Projected snow cover changes in the CCSM3 A1B integrations and their influence on the climate

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Funded by NSF, ARCSS

- Snow cover changes in CCSM3 fully coupled A1B GHG experiments, 2080-99 --- compared to 20th century control 1980-99

- Repeating monthly seasonal cycle of snow depth distribution - used to force two atmosphere-land simulations

- CCSM3 f-conf. (active atmosphere; modified land to impose snow depth)

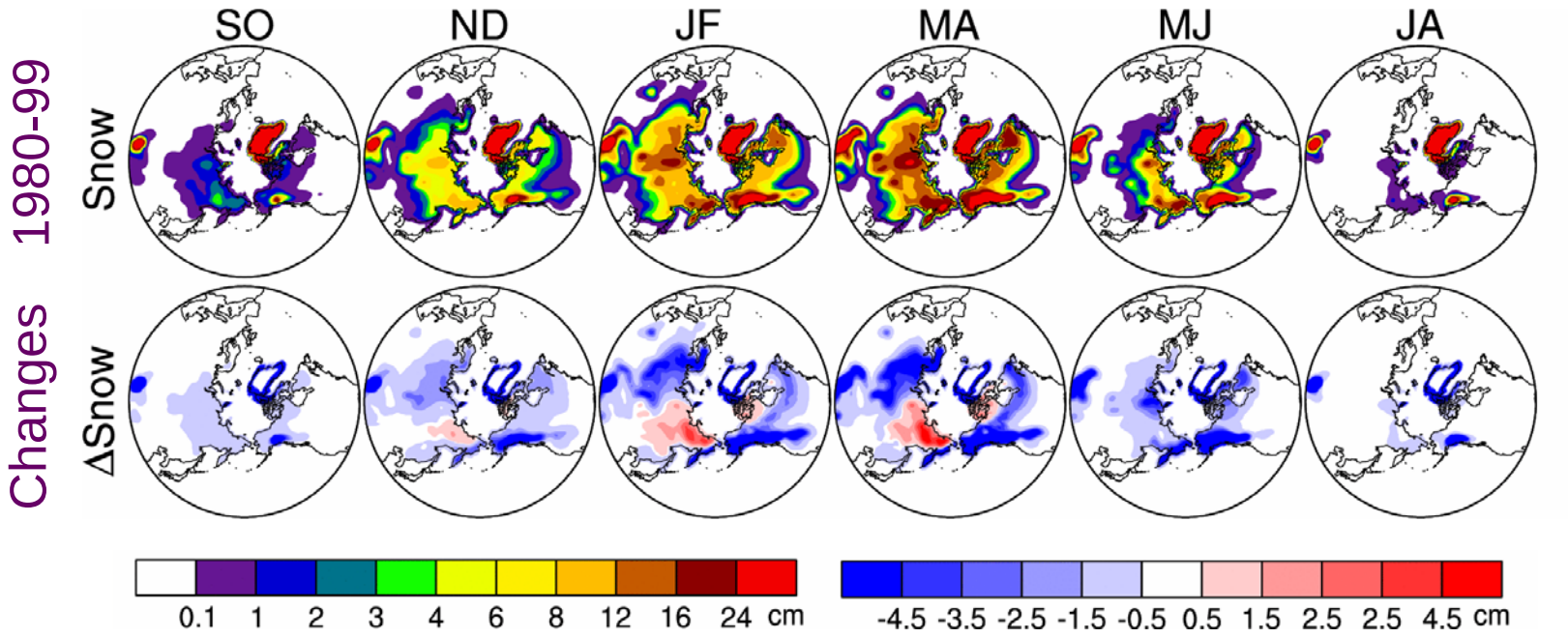
- T-85 atmosphere resolution, 60 year simulations

