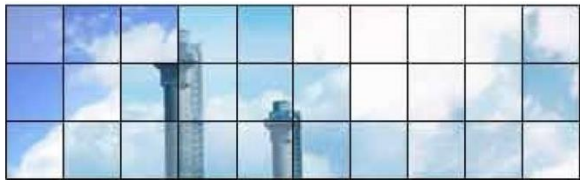
Atmospheric Dispersion Modelling Liaison Committee (ADMLC)

Dense gas dispersion modelling in complex terrain, with a focus on carbon dioxide pipelines

ADMLC Webinar, 14:00-17:00 GMT, Tuesday 7 March 2023

Simon Gant (ADMLC Chair, Health and Safety Executive)



ADMLC Membership

AWE

[dstl]

Met Office

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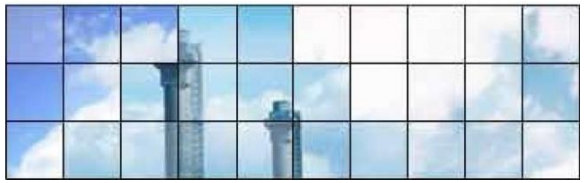
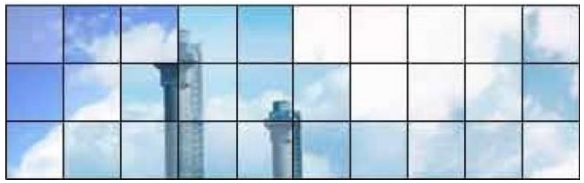


ADMLC Recent News

- **January 2021**: **“**Guidelines for the Preparation of Short Range Dispersion Modelling Assessments for Compliance with Regulatory Requirements” – An Update to the ADMLC 2004 Guidance https://admlc.com/model-guidelines/

- **July 2021**: Report published on “Dense-gas dispersion for industrial regulation and emergency response” by Rachel Batt (HSE)
  - Spreadsheet of datasets for model validation
  - Spreadsheet of previous incidents
  - https://admlc.com/publications/

- **September 2021**: Report published on “A Review of Approaches to Dispersion Modelling of Odour Emissions and Intercomparison of Models and Odour Nuisance Assessment Criteria” by CERC and ELLE https://admlc.com/publications/



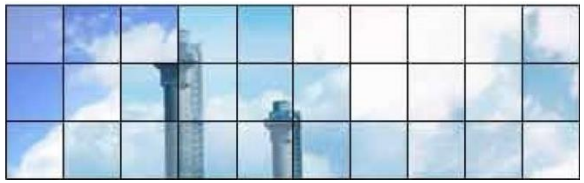
ADMLC Recent News

- **Ongoing**: “Investigating the impact of applying different grid resolutions of numerical weather prediction met data in atmospheric dispersion modelling”
- Project commissioned with CERC and UKHSA
- Scope:
  - Review of NWP models
  - Comparison of model endpoints for NWP datasets
  - Comparison studies for regulatory atmospheric dispersion modelling
  - Potential for double counting of the impact of terrain
  - Use of NWP met data for probabilistic accident consequence assessments
- Timeline: final report to be issued to ADMLC in June 2023

ADMLC Recent News

- **Future work**: “Review of methods used to assess the performance of atmospheric dispersion models”
- Scope:
  - Literature review
  - Case studies
  - Guidance on application of model evaluation methods to different scenarios
- Closing date for expressions of interest: 10 March 2023
- http://www.admlc.com/work

ADMLC welcomes partnerships with other funding agencies or self-funding research organisations on topics of mutual interest



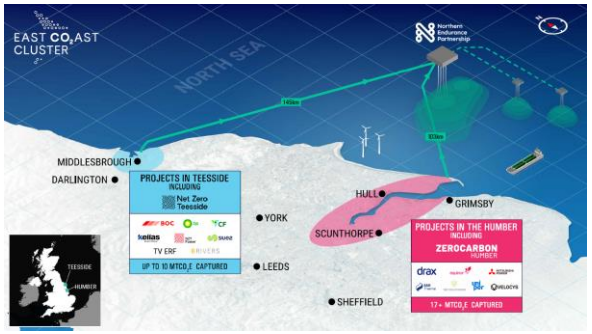
ADMLC Webinars

- **May 2021**: “Dispersion modelling and satellites”
- **February 2022**: “Use of dispersion modelling for sensor network design to facilitate source attribution, emissions estimation and incident response”
- Recordings available: http://www.admlc.com/events

