G8 Research Councils Initiative on Multilateral Research Funding

G8MUREFU-FP-179-014

ExArch

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Leading Principal Investigator		Project data
Martin Juckes (Science and Technology Facilities Council)	Total project cost	**1.439 K€**
	Project begin:	**01.03.2011**
	Duration:	**3.25 years**

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Principal Investigator (7)	Total project cost
Venkatramani Balaji, Princeton University	244 K€
Michael Lautenschlager, Deutsches Klimarechenzentru...	247 K€
Sébastien Denvil, Institut Pierre Simon Laplace	197 K€
Bryan Lawrence, Science and Technology Facilities Cou...	0 K€
Paul Kushner, University of Toronto, Department of Phy...	170 K€
Duane Waliser, University of California, Los Angeles	233 K€

Summary

Climate science demands on data management are growing rapidly as climate models grow in the precision with which they depict spatial structures and in the completeness with which they describe a vast range of physical processes.
For the Climate Model Inter-comparison Project 5 (CMIP5), a distributed archive is being constructed to provide access to what is expected to be in excess of 10 Peta-bytes of global climate change projections. The data will be held at 30 or more computing centres and data archives around the world, but for users it will appear as a single archive described by one catalogue. In addition, the usability of the data will be enhanced by a three-step validation process and the publication of Digital Object Identifiers (doi) for all the data.
For many users the spatial resolution provided by the global climate models (around 150km) is inadequate: the CORDEX project will provide data scaled down to around 10km. Evaluation of climate impacts often revolves around extremes and complex impact factors, requiring high volumes of data to be stored. At the same time, uncertainty about the optimal configuration of the models imposes the requirement that each scenario be explored with multiple models.
This project will explore the challenges of developing a software management infrastructure which will scale to the multi-exabyte archives of climate data which are likely to be crucial to major policy decisions in by the end of

Summary - Fortsetzung

the decade. Support for automated processing of the archived data and metadata will be essential. In the short term goal, strategies will be evaluated by applying them to the CORDEX project data.

Signature	Chilton, Didcot, 25.08.2010 --- Juckes

Further particulars	
End Date	31.05.2014
Key words	climate, data management, server side processing, impacts, scalable archive design
Executive summary	The climate modelling community faces huge challenges if it is to meet demands for quantitative predictions of risks associated with anthropogenic climate change. Meeting these demands is certain to push computing resources to their limits, to the exa-scale and beyond. The problems associated with creating codes to run at the exascale need urgent attention, but the problems associated with handling the data products that will be produced in staggering volumes by exascale computing cannot be neglected. The exascale data archive must deal with increased spatial and temporal precision in data, increased completeness in the range of bio-geophysical variables which need to be described, and increased sampling of the inherent uncertainty in projections of the future. In addition, as climate science becomes a basis for far reaching policy decisions, there is a pressing need to achieve faster delivery of results and greater reliability. The ExArch proposal is principally a framework (incorporating a strategy, prototype infrastructure and demonstration usage examples) for the scientific interpretation of multi-model ensembles at the peta- and exa-scale. Specifically, we plan to do this in the context of the imminent CMIP5 archive, which will be largest of its kind ever assembled in this domain. We will further extend the challenge by attaching the ExArch framework to the CORDEX experiment, which will push even beyond CMIP5 in resolution, albeit on the regional scale. The project will consider a range of test scientific use cases for an exascale archive and develop a software infrastructure to support them. The project will consider data mining issues, where the scientist is interested in data meeting complex criteria: evaluation of a flexible range of criteria in the archive will be supported. The project will also contributing to enhancing the reproducibility and transparency of climate analysis methods. Through the inclusion of the UCLA team, the project will address the use of observations to evaluate model projections. The project will tackle the exascale challenges on four fronts: (1) Strategy development; (2) CMIP5 and CORDEX archives: demonstration use cases; (3) scalable design and (4) intelligent data mining. Strategy development will take place in two phases, the first focussing on hardware and the basic file transfer mechanisms (such as GridFTP). This phase will produce a report outlining likely futures in low, medium and high investment scenarios. The second stage of the strategy development will look at the range of services to users which could be supported in an exascale archive under the scenarios described in the first phase. In order to ensure that the processing capabilities investigated by the project are relevant to climate science, a demonstration analysis will be completed on the CMIP5 and CORDEX data archives. The CMIP5 archive may exceed 10Pb of data distributed over up to 30 data nodes. Analysis of this archive by traditional means will be very challenging. The data in this archive will be, however, of low spatial resolution. Analysis of impacts relevant features will be carried out using the higher resolution CORDEX archive.

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Executive summary

Scalable design is clearly essential. Scalability is a particular concern in quality control since scientific quality control of model output has traditionally had a heavy reliance on evaluation methods with subjective aspects including visual inspection and metrics that vary among modelling groups. Extensibility of the Climate Data Operators (CDO) library will be improved, so that outputs (which typically reflect an evaluation of a small number of files) are suitable for input into a meta-analysis.

Many scientific analyses start with an overview of a large volume of data and then devote the bulk of the work to detailed analysis of a small fraction of the data. Intelligent data mining will make it possible for users to carry out preliminary analyses without transferring any data from the archive. It will also provide resource use and throughput time estimates and scheduling required to complete requested calculations.

The project will be organised around the following 8 objectives:

A)Provenance and quality meta-data supporting the formulation of complex scientific queries across the distributed archive;
B)Fault tolerant collection and distribution of data and meta-data;
C)Unambiguous query syntax to support re-use and chaining of results;
D)Robust server side resource management;
E)Efficient distribution of large data volumes from multiple sources to multiple delivery points;
F)Interfaces which ensure security, transparency and inter-operability with Earth observation archives.

G)Evaluation of distributions of projected climate variables (for example, temperature, precipitation, windiness);
H)Evaluation of statistics for features (such as tropical and extra-tropical cyclones, extreme precipitation and drought) and essential climate variables;
I)Flexible specification of models and experiments used for ensemble calculations.

The research will be organised into 3 work packages: management and strategy development, information technology and climate science and data validation. The central subject of this project is the infrastructure to support scientific analysis of large distributed datasets. Many of the informatics problems which need to be resolved are already well characterised, but it is essential that the solutions developed in the informatics context are tested against real problems of interest to scientists today. WP3 will provide this proof of utility, so that at the end of the project the infrastructure will be available together with a suite of analysis codes which exploit it to produce derived products of current scientific interest. WP3 will also provide quantitative quality control information, which will allow users of an archive with millions of datasets to avoid using data which has been published for validation and is not suitable for detailed analysis. This information will feed back into the detailed metadata systems established in WP2.

