Wolkenfysica Simulatie

- Keuze onderwerpen binnen natuurkunde:
  - Kern- & Deeltjesprocessen
  - Relativiteitstheorie
  - Biofysica
  - Geofysica

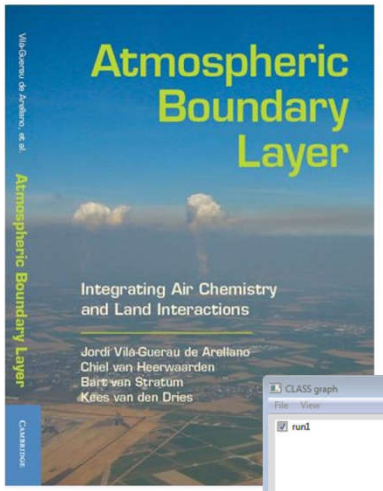
Wolkenfysica Simulatie

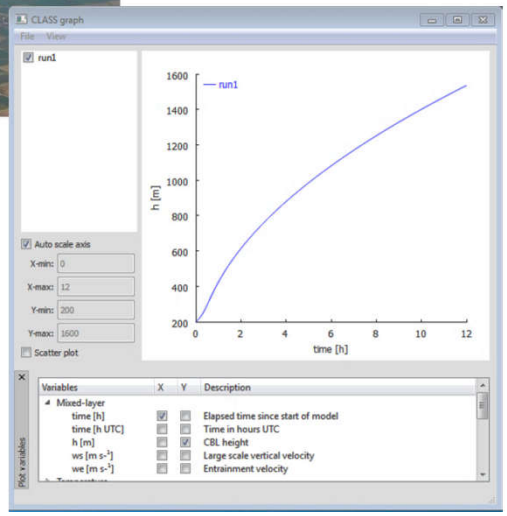
- Beta steunpunt: onderzoekend leren via simulaties
  - (Jeroen Sijbers, Guido Linssen, Durk Veenstra)
- Meteorologie en Luchtkwaliteit
  - (Jordi Vila, Arnold Moene)
- Qlvr

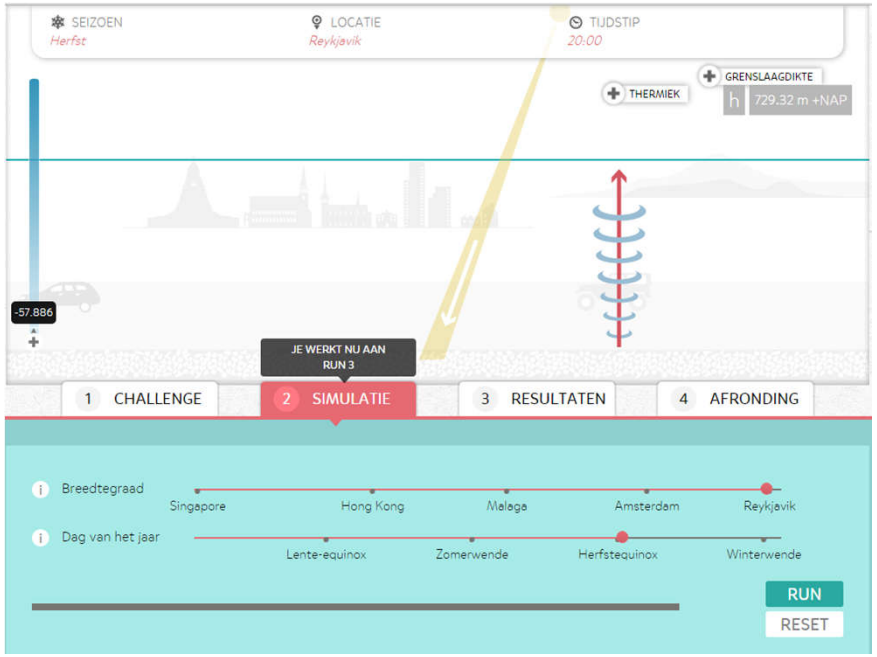
Wolkenfysica Simulatie

Arnold Moene, Tim Voskamp en Guido Linssen

CLASS → Wolkenfysica Simulatie

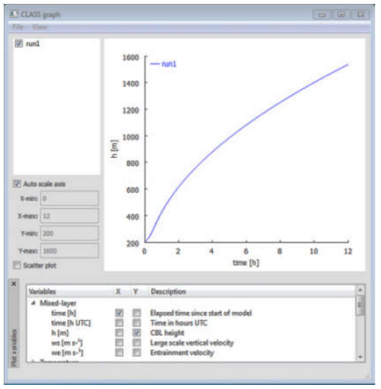






CLASS:
Chemistry Land-surface Atmosphere Soil Slab Model

Doelstellingen CLASS



- Inhoudelijk:
  - Begrijpen van het systeem bodem-vegetatie-atmosfeer (incl. chemie en wolken)
- Pedagogisch:
  - Ontwikkeling van wetenschappelijke methode
  - Formuleren van onderzoeksvraag of werk-hypothese
  - Ontwerp van numerieke experimenten
  - Systematiseren

CLASS gebruikt in onderzoek

nature geoscience

LETTERS

PUBLISHED ONLINE: 2 SEPTEMBER 2012 | DOI: 10.1038/NGEO1554

Modelled suppression of boundary-layer clouds by plants in a CO_2-rich atmosphere

Jordi Vilà-Guerau de Arellano[1]*, Chiel C. van Heerwaarden[2] and Jos Lelieveld[3,4]

QUARTERLY JOURNAL OF THE ROYAL METEOROLOGICAL SOCIETY
Q. J. R. Meteorol. Soc. 135: 1277–1291 (2009)
Published online 3 June 2009 in Wiley InterScience
(www.interscience.wiley.com) DOI: 10.1002/qj.431

RMetS
Royal Meteorological Society

Interactions between dry-air entrainment, surface evaporation and convective boundary-layer development

Chiel C. van Heerwaarden*, Jordi Vilà-Guerau de Arellano, Arnold F. Moene and Albert A. M. Holtslag

Meteorology and Air Quality Section, Wageningen University, The Netherlands

JOURNAL OF GEOPHYSICAL RESEARCH, VOL. 113, D12119, doi:10.1029/2007JD009583, 2008

Diurnal and vertical variability of the sensible heat and carbon dioxide budgets in the atmospheric surface layer

Pau Casso-Torralba,[1,2] Jordi Vilà-Guerau de Arellano,[2] Fred Bosveld,[3] Maria Rosa Alex Vermeulen,[4] Cindy Werner,[5] and Eddy Moors[6]

Atmospheric Chemistry and Physics

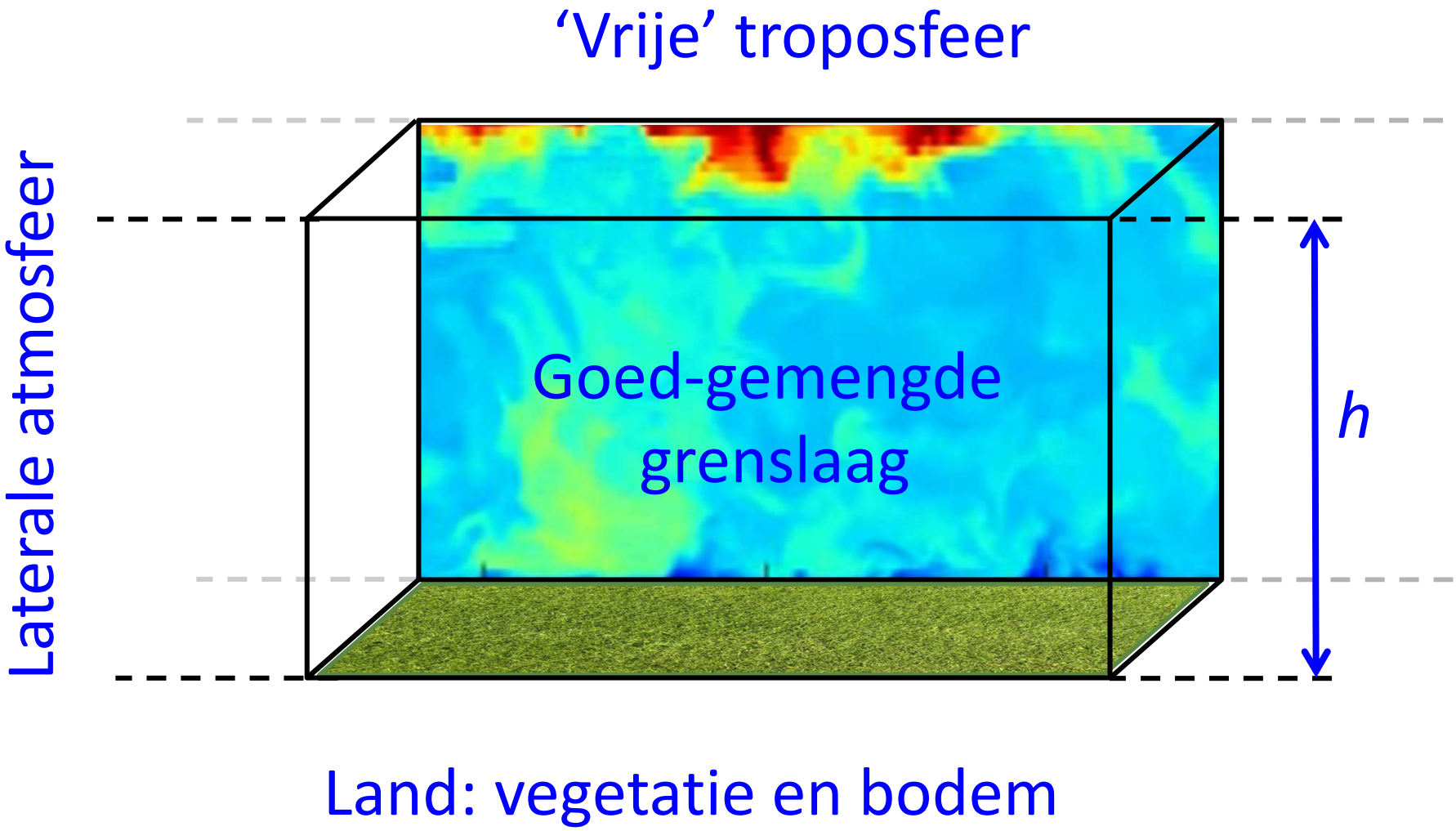
Atmos. Chem. Phys., 12, 9335–9353, 2012
www.atmos-chem-phys.net/12/9335/2012/
doi:10.5194/acp-12-9335-2012
© Author(s) 2012. CC Attribution 3.0 License.

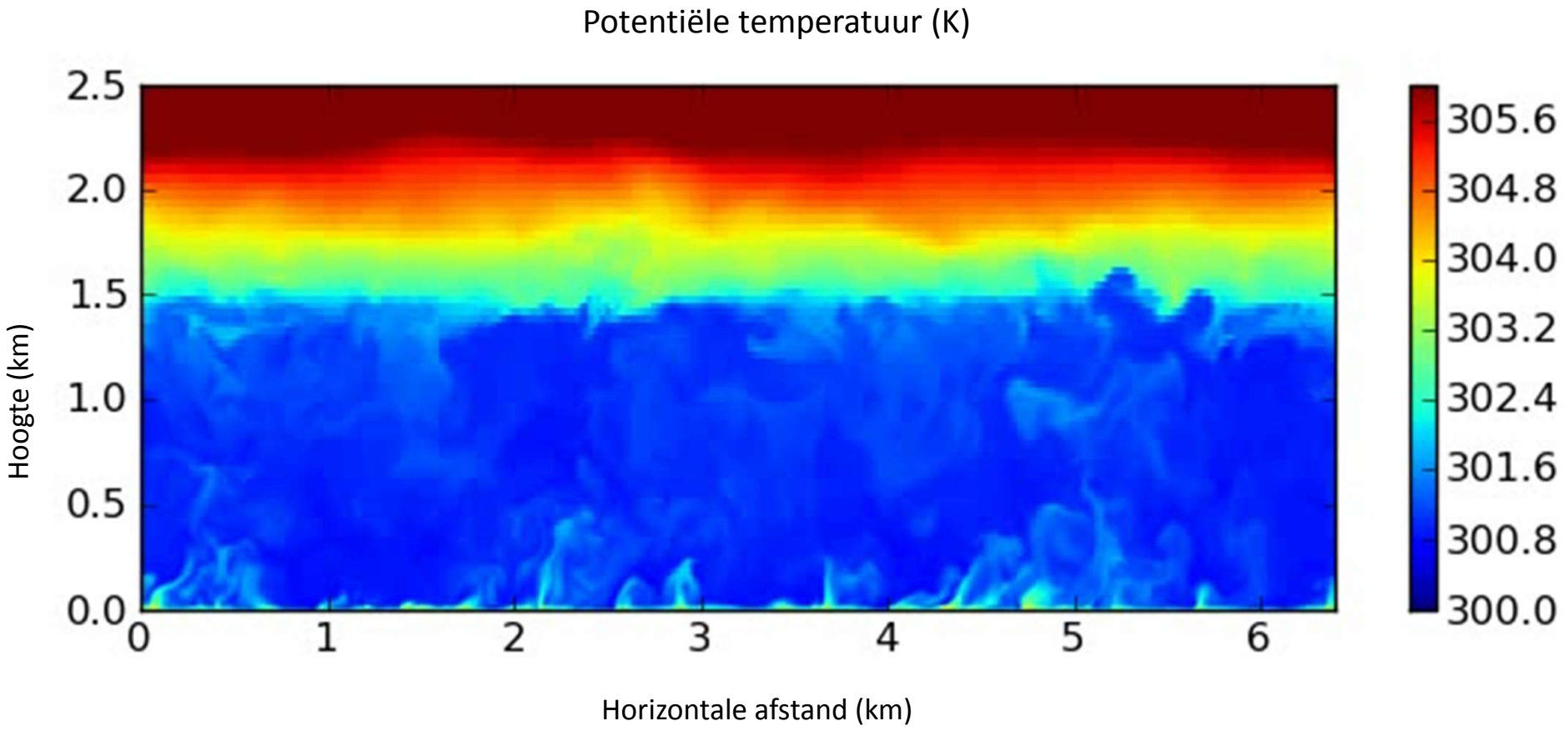
Characterization of a boreal convective boundary layer and its impact on atmospheric chemistry during HUMPPA-COPEC-2010

