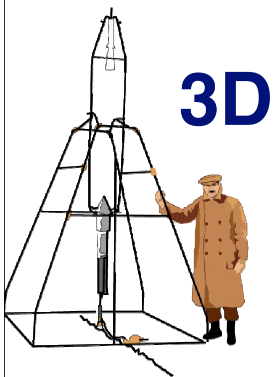


3DRT - Clouds (I3RC) and Vegetation (RAMI)
Status and perspectives

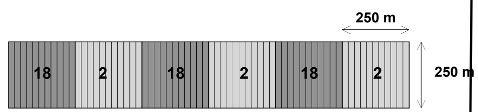
R. Cahalan, F. Evans, A. Marshak, B. Mayer, L. Oreopoulos,
R. Pincus, T. Varnai, B. Pinty, J-L. Widlowski,
& the I3RC & RAMI Groups

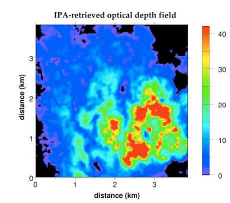
IRC @ IRS2008, Iguaçu, Brasil

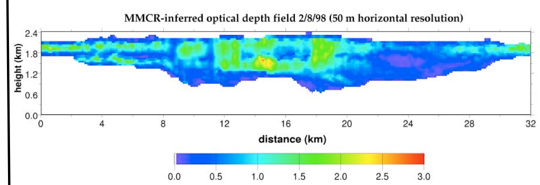
I3RC = Int'l Intercomparison of 3D Radiation Codes

Initiated at 1998 GRP meeting in St Andrews
Activity of 3DWG of Int'l Radiation Commission
Now 7 "Cases" with many "Experiments"

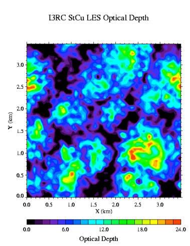
Phase 1

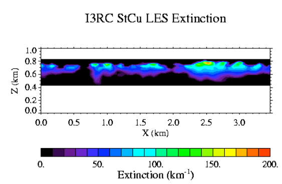


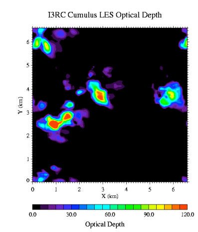


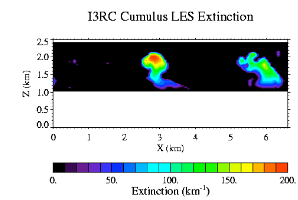


Phase 2

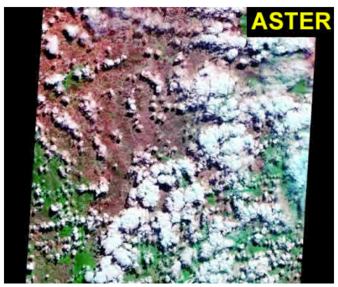


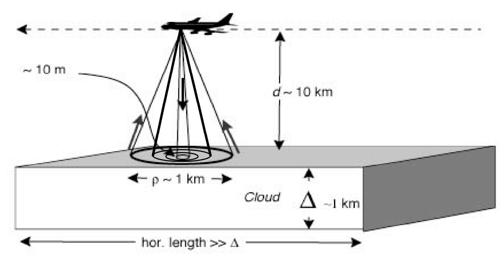






Phase 3

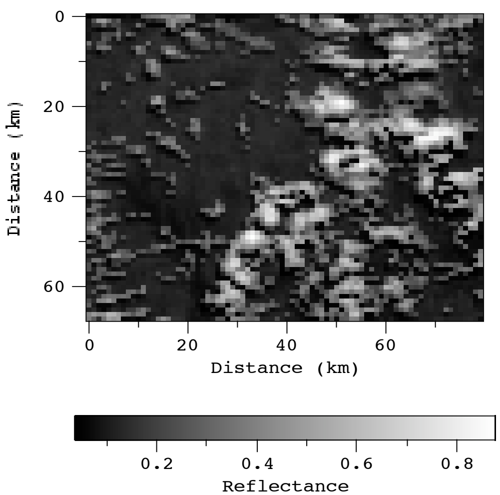


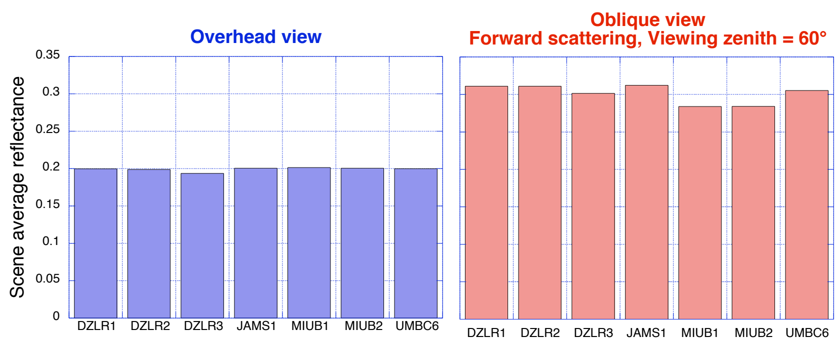


Phase 3 Intercomparisons (12 models participated)

