National Aeronautics and Space Administration
Goddard Institute for Space Studies

Goddard Space Flight Center
Sciences and Exploration Directorate
Earth Sciences Division

GISS ModelE Progress and Plans

WGCM, Princeton, Nov 2016

Gavin Schmidt and team

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GISS Post-CMIP5 Progress

MJO variability and prediction skill

Self-generated QBO

Enhancements to forcings (irrigation, volcanic, solar)

Better use of single forcing runs

Greatly improved ocean/sea ice simulations

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Planned GISS CMIP6 Configurations

Multiple configs w/variations for DECK runs:

1. GISS-E2.1 (ready)

   Variations: OMA vs MATRIX; R vs H ocean; L40 vs L96/102

2. GISS-E3 (mid-2017)

   C90+L96/102, same oceans; self-generated QBO, MATRIX aerosols, M&G cloud microphysics, cold pool convection

3. GISS-E4 (2018?)

   C180+L96/102, GO2 (GISS Ocean 2) (cubed sphere/ALE vertical)

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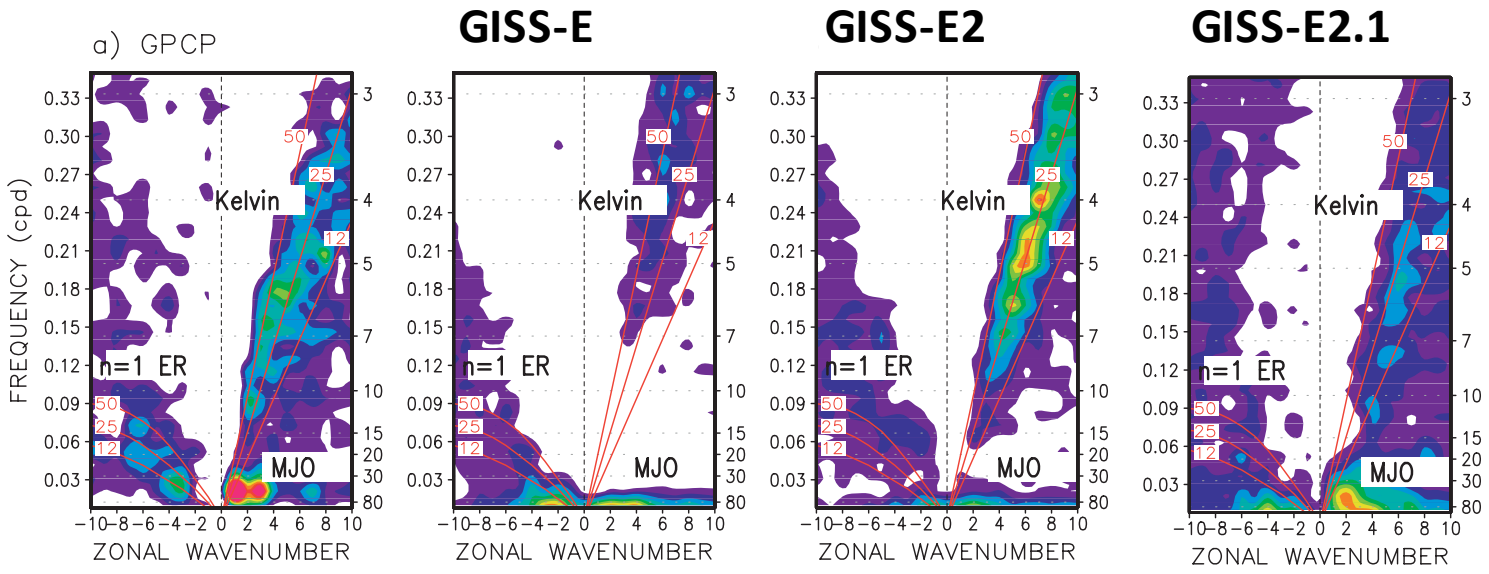
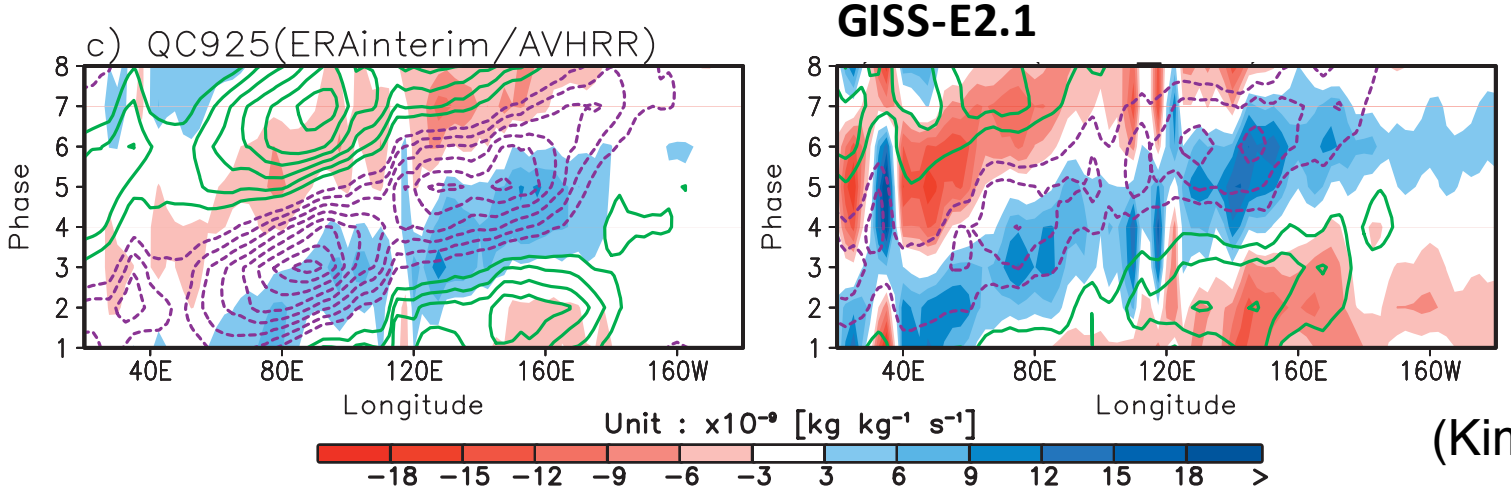
Newly resolved modes I: MJO





