Status of WACCM

CESM2(WACCM6)

- High-top atmospheric component of CESM2 (0.95° x 1.25° horizontal resolution, 70L)
- Orographic, frontal and convective GW parameterizations (orographic parameterization completely updated). New PBL drag
- Prognostic aerosol parameterization (MAM4)
- 2° version now available as part of CESM2.1.1 release (paleo simulations; basis for building WACCM-X, etc.)
- New boundary layer physics; shallow convection scheme (CLUBB)
- JPL-15 chemistry; updated TSMLT scheme; other chemistry options available (MA, MA-D)
- Volcanic aerosols from Neely and Schmidt (2016) database
- SOA from Tilmes et al. (*JAMES*, 2019) Volatility Basis Set (VBS) scheme
- CMIP6 wavelength resolved solar variability specification
- Can generate a QBO internally (with some caveats; see later)

details: Gettelman et al., 2019: *JGR* **124**, 12,380-12,403, https://doi.org/10.1029/2019JD030943

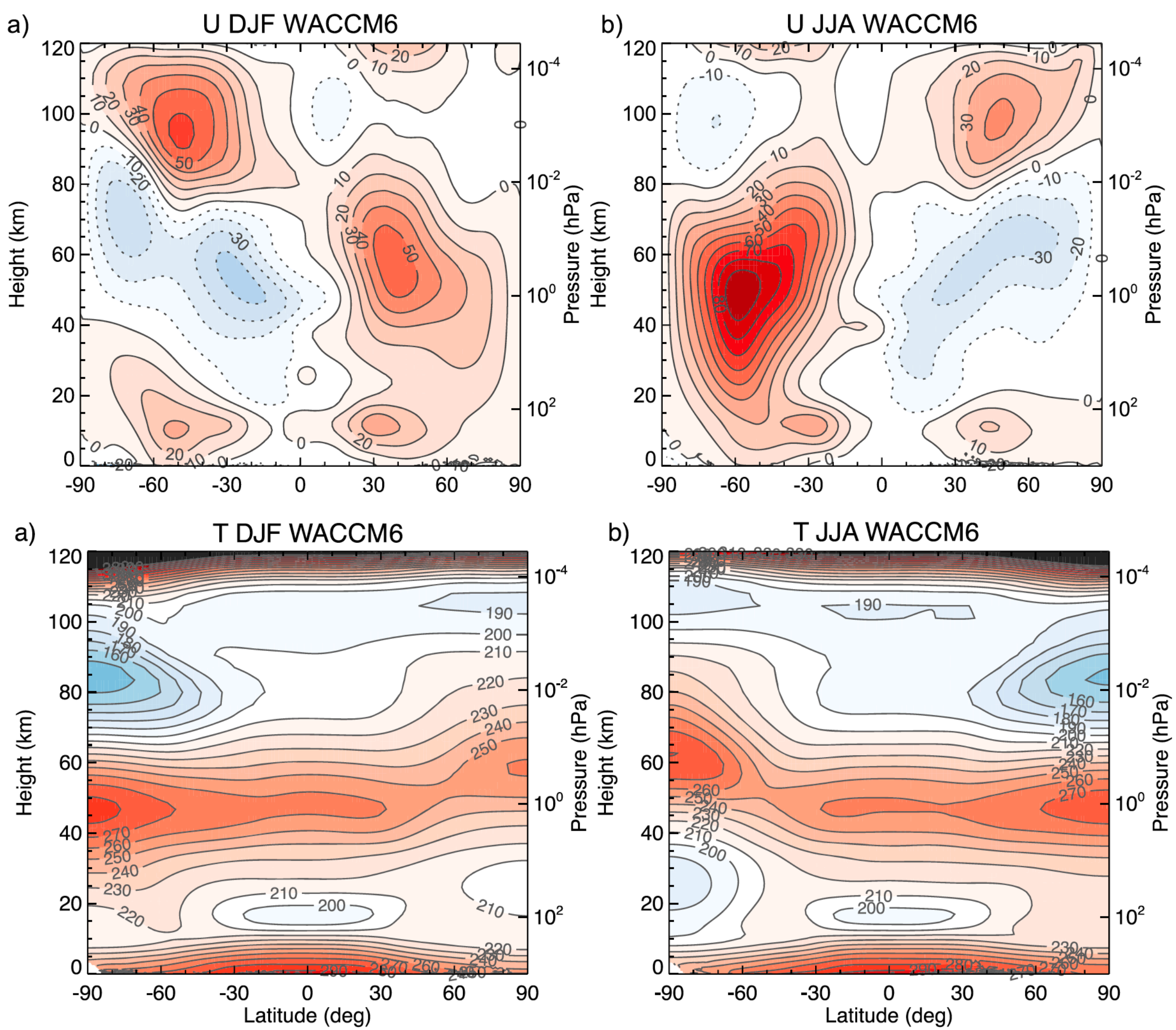
WACCM6 configurations and cost

Table 2
WACCM/CAM Configurations Used in This Paper, Including cost (CPU-Hours) of the Model

Name	WACCM6	WACCM6-SD	CESM2-WACCM6	CESM2-WACCM6	WACCM6-SC
Description	Historical (AMIP)	Specified Dynamics	Coupled 1850 Control	Coupled Historical	Specified Chemistry
WACCM component set	FWHIST	FWSD	BW1850	BWHIST	FWscHIST
CAM component set	FHIST	FWSD	B1850	BHIST	FHIST
WACCM ensembles	3	1	1	3	1
# years or dates	1950–2014	2005–2017	500 years	1850–2014	1979–2014
Coupled ocean/ice	No	No	Yes	Yes	No
Specified dynamics	No	Yes	No	No	No
Chemistry	TSMLT1	TSMLT1	TSMLT1	TSMLT1	Specified
CPU-hrs/sim-year	22,000	21,000	27,000	30,000	5,700

