

A satellite-style map of the Mediterranean region, showing the Mediterranean Sea, the Iberian Peninsula, Italy, Greece, and the Middle East. The land is shown in shades of green and brown, while the sea is a deep blue. The text is overlaid on the map.

Lightning-Rainfall Relationships in Mediterranean Winter Thunderstorms

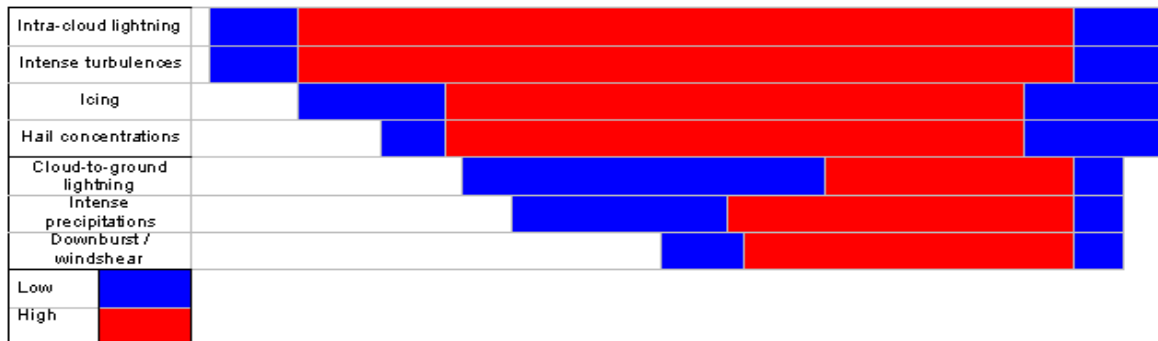
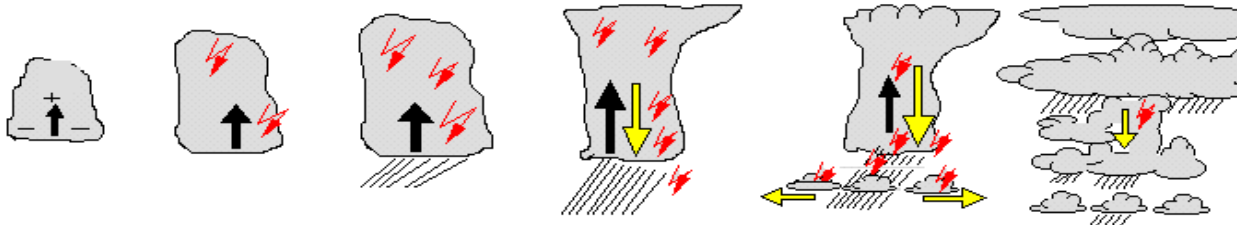
Colin Price and Bela Federmesser

**Dept. of Geophysics and Planetary Science
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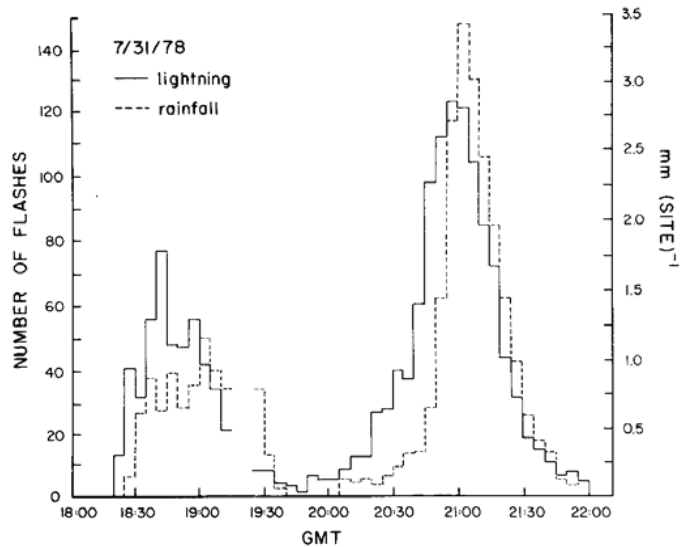
cprice@flash.tau.ac.il

