# Comparisons of GFDL Time slice and CRCM cloud simulations with GOES Satellite Observations

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**Randall J. Alliss**

**Atmospheric Sciences & Engineering Department**
**Northrop Grumman**

# Introduction & Motivation

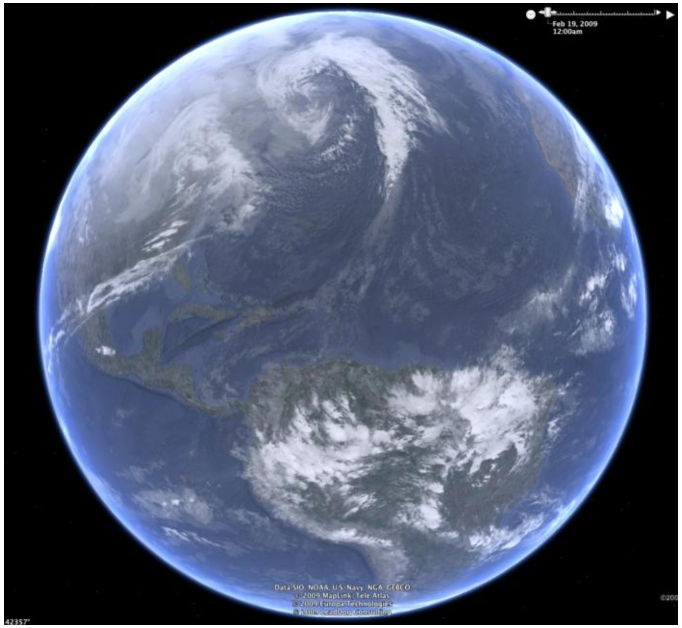
- We are interested in the impact of clouds on free space optical communication systems
- Majority of cloud types will negatively impact the transmission of an optical signal therefore lowering system performance
- Developed a climatology of clouds over CONUS to provide insight into how an optical communication system might perform
- What is the impact of a warming climate and changes in cloudiness on the performance of these systems?
- Model output from NARCCAP has allowed us to address some of these questions

