



International Workshop on  
Offshore Geologic CO<sub>2</sub> Storage



# STEMM-CCS Open Science Meeting and 4<sup>th</sup> International Workshop on Offshore Geologic CO<sub>2</sub> Storage

11-12 February 2020

*Hosted by the University of Bergen*

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## STEMM-CCS Open Science Meeting & 4th International Workshop on Offshore Geologic CO<sub>2</sub> Storage

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### Acknowledgements

The organisers are grateful to CLIMIT, STEMM-CCS, GCCC and IEAGHG for their support for this meeting, with particular thanks to the University of Bergen for hosting the event and providing logistical assistance.

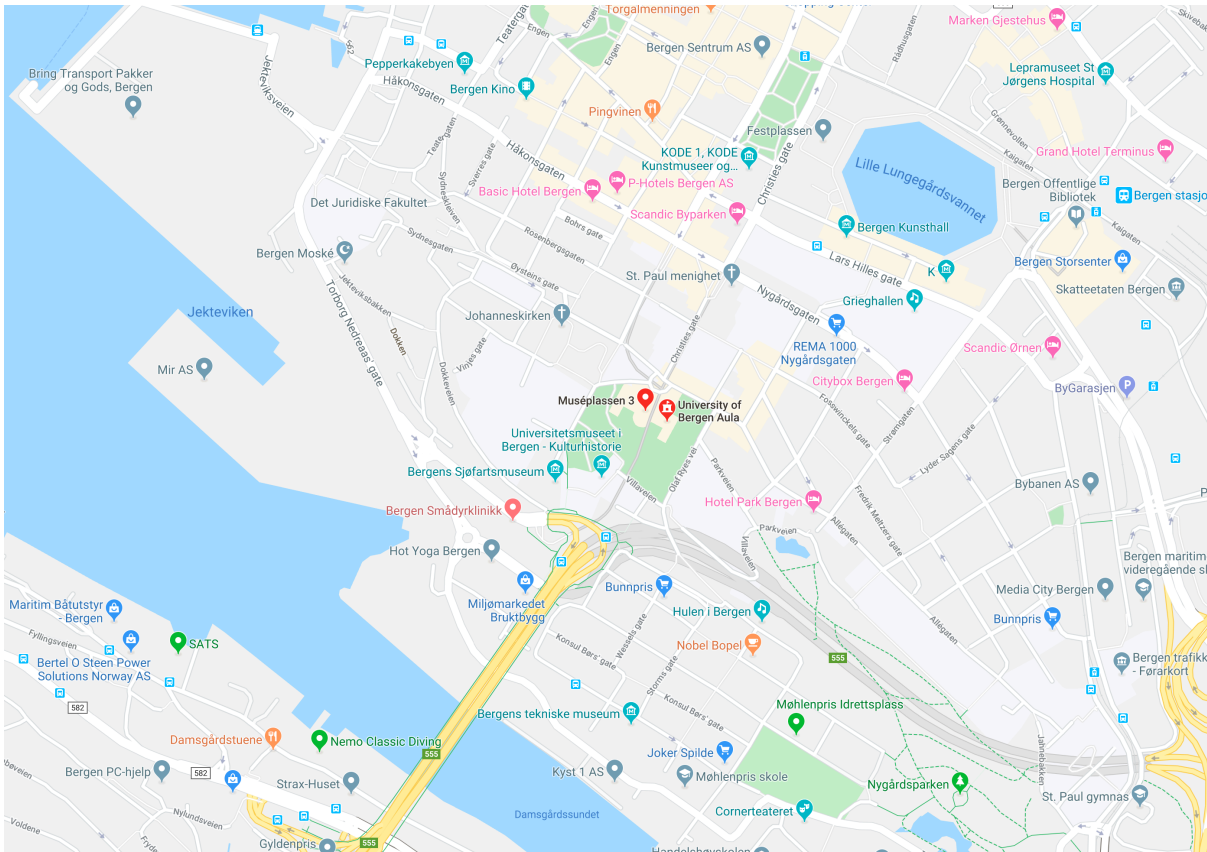


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## Meeting Venue

The University Aula, Museplassen 3, Bergen

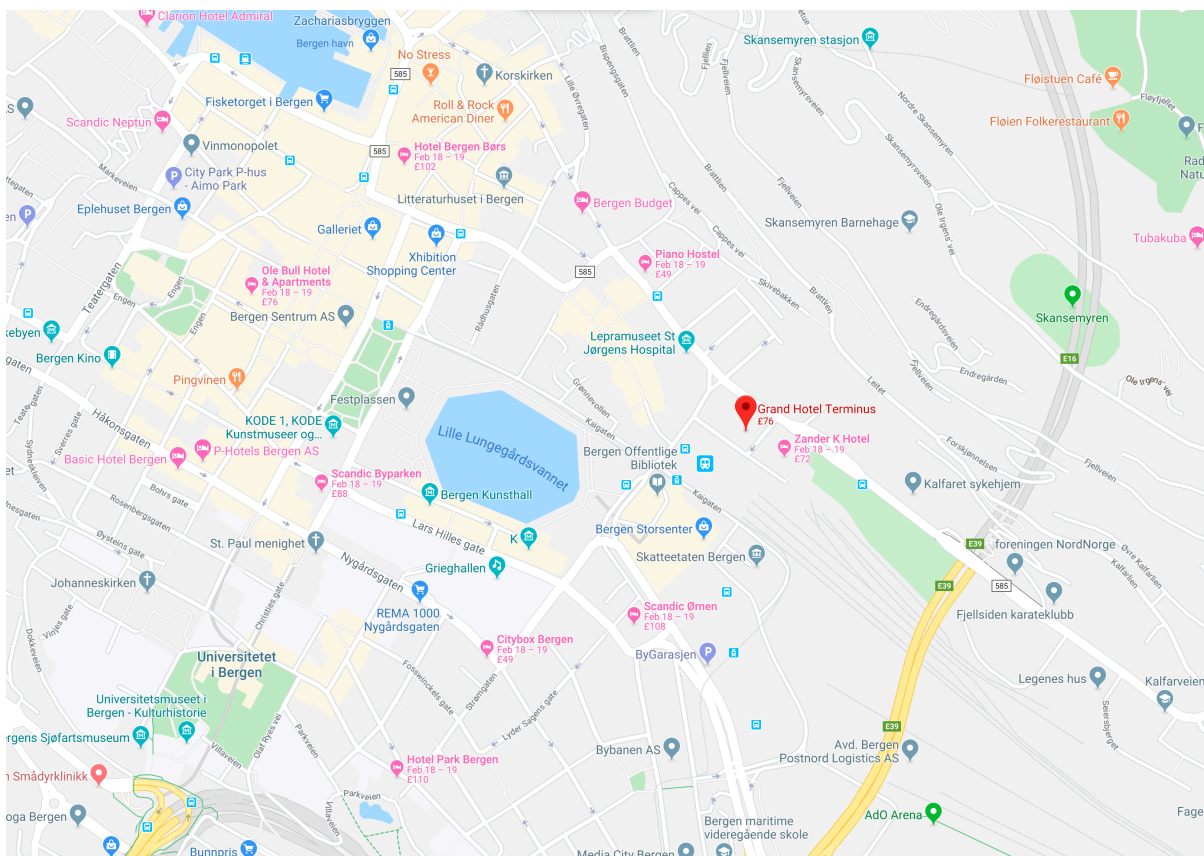
Entry through Muséhagen, the museum garden, from Olaf Ryes vei.



# Conference Dinner Venue

Grand Hotel Terminus, Zander Kaaes gate 6, 5015 Bergen

Wednesday 12<sup>th</sup> February at 19:00.