The Relationship Between Lightning and Thunderstorm Development

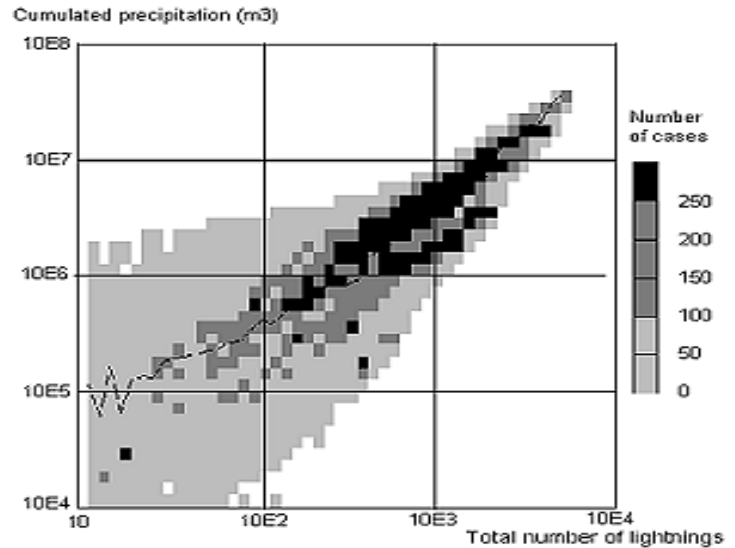
BIRTH	STORM ONSET	DEVELOPMENT	MATURITY	DECAY DOWNBURST	DISSIPATION
Beginning of electrification mechanisms	Beginning of internal lightning activity	Intensification of intra-cloud lightning activity with storm development. Internal lightning activity reveals the severe storm areas.	Internal lightning activity culminates with maximum vertical development of thundercloud Beginning of significant cloud to ground lightning activity.	Internal lightning activity decay precedes downburst phenomena. Ground lightnings culminate.	Scarce intra-cloud lightnings remain.



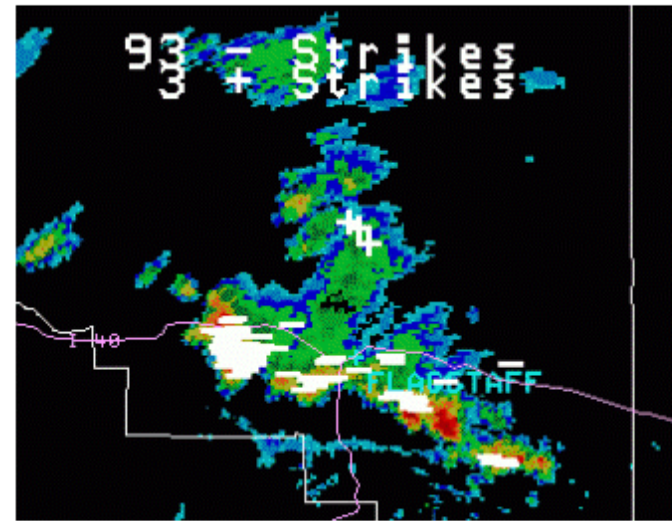
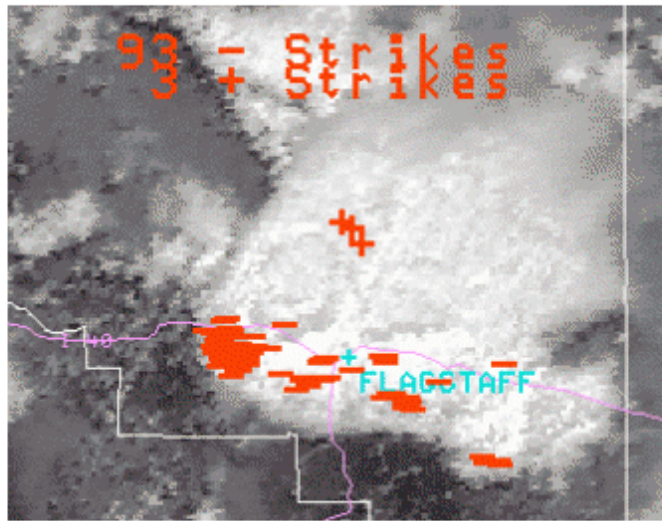
Relationship Between Lightning and Rainfall



