Modelling of the influence of methane emissions in the North Sea region with ICON-ART

C. Scharun\textsuperscript{1}, R. Ruhnke\textsuperscript{1}, H. Guggenberger\textsuperscript{1}, J. Schröter\textsuperscript{1}, M. Weimer\textsuperscript{2}, P. Braesicke\textsuperscript{1}

\textbf{Motivation}

\textbf{Significance of methane (CH\textsubscript{4})}:
- Second most important greenhouse gas (GHG) after CO\textsubscript{2}
- Important source for O\textsubscript{3} in the troposphere
- Current increase: \textasciitilde 6 ppbv yr\textsuperscript{-1}
- Short atmospheric lifetime for GHG: \textasciitilde 30 yr
- Transported over long distances

\textbf{Sources and sinks of methane}:
- Uncertainties concerning the global distribution of sources and sinks \[2\]
- Largest loss of CH\textsubscript{4} due to its reaction with the OH radical \[3\]
- Discrepancies of bottom-up and top-down approaches \[4\]
- Quantification of processes

\textbf{Anthropogenic methane emissions in EDGAR dataset} \[1\] in January 2010, data from ECCAD \[7\]

\textbf{The ICON-ART model}

\textbf{ICON-ART Version 2.3 Setup}:
- Globally constant initialisation value: 1850 ppbv CH\textsubscript{4}, (at lowest model level)
- Simulation period: 2018-01-01 to 2019-01-01
- Global grid resolution: Horizontal: \Deltax \textasciitilde 80 km
- Vertical: 90 Levels from 0 to \textasciitilde 80 km
- Input emission inventory: EDGARv4.3.2 (monthly mean, 0.1°\times0.1°)
- ICOsahedral Nonhydrostatic model with Aerosols and Reactive Trace gases
  - Output: O\textsubscript{3}, CH\textsubscript{4}, \textasciitilde 0.5°\times0.5°, \Deltat \textasciitilde 12 hours
  - ICON-ART chemistry mode: Tracer with simplified OH chemistry
  - Simulations:
    - 1) Unmodified EDGAR emissions
    - 2) Homogeneous distributed methane emissions in the North Sea Region

\textbf{Modelling methane}

\textbf{Methane VMR in the North Sea region at lowest model level – Simulation 2 together with measurements} \[9\]

\textbf{Conclusion}
- Simulation 1 shows higher VMR of methane than simulation 2 in the North Sea region after 365 days at lowest model level
- Good match of simulation results and values from measurement sites around the North Sea region although initialisation of model is slightly too low
- The anti-correlation between OH and CH\textsubscript{4} is visible in the simulation results
- The variability of homogeneous distributed CH\textsubscript{4} sources leads to small differences in the methane as well as OH distribution

\textbf{Outlook}
- Adjustment of CH\textsubscript{4} emission fluxes from the North Sea
- Investigation of the global impact of adjusted emission fluxes for CH\textsubscript{4} budget
- ICON-ART “Full chemistry” CH\textsubscript{4} – HO\textsubscript{2} – NO\textsubscript{2} – O\textsubscript{3} simulations of the North Sea with a few kilometers horizontal resolution

\textbf{References}

\texttt{christian.scharun@kit.edu}