Meteorological station

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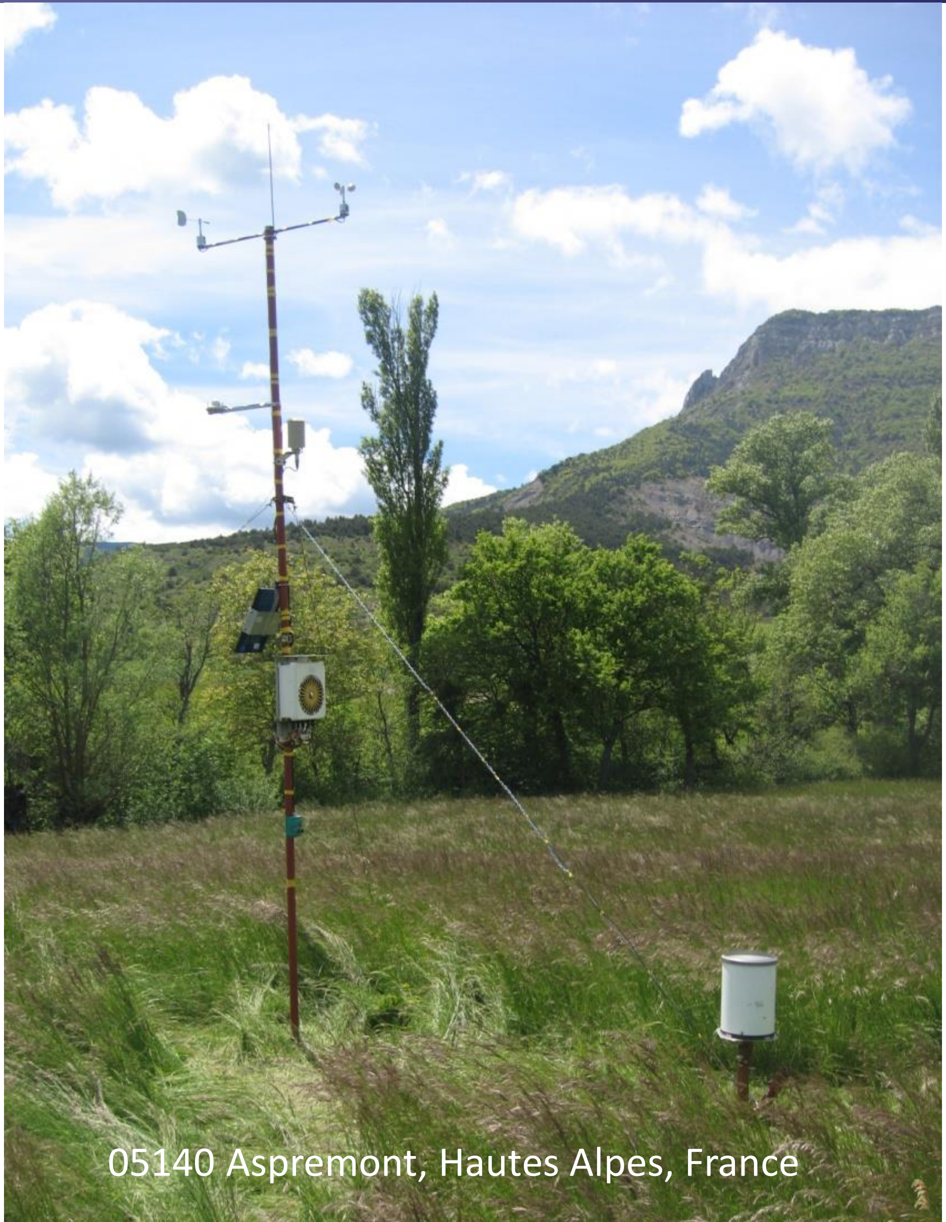

Relative humidity (*RH*)

