

# Package: TreeDep (via r-universe)

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**Type** Package

**Title** Air Pollution Removal by Dry Deposition on Trees

**Version** 0.1.3

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**Description** The model estimates air pollution removal by dry deposition on trees. It also estimates or uses hourly values for aerodynamic resistance, boundary layer resistance, canopy resistance, stomatal resistance, cuticular resistance, mesophyll resistance, soil resistance, friction velocity and deposition velocity. It also allows plotting graphical results for a specific time period. The pollutants are nitrogen dioxide, ozone, sulphur dioxide, carbon monoxide and particulate matter. Baldocchi D (1994) <doi:10.1093/treephys/14.7-8-9.1069>. Farquhar GD, von Caemmerer S, Berry JA (1980) Planta 149: 78-90. Hirabayashi S, Kroll CN, Nowak DJ (2015) i-Tree Eco Dry Deposition Model. Nowak DJ, Crane DE, Stevens JC (2006) <doi:10.1016/j.ufug.2006.01.007>. US EPA (1999) PCRAMMET User's Guide. EPA-454/B-96-001. Weiss A, Norman JM (1985) Agricultural and Forest Meteorology 34: 205—213.

**License** GPL-2

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<i>Bizkaia_data</i>	<i>Weather and environmental hourly data in Bizkaia province, Spain</i>
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**Description**

Weather and air pollution concentration hourly data in Bizkaia province (Spain)

**Usage**

`Bizkaia_data`

**Format**

A data frame with hourly data

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<i>Conc_CO</i>	<i>Conc_CO - Extracts data of hourly concentration of CO</i>
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---

**Description**

*Conc\_CO* - Extracts data of hourly concentration of CO

**Usage**

`Conc_CO(x)`

**Arguments**

x                    A data frame containing hourly data of CO concentration and other variables (Dates (e.g. 01/01/2016 00:00:00), Hum (%), Pres (kPa), Precip (mm), Rad (W m-2), Temp (C), Wind (m s-1), Daylight (Night or Daylight), BAI, LAI)

**Value**

Hourly data of concentration of CO (micrograms m-3)

**Examples**

```
data(Bizkaia_data)
Conc_CO(x = Bizkaia_data)
```

---

Conc\_NO2

*Conc\_NO2 - Extracts data of hourly concentration of NO2*

---

**Description**

Conc\_NO2 - Extracts data of hourly concentration of NO2

**Usage**

Conc\_NO2(x)

**Arguments**

x                    A data frame containing hourly data of NO2 concentration and other variables (Dates (e.g. 01/01/2016 00:00:00), Hum (%), Pres (kPa), Precip (mm), Rad (W m-2), Temp (C), Wind (m s-1), Daylight (Night or Daylight), BAI, LAI)

**Value**

Hourly data of concentration of NO2 (micrograms m-3)

**Examples**

```
data(Bizkaia_data)
Conc_NO2(x = Bizkaia_data)
```

---

Conc\_O3

*Conc\_O3 - Extracts data of hourly concentration of O3*

---

**Description**

Conc\_O3 - Extracts data of hourly concentration of O3

**Usage**

Conc\_O3(x)

**Arguments**

x                    A data frame containing hourly data of O3 concentration and other variables (Dates (e.g. 01/01/2016 00:00:00), Hum (%), Pres (kPa), Precip (mm), Rad (W m-2), Temp (C), Wind (m s-1), Daylight (Night or Daylight), BAI, LAI)

**Value**

Hourly data of concentration of O3 (micrograms m-3)

**Examples**

```
data(Bizkaia_data)
Conc_O3(x = Bizkaia_data)
```

---

**Conc\_PM10***Conc\_PM10 - Extracts data of hourly concentration of PM10*

---

**Description**

Conc\_PM10 - Extracts data of hourly concentration of PM10

**Usage**

```
Conc_PM10(x)
```

**Arguments**

x                    A data frame containing hourly data of PM10 concentration and other variables (Dates (e.g. 01/01/2016 00:00:00), Hum (%), Pres (kPa), Precip (mm), Rad (W m-2), Temp (C), Wind (m s-1), Daylight (Night or Daylight), BAI, LAI)

**Value**

Hourly data of concentration of PM10 (micrograms m-3)

**Examples**

```
data(Bizkaia_data)
Conc_PM10(x = Bizkaia_data)
```

---

**Conc\_SO2***Conc\_SO2 - Extracts data of hourly concentration of SO2*

---

**Description**

Conc\_SO2 - Extracts data of hourly concentration of SO2

**Usage**

```
Conc_SO2(x)
```

**Arguments**

x                    A data frame containing hourly data of SO2 concentration and other variables (Dates (e.g. 01/01/2016 00:00:00), Hum (%), Pres (kPa), Precip (mm), Rad (W m-2), Temp (C), Wind (m s-1), Daylight (Night or Daylight), BAI, LAI)

**Value**

Hourly data of concentration of SO2 (micrograms m-3)

**Examples**

```
data(Bizkaia_data)
Conc_SO2(x = Bizkaia_data)
```

---

Daylight	<i>Daylight - Generates hourly daylight data ("Night" and "Daylight") in a specific year</i>
----------	--

---

**Description**

Daylight - Generates hourly daylight data ("Night" and "Daylight") in a specific year