H. G. Ouwersloot[1,2], J. Vilà-Guerau de Arellano[1], A. C. Nölscher[2], M. C. Krol[1], L. N. Ganzeveld[3], C. Breitenberger[2], I. Mammarella[4], J. Williams[2], and J. Lelieveld[2]

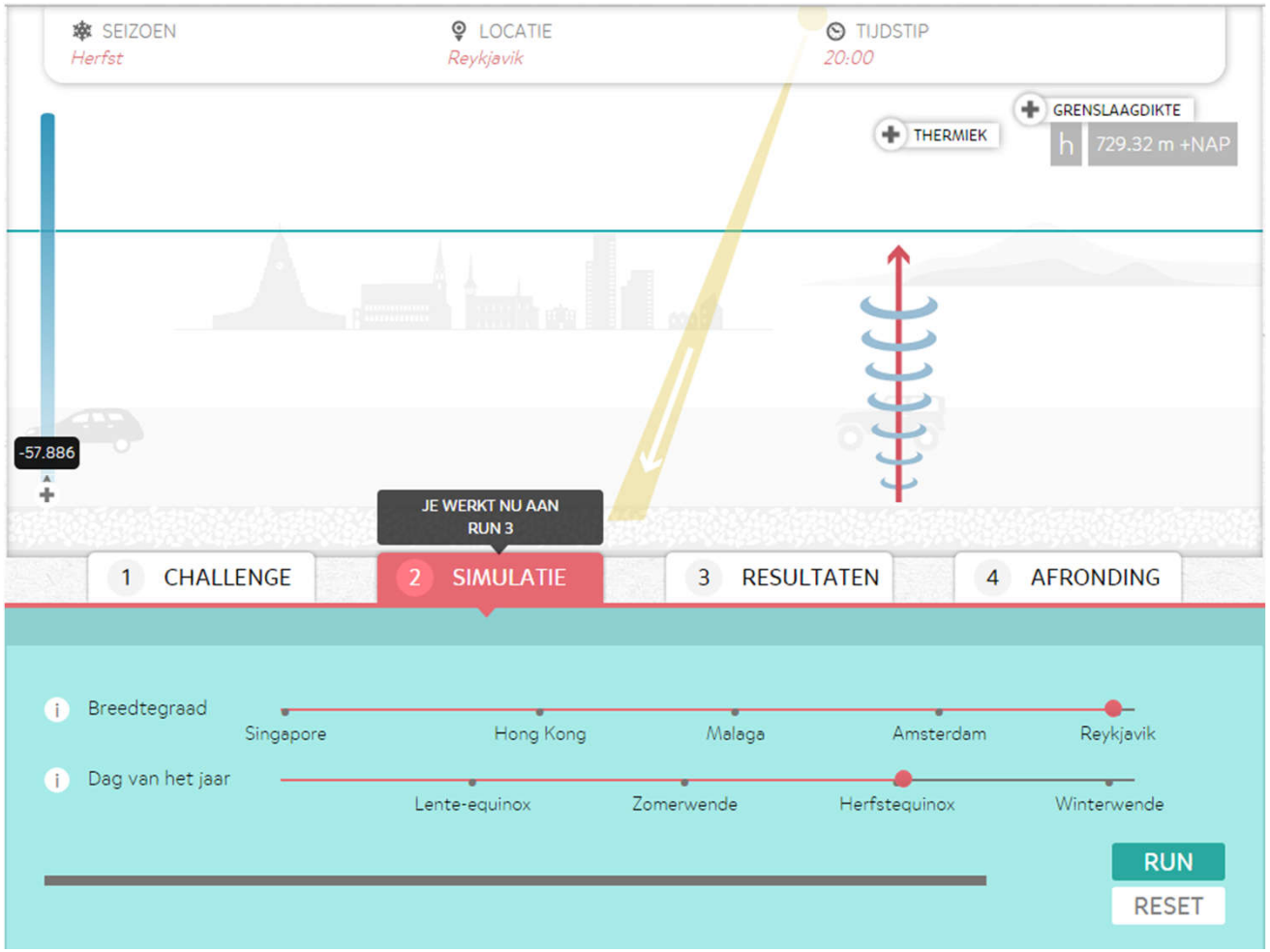

Grenslaag
Oppervlak
Wolken
Challenge 1a
Challenge 2a
Challenge 4

De grenslaag : een doos met hoogte *h*




Potentiële temperatuur (K)
Hoogte (km)
2.5
2.0
1.5
1.0
0.5
0.0
0
1
2
3
4
5
6
305.6
304.8
304.0
303.2
302.4
301.6
300.8
300.0
Horizontale afstand (km)

http://www.betasimulaties.nl

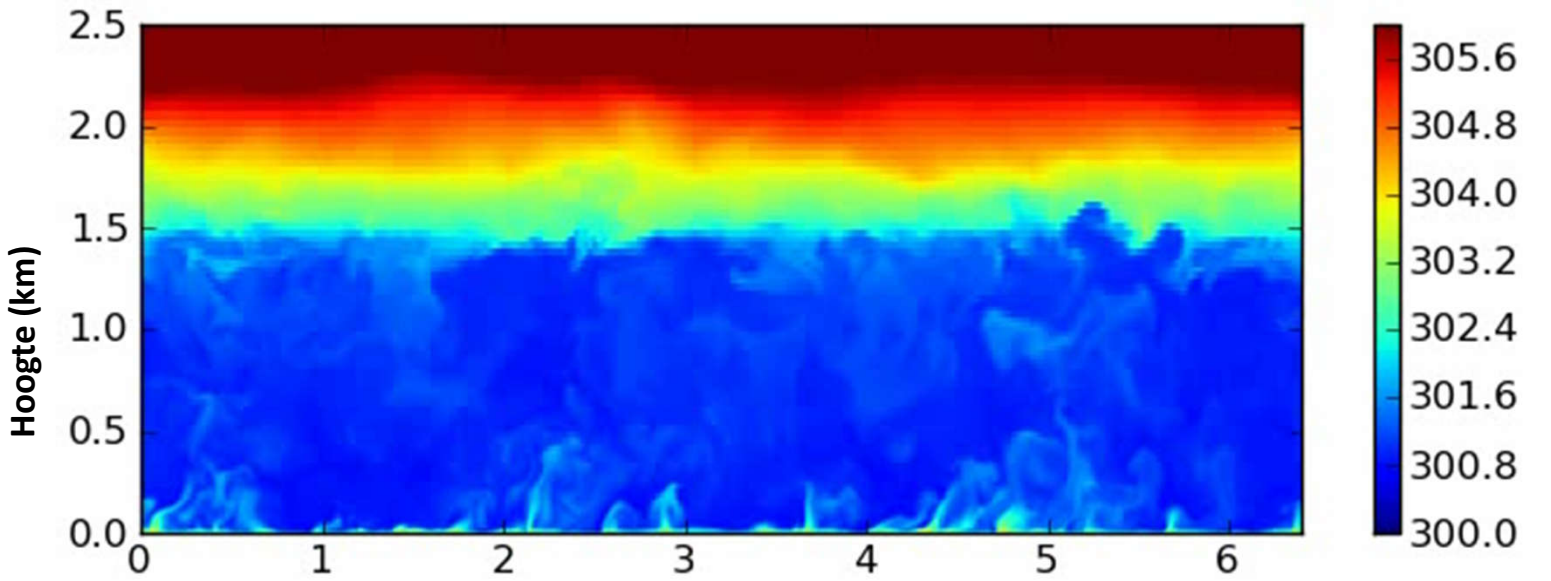


Time to play

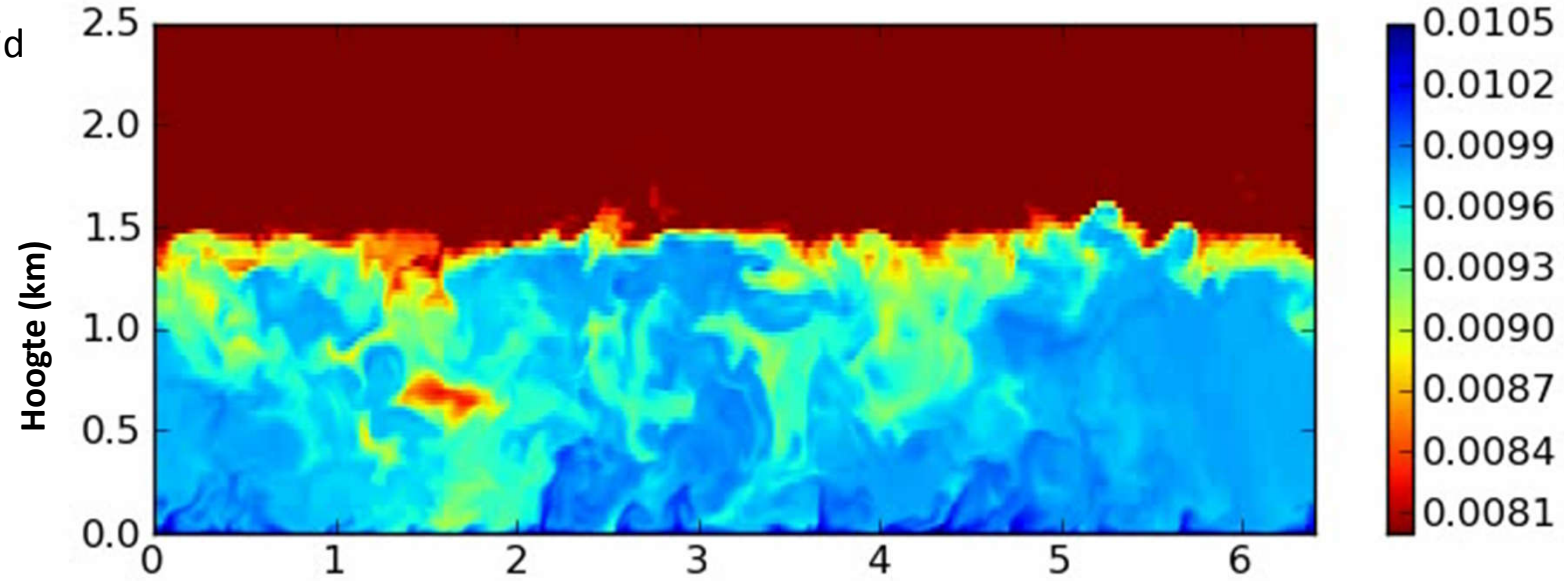
- Doel: grenslaag in zomer 1000-1500 meter
- Challenge 1a
- Variabelen: datum (neem ‘zomer’ letterlijk) + breedtegraad


Grenslaag
Oppervlak
Wolken
Challenge 1a
Challenge 2a
Challenge 4

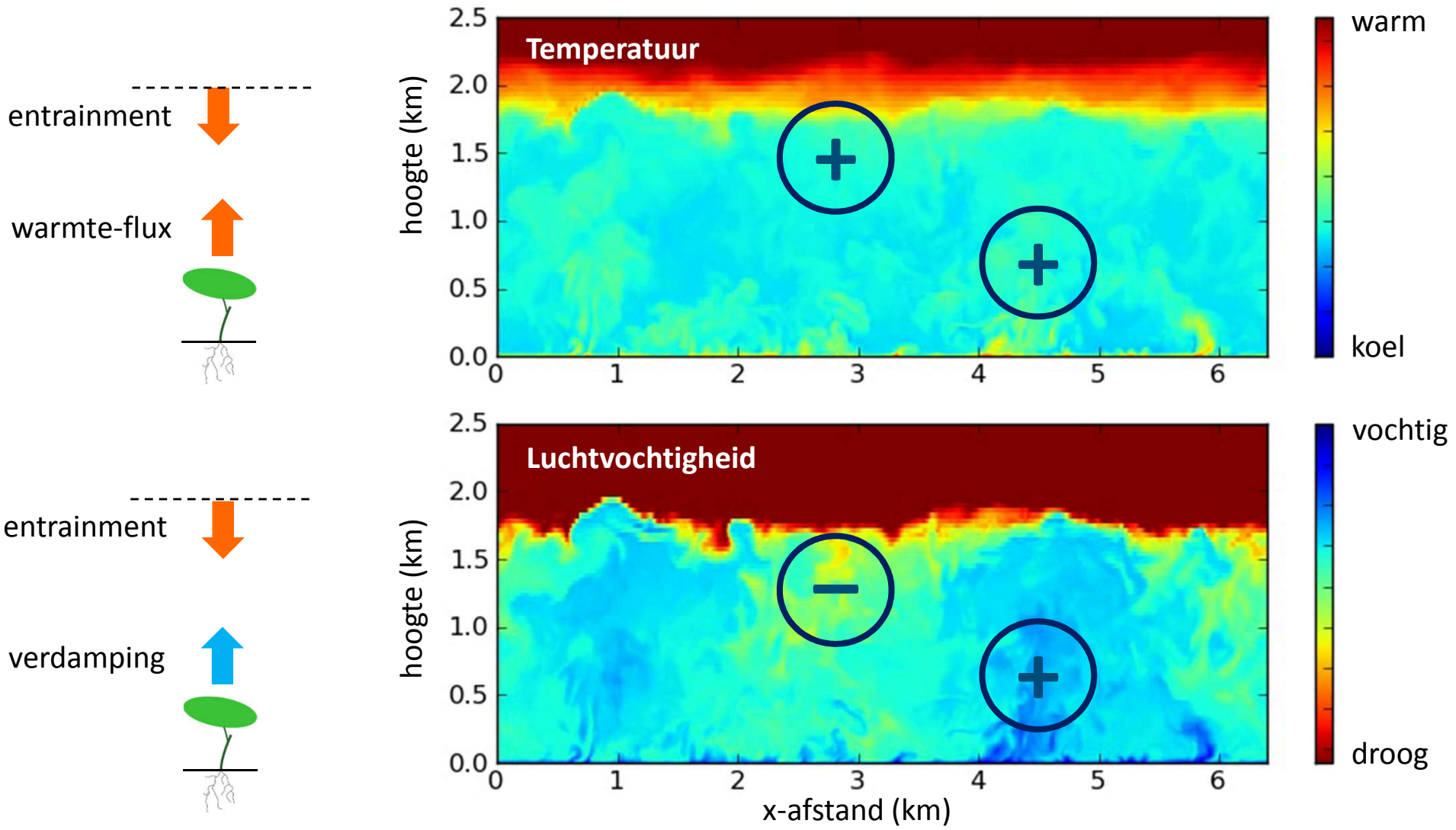
Potentiële temperatuur (K)



