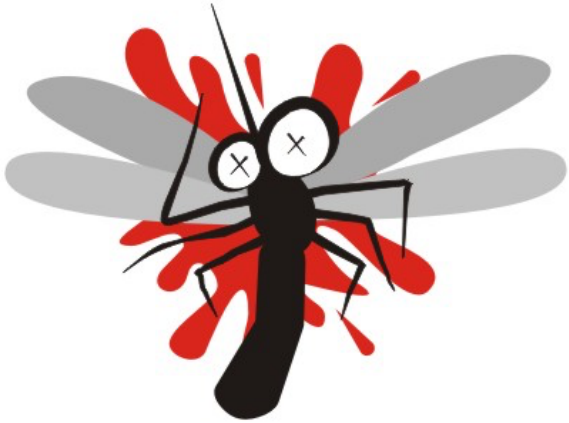
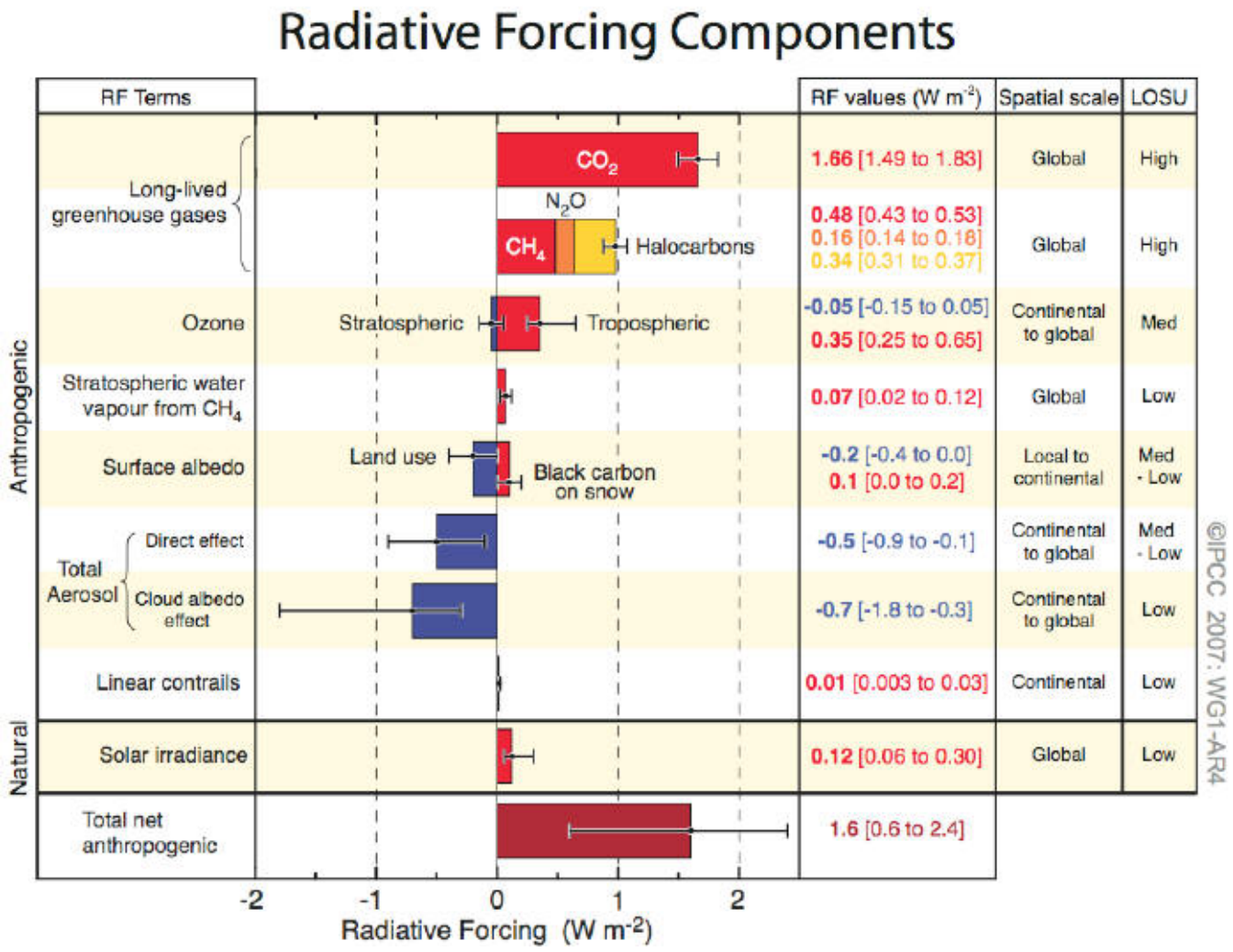
Blue mosquitoes: let’s burn the Arctic!

