CRESCENDO GA and LandMIP meetings
8 – 12 OCT 2018, TOULOUSE - AGENDA

Venue: http://www.meteo.fr/cic/

Getting to the venue: http://www.meteo.fr/cic/meetings/venue.html

Important information: ALL participants must bring a photo ID to pass the security control at Météo-France campus

	8th Oct	9th Oct	10th Oct		11th Oct	12th Oct
9.00-10.30	Plenary I	Break out session I	Plenary IV		LandMIP/ NEMO	LandMIP/ NEMO
10.30	Coffee break					
11.00-13.00	Plenary I cont.	Break out session II	Plenary IV cont.		LandMIP/ NEMO	LandMIP/ NEMO
13.00	Lunch					
14.00-15.30	Poster viewing Plenary II	Plenary III	Joint plenary CRESCENDO/LandMIP		LandMIP/ NEMO	LandMIP/ NEMO
15.30	Coffee break					
16.00-17.30	Plenary II cont.	Plenary III cont. Governing Board meeting [a]	Joint plenary CRESCENDO/LandMIP	SSB and IAB meeting [b]	LandMIP/ NEMO	LandMIP/ NEMO
18.00	Ice-breaker				Ice-breaker	
19.30		Project dinner (Toulouse city centre)				
~20.30	Bus to Toulouse downtown		Public Outreach event (Toulouse city centre)		Bus to Toulouse downtown	

[a] Governing Board Meeting: one representative from each CRESCENDO Partner
[b] SSB and IAB meeting: RT leads (at least one per RT) + Colin + Alberto + Advisory Board members

Rooms:	Plenary sessions:	Central Auditorium – access through ground level
	Break-out groups:	Meetings Rooms 1-4 – access through 1st floor

Detailed agenda:

Monday 8th Oct, Day 1 (CRESCENDO only)

8.30 – 9.00 Registration and coffee

9.00 – 10.30 Plenary I

9.00 – 9.15 Welcome and practical information: Colin Jones (U. Leeds), Marc Pontaud (Meteo France)

9.15 – 9.45 Invited Talk: Earth system modelling at Meteo-France: David Salas y Melia (Meteo France)

9.45 - 10.30 3 x 15 contributed science talks

- Sujan Koirala (MPI): Evaluation of carbon turnover times in CRESCENDO model simulations.
- Rosie Fisher (NCAR/CERFACS): Developments in the Community Land Model representations of Nitrogen cycling, vegetation demography, and plant trait representation.
- Christine Delire or Xavier Morel (Meteo France): Peat soil C and CH4 emissions : new data from Nuuk (Greenland) and SURFEX model development

10.30 - 11.00 Coffee Break

11.00 – 13.00 Plenary I continues:

11.00 – 11.15 Philippe Peylin (LSCE): Ongoing developments of the ORCHIDEE land surface model for CRESCENDO and model GPP evaluation.

11.15 - 11.30 Valeriu Predoi (U. Reading): Update on ESMValTool

11.30 – 11.45 Lee de Mora (PML): Demonstrating the evaluation of the marine component of CMIP5 models using ESMValTool.

11.45 – 12.00 ESMValTool Q&A session

12.00 – 13.00 Poster presentations (2 mins per poster presenter/one single slide)

13.00 - 14.00 Lunch

14.00 – 15.00 Poster viewing session

15.00 – 18.00 Plenary II

15.00 – 15.15 Overall project update: Colin

15.15 – 15.30 Project management update: Alberto

15.30 – 15.50 RT1 Pierre or Parv

15.50 – 16.10 RT2 Tatiana or Chris

16.10 – 16.40 Coffee break

16.40 – 17.00 RT3 Ruth Lorenz

17.00 – 17.20 RT4 Matt Gidden/Maarten van den Berg

17.20 – 17.40 RT5 Helena and Stefan

17.40 – 18.00 Organize break out groups for day 2 (include 2 mins per BG on planned content of discussions etc)