(Kim et al, 2012)

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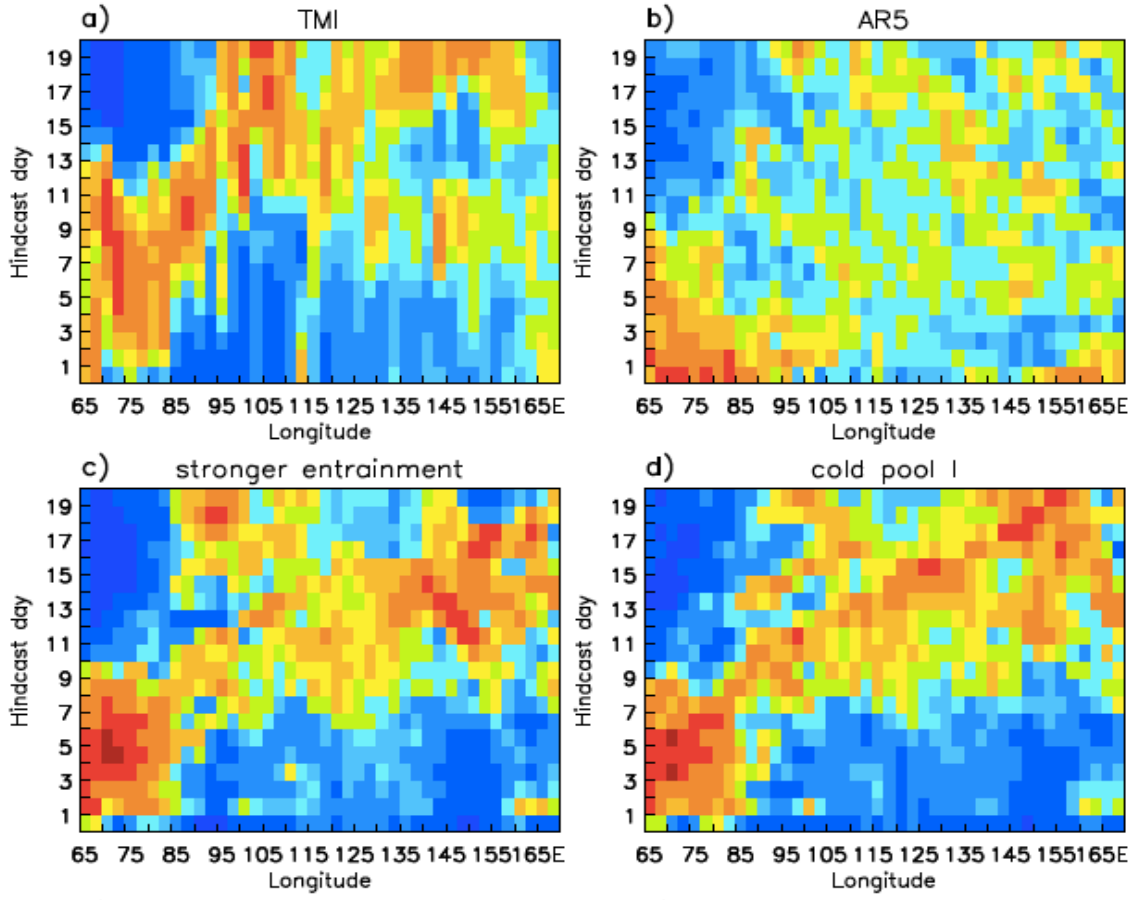
Cold pool parameterization:

