Research Subcontract

Machine Learning for Advanced Storm
Surge Prediction Project

1 January 2021

MetService
TE RATONGA TIRORANGI

Parties and Work Programme Details

1.1   Subcontractor

Name:	**Fundación Leonardo Torres Quevedo (of the University of Cantabria) (Subcontractor)**
Address:	E.T.S. de Ingenieros de Caminos, C. Y P. – Avda. de los Castros, 44 – 3º, 39004 Santander
Primary Contact:	Jorge Castro González Managing Director E; fltqadmon@unican.es / T +34 942 201 705
Secondary Contact:	Fernando Mendez Incera Associate Professor & Head of GeoOcean Group E; mendezf@unican.es / T +34 20 18 003

1.2   Contractor

Name:	**Meteorological Service of New Zealand Limited (MetService)**
Address:	30 Salamanca Road, Kelburn, Wellington 6012, New Zealand
Primary Contact:	Anna Phillips Office and Finance Manager – MetOcean Solutions E; a.phillips@metocean.co.nz / T +64 27 4447797
Secondary Contact:	Sebastien Delaux Project Lead E; s.delaux@metocean.co.nz

The parties to this Agreement are MetService and the Subcontractor.

This agreement (**Agreement**) comprises:

- This clause 1
- Clause 2 (Terms and Conditions); and
- The attached Schedules.

1.3 Signatories

Each party agrees to be bound according to the terms and conditions of this Agreement.

Signed by Meteorological Service of New Zealand Limited

Signed by The University of Cantabria - FLTQ

Signature	Signature
	Jorge Castro
Name of authorised signatory	Name of authorised signatory
	Managing Director
Position	Position
	25/02/2021
Date	Date

1.4 Work Programme

Name:	**Ministry of Business, Innovation and Employment (MBIE)**
Address:	15 Stout Street, Wellington 6011, New Zealand
Primary Contact:	Ashok Parbhu Investment Manager Ashok.Parbhu@mbie.govt.nz
Work Programme	Work Programme Agreement MSVC1901 under Science Investment Contract: METSERV, as amended.

2 Terms and Conditions

2.1 Background

A.   MetService has been contracted by the Ministry of Business Innovation and Employment (**MBIE**) to provide certain research services and deliverables to MBIE.

B.   The Subcontractor agrees to provide the services and deliverables outlined in Schedule One (the **Services**) in accordance with the terms and conditions in this Agreement to support MetService's Science Investment Contract and Work Program Agreement with MBIE (the **MBIE Contract**) and the work programme described in clause 1.4 (**Work Programme**).

2.2 Agreement

2.2.1 APPOINTMENT AND TERM

2.2.1.1 Appointment

MetService appoints the Subcontractor to provide the Services on the terms and conditions set out in this Agreement, and the Subcontractor accepts that appointment and the terms and conditions set out in this Agreement.

2.2.1.2 Term

The Agreement will commence on the start date and end at the time specified in Schedule One, subject to earlier termination of this Agreement in accordance with its terms ("Term").

In this Agreement "Business Day" means any day other than Saturday, Sunday or a public holiday in Wellington.

2.2.2 SERVICES

2.2.2.1 MBIE-led Variation and Change Events

    i.   The Services to be provided by the Subcontractor are subject to ongoing funding from MBIE. If at any time MBIE changes the funding, research priorities and/or objectives of the Work Programme then MetService is entitled, acting reasonably, to vary the Services (and associated remuneration) to be provided by the Subcontractor by giving written notice to the Subcontractor. Any variation under this clause may only be made after consulting in good faith with the Subcontractor, provided that the form and extent of any variation shall be at MetService's sole discretion.

    ii.   The following matters constitute a Change Event:

        a.   an impact statement, research aim, critical step, key deliverable or any other significant aspect of the Agreement, MBIE Contract or Work Program cannot be, or is unlikely to be, delivered by the dates specified in, or in the manner contemplated by this Agreement;

        b.   MBIE or MetService is not satisfied with the progress the Subcontractor has made in relation to the delivery of an impact statement, research aim, critical step, key deliverable or any other significant aspect of this Agreement;

        c.   there is a change in the involvement of Key Personnel;

> d. there is a significant decrease in the Subcontractor's employees, contractors or other resources which may impact on the Subcontractor's ability to provide the Deliverables set out in Schedule One by the stated dates; or
>
> e. the Subcontractor materially fails to deliver the Services in accordance with this Agreement.

iii. If a Change Event occurs:

> a. A party must give the other party notice as soon as reasonably practicable after it becomes aware that a Change Event has occurred or is likely to occur and, neither party may raise a dispute under clause 2.2.10 if a Change Event is notified; and
>
> b. MetService may suspend payment of all or part of the Fees to the Subcontractor.

iv. The parties may, at any time after receipt of the notice of a Change Event:

> a. agree that the circumstances giving rise to the Change Event no longer exist;
>
> b. agree to vary the Work Program; or
>
> c. agree that no further action Is required in respect of the Change Event.

v. The Subcontractor must try to remedy the Change Event by no later than 3 months (or any other period agreed in writing by the Parties) after the date the notice of the Change Event was given.

vi. If the Change Event has not been remedied to MetService's satisfaction MetService may terminate this Agreement with immediate effect by giving written notice to the Subcontractor.

vii. The Subcontractor will provide any information, access and assistance, at the request of MetService, that is needed to assist with any review requested by MBIE, or conducted by the Board established by the Minister for Science and Innovation under the Research, Science and Technology Act 2010 to make decisions with respect to proposal and funding (**Science Board**), that considers the impact of the Change Event on the provision of the Services or delivery of the Deliverables.

viii. Where a variation to this Agreement is proposed by MetService due to a Change Event, MetService and the Subcontractor will take action to give effect to that variation, including any variation to this Agreement.

ix. The parties agree nothing in this clause 2.2.2.1 prevents MBIE from terminating the Agreement under clause 2.2.9.

2.2.2.2 Supply

i. The Subcontractor shall provide the Services and Deliverables in accordance with the timeframes set out in the Schedule. If at any time during the term of this Agreement the Subcontractor anticipates or becomes aware of any events or circumstances that have hindered or delayed, or may hinder or delay, the performance of the Subcontractor's obligations under a Schedule or this Agreement ("Delivery Issue"), the Subcontractor must notify MetService immediately (and for the avoidance of doubt, failure to notify MetService is a material breach of this Agreement). The notice must set out, in as much detail as is reasonably practicable, the nature and origins of the Delivery Issue and its likely impact on the Services, and an outline of the steps available to each party to overcome or mitigate its effects.

ii. If the Delivery Issue arises from MetService's negligence or breach of its obligations under the Agreement, or an event of Force Majeure, provided the Subcontractor gives notice in accordance with clause 2.2.2.2i, the Subcontractor is entitled to relief in the form of an extension to the timeframes in the Schedule, or a reduction in scope of the Deliverables, or a combination of the both, (in each case, "Relief") as reasonably necessary to allow for the additional time and effort likely to be required to complete the Services and Deliverables.

    iii.   The choice and degree of Relief is to be determined by MetService, acting reasonably, objectively and in consultation with the Subcontractor. Relief under this Clause 2.2.2.2 is the Supplier's sole remedy for the effects of MetService's negligence or breach of its obligations under the Agreement, in terms of the cost, resource, time and effort required in order for the Subcontractor to provide the Services and Deliverables in accordance with the Agreement.

2.2.2.3   Performance of the Services

In providing the Services, the Subcontractor shall:

    i.   provide all tools, equipment, personnel, processes and resources required to provide the Services;

    ii.   use appropriately qualified, skilled and experienced personnel, as defined in Schedule One;

    iii.   advise MetService in writing of any proposed changes to Key Personnel; MetService reserves the right to decline such proposed changes;

    iv.   provide all assistance reasonably required to assist MetService in complying with the MBIE Contract, comply with the reasonable directions of MetService from time to time and co-operate with the MBIE and MetService's other service providers to the extent reasonably practicable;

    v.   minimise any disruption to MetService's business and the activities of its employees and other service providers;

    vi.   comply with all applicable laws and maintain all licences, approvals and permits required to provide the Services;

    vii.   ensure that all statements, opinions and reports given by it or any of its personnel are given in good faith (upon reasonable grounds), and in the reasonable belief that such contents, opinions and reports are accurate, correct and not misleading;

    viii.   ensure that it promotes and advances the interests and reputation of MetService, MBIE or any of MetService's clients and shall not do anything (or omit to do anything) that may harm or damage the reputation or goodwill of MetService, MBIE or any of MetService's clients;

    ix.   keep MetService promptly advised at all times of all material matters concerning the provision of the Services, including any breach or likely breach of the Subcontractor's obligations under this Agreement; and

    x.   without limiting sub-clauses i. to ix., ensure the Services are provided in a timely, honest, courteous and professional manner and with all due care, skill, diligence and efficiency which would ordinarily be expected from a skilled and experienced professional, performing the same type of services, under the same or similar circumstances.

2.2.2.4   Subcontracting

The Subcontractor shall not use the services of any third party in providing the Services and performing its obligations under this Agreement, without the prior written consent of MetService. If required, the Subcontractor shall provide sufficient details of any proposed third party to MetService that explains the third party's suitability to deliver Services. The Subcontractor must ensure the third party complies with the terms and conditions of this Agreement. The Subcontractor remains liable for its obligations under this Agreement despite any subcontracting, assignment or transfer.

2.2.2.5   Subcontractor equipment

MetService shall not be liable for any loss or damage to the Subcontractor's equipment or other property during or in connection with the performance of this Agreement. The Subcontractor will during the term of this Agreement arrange and maintain adequate insurance to cover loss or damage to the Subcontractor's property.

