Package 'cffdrs.core'

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Type Package

Title Canadian Forest Fire Danger Rating System

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Depends R(>= 3.2.2)

Description This project provides a group of new functions to calculate the outputs of the two main components of the Canadian Forest Fire Danger Rating System (CFFDRS) Van Wagner and Pickett (1985) <https://cfs.nrcan.gc.ca/publications?id=19973>) at various time scales: the Fire Weather Index (FWI) System Wan Wagner (1985) <https://cfs.nrcan.gc.ca/publications?id=19927> and the Fire Behaviour Prediction (FBP) System Forestry Canada Fire Danger Group (1992) <http://cfs.nrcan.gc.ca/pubwarehouse/pdfs/10068.pdf>.

License GPL-2

URL https://r-forge.r-project.org/projects/cffdrs/

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R topics documented:

`cffdrs.core-package` *Canadian Forest Fire Danger Rating System*

Description

The cffdrs.core package allows R users to calculate the outputs of the two main components of the Canadian Forest Fire Danger Rating System (CFFDRS; http://cwfis.cfs.nrcan.gc.ca/background/summary/fdr): the Fire Weather Index (FWI) System (http://cwfis.cfs.nrcan.gc.ca/background/summary/fwi) and the Fire Behaviour Prediction (FBP) System (http://cwfis.cfs.nrcan.gc.ca/background/summary/fbp) along with additional methods created and used Canadian fire modelling. These systems are widely used internationally to assess fire danger (FWI System) and quantify fire behavior (FBP System).

Details

The FWI System (Van Wagner 1987) is based on the moisture content and the effect of wind of three classes of forest fuels on fire behavior. It consists of six components: three fuel moisture codes (Fire Fuel Moisture Code, Duff Moisture Code, Drought Code), and three fire behavior indexes representing rate of spread (Initial Spread Index), fuel consumption (Buildup Index), and fire intensity (Fire Weather Index). The FWI System outputs are determined from daily noon weather observations: temperature, relative humidity, wind speed, and 24-hour rainfall.

The FBP System (Forestry Canada Fire Danger Group 1992; Hirsch 1996) provides a set of primary and secondary measures of fire behavior. The primary outputs consist of estimates of fire spread rate, fuel consumption, fire intensity, and fire description (i.e., surface, intermittent, or crown fire). The secondary outputs, which are not used nearly as often, give estimates of fire area, perimeter,

perimeter growth rate, and flank and back fire behavior based on a simple elliptical fire growth model. Unlike the FWI System, which is weather based, the FBP System also requires information on vegetation (hereafter, fuel types) and slope (if any) to calculate its outputs. Sixteen fuel types are included in the FBP System, covering mainly major vegetation types in Canada.

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Author(s)

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References

1. Van Wagner, C.E. and T.L. Pickett. 1985. Equations and FORTRAN program for the Canadian Forest Fire Weather Index System. Can. For. Serv., Ottawa, Ont. For. Tech. Rep. 33. 18 p.

2. Van Wagner, C.E. 1987. Development and structure of the Canadian forest fire weather index system. Forest Technology Report 35. (Canadian Forestry Service: Ottawa).

3. Lawson, B.D. and O.B. Armitage. 2008. Weather guide for the Canadian Forest Fire Danger Rating System. Nat. Resour. Can., Can. For. Serv., North. For. Cent., Edmonton, AB.

4. Hirsch K.G. 1996. Canadian Forest Fire Behavior Prediction (FBP) System: user's guide. Nat. Resour. Can., Can. For. Serv., Northwest Reg., North. For. Cent., Edmonton, Alberta. Spec. Rep. 7. 122p.

5. Forestry Canada Fire Danger Group. 1992. Development and structure of the Canadian Forest Fire Behavior Prediction System. Forestry Canada, Ottawa, Ontario Information Report ST-X-3. 63 p. http://cfs.nrcan.gc.ca/pubwarehouse/pdfs/10068.pdf

6. Wotton, B.M., Alexander, M.E., Taylor, S.W. 2009. Updates and revisions to the 1992 Canadian forest fire behavior prediction system. Nat. Resour. Can., Can. For. Serv., Great Lakes For. Cent., Sault Ste. Marie, Ontario, Canada. Information Report GLC-X-10, 45p. http://publications.gc.ca/collections/collection_2010/nrcan/Fo123-2-10-2009-eng.pdf

7. Tymstra, C., Bryce, R.W., Wotton, B.M., Armitage, O.B. 2009. Development and structure of Prometheus: the Canadian wildland fire growth simulation Model. Nat. Resour. Can., Can. For. Serv., North. For. Cent., Edmonton, AB. Inf. Rep. NOR-X-417.

