Update on RTTOV developments

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What is RTTOV?

Estimate of atmospheric state and surface parameters for observation point X

View angle + sun angles

RT model for required sensor

Time ~ 1ms for 20 chans

Radiances for required satellite channels $y=H(X)$ and optionally jacobians as TL, AD, or K

$$H \equiv \frac{\partial y_i}{\partial X_j}$$

RTTOV is developed by NWP SAF

RTTOV users status

Number of RTTOV-8 users provided code = 334

Number of RTTOV-9 users provided code = 318

(160 requests over past year)

Continuing requests for RTTOVv87 as it is needed within the WRF model

RTTOV-9 coefficient files

Infrared

- Radiometers
  - •GENLN2 RTTOV-7 predictors
  - •LBLRTMv11.1 RTTOV-7 predictors
- IASI/AIRS options:
  - •GENLN2 RTTOV-7
  - •kCARTA RTTOV-7 (METO ops, ECMWF ops)
  - •LBLRTMv11.1 RTTOV-9 predictors

Microwave

- RTTOV-7 predictors
- 22GHz new water line width/183GHz ozone included in mixed gases
- Improved computation of layer mean quantities
- Zeeman removed but Y. Han parameterisation for AMSU-A/SSMIS

New instruments available

- FY-2 (3,4) (VISSR imager)
- FY-3A (MWHS, MWTS, IRAS, MWRI)
- COMS (imager)
- NOAA-19 (HIRS, AVHRR, AMSU-A, MHS)
- Kalpana (imager)
- GOES-13/14 (imager, sounder) 16 (ABI)
- DMSP F14 (SSMT/2)
- METEOR-3M (MSU-R)
- MeghaTropiques (Saphir, Madras)
- METOP/IASI & Aqua AIRS (LBLRTMv11.1)

