Ozone data for climate models: A comparison of three datasets and their climate impact

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Randel & Wu

- Zonal mean ozone dataset
- From January 1979 to December 2005
- Randel & Wu (2007), *JGR*, 112(D6), doi: 10.1029/2006JD007339
- Raw zonal mean, monthly mean values calculated from SAGE I, SAGE II, and ozonesonde data from Resolute and Syowa
- Used multiple linear regression to calculate anomalies, then added them to the climatology from Fortuin & Kelder

SPARC

- Zonal mean ozone dataset
- From January 1850 to December 2099
- Cionni et al. (2011), *ACP*, 11(21), doi: 10.5194/acp-11-11267-2011
- Based on the Randel & Wu dataset, with some reduced regression basis functions
- Combined with chemistry-climate model output to cover early and future time period, and troposphere

BDBP

- Zonal mean ozone dataset
- From January 1979 to December 2008
- based on the database described in **Hassler et al.** (2008), *ACP*, 8(17), 5403-5421.
- Raw zonal mean, monthly mean values calculated from SAGE I, SAGE II, HALOE, POAM 2, POAM 3 and ozonesonde data
- Used multiple linear regression to fill data gaps (several basis functions)

Dataset comparison

	BDBP	RW07	SPARC
Ozone units	ppmv molecules/m^2	DU/km	ppmv
Vertical units	km hPa	km	hPa
Temporal resolution	monthly	monthly	monthly
Zonal bands	87.5°S-87.5°N, 5° bands	90°S-90°N, 5° bands	90°S-90°N, 5° bands
# of vertical levels	70	50	24
Highest pressure level	70 km 0.046 hPa	50 km (0.81 hPa*)	1.0 hPa
Time period covered	01/1979 – 12/2008	01/1979 – 12/2005	01/1979 – 12/2010
Includes troposphere	✔	✖	✔
Includes stratosphere	✔	✔	✔
Regression model output	✔	✔	✔
Linear Trend BF	✔	✖	✖
EESC BF	✔	✔	✔
QBO BF	✔ (2 orthog.)	✔ (2 orthog.)	✖
Solar cycle BF	✔	✔	✔
Volcano BF	✔	✖	✖
ENSO BF	✔	✖	✖

* if converted with a standard atmosphere

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Linear Trend BF	✔	✖	✖
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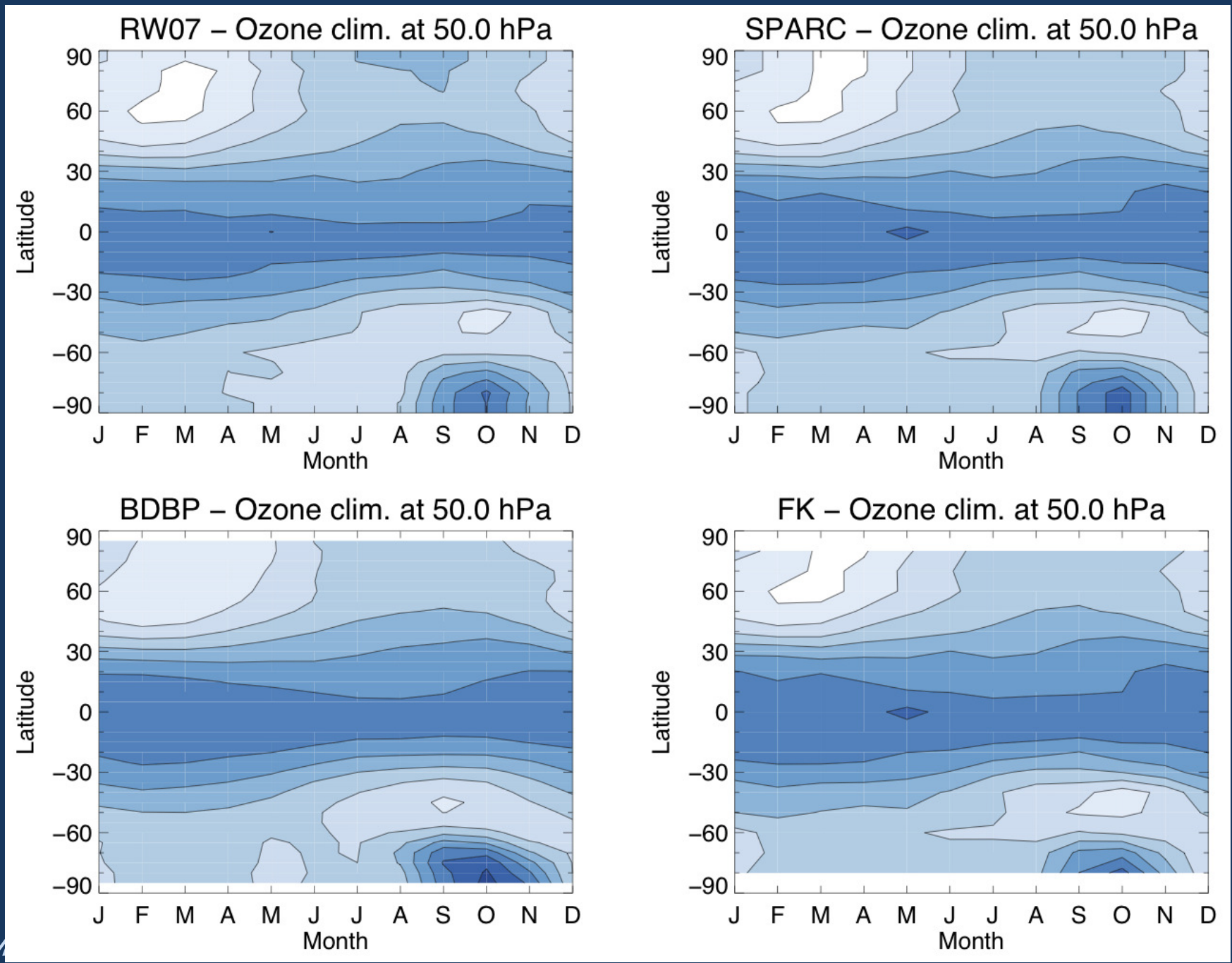
Solar cycle BF	✔	✔	✔
Volcano BF	✔	✖	✖
ENSO BF	✔	✖	✖

