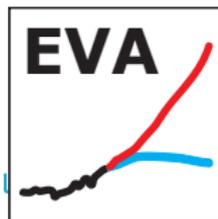# New version of NorESM

Alf Grini, Alf Kirkevåg, Øyvind Seland, Dirk Olivie, Trond Iversen, Michael Schultz

September 29th 2014
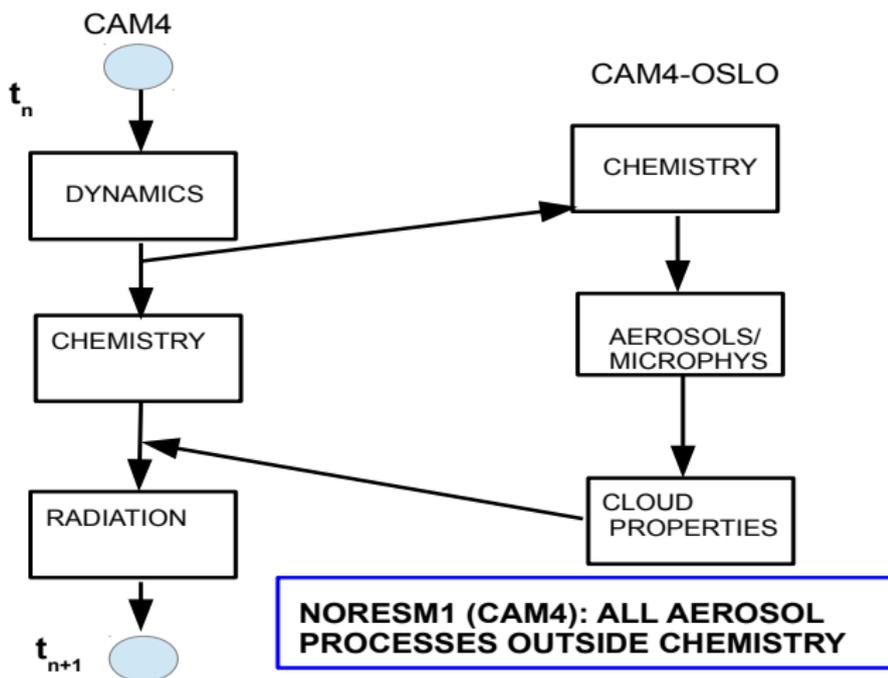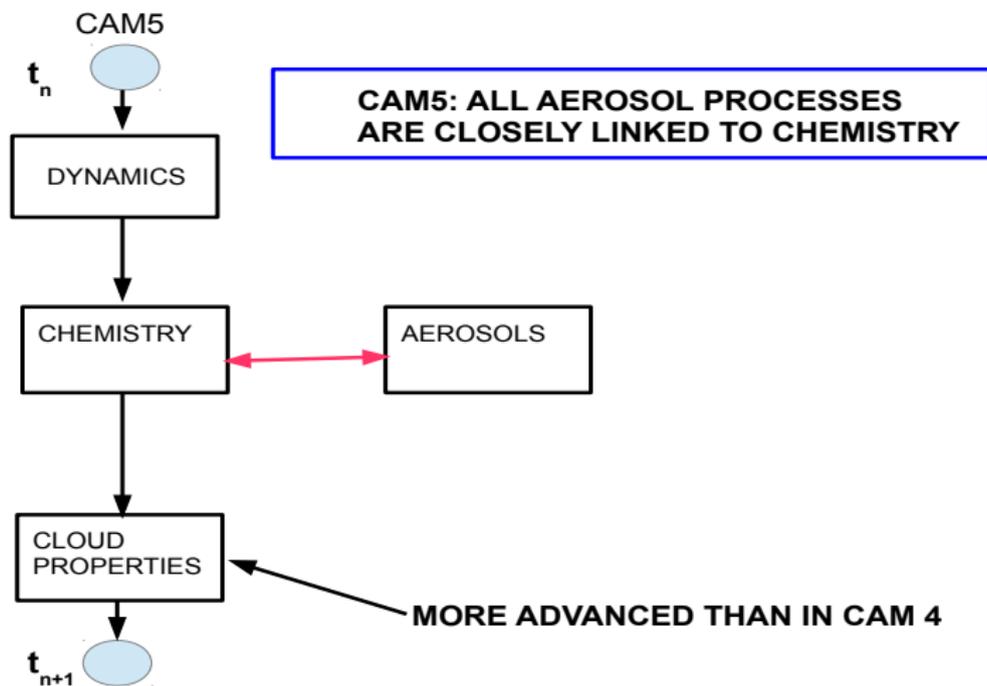
Table of contents

Going from CAM4 to CAM5 as host model

- CAM4 did not have size resolved aerosols (NorESM1 did). CAM5 has size resolved aerosols by default (MAM, modal aerosol model)

- NorESM1 carried tracers in clear air CAM5 carries tracers in clear air and cloud water.

