



# Distribution of winter lightning around the world using Blitzortung

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Blitzortung, an LLS, examined the lightning trends in North America, Europe, Japan, and Australia. An investigation was conducted to determine whether the two conditions for winter lightning in Japan, cold continental air and warm ocean currents, were satisfied, with particular attention paid to areas where winter lightning has been shown to occur. The results showed that these conditions were met in the Gulf of Mexico and the Atlantic Ocean in North America, the Mediterranean Sea and Norway, the Sea of Japan and the Pacific Ocean off the coast of Ibaraki Prefecture, and the Tasman Sea. Therefore, it is presumed that winter lightning occurs in areas at 25° north and south or higher latitudes, where there is continental cold air to the west and warm ocean currents to the east. An investigation of the extent to which continental cold air is related to winter lightning showed that the range of influence extended to approximately 2000 km in all areas. However, it is unclear whether the electrical characteristics are the same as those of winter lightning in the Sea of Japan, and further investigation is required.



Fig.1 Blitzortung coverage area

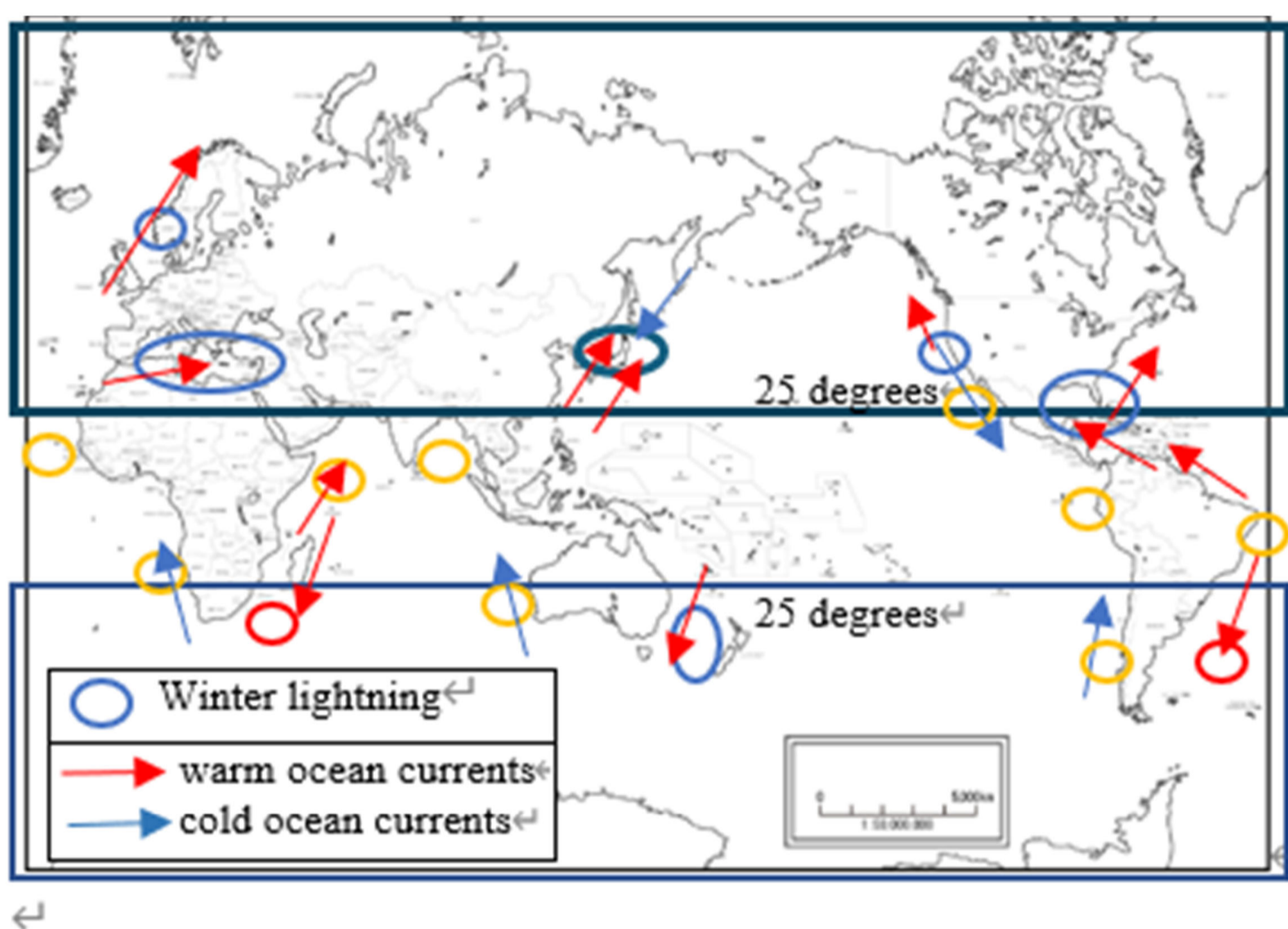


Fig.3 Location of winter lightning

Fig.2: The monthly global lightning distribution for 2017 was created using Blitzortung with red circles indicating the locations at which winter lightning was estimated.

