NAME

average_data – average input data

SYNOPSIS

int average_data (int *len***, int** *num***, double ****_data_**, double ***_avg_**, double ***_dev_**);**

ARGUMENTS

len	length of each spectra
num	number of spectra
data	*num* spectral data
avg	average of spectra
dev	standard deviation of data

NAME

compute_rrs – compute Rrs using method 2 of Ocean Optics Protocols

SYNOPSIS

int compute_rrs (int *n*, **double ***_S_sky_, **double ***_S_sfc_, **double ***_S_g_, **double ***_R_g_, **double ***_Rrs_, **double ***_Rrs_sfc_, **double ***_Rrs_sky_, **double ***_Ed_**);**

ARGUMENTS

n	length of spectra
S_sky	input uncalibrated measured sky spectra
S_sfc	input uncalibrated measured surface spectra
S_g	input uncalibrated measured gray-card spectra
R_g	input gray card reflectance
Rrs	output total remote sensing reflectance
Rrs_sfc	output surface reflectance
Rrs_sky	output sky reflectance
Ed	downwelling irradiance

DESCRIPTION

This computes the remote sensing reflectance following Method 2 of the Ocean Optics Protocols, Vol III, Chapter 3. Additionally, it computes the surface and sky reflectance used by several correction methods.

NAME

decode_asd_header – decode ASD data buffer to ASD header struct

SYNOPSIS

int decode_asd_header (HDR ****hdr*, char ****buf***);**

ARGUMENTS

hdr	returned header
buf	buffer containing ASD header stream

DESCRIPTION

This routine will parse through the ASD header stream located in *buf* and unpack it into an ASD header. It is returned in *hdr*.

NAME

find_index – find index of wavelength

SYNOPSIS

int find_index (int *n*, **double ***_wavel_, **double** *w*)**;**

ARGUMENTS

n	length of wavel
wavel	array of wavelengths (nm)
w	wavelength to find in *wavel* array

DESCRIPTION

Finds the first index greater than w in *wavel*. It assumes that *wavel* is monotonically increasing.

NAME

get_input – get sky, water, ref spectra and wavelength

SYNOPSIS

int get_input (int ****nchannels*);**

ARGUMENTS

nchannels number of channels read

DECRIPTION

Using global variables sfc_files, ref_files, sky_files, this routine determines if the input file is an ASD file, a SPECTRIX file or SIMBIOS file. Depending on type, the appropiate routine is called to read in and compute the average sky, reference, and water spectra are. This are returned in global variables skyavg, skydev, wateravg, waterdev, refavg, refdev. The wavel of the instrument is also returned.

Memory of each of these array are allocated by each read routine.

NAME

get_insitu – read a and b from insitu data file

SYNOPSIS

int get_insitu (const char ****file*, int ****n***, double *****wavel***, double *****a***, double *****b***);**

ARGUMENTS

file	file containing insitu data
n	number of insitu returned
wavel	wavelength of insitu data
a	absorption data
b	scattering data

DESCRIPTION

This routine will read in the absorption and scattering data from an insitu data file. The arrays wavel, a, b are allocated in this routine.

FORMAT

It assumes that the file format is comma separated values. No header.

NAME

get_spx_input – get input data from Spectrix

SYNOPSIS

int get_spx_input (char *****sky_files*, char *****ref_files***, char *****sfc_files***, double *****skyavg***, double *****skydev***, double ****skymin***, double ****skymax***, double *****wateravg***, double *****waterdev***, double ****watermin***, double ****watermax***, double *****refavg***, double *****refdev***, double ****refmin***, double ****refmax***, double *****wavel***, int** ***verb*****);**

ARGUMENTS

sky_files	files containing sky readings
ref_files	files containing plaque (grey-card) readings
sfc_files	files containing surface (water) readings
skyavg	average sky reading
skydev	deviation of sky readings
skymin	minium of all sky readings
skymax	maximum of all sky readings
wateravg	average water reading
waterdev	deviation of water readings
watermin	minium of all water readings
watermax	maximum of all water readings
refavg	average reference reading
refdev	deviation of reference readings
refmin	minium of all reference readings
refmax	maximum of all reference readings
wavel	wavelength of spectra
verb	ask routine to be verbose

DESCRIPTION

This routine reads in the spectrix data which may or may not exist in separate files. If in a single file, the sfc_files[0] should be set to that file. In this case, the spectra must be collected in the correct order (ref, water, water, water, sky) and repeat three times.

