

Climatologies of Upper-Level Turbulence over the Continental U.S. and Oceans

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Aerospace Meteorology

Portland OR

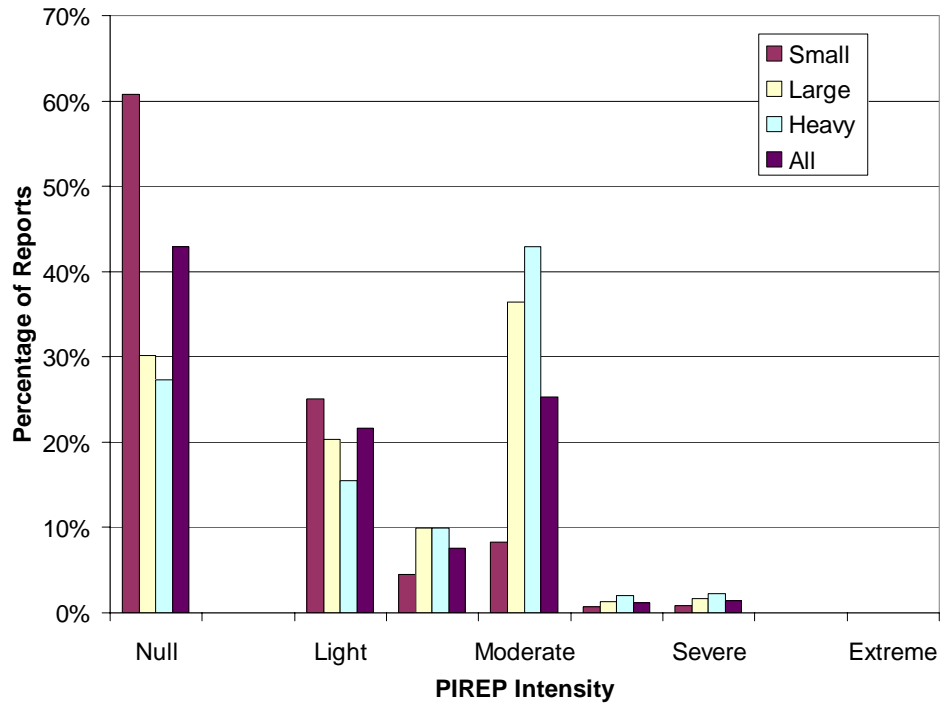
14 May 2002

Turbulence climatologies based on pilot reports (PIREPs)

- Pilot reports of turbulence (or smooth) are recorded in NWS's Family of Services communication gateway
- PIREPs have been archived since March 1992 => 2,044,566, >20,000 ft => 551,445
- Used to develop distributions of turbulence
 - By Altitude
 - Temporally (hour, day, year)
 - Geographically (over CONUS, oceans)

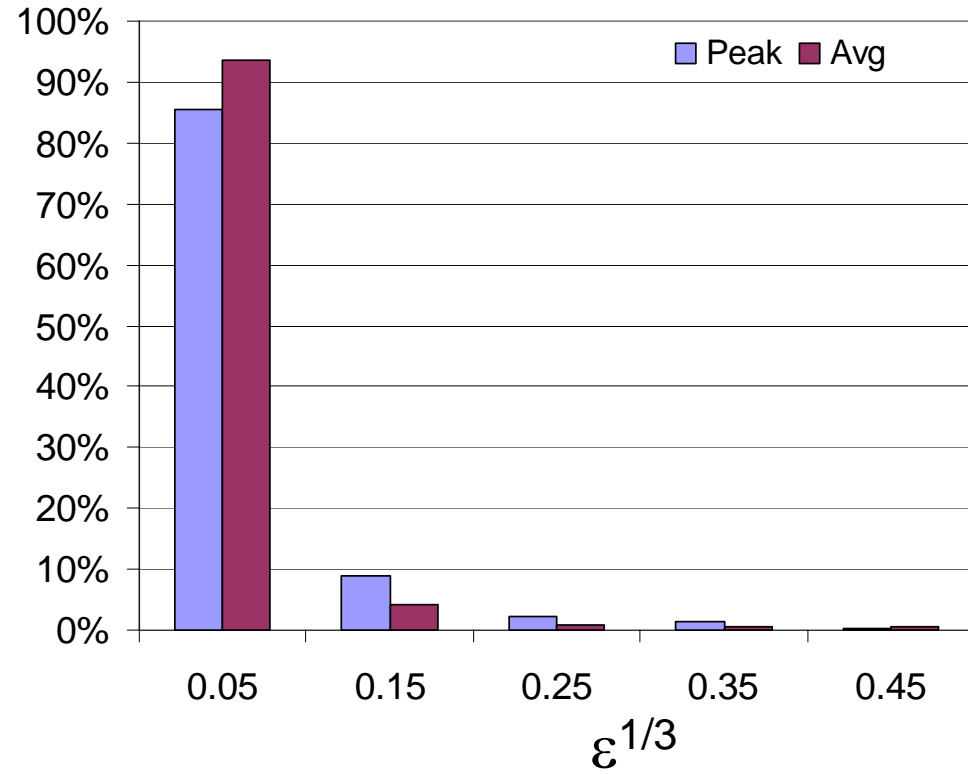
Distribution by PIREP intensities

PIREPs

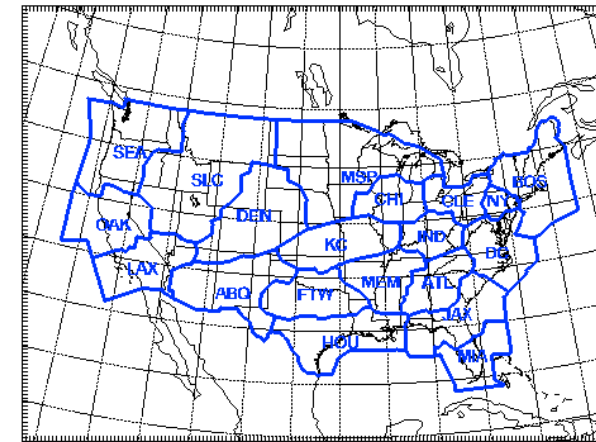
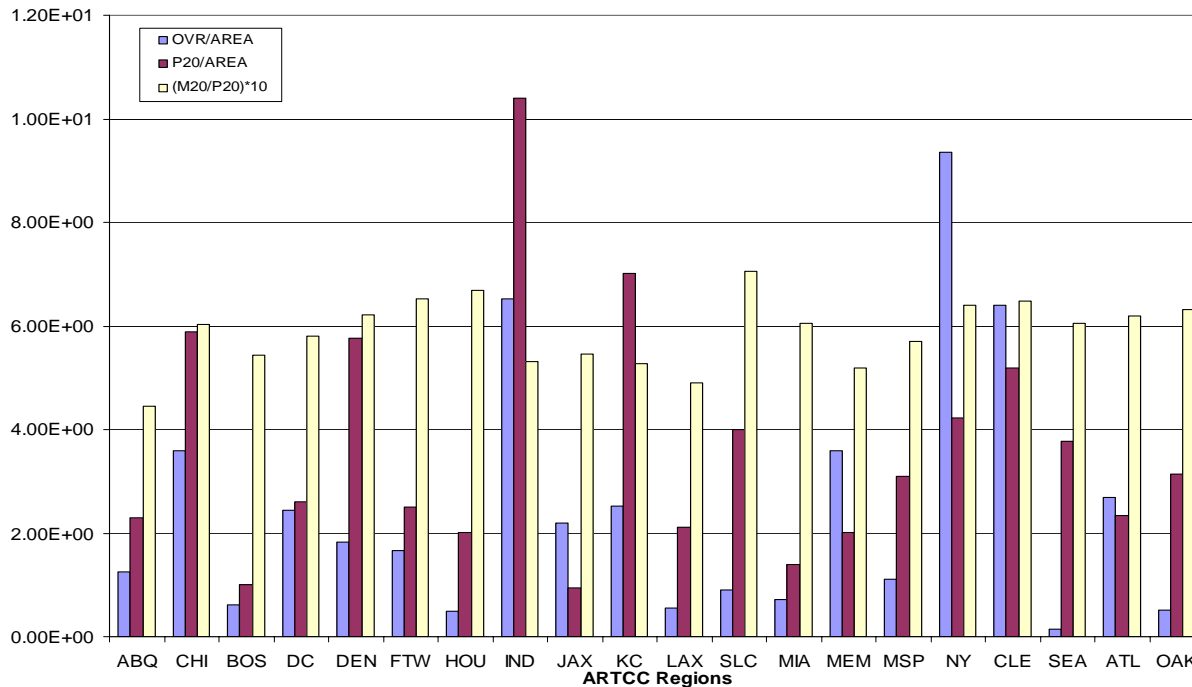