See Also

fbp, fireSeason, fwi, gfmc, hffmc, sdmc, wDC

BackRos *Back Fire Rate of Spread Calculator*

Description

Calculate the Back Fire Spread Rate. All variables names are laid out in the same manner as Forestry Canada Fire Danger Group (FCFDG) (1992).

Usage

```
BackRos(FUELTYPE, FFMC, BUI, WSV, FMC, SFC, PC, PDF, CC, CBH)
```

Arguments

FUELTYPE	The Fire Behaviour Prediction FuelType
FFMC	Fine Fuel Moisture Code
BUI	Buildup Index
WSV	Wind Speed Vector
FMC	Foliar Moisture Content
SFC	Surface Fuel Consumption
PC	Percent Conifer
PDF	Percent Dead Balsam Fir
CC	Degree of Curing (just "C" in FCFDG 1992)
CBH	Crown Base Height

Value

BROS: Back Fire Rate of Spread

References

https://cfs.nrcan.gc.ca/publications/download-pdf/10068 Development and Structure of the Canadian Forest Fire Behavior Prediction System." Technical Report ST-X-3, Forestry Canada, Ottawa, Ontario.

Bui *Build Up Index Calculator*

Description

Buildup Index Calculation. All code is based on a C code library that was written by Canadian Forest Service Employees, which was originally based on the Fortran code listed in the reference below. All equations in this code refer to that document. Equations and FORTRAN program for the Canadian Forest Fire Weather Index System. 1985. Van Wagner, C.E.; Pickett, T.L. Canadian Forestry Service, Petawawa National Forestry Institute, Chalk River, Ontario. Forestry Technical Report 33. 18 p.

Usage

```
Bui(dmc, dc)
```

Arguments

dmc	Duff Moisture Code
dc	Drought Code

Value

A single Build Up Index value

References

http://cfs.nrcan.gc.ca/pubwarehouse/pdfs/19927.pdf Development and structure of the Canadian Forest Fire Weather Index System. 1987. Van Wagner, C.E. Canadian Forestry Service, Headquarters, Ottawa. Forestry Technical Report 35. 35 p.

BuildupEffect *Build Up Effect Calculator*

Description

Computes the Buildup Effect on Fire Spread Rate. All variables names are laid out in the same manner as Forestry Canada Fire Danger Group (FCFDG) (1992).

Usage

```
BuildupEffect(FUELTYPE, BUI)
```

Arguments

FUELTYPE	The Fire Behaviour Prediction FuelType
BUI	The Buildup Index value

Value

BE: Build up effect

References

https://cfs.nrcan.gc.ca/publications/download-pdf/10068 Development and Structure of the Canadian Forest Fire Behavior Prediction System." Technical Report ST-X-3, Forestry Canada, Ottawa, Ontario.

Cfb *Crown Fraction Burned Calculator*

Description

Calculate Calculate Crown Fraction Burned. To calculate CFB, we also need to calculate Critical surface intensity (CSI), and Surface fire rate of spread (RSO). The value of each of these equations can be returned to the calling function without unecessary additional calculations.

Usage

```
Cfb(FUELTYPE, FMC, SFC, ROS, CBH, option = "CFB")
```

Arguments

FUELTYPE	The Fire Behaviour Prediction FuelType
FMC	Foliar Moisture Content
SFC	Surface Fuel Consumption
ROS	Rate of Spread
CBH	Crown Base Height
option	Which variable to calculate(ROS, CFB, RSC, or RSI)

Details

All variables names are laid out in the same manner as Forestry Canada Fire Danger Group (FCFDG) (1992). Development and Structure of the Canadian Forest Fire Behavior Prediction System." Technical Report ST-X-3, Forestry Canada, Ottawa, Ontario.

