A photograph of an offshore wind farm with several white wind turbines in a line across a blue sea under a clear sky. The perspective is from a low angle, looking down the line of turbines.

De-risking windfarms with an interoperable, interconnected environment for Integrated Ground Model building and management.

13th March 2024

Fiamma Giovacchini –
Geologist and Customer
Solutions Specialist,
Seequent



Scene Setting

The Need

- **Global expectations** for offshore wind capacity to meet clean energy targets for 2030
- **Speed of growth = pressure** on contractors and operators to commission offshore windfarms

The Challenges

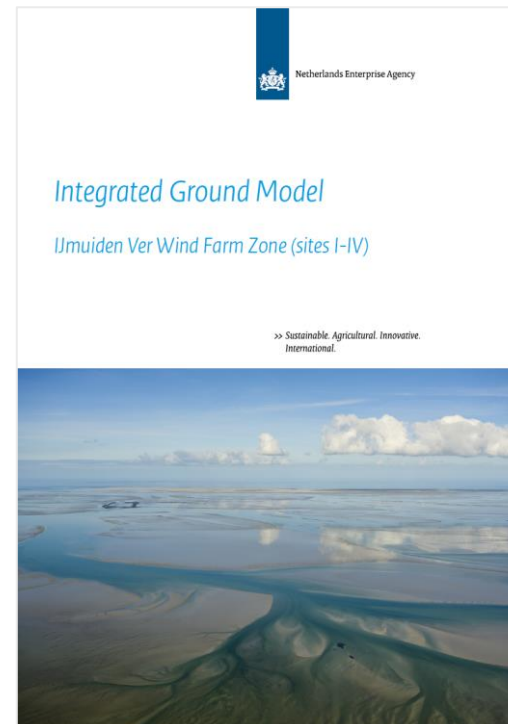
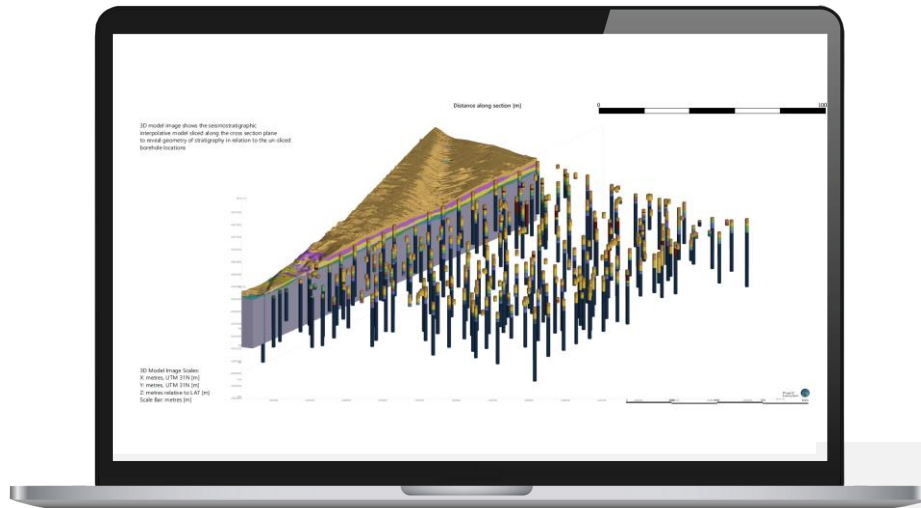
- **Inflation and interest rates** “disproportionately impacted offshore wind, which saw a 50% rise in its LCOEs (Levelised Costs of Energy) from 2021 to 2023.” - *Deloitte Research Center for Energy & Industrials, US*
- **High costs associated to offshore investigations and installation** of offshore wind arrays
- **Increased size of arrays and turbine & power drive increase** lead to increased impact of uncertainty and risk
- **Data** can be **locked**
- **Multidisciplinary teams – risk of siloing**
- **Lack of interoperability**
- **Multiple stakeholders** – owners, operators, investors, consultants, regulators, insurers

What Do We Mean by Integrated Ground Model?

‘The Integrated Ground Model (IGM) at the IJV Investigation Area is the result of iterative integration techniques using a wide range of datasets and processes.’

The scope for the integrated ground model and digital deliverables includes:

- Evolutionary **geological setting**
- Geophysical units and **seismostratigraphy**
- **Summary of soil units**
- **Integration of geophysical units and soil units** for the site to develop soil province maps
- **Geo-risk register**
- **Compilation of geodata and GIS formats;**
- **3D geological model**



‘Engineering Geological Model (EGM) – a comprehensive knowledge framework that allows for the logical evaluation and interpretation of the geological (...) conditions that could impact a project and their engineering characteristics. The EGM comprises both conceptual and observational components and may consist of a number of interrelated models and approaches. The Geological Model, the Geotechnical Model and a Geohazard Assessment are outputs from the EGM knowledge framework.’

