A joint initiative of

AerChemMIP

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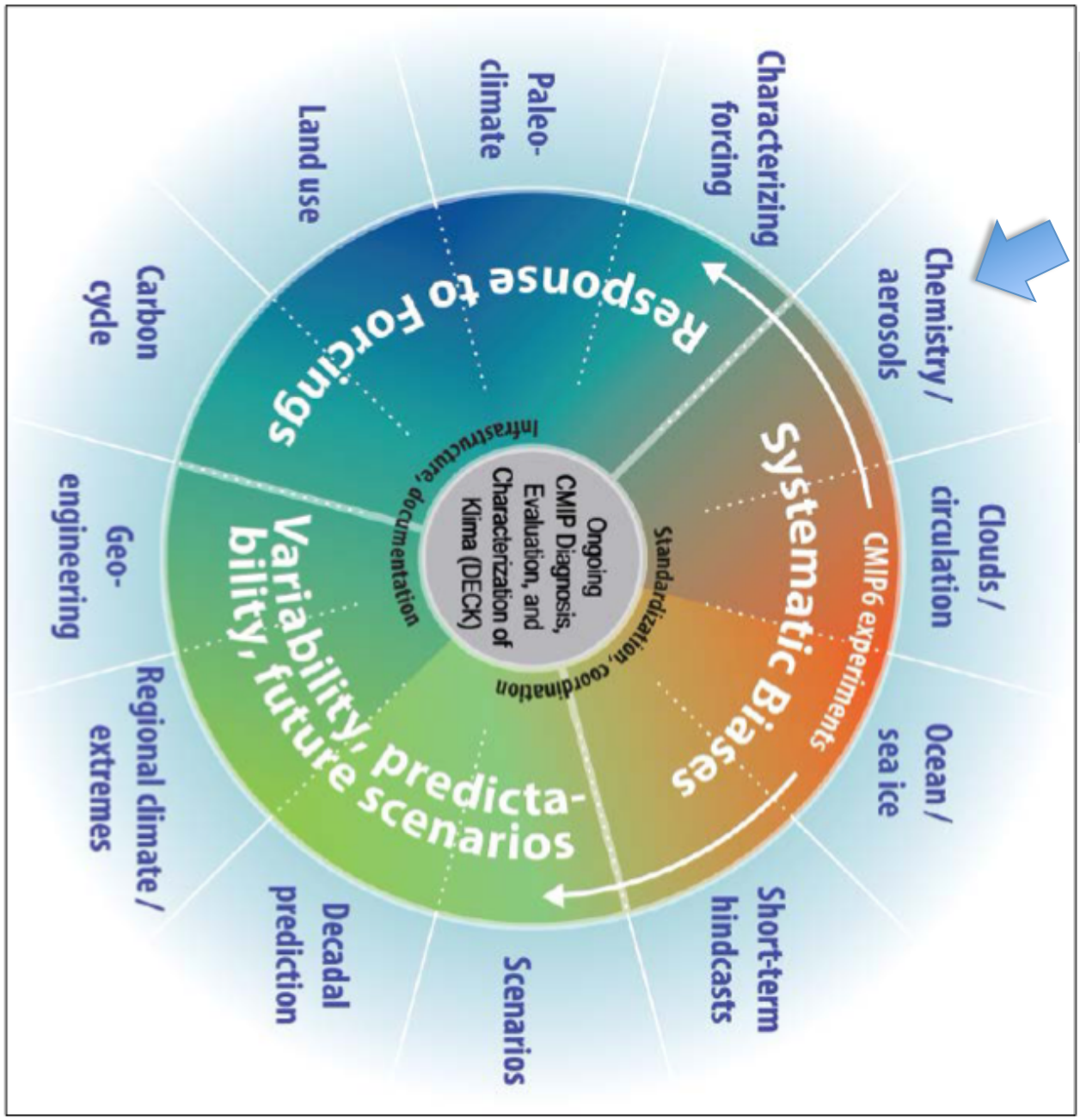
Climate Model Intercomparisons: Preparing for the Next Phase

climate variability, climate predictability, and uncertainties in scenarios?

Within this scientific framework, a more distributed organization for CMIP6 than in previous phases of CMIP is proposed. This would fall under the oversight of the CMIP Panel (see



AerChemMIP

Motivation for having AerChemMIP

- Address shortcomings of CMIP5 with respect to composition&forcing&response (mostly aerosols and ozone)
- Interactive chemistry and aerosol is state-of-the-art in many climate models… What are the effects on climate?