RETURNS

The number of channels in the spectra

NAME

get_spx_wavel – get wavelength for SPX

SYNOPSIS

int get_spx_wavel (int *n*, **double ***_wavel_**);**

ARGUMENTS

n	number of spectra
wavel	wavelength of spectra

DESCRIPTION

Return wavelength from SPX. The data from the Spectrix is written "backwards" from NIR to ultra-violet (800nm to 300nm). This routine returns the wavelengths from ultra-violet to NIR.

NAME

get_water_depth – get water depth from bathymetry

SYNOPSIS

int get_water_depth (simbios_header_t ****hd*);**

ARGUMENTS

hd SIMBIOS header

DESCRIPTION

Sets the water depth in the SIMBIOS header by reading the APS default bathymetry file.

NAME

inversion_path1 − surface correction using 715, 735 nm values

SYNOPSIS

int inversion_path1 (int *n*, **double ***_wavel_, **double ***_Rrs_sfc_, **double ***_Rrs_sky_, **double ***_Rrs_, **double ***_a_, **double ***_b_**);**

ARGUMENTS

n	length of spectrum
wavel	wavelength of spectra
Rrs_sfc	input water remote sensing reflectance (Rt)
Rrs_sky	input sky remote sensing reflectance (Rsky)
Rrs	output remote sensing reflectance
a	output total absorption
b	output total scattering

DESCRIPTION

This routine performs path 1 of the correction from Gould, et al (2001). Here no in-situ data is available to modify the algorithm.

REFERENCES

Gould, R. W. Jr, R. A. Arnone, and M. Sydor, Absorption, Scattering,

AND REMOTE SENSING REFLECTANCE IN COASTAL WATERS

Testing a new Inversion Algorithm, *Journal of Coastal Research*, Vol 17, No 2, pp 328-341, Spring 2001.

NAME

inversion_path2 – surface correction using 715, 735 nm values

SYNOPSIS

int inversion_path2 (int *n*, **double** *****_wavel_, **double** *****_Rrs_sfc_, **double** *****_Rrs_sky_, **int** *n_insitu*, **double** *****_wavel_insitu_, **double** *****_a_insitu_, **double** *****_b_insitu_, **double** *****_Rrs_, **double** *****_a_, **double** *****_b_**);**

ARGUMENTS

n	length of spectrum
wavel	wavelength of spectra (nm)
Rrs_sfc	input water remote sensing reflectance (Rt)
Rrs_sky	input sky remote sensing reflectance (Rsky)
n_insitu	number of insitu values
wavel_insitu	input insitu wavelength (nm)
a_insitu	input insitu absorption data
b_insitu	input insitu scattering data
Rrs	output remote sensing reflectance
a	output total absorption
b	output total scattering

DESCRIPTION

This routine performs path 2 of the correction from Gould, et al (2001). Here in-situ data must be available to modify the algorithm.

REFERENCES

Gould, R. W. Jr, R. A. Arnone, and M. Sydor, Absorption, Scattering,

AND REMOTE SENSING REFLECTANCE IN COASTAL WATERS

Testing a new Inversion Algorithm, *Journal of Coastal Research*, Vol 17, No 2, pp 328-341, Spring 2001.

NAME

new_det_resp – create new modis_detector_resp_t object

SYNOPSIS

modis_detector_resp_t * new_det_resp (int *det*, **GArray ***wave*, **GArray ***resp*);

ARGUMENTS

det	detector number
wave	wavelengths for detector
resp	response function

DESCRIPTION

Allocate and fill in a modis_detector_resp_t object.