- SST and ice cover and ice thickness from CCSM3, 20th cen. 1980-99

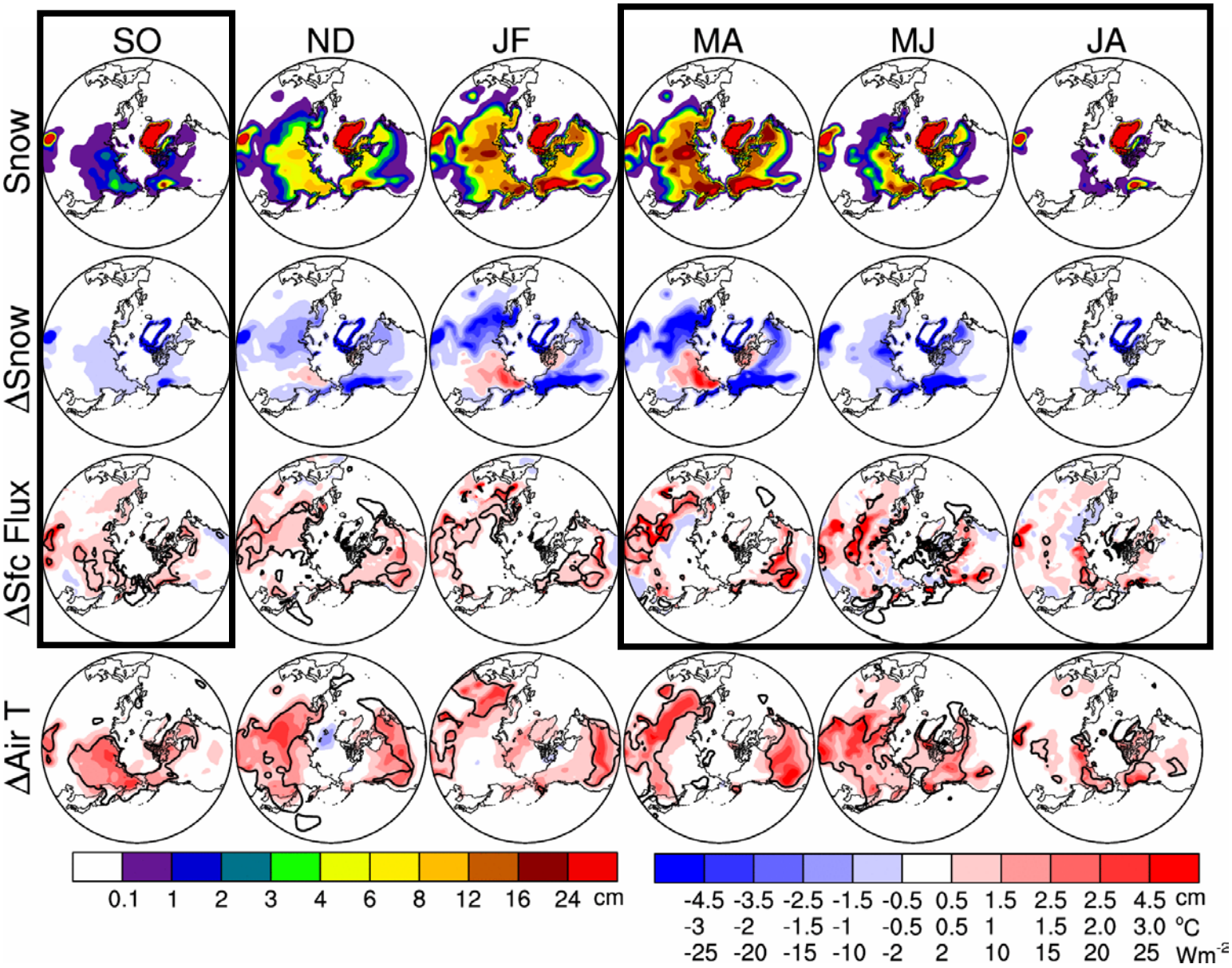
- A companion study to one looking at the influence of projected changes in sea-ice (Deser et al., submitted to J. of Climate)

1980-99 snow depth and Δsnow (2080-99 A1B - 1980-99)

Snow depth cm liquid water equivalent (lwe)



1980-99 snow and Δsnow, ΔSfc Flux, ΔAir T



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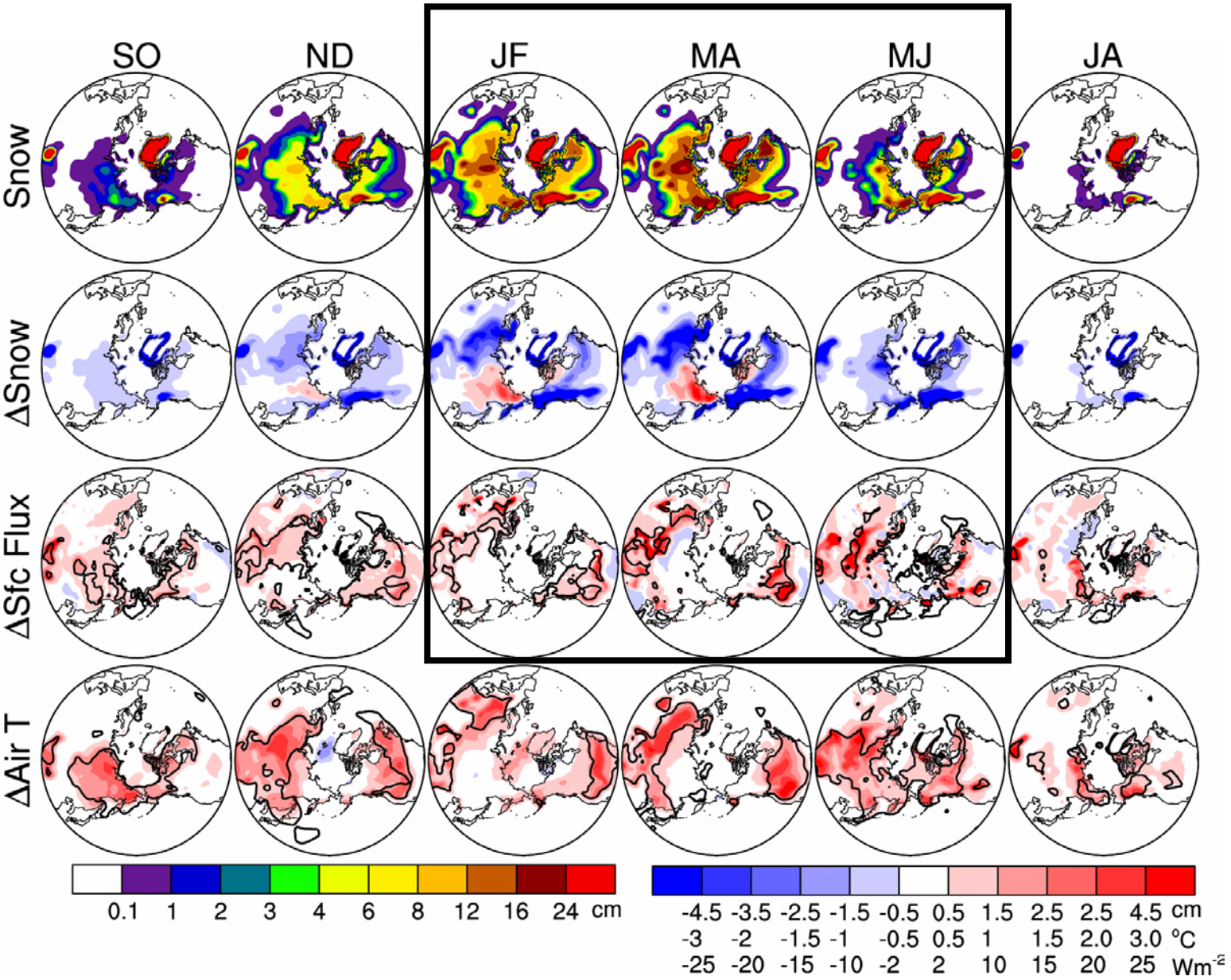