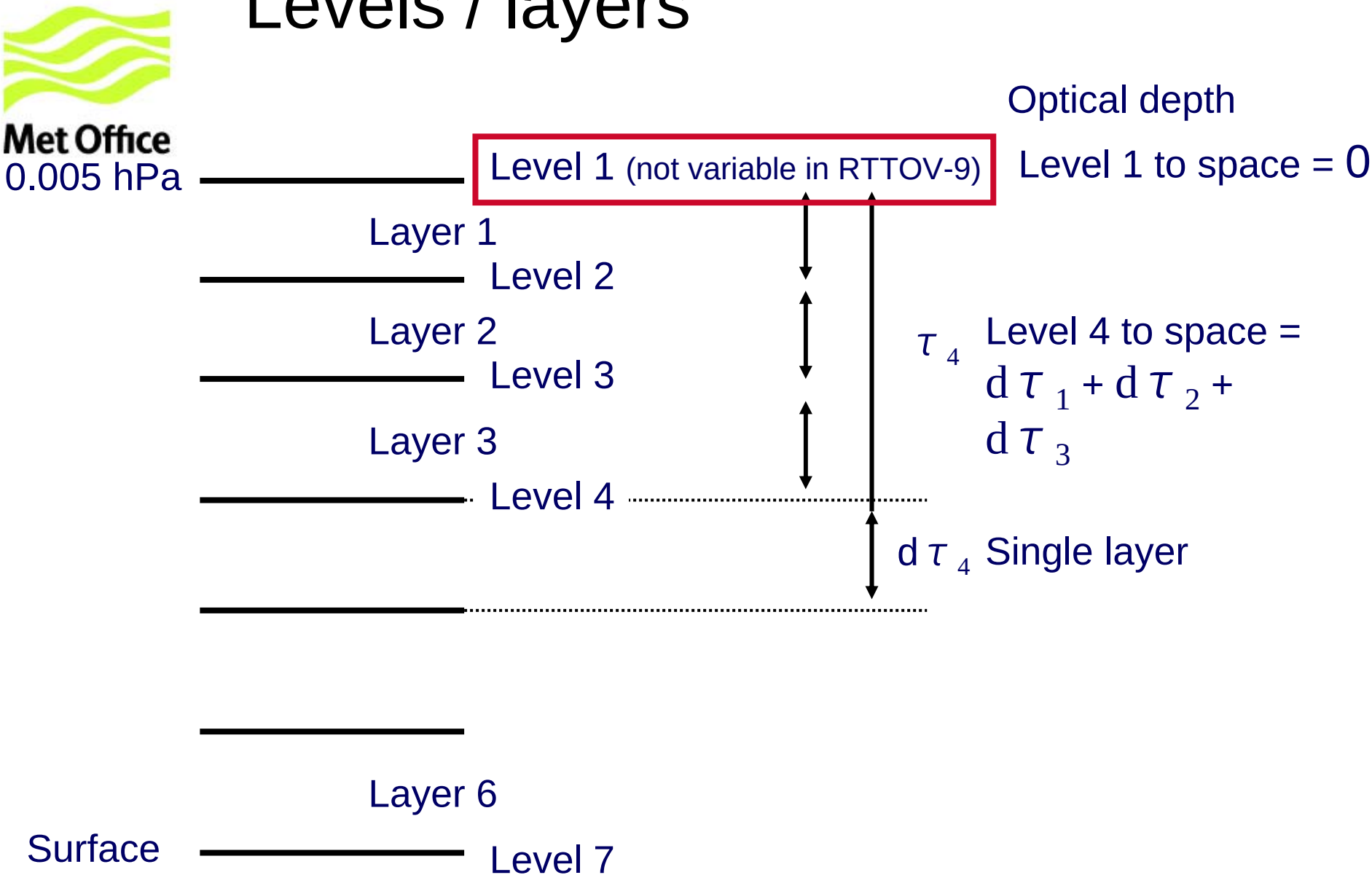
New SSU coefficients

- CO_2 cell pressures 108.00, 40.00, 14.50 hPa
- LBLRTM_v11.3 ! line-by-line
- AER_v2.1 ! spectroscopic database
- MT_CKD_2.0 ! Water Vapour continuum
- TIGR-43
- RTTOV-8 predictors for mixed, water vapour and CO_2
- Coeffs for TIROS-N, NOAA-6, NOAA-7, NOAA-8, NOAA-9, NOAA-11 (2 parts) and NOAA-14

RTTOV-10 science developments

- Include top layer variables (0.005hPa) in input
- Zeeman splitting for AMSU-A and SSMIS (Y.Han)
- FASTEM-4 (Mark Liu's poster)
- PCs in RTTOV for IASI/AIRS (Marco's talk)
- More than 1 type of cloud per level for cloudy IR simulations. Same cloud fraction.
- RTTOV_SCATT updates
- IR and MW surface emissivity atlases (Eva and Filipe's talks)

Levels / layers



Zeeman Effect in RTTOV-10

Magnitude and direction of magnetic field alters pattern of absorption. Effect depends on the position of oxygen lines and channel passband Moves peak of channel weighting function up or down warming or cooling, depending on the temperature profile used

Variation of brightness temperature with magnetic field magnitude

(10 μT=0.1 gauss)

	SSMIS				AMSU-A
	Ch19	**Ch20**	**Ch21**	**Ch22**	**Ch14**
20 μT	242.33	234.02	260.20	251.96	251.95 K
40 μT	244.83	234.63	259.36	252.14	252.11 K
60 μT	248.02	237.93	256.34	252.41	252.47 K

Variation of brightness temperature with angle between field and radiation path

		AMSU-A
		Ch14
60 μT	**cosine = 0.0**	252.47 K
60 μT	**cosine = 0.5**	252.39 K
60 μT	**cosine = 1.0**	252.15 K

FASTEM-4 (Mark Liu)

- The FASTEM model was developed for frequencies in the range 20-60 GHz and is biased at higher and lower frequencies.
- Several critical components such as variable sea surface salinity and a full Stokes vector have not been generally taken into account.
- A new permittivity model has been generated from measurements of fresh and salt water at frequencies between 1.4 GHz and 410 GHz.
- A modified sea surface roughness model from Durden and Vesecky
- Also included in CRTM (OEMM) and has resulted in some major improvements in microwave radiance simulations.