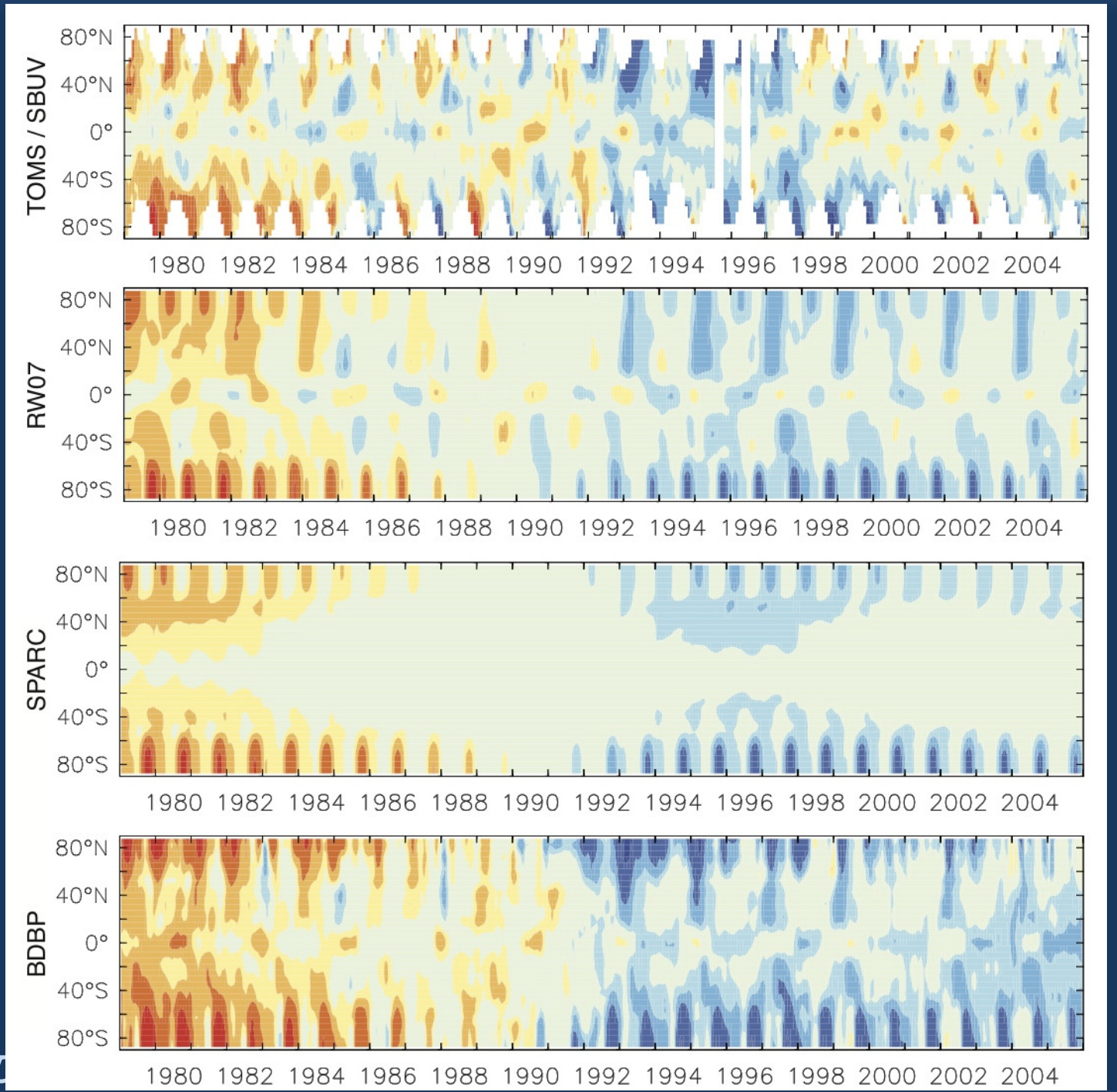
* if converted with a standard atmosphere