Need to organise contributions for CMIP6

- Define combined metrics and diagnostics for composition/forcing/ response evaluation
- Identify science questions of relevance to CMIP6 and define the associated simulations
- Provide single entity based on AeroCom and CCMI to interact with other CMIP6 contributors on emissions, interactions and forcing estimates.

AerChemMIP grand challenges

What is the role of short-lived climate forcers in the historical climate and future projections? How will it change under climate change? Interactions between climate and air quality policies (win-win situations), linking to health and air quality communities (impact on agriculture)? Land-use to chemistry and reverse. Role in climate systematic biases from misrepresentation of aerosols (forcing and feedbacks) (Precipitation)

What is the importance of natural aerosols, biogeochemistry couplings and other feedbacks?

Modelling teams targetted

- Full GCMs with aerosol and chemistry forcing participating in CMIP6, with capacity to manipulate radiative forcing routines and chemical species diagnostics

- GCM Teams which showed interest so far:
  NorESM, CESM, GISS, GFDL, HadGEM, MIROC, IPSL

- MIPs to coordinate with:
  CMIP, SCENARIOMIP, RFMIP, PDRMIP, LUMIP, DAMIP, PMIP…

Diagnostics packages AerChemMIP

Package Name Science Topic	Description	AerChemMIP Experiment Class
AerChemMIP core documentation	*Budgets, emissions, depositions, burdens* *aod_{sp}+aaod (all-sky&clear sky)* *3d fields, vertical integrated emissions*	*RFDOC, HIST, CLIM, SLCFLU, FDBCK*
Forcing	ERF, triple call radiation Separate ERFari+aci, scattering&absorption	*RFDOC, FDBCK, HIST*
AQ Air Quality	*Surface pm25, pm10, o3,* *daily mean and max*	*RFDOC,HIST,SCMIP, SLCFLU,FDBCK*
Transport Lifetimes	*Age of Air, tracers, ….* *tbd w CCMI/AeroCom*	*HIST, SCMIP*
Fields Time Varying Climatology	*3D concentrations* *aerosol species mass, ozone, oxidants* *Deposition nitrogen, bc* *Monthly, 10 y average 1850-2100*	*CLIM*
CMIP	*Standard CMIP output*	