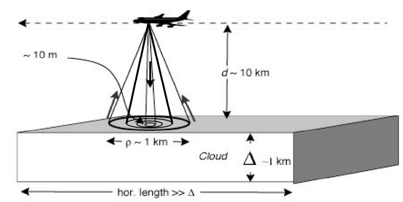
Solar reflectance

Overhead view
(simulated by JAMS model)



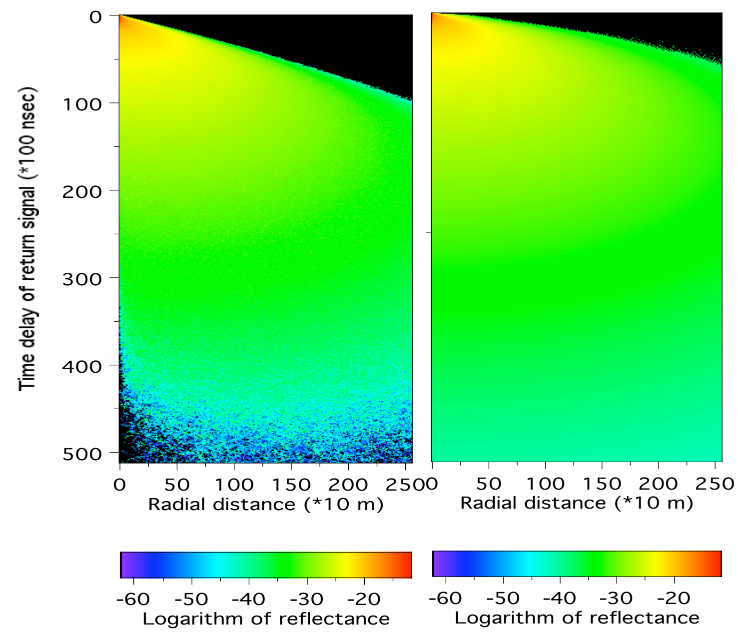


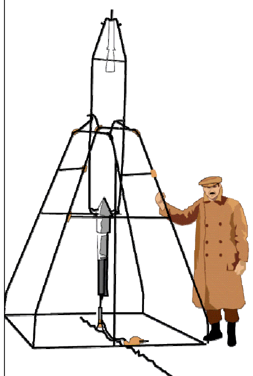
Lidar multiple scattering



DZLR
(Monte Carlo method)

URDG
(TDTS method)





Simulation of 3D photon transport

- Animation of scalar flux $(I^{+}+I^{-})$
  - Colour scale is logarithmic
  - Represents 5 orders of magnitude
- Domain properties:
  - 500-m thick
  - 2-km wide
  - Optical depth of 20
  - No absorption
- In this simulation the lateral distribution is Gaussian at each height and each time

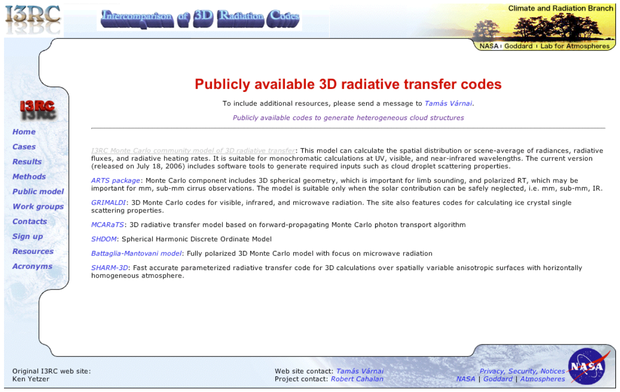
I3RC Status and Plans

I3RC community code for 3D radiative transfer

- Release 1: July 2005, Release 2: July 2006 – vs SHDOM, more *flexible* & *faster* for many problems
- Over 40 downloads in 2007 (since we started keeping track)
- Radiative fluxes, heating rates, and radiances for any view direction
- Scene-average values and complete fields
- Single wavelength, but k-distribution for gaseous absorption in preparation
- Release 3 due Oct 2007: arbitrary surface BRDFs, Iwabuchi Russian roulette for speedy intensities, and MPI driver
- Open Source Licensing to encourage further development and widest usage

Information on 3D radiative transfer codes (including I3RC community code)

- I3RC Programmer Guide & Primer now available
- Wikipedia: http://en.wikipedia.org/wiki/List_of_atmospheric_radiative_transfer_codes
- I3RC website: http://i3rc.gsfc.nasa.gov/ (also includes other resources such as 3D-related publications)



Plans

- *Easy-to-use community model* of 3D radiative transfer: online 3D simulator, executables
- *Automated code verification* - online system like RAMI’s
- *Illustrative archive* of 3D radiative effects

3DRT application: Ice & Snow Thickness from THOR

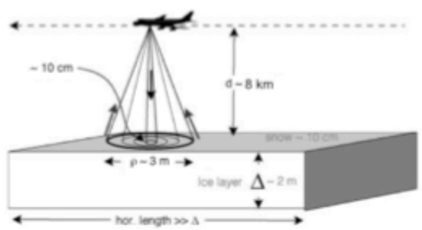


Figure 1. Schematic diagram of airborne sea ice measurements using offbeam lidars.

