Clouds over the Antarctic Peninsula (E. Gilbert, Imageo)

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REVISITING TEMPERATURE SENSITIVITY: **HOW DOES ANTARCTIC SNOWFALL CHANGE WITH WARMING?**

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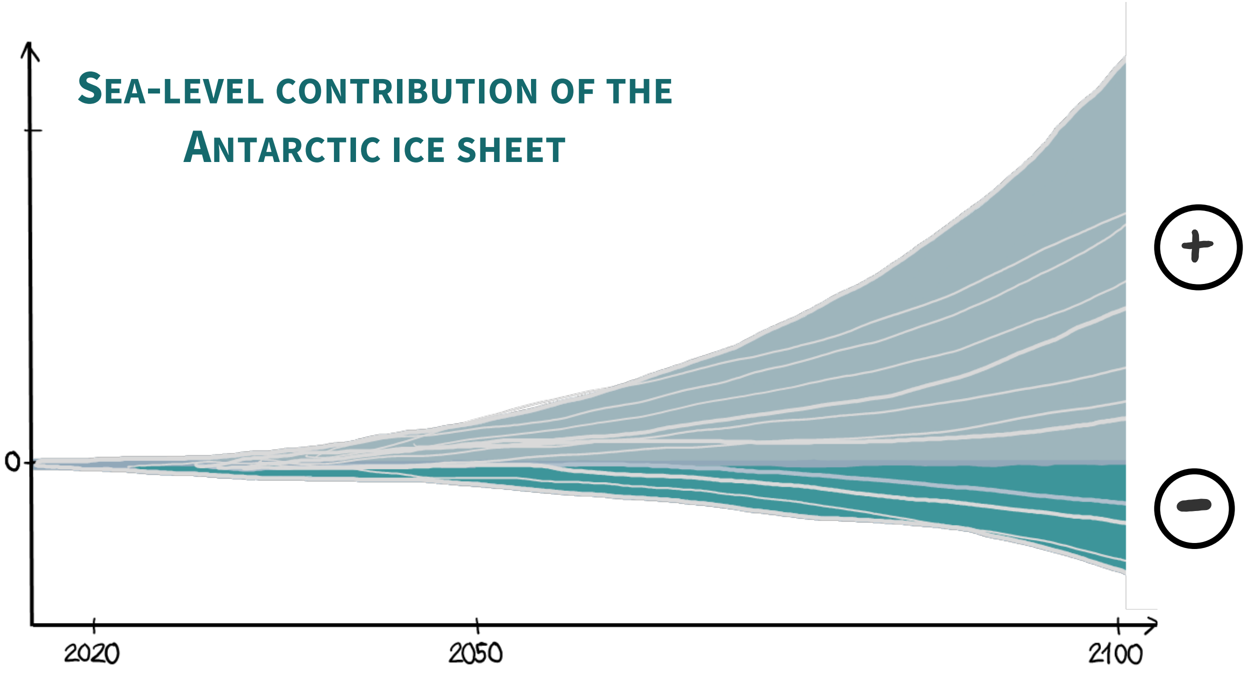
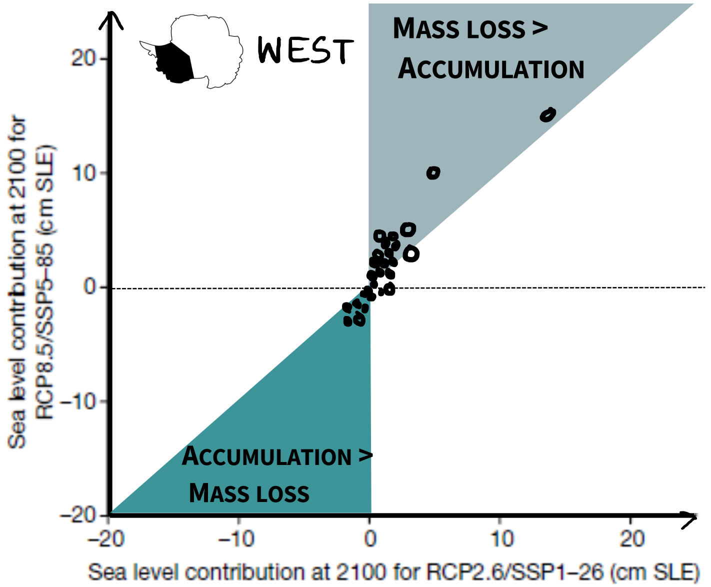
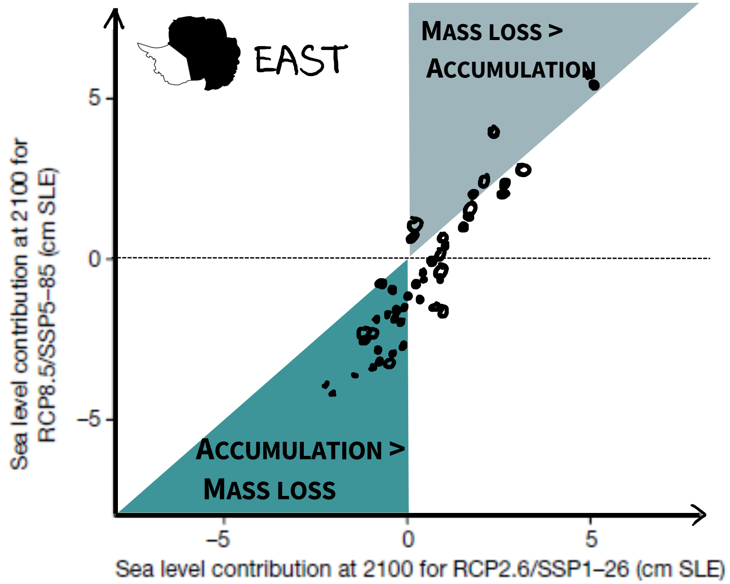
Motivation: Mass gains under warming?







