



Norwegian  
Meteorological  
Institute

**A new factor explaining more extreme rain - the reduction in global area with rainfall.**

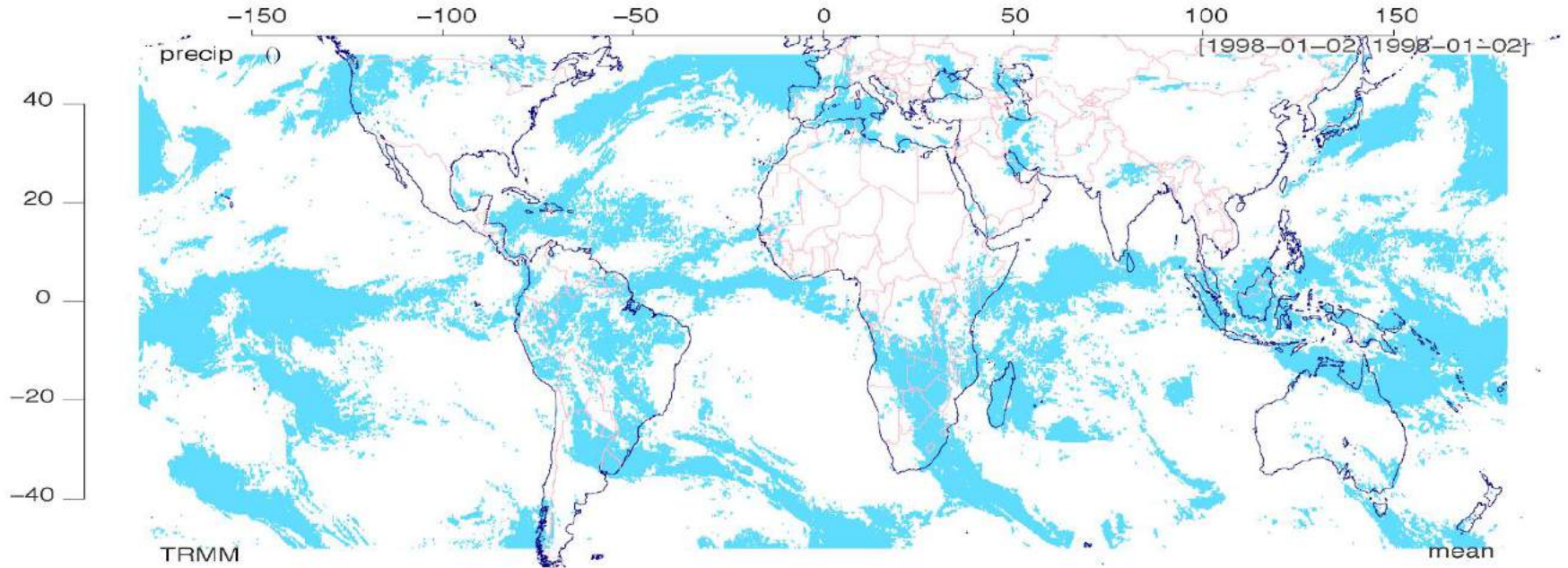
[@RasmusBenestad](#)





