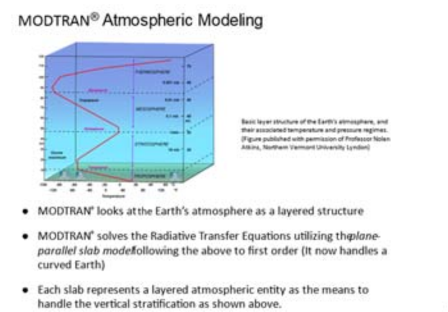
Ontar 2021 Virtual Workshop

<u>Our philosophy</u>: To best teach the material, we are going to give you many models that you can modify for your own use, while doing your own calculations.

Session 1: Basic

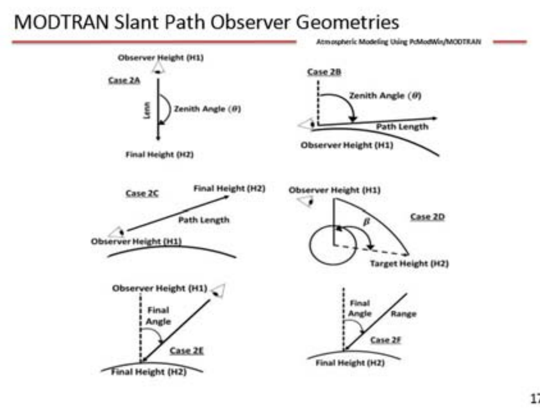
Atmospheric Modeling Using PcModWin®/MODTRAN®

- Learning Outcomes
- PcModWin and MODTRAN
- Why Use Introduction
- MODTRAN® ?
- MODTRAN® vs Koschmeider Equation Comparisons



MODTRAN®

- The MODTRAN® Model
- MODTRAN® Light Characterization
- Most Important Parameters in Any Calculation
- The MODTRAN® Spherical Refractive Geometry
- MODTRAN Slant Path Observer Geometries
- MODTRAN® Atmospheric Modeling
- The MODTRAN® Built-In Databases
- The MODTRAN® Atmospheric Profiles
- The MODTRAN® Boundary Layer Aerosol Models (0-2 km)
- The MODTRAN® Outputs
- MODTRAN® Output Files
- Limitation of MODTRAN®
- Sources of Error in any MODTRAN® Calculation

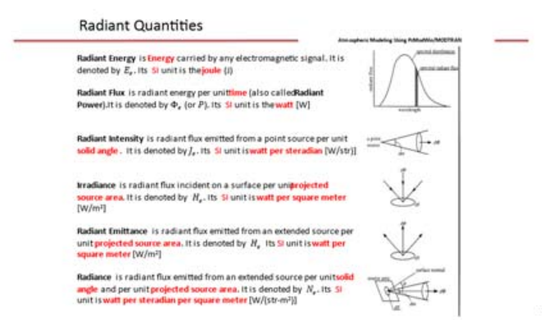


Blackbody Radiation

- Blackbody Radiation Sources
- Spectro-Radiometric Conversions
- Radiometry Entities
- Radiant Parameters

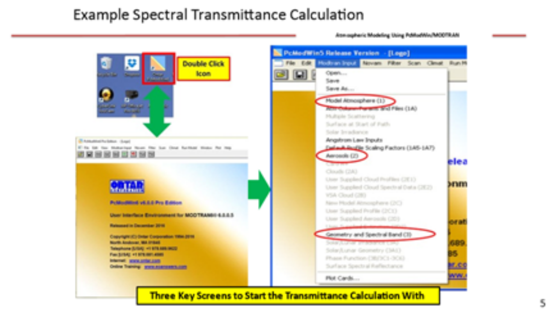
Basis for the Spectral Transmittance Modeling of the Atmosphere

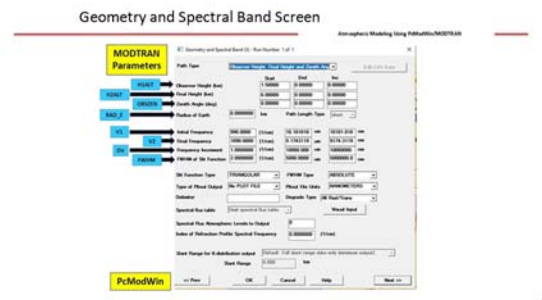
- Degradation from Atmospheric Absorption and Scattering
- Spectral Transmittance for the Earth's Atmosphere
- PcModWin Atmospheric Transmission Example