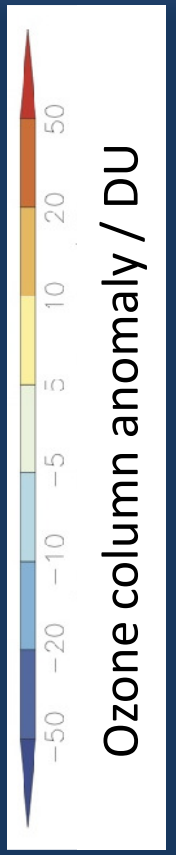
Ozone climatology – 50 hPa



Fortuin & Kelder (1998), *JGR*, 103(D24), 31709–31734.

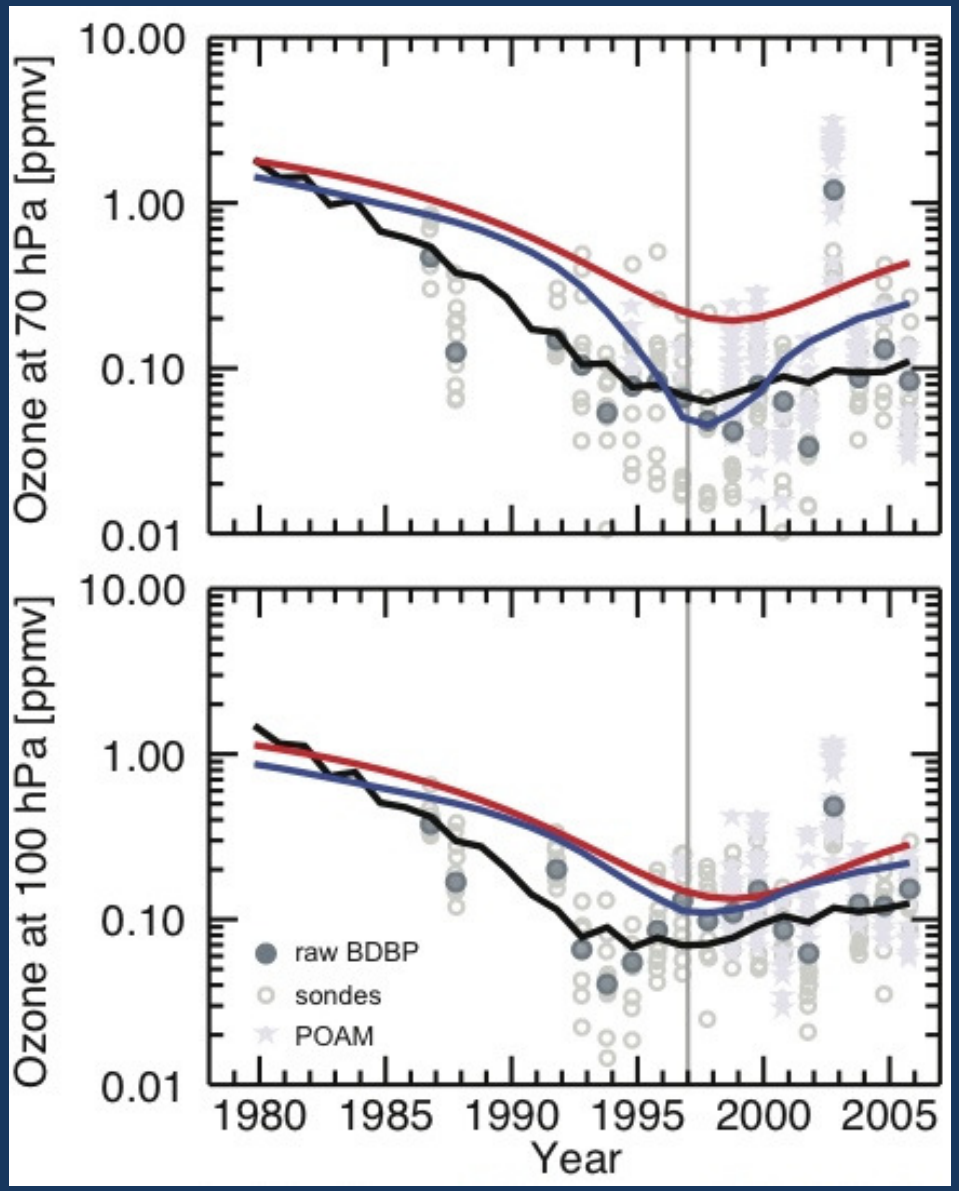
Integrated ozone – anomalies

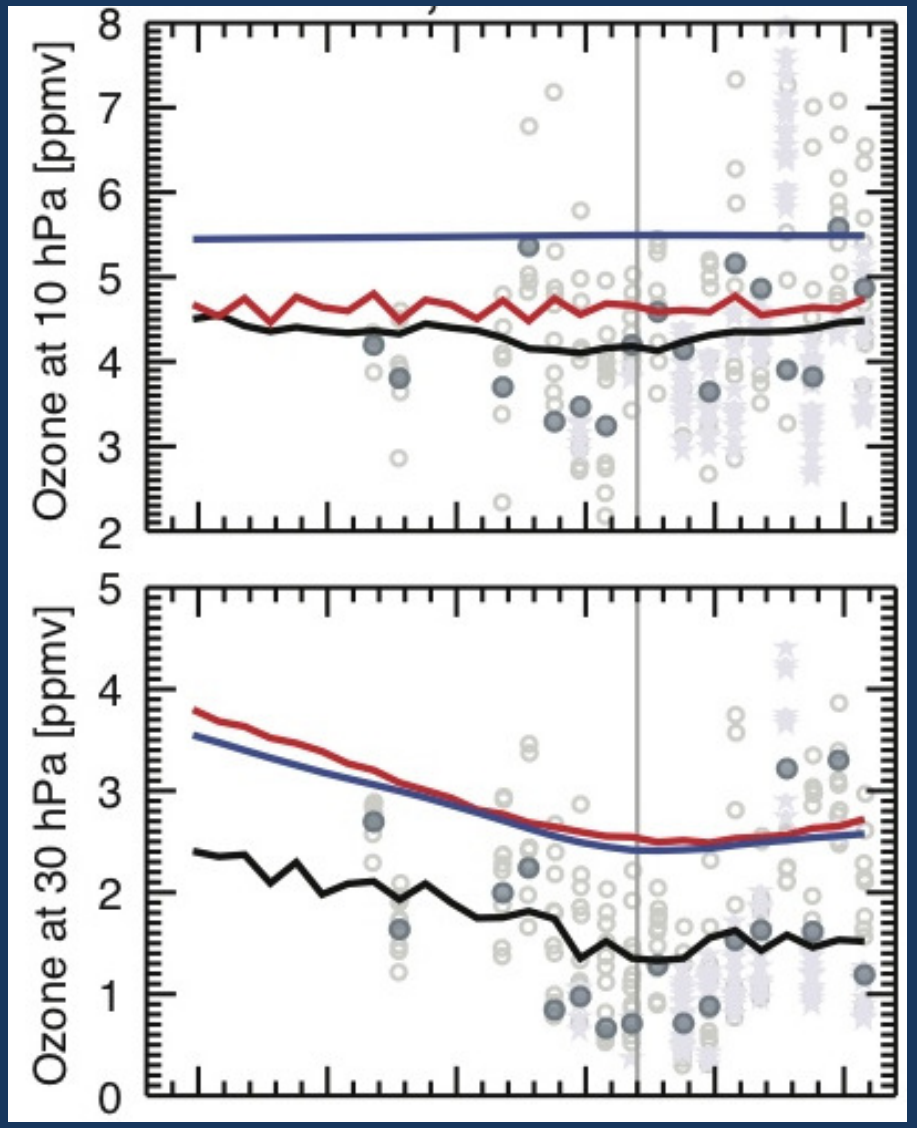




