

Package ‘humidity’

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Type Package

Title Calculate Water Vapor Measures from Temperature and Dew Point

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Description

Vapor pressure, relative humidity, absolute humidity, specific humidity, and mixing ratio are commonly used water vapor measures in meteorology. This R package provides functions for calculating saturation vapor pressure (hPa), partial water vapor pressure (Pa), relative humidity (%), absolute humidity (kg/m³), specific humidity (kg/kg), and mixing ratio (kg/kg) from temperature (K) and dew point (K). Conversion functions between humidity measures are also provided.

Depends R (>= 3.2)

Suggests dplyr, knitr, bookdown

License GPL-3

URL <https://github.com/caijun/humidity>

BugReports <https://github.com/caijun/humidity/issues>

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AH	<i>calculate absolute humidity</i>
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Description

calculate absolute humidity ρ_w based on partial water vapor pressure e at temperature t

Usage

AH(e , t , isK = TRUE)

Arguments

e	partial water vapor pressure in Pascal (Pa)
t	temperature in Kelvin (K) or in degree Celsius ($^{\circ}\text{C}$)
isK	logical indicator whether temperature is in Kelvin (K). The default value is TRUE.

Value

numeric absolute humidity ρ_w (kg/m^3)

Author(s)

Jun Cai (<caijun@fudan.edu.cn>), Young Research Fellow at the School of Public Health, Fudan University

See Also

[WVP1](#), [WVP2](#), [RH](#), [SH](#).

Examples

```
t <- 273.15
Es <- SVP(t)
e <- WVP2(T0, Es)
AH(e, t)
```

C2K

Celsius to Kelvin conversion

Description

convert temperature in degree Celsius (°C) into Kelvin (K)

Usage

```
C2K(C)
```

Arguments

C temperature in degree Celsius (°C)

Value

numeric temperature in Kelvin (K)

Author(s)

Jun Cai (<caijun@fudan.edu.cn>), Young Research Fellow at the School of Public Health, Fudan University

See Also

[K2C](#).

Examples

```
T0 # zero degrees Celsius in Kelvin (K)
C2K(T0)
```

Es.T0

Saturation vapor pressure (hPa) at 0 degrees Celsius

Description

$e_s(T_0) = 6.11hPa$ is the saturation vapor pressure at 0 degrees Celsius ($T_0 = 273.15K$).

Usage

Es.T0

See Also

[T0](#)

ivs

Viability of influenza A virus for 1 hour after spraying

Description

A dataset containing airborne virus particles of influenza A for viable survival in the dark at controlled temperature and relative humidity for 1 hour after spraying.

Usage

ivs

Format

A data frame with 11 rows and 3 variables:

- T: temperature in degree Celsius (7.5–32.0)
- RH: relative humidity in percentage (20–82)
- PV: percentage of viable virus (6.6–78.0)

Source

Harper, G. J. (1961). *Airborne micro-organisms: survival tests with four viruses*. *Journal of Hygiene*, 59(04), 479-486.

ivt	<i>Aerosol transmission efficiency of influenza A virus from guinea pigs to guinea pigs</i>
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Description

A dataset containing aerosol transmission efficiency of influenza A virus from four infected guinea pigs to four exposed guinea pigs under conditions of controlled temperature and relative humidity.

Usage

ivt

Format

A data frame with 24 rows and 4 variables:

- T: temperature in degree Celsius (5–30)
- RH: relative humidity in percentage (20–80)
- PT: transmission efficiency in percentage (0–100)
- source: data source

Source

Lowen, A. C., Mubareka, S., Steel, J., & Palese, P. (2007). *Influenza virus transmission is dependent on relative humidity and temperature*. PLoS pathogens, 3(10), e151.

Lowen, A. C., Steel, J., Mubareka, S., & Palese, P. (2008). *High temperature (30°C) blocks aerosol but not contact transmission of influenza virus*. Journal of virology, 82(11), 5650-5652.

K2C	<i>Kelvin to Celsius conversion</i>
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Description

convert temperature in Kelvin (K) into degree Celsius (°C)

Usage

K2C(K)

Arguments

K temperature in Kelvin (K)

Value

numeric temperature in degree Celsius ($^{\circ}\text{C}$)

Author(s)

Jun Cai (<cai jun@fudan.edu.cn>), Young Research Fellow at the School of Public Health, Fudan University

See Also

[C2K](#).