Small <41,000 lbs max, Heavy>255,000 lbs max

In-situ



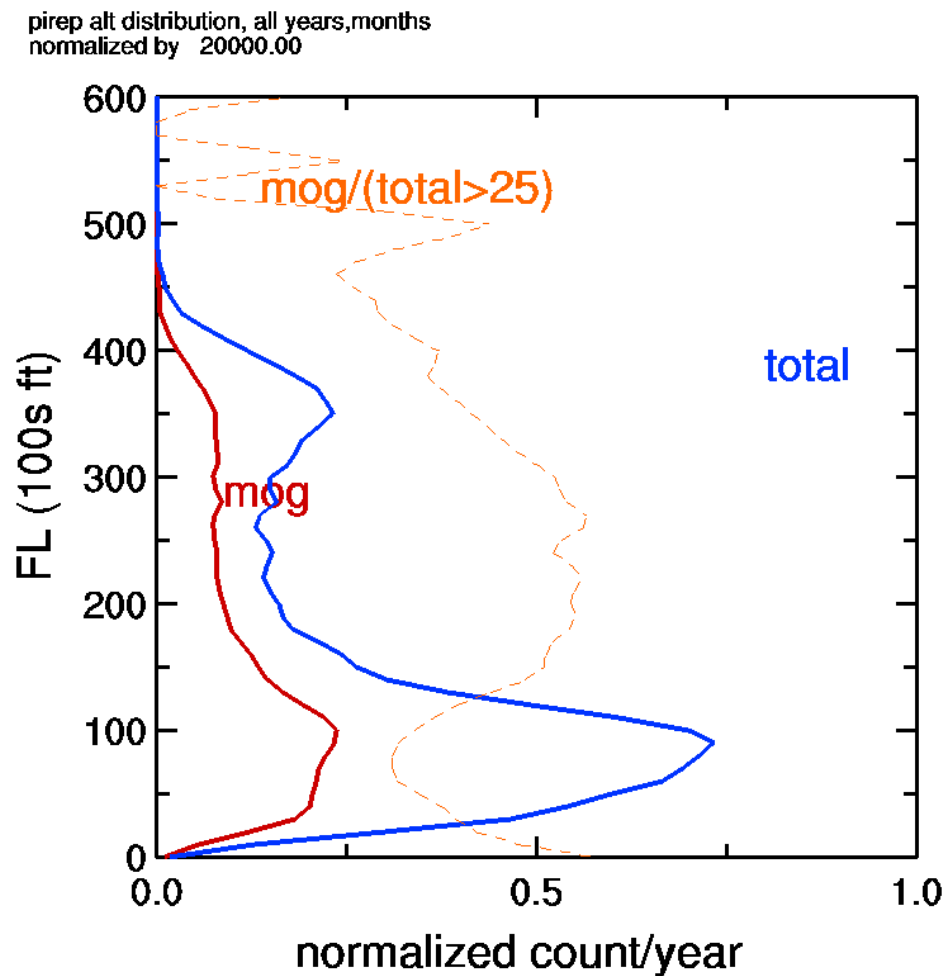
MOG/TOTAL PIREPs ratio eliminates most air traffic biases



Areal plot of ARTCC regions used in assessing air traffic patterns.

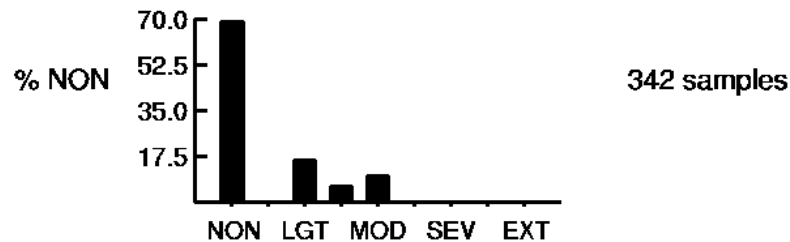
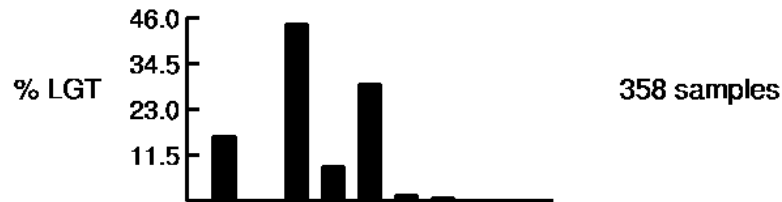
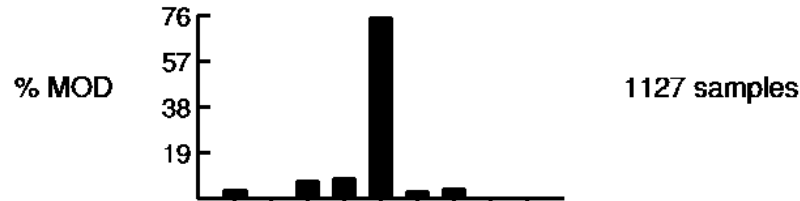
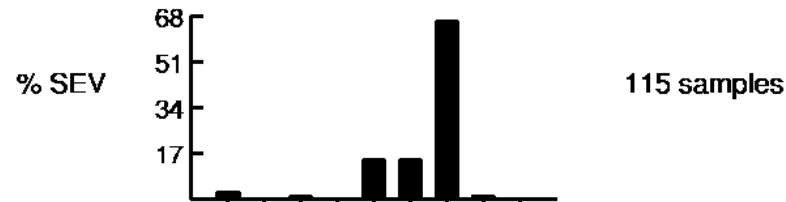
Commercial air traffic overflight density (blue), pirep density (red), and mog/total pirep ratio for each ARTCC region.

