Observations for Climate: A High-Resolution Real-Time Analysis of Global Precipitation and Its Applications

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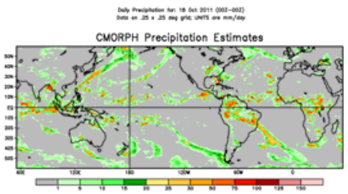
I. Objectives

- To describe the construction of a high resolution analysis of global precipitation through integrating information from satellite and gauge observations
- To examine diurnal variations of precipitation depicted in our precipitation data set and three new global reanalyses (CFSR, MERRA, and ERA-I)
- To compare the global oceanic precipitation with the sea surface salinity (SSS) from the NASA / Aquarius

II. Bias Corrected CMORPH

1) CMORPH

- CPC Morphing Technique (Joyce et al. 2004)
- High-res global precipitation estimates by integrating information from multiple satellite platforms
  - 8kmx8km; globe (60°S-60°N)
  - 30-min; from 1998 to the present
- Contains bias over both land and ocean

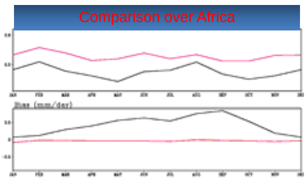


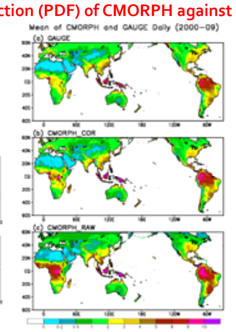
2) CMORPH Bias Correction

- Over Land
  - Assuming gauge analysis contains no bias over locations with stations
  - Matching the probability density function (PDF) of CMORPH against that of a daily gauge analysis

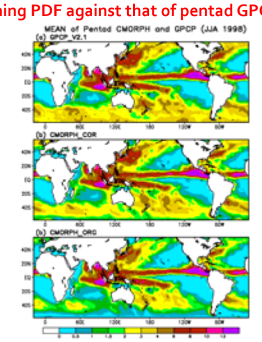
3) Bias correction results over Land

- 2000-2009 annual mean
- Large-scale bias corrected



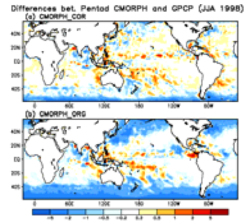


- Over Ocean
  - Calibration against a long-term record (pentad GPCP analysis at 2.5°lat/lon resolution)
  - Facilitate the examination of calibrated CMORPH from a climate perspective
  - Matching PDF against that of pentad GPCP



4) Bias correction results over Ocean

Very close agreement in magnitude after the calibration



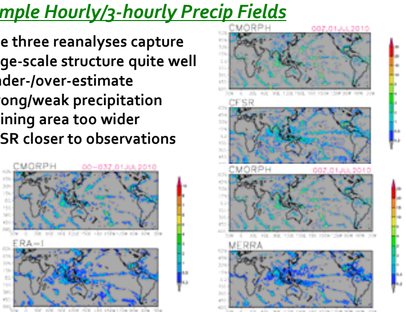
III. Global Precipitation and Its Diurnal Cycle

1) Data

- Observation:
  Bias-Corrected CMORPH
  - *8kmx8km, over the globe (60°S-60°N)*
  - *30-min interval, from 1998 to the present*
  - *Integrated to the model space/time resolution*
- CFSR
  - *T382 (~35km)*
  - *Hourly precipitation*
- MERRA
  - *2/3°longitude x 1/2°latitude*
  - *Hourly precipitation*
- ERA-Interim
  - *1.5° lat/lon*
  - *Three-Hourly precipitation*

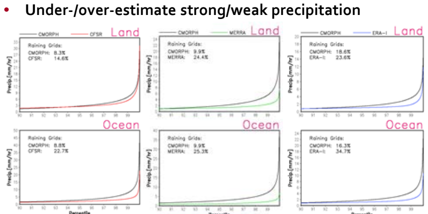
2) Sample Hourly/3-hourly Precip Fields

- The three reanalyses capture large-scale structure quite well
- Under-/over-estimate strong/weak precipitation
- Raining area too wider
- CFSR closer to observations



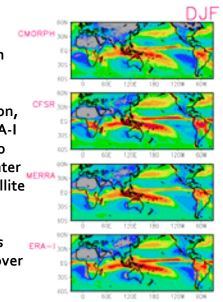
3) Hourly/3-hourly Precip PDF

- Percentile precipitation intensity at the original model resolution computed using data for July 2010
- The three reanalyses generate wider raining areas than the observation
- Under-/over-estimate strong/weak precipitation



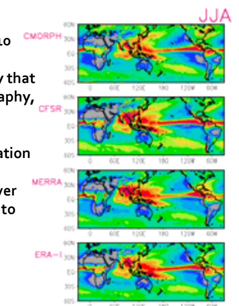
4) DJF Mean

- DJF Mean for 1998 – 2010
- Very close agreement with the observation in spatial distribution patterns
- Larger oceanic precipitation, especially in CFSR and ERA-I
- CMORPH precipitation too small over land during winter caused by inability of satellite observations to pick up snowfall
- Precipitation in reanalyses larger than observations over most tropical land areas



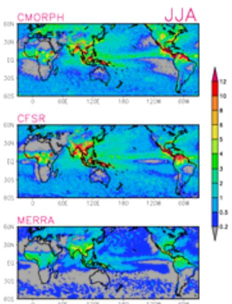
5) JJA Mean

- JJA Mean for 1998 – 2010
- Spatial pattern of precipitation, especially that associated with topography, well reproduced by the reanalyses
- Larger oceanic precipitation in CFSR and ERA-I
- Weaker precipitation over mid-latitude compared to the CMORPH
- Heavier rainfall over Maritime-continent