- CAM5 has all aerosol tracers closely coupled to MOZART chemistry

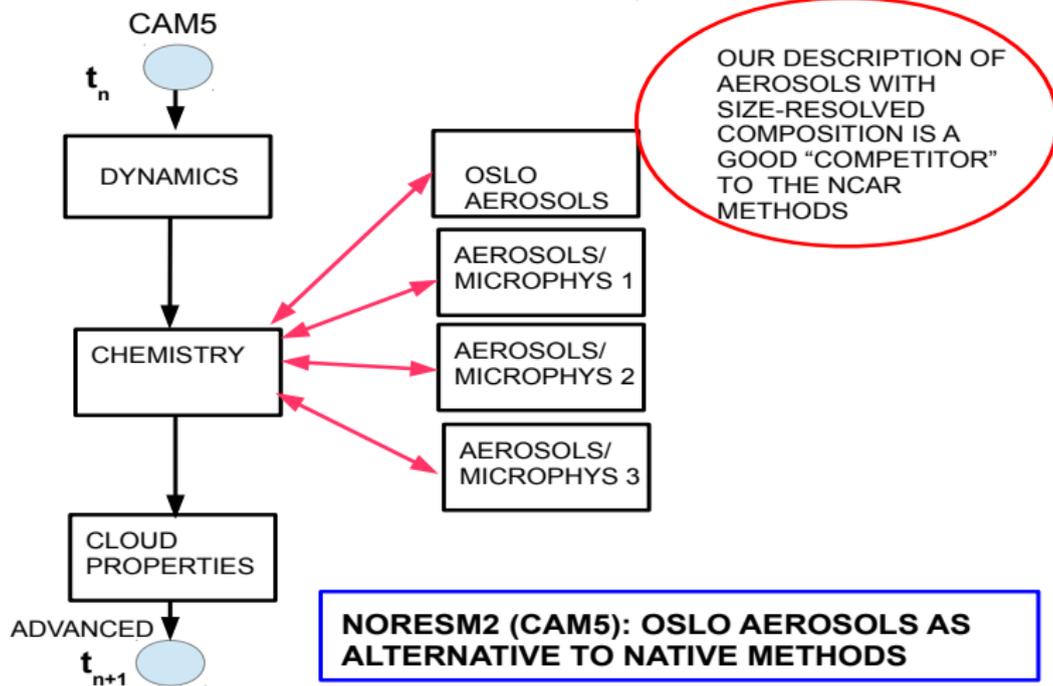- CAM4 (NorESM) had all the aerosol code as part of the physics code.

