

# Impact of Arctic Clathrate Emissions

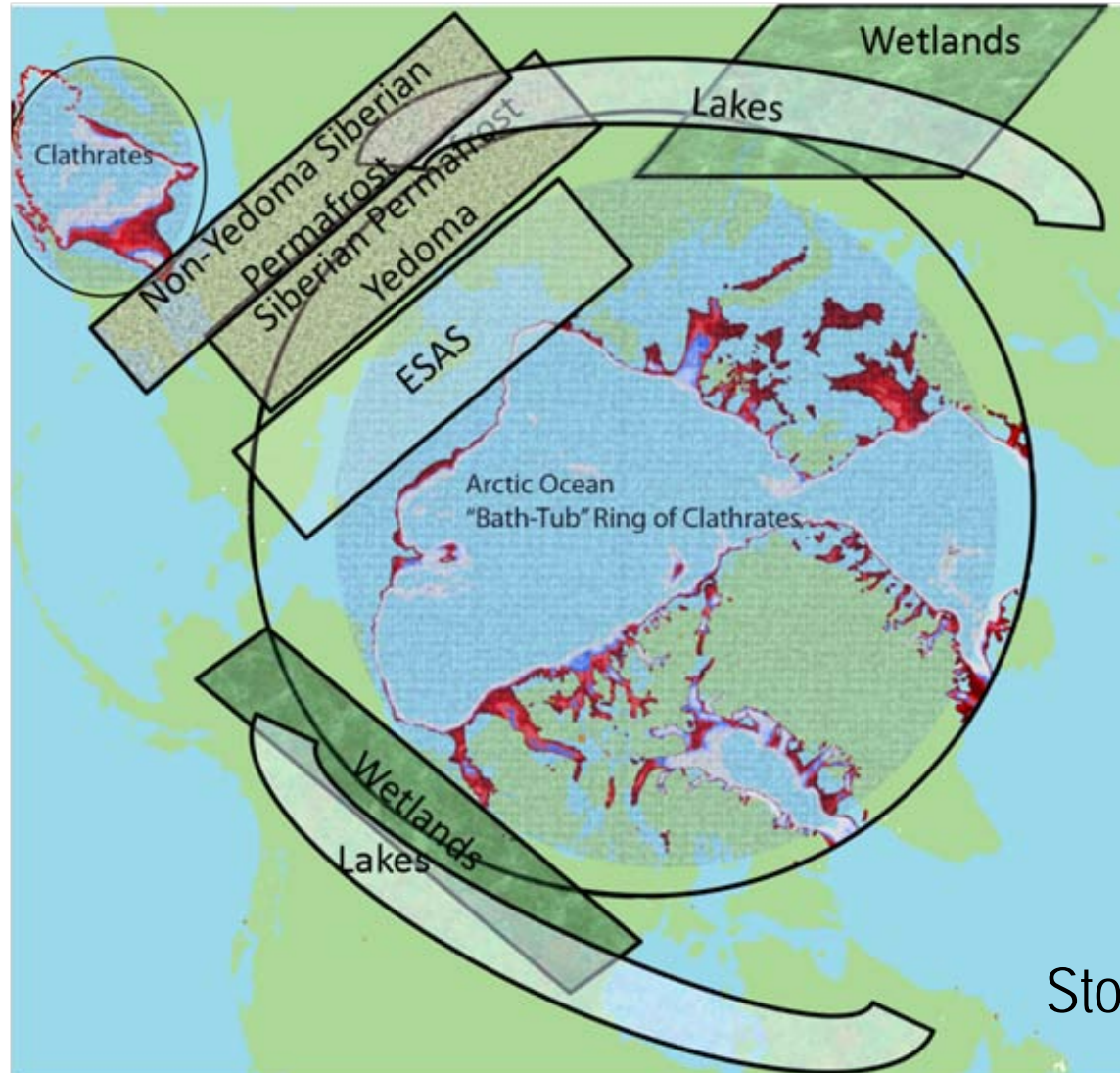
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S. Elliott (LANL)

