Cloud, radiation, and precipitation changes with midlatitude strenght and frequency and the resulting climate feedbacks in simulations and models

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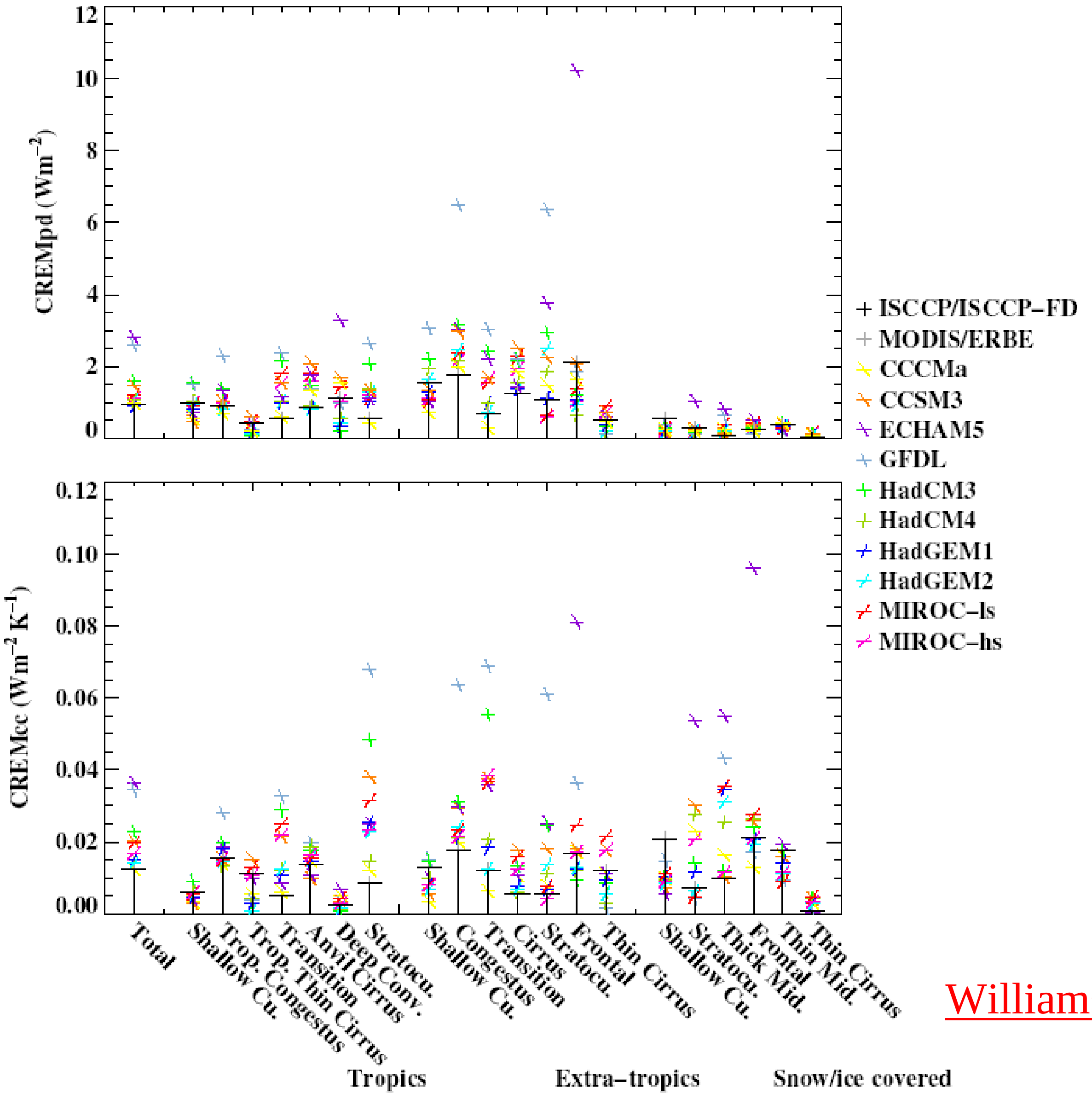
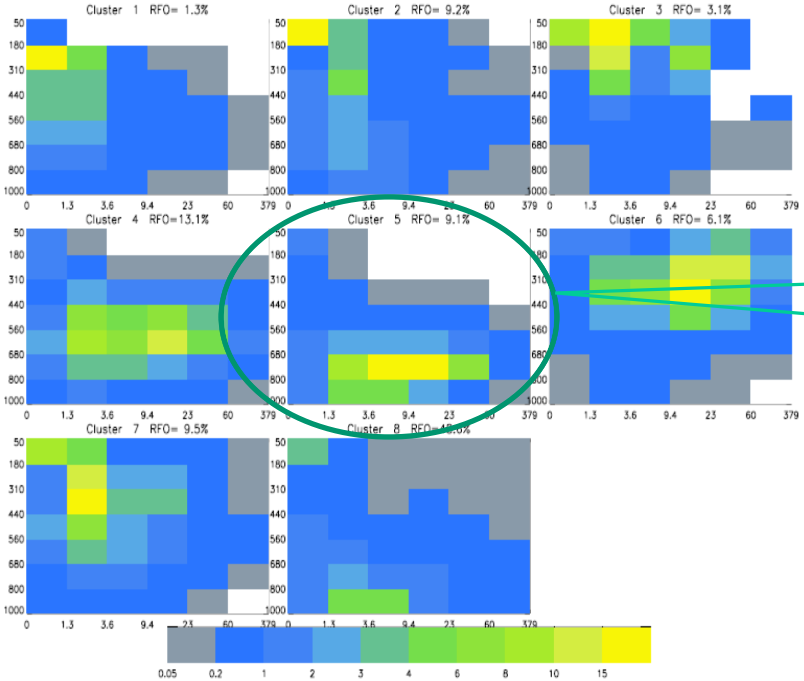
Extratropical clouds, contrary to popular belief, produce the largest spread among GCM cloud radiative signatures

