

The AMOC in CMIP6 Models

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October 14, 2020



Atlantic Meridional Overturning Circulation (AMOC)



- How well do CMIP6 models represent AMOC?
 - Compare with RAPID/SAMBA arrays
- What do CMIP6 models predict for AMOC decline in 21st century?

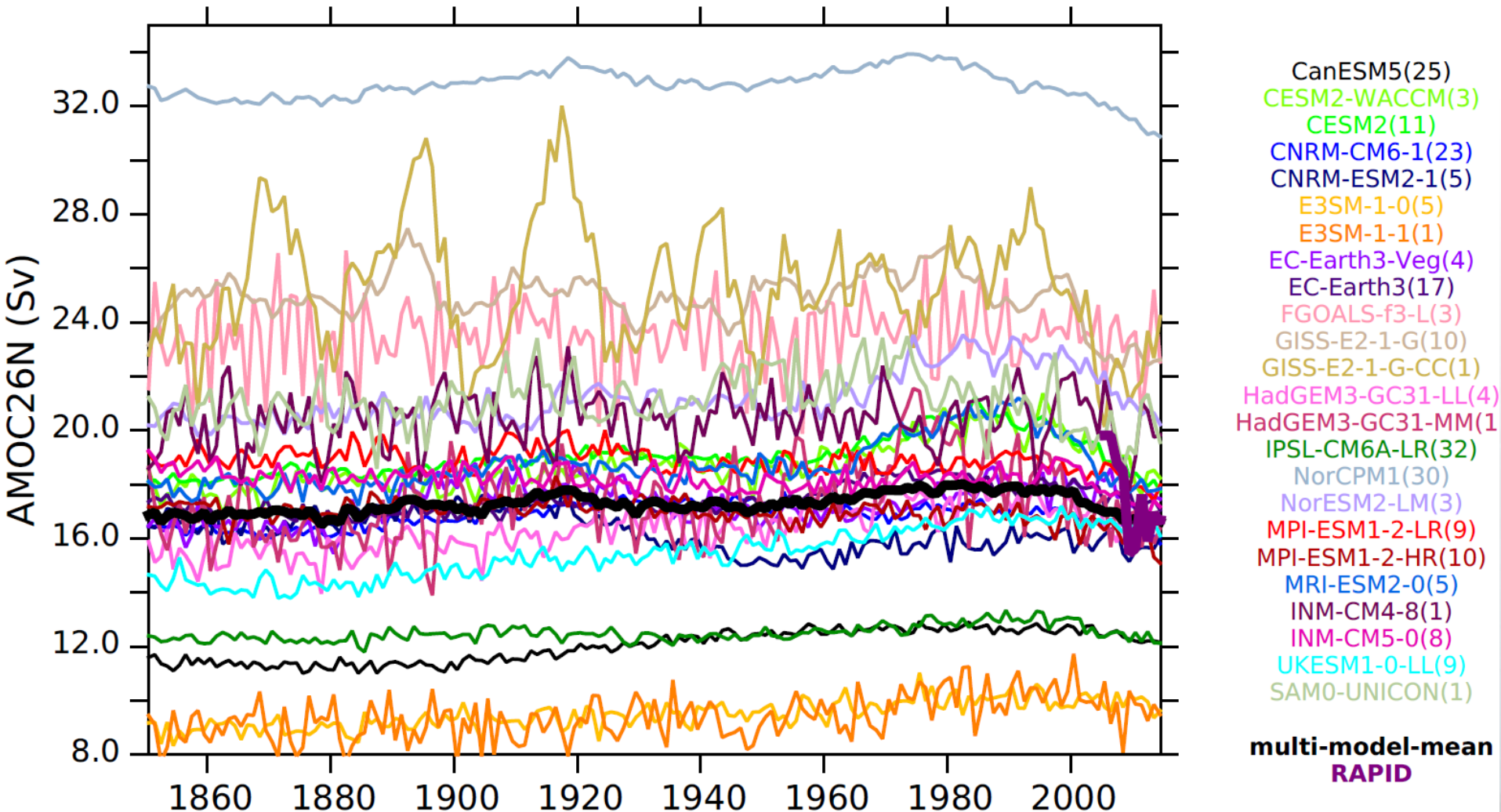
The Experiments



- Historical
 - 1850-2014
 - ‘Observed’ GHG + aerosol forcing
- 4 Tier-I Shared Socioeconomic Pathways (SSPs)
 - SSP1-2.6
 - SSP2-4.5
 - SSP3-7.0
 - SSP5-8.5
- 27 models provided AMOC for historical
- 18 models provided AMOC for SSPs