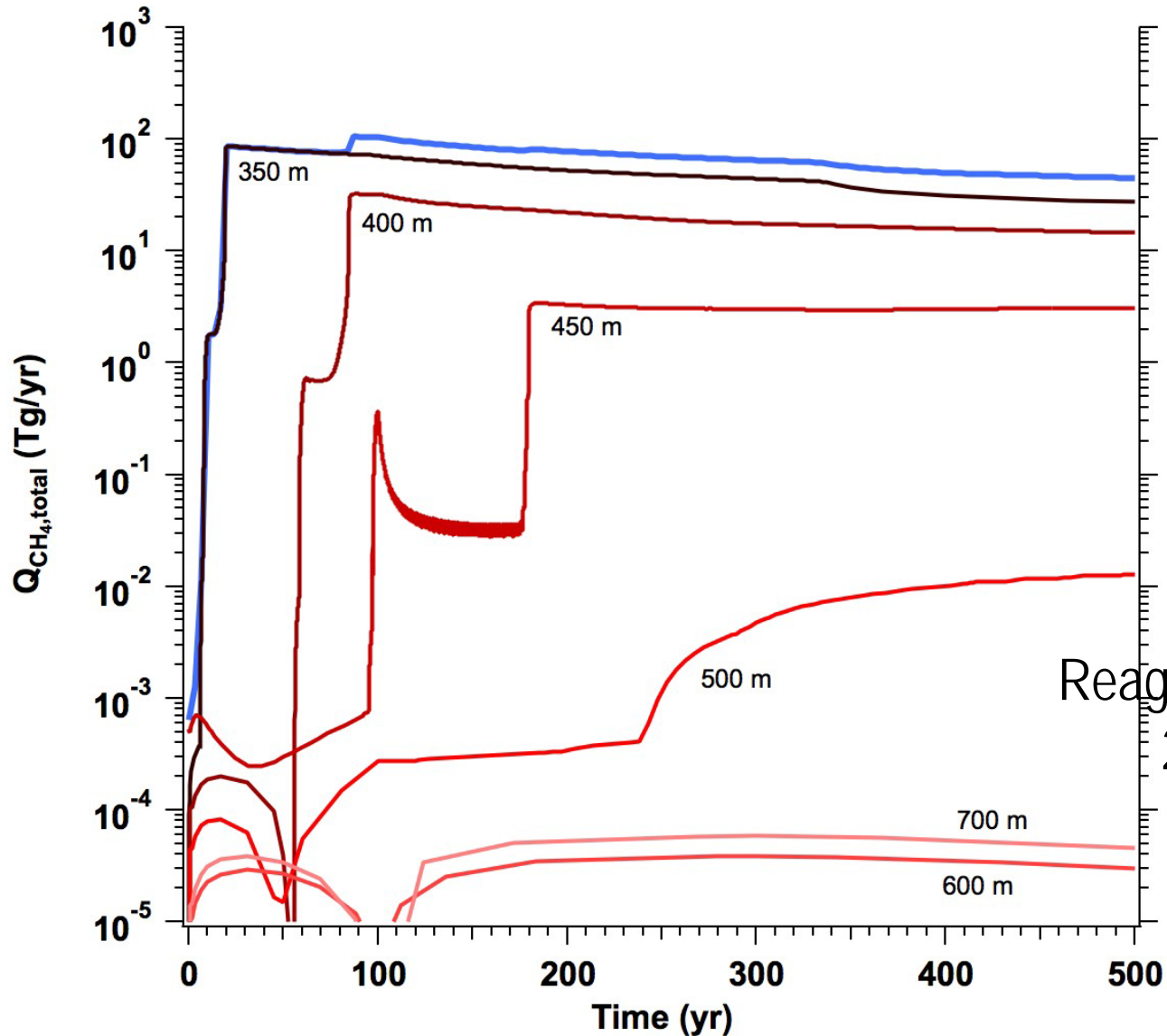
**DOE IMPACTS project on abrupt climate change**

