

Detection of a weakening Southern Ocean carbon sink

Nikki Lovenduski

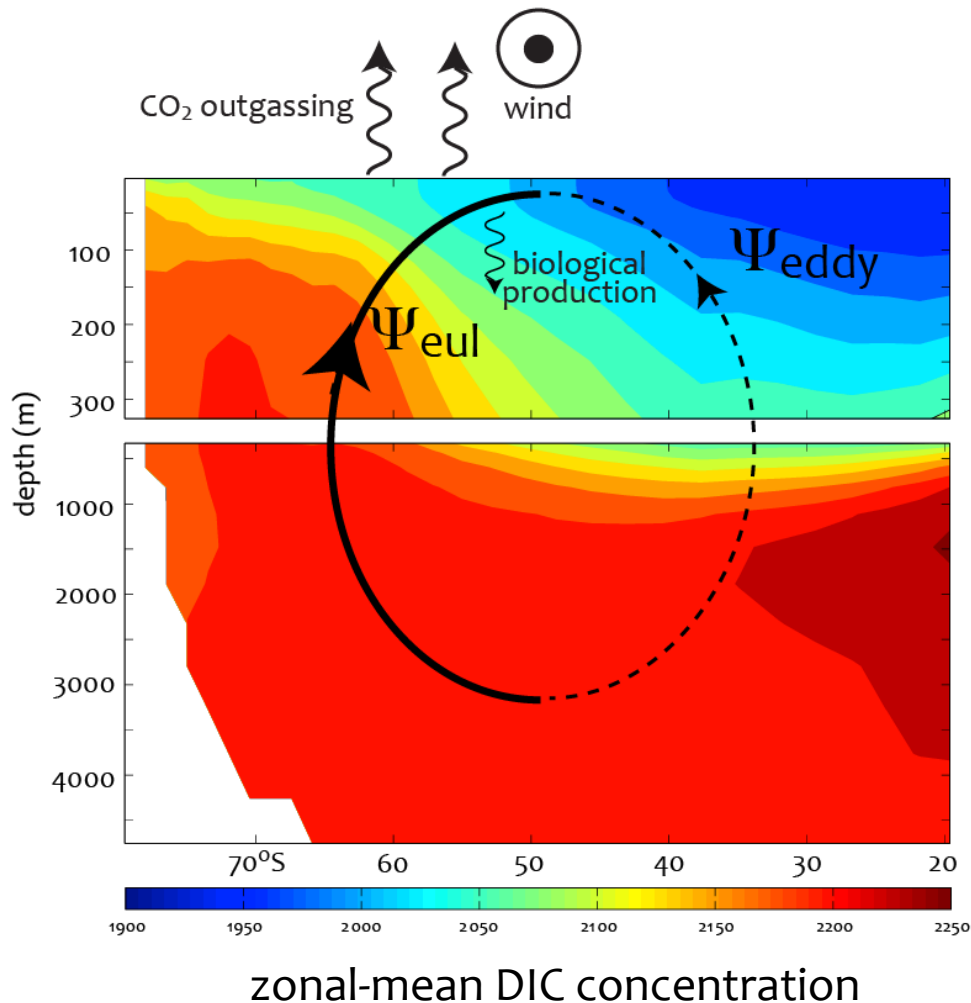
University of Colorado Boulder

Thanks to

Galen McKinley and Amanda Fay

University of Wisconsin - Madison

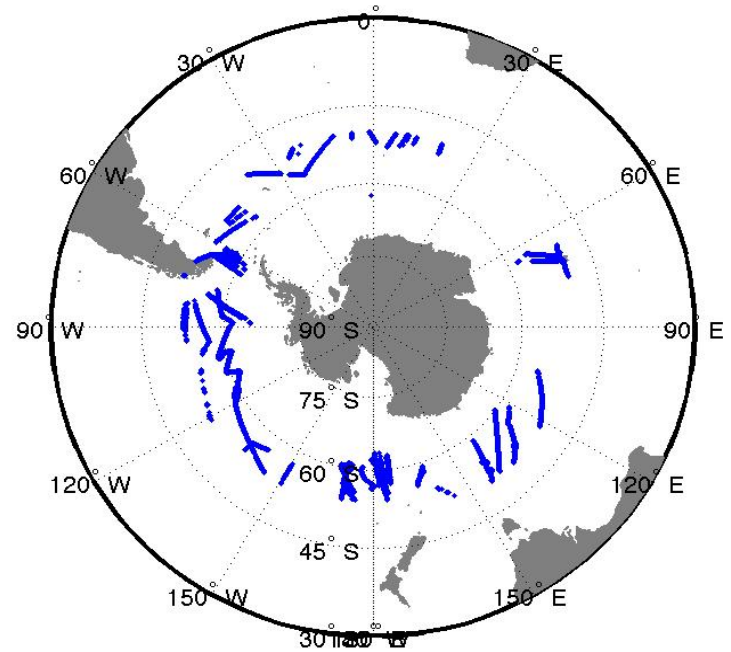
Corroborating model results



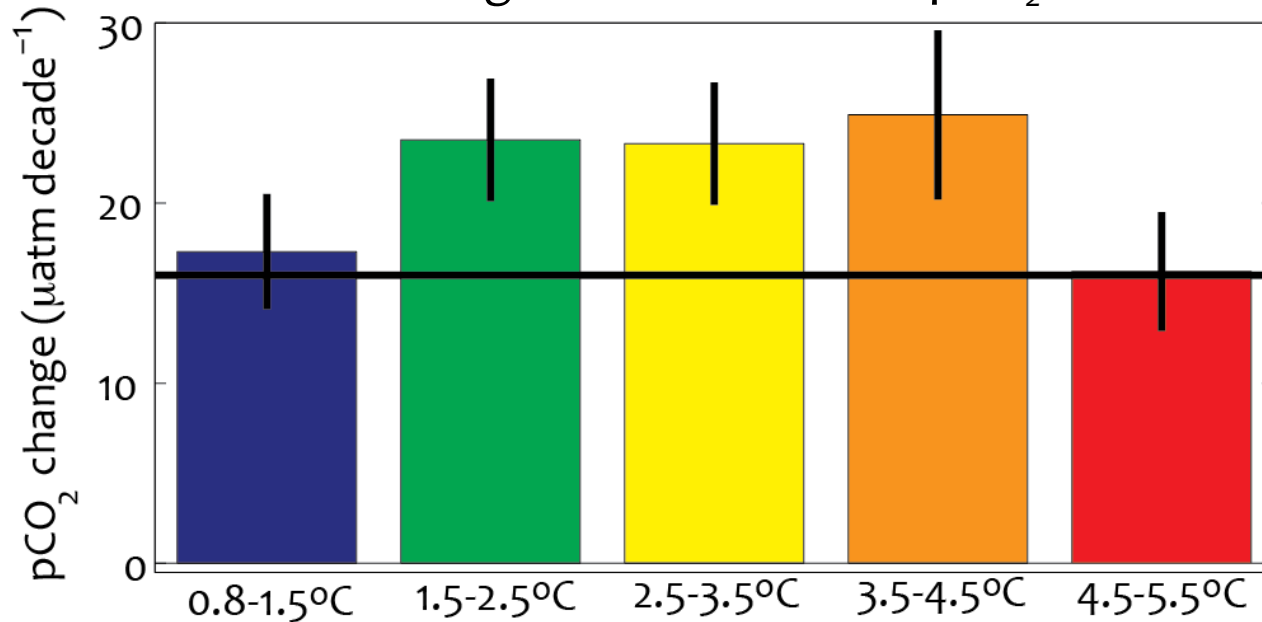
Model	Reference
Bern3D	Tschumi et al. 2008
CCSM/CESM	Lovenduski et al. 2007 Wang and Moore 2012 Lovenduski et al. 2013
CSIRO	Lenton et al. 2007
IPSL	LeQuéré et al. 2007 Lenton et al. 2009
LOVECLIM	Menviel et al. 2008
MITgcm	Lovenduski and Ito 2009 Hauck et al. 2013
NASA GISS	Romanou et al. 2013
UVic	Zickfeld et al. 2007 Swart et al. 2014