## Conference Programme

Tuesday 11 February 2020	
08:30	Registration
09:00	Welcome from University of Bergen – Pro-Rector Margareth Hagen
09:05	Welcome from STEMM-CCS and the Offshore Workshop – Doug Connelly (STEMM-CCS), Katherine Romanak and Tim Dixon (Offshore Workshop)
09:15	CCUS activities in Bergen – Dean Gunn Mangerud, University of Bergen
<b>Session 1. Technological and Engineering challenges</b> <i>Chair: Matt Mowlem, NOC</i>	
09:30	STEMM-CCS: Pushing the boundaries – Doug Connelly, National Oceanography Centre
09:45	<b>Invited talk:</b> Enabling a CO <sub>2</sub> release experiment in the North Sea – Kevin Saw, National Oceanography Centre
10:00	An Overview of the Design, Build and Testing of the CO <sub>2</sub> Injection Rig – Allan Spencer, Cellula Robotics
10:15	Shallow subsurface coring with a robotic seafloor drill – Oliver Peppe, British Geological Society
10:30	Development and deployment of a suite of autonomous in situ carbonate sensors for the STEMM-CCS gas release experiment – Samuel Monk, National Oceanography Centre
10:45	pH optodes for CO <sub>2</sub> leakage detection – Sergey Borisov, TU Graz
11:00	Coffee & Posters
<b>Session 2. Infrastructure</b> <i>Chair: Paulo Negrals Seabra</i>	
11:20	Use of existing infrastructure and knowledge base by Northern Lights – Philip Ringrose, Equinor
11:35	How to develop storage near and around existing infrastructure – Russ Gilbert, Pale Blue Dot
11:50	Issue with re-use of depleted fields infrastructure – lessons from Porthos project – Filip Neele, TNO
12:05	Plugging and abandoning well strategies for storage development – Sarah Gasda, NORCE Norwegian Research Centre / University of Bergen
12:20	Discussion
12:30	Lunch & Posters

<b>Session 3: Understanding complexity</b>	
<i>Chair: Christian Berndt, GEOMAR</i>	
13:30	<b>Invited talk:</b> What is sufficient for a “baseline”? – Jerry Blackford, Plymouth Marine Laboratory
13:45	Water column environmental baseline assessment for offshore CCS sites: analysis of field data from the Goldeneye storage complex – Mario Esposito, GEOMAR
14:00	The pH distribution in and around a CO <sub>2</sub> vent – Dirk der Beer, Max Planck Institute
14:15	<b>Invited talk:</b> Geophysical approaches to fluid flow in the subsurface and water column – Jon Bull, University of Southampton
14:30	Underground CO <sub>2</sub> storage assurance - The assessment of onshore geological analogues of fluid-escape systems – Panoche Hills, California – Ben Callow, University of Southampton
14:45	Elastic and hydromechanical properties of fractured sandstone reservoirs during and after CO <sub>2</sub> storage – Ismael Falcon Suarez, National Oceanography Centre
15:00	Relating geophysical properties from control source electromagnetic and seismic data at a fluid escape structure in the Northern North Sea – Naima Yilo, University of Southampton
15:15	Coffee & Posters
<b>Session 4: Deep Subsurface Monitoring and modelling offshore CO<sub>2</sub> storage</b>	
<i>Chair: Philip Ringrose, Equinor</i>	
15:30	Geophysical monitoring in the overburden, what can we detect? – Martin Landro, NTNU
15:45	Offshore monitoring for CCS – safe and effective monitoring at lower costs – Marcella Dean, Shell
16:00	Pressure, faults, and CO <sub>2</sub> leakage – Jen Roberts, University of Strathclyde
16:15	Discussion
<b>Session 5: Regulatory Frameworks</b>	
<i>Chair: Owain Tucker, Shell</i>	
16:30	Whose fault is it when a well leaks, review of regs in different CCS countries – Ingvild Ombudstvedt, IOM Law
16:40	London Protocol CO <sub>2</sub> Export Resolution – Tim Dixon, IEAGHG
16:50	Legal aspects of re-use of infrastructure – Martha Roggenkamp, University of Groningen
17:00	Offshore best practice in the USA – Brian Hill, CrescentRI
17:15	Discussion
17:30	Meeting close