# Satellite data

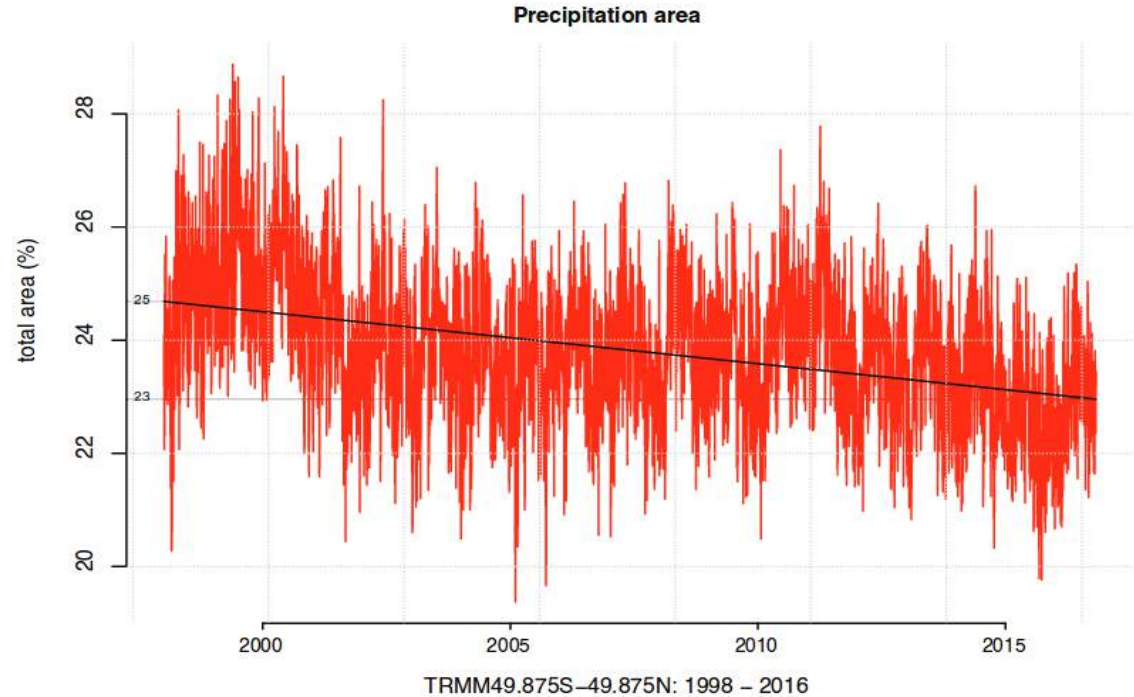
# The area of rainfall on a random day





# The area of 24-hr rainfall has decreased

More concentrated  
rain over **smaller  
area**: more floods  
and droughts



**Figure 2.** Time series of the rainfall area based on daily TRMM data expressed as the fraction of the total surface area between 50°S–50°N. A linear trend analysis indicates a change in the estimated rainfall area from 25% to 23% over the 1998–2016 period. The trend is statistically significant at the 1% level.

A photograph of a rain gauge in a field of solar panels. The rain gauge is a white, funnel-shaped device with a black cable connected to its top. It is positioned in the foreground, slightly to the left of the center. The background consists of a field of solar panels, which are white and rectangular, mounted on metal frames. The ground is covered in dry, brown grass. The sky is clear and blue. The text "Rain gauge data" is overlaid in white at the bottom of the image.

