WCRP Task team for the Intercomparison of ReAnalyses (TIRA): Motivation and Progress

Michael Bosilovich, Masatomo Fujiwara,
Jan Keller and Matthias Tuma

(with input from the TIRA telecons)

Need for international collaboration regarding reanalyses

- WCRP Data Advisory Council (WDAC) generally organizes a regular (every 4-5 years) international conference on reanalyses
- Otherwise, there is no specific international collaborative group for reanalyses development and users
- Reanalyses data gets wide use across the WCRP spectrum of panels and working groups
- Need for expert and developer guidance

Task Team Members

- Magdelena Balmaseda (ECMWF/CLIVAR)
- Michael Bosilovich (NASA/GMAO Co-Chair)
- Cathy Smith (CIRES/WRIT)
- Gil Compo (CIRES/20CR)
- Masatomo Fujiwara Co-Chair (Hokkaido U./SPARC/S-RIP)
- Jan Keller Co-Chair (DWD/Regional Reanalysis)
- Hans Hersbach (ECMWF)
- Shinya Kobayashi (JMA)
- Wesley Ebisuzaki (NOAA/EMC)
- Remy Roca (GEWEX)
- Chenghu Sun (CMA/NMIC)
- Andrea Storto (CCMC)
- Gerald Potter (NASA/CREATE)
- Otis Brown (NCSU/WDAC)
- Matthais Tuma (WCRP)

Main Objectives of TIRA

The primary charge to the TIRA is to develop a reanalysis intercomparison project plan that will attain the following objectives.

1) To foster understanding and estimation of uncertainties in reanalysis data by intercomparison and other means
2) To communicate new developments and best practices among the reanalyses producing centers
3) To enhance the understanding of data and assimilation issues and their impact on uncertainties, leading to improved reanalyses for climate assessment
4) To communicate the strengths and weaknesses of reanalyses, their fitness for purpose, and best practices in the use of reanalysis datasets by the scientific community

Ocean Re-Analyses:
Demonstrating the value of ocean observations

ORA-IP: Ocean Reanalysis Intercomparison Project

Objectives:

To quantify signal/noise from Ensemble

To gain insight into ocean variability and trends

To identify current system deficiencies

To measure progress

To exploit existing multi-ORA ensemble
- For real-time ocean monitoring
- For climate indicators
- For model validation
- For initialization of coupled models

ORAIP Special Issue in Climate Dynamics

ORAIP v1 data repository with version control

Real time Multi-ORA Monitoring

Create-IP
Concept-heat
EOS-Polar Intercomparison
CMEMS

SPARC Reanalysis IP

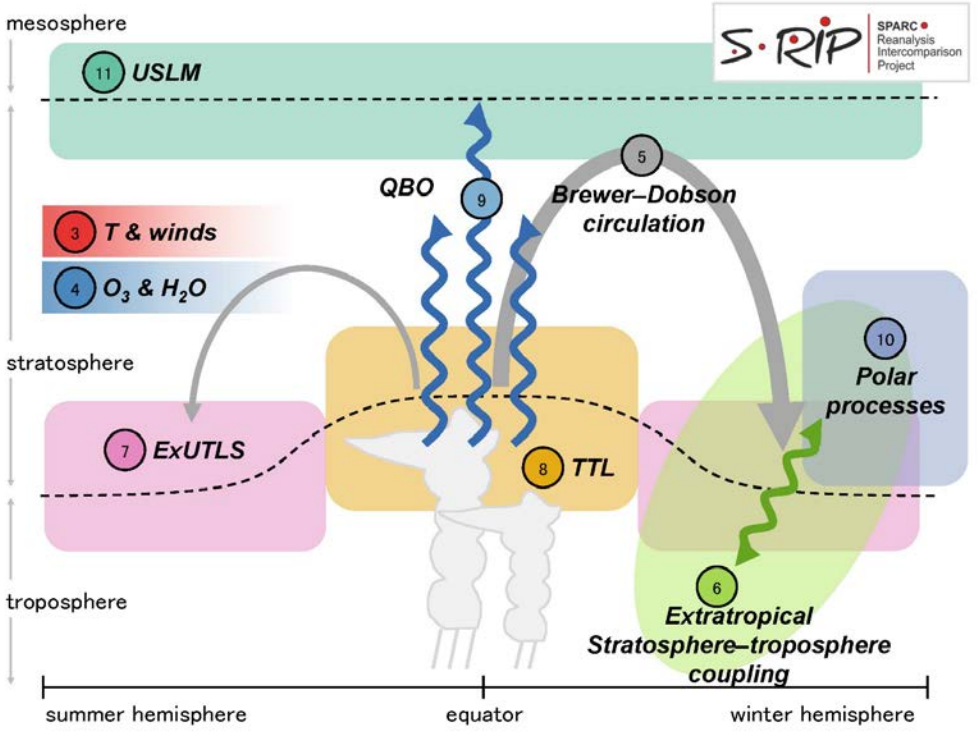
Co-leads: M. Fujiwara, G. Manney, L. Gray

