

Comparing Vertical Distributions of Cloud Liquid Water and Ice from MODIS Collections 5 and 6 to CMIP5 Model Simulations

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Paper 639

I. Introduction

Global climate models have improved considerably, yet clouds still represent a large factor of uncertainty.

Observations have the potential to constrain uncertainties:

- Compare satellite retrievals with global climate model simulations to pinpoint where they differ
- Focus on cloud variables at different vertical levels

In this study, we build our own gridded product from MODIS Level 2 data specifically to compare MODIS and GISS cloud water path for three different cloud height regimes.

II. Methodology

Uniform Space-Time Gridding (Smith et al., 2013):

- Filter and grid satellite data based on science question trying to answer:

How does the vertical partitioning of cloud water path (CWP) in the atmosphere affect comparisons between GISS-E2-H CMIP5 model simulations and Aqua MODIS satellite retrievals of CWP?

Model data:

GISS-E2-H

CMIP5 monthly "Historical" 2003-2005 and "historicalExt" 2006-2012 runs

Cloud water path (clivi, clwvi)
Cloud water mass fraction (cli, clw)

- Integrate mass fraction over desired pressure levels to get CWP for different height regimes

Satellite data:

Aqua MODIS Level 2 (MYD06)
Collections 5.1 and 6
May 2003-2012

Cloud water path (CWP)
Cloud top pressure (CTP)
Cloud fraction (CF)
Cloud mask

Satellite filtering and gridding criteria:

Space Gridding:

- Grid size: 2° x 2°
- Viewing angle: ≤32°
- Determination of cloudiness:
 - Is there a cloud?
 - Is there a CWP retrieval?
 - Is it an ice cloud or water cloud?
- Quality filter: uncertainty < 80%
- Height filters: based on CTP

We account for the change in CTP resolution of 5km in C5 to 1km in C6.

Time Gridding:

- Minimum number of observations threshold
- Daily average created from filtered data
- Daily averages used to make monthly average



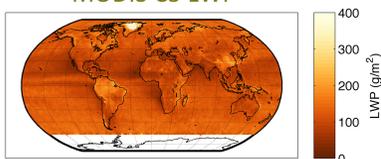
IV. Acknowledgements & References

NASA Grants NNX10AP06G and NNX11AO55G
Aqua MODIS Collections 5.1 and 6 data collected from the Goddard Space Flight Center LAADS Web: <http://ladsweb.nascom.nasa.gov/>
World Climate Research Programme's Working Group on Coupled Modelling
NASA Goddard Institute for Space Studies; GISS-E2-H data obtained from CMIP5 data portal: <http://pcmdi9.llnl.gov/esgf-web-fe/>
Baum, B., et al., 2012: MODIS cloud-top property refinements for Collection 6. *J. Appl. Meteor. and Climatol.*, **51(6)**, doi:10.1175/JAMC-D-11-0203.1.
Platnick, S., et al., 2013: MODIS cloud optical properties: Exec. Summary of Collection 6 Level-2 Optical property changes for MOD06/MYD06, http://modis-atmos.gsfc.nasa.gov/_docs/C6MOD06OPEExecSum.pdf.
Smith, N., et al., 2013: A uniform space-time gridding algorithm for comparison of satellite data products: Characterization and sensitivity studies. *J. Appl. Meteor. Climatol.*, **52(1)**, doi:10.1175/JAMC-D-12-031.1

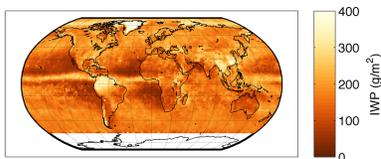
III. Results

MODIS C5

MODIS C5 LWP



MODIS C5 IWP

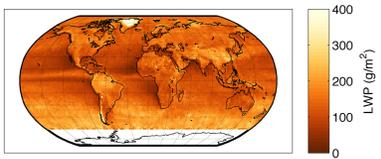


MODIS C6 cloud product changes and improvements: (Baum et al., 2012; Platnick et al., 2013)

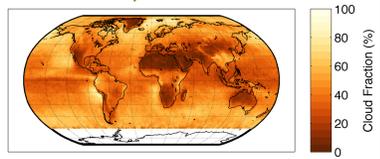
- 1 km CTP horizontal resolution (previously 5 km)
- Avoid problems with low-level inversion layers to determine low-level marine cloud heights by using collocated 11 μm BT lapse rate and CALIPSO low-level cloud heights, and sea surface temperature
- Cloud mask uses NDVI to enhance expected surface reflectances, which decreases number of pixels designated as "desert", and reduces "probably clear" and "probably cloudy" designations in vegetated and semiarid regions
- Overall reduced uncertainty in cloud retrievals due to use of surface and effective cloud emissivities
- Incorporation of IR phase into optical property phase determination tests

