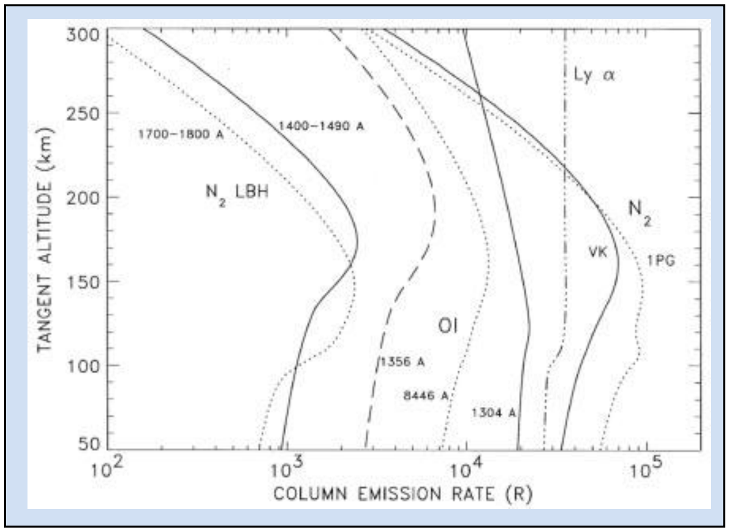
AURIC

Computational Physics, Inc.

The Atmospheric Ultraviolet Radiance Integrated Code (AURIC) is a software package developed by Computational Physics, Inc. (CPI) for the Air Force Phillips Laboratory (subsequently the Air Force Research Laboratory [AFRL]) for upper atmospheric radiance modeling from the far ultraviolet to the near infrared. It effectively extends the MODTRAN® code for calculating atmospheric transmittance and radiance (infrared and Rayleigh plus aerosol scattering of sunlight) to altitudes above 100 km and wavelengths down to 80 nm.



Limb profiles in Rayleighs for 60° solar zenith angle and a Hinteregger solar EUV spectrum based on F10.7 = 150, plus profiles for the optically thick OI 1304 Å and HI 1216 Å features. The difference in shape between the two LBH profiles is due to differences in O2 Schumann-Runge opacity.

The AURIC model is designed for the prediction and interpretation of terrestrial airglow emissions from the EUV to the NIR [Strickland *et al.*, 1999; Bishop and Feldman, 2003]. The model is capable of producing volume excitation rates (VERs) of nearly all known terrestrial EUV and FUV emissions and most bright emissions in the Visible and NIR. AURIC has been used to study the N_2 EUV airglow from the Earth [Siskind *et al.*, 1995; Strickland *et al.*, 1997; Majeed and Strickland, 1997; Bishop and Feldman, 2003; Bishop *et al.*, 2007], and results from earlier versions of the model were scaled to study the N_2 EUV airglow of Titan [Strobel *et al.*, 1992; Stevens, 2001] and Triton [Strobel *et al.*, 1992; Stevens, 2002].

	Atomic Emission	λ (nm)	Main Excitation Sources
Dayside			
	OI ($^3S^o \to {}^3P$)	130.2 + 130.5 + 130.6	e^- + O,O_2, solar resonant scattering
	OI ($^5S^o \to {}^3P$)	135.6 + 135.9	e^- + O,O_2
	OI ($^3S^o \to {}^1D$)	164.1	130.4 nm total source function
	OI ($^1S \to {}^3P$)	297.2	(see Table 3)
	OI ($^1S \to {}^1D$)	577.7	(see Table 3)
	OI ($^1D \to {}^3P$)	630.0, 636.4	(see Table 3)
	OI ($^5P \to {}^5S^o$)	777.4	e^- + O,O_2
	OI ($^3P \to {}^3S^o$)	844.6	e^- + O,O_2
	NI ($^4P \to {}^4S^o$)	113.4	e^- + N,N_2
	NI ($^2P \to {}^2D^o$)	149.3	e^- + N,N_2
	NI ($^2P \to {}^2P^o$)	174.3	e^- + N,N_2
	NI ($^2P^o \to {}^4S^o$)	346.6	(see Table 3)
	NI ($^2D^o \to {}^4S^o$)	520.0	(see Table 3)
	OII ($^2P^o \to {}^4S^o$)	247.0 + 247.1	(see Table 3)
	OII ($^2P^o \to {}^2D^o$)	732.0, 733.0	(see Table 3)
	OII ($^2D^o \to {}^4S^o$)	372.6 + 372.9	(see Table 3)
	NII ($^3D^o \to {}^3P$)	108.5	$h\nu$ + N_2, e^- + N_2
	NII ($^5S^o \to {}^3P$)	213.9, 214.3	$h\nu$ + N_2
Nightside			
	OI ($^3S^o \to {}^3P$)	130.2 + 130.5 + 130.6	O^+,e^- recombination
	OI ($^5S^o \to {}^3P$)	135.6 + 135.9	O^+,e^- recombination
	OI ($^3S^o \to {}^1D$)	164.1	130.4 nm total source function
	OI ($^1S \to {}^3P$)	297.2	O atom recombination
	OI ($^1S \to {}^1D$)	577.7	O atom recombination
	OI ($^1D \to {}^3P$)	630.0, 636.4	O_2^+ dissociative recombination
	OI ($^5P \to {}^5S^o$)	777.4	O^+,e^- recombination
	OI ($^3P \to {}^3S^o$)	844.6	O^+,e^- recombination
Global			
	HI Lyman α ($^2P \to {}^2S$)	121.6	solar resonant scattering