Difference in design using CAM4 or CAM5 as host

CAM4

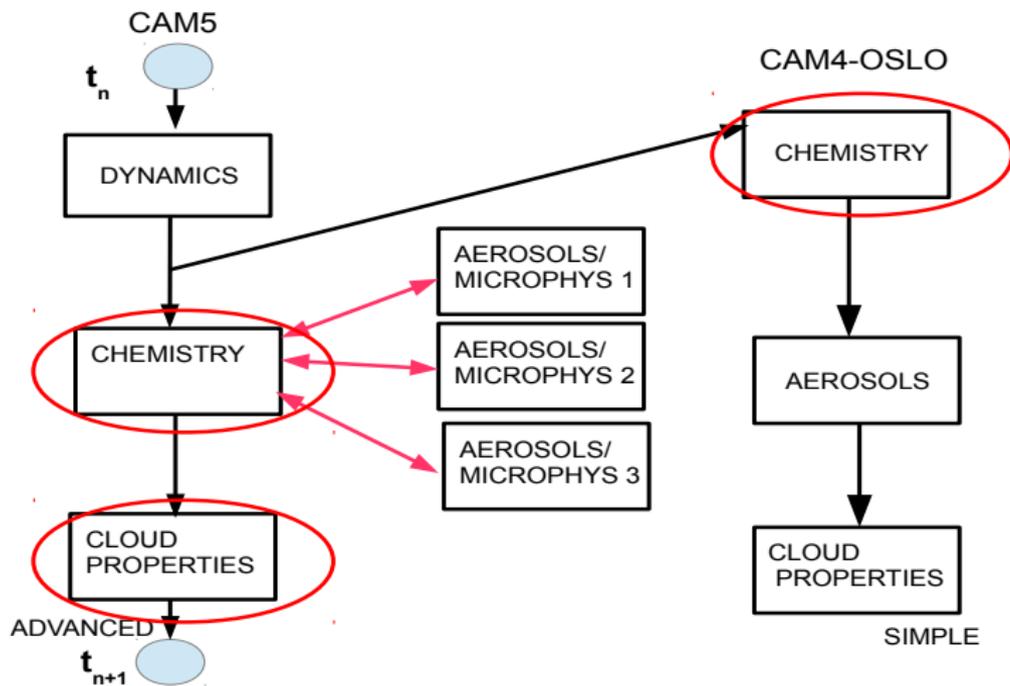t_n

DYNAMICS

CAM4-OSLO

CHEMISTRY

CHEMISTRY

AEROSOLS/
MICROPHYS

RADIATION

CLOUD
PROPERTIES

t_{n+1}

NORESM1 (CAM4): ALL AEROSOL
PROCESSES OUTSIDE CHEMISTRY

EVA

Meteorological
Institute

Difference in design using CAM4 or CAM5 as host

Difference in design using CAM4 or CAM5 as host

CAM5

t_n

DYNAMICS

CHEMISTRY

CLOUD PROPERTIES

ADVANCED

t_{n+1}

OSLO AEROSOLS

AEROSOLS/ MICROPHYS 1

AEROSOLS/ MICROPHYS 2

AEROSOLS/ MICROPHYS 3

OUR DESCRIPTION OF AEROSOLS WITH SIZE-RESOLVED COMPOSITION IS A GOOD "COMPETITOR" TO THE NCAR METHODS

NORESM2 (CAM5): OSLO AEROSOLS AS ALTERNATIVE TO NATIVE METHODS

EVA

Meteorologisk
Institute

Chemistry

Chemistry

CHEMISTRY?

Chemistry

CHEMISTRY?

CAM-Oslo has similar
(but older)
Versions than CAM5

DRY/WET
DEPOSITION
OF GAS

CHEMISTRY

EMISSIONS
Reading and
time-interpolating files

PHOTOLYSIS
CAM-Oslo is similar
But older than CAM 5

IN CLOUD
CHEMISTRY
?
CAM-Oslo has different
Version than CAM-5

EQUATION
SOLVER
CAM-Oslo is less
advanced than CAM 5

SYSTEM FOR
"CONSTANT"
TRACERS
Reading and time-
Interpolating files

EVA

Meteorological
Institute

Develop CAM5-Oslo

**CHEMISTRY
(production/loss
in clair air and in
cloud droplets)**

**ACTIVATION/CLOUD
PROCESSING**

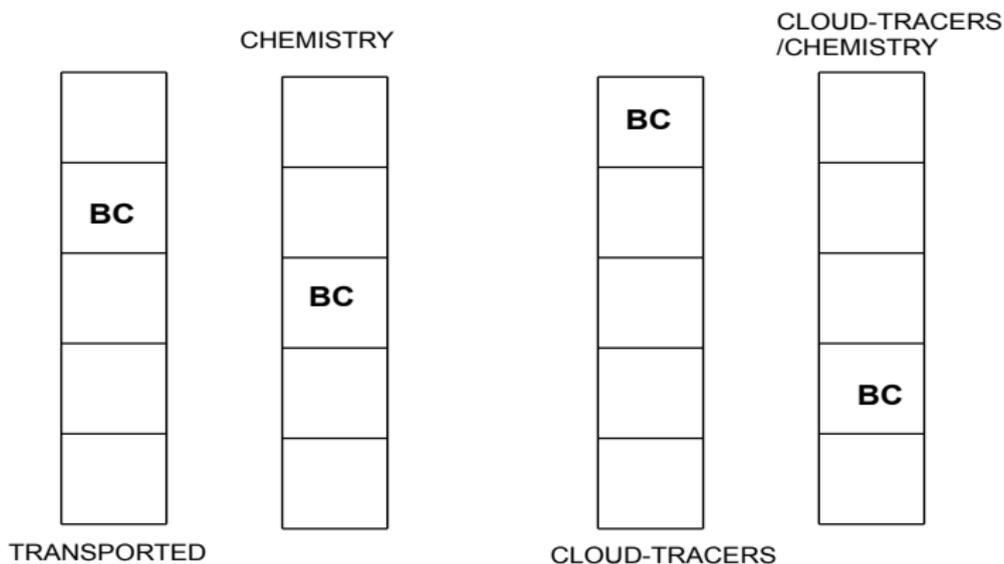**(moves between clair air
and cloud droplets)**

