



Met Office

What can RTTOV-9 do for me?

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Pascal Brunel and Philippe Marguinaud (MeteoFrance)

Talk outline

- What is RTTOV? **R**adiative **T**ransfer for **TOVs**
- Differences from RTTOV-8
- Coefficient files
- Profile Interpolation
- Performance on various platforms
- How do I get it?
- Performance for IASI (Marco's talk)

What is RTTOV?

View angle +
sun angles



Estimate of atmospheric state
and surface parameters for
observation point X



**RT model
for required sensor**



Time ~ 1ms
for 20 chans

Radiances for required satellite channels $y=H(X)$
and optionally jacobians $H \equiv \frac{\partial y_i}{\partial X_j}$
as TL, AD, or K

RTTOV status

RTTOV-87 status released May 2005

Number of licence requests = 313

RTTOV-91 status released Mar 2008

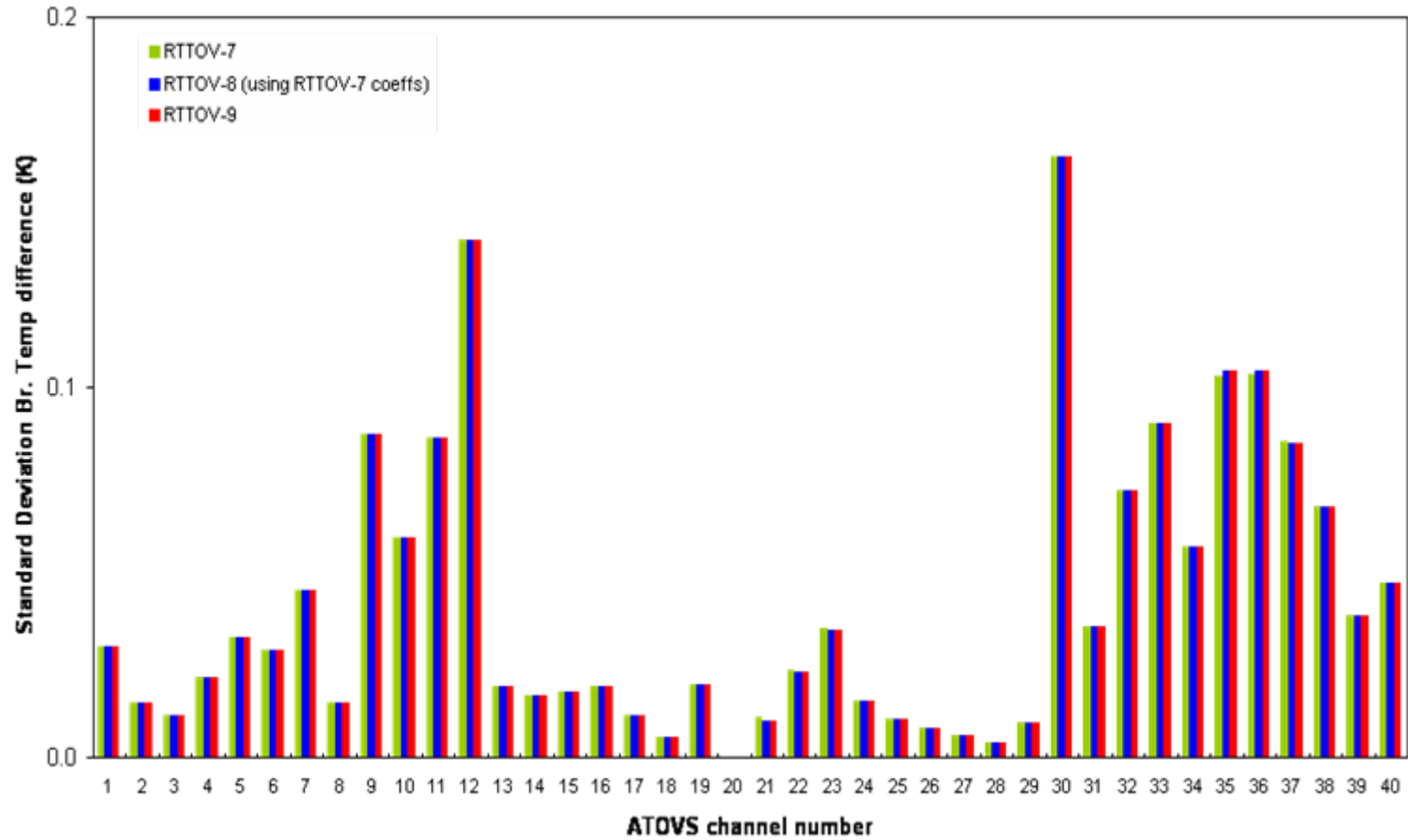
Number of licence requests = 53



Differences from RTTOV-8

- Parameterised aerosol scattering for a range of user aerosol components
- New cloud parameterised scattering for infrared sensors inside RTTOV
- Linear in optical depth approximation for the Planck function to improve the accuracy of the radiance computation
- Include reflected solar radiation for wavelengths below 5 microns.
- Now six variable gas profiles which can be supplied to RTTOV (H_2O , O_3 , CO_2 , + N_2O , CO , CH_4)
- Further optimisation of optical depth computations for all gases for high resolution IR sensors (RTTOV-9 predictors)
- An altitude dependent variation of local zenith angle and optionally allow for atmospheric refraction
- The input profile levels can be defined by user and the radiances and transmittances output are on the same levels allowing better mapping of computed jacobians on to user levels
- Simplified interface to avoid need to specify polarisation (NB SSM/I chan numbers)
- The 2m surface humidity variable can now be an active variable in the state vector
- The Mie scattering tables used by RTTOV_SCATT updated to increase their dynamic range