Left: Sketch of ISMIP6 simulations adapted from **Seroussi et al., 2020**

Right: Sea-level response to different greenhouse gas emissions scenarios adapted from **Edwards et al., 2021**

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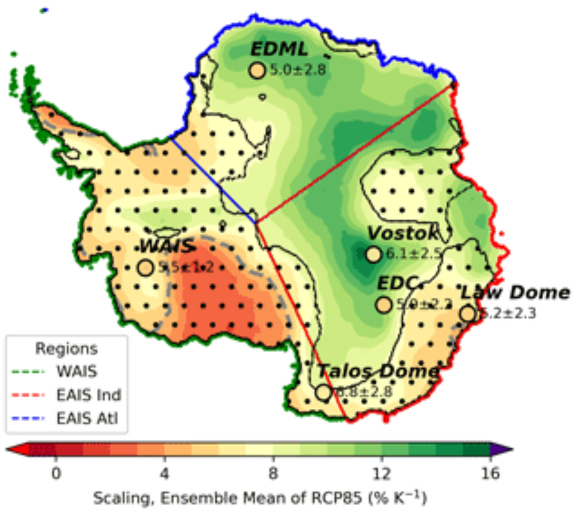
How much snowfall? Sensitivity factor used for precipitation scaling

$$P(t) = P_0 \, [\, 1 + \alpha \cdot T\,(t)\,]$$

- Literature values vary between 4 - 10 % K^{-1} from ice cores, regional and global climate model data
- **Sensitivity, α** , assumed to be constant

Rodehacke et al., 2020
using CMIP5 model data



1.	**Using exponential function**	$P(t) = P_0 \, \exp[\, \alpha \cdot T\,(t)]$
2.	**Spatially resolved** $\alpha = f$ (lon,lat)	$P(t) = P_0 \, \exp[\alpha\,(lon,lat) \cdot T\,(t)]$
3.	**Temperature-dependent** $\alpha = f$ (T)	$P(t) = P_0 \, \exp[\alpha\,(lon,lat, T) \cdot T\,(t)]$

$$\frac{d\ln e_s}{dT} = \frac{L}{R\,T^2} = \alpha(T)$$

as in Held and Soden (2006)