# Objectives

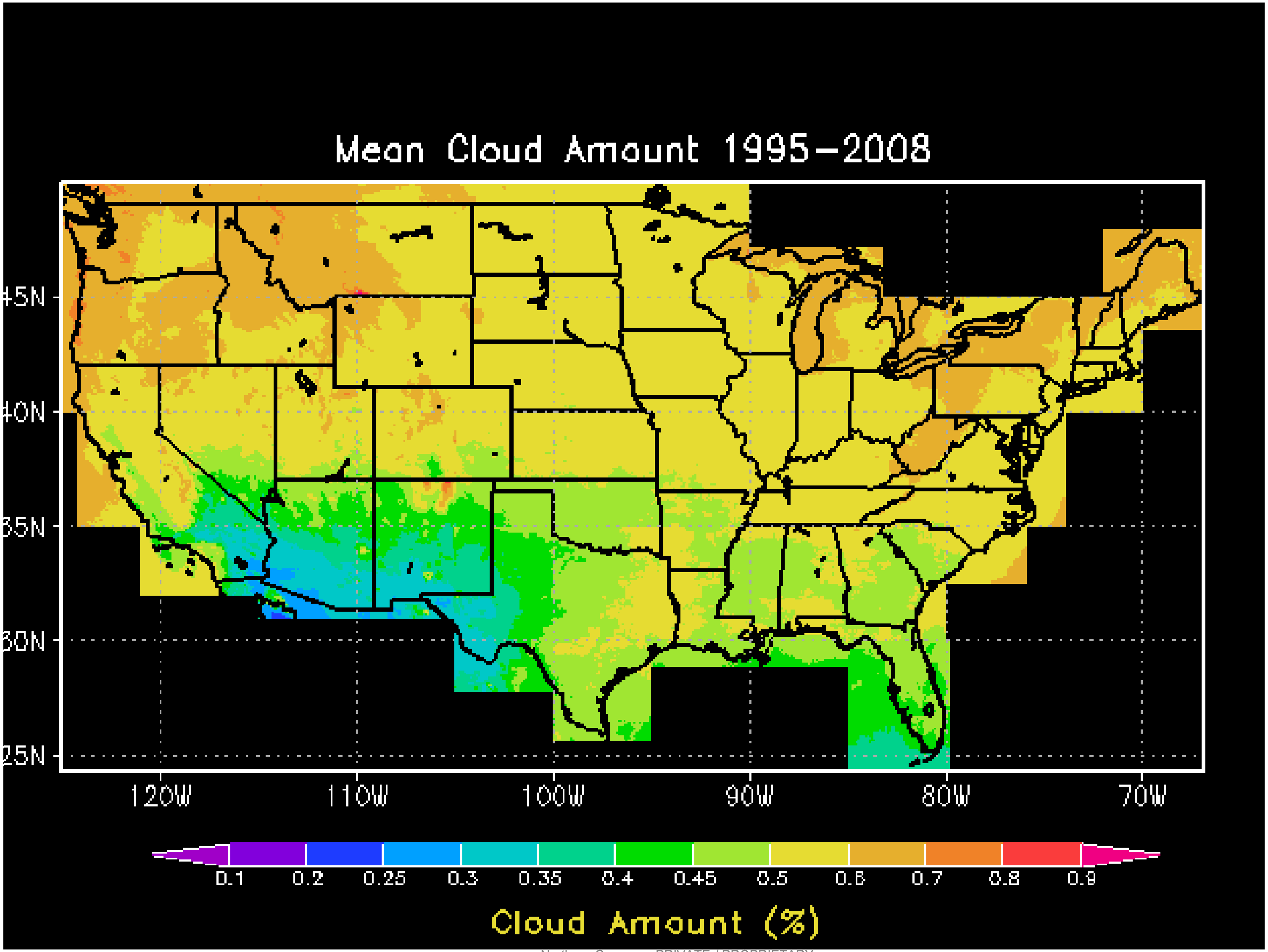
- Evaluate total cloud amount from the GFDL time slice and the CGCM3/CRCM runs
- Compare the GFDL and CRCM clouds for the overlapping period 1995 – 2000 to those of our GOES cloud database
- Show impact of modeled clouds on optical communications system performance

# Overview of Cloud database

- Cloud Mask Generator (CMG) software uses high resolution, multi-spectral, geostationary imagery (e.g., GOES) to characterize the distribution of clouds over CONUS
- CMG algorithm produces a cloud / no cloud decision for each ~4km field of view at ~ 15 minute resolution between 1995 and present
- Validation of algorithm performed by comparing to ground based instrumentation and surface observations
- Long period of record allows for statistical analysis of data and comparisons to climate runs