Hélène Angot, Anne Sledd,
José Luis Rodríguez Solís



Effect of aerosols on sea-ice?



Effect of aerosols on sea-ice?

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Impact of aerosol emission controls on future Arctic sea ice cover

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Key Points:
- Projected aerosol emission reductions drive a sea ice extent decrease of about 1 million square kilometers by 2100
- Aerosol changes drive 25% of the simulated sea ice extent reduction in RCP 4.5 and 40% in RCP 2.5
- Aerosol reductions result in an ice-free Arctic about 10 years earlier than would otherwise occur

Supporting Information:
- Figure S1
- Figure S2

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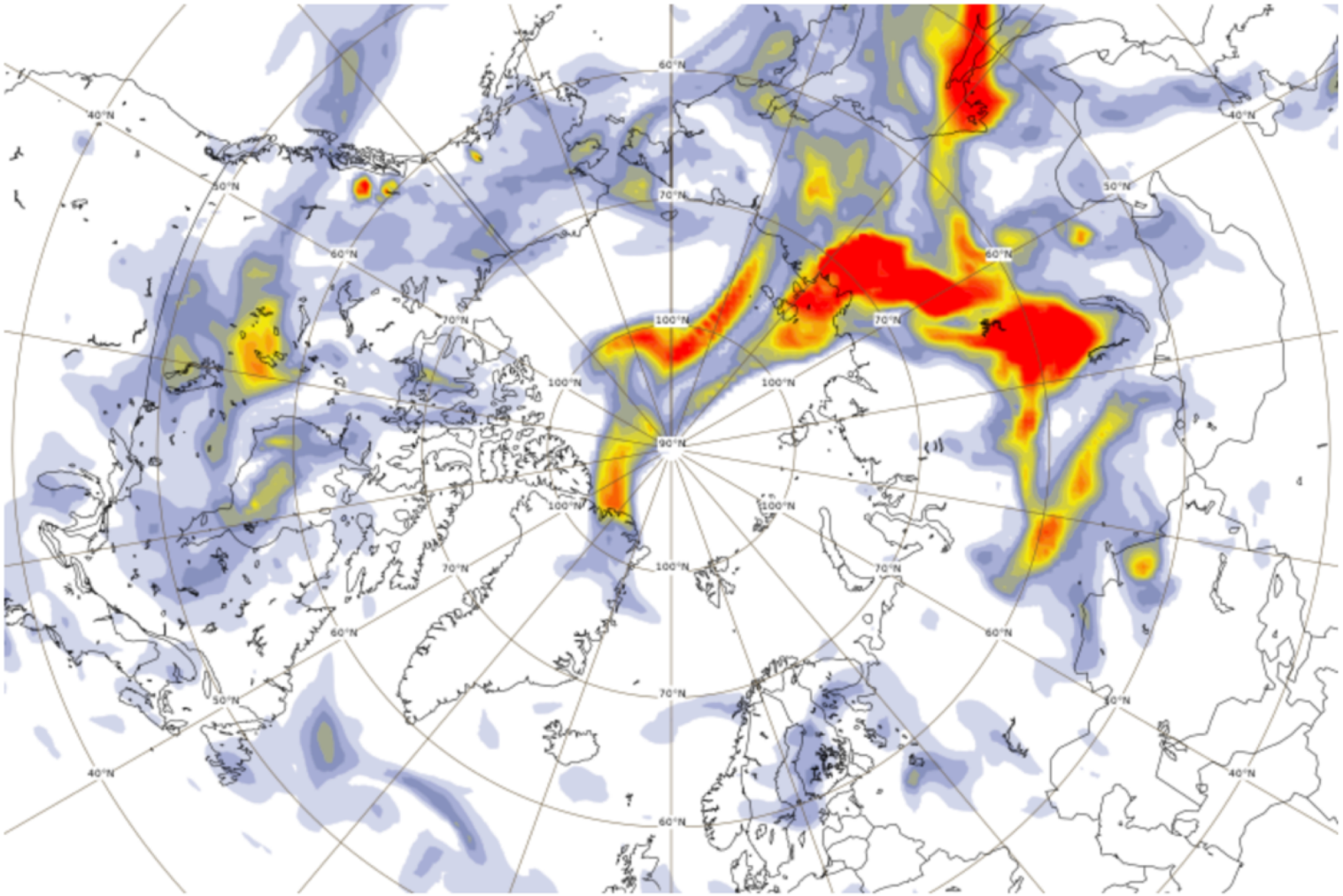
Abstract We examine the response of Arctic sea ice to projected aerosol and aerosol precursor emission changes under the Representative Concentration Pathway (RCP) scenarios in simulations of the Canadian Earth System Model. The overall decrease in aerosol loading causes a warming, largest over the Arctic, which leads to an annual mean reduction in sea ice extent of approximately 1 million km^2 over the 21st century in all RCP scenarios. This accounts for approximately 25% of the simulated reduction in sea ice extent in RCP 4.5, and 40% of the reduction in RCP 2.5. In RCP 4.5, the Arctic ocean is projected to become ice-free during summertime in 2045, but it does not become ice-free until 2057 in simulations with aerosol precursor emissions held fixed at 2000 values. Thus, while reductions in aerosol emissions have significant health and environmental benefits, their substantial contribution to projected Arctic climate change should not be overlooked.