Northern Hemisphere: Winter lightning from December to March.  
Southern Hemisphere: Winter lightning from June to September.

### Conditions for Winter Lightning

- (1) High sea surface temperature (warm ocean current)
- (2) Cold air from the continent to the west (cold air mass)

When these two conditions coincide, the temperature gradient increases and the atmosphere becomes unstable.

Sea Surface Temperature in winter	Cold Air West and northwest of winter lightning occurrence areas
① Gulf of Mexico: 20-25°C	① North America
② Mediterranean Sea: 10-20°C	② Europe, Greenland and Iceland
③ The Sea of Japan: 5-15°C	③ Eurasia
④ The Tasman Sea: 12-13°C	④ Australia

The continents are cooled by radiative cooling, and the westerlies blow the cold air eastward. The positional relationship is the same.

Winter lightning occur when two conditions coincide. However, within 25 degrees latitude from the equator, radiative cooling is weak, and the temperature gradient between the cold air in the upper atmosphere and the sea surface temperature is gentle, so winter lightning are unlikely to occur.

Fig.3 →Arrow: Red indicates warm currents, blue indicates cold currents  
○ Blue circles indicates areas where winter lightning occur  
○ Red circles indicates areas outside the Blitz area but where the conditions for winter lightning are met  
○ Orange circles indicates areas where the two conditions are not met and therefore winter lightning are unlikely to occur

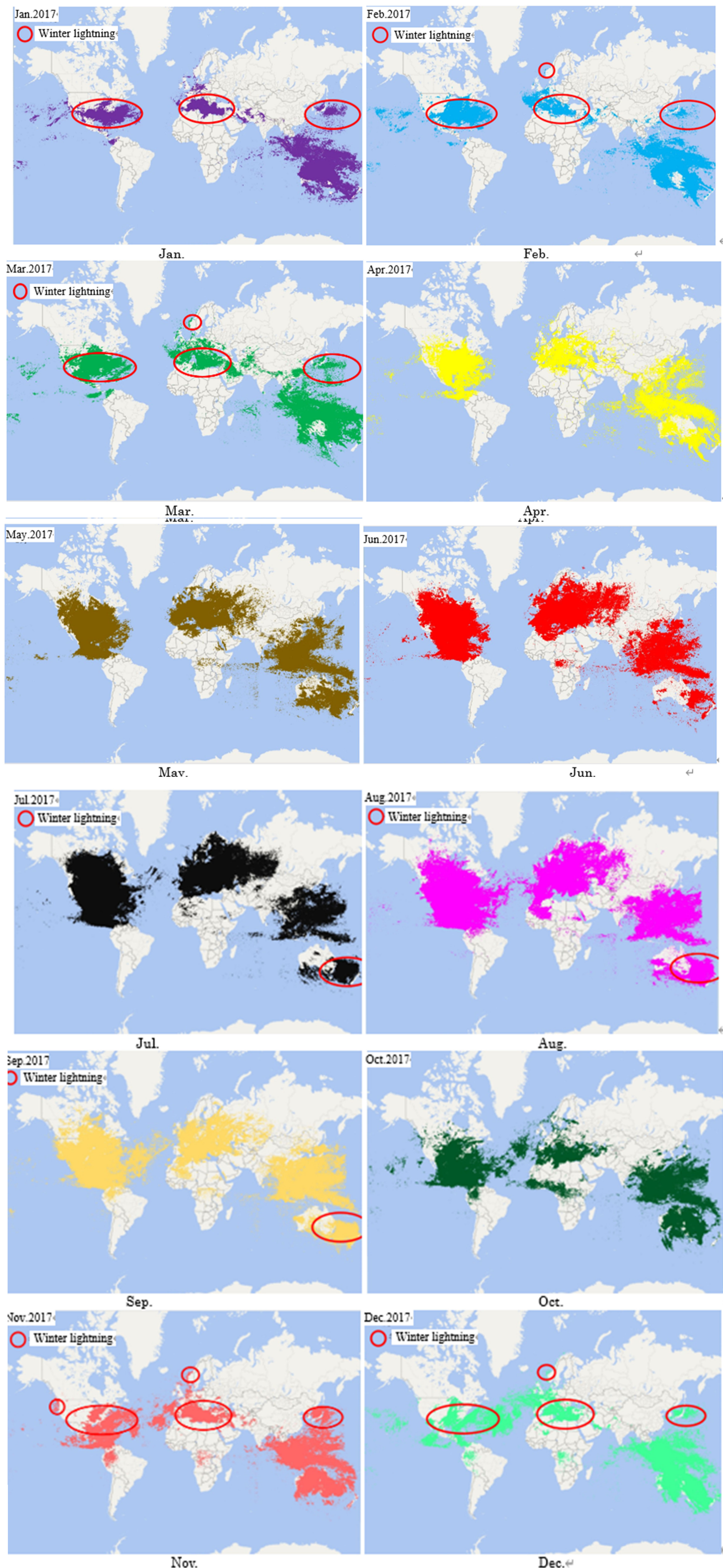


Fig.2 Monthly lightning distribution obtained using Blitzortung (2017)