TRANSPORT

**(moves tracers in clair air
only!!)**

DRY/WET DEPOSITION

**(acts on tracers in clair
air and cloud droplets)**

EVA

Meteorological
Institute

Develop CAM5-Oslo

INDEXING OF TRACERS

Develop CAM5-Oslo

CONSEQUENCE FOR THE PROGRAMMER

```
do n=1,nModes
  do nt = getNumberOfTracersInMode(n)
    Index = getChemistryIndex(n,nt)
    !! Index = getCloudChemistryIndex(n,nt)
    Call doSomething(index)
  End do
End do
```

Promised add-ons in NorESM2 (after changed host model)

- Explicit nucleation (code from Risto)
- Interactive dust emissions
- Interactive DMS and POM emissions
- Improve sulfate wet phase chemistry
- Aerosol scavenging take into account mixing state
- Investigate semi volatile aerosol (nitrate and SOA)
- Maintain full chemistry research version

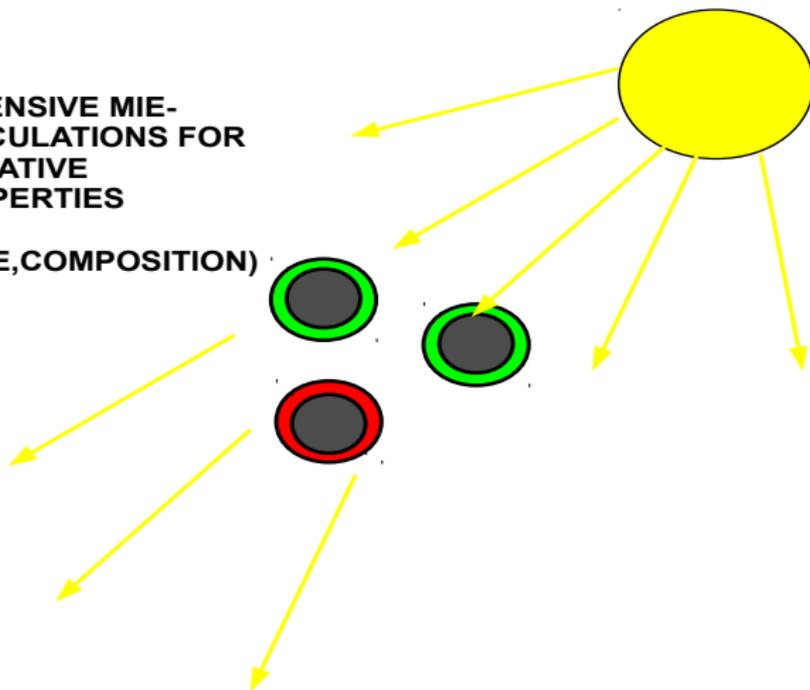# What motivates a choice of aerosol package??
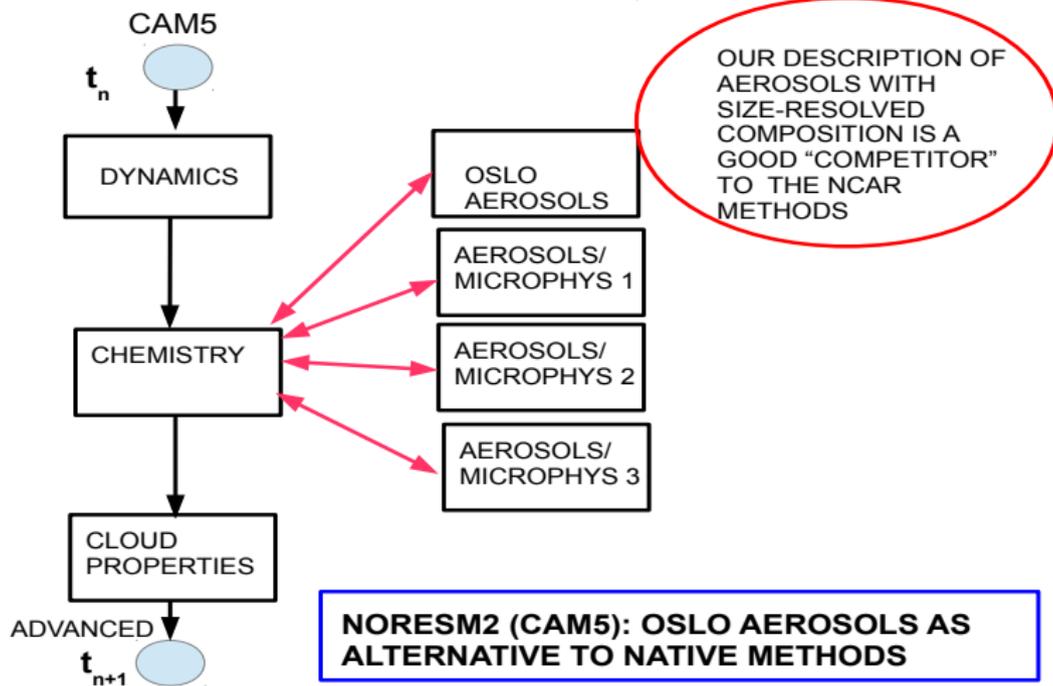
Calculating the aerosol properties
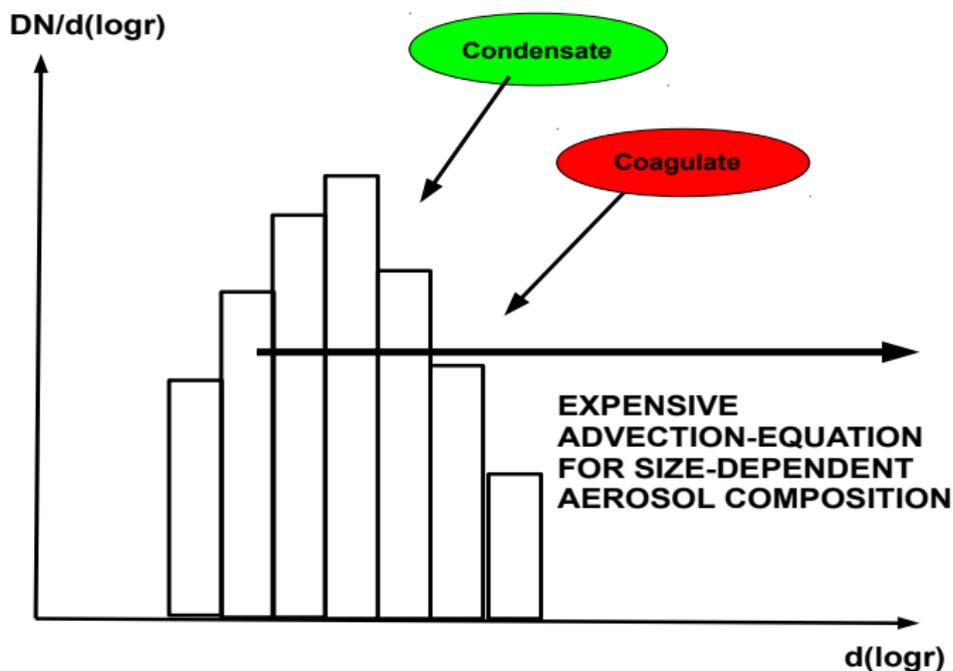
Calculating the aerosol properties

EXPENSIVE MIE-CALCULATIONS FOR RADIATIVE PROPERTIES ==> f(SIZE,COMPOSITION)