The institutes contributing to the team have overlapping expertise, but within this project they will have a primary focus on the following roles: BADC, web processing services; Princeton, design of a query syntax for web processing; IPSL, extending and exploiting the common information

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Executive summary	model; DKRZ, portable processing operators and quality control; Toronto, scientific diagnostics; UCLA, satellite data for model evaluation. The project will use the G8 research initiative primarily for early career scientists (including one PhD student). The majority of PI time is funded from existing sources. A letter of support from Ghassem Asrar is attached to the project description.
Management Plan	INDEX 1.Overview 2.Project team 3.Management strategy 4.Advisory Board 5.Communication and management tools 6.Strategy workshops 7.Carbon footprint 8.Reporting --- 1. Overview The project has three work packages and 26 tasks. Each work package and task has a designated leader, listed in Annex 1 of the description of work. Work package leaders will be responsible for keeping an overview of tasks in their work package, and ensuring that communication between tasks and work packages is functioning as planned. Task leaders will coordinate the delivery of each task and submit periodic reports. Work packages 1, 2 and 3 will be led by STFC, Princeton and Uni. Toronto respectively. The work package leader will be responsible for ensuring that the tasks interact appropriately and that they combine to deliver the objectives of the project. This project will take place in the context of a complex web of collaborative projects and networks. The project is closely aligned with the aims of the GO-ESSP consortium and will operate, as far as possible, within that framework in order to reduce the requirement for additional infrastructure and meetings. The project will have an oversight board to provide feedback on the delivery plan, the mid-project report (see section 8 below) and participate in the final strategy workshop. During the project the progress in each task will be monitored using an on-line project management tool. 2. Project team The ExArch team has been centrally involved in building data archive systems at the peta-scale. It includes members in the experimental design of large coordinated modelling campaigns; designers of the Earth System Grid Federation (the federation running the CMIP5 archive: tiny.cc/esgfed); members of the CURATOR (a US NSF project: earthsystemcurator.org), METAFOR and IS-ENES EU FP7 projects (metaforclimate.eu/, is.enes. org) involved in defining, collecting and displaying model provenance meta-data; all of whom have been active in the planning of the CMIP5 experimental protocol and data distribution design. In addition to these funded projects, the team are actively involved in the GO-ESSP collaborative framework (go-essp.gfdl.noaa.gov). Team members provide data services for the regional modelling communities at the national level: ExArch will join these national archives into a coherent whole and explore

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Management Plan	the added value associated with a comprehensive distributed archive. The institutes contributing to the team have overlapping expertise, but within this project they will have a primary focus on the following roles: BADC, web processing services; Princeton, design of a query syntax for web processing; IPSL, extending and exploiting the common information model; DKRZ, portable processing operators and quality control; Toronto, scientific diagnostics; UCLA, satellite data for model evaluation. 3. Management Strategy Given the distributed nature of the project and inevitable dependencies on other nationally and internationally funded projects, reliable and effective communication will be essential to good project management. An on-line project management tool will be used to ensure all partners have ready access to information about project progress, and frequent telephone conferences will be held to ensure that the on-line information is kept up to date. The strategy development process will provide a strong unifying theme. Peer reviewed publications will be a major component of the project outputs: in order to ensure that these are produced in a coherent and timely way the project partners will share and review outline articles. The outline articles will be produced early in the project. A project delivery plan will be completed in month 3 of the project, providing a schedule of meetings and milestones in the first 18 months, identifying risks and opportunities, and defining the tasks to be completed in the first 18 months in greater detail. The delivery plan will be updated annually. A Gantt chart and risk matrix will be included in the project delivery plan. Integration between partners will be supported by ensuring that at least two institutions are assigned to each task. In some cases one partner may be contributing only reviewing and assessment of outcomes and their consistency with requirements from other tasks. 4. Advisory board In order to gain a broader input on the project progress and priorities an advisory board will be appointed. Four members have already agreed to participate and will be able to offer valuable advice in the early stages of the project, particularly with regard to the project delivery plan: Dean Williams (PCMDI) will provide essential coordination between our activities and the work being led by PCMDI to deploy the CMIP5 archive; Colin Jones (co-chair of the WCRP Task Force on Regional Downscaling) will advise on scientific priorities regarding the processing of CORDEX data; Ghassem Asrar (WCRP) will give use the strategic perspective from the WMO; and Pierre-Philippe Mathieu (ESA) will provide interactions with the ESA climate change initiative. The advisory board will be asked to review the project delivery plan to be drawn up in month 4 and the periodic reviews (see below). They will also be invited to attend the final strategy meeting. Travel funds are also requested for an additional two board members to be appointed during the project. 5. Communication and management tools The project will utilise a range of media to ensure efficient communication.

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Management Plan	Regular discussions will be held at bi-weekly telephone conferences supported by web-conferencing facilities (such as EVO – evo.caltech.edu) which allow presentations and other documents to be shared and viewed together during the phone conference. The telephone conferences will alternate between management progress reviews (with one participant from each partner organisation) and detailed discussions of specific tasks. An archived email list will be established. Two wiki sites will be set up: one open to the public to facilitate sharing of documents with a broader community, and one private for internal documents. The private wiki will be on a TRAC (trac.edgewall.com) project management website (or equivalent), also providing a ticketing system to support task management. In the first month of the project , the Lead PI will ensure that an entry is created for each project task. In the 2nd month of the project, the task leaders will generate a set of sub-tasks, each with a short description, estimated start and completion times and assigned manpower. This will form the basis of the project roadmap, after it has been reviewed for conflicts. We investigate the use of “dual-venue” meetings, in which participants gather at one location in Europe and a second in N. America. This will achieve greater focus than a simple telephone conference with delegates at their desks without the overheads of long distance travel (e.g. see http: //www.nmk.co.uk/articles/1139). 6. Strategy workshops The project will support community efforts to define a strategy for delivering exascale data management services. Two workshops will be organised, the first to focus on point to point data transport issues, and the second to look service requirements and delivery options. The data transport workshop will cover issues of network capacity and primary transport software (such as GridFTP). The one-day workshop will be held in Europe in of 2012 Autumn, coinciding with a 3-day GO-ESSP meeting where many project partners will participate. The workshop will define high, medium and low scenarios for expected services in the coming decade. The second workshop will coincide with the fall AGU meeting (San Francisco, December 2013 – month 34 of the project). The AGU meeting will be used to disseminate project results and engage with the broader scientific community. The project team will prepare a white paper in advance of each workshop, and a report will be published after each workshop. The project will provide two months of project management support and some financial support for the workshops. 7. Carbon footprint Energy management is becoming an increasingly important aspect of information technology as power requirements steadily increase. This project will contribute to energy efficiency through efficient use of hardware