Observed wintertime pCO₂ changes 1986-2010

Wintertime data locations →

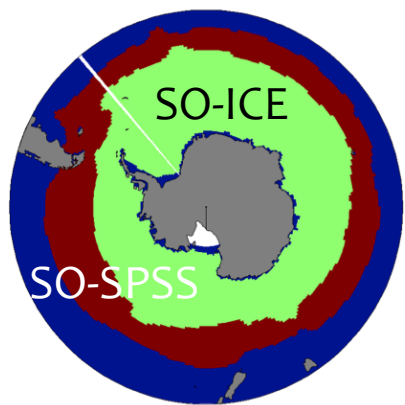


Change in surface ocean pCO₂



Change in
atmospheric
pCO₂

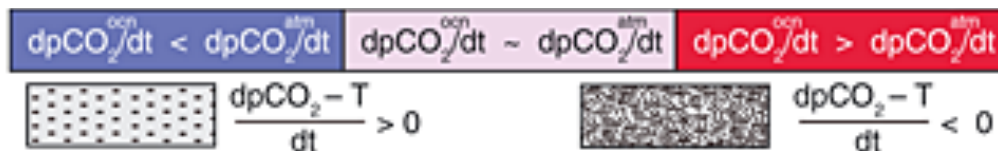
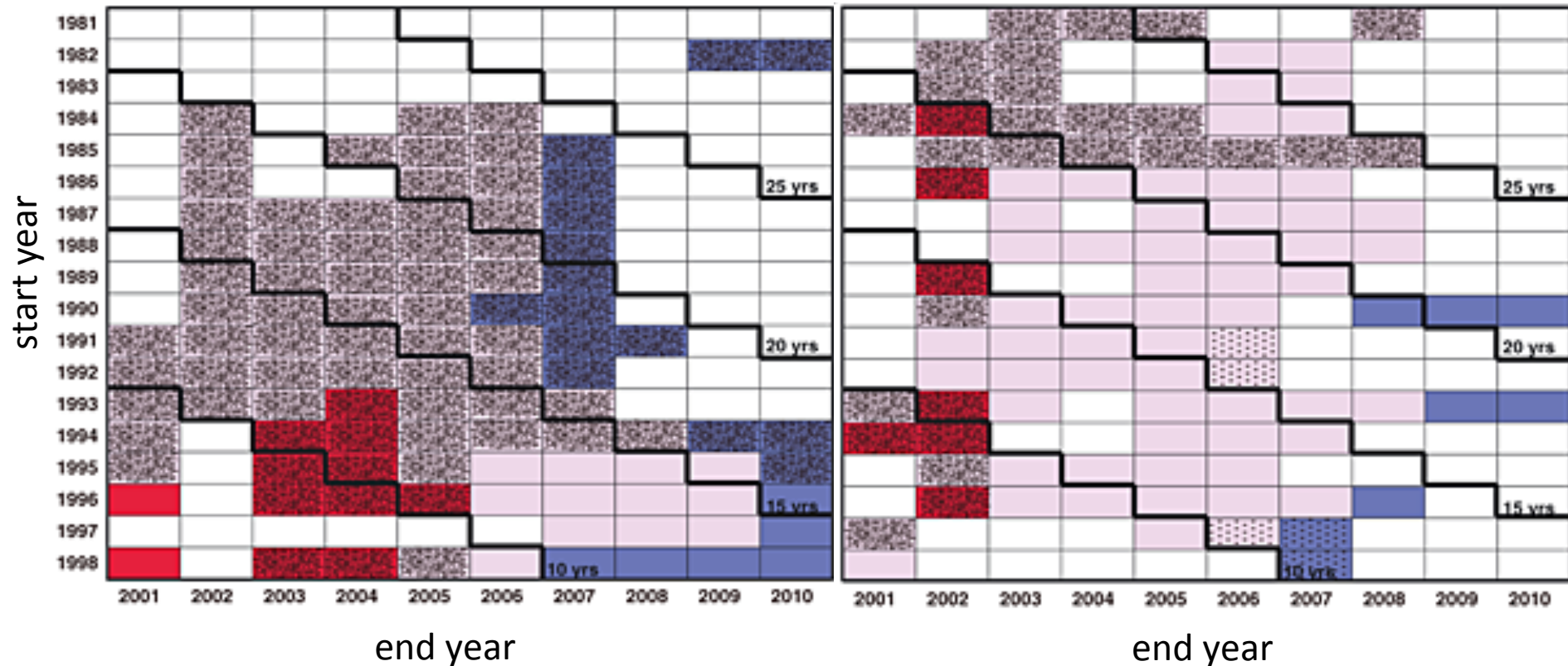
data from
Takahashi et al. (2012)



