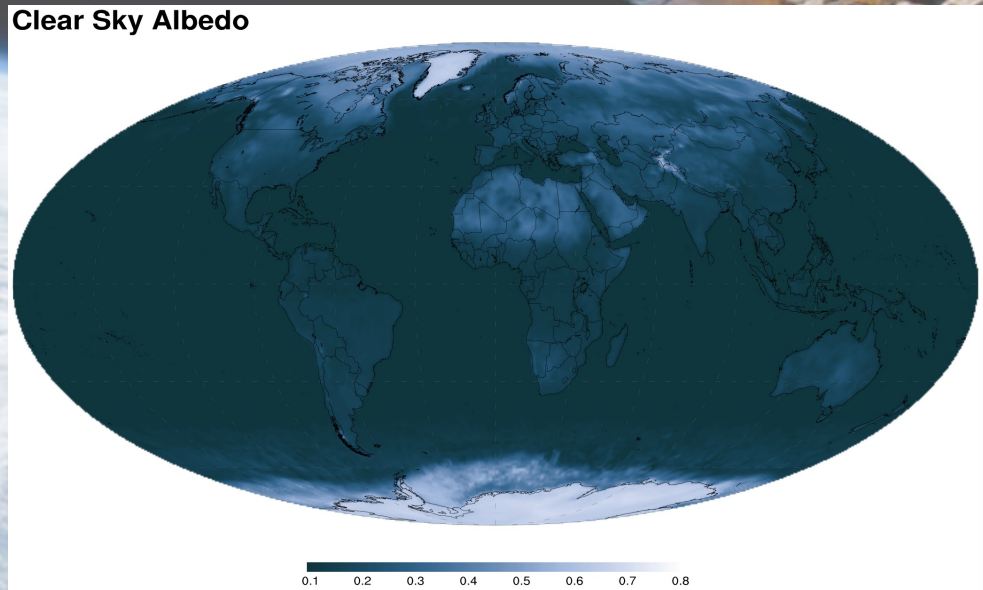
מכון ויצמן למדע
WEIZMANN INSTITUTE OF SCIENCE

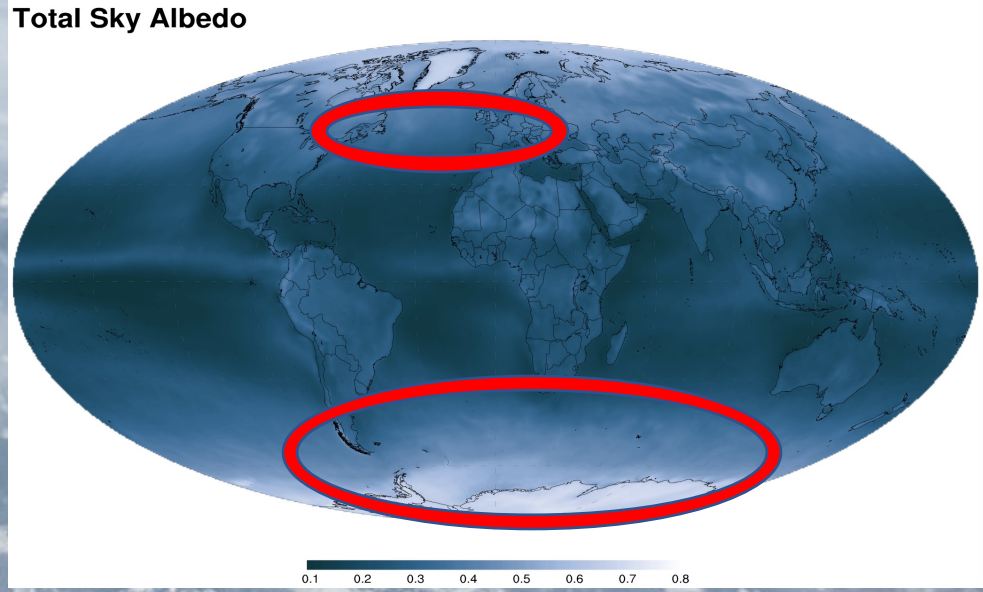
The Role of Baroclinic Activity in Controlling Earth's Albedo in the Present and Future Climates

Or Hadas, Yohai Kaspi, Joaquin Blanco, Rodrigo Caballero, George Datseris, Bjorn Stevens, Sandrine Bony

Albedo symmetry

- Albedo: the amount of reflected sunlight
- The NH clear sky albedo is higher by 16%
- Balanced by a Cloudier SH.



