

UCL

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SC/PHYS/ASTR

**Reconstruction of the 1979-2005
Greenland ice sheet surface mass balance
using the regional climate model MAR**

by

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Vienna
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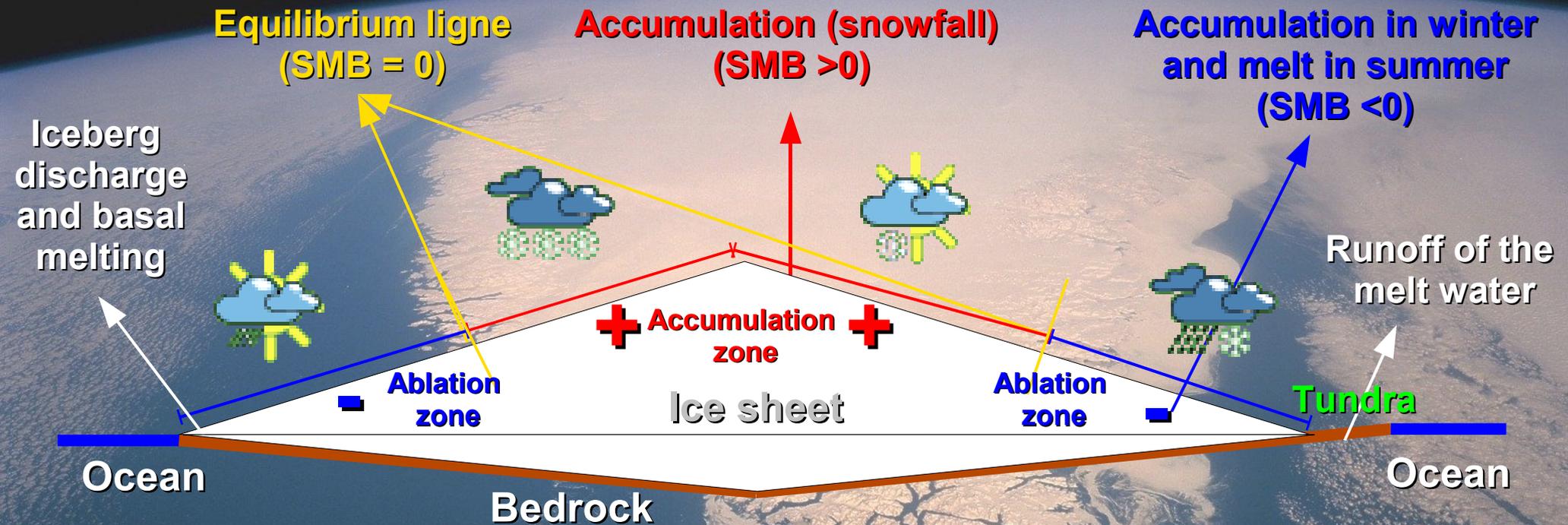
Plan