Value

CFB, CSI, RSO depending on which option was selected. _Default:_ "CFB"

References

https://cfs.nrcan.gc.ca/publications/download-pdf/10068 Development and Structure of the Canadian Forest Fire Behavior Prediction System." Technical Report ST-X-3, Forestry Canada, Ottawa, Ontario.

Dc *Drought Code Calculator*

Usage

```
Dc(dc_yda, temp, rh, prec, lat, mon, lat.adjust = TRUE)
```

Arguments

dc_yda	The Drought Code from previous iteration
temp	Temperature (centigrade)
rh	Relative Humidity (
	\itemprecPrecipitation(mm)
	\itemlatLatitude (decimal degrees)
	\itemmonMonth (1-12)
	\itemlat.adjustLatitude adjustment (TRUE, FALSE, default=TRUE)
	A single drought code value
	Drought Code Calculation. All code is based on a C code library that was written by Canadian Forest Service Employees, which was originally based on the Fortran code listed in the reference below. All equations in this code refer to that document. Equations and FORTRAN program for the Canadian Forest Fire Weather Index System. 1985. Van Wagner, C.E.; Pickett, T.L. Canadian Forestry Service, Petawawa National Forestry Institute, Chalk River, Ontario. Forestry Technical Report 33. 18 p. Additional reference on FWI system Development and structure of the Canadian Forest Fire Weather Index System. 1987. Van Wagner, C.E. Canadian Forestry Service, Headquarters, Ottawa. Forestry Technical Report 35. 35 p.
	http://cfs.nrcan.gc.ca/pubwarehouse/pdfs/19927.pdf Development and structure of the Canadian Forest Fire Weather Index System. 1987. Van Wagner, C.E. Canadian Forestry Service, Headquarters, Ottawa. Forestry Technical Report 35. 35 p.

Direction *Direction definer*

Description

New DIRECTION function to determine clockwise or counter-clockwise "interpretation"

Usage

```
Direction(bearingT1T2, bearingT1T3, ThetaAdeg)
```

Arguments

bearingT1T2	Bearing between T1 and T2
bearingT1T3	Bearing between T1 and T3
ThetaAdeg	Direction

Value

DIR - a direction in degrees

DistT *Distance at time t calculator*

Description

Calculate the Head fire spread distance at time t. In the documentation this variable is just "D".

Usage

```
DistT(FUELTYPE, ROSeq, HR, CFB)
```

Arguments

FUELTYPE	The Fire Behaviour Prediction FuelType
ROSeq	The predicted equilibrium rate of spread (m/min)
HR	The elapsed time (min)
CFB	Crown Fraction Burned

Details

All variables names are laid out in the same manner as Forestry Canada Fire Danger Group (FCFDG) (1992). Development and Structure of the Canadian Forest Fire Behavior Prediction System." Technical Report ST-X-3, Forestry Canada, Ottawa, Ontario.

Value

DISTt - Head fire spread distance at time t

Dmc *Duff Moisture Code Calculator*

Usage

```
Dmc(dmc_yda, temp, rh, prec, lat, mon, lat.adjust = TRUE)
```

Arguments

dmc_yda	The Duff Moisture Code from previous iteration
temp	Temperature (centigrade)
rh	Relative Humidity (\itemprecPrecipitation(mm) \itemlatLatitude (decimal degrees) \itemmonMonth (1-12) \itemlat.adjustLatitude adjustment (TRUE, FALSE, default=TRUE) A single drought moisture code value Duff Moisture Code Calculation. All code is based on a C code library that was written by Canadian Forest Service Employees, which was originally based on

the Fortran code listed in the reference below. All equations in this code refer to that document.

Equations and FORTRAN program for the Canadian Forest Fire Weather Index System. 1985. Van Wagner, C.E.; Pickett, T.L. Canadian Forestry Service, Petawawa National Forestry Institute, Chalk River, Ontario. Forestry Technical Report 33. 18 p.

Additional reference on FWI system

Development and structure of the Canadian Forest Fire Weather Index System. 1987. Van Wagner, C.E. Canadian Forestry Service, Headquarters, Ottawa. Forestry Technical Report 35. 35 p.

http://cfs.nrcan.gc.ca/pubwarehouse/pdfs/19927.pdf Development and structure of the Canadian Forest Fire Weather Index System. 1987. Van Wagner, C.E. Canadian Forestry Service, Headquarters, Ottawa. Forestry Technical Report 35. 35 p.