2.2.2.6   Reports

The Subcontractor will prepare and maintain accurate and systematic records in relation to the Services and promptly provide MetService with such information related to the Services at any time upon request by MetService, including allowing MetService to copy those records. All reports must be in such detail and formatted in such a manner as specified in Schedule One and, without limiting the more general obligations in this clause, must (i) meet the required MBIE reporting requirements; and (ii) provide progress updates upon request.

2.2.2.7   Warranty

The Subcontractor warrants that the Services will conform to any requirement set out in Schedule One.

2.2.3   REMUNERATION

2.2.3.1   Fees

i.   In consideration for the provision of the Services in accordance with this Agreement, MetService shall pay to the Subcontractor the amounts specified in Schedule One (**Fees**).

ii.   Unless specified otherwise in Schedule One, the Fees shall constitute the full amount payable to the Subcontractor for the Services and MetService shall not be required to reimburse the Subcontractor for any costs or expenses incurred by the Subcontractor in performing the Services or otherwise complying with its obligations under this Agreement.

iii.   The Subcontractor must not fraudulently misuse or misappropriate the Fees.

2.2.4   PAYMENT

2.2.4.1   Invoices

i.   Subcontractor shall provide MetService with invoices for the Fees payable by MetService under this Agreement in the manner specified in Schedule One.

ii.   Each invoice issued by the Subcontractor shall:

   a.   contain the associated MetService purchase order number and project reference/name;

   b.   contain sufficient information to enable MetService to establish the accuracy of the invoice, including a breakdown of the Fees and shall be accompanied by documentation sufficient to evidence the Services to which the Fees relate; and

   c.   be in the form of a tax invoice for goods and services tax ("GST") purposes.

iii.   If MetService disputes the accuracy of any invoice, MetService shall give notice of that fact to the Subcontractor. MetService shall pay the undisputed portion of the invoice and may withhold payment of the portion disputed until the dispute has been resolved by the parties.

2.2.4.2   Timing

The Subcontractor will render its invoices in accordance with the timetable set out in Schedule One. Subject to clause 2.2.4.1(iii) payment of each invoice will be made by MetService no later than the 20th of the month (or nearest Friday to the 20th) following the date of receipt of each tax invoice.

2.2.4.3   Interest

No interest is payable by MetService in respect of payments to be made by MetService under this Agreement.

2.2.4.4   New Zealand Dollars

All amounts payable, and amounts referred to in this Agreement are in New Zealand dollars.

2.2.4.5   GST

All Fees and any other payments, royalties or charges payable under this Agreement exclude GST, but are inclusive of all other applicable taxes, including withholding tax, unless specifically provided otherwise in Schedule One.

2.2.5   HEALTH AND SAFETY

2.2.5.1   MetService health and safety management

The Subcontractor agrees to comply at all times with the *MetService Contractor Health and Safety Minimum Requirements Standard*.

2.2.5.2   Suspension of Services

In addition to clause 20 of the *MetService Contractor Health and Safety Minimum Requirements Standard*, should it come to MetService's attention that the Subcontractor is failing or has failed to meet the health and safety requirements under this Agreement, MetService may, without limiting its other rights and remedies, immediately suspend all or part of the Services by written notice to the Subcontractor. The refusal or failure of the Subcontractor to remedy the matters specified in this notice to the reasonable satisfaction of MetService within five (5) Business Days of the Services being suspended shall constitute a material breach of this Agreement.

2.2.5.3   Indemnity

If, by reason of any breach by the Subcontractor of the health and safety requirements of this Agreement, a claim or prosecution is brought against MetService, then the Subcontractor agrees to indemnify MetService against all costs (including legal costs calculated on a solicitor/client basis), expenses, claims, damages or reparation orders which MetService may incur or be liable to pay in respect of the claim or the defence thereof. Nothing in this clause affects the prohibition against indemnification for fines or infringement fees under the Health and Safety at Work Act 2015.

2.2.6   HUMAN AND ANIMAL WELFARE ETHICS APPROVAL

2.2.6.1   Subcontractor's Responsibility

i.   Where the Subcontractor's activities in delivering the Services involve humans or the use of crustacean or vertebrate animals the Subcontractor is required to assess whether those activities require Human or Animal Welfare Ethics Approval.

ii.   Notwithstanding the Subcontractor's determination under sub-clause (i) MetService may require the Subcontractor to seek Human or Animal Welfare Ethics Approval for its activities in delivering the Services.

iii. Where Human or Animal Welfare Ethics Approval is required the Subcontractor shall, prior to commencing such activities:

a.   inform MetService in writing of the need to obtain approval, and

b.   make the necessary approval application(s), and

c.   inform MetService in writing of the outcome of any such application(s).

iv.   The Subcontractor shall not undertake any activity requiring Human or Animal Welfare Ethics Approval until the required approvals have been obtained.

2.2.7   INTELLECTUAL PROPERTY

2.2.7.1   Definition

For the purposes of this Agreement, **Intellectual Property Rights** includes copyright and all rights existing anywhere in the world conferred under statute, common law or equity relating to inventions (including patents), registered or unregistered trademarks and designs, circuit layouts, data and databases, confidential information, know-how, and all other rights resulting from intellectual activity. **Intellectual Property** has a consistent meaning.

2.2.7.2   Intellectual Property Policies and Principles

The parties agree to comply with the Intellectual Property Policies and Principles set out in Schedule Three.

2.2.7.3   Existing Intellectual Property

i.   All Intellectual Property which is owned by, or proprietary to, a party at the start date or developed by (or on behalf of) a party other than pursuant to this Agreement shall remain the exclusive property of that party

ii.   Nothing in this Agreement confers on either party any right or interest in, or licence to use any of the Existing Intellectual Property of the other party, except that:

a.   to the extent that existing intellectual property of the Parties (or its licensors) is incorporated into any Deliverable under this Agreement parties grant to the other, an irrevocable, perpetual, non-exclusive, royalty-free licence to access, use, copy, disclose and modify (and sublicense to MBIE to access, use, copy, disclose and modify, to the extent required to ensure compliance by MetService with its MBIE Contract) any such Intellectual Property as may be necessary to enable the parties and MBIE to obtain the full use, benefit and enjoyment of the Services and the related deliverables; and

b.   If a Deliverable incorporates any Existing Intellectual Property that is owned by a third party, the licence in clause 2.2.7.3 is subject to any restrictions relating to that third party Intellectual Property that were disclosed to MetService at the time the Subcontractor supplied the Deliverable to MetService, or otherwise specifically accepted by MetService.

2.2.7.4   New Intellectual Property

    a.   Subject to clause 2.2.7.3.i, unless otherwise specified in Schedule One:

        i.   all new Intellectual Property created or developed by the Subcontractor in providing the Services, is owned by the Subcontractor from the date of creation.

        ii.   MetService shall have an irrevocable, perpetual, non-exclusive, royalty-free licence to access, use, copy, disclose and modify (and sublicense to MBIE to access, use, copy, disclose and modify, to the extent required to ensure compliance by MetService with its MBIE Contract) any such Intellectual Property for its internal and external business purposes, including commercialisation of new Intellectual Property, and academic research and publication.

        iii.   the Subcontractor undertakes to and agrees that it shall grant a licence to other subcontractors engaged by MetService to contribute to the Work Program on the following basis in accordance a standard MIT open source licence:

           1.   Attribution: Copyright 2020, [*insert copyright holder e.g. UniServices/AoU*];

           2.   Permission is hereby granted, free of charge, to any person obtaining a copy of this software and associated documentation files (the "Software"), to deal in the Software without restriction, including without limitation the rights to use, copy, modify, merge, publish, distribute, sublicense, and/or sell copies of the Software, and to permit persons to whom the Software is furnished to do so, subject to the following conditions:

               a.   The above copyright notice and this permission notice shall be included in all copies or substantial portions of the Software.

               b.   THE SOFTWARE IS PROVIDED "AS IS", WITHOUT WARRANTY OF ANY KIND, EXPRESS OR IMPLIED, INCLUDING BUT NOT LIMITED TO THE WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE AND NONINFRINGEMENT. IN NO EVENT SHALL THE AUTHORS OR COPYRIGHT HOLDERS BE LIABLE FOR ANY CLAIM, DAMAGES OR OTHER LIABILITY, WHETHER IN AN ACTION OF CONTRACT, TORT OR OTHERWISE, ARISING FROM, OUT OF OR IN CONNECTION WITH THE SOFTWARE OR THE USE OR OTHER DEALINGS IN THE SOFTWARE.

    b.   The parties agree that any Intellectual Property developed by the Subcontractor when providing the Services or Deliverables relating specifically to the trained models or model weights including any improvements, enhancements, or modifications to the Trained AI IP created or developed by the Subcontractor during the term of the Agreement ("**Trained AI IP**") will be owned by the Subcontractor in accordance with clause 2.2.7.4.a. However, the Subcontractor acknowledges and agrees that it must only use the Trained AI IP solely for academic research and publication.

    c.   Despite clause 2.2.7.4aii, all Trained AI IP will be licensed to the Contractor under the following license terms:

        i.   With effect from the start date of the Agreement, the Subcontractor grants to MetService an exclusive, irrevocable, perpetual, royalty free licence to access, use, disclose, modify and sublicence the Trained AI IP for its internal and external business and operational purposes, including commercialization. To avoid doubt, the supply of the Trained AI IP directly or indirectly to any business that is a competitor of MetService will breach the exclusive licence as set out in this clause 2.2.7.4i.

    ii.   MetService acknowledges that the Subcontractor owns all right, title and interest in the Trained AI IP. To the extent that the rights do not automatically vest in the Subcontractor in accordance with the intention of this paragraph, MetService assigns, with effect from the date at which the relevant rights arise, those rights so as to give effect to the intention of this paragraph.