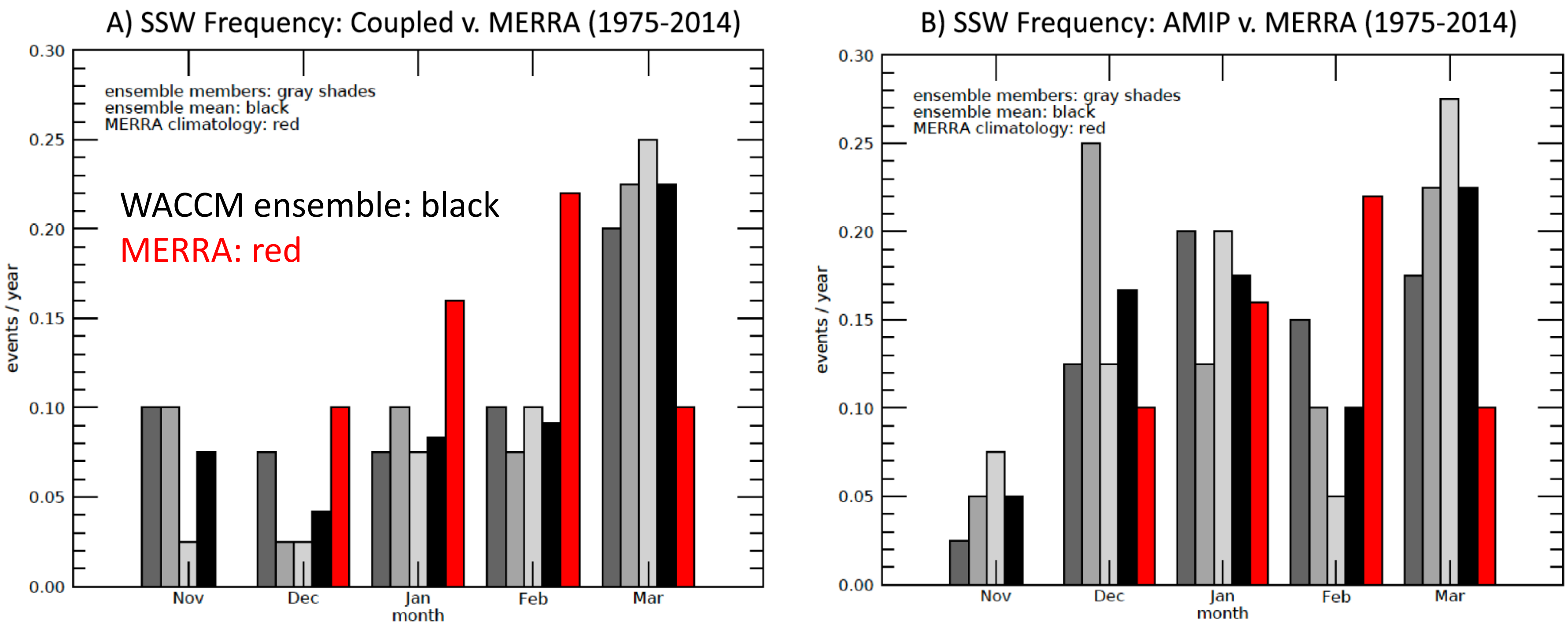
Gettelman et al. (JGR 2019)

Climatological fields



Gettelman et al. (JGR 2019)

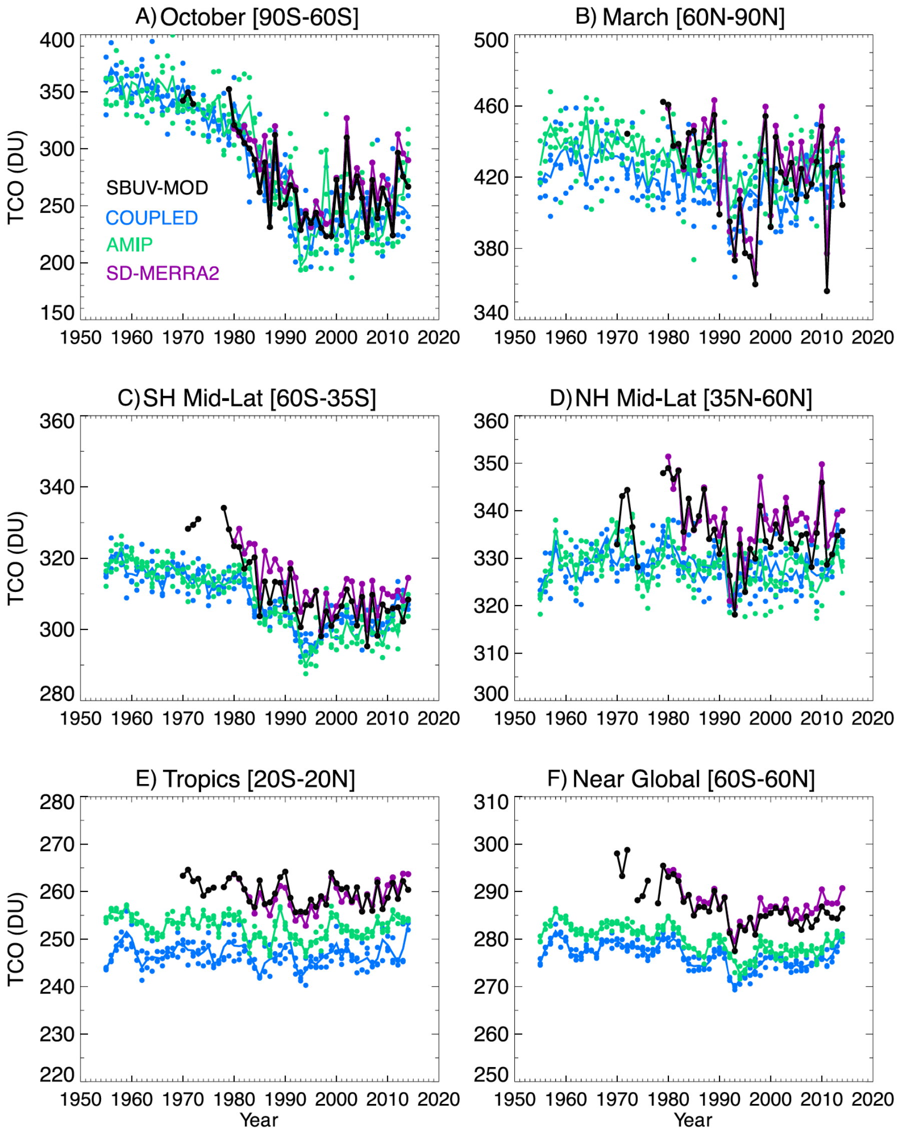
SSW climatology



Gettelman et al. (JGR 2019)