`Fbp` *Fire Behaviour Prediction System Calculation (hidden)*

Description

Fire Behavior Prediction System calculations. This is the primary function for calculating FBP for a single timestep. Not all equations are calculated within this function, but have been broken down further.

Usage

```
Fbp(input = NULL, output = "Primary")
```

Arguments

`input`	Data frame of required and optional information needed to calculate FBP function. View the arguments section of the fbp manual (fbp.Rd) under "input" for the full listing of the required and optional inputs.
`output`	What fbp outputs to return to the user. Options are "Primary", "Secondary" and "All". _Default:_ "Primary"

Value

output: Either Primary, Secondary, or all FBP outputs in a data.frame

FbpC6 *C-6 Conifer Plantaion Fire Spread Calculator*

Description

Calculate c6 (Conifer plantation) Fire Spread. C6 is a special case, and thus has it's own function. To calculate C6 fire spread, this function also calculates and can return ROS, CFB, RSC, or RSI by specifying in the option parameter. All variables names are laid out in the same manner as Forestry Canada Fire Danger Group (FCFDG) (1992). Development and Structure of the Canadian Forest Fire Behavior Prediction System." Technical Report ST-X-3, Forestry Canada, Ottawa, Ontario.

Usage

```
FbpC6(FUELTYPE, ISI, BUI, FMC, SFC, CBH, ROS, CFB, RSC, option = "CFB")
```

Arguments

FUELTYPE	The Fire Behaviour Prediction FuelType
ISI	Initial Spread Index
BUI	Buildup Index
FMC	Foliar Moisture Content
SFC	Surface Fuel Consumption
CBH	Crown Base Height
ROS	Rate of Spread
CFB	Crown Fraction Burned
RSC	Crown Fire Spread Rate (m/min)
option	Which variable to calculate(ROS, CFB, RSC, or RSI) _Default:_ "CFB"

Value

ROS, CFB, RSC or RSI depending on which option was selected

References

https://cfs.nrcan.gc.ca/publications/download-pdf/10068 Development and Structure of the Canadian Forest Fire Behavior Prediction System." Technical Report ST-X-3, Forestry Canada, Ottawa, Ontario.

Ffmc *Fine Fuel Moisture Code Calculation*

Usage

```
Ffmc(ffmc_yda, temp, rh, ws, prec)
```

Arguments

ffmc_yda	The Fine Fuel Moisture Code from previous iteration
temp	Temperature (centigrade)
rh	Relative Humidity (\itemwsWind speed (km/h) \itemprecPrecipitation (mm) A single fine fuel moisture code value Fine Fuel Moisture Code Calculation. All code is based on a C code library that was written by Canadian Forest Service Employees, which was originally based on the Fortran code listed in the reference below. All equations in this code refer to that document. Equations and FORTRAN program for the Canadian Forest Fire Weather Index System. 1985. Van Wagner, C.E.; Pickett, T.L. Canadian Forestry Service, Petawawa National Forestry Institute, Chalk River, Ontario. Forestry Technical Report 33. 18 p. Additional reference on FWI system Development and structure of the Canadian Forest Fire Weather Index System. 1987. Van Wagner, C.E. Canadian Forestry Service, Headquarters, Ottawa. Forestry Technical Report 35. 35 p.

Fi *Fire Intensity Calculator*

Description

Calculate the Predicted Fire Intensity

Usage

```
Fi(FC, ROS)
```

Arguments

FC	Fuel Consumption (kg/m^2)
ROS	Rate of Spread (m/min)

Details

All variables names are laid out in the same manner as Forestry Canada Fire Danger Group (FCFDG) (1992). Development and Structure of the Canadian Forest Fire Behavior Prediction System." Technical Report ST-X-3, Forestry Canada, Ottawa, Ontario.

Value

FI: Fire Intensity (kW/m)

`FlankRos` *Flank Fire Rate of Spread Calculator*

Description

Calculate the Flank Fire Spread Rate.