Formed from downdrafts, used to restrict occurrence of weakly entraining plumes

GISS-E2

YOTC 20-day MJO rain hindcast Hovmöller diagrams

(0.63 20-day correlation with TRMM TMI with cold pool vs. 0.70 TMI-Radar correlation)



GISS-E3

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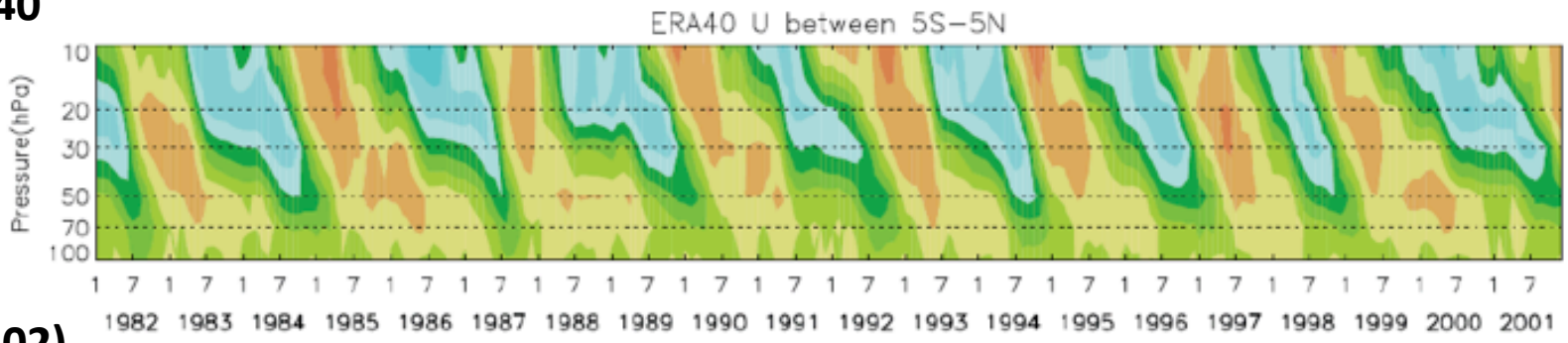
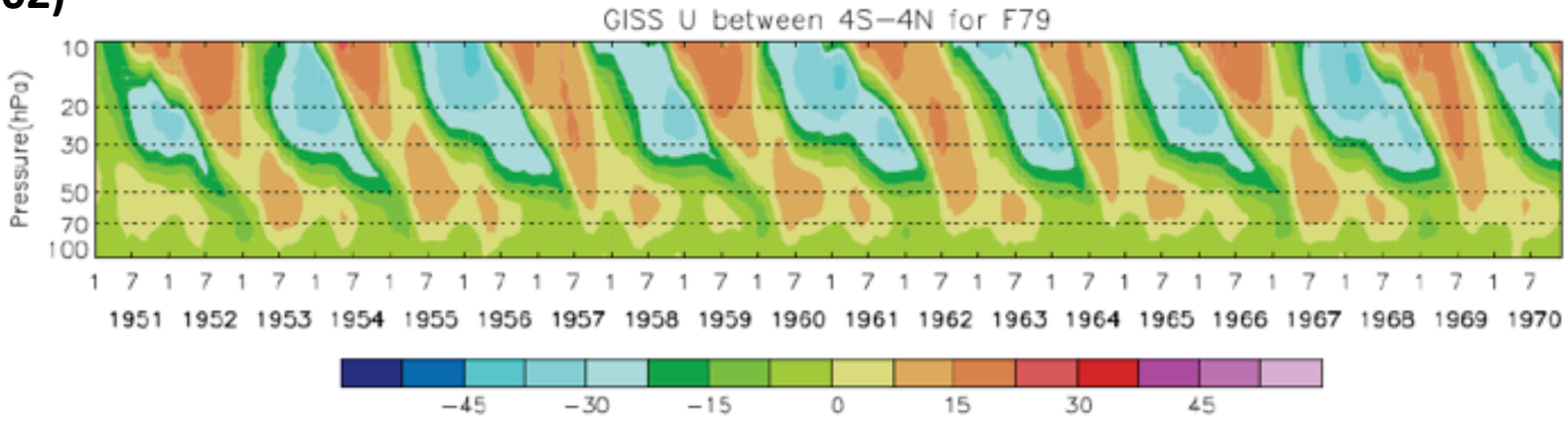
Self-generated stratospheric QBO