Piegrass et al., 1978

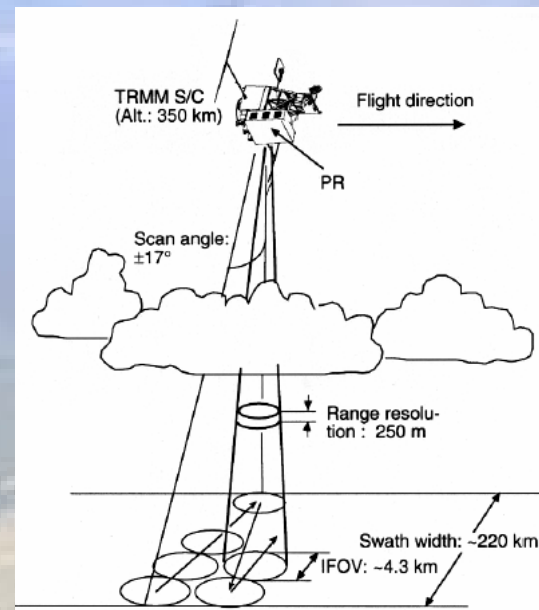
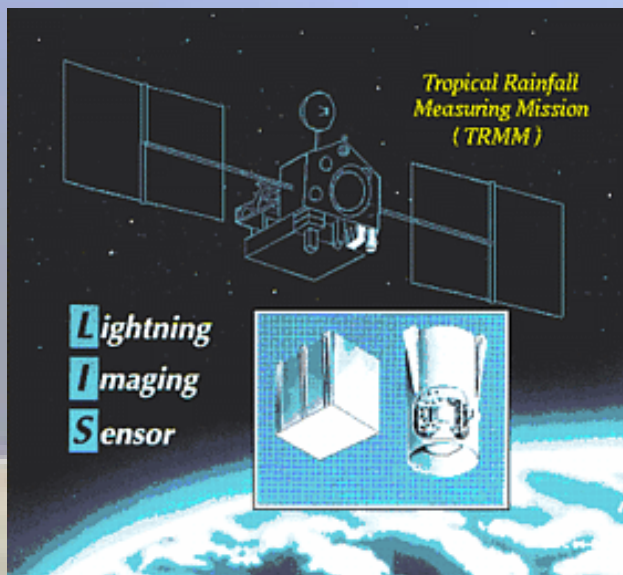
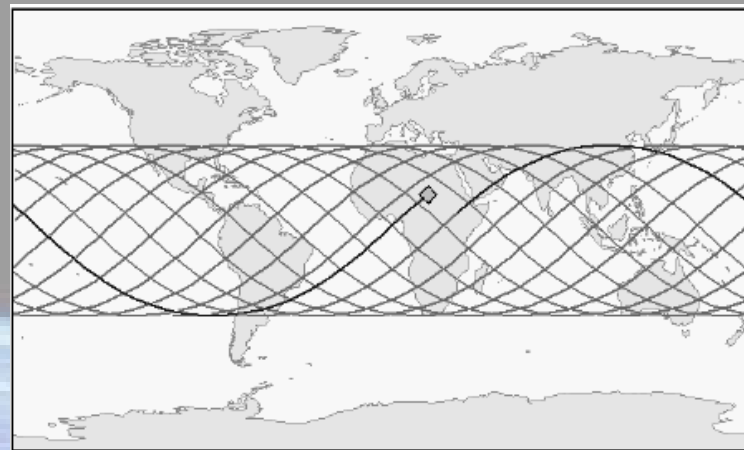
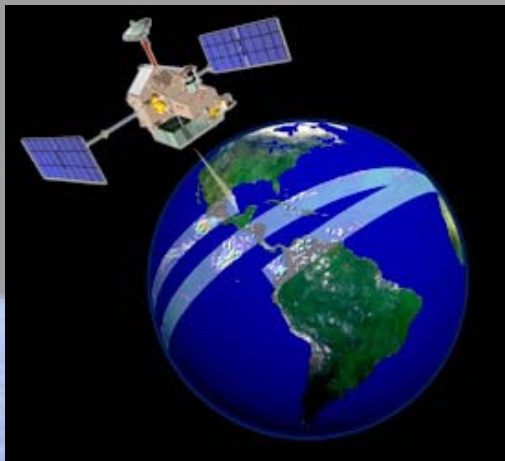


(NASA, MSFC)