1. Mass balance
2. MAR model
3. Results
4. Conclusion

1. Definition: Mass balance

Surface Mass Balance \approx accumulation – runoff of the melt water

Ice sheet Mass Balance \approx accumulation – runoff – iceberg calving

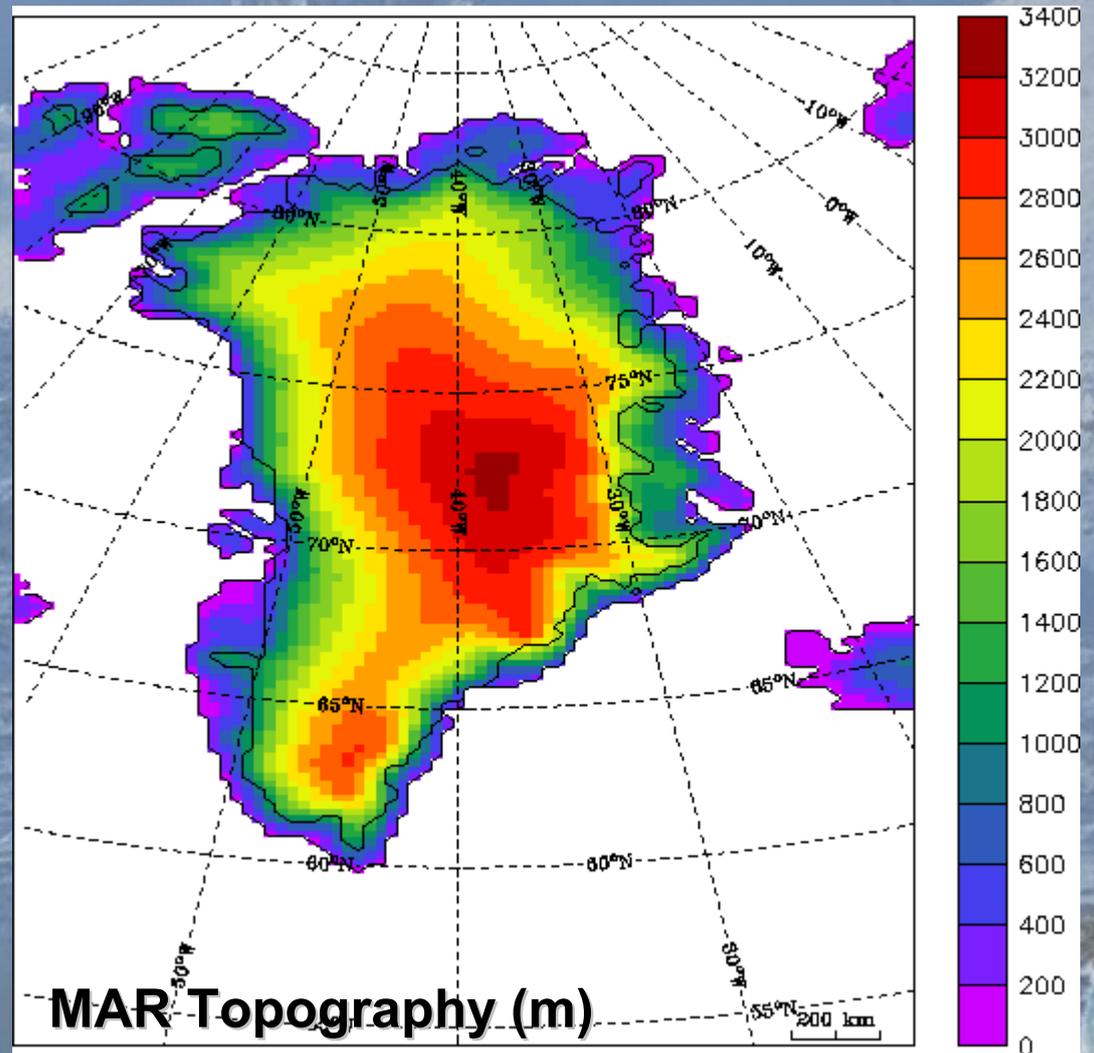


A warmer climate suggests more snowfall in winter and more melt in summer !

➡ What will be dominant in the future ?

2. MAR model

Begin	01/09/1978	
End	31/12/2005	
Simulated domain	2000 km x 3750 km	
Resolution	25 km	
1 st level	3m	
time step	120s	
Boundaries forcing	ERA-40 6-hourly	
Vertical levels	Atmosphere	30
	Snow	20
	Tundra	7
Ocean	ERA SST	
Sea-ice	ERA Sea-ice	