**Usage**

```
Daylight(shortest_day_sunrise, shortest_day_sunset, longest_day_sunset0, Year)
```

**Arguments**

shortest_day_sunrise	Sunrise time in the shortest day in the Northern Hemisphere (December 21) using decimals for minutes (e.g. 8.4)
shortest_day_sunset	Sunset time in the shortest day in the Northern Hemisphere (December 21) using decimals for minutes (e.g. 17.8)
longest_day_sunset0	Sunset time in the longest day in the Northern Hemisphere (June 21) using decimals for minutes (e.g. 21.9)
Year	Year to generate hourly daylight data (e.g. 2015)

**Value**

A dataframe with hourly daylight values is generated

**Examples**

```
Daylight (shortest_day_sunrise = 8.4,
shortest_day_sunset = 17.8,
longest_day_sunset0 = 21.9,
Year = 2016)
```

---

Dep_CO	<i>Dep_CO - Calculates hourly deposition of CO on vegetation</i>
--------	--

---

**Description**

Dep\_CO - Calculates hourly deposition of CO on vegetation

**Usage**

```
Dep_CO(x, z_0 = 1)
```

**Arguments**

x	A data frame containing hourly data of CO concentration and other variables (Dates (e.g. 01/01/2016 00:00:00), Hum (%), Pres (kPa), Precip (mm), Rad (W m-2), Temp (C), Wind (m s-1), Daylight (Night or Daylight), BAI, LAI)
z_0	Roughness length value (m)

**Value**

Hourly data of deposition of CO on vegetation (g m-2 h-1)

**Examples**

```
data(Bizkaia_data)
Dep_CO(x = Bizkaia_data, z_0 = 1)
```

---

Dep_CO_a	<i>Dep_CO_a - Calculates the annual value of deposition of CO on vegetation</i>
----------	---

---

**Description**

Dep\_CO\_a - Calculates the annual value of deposition of CO on vegetation

**Usage**

```
Dep_CO_a(x, z_0 = 1)
```

**Arguments**

x	A data frame containing hourly data of CO concentration and other variables (Dates (e.g. 01/01/2016 00:00:00), Hum (%), Pres (kPa), Precip (mm), Rad (W m-2), Temp (C), Wind (m s-1), Daylight (Night or Daylight), BAI, LAI)
z_0	Roughness length value (m)

**Value**

Annual value of deposition of CO on vegetation (g m<sup>-2</sup> yr<sup>-1</sup>)

**Examples**

```
data(Bizkaia_data)
Dep_CO_a(x = Bizkaia_data, z_0 = 1)
```

---

Dep\_NO2

*Dep\_NO2 - Calculates hourly deposition of NO2 on vegetation*

---

**Description**

Dep\_NO2 - Calculates hourly deposition of NO2 on vegetation

**Usage**

```
Dep_NO2(x, z_0 = 1)
```

**Arguments**

x	A data frame containing hourly data of NO2 concentration and other variables (Dates (e.g. 01/01/2016 00:00:00), Hum (%), Pres (kPa), Precip (mm), Rad (W m <sup>-2</sup> ), Temp (C), Wind (m s <sup>-1</sup> ), Daylight (Night or Daylight), BAI, LAI)
z_0	Roughness length value (m)

**Value**

Hourly data of deposition of NO2 on vegetation (g m<sup>-2</sup> h<sup>-1</sup>)

**Examples**

```
data(Bizkaia_data)
Dep_NO2(x = Bizkaia_data, z_0 = 1)
```



---

Dep_NO2_a	<i>Dep_NO2_a - Calculates the annual value of deposition of NO2 on vegetation</i>
-----------	---

---

**Description**

Dep\_NO2\_a - Calculates the annual value of deposition of NO2 on vegetation

**Usage**

Dep\_NO2\_a(x, z\_0 = 1)

**Arguments**

x	A data frame containing hourly data of NO2 concentration and other variables (Dates (e.g. 01/01/2016 00:00:00), Hum (%), Pres (kPa), Precip (mm), Rad (W m-2), Temp (C), Wind (m s-1), Daylight (Night or Daylight), BAI, LAI)
z_0	Roughness length value (m)

**Value**

Annual value of deposition of NO2 on vegetation (g m-2 yr-1)

**Examples**

```
data(Bizkaia_data)
Dep_NO2_a(x = Bizkaia_data, z_0 = 1)
```

---

Dep_O3	<i>Dep_O3 - Calculates hourly deposition of O3 on vegetation</i>
--------	--

---

**Description**

Dep\_O3 - Calculates hourly deposition of O3 on vegetation

**Usage**

Dep\_O3(x, z\_0 = 1)

**Arguments**

x	A data frame containing hourly data of O3 concentration and other variables (Dates (e.g. 01/01/2016 00:00:00), Hum (%), Pres (kPa), Precip (mm), Rad (W m-2), Temp (C), Wind (m s-1), Daylight (Night or Daylight), BAI, LAI)
z_0	Roughness length value (m)

**Value**

Hourly data of deposition of O3 on vegetation (g m<sup>-2</sup> h<sup>-1</sup>)

**Examples**

```
data(Bizkaia_data)
Dep_O3(x = Bizkaia_data, z_0 = 1)
```

---

Dep_O3_a	<i>Dep_O3_a - Calculates the annual value of deposition of O3 on vegetation</i>
----------	---