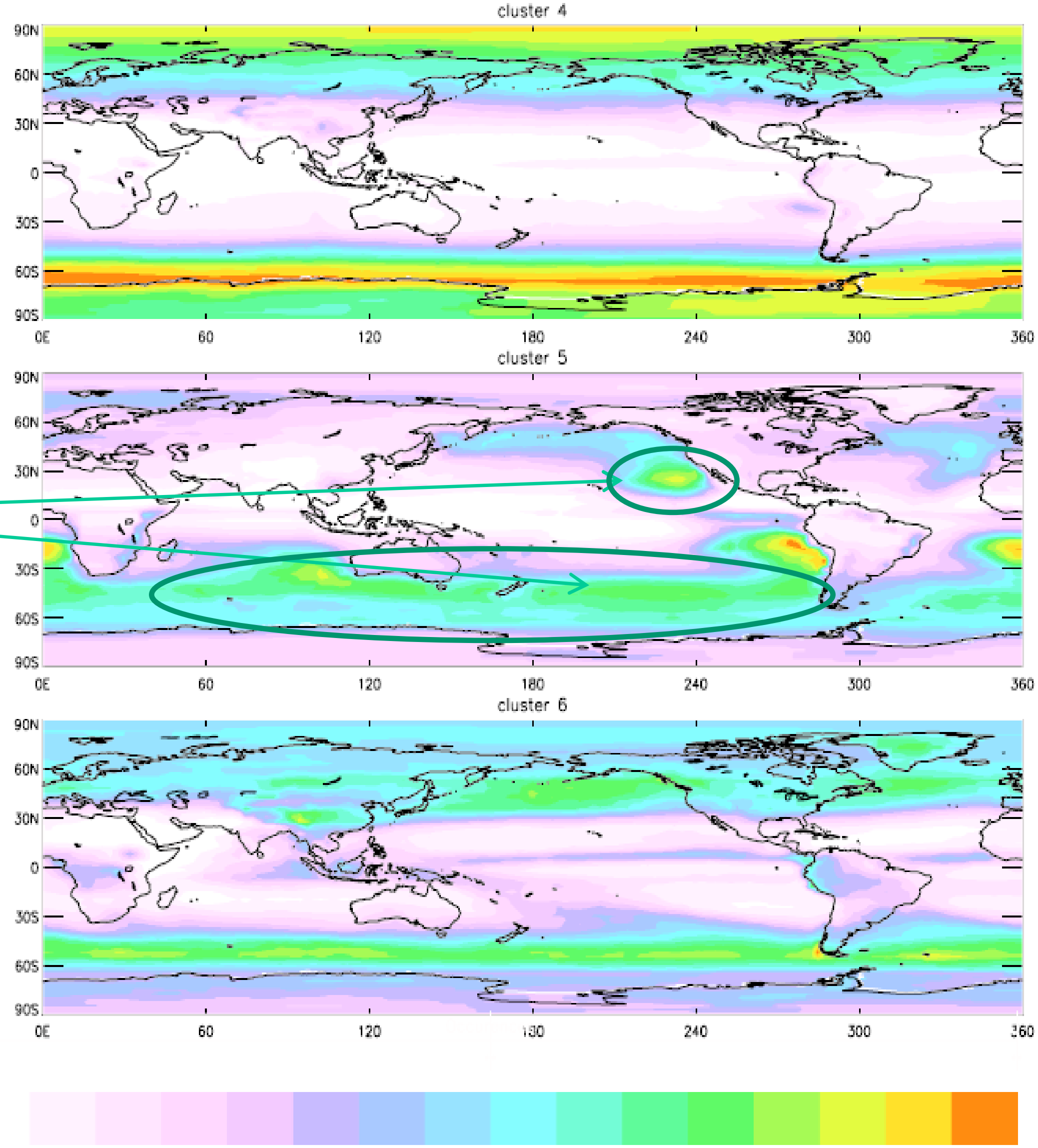
Cloud-type contributions to model spread in TOA radiation/feedbacks



