RTTOV v11.2 Performance Tests

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This documentation was developed within the context of the EUMETSAT Satellite Application Facility on Numerical Weather Prediction (NWP SAF), under the Cooperation Agreement dated 1 December, 2006, between EUMETSAT and the Met Office, UK, by one or more partners within the NWP SAF. The partners in the NWP SAF are the Met Office, ECMWF, KNMI and Météo France.

Change record			
Version	Date	Author / changed by	Remarks
1.0	17/06/14	David Rundle	Original draft

This document describes the tests performed to compare the performance of RTTOV v11.2 with that of RTTOV v11.1.

Tests were performed on IBM and Intel architectures. Calculations were performed for AMSU-A (all channels) and IASI (183 channels). Runs were carried out both with and without interpolation, for one profile at a time and for several profiles at a time (for AMSU-A only).

For AMSU-A, the FASTEM-5 surface emissivity model was used in both RTTOV v11.1 and v11.2. The ISEM emissivity model was used for IASI. The tests were set up identically for both versions with the same options being selected for each and the same 54 level coefficient files being used in both cases.

Tests 17-24 used a 54-level clear-sky profile and either a 54-level, version 7 predictor coefficient files or a 101-level, version 7 predictor coefficient file. Tests 25-32 used a 101-level clear-sky profile and either a 54-level, version 9 predictor coefficient files or a 101-level, version 9 predictor coefficient file.

Tests 33-36 used a 54-level clear-sky profile (ocean) and version 9 predictor coefficient file and the effects of Rayleigh scattered solar radiation were taken into account (VIS/NIR channels). RTTOV also modelled the surface reflectance.

Tests 37-56 used a 101-level clear-sky profile and a 101-level, version 9 predictor coefficient file for clear-sky calculations. Tests 37-48 used cloud and/or aerosol profiles on 101 levels. Tests 49-56 used a 101-level PC coefficient file.

The following table lists the clear-sky tests:

Test Number	Platform	Sensor	Coefs pred/levels	nchannels	nprofiles per call	Interp?	notes	Model
1	noaa	amsua	v7, 54	15	1	N		direct
2	noaa	amsua	v7, 54	15	10	N		direct
3	noaa	amsua	v7, 101	15	1	Y		direct
4	noaa	amsua	v7, 101	15	10	Y		direct
5	noaa	amsua	v7, 54	15	1	N		K
6	noaa	amsua	v7, 54	15	10	N		K
7	noaa	amsua	v7, 101	15	1	Y		K
8	noaa	amsua	v7, 101	15	10	Y		K
9	noaa	amsua	v7, 54	15	1	N		TL
10	noaa	amsua	v7, 54	15	10	N		TL
11	noaa	amsua	v7, 101	15	1	Y		TL
12	noaa	amsua	v7, 101	15	10	Y		TL
13	noaa	amsua	v7, 54	15	1	N		AD
14	noaa	amsua	v7, 54	15	10	N		AD
15	noaa	amsua	v7, 101	15	1	Y		AD
16	noaa	amsua	v7, 101	15	10	Y		AD
17	metop	iasi	v7, 54	183	1	Y		direct
18	metop	iasi	v7, 101	183	1	N		direct
19	metop	iasi	v7, 54	183	1	Y		K
20	metop	iasi	v7, 101	183	1	N		K
21	metop	iasi	v7, 54	183	1	Y		TL
21	metop	iasi	v7, 101	183	1	N		TL
23	metop	iasi	v7, 54	183	1	Y		AD
24	metop	iasi	v7, 101	183	1	N		AD
25	metop	iasi	v9, 54	183	1	Y		direct
26	metop	iasi	v9, 101	183	1	N		direct
27	metop	iasi	v9, 54	183	1	Y		K
28	metop	iasi	v9, 101	183	1	N		K
29	metop	iasi	v9, 54	183	1	Y		TL
30	metop	iasi	v9, 101	183	1	N		TL
31	metop	iasi	v9, 54	183	1	Y		AD
32	metop	iasi	v9, 101	183	1	N		AD

33	msg	seviri	v9, 54	3	1	N	solar	direct
34	msg	seviri	v9, 54	3	1	N	solar	K
35	msg	seviri	v9, 54	3	1	N	solar	TL
36	msg	seviri	v9, 54	3	1	N	solar	AD

The following table lists the cloud and aerosol-affected tests:

Test Number	Platform	Sensor	Coefs pred/levels	nchannels	nprofiles per call	Interp?	Notes	Model
37	metop	iasi	v9, 101	183	1	N	aer	direct
38	metop	iasi	v9, 101	183	1	N	aer	K
39	metop	iasi	v9, 101	183	1	N	aer	TL
40	metop	iasi	v9, 101	183	1	N	aer	AD
41	metop	iasi	v9, 101	183	1	N	cld	direct
42	metop	iasi	v9, 101	183	1	N	cld	K
43	metop	iasi	v9, 101	183	1	N	cld	TL
44	metop	iasi	v9, 101	183	1	N	cld	AD
45	metop	iasi	v9, 101	183	1	N	aer+cld	direct
46	metop	iasi	v9, 101	183	1	N	aer+cld	K
47	metop	iasi	v9, 101	183	1	N	aer+cld	TL
48	metop	iasi	v9, 101	183	1	N	aer+cld	AD

The following table lists the Principle Component tests:

Test Number	Platform	Sensor	Coefs pred/levels	channels/ pcscores	nprofiles per call	Reconstructed radiances/jacobians	Model
49	metop	iasi	v9, 101	300/100	1	N	direct
50	metop	iasi	v9, 101	300/100	1	N	K
51	metop	iasi	v9, 101	300/100	1	N	TL
52	metop	iasi	v9, 101	300/100	1	Y	AD
53	metop	iasi	v9, 101	300/100	1	Y	direct
54	metop	iasi	v9, 101	300/100	1	Y	K
55	metop	iasi	v9, 101	300/100	1	Y	TL
56	metop	iasi	v9, 101	300/100	1	Y	AD

Each test was run for a large number of profiles. The median result of 3 runs is reported here. The total number of profiles processed in each test is given in the following tables:

Tests 1-32:

AMSU-A Direct/TL/AD/K	10000 profiles
IASI direct/TL/AD	10000
IASI K	1000

Tests 33-36:

SEVIRI Direct/TL/AD/K	100000 profiles

Tests 37-56:

IASI Direct/TL/AD	1000 profiles
IASI K	100

The timing results are shown in the table on the following page; all times given are times *per profile* in ms. Notes on results:

- All timings were taken from the RTTOV test suite.
- ifort version 14.0.3 and gfortran 4.4.6 (distributed with RHEL 6.4) was used on the Intel platform and XLF 14.1 was used on an IBM POWER7 supercomputer.
- For clear-sky simulations (Tests 1-36) RTTOV v11.2 generally runs as fast as RTTOV v11.1. There is a moderate improvement in performance for the K code on all platforms.
- Performance using the gfortran compiler has regressed slightly. This will be investigated and addressed in future updates.
- Simulated solar-affected channels (tests 33-36) are significantly faster, especially the K code and particularly so on the Intel platform.
- For cloud and aerosol-affected simulations, the RTTOV v11.2 code is significantly faster than RTTOV v11.1 for all codes.
- For simulations using PC-RTTOV, the RTTOV v11.2 code is significantly faster than RTTOV v11.1 for the K code and slightly faster in the direct and tangent linear using ifort.
- Tests that are at least 10% faster for RTTOV 11.2 vs 11.1 are highlighted in green and those that are 10% slower are highlighted in red. Tests that are over 5% faster but less than 10% faster are highlighted in orange whereas those that are between 5% and 10% slower are highlighted in orange