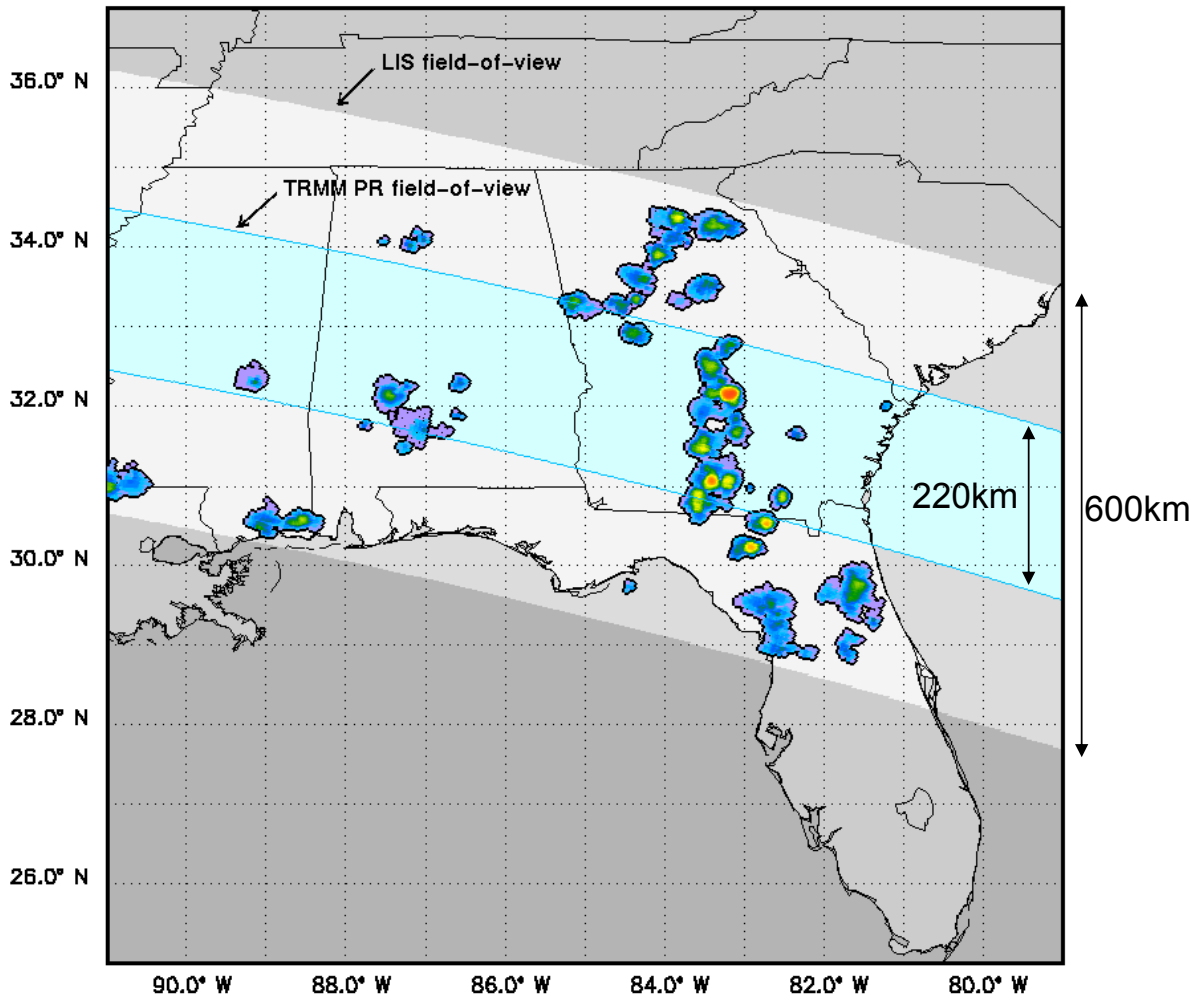


- Satellite-lightning overlay is particularly useful when
 - radar beam is blocked by terrain
 - storms are far from radar
 - radar fails
 - Detecting vertical wind shear

Tropical Rain Measuring Mission (TRMM) satellite



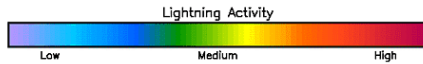
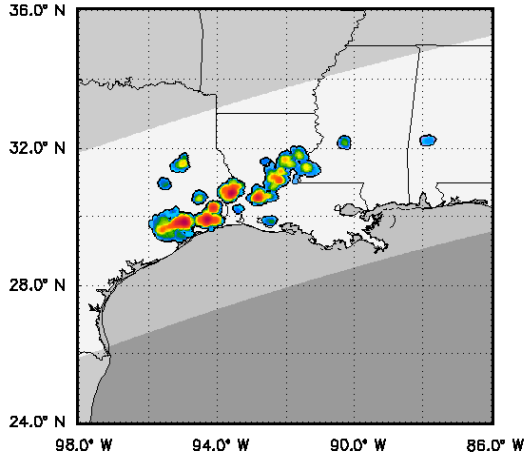
1998-08-16 20:27:00 UTC Orbit 04131



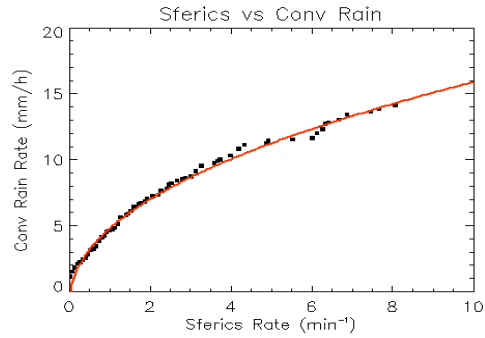
Lightning Activity



LIS

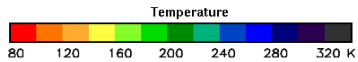
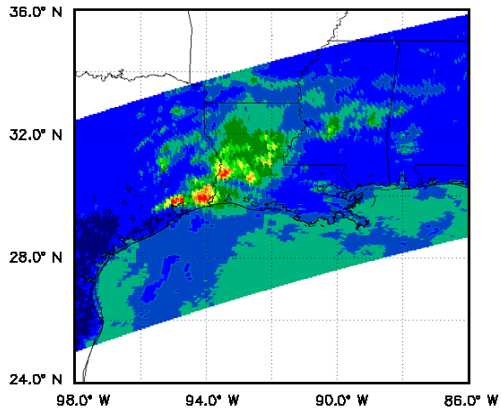


