MIL supplemental slides

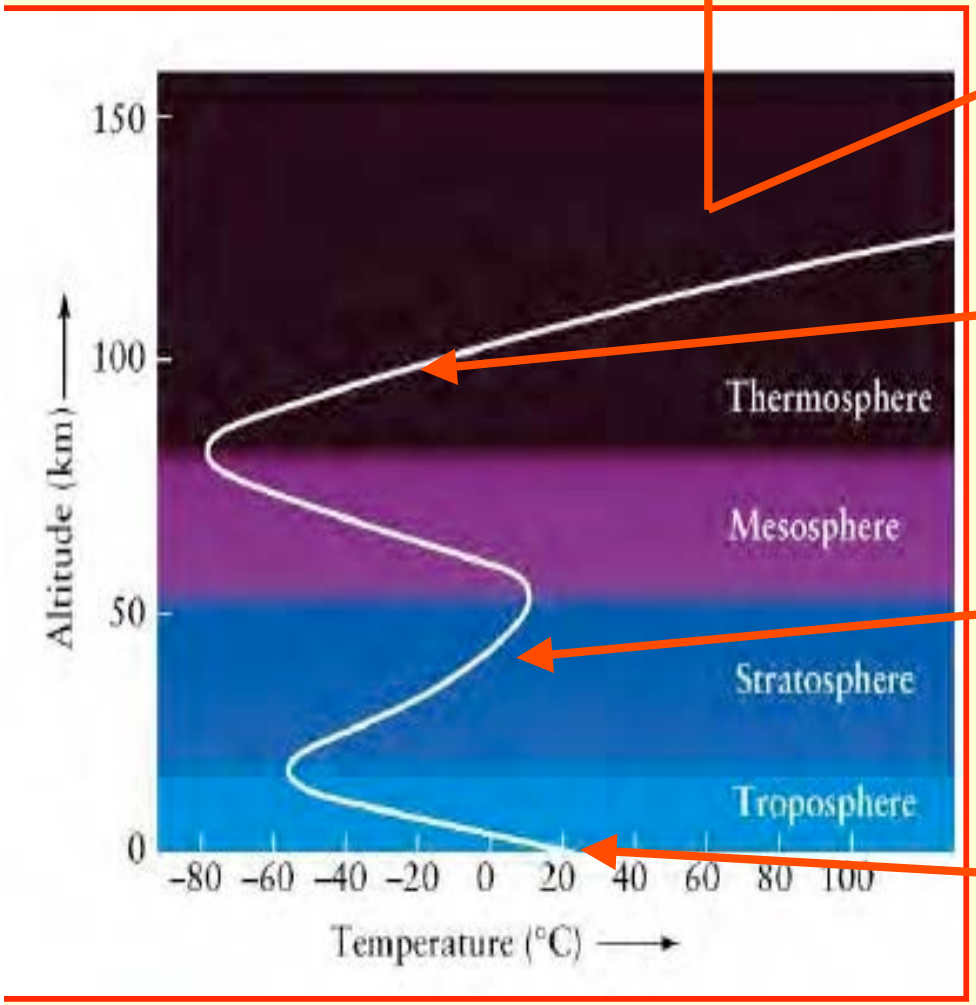
Airglow and lidar observatories at different sites around the globe are studying the aeronomy of the upper atmosphere.

Interesting science and important applications.

Mesosphere major focus for large fraction of these.

Focus of talk pretty much on thermal profile so:

Why does the Atmospheric Temperature vary with Altitude?



Ionization:

O, N_2, O_2 + sunlight ® e + …

Oxygen Heating:

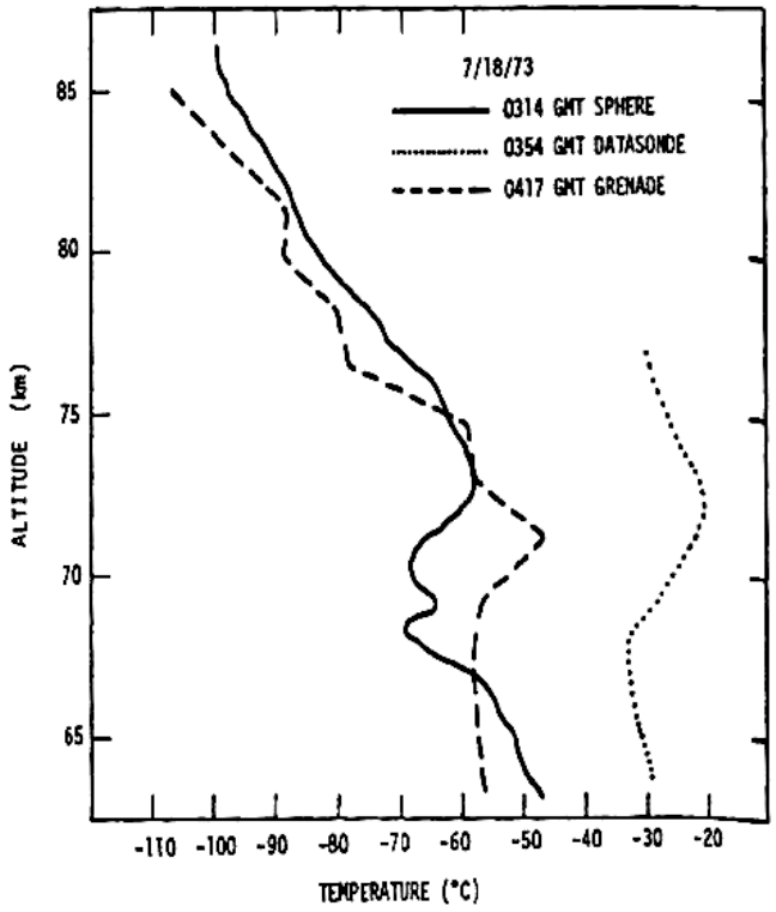
O_2 + sunlight ® O + O

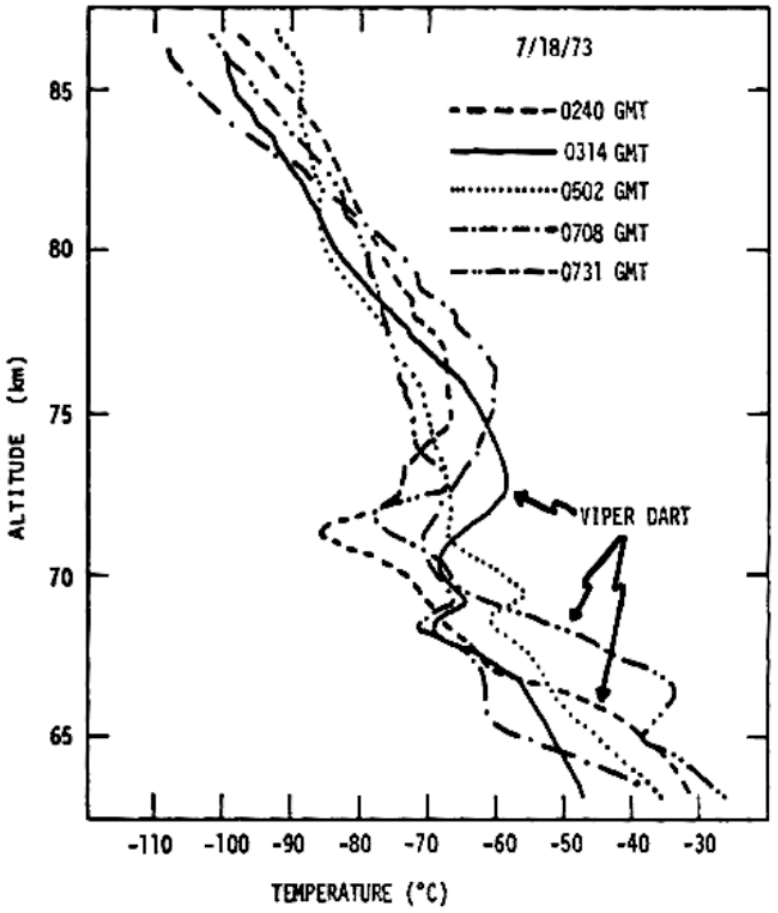
Ozone Heating:

O_3 + sunlight ® O + O_2

Surface Heating

First Results illustrating MIL events





Different techniques

Repetitive Occurrences, same day

Important clue

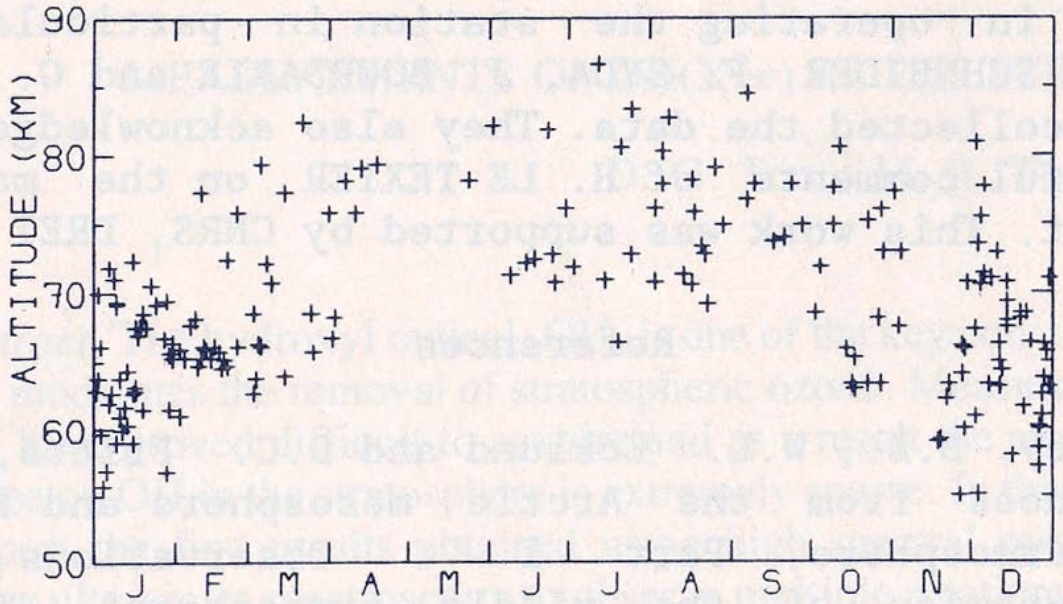


Fig. 5 Altitude of the secondary minimum of temperature versus the day of the year for all OHP profiles from June 1981 to September 1986 for which a temperature inversion has been detected (10 K criterion).

The French lidar work found that MILs show change in height between winter and summer.

(natural to think of one mechanism, changing circumstances, but actually two different forcings - PW versus GW)

