Response of Meridional Wind to Greenhouse Gas Forcing, Arctic Sea-ice loss and Arctic Amplification

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Introduction

- Meridional wind (v) greatly contributes to thermal and moisture advection due to large meridional gradients in these fields.
- Arctic amplification (AA) weakens meridional temperature gradients and is hypothesized to weaken zonal wind and cause wavier circulation with stronger v over northern mid-high latitudes.
- Using novel climate model simulations, we explored the effect of AA and the effect of increased CO2 without AA.

Data and methods

Three CESM1 coupled simulations

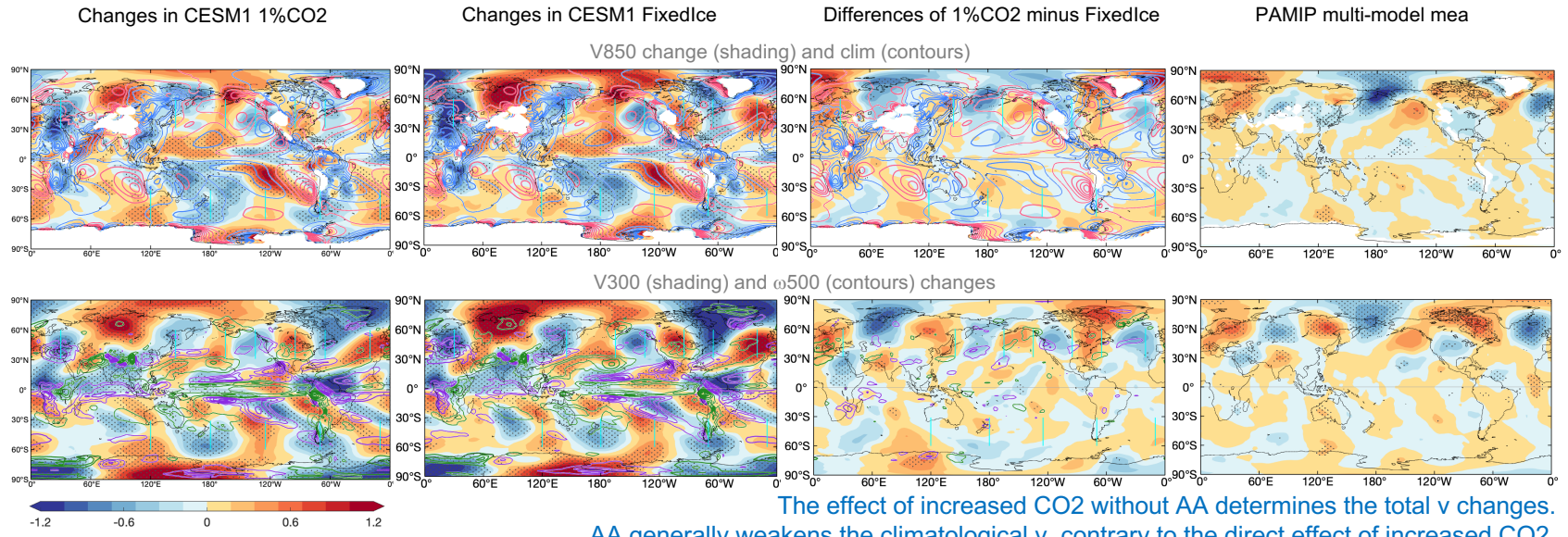
a) **CTL run** = a 150-year pre-industrial control run,
b) **1%CO2 run** = a 235-year standard 1% CO2 run with fully coupled sea-ice dynamics and 1% per year CO2 increase,
c) **FixedIce run** = the same as the 1%CO2 run but with fixed sea-ice concentration (SIC) north of 30° N.

Changes in the 1%CO2 and FixedIce runs relative to CTL climatology to represent the response to CO2-induced global warming (including the effect of AA) and the response to CO2 induced background warming (without AA and sea-ice loss).

The difference between the 1%CO2 and FixedIce runs largely represents the effect of AA and the occurring Arctic sea ice loss alone without the effect of the background warming.

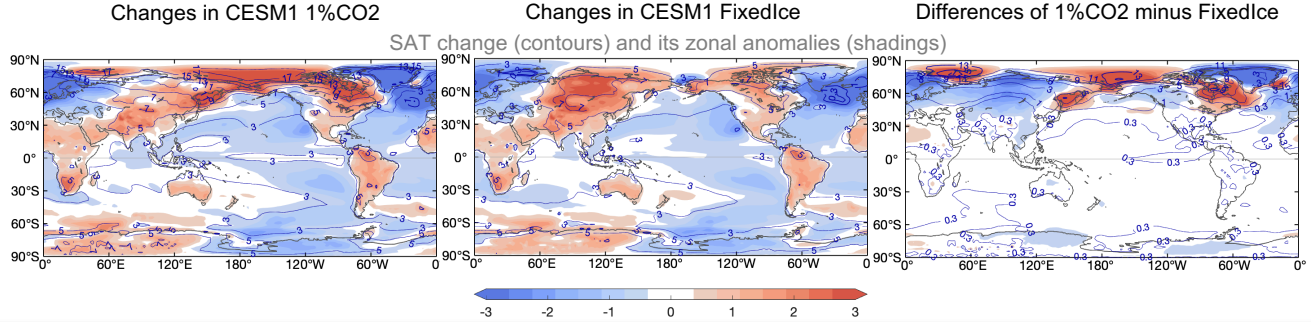
A pairs of PAMIP experiments from three OAGCM models (CESM1-WACCM-SC, HadGEM3-GC31-MM, NorESM2-LM)
pa-futArcSIC minus pa-pdSIC

v change patterns in response to CO2 forcing and AA



The effect of increased CO2 without AA determines the total v changes.
AA generally weakens the climatological v, contrary to the direct effect of increased CO2.

Potential contributions from land-ocean thermal contrast



Over northern mid-high latitudes, Arctic sea-ice loss and AA enhance the land-ocean thermal contrast, while increased CO2 alone weakens it, resulting in opposite changes in zonal temperature gradients and thus v.

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