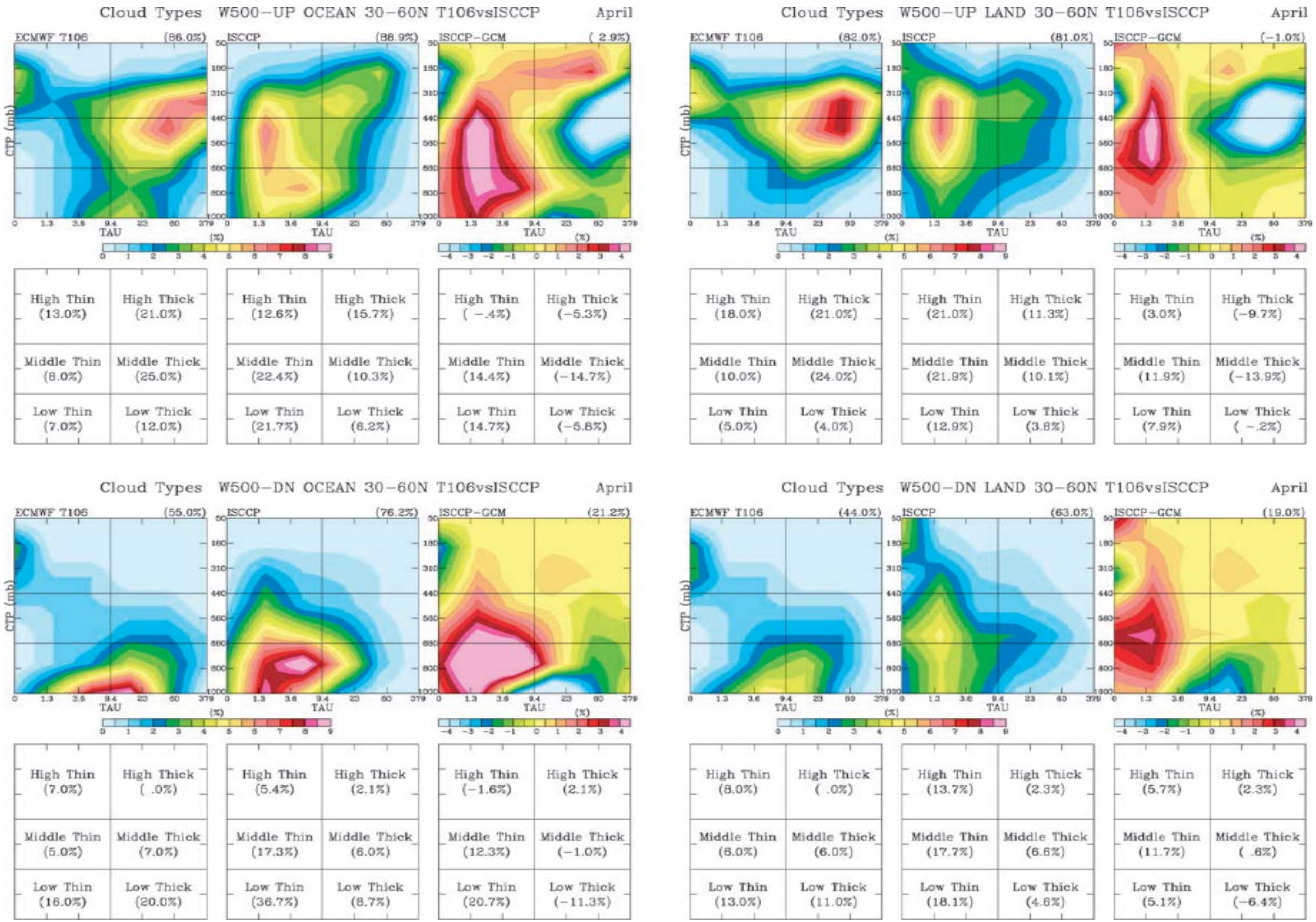
Williams and Webb 2008

Preliminary results of global cluster analysis`





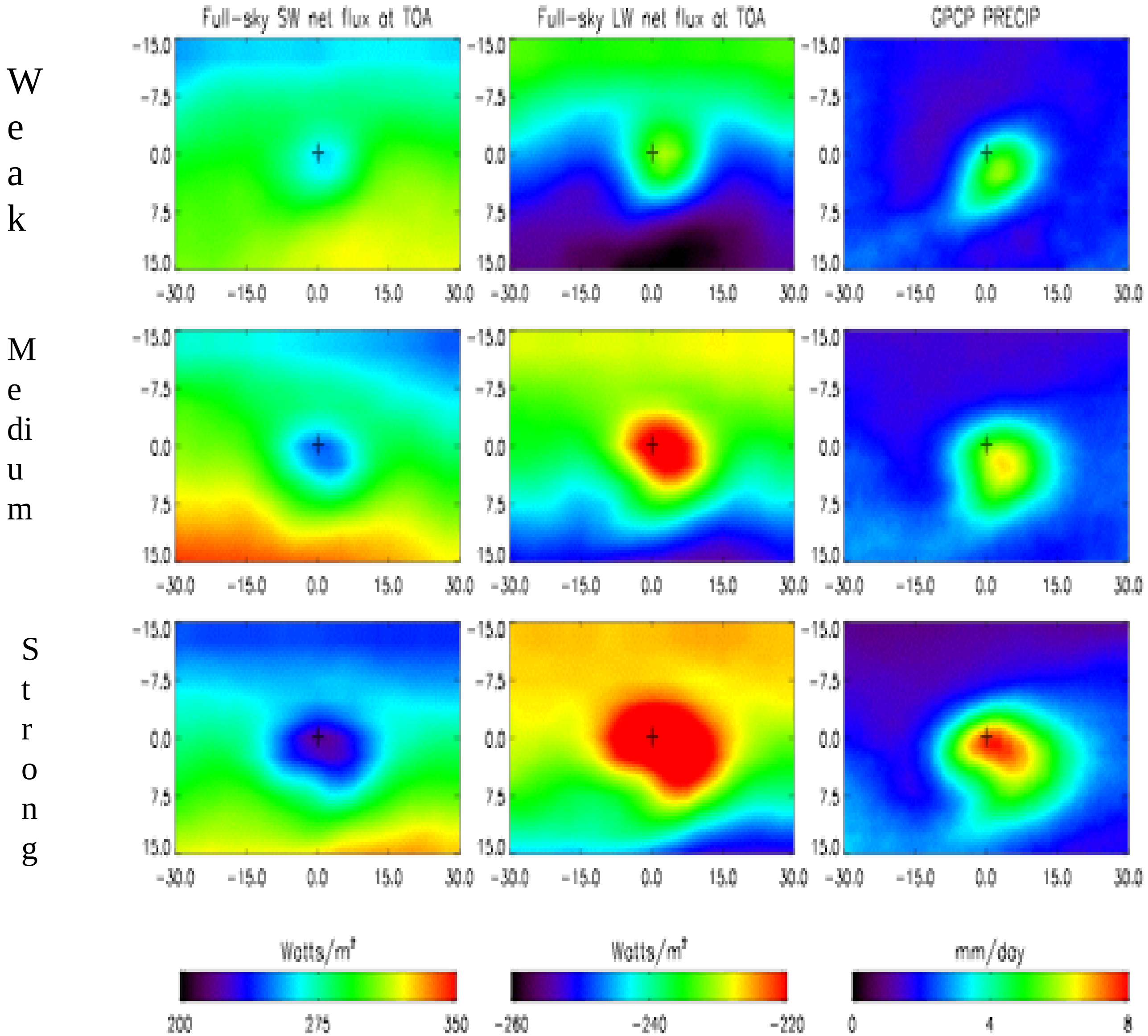
Why do we treat subtropical and extratropical stratocumulus clouds separately?



Low clouds in subsidence regime are the main source of error in midlatitude cloud simulations