Many enhancements have been made to AURIC since its inception, including a more comprehensive chemistry model (for neutral and ionospheric species), new radiative transfer capabilities, the option of performing photoelectron energy degradation with or without transport, updates to electron impact cross sections (Majeed and Strickland, 1997; Strickland et al., 1997), and the addition of new emission features. AURIC is currently in use by a number of organizations: NRL, Aerospace Corp., and JHU/APL. Examples of application papers using AURIC can be found at http://www.cpi.com.

AURIC has been validated against numerous published rocket and satellite data, and shown to have good overall agreement with the measurements. The airglow modeling capabilities of AURIC make it a powerful tool for characterizing optical backgrounds at thermospheric altitudes, for developing remote sensing algorithms, for simulating data from rocket and satellite optical instrumentation, as well as conducting science investigations.

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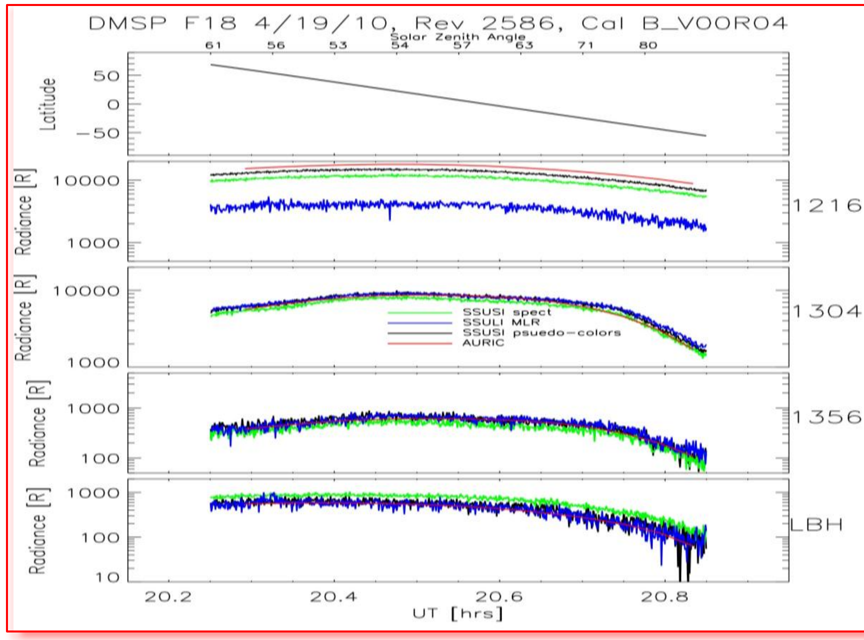
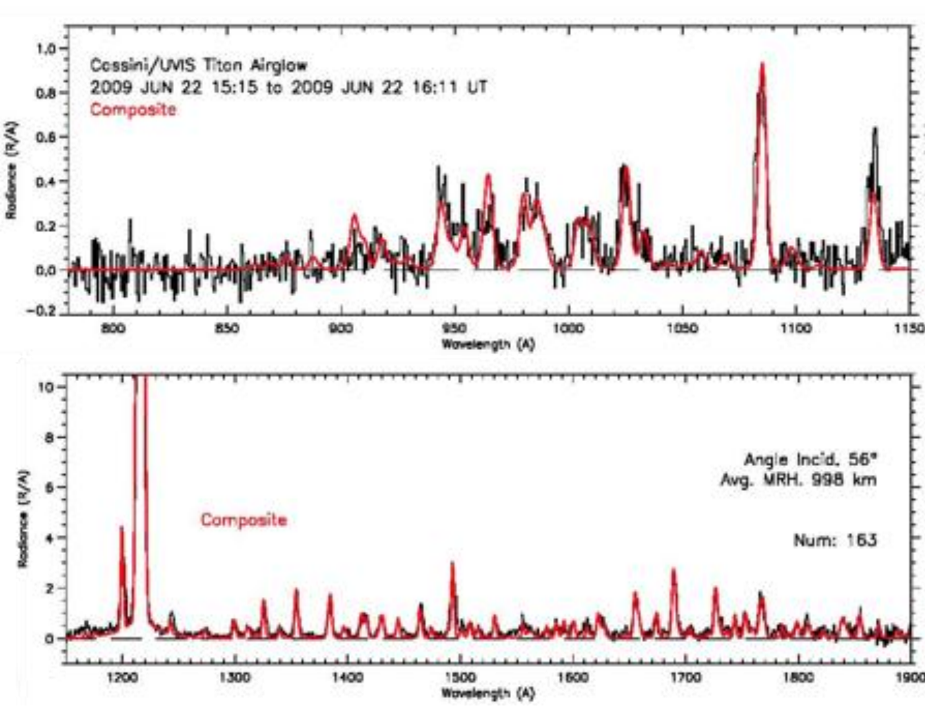
More recently, AURIC has played a critical role in the calibration of the Special Sensor Ultraviolet Spectrographic Imager (SSUSI) and the Special Sensor Ultraviolet Limb Imager (SSULI) instruments onboard the Defense Meteorological Satellite Program (DMSP) F18 satellite. In this role, AURIC model results have been used to quantify and understand differences in coincident measurements from these two instruments. Good agreement between AURIC model radiances and coincident FUV measurements from SSUSI and SSULI illustrates important contributions by AURIC in the assessment of instrument performance, and therefore on the quality of retrieval products obtained from these and other instruments. AURIC also serves as a forward model for a number of operational FUV retrieval algorithms.



