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Atmospheric Measurement Techniques Discussions

Interactive comment on "Lightning Data Analysis of the CMA Network in China" *by* Feng Li et al.

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First of all, thank you very much for the comments of the reviewer. To sum up, reviewer mainly have 3 questions and suggestions, as following, authors answer one by one. 2.Q1. reviewer recommend adding detailed descriptions of lightning location and intensity algorithms in the manuscript. PS: Four lightning location algorithms and lightning intensity algorithms discussed in this paper have been published in detail in the literature "principles and techniques of lightning detectionïijĹMa. 2015ïijL'".Furthermore, there are too many content descriptions and formulas in the algorithm, which is not suitable for detailed description in this article. If you are interested, you can refer to the literature(Ma.2015.Below we will provide some reference content, see Figure 1-3).

The main purpose of this paper is to analyze the application of these algorithms in the National Lightning network and the application of lightning data. In order to evaluate

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the improvement of operation capability of lightning network.The algorithm itself is not the focus of this article.

Q2ïijŽreviewer wondered what's purposes and scientific reasons for analysis and comparison of lightning location algorithms 'using frequency' in this manuscripts

PSïijŽThis is a good question. As we all know, the quality of the lightning detection network depends on the efficiency and accuracy of the lightning location. However, it is very difficult to confirm the efficiency and accuracy of lightning location.However, it is generally accepted that both the hybrid method and the multi-station method are better than the two-station method, the magnetic direction method and the amplitude method in the positioning efficiency and accuracy. Due to the geographical conditions, the number of base stations and network layout, CMA lightning network can not be all unified use multi-station positioning algorithm. Our strategy is to automatically select the location algorithm in the business software based on the number of detectors detected by one of the lightning signals.From the point of view of spatial distribution, where the higher the frequency of mult-station method is, the more reasonable the base station is, the higher the quality of lightning dataãĂĆFrom the point of view of time variation, the higher frequency is selected by the multi-station method, the higher the detection ability of the whole lightning network, and the higher the quality of the lightning data, andÂăviceÂăversa. The above is the scientific reason and purpose of analyzing and comparing the frequency of using the lightning location algorithm in this paper.This also is a method to evaluate the performance of CMA lightning detection network in this paper.

Q3ïijŽReviewer recommend more analysis of lightning, especially the evidence that lightning is more likely to occur in winter, and suggest an analysis of the relationship between lightning and some climatic information. QS:That's a very good suggestion. Study on Lightning climatology, scholars including China scholars, has done a lot of analysis, including the relationship between lightning and ground temperature, water vapor, aerosol concentration, weather system and geographical conditions, also re-

veals the characteristics and causes of lightning climate change. According to the suggestion of reviewers, we will add analysis on the correlation between China's lightning changes and air temperature, atmospheric tropospheric layer height and atmospheric water content, and to reveals the reasons for its abnormal climatology. Thank you for your expert guidance. Specific content is added to this manuscript or another research paper.

Thanks again for the reviewers' comments and suggestion.

Please also note the supplement to this comment:
https://www.atmos-meas-tech-discuss.net/amt-2016-380/amt-2016-380-AC1-supplement.pdf