2.2.7.5   Other Intellectual Property Obligations

    c.   The parties acknowledge the principles of Māori data sovereignty and agree to work together in good faith and use reasonable endeavours to respect these principles subject to clauses 2.2.7.2 to 2.2.7.4.

    d.   In carrying out its obligations under the Agreement, the Subcontractor agrees to comply with reasonable Intellectual Property Rights management protocols notified to it from time to time by MetService, including specific protocols for the management of mātauranga (or Māori pre-existing Intellectual Property Rights).

2.2.7.6   Notification

At any time during the term of this Agreement, upon the completion of the Services, and/or termination or expiration of this Agreement representatives of MetService and the Subcontractor shall meet to discuss the new Intellectual Property arising as a result of the provision of the Services by the Subcontractor. At such a meeting, the Subcontractor must notify MetService of all Intellectual Property developed, and of all opportunities known to the Subcontractor for the development and/or potential commercialisation of that new Intellectual Property.

2.2.7.7   Other Activities

Unless otherwise agreed in writing, nothing in this Agreement will impair MetService's right to acquire, licence, provide, develop or commercialise for itself or other (or to have others acquire, licence, provide, develop or commercialise for MetService) the same or similar technology, services and/or products as contemplated by this Agreement.

2.2.7.8   IP Warranty

The Subcontractor warrants that:

    a.   to the best of its knowledge the provision of the Services and the use and possession of the related Deliverables by MetService and/or MBIE in accordance with this Agreement will not infringe the Intellectual Property Rights of any third party; and except as disclosed otherwise by the Subcontractor, the deliverables are the original work of the Subcontractor.

    b.   The Subcontractor will have no liability for failure to meet the warranty set out in clause 2.2.7.8a to the extent the failure is caused by the use or incorporation of a Deliverable in, or in combination with, another product or item, where, but for such use or incorporation, the Deliverable would not have given rise to a claim for infringement of the third party's rights

2.2.7.9   IP Indemnity

    a.   The Subcontractor indemnifies MetService and MBIE from any expenses, damage, loss or liability (including legal fees on a full indemnity basis) arising from any claim or proceeding, to the extent that the claim or proceeding alleges that MetService or MBIE's use and

possession of the Services or Deliverables in accordance with this Agreement infringes the rights of any third party (IP Claim).

b. The indemnity in clause 2.2.7.9(a) is subject to MetService or MBIE (as applicable) promptly notifying the Subcontractor in writing of any IP Claim, making no admission of liability and not otherwise prejudicing or settling the IP Claim without the Subcontractor's prior written consent, and giving the Subcontractor complete authority and information required for the Subcontractor to conduct and/or settle the negotiations and litigation relating to the IP Claim, The costs incurred or recovered are for the Subcontractors account.

c. If at any time an IP Claim is made, or in either party's reasonably opinion is likely to be made, then in defence or settlement of the IP Claim, the Subcontractor may:

   i. obtain for MetService the right to continue using the items that are the subject of the IP Claim; or

   ii. modify, re-perform or replace the items that are the subject of the IP Claim so they become non-infringing.

2.2.8   CONFIDENTIALITY

2.2.8.1   Confidential Information

Confidential Information means:

   i. the terms and conditions of this Agreement;
   ii. information which is by its nature confidential; or, which the discloser advises the recipient is confidential and includes the terms of this Agreement; and
   iii. includes anything disclosed before the start date of this Agreement or arises from this Agreement in any form.

2.2.8.2   Security

Each party agrees that, unless it has the prior written consent of the other party, it will:

   i. keep confidential at all times the Confidential Information of the other party;

   ii. not use any Confidential Information belonging to the other party for any purpose other than as required by this Agreement;

   iii. only disclose Confidential Information to employees, officers or professional advisers on a need-to-know basis and shall be liable to the discloser for any breach by those persons of these confidentiality obligations; and

   iv. ensure that any personnel or professional advisor to whom a party discloses the other party's Confidential Information is aware of, and complies with, the provisions of this clause 2.2.8.

2.2.8.3   Exclusions

The obligations of confidentiality in clause 2.2.8.2 do not apply to disclosure:

   i. of information which at the date of this Agreement is in the public domain or subsequently enters the public domain without fault on the part of the recipient;
   ii. of information that is received in good faith by the recipient from a third party; or

iii. of information which is at the date of this Agreement, independently developed by, or already properly in the possession of, the recipient and which the recipient can demonstrate by written record to be previously known to the recipient; or

iv. where disclosure is required by law.

v. to MBIE:

    a. for the purpose of fulfilling its obligations under the MBIE Contract; or

    b. to enable MBIE to disclosure relevant Confidential Information to Minister, any of MBIE's advisors (including third parties) and any other governmental agency (including any Crown entity)

provided that any person to whom the Confidential Information is disclosed is bound in writing by obligations no less onerous that clause 2.2.8.2 prior to disclosure.

2.2.8.4   Confidential Information Breaches

The parties acknowledge that any breach of this confidentiality obligation may result in damages for which monetary compensation would not be an adequate remedy and that the affected party is entitled to specific performance or injunctive relief in addition to any other remedies at law or in equity.

2.2.8.5   Third Parties

i. Where the Subcontractor wants to disclose any of MetService's Confidential Information to a third party (including, for the avoidance of doubt, to other subcontractors who are providing services to MBIE under the Work Programme), for the purposes of enabling that third party to assist in the provision of the Services, the Subcontractor shall notify MetService of its intention to disclose, the nature and extent of that disclosure and identify the party to whom disclosure will be made;

ii. The Subcontractor shall only disclose that confidential information after receiving express written agreement from MetService; and

iii. Prior to disclosing any MetService Confidential Information, the Subcontractor will advise the third party of its confidentiality obligations under this Agreement and ensure the third party agrees to be bound by the same obligations of confidence.

2.2.8.6   Security

The Subcontractor will use all reasonable endeavours to protect all information and materials provided by MetService, in the possession, power or control of the Subcontractor connected with this Agreement from unauthorised access, or use, by a third party or misuse, damage or destruction by any person.

2.2.8.7   Delivery Up

Upon termination or expiration of this Agreement clause 2.2.8 will remain in effect. The Subcontractor will cease to use and will upon request deliver up to MetService all documents, information, data and other material relating to or connected with the confidential information arising from this Agreement and all copies and duplicates of those items.

2.2.8.8   Publicity

Neither party may use the name, logo or trade marks of the other party or its Affiliates in any publicity or marketing without the other party's prior written consent, such consent not to be unreasonably withheld, delayed or conditioned

2.2.8.9   Publication

The parties reserve the right to publish or otherwise make public the data resulting from the Services. Authorship shall be determined in accordance with commonly accepted practices for scientific publications. Despite the previous sentence, the party so wishing to publish or make public shall submit any manuscript or release to the other party at least thirty (30) days prior to publication or release so that party may review the submission for any of its proprietary information that it may desire to protect. If the recipient identifies proprietary information that it desires to protect, the recipient may require delay of the submission for publication for up an additional sixty (60) days. The recipient may require any of its Confidential Information to be deleted from the submission, provided that the removal of such information does not have the effect of making the publication false, misleading, inaccurate or incomplete.

2.2.9   TERMINATION

2.2.9.1   Suspension of Obligations

Without limiting any other right or remedy of MetService under this Agreement or at law, MetService may suspend performance of its obligations under this Agreement or require the suspension by the Subcontractor of its obligations under this Agreement at any time if such suspension is required to comply with its obligations under the MBIE Contract or otherwise where the Subcontractor is in default in the performance of its obligations under this Agreement.

2.2.9.2   Termination for Cause

   i.   If the Subcontractor commits a material breach of this Agreement, or otherwise defaults in the performance of any of its duties or obligations under this Agreement and the default is not remedied within 10 Business Days of MetService providing the Subcontractor with written notice specifying the default, then MetService may, by giving written notice to the Subcontractor, terminate this Agreement with immediate effect.

   ii.   If the Subcontractor commits a material breach of this Agreement which is not capable of remedy, then MetService may, by giving written notice to the Subcontractor, terminate this Agreement with immediate effect.

   iii. If MBIE discontinues funding for the Work Programme or changes the research priorities and/or objectives of the Work Programme to the extent that the Services are no longer required by MetService, then MetService shall be able to terminate this Agreement with immediate effect by providing notice to the Subcontractor of such termination. MetService undertakes to provide as much notice of such termination as possible upon becoming aware of such matters from MBIE.

   iv.   If the Subcontractor fraudulently misuses or misappropriates any Fees, MetService may suspend the Fees or terminate this Agreement immediately by notice to the Subcontractor.

   v.   Either party may terminate immediately this Agreement if the other party becomes insolvent, is unable to pay its debts, becomes bankrupt, makes an arrangement with its creditors, or has a receiver, liquidator, administrator, trustee or manager appointed.

2.2.9.3   Early Termination

   i.   If MetService considers (acting reasonably) that the Subcontractor is unable to supply the Services (including the supply of a deliverable) in accordance with the timetable set out in Schedule One, it may terminate this Agreement at any time by giving 90 days' notice to the Subcontractor.

ii.   Met Service may terminate this Agreement immediately upon notice to the Subcontractor where the Science Board or MBIE terminates the Work Programme Agreement or the Science Investment Contract, for whatever reason.

2.2.9.4   Repayment of Fees

i.   Upon termination of this Agreement for any reason MetService will only be liable to pay Fees for Services delivered in accordance with this Agreement before the effective date of termination, and the Subcontractor will:

   a.   stop providing the Services;
   b.   immediately do everything reasonably possible to reduce its losses, costs, and expenses arising from termination of this Agreement; and

ii.   refund the balance of any payments made by MetService for Services not performed at the date of termination.

iii.   If this Agreement is terminated under clause 2.2.9.2 iv, MetService may require the Subcontractor to return all Fees paid up to the date of termination, together with interest on all sums due, which will be charged on a daily basis at a rate that is the same credit and debit rate that is charged by Inland Revenue on each day on which interest is charged by MetService, from the date on which the Subcontractor was paid money by MetService to the date the Subcontractor returns the money.