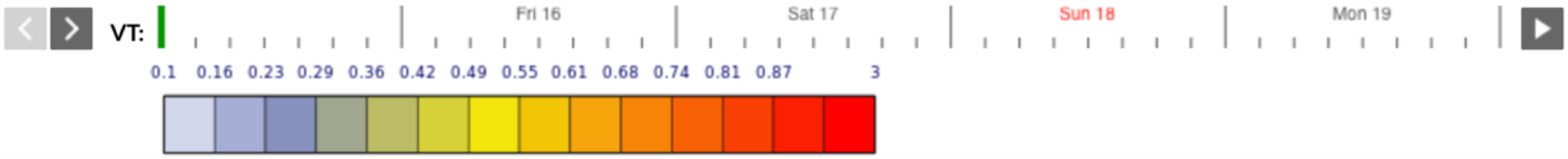
The projection in all RCPs is a drastic reduction in aerosols emissions (Lamarque et al., 2011)

Effect of arctic wildfires aerosols on sea-ice?

Biomass burning aerosol optical depth at 550 nm (provided by CAMS, the Copernicus Atmosphere Monitoring Service)

Thursday 15 Aug, 00 UTC T+3 Valid: Thursday 15 Aug, 03 UTC





Effect of arctic wildfires aerosols on sea-ice?

Step#0: Let's burn the Arctic!

Step#1: Successfully increase number of fires and associated aerosol emissions in the Arctic (aim for 2019 wildfire occurrence)

Step#2: Implement increased fires in fully coupled cmip6 runs

Effect of arctic wildfires aerosols on sea-ice?

Step#0: Let's burn the Arctic!