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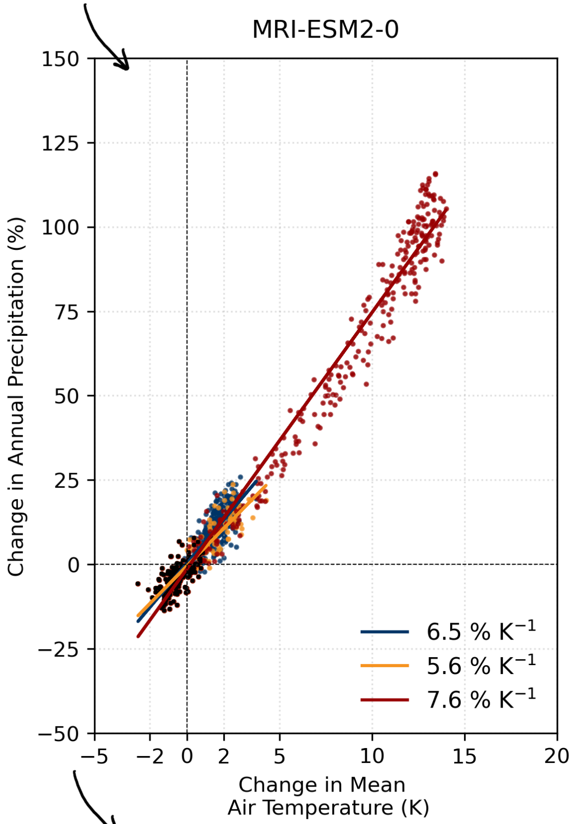
Example model result: MRI-ESM-2-0