Relationship Between Sferics Rate from STARNET-1 and Convective Rainfall Rates

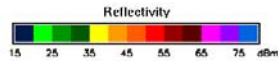
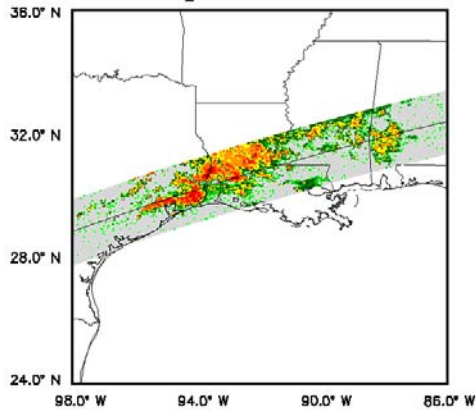


Convective rainfall, R , from TRMM Microwave Imager (TMI) GPROF algorithm averaged over 0.5×0.5 degree areas vs sferics rate, S , from STARNET-1 within 0.5×0.5 degree areas accumulated within 15 minutes of the TRMM overpass time. The points were obtained from histogram matching and the least squares fitted curve is $R = 5.87 * S^{0.46}$.

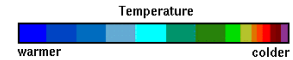
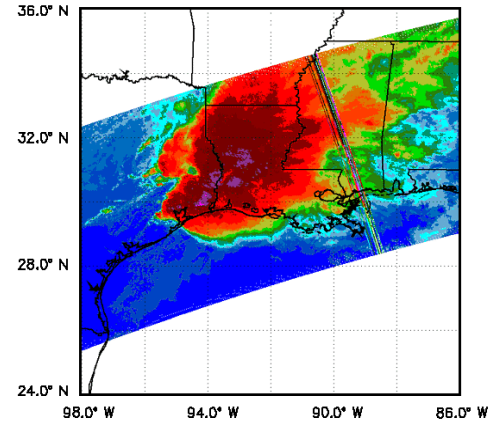
TMI - 85 GHz

