Themes of GMAO's work

- Weather Analysis and Prediction
- Seasonal-to-Decadal Analysis and Prediction
- Reanalysis
- Global Mesoscale Modeling
- Observing System Science

- These (non-orthogonal) themes span GMAO's main focus areas
- Strong emphasis on NASA's Earth Observations (use, support, planning)
- GEOS-5 research uses the same systems as used for product generation
- GEOS-5 is a modular system, encompassing many Earth System components

Applications of GEOS GCM

- Global Mesoscale: ~12 km up to ~1.5 km
- GEOS Atmospheric Data Assimilation System (ADAS)
  - Assimilation, forecasts at ~12 km, Ensembles at ~50 km
  - Reanalysis at ~50 km – MERRA-2
- Seasonal Prediction (Coupled Atmosphere-Ocean + ODAS)
  - Atmosphere at ~100 (50) km, Ocean at ~50 km
- Coupled Chemistry: ~100 km for climate, up to ~12 km targeted
- Atmosphere only Climate (AMIP): ~100 km to ~25 km
- Coupled Ocean climate, decadal: ~100 km, moving to ~50 km
- Chemistry Transport, Single Column, Various "offline" applications

Single GCM for all applications, all include "replay" capability

GMAO Updates (2016-2017)

NWP

- GEOS-5 Atmospheric Data Assimilation System (ADAS) is now running in production at 12 km with an upgraded AGCM and 4DEnVar DAS. Significant improvement of forecast skill.
- Implementation of open ocean Skin Temperature Analysis was included in production NWP system
- GMAO contribution to SMAP Project: Version 2 of Level-4 products released

Subseasonal/Seasonal

- LETKF Ocean Data Assimilation System was incorporated into GEOS
- Release of new model/ocean data assimilation system for sub/seasonal forecasts – hindcasts began

Reanalysis

- M2R12K, the global 12 km 10-year "replay" to MERRA-2, was completed and analyzed
- Peer-reviewed publications and Technical Memoranda documenting MERRA-2

Other Accomplishments

- Versatile, ESMF based Chemistry Transport Model released
- GEOSChem chemistry module incorporated into GEOS GCM
- Quasi real time coupled chemistry forecasts using GEOSChem chemistry

Under Active Development – Moist Physics in AGCM

- Univ of Washington shallow convection
- Grell-Freitas cumulus parameterization

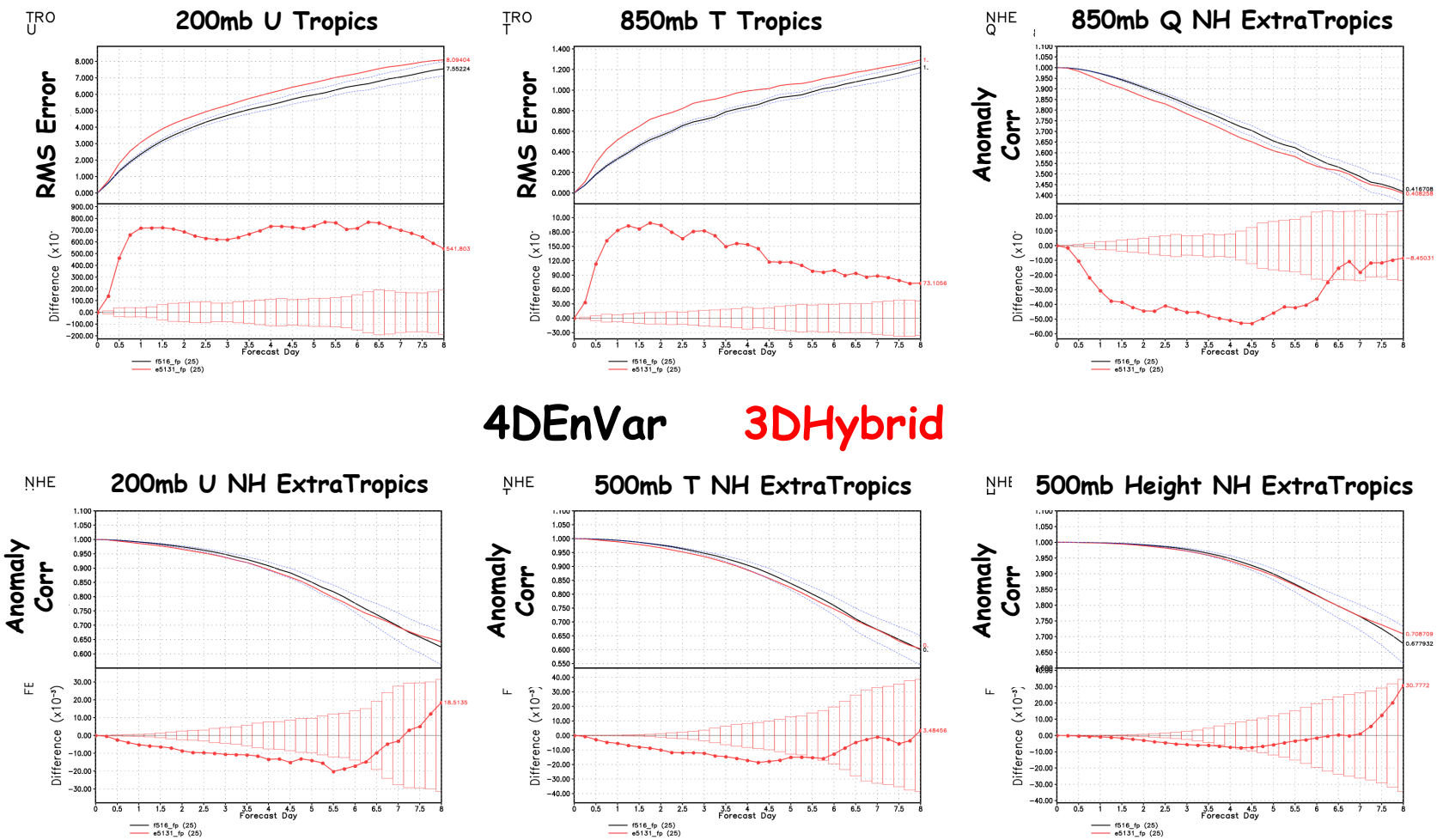
GEOS Hybrid 4D-EnVar implemented Jan 2017

