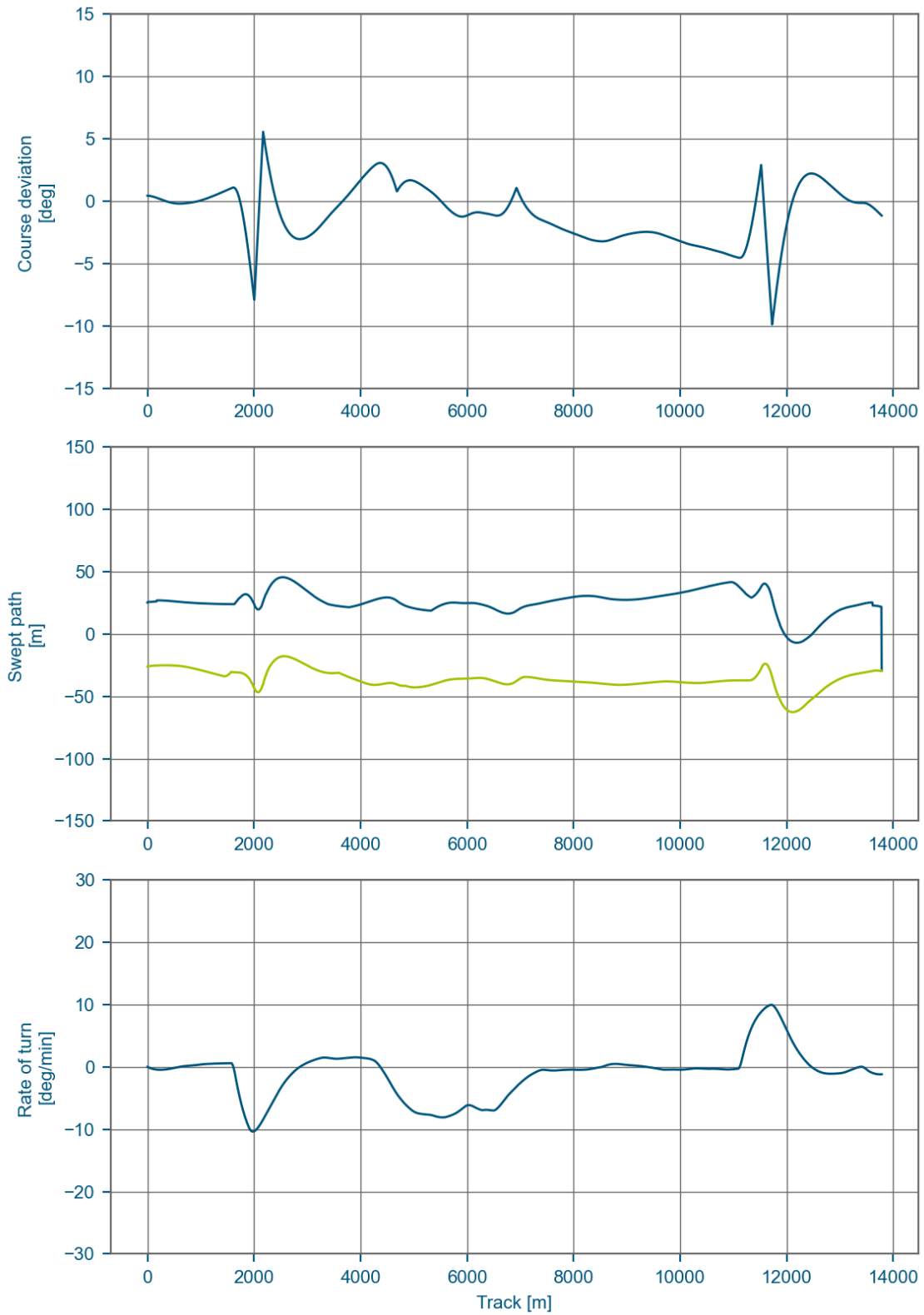
Figure 2.57: S.C. 8: spatial overview plot.



**Figure 2.58:** S.C. 8: zoom-in of spatial overview plot, crossing segment.



**Figure 2.59:** S.C. 8: engine RPM, SOG, rudder angle, vs. distance.



**Figure 2.60:** S.C. 8: course deviation (drift angle), swept path, RoT, vs. distance.

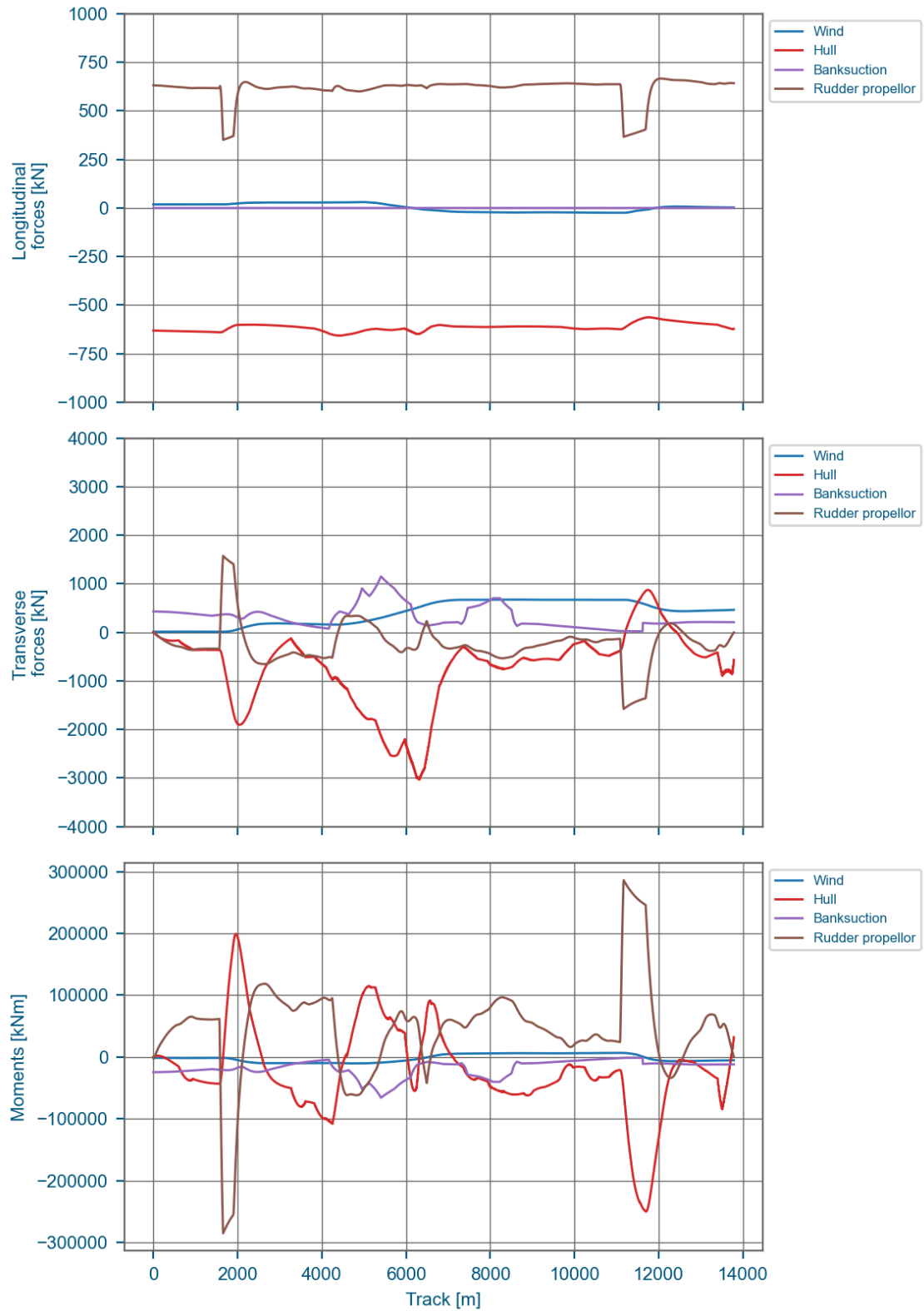


Figure 2.61: S.C. 8: forces, moments, vs. distance.

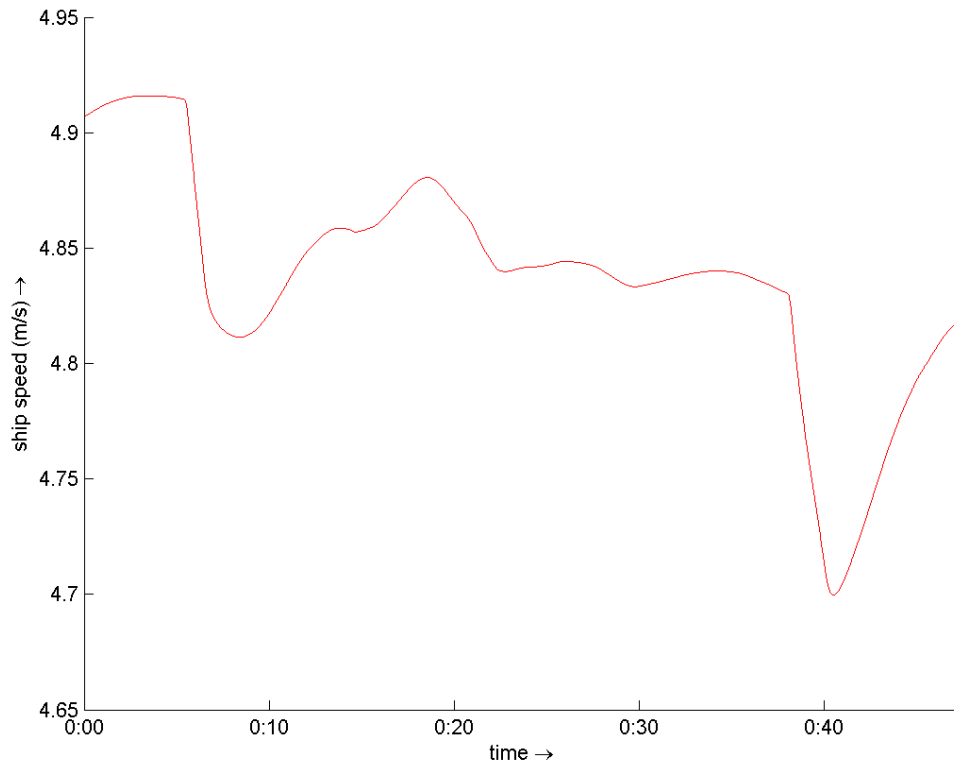


Figure 2.62: S.C. 8: SOG, vs. time.

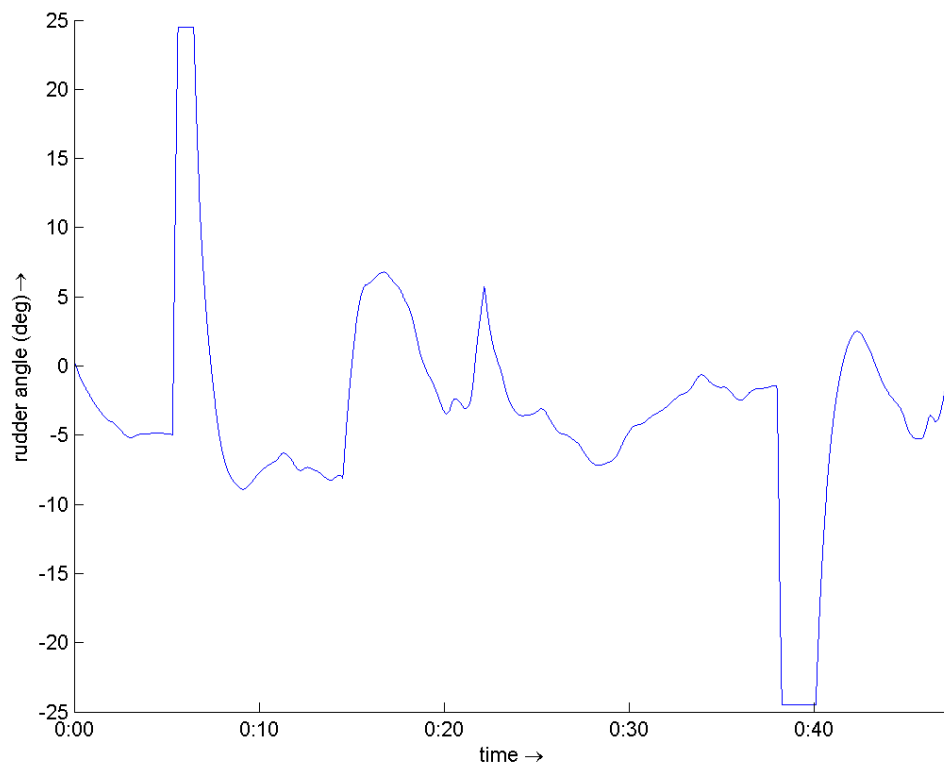


Figure 2.63: S.C. 8: rudder angle, vs. time.

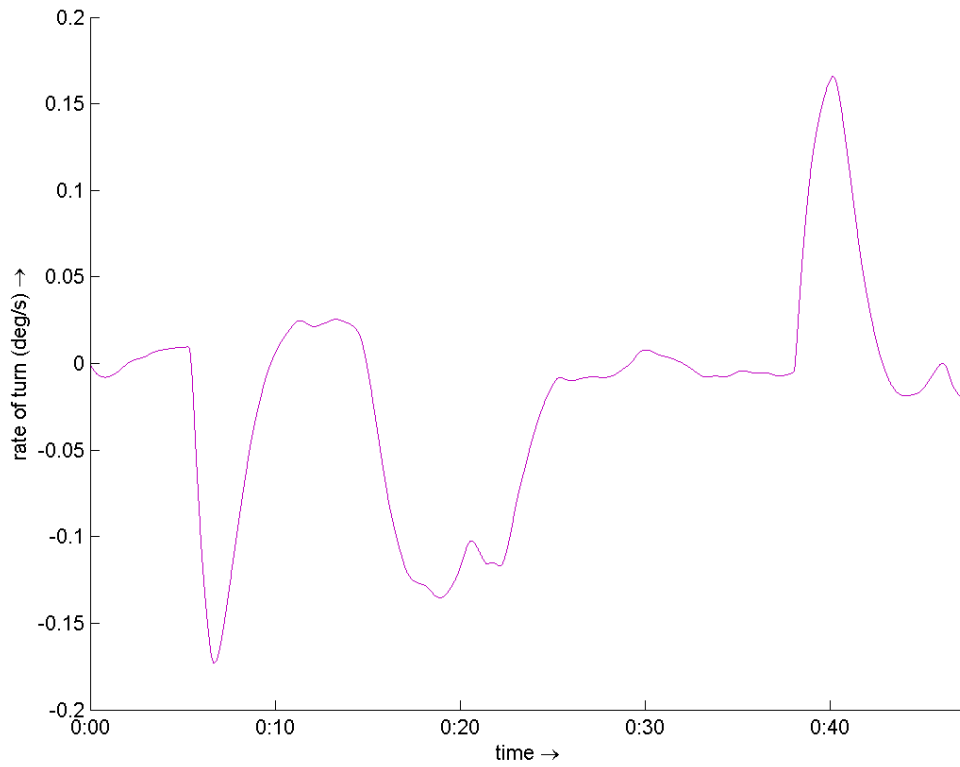


Figure 2.64: S.C. 8: RoT, vs. time.

## Simulation Case 9

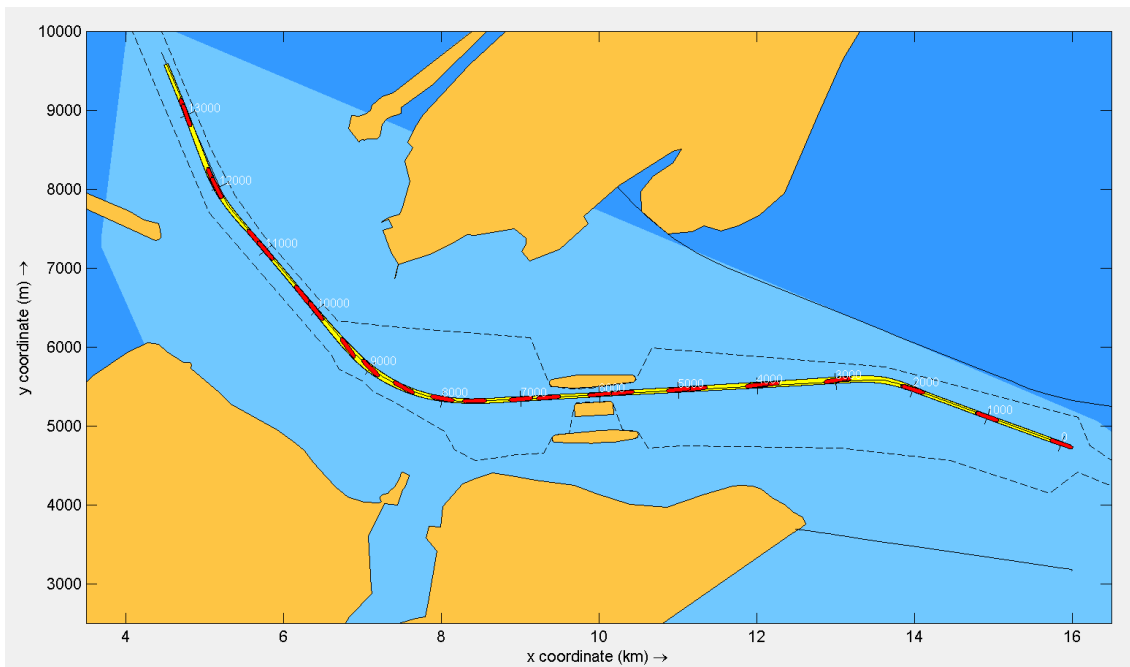
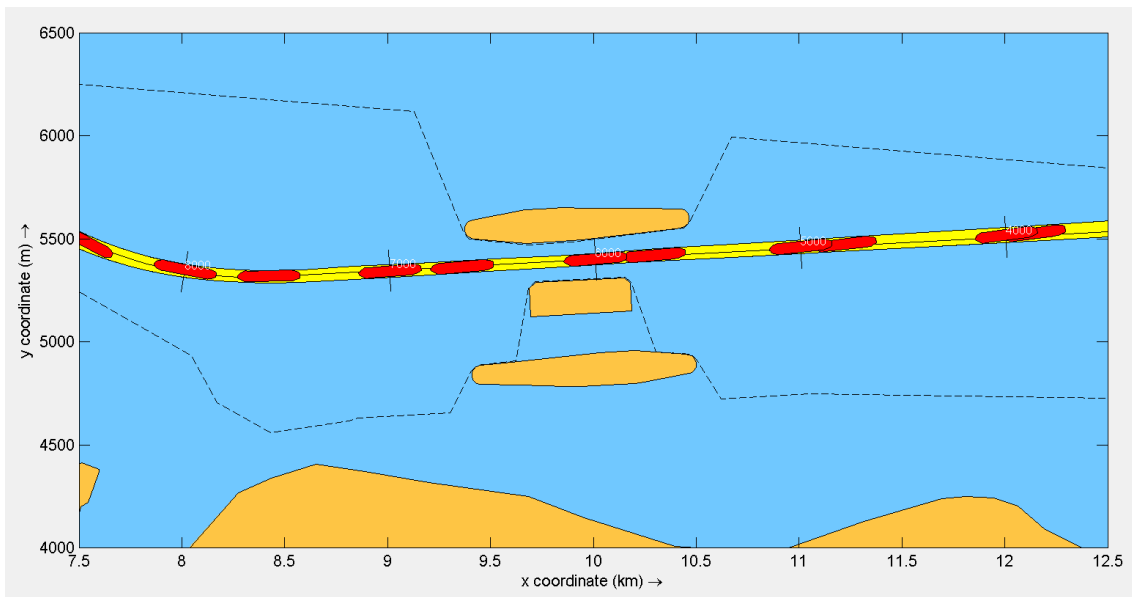


Figure 2.65: S.C. 9: spatial overview plot.



**Figure 2.66:** S.C. 9: zoom-in of spatial overview plot, crossing segment.

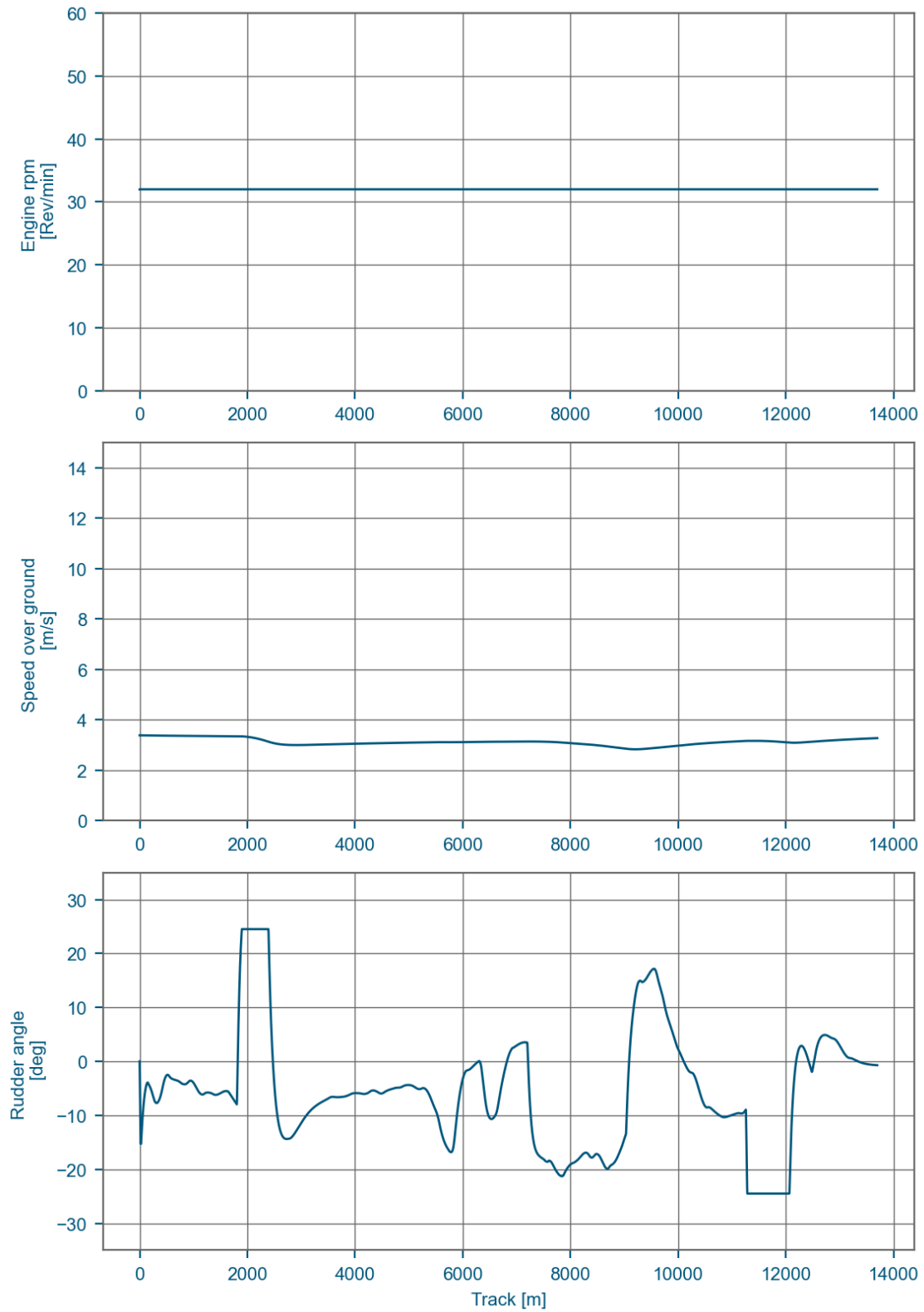
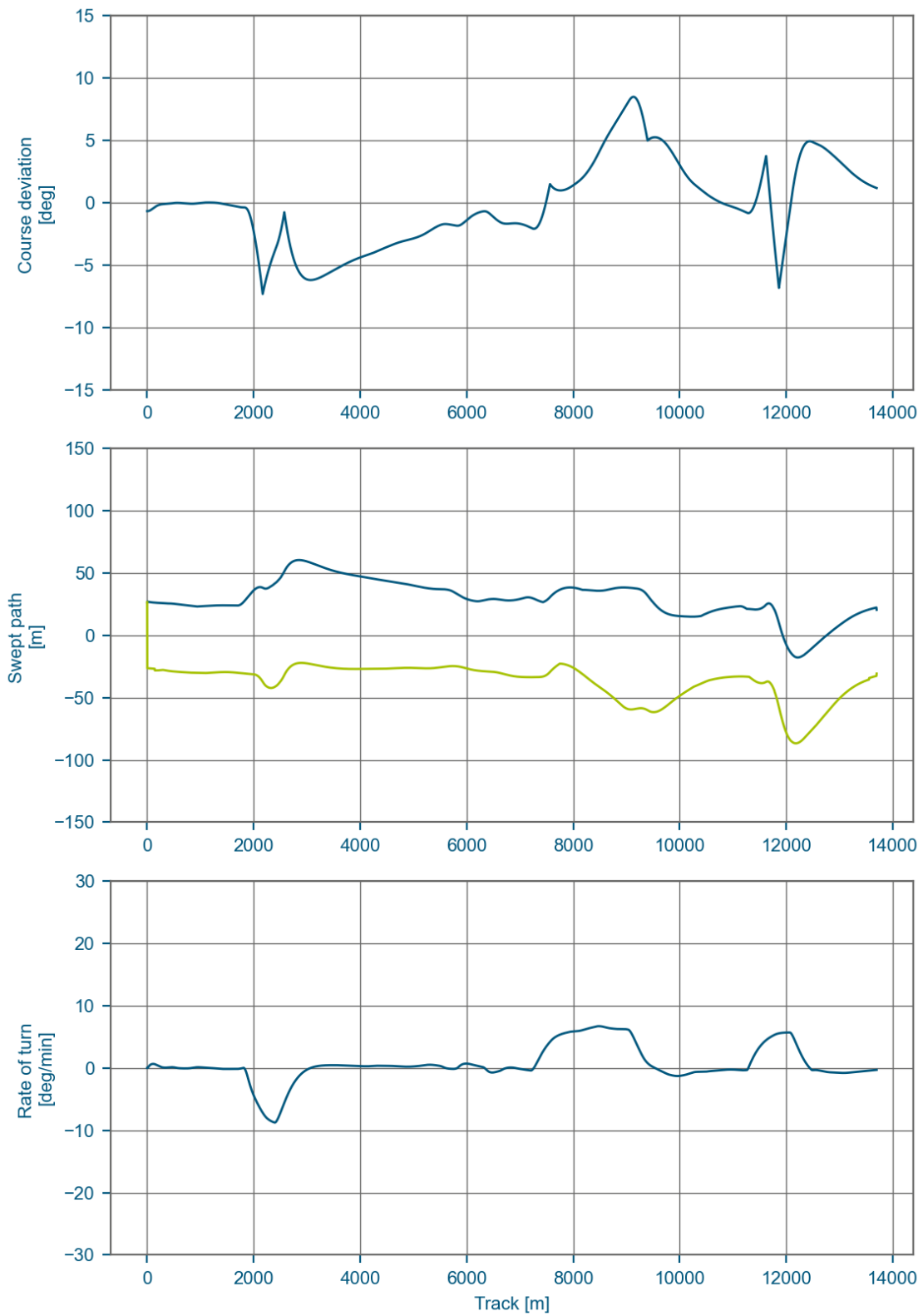


Figure 2.67: S.C. 9: engine RPM, SOG, rudder angle, vs. distance.



**Figure 2.68:** S.C. 9: course deviation (drift angle), swept path, RoT, vs. distance.

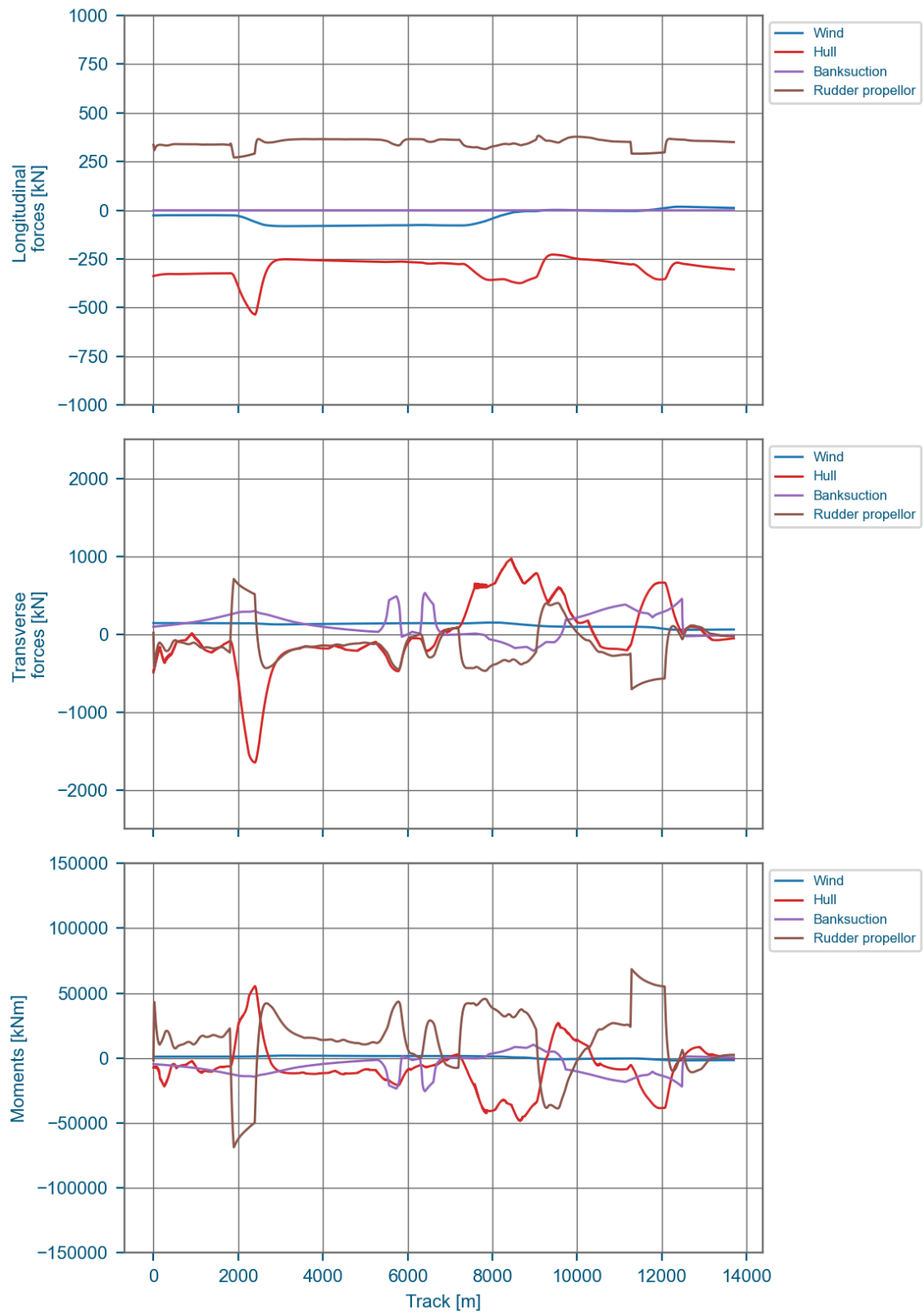


Figure 2.69: S.C. 9: forces, moments, vs. distance.

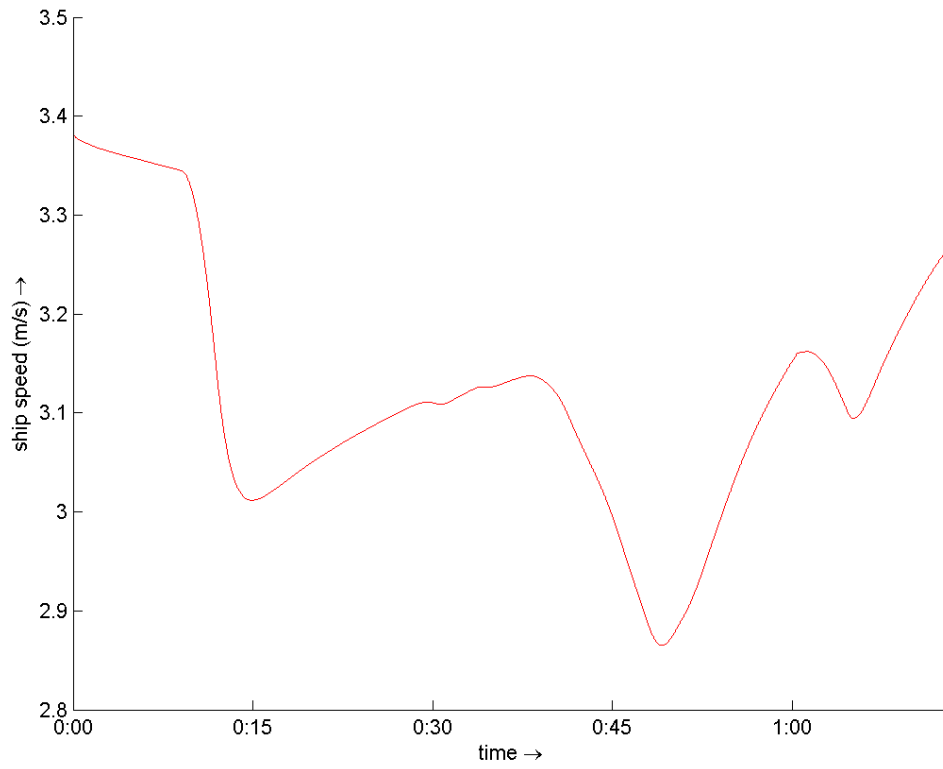


Figure 2.70: S.C. 9: SOG, vs. time.

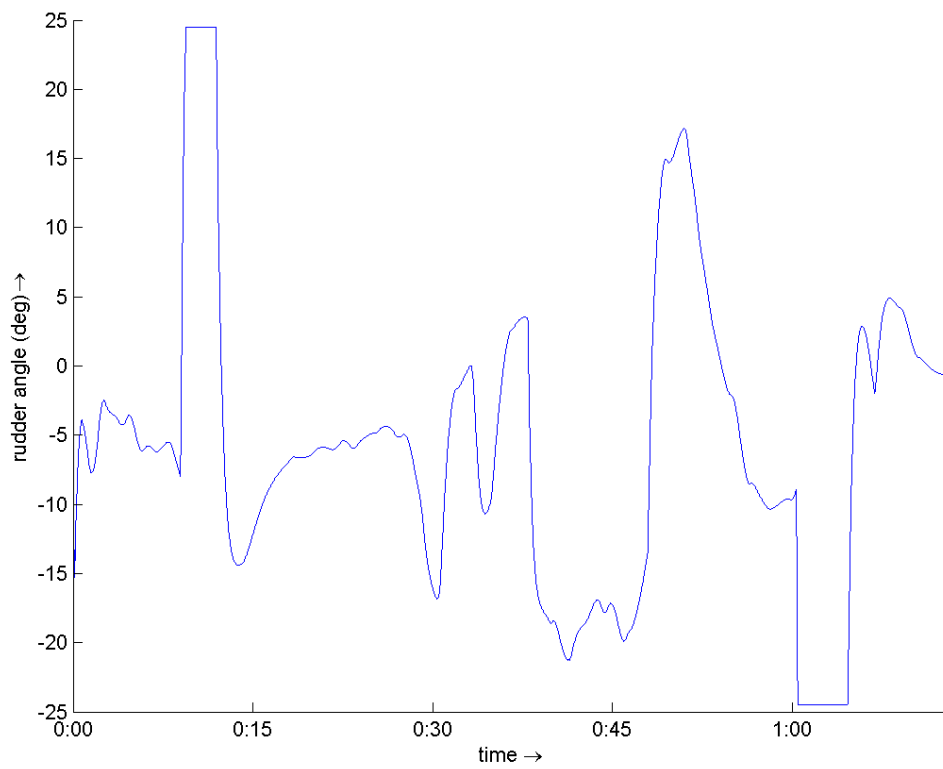


Figure 2.71: S.C. 9: rudder angle, vs. time.

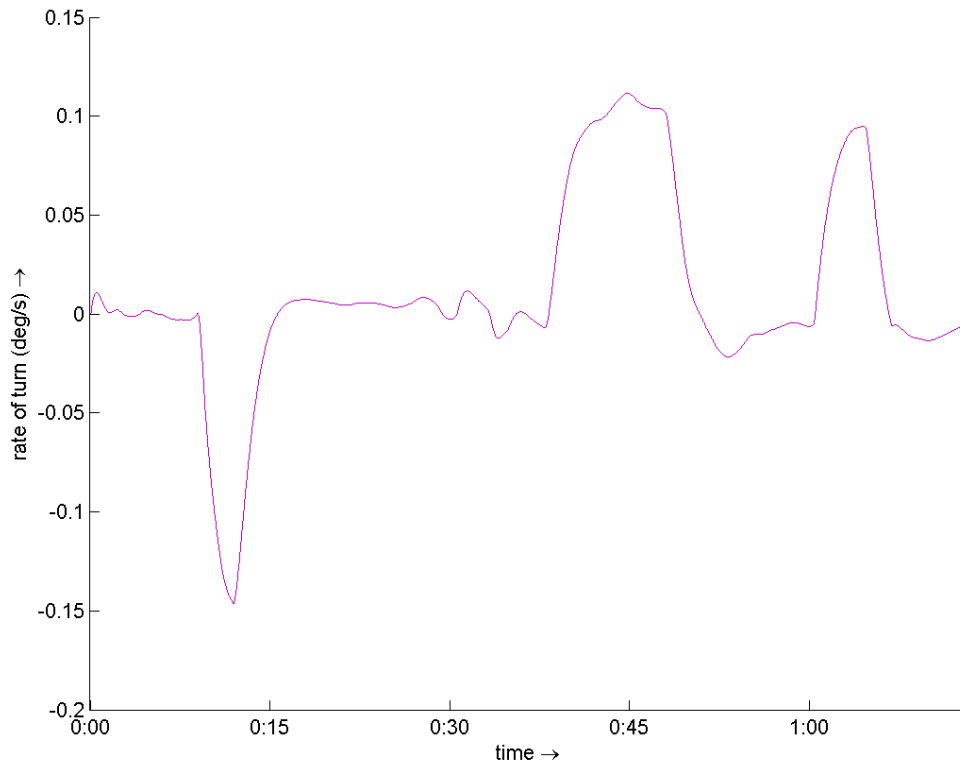


Figure 2.72: S.C. 9: RoT, vs. time.

## Simulation Case 10

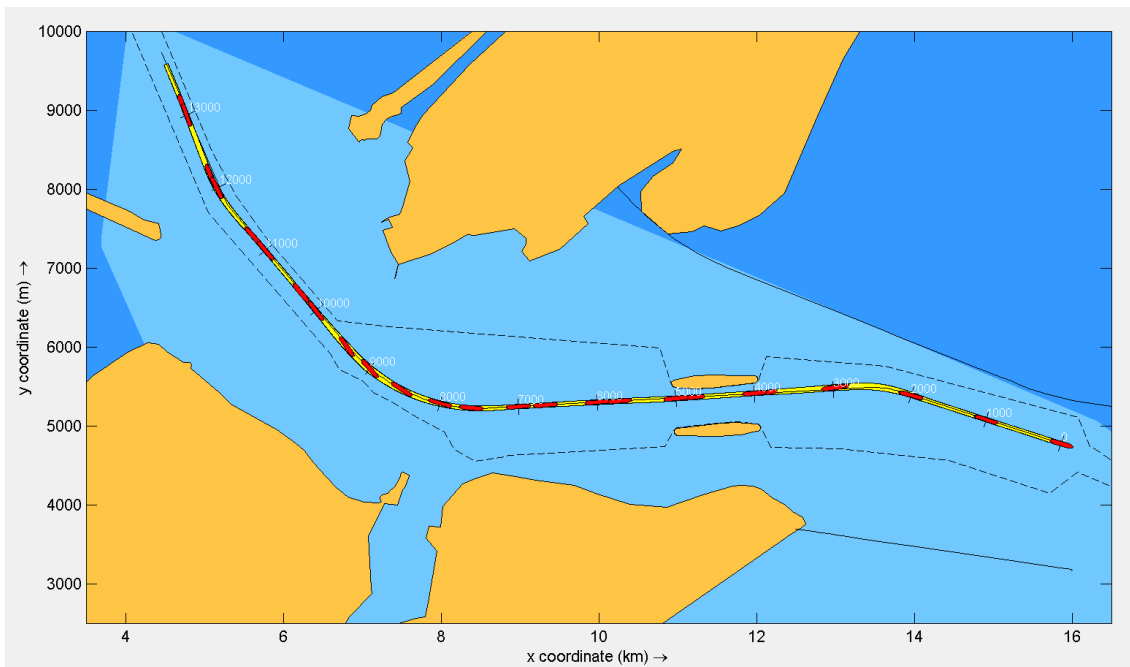
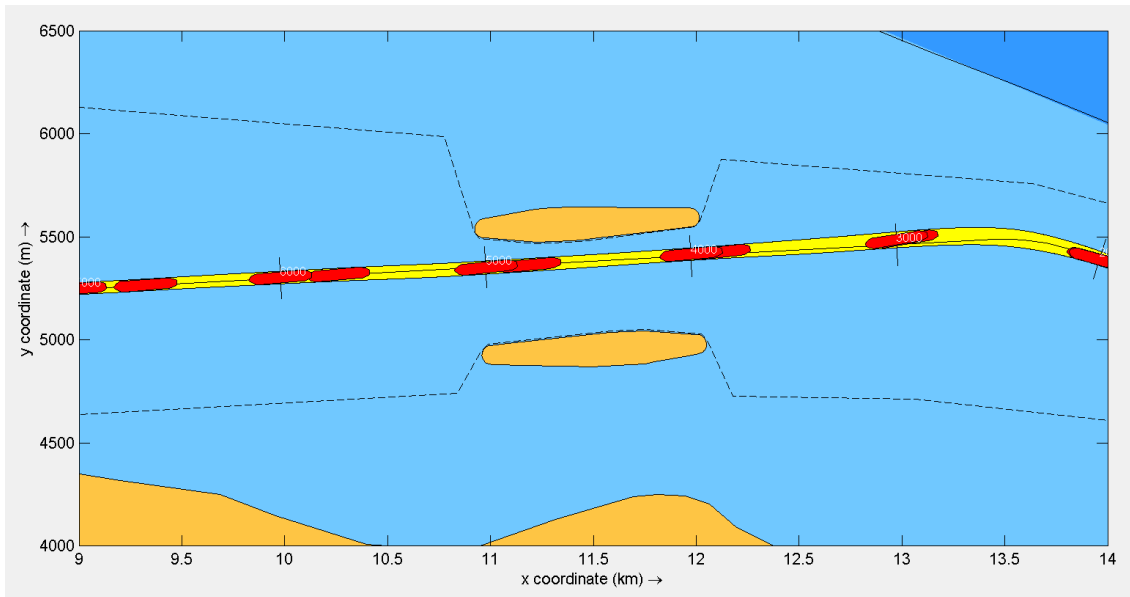


Figure 2.73: S.C. 10: spatial overview plot.



**Figure 2.74:** S.C. 10: zoom-in of spatial overview plot, crossing segment.

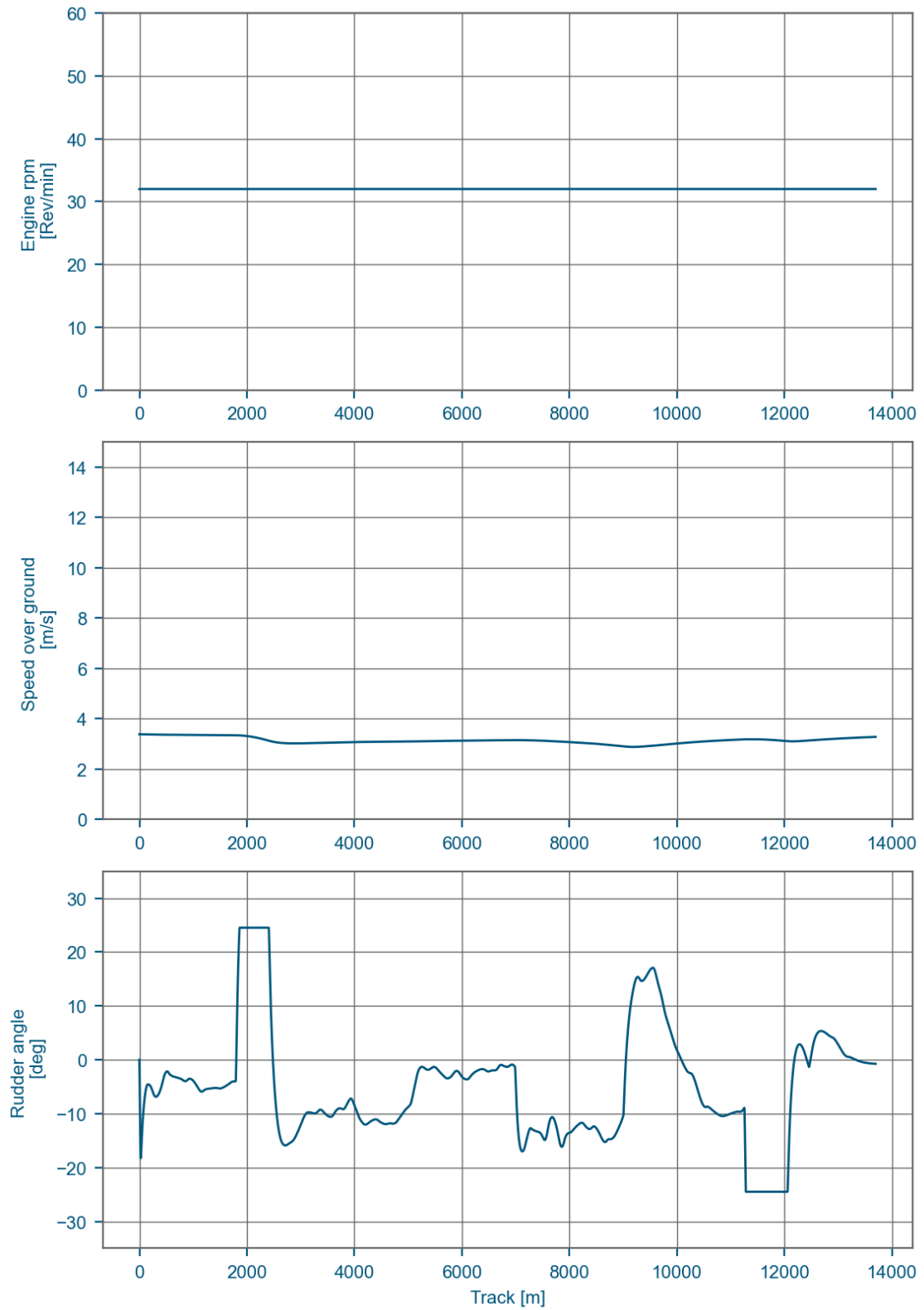
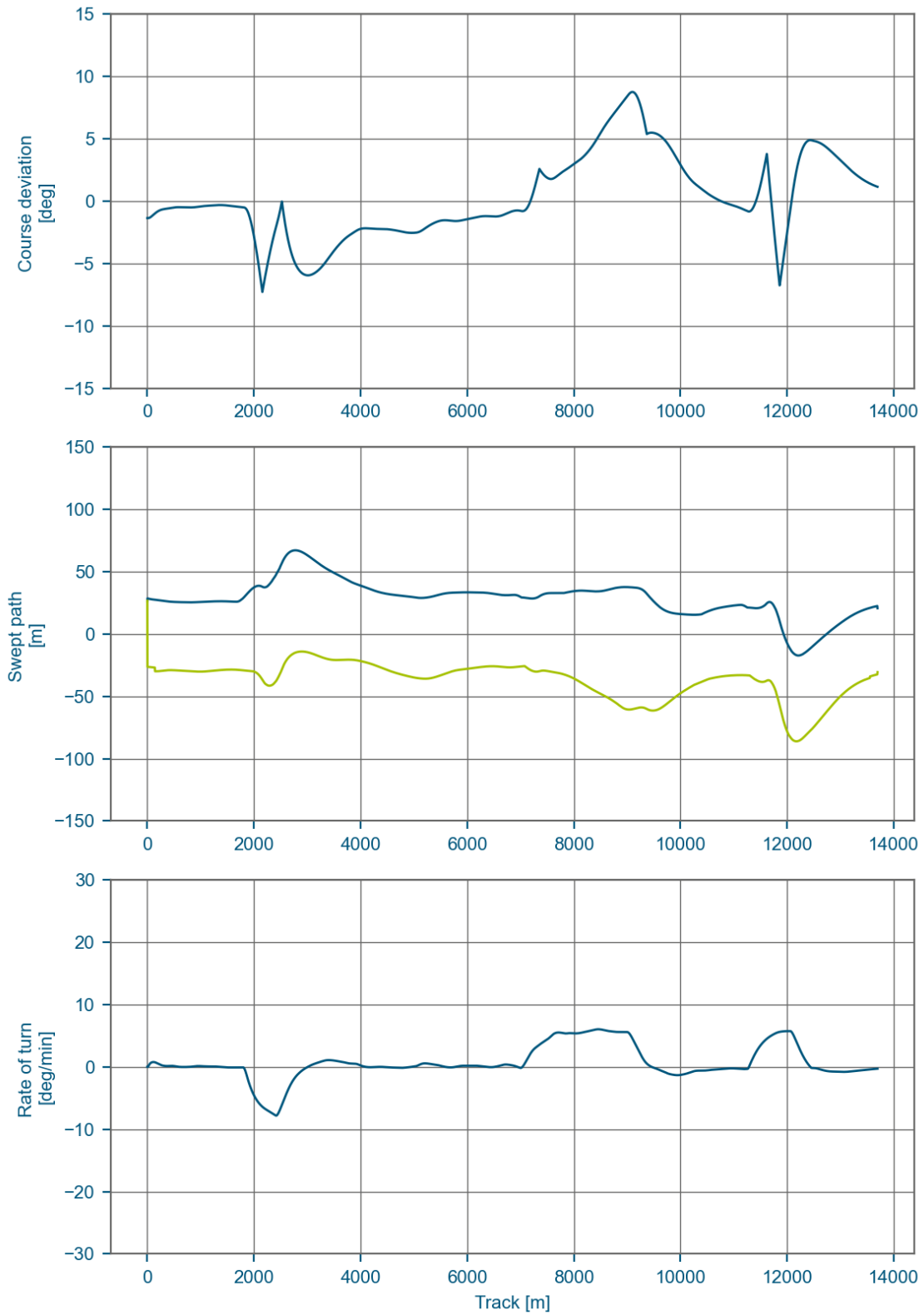


Figure 2.75: S.C. 10: engine RPM, SOG, rudder angle, vs. distance.



**Figure 2.76:** S.C. 10: course deviation (drift angle), swept path, RoT, vs. distance.

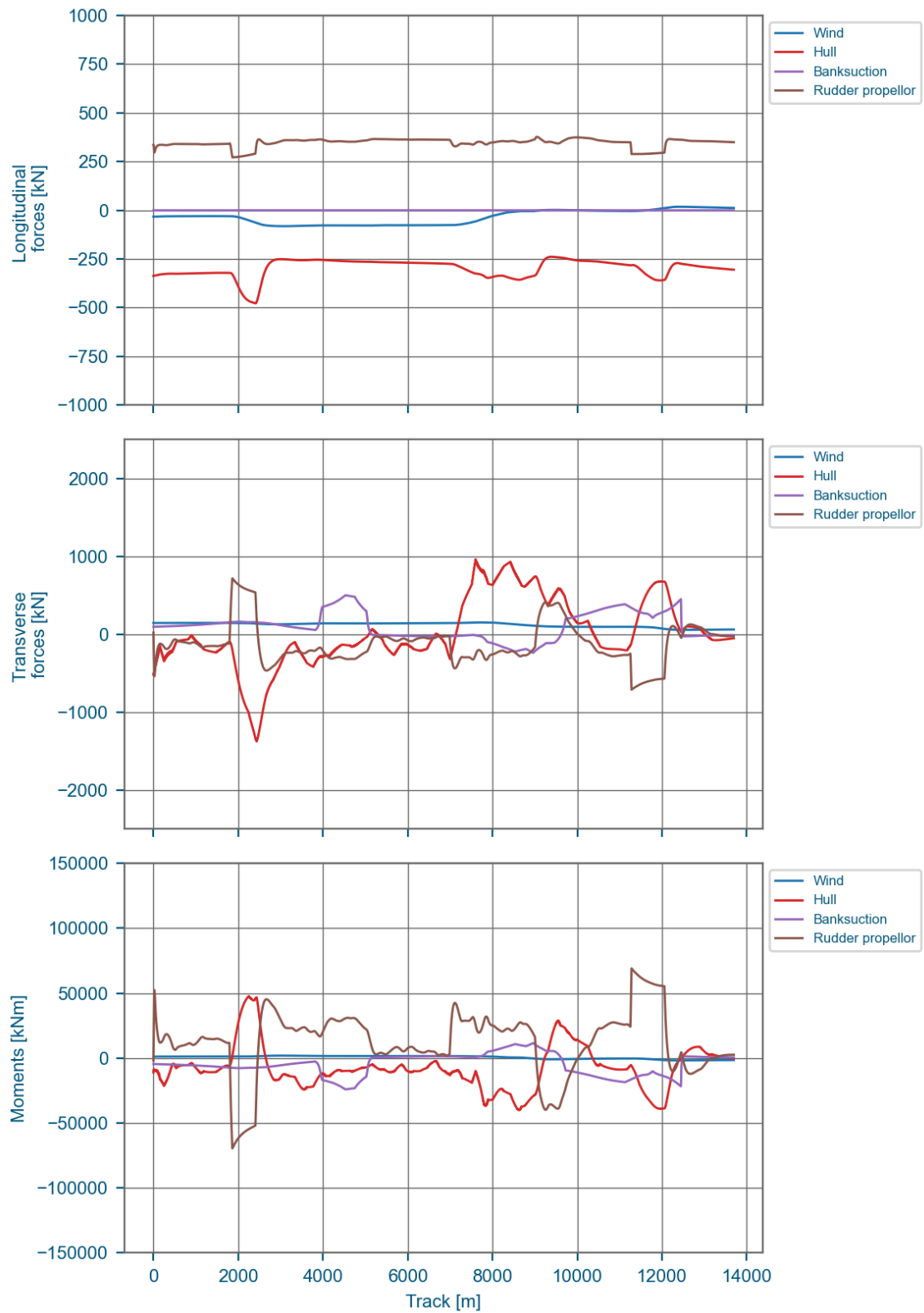


Figure 2.77: S.C. 10: forces, moments, vs. distance.

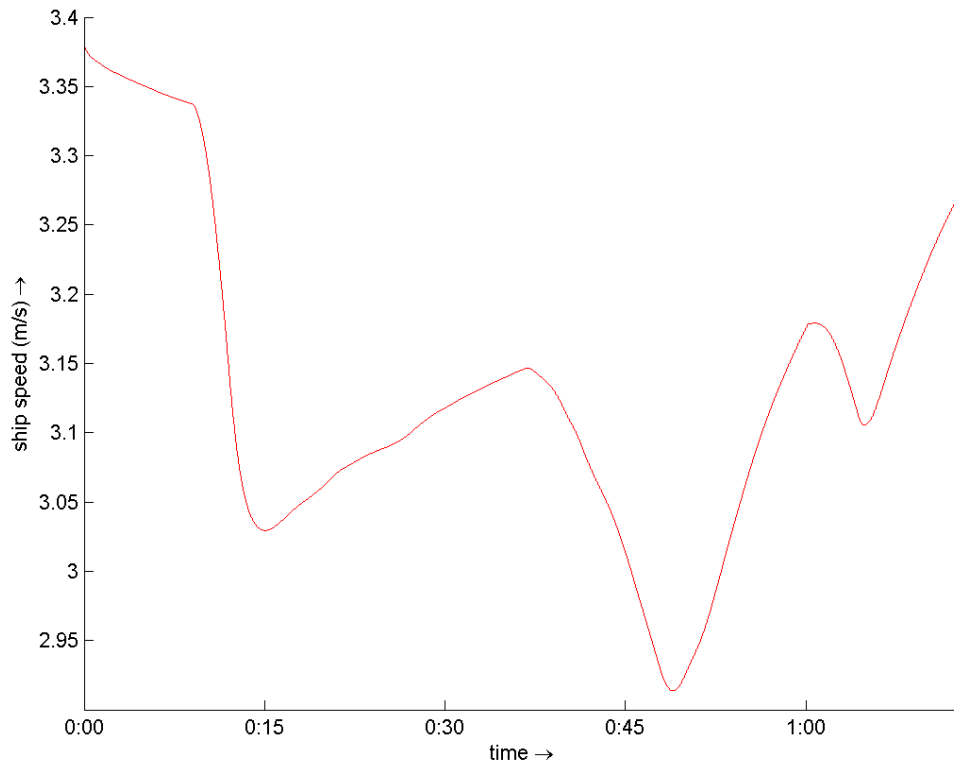


Figure 2.78: S.C. 10: SOG, vs. time.

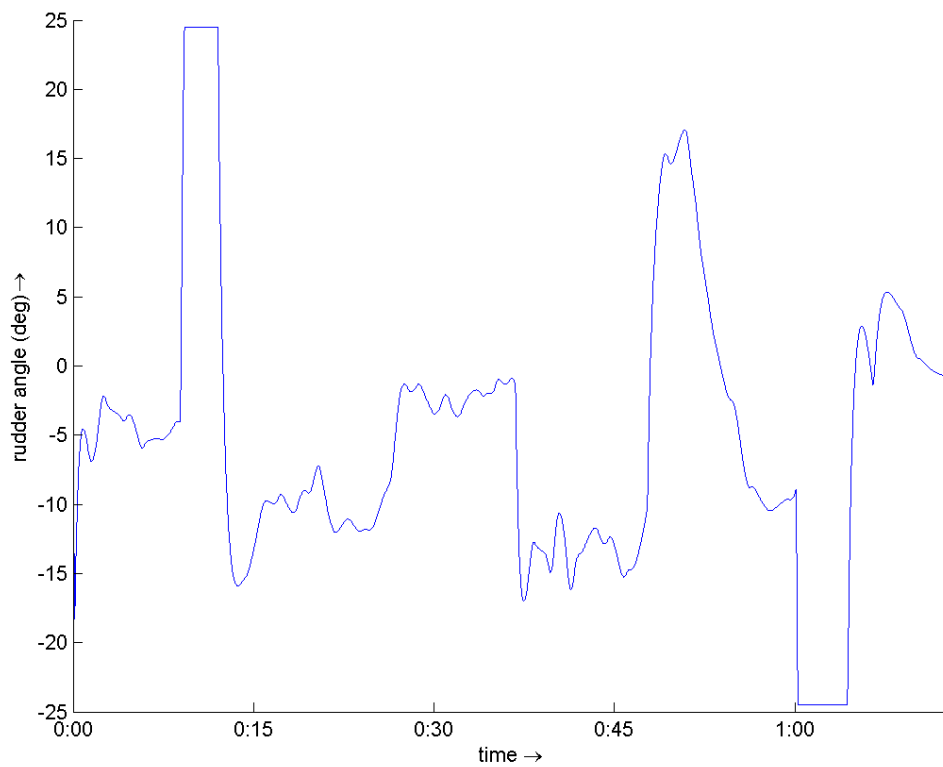


Figure 2.79: S.C. 10: rudder angle, vs. time.

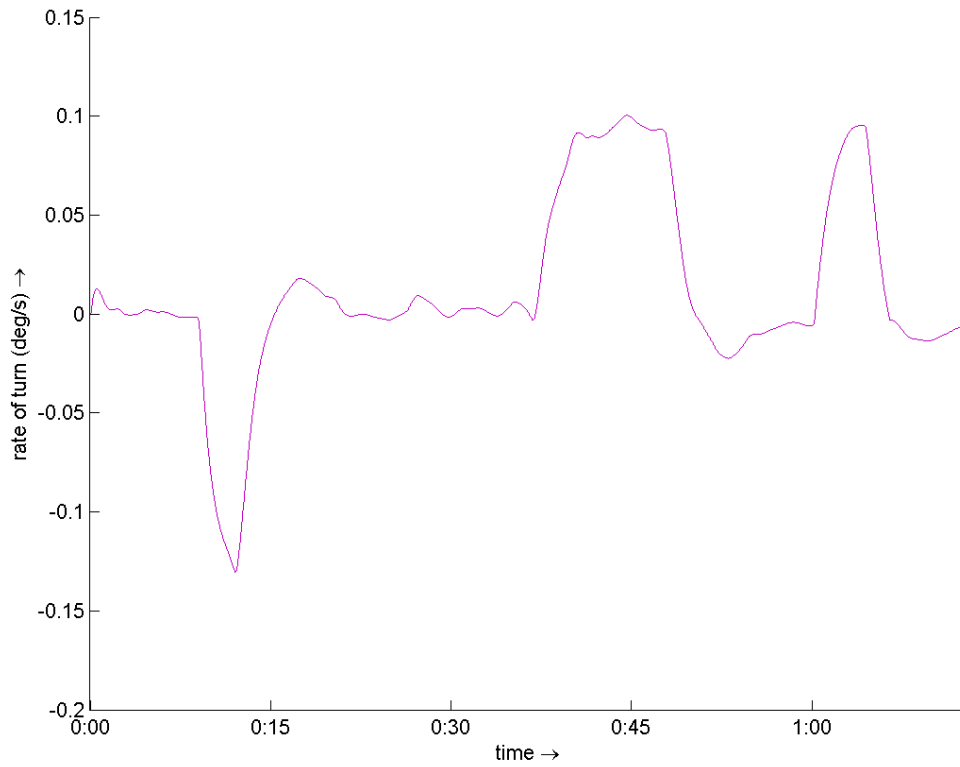


Figure 2.80: S.C. 10: RoT, vs. time.

## Simulation Case 11

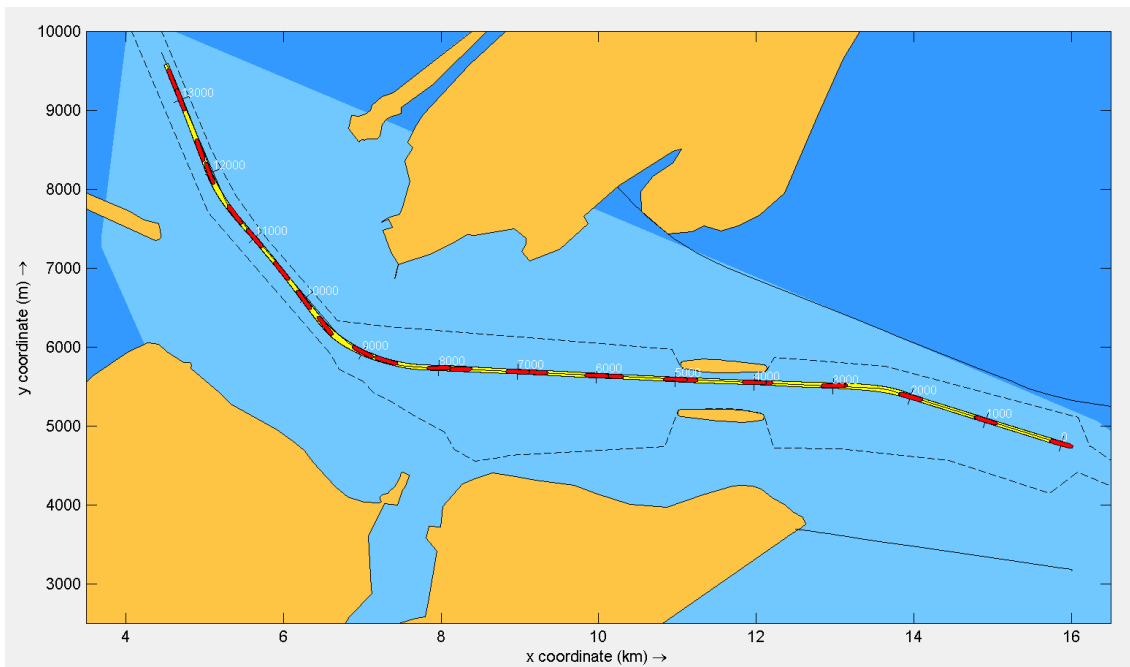
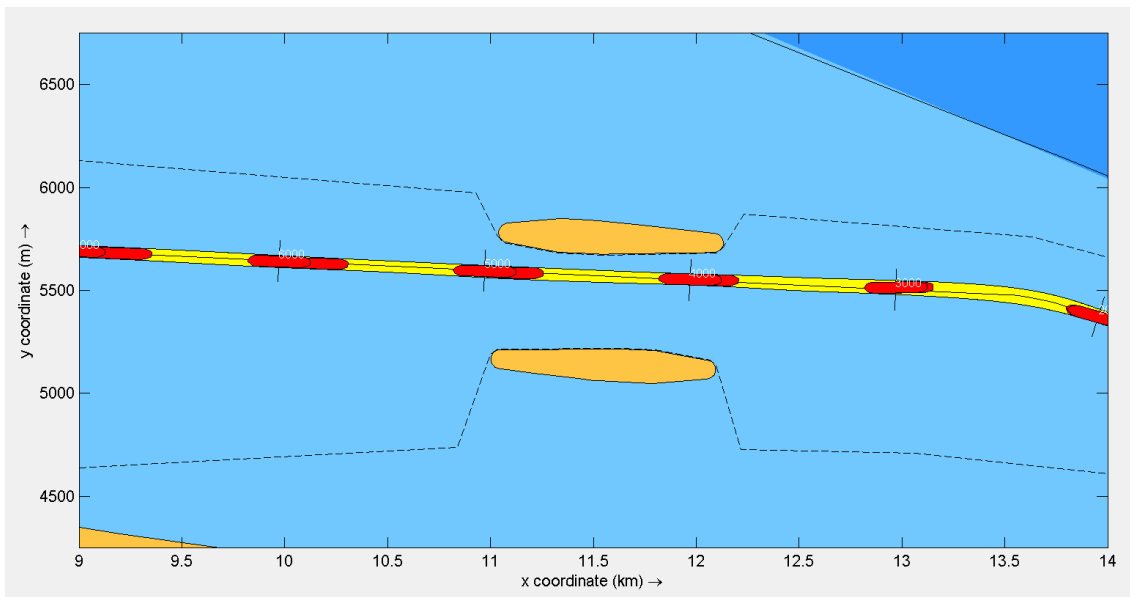


Figure 2.81: S.C. 11: spatial overview plot.



**Figure 2.82:** S.C. 11: zoom-in of spatial overview plot, crossing segment.

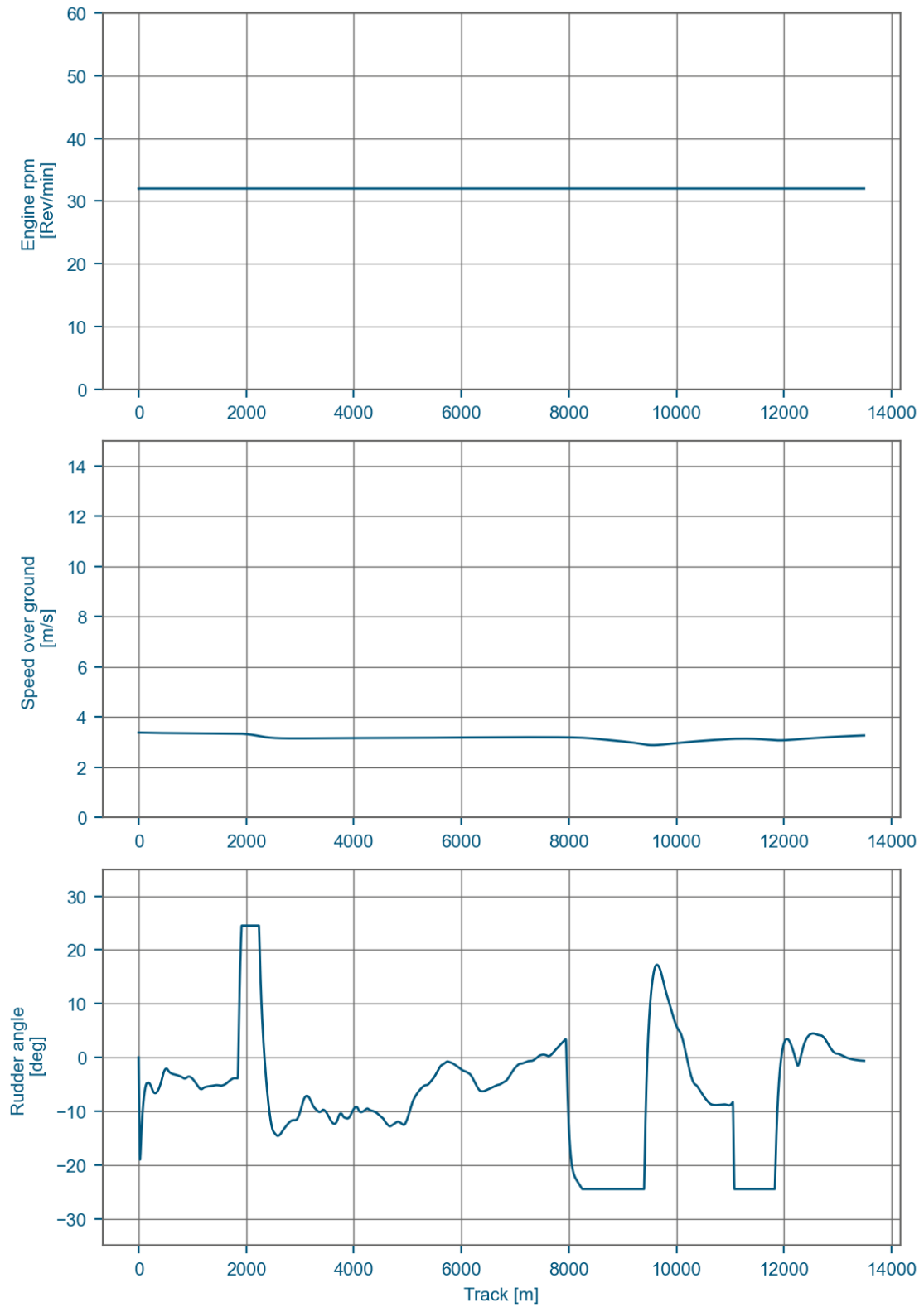
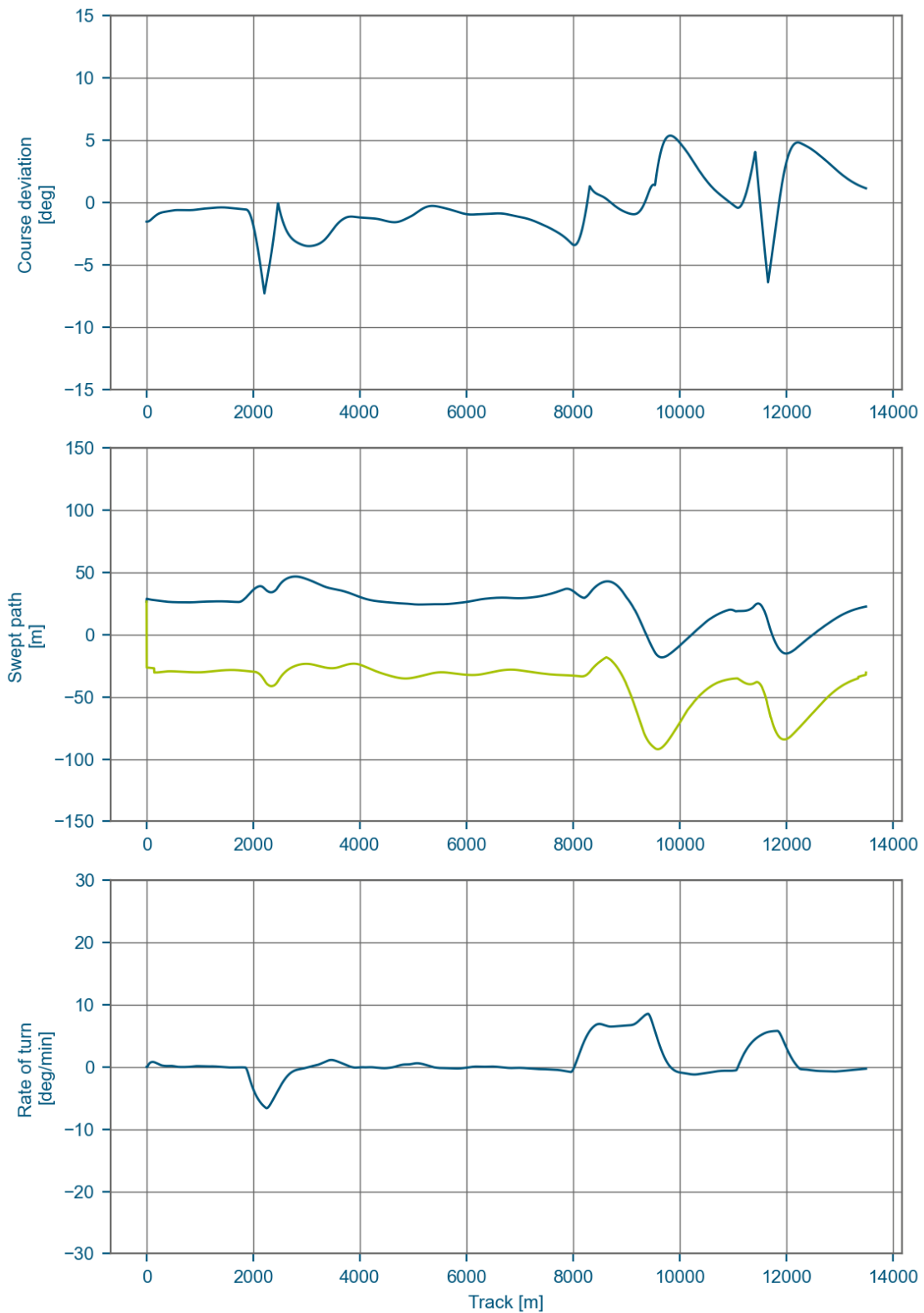


Figure 2.83: S.C. 11: engine RPM, SOG, rudder angle, vs. distance.



**Figure 2.84:** S.C. 11: course deviation (drift angle), swept path, RoT, vs. distance.

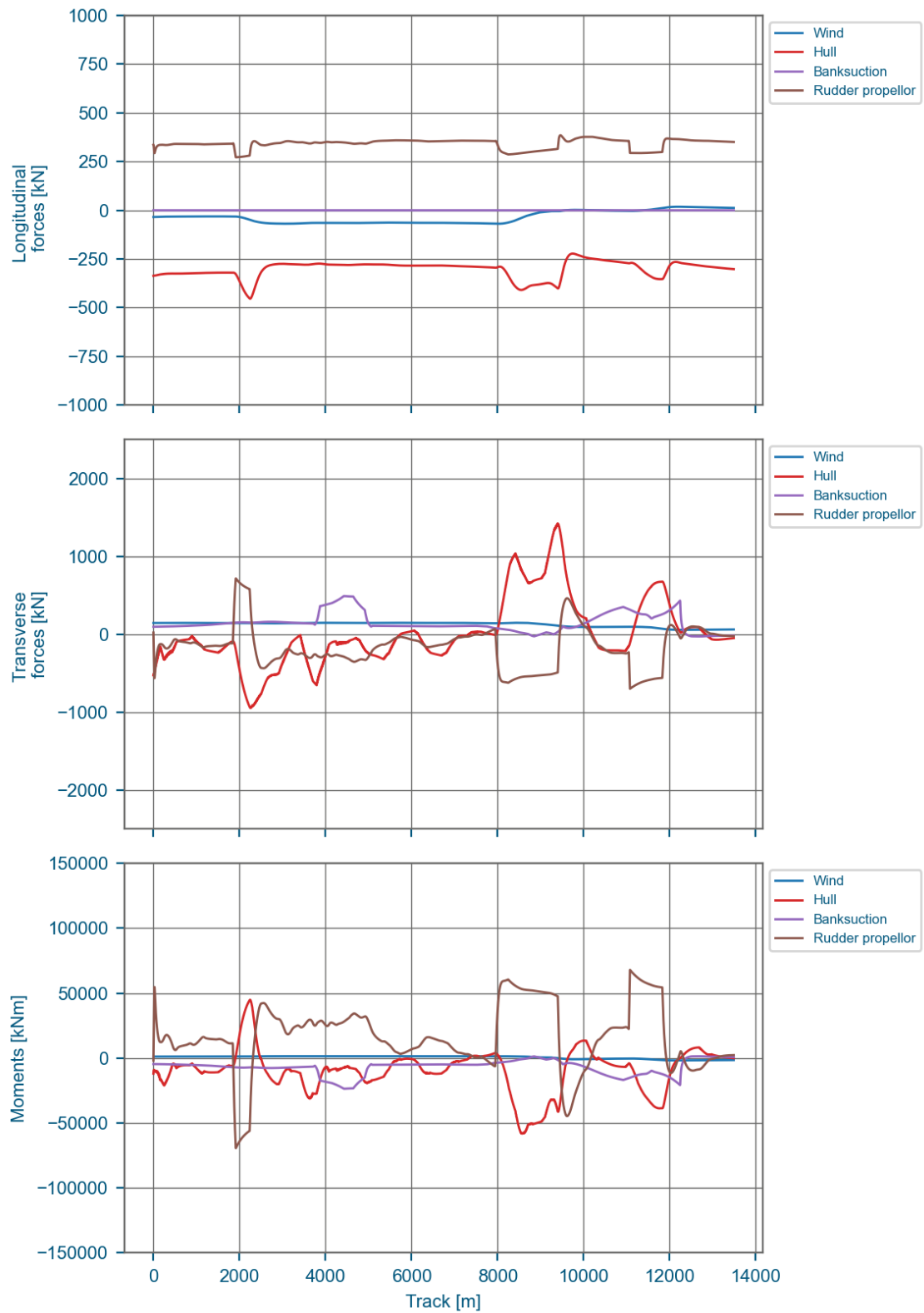


Figure 2.85: S.C. 11: forces, moments, vs. distance.

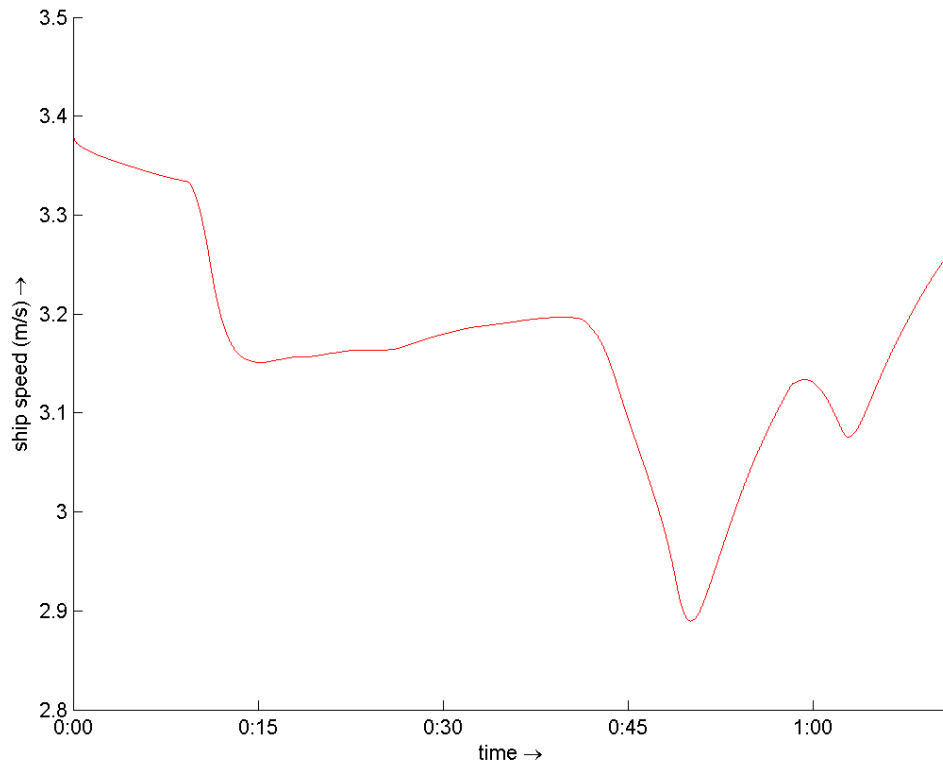


Figure 2.86: S.C. 11: SOG, vs. time.

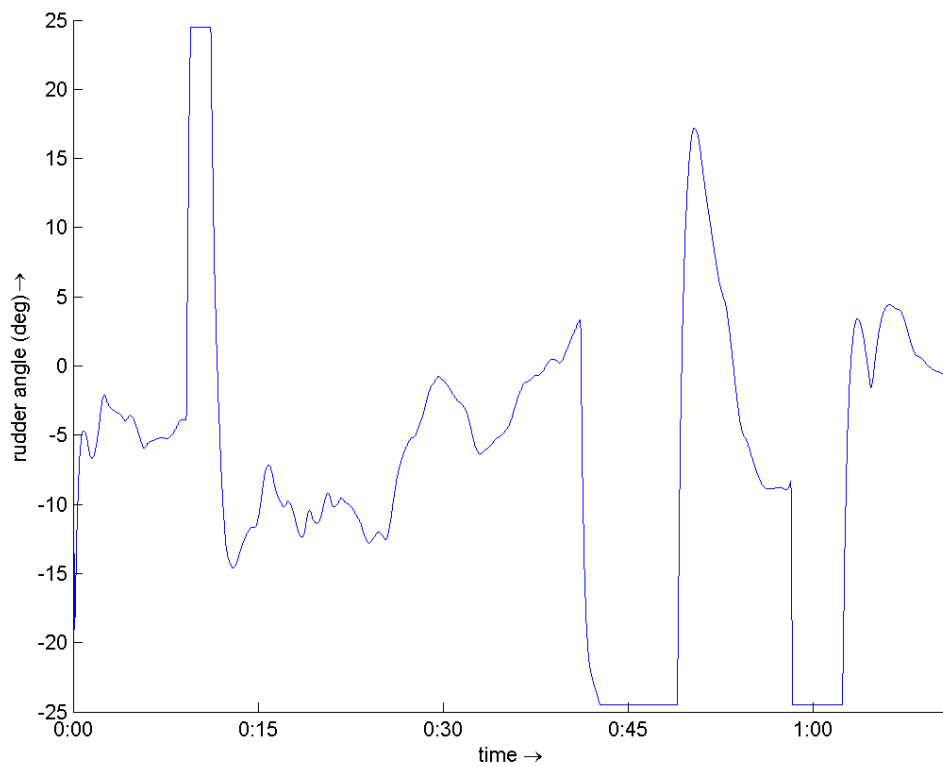


Figure 2.87: S.C. 11: rudder angle, vs. time.

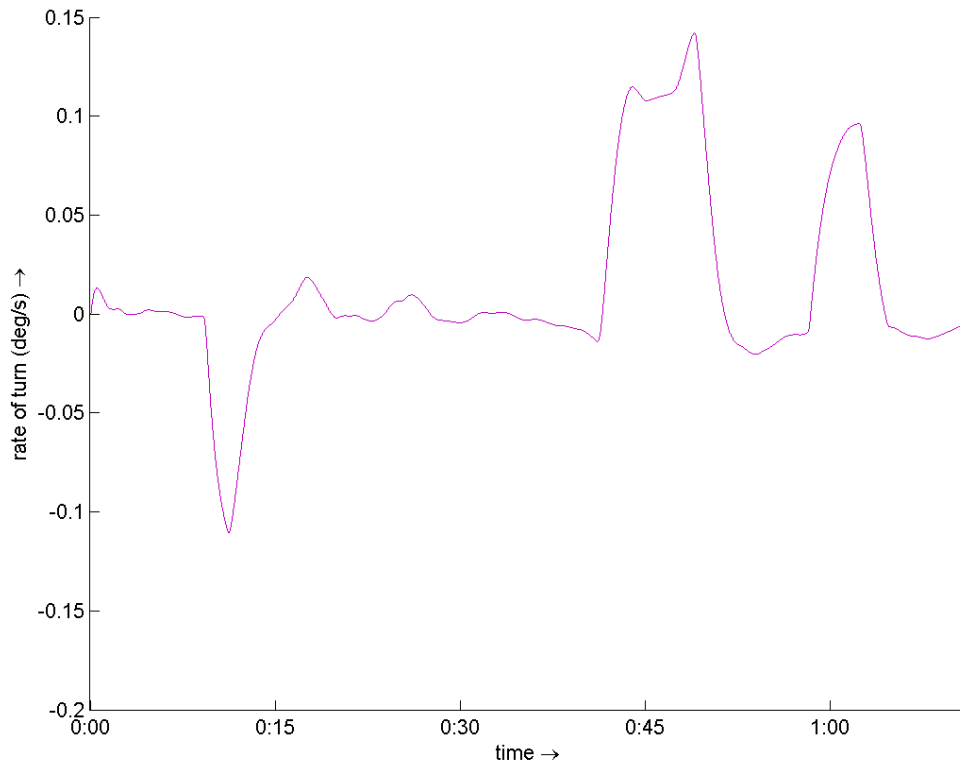


Figure 2.88: S.C. 11: RoT, vs. time.

## Simulation Case 12

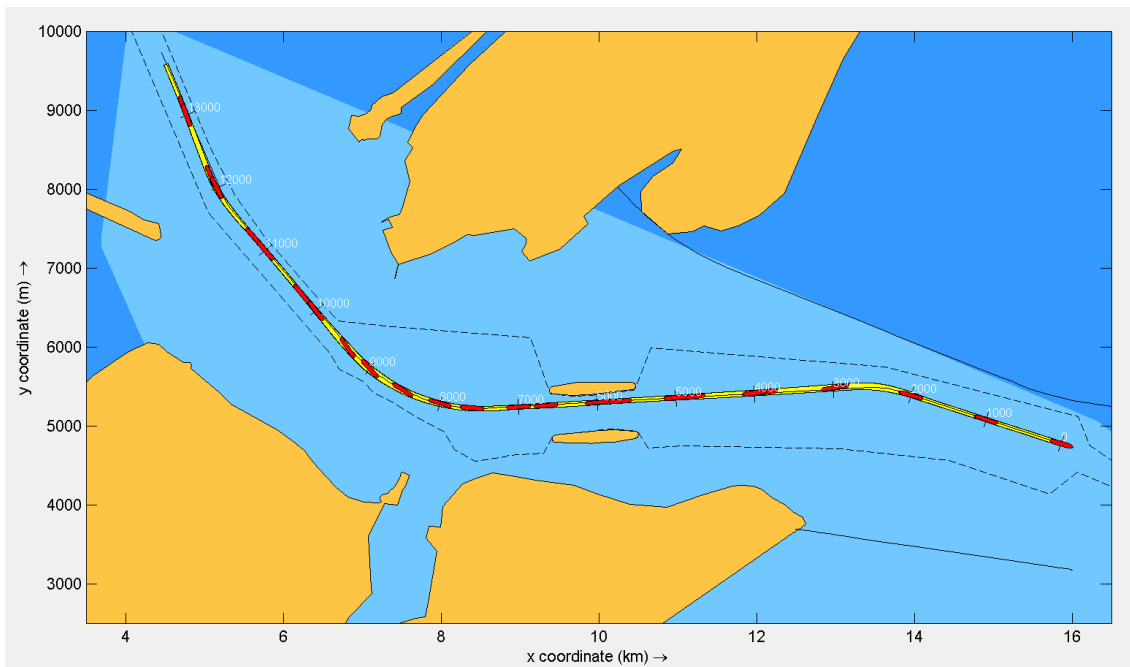
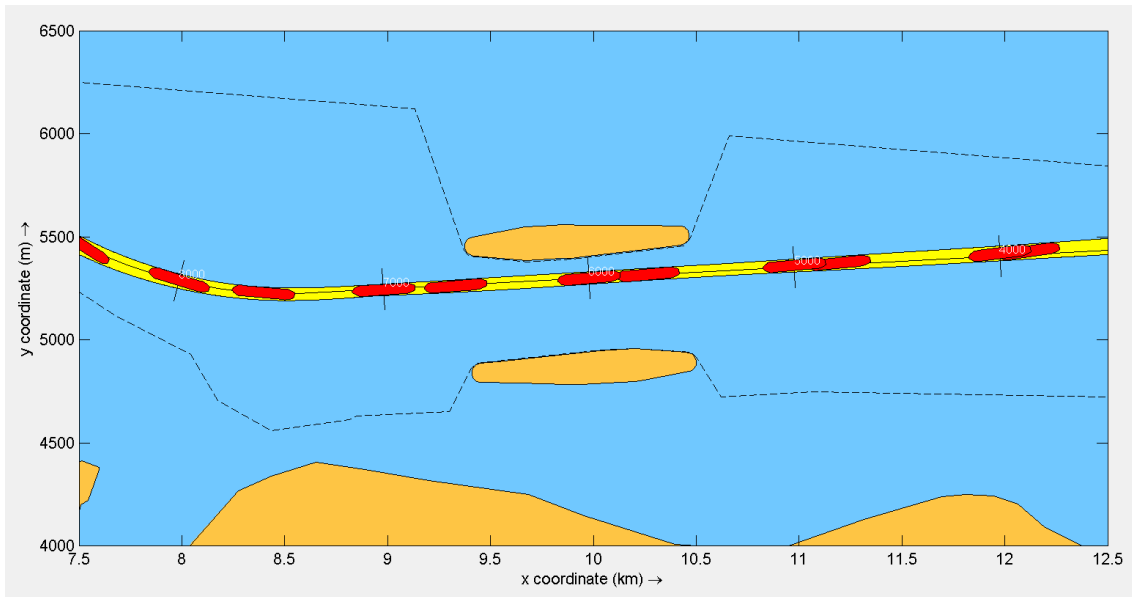


Figure 2.89: S.C. 12: spatial overview plot.



**Figure 2.90:** S.C. 12: zoom-in of spatial overview plot, crossing segment.

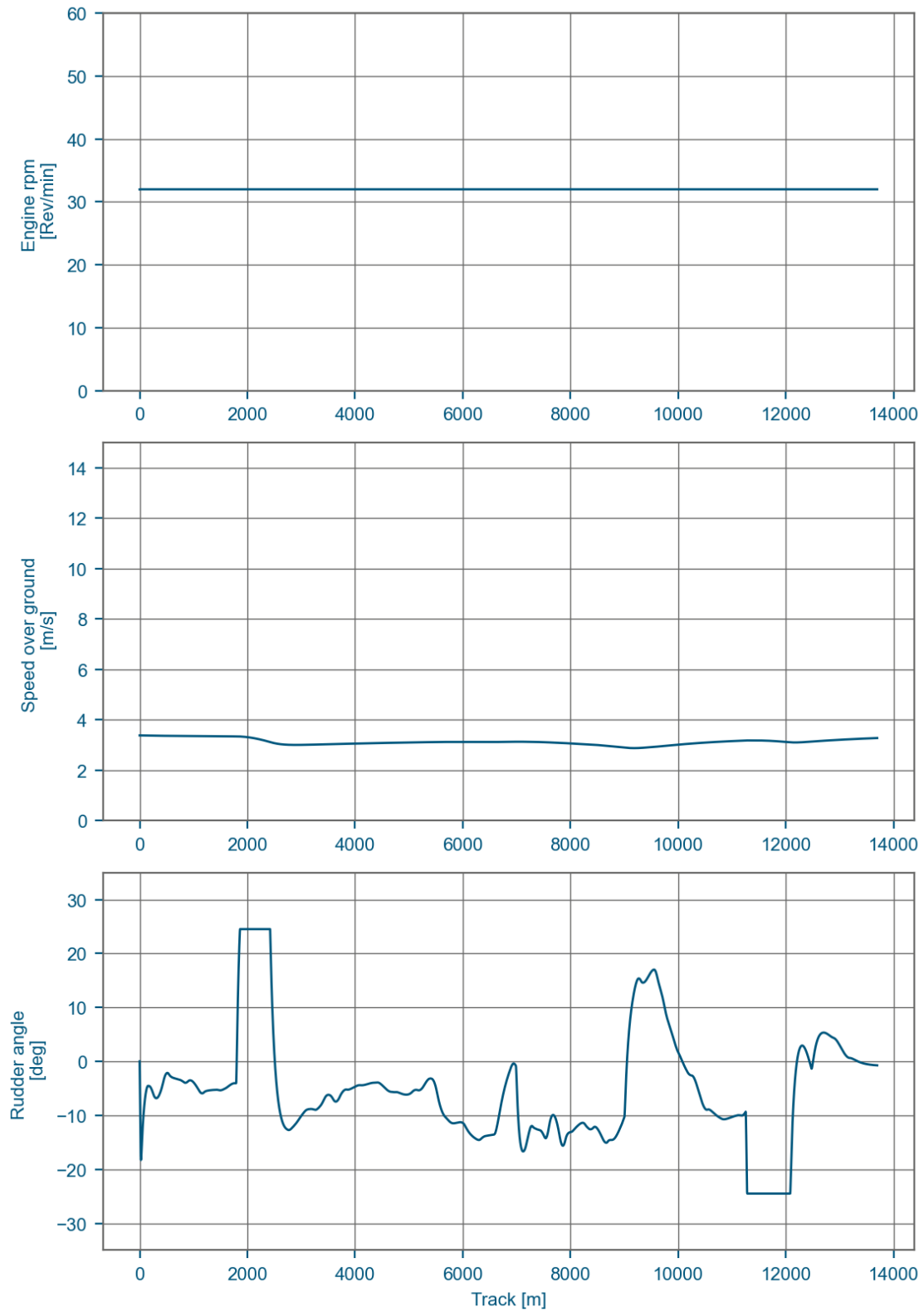
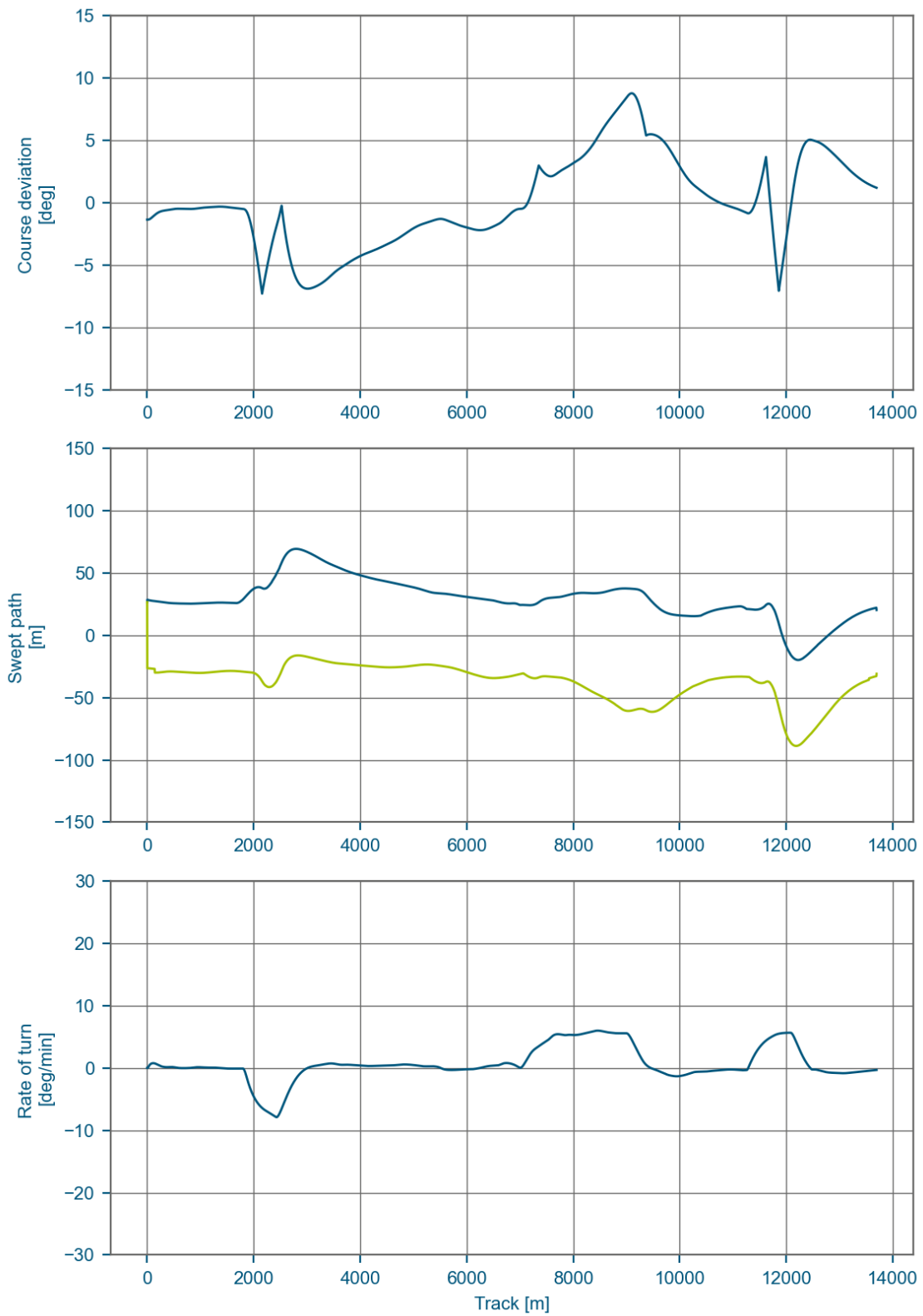


Figure 2.91: S.C. 12: engine RPM, SOG, rudder angle, vs. distance.



**Figure 2.92:** S.C. 12: course deviation (drift angle), swept path, RoT, vs. distance.

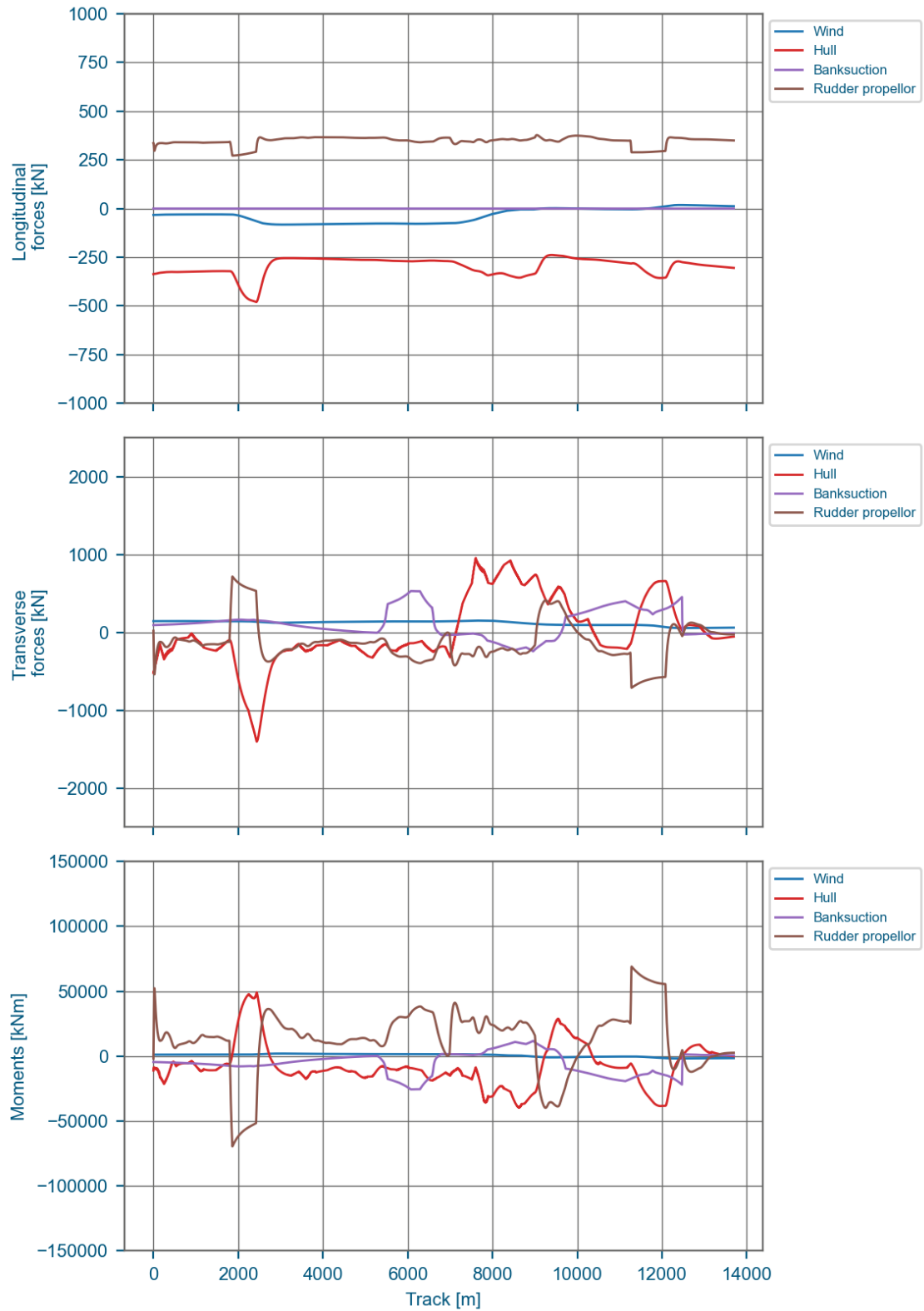


Figure 2.93: S.C. 12: forces, moments, vs. distance.

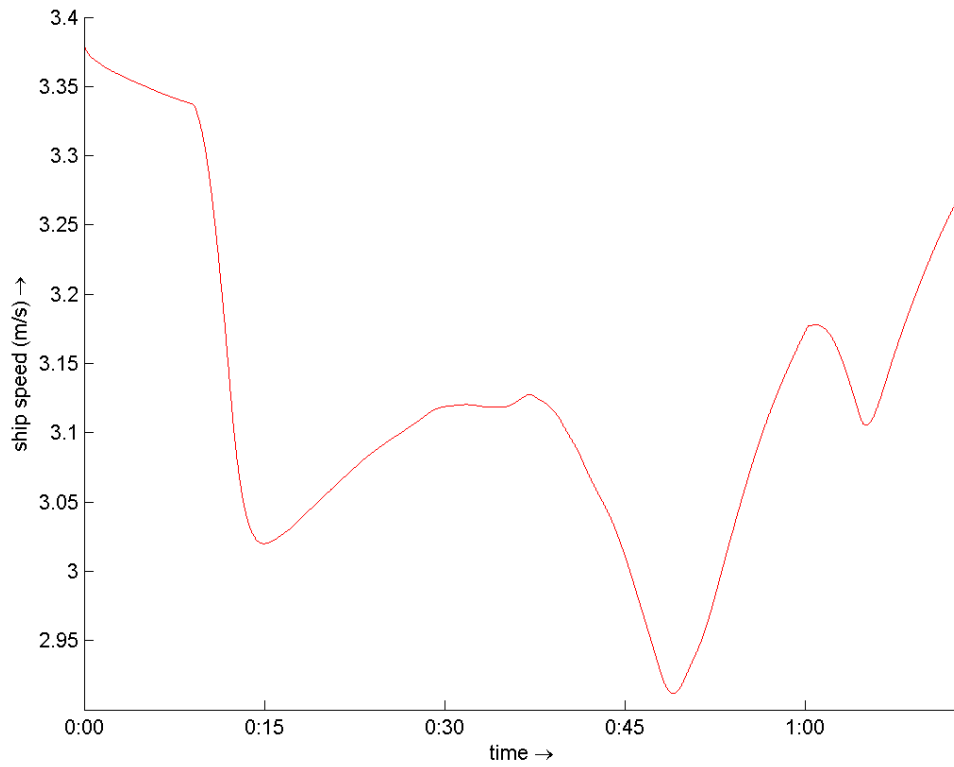


Figure 2.94: S.C. 12: SOG, vs. time.

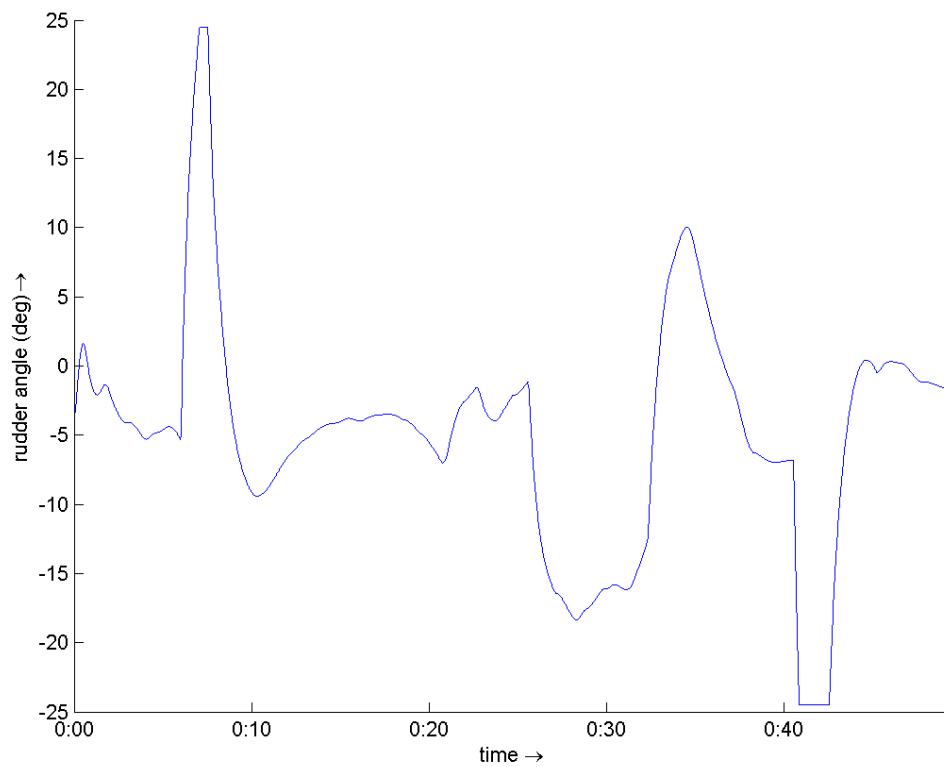


Figure 2.95: S.C. 12: rudder angle, vs. time.

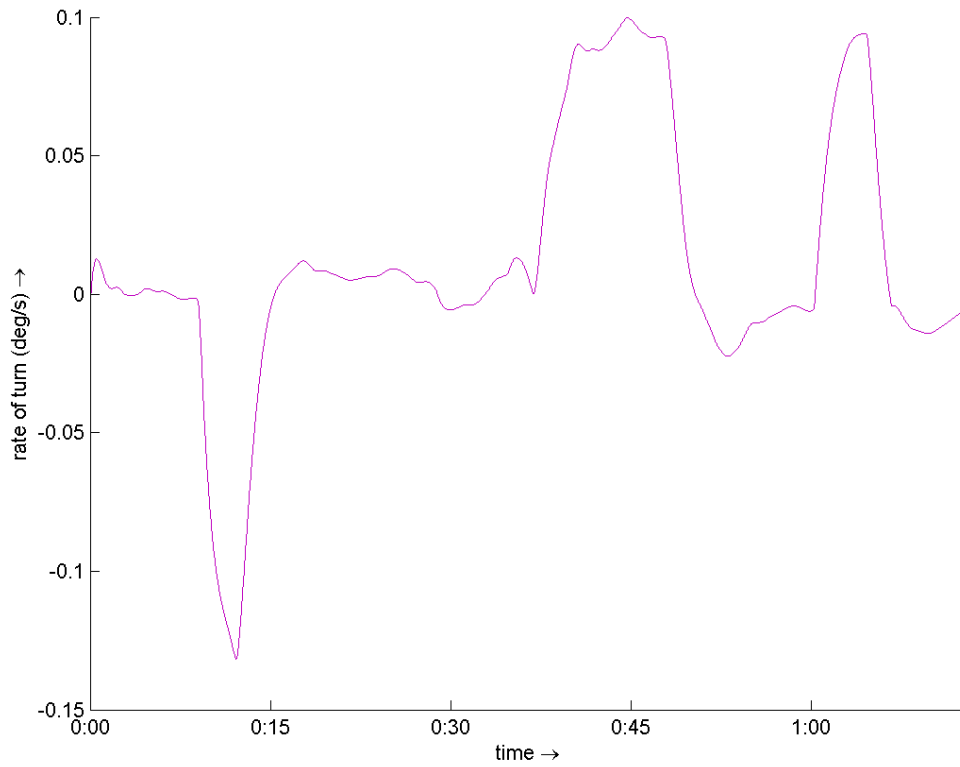


Figure 2.96: S.C. 12: RoT, vs. time.

### Simulation Case 13

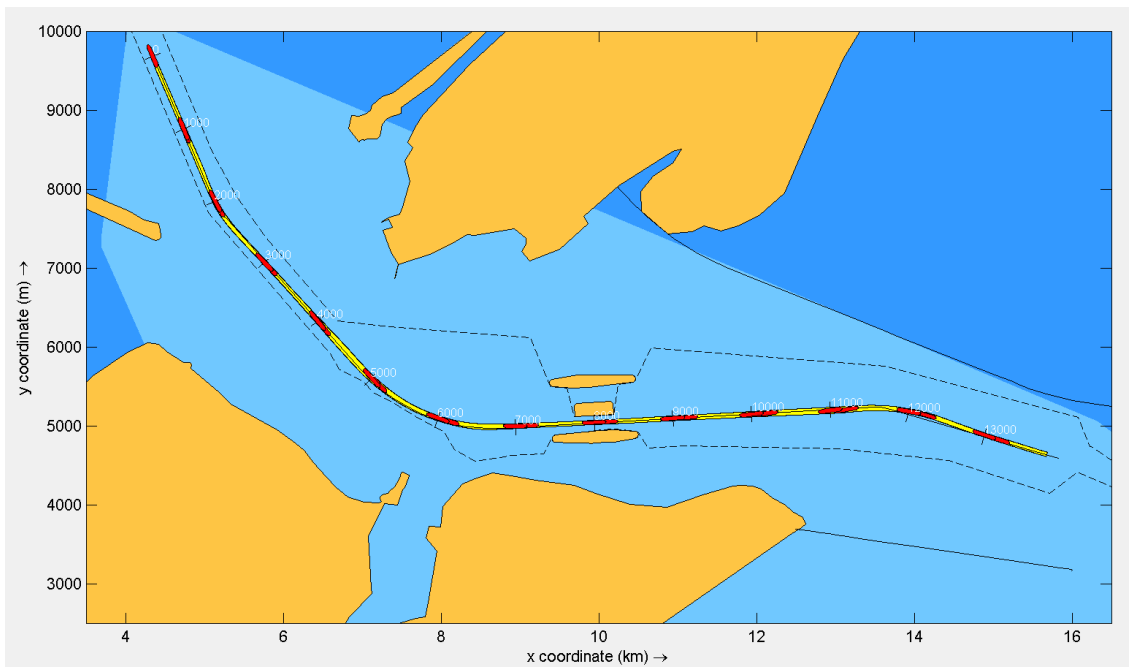
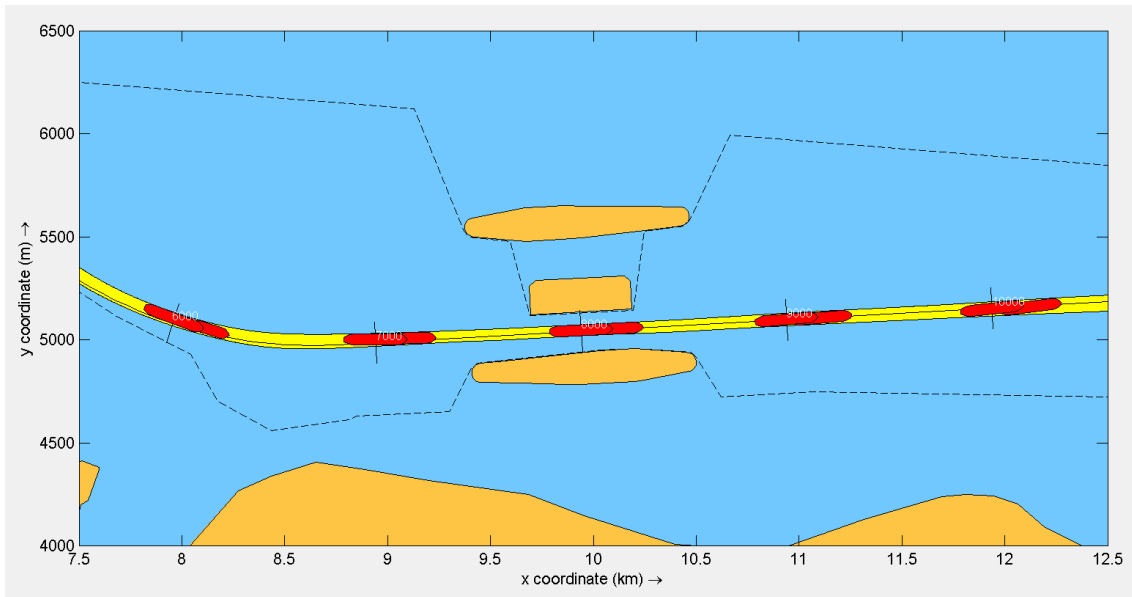


Figure 2.97: S.C. 13: spatial overview plot.



**Figure 2.98:** S.C. 13: zoom-in of spatial overview plot, crossing segment.

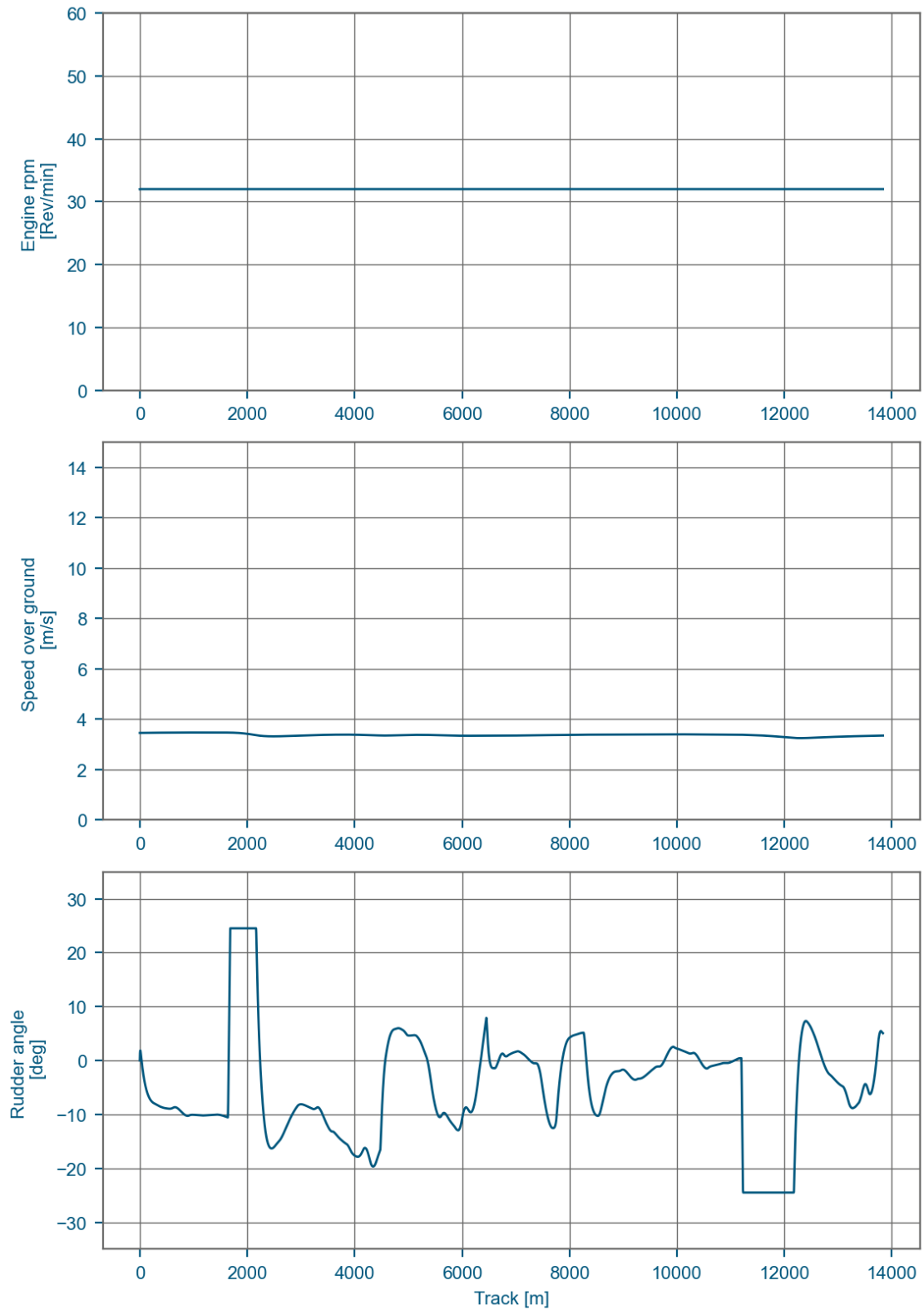


Figure 2.99: S.C. 13: engine RPM, SOG, rudder angle, vs. distance.