Examples

K2C(0)

L	<i>Latent heat of water vapor</i>
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Description

Latent heat of water vapor $L = 2.5 \times 10^6 \text{ J/kg}$

Usage

L

Md	<i>Molecular weight of dry air</i>
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Description

Molecular weight of dry air $M_d = 28.9634 \text{ g/mol}$

Usage

Md

See Also

[Mw](#)

MR *calculate mixing ratio*

Description

calculate mixing ratio ω based on specific humidity q

Usage

MR(q)

Arguments

q specific humidity q (kg/kg)

Value

numeric mixing ratio ω (kg/kg)

Author(s)

Jun Cai (<caijun@fudan.edu.cn>), Young Research Fellow at the School of Public Health, Fudan University

See Also

[SH](#).

Examples

```
t <- 273.15
Es <- SVP(t)
e <- WVP2(70, Es)
q <- SH(e, p = 101325)
MR(q)
```

Mw *Molecular weight of water vapor*

Description

Molecular weight of water vapor $M_w = 18.01528g/mol$

Usage

Mw

See Also[Md](#)

RH*calculate relative humidity*

Description

calculate relative humidity ψ based on temperature t and dew point T_d

Usage

```
RH(t, Td, isK = TRUE)
```

Arguments

<code>t</code>	temperature in Kelvin (K) or in degree Celsius (°C)
<code>Td</code>	dew point in Kelvin (K) or in degree Celsius (°C)
<code>isK</code>	logical indicator whether temperature is in Kelvin (K). The default value is TRUE.

Value

numeric relative humidity in %.

Author(s)

Jun Cai (<cai.jun@fudan.edu.cn>), Young Research Fellow at the School of Public Health, Fudan University

See Also[AH](#), [SH](#).**Examples**

```
RH(30, 15, isK = FALSE)
```

Rw *Specific gas constant of water vapor*

Description

Specific gas constant of water vapor $R_w = \frac{1000R}{M_w} = 461.52J/(kgK)$, where $R = 8.3144621J/(molK)$ is the molar **gas constant** and $M_w = 18.01528g/mol$ is the molecular weight of water vapor.

Usage

Rw

See Also

[Mw](#)

SH *calculate specific humidity*

Description

calculate specific humidity q based on partial water vapor pressure e under given atmospheric pressure p

Usage

SH(e , $p = 101325$)

Arguments

e partial water vapor pressure in Pascal (Pa)
 p atmospheric pressure in Pascal (Pa). The default is standard atmospheric pressure of 101325Pa.

Value

numeric specific humidity q (kg/kg)

Author(s)

Jun Cai (<caijun@fudan.edu.cn>), Young Research Fellow at the School of Public Health, Fudan University

See Also

[WVP2](#), [WVP2](#), [AH](#), [RH](#), [MR](#).

Examples

```
t <- 273.15
Es <- SVP(t)
e <- WVP2(70, Es)
SH(e, p = 101325)
```

SH2RH*convert specific humidity into relative humidity*

Description

Climate models usually provide specific humidity only; however, relative humidity is used to compute **heat index** that is really useful for health impacts studies. This function converts specific humidity q into relative humidity ψ at temperature t and under atmospheric pressure p .

Usage

```
SH2RH(q, t, p = 101325, isK = TRUE)
```

Arguments

<code>q</code>	specific humidity q (kg/kg)
<code>t</code>	temperature in Kelvin (K) or in degree Celsius ($^{\circ}C$)
<code>p</code>	atmospheric pressure in Pascal (Pa). The default is standard atmospheric pressure of 101325Pa.
<code>isK</code>	logical indicator whether temperature is in Kelvin (K). The default value is TRUE.

Value

numeric relative humidity in %.

Author(s)

Jun Cai (<caijun@fudan.edu.cn>), Young Research Fellow at the School of Public Health, Fudan University

See Also

[AH](#), [SH](#).

Examples

```
SH2RH(0.005867353, 22.25, p = 101325, isK = FALSE)
```

SVP	<i>calculate saturation vapor pressure</i>
-----	--

Description

calculate saturation vapor pressure E_s at temperature t , using the Clausius-Clapeyron equation or the Murray equation.