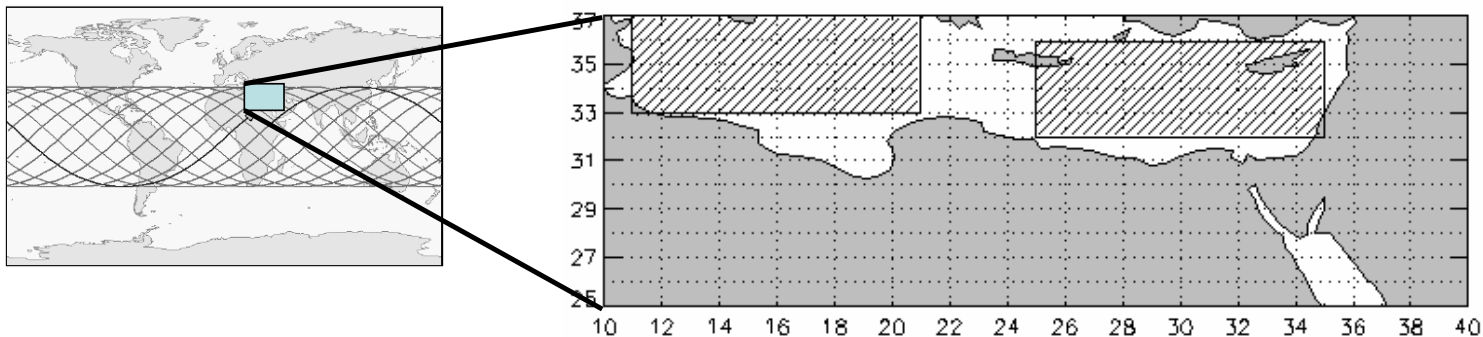


Precipitation Radar

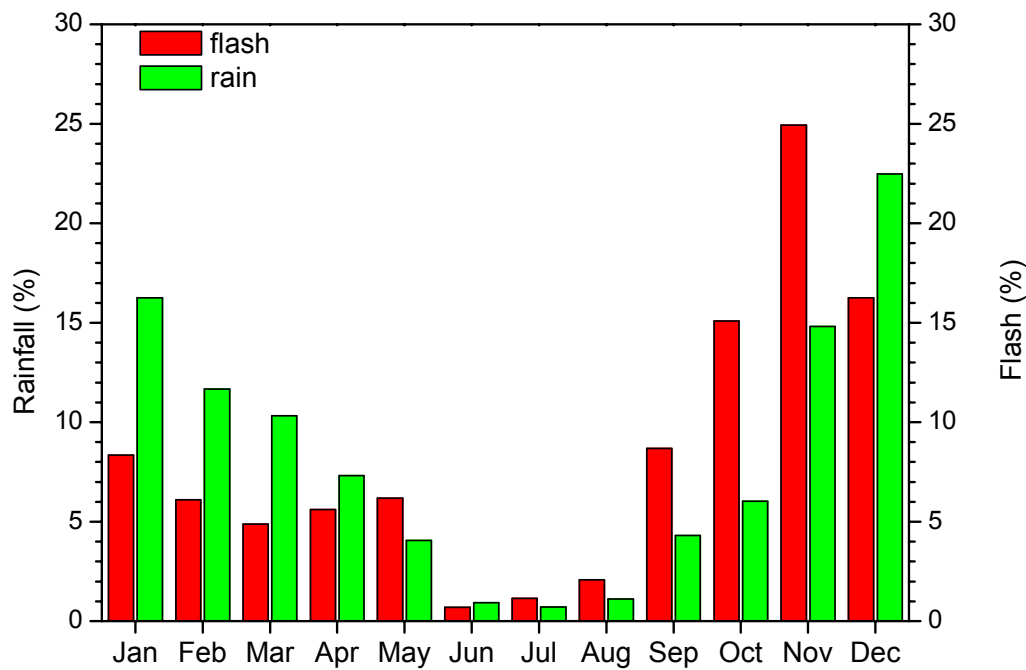


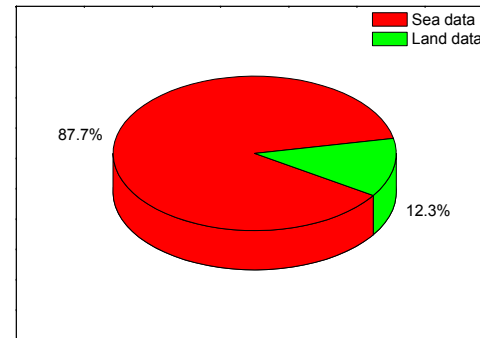
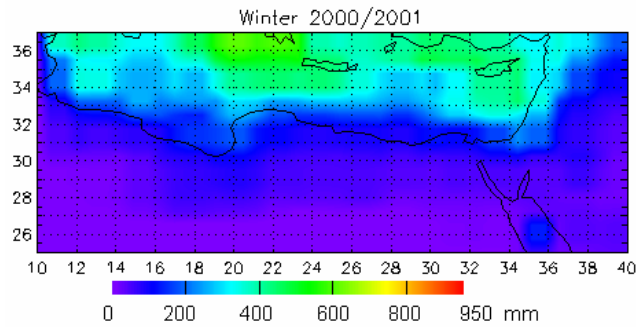
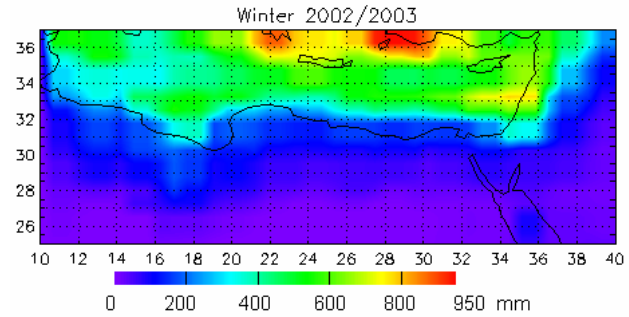
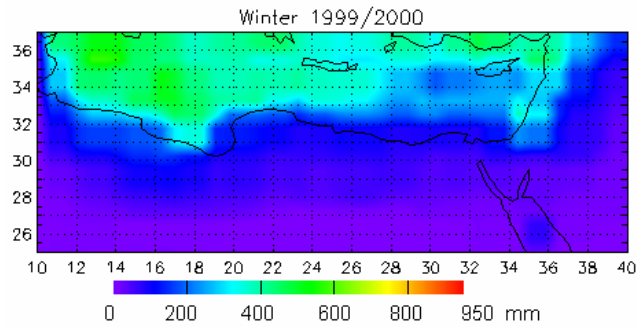
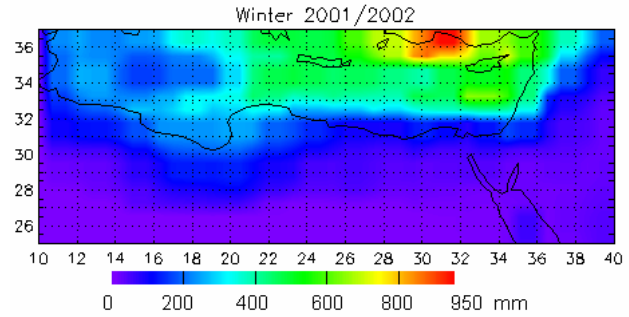
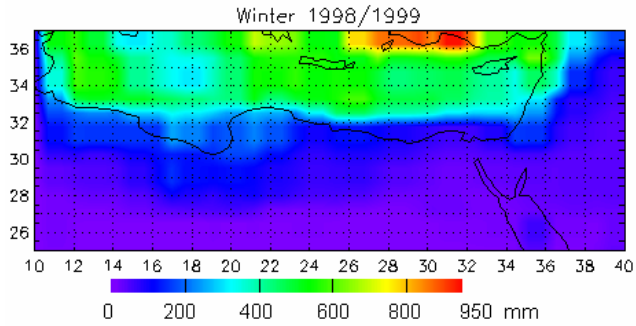
VIRS - IR





