



# Arctic Clouds in HadGEM2-ES: Interaction with DMS

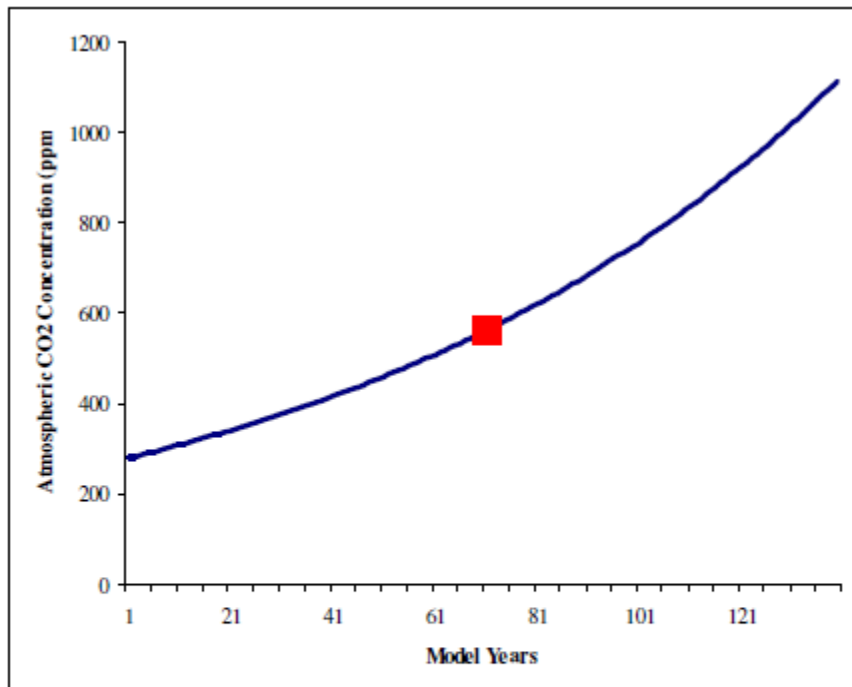
Jeff Ridley, Rosie Sheward and Paul Halloran

Met Office Hadley Centre



# Clouds & DMS

- Evaluating impact of DMS with climate change
- Changes in the Arctic
- Impact on clouds & radiation
- Summary



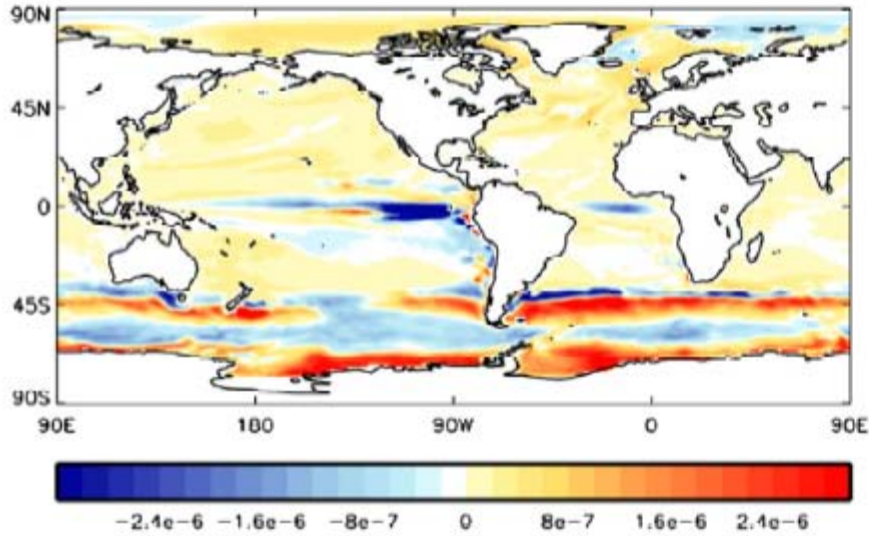
**Figure 1 | Atmospheric CO<sub>2</sub> concentration for interactive DMS (Ajeld) and fixed DMS (Ajnud) runs.** The red square indicates the point at which 2xCO<sub>2</sub> is reached (year 70).