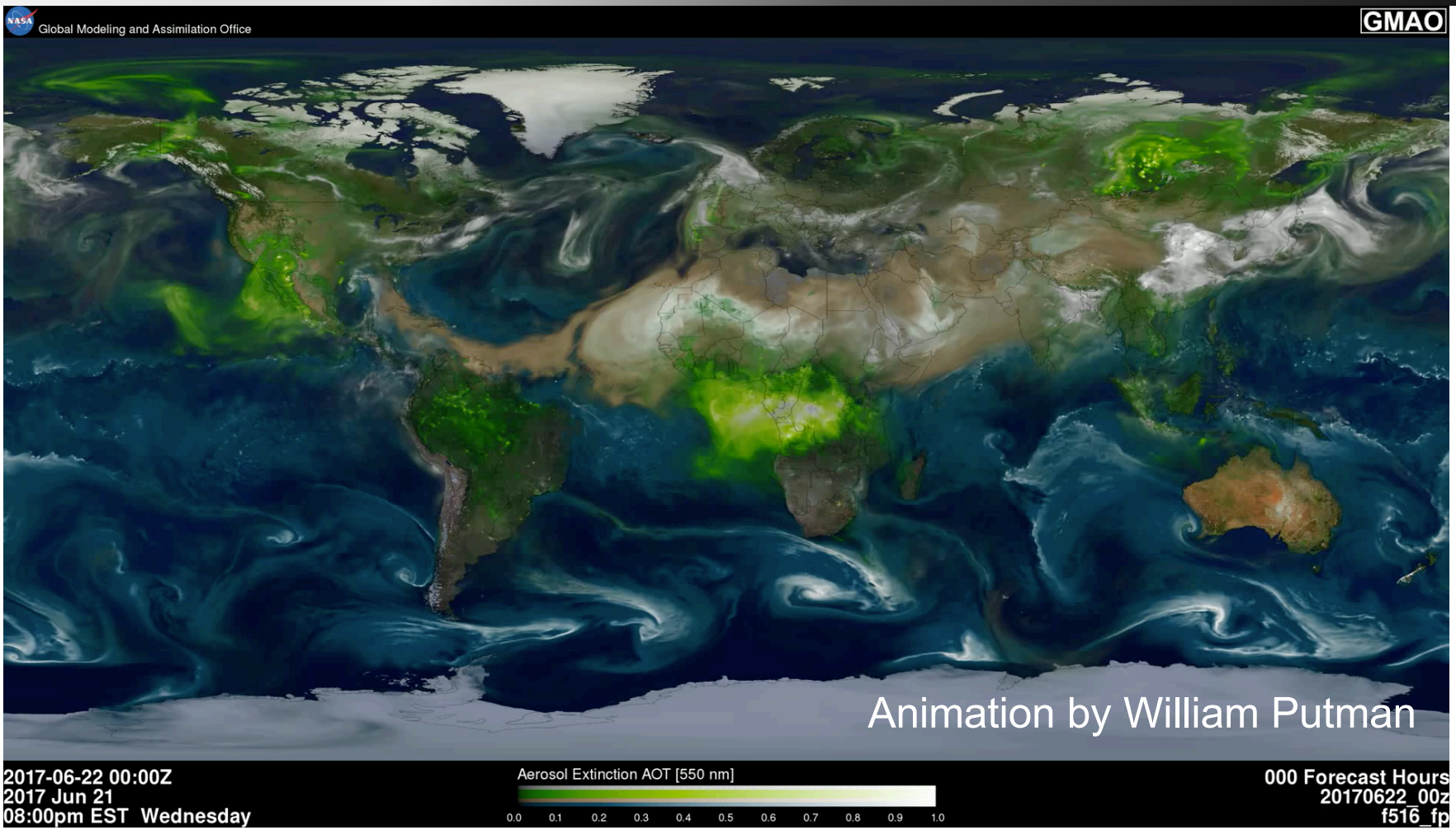
FV3 Dynamical Core
GEOS Physics
GSI + Semi-Coupled Skin SST Analysis
GOCART Aerosols + Assimilation

Key Updates

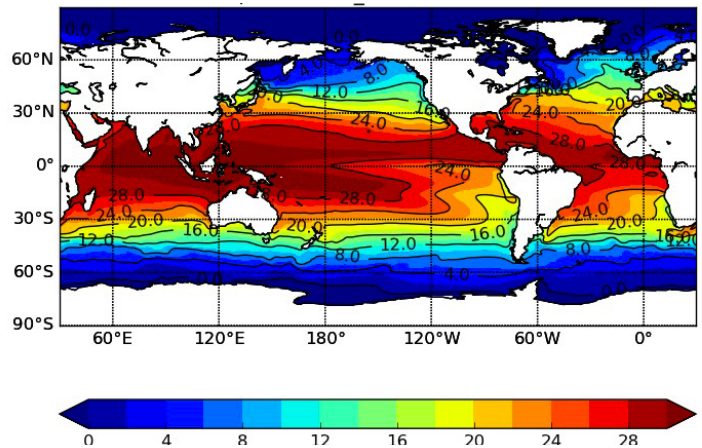
- Hybrid 4D-EnVar analysis
- Increased resolution
  - GCM: C720 L72 (12.5 km)
  - GSI: 1152x721 L72 (25 km)
  - EnKF: 32xC180 L72 (50 km)
- Retuned moist physics
- Additional aerosols (Nitrates)

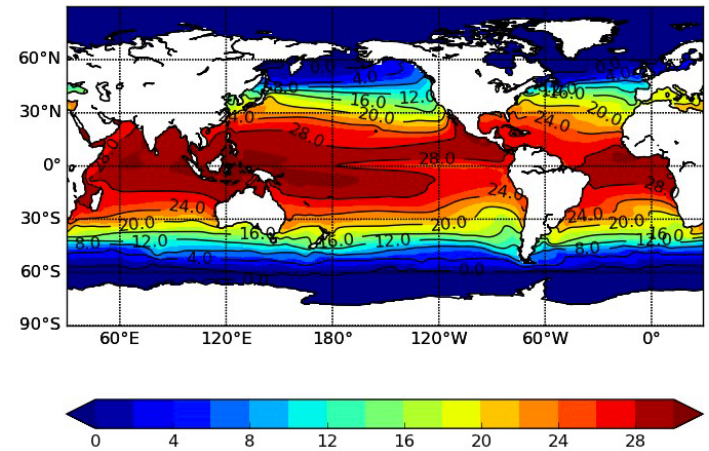
Improvements in forecast skill score (Jan, Feb)