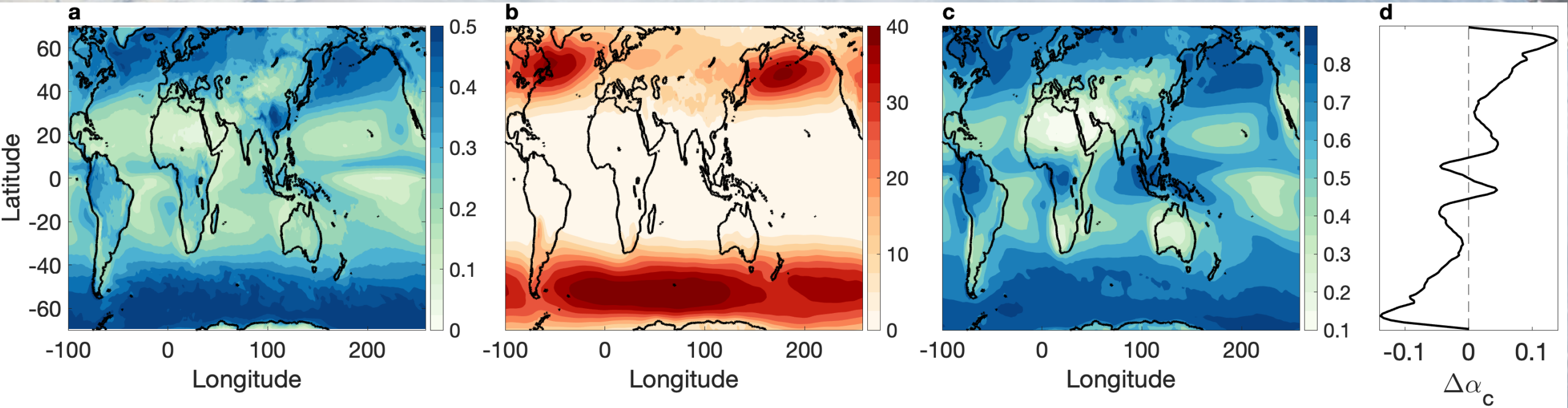


From: CERES-Aqua, NASA

Albedo and baroclinic activity

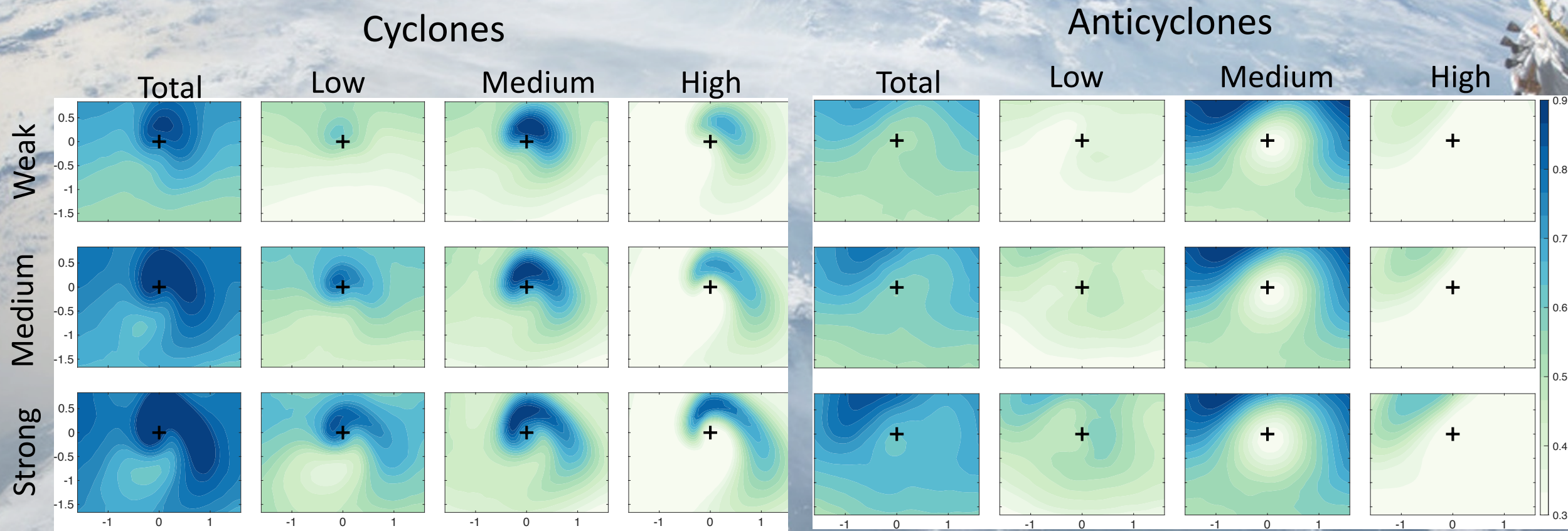
- The main contributor is the midlatitude
- Eddy kinetic energy and albedo (and cloudiness) are highly correlated