Tropical zonal mean winds

ERA40



GISS-E2.1(L102)



Rind et al (2014)

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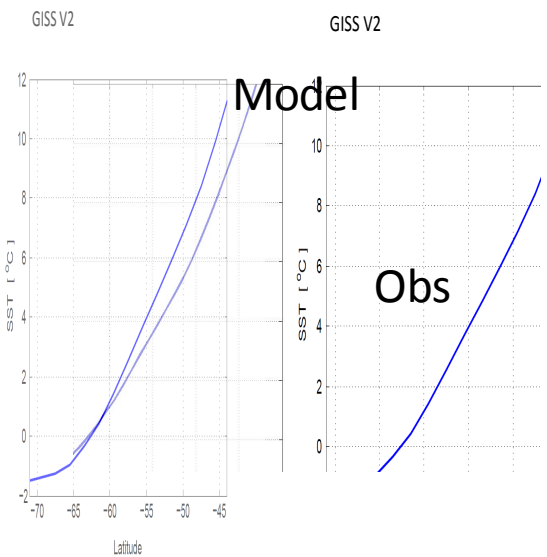
Ocean model improvements

Reformulation of GM eddy parameterisation

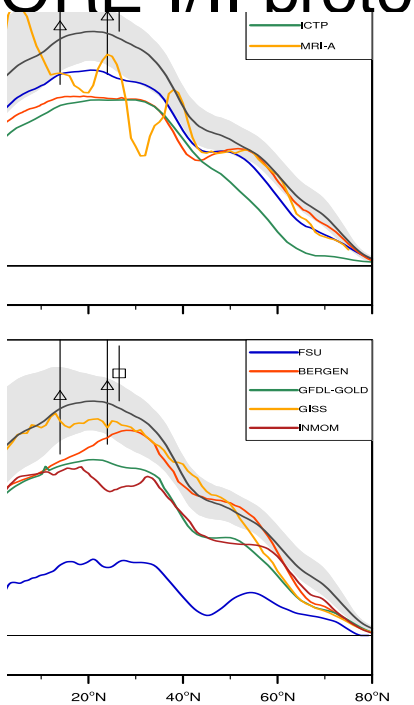
GISS-Vertical Mixing Scheme

Inclusion of GM vertical dependence

Evaluation with stand-alone ocean CORE-I/II protocol



Zonal mean SST gradients
Southern Ocean



AMOC Heat flux 26°N
CORE II: Danabasoglu et al (2014)