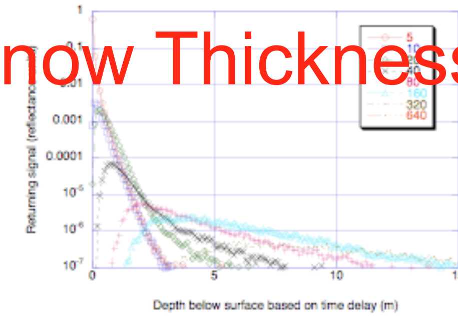


Figure 3. Simulated THOR4Ice data for 2 m thick ice covered by 15 cm snow. The legend indicates the outer radius (in cm) of each annular field-of-view.

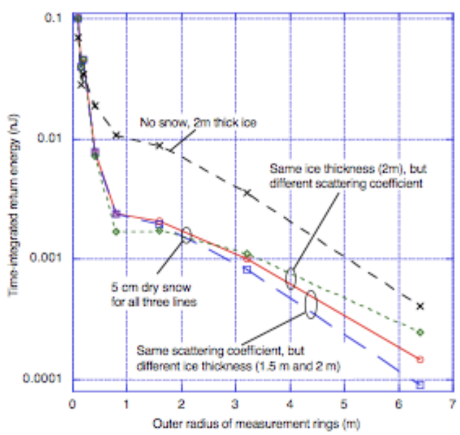


Figure 2. Simulated offbeam lidar signals for various snow and sea ice conditions. The figure was created

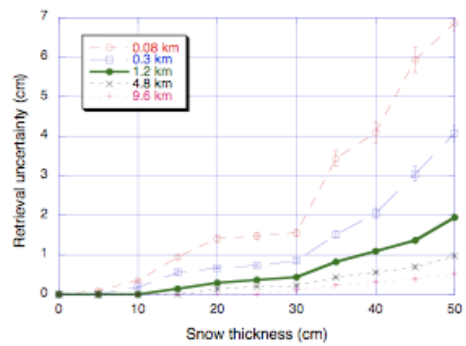
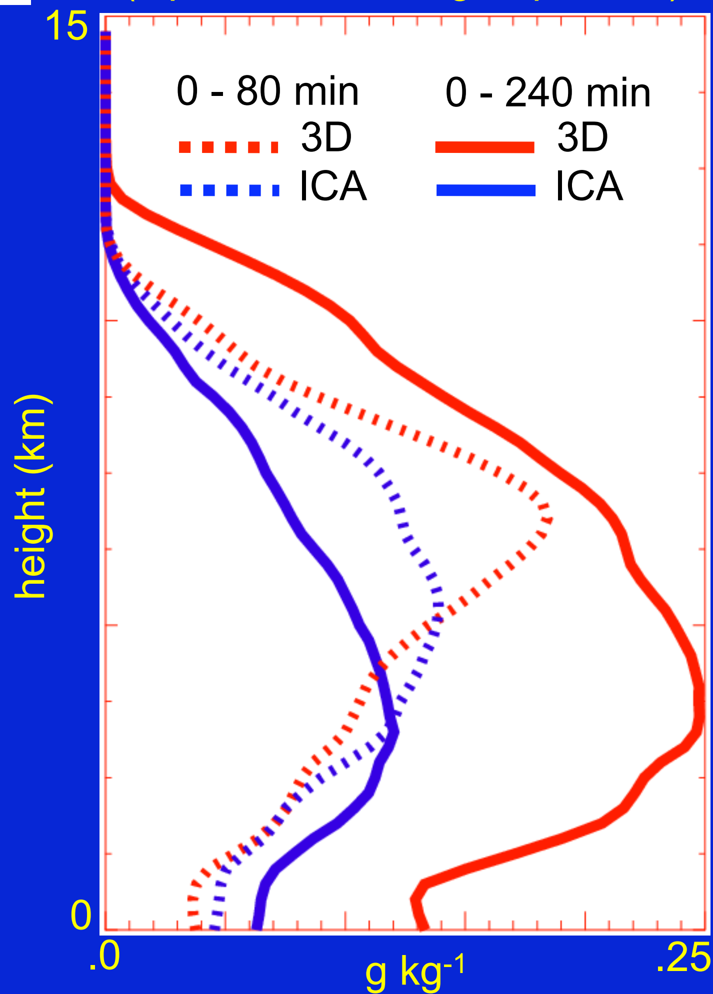


Figure 4. Retrieval uncertainties caused by observational noise. Each curve is for a different horizontal resolution. The calculations are for 30° solar elevation and old snow. The error bars indicate the uncertainty in retrieval uncertainty estimates that arises from the random nature of simulated observational noise.

