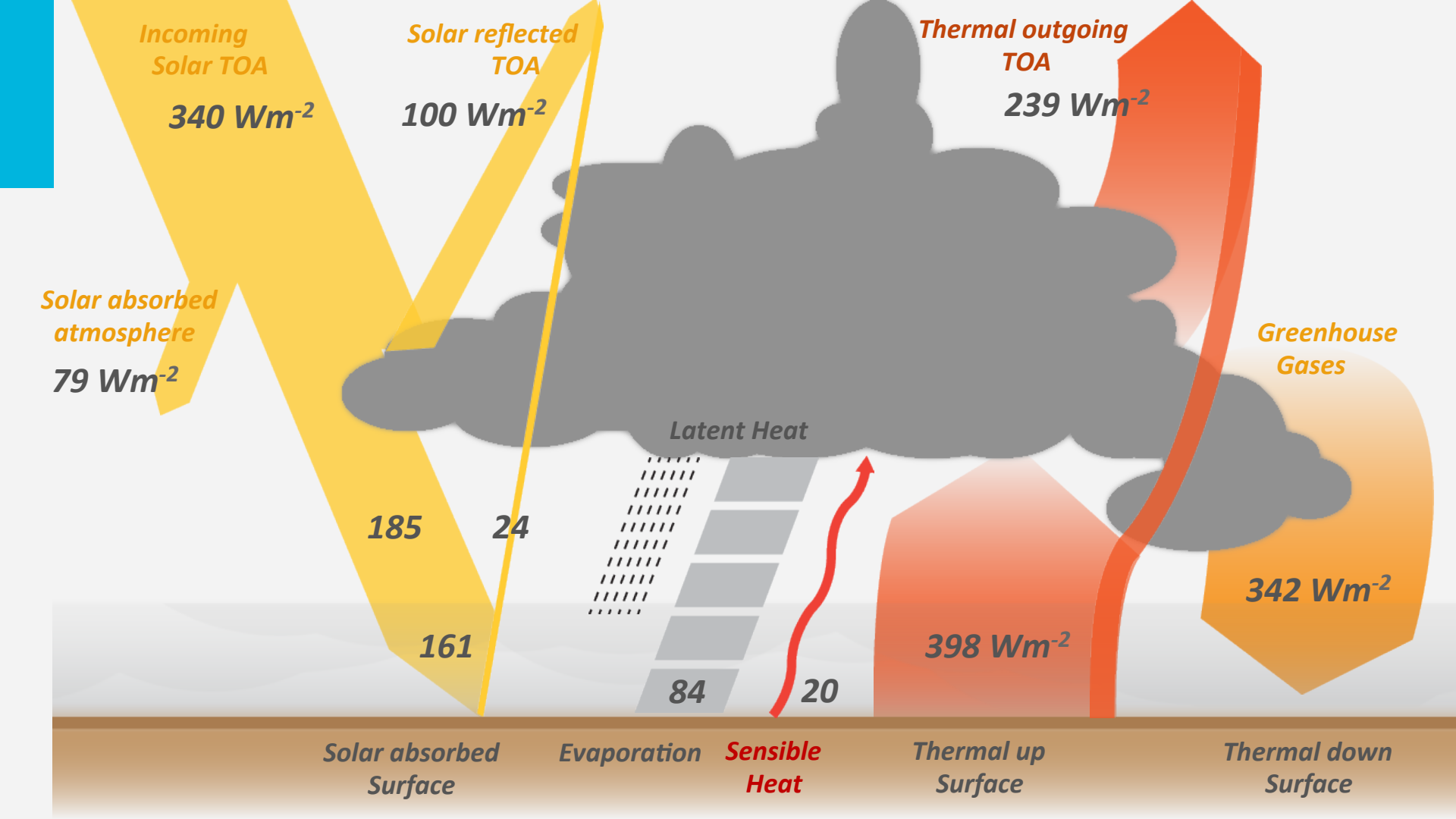
WCC 3: Clouds

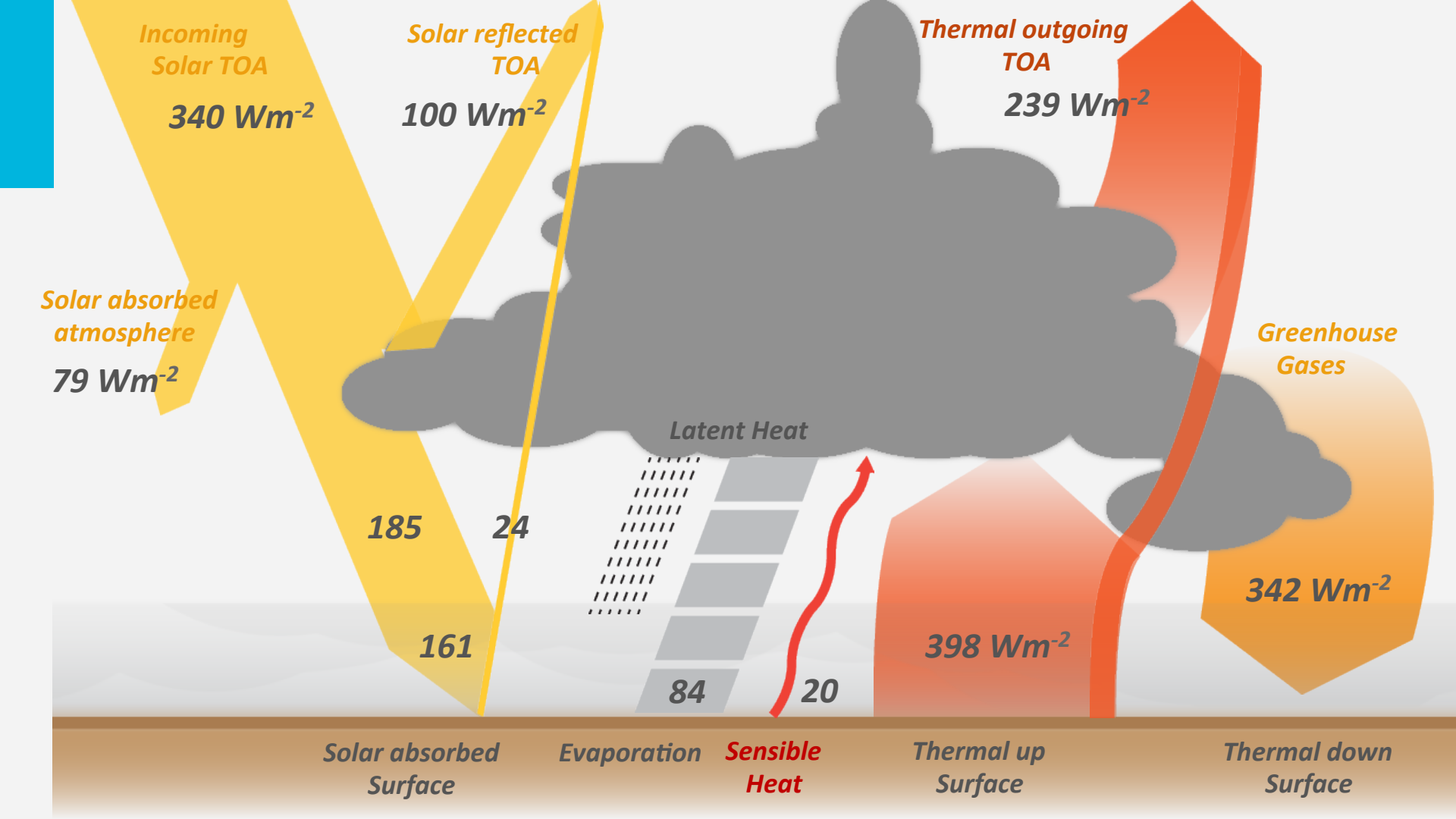
CTB3300WCx: Introduction to Water and Climate

Prof.dr.ir. Herman Russchenberg


Incoming Solar TOA
340 Wm-2
Solar reflected TOA
100 Wm-2
Thermal outgoing TOA
239 Wm-2
Solar absorbed atmosphere
79 Wm-2
Greenhouse Gases
Latent Heat
185
24
161
84
20
398 Wm-2
342 Wm-2
Solar absorbed Surface
Evaporation
Sensible Heat
Thermal up Surface
Thermal down Surface

