Package 'AtmRay'

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Type Package

Title Acoustic Traveltime Calculations for 1-D Atmospheric Models

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Description Calculates acoustic traveltimes and ray paths in 1-D, linear atmospheres. Later versions will support arbitrary 1-D atmospheric models, such as radiosonde measurements and standard reference atmospheres.

Suggests RSEIS

License GPL

LazyLoad yes

Repository CRAN

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NeedsCompilation yes

R topics documented:

`A2P.lin` *Convert Between Incidence Angle and Ray Parameter*

Description

Given an atmosphere and elevation, converts incidence angle to ray parameter, or vice-versa.

Usage

```
A2P.lin(angle, z, az, ATM)
P2A.lin(p, z, az, ATM)
```

Arguments

`p`	Ray parameter (s/m)
`angle`	Incidence angle (from vertical) in degrees
`z`	Elevation (m)
`az`	Compass azimuth (degrees)
`ATM`	Linear atmosphere

Value

Ray parameter (s/m) or incidence angle (degrees).

Author(s)

Jake Anderson

Examples

```
ATM = CheckAtm.lin()
A2P.lin(50, 50, 0, ATM)
P2A.lin(0.002321347, 50, 0, ATM)
```

`CheckAtm.lin` *Check Linear Atmosphere*

Description

Verifies that an atmosphere contains all required elements and fills in missing elements with default values.

Usage

```
CheckAtm.lin(ATM = list())
```

Arguments

`ATM`	List that may include characteristics of an atmosphere

Details

A linear atmosphere variable must contain the elements described in the "Value" section. Default values for these are as follows: z0: 0 c0: 330 wx0: 0 wy0: 0 rho0: 1.2929 * exp(-ATM$z0/6800) gc: -10^9 gwx: 0 gwy: 0 grho: -0.0001901058 * exp(-ATM$z0/6800)

Other functions may encounter problems when working with an effective sound speed gradient of zero.

Value

List including the following elements:

`z0`	Elevation of intercept layer (m)
`c0`	Intrinsic sound speed at intercept layer (m/s)
`wx0`	Zonal (east-west) wind at intercept layer (m/s)
`wy0`	Meridional (north-south) wind at intercept layer (m/s)
`rho0`	Density at intercept layer (kg/m^3)
`gc`	Vertical intrinsic sound speed gradient (1/s)
`gwx`	Vertical zonal wind gradient (1/s)
`gwy`	Vertical meridional wind gradient (1/s)
`grho`	Vertical density gradient (kg/m^4)

Author(s)

Jake Anderson

Examples

```
# quickly make a new default atmosphere
ATM = CheckAtm.lin()

# fill in missing values for an existing atmosphere
ATM = list(c0 = 343, gc = -0.006)
ATM = CheckAtm.lin(ATM)
```

`MakeArrivals.lin` *Calculate Arrival Function*

Description

Calculates arrival time and arrival amplitude of many sources to produce an arrival function.

Usage

```
MakeArrivals.lin(xs, ys, zs, xr, yr, zr, dt, nt, timing, ATM = CheckAtm.lin(list()))
```

Arguments

`xs`	source location abscissae (m)
`ys`	source location ordinates (m)
`zs`	source location elevations (m)
`xr`	receiver location abscissae (m)
`yr`	receiver location ordinates (m)
`zr`	receiver location elevations (m)
`dt`	time interval (s)
`nt`	number of time steps to evaluate
`timing`	source times (s)
`ATM`	linear atmosphere

Details

This is suitable for calculating arrival functions for spatially distributed acoustic sources. Each of sx, sy, and sz should be the same length, and each of rx, ry, and rz should be the same length.

Value

Returns a matrix of dimension nt x length(rx), with rows corresponding to time steps and columns to receivers.

Author(s)

Jake Anderson

Examples

```
MakeArrivals.lin(xs = c(100, 150), ys = c(100, 150), zs = c(100, 150), xr = 0, yr = 0, zr = 0, dt = 0.01, nt = 100,
```

`MakeAtmList.lin` *Make List of Linear Atmospheres*

Description

Given a set of values that must be taken by each field in a linear atmosphere, returns a list of atmospheres that span all combinations of those values (similar to meshgrid).

