COLLABORATION AGREEMENT

The signing of this Collaboration Agreement is retroactive to April 11th, 2019.

The Participants:

1. The **MET OFFICE**, for and on behalf of the Secretary of the State for the Department of Business, Energy and Industrial Strategy (**BEIS**) of the United Kingdom of Great Britain and Northern Ireland, whose principal place of business is located at FitzRoy Road, Exeter, EX1 3PB, United Kingdom ("**MET OFFICE**"); and on the other side

2. The **MINISTRY OF SCIENCE, TECHNOLOGY AND INNOVATIONS** of the Federative Republic of Brazil ("**MCTI**"), through:

The National Centre for Monitoring and Early Warning of Natural Disasters located at Estrada Doutor Altino Bondesan 500, São José dos Campos – SP, BR, CEP 12.247-016 ("**CEMADEN**");

The National Institute for Space Research, located at Av. dos Astronautas, 1.758 Jd. Granja, Sao Jose dos Campos, SP, BR CEP: 12630-000 ("**INPE**"); and

The National Institute for Amazon Research located at Av. André Araújo, 2936, Petrópolis, Manaus, AM, BR, CEP: 69067-375; ("**INPA**"),

(hereinafter singularly named as "Participant" and collectively named as "the Participants"),

CONSIDERING the Basic Arrangement of Scientific and Technological Cooperation between the Federative Republic of Brazil and the Government of the United Kingdom of Great Britain and Northern Ireland, signed on 3 December 1997;

CONSIDERING the Memorandum of Understanding between the Ministry of Science, Technology and Innovation of the Federative Republic of Brazil and the Department for Business, Innovation and Skills (BIS) of the Government of the United Kingdom of the Great Britain and Northern Ireland concerning Science and Innovation Cooperation within the Newton Fund, signed on 27 August 2015;

CONSIDERING the participants have common interests in meteorology, climate change and related sciences and wish to co-operate in a manner that allows the exchange of scientific resources, personnel and technical knowledge on the basis of equality, reciprocity and mutual benefit;

CONSIDERING The Participants signed a Collaboration Agreement in October 2016, which was a formal agreement to support collaborative research activities, and which expired on 11th April 2019.

Under the scope of this Collaboration Agreement, hereinafter named as "Agreement", the Participants have agreed the following:

1. PURPOSE OF THE AGREEMENT

The overarching aims of this Agreement are to enhance:

- understanding of recent climate changes and Brazil's role in mitigation activities and carbon budgets to inform international negotiations;
- underpinning capability in Climate modelling in Brazil; and,
- projections of future extremes and impacts, from seasonal to centennial timescales, to inform decision-making and contribute to disaster risk reduction in Brazil.

2. AREAS OF COOPERATION

2.1. Taking into account the outline project proposal of the "Climate Science for Service Partnership Brazil" (CSSP Brazil), here called as ***Research Plan*** and presented at **Annex 1**, the Participants established as a starting point for this cooperation the following areas:

a) Carbon cycle modelling and assessment;

b) Climate and Earth System modelling;

c) Disaster risk reduction capability.

2.2. Further areas can be recommended by the **Executive Committee** established under the terms of this Agreement.

3. DEFINED TERMS

3.1. The words and phrases below shall have the following meanings:

Agreement	means this agreement in its entirety including all licences, the Research Plan, any attachments and any future written amendments, modifications and supplements.
Background IPR	means those Intellectual Property Rights, excluding Resulting IPR, which a Participant contributes and which is necessary to meet the Participants' obligations under the Research Plan;
Commencement Date	means April 11th 2019 notwithstanding the date or dates of execution of this Agreement.
Resulting IPR	means new Intellectual Property Rights, excluding Background IPR, that are created by the Participants in the course of undertaking the activities in the Research Plan;
Intellectual Property Rights	means any intellectual property rights including but not limited to copyrights, moral rights, database rights, patent rights, trade mark rights, domain name rights, trade secret or design rights (whether

	registered or unregistered) or where relevant any application for any such rights in any jurisdiction, but does not include genetic material, resources or property.
Research Plan	means the agreed programme of work as detailed in **the Annex I (CSSP Brazil)** of this Agreement.
Work Package	means the annual planning of work containing the schedule of joint activities planned for each area of cooperation, agreed periodically by the **Executive Commitee and outlined in its resolutions** under the terms of this Agreement.

3.2. The headings to these conditions are for ease of reference only and do not affect the interpretation or construction of these conditions.

4. THE IMPLEMENTATION OF THE AGREEMENT

4.1. The implementation of this Agreement will follow the Research Plan agreed by the Participants (**Annex I**), reviewed and undertaken by the Executive Committee under the terms of this Agreement at all times thereafter.

4.2. The Participants will make efforts to provide the necessary conditions in order to comply with the aims of this Agreement and working arrangements of the Research Plan, including availability, mobility and capacity-building of researchers and managers in both directions, in accordance with the terms of any subvention or grant agreements that eventually could be afforded in the scope of the Research Plan.