## Model Simulation Description:

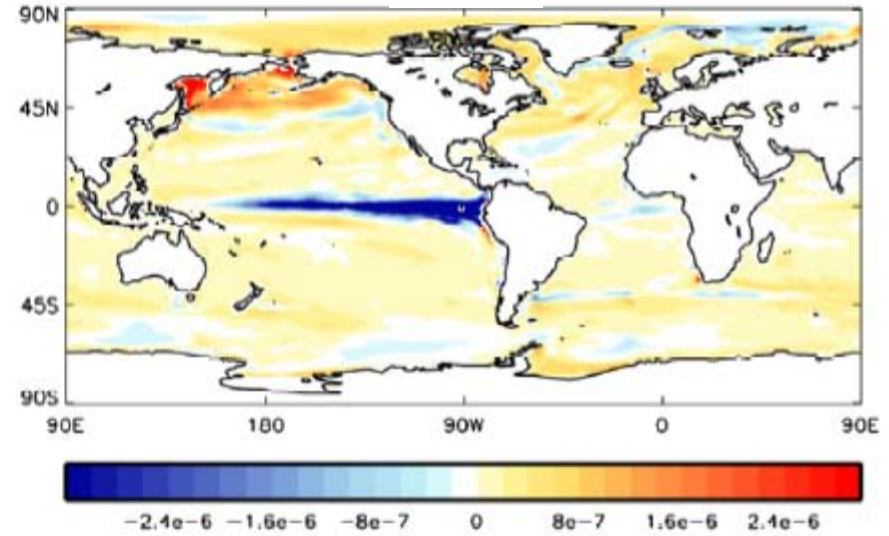
**Full** – 1% CO<sub>2</sub> increase per year from pre-industrial conditions to 4xCO<sub>2</sub> (140 years). Fully interactive ocean-atmosphere DMS scheme, allows feedback.

**Fixed** - 1% CO<sub>2</sub> increase per year from pre-industrial conditions to 4xCO<sub>2</sub> (140 years). Fixed ocean DMS concentration. Ocean DMS changes as a function of mixed layer depth and phytoplankton concentration as in AJELD, but this is replaced by a fixed concentration in the atmosphere scheme at the start of each timestep. No DMS feedback can occur.