NAME

normalize_rrs – subtract an offset from an input spectra

SYNOPSIS

int normalize_rrs (int *n***, double** *offset***, double ***_in_**, double ***_out_**);**

ARGUMENTS

n	number of values
offset	normalization offset
in	input spectra
out	output spectra

DESCRIPTION

This routine will subtract the offset from the input spectra and place the result in the output spectra. This has the

NAME

optimize – correct Rrs using Ping's optimize method

SYNOPSIS

int optimize (int *n***, double ***_wavel_**, double ***_Rrs_sfc_**, double ***_Rrs_sky_**, double ***_Rrs_ray_**, double ***_Rrs_**);**

ARGUMENTS

n	length of spectra
wavel	wavelength of spectra
Rrs_sfc	input surface reflectance
Rrs_sky	input sky reflectance
Rrs_ray	output Rayleigh corrected remote sensing reflectance
Rrs	output water-leaving remote sensing reflectance

DESCRIPTION

This routine corrects the spectrum using the optimize method of Lee, et al (1997).

NAME

proc_seawifs – apply relative spectral response to input rrs

SYNOPSIS

void proc_seawifs (int *nchannels*, **double** **wavel*, **double** **rrs_std*, **double** **rrs_p*, **double** **rrs_g1*, **double** **rrs_g2*, **char** **ofile*, **simbios_header_t** **simbios*);

ARGUMENTS

nchannels	number of input channels
wavel	wavelength of input spectra
rrs_std	SeaWiFS protocol remote sensing reflectance
rrs_p	Lee (1997) remote sensing reflectance
rrs_g1	Gould (2001) Path 1 remote sensing reflectance
rrs_g2	Gould (2001) Path 2 remote sensing reflectance
ofile	file to write results
simbios	SIMBIOS header for output file

NAME

procrrs – main processing of in situ data

SYNOPSIS

int procrrs (*void***);**

ARGUMENTS

void	no arguments

DESCRIPTION

This routine is the main processing routine of the in situ processing program. It gets the input data, albedo and computes the remote sensing reflectance. Then, it calls three correction methods including Lee et al (1997), Steward/Carder (1985), and Gould, et al (2001). If user selected an in situ data file, Gould (2001), Path 2, is performed. Next, the relative spectral response for SeaWiFS and MODIS are applied to in situ reflectance. Finally, the inherent optical property algorithms are run on the in situ reflectance. These include the QAA and Arnone algorithm.

NAME

rd_asd – read in ASD file

SYNOPSIS

int rd_asd (const char * *file***, HDR ***_hdr_**, double ***_data_**);**

ARGUMENTS

file	filename of ASD file
hdr	returned header
data	returned reflectance

DESCRIPTION

This routine will read in the ASD file pointed to by *file* and return the data in *data* and all the header information in *hdr*. If the user just wish to read in the header, set *data* to NULL.

NAME

read_modis_response –

SYNOPSIS

int read_modis_response (char ****file*, modis_band_resp_t ****band_resp***);**

ARGUMENTS

file	file containing the MODIS relative spectral response for a band
band_resp	relative spectral response read from file

DESCRIPTION

The ASCII MODIS relative spectral response files contain 4 columns. The first is the band number followed by the channel (detector). The next two columns contain the wavelength and response for that wavelength. The file may contain comments using the '#' character.

NAME

read_raw_spx_spectra – read a single raw spectrix scan

SYNOPSIS

int read_raw_spx_spectra (FILE ****fp*, double ****in***, double ****dark***, double ****it***);**

ARGUMENTS

fp	FILE pointer to the spectrix data file
in	spectrix data
dark	dark spectrix data
it	integration time

DESCRIPTION

Returns data from SPX. The data from the Spectrix is written "backwards" from NIR to Ultraviolet (800nm to 300nm). This routine reverses that order.

For each reading, the spectrix data writes a seven line header, followed by 512 lines of spectra data (NIR to Ultraviolet) with shutter open, and another 512 lines of spectra data with shutter closed (dark current).