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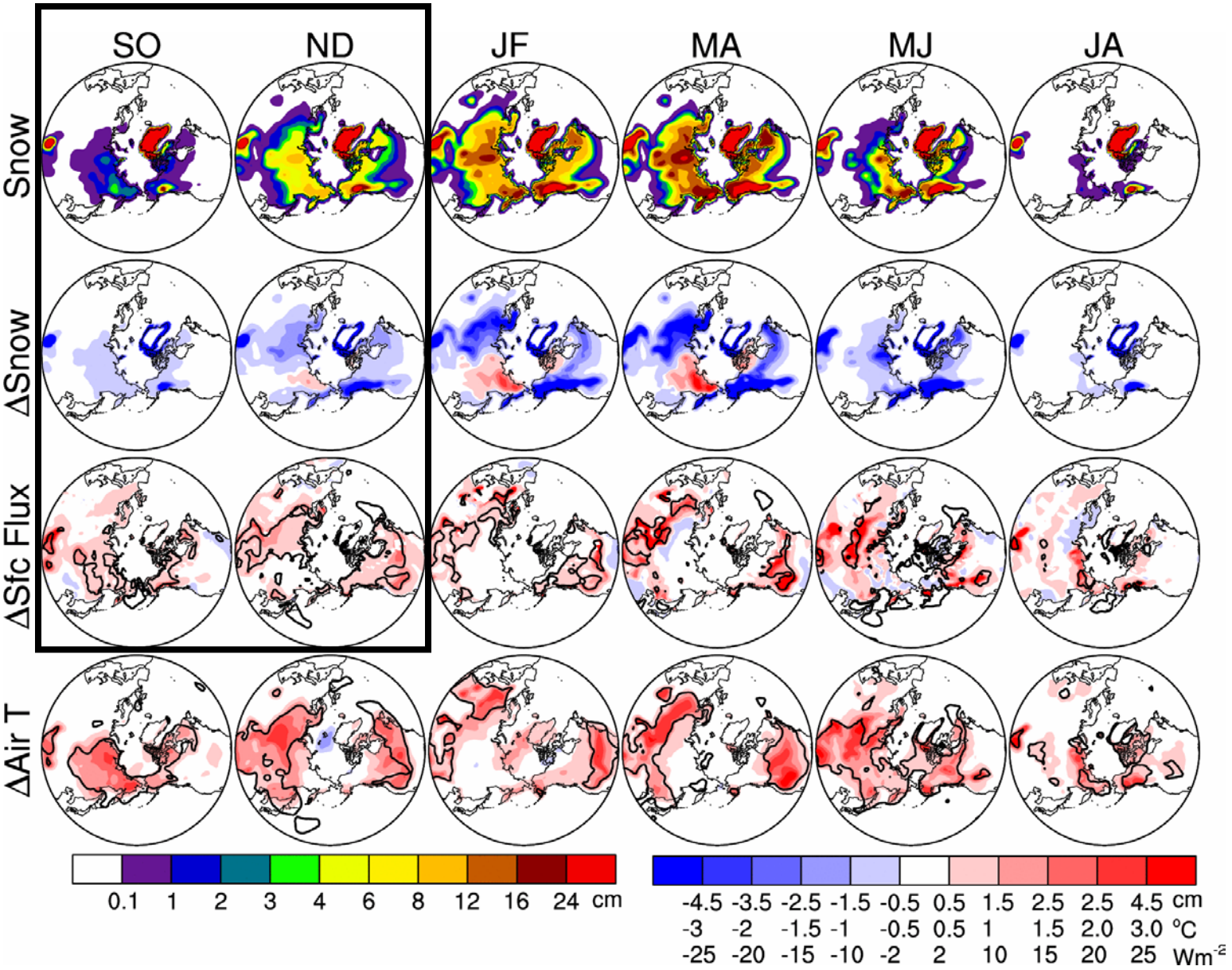