Performance for ATOVS



New coefficient files available

MeghaTropiques

- Saphir and Madras (to be updated)

DMSP-F14

- SSM/T-2

Coming soon:

DMSP-F17 SSMIS

FY-3 sensors

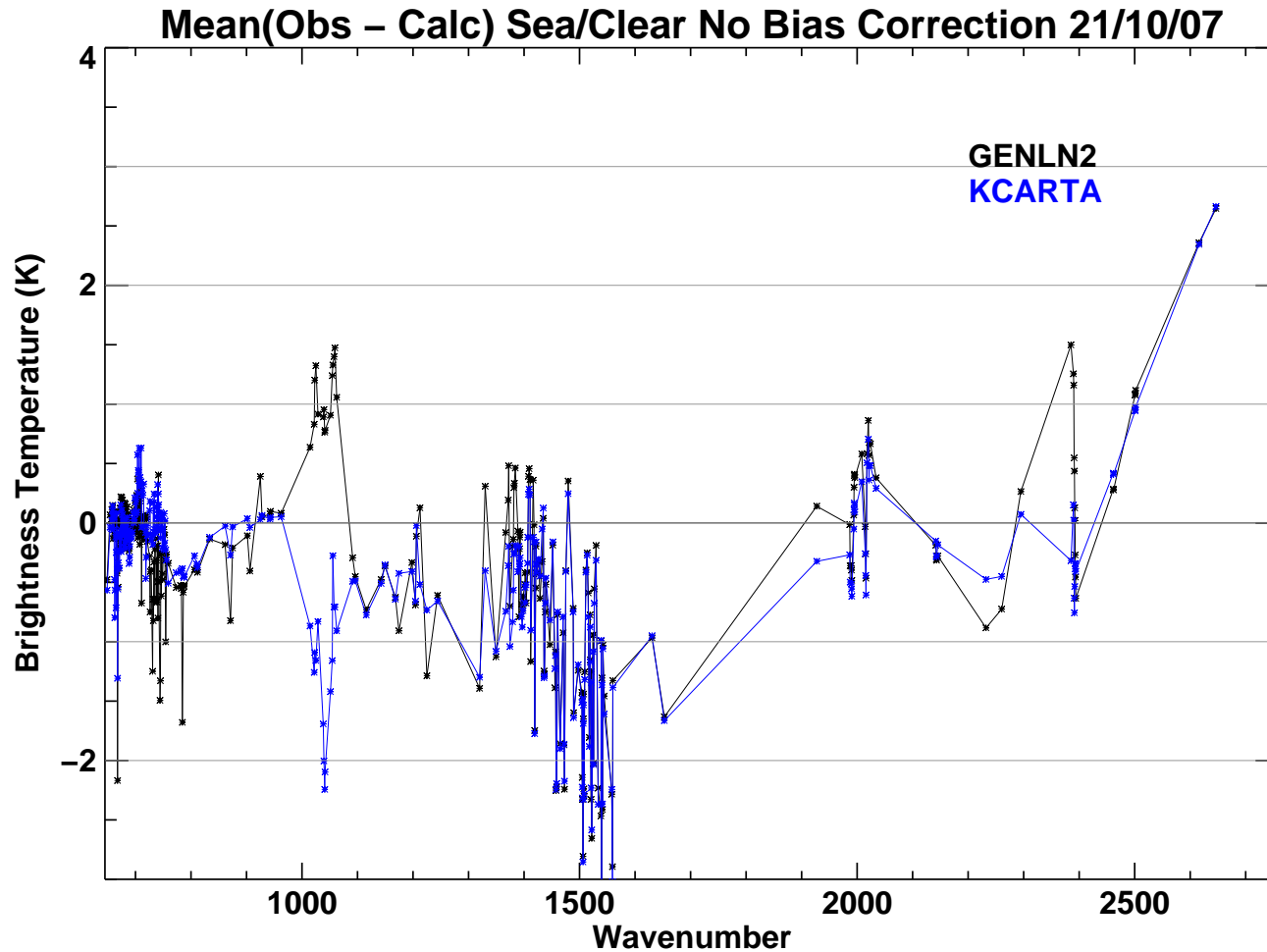
NPP sensors

RTTOV-9 coefficient files

Infrared

- Radiometers
 - GENLN2 RTTOV-7 predictors
- IASI/AIRS options:
 - GENLN2 RTTOV-7
 - kCarta RTTOV-7 (METO ops, ECMWF ops)
 - GENLN2 RTTOV-9 (all trace gases)
 - LBLRTM coming soon with new 90L profile set