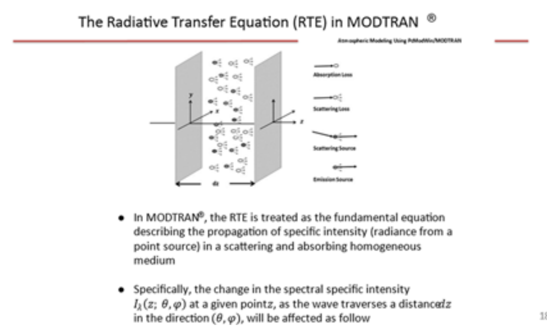
Session 2: Basic - Intermediate

PcModWin Procedure for Modeling Spectral Transmittance



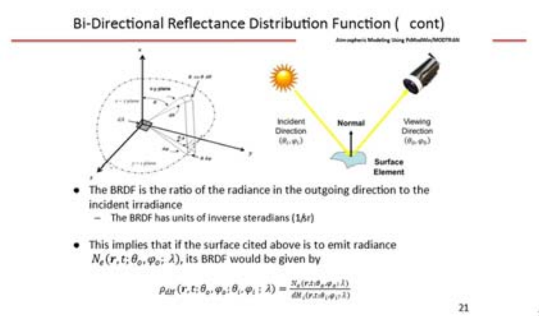


PcModWin – Enhanced for Custom Atmospheres



Session 3: Intermediate

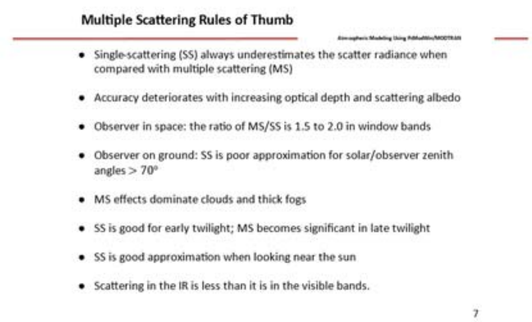
Spectral Radiance Components



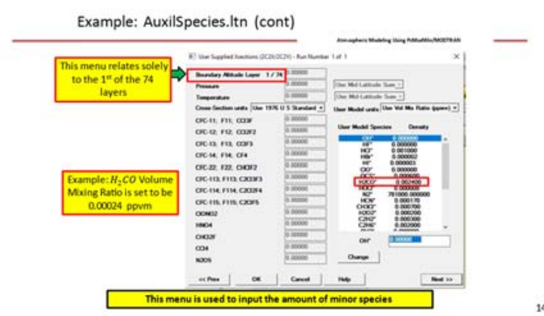
Two Multiple Scattering Algorithms in MODTRAN®
Multiple Scattering / Wavelength Considerations
Multiple Scattering Rules of Thumb

Using PcModWin to Model Spectral Radiance

Spectral Radiance Calculation Way Ahead
PcModWin / MODTRAN Test Cases
(05vs1500mGround.ltn
PcModWin Test Case Directory
“Model Atmosphere” Screen for “05vs15nadirRAD.ltn”
"Surface Parameter" Screen for "05vs15nadirRAD.ltn”
“Solar Irradiance Parameter” Screen for “05vs15nadirRAD.ltn”
“Solar / Lunar Geometry” Screen for “05vs15nadirRAD.ltn”
Technical Report Figure for “05vs15nadirRAD.ltn”



Session 4: Intermediate

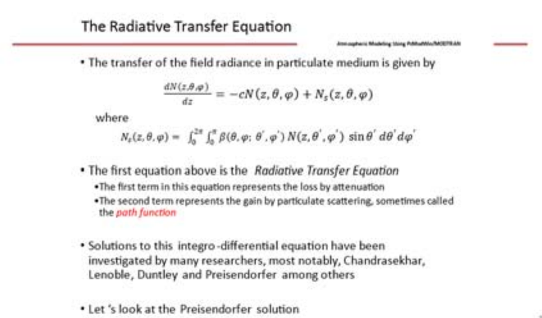


Advanced PcModWin Topics

New Model Atmosphere (NMA):
User Defined Properties
New Model Atmosphere
Example Calculation: AuxilSpecies.ltn
Exporting the Minor Species to Excel
Plotting the Minor Species
Another NMA Example (UserPath.ltn)

PcModWin Calculations Using Radiosonde Data

Characterization of the atmosphere is the MOST Important set of inputs.
Best Characterization of Aerosols
How to Obtain Atmospheric Data ?
How to Obtain More Realistic Atmospheric Data ?
PcModWin Radiosonde Downloads from the Internet
Use 05vs15nadirRad as an example
Configuring & Radiosonde Downloads
Calculation Comparing US Standard and Radiosonde Data



Correlated-k Calculations

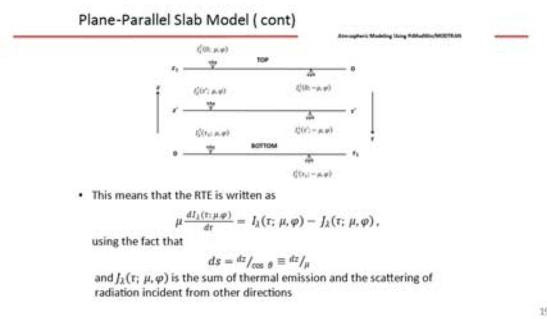
Correlated k-Distribution
Correlated k Example

