

ECMWF MACC-II Aerosol system: evaluation of model performances at MPLNET NCU lidar station

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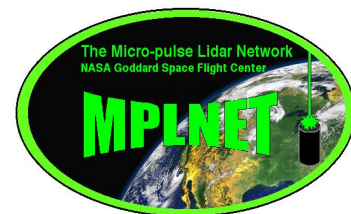
² NASA, Code 612, Goddard Space Flight Center, Greenbelt, MD, USA

³ ECMWF, Shienfield Park, Reading, UK,

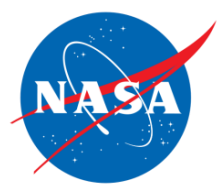
⁴ National Central University, Taipei, Taiwan



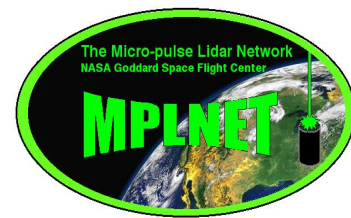
Motivation



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- To use an aerosol modeling system with confidence, model performance must be evaluated against observations
 - Aerosol **vertical distribution** is **poorly quantified** due to the numerous uncertainties on direct emissions and secondary processes
 - Assessing ECWMF MACC-II model perfs: Case study at NCU MPLNET permanent observational site in Taiwan, 23-25 March 14
-



The NASA Micro-Pulse Lidar Network (MPLNET)



Principal Investigator:

Judd Welton, NASA GSFC Code 612

Network Manager:

Sebastian Stewart, SSAI GSFC Code 612

Data Processing:

Phillip Haftings, SSAI GSFC Code 612

Larry Belcher, SSAI GSFC Code 612

Science Team:

James Campbell, Naval Research Lab

Jasper Lewis, UMBC GSFC Code 612

Simone Lolli, UMBC GSFC Code 612

Administrative Support:

Erin Lee, SSAI GSFC Code 612

CALIPSO Validation Activities:

Judd Welton, James Campbell

AERONET & Synergy Tool Partnership:

Brent Holben, NASA GSFC Code 614.4

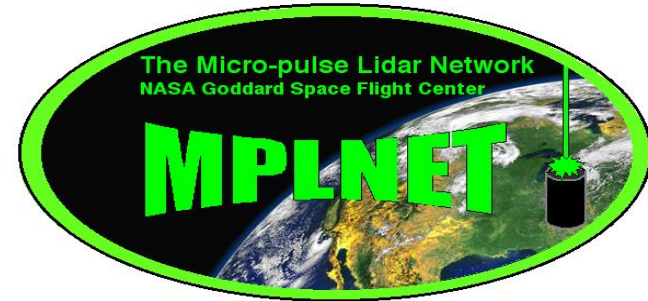
Dave Giles, NASA GSFC Code 614.4

NASA SMARTLABS Field Deployments:

Si-Chee Tsay, NASA GSFC Code 613

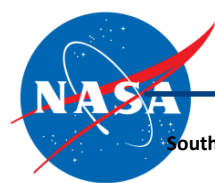
Site Operations & Science Investigations

.... many network partners around the world

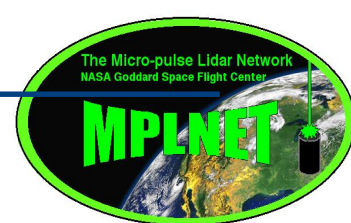


MPLNET information and results shown here are the result of efforts by all of our network partners!

MPLNET is funded by the NASA Radiation Sciences Program and the Earth Observing System



MPLNET Overview



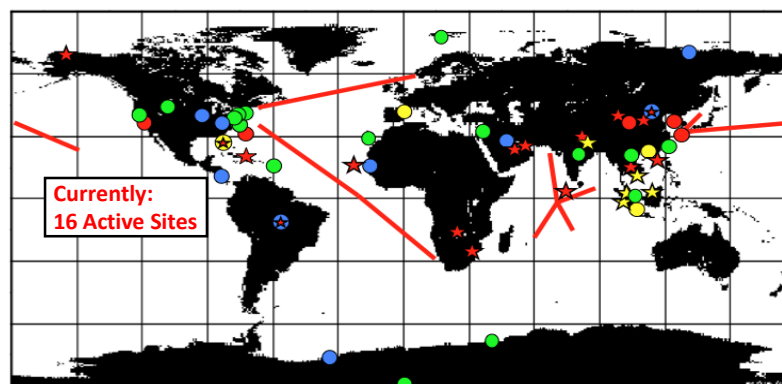
South Pole MPLNET Site:
1999-current



Micro Pulse Lidar
(GSFC Patent)



MPLNET Sites: 2000 - current



- active
- inactive
- planned
- proposed
- long term site
- ☆ field campaign
- ⊗ former field campaign, planned/proposed site
- ship cruise

* most sites co-located with AERONET

MPLNET: 8.8 Trillion Laser Shots, 59 Minutes of data and counting...

- A federated network of micro pulse lidar sites around the world, coordinated and lead from Goddard Space Flight Center
- Co-location with related networks, including NASA AERONET
- Local, regional, and global scale contributions to atmospheric research
- Satellite validation
- Aerosol climate and air quality model validation
- Impact of aerosol & cloud heights on direct and indirect climate effects
- Support for wide variety of field campaigns

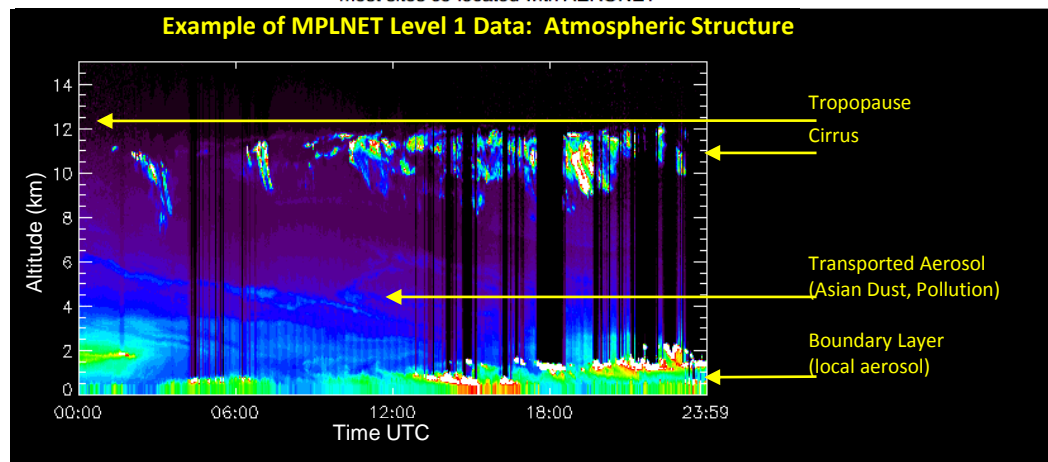
What's New?