Energy balance at the top of the atmosphere

Solar energy in:	***340 Wm^{-2}***
Solar energy out:	***- 100 Wm^{-2}***
Infrared energy out:	***- 239 Wm^{-2}***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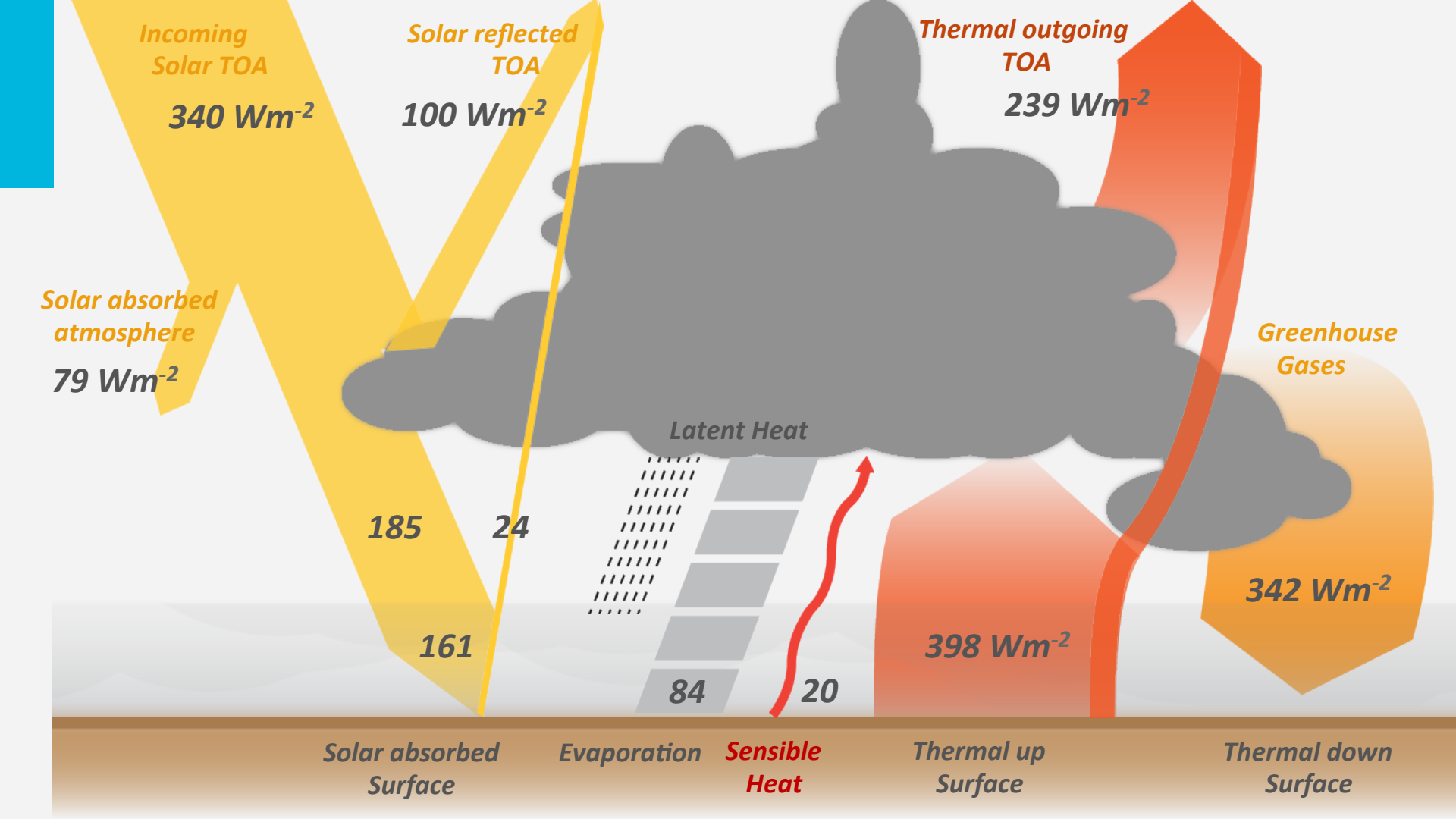
Energy balance at the surface