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Management Plan	resources (e.g. reducing data transfer requirements by performing calculations near the data). In order to provide some measure of the significance of these measures a project energy budget will be kept. An initial audit suggests the project will have a footprint of roughly 191 tonnes CO2 equivalent. Offsetting this at £10/tonne will add £1915 to the cost of the project. A rough estimate of the carbon footprint is 25 tonnes CO2 from flights plus a further 45 tonnes CO2 equivalent, 88 tonnes from servers and associated air-conditioning and 33 tonnes from general office usage. Taxi and rail travel will make marginal additional contributions. 8. Reporting Progress reports will be submitted at month 18 and at end of project (subject to confirmation of project requirements). In each case a provisional report will be circulated to the advisory board 2 months prior to the final delivery date to allow for feedback. The advisory board will also be invited to review the project delivery plan.
Outcome and dissemination plan	OUTCOMES ========== - Research papers: The project will produce peer reviewed research papers on a range of topics listed in the dissemination plan below. - Infrastructure: The research objectives will require deployment of distributed data archive infrastructure which pushes the boundaries of current potential. The project will deliver a functional prototype processing service, which will be evaluated through the calculation of a range of climate science diagnostics. An instance of the processing services will be integrated into operational services at STFC after the end of this project. - Strategy: A roadmap to exascale data services will be developed through the two strategy workshops (described in the management plan) and published in the associated reports. - Training: The project will employ an undergraduate student and a research student (both at Uni. Toronto) and early career scientists. DISSEMINATION PLAN ========== The strategy documents will be disseminated by engaging with the wider community through the GO-ESSP framework. Workshops reports will be published and disseminated via community mailing lists within three months of the workshops. The final strategy document will be submitted for peer review publication. Peer reviewed publications on the following topics: -- Data mining in an exascale climate archive -- A query syntax to support climate data analysis -- Efficient cache exploitation in multi-step processes -- Near archive processing: enabling exascale science -- Automated meta-data collection from climate models -- Code management and configuration capture in Earth System Models -- Exploring the Common Information Model capacity to describe Earth Observation data

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Outcome and dissemination plan	-- Cyclone tracks and climate variability in CMIP5 and CORDEX: a preliminary analysis testing new climate data technologies -- Evaluation of extreme precipitation, temperature, and wind events in CMIP5 and CORDEX -- Evaluation of snow processes in a changing climate: global model and regional model perspectives -- Comparison of moist energy budgets in the storm tracks of CMIP5 and CORDEX multi-model ensembles and their sensitivity to physical parametrizations." -- Structured quality assurance to support data selection in and exa-cale archive Reports -- Additional reports will be published on the project web site Presentations and posters Project results will be presented at a range of national and international events -- EGU General Assemblies, primarily in the Earth & Space Science Informatics (ESSI) session; -- AGU General Assemblies, also focusing on the ESSI session; -- GO-ESSP meeting(s) in 2012 and early 2014 (if it falls within the project time frame); Message boards, email lists and web-sites. The partners will use their existing avenues of communication to disseminate key results: web-pages; email lists; involvement in other collaborative projects and networks (such as ENES).
Suggested reviewers	Peter Fox Rensselaer Polytechnic Institute, World Tetherless Constellation, Troy, United States email: pfox@cs.rpi.edu tel: 0015182764464 Jochem Marotzke Max Planck Institute for Meteorology Bundesstr. 53 D-20146 Hamburg Germany Email: jochem.marotzke@zmaw.de Phone: 0049-40-41173-440 Myles Allen, Oxford University, AOPP, Clarendon Lab., Parks Rd., Oxford, OX1 3PU, UK; Email: myles.allen@physics.ox.ac.uk Steve Hankin, NOAA/PMEL

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Suggested reviewers	7600 Sand Point Way NE, Seattle, WA 98115-0070 email: Steven.C.Hankin@noaa.gov tel: 001 206 526-6080, FAX: 001 (206) 526-6744 Professor John Mitchell, OB,E FRS, UK Met Office FitzRoy Road, Exeter, EX1 3PB, United Kingdom. Tel: 0044(0)1392884604 Fax: 0044 (0) 870 9005050 E-mail: john.f.mitchell@metoffice.gov.uk Jeff Anderson National Center for Atmospheric Research 1850 Table Mesa Drive Boulder, CO 80307-3000 http://www.image.ucar.edu/staff/jla/JeffreyAndersonCV.pdf email: jla@ucar.edu tel: 001 303 497 8991 Francis Zwiers, Environment Canada Environment Canada Inquiry Centre 351 St. Joseph Boulevard Place Vincent Massey, 8th Floor Gatineau, Quebec K1A 0H3 Telephone: 819-997-2800 email: francis.zwiers@ec.gc.ca John Fyfe Canadian Centre for Climate Modelling and Analysis SCI A245 Telephone: 250-363-8236 Fax: 250-363-8247 Email:John.Fyfe@ec.gc.ca Ricky Rood (University of Michigan) 2525 Space Research Building University of Michigan 2455 Hayward St. Ann Arbor, MI 48109-2143 e-mail: rbrood@umich.edu Veronika Eyring Deutsches Zentrum für Luft- und Raumfahrt (DLR) Institut für Physik der Atmosphäre (IPA) Oberpfaffenhofen 82234 Wessling, Germany Phone: 0049-8153-28-2533

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Suggested reviewers	Email: veronika.eyring@dlr.de William (Bill) Collins Senior Scientist and Department Head Professor in Residence Professor, University of California, Berkeley Climate Science Department Lawrence Berkeley National Lab 1 Cyclotron Road MS 90-1116 Berkeley, CA 94720 Phone: 510-495-2407 Fax: 510-486-5686 email: wdcollins@lbl.gov Reinhard Georg Budich Max-Planck-Institut für Meteorologie Bundesstr. 53 D-20146 Hamburg Germany Email: reinhard.budich@zmaw.de tel: 0049-40-41173-369 Fax: 0049-40-41173-616 Lawrence Buja, NCAR 1850 Table Mesa Drive Boulder, CO 80305 phone 303-497-1330 emails: southern@ucar.edu Prof Peter Clarke, University of Edinburgh Director of The National e-Science Centre Chair of e-Science, University of Edinburgh e-Science Institute Edinburgh EH8 9AA, UK email: clarke@nesc.ac.uk Tel: +44 (0)131 651 4210 Fax: +44 (0)131 650 9819 Dr Richard Swinbank, UK Met Office, Met Office Middle Atmosphere Group FitzRoy road Exeter, EX1 3PB, UK email: richard.swinbank@metoffice.com tel: 0044 (0) 1392 88 6619.
Potential reviewers to avoid for direct competition reasons	

Provisional Financial Summary

LPI Science and Technology Facilities Council	Expenses for facilities and equipment (K€)	Expenses for consumables (K€)	Travel expenses (K€)	Salaries (K€)	Other (K€)	Total requested budget (K€)
2011		3	1	25	29	**58**
2012			1	50	60	**111**
2013			1	50	61	**111**
2014			13	25	31	**68**

Total LPI Cost: 348 K€

PI 1 Princeton University	Expenses for facilities and equipment (K€)	Expenses for consumables (K€)	Travel expenses (K€)	Salaries (K€)	Other (K€)	Total requested budget (K€)
2011		2	2	23	8	**34**
2012			3	56	20	**79**
2013			3	58	21	**82**
2014			2	35	13	**49**

Total PI 1 Cost: 244 K€

PI 2 Deutsches Klimarechenzentrum	Expenses for facilities and equipment (K€)	Expenses for consumables (K€)	Travel expenses (K€)	Salaries (K€)	Other (K€)	Total requested budget (K€)
2011		20	4	51	15	**90**
2012			5	56	12	**73**
2013			5	56	16	**77**
2014			1	5	1	**7**

Total PI 2 Cost: 247 K€

Provisional Financial Summary

PI 3 Institut Pierre Simon Laplace	Expenses for facilities and equipment (K€)	Expenses for consumables (K€)	Travel expenses (K€)	Salaries (K€)	Other (K€)	Total requested budget (K€)
2011	15	3	4	49		**71**
2012			6	54		**60**
2013			4	54		**58**
2014			4	4		**8**

Total PI 3 Cost: 197 K€

PI 5 Science and Technology Facilities Council	Expenses for facilities and equipment (K€)	Expenses for consumables (K€)	Travel expenses (K€)	Salaries (K€)	Other (K€)	Total requested budget (K€)
2011						
2012						
2013						
2014						

Total PI 5 Cost: 0 K€

Provisional Financial Summary

PI 6 University of Toronto, Department of Physics	Expenses for facilities and equipment (K€)	Expenses for consumables (K€)	Travel expenses (K€)	Salaries (K€)	Other (K€)	Total requested budget (K€)
2011		3	3	33		**39**
2012		4	4	41	1	**50**
2013		4	4	42	1	**51**
2014		2	2	26		**30**

Total PI 6 Cost: 170 K€

PI 7 University of California, Los Angeles	Expenses for facilities and equipment (K€)	Expenses for consumables (K€)	Travel expenses (K€)	Salaries (K€)	Other (K€)	Total requested budget (K€)
2011	2		1	25	29	**57**
2012			3	25	31	**59**
2013			1	26	31	**58**
2014			1	26	32	**59**

Total PI 7 Cost: 233 K€

Total Cost: 1.439 K€

Leading Principal Investigator

non G8-Partner - Cooperation Partners	
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Principal Investigator details	Martin Juckes is currently leading a work-package within the EU FP7 project IS-ENES to deploy data services for the European contribution to the World Climate Research Program (WCRP) CMIP5 archive which will form the basis of the next IPCC Assessment Report. He is also manager of the IPCC Data Distribution Centre (www.ipcc-data.org) and ex-officio member of the IPCC Task Group on Data and Scenario Support for Impact and Climate Analysis. He is author of a number of papers on atmospheric dynamics, data assimilation and reconstructing the past climate. M. N. Juckes, 1994: Quasigeostrophic Dynamics of the Tropopause. Journal of the Atmospheric Sciences 51, 2756-2768. M. N. Juckes, 2000: The Static Stability of the Midlatitude Troposphere: The Relevance of Moisture. Journal of the Atmospheric Sciences, 57, 3050-3057.

	M. N. Juckes, 2001: A generalization of the transformed Eulerian-mean meridional circulation. Quarterly Journal of the Royal Meteorological Society, 127, 147-160. doi: 10.1002/qj.49712757109 M. N. Juckes, B. N. Lawrence, 2006: Data assimilation for re-analyses: potential gains from full use of post-analysis-time observations. Tellus A, 58, 171-178. doi:10.1111/j.1600-0870.2006.00167.x M. N. Juckes, 2006: Evaluation of MIPAS ozone fields assimilated using a new algorithm constrained by isentropic tracer advection. Atmos. Chem. Phys., 6, 1549-1565. doi:10.5194/acp-6-1549-2006
Total funding requested for 2011 (in KEUR)	58
Total funding requested for 2012 (in KEUR)	111
Total funding requested for 2013 (in KEUR)	111
Total funding requested for 2014 (in KEUR)	68
Funding from other sources (current and pending support)	Resources directly supporting project: ========== PI time: 1 month per project year: Storage: 50Tb These resource will be funded out of core support for BADC data services from NERC. Additional support: ========== Additional work supporting the project aims is being done with funding from EU FP7 (METAFOR and IS-ENES), core funding and knowledge transfer funding from NERC to support climate science in the UK, and funding from DEFRA to support exploitation of UK Met Office climate projections and the IPCC assessment process. Together these funding streams support a £2m effort at BADC on informatics research, infrastructure deployment, and service provision connected with the

Budget Justification	CMIP5 archive. Currency of budget calculation: Pounds sterling (GBP) Conversion rate: 1GBP = 1.2 Euros Expenses for facilities and equipment: ========== None Expenses for consumables: ========== Linux workstation for researcher: £3k Travel: ====== Specific venues may change. (a) GO-ESSP meeting, Europe, Autumn 2012: £1.2k (b) Fall AGU, San Francisco, December 2014; £2.5k (c) Two short European meetings: £800 (d) Advisory board: an advisory board of 6 people will provide the project with links to the broader scientific community. Ghassem Asrar (Chair of WCRP), Colin Jones (co-chair of the WCRP Task Force on Regional Downscaling), Pierre Philippe Mathieu (ESA, Climate Change Initiative) and Dean Williams (PCMDI) have already agreed to participate in the board. Two further members will be sought in the first months of the project. Funds for the board to attend the Fall AGU meeting in San Francisco, Dec. 2014 are requested, estimated on the basis of 4 travelling from Europe and 2 from N. America: £6k travel plus £7.5k subsistence. More details of the role of the adbisory board are in the management plan. Salaries: ======== Software developer to carry out IT research and support climate science: 33 months at STFC band D: £122k Support for porject management: 9 months at STFC band D: £33k Other: =====

(a) Page charges for 2 publications: £2k
(b) Estates are charged at £11k per FTE: £41k
(c) Indirect costs charget at £41k per FTE: £142k
(d) Carbon offsetting is estimated to cost (see management plan): £2k

Note: Under the terms of the Full Economic Costing system, the funding request to NERC covers 80% of the above costs, amounting to: £290k

Principal Investigator 1

non G8-Partner - Cooperation Partners	
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Highest academic qualification	
Principal Investigator details	Dr. V. Balaji heads the Modeling Systems Group serving developers of Earth System models at GFDL and Princeton University. With a background in physics and climate science, he has become an expert in the area of parallel computing and scientific infrastructure, providing high-level programming interfaces for expressing parallelism in scientific algorithms. He has pioneered the use of frameworks (such as the Flexible Modeling System: FMS, as well as community standards such as ESMF and PRISM) allowing the construction of climate models out of independently developed components sharing a technical architecture; and of curators (FMS Runtime Environment FRE) for the execution of complex workflows to manage the complete climate modeling process. The Earth System Curator (US) and Metafor (EU) projects, in which he plays a key role, have developed the use of a common information model which allows the execution of complex scientific queries on model data archives.

	Dr. Balaji plays advisory roles on NSF, NOAA and DOE review panels, including the recent series of exascale workshops. He is a sought-after speaker and lecturer and is committed to provide training in the use of climate models in developing nations, leading workshops to advanced students and researchers in South Africa and India. Publications: Dunlap et al 2009: Earth system curator: metadata infrastructure for climate modeling. Earth Science Informatics, 1(3):131--149. Zhou et al, 2006: Cross-organization interoperability experiments of weather and climate models with the Earth System Modeling Framework. Concurrency and Computation, 19, 583--592. Balaji et al 2006: The Exchange Grid: [...] Parallel Computational Fluid Dynamics: Theory and Applications, Proc. 2005 Int. Conf. on Parallel Computational Fluid Dynamics, Elsevier (2006).
Total funding requested for 2011 (in KEUR)	34
Total funding requested for 2012 (in KEUR)	79
Total funding requested for 2013 (in KEUR)	82
Total funding requested for 2014 (in KEUR)	49
Funding from other sources (current and pending support)	Hardware resources for the project (a publicly accessible disk archive of about 20 TB for testing and prototyping) will come out of existing funding. PI time for the project (3 months total) will also be provided from existing funding.
Budget Justification	Consumables: ========== Computer for postdoc $2,000 (year 1 only) Miscellaneous supplies $500 Travel: ====== Two meetings per year to collaborate in Europe with G8 members Airfare: $1,000 Hotel and per diem: $1,000

Total: $2,000/trip

Salaries:

========

Full-time 12 month entry level postdoc at $52,000 plus benefits @34.5% (salary inflation of 3% per year)

Contribution to project: The postdoc will lead an effort to develop a query syntax to perform mathematical, statistical and scientific manipulations of model data on distributed archives. PI Balaji will devote 1 month of time to providing postdoc oversight, and leadership of WP2. These costs will come out of existing funding.

Other:

======

Publications charges in project year 2 and 3 are expected on aspects of query syntax development and implementation.

Indirect Costs:

==========

29.6% overhead of total direct costs

Principal Investigator 2

non G8-Partner - Cooperation Partners	
Family Name	Lautenschlager
First Name(s)	Michael
Name of University/research institute	Deutsches Klimarechenzentrum
Position	Head, Data Management
Street name and number	Bundesstraße 45a
PO Box	
Postal/Zip code	D-20146
Cedex/State/Province	
City	Hamburg
Country	Germany
Phone	040 / 460094 - 118
Fax	
eMail	lautenschlager@dkrz.de
Web site	http://www.dkrz.de/dkrz/about/staff/staffmember?name=lautenschlager&setlang=en_US
Highest academic qualification	PhD
Principal Investigator details	Michael Lautenschlager is leading the scientifci data management at DKRZ (Deutsches Klimarechenzentrum GmbH, www.dkrz.de) and the ICSU World Data Center Climate (www.wdc-climate.de) with its long-term archiving focus. He is currently leading a work-package within the EU FP7 project IS-ENES to deploy a data portal for the European contribution to the World Climate Research Program (WCRP) CMIP5 archive which will form the basis of the next IPCC Assessment Report. Michael Lautenschlager is also a manager of the IPCC Data Distribution Centre (www.ipcc-data.org). Klump, J., R. Bertelmann, J. Brase, M. Diepenbroek. H. Grobe, H. Höck, M. Lautenschlager, U. Schindler, I. Sens and J. Wächter, 2006: Data Publication in the Open Access Initiative. CODATA Data Science Journal, p79-83

	Toussaint, F. und M. Lautenschlager, 2006: World Data Center for Climate – Produkte und Services für die Klimaforschung. In: Klimastatusbericht 2005, pp65-69. Toussaint, F., M. Lautenschlager und H. Luthardt, 2007: World Data Center for Climate – Support for the CEOP Project in Terms of Model Output. Journal Met. Soc. Japan, Vol. 85A, pp. 475-485. Lautenschlager, M. and W. Stahl, 2007: Long-Term Archiving of Climate Model Data at WDC Climate and DKRZ. In: E. Mikusch (Ed.): PV2007 – Ensuring the Long-Term Preservation and Value Adding to Scientific and Technical Data, Conference Proceedings. DLR, German Remote Sensing Data Center, Oberpfaffenhofen, 2007 Lautenschlager, M. (2008): Preservation of Earth System Model Data. Digital Preservation Europe, Briefing Paper 30th June 2008 (URL: http: //www.digitalpreservationeurope.eu/)
Total funding requested for 2011 (in KEUR)	90
Total funding requested for 2012 (in KEUR)	73
Total funding requested for 2013 (in KEUR)	77
Total funding requested for 2014 (in KEUR)	7
Funding from other sources (current and pending support)	3 PI months time spent on the project (cost 27600 EUR) will be provided by DKRZ core funding.
Budget Justification	Consumables: ========== (1) Linux workstation for researcher: 2000 EUR; (2) 18000 EUR project disk space (20Tb) which will be integrated into DKRZ infrastructure. Travel: ====== Travel expenses are calculated for 3500 EUR per transatlantic travel (5-7 days) and 2000 EUR per European travel (2-4 days) Salaries:

========

The DFG salary for a young scientist, full time over 36 months

Other:

======

(1) Expenses for printing and outreach

(5) The "Programmpauschale DFG" is the standard DFG administrative flat rate of 20% applied to all costs

Principal Investigator 3

non G8-Partner - Cooperation Partners	
Family Name	Denvil
First Name(s)	Sébastien
Name of University/research institute	Institut Pierre Simon Laplace
Position	Ingénieur en calcul scientifique
Street name and number	4, Place de Jussieu
PO Box	
Postal/Zip code	75252
Cedex/State/Province	05
City	Paris
Country	France
Phone	0033 1 44 27 21 10
Fax	0033 1 44 27 61 71
eMail	sebastien.denvil@ipsl.jussieu.fr
Web site	
Highest academic qualification	Master in applied mathematics
Principal Investigator details	Sébastien Denvil is currently leading a work-package within the EU FP7 project METAFOR to provide content to formally test the CIM schema and the services. This objective leads to two types of tasks: production of the content and testing the content. Within the IS-ENES EU FP7 project he leads the IPSL data services activity for the European contribution to the World Climate Research Program (WCRP) CMIP5. He was involved in the ENSEMBLES EU FP6 project in the production of seasonal to decadal hindcasts and climate change scenarios (Model Engine Part 1, http://ensembles-eu.metoffice.com). He is also responsible for the IPSL climate modelling group reference simulations and data distribution. Influence of solar variability, CO2 and orbital forcing during the last millennium in the IPSLCM4 model, J. Servonnat, P. Yiou, M. Khodri, D. Swingedouw, and S. Denvil, Climate of the Past (submitted) Climate change under aggressive mitigation: The ENSEMBLES

	multi-model experiment : T.C. Johns, J.-F. Royer, I. Höschel, H. Huebener, E. Roeckner, E. Manzini, W. May, J.-L. Dufresne, O.H. Otterå, D.P. van Vuuren, D. Salas y Melia, M.A. Giorgetta, S. Denvil, S. Yang, P.G. Fogli, J. Körper, J.F. Tjiputra, E. Stehfest, C.D. Hewitt, Climate Dynamics (submitted) Key features of the IPSL ocean atmosphere model and its sensitivity to atmospheric resolution : Olivier Marti , P. Braconnot, J.-L. Dufresne, J. Bellier, R. Benshila, S. Bony, P. Brockmann, P. Cadule, A. Caubel, F. Codron, N. de Noblet, S. Denvil, L. Fairhead, T. Fichefet, M.-A. Foujols, P. Friedlingstein, H. Goosse, J.-Y. Grandpeix, E. Guilyardi, F. Hourdin, A. Idelkadi, M. Kageyama, G. Krinner, C. Lévy, G. Madec, J. Mignot, I. Musat, D. Swingedouw and C. Talandier, Climate Dynamics ISSN 0930-7575 (Print) 1432-0894 (Online) Vol 32, No. 1, Jan. 2010.
Total funding requested for 2011 (in KEUR)	71
Total funding requested for 2012 (in KEUR)	60
Total funding requested for 2013 (in KEUR)	58
Total funding requested for 2014 (in KEUR)	8
Funding from other sources (current and pending support)	PI time : 3 months Sébastien Denvil IR2 CNRS pay grade IR2: 16k euros 1 month technical support, University Pierre & Marie Curie (affiliated to IPSL) pay grade IE2: 4k euros Hardware and computing resources will be provided by GENCI (Grand Equipement National de Calcul Intensif, www.genci.fr) and IPSL. The above resources will be applied to the project directly. Additional work supporting the project aims is being done with funding from EU FP7 (METAFOR and IS-ENES), core funding and knowledge transfer funding from CNRS/CEA to support climate science in France, and funding from INSU to support exploitation of IPSL climate projections and the IPCC assessment activity. Together these funding streams support a €2m effort at CNRS/CEA on climate modelling research, informatics research, infrastructure deployment, and service provision connected with the

Budget Justification	CMIP5 activity. IPSL budget justification. Currency: Euros Expenses for facilities and equipment: Storage for local project data (20 Tb): 15k euros Expenses for consumables: ========== (a) PC for researcher: 3k Euros Travel: ====== Specific venues may change. (a) GO-ESSP meeting, Europe, Autumn 2012: Transport, 1k euros; Hotel and subsistence,1.2k euros ; (b) Fall AGU, San Francisco, December 2014: Transport, 2k euros; Hotel and subsistence, 1.6k euros; (c) Visit 3 to 4 modelling group during the design and implementation phase of the CIM compliant library : Transport, 6k euros; Hotel and subsistence, 4.8k euros; Salaries: ======== Salary for one research engineer. Total months on project: 36 Percentage of full-time: 100% Pay scale: IR2 Total amount requested: 162000 Amount which is overheads: 129600 Overheads as percentage of pay: 80% Contribution to project: The research engineer will work on the design and implementation of a library (for inclusion in GCMs) used to produced CIM compliant files, describing representation and parameterization of physical processes, providing the major input into tasks T9 and T10. The

individual will require a detailed knowledge of the fortran90 and python programming language and its use in providing web services (doing the link with the so called METAFOR services). The library will implement algorithms capturing GCM configuration information, producing CIM compliant files ready to be push to the METAFOR services (prerequisite to high level query).

Principal Investigator 4

non G8-Partner - Cooperation Partners	Yes
Family Name	Aloisio
First Name(s)	Giovanni
Name of University/research institute	CMCC & Engineering Faculty of the University of Salento, Lecce-Italy
Position	Professor of Information Processing Systems
Street name and number	Via per Monteroni
PO Box	
Postal/Zip code	73100
Cedex/State/Province	
City	Lecce
Country	Italy
Phone	(+39) 0832.29.7221
Fax	
eMail	giovanni.aloisio@unisalento.it
Web site	http://www.cmcc.it/about-cmcc/prof.-giovanni-aloisio
Highest academic qualification	Full Professor
Principal Investigator details	Giovanni Aloisio is full professor of Information Processing Systems at the Engineering Faculty of the University of Salento, Lecce, Italy and head of the Division “Scientific Computing and Operations” (SCO) at the Euro-Mediterranean Center for Climate Change (CMCC). His expertise concerns high performance computing, grid & cloud computing and distributed data management. He has been a co-founder of the European Grid Forum (Egrid) which then merged into the Global Grid Forum (GGF), now Open Grid Forum (OGF). He was involved in the EGEE EU FP5-FP6 grid projects (Enabling Grids for E-science, http://www.eu-egee.org/). He is the responsible for CMCC of the EU-FP7 IS-ENES (InfraStructure for the European Network for Earth System modelling) project. He is the responsible for ENES of the EU-FP7 EESI (European Exascale Software Initiative) project and member of the ENES HPC Task Force. He is a key expert of IESP (International Exascale Software Project, http://www. exascale.org/iesp/) project, whose main goal is the definition of the roadmap for a common, open source software infrastructure for scientific

	computing at exascale. He is the coordinator of the Climate-G project (https://grelc.unile.it:8443/ClimateG-DDC-v2.0/). He is the author of more than 100 papers in referred journals on parallel & grid computing. [1] G. Aloisio, S. Fiore, “Towards exascale distributed data management”, International Journal of High Performance Computing Applications, Vol. 23, No. 4, 398-400 (2009) DOI: 10.1177/1094342009347702. [2] S. Fiore, S. Vadacca, A. Negro, G. Aloisio, “Data Issues at the Euro-Mediterranean Centre for Climate Change”, Journal of Earth Science Informatics, pp. 23-35, 2009, DOI: 10.1007/s12145-009-0023-x, Ed. Springer.
Funding from other sources (current and pending support)	
Budget Justification	

Principal Investigator 5

non G8-Partner - Cooperation Partners	
Family Name	Lawrence
First Name(s)	Bryan
Name of University/research institute	Science and Technology Facilities Council
Position	Head of Centre for Environmental Data Archival
Street name and number	Rutherford Appleton Laboratory
PO Box	
Postal/Zip code	OX11 0QX
Cedex/State/Province	
City	Didcot
Country	UK
Phone	0044 1235 445012
Fax	
eMail	bryan.lawrence@stfc.ac.uk
Web site	http://home.badc.rl.ac.uk/lawrence/
Highest academic qualification	PhD
Principal Investigator details	Bryan Lawrence leads the Centre for Environmental Data Archival, comprising the British Atmospheric Data Centre, the NERC Earth Observation Data Centre and the IPCC Data Distribution Centre. He is a PI on a number of relevant projects: the NERC Data Grid delivering a federated infrastructure for NERC data services, Models and Impact Relevant Prediction delivering derived products from CMIP5, and the EU FP7 METAFOR project delivering the structured metadata for the CMIP5 archive. He is also a founding member of the GO-ESSP collaborative project. Lowe, A. Woolf, B. Lawrence and S. Pascoe (2009): Integrating the Climate Science Modelling Language with geospatial software and services. doi:10.1080/17538940902866161 Int.J. Digital Earth, 2, 29-39. B.N. Lawrence,R. Lowry, P. Miller, H. Snaith, and A. Woolf (2009): Information in environmental data grids. Phil. Trans. R. Soc. A, 367, 1003 -

	1014. doi:10.1098/rsta.2008.0237. S.E. Latham, R. Cramer, M. Grant, P. Kershaw, B.N. Lawrence, R. Lowry, D. Lowe, K O'''''''Neill, P. Miller, S. Pascoe, M. Pritchard, H. Snaith, A. Woolf (2009): The NERC DataGrid Services. Phil. Trans. R. Soc. A (2009) 367, 1015- 1019. doi:10.1098/rsta.2008.0238. Lawrence, B.N., P. Kershaw and J. Blower, 2007: Practical access control with NDG-security. In Proc. UK e-Science All Hands Meeting, 2007 (ed. S. Cox)
Total funding requested for 2011 (in KEUR)	
Total funding requested for 2012 (in KEUR)	
Total funding requested for 2013 (in KEUR)	
Total funding requested for 2014 (in KEUR)	
Funding from other sources (current and pending support)	1.5 months staff time for this co-PI is funded independently.
Budget Justification	Funding for STFC is under lead PIs entry.

Principal Investigator 6

non G8-Partner - Cooperation Partners	
Family Name	Kushner
First Name(s)	Paul
Name of University/research institute	University of Toronto, Department of Physics
Position	Associate Professor
Street name and number	60 St. George St.
PO Box	
Postal/Zip code	M5S 1A7
Cedex/State/Province	Ontario
City	Toronto
Country	Canada
Phone	
Fax	
eMail	
Web site	http://pjk.atmosp.physics.utoronto.ca
Highest academic qualification	PhD
Principal Investigator details	Paul J. Kushner has been an associate professor in the Department of Physics at the University of Toronto since 2004. Prior to that, he was a research scientist in the U.S. National Oceanographic and Atmospheric Administration (NOAA) Geophysical Fluid Dynamics Laboratory (GFDL) in Princeton NJ, and a lecturer in the Dept. of Geosciences at Princeton University. He was one of the co-leaders of the GFDL Global Atmospheric Model Development Team (GAMDT). In that capacity, Prof. Kushner helped apply and implement the Flexible Modeling System (FMS) in GFDL""s model development process; the development and implementation of FMS represented a fundamental advance in Earth System simulation capabilities in parallel computing and was a critical part of the later development of the Earth System Modeling Framework (ESMF). He currently serves as a member of the Scientific Steering Committee for the Community Climate System Model of the National Centre for

	Atmospheric Research (NCAR), and has served as an editor of the Journal of Climate, a premier journal in the area of climate science. Kushner""s research group uses HPC intensive climate prediction models and techniques of theoretical physics to learn about the atmosphere""s circulation and how it will respond to climate change. Fletcher, C. G., S. C. Hardiman, P. J. Kushner, and J. Cohen, 2009: The dynamical response to snow cover perturbations in a large ensemble of atmospheric GCM integrations, J. Climate, 22, 1208-1222. doi:10. 1175/2008JCLI2505.1 Sigmond, M., J. F. Scinocca, and P. J. Kushner, 2008: Impact of the stratosphere on tropospheric climate change, Geophys. Res. Lett., 35, L12706, doi:10.1029/2008GL033573. The GFDL Global Atmospheric Model Development Team (GAMDT , Anderson et al.), 2004: The new GFDL global atmosphere and land model AM2/LM2: Evaluation with prescribed SST simulations. J. Climate, 17, 4641-4672.
Total funding requested for 2011 (in KEUR)	39
Total funding requested for 2012 (in KEUR)	50
Total funding requested for 2013 (in KEUR)	51
Total funding requested for 2014 (in KEUR)	30
Funding from other sources (current and pending support)	Prof. Kushner''s salary is provided by the University of Toronto, and his research group funding comes from the University of Toronto, the Canadian Foundation for Climate and Atmospheric Sciences, Indian and Northern Affairs Canada (INAC), and the Natural Science and Engineering Research Council of Canada (NSERC). Computer equipment and storage purchased from these sources will be used in the project. Prof. Kushner will devote 3 months to the project (18000 Euros). The requested resources will be applied to the project directly. This project represents a new initiative for Prof. Kushner''s research group and the funding requested does not overlap with funding from other sources. Prof. Kushner is not seeking funding for related projects and therefore there are no related proposals pending.

	Task T25 of this project will complement climate research activities related to simulation and observation of cryospheric processes and atmospheric circulation from grants from the Federal International Polar Year Cryosphere Network (INAC/NSERC, ending fall 2011) and from the NSERC Strategic Project Program (ending 2013) that support a postdoctoral fellow and two students. Support from these sources is valued at approximately 150,000 Euros over the proposed funding period for this project.
Budget Justification	Currency in which budget has been calculated: Canadian Dollars (CDN) Conversion rate: 1.3615 CDN/Euro Expenses for facilities and equipment: None ========== Expenses for consumables (12547 Euro/17083 CDN): ========== (a) PCs for research for postdoc and student: 1547 Euro/2106 CDN The funds will purchase a Dell or equivalent desktop workstation for a student (estimated cost 1000 Euros/1362 CDN including maintenance contract) and will contribute 547 Euros/ 745 CDN towards the cost of a laptop computer for the postdoctoral fellow (estimated cost of Apple Powerbook 2042 Euros/2780 CDN including maintenance) . (b) Storage for local project data (22Tb):11000 Euros/14977 CDN Funds will pay 25% of cost of large storage array from Open Storage Solutions, plus maintenance. Travel (12547 Euros/17083 CDN): ========== Specific venues may change. (a) GO-ESSP meeting, Europe, Autumn 2012, for postdoc , student, partial funding of professor: Transport, 3000 Euros/4085 CDN; Hotel and subsistence, 3000/4085CDN; (b) Fall AGU, San Francisco, December 2014 for postdoc, student, partial funding of professor: Transport, 2200 Euros/2995 CDN; Hotel and subsistence, 3000/40785 CDN; (c) Collaborative travel to visit U.S. collaborators (Princeton University): Transport: 600 Euros/817 CDN, Hotel and subsistence: 747 Euros/1017

CDN

Salaries:

=======

Salary for postdoctoral fellow/research associate:

Total months on project: 39

Percentage of full-time: 75%

Pay scale: Postdoctoral stipend, University of Toronto for 24 months, then Research Associate Term Contract, University of Toronto for 15 months

Total amount requested: 90960 Euros/123842 CDN

Amount which is overheads: no overhead

Overheads as percentage of pay: zero

Contribution to project: The postdoctoral fellow will be responsible for carrying out climate diagnostics tasks (further details in Annex 1 of description of work) including testing and applying the CDO operator suite to the ExArch database.

Salary for M.Sc./Ph.D. student and summer undergraduate student:

Total months on project: 39 (M.Sc./Ph.D. student) + 10 (summer undergraduate)

Percentage of full-time: 100%

Pay scale: M.Sc/Ph.D. student stipend, University of Toronto, Department of Physics. The Department of Physics offers a Ph.D. program which starts with a one year M.Sc. level probation phase. NSERC summer undergraduate student support

Total amount requested: 51169 Euros/69667 CDN

Amount which is overheads: no overhead

Overheads as percentage of pay: zero

Contribution to project:

The students will analyze selected aspects of changes related to extratropical eddy statistics and modes of extratropical variability. They will also analyze cryospheric and land-surface changes, including those related to snow processes, lake

mixing dynamics, and terrestrial biosphere variabilty and change. The students will be responsible for statistical analyses using the ExArch database and the CDO diagnostics suite. The students will work with collaborators at Environment Canada, NOAA GFDL, and NCAR.

Principal Investigator 7

non G8-Partner - Cooperation Partners	
Family Name	Waliser
First Name(s)	Duane
Name of University/research institute	University of California, Los Angeles
Position	Adjunct Professor
Street name and number	405 Hilgard Avenue
PO Box	
Postal/Zip code	90095
Cedex/State/Province	California
City	Los Angeles
Country	USA
Phone	001-818-393-4094
Fax	
eMail	waliser@atmos.ucla.edu
Web site	
Highest academic qualification	PhD
Principal Investigator details	Duane Waliser is a scientist at JPL/CalTech. He also holds a joint appointment as an adjunct professor at Department of Atmospheric and Oceanic Sciences, University of California Los Angeles. He specializes in climate dynamics, tropical meteorology and the application of spaceborne remote sensing towards climate sciences with emphasis on prediction-predictability, the MJO, convection/clouds, the link between tropical convection and California's hydroclimate, and the impact of climate change on ecosystems, and water resources. He is currently a co-Chair of the Science Working Group on the WWRP/THORPEX-WCRP Year of Convection activity, a member of the CALIPSO/CloudSat Science Team, and co-chair of the US CLIVAR Madden-Julian Oscillation Working Group (soon to be WCRP/WWRP MJO Task Force). Publications: ==========

Waliser, D. E., J. Kim, Y. Xue, Y. Chao, A. Eldering, R. Fovell, Q. Li, K.-N. Liou, J. McWilliams, F. De Sale, and Y. Yu, 2009: Simulating the Sierra Nevada snowpack: the impact of snow albedo and multi-layer snow physics. California Climate Change Report, CEC-500-2009-030-D, California Energy Commission.

Waliser, D. E., B. J. Tian, M. J. Schwartz, X. Xie, W. T. Liu, and E. J. Fetzer, 2009: How well can satellite data characterize the Water Cycle of the Madden-Julian Oscillation?, Geophys. Res. Lett. In Press.

Jiang, X., D. E. Waliser, W. S. Olson, et al, 2009: Vertical Heating Structures Associated with the MJO as Characterized by TRMM Estimates, ECMWF Reanalyses and Forecasts: A Case Study during 1998-99 Winter, J. Climate - TRMM heating special section, In Press.

Waliser, D. E., J. F. Li, C. Woods, R. Austin, J. Bacmeister, J. Chern, A. Del Genio, J. Jiang, Z. Kuang, H. Meng, P. Minnis, S. Platnick, W.B. Rossow, G. Stephens, S. Sun-Mack, W.K. Tao, A. Tompkins, D. Vane, C. Walker, D. Wu, 2009: Cloud Ice: A Climate Model Challenge With Signs and Expectations of Progress, J. Geophys. Res.- CloudSat Special Section, 114, D00A21, doi:10.1029/2008JD010015.

Sperber, K. R., J.M. Slingo, D.E. Waliser, P.M. Inness, 2008: Coarse-Resolution Models Only Partly Cloudy, Science 320 (5876), 612a, DOI: 10.1126/science.320.5876.612a

Total funding requested for 2011 (in KEUR)	57
Total funding requested for 2012 (in KEUR)	59
Total funding requested for 2013 (in KEUR)	58
Total funding requested for 2014 (in KEUR)	59
Funding from other sources (current and pending support)	
Budget Justification	Currency in which budget has been calculated: US Dollars (USD) Conversion rate: 1USD = 0.78Euro

Facilities:

=========

Computer User Fee (Access, support, and maintenance of high-performing network of computers needed for project): USD2,800

Consumables:

==========

None

Travel:

======

1. San Francisco, CA - AGU Conference - 4 days -- USD1,806
2. GO-ESSP Workshop, Europe, Autumn 2012 -- USD3,348
3. GFDL, Princeton NJ (2 days) -- USD1,178
4. University of Toronto (2 days) -- USD1,078

Total: USD7,410

Salaries:

========

Duane Waliser (1 month), Jinwon Kim (7.6 months), IT support (7.6 months).

Jinwon Kim is a researcher at the Joint Institute for Regional Earth System Science and Engineering (JIFRESSE), University of California Los Angeles. He specializes in regional climate modeling with a special emphasis on the impact of climate change on California's hydroclimate, ecosystems, and water resources. He is currently involved in a JPL-JIFRESSE effort for constructing a model evaluation system to utilize the recent satellite remote sending data towards detailed model evaluation. Recent publications:

Kim, J., R. Fovell, A. Hall, Q. Li, K.-N. Liou, J. McWilliams, Y. Xue, X. Qu, and S. Kapnick, 2009: A projection of the cold season hydroclimate in California in mid-twenty-first century under the SRES-A1B emission scenario. California Climate Change Report, CEC-500-2009-029-D, California Energy Commission.

Waliser, D., J. Kim, Y. Xue, Y. Chao, A. Eldering, R. Fovell, Q. Li, K.-N. Liou, J. McWilliams, F. De Sale, and Y. Yu, 2009: Simulating the Sierra Nevada snowpack: the impact of snow albedo and multi-layer snow physics. California Climate Change Report, CEC-500-2009-030-D, California Energy Commission.

Total salary: USD131,505

Other:
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Benefits are paid at rates of approximately 7%, 40% and 30% for the Waliser, Kim and IT support staff respectively: USD45,048

Technology Infrastructure Fee (TIF) is accessed to each project fund number to support the technology infrastructure services that support the entire campus, including the CLA backbone, Commodity Internet, Internet2, BOL services, Connect2, and underground inter-building wiring/cabling and maintenance. Project specific Information Technology Services are also charged to this project.

Cost $40.75/month/FTE -- USD628

Materials and Supplies (data storage & telecommunication) -- USD824

Publication costs: USD6000

Facilities and Administration (F&A) charge: Cost of On-Campus rate of 54. 0% of the Modified Total Direct Cost (MTDC). A copy of agreement can be found: http://www.research.ucla.edu/ocga/sr2/idcinfo.htm: USD104,889