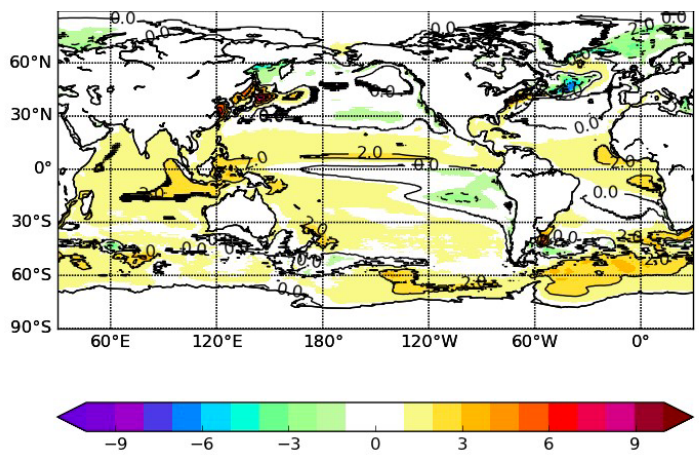

Global Modeling and Assimilation Office
GMAO
Animation by William Putman
2017-06-22 00:00Z
2017 Jun 21
08:00pm EST Wednesday
Aerosol Extinction AOT [550 nm]
0.0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1.0
000 Forecast Hours
20170622_00z
f516_fp

