Impact of Arctic Clathrate Emissions

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DOE IMPACTS project on abrupt climate change
Warming may release methane from large Arctic reservoirs

Stolaroff, et al., 2012
Onset of Clathrate emissions expected to be abrupt

Reagan, et al., 2011
Fraction of methane that passes through ocean is uncertain, but could be large.
Two steady-state simulations:
- 2000 control,
- 2000 control + clathrate emissions in the arctic.

CESM with:
- Fast chemistry (CH$_4$ emissions, strat-chem),
- Full ocean.

Control has 629 Tg(CH$_4$)/yr (to give 1.79 ppm)
Clathrate adds 139 Tg(CH$_4$)/yr
Model CH$_4$ has similar annual means and variability to obs., but larger IH gradient

OBS from CMDL network
Arctic methane emission produces non-uniform concentration increase

- 20% increase in global emissions => 30-60% conc. increases.
Temperature increase is greatest in Arctic

Annual-mean surface temperature increase due to clathrate emission (K)
Ozone increases most in polluted regions
Large increases in methane variability

Ratio of interannual variability of surface methane concentration
Ozone variability increases significantly

- Ozone variability over southern ocean is probably enhanced because methane is a larger fraction of the hydrocarbons, so its variability has a larger effect.
Long-timescale variability is also increased with clathrate emissions.
Long-term variability increase in wavelet spectra too

Wavelet Power Spectrum of Global Mean Surface Temperature

Simulation year

Control

Clathrate emission
Conclusions

• Warming may release methane from large Arctic reservoirs.
• Clathrate methane emission scenario changes mean: methane, ozone, temperature, precip.
• Methane increase is non-uniform.
• Variability changes too in: methane, ozone.
• Long-timescale variability is also increased.