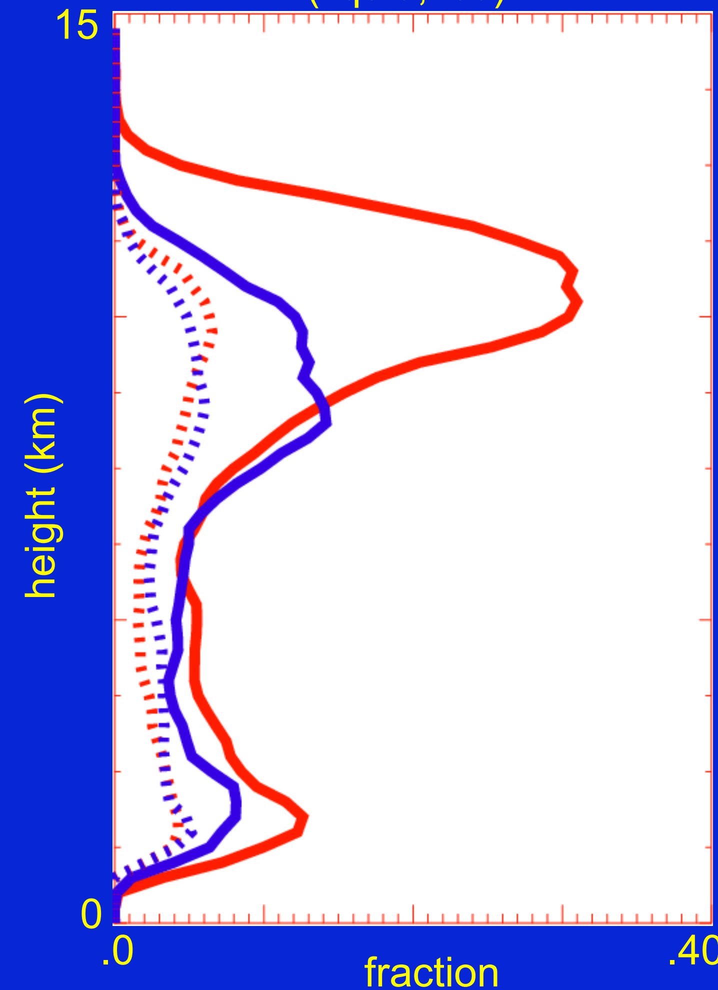
3DRT application: WRF Convective Lifecycles

