White Paper

# SEASTATES: Metocean Hindcast Model for Northeast Asia

## Validation summary

February 2021

Innovative Thinking - Sustainable Solutions

ABP mer

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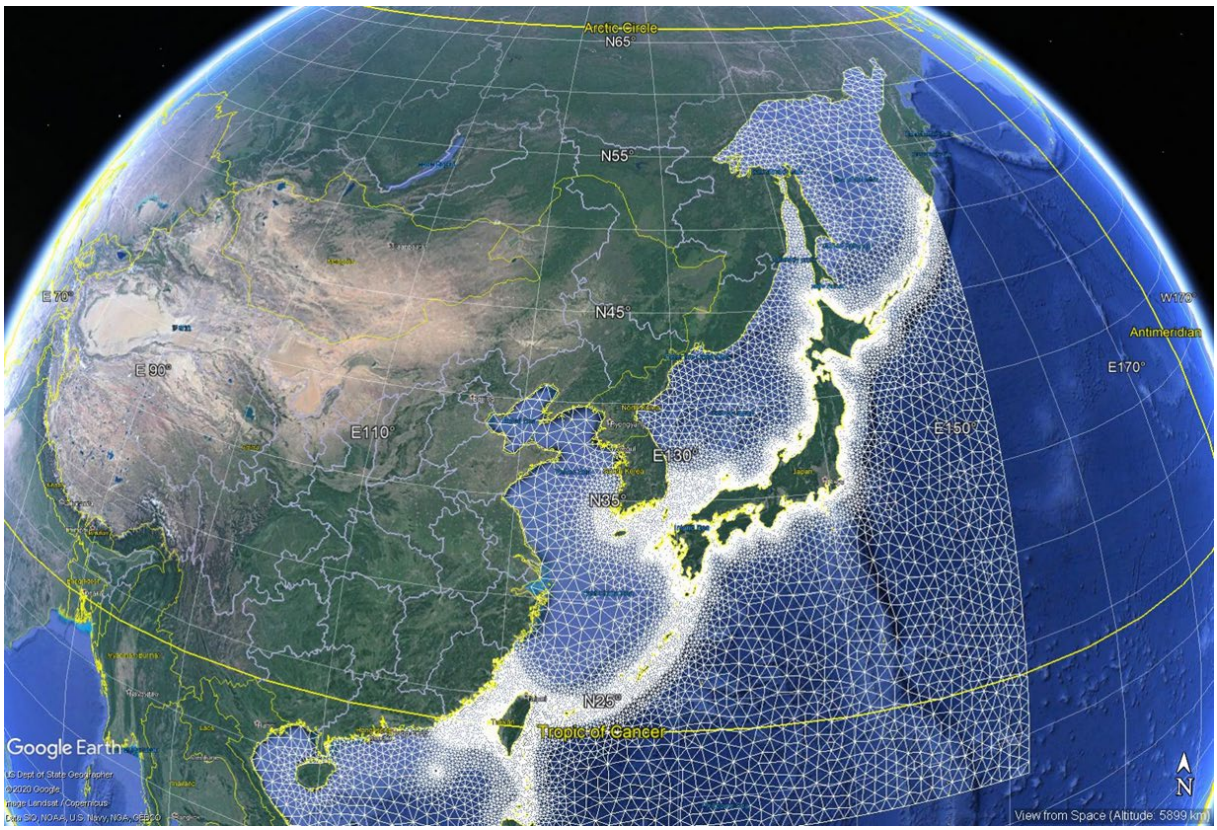

# Summary

A detailed knowledge of the marine environment is important for the design, operation and decommissioning of offshore installations. Robust and cost-effective engineering design, and operational planning for construction and maintenance rely on accurate data to inform decision making. To support marine industry, ABPmer has developed its SEASTATES metocean information service (http://www.seastates.net).

As part of our ongoing service development, we created the SEASTATES Northeast Asia Metocean Database to provide wind and wave parameters across the northeast Pacific Ocean.

The database is underpinned by our metocean hindcast model for Northeast Asia. The hindcast model is run from the beginning of January 1979 and is updated regularly. At the time of writing, the hindcast provides a *circa* 40-year database of wind and wave parameters suitable for applications including site characterisations, metocean analysis and local model boundary conditions.

A detailed assessment of the SEASTATES Northeast Asia Model has shown that the hindcast model accurately represents the wind and wave conditions at various stations in the model domain, as well as the individual wave components.