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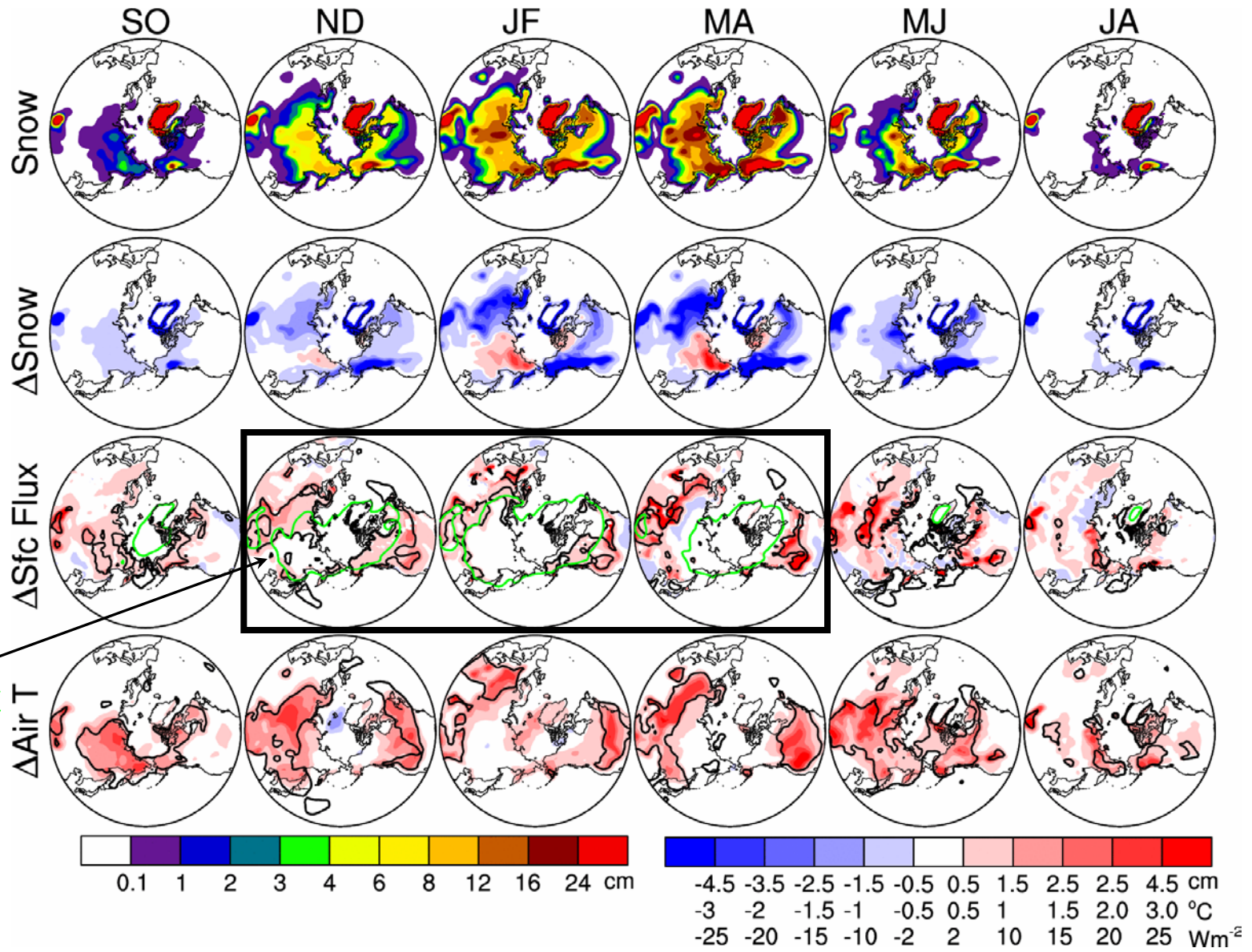