Cloud Albedo | Eddy Kinetic Energy | Cloud Cover | ΔAlbedo



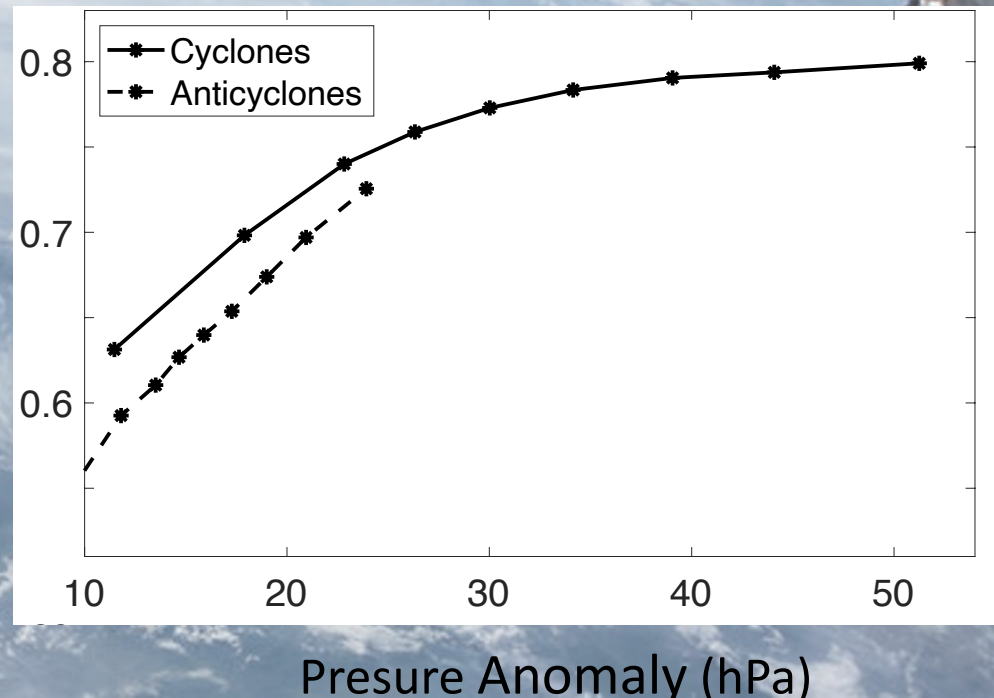
Single Storm Perspective

- Strong barcolinic eddies create more clouds
- Cyclone: more high and mid clouds in the warm sector
- Anticyclones: more low clouds in the downdraft region