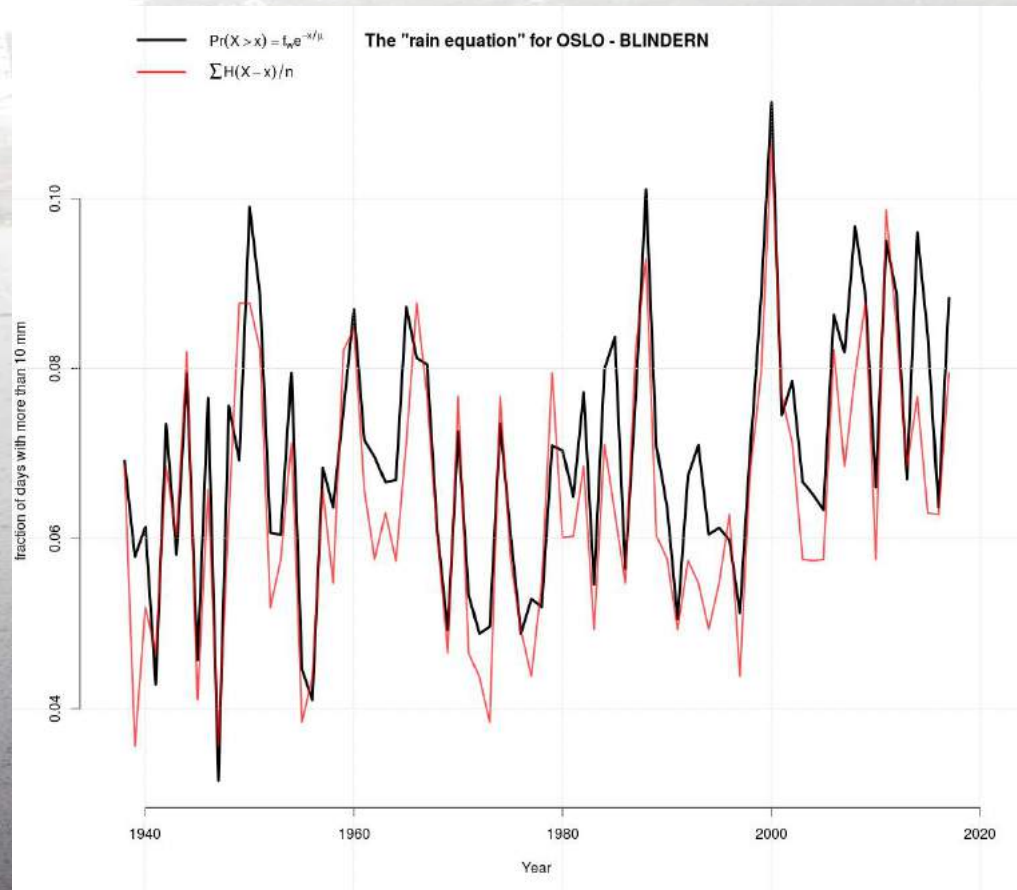
**Rain gauge data**

# Probability of heavy rain

$$\Pr(X > x) = f_w e^{-\frac{x}{\mu}}$$

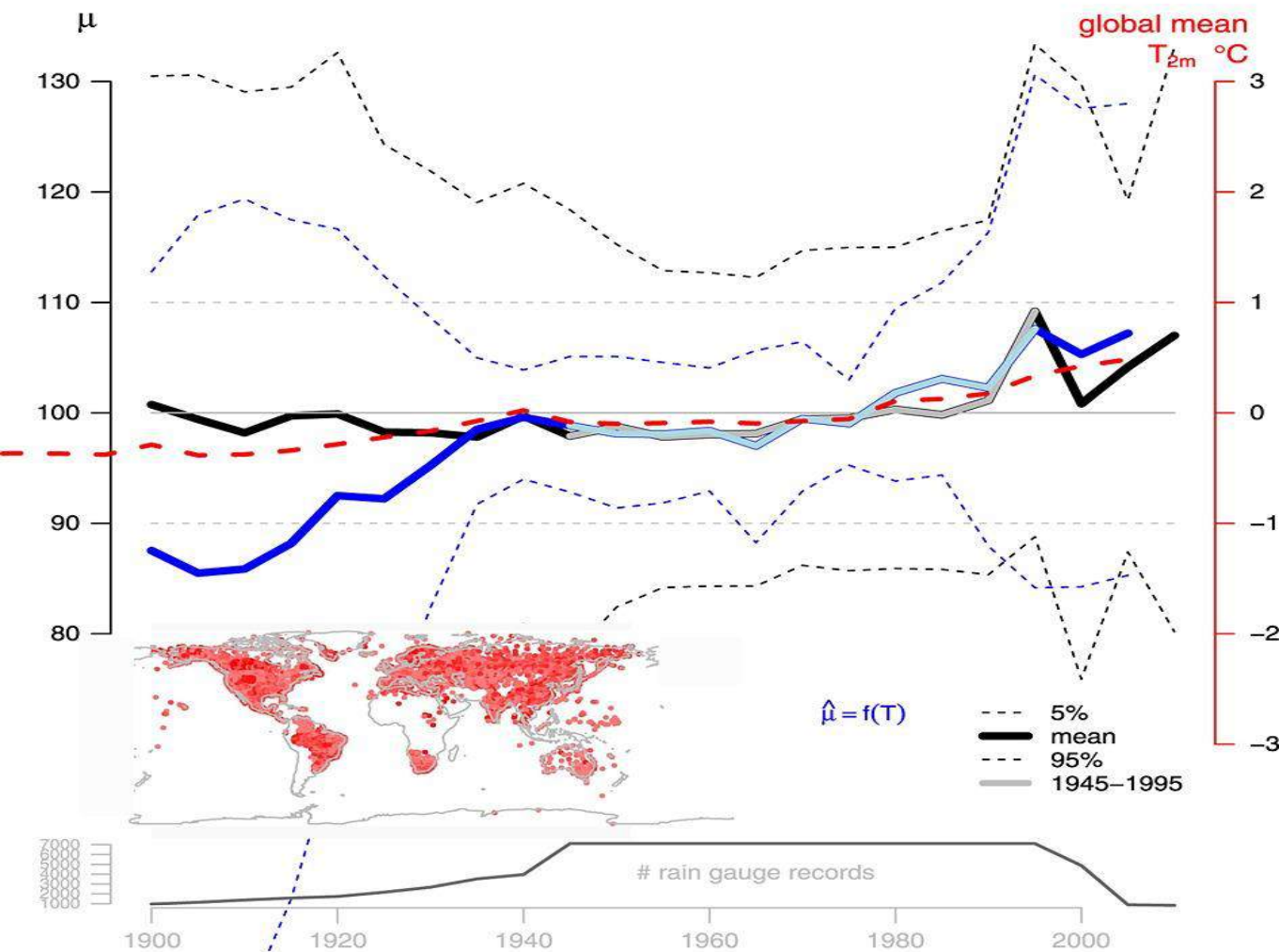
$f_w$  = wet-day frequency

$\mu$  = wet-day mean  
precipitation





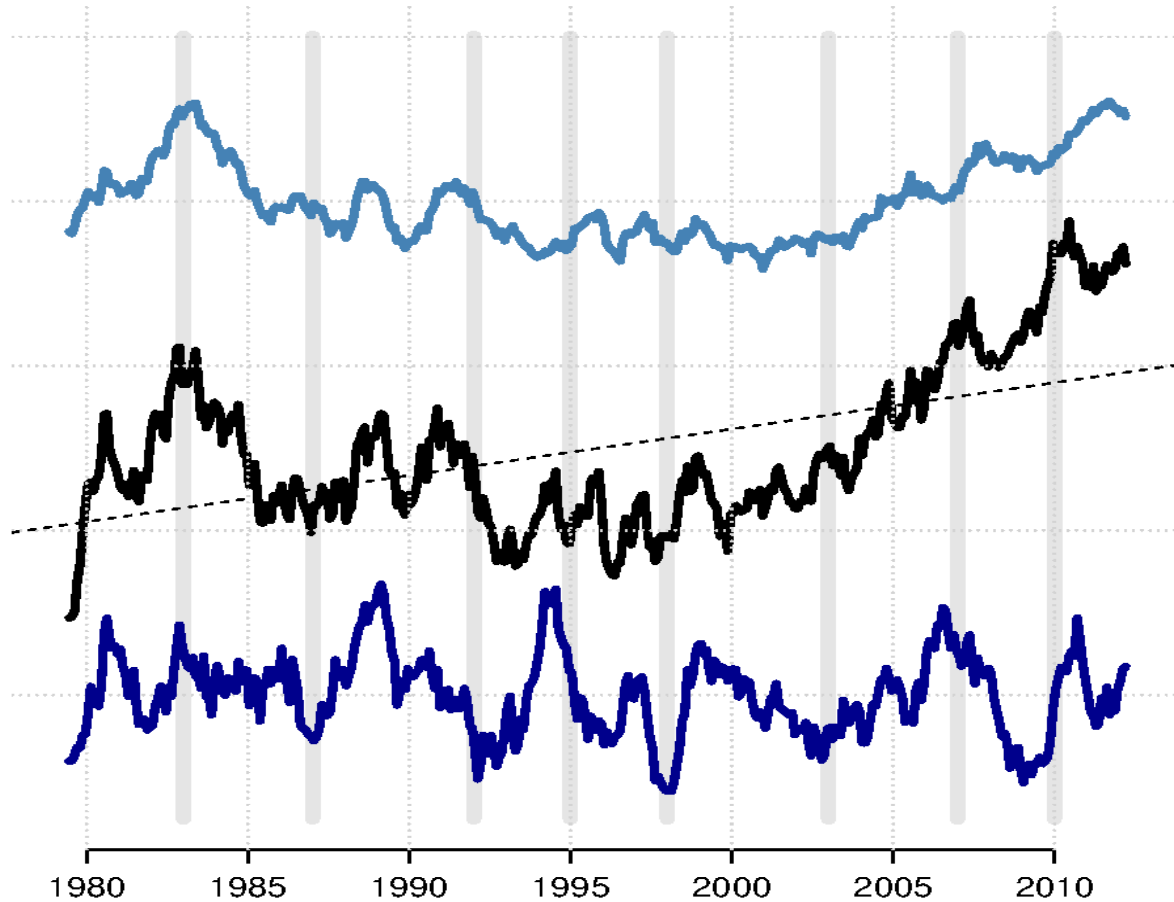
# Global statistics for $\mu$





- 
- **Changes in convection and cloud climatology?**

## Atmospheric overturning anomaly



$$\eta(z, t) = \text{var}_i(a_i w_i(z, t)) \rho(z)$$

**Upper  
troposphere  
(> 6.5 km)**

**Middle  
troposphere  
(1.0-6.5 km)**

**Lower  
troposphere (<  
1.0 km)**

# Summary

- Three explanations for more extreme rains: (1) vapour concentration, (2) higher clouds, (3) **smaller rainfall area**
- More **atmospheric overturning** and changed clouds
- More **floods** and **droughts** expected with smaller rainfall area
- **Additional indicators** on climate change: atmospheric overturning, precipitation area.