2.2.9.5   Termination Without Prejudice

Expiry or termination of this Agreement:

i.   is without prejudice to any other right, power or remedy of a party under this Agreement, at law, or otherwise; and

ii.   shall not terminate any provisions of this Agreement which by their nature should survive termination (including clauses 2.2.7, 2.2.8, 2.2.9, 2.2.11 and 2.2.12.1).

2.2.10 DISPUTES

2.2.10.1 Negotiation

In the event of any dispute arising from or relating to this Agreement or the breach thereof, a party will as soon as reasonably practical give the other written notice of that dispute. The parties shall then use their best efforts to settle the dispute. To this effect, they shall discuss, consult or negotiate with each other in good faith and attempt to reach a just and equitable solution satisfactory to both parties.

2.2.10.2 Mediation

If within ten (10) Business Days of receipt of notice of a dispute, negotiation fails to resolve the dispute, it shall upon the written request of either party be referred to mediation. The parties will then agree on a suitable and mutually acceptable person to act as mediator. In the absence of agreement as to the identity of a suitable mediator the matter will be referred to the chairperson of Resolution Institute, or that person's delegated representative, to appoint a suitable mediator.

2.2.10.3 Mediation Process

The parties will agree upon a suitable and mutually acceptable framework and process to advance mediation to a successful outcome. In the absence of agreement as to a suitable framework / process the mediator will

determine a suitable procedure at the request of either party. The parties will attend and advance the mediation in good faith and attempt to reach a just and equitable solution satisfactory to both parties.

2.2.10.4 Disputes Not Resolved by Mediation

A dispute that is not resolved by mediation, within fifteen (15) Business Days of the appointment of a suitable mediator, may be referred to the Courts by either party.

2.2.10.5 Urgent Relief

Nothing in this Agreement will stop a party from commencing Court proceedings in relation to any dispute in connection with this Agreement, at any time where that party seeks urgent injunctive or interim relief.

2.2.11 LIABILITY AND INDEMNITY

2.2.11.1 Liability

a. The total cumulative liability of MetService under and in connection with this Agreement (whether in contract, tort, (including negligence) or equity), shall not exceed an amount equal to the Fees payable by MetService under the Agreement. Nothing in this clause 2.2.11.1a applies to limit MetService's liability under or in connection to the Agreement for:

   i. personal injury or death;

   ii. fraud or wilful misconduct; or

   iii. a breach of clause 2.2.7 (Intellectual Property), or clause 2.2.8 (Confidentiality).

b. The total cumulative liability of the Subcontractor under and in connection with the Agreement (whether in contract, tort (including negligence), or equity), shall not exceed $2,000,000. Nothing in this clause 2.2.11.1b applies to limit the Subcontractors liability:

   i. under the indemnities in clauses 2.2.5.3 (Health & Safety), 2.2.7.9 (Intellectual Property), or 2.2.11.2 (Indemnity); or

   ii. under or in connection with the Agreement for:

      1. personal injury or death;

      2. fraud or wilful misconduct;

      3. a breach of clause 2.2.8 (Confidentiality); or

      4. the Subcontractor's liability under clause 2.2.11.1 (MBIE Repayment)

c. Despite anything to the contrary in this Agreement, if the Subcontractor fraudulently misuses or misappropriates Fees and MetService is required to repay funds under the MBIE Contract or Work Plan Agreement, the Subcontractor is liable to MetService for whatever portion of funds must be repaid, up to $2,000,000. For the avoidance of doubt, repayment of funds under the MBIE Contract is a direct loss.

2.2.11.2 Indemnity

The Subcontractor shall indemnify MetService against:

   i. any liability, loss, damage, cost or expense that MetService incurs under the MBIE Contract to the extent such liability has arisen as a direct result of the Subcontractor's breach of its obligations under this Agreement; and

   ii. any claim, action, proceeding, judgment, damage, loss, expense or liability (including under or in connection with the MBIE Contract) incurred or suffered by or brought or made or recovered against MetService in connection with the negligence, unlawfulness or wilful default of the Subcontractor (or

any of its personnel, agents or representatives) or a breach of any term of this Agreement by the Subcontractor.

2.2.11.3 Consequential loss

Notwithstanding any other term of this Agreement, neither party will be liable for any special, indirect or consequential loss or damage, or for any loss of business, goodwill, reputation, data or profit, whether or not the possibility of such loss or damage could have been reasonably foreseen. This clause 2.2.11.2 shall not apply to a party's liability under clauses 2.2.7.7 (IP Warranty), 2.2.7.8 (IP Indemnity) or 2.2.8 (Confidentiality).

2.2.11.4 Remedy

Without limiting any other right or remedy available to MetService in respect of a breach of this Agreement by the Subcontractor, where the Subcontractor fails to provide any Service in accordance with the terms of this Agreement, the Subcontractor shall promptly re-supply or remedy (as applicable) the relevant Service.

2.2.11.5 No liability for the other's failure:

Neither party will be responsible, liable, or held to be in breach of this Agreement for any failure to perform its obligations under this Agreement or otherwise, to the extent the failure is directly caused by the other party failing to comply with its obligations under this Agreement, or by the negligence or misconduct of the other party or its personnel.

2.2.11.6 Mitigation

Each party must take reasonable steps to mitigate any loss or damage, cost or expense it may suffer or incur arising out of anything done or not done by the other party under or in connection with this Agreement.

2.2.12 GENERAL

2.2.12.1 Not Used

2.2.12.2 Notices

All notices shall be delivered by hand or be sent by facsimile, fastpost or email to the contacts detailed in clause 1.1. Any notice sent by:

i.   facsimile or email will be deemed to have been received on the following Business Day in the place of receipt; or,
ii.   fastpost will be deemed to have been received two Business Days after posting.

2.2.12.3 Entire Agreement

i.   This Agreement (including the Schedules) constitutes the entire agreement between the parties with respect to the Services.
ii.   This Agreement supersedes all prior understandings, written or oral, which will be of no further force or effect.

2.2.12.4 Waiver

i.   No failure or delay on the part of any party in exercising any power or right under this Agreement will operate as a waiver, nor will any single or partial exercise of such right or power preclude any other or future exercise of the same or any other right or power under this Agreement.

    ii.   No waiver by any party or any provision of this Agreement will be binding unless expressly made and confirmed in writing by the party and all other parties to this Agreement. Further, any such waiver will relate only to such matter, non-compliance or breach to which it expressly relates and will not apply to any subsequent non-compliance, breach, or other matter.

2.2.12.5   Insurance

The Subcontractor will effect and maintain for the duration of the Agreement, and for a period of two years after termination or expiry, with a reputable third party insurance provider, adequate public liability and professional indemnity insurance, and such other insurance policies that a prudent entity supplying the Services would maintain, taking into account the Subcontractor's risks and potential liabilities under the Agreement. The insurance must cover the Subcontractor and all persons involved in delivering the Services, including the Subcontractor's officers, employees, contractors and agents, as co-insured If reasonably requested from MetService from time to time, the Subcontractor will promptly provide evidence of its compliance with this clause 2.2.12.5.

2.2.12.6   Subcontractor Arrangement

    i.   Nothing in this Agreement creates a partnership, employment, agency or other fiduciary relationship between the parties. The Subcontractor is an independent contractor and does not have any right or power to bind or act on behalf of MetService without MetService's prior written consent.

    ii.   As an independent contractor, the Subcontractor is liable for all its own taxes and levies relating to it or any of its employees, agents or contractors. The Subcontractor indemnifies MetService against the cost of any such taxes or levies.

2.2.12.7   Assignment

    i.   The Subcontractor will not assign or otherwise transfer the benefits and obligations under this Agreement to any other party unless it receives the prior written consent of MetService.

    ii.   This Agreement will be binding upon, and ensure to the benefit of, all successors, licensees, trustees and permitted assigns.

2.2.12.8   Variation

Subject to clause 2.2.2.1 no modification, alteration or addition to this Agreement will be binding upon the parties unless it is in writing and signed or acknowledged at the appropriate level of each party.

2.2.12.9   Severability

If any provision of the Agreement is void or unenforceable, for any reason, the remainder of the Agreement will remain in full force and effect and will not be terminated.

2.2.12.10 Counterparts

    i.   This Agreement may be executed in two or more counterparts, each of which shall still be deemed an original, but all of which together will constitute one and the same instrument.

    ii.   A facsimile copy of this Agreement shall be deemed to be an original counterpart.

2.2.12.11 Governing Law

This Agreement will be governed by and interpreted in accordance with the laws of New Zealand and submits to the exclusive jurisdiction of the New Zealand Courts.

2.2.12.12 Force Majeure

Neither party shall be responsible for any failure or delay in complying with the terms of this Agreement where such failure or delay results from events beyond its control. The affected party must resume its obligations under this Agreement as soon as it reasonably can after the force majeure event ceases. Any significant event like this should be notified to either party as soon as reasonably practicable.

Schedule One: Services

Services and Deliverables

Description of Services	The Subcontractor's role in the delivery of The Machine Learning for Storm Surge Prediction Project is to contribute scientific expertise, research facilities and research activities to meet the Research Aims.
Key Personnel	The Subcontractor will provide the following key personnel, with the associated roles and responsibilities, to deliver the Services.