Session 5: Intermediate

Mapping MODTRAN Parameters Into PcModWin Screen Entries

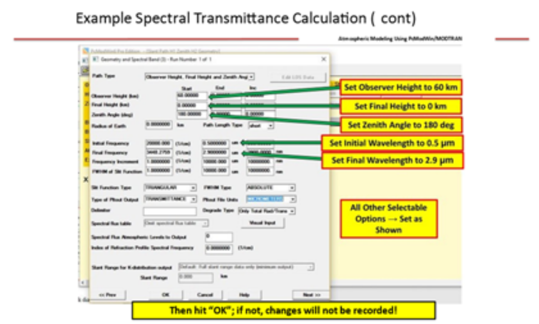
Model Atmosphere Screen
Atmospheric Column Parameters and Files Screen
Aerosol Model Screen

Geometry and Spectral Band Screen
Bi-Directional Reflectance Distribution Function



Bi-Directional Reflectance Distribution Function (BRDF)

Surface Reflectance
Bi-Directional Reflectance Distribution Function
Specular Surfaces
Diffuse Surfaces and Albedo
Diffuse Surfaces and Lambert's Law
PcModWin Lambertian Model Setup
Spectral BRDF and Lambertian Options in MODTRAN
Table of 49 Available "CSALB" (Variable) Spectral Curves
Example Calculation (Lambertian.ltn)
Spectral BRDF and Lambertian Options in MODTRAN (cont)
Table of 20 Available BRDF Models
Example Calculation Calculation (BRDF.ltn)
Surface Parameter Screen for "BRDF.ltn"
Modified Surface Parameter Screen for "BRDF.ltn"
Example Calculation ("BRDFsavASC.ltn)



Spectral Aerosol Profile

"Spectral Aerosol Profile" Selection
Spectral Aerosol Profile (SAP) for "UserPathDistort.ltn" d
Sample Calculation (UserPathDistort.ltn)

Session 6: Advanced

Line-By-Line Calculations

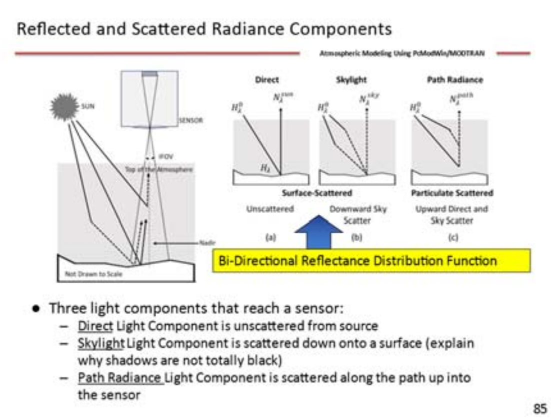
Descriptions of Case AnLBLTemplate.ltn: input parameters, graphical and text output files

Navy Maritime Model

Descriptions of Case NavyMaritime.ltn: input parameters, graphical and text output files

Multiple-Line-of-Sight (MLOS)

Descriptions of Case ElevAngMWRITthm.ltn: input parameters, graphical and text output files



Another MLOS Example - Lut01thm.ltn

Descriptions of Case Lut01thm.ltn : input parameters, graphical and text output files

Session 7: Advanced

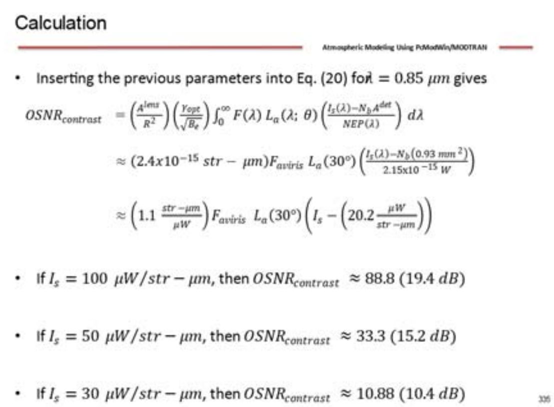
User Defined Cirrus Test Case

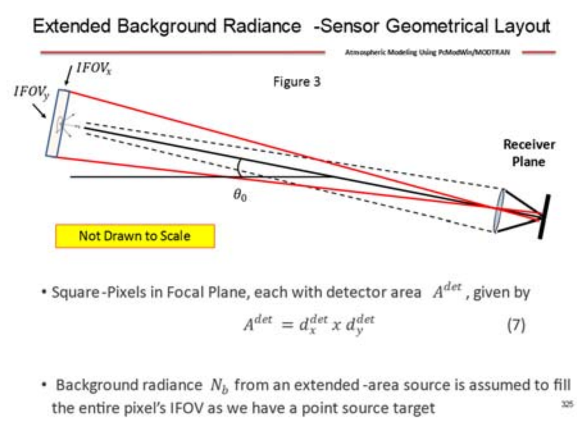
Descriptions of Case UserDefinedCir.ltn : input parameters, graphical and text output files

User Defined Cloud Test Case

Descriptions of Case UserDefined Cld.ltn : input parameters, graphical and text output files

Session 8: Optical Signal Detection I





Session 9: Optical Signal Detection II

Normalized Spectral Detectivity

Noise Equivalent Temperature Difference

Example calculations: Horizontal link near the earth's surface

Example calculations: NETD for a lossy atmosphere in LWIR using Koschmeider Eu.