GISS Ocean 2 (GO2) Model

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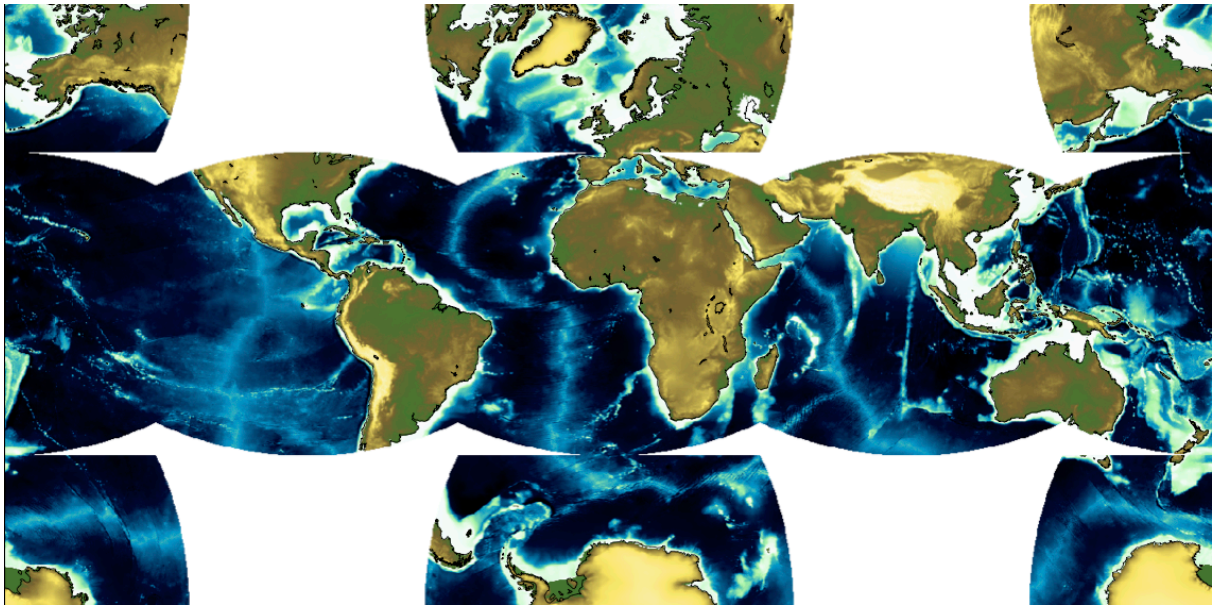
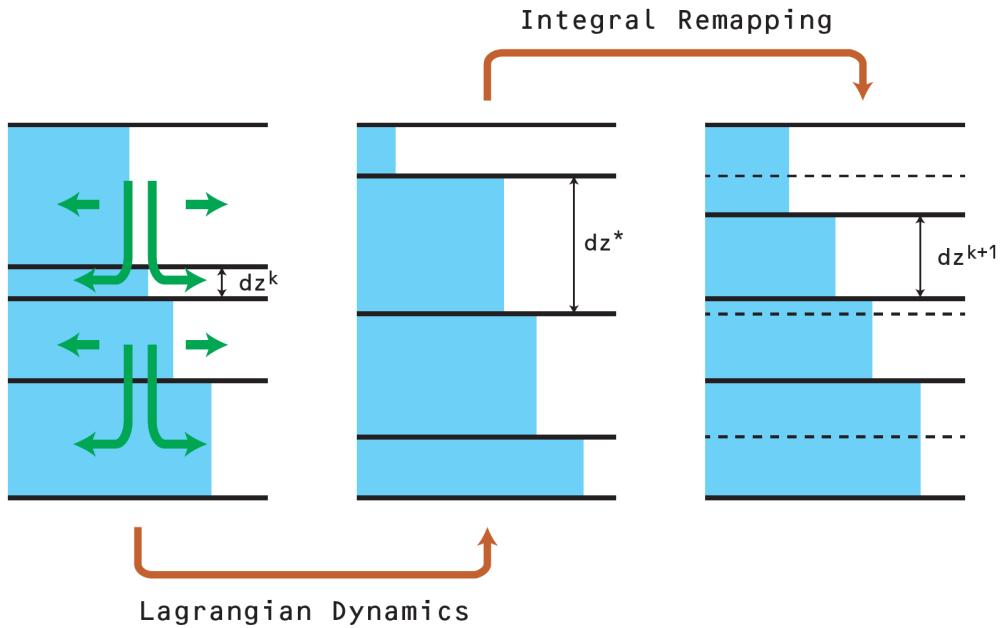
Orthogonal Cubed-Sphere grid
C720 goal (1/8°)