Distribution of PIREP intensities by altitude



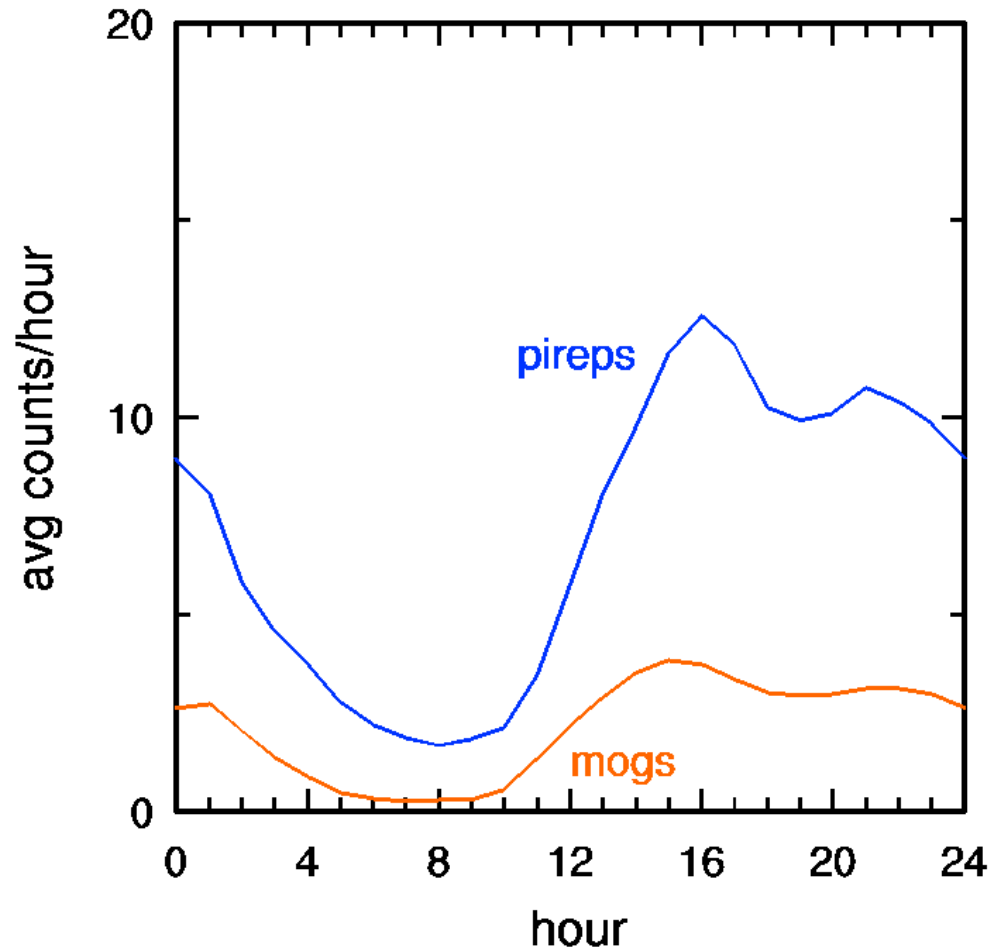
PIREP consistencies

years included=1992-2001 months included= 1-12
delt(hr)= 1.00 delh(ft)= 1000 dels(km)= 50 minalt(ft)=20000 minsev=0 minwt= 0



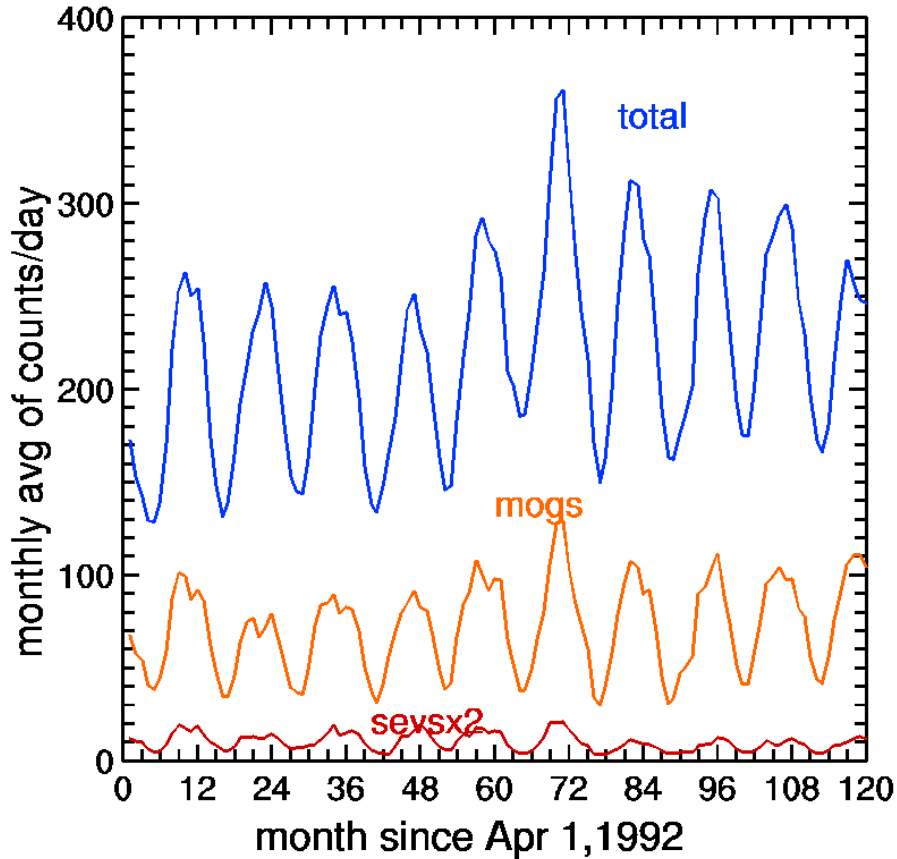
Distribution with time of day

average pireps/hr, all years, months
total pireps for all alts > 20000 ft
x = lightning flashes / 500 o = mog pireps > FL200