- SSP1-26
- SSP2-45
- SSP5-85

0. Using relative changes

$$P(t) = P_0\,[\,1 + \alpha \cdot T(t)\,]$$



CMIP6 ENSEMBLE MEAN

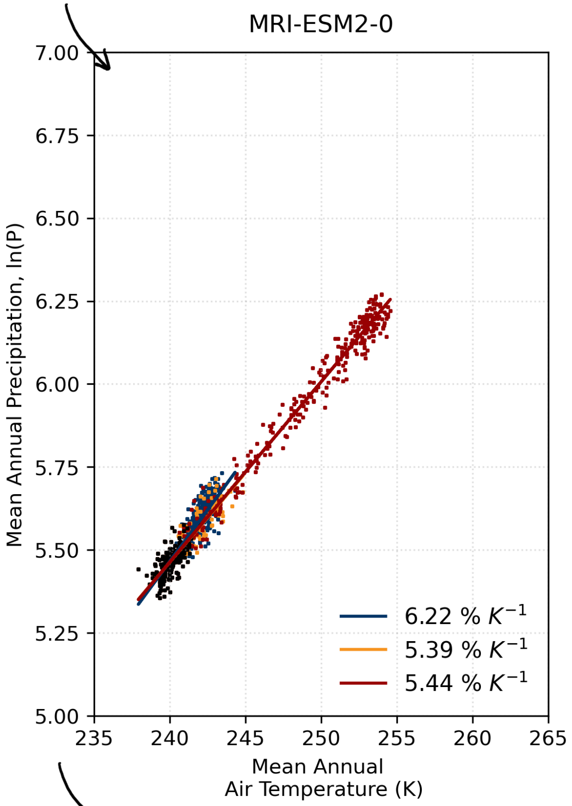
5.36 ± 1.19 % K^{-1}

5.52 ± 1.21 % K^{-1}

6.23 ± 1.82 % K^{-1}

1. Using exponential function

$$P(t) = P_0 \exp[\,\alpha \cdot T(t)\,]$$



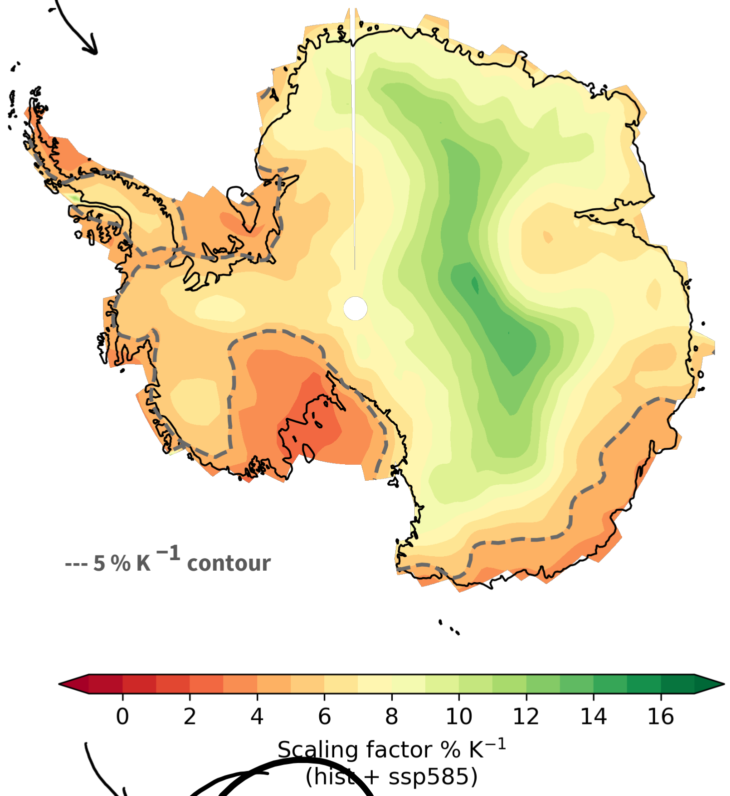
5.26 ± 1.12 % K^{-1}

5.29 ± 1.08 % K^{-1}

5.28 ± 0.93 % K^{-1}

2. Spatially resolved $\alpha = f\,(\text{lon,lat})$

$$P(t) = P_0 \exp[\,\alpha\,(\text{lon,lat}) \cdot T(t)\,]$$



$\alpha = f\,(T)$?