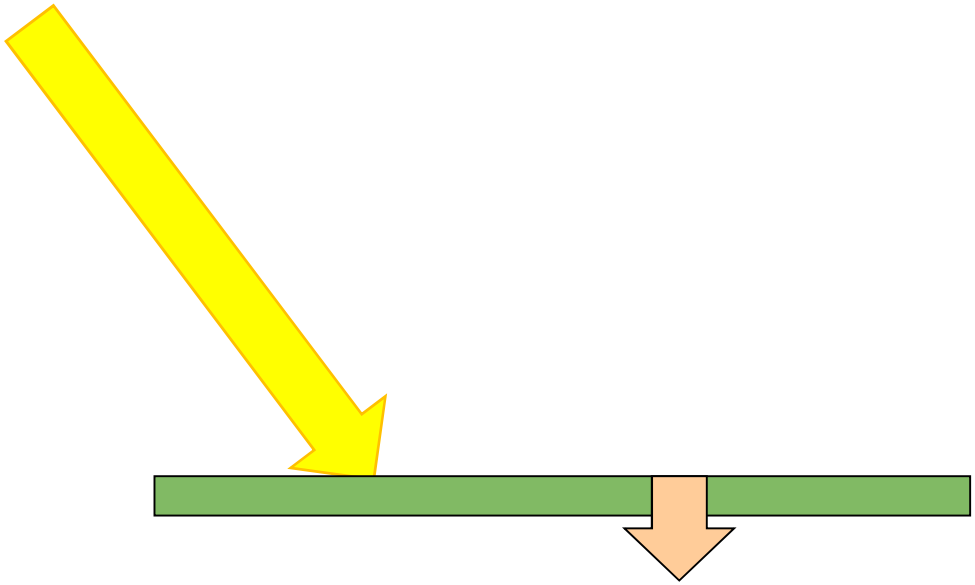
Luchtvochtigheid (kg/kg)



Temperatuur en vocht: bijdrages aan balans



Beschikbare energie



$Q^* = K^* + L^*$

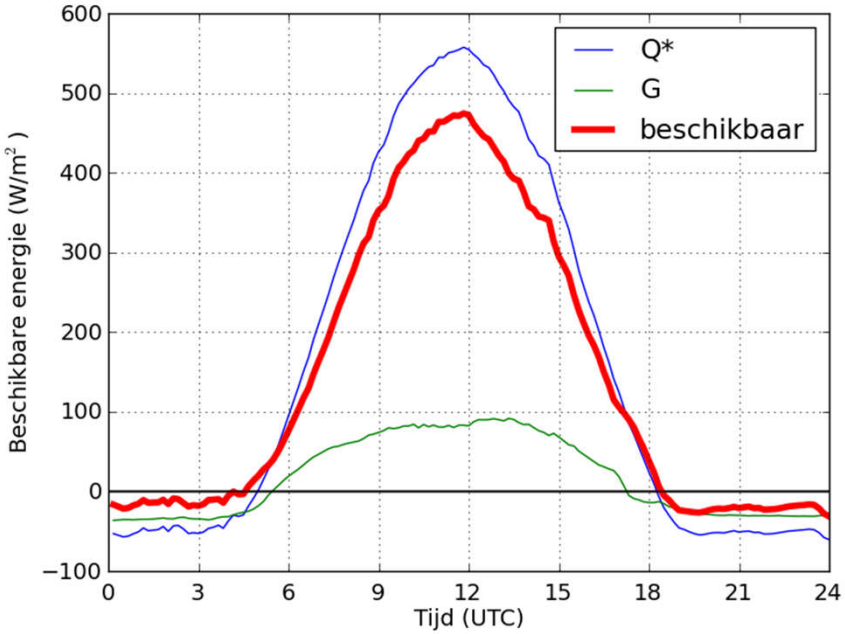
Netto straling

G

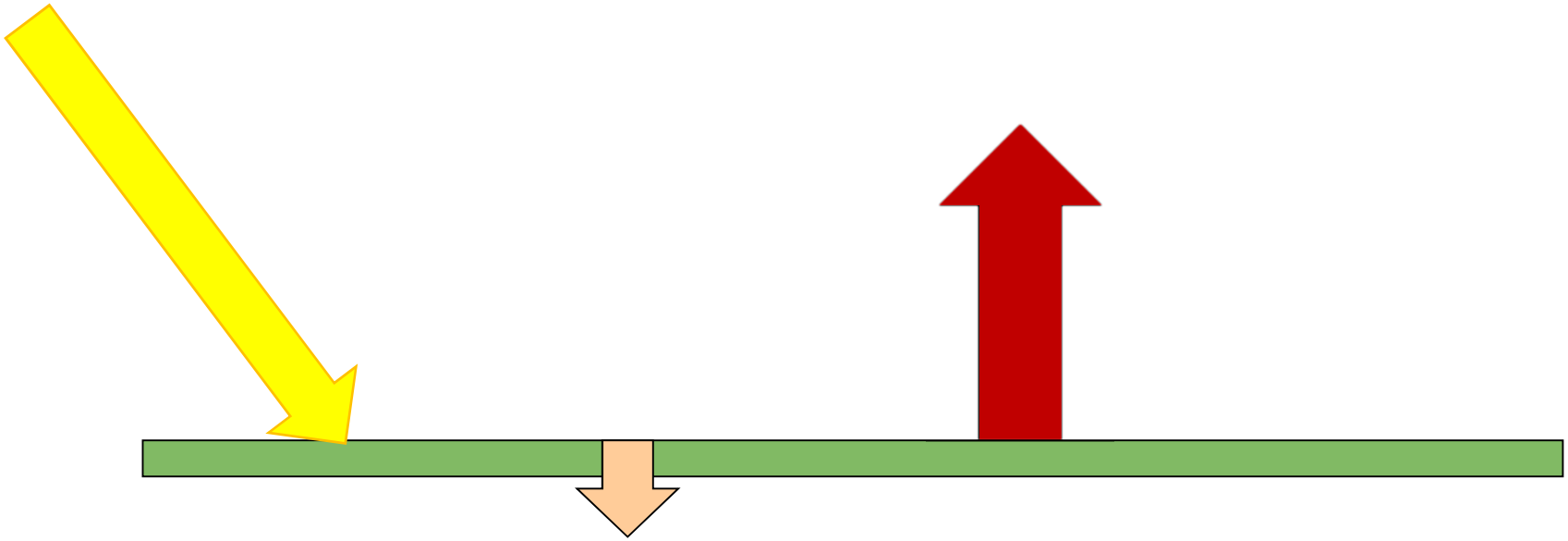
Bodem warmte flux

Q^* -G

Beschikbare energie



Gebruikt voor opwarming lucht



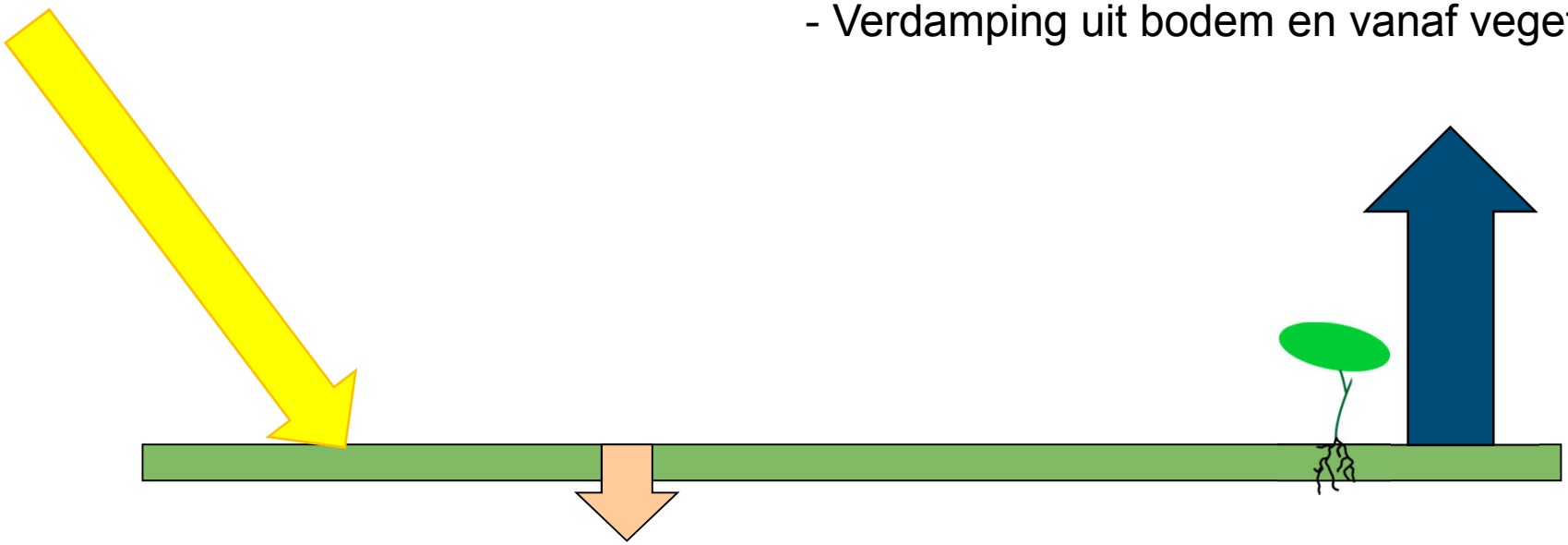
$Q^* = K^* + L^*$
Netto straling

G
Bodem warmte flux

H
Voelbare warmte flux

Gebruikt voor verdampen water

- Transpiratie
- Verdamping uit bodem en vanaf vegetatie



$Q^* = K^* + L^*$

Netto straling

G

Bodem warmte flux

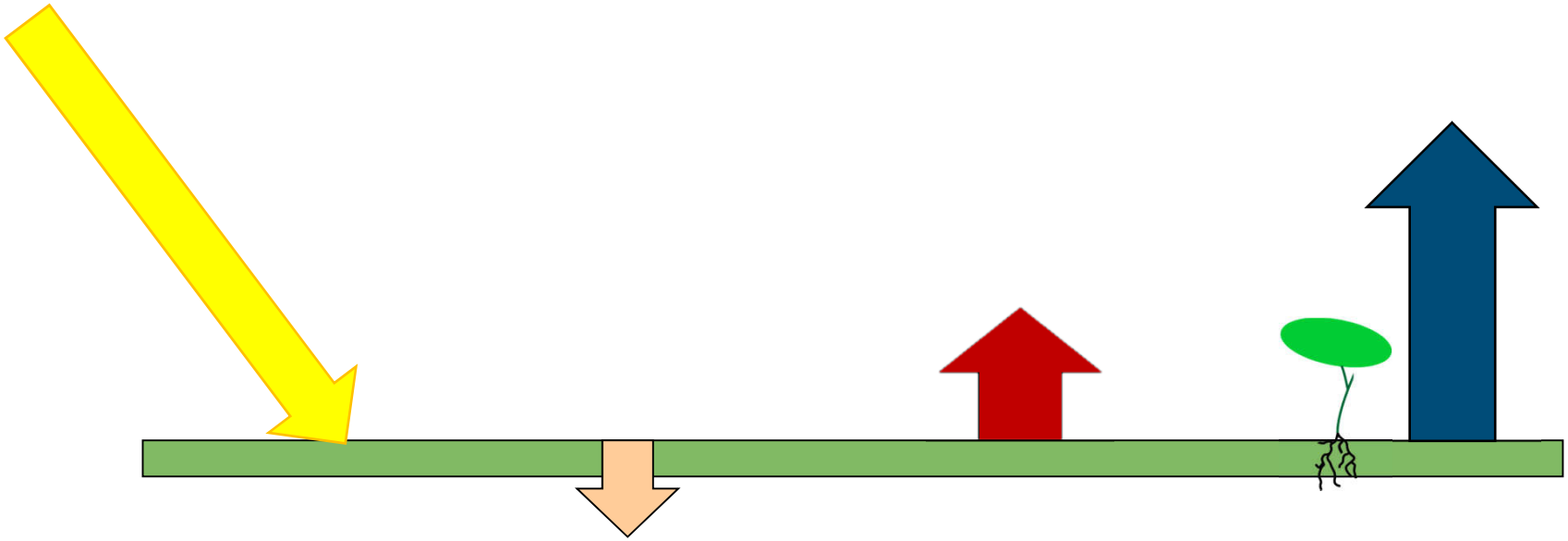
E

Waterdamp flux E

Latente warmte flux L_vE

H vs. L_vE: beschikbaarheid water

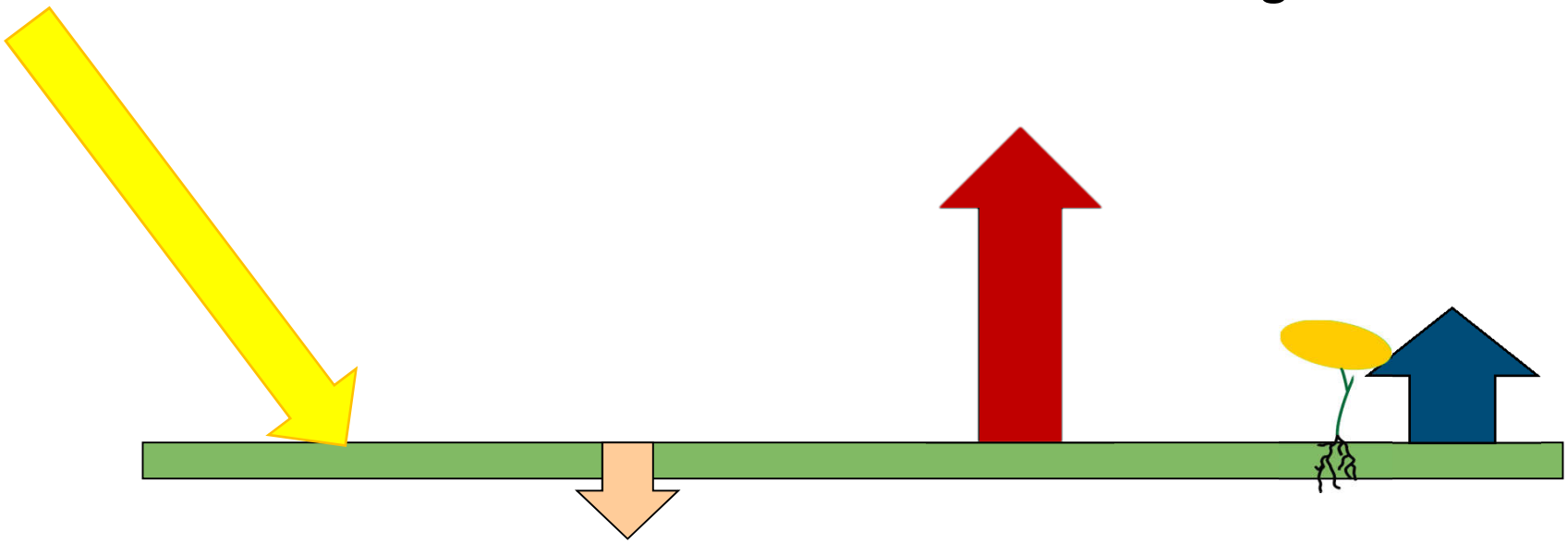
Voldoende water



$Q^* = K^* + L^*$	G	H	L_vE
Netto straling	Bodem warmte flux	Voelbare warmte flux	Latente warmte flux L_vE Waterdamp flux E