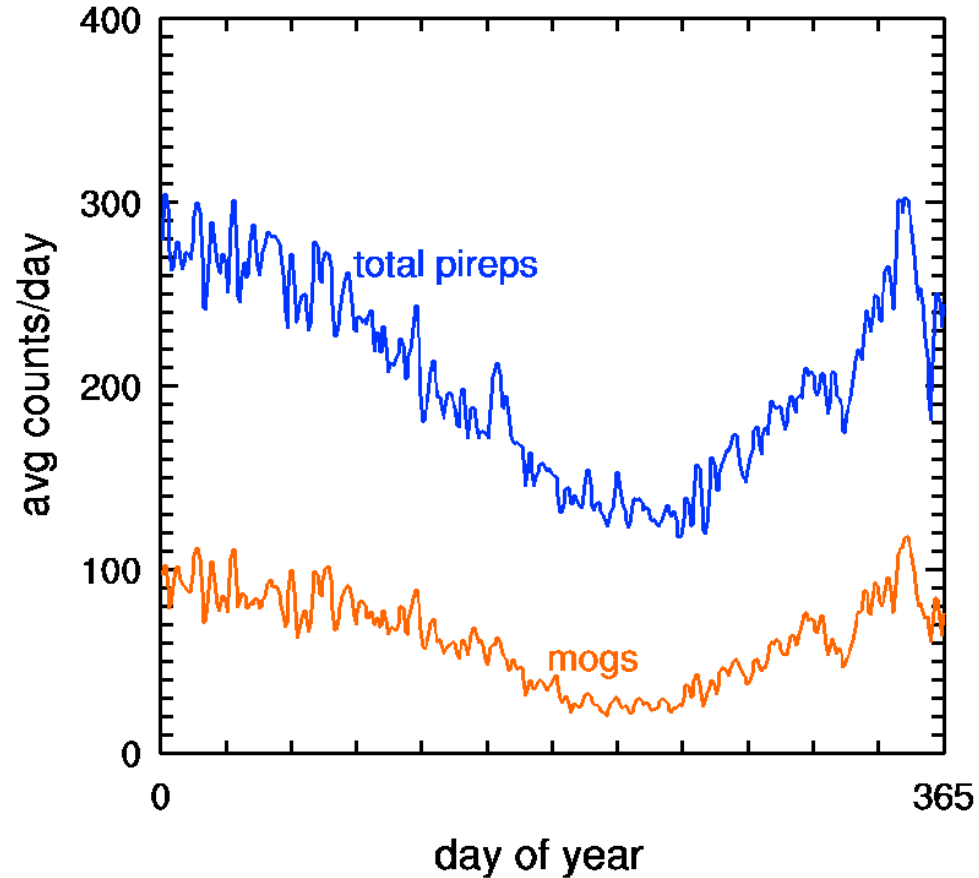


PIREP counts with time of year

monthly avg pireps 1992-2001, alts>20,000 ft

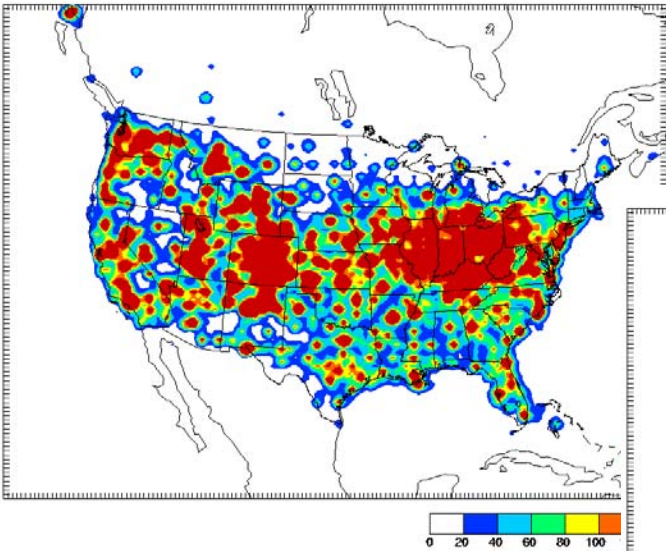


average pireps/day, all years, months, alts>20,000ft
x=lightning flashes/20000 o=pireps