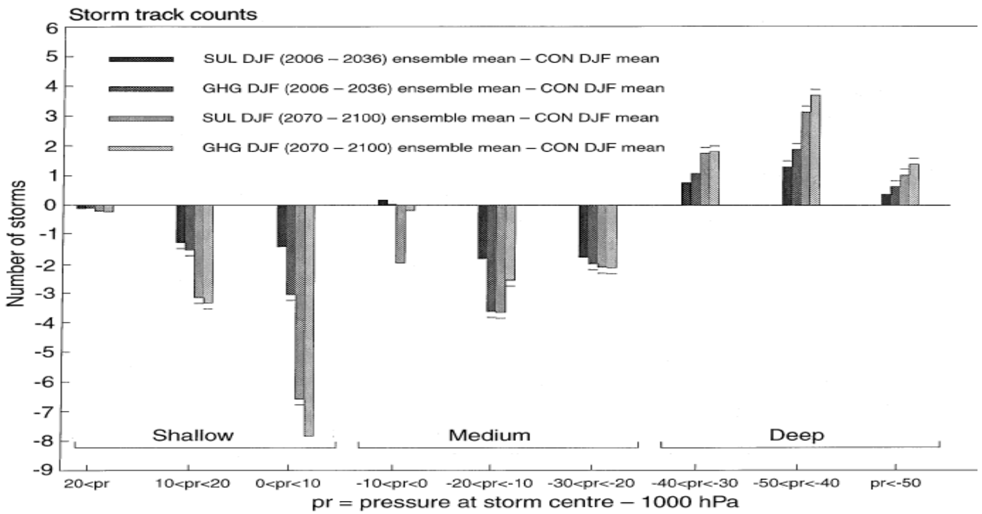
Tselioudis and Jakob 2004

How do radiation and precipitation fields change with storm strength and frequency?



Tselioudis and Rossow 2007

UKMO prediction for 2XCO2 storm changes (Carnell and Senior 1998)



What if the UKMO prediction materialized?