Name	Roles and responsibilities (Deliverables)
Fernando Mendez	Science Lead Research Aim Team Lead: RA2 Team member: RA3 Tag member: Yes Scientific Expert: Data analysis, extreme events, statistical downscaling, statistical analysis Supervisor: A. Rueda Deliver: CS1.1.4 (review), RA2, CS1.2.1, CS1.2.2, CS1.2.3, CS1.2.4, CS1.2.5, CS1.3.5, CS1.5.2 (case studies) • Provide results of slp analysis in form of principal components to be used in RA2 for one site. • Provide slp analysis for all sites of interest.
Ana Cristina Rueda [Postdoctoral Fellow]	Team member: RA2, RA3 Deliver with supervisor: CS1.2.1, 1.2.2, 1.2.3, 1.2.4, 1.2.5, 1.3.2, 1.3.3, 1.3.4, 1.3.5,1.5.2(case studies)
Scientific Coder	Team member: RA2 Scientific Expert: Computer Science, Machine Learning
PhD Student	University appointed PhD student to provide assistance

Subcontract Managers	Anna Phillips (for MetService) Jorge Castro González (for the Subcontractor)

Subcontract Administrators	Anna Phillips (for MetService)
	Jorge Castro González (for the Subcontractor)
Start Date	01 February 2021
Finish Date	30 September 2022
Remuneration	Year 1 (from 01 Feb 2021 up to and including 30 September 2021): NZD$167,571 exclusive of GST
	Year 2 (from 01 Oct 2021 up to and including 30 September 2022): NZD$223,429 exclusive of GST
	_____
	Total Contract value: $391,000.00 exclusive of GST
	All amounts are in NZD and will be paid in NZD to the supplier's nominated bank account.
Invoice Frequency	Invoices shall be issued to MetService in line with completion, or satisfactory progress towards completion, of the Deliverables set out in this Schedule One. Determination of satisfactory progress towards completion of Deliverables shall be determined firstly with the TAG but finally at MetService's sole discretion. For the sake of clarity, all deliverables must be submitted to MetService, and quality checked by MetService, prior to invoicing.
	The Subcontractor shall send no more than 12 invoices annually.
	Invoices should be sent to accounts@metocean.co.nz and must include this Agreement reference MSVC1901_UoCantanbria_01.
Co-funding	N/A
Deliverables	The Contractors Deliverables include this section and the roles and responsibilities detailed in the Key Personnel table; all to be interpreted in conjunction with the Definitions, Method contained in this Schedule One and with Schedule Two.

| Dates	
Year 1 - Q2 February– March 2021	TAG team defined, project governance established, and first TAG team meeting conducted (joint UW, UoC, MS milestone) Finalised protocol for data and code sharing (joint UW, UoC, MS milestone) Numerical platform presented to TAG team for approval (joint MS, UoC milestone) Post-doc set to work on project
Year 1 - Q3 April – June 2021	Python environment developed, presented to all teams and made available to team (joint MS, UoC milestone) Download of predictor datasets complete. Slp analysis in form of principal components for all sites of interest complete. Final datasets decided and communicated with TAG
Year 1 - Q4 July – September 2021	Beta version of RA2 machine learning algorithm developed and available to team

		Results of beta version of RA2 machine learning algorithm for one tidal station presented to TAG Location of points along NZ coastline for which RA3 machine learning algorithm will be trained finalised and presented to TAG (joint MS, UoC) Framework for the application of machine learning algorithm across model domain(s) developed and presented to TAG (joint MS, UoC) Section of annual report delivered to project lead due 15th August in preparation for submission to MBIE
	Year 2 - Q1 October – December 2021	Final version of RA2 machine learning algorithm available to team Training of final version of RA2 machine learning algorithm completed at all selected sites Verification of final version of RA2 machine learning algorithm complete and presented to TAG Collate results into draft paper for circulation to RA team leads for review
	Year 2 - Q2 January – March 2022	Sensitivity analysis of final version of RA2 machine learning algorithm completed and presented to TAG Prototype of machine learning algorithm extended to offshore NZ coast that uses satellite data as input developed and available to team
	Year 2 - Q3 April – June 2022	Performance of algorithm extended to offshore NZ coast presented to TAG Delivery of final submission of paper/s
	Year 2 - Q4 July – September 2022	Section of annual report delivered to project lead due 15th August in preparation for submission to MBIE Final release of machine learning algorithm code done

+ attend quarterly TAG meetings, project planning meetings and Hui in New Zealand or on Zoom as applicable.
+ overall scientific leadership
+ lead RA2

Method	RA2. The core task of this RA is the development and testing of an algorithm based on machine-learning to predict storm surge at the in-situ observation locations around New Zealand. Our previous research in the area of machine-learning, has shown that accurate and robust predictions of storm surge time series can be achieved using the "deep learning" approach. We propose an algorithm based on a neural network to model the relationship between input variables (sea level, pressure fields, obtained from a local weather model, and storm surge outputs from a freely available, coarse global hydrodynamic model (e.g. NOAA's RTOFS model, or the Mercator model) and surge levels at a number of New Zealand tidal gauges (Figure 2) with data processed in RA1. The structure of the machine learning algorithm consists of a convolutional component, which extracts spatial characteristics from the global model and weather maps (e.g., sea level pressure fields) and a recurrent component based on Long-Short Term Memory (LSTM) layers to model these characteristics over time. The algorithm will be implemented using Python with Keras and Tensorflow, and the code will be made available online through a novel international initiative (BlueMath) that aims at providing freely available tools for the analysis of coastal hazards.

-Our previous work using LSTM provides convincing evidence that the algorithm is powerful at a relatively low computational cost, making it suitable for forecasting and operational purposes. The ability of the algorithm to self-regulate and find the optimal number of convolutions, drives the unprecedented accuracy of the approach.

-At each water level station, we will use part of the data to train (usually about 60% of the data is sufficient for this purpose) the algorithm and the remaining data will be reserved for validation. This stage of research will inevitably require painstaking sensitivity analysis to optimize parameters of the algorithm in the training process and to ensure that results are reliable and robust.

-While the instrumented stations are all at relatively small water depths, predictions of storm surge in deeper areas are also relevant. For this purpose, the weights of the LSTM algorithm will be re-tuned using altimeter measurements from satellite. The measurements are freely available, and we already have extensive in house experience using data from satellite altimeters.

-Even though the spatial coverage of the nearshore instrumented stations if far from optimal, the early development of LSTM predictors within the project will form the basis for discussion with end-users on the model predictive ability and the development of an operational tool to make the storm surge predictions available in real time at a wider range of sites. The algorithm is also generalizable, applicable globally and of broad interest so that results will be published in international peer-reviewed journals.
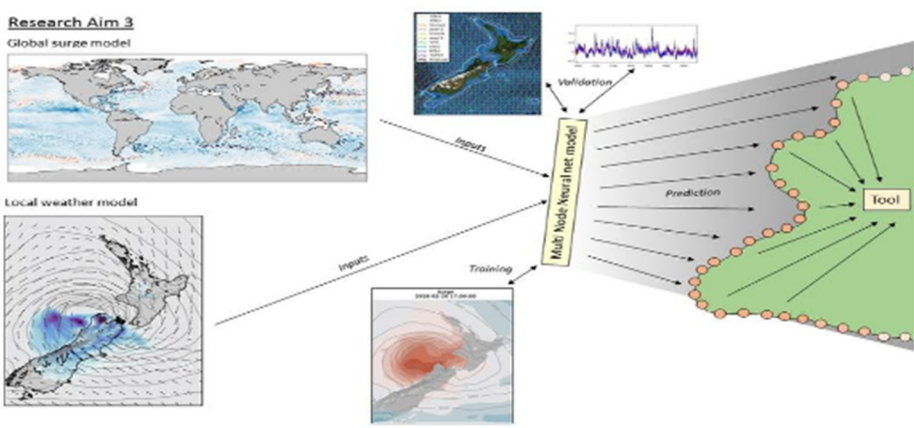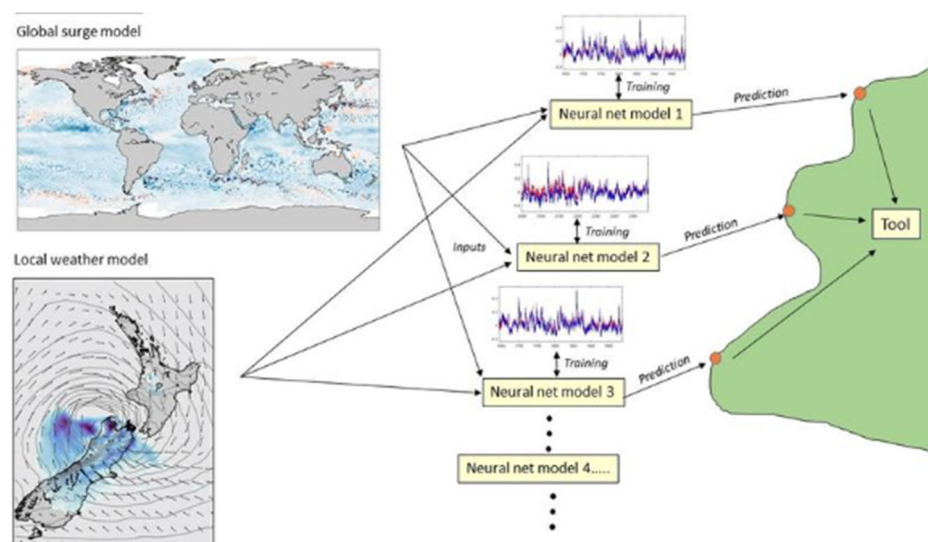