# Warming may release methane from large Arctic reservoirs



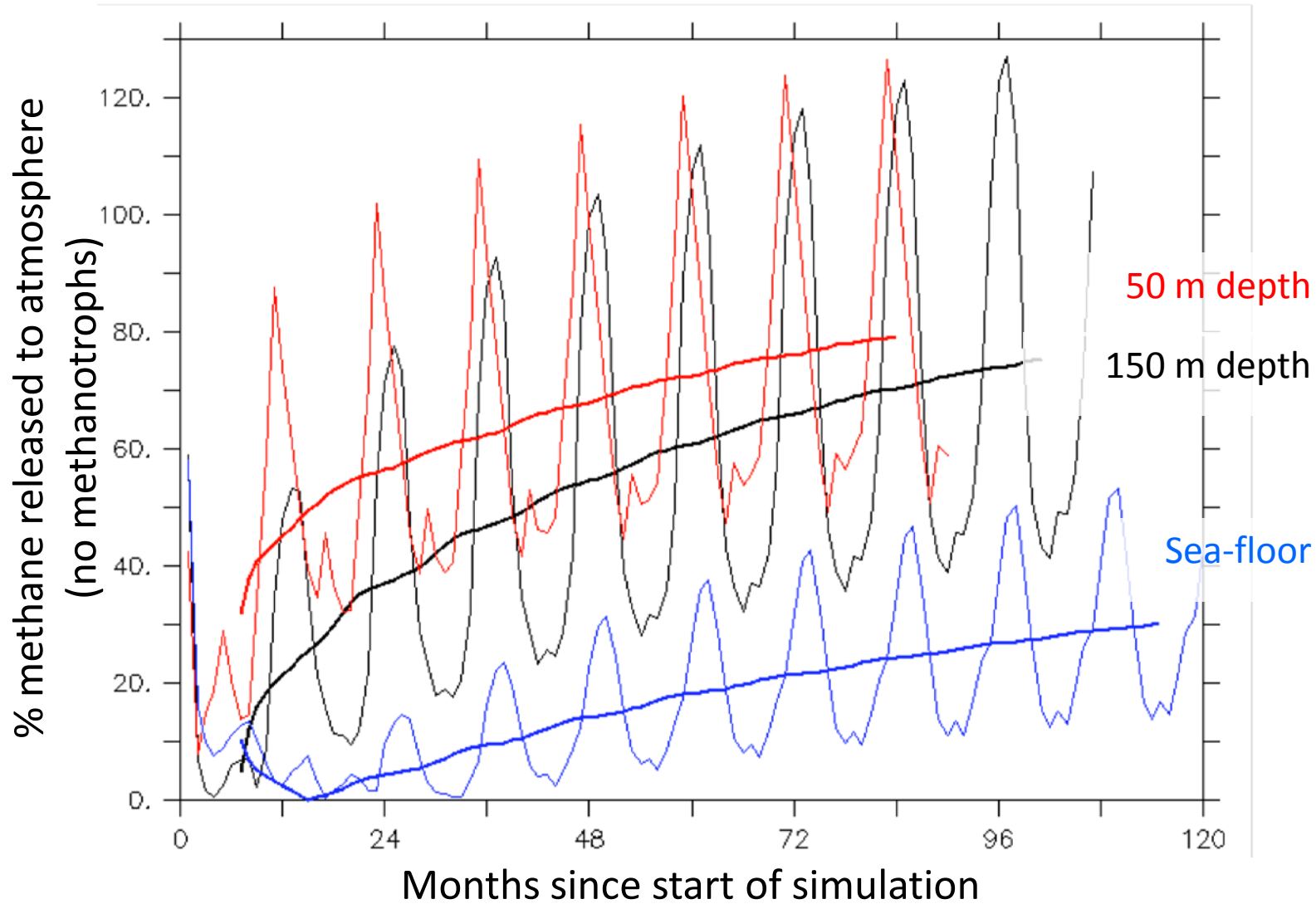
Stolaroff, et al.,  
2012

# Onset of Clathrate emissions expected to be abrupt



Reagan, et al.,  
2011

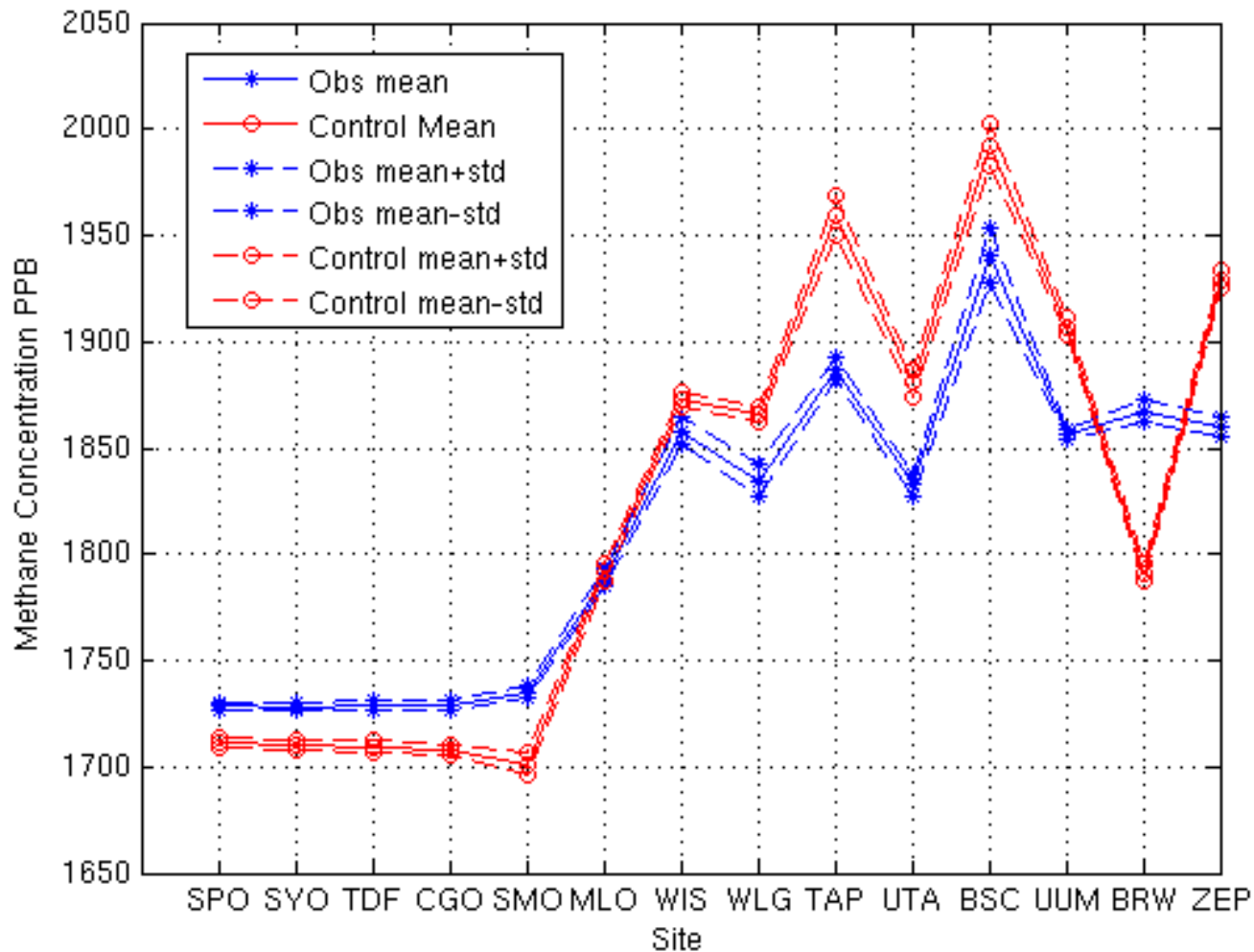
# Fraction of methane that passes through ocean is uncertain, but could be large