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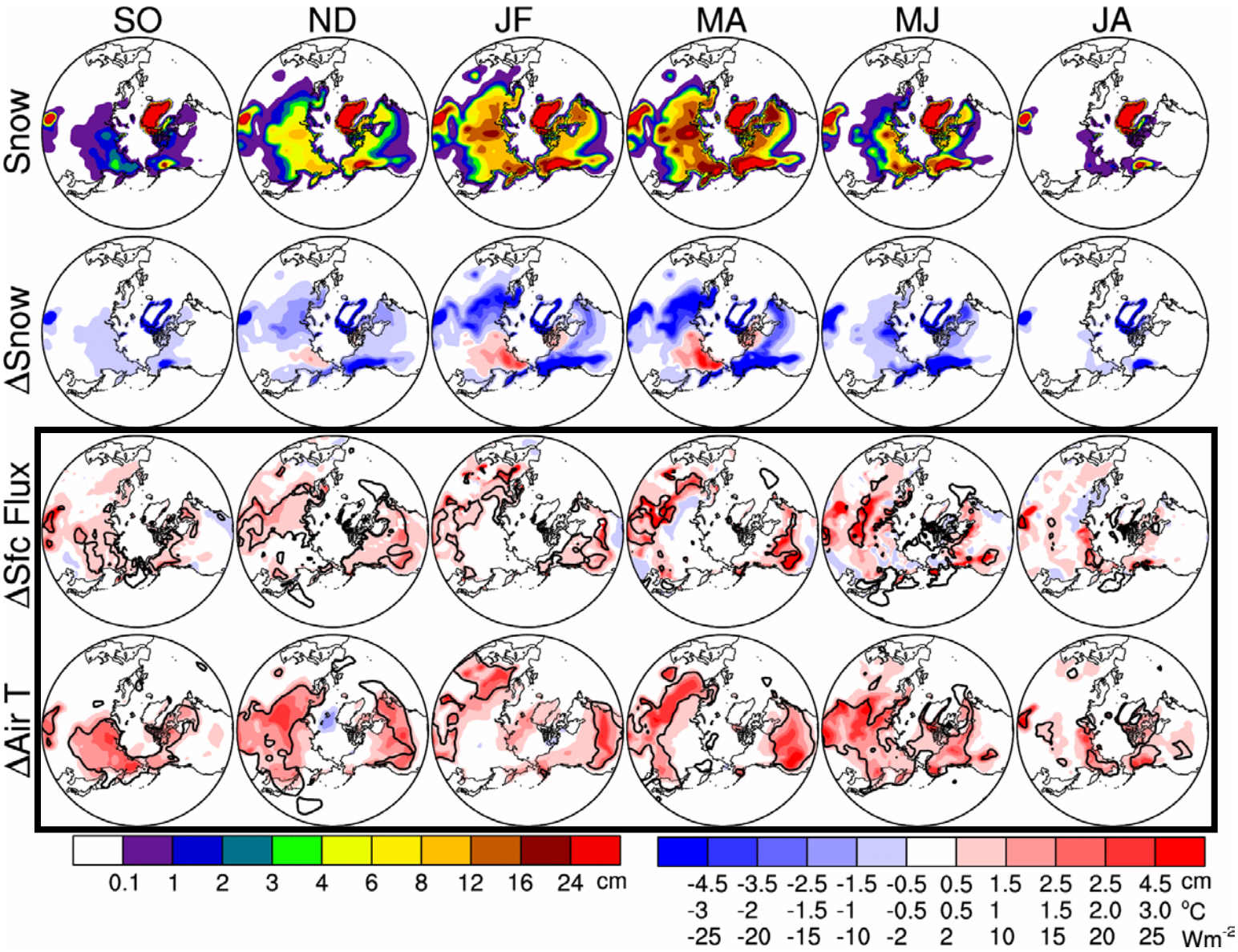
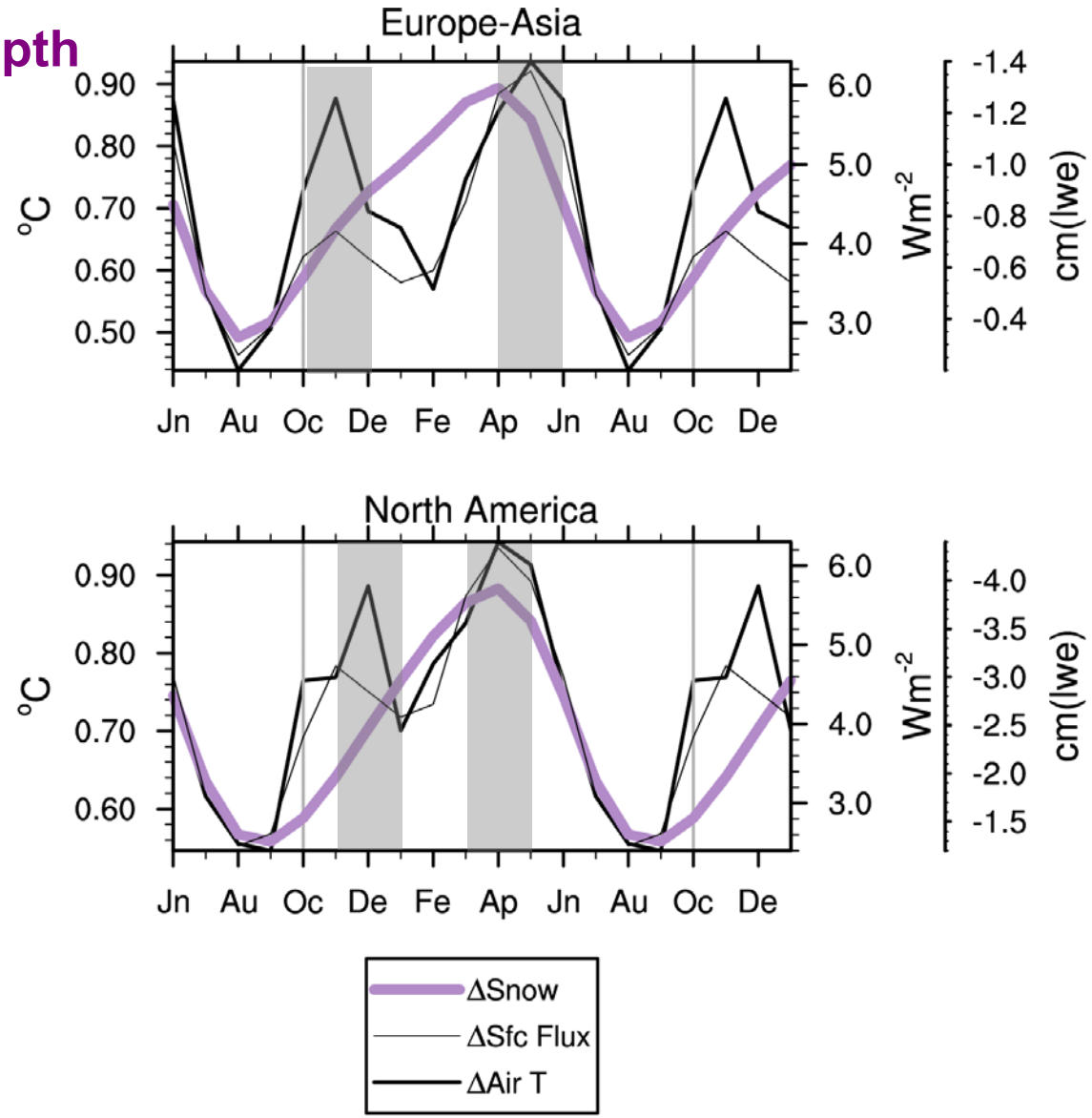