~18.00 Ice Breaker and poster viewing *(return to downtown Toulouse by bus afterwards)*

Tuesday 9th Oct, Day 2 (CRESCENDO only)

9.00 – 10.30 Break out session I

- *Representative from each modelling group + WP10, 11 ,12, 14: Colin to chair (Review and finalize status of ESM DECK, historical and scenarioMIP simulations)*
- *WP1 and WP4 (land) and an ESMVal person (WP7): Victor and Soenke to chair*
- *WP2 and WP5 (ocean) and ESMVal person (WP7): Laurent and Roland to chair*
- *WP3 and WP6 (atmosphere) and ESMVal person (WP7): Fiona and Ken to chai*
- *WP13: Helena to chair*

10.30 - 11.00 Coffee Break

11.00 – 13.00 Break out session II

- *WP1 and WP4 (land) and an ESMVal person (WP7): Victor and Soenke to chair*
- *WP2 and WP5 (ocean) and ESMVal person (WP7): Laurent and Roland to chair*
- *WP3 and WP6 (atmosphere) and ESMVal person (WP7): Fiona and Ken to chair*
- *WP9 + required atmosphere (WP3/6) people and modelling group reps: Bill Collins to chair*
- *WP10, WP11, WP12, WP14 : Traceability, scenarioMIP and data for impacts & downscaling: Ralf and Till to chair*

13.00 - 14.00 Lunch

14.00 – 17.30 Plenary III

14.00 – 15.30 6 x 15 min contributed science talks:

- Tatiana Ilyna (MPI): C-Cycle predictability: a marine perspective
- Daniele Peano (CMCC): Variability of simulated and observed growing season onset/offset
- Sarah Berthet (Meteo France): How does high resolution impact climate in a global ocean-biogeochemical coupled model?
- Nicolas Vuichard (LSCE): Accounting for Carbon and Nitrogen interactions in the Global Terrestrial Ecosystem Model ORCHIDEE : multi-scale evaluation of gross primary production.
- Mark Williamson (U. Exeter): Assumptions for Emergent Constraint on Climate Sensitivity from Global Temperature Variability
- Friederike Fröb (MPI): Detectability of climate engineering through solar radiation management and artificial ocean alkalinisation

15.30 – 16.00 Coffee break

16.00 – 16.30 2 x 15 min contributed science talks:

- Dirk Olivie (Met Norway): Modelling DMS in a coupled climate model and estimation of its feedback strength
- Cat Scott (U. Leeds): Representing natural aerosols in ESMs

In parallel:
16.30 – 17.30 CRESCENDO Governing Board Meeting (one representative from each partner to attend)

16.30 – 17.30 Extra time for break out group continuations or new break out groups:
Suggested groups: *i) WP1 and WP3 (land-atmosphere)*
ii) WP2 and WP3 (ocean-atmosphere)

~ 19.30 – 21.30 Project Dinner in Toulouse at La Cendrée (http://www.lacendree.com/), 11 rue des Tourneurs, 31000 Toulouse (map: https://goo.gl/maps/tg2V6Uwqky52)

Wed 10th Oct, Day 3

9.30 - 10.30 Plenary IV

9.30 – 10.00 Invited Talk: Earth system modelling at NCAR: Dave Lawrence (NCAR)

10.00 – 10.30 Invited talk: Earth system modelling at GFDL: Elena Shevliakova (NOAA/GFDL)

10.30 - 11.00 Coffee Break

11.00– 13.00 Plenary IV continues

11.00 – 12.30 RT updates: 1, 2, 3 ,4 ,5 (18 mins each)

12.30 - 13.00 Project update, upcoming activities/plans, discussion: Colin + Alberto