- Annual frequency is good; seasonal distribution has **too many late SSW**

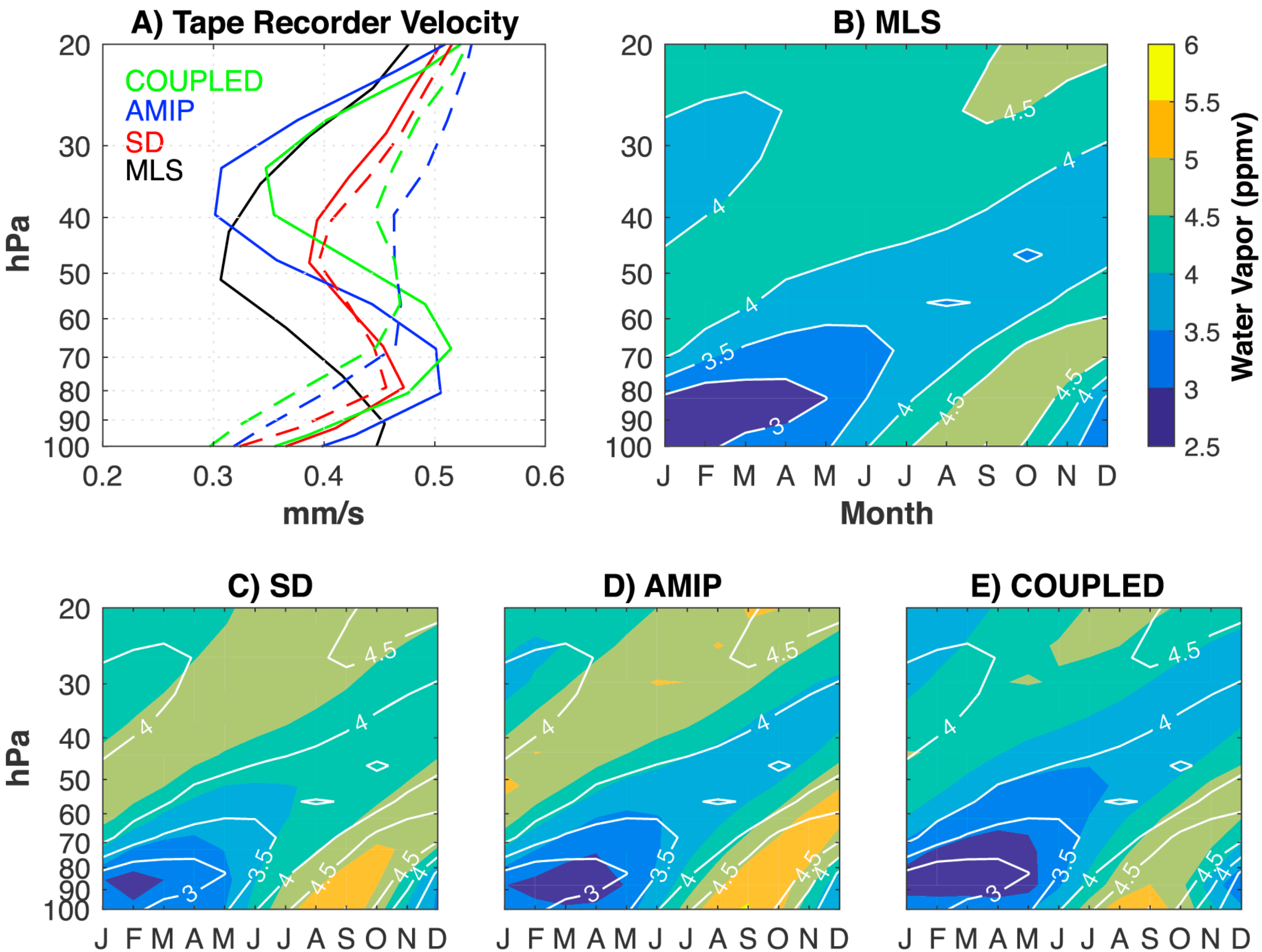
long-term O_3 evolution



- Excellent simulation of O_3 hole development and incipient recovery
- Overestimates tropical O_3 by about 6-8%

Gettelman et al. (JGR 2019)