NAME

read_simbios_lvl0_refl_data – read SIMBIOS level-0 reflectance data

SYNOPSIS

int read_simbios_lvl0_refl_data (const char ****file*, int ****num***, double *****wave***, double *****S_sky***, double *****S_ref***, double *****S_sfc***, simbios_header_t ****hd***);**

ARGUMENTS

file	NRL SIMBIOS file containing remote sensing reflectance
num	number of values
wave	wavelength of remote sensing reflectance
S_sky	uncalibrated sky reflectance
S_ref	uncalibrated grey reflectance
S_sfc	uncalibrated sea surface reflectance
hd	SIMBIOS header to use for output file

DESCRIPTION

Reads in the uncalibrated sky, reference, and sea surface reflectance from an NRL created SIMBIOS file.

NAME

read_simbios_rrs_data – read SIMBIOS rrs file created by NRL

SYNOPSIS

int read_simbios_rrs_data (const char * *file*, **int *** *num*, **double **** *wave*, **double **** *rrs*);

ARGUMENTS

file	NRL SIMBIOS file containing remote sensing reflectance
num	number of values
wave	wavelength of remote sensing reflectance
rrs	remote sensing reflectance

DESCRIPTION

Reads in the remote sensing reflectance from an NRL created SIMBIOS file

NAME

read_spx_input – read input from SPX data file

SYNOPSIS

int read_spx_input (char ** *files***, double **** *data***, int *** *nspectra***);**

ARGUMENTS

files	array of input files
data	array of spectra data
nspectra	number spectra read from file

DESCRIPTION

The SPX data files contains 1031 lines per target reading. The first 7 lines are header information, followed by 512 lines of data, followed by 512 lines of dark current data. During normal operation, all fifteen readings are stored in a single file.

NAME

read_spx_spectra – read a single raw spectrix scan

SYNOPSIS

int read_spx_spectra (FILE * *fp*, **double *** *data*);

ARGUMENTS

fp	FILE pointer to the spectrix data file
data	spectrix data

DESCRIPTION

Returns a spectra reading from a Spectrix file. The returned data has been dark corrected and normalized to 1 sec integration time.

NAME

read_swfresp – read the seawifs response file.

SYNOPSIS

int read_swfresp (char ***_file_, double ***_resp[8]_**, double ***_wavel_**);**

ARGUMENTS

file	response file
resp[8]	-- undescribed --
wavel	wavelength of each response

DESCRIPTION

This ASCII file contains 9 columns. The first is the wavelengh (starts at 380) and increments by 1 nm wavelengths to 1150. We are only interested in up to 800 nm, so we read in only the first 421 lines.

NAME

rrs_modis – compute mean Rrs weighted by MODIS relative spectral response

SYNOPSIS

int rrs_modis (const char ***_dir_, int** _num_rrs_**, double ***_wavel_**, double ***_rrs_**, double ***_mod_rrs[7]_**);**

ARGUMENTS

dir	directory contaning MODIS relative spectral response files
num_rrs	number of input Rrs values
wavel	wavelengths of input Rrs values
rrs	input Rrs values
mod_rrs[7]	-- undescribed --

DESCRIPTION

Interpolates the Rrs input data from instrument wavelengths to that of the relative spectral response file (varies from 2nm to 1nm), then calculates an effective mean Rrs weighted by the spectral response of MODIS (for each band and detector).

RETURNS

The *mod_rrs* parameter contains the seven modis ocean wavelengths (412,443, 488,532,555,667,678) for each detector (0-9) and an average of all ten detectors (10).

NAME

rrs_seawifs – apply SeaWiFS relative spectral response to Rrs data

SYNOPSIS

int rrs_seawifs (char ****file*, int** *n***, double ****wavel***, double ****rrs***, double ****swf_rrs***);**

ARGUMENTS

file	file name
n	number of spectra
wavel	wavelength of spectral
rrs	remote sensing reflectance
swf_rrs	mean SeaWiFS reflectance for each channel

DESCRIPTION

Interpolates the input Rrs to relative spectral response file wavelengths and then calculate an effective mean Rrs weighted by the spectral response of SeaWiFS (for each channel).