Solar energy in:	***161 Wm^{-2}***	
Energy flow out:		
latent heat	***- 84 Wm^{-2}***	
sensible heat	***- 20 Wm^{-2}***	
thermal radiation	***- 57 Wm^{-2}***	***+***
Total:	***161 Wm^{-2}***	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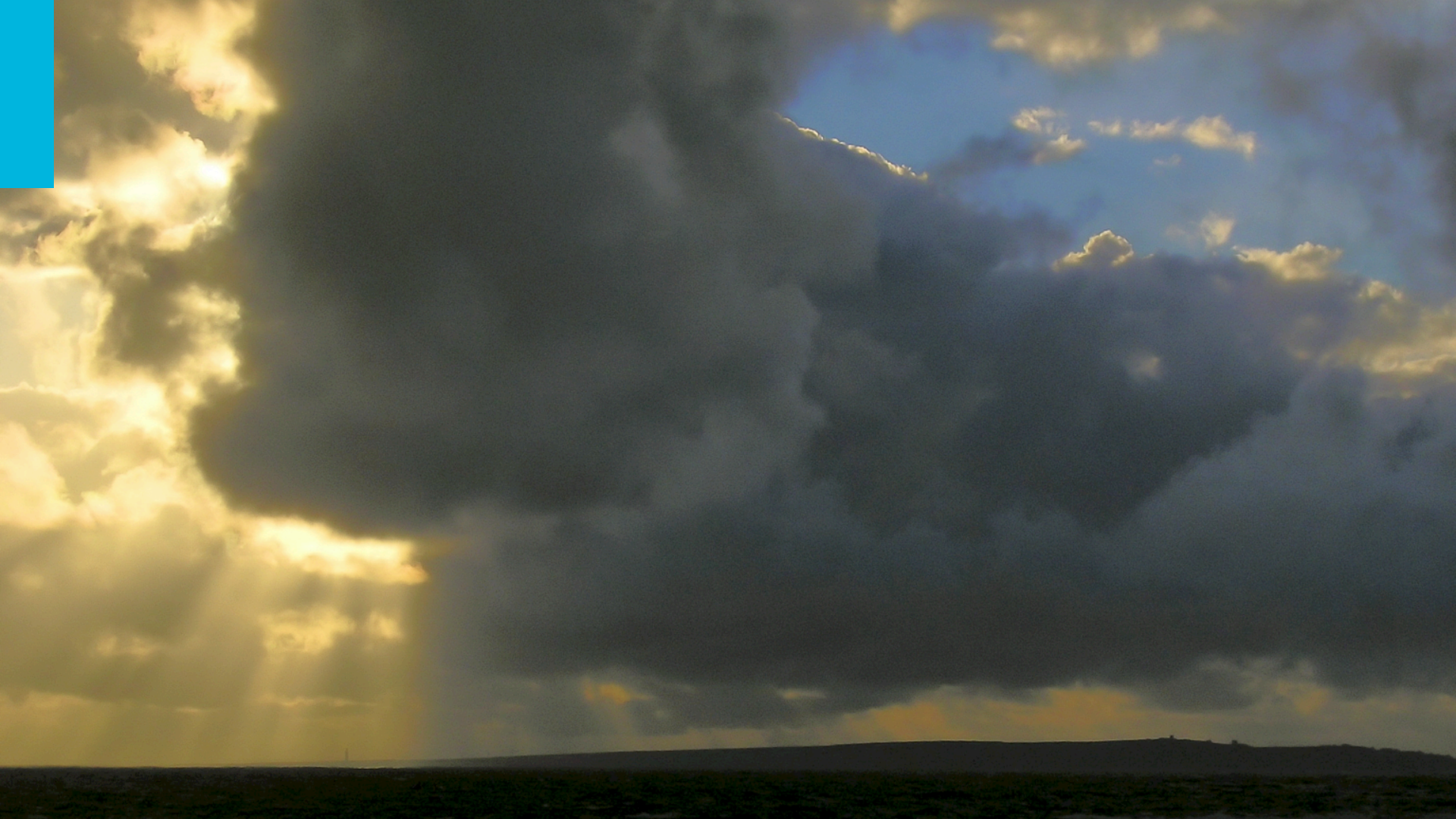
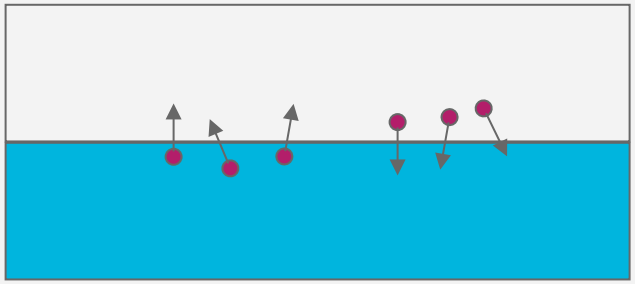