Report Editors: M. Fujiwara, G. Manney, L. Gray, J. Wright

	Chapter Title	Chapter Co-leads
1	Introduction	Masatomo Fujiwara, Gloria Manney, Lesley Gray
2	Description of the Reanalysis Systems	Jonathon Wright, Masatomo Fujiwara, Craig Long
3	Overview of Temperature and Winds	Craig Long, Masatomo Fujiwara
4	Overview of Ozone and Water Vapour	Michaela Hegglin, Sean Davis
5	Brewer-Dobson Circulation	Thomas Birner, Beatriz Monge-Sanz
6	Extratropical Stratosphere-Troposphere Coupling	Edwin Gerber, Patrick Martineau
7	Extratropical UTLS	Cameron Homeyer, Gloria Manney
8	Tropical Tropopause Layer	Susann Tegtmeier, Kirstin Krüger
9	QBO	James Anstey, Lesley Gray
10	Polar Processes	Michelle Santee, Alyn Lambert, Gloria Manney
11	Upper Strato. Lower Mesosphere	Lynn Harvey, John Knox
12	Synthesis Summary	Fujiwara, Manney, Gray

S-RIP SPARC Reanalysis Intercomparison Project

https://s-rip.ees.hokudai.ac.jp/



Inter-journal special issue on "The SPARC Reanalysis Intercomparison Project (S-RIP)" in *Atmospheric Chemistry and Physics* (**ACP**) and *Earth System Science Data* (**ESSD**) - **29 papers**

Advancing Reanalysis

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Welcome to the Reanalyses site.

Members will need to login to the site to see more information.

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  1 week 6 days ago
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  1 month ago
- International Surface Pressure Databank Contributing Organizations
  1 month ago

Reanalyses.org Home Page

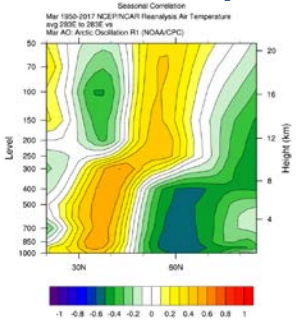
Submitted by esrl_admin on Fri, 06/18/2010 - 13:55

- Grass Roots Community effort including developers and users
- News and Highlight announcements
- Basic Info
- Questions and Comments

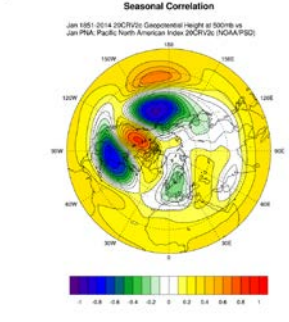
Reanalysis is a scientific method for developing a comprehensive record of how weather and climate are changing over time. In it, observations and a numerical model that simulates one or more aspects of the Earth system are combined objectively to generate a synthesized estimate of the state of the system. A reanalysis typically extends over several decades or longer, and covers the entire globe from the Earth's surface to well above the stratosphere. Reanalysis products are used extensively in climate research and services, including for monitoring and comparing current climate conditions with those of the past, identifying the causes of climate variations and change, and preparing climate predictions. Information derived from reanalyses is also being used increasingly in commercial and business applications in sectors such as energy, agriculture, water resources, and insurance.

Upcoming New **WRIT** (Web-based Reanalysis Intercomparison Tools) from NOAA ESRL/PSD

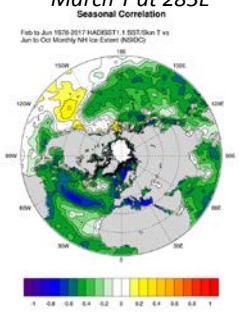
WRIT seasonal correlations (new)



AO correlation with R1 March T at 283E



PNA correlation with 20CRV2c Jan 500Z



NH Ice Extent for summer lagged correlation with spring HadISST1.1 SST

WRIT Time-series and Climate Indices(soon)

Add functionality to WRIT time-series page:

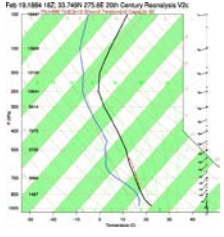
- Add climate and ocean index time-series. For example PNA, NP, Nino 3.4.
- Calculate indices from different reanalysis datasets
- Allow lead/lag
- Add additional statistical techniques such as Wavelet analysis.