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$$RH = \frac{e_a}{e_s}$$

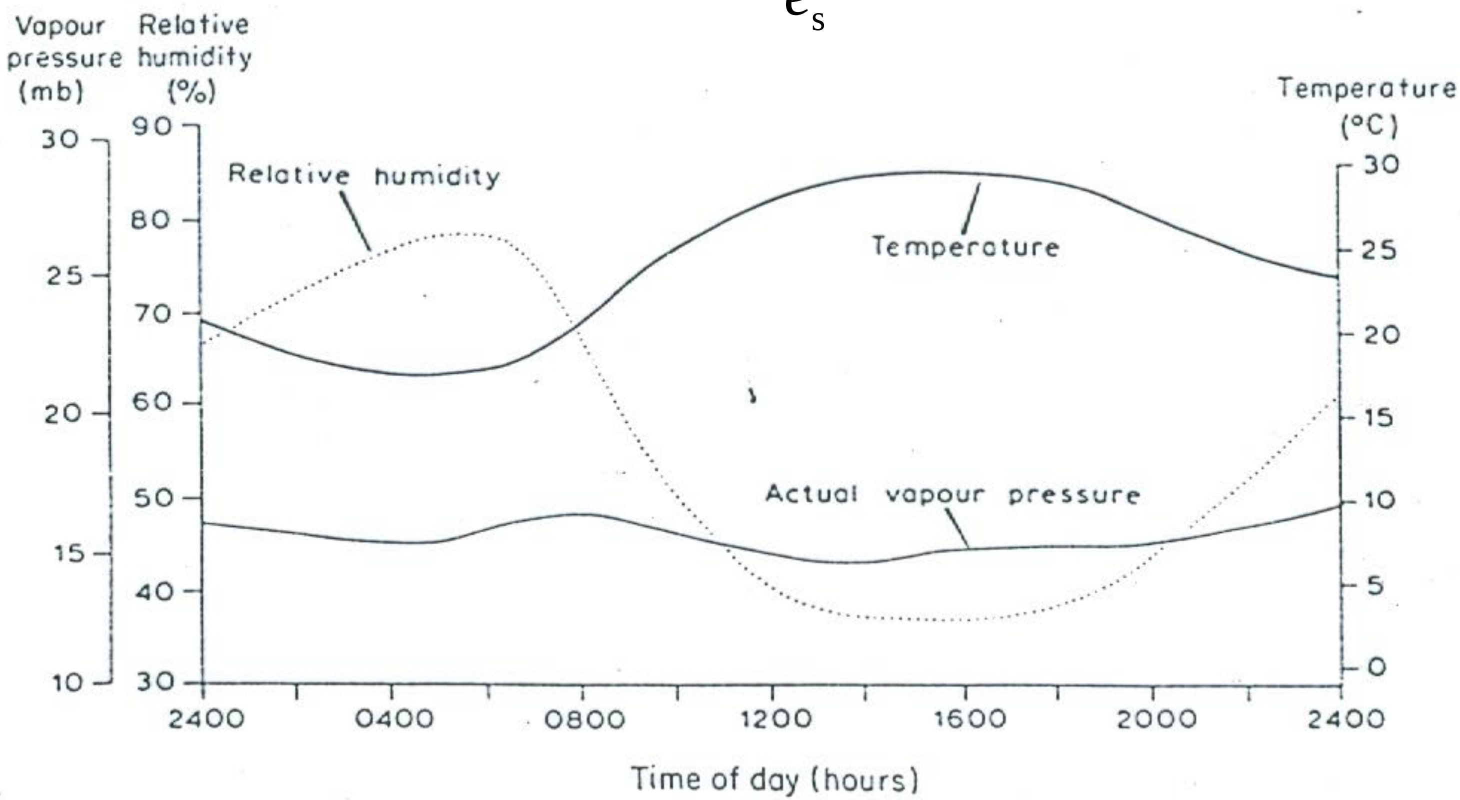

Figure 4.3 *An example of the diurnal variation of vapour pressure, relative humidity and air temperature* (*from an original diagram in ASCE, 1949*).