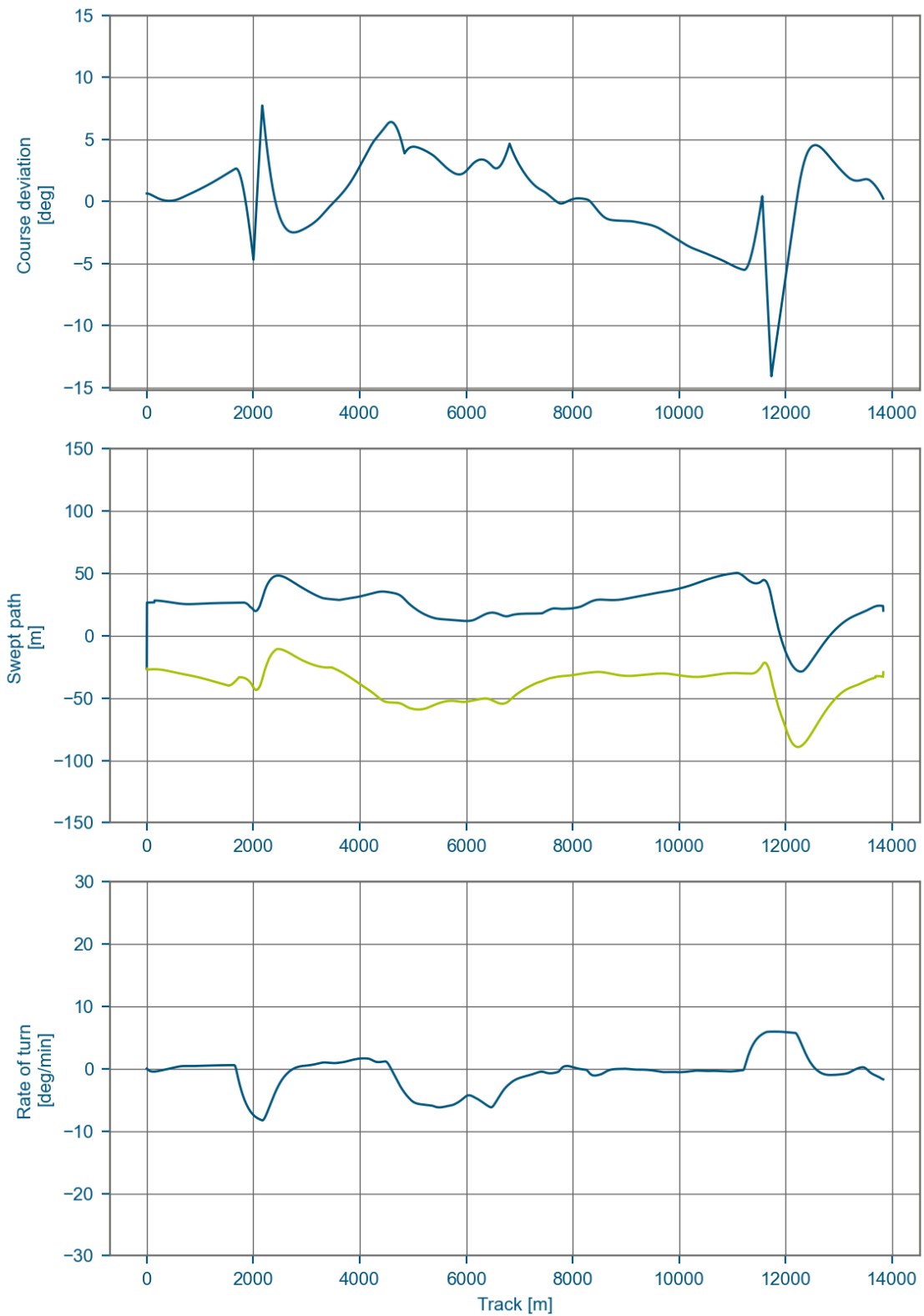


Figure 2.100: S.C. 13: course deviation (drift angle), swept path, RoT, vs. distance.

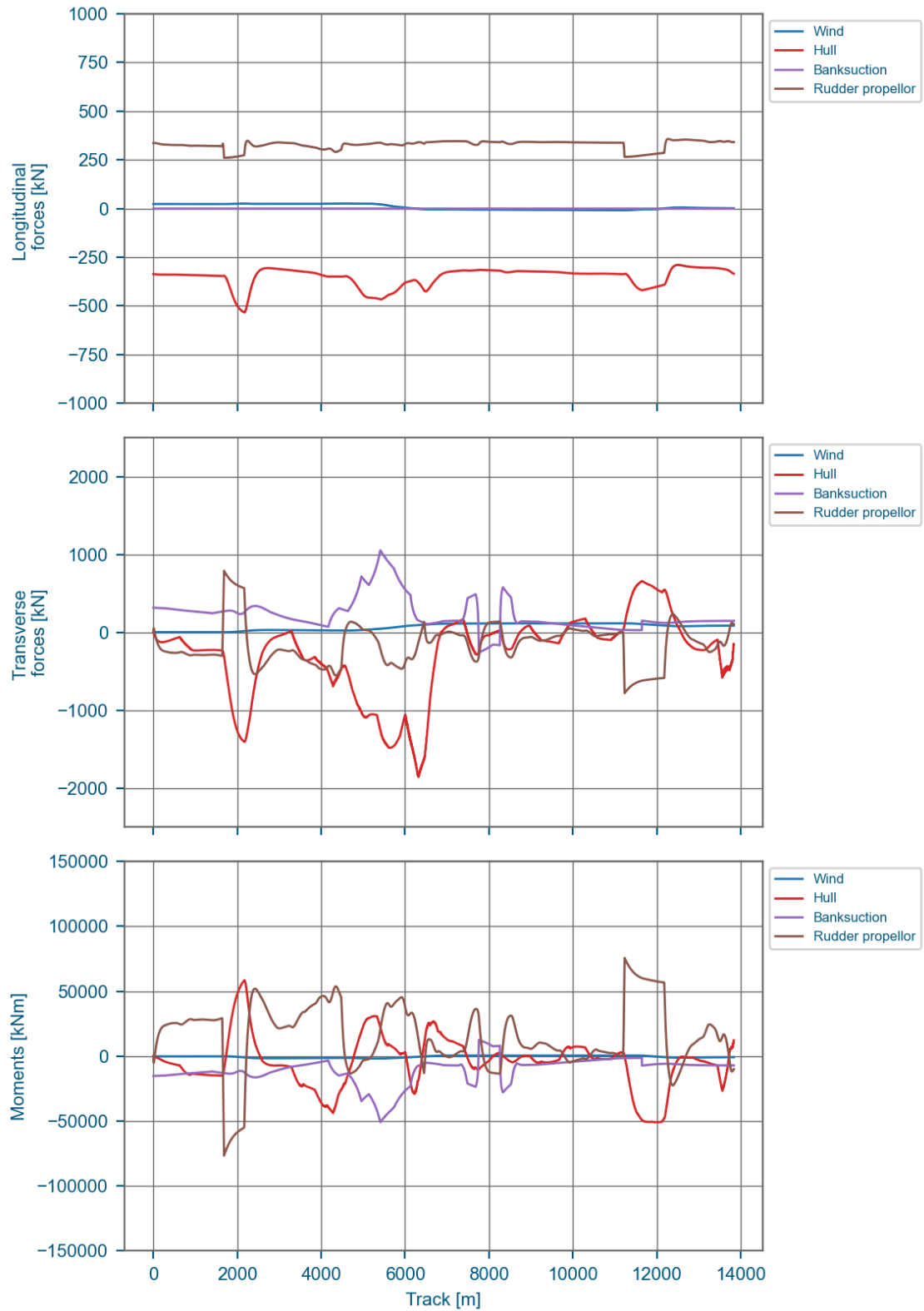


Figure 2.101: S.C. 13: forces, moments, vs. distance.

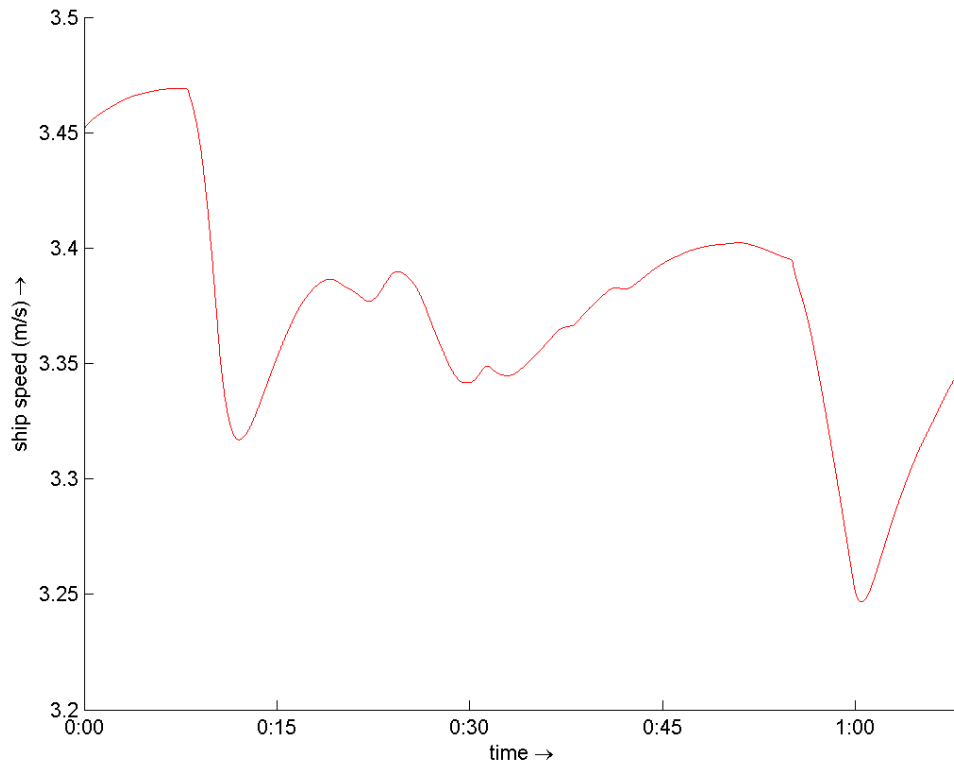


Figure 2.102: S.C. 13: SOG, vs. time.

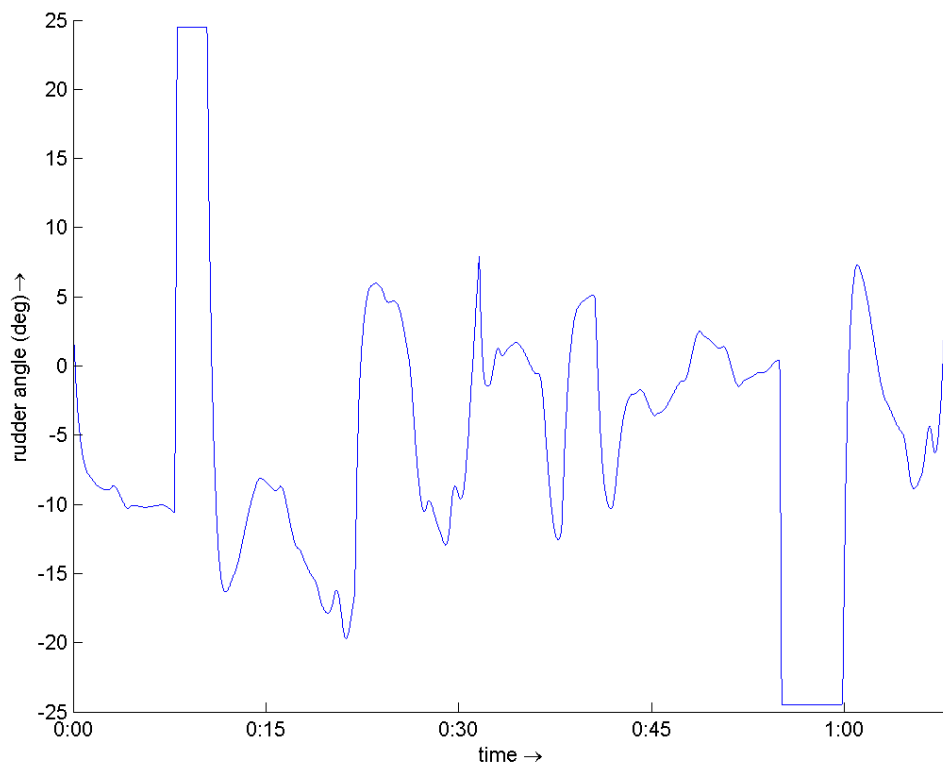


Figure 2.103: S.C. 13: rudder angle, vs. time.

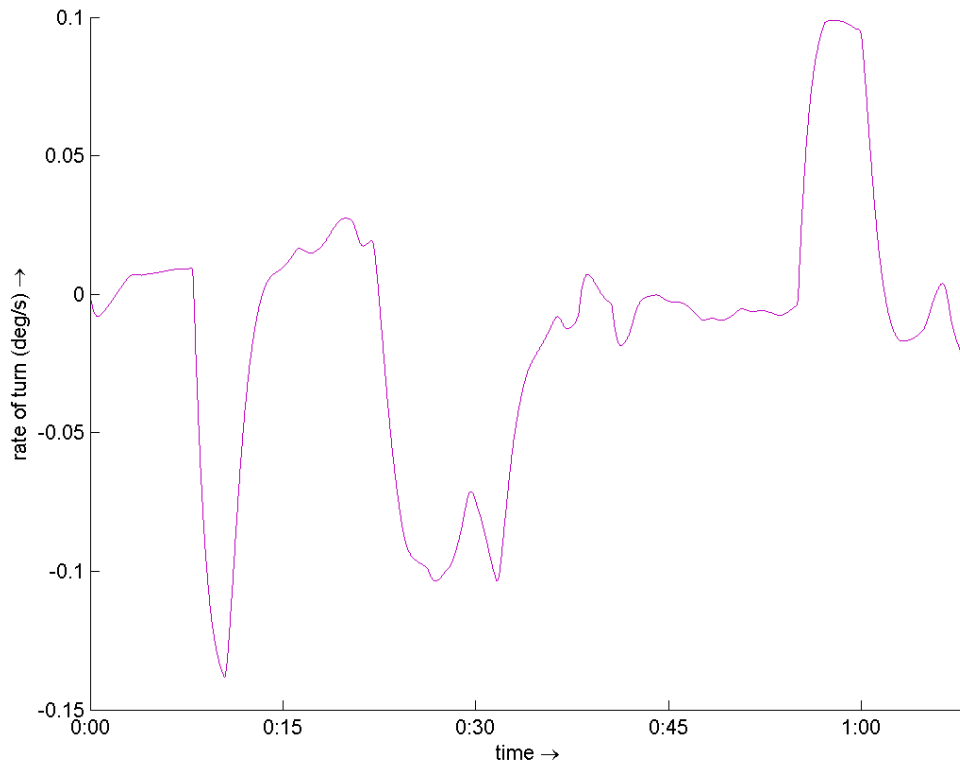


Figure 2.104: S.C. 13: RoT, vs. time.

## Simulation Case 14

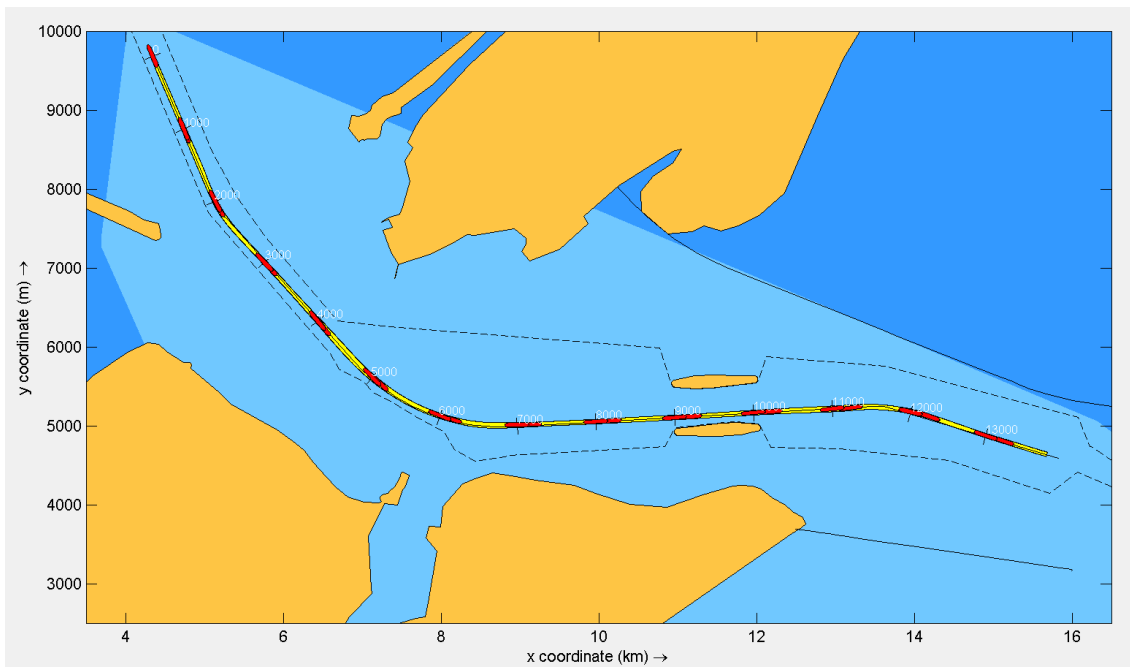
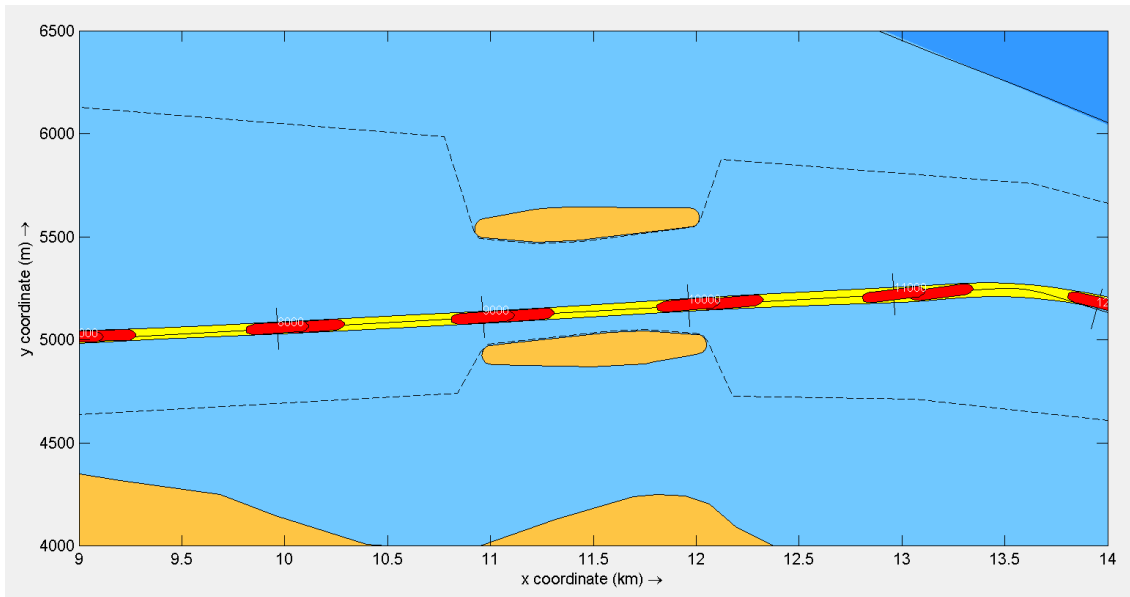


Figure 2.105: S.C. 14: spatial overview plot.



**Figure 2.106:** S.C. 14: zoom-in of spatial overview plot, crossing segment.

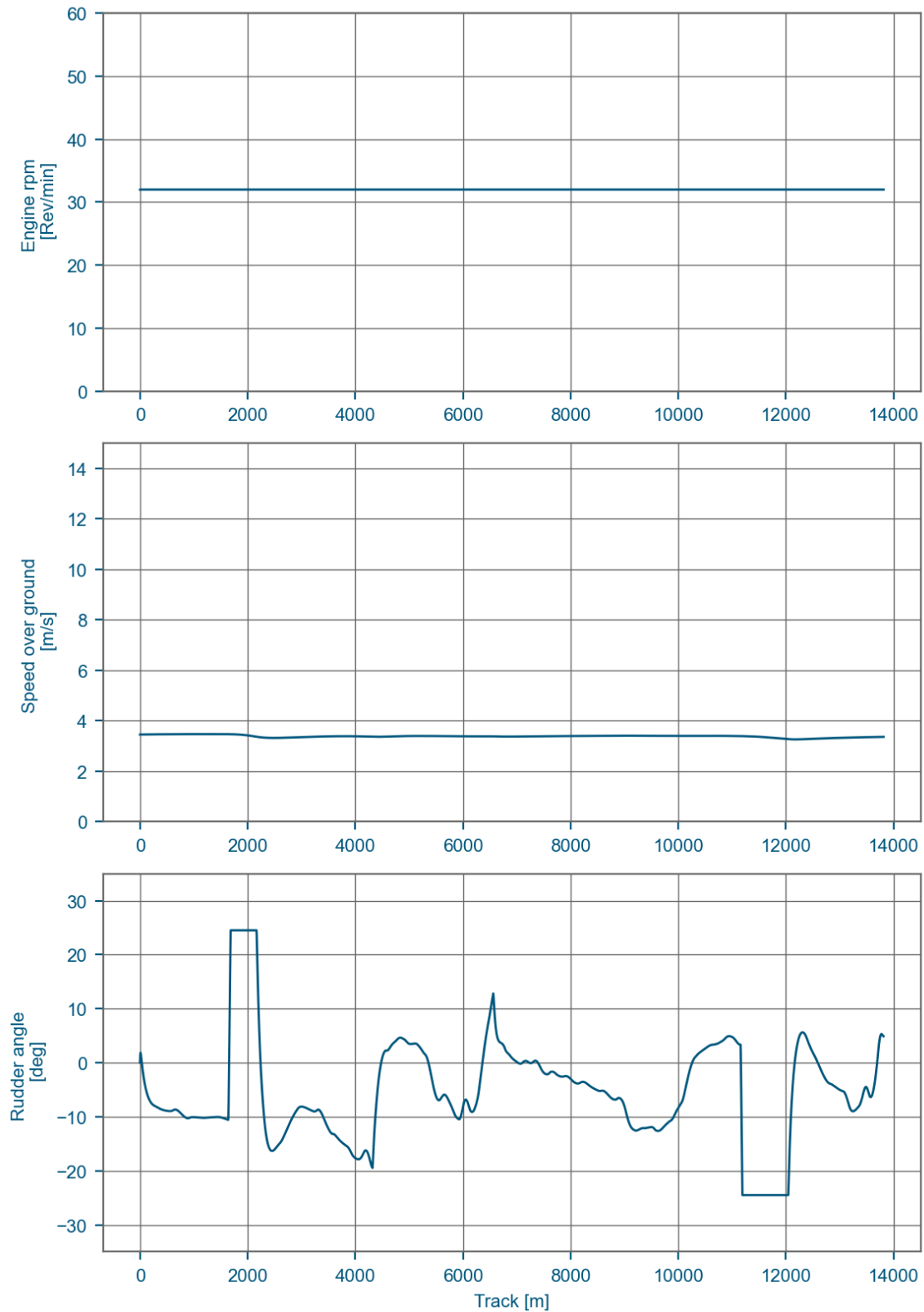


Figure 2.107: S.C. 14: engine RPM, SOG, rudder angle, vs. distance.

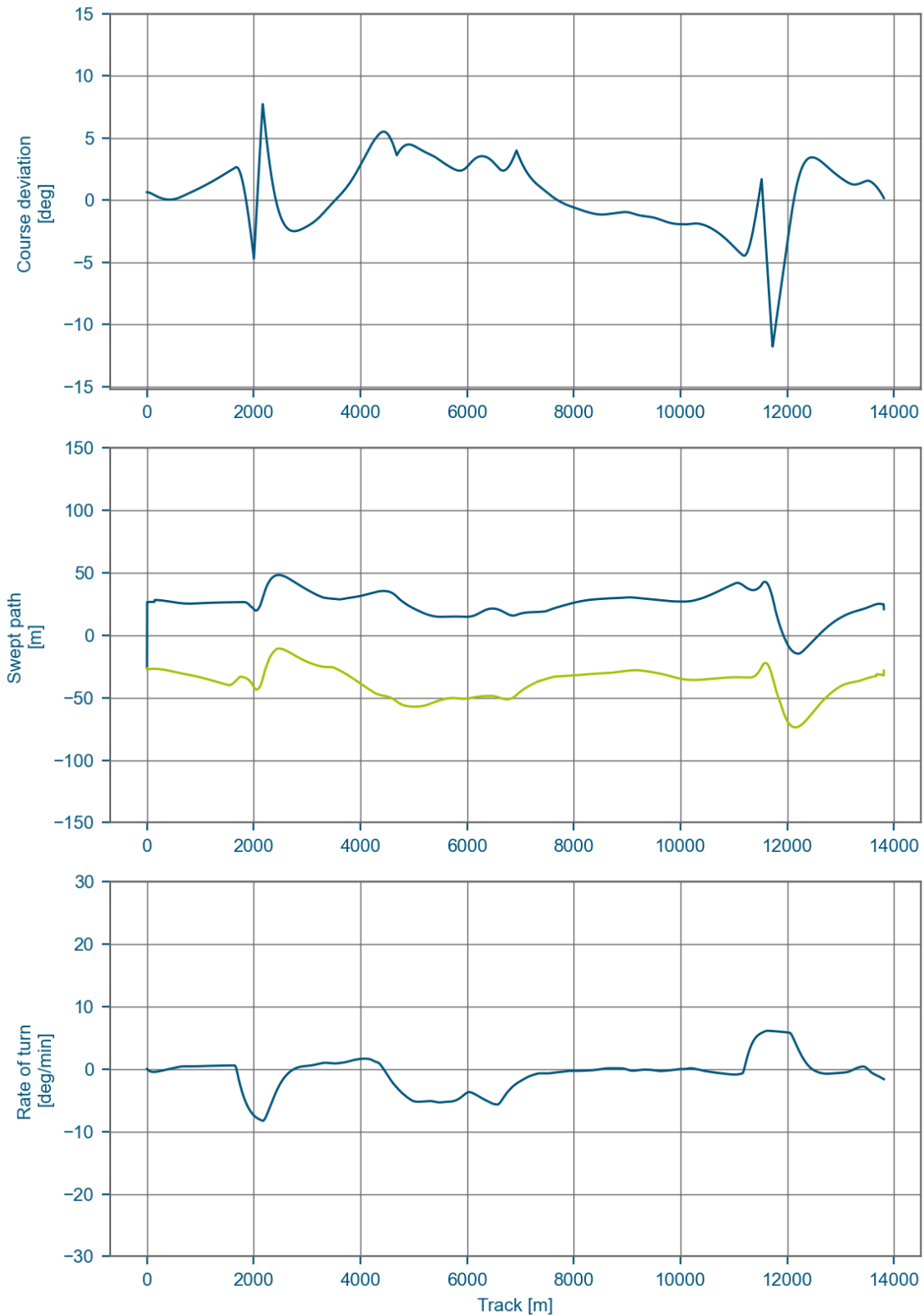


Figure 2.108: S.C. 14: course deviation (drift angle), swept path, RoT, vs. distance.

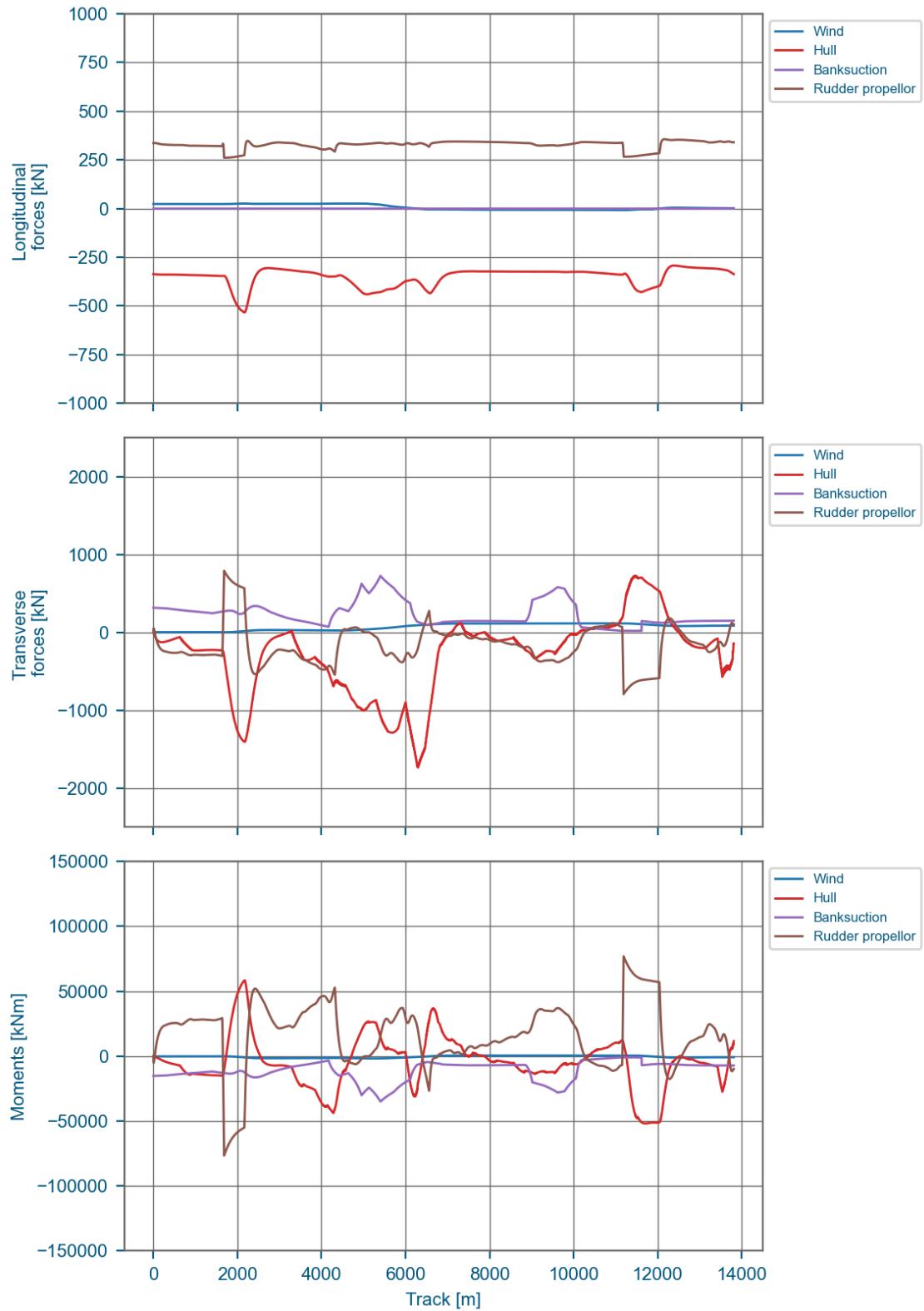


Figure 2.109: S.C. 14: forces, moments, vs. distance.

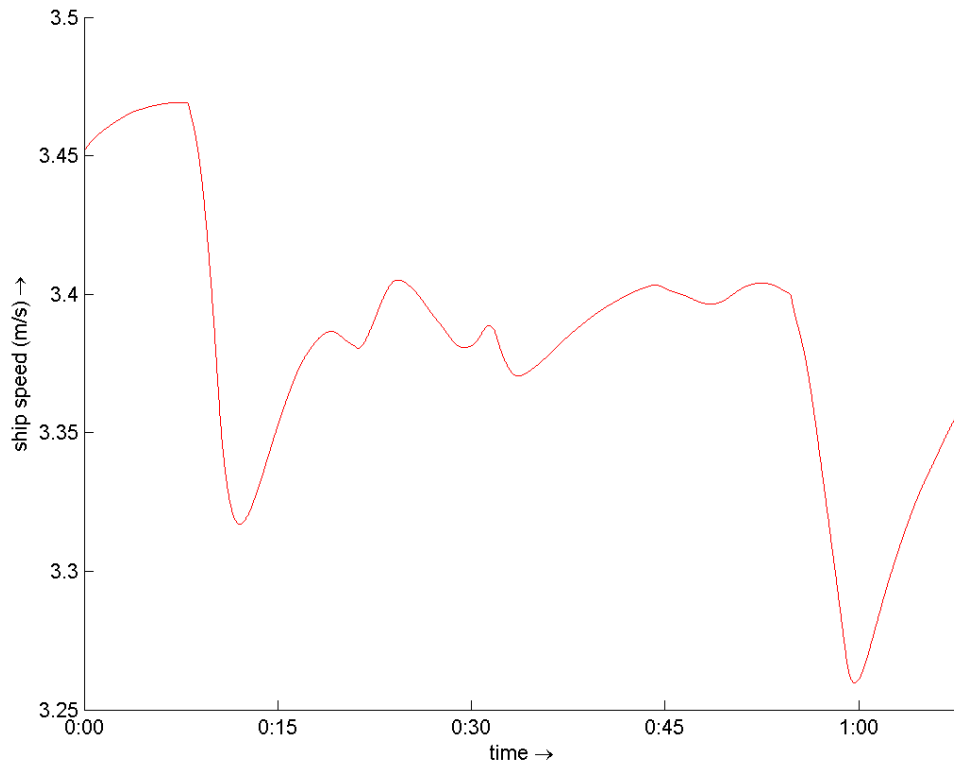


Figure 2.110: S.C. 14: SOG, vs. time.

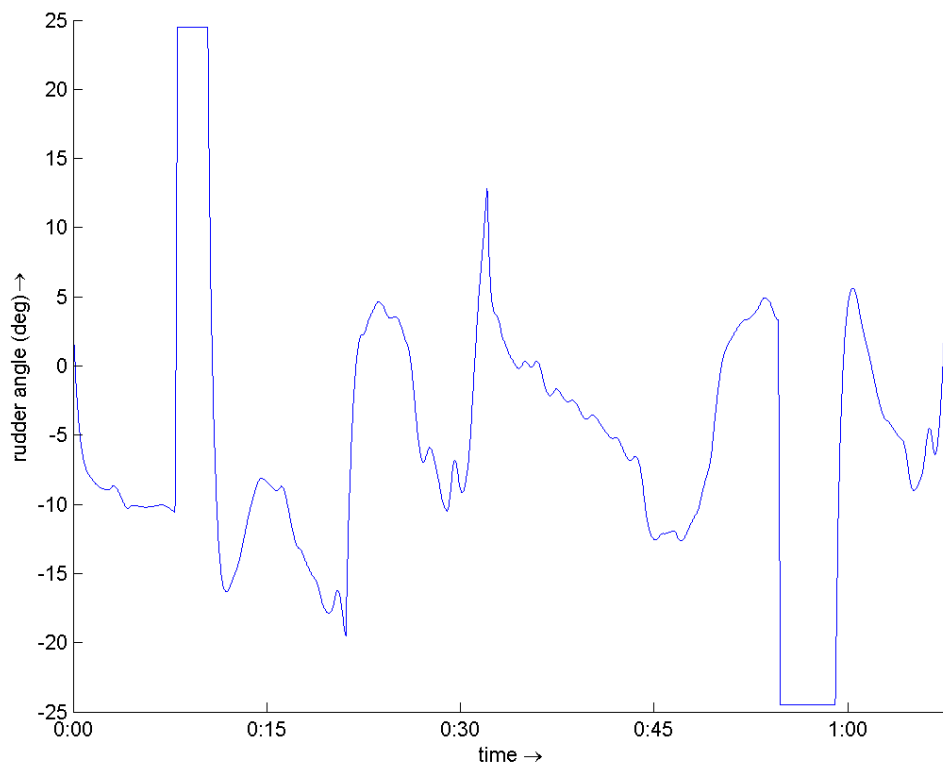


Figure 2.111: S.C. 14: rudder angle, vs. time.

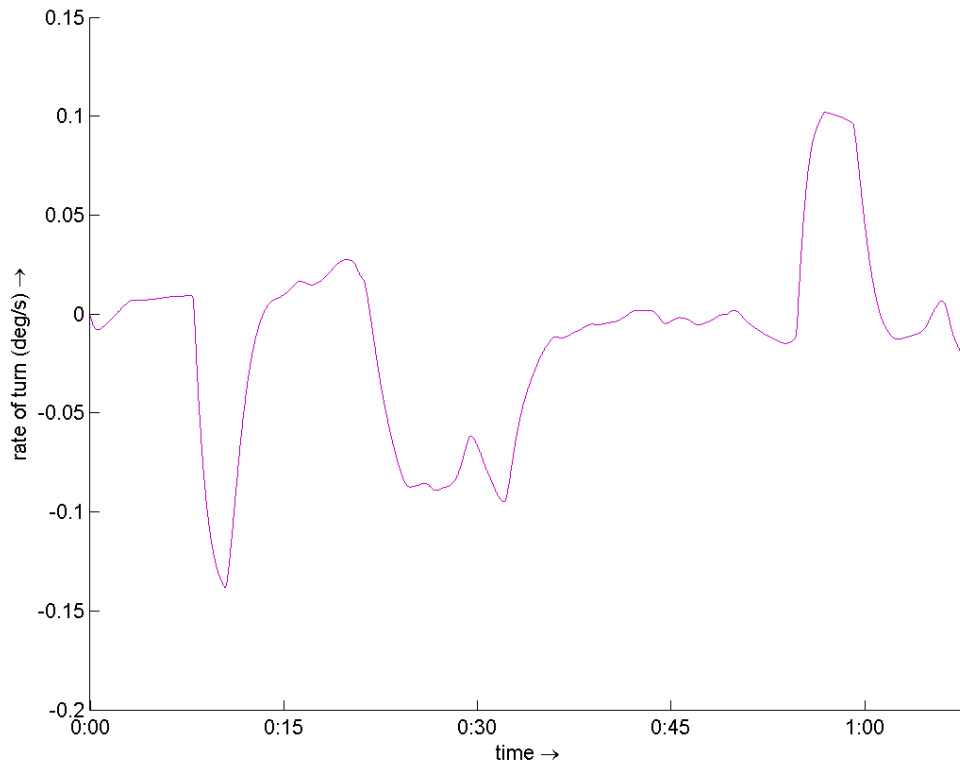


Figure 2.112: S.C. 14: RoT, vs. time.

## Simulation Case 15

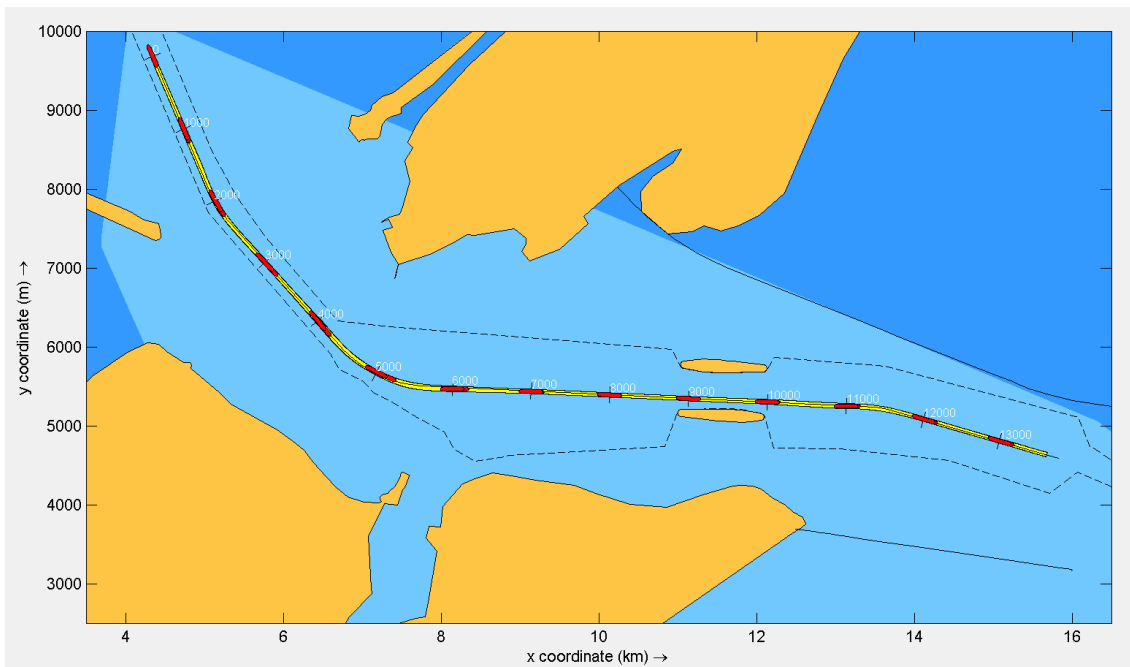
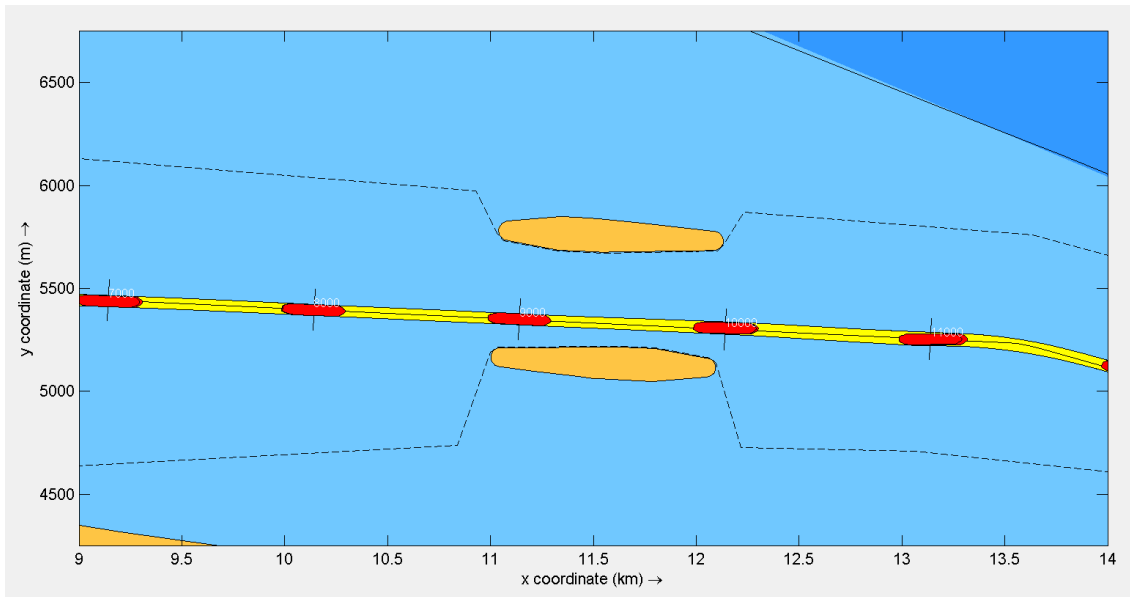


Figure 2.113: S.C. 15: spatial overview plot.



**Figure 2.114:** S.C. 15: zoom-in of spatial overview plot, crossing segment.

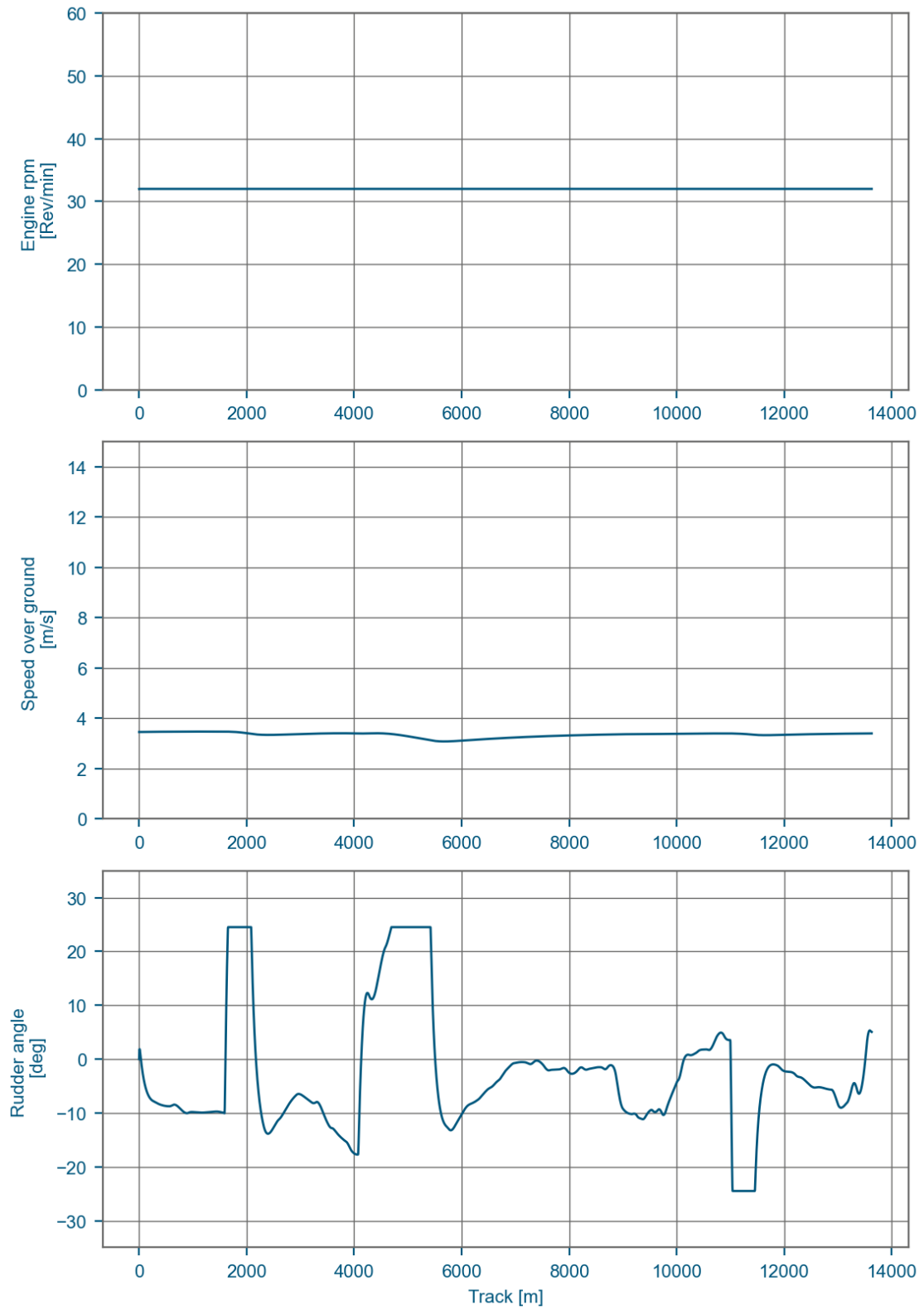


Figure 2.115: S.C. 15: engine RPM, SOG, rudder angle, vs. distance.

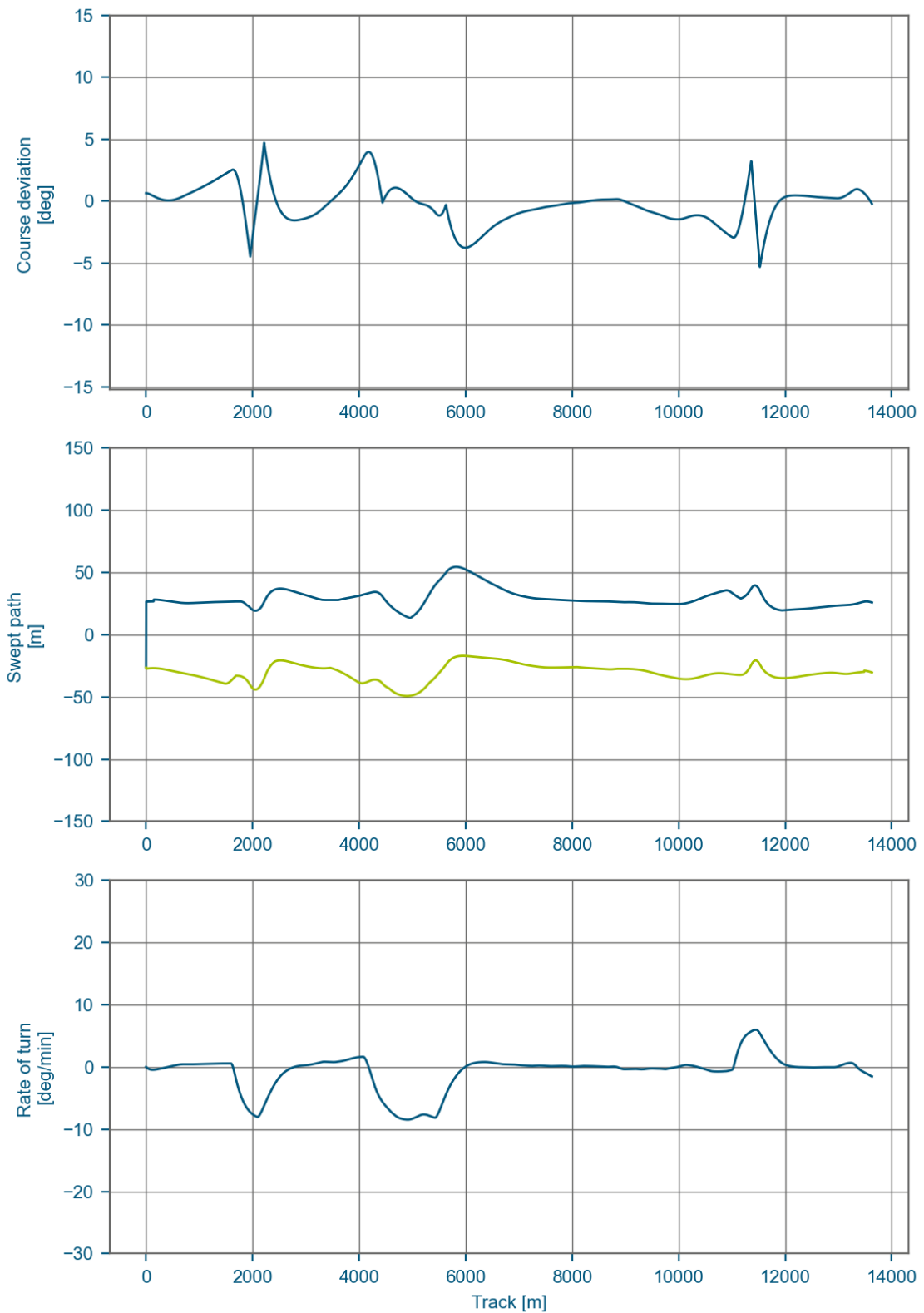


Figure 2.116: S.C. 15: course deviation (drift angle), swept path, RoT, vs. distance.

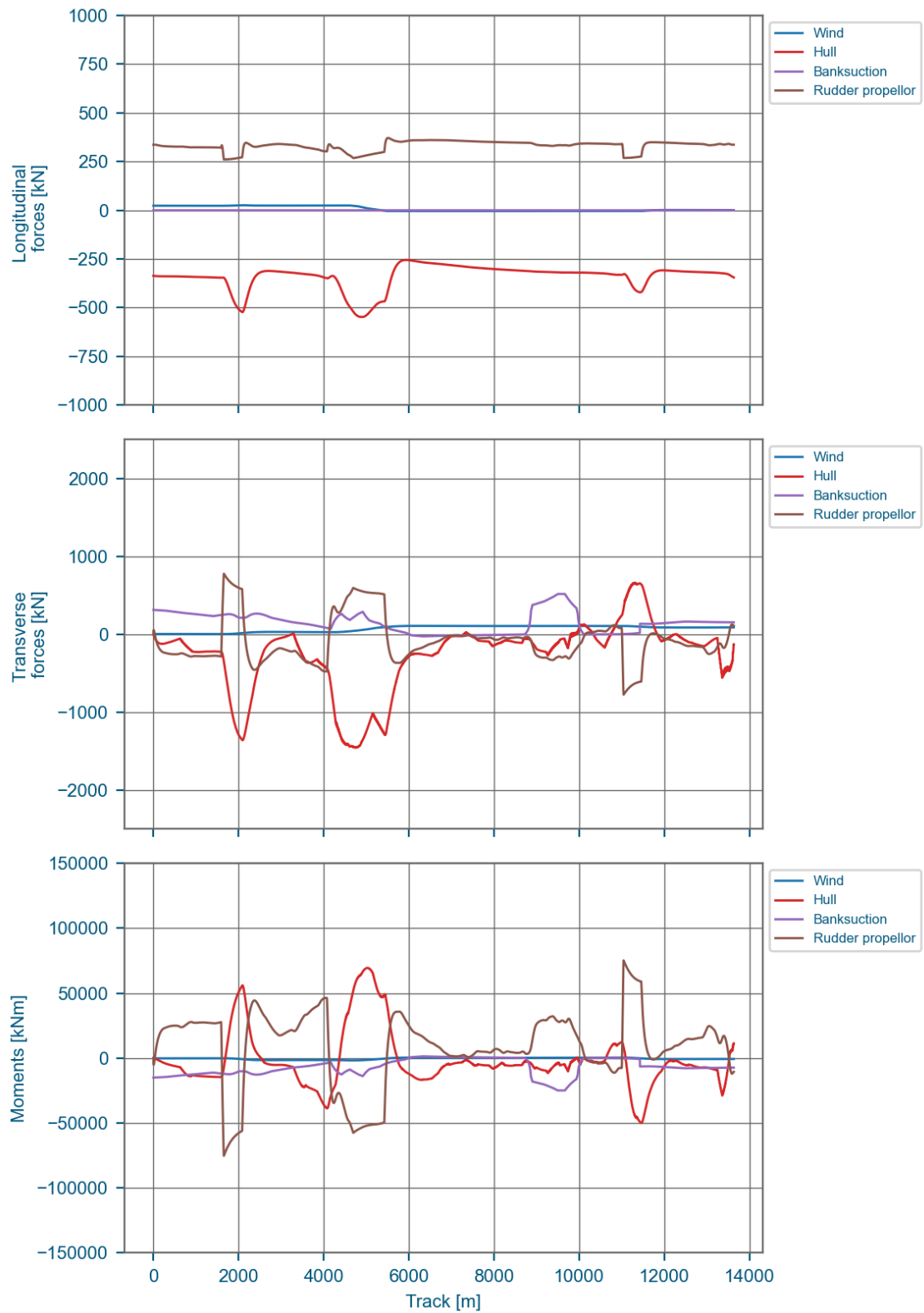


Figure 2.117: S.C. 15: forces, moments, vs. distance.

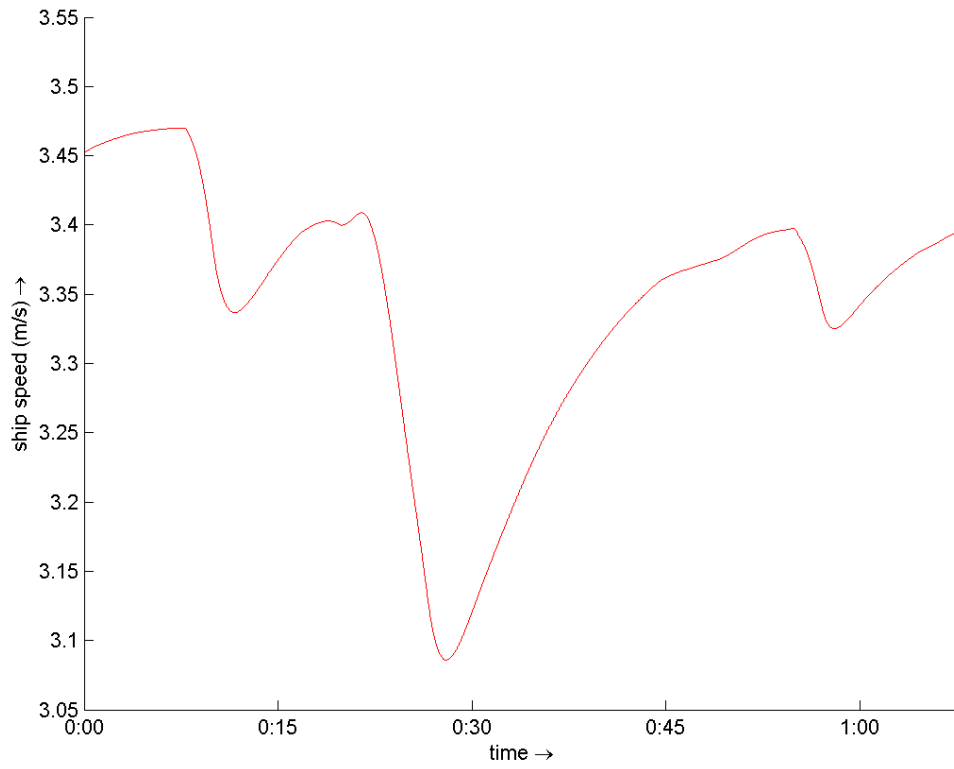


Figure 2.118: S.C. 15: SOG, vs. time.

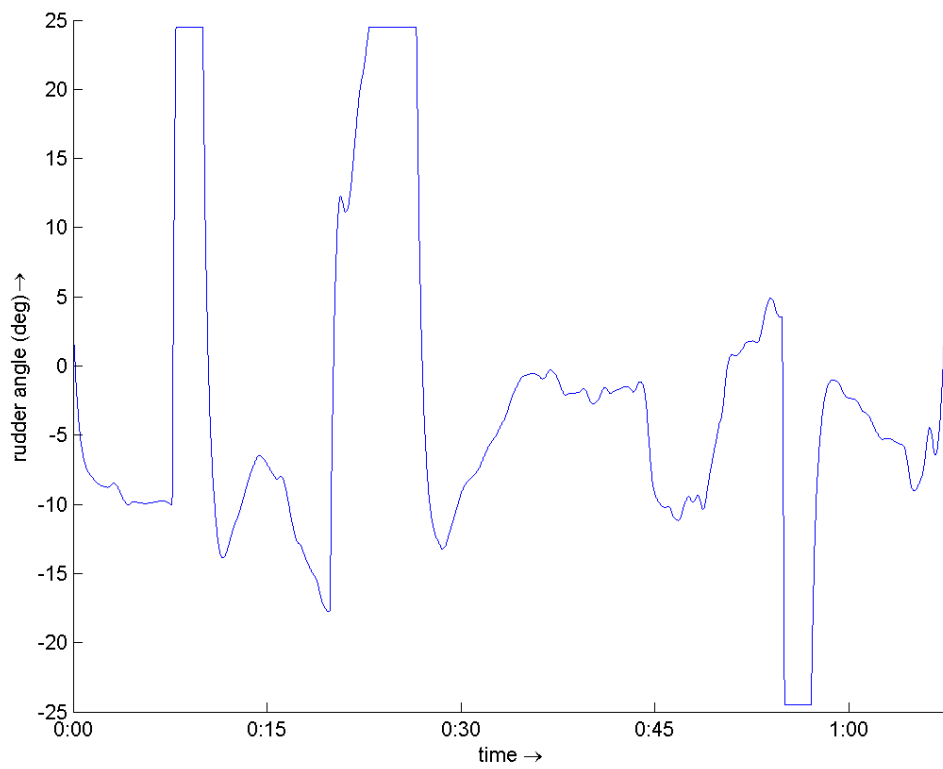


Figure 2.119: S.C. 15: rudder angle, vs. time.

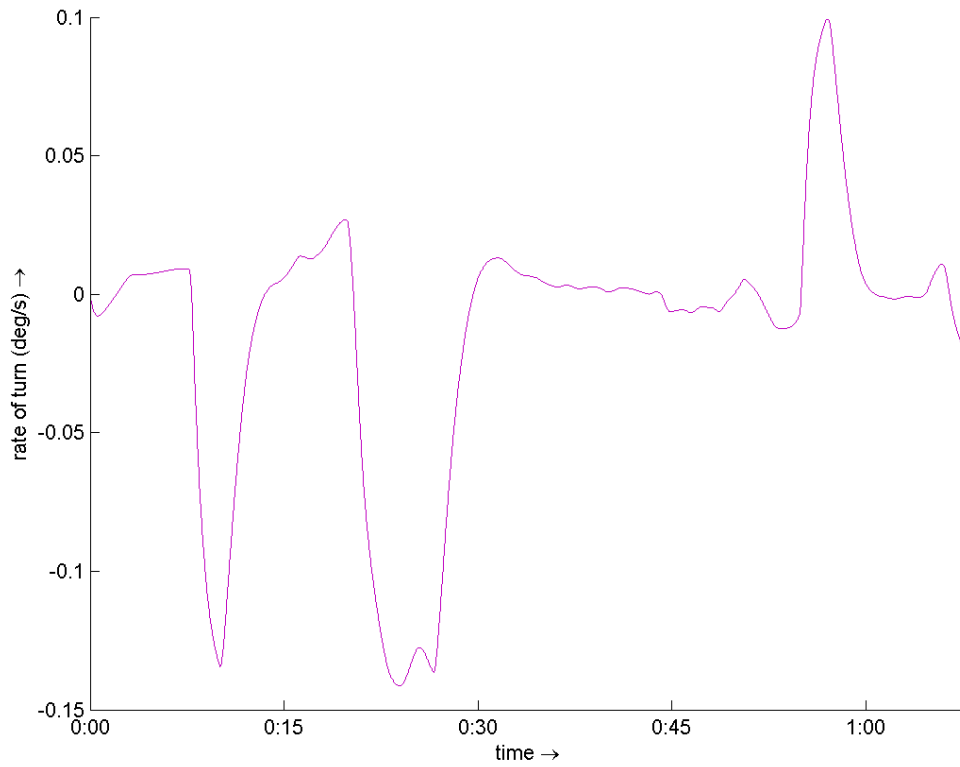


Figure 2.120: S.C. 15: RoT, vs. time.

## Simulation Case 16

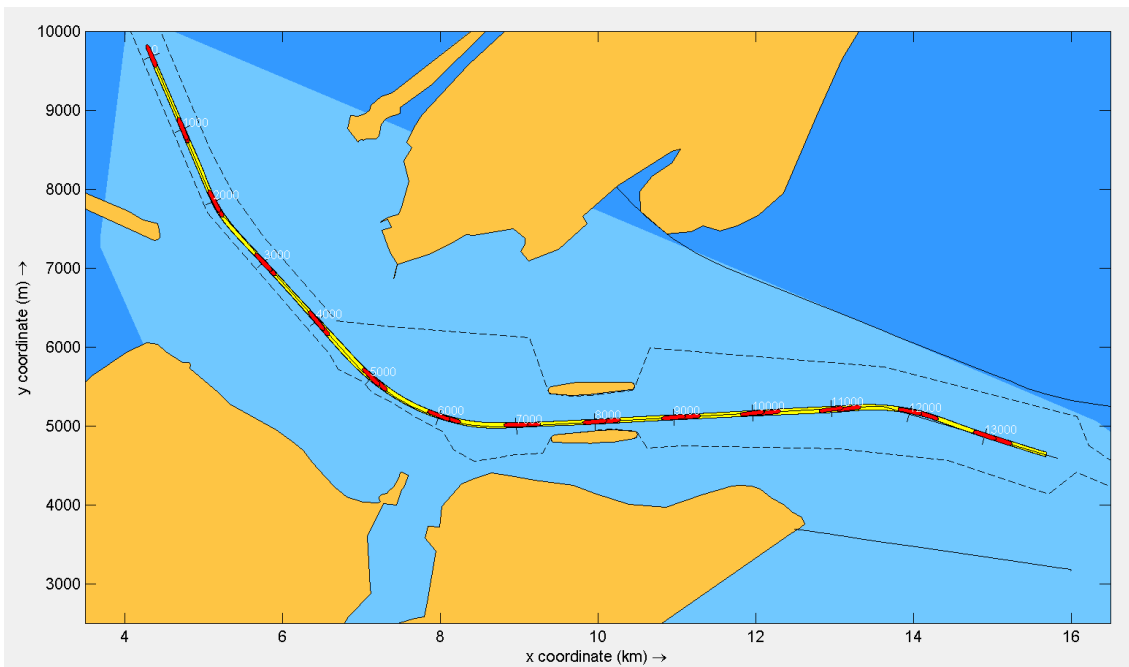
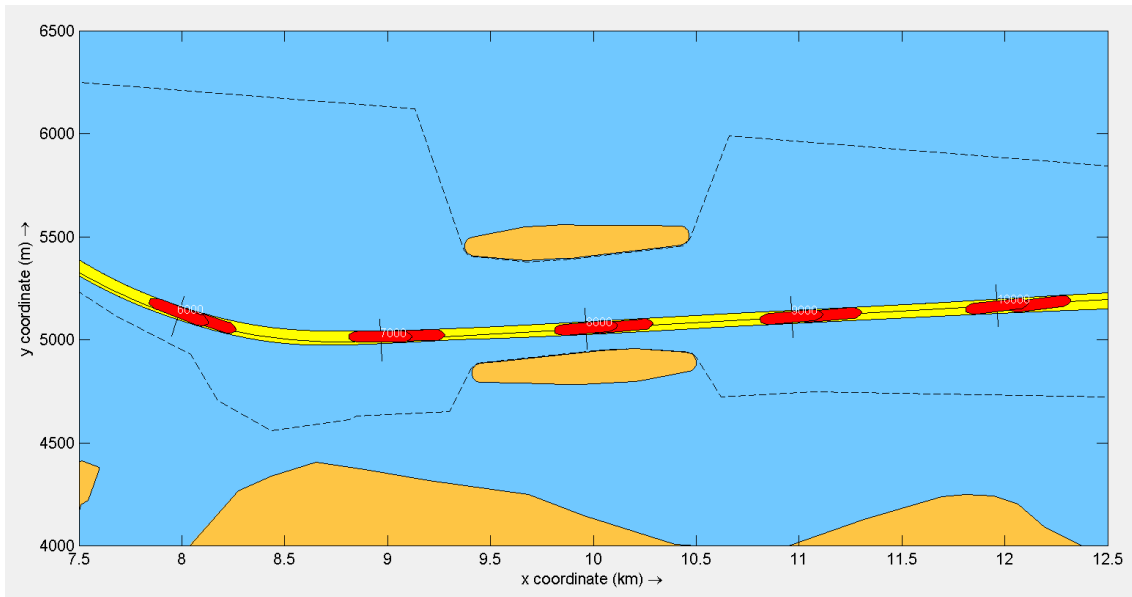


Figure 2.121: S.C. 16: spatial overview plot.



**Figure 2.122:** S.C. 16: zoom-in of spatial overview plot, crossing segment.

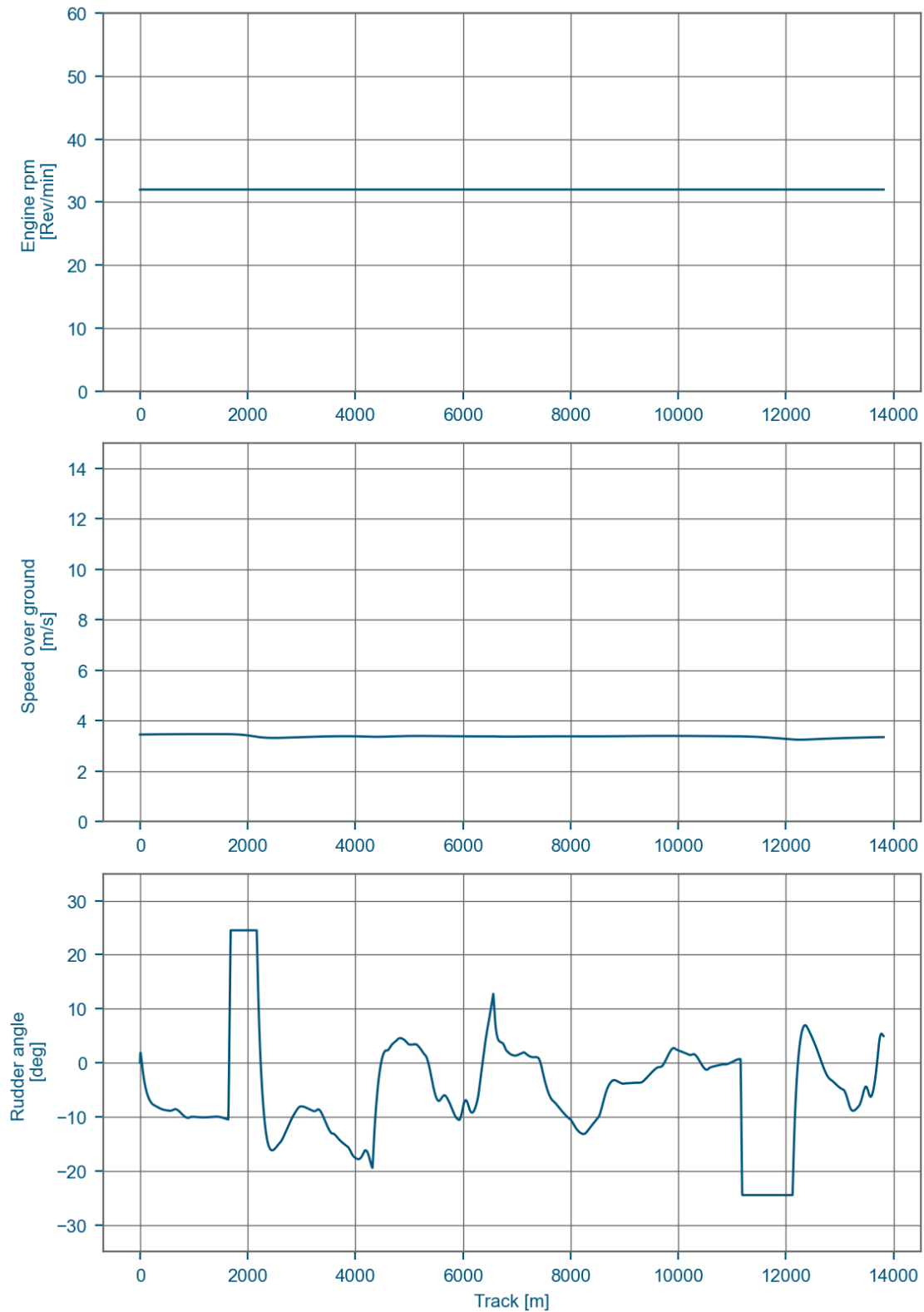


Figure 2.123: S.C. 16: engine RPM, SOG, rudder angle, vs. distance.

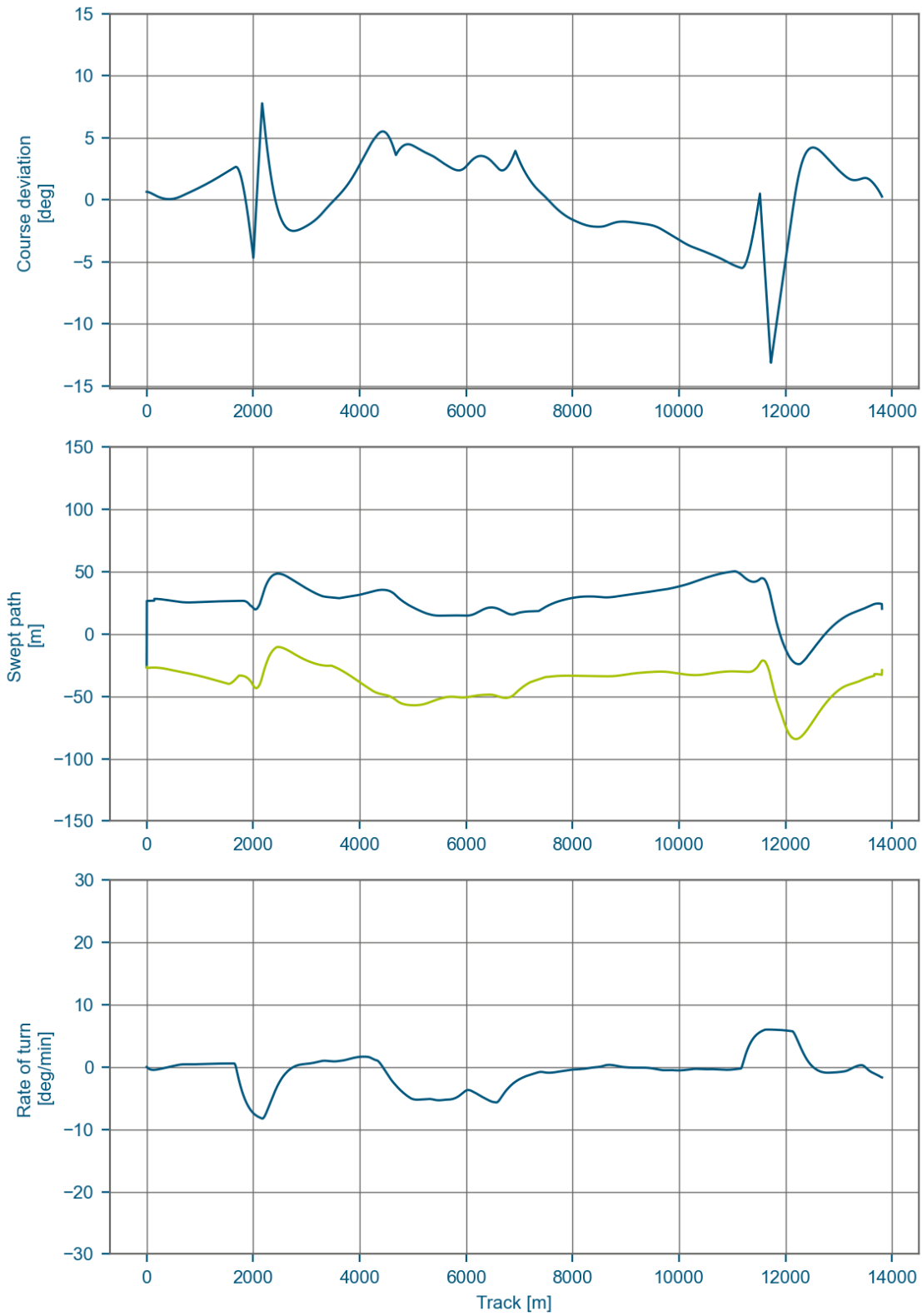


Figure 2.124: S.C. 16: course deviation (drift angle), swept path, RoT, vs. distance.

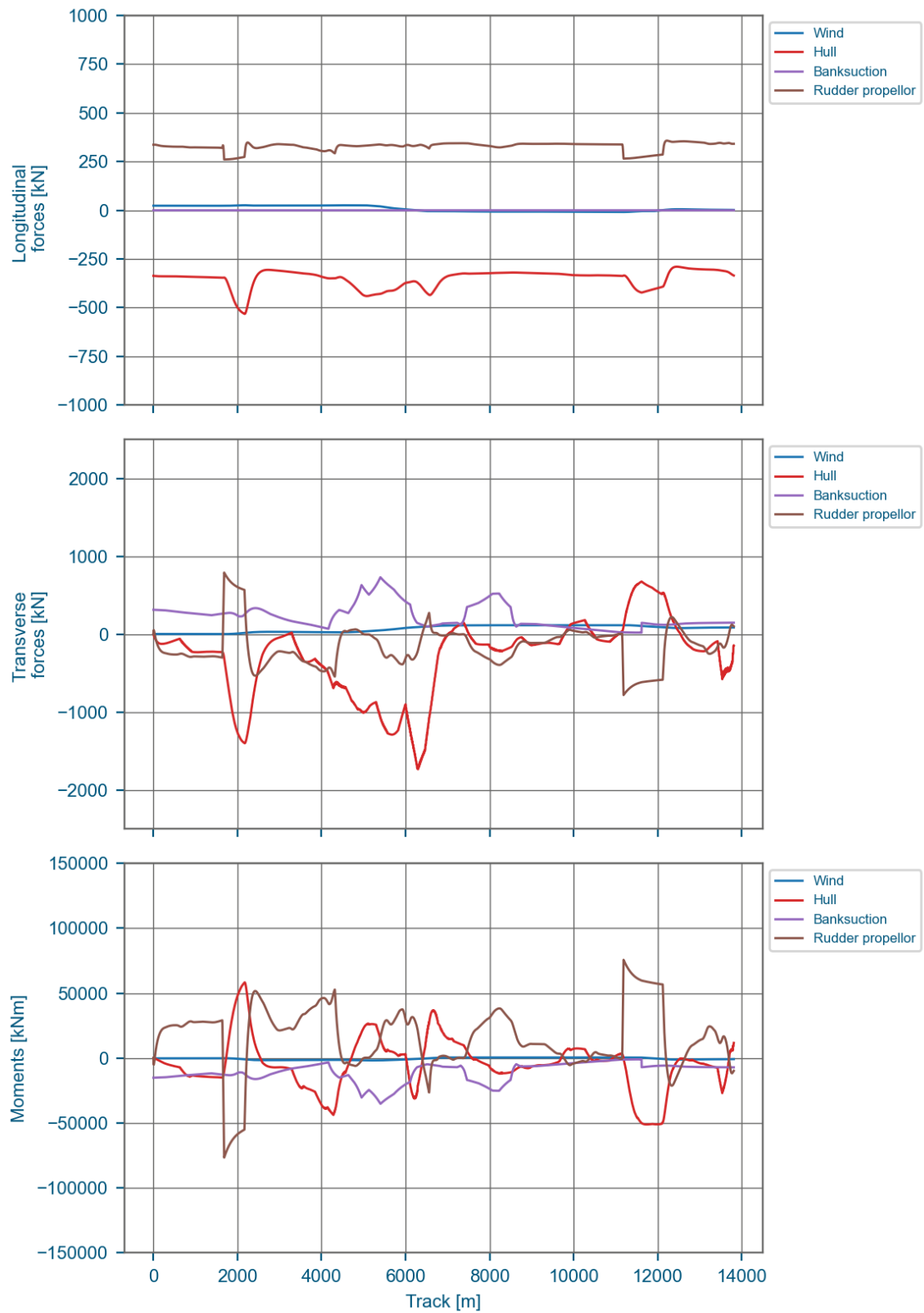


Figure 2.125: S.C. 16: forces, moments, vs. distance.

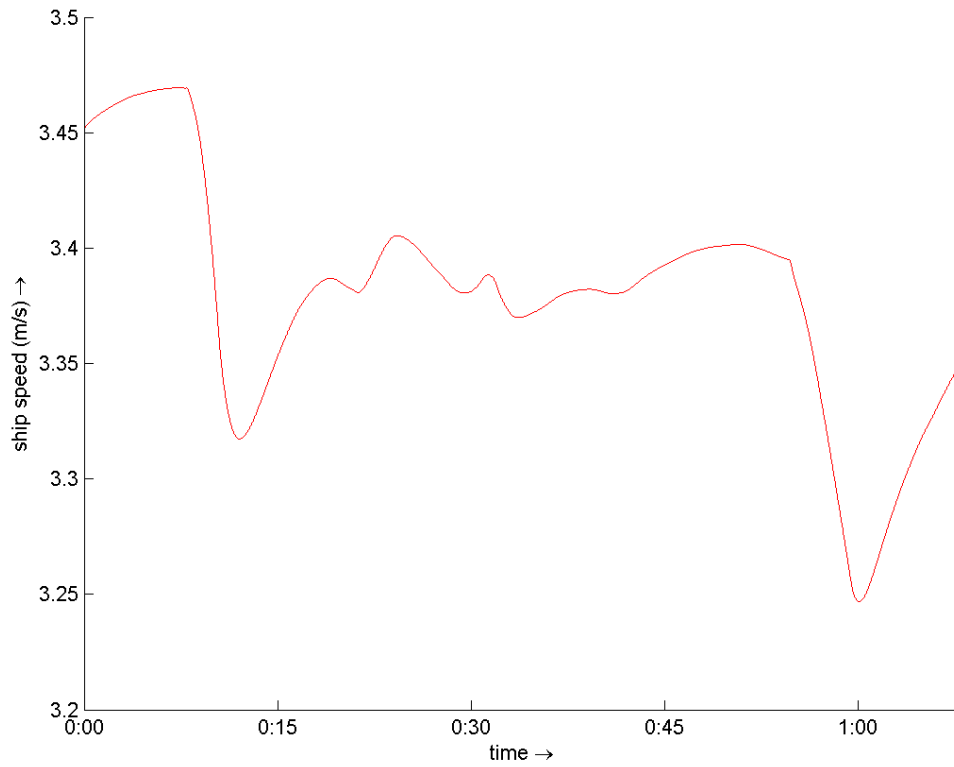


Figure 2.126: S.C. 16: SOG, vs. time.

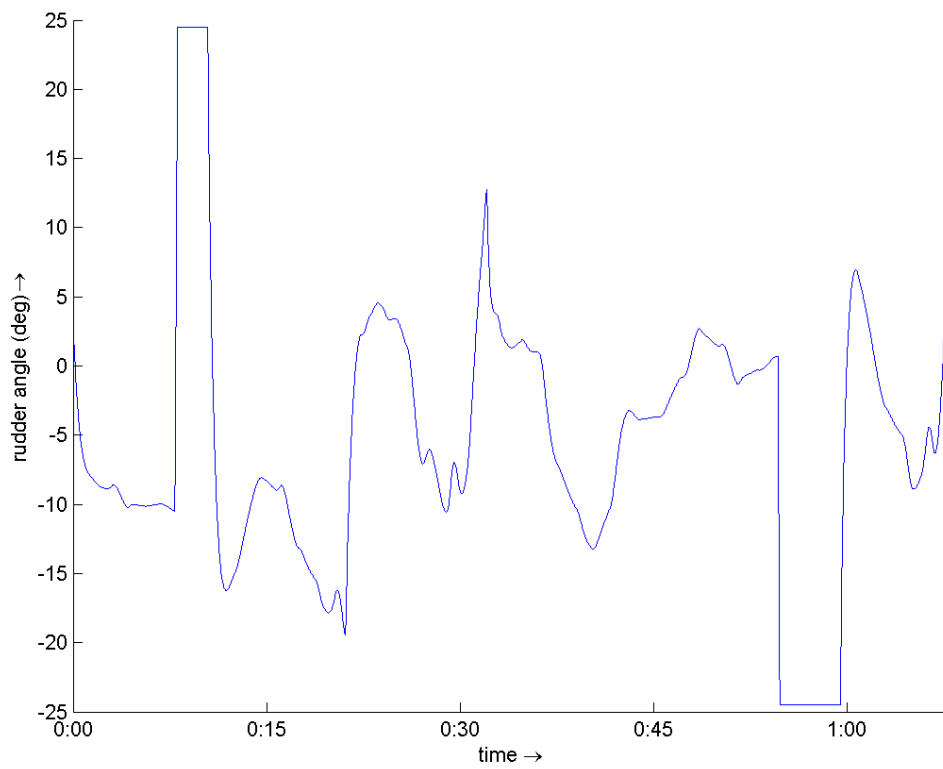


Figure 2.127: S.C. 16: rudder angle, vs. time.

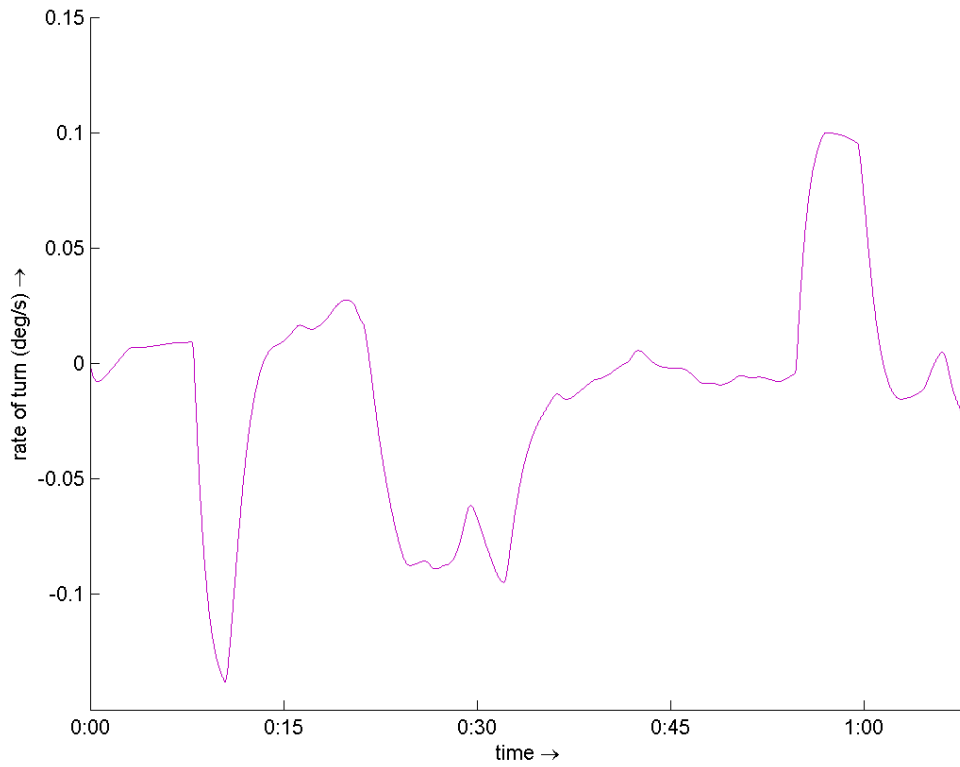


Figure 2.128: S.C. 16: RoT, vs. time.

## Simulation Case 17

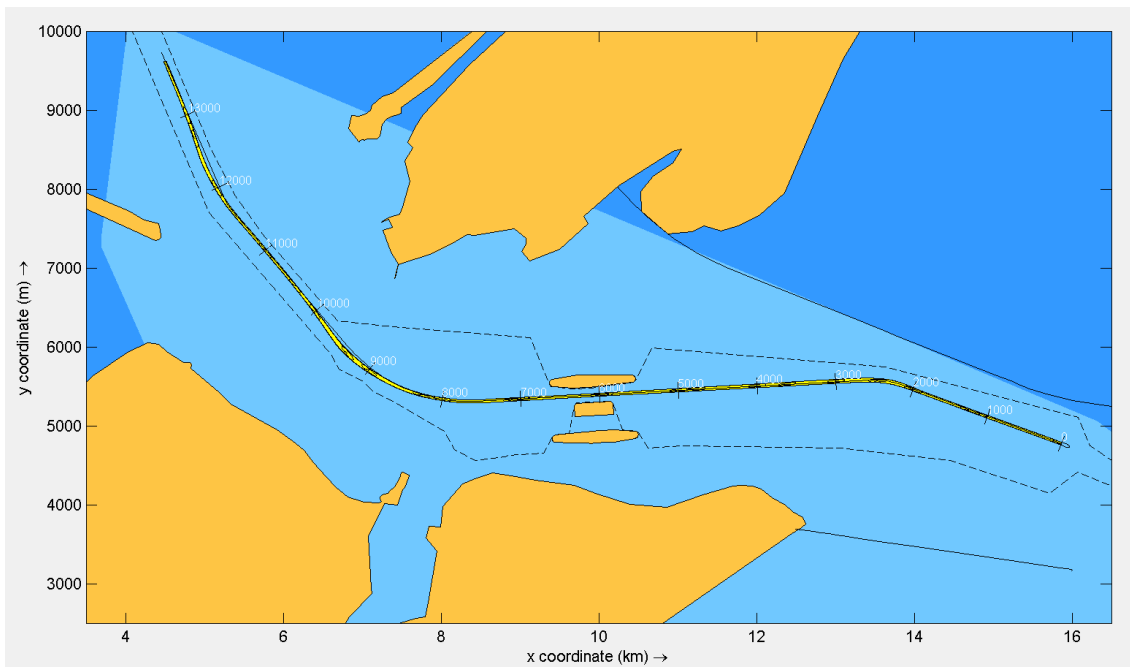
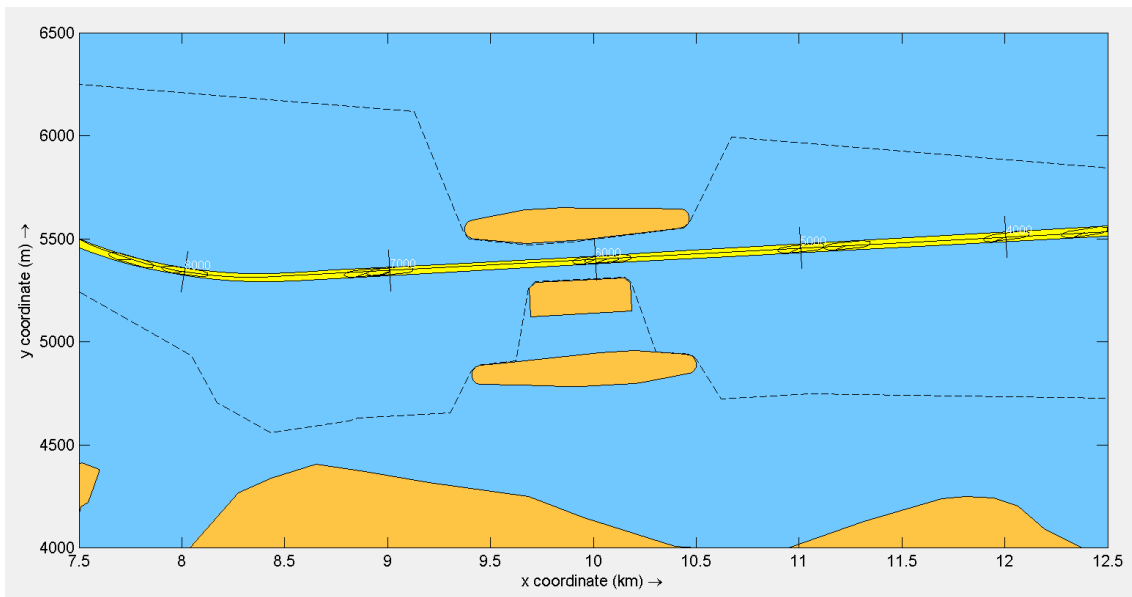


Figure 2.129: S.C. 17: spatial overview plot.



**Figure 2.130:** S.C. 17: zoom-in of spatial overview plot, crossing segment.

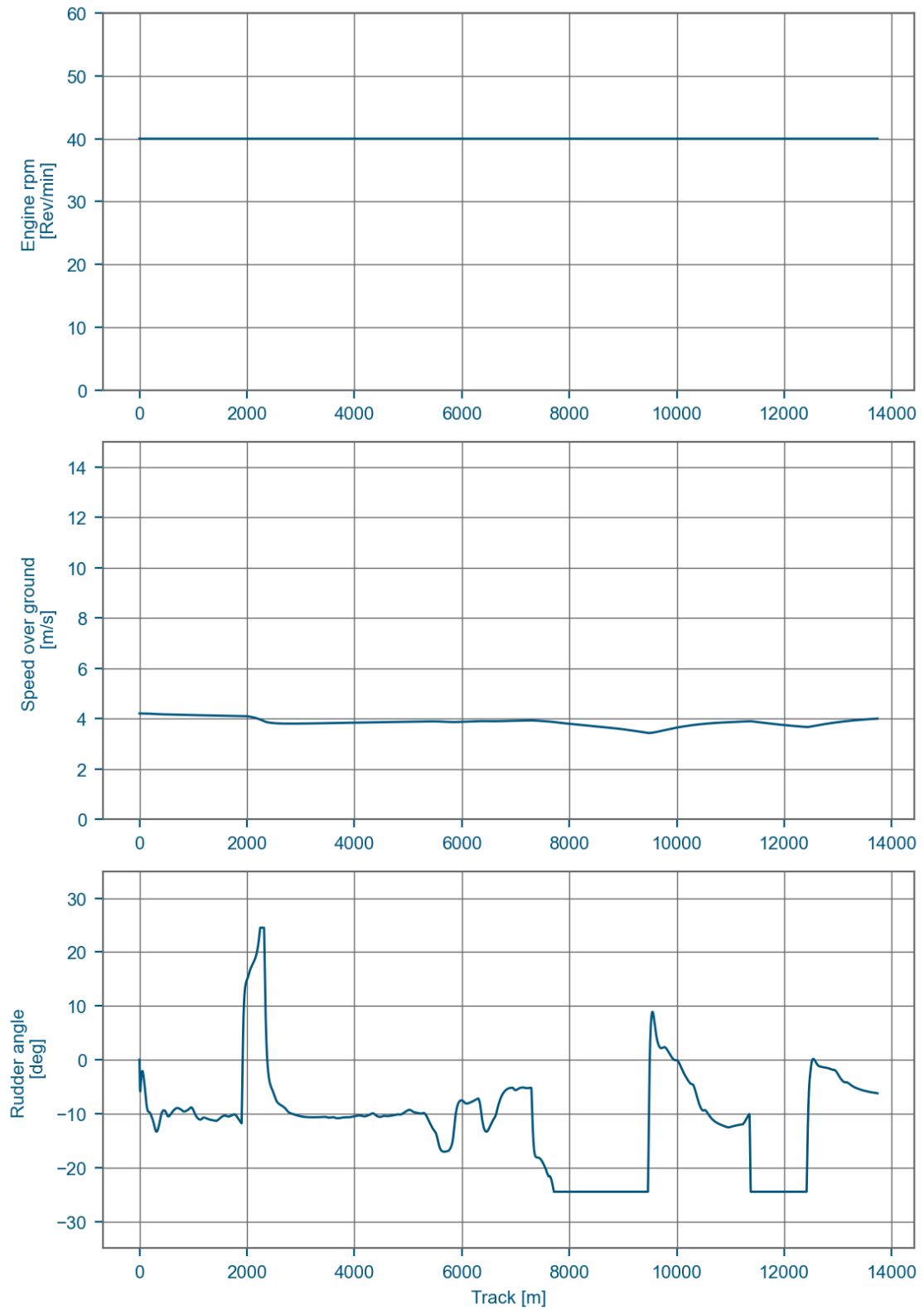


Figure 2.131: S.C. 17: engine RPM, SOG, rudder angle, vs. distance.

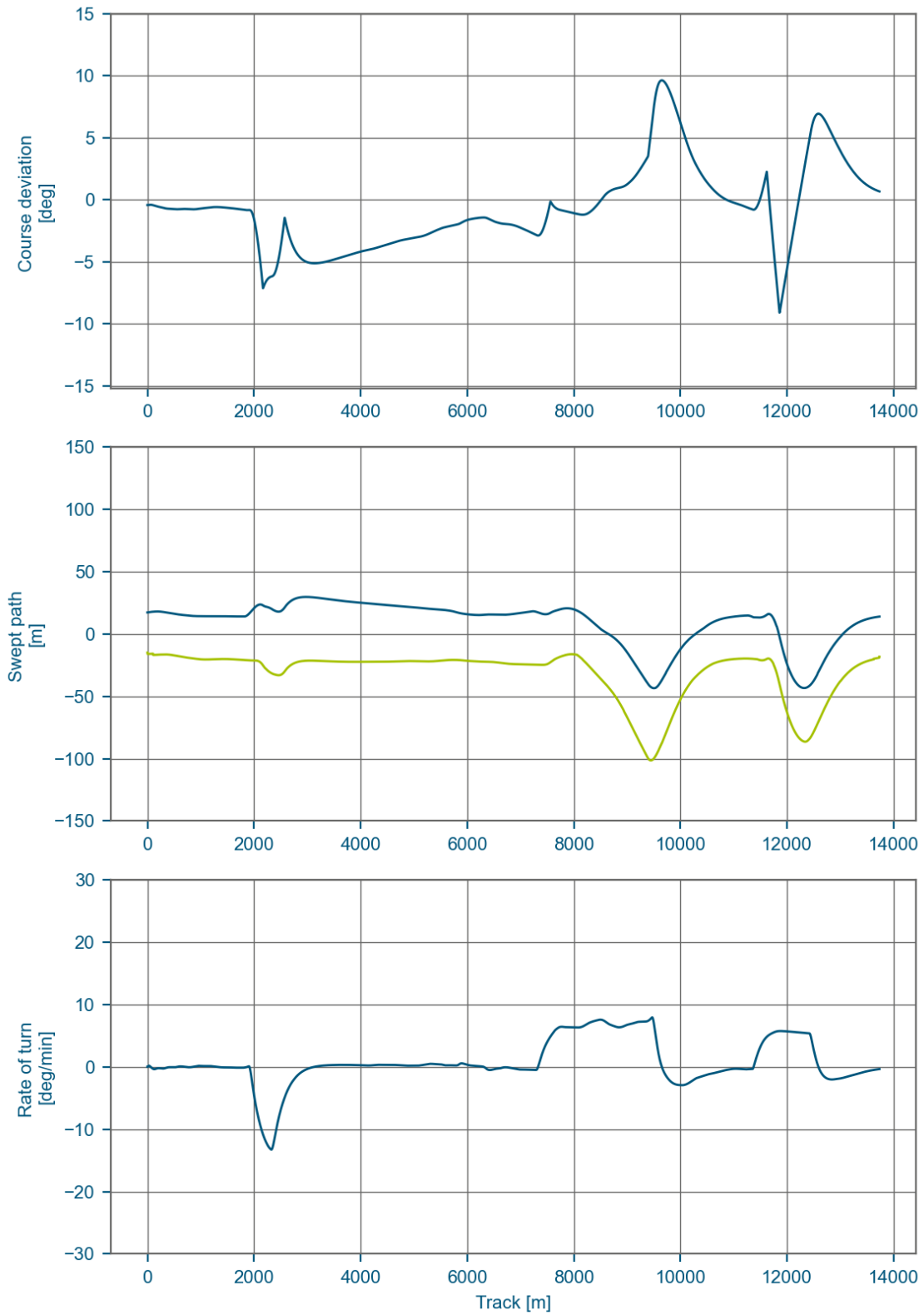


Figure 2.132: S.C. 17: course deviation (drift angle), swept path, RoT, vs. distance.

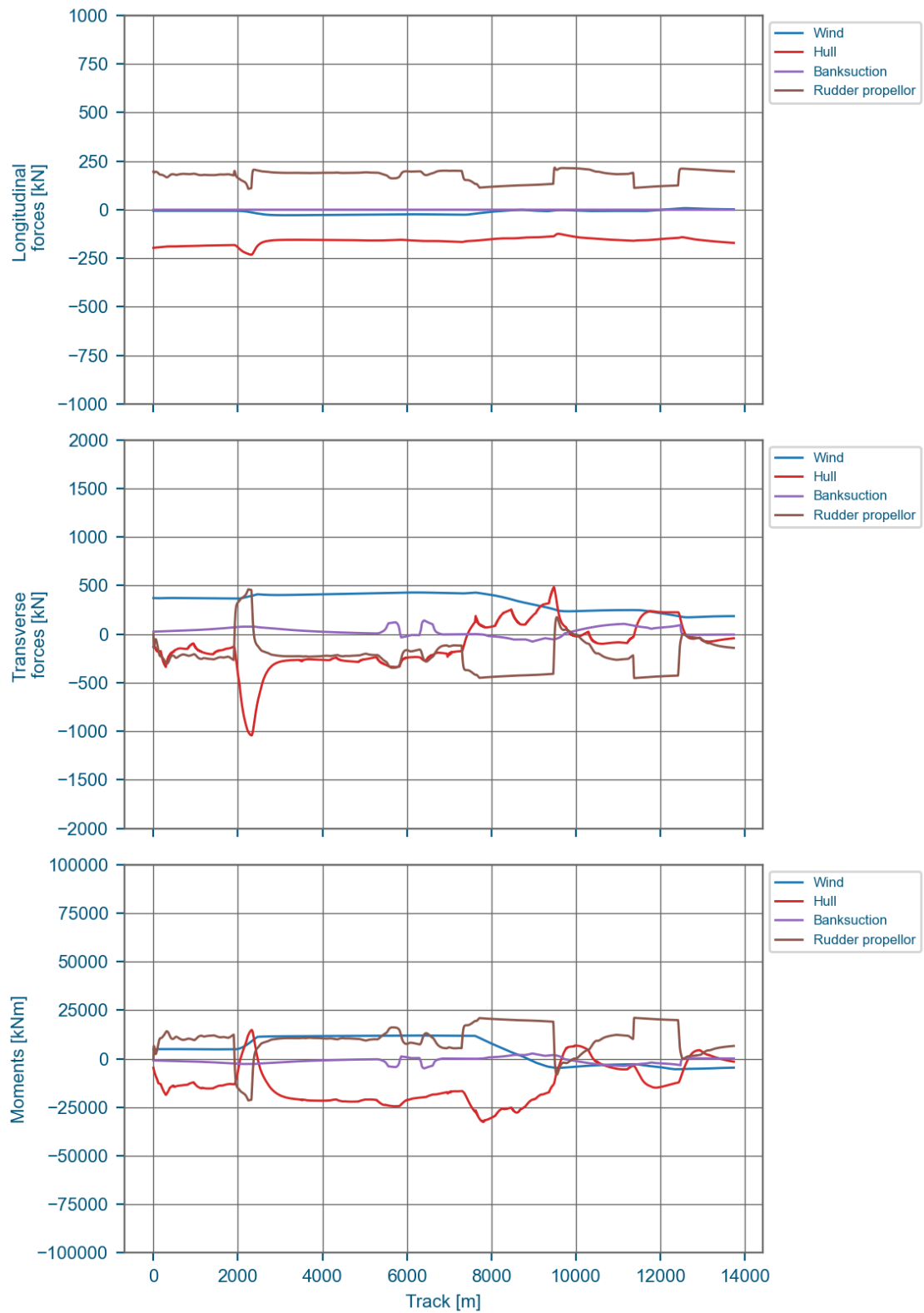


Figure 2.133: S.C. 17: forces, moments, vs. distance.

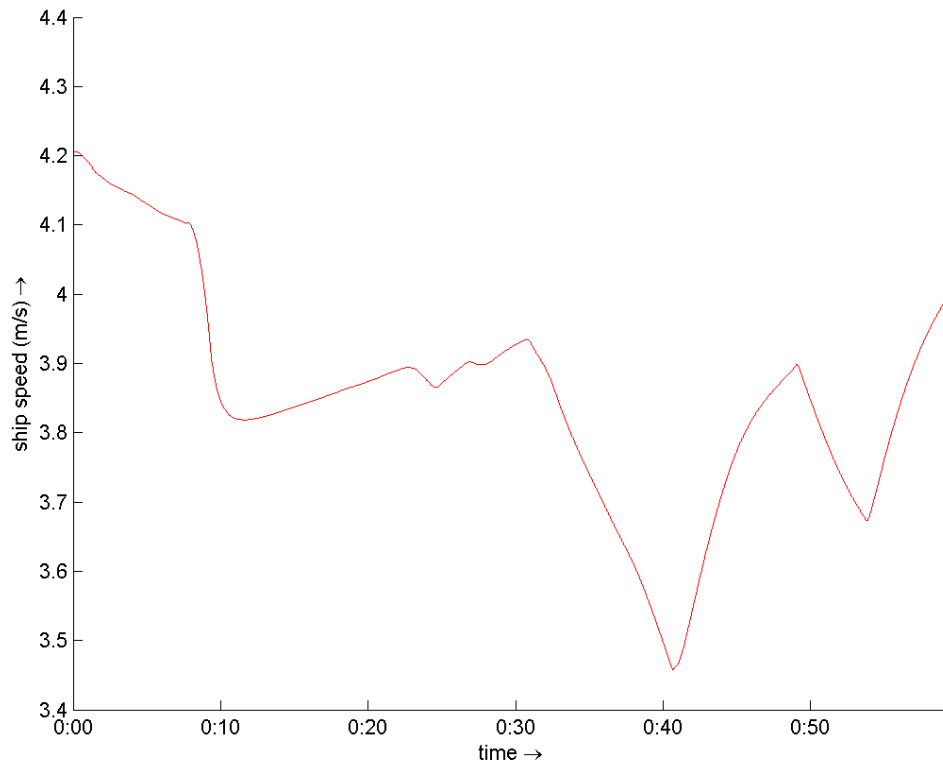


Figure 2.134: S.C. 17: SOG, vs. time.

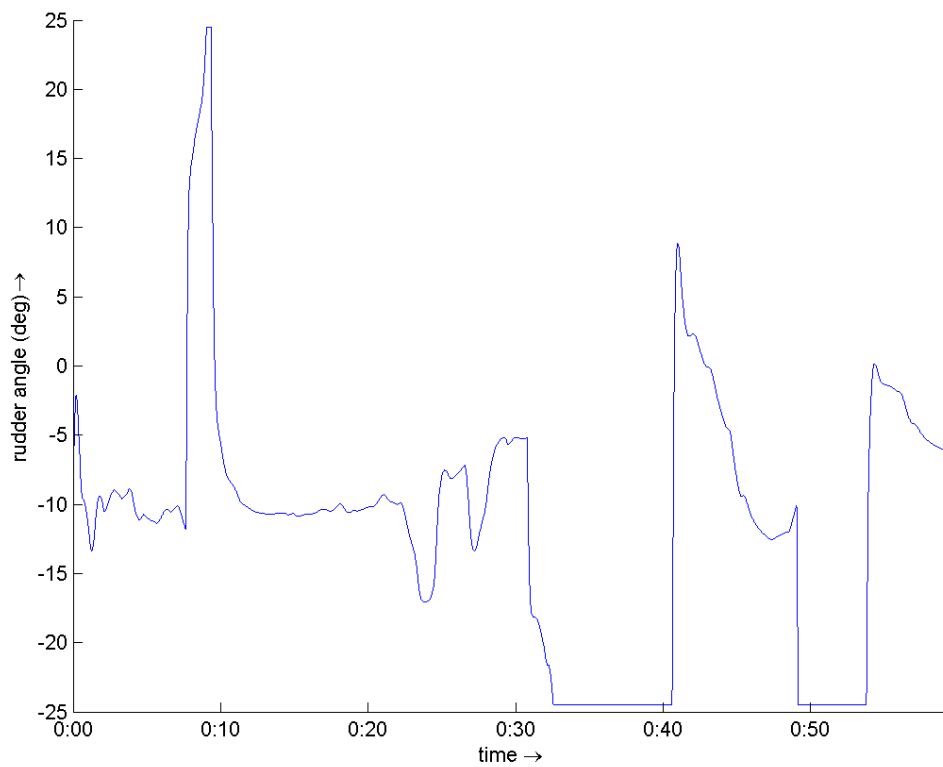


Figure 2.135: S.C. 17: rudder angle, vs. time.

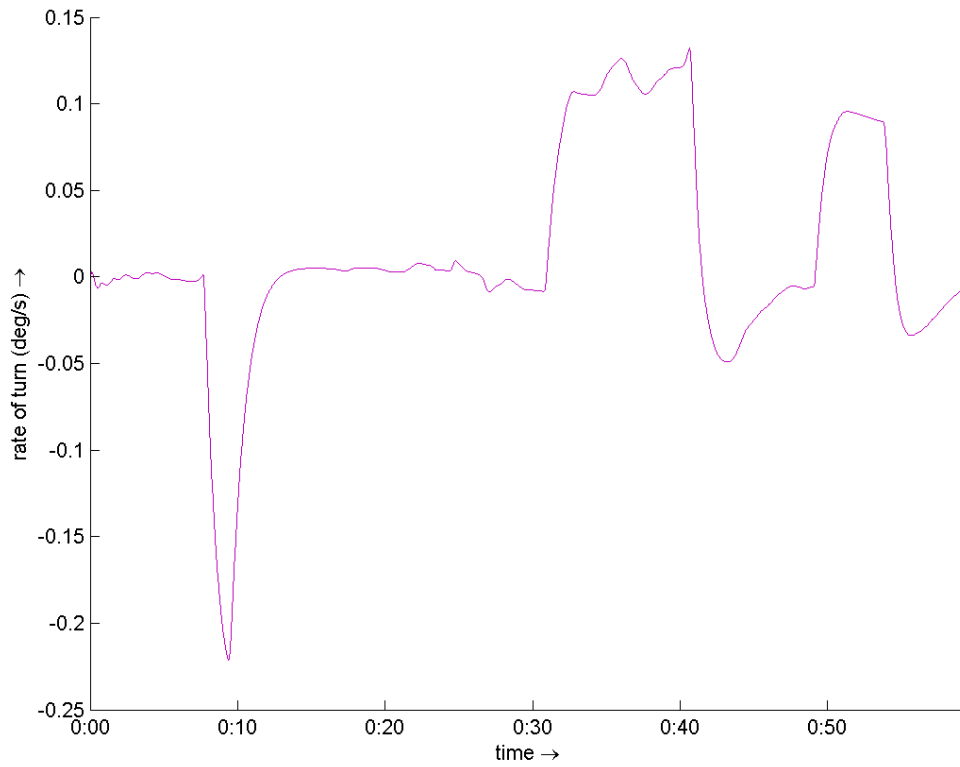


Figure 2.136: S.C. 17: RoT, vs. time.

## Simulation Case 18

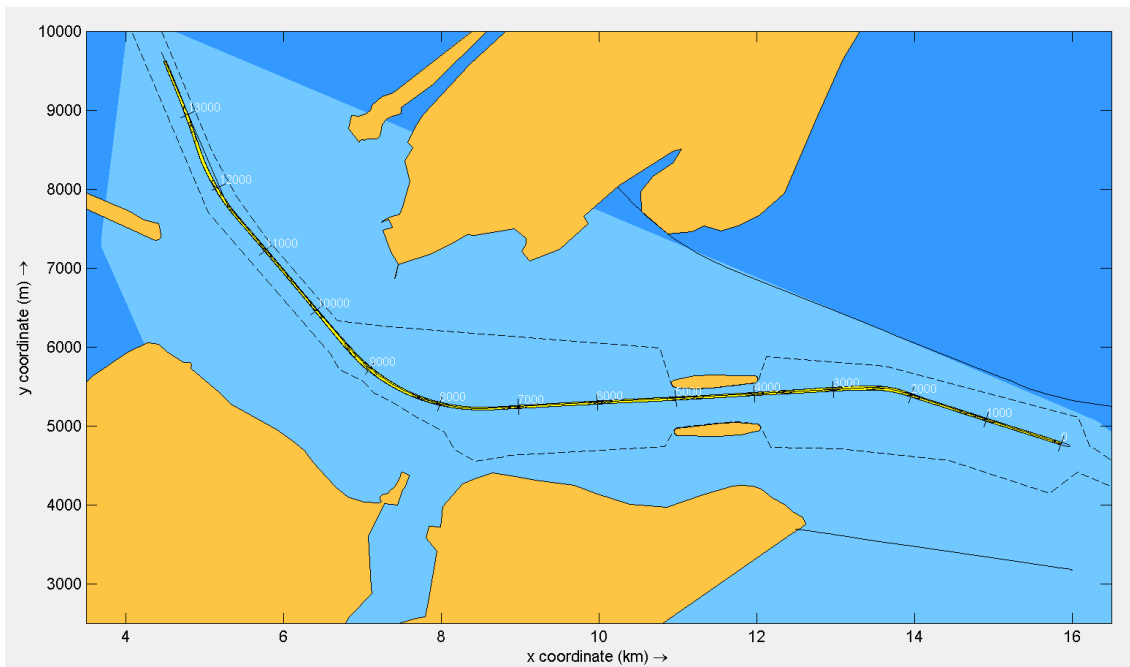
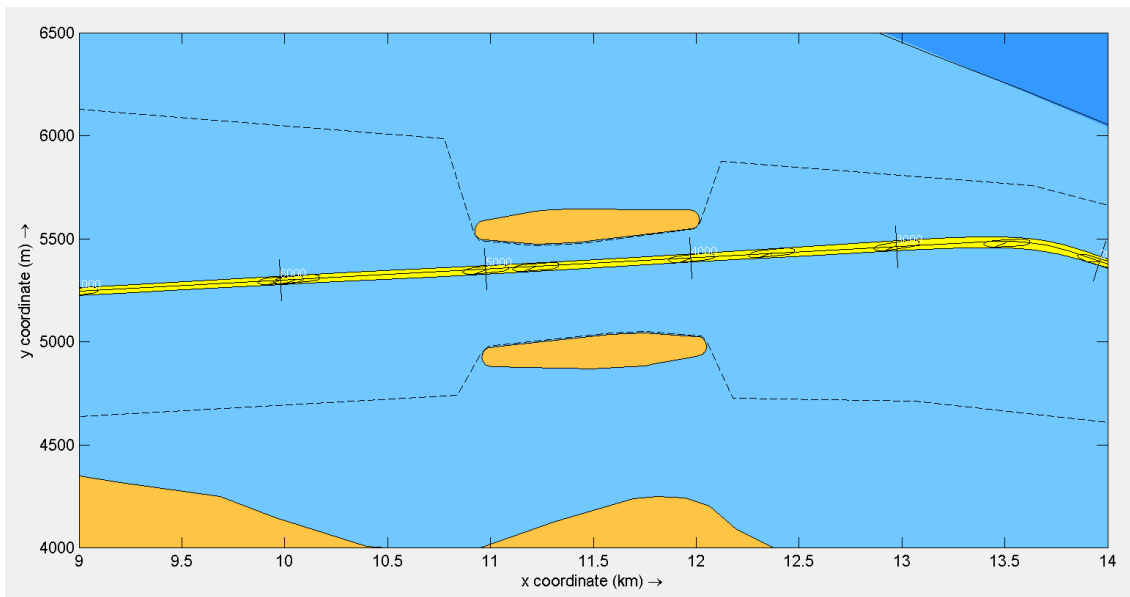


Figure 2.137: S.C. 18: spatial overview plot.



**Figure 2.138:** S.C. 18: zoom-in of spatial overview plot, crossing segment.

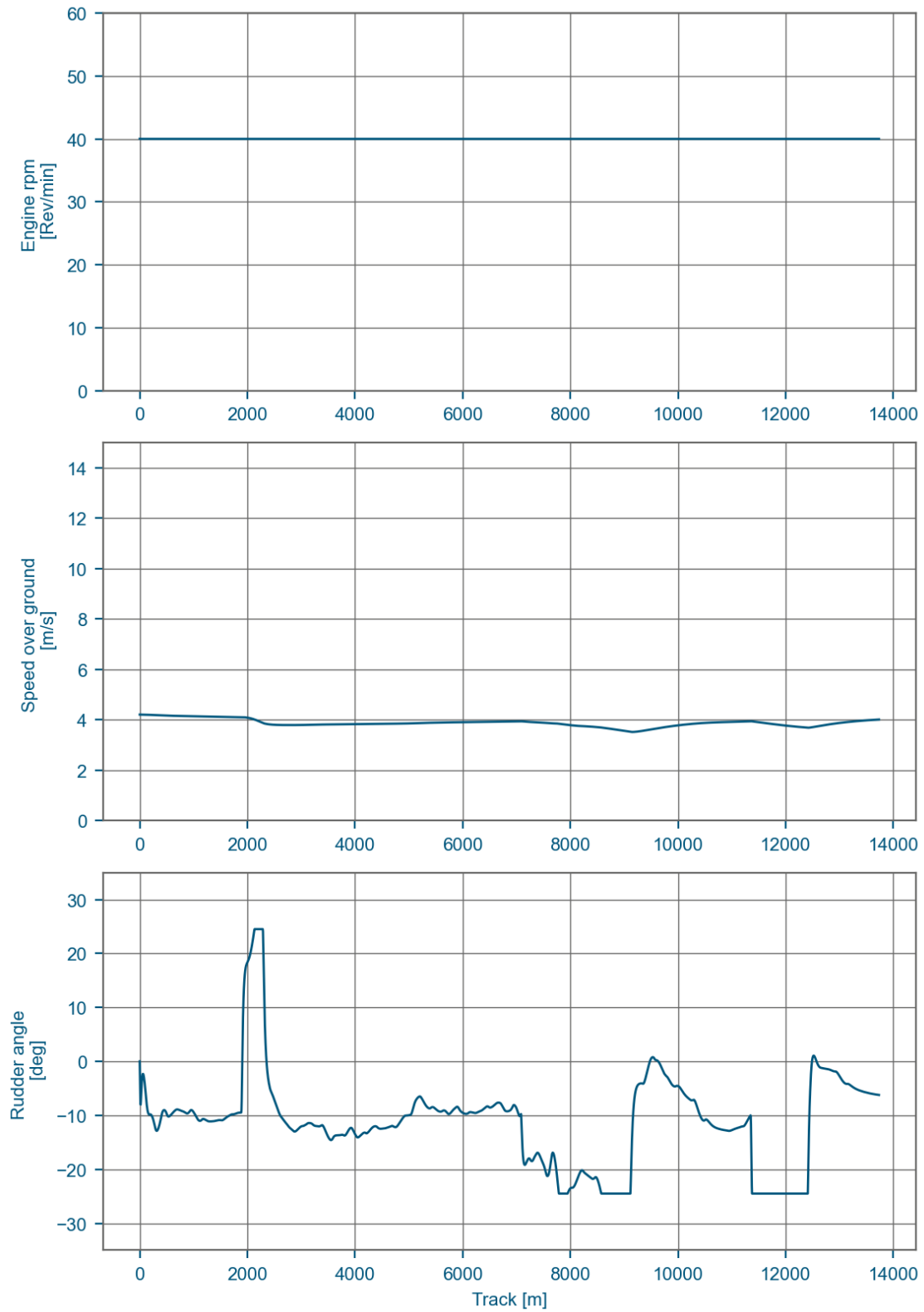


Figure 2.139: S.C. 18: engine RPM, SOG, rudder angle, vs. distance.