	30-65N DJF		30-65N JJA	
	SW (W/m²)	LW (W/m²)	SW (W/m²)	LW (W/m²)
Storm Strength ⬆	-3,7	+1.5	-1.9	+1.6
Storm Frequency ⬇	+2.6	-1.4	+1.9	-1.0
Total	-1.1	+0.1	0.0	+0.6
	30-65S JJA		30-65S DJF	
	SW (W/m²)	LW (W/m²)	SW (W/m²)	LW (W/m²)
Storm Strength ⬆	-4.9	+2.5	-3.7	+1.4
Storm Frequency ⬇	+1.4	-0.3	+1.9	-0.4
Total	-3.5	+2.2	-1.8	+1.0

Table 1: Net TOA shortwave and longwave flux changes with storm strength and frequency

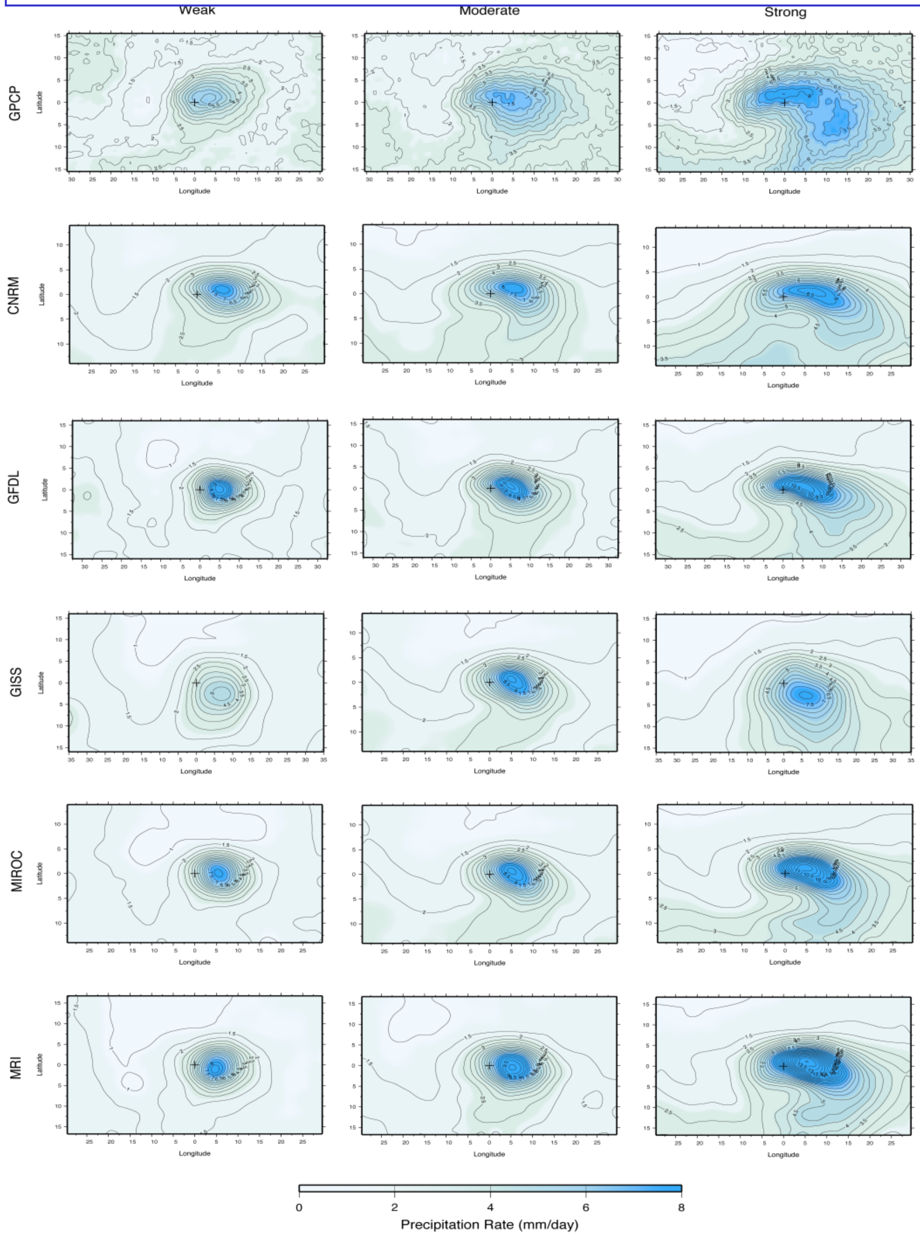
	Precipitation (mm/day) 30-65N	
	DJF	JJA
Storm Strength ⬆	+0.10	+0.08
Storm Frequency ⬇	-0.02	-0.03
Total	+0.08	+0.05