Penman-Monteith equation

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$$E_a = 0.408 \times \frac{\Delta R_n + \dfrac{105.028\,(e_s - e_a)}{r_a}}{\Delta + 0.067\left(1 + \dfrac{r_s}{r_a}\right)}$$

Earth’s surface energy balance

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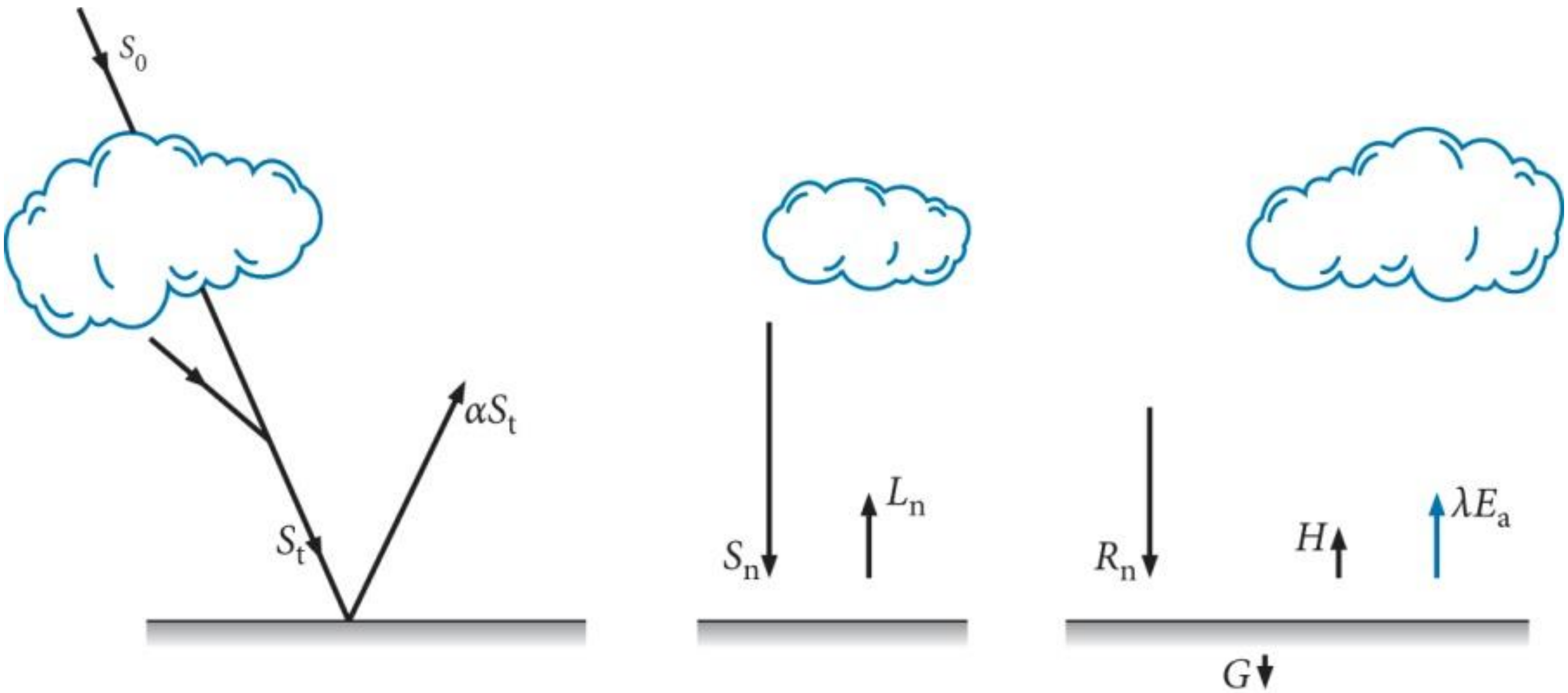