Context for today's webinar

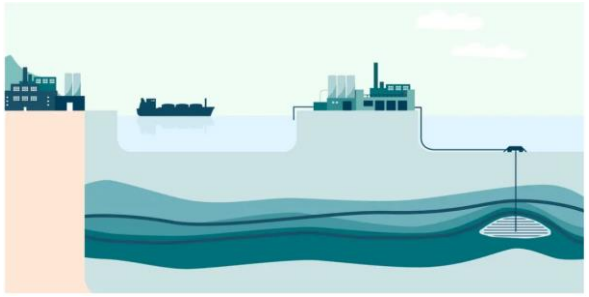
- Net Zero is currently driving a rapid growth internationally in Carbon Capture and Storage (CCS) projects
- Bulk transport of CO_2 by pipeline and/or ship

https://hynet.co.uk

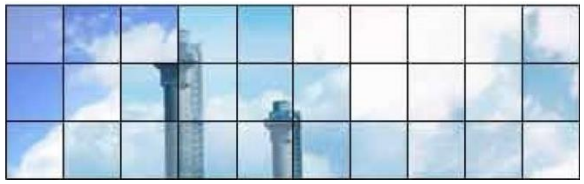


https://eastcoastcluster.co.uk/

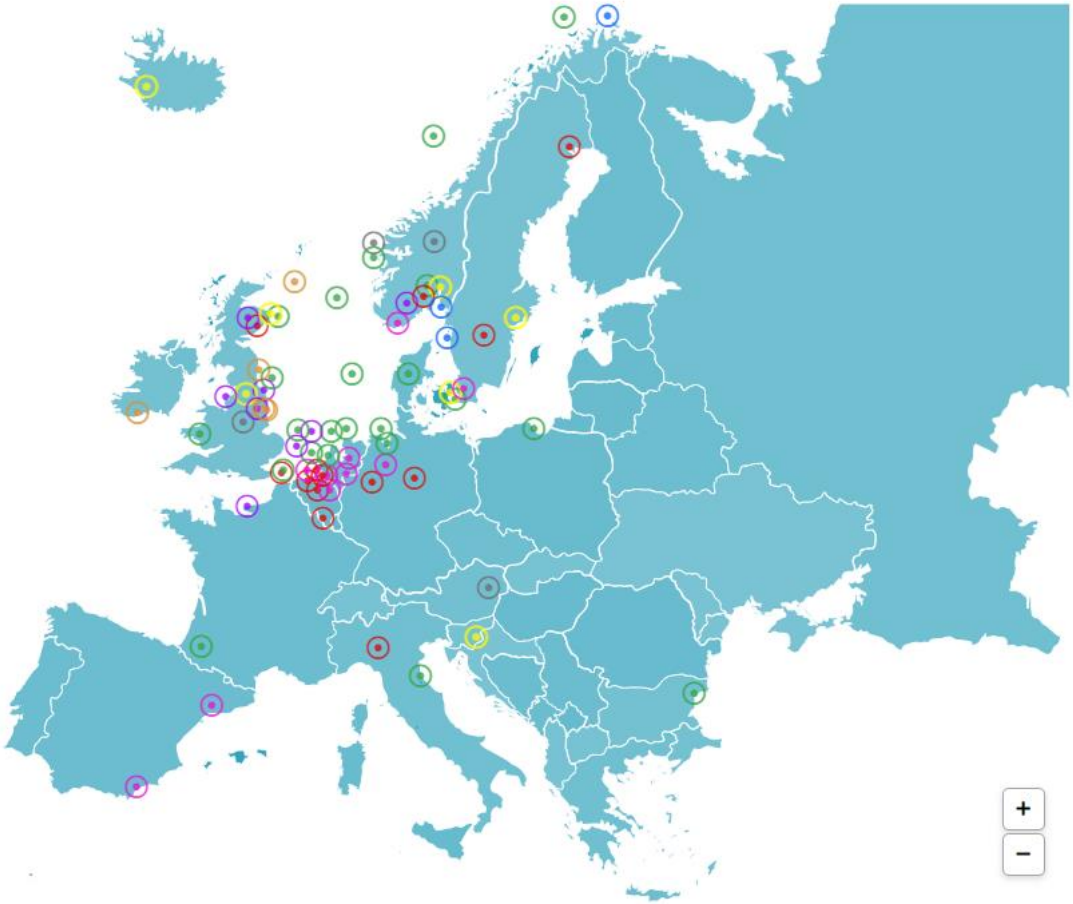
https://www.porthosco2.nl



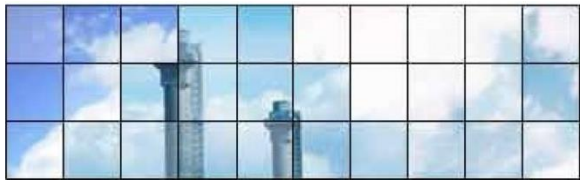
https://norlights.com



Net Zero and CCS

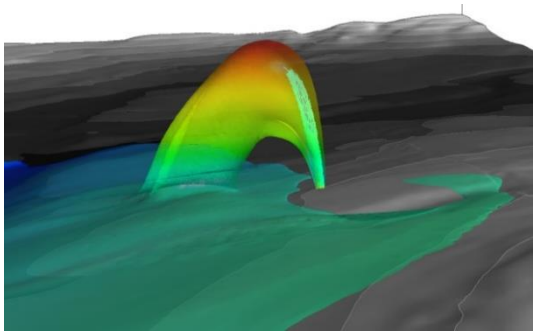


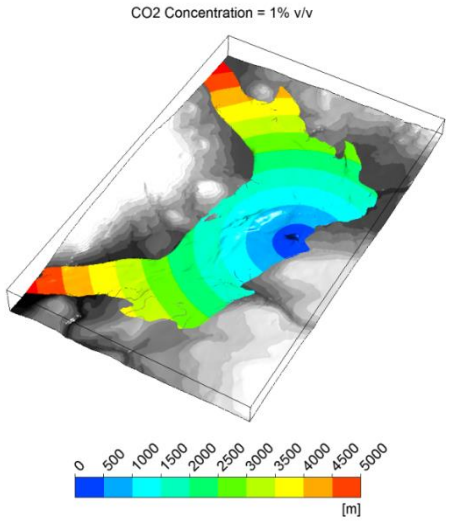
Market ready CCUS projects: https://zeroemissionsplatform.eu

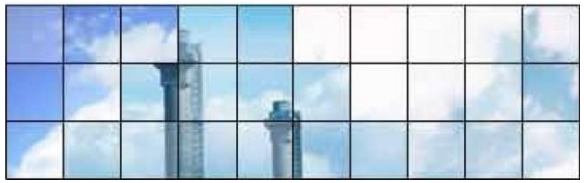


CO_2 Pipeline Research

- Significant research into CO_2 pipeline safety in period 2005-2015
  - e.g. COOLTRANS, CO2PipeTrans, COSHER, MATTRAN projects
- CO_2 is either a vapour or solid at atmospheric pressure
- Sublimation temperature -78°C at atmospheric pressure
- Vapour density 2.3 times greater than air at -78°C
- Cold CO_2 gas from pipeline release would tend to flow along the ground, collecting in low-lying areas
- Toxicity (https://doi.org/10.1186%2Fs12245-017-0142-y)
  - Concentration > 5% v/v: hyper-ventilating, confusion, lethargy
  - Concentrations > 10% v/v: convulsions, coma, death







Pipeline Risk Assessment and Emergency Planning

- Satartia, Mississippi CO_2 pipeline incident in 2020 demonstrated that terrain can influence dispersion of dense CO_2 clouds