Usage

```
MakeAtmList.lin(z0 = 0, c0 = 343, gc = 0, wx0 = 0, gwx = 0, wy0 = 0, gwy = 0, rho0 = 1.2929 * exp(-z0/68
```

Arguments

`z0`	Elevation of intercept layer (m)
`c0`	Intrinsic sound speed at intercept layer (m/s)
`wx0`	Zonal (east-west) wind at intercept layer (m/s)
`wy0`	Meridional (north-south) wind at intercept layer (m/s)
`rho0`	Density at intercept layer (kg/m^3)
`gc`	Vertical intrinsic sound speed gradient (1/s)
`gwx`	Vertical zonal wind gradient (1/s)
`gwy`	Vertical meridional wind gradient (1/s)
`grho`	Vertical density gradient (kg/m^4)

Details

This is useful for modeling wave propagation in a range of atmospheres when actual atmospheric characteristics are poorly constrained.

Value

List of linear atmospheres.

Author(s)

Jake Anderson

Examples

```
# make atmospheres spanning a range of base sound speeds and
# sound speed gradients
c0 = seq(330, 336, 0.1)
gc = seq(-0.006, -0.004, 0.0005)

ATM_list = MakeAtmList.lin(c0 = c0, gc = gc)
```

`meshgrid` *Create a mesh grid like in Matlab*

Description

Creates 2D matrices for accessing images and 2D matrices

Usage

```
meshgrid(a, b)
```

Arguments

a	x vector components
b	y vector components

Details

returns outer product of x-compnents and y-components for use as index arrays

Value

x	length(y) by length(x) matrix of x indicies
y	length(y) by length(x) matrix of y indicies

Author(s)

Jonathan M. Lees<jonathan.lees@unc.edu>

Examples

```
meshgrid(1:5, 1:3)
```

meshgridn *Multi-Dimensional Meshgrid*

Description

Inputs a list of vectors, and returns a list of vectors such that every possible combination of input vector values occurs once in the output.

Usage

```
meshgridn(L)
```

Arguments

L	list of vectors

Value

List of vectors of equal length such that each combination of elements drawn from the input vectors occurs exactly once in the output list.

Author(s)

Jake Anderson

Examples

```
meshgridn(list(1:5, 10:12, 100:104))
```

P4X.lin *Find Ray Parameter for Distance*

Description

Calculates ray parameter and azimuth of a ray that reaches some given point, using a 2-D iterative optimization search.

Usage

```
P4X.lin(x, y, zs, zr, ATM = CheckAtm.lin(list()), maxerror = 3)
```

Arguments

x	Abscissa of receiver relative to source (m)
y	Ordinate of receiver relative to source (m)
zs	Elevation of source (m)
zr	Elevation of receiver (m)
ATM	Linear atmosphere
maxerror	Maximum permitted error for solution (m)

Details

'maxerror' should be set with the necessary arrival time precision in mind. Smaller values of maxerror will produce more accurate arrival locations (and arrival times), but will require longer calculation times.

Value

List with following elements:

p	ray parameter
az	azimuth
error	distance between inputs (x,y) and final position of result ray

Author(s)

Jake Anderson

Examples

```
ATM = CheckAtm.lin()
P4X.lin(100, 100, 100, 00, ATM)
P4X.lin(100, 100, 100, 00, ATM, 0.01)
```

P4X.lin_no_c *Find Ray Parameter for Distance*

Description

Calculates ray parameter and azimuth of a ray that reaches some given point, using a 2-D iterative optimization search. Does not use compiled C code, so is slower, but in case of some bug in the C code, this function will still work.

Usage

```
P4X.lin_no_c(x, y, zs, zr, ATM = CheckAtm.lin(), maxerror = 3)
```

Arguments

x	Abscissa of receiver relative to source (m)
y	Ordinate of receiver relative to source (m)
zs	Elevation of source (m)
zr	Elevation of receiver (m)
ATM	Linear atmosphere
maxerror	Maximum permitted error for solution (m)

Details

'maxerror' should be set with the necessary arrival time precision in mind. Smaller values of maxerror will produce more accurate arrival locations (and arrival times), but will require longer calculation times.