---

**Description**

Dep\_O3\_a - Calculates the annual value of deposition of O3 on vegetation

**Usage**

```
Dep_O3_a(x, z_0 = 1)
```

**Arguments**

x	A data frame containing hourly data of O3 concentration and other variables (Dates (e.g. 01/01/2016 00:00:00), Hum (%), Pres (kPa), Precip (mm), Rad (W m <sup>-2</sup> ), Temp (C), Wind (m s <sup>-1</sup> ), Daylight (Night or Daylight), BAI, LAI)
z_0	Roughness length value (m)

**Value**

Annual value of deposition of O3 on vegetation (g m<sup>-2</sup> yr<sup>-1</sup>)

**Examples**

```
data(Bizkaia_data)
Dep_O3_a(x = Bizkaia_data, z_0 = 1)
```

---

Dep_PM10	<i>Dep_PM10 - Calculates hourly deposition of PM10 on vegetation</i>
----------	--

---

**Description**

Dep\_PM10 - Calculates hourly deposition of PM10 on vegetation

**Usage**

```
Dep_PM10(x, z_0 = 1)
```

**Arguments**

x	A data frame containing hourly data of PM10 concentration and other variables (Dates (e.g. 01/01/2016 00:00:00), Hum (%), Pres (kPa), Precip (mm), Rad (W m-2), Temp (C), Wind (m s-1), Daylight (Night or Daylight), BAI, LAI)
z_0	Roughness length value (m)

**Value**

Hourly data of deposition of PM10 on vegetation (g m-2 h-1)

**Examples**

```
data(Bizkaia_data)
Dep_PM10(x = Bizkaia_data, z_0 = 1)
```

---

Dep_PM10_a	<i>Dep_PM10_a - Calculates the annual value of deposition of PM10 on vegetation</i>
------------	---

---

**Description**

Dep\_PM10\_a - Calculates the annual value of deposition of PM10 on vegetation

**Usage**

```
Dep_PM10_a(x, z_0 = 1)
```

**Arguments**

x	A data frame containing hourly data of PM10 concentration and other variables (Dates (e.g. 01/01/2016 00:00:00), Hum (%), Pres (kPa), Precip (mm), Rad (W m-2), Temp (C), Wind (m s-1), Daylight (Night or Daylight), BAI, LAI)
z_0	Roughness length value (m)

**Value**

Annual value of deposition of PM10 on vegetation (g m<sup>-2</sup> yr<sup>-1</sup>)

**Examples**

```
data(Bizkaia_data)
Dep_PM10_a(x = Bizkaia_data, z_0 = 1)
```

---

Dep\_SO2

*Dep\_SO2 - Calculates hourly deposition of SO2 on vegetation*

---

**Description**

Dep\_SO2 - Calculates hourly deposition of SO2 on vegetation

**Usage**

```
Dep_SO2(x, z_0 = 1)
```

**Arguments**

x	A data frame containing hourly data of SO2 concentration and other variables (Dates (e.g. 01/01/2016 00:00:00), Hum (%), Pres (kPa), Precip (mm), Rad (W m <sup>-2</sup> ), Temp (C), Wind (m s <sup>-1</sup> ), Daylight (Night or Daylight), BAI, LAI)
z_0	Roughness length value (m)

**Value**

Hourly data of deposition of SO2 on vegetation (g m<sup>-2</sup> h<sup>-1</sup>)

**Examples**

```
data(Bizkaia_data)
Dep_SO2(x = Bizkaia_data, z_0 = 1)
```

---

Dep_SO2_a	<i>Dep_SO2_a - Calculates the annual value of deposition of SO2 on vegetation</i>
-----------	---

---

**Description**

Dep\_SO2\_a - Calculates the annual value of deposition of SO2 on vegetation

**Usage**

Dep\_SO2\_a(x, z\_0 = 1)

**Arguments**

x	A data frame containing hourly data of SO2 concentration and other variables (Dates (e.g. 01/01/2016 00:00:00), Hum (%), Pres (kPa), Precip (mm), Rad (W m-2), Temp (C), Wind (m s-1), Daylight (Night or Daylight), BAI, LAI)
z_0	Roughness length value (m)

**Value**

Annual value of deposition of SO2 on vegetation (g m-2 yr-1)

**Examples**

```
data(Bizkaia_data)
Dep_SO2_a(x = Bizkaia_data, z_0 = 1)
```

---

Dep_vel_CO	<i>Dep_vel_CO - Calculates hourly deposition velocity for CO</i>
------------	--

---

**Description**

Dep\_vel\_CO - Calculates hourly deposition velocity for CO

**Usage**

Dep\_vel\_CO(x, z\_0 = 1)

**Arguments**

x	A data frame containing hourly data of weather variables (e.g. Hum (%), Pres (kPa), Precip (mm), Rad (W m-2), Temp (C), Wind (m s-1), Daylight (Night or Daylight))
z_0	Roughness length value (m)

**Value**

Hourly data of deposition velocity for CO (m s-1)

**Examples**

```
data(Bizkaia_data)
Dep_vel_CO(x = Bizkaia_data, z_0 = 1)
```

---

Dep\_vel\_NO2

*Dep\_vel\_NO2 - Calculates hourly deposition velocity for NO2*

---

**Description**

Dep\_vel\_NO2 - Calculates hourly deposition velocity for NO2

**Usage**

```
Dep_vel_NO2(x, z_0 = 1)
```

**Arguments**

x	A data frame containing hourly data of weather variables (e.g. Hum (%), Pres (kPa), Precip (mm), Rad (W m-2), Temp (C), Wind (m s-1), Daylight (Night or Daylight))
z_0	Roughness length value (m)

**Value**

Hourly data of deposition velocity for NO2 (m s-1)