Phase changes: water in the atmosphere



Vapour

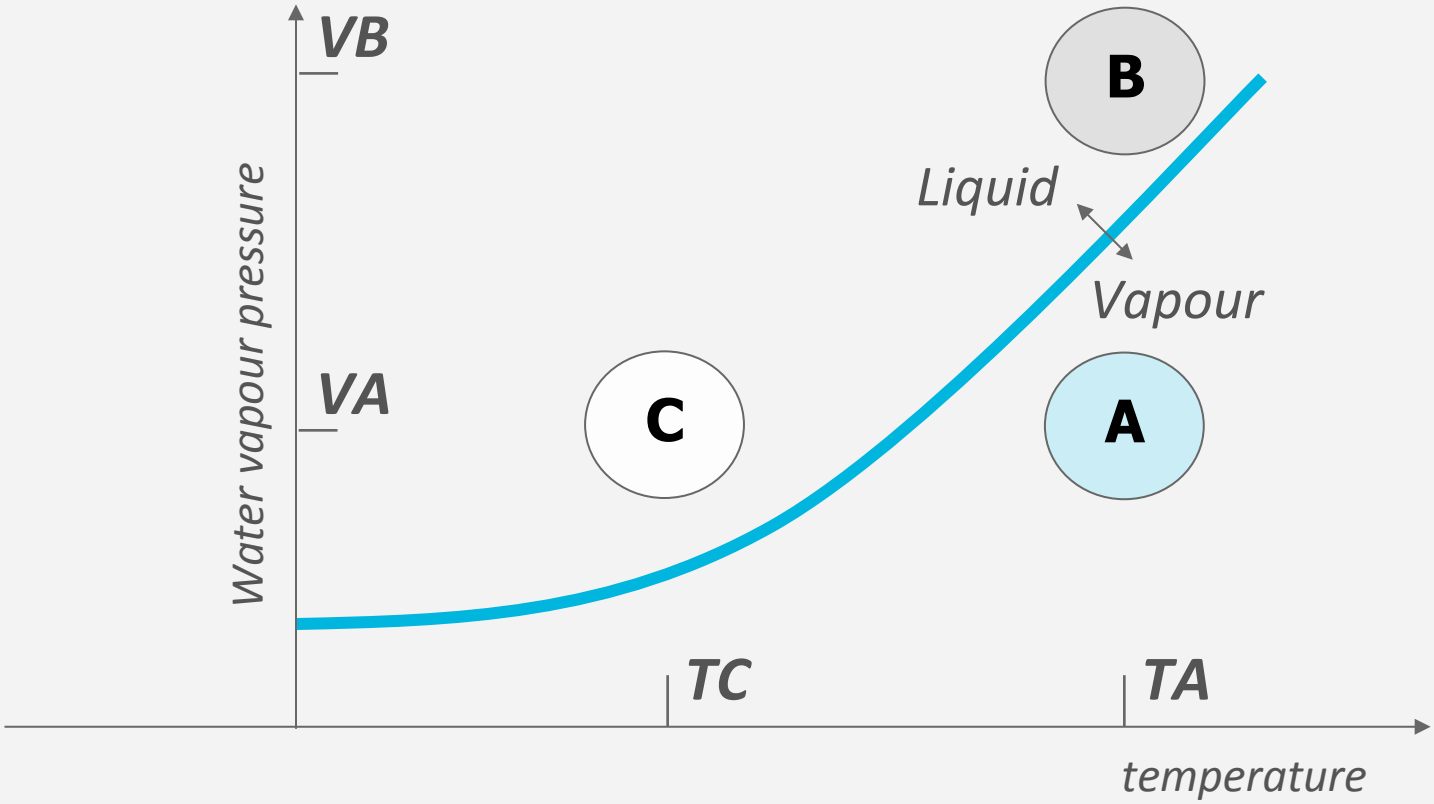
Liquid

When saturated at given temperature:

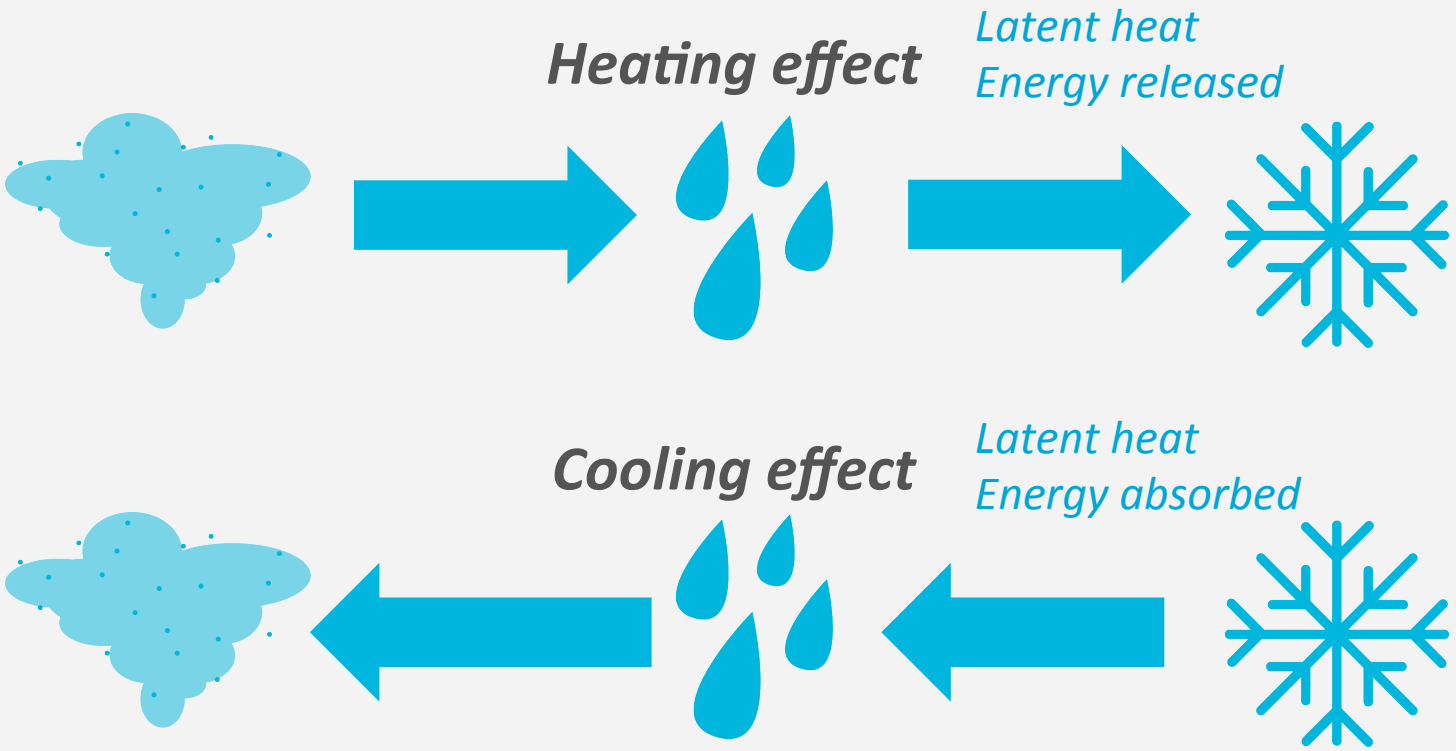
- *Equilibrium pressure*