# CESM configuration

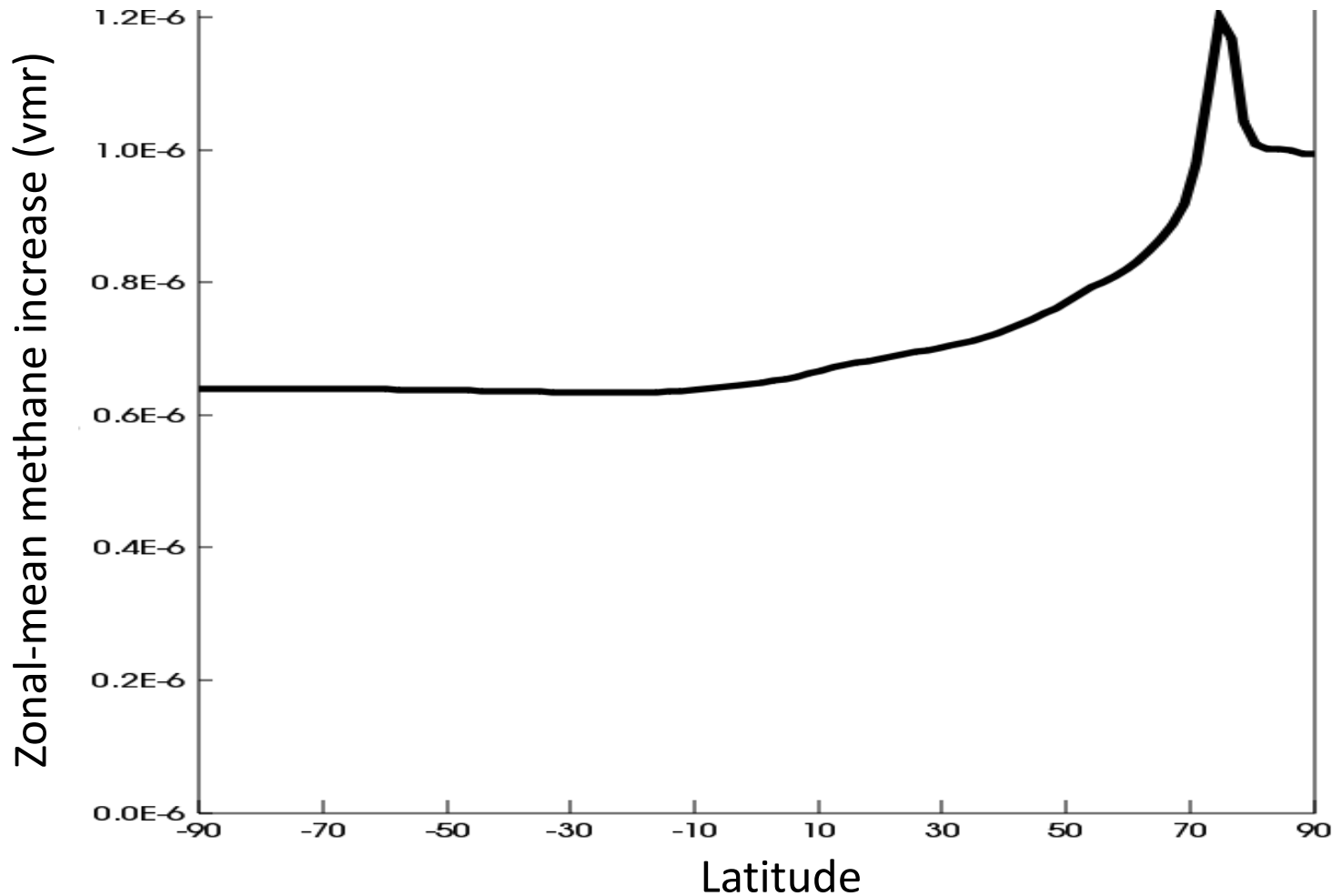
- ❖ Two steady-state simulations:
  - 2000 control,
  - 2000 control + clathrate emissions in the arctic.
- ❖ CESM with:
  - Fast chemistry (CH<sub>4</sub> emissions, strat-chem),
  - Full ocean.
- ❖ Control has 629 Tg(CH<sub>4</sub>)/yr (to give 1.79 ppm)
- ❖ Clathrate adds 139 Tg(CH<sub>4</sub>)/yr