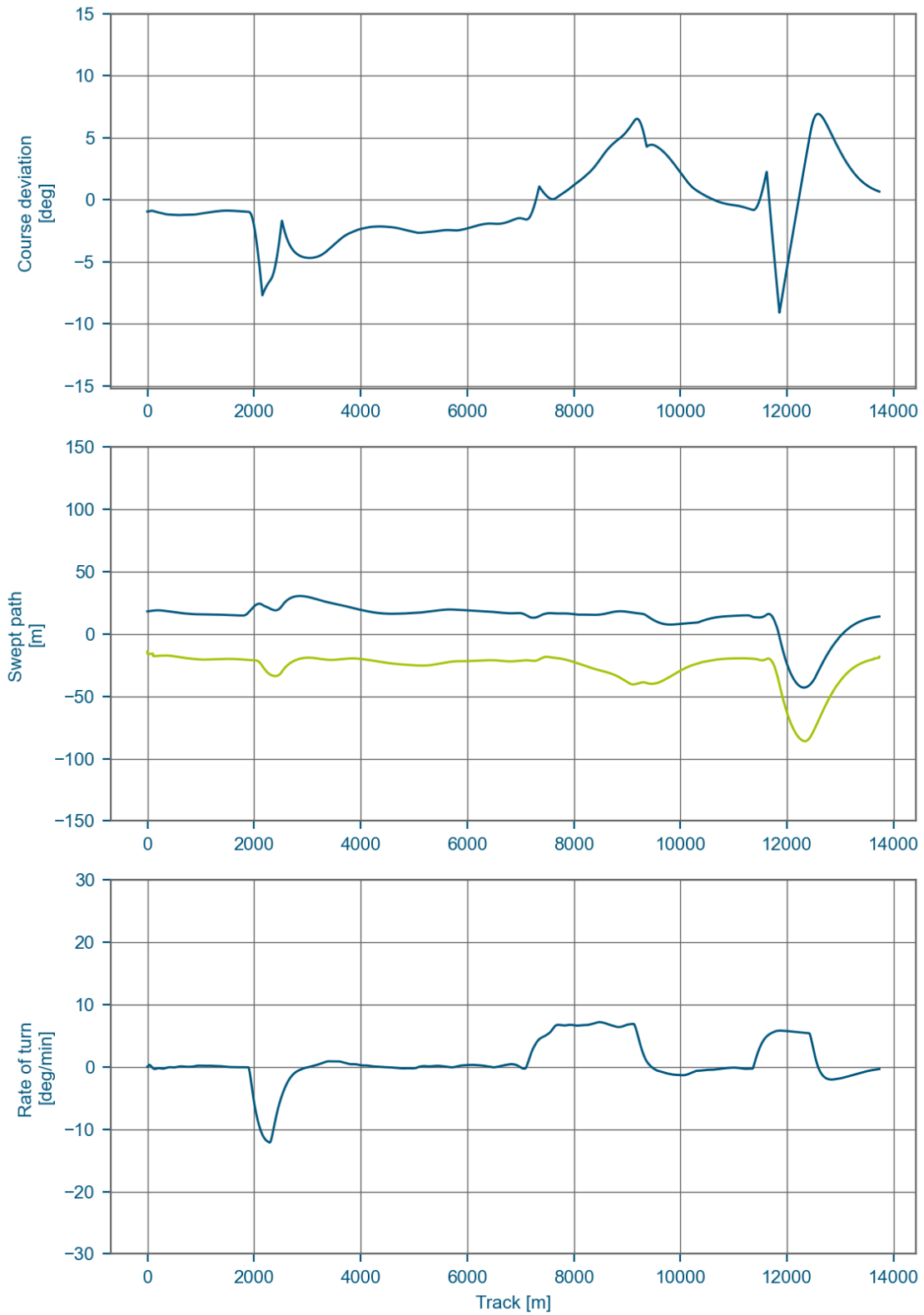


Figure 2.140: S.C. 18: course deviation (drift angle), swept path, RoT, vs. distance.

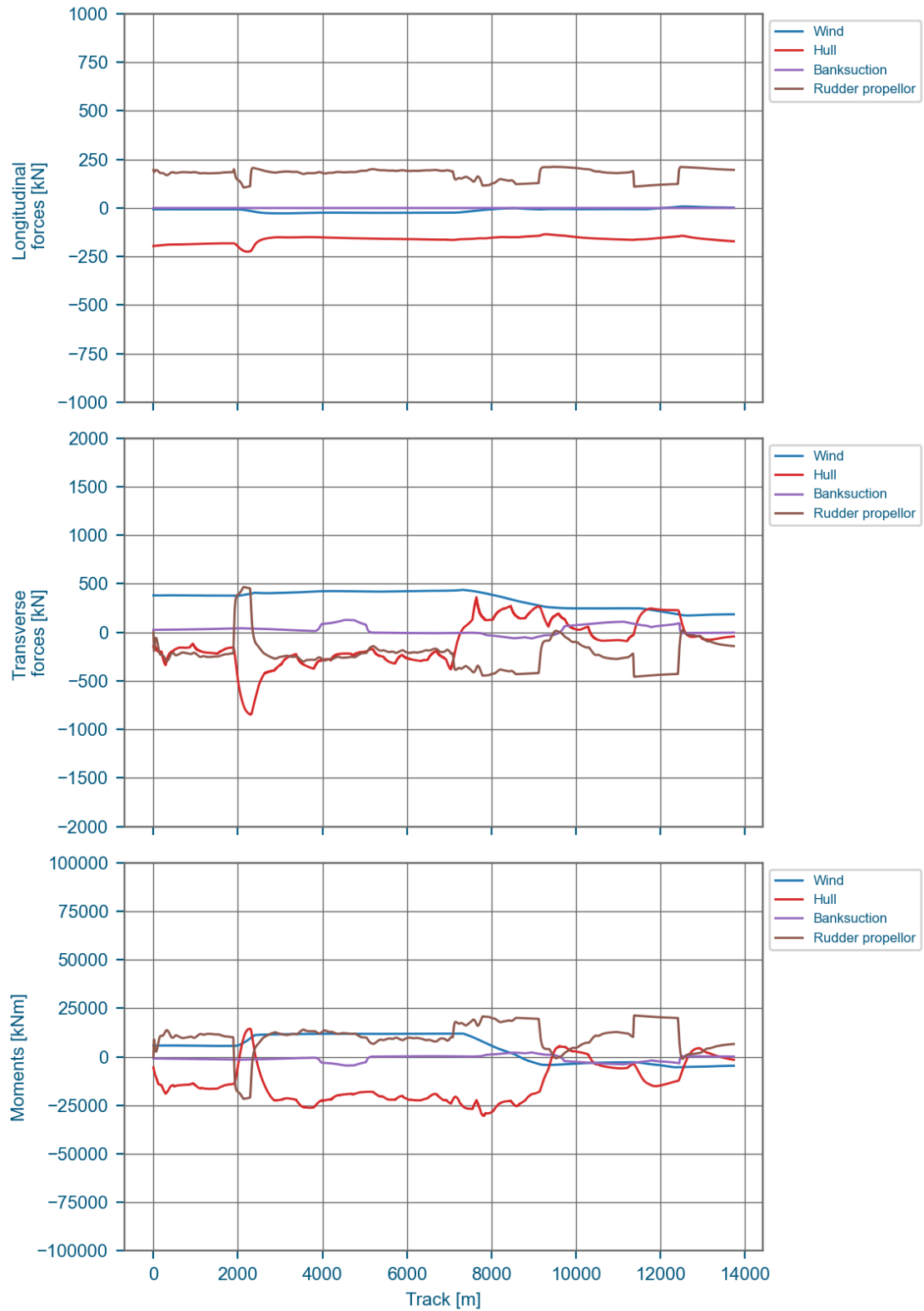


Figure 2.141: S.C. 18: forces, moments, vs. distance.

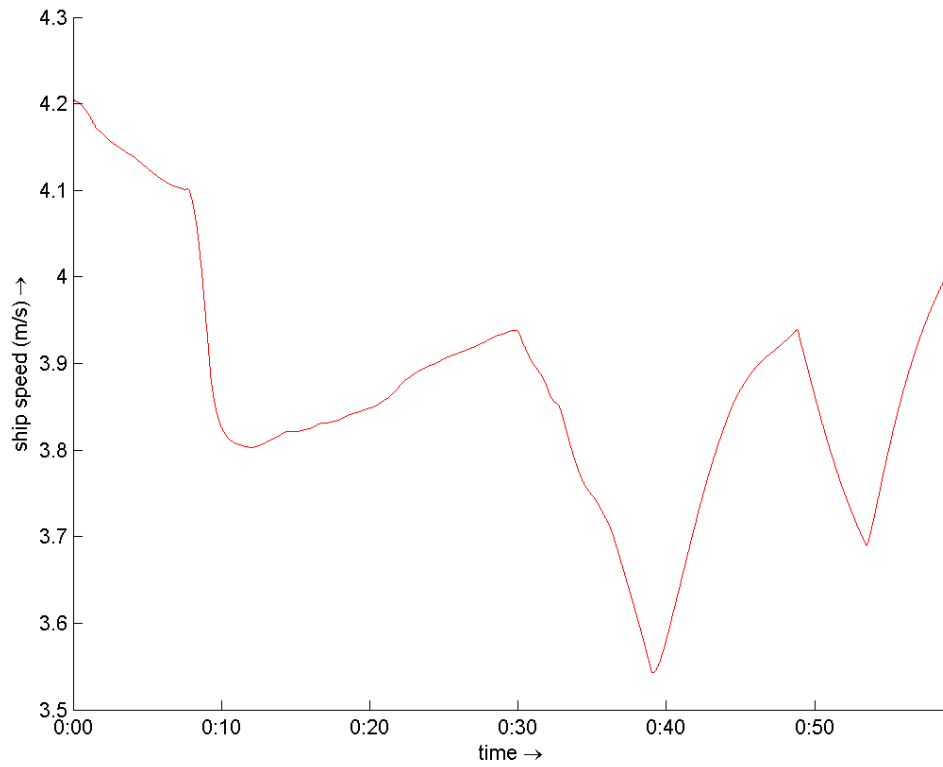


Figure 2.142: S.C. 18: SOG, vs. time.

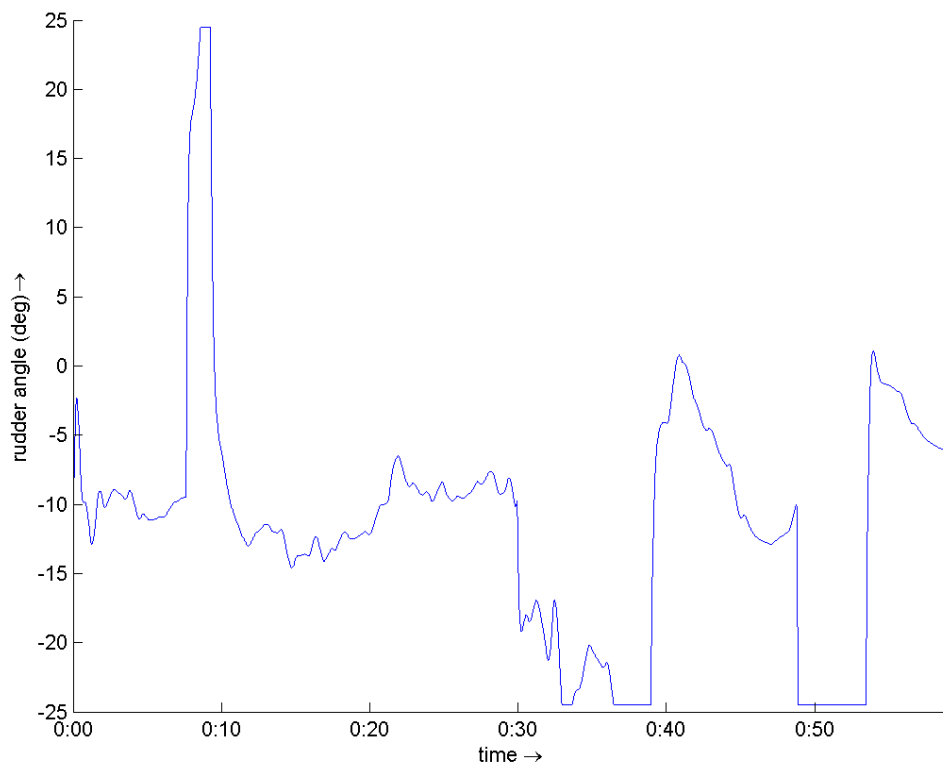


Figure 2.143: S.C. 18: rudder angle, vs. time.

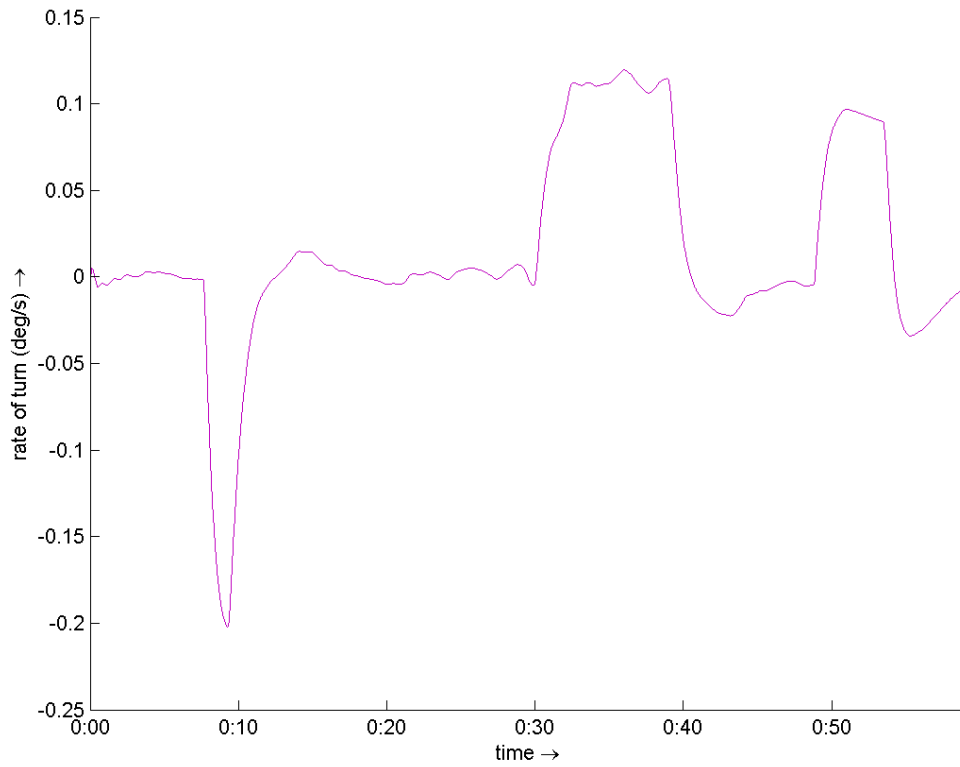


Figure 2.144: S.C. 18: RoT, vs. time.

## Simulation Case 19

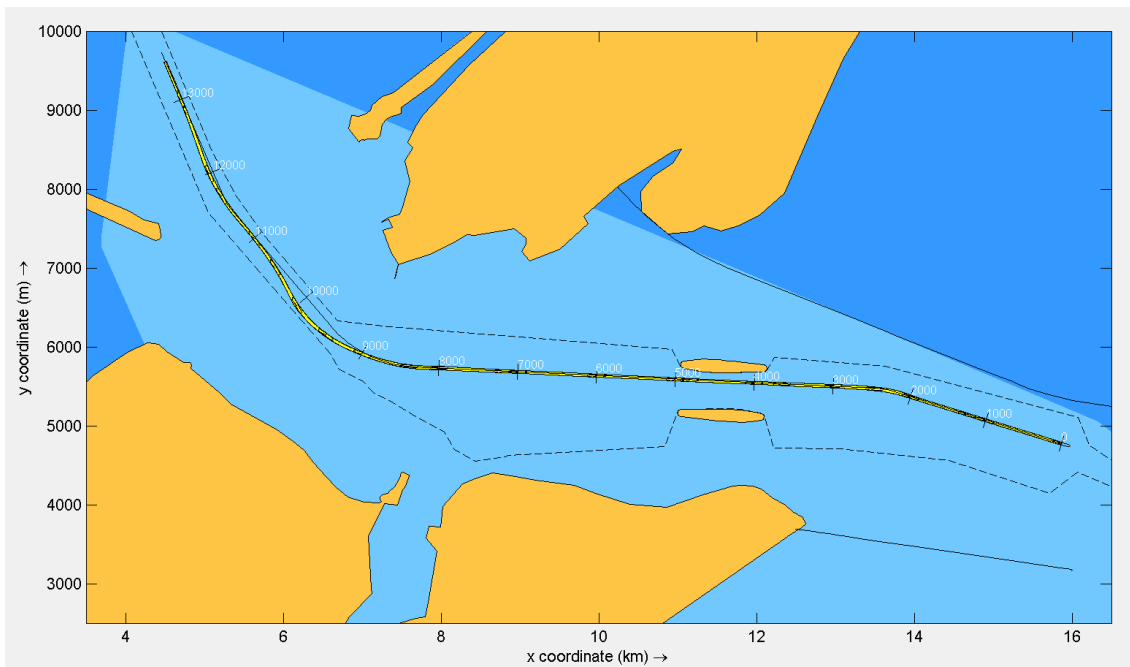
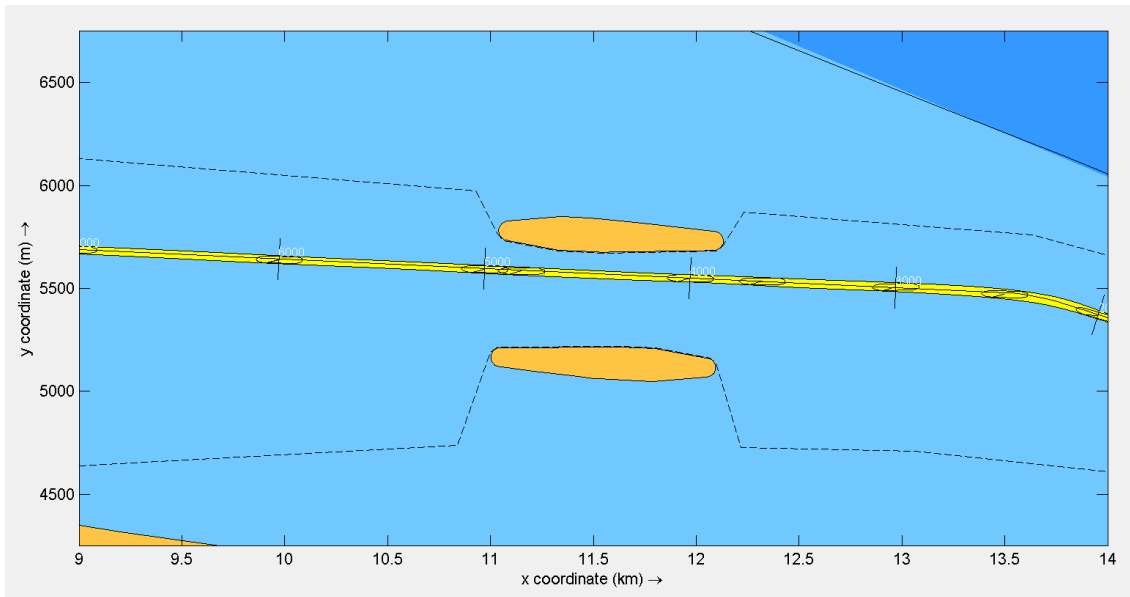


Figure 2.145: S.C. 19: spatial overview plot.



**Figure 2.146:** S.C. 19: zoom-in of spatial overview plot, crossing segment.

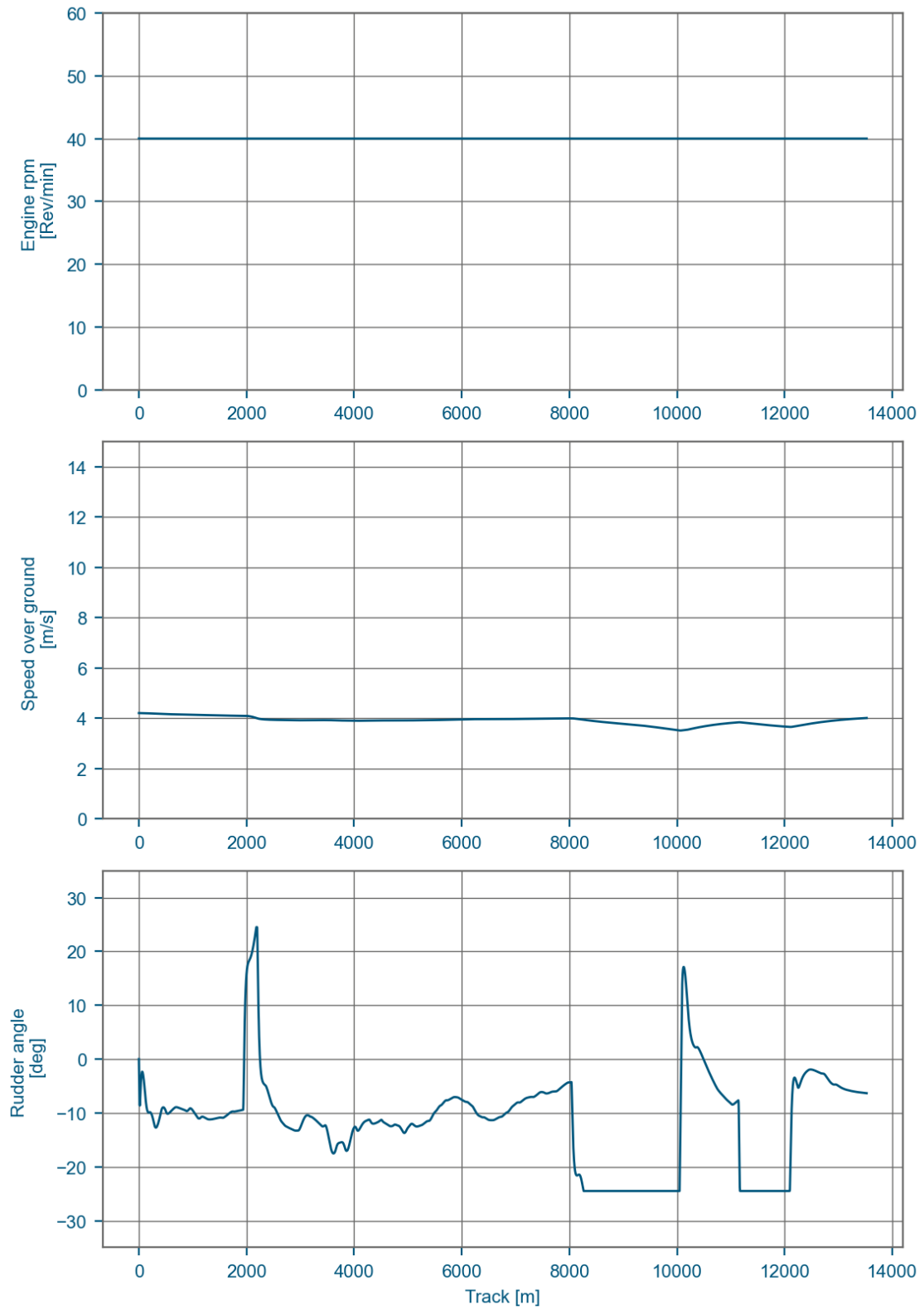


Figure 2.147: S.C. 19: engine RPM, SOG, rudder angle, vs. distance.

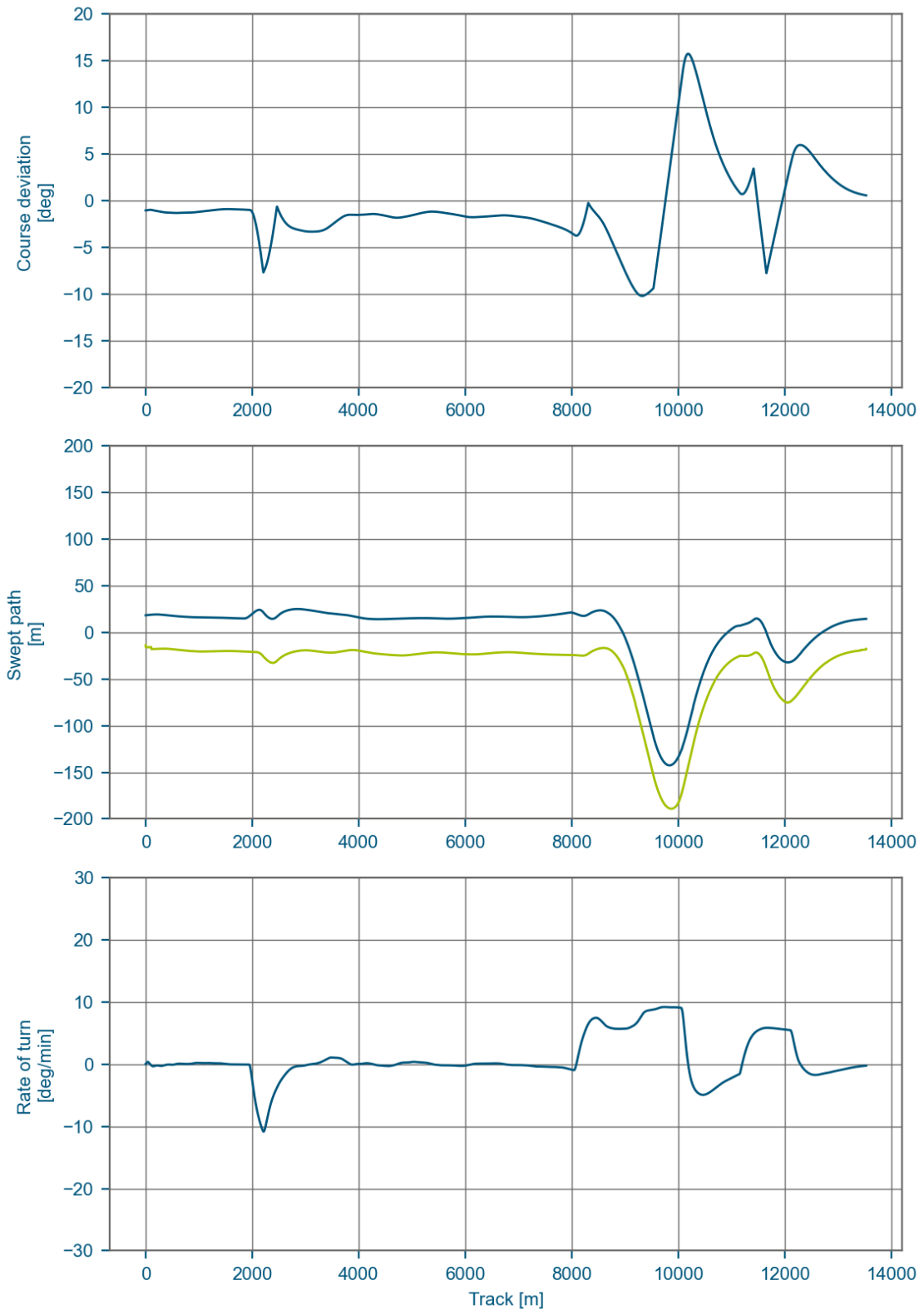


Figure 2.148: S.C. 19: course deviation (drift angle), swept path, RoT, vs. distance.

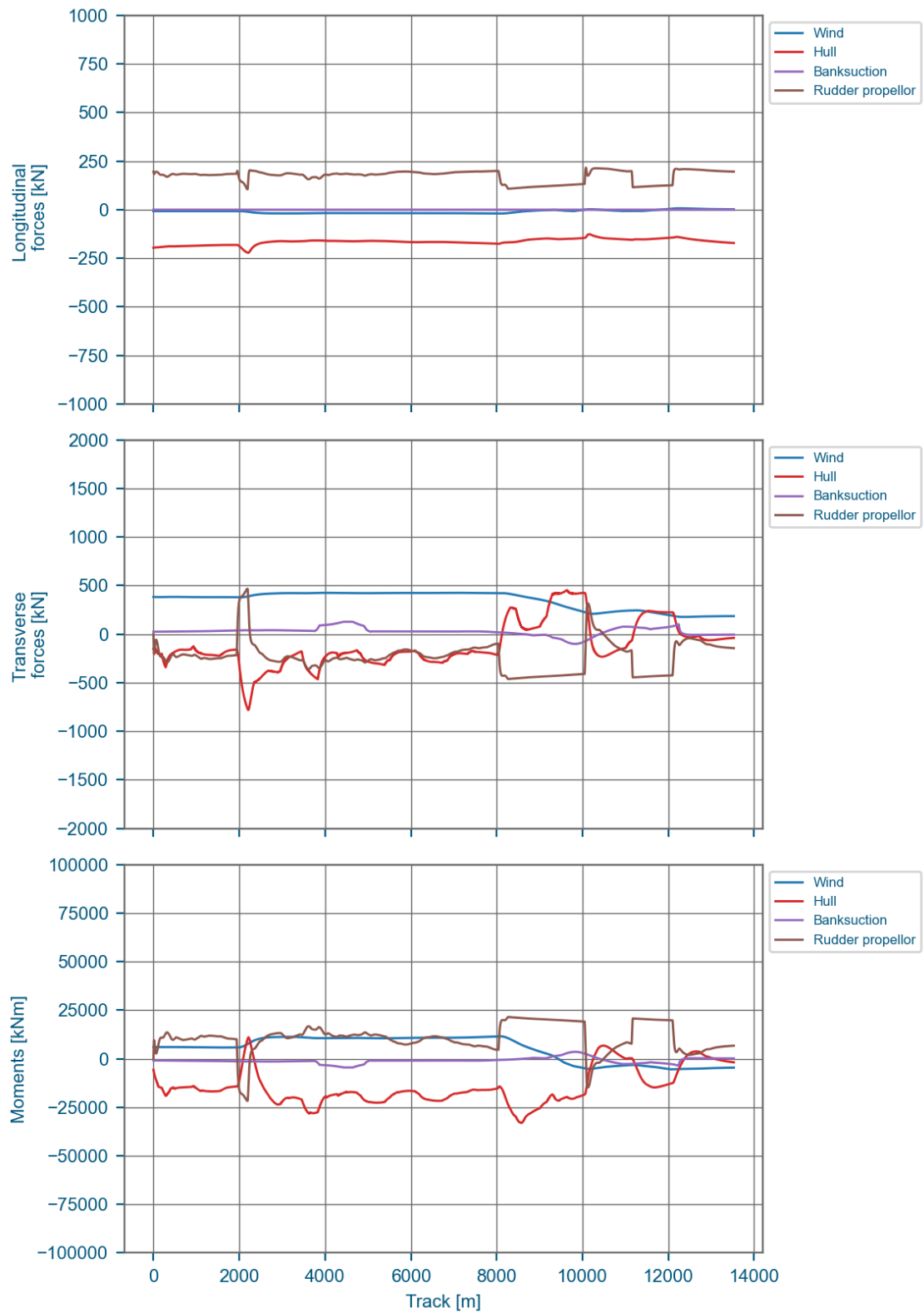


Figure 2.149: S.C. 19: forces, moments, vs. distance.

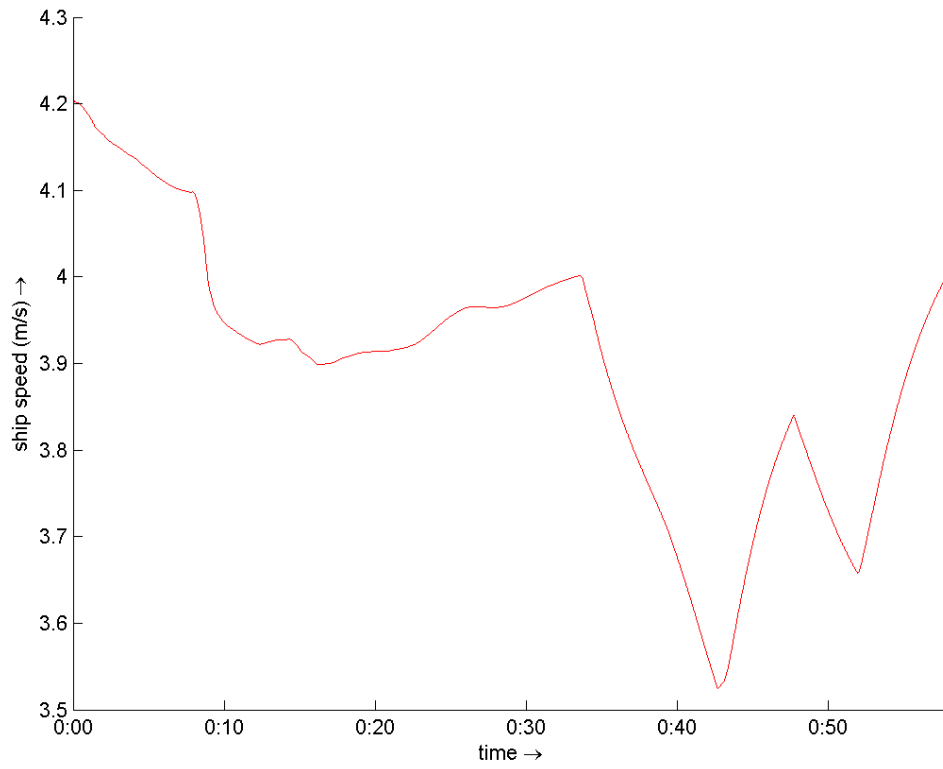


Figure 2.150: S.C. 19: SOG, vs. time.

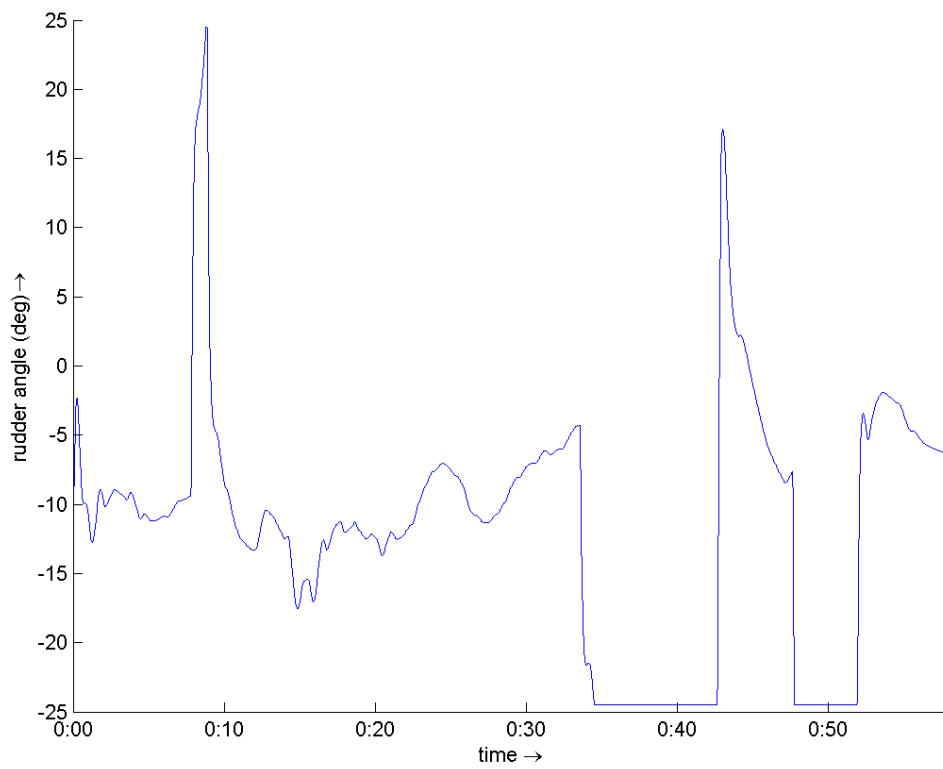


Figure 2.151: S.C. 19: rudder angle, vs. time.

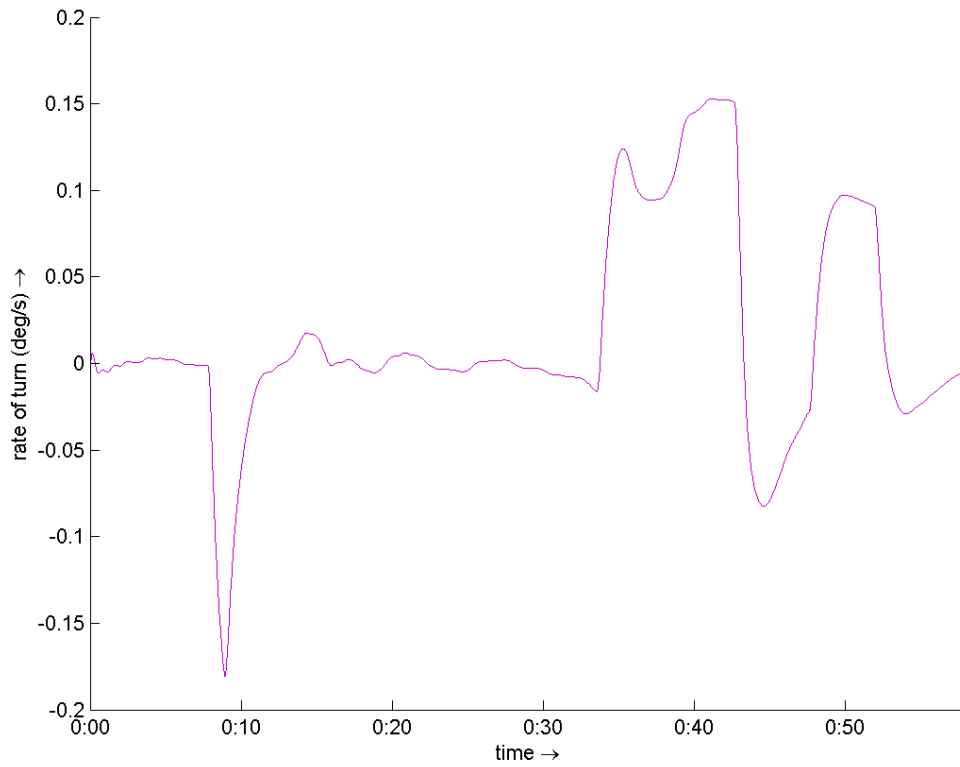


Figure 2.152: S.C. 19: RoT, vs. time.

## Simulation Case 20

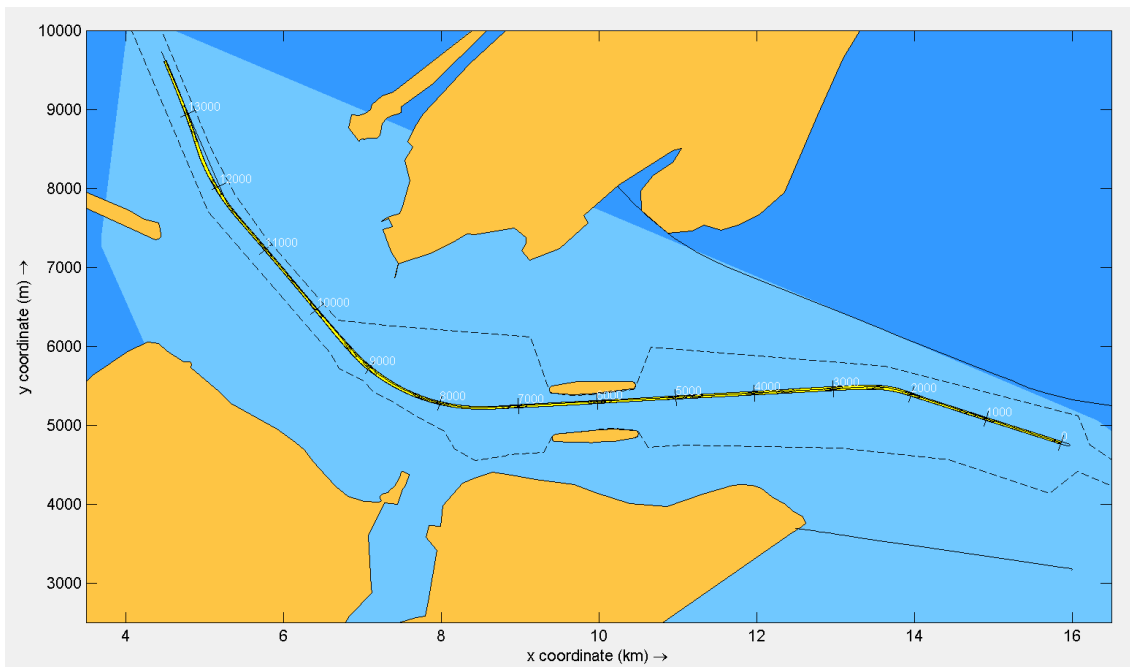
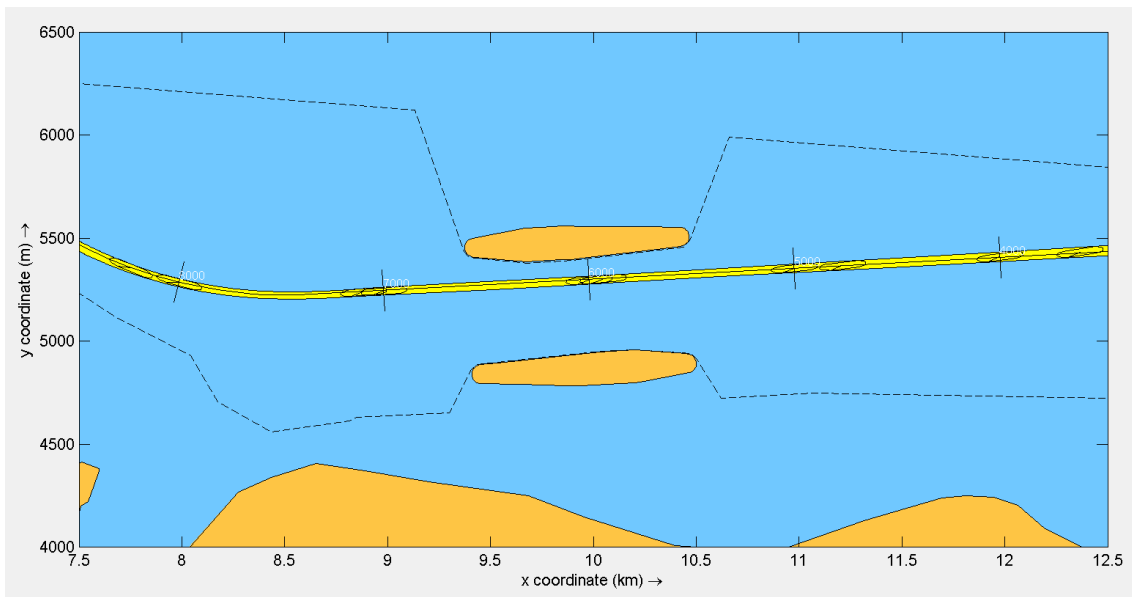


Figure 2.153: S.C. 20: spatial overview plot.



**Figure 2.154:** S.C. 20: zoom-in of spatial overview plot, crossing segment.

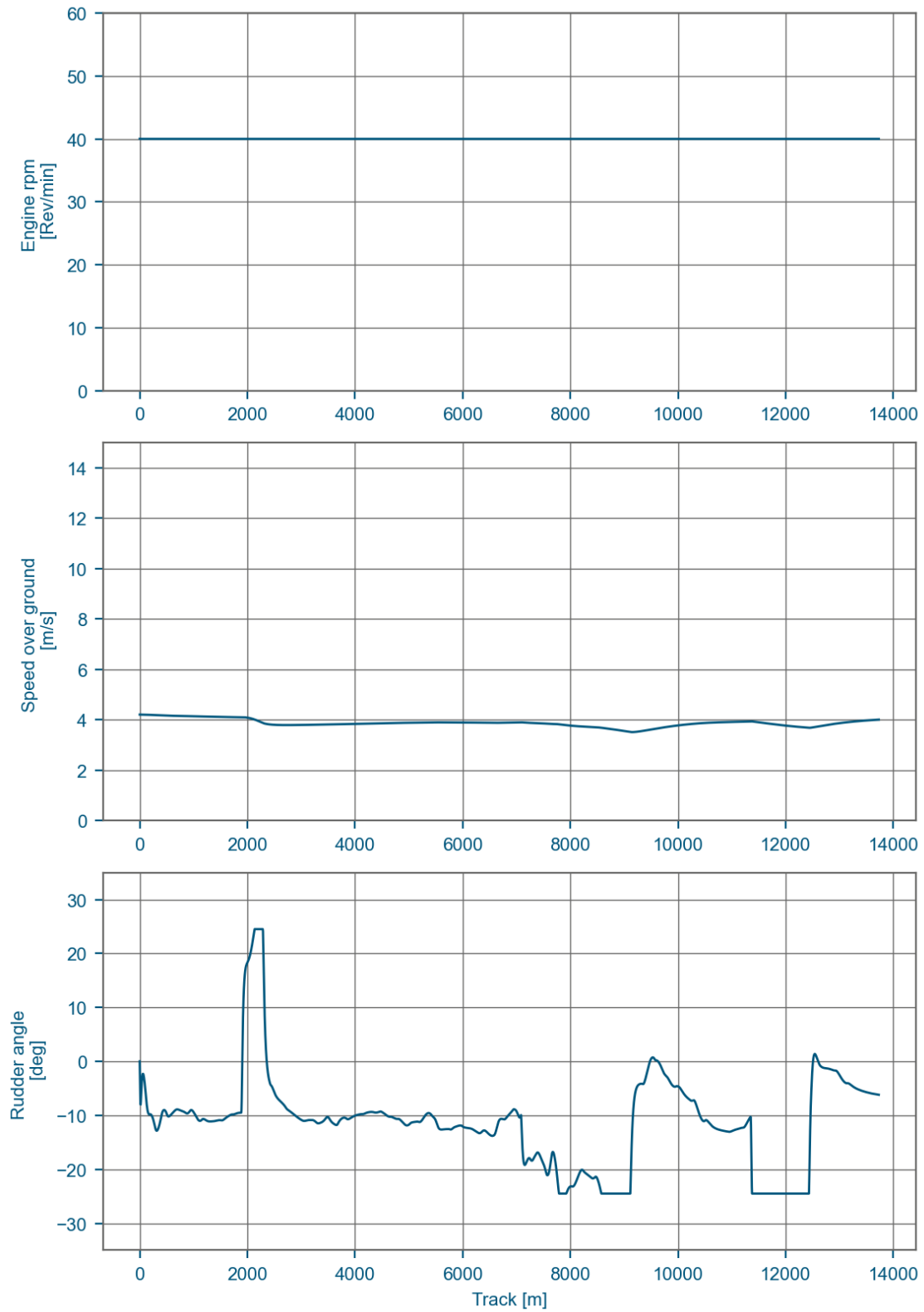


Figure 2.155: S.C. 20: engine RPM, SOG, rudder angle, vs. distance.

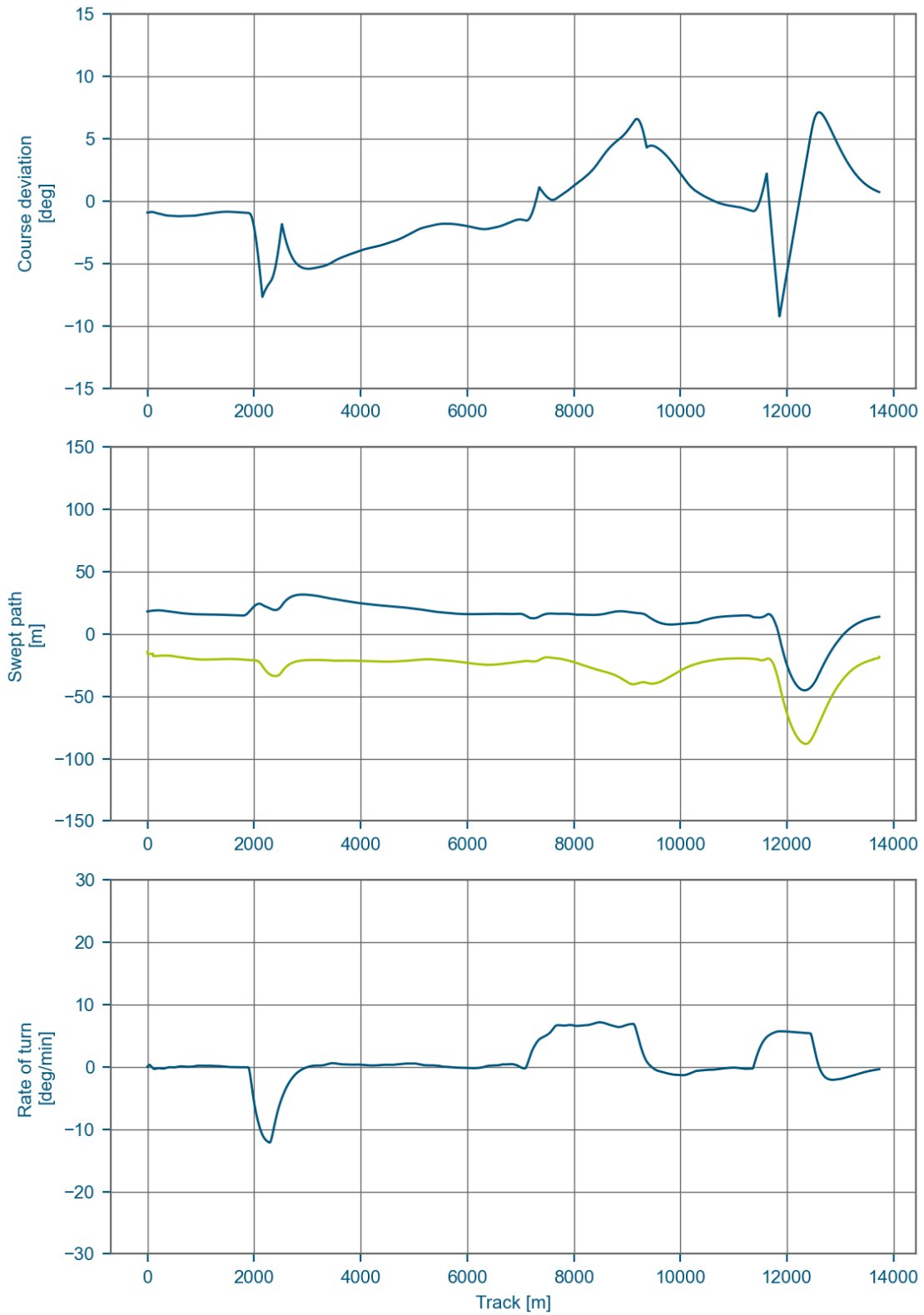


Figure 2.156: S.C. 20: course deviation (drift angle), swept path, RoT, vs. distance.

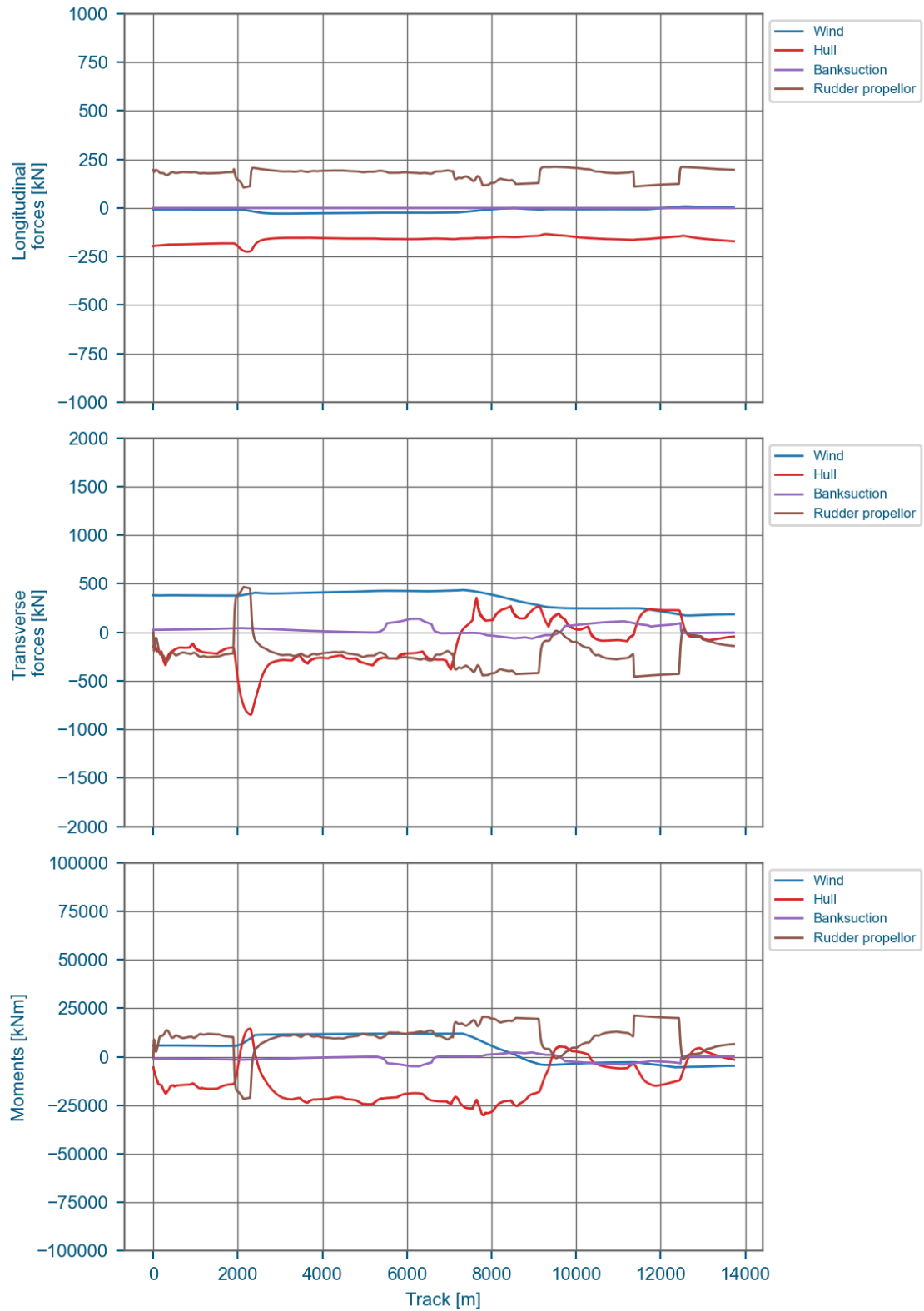


Figure 2.157: S.C. 20: forces, moments, vs. distance.

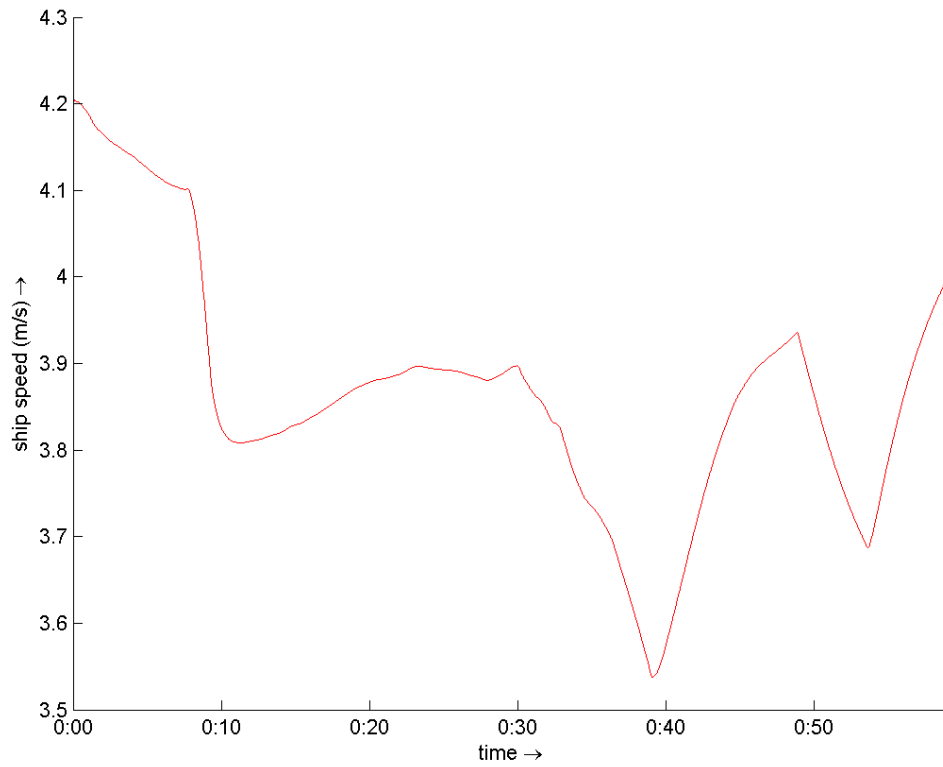


Figure 2.158: S.C. 20: SOG, vs. time.

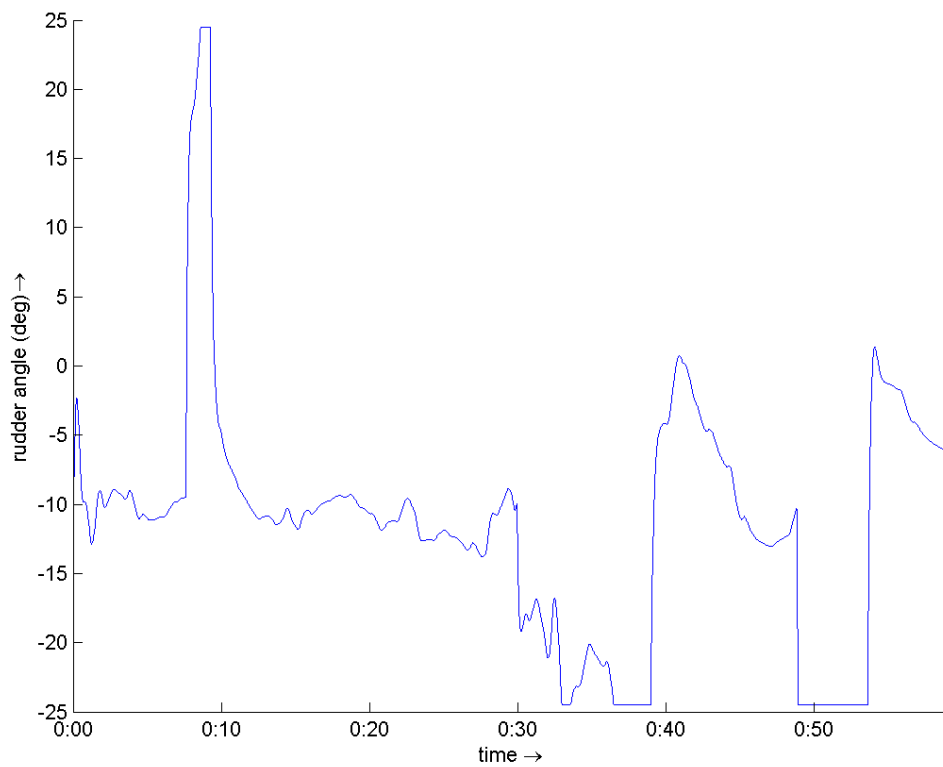


Figure 2.159: S.C. 20: rudder angle, vs. time.

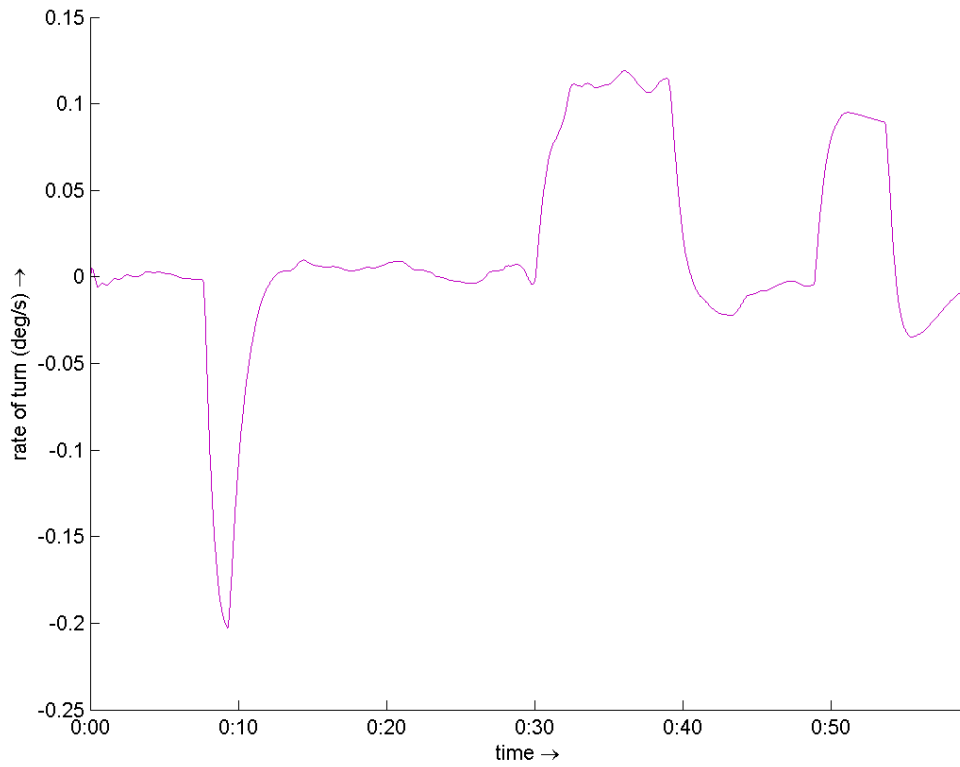


Figure 2.160: S.C. 20: RoT, vs. time.

## Simulation Case 21

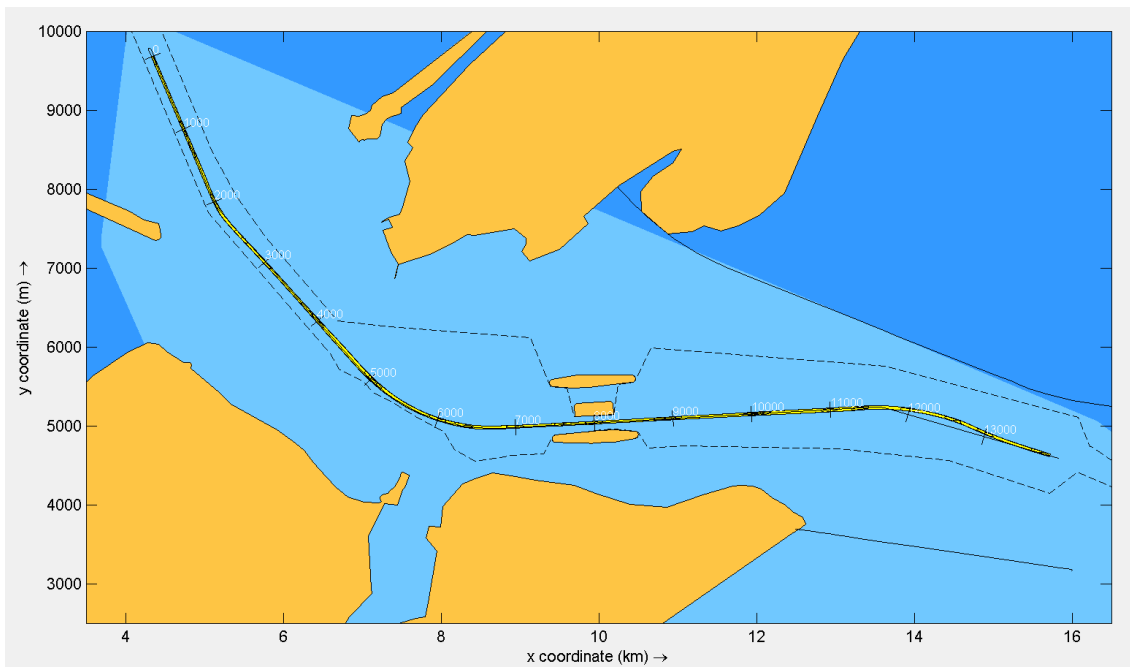
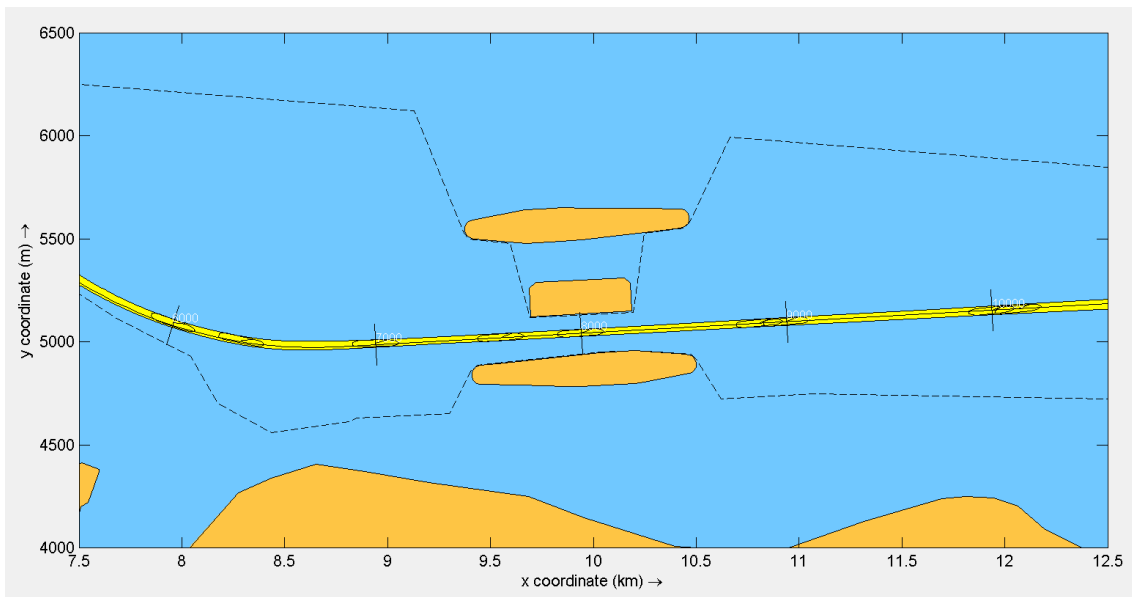


Figure 2.161: S.C. 21: spatial overview plot.



**Figure 2.162:** S.C. 21: zoom-in of spatial overview plot, crossing segment.

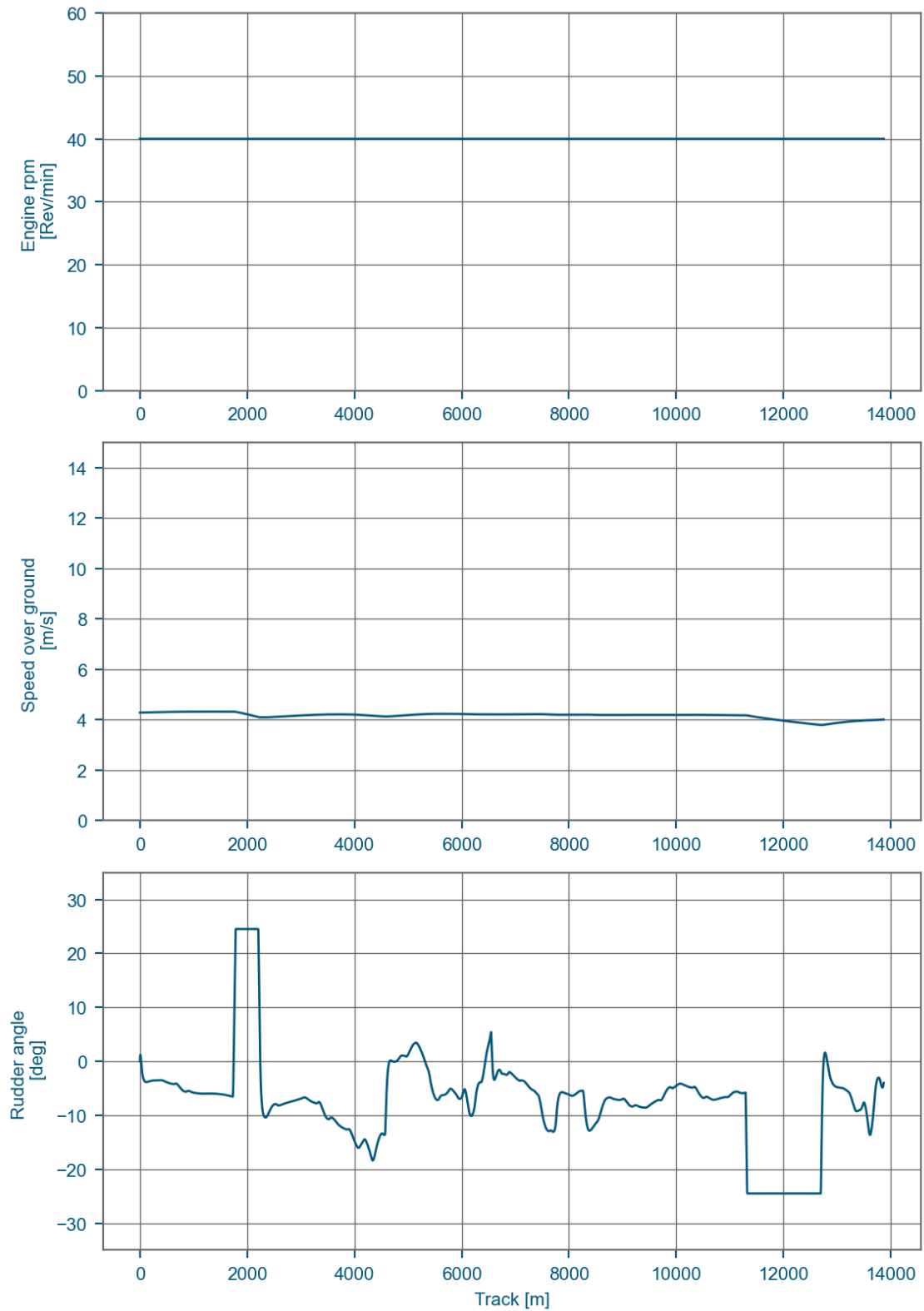


Figure 2.163: S.C. 21: engine RPM, SOG, rudder angle, vs. distance.

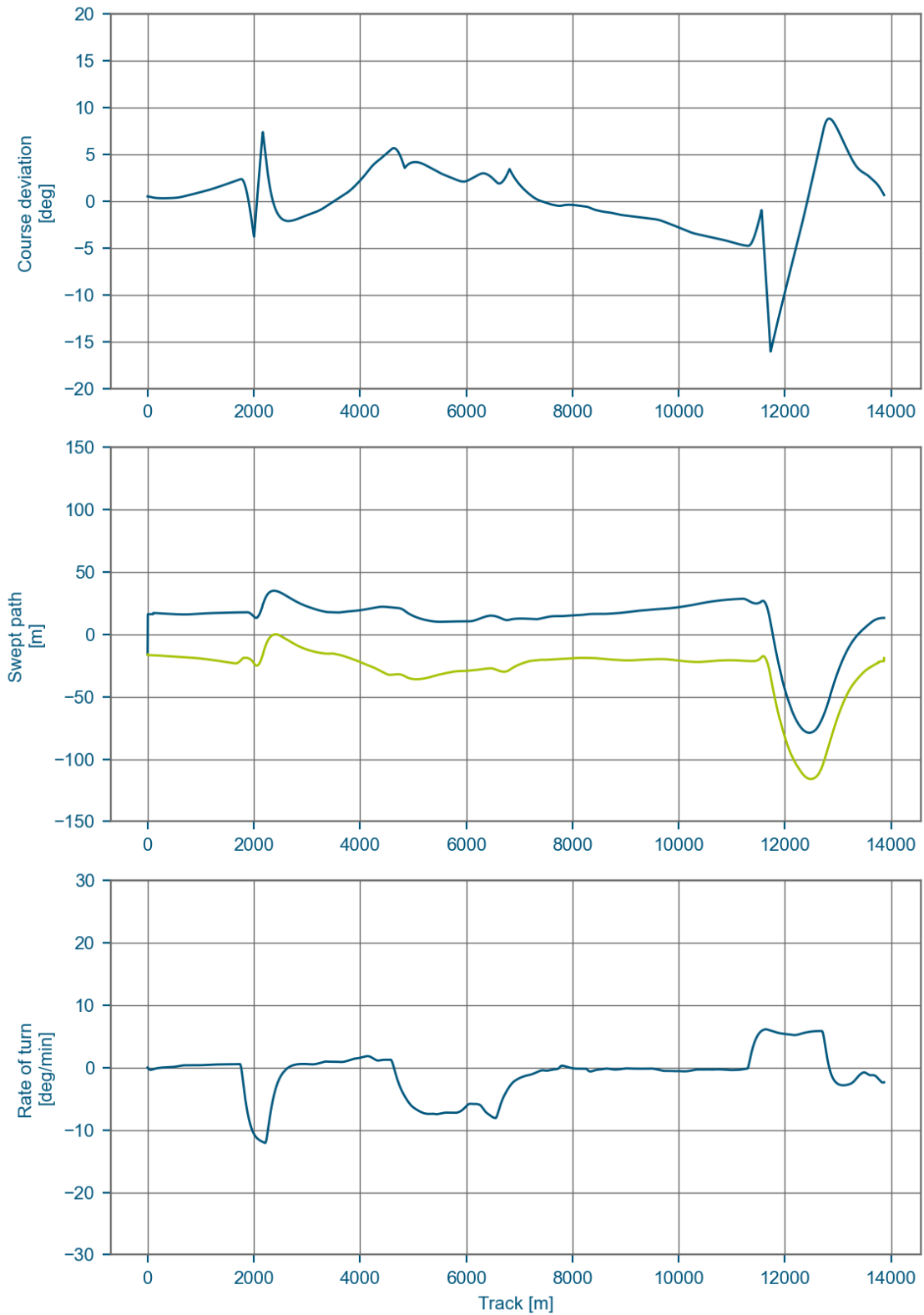


Figure 2.164: S.C. 21: course deviation (drift angle), swept path, RoT, vs. distance.

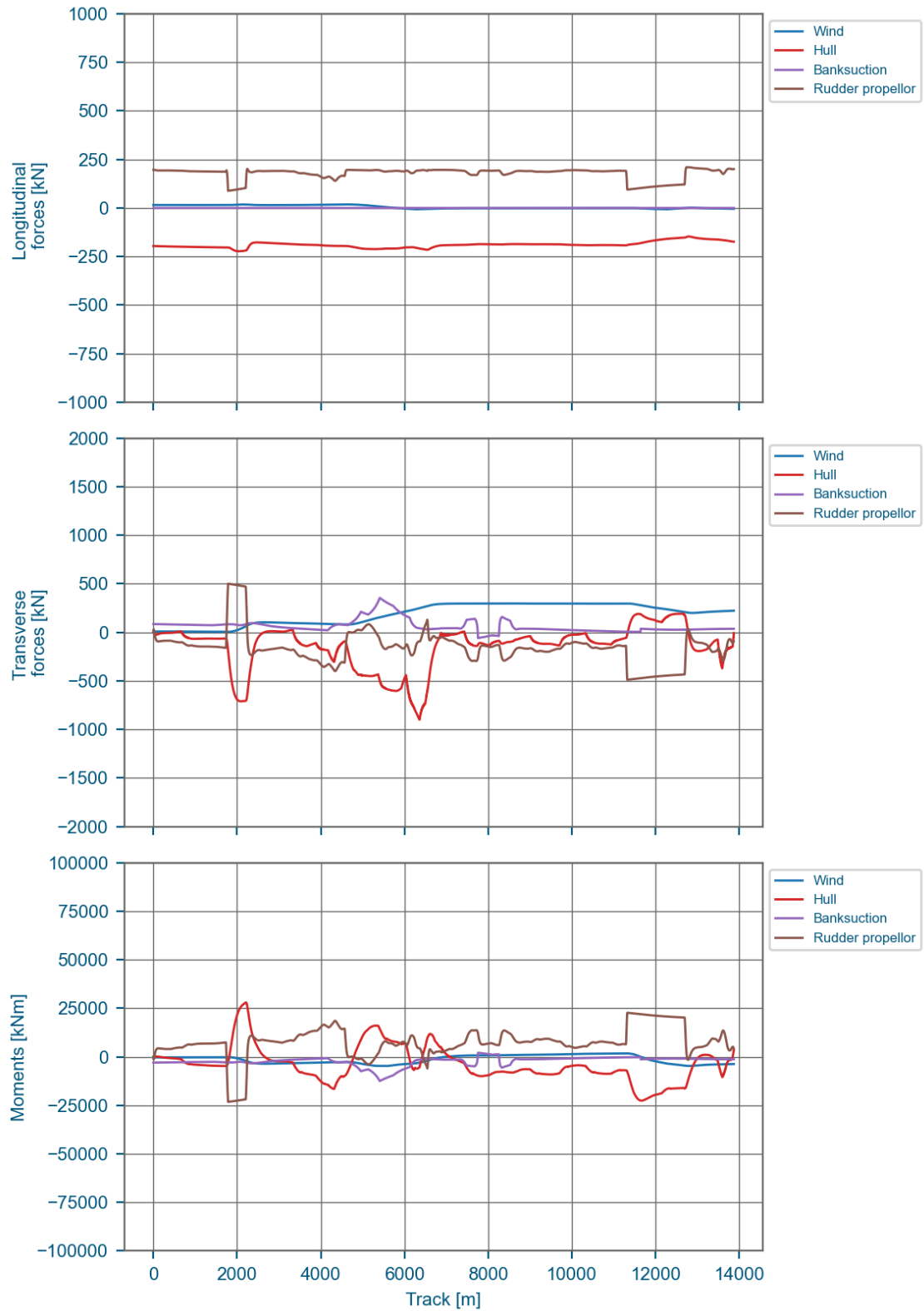


Figure 2.165: S.C. 21: forces, moments, vs. distance.

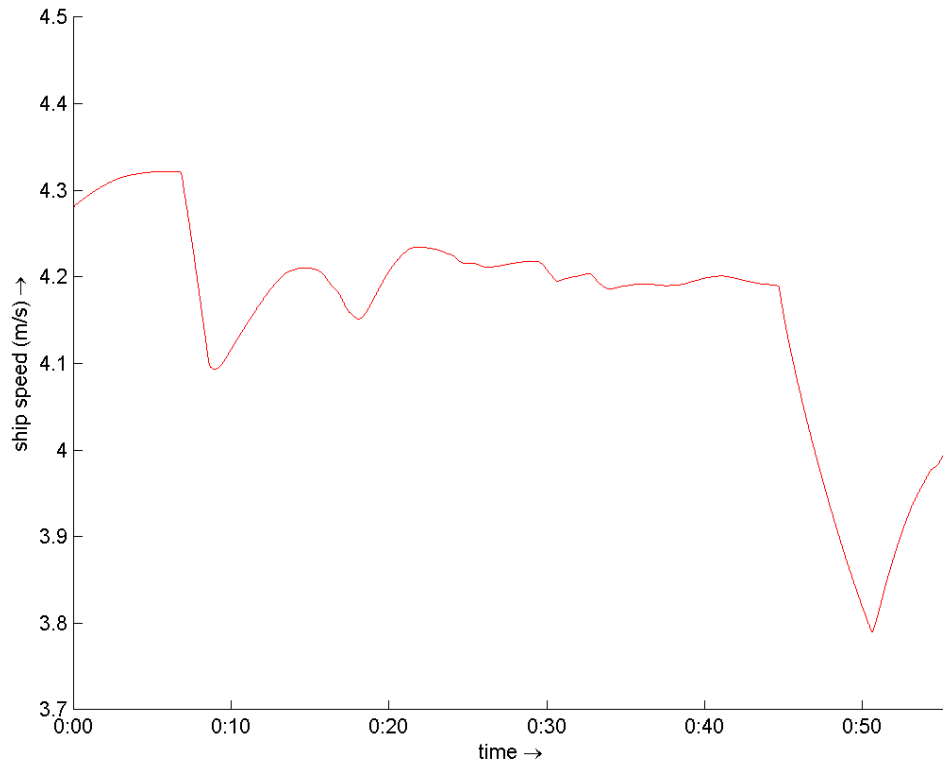


Figure 2.166: S.C. 21: SOG, vs. time.

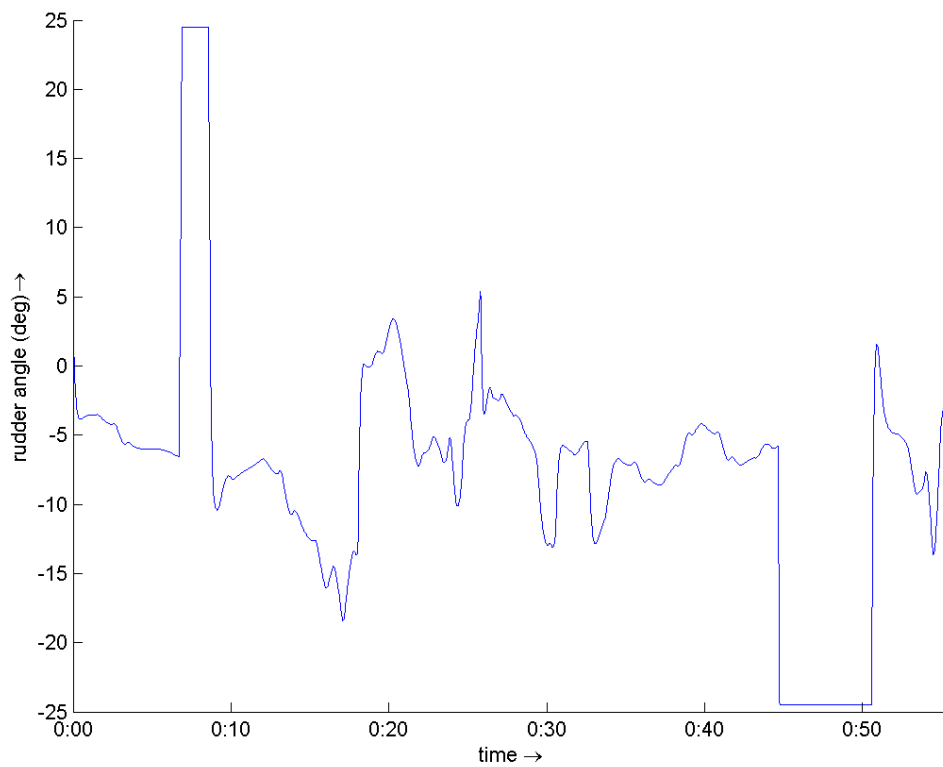


Figure 2.167: S.C. 21: rudder angle, vs. time.

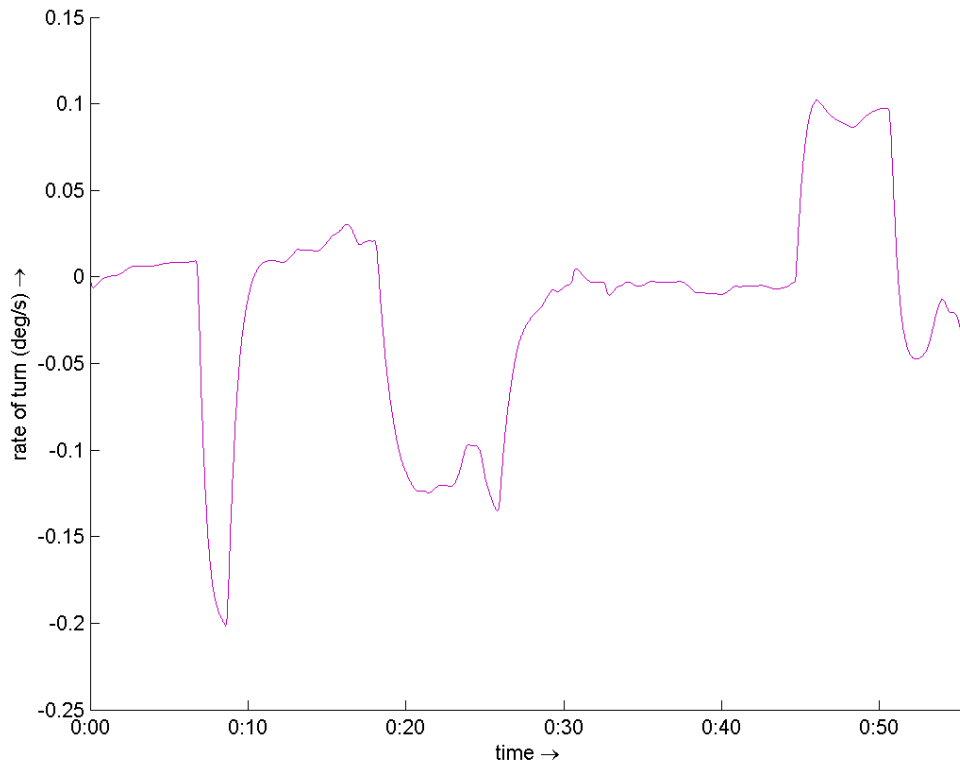


Figure 2.168: S.C. 21: RoT, vs. time.

## Simulation Case 22

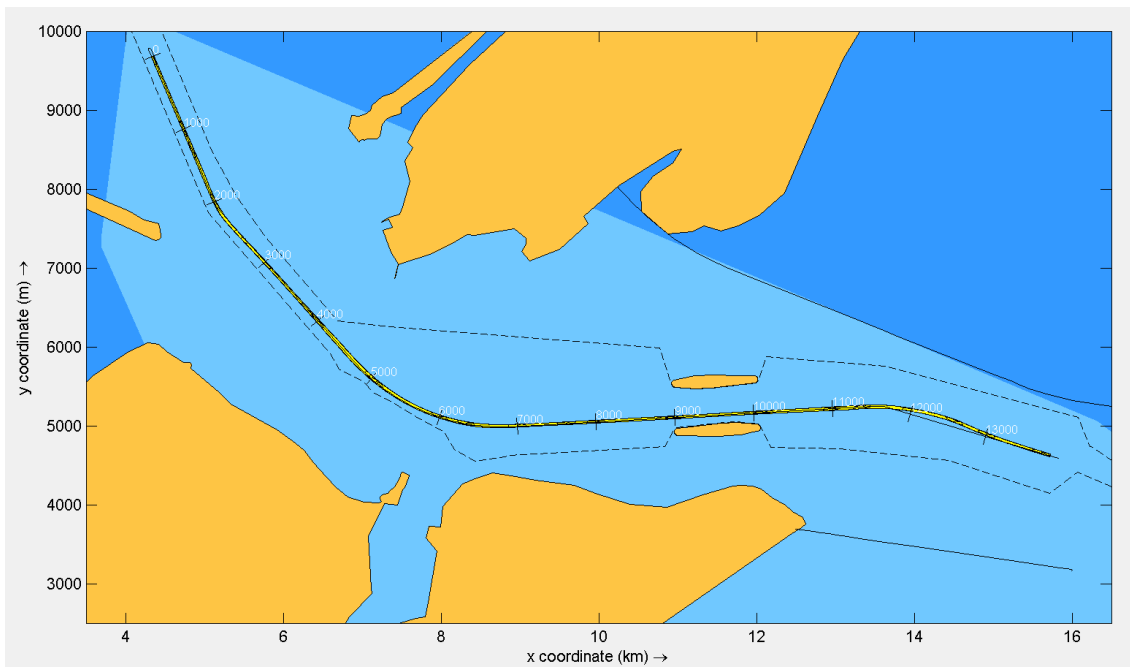
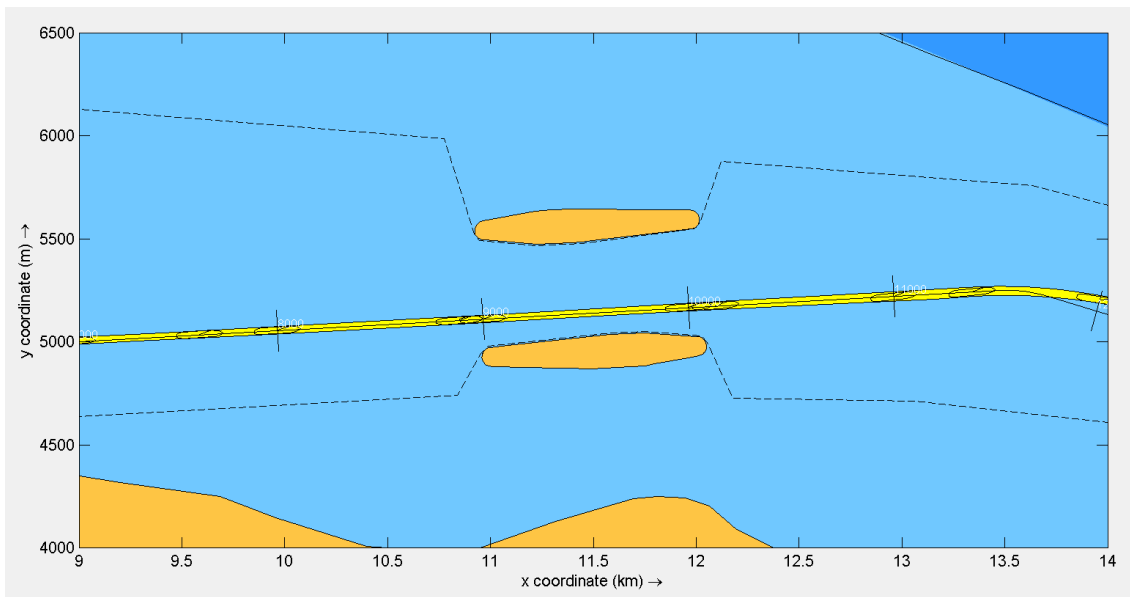


Figure 2.169: S.C. 22: spatial overview plot.



**Figure 2.170:** S.C. 22: zoom-in of spatial overview plot, crossing segment.

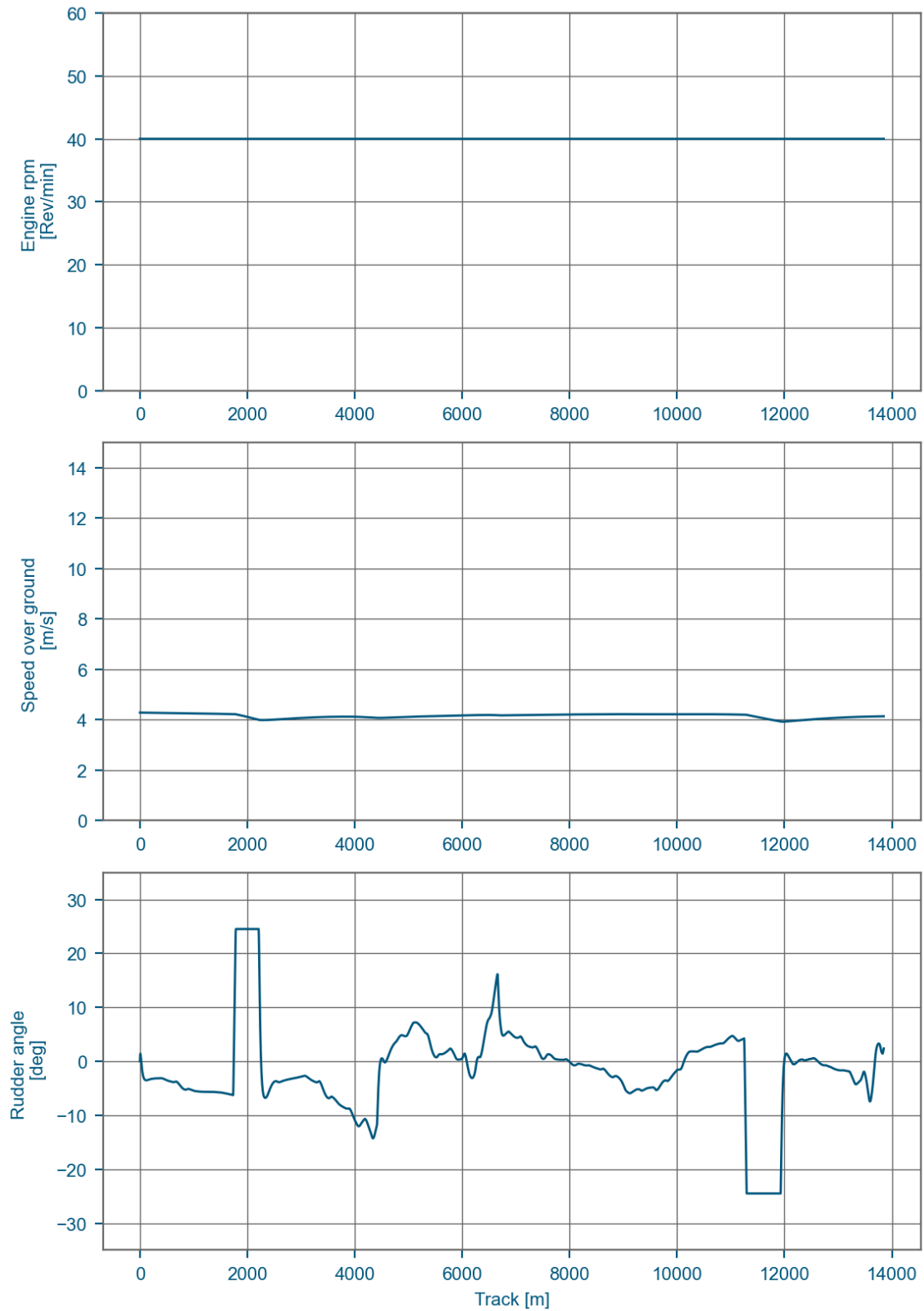


Figure 2.171: S.C. 22: engine RPM, SOG, rudder angle, vs. distance.

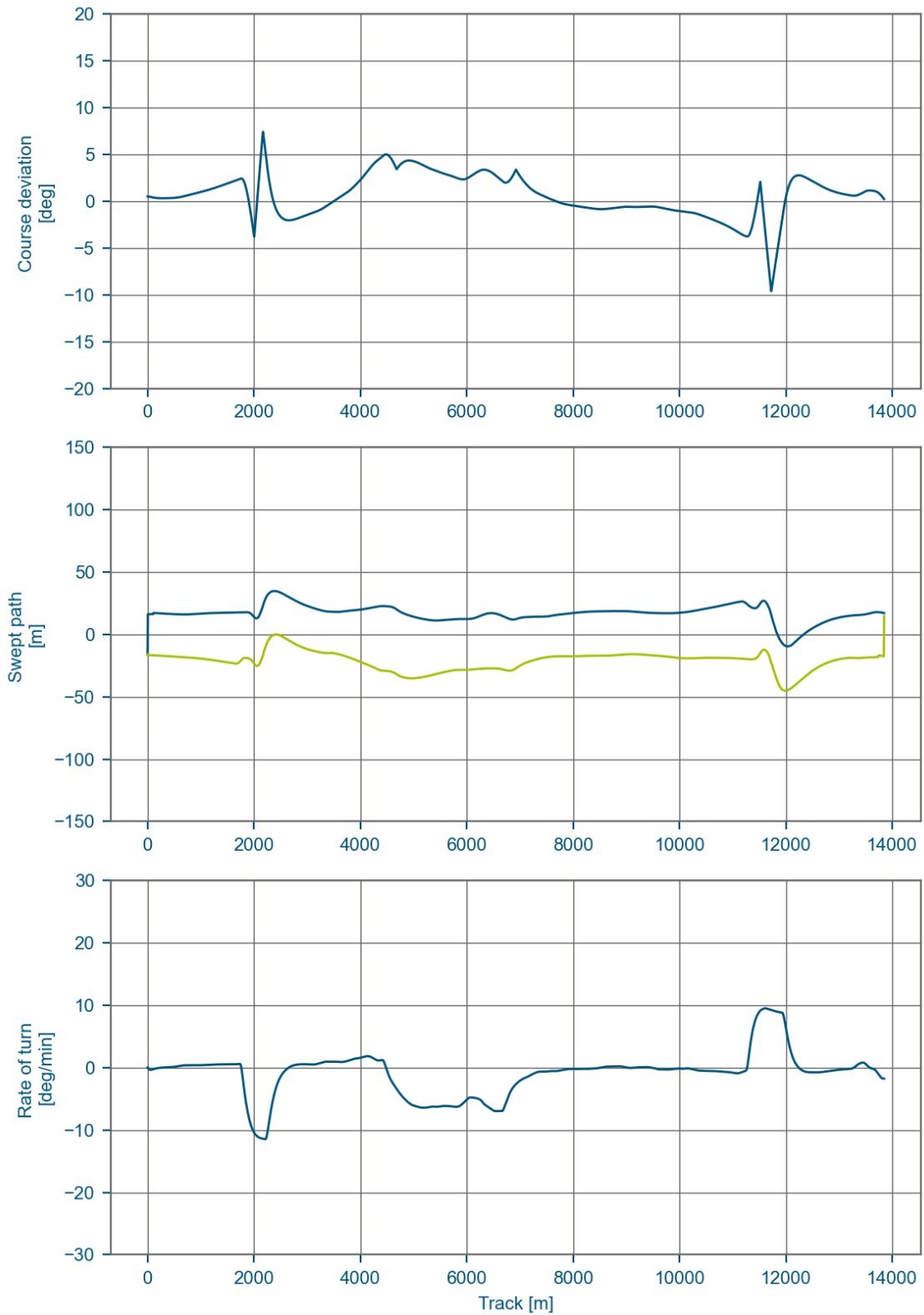


Figure 2.172: S.C. 22: course deviation (drift angle), swept path, RoT, vs. distance.

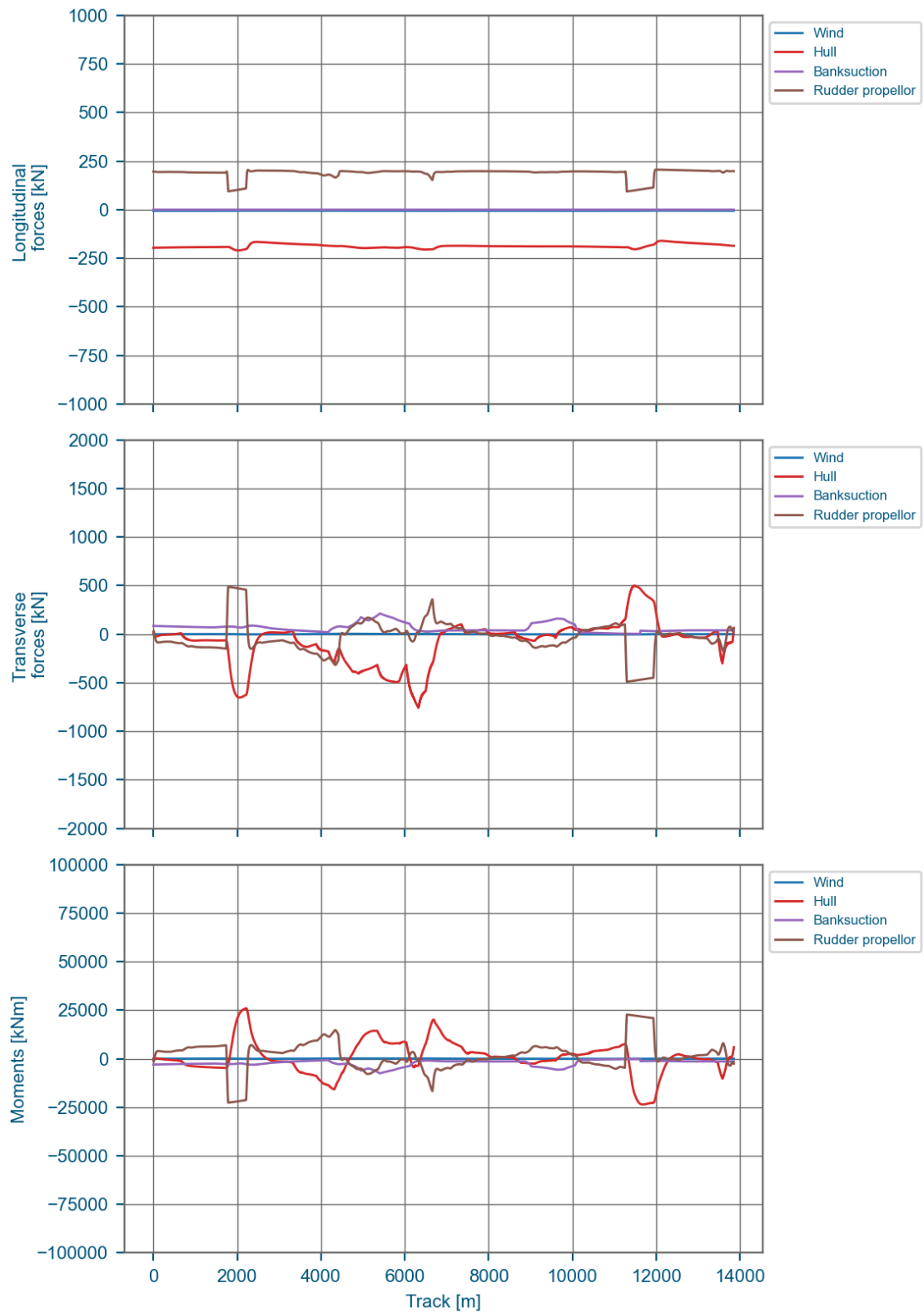


Figure 2.173: S.C. 22: forces, moments, vs. distance.

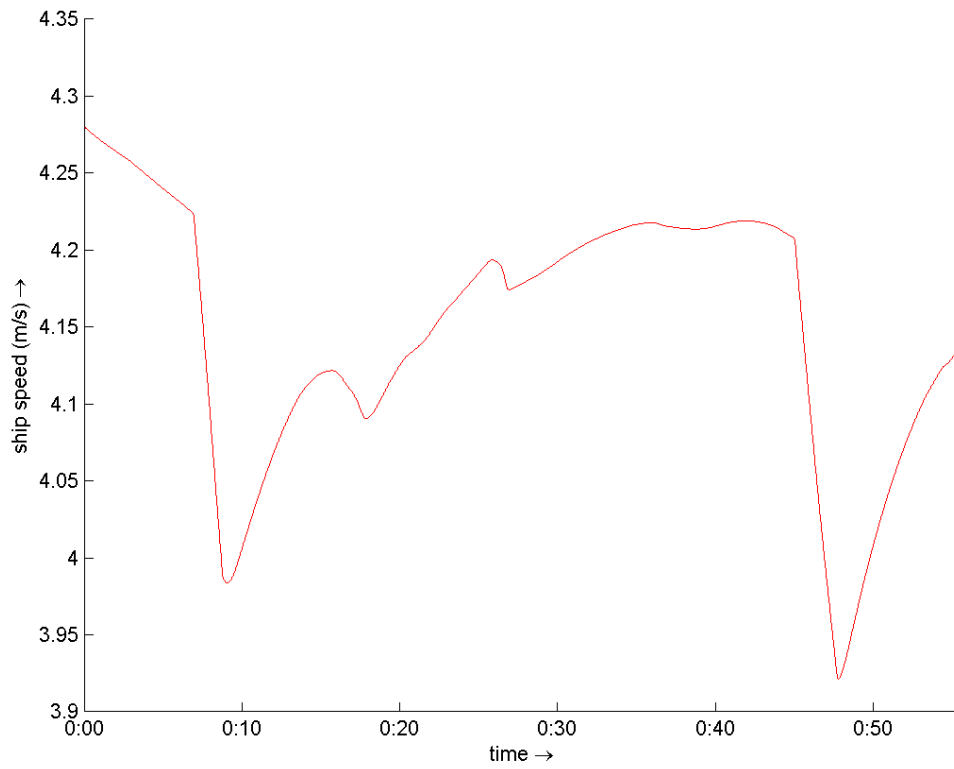


Figure 2.174: S.C. 22: SOG, vs. time.

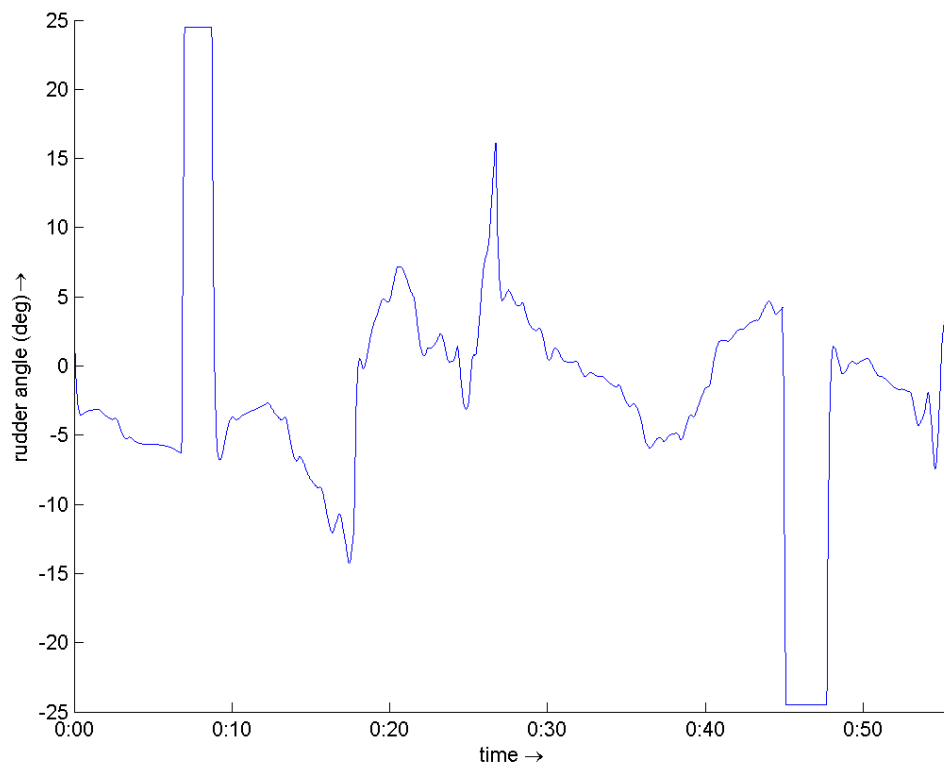


Figure 2.175: S.C. 22: rudder angle, vs. time.

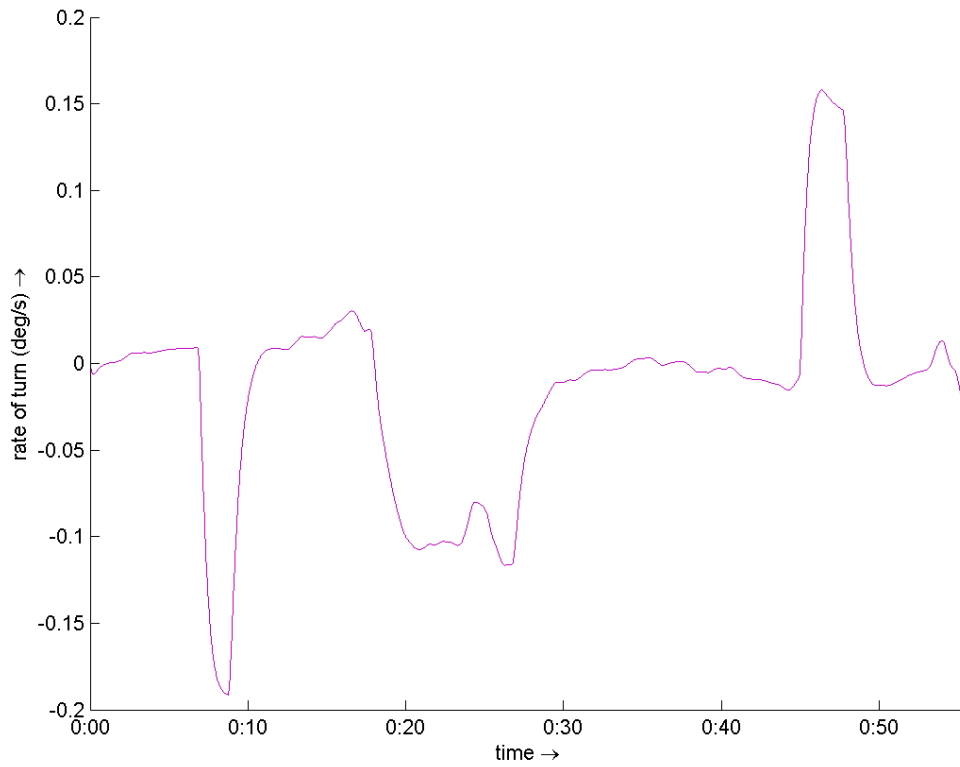


Figure 2.176: S.C. 22: RoT, vs. time.

### Simulation Case 23

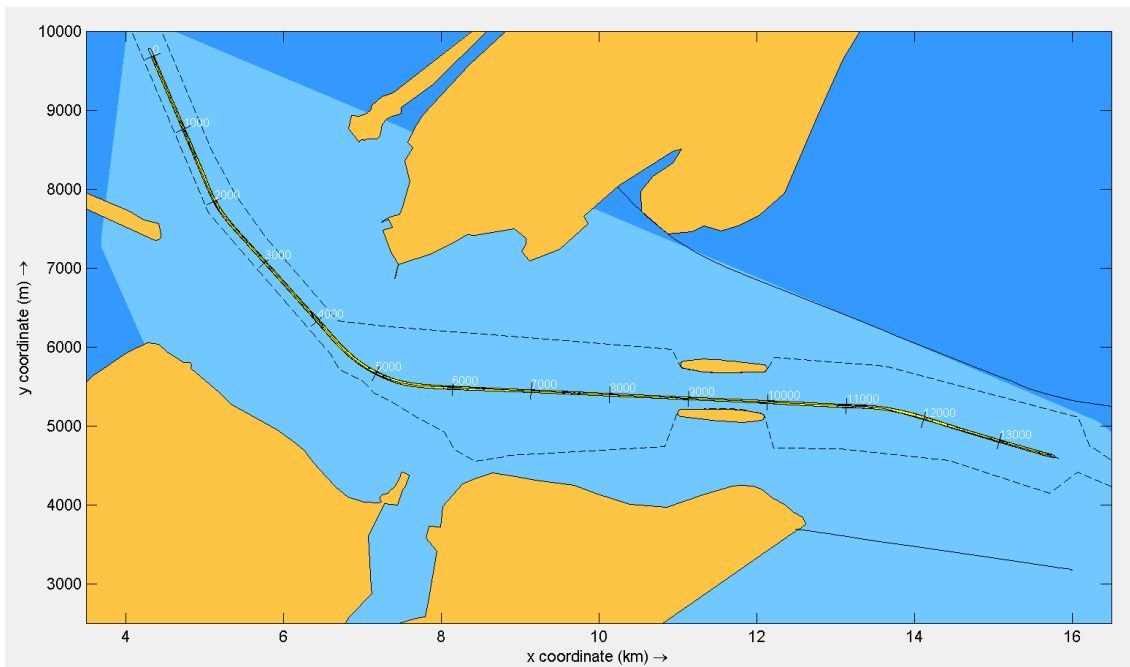
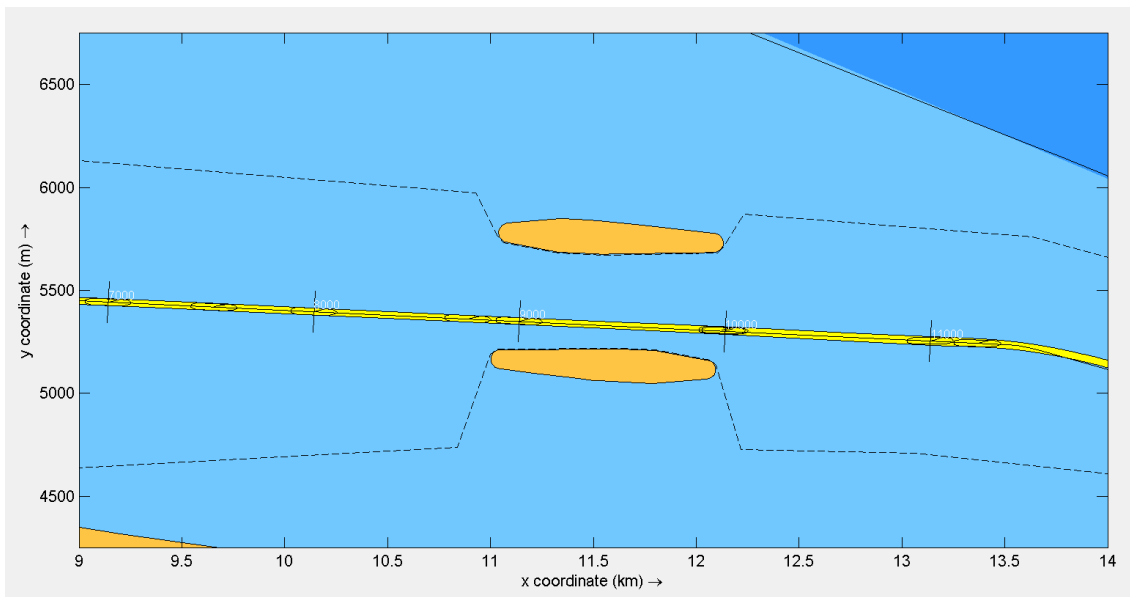


Figure 2.177: S.C. 23: spatial overview plot.



**Figure 2.178:** S.C. 23: zoom-in of spatial overview plot, crossing segment.

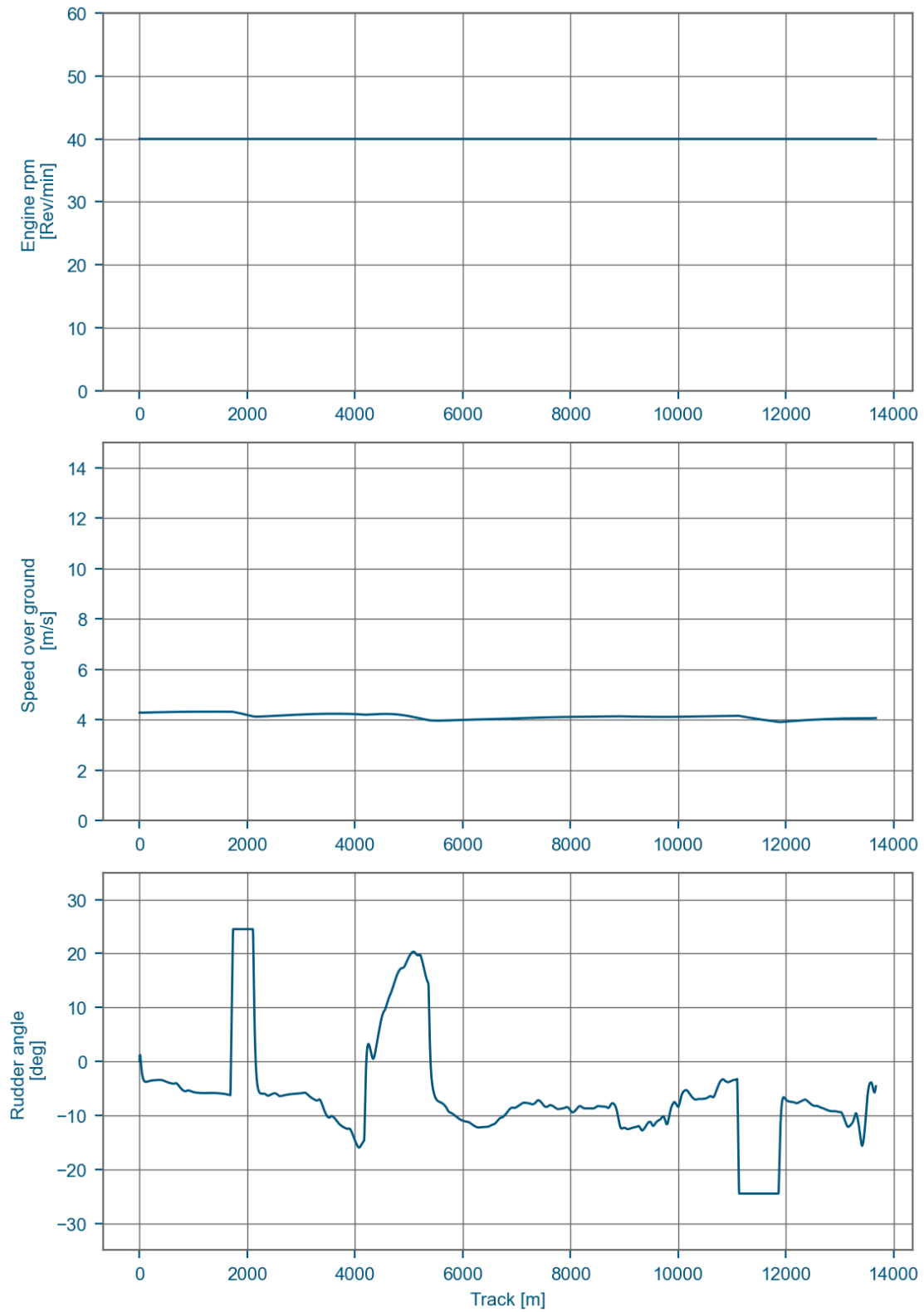


Figure 2.179: S.C. 23: engine RPM, SOG, rudder angle, vs. distance.