13.00 - 14.00 Lunch

14.00 – 16.00 Joint plenary CRESCENDO/LandMIP

- 14.00 – 14.10 Aims of joint session (15 mins): Sonia Seneviratne
- 14.10 – 14.20 CRESCENDO project overview (15 mins): Colin
- 14.20 - 14.40 ScenarioMIP and IAM scenarios overview: Kate Calvin, Detlef van Vuuren
- 14.40 – 15.00 C4MIP: Chris Jones, Pierre Friedlingstein
- 15.00 - 15.20 LUMIP: Dave Lawrence
- 15.20 - 15.40 LS3MIP: Gerhard Krinner, Sonia Seneviratne
- 15.40 - 16.00 Carbon predictability: a terrestrial perspective: Tatiana Ilyina

16.00 – 16.30 Coffee break

In parallel:
16.15 – 17.30 CRESCENDO SSB and IAB meeting (*IAB members and RT leads*)

16.30 – 18.00 Joint plenary CRESCENDO/LandMIP continues

- 16.30 - 17.50: CMIP6 context and MIP science presentations (4 x 20 min):
  - Forrest Hoffman: Nonlinear Interactions between Climate and Atmospheric Carbon Dioxide Drivers of Carbon Cycle Changes from 1850 to 2300
  - Wim Thiery: Warming of hot extremes alleviated by expanding irrigation
  - Sonia Seneviratne: Assessing land-climate interactions in low-emissions scenarios: A joint LS3MIP, LUMIP and C4MIP perspective
  - Roland Seferian: Land-related research at CNRM
- 17.50 - 18.00: Closing of first day

~ 20.30 – 23.00 Public Outreach event in Toulouse at Salle du Sénéchal, 17 Rue de Rémusat, 31000 Toulouse (map: https://goo.gl/maps/hGNsWgAL5eE2)

Thursday 11th, Day 4 (LandMIP only)

09:00-10:30 Theme 1: C4MIP science talks (5 talks):

- Koven: Exploring the dynamics of permafrost carbon in ESMs (20 min)
- Tachiiri: Decomposing regional carbon-concentration and carbon-climate feedback (20 min)
- Humphrey : Sensitivity of CO2 growth rate to observed terrestrial water storage changes: implications for MIPs (20 min)
- UKESM1: combination of Jones/Wiltshire/Liddicoat abstracts (15min)
- GISS: combination of Kiang and Aleinov abstracts (15min)

10:30-11:00 – Coffee break

11:00-12:30 Theme 2: LUMIP Science talks (4 talks, 20 min each)

- Peter Lawrence - Investigating the climate and carbon cycle impacts of CMIP6 Land Use and Land Cover Change in the Community Earth System Model (CESM2)
- Danica Lombardozzi - The impact of agricultural management practices on carbon, water, and energy fluxes
- Lena Boysen - The climatic effects of idealized global deforestation experiments in the MPI-ESM (and other models, if available)
- Elena Shevliakova - The challenges of capturing secondary lands dynamics in the CMIP6 historical experiments: implications for regional climate and carbon storage

12:30 -14:00 Lunch

14:00-15:30 Theme 3: LS3MIP Science talks (4 talks, 20 min each)

- May: Contributions of soil moisture interactions to the climate biases in the EC-Earth earth system model
- Ardilouze: Reduction of climate model precipitation bias over continents in summer: method and impact on seasonal prediction skill
- Hauser: Potential of global land water recycling to mitigate local temperature extremes
- Jia: Historical land simulations by the Land Surface Model for Chinese Academy of Sciences

15:30-16:00 – Coffee break

16:00 -16:15 Poster introduction (1 slide/1min per poster)

16:15 - 18:00 Poster session

18:00 Ice Breaker/Reception and continuation of the poster session *(return to downtown Toulouse by bus afterwards)*

Friday 12th, Day 5 (LandMIP only)

9:00 - 10:00 Cross cutting session:

- Forrest Hoffman - ILAMB update (20 min)
- Robertson: Comparison of Trendy Models using ILAMB (20 min)
- Hyungjun Kim: LandMIP offline simulations and forcing data (20 min)

10:00-10:30 - Coffee break; shift to breakout rooms

10:30 - 12:30 Break out groups per MIP

- LS3MIP (including discussion on SnowMIP from Krinner; Chad; Cecile)
- C4MIP
- LUMIP