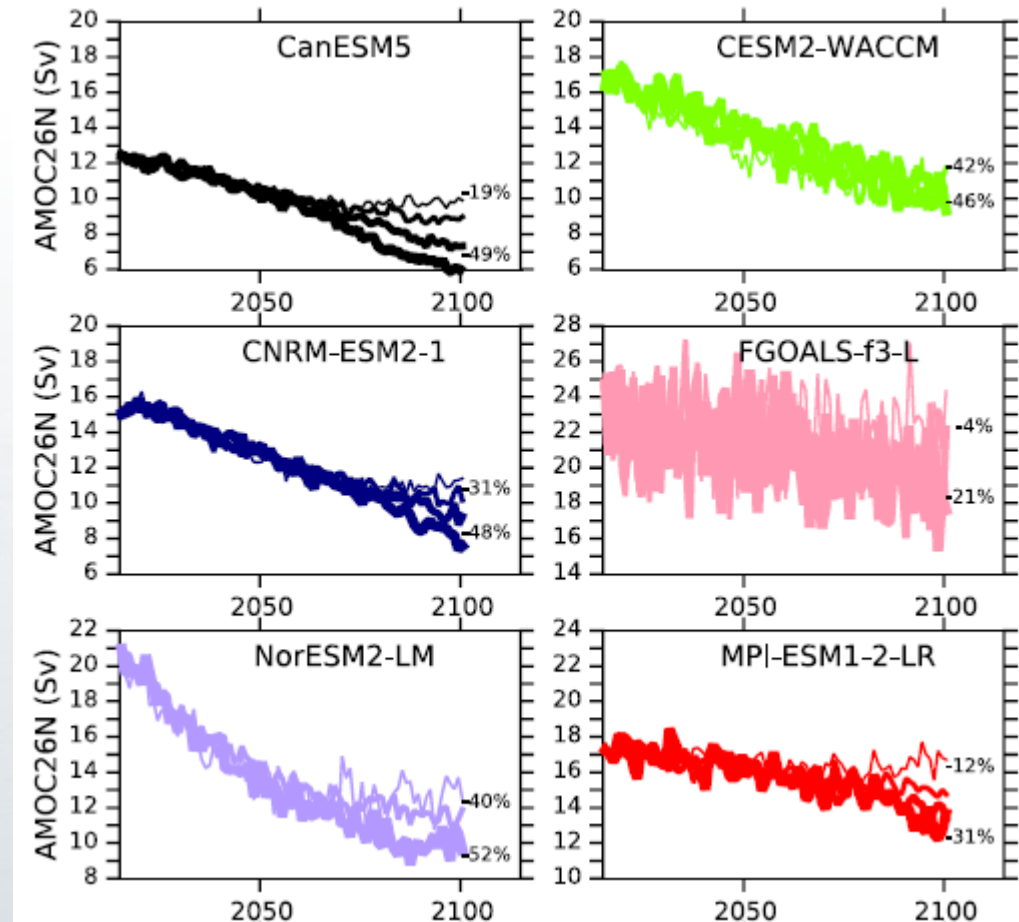
| Model | Modeling center | Key reference |
|-----------------|---------------------|--|
| ACCESS-CM2 | CSIRO-ARCCSS | Bi et al. (2013) ^a |
| ACCESS-ESM1-5 | CSIRO | Law et al. (2017); Ziehn et al. (2017) |
| CanESM5 | CCCma | Swart et al. (2019a) |
| CESM2 | NCAR | Danabasoglu et al. (2020) |
| CESM2-WACCM | NCAR | Danabasoglu et al. (2020) |
| CNRM-CM6-1 | CNRM-CERFACS | Voltaire et al. (2019) |
| CNRM-CM6-1-HR | CNRM-CERFACS | Voltaire et al. (2019) |
| CNRM-ESM2 | CNRM-CERFACS | Séférian et al. (2019) |
| E3SM-1-0 | E3SM Project | Golaz et al. (2019) |
| E3SM-1-1 | E3SM Project | Golaz et al. (2019) |
| EC-Earth3 | EC-Earth Consortium | Hazeleger et al. (2012) ^a |
| EC-Earth3-Veg | EC-Earth Consortium | Hazeleger et al. (2012) ^a |
| FGOALS-f3-L | CAS | He et al. (2019) |
| GISS-E2-1-G | NASA-GISS | Schmidt et al. (2014) ^a |
| GISS-E2-1-G-CC | NASA-GISS | Schmidt et al. (2014) ^a |
| HadGEM3-GC31-LL | MOHC | Kuhlbrodt et al. (2018) |
| HadGEM3-GC31-MM | MOHC | Williams et al. (2018) |
| INM-CM4-8 | INM | Volodin et al. (2018) |
| INM-CM5-0 | INM | Volodin et al. (2017) |
| IPSL-CM6A-LR | IPSL | Dufresne et al. (2013) ^a |
| MPI-ESM1-2-LR | MPI | Mauritsen et al. (2019) |
| MPI-ESM1-2-HR | MPI | Müller et al. (2018) |
| MRI-ESM2-0 | MRI | Yukimoto et al. (2019) |
| NorCPM1 | NCC | Counillon et al. (2016) |
| NorESM2-LM | NCC | Bentsen et al. (2013) ^a |
| SAM0-UNICON | SNU | Park et al. (2019) |
| UKESM1-0-LL | MOHC | Sellar et al. (2019) |