Comparison of GENLN2 vs kCarta



RTTOV coefficient file options

Gas	RTTOV-7 Code RTTOV-7 predictors only		RTTOV-8 code RTTOV-7/8 predictors (NB only 7 for MW)		RTTOV-9 code RTTOV-7/8/9 predictors (7 for MW, 9 for Hires)	
	Profile	Coeffs	Profile	Coeffs	Profile	Coeffs
Mixed	Y	Y	Y	Y	Y	Y
H2O	Y	Y	Y	Y	Y	Y
O3	Y	O	O	O	O	O
CO2	N	N	O	O	O	O
N2O	N	N	N	N	O	O
CO	N	N	N	N	O	O
CH4	N	N	N	N	O	O

Y=Mandatory
O=Optional
N=Not possible

All 43 levels except AIRS/IASI which can be 101 levels

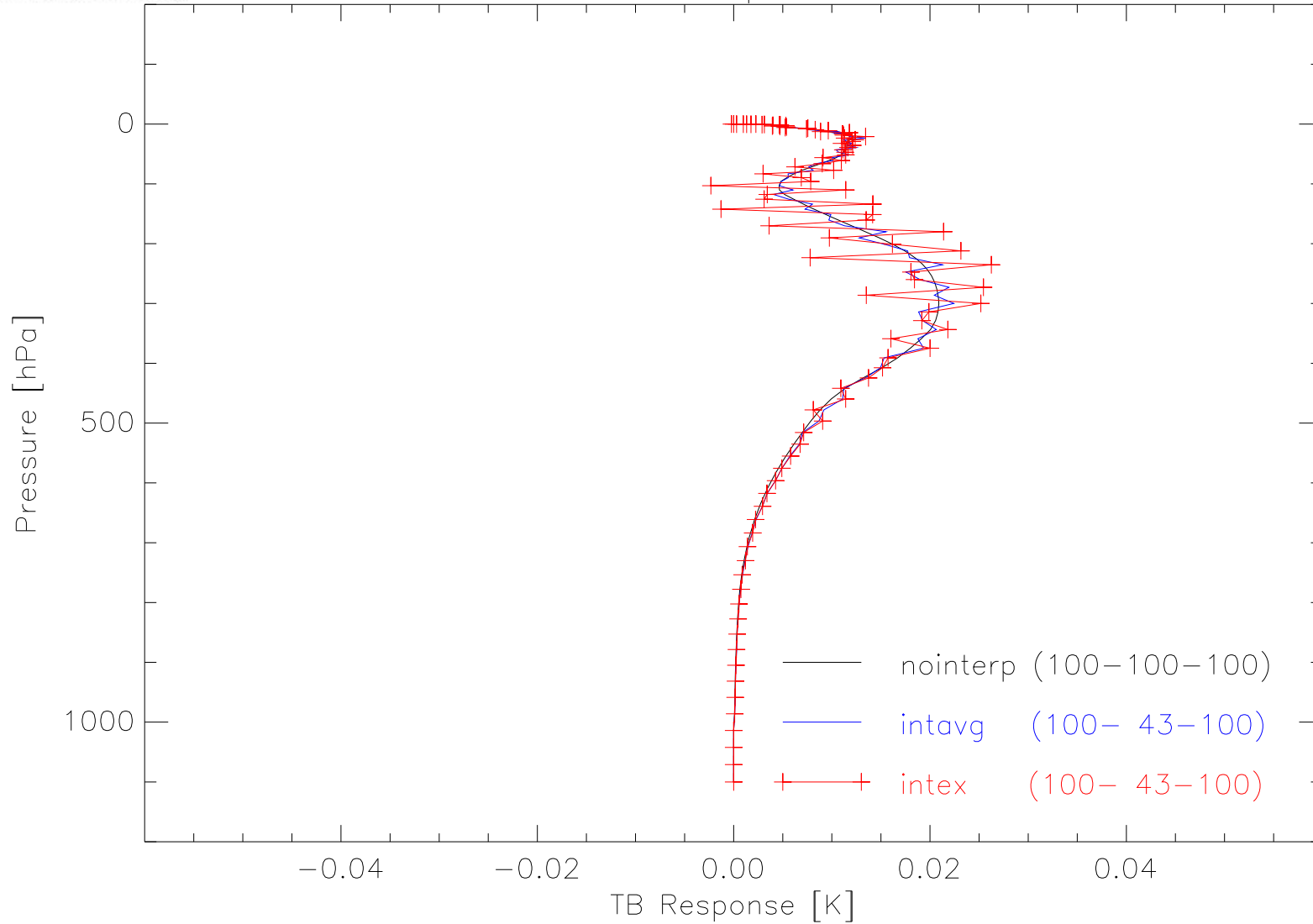
N.B. + Planck weighted coeff files for a few sensors with broad spectral channels (e.g. SEVIRI)

Interpolation of user profile

- The interpolator 'INTAVG' was developed by Yves Rochon et al. (Environment Canada) *ITSC-15 and paper in QJRMS*
- INTAVG avoids the problem of 'blind levels' because all source levels eventually contribute
- Weights applied to user input profile values
- Output profile integrated over weighted input values

Interpolation 100 (user) 43 (rttov)