**Examples**

```
data(Bizkaia_data)
Dep_vel_NO2(x = Bizkaia_data, z_0 = 1)
```

---

Dep_vel_O3	<i>Dep_vel_O3 - Calculates hourly deposition velocity for O3</i>
------------	--

---

**Description**

Dep\_vel\_O3 - Calculates hourly deposition velocity for O3

**Usage**

```
Dep_vel_O3(x, z_0 = 1)
```

**Arguments**

x	A data frame containing hourly data of weather variables (e.g. Hum (%), Pres (kPa), Precip (mm), Rad (W m-2), Temp (C), Wind (m s-1), Daylight (Night or Daylight))
z_0	Roughness length value (m)

**Value**

Hourly data of deposition velocity for O3 (m s-1)

**Examples**

```
data(Bizkaia_data)
Dep_vel_O3(x = Bizkaia_data, z_0 = 1)
```

---

Dep_vel_PM10	<i>Dep_vel_PM10 - Calculates hourly deposition velocity for PM10</i>
--------------	--

---

**Description**

Dep\_vel\_PM10 - Calculates hourly deposition velocity for PM10

**Usage**

```
Dep_vel_PM10(x, z_0 = 1)
```

**Arguments**

x	A data frame containing hourly data of weather variables (e.g. Hum (%), Pres (kPa), Precip (mm), Rad (W m-2), Temp (C), Wind (m s-1), Daylight (Night or Daylight))
z_0	Roughness length value (m)

**Value**

Hourly data of deposition velocity for PM10 (m s-1)

**Examples**

```
data(Bizkaia_data)
Dep_vel_PM10(x = Bizkaia_data, z_0 = 1)
```

---

Dep\_vel\_SO2

*Dep\_vel\_SO2 - Calculates hourly deposition velocity for SO2*

---

**Description**

Dep\_vel\_SO2 - Calculates hourly deposition velocity for SO2

**Usage**

```
Dep_vel_SO2(x, z_0 = 1)
```

**Arguments**

x	A data frame containing hourly data of weather variables (e.g. Hum (%), Pres (kPa), Precip (mm), Rad (W m-2), Temp (C), Wind (m s-1), Daylight (Night or Daylight))
z_0	Roughness length value (m)

**Value**

Hourly data of deposition velocity for SO2 (m s-1)

**Examples**

```
data(Bizkaia_data)
Dep_vel_SO2(x = Bizkaia_data, z_0 = 1)
```



---

Fric_vel	<i>Fric_vel - Calculates friction velocity on an hourly basis</i>
----------	---

---

**Description**

Fric\_vel - Calculates friction velocity on an hourly basis

**Usage**

```
Fric_vel(x, z_0 = 1)
```

**Arguments**

x	A data frame containing hourly data of weather variables (e.g. Hum (%), Pres (kPa), Precip (mm), Rad (W m-2), Temp (C), Wind (m s-1), Daylight (Night or Daylight))
z_0	Roughness length value (m)

**Value**

Hourly data of friction velocity (m s-1)

**Examples**

```
data(Bizkaia_data)
Fric_vel(x = Bizkaia_data, z_0 = 1)
```

---

LAI_deciduous	<i>LAI_deciduous - Generates hourly data of leaf and bark area index for deciduous trees in a specific year</i>
---------------	---

---

**Description**

LAI\_deciduous - Generates hourly data of leaf and bark area index for deciduous trees in a specific year

**Usage**

```
LAI_deciduous(Year, BAI_value, LAI_value, day_decay_ini, month_decay_ini,
              days_duration_decay, day_emergence_ini, month_emergence_ini,
              days_duration_emergence)
```

**Arguments**

Year	Year to generate leaf and bark area index (e.g. 2015)
BAI_value	Bark area index value (e.g. 0.1)
LAI_value	Maximum value of leaf area index value (e.g. 1.5)
day_decay_ini	Day of the month leaves start to decay (between 1 and 31; e.g., 15)
month_decay_ini	Month of the year leaves start to decay (between 1 and 12; e.g., 10)
days_duration_decay	The duration of leaf decay in number of days (e.g., 50)
day_emergence_ini	Day of the month leaves start to emerge (between 1 and 31; e.g., 1)
month_emergence_ini	Month of the year leaves start to emerge (between 1 and 12; e.g., 4)
days_duration_emergence	The duration of leaf emergence in number of days (e.g., 20)

**Value**

A dataframe with LAI and BAI hourly values is generated

**Examples**

```
LAI_deciduous(Year = 2016,
BAI_value = 0.1,
LAI_value = 1.5,
day_decay_ini = 15,
month_decay_ini = 10,
days_duration_decay = 100,
day_emergence_ini = 1,
month_emergence_ini = 4,
days_duration_emergence = 20)
```

---

LAI_evergreen	<i>LAI_evergreen - Generates hourly data of leaf and bark area index for evergreen trees in a specific year</i>
---------------	---

---

**Description**

LAI\_evergreen - Generates hourly data of leaf and bark area index for evergreen trees in a specific year

**Usage**

```
LAI_evergreen(Year, LAI_value, BAI_value)
```

**Arguments**

Year	Year to generate leaf and bark area index (e.g. 2015)
LAI_value	Mean value of leaf area index (e.g. 1.3)
BAI_value	Bark area index value (e.g. 0.1)