FHIST_BDRD	HIST_CAM60_CLM50%BGC-CROP_CICE%PRES_DOCN%DOM_MOSART_CISM2%NOEVOLVE_SWAV_BGC%BDRD	cam	Defined

Scientifically Supported Grids

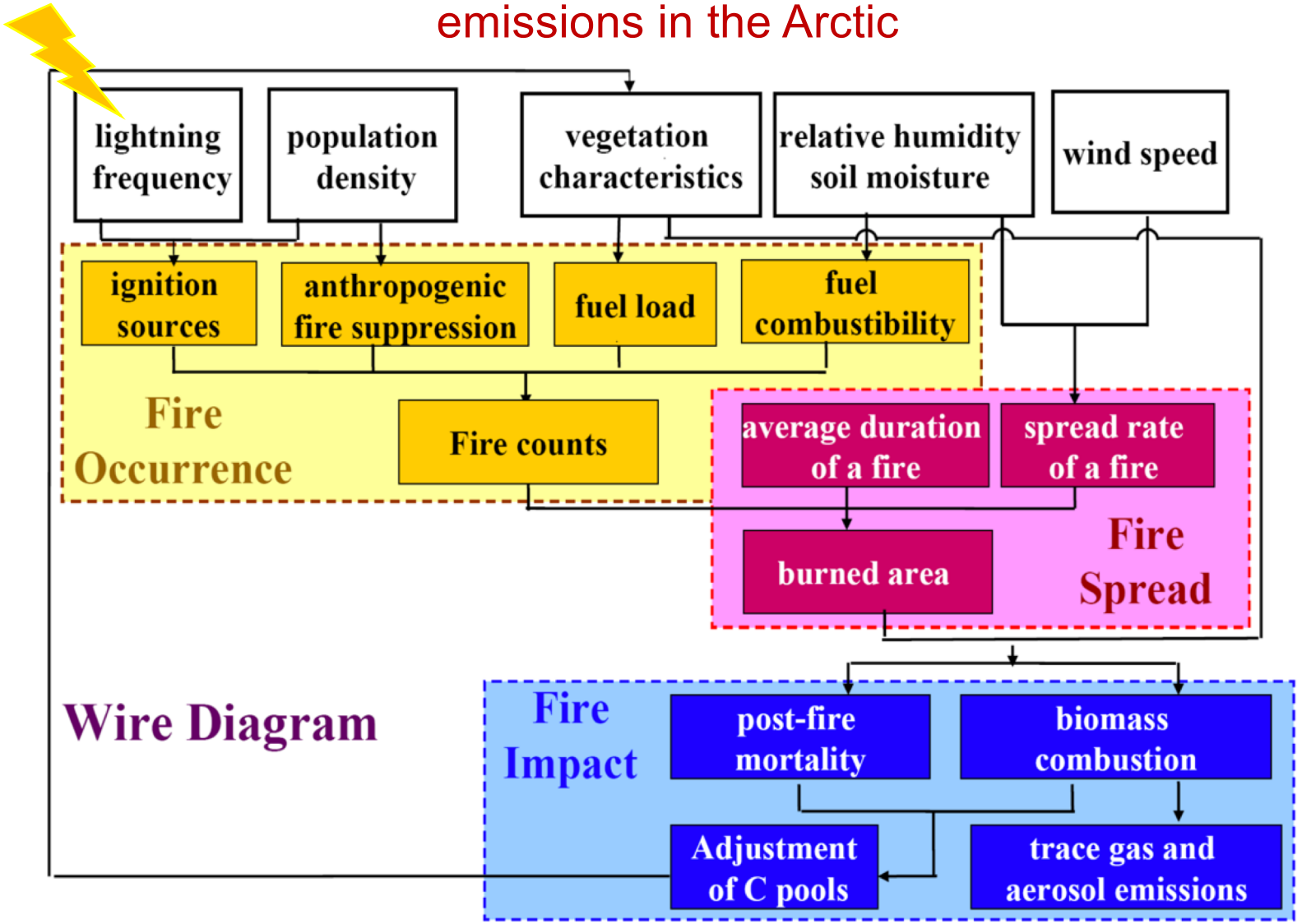
Details

	Value	Description
Initialization Time	HIST	1850: Pre-Industrial; 2000 present day: Additional initialization times defined by components.
Atmosphere	CAM60	CAM cam6 physics:
Land	CLM50%BGC-CROP	clm5.0:BGC (vert. resol. CN and methane) with prognostic crop:
Sea-Ice	CICE%PRES	Sea ICE (cice) model version 5 :prescribed cice
Ocean	DOCN%DOM	DOCN prescribed ocean mode
River runoff	MOSART	MOSART: MOdel for Scale Adaptive River Transport
Land Ice	CISM2%NOEVOLVE	cism2 (default, higher-order, can run in parallel):cism ice evolution turned off (this is the standard configuration unless you're explicitly interested in ice evolution):
Wave	SWAV	Stub wave component
Ocean Biogeochemistry	BGC%BDRD	BGC CO2=diag, rad CO2=diag:

- 1 control run + 1 experiment: 10 years (5 for spin up)

Effect of arctic wildfires aerosols on sea-ice?

Step#1: Successfully increase number of fires and associated aerosol emissions in the Arctic



(Li et al. 2012, Biogeosciences)

Effect of arctic wildfires aerosols on sea-ice?