4.3. The arrangements to be set out for collaboration between the Participants relates to the Research Plan and to no other joint activity that may be carried out beyond the endorsement of the Executive Committee.

4.4. This Agreement does not relate to the production or use of genetic materials, resources or property.

5. PROJECT MANAGEMENT

5.1. An Executive Committee formed by representatives of Participants, as follow, will carry out the project management:

- Director of Met Office Hadley Centre;
- Director of CEMADEN;
- Director of INPE;
- Director of INPA.

5.2. The Executive Committee meetings may also be attended or represented by scientific leaders from each institute, when designated by the respective Directors.

5.3. Matters of project management and working arrangements for the research activities will be contained in the **Work Package** (annual activity plan) agreed upon by the Executive Committee and outlined in its Resolutions.

5.4. Additional areas of cooperation or subjects of interest of all Participants fitting into the overarching aims of this Agreement can be proposed by the Executive Committee and endorsed through Complementary Adjustments or Additional Terms to this Agreement.

5.5. Formal communications between Participants under the scope of this Agreement should ideally be through the following focal points of the Executive Committee:

- Director of Met Office Hadley Centre;
- Director of CEMADEN.

6. DURATION

6.1. This Agreement shall become effective from the Commencement Date until 31st March 2021 unless terminated by the Participants in accordance with the provisions of **Clause 12**.

6.2. On expiry of the initial term, the Participants may agree in writing to extend the duration of the Agreement, for a further term of up 2 years, or as agreed by the Participants, unless terminated by the Participants in accordance with the provisions of **Clause 12**.

7. RESPONSIBILITIES OF THE PARTICIPANTS AND LIABILITY

7.1. For the purpose of enabling the Participants to work together, it is agreed that each of the Participants:

a) shall devote sufficient resources and expertise to enable the work under the Research Plan to proceed in a competent and timely manner, in line with recognised best practices for such work;

b) ensure that the relationship and all dealings between the Participants are undertaken, promptly, openly and transparently and that disputes and differences are identified and resolved as soon as reasonably practicable;

c) recognise and understand each other's objectives, needs, capabilities, responsibilities and constraints, regarding the activities in the Research Plan and other related activities.

7.2. A Participant visiting or working at an establishment of the other Participant, shall abide by the rules and procedures of that establishment.

7.3. In respect of Background IPR, Resulting IPR, information and/or materials supplied by one Participant to another under this Agreement, the supplying Participant shall be under no obligation or liability and no warranty condition or representation of any kind is made, given or to be implied as to the sufficiency, accuracy or fitness for purpose of such information or materials or, the absence of any infringement of any proprietary rights of third parties by the use of such information and materials and the recipient Participant shall in any case be entirely responsible for the use to which it puts such information and materials. Notwithstanding the foregoing, no Participant shall supply Background IPR to another Participant under this

Agreement in the knowledge that the use of the Background IPR by that Participant will infringe the proprietary rights of any third parties.

7.4. Subject to **Clause 21.3**, the total liability of any Participant under this Agreement shall not exceed the total amount of monies to be received by such Participant in connection with the Project.

8. RELATIONSHIP OF THE PARTICIPANTS

8.1. The relationship of the Participants is exclusively that of independent entities and nothing contained in this Agreement shall be construed as creating any partnership, joint venture, agency or other fiduciary relationship between the Participants.

8.2. Each Participant recognises that it has no authority to make or give any contract, representation, warranty, undertaking or other commitment on behalf of the other Participant, save as expressly authorised in writing by the other Participant.

9. IPR OWNERSHIP

9.1. Each Participant shall promptly disclose in confidence to the other Participants all Resulting IPR during the term of this Agreement and all Participants shall co-operate, where required, in relation to the preparation and prosecution of patent applications and any other Resulting IPR applications, and in relation to any legal proceedings concerning such patents and patent applications and any other Resulting IPR applications. Subject to **Clause 9.4** the Participants agree to pay an equal share of any costs arising.

9.2. Each Participant shall own the Resulting IPR generated by it under the Project and shall be responsible for securing ownership of such Resulting IPR from its employees, students and other agents.

9.3. Nothing contained in this Agreement or any licence agreement pertaining to this Project shall affect the absolute and unfettered rights of each Participant in all inventions, discoveries and Intellectual Property Rights contained in its Background IPR and the provisions of clause 8 shall apply to all such Background IPR.

9.4. Unless agreed otherwise, each Participant shall undertake and continue at its expense the timely prosecution and maintenance of all Resulting IPR which is solely owned by that Participant.

9.5. In the event that any of the Participants are jointly responsible for generating Resulting IPR, such Participants hereby assigns all of their interest in such Resulting IPR ("Joint Resulting IPR") to INPE, as a continuing obligation, with full title guarantee for the full duration of such rights, wherever in the world enforceable.