Production-tagged Solution

- "Modal" schemes: Number concentration is transported separately from the mass concentrations and the ratio of number to mass gives the aerosol size
- Production-tagged solution:
    - **Off-line**: Pre-calculate change in size distribution from added pollutants (growth and optical properties)
    - **Off-line**: Store the result in look up tables
    - **In climate model**: Transport original aerosol distribution separately from the "pollutants"
    - **In Climate model**: Look up size properties during model run
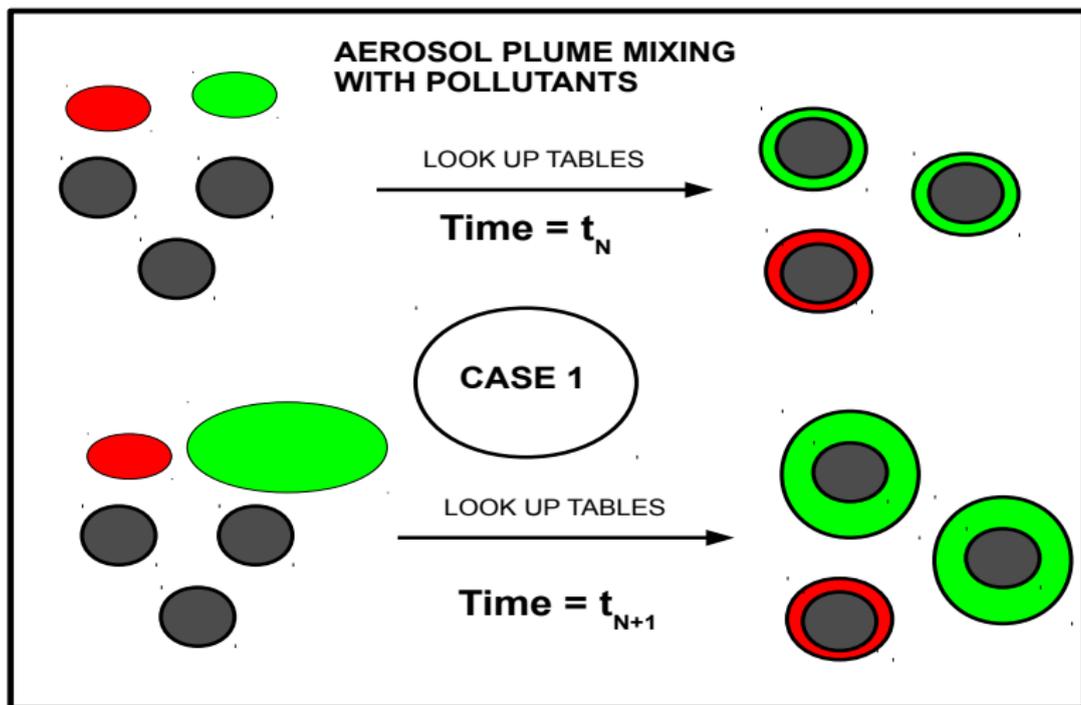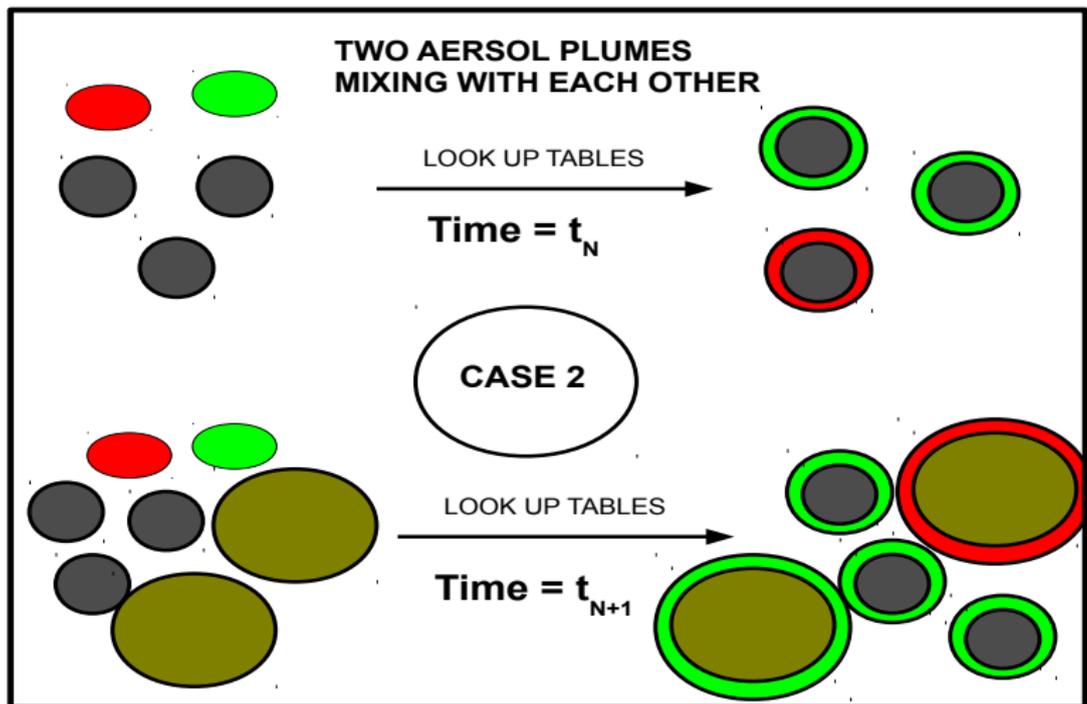
Look-up tables??
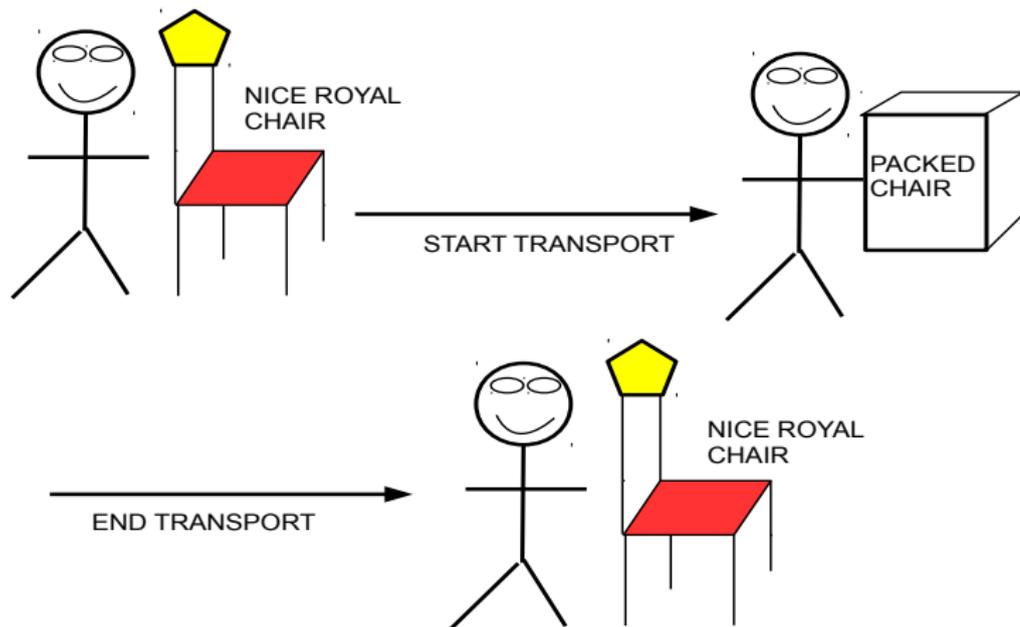
Look-up tables??
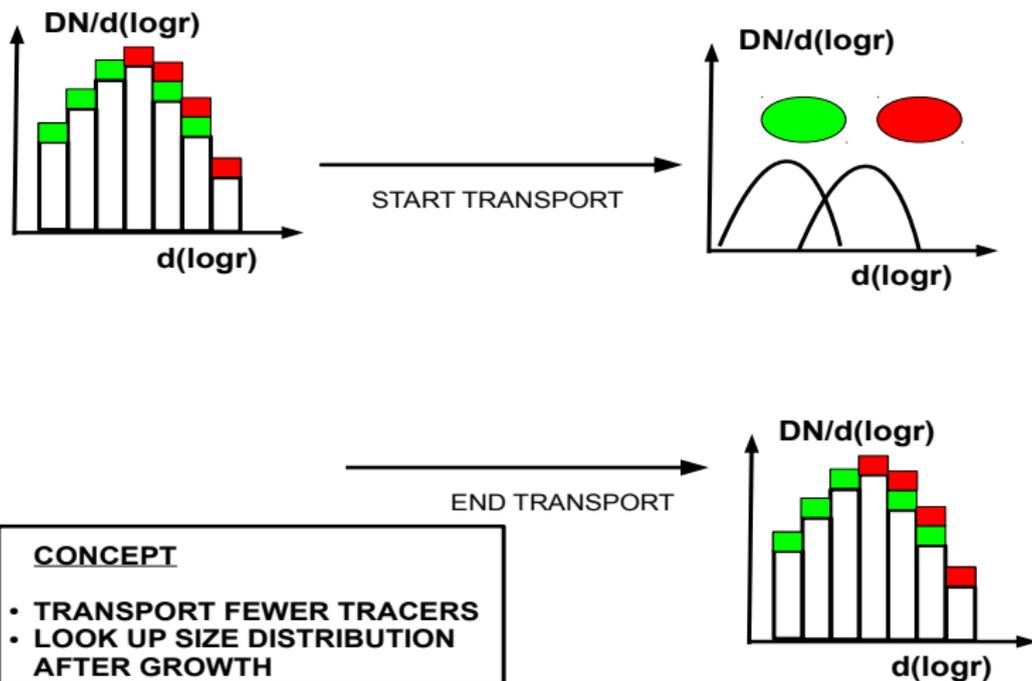
A note on dynamical vs steady state