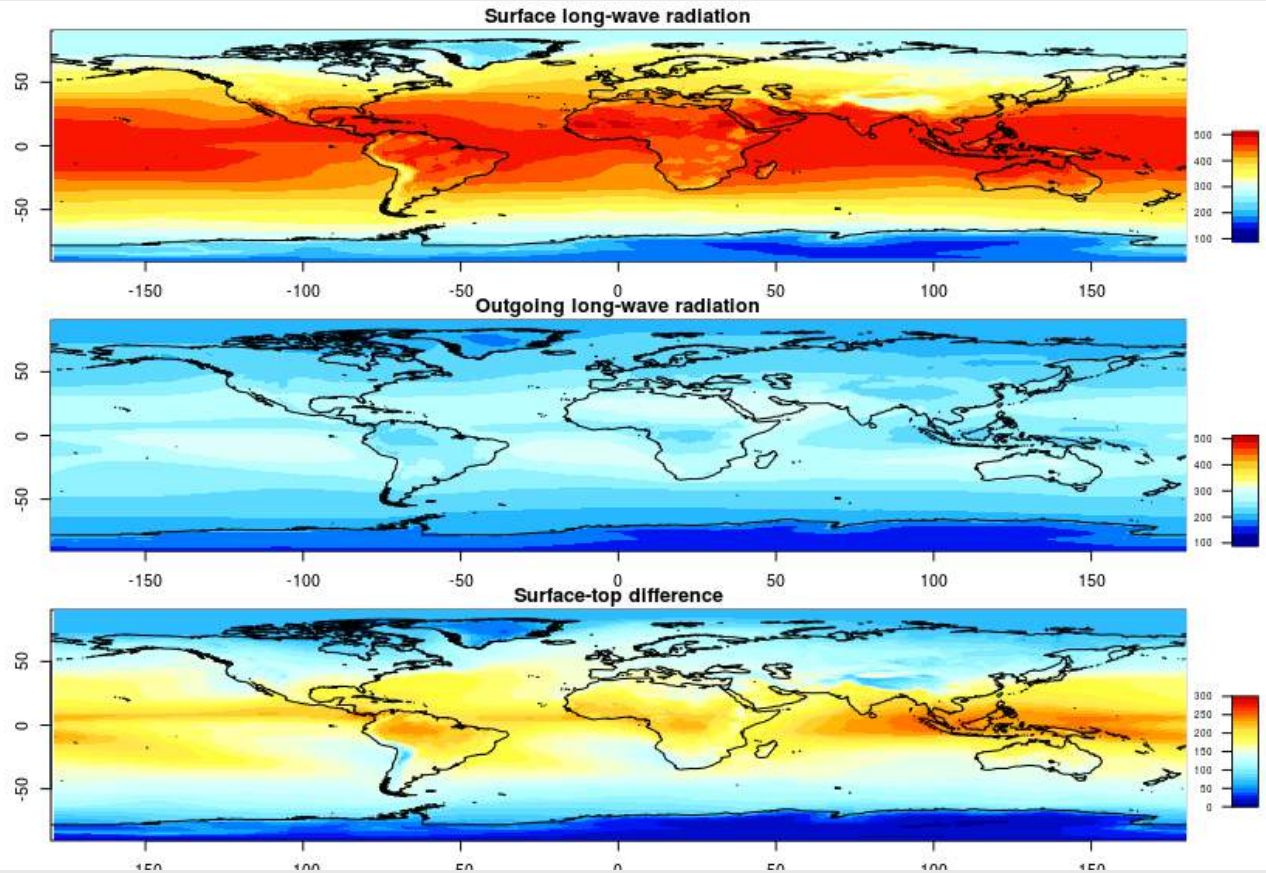




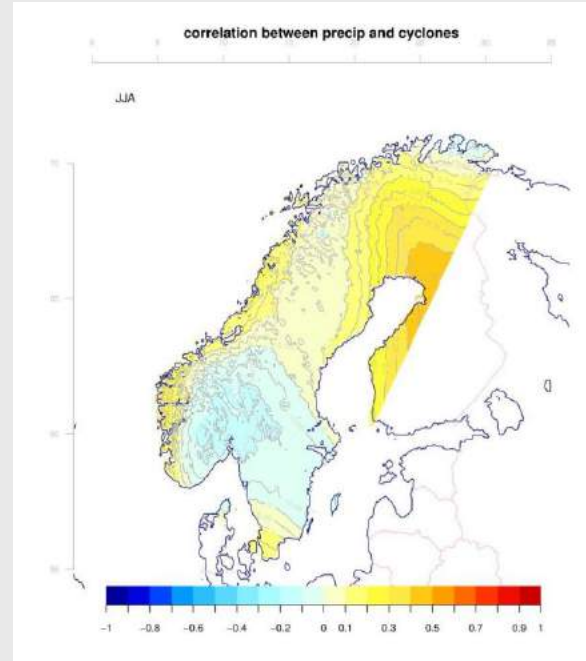
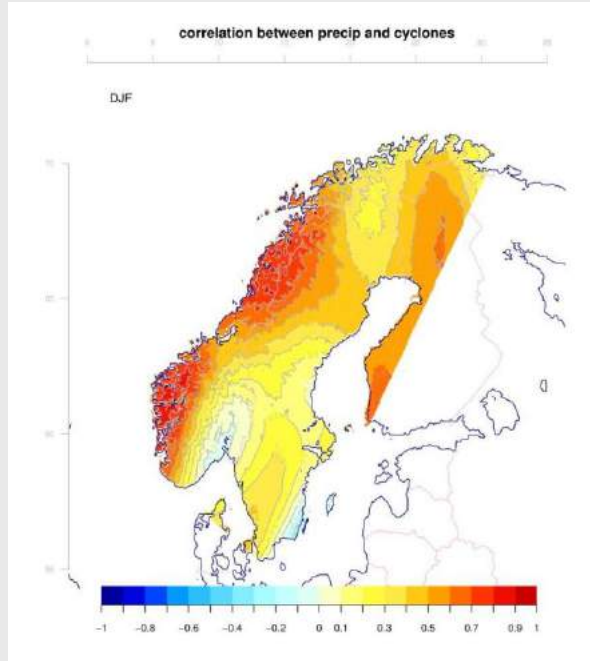
Norwegian  
Meteorological  
Institute