ABPmer now provides a range of metocean services across Northeast Asia. These include the following:

- High level climatological characterisation of meteorological and oceanographic processes;
- Long-term (40-year duration) time series of non-cyclone wind and wave data, calibrated against satellite observations and, where available, against *in situ* measurements;
- Model simulation of winds and waves associated with historical tropical cyclone events;
- Operational metocean statistics; and
- Extreme metocean statistics.

Our team of highly experienced metocean consultants using an extensive suite of metocean analytical software have undertaken many projects worldwide, meeting the requirements and expectations of major international offshore operators and certifying authorities.

This document provides an introduction to our SEASTATES model for Northeast Asia.

# Model Set-up

## Overview

The SEASTATES Northeast Asia Model has been built using the state-of-the-art Danish Hydraulic Institute (DHI) software package MIKE21FM (Flexible Mesh). The modelling system was developed by DHI for applications within oceanographic, coastal and estuarine environments.

MIKE21 Spectral Wave (SW) simulates wave growth and propagation in the area of interest. This approach follows that used to produce further regional models within ABPmer including the SEASTATES Wave Hindcast Model of the North Atlantic and North-eastern European Continental Shelf.

## Spatial domain

The MIKE SW model is configured with an unstructured grid (interlocking triangles of variable size and orientation). The mesh is designed to provide particularly high resolution in Japanese, South Korean and Taiwanese coastal waters.

The mesh is divided into five different areas of resolution, from 50 km in the deeper offshore areas of the model, increasing to approximately 7.5 km around South Korea and the island chain joining Taiwan and Japan. At its finest, the model is approximately 3 km resolution within 50 km of the Japanese and Taiwanese coastline.

The model accounts for the physical processes of wind wave growth and spectral transfer across large open water fetches, as well as wave transformation (shoaling, refraction, breaking etc.) in coastal and shallow water regions. The model grid is shown in Figure 1, Figure 2 and Figure 3.