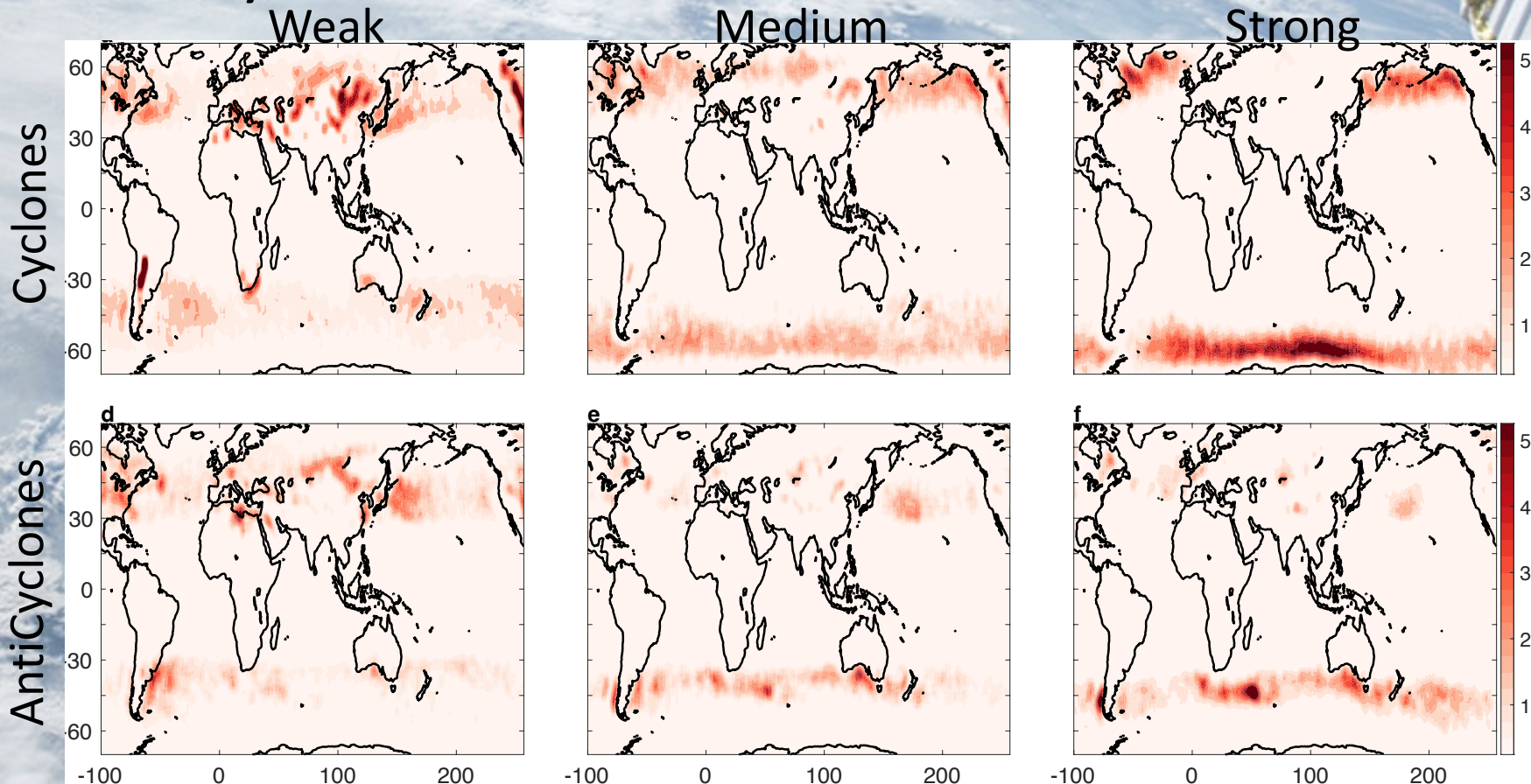
Single Storm Perspective

- For anticyclones, the relation is quite linear.
- However, the curve saturates for strong cyclones.