- Penang new site August 2014
- More sites in Africa and in South America
- Ongoing interactions with both Aerocom and ICAP communities (climate and operational air quality modeling)

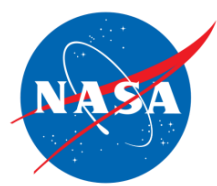
Investigators, Partners, & Collaborators:

- Principal Investigator: Judd Welton/612
- Brent Holben/618
- Si-Chee Tsay/613
- Sebastian Stewart/SSAI/612
- Simone Lolli/JCET-UMBC/612
- Phillip Haftings/SSAI/612
- James Campbell/NRL
- Larry Belcher/SSAI/612
- Jasper Lewis/JCET/612
- All Network Partners Worldwide

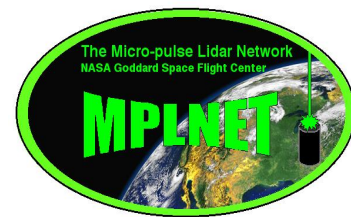
Example of MPLNET Level 1 Data: Atmospheric Structure



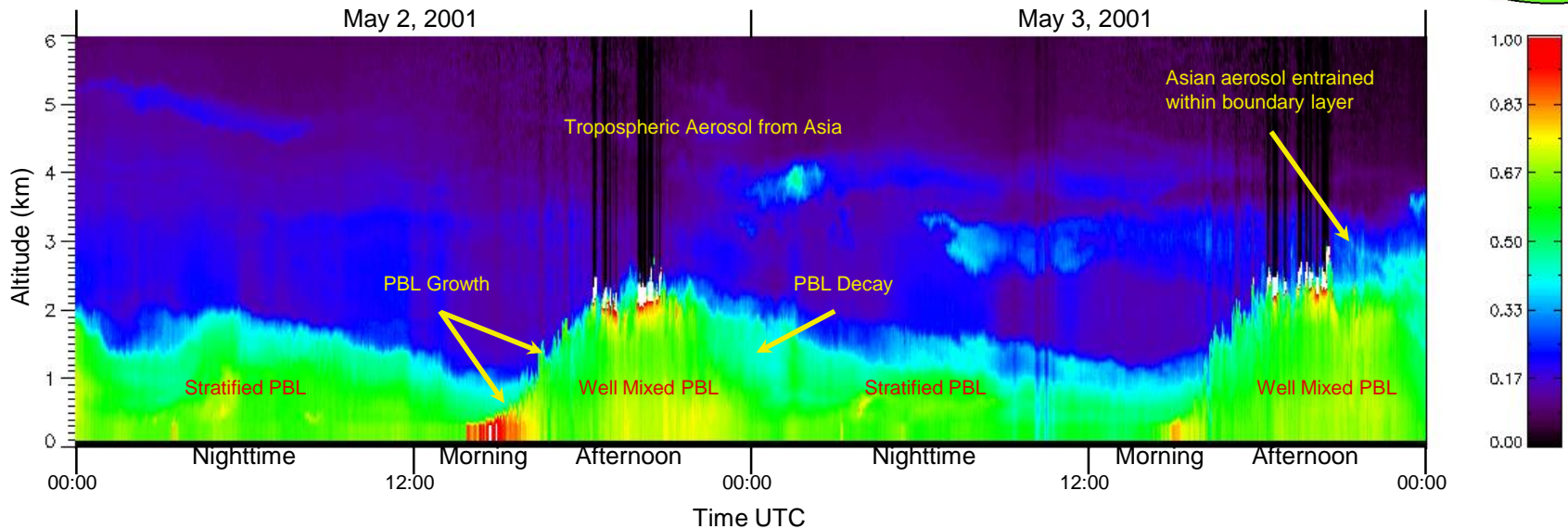
<http://mplnet.gsfc.nasa.gov>



MPLNET Data Products



Level 1 MPLNET Signals from NASA Goddard



MPLNET Data Products:

near real time: 1 hour or 1 day

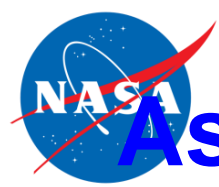
Level 1 NRB Signals, Diagnostics
(near real time, no quality screening)

Level 1.5 Level 1.5b: Aerosol, Cloud, PBL Heights and Vertical Feature Mask
Level 1.5a: **Aerosol Backscatter, Extinction, Optical Depth Profiles and Lidar Ratio**
(near real time, no quality screening)

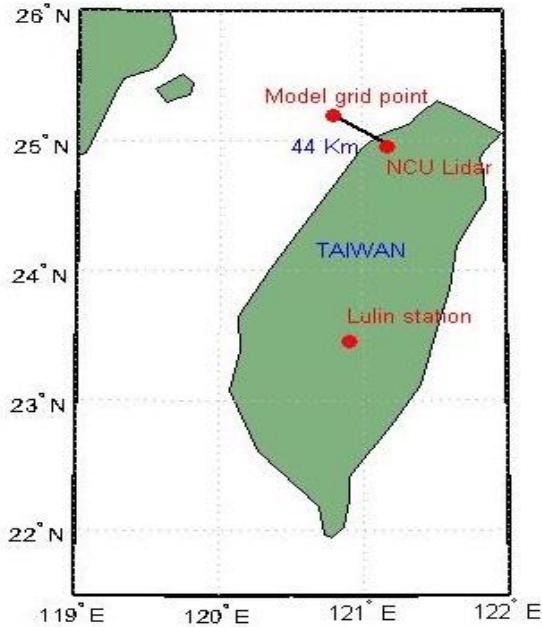
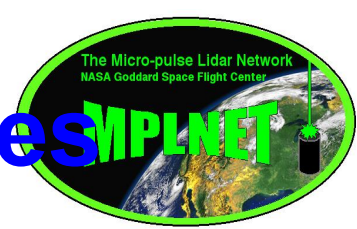
Level 2 Operational Products Under Development (beta data available upon request)
(not real time, quality assured)

All data are publicly available in netcdf format. Errors included for all data products.

Data policy same as AERONET. We are a federated network, individual site providers deserve credit.