Usage

```
SVP(t, isK = TRUE, formula = c("Clausius-Clapeyron", "Murray"))
```

Arguments

t	temperature in Kelvin (K) or in degree Celsius (°C)
isK	logical indicator whether temperature is in Kelvin (K). The default value is TRUE.
formula	the formula is used for calculating saturation vapor pressure. By default the Clausius-Clapeyron equation is used.

Value

numeric saturation vapor pressure in hectopascal (hPa) or millibar (mb)

Author(s)

Jun Cai (<cai.jun@fudan.edu.cn>), Young Research Fellow at the School of Public Health, Fudan University

See Also

[SVP.ClaCla](#), [SVP.Murray](#).

Examples

```
SVP(273.15)
```

SVP.ClaCla	<i>calculate saturation vapor pressure using the Clausius-Clapeyron equation</i>
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Description

calculate saturation vapor pressure E_s at temperature t , using the Clausius-Clapeyron equation.

Usage

SVP.ClaCla(t)

Arguments

t temperature in Kelvin (K)

Value

numeric saturation vapor pressure in hectopascal (hPa) or millibar (mb)

Author(s)

Jun Cai (<caijun@fudan.edu.cn>), Young Research Fellow at the School of Public Health, Fudan University

References

Shaman, J., & Kohn, M. (2009). *Absolute humidity modulates influenza survival, transmission, and seasonality*. Proceedings of the National Academy of Sciences, 106(9), 3243-3248.

Wallace, J. M., & Hobbs, P. V. (2006). *Atmospheric science: an introductory survey* (Vol. 92). Academic press.

See Also

[SVP.Murray](#), [SVP](#).

Examples

T0 # zero degrees Celsius in Kelvin (K)
SVP.ClaCla(T0)

SVP.Murray *calculate saturation vapor pressure using the Murray equation*

Description

calculate saturation vapor pressure E_s at temperature t , per the equation proposed by Murray (1967).

Usage

SVP.Murray(t)

Arguments

t temperature in Kelvin (K)

Value

numeric saturation vapor pressure in hectopascal (hPa) or millibar (mb)

Author(s)

Jun Cai (<cai.jun@fudan.edu.cn>), Young Research Fellow at the School of Public Health, Fudan University

References

Murray, F. W. (1967). *On the Computation of Saturation Vapor Pressure*. Journal of Applied Meteorology, 6(1), 203-204.

See Also

[SVP.ClaCla](#), [SVP](#).

Examples

T0 # zero degrees Celsius in Kelvin (K)
SVP.Murray(T0)

T0 *Zero degrees Celsius in Kelvin*

Description

Temperature corresponding to 0 degrees Celsius on the Kelvin scale.

Usage

T0

WVP1 *calculate partial water vapor pressure given dew point*

Description

calculate partial water vapor pressure e based on dew point T_d

Usage

WVP1(Td, isK = TRUE)

Arguments

Td	dew point in Kelvin (K) or in degree Celsius (°C)
isK	logical indicator whether temperature is in Kelvin (K). The default value is TRUE.

Value

numeric partial vapor pressure in hectopascal (hPa) or millibar (mb)

Author(s)

Jun Cai (<caijun@fudan.edu.cn>), Young Research Fellow at the School of Public Health, Fudan University

See Also

[SVP](#), [SVP.ClaCla](#).

Examples

```
T0 # zero degrees Celsius in Kelvin (K)
WVP1(T0)
```

WVP2 *calculate partial water vapor pressure given relative humidity and saturation water vapor pressure*

Description

calculate partial water vapor pressure e based on relative humidity ψ and saturation water vapor pressure at temperature t

Usage

WVP2(psi, Es)

Arguments

psi	relative humidity ψ in percentage (%)
Es	saturation vapor pressure e_s (hPa) at temperature t , which can be calculated by calling SVP function.

Value

numeric partial water vapor pressure in Pascal (Pa)

Author(s)

Jun Cai (<caijun@fudan.edu.cn>), Young Research Fellow at the School of Public Health, Fudan University

See Also

[SVP](#), [SVP.ClaCla](#), [SVP.Murray](#).

Examples

```
Es <- SVP(273.15)
WVP2(70, Es)
```

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