WRIT Vertical Profiles

Plot different vertical products:

- Vertical profiles/Skew-T
- Vertical transects
- Height-Time

SE US Feb 19-20 1884 tornado outbreak 20CRV2c

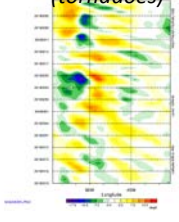


WRIT Time-sections

Plot Daily means or anomalies

- Time/latitude o Time/longitude

US 1000mb Ta from R1 02-03/2018 (tornadoes)

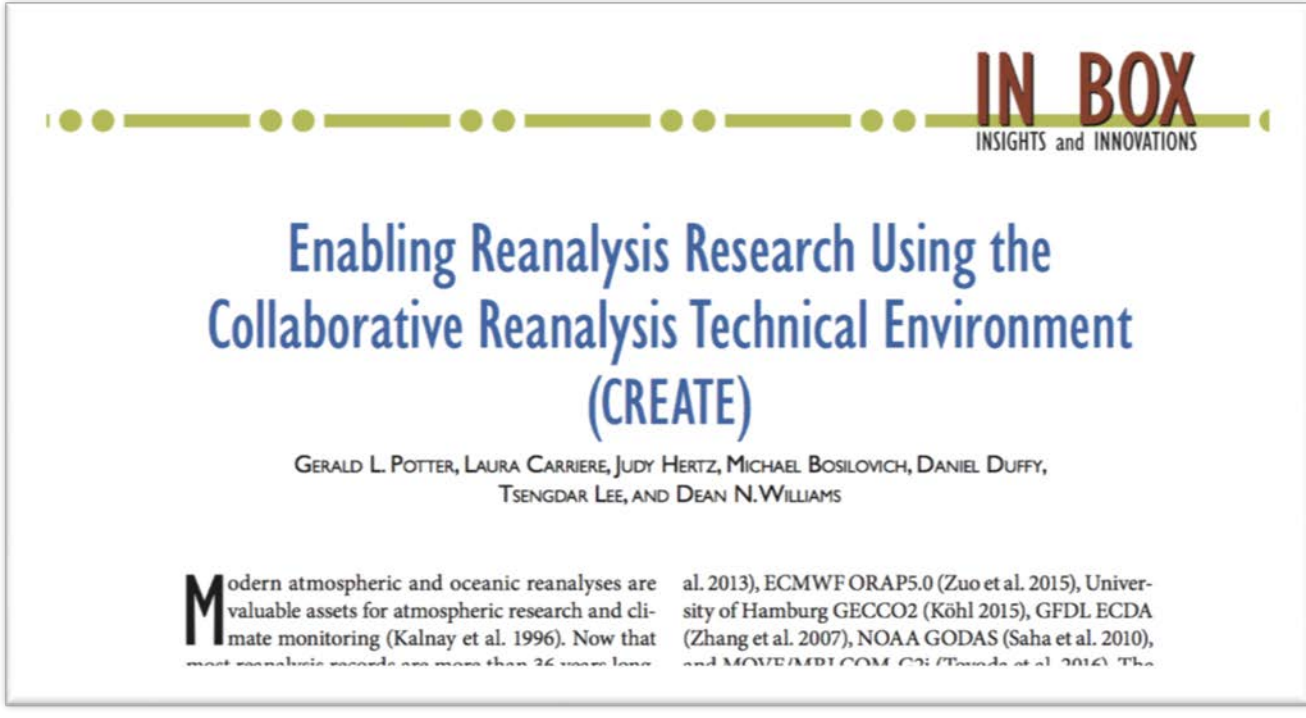


https://www.esrl.noaa.gov/psd/data/writ/

CREATE reanalysis data service

May 2018 issue of the *Bulletin of the American Meteorology Society*

- Describes repackaging and consistent distribution of the world's major atmospheric and oceanic reanalyses.
- Presents examples of the usefulness of examining multiple reanalyses.
- Each reanalysis is updated as it becomes available and added to the Earth System Grid Federation (ESGF) alongside IPCC Present Day Climate Simulations.
- Selected data is also available for subsetting (TDS), visualization (CREATE-V) and server side analytics (EDAS).



IN BOX
INSIGHTS and INNOVATIONS

Enabling Reanalysis Research Using the Collaborative Reanalysis Technical Environment (CREATE)