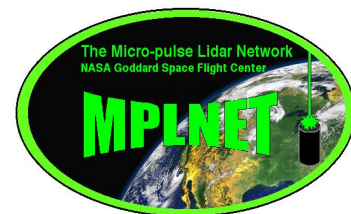
Assessing MACC-II performances



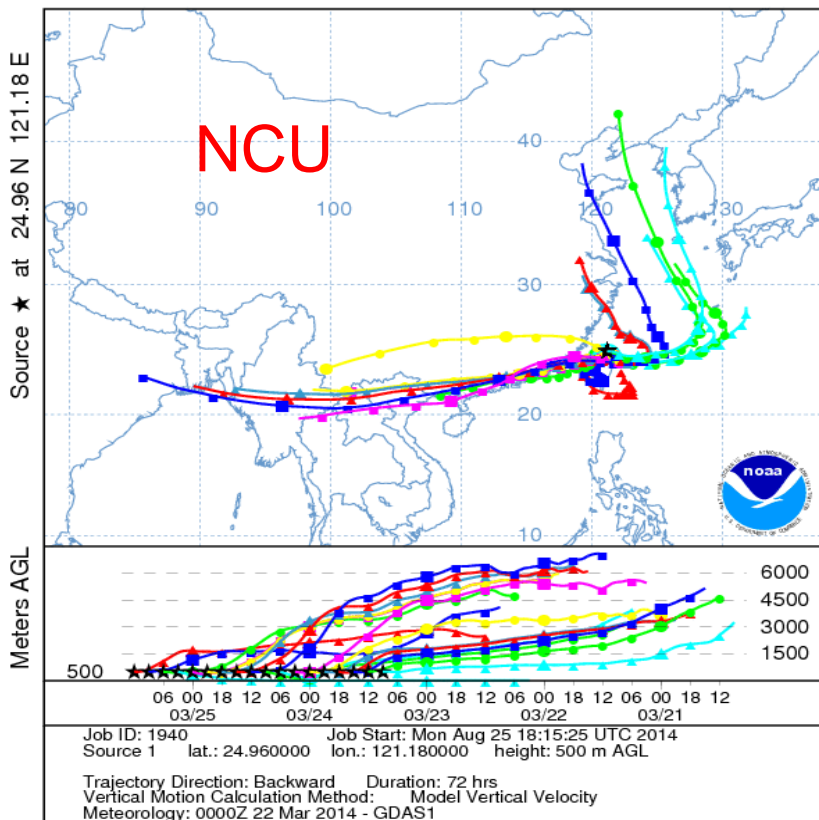
- MACC-II: extinction profiles from 0000UTC 23 March 2014 to 0000UTC 26 March 2014 each 3 hours
- Lidar Data: gridded extinction profiles
- *In-situ* pm2.5 and pm10 measurements at NCU and Lulin stations



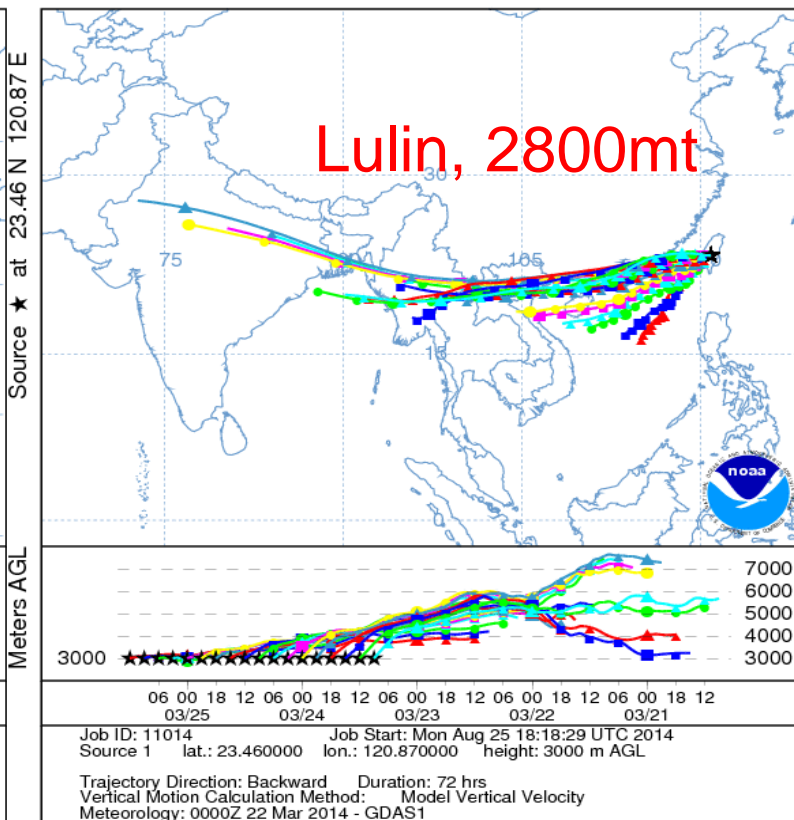
Hysplit Trajectories

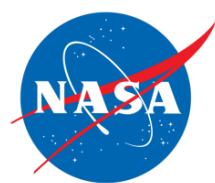


NOAA HYSPLIT MODEL
Backward trajectories ending at 1200 UTC 25 Mar 14
GDAS Meteorological Data

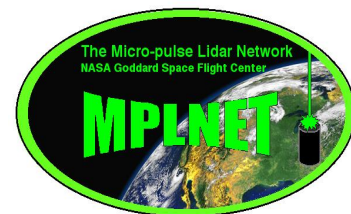


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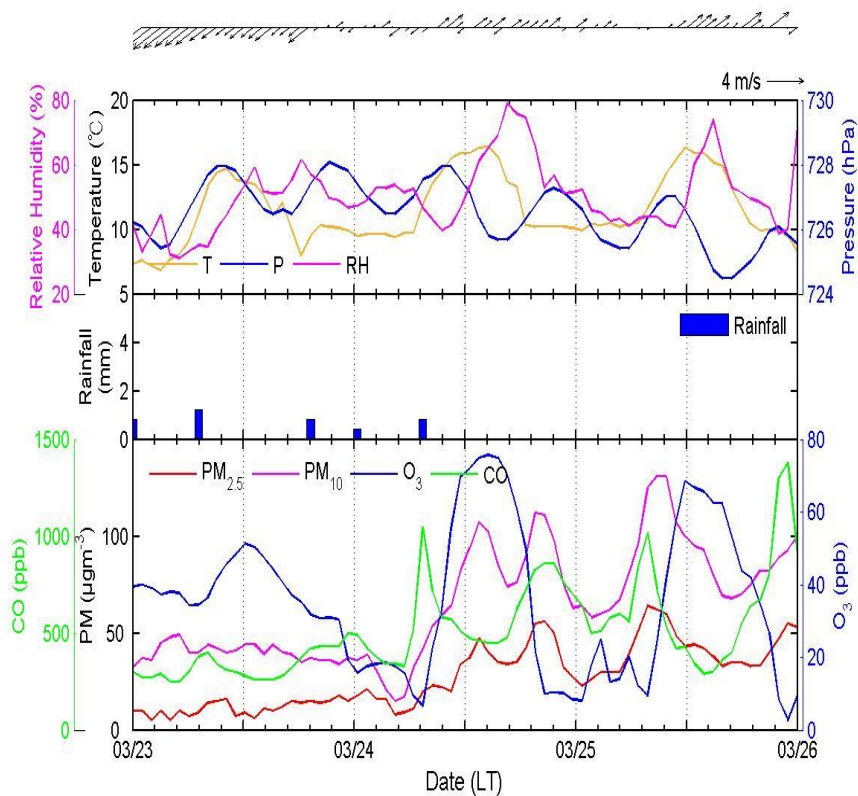