H vs. L_vE: beschikbaarheid water

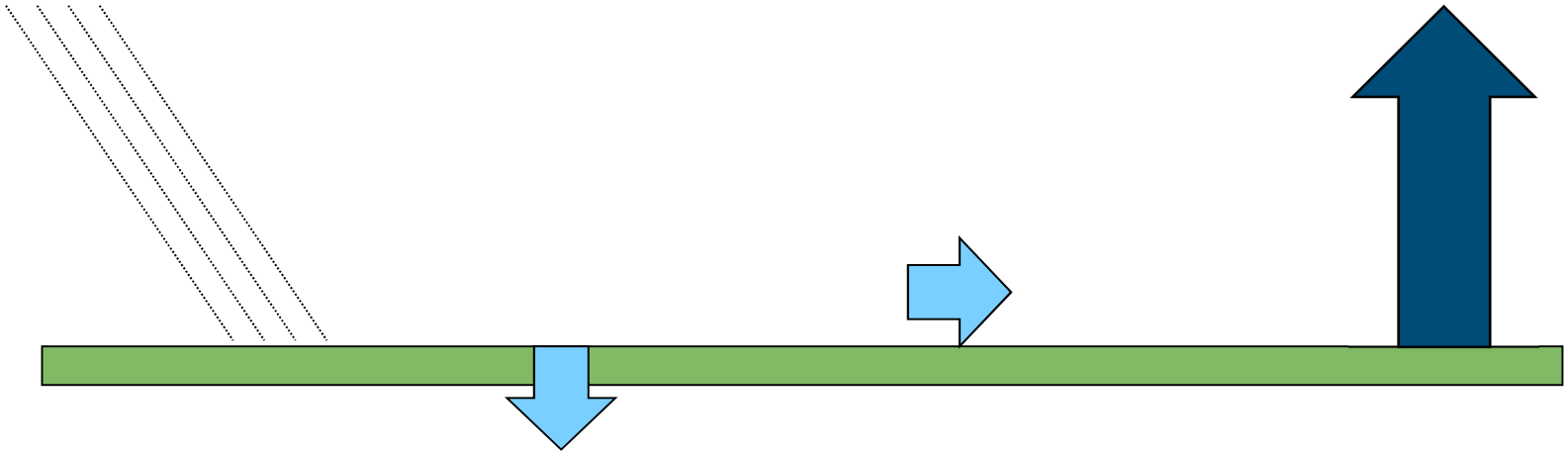
Droog



$Q^* = K^* + L^*$	G	H	L_vE
Netto straling	Bodem warmte flux	Voelbare warmte flux	Latente warmte flux L_vE Waterdamp flux E

Water-balans

Voldoende water



P
Neerslag

I
Infiltratie

R
Horizontale afstroming

E
Verdamping *E*

Water-balans

Droog

P
Neerslag

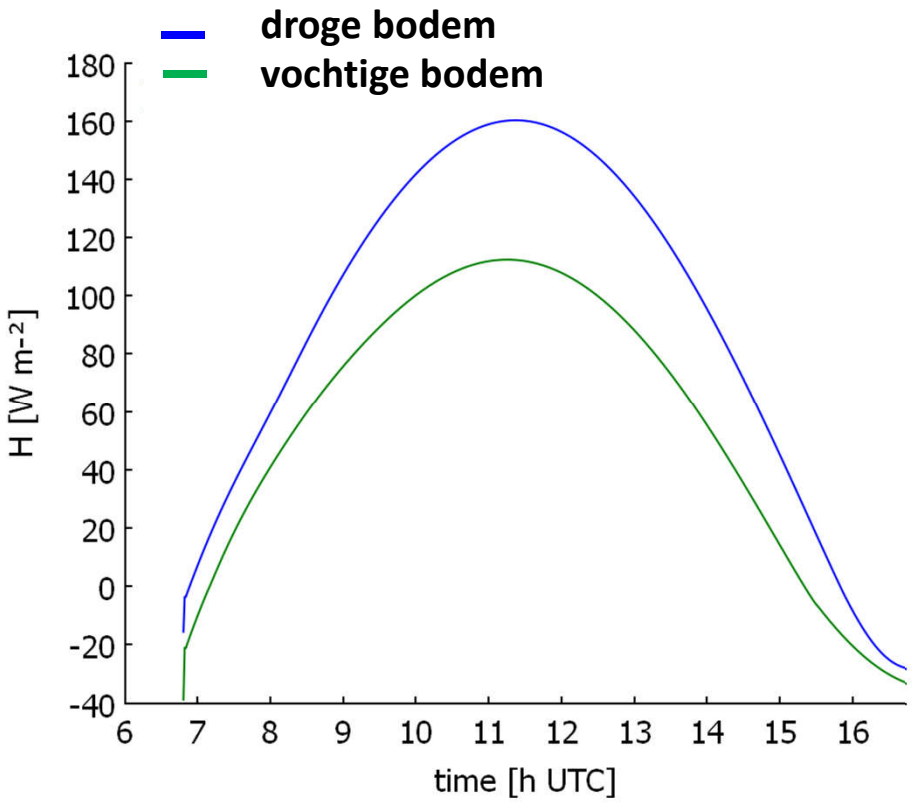
I
Infiltratie

R
Horizontale afstroming

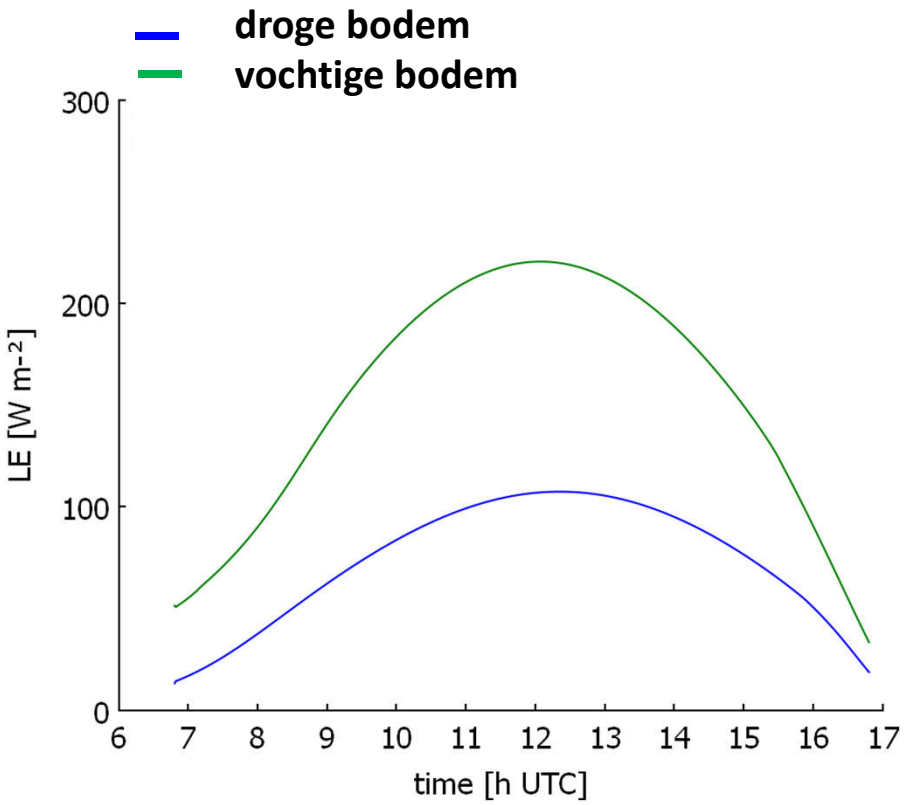
E
Verdamping *E*

H vs. L_vE: beschikbaarheid water

Warmte-flux



Verdamping

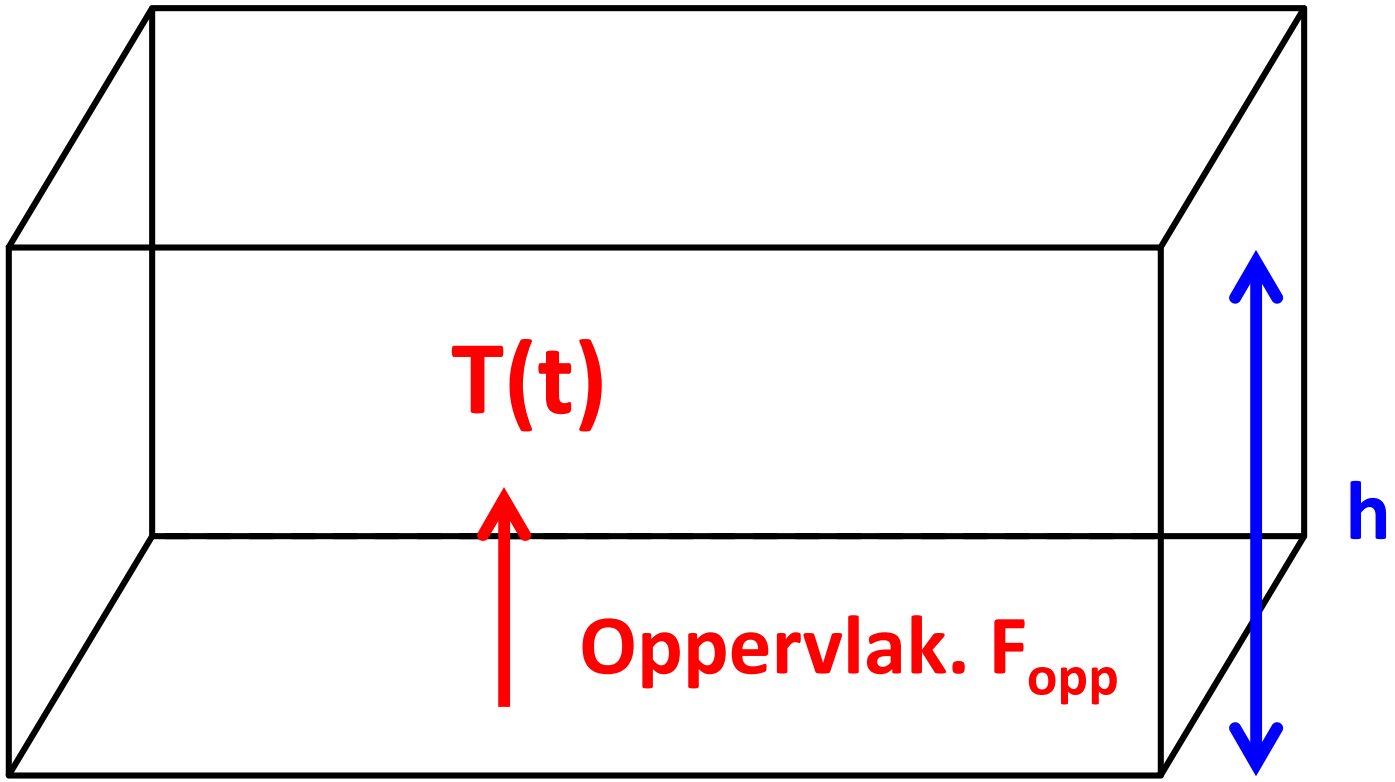


Time to play

- Doel: hete dag met
  - latente warmtestroom/verdamping > 50 W/m^2
  - voelbare warmte stroom > 300 W/m^2
  - extra eis: nettostraling < 450 W/m^2
- Challenge 2a
- Variabelen: datum + breedtegraad + bodemvocht

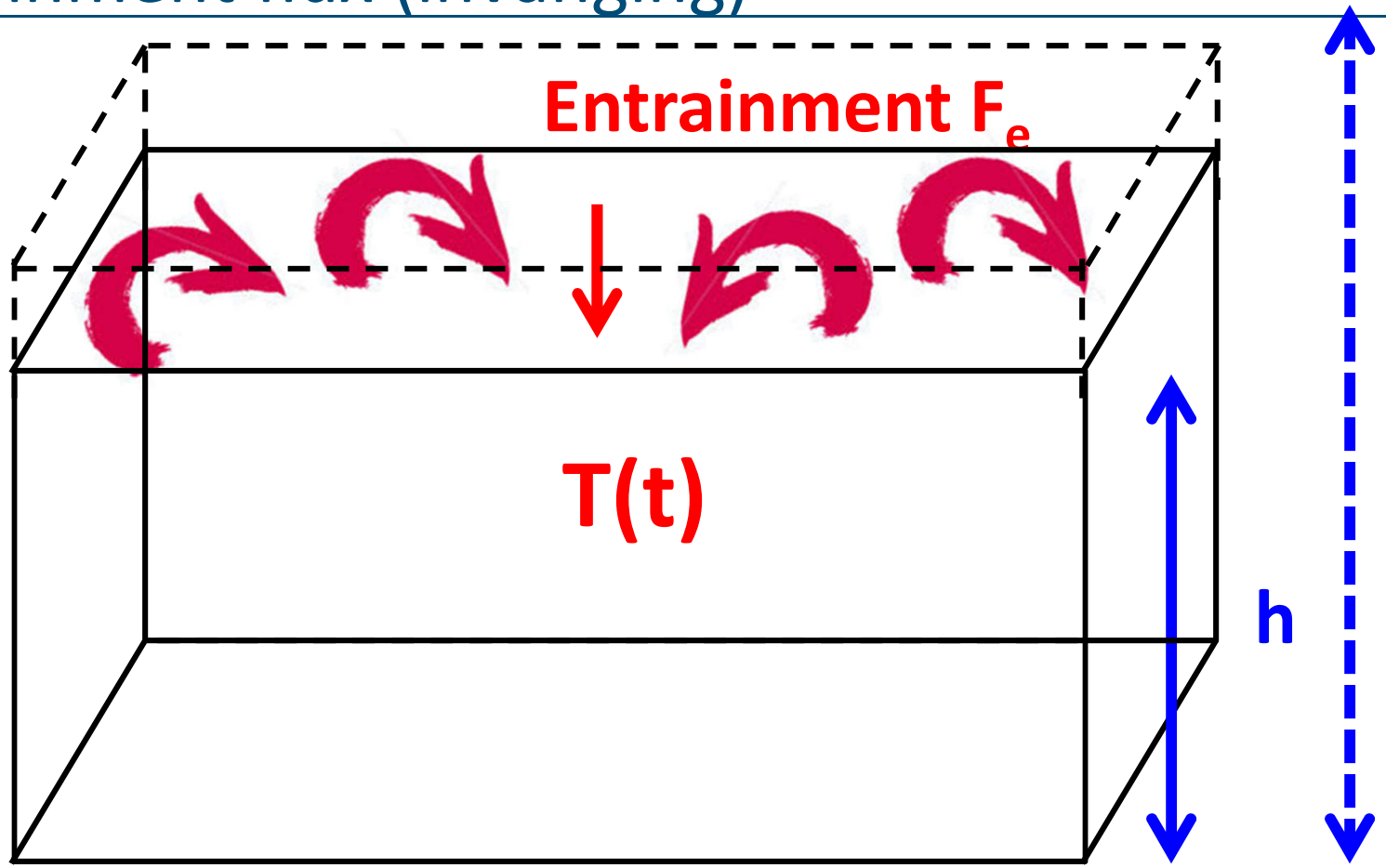

Grenslaag
Oppervlak
Wolken
Challenge 1a
Challenge 2a
Challenge 4

Boekhouding voor bijv. warmte:



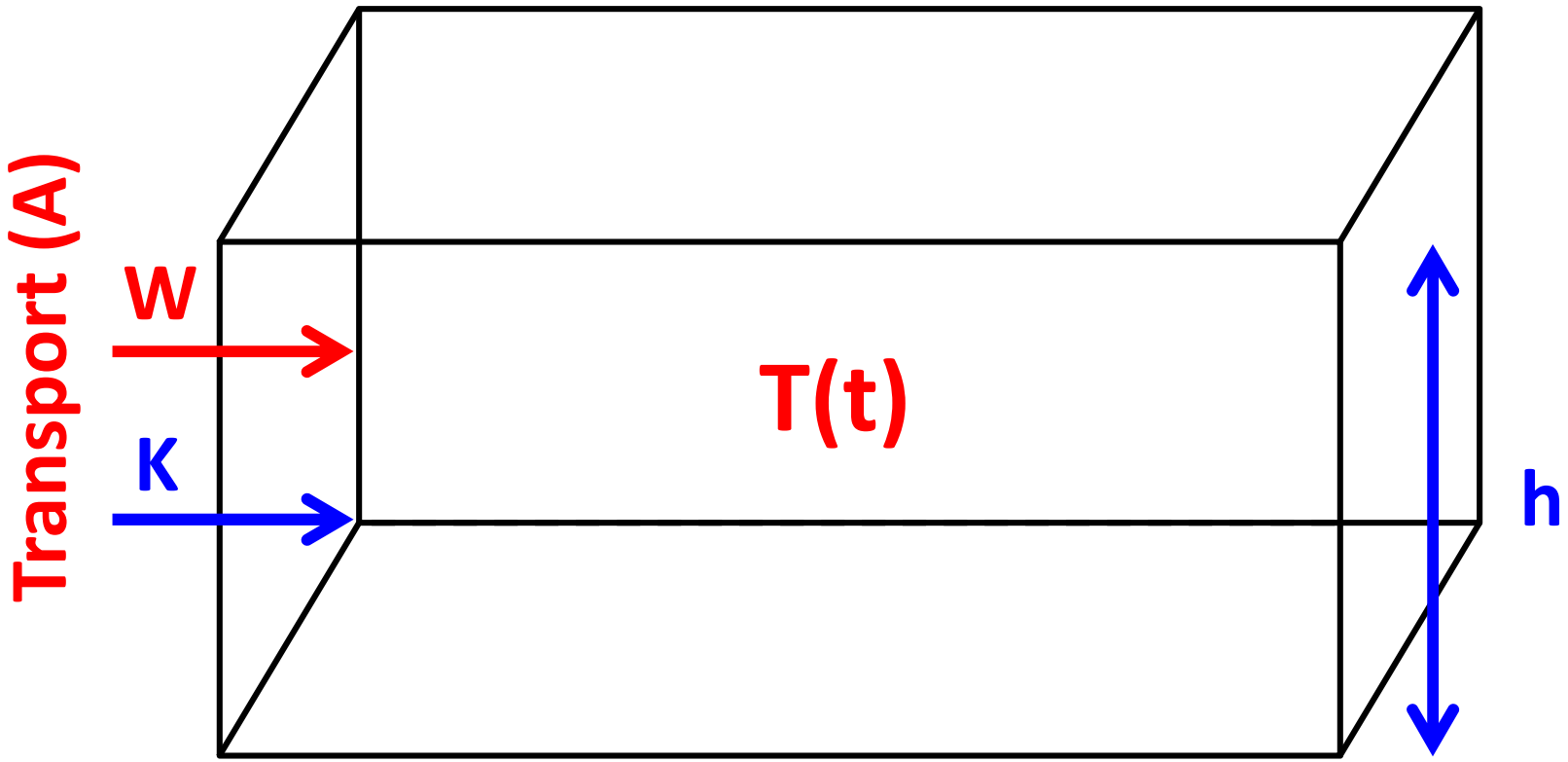
$$\frac{dT}{dt} = \frac{F_{\text{opp}}}{h} \quad [K/s] \qquad \begin{matrix} F_{\text{opp}}\,[Km/s] \\ h[m] \end{matrix}$$

Entrainment flux (invanging)



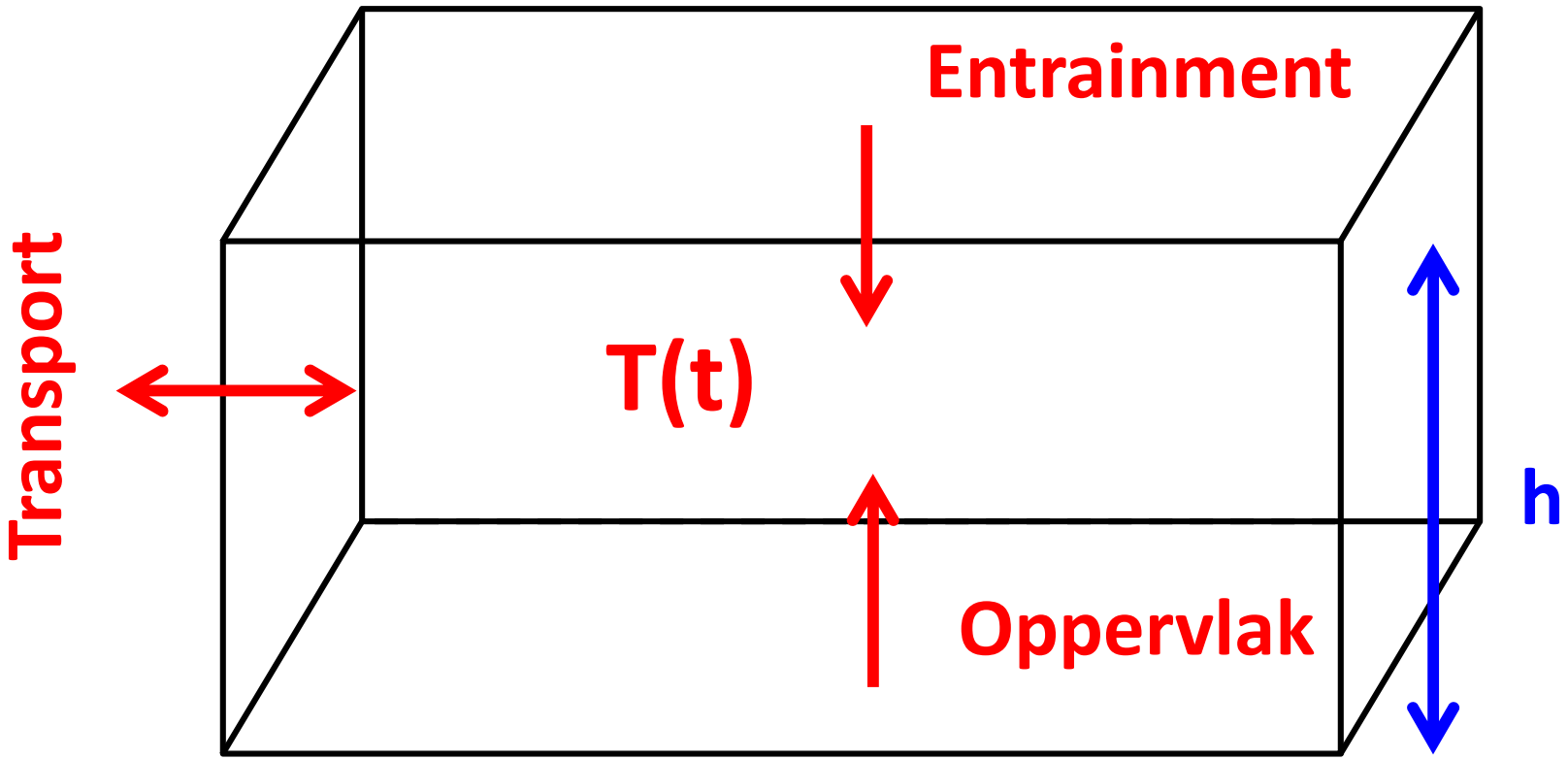
$$\frac{dT}{dt} = \frac{F_e}{h} \qquad [K/s] \qquad F_e[Km/s] \qquad h[m]$$

Laterale warmte flux



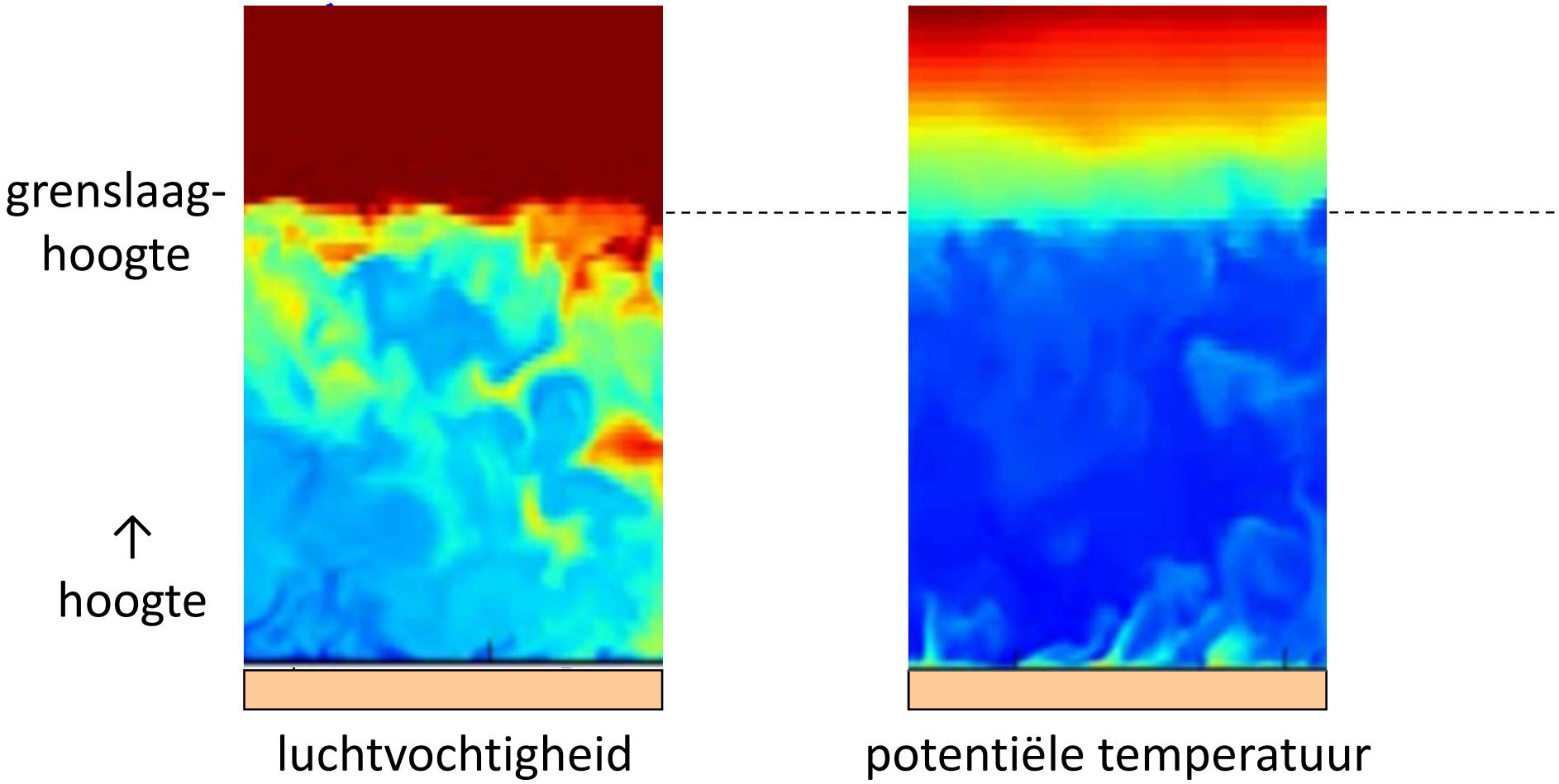
$$\frac{dT}{dt} = A$$

Totale budget T(t)