**Value**

A dataframe with LAI and BAI hourly values is generated

**Examples**

```
LAI_evergreen(Year = 2016,
BAI_value = 0.1,
LAI_value = 1.3)
```

---

Res_aero	<i>Res_aero - Calculates aerodynamic resistance on an hourly basis</i>
----------	--

---

**Description**

Res\_aero - Calculates aerodynamic resistance on an hourly basis

**Usage**

```
Res_aero(x, z_0 = 1)
```

**Arguments**

x	A data frame containing hourly data of weather variables (e.g. Hum (%), Pres (kPa), Precip (mm), Rad (W m <sup>-2</sup> ), Temp (C), Wind (m s <sup>-1</sup> ), Daylight (Night or Daylight))
z_0	Roughness length value (m)

**Value**

Hourly data of aerodynamic resistance (s m<sup>-1</sup>)

**Examples**

```
data(Bizkaia_data)
Res_aero(x = Bizkaia_data, z_0 = 1)
```

---

Res_boun_CO	<i>Res_boun_CO - Calculates hourly boundary layer resistance for CO</i>
-------------	---

---

**Description**

Res\_boun\_CO - Calculates hourly boundary layer resistance for CO

**Usage**

```
Res_boun_CO(x, z_0 = 1)
```

**Arguments**

x	A data frame containing hourly data of weather variables (e.g. Hum (%), Pres (kPa), Precip (mm), Rad (W m-2), Temp (C), Wind (m s-1), Daylight (Night or Daylight))
z_0	Roughness length value (m)

**Value**

Hourly data of boundary layer resistance for CO (s m-1)

**Examples**

```
data(Bizkaia_data)
Res_boun_CO(x = Bizkaia_data, z_0 = 1)
```

---

Res_boun_CO2	<i>Res_boun_CO2 - Calculates hourly boundary layer resistance for CO2</i>
--------------	---

---

**Description**

Res\_boun\_CO2 - Calculates hourly boundary layer resistance for CO2

**Usage**

```
Res_boun_CO2(x, z_0 = 1)
```

**Arguments**

x	A data frame containing hourly data of weather variables (e.g. Hum (%), Pres (kPa), Precip (mm), Rad (W m-2), Temp (C), Wind (m s-1), Daylight (Night or Daylight))
z_0	Roughness length value (m)

**Value**

Hourly data of boundary layer resistance for CO2 (s m-1)

**Examples**

```
data(Bizkaia_data)
Res_boun_CO2(x = Bizkaia_data, z_0 = 1)
```

---

Res_boun_NO2	<i>Res_boun_NO2</i> - Calculates hourly boundary layer resistance for NO2
--------------	---

---

**Description**

Res\_boun\_NO2 - Calculates hourly boundary layer resistance for NO2

**Usage**

```
Res_boun_NO2(x, z_0 = 1)
```

**Arguments**

x	A data frame containing hourly data of weather variables (e.g. Hum (%), Pres (kPa), Precip (mm), Rad (W m-2), Temp (C), Wind (m s-1), Daylight (Night or Daylight))
z_0	Roughness length value (m)

**Value**

Hourly data of boundary layer resistance for NO2 (s m-1)

**Examples**

```
data(Bizkaia_data)
Res_boun_NO2(x = Bizkaia_data, z_0 = 1)
```

---

Res_boun_O3	<i>Res_boun_O3 - Calculates hourly boundary layer resistance for O3</i>
-------------	---

---

**Description**

Res\_boun\_O3 - Calculates hourly boundary layer resistance for O3

**Usage**

```
Res_boun_O3(x, z_0 = 1)
```

**Arguments**

x	A data frame containing hourly data of weather variables (e.g. Hum (%), Pres (kPa), Precip (mm), Rad (W m-2), Temp (C), Wind (m s-1), Daylight (Night or Daylight))
z_0	Roughness length value (m)

**Value**

Hourly data of boundary layer resistance for O3 (s m-1)

**Examples**

```
data(Bizkaia_data)
Res_boun_O3(x = Bizkaia_data, z_0 = 1)
```

---

Res_boun_SO2	<i>Res_boun_SO2 - Calculates hourly boundary layer resistance for SO2</i>
--------------	---

---

**Description**

Res\_boun\_SO2 - Calculates hourly boundary layer resistance for SO2

**Usage**

```
Res_boun_SO2(x, z_0 = 1)
```

**Arguments**

x	A data frame containing hourly data of weather variables (e.g. Hum (%), Pres (kPa), Precip (mm), Rad (W m-2), Temp (C), Wind (m s-1), Daylight (Night or Daylight))
z_0	Roughness length value (m)

**Value**

Hourly data of boundary layer resistance for SO<sub>2</sub> (s m<sup>-1</sup>)

**Examples**

```
data(Bizkaia_data)
Res_boun_SO2(x = Bizkaia_data, z_0 = 1)
```

---

Res_cano_CO	<i>Res_cano_CO - Calculates hourly canopy resistance for CO</i>
-------------	---

---

**Description**

Res\_cano\_CO - Calculates hourly canopy resistance for CO

**Usage**

```
Res_cano_CO(x)
```

**Arguments**

x	A data frame containing hourly data of weather variables (e.g. Hum (%), Pres (kPa), Precip (mm), Rad (W m <sup>-2</sup> ), Temp (C), Wind (m s <sup>-1</sup> ), Daylight (Night or Daylight))
---	---

**Value**

Hourly data of canopy resistance for CO (s m<sup>-1</sup>)