Arbitrary Lagrangian Eulerian (ALE) vertical coordinate



MATRIX Aerosol model

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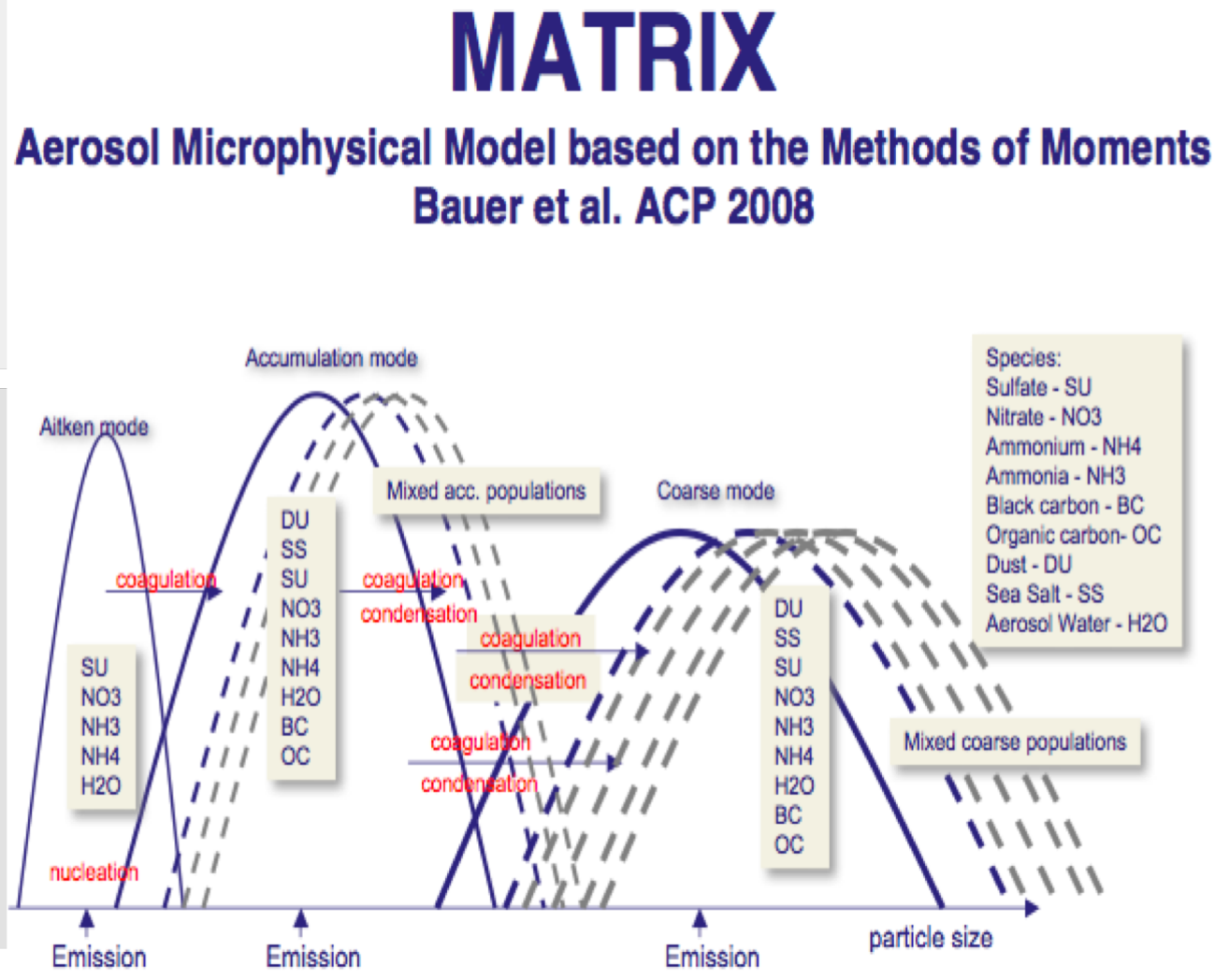
Ternary Nucleation:
$H_2SO_4 - H_2O - NH_3$
(Napari et al 2002)
Ion induced nucleation:
(Turco et al 1998)
New particle formation: growth
(Bauer et al 2008)