Example calculations: NETD in MODTRAN "Rural-Vis=23 km"

Remote Sensing Example

Two Channel-Spectral Processing

Target Blackbody Curves

Notional Data Set

Multi-Spectral/Multi-Frame Processing

ORIGINAL MWIR and LWIR TAHOE IMAGES

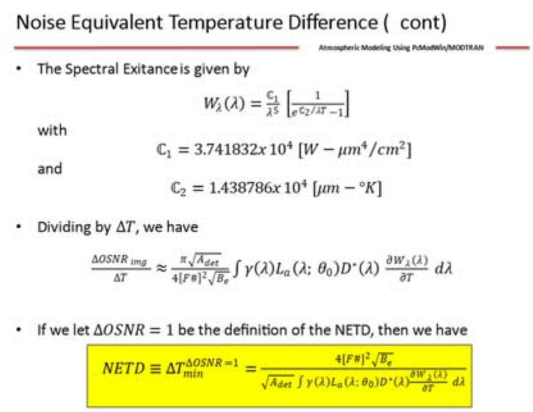
40 Frame Averaged Weighted Differenced Images

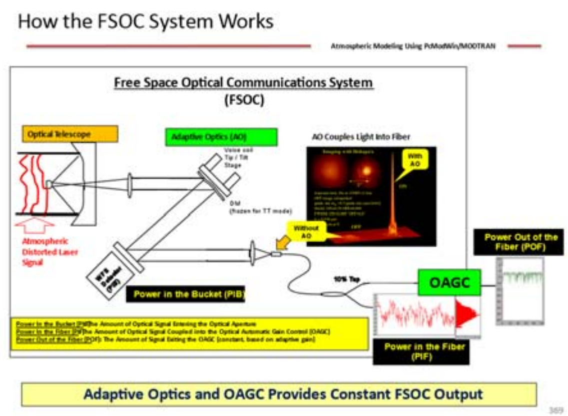
Airborne Wireless Communications

How the FSOC System Works

Compensation for Turbulent Fade

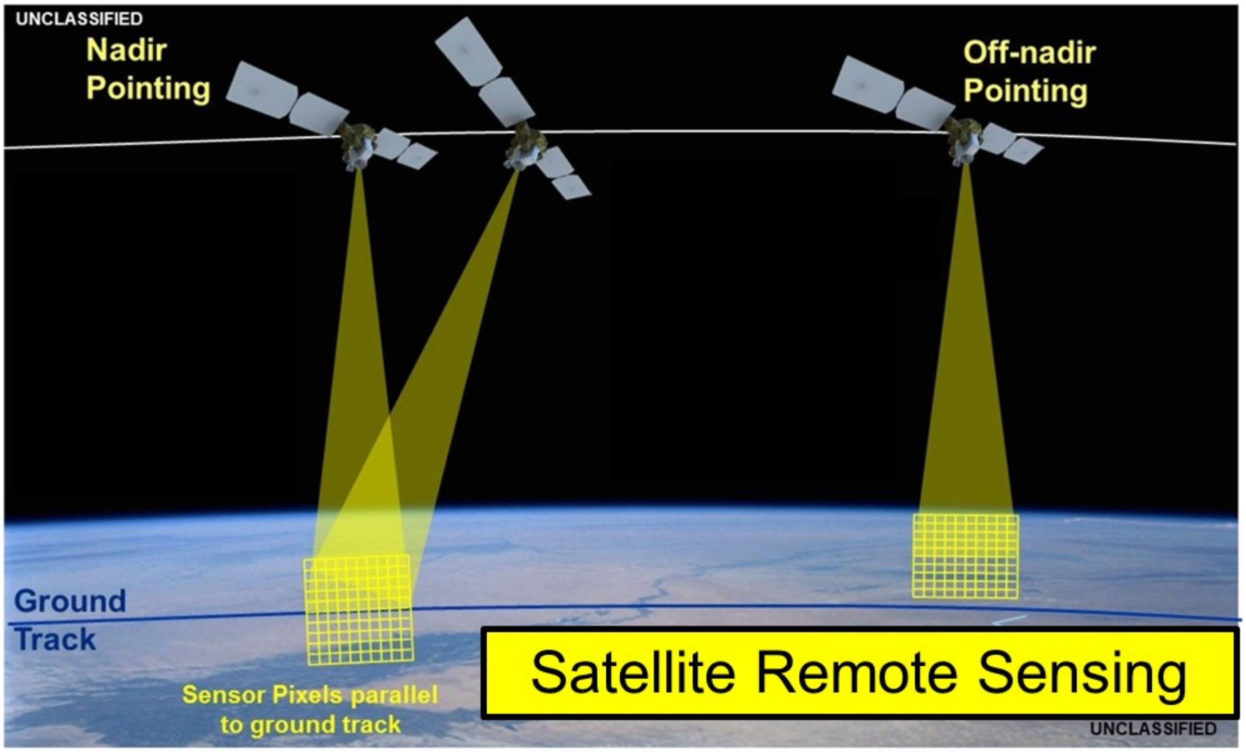
FSOC Received Power Model





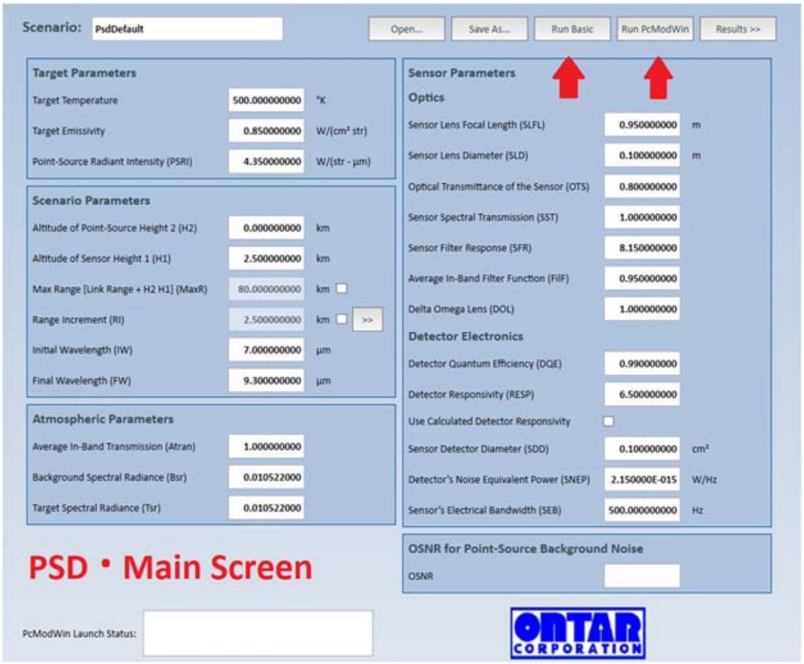
PSD: Point Source Detection

New Software



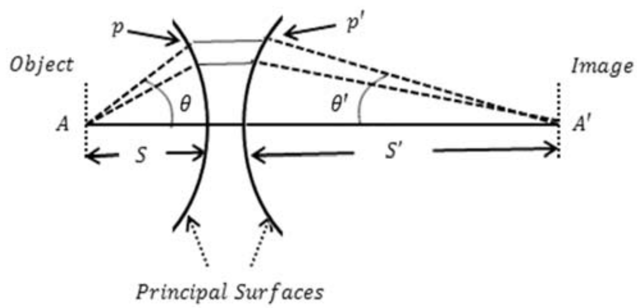