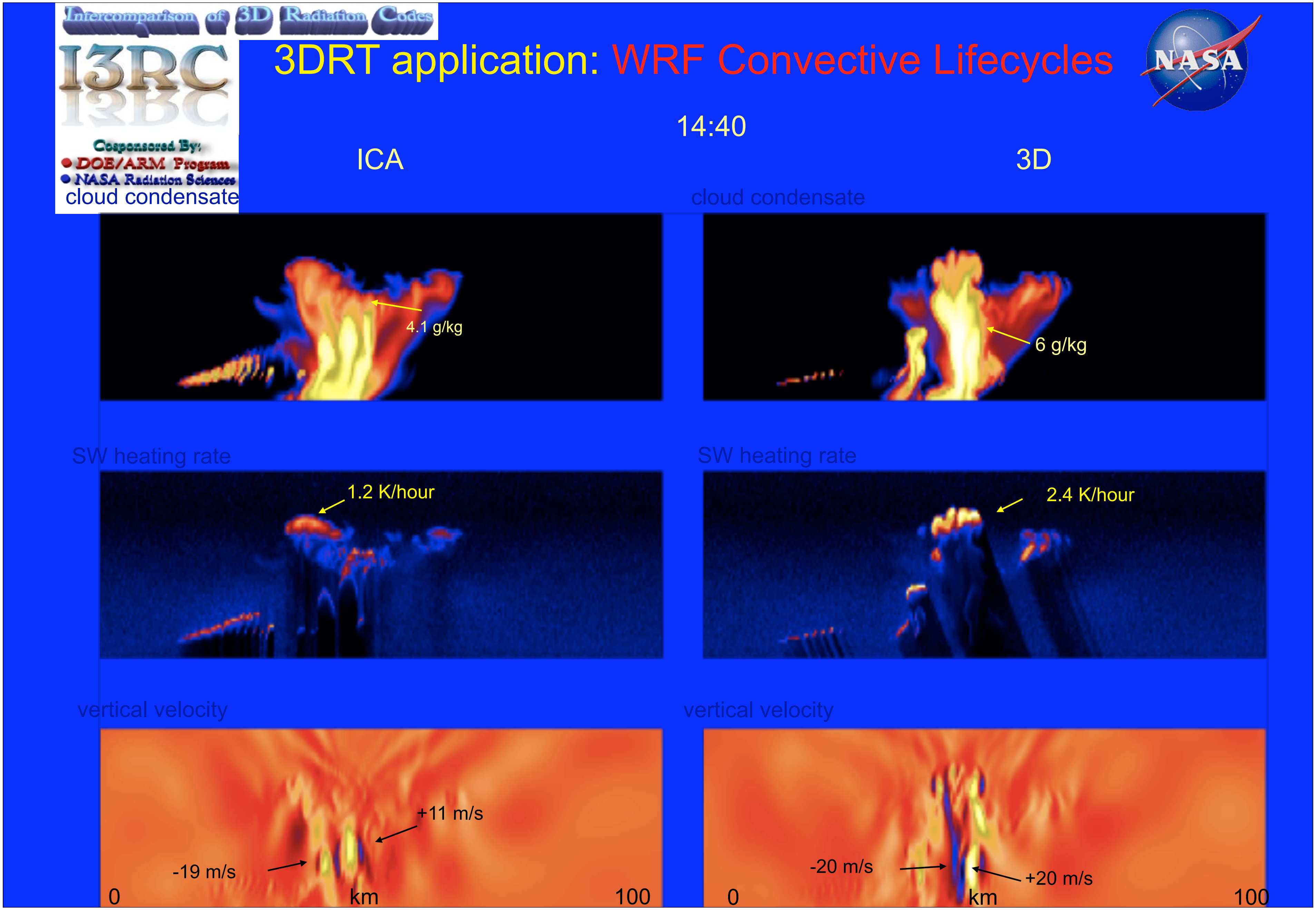
Periodic boundary

domain average condensate
(liquid, ice, snow, graupel,rain)

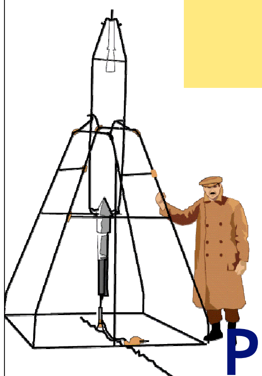


cloud fraction
(liquid, ice)




Intercomparison of 3D Radiation Codes
I3RC
Cosponsored By:
DOE/ARM Program
NASA Radiation Sciences
3DRT application: WRF Convective Lifecycles
NASA
14:40
ICA
3D
cloud condensate
cloud condensate
4.1 g/kg
6 g/kg
SW heating rate
SW heating rate
1.2 K/hour
2.4 K/hour
vertical velocity
vertical velocity
+11 m/s
-19 m/s
-20 m/s
+20 m/s
0
km
100
0
km
100

RAdiative transfer Model Intercomparison (RAMI)

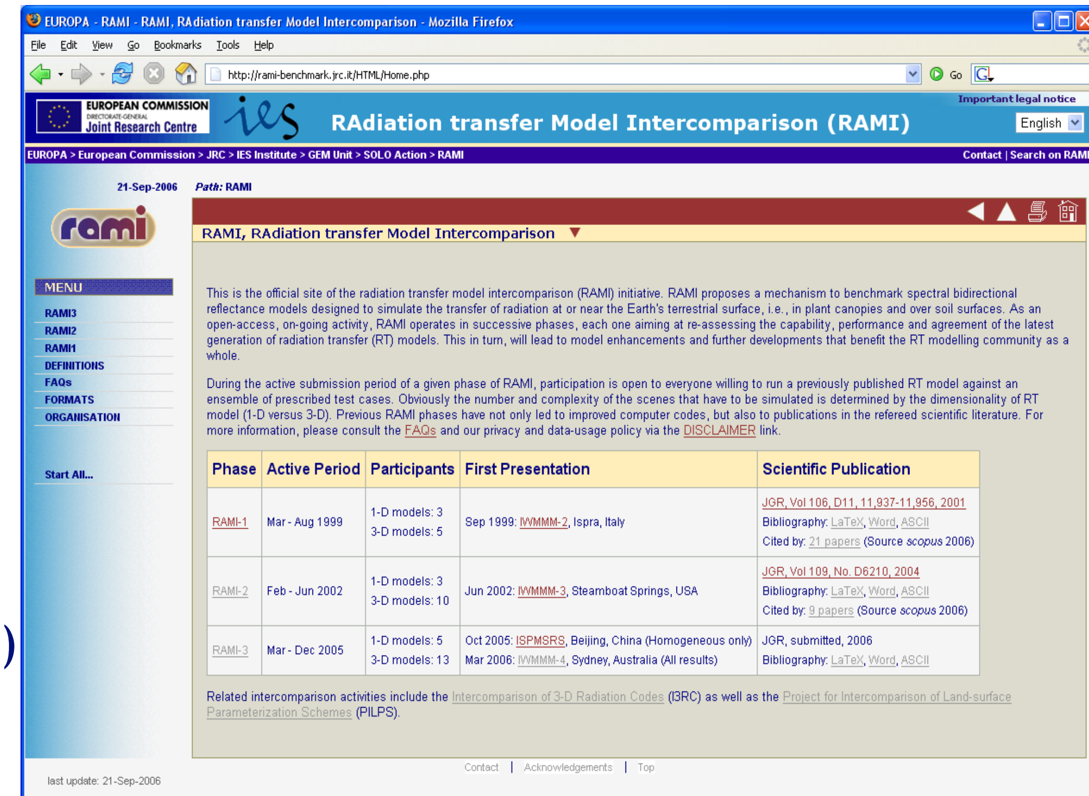


Purpose:

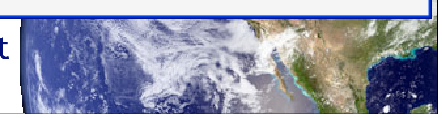
- Common platform .
- Document uncertainties and errors among models.
- Establish protocol.
- Foster debate.