RTTOV_SCATT developments

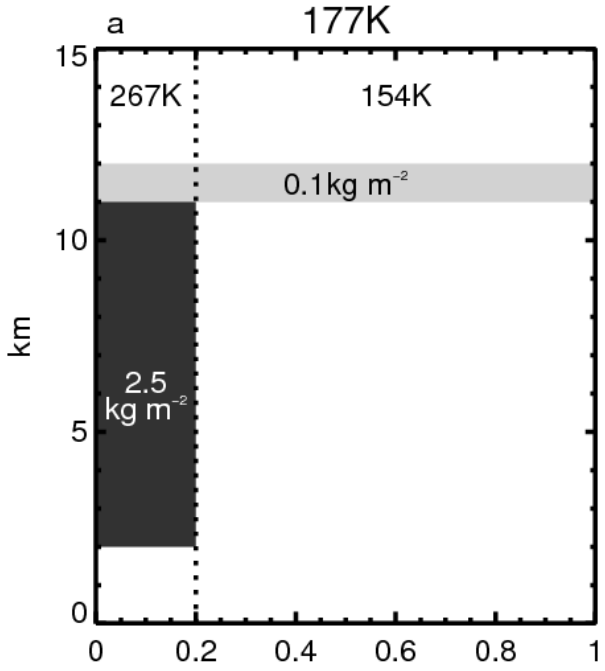
Currently in RTTOV-10:

- Optional user specification of cloud fraction
- Compatible with changes in RTTOV, (e.g. levels / layers)
- Minor bug fixes

In development for RTTOV-10:

- 30% performance increase
- Revised cloud overlap (Geer et al. 2009, introduced as an option with RTTOV v9.3) to be made default