Test Number	Intel gfortran v11.1	Intel gfortran v11.2	Intel gfortran v11.1:v11.2	Intel ifort v11.1	Intel ifort v11.2	Intel ifort v11.1:v11.2	IBM v11.1	IBM v11.2	IBM v11.1:v11.2
1	0.134	0.141	0.95	0.083	0.080	1.03	0.097	0.094	1.03
2	0.121	0.126	0.96	0.067	0.065	1.03	0.071	0.074	0.96
3	0.236	0.249	0.95	0.130	0.130	1.00	0.150	0.150	1.00
4	0.203	0.215	0.95	0.109	0.106	1.02	0.132	0.122	1.08
5	0.348	0.351	0.99	0.267	0.253	1.06	0.301	0.288	1.05
6	0.365	0.387	0.94	0.276	0.257	1.07	0.365	0.347	1.05
7	0.714	0.745	0.96	0.391	0.397	0.99	0.444	0.441	1.01
8	0.671	0.694	0.97	0.405	0.401	1.01	0.546	0.536	1.02
9	0.228	0.229	0.99	0.152	0.151	1.01	0.184	0.181	1.02
10	0.198	0.208	0.95	0.123	0.121	1.01	0.145	0.145	1.00
11	0.402	0.410	0.98	0.236	0.243	0.97	0.287	0.281	1.02
12	0.344	0.350	0.98	0.199	0.198	1.00	0.248	0.250	0.99
13	0.258	0.262	0.99	0.181	0.178	1.02	0.205	0.204	1.01
14	0.228	0.241	0.94	0.148	0.149	1.00	0.167	0.172	0.97
15	0.483	0.521	0.93	0.274	0.282	0.97	0.323	0.326	0.99
16	0.416	0.456	0.91	0.237	0.240	0.99	0.302	0.301	1.00
17	1.56	1.69	0.93	0.75	0.78	0.96	1.04	1.10	0.95
18	2.73	2.76	0.99	1.24	1.29	0.97	1.77	1.75	1.01
19	5.18	5.14	1.01	3.57	3.51	1.02	5.24	5.05	1.04
20	8.97	9.25	0.97	5.23	5.37	0.97	7.58	7.54	1.01
21	2.60	2.67	0.97	1.34	1.39	0.96	2.00	2.04	0.98
22	4.18	4.29	0.97	2.29	2.33	0.98	3.13	3.17	0.99
23	2.97	3.07	0.97	1.71	1.77	0.97	2.77	2.47	1.12
24	5.31	5.52	0.96	2.81	2.87	0.98	4.05	4.09	0.99
25	3.23	3.36	0.96	1.88	1.80	1.04	2.02	1.97	1.02
26	4.07	4.14	0.98	2.17	2.10	1.04	2.34	2.35	1.00
27	25.54	24.26	1.05	16.49	15.05	1.10	20.03	19.51	1.03
28	24.91	23.12	1.08	16.59	15.41	1.08	19.81	19.69	1.01
29	6.04	6.02	1.00	3.71	3.47	1.07	3.86	3.79	1.02
30	6.99	7.13	0.98	4.11	3.92	1.05	4.24	4.28	0.99
31	7.24	7.24	1.00	5.11	5.07	1.01	6.53	6.25	1.04
32	8.69	8.25	1.05	5.76	5.65	1.02	7.08	7.14	0.99
33	0.302	0.267	1.13	0.186	0.165	1.13	0.167	0.164	1.02
34	0.435	0.376	1.16	0.326	0.259	1.26	0.289	0.269	1.07
35	0.443	0.400	1.11	0.342	0.277	1.24	0.304	0.277	1.10
36	0.591	0.493	1.20	0.517	0.338	1.53	0.443	0.397	1.12

Test Number	Intel gfortran v11.1	Intel gfortran v11.2	Intel gfortran v11.1:v11.2	Intel ifort v11.1	Intel ifort v11.2	Intel ifort v11.1:v11.2	IBM v11.1	IBM v11.2	IBM v11.1:v11.2
37	7.67	6.58	1.17	4.28	3.42	1.25	4.84	4.03	1.20
38	39.80	33.00	1.21	25.70	21.10	1.22	31.20	27.10	1.15
39	15.03	11.45	1.31	9.20	6.90	1.33	9.96	7.68	1.30
40	19.45	13.96	1.39	12.56	9.36	1.34	15.30	11.58	1.32
41	129.84	104.96	1.24	65.34	47.72	1.37	63.70	44.24	1.44
42	265.00	199.70	1.33	174.40	112.10	1.56	228.30	156.00	1.46
43	223.89	182.91	1.22	120.58	87.71	1.37	118.63	84.48	1.40
44	241.09	192.06	1.26	146.63	99.94	1.47	191.98	121.89	1.58
45	122.79	108.16	1.14	64.89	48.78	1.33	63.69	45.39	1.40
46	277.20	217.70	1.27	166.00	116.40	1.43	230.20	159.80	1.44
47	222.33	191.46	1.16	121.87	88.87	1.37	118.65	86.08	1.38
48	251.63	201.66	1.25	148.12	102.62	1.44	194.69	124.23	1.57
49	6.40	6.71	0.95	4.45	4.05	1.10	4.38	4.49	0.98
50	71.70	57.30	1.25	62.10	41.20	1.51	84.80	53.70	1.58
51	10.95	11.18	0.98	8.00	7.30	1.10	7.75	7.91	0.98
52	12.15	12.74	0.95	10.17	9.94	1.02	11.91	12.05	0.99
53	6.45	6.68	0.97	4.18	3.75	1.11	4.25	4.28	0.99
54	192.90	81.90	2.36	178.50	52.50	3.40	118.10	71.80	1.64
55	11.08	11.41	0.97	7.96	7.04	1.13	7.68	7.83	0.98
56	12.20	12.95	0.94	10.06	9.85	1.02	11.78	11.73	1.00