New S2S2D vs Control -- SST Annual Mean from "Perpetual" run

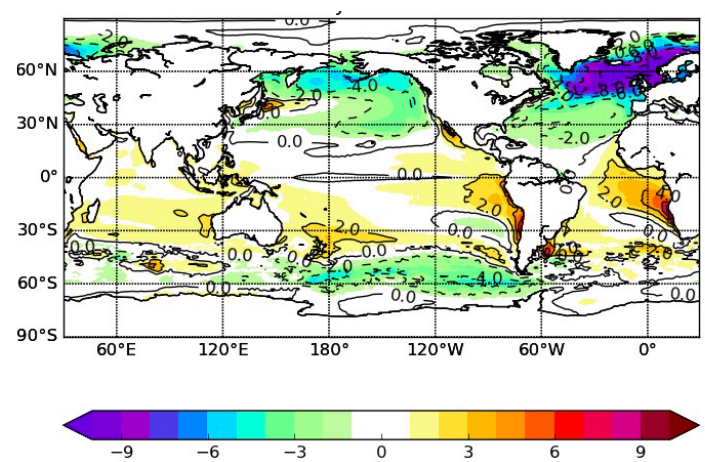




New S2S2D

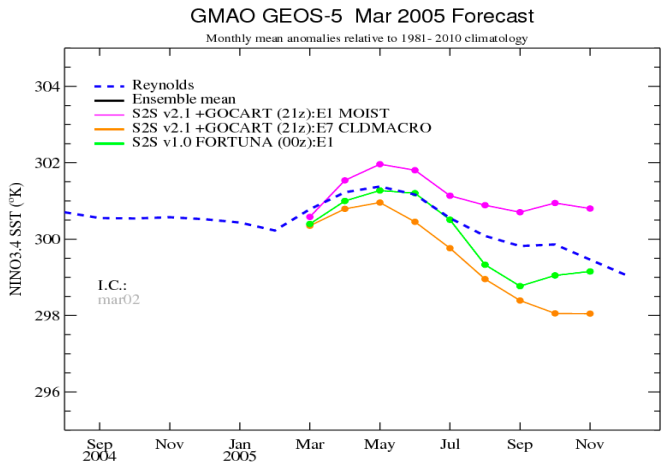


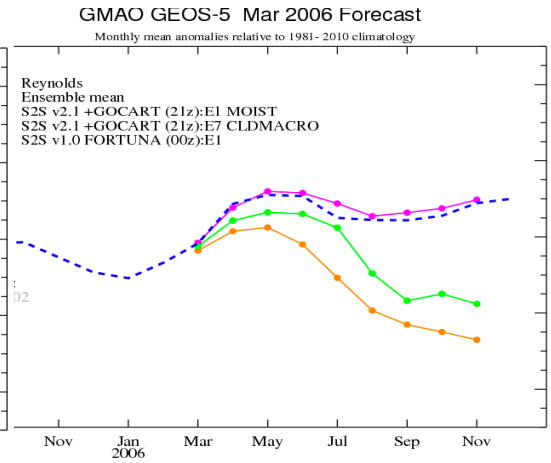
Old S2S2D

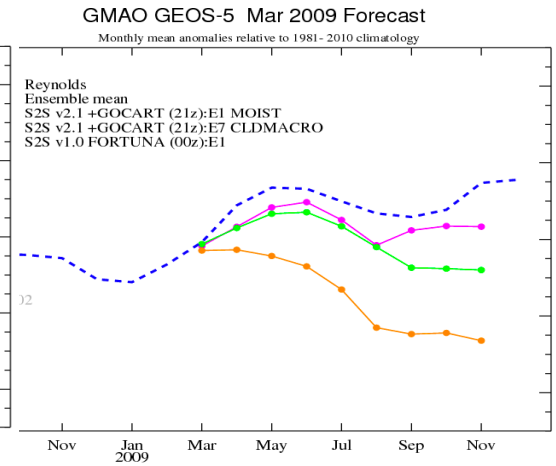


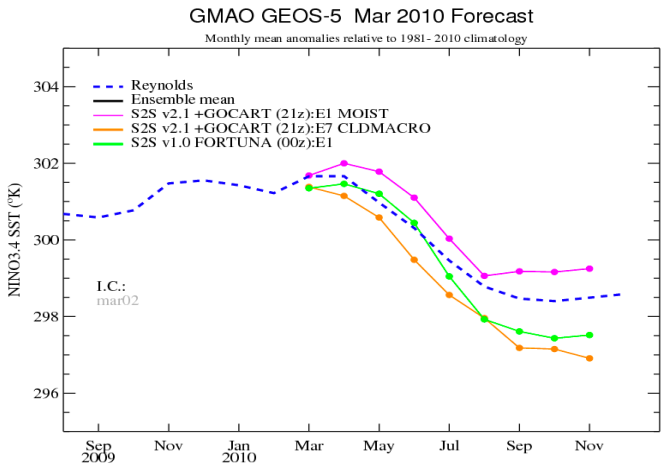