Storm Distribution

- Weak Cyclones are mostly in the NH and over land
- Strong cyclones are mostly over the SH and over Ocean

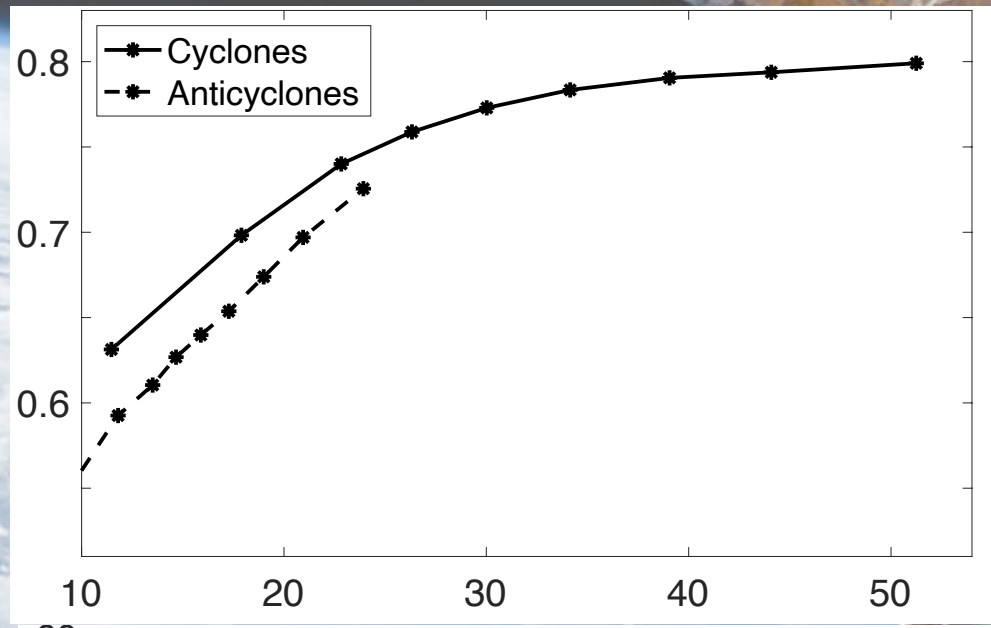


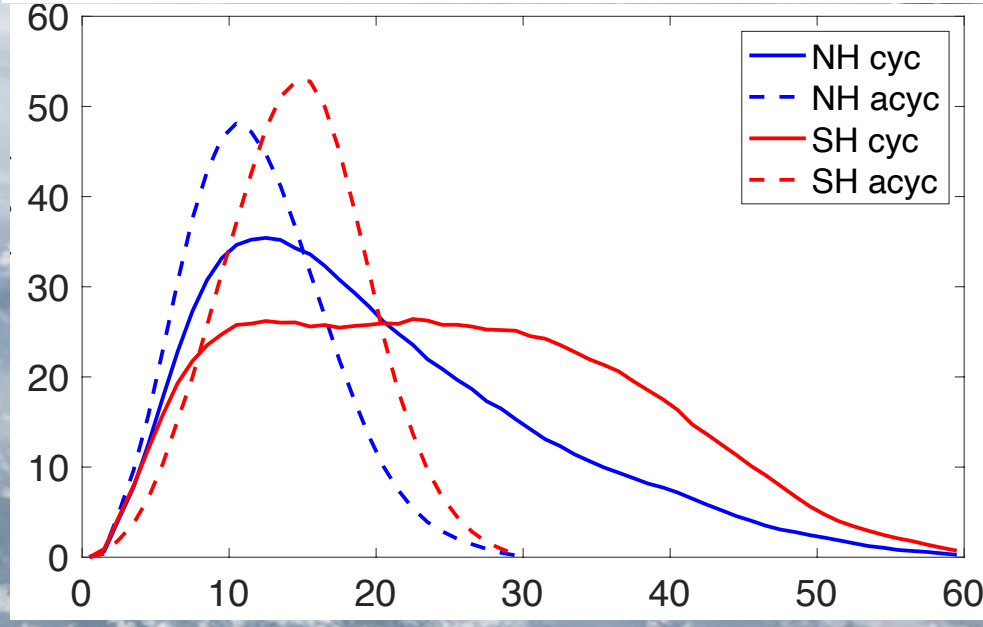
Hemispheric Cloud Asymmetry

- Using this relations and the distribution of eddies we can calculate the expected difference in clouds:
  - ERA5 difference: 15%