Packages should motivate, link purpose to effort needed

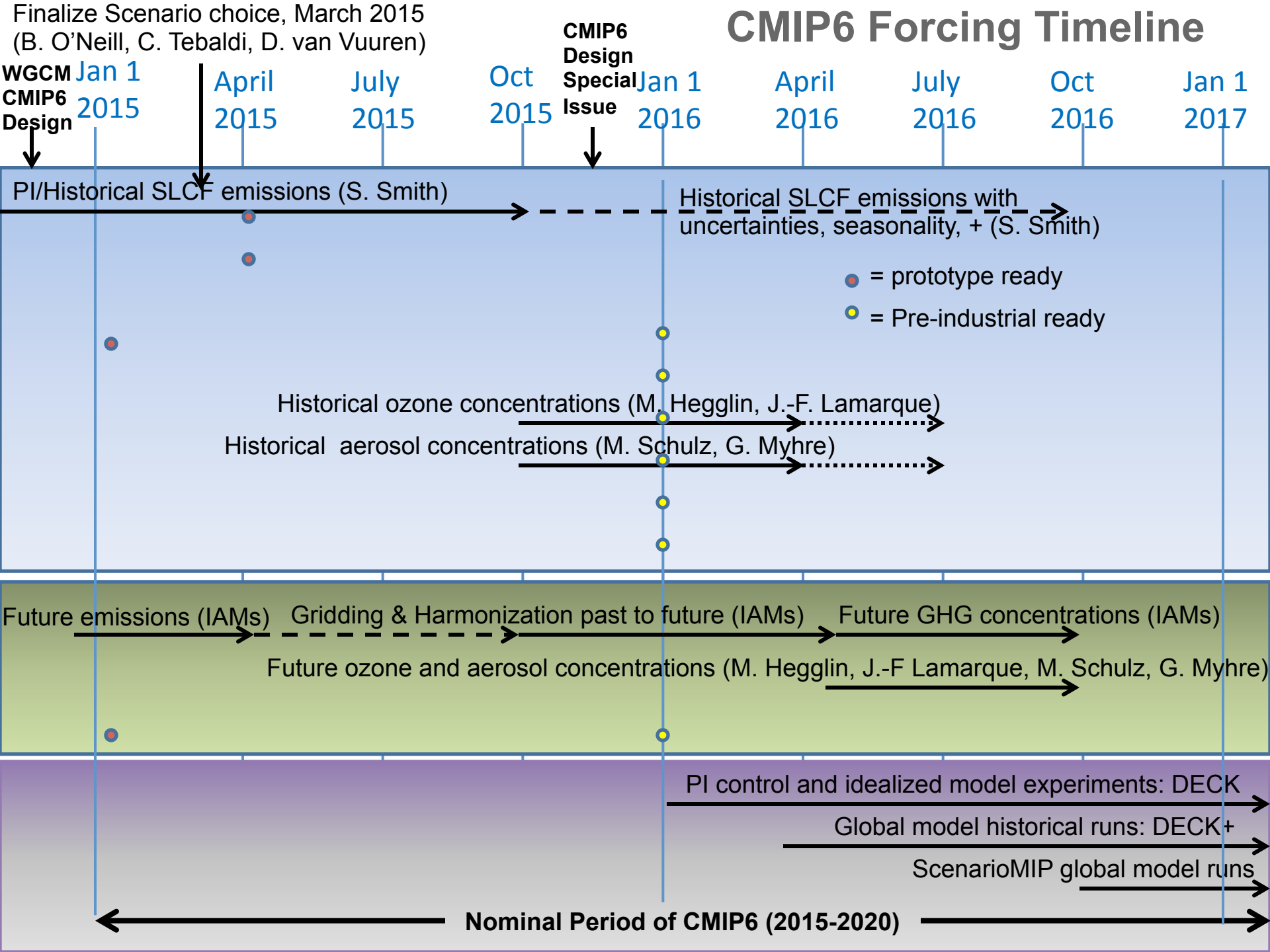
Storage on ESGF nodes

AerChemMIP experiments 1/6
Production of a time varying climatology for those GCMs requiring concentration input or idealized experiments

Purpose ***ExpName***	**Years Type**	**Description**	**Diagnostic package**
Aerosol&Ozone Fields *CLIM*	Selected Quick CTMs AGCMs	Time varying climatology "Decadal" (1850-2100) and annual(1960-2015) , based on reference emissions (Lamarque updated + SSPx)	AerChemMIP Fields

Timing of production of these fields on next page…

Tier 1 / Tier 2 / Tier 3 experiments


CMIP6 Forcing Timeline
Finalize Scenario choice, March 2015
(B. O'Neill, C. Tebaldi, D. van Vuuren)
WGCM CMIP6 Design
CMIP6 Design Special Issue
Jan 1 2015
April 2015
July 2015
Oct 2015
Jan 1 2016
April 2016
July 2016
Oct 2016
Jan 1 2017
PI/Historical SLCF emissions (S. Smith)
Historical SLCF emissions with uncertainties, seasonality, + (S. Smith)
= prototype ready
= Pre-industrial ready
Historical ozone concentrations (M. Hegglin, J.-F. Lamarque)
Historical aerosol concentrations (M. Schulz, G. Myhre)
Future emissions (IAMs)
Gridding & Harmonization past to future (IAMs)
Future GHG concentrations (IAMs)
Future ozone and aerosol concentrations (M. Hegglin, J.-F Lamarque, M. Schulz, G. Myhre)
PI control and idealized model experiments: DECK
Global model historical runs: DECK+
ScenarioMIP global model runs
Nominal Period of CMIP6 (2015-2020)

AerChemMIP experiments 2/6
Forcing Documentation

Purpose ***ExpName***	**Years Type**	**Description**	**Diagnostic package**
Forcing Efficiencies (RFE) *RFDOC* with RFMIP	AGCM 5 years If nudged 30 years otherwise	*Using PI control:* ***## PD aerosol&ozone (aerosol interacts)*** ***## PD aerosol&ozone (BC interacts)*** ***## PD aerosol&ozone (ozone interacts)***	AerChemMIP Forcing
WMGHG forcing		## PD CH4 ## PD N20 ## PD CO2 ## PD CFC/HCFC with strat/trop chemistry	
RFE linearity		## PD *10% ## PD *2 f(PI control) ## PD *10% ## PD *2 f(Future RCP85)	
CMIP DECK		*## PI control* *## Future RCP85*	CMIP

Emissions: Should be consistent with historical CMIP5/CMIP6 emissions // PD: 2015