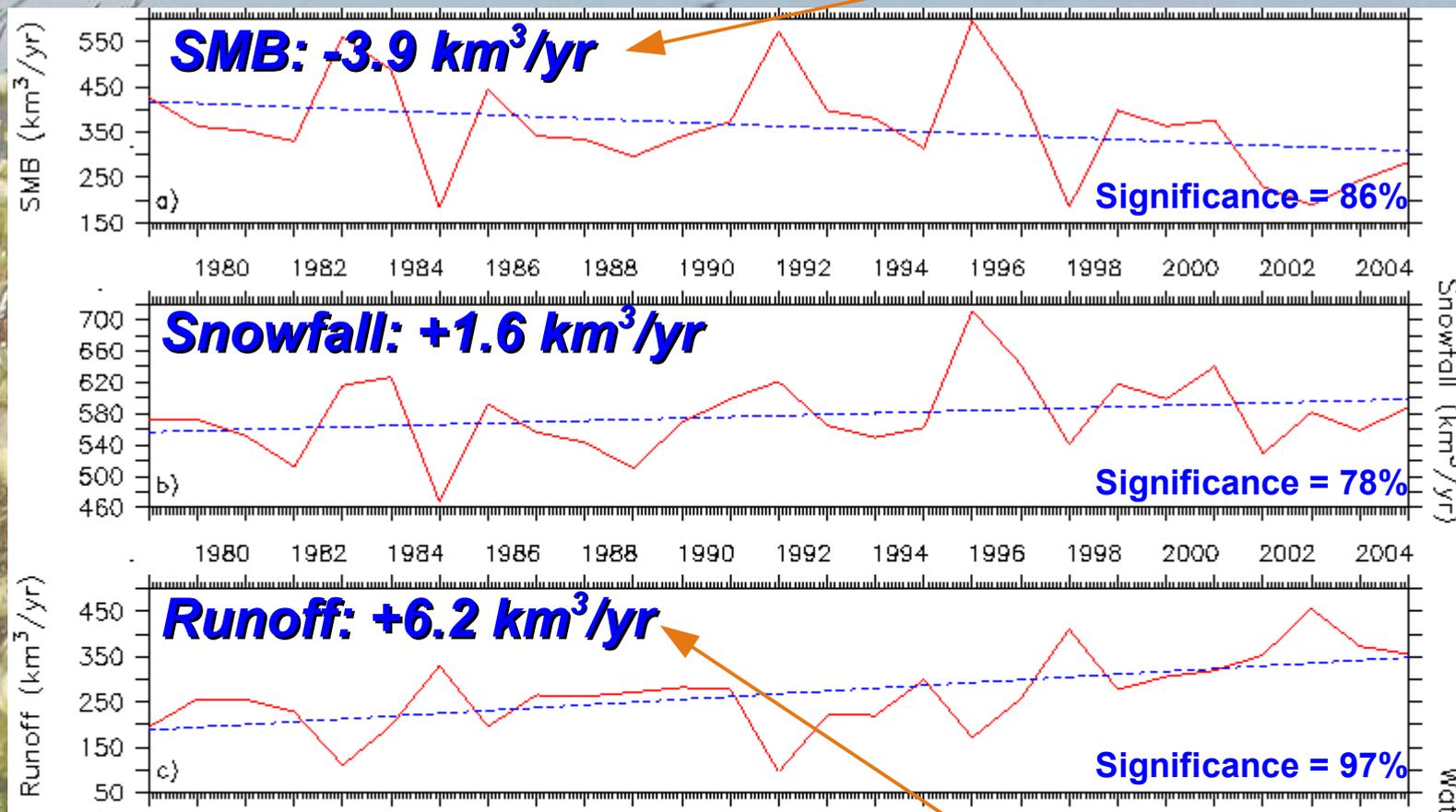


**Coupled with a snow model
but not with an ice sheet model !**

3. 1979-2005 SMB (1/5)

SMB \cong Snowfall - Runoff

~ 1.0 mm/yr in mean sea level rise

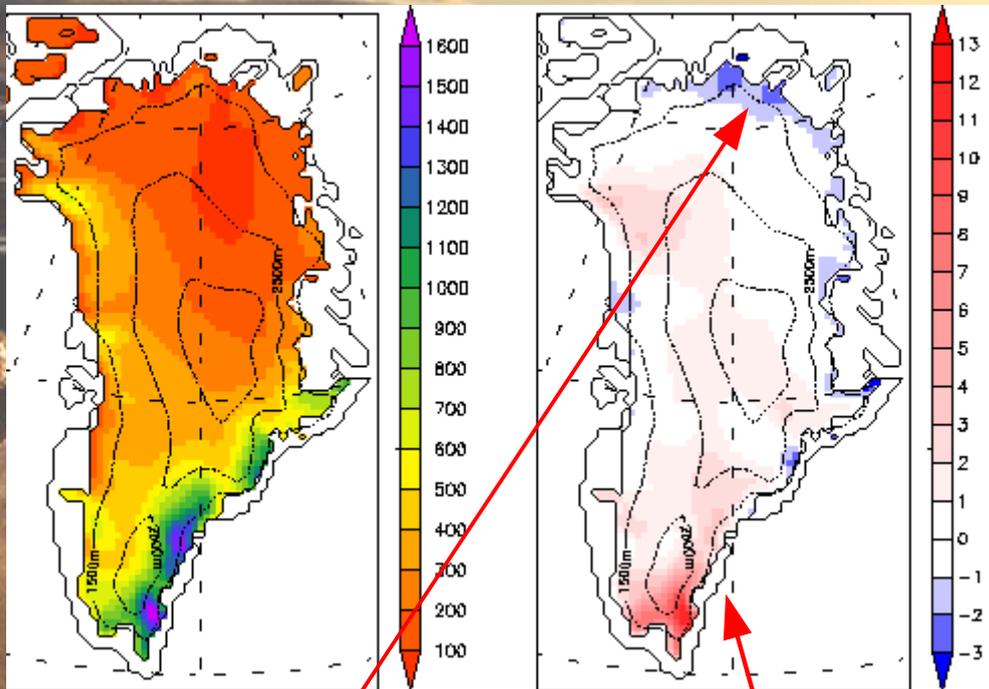


Water vapour fluxes: $+0.4 \text{ km}^3/\text{yr}$
Rainfall: $+0.3 \text{ km}^3/\text{yr}$

~ 1.7 mm/yr in mean sea level rise but underestimated by MAR

3. 1979-2005 SMB (2/5)