  - MODIS difference: 17%
  - Calculated difference: 18%
    (12% cyclones, 6% anticyclones)

$$\mathrm{TCC}_{\mathrm{cyc}} \sim \sum_i \sigma(s_i) \cdot N_i \,,\; \mathrm{TCC}_{\mathrm{acyc}} \sim \sum_i \lambda(s_i) \cdot N_i,$$

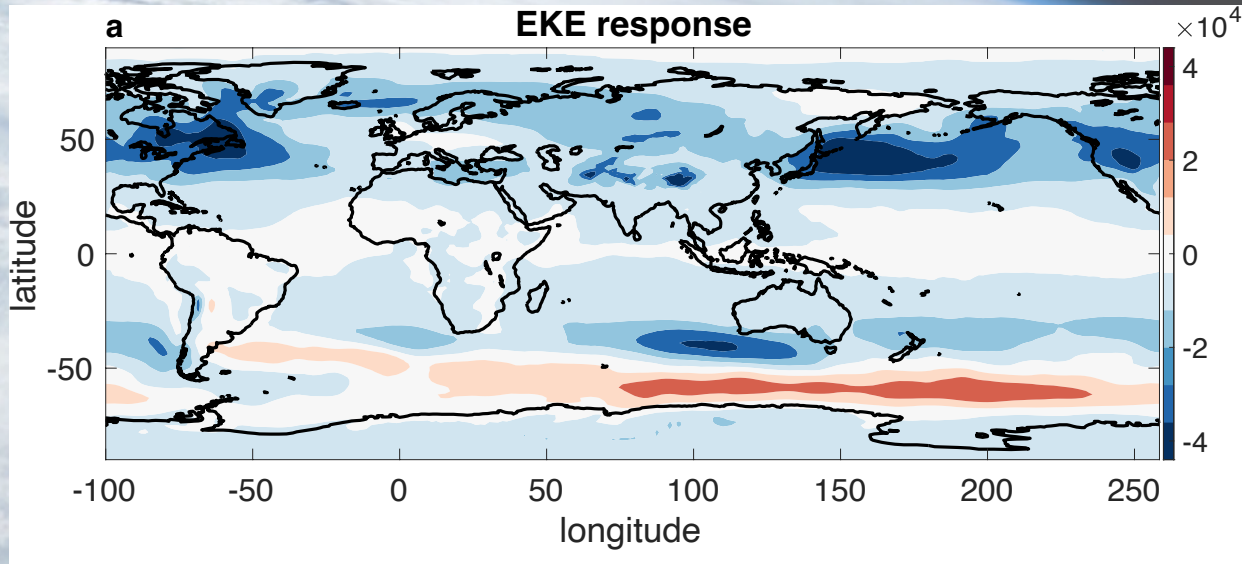
$$\mathrm{TCC} = \mathrm{TCC}_{\mathrm{cyc}} + \mathrm{TCC}_{\mathrm{acyc}}$$