Table 1: Net precipitation changes with storm strength and frequency

GO → F
GCM → F

Tselioudis and Rossow 2007

Precipitation Changes with Storm Strength in Observations and in IPCC Models

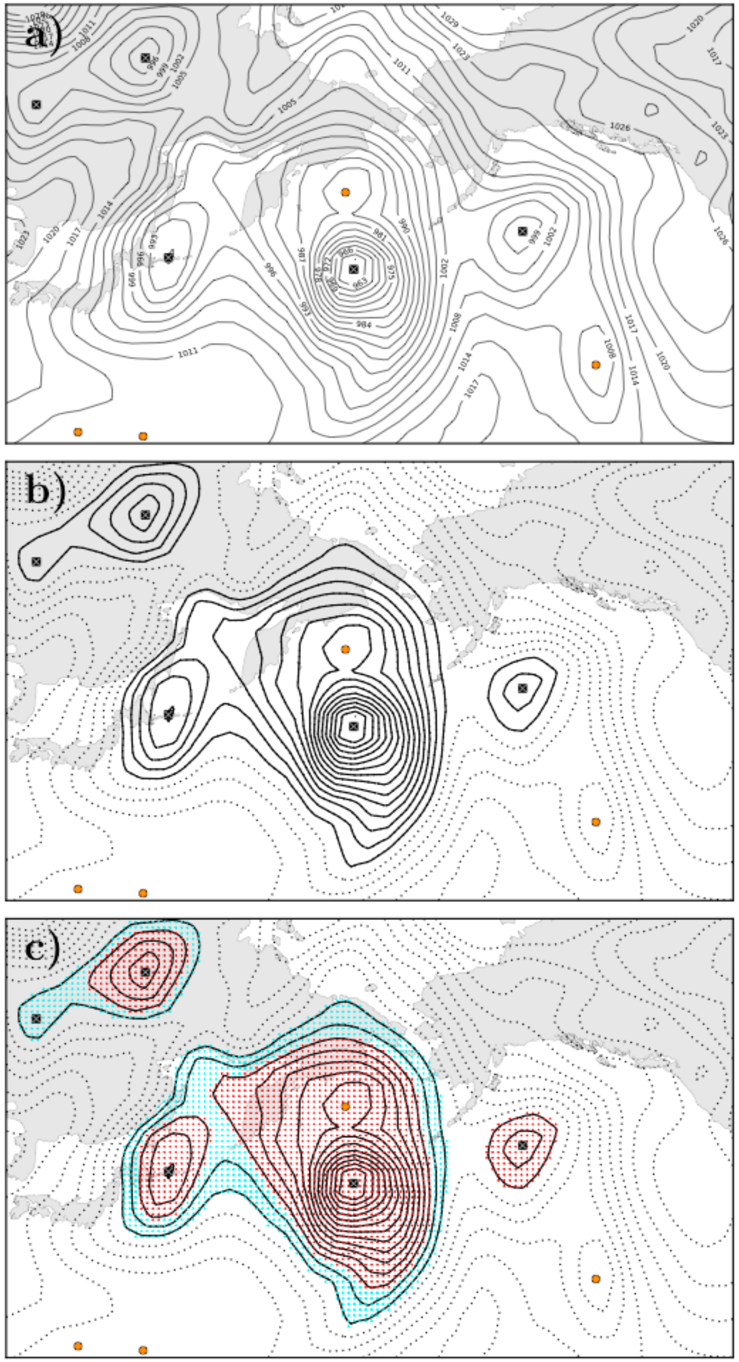


Problems in using GCMs to derive F

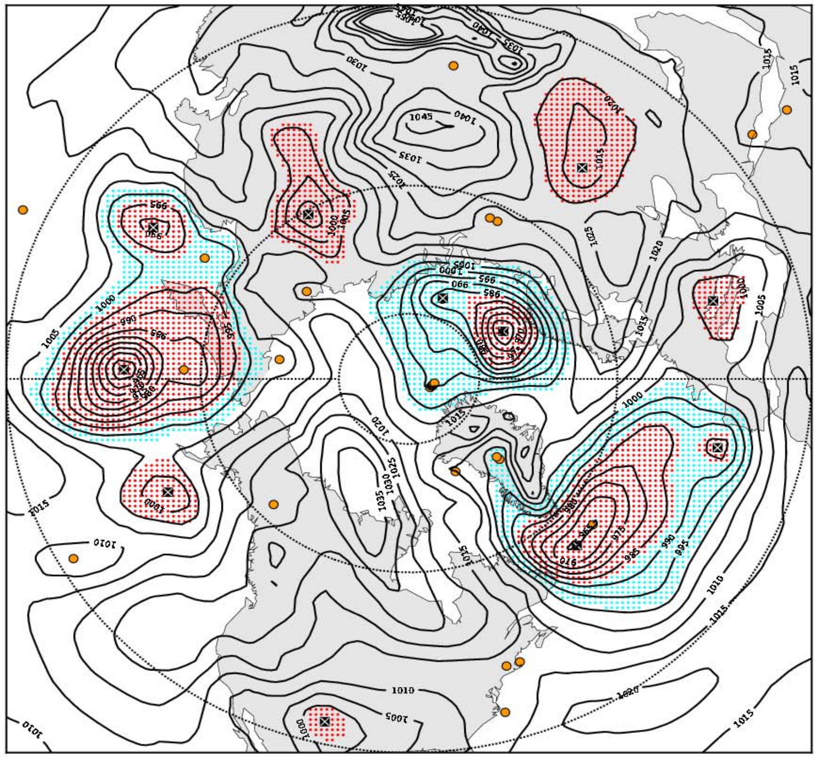
Calculation of midlatitude precipitation changes with climate assuming UKMO-predicted storm changes