Area averaged ΔSnow depth, ΔSfc Flux, ΔAir T

ΔSnow depth

ΔSfc Flux

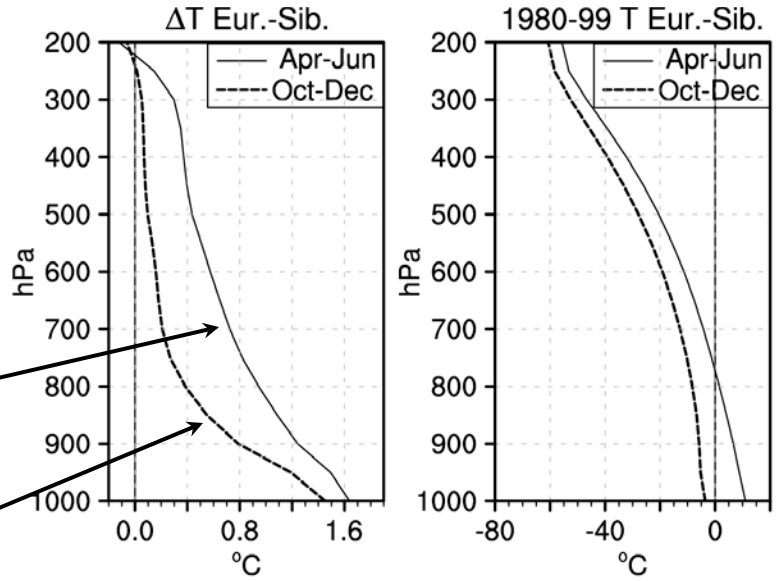
ΔAir T



Inverted

Spring & Fall vertical profiles ΔT, 1980-99 T

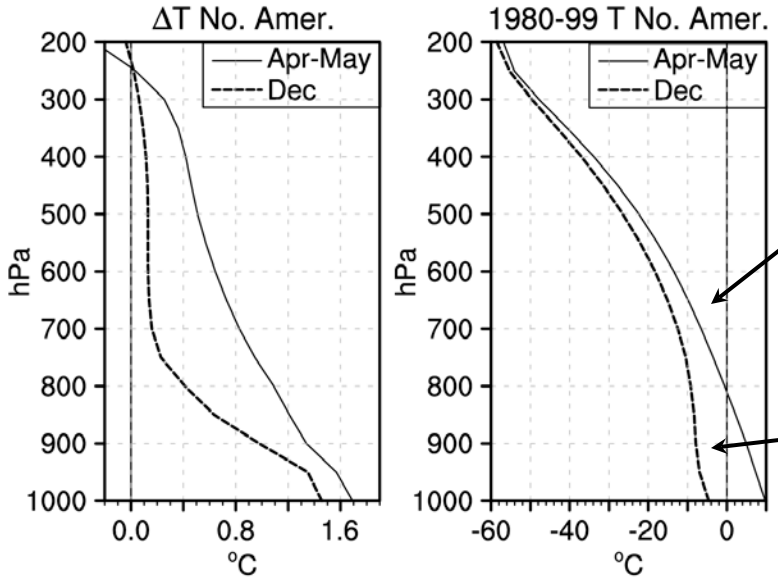
Europe-Asia



Spring deeper

Fall shallower

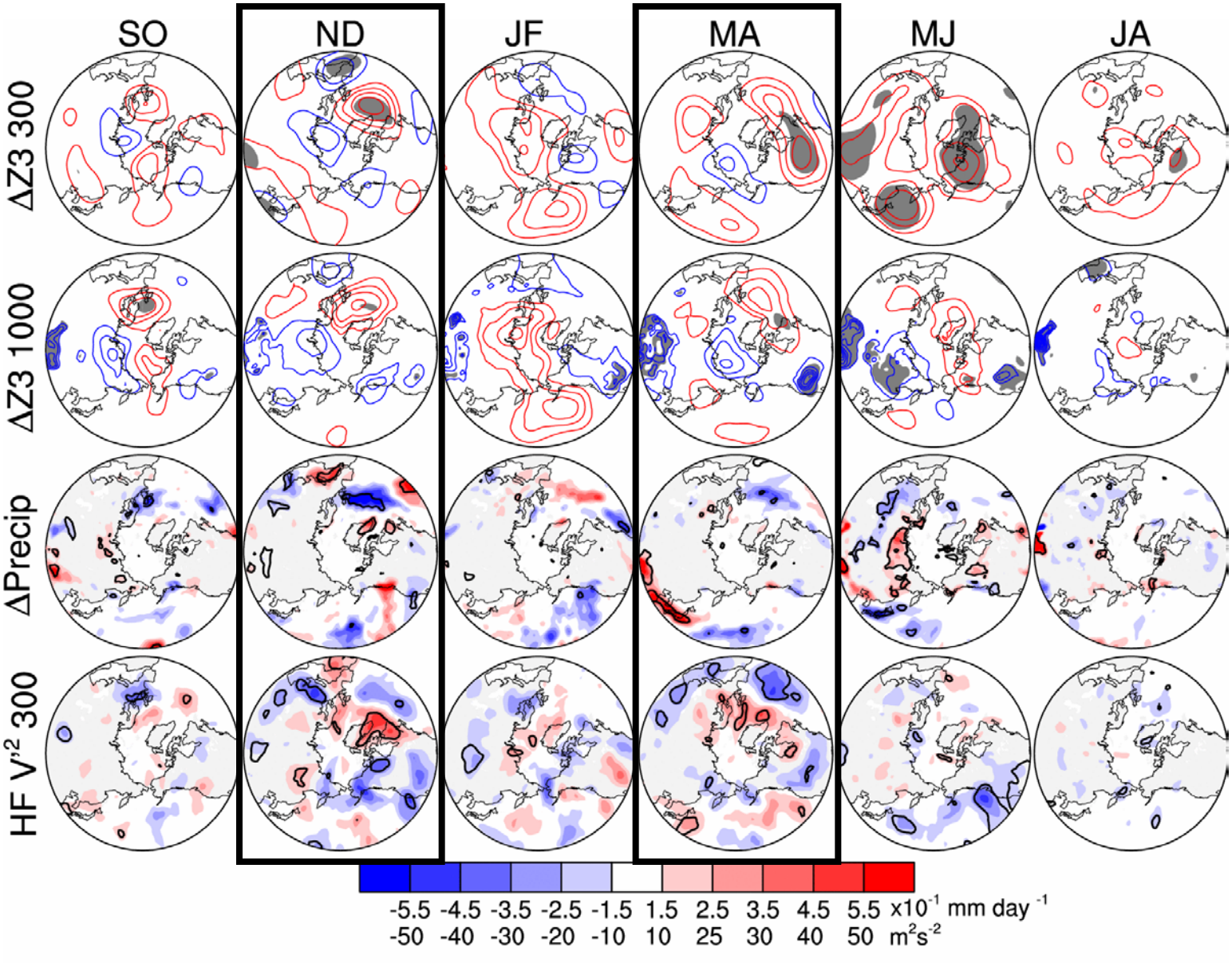
North America



Spring less stable

Fall more stable

Dynamic and precipitation anomaly responses



Summary

• We performed two 60-year simulations imposing the snow depth distribution taken from CCSM3 coupled integrations for 20th century 1980-99 and A1B GHG, 2080-99.

• Future snow depth and coverage projections include decreases associated with GHG warming and increases associated with a wetter climate and in regions that remain cold

• Snow depth and coverage changes are associated with changes in surface fluxes that warm the overlying atmosphere - the relationship between snow, changes in snow and surface fluxes vary with location and season.