Step#1: Successfully increase number of fires and associated aerosol emissions in the Arctic

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Ocean	DOCN%DOM	DOCN prescribed ocean mode
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Land Ice	CISM2%NOEVOLVE	cism2 (default, higher-order, can run in parallel):cism ice evolution turned off (this is the standard configuration unless you're explicitly interested in ice evolution):
Wave	SWAV	Stub wave component
Ocean Biogeochemistry	BGC%BDRD	BGC CO2=diag, rad CO2=diag:

- 1 control run + 1 experiment: 10 years (5 for spin up)
- Variables of interest: burned area, aerosol emissions
- Daily outputs, resolution: f09_f09_mg17

Machine	Compset	Resolution	Compiler	mpilib	Total PEs	Cost pe-hrs/yr	ThruPut yrs/day	File Date
cheyenne	FCHIST	f09_f09_mg17	Intel	mpt	3456	6003.07	4.61	2018-05-21 18:16:07

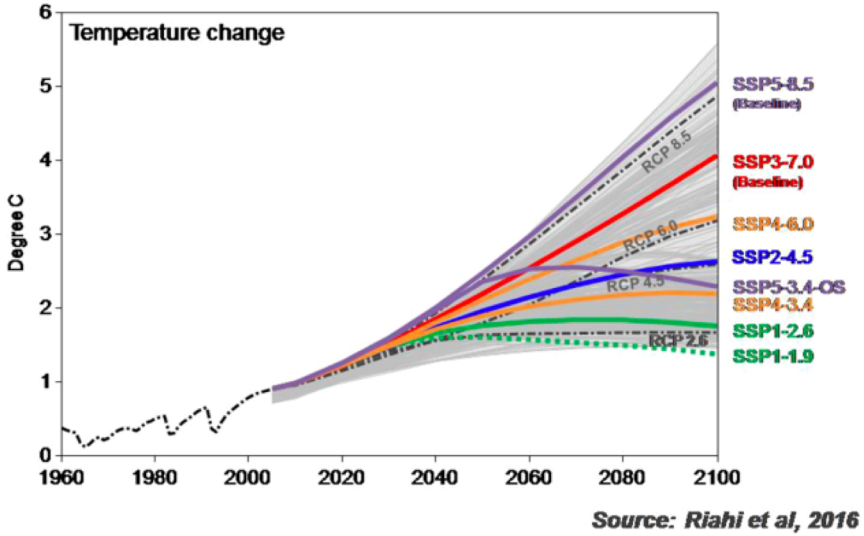
Effect of arctic wildfires aerosols on sea-ice?

Step#2: Implement increased fires in fully coupled cmip6 runs

- Branch simulations using cmip6 runs as control

Tier 1:

1) SSP2-4.5
~~2) SSP3-7.0~~
3) SSP5-8.5
With same increase in wildfire occurrence (and every year)



Source: Riahi et al, 2016

Model Cost	~ 5200 pe-hrs/simulated year
Model Throughput	~ 23 simulated years/day

With 141 nodes and 12 tasks per node

~2T of storage
~1 million pe-hrs

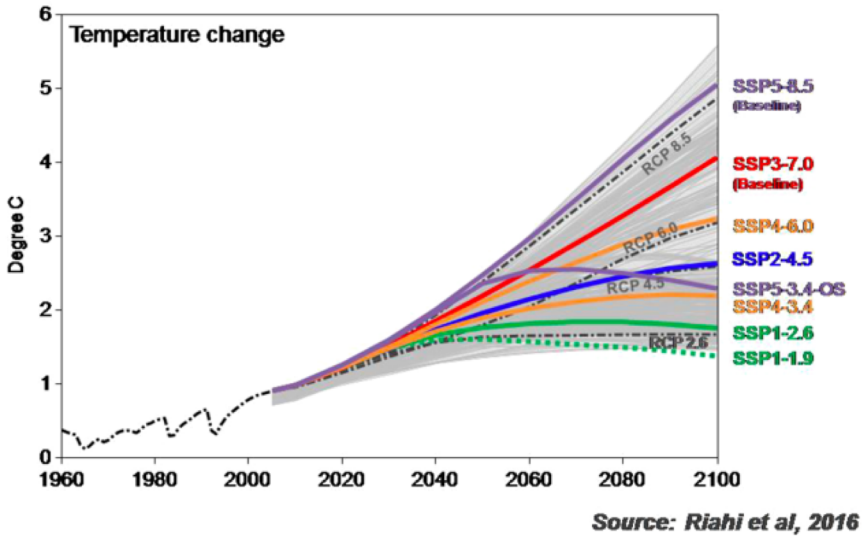
Effect of arctic wildfires aerosols on sea-ice?

Step#2: Implement increased fires in fully coupled cmip6 runs

- Branch simulations using cmip6 runs as control

Tier 2:

Control: 2019 wildfires (tier 1 simulation)
1) SSP5-8.5: +25%
2) SSP5-8.5: +50%



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