Aerosol Microphysics:
- Simulation of aerosol mass, mixing state and size distributions (1). Needed for:
- **Indirect effects**: Microphysical parameter. of aerosol - cloud activation (1,2)
- **Direct effects**: Radiation scheme coupled to aerosol shape and mixing state information (3)



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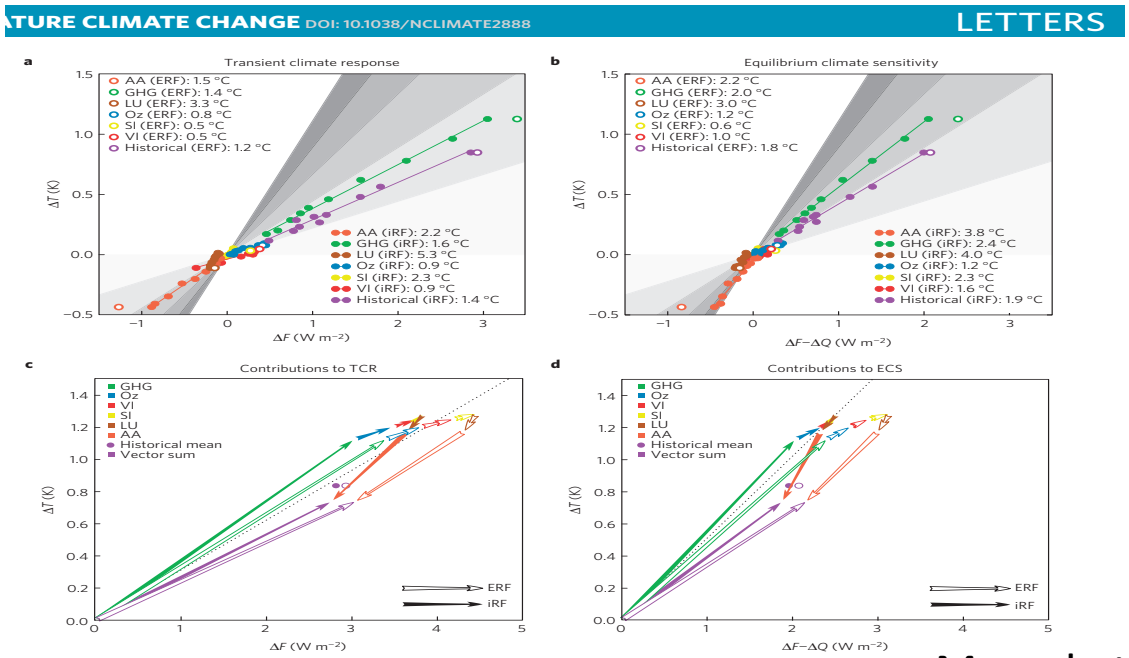
Efficacy of forcings in transient runs

Use historicalMisc runs + forcing calculations to assess predictability of TCR+ECS from historical transients

Historical runs ***underpredict*** sensitivity



Marvel et al, 2016

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Forcing improvements

Irrigation (water added to land surface, either from rivers or groundwater)

Greater differentiation in LU (crops, pasture etc.)