Trend in $p\text{CO}_2^{\text{oc}}$ vs. $p\text{CO}_2^{\text{atm}}$ trend

SO-ICE

SO-SPSS



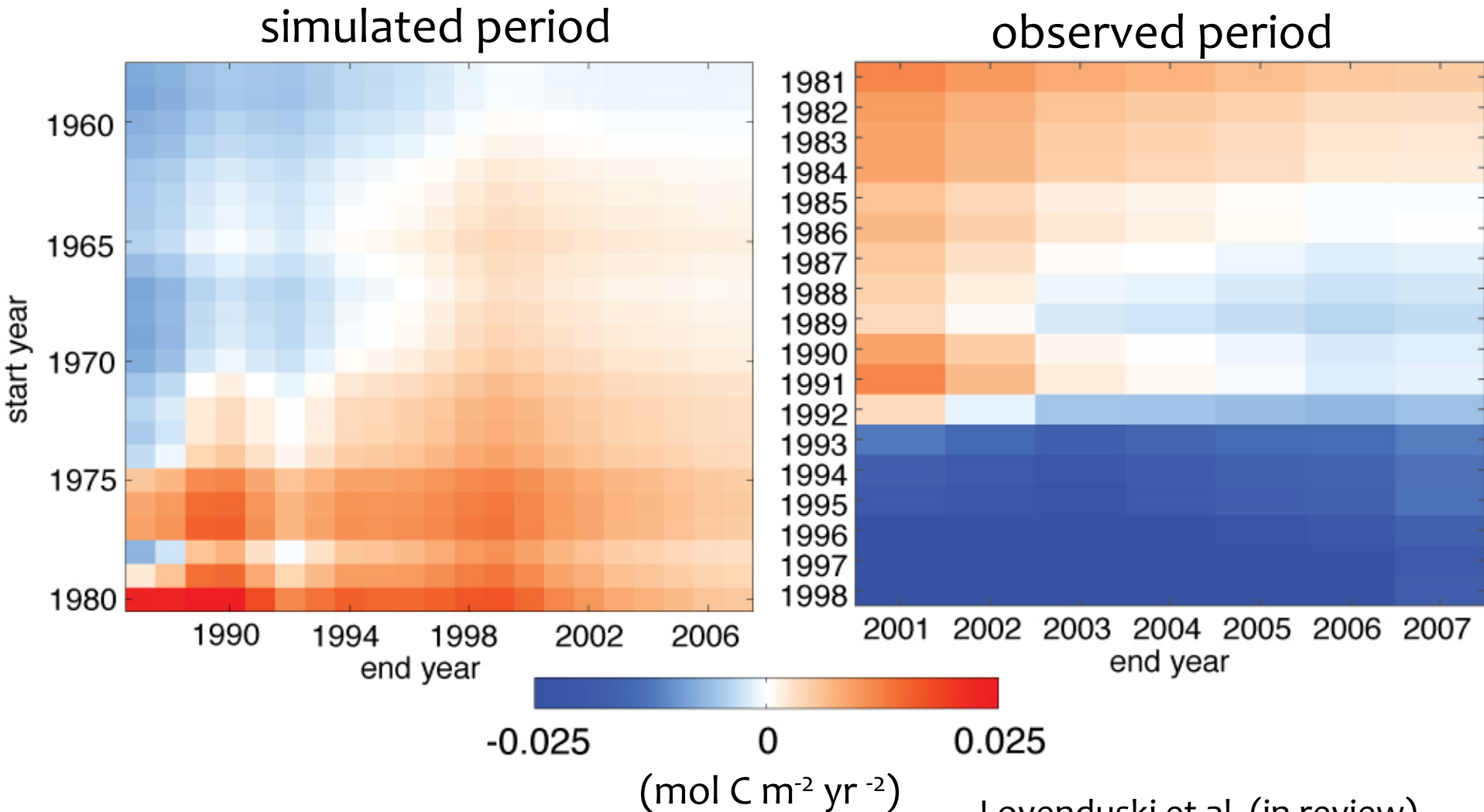
Fay and McKinley (2013)