	Storm Strength	Storm Frequency	Total
GPCP	+0.1 (mm/day)	-0.02 (mm/day)	+0.08 (mm/day)
CNRM	+0.08	-0.14	-0.06
GFDL	+0.08	-0.11	-0.03
GISS	+0.05	-0.10	-0.05
MIROC	+0.08	-0.11	-0.03
MRI	+0.10	-0.11	-0.01

•All models estimate correctly the increase in precipitation due to increasing storm strength but overestimate the decrease in precipitation due to decreasing storm frequency. This is because all models produce very little midlatitude precipitation outside storm events. As a result, models produce a negative rather than a positive precipitation feedback when the two UKMO-predicted storm changes are applied together

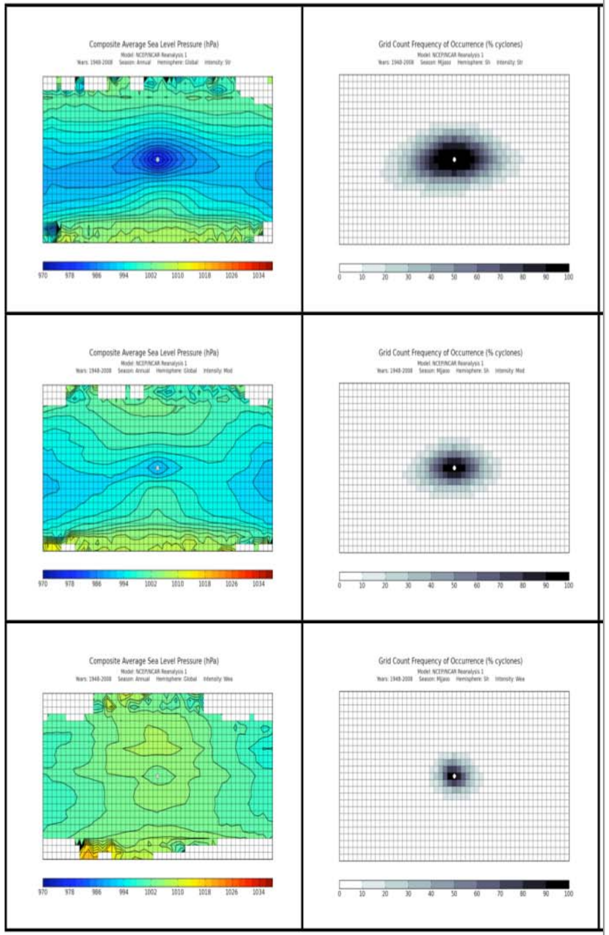


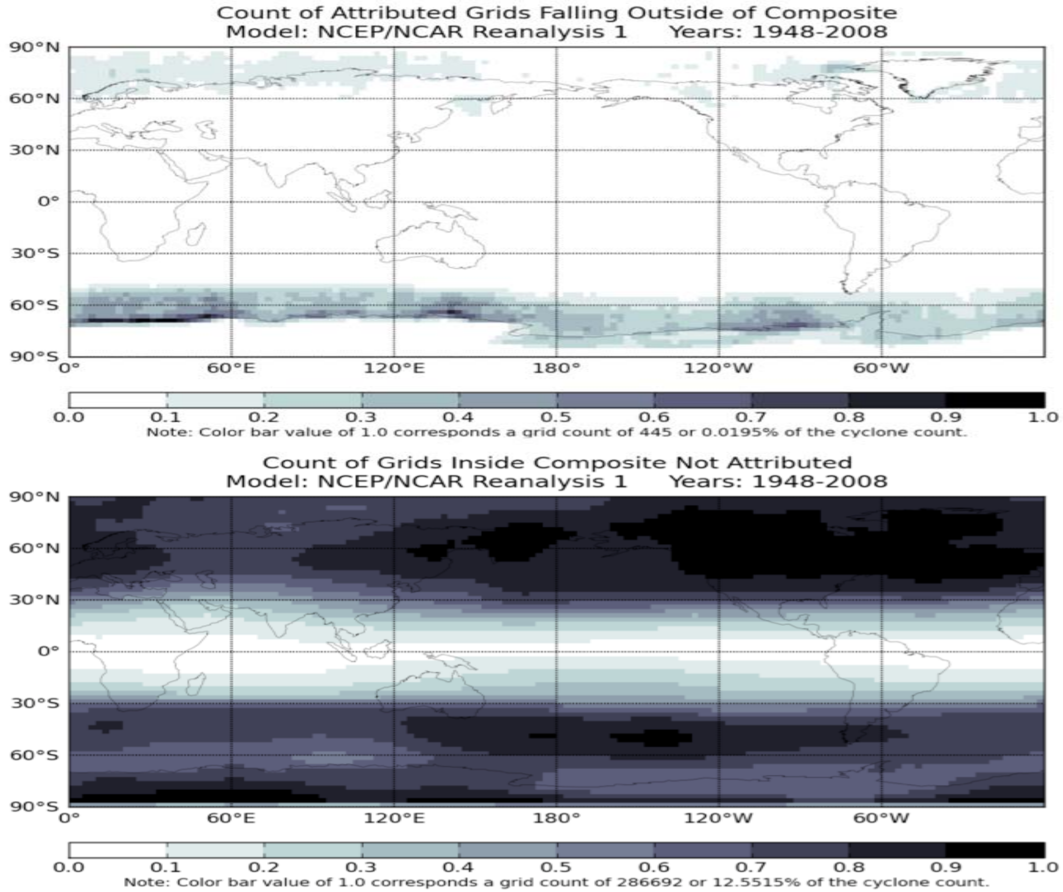
Dynamic definition of storm area of influence



- Dynamic definition of storm area that allows better attribution of clouds/radiation/precipitation to storm influence
- Feedback study is redone using the improved dynamic storm area definition.

