Global relationships between lightning and ice water path characteristics from WWLLN and AMSU-B/MHS

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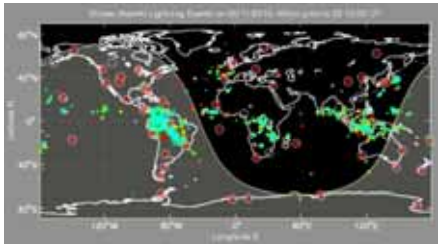
World Wide Lightning Location Network



- The WWLLN provides the Global lightning MAP every 10 min at http://wwlln.net/ .

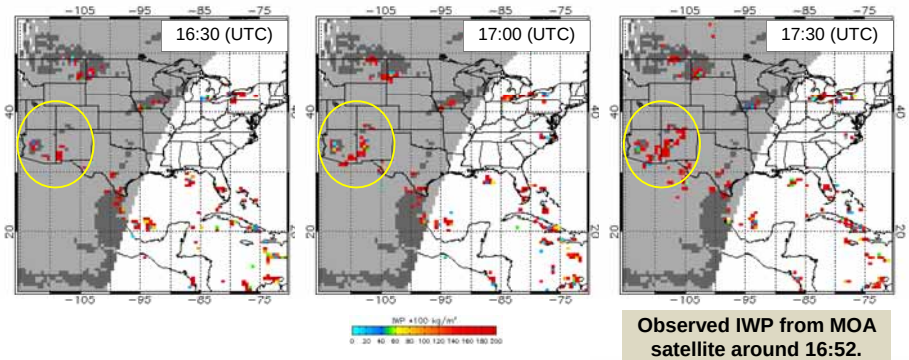
Motivations

- Satellite hydrometer information is not global coverage for continuous monitoring.
- **The lightning activity provided by the WWLLN can be useful to fill the gaps of the polar-orbiting restrictions and to estimate convective regions.**

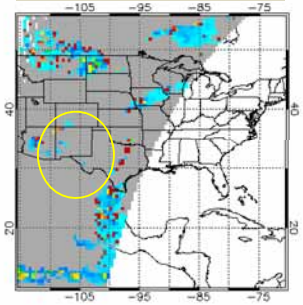
We focus on the **Ice Water Path (IWP)** as frozen hydrometeors provided *by NOAA Microwave Surface and Precipitation Products System.*

2. IWP Estimations & Validation from Lightning Density

Estimated IWP from Lightning Density on July 23, 2010.



Observed IWP from MOA satellite around 16:52.



- WWLLN estimated convective regions of storms, and provide us with good information about developments of thunderstorms.
- However, they provide the over-estimated IWP.

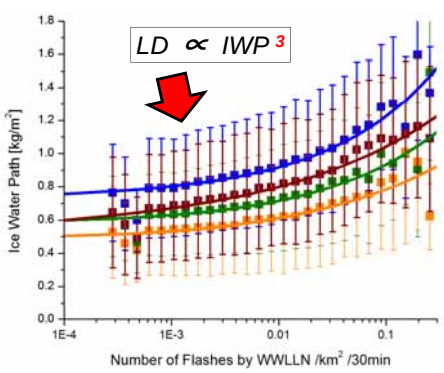
IWP from MSPPS is mainly estimated by radiometers at 89 & 157 GHz.

1. Lightning Density (LD) and Ice Water Path (IWP) relationship

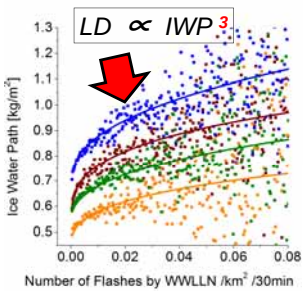
Method

1. We pick up the IWP of large hydrometeors values in grid boxes of 0.5 by 0.5 degree pixels during each AMSU-B/MHS overpass, and classified the pixels as “Strong Convective”(SC), “Moderate Convective”(MC) or not [Ferraro et al., 2005].
2. Lightning Density (LD) is the half-hour number of strokes in each pixel around the time of satellite overpass.
3. We divide the lightning data into bins using a regular interval and a logarithmic division. (The average surface of pixel is 2600 km^2.)
4. The method used LD and IWP coincidentally observed over the area of individual grid pixels during each AMSU-B/MHS overpass.