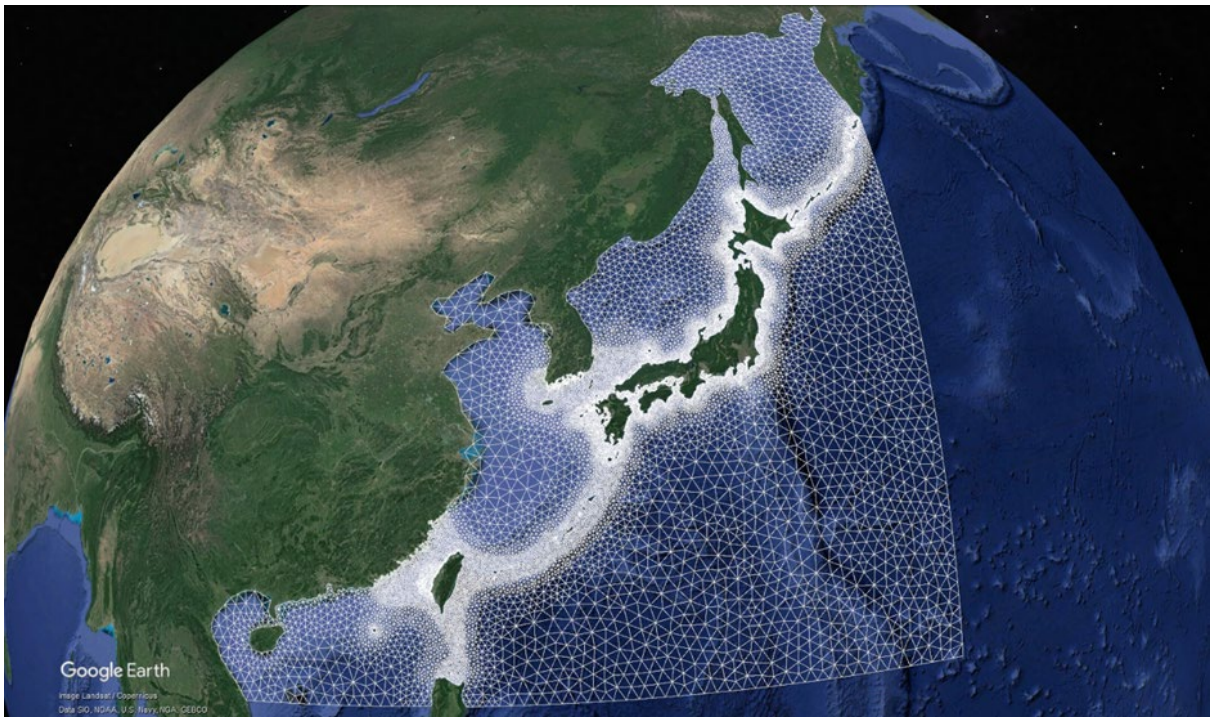


**Figure 1. ABPmer Northeast Asia Metocean Hindcast Model Grid – Full Domain**

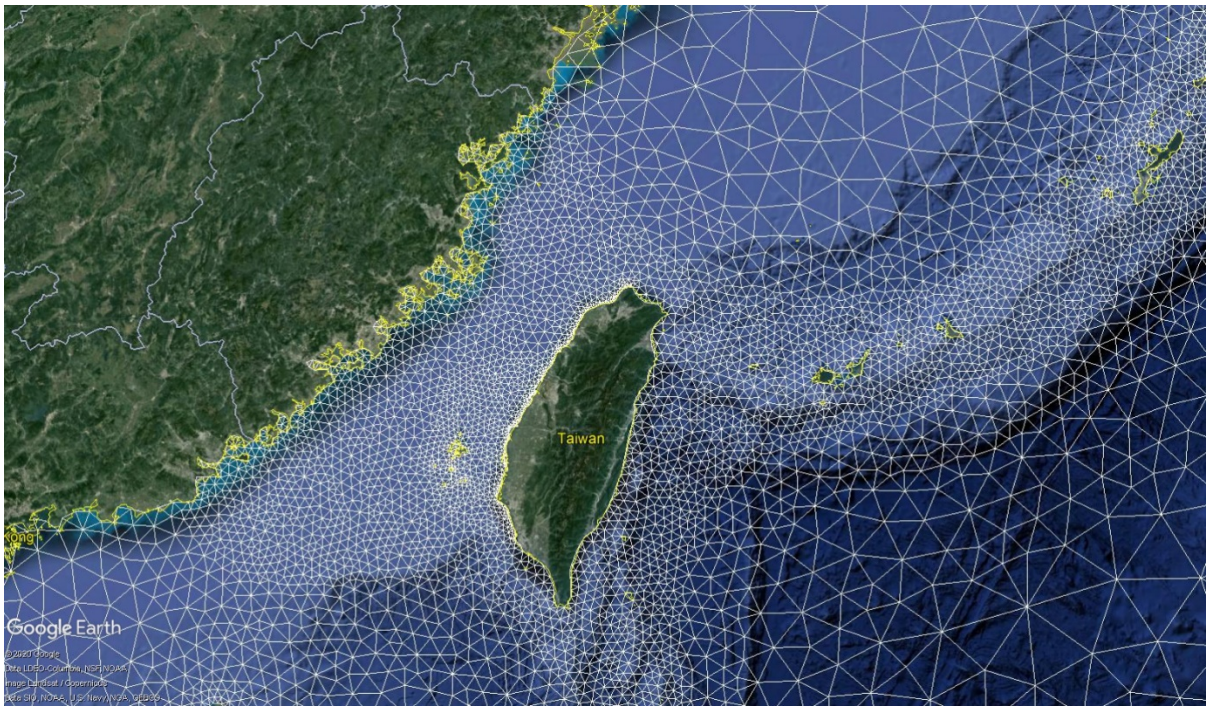


**Figure 2. ABPmer Northeast Asia Metocean Hindcast Model Grid – Taiwan and Adjacent Waters**

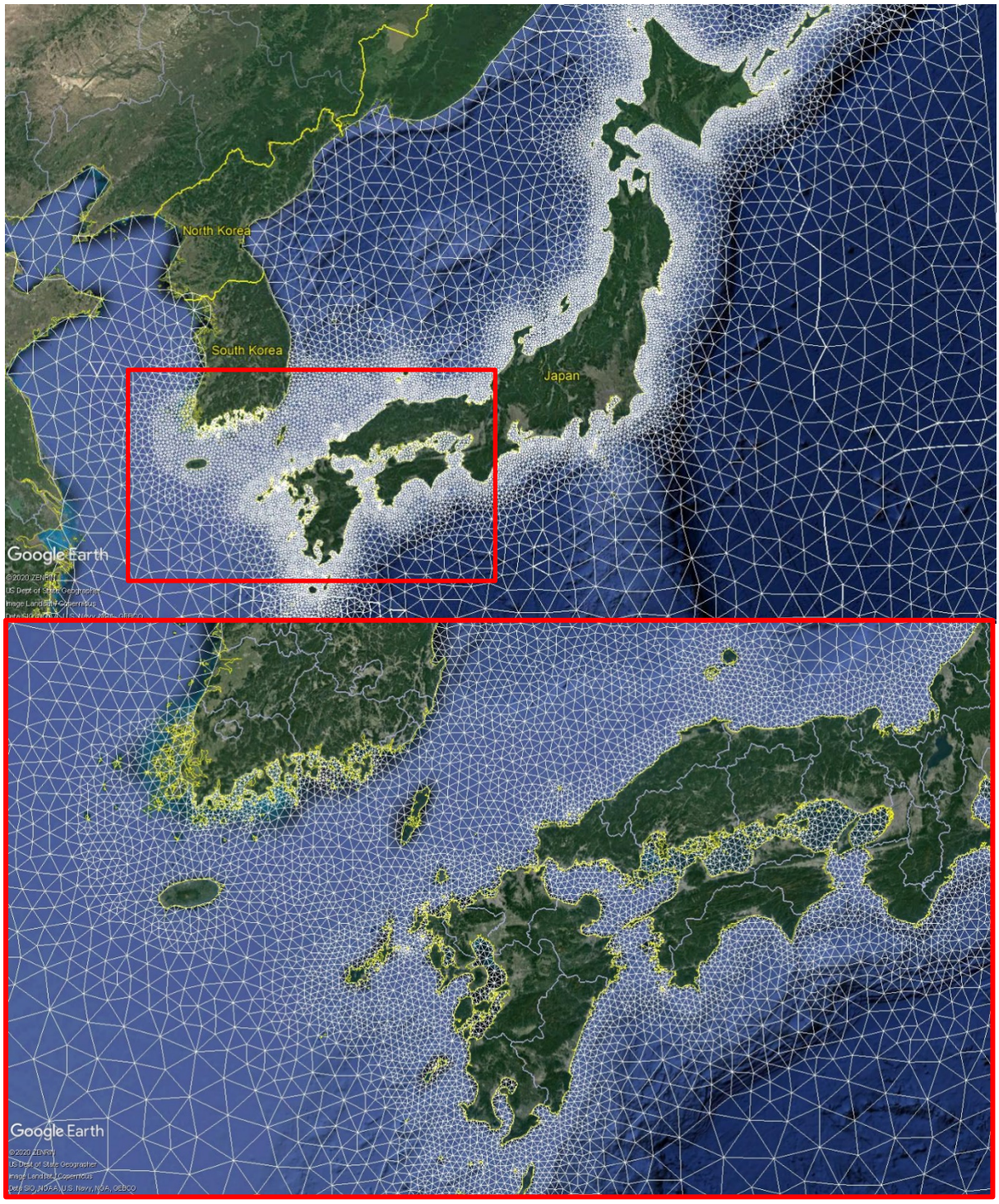


**Figure 3. ABPmer Northeast Asia Metocean Hindcast Model Grid – High Resolution Around Japan, South Korea and Adjacent Waters**

# Bathymetry

Bathymetry data were sourced from GEBCO (www.gebco.net), at a spatial resolution of 30 arc-seconds (850-900 m) (Figure 4). GEBCO bathymetry includes charted and other sounding data in shallower water areas and has been used successfully by ABPmer to build a number of regional scale models.