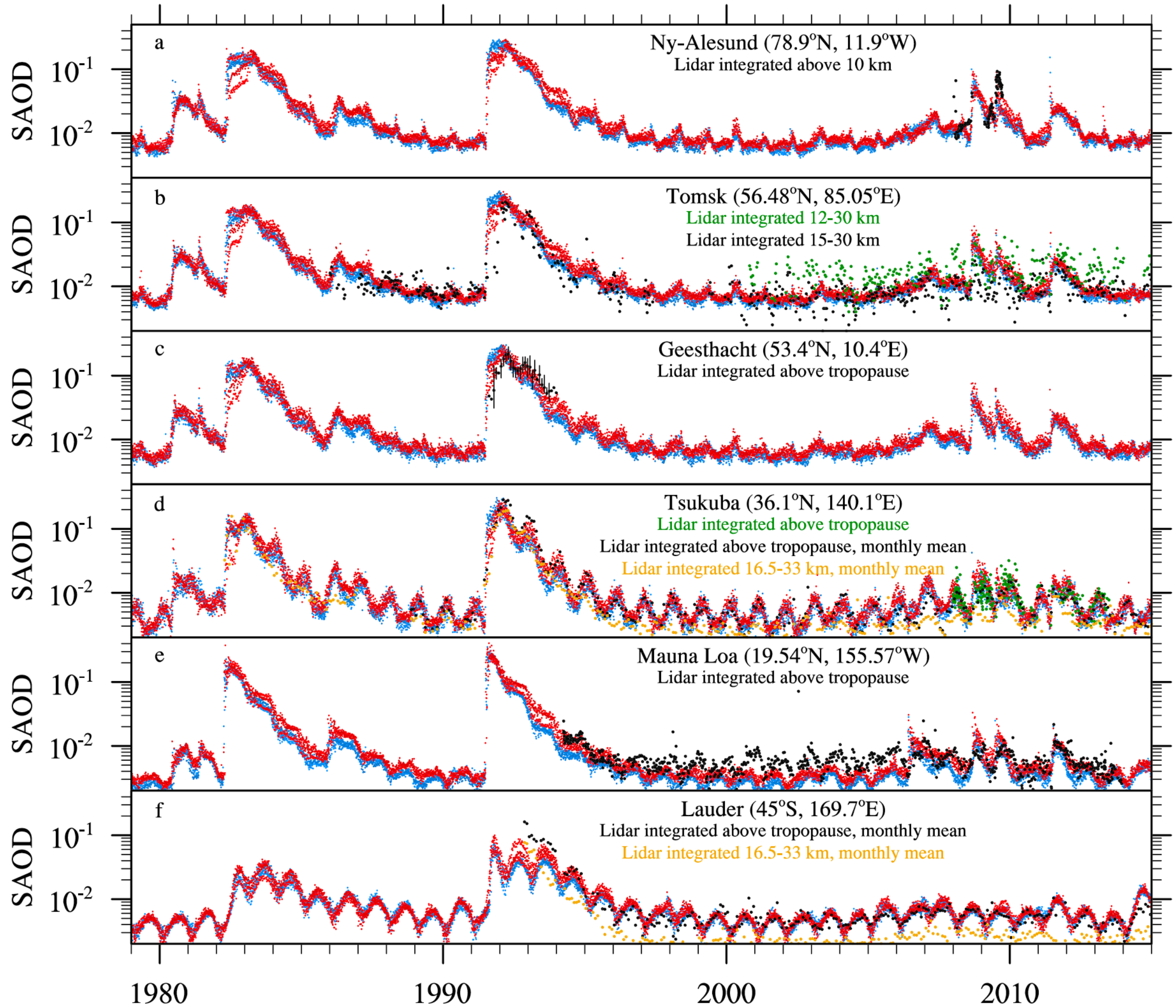
H_2O "tape recorder" signal



- Tape recorder a bit too fast

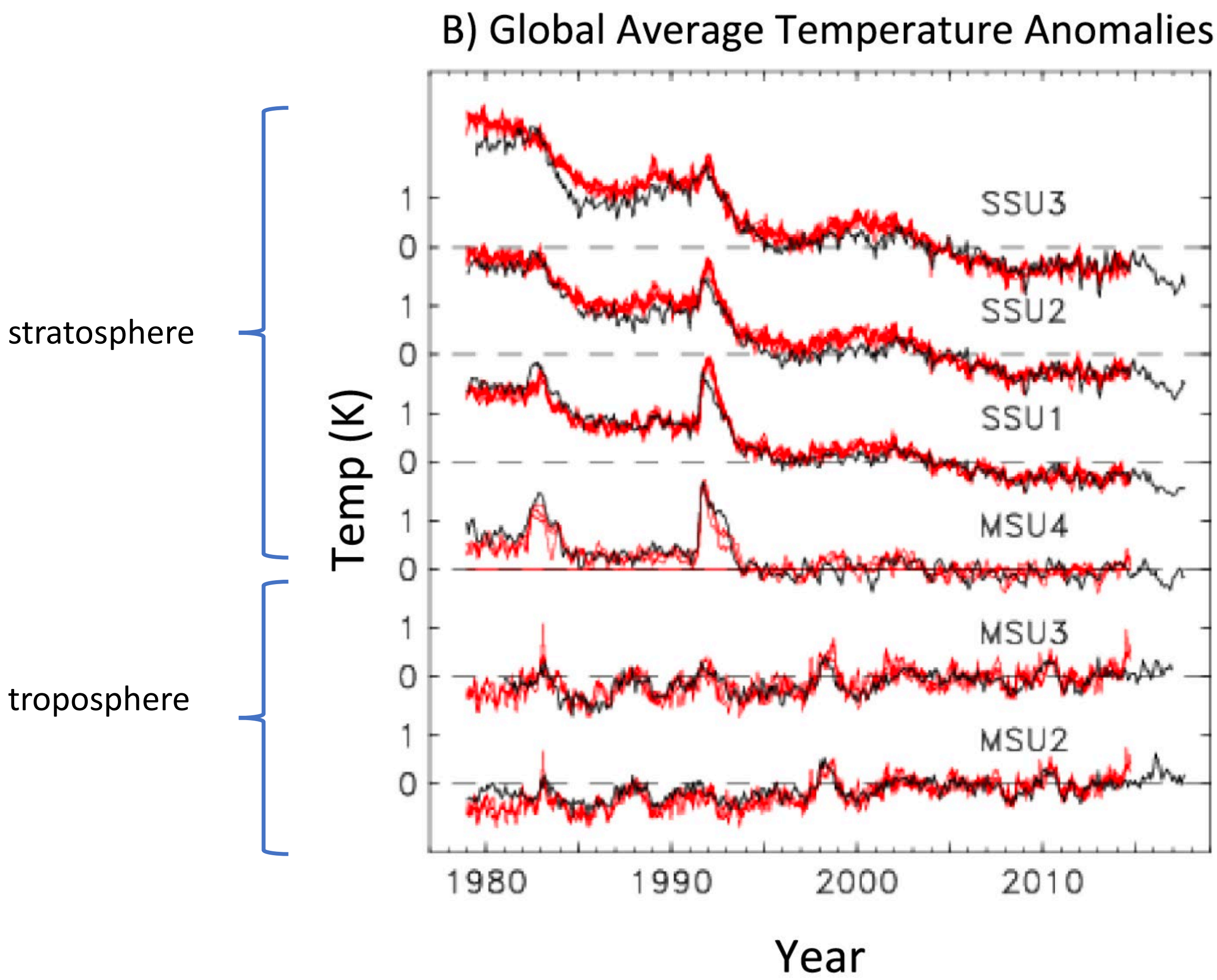
Gettelman et al, (JGR 2019)

Stratospheric volcanic aerosols



Gettelman et al, (JGR 2019)