RA3. MetOcean currently runs a regional hydrodynamic forecasting system around New Zealand. It is based on the primitive equation hydrodynamical ROMS model version 3.7 [15]. This ocean model has been used widely in the scientific community and industry for a range of ocean basin, regional and coastal scales. ROMS has a curvilinear horizontal coordinate system and solves the hydrostatic, primitive equations subject to a free-surface condition. Its terrain-following vertical coordinate system results inaccurate modelling of areas of variable bathymetry, allowing the vertical resolution to be inversely proportional to the local depth. Metservice is currently upgrading this model to a a national data assimilative ocean model through the MBIE funded MOANA project. As part of this effort, a 25- years high resolution

oceanic hindcast was simulated - known as the MOANA backbone. This simulation presents horizontal resolution ranging from 4 to 5.7km, and 40 vertical terrain-following vertical levels. The domain covers the area shown in Figure 3. Bathymetry was sourced from GEBCO for deep ocean areas and New Zealand electronic navigation charts, ensuring the highest possible accuracy near the coastline. This simulation is able to represent the large scale circulation around New Zealand and meso-scale features, such as oceanic eddies, that may impact the local sea surface height. It also includes oceanic tides and the response to the atmospheric pressure variability through the inverse barometer effect, resulting in a significant improvement in ability to simulate storm surge in comparison to the global models. This hindcast will be used as the training target for RA3.
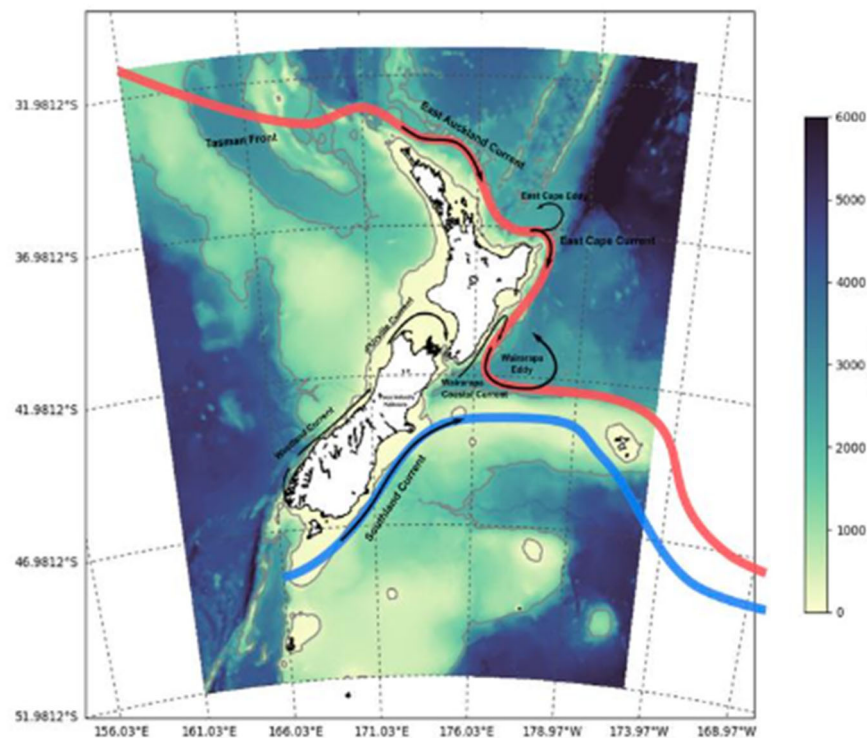
The same algorithms used in RA2 will be developed and implemented to learn and reproduce model predictions in RA3. The weights of the trained algorithms in RA2 will be evaluated using recent techniques (e.g., transfer functions) to rapidly optimize algorithm development and application in RA3.Despite sharing architecture and some input variable (Figure 4), the predictive algorithm is fundamentally different from the one in RA2 since it invokes additional input variables (i.e., the Metservice numerical simulations). The main advantage of this algorithm is its spatial resolution which mimics the one from the numerical model (4km) and which will provide sufficient coverage of the New Zealand coastline. In the event that the 4km national model is not of adequate resolution to resolve the storm surge along complex regions of the NZ coastline, we will also explore an even higher resolution regional dataset. The Moana project will also produce regional hindcasts around Kaikoura, the Bay of Plenty, and the Hauraki Gulf with resolution of 1 km or higher. One or more of these models will be chosen to use as the base to retrain the machine-learning algorithms, and the improvements this provides will be quantified. This will serve as a proof of concept that higher resolution historical models can be used to effectively increase the accuracy of the forecast product.

Other Considerations	Any project associated equipment are incorporated in the contracted remuneration.

Travel and associated expenses for Ana Cristina Rueda to visit Auckland and Raglan, New Zealand for one month during this project will be considered if allowable.

Travel to New Zealand

The Service Provider may be required to travel to New Zealand at least once during the course of this project. In most cases the Company will make and pay for travel expenses directly. Where travel has been pre-approved and the Service Provider has made arrangements themselves, the Company agrees to reimburse the Service Provider for:
Economy return flights
Accommodation (noting the MetOcean staff house is the first option and accommodation expenses will only be reimbursed when alternative accommodation needs to be sourced)
Transfers from Auckland airport to Raglan and return |
| **Issues and Risk Management** | The Subcontractor will advise the Project Manager of any project issue, risk or opportunity as soon as is reasonably practicable.

Subcontractor will liaise with Project Manager to keep the central StormSurge Project Risk and Issues Register, and Change Log updated and take part in associated risk assessments. |
| **Definitions** | "Bay of Plenty Coastal Model" means a high resolution (~1 km x 1 km) hydrodynamic model developed and validated through the Moana Project;

"Calypso" means Calypso Science Limited

"Critical Steps" or "CS" means the critical set of project activities required to deliver The Machine Learning for Storm Surge Prediction Project, which have been assigned to a Team Lead and are described in Appendix 1. It is expected that the Team Lead develops a Work Package, for each Critical Step within 30 days of execution of this Agreement;

"Issues and Risk Register" means the database, named Machine Learning for Storm Surge Prediction Issues & Risk Register, that captures project issues; including type, description, status and owner, and, project risks and opportunities; including their owners, their assessments pre and post-mitigation, their response strategy, action plans and response timing; |

"Kaikoura Coastal Model" means a high resolution (~1 km x 1 km) hydrodynamic model developed and validated through the Moana Project;

"Machine Learning for Storm Surge Prediction Report Template" means the templates, supplied by MetService, designed to meet the reporting requirements of MBIE with regards to delivery of the work plan, in accordance with the Work Plan Agreement and the Science Investment Agreement and the communications requirements of The Machine Learning for Storm Surge Prediction Project;

"MetOcean Solutions" or "MOS" means the division of MetService responsible for delivering certain parts of The Machine Learning for Storm Surge Prediction Project, as defined by the Project Manager;

"Moana Forecast" the ocean forecast ROMS model developed through the Moana Project;

"Moana Hindcast" or "Backbone Model" means the 25+ years hydrodynamic free running ROMS model developed and validated by MOS through the Moana Project ;

"Moana Project" means the project, funded by MBIE via an Endeavour grant, being delivered by MOS. MOS will use reasonable endeavours to make any open source model and the like available to The Machine Learning for Storm Surge Prediction Project, as available;

"Moana Reanalysis" means the 25+ years 4DVar data assimilating hydrodynamic ROMS model developed and validated by MOS through the Moana Project;

"Paper" means a piece of academic writing based on the author's original research and the analysis and interpretation of the research findings on a topic related to the research progression of The Machine Learning for Storm Surge Prediction Project;

"Project Manager" means the person, appointed by MetService, responsible for (i) the day-to-day management of The Machine Learning for Storm Surge Prediction Project, (ii) ensuring the Subcontractor delivers Services to the required standard of quality within specified constraints, and (iii) The Machine Learning for Storm Surge Prediction Project producing a result capable of delivering benefits described in the Work Plan Agreement;

"Project Support" means the MetService team, including the Programme Management Office, configuration librarian and other project administrative support;

"Postdoctoral Fellow" or "PDF" means the early career researcher holding a PhD appointed to The Machine Learning for Storm Surge Prediction Project, as detailed in Appendix 2;

"RA1" means the RA entitled 'Develop a database of quality-controlled water level observations for locations around NZ';

"RA2" means the RA entitled 'Develop a machine learning predictor of storm surge';

"RA3" means the RA entitled 'Develop a spatially-explicit machine learning predictor';

"RA4" means the RA entitled 'Develop prototype operational system';

"RA5" means the RA entitled 'Consult with coastal iwi to understand the information needed to successfully prepare for coastal flooding hazards';

"Research Aim" or "RA" means any of the five fundamental research objectives of The Machine Learning for Storm Surge Prediction Project, as defined in Appendix 1 of this Agreement;

"Research Aim Lead" means the person with the responsibility to (i) provide quality & risk management of scientific programme, (ii) provide scientific expertise and attend relevant TAG meetings, (iii) contribute to the organisation of workshops, (iv) attend and present research findings, (v) provide input to team members to advance the project goals, and (vi) coordinate RA reporting.

"ROMS" means the hydrodynamic model – the Regional Ocean Modelling System;

"Scientific Expert" means a research-active scientist, involved in research in the relevant field holding a doctoral degree, or being appropriately qualified to provide scientific expertise to meet the Research Aims of The Machine Learning for Storm Surge Prediction Project;

"Supervisor" means a research-active scientist, involved in research in the relevant field holding a doctoral degree, or being appropriately qualified, who is a staff member at a university and will be overall responsible for the supervision of the PDF, PhD candidate or MSc candidate and for assistance in the provision of research resources;

"Team Lead" means the person, who is also the Research Aim Lead, with the responsibility to ensure production of products and other core deliverables, they have defined in the Work Packages and in the Agreement, to an appropriate quality, in a timescale and cost acceptable to the Project Board;

"Team Member" means the persons responsible for the delivery and/or co-delivery of Work Packages, under the management and guidance of the Team Lead;

"Technical Advisory Group" or "TAG" means the group of Scientific Experts, appointed by the project science lead and Project Manager who will provide scientific and technical guidance, quality assurance and progress evaluation. The appointed TAG members will attend meetings either in person or via video conferencing at strategic points as identified project delivery plan;

"The Machine Learning for Storm Surge Prediction Project" means the project, funded by MBIE and described in the Work Plan Agreement, which combines [define], and meet the defined Research Aims;

" UoC" means University of Cantabria

"UoW" means University of Waikato

"Work Package" means a grouping of work activities, defined by the Team Lead in conjunction with the Project Manager, which have been developed by and assigned to a Team Lead to produce one or more products and are described in the project delivery plan. A Work Package is therefore a set of information about one or more required products. A Work Package can contain the following: a Work Package description, product descriptions, techniques to be

used, tolerances, date of agreement between Project Manager and Team Lead how the Team Lead will report to the Project Manager, and quality information.