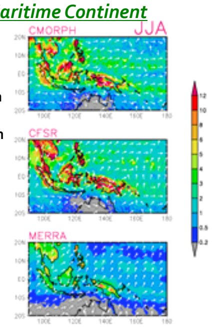
6) JJA Diurnal Amplitude

- Standard deviation of 24 hourly means for 1998-2010 (mm/day)
- Diurnal amplitude in CFSR is very similar to that in the observations but presents smaller / larger over ocean, extra-tropical land / tropical land
- Diurnal amplitude in MERRA is generally smaller than that in the observations over tropics and extra-tropics in northern hemisphere and is almost diminished over extra-tropics in southern hemisphere

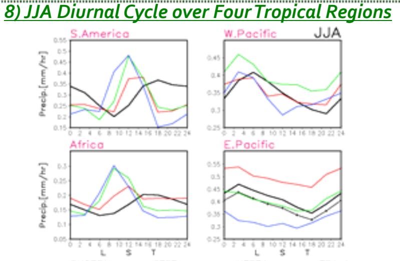


7) JJA Diurnal Cycle over Maritime Continent

- Amplitude (mm/day) color shading
- Arrow timing (LST) of maximum hourly precipitation (N=00; E=06; S=12; W=18)
- Spatial pattern of amplitude in association with land / sea contrasts
- CFSR represent minimum amplitude over ocean along coast lines
- Phase in general agreement with observations



8) JJA Diurnal Cycle over Four Tropical Regions



- Peak in the reanalyses comes earlier
- Amplitude in the reanalyses is larger / smaller over tropical land / ocean

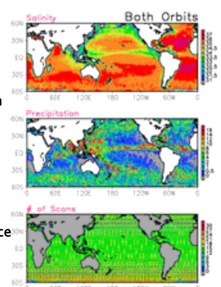
IV. Oceanic Precipitation and Salinity

1) Data and Comparison Method

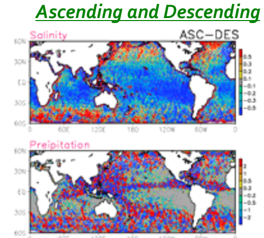
- Sea Surface Salinity (SSS)
  - *Observations from NASA Aquarius*
  - *52-day from August 25 – October 15, 2011*
  - *Original FOV ~100km*
  - *Ascending / Descending orbits at 18LST / 06LST*
  - *Gridded into 1°lat/lon grid*
- Bias-corrected CMORPH precipitation
  - *Original resolution at 8km / 30-min*
  - *Integrated into mean precipitation at 1°lat/lon resolution over a period of 30-min, 1-hour,…30-day ending at the Aquarius observation times*
- Comparison
  - *Compare the instantaneous SSS with precipitation for a period of varying length ending at the observation time*

2) 52-Day Mean

- Averaged over a 52-day period from August 25 to October 15, 2011
- Only CMORPH precipitation data co-located with the Aquarius observations used in calculations
- ~15 times of scanning from ascending & descending orbits
- Overall good correspondence between SSS and P
- Low SSS near coasts



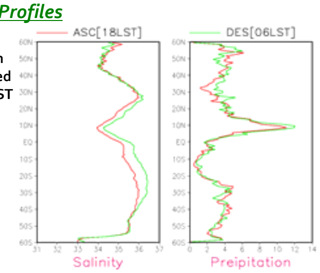
3) Differences between Ascending and Descending



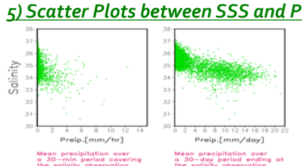
- Data too noisy due to short record

4) Longitudinal Profiles

- Apparent differences in both SSS and P observed at two different LST
- Differences in P attributable to diurnal cycle
- Differences in SSS seem not in direct correspondence with those in P??



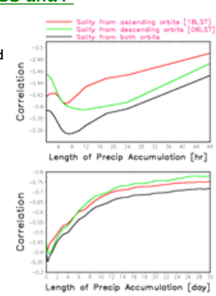
5) Scatter Plots between SSS and P



- Comparisons between instantaneous SSS from Aquarius with precipitation averaged over different periods ending at the SSS observation times
- Data collected over central Pacific [10°S-10°N; 180°-160°W]
- In general, SSS decreases with P
- Better agreement between SSS and P averaged over a longer period

6) Correlation btw SSS and P

- Correlation between instantaneous SSS from Aquarius and P averaged over time period of different lengths ending at the SSS observation time
- Data collected from the 52-day period over Central Pacific
- Correlation is high with instantaneous P, decreases as the averaging period extends to ~several hours before increasing with the time



V. Summary

- A high-resolution global precipitation analysis constructed for a 13-year+ period from 1998 to the present by adjusting the CMORPH satellite estimates
- Global precipitation and its diurnal cycles depicted in three sets of new analyses are examined using the 13-year high-resolution analysis
  - *The three sets of high-resolution reanalyses are capable of depicting detailed structures of global precipitation*
  - *The reanalyses tend to under-/over-estimate strong / weak precipitation, generating wider raining areas than observations*
  - *Diurnal cycle of precipitation is reasonably well reproduced by the CFSR, with stronger / weaker amplitude over tropical land / ocean and a peak time 2-4 hours earlier*
- Preliminary work conducted to investigate relationship between oceanic P and SSS
  - *Clear relationship between SSS and P, especially for averaging period > 10 days*
  - *Aquarius provide important information on SSS*