Comparison of AURIC model results (green) for spectral bands at 1216 Å, 1304 Å, 1356 Å, and N_2 LBH [1400 - 1500 Å] with coincident SSUSI (red and purple) and SSULI (blue) nadir-viewing data measured on April 19, 2010. The SSULI 1216 Å data is low relative to SSUSI and AURIC due to an instrument burn-in at the SSULI 1216 Å line center.

AURIC consists of portable FORTRAN source code for calculating airglow spectral radiances and densities of chemically active species. A text-based user interface is provided for tailoring the execution of the dayglow and nightglow codes for specific applications. In line with its operational status, the software compiles and executes under several common operating systems: Linux, Mac OS, and Windows. An AURIC User's Manual has also been written with detailed information on the operation of the model on Linux, Mac OS, and Windows systems along with numerous tables and illustrations of inputs and outputs.



Spectral analysis of a Cassini-Huygens/UVIS Titan airglow spectrum from June 2009 showing a composite AURIC fit to data corresponding to the EUV (top) and FUV (bottom). The solar zenith angle and tangent height are indicated in the figure.

With relatively minor modifications to input files, AURIC is sufficiently flexible that specification of a different model atmosphere and solar irradiance at Mars, Titan, and Pluto, for example, can yield radiances produced by photoelectrons or photodissociative ionization/excitation (PDI/PDE) [Meier *et al*., 1991; Samson *et al*., 1991; Bishop and Feldman, 2003]. To demonstrate this flexibility, a prototype AURIC-Titan model was developed for comparison of AURIC spectral radiances with Cassini-Huygens/UVIS data measured on June 22, 2009 [Stevens *et al*., 2011]. Agreement between AURIC and the UVIS data is exceptionally good across the EUV and FUV. These results give us confidence that AURIC can be further generalized for application to other planetary atmospheres in the solar system, particularly those of Mars and Pluto.