GERALD L. POTTER, LAURA CARRIERE, JUDY HERTZ, MICHAEL BOSILOVICH, DANIEL DUFFY, TSENGDAR LEE, AND DEAN N. WILLIAMS

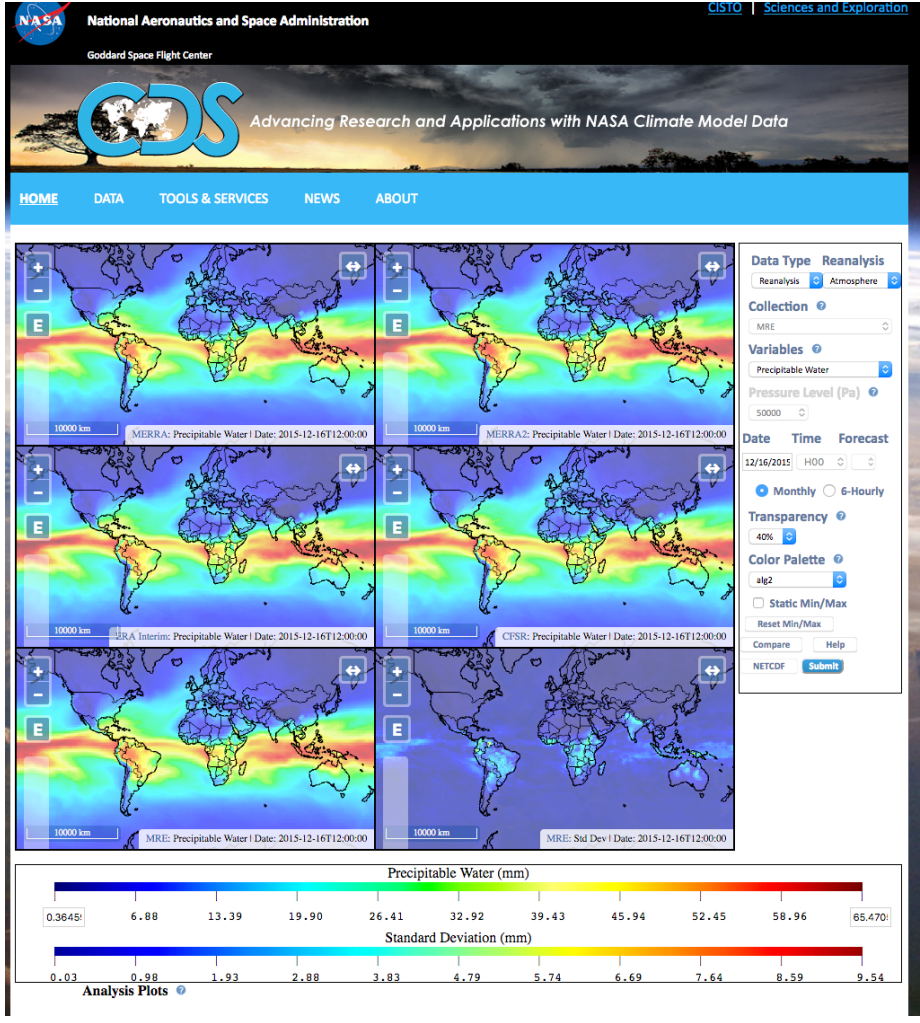
Modern atmospheric and oceanic reanalyses are valuable assets for atmospheric research and climate monitoring (Kalnay et al. 1996). Now that

al. 2013), ECMWF ORAP5.0 (Zuo et al. 2015), University of Hamburg GECCO2 (Köhl 2015), GFDL ECDA (Zhang et al. 2007), NOAA GODAS (Saha et al. 2010),

NASA NCCS's CREATE-V provides quick look reanalysis comparison capability

- For multiple reanalyses quick look visualization and comparison.
- Includes both atmospheric and ocean reanalyses as well as ensemble means and standard deviations. Monthly and Daily
- Options to select date, level, color map, and scale.
- See Laura Carriere's Poster (A13M-2654)

Precipitable water for 4 reanalyses, the multiple reanalysis ensemble average and standard deviation.