The EGM development process is illustrated in Figure 1-3 and detailed below.

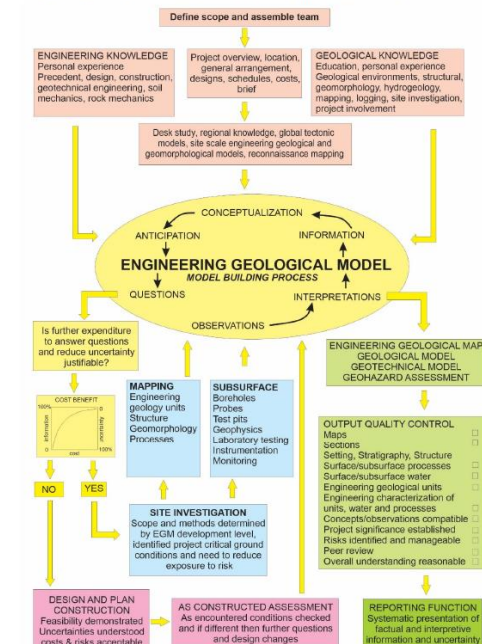


Figure 1-3 The EGM development process.

<https://www.iaeg.info/C25EGMGuidelines/>

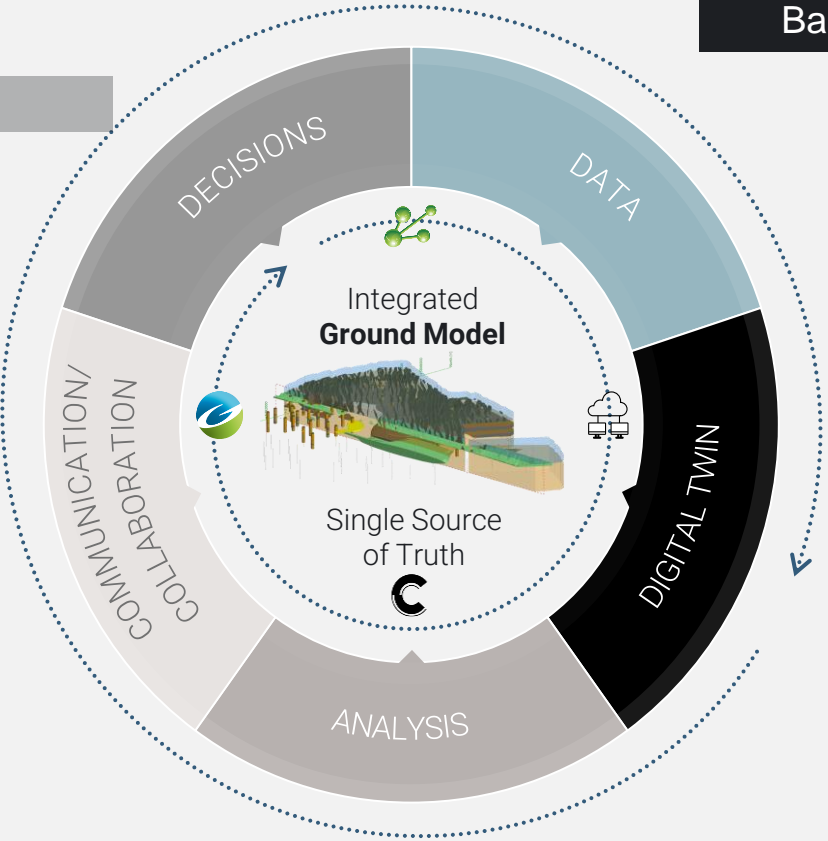


Characteristics of Integrated Ground Models

Utilise and integrate
multiple datasets

Based on all the existing data and knowledge

Result of a collaborative process



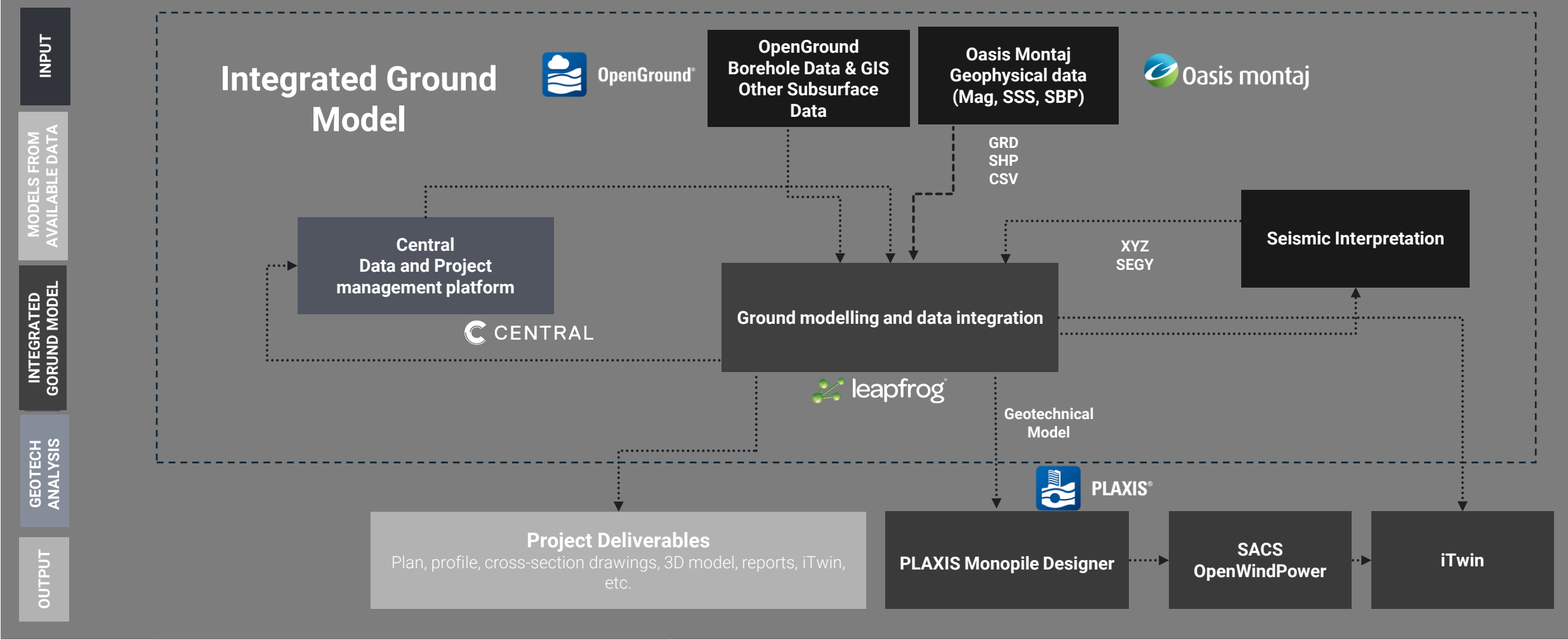
Based on best practice

Evergreen

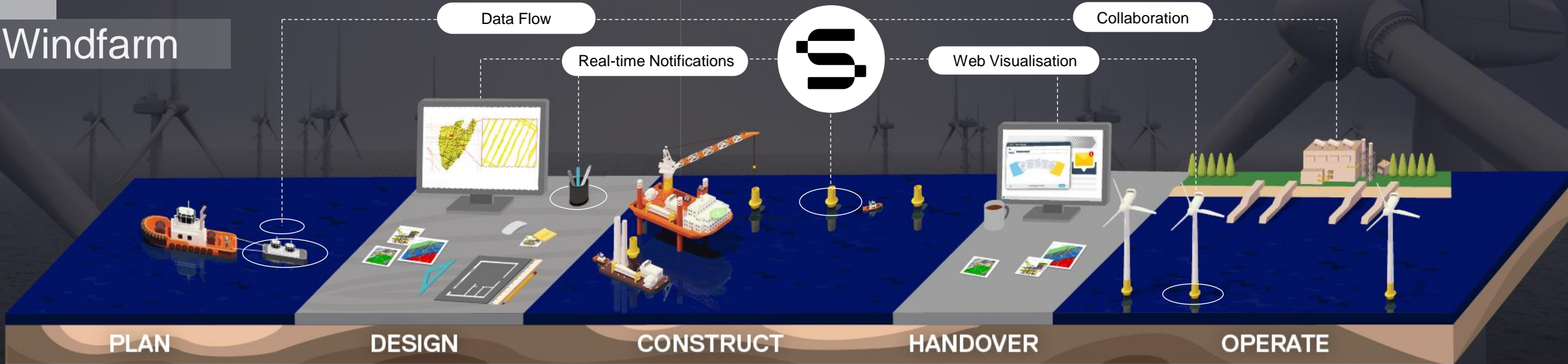
High interoperability



Offshore Wind Farm Ground Modelling Workflow



Windfarm



Geotechnical Digital Twin & Cloud Collaboration

Preliminary Site Analysis	Integrated Ground Model	Analysis and Design	Design Revision & Verification	Construction	Asset Operation and Monitoring
leapfrog	Oasis montaj	PLAXIS	SACS	OpenWindPower	
	Geotechnical Information Management	OpenGround			
CENTRAL				iTwin	
					AssetWise

- The **Hollandse Kust Wind Farm** covers 356 km^2 and is divided into four sites, each of which can accommodate 350 MW
- The location of this project is Hollandse Kust Zuid
- This site is 18 kilometres off the coast, in the area between The Hague and Zandvoort
- We thank the Netherlands Enterprise Agency for making this data freely available for the public to use

Acknowledgements

Seequent would like to acknowledge the Netherlands Enterprise Agency for releasing the Hollandse Kust data package under a creative commons license (4.0 CC BY SA), which has formed the basis of this integrated modelling study. Open-source data are a key driver of innovation and therefore a crucial aspect of defining best-practice for offshore wind farm development.