# Thank you for your attention!

# Heat loss

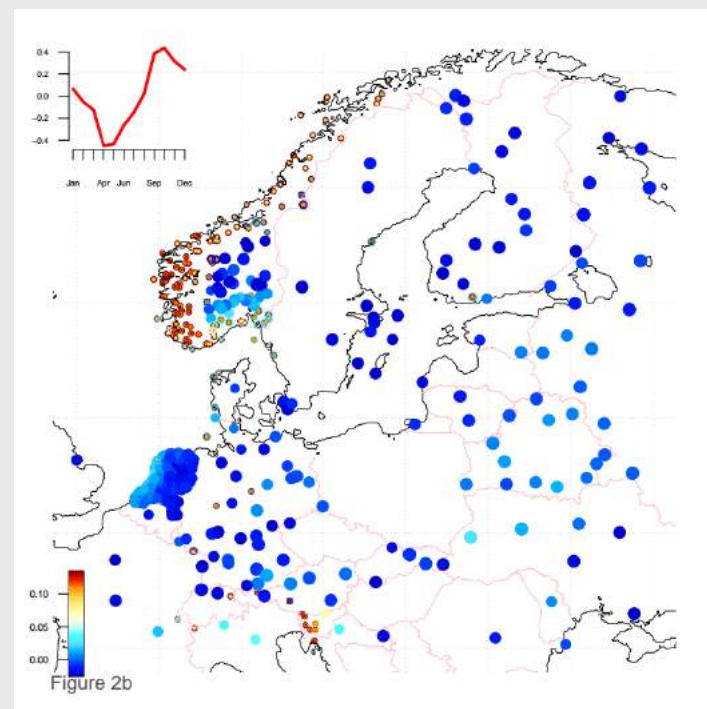
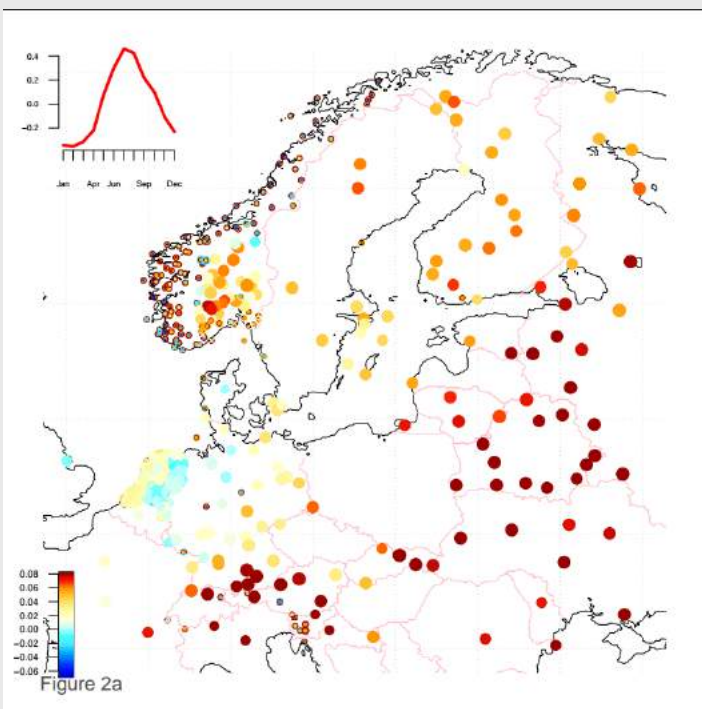