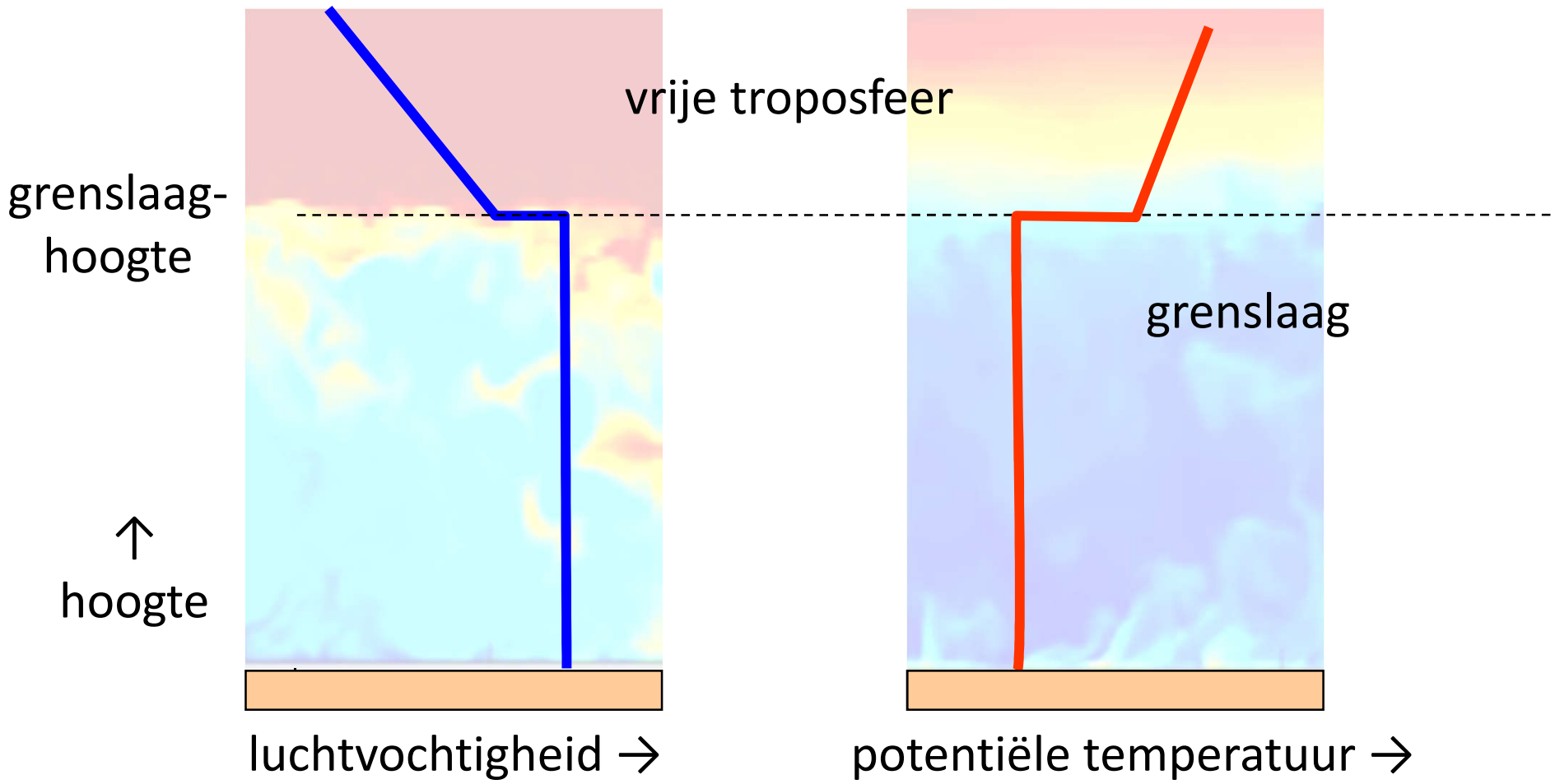


$$\frac{dT}{dt} = \frac{1}{h}\left(F_s - F_e\right) + A$$

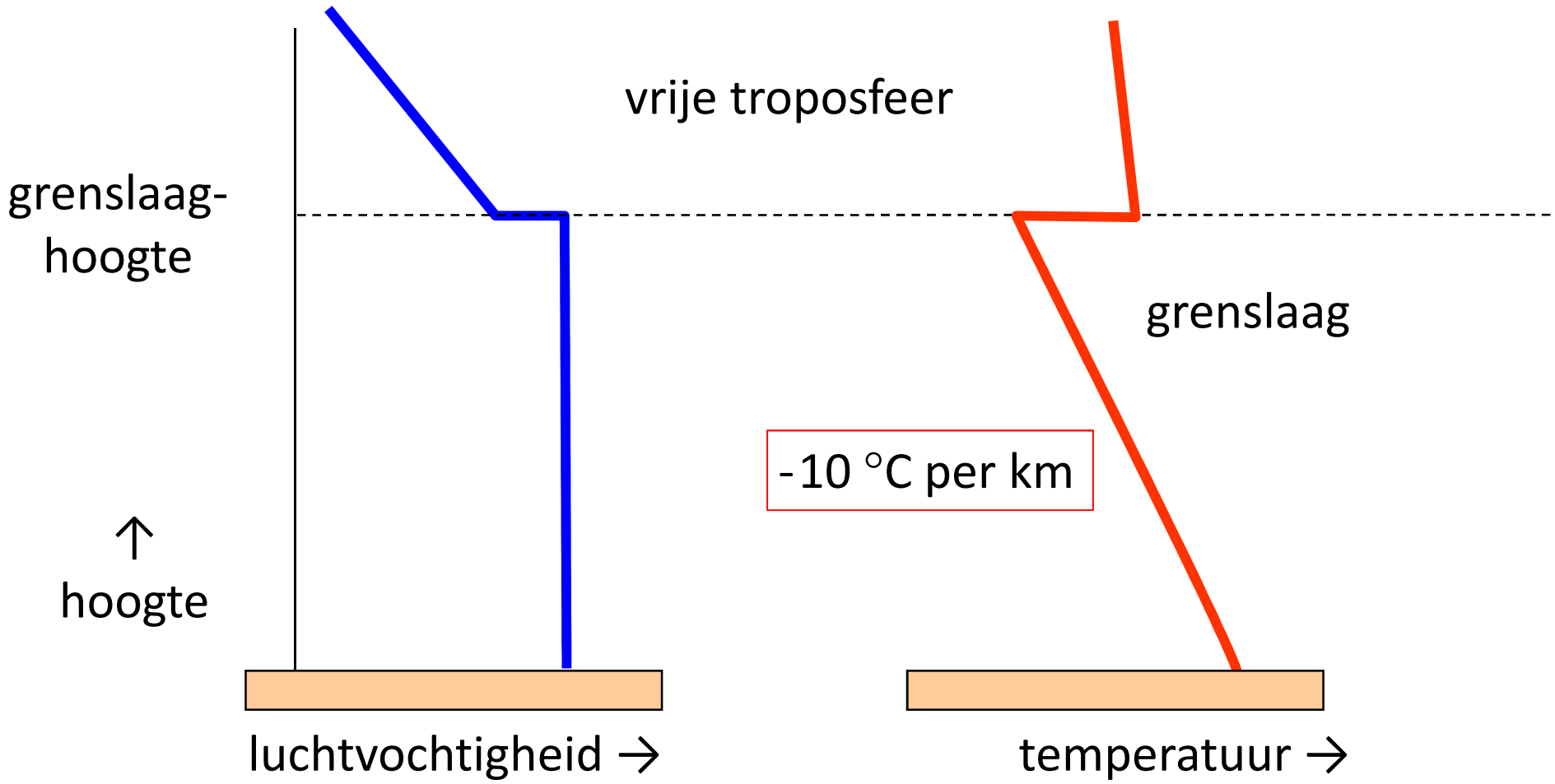
Opbouw grenslaag: vocht en temperatuur



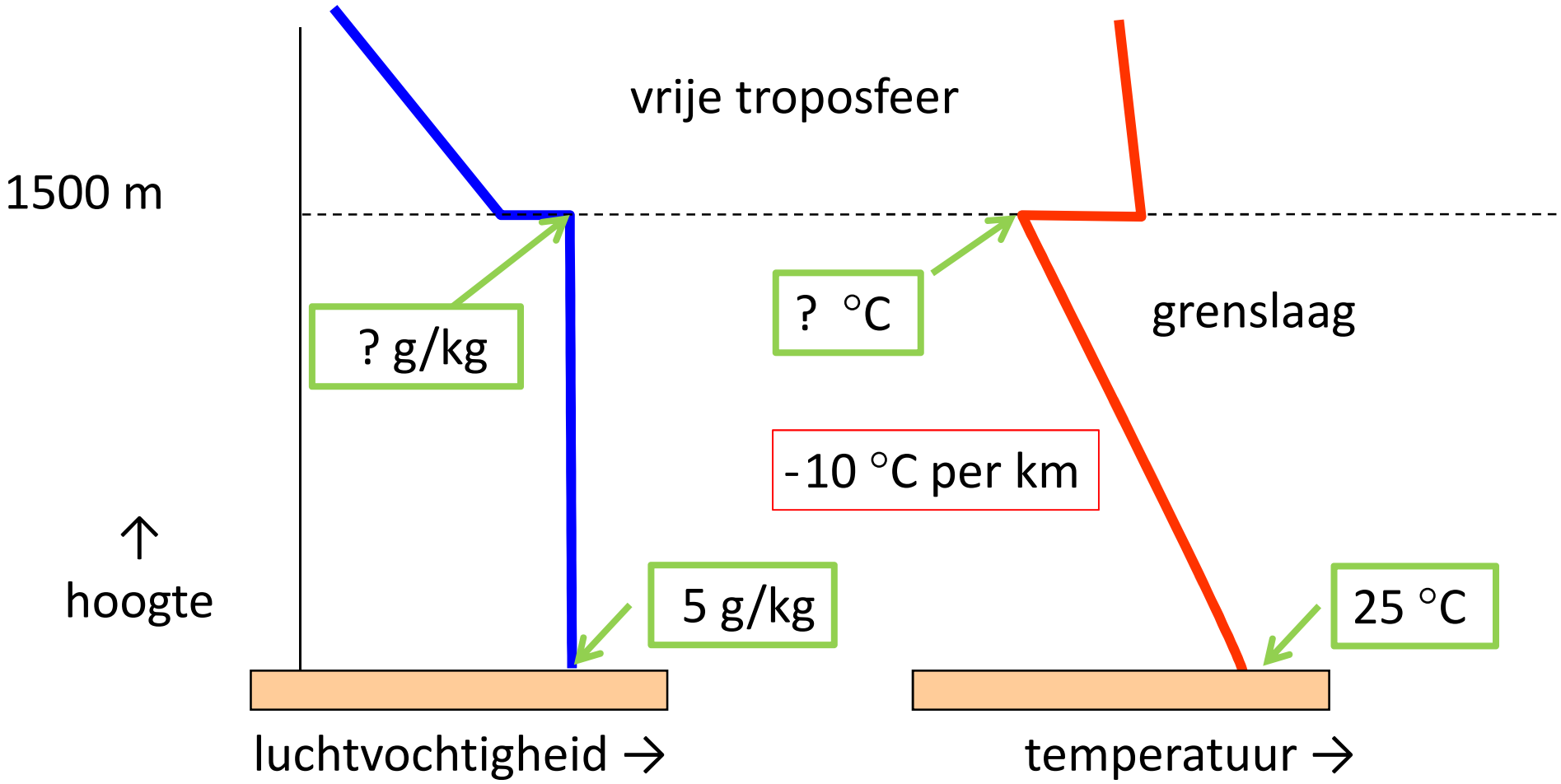
Verticale profielen: vocht en temperatuur



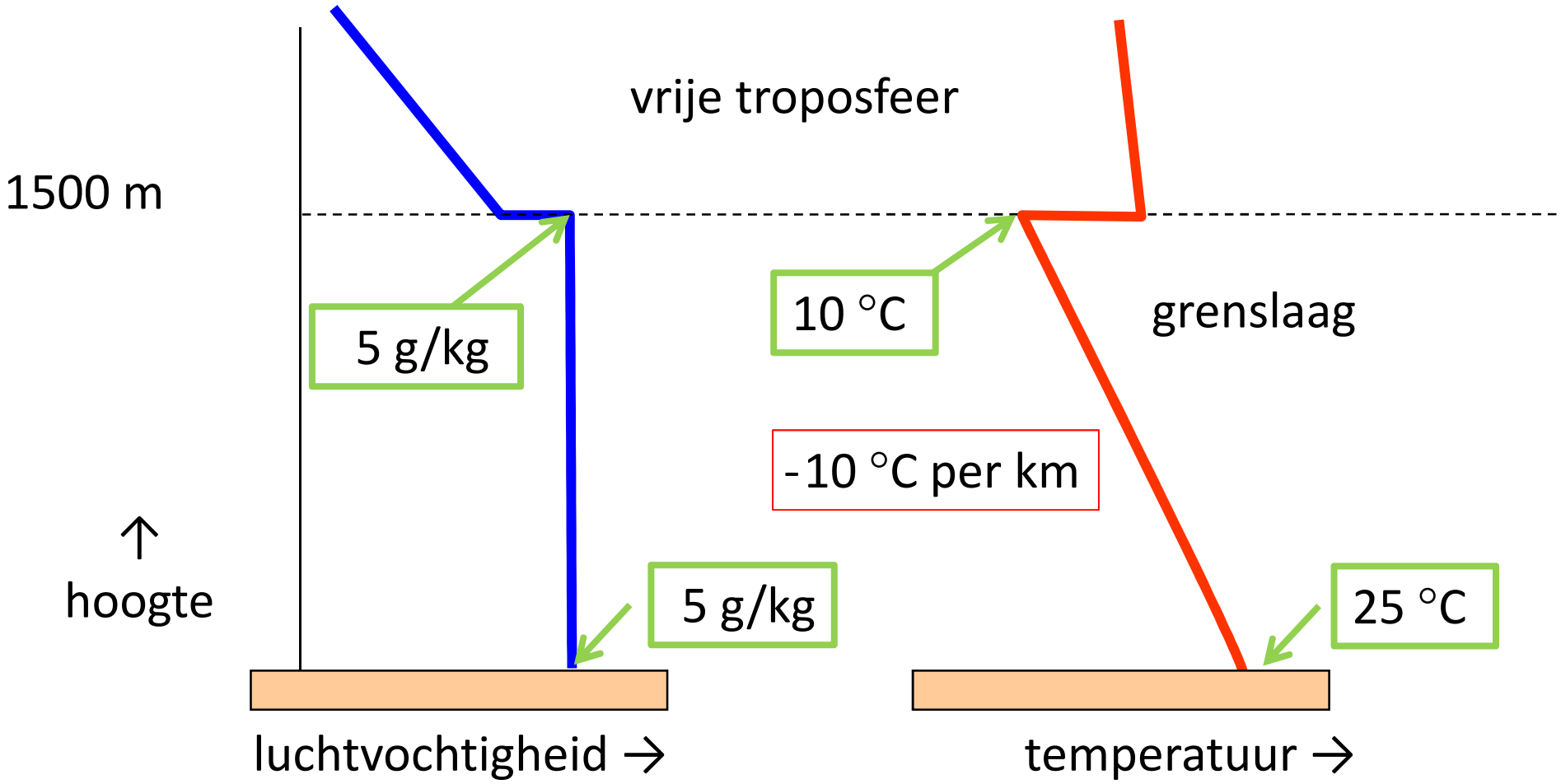
Verticale profielen: vocht en temperatuur



Verticale profielen: waarden op 1500 m?