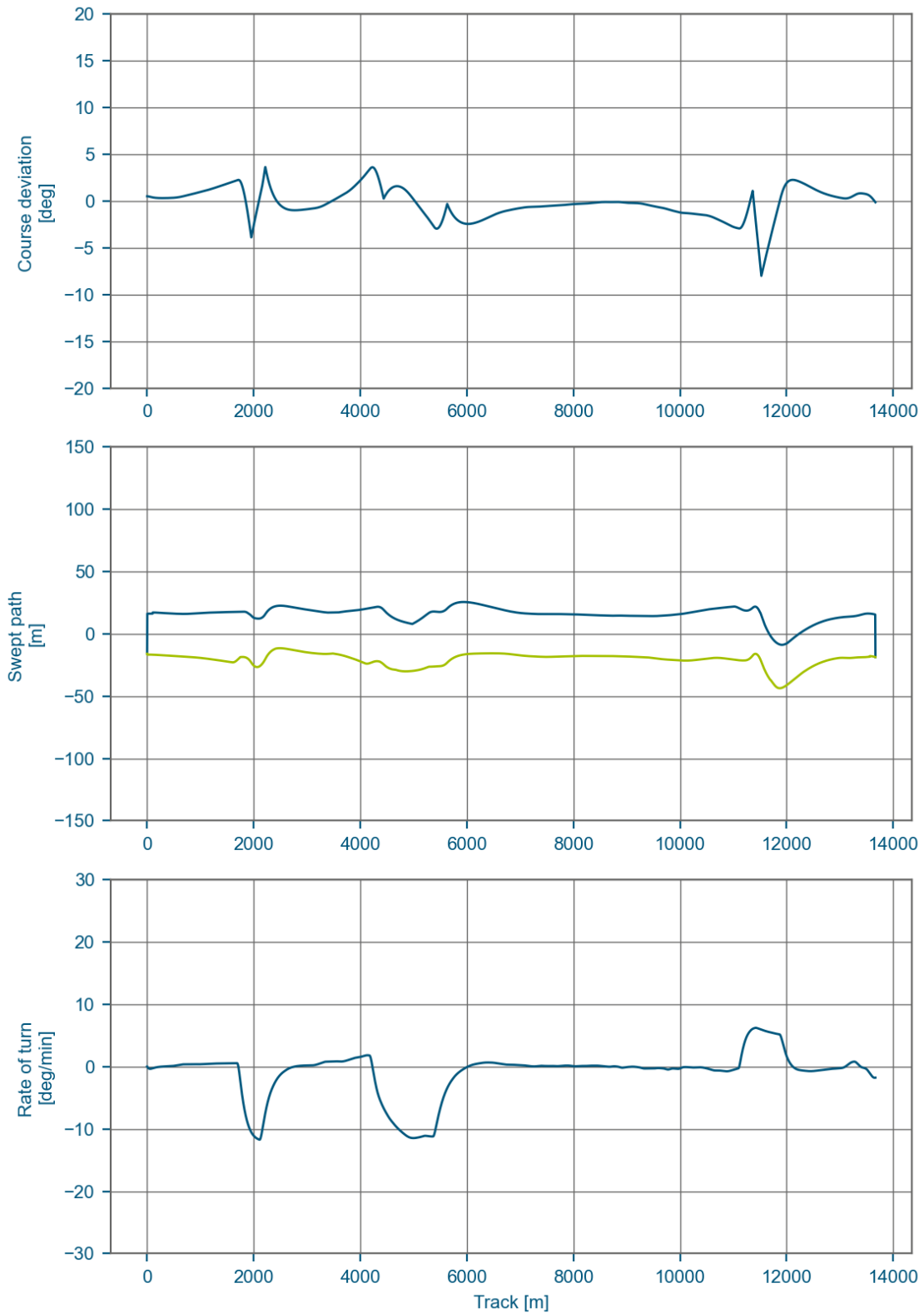


Figure 2.180: S.C. 23: course deviation (drift angle), swept path, RoT, vs. distance.

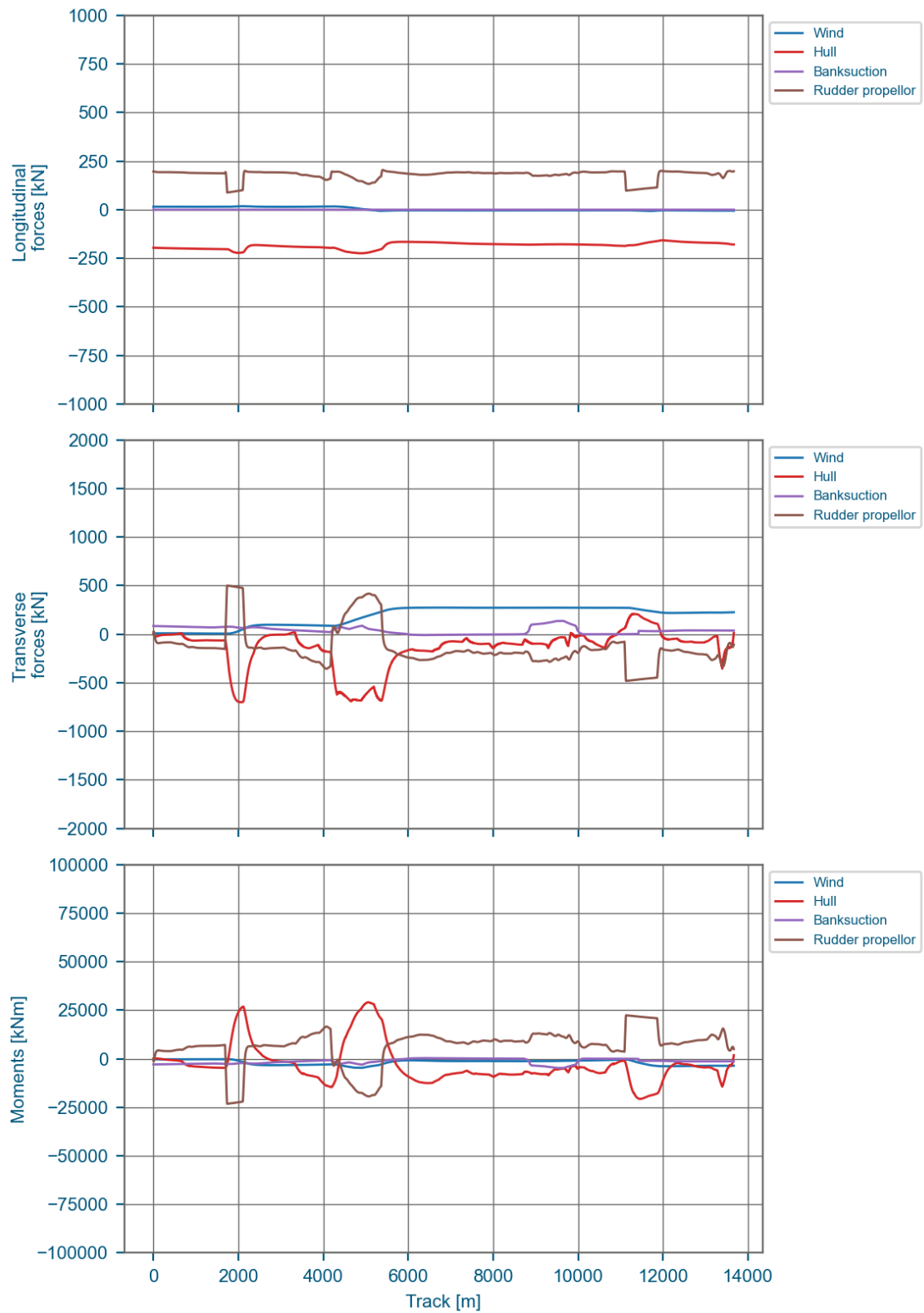


Figure 2.181: S.C. 23: forces, moments, vs. distance.

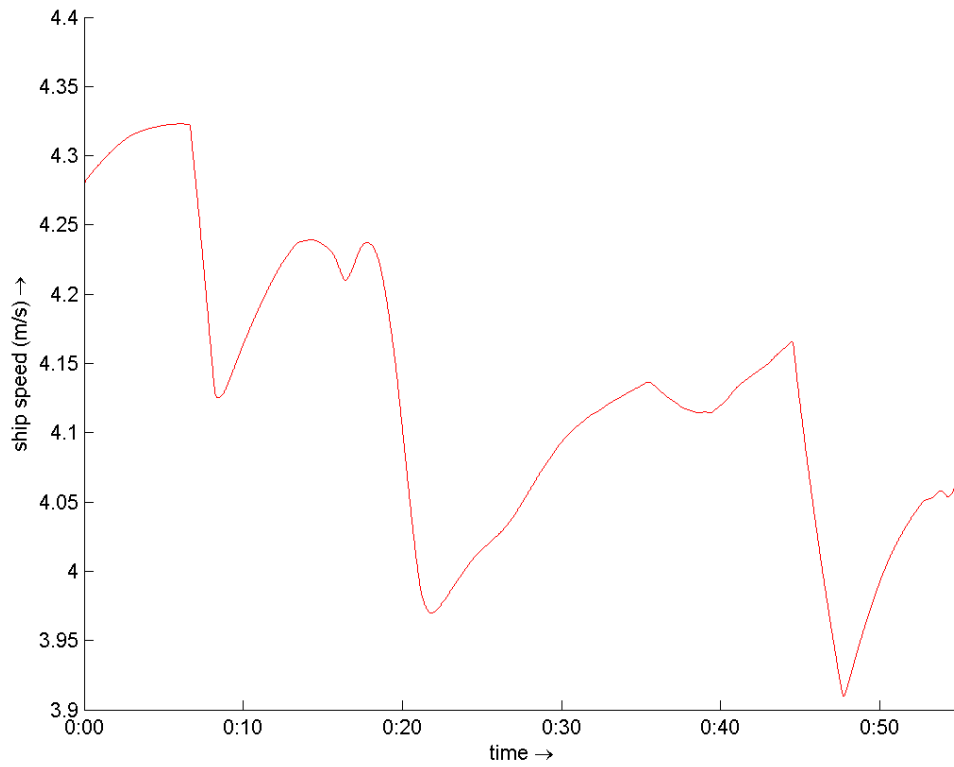


Figure 2.182: S.C. 23: SOG, vs. time.

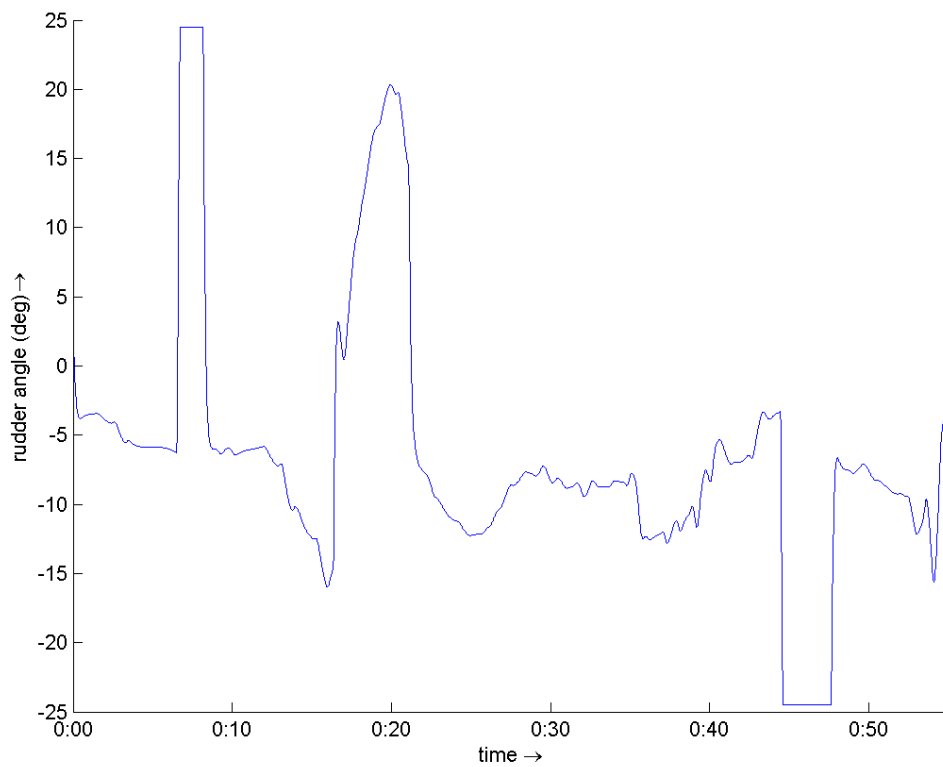


Figure 2.183: S.C. 23: rudder angle, vs. time.

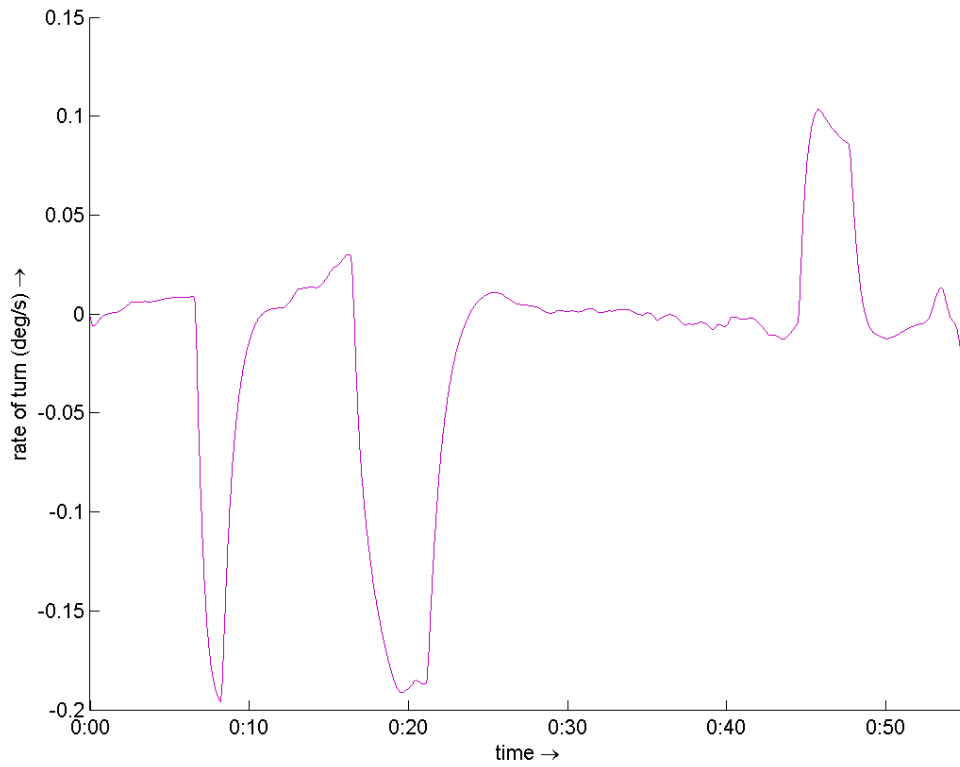


Figure 2.184: S.C. 23: RoT, vs. time.

## Simulation Case 24

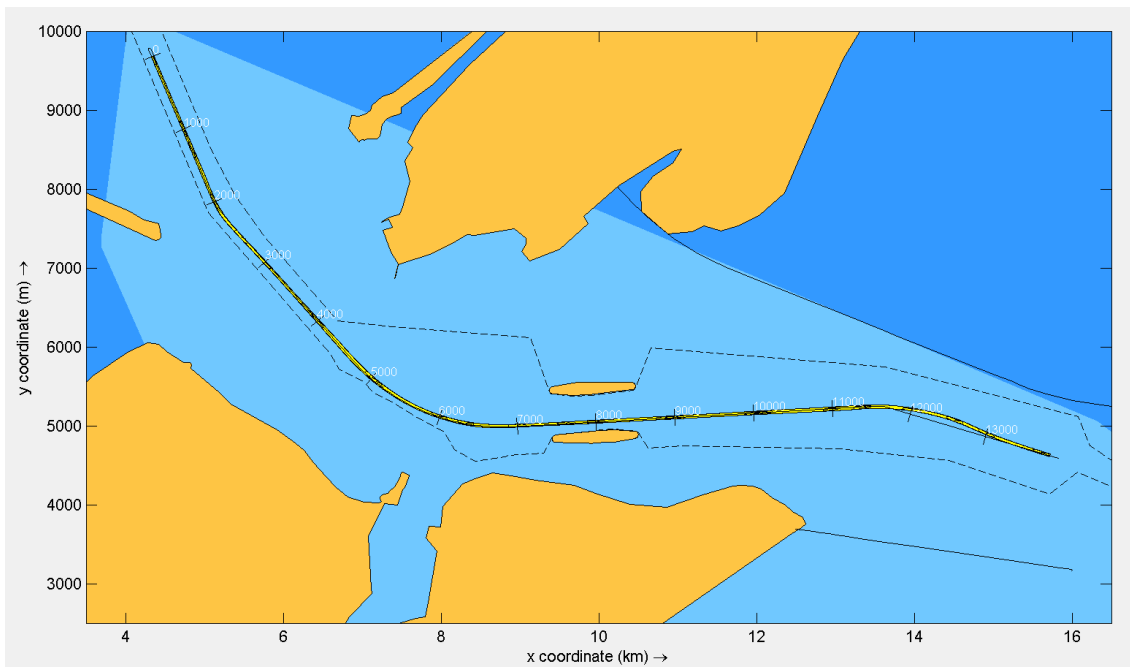
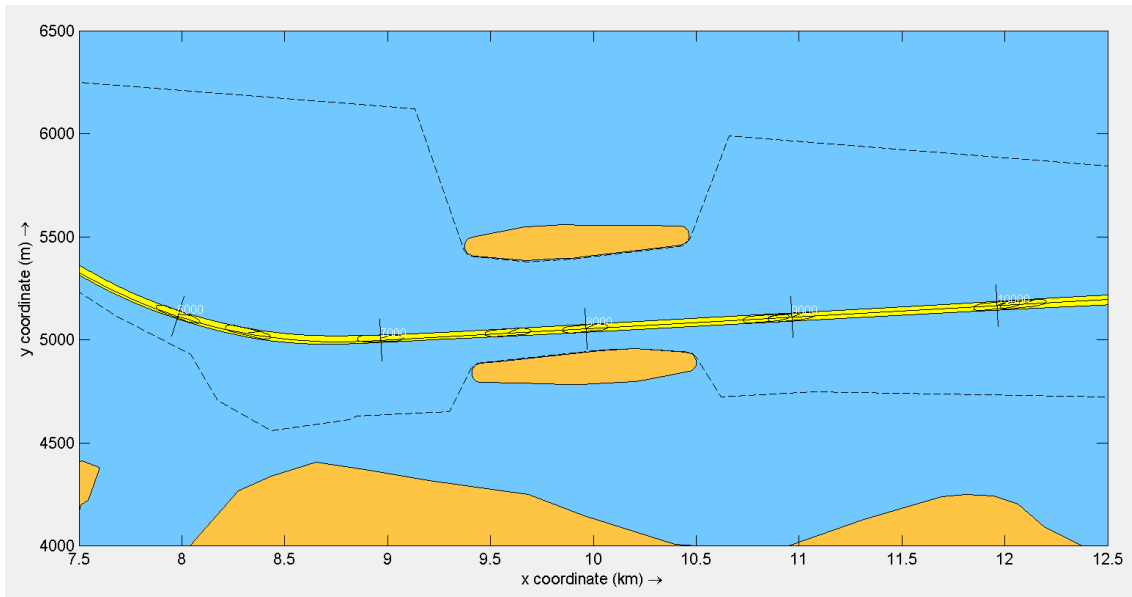


Figure 2.185: S.C. 24: spatial overview plot.



**Figure 2.186:** S.C. 24: zoom-in of spatial overview plot, crossing segment.

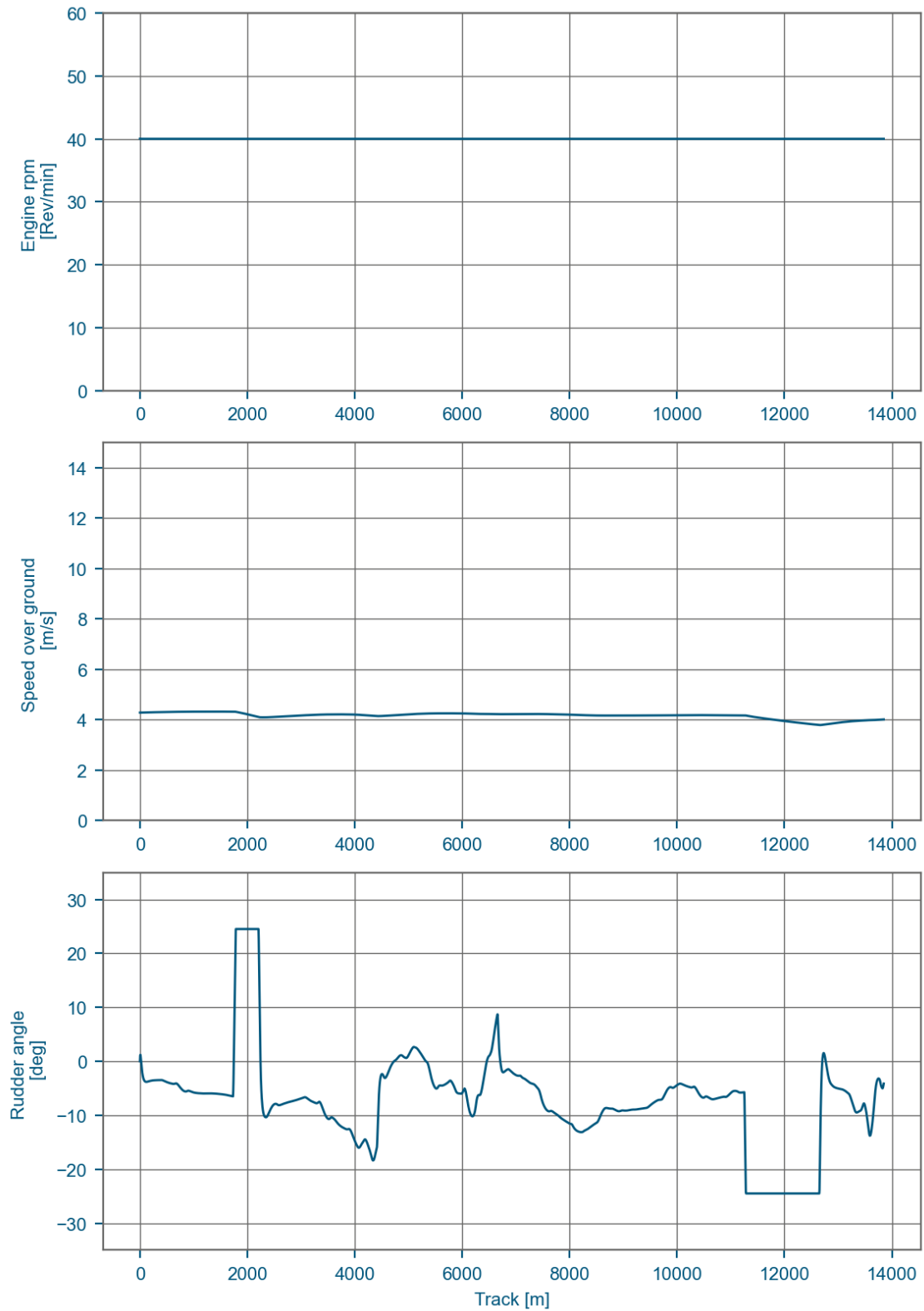


Figure 2.187: S.C. 24: engine RPM, SOG, rudder angle, vs. distance.

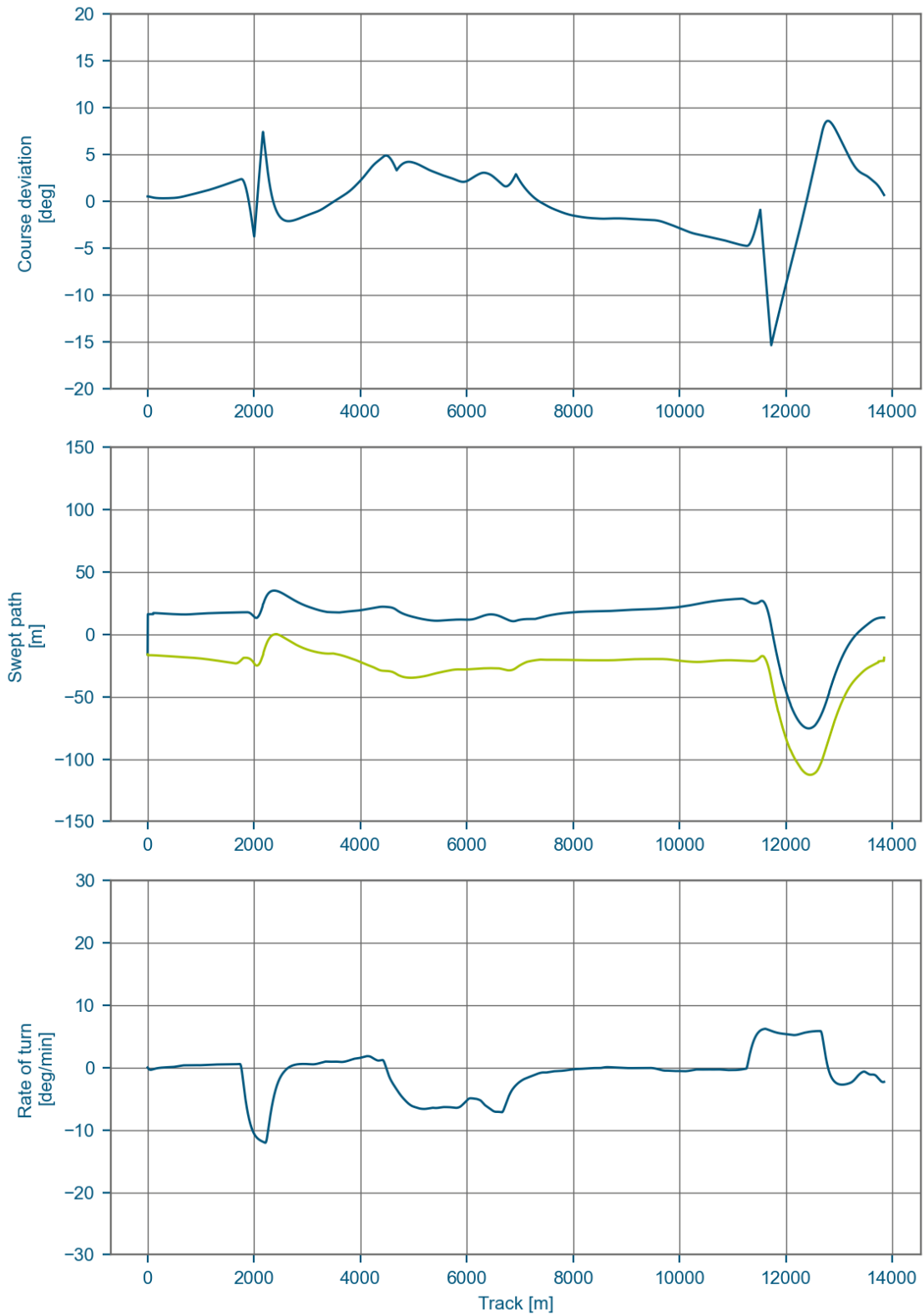


Figure 2.188: S.C. 24: course deviation (drift angle), swept path, RoT, vs. distance.

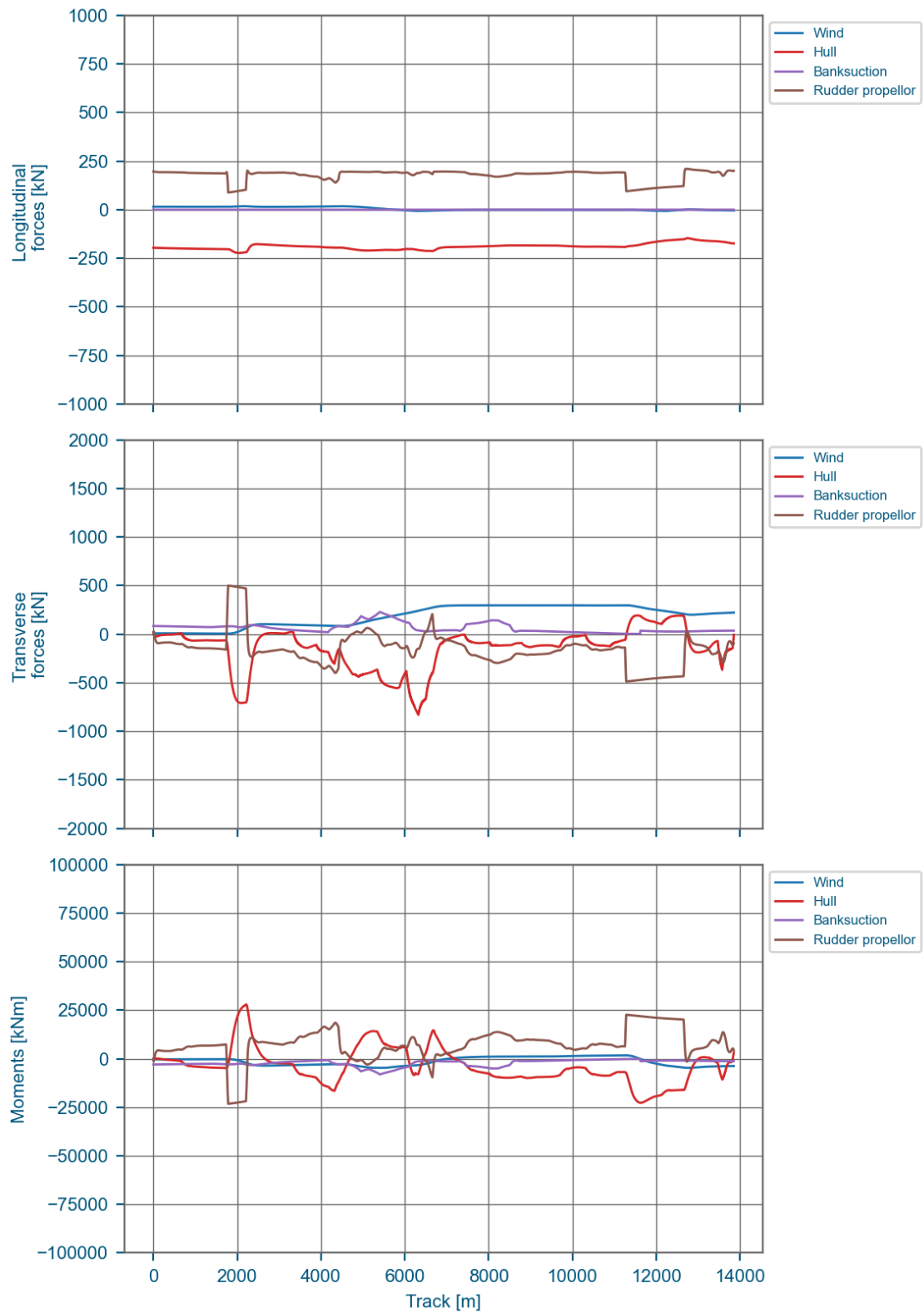


Figure 2.189: S.C. 24: forces, moments, vs. distance.

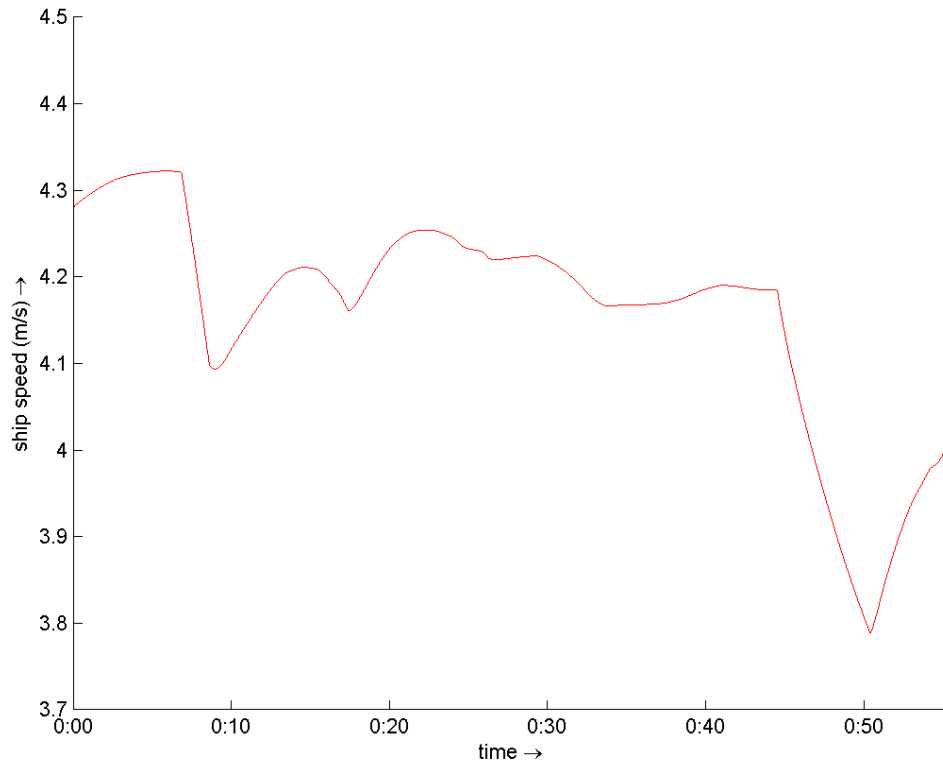


Figure 2.190: S.C. 24: SOG, vs. time.

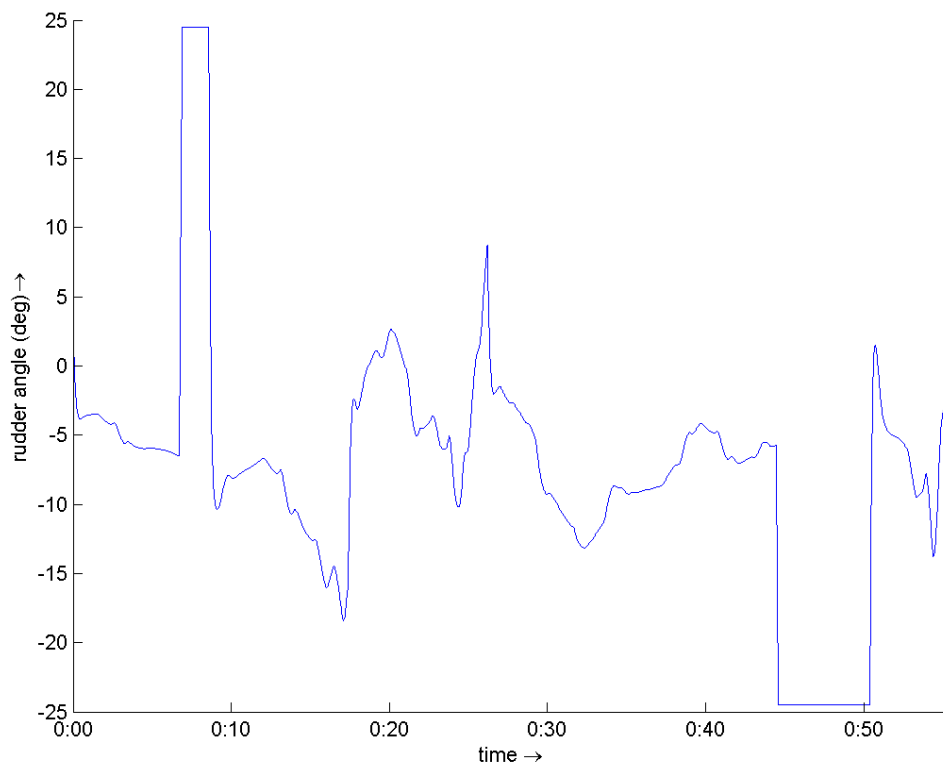


Figure 2.191: S.C. 24: rudder angle, vs. time.

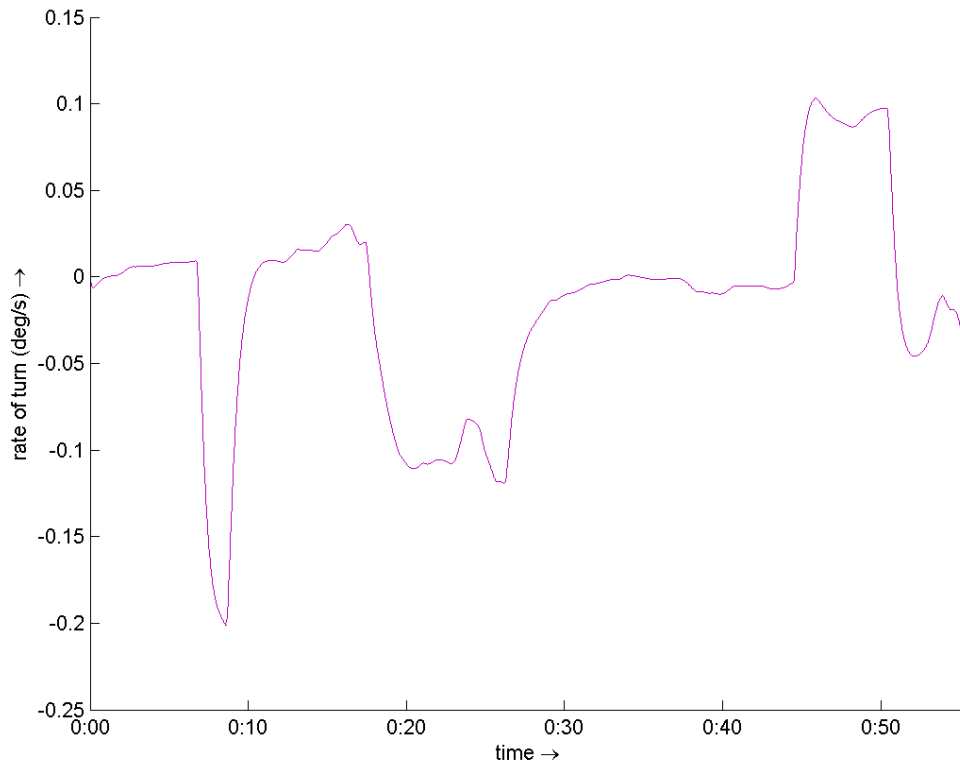


Figure 2.192: S.C. 24: RoT, vs. time.

## Simulation Case 25

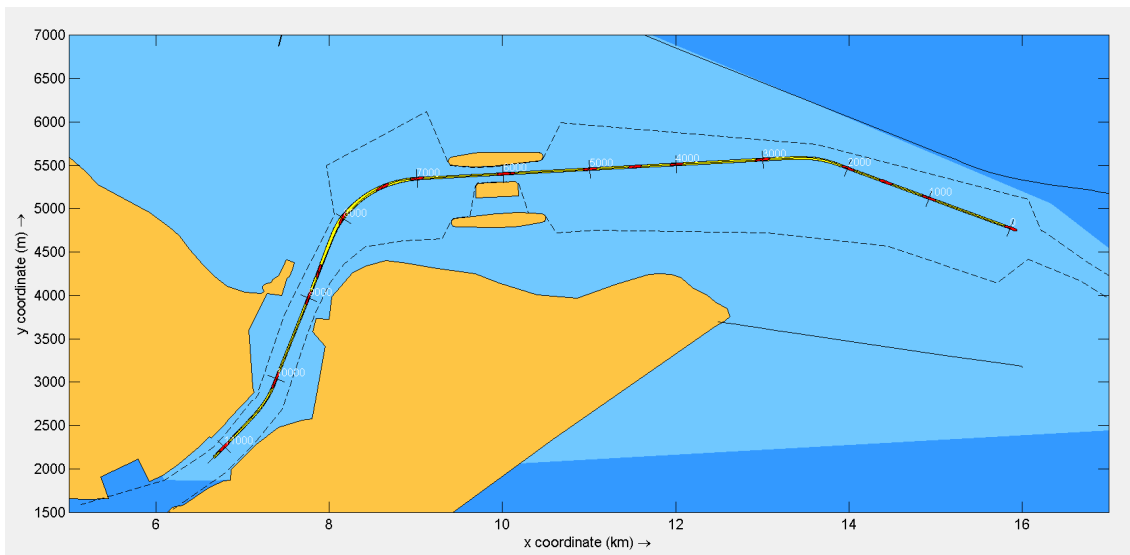
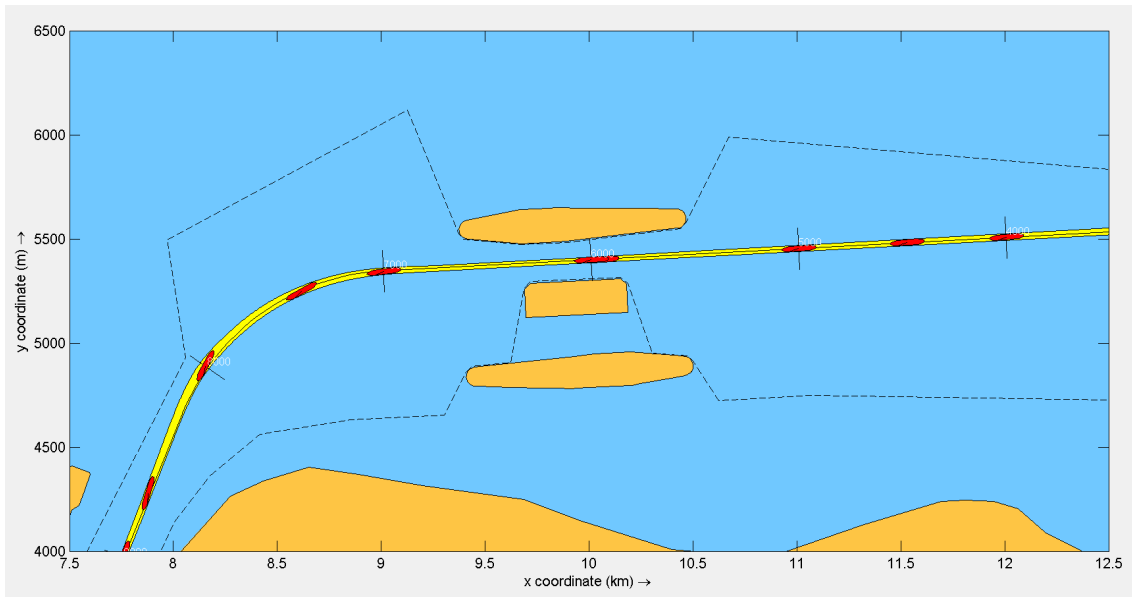


Figure 2.193: S.C. 25: spatial overview plot.



**Figure 2.194:** S.C. 25: zoom-in of spatial overview plot, crossing segment.

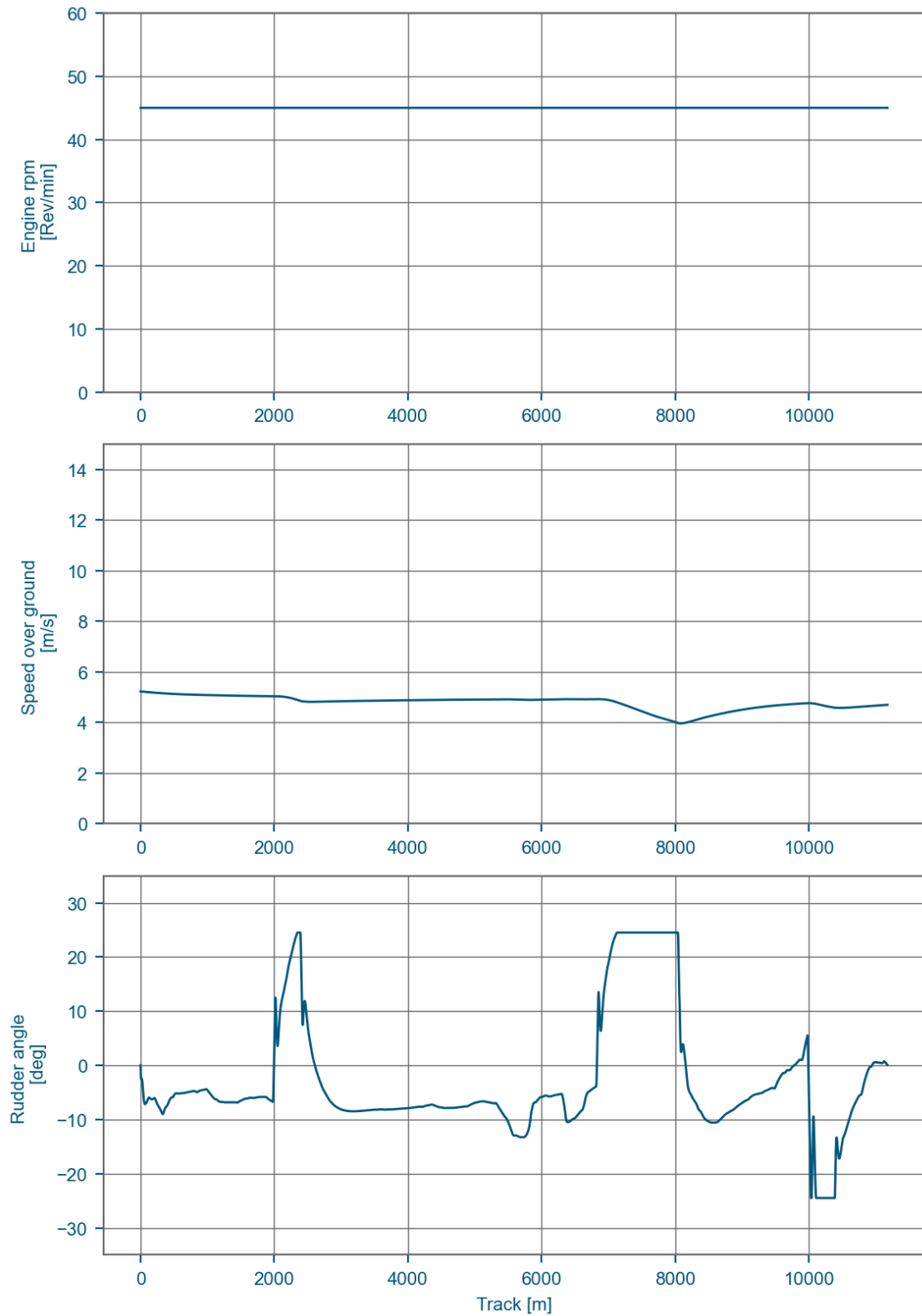
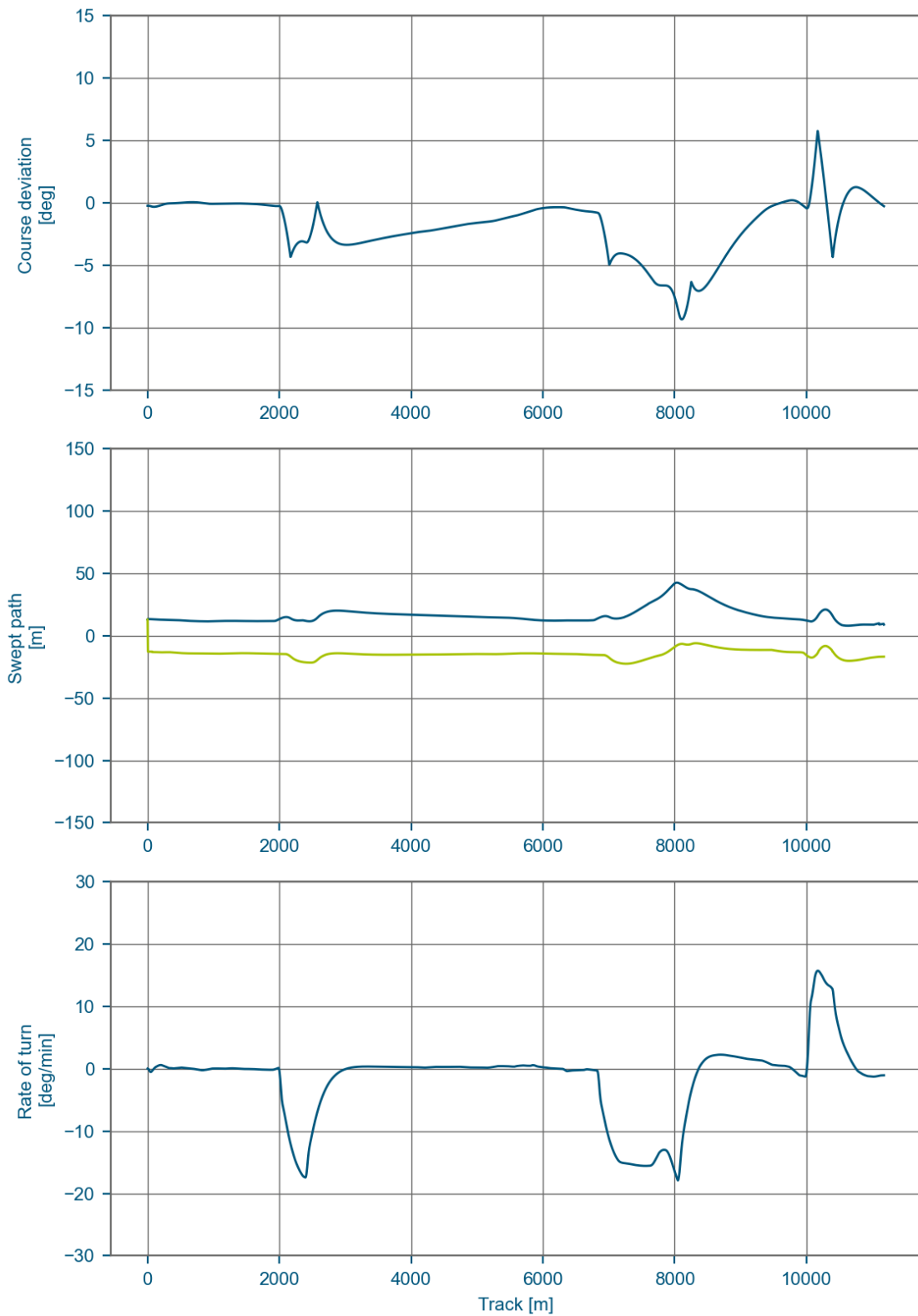


Figure 2.195: S.C. 25: engine RPM, SOG, rudder angle, vs. distance.



**Figure 2.196:** S.C. 25: course deviation (drift angle), swept path, RoT, vs. distance.

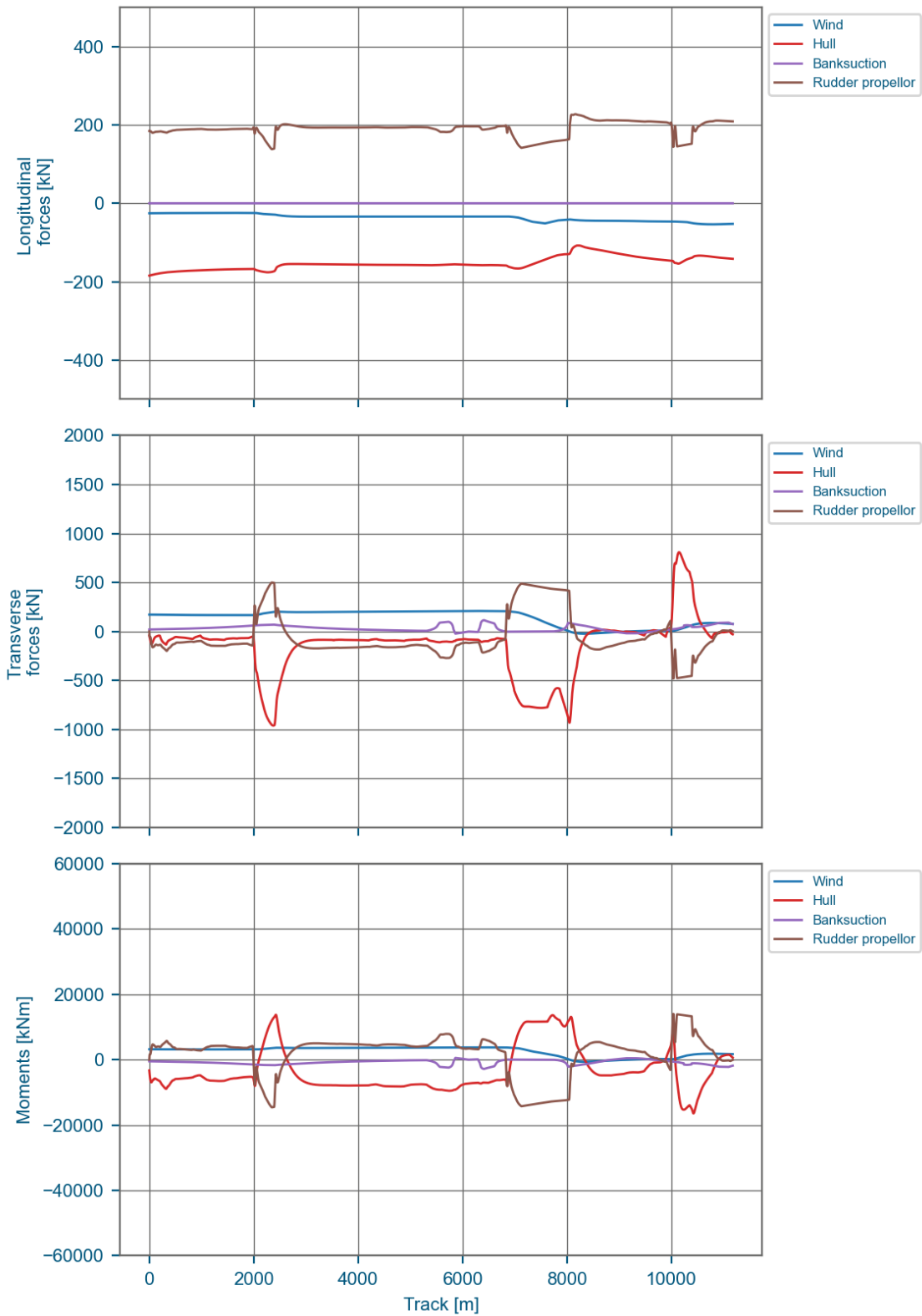


Figure 2.197: S.C. 25: forces, moments, vs. distance.

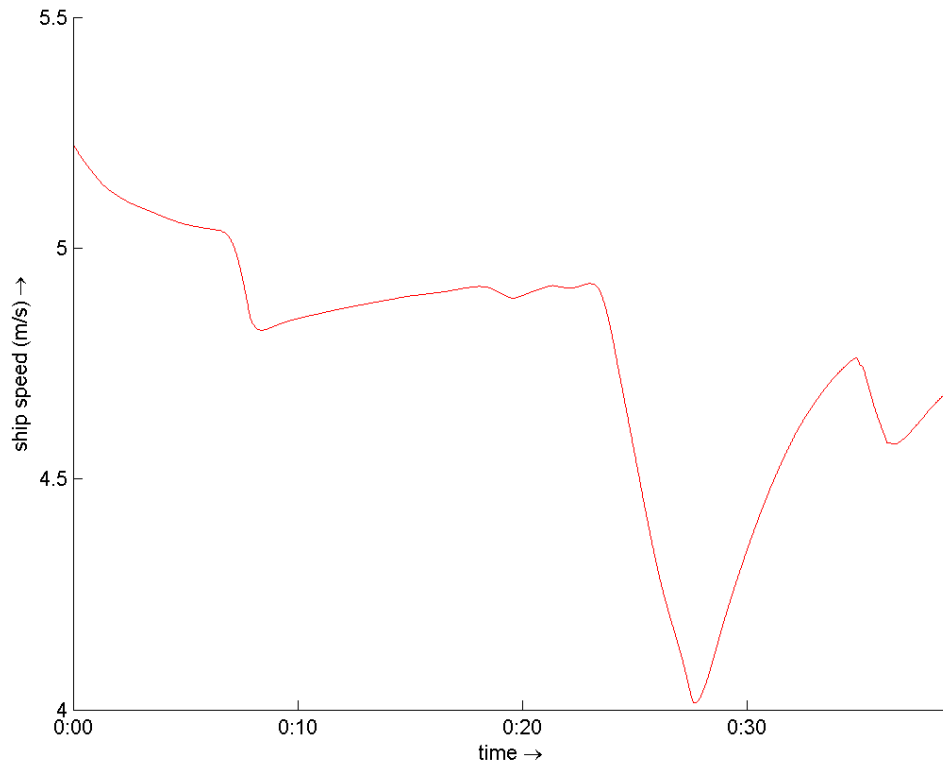


Figure 2.198: S.C. 25: SOG, vs. time.

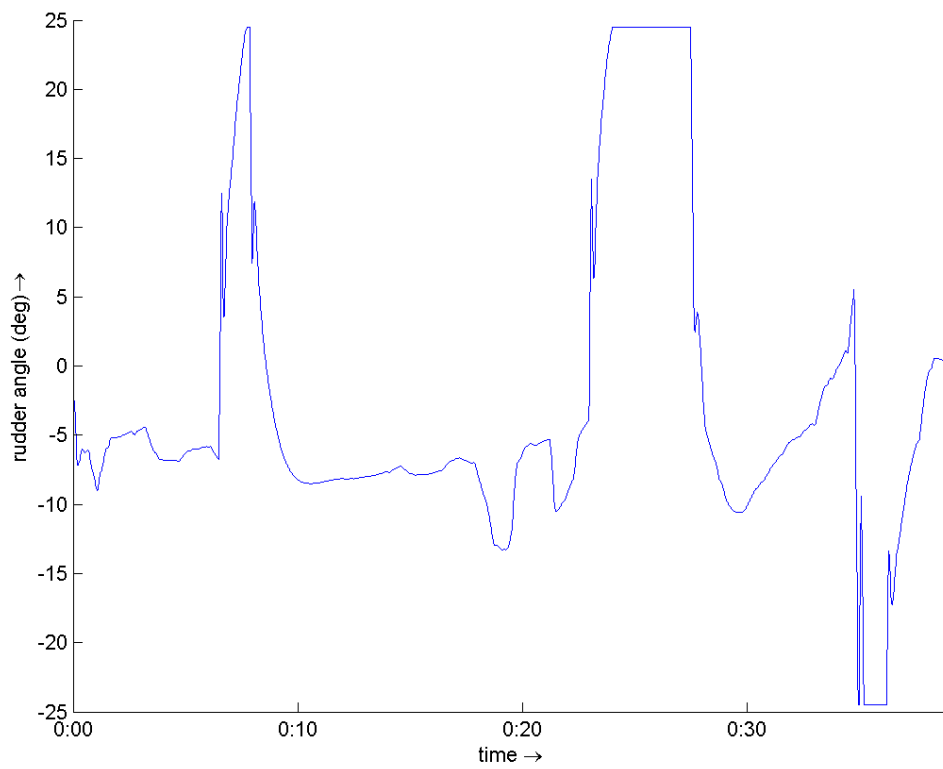


Figure 2.199: S.C. 25: rudder angle, vs. time.

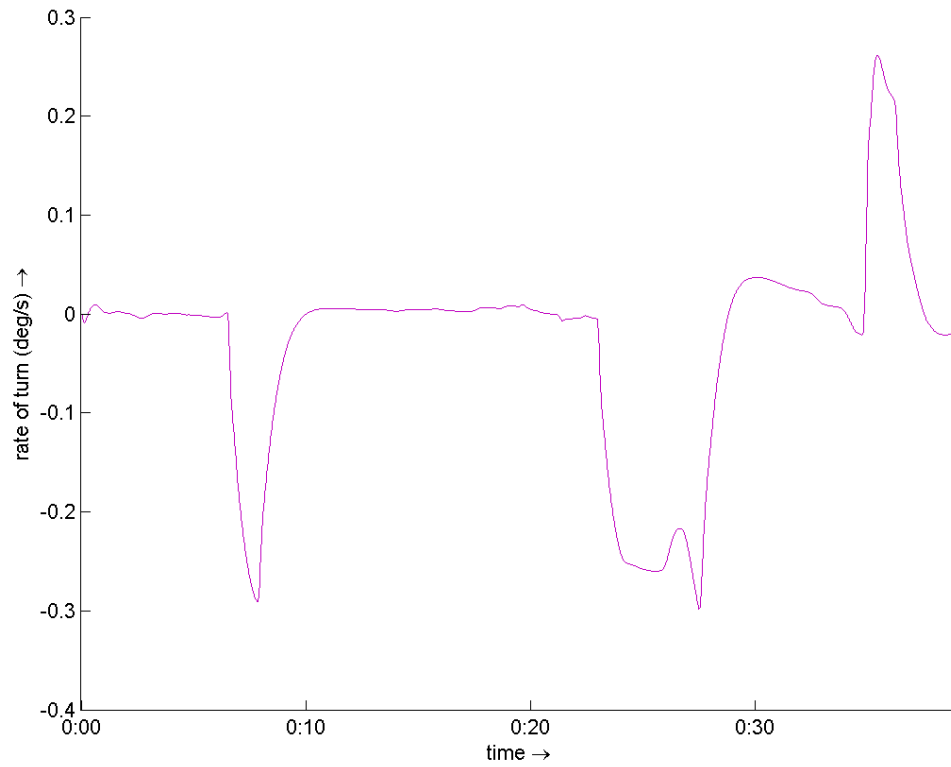


Figure 2.200: S.C. 25: RoT, vs. time.

## Simulation Case 26

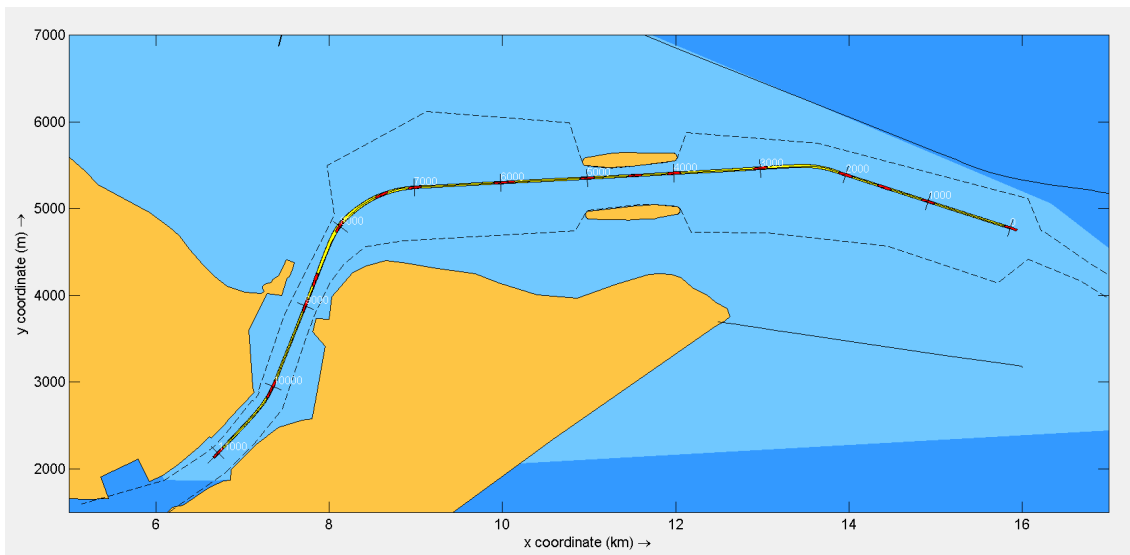
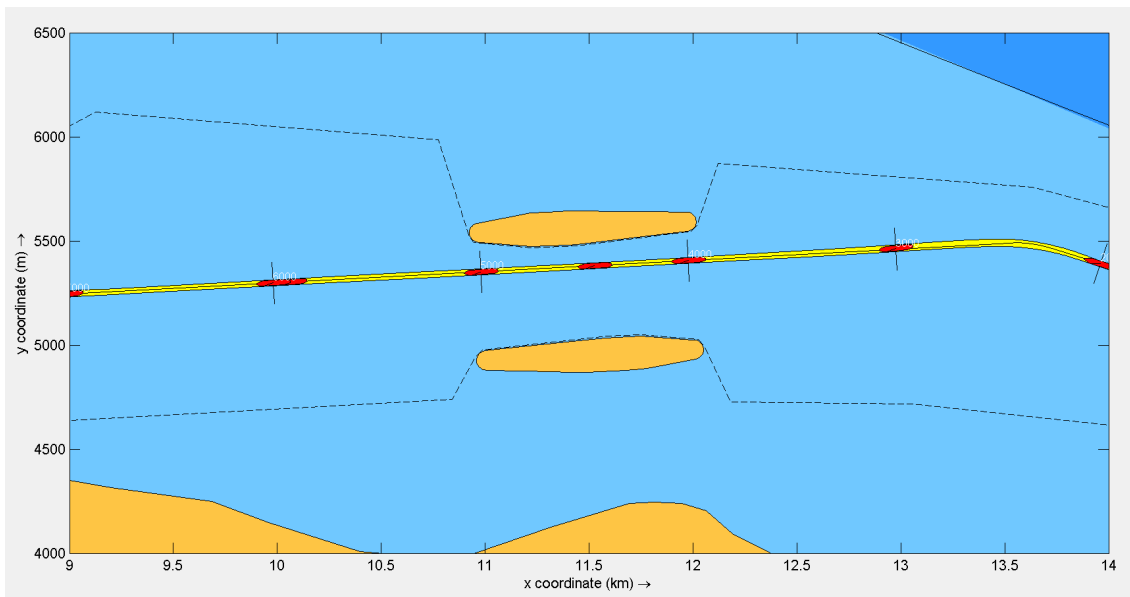


Figure 2.201: S.C. 26: spatial overview plot.



**Figure 2.202:** S.C. 26: zoom-in of spatial overview plot, crossing segment.

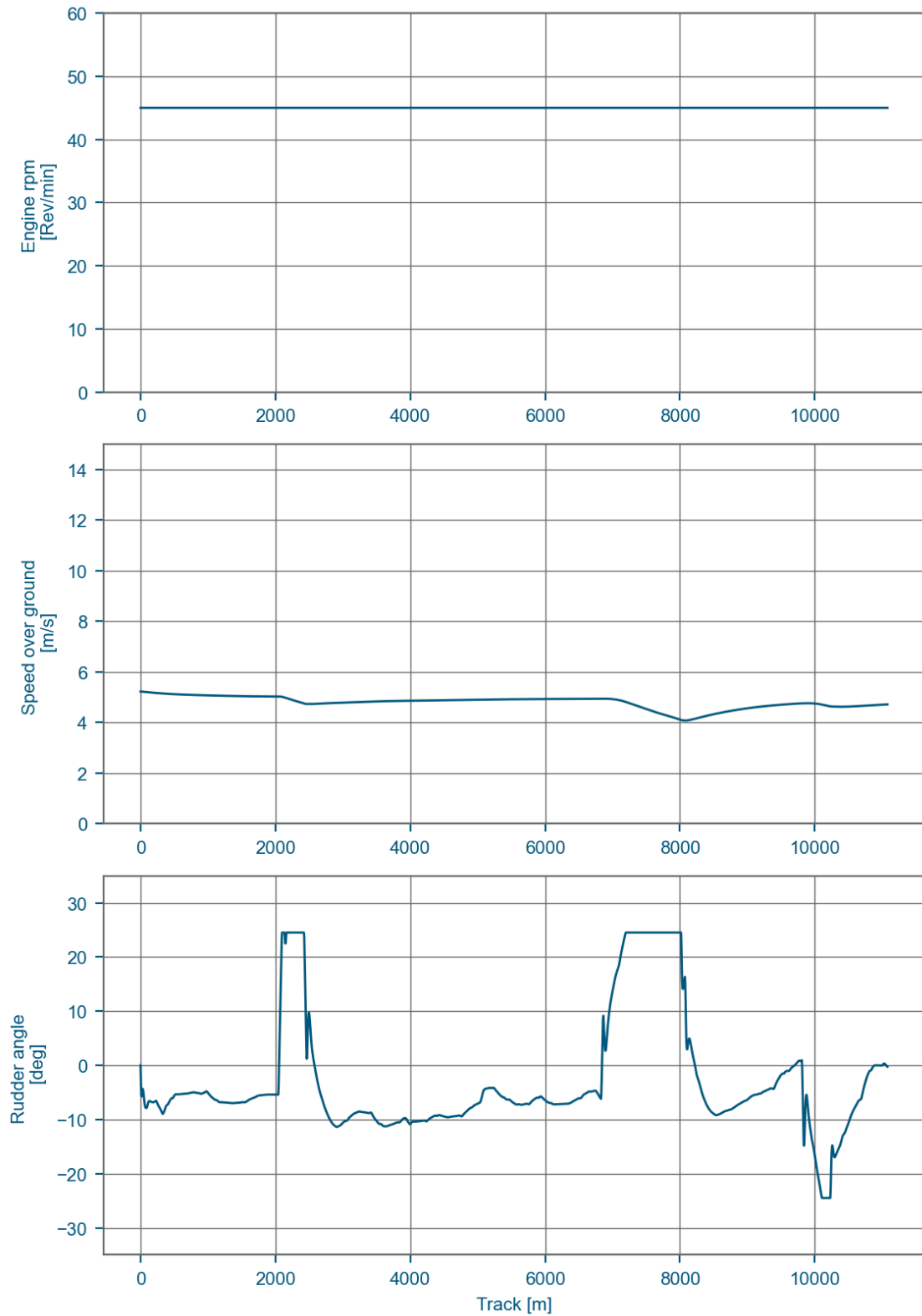


Figure 2.203: S.C. 26: engine RPM, SOG, rudder angle, vs. distance.

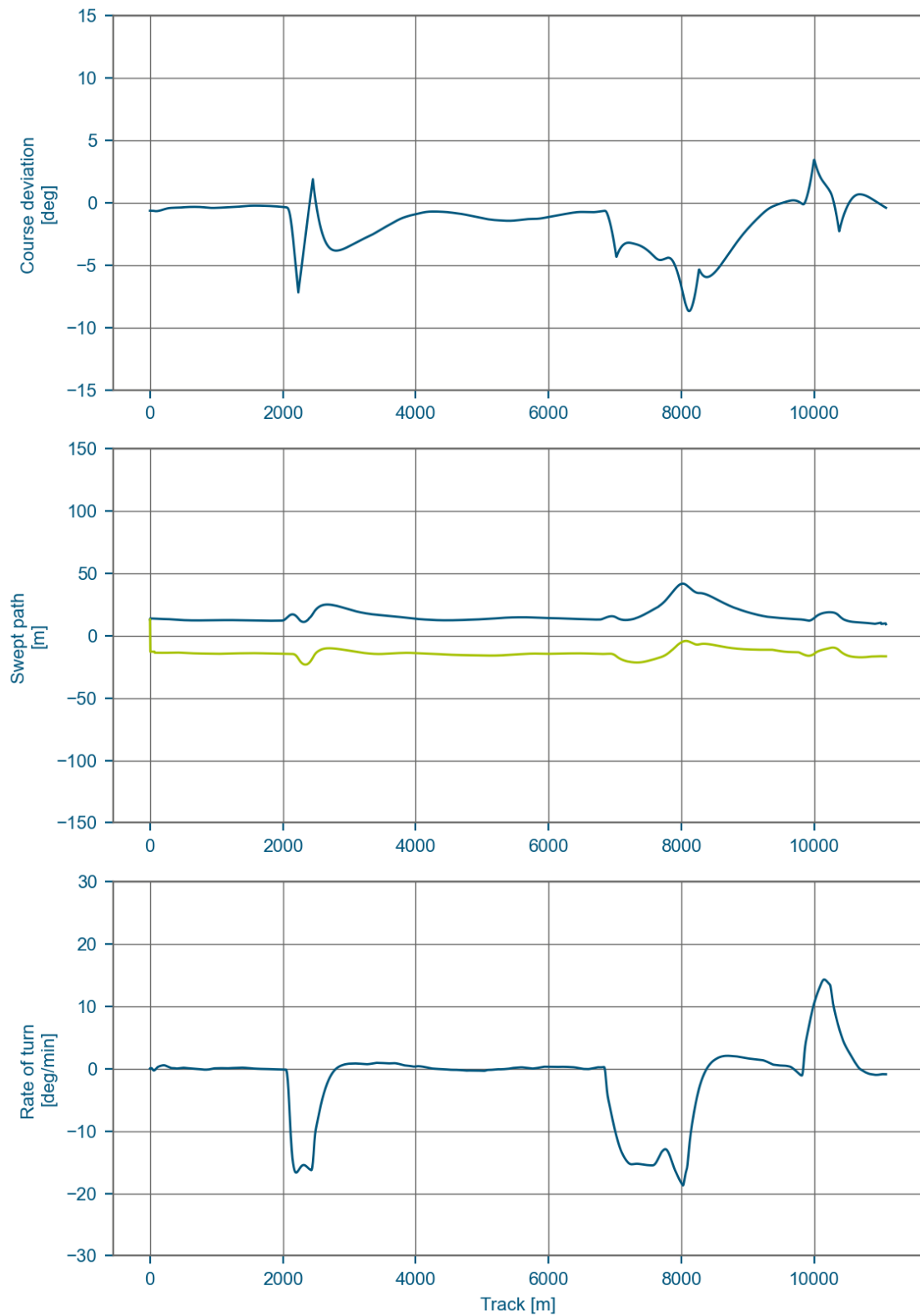


Figure 2.204: S.C. 26: course deviation (drift angle), swept path, RoT, vs. distance.

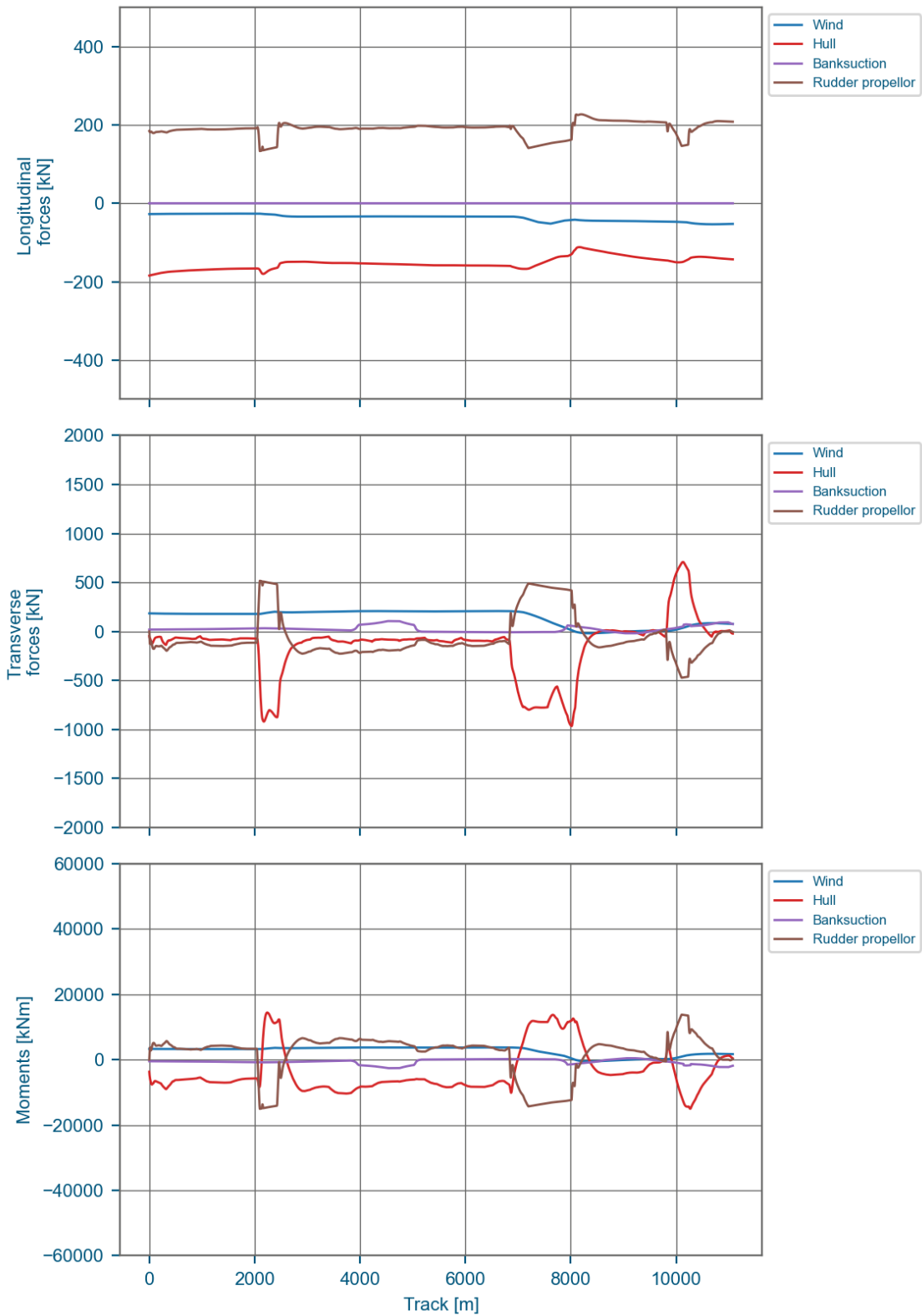


Figure 2.205: S.C. 26: forces, moments, vs. distance.

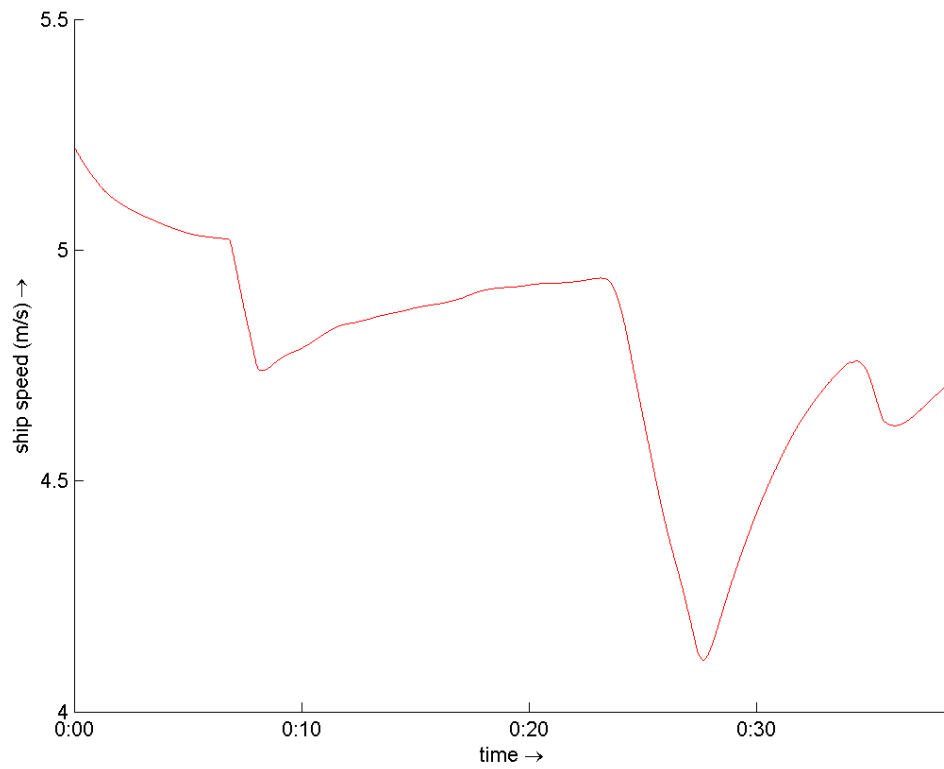


Figure 2.206: S.C. 26: SOG, vs. time.

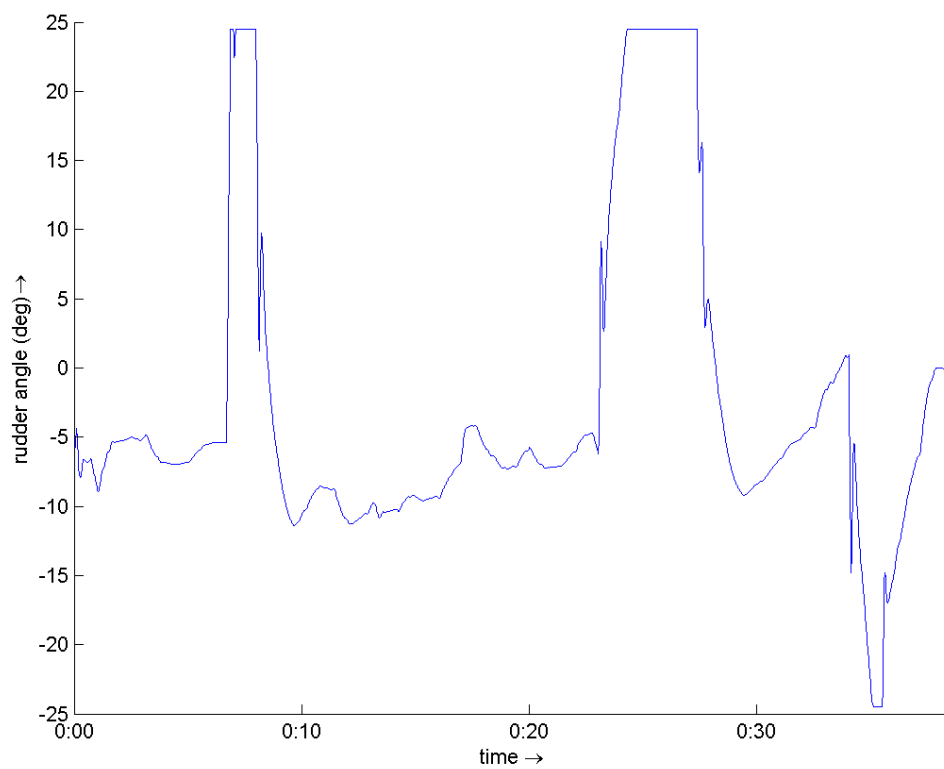


Figure 2.207: S.C. 26: rudder angle, vs. time.

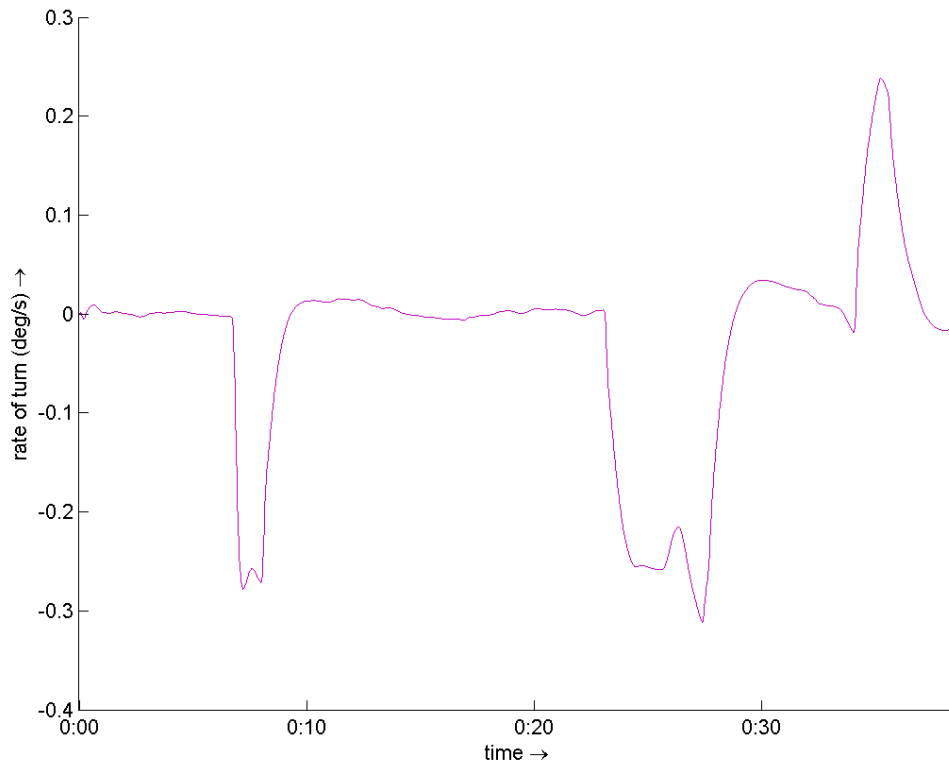


Figure 2.208: S.C. 26: RoT, vs. time.

## Simulation Case 27

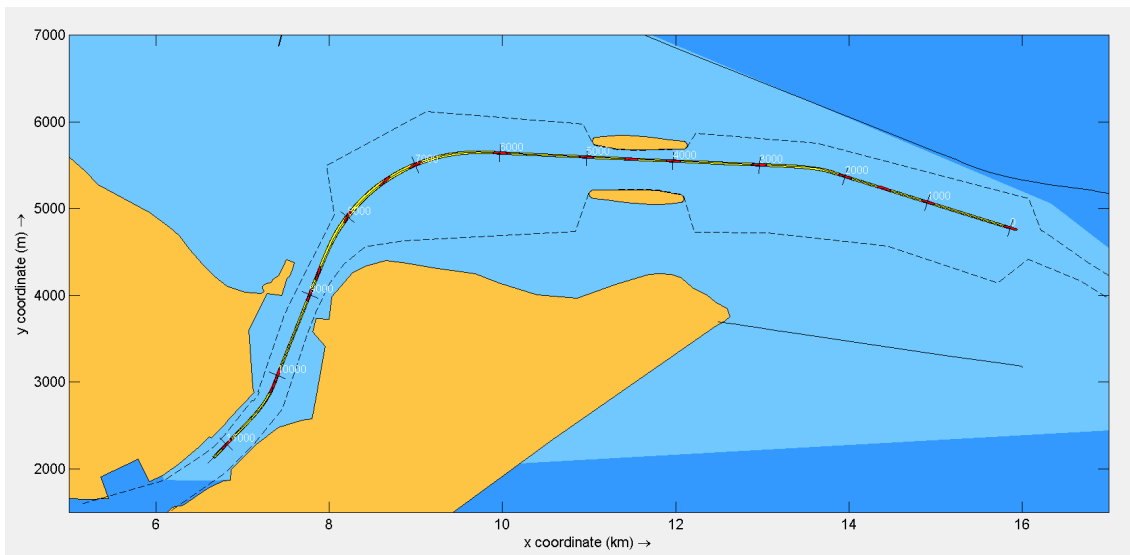
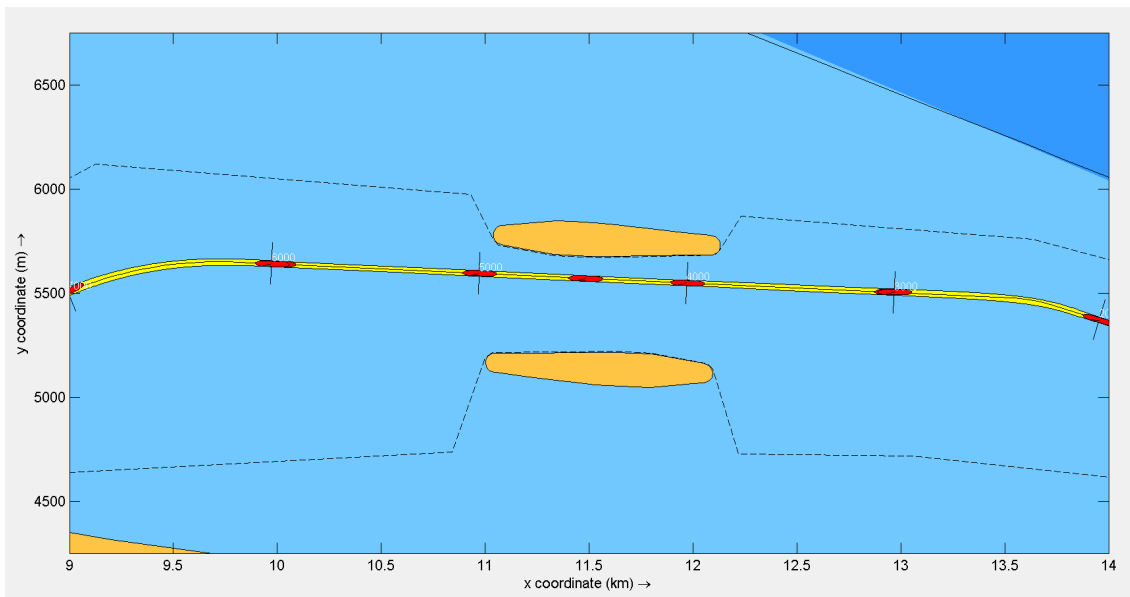


Figure 2.209: S.C. 27: spatial overview plot.



**Figure 2.210:** S.C. 27: zoom-in of spatial overview plot, crossing segment.

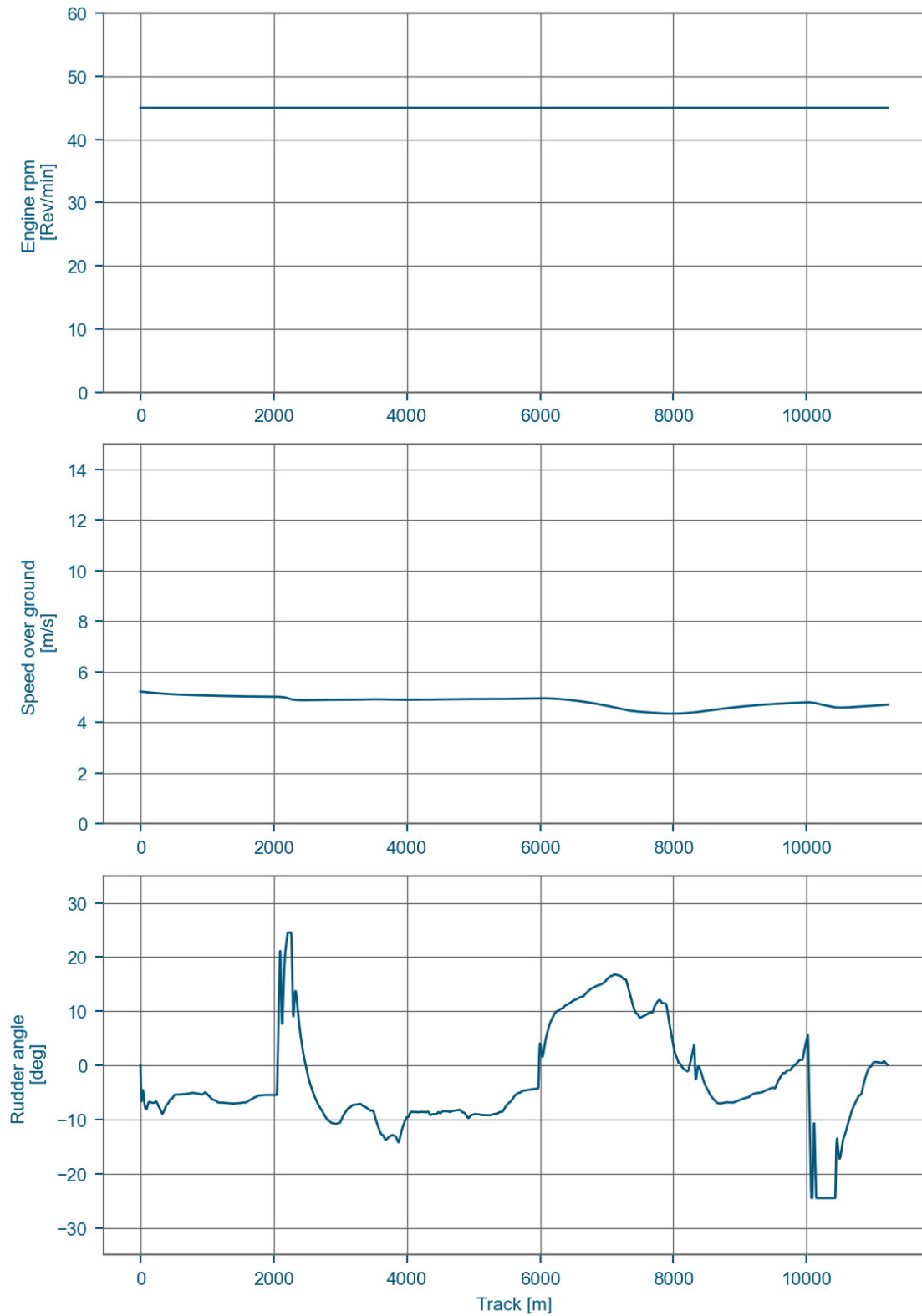


Figure 2.211: S.C. 27: engine RPM, SOG, rudder angle, vs. distance.

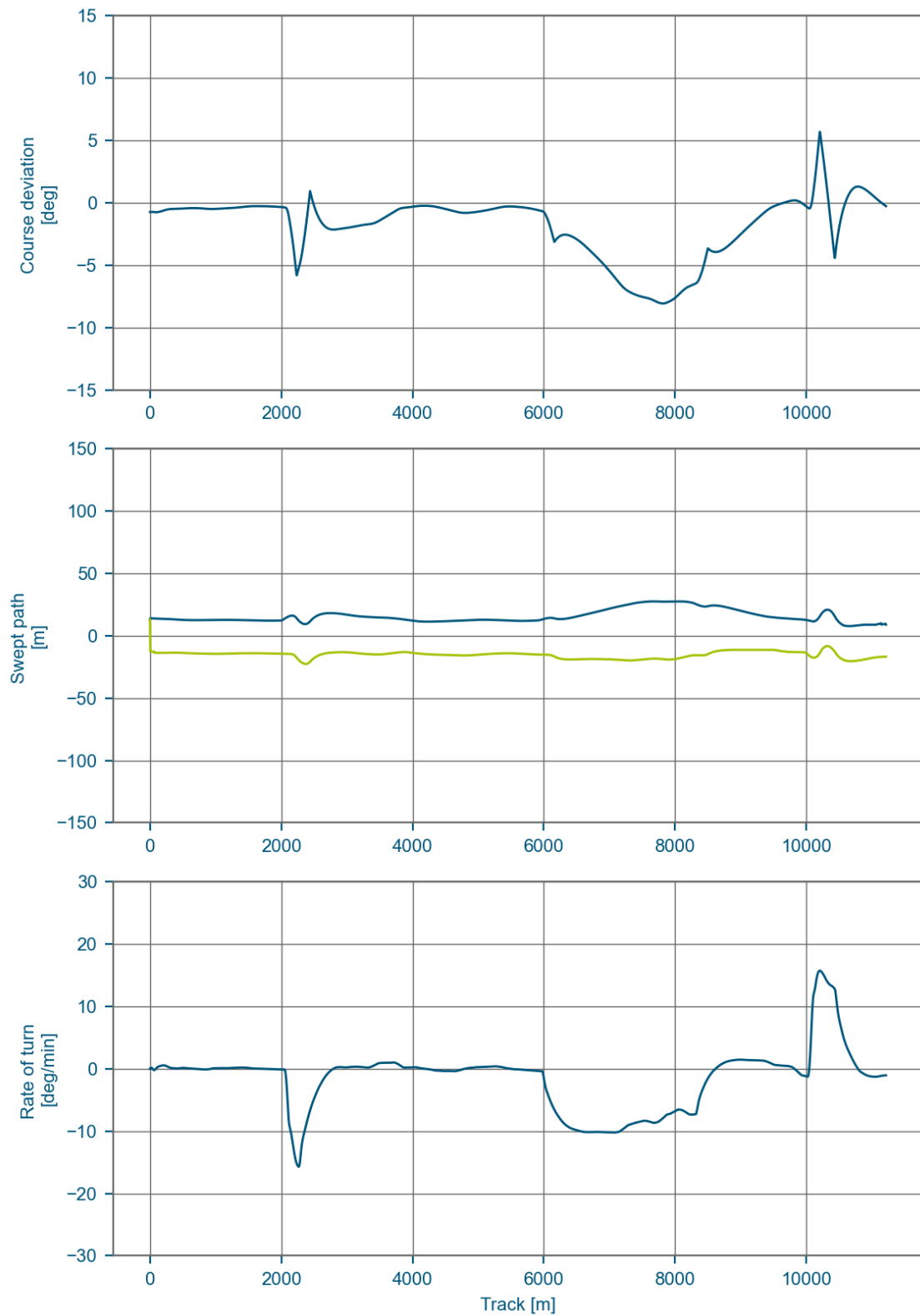


Figure 2.212: S.C. 27: course deviation (drift angle), swept path, RoT, vs. distance.

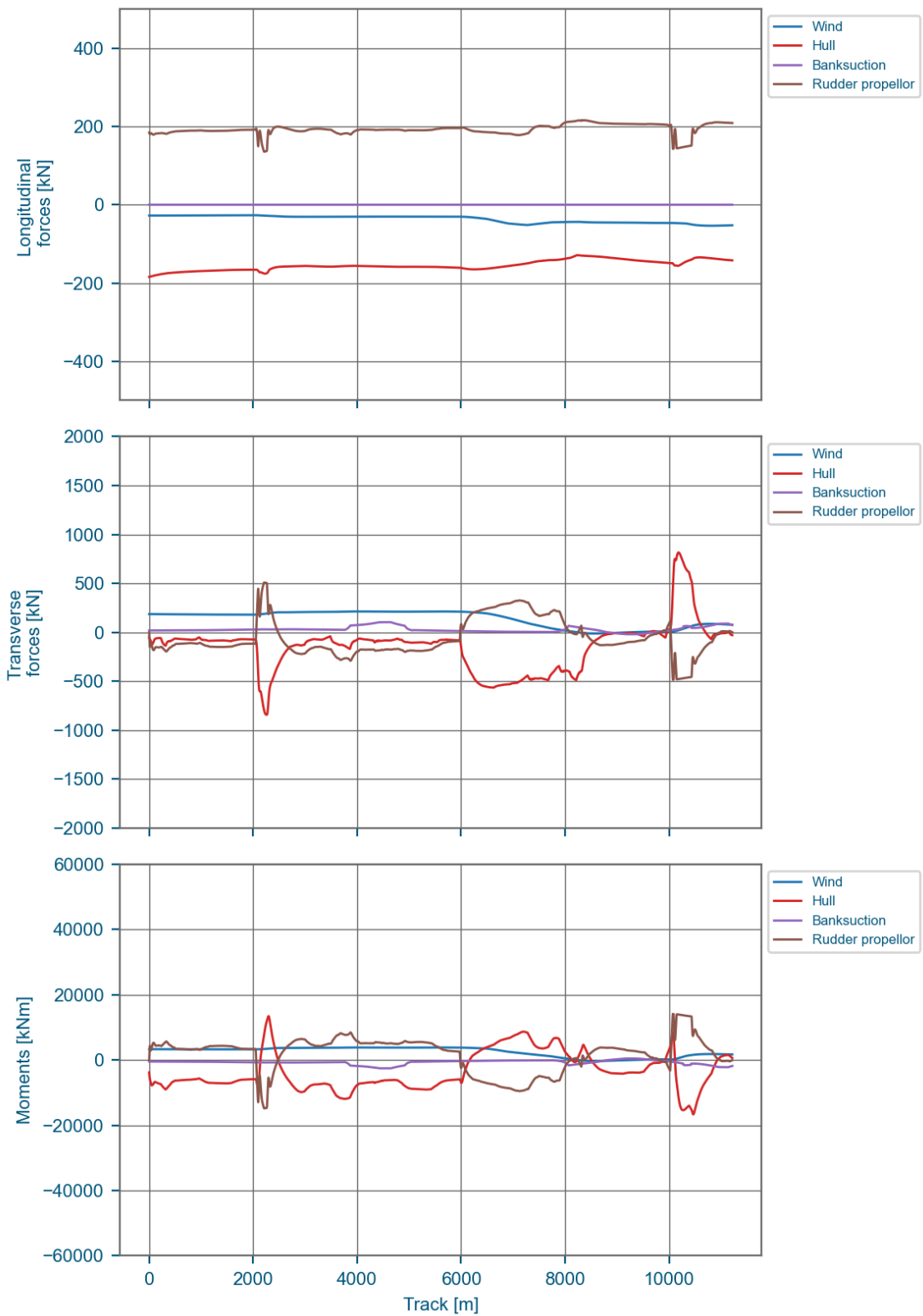


Figure 2.213: S.C. 27: forces, moments, vs. distance.

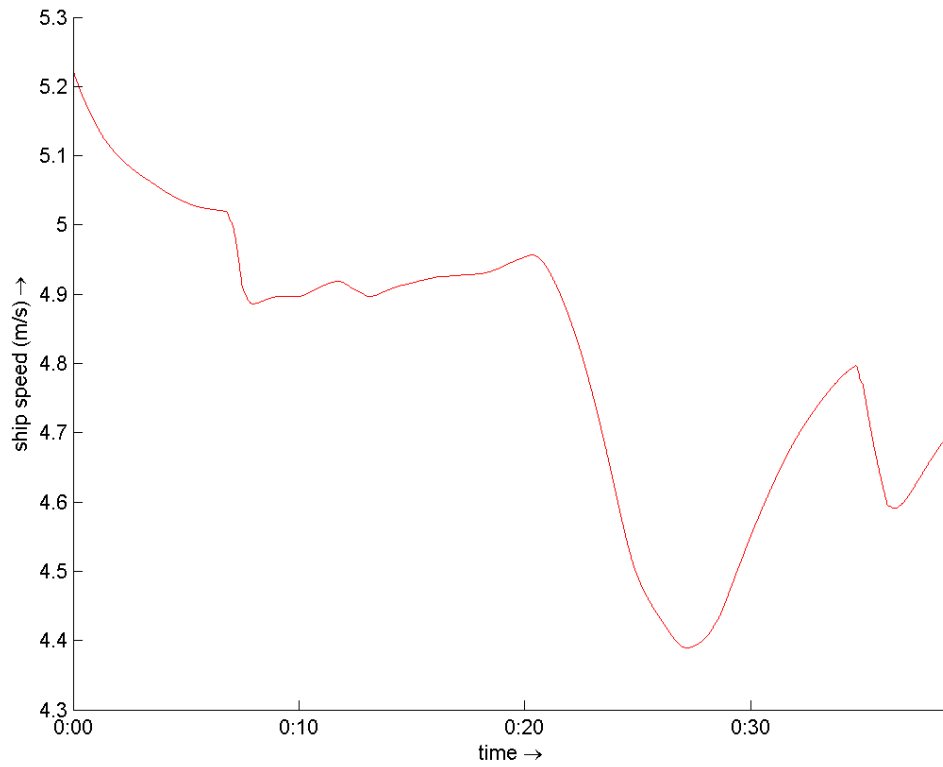


Figure 2.214: S.C. 27: SOG, vs. time.

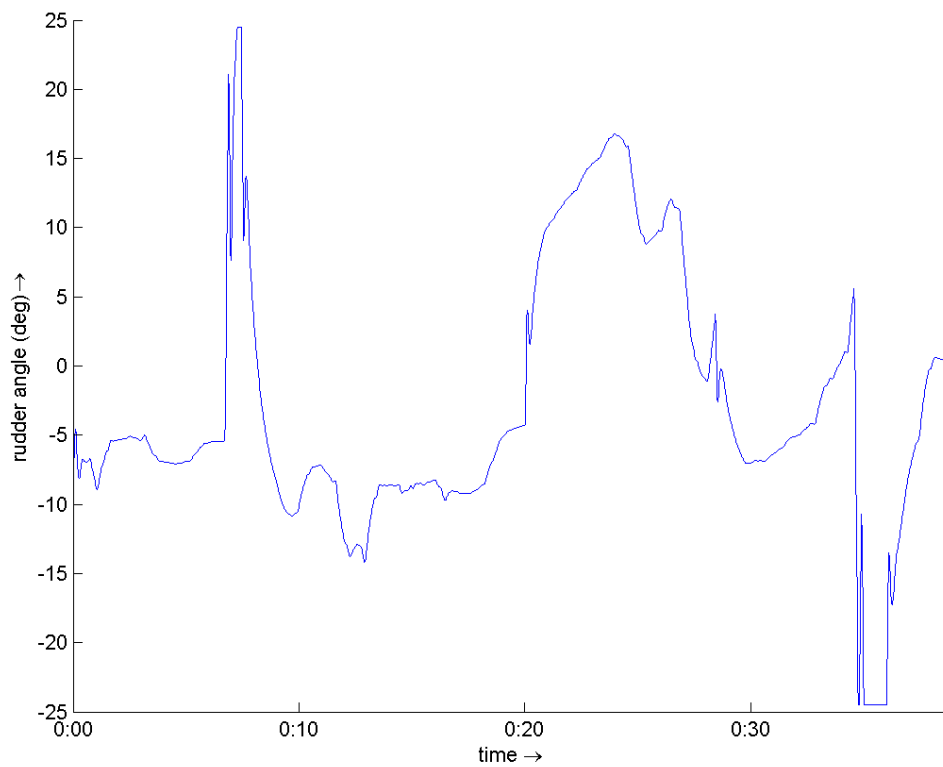


Figure 2.215: S.C. 27: rudder angle, vs. time.

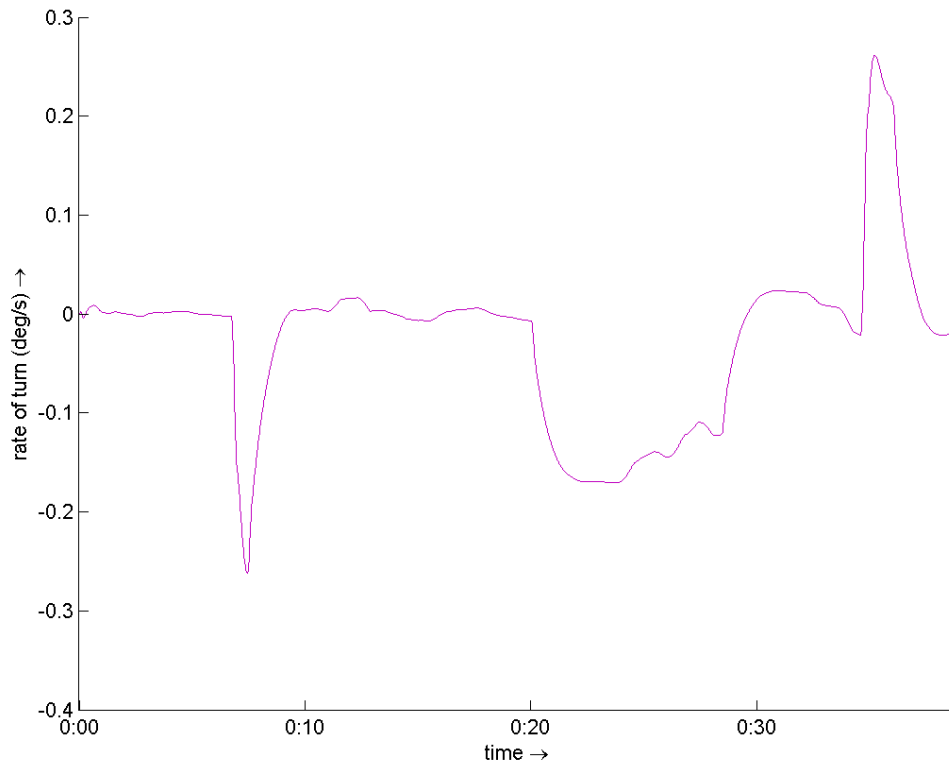


Figure 2.216: S.C. 27: RoT, vs. time.

## Simulation Case 28

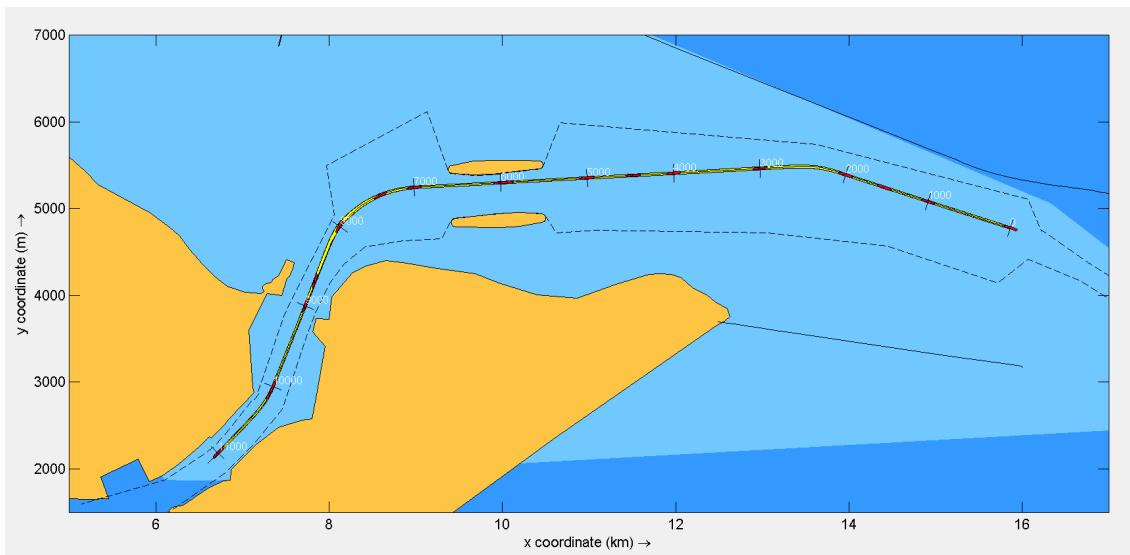
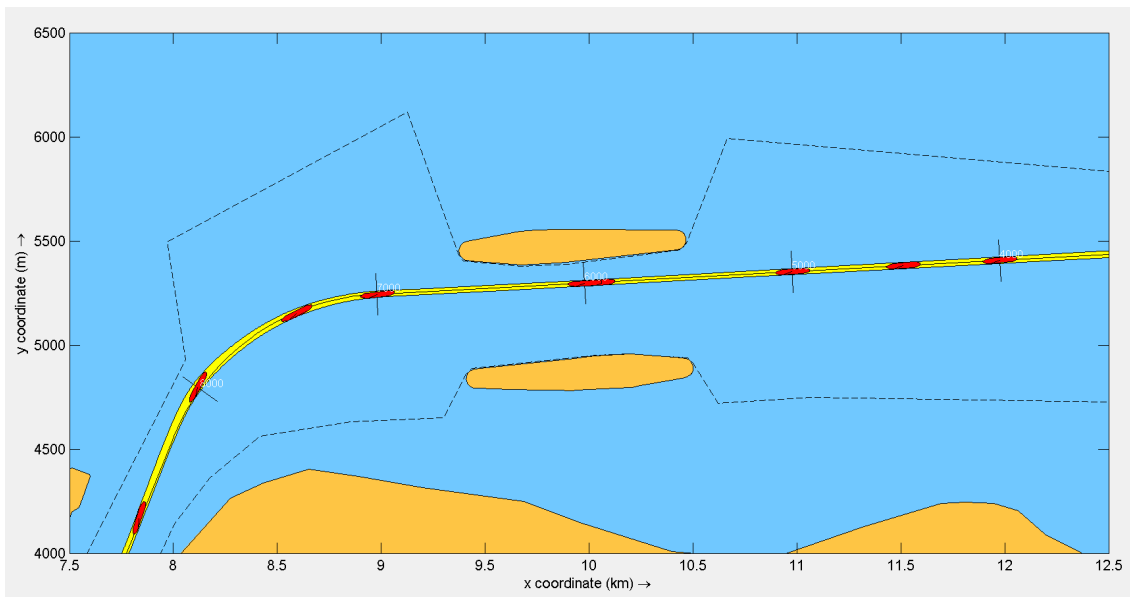


Figure 2.217: S.C. 28: spatial overview plot.



**Figure 2.218:** S.C. 28: zoom-in of spatial overview plot, crossing segment.

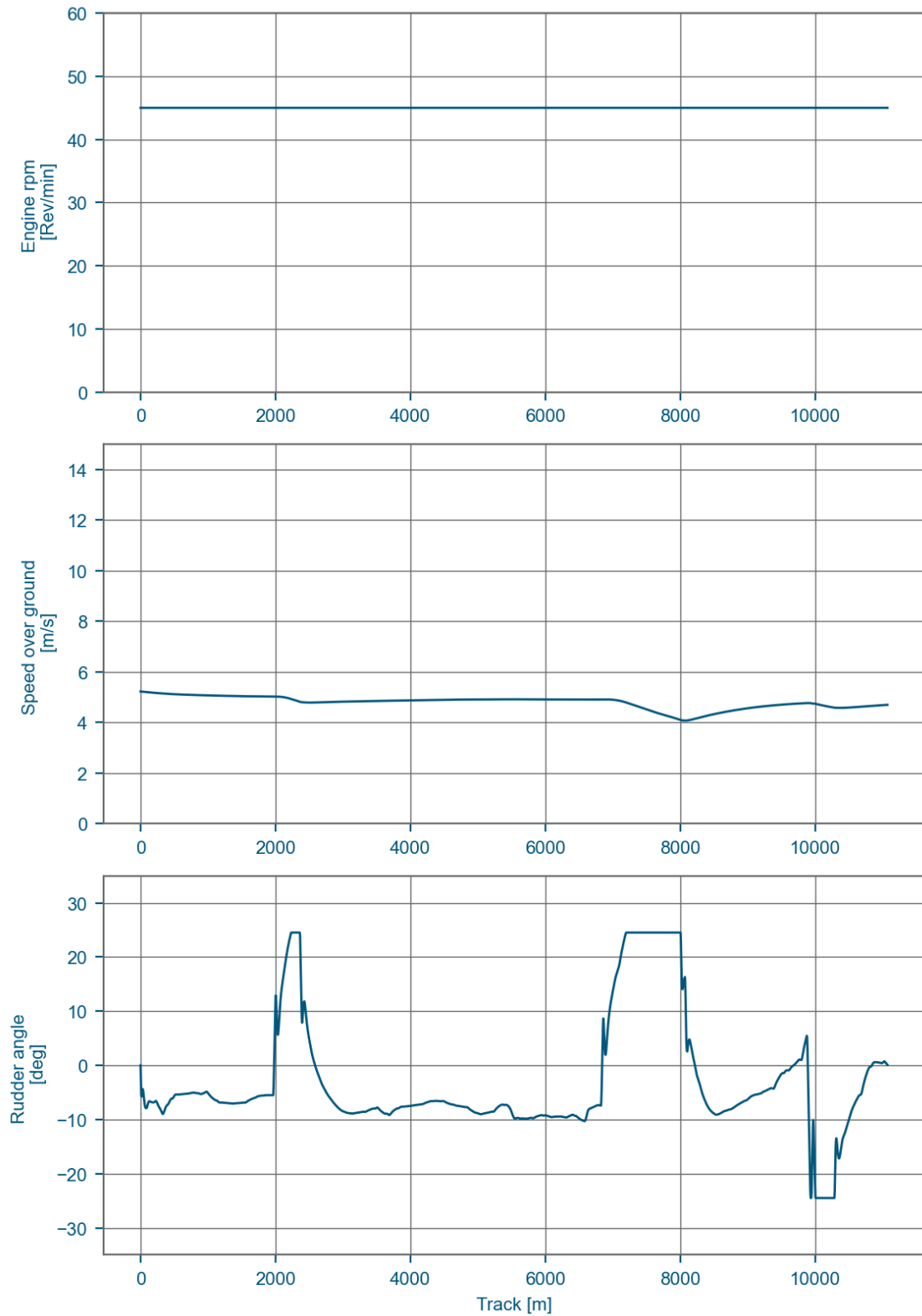
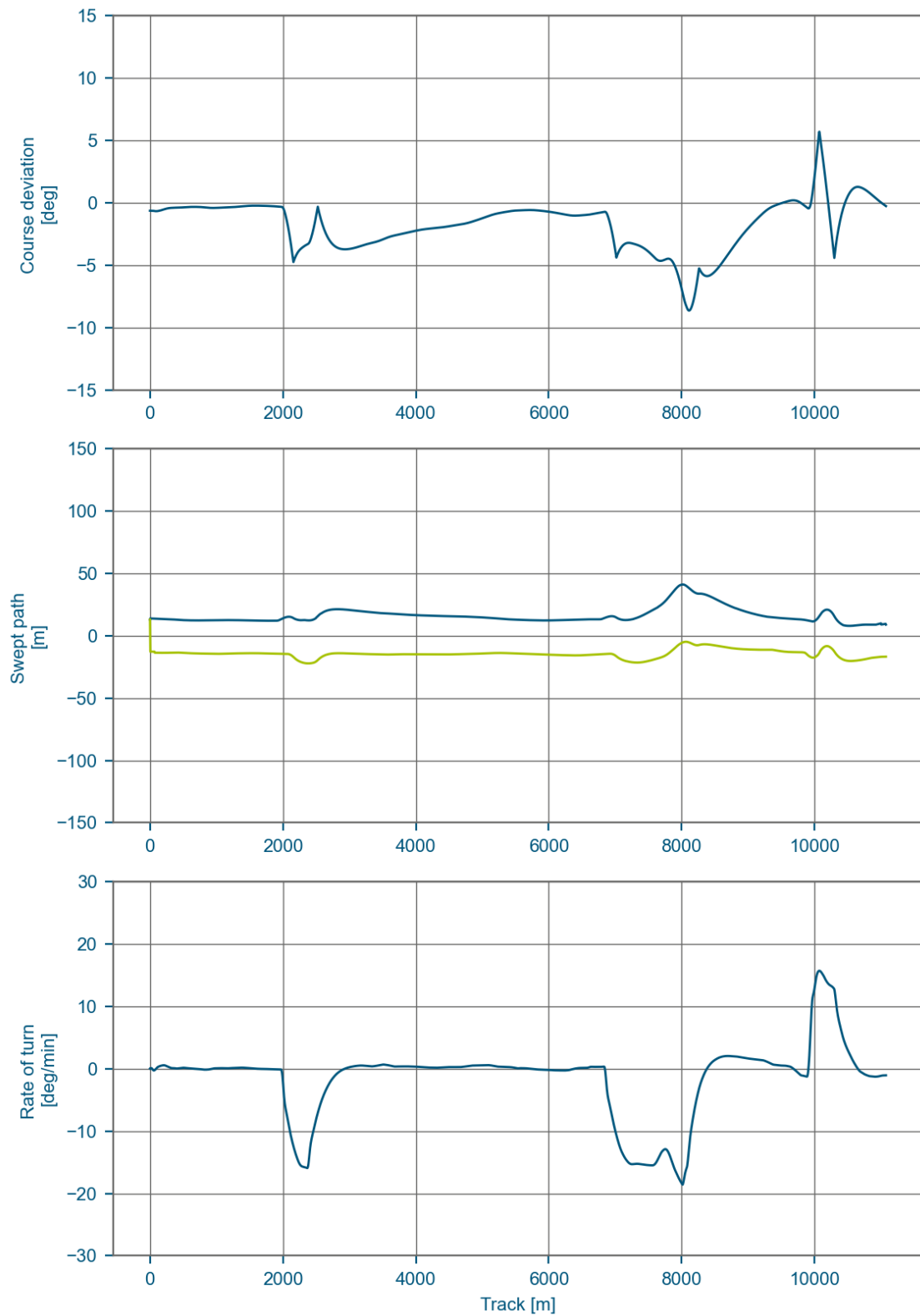


Figure 2.219: S.C. 28: engine RPM, SOG, rudder angle, vs. distance.