Systems engineers design sensors to detect targets at ranges from tens to hundreds of kilometers using both single detectors and focal plane arrays.

Ontar's new PSD (Point Source Detections) software calculates OSNR and other metrics needed by systems designers using Target, Scenario, Atmospheric, Sensor Optics and Sensor Detector parameters.

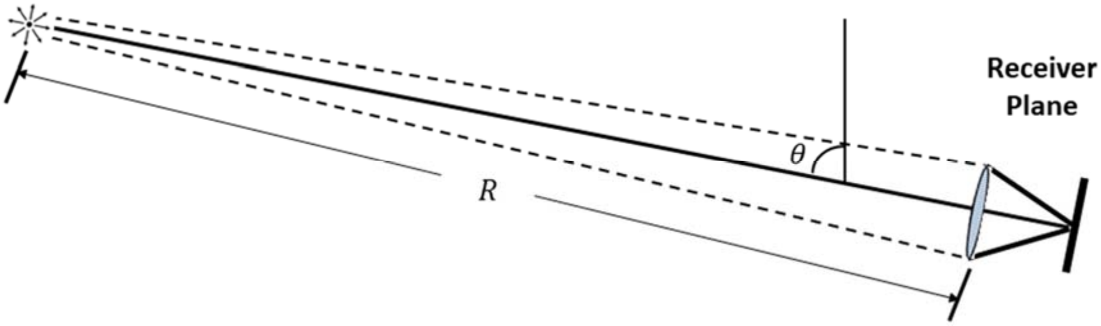


It executes as both a stand-alone software package **and** integrated with our **NEW PcModWin – Scenario** software in the Run Basic and Run PcModWin modes depicted by the ⬆s in the figure.

This figure is the main PSD input screen showing the input parameters and run modes. The software was developed cooperatively with Dr. Larry B. Stotts.