Slide Courtesy of Yury Vikhliaev

New S2S2D vs Control – NINO 3.4 from Hindcasts



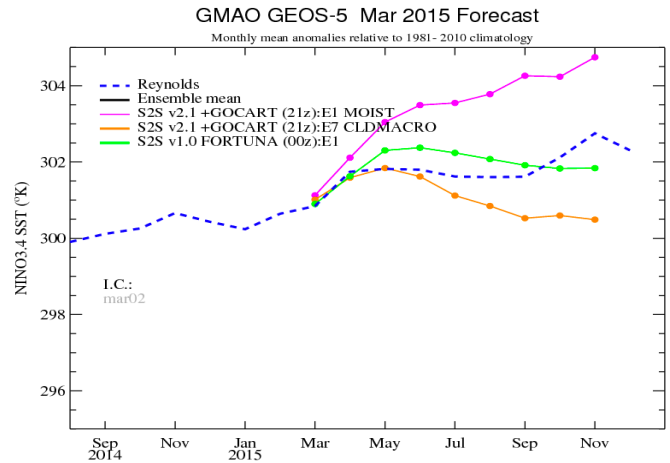




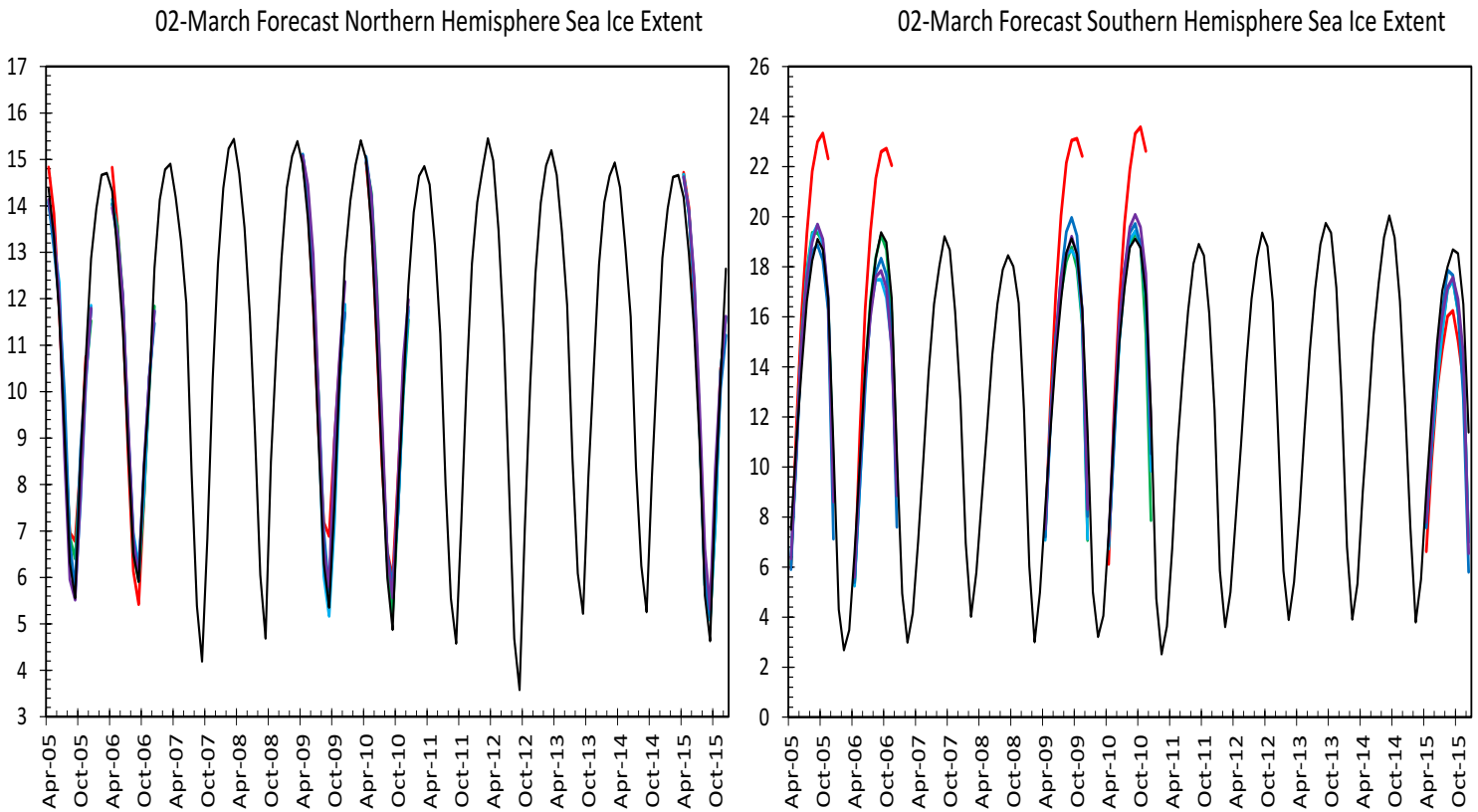


Control
New S2S2D

Slide Courtesy of Jelena Marshak

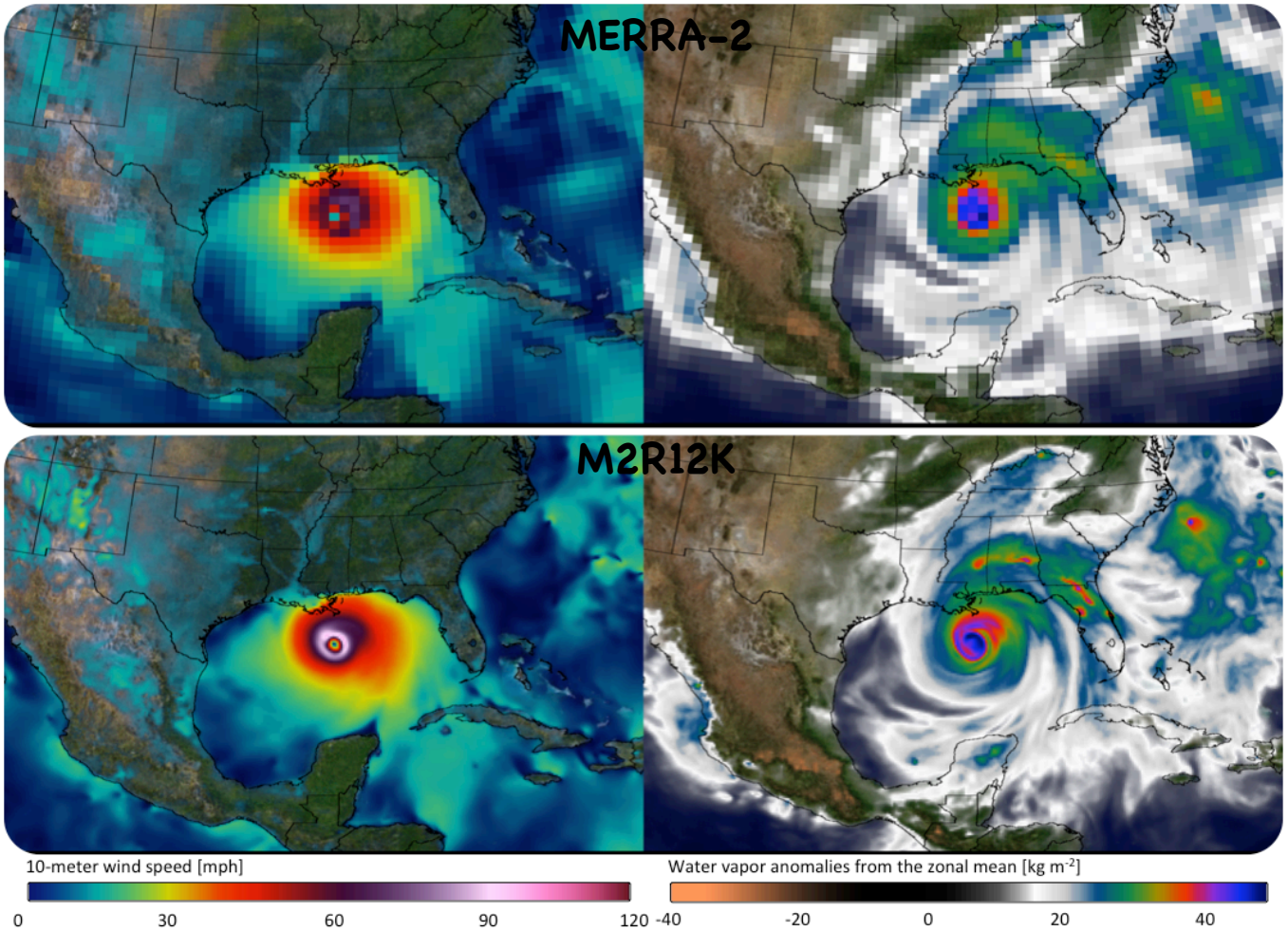


New S2S2D vs Control – Sea Ice Extent from Hindcasts