# Model CH<sub>4</sub> has similar annual means and variability to obs., but larger IH gradient



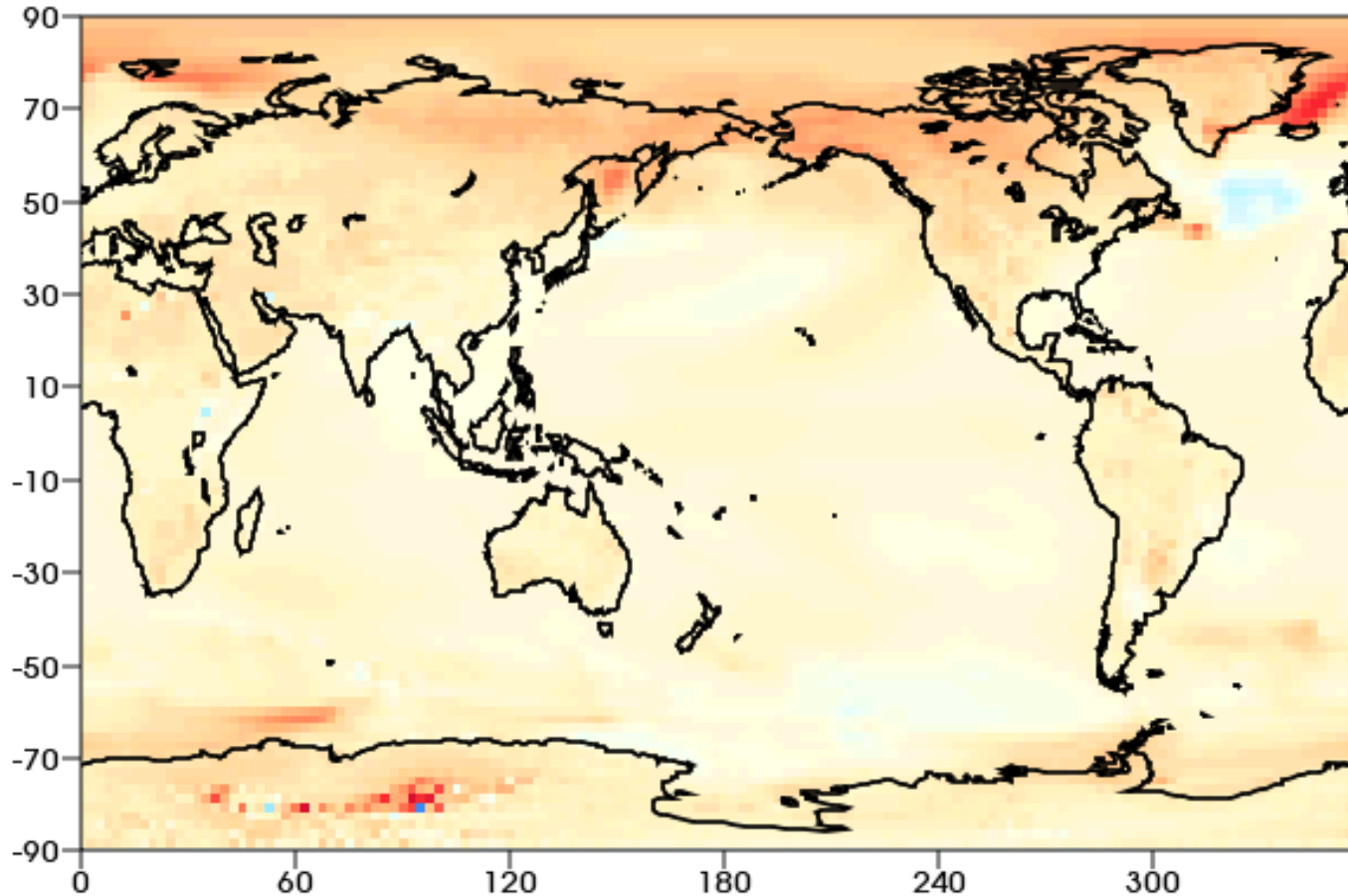
OBS from CMDL network

# Arctic methane emission produces non-uniform concentration increase

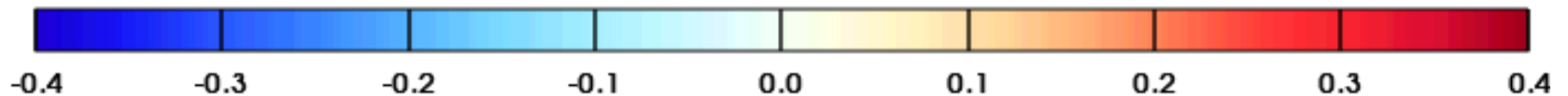


❖ 20% increase in global emissions => 30-60% conc. increases.

# Temperature increase is greatest in Arctic

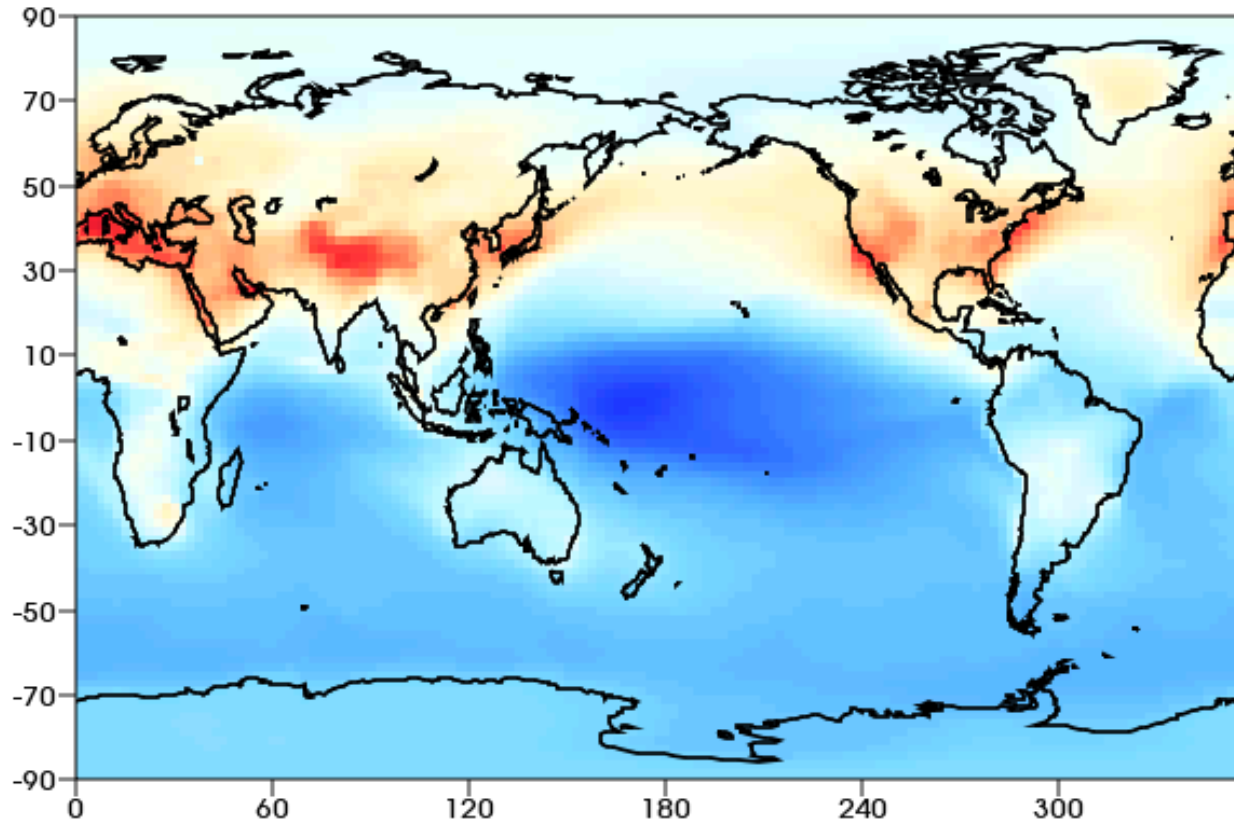


Annual-mean surface temperature increase due to clathrate emission (K)