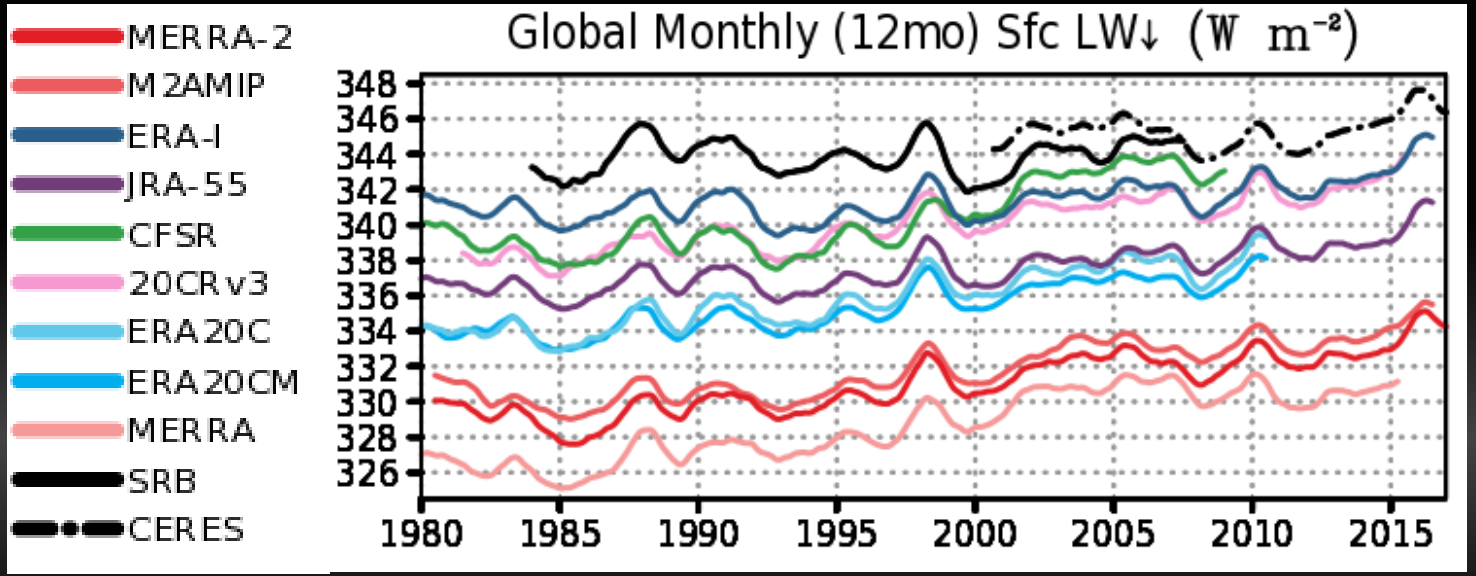


Pilot Intercomparison

- At ICR5 (Rome, Nov 17) group discussion on next steps needed to define a WCRP Project for the Intercomparison of Reanalyses
- Document – develop a document that highlights best practices and terms of reference
- Somewhat more interest: Develop one (or more) **Pilot Intercomparison Project(s)** that some in the team can start, with a goal of real world experience interacting in group activities that have some direct affect on TIRA and the participants

- Regional Project - Precipitation
- Possible Global Topics
- [1] Surface temperature
- [2] Ocean surface fluxes
- [3] Precipitation
- [4] Radiation
- [5] **Energy budget**
- [6] Water cycle
- [7] Surface Winds (Wind Energy)

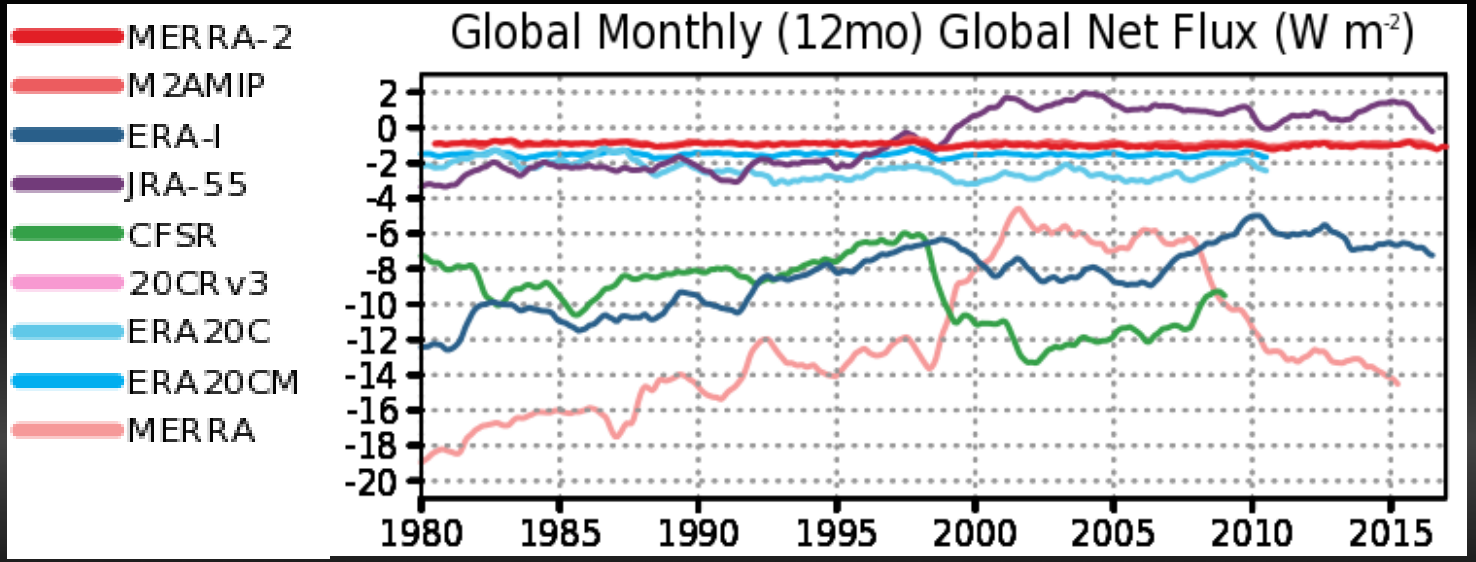
Energy Budget Pilot Study



Downward Longwave Radiation at the Surface

- MERRA, MERRA-2 and M2AMIP use Chou Suarez radiation parameterization. This underestimates cloud effects, so the LW down is biased low. This is being addressed for future reanalyses.
- GEWEX Surface Radiation Budget - a new version is coming “soon”
- This is determined by the atmospheric temperature and cloud effect