# Climatology of Clouds over CONUS derived from GOES



# Mean Cloud Fraction over CONUS 1995-2000
# GOES CMG vs. CRCM and GFDL

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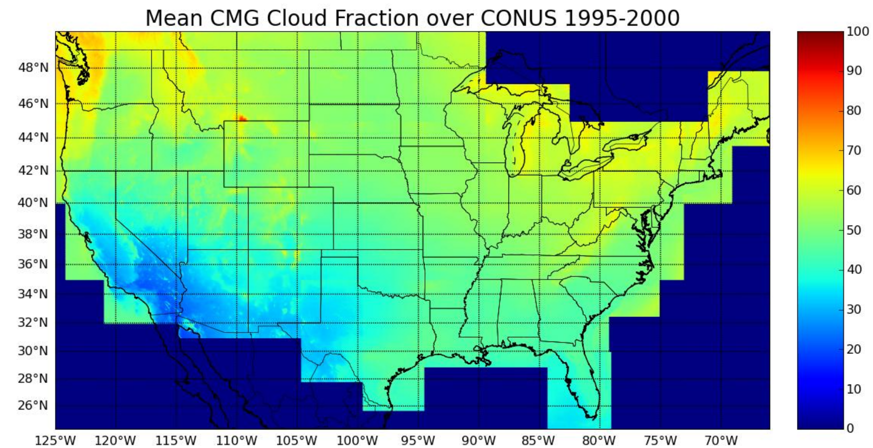
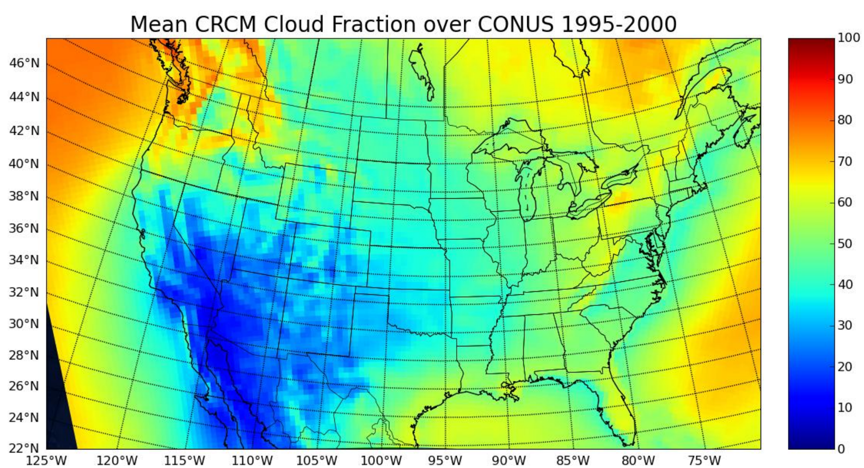
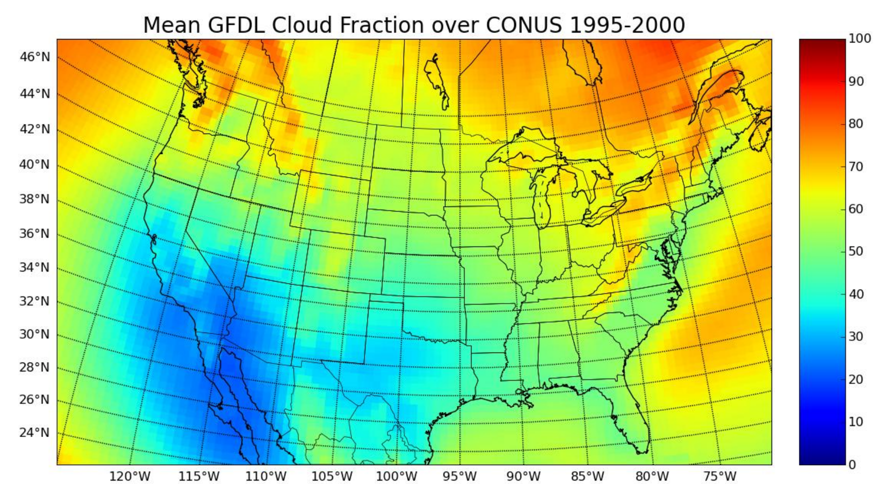
- CMG and climate models show similar large scale spatial cloud patterns
- CRCM shows a much larger area of low cloud fraction in the Southwest than both the CMG and the GFDL model
- CRCM model is cloudier in the Gulf Coast region than the CMG
- GFDL is cloudier over the Appalachian Mountains than CMG or the CRCM model
- Florida is cloudier in the CRCM compared to CMG and GFDL