**Figure 2.220:** S.C. 28: course deviation (drift angle), swept path, RoT, vs. distance.

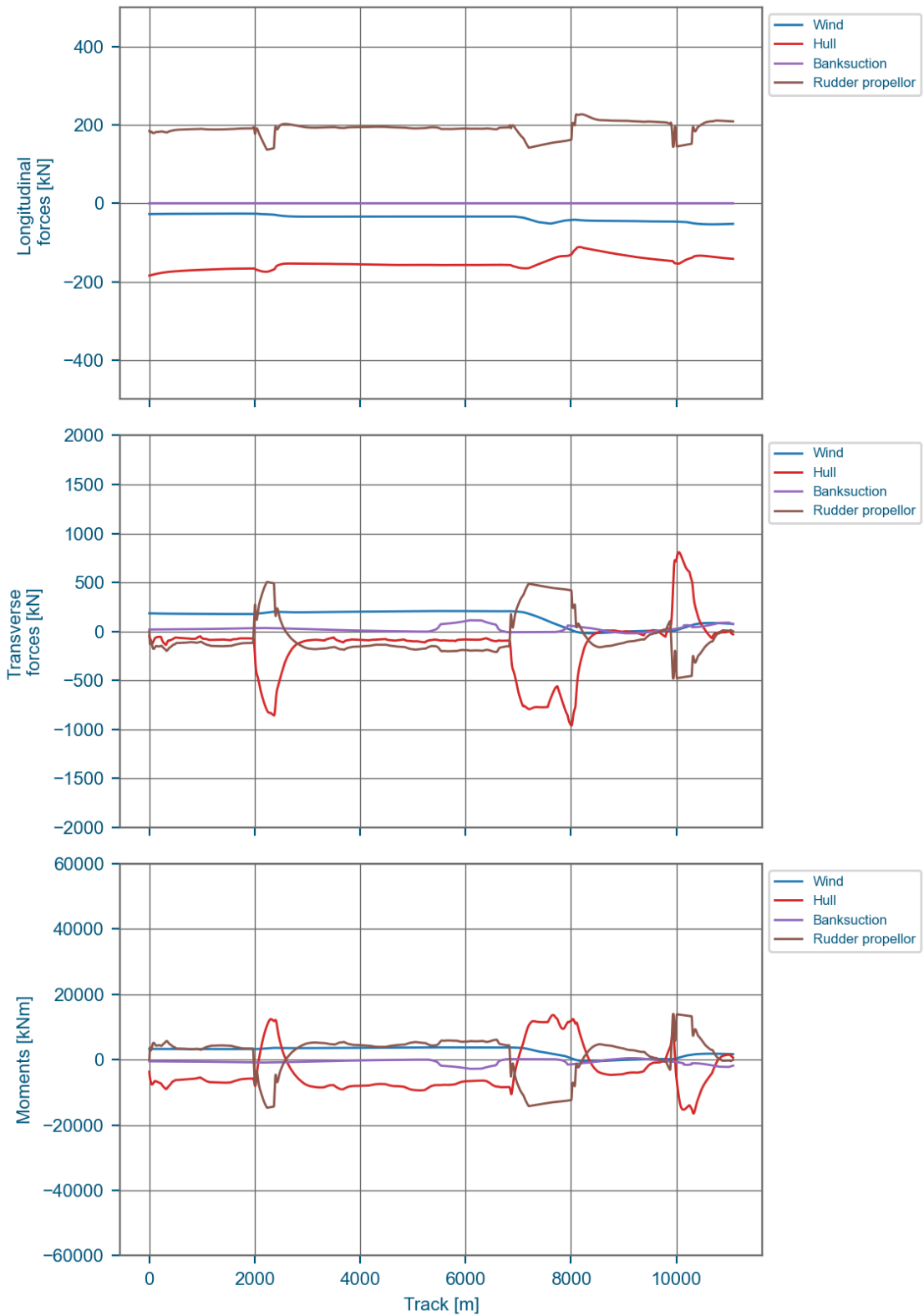


Figure 2.221: S.C. 28: forces, moments, vs. distance.

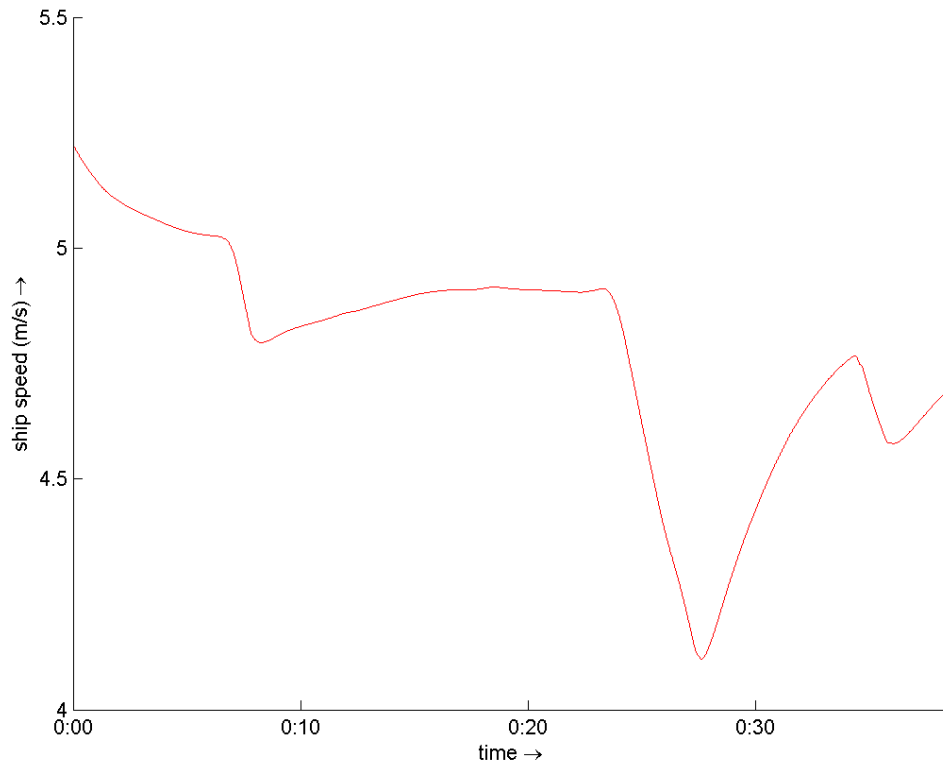


Figure 2.222: S.C. 28: SOG, vs. time.

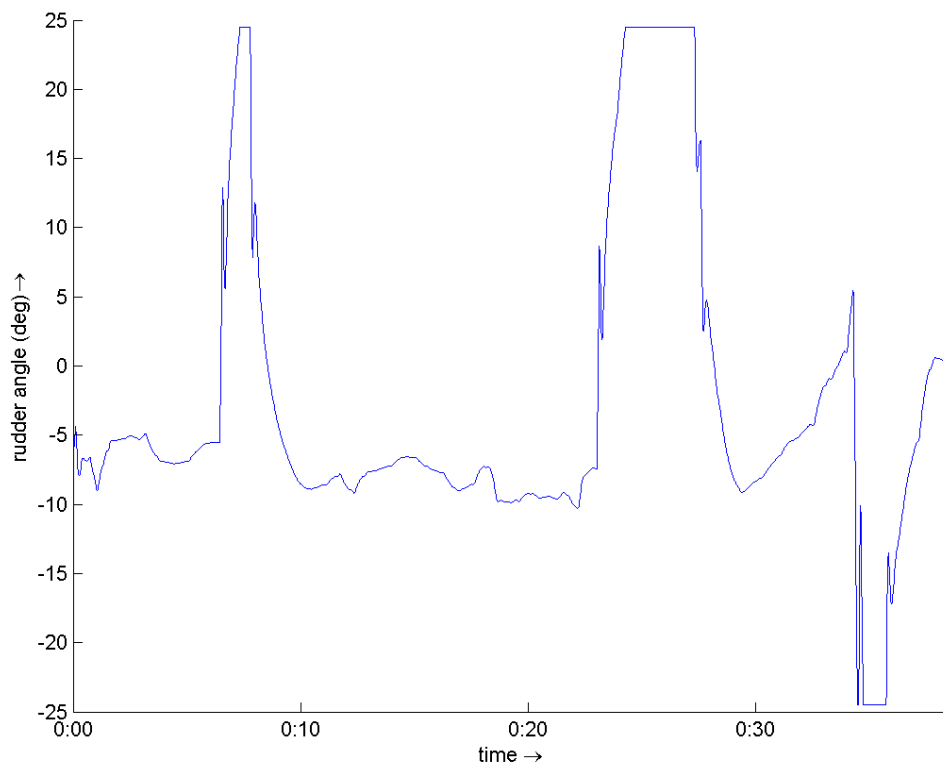


Figure 2.223: S.C. 28: rudder angle, vs. time.

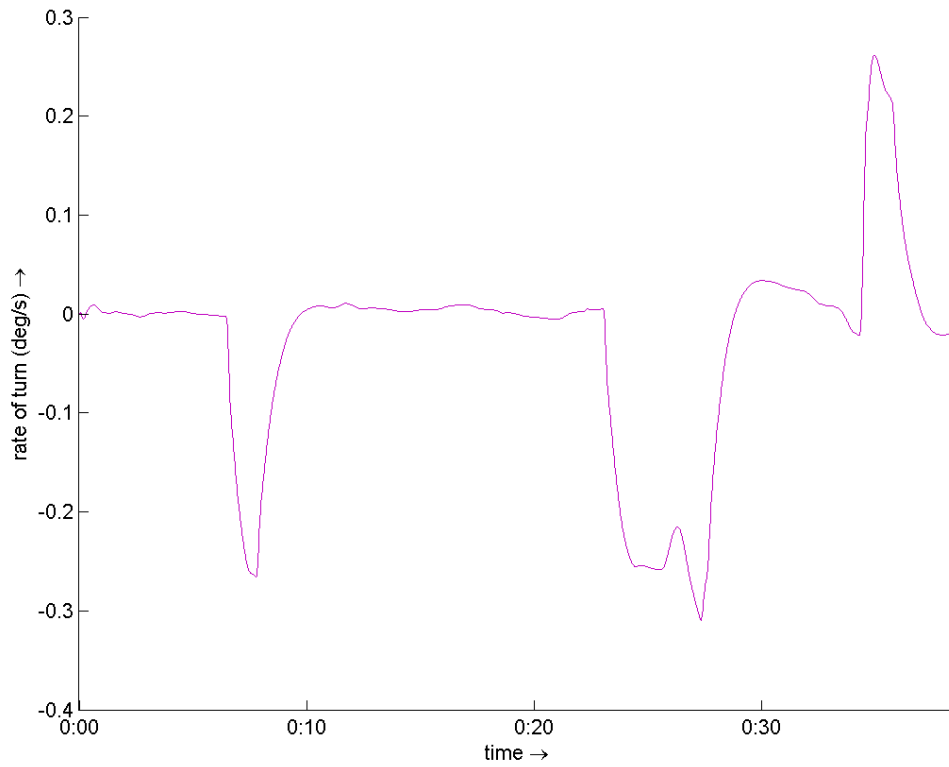


Figure 2.224: S.C. 28: RoT, vs. time.

## Simulation Case 29

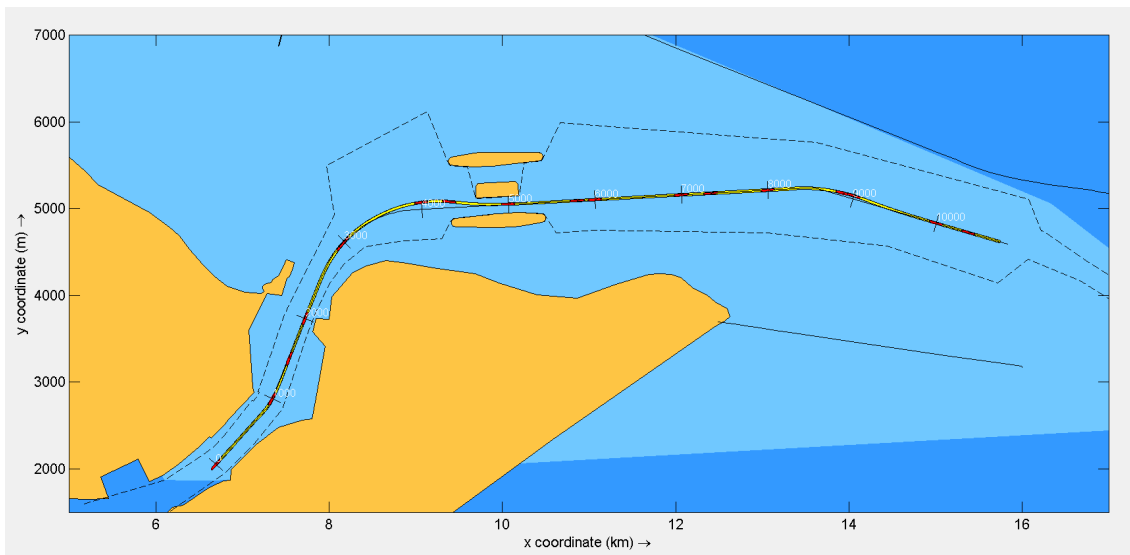
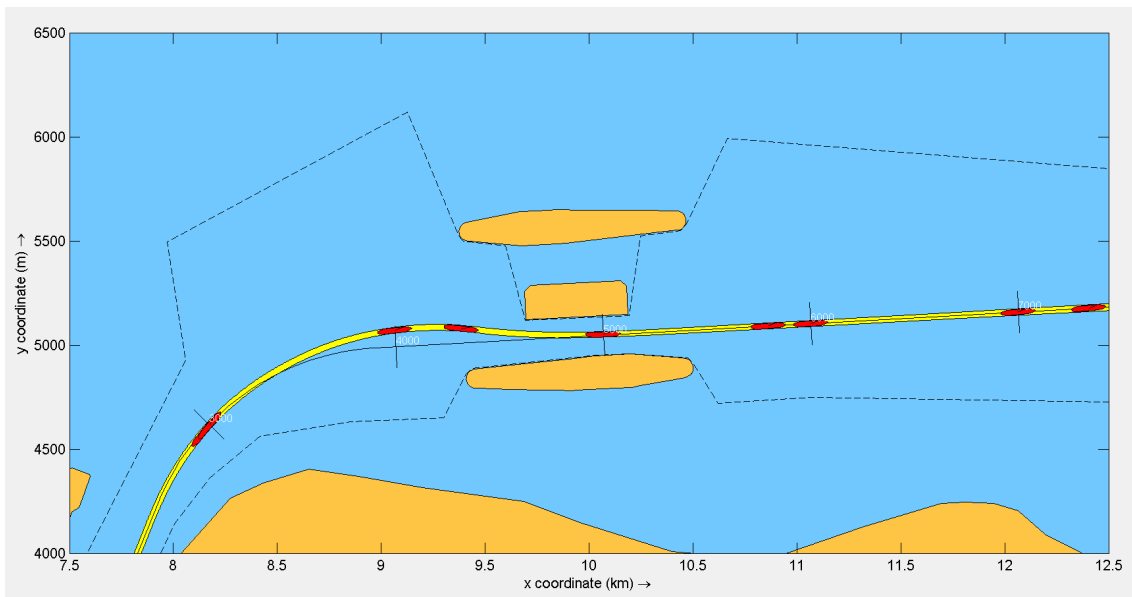


Figure 2.225: S.C. 29: spatial overview plot.



**Figure 2.226:** S.C. 29: zoom-in of spatial overview plot, crossing segment.

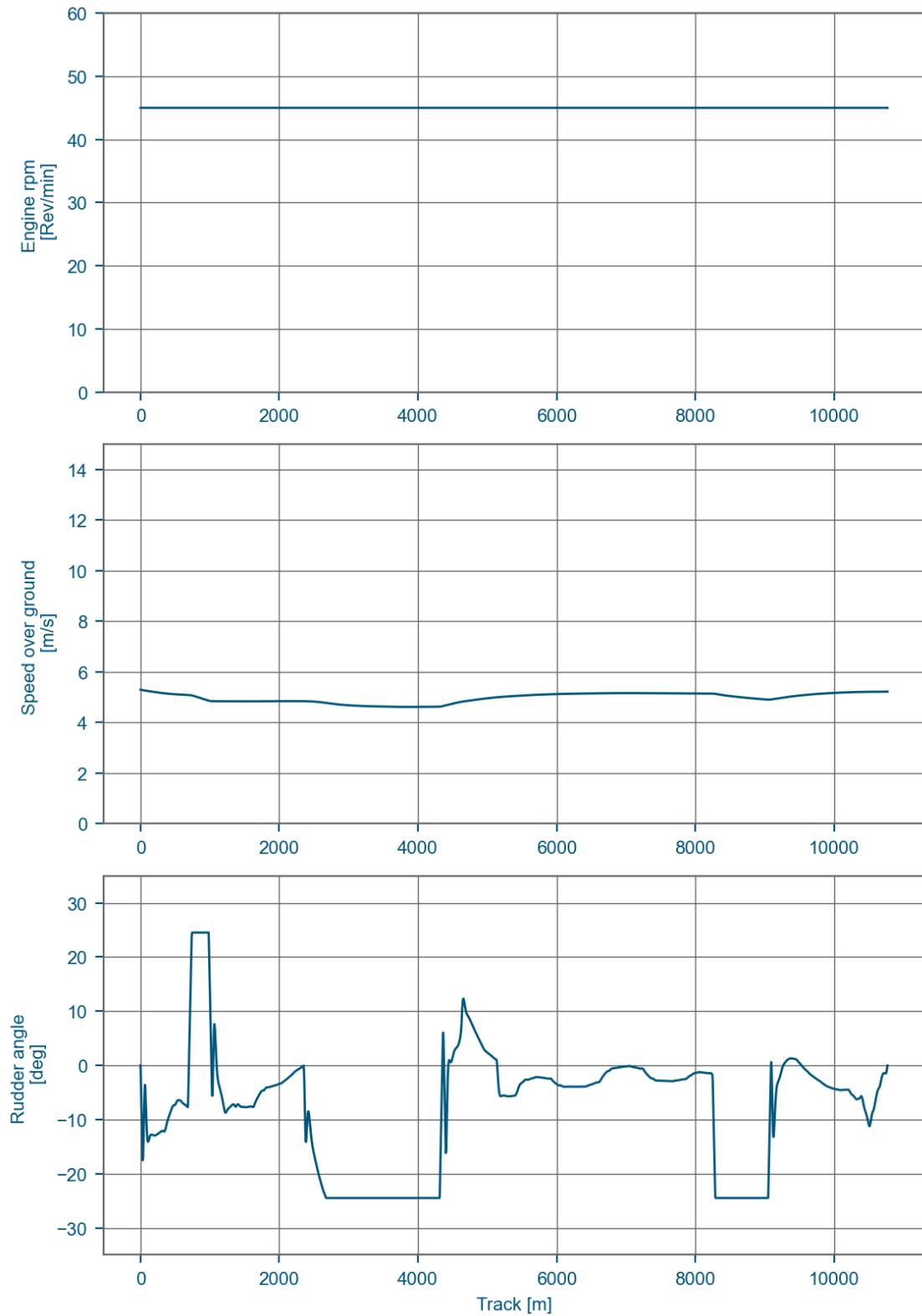


Figure 2.227: S.C. 29: engine RPM, SOG, rudder angle, vs. distance.

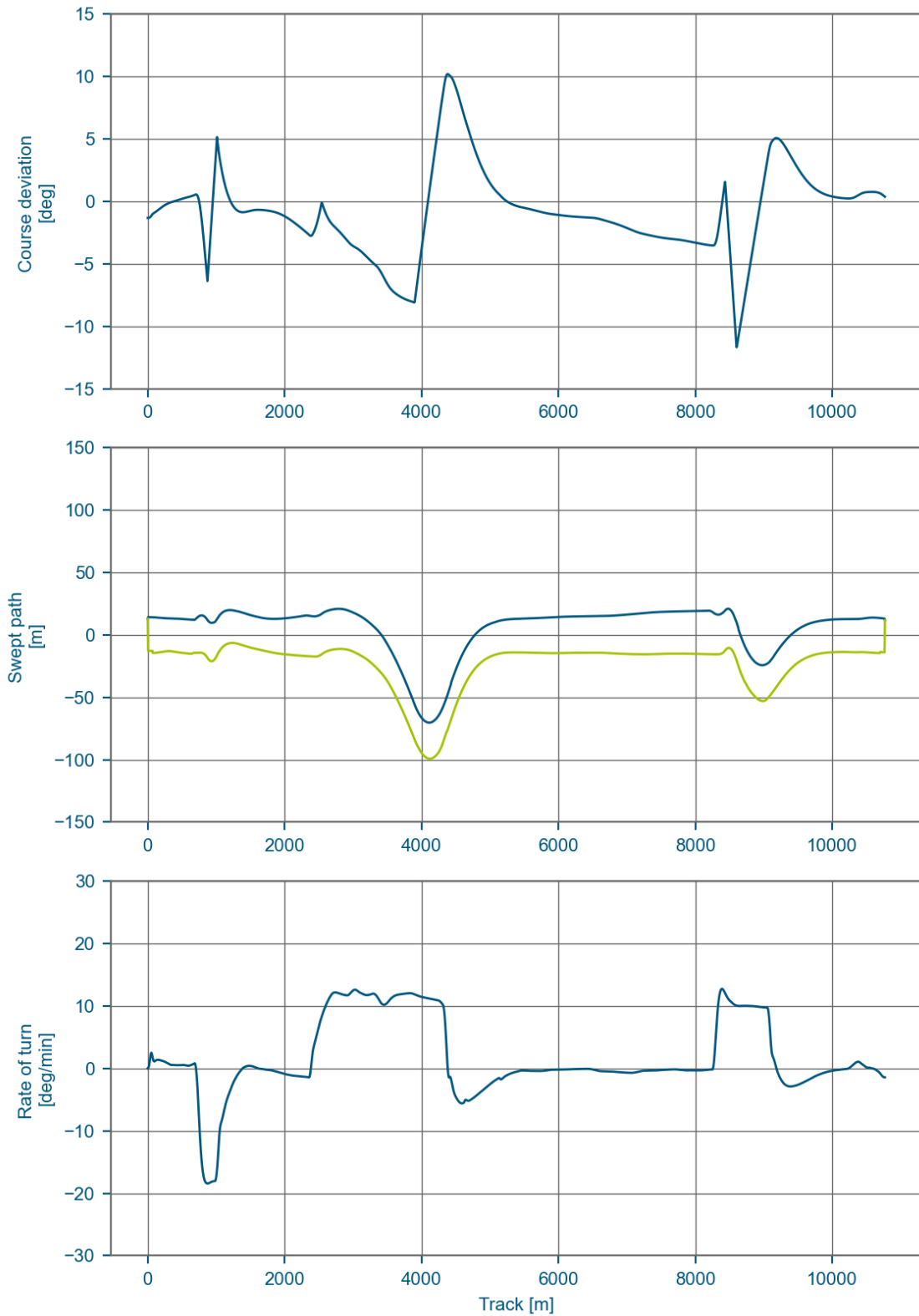


Figure 2.228: S.C. 29: course deviation (drift angle), swept path, RoT, vs. distance.

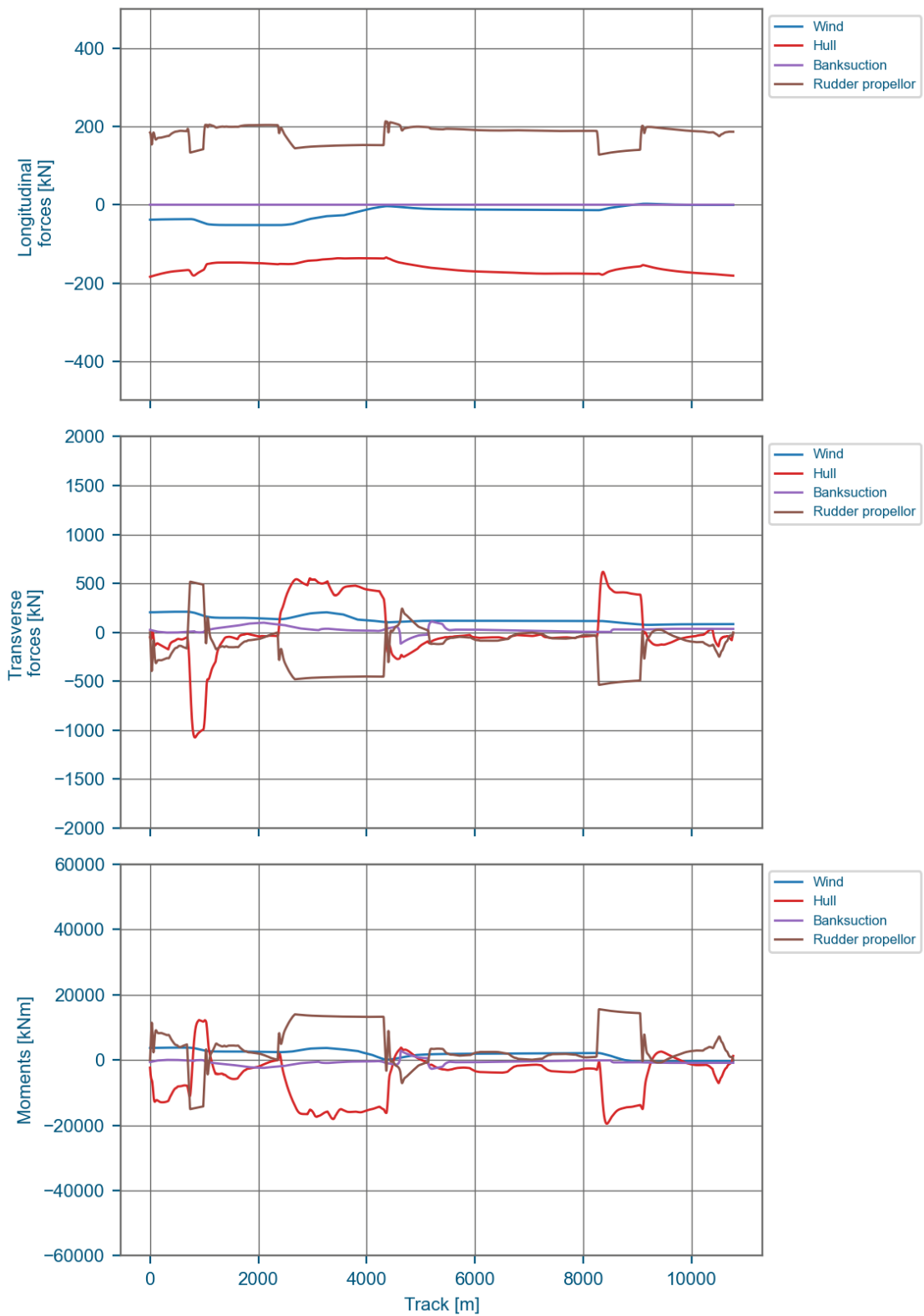


Figure 2.229: S.C. 29: forces, moments, vs. distance.

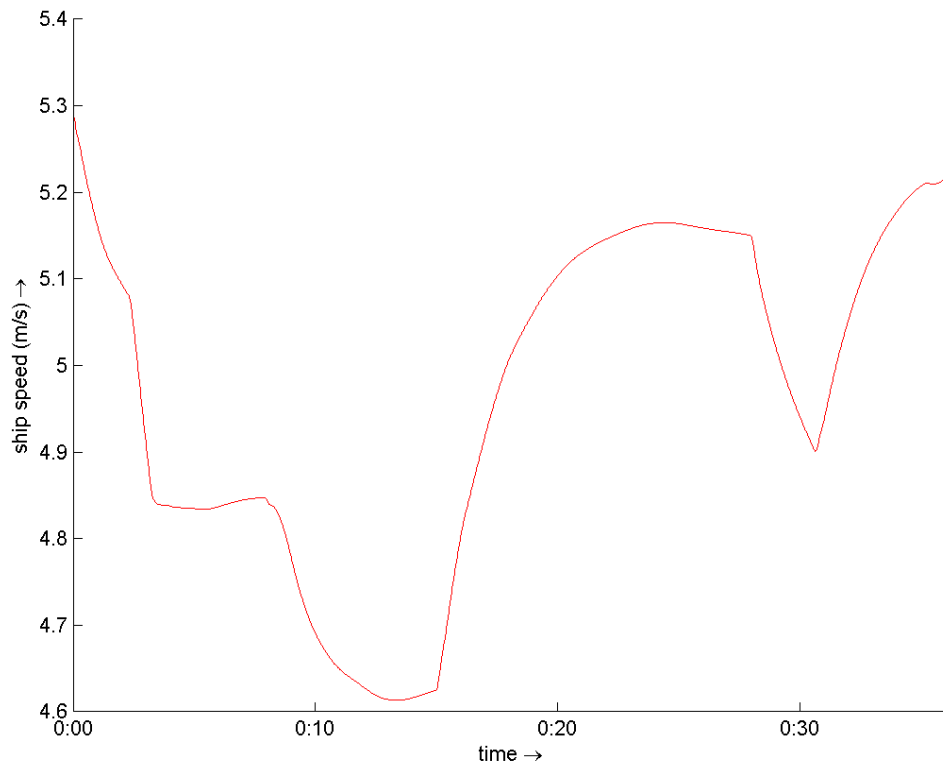


Figure 2.230: S.C. 29: SOG, vs. time.

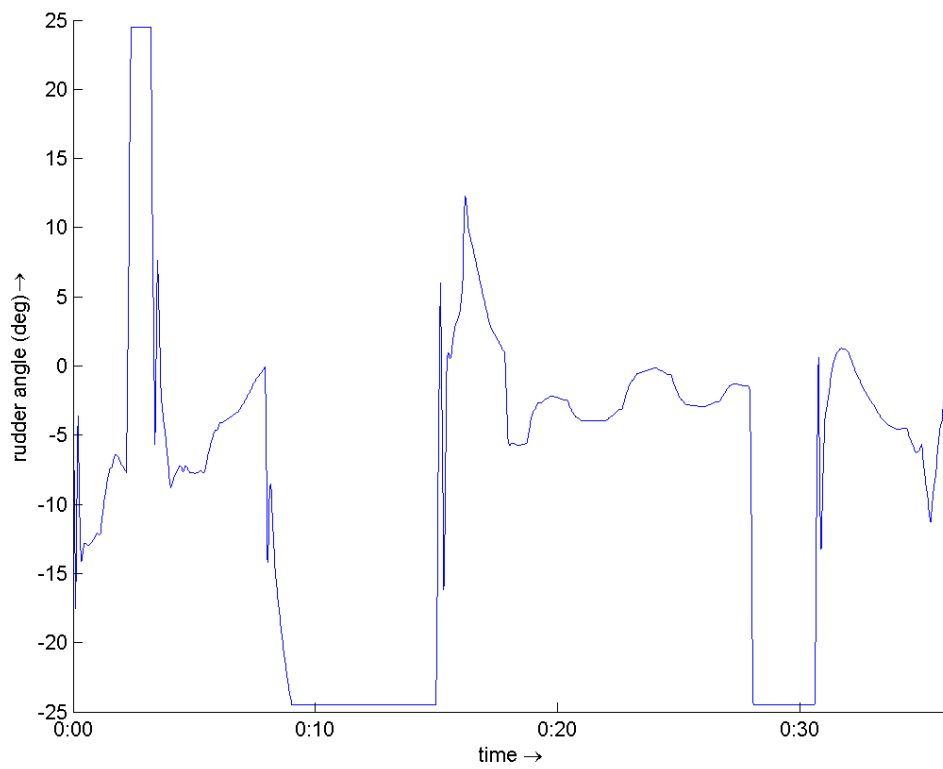


Figure 2.231: S.C. 29: rudder angle, vs. time.

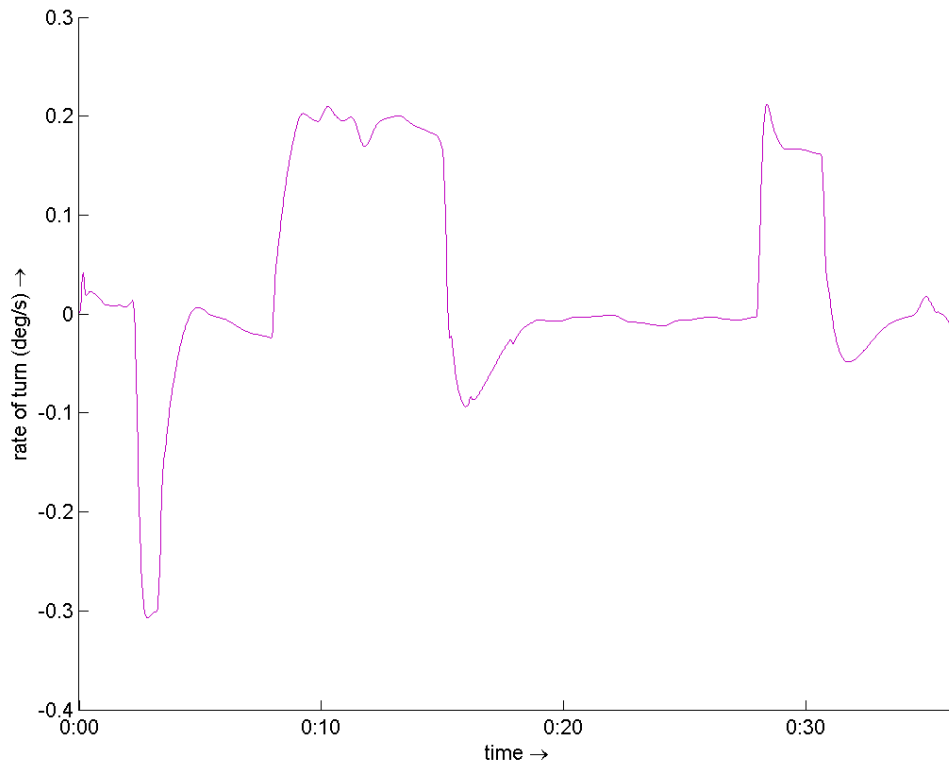


Figure 2.232: S.C. 29: RoT, vs. time.

### Simulation Case 30

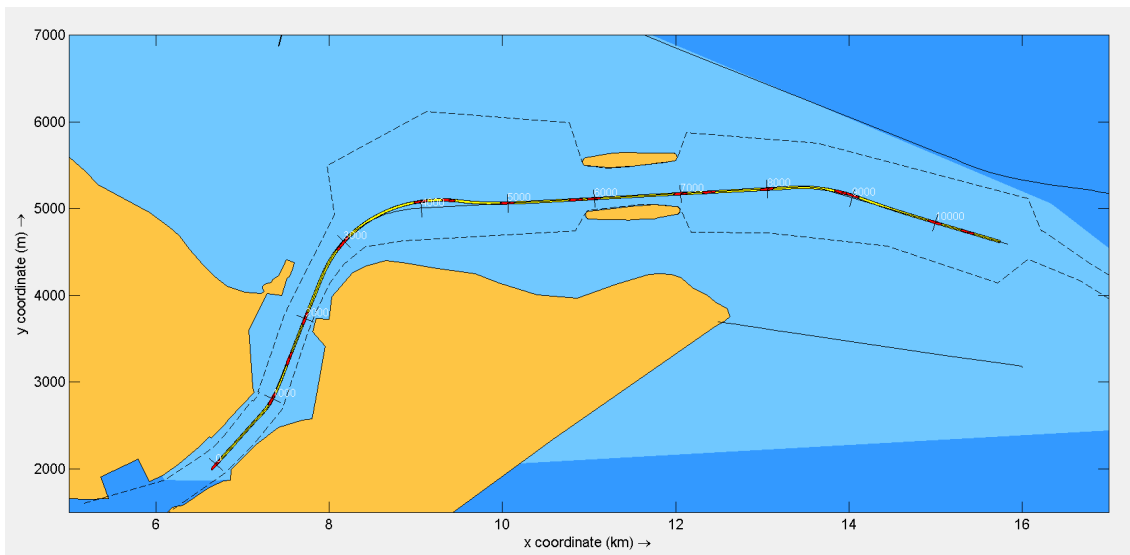
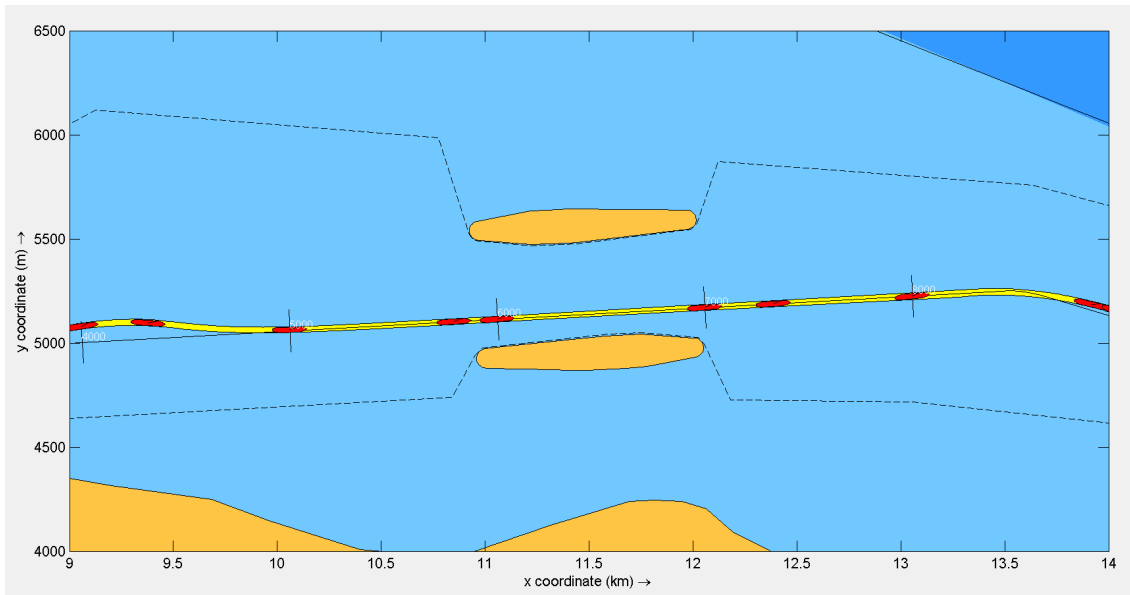


Figure 2.233: S.C. 30: spatial overview plot.



**Figure 2.234:** S.C. 30: zoom-in of spatial overview plot, crossing segment.

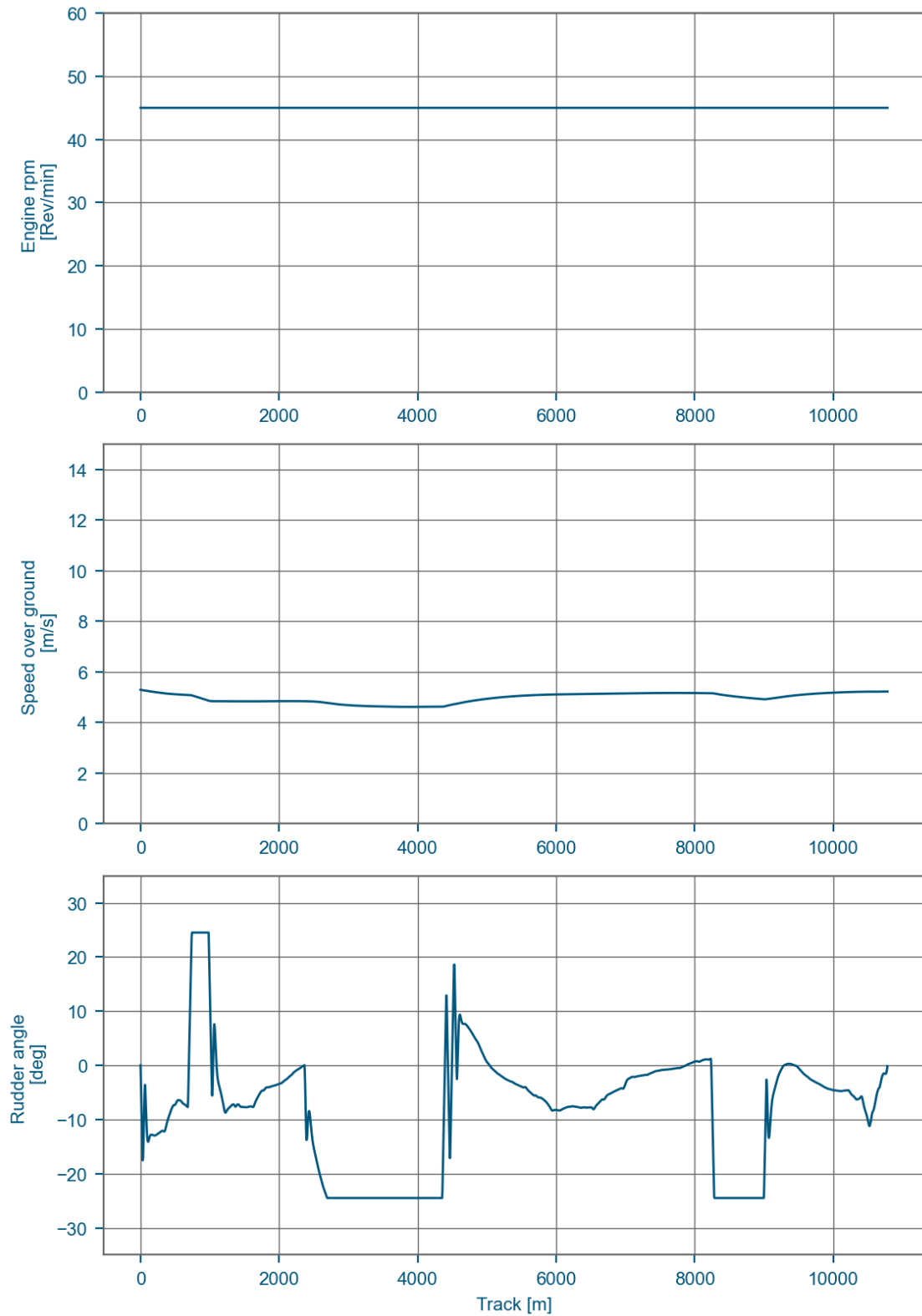


Figure 2.235: S.C. 30: engine RPM, SOG, rudder angle, vs. distance.

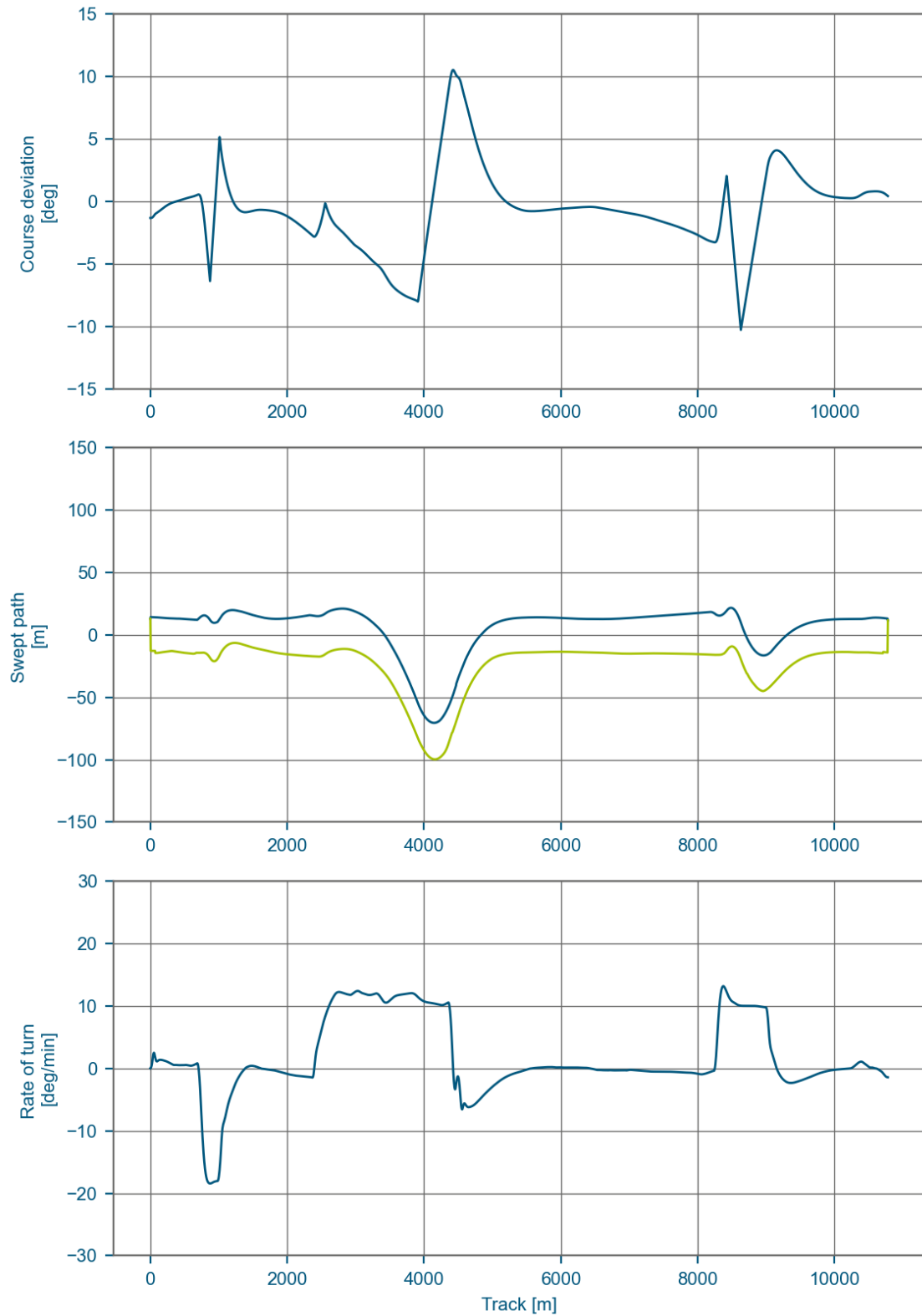


Figure 2.236: S.C. 30: course deviation (drift angle), swept path, RoT, vs. distance.

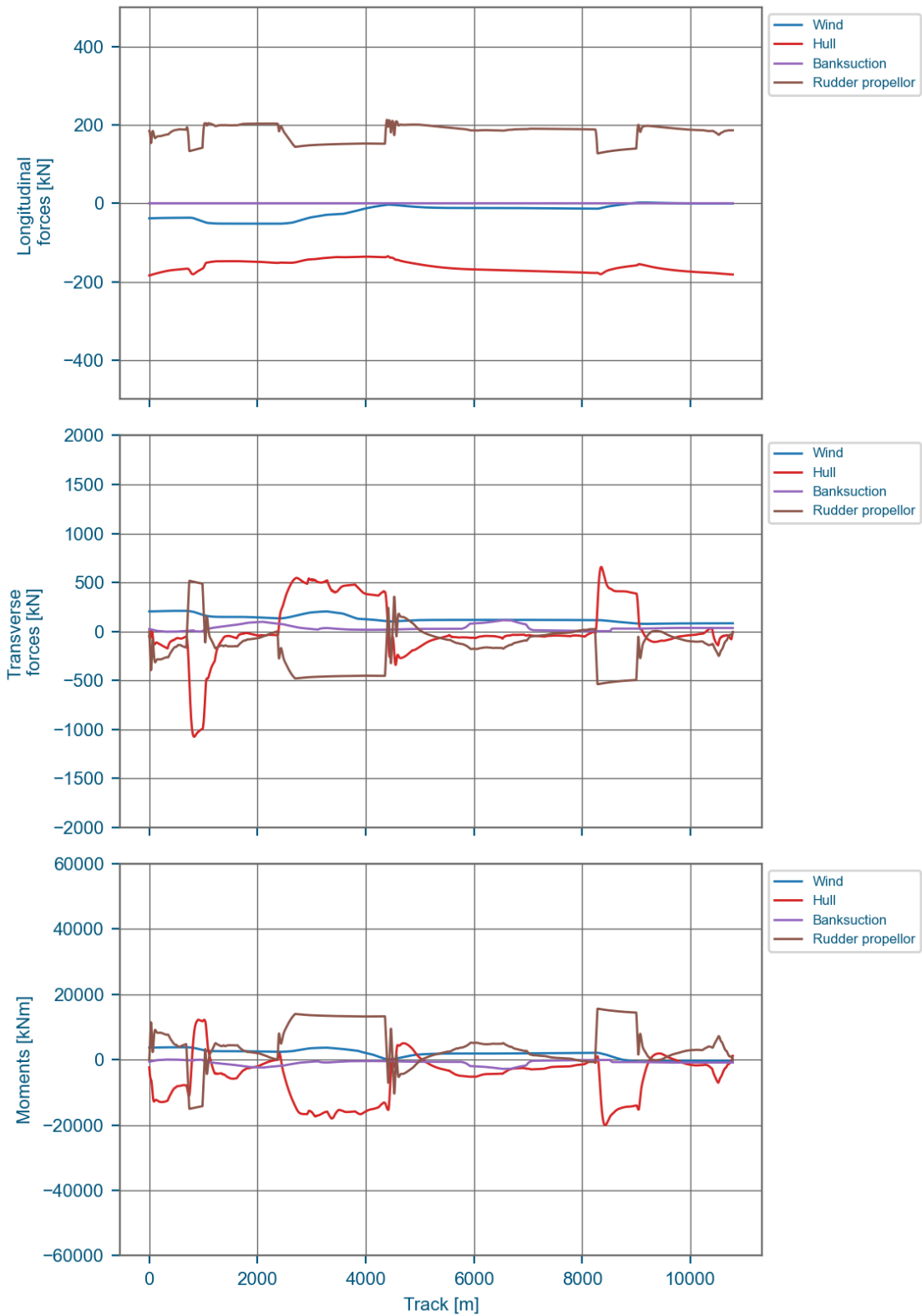


Figure 2.237: S.C. 30: forces, moments, vs. distance.

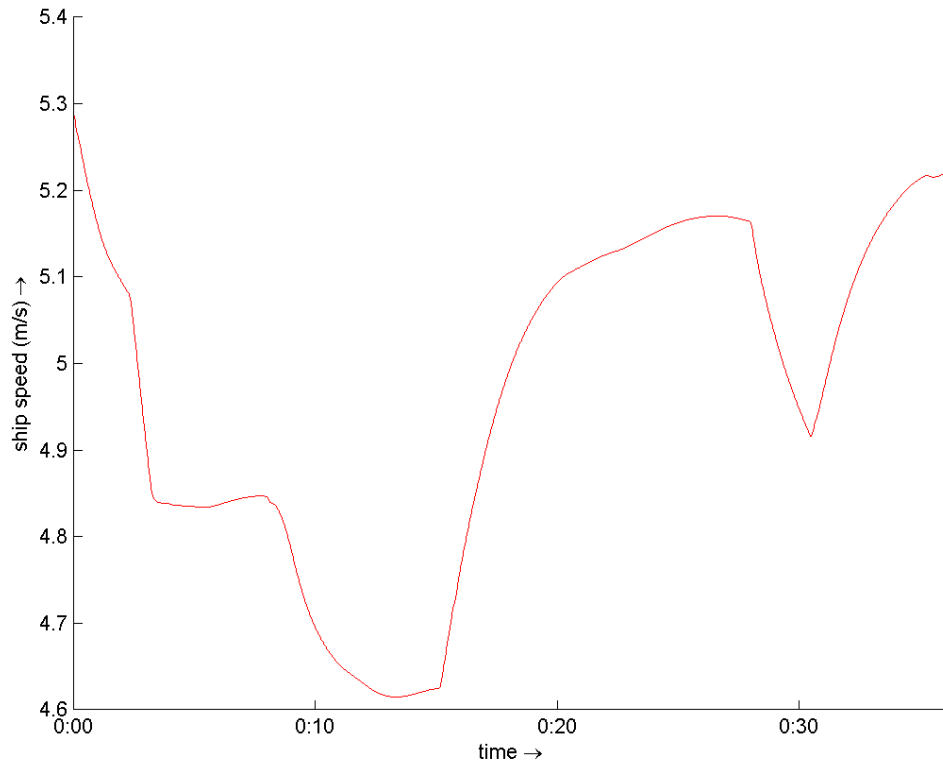


Figure 2.238: S.C. 30: SOG, vs. time.

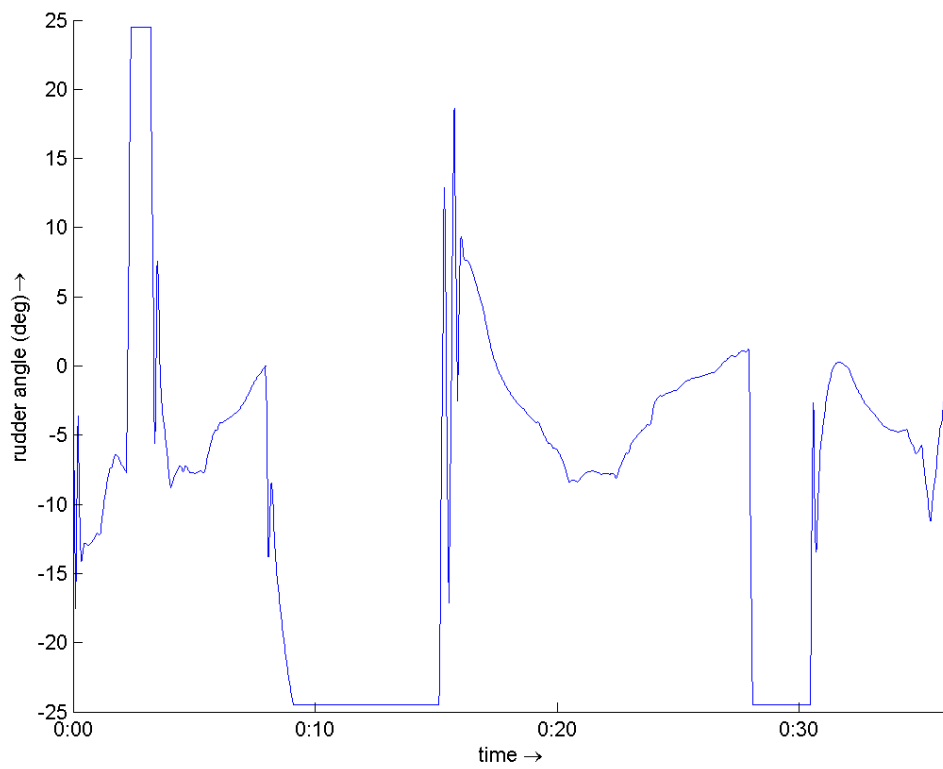


Figure 2.239: S.C. 30: rudder angle, vs. time.

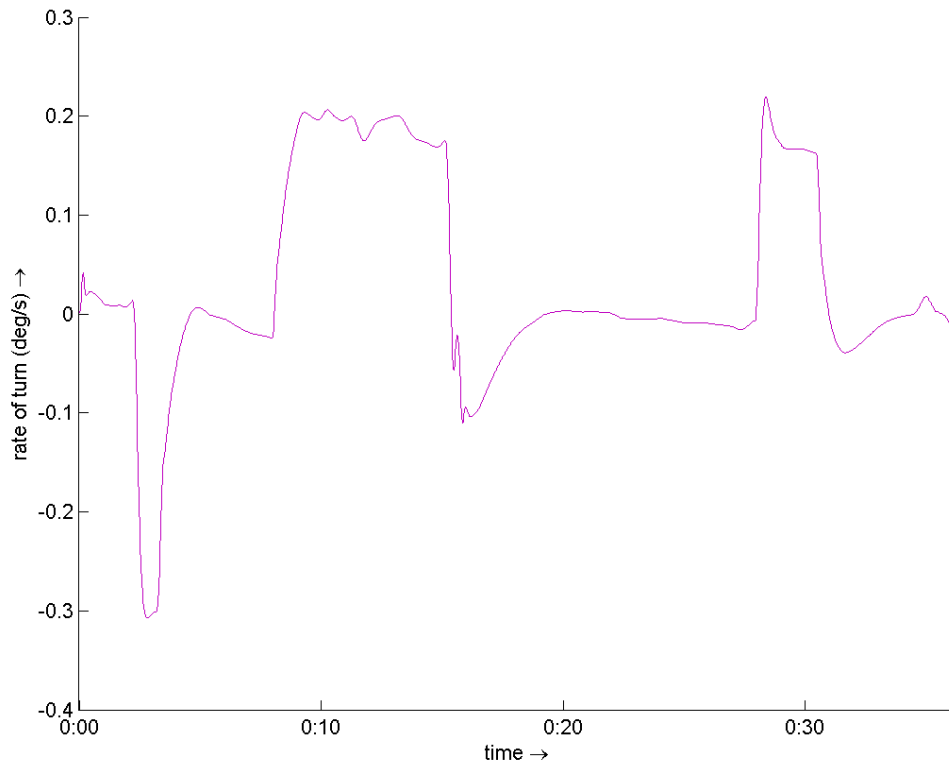


Figure 2.240: S.C. 30: RoT, vs. time.

### Simulation Case 31

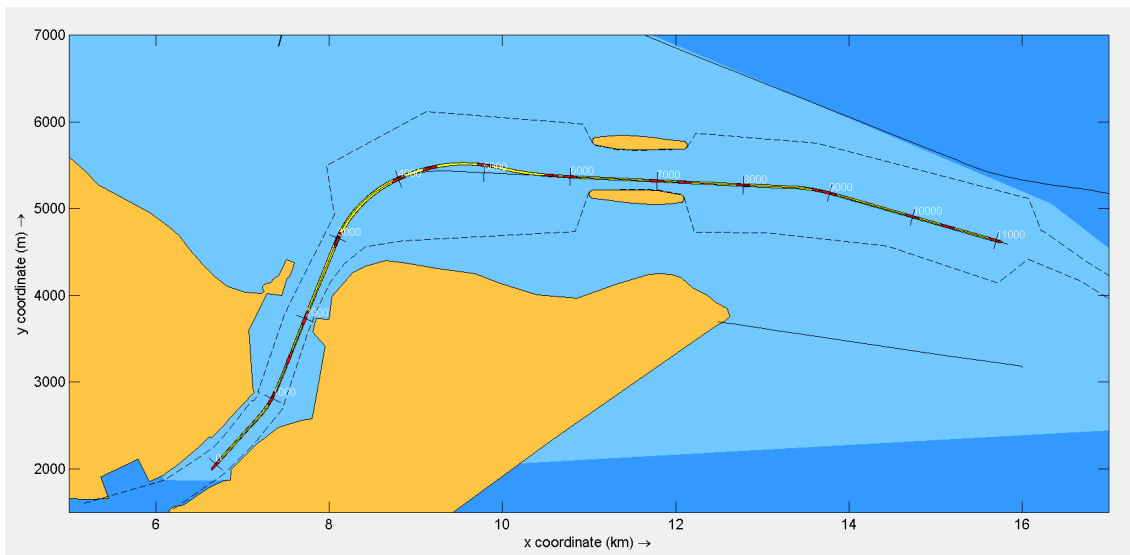
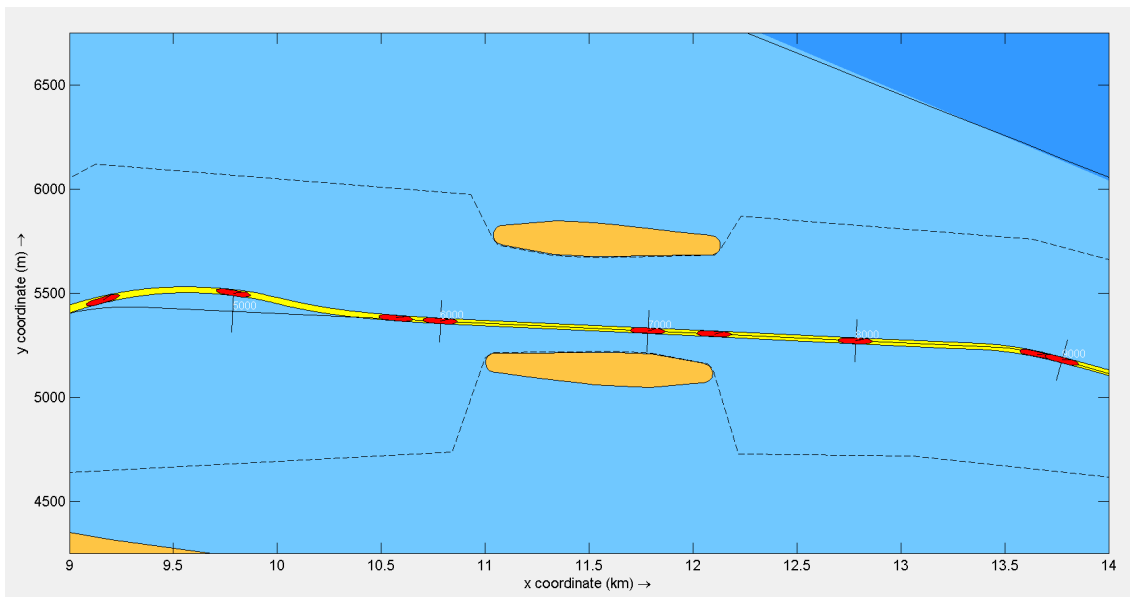


Figure 2.241: S.C. 31: spatial overview plot.



**Figure 2.242:** S.C. 31: zoom-in of spatial overview plot, crossing segment.

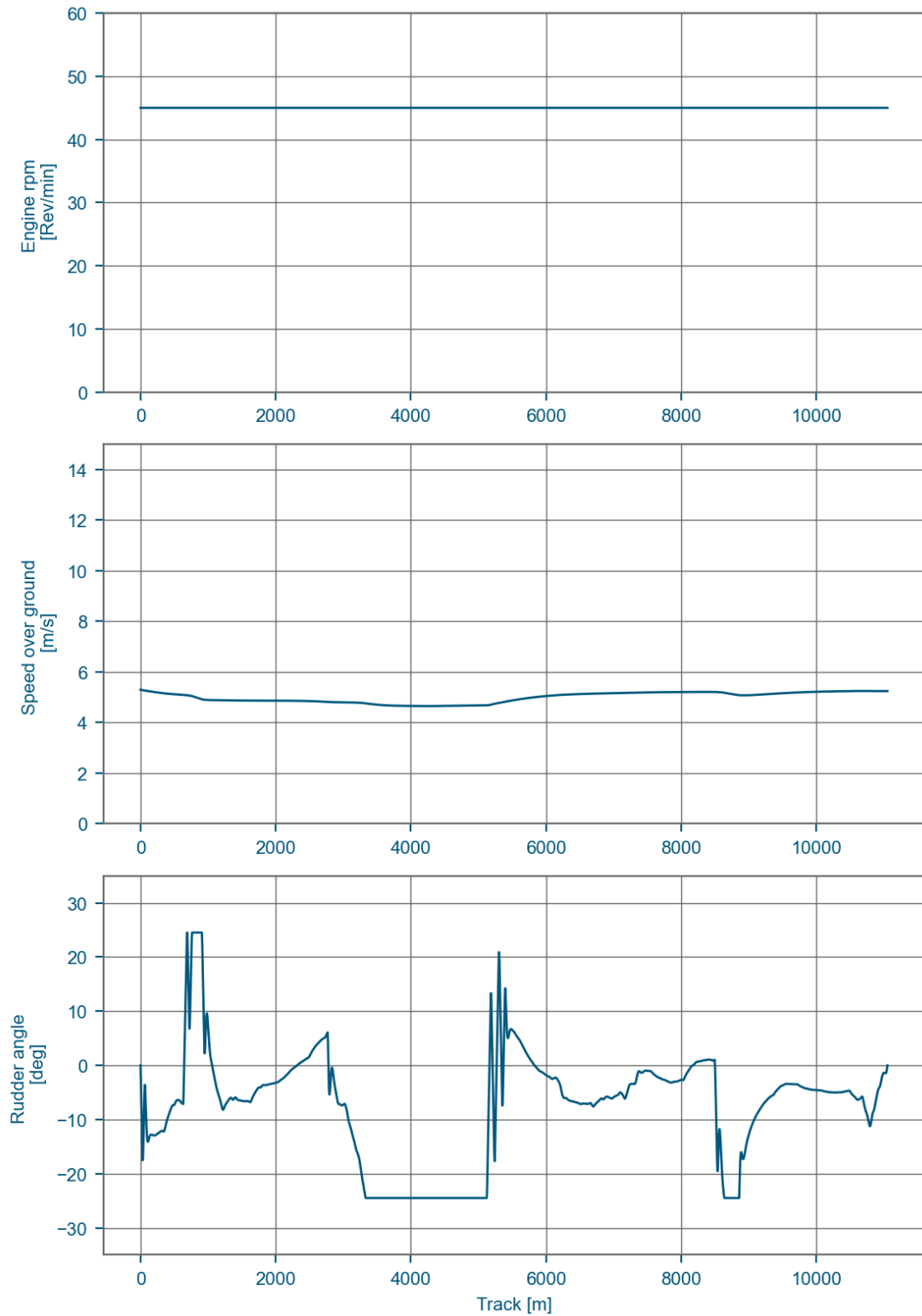


Figure 2.243: S.C. 31: engine RPM, SOG, rudder angle, vs. distance.

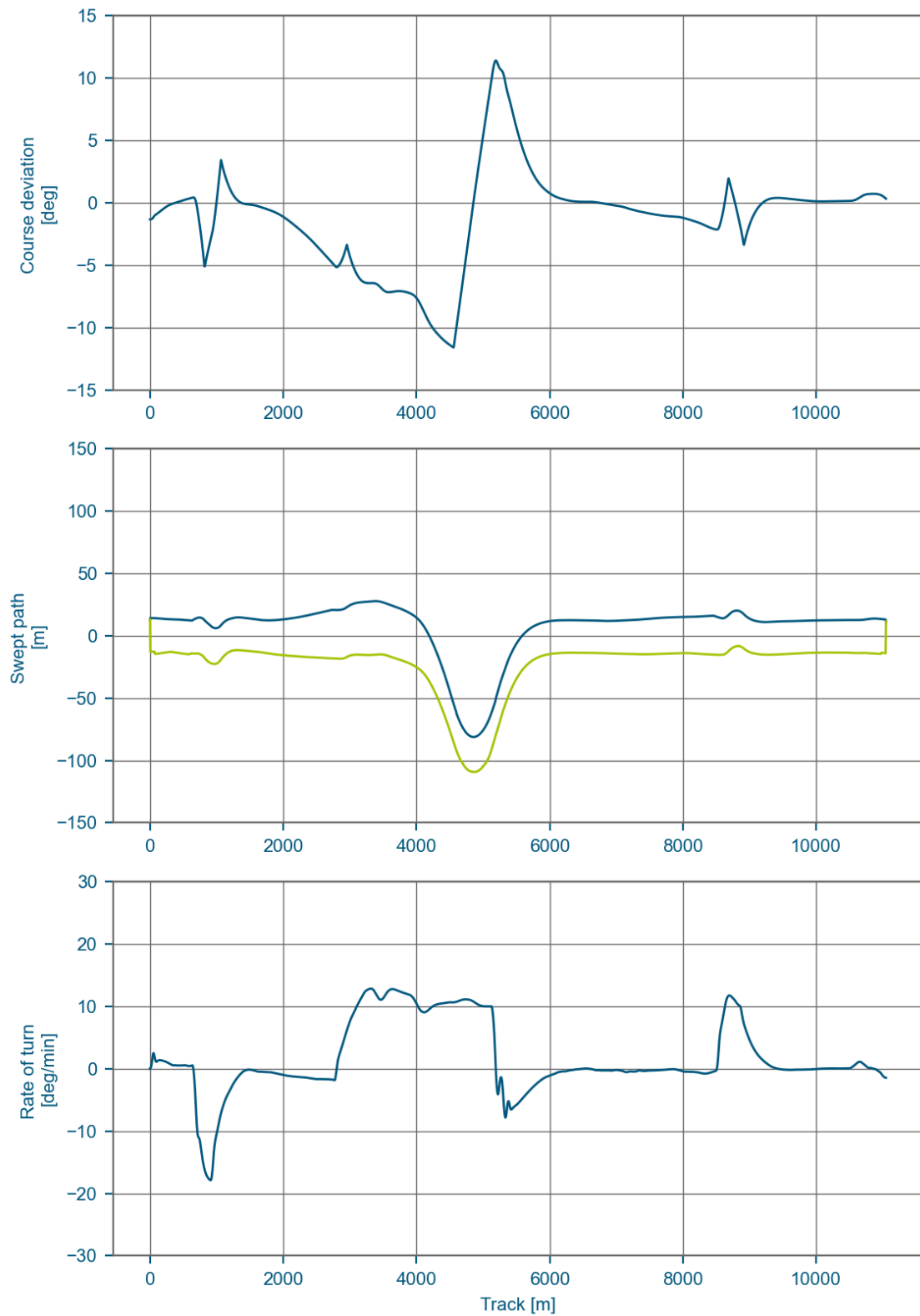


Figure 2.244: S.C. 31: course deviation (drift angle), swept path, RoT, vs. distance.

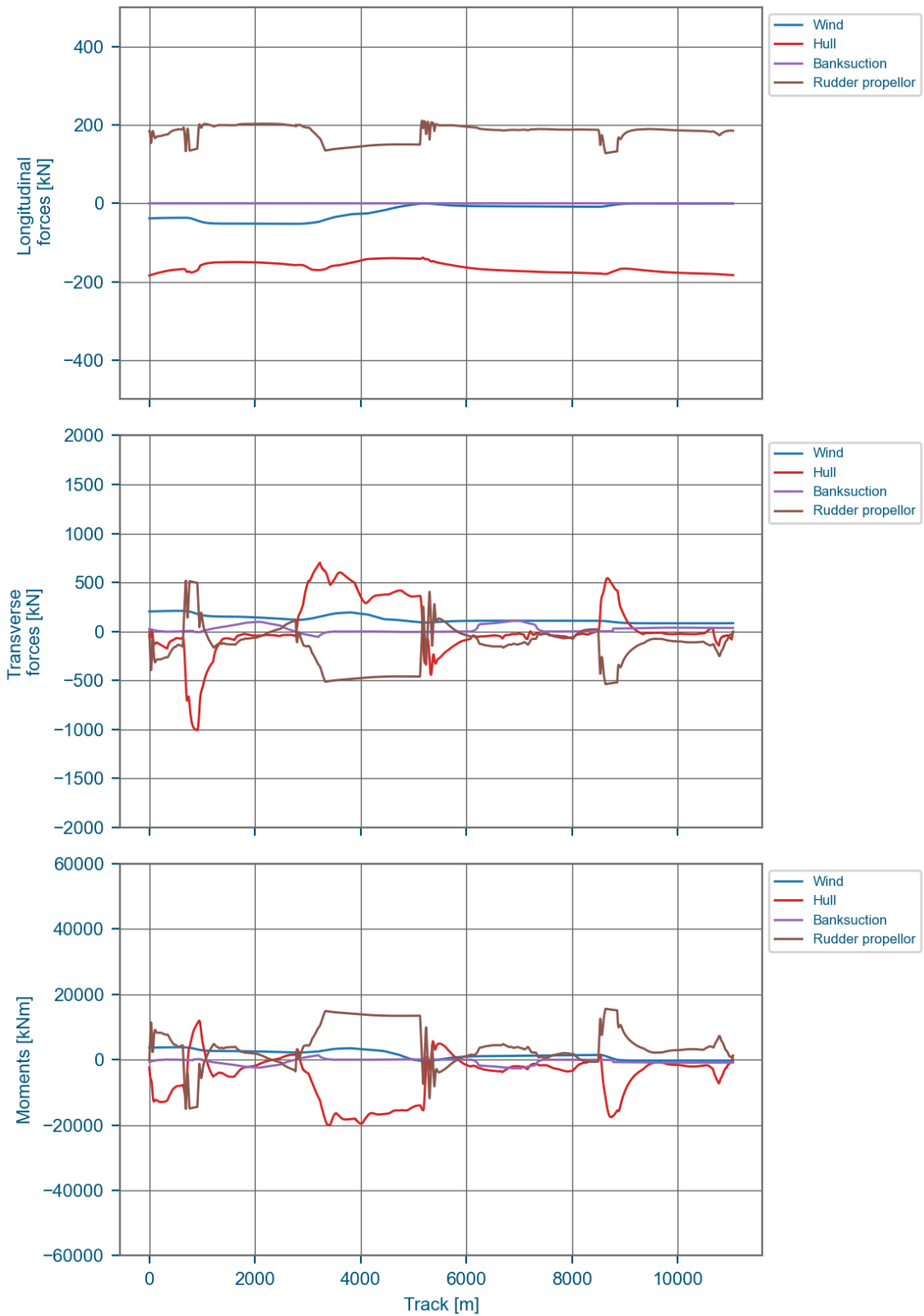


Figure 2.245: S.C. 31: forces, moments, vs. distance.

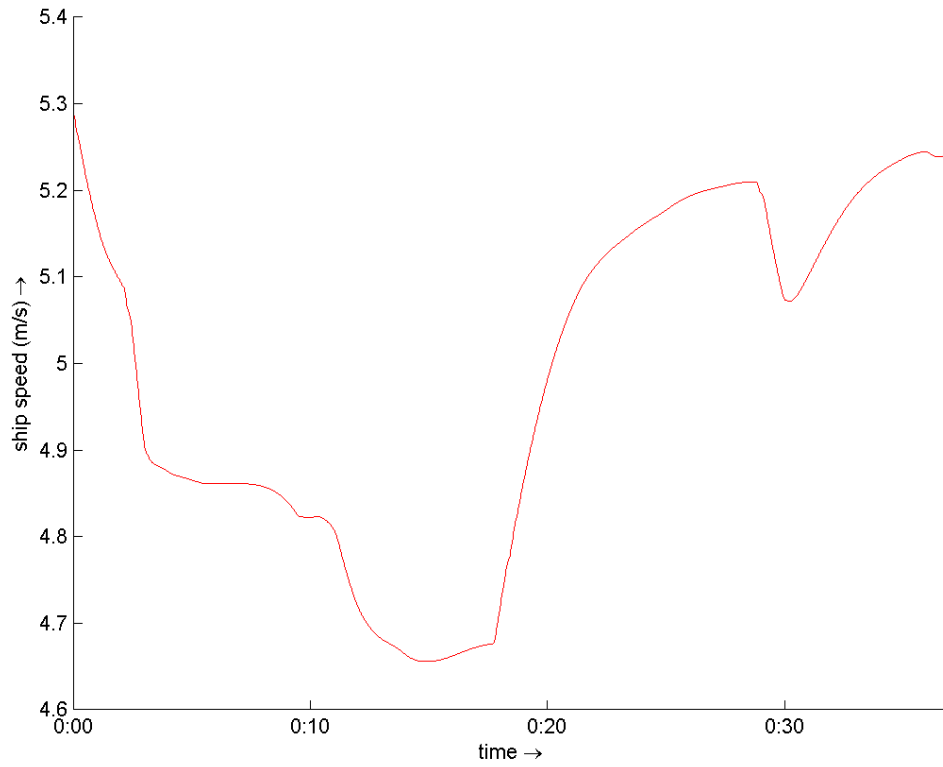


Figure 2.246: S.C. 31: SOG, vs. time.

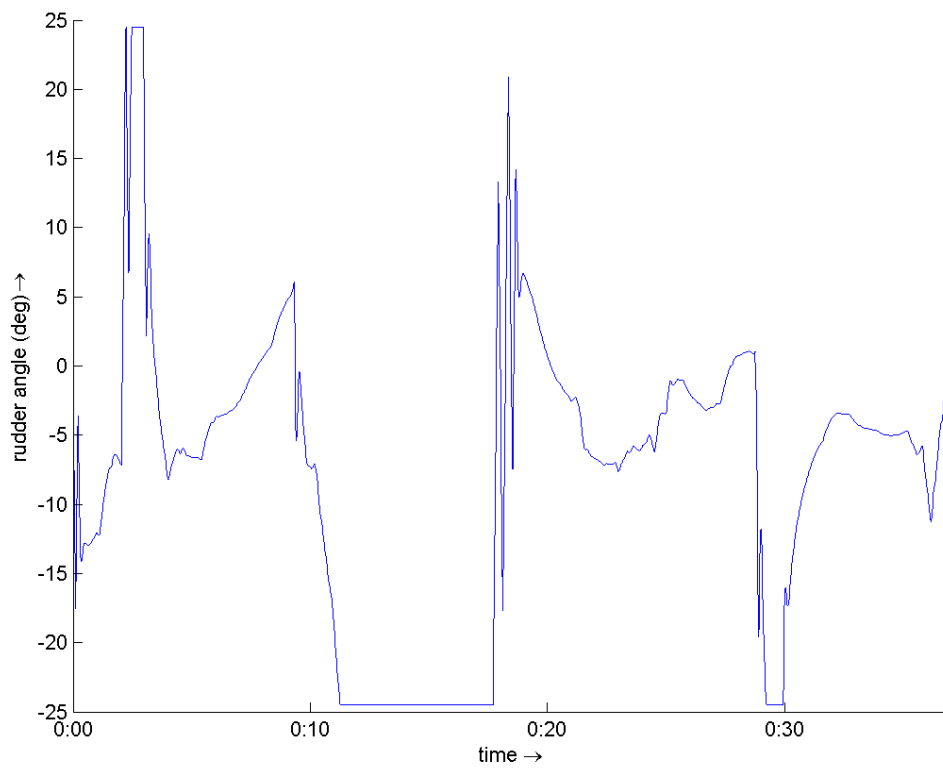


Figure 2.247: S.C. 31: rudder angle, vs. time.

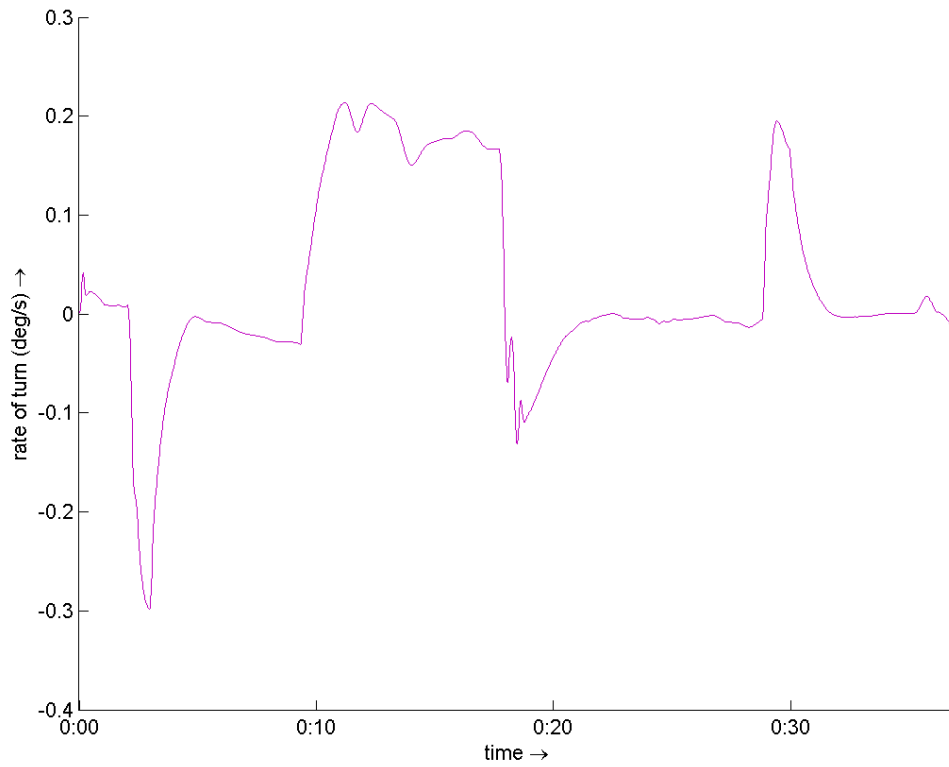


Figure 2.248: S.C. 31: RoT, vs. time.

## Simulation Case 32

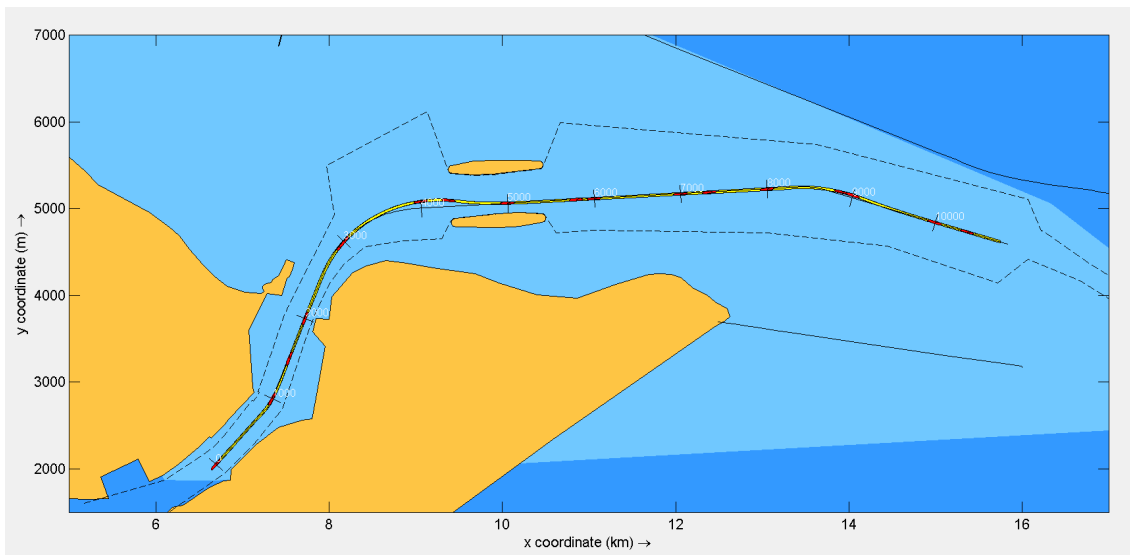
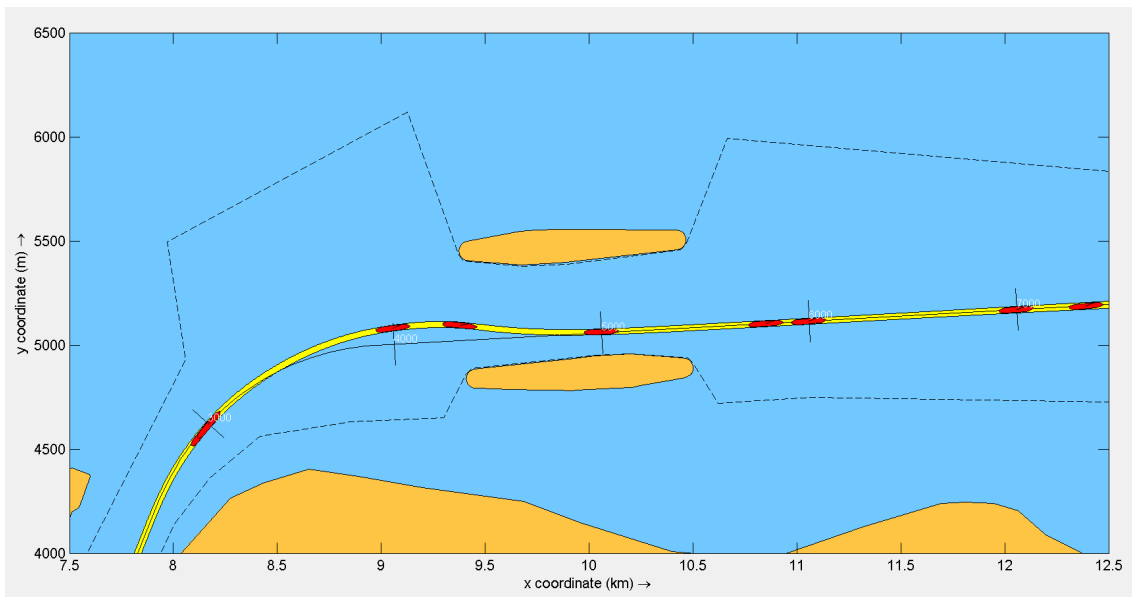


Figure 2.249: S.C. 32: spatial overview plot.



**Figure 2.250:** S.C. 32: zoom-in of spatial overview plot, crossing segment.

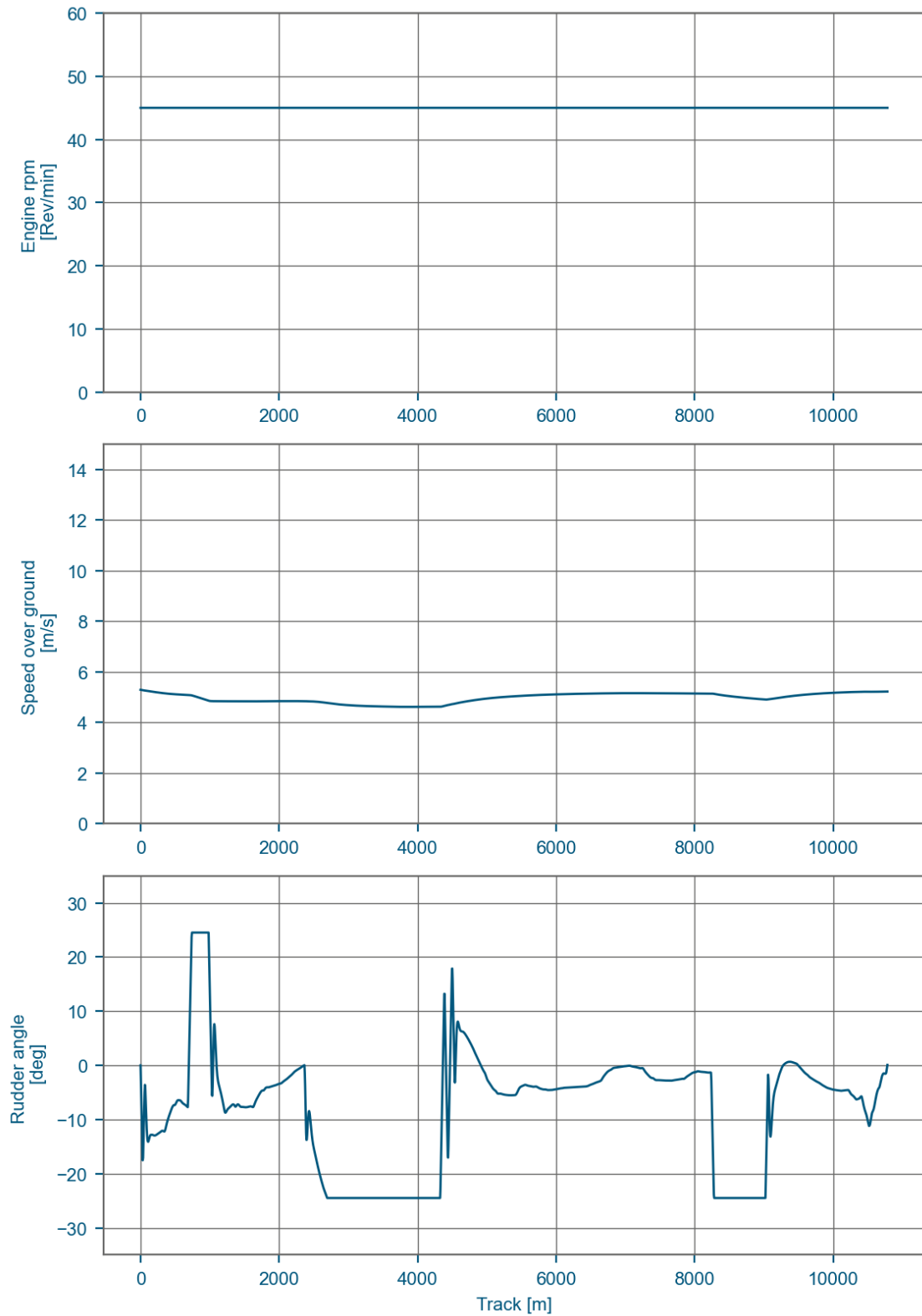


Figure 2.251: S.C. 32: engine RPM, SOG, rudder angle, vs. distance.

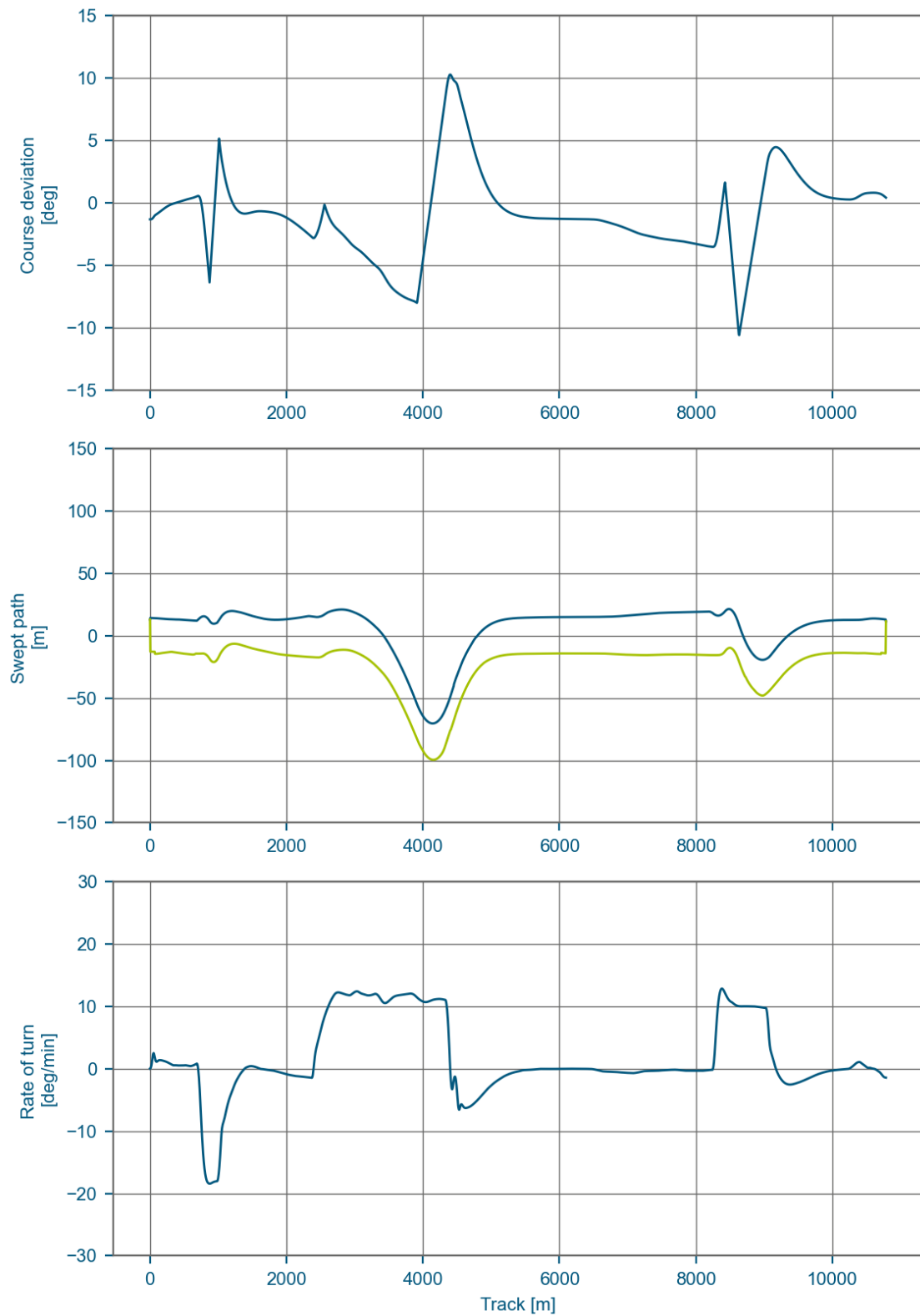


Figure 2.252: S.C. 32: course deviation (drift angle), swept path, RoT, vs. distance.

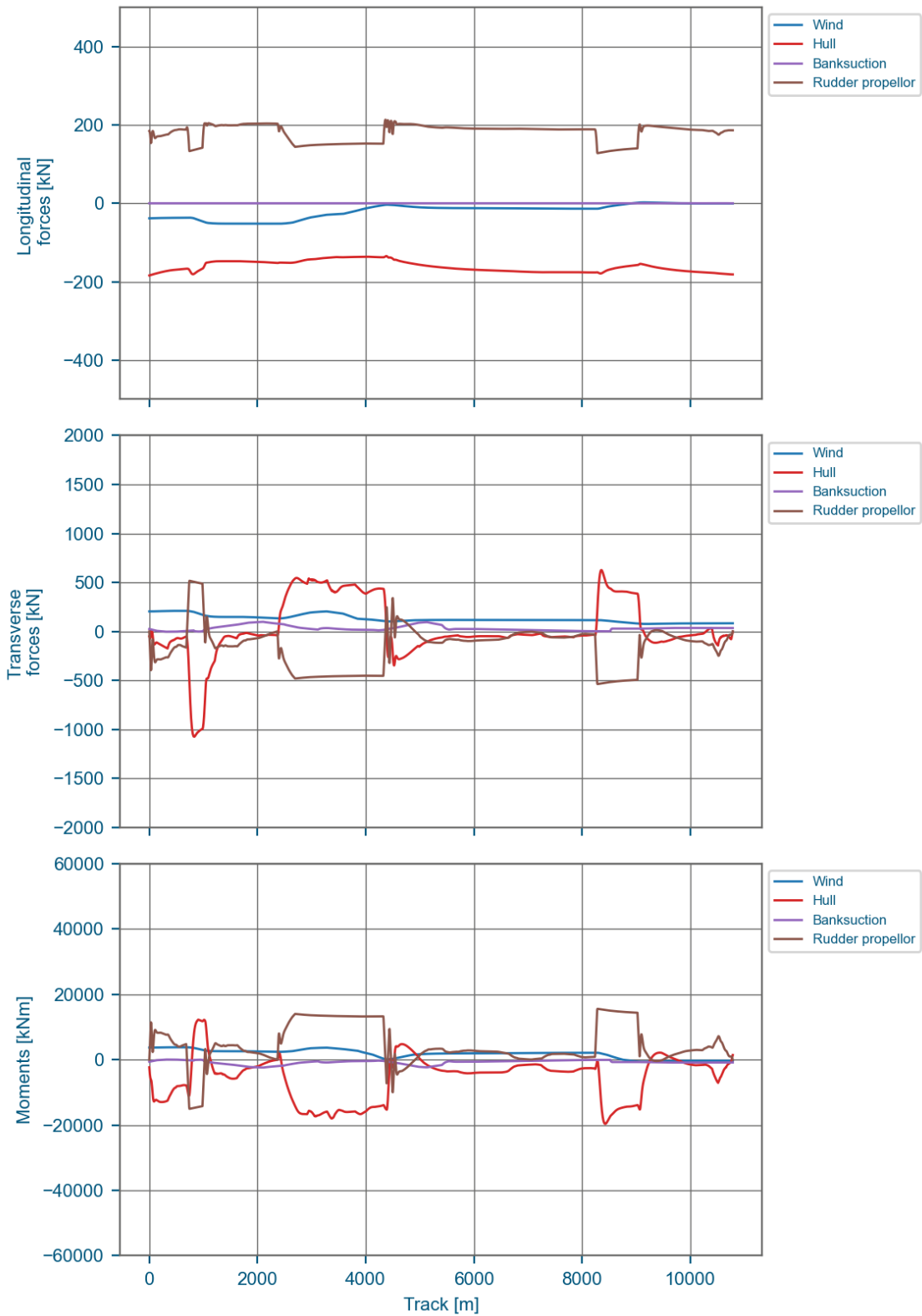


Figure 2.253: S.C. 32: forces, moments, vs. distance.

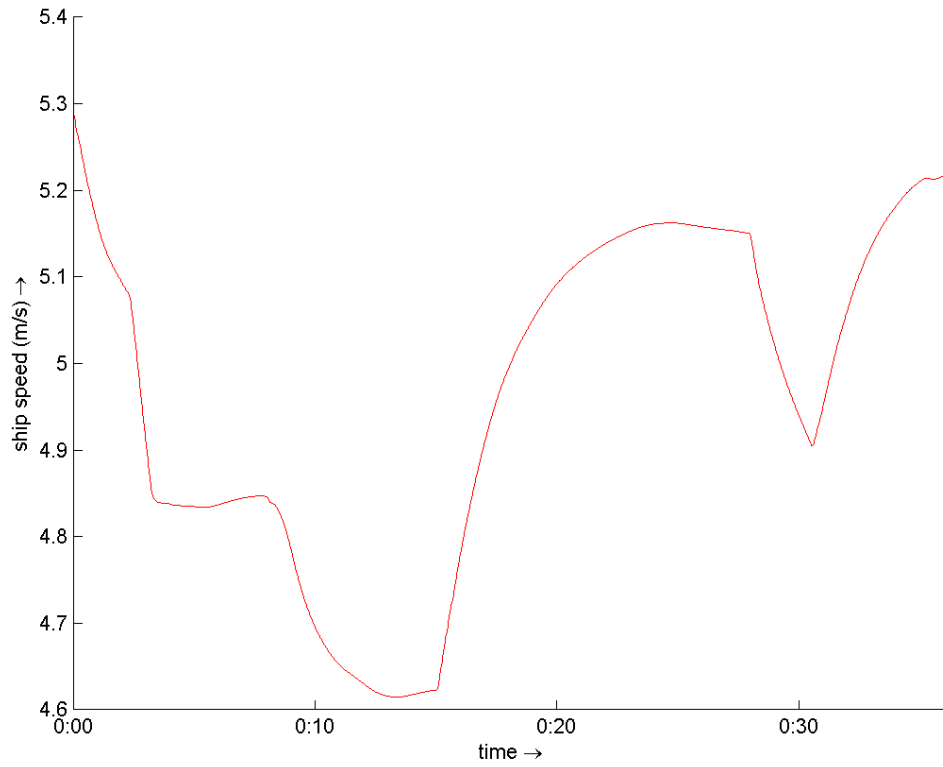


Figure 2.254: S.C. 32: SOG, vs. time.

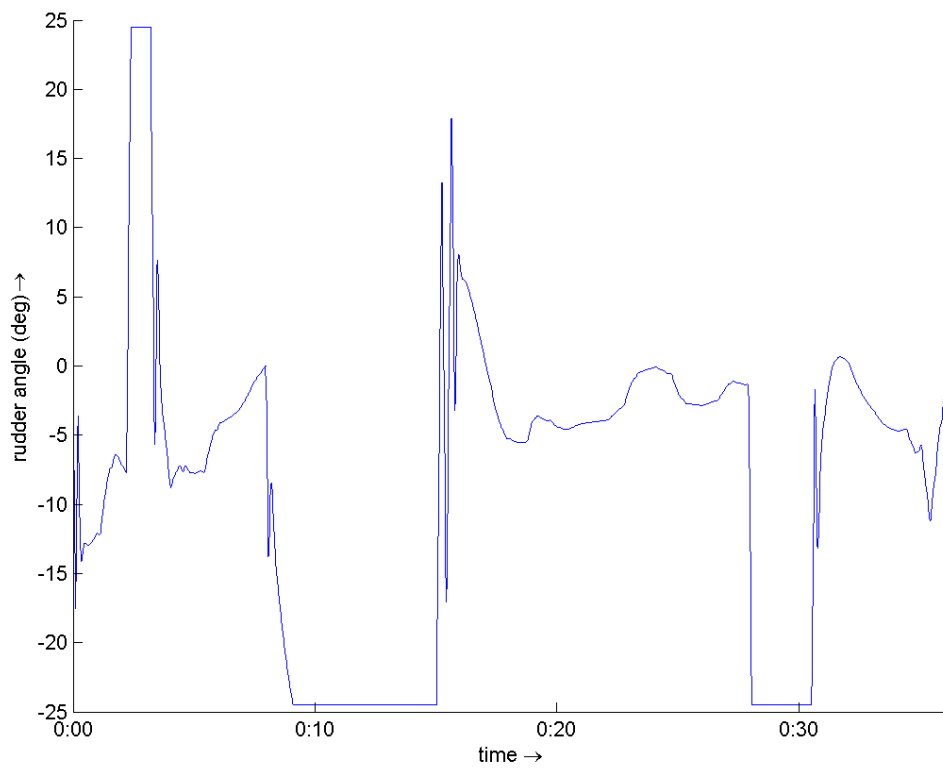


Figure 2.255: S.C. 32: rudder angle, vs. time.

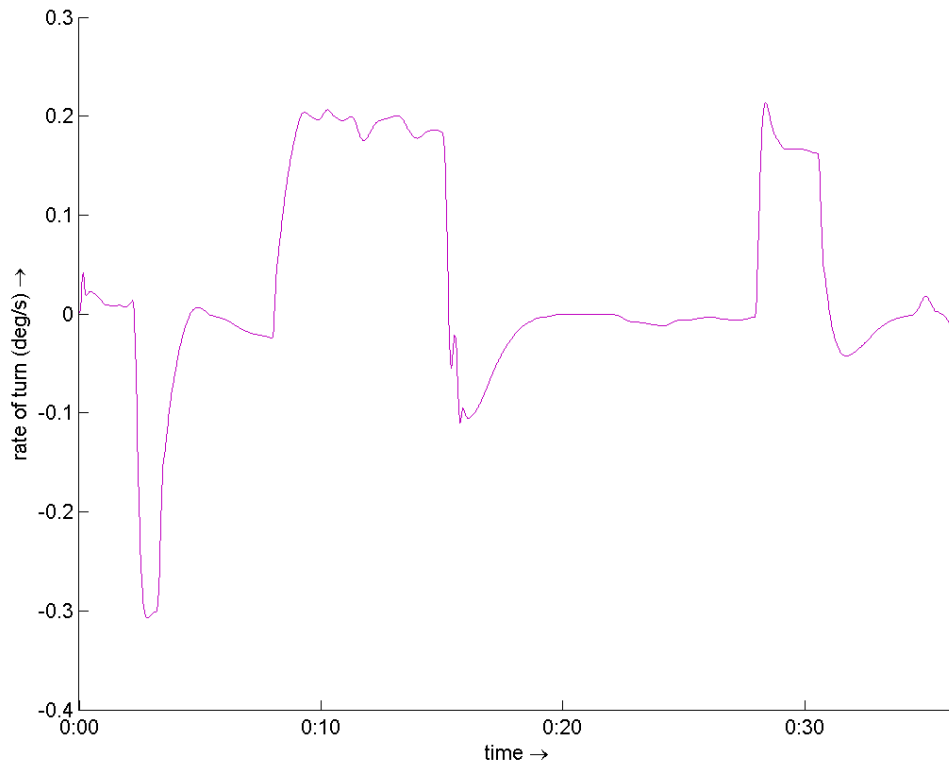


Figure 2.256: S.C. 32: RoT, vs. time.

### Simulation Case 33

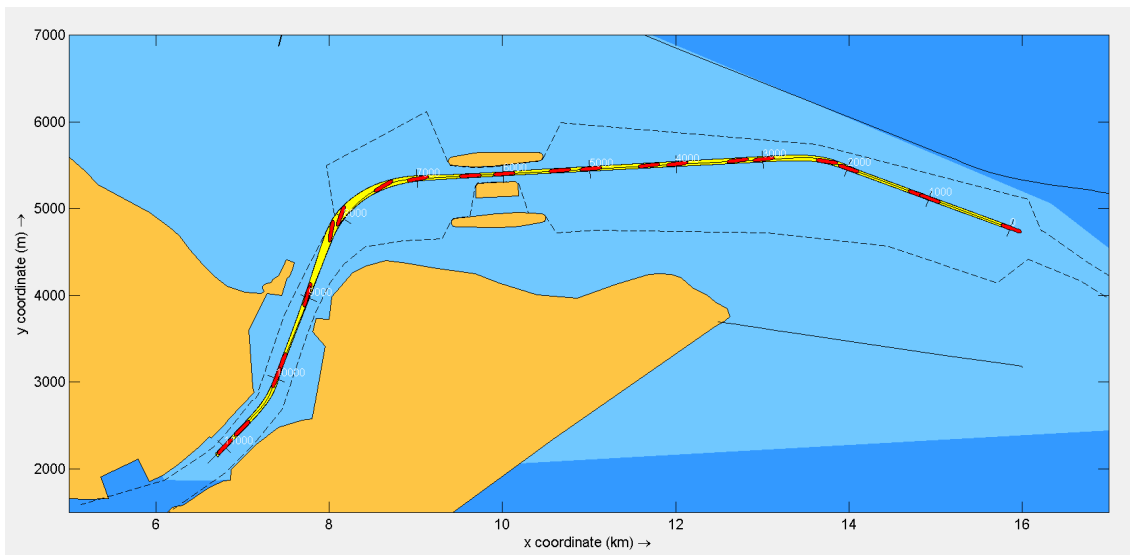
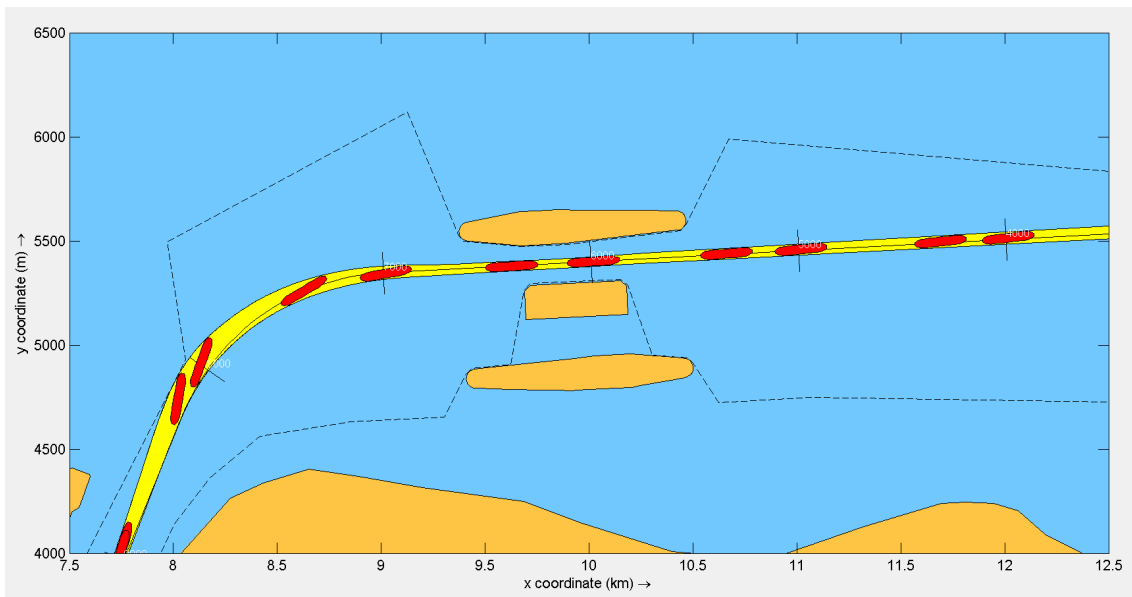


Figure 2.257: S.C. 33: spatial overview plot.



**Figure 2.258:** S.C. 33: zoom-in of spatial overview plot, crossing segment.

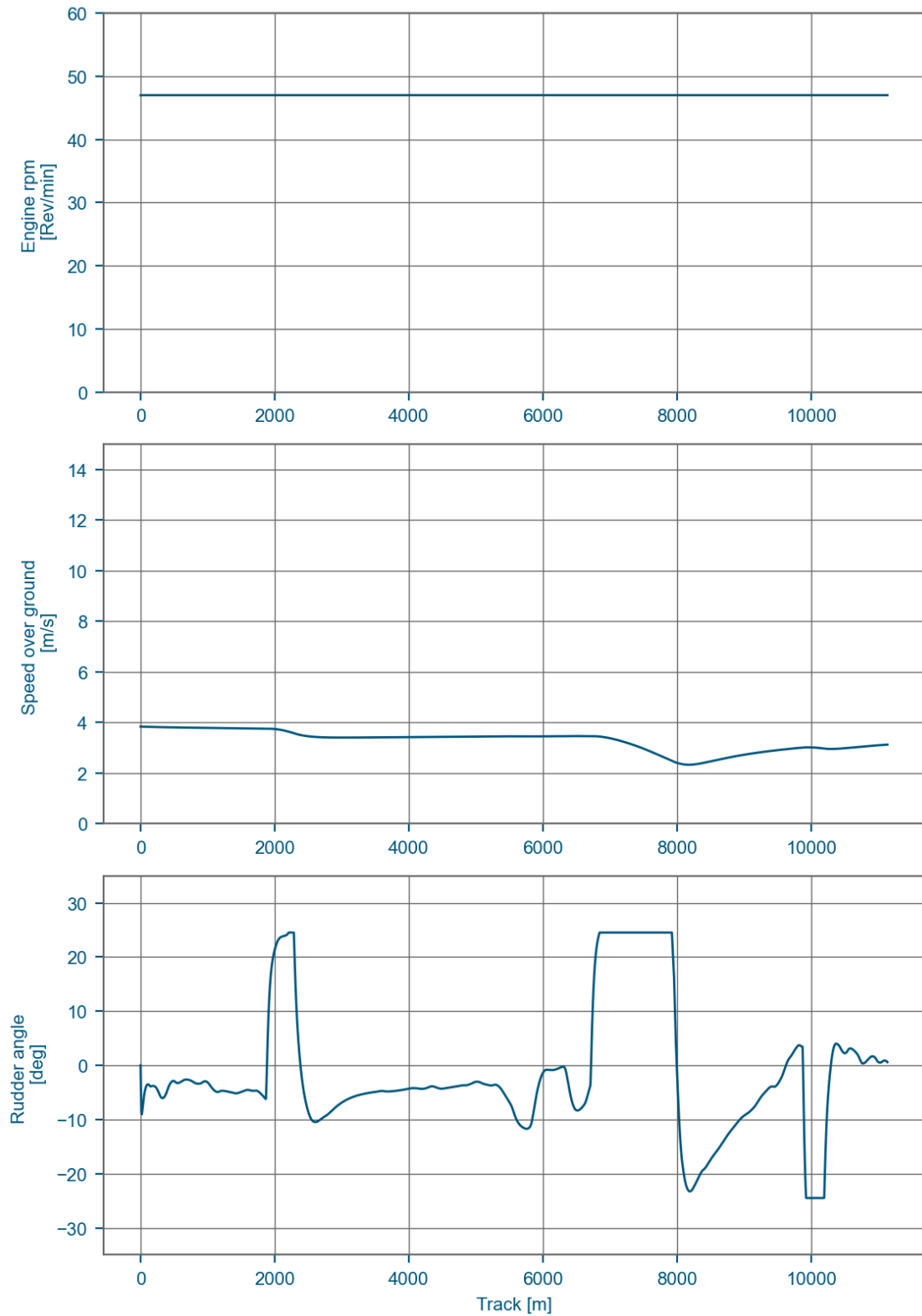


Figure 2.259: S.C. 33: engine RPM, SOG, rudder angle, vs. distance.

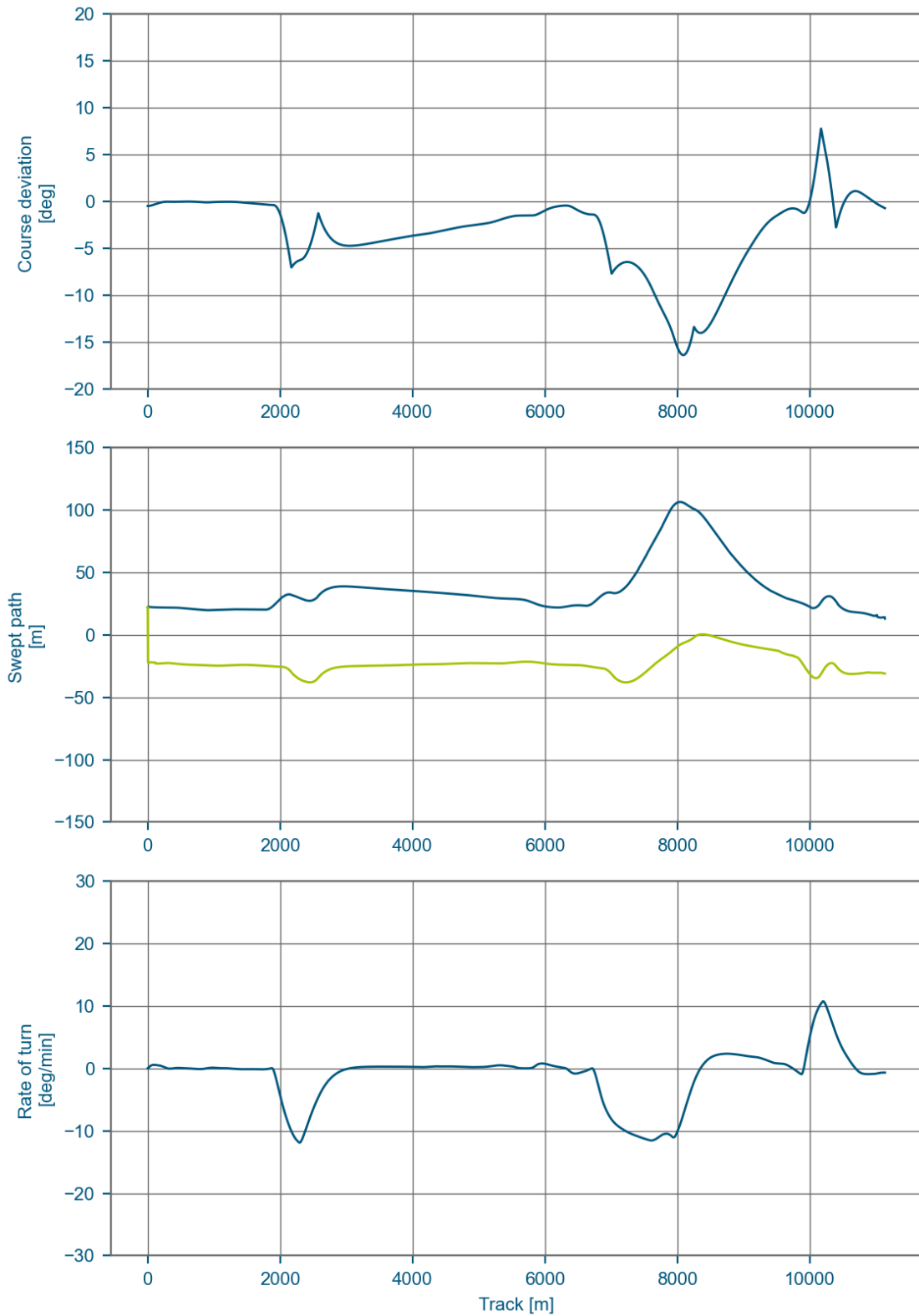


Figure 2.260: S.C. 33: course deviation (drift angle), swept path, RoT, vs. distance.

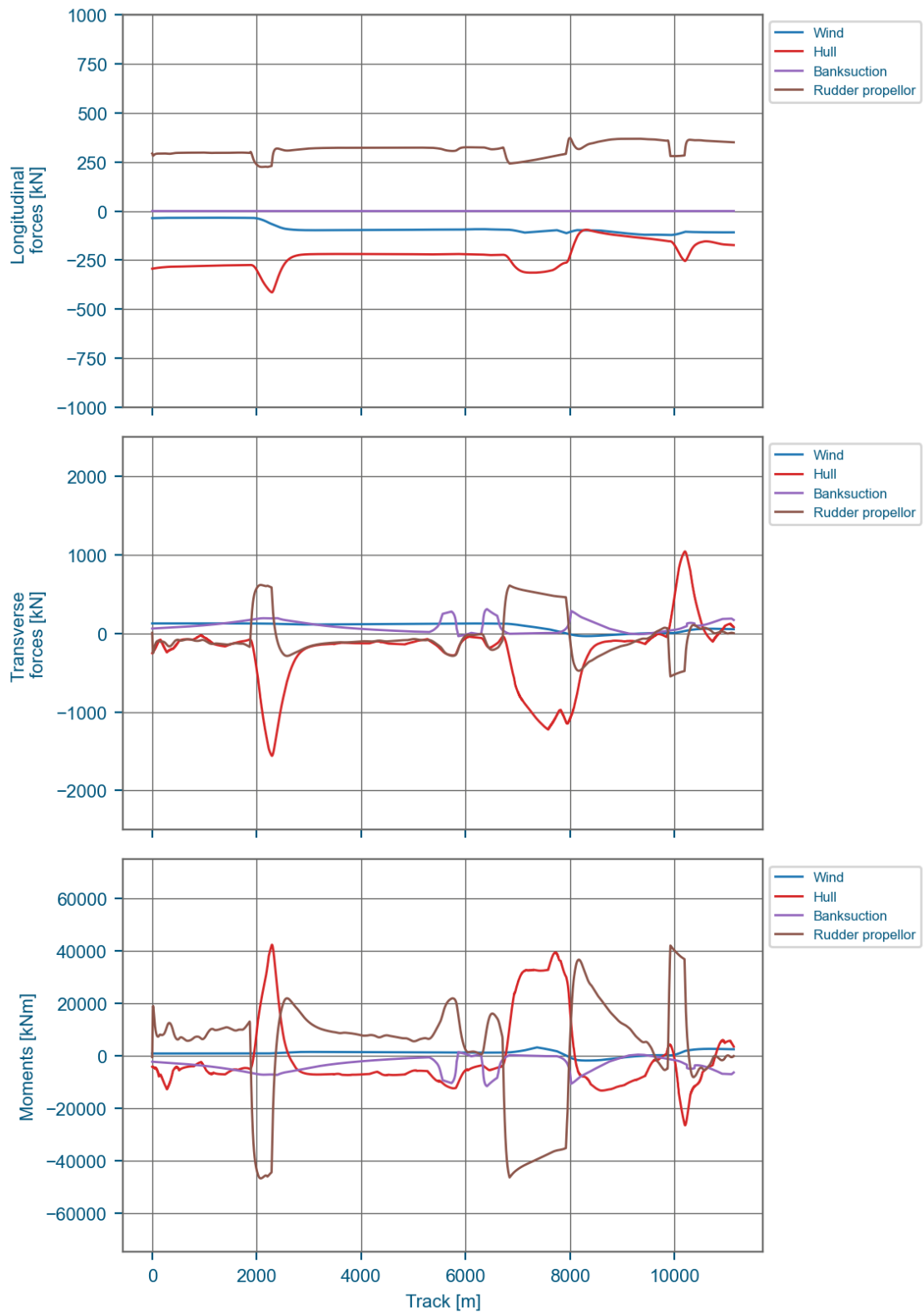


Figure 2.261: S.C. 33: forces, moments, vs. distance.