Snowfall



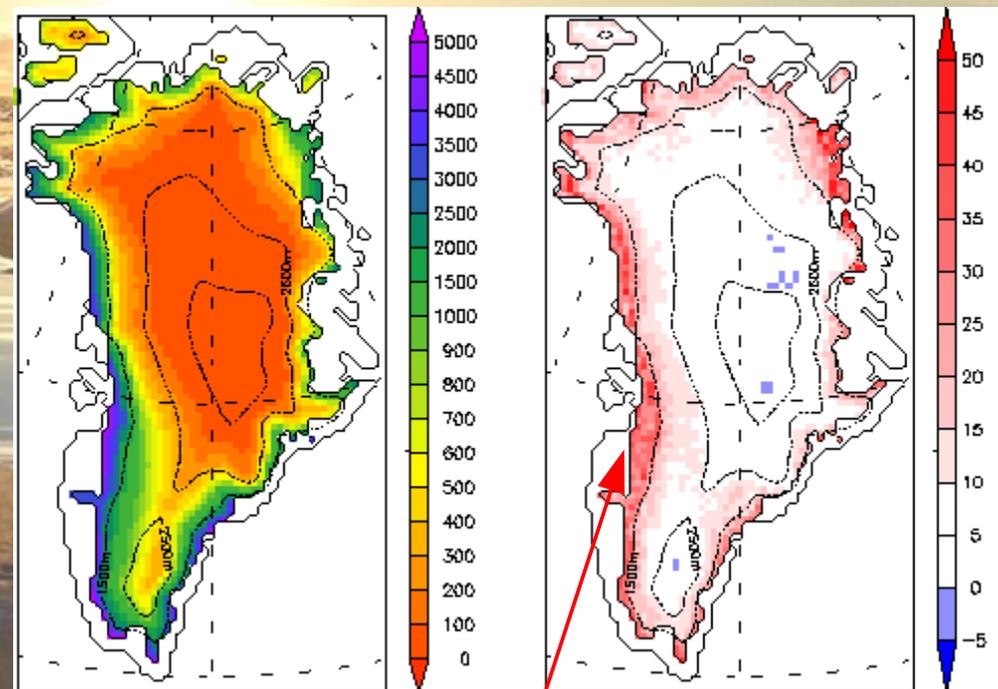
Yearly mean (mm)

Trend (mm yr⁻¹)

Part of snowfall becomes rainfall

Higher snowfall

Available melt water



Yearly mean (mm)

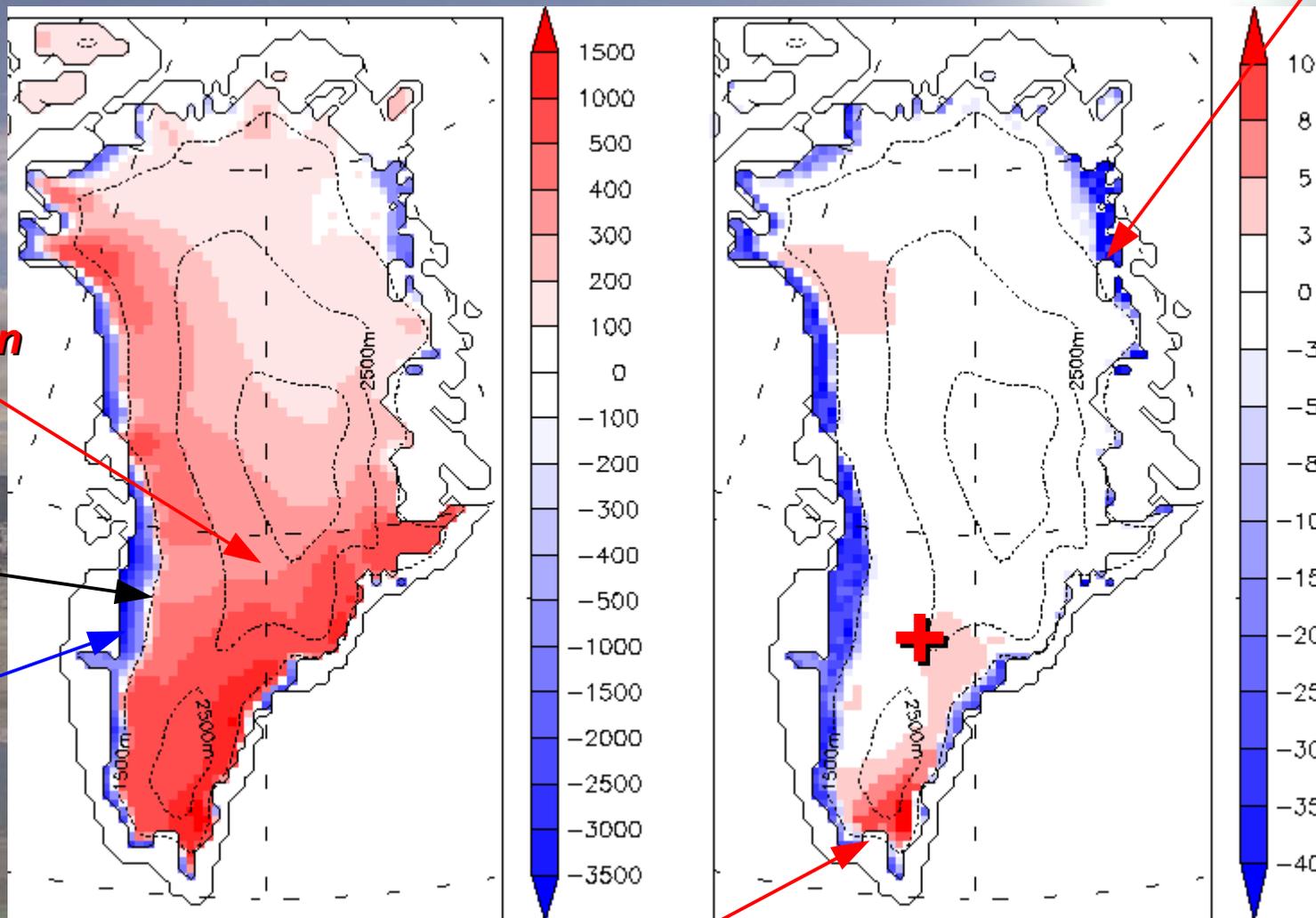
Trend (mm yr⁻¹)