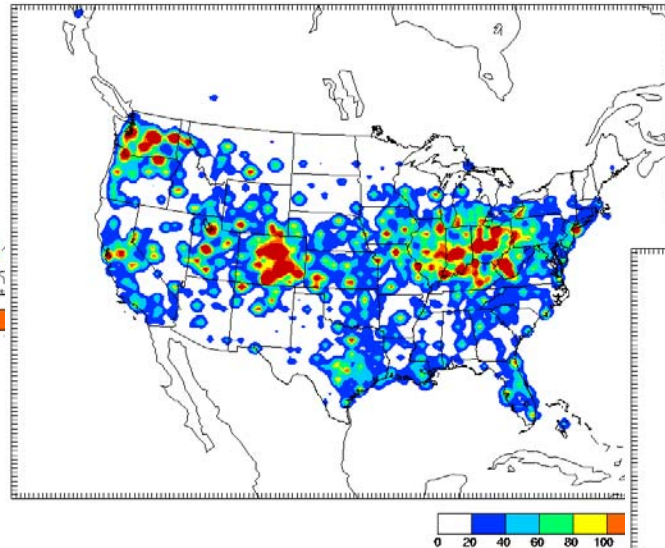


Annual geographic distribution

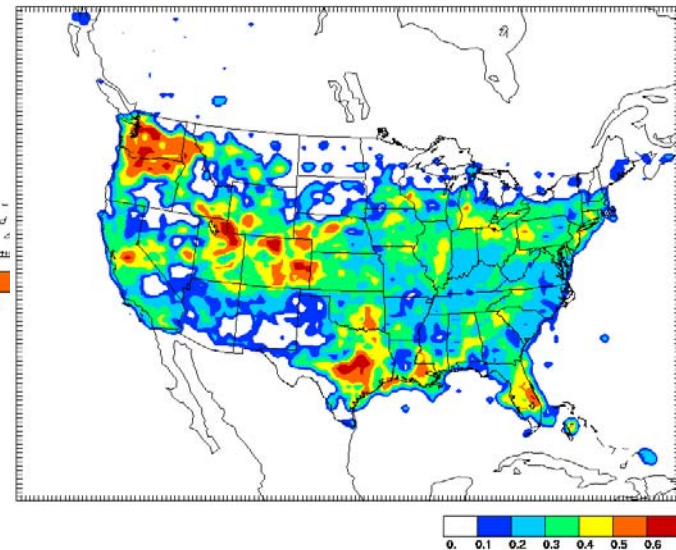
total



MOGs



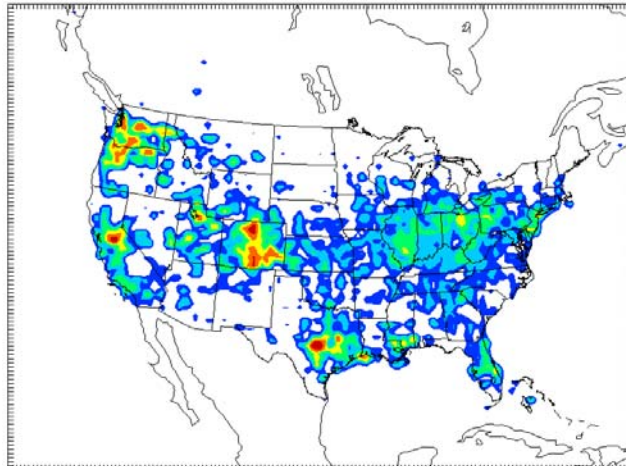
MOGs/total



Seasonal distribution of mog/totals

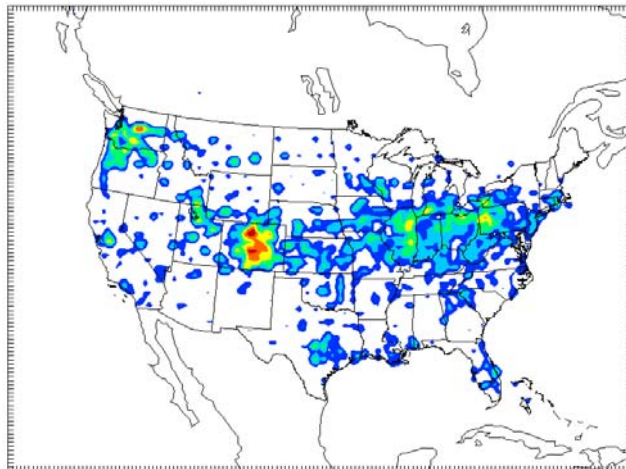
10 year mogs/total for months 1-3 nmin=20
mog/total for all alts>20000 ft
cmax,cmin,cnt = 0.72 0.00 0.10

Jan-Mar



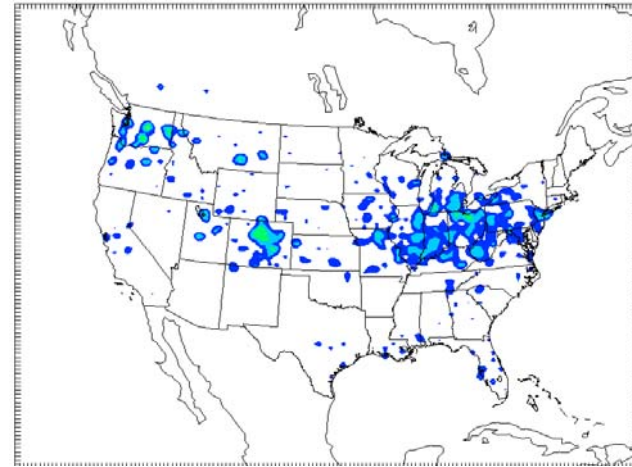
10 year mogs/total for months 4-6 nmin=20
mog/total for all alts>20000 ft
cmax,cmin,cnt = 0.65 0.00 0.10

Apr-Jun



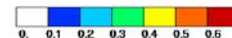
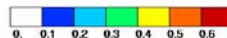
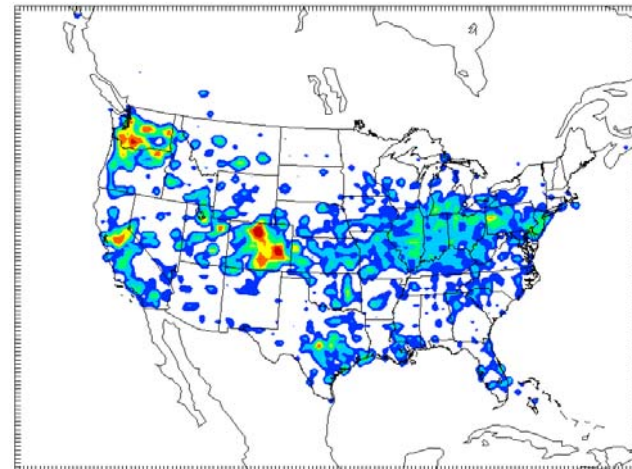
10 year mogs/total for months 7-9 nmin=20
mog/total for all alts>20000 ft
cmax,cmin,cnt = 0.43 0.00 0.10

Jul-Sep

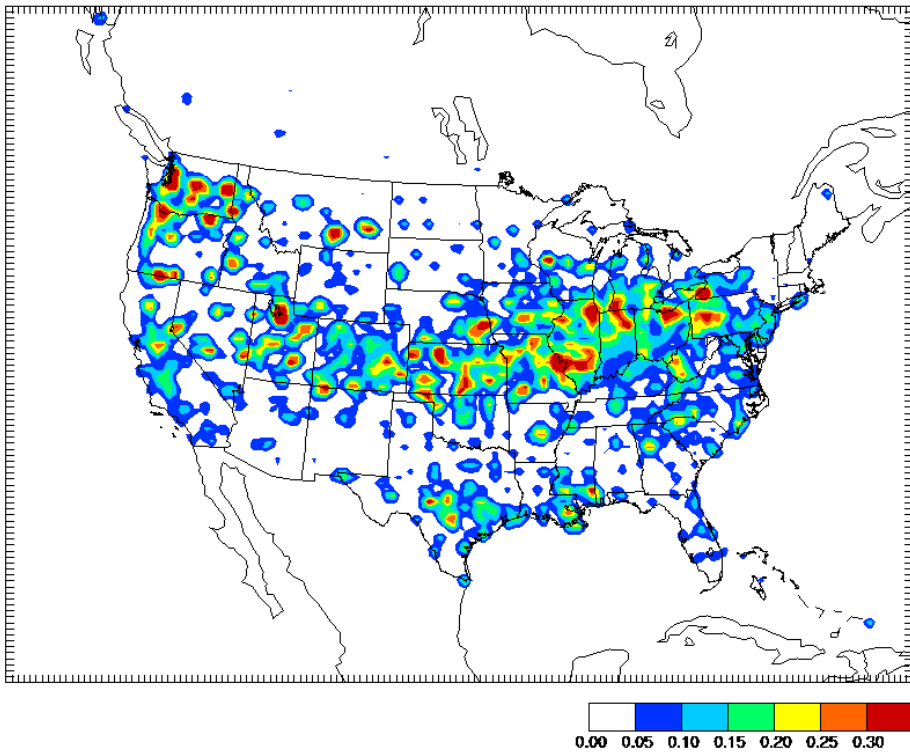


10 year mogs/total for months 10-12 nmin=20
mog/total for all alts>20000 ft
cmax,cmin,cnt = 0.72 0.00 0.10