Energy Budget Pilot Study

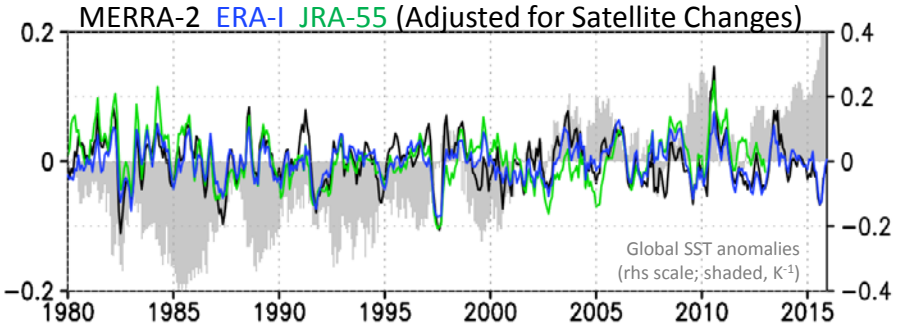


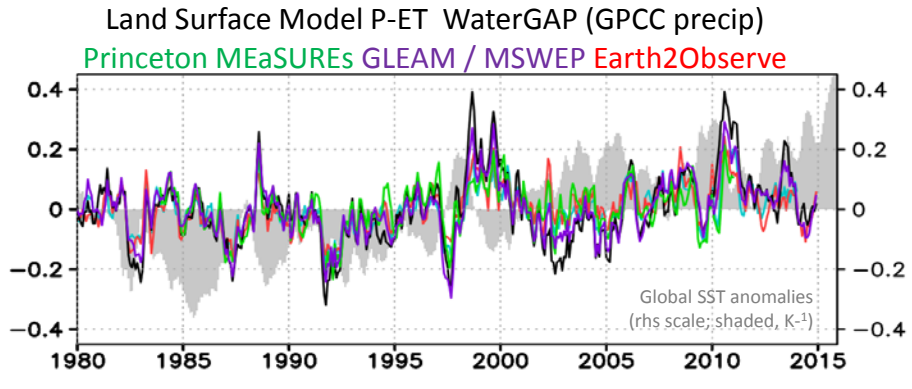
Net Global Heating: TOA minus Sfc Net

- Model and Reduced observing reanalyses have smallest most consistent net atmospheric heating
- Changing observing system affects the energy budgets of all satellite data reanalyses
- Significant improvements going from MERRA to MERRA-2
- MERRA-2 includes the heating due to the analysis, adding that into the budget brings the net heating to nearly the same value as the MERRA-2 AMIP model.

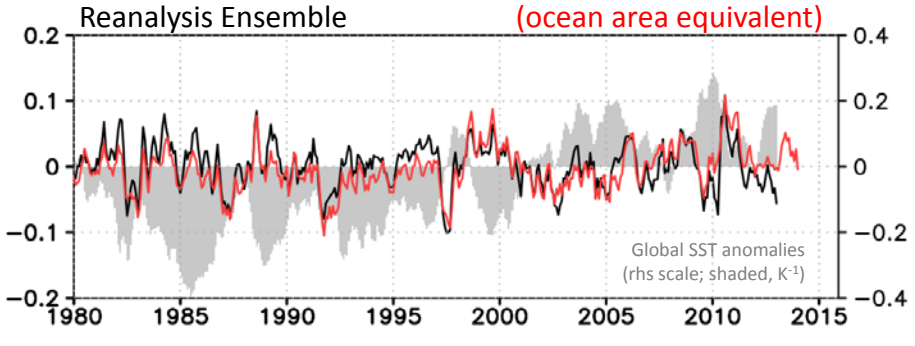
Consistency of Interannual to Decadal Variability in Land / Ocean Moisture Transport Between Reanalyses and Observationally Constrained Land Surface Models

60° N/S land /ocean domains (units mmd^{-1})



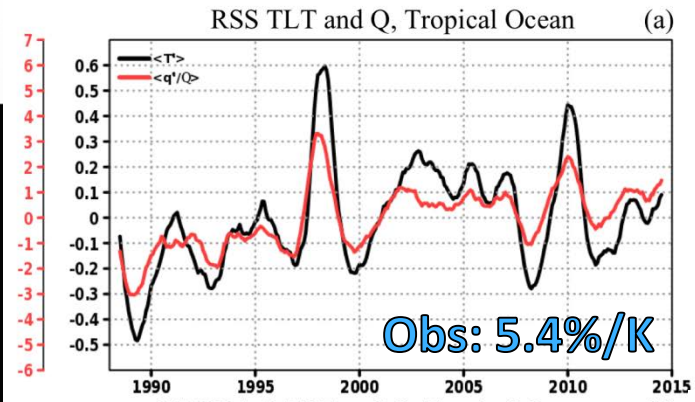


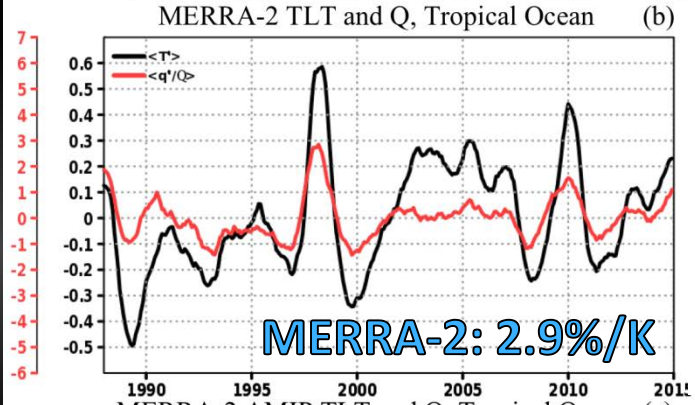
- Vertically-integrated moisture flux divergence over ocean should balance P-ET over land (Accounting for land/ocean fraction done and small atmospheric storage ignored).
- Reanalysis vertically-integrated moisture flux divergence is adjusted via EOF analysis to remove signals related to changes in passive microwave satellite assimilation.
- ENSO events exert major controls with warm (cold) SSTs reducing (increasing) moisture transport to land. Response lags SST forcing.