<b>Wednesday 12 February</b>	
<b>Session 6: Detection, Quantification &amp; Qualification</b>	
<i>Chair: Guttorm Alendal, University of Bergen</i>	
09:00	<b>Invited talk:</b> Making containment verification cost effective: new methods for autonomous observation of offshore CCS reservoir integrity – Matt Mowlem, National Oceanography Centre
09:15	Lab on chip carbonate sensors for quantification and mapping of a plume of dissolved CO <sub>2</sub> – Allison Schaap, National Oceanography Centre
09:30	Utility of tracers for CO <sub>2</sub> leakage detection and quantification in the marine environment – Rachael James, University of Southampton
09:45	The migration of carbon dioxide within shallow sediments at the STEMM-CCS release site: analysis of AUV-mounted Chirp sub-bottom profiling data – Ben Roche, University of Southampton
10:00	Leakage monitoring and quantification by tracing and modelling dissolved CO <sub>2</sub> plumes at the Goldeneye CO <sub>2</sub> release experiment – Jonas Gros, GEOMAR
10:15	The Cseep method as a monitoring tool to detect and quantify CO <sub>2</sub> seepage – Abdirahman Omar, NORCE Norwegian Research Centre
10:30	Modelling of leakage scenarios to determine impact and anomaly criteria for detection – Marius Dewar, Plymouth Marine Laboratory
10:45	Coffee & Posters
<b>Session 7: Project Updates</b>	
<i>Chair: Tip Meckel, Gulf Coast Carbon Center, Bureau of Economic Geology</i>	
11:15	Northern Lights project – Philip Ringrose, Equinor
11:21	Lula – Paulo Negrais Seabra, former Petrobras
11:27	Tomakomai – Jiro Tanaka, JCCS
11:33	US storage resource assessments – Darin Damiani, US DOE
11:39	GoMCARB Partnership -Tip Meckel, UTBEG
11:45	SECARB Offshore Partnership – Mike Godec, ARI
11:51	South Africa offshore feasibility study – KB Trivedi, PetroSA
11:57	NORDICCS/BASRECCS – Gry Mol Mortensen, SGU
12:03	Porthos and Athos Projects - Filip Neele, TNO
12:09	Net Zero Teesside Project UK – Philippe Legrand, BP
12:15	Acorn – Russ Gilbert, Pale Blue Dot
12:21	Discussion

12:35	Lunch & Posters
<b>Session 8: Emerging CCS country needs and progress</b> <i>Chair: Katherine Romanak, University of Texas</i>	
14:00	Trinidad & Tobago – Lorraine Sobers, UWI
14:10	Korea – Se Won Chang, CCS Research Center in Kongju National University
14:20	Taiwan – Katherine Romanak, BEG
14:30	Discussion - Global Sum up – Tim Dixon, IEAGHG
<b>Session 9: Synthesis – the end products</b> <i>Chair: Doug Connelly, National Oceanography Centre</i>	
14:45	<b>Invited talk:</b> Beyond STEMM-CCS: Implications for offshore CCS and marine CO <sub>2</sub> monitoring – Chris Pearce, National Oceanography Centre
15:00	The STEMM-CCS online monitoring and decision support tool – Anna Lichtschlag, National Oceanography Centre
15:15	<b>Invited talk:</b> Industry perspective on results of STEMM-CCS project – Marcella Dean, Shell
15:30	STEMM-CCS: informing regulatory bodies and policy makers – Doug Connelly, National Oceanography Centre
15:40	Panel discussion on implications and application of STEMM-CCS outcomes – Chair: Vikki Gunn, Seascope Consultants
16:00	Coffee & Posters
<b>Session 10: Wrap up</b> <i>Chair: Katherine Romanak and Tim Dixon</i>	
16:15	Brainstorming towards an international collaborative project and funding
	Conclusions and recommendations
17:00	Closing remarks – Doug Connelly (STEMM-CCS), Katherine Romanak and Tim Dixon (Offshore Workshop)
17:05	Meeting close
19:00	Dinner at the Grand Hotel Terminus, Zander Kaaes gate 6, 5015 Bergen