NAME

run_arnone – run Arnone algorithm on input spectra

SYNOPSIS

void run_arnone (int *n***, double ***_wavel_**, double ***_rrs_**, double ***_a_**, double ***_bb_**);**

ARGUMENTS

n	length of spectra
wavel	wavelength of spectra
rrs	input remote sensing reflectance
a	output total absorption
bb	output backscattering

DESCRIPTION

Perform the Arnone algorithm on the input spectra and return the total absorption and backscattering.

NAME

run_qaa – run QAA algorithm on input spectra

SYNOPSIS

void run_qaa (int *n***, double ***_wavel_**, double ***_rrs_**, double ***_a_**, double ***_adg_**, double ***_aph_**, double ***_bb_**);**

ARGUMENTS

n	length of spectra
wavel	wavelength of spectra
rrs	input remote sensing reflectance
a	output total absorption
adg	output detris/CDOM absorption
aph	output phytoplankton absorption
bb	output backscattering

DESCRIPTION

Perform the QAA algorithm on the input spectra and return the total absorption and backscattering.

NAME

set_asd_time_limits – set data time range from all input files

SYNOPSIS

void set_asd_time_limits (char *****sky_files*, char *****ref_files***, char *****sfc_files***);**

ARGUMENTS

sky_files	array of sky target files
ref_files	array of gray card target files
sfc_files	array of sea surface target files

DESCRIPTION

This routine gets the time of each input ASD file from the three lists and determines the earliest and latest time limits. The *simbios* variables *start_date*, *start_time*, *end_date*, and *end_time* are then updates with the appropriate values.

NAME

white_normalize_rrs – correct rrs assuming white skylight

SYNOPSIS

double white_normalize_rrs (int *n*, **double ***_wavel_, **double ***_in_, **double ***_out_**);**

ARGUMENTS

n	number of values
wavel	wavelength of spectra
in	input remote sensing reflectance
out	output remote sensing reflectance (white skylight corrected)

DESCRIPTION

This routine will correct the input spectra by assuming that if the ocean is totally absorbing ("black") at 750 nm (and longer wavelengths), then Rrs(750) should be zero if the reflected skylight term was properly corrected for it. This correction assumes that the skylight term is white (not wavelength dependent).

This routine will examine all the Rrs from 700 to 825 to determine the lowest value to be used in subtracting from the input spectra. This range will hopefully guard against a resulting normalized output spectra with negative values.

RETURNS

The normalization value computed

REFERENCE

Ocean Optics Protocols For Satellite Ocean Color Sensor Validation, Revision 4, Volume III, page 28.

NAME

wr_arnone_data – output Arnone IOP data to file

SYNOPSIS

int wr_arnone_data (char ****filename*, simbios_header_t ****hd***, int** *n***, double ****wavel***, double ****a***, double ****bb***);**

ARGUMENTS

filename	file name to write file
hd	SIMBIOS header structure
n	number of SeaWiFS values
wavel	wavelength of spectra
a	total absorption spectra
bb	backscattering spectra

DESCRIPTION

Writes a SIMBIOS file containing inherent optical properties derived from Arnone algorithm

NAME

wr_gould_data – output Gould IOP data to file

SYNOPSIS

int wr_gould_data (char ***_filename_, simbios_header_t ***_hd_**, int** _n_**, double ***_wavel_**, double ***_a_**, double ***_b_**, double ***_a2_**, double ***_b2_**);**

ARGUMENTS

filename	file name to write file
hd	SIMBIOS header structure
n	number of SeaWiFS values
wavel	wavelength of spectra
a	total absorption spectra (Path 1)
b	total scattering spectra (Path 1)
a2	total absorption spectra (Path 2)
b2	total scattering spectra (Path 2)

