Small eddies produce global effects on climate change

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The increasing strength of winds over the Southern Ocean has extended its ability to absorb carbon dioxide, effectively delaying the impacts of global warming.

New research published in the *Journal of Physical Research* found the intensifying wind over that ocean increased the speed and energy of eddies and jets, which are responsible in large part for the movement of nutrients, heat and salt across the ocean basin.

The increased movement and overturning of these eddies and jets has accelerated the carbon cycle and driven more heat into the deep ocean.

"Considering the Southern Ocean absorbs something like 60% of heat and anthropogenic CO2 that enters the ocean, this wind has a noticeable effect on global warming," said lead author Dr Andy Hogg from the Australian National University Hub of the ARC Centre of Excellence for Climate System Science.

"To put this in some kind of context, if those small scale eddies did not increase with wind stress then the saturation of carbon dioxide in the Southern Ocean sink would occur twice as rapidly and more heat would enter our atmosphere and sooner."

Despite having one of the most powerful currents in the world in the form of the Antarctic Circumpolar Current, eddies dominate the circulation of the Southern Ocean. Until this research, a major

uncertainty around the future impacts of climate change was whether the eddy field would change with stronger winds or whether it would remain static.

Using satellite observations the study has given the first direct evidence that the Southern Ocean eddy field has increased in recent decades and that this increase can be attributed to the increase in winds around the Southern Ocean.

The intensification of winds in the Southern Ocean is a result of both the depletion of ozone and global warming's affects on the Southern Annular Mode (SAM). The SAM is a measure of the position of a belt of westerly winds that circle Antarctica.

When climate scientists talk about a positive SAM it means that belt of westerlies has moved closer to the Antarctic. A negative SAM means the wind belt has moved closer to the equator. The position of the SAM can vary from year to year but the long-term trend has been for increasingly positive SAM events.

"Interestingly, we found the movement and strength of the SAM played the largest role in increasing the energy of the eddies in the Southern Ocean over periods of less than a decade but there were clear delays between the timing of the SAM and its effect on the eddies," said Dr Hogg.

"The increase in kinetic energy of these eddies actually only became apparent a few years after a strong SAM event."

Although the impact of SAM events over the short term was an interesting finding, it was the long-term trend over multiple decades of observations that gave a crucial indication of the changes occurring in the Southern Ocean.

"If the winds continue to increase as a result of global warming, then we will continue to see increased energy in eddies and jets that will have significant implications for the ability of the Southern Ocean to store carbon dioxide and heat," said Dr Hogg.

"Remarkable as it seems these relatively small eddies and jets are doing the heavy lifting in the ocean driving heat into the Southern Ocean and slowing the impacts of global warming."

More information: *Journal of Physical Research*, onlinelibrary.wiley.com/doi/10 … 014JC010470/abstract

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