• The seasonal cycle of area average snow depth changes has a single peak during April but sfc flux and Air T changes have two peaks: in Fall/Winter and Spring

• The spring warming is associated with larger surface heat fluxes (SH, LH & LW) and the T response is deeper. The fall warming with smaller surface heat fluxes (LH & LW), T response is shallower.

• Differences in the depth of the response may be partly explained owing to differences in static stability.

On going work

- Understanding the fall & spring peaks in Sfc Flux and Air T curves in relation to the single peak during spring in the snow depth anomalies

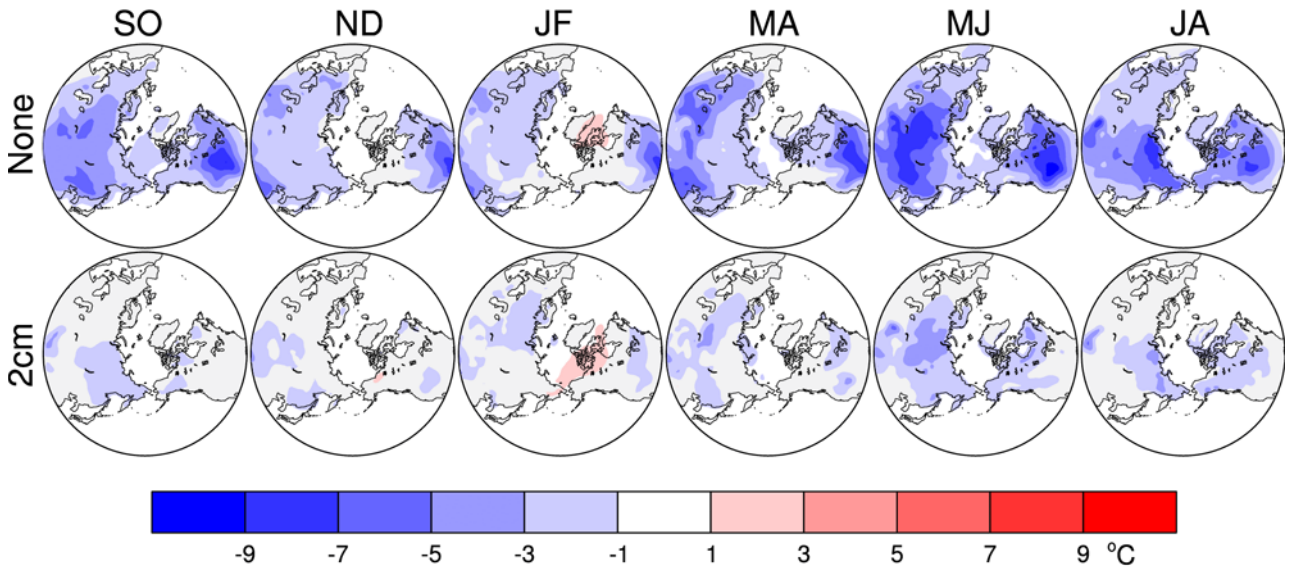
- Clarifying the relationship between snow depth anomalies and surface heat flux anomalies - in particular LH and LW