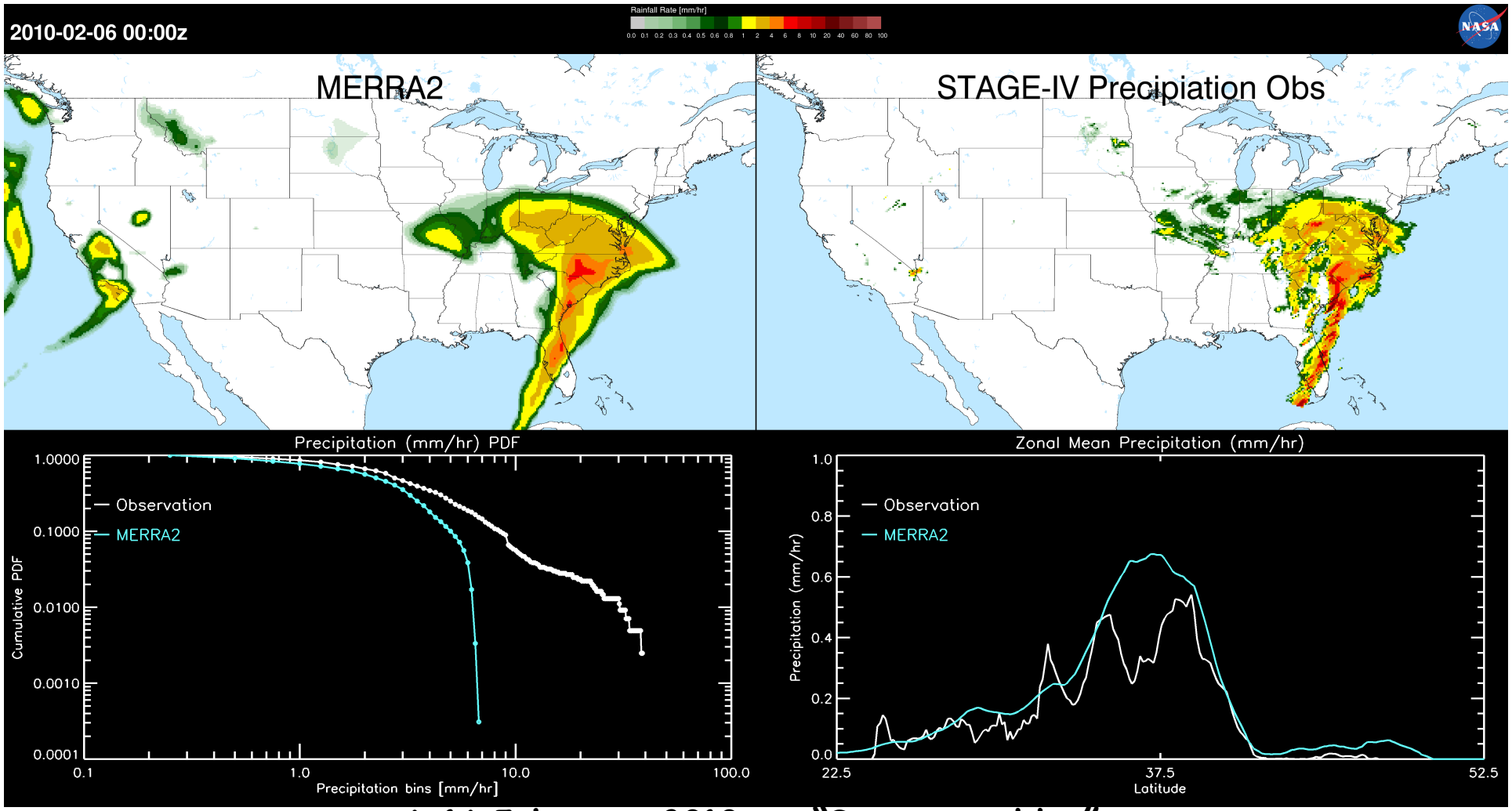
Slide Courtesy of Richard Cullather

M2R12K - MERRA-2 Replay at 12.5-Km -- 16 Years: 2000-2015



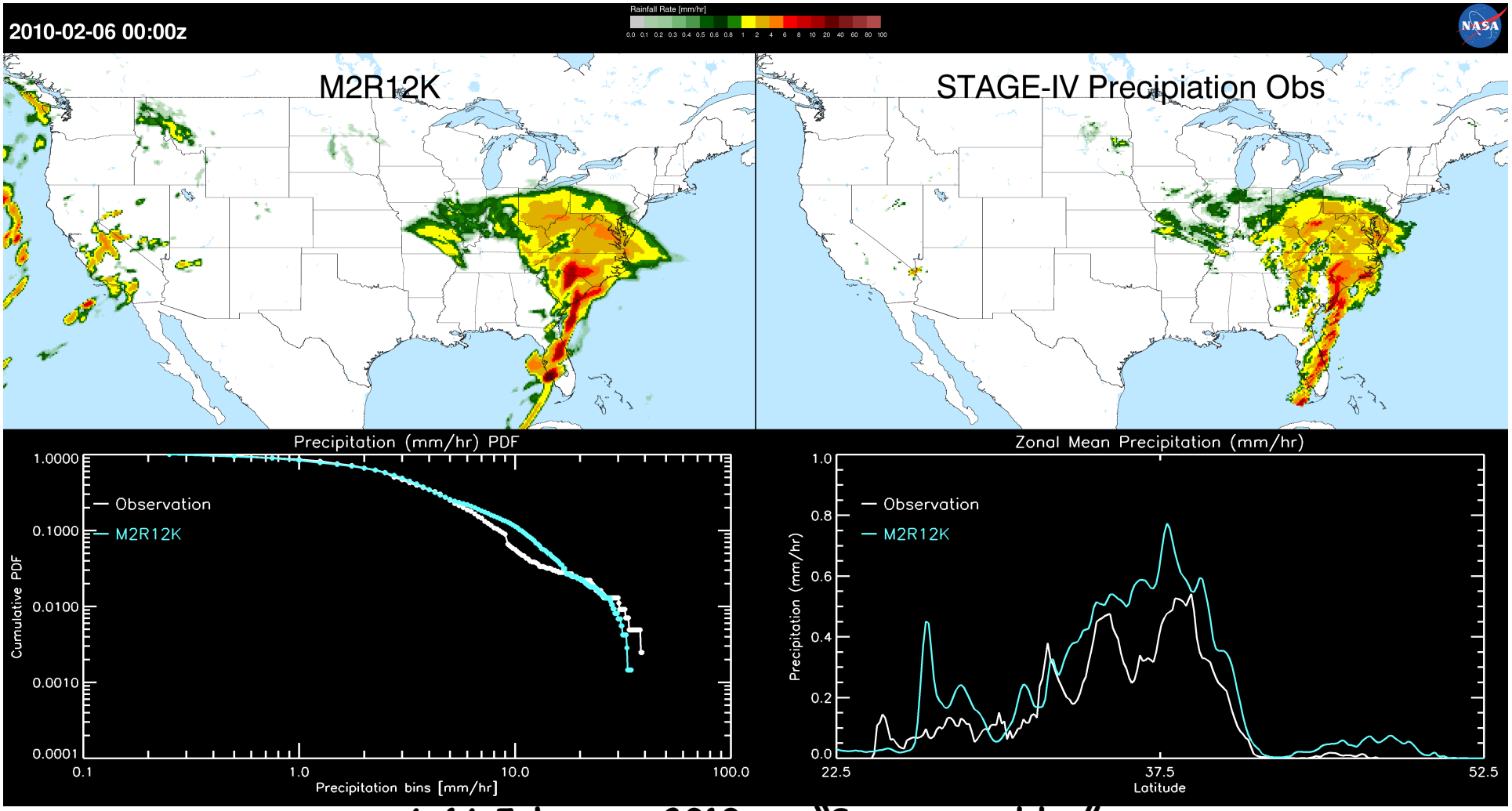
Slide Courtesy of Wiliam Putman

Hurricane Katrina on August 29th 2005 at 00z



4-14 February 2010 - "Snowmageddon"