The melt increases everywhere !

3. 1979-2005 SMB (3/5)

Surface mass balance

Decrease in the ablation zone



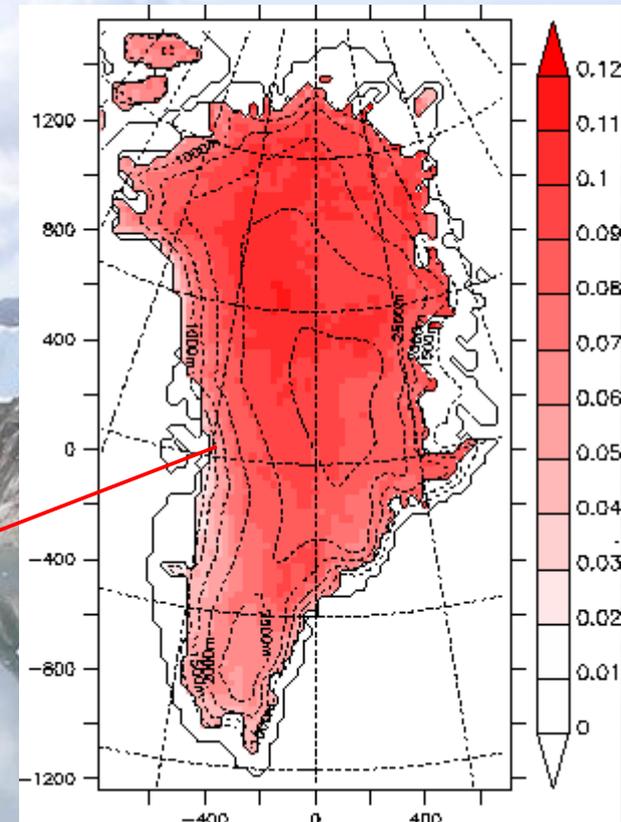
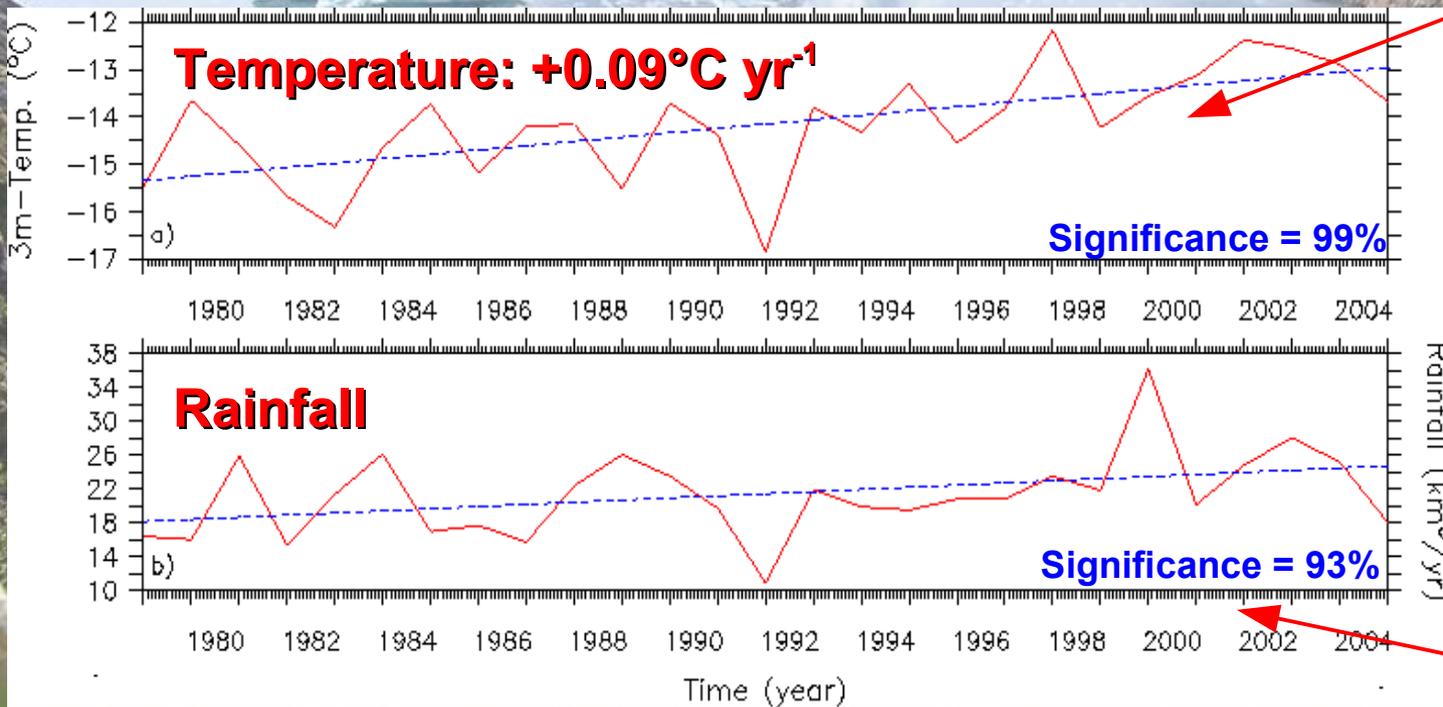
Yearly mean (mm)