Storm size varies systematically with storm strength





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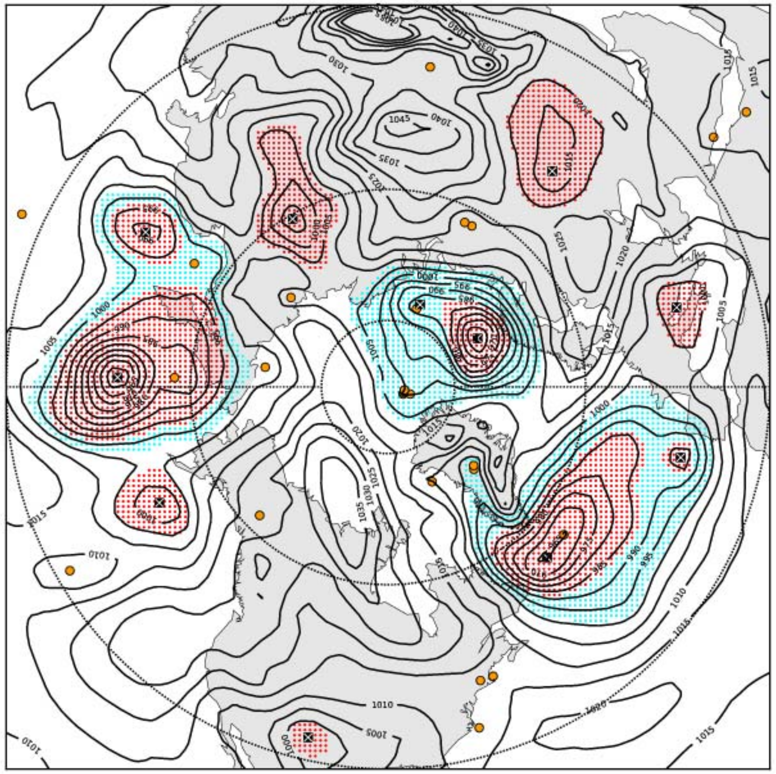
Ways to utilize the midlatitude storm 'Process Based' feedback evaluation method

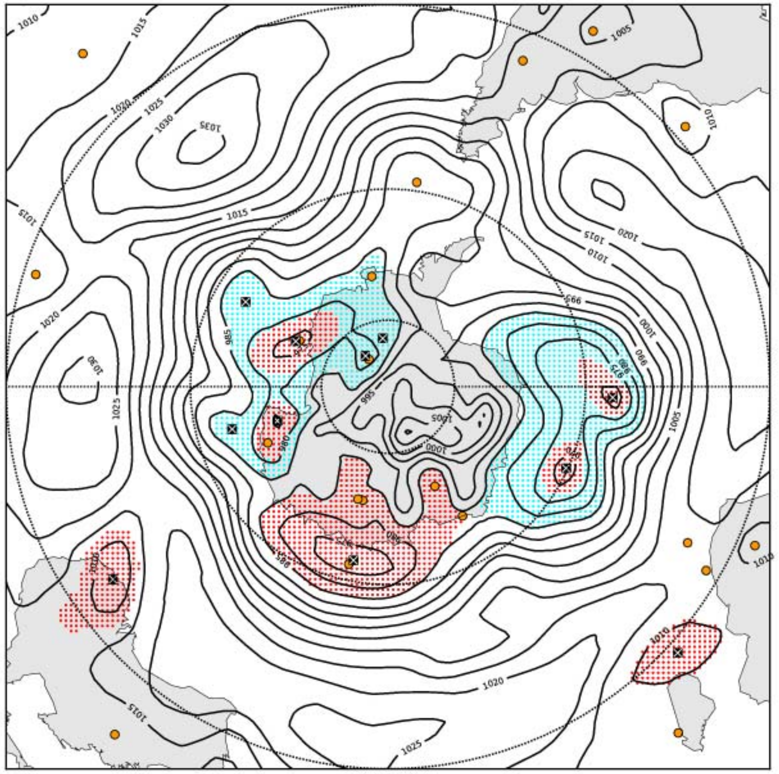
Quantitative:

- Derive quantitative metrics for the method – simulation of cloud/radiation/precipitation changes with storm strength and between storm-non storm regimes.
- Use successful models to derive feedback parameter

Qualitative:

- Use successful models to understand feedback mechanisms not resolved by observations – e.g. effect of diabatic heating on storm cloud and precipitation formation mechanisms.





Dynamic definition of storm area that allows better attribution of clouds/radiation/precipitation to storm influence

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