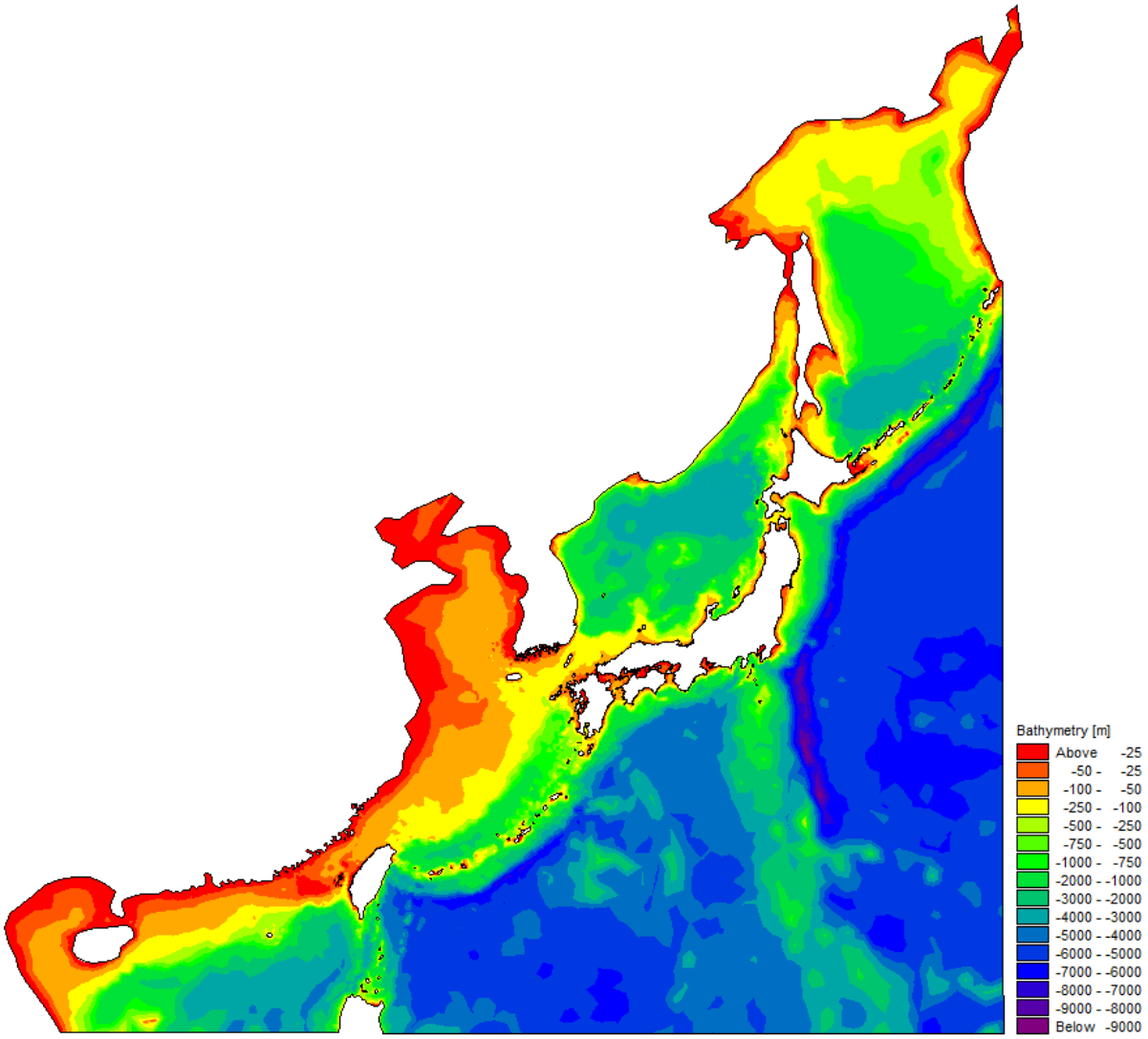


**Figure 4. Interpolated GEBCO Bathymetric Data Over the Model Domain**

## Meteorological forcing

The model is forced by hindcast surface wind fields, validated against long-term satellite altimeter observations. The NOAA National Centers for Environmental Prediction Climate Forecast System Reanalysis and Reforecast (CFSR) (www.ncdc.noaa.gov) provides a homogeneous dataset of historical hourly wind speed and direction for the full duration of the hindcast period (January 1979 to May 2019).

## Wave boundaries

Wave boundary conditions for the model have been obtained from the WAVEWATCH III® Hindcast Phase 2 hindcast database (polar.ncep.noaa.gov), provided by the Marine Modelling and Analysis Branch of the NOAA NWS NCEP Environmental Modelling Centre. The database provides three-hourly total sea wave height, period and direction parameters at 0.5-degree resolution along the open boundaries of the model for the period January 1979 to May 2019. Data are extracted along the two open model boundaries, on the southern and eastern edges of the model domain, with wave parameters varying in both space and time.

## Output parameters

The resultant hindcast provides a range of wave height, period and direction parameters, including Hs, Tz, Tp, peak and mean direction, at hourly intervals, from January 1979. Total sea and separated wind sea and swell sea components are available.