Volcanic forcing by emission

Solar forcing uncertainty

Aerosol forcing - uncertain pre-cursor emissions and atm. processing

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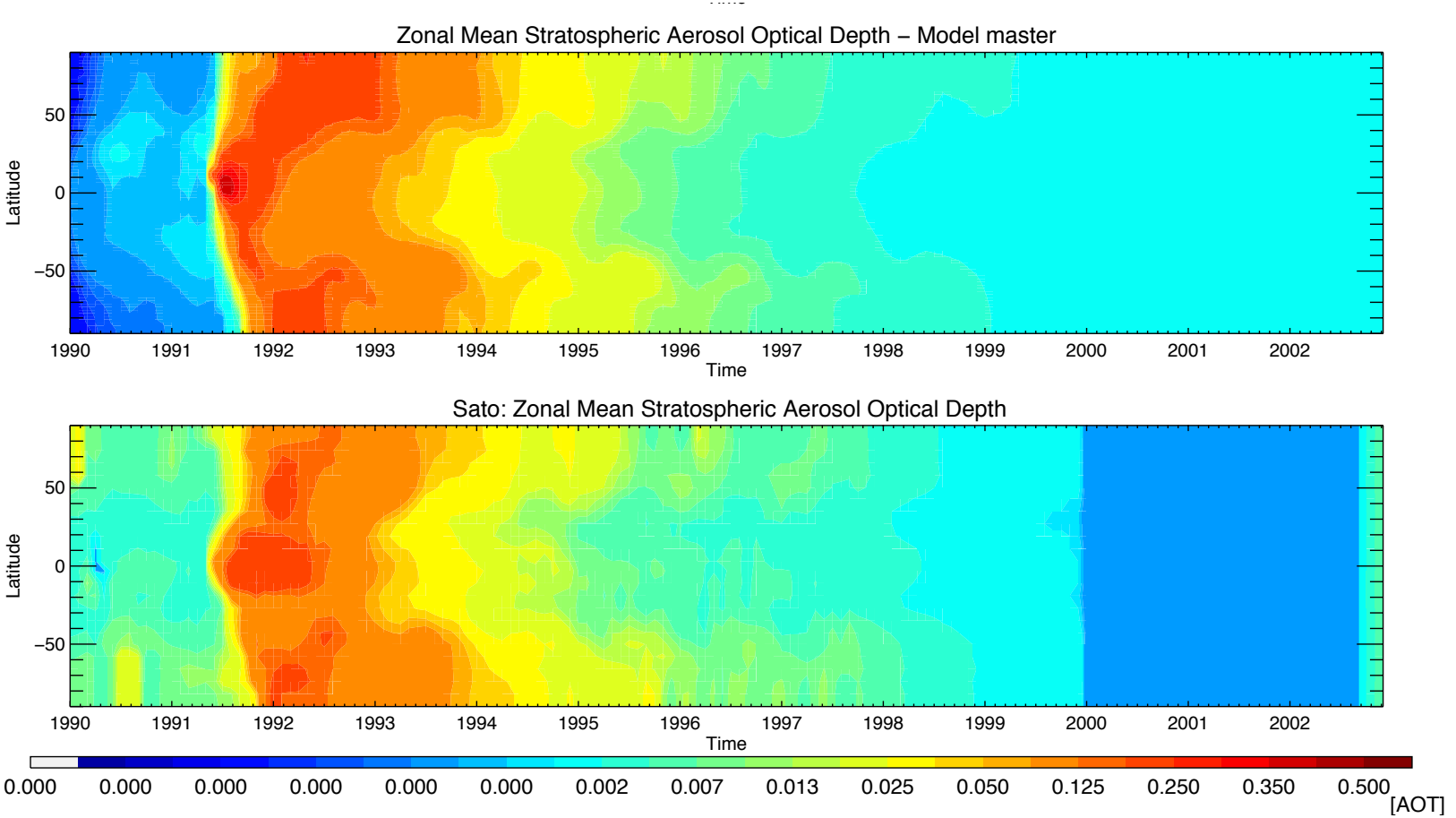
Interactive simulation of explosive volcanoes

Pinatubo AOD via GISS E2.1 + MATRIX



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MIP foci

1) DAMIP - single forcing ensembles (also SolarMIP/VolMIP/LUMIP)

2) RFMIP - Essential complement to understanding responses for all relevant expts.

3) AerChemMIP

4) CFMIP

5) PMIP - ‘out-of-sample’ evaluations

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GISS CMIP concerns

Forcing variations and expansion ✓

Greater (controlled) structural variations in models ✓

Greater interactions ✓

Better stratosphere and trop/strat coupling ✓

Feedback to model groups from users ? ?

Tracking of data use (DOI or PIDs) ?

Complete enough simulations to multiply/constrain ECS ?

Derived data connection to original files ✗