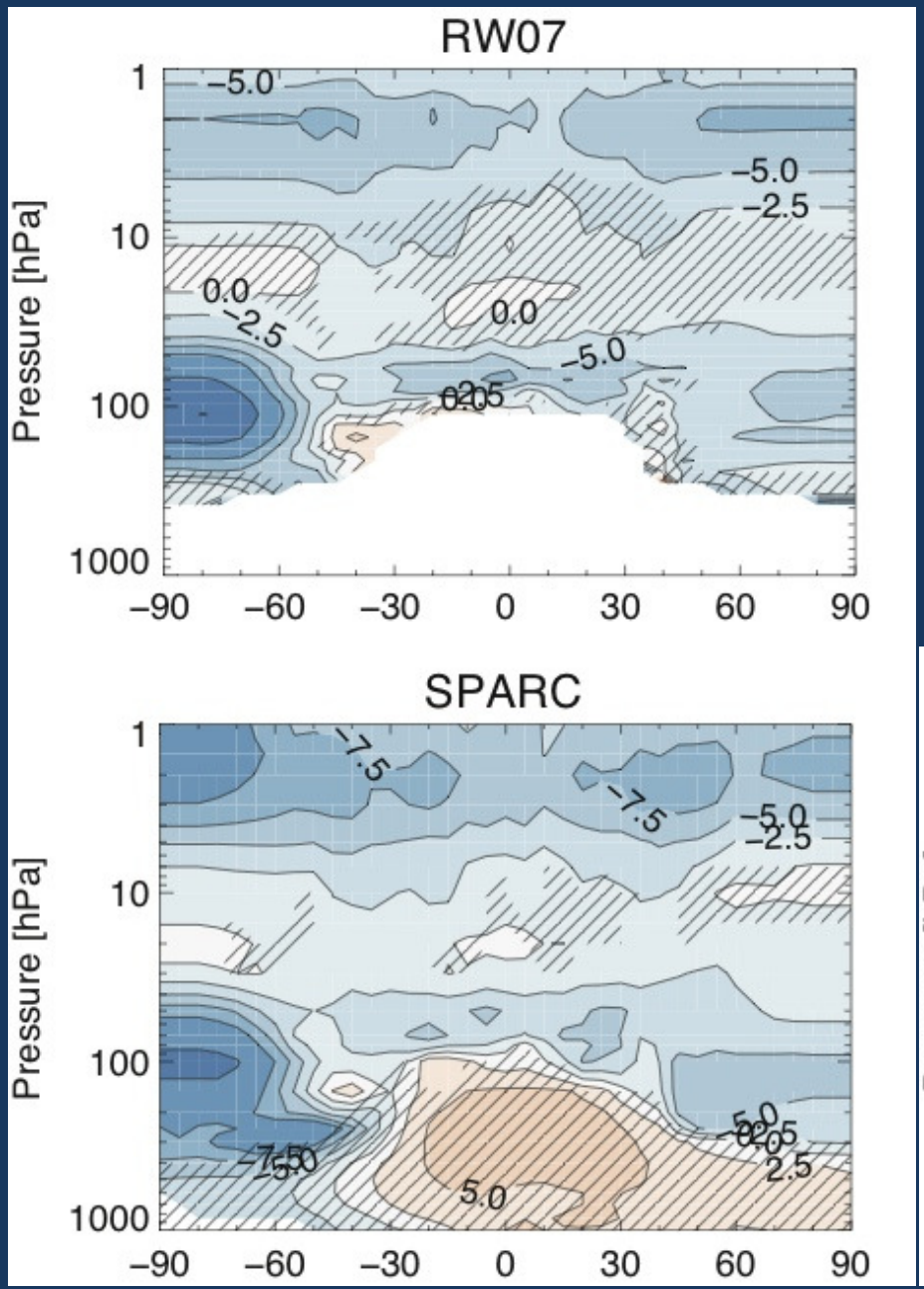
Note:
RW07, SPARC, and BDBP are only integrated from 250 – 1 hPa.