Improved cloud overlap



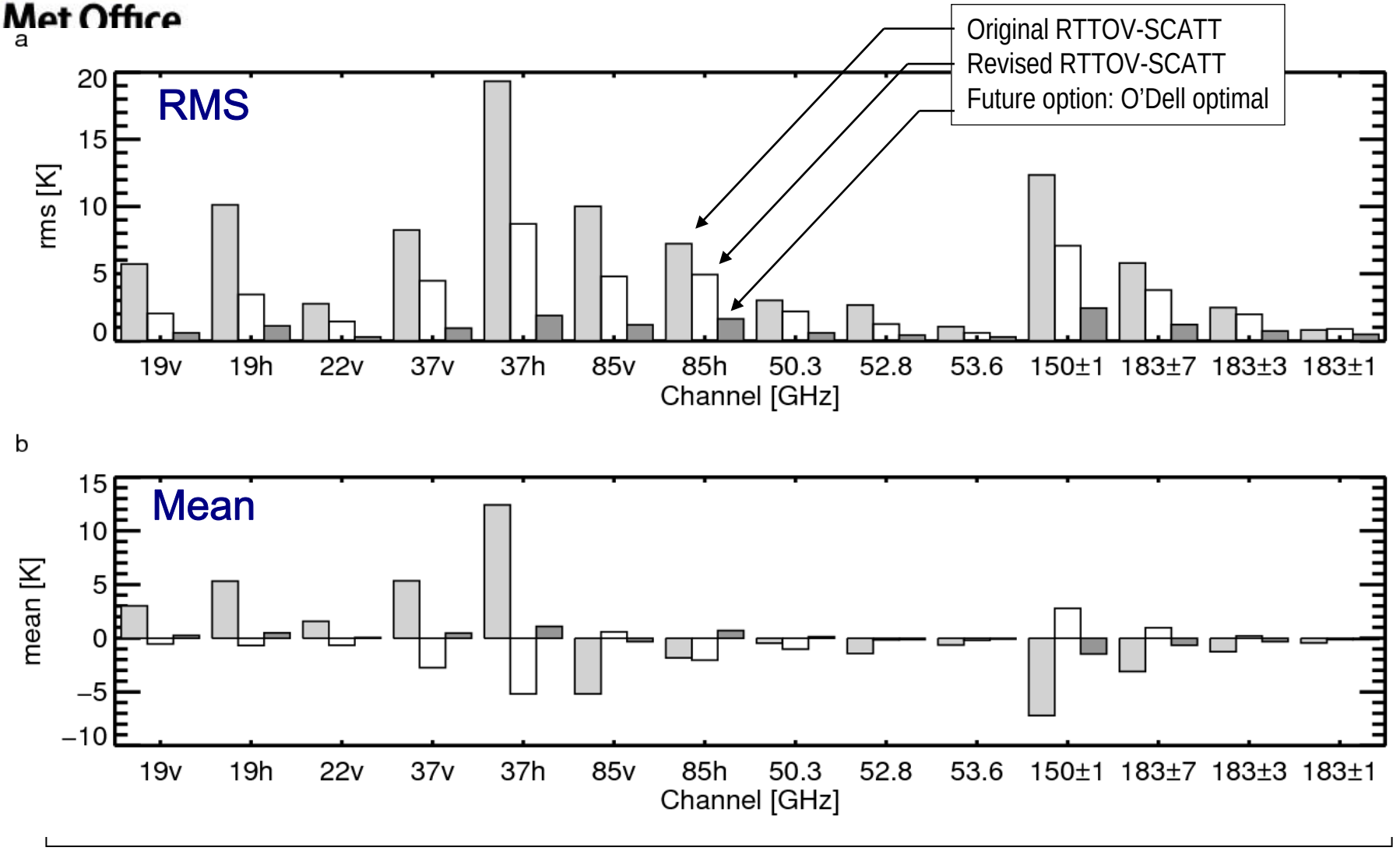
Multiple independent columns

Original RTTOV-SCATT

Revised RTTOV-SCATT

JAMC, submitted, 2009

Comparisons to reference 20 IC simulations: rain-affected areas



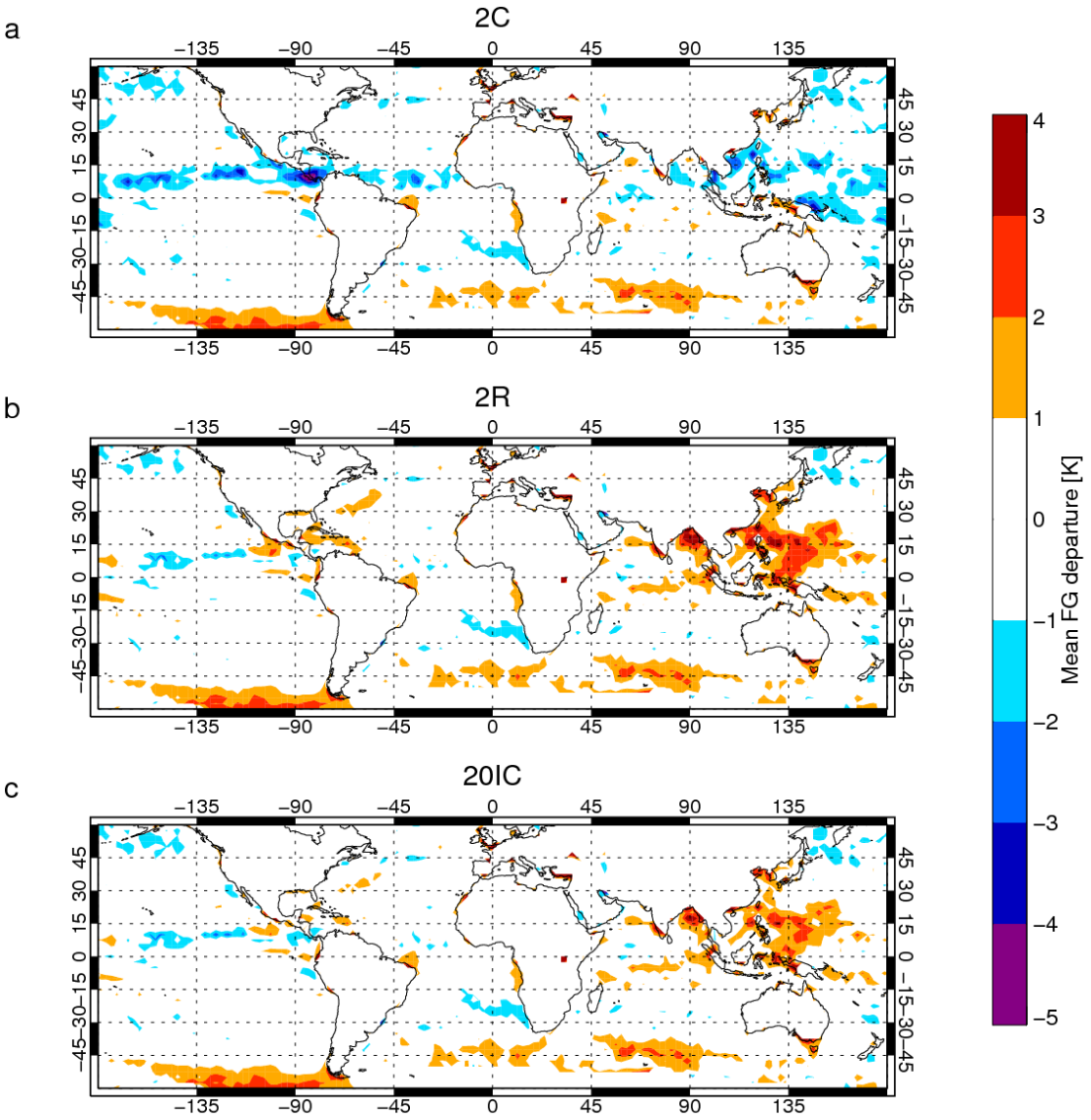
Observation – first guess statistics

(Mean, 1st-20th July 2007) channel 19v SSM/I

Original RTTOV-SCATT

Revised RTTOV-SCATT

Reference: 20 independent columns



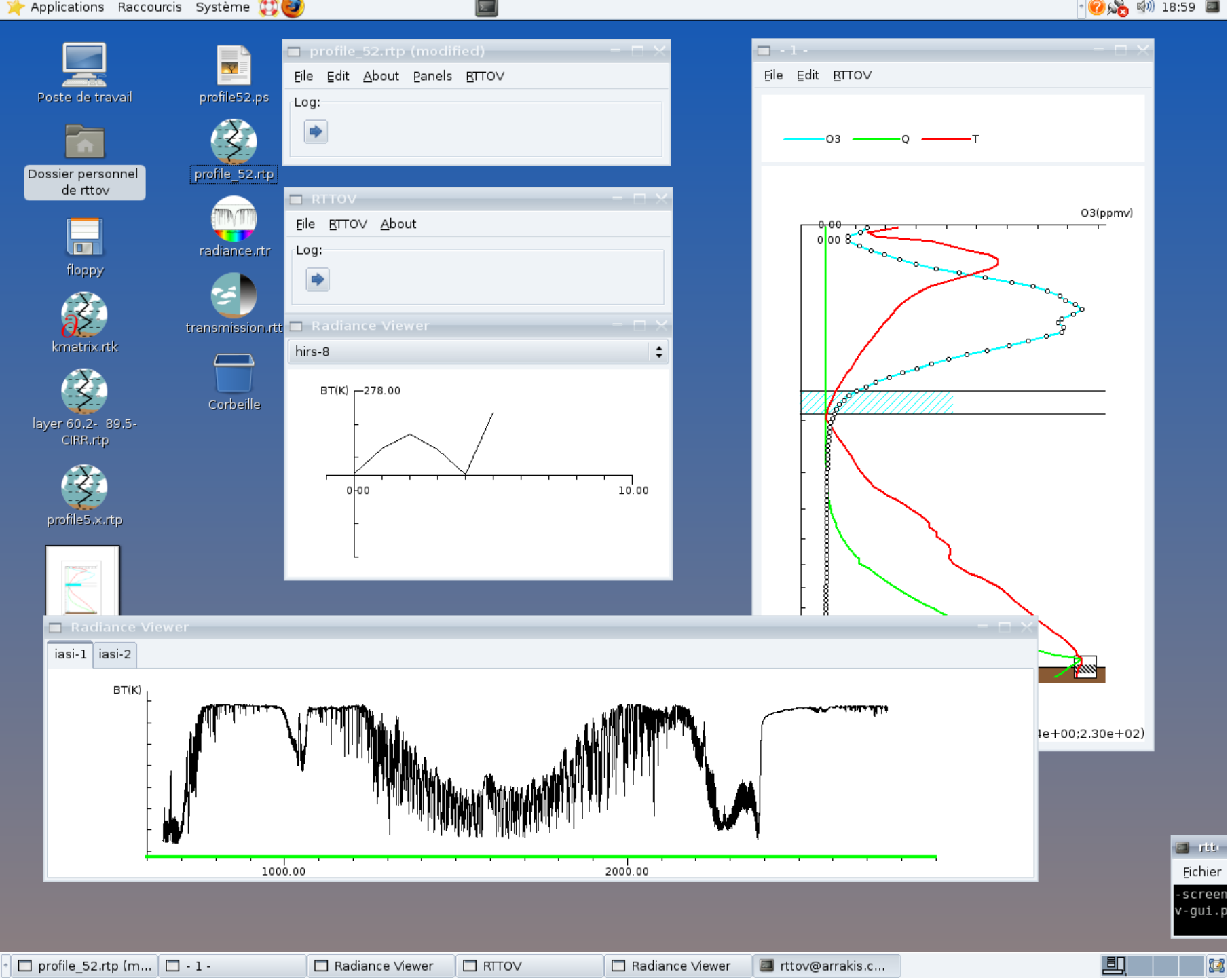
RTTOV Technical Developments

- New organisation of the code and new makefile
- Reduction of the no. of arguments for top level routines
- I/O routines separated by coeff file and ascii/binary access
- One allocation routine by derived type
- All coefficients in one structure
- Control parameters in one structure
- Assumed size arrays
- Homogeneous profiles (same gases assumed in 1 call)
- TL/AD/K consistently use rttov_direct for the direct part
- Error handling tells user the line number in code

RTTOV utility software

New associated software to help RTTOV users:

- More flexible test program controlled by scripts
- Generic coefficient generation software
- Mie coefficient generation software (_SCATT)
- RTTOV GUI (next slide)


Applications
Raccourcis
Système
18:59
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:
RTTOV
File RTTOV About
Log:
Radiance Viewer
hirs-8
BT(K)
278.00
0.00
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O3 Q T
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iasi-1 iasi-2
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1000.00
2000.00
rtt