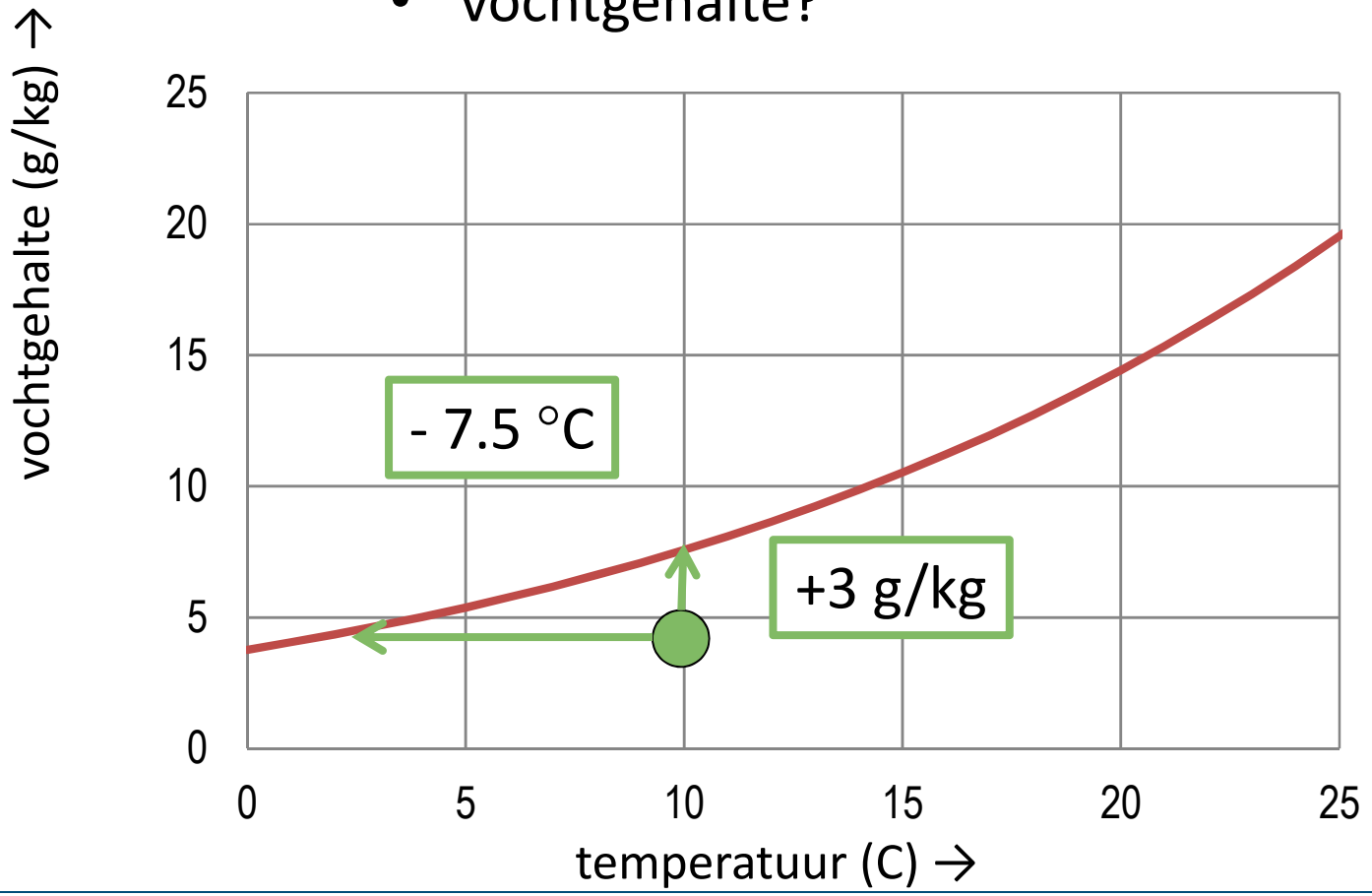
Verticale profielen: waarden op 1500 m?



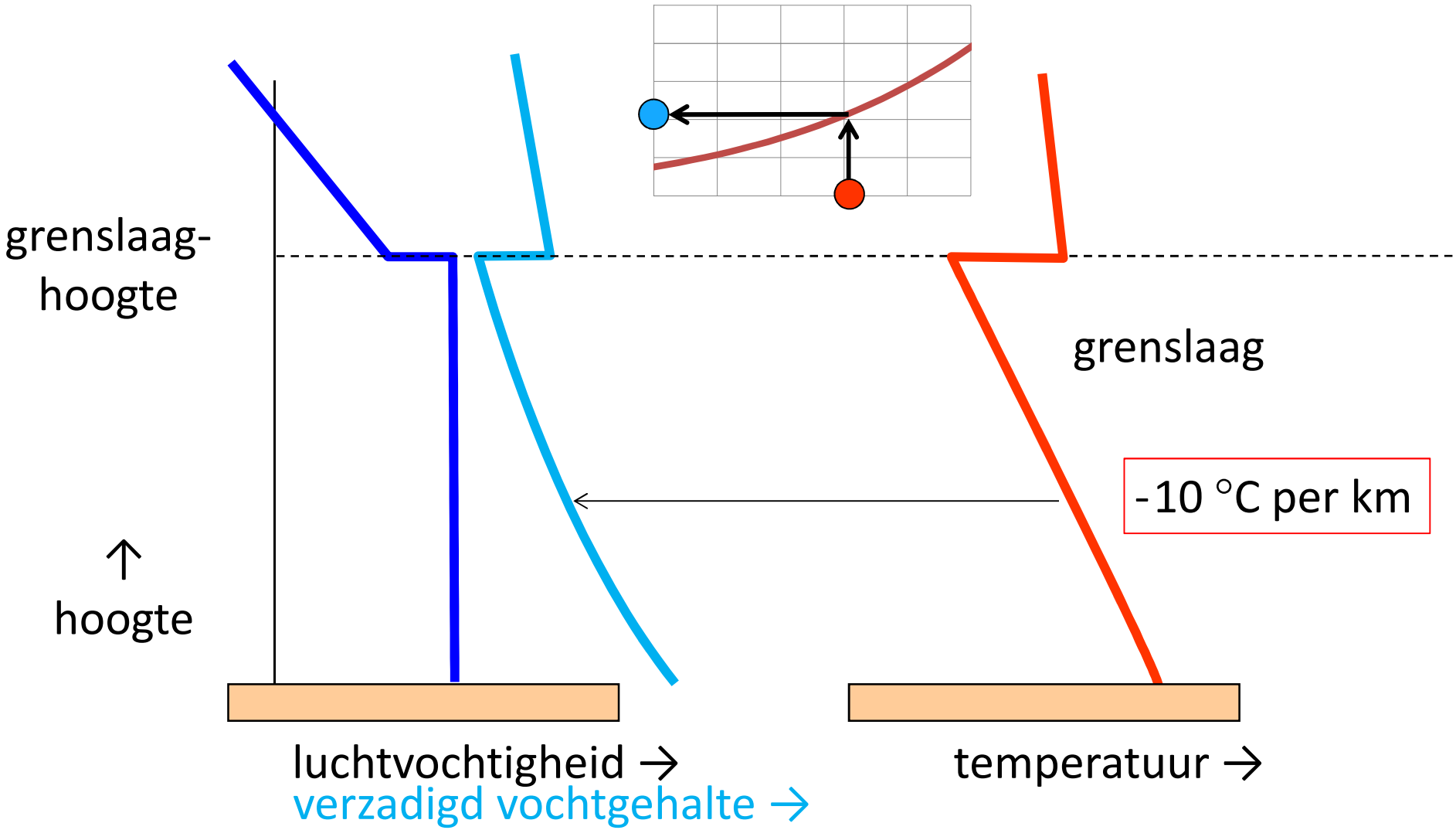
Verzadigd vochtgehalte van lucht

Verzadiging door verandering van:

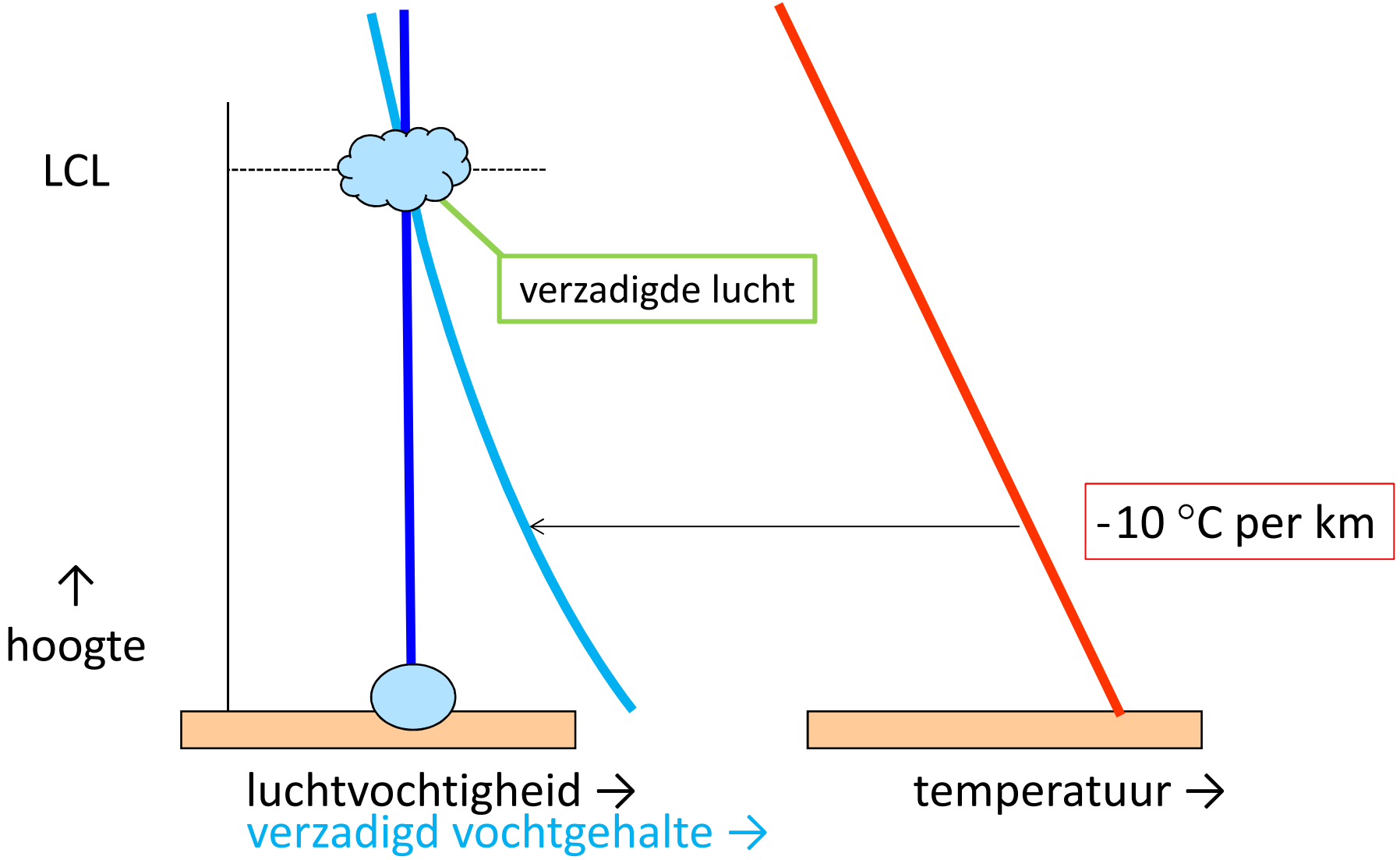
- temperatuur?
- vochtgehalte?



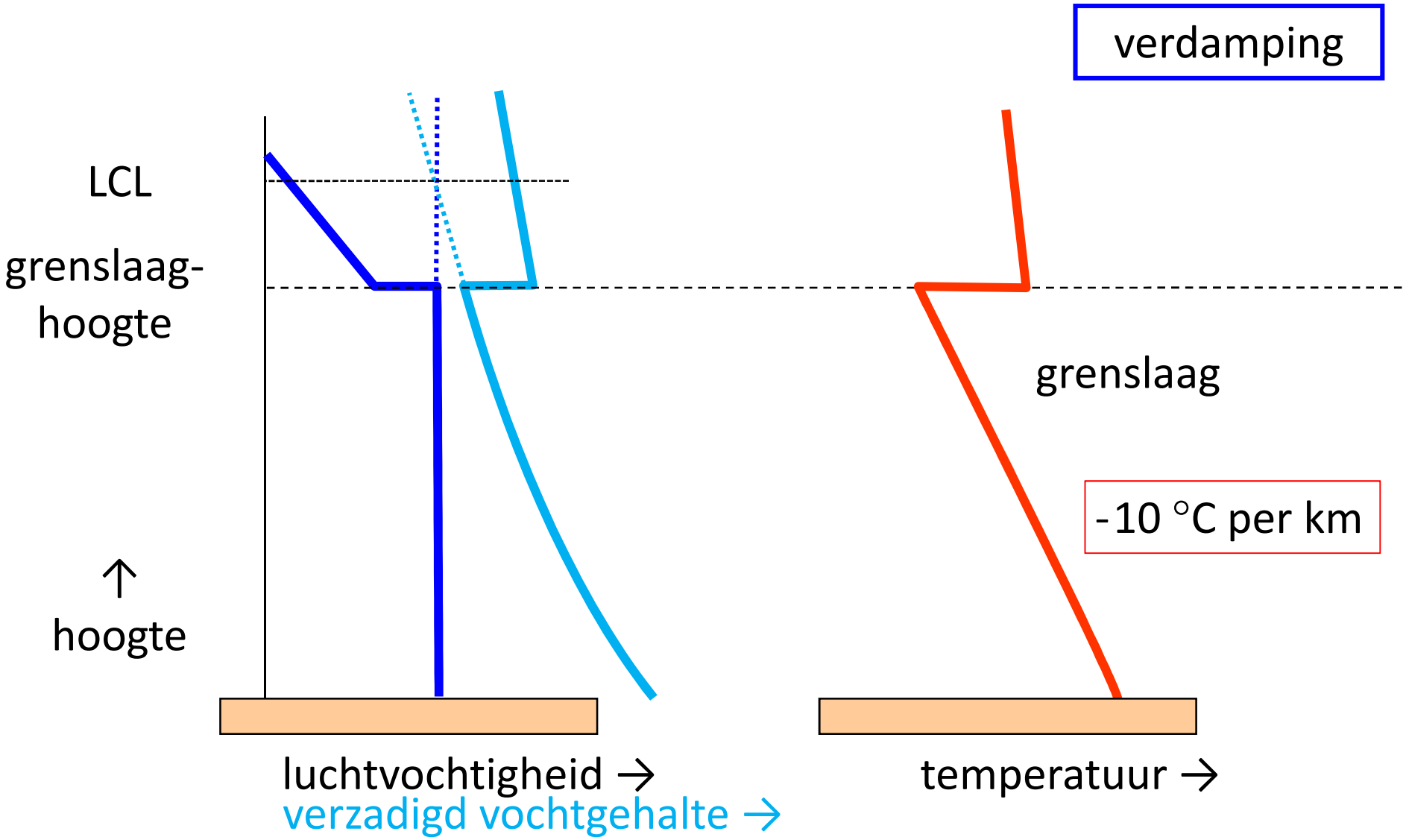
Wolken: verzadiging binnen de grenslaag?