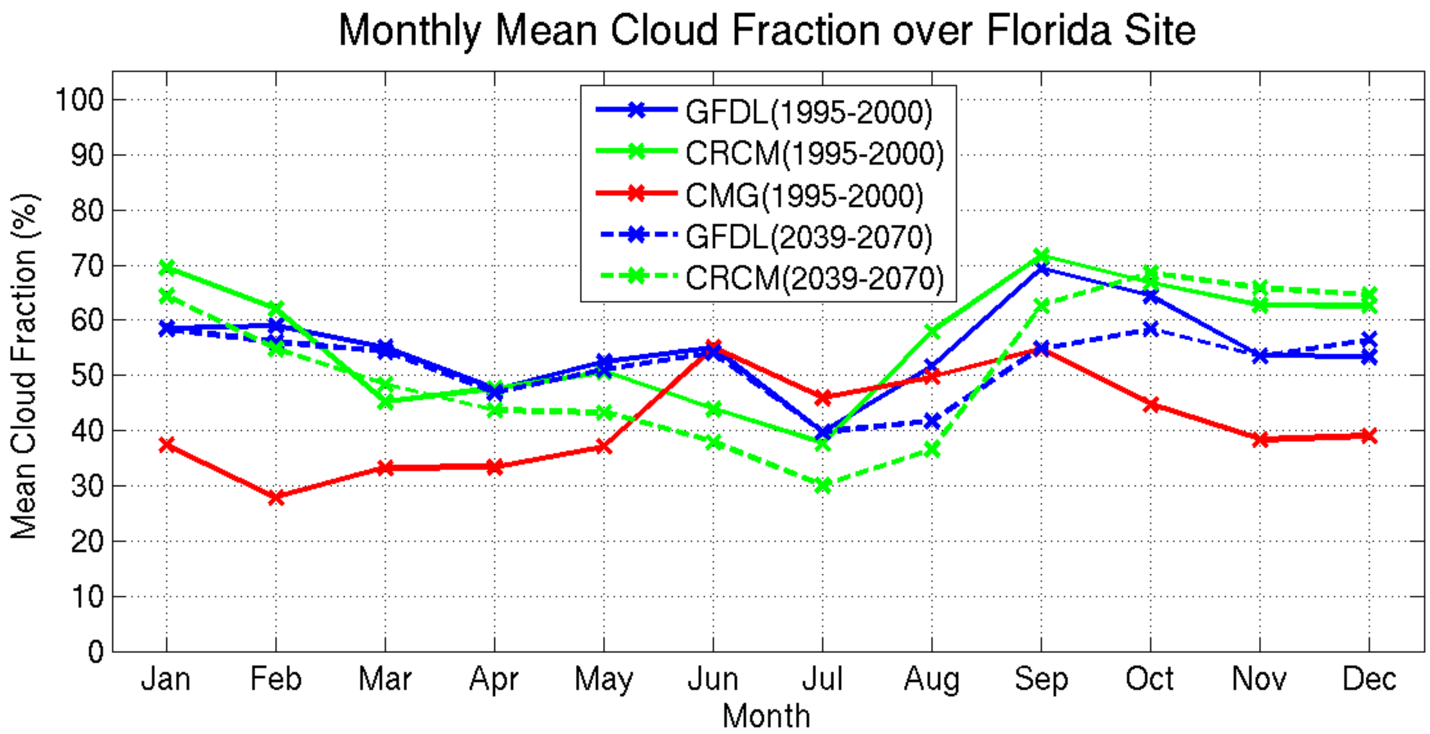


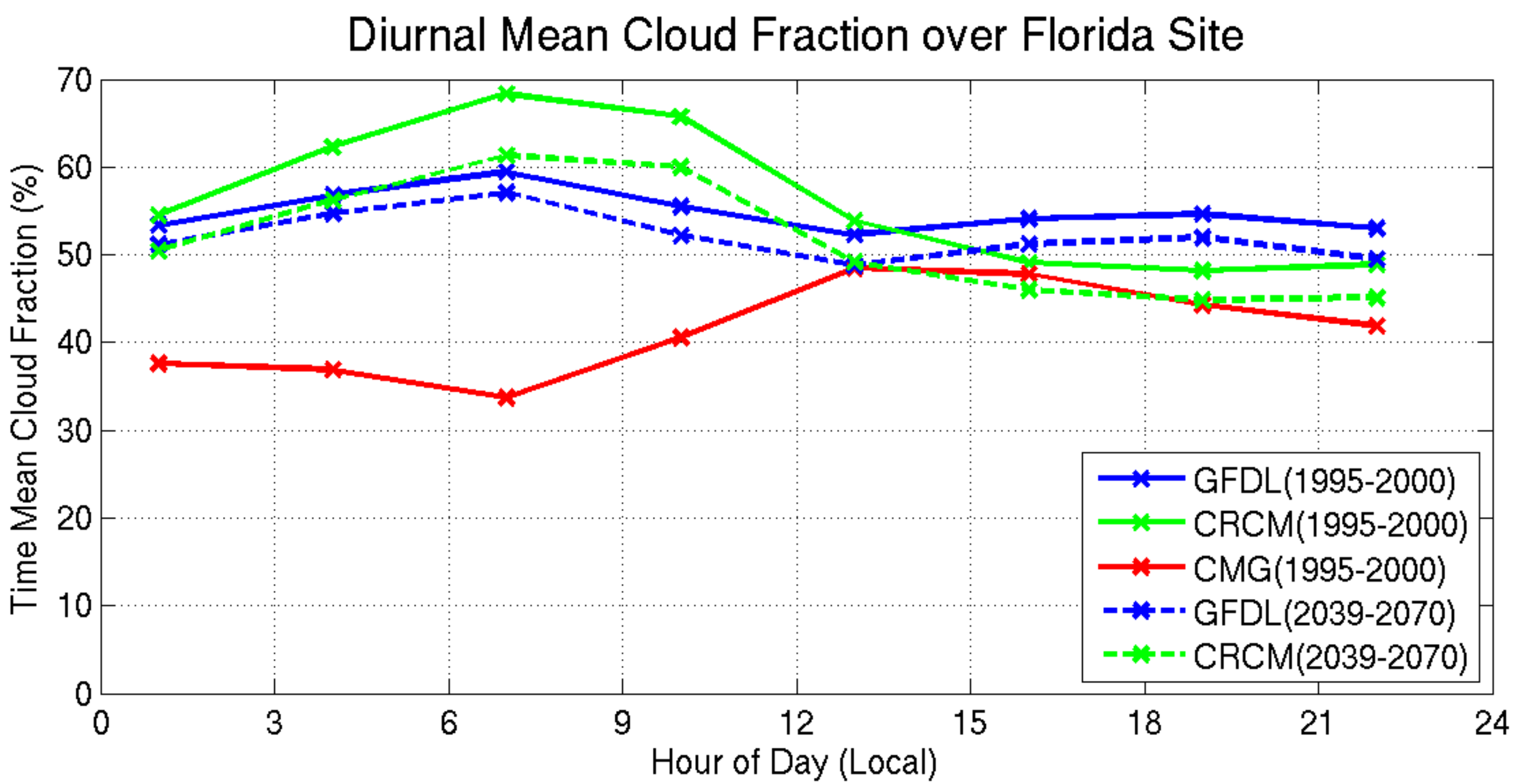
# Monthly Mean Cloud Fraction at Specific Locations (1995 -2000) & Future Runs