Research questions

1. Are CO₂ flux trends affected by the choice of start/end year or season?
2. Does the observational sampling introduce biases into the $\Delta p\text{CO}_2$ trends?
3. Do we have enough observational data to detect a weakening CO₂ sink?

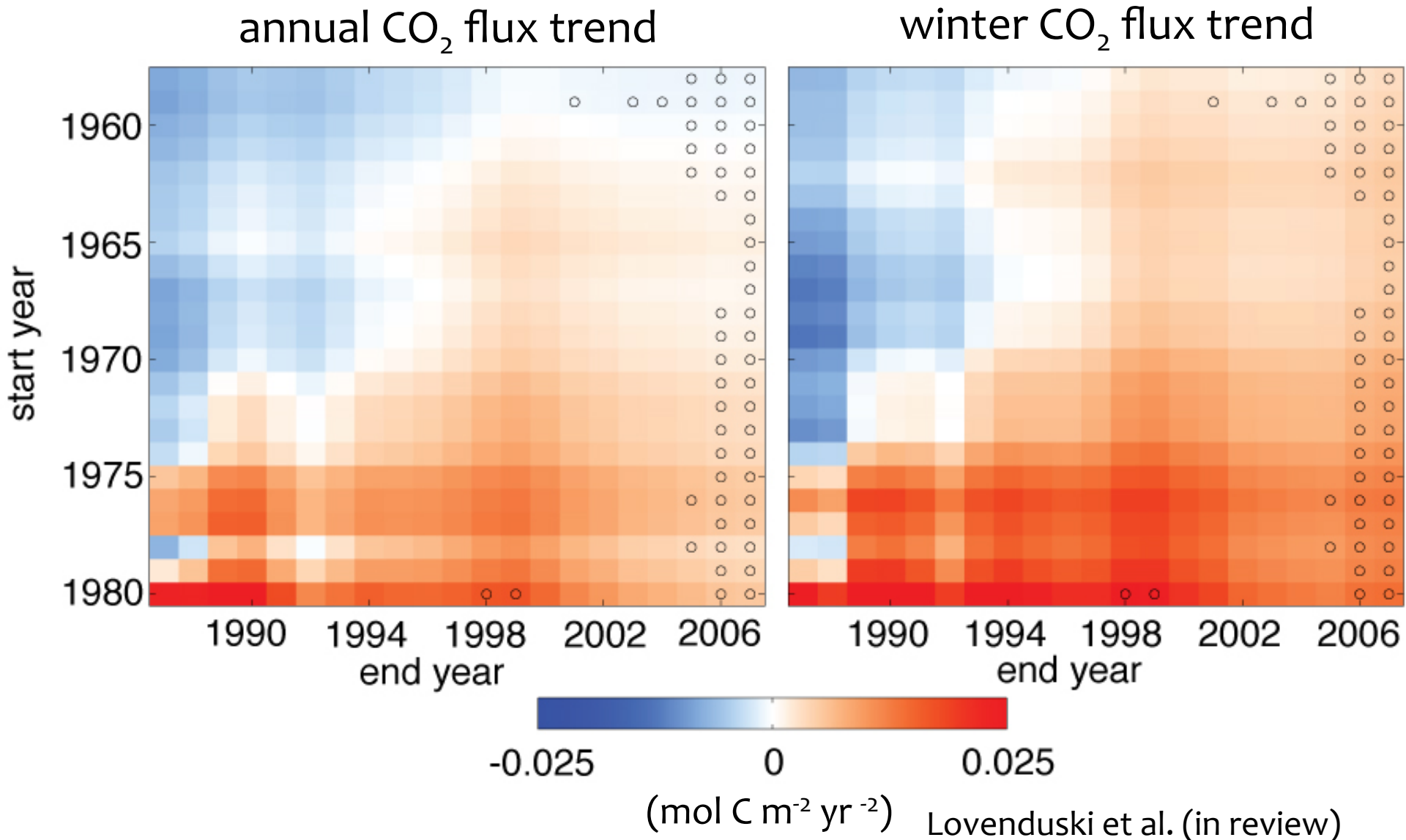
Does the start/end year matter?