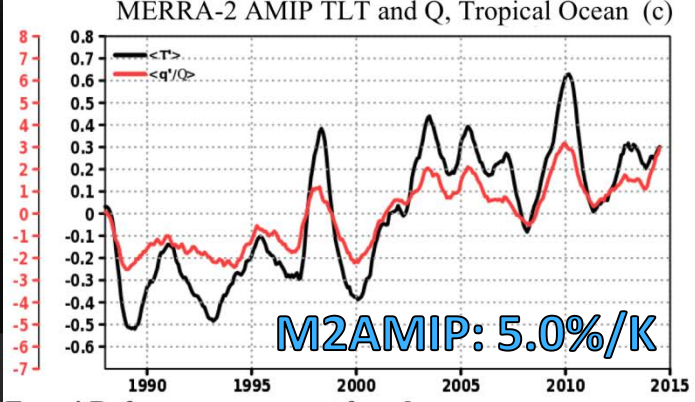


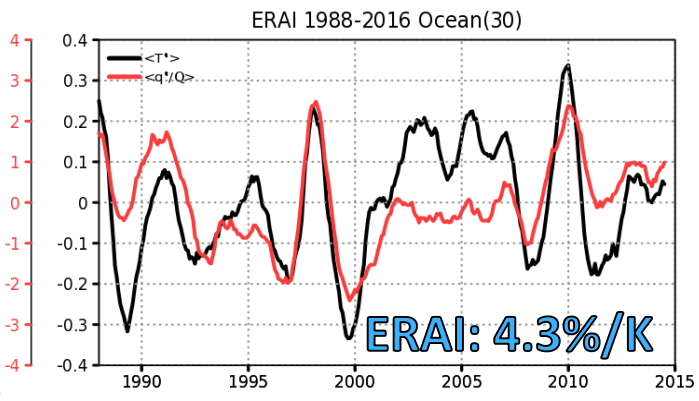
See Robertson et al (Poster #H33K-2230 Wed)

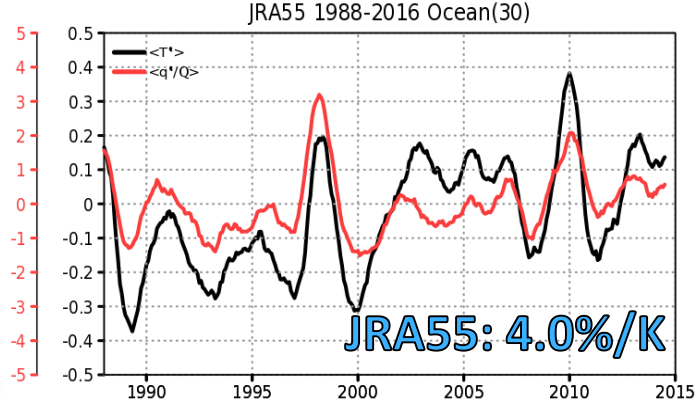
Water Cycle Example: Clausius-Clapyeron











- Using TLT and TPW, MERRA-2 shows a weaker C-C relationship compared to RSS obs and AMIP simulation
- Analysis increment counters some local evaporative increases
- Other reanalyses also show a weak C-C relationship
- Bosilovich et al. (2016, JClim); Schröder et al. (2016, JAMC)

Daily 1°x1° precipitation observations from ground-based, satellite and reanalysis datasets to support intercomparison and assessment

Rémy Roca[1], Lisa Alexander[2], Michael Bolisovitch[3], G Potter[3], Margot Bador[2], Steefan Contractor[2], Rômulo Jucá[1], and Sophie Cloché[4]

Objectives

In support of the assessment effort recently initiated under the auspices of GEWEX/GDAP and IPWG (Haddad and Roca, 2017) and supporting a dedicated joint effort by the WCRP Grand Challenge on Weather and Climate Extremes and GEWEX/GDAP to analyze extreme events and their characteristics (Alexander et al., 2018 GEWEX Newsletter), a large database of gridded precipitation products has been assembled.

Here we present the database that includes ground-based, satellite and reanalysis products and a preliminary analysis of the ensemble of products.

All the products listed in the table have been regridded and formatted with a common:

- 1°x1° daily grid and
- annual file format (netCDF)

Preliminary results of intercomparisons

1) Tropical land

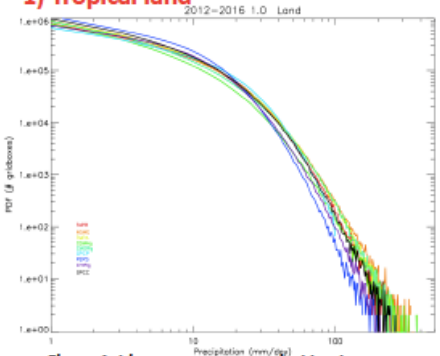


Figure 1: histograms over tropical land.