9.6. Pursuant to **Clause 9.5** INPE grants to those Participants who have contributed to the creation of the Joint Resulting IPR, "(Contributing Participants") as a continuing obligation, a perpetual, irrevocable, non-exclusive, royalty-free and fully paid-up, worldwide right and licence to produce, re-produce, copy, develop, publish and/or adapt any Joint Resulting IPR assigned to INPE as a result of **Clause 9.5**., for any purpose including, without limitation, commercial exploitation for the full duration of such rights, such right and licence to include the right to sub-licence or otherwise transfer the licence to any third party.

9.6.1. In the event that any non-contributing Participant wishes to commercially exploit any Joint Resulting IPR, INPE shall grant to such Participant a non-exclusive licence to use such IPR for that purpose, whose appropriate terms shall be agreed by the Contributing Participants, including a royalty and/or other appropriate form of remuneration which is fair and reasonable taking into consideration the respective financial and technical contributions of the Participants concerned to the development of the Joint Resulting IPR, the expenses incurred in securing intellectual property protection thereof and the costs of its commercial exploitation and any use of Background IPR.

9.7. Notwithstanding the licence granted by INPE to the other Participants by **Clause 9.6**, the other Participants acknowledge that, pursuant to **Clause 9.5**, INPE has all rights on a perpetual worldwide basis to produce, re-produce, copy, publish, develop, adapt, offer for sale, sell and/or distribute or otherwise use the Joint Resulting IPR for any purpose or dealing including, without limitation, commercial exploitation for the full duration of such rights.

9.8. The Participants shall execute and / or shall procure that any other person it shall engage in the Research executes, all documents and assignments and do all such things necessary to ensure that the benefits of the rights granted under **Clauses 9 and 10** may be peacefully enjoyed.

10. USE OF IPR

10.1. In addition to the rights granted under **Clause 9.6**, each Participant grants to the other Participant a non-exclusive, royalty-free licence to:

a) use Resulting IPR solely owned by that Participant for internal research and development purposes and

b) use its Background IPR for the purpose of undertaking the Project and to enable the use of the Resulting IPR pursuant to Clauses 9.5, 9.6 and 10.1(a).

10.2. In the event that any Participant wishes to commercially exploit Resulting IPR owned by another Participant, other than Resulting IPR assigned or licensed under **Clauses 9.5 or 9.6**, the owner of the Resulting IPR shall grant to such Participant a non-exclusive licence to use such Resulting IPR for that purpose, subject to the agreement of appropriate terms in relation thereto, including a royalty and/or other appropriate form of remuneration which is fair and reasonable taking into consideration the respective financial and technical contributions of the Participants concerned to the development of the Resulting IPR, the expenses incurred in securing intellectual property protection thereof and the costs of its commercial exploitation and any use of Background IPR.

10.3. In addition, the rights granted above, each Participant agrees (where it is free and reasonably able to do so) to license on fair and reasonable terms its Resulting IPR and Background IPR that may be required to enable the other Participants to exploit their own Resulting IPR, always subject to the obligations of confidentiality under **Clause 11**.

11. CONFIDENTIALITY

11.1. Each of the Participants undertake to the other that, while this Agreement is in force and at any time thereafter, confidential information shall be kept secret and

confidential an not disclosed to any third party (save as may be necessary for the purposes of this Agreement and for those third parties who may assist in the collaboration and are identified in the Research Plan, or if it is required to be disclosed by any law or regulatory authority). For the avoidance of doubt Confidential Information means:

a) information including business information and information relating to this Agreement; or

b) documents and data stored by any means and disclosed by either Participant, and which:

I - is marked as proprietary or confidential information; or

II - is of an inherently confidential nature (including information relating to the intellectual property rights of the disclosing Participant and information which has commercial value) and which the receiving Participant knows or ought to know is confidential; or

III - is agreed in writing subsequently by the Participants to be confidential; and

IV - includes any copies of such information, documents and data, in any form.

11.2. The undertaking in **Clause 11.1** above shall not apply to Confidential Information:

a) which, at the time of disclosure, has already been published or is otherwise in the public domain other than through breach of the terms of this Agreement;

b) which, after disclosure to the Participants, is subsequently published or comes into the public domain by means other than an action or omission on the part of any of the Participants;

c) which a Participant can demonstrate was known to them or subsequently independently developed by them prior to the date of disclosure and was not acquired as a result of activities undertaken under this Agreement;

d) lawfully acquired from third parties who had a right to disclose it with no obligations of confidentiality to any of the Participants.

11.3. Staff and students and any agents, consultants or sub-contractors engaged to work on the Research Plan under this Agreement will be subject to the principles of confidentiality outlined in this **Clause 11**.

12. TERMINATION

12.1. Either Participant may terminate this Agreement by written notice if the other Participant:

a) breaches any material provision of this Agreement and fails to remedy such breach within thirty (30) days of written notice describing the breach; or

b) becomes insolvent or seeks protection under any bankruptcy, receivership, trust, deed, creditor's arrangement, or comparable proceeding, or if any such proceeding is instituted against the other and not dismissed within sixty (60) days; or

c) infringes the Intellectual Property Rights of the other Participant; or

d) ceases to do business, or otherwise terminates its business, other than by reason of a sale of all or substantially all of the assets of such Participant or the merger or consolidation of such Participant.