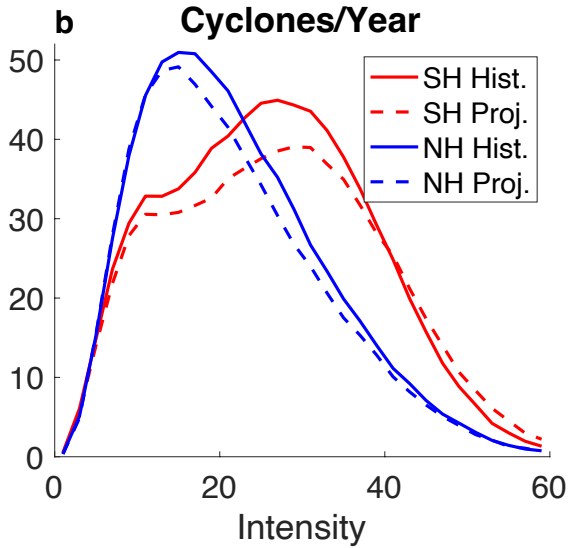


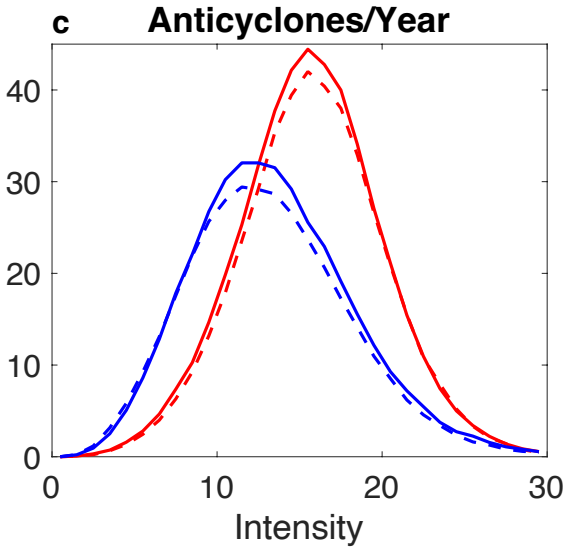


Albedo Symmetry in Future Climate

- CMIP6 prediction: stronger NH weakening.
- This allegedly mean symmetry breaking.