HIRS Chan-04: Temperature Jacobians



Aerosol types available

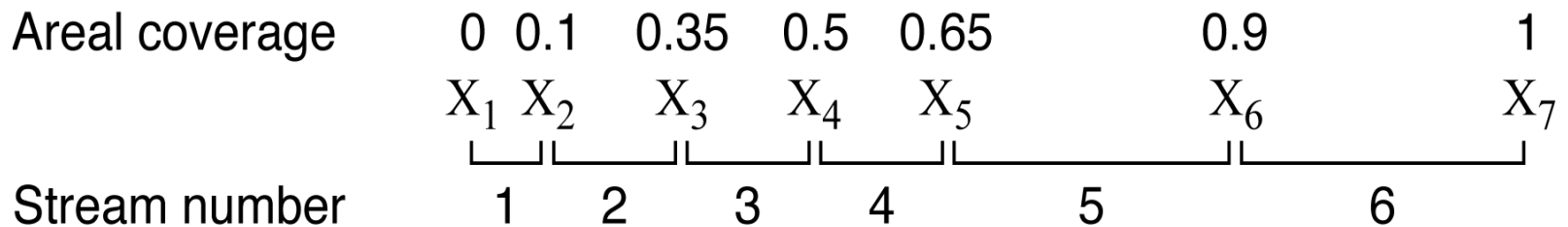
Column 1:	Insoluble	(INSO)
Column 2:	Water soluble	(WASO)
Column 3:	Soot	(SOOT)
Column 4:	Sea salt (acc. mode)	(SSAM)
Column 5:	Sea salt (coa. mode)	(SSCM)
Column 6:	Mineral (nuc. mode)	(MINM)
Column 7:	Mineral (acc. mode)	(MIAM)
Column 8:	Mineral (coa. mode)	(MICM)
Column 9:	Mineral transported	(MITR)
Column 10:	Sulphate droplets	(SUSO)
Column 11:	Volcanic ash	(VOLA)

Different types of cloud parameterised

Column 1:	Stratus Continental	(STCO)
Column 2:	Stratus Maritime	(STMA)
Column 3:	Cumulus Continental Clean	(CUCC)
Column 4:	Cumulus Continental Polluted	(CUCP)
Column 5:	Cumulus Maritime	(CUMA)
Column 6:	Cirrus	(CIRR)

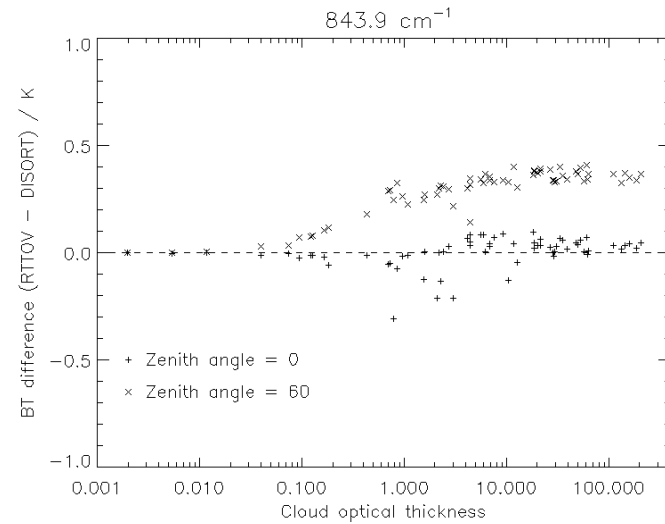
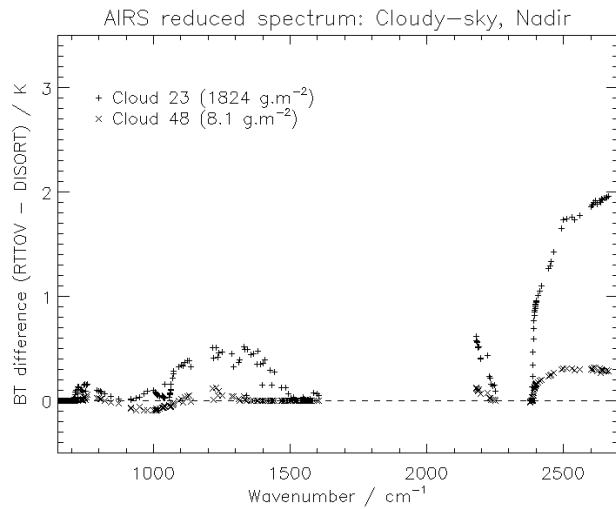
Representation of cloud

Layer	CFR (%)	Cloud displacement in each stream					
1	0	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow
2	50	Blue	Blue	Blue	Yellow	Yellow	Yellow
3	0	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow
4	30	Yellow	Yellow	Blue	Blue	Yellow	Yellow
5	80	Yellow	Blue	Blue	Blue	Blue	Yellow
6	0	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow
7	0	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow



$$L^{cloudy} = \sum_{s=1}^{n_c} (X_{s+1} - X_s) L_s^{overcast} + L^{clear} (1 - X_{n_c+1})$$

Validation of cloudy simulations



Radiative impact of stratus maritime cloud type (left) and difference between RTTOV and DISORT calculations (right) for two different cloud profiles.