global-mean T vs. observations

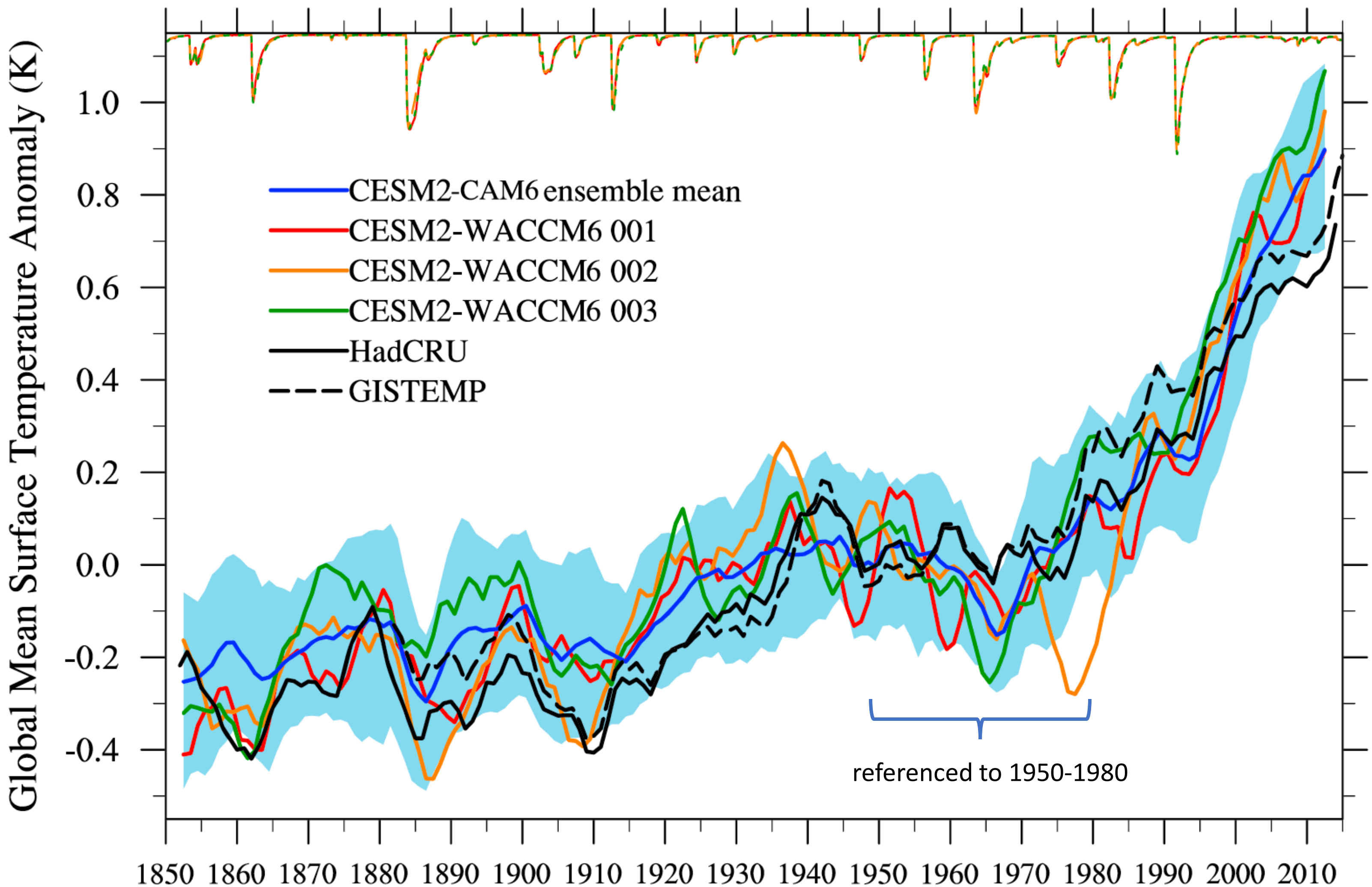


WACCM6 AMIP
vs. satellite data

- Note good volcanic response and solar-cycle signal

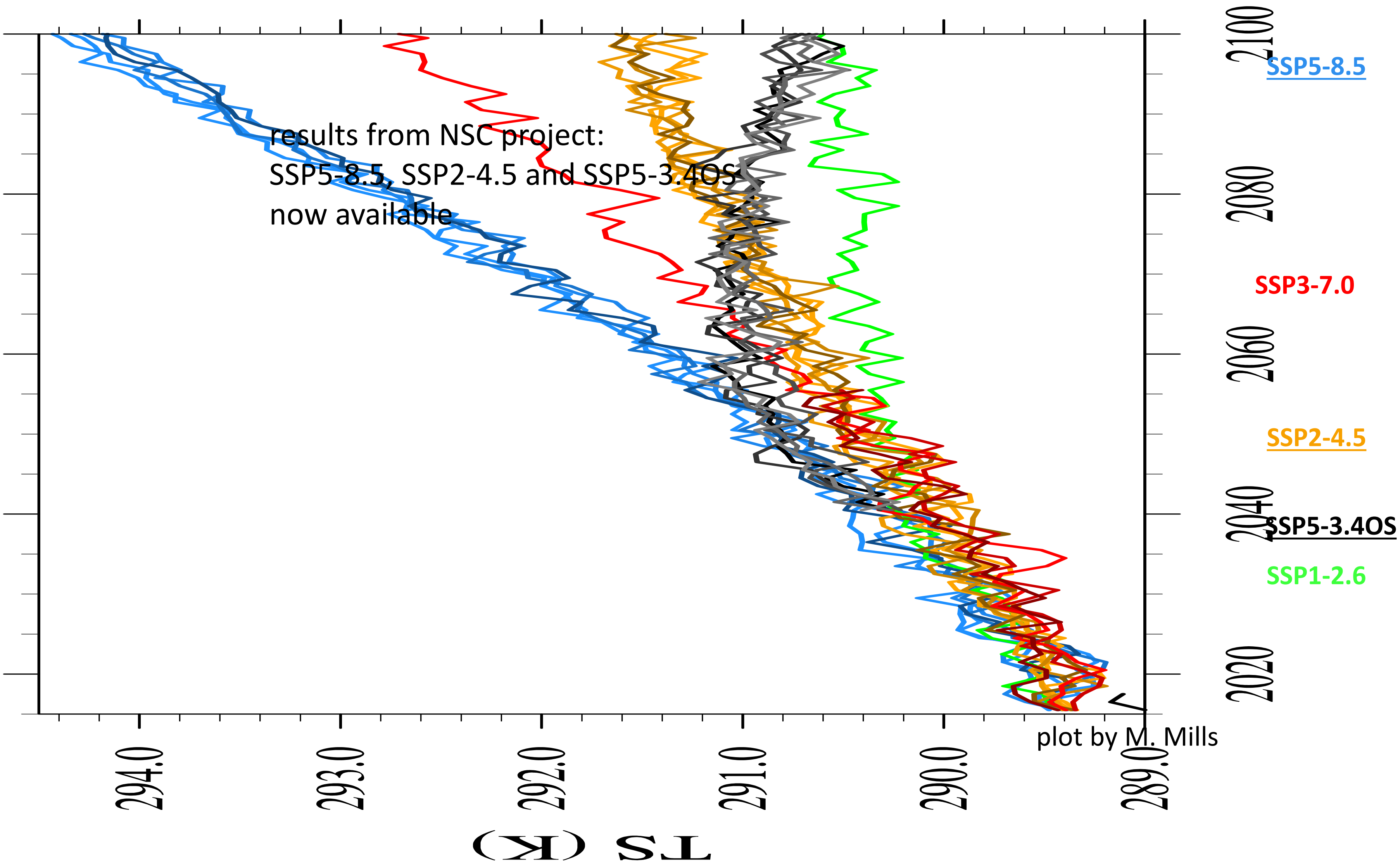
Gettelman et al. (JGR 2019)