12.2. The agreement may be terminated in accordance with **Clause 16** of this Agreement ('Funding and Costs').

12.3. The Participants may agree in writing to terminate this Agreement by mutual consent.

12.4. Termination of this Agreement by either Participant shall not affect the rights and obligations of the Participants accrued prior to the effective date of termination of this Agreement.

13. CONSEQUENCES OF TERMINATION

In the event that termination arises pursuant to **Clause 12.1** then

a) the licence to use the non-defaulting Participant's Background IPR and Resulting IPR granted to defaulting Participant under **Clause 10.1** shall cease and any Background IPR and Resulting IPR belonging to the non-defaulting Participant shall be destroyed or returned to that Participant;

b) the licence to use the defaulting Participant's Background IPR and Resulting IPR granted to the non-defaulting Participant under **Clause 10.1** in respect of the defaulting Participant's Background IPR and Resulting IPR, provided up to the date of termination, shall continue for non-commercial research purposes only;

c) in the event that termination arises pursuant to **Clause 12.2** then the licence granted between the Participants under **Clause 10.1** to use each others Background IPR and the Resulting IPR provided up to the date of termination shall continue for non-commercial research purposes only; and

d) the provisions of **Clauses 9, 10, 14, 19** shall survive termination of this Agreement.

14. PUBLICATION

14.1. Subject to the provisions of **Clauses 9, 10 and 11** a Participant shall not disclose or publish information or Resulting IPR for the duration of the Agreement without the consent of the other Participant. Such consent shall not be unreasonably withheld or delayed.

14.2. Where in the opinion of a Participant a proposed publication contains material which may be patentable or commercially sensitive subject matter then the Participant proposing to publish may be requested to refrain from doing so for a maximum of 2 months to allow for any application for patent protection to take place or amend the proposed publication to remove such material.

14.3. Nothing contained in this Agreement shall prevent the submission of a thesis to examiners in accordance, where appropriate, with the no less terms than specified in **Clause**

11 of this Agreement. The student concerned shall request that access to such thesis be restricted for a minimum of two (2) years.

15. NOTICES

15.1. Any notice in connection with this Agreement shall be in writing and may be delivered by hand, pre-paid first class post, special delivery post, airmail or facsimile, or e-mail addressed to the recipient at its registered office or its address or facsimile number as the case may be (or such other address, or facsimile number as may be notified in writing from time to time).

15.2. The notice is deemed to have been duly served:

a) if delivered by hand, when left at the proper address for service;

b) if given or made by prepaid first class post or special delivery or airmail post, 48 hours after being posted or in the case of airmail 14 days after being posted (excluding days other than business days);

c) if given or made by facsimile or e-mail, at the time of transmission, provided that a confirming copy is sent by first class pre- paid post to the other Participant within 24 hours after transmission; provided that, where in the case of delivery by hand or transmission by facsimile, such delivery or transmission occurs either after 4.00 p.m. on a business day, or on a day other than a business day, service shall be deemed to occur at 9.00 a.m. on the next following business day (such times being local time at the address of the recipient).

16. FUNDING AND COSTS

16.1. The Met Office's performance of its obligations under this Agreement is subject to the Met Office's receipt of a Newton Fund Grant Award from the Department of Business, Energy and Industrial Strategy (the "Grant Award") and the terms and conditions of the Grant Award. The Met Office may terminate this Agreement without liability on notice to the other Parties in the event the Grant Award:

a) is not received by the Met Office,or

b) that the terms and conditions of the Grant Award, including but not limited to the monetary amount of the grantaward, are inconsistent with the terms of this Agreement, including but not limited to the programme of work as detailed in the Additional Remarks presented in the **item 4 of Annex I** of thisAgreement.

16.2. The Brazilian Institutes' performance (CEMADEN, INPE and INPA) is not committed to specific allocation of any financial resources by the Brazilian side. The Participants acknowledge that their respective contributions related to the activities under the terms of this Agreement will be subject to the availability of appropriate resources, bearing in mind the Brazilian contribution will be in kind, such as those related to matched efforts described at **Clause 16.5**.

16.3. Each Participant shall bear its own respective costs incurred by it as a result of its obligations and efforts under this Agreement save where otherwise agreed between the Participants.

16.4. The Participants acknowledge that a UK government condition when securing funding from the UK Newton Fund grant award is that match funding or matched effort is obtained by the partner country (Brazil). The Participants undertake to use their best endeavours to fulfil this requirement. The Met Office may terminate this Agreement in the event that any match or matched effort required as a condition of the Grant Award is not provided by the partner country.

16.5. Subject always to **Clause 16.1**, it is anticipated by the Participants that matched effort may constitute, but not be limited to, staff resource/effort committed to the project, high performance computer (HPC) resource and access granted to data sets not freely available, or a combination of such resources.

16.6. Information on Matching will be collated annually. The method for doing this will be discussed and agreed between UK and Brazilian partners.