# Precipitation & mid-latitude cyclones



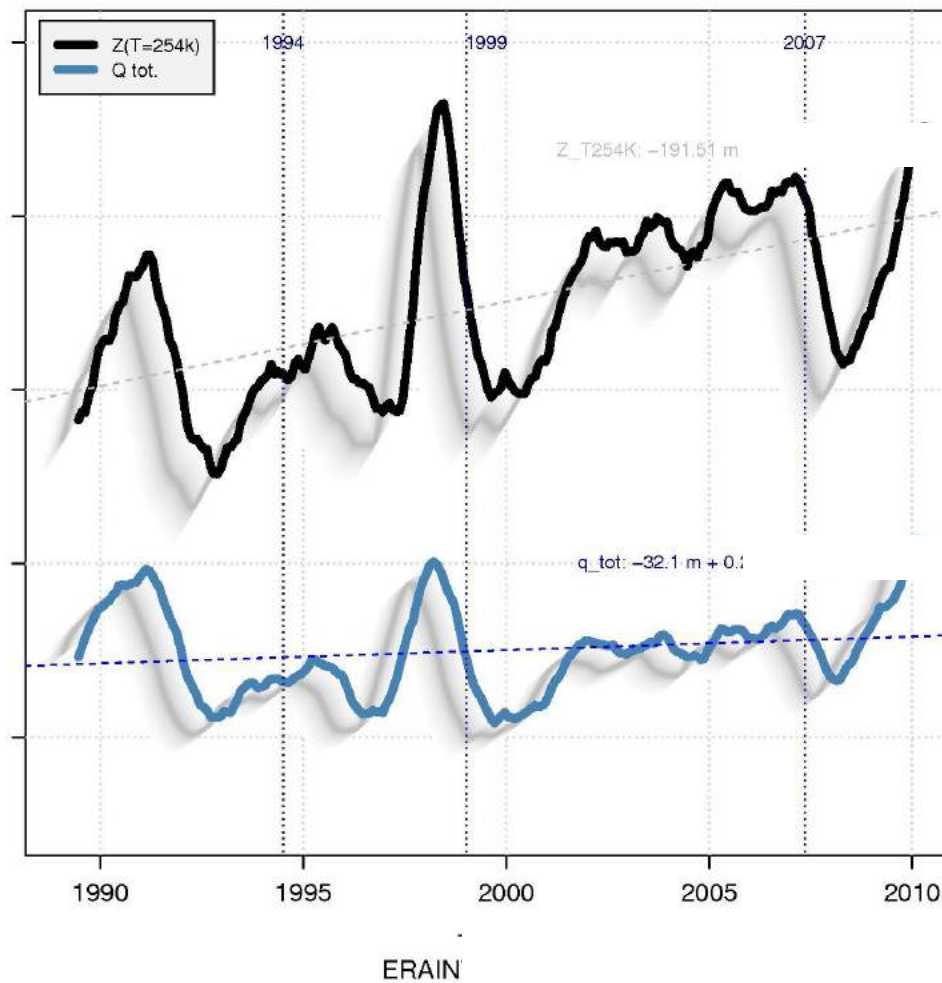
Mid-latitude cyclones more important in winter on the west coast (left) and less important for summer showers (right).





Geographically different mean seasonal-cycle in wet-day mean precipitation reflect different precipitation generating mechanisms.

## Atmospheric bulk emission level and moisture



# More precipitation in the Tropics