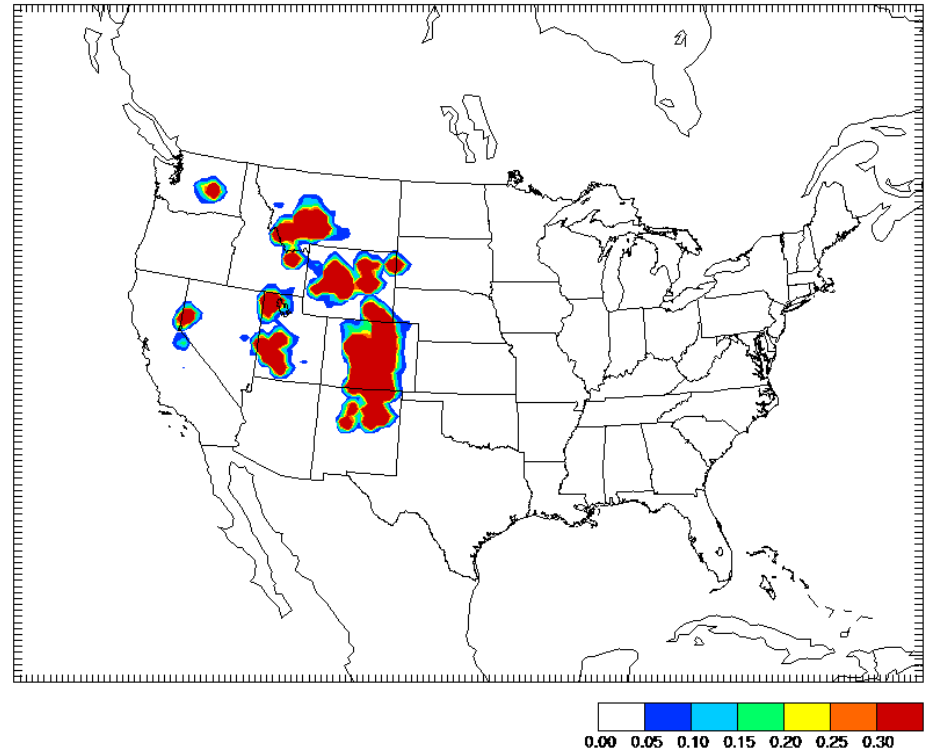
Oct-Dec



CAT, mountain wave PIREPs

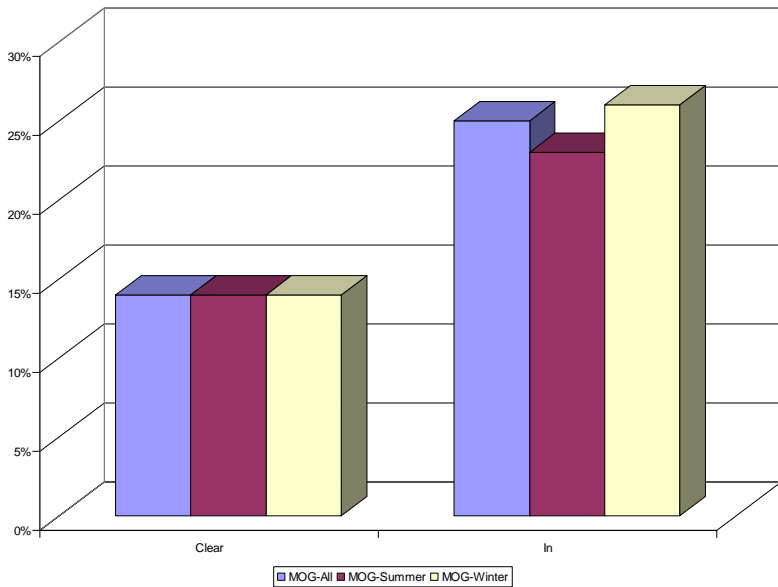


“CAT”

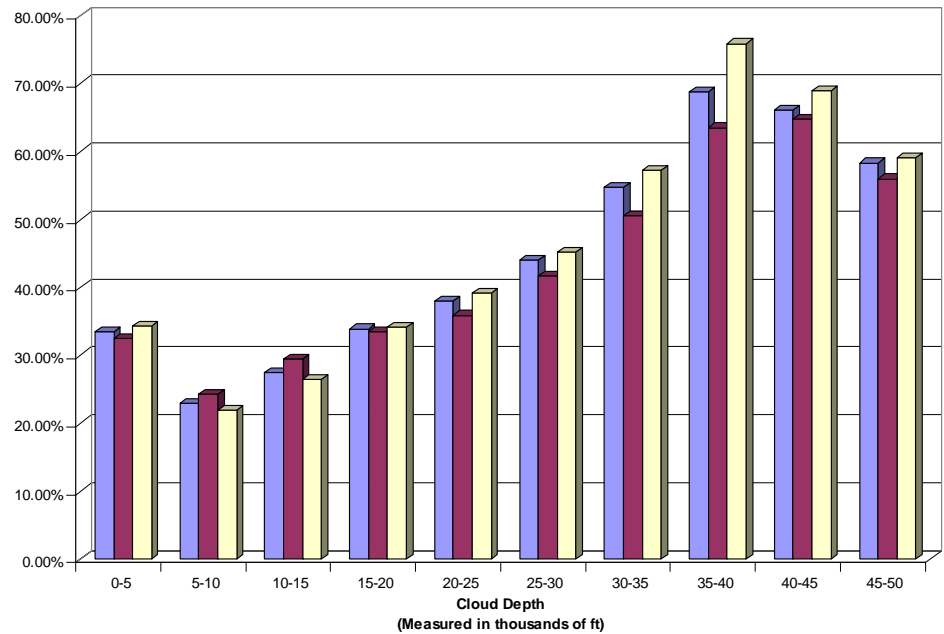


“MWT”

Relation to clouds*



Percentage of MOG PIREPs in/out cloud

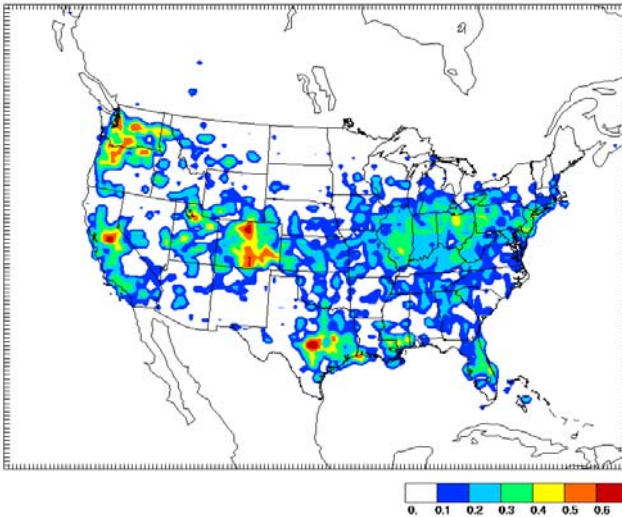


Percentage of MOG PIREPs as a function of cloud depth

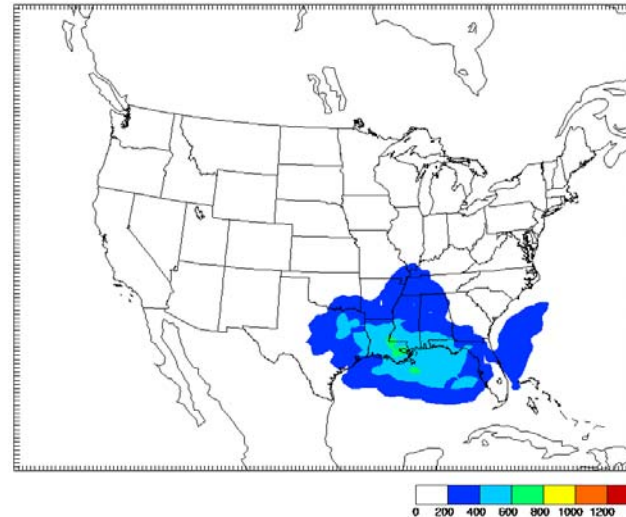
*J. Wolff, R. Sharman, B. Bernstein, "Climatology study of aircraft turbulence versus cloud cover," JP1.18