Usage

```
FlankRos(ROS, BROS, LB)
```

Arguments

`ROS`	Fire Rate of Spread (m/min)
`BROS`	Back Fire Rate of Spread (m/min)
`LB`	Length to breadth ratio

Details

All variables names are laid out in the same manner as Forestry Canada Fire Danger Group (FCFDG) (1992). Development and Structure of the Canadian Forest Fire Behavior Prediction System." Technical Report ST-X-3, Forestry Canada, Ottawa, Ontario.

Value

FROS Flank Fire Spread Rate (m/min) value

`Fmc` *Foliar Moisture Content Calculator*

Description

Calculate Foliar Moisture Content on a specified day. All variables names are laid out in the same manner as Forestry Canada Fire Danger Group (FCFDG) (1992). Development and Structure of the Canadian Forest Fire Behavior Prediction System." Technical Report ST-X-3, Forestry Canada, Ottawa, Ontario.

Usage

```
Fmc(LAT, LONG, ELV, DJ, D0)
```

Arguments

LAT	Latitude (decimal degrees)
LONG	Longitude (decimal degrees)
ELV	Elevation (metres)
DJ	Day of year (offeren referred to as julian date)
D0	Date of minimum foliar moisture content. _If D0, date of min FMC, is not known then D0 = NULL._

Value

FMC: Foliar Moisture Content value

Fwi *Fire Weather Index Calculation.*

Description

All code is based on a C code library that was written by Canadian Forest Service Employees, which was originally based on the Fortran code listed in the reference below. All equations in this code refer to that document.

Usage

```
Fwi(isi, bui)
```

Arguments

isi	Initial Spread Index
bui	Buildup Index

Details

Equations and FORTRAN program for the Canadian Forest Fire Weather Index System. 1985. Van Wagner, C.E.; Pickett, T.L. Canadian Forestry Service, Petawawa National Forestry Institute, Chalk River, Ontario. Forestry Technical Report 33. 18 p.

Additional reference on FWI system

Development and structure of the Canadian Forest Fire Weather Index System. 1987. Van Wagner, C.E. Canadian Forestry Service, Headquarters, Ottawa. Forestry Technical Report 35. 35 p.

Value

A single fwi value

Isi *Initial Spread Index Calculator*

Description

Computes the Initial Spread Index From the FWI System. Equations are from Van Wagner (1985) as listed below, except for the modification for fbp takene from FCFDG (1992).

Usage

```
Isi(ffmc, ws, fbpMod = FALSE)
```

Arguments

ffmc	Fine Fuel Moisture Code
ws	Wind Speed (km/h)
fbpMod	TRUE/FALSE if using the fbp modification at the extreme end

Details

Equations and FORTRAN program for the Canadian Forest Fire Weather Index System. 1985. Van Wagner, C.E.; Pickett, T.L. Canadian Forestry Service, Petawawa National Forestry Institute, Chalk River, Ontario. Forestry Technical Report 33. 18 p.

Forestry Canada Fire Danger Group (FCFDG) (1992). Development and Structure of the Canadian Forest Fire Behavior Prediction System." Technical ReportST-X-3, Forestry Canada, Ottawa, Ontario.

Value

ISI - Intial Spread Index

Lb *Length-to-Breadth ratio*

Description

Computes the Length to Breadth ratio of an elliptically shaped fire. Equations are from listed FCFDG (1992) except for errata 80 from Wotton et. al. (2009).

Usage

```
Lb(FUELTYPE, WSV)
```

Details

All variables names are laid out in the same manner as Forestry Canada Fire Danger Group (FCFDG) (1992). Development and Structure of the Canadian Forest Fire Behavior Prediction System." Technical Report ST-X-3, Forestry Canada, Ottawa, Ontario.

Wotton, B.M., Alexander, M.E., Taylor, S.W. 2009. Updates and revisions to the 1992 Canadian forest fire behavior prediction system. Nat. Resour. Can., Can. For. Serv., Great Lakes For. Cent., Sault Ste. Marie, Ontario, Canada. Information Report GLC-X-10, 45p.

@param FUELTYPE The Fire Behaviour Prediction FuelType @param WSV The Wind Speed (km/h)

Value

Length to Breadth ratio value

LbT *Length-to-Breadth ratio at time t*

Description

Computes the Length to Breadth ratio of an elliptically shaped fire at elapsed time since ignition. Equations are from listed FCFDG (1992) and Wotton et. al. (2009), and are marked as such.