MODIS C6

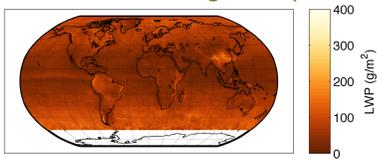
MODIS C6 LWP



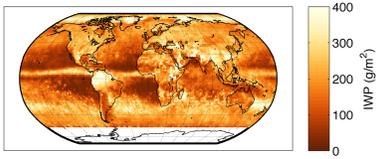
MODIS C6 Liquid Cloud Fraction



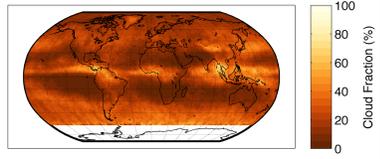
MODIS C6 LWP weighted by CF



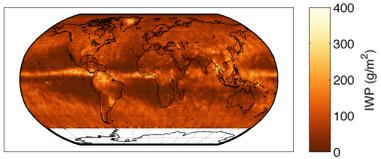
MODIS C6 IWP



MODIS C6 Ice Cloud Fraction



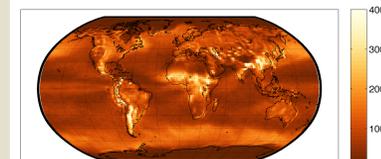
MODIS C6 IWP weighted by CF



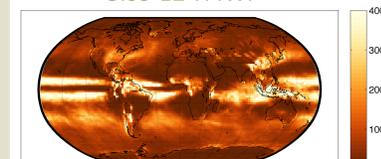
Filtered Average CWP x Cloud Fraction (CF) = CWP weighted by CF

GISS-E2-H

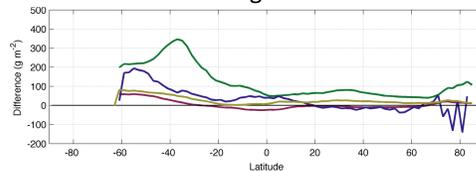
GISS-E2-H LWP



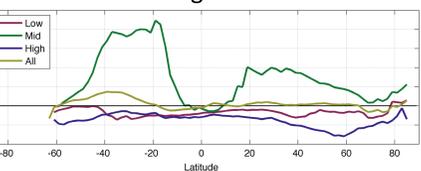
GISS-E2-H IWP



C6 - C5 Zonal Avg. LWP Difference



C6 - C5 Zonal Avg. IWP Difference



MODIS C6 – C5

Mid-level CWP increases in C6
High-level IWP decreases in C6
IWP over Greenland decreases in C6

Global Avg. Differences

Height level	LWP % Diff	IWP % Diff
All	22	7
High	0	-42
Mid	84	115
Low	19	-28

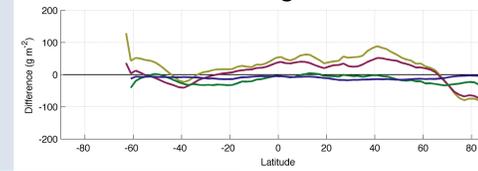
GISS – MODIS C6

GISS overestimates high-level IWP and produces a double ITCZ
GISS overestimates low-level LWP over mountains

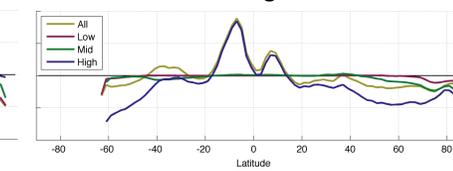
Global Avg. Differences

Height level	LWP % Diff	IWP % Diff
All	59	44
High	-91	-17
Mid	-39	-31
Low	34	-33

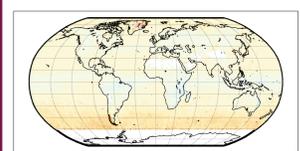
GISS – C6 Zonal Avg. LWP Difference



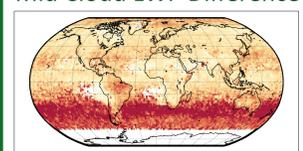
GISS – C6 Zonal Avg. IWP Difference



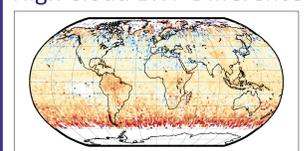
Low Cloud LWP Difference



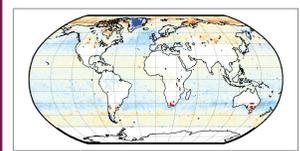
Mid Cloud LWP Difference



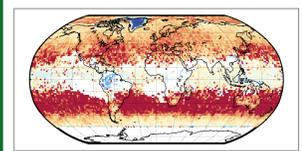
High Cloud LWP Difference



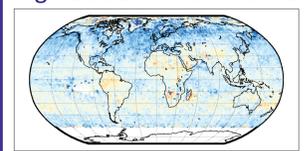
Low Cloud IWP Difference



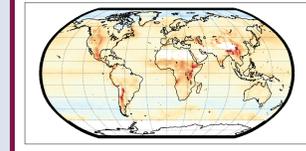
Mid Cloud IWP Difference



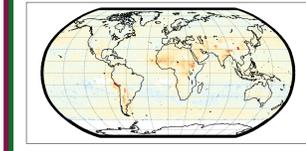
High Cloud IWP Difference



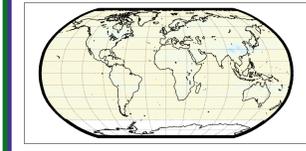
Low Cloud LWP Difference



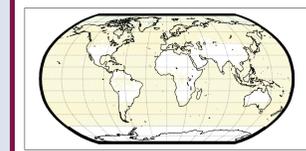
Mid Cloud LWP Difference



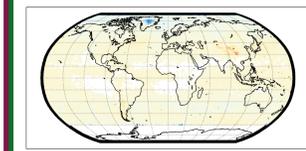
High Cloud LWP Difference



Low Cloud IWP Difference



Mid Cloud IWP Difference



High Cloud IWP Difference