Organisation:

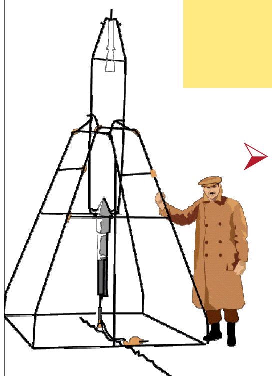
- Led by JRC in Italy
- Steering committee (RAB)
- Triennial phases



http://rami-benchmark.jrc.it



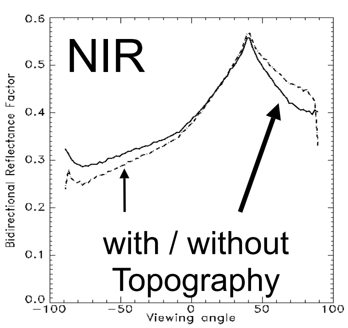
RAMI Topics

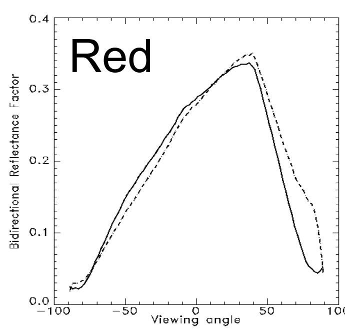


- directionally-varying and hemispherically-integrated quantities (BRFs & fluxes)

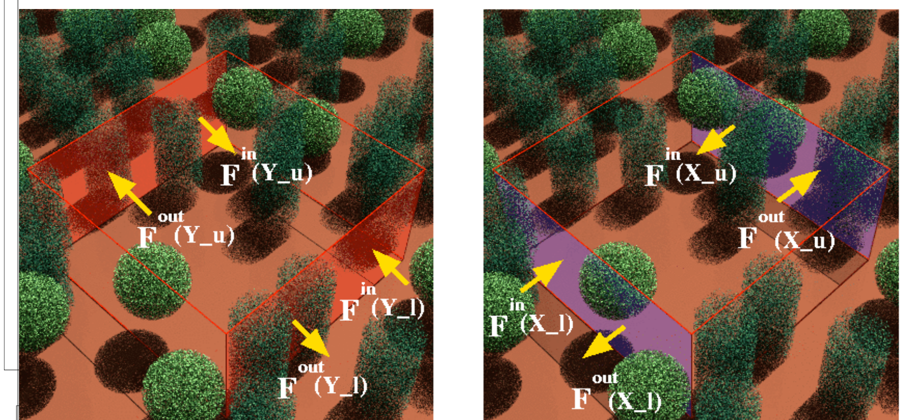
- domain-averaged and local (resolved) quantities.

- focus on science issues
  - horizontal fluxes
  - surface topography

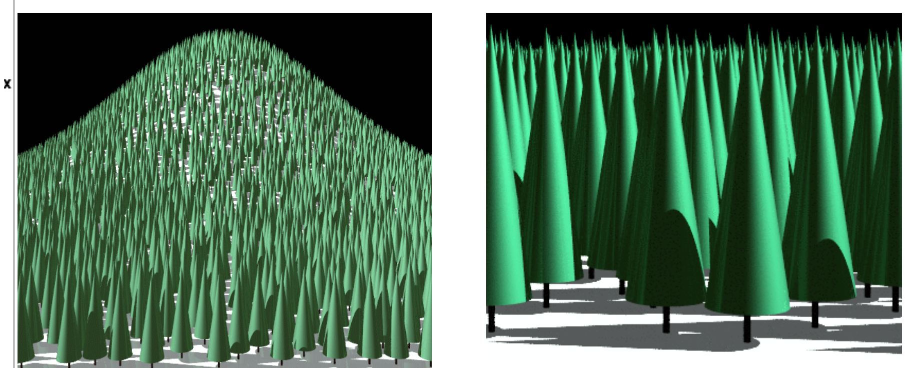




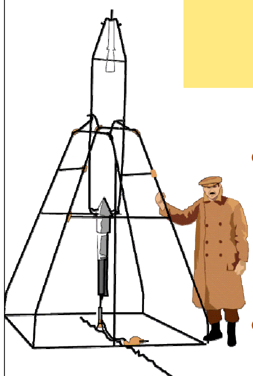
Impact of horizontal radiation fluxes



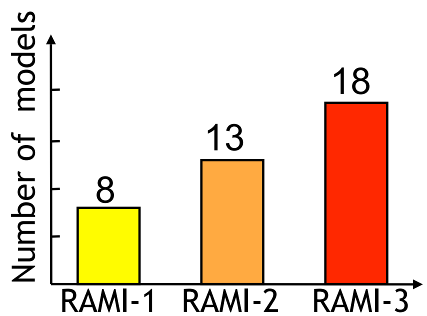
Impact of surface topography



RAMI-3 results published



- More models participated than during RAMI-1 (2001) or RAMI-2 (2004)
- Models evaluated both in relative & absolute terms
- Model agreement is better than during RAMI-2 (2004)