Usage

```
LbT(FUELTYPE, LB, HR, CFB)
```

Arguments

FUELTYPE	The Fire Behaviour Prediction FuelType
LB:	Length to Breadth ratio
HR:	Time since ignition (hours)
CFB:	Crown Fraction Burned

Details

All variables names are laid out in the same manner as Forestry Canada Fire Danger Group (FCFDG) (1992). Development and Structure of the Canadian Forest Fire Behavior Prediction System." Technical Report ST-X-3, Forestry Canada, Ottawa, Ontario.

Wotton, B.M., Alexander, M.E., Taylor, S.W. 2009. Updates and revisions to the 1992 Canadian forest fire behavior prediction system. Nat. Resour. Can., Can. For. Serv., Great Lakes For. Cent., Sault Ste. Marie, Ontario, Canada. Information Report GLC-X-10, 45p.

Value

Length to Breadth ratio at time since ignition

Ros *Rate of Spread Calculation*

Usage

```
Ros(FUELTYPE, ISI, BUI, FMC, SFC, PC, PDF, CC, CBH)
```

Arguments

ISI	Intiial Spread Index
BUI	Buildup Index
FMC	Foliar Moisture Content
SFC	Surface Fuel Consumption (kg/m^2)
PC	Percent Conifer (
	\itemPDFPercent Dead Balsam Fir (
	\itemCCConstant
	\itemCBHCrown to base height(m)
	\itemFUELTYPETheFire Behaviour Prediction FuelType
	ROS - Rate of Spread (m/min) value
	Computes the Rate of Spread prediction based on fuel type and FWI conditions. Equations are from listed FCFDG (1992) and Wotton et. al. (2009), and are marked as such.
	All variables names are laid out in the same manner as Forestry Canada Fire Danger Group (FCFDG) (1992). Development and Structure of the Canadian Forest Fire Behavior Prediction System." Technical Report ST-X-3, Forestry Canada, Ottawa, Ontario.
	Wotton, B.M., Alexander, M.E., Taylor, S.W. 2009. Updates and revisions to the 1992 Canadian forest fire behavior prediction system. Nat. Resour. Can., Can. For. Serv., Great Lakes For. Cent., Sault Ste. Marie, Ontario, Canada. Information Report GLC-X-10, 45p.

RosT *Rate of spread at time t calculation*

Description

Computes the Rate of Spread prediction based on fuel type and FWI conditions at elapsed time since ignition. Equations are from listed FCFDG (1992).

Usage

```
RosT(FUELTYPE, ROSeq, HR, CFB)
```

Arguments

FUELTYPE	The Fire Behaviour Prediction FuelType
ROSeq	Equilibrium Rate of Spread (m/min)
HR	Time since ignition (hours)
CFB	Crown Fraction Burned

Details

All variables names are laid out in the same manner as Forestry Canada Fire Danger Group (FCFDG) (1992). Development and Structure of the Canadian Forest Fire Behavior Prediction System." Technical Report ST-X-3, Forestry Canada, Ottawa, Ontario.

Value

ROSt - Rate of Spread at time since ignition value

RosTheta *Rate of spread at a point along the perimeter calculator*

Description

Computes the Rate of Spread at any point along the perimeter of an elliptically shaped fire. Equations are from Wotton et. al. (2009).

Usage

```
RosTheta(ROS, FROS, BROS, THETA)
```

Arguments

ROS	Rate of Spread (m/min)
FROS	Flank Fire Rate of Spread (m/min)
BROS	Back Fire Rate of Spread (m/min)
THETA	
FUELTYPE	The Fire Behaviour Prediction FuelType

Details

Wotton, B.M., Alexander, M.E., Taylor, S.W. 2009. Updates and revisions to the 1992 Canadian forest fire behavior prediction system. Nat. Resour. Can., Can. For. Serv., Great Lakes For. Cent., Sault Ste. Marie, Ontario, Canada. Information Report GLC-X-10, 45p.