12:30 -13:30 Lunch

13:30 - 15:00

- Plenary on break out groups
- Wrap up

15:00 End of the meeting, and continuation of discussion for participants leaving on Saturday

CRESCENDO POSTER LIST:

Poster boards available for portrait A0 standard poster size

Last name	First name	Title
BERGMAN	Tommi	Evaluation of EC-Earth CRESCENDO AMIP simulations
BEUSCH	Lea	Emulating Earth System Model Temperatures
Brunner	Lukas	Reducing uncertainty in near-term European climate predictions: setup and first results of a model weighting approach
BURKE	Eleanor	1 - Simulated permafrost nitrogen interactions
		2 - Model evaluation at high latitudes
BUTENSCHÖN	Momme	Trophic regimes of the global ocean and their evolution under climate change
CHECA-GARCIA	Ramiro	Constraints from observations used to improve Dust natural cycle in ESMs
DAVIES-BARNARD	Taraka	Biological Nitrogen Fixation in JULES
D'ONOFRIO	Donatella	Vegetation-fire-precipitation relationships in sub-Saharan Africa: evaluation and comparison of LPJ-GUESS and JSBACH DGVMs
GAYLER	Veronika	Recent JSBACH developments for CMIP6
KUHLBRODT	Till	Large-scale ocean circulation in the Crescendo ESMs: first steps of an analysis
LORENZ	Ruth	Can we beat climate model democracy in ensemble projection?
MÄKELÄ	Jarmo	Methane emission diagnostics for ESMValTool
NABAT	Pierre	Aerosol modeling and radiative forcing in CNRM-ESM2-1 simulations
NIERADZIK	Lars	LPJ-GUESS within EC-Earth CMIP6 - Status and first results
O'CONNOR	Fiona	1 - UKESM1: An assessment of the pre-industrial to present-day anthropogenic forcing
		2 - Quantifying process sensitivities in an Earth system modelling framework
PADRON	Ryan	Observational Constraints Reduce Likelihood of Extreme Changes in Multi-Decadal Land Water Availability
PALMIÉRI	Julien	Preparing the UKESM-based OMIP simulation.
SUN	Wenbin	Sensitivity of Tibetan permafrost carbon to climate forcing
TAKANO	Yohei	What controls the ocean decadal deoxygenation and heat uptake? - Early Results from pre-OMIP Simulations
YOOL	Andrew	Spin-up and Historical simulation evaluation of the oceans in UKESM1
YOSHIOKA	Masaru	Comparisons of multi-model outputs with satellite and ground-based measurements of aerosol optical depths

LandMIP POSTER LIST:

(Spaces still available, participants are welcome to bring additional posters to the ones listed below)

Last name	First name	Title
ALEINOV	Igor	GISS GCM ModelE2 Land Carbon Results for CMIP6-C4MIP Tier-1 and Tier-2 Experiments
BROVKIN	Victor	Earth System Models Underestimate Carbon Fixation by Plants in the High Latitudes
HAJIMA	Tomohiro	Comparison of residence time of land carbon in Earth system models
HAUSER	Mathias	Potential of global land water recycling to mitigate local temperature extremes
JI	Duoying	Permafrost carbon emissions diagnosed with BNU-ESM land model
LI	Ruichao	Global evaluation of soil temperature using a land surface model CAS-LSM with soil freeze-thaw front dynamics
MÄKELÄ	Jarmo	Methane emission diagnostics for ESMValTool
PAK	Bernard	ACCESS: The Australian Community Climate and Earth System Simulator
PEANO	Daniele	The CMCC contribution to LandMIPs: the land-carbon cycle in CMCC-CM2
PEYLIN	Philippe	Updates of the CMIP6 land surface model compared to CMIP5
		First results of CMIP6 runs around the C-cycle
STACKE	Tobias	Assimilating land surface states into the MPI Earth System Model
SUN	Wenbin	Sensitivity of Tibetan permafrost carbon to climate forcing
WANG	Yan	Evaluating the snow simulations from a land surface model CAS-LSM
WANG	Longhuan	Simulation and evaluation study of soil moisture by using CAS-LSM
WILTSHIRE	Andy	Carbon Cycle Feedbacks in UKESM
ZHANG	Yuan	Increased global land carbon sink due to aerosol-induced cooling