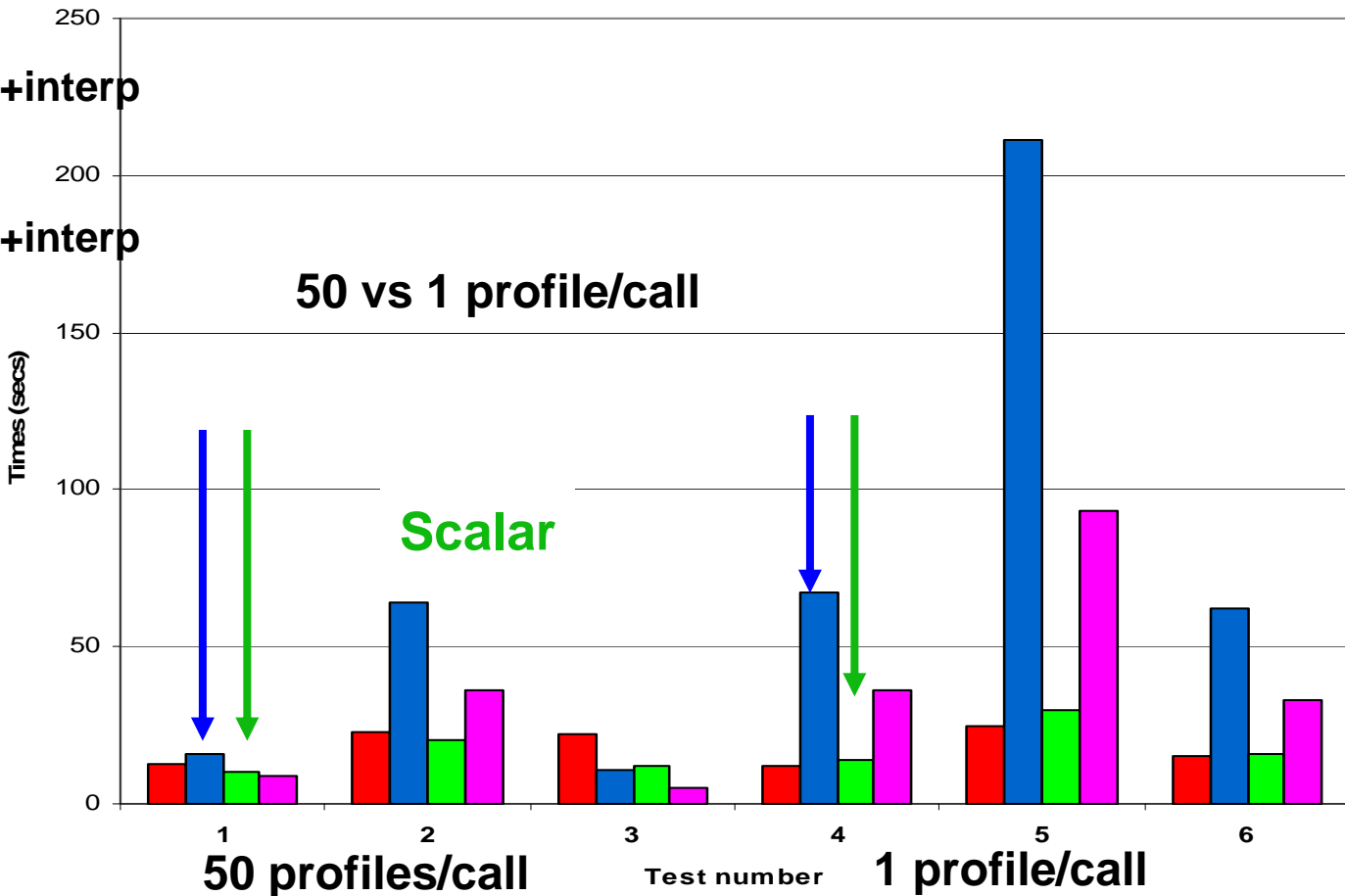


Forward model times 50,000 profiles for AMSU-A and HIRS

RTTOV-9 Timings

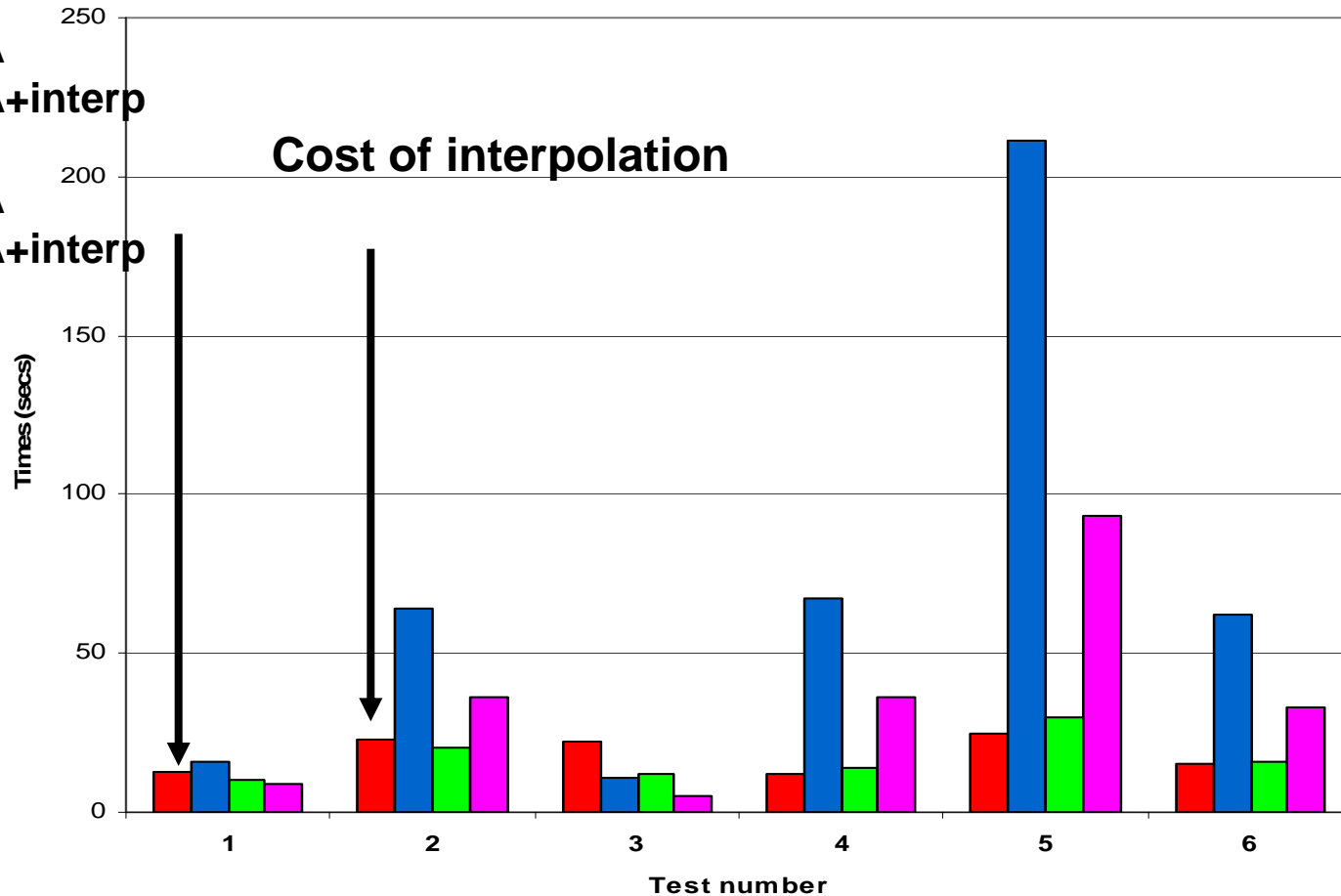


- 1=AMSU-A
- 2=AMSU-A+interp
- 3=HIRS
- 4=AMSU-A