Schedule Two:

Postdoctoral Research Fellow Position Description

Title: Post-Doctoral Fellow for 'Machine Learning for Storm Surge Prediction' project (MSVC1901)
Contracting Division: Fundación Leonardo Torres Quevedo
Location: Spain
Responsible to: F. Mendez (RA2: University of Cantabria)
Collaborating with: K. Bryan (RA1: University of Waikato), S. Delaux (RA3. MetService), J. Perez (RA4. MetService), N. Puketapu-Waite (RA5: MetService)
Date: February 2021

❦ Purpose

A postdoctoral researcher with expertise in statistical downscaling and coastal hazards, and the capacity and capability to support the RA Team Leads deliver the 'Machine Learning for Storm Surge Prediction' project.

❦ Accountabilities

Team Member to support delivery of a number of Critical Steps, predominantly for Research Aim 2 and Research Aim 3, under the supervision of the relevant RA Team Lead. Accountabilities, dependent on capacity, likely to include support in delivery of the following Critical Steps[1]:

CRITICAL STEP 1.2.1: DEVELOP A MACHINE LEARNING ALGORITHM.

- Develop python environment and deliver to RA3 and RA4.
- Download required training datasets (e.g. MSLP and SSH fields from global models and UC).
- Develop beta version of predictor focusing on a single site location.
- Compare and contrast results with existing multivariate statistical methods.

CRITICAL STEP 1.2.2: TRAIN AND TEST THE ALGORITHM.

- Train and test the algorithm using the meta-database developed in Research Aim 1.
- Apply to and validate all site locations provided by RA1.
- Develop final version of predictor focusing for a single site location and deliver to RA3 and RA4.

CRITICAL STEP 1.2.3:   DEVELOP NEW ALGORITHM FOR THE OFFSHORE NZ.

- Develop an algorithm that uses satellite data as input (satellite data from RA1).
- Extend and test results to the offshore NZ coast. (GC/AR)

CRITICAL STEPSTEP 1.2.4: DISCUSS MODEL WITH END-USERS.

- Prepare presentations.

---

[1] see also Appendix 1 for a detailed description of the Research Aims and Critical Steps

- Participate in Hui.

CRITICAL STEP 1.2.5: PUBLISH RESULTS.

- Report results in at least one peer-reviewed journal article in a popular journal.
- Collate results into a draft Paper for circulation to RA Team Leads for review.

CRITICAL STEP 1.3.2: TRAIN AGAINST MODEL DATA.

- Use the methodologies developed in Research Aim 2 against model time series.
- Develop a framework for the application of ML algorithm across model domain(s).
- Test training against model time-series at the same tidal station as UA use.

CRITICAL STEP 1.3.3: EXTEND TO SPATIAL DOMAIN.

- Use newly trained algorithm to extend spatial domain to the whole NZ coast using the high-resolution model in place of the observations.
- Train ML algorithm against model output along the NZ coastline.

CRITICAL STEP 1.3.4: DISCUSS MODEL WITH END-USERS.

- Prepare presentations.
- Participate in Hui.

CRITICAL STEP 1.3.5: PUBLISH RESULTS.

- Report results in at least one peer-reviewed journal article in a popular journal.
- Collate results into a draft Paper for circulation to RA Team Leads for review.

Impact Statement, Research Aims and Critical Steps

The Impact Statement, Research Aims (RA) and Critical Steps (CS) of the Machine Learning for Storm Surge Prediction Project are:

Impact Statement 1: Provide a new tool to predict storm surge around the NZ coast

Critical Steps of Machine Learning for Storm Surge Prediction Project will develop an innovative method for the prediction of coastal storm-surge, applying state-of-the-art machine-learning techniques to link evolving weather patterns to storm-surge events through "deep learning". The project will train and verify our algorithms using localised in-situ water-level data, and then develop a spatial learning component using satellite and model data, thereby extending high-resolution predictions to cover the entire NZ coastline. This method will be developed into a general framework that can be applied around the NZ coastline and, if successful, developed into a demonstration forecast product. The tool will have unprecedented capability to provide detailed and accurate surge information at timescales that are immediately useful to emergency response services and agencies which are tasked with managing adaptation strategies to sea-level rise.

Impact Statement 1 > Research Aim 1: Develop a database of quality-controlled water level observations for locations around NZ, in order to meet the requirements and intent of Impact Statement 1 above. Critical Steps include:

CRITICAL STEP 1.1.1: COLLECT IN SITU WATER OBSERVATION. Collect existing timeseries obtained from in situ water level observation stations from both open coast and protected environments. This step includes:

- Finalise database format needed in consultation with other RA leads;
- Finalise location of the database for ease of access across teams, e.g. Nesi or other commonly accessible location;
- Download publicly available raw water level datasets and add to database (e.g. linz);
- Obtain proprietary raw water level datasets and add to database (e.g. NIWA);
- Determine methodology for data QC and calibration; and
- Apply QC to all site data

CRITICAL STEP 1.1.2: COLLECT SATELLITE OBSERVATIONS. Collect available satellite measurements of water levels around NZ, and extract them onto machine learning nodes. This step includes:

- Download satellite data from suitable inter-calibrated and QCed coastal altimeter dataset and add to the database; and
- Apply any required QC and calibration from methodologies developed above.

CRITICAL STEP 1.1.3: CREATE A META-DATABASE. Create a meta-database to include water levels from satellite, in situ and high-resolution numerical modelling output (obtained from Metservice) in a format accessible by machine-learning tools.

CRITICAL STEP 1.1.4: MAKE META-DATABASE AVAILABLE. Make meta-database available to the Team Lead of Research Aim 2 and the Team Lead of Research Aim 3. This steps includes:

- Finalise database format needed in consultation with other RA Team Leads; and
- Finalise location of the database for ease of access, e.g. Nesi or other commonly accessible location.

 CRITICAL STEP 1.1.5: DEVELOP A TOOL TO ANALYSE WATER LEVEL DATA. Develop a robust and reliable tool to analyse water level data and provide it to RCs. Provide quality control/verification information for incorporation in tool documentation, in order to meet the requirements and intent of Impact Statement 1 above. This steps includes:

- Develop a tool that extracts and analyses storm surge data from water level datasets in Python. The needed functionality of the tool will be approved by the TAG.
- Test the tool on a potential user(s) and modify the tool; and
- Write documentation for the tool, after consultation with the TAG on format and target audience of the tool.

Impact Statement 1 > Research Aim 2: Develop a machine learning predictor of storm surge, in order to meet the requirements and intent of Impact Statement 1 above. Critical Steps include:

CRITICAL STEP 1.2.1: DEVELOP A MACHINE LEARNING ALGORITHM. Develop a machine learning algorithm based on "deep learning" that links weather maps and global water level models to in situ observed storm surge at the coast.

- Determine compute location (likely Nesi). Design the numerical platform for this location.
- Develop python environment and deliver to RA3 and RA4.
- Download required training datasets (e.g. MSLP and SSH fields from global models and UC);
- Develop beta version of predictor focusing on a single site location; and
- Compare and contrast results with existing multivariate statistical methods.

CRITICAL STEP 1.2.2: TRAIN AND TEST THE ALGORITHM. Train and test the algorithm using the meta-database developed in Research Aim 1.

- Apply to and validate all site locations provided by RA1; and
- Develop final version of predictor focusing on a single site location and deliver to RA3 and RA4.

CRITICAL STEP 1.2.3: DEVELOP NEW ALGORITHM FOR THE OFFSHORE NZ.

- Develop an algorithm that uses satellite data as input (satellite data from RA1); and
- Extend and test results to the offshore NZ coast.

CRITICAL STEP 1.2.4: DISCUSS MODEL WITH END-USERS.

- Develop end-user engagement strategy with other Research Aim Team Leads;
- Prepare presentations; and
- Participate in Hui.

CRITICAL STEP 1.2.5: PUBLISH RESULTS. Report results in at least one peer-reviewed journal article in a popular journal.

- Include results into a draft Paper for circulation to RA leads for review;
- All Research Aim Team Leads to review and edit Paper; and
- Submit, and have published, a Paper to an international peer-reviewed journal.

Impact Statement 1 > Research Aim 3: Develop a spatially-explicit machine learning predictor, using methodology provided in Research Aim 2 and training dataset provided in Research Aim 1, in order to meet the requirements and intent of Impact Statement 1 above. Critical Steps include:

CRITICAL STEP 1.3.1: DEVELOP STORM SURGE DATABASE. Use existing model simulations from Metservice to develop a database of storm surge around the NZ coastline.

- Download relevant fields from the MOANA backbone model from Metocean onto NESI and/or other platforms for analysis;
- Develop altimeter validation framework for coastal storm surge validation;
- Verify raw model against site data from RA1;
- Verify raw model against altimeter data from RA1; and
- If accuracy of Moana backbone is found to be insufficient for use as a training target, download and validate one or more of the Moana regional nests (e.g. Bay of Plenty).