CO₂ flux trend, SO-SPSS



Lovenduski et al. (in review)

Is the CO₂ flux trend larger in winter?



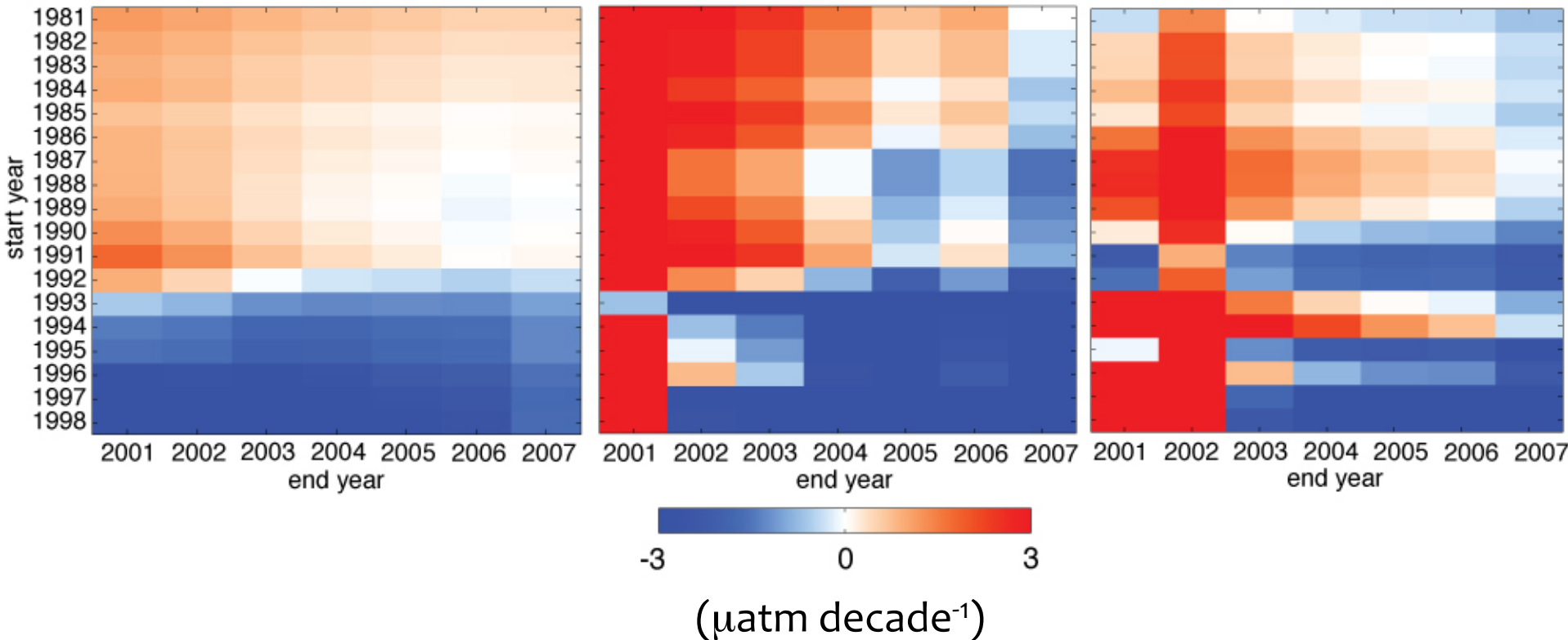
Do we have observational biases?

