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## ***Interactive comment on “Implications of all season Arctic sea-ice anomalies on the stratosphere” by D. Cai et al.***

### **Anonymous Referee #1**

Received and published: 9 July 2012

This paper examines the impact of reduced Arctic sea ice extent (SIE) on the tropospheric and stratospheric circulation, in time-slice simulations with a chemistry-climate model. A weak cooling influence is found in summer due to surface albedo changes, concomitant with a slight ozone reduction in the upper stratosphere. Only in November is there a consistent and statistically significant response from the surface up to the stratosphere, involving a warming at the lower levels, a weakening of the Aleutian Low, and a reduction of the wave driving into the stratosphere. The colder polar stratosphere and the strengthened polar vortex coincide with a positive anomaly of the Arctic Oscillation.

This paper addresses a topic that has been very little explored. I find the paper suitable for publication after some revisions. The manuscript would also gain by getting more

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polished, and I would recommend that a native English speaker proof-reads the article.

Major comments Most studies (albeit not carried with a chemistry-climate model resolving the stratosphere) indicate a tendency for a more negative winter-mean NAO or AO with reduced Arctic SIE (e.g. Francis, GRL, 2009). This study on the other hand tends to show an enhanced positive AO, and a strengthened vortex, at least in November. This may indicate that the seasonality of the response is important. In fact, a recent study by Orsolini et al. (Climate Dynamics, 2012) dealing with the impact of the reduced SIE in 2007 in coupled ocean-atmosphere model, did show a response extending into the stratosphere in autumn. In November, their response also showed a weakened Aleutian Low, in rough agreement with this study. Consequently, I think that Section 3.5 should be improved, focussing the discussion on what is statistically significant. The link with that study and previously mentioned studies should be made clearer. The significance should be incorporated in the Fig 9 and 10. I gather that the Nov-Mar change in the AO distribution (indicating a tendency for a more neutral or negative phase) is weakly significant, and that only the November distribution change is significant at the 95% level. The latter result is consistent with the rest of the paper. Why keep Fig 9 if it is inconclusive?

The following three sections should be re-written for clarity of the result presentations. The section 3.4 on the meridional heat flux needs to be clarified. In order to follow the discussion on the heat flux influence, what should be shown are the separate stationary and transient contributions, if the latter is significant. The wording should be improved in that section. What the authors are discussing is the \*zonal-mean\* meridional eddy heat flux, and over a broad latitude range (40N-80N), not just over middle latitudes. The figures should be introduced less passively. Summary. The summary would gain by being more ordered, avoiding back and forth presentations of the results. It would also gain by stressing the differences with other studies, e.g. on the sign of the AO response.

As an additional note, the key issue remains how to explain the weakening of the

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Aleutian Low by the SIE reduction, through transient eddies or other mechanisms. This is not clearly addressed by this paper. Could the authors comment on this?

Minor comments L13-15: Make clearer that only in November are results significant, and that the winter-mean AO changes are very weakly significant. Figs.3 and 6: Please label the x-axis similarly in all figures, for ease of comparison.

English / phrasing / typos L15: analogue -> use related or congruent with L32: temporal L42: to reduce planetary waves, while contrarily... L43: Trends... are L54 : conditions. ..., a potential stratospheric feedback. .... L63: remove \*they cause\* L104: invariant is not appropriate here. Unchanged is better L114: "North Polar sea" is not standard usage. Also \*Sea of Okhotsk\* L121: rephrase as unclear. \*Analysis\* L122: all-season is used twice L143: use \*dual\* rather than diametric L155: the seasonal changes in ocean-atmosphere temperature gradient L169: \*descent\* of reflecting radiation ? Use downwelling ? L171: as a consequence of L179: the well-understood temperature dependencies L184: reveals or displays, not \*offers\* L185: which continues There are numerous grammatical and English mistakes in Sections 3.4, 3.5 and 5.

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Interactive comment on Atmos. Chem. Phys. Discuss., 12, 12423, 2012.

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