More detailed spectral outputs (direction and frequency) are also available for selected locations. Spectral data are also available to provide boundary conditions for even higher resolution local models if and where required.

# Model Validation

The hindcast wave dataset has been validated against wave buoy data around Taiwan and long-term satellite altimeter measurements at locations around the Japanese and Taiwanese coastlines.

A summary of validation plots is shown in Figure 5 and Figure 6.

Overall, the detailed validation demonstrates that the SEASTATES Northeast Asia Model provides an accurate and reliable hindcast of non-cyclonic wave conditions to inform a wide range of applications including engineering design and operational planning.

The model provides an improved description of regional and local scale wave climate, with higher resolution and greater accuracy in shelf and coastal areas, over a longer period than is currently otherwise available.

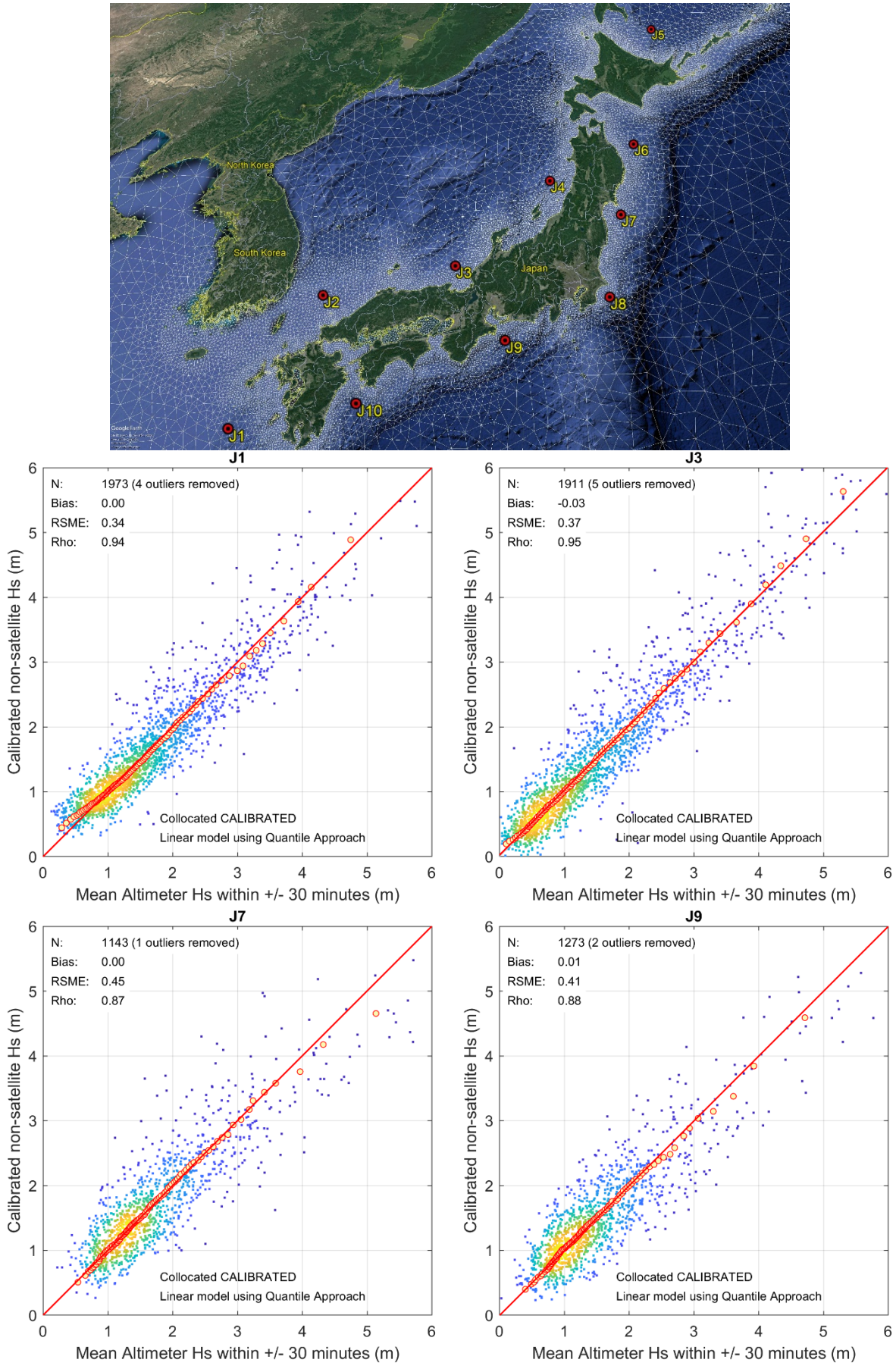


**Figure 5. Selected Model Validation Locations - Japan**

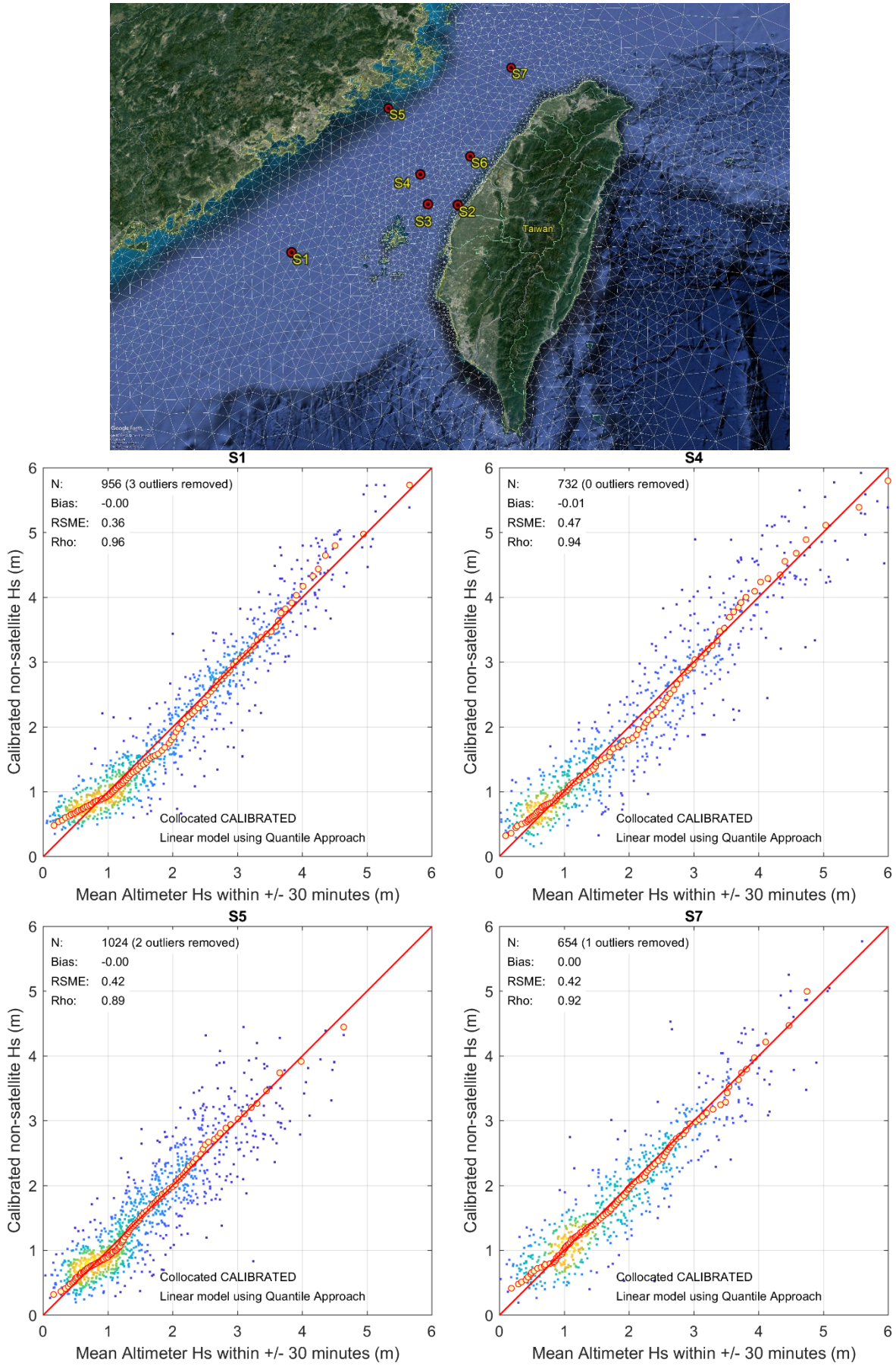


**Figure 6. Selected Model Validation Locations - Taiwan**

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