- Dynamical system $A_{t+1} = A_t + \frac{dA}{dt} \times dt$
- Steady state system $A_{ss} = f(A_{total}, properties)$
- The look up tables are a "steady state" like system!

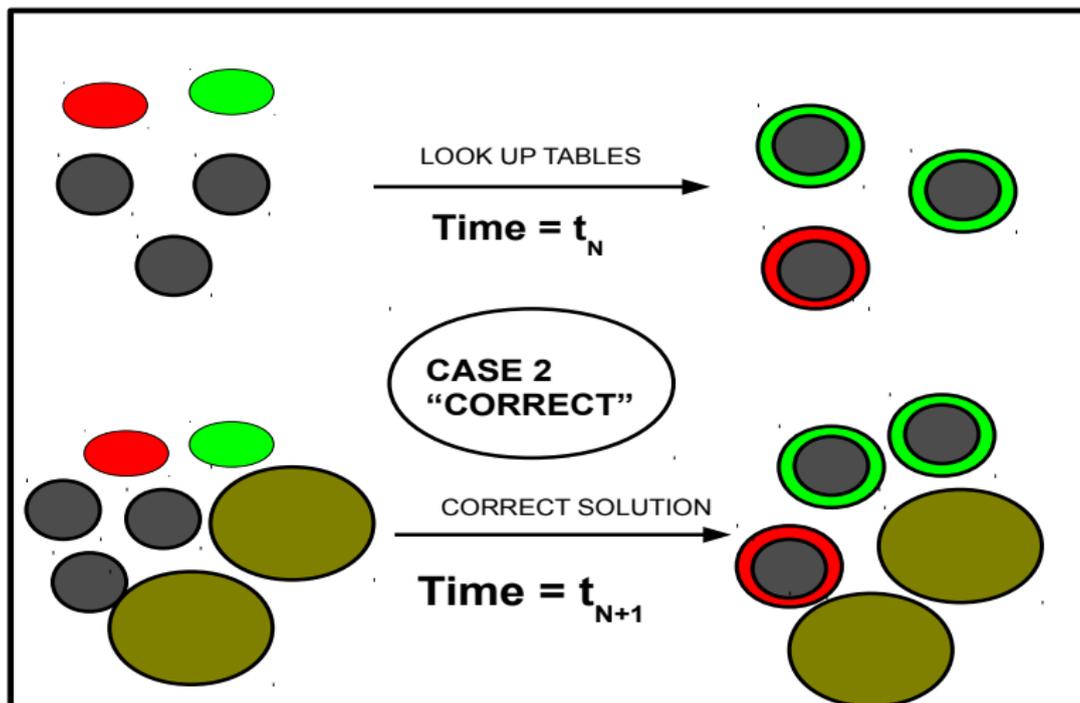# What does "steady state" mean in this context?

What does "steady state" mean in this context?

What does "steady state" mean in this context?

Conclusion

- Our "production tagged" solution is currently ported from CAM4 to CAM5
- This gives the user an additional choice of aerosol package ("competitor" to NCAR packages)
- Native NCAR packages use a modal approach
- Our approach uses a detailed sectional model and a steady-state approach combined with look up tables
- NorESM2 we will take advantage of the MOZART chemistry scheme to remove some old features.