**DJF**

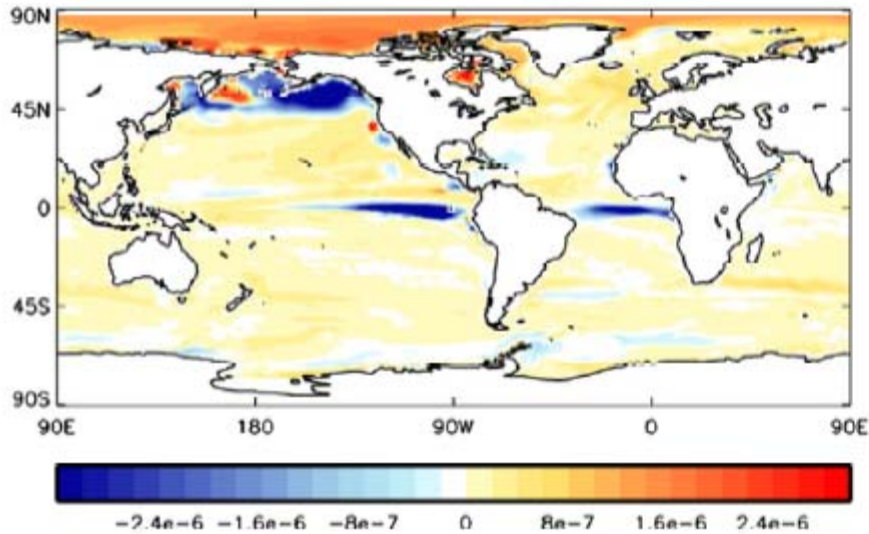


**MAM**

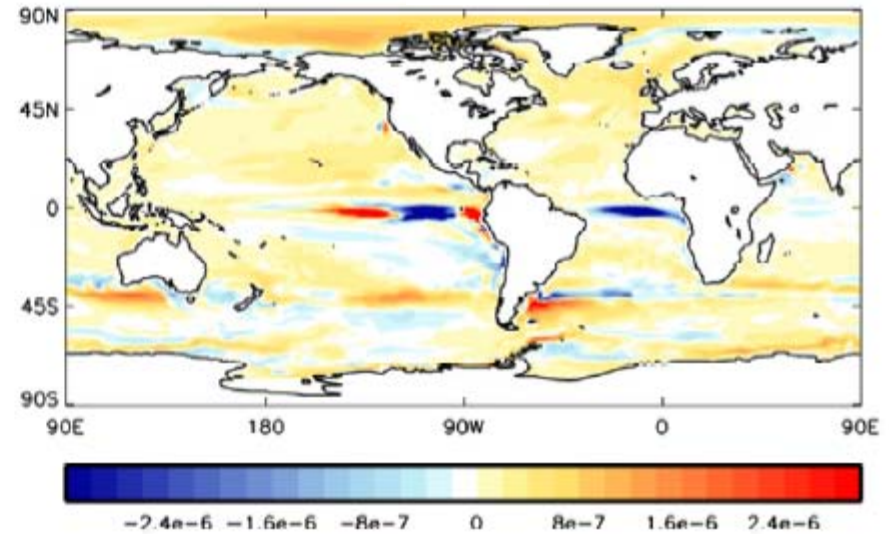


**Ocean DMS concentration changes at 4xCO<sub>2</sub> (20 year mean vs control)**

**JJA**



**SON**





DMS concentration

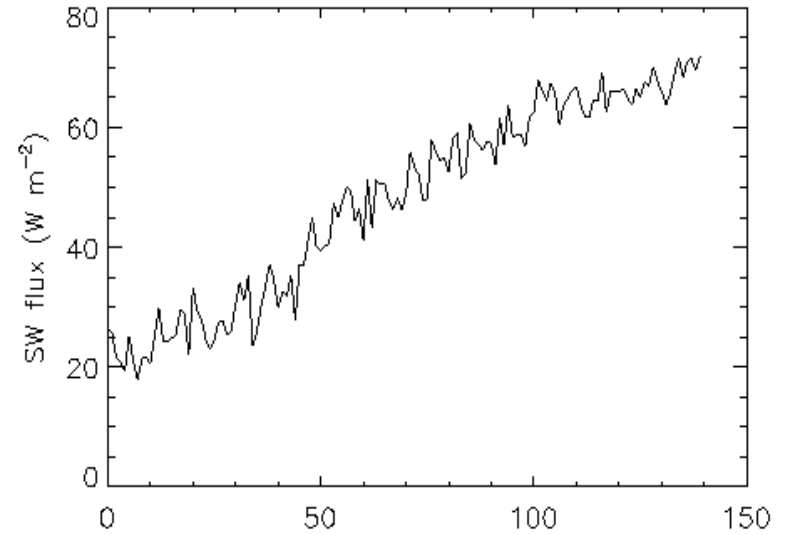
Mixed layer depth

SW flux into ocean

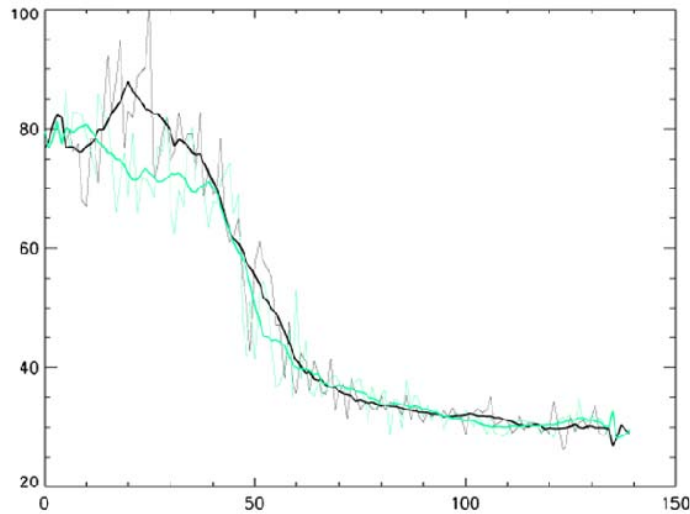
Phytoplankton conc.