ABSTRACTS - CRESCENDO POSTERS:

BERGMAN Tommi KNMI tommi.bergman@knmi.nl

Evaluation of EC-Earth CRESCENDO AMIP simulations

BEUSCH Lea ETH Zurich lea.beusch@env.ethz.ch

Emulating Earth System Model Temperatures

Earth System Models (ESMs) are valuable tools to explore the Earth system's response to a given greenhouse gas forcing scenario. Due to their complexity, they are computationally expensive and it is only feasible to generate a limited number of realizations. Impact and integrated assessment modelers, however, could profit from increasing the number of realizations to better account for climate variability. Here, we present a method to stochastically generate large ensembles of yearly, spatio-temporally correlated, grid point level temperature anomalies on land given a global mean temperature anomaly. While the deterministic response at each grid point is modeled as a function of global mean temperature anomalies with an artificial neural network, stochastic variability is generated by simulating the residuals from an AR(1) process with spatially correlated innovations.

Brunner Lukas ETH Zurich lukas.brunner@env.ethz.ch

Reducing uncertainty in near-term European climate predictions: setup and first results of a model weighting approach

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BURKE Eleanor Met Office eleanor.burke@metoffice.gov.uk

1) Simulated permafrost nitrogen interactions

Including a representation of permafrost nitrogen interactions within the JULES global land surface model reduces the carbon lost from the northern high latitudes under climate change.

2) Model evaluation at high latitudes

BUTENSCHÖN Momme CMCC momme.butenschon@cmcc.it

Trophic regimes of the global ocean and their evolution under climate change

Primary Production and sea-surface temperature are the main environmental variables influencing the trophic state of an ecosystem in providing the metabolic energy available to marine organisms. While the rise of global average sea surface temperature with climate change is an established and undisputed fact in the scientific community, recent works have provided increased levels of evidence and certainty in the decline of global average primary production. These changes will doubtlessly impact the trophic regimes of the global ocean and their extent, and ultimately determine the amount of food that the global ocean is capable to deliver sustainably.

This work investigates the evolution of these regimes under various future conditions of climate change by applying an unsupervised artificial neural network algorithm to define the trophic regimes of the global ocean on an ensemble of future projections from the CMIP5 archive of the two key variables considering each ensemble member's capability to represent their short-term variability with respect to estimates from satellite imagery. In a training phase of the algorithm, the mean levels and seasonal cycles of temperature and primary production at present day conditions are used to define the trophic regimes, the evolution of which is projected in a second step classifying the future data.

This ensemble approach allows for an unprecedented, well constrained map quantifying the future extends of the trophic regimes of the global ocean under varying mitigation strategies.

CHECA-GARCIA Ramiro LSCE-IPSL rcheca@lsce.ipsl.fr

Constraints from observations used to improve Dust natural cycle in ESMs

The natural dust cycle consists of the following processes: emission, transport, interaction with radiation, and finally deposition over land and oceans. This work analyses the dust cycle with amulti-model approach based on several CRESCENDO-ESM models and their validation against observations. We start from a comparison of global mean dust budget both, annually and seasonally. However, the dust cycle show large regional contrasts, hence, we also analyzed the contribution of 16 different regions to the dust budget. The optical aerosol depth of dust in the context of all together aerosol optical depth allow us to compare the models with satellite measurements and ascertain the contributions of dust to the energy budget of the climate system by its interaction with the radiation. One focus of the analysis is the steep gradient of dust optical depth across the subtropical Atlantic region that is conditioned by the dust size distribution.