Tier 1 / Tier 2 / Tier 3 experiments

Simulations run by other MIPs anyway

AerChemMIP experiments 3/6
Forcing Historic attribution

Purpose ***ExpName***	**Years** **Type**	**Description**	**Diagnostic package**
Historical attribution *HIST* With DAMIP	165y AOGCM	Transient, 1850-2015, ensemble **## GHG-only+SLCF Prec (ozone+aer-RF!)** ## GHG-only+SLCF Precursors (aer-RF! opt)	AerChemMIP AQ CMIP
With RFMIP	165y AGCM	Transient, 1850-2015, ensemble ## GHG-only ## GHG-only+SLCF Prec (ozone+aer-RF!)	AerChemMIP Forcing
CMIP DECK	165y AOGCM	Transient, 1850-2015, ensemble ## *Historic all forcings* ## *GHG-only*	CMIP

Tier 1 / Tier 2 / Tier 3 experiments

Simulations run by other MIPs anyway

AerChemMIP experiments 4/6
Future scenarios & sensitivity studies
to understand SLCF-climate-land use interactions

Purpose ***ExpName***	**Years** **Type**	**Description**	**Diagnostic package**
Future Climate Response to SLCFs *SLCFRESP* with SCENARIOMIP	40y AOGCM	Transient, 2015-2055, ensemble ## **SSP3RCP7 w SSP1-SLCF emissions** ## SSP3RCP7 w SSP1-SLCF emissions +CH4	AerChemMIP AQ CMIP
	100y AOGCM	Transient, 2015-2055, ensemble *## low SLCF (SSP1) RCP2.6* *## high SLCF (SSP3) RCP7*	AerChemMIP AQ CMIP
SLCF/NatAerosols and Land Use interactions *LU-SLCF* with SCENARIOMIP LUMIP	10y AGCM CTMs	TBD Time slices @2050 @2090 SSP1 + SSP3 + SSP3-NFC emissions combined with High/Low Land Use emissions Dust, N2O, NO, NH3, Fire, CH4	AerChemMIP AQ
	250y AOGCM	*##Reference: HIST+SSP3 1850-2100*	AerChemMIP CMIP

Tier 1 / Tier 2 / Tier 3 experiments

Simulations run by other MIPs anyway

AerChemMIP experiments 5/6
Feedback analysis
with focus on natural aerosols

Purpose ***ExpName***	**Years** **Type**	**Description**	**Diagnostic package**
Feedbacks involving natural aerosol *FDBCK* PMIP	5/30y AGCM	## *PI control* ## **PI*2 natural emissions** (**dust, sea salt**, DMS, BB, VOC)	AerChemMIP Forcing
CMIP SCENARIOMIP	250y 85y AOGCM	## *DECK – 4xC02* ## Future reference SSP3 scenario	AerChemMIP CMIP

Tier 1 / Tier 2 / Tier 3 experiments

Simulations run by other MIPs anyway

AerChemMIP experiments 6/6
Aerocom/CCMI exploration of importance coupling aerosol/chemistry

Purpose ***ExpName***	**Years Type**	**Description**	**Diagnostic package**
Aerosol Chemistry Coupling	1-5y	CTRL : Coupled aerosol/chemistry Perturbation Runs : emissions / concentrations /reactions tbd	AerChemMIP AQ Transport
Heterogeneous Chemistry	1-5y	CTRL : Coupled aerosol/chemistry Perturbation runs: het reactions tbd	AerChemMIP
Regional Response	200y AOGCM	##Idealized Experiment, Prescribed forcing and heating profiles, eg regional solar irradiance perturbation	AerChemMIP Forcing CMIP
Climate impact on Ozone	AGCM	Identify ozone production in stratosphere and troposphere due to future climate Time slice in 2050? Colored ozone tracer? Differential runs?	AerChemMIP Transport

Tier 1 / Tier 2 / Tier 3 experiments

Simulations run by other MIPs anyway

AerChemMIP Time line

2014

August Land Use – AerChemMIP feedback workplan draft
Mid September Description send to CMIP panel

29.9. - 2.10. AeroCom meeting, Steamboat Springs, Co
3 monthly Autum/winter telecons on AerChemMIP/ScenarioMIP/LUMIP planning

2015

January: Preindustrial Concentration fields ready
Summer/Autumn: Historic/Future Concentration fields ready
Autumn AerChemMIP decription submission to GMD

5.10. – 9.10. AerChemMIP/CCMI/AeroCom joint meeting Frascati, Italy --- RFMIP is invited to come and meet

2015/16: First pilot studies on forcing documentation
2016/17: CMIP6 runs start