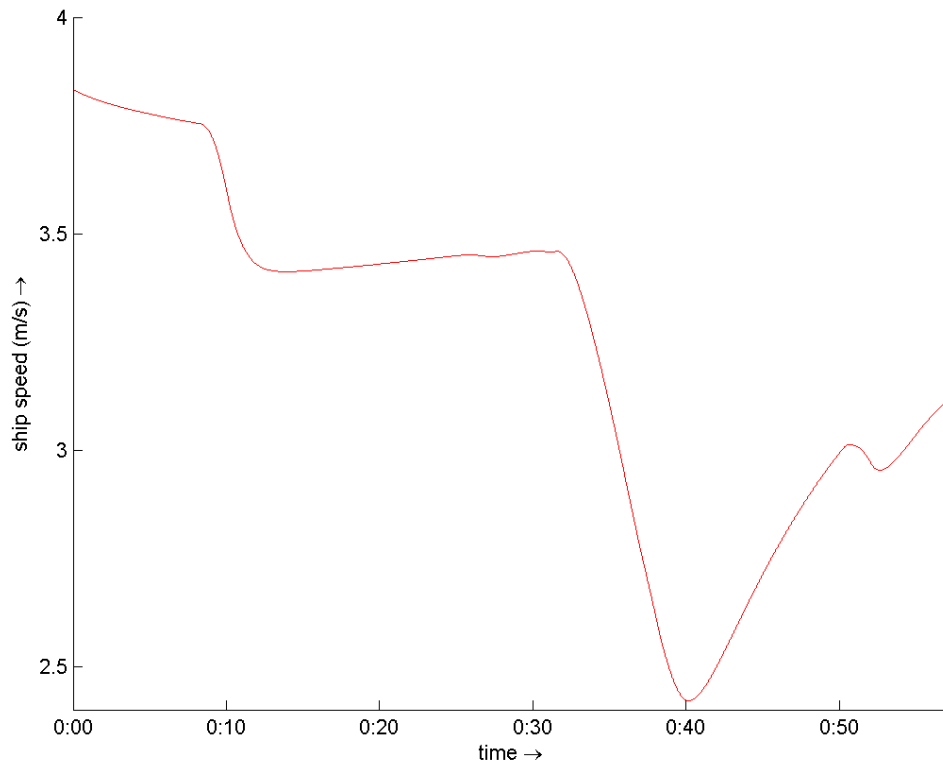


Figure 2.262: S.C. 33: SOG, vs. time.

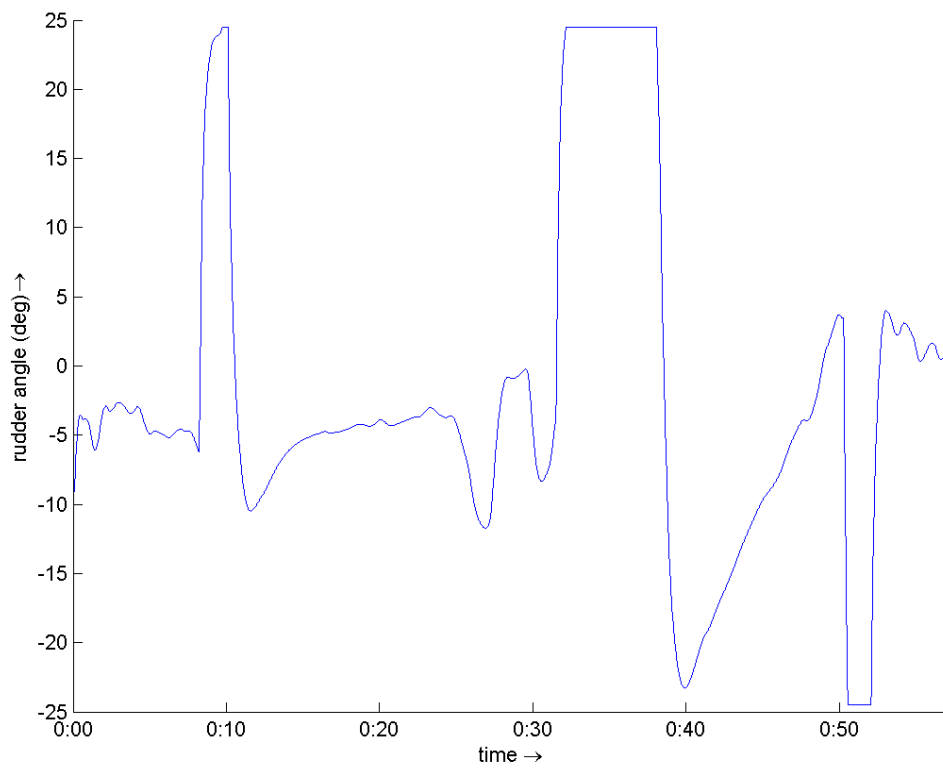


Figure 2.263: S.C. 33: rudder angle, vs. time.

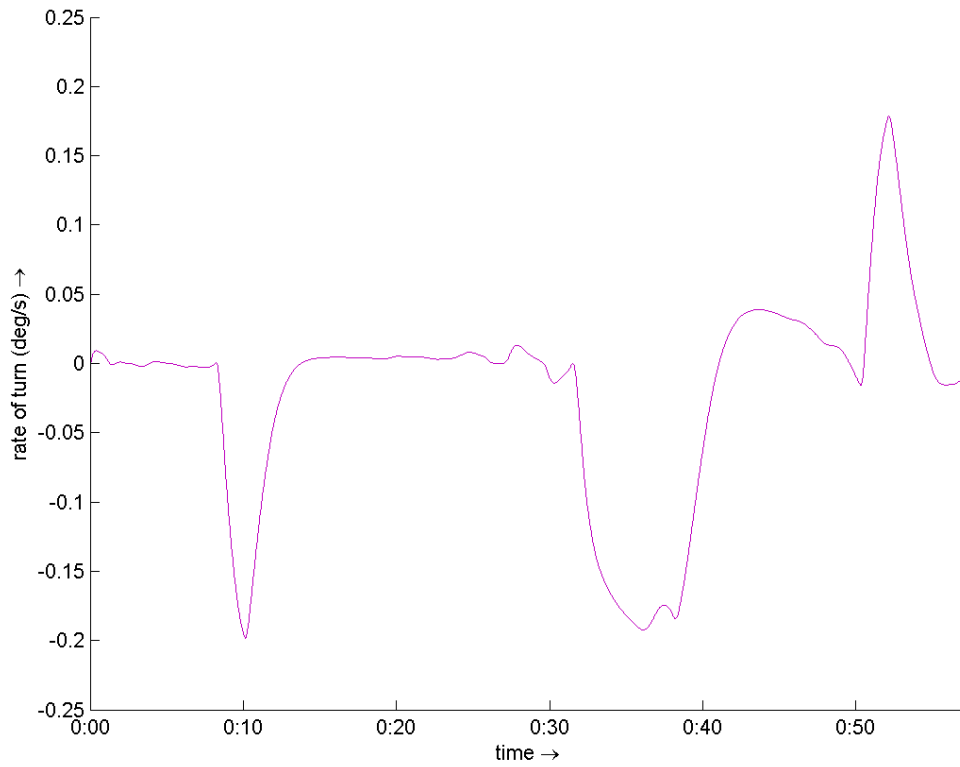


Figure 2.264: S.C. 33: RoT, vs. time.

### Simulation Case 34

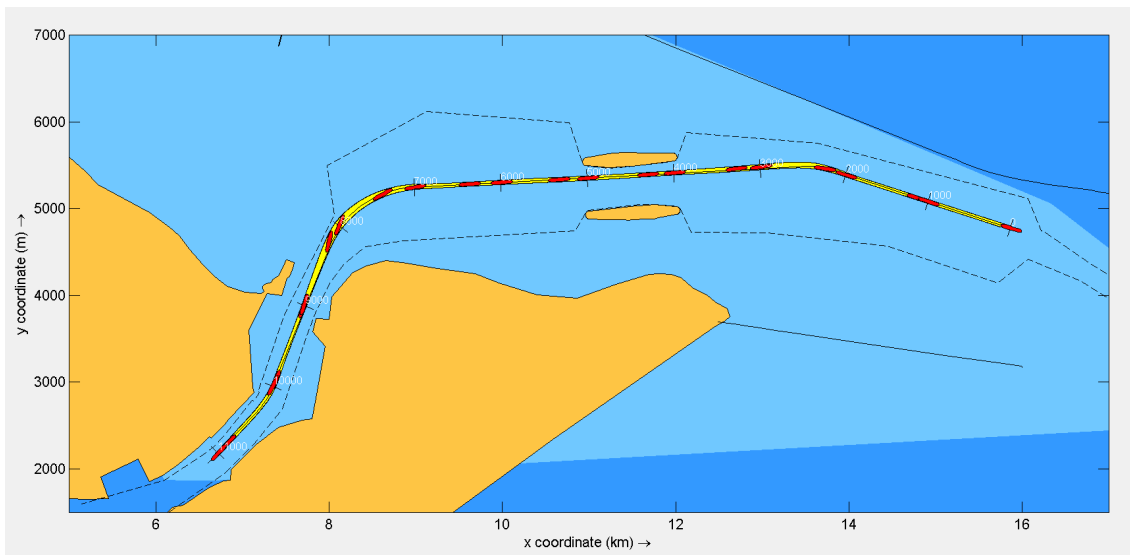
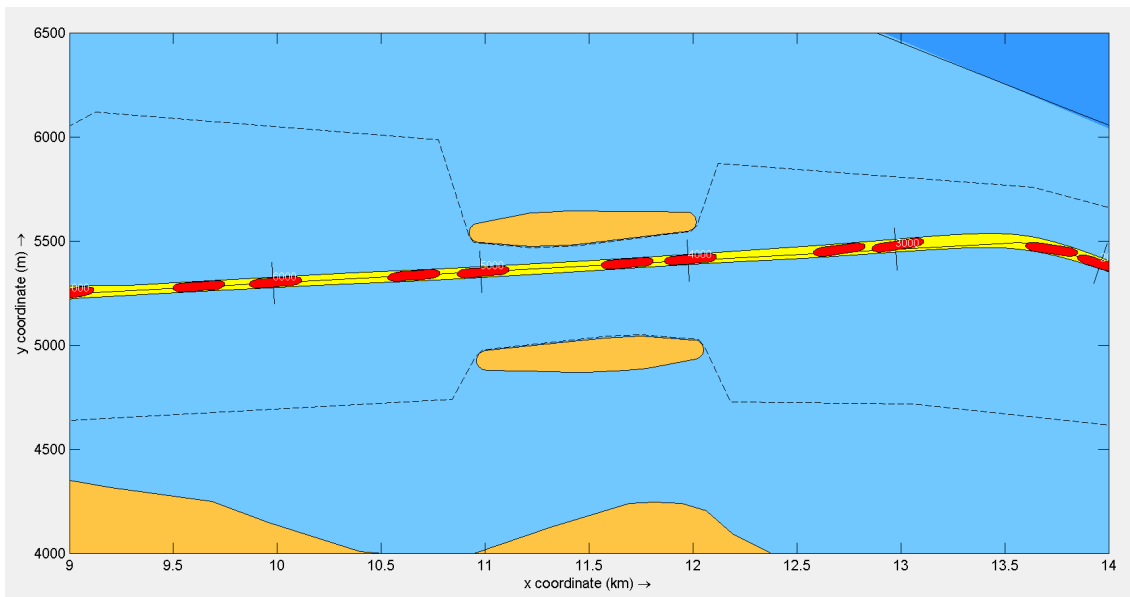


Figure 2.265: S.C. 34: spatial overview plot.



**Figure 2.266:** S.C. 34: zoom-in of spatial overview plot, crossing segment.

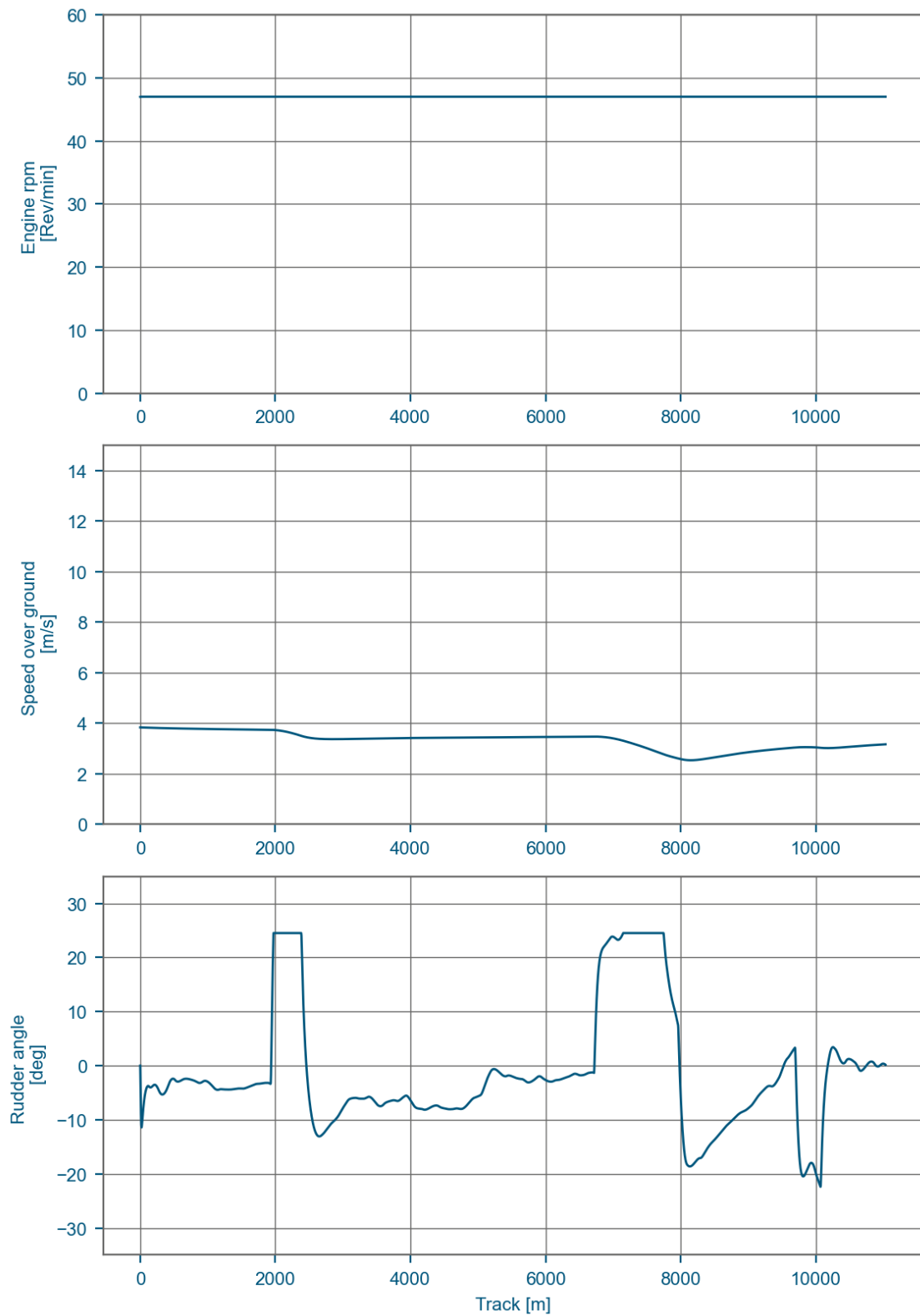


Figure 2.267: S.C. 34: engine RPM, SOG, rudder angle, vs. distance.

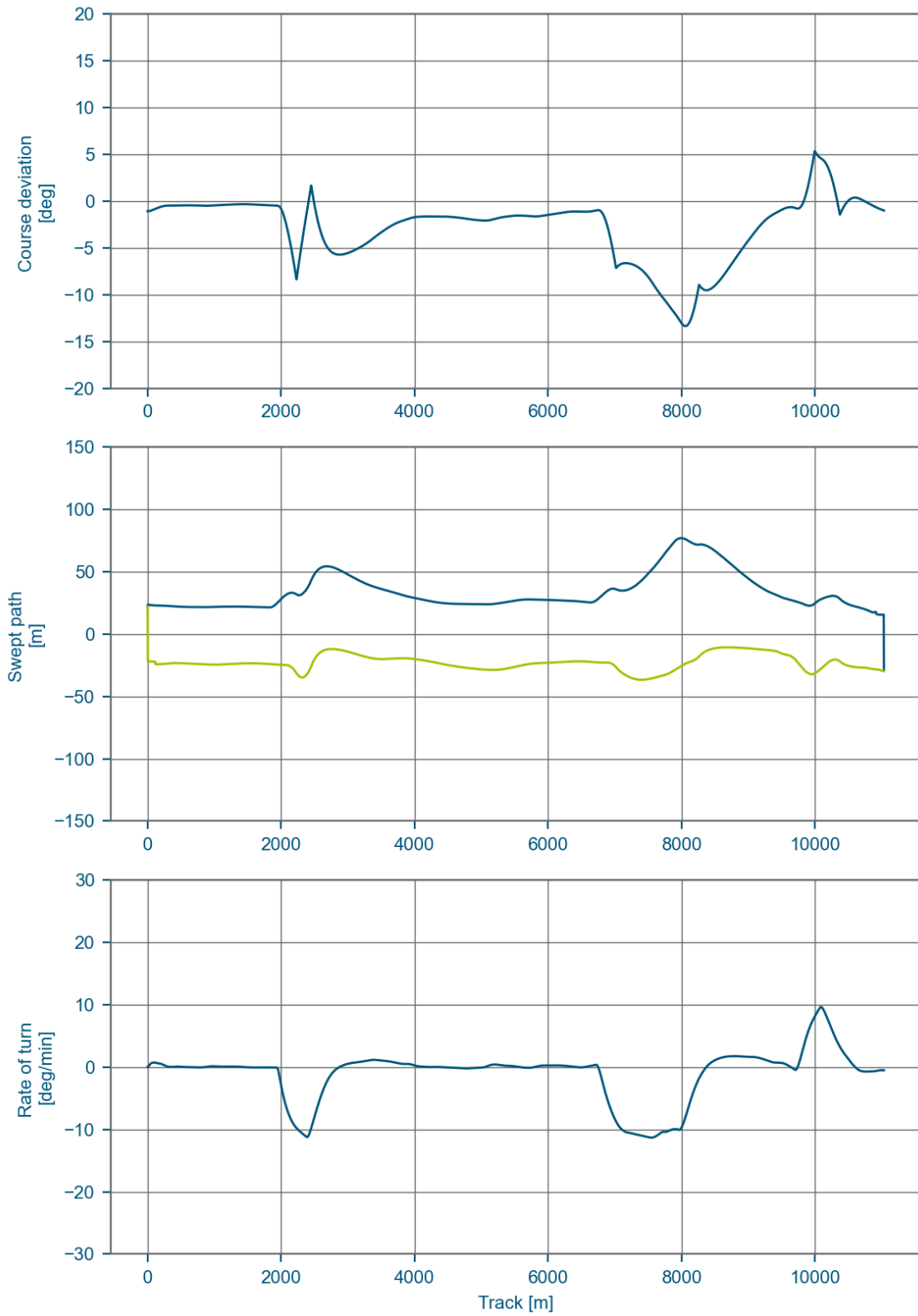


Figure 2.268: S.C. 34: course deviation (drift angle), swept path, RoT, vs. distance.

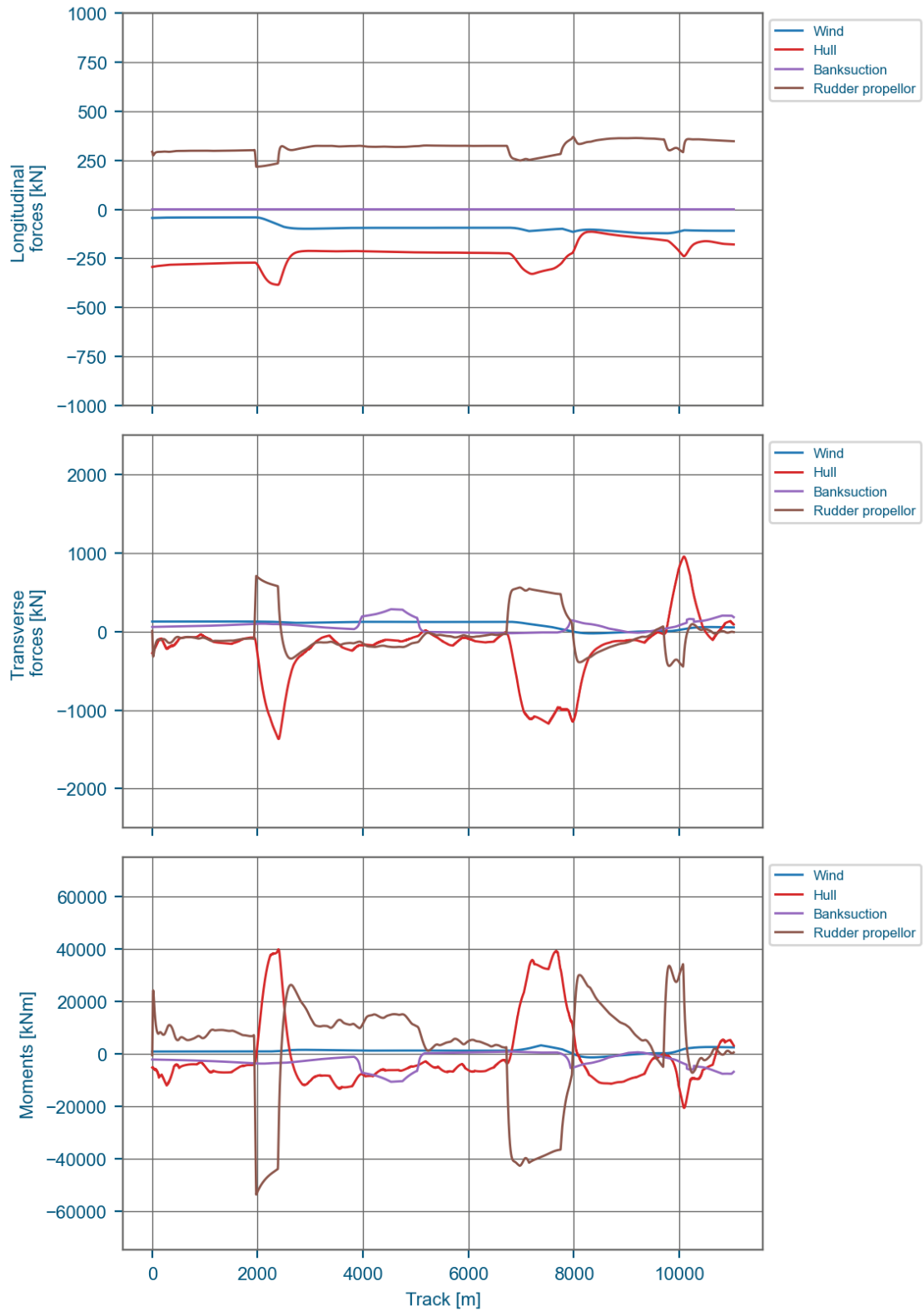


Figure 2.269: S.C. 34: forces, moments, vs. distance.

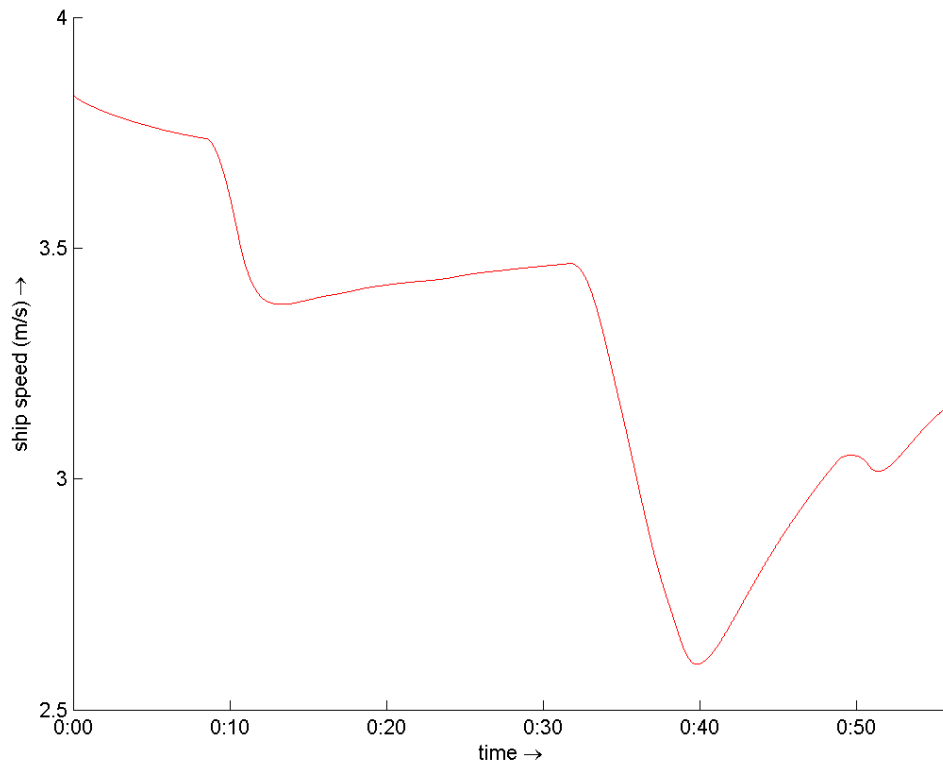


Figure 2.270: S.C. 34: SOG, vs. time.

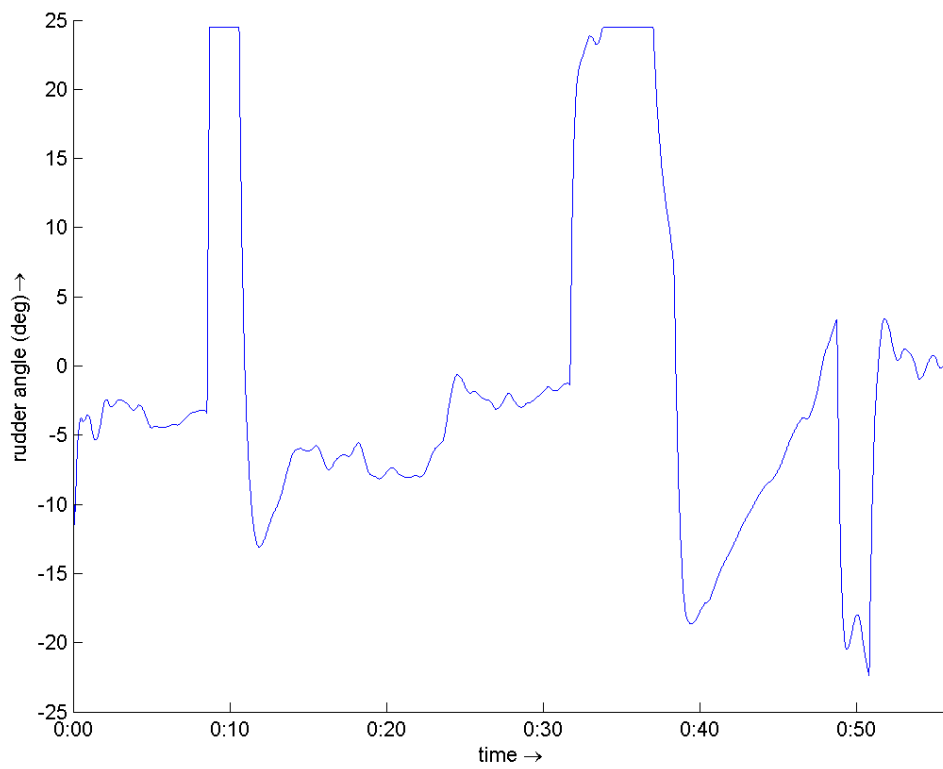


Figure 2.271: S.C. 34: rudder angle, vs. time.

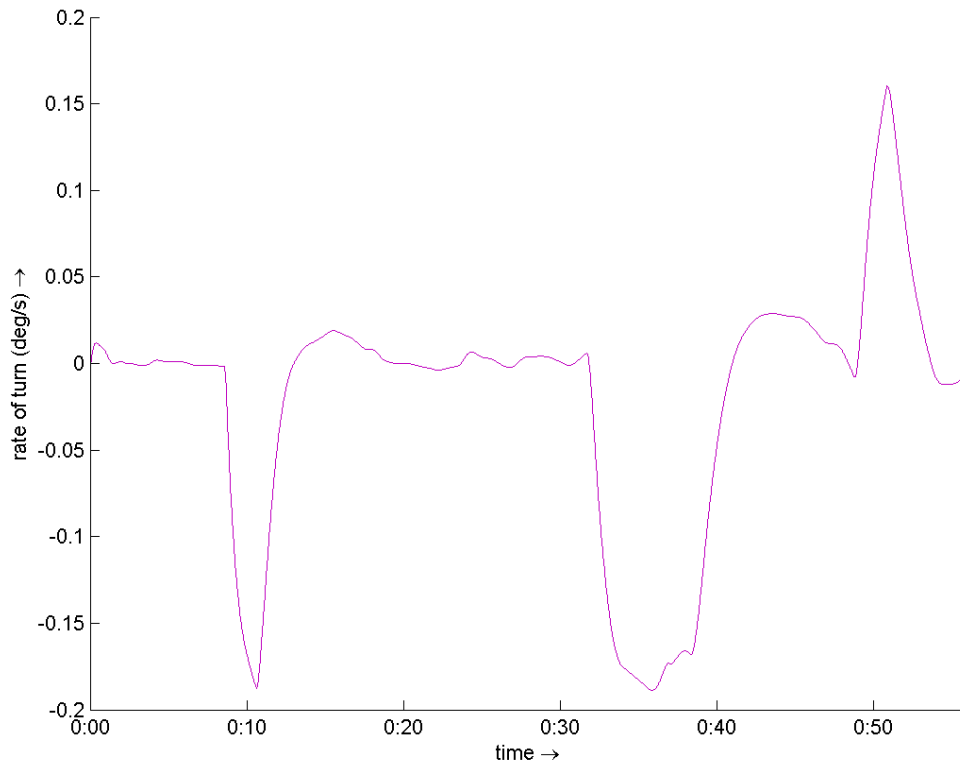


Figure 2.272: S.C. 34: RoT, vs. time.

### Simulation Case 35

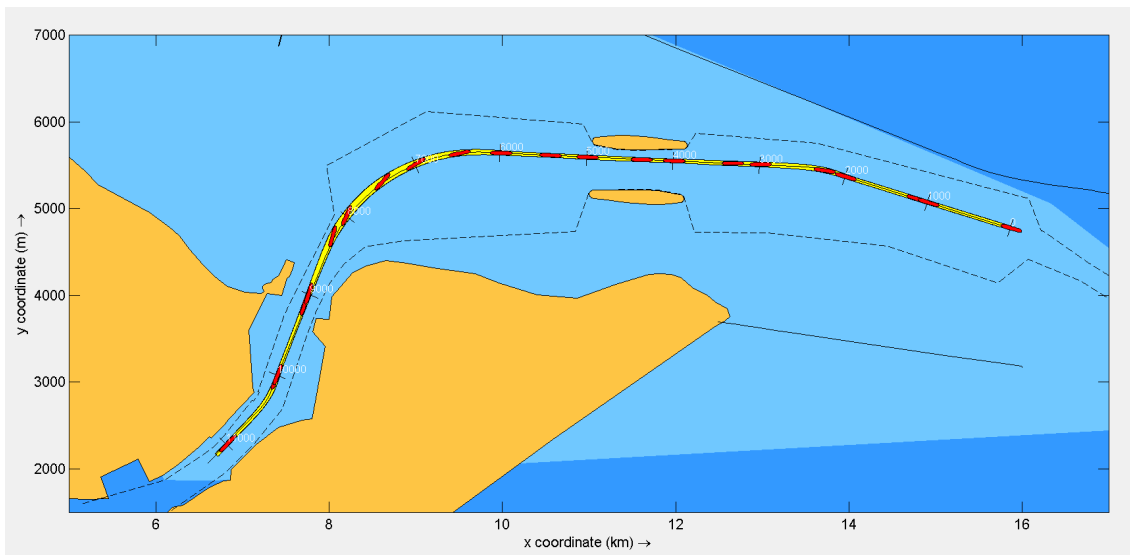
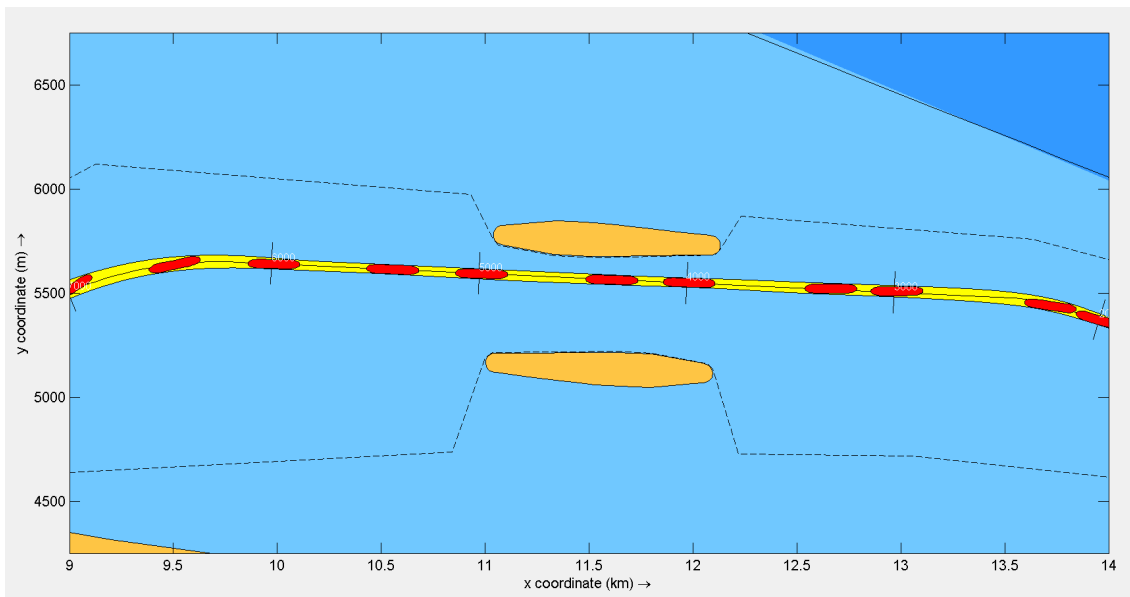


Figure 2.273: S.C. 35: spatial overview plot.



**Figure 2.274:** S.C. 35: zoom-in of spatial overview plot, crossing segment.

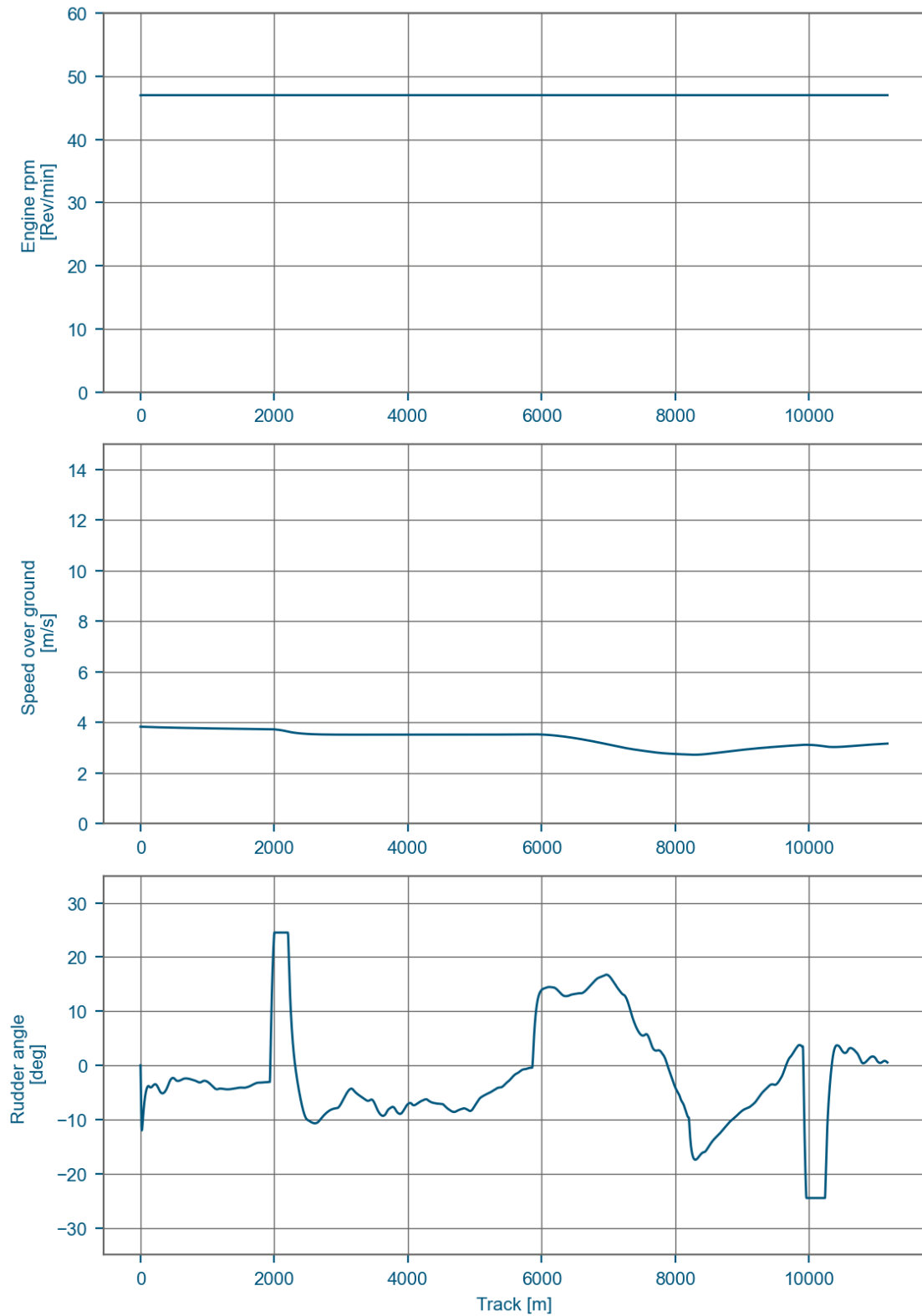


Figure 2.275: S.C. 35: engine RPM, SOG, rudder angle, vs. distance.

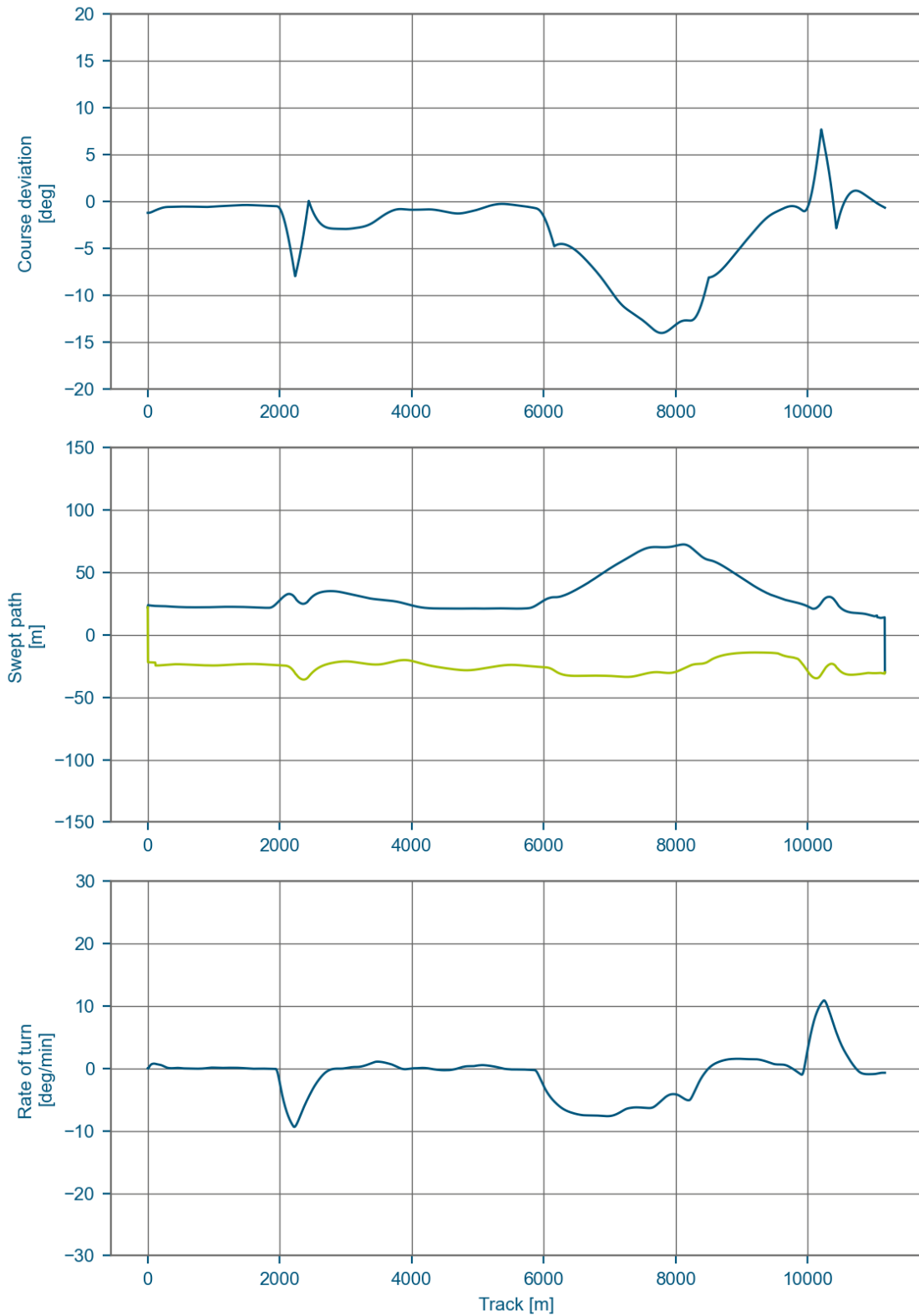


Figure 2.276: S.C. 35: course deviation (drift angle), swept path, RoT, vs. distance.

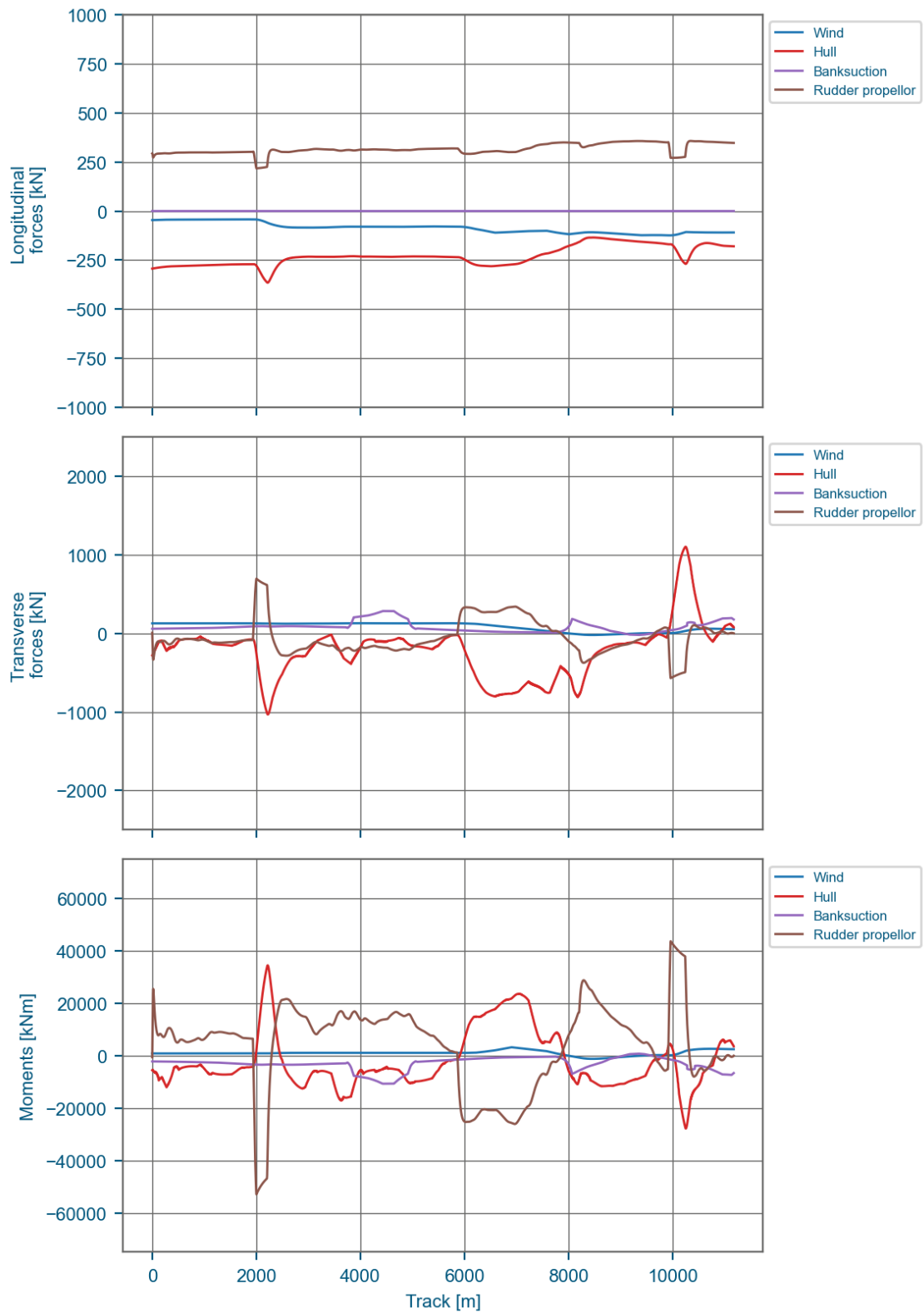


Figure 2.277: S.C. 35: forces, moments, vs. distance.

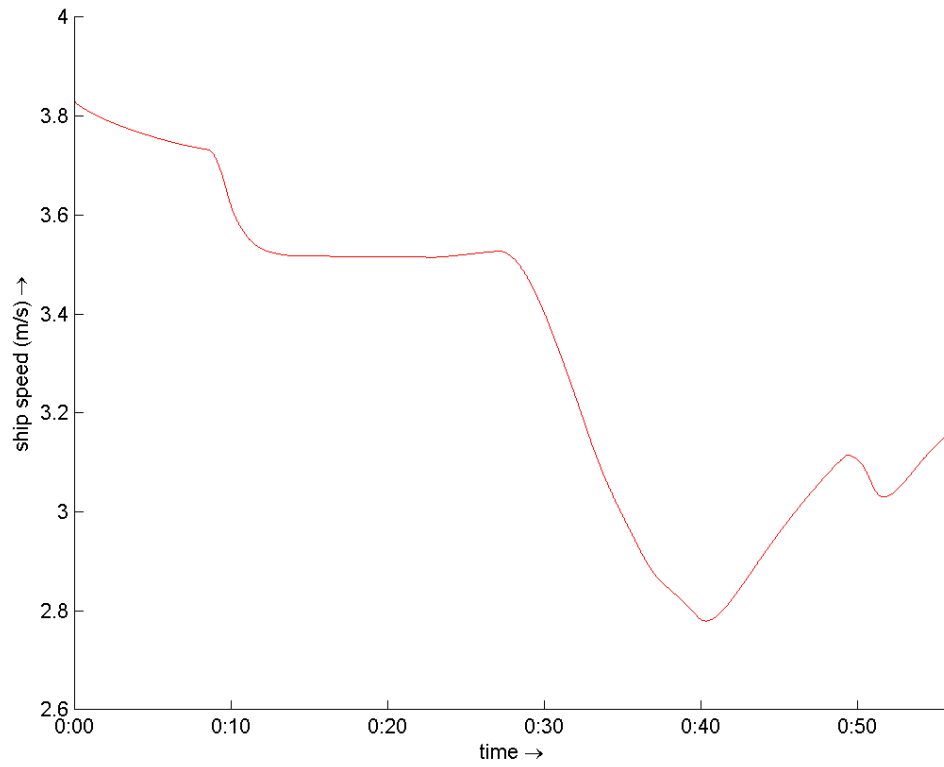


Figure 2.278: S.C. 35: SOG, vs. time.

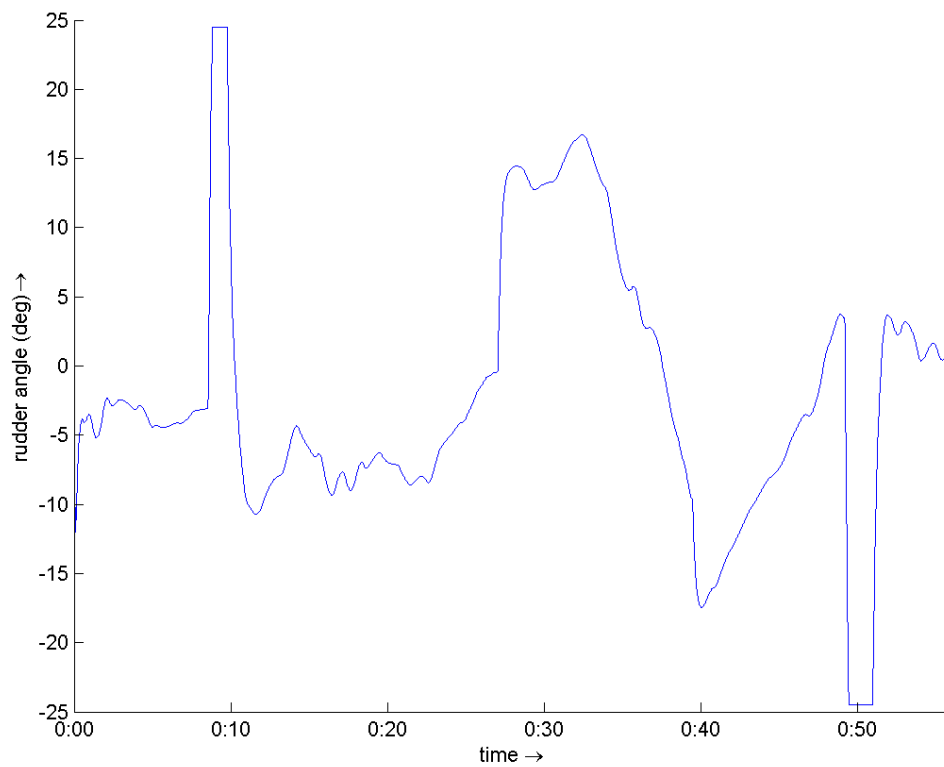


Figure 2.279: S.C. 35: rudder angle, vs. time.

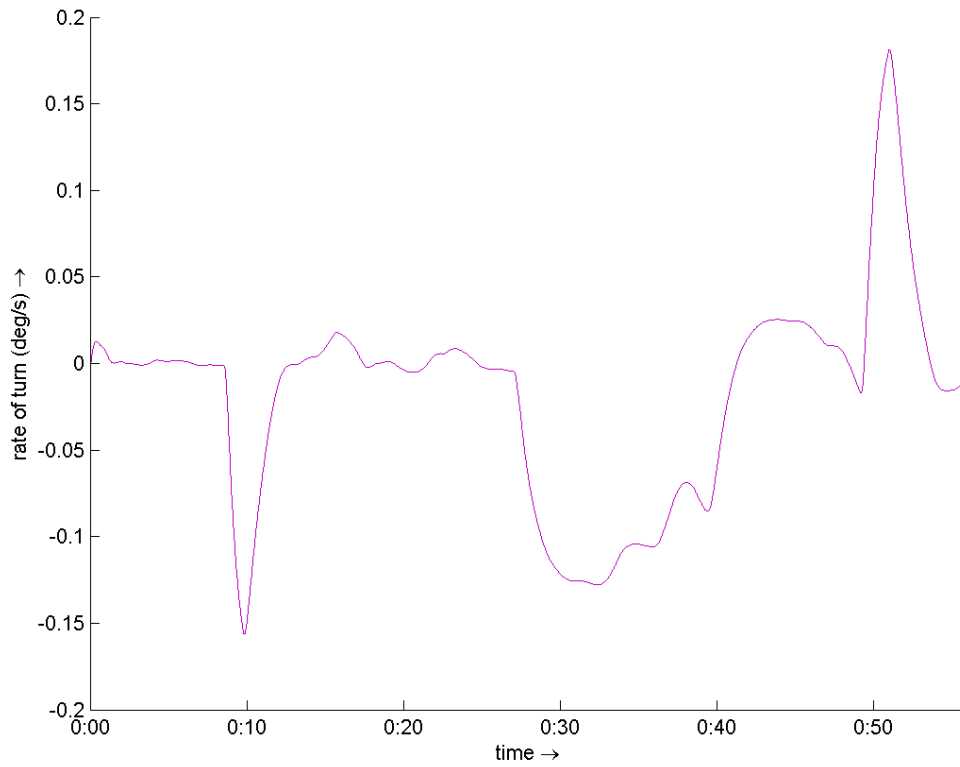


Figure 2.280: S.C. 35: RoT, vs. time.

## Simulation Case 36

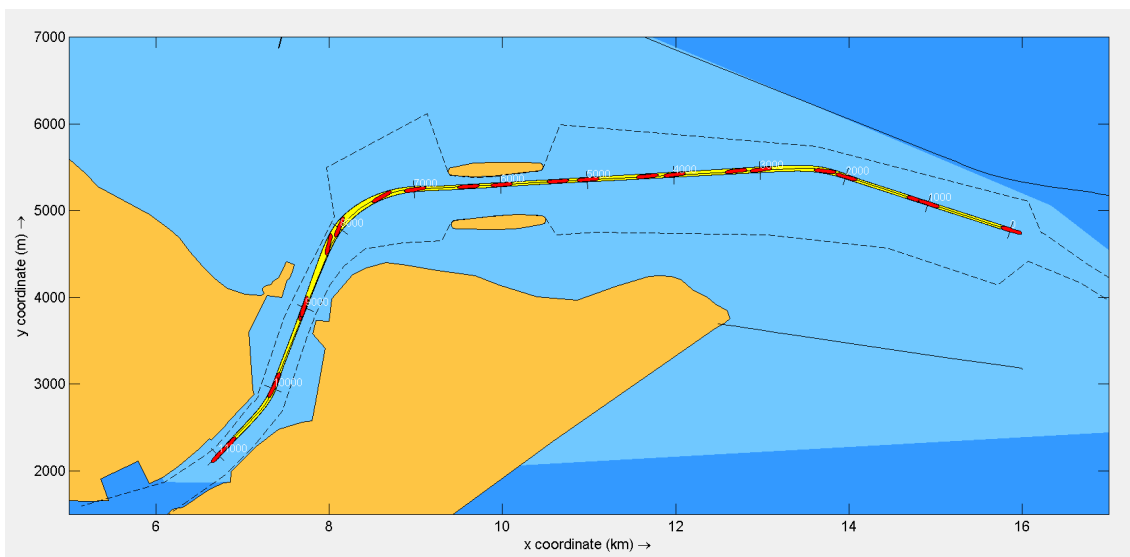
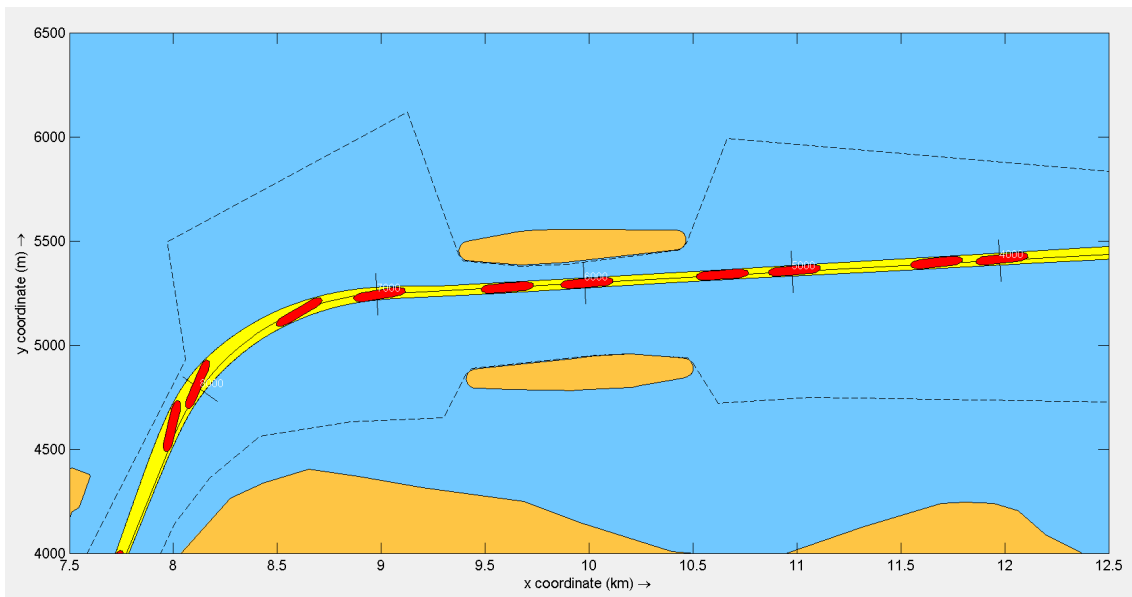


Figure 2.281: S.C. 36: spatial overview plot.



**Figure 2.282:** S.C. 36: zoom-in of spatial overview plot, crossing segment.

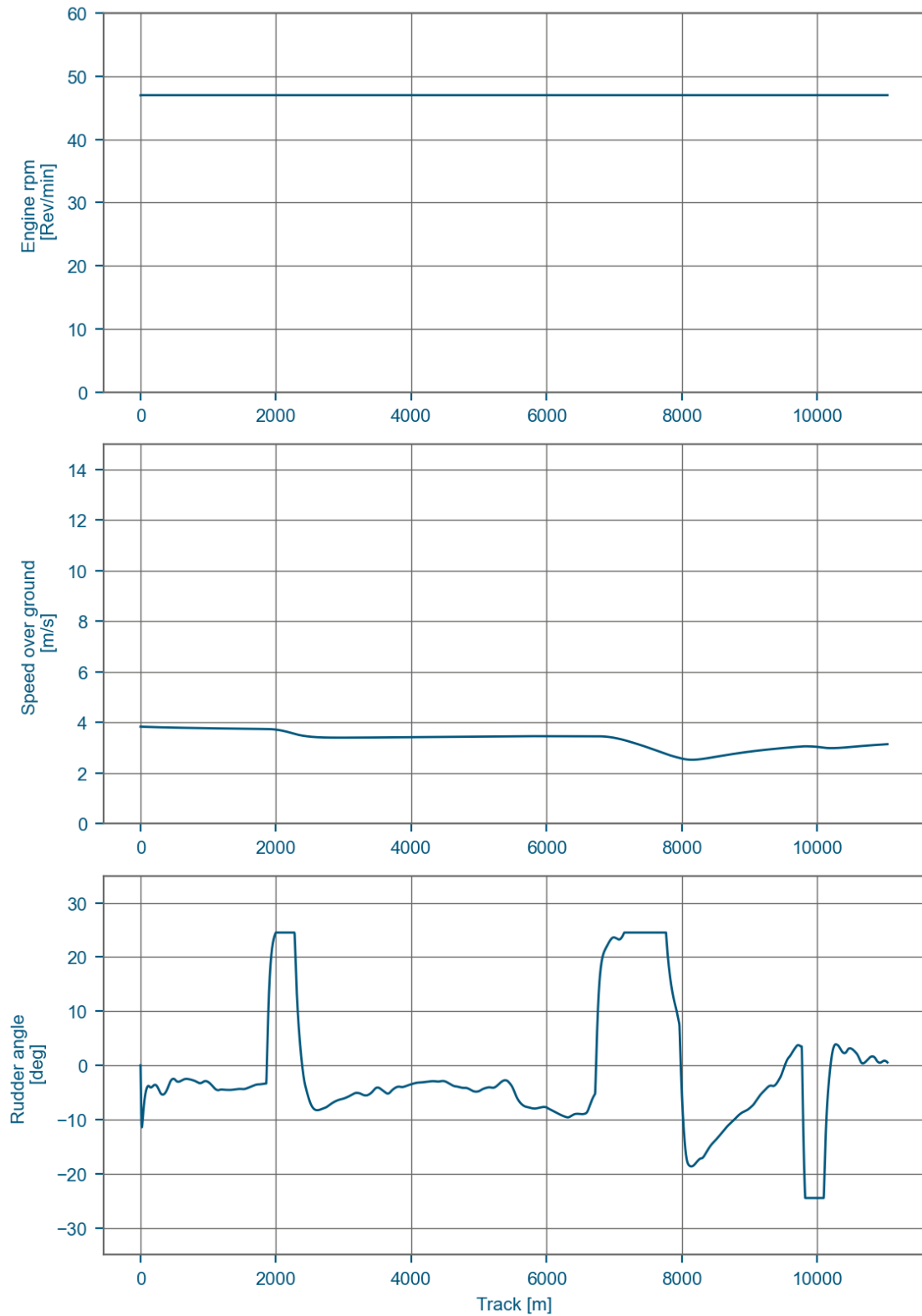


Figure 2.283: S.C. 36: engine RPM, SOG, rudder angle, vs. distance.

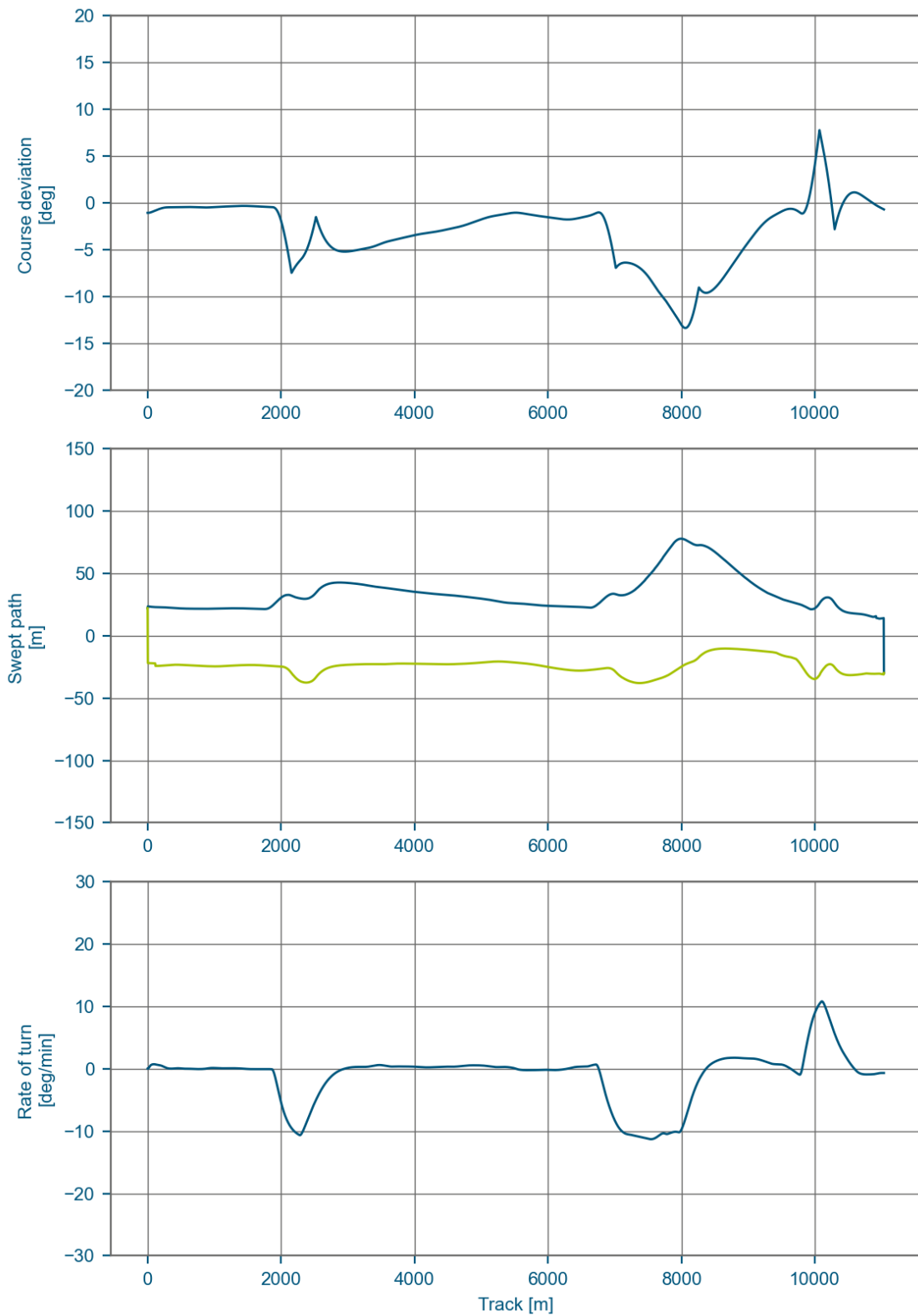


Figure 2.284: S.C. 36: course deviation (drift angle), swept path, RoT, vs. distance.

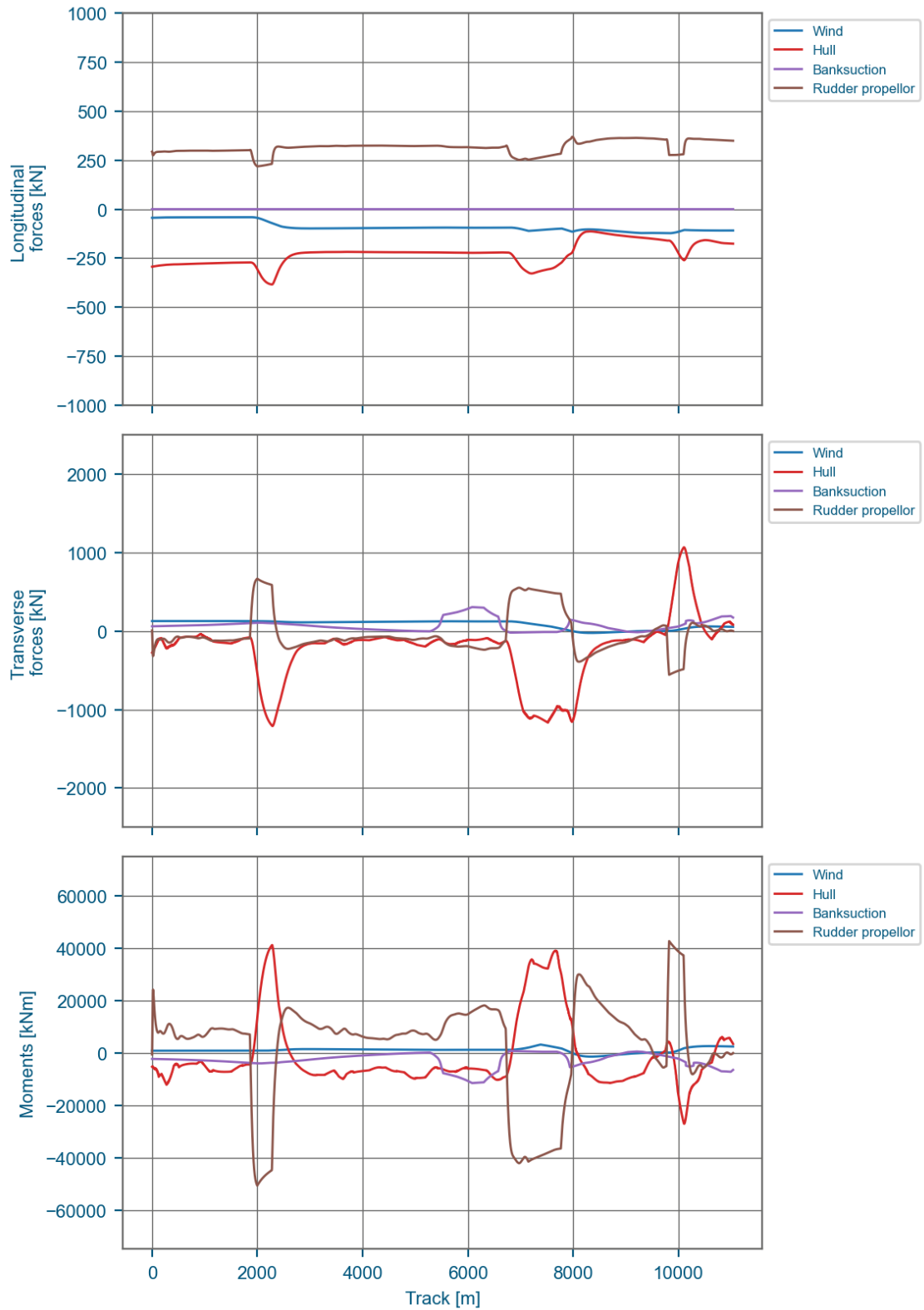


Figure 2.285: S.C. 36: forces, moments, vs. distance.

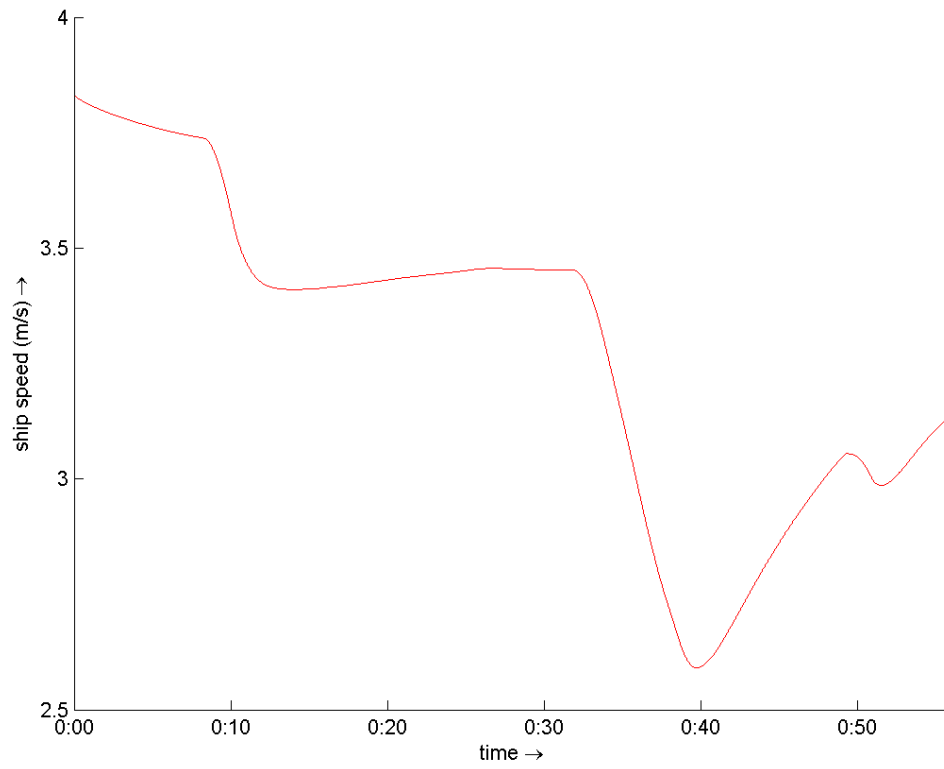


Figure 2.286: S.C. 36: SOG, vs. time.

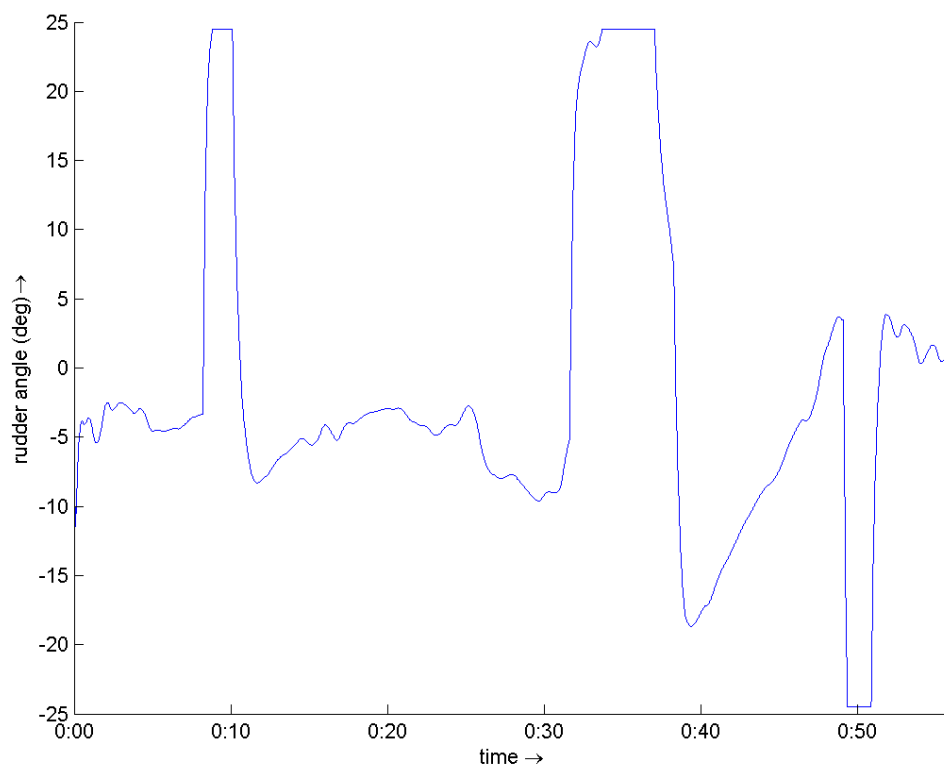


Figure 2.287: S.C. 36: rudder angle, vs. time.

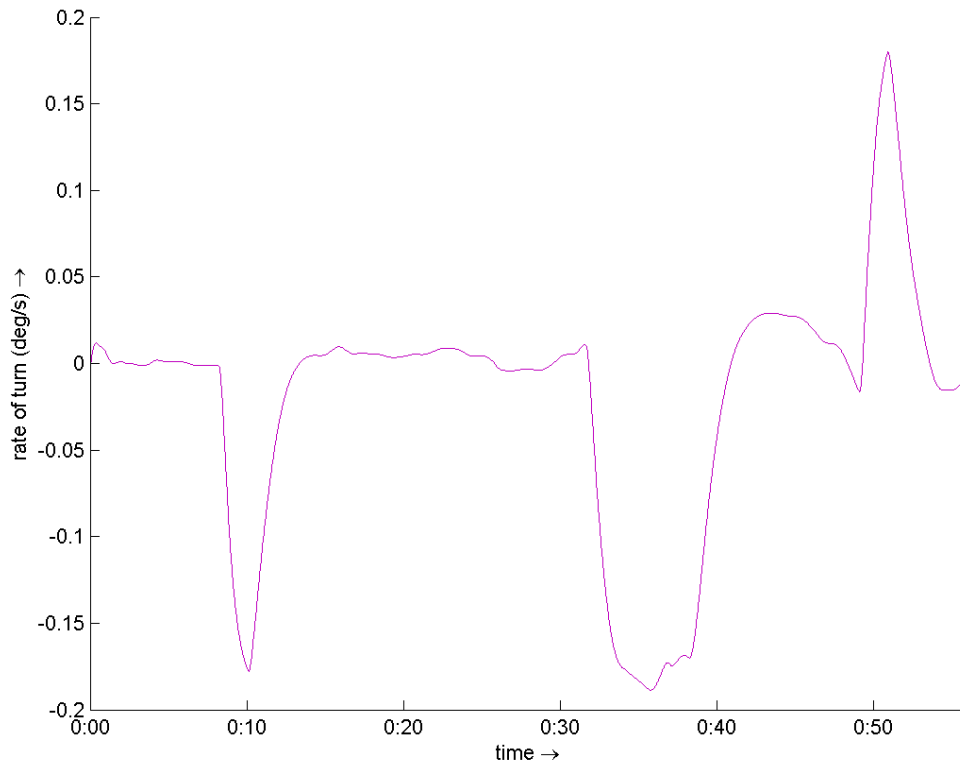


Figure 2.288: S.C. 36: RoT, vs. time.

### Simulation Case 37

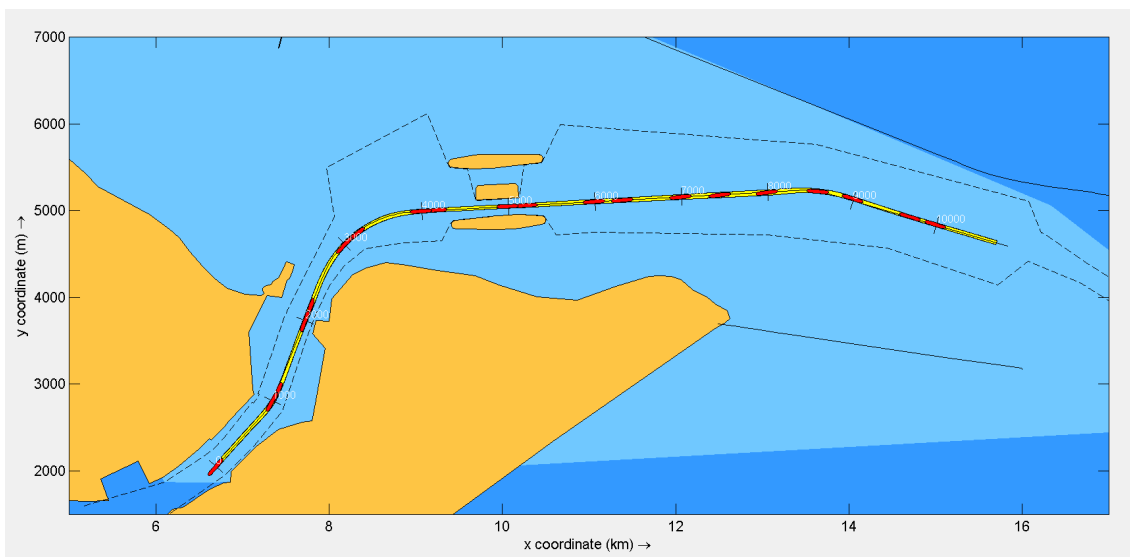
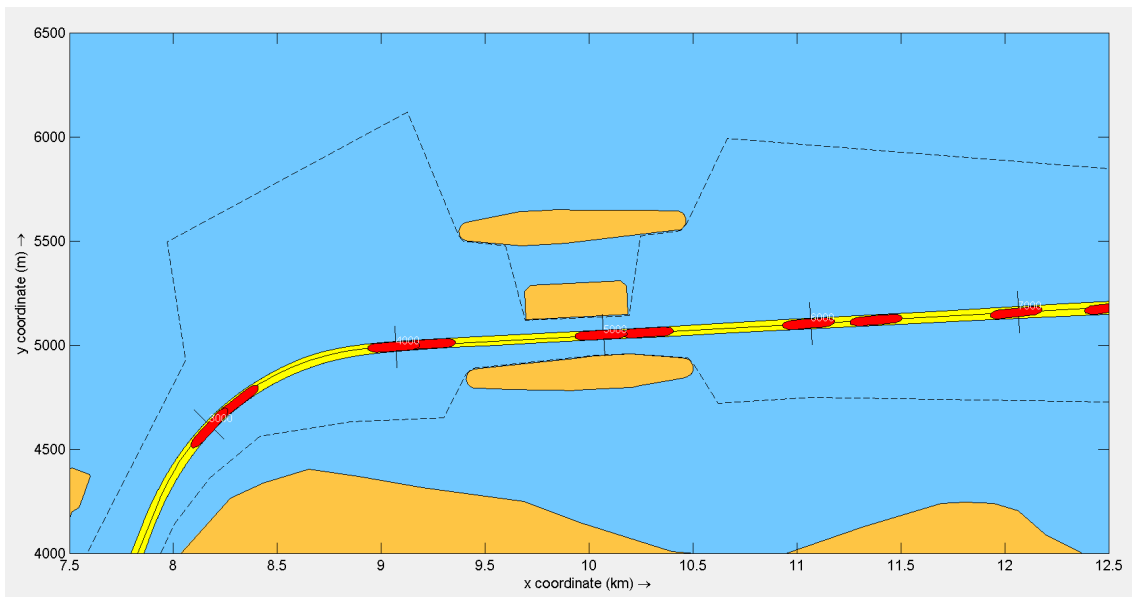


Figure 2.289: S.C. 37: spatial overview plot.



**Figure 2.290:** S.C. 37: zoom-in of spatial overview plot, crossing segment.

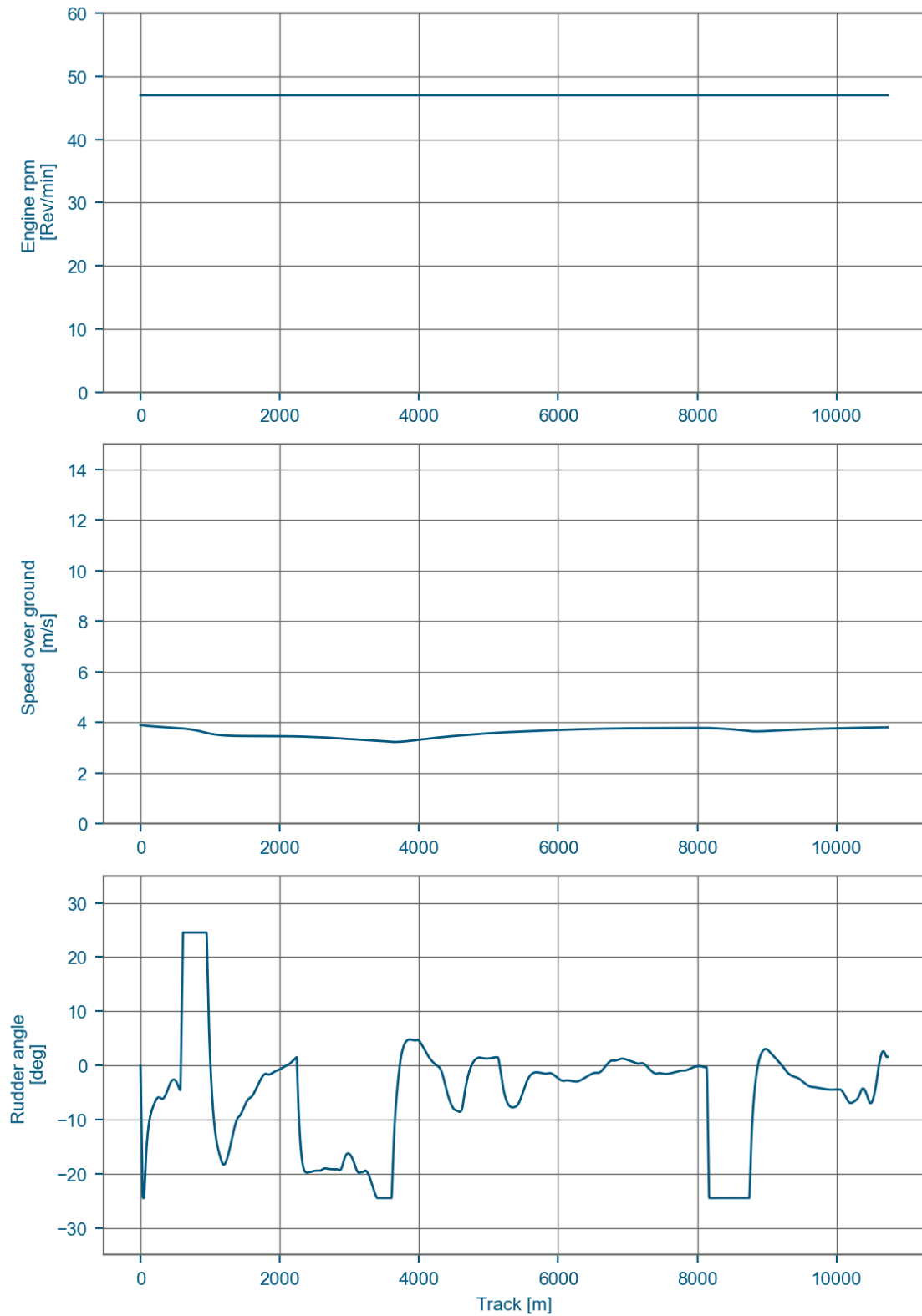


Figure 2.291: S.C. 37: engine RPM, SOG, rudder angle, vs. distance.

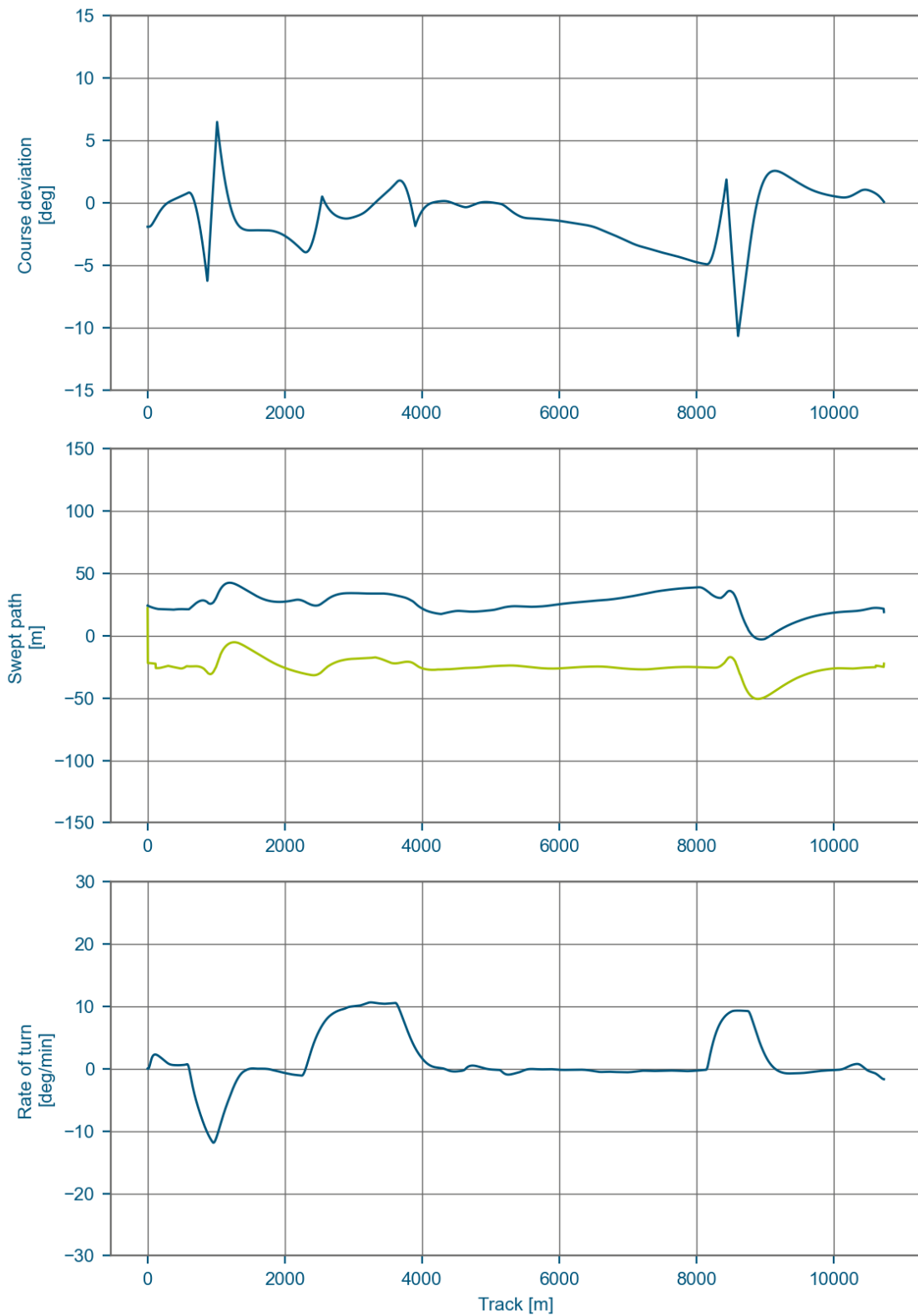


Figure 2.292: S.C. 37: course deviation (drift angle), swept path, RoT, vs. distance.

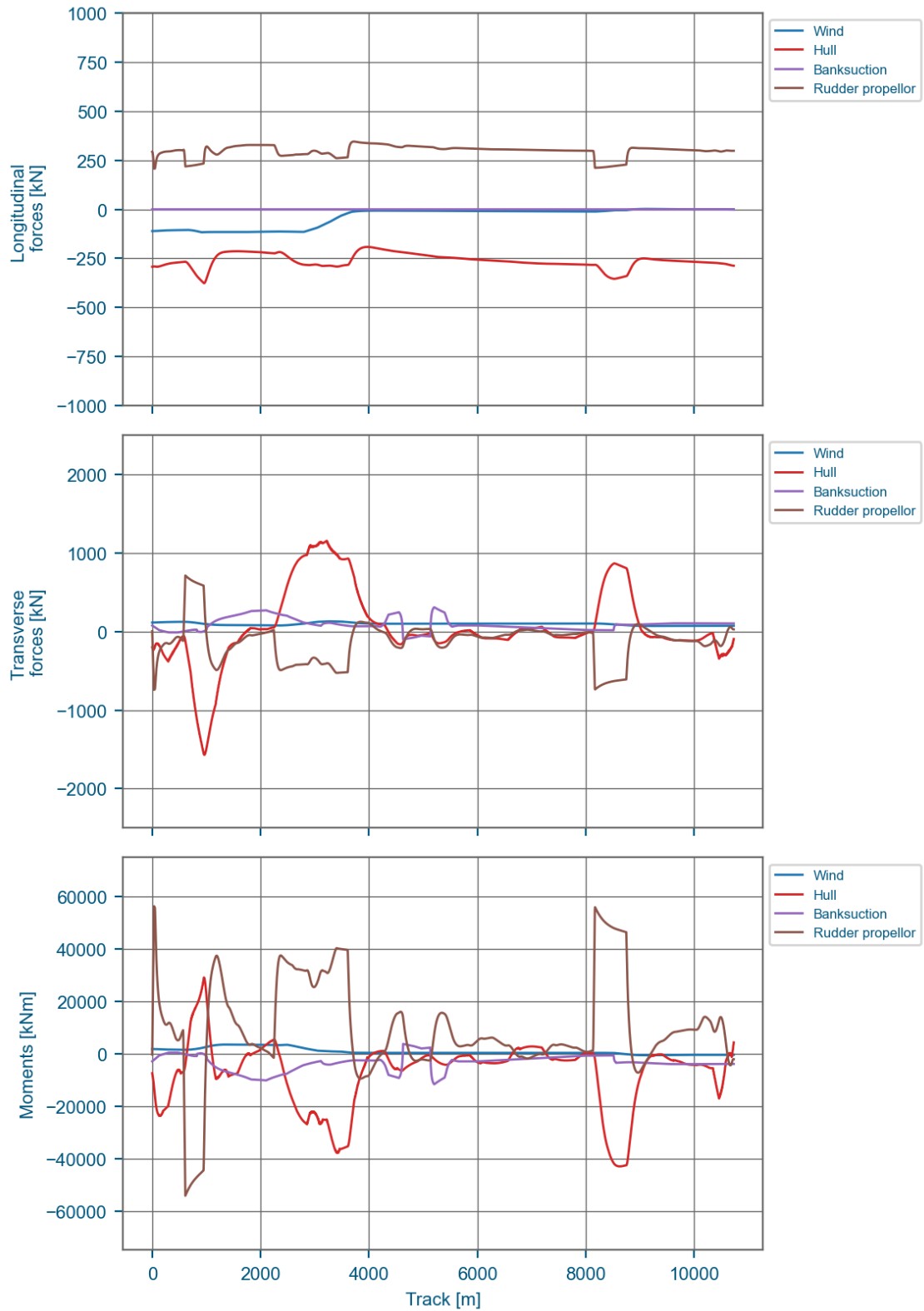


Figure 2.293: S.C. 37: forces, moments, vs. distance.

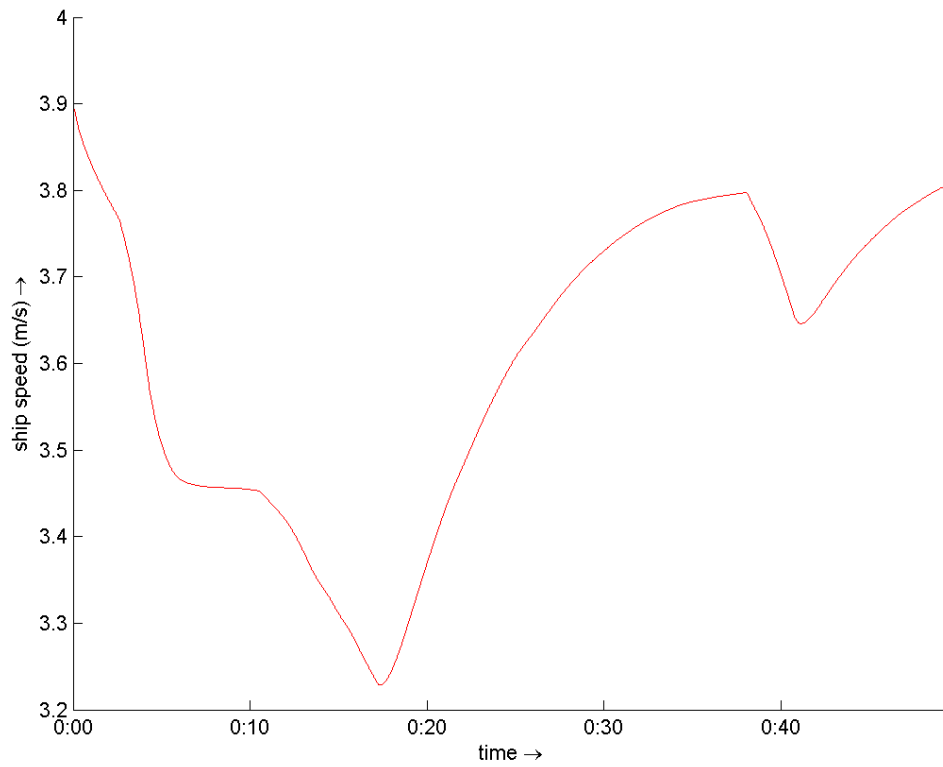


Figure 2.294: S.C. 37: SOG, vs. time.

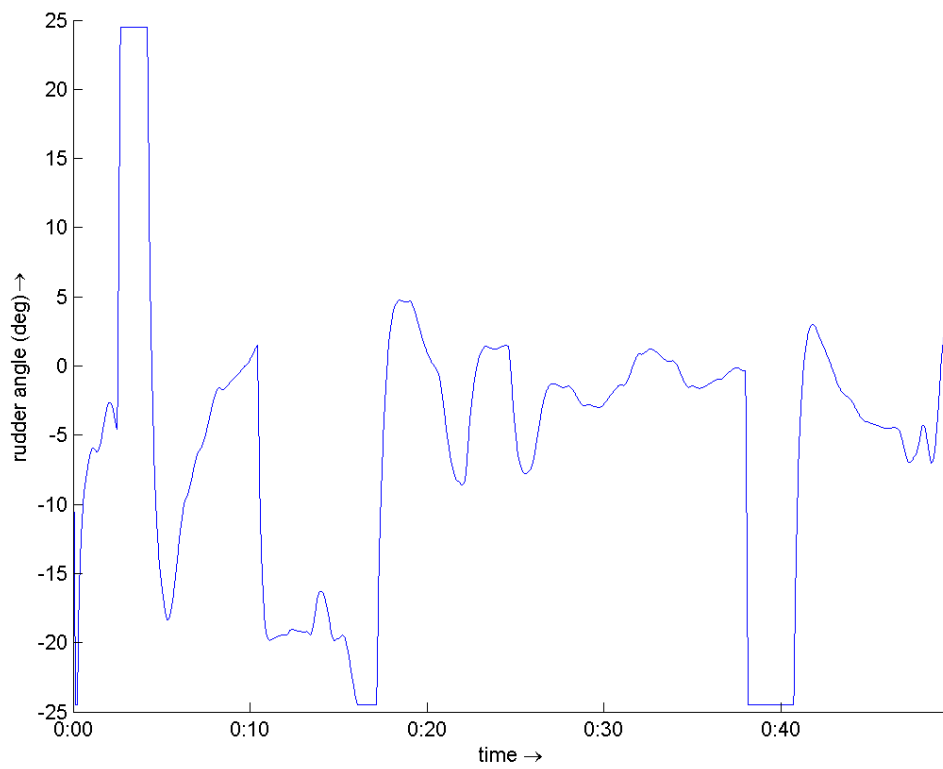


Figure 2.295: S.C. 37: rudder angle, vs. time.

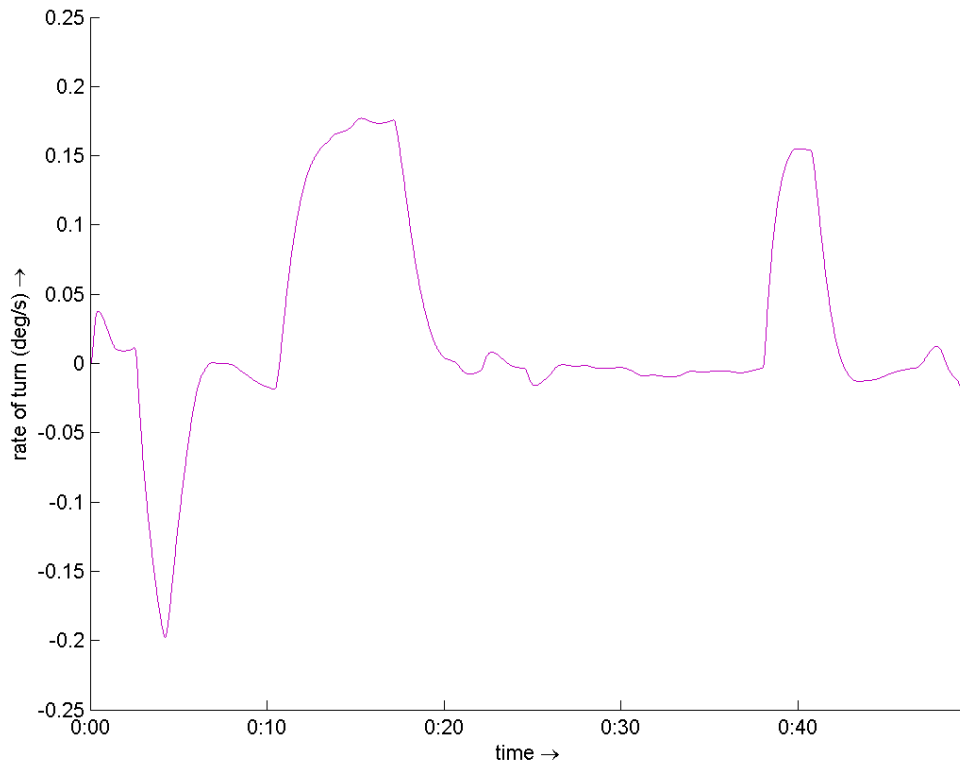


Figure 2.296: S.C. 37: RoT, vs. time.

### Simulation Case 38

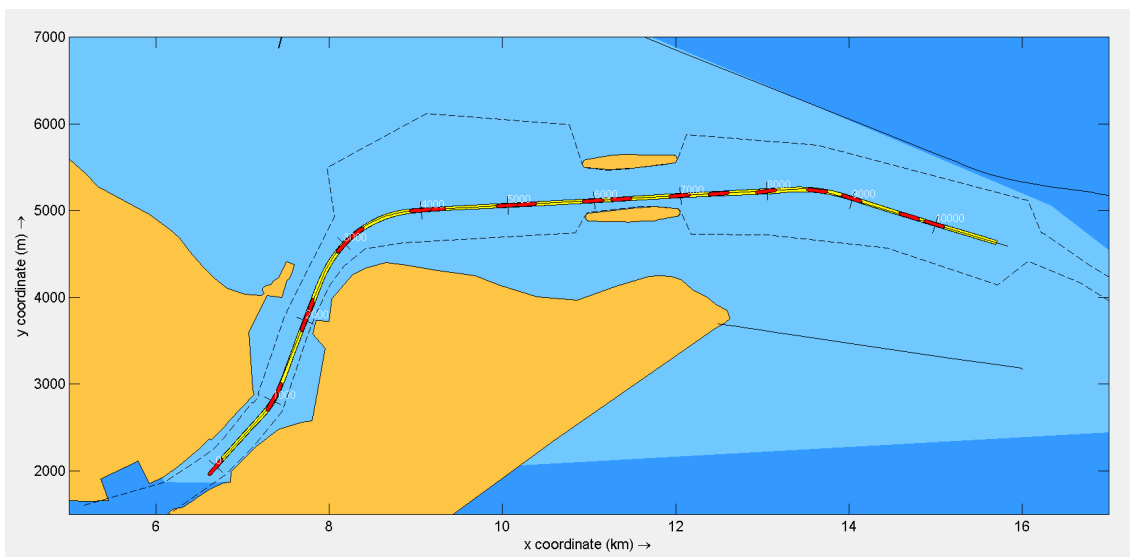
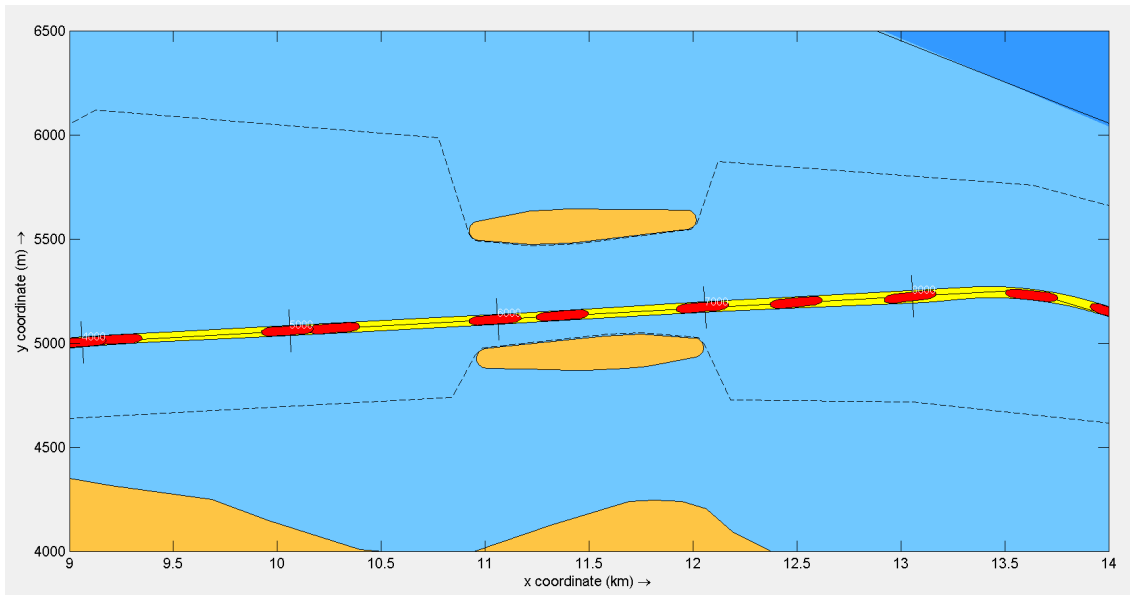


Figure 2.297: S.C. 38: spatial overview plot.



**Figure 2.298:** S.C. 38: zoom-in of spatial overview plot, crossing segment.

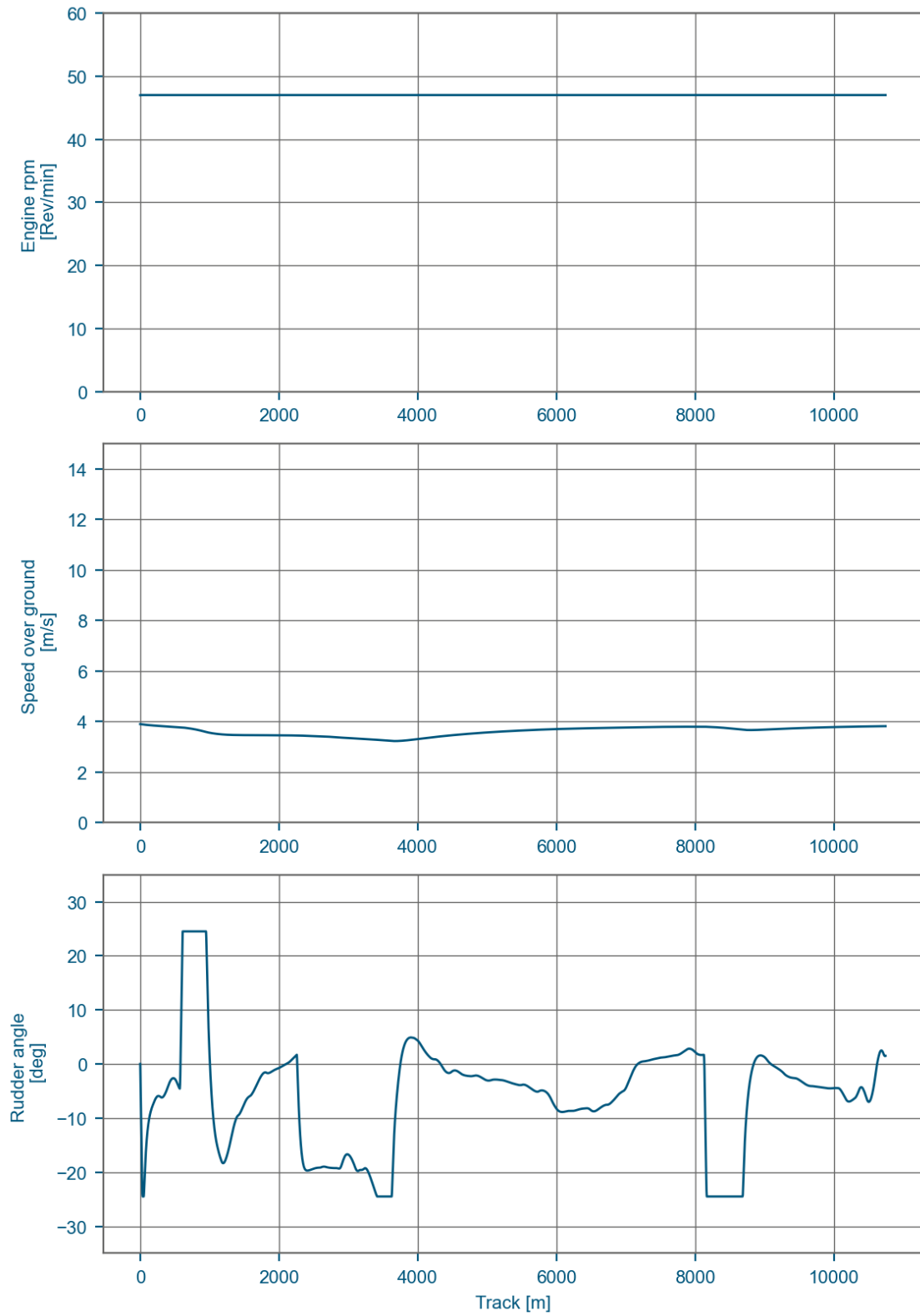


Figure 2.299: S.C. 38: engine RPM, SOG, rudder angle, vs. distance.

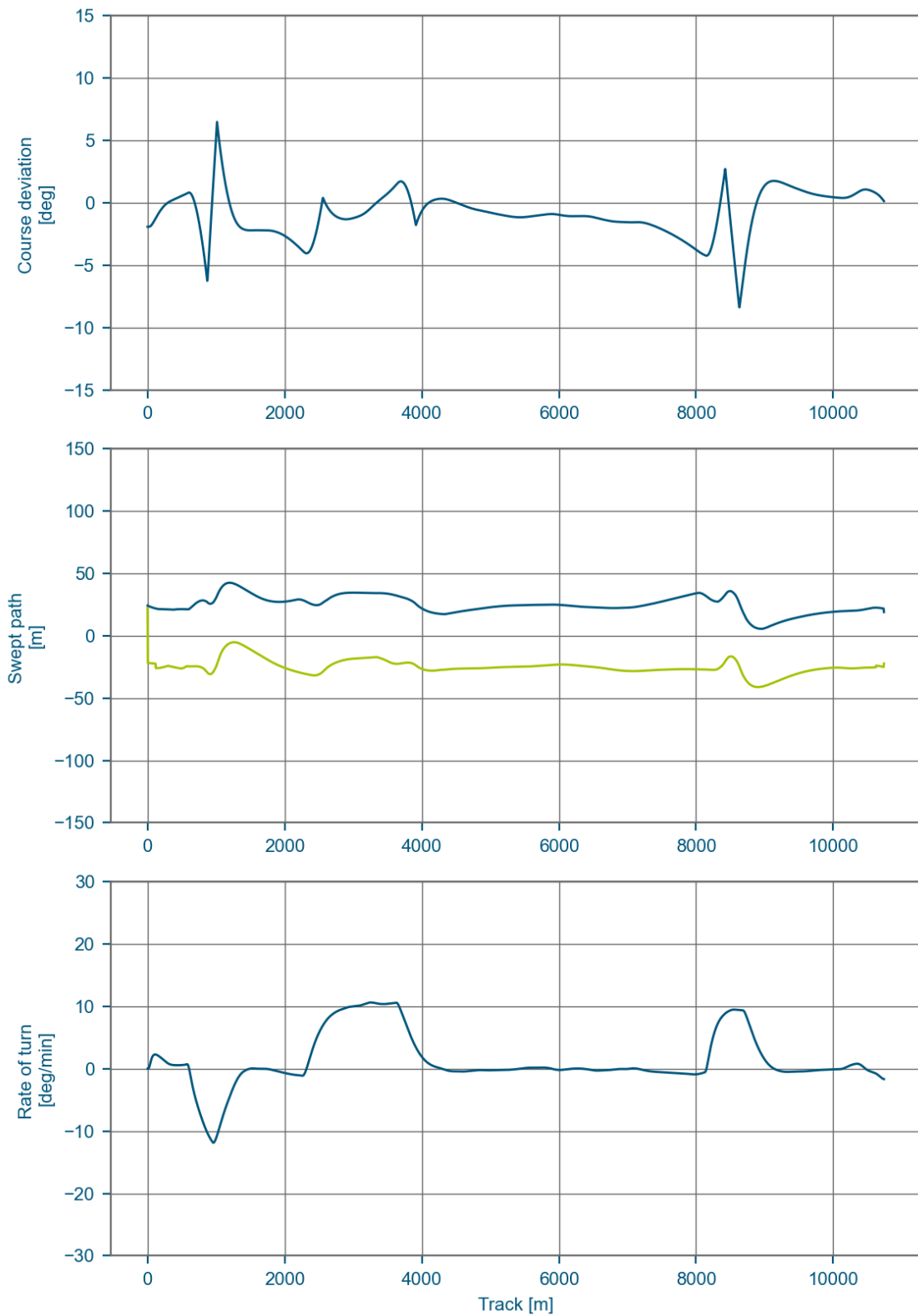


Figure 2.300: S.C. 38: course deviation (drift angle), swept path, RoT, vs. distance.

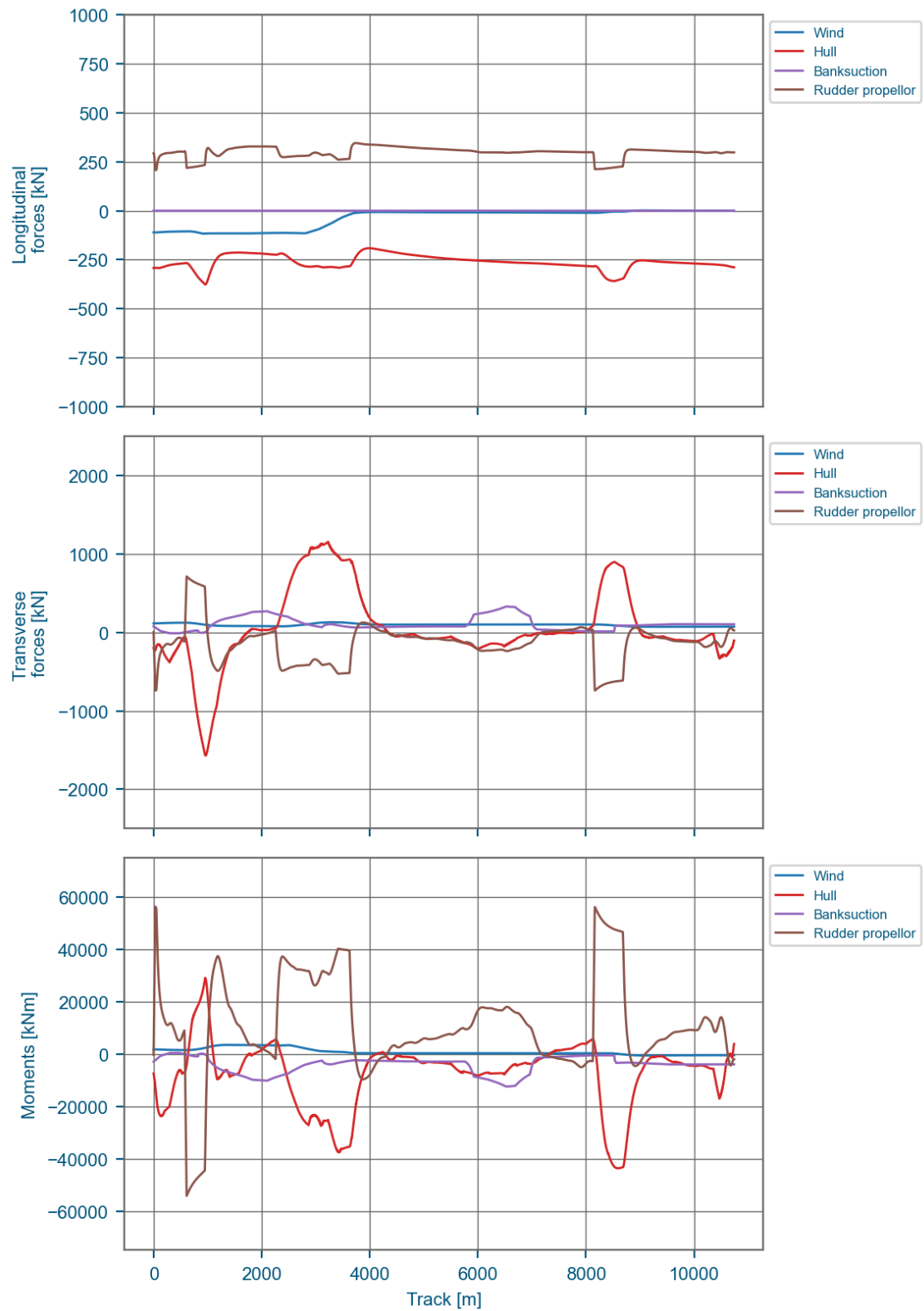


Figure 2.301: S.C. 38: forces, moments, vs. distance.

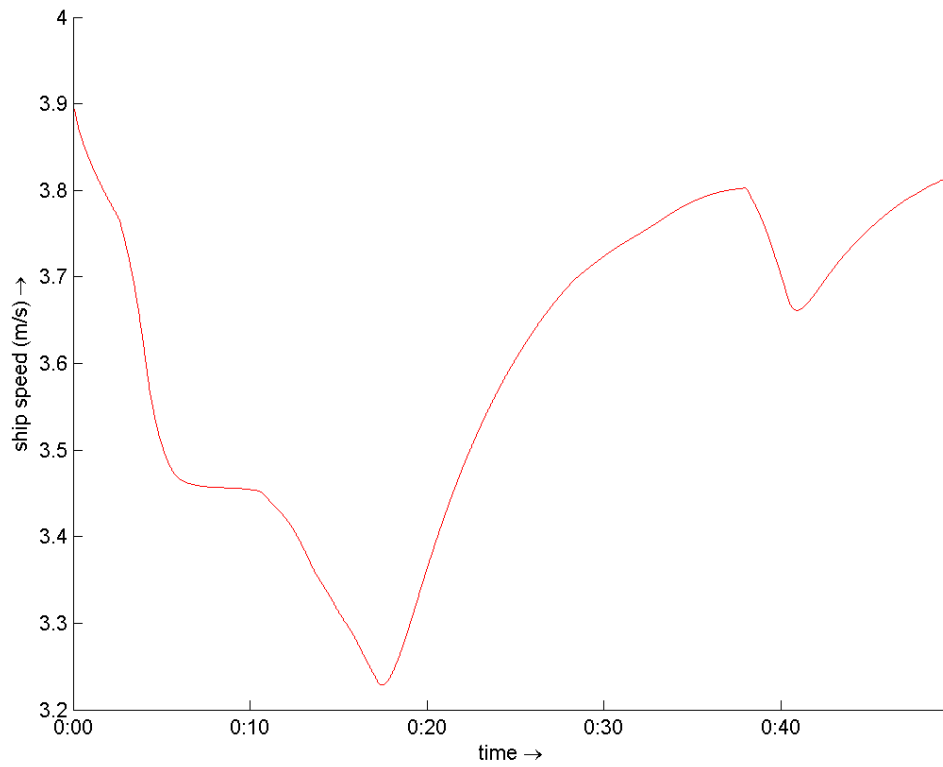


Figure 2.302: S.C. 38: SOG, vs. time.