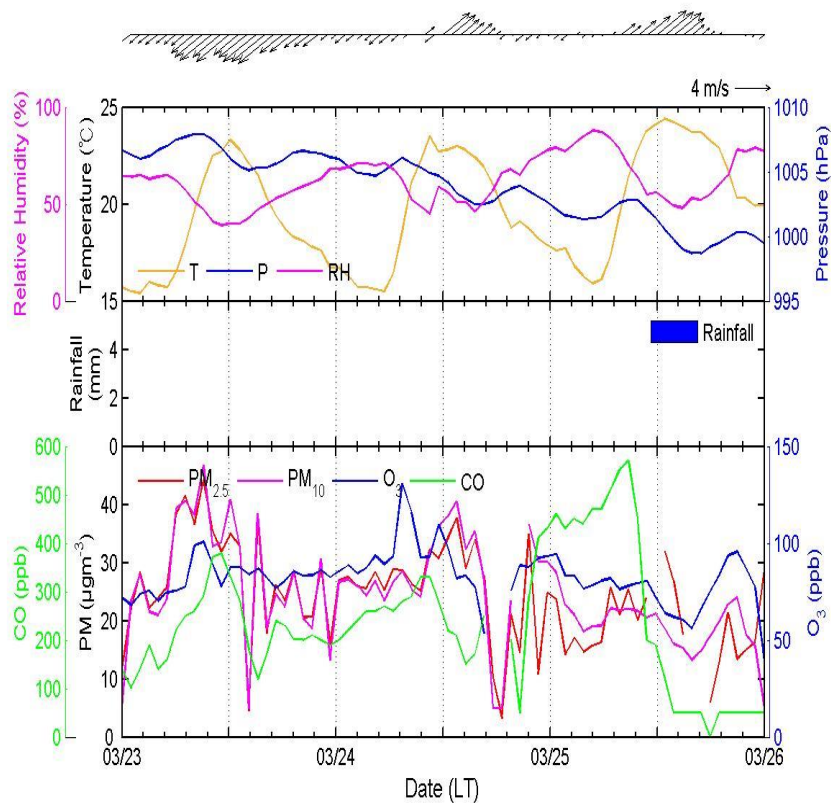
In-situ PM_{2.5} and PM₁₀

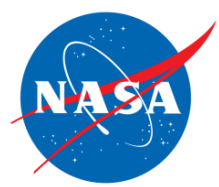


EPA Pingzhen Air Quality Data and NCU Meteorology Data
20140323~20140325

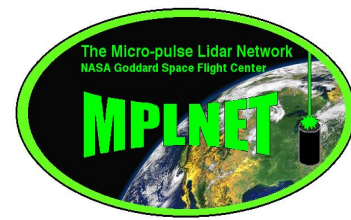


Lulin EPA Air Quality Data and Meteorology Data
20140323~20140325





Metric (Boylan and Russel)



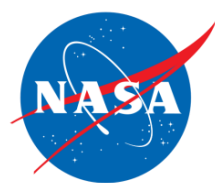
- Mean Fractional Error (**MFE**)

$$MFE = \frac{2}{N} \sum_{i=1}^N \frac{|\alpha_{mod,i} - \alpha_{obs,i}|}{(\alpha_{mod,i} + \alpha_{obs,i})}$$

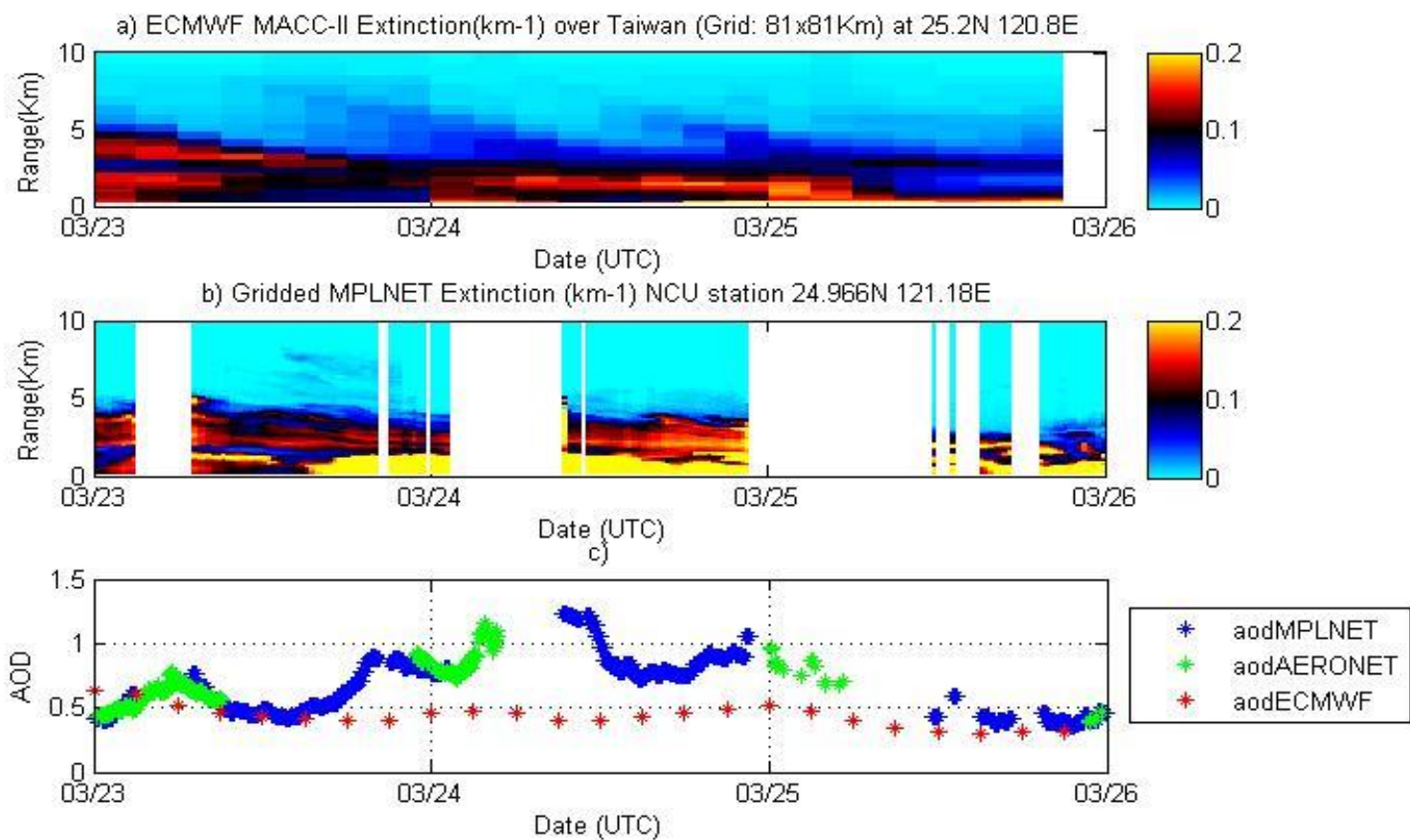
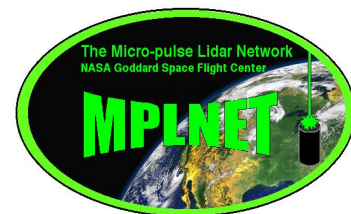
- Mean Fractional Bias (**MFB**)