## Poster presentations

Poster title	First author
Deployment of benthic chambers at the Goldeneye CO <sub>2</sub> -release field experiment: Lessons learned for CCS leak detection.	Jonas Gros, GEOMAR
Aquatic Eddy Covariance, a Highly Sensitive Tool for the Quantification of a Release of Dissolved Inorganic Carbon at the Seafloor	Dirk Koopmans, Max Planck Institute, Bremen
Deviations from environmental baseline: indication of CO <sub>2</sub> leakage from real-time measurements	María Martínez Cabanas, GEOMAR
Passive acoustic quantification at the STEMM-CCS release site - application of beam forming techniques	Jianghui Li, University of Southampton
Reactive transport modelling insights into CO <sub>2</sub> migration through sub-vertical fluid flow structures.	Hector Marin-Moreno, National Oceanography Centre
A novel set-up for combined imaging and flow-through experiments with sediment cores	Elke Kossel, GEOMAR
Effect of CO <sub>2</sub> saturated seawater injection on transport properties of the sealing formations	Sourav Sahoo, National Oceanography Centre
Above the pipe – Geometry and formation processes of cold seeps in sands and sandstone derived from UAV-based analyses of an Early Eocene methane seep system, near Varna, Bulgaria.	Christoph Böttner, GEOMAR
Ocean-bottom seismic experiment for characterization of a gas chimney beneath the actively seeping Lunde pockmark, Vestnesa Ridge, W-Svalbard Margin	Sunny Singhroha, Center for Arctic Gas Hydrates, Environment and Climate
4D time-lapse seismic interpretation of gas chimneys, Vestnesa Ridge offshore W-Svalbard	Malin Waage, Center for Arctic Gas Hydrates, Environment and Climate
Subsurface fluid flow quantification in a gas chimney using modeling of 4D seismic data	Sunny Singhroha, Center for Arctic Gas Hydrates, Environment and Climate
High resolution subsurface characterisation at Scanner Pockmark region using broadband seabed seismic data	Farid Jedari-Eyvazi, University of Southampton
Fracture characterisation using shear-wave splitting analysis of azimuthal anisotropy in the Scanner Pockmark area, North Sea	Adam Robinson, University of Southampton
P-wave velocity anisotropy in the Scanner Pockmark area, northern North Sea	Gaye Bayracki, National Oceanography Centre
Sediment porosity at the Scanner Pockmark in the North Sea from controlled source electromagnetic data	Romina Gehrmann, University of Southampton
Applications of a Machine Learning Extrapolating Technique in CCS Monitoring	Kristian Gundersen, University of Bergen
Biogeochemical consequences of a short-term CO <sub>2</sub> leak in the water column: field experiment and modelling	Evgeniy Yakushev, NIVA
Predictions of Relative Permeability of Water-CO <sub>2</sub> Flow at Pore Scale by LBM	Amin Zarareh, Heriot Watt University
The Effects of Numerical Schemes on the Predictions of Permeability of a Berea Sample by Direct Numerical Simulation	Nidal Saab, Heriot Watt University