October time series, 90°S to 85°S

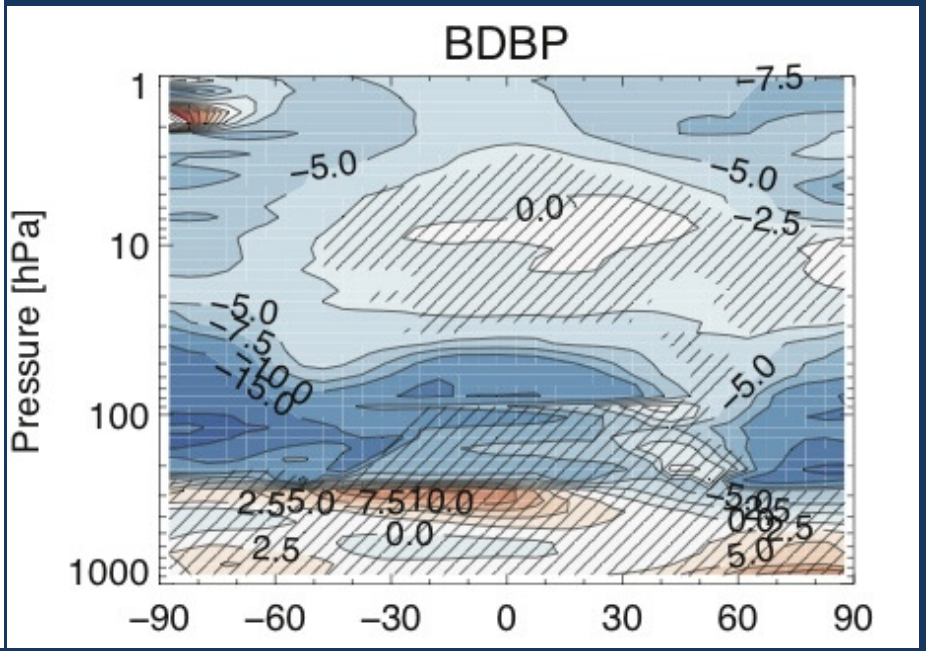


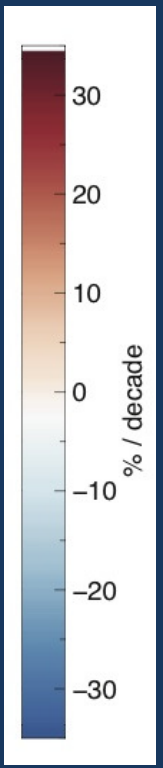


Annual mean trends [%/decade]