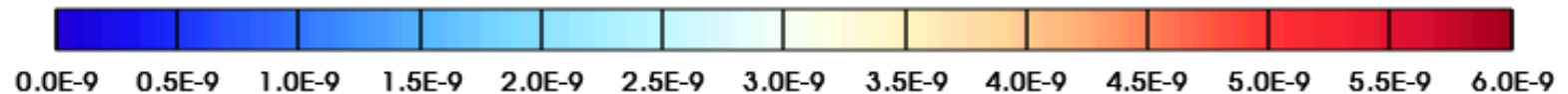




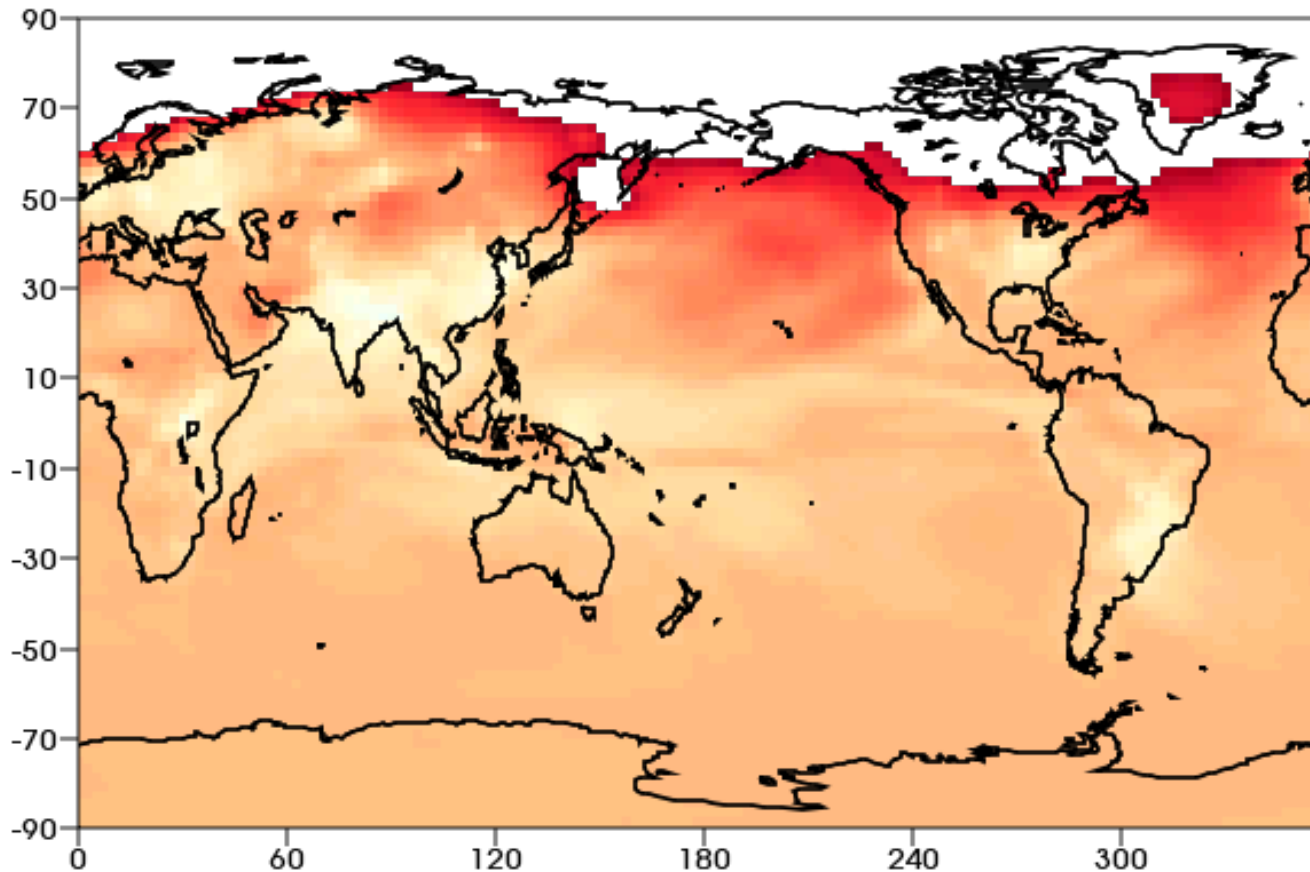
# Ozone increases most in polluted regions



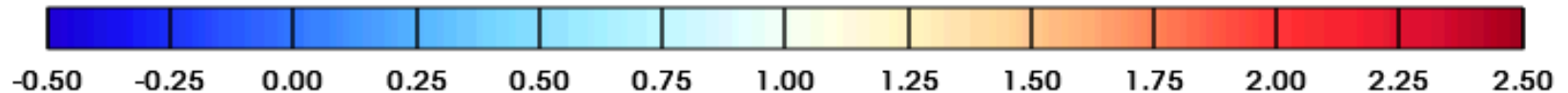
Annual-mean surface ozone increase due to clathrate emission (vmr)