When a radiation source is imaged by an optical system, the observed image only captures radiance within the solid angle subtended by the clear aperture of said optical system and zero, elsewhere as depicted in the figure above.



The figure above depicts the sensor geometry for a point source detection scenario. The point source is at Altitude H2 illuminating a sensor at the Observer Altitude H1 from a distance R away at a zenith angle θ. The point-source has radiant intensity $I_s[W/str]$. The sensor uses a lens of diameter d_{lens} and focal length f

For example, the Optical Signal to Noise Ratio for this scenario is approximated by:

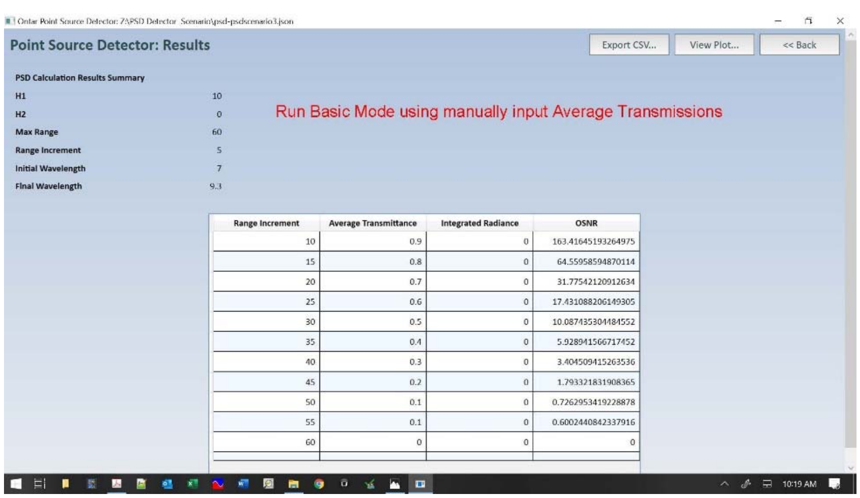
$$OSNR = \frac{\mathcal{R}_\lambda P_s}{\sqrt{B_e}\ NEP} \approx \frac{\gamma_{sensor}\ L_a I_s\ \Delta\Omega_{lens}\ \Delta\lambda}{\sqrt{B_e}\ NEP} \approx \frac{\gamma_{sensor}\ L_a I_s\ \Delta\lambda}{\sqrt{B_e}\ NEP}\left(\frac{A^{lens}}{R^2}\right)$$

Also Contrast, Detection Range, and other metrics are calculated.

RUN Basic Mode:

In the stand-alone mode the user inputs the parameters in the Main Screen as well as the atmospheric transmission, target, and background signatures.

Tabular output for a down viewing scenario at ranges from 10 to 60 Kms in 5 Km increments.



Ontar Point Source Detector: Z:\PSD Detector Scenario\psd-psdscenario3.json

Point Source Detector: Results

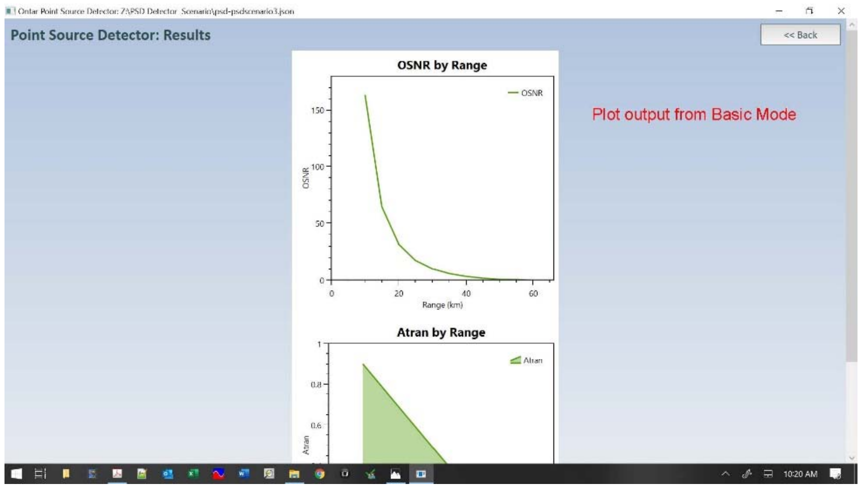
Export CSV... View Plot... << Back

PSD Calculation Results Summary

H1	10
H2	0
Max Range	60
Range Increment	5
Initial Wavelength	7
Final Wavelength	9.3