Absorbed shortwave radiation $S_n = (1 - \alpha)S_t$

Net radiation $R_n = S_n - L_n$

Non-radiative energy flux densities G, H, and λE_a: $R_n = G + H + \lambda E_a$

Atmospheric demand

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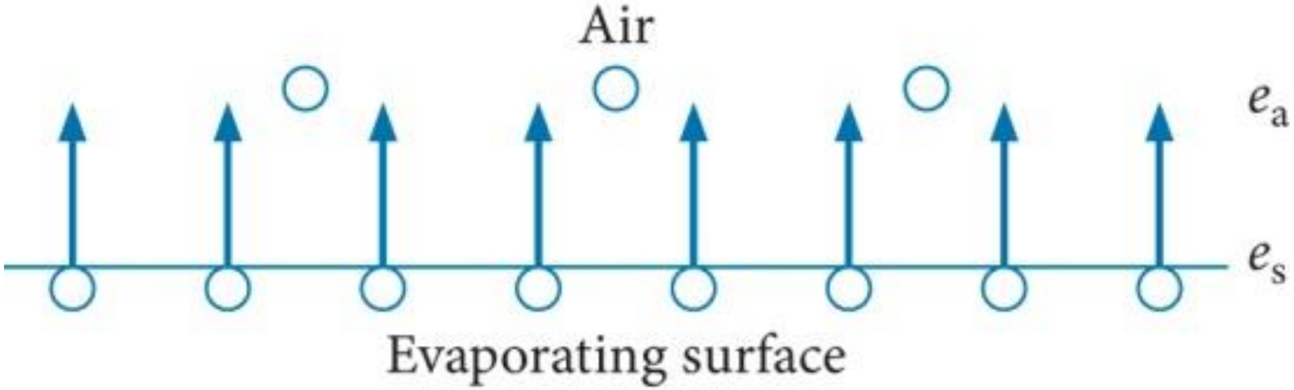

saturation deficit $e_s - e_a$

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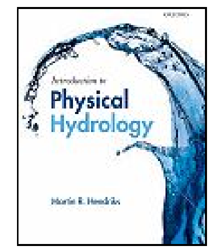

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Spreadsheet model: input

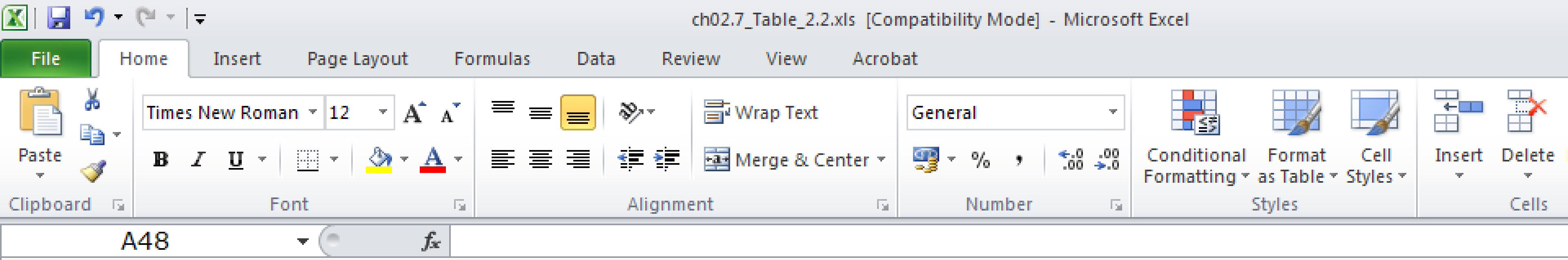
https://www.youtube.com/user/MartinRHendriks/videos

ch02.7_Table_2.2.xls [Compatibility Mode] - Microsoft Excel

	A	B	C	D	E	F
1	**Introduction to Physical Hydrology - Martin R. Hendriks**	**Available at https://global.oup.com/uk/orc/geography/hendriks/**				
2	**Table 2.2 Estimation of evaporation from a forest, grassland and open water surface using the Penman-Monteith equation**					
3						
4	**Equation parameters/variables**					
5	a_s (-)		0.25			
6	b_s (-)		0.50			
7	a_e (-)		0.34			
8	b_e (kPa$^{-0.5}$)		-0.14			
9	a_c (-)		0.25			
10	b_c (-)		0.75			$b_c = 1 - a_c$
11						
12	**Data**					
13	Air temperature, T (°C)		20.0			Thermometer
14	Relative humidity, RH (-)		0.75			Relative humidity sensor
15	Sun's short wave radiation, S_0 (MJ m^{-2} day^{-1})		37.50			Figure B2.12.2
16	Number of bright sunshine hours per day, n (hour)		8.15			Campbell-Stokes sunshine recorder
17	Total day length, N (hour)		16.3			Table B2.12.2
18						
19	**Land use data**	forest	grassland	open water		
20	Albedo, α (-)	0.15	0.23	0.08		Table B2.12.1
21	Aerodynamic resistance, r_a (s m^{-1})	5	69	110		Table 2.1
22	Surface resistance, r_s (s m^{-1})	150	69	0		Table 2.1