**Examples**

```
data(Bizkaia_data)
Res_cano_CO(x = Bizkaia_data)
```

---

Res_cano_NO2	<i>Res_cano_NO2 - Calculates hourly canopy resistance for NO2</i>
--------------	---

---

**Description**

Res\_cano\_NO2 - Calculates hourly canopy resistance for NO<sub>2</sub>

**Usage**

```
Res_cano_NO2(x)
```

**Arguments**

x A data frame containing hourly data of weather variables (e.g. Hum (%), Pres (kPa), Precip (mm), Rad (W m<sup>-2</sup>), Temp (C), Wind (m s<sup>-1</sup>), Daylight (Night or Daylight))

**Value**

Hourly data of canopy resistance for NO<sub>2</sub> (s m<sup>-1</sup>)

**Examples**

```
data(Bizkaia_data)
Res_cano_NO2(x = Bizkaia_data)
```

---

Res\_cano\_O3

*Res\_cano\_O3 - Calculates hourly canopy resistance for O<sub>3</sub>*

---

**Description**

Res\_cano\_O3 - Calculates hourly canopy resistance for O<sub>3</sub>

**Usage**

```
Res_cano_O3(x)
```

**Arguments**

x A data frame containing hourly data of weather variables (e.g. Hum (%), Pres (kPa), Precip (mm), Rad (W m<sup>-2</sup>), Temp (C), Wind (m s<sup>-1</sup>), Daylight (Night or Daylight))

**Value**

Hourly data of canopy resistance for O<sub>3</sub> (s m<sup>-1</sup>)

**Examples**

```
data(Bizkaia_data)
Res_cano_O3(x = Bizkaia_data)
```



---

`Res_cano_SO2`*Res\_cano\_SO2 - Calculates hourly canopy resistance for SO2*

---

**Description**

`Res_cano_SO2` - Calculates hourly canopy resistance for SO2

**Usage**

```
Res_cano_SO2(x)
```

**Arguments**

`x` A data frame containing hourly data of weather variables (e.g. Hum (%), Pres (kPa), Precip (mm), Rad (W m<sup>-2</sup>), Temp (C), Wind (m s<sup>-1</sup>), Daylight (Night or Daylight))

**Value**

Hourly data of canopy resistance for SO2 (s m<sup>-1</sup>)

**Examples**

```
data(Bizkaia_data)
Res_cano_SO2(x = Bizkaia_data)
```

---

`Res_cuti_NO2`*Res\_cuti\_NO2 - Calculates hourly cuticular resistance for NO2*

---

**Description**

`Res_cuti_NO2` - Calculates hourly cuticular resistance for NO2

**Usage**

```
Res_cuti_NO2(x)
```

**Arguments**

`x` A data frame containing hourly data of weather variables (e.g. Hum (%), Pres (kPa), Precip (mm), Rad (W m<sup>-2</sup>), Temp (C), Wind (m s<sup>-1</sup>), Daylight (Night or Daylight))

**Value**

Hourly data of cuticular resistance for NO2 (s m<sup>-1</sup>)

**Examples**

```
data(Bizkaia_data)
Res_cuti_N02(x = Bizkaia_data)
```

---

Res\_cuti\_O3

*Res\_cuti\_O3 - Calculates hourly cuticular resistance for O3*


---

**Description**

Res\_cuti\_O3 - Calculates hourly cuticular resistance for O3

**Usage**

```
Res_cuti_O3(x)
```

**Arguments**

x                    A data frame containing hourly data of weather variables (e.g. Hum (%), Pres (kPa), Precip (mm), Rad (W m-2), Temp (C), Wind (m s-1), Daylight (Night or Daylight))

**Value**

Hourly data of cuticular resistance for O3 (s m-1)

**Examples**

```
data(Bizkaia_data)
Res_cuti_O3(x = Bizkaia_data)
```

---

Res\_cuti\_SO2

*Res\_cuti\_SO2 - Calculates hourly cuticular resistance for SO2*


---

**Description**

Res\_cuti\_SO2 - Calculates hourly cuticular resistance for SO2

**Usage**

```
Res_cuti_SO2(x)
```

**Arguments**

x                    A data frame containing hourly data of weather variables (e.g. Hum (%), Pres (kPa), Precip (mm), Rad (W m-2), Temp (C), Wind (m s-1), Daylight (Night or Daylight))

**Value**

Hourly data of cuticular resistance for SO2 (s m-1)

**Examples**

```
data(Bizkaia_data)
Res_cut_S02(x = Bizkaia_data)
```

---

Res\_meso\_NO2

*Res\_meso\_NO2 - Calculates hourly mesophyll resistance for NO2*

---

**Description**

Res\_meso\_NO2 - Calculates hourly mesophyll resistance for NO2

**Usage**

```
Res_meso_NO2(x)
```

**Arguments**

x                    A data frame containing hourly data of weather variables (e.g. Hum (%), Pres (kPa), Precip (mm), Rad (W m-2), Temp (C), Wind (m s-1), Daylight (Night or Daylight))

**Value**

Hourly data of mesophyll resistance for NO2 (s m-1)

**Examples**

```
data(Bizkaia_data)
Res_meso_NO2(x = Bizkaia_data)
```

---

Res\_meso\_O3

*Res\_meso\_O3 - Calculates hourly mesophyll resistance for O3*

---

**Description**

Res\_meso\_O3 - Calculates hourly mesophyll resistance for O3

**Usage**

```
Res_meso_O3(x)
```

**Arguments**

x A data frame containing hourly data of weather variables (e.g. Hum (%), Pres (kPa), Precip (mm), Rad (W m<sup>-2</sup>), Temp (C), Wind (m s<sup>-1</sup>), Daylight (Night or Daylight))