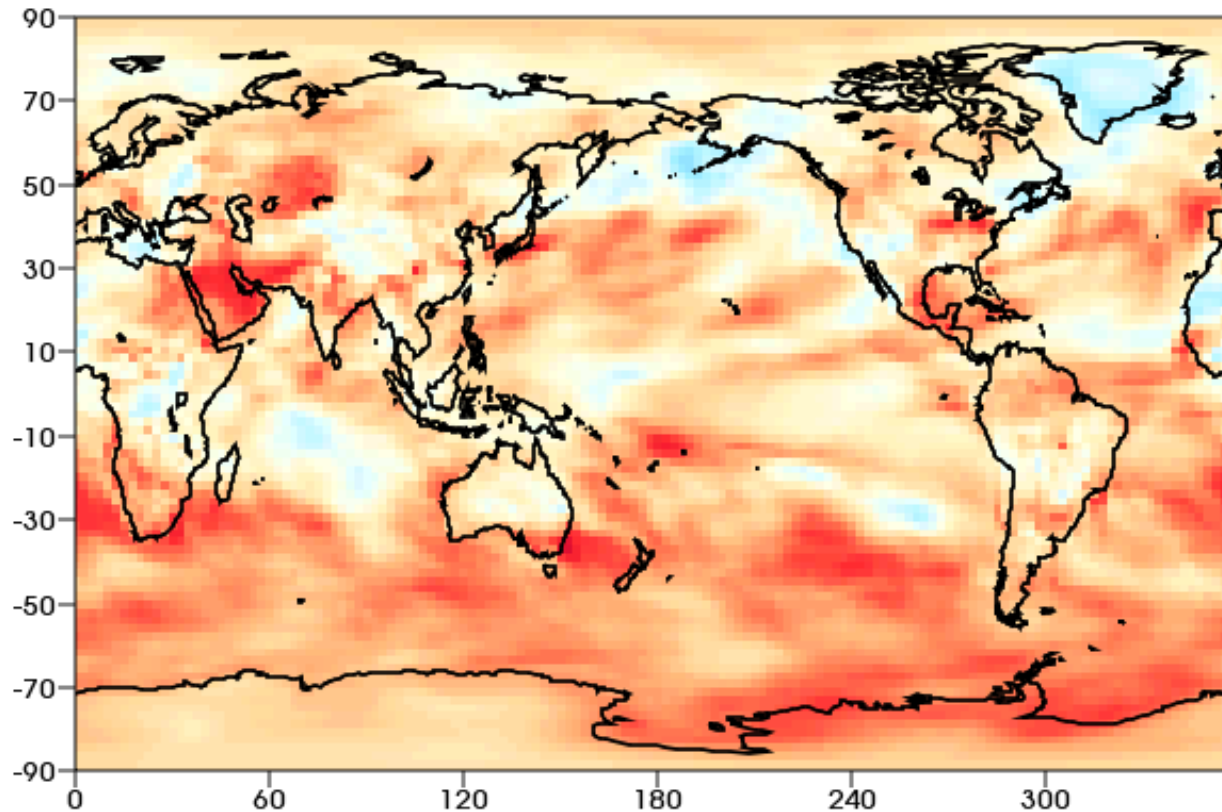
# Large increases in methane variability



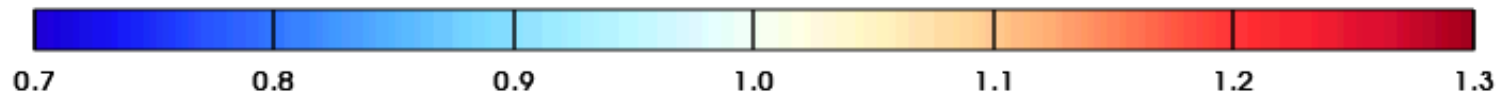
Ratio of interannual variability of surface methane concentration