Trend (mm yr⁻¹)

Increase in the accumulation zone

3. 1979-2005 SMB (4/5)

Why does the runoff increase since 1979?

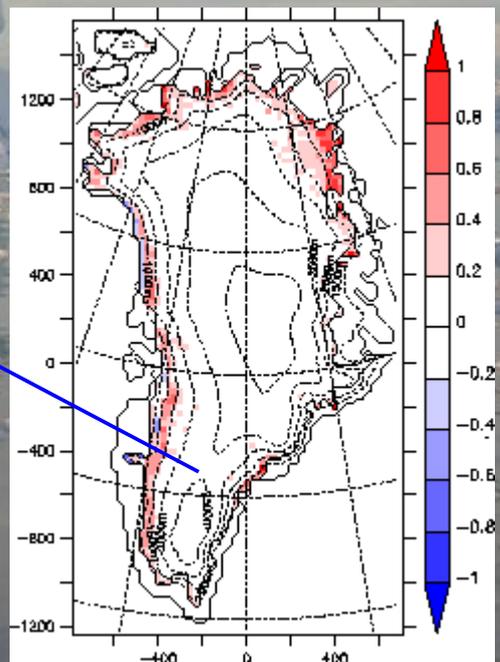
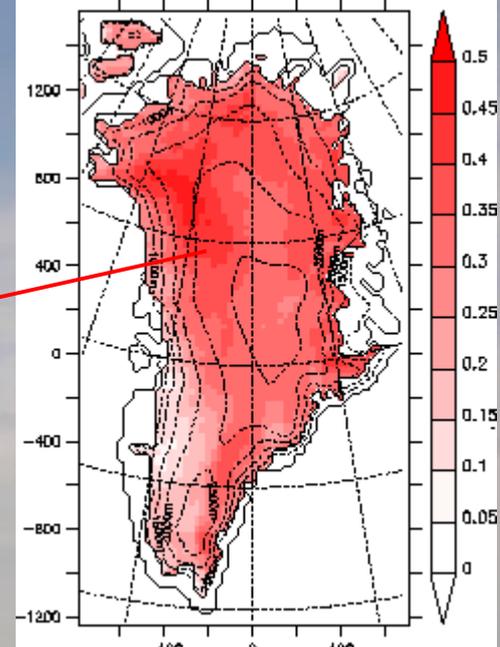
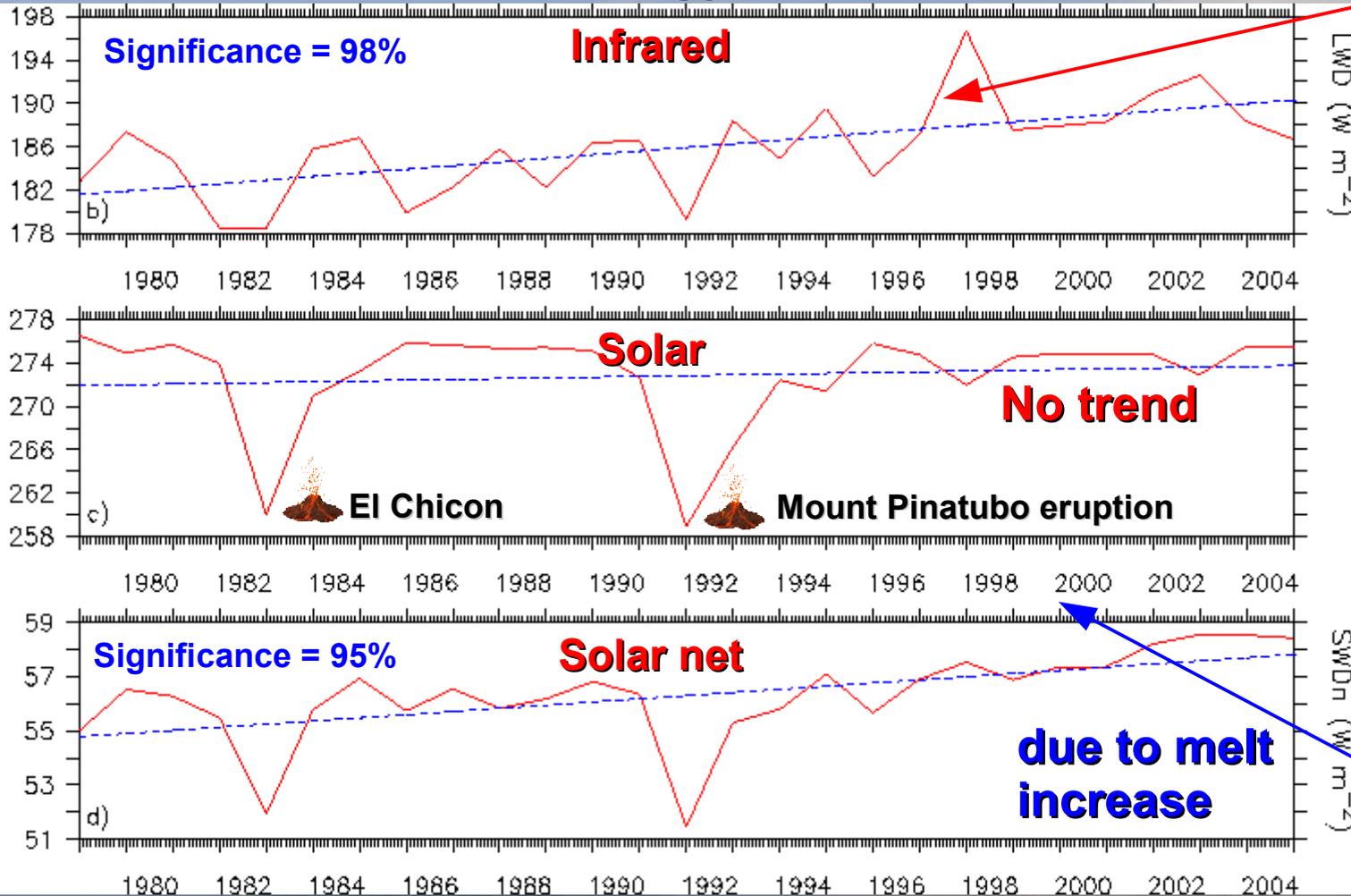


Trend of summer 3m-temperature (°C yr⁻¹)

5 % of the runoff increase.

3. 1979-2005 SMB (5/5)