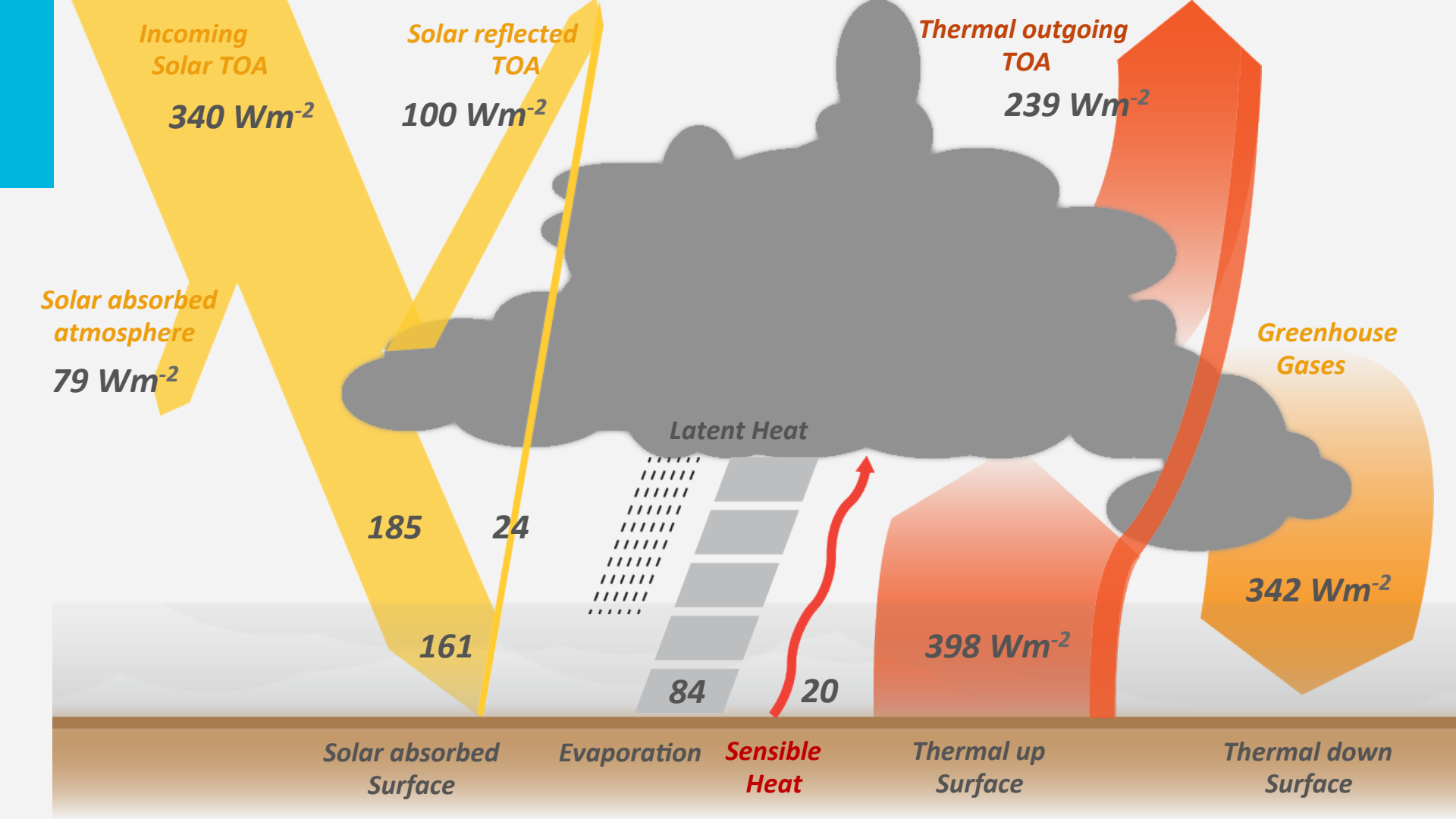
Increasing temperature: increasing saturation pressure