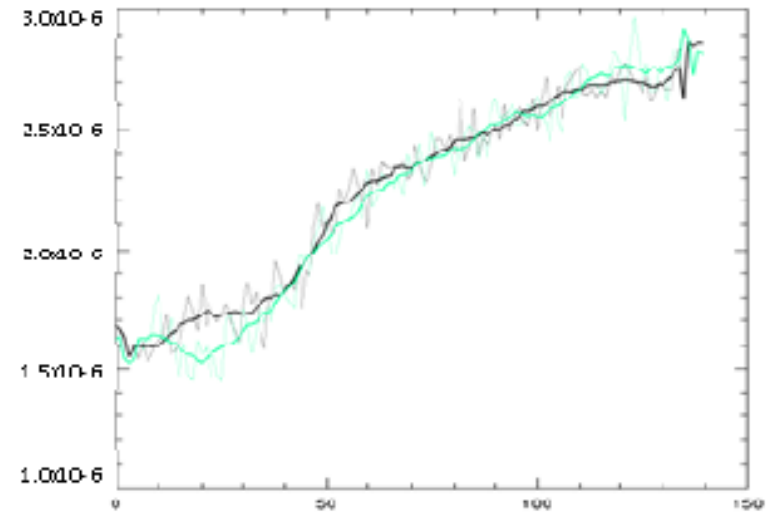
### SW flux to Arctic ocean JJA



### MLD Arctic JJA

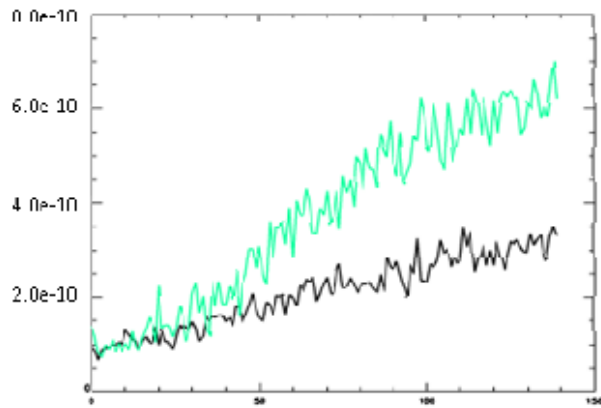


### DMS Conc (ocean) Arctic JJA

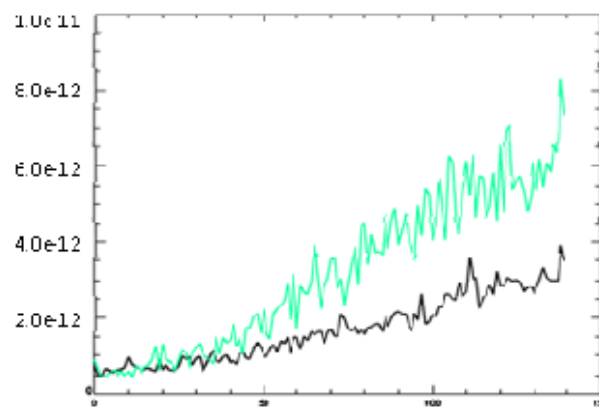




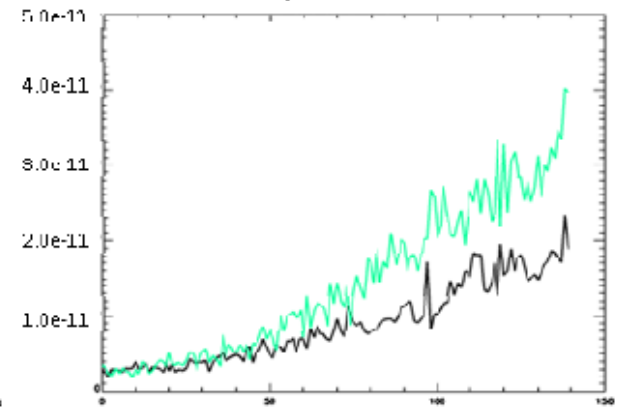
Atm DMS conc JJA level 1



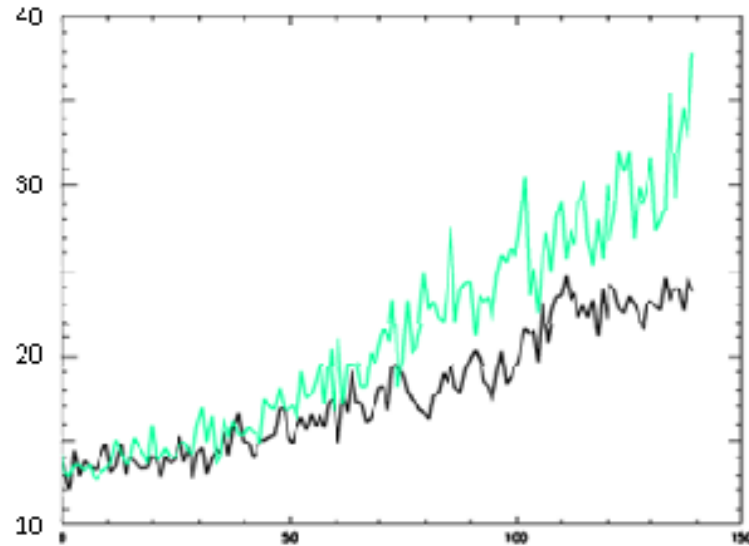
Atm SO2 conc JJA level 1



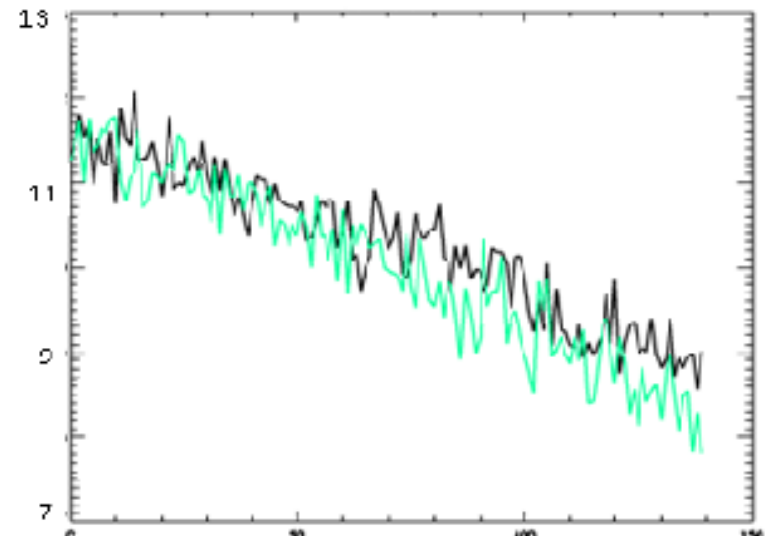
Atm Total Sulphate conc JJA level 1



Atms CCNC JJA Level 1

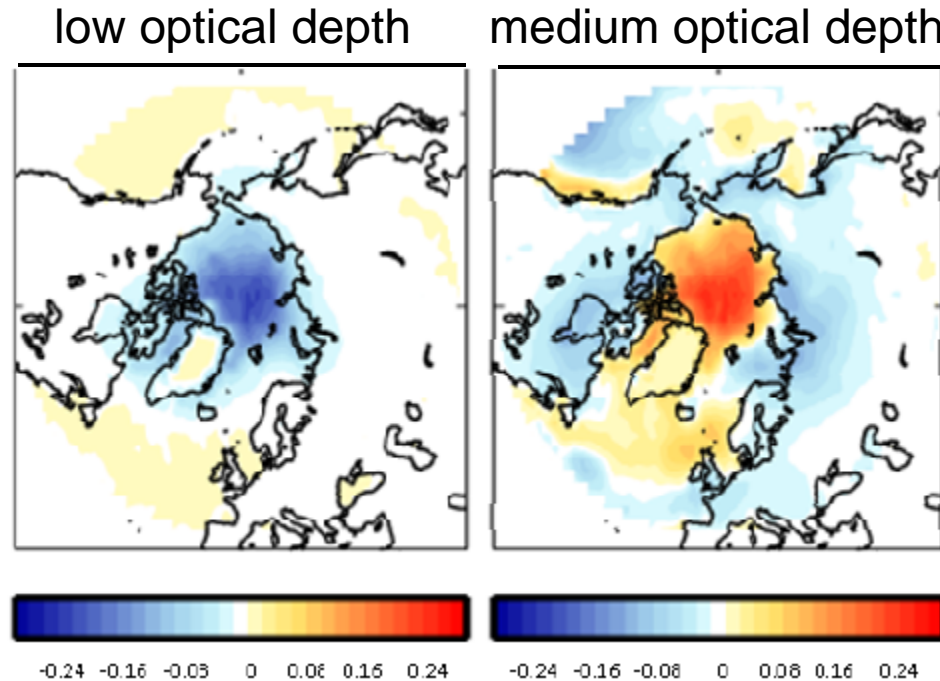


Atms Effective Radius JJA Level 1





## Fractional change in JJA low top cloud properties to 4 x CO<sub>2</sub>



Downwards Surface Shortwave (JJA) 60 W m<sup>-2</sup> less by 4xCO<sub>2</sub>

Component attributable to DMS cloud interaction is 1.1 ± 0.7 W m<sup>-2</sup>

Impact: Sea ice decline retarded – area mean TOA clear sky albedo +9 W m<sup>-2</sup>



# Summary

- Arctic summer clouds gain optical depth (increased liquid water content)
- Available down-welling SW reduced by  $60 \text{ W m}^{-2}$  (at  $4\times\text{CO}_2$ )
- Small DMS influenced 1<sup>st</sup> indirect aerosol effect detected.
- Ice-free Arctic (September) delayed by 6 years.