Run Basic Mode using manually input Average Transmissions

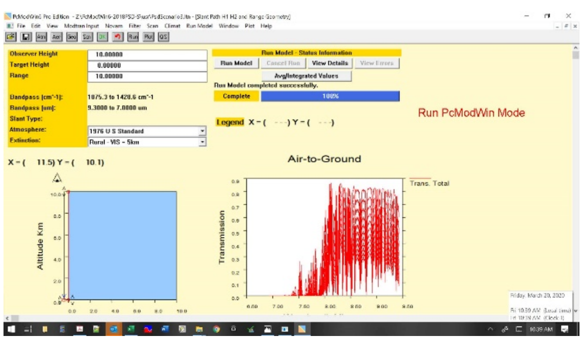
Range Increment	Average Transmittance	Integrated Radiance	OSNR
10	0.9	0	163.41645193264975
15	0.8	0	64.55958594870114
20	0.7	0	31.77542120912634
25	0.6	0	17.431088206149305
30	0.5	0	10.087435304484552
35	0.4	0	5.928941566717452
40	0.3	0	3.404509415263536
45	0.2	0	1.793321831908365
50	0.1	0	0.7262953419228878
55	0.1	0	0.6002440842337916
60	0	0	0

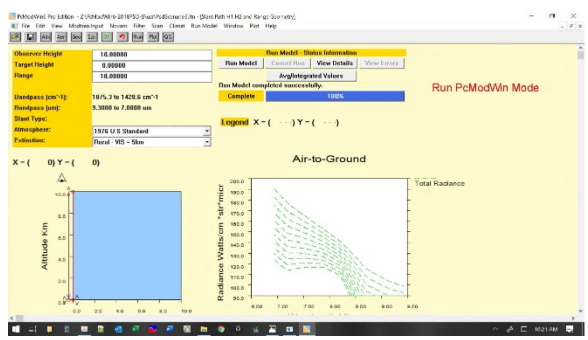


Run PcModWin Mode:

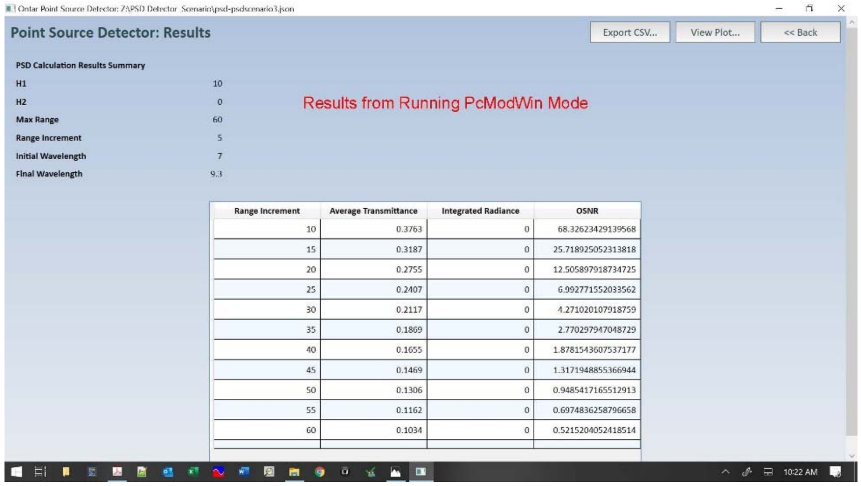
In this mode the user inputs the scenario and system parameters on the main screen. At execution, the PSD software is interrupted and transmits parameters to PcModWin – Scenario. This is like the interface Ontar's designed for NVESD's NVTherm-IP to interface PcModWin5 with NVTHERM.

The user has the capability to change any MODTRAN® parameters except those specified on the main screen such as wavelength interval, altitudes, ranges, zenith angle etc. Hence the user has access to ALL other parameters such as aerosols, scattering, atmospheric profiles, radiosonde etc.