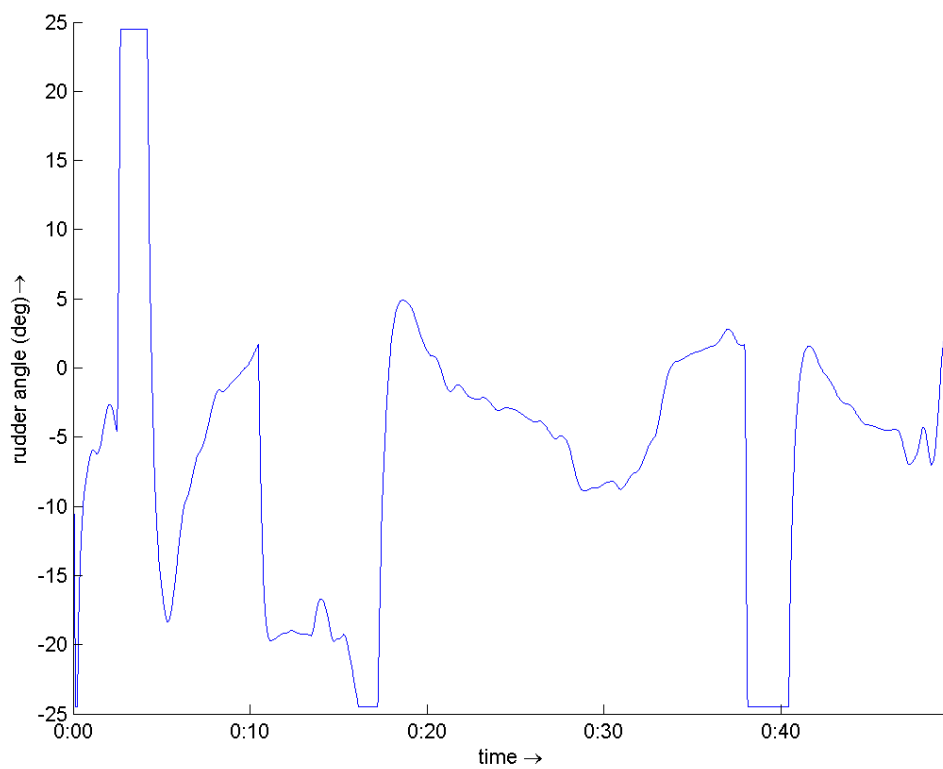


Figure 2.303: S.C. 38: rudder angle, vs. time.

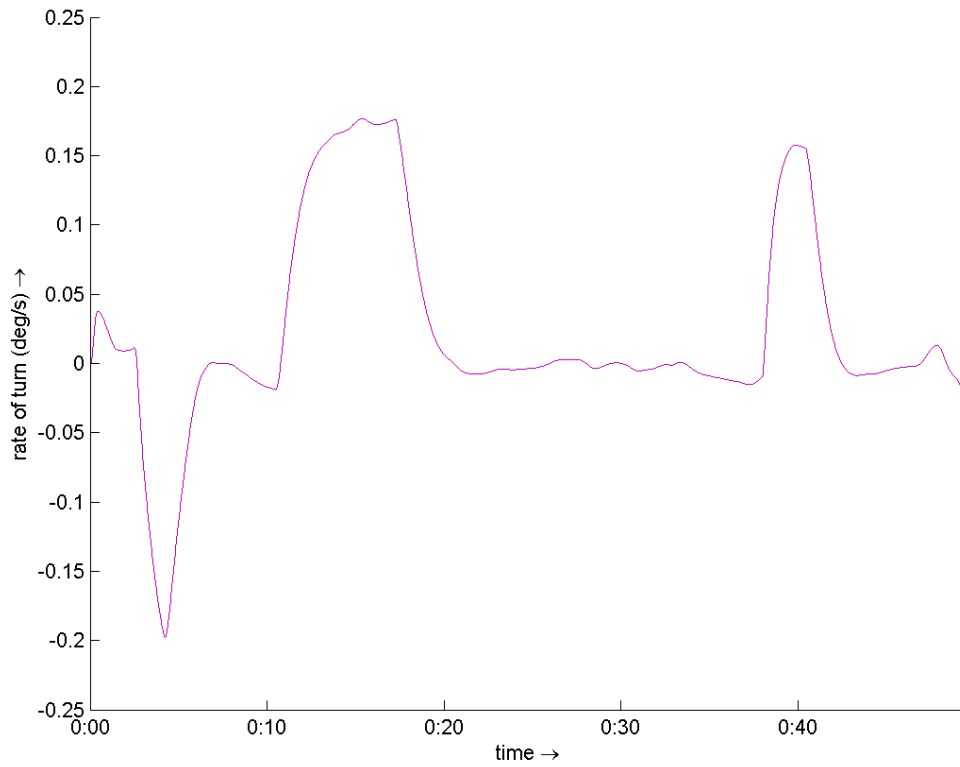


Figure 2.304: S.C. 38: RoT, vs. time.

### Simulation Case 39

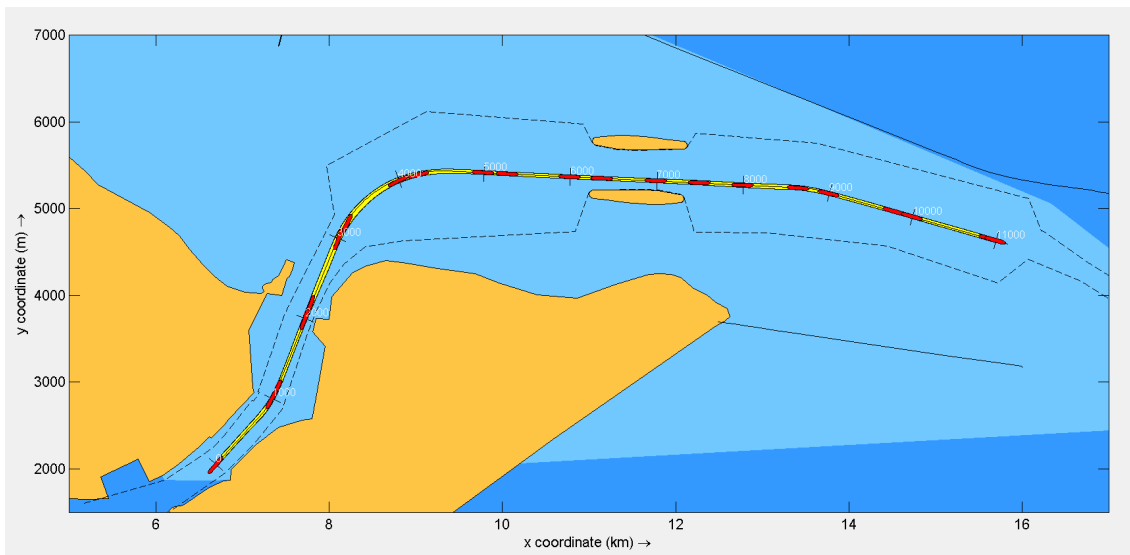
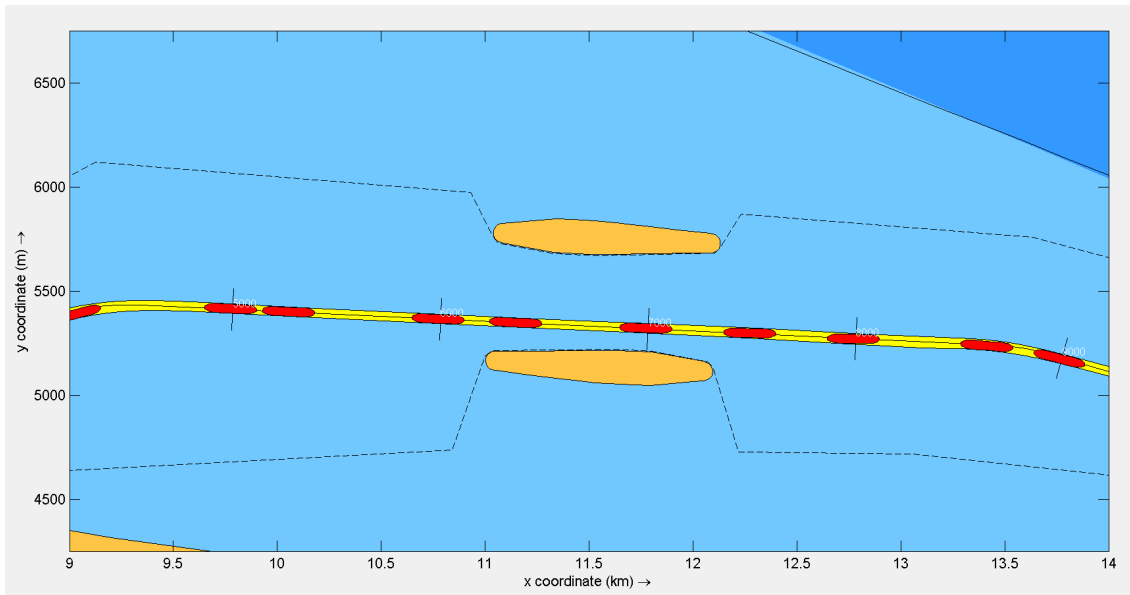


Figure 2.305: S.C. 39: spatial overview plot.



**Figure 2.306:** S.C. 39: zoom-in of spatial overview plot, crossing segment.

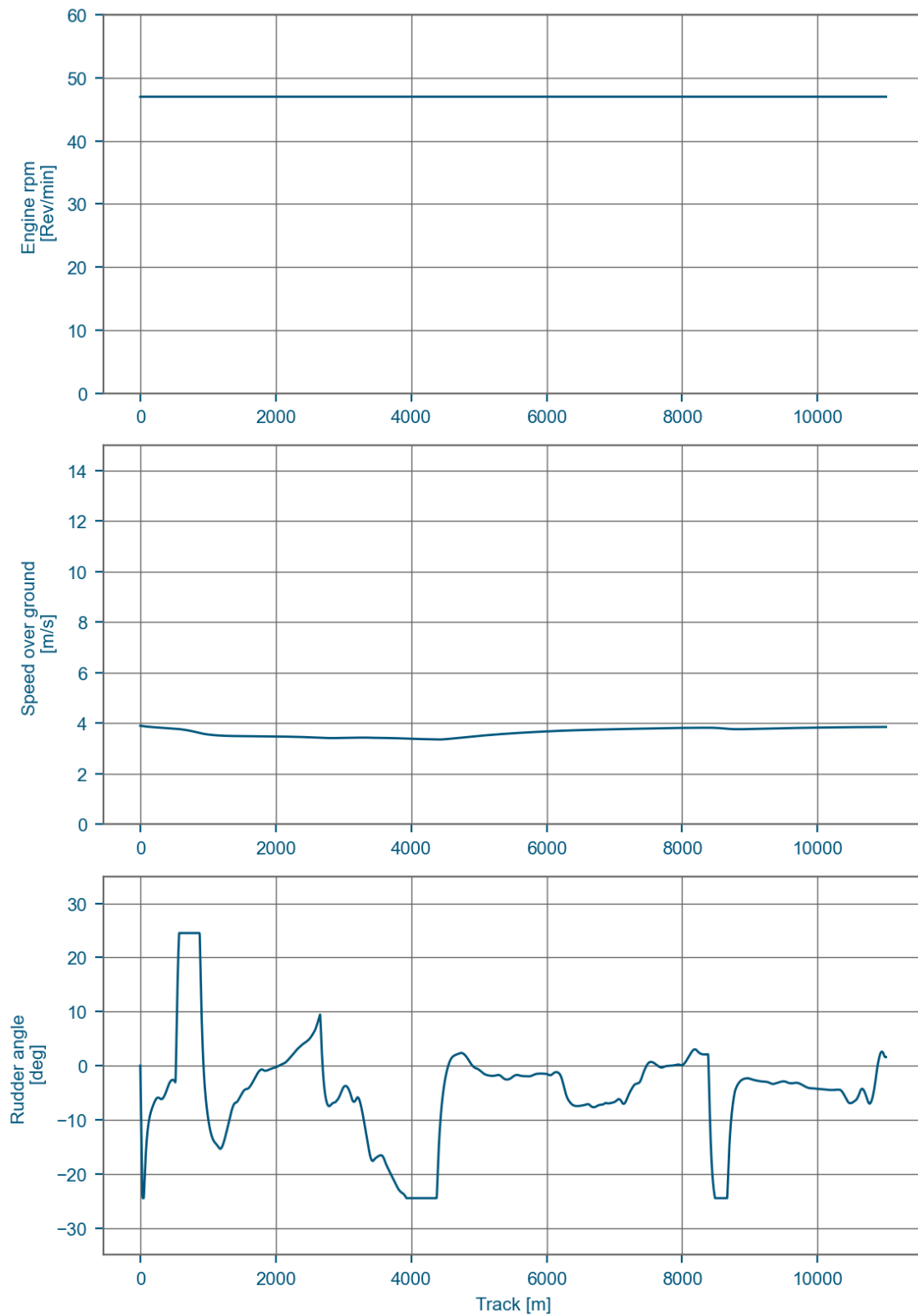


Figure 2.307: S.C. 39: engine RPM, SOG, rudder angle, vs. distance.

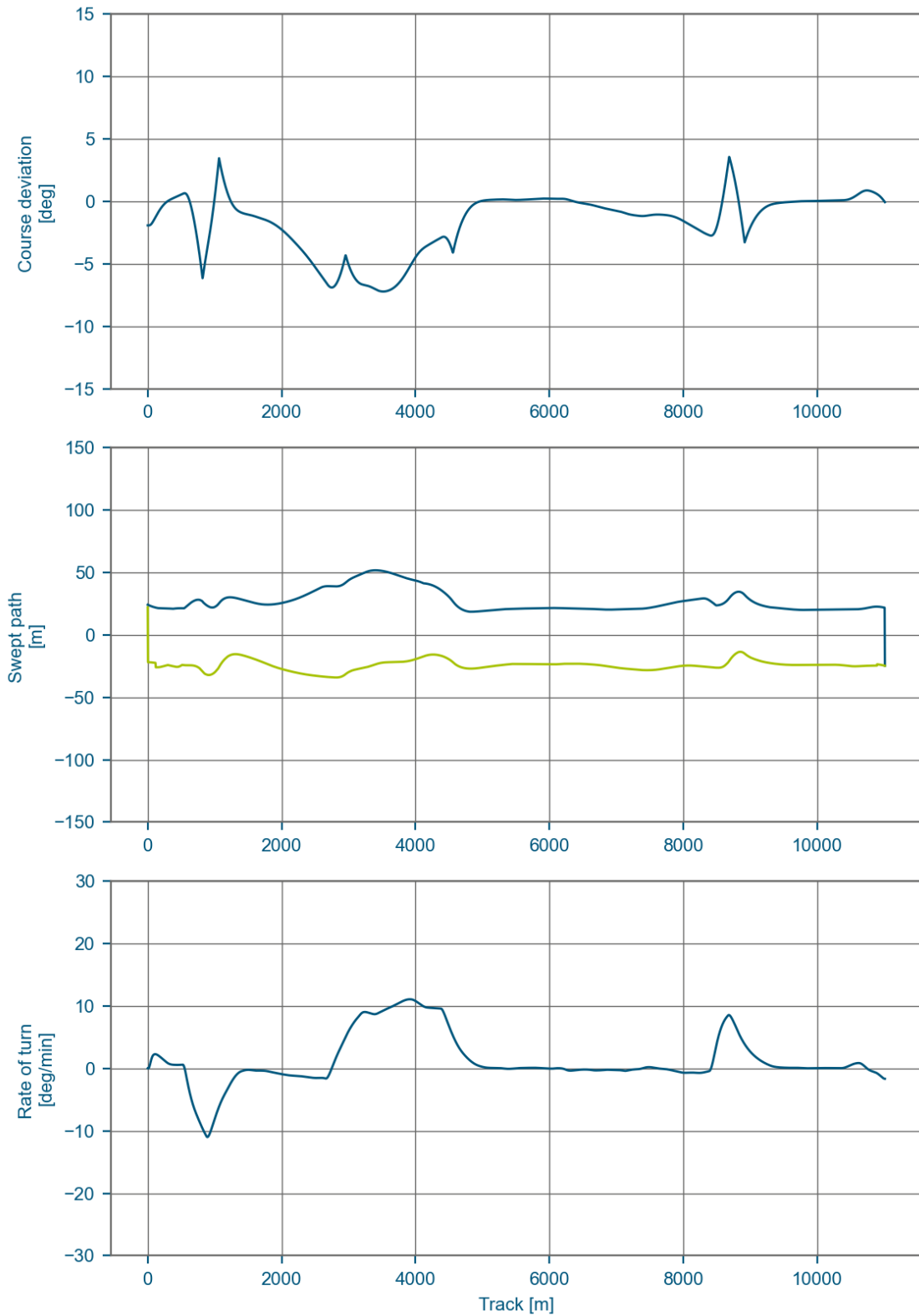


Figure 2.308: S.C. 39: course deviation (drift angle), swept path, RoT, vs. distance.

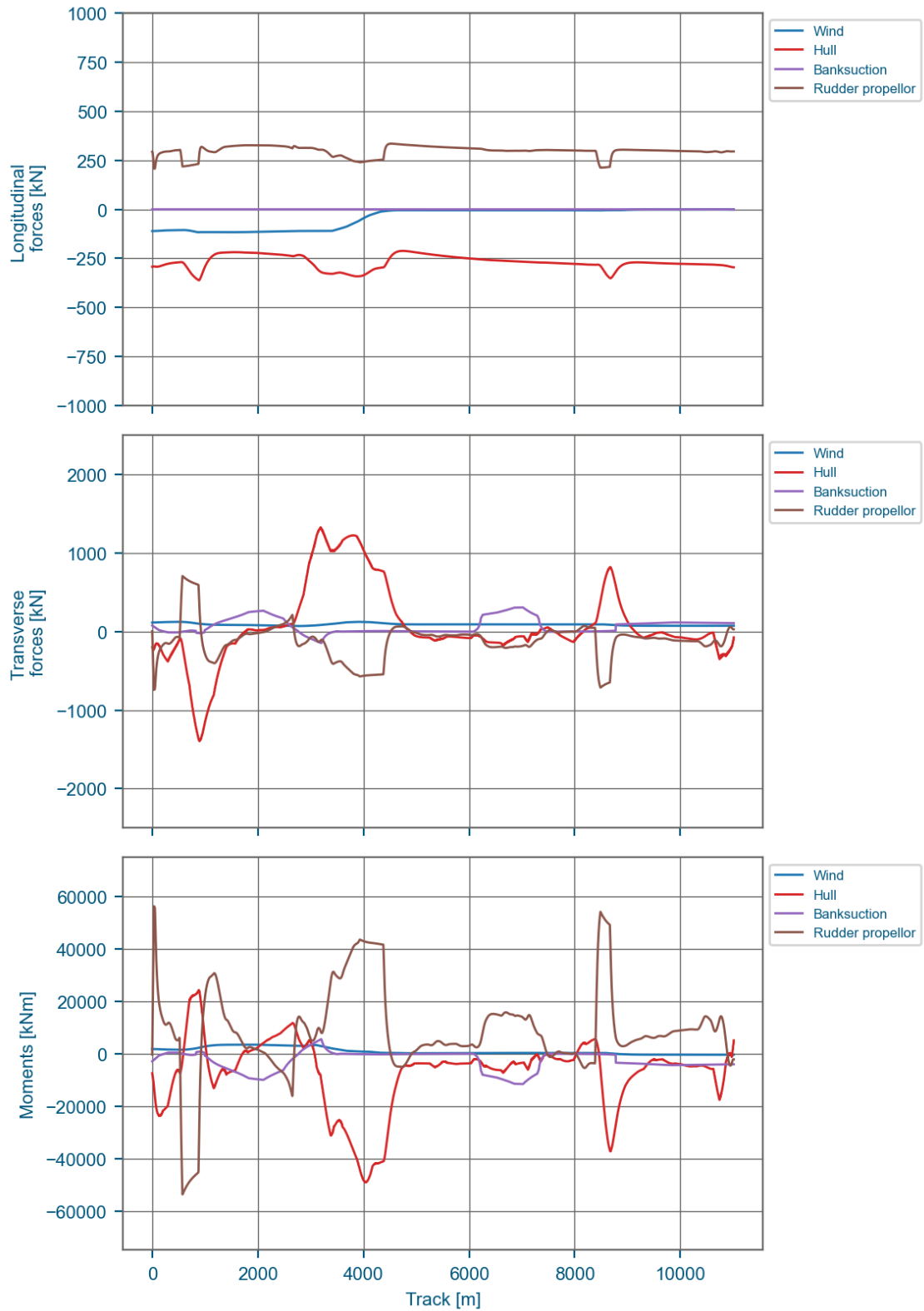


Figure 2.309: S.C. 39: forces, moments, vs. distance.

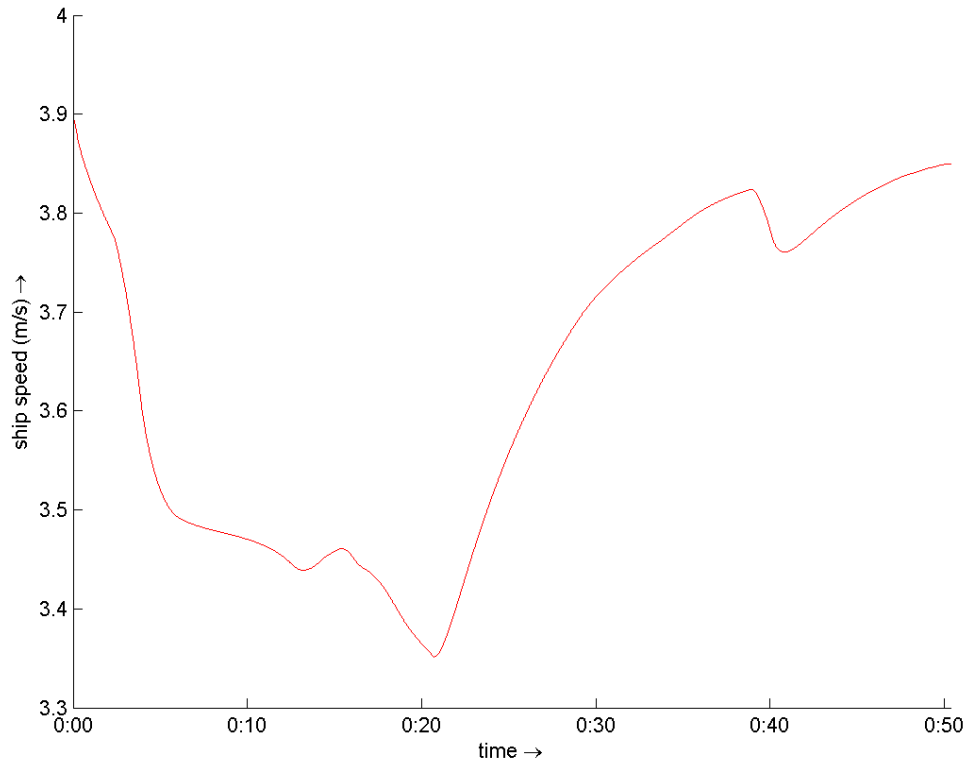


Figure 2.310: S.C. 39: SOG, vs. time.

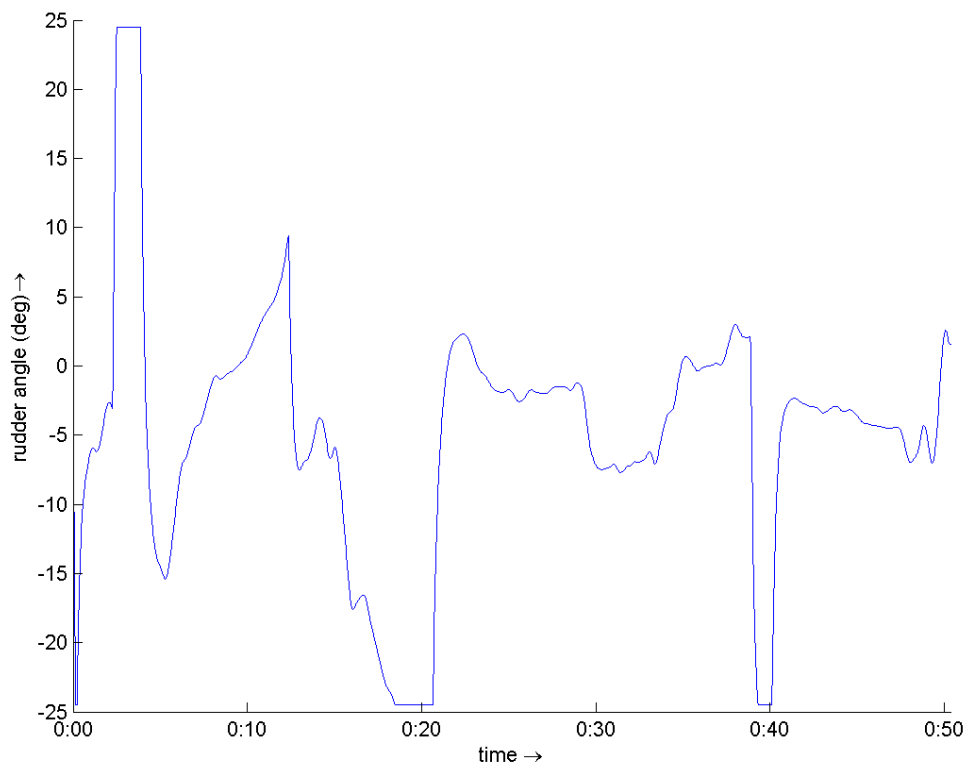


Figure 2.311: S.C. 39: rudder angle, vs. time.

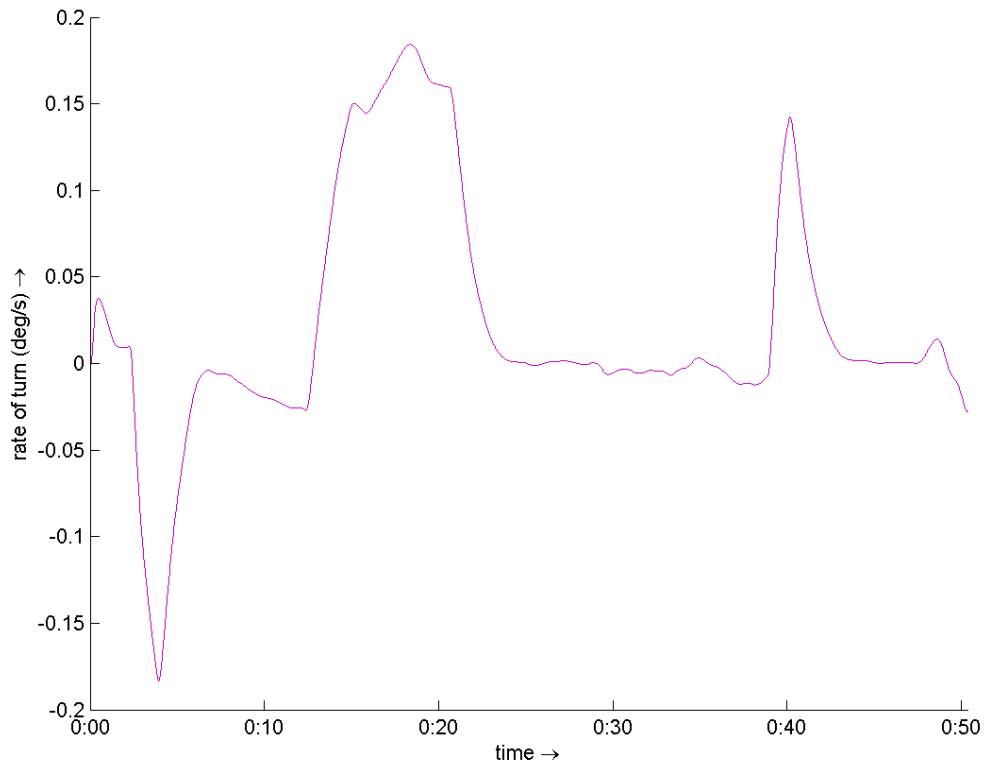


Figure 2.312: S.C. 39: RoT, vs. time.

## Simulation Case 40

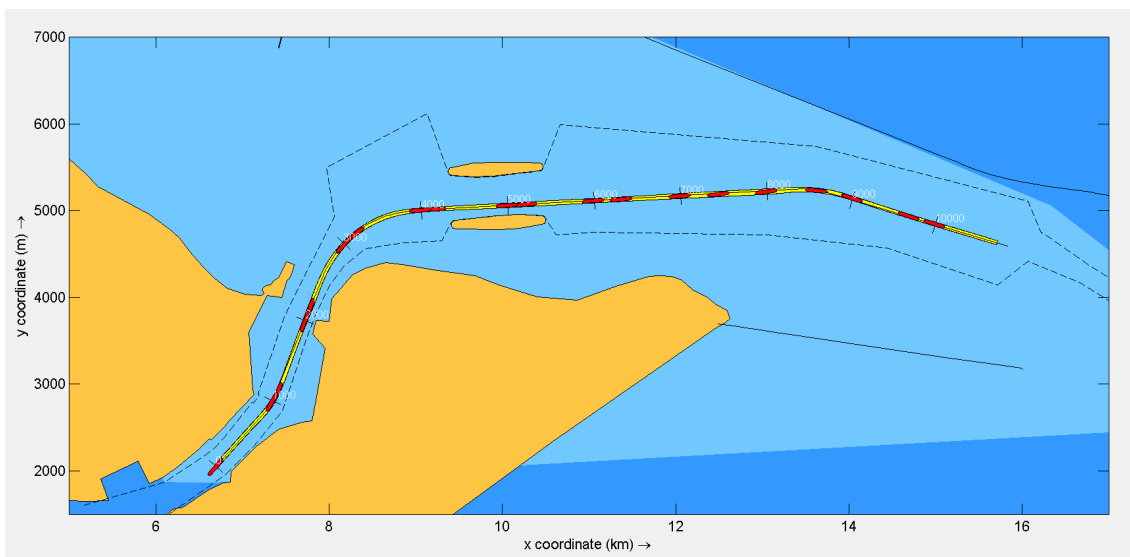
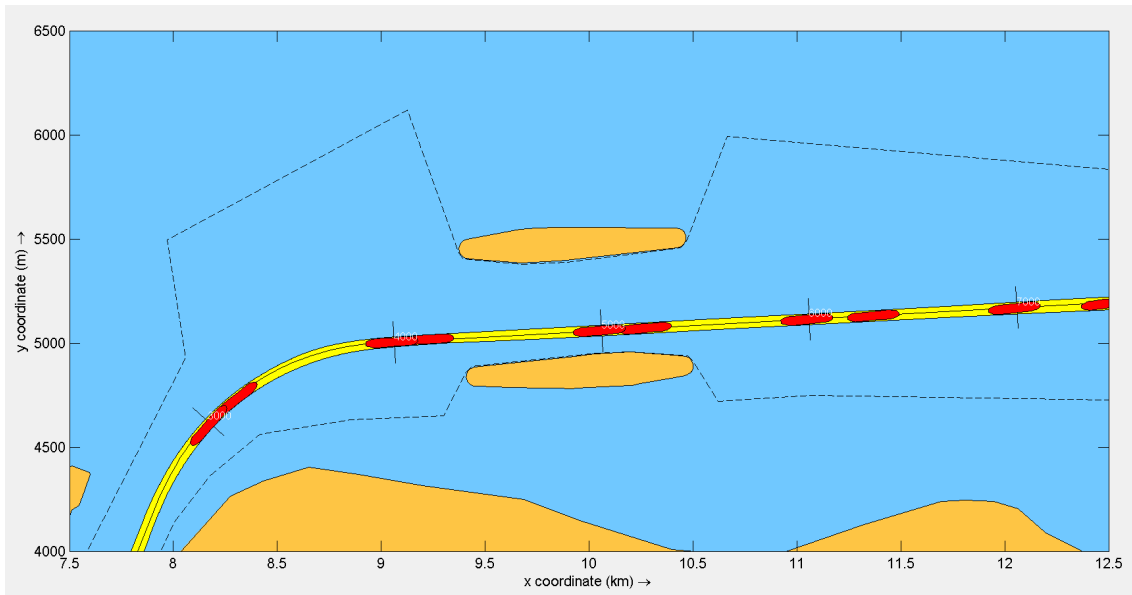


Figure 2.313: S.C. 40: spatial overview plot.



**Figure 2.314:** S.C. 40: zoom-in of spatial overview plot, crossing segment.

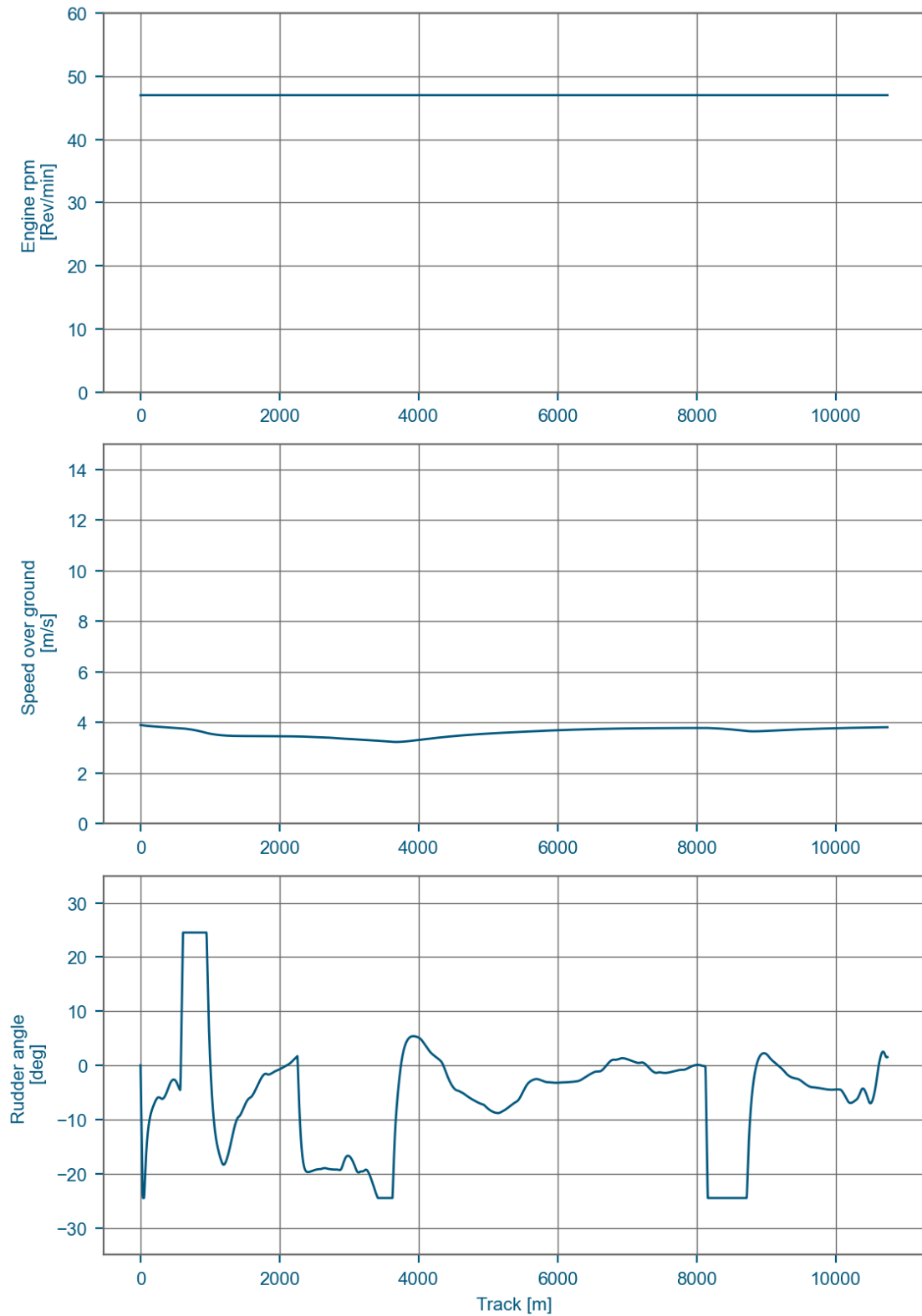


Figure 2.315: S.C. 40: engine RPM, SOG, rudder angle, vs. distance.

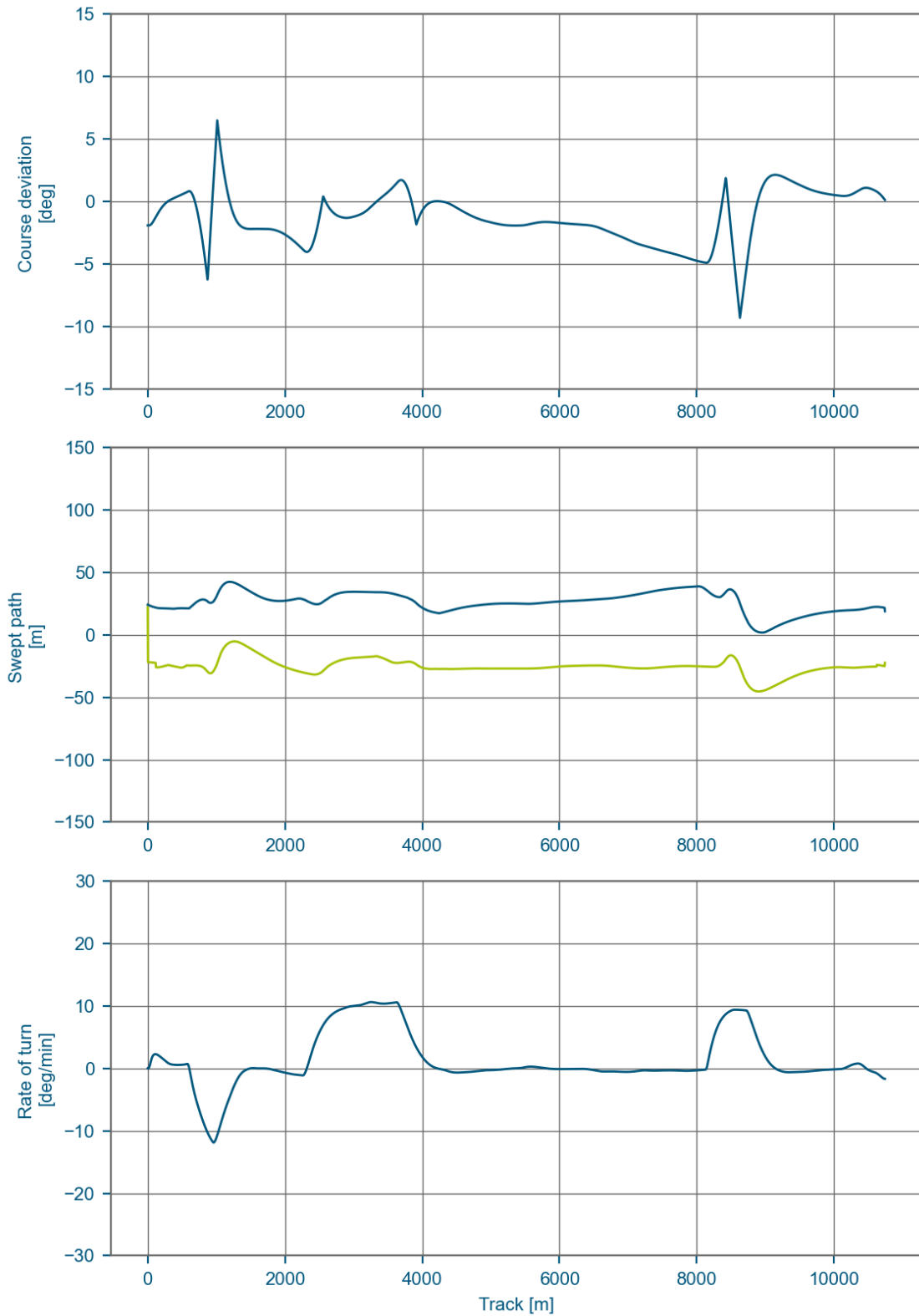


Figure 2.316: S.C. 40: course deviation (drift angle), swept path, RoT, vs. distance.

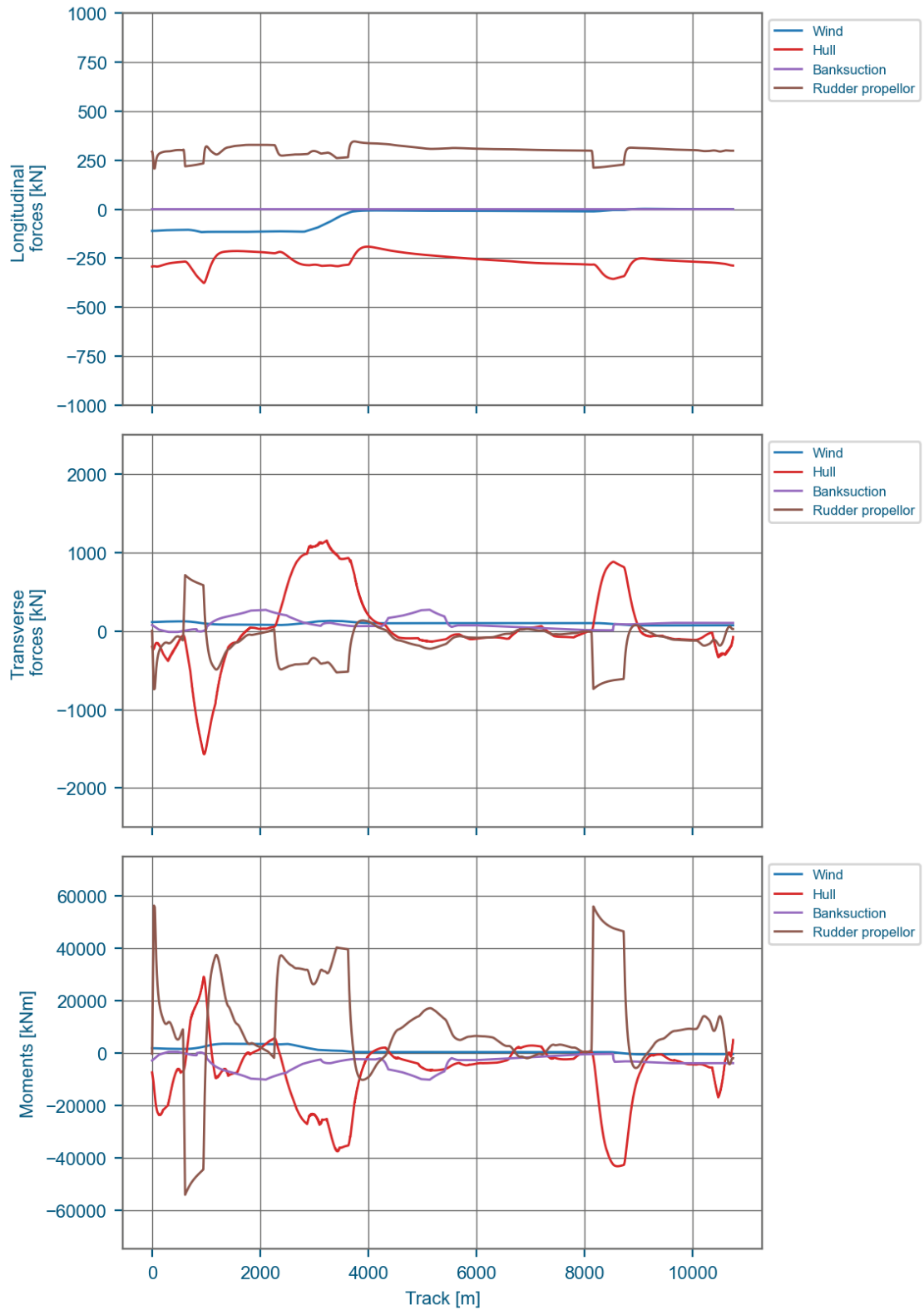


Figure 2.317: S.C. 40: forces, moments, vs. distance.

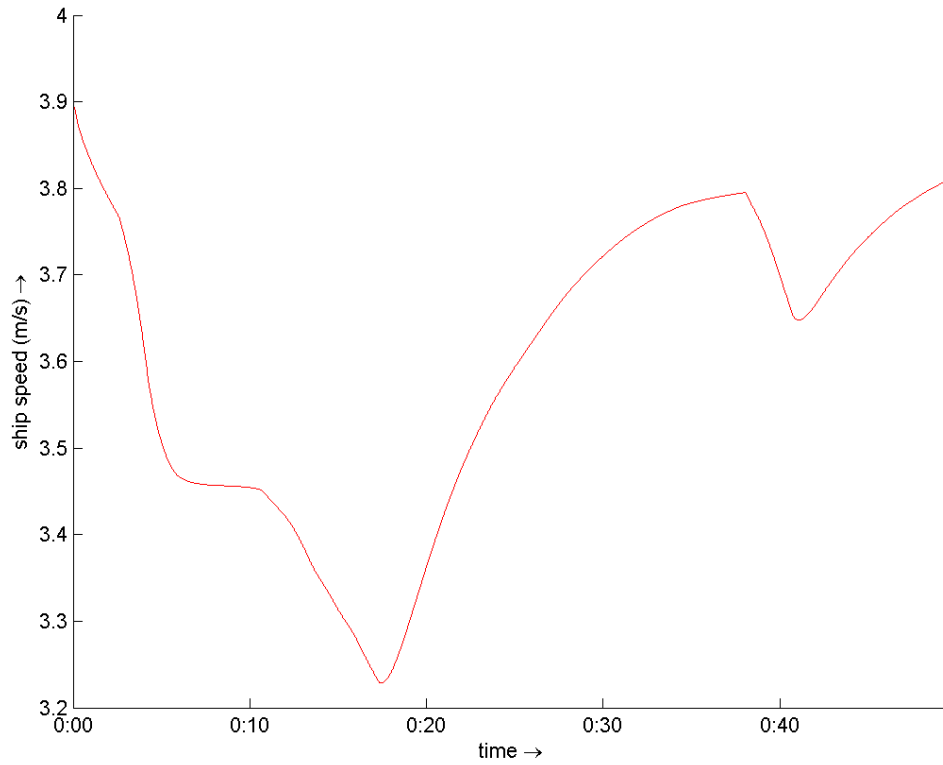


Figure 2.318: S.C. 40: SOG, vs. time.

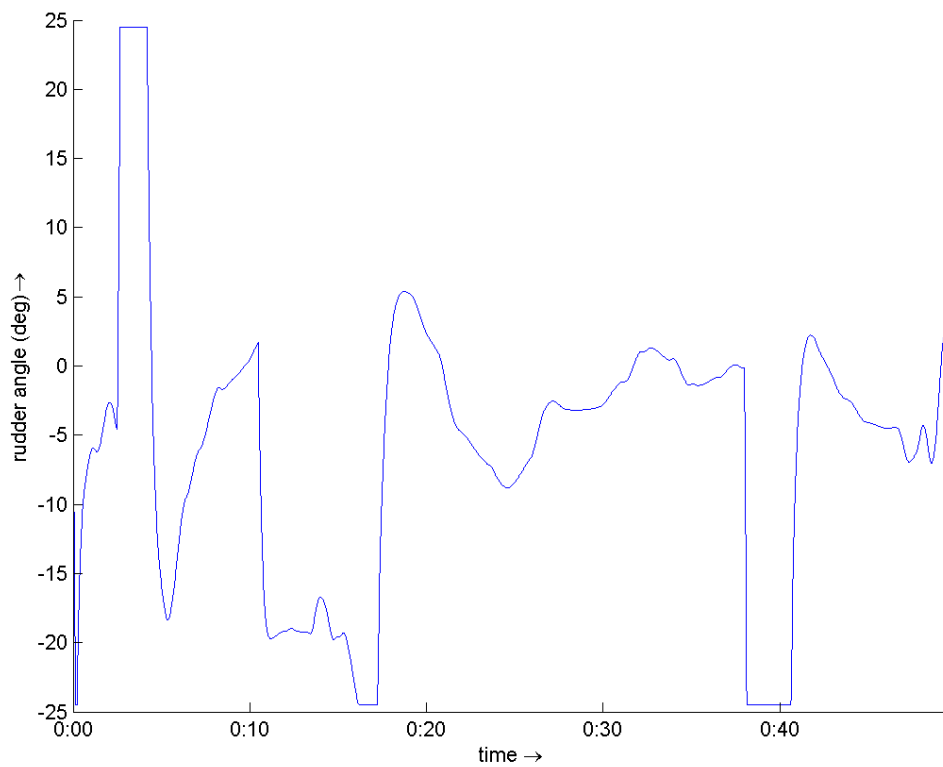


Figure 2.319: S.C. 40: rudder angle, vs. time.

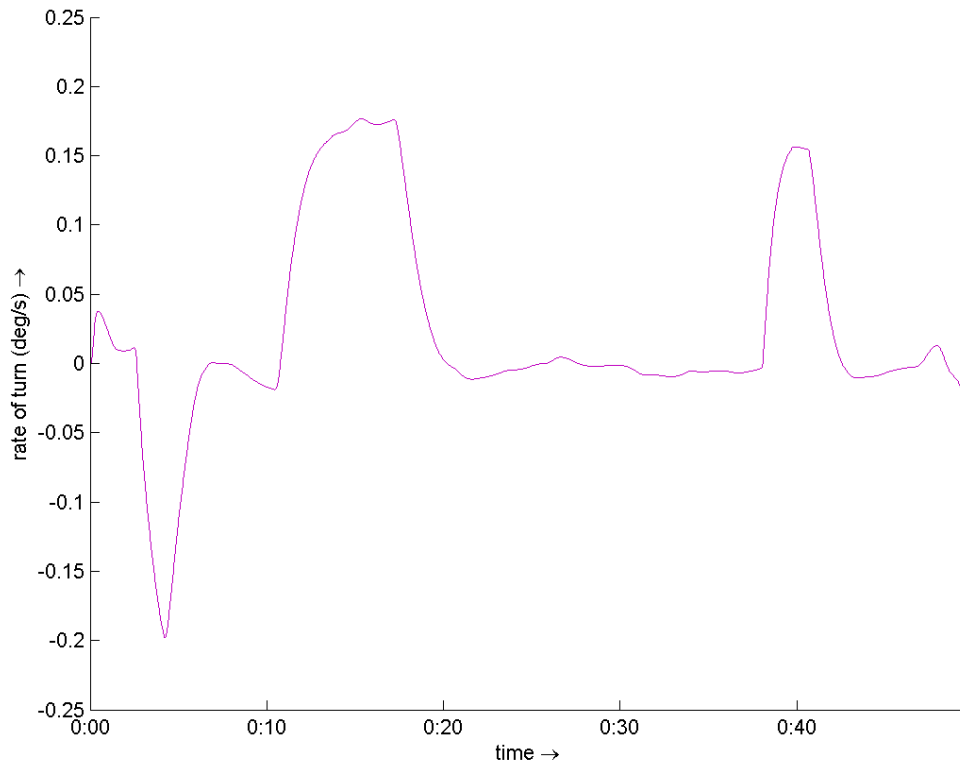


Figure 2.320: S.C. 40: RoT, vs. time.

## Simulation Case 41

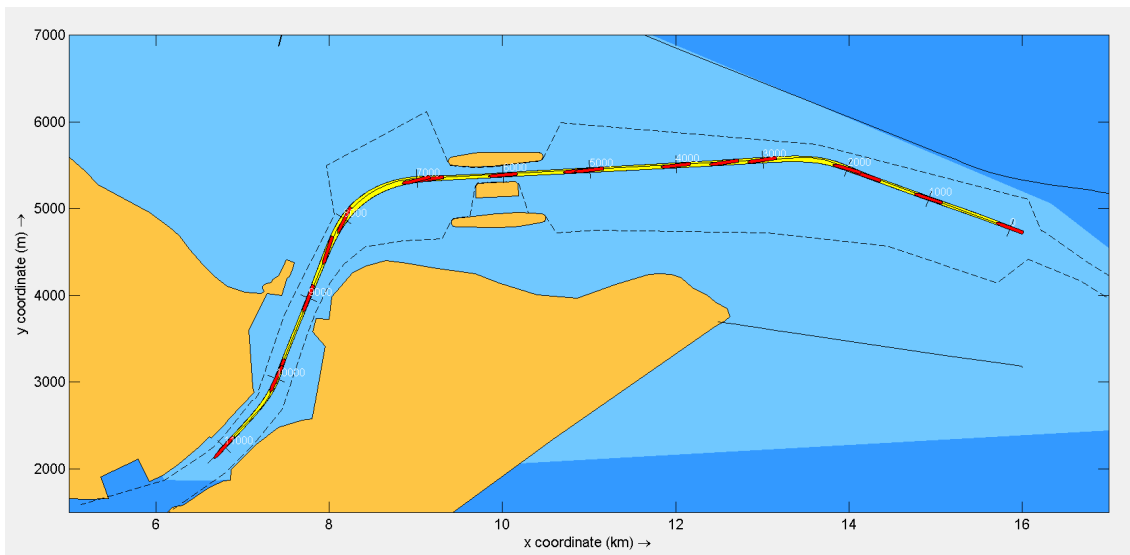
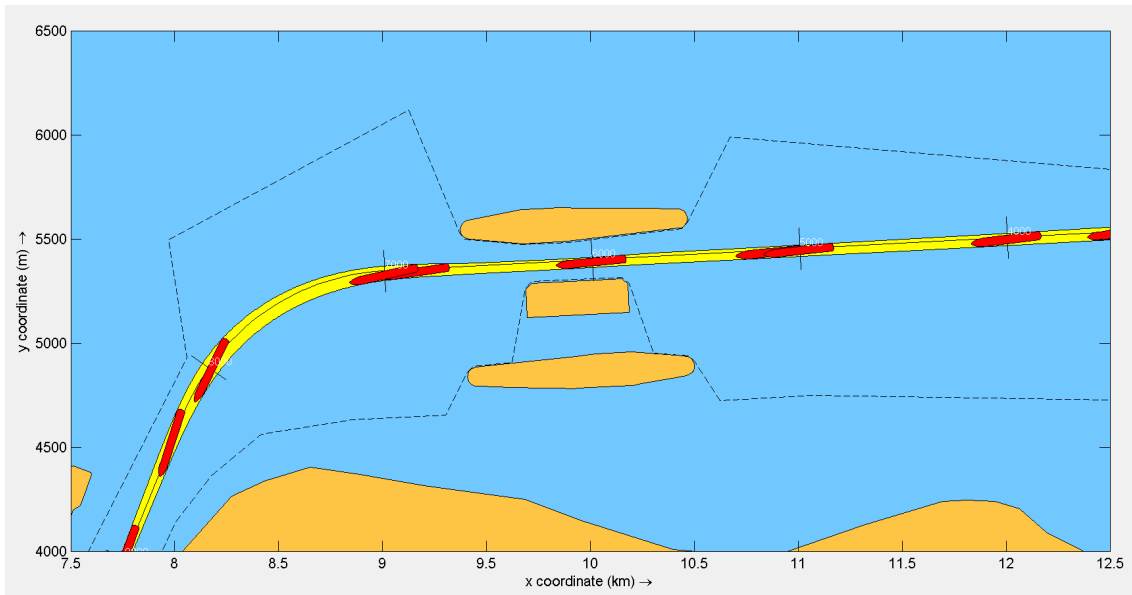


Figure 2.321: S.C. 41: spatial overview plot.



**Figure 2.322:** S.C. 41: zoom-in of spatial overview plot, crossing segment.

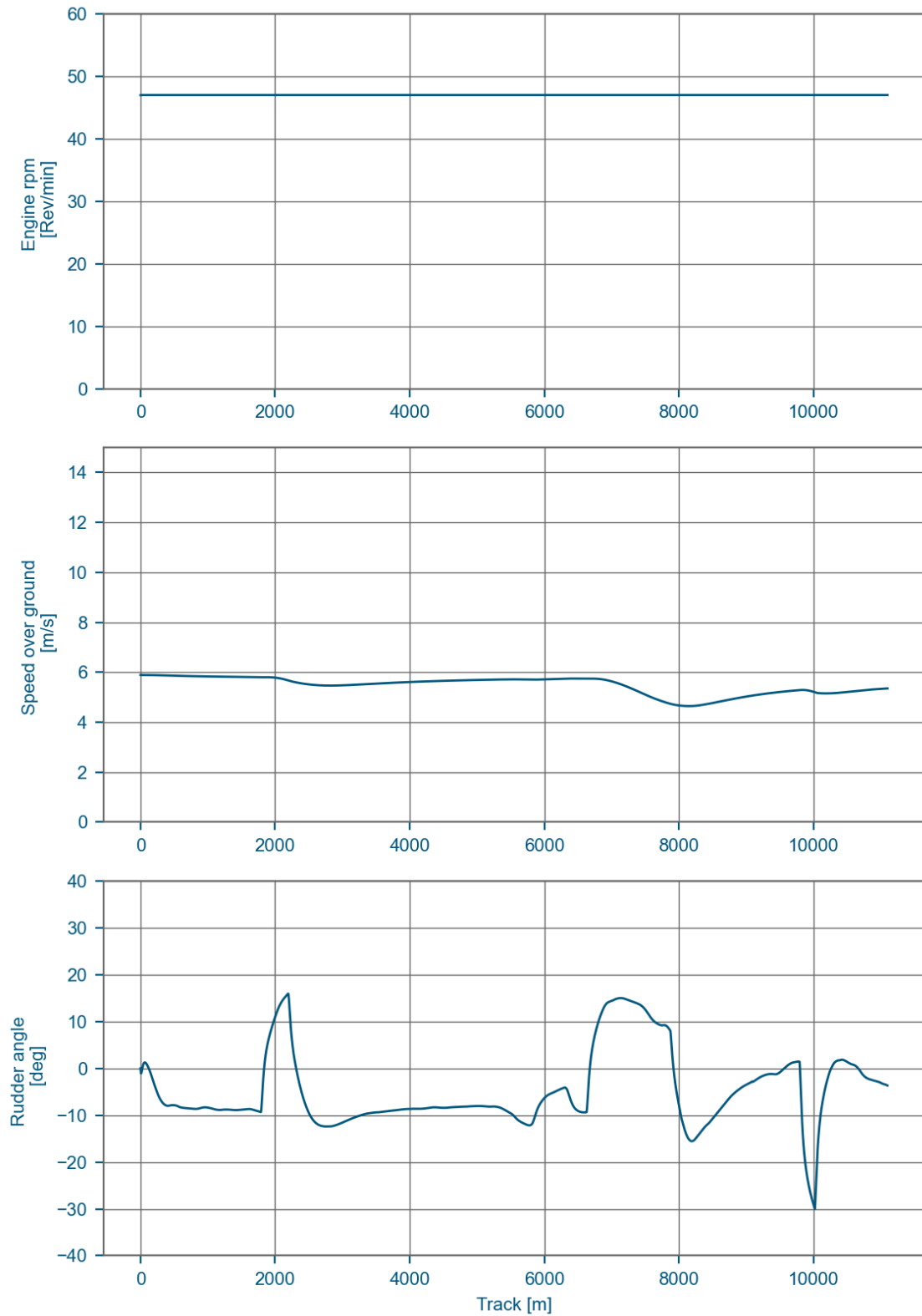


Figure 2.323: S.C. 41: engine RPM, SOG, rudder angle, vs. distance.

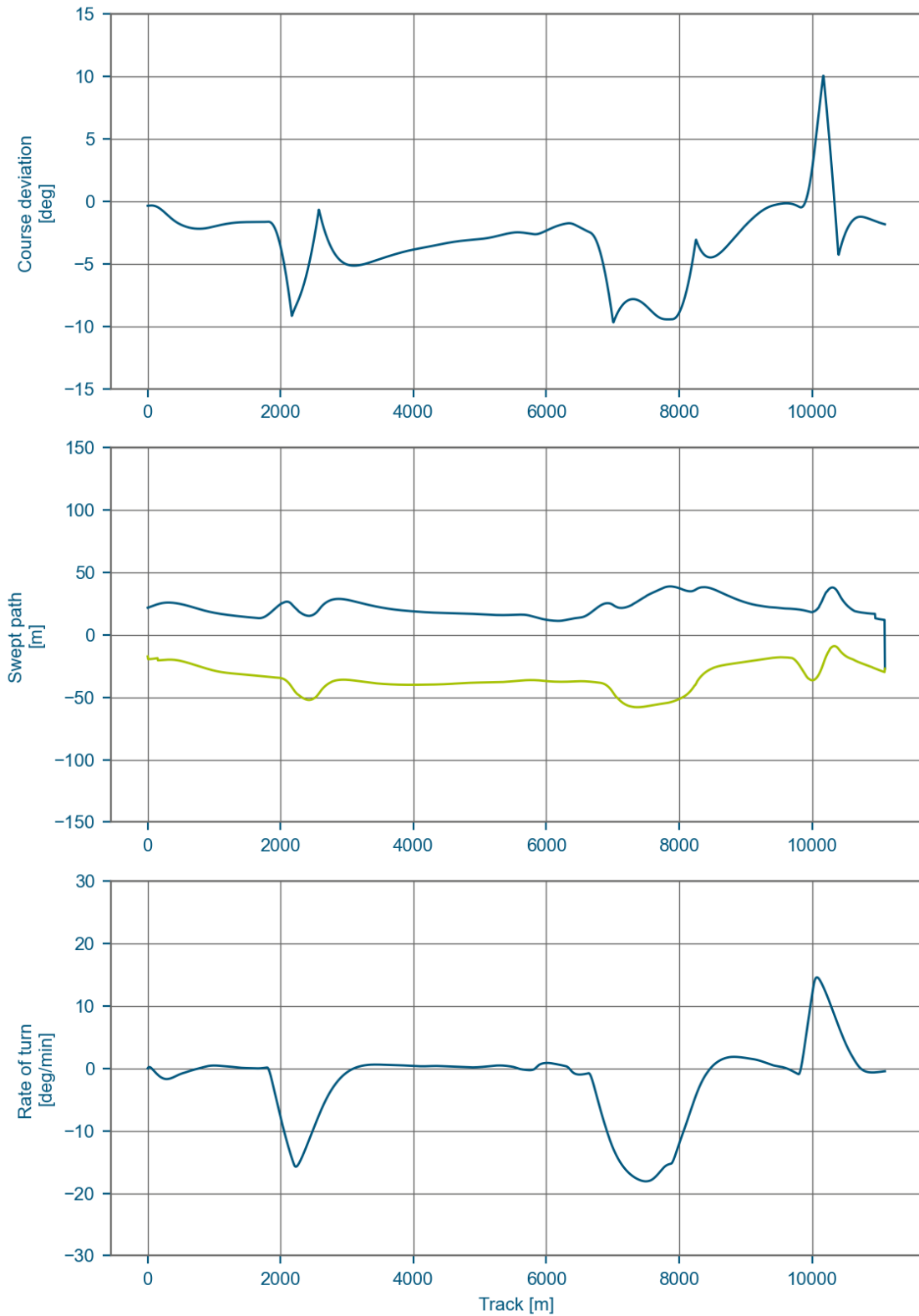


Figure 2.324: S.C. 41: course deviation (drift angle), swept path, RoT, vs. distance.

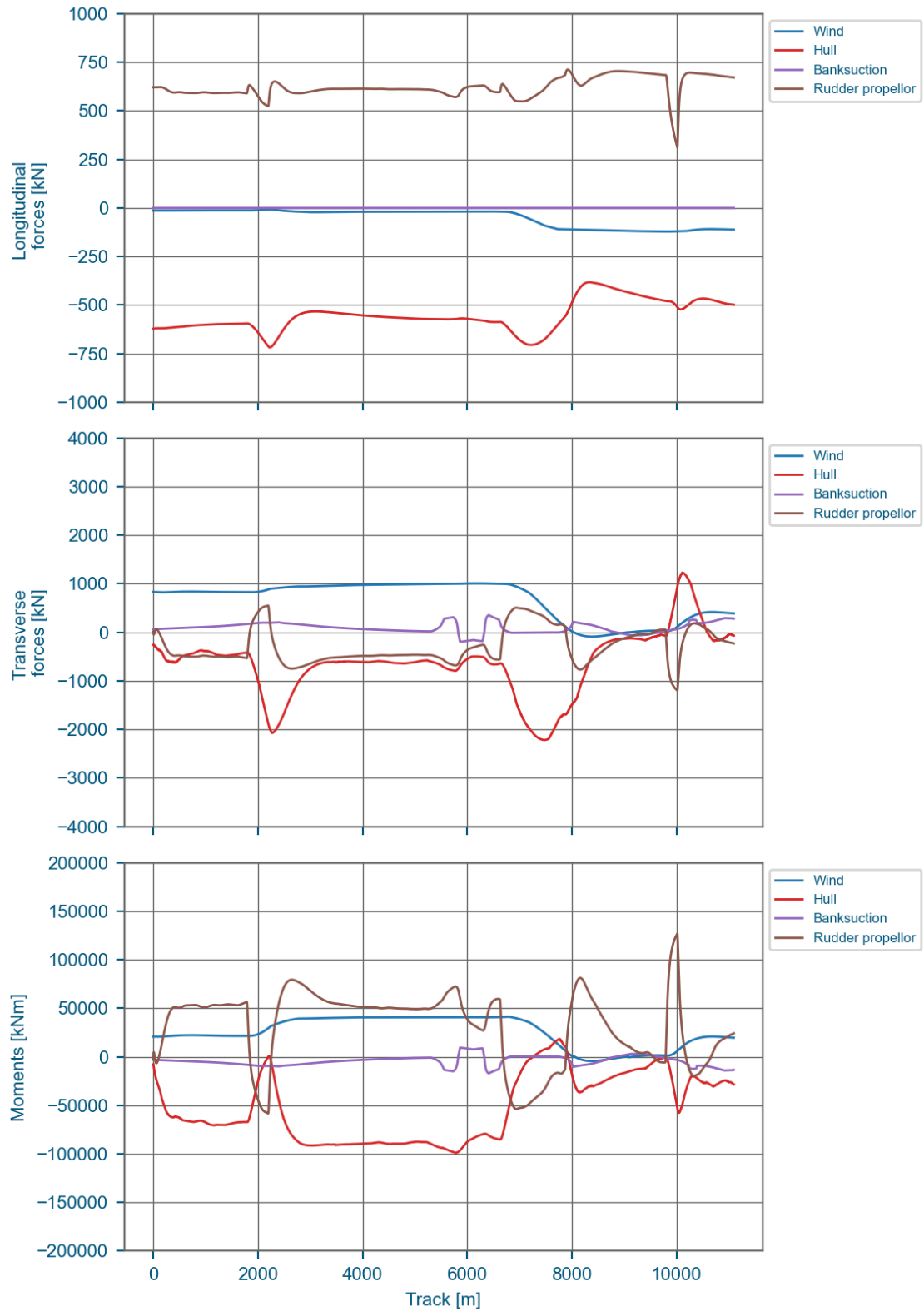


Figure 2.325: S.C. 41: forces, moments, vs. distance.

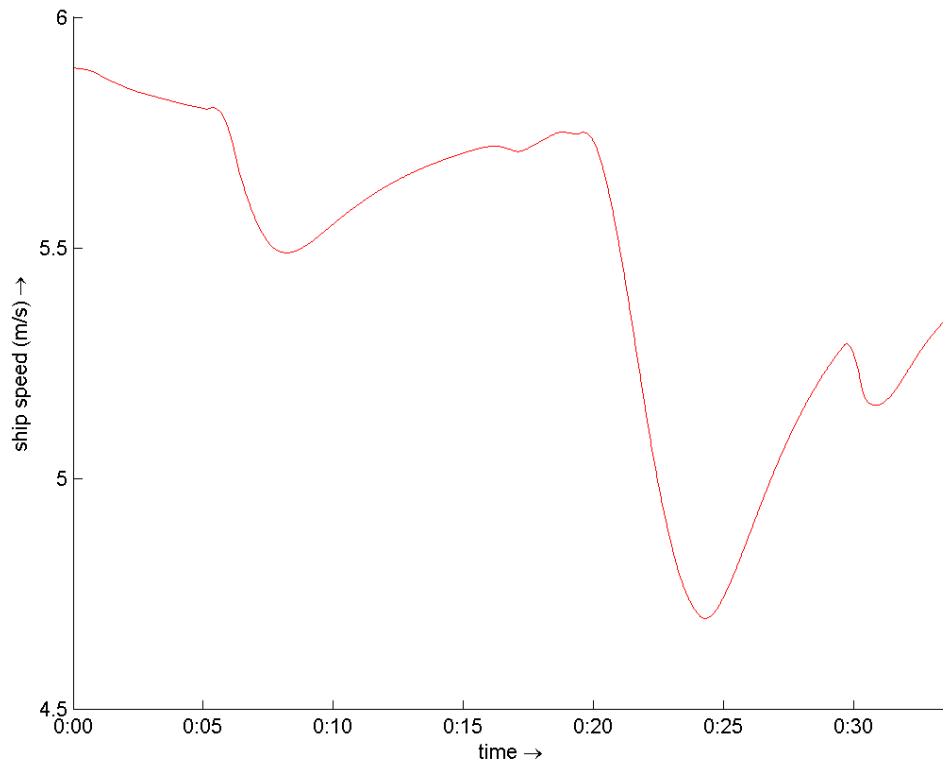


Figure 2.326: S.C. 41: SOG, vs. time.

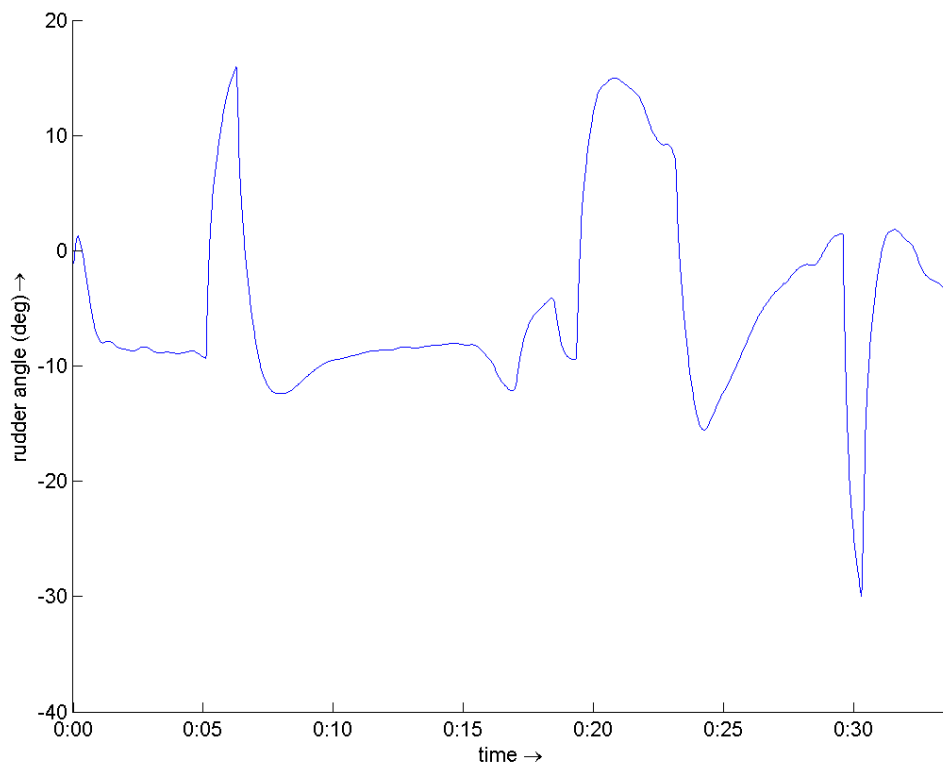


Figure 2.327: S.C. 41: rudder angle, vs. time.

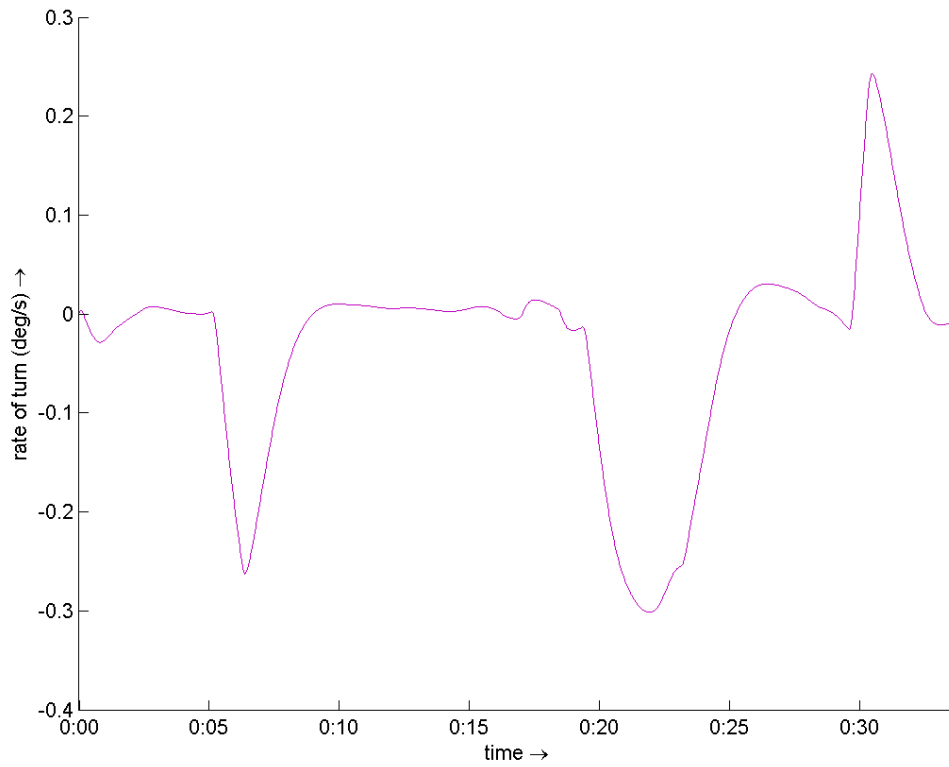


Figure 2.328: S.C. 41: RoT, vs. time.

## Simulation Case 42

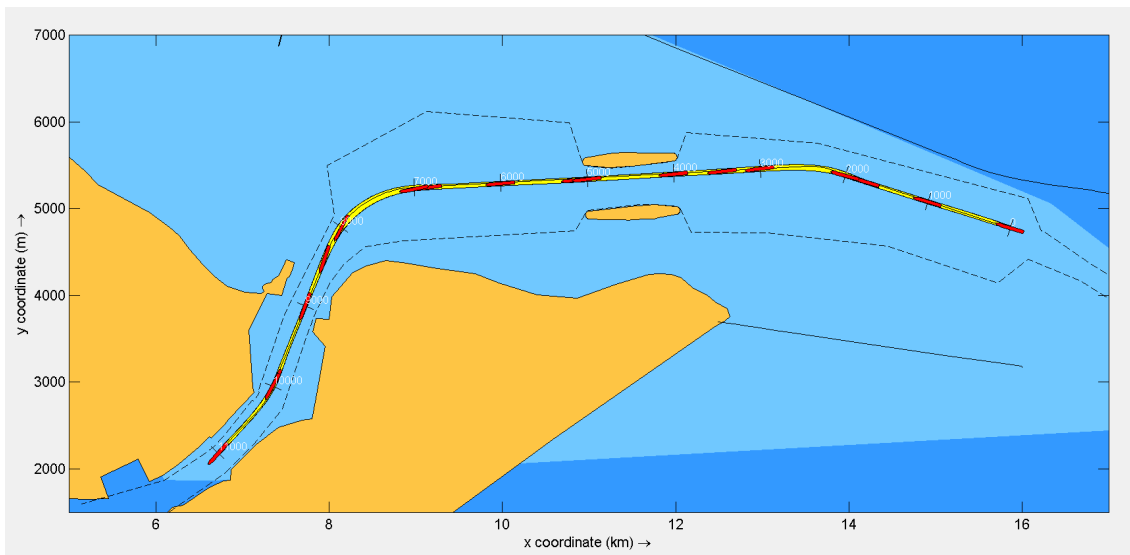
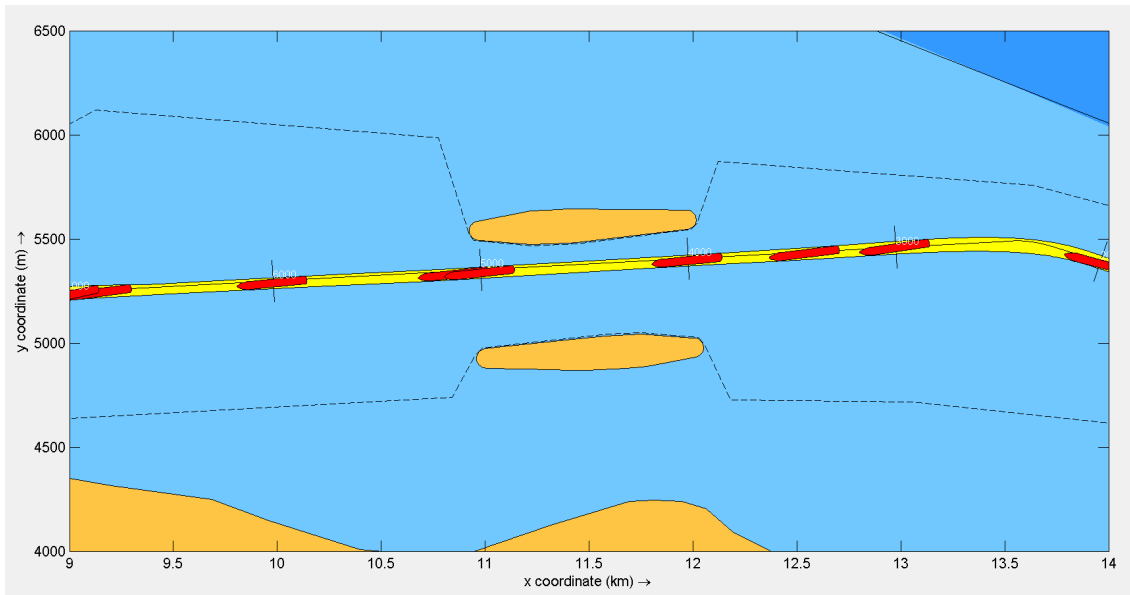


Figure 2.329: S.C. 42: spatial overview plot.



**Figure 2.330:** S.C. 42: zoom-in of spatial overview plot, crossing segment.

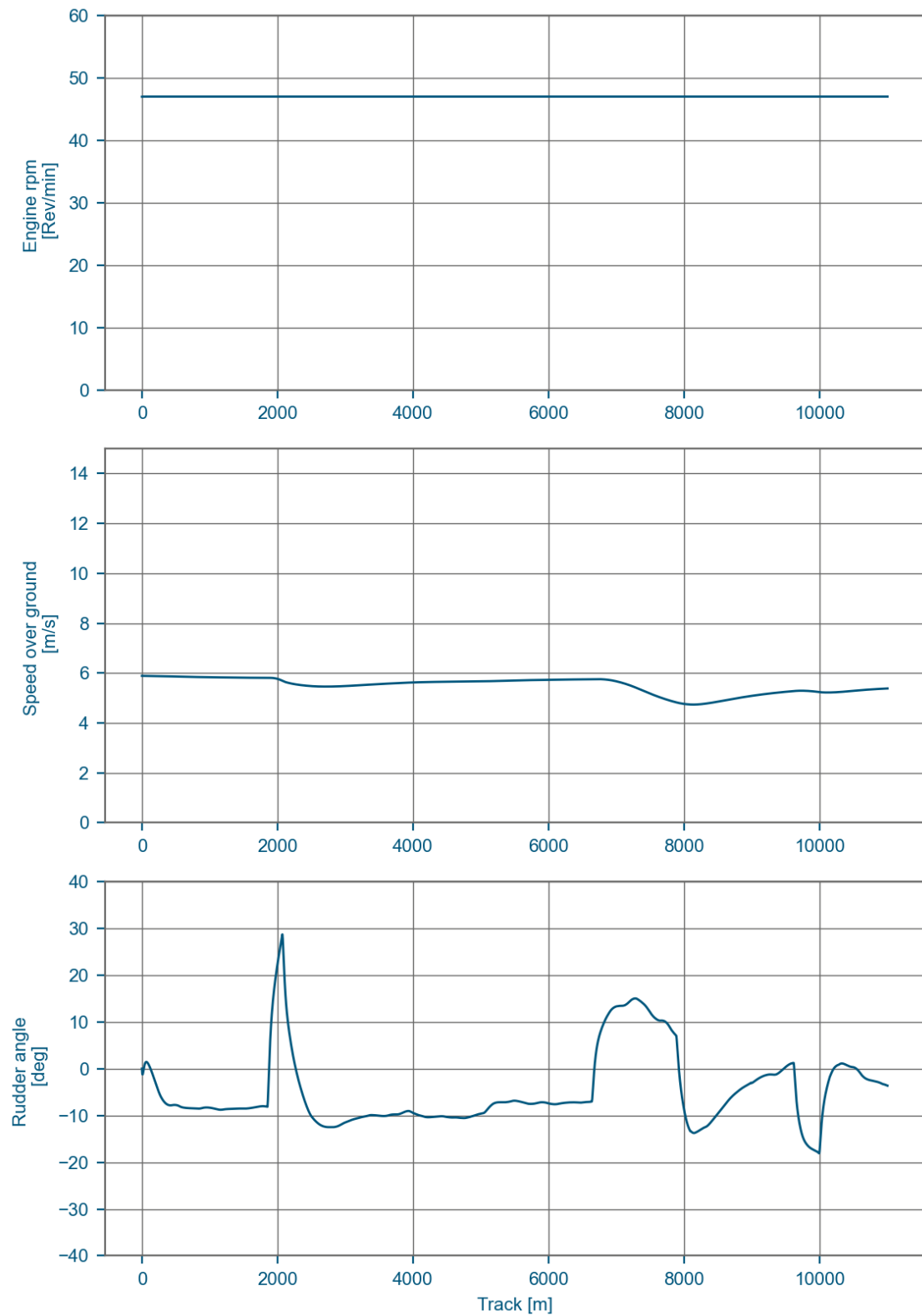


Figure 2.331: S.C. 42: engine RPM, SOG, rudder angle, vs. distance.

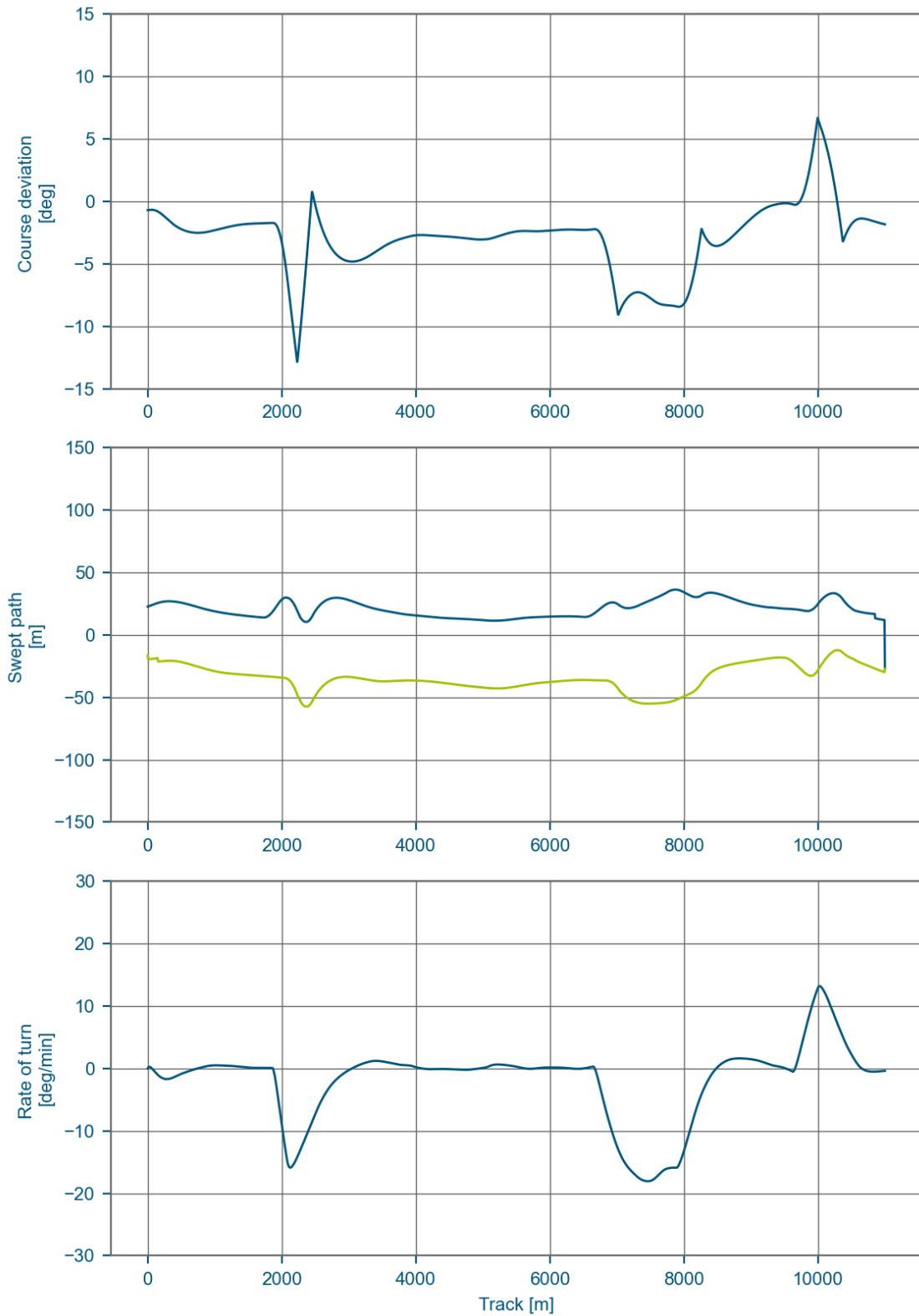


Figure 2.332: S.C. 42: course deviation (drift angle), swept path, RoT, vs. distance.

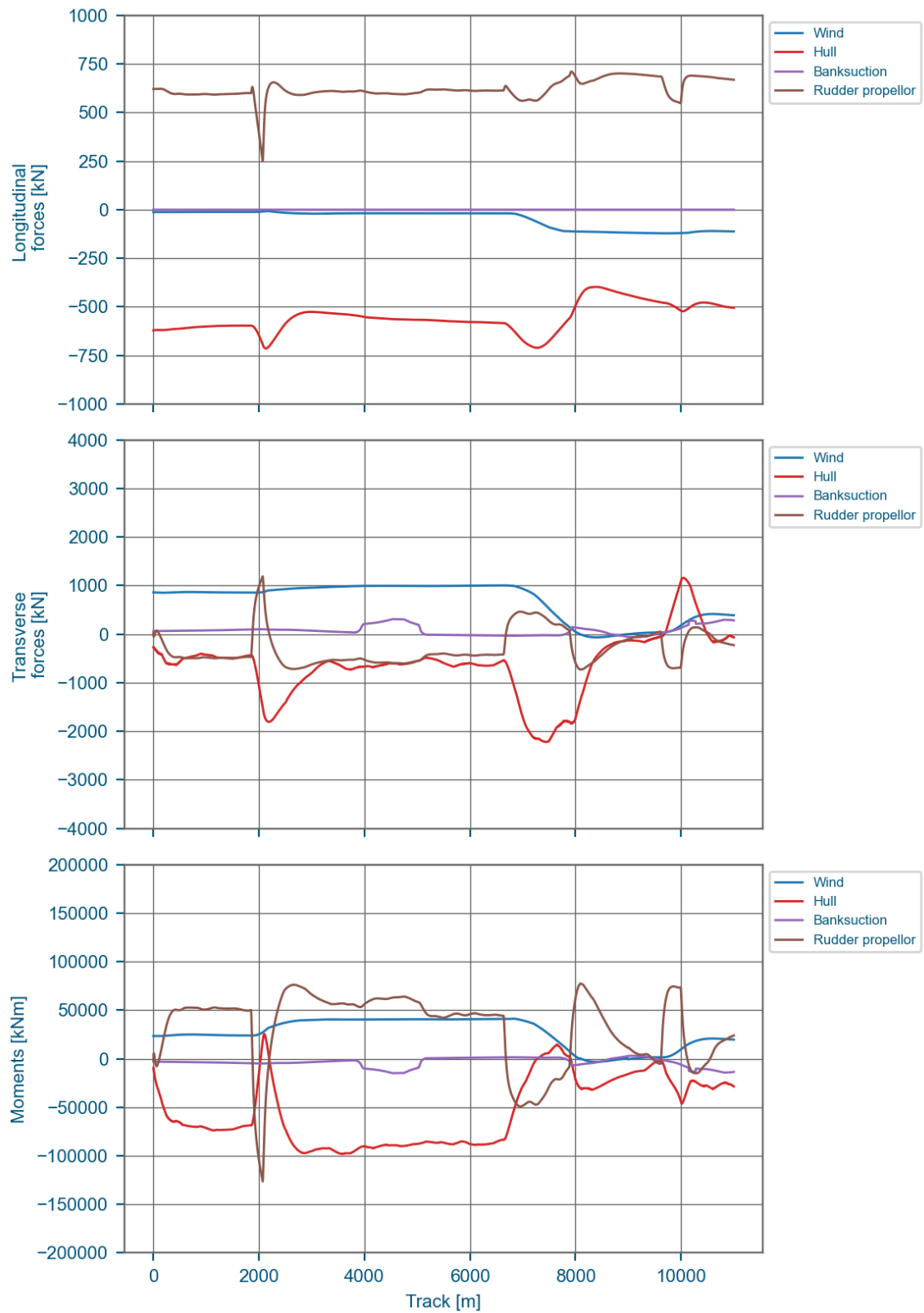


Figure 2.333: S.C. 42: forces, moments, vs. distance.

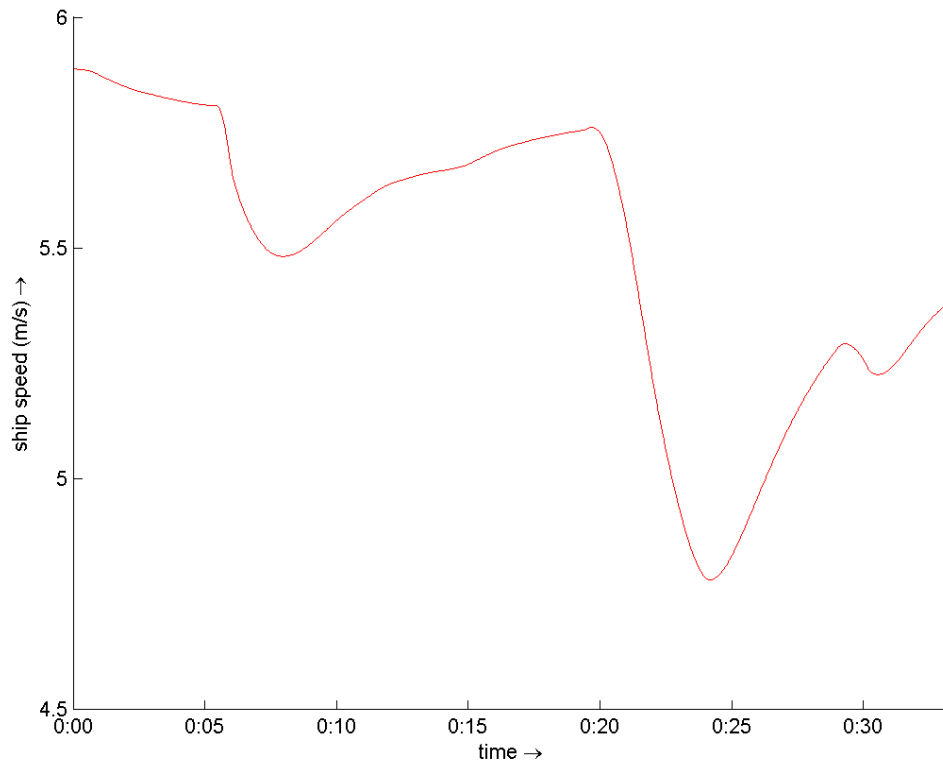


Figure 2.334: S.C. 42: SOG, vs. time.

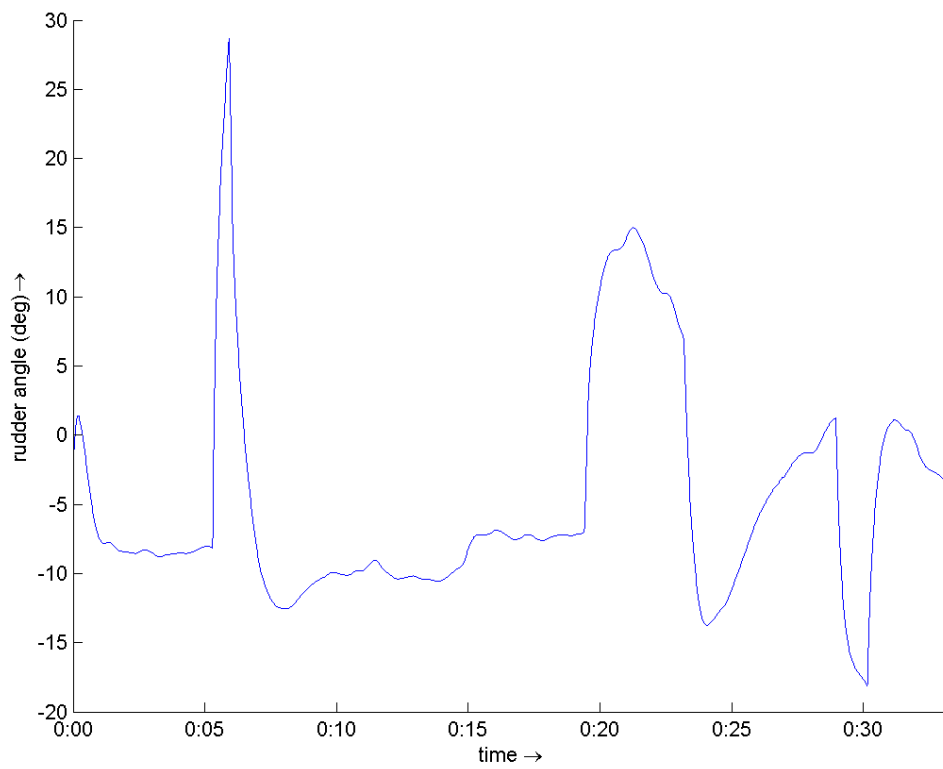


Figure 2.335: S.C. 42: rudder angle, vs. time.

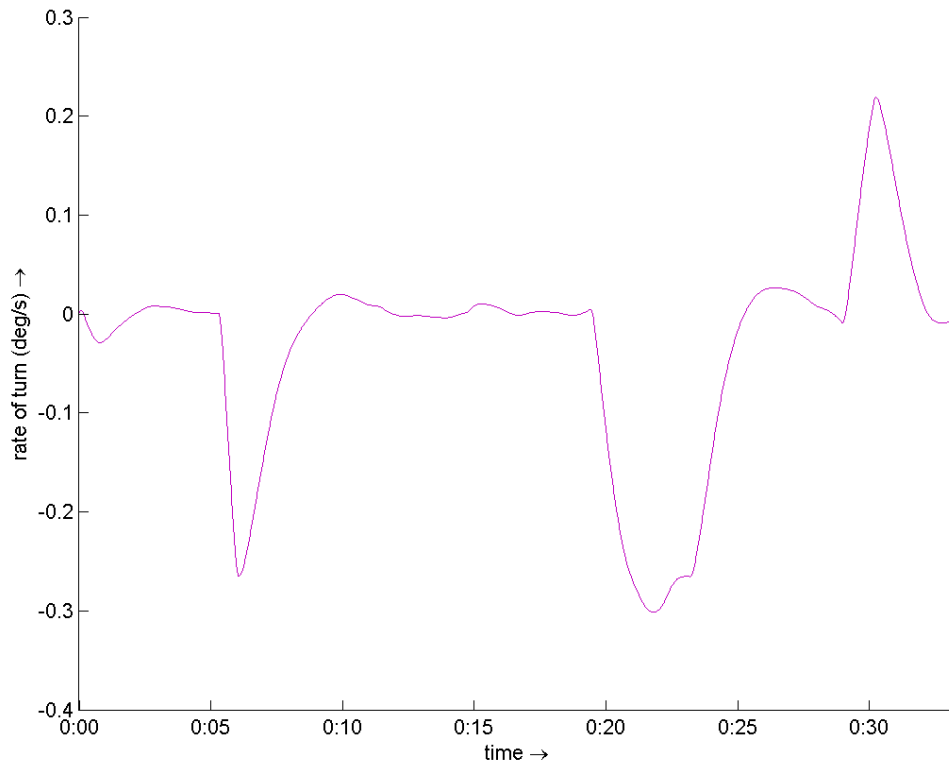


Figure 2.336: S.C. 42: RoT, vs. time.

### Simulation Case 43

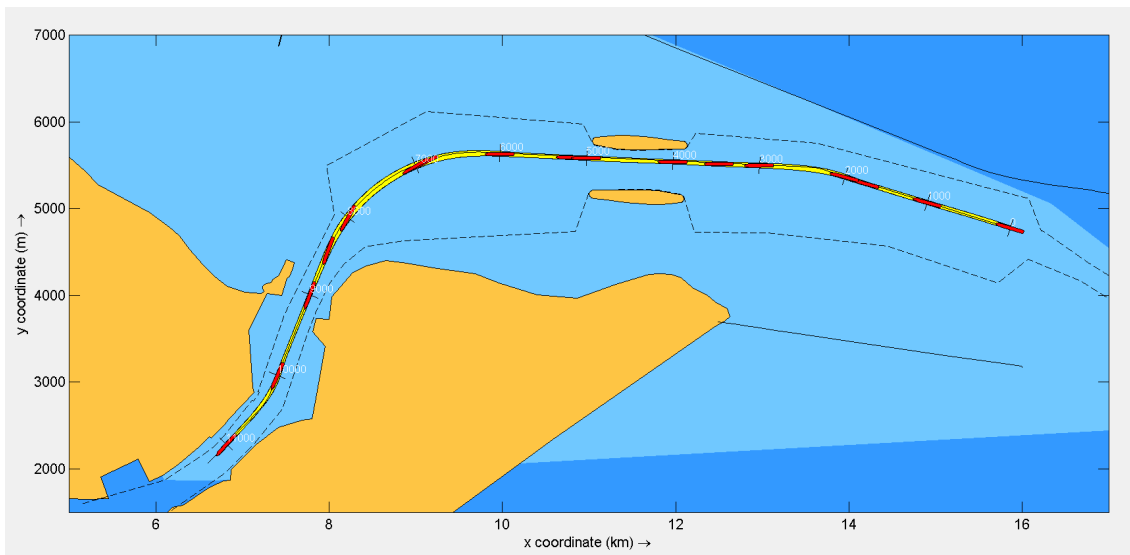
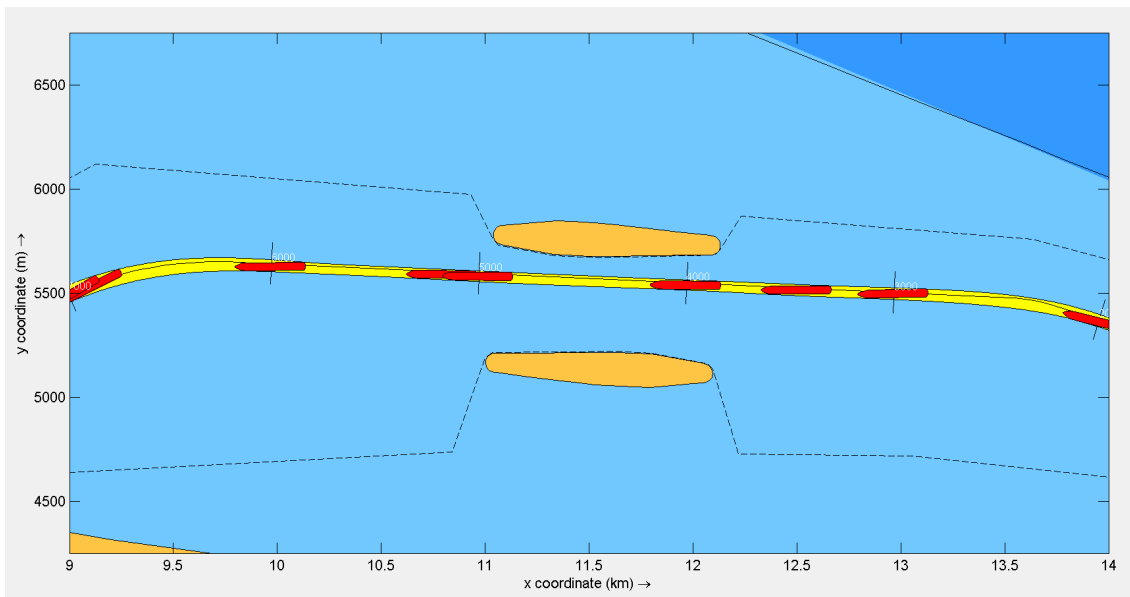


Figure 2.337: S.C. 43: spatial overview plot.



**Figure 2.338:** S.C. 43: zoom-in of spatial overview plot, crossing segment.

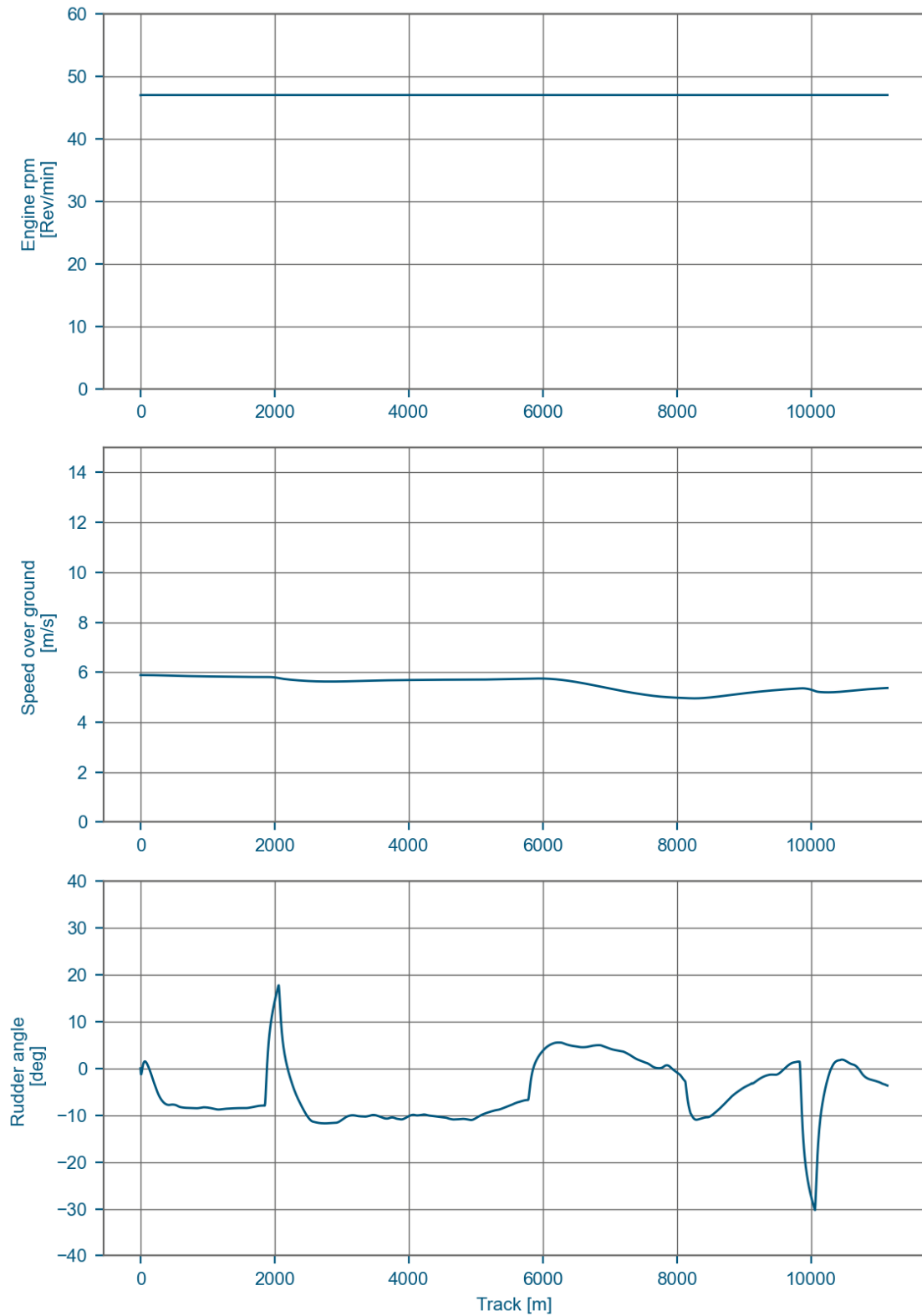


Figure 2.339: S.C. 43: engine RPM, SOG, rudder angle, vs. distance.

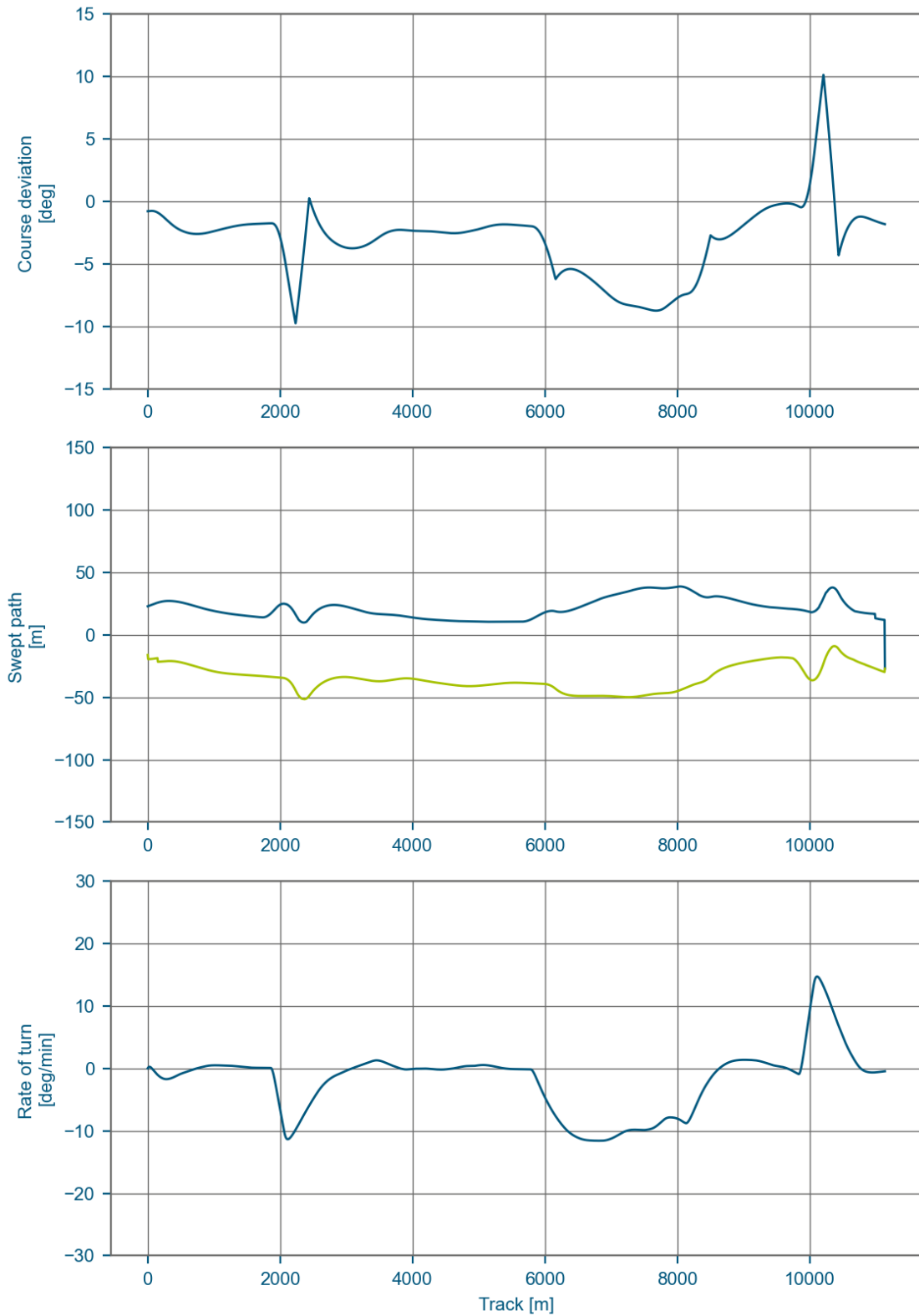


Figure 2.340: S.C. 43: course deviation (drift angle), swept path, RoT, vs. distance.

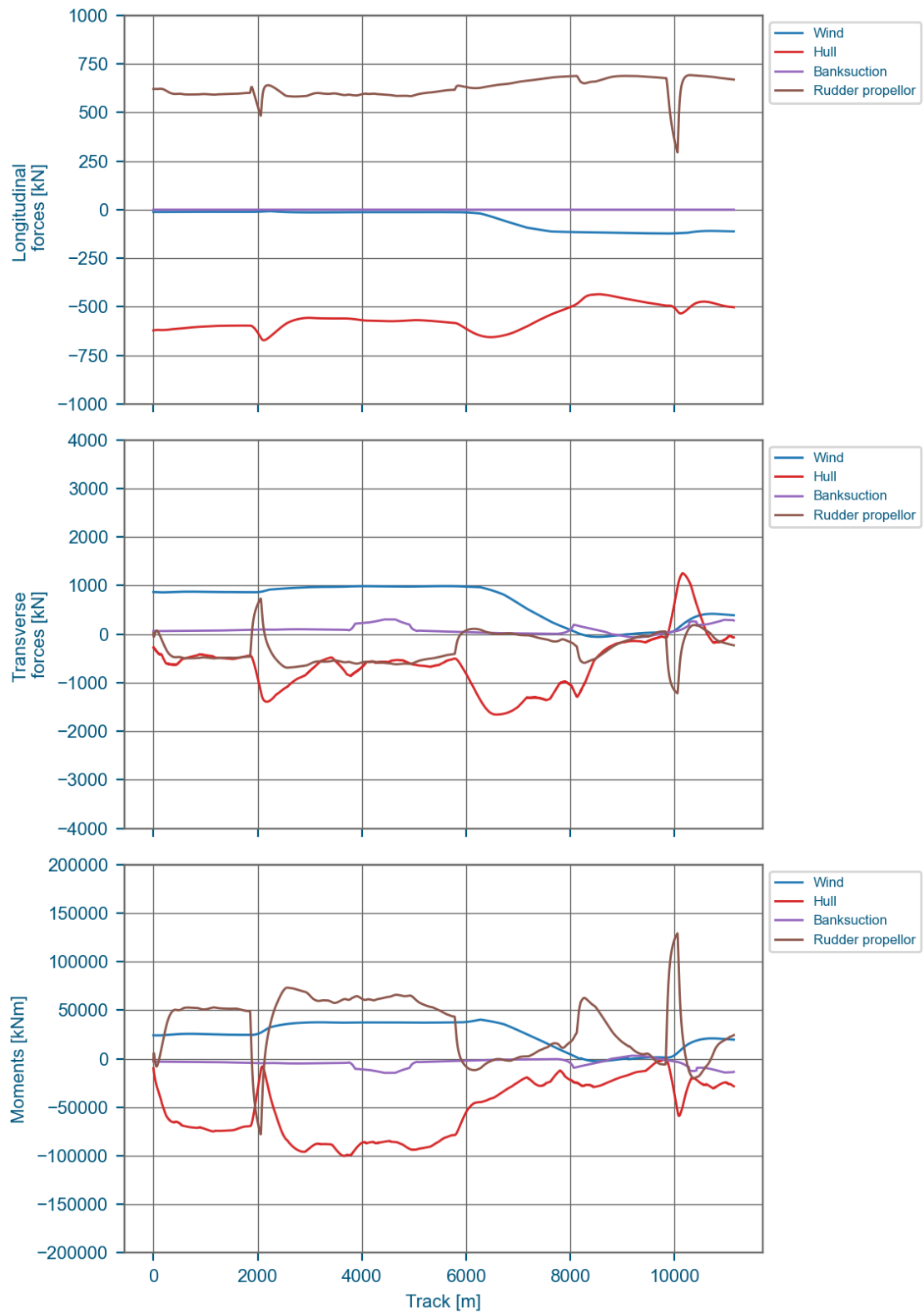


Figure 2.341: S.C. 43: forces, moments, vs. distance.

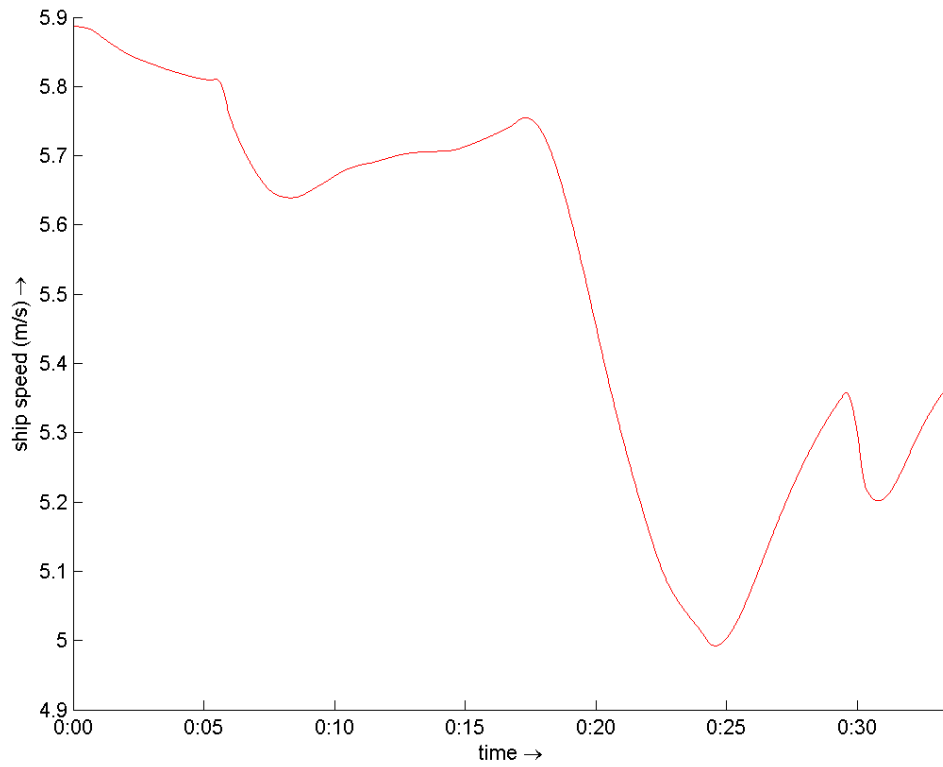


Figure 2.342: S.C. 43: SOG, vs. time.

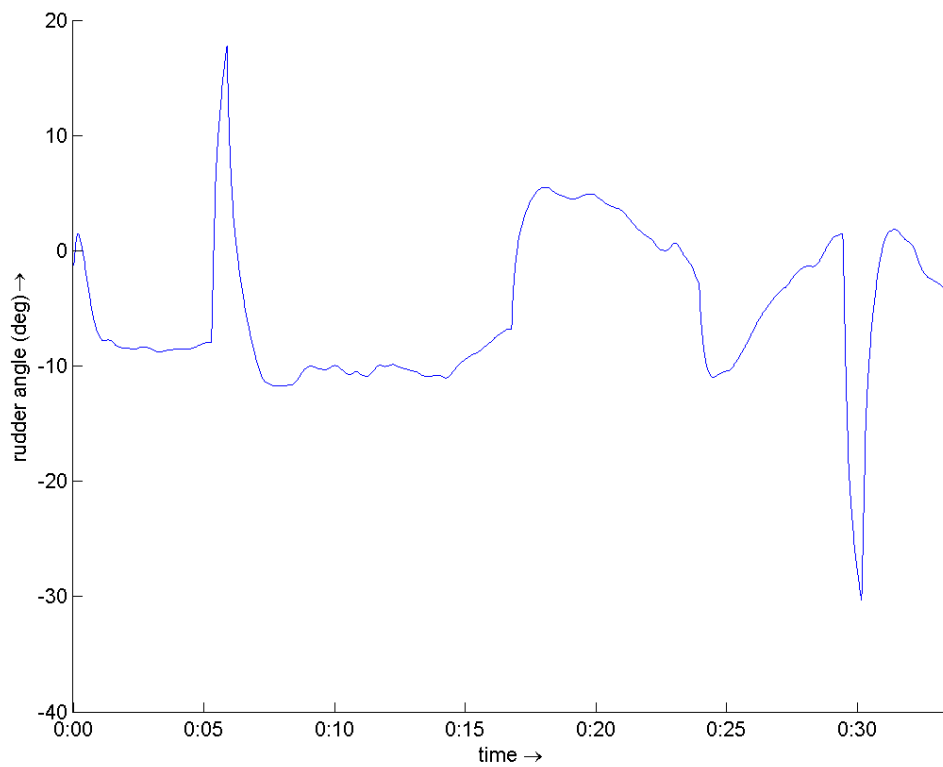


Figure 2.343: S.C. 43: rudder angle, vs. time.