## Results are highly dependent on Location



# Diurnal Variations in Clouds at Specific Locations (1995 – 2000) and Future Runs

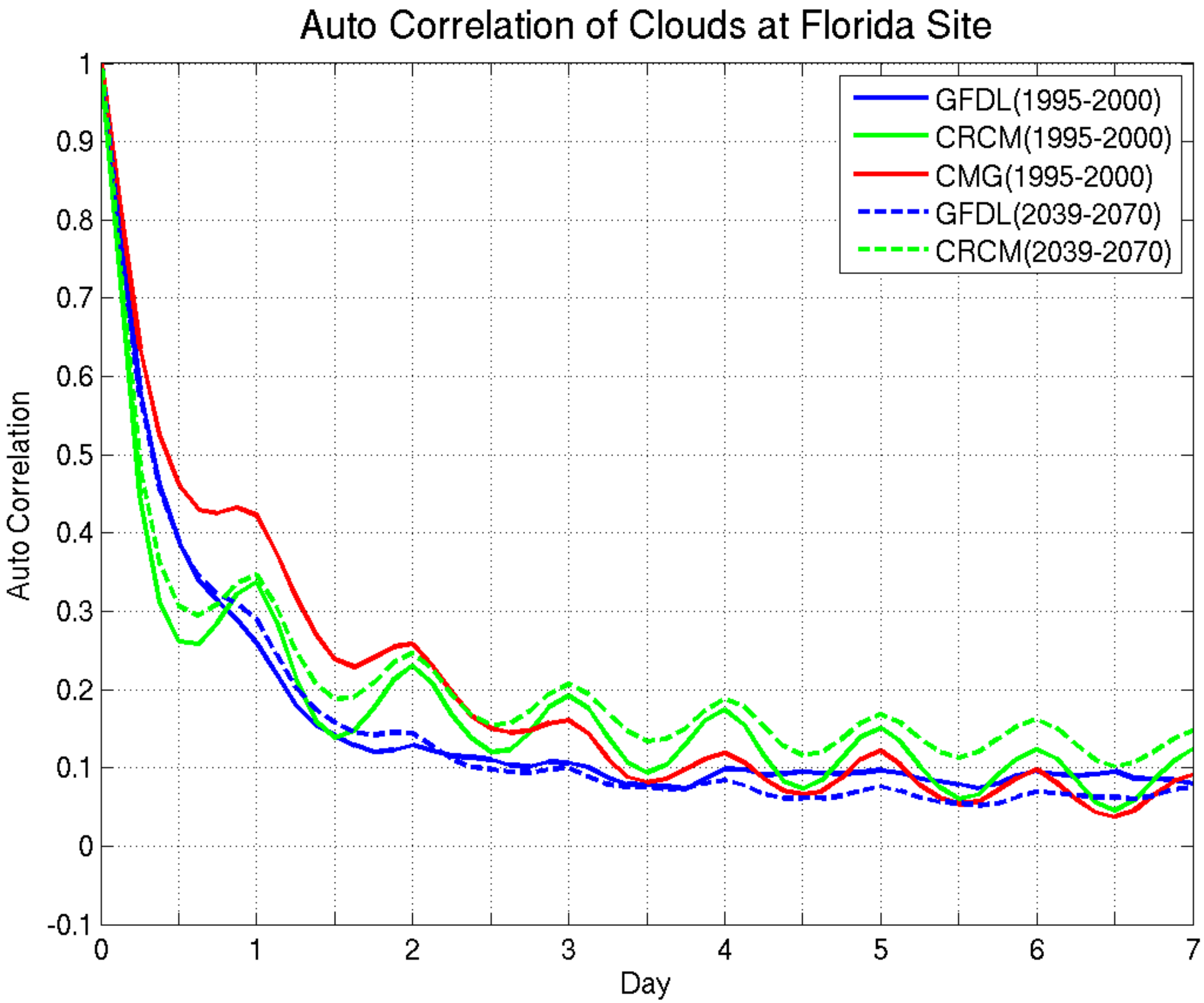





Diurnal variations are out of phase at SC and FL locations relative to observations

# Auto Correlations of Clouds at specific locations

CRCM Produces a high amplitude, diurnal varying, auto correlation not seen in the observations at the TX site



# Applications to Optical Communications

- Lasercom Network Optimization Tool (LNOT) is a decision aid tool
- Uses the cloud climatology to determine an optimal network of sites which will provide high cloud free availability
- We compare our LNOT results to the NARCCAP GFDL and CRCM runs for both the current and future runs

# Climate predictions appear to have a cloudy bias and produce a slightly lower availability compared to their current runs