Relation to lightning

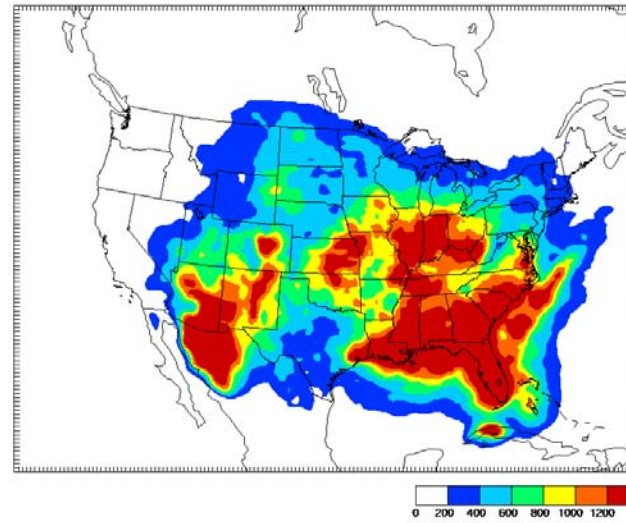
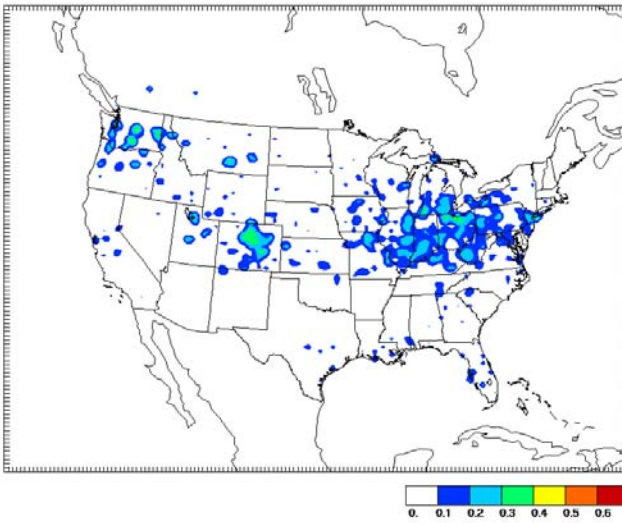
MOG/TOTAL PIREPs



C-G lightning flash densities



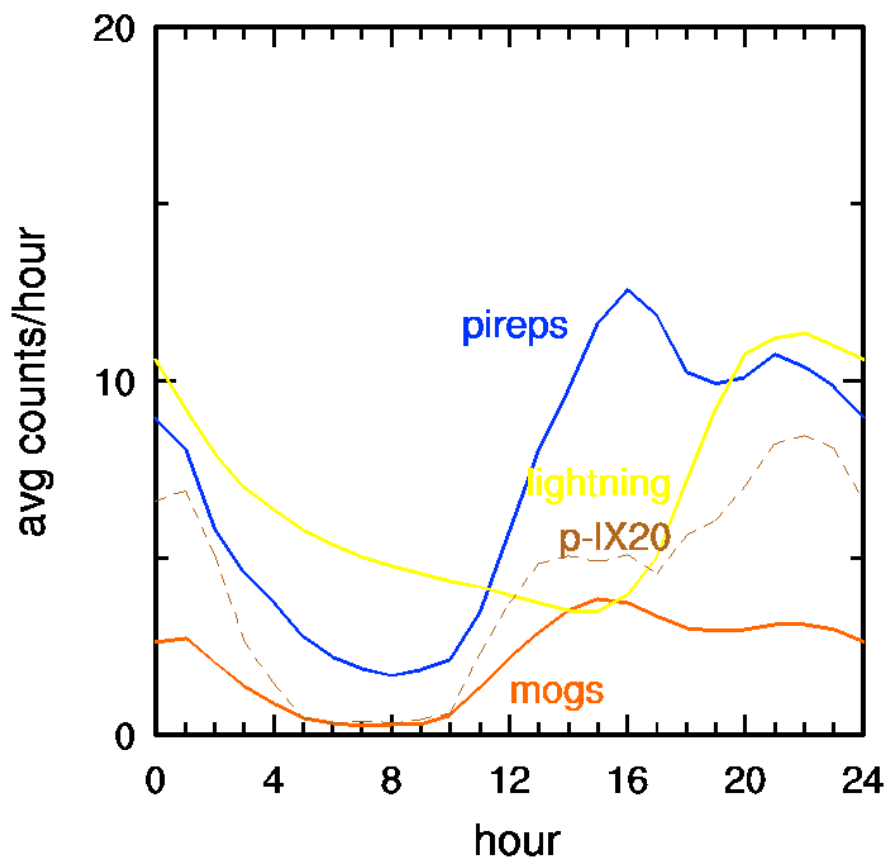
Jan-Mar



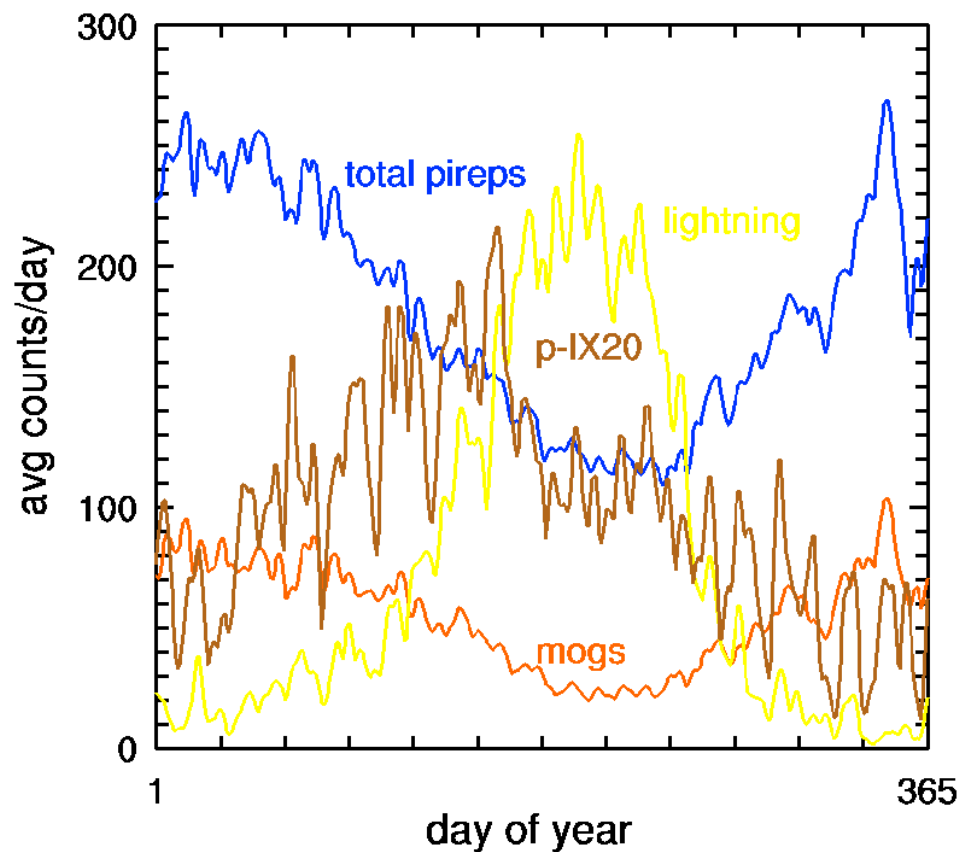
Jul-Sep

Relation to lightning (cont.)