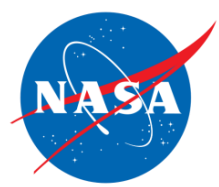
$$MFB = \frac{2}{N} \sum_{i=1}^N \frac{(\alpha_{obs,i} - \alpha_{mod,i})}{(\alpha_{mod,i} + \alpha_{obs,i})}$$

- Performance Goal: MFE < 50% and - 30% < MFB < 30%
- Performance Criteria: MFE < 75% and - 60% < MFB < 60%

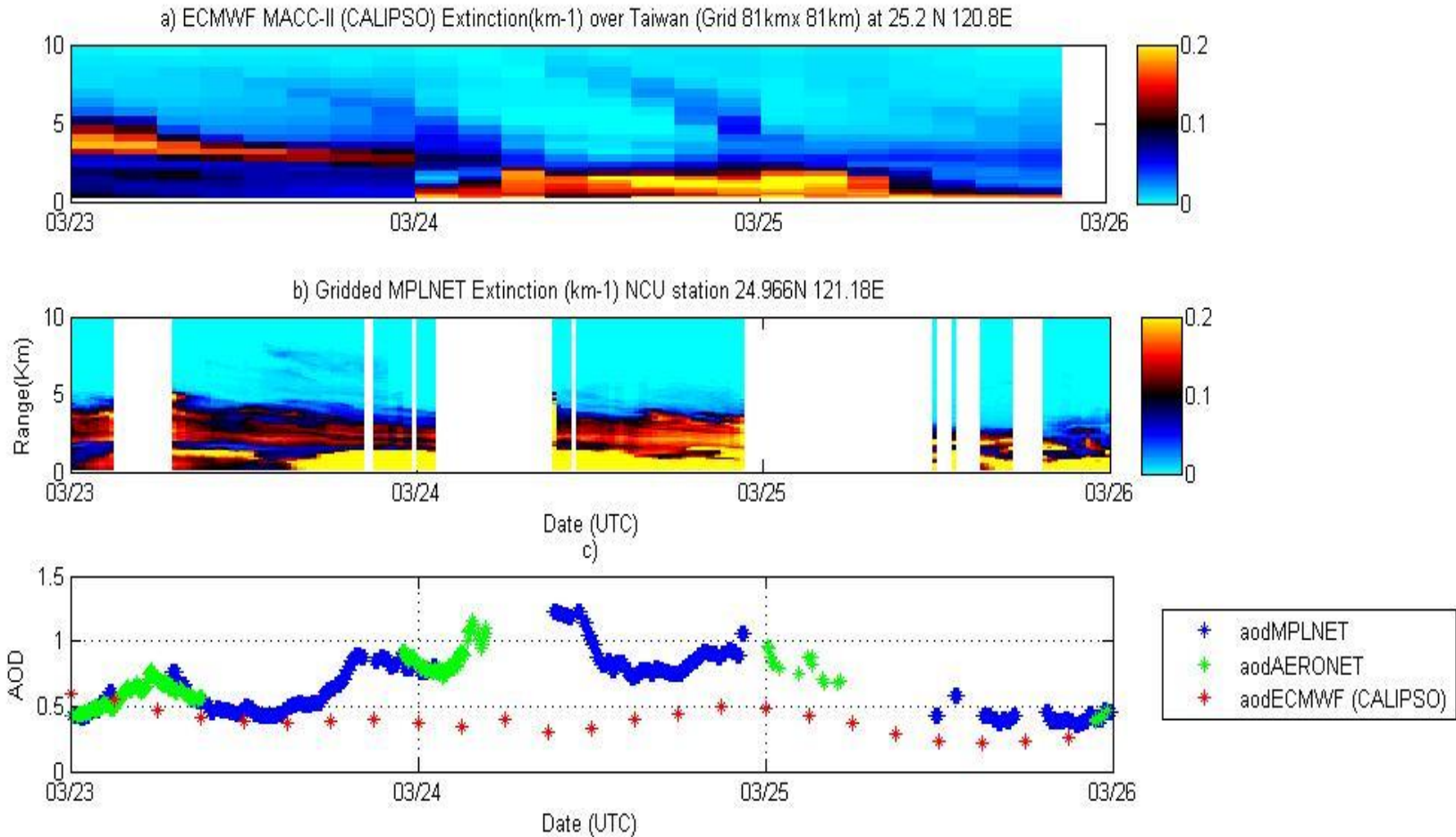
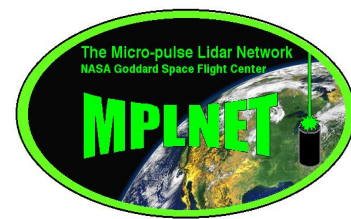


23-26 March 2014 NCU



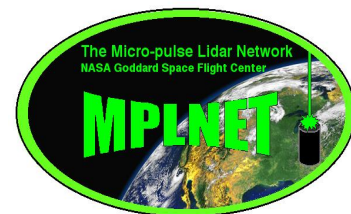


23-26 March 2014 (CALIPSO)