DESCRIPTION

Writes a SIMBIOS file containing inherent optical properties derived from Gould (Path 1 and Path 2) algorithm

NAME

wr_level0_data – output insitu uncalibrated repsonse

SYNOPSIS

int wr_level0_data (char ***_filename_, simbios_header_t ***_hd_**, int** _n_**, double ***_wavel_**, double ***_wateravg_**, double ***_skyavg_**, double ***_refavg_**);**

ARGUMENTS

filename	file name to write file
hd	SIMBIOS header structure
n	number of SeaWiFS values
wavel	wavelength of spectra
wateravg	average sea surface reflectance
skyavg	average sky reflectance
refavg	average reference reflectance

DESCRIPTION

Writes a SIMBIOS type of averaged sea surface, sky, and reference reflectance.

NAME

wr_modis – output MODIS response

SYNOPSIS

int wr_modis (char ****filename*, simbios_header_t ****hd***, double ****wavel***, double ****mod_rrs[7]***, double ****mod_rrs_p[7]***, double ****mod_rrs_g1[7]***, double ****mod_rrs_g2[7]***);**

ARGUMENTS

filename file name to write file

hd SIMBIOS header structure

wavel MODIS wavelengths

mod_rrs[7] -- undescribed --

mod_rrs_p[7] -- undescribed --

mod_rrs_g1[7] -- undescribed --

mod_rrs_g2[7] -- undescribed --

DESCRIPTION

Writes a SIMBIOS type of MODIS repsonse data

NAME

wr_qaa_data – output QAA IOP data to file

SYNOPSIS

int wr_qaa_data (char ***_filename_, simbios_header_t ***_hd_**, int** _n_**, double ***_wavel_**, double ***_a_**, double ***_adg_**, double ***_aph_**, double ***_bb_**);**

ARGUMENTS

filename	file name to write file
hd	SIMBIOS header structure
n	number of SeaWiFS values
wavel	wavelength of spectra
a	total absorption spectra
adg	detris/gelbstuff spectra
aph	phytoplankton spectra
bb	backscattering spectra

DESCRIPTION

Writes a SIMBIOS file containing inherent optical properties derived from QAA algorithm

NAME

wr_rrs_data – output rrs data to file

SYNOPSIS

int wr_rrs_data (char ****filename*, simbios_header_t ****hd***, int** *n***, double ****wavel***, double ****rrs_sfc***, double ****rrs_std***, double ****rrs_w***, double ****rrs_g1***, double ****rrs_g2***, double ****rrs_p***);**

ARGUMENTS

filename	file name to write file
hd	SIMBIOS header structure
n	number of SeaWiFS values
wavel	wavelength of spectra
rrs_sfc	sea surface reflectance
rrs_std	SeaWiFS Protocol remote sensing reflectance (w/Fresnel)
rrs_w	normalized remote sensing reflectance (white)
rrs_g1	Gould (Path 1) corrected remote sensing reflectance
rrs_g2	Gould (Path 2) corrected remote sensing reflectance
rrs_p	Lee corrected remote sensing reflectance

DESCRIPTION

Writes a SIMBIOS file containing remote sensing reflectance computed according to Optics Protocols and three residual correction methods.

NAME

wr_seawifs – output SeaWiFS response

SYNOPSIS

int wr_seawifs (char ****filename*, simbios_header_t ****hd***, int** *n***, double ****wavel***, double ****swf_rrs***, double ****swf_rrs_p***, double ****swf_rrs_g1***, double ****swf_rrs_g2***);**

ARGUMENTS

filename	file name to write file
hd	SIMBIOS header structure
n	number of SeaWiFS values
wavel	SeaWiFS wavelengths
swf_rrs	SeaWiFS response of SeaWiFS Protocol Rrs
swf_rrs_p	SeaWiFS response using Lee (1997)
swf_rrs_g1	SeaWiFS response using Gould (2001), Path 1
swf_rrs_g2	SeaWiFS response using Gould (2001), Path 2

DESCRIPTION

Writes a SIMBIOS type of SeaWiFS repsonse data