Eastern Mediterranean
1998-2003





Coincident observations of rainfall and lightning from TRMM

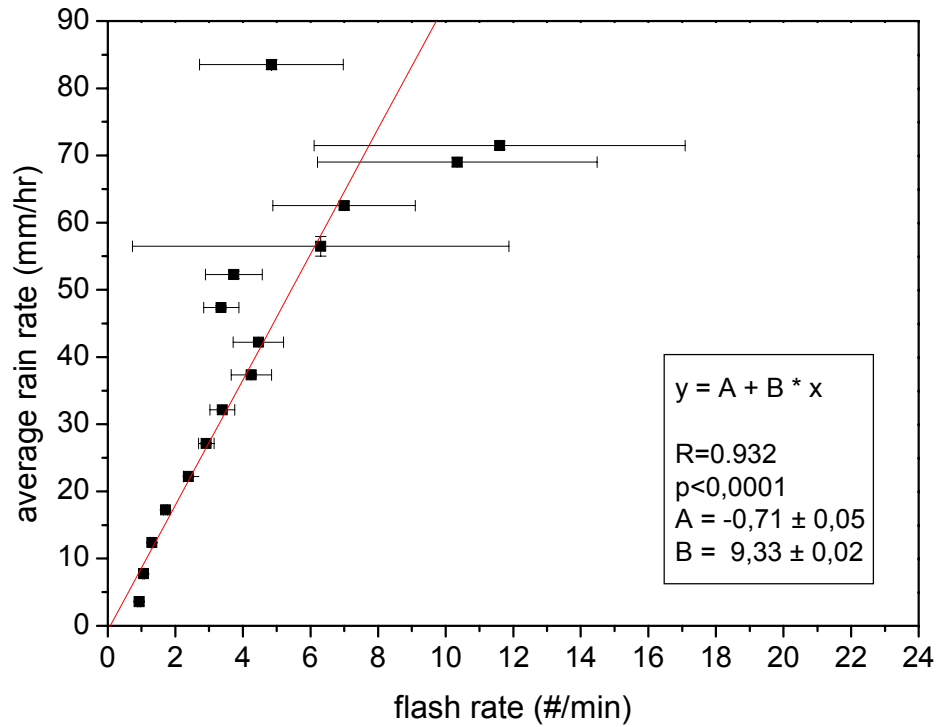
Overpasses with both PR and LIS data

Winter	December	January	February	March
1997/1998	33	56	31	55
1998/1999	59	61	27	50
1999/2000	43	57	43	26
2000/2001	67	46	57	25
2001/2002	67	40	33	41
2002/2003	63	43	61	48

Number of flashes coincident with PR data, and % of total LIS data

Winter	December	%	January	%	February	%	March	%
1997/1998	265	27.1	481	43.7	84	32	265	58
1998/1999	243	34.9	347	61.3	66	56.4	192	40.1
1999/2000	239	44.8	100	47.8	104	36.6	97	55.7
2000/2001	535	54.6	260	47.6	357	57.1	27	34.2
2001/2002	534	50.8	108	54.5	182	29.1	237	69.1
2002/2003	872	47.3	250	44.1	244	41.5	206	42.3
Mean	2688	44.2	1546	48.5	1037	41.4	1024	51