WACCM6 historical simulations

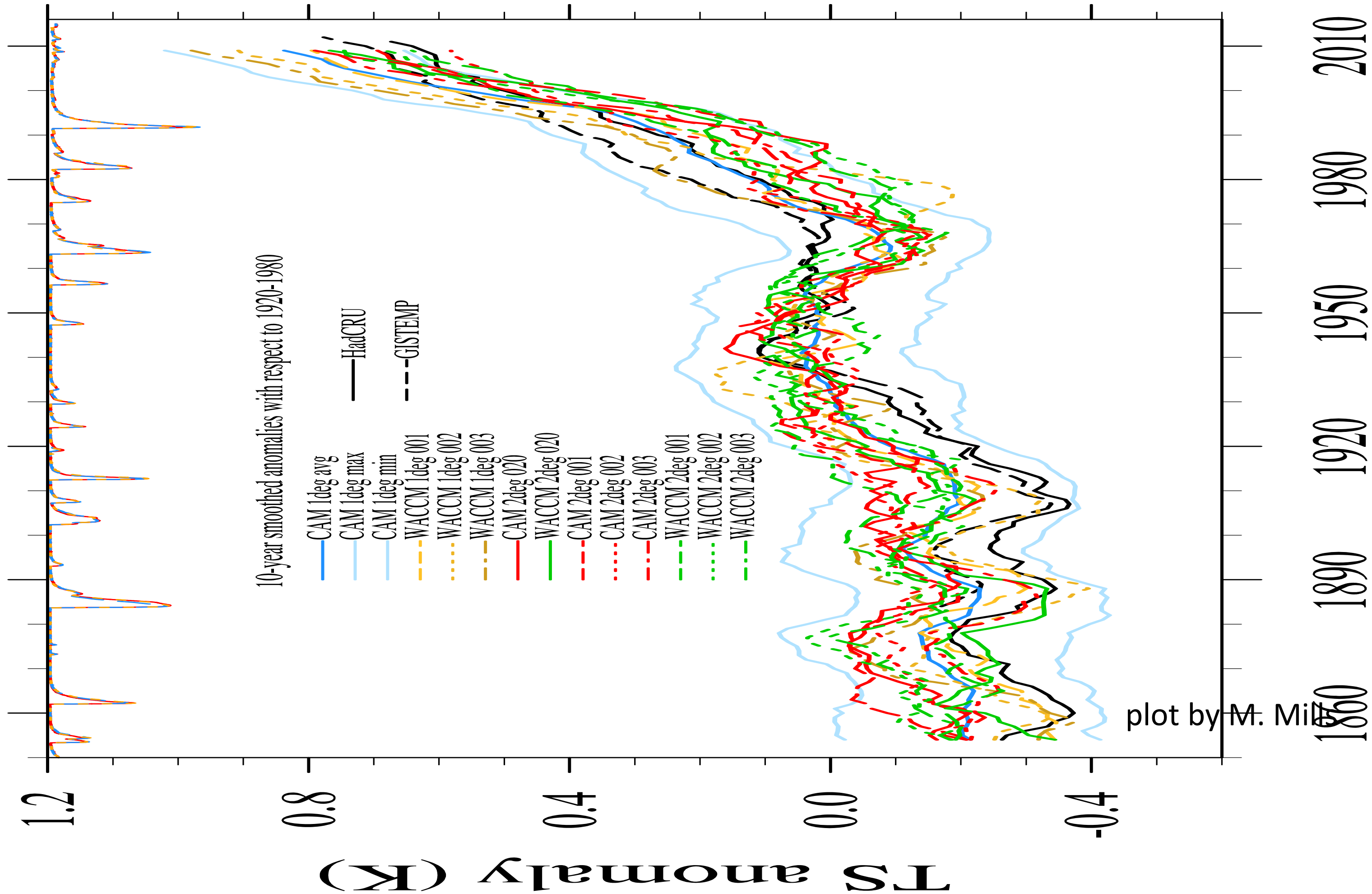


Gettelman et al. (JGR 2019)