- 5=AMSU-A+interp
- 6=HIRS



Interpolation costs (official version)

RTTOV-9 Timings



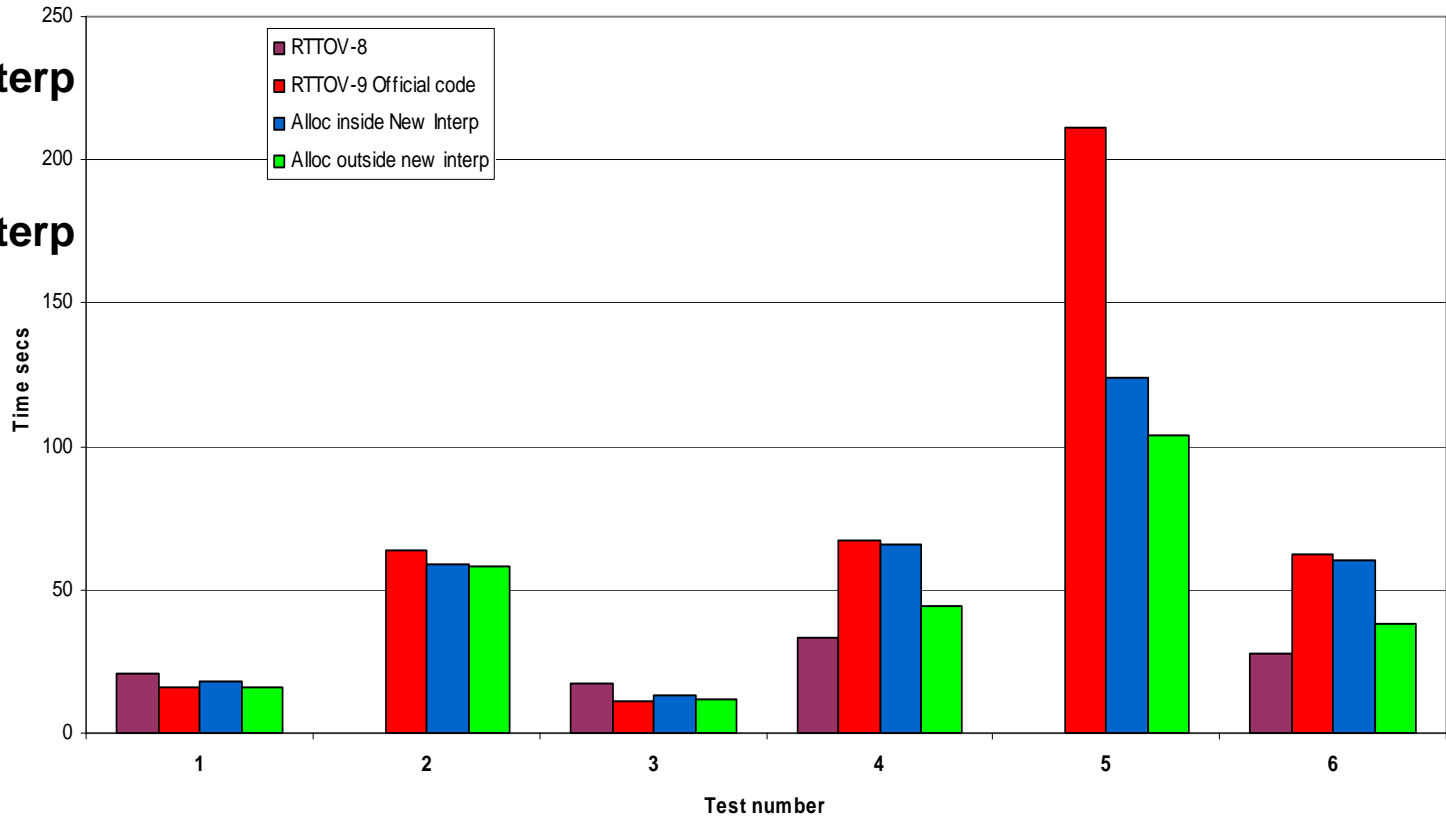
1=AMSU-A
 2=AMSU-A+interp
 3=HIRS
 4=AMSU-A
 5=AMSU-A+interp
 6=HIRS