DAVIES-BARNARD TarakaUniversity of Exeter t.davies-barnard@exeter.ac.uk

Biological Nitrogen Fixation in JULES

Biological Nitrogen Fixation is an important source of new nitrogen globally. However, both the global amount of nitrogen fixed and the spatial distribution and the balance between symbiotic and free-living nitrogen is currently unclear. We show developments and improvements to the method of spatial distribution of BNF in JULES and compare this to a new, MODIS biome based assessment of BNF.

D'ONOFRIO Donatella ISAC-CNR d.donofrio@isac.cnr.it

Vegetation-fire-precipitation relationships in sub-Saharan Africa: evaluation and comparison of LPJ-GUESS and JSBACH DGVMs

In this poster we present a comparison of the outcomes of the two state-of-the–art LPJ-GUESS and JSBACH DGVMs in tropical Africa, evaluating the models' ability in representing the distributions of grasslands, savannas and forests and the transition between them, and at the same time assessing which key ecological processes need to be included or improved within these models.

To this end, we compare the relationships of tree and grass cover with precipitation and fire and we validate the patterns of grasslands, savannas (known together as tropical grassy biomes) and forests from models against remote-sensing data (from MODIS, TRMM, ESA CCI LC). Since the prevalent mechanisms determining observed biome occurrence and distribution change with mean annual rainfall (MAR), this evaluation is performed also separately for three different MAR ranges.

The two DGVMs are characterized by different spatial resolutions and a by different complexity of the representation of vegetation and fire processes. They are also currently used in two Earth System Models (ESM), the EC-Earth and the MPI-ESM.

The comparison of the relationships between climate, vegetation and fire between DGVMs and observations allows to identify specific possible improvements in the model representations of ecological processes, such as tree-grass competition and vegetation-fire interactions, which can consequently allow to improve ESMs simulations.

GAYLER Veronika MPI for Meteorology veronika.gayler@mpimet.mpg.de

Recent JSBACH developments for CMIP6 JSBACH3 is the land surface scheme of the Max Planck Earth System Model MPI-ESM. One of the major development tasks of JSBACH3 for CMIP6, was an improvement of the land carbon cycle. This comprises the implementation of three new model components: the data based soil and litter decomposition model YASSO, the process based fire model Spitfire, and carbon pools for biomass affected by land use, i.e. anthropogenic land cover change, wood harvest and crop harvest. Additionally, the functionality of the nitrogen cycle was extended.

KUHLBRODT Till University of Reading t.kuhlbrodt@reading.ac.uk

Large-scale ocean circulation in the Crescendo ESMs: first steps of an analysis

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LORENZ Ruth ETH Zurich ruth.lorenz@env.ethz.ch

Can we beat climate model democracy in ensemble projection?

To effectively plan adaptation to climate change we need climate projections which cover all potential outcomes. At the same time we need projections to be as narrow as possible, to be able to adapt to these potential outcomes. Uncertainties in climate projections are a result of natural variability, scenario uncertainty and model uncertainty. Model uncertainty can potentially be decreased by giving more weight to those models in multi- model ensembles that are more skillful and realistic for a specific process or application.

We compare multiple approaches on how multi-model ensemble averages can be calculated; an arithmetic multi-model mean as in IPCC AR5, a weighted multi-model mean taking into account performance and independence (Knutti et al., 2017) and the average of the ten best models based on Root Mean Squared Errors over the historical period. We investigate how the different approaches influence the projection of temperature over Central Europe and test the skill of the physical models in a perfect model test. The perfect model test assumes one of the model runs to be the truth and tests if the rest of the ensemble is able to predict this ”truth”.

Weighting the multi-model based on performance and independence improves the skill on average and this skill is largest compared to the other approaches. However, spread is large depending on which model is used as truth, which diagnostics we use to inform the method, how many of these diagnostics we use, and how long the time series is to inform the method. There is no clear relationship between how many diagnostics we use and skill, adding diagnostics can increase or decrease the skill. Therefore, we conclude that not only a single diagnostic should be used because this is prone to overfitting and close attention has to be payed to choose which diagnostics are used to inform the weighting scheme.