CRITICAL STEP 1.3.2: TRAIN AGAINST MODEL DATA. Use the methodologies developed in Research Aim 2 against model time series.

- Implement python environment developed at UoC into a docker;
- Implement ML algorithm developed by post-doc and UoC into a docker;
- Develop a framework for the application of ML algorithm across model domain(s);
- Test training against model time-series at the same tidal station as UoC use; and

CRITICAL STEP 1.3.3: EXTEND TO SPATIAL DOMAIN. Use newly trained algorithm to extend spatial domain to the whole NZ coast using the high-resolution model in place of the observations.

- Train ML algorithm against model output along the NZ coastline. If deemed sufficiently accurate, using the MOANA backbone, otherwise, a MOANA regional nest;
- If compute constraints allow, extend from point outputs to image outputs using recurrent to convolutional recurrent networks;
- Verify results against sites from RA1 database; and
- Verify results against altimeter results from RA1 database.

CRITICAL STEP 1.3.4: DISCUSS MODEL WITH END-USERS. Discuss model with end-users.

- Review and amend end-user engagement strategy, with other Research Aim Team Leads, to ensure the intent of Impact Statement 1 will be met;
- Prepare reports/presentations; and
- Participate in Hui.

CRITICAL STEP 1.3.5: PUBLISH RESULTS. Report results in at least one peer-reviewed journal article in a popular journal.

- Include results into a draft Paper for circulation to RA leads for review;
- All Research Aim Team Leads to review and edit Paper; and
- Submit, and have published, a Paper to an international peer-reviewed journal.

Impact statement 1 > Research Aim 4: Develop prototype operational system at two key forecast sites, in order to meet the requirements and intent of Impact Statement 1 above. Critical Steps include:

CRITICAL STEP 1.4.1: PREPARE OPERATIONAL FRAMEWORKS. Prepare frameworks for running machine-learning algorithms developed in RA2 and RA3 as part of the routine operational forecasting system.

- Implement docker in scheduler/SPP framework or other.

CRITICAL STEP 1.4.2: PREPARE OPERATIONAL DOWNLOADS. Ensure that all required global input datasets are being downloaded routinely, and add those that are not.

- Add any missing downloads required as inputs into ML predictor to the scheduler;
- Register datasets in the metadataserver; and
- Make available to internal APIs.

CRITICAL STEP 1.4.3: PRODUCE A REAL TIME DEMONSTRATION FORECAST. Use these inputs with the methodologies developed in RA3 to produce a real time demonstration forecast at the two sites identified in RA5.

- Implement docker in scheduler and/or SPP framework or other; and
- Make the required alterations to data input retrieval methods to fetch inputs using Metservice internal APIs (forecast and regrid).

CRITICAL STEP 1.4.4: DATA VISUALISATION PLATFORM. Add output forecast to existing Metocean data visualisation platform.

- Make available to the frontend (MOV/MOV2) via internal APIs.

CRITICAL STEP 1.4.5: MAKE DATA AVAILABLE THROUGH API. Make raw data available through API for low bandwidth applications.

- Make available via external APIs

Impact statement 1 > Research Aim 1.5: Consult with coastal iwi to understand the hazard warnings and information needed to successfully prepare for coastal flooding hazards, in order to meet the requirements and intent of Impact Statement 1 above. Critical Steps include:

CRITICAL STEP 1.5.1: SELECT SITES. Select with the help of existing MetService, Whakatohea, Taranaki, and University of Waikato contacts, two case studies with vulnerable sites (marae, urupa), where iwi are open to discussions on flooding hazards. Step to include:

- identification of key stakeholders (including all project 'end-users') and mechanisms for engagement;
- development of an iwi engagement strategy, including workshops, to explore improvements in the delivery of hazard warnings and receive feedback on their utility and accessibility. The strategy will be approved by the TAG;
- development of an end-user engagement strategy. The strategy will be approved by the TAG; and
- identification of two case study sites and development of project delivery plan. The sites and plan will be approved by the TAG.

CRITICAL STEP 1.5.2: CONTINUED ENGAGEMENT. Continued engagement, including with wider End-User Group throughout the project. Step to include:

- delivery of the iwi engagement strategy;
- co-identification, with iwi, of the best methods for delivery of coastal hazard warnings to iwi; and
- co-identification, with iwi, of the strategy for delivery of coastal hazard warnings to iwi; and
- delivery of the project delivery plan, including two case studies.

CRITICAL STEP 1.5.3: COMMUNICATION OF OUTCOMES.

- communicate outcomes in-line with iwi engagement strategy and project delivery plan.

DELIVERING IMPACT STATEMENT 1: PROJECT APPROACH AND RESEARCH AIM INTERFACES
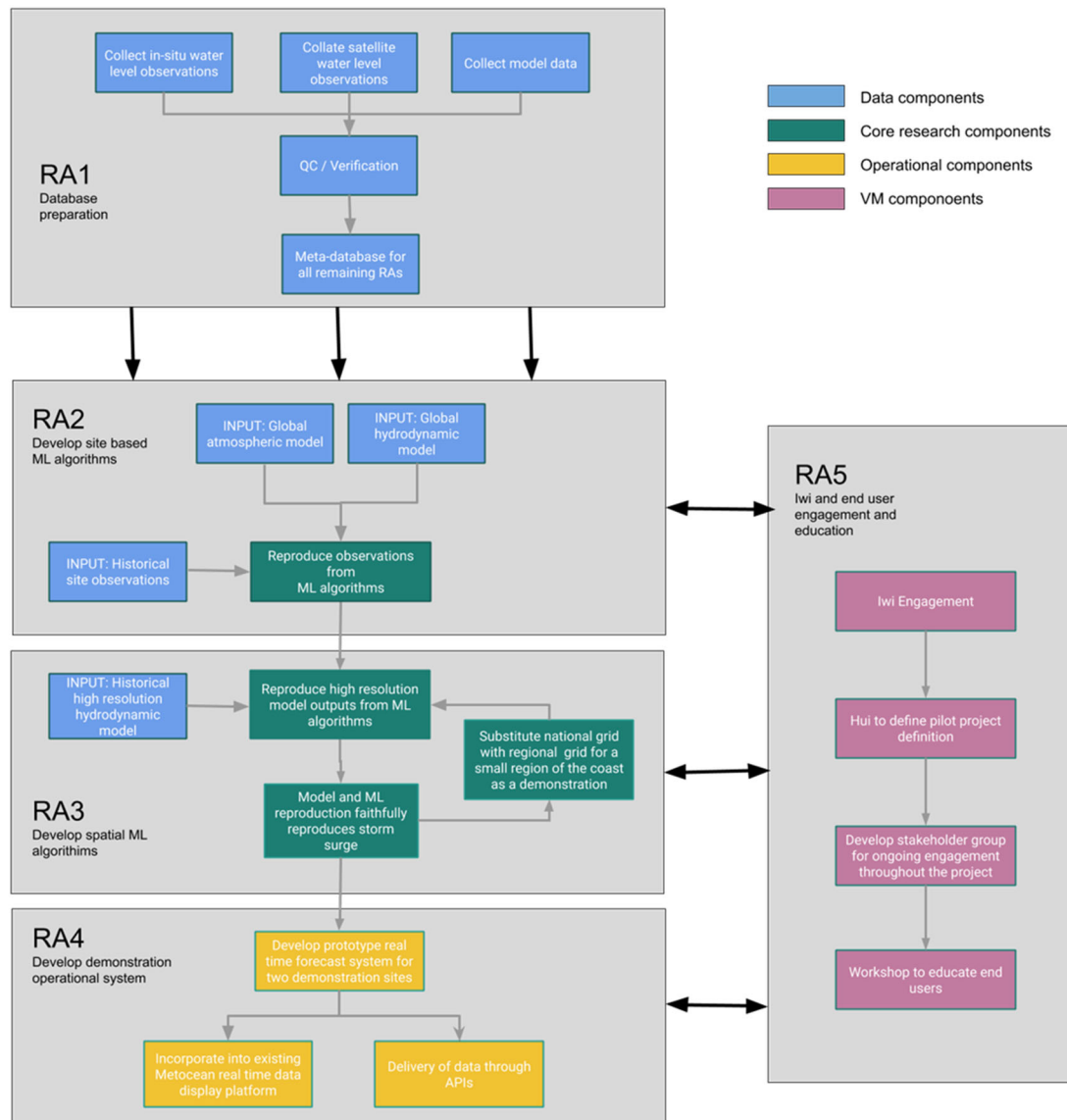
Schedule Three: Intellectual Property Policies and Principles

With regards to intellectual property, MetService and the Contractor will:

1. use best endeavours to maximise benefits to New Zealand through appropriate risk assessment, licencing and management of any intellectual property rights;
2. acknowledge the relevant ownership and rights associated with all new intellectual property;
3. advise relevant researchers and employees of the actual or potential value of new intellectual property and their options (if any) to add value;
4. advise researchers of any actual or potential confidentiality issues relating to intellectual property rights;
5. develop clear and binding obligations for relevant staff, in relation to management and protection of intellectual property rights;
6. identify protectable and potentially commercially valuable new intellectual property rights and to prevent the infringement of existing or third party intellectual property rights (or future development and commercialisation thereof);
7. ensure that, in relation to intellectual property rights (i) conflicts of interest are identified and promptly resolved, (ii) good scientific conduct standards are met, including sound record keeping and human and animal experimentation ethics, and (iii) all legal and regulatory obligations are met;
8. properly consider cultural, Treaty of Waitangi and Māori issues including (i) the principles of Māori data sovereignty and (ii) management of mātauranga (or Māori pre-existing intellectual property rights); and
9. give preferential access to competent New Zealand-based firms to develop the intellectual property rights; always ensuring Principle 1 above is achieved.