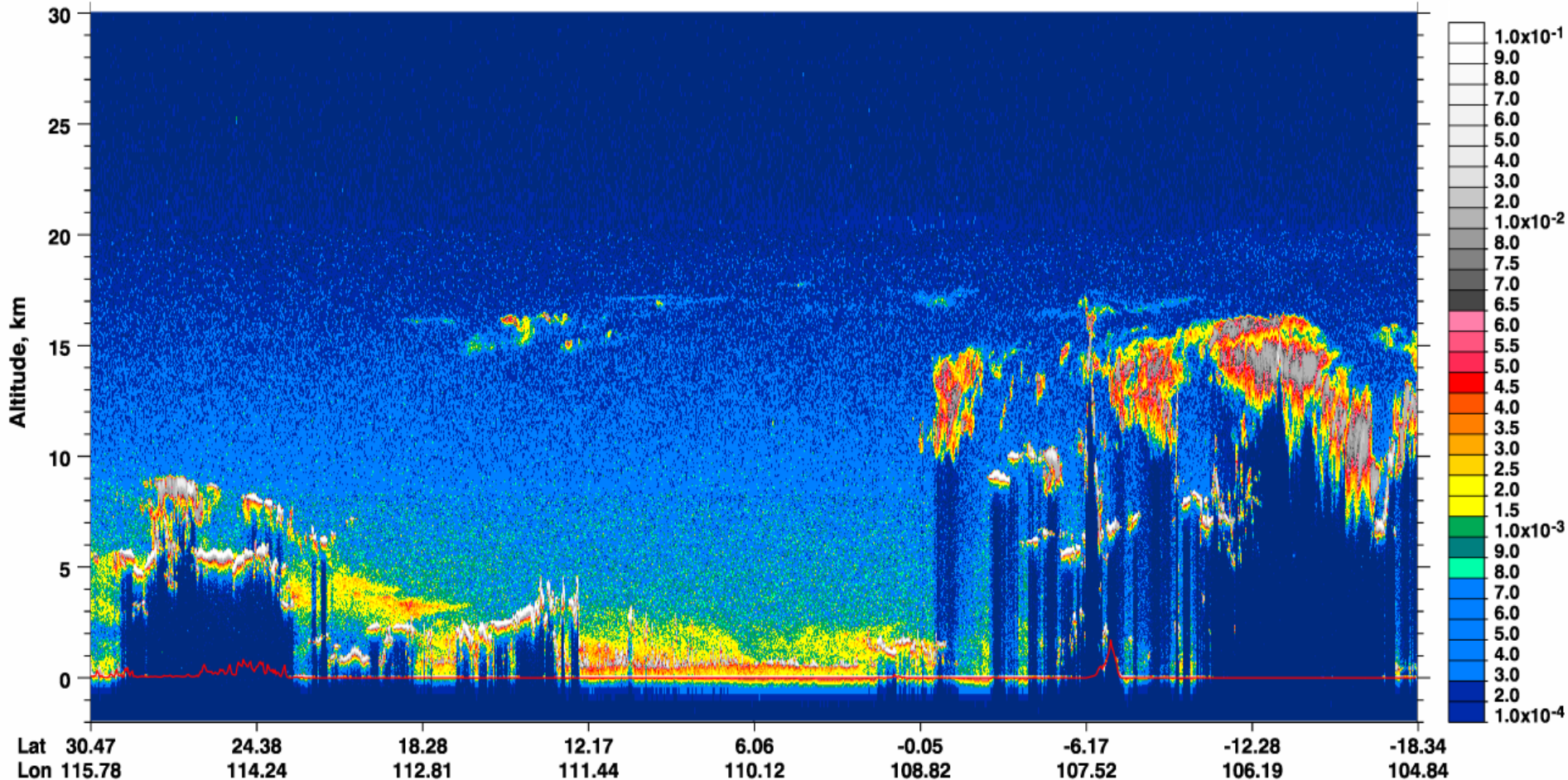


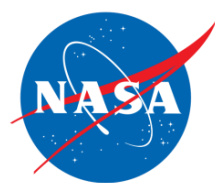


Global

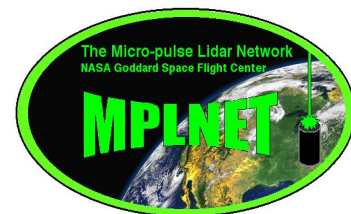


532 nm Total Attenuated Backscatter, $\text{km}^{-1} \text{sr}^{-1}$ UTC: 2014-03-22 18:21:26.9 to 2014-03-22 18:34:55.6 Version: 3.30 Standard Nighttime

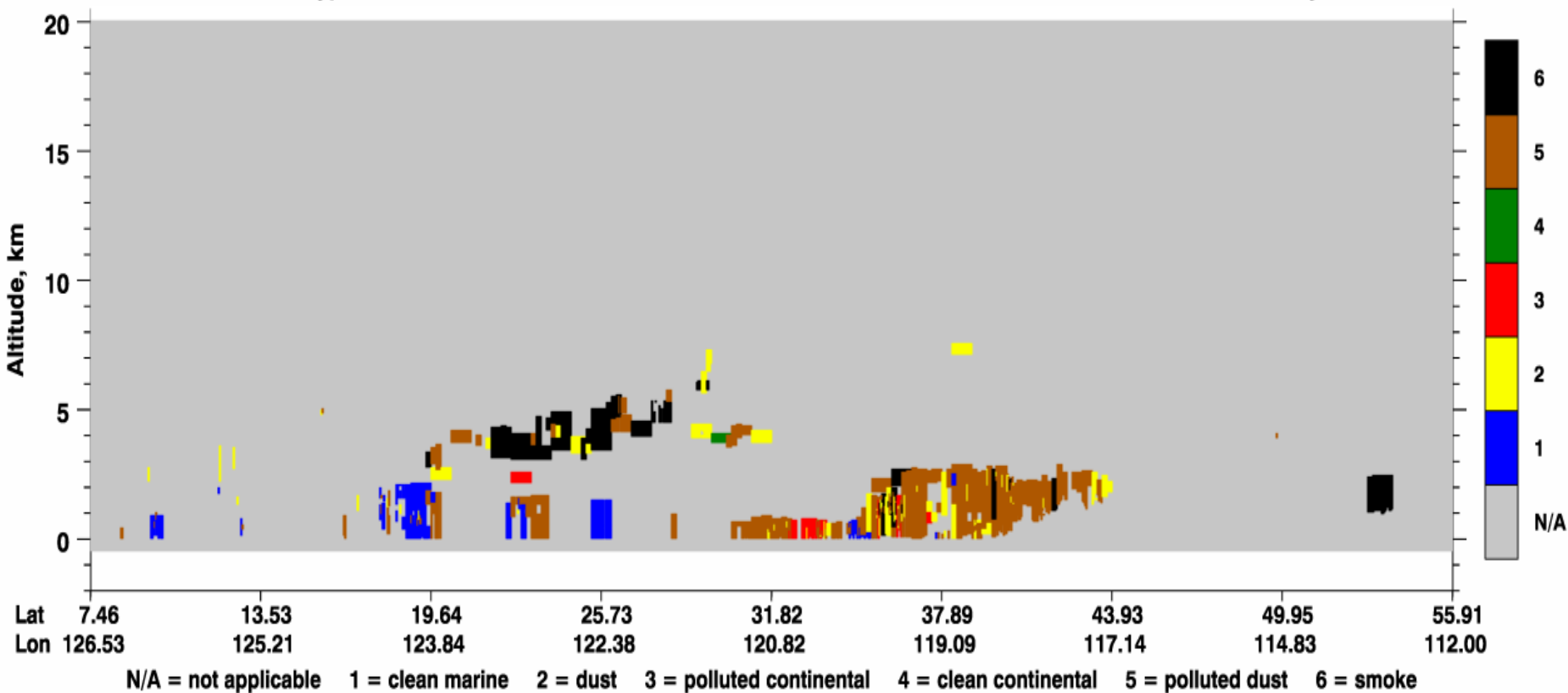


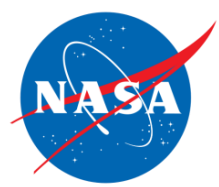


CALIPSO on 23 March 2014



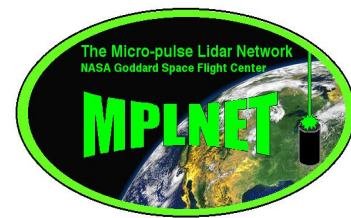
Aerosol Subtype UTC: 2014-03-23 05:14:44.7 to 2014-03-23 05:28:13.4 Version: 3.30 Standard Daytime