Spreadsheet model: output

https://www.youtube.com/user/MartinRHendriks/videos



	A	B	C	D	E	F
24	**Calculations**	**Available at https://global.oup.com/uk/orc/geography/hendriks/**				
25	Cloudiness fraction, *n/N* (-)		0.5			*n* and *N* from above
26	Saturation vapour pressure, e_s (kPa)		2.338			Equation B2.2.3
27	Actual vapour pressure, e_a (kPa)		1.754			Equation B2.2.4
28	Net radiation at the earth's surface, R_n (MJ m^{-2} day^{-1})	12.44	10.94	13.75		Equation B2.12.6
29	Gradient of the saturation pressure curve, Δ (kPa °C^{-1})		0.145			Equation 2.3
30						
31	**Evaporation (mm day^{-1})**	**2.6**	**3.6**	**4.9**		Equation 2.2
32						
33	Latent heat transfer from the earth's surface (MJ m^{-2} day^{-1})	6.33	8.87	12.03		Multiply the evaporation by λ
34	Sensible heat transfer from the earth's surface (MJ m^{-2} day^{-1})	6.10	2.07	1.72		Equation B2.12.7
35						
36						
37						
38						
39						
40						

FAO Penman-Monteith equation

Source: http://www.fao.org/docrep/X0490E/x0490e00.htm#Contents

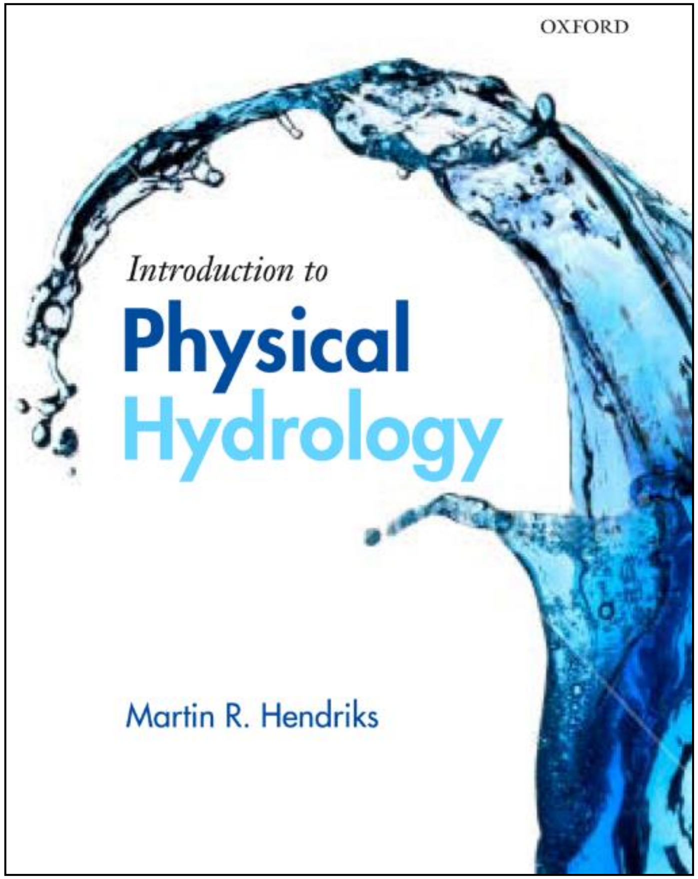
Allen et al. (1998):

$$E_{\mathrm{rc}} = \frac{0.408\,\Delta\,(R_{\mathrm{n}} - G) + \gamma \dfrac{900}{T + 273} u_2\,(e_{\mathrm{s}} - e_{\mathrm{a}})}{\Delta + \gamma\left(1 + 0.34\,u_2\right)}$$

K_{c} = crop coefficient of a particular crop at a certain growth stage:

$$E_{\mathrm{p}} = K_{\mathrm{c}} \times E_{\mathrm{rc}}$$

References



Allen, R.G., Pereira, L.S., Raes, D., and Smith, M. (1998). Crop evapotranspiration. Guidelines for computing crop water requirements. FAO Irrigation and drainage paper 56. Food and Agriculture Organization of the United Nations (FAO), Rome. http://www.fao.org/docrep/X0490E/x0490e00.htm#Contents

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