$\Delta p\text{CO}_2$ trend, SO-SPSS

full model

model sampled
as observed

observed



Lovenduski et al. (in review)

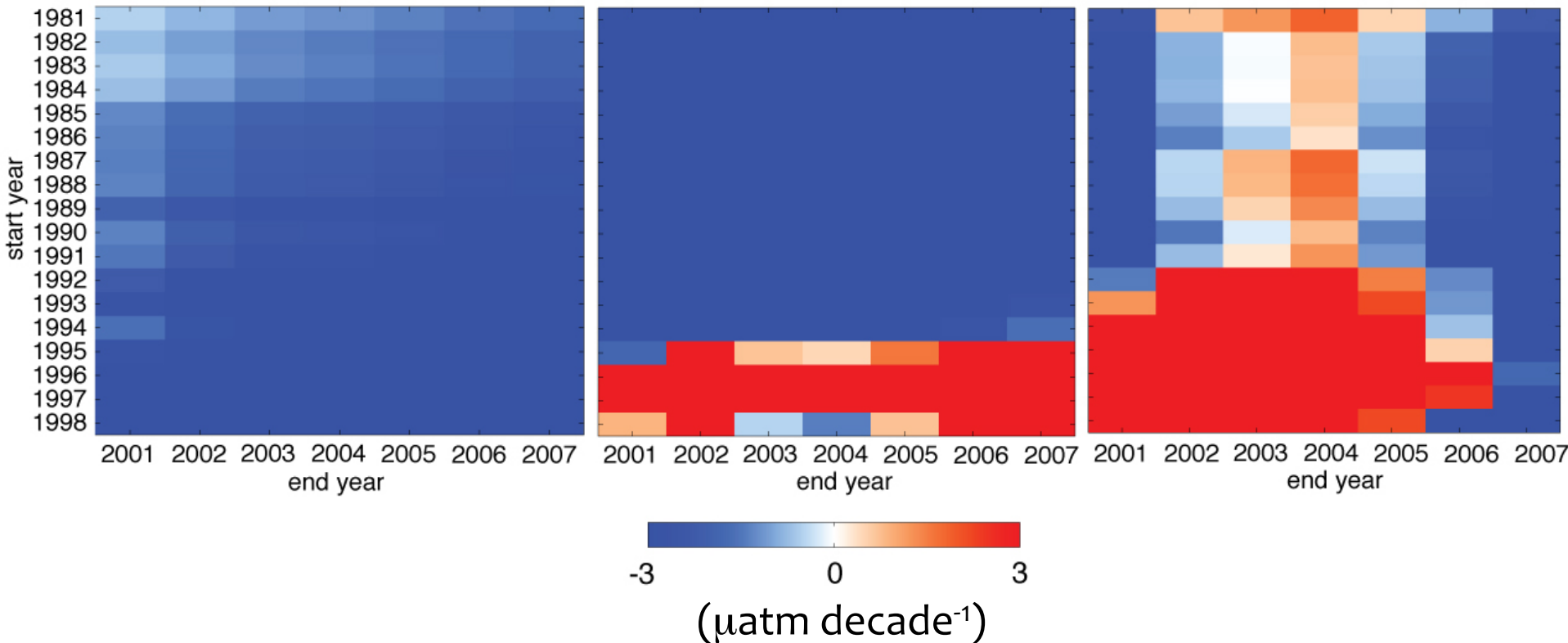
Do we have observational biases?