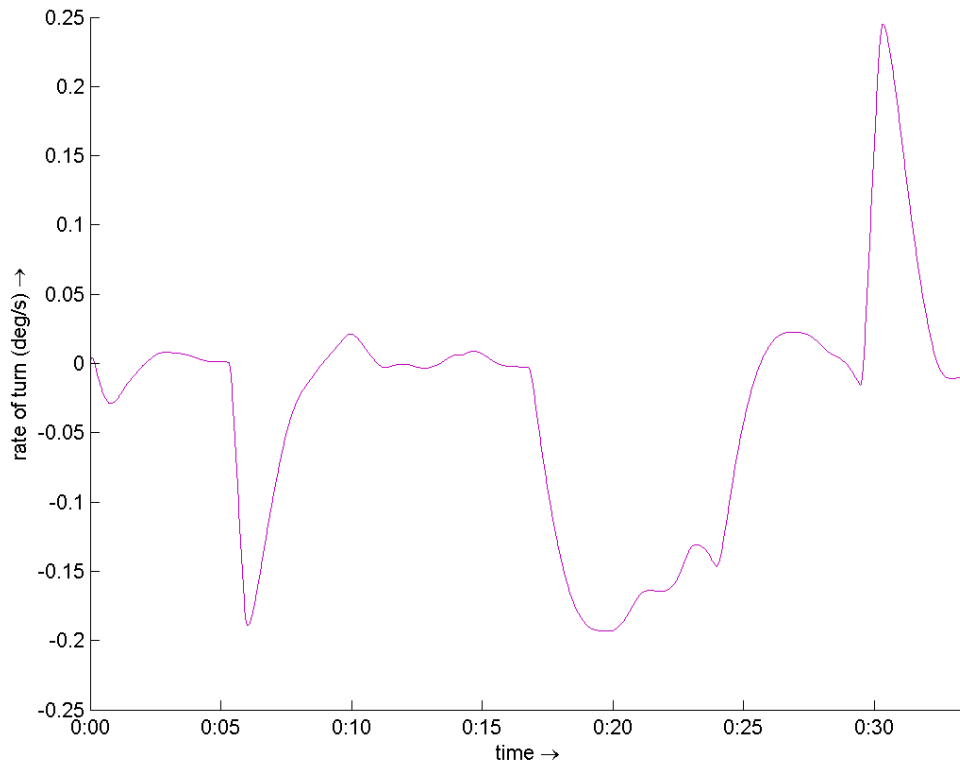


Figure 2.344: S.C. 43: RoT, vs. time.

## Simulation Case 44

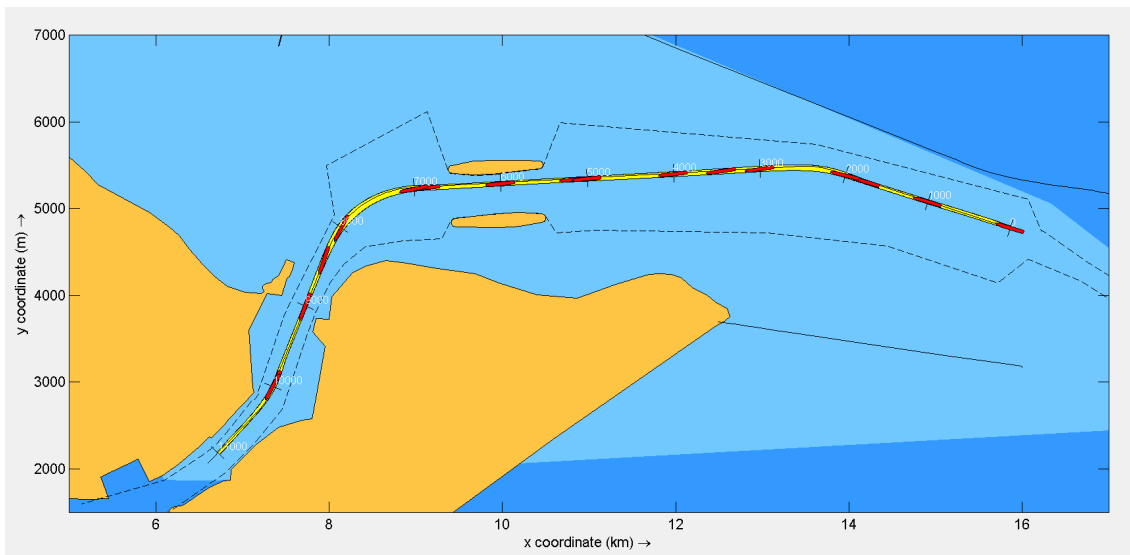
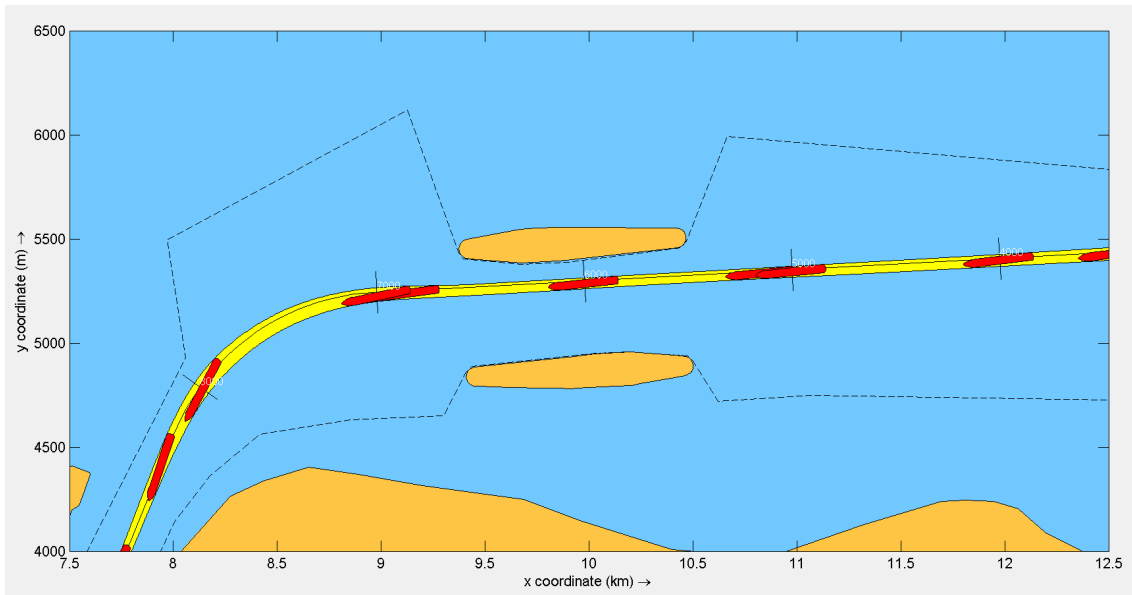


Figure 2.345: S.C. 44: spatial overview plot.



**Figure 2.346:** S.C. 44: zoom-in of spatial overview plot, crossing segment.

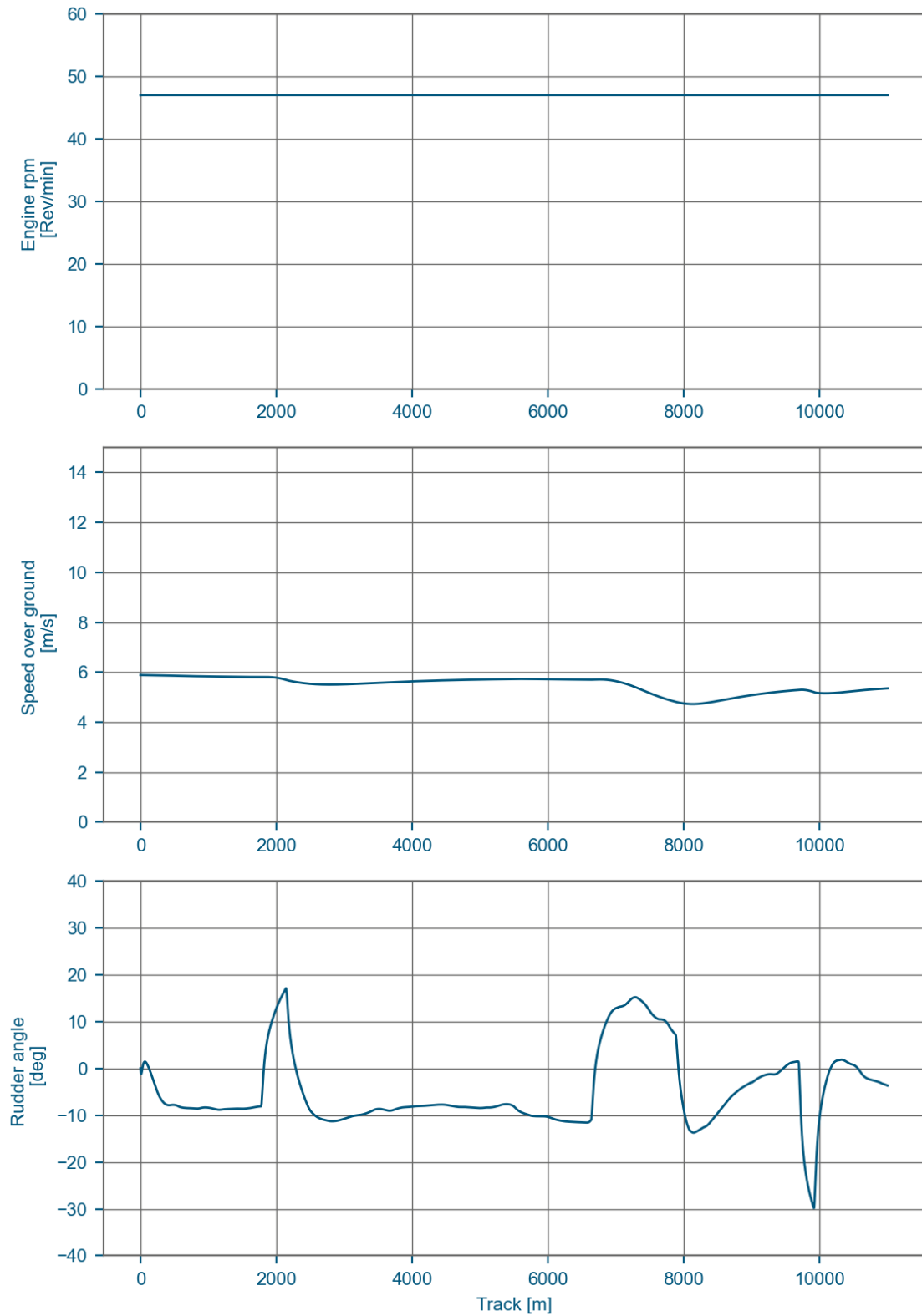


Figure 2.347: S.C. 44: engine RPM, SOG, rudder angle, vs. distance.

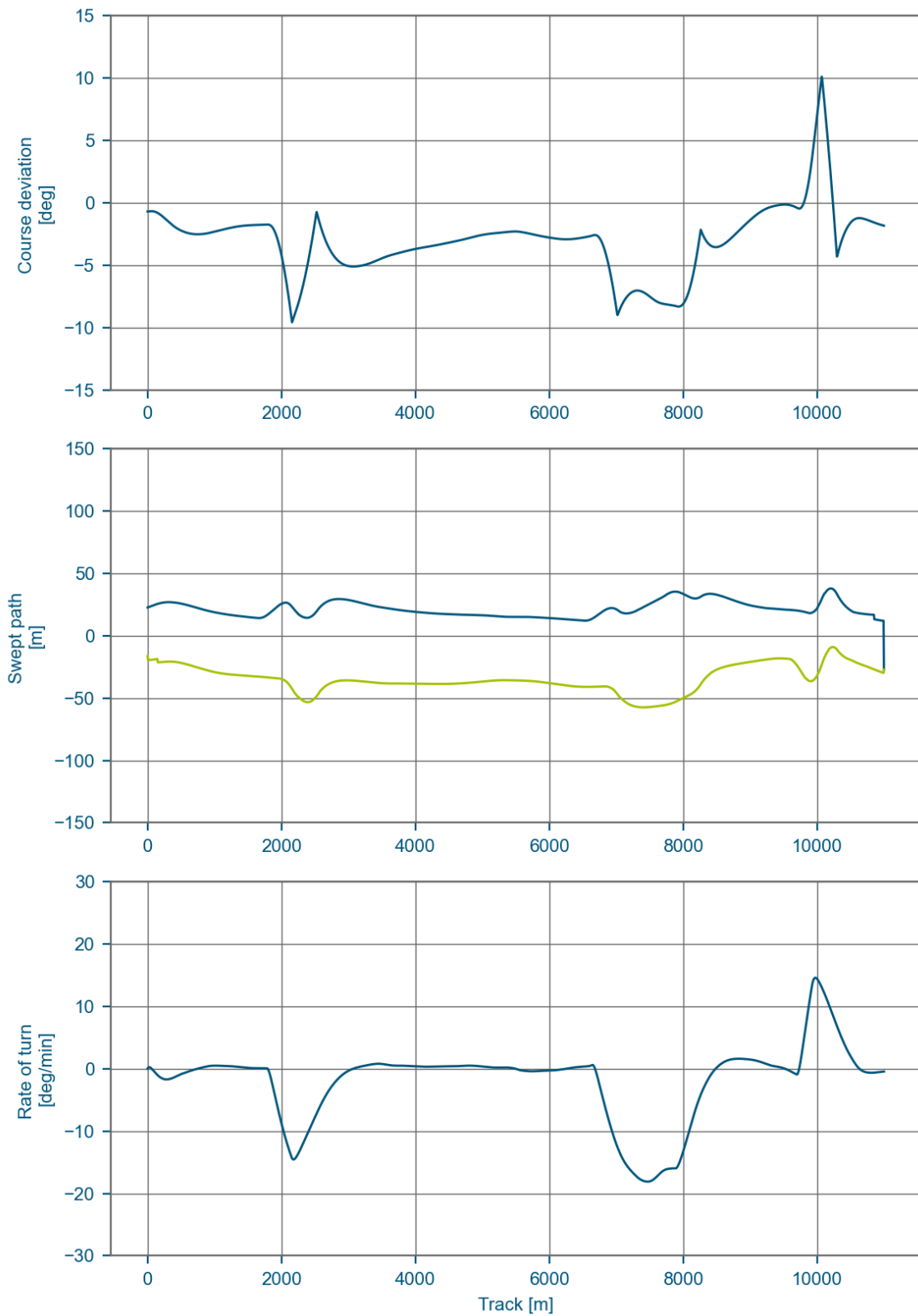


Figure 2.348: S.C. 44: course deviation (drift angle), swept path, RoT, vs. distance.

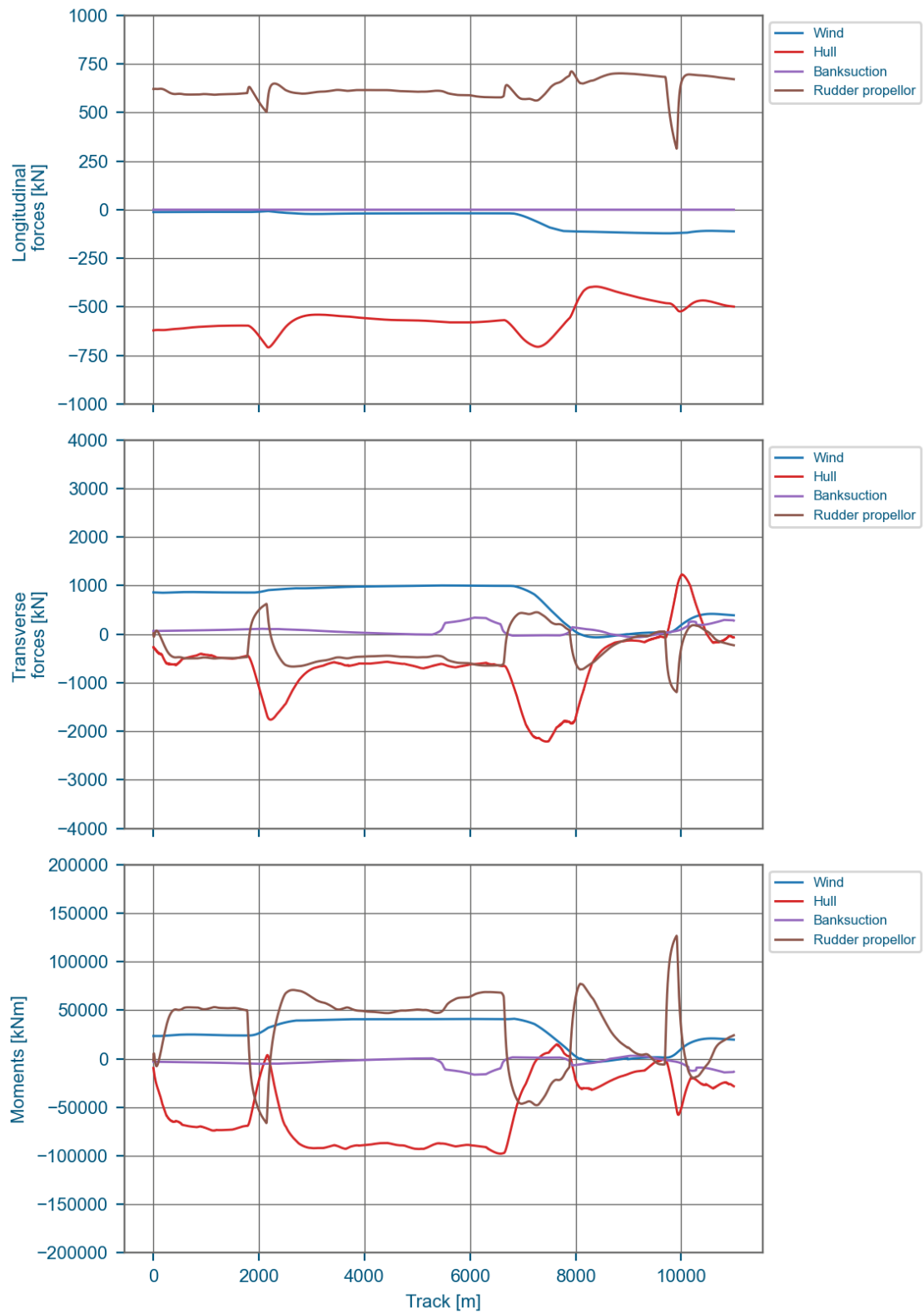


Figure 2.349: S.C. 44: forces, moments, vs. distance.

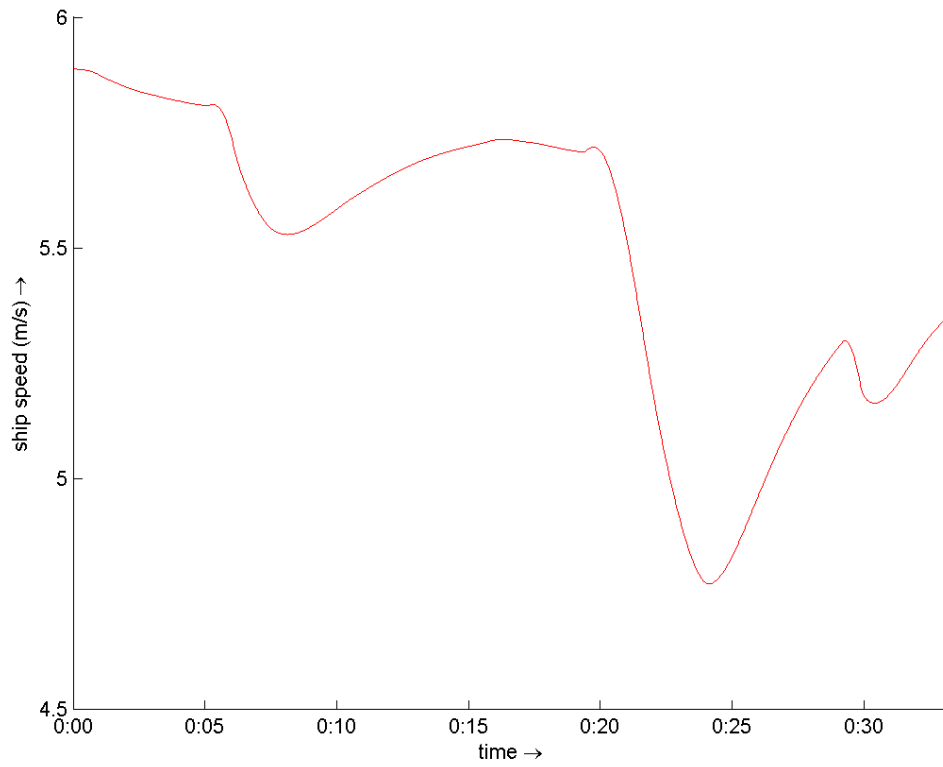


Figure 2.350: S.C. 44: SOG, vs. time.

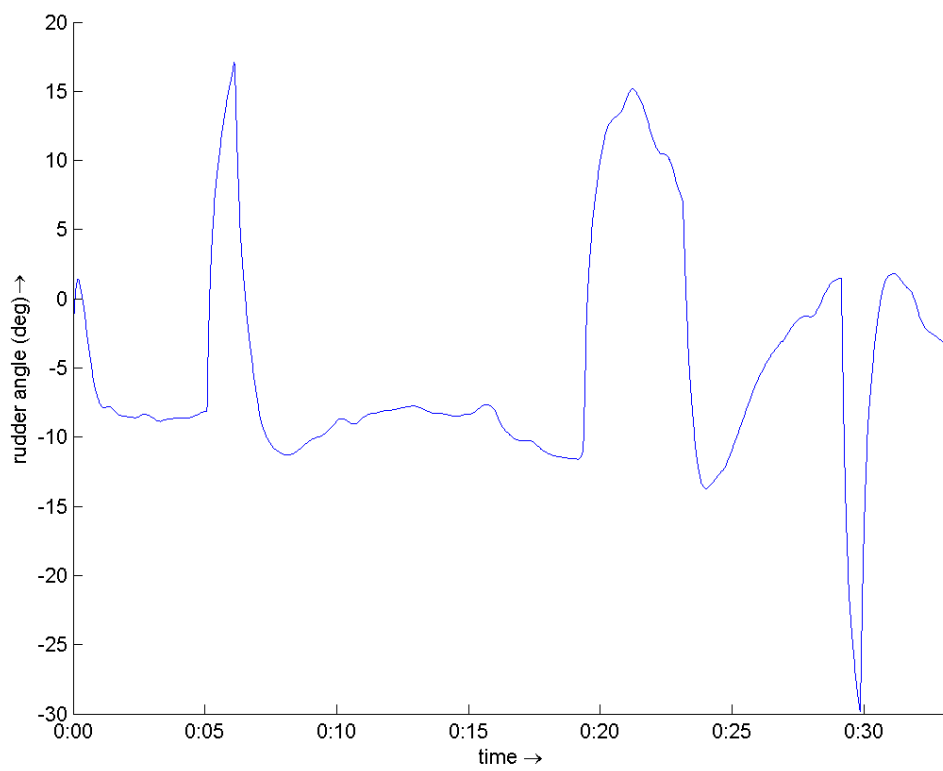


Figure 2.351: S.C. 44: rudder angle, vs. time.

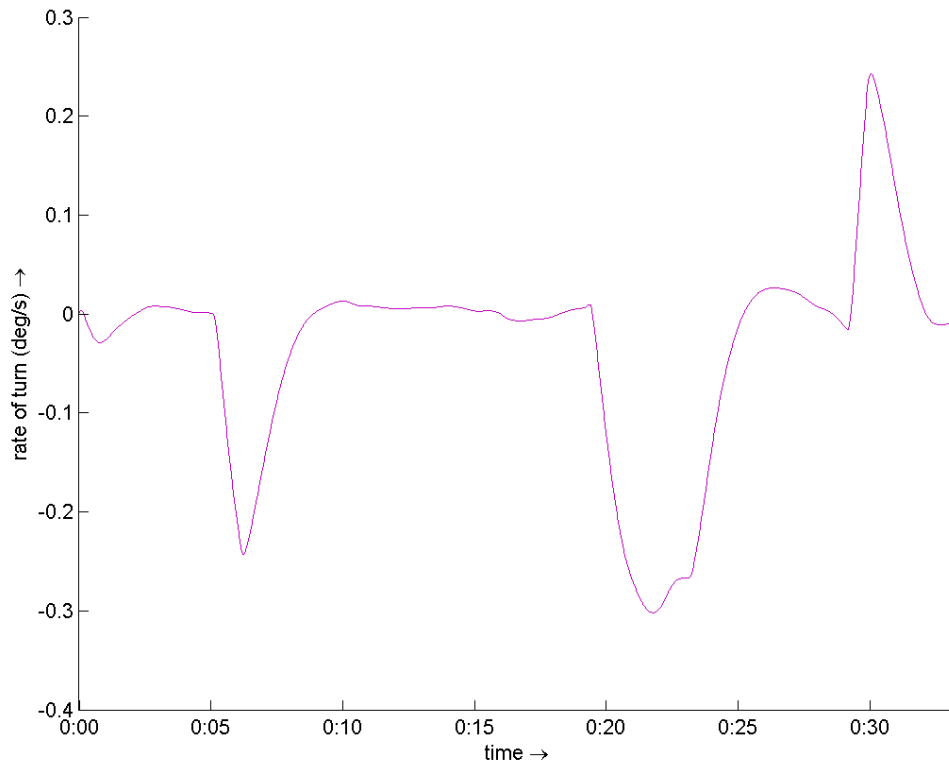


Figure 2.352: S.C. 44: RoT, vs. time.

## Simulation Case 45

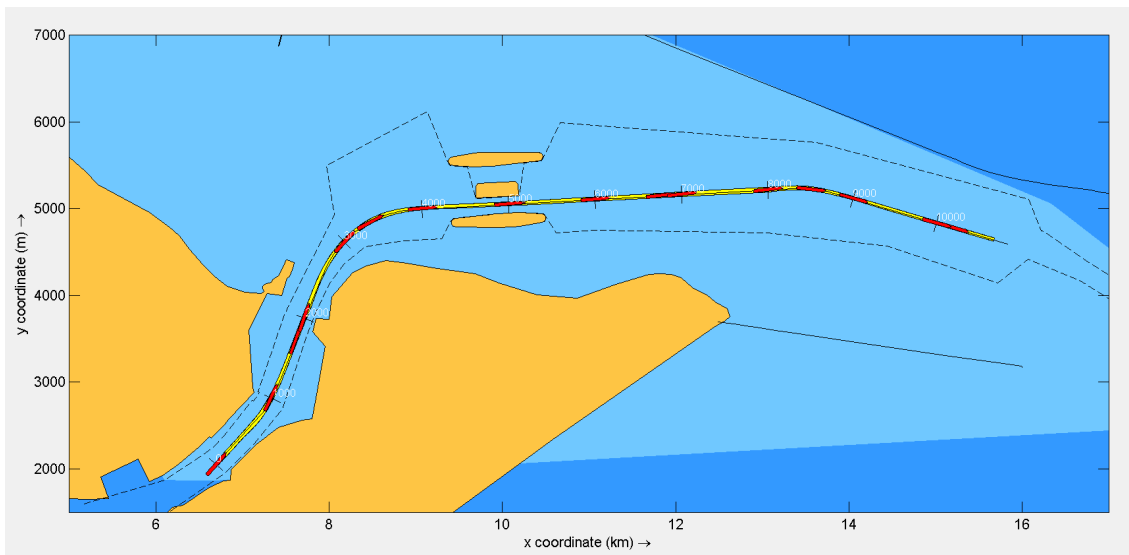
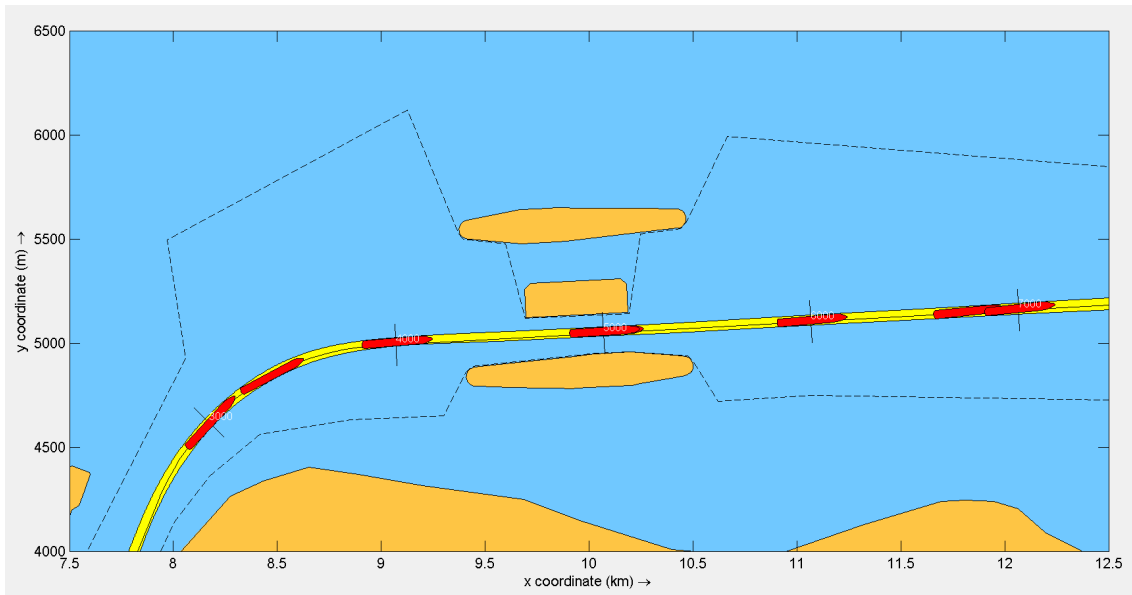


Figure 2.353: S.C. 45: spatial overview plot.



**Figure 2.354:** S.C. 45: zoom-in of spatial overview plot, crossing segment.

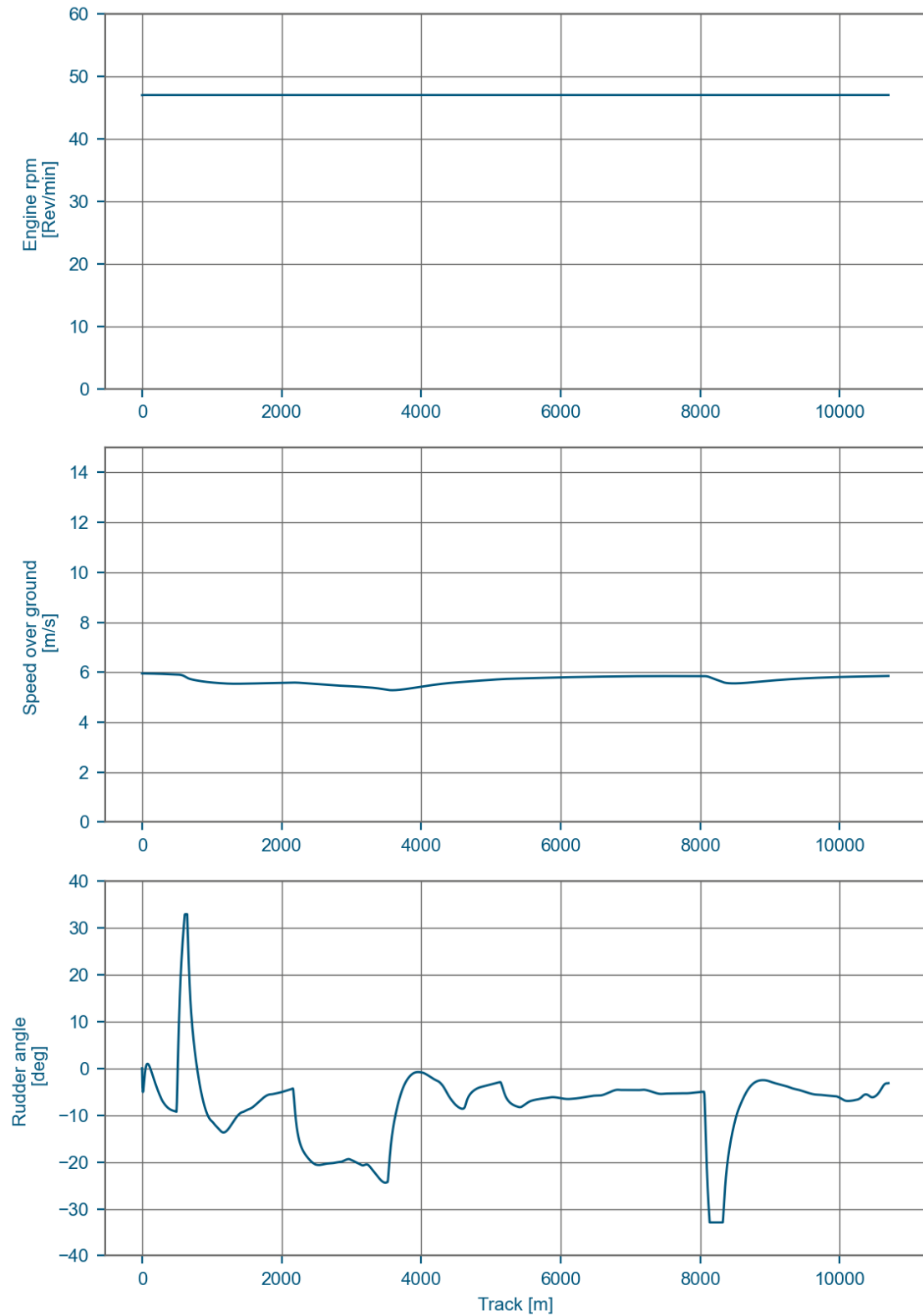


Figure 2.355: S.C. 45: engine RPM, SOG, rudder angle, vs. distance.

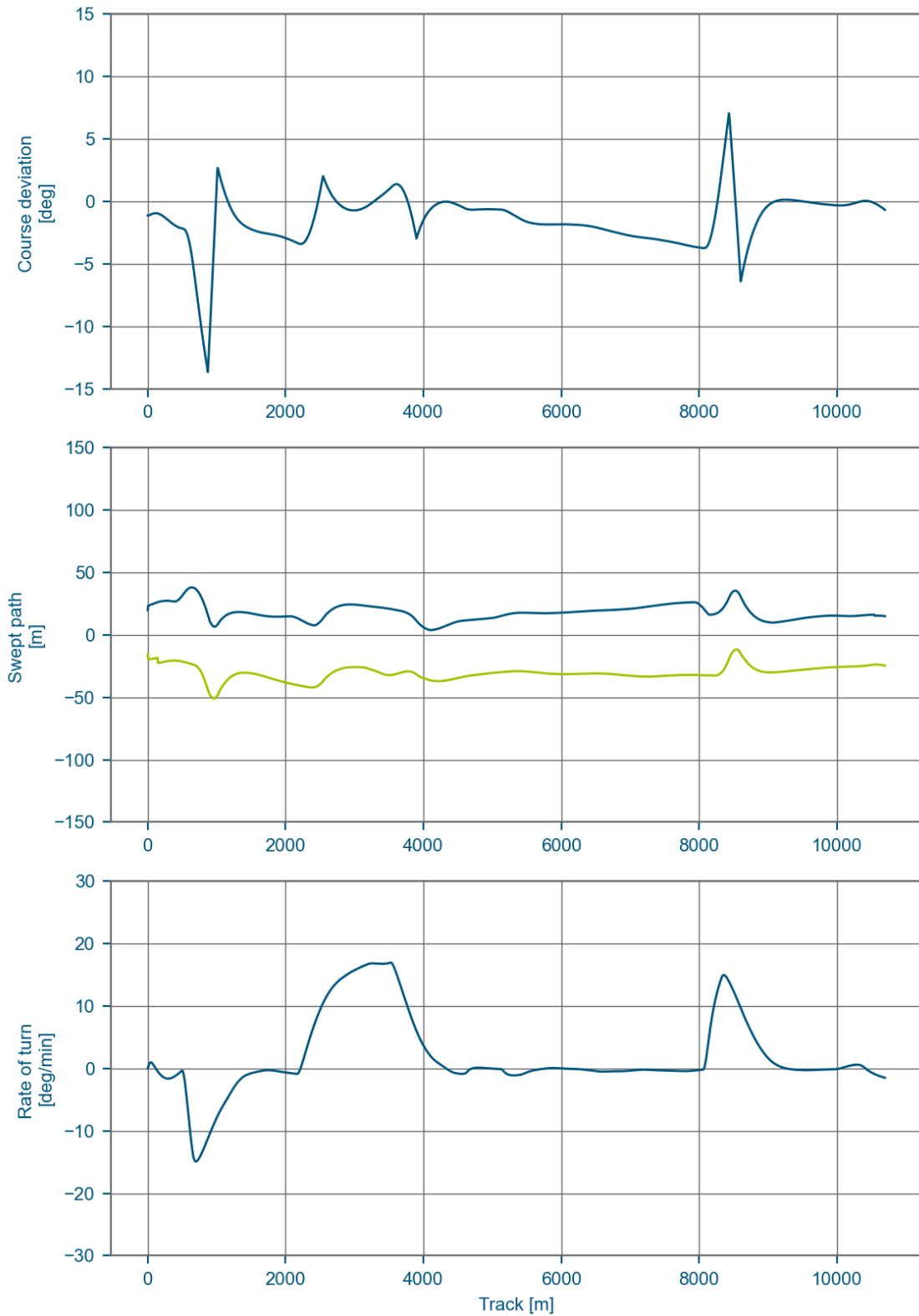


Figure 2.356: S.C. 45: course deviation (drift angle), swept path, RoT, vs. distance.

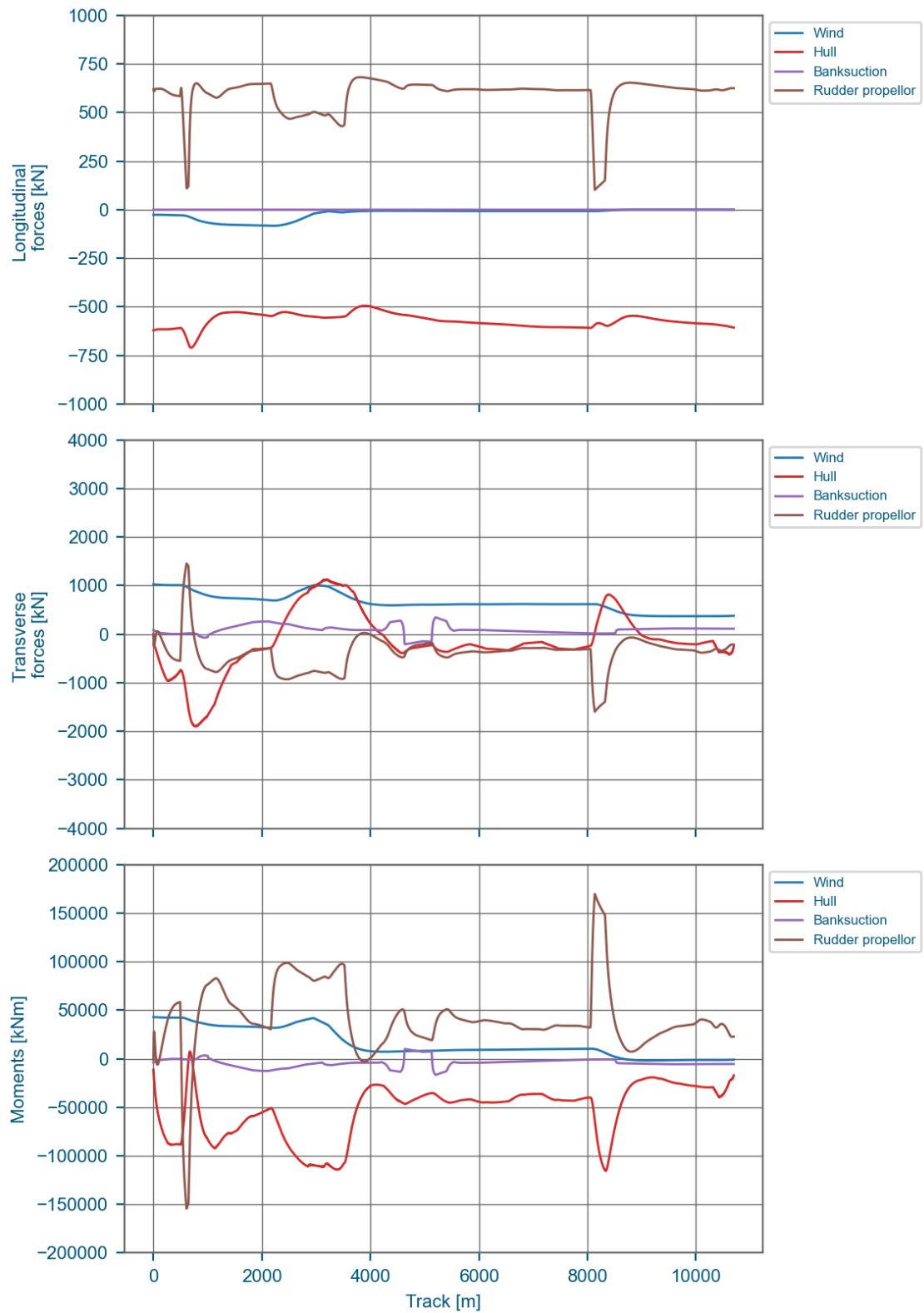


Figure 2.357: S.C. 45: forces, moments, vs. distance.

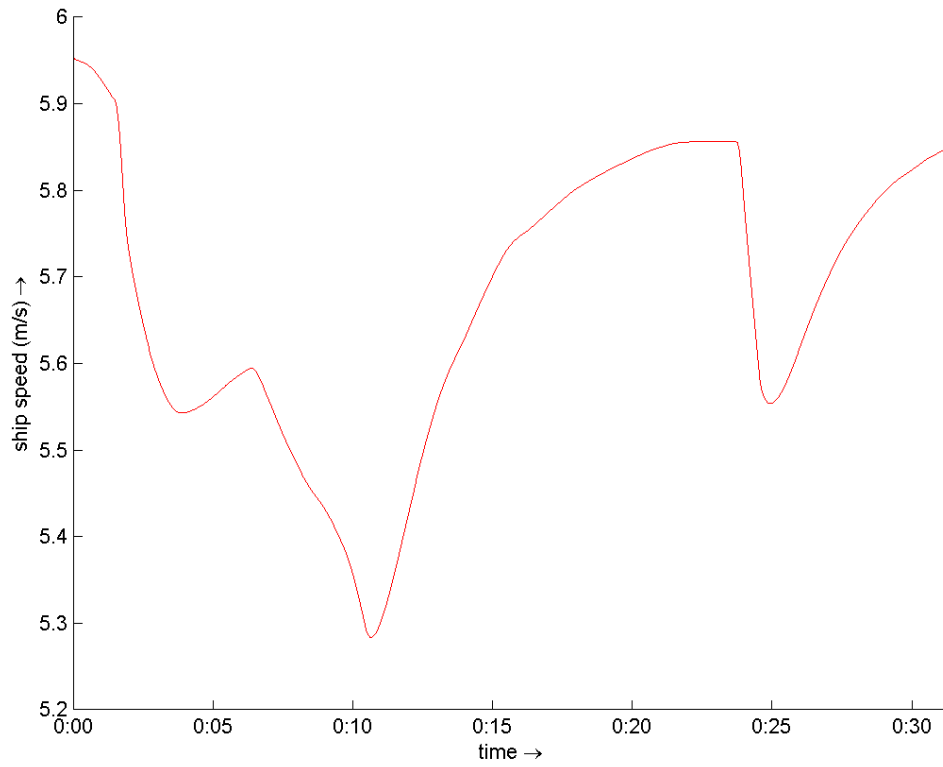


Figure 2.358: S.C. 45: SOG, vs. time.

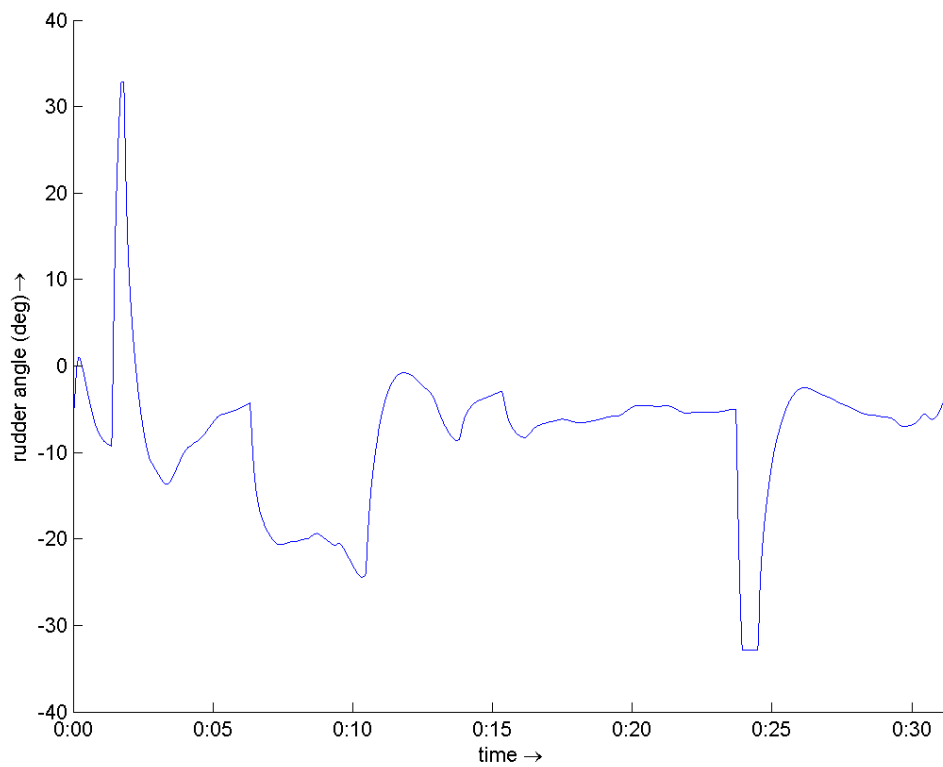


Figure 2.359: S.C. 45: rudder angle, vs. time.

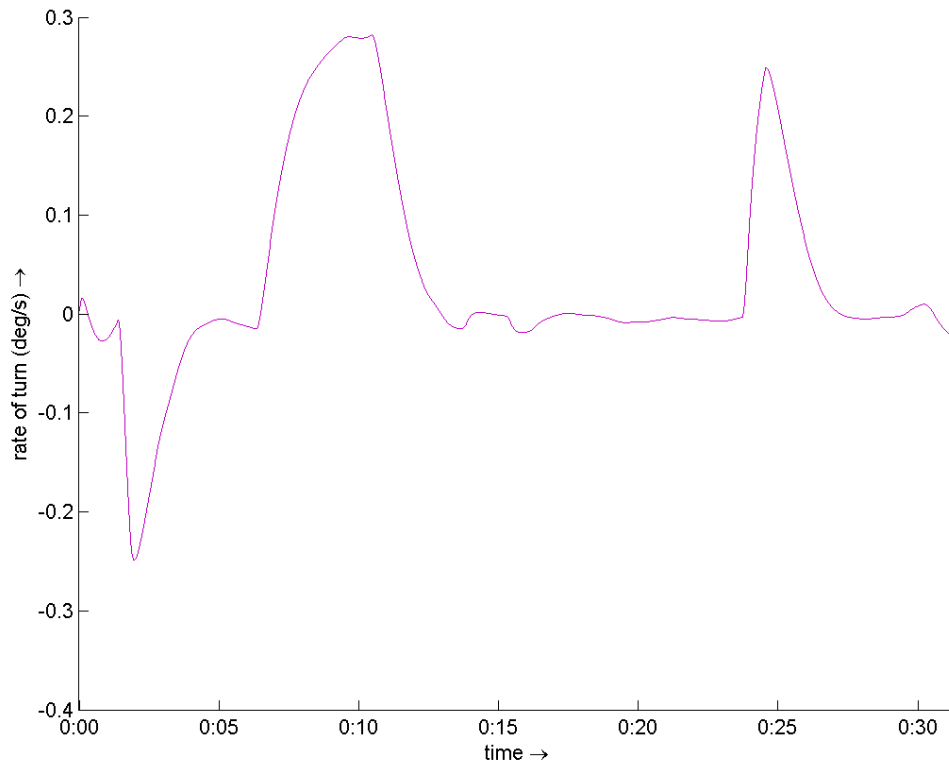


Figure 2.360: S.C. 45: RoT, vs. time.

## Simulation Case 46

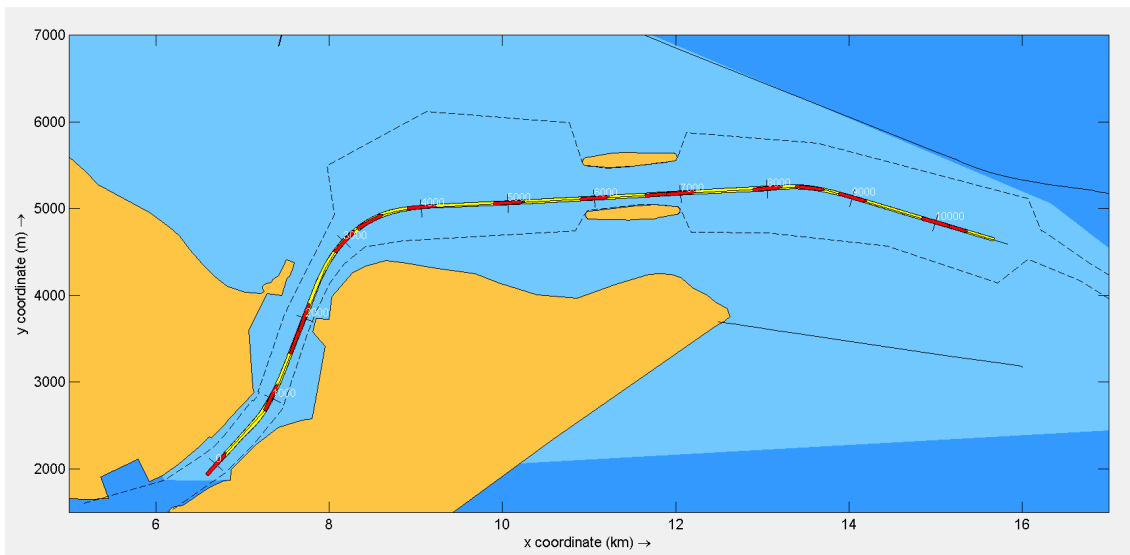
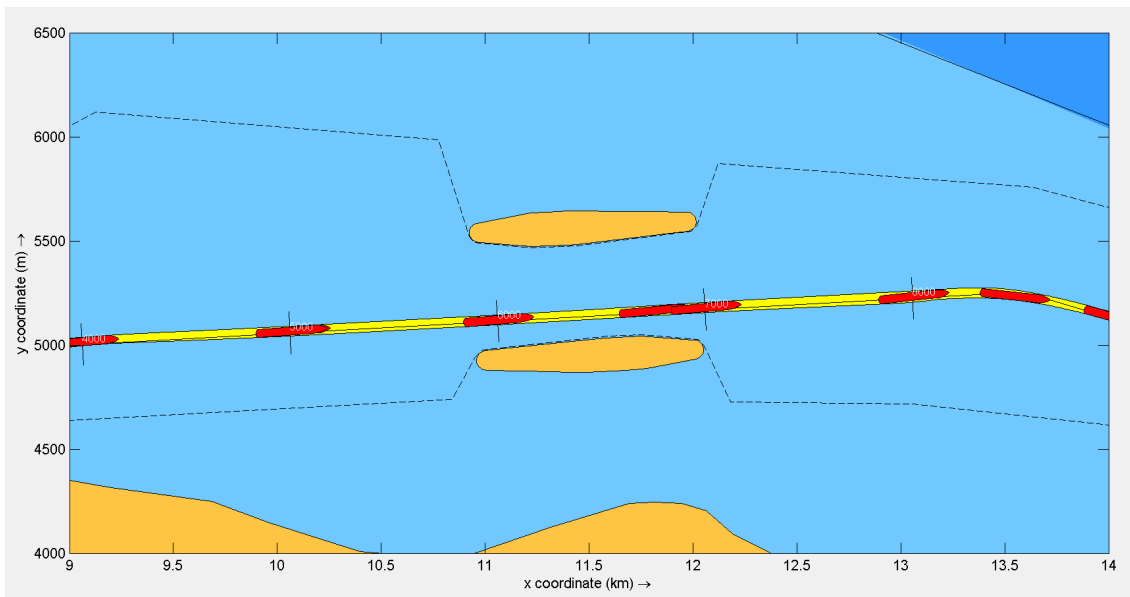


Figure 2.361: S.C. 46: spatial overview plot.



**Figure 2.362:** S.C. 46: zoom-in of spatial overview plot, crossing segment.

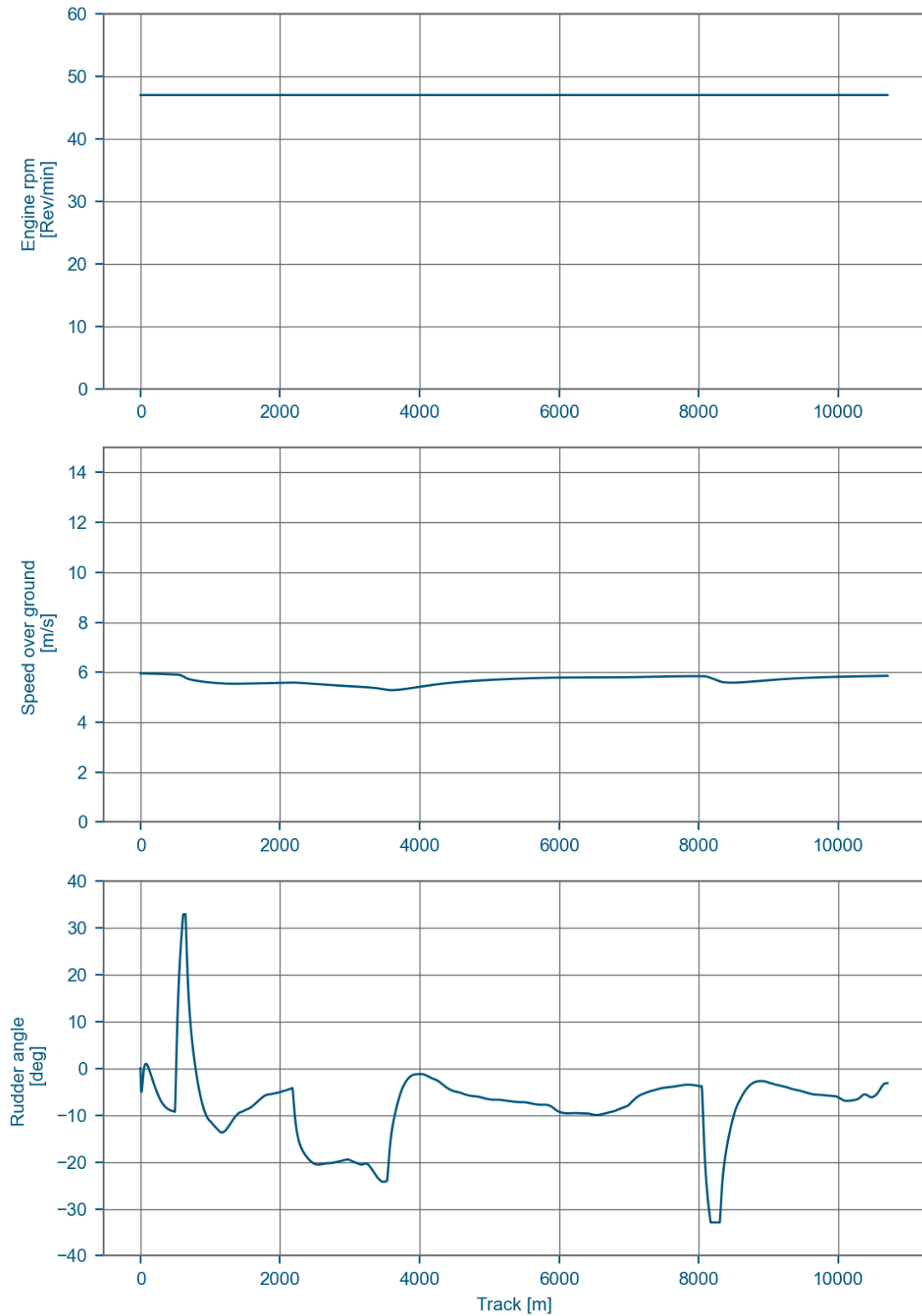


Figure 2.363: S.C. 46: engine RPM, SOG, rudder angle, vs. distance.

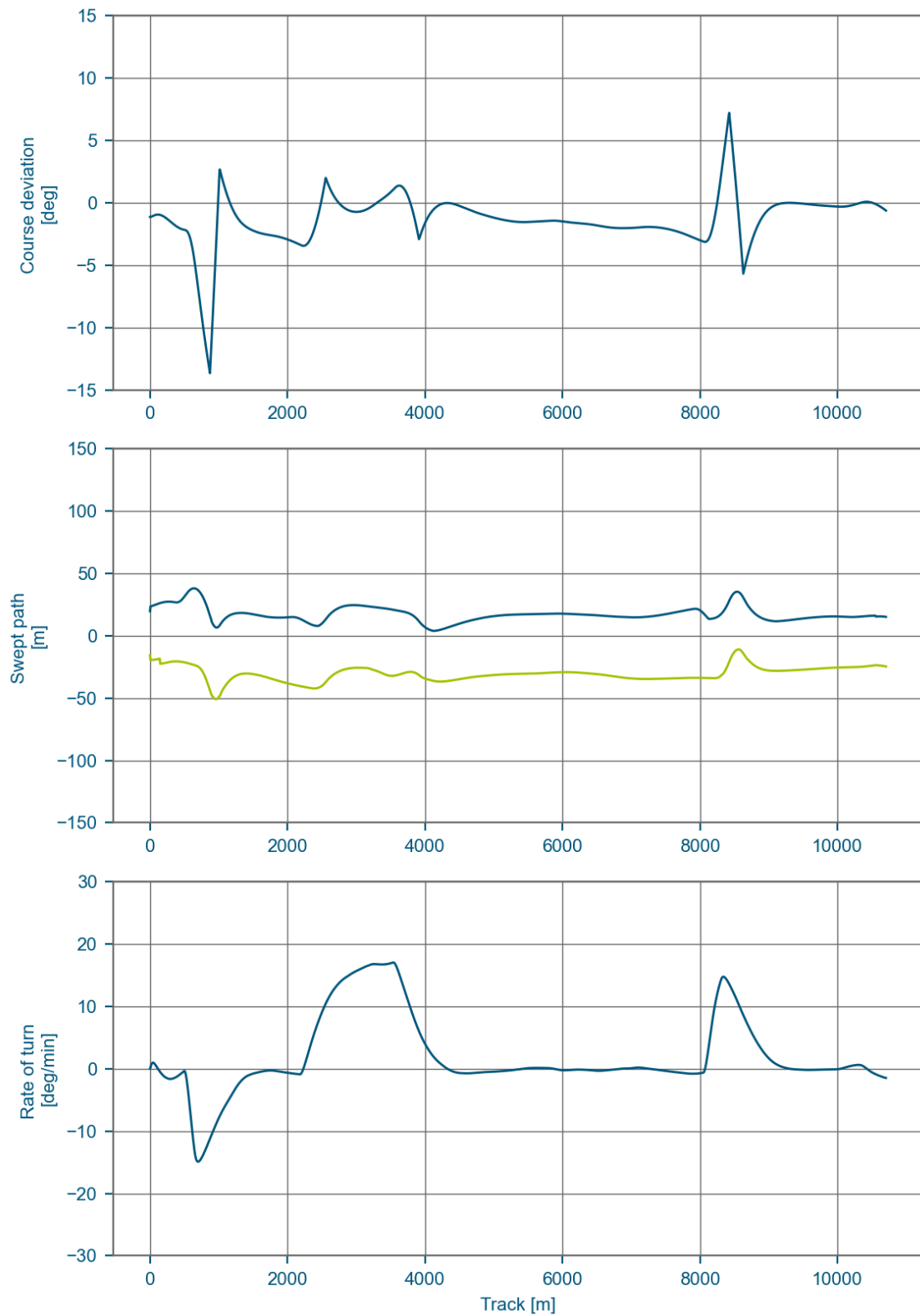


Figure 2.364: S.C. 46: course deviation (drift angle), swept path, RoT, vs. distance.

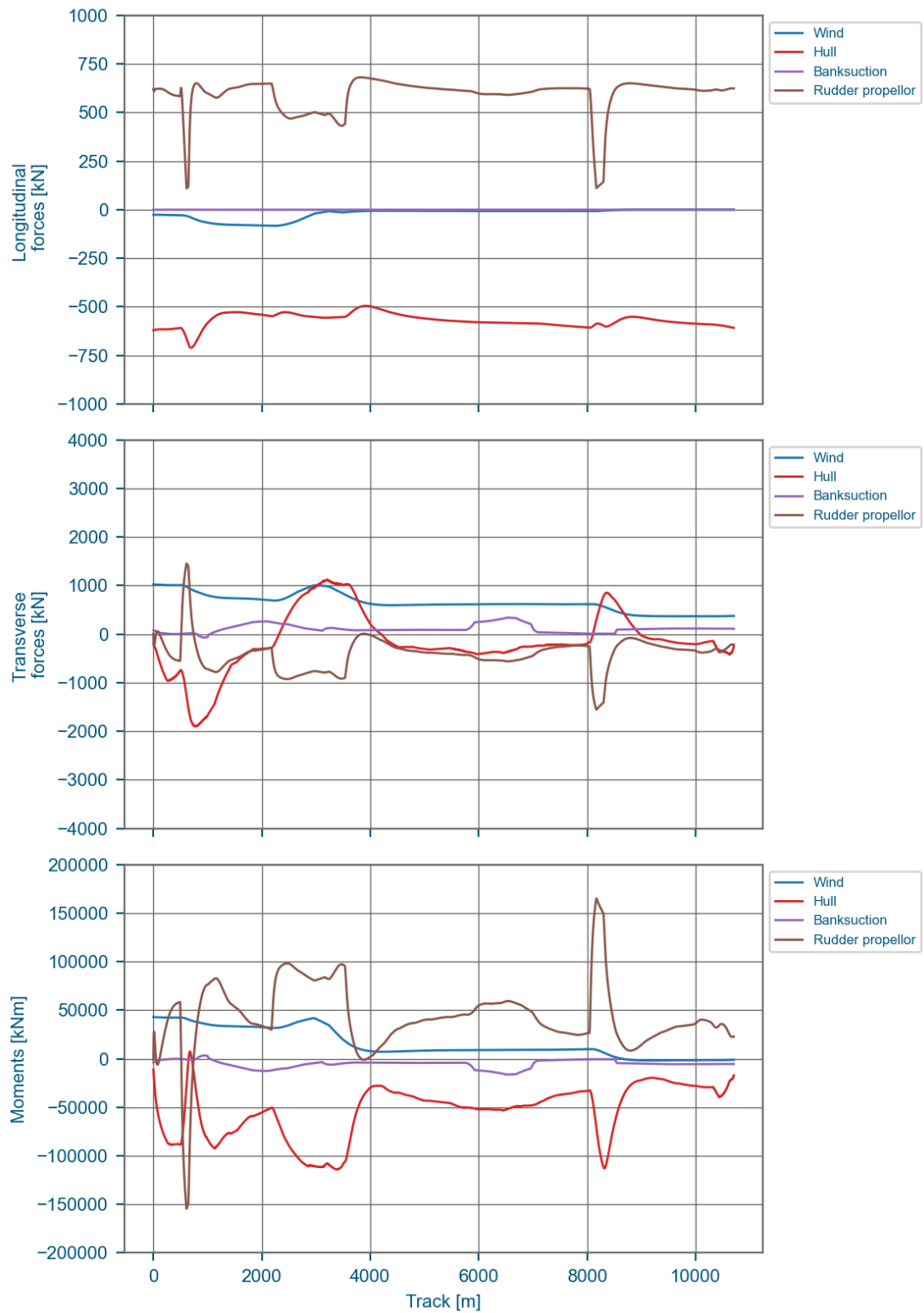


Figure 2.365: S.C. 46: forces, moments, vs. distance.

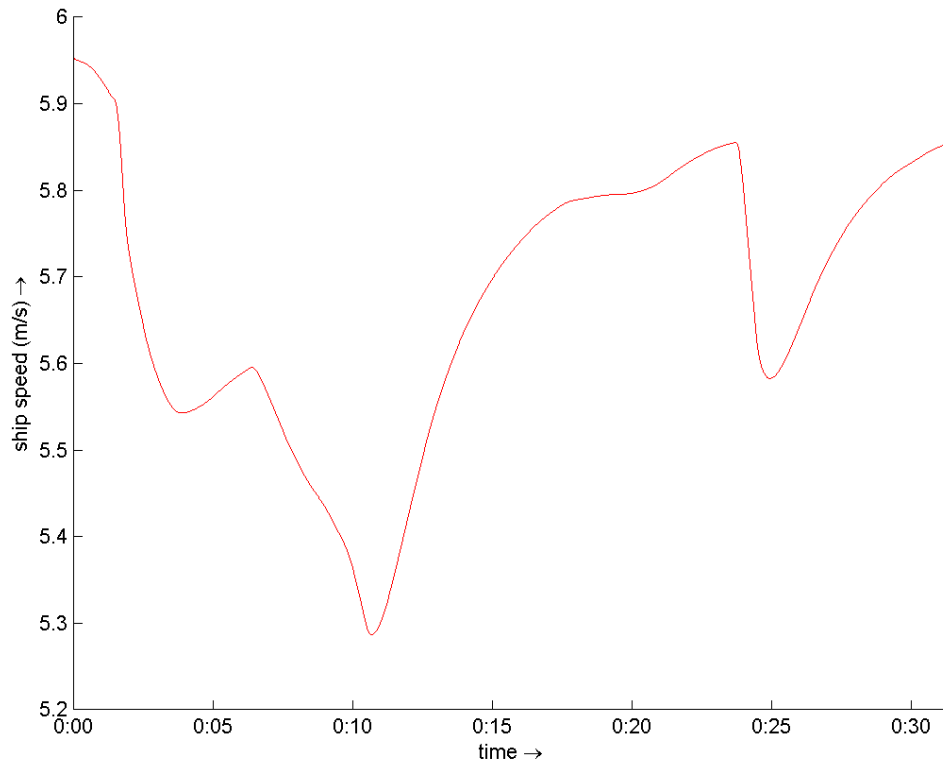


Figure 2.366: S.C. 46: SOG, vs. time.

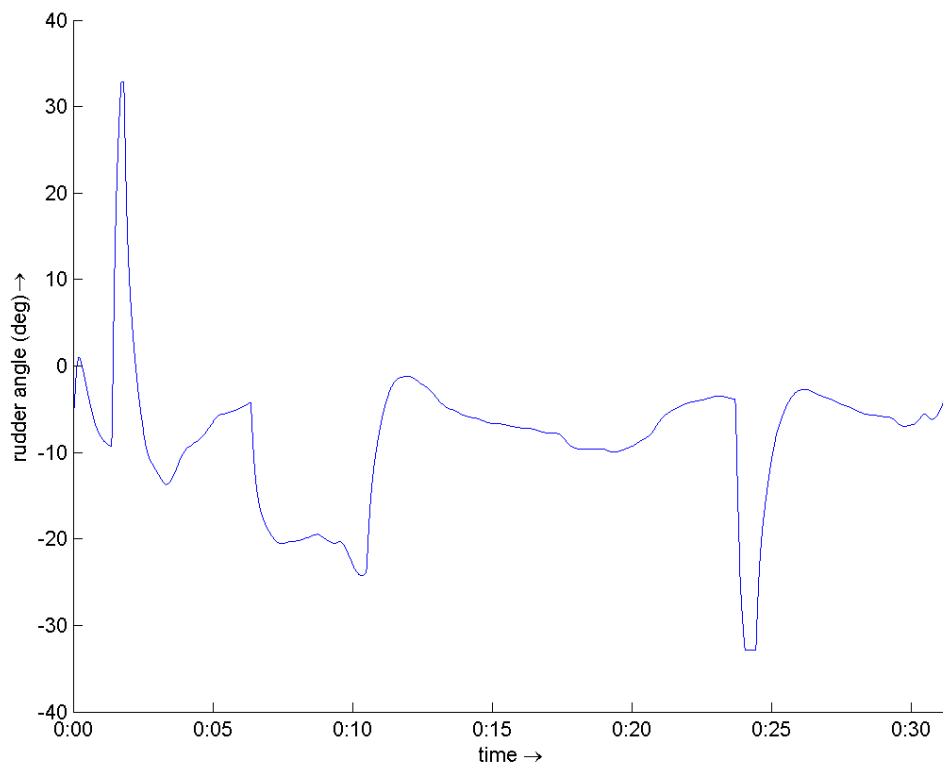


Figure 2.367: S.C. 46: rudder angle, vs. time.

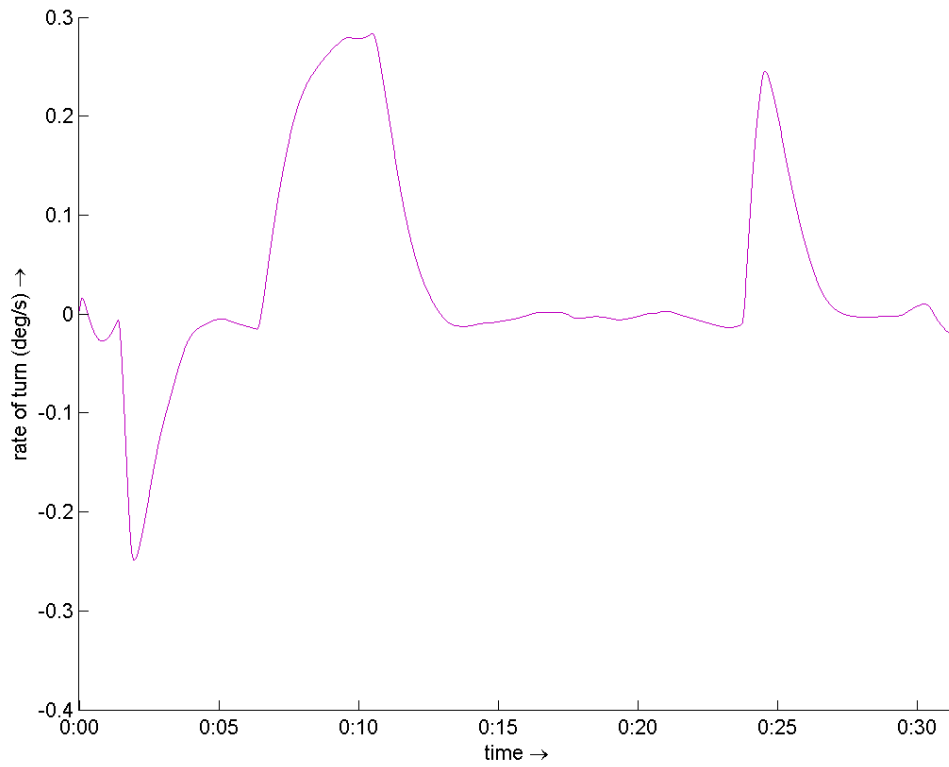


Figure 2.368: S.C. 46: RoT, vs. time.

## Simulation Case 47

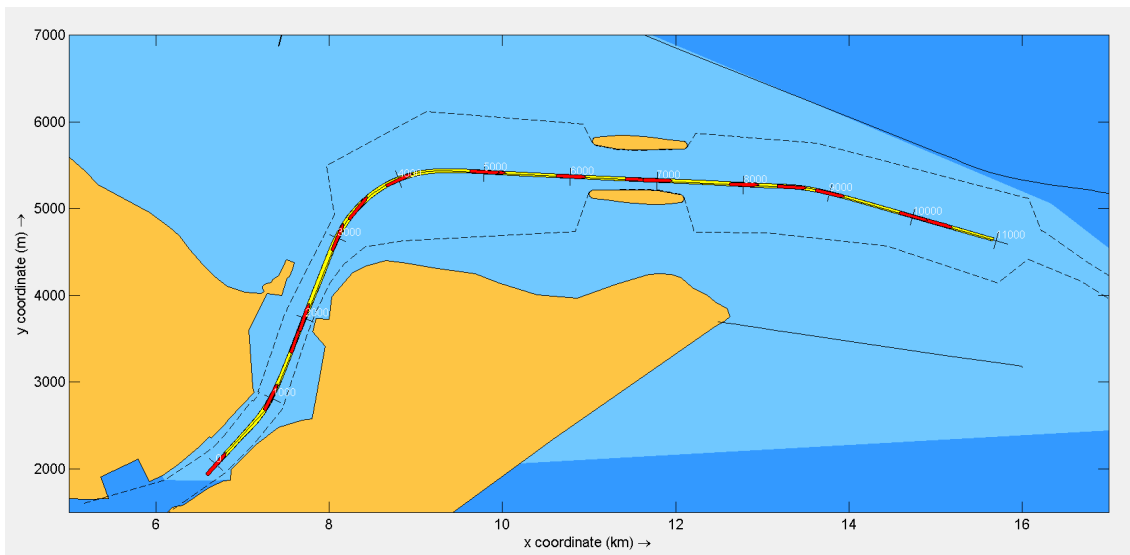
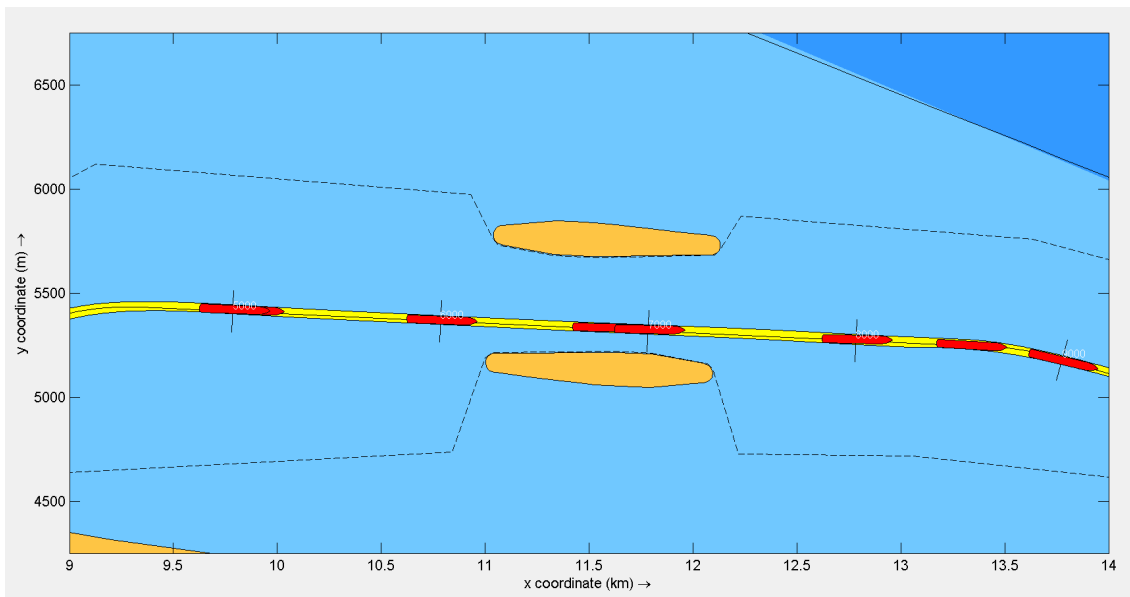


Figure 2.369: S.C. 47: spatial overview plot.



**Figure 2.370:** S.C. 47: zoom-in of spatial overview plot, crossing segment.

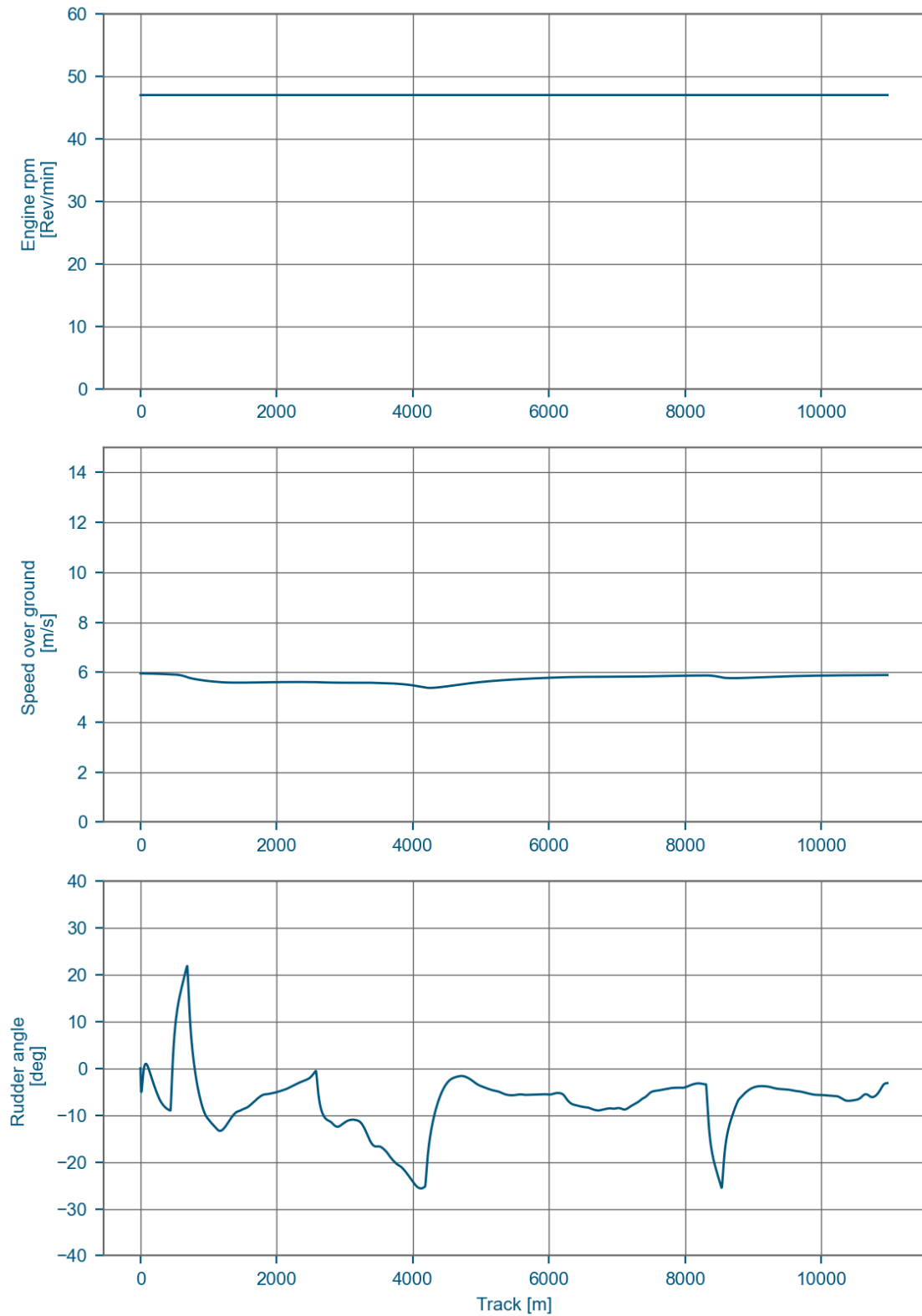


Figure 2.371: S.C. 47: engine RPM, SOG, rudder angle, vs. distance.

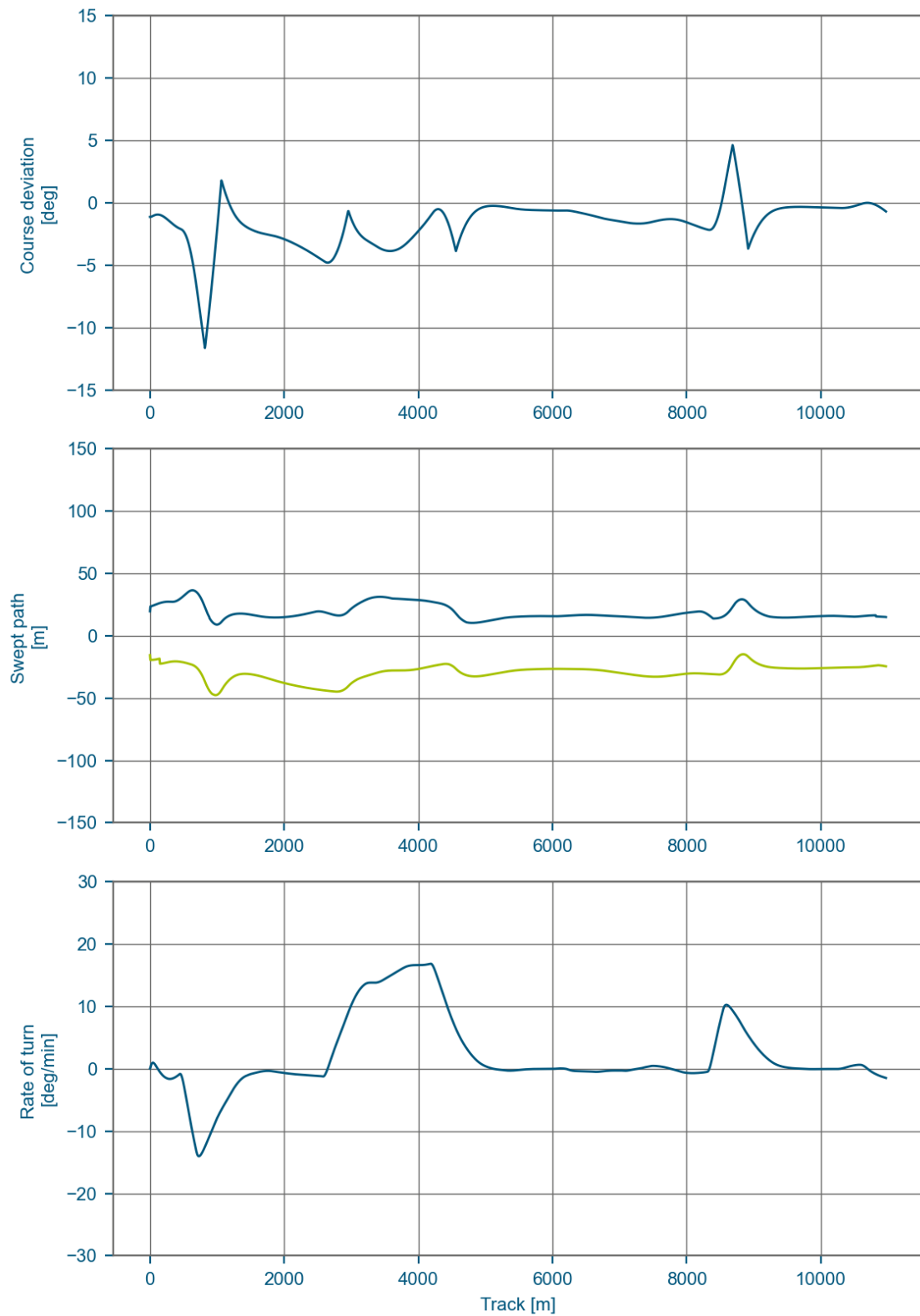


Figure 2.372: S.C. 47: course deviation (drift angle), swept path, RoT, vs. distance.

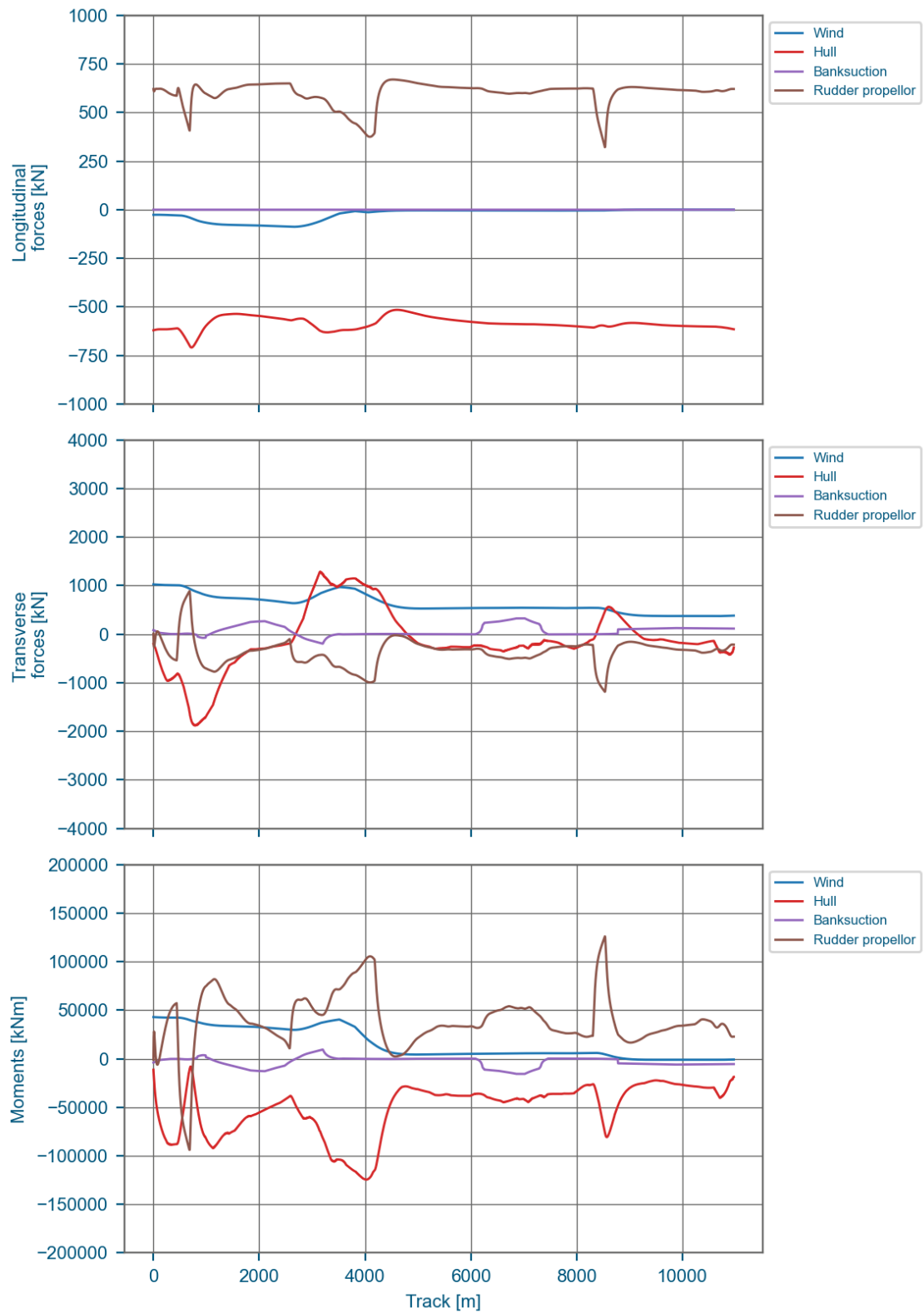


Figure 2.373: S.C. 47: forces, moments, vs. distance.

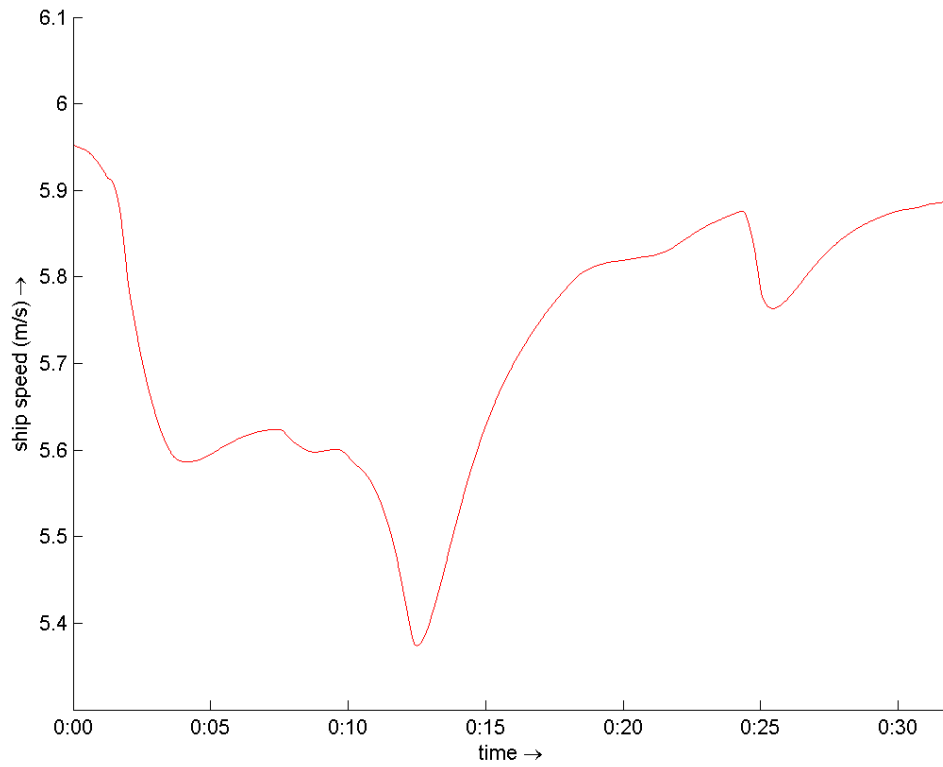


Figure 2.374: S.C. 47: SOG, vs. time.

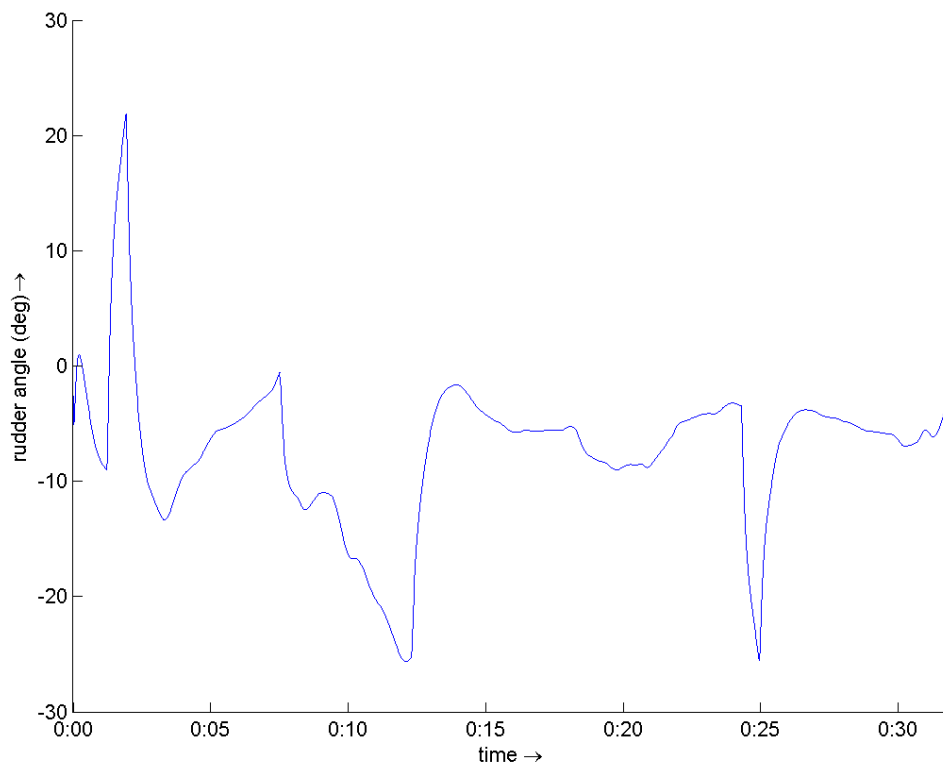


Figure 2.375: S.C. 47: rudder angle, vs. time.

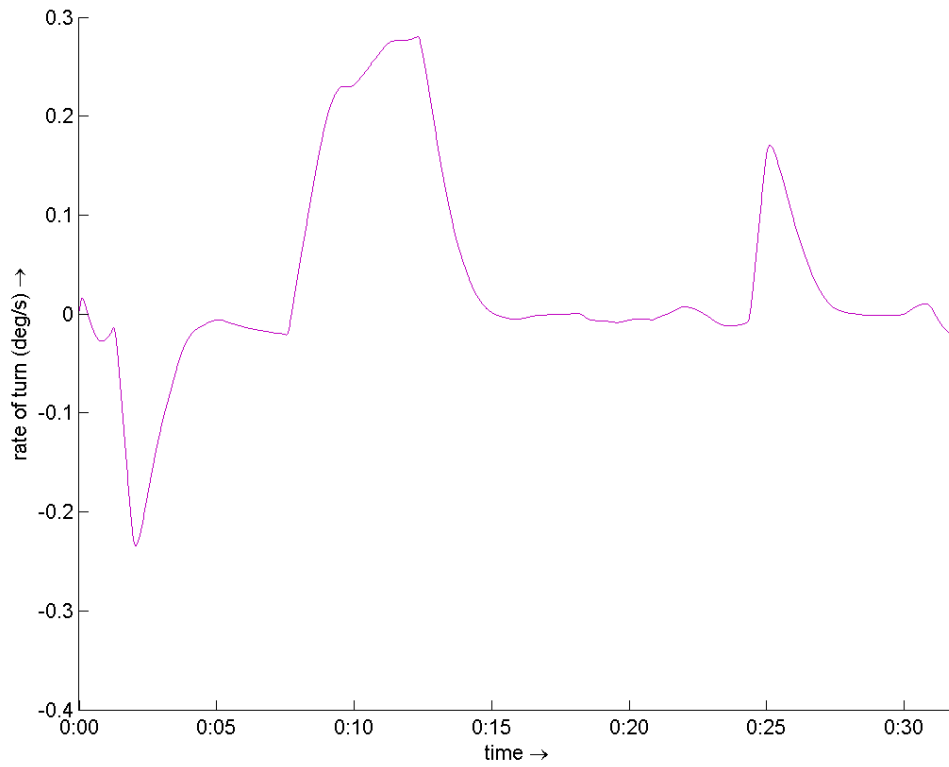


Figure 2.376: S.C. 47: RoT, vs. time.

## Simulation Case 48

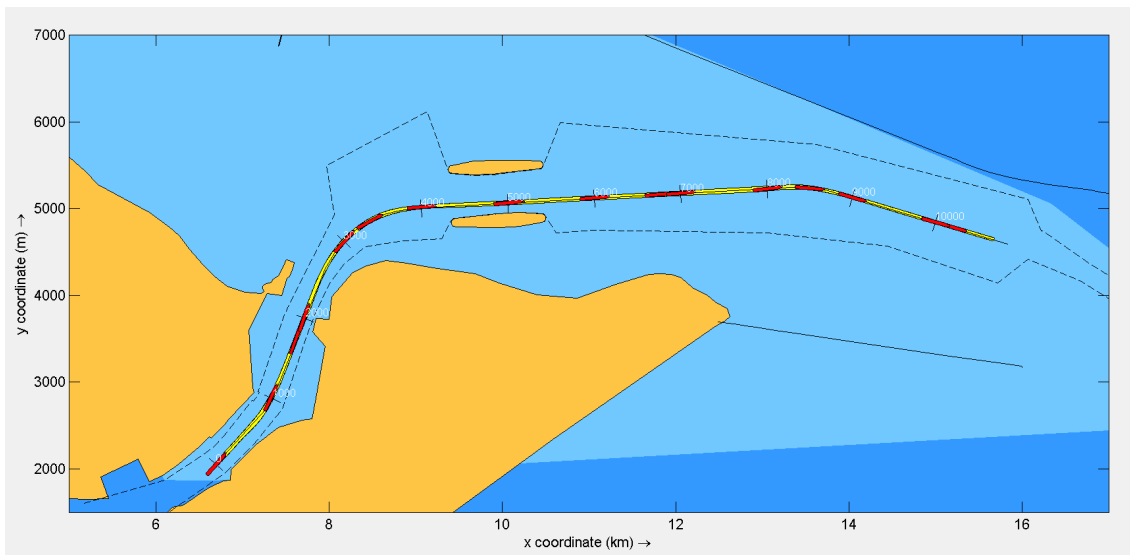
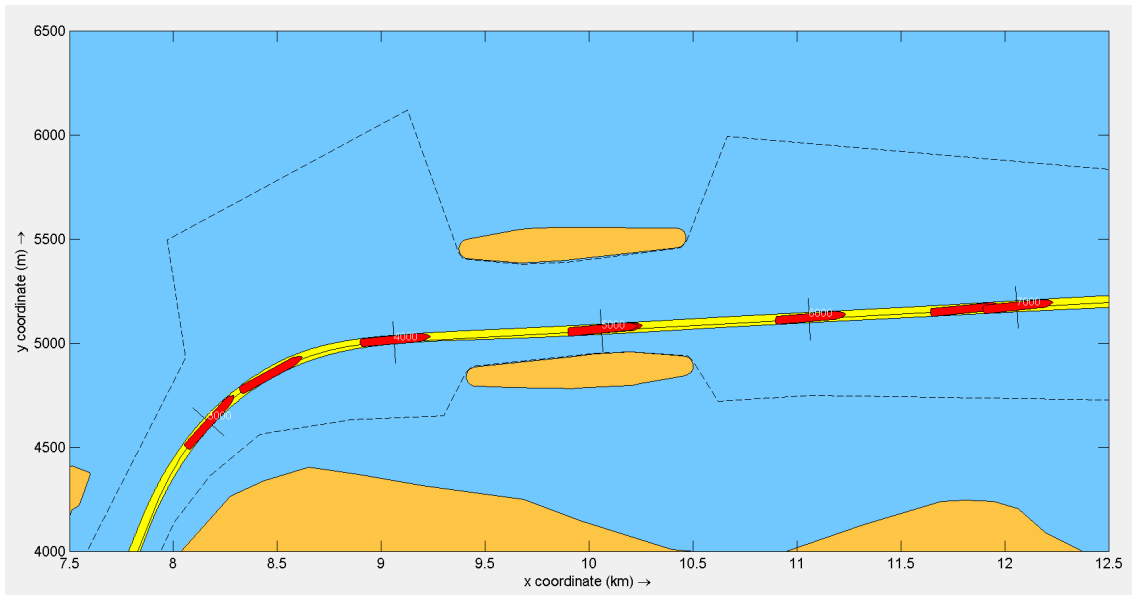


Figure 2.377: S.C. 48: spatial overview plot.



**Figure 2.378:** S.C. 48: zoom-in of spatial overview plot, crossing segment.

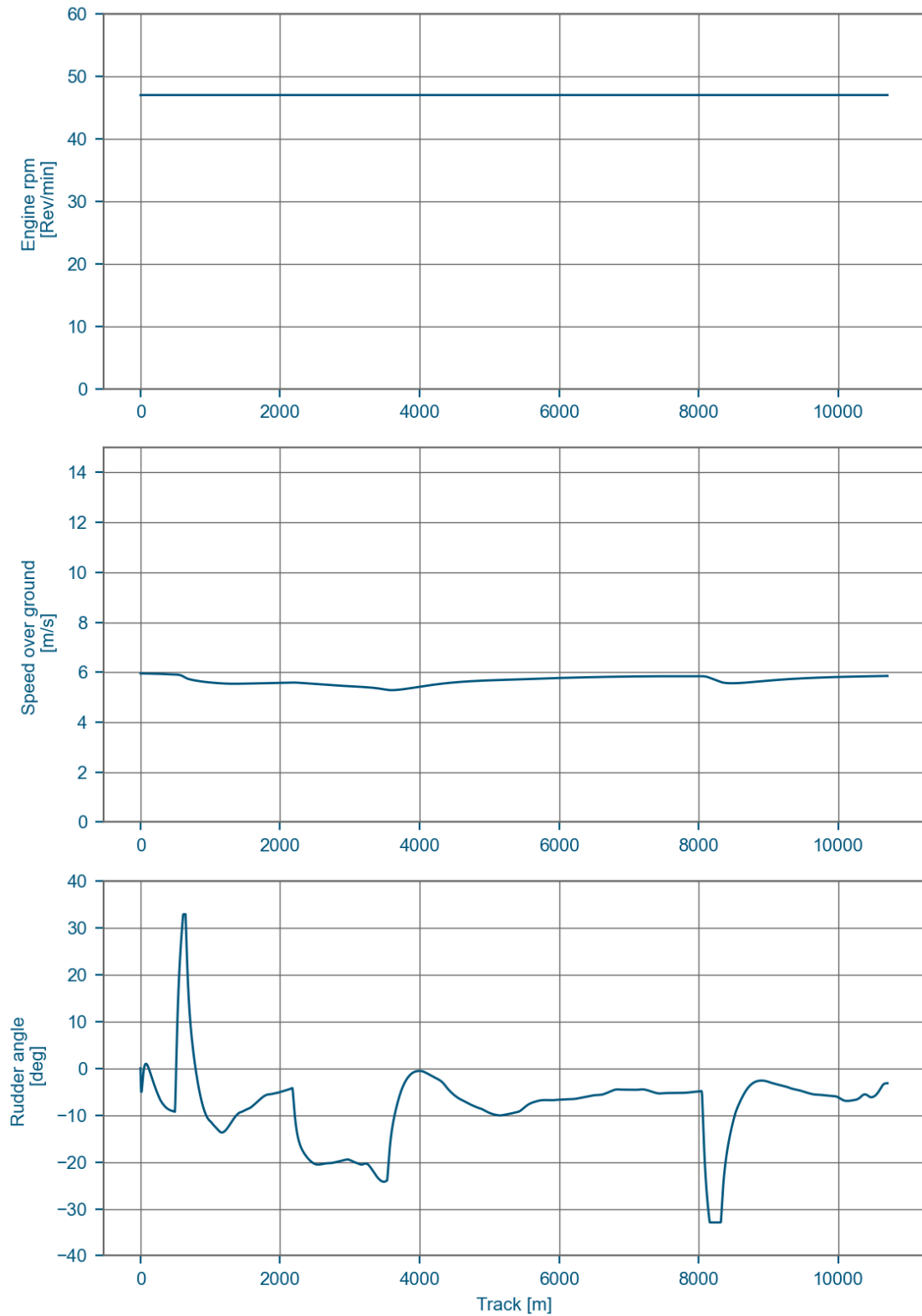


Figure 2.379: S.C. 48: engine RPM, SOG, rudder angle, vs. distance.

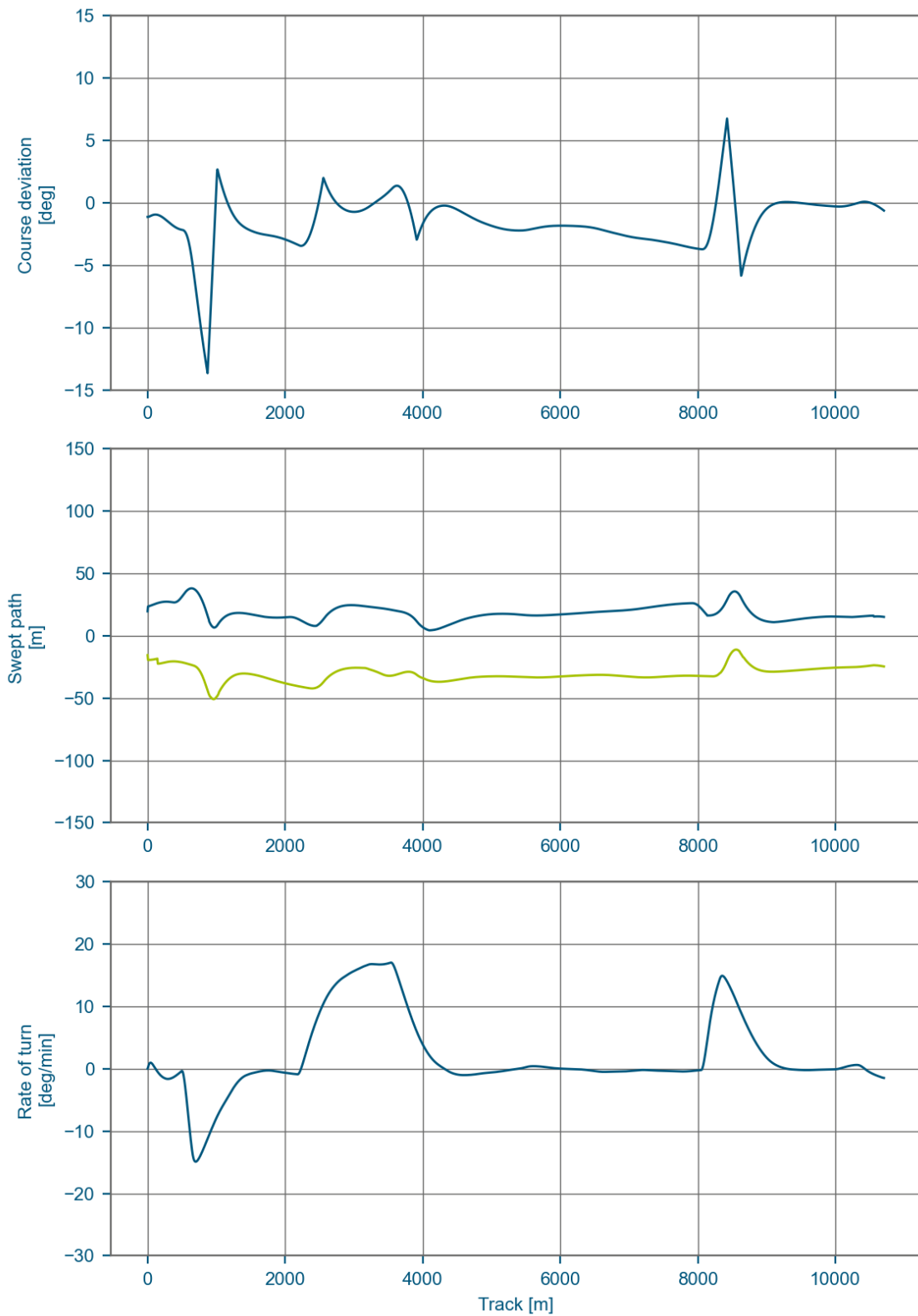


Figure 2.380: S.C. 48: course deviation (drift angle), swept path, RoT, vs. distance.

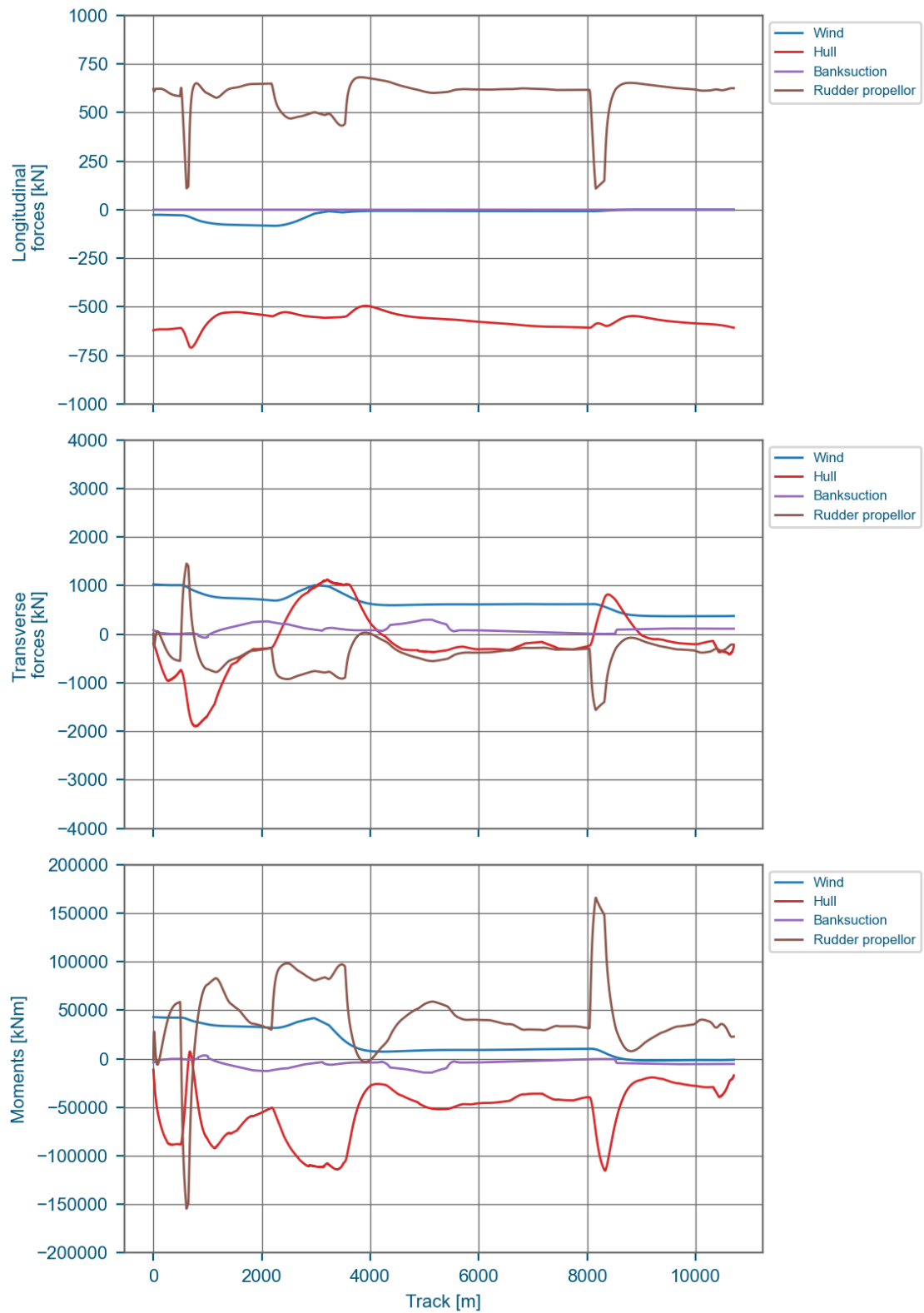


Figure 2.381: S.C. 48: forces, moments, vs. distance.

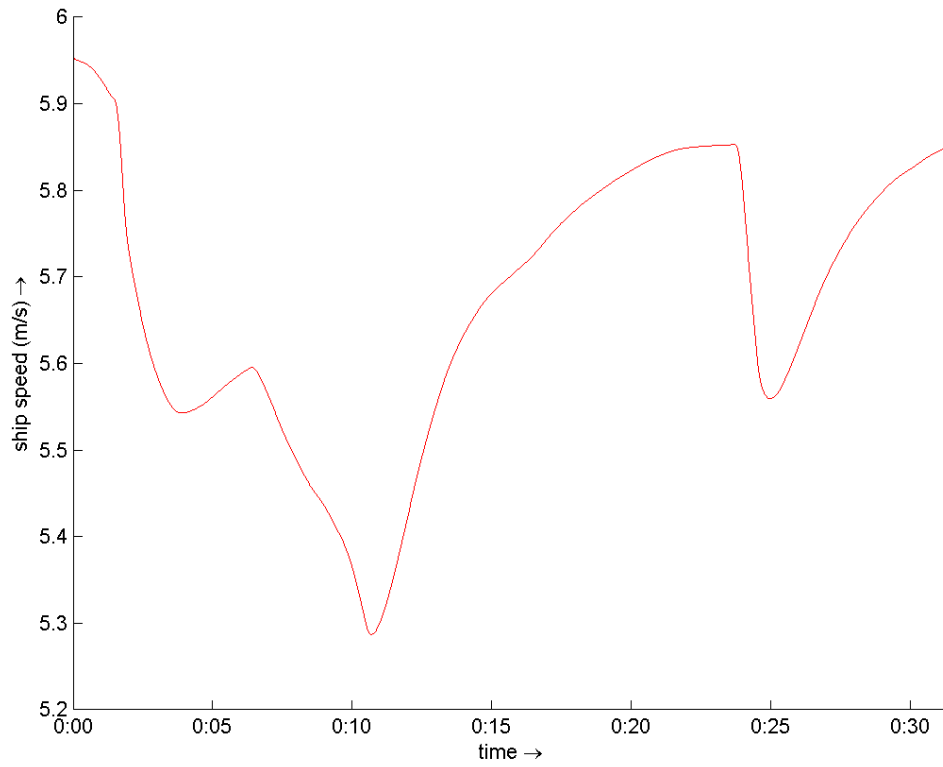


Figure 2.382: S.C. 48: SOG, vs. time.

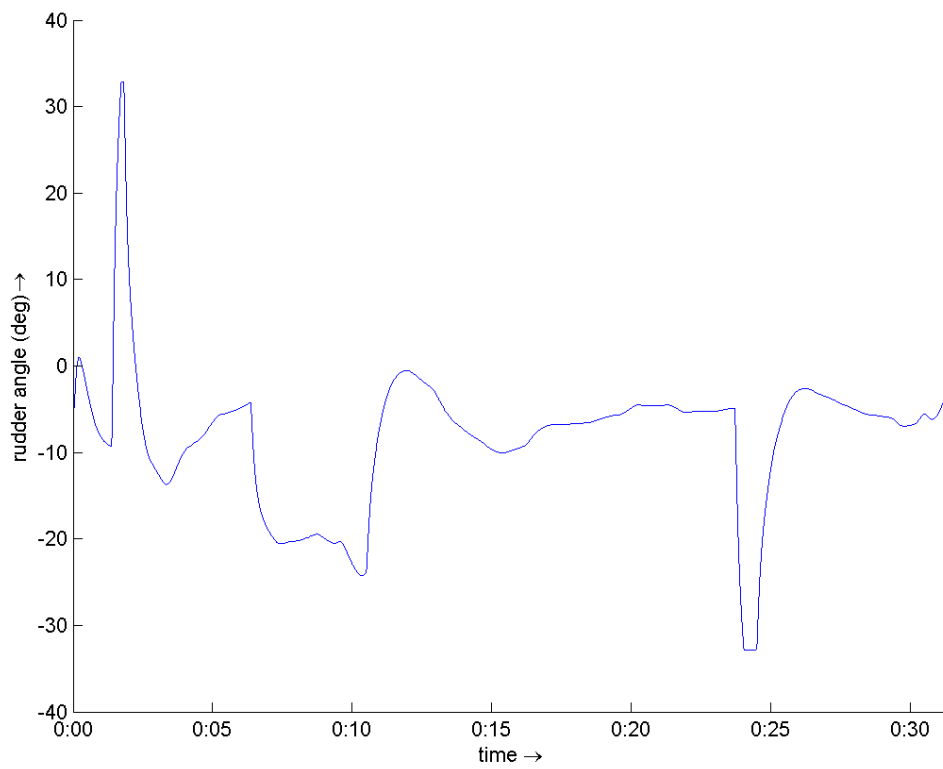
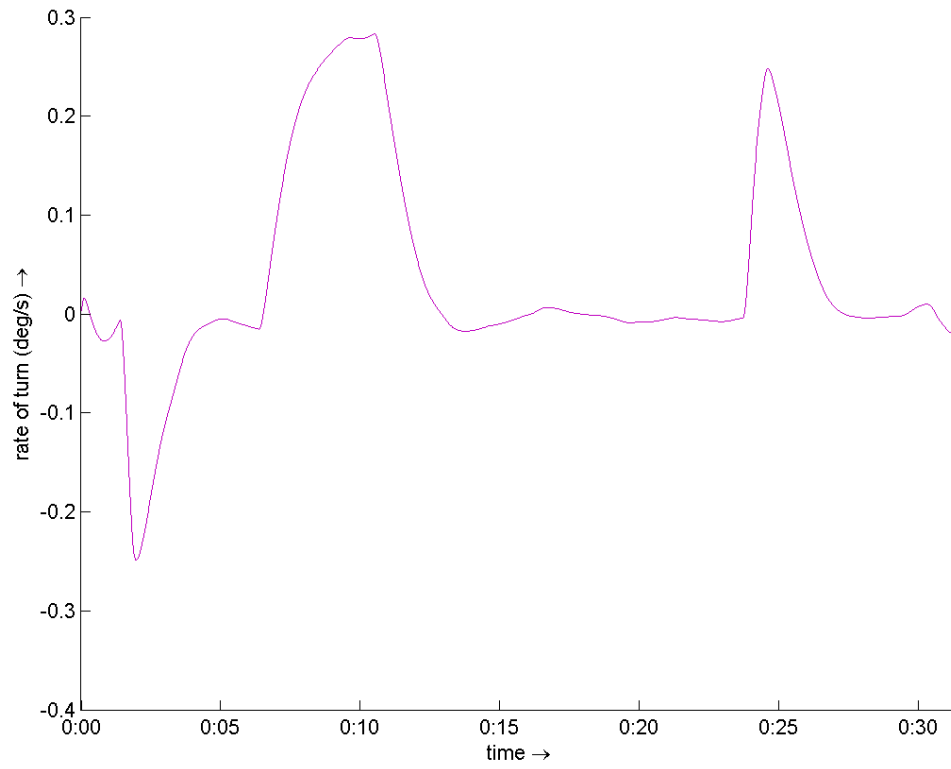


Figure 2.383: S.C. 48: rudder angle, vs. time.



**Figure 2.384:** S.C. 48: RoT, vs. time.