MÄKELÄ Jarmo FMI jarmo.makela@fmi.fi

Methane emission diagnostics for ESMValTool

We are developing new diagnostics for the Earth System Model Evaluation Tool to analyse e.g. wetland methane emissions and the wetland extent.

NABAT Pierre Météo-France pierre.nabat@meteo.fr

Aerosol modeling and radiative forcing in CNRM-ESM2-1 simulations

The sensitivity of aerosols in climate is still subject to large uncertainties. The CNRM Earth System Model CNRM-ESM2-1 now includes an interactive aerosol scheme, enabling us to improve the representation of aerosols and their effects on climate. CRESCENDO simulations in pre-industrial and present day conditions have been performed in order to estimate the aerosol direct forcing. We will also present the first results of the AerChemMIP simulations to complete this estimation of aerosol direct forcing.

NIERADZIK Lars Lund University lars.nieradzik@nateku.lu.se

LPJ-GUESS within EC-Earth CMIP6 - Status and first results

O'CONNOR Fiona Met Office fiona.oconnor@metoffice.gov.uk

1) UKESM1: An assessment of the pre-industrial to present-day anthropogenic forcing

A quantitative understanding of the role of different forcing agents in both historical and future climate change remains a key motivation and scientific question for the forthcoming 6th Coupled Model Intercomparison Project (CMIP6). Fundamental to this question is the impact of physical and chemical perturbations due to anthropogenic activities on the Earth's radiative balance. In this work, effective radiative forcings (ERFs) are quantified for different anthropogenic forcing agents with the UK's Earth System Model, UKESM1. By using a single modelling framework and adopting the protocol from the Radiative Forcing Model Intercomparison Project (RFMIP), pre-industrial to present-day ERFs are calculated consistently for all anthropogenic climate forcers. The forcing agents considered here are the long-lived well-mixed greenhouse gases (GHGs), stratospheric and tropospheric ozone (O3), aerosols, and land use change. In particular, additional UKESM1 simulations are used to attribute the methane ERF, as an example, to forcing by methane, tropospheric O3, aerosols, and stratospheric water vapour, and to attribute the tropospheric O3 ERF to its individual precursors. The impact of pre-industrial to present-day oxidant changes on aerosol forcing is also explored.

2) Quantifying process sensitivities in an Earth system modelling framework

Understanding how the uncertainties around physical parameters, model-driving variables and initial/boundary conditions propagate through the chain of processes represented in a fully coupled Earth system model is one of the cornerstones in model development and evaluation. Complete and detailed understanding of model and process sensitivities will ultimately yield more robust and reliable projections of future climate and state changes in the Earth system. Every sensitivity analysis requires a procedural method for assessing the sensitivities and a metric for quantifying them. The most commonly applied method in climate and Earth system modelling arguably still is the one-factor-at-a-time (OFAT) differential approach, but it has to be recognised that more sophisticated methods have been developed and applied successfully in recent times (e.g., model emulators, monte carlo methods, etc.). Typically, OFAT differential analysis consists of a control simulation and a series of targeted model perturbation experiments probing the extent to which a variation in a particular input quantity affects model prognostic and/or diagnostic output. One challenge in the assessment of this impact on model output, which we interpret as the 'sensitivity', is defining a measure with which to quantify sensitivities across an increasing number of processes and variables. How can we compare like-for-like the sensitivities across this vast and rapidly growing phase space that spans many orders of magnitude and, even more challenging, many physical units? Here, we propose a novel metric for intra- and inter-model comparisons of sensitivities that has been designed to overcome this hurdle by using a dimensionless and normalised quantity of measure.

PADRON Ryan ETH Zurich ryan.padron@env.ethz.ch

Observational Constraints Reduce Likelihood of Extreme Changes in Multi-Decadal Land Water Availability

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PALMIÉRI Julien NOC julien.palmieri@noc.ac.uk

Preparing the UKESM-based OMIP simulation.