WACCM6 small-ensemble scenarios

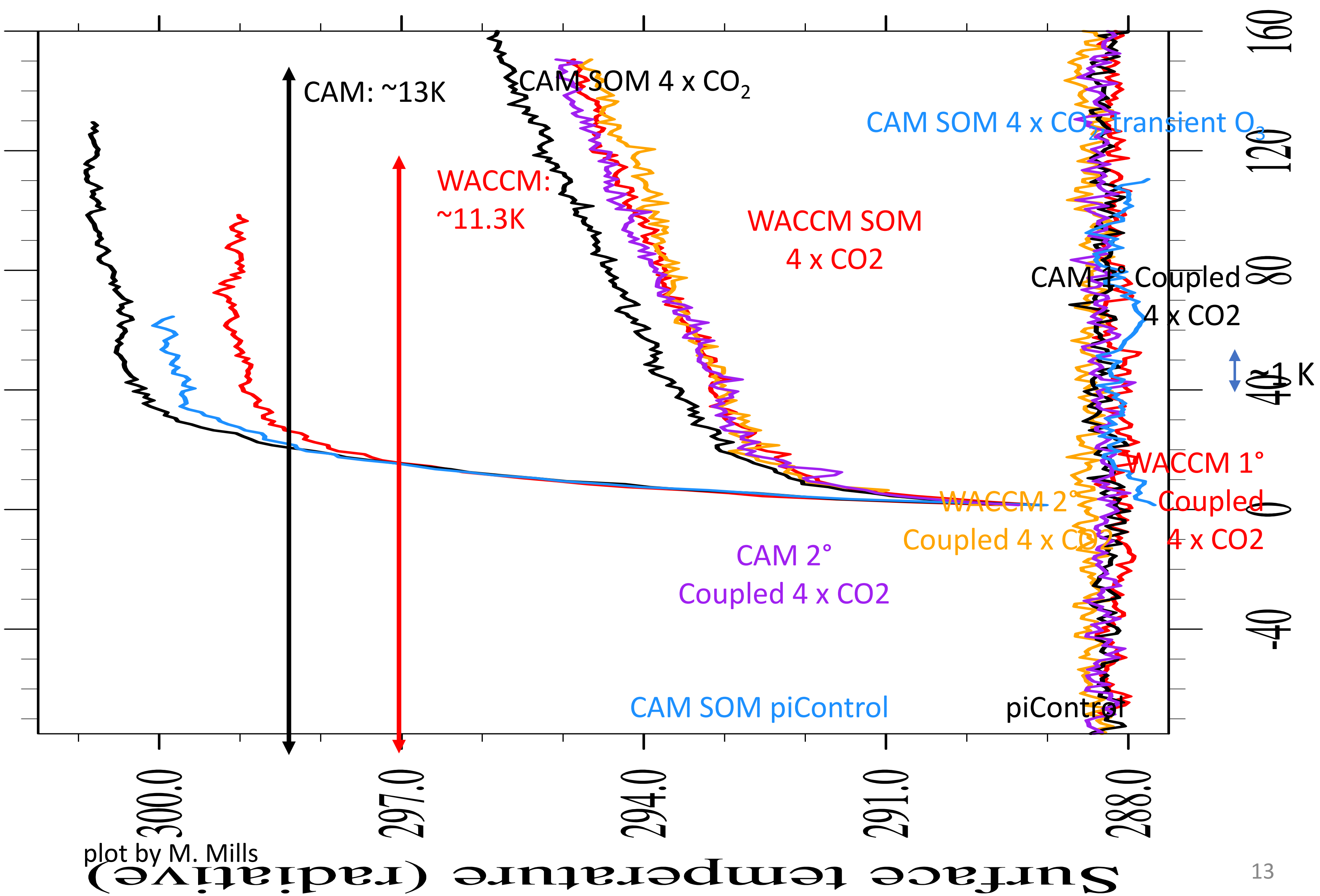


2° version of CESM2(WACCM6)



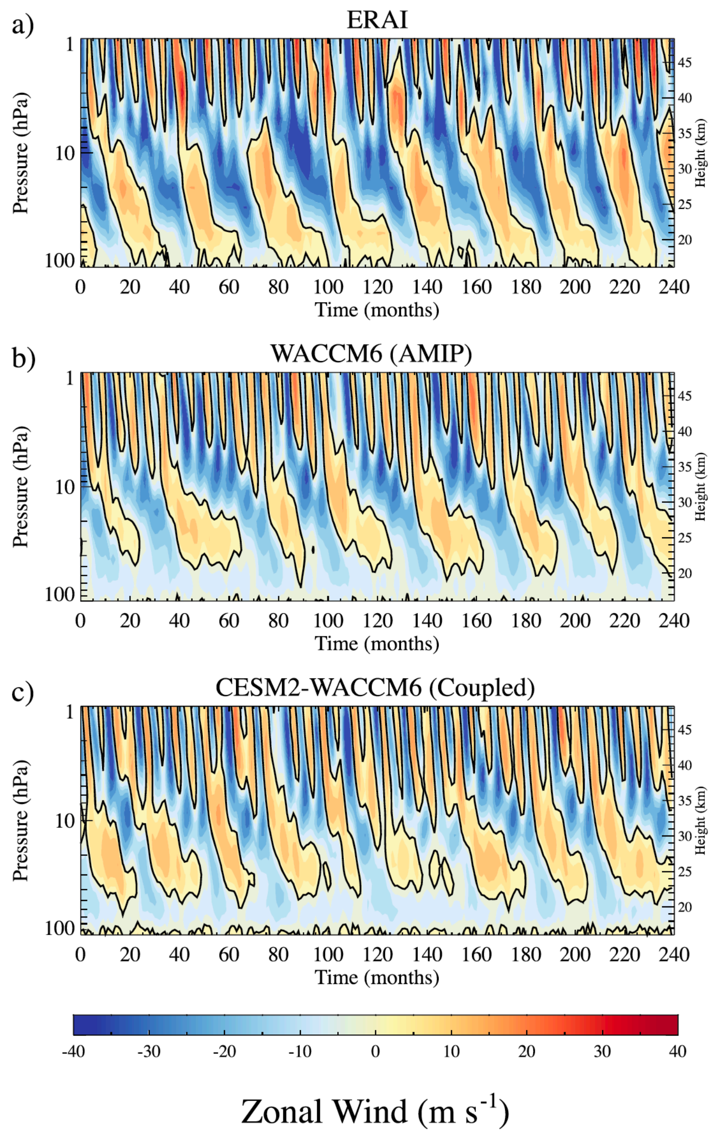
- 2° version of WACCM6 now available
- DECK simulations performed
- Historical T_S consistent with 1° models