Surface energy balance



+ no change for both sensible and latent heat fluxes



External forcings: CO_2

Not explained by the natural variability (NAO, ...)

5. Conclusion (1/2)

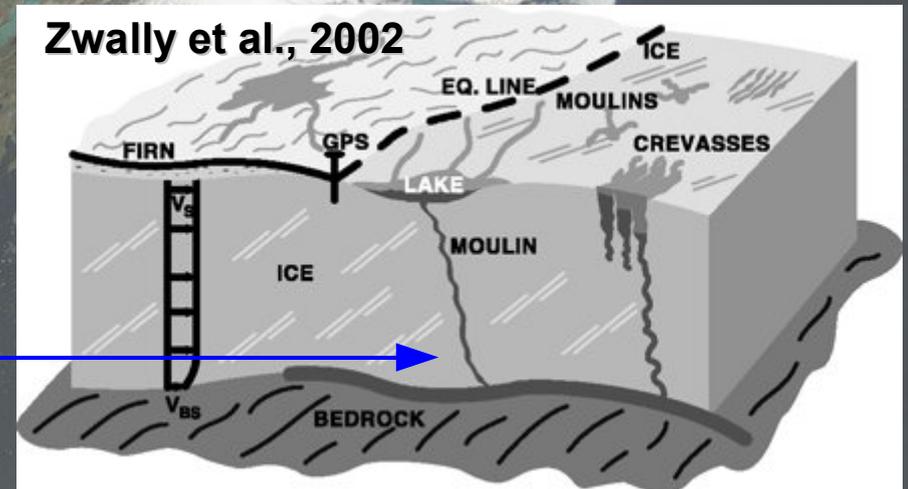
These results suggest :

- an **acceleration of surface melt** is larger than the heavier snowfall
- a **SMB decreasing**.