JOURNAL OF GEOPHYSICAL RESEARCH, VOL. 112, D09111, doi:10.1029/2006JD007821, 2007

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Third Radiation Transfer Model Intercomparison (RAMI) exercise: Documenting progress in canopy reflectance models

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[1] The Radiation Transfer Model Intercomparison (RAMI) initiative benchmarks canopy reflectance models under well-controlled experimental conditions. Launched for the first time in 1999, this triennial community exercise encourages the systematic evaluation of canopy reflectance models on a voluntary basis. The first phase of RAMI focused on documenting the spread among radiative transfer (RT) simulations over a small set of primarily 1-D canopies. The second phase expanded the scope to include structurally complex 3-D plant architectures with and without background topography. Here sometimes significant discrepancies were noted which effectively prevented the definition of a reliable "surrogate truth," over heterogeneous vegetation canopies, against which other RT models could then be compared. The present paper documents the outcome of the third phase of RAMI, highlighting both the significant progress that has been made in terms of model agreement since RAMI-2 and the capability of/need for RT models to accurately reproduce local estimates of radiative quantities under conditions that are reminiscent of in situ measurements. Our assessment of the self-consistency and the relative and absolute performance of 3-D Monte Carlo models in RAMI-3 supports their usage in the generation of a "surrogate truth" for all RAMI test cases. This development then leads (1) to the presentation of the "RAMI Online Model Checker" (ROMC), an open-access web-based interface to evaluate RT models automatically, and (2) to a reassessment of the role, scope, and opportunities of the RAMI project in the future.

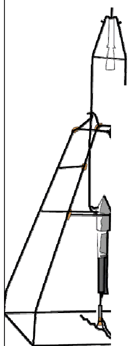
Citation: Widlowski, J.-L., et al. (2007), Third Radiation Transfer Model Intercomparison (RAMI) exercise: Documenting progress in canopy reflectance models, *J. Geophys. Res.*, *112*, D09111, doi:10.1029/2006JD007821.

60-70% of all canopy RT models have participated in RAMI

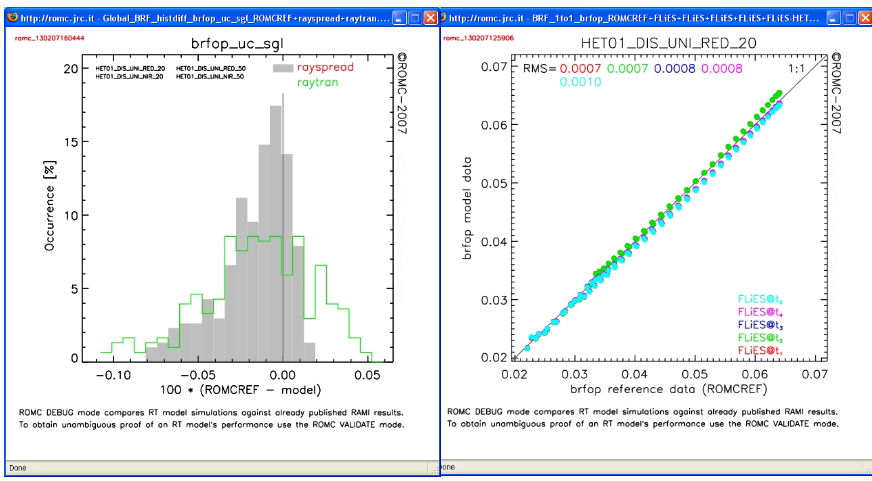
EUROPEAN COMMISSION
DIRECTORATE-GENERAL
Joint Research Centre

Institute for Environment and Sustainability

RAMI On-line Model Checker (ROMC)



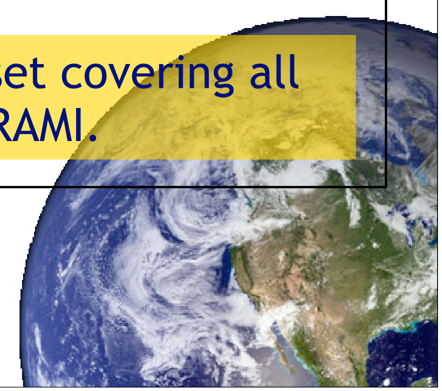
The ROMC's *interactive mode* allows users to compare the performance of different versions of a single model, or, else to evaluate multiple models.
All ROMC graphs are available as .ps



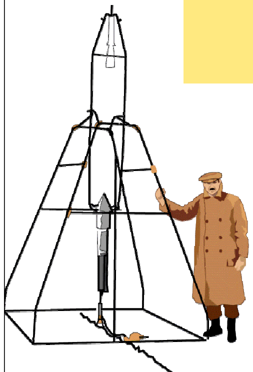
web-based tool for rapid & autonomous evaluations of canopy RT models.

1. registered user selects test cases,
2. offline implementation & running of test cases using users model,
3. uploading of test case to ROMC and comparison with reference,
4. downloading of results graphs.