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-screen
v-gui.p
profile_52.rtp (m...
- 1 -
Radiance Viewer
RTTOV
Radiance Viewer
rttov@arrakis.c...

Longer-term developments

- Addition of capability to simulate visible and near infrared satellite channels (e.g. for assimilation of aerosol optical depth)
- Addition of Non LTE correction for shortwave infrared sounding channels
- Addition of capability to simulate the Meteosat Third Generation IR sounder
- Project to run RTTOV on GPU processors (see Allen Huang)

Proposed: RTTOV user group

- Proposal to create a RTTOV user group which is independent from the developers.
- This is to ensure needs/concerns of users which have to interface the code with their software can be voiced and fed into the development process.
- One option is to create a users forum where RTTOV users can share experiences
- Need someone to take this on. Volunteers?
- Please discuss and talk to me.

RTTOV-10 beta testers?

- 3 month contract with NWP SAF to evaluate beta version of RTTOV-10 code
- July-Sep 2010
- Report on code and documentation fedback to developers
- If interested come and see me.

RTTOV web site

http://research.metoffice.com/research/interproj/nwpsaf/rtm

RTTOV radiative transfer model and profile datasets

What is RTTOV? A brief explanation can be seen here.

Profile datasets

60L datasets:

- Documentation for 60L profiles available below (pdf) and definitions of model levels
- Diverse 52 profile dataset from ECMWF 60L model profiles (0.35 Mb) & associated surface variables (5 Kb)
- ECMWF 60L profile datasets from model fields and documentation (gzipped tar file, 14 Mb)