Simulation and Prediction of CO <sub>2</sub> leakage from STEMM-CCS field experiments	Umer Saleem, Heriot Watt University
Greenhouse gas emissions from marine decommissioned hydrocarbon wells: leakage detection, monitoring and mitigation strategies	Christoph Böttner, GEOMAR
Operation and decommissioning of storage facilities for CCS activities in Brazil.	Romario de Carvalho Nunes, University of São Paulo
Prospectivity of noble gas tracers in CCS monitoring schemes	Anja Sundal, University of Oslo
Impact potential of hypersaline brines released into the marine environment as part of reservoir pressure management.	Jerry Blackford, Plymouth Marine Laboratory
Scope and key findings from the ACT4storage project	Ann Blomberg, Norwegian Geotechnical Institute
An integrated geomechanical workflow for storage integrity screening	Thibault Candela, TNO
Carbon dioxide capture, transport, and storage and its definition competences in Brazil.	Israel Lacerda de Araújo, Imperial College London
Induced-seismicity geomechanics for controlled CO <sub>2</sub> storage in the North Sea	Joonsang Park, Norwegian Geotechnical Institute
Modeling and Monitoring of Offshore CO <sub>2</sub> Leakage for the GoMCarb Project	C.M. Oldenburg, Lawrence Berkeley National Laboratory
Legal Aspects for CCS in Depleted Oil & Gas Fields in Brazil: a case of study	Raíssa Moreira Lima, University of São Paulo
CO <sub>2</sub> Storage Resource Assessment and Development Roadmap for Mid-Atlantic Offshore Region of USA	Neeraj Gupta, Battelle
Where to Store the Carbon? Adapting Petroleum Exploration Tools to Identify and High-grade CCS Sites	Alex Bump, University of Texas-BEG
Does CO <sub>2</sub> concentration in seawater continue to rise during CO <sub>2</sub> leakage?	Keisuke Uchimoto, Geological Carbon Dioxide Storage Technology Research Association / RITE
Carbon Storage and its property rights	Isabela Morbach Machado de Silva University of São Paulo
Dynamic changes in fault permeability – How can experimental work provide support for fault seal integrity?	Elin Skurtveit, Norwegian Geotechnical Institute
Regional identification of seal bypass systems for CO <sub>2</sub> storage: A case study from the Northern North Sea	C. Lloyd, University of Manchester
World's First Carbon Sequestration Project in Salt Caverns Built Offshore in Ultra Deep Waters in Brazil	Pedro V. M Costa, University of São Paulo
Potential of Carbon Storage in the offshore Santos Basin, Brazil: geological & economic possibilities.	Mariana Ciotta, University of São Paulo
Solid Carbon - A Negative Emission Technology Investigation of Carbon Capture and Geological Storage in the Deep Ocean Cascadia Basin Basalt	Martin Scherwath, Ocean Networks Canada
Cross-border CO <sub>2</sub> transportation for storage lowers public support for CCS	Christine Merk, Kiel Institute for the World Economy

## Conference Steering Committees

### **For STEMM-CCS**

Doug Connelly, National Oceanography Centre

Guttorm Alendal, University of Bergen

Vikki Gunn, Seascope Consultants

Jerry Blackford, Plymouth Marine Laboratory

Carla Sands, National Oceanography Centre

Tim Dixon, IEAGHG

Katherine Romanak, BEG

### **For the 4<sup>th</sup> International Workshop on Offshore Geologic CO<sub>2</sub> Storage**

Tim Dixon, IEAGHG (Chair)

Katherine Romanak, BEG (Co-chair)

Guttorm Alendal, University of Bergen (Host)

Susan Hovorka, BEG

Tip Meckel, BEG

Noel Kamrajh and Tony Surridge, SANEDI

Filip Neele, TNO

Paulo Negrais Seabra- Independent Consultant (formerly Petrobras)

Ryozo Tanaka, RITE

Owain Tucker, Shell

Philip Ringrose, Statoil

Mark Ackiewicz, US DOE

Doug Connelly, National Oceanography Centre

Alex Bump, BEG

Carla Sands, National Oceanography Centre

Qi Li, China Academy of Sciences