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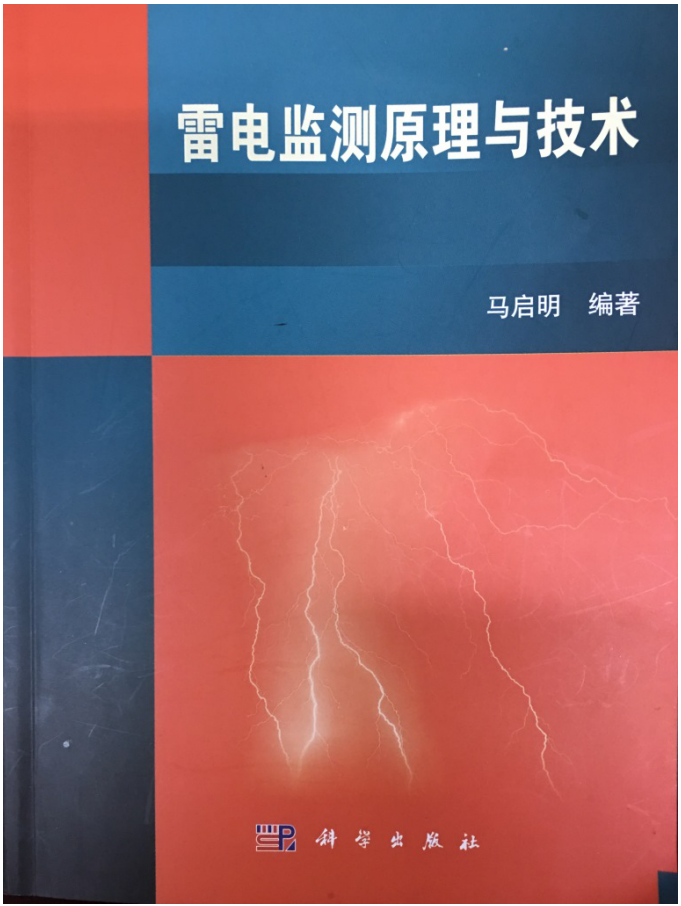


Fig. 1. algorithm reference book

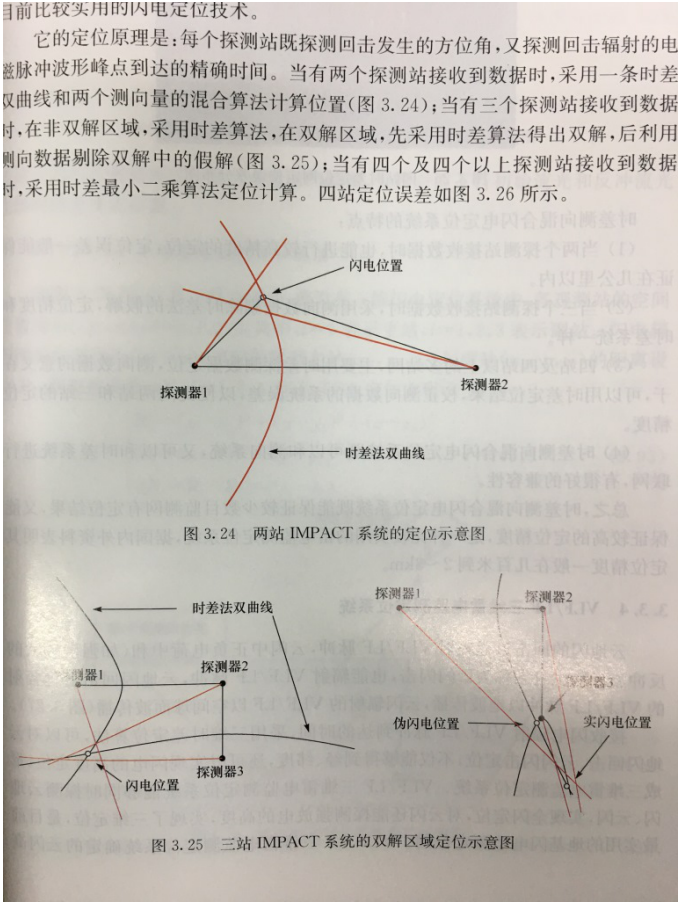
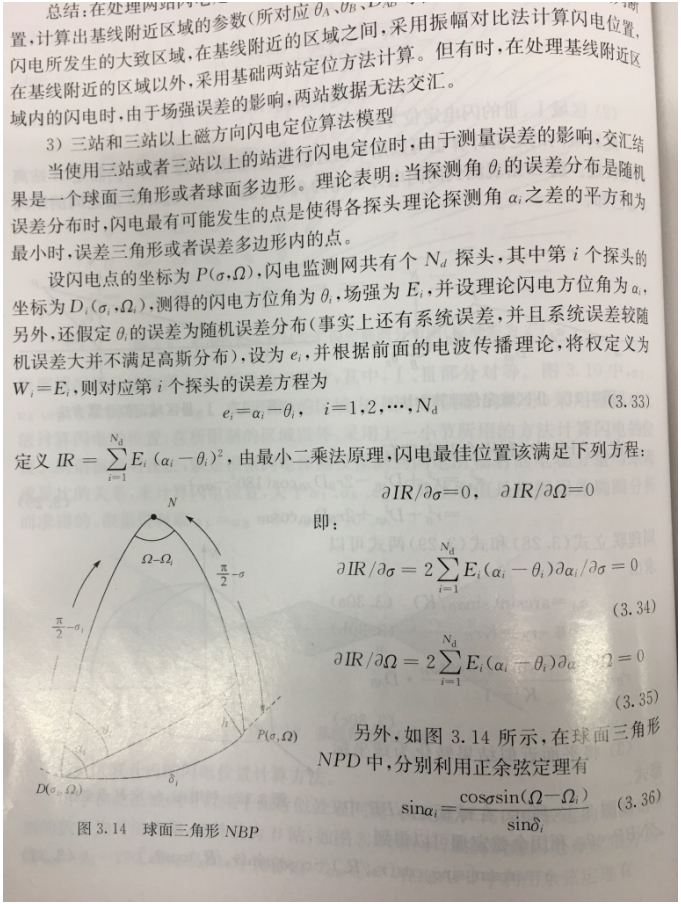