Clausius-Clapeyron



Effect phase change on energy balance

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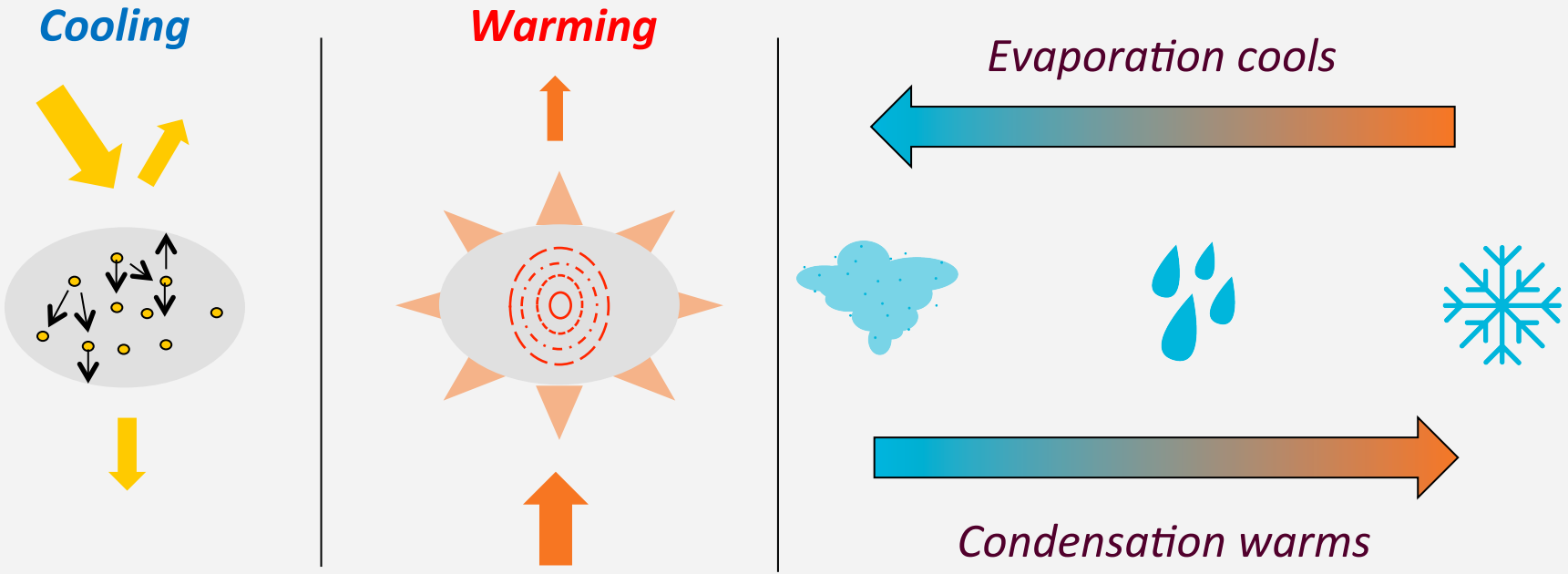
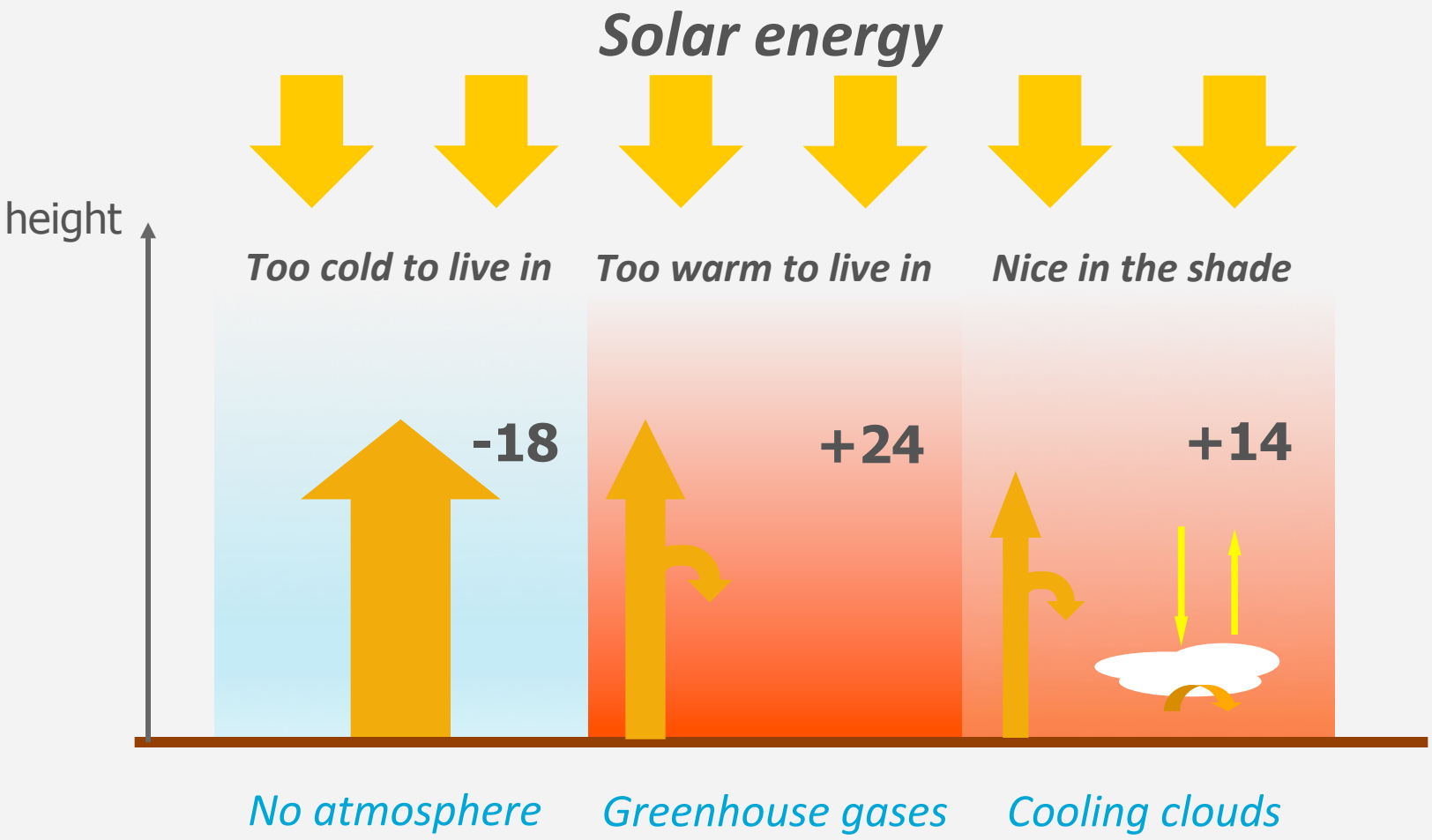
Clouds and Climate



The radiation balance: a status quo?

Higher temperatures → more water vapour → more clouds ?

- *Trapping heat from earth:* ***Warming***
- *More reflection of sunlight:* ***Cooling***


Solar energy
height
Too cold to live in
Too warm to live in
Nice in the shade
-18
+24
+14
No atmosphere
Greenhouse gases
Cooling clouds

The cloud questions

- *How much light reaches the earth?*
- *How much is reflected into space?*
- *How much heat leaves the earth?*
- *How much water condenses or evaporates?*
- *How much water precipitates?*

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