Time Series: AMOC @26N



Future AMOC Behavior

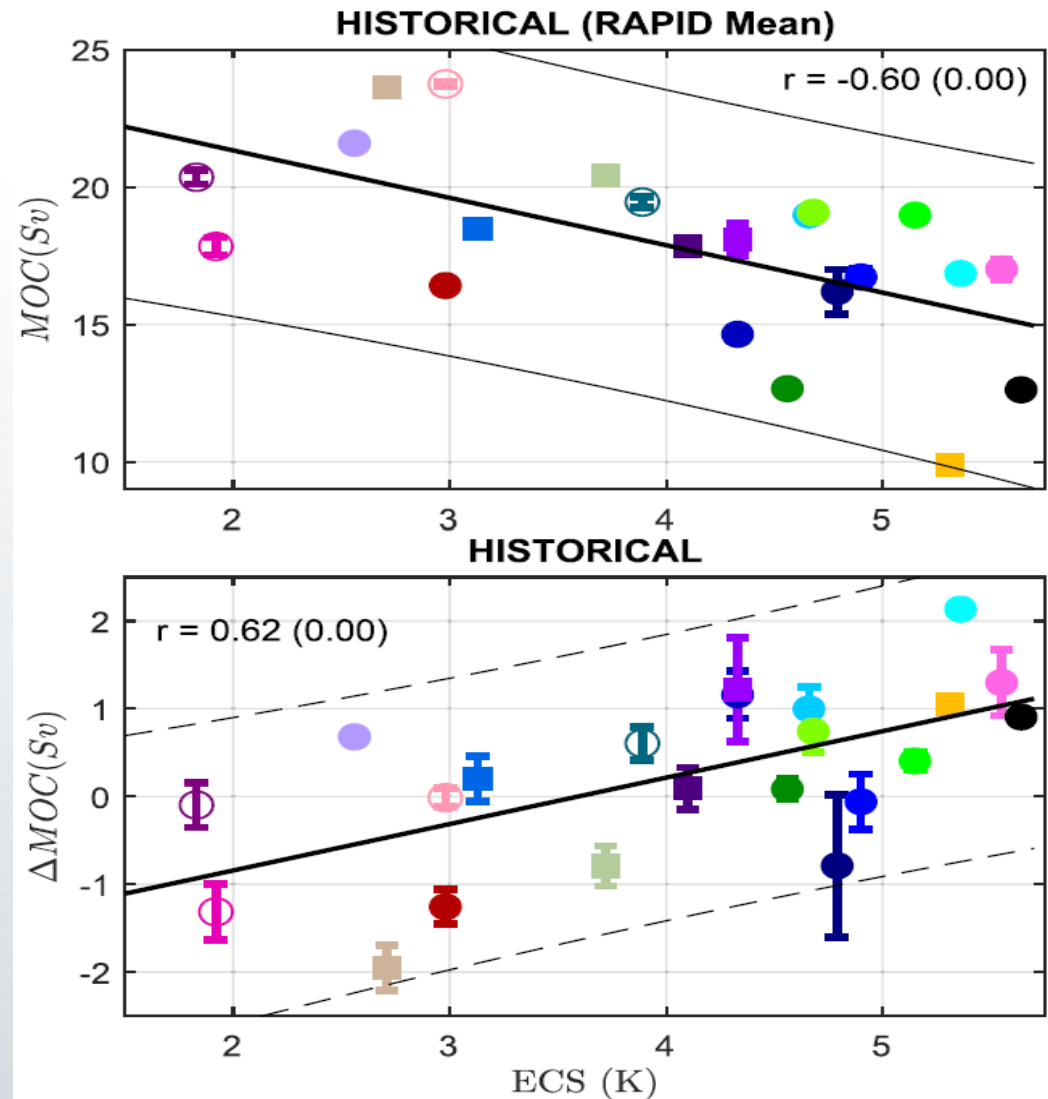
- Models almost show no difference in response to different SSP scenarios through 2060!
 - 21st Century AMOC decline is already committed



From thin to thick: SSP126, SSP245, SSP370, SSP 585

Relationship: AMOC vs. ECS

- Relationship between mean AMOC and Effective Climate Sensitivity
 - Weak sensitivity \leftrightarrow strong AMOC
- But also, link between ECS and AMOC trends
 - Low (high) ECS models have negative (positive) trend over historical period



Conclusions



- Multi-model mean AMOC is close to observations
 - But models still have huge spread
- Much of 21st century decline already committed
 - Almost no sensitivity to SSP scenario until 2060
- Significant relationships between ECS and mean AMOC strength and 21st century decline