THEMES:

Importance of chemistry on climate change ?
- **-main impacts and uncertainties**
- **-are coupled chemistry-climate simulations necessary?**

Impact of changes in climate on chemistry?
- **- main sensitivities and uncertainties**

SUB-THEME:

Parameterizations and the evaluation and testing of models
- **- putting confidence in our answers**

Importance of chemistry to climate change:

-Chemistry is probably most important is so far as it impacts other processes:

Aerosols (formation, composition)
- -oxidants
- -secondary organics
- -influences on CCN and changes in cloud properties

Changes in circulation (strat. and upper trop.?)
- - impacts on hydrological cycle
- - impact on strat/trop exchange
- - changes in strat. composition

Influences on the carbon cycle
- - through nitrogen deposition
- - through ozone

-In many cases the interaction remains to be fully quantified.
-Do we need full coupled chemistry to implement?

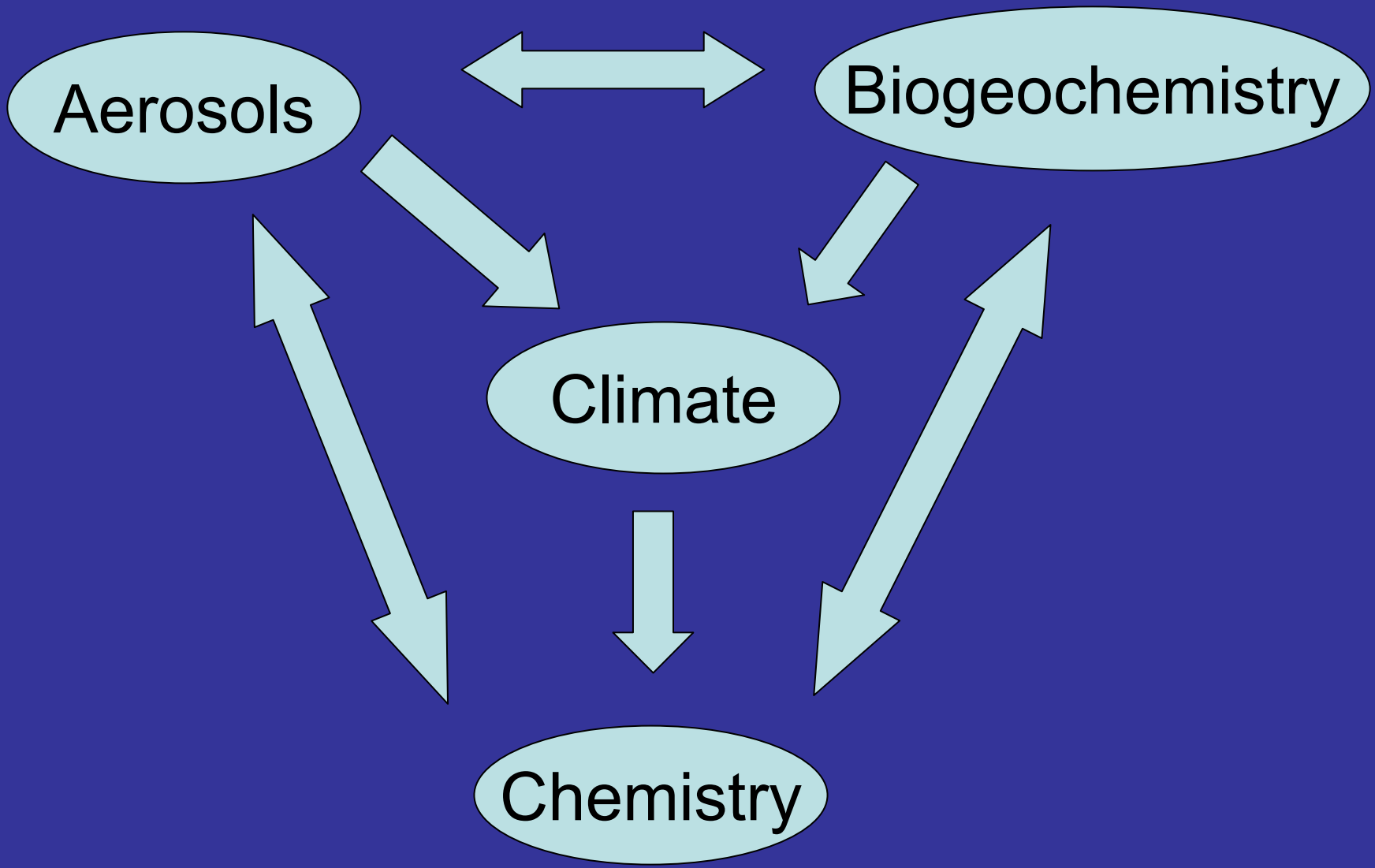
Importance of chemistry to climate change:

-Comparatively, changes in chemical composition are probably not as important to climate (on short timescales – 100's of years)

Radiative impact of ozone and CH4 likely to be dwarfed by that of CO2

Changes in O3 and OH due to climate change estimated to be relatively small *O*(10%)

Impact of changes in biogenic emissions, lightning NOx not likely to affect these conclusions


Aerosols
Biogeochemistry
Climate
Chemistry

Impact of chemistry on climate:

Do we need fully coupled chemistry-climate models (the case has not been made)?

Asynchronous coupling may be a viable option, but:

--How long does it take chemistry to reach quasi-equilibrium given a new climactic state?

--How long does it take chemistry-climate system to reach equilibrium given chemical feedbacks on climate system?

--Does variability not captured by asynchronous coupling feed back into the climate system?

Impact of climate on chemistry:

Low confidence, high sensitivity and high importance:

--Changes in circulation and meteorology (including convection, pblh, and ste)
--Changes in water vapor
--Changes in Lightning NOx
--Changes in Biogenic Emissions

Items that shake our confidence:

1. While ozone concentrations are “well” modeled, large differences in the budget occur between different models
2. NOy partitioning and HOx budgets
3. Role of heterogeneous processes
4. Parameterized convective transport of species
5. Effect of hydrological cycle on chemistry (Washout, cloud chemistry, microphysics)
6. STE (troposphere to stratosphere)

Models parameterization are tuned (unconsciously or consciously) to give the right answer under present day conditions. e.g.,

- emissions
- stratospheric ozone
- lightning NOx
- chemical mechanism

Will the tuning work under other conditions?

-Maybe, if the parameterization is physically based.

Test of models under different conditions

--Interannual variability
--Paleoclimate simulations
--Perturbed conditions (ENSO, Pinatubo…)
--Preindustrial simulations

Do we get the right answer for the right reasons

-Critical evaluation of model under present-day conditions:

-Measurements of many species

-Accurate a-priori emission estimates to constrain problem