- Comparing and contrasting the response to snow to the response to ice and the fully coupled A1B forcing scenario

Δ Air T: imposed snow - active snow

First experiments simply wrote over snow amount in the land model

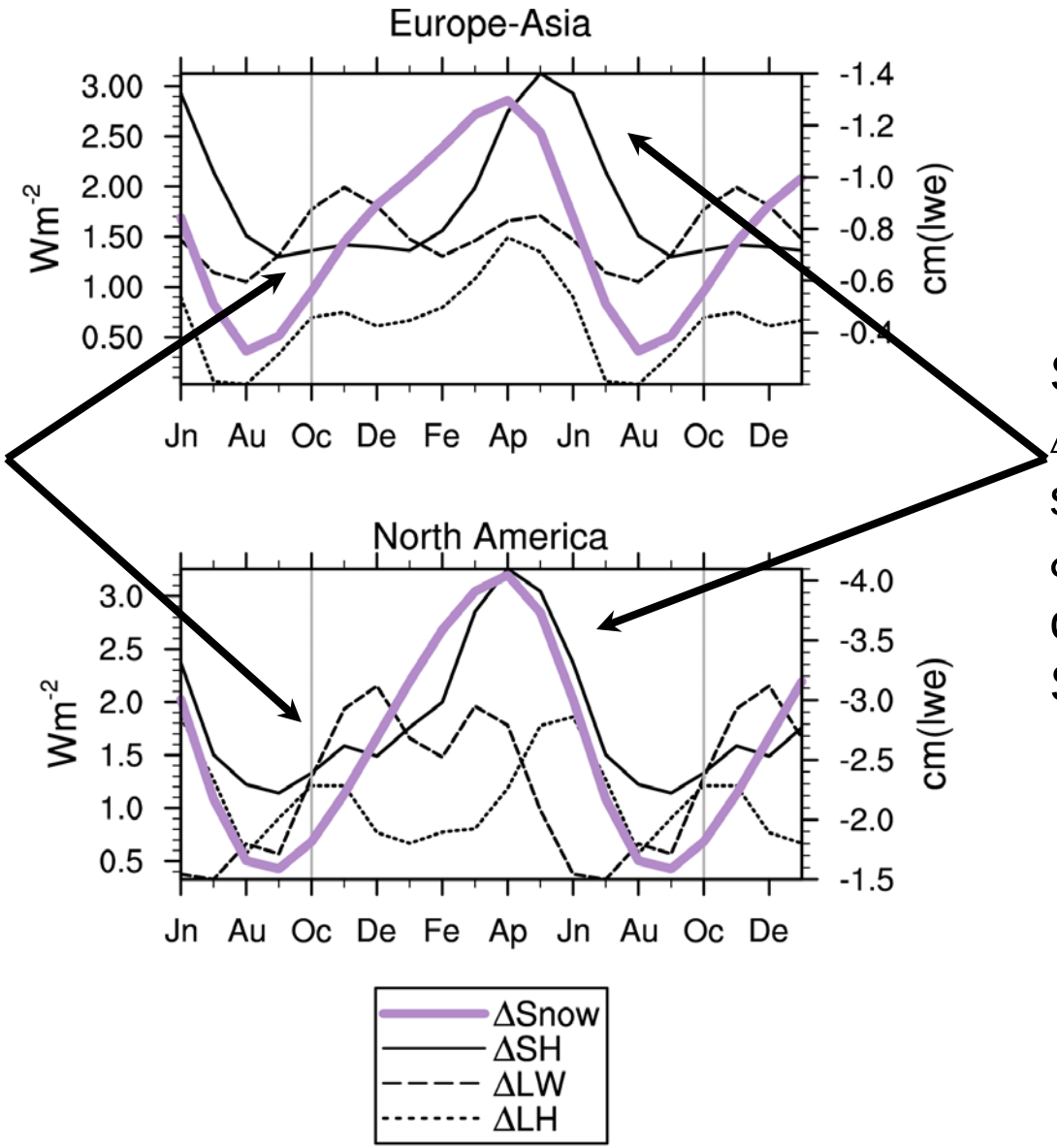
Small amounts producing big effects



Tried various minimum values and subjectively arrived at 2cm lwe as a compromise between limited intervention and Δ Air T

Seasonal Δsnow, ΔSH, ΔLH, ΔLW

Fall: ΔLW & ΔLH contribute to Sfc Flux, ΔSH small role if any



Spring: Large ΔSH + smaller ΔLH & ΔLW contribute to Sfc Flux