climate sensitivity vs. CAM6



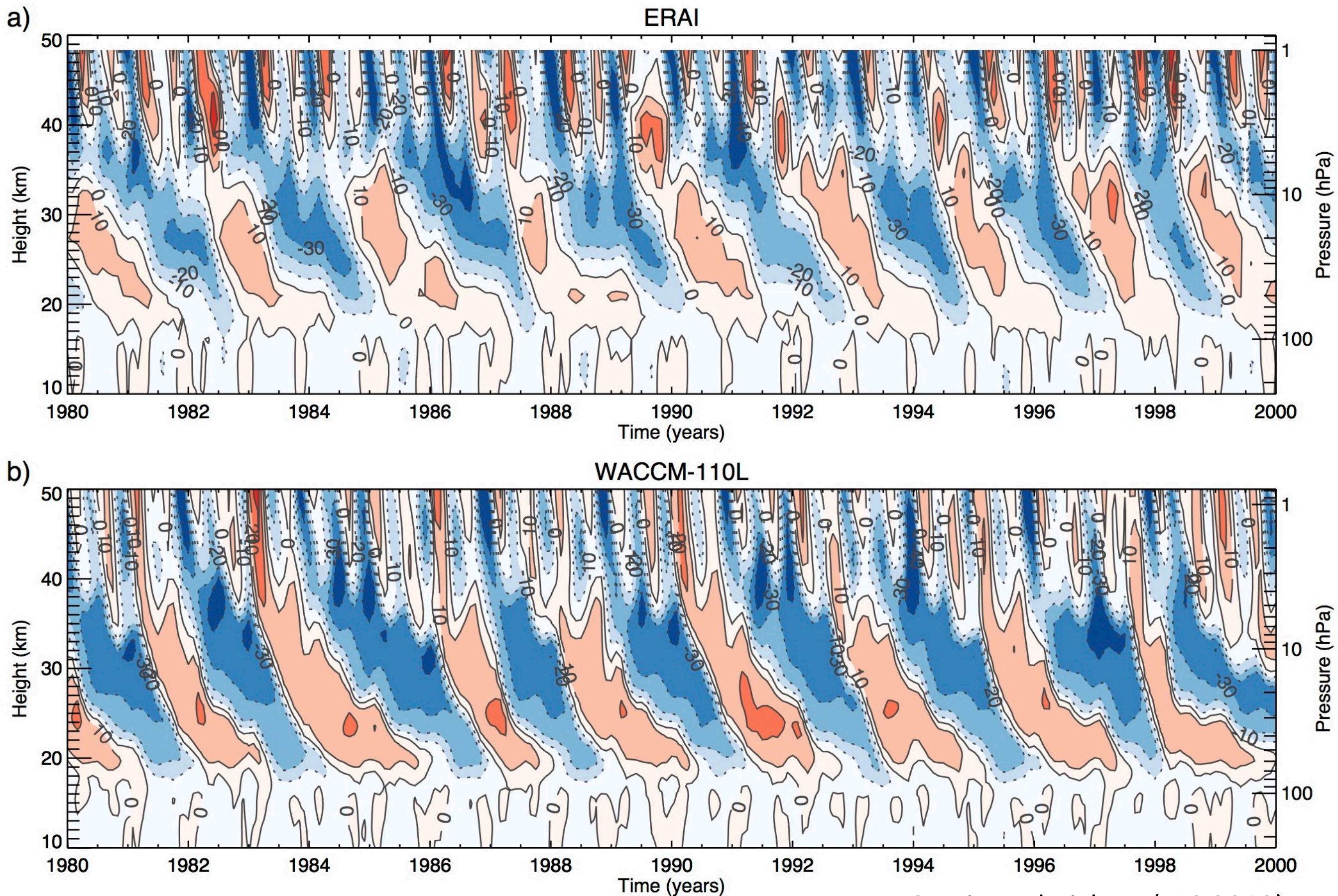
plot by M. Mills

QBO and standard vertical resolution (70L)



Gettelman et al, (JGR 2019)

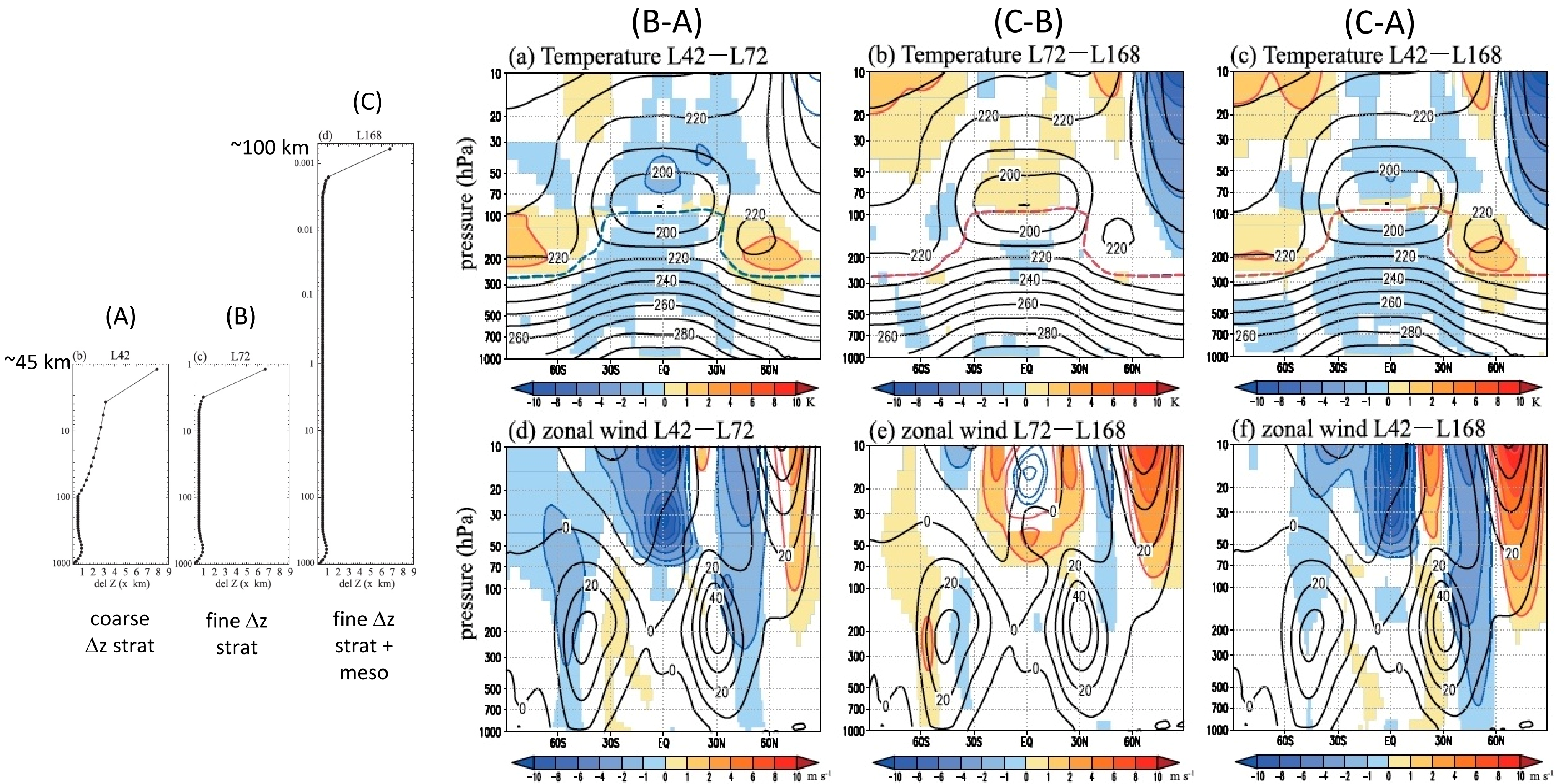
QBO and high-vertical resolution (110L)



Garcia and Richter (JAS 2019)

- Results from WACCM5.4, 110L
- Similar results can now be ontained with WACCM6

more on vertical resolution



Kawatani et al, *JAS* 2019

- Fine vertical resolution makes a difference outside the Tropics in the Japanese model

Future choices

- WACCM6 is expensive to run (~ 10 x CAM6)
- Most of the expense is due to chemistry (~ 5 x); the rest (~ 2 x) is due to additional levels in WACCM (32L vs. 70L standard)
- Chemistry is necessary to provides radiative and oxidant fields for CAM (or for SC-WACCM); this expense cannot be avoided unless CESM wants to outsource these calculations
- Higher vertical resolution is required to address stratospheric physics (→ more levels; a linear in crease in cost)
- Higher resolution above the tropopause may not be of interest to CAM

…

- It might be desirable not to have to maintain multiple CESM models. Is it possible to do so given the above considerations?