SUN Wenbin Beijing Normal University wenbin_sun@mail.bnu.edu.cn

Sensitivity of Tibetan permafrost carbon to climate forcing

The climate change over Tibetan Plateau has attracted great attention due to its unique geographic location and high elevation. During the past decades, the Tibetan Plateau becomes warmer and wetter and the Tibetan permafrost degrades with climate warming. In this study, we assess the sensitivity of the Tibetan permafrost soil and vegetation carbon to air temperature, precipitation and atmospheric CO2 concentration simulated by eight land surface models (CLM4.5, ISBA, JULES, LPJ-GUESS, ORCHIDEE, ORCHIDEE-MICT, TEM and UW-VIC) during 1960-2009. Most of models simulate an increase in vegetation and soil carbon densities from 1960 to 2009 with Tibetan permafrost degradation. The averaged increasing rate of vegetation and soil carbon is 0.99 gCm-2yr-2 and 4.34 gCm-2yr-1, respectively. One model shows opposite trend with decreasing vegetation and soil carbon density over Tibetan permafrost region, although it behaves similarly as other models in simulating Northern Hemisphere high-latitude permafrost carbon change. All models suggest that atmospheric CO2 is the dominant cause driving Tibetan permafrost carbon change, and the sensitivity of Tibetan permafrost carbon density to atmospheric CO2 is positive. Precipitation and air temperature also play important roles, and most of models show positive sensitivity of Tibetan permafrost carbon to warming air temperature and weakly increasing precipitation. Moreover, we compared the sensitivities of soil and vegetation carbon to air temperature over Tibetan permafrost region with that over Northern Hemisphere high-latitude permafrost regions in the coming century. Tibetan Plateau and Northern Hemisphere high-latitude permafrost regions display similar soil carbon sensitivity to air temperature of 0.23 and 0.21 kgC m-2 K-1 respectively, while a very different vegetation carbon sensitivity to air temperature of 0.09 and 0.27 kgC m-2 K-1 respectively. The difference in vegetation carbon sensitivities might be related to different vegetation types and their coverages. Overall, the models exhibit large discrepancies in simulated permafrost carbon change, which suggests the current land surface models need further improvements to better simulating Tibetan permafrost soil physics and carbon dynamics.

TAKANO Yohei MPI for Meteorology yohei.takano@mpimet.mpg.de

What controls the ocean decadal deoxygenation and heat uptake? - Early Results from pre-OMIP Simulations

Observational studies reveal substantial ocean deoxygenation and increased ocean heat uptake in the past decades. These two properties are known to be tightly connected. Despite the fact that ocean warming leads to deoxygenation, Earth System Models (ESMs) still struggles to simulate the observed trends in oxygen inventory and heat content. One possible reason is the role of decadal climate variability.

The decadal changes in oxygen inventory cannot be fully explained by changes in thermodynamics alone, indicating the important role of changes in ocean circulation and biology. Climate variability could modulate these processes on decadal timescales but the observed climate variability is not necessarily simulated in the ESMs due to the fact that the models have their own internal climate variability, which vary in magnitude and phase, in the coupled climate system.

Here we present early results from the comparison of ocean model simulations driven by the atmospheric reanalysis forcing (calling pre-OMIP). We will present decadal changes in both oxygen inventory and heat uptake based on the results from three model simulations and observations. Our study will provide first indications of the importance of decadal climate variability on determining oxygen inventory and trend. Hence, it will also provide guidance on accuracy and uncertainty of future deoxygenation projected in the ESMs. We aim on stimulating the discussion on near term strategy of how we analyze upcoming OMIP simulations within the context of climate variability and changes in ocean physics and biogeochemistry based on our preliminary analysis.

YOOL Andrew **National Oceanography Centre** **axy@noc.ac.uk**

Spin-up and Historical simulation evaluation of the oceans in UKESM1

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Comparisons of multi-model outputs with satellite and ground-based measurements of aerosol optical depthsI will show some of the plots of simulated AODs spatially and temporally collocated with MODIS and AERONET measurements.