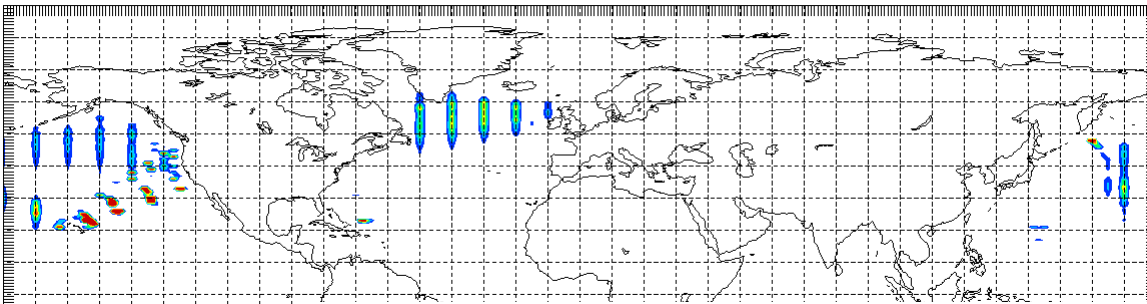
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total pireps for all alts > 20000 ft
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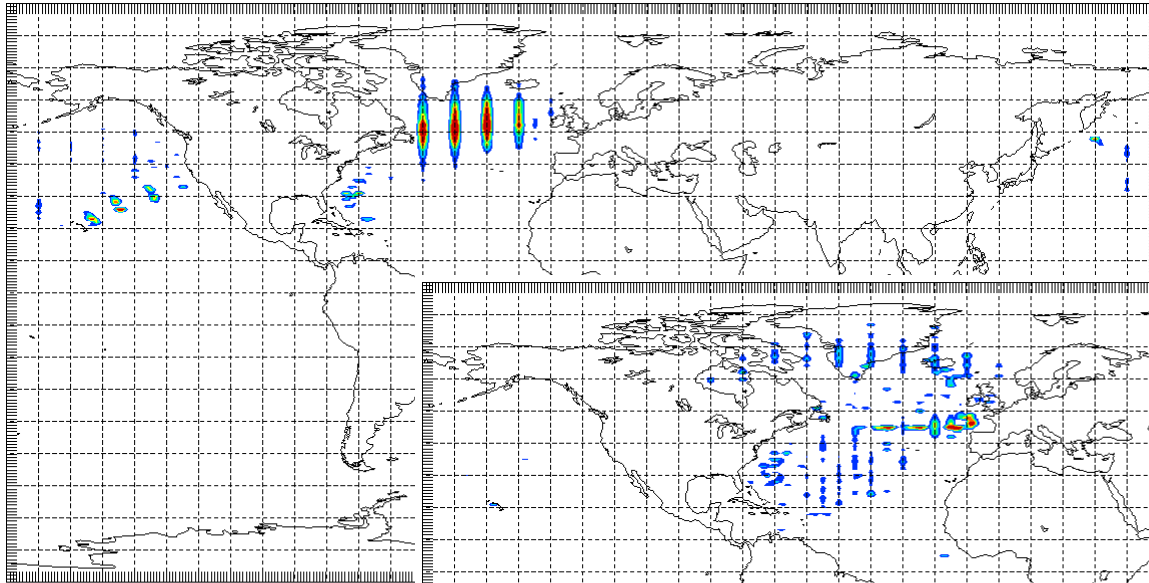
average pireps/day, all years, months, alts > 20,000 ft
x = lightning flashes / 1000 o = pireps



PIREPs over the oceans

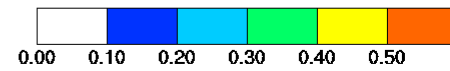
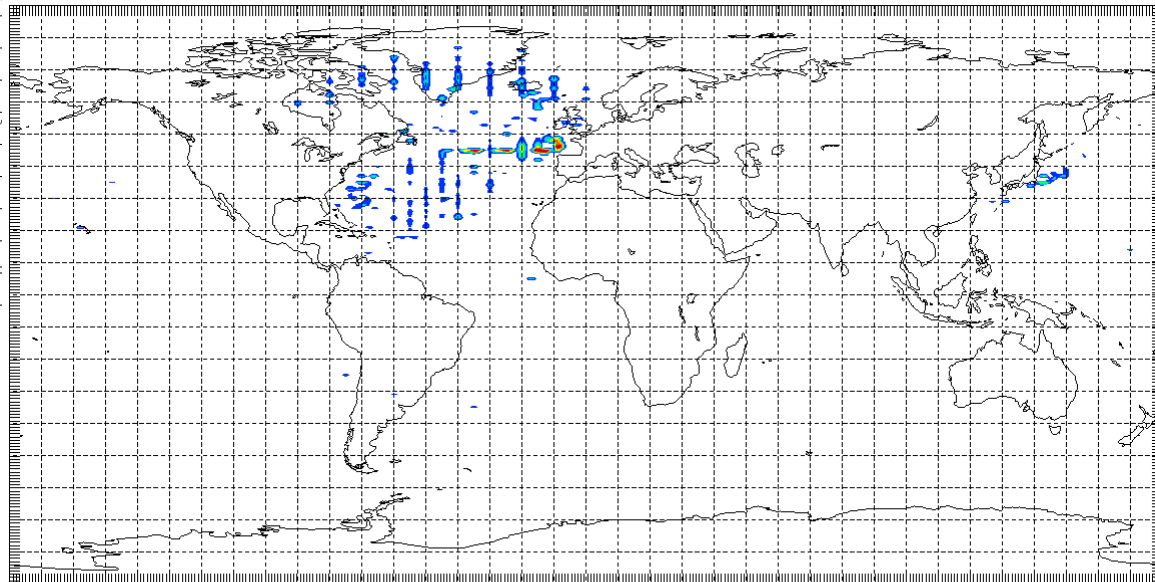


total



MOGs

MOGs
total



Conclusions

- PIREP reported intensities are not representative of the true extent of turbulence
- PIREP reported intensities are consistent
- PIREP intensities are fairly uniform with altitude
- MOG/TOTAL PIREPs eliminates most regional air traffic biases
- Turbulence > 20,000 ft incidence is greater in winter
- Most turbulence > 20,000 ft is over western Most turbulence is associated with cloud
- Little turbulence > 20,000 ft is related to convective cloud (lightning)