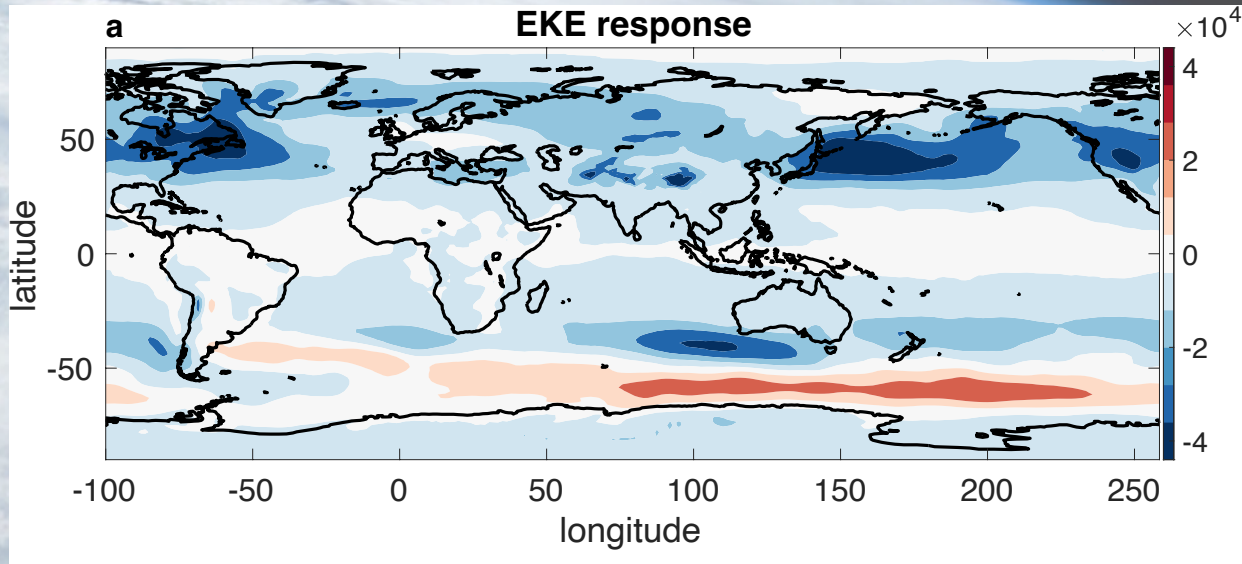


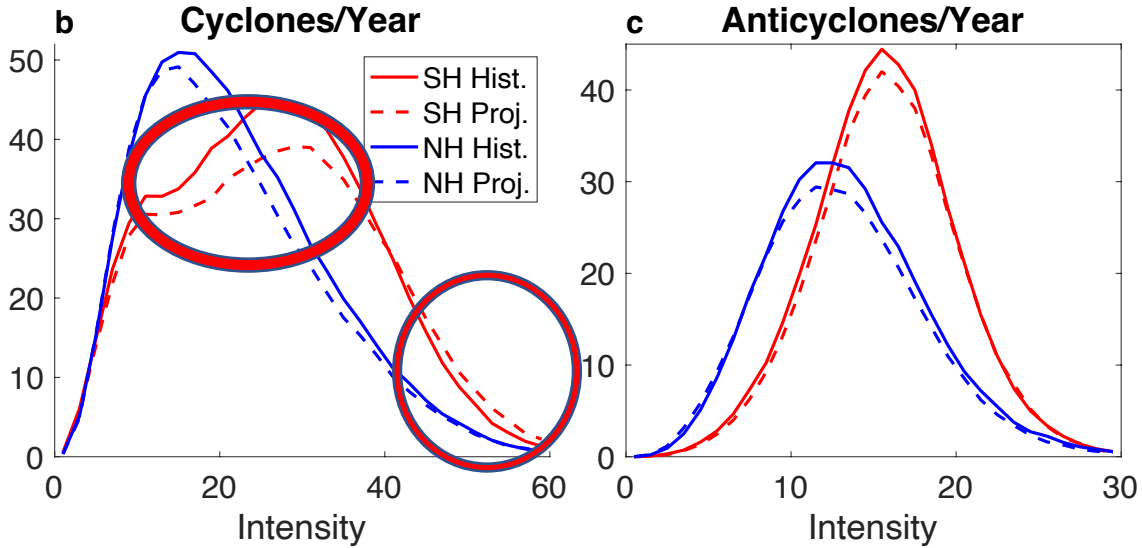




Albedo Symmetry in Future Climate

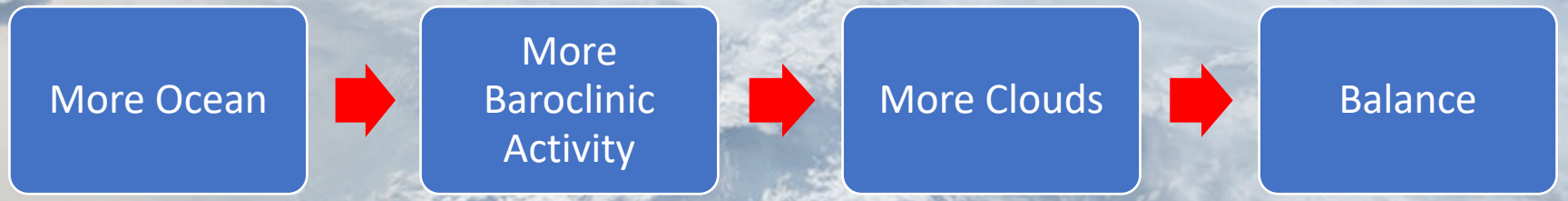
- The calculated cloudiness, based on the intensity-cloudiness relation and the predicted storm distributions predict a possible preservation of the symmetry.
- This is due to skewness increase of the SH cyclone intensity distribution.





Conclusions

- EKE and cloudiness are highly corelated.
- Strong baroclinic eddies are cloudier.
- The hemispheric difference in cloudiness can be predicted by the difference in storminess.



- The CMIP6 storminess response predict that this symmetry might persist in future climate.