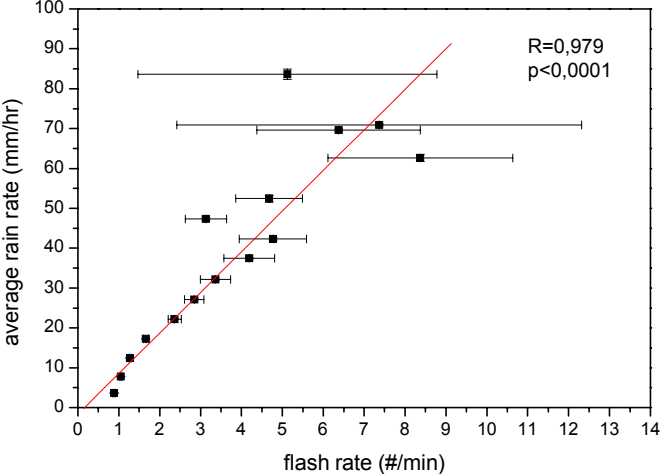
1997-2003 gridded data 0.5x0.5 degrees



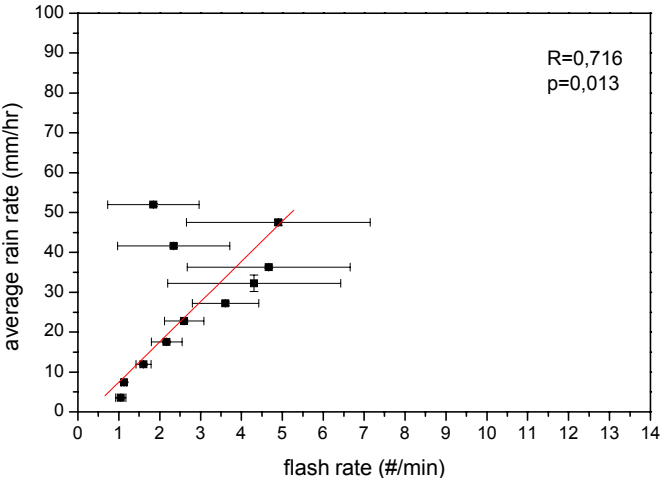
$$RR = 9.33FR - 0.71$$

$$r^2=0.86$$

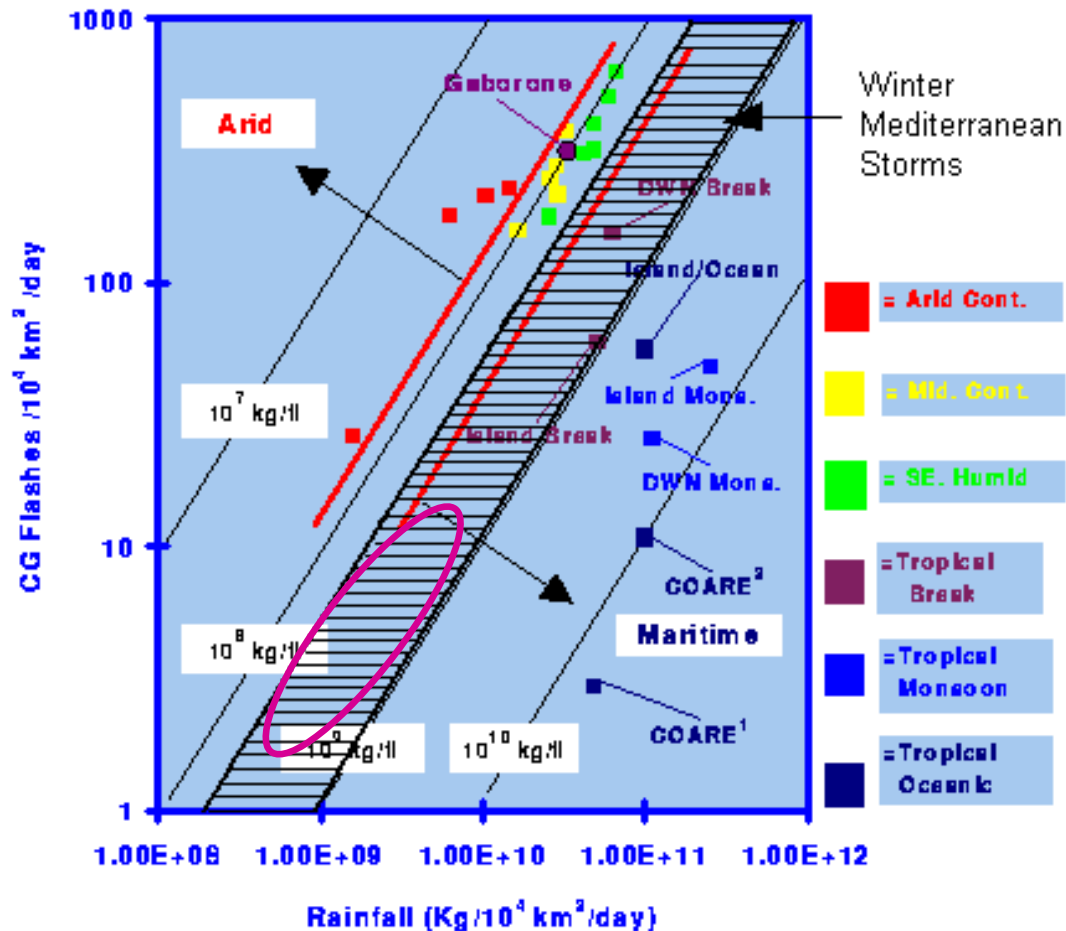
Sea



Land



Warm-Season Normalized Rain-Yields



*GOARE¹ = $5 \times 10^4 \text{ km}^2$ (Radar Est. Rainfall)

*GOARE² = $3 \times 10^6 \text{ km}^2$ (GPI Est. Rainfall; ocean only)

Petersen and Rutledge (1998)

Summary and Conclusions

- ✓ The maximum rainfall over the Mediterranean Sea occurs during December, while the maximum lightning activity occurs during November.
- ✓ On a storm-by-storm basis, lightning frequency and convective rainfall are strongly correlated with each other.
- ✓ Lightning may be used as a tool to estimate Mediterranean convective rainfall in regions without radar coverage.
- ✓ The highly significant correlations imply that lightning data may be a useful tool in short-term forecasts of flash floods in the Mediterranean region.

Price, C., and B. Federmesser, 2006: Lightning-Rainfall Relationships in Mediterranean Winter Thunderstorms, *Geophys. Res. Lett.*, in press.