RTTOV-8 vs RTTOV-9 vs 9+

RTTOV timings on Met Office NEC

- 1=AMSU-A
- 2=AMSU-A+interp
- 3=HIRS
- 4=AMSU-A
- 5=AMSU-A+interp
- 6=HIRS



50 profiles/call

1 profile/call



RTTOV-9 web site

Version 9_1 of RTTOV was released in March 2008 and is available to licensed users free of charge. To become a licensed user of RTTOV v9, please send a request using the [RTTOV-9 Request Form](#).

- RTTOV-9 documentation

- [RTTOV-9 Users' guide](#) (pdf)
- RTTOV-9 Science and validation report (pdf) (in preparation)
- [RTTOV-9 Top level design](#) (pdf)
- [Fortran Compilers tested with RTTOV-9 code](#) (pdf)
- [RTTOV-9 performance on different platforms](#) (pdf)

- [RTTOV-9 1 known bugs](#)

Please report any bugs you find in RTTOV-9 using the [NWP SAF Feedback Form](#).

- RTTOV-9 optical depth predictors for AIRS and IASI based on GENLN2 on 100L:

- [AIRS](#) (bzipped file 49Mb)
- [IASI](#) (bzipped file 188Mb)

- RTTOV-9 microwave optical depth predictors for DMSP-14 SSM/T-2:

- [SSM/T-2](#) (bzipped file 32K)

- RTTOV-9 IR aerosol scattering coefficients:

- [AIRS](#) (bzipped file 18Mb)
- [IASI](#) (bzipped file 97Mb)

- RTTOV-9 IR cloud scattering coefficients:

- [AIRS](#) (bzipped file 28Mb)
- [IASI](#) (bzipped file 161Mb)

(note the corresponding RTTOV-7 and RTTOV-8 optical depth coeffs are on the [RTTOV-7](#) and [RTTOV-8](#) pages).

- RTTOVSCATT microwave scattering coefficient files for RTTOV-9:

- Download the following file for AMSU-A: [AMSU-A](#) (bzipped 35 Mb file)
- Download the following file for SSMI: [SSMI](#) (bzipped 9Mb file)
- Download the following file for SSMIS: [SSMIS](#) (bzipped 40Mb file)
- Download the following file for AMSR: [AMSR-E](#) (bzipped 14Mb file)
- Download the following file for TMI: [TMI](#) (bzipped 12Mb file)

Poste de travail

Dossier personnel de rttov

floppy

kmatrix.rtk

layer 60.2- 89.5- CIRR.rtp

profile5.x.rtp

profile52.ps

profile_52.rtp

radiance.rtr

transmission.rtt

Corbeille

profile_52.rtp (modified)

File Edit About Panels RTTOV

Log:

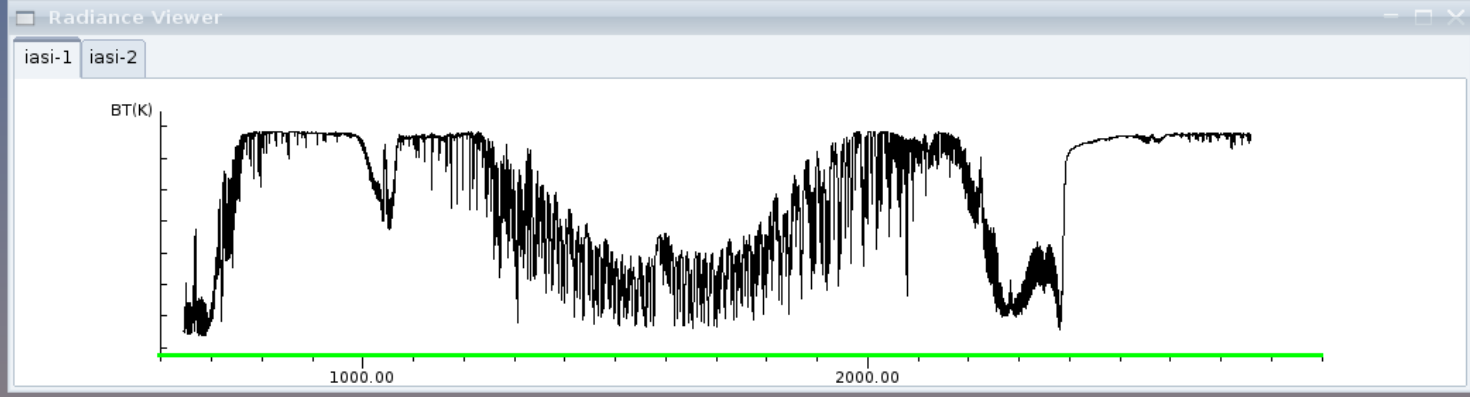
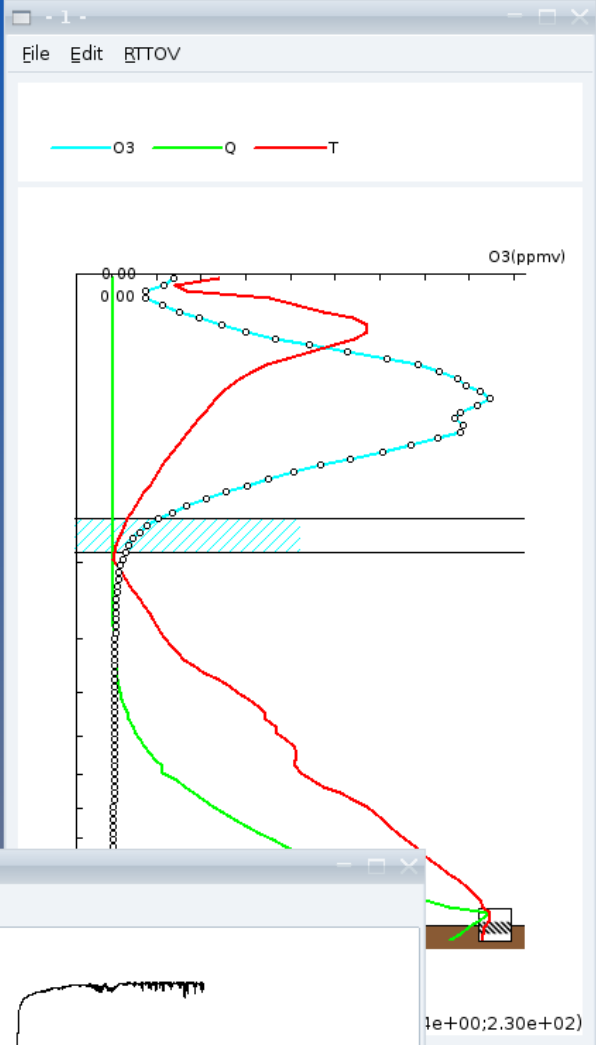
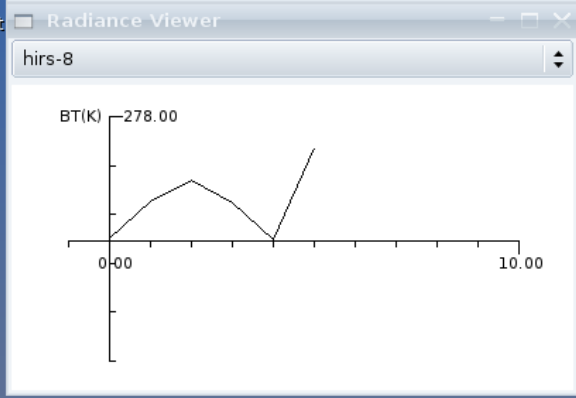
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RTTOV

File RTTOV About

Log:

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rtt...

Echier

-screen

v-gui.p

Plans for RTTOV-10

- Include Zeeman splitting for AMSU-A (14) and SSMIS (Yong Han)
- Provide new LBLRTM based coefficients for AIRS/IASI and CrIS
- Add Non-LTE using SARTA or similar approach
- Rewrite coeff generation software and make available to users
- Upgrade FASTEM-3 microwave ocean surface emissivity
- Upgrade FASTEM-3 over land for lower frequencies (SMOS)
- Make 'hidden' top layer to be defined by user
- Add new SSU predictors for reanalyses
- Design for including PCRTM capability
- *Simple VIS/NIR optical depth and scattering calculations*



RTTOV-9 LITE CD

Free CD with sample of RTTOV-91 code

- Only forward model (not TL/AD/K)
- HIRS and AMSU coeff files provided
- Computes top of atmosphere radiances
- Surface emissivity must be supplied
- No cloud or aerosol capability

Available from me while stocks last.

To get official code go to:

http://www.metoffice.com/research/interproj/nwpsaf/request_forms/request_rtov_9.html

and complete licence form to get free copy of RTTOV-91



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Questions and answers