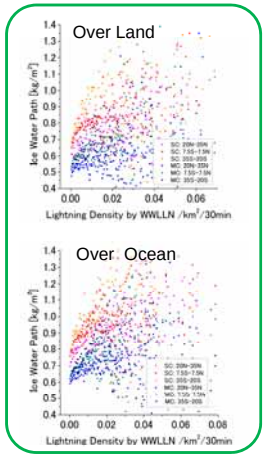
SC over Ocean MC over Ocean
SC over Land MC over Land



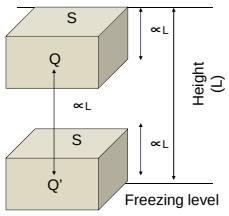
SC over Ocean MC over Ocean
SC over Land MC over Land



LD – IWP relationship over 60S-60N



Dimensional analysis



[e.g., Yoshida et al., 2009]

From charge distribution

$W \propto QQ'/L$

$\propto IWP^2 L$

$\propto IWP^3$

From Lightning activity

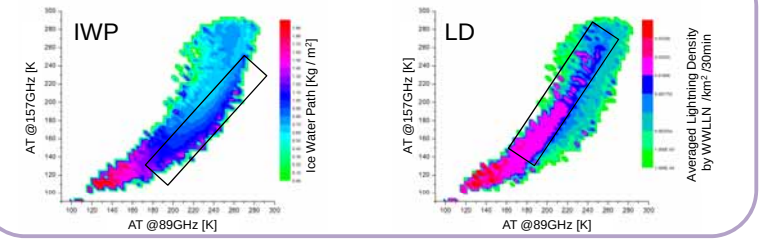
$W \propto LD$

$LD \propto IWP^3$

89GHz and 157GHz Relationship

in Strong Convective over Ocean.

- Temperatures relationships at LD and IWP are different at higher temperature.



Future Works

- To find the difference of LD-IWP relationship, we will analyze the issue from the power of lightning stroke. [Hutchins et al. 2010]
- To identify and nowcast the shape and movement of the convective clouds by tracking lightning activities.
- Remediation of the over estimated IWP by WWLLN.
- To suggest an alternative element to IWP in affinity for lightning.

Our estimated **LD-IWP relationships** have a stark **difference between** over **Land** and **Ocean**. By contrast, LD-IWP relationships over **Land** is similar than that over **ocean** from the LIS observation [Petersen et al., 2005]. The storms over **Land** product lightning (total of CG + CC) flashes at rates that is similar from those over **Ocean** [Boccippio et al, 2000].

This indicates that distributions of peak current of strokes over Ocean is different from that over Land.

1. Abarca et al., An evaluation of the Worldwide Lightning Location Network (WWLLN) using the National Lightning Detection Network (NLDN) as ground truth, *JGR.*, **115** (2010).
2. Boccippio et al., Regional Differences in Tropical Lightning Distributions. *J. Appl. Meteor.*, **39** (2000).
3. Ferraro et al., NOAA operational hydrological products derived from the Advanced Microwave Sounding Unit, *IEEE. Trans. Geosci. Remote Sens.*, **43** (2005)
4. Hutchins et al., Global Estimates of Lightning Peak Current from the WWLLN, AGU Fall Meeting, AE24A-07 (2010).
5. Petersen et al., TRMM observations of the global relationship between ice water content and lightning, *GRL*, **32** (2005).
6. Yoshida et al., A fifth-power relationship for lightning activity from Tropical Rainfall Measuring Mission satellite observations, *JGR*, **114** (2009)