- Can dispersion models take into account terrain effects for pipeline risk assessment and emergency planning?
- Different modelling approaches:
  - Integral, Gaussian puff, shallow-layer, Computational Fluid Dynamics (CFD), hybrid CFD/mass-consistent models, Lattice Boltzmann, emulators, correlations
- Example of modelling requirements:
  - 100 km long pipeline, model release location every 50 m = 2,000 runs
  - 4 release diameters (25 mm, 75 mm, 110 mm, full bore) = 8,000 runs
  - 12 wind directions = 96,000 runs
  - 4 weather classes (F2.4, D2.4, D4.3, D6.7) = 384,000 runs
- If each dispersion simulation takes 1 minute computer run-time:
  - 384,000 minutes = 267 days run time
- If each simulation took 1 hour, then it would require 44 years run-time

Model Validation

- Do we have sufficient field-scale experimental data to validate dense-gas dispersion models with terrain?
  - See review by Batt (2021) http://www.admlc.com/publications
  - Burro 8 trial: LNG spill on water
    - https://doi.org/10.1016/0304-3894(82)80034-4
  - COOLTRANS CO_2 trials at DNV Spadeadam
    - Allason et al. https://doi.org/10.1115/IPC2014-33384
  - Jack Rabbit I chlorine and ammonia trials
    - 2 m deep, 50 m diameter shallow depression
    - https://www.uvu.edu/es/jack-rabbit/
  - Picknett (1981) refrigerant trials at Porton Down
    - https://doi.org/10.1016/0004-6981(81)90181-5
- Cannot be confident in model predictions without reliable validation data