$\Delta p\text{CO}_2$ trend, SO-ICE

full model

model sampled
as observed

observed

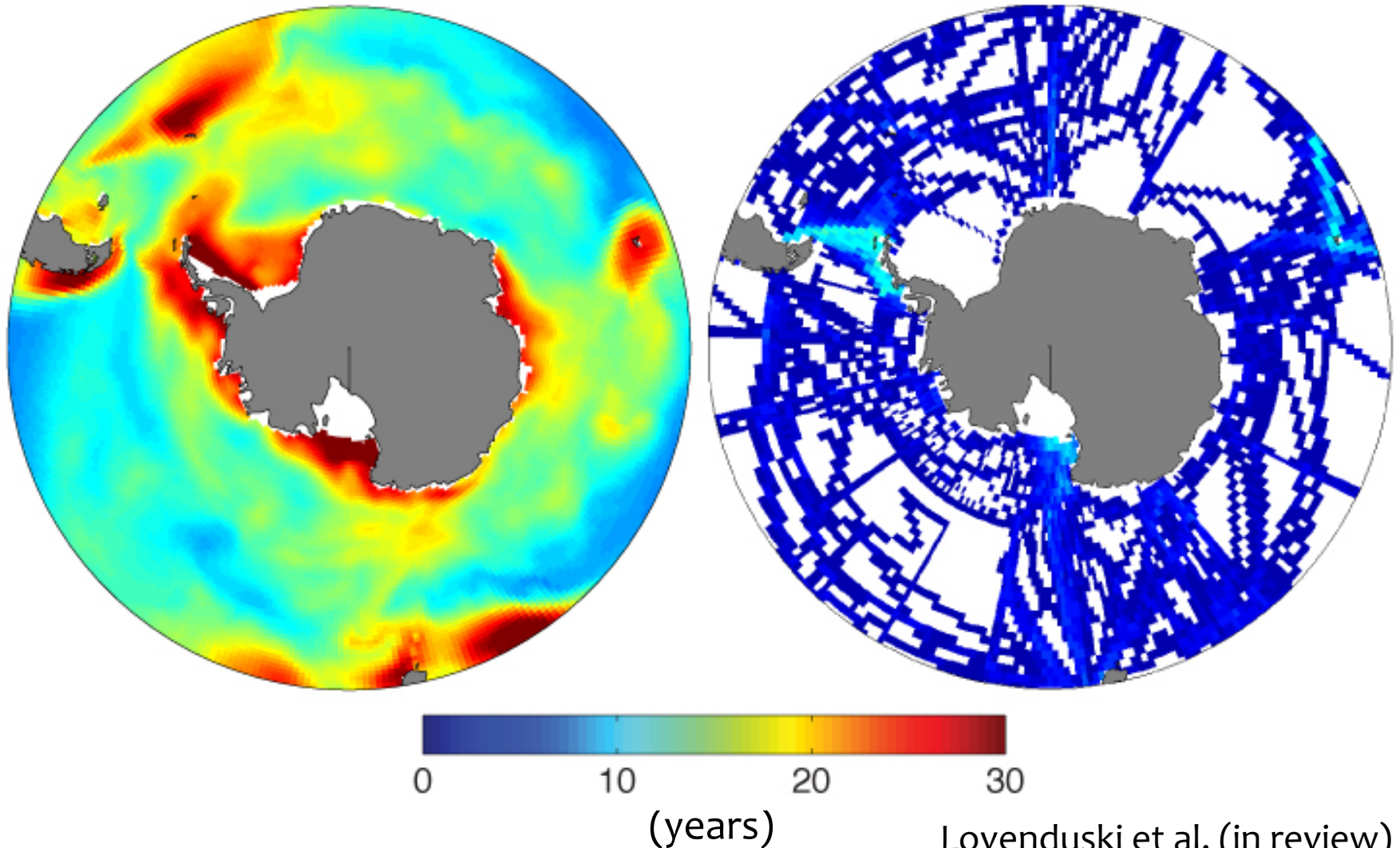


Lovenduski et al. (in review)

Do we have enough data?

Required length of time series

Years of data available



Conclusions

1. Are CO₂ flux trends affected by the choice of start/end year or season?
Start/end year: Yes.
Season: Not significantly.
2. Does the observational sampling introduce biases into the $\Delta p\text{CO}_2$ trends?
In SO-SPSS: Only slightly.
In SO-ICE: Yes, but also model bias.
3. Do we have enough observational data to detect a weakening CO₂ sink?
No, but one promising route to detection is data from the Drake Passage time series.