Uncertainty Evaluation and Modelling

- Attribution of confidence level to different input datasets
- Confidence model
- Confidence heatmaps for each modelled surface

Acknowledgements

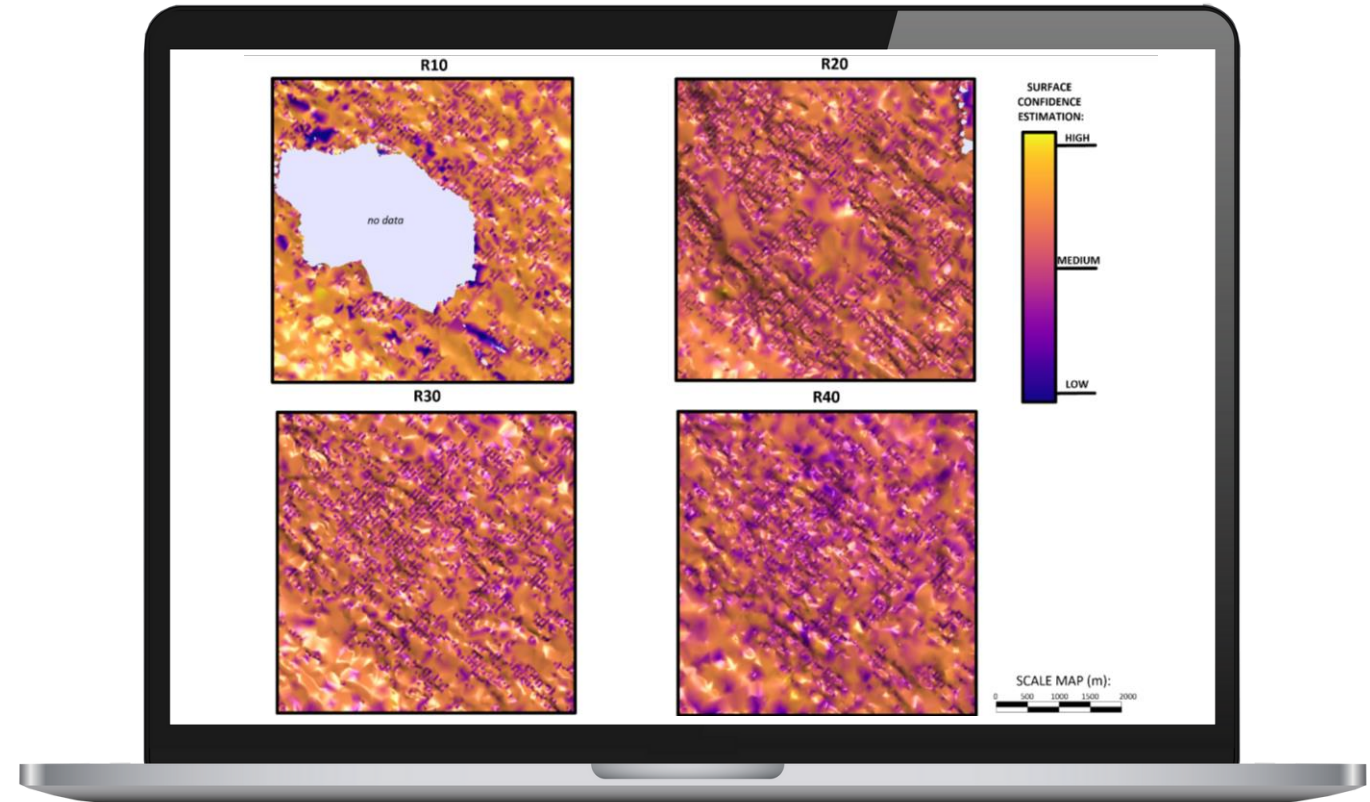
3D Ground Model: An Alternative Approach for the Treatment of Heterogeneously Distributed Spatial Data

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Benefits of Integrated Ground Models

High cost of offshore investigations and installation (inflation)

Increased size & power of arrays increase in uncertainty and risk

Data silos – Multidisciplinary teams working on different datasets

Lack of Interoperability of that data

Cost/Design Optimization – reduce design conservatism

Improve understanding of uncertainty
Improved investigation planning
Less delays

Removing silos & promoting collaboration thanks to common cloud environment

Unlocking the data - Data from different domains is integrated within the same environment

Safety – Reduce Lost Time, Incidents, or Worse