Using the 2012-2016 period, the histograms of precipitation for land only (30°s-30°n) have been computed for a suite of products (Figure 1). The analysis reveals that the spread within this subset of nine satellite products depends upon the rain regimes. From 1 to 20 mm/d, the spread reaches less than 10%. From 20 to ~100 mm/d, it grows up to 100% while above 100 mm/d, the spread can reach up to 300%.

This suggests that while this ensemble of products is consistent for a large part of the precipitation spectrum, its characterization of the extremes of the distribution is not robust.

Current status of the database

Product shortname and version	Period used	Spatial coverage	Use of rain gauges data	Use of IR satellite data	Use of MW satellite data rainfall estimate	Main Scientific References and ATBD
Satellite based quasi global						
3B42 v7.0	1998-2016	50°s-50°n	Yes	Yes	multiple platform	(Huffman et al. 2009)
3B42 v7.0 IR	1998-2016	50°s-50°n	No	Yes	No	(Huffman et al. 2009)
3B42 v7.0 MW	1998-2016	50°s-50°n	No	No	Yes	(Huffman et al. 2009)
GSMAP-RNL-gauges v6.0	2001-2013	50°s-50°n	Yes	yes	Yes	(Kubota et al., 2007)
GSMAP-RNL-no gauges v6.0	2001-2013	50°s-50°n	No	yes	Yes	(Kubota et al., 2007)
GSMAP-NRT-gauges v6.0	2001-2017	50°s-50°n	Yes	yes	Yes	(Kubota et al., 2007)
GSMAP-NRT-no gauges v6.0	2001-2017	50°s-50°n	No	yes	Yes	(Kubota et al., 2007)
PERSIANN CDR v1 r1	1983-2017	50°s-50°n	yes	Yes	No	(Ashouri et al., 2015)
CMORPH V1.0, RAW	1998-2017	60°s-60°n	No	Yes	Yes	(Xie et al., 2017)
CMORPH V1.0, CRT	1998-2017	60°s-60°n	Yes	Yes	Yes	(Xie et al., 2017)
GPCP 1DD CDR v1.3	1997-2017	90°s-90°n	Yes	Yes	One platform	(Huffman et al. 2001)
Land Only						
CHIRPS v2.0	1981-2016	50°s-50°n	Yes	Yes	No	(Funk et al. 2015)
CHIRP v2.0	1981-2016	50°s-50°n	Climatology	Yes	No	(Funk et al. 2015)
SM2RAIN-CCI	1998-2015	Global	No	No	No	(Ciabatta et al., 2018)
Ocean only						
HOAPS	1996-2014	ocean only	No	no	Yes	(Andersson et al., 2017)
Satellite based regional						
TAPEER v1.5	2012-2016	30°s-30°n	No	Yes	multiple platform	(Roca et al, 2018)
TAMSAT v2	1983-2017	Africa	Yes	Yes	No	(Maidment et al;. 2017)
TAMSAT v3	1983-2017	Africa	Yes	Yes	No	(Maidment et al;. 2017)
ARC v2	1983-2017	Africa	Yes	Yes	No	Novella andThiaw, 2013
Rain gauges based						
GPCC Full Daily V2018	1982-2016	60°s-90°n	Yes	No	No	(Schneider et al., 2018)
REGEN long	1950-2013		Yes	No	No	
REGEN	1950-2013		Yes	No	No	
Atmospheric reanalysis						
MERRA 1	1979-2015	global				
MERRA 2	1980-2017	global				
JRA-55	1958-2017	global				
ERAinterim	1979-2017	global				
CFSR	1979-2017	global				

Want your dataset in the GDAP database ? Drop us an email (roca@legos.obs-mip.fr)

Intercomparing and understanding reanalyses will continue to be important

- JMA – JRA-3Q starting in 2019
- NASA GMAO – moving toward coupled Earth
- ECMWF – ERA5 nearing complete release
- NCEI - Coupled Hybrid Data Assimilation and Forecast System
- 20CR v3 – Presently in early evaluation
- CMA – producing and operational climate reanalysis
- Regional, Ocean, Land, Cryosphere reanalyses are providing many other useful data sources

TIRA Main Objective: Developing a Reanalysis Intercomparison Project

- Perhaps more of a coordinating body, than an actual project
  - Examples, the GEWEX Hydroclimatology Panel as a coordinating body for Continental Scale Experiments or GEWEX Data and Analysis Panel governance of observational data assessments
- Could have membership that includes the disciplinary projects as well as developing centers
- Maintain and promote best practices and promotes communication of results
- Still needs discussion

Thanks!

Michael.Bosilovich@nasa.gov

http://reanalyses.org/atmosphere/wcrp-task-team-intercomparison-reanalyses-tira