**Value**

Hourly data of mesophyll resistance for O3 (s m<sup>-1</sup>)

**Examples**

```
data(Bizkaia_data)
Res_meso_O3(x = Bizkaia_data)
```

---

Res\_meso\_SO2

*Res\_meso\_SO2 - Calculates hourly mesophyll resistance for SO2*

---

**Description**

Res\_meso\_SO2 - Calculates hourly mesophyll resistance for SO2

**Usage**

```
Res_meso_SO2(x)
```

**Arguments**

x A data frame containing hourly data of weather variables (e.g. Hum (%), Pres (kPa), Precip (mm), Rad (W m<sup>-2</sup>), Temp (C), Wind (m s<sup>-1</sup>), Daylight (Night or Daylight))

**Value**

Hourly data of mesophyll resistance for SO2 (s m<sup>-1</sup>)

**Examples**

```
data(Bizkaia_data)
Res_meso_SO2(x = Bizkaia_data)
```

---

Res\_soil                      *Res\_soil - Calculates soil resistance on an hourly basis*

---

**Description**

Res\_soil - Calculates soil resistance on an hourly basis

**Usage**

```
Res_soil(x, r_soil_inleaf = 2941, r_soil_outleaf = 2941)
```

**Arguments**

x                      A data frame containing hourly data of weather and other variables (e.g. Hum (%), Pres (kPa), Precip (mm), Rad (W m-2), Temp (C), Wind (m s-1), Daylight (Night or Daylight), BAI, LAI)

r\_soil\_inleaf      Resistance value during in-leaf season

r\_soil\_outleaf     Resistance value during in-leaf season

**Value**

Hourly data of soil resistance (s m-1)

**Examples**

```
data(Bizkaia_data)
Res_soil(x = Bizkaia_data, r_soil_inleaf = 2941, r_soil_outleaf = 2941)
```

---

Res\_stom\_NO2                      *Res\_stom\_NO2 - Calculates stomata resistance on an hourly basis*

---

**Description**

Res\_stom\_NO2 - Calculates stomata resistance on an hourly basis

**Usage**

```
Res_stom_NO2(x, m2 = 1, m3 = 4)
```

**Arguments**

x                      A data frame containing hourly data of weather and other variables (e.g. Hum (%), Pres (kPa), Precip (mm), Rad (W m-2), Temp (C), Wind (m s-1), Daylight (Night or Daylight), BAI, LAI)

m2                     Dimensionless slope for different air pollutants

m3                     Dimensionless slope for different species

**Value**

Hourly data of stomata resistance (s m-1)

**Examples**

```
data(Bizkaia_data)
Res_stom_N02(x = Bizkaia_data)
```

---

Res\_stom\_O3

*Res\_stom\_O3 - Calculates stomata resistance on an hourly basis*

---

**Description**

Res\_stom\_O3 - Calculates stomata resistance on an hourly basis

**Usage**

```
Res_stom_O3(x, m2 = 1, m3 = 4)
```

**Arguments**

x	A data frame containing hourly data of weather and other variables (e.g. Hum (%), Pres (kPa), Precip (mm), Rad (W m-2), Temp (C), Wind (m s-1), Daylight (Night or Daylight), BAI, LAI)
m2	Dimensionless slope for different air pollutants
m3	Dimensionless slope for different species

**Value**

Hourly data of stomata resistance (s m-1)

**Examples**

```
data(Bizkaia_data)
Res_stom_O3(x = Bizkaia_data)
```

---

 Res\_stom\_SO2

*Res\_stom\_SO2 - Calculates stomata resistance on an hourly basis*


---

**Description**

Res\_stom\_SO2 - Calculates stomata resistance on an hourly basis

**Usage**

```
Res_stom_SO2(x, m2 = 1, m3 = 4)
```

**Arguments**

x	A data frame containing hourly data of weather and other variables (e.g. Hum (%), Pres (kPa), Precip (mm), Rad (W m-2), Temp (C), Wind (m s-1), Daylight (Night or Daylight), BAI, LAI)
m2	Dimensionless slope for different air pollutants
m3	Dimensionless slope for different species

**Value**

Hourly data of stomata resistance (s m-1)

**Examples**

```
data(Bizkaia_data)
Res_stom_SO2(x = Bizkaia_data)
```

---

 Res\_Tot\_CO

*Res\_Tot\_CO - Calculates hourly total resistance for CO*


---

**Description**

Res\_Tot\_CO - Calculates hourly total resistance for CO

**Usage**

```
Res_Tot_CO(x, z_0 = 1)
```

**Arguments**

x	A data frame containing hourly data of weather variables (e.g. Hum (%), Pres (kPa), Precip (mm), Rad (W m-2), Temp (C), Wind (m s-1), Daylight (Night or Daylight))
z_0	Roughness length value (m)

**Value**

Hourly data of total resistance for CO (s m-1)

**Examples**

```
data(Bizkaia_data)
Res_Tot_CO(x = Bizkaia_data, z_0 = 1)
```

---

Res\_Tot\_NO2

*Res\_Tot\_NO2 - Calculates hourly total resistance for NO2*

---

**Description**

Res\_Tot\_NO2 - Calculates hourly total resistance for NO2

**Usage**

```
Res_Tot_NO2(x, z_0 = 1)
```

**Arguments**

x	A data frame containing hourly data of weather variables (e.g. Hum (%), Pres (kPa), Precip (mm), Rad (W m-2), Temp (C), Wind (m s-1), Daylight (Night or Daylight))
z_0	Roughness length value (m)