Value

ROSTHETA - Rate of spread at point theta(m/min)

Sfc *Surface Fuel Consumption Calculator*

Usage

```
Sfc(FUELTYPE, FFMC, BUI, PC, GFL)
```

Arguments

FUELTYPE	The Fire Behaviour Prediction FuelType
FFMC	Fine Fuel Moisture Code
BUI	Buildup Index
PC	Percent Conifer (
	\itemGFLGrass Fuel Load (kg/m^2)
	SFC Surface Fuel Consumption (kg/m^2)
	Computes the Surface Fuel Consumption by Fuel Type. All variables names are laid out in the same manner as FCFDG (1992) or Wotton et. al (2009)
	Forestry Canada Fire Danger Group (FCFDG) (1992). "Development and Structure of the Canadian Forest Fire Behavior Prediction System." Technical Report ST-X-3, Forestry Canada, Ottawa, Ontario.
	Wotton, B.M., Alexander, M.E., Taylor, S.W. 2009. Updates and revisions to the 1992 Canadian forest fire behavior prediction system. Nat. Resour. Can., Can. For. Serv., Great Lakes For. Cent., Sault Ste. Marie, Ontario, Canada. Information Report GLC-X-10, 45p.

Slope *Slope Adjusted wind speed or slope direction of spread calculation*

Usage

```
Slope(
  FUELTYPE,
  FFMC,
  BUI,
  WS,
  WAZ,
  GS,
  SAZ,
  FMC,
  SFC,
  PC,
  PDF,
  CC,
  CBH,
  ISI,
  output = "RAZ"
)
```

Arguments

FUELTYPE	The Fire Behaviour Prediction FuelType
BUI	The Buildup Index value
WS	Windspeed (km/h)
WAZ	Wind Azimuth
GS	Ground Slope (\itemSAZSlope Azimuth \itemFMCFoliar Moisture Content \itemSFCSurface Fuel Consumption (kg/m^2) \itemPCPercent Conifer (\itemPDFPercent Dead Balsam Fir (\itemCCConstant \itemCBHCrown Base Height (m) \itemISIInitial Spread Index \itemoutputType of variable to output (RAZ/WSV, default=RAZ) RAZ or WSV - Rate of spread azimuth (degrees) or Wind Slope speed (km/hr) Calculate the net effective windspeed (WSV), the net effective wind direction (RAZ) or the wind azimuth (WAZ). All variables names are laid out in the same manner as FCFDG (1992) and Wotton (2009). Forestry Canada Fire Danger Group (FCFDG) (1992). "Development and Structure of the Canadian Forest Fire Behavior Prediction System." Technical Report ST-X-3, Forestry Canada, Ottawa, Ontario. Wotton, B.M., Alexander, M.E., Taylor, S.W. 2009. Updates and revisions to the 1992 Canadian forest fire behavior prediction system. Nat. Resour. Can., Can. For. Serv., Great Lakes For. Cent., Sault Ste. Marie, Ontario, Canada. Information Report GLC-X-10, 45p.

Tfc *Total Fuel Consumption calculation*

Usage

```
Tfc(FUELTYPE, CFL, CFB, SFC, PC, PDF, option = "TFC")
```

Arguments

FUELTYPE	The Fire Behaviour Prediction FuelType
CFL	Crown Fuel Load (kg/m^2)
CFB	Crown Fraction Burned (0-1)
SFC	Surface Fuel Consumption (kg/m^2)
PC	Percent Conifer (\itemPDFPercent Dead Balsam Fir (\itemoptionType of output (TFC, CFC, default=TFC) TFC Total (Surface + Crown) Fuel Consumption (kg/m^2) OR CFC Crown Fuel Consumption (kg/m^2)

Computes the Total (Surface + Crown) Fuel Consumption by Fuel Type. All variables names are laid out in the same manner as FCFDG (1992) or Wotton et. al (2009)

Forestry Canada Fire Danger Group (FCFDG) (1992). "Development and Structure of the Canadian Forest Fire Behavior Prediction System." Technical Report ST-X-3, Forestry Canada, Ottawa, Ontario.

Wotton, B.M., Alexander, M.E., Taylor, S.W. 2009. Updates and revisions to the 1992 Canadian forest fire behavior prediction system. Nat. Resour. Can., Can. For. Serv., Great Lakes For. Cent., Sault Ste. Marie, Ontario, Canada. Information Report GLC-X-10, 45p.

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