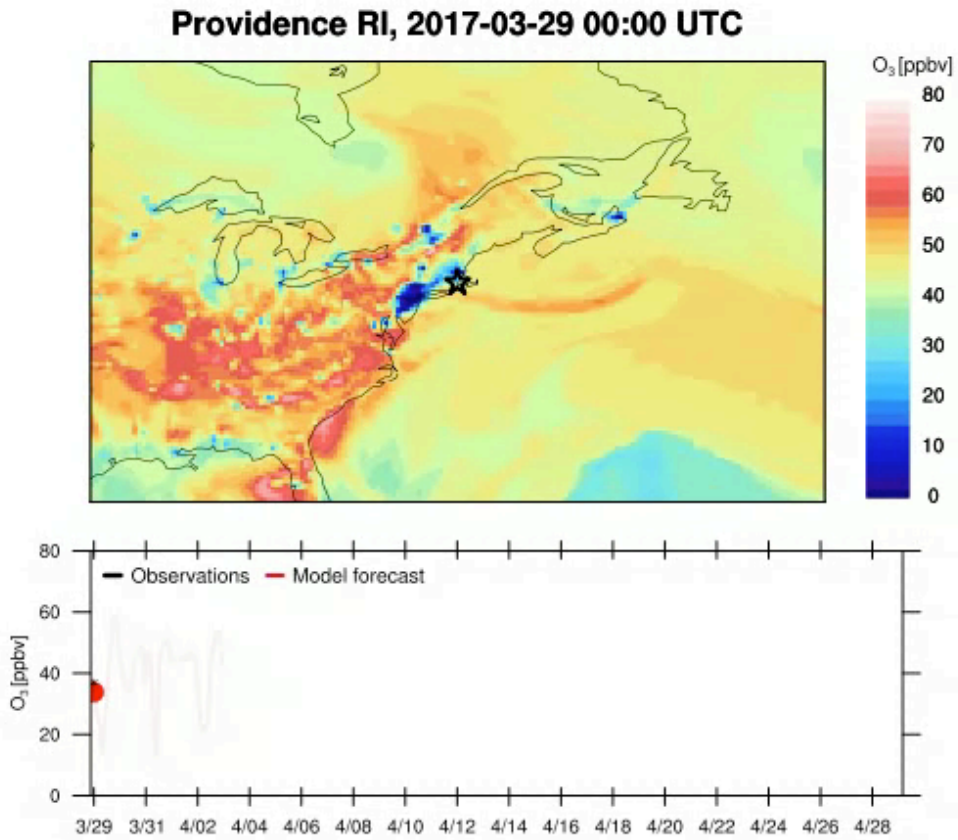
Slide Courtesy of Wiliam Putman



4-14 February 2010 - "Snowmageddon"