- piecewise linear trend
- 1979-1997
- hashed: not significant on 2-σ level

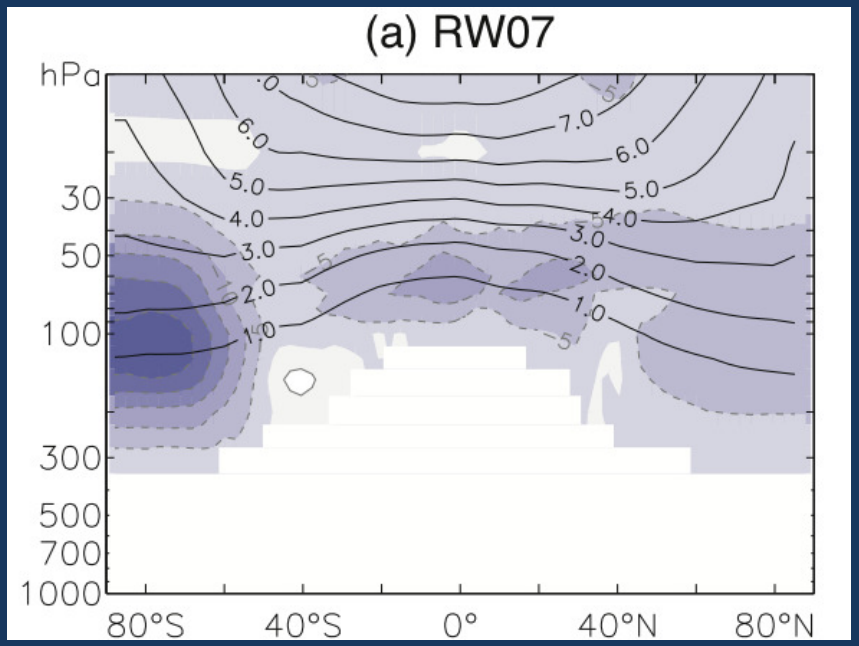


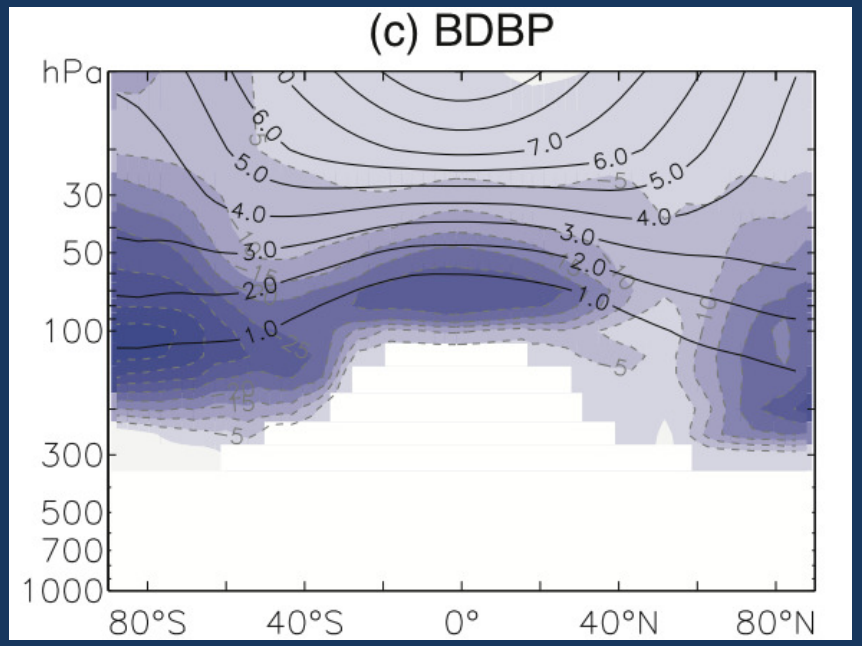


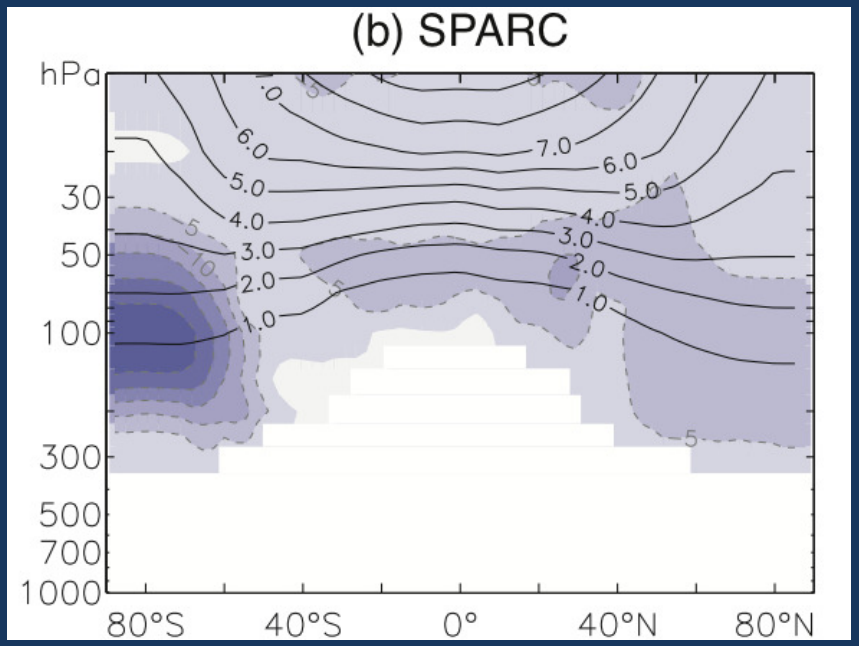
Climate modeling

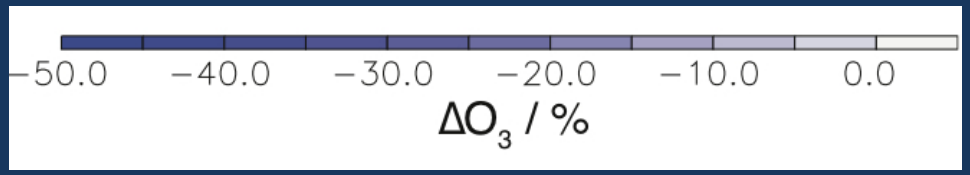
- Community Atmosphere Model (CAM3)
- two different simulations:
  1. "pre-ozone hole", avg. 1979-1981
  2. "deep ozone hole", avg. 1995-1997
- only difference in each simulation: strat. ozone forcing used as model input
- same SSTs, sea ice, CO_2 and methane
- 100-year time slice integrations