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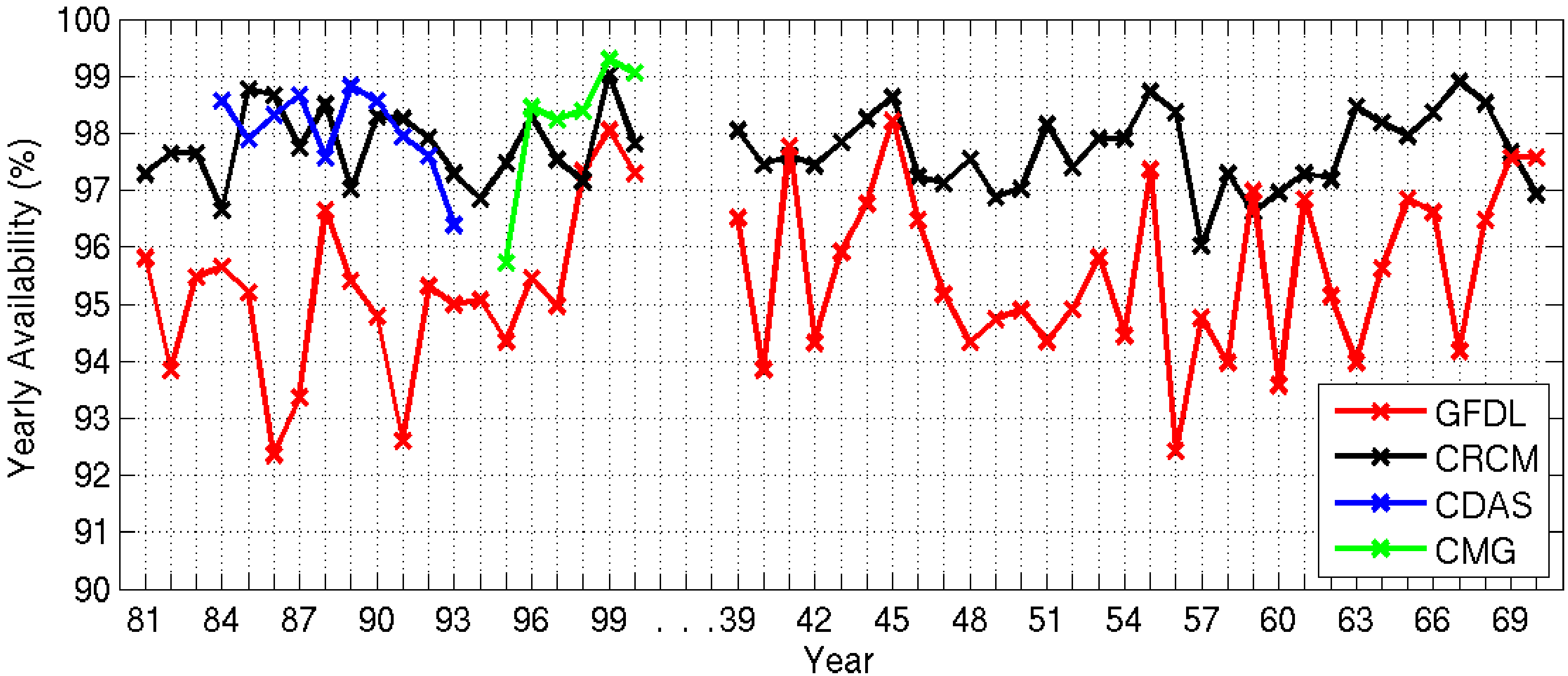
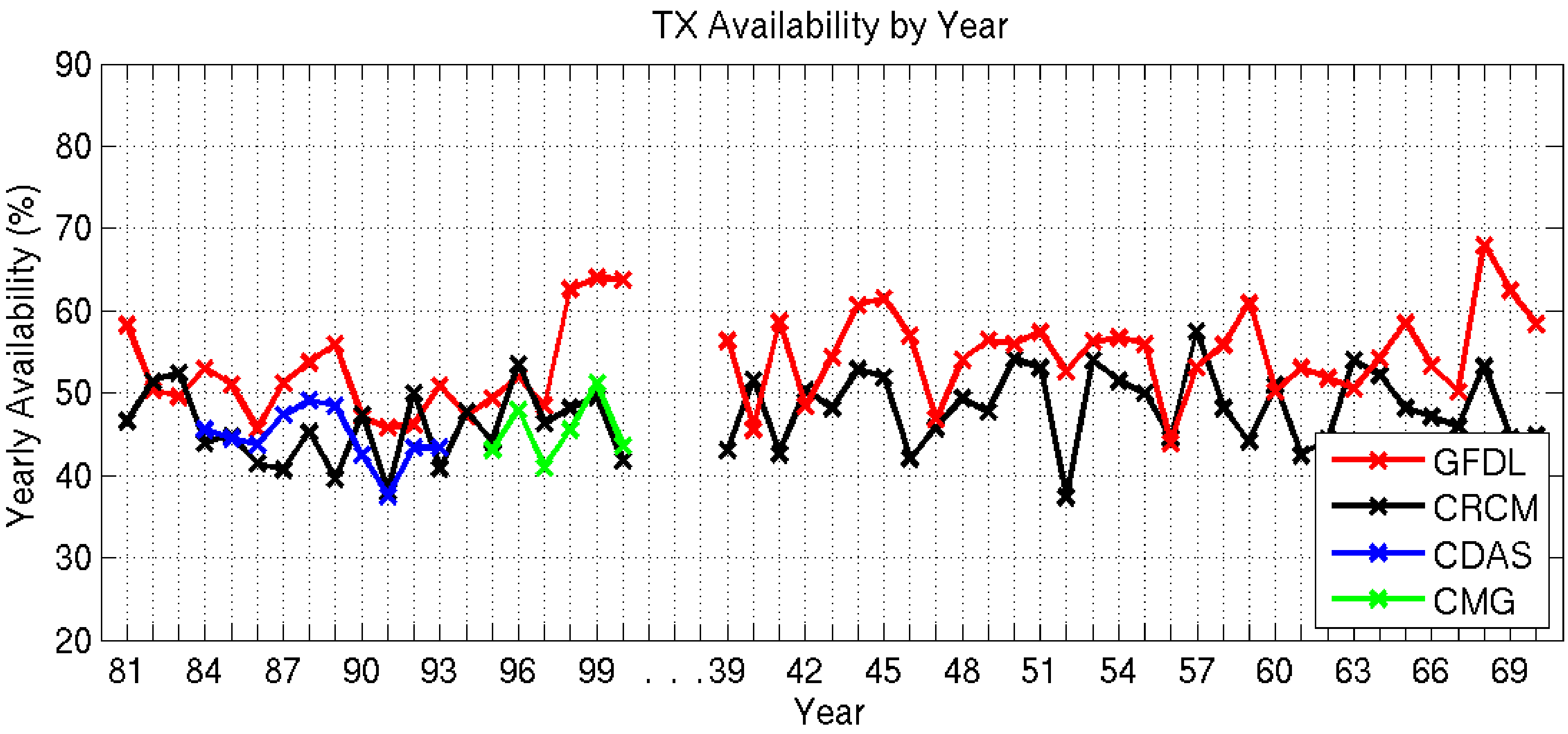



| Availability (%) | 1995-2000 | Future (39-70) |
|---|---|---|
| CMG | 98.20 | X |
| GFDL | 96.24 | 95.57 |
| CRCM | 97.88 | 97.71 |

# Florida is the main contributor to lower overall performance in both current and future runs



# Summary & Discussion

- GFDL & CRCM climate runs have been valuable in studying the cloud distributions over CONUS
- Simulations were used to study impact on performance of an optical communications system
- The models reproduce the large scale distribution of clouds but differ on many of the details
- Appears to be a cloudy bias in the models w.r.t our application
- Would like to understand from the modelers their opinions on the validity of the simulated clouds
- We are now downscaling using WRF 3.1.1 at 12 km to evaluate the sensitivity to resolution