Value

List with following elements:

p	ray parameter
az	azimuth
error	distance between inputs (x,y) and final position of result ray

Author(s)

Jake Anderson

Examples

```
ATM = CheckAtm.lin()
P4X.lin_no_c(100, 100, 100, 00, ATM)
P4X.lin_no_c(100, 100, 100, 00, ATM, 0.01)
```

PlotAtm.lin *Plot Linear Atmosphere*

Description

Makes a plot showing effective sound speed structure.

Usage

```
PlotAtm.lin(ATM, zlim = c(0, 100), winddir = 90, col =
sky.colors(500),
TOPO = NULL)
```

Arguments

ATM	Linear Atmosphere
zlim	Height limits in plot
winddir	Direction of wind to plot
col	color vector, such as the output of heat.colors
TOPO	list containing vectors x and y, and matrix z, or NULL

Details

When plotting topography, an east-west cross-section where TOPO$y is zero is plotted. TOPO should be formatted as a potential input to functions like 'contour' or 'image'.

Value

None; plot side effects only.

Author(s)

Jake Anderson

Examples

```
ATM = CheckAtm.lin()
PlotAtm.lin(ATM)
```

Prop.lin *Acoustic Ray Tracing*

Description

Given a ray parameter, azimuth, source/receiver elevations, calculates where ray lands at receiver elevation.

Usage

```
Prop.lin(p, az, zs, zr, ATM = CheckAtm.lin(list()))
```

Arguments

p	ray parameter (s/m)
az	azimuth (degrees)
zs	source elevation (m)
zr	receiver elevation (m)
ATM	Linear atmosphere

Value

List including the following elements:

x, y	ending position of ray
t	arrival time of ray
A	arrival amplitude
p	ray parameter

Author(s)

Jake Anderson

References

Garces, M.A., Hansen, R.A., Lindquist, K.G., 1998. Traveltimes for infrasonic waves propagating in a stratified atmosphere. Geophysical Journal International 135, 255-263.

Examples

```
ATM = CheckAtm.lin()
Prop.lin(0.001, 45, 100, 0, ATM)
```

Prop.lin_no_c *Acoustic Ray Tracing*

Description

Given a ray parameter, azimuth, source/receiver elevations, calculates where ray lands at receiver elevation. Does not use compiled C code, so is slower, but in case of some bug in the C code, this function will still work.

Usage

```
Prop.lin_no_c(p, az, zs, zr, ATM = CheckAtm.lin(list()))
```

Arguments

p	ray parameter (s/m)
az	azimuth (degrees)
zs	source elevation (m)
zr	receiver elevation (m)
ATM	Linear atmosphere

Value

List including the following elements:

x, y	ending position of ray
t	arrival time of ray
A	arrival amplitude
p	ray parameter

Author(s)

Jake Anderson

References

Garces, M.A., Hansen, R.A., Lindquist, K.G., 1998. Traveltimes for infrasonic waves propagating in a stratified atmosphere. Geophysical Journal International 135, 255-263.

Examples

```
ATM = CheckAtm.lin()
Prop.lin_no_c(0.001, 45, 100, 0, ATM)
```

RESCALE *Rescale a vector to fit in a certain range*

Description

Rescale a vector to fit in a certain range

Usage

```
RESCALE(x, nx1, nx2, minx, maxx)
```

Arguments

x	vector
nx1	new minimum
nx2	new maximum
minx	old min
maxx	old max

Details

Used for graphics.

Value

scale vector is returned

Author(s)

Jonathan M. Lees<jonathan.lees.edu>

Examples

```
x = rnorm(10)
RESCALE(x, 3, 9, min(x), max(x) )
```

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sky.colors *Sky Colormap*

Description

Returns a vector of colors one would see in a sunrise, ranging from orange to blue.

Usage

```
sky.colors(n)
```

Arguments

n	length of output color vector

Value

Vector of colors of length n.

Author(s)

Jake Anderson

Examples

```
col = sky.colors(12)
M = matrix(1:12, 12, 1)
image(M, col = col)
```

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