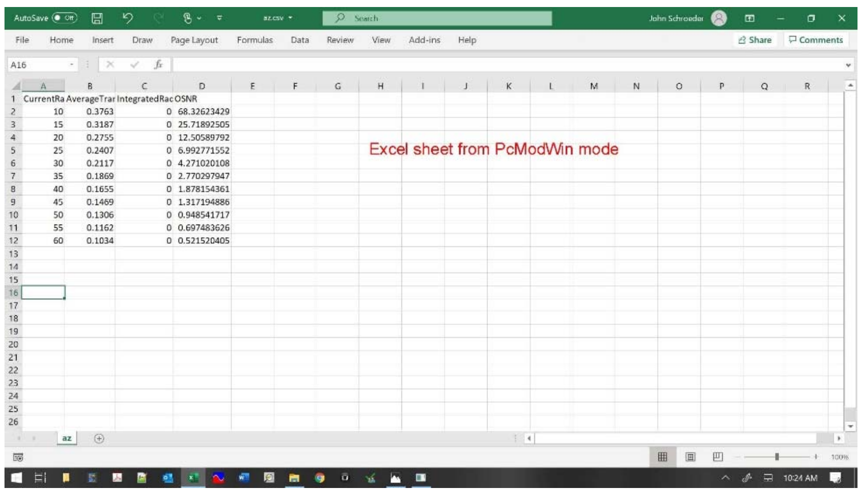




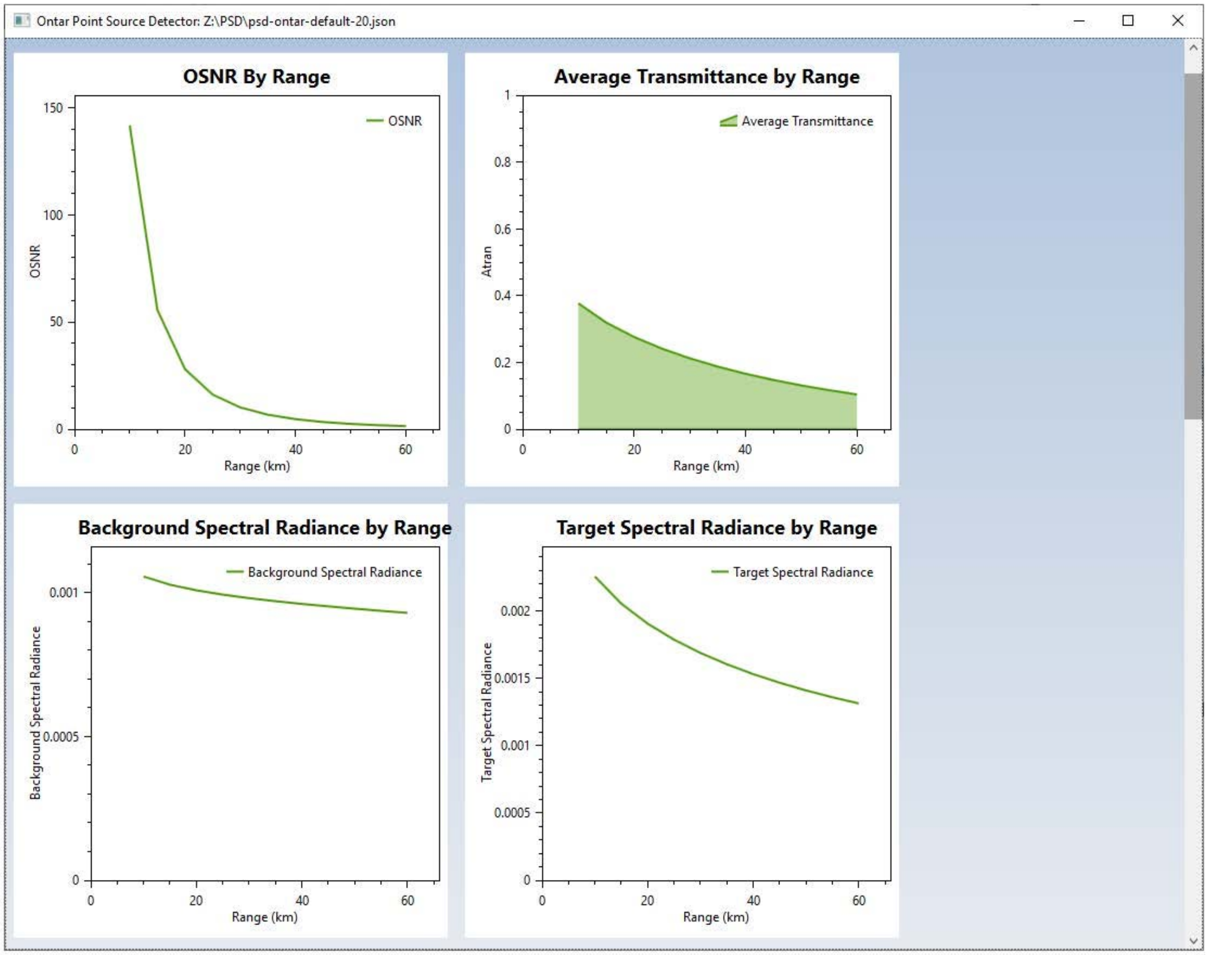
Atmospheric Transmissions and Radiance for the scenario described about.



Range Increment	Average Transmittance	Integrated Radiance	OSNR
10	0.3763	0	68.32623429139568
15	0.3187	0	25.718925052313818
20	0.2755	0	12.505897918734725
25	0.2407	0	6.992771552033562
30	0.2117	0	4.271020107918759
35	0.1869	0	2.770297947048729
40	0.1655	0	1.8781543607537177
45	0.1469	0	1.3171948855366944
50	0.1306	0	0.9485417165512913
55	0.1162	0	0.6974836258796658
60	0.1034	0	0.5215204052418514



CurrentRa	AverageTrar	IntegratedRac	OSNR
10	0.3763	0	68.32623429
15	0.3187	0	25.71892505
20	0.2755	0	12.50589792
25	0.2407	0	6.992771552
30	0.2117	0	4.271020108
35	0.1869	0	2.770297947
40	0.1655	0	1.878154361
45	0.1469	0	1.317194886
50	0.1306	0	0.948541717
55	0.1162	0	0.697483626
60	0.1034	0	0.521520405



PSD outputs for the scenario described above.