Reference data set covering all test cases from RAMI.



http://romc.jrc.it



RAMI-4 and beyond (1)

Validation of existing remote sensing products (fAPAR, LAI)

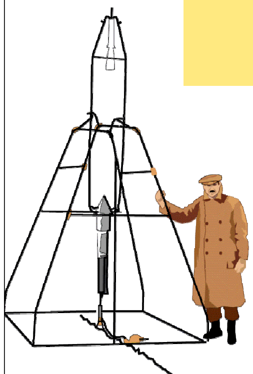
Generate realistic representations of existing validation sites:

- use in-situ measurements and imagery.
- sample different biomes (SAFARI, BOREAS).
- ideal scene size 250x250 to 500x500 m^2.

- Apply typical in-situ measurements within these scenes:
  - reproduce measurements of existing field instruments (TRAC, LICOR, fisheye lens),
  - evaluate appropriateness of theory used in their interpretation (1-D medium),
  - provide optimal sampling strategies for correct up-scaling at known validation sites.

Courtesy of P. Lewis & M. Disney

RAMI-4 and beyond (2)

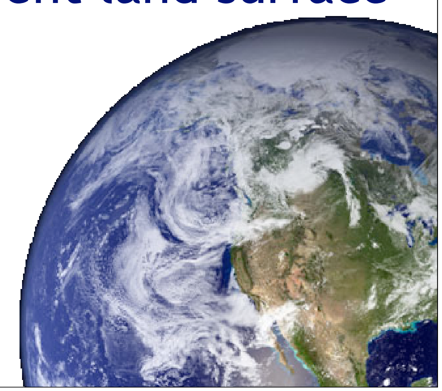


Support to space agencies and policymakers (GMES)

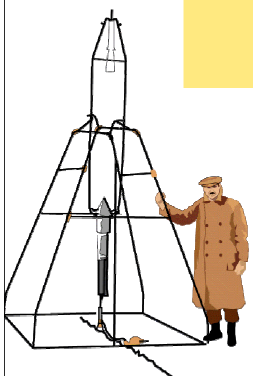
- Evaluate inverse mode performance of RT models
- Introduce RT model certificates

Contribute to international programmes (GEWEX, CEOS)

- Develop optimal sampling strategies for the correct up-scaling of field measurements at existing validation sites
- Evaluate the radiative parameterisations of current land surface schemes (RAMI4PILPS project).



RAMI4PILPS



Goal:

Assess the accuracy and reliability of the shortwave radiation transfer schemes that are currently used in the parameterisation of land surfaces in SVATs, GCMs, and NWP models.

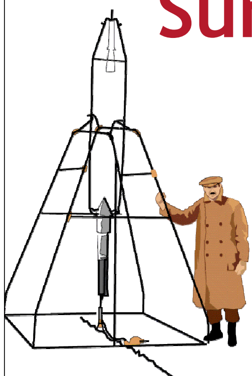
- Use the RAMI-3 MC reference models as 'surrogate truth'

proposed test cases

1-D CANOPIES		3-D CANOPIES	
grasslands	closed forest canopies	shrublands	open forest canopies
			
Given detailed 1-D canopy descriptions, what are the values of the three fluxes R, A, and T?		Given detailed 3-D canopy descriptions and R how is the remaining energy split between A and T?	

RAMI4PILPS starts April 2008

Summary:



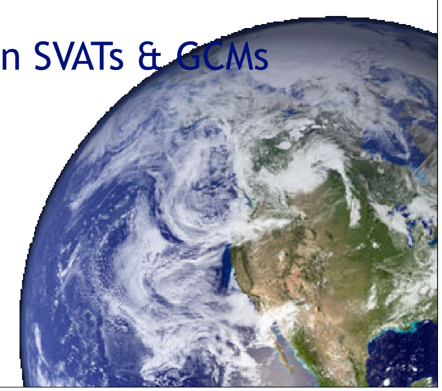
- RAMI benchmarking mechanism is in place
  - model participation increases and performances improve
  - benefits of large-scale intercomparison activity are harvested

  by RT model developers, their customers and the scientific community.

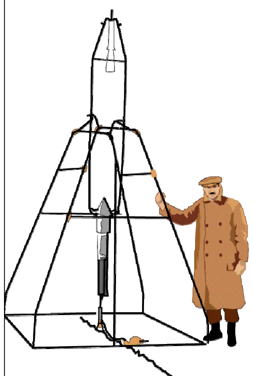
- RAMI Online Model Checker (ROMC) now available
  - allows debugging/validation of canopy RT models at any time.
  - uses RAMI “surrogate truth” derived form credible 3-D MC models.
  - facilitates participation of new models in future phases of RAMI.

The **ROMC** is an *indicative* model evaluator
RAMI aims at *comprehensive* model evaluation

- RAMI4PILPS soon to be launched
  - Assessment of the radiative surface flux parameterisation in SVATs & GCMs



Future 3DRT Group Activities



- *Easy* to use I3RC open source code
- *Automated* code validation
- Multi-*angle* instrument design/simulation
- Multi-*instrument* retrieval
- Test ICA and other *parameterizations* for GCMs
- Test neural net & other "*3D shortcuts*" for WRF
- *Omnivorous* Open Source: I3RC4*Vegetarians*?
- *RadiationOpensourceCryoMeso&SnowOceanClimateModels*:

➡ *ROCM&SOCMs*