These change are likely **due to the human activities**.

Remark:

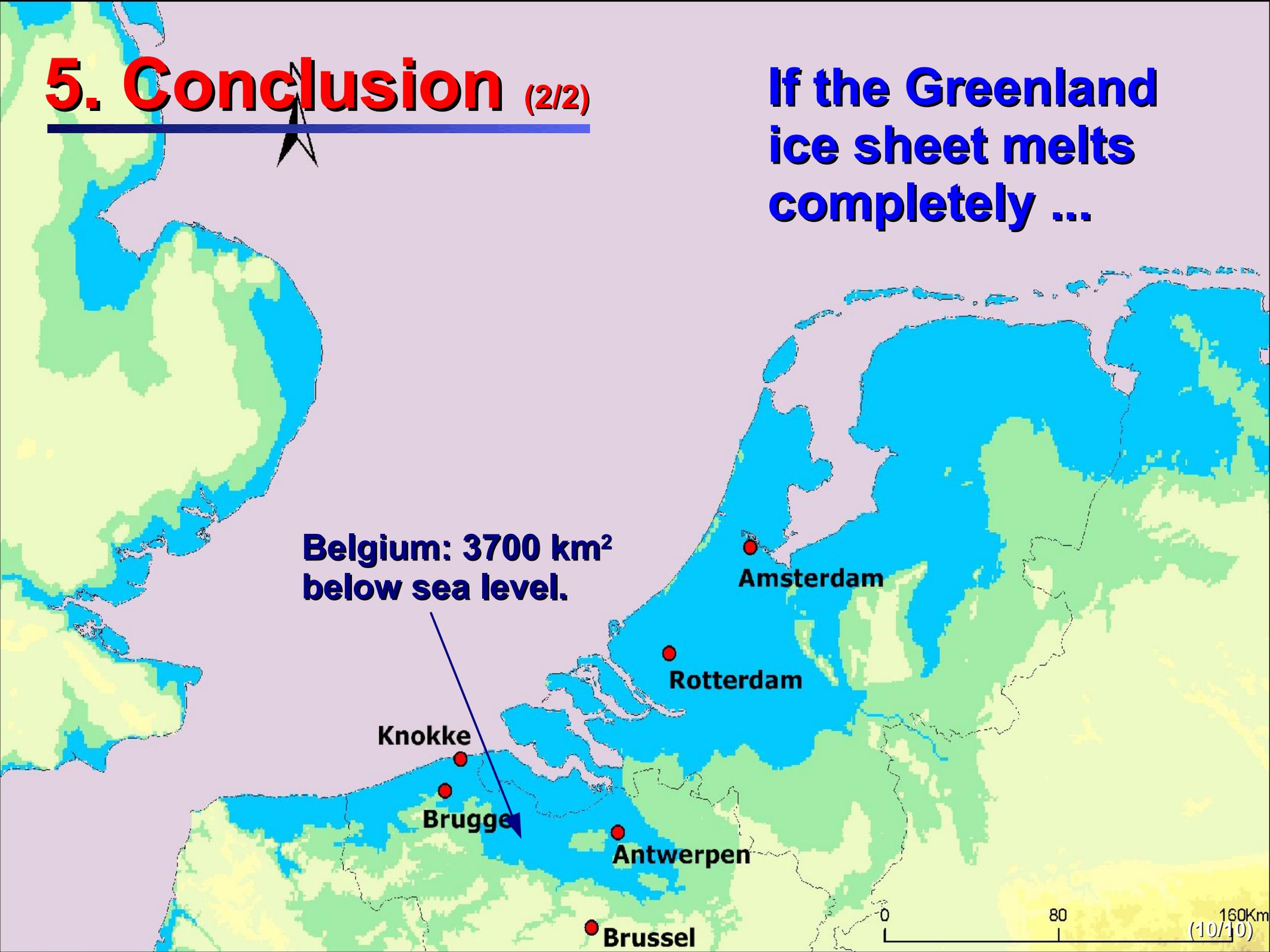
Acceleration of the glacier discharge because likely the melt water lubricates the ice/bedrock interface.



5. Conclusion (2/2)

If the Greenland ice sheet melts completely ...

Belgium: 3700 km²
below sea level.



Amsterdam

Rotterdam

Knokke

Brugge

Antwerpen

Brussel

0

80

160Km
(10/10)

An aerial photograph of a mountain range, likely the Alps, covered in snow. A grid of thin lines is overlaid on the image, suggesting a geographic coordinate system. The text "Thanks for your attention !" is centered in the image in a bold, red, italicized font.

***Thanks for
your attention !***

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