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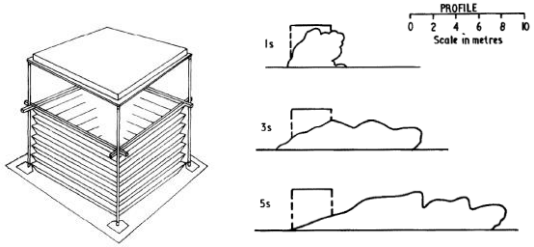
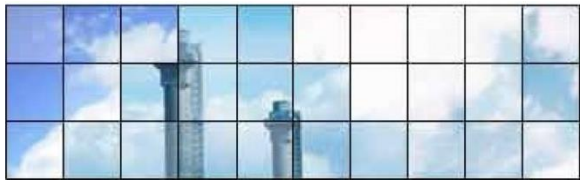




Webinar Programme

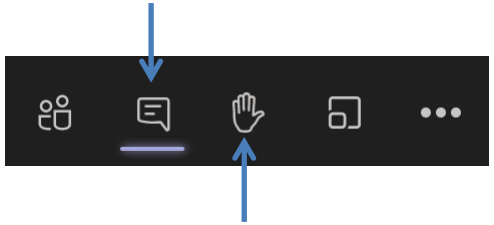
14:00 – 14:15	**Simon Gant** Welcome and introduction
14:15 – 14:30	**Max Kieba (PHMSA)** “Introductory remarks and review of the Satartia CO_2 pipeline incident”
14:30 – 14:50	**Dan Allason, Ann Halford and Karen Warhurst (DNV, UK)** “Carbon dioxide pipeline experiments and modelling”
14:50 – 15:10	**Lauris Joubert (INERIS, France)** “Experimental campaign of massive CO_2 releases in urban areas”
15:10 – 15:30	**Chris Dixon (Shell, UK)** “Development of a shallow-layer model for dense-gas dispersion”
15:30 – 15:40	**BREAK**
15:40 – 16:00	**Sam Wang (Texas A&M, USA)** “Determination of potential impact radius for CO_2 pipelines using machine learning approach”
16:00 – 16:20	**Mike Brown (Los Alamos National Laboratory, USA)** “QUIC mountainous terrain and dense gas capabilities”
16:20 – 16:40	**Ian Sykes (Xator Corporation)** “SCIPUFF modelling of dense-gas dispersion”
16:40 – 17:00	**DISCUSSION**

Times are GMT

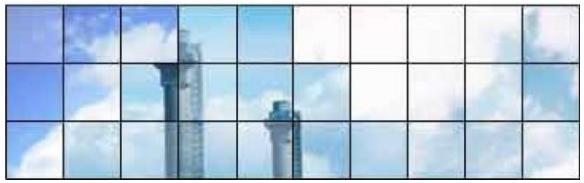
Webinar Programme

Webinar is being recorded on video
Slides and video will be made available on the ADMLC website

- Please mute your microphone if you're not speaking
- Please add any comments/questions for the discussion session in the **chat window**
- Please **raise your hand** if you would like to speak in the discussion session



PRESENTATIONS



Further Discussions?

Would you like to be involved in further discussions on the topic of dense-gas dispersion in complex terrain and CO_2 pipelines?

With a view to a potential collaborative future Joint-Industry Project on:

1. New field-scale CO_2 dispersion experiments in complex terrain
2. Model development and validation

If so, please let us know:

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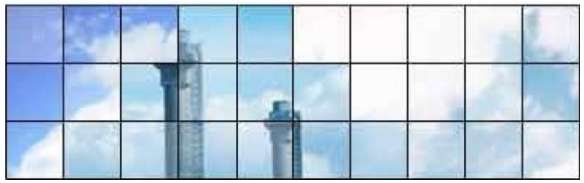
martin.thomson@hse.gov.uk
zoe.chaplin@hse.gov.uk

Aiming to hold a follow-up Teams meeting if there is sufficient interest



ADMLC Seminar, 4 October 2023
UKHSA, Harwell, Nr Oxford

Dry deposition and surface chemical reactivity

Speakers:

- Steven Hanna (Hanna Consultants)
- Jon Pleim (US EPA)
- Tom Spicer (University of Arkansas)
- Jenny Stocker (CERC)
- Nebila Lichiheb (NOAA)
- Eiko Nemitz and Benjamin Loubet (UKCEH and INRAE)
- Helen Webster (Met Office)
- Oscar Bjornham (FOI)
- Roy Wichink Kruit (RIVM)

Details to be announced shortly…

Thank you

Thanks to all our presenters and the ADMLC Secretariat for organising this webinar

- Justin Smith and Peter Bedwell (UKHSA)

We would welcome feedback: admlc@ukhsa.gov.uk

- What worked well?
- What could we improve?
- Breakout networking sessions during the coffee break?
- Future ideas for ADMLC webinars?