# Ozone variability increases significantly

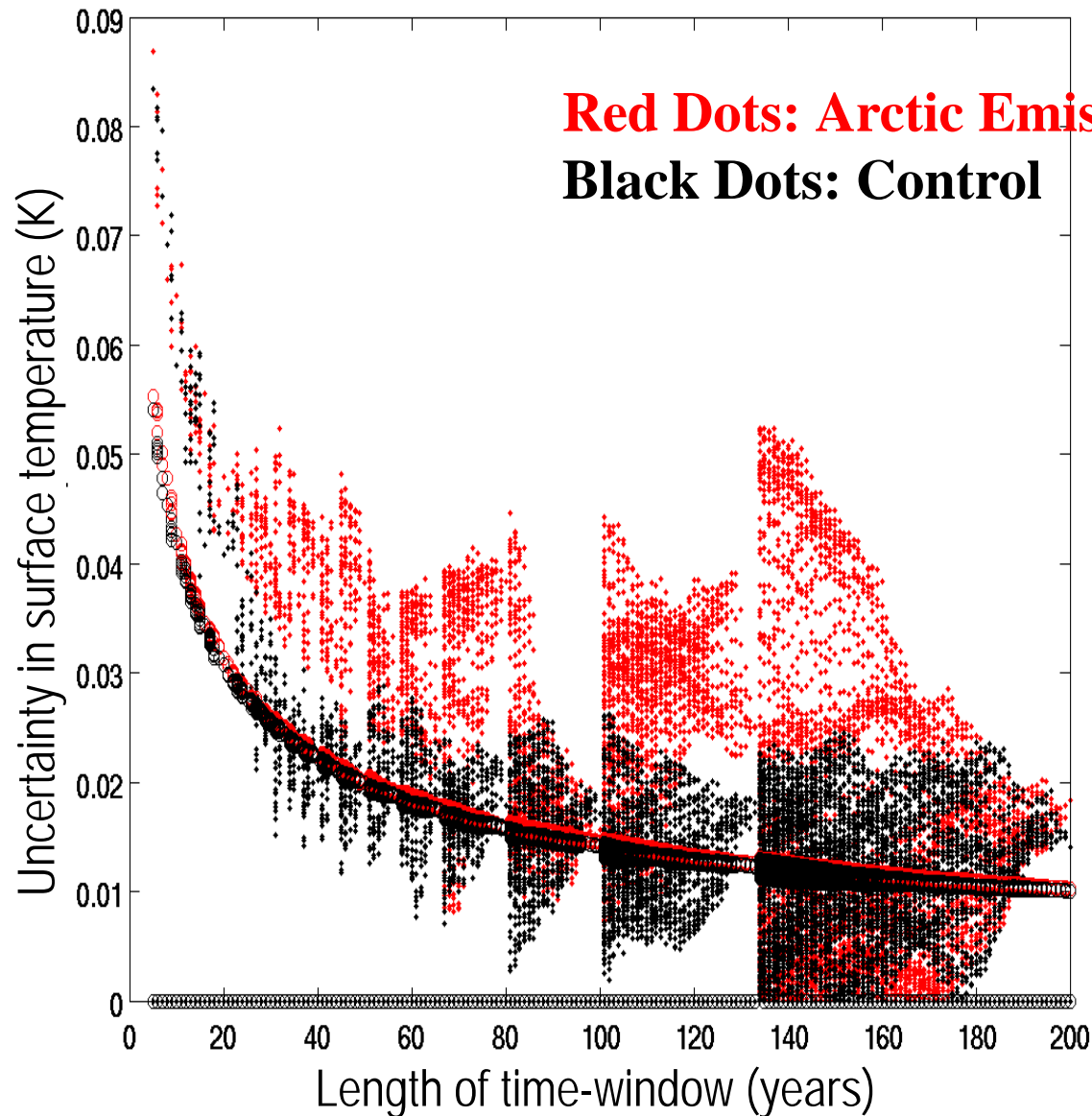


Ratio of interannual variability of surface ozone concentration



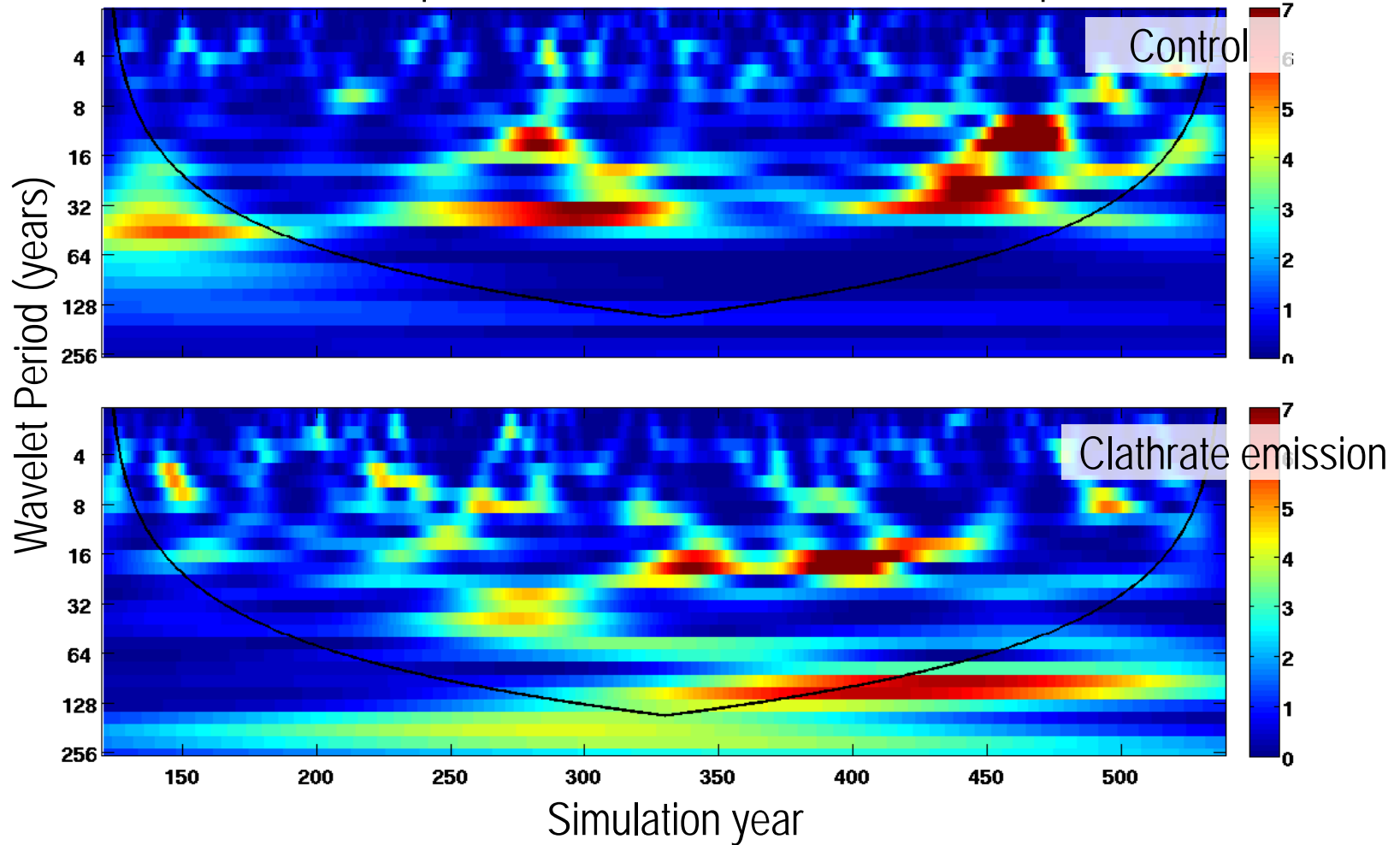
- ❖ Ozone variability over southern ocean is probably enhanced because methane is a larger fraction of the hydrocarbons, so its variability has a larger effect.

# 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



# 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.