91L profile datasets:

- Documentation for 91L profiles available below (pdf) and definitions of model levels
- Diverse 91L profile dataset from ECMWF 91L model fields and associated surface variables (gzipped tar file, 68Mb)
- 83 profile subset of profile dataset above interpolated onto 101 levels here and documentation here.

Brief outline of plans for the profile datasets:

- Look at improving the database with trace gas variability, particularly for principal component applications.
- In time the dataset will be expanded to describe trace gas and aerosol variability following developments in the GEMS environmental monitoring activities at ECMWF.

RTTOV code

A brief description of RTTOV can be seen here.

RTTOV code updates, documentation, updated coefficient files and bug reports (click on model version you require)

- RTTOV v5
- RTTOV v6
- RTTOV v7 (users who want the old RTTOV v7 model please use the Feedback Form)
- RTTOV v8
- RTTOV v9

Version 9_3 of RTTOV was released in November 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 v9 Request Form.

Reports and plans on radiative transfer model development within the NWP SAF

Example applications of RTTOV.

Details of RTTOV v9 (released 17 March 2008)

Future plans for RTTOV

Sources of Emissivity Data for RTTOV Users

Questions and answers

International TOVS Study Conference, 17th, ITSC-17, Monterey, CA, 14-20 April 2010. Madison, WI, University of Wisconsin-Madison, Space Science and Engineering Center, Cooperative Institute for Meteorological Satellite Studies, 2011.