9.22 ± 0.99 % K^{-1}

8.53 ± 0.88 % K^{-1}

7.51 ± 0.74 % K^{-1}

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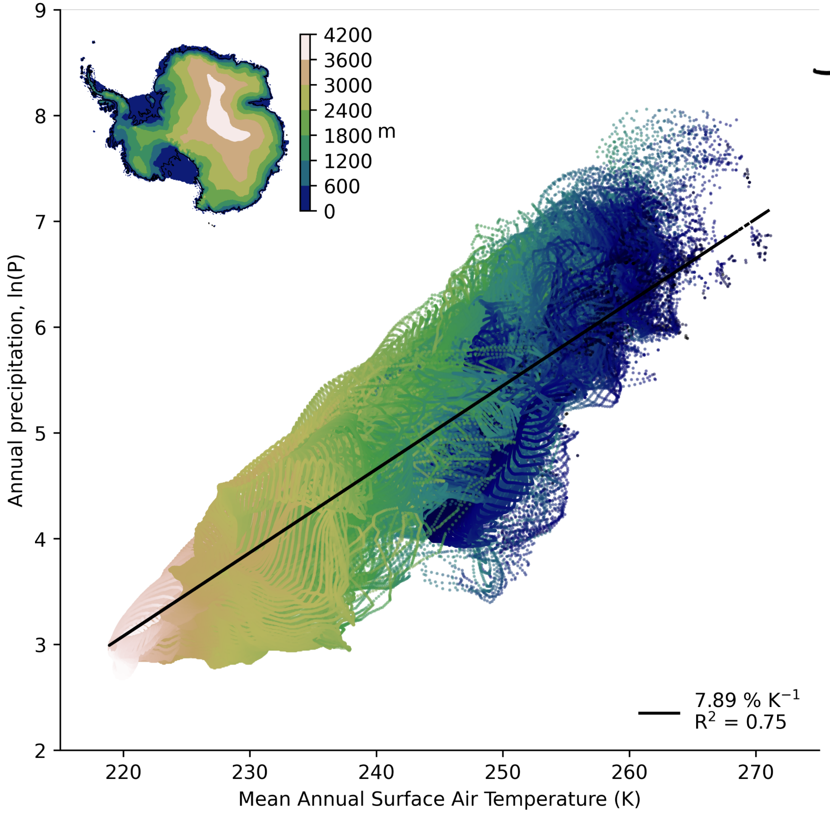
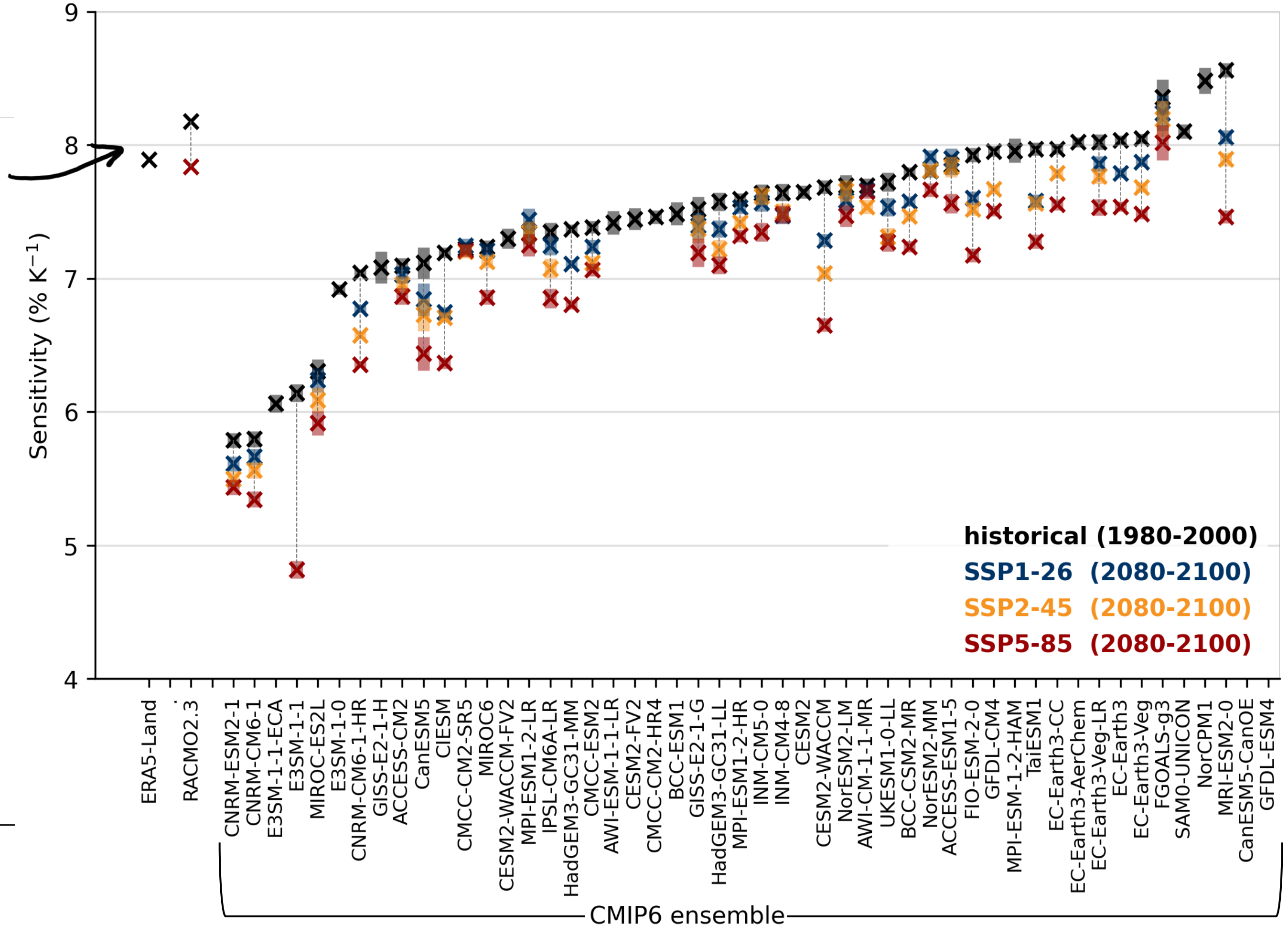
3. Temperature-dependent $\alpha = f\,(T)$?

$$P(t) = P_0 \exp[\alpha\,(\mathrm{lon,lat},T)\cdot T\,(t)]$$

ERA5-Land reanalysis (1981-2000)





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In summary ...

- **Linear approximation** to exponential function **too imprecise** for long-running simulations
- **Continent-wide scaling factor** at **5.3 % K $^{-1}$** (CMIP6)
- **Local** sensitivities **differ widely**!
- **Spatial parameterization $\alpha = f$ (lon,lat)** needed to capture local characteristics
- Local **scenario-dependent sensitivity:**

Temperature-dependent scaling factor $\alpha = f$(lon,lat, T)

needed **for high-end sea-level rise** simulations!

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THANK YOU!

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