**Value**

Hourly data of total resistance for NO2 (s m-1)

**Examples**

```
data(Bizkaia_data)
Res_Tot_NO2(x = Bizkaia_data, z_0 = 1)
```



---

Res_Tot_O3	<i>Res_Tot_O3 - Calculates hourly total resistance for O3</i>
------------	---

---

**Description**

Res\_Tot\_O3 - Calculates hourly total resistance for O3

**Usage**

```
Res_Tot_O3(x, z_0 = 1)
```

**Arguments**

x	A data frame containing hourly data of weather variables (e.g. Hum (%), Pres (kPa), Precip (mm), Rad (W m-2), Temp (C), Wind (m s-1), Daylight (Night or Daylight))
z_0	Roughness length value (m)

**Value**

Hourly data of total resistance for O3 (s m-1)

**Examples**

```
data(Bizkaia_data)
Res_Tot_O3(x = Bizkaia_data, z_0 = 1)
```

---

Res_Tot_SO2	<i>Res_Tot_SO2 - Calculates hourly total resistance for SO2</i>
-------------	---

---

**Description**

Res\_Tot\_SO2 - Calculates hourly total resistance for SO2

**Usage**

```
Res_Tot_SO2(x, z_0 = 1)
```

**Arguments**

x	A data frame containing hourly data of weather variables (e.g. Hum (%), Pres (kPa), Precip (mm), Rad (W m-2), Temp (C), Wind (m s-1), Daylight (Night or Daylight))
z_0	Roughness length value (m)

**Value**

Hourly data of total resistance for SO<sub>2</sub> (s m<sup>-1</sup>)

**Examples**

```
data(Bizkaia_data)
Res_Tot_SO2(x = Bizkaia_data, z_0 = 1)
```

---

TreeDep

*TreeDep Package*

---

**Description**

The model estimates air pollution removal by dry deposition on trees. It also estimates aerodynamic resistance, boundary layer resistance, canopy resistance, stomatal resistance, cuticular resistance, mesophyll resistance, soil resistance, friction velocity and deposition velocity. It also allows plotting graphical results for a specific time period. The pollutants are nitrogen dioxide, ozone, sulphur dioxide, carbon monoxide and particulate matter.

**Author(s)**

Silvestre Garcia de Jalon <s.garciadejalon@gmail.com>

---

TreeDep\_plot

*TreeDep\_plot - Generates a plot for selected variables and dates.*

---

**Description**

TreeDep\_plot - Generates a plot for selected variables and dates.

**Usage**

```
TreeDep_plot(my_data, variable1, variable2 = "Non-existent", start_month,
             start_day, stop_month, stop_day)
```

**Arguments**

my_data	A data frame containing hourly data pollutant concentration and other variables (Dates (e.g. 01/01/2016 00:00:00), Hum (%), Pres (kPa), Precip (mm), Rad (W m <sup>-2</sup> ), Temp (C), Wind (m s <sup>-1</sup> ), Daylight (Night or Daylight), BAI, LAI)
variable1	Variable to be plotted (e.g., "Dep_NO2", "Conc_O3", "Wind", "Temp")
variable2	Variable to be plotted (e.g., "Dep_NO2", "Conc_O3", "Wind", "Temp")
start_month	First month of the year in the plot (between 1 and 12; e.g., 3)
start_day	First day of the month in the plot (between 1 and 31; e.g., 4)
stop_month	Last month of the year in the plot (between 1 and 12; e.g., 11)
stop_day	Last day of the month in the plot (between 1 and 31; e.g., 22)

**Details**

The variables that can be plotted are: "Hum", "Pres", "Precip", "Rad", "Temp", "Wind", "BAI", "LAI", "Fric\_vel", "Res\_aero", "Res\_boun\_CO2", "Res\_soil", "Conc\_NO2", "Dep\_NO2", "Dep\_vel\_NO2", "Res\_boun\_NO2", "Res\_cuti\_NO2", "Res\_stom\_NO2", "Res\_meso\_NO2", "Res\_cano\_NO2", "Res\_Tot\_NO2", "Conc\_O3", "Dep\_O3", "Dep\_vel\_O3", "Res\_boun\_O3", "Res\_cuti\_O3", "Res\_stom\_O3", "Res\_meso\_O3", "Res\_cano\_O3", "Res\_Tot\_O3", "Conc\_SO2", "Dep\_SO2", "Dep\_vel\_SO2", "Res\_boun\_SO2", "Res\_cuti\_SO2", "Res\_stom\_SO2", "Res\_meso\_SO2", "Res\_cano\_SO2", "Res\_Tot\_SO2", "Conc\_CO", "Dep\_CO", "Dep\_vel\_CO", "Res\_boun\_CO", "Res\_cano\_CO", "Res\_Tot\_CO", "Conc\_PM10", "Dep\_PM10", "Dep\_vel\_PM10".

**Value**

A plot with the variables and dates selected

**Examples**

```
TreeDep_plot(my_data = Bizkaia_data,  
variable1 = "Dep_PM10",  
variable2 = "Wind",  
start_month = 6,  
stop_month = 7,  
start_day = 25,  
stop_day = 3)
```

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