17. FORCE MAJEURE

17.1. No Participant shall be liable for any failure to perform or any delay in performing its obligations under this Agreement, if the failure or delay is due directly or indirectly to any cause beyond the reasonable control of that Participant, which shall include but not be limited to the following:

a) any act of God, fire, flood, explosion, accident, war, governmental actions, which for the avoidance of doubt, includes a Government intervention in the event of a crisis, strikes, civil disturbance or emergency; or

b) any major plant or equipment failure which results in closure of a facility.

17.2. In the event of failure or delay arising from such circumstances, the affected Participant shall provide full details to the other Participant and shall take all reasonable steps to mitigate the effect of the delay. Performance of the Agreement shall be suspended for such time as the delay continues.

18. AMENDMENTS TO AGREEMENT

This Agreement may be amended at any time by the written agreement of the Participants and no variation to this Agreement shall be effective unless made in writing and signed by a person with the appropriate authority from both Participants.

19. DISPUTE PROCEDURE

19.1. Every endeavour shall be made to resolve disputes in the first instance by the project board.

19.2. In the event that the dispute cannot be resolved under **Clause 19.1** the matter shall be referred to a senior management level and thereafter to the Chief Executives of both Participants for final resolution.

19.3. Any dispute, controversy or claim arising out of or relating to the agreement, or the breach, termination or invalidity thereof, that cannot be resolved by negotiation shall be submitted to conciliation in accordance with the UNCITRAL conciliation rules. The place of

conciliation shall be Geneva. The language to be used in the conciliation shall be English. If, and to the extent that any such dispute, controversy or claim has not been settled pursuant to the conciliation within sixty (60) days of the commencement of the conciliation it shall, upon the filing of a request for arbitration by either party, be referred to and finally determined by arbitration in accordance with the UNCITRAL arbitration rules as at present in force. There shall be a sole arbitrator. The place of arbitration shall be Geneva. The language to be used in the arbitral proceedings shall be English.

20. COUNTERPARTS

This Agreement may be executed in two counterparts, both of which, taken together, shall constitute one and the same agreement, and a Participant may enter into this Agreement by executing a counterpart.

21. DISCLAIMER

21.1. Each Participant undertakes to use reasonable endeavours to ensure that its work on the Project is carried out in accordance with accepted scientific principles and standards but makes no representation or warranty that any Resulting IPR will be fit for any particular purpose, and accepts no responsibility for any use which may be made of any Resulting IPR, materials, information, apparatus, method or process arising from its work or otherwise supplied to or to which a Participant gains access.

21.2. It is therefore agreed that any Participant utilising such Resulting IPR, materials, information, apparatus, method or process is fully responsible and liable for any subsequent loss, costs, claims and demands arising from that use, unless such loss, costs, claims and demands arise out of the default or negligence on the part of the supplying Participant.

21.3. For the avoidance of doubt, nothing in **Clause 7** limits or excludes the liability of any Participant for death or personal injury caused by its negligence, or for fraud of any kind whatsoever.

22. NON ASSIGNMENT

This Agreement or any of the rights or obligations hereunder may not be assigned or otherwise transferred or sub-contracted by any Participant without the express prior written consent of the other Participants.

23. ANTI BRIBERY & ANTI CORRUPTION

The Participants shall comply with all applicable laws, statutes, regulations and codes relating to anti-bribery and anti-corruption, applicable in their respective territories.

24. MISCELLANEOUS

24.1. No Participant or Participants shall hold another liable for any damages, dispute or injury arising during the undertaking of the Project unless caused by the negligence or fraud of an employee, student or agent of that Participant or Participants. Neither shall any

Participant be liable to another for indirect or consequential loss or damage arising from their use of the results of the Project.

24.2. If any part or any provision of this Agreement shall to any extent prove invalid or unenforceable in law, the remainder of such provision and all other provisions of this Agreement shall remain valid and enforceable to the fullest extent permissible by law, and such provision shall be deemed to be omitted from this Agreement to the extent of such invalidity or unenforceability. The remainder of this Agreement shall continue in full force and effect and the Parties shall negotiate in good faith to replace the invalid or unenforceable provision with a valid, legal and enforceable provision which has an effect as close as possible to the provision or terms being replaced.

24.3. No failure to exercise or delay in the exercise of any right or remedy which any Participant may have under this Agreement or in connection with this Agreement shall operate as a waiver thereof, and nor shall any single or partial exercise of any such right or remedy prevent any further or other exercise thereof or of any other such right or remedy.

24.4. Each Participant represents and warrants to the others that it has full power and authority to enter into this Agreement and to carry out the actions contemplated under this Agreement.

24.5. Except as otherwise expressly provided for herein, the Participants confirm that nothing in this Agreement shall confer or purport to confer on any third party any benefit or any right to enforce any term of this Agreement.

24.6. Neither Participant shall use the other's name, crest, logo or registered image for any purpose without the express permission of the other Participant.

24.7. This Agreement is drafted in the English language and in Portuguese. The English language version of this Agreement shall prevail if there is a conflict between the two versions.

