DO CAM3 SIMULATIONS CONVERGE WITH INCREASING HORIZONTAL RESOLUTION?

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Do simulations from AGCMs converge with increasing resolution?

Should simulations converge?

Are there reasons to believe them if they do not converge?

How should convergence be defined?

Should the smaller scales be believed?
Aqua-planet Simulations


http://www.met.reading.ac.uk/~mike/APE/ape_home.html

Atmospheric model with complete parameterization suite

Idealized surface
no land (or mountains), no sea ice
specified global sea surface temperatures everywhere
simple geometry
Community Atmosphere Model (CAM3)

Eulerian Spectral Transform
Finite Volume
Semi-Lagrangian Spectral Transform

2 degree Finite Volume is equivalent to T42 Spectral Transform
1 degree Finite Volume is equivalent to T85 Spectral Transform
STANDARD EULERIAN SPECTRAL CAM3

PRECIPITATION

LATITUDE

mm/day

T42

T85
“JUST CHANGED RESOLUTION”

TIME STEP
GRID
SPECTRAL TRUNCATION
DIFFUSION
PARAMETERS
PARAMETERIZATION DT = 5

PRECIPITABLE WATER

PRECEPITATION

TOTAL CONVEG STABLE
PARAMETERIZATION DT = 5

**EULERIAN**

**FV**

**SEMI-LAGRANGIAN**
SURFACE PRESSURE

T0

T1

T3

T7

T15

NO TRUNCATION
CLOUD FRACTION

T0

T1

T3

T7

T15

NO TRUNCATION

[Graphs showing the fraction of cloud coverage across different latitudes for various scenarios labeled T0, T1, T3, T7, and T15, with a separate graph for 'NO TRUNCATION'. Each graph plots the fraction of cloud coverage against latitude, with different lines representing different scenarios such as T42, 2x2.5, T85, 1x1.25, T170, 0.5x0.625, and T340.]
PARAMETERIZATION DT = 5

SPECTRAL

T42

T85  2 PT AVE

T170  4 PT AVE

T340  8 PT AVE

2 DEG

1 DEG  2 PT AVE

0.5 DEG  4 PT AVE

PARAMETERIZATION DT = 5

SPECTRAL

T42

T85  2 PT AVE

T170  4 PT AVE

T340  8 PT AVE

2 DEG

1 DEG  2 PT AVE

0.5 DEG  4 PT AVE

PARAMETERIZATION DT = 5

SPECTRAL

T42

T85  2 PT AVE

T170  4 PT AVE

T340  8 PT AVE

2 DEG

1 DEG  2 PT AVE

0.5 DEG  4 PT AVE

PARAMETERIZATION DT = 5

SPECTRAL

T42

T85  2 PT AVE

T170  4 PT AVE

T340  8 PT AVE
SYMMETRIC
PARAMETERIZATION DT = 5

T42

T85

T170

T340

SPECTRAL

FV

2 DEG

1 DEG

0.5 DEG
SYMMETRIC
PARAMETERIZATION DT = 5
TROPICAL PRECIPITATION PDF

T42

T85

T170
TROPICAL PRECIPITATION PDF
PARAMETERIZATION DT = 5

T21 SCALES

T85 SCALES

T42 SCALES

T170 SCALES
TROPICAL PRECIPITATION PDF
PARAMETERIZATION DT = 5

T42 SCALES
MID-LATITUDE PRECIPITATION PDF
PARAMETERIZATION DT = 5

T21 SCALES

T85 SCALES

T42 SCALES

T170 SCALES
MID-LATITUDE PRECIPITATION PDF

PARAMETERIZATION DT = 5

T42 SCALES
Develop parameterizations independent of time step
(or apply them in a range where independent)

(Removing the parameterization DT dependency)

Large scales do not converge for all fields

Is this due to parameterizations?

Should parameterizations be tuned to give convergent solutions?
TROPICAL WAVES

Converge at relatively high resolution

VARIABILITY

Larger scales converge

Need at least T85 or 1 degree resolution

Discard smallest half of scales