O3 changes

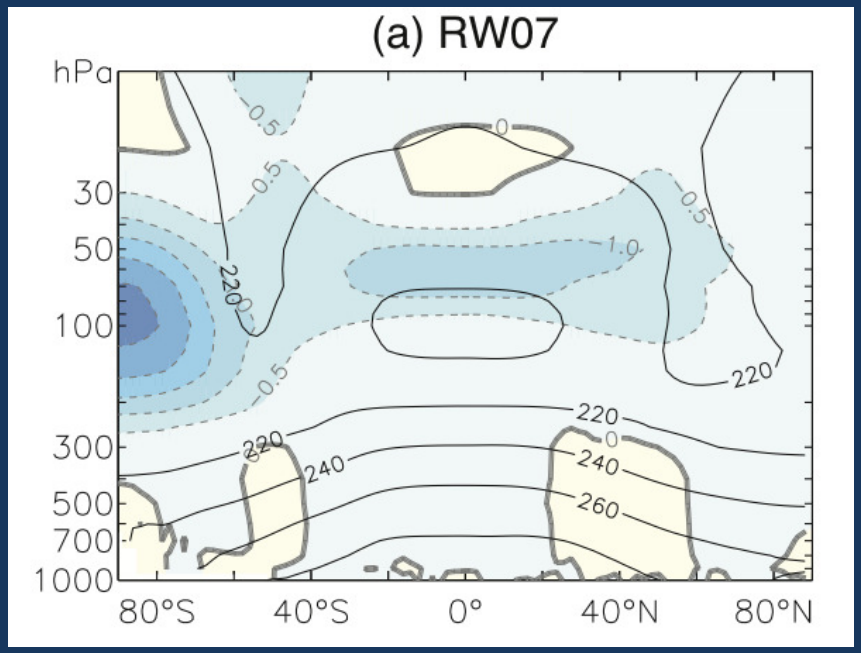

(a) RW07
hPa
30
50
100
300
500
700
1000
80°S
40°S
0°
40°N
80°N

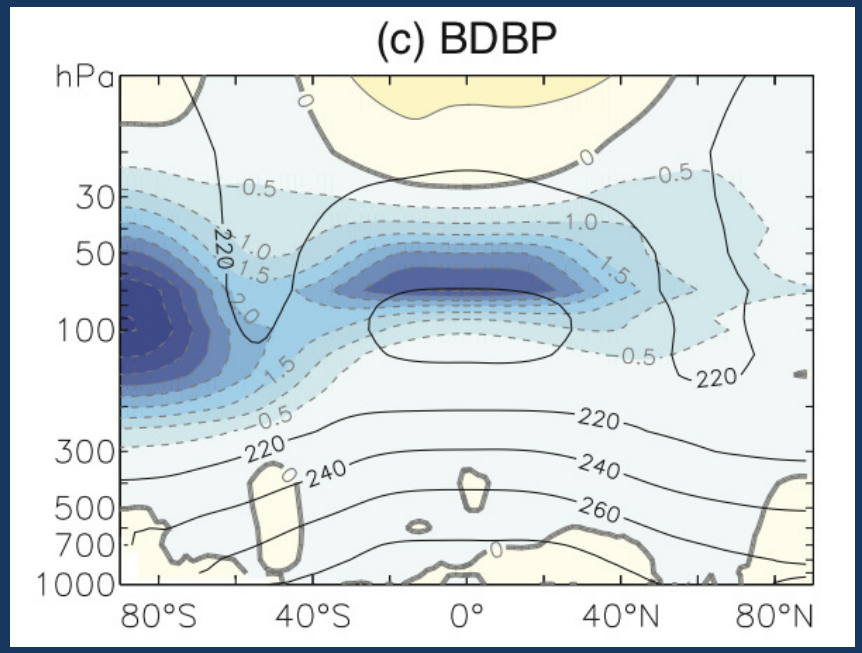

(c) BDBP
hPa
30
50
100
300
500
700
1000
80°S
40°S
0°
40°N
80°N

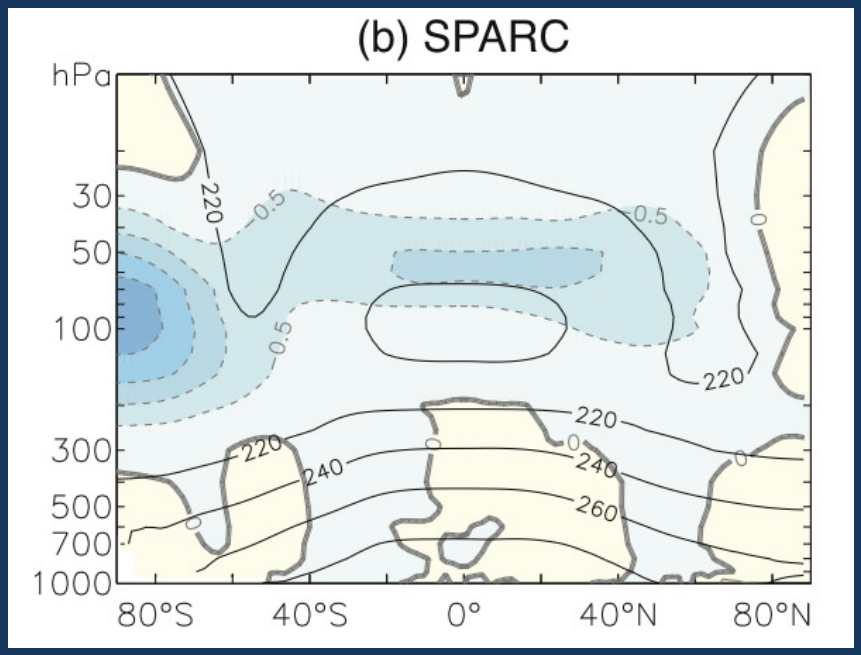

(b) SPARC
hPa
30
50
100
300
500
700
1000
80°S
40°S
0°
40°N
80°N


−50.0
−40.0
−30.0
−20.0
−10.0
0.0
ΔO3 / %

Effects on zonal mean temp.







Summary

- most *realistic variability*: BDBP
- best *established* and *tested*: RW07
- best suitable for *long climate runs*: SPARC
- *Antarctic spring ozone loss*: underestimated in RW07 and SPARC
- *Arctic spring ozone loss*: underestimated in RW07 and SPARC, likely overestimated in BDBP
- *tropical ozone depletion*:
  most likely overestimated in BDBP, most likely underestimated in RW07 and SPARC