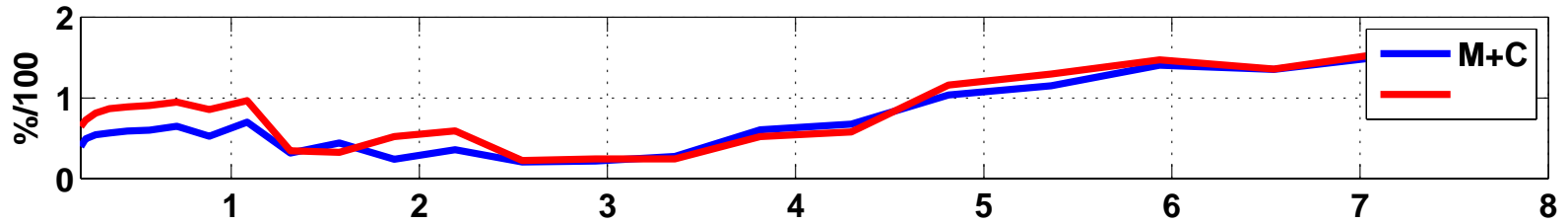


Performances Evaluation

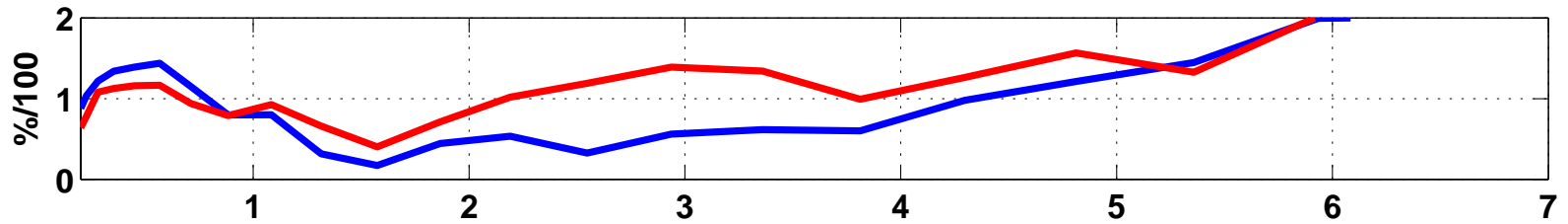
MFE



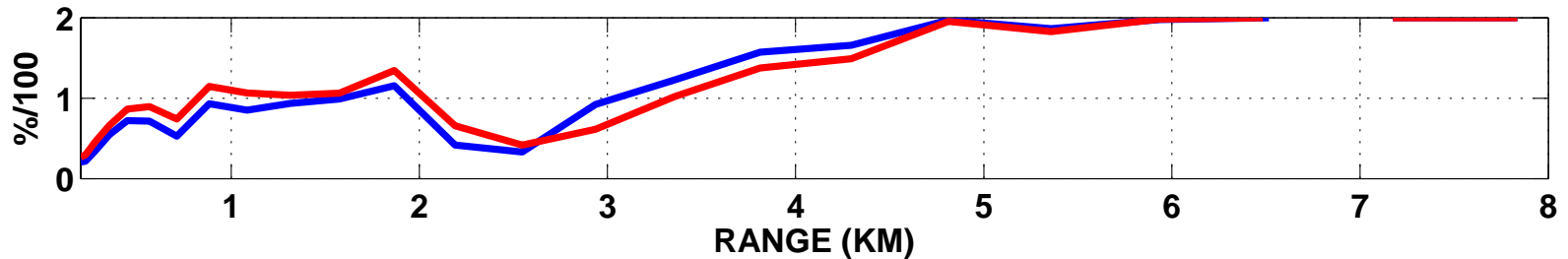
MFE 23 MARCH 2014

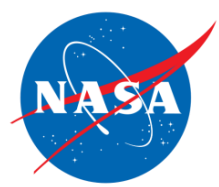


MFE 24 MARCH 2014

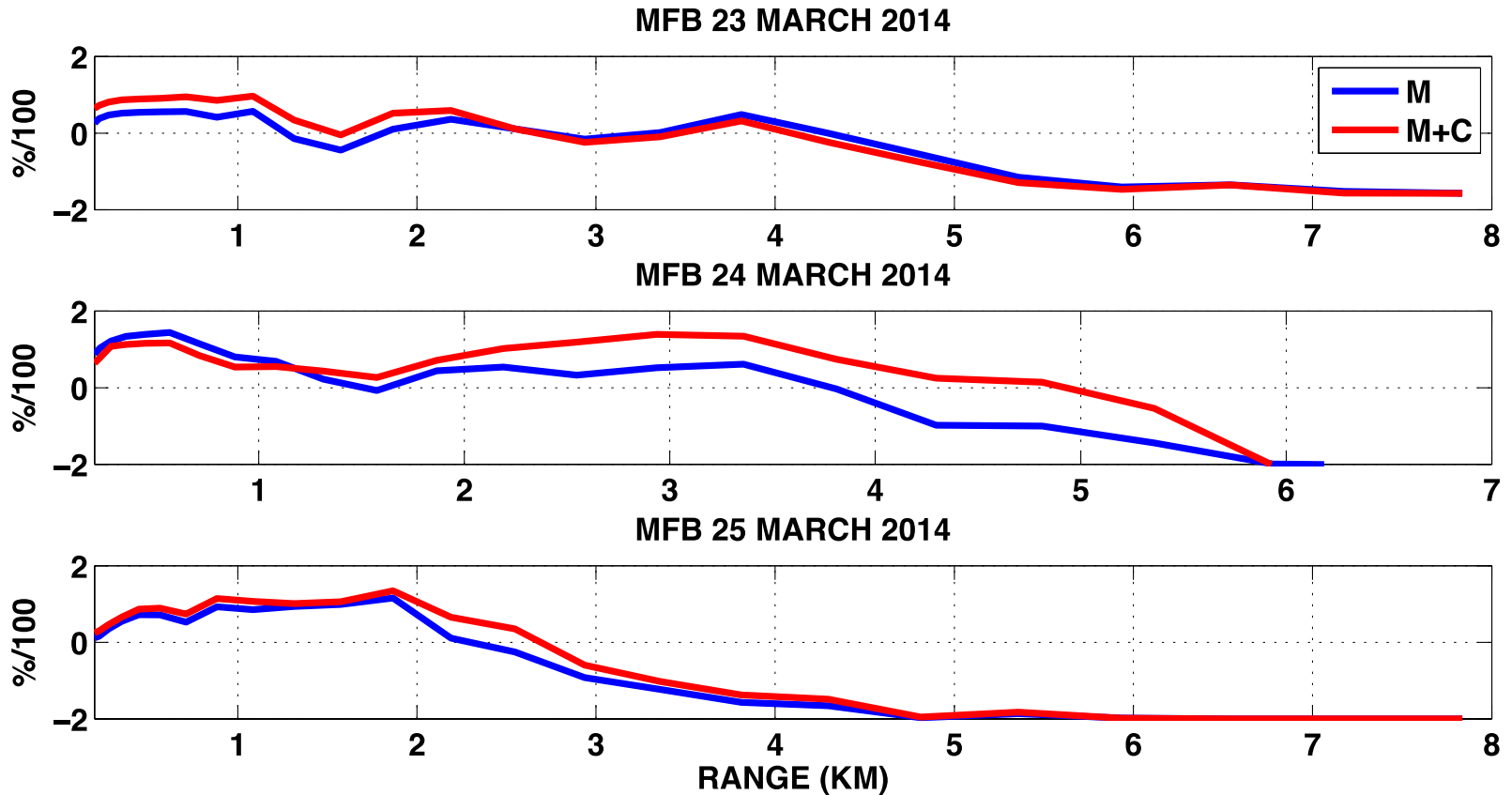
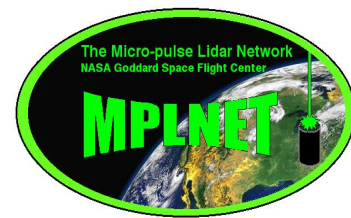