Fig. 2. Location algorithm extract examples



总结：在处理两站[illegible]置，计算出基线附近区域的参数(所对应 θ_A、θ_B、[illegible]闪电位置，闪电所发生的大致区域，在基线附近的区域之间，采用振幅对比法计算闪电位置，在基线附近的区域以外，采用基础两站定位方法计算。但有时，在处理基线附近区域内的闪电时，由于场强误差的影响，两站数据无法交汇。

3) 三站和三站以上磁方向闪电定位算法模型

当使用三站或者三站以上的站进行闪电定位时，由于测量误差的影响，交汇结果是一个球面三角形或者球面多边形。理论表明：当探测角 θ_i 的误差分布是随机误差分布时，闪电最有可能发生的点是使得各探头理论探测角 α_i 之差的平方和为最小时，误差三角形或者误差多边形内的点。

设闪电点的坐标为 $P(\sigma,\Omega)$，闪电监测网共有个 N_d 探头，其中第 i 个探头的坐标为 $D_i(\sigma_i,\Omega_i)$，测得的闪电方位角为 θ_i，场强为 E_i，并设理论闪电方位角为 α_i，另外，还假定 θ_i 的误差为随机误差分布(事实上还有系统误差，并且系统误差较随机误差大并不满足高斯分布)，设为 e_i，并根据前面的电波传播理论，将权定义为 $W_i=E_i$，则对应第 i 个探头的误差方程为

$$e_i=\alpha_i-\theta_i,\quad i=1,2,\cdots,N_d \tag{3.33}$$

定义 $IR=\sum_{i=1}^{N_d}E_i(\alpha_i-\theta_i)^2$，由最小二乘法原理，闪电最佳位置该满足下列方程：

$$\partial IR/\partial\sigma=0,\quad \partial IR/\partial\Omega=0$$

即：

$$\partial IR/\partial\sigma=2\sum_{i=1}^{N_d}E_i(\alpha_i-\theta_i)\partial\alpha_i/\partial\sigma=0 \tag{3.34}$$

$$\partial IR/\partial\Omega=2\sum_{i=1}^{N_d}E_i(\alpha_i-\theta_i)\partial\alpha_i/\partial\Omega=0 \tag{3.35}$$

另外，如图 3.14 所示，在球面三角形 NPD 中，分别利用正余弦定理有

$$\sin\alpha_i=\frac{\cos\sigma\sin(\Omega-\Omega_i)}{\sin\delta_i} \tag{3.36}$$

图 3.14 球面三角形 NBP

Fig. 3. Location algorithm extract examples