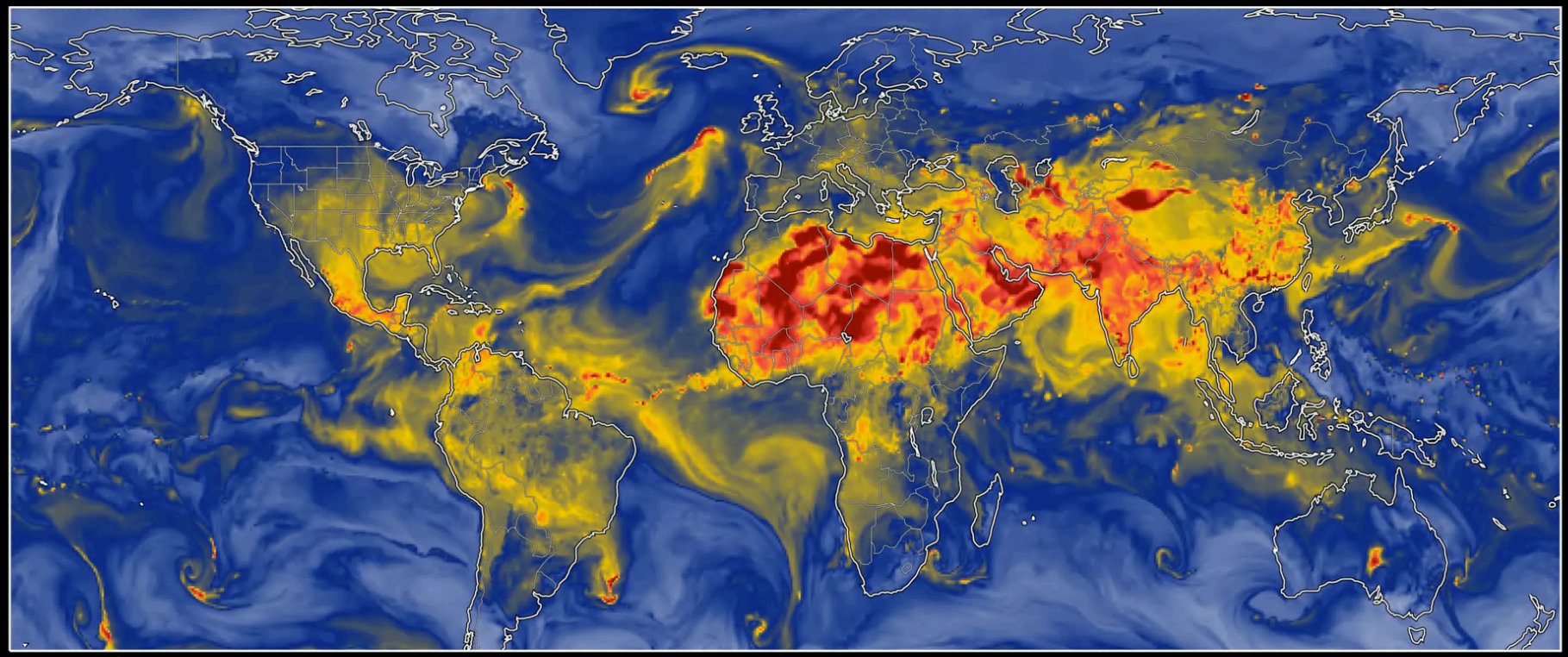
Slide Courtesy of Wiliam Putman

GEOS Air-quality forecasts at Providence, RI



Animation Courtesy of Christoph Keller

Air Quality Health Index



GEOS-5 1/4°

GEOS-Chem v11-02

Mon 15 May 2017 | Tue 16 May | Wed 17 May | Thu 18 May | Fri 19 May

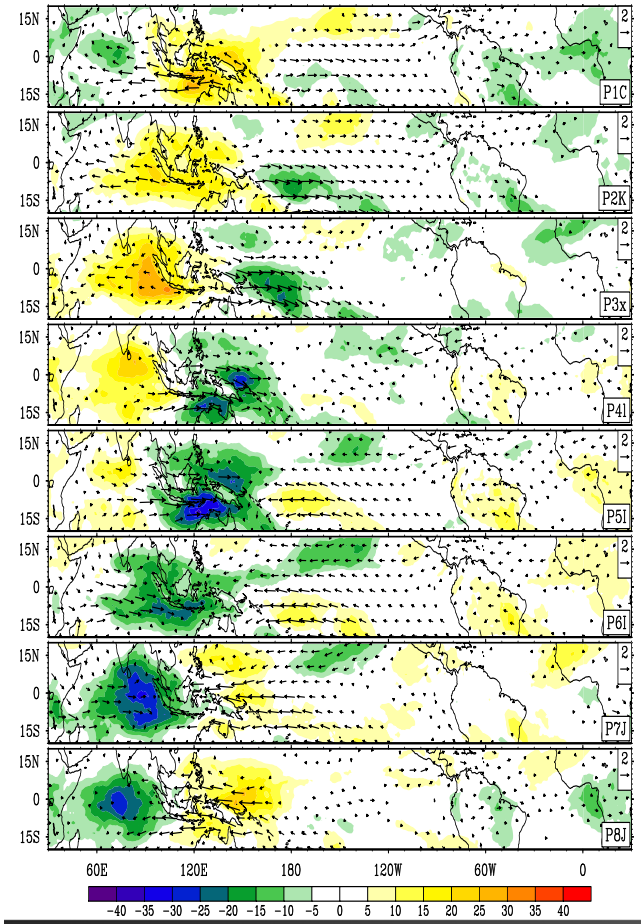
0 1 2 3 4 5 6 7 8 9 10

Global Modeling and Assimilation Office
NASA Goddard Space Flight Center

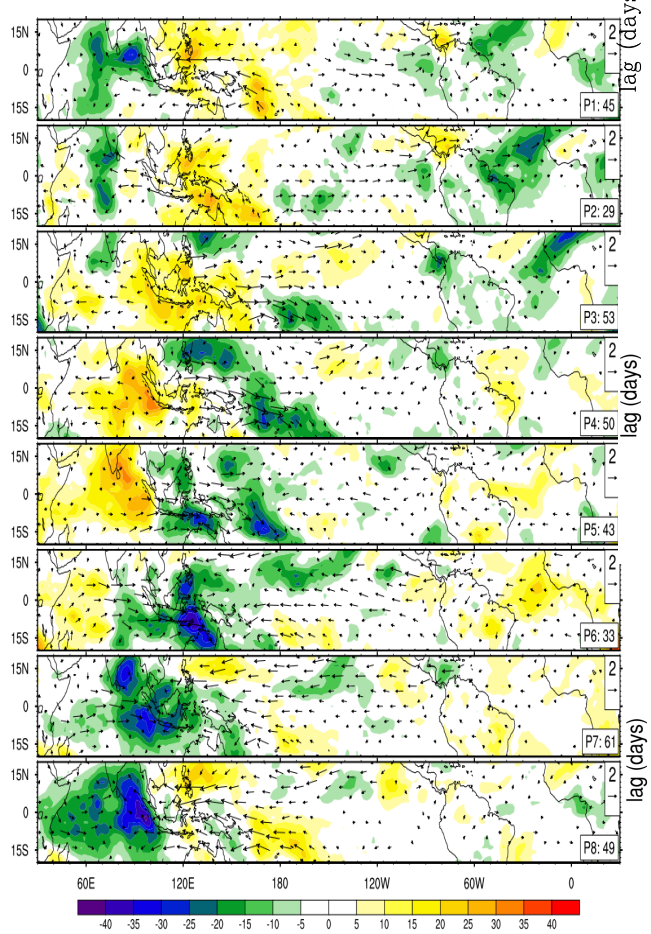
Atmospheric Chemistry Modeling Group
Harvard University

Implementation of UW Shallow Convection Potential improvements in GEOS MJO

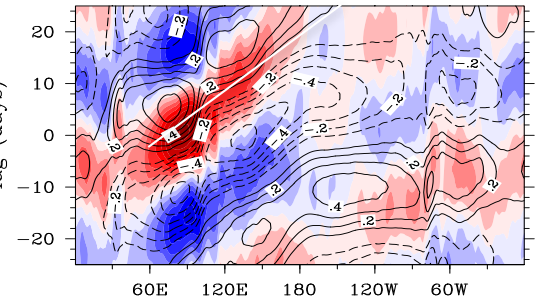
EC Interim wind, NOAA OLR



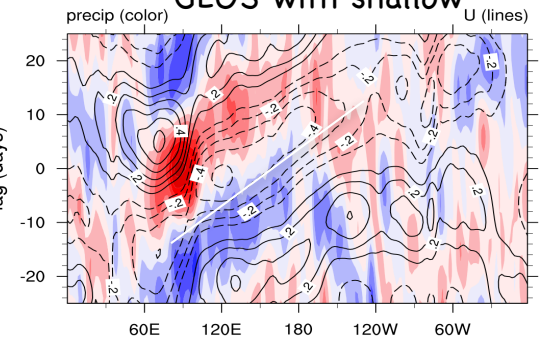
GEOS with shallow convection



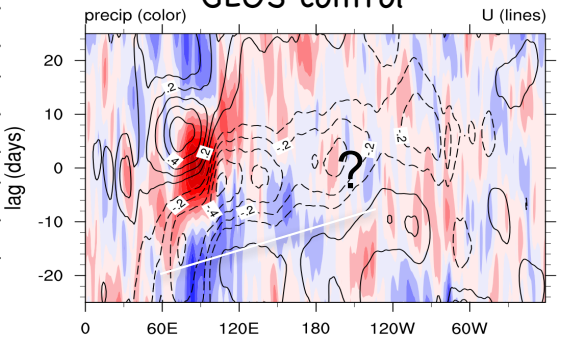
EC Interim, GPCP



GEOS with shallow



GEOS control



Slide Courtesy of Nathan Arnold

Replacement of RAS with Grell-Freitas cumulus parameterization

RAS to Grell-Freitas (GF): "Resolution Dependant" to "Scale Aware"

Resolution	RAS Convective/Total Precip (mm/day)	GF Convective/Total Precip (mm/day)
~50 km	1.2 / 2.8	1.75 / 3.19
~25 km	0.52 / 3.	1.6 / 3.2
~12 km	0.42 / 2.9	1.19 / 3.17
~9 km		0.84 / 3.22
~6.25 km		0.53 / 3.28

Results Courtesy of
Saulo Freitas