MFE 25 MARCH 2014



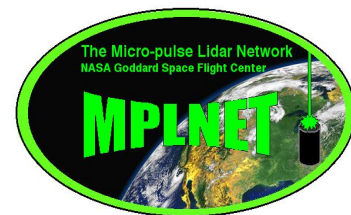


Performances Evaluation MFB

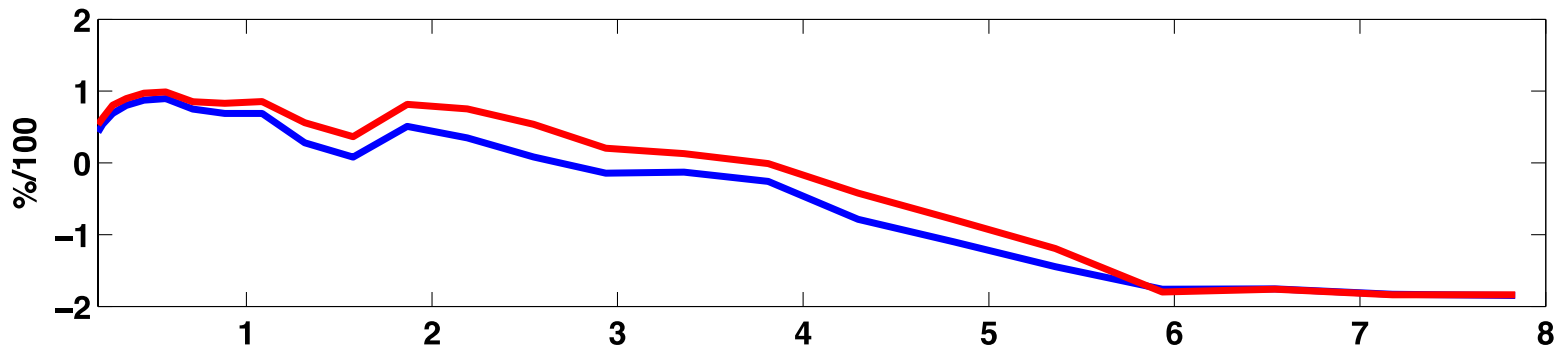




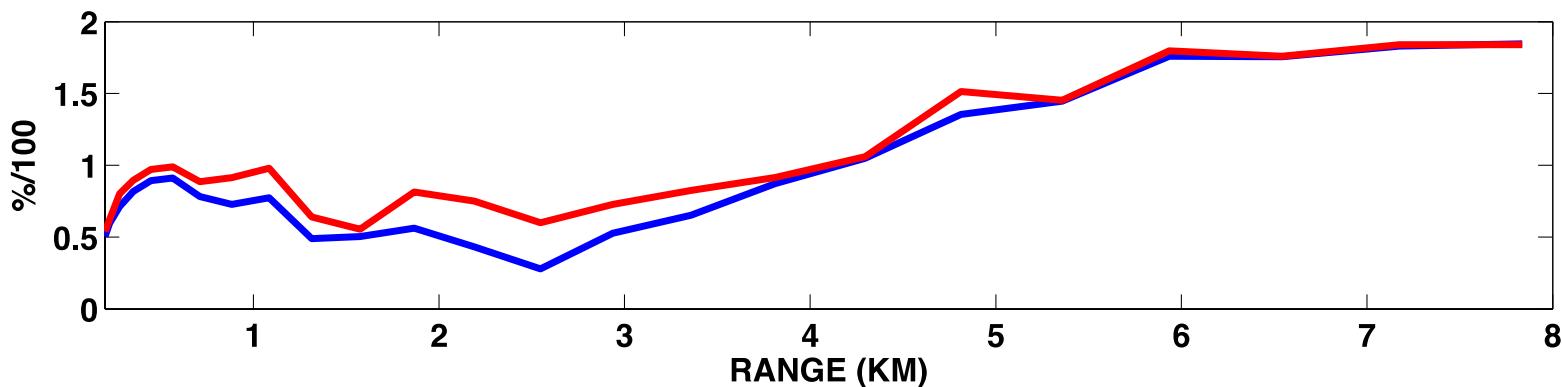
Global MFE-MFB 23-25 March

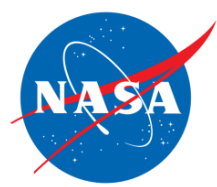


MFB 23-25 MARCH 2014

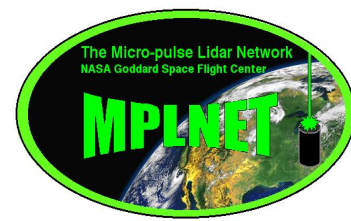


MFE 23-25 MARCH 2014

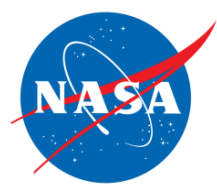




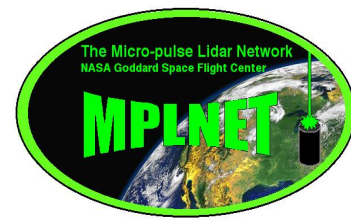
Conclusions



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- The MACC-II model performances were evaluated with lidar observations at NCU, Taiwan, from 23-25 March 2014.
 - Analysis put in evidence that MPLNET lidar data may be a useful tool to evaluate how DA from CALIPSO works.
 - Ad-hoc study is needed (and hopefully performed), where a single profile is assimilated and the model behavior evaluated
-



Thank you



MPLNET STAFF

- *PI: Judd Welton/612*
- *James Campbell/NRL, CA*
- *Jasper Lewis/JCET-UMBC/612*
- *Simone Lolli/JCET-UMBC/612*
- *Larry Belcher/SSAI/612*
- *Sebastian Stewart/SSAI/612*
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