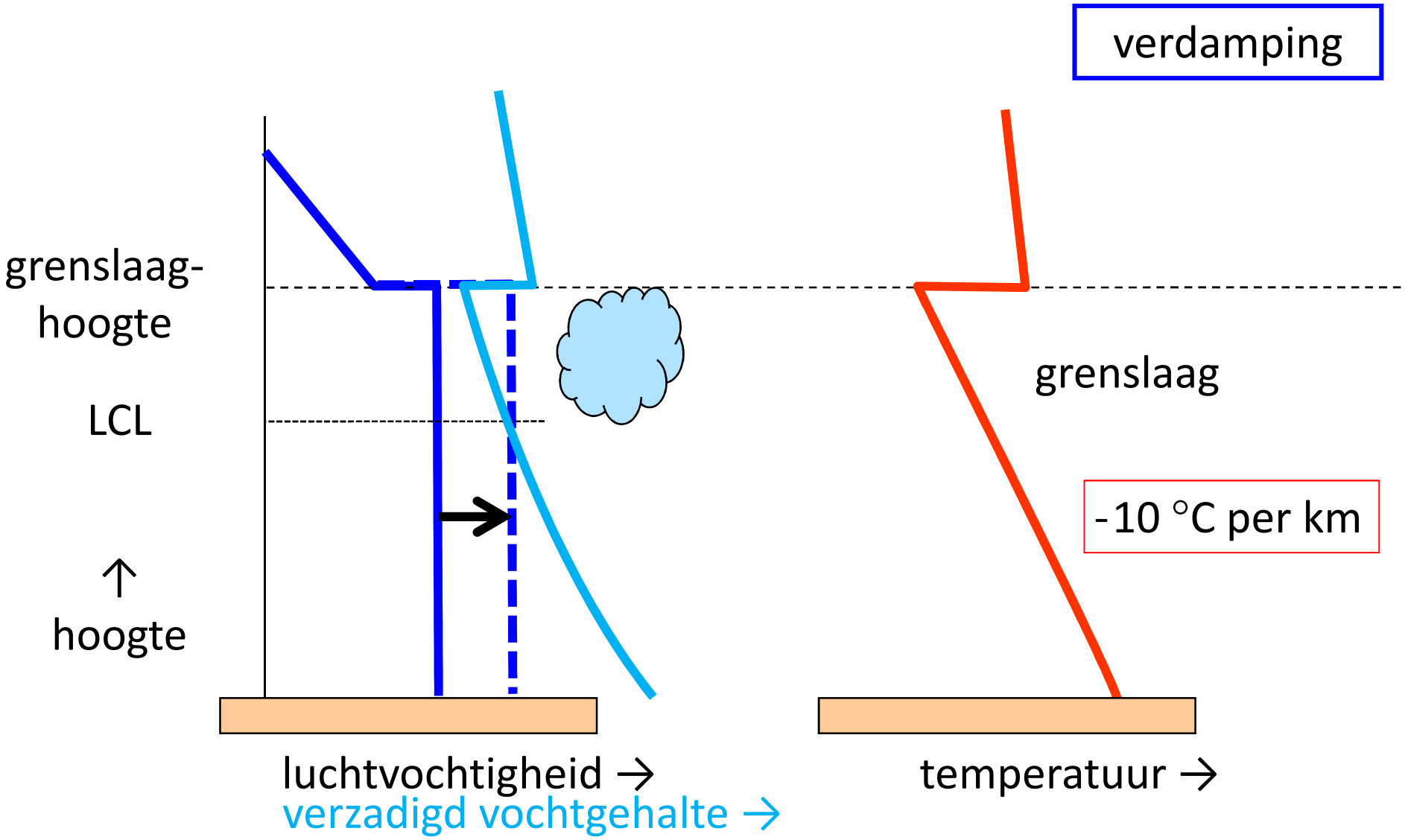
Wolken: Lifting Condensation Level (LCL)



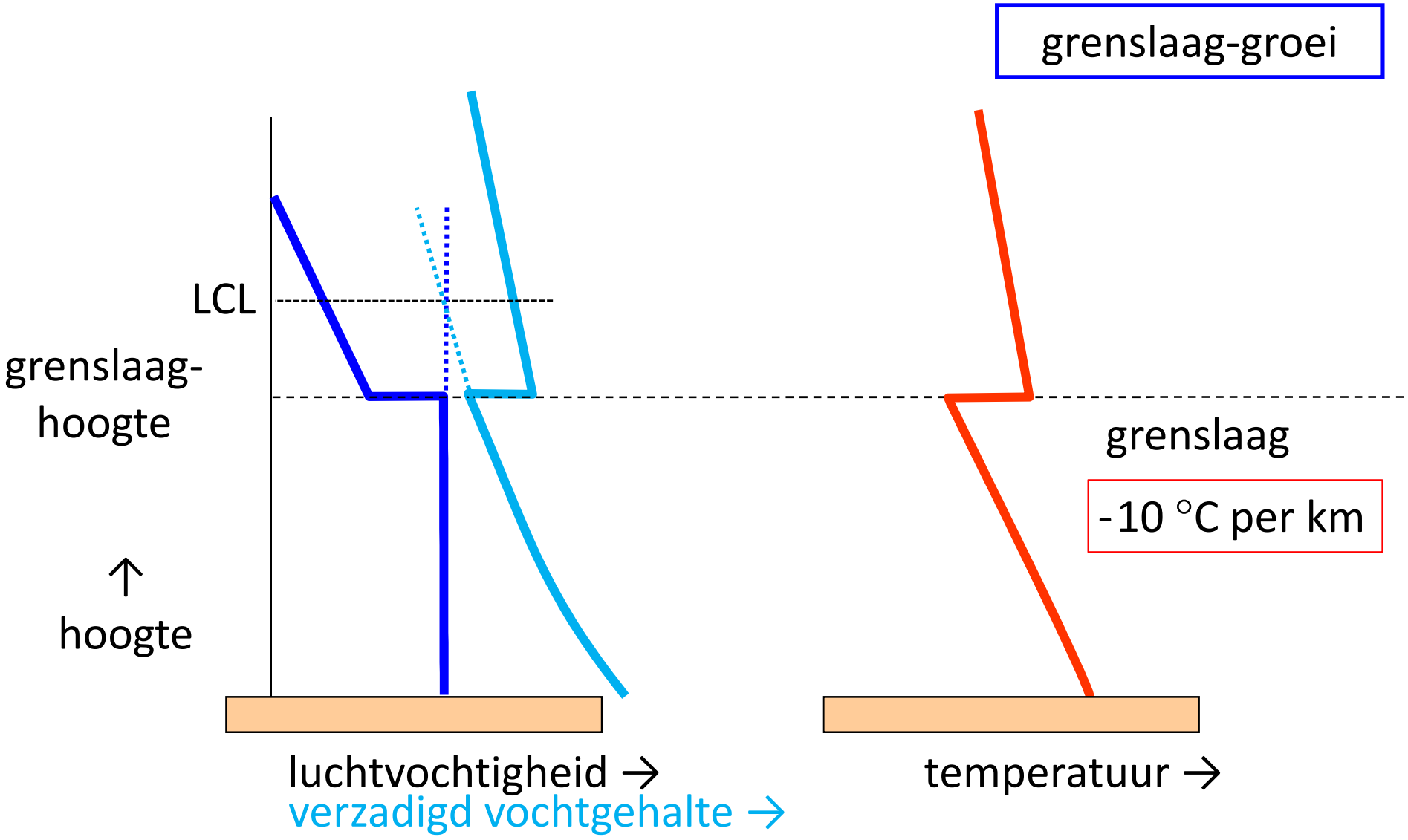
Wolken: hoe bereiken we verzadiging?



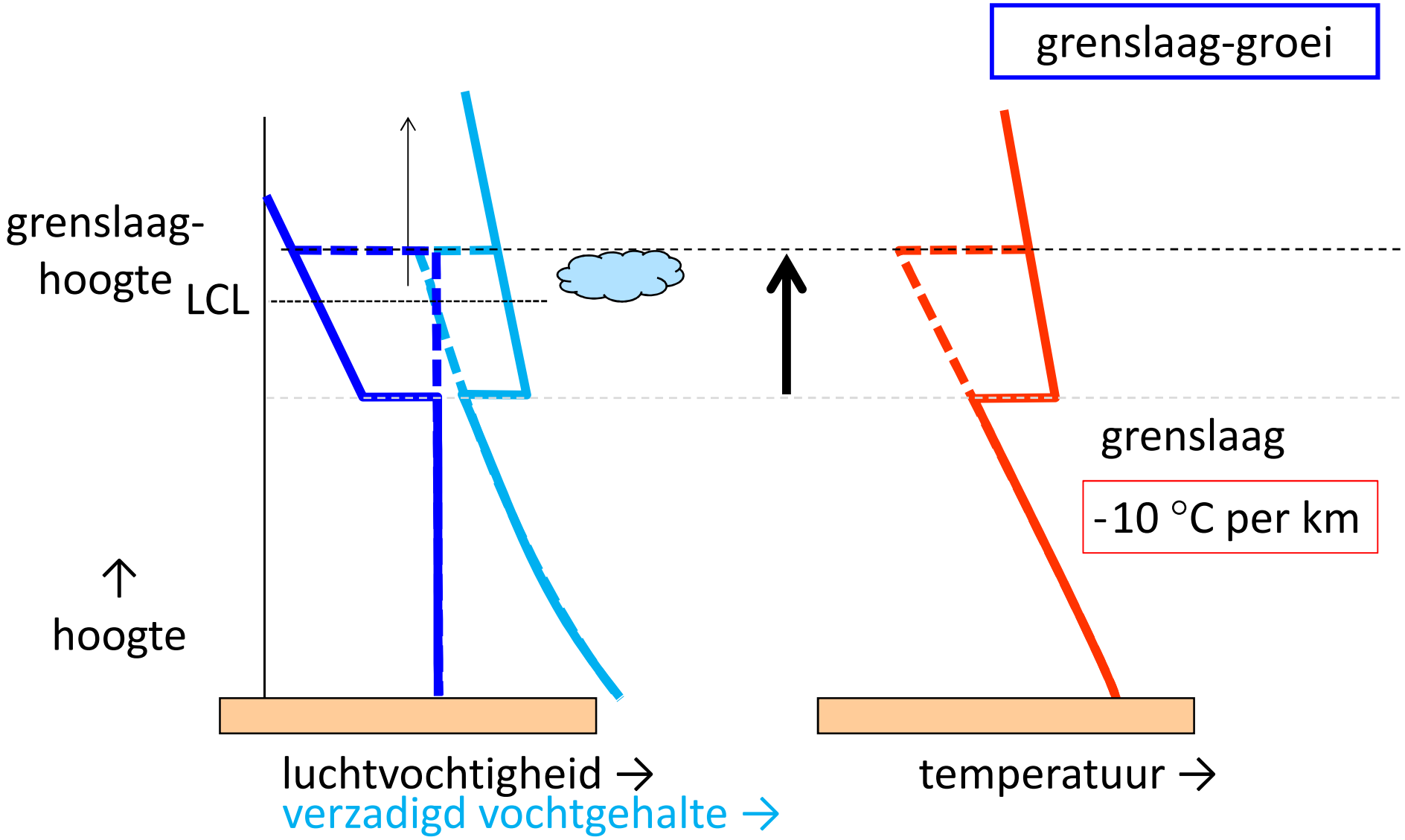
Wolken: hoe bereiken we verzadiging?



Wolken: hoe bereiken we verzadiging?



Wolken: hoe bereiken we verzadiging?



Time to play


Grenslaag
Oppervlak
Wolken
Challenge 1a
Challenge 2a
Challenge 4

Time to play

- Doel: met welke aanpassingen kun je wolken laten ontstaan? Wanneer lossen de wolken ‘s middags weer op, en wanneer niet?
- Challenge 4 (oppervlak = gras)
  - initiele temperatuur → 15.5 C
  - initiele luchtvochtigheid → 8 g/kg
- Variabelen: datum + bodemvocht + start vocht q0 + start temperatuur T0

Grenslaag	Oppervlak	Wolken	Vegetatie
Challenge 1a	Challenge 2a	**Challenge 4**	

Afsluiting

- Van onderzoek naar onderwijs (HO en VO)
- Mogelijkheden VO:
  - Geofysica
  - NLT
  - Link tussen biologie en natuurkunde
  - Profielwerkstuk (volledige vrijheid in ‘Zandbak’)
- Feedback en vragen welkom:
  - betasteunpunt@wur.nl
  - arnold.moene@wur.nl