Signed by

Kyle Lischak

KYLE LISCHAK
Head of Legal
For and on behalf of
MET OFFICE, for and on behalf of Secretary of State for the Department of Business, Energy and Industrial Strategy of the United Kingdom and Northern Ireland
(Authorised signatory)
Date

MARCOS CESAR PONTES
Minister
For and on behalf of
Ministry of State of Science, Technology and Innovations
(Authorised signatory)
Date

OSVALDO LUIZ LEAL DE MORAES
Director
For and on behalf of
The National Centre for Monitoring and Early Warning of Natural Disasters - CEMADEN
(Authorised signatory)
Date

CLEZIO MARCOS DE NARDIN
Director
For and on behalf of
The National Institute of Space Research - INPE
(Authorised signatory)
Date

HILLÂNDIA BRANDÃO DA CUNHA
Deputy Director
For and on behalf of
The National Institute for Amazon Research - INPA
(Authorised signatory)
Date

ANNEX 1: RESEARCH PLAN

CLIMATE SCIENCE FOR SERVICE PARTNERSHIP BRAZIL (CSSP BRAZIL)

The Newton Fund's aim is to develop science and innovation partnerships that promote economic development and welfare in partnering countries.

CSSP Brazil – Project Objective

The Met Office is a Delivery Partner for the Newton Fund and we wish to work collaboratively with institutions in Brazil and the UK to engage in scientific climate-based research to support the development of shared capability in climate services and inform decision-makers in climate mitigation and adaptation strategy.

The Met Office has long-standing collaborations with INPE (National Institute for Space Research) and INPA (National Institute for Amazon Research)

The overarching aims of this project are to enhance:

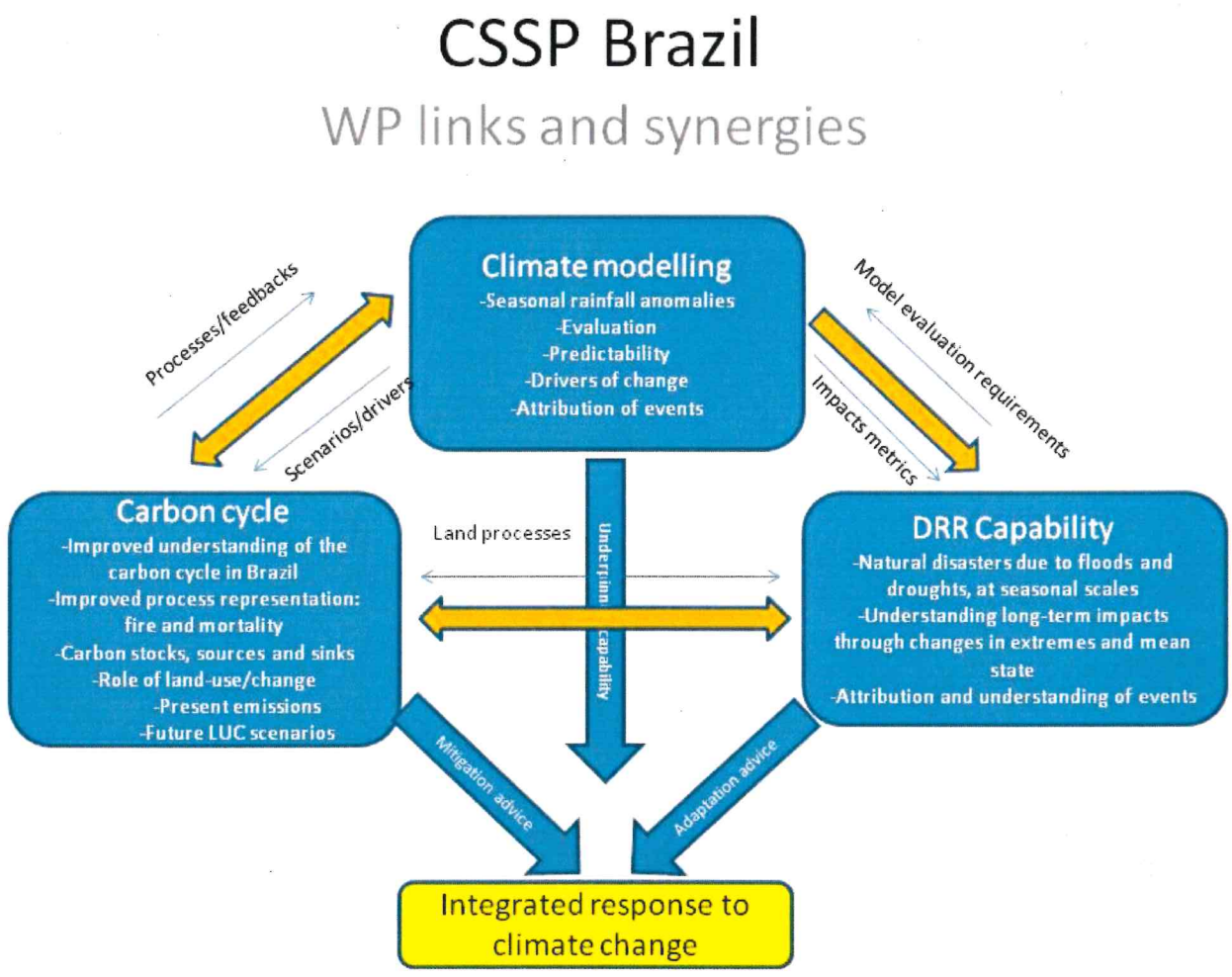
- Understanding of recent climate changes and Brazil's role in mitigation activities and carbon budgets to inform international negotiations;

- Underpinning capability in Climate modelling in Brazil;
- Projections of future extremes and impacts, from seasonal to centennial timescales, to inform decision making and contribute to disaster risk reduction in Brazil.

CSSP Brazil – Proposed Research Topics

At this stage there are three high level proposals for research topics. They align broadly with the objectives above but have significant synergies and interactions. They are:

- Carbon cycle modelling and assessment
- Climate and Earth System modelling
- Disaster risk reduction capability



Schematic of how the 3 Work Packages align and contribute to a common goal.

1. Science Research Topic 1: Improved carbon cycle modelling to inform mitigation policy

Objective:

Improved understanding through observations, field studies and numerical modelling of the carbon balance of Brazil with a focus on the Amazonian forest but interest also

in other ecosystems. Compare carbon cycle models with local field studies and manipulation experiments to develop and improve the models and constrain projections.

Potential activities:

- Development and improvement of land-surface model processes in tropical forest and other Brazilian ecosystems such as fire, mortality, forestry, secondary regrowth or biofuels.
- Evaluation of model performance and sensitivity against measurement campaigns and manipulation experiments such as:
    - Tree size and functioning (RAINFOR and other existing data sets), carbon dioxide, evaporation, stream-flow and soil moisture;
    - The new Free-Air CO2 Enrichment (FACE) study of forest responses to elevated CO2. This represents a critical gap in our knowledge and has not yet been carried out in a tropical forest;
    - Eddy covariance data, (e.g. studies currently being developed in the Amazon and Caatinga – a semi-arid region);
    - Biomass mapping and ground-truthing of satellite remote sensing.
- Assessment of model simulations of present day carbon stocks and sinks, land use emissions, and future scenarios of climate and land-use change.

The project will mainly focus on use and development of two land surface models: JULES and InLand run under common protocols, but will also draw on, and contribute to, the annual carbon budget of the Global Carbon Project, and TRENDY model analysis of the global terrestrial carbon cycle.

Benefits:

This will provide robust science background for mitigation policy ~~both~~ through improved quantification of the global carbon cycle, including natural carbon sinks which are important for 'overshoot and recovery' scenarios. Specifically, quantitative assessment of tropical forest carbon stocks and sinks will contribute to:

- the Brazilian Government Working Group on REDD+, contributing to the lineation of the scientific basis for the deforestation carbon emissions reference level.
- Preparation of the Third National Communication on GHG emissions to the UNFCCC, on the LULUCF sector.

2. Science Topic 2: Climate model development

Objective:

Collaborative work to share expertise in coupled climate model development to improve capability and enhance the quality of data underpinning climate services (see Science Research Topic 3 below). Specific interest in simulation of precipitation over Brazil / South America at seasonal timescales.

Work can cut across a range of modelling approaches from high-resolution relatively short-term (seasonal-decadal) predictions to increased- complexity (incl. biogeochemistry) decadal-centennial projections. Both Met Office and CPTEC/INPE have forecasting capabilities on shorter timescales (NWP and up to 1 month) but they are not in scope for this CSSP project. The unifying theme of this WP is therefore on rainfall at seasonal scales either within a seasonal forecast context or in the context of how long-0term climate change may affect seasonal scale precipitation.

Similarly, code optimisation and scalability for improved HPC exploitation are important activities but out of scope in this project.

Background:

Since 1995 CPTEC/INPE began operational forecasting in the form of ensemble seasonal prediction for the next season. North-East Brazil is one of the regions of the globe with a high level of predictability in seasonal forecasts - the Met Office publishes seasonal forecasts for this region. There is INPE expertise in tropical atmospheric dynamics and Earth System Modelling (especially land surface, vegetation, fire and biomass burning aerosols). Biogeochemical forcings and feedbacks play a leading order role in tropical climate change, but important processes such as vegetation dynamics, tropical wetland processes, wildfires and aerosols are not well represented in models. As model complexity increases it is vital that reliable and process-based evaluation is developed to ensure models and their projections are as robust as possible

The strategic objective of the CPTEC / INPE is to be a world reference, at least in South America, in research and modelling of an integrated system. This would allow better planning of activities related to potable water availability, electric power, the rational use of water resources and food safety in Brazil with direct benefits to WP3.

Potential activities:

In this topic we propose sharing experience and expertise in model development activities, including development of processes relevant to S. America and process-based evaluation metrics which are vital for ensuring realistic behaviour of the coupled Earth System model. Understanding of, simulation of, and evaluation of precipitation over South America at seasonal timescales is a particular focus.

- Seasonal forecasting. Understanding the predictability of S. America on seasonal-decadal timescales including links to large scale dynamics and modes (ENSO, Atlantic SSTs) and drivers of change such as GHGs, aerosols and land-use. Met Office can make existing seasonal forecast data available for analysis over this region. INPE may perform new seasonal forecasts at a resolution TBD. This will allow a joint analysis of initialised predictability of seasonal rainfall over Brazil;

- Investigation of the role of forcings on seasonal-scale precipitation, and changes in seasonal precipitation. Development of event- attribution techniques to look at the role of forcings (such as aerosol or land-use) and feedbacks (such as fire emissions, ET or precip-recycling) on seasonal scale precipitation;

- Model evaluation including coupled processes. Global model evaluation, but with focus on S. American performance, particularly on precipitation. Improved metrics of performance will be developed beyond simple time-mean measures. Development of routine process- based evaluation metrics that affect precipitation, including: microphysics, clouds, aerosols (from emissions to cloud interactions), large- scale circulation, hydrology and evaporation (tie in to observation campaigns such as SAMBBA and inversion modelling).

These three separate strands of research could be brought together to explore and analyse a specific event such as the 2014 Sao Paulo drought.

Benefits:

This research topic would contribute to capacity building in climate modelling, especially simulation of precipitation which is seen as a crucial output. It would also build confidence in the model projections for this region to inform both mitigation and adaptation policies across timescales.

3. Science Topic 3: Climate Impacts and Disaster Risk Reduction

Objective:

Collaborative work with UK and Brazilian institutions to carry out climate impacts research to help underpin the development of climate services directed to risk reduction of natural disasters.

Improve the translation of climate information ~~on climate~~ (including variability and changes in extremes) into impacts and also improve the subsequent communication of this information.

Motivation:

The goal of this Newton Fund project is to build climate science capability to help deliver climate services for disaster risk reduction.

The Brazilian National Centre for Monitoring and Early Warning of Natural Disasters (CEMADEN) works with pre- and during disaster aspects, including monitoring weather and climate conditions and geomorphologic aspects that could potentially trigger natural disasters. Many of the disasters in Brazil are water related: landslides, floods, flash floods and drought. The focus of CSSP Brazil would be developing understanding and capability in order to support disaster risk reduction.

This WP links strongly to outputs in capability and modelling in WP2 Climate Modelling, and has useful synergies with WP1 in the development of land surface modelling. It will draw on seasonal forecasting of extremes and also longer-scale projections of climate change and changes in variability. These can be used for impacts studies and vulnerability assessments for adaptation options. Improved understanding of the role of land surface processes in droughts and floods will have mutual benefits with carbon cycle modelling.

Potential activities:

In this topic we will improve understanding of natural disasters associated with climate variability and change and develop tools to apply disaster risk reduction. Common areas of interest include hydrological and agricultural impacts, and ecosystem services.

- Development and improvement of impacts metrics to be applied across timescales from seasons to centuries. Specific interest areas include water availability, energy supply, flooding – both flash floods/landslides – drought and disturbances such as fire and blow-downs;
- Enhancing capability of early warning systems for climate-related natural disasters
    - Development of dissemination and communication pathways, including data access and visualization;
- Attribution of climate events such as the current drought and water crisis in the Metropolitan Region of São Paulo
    - Attribution to global change or regional drivers such as land-use change.

Benefits:

This would develop scientific capability to underpin early warning and alerts to the Civil Defence and the population in the short term, and in the longer term benefit policymaking on managing climate extremes and risk of natural disasters, international development and contingency planning for disaster relief and humanitarian aid.

4. Additional Remarks

4.1. CSSP Brazil - Scale and Spread of Potential Funding

The Met Office has applied to the Newton Fund for the UK element of funding for this collaborative project with Brazil over three financial years (FY) beginning April 2016.

UK Newton Fund grant awards are confirmed on an annual basis by the UK government department Business, Energy and Industrial Strategy (BEIS).

The spread of UK funding for CSSP Brazil research is indicated as follows:

FY16/17 (April 2016 - March 2017)	£665,000
FY 17/18 (April 2017 - March 2018)	£1,200,000
FY 18/19 (April 2018 - March 2019)	£2,100,000
FY 19/20 (April 2019 - March 2020)	£2,750,000
FY 20/21 (April 2020 - March 2021)	£3,200,000

4.2. Brazil – project contribution requirements

A condition of the UK Newton Fund grant award is that there are contributions from the partner country of an equivalent level ('matching efforts').

Contributions from the three partner organisations (CEMADEN, INPE and INPA) could, for example, comprise a combination of staff resource/effort committed to the project, high performance computer (HPC) resource and access granted to data sets not freely available.

In order to secure BEIS' support for the UK's contribution to the project, matching from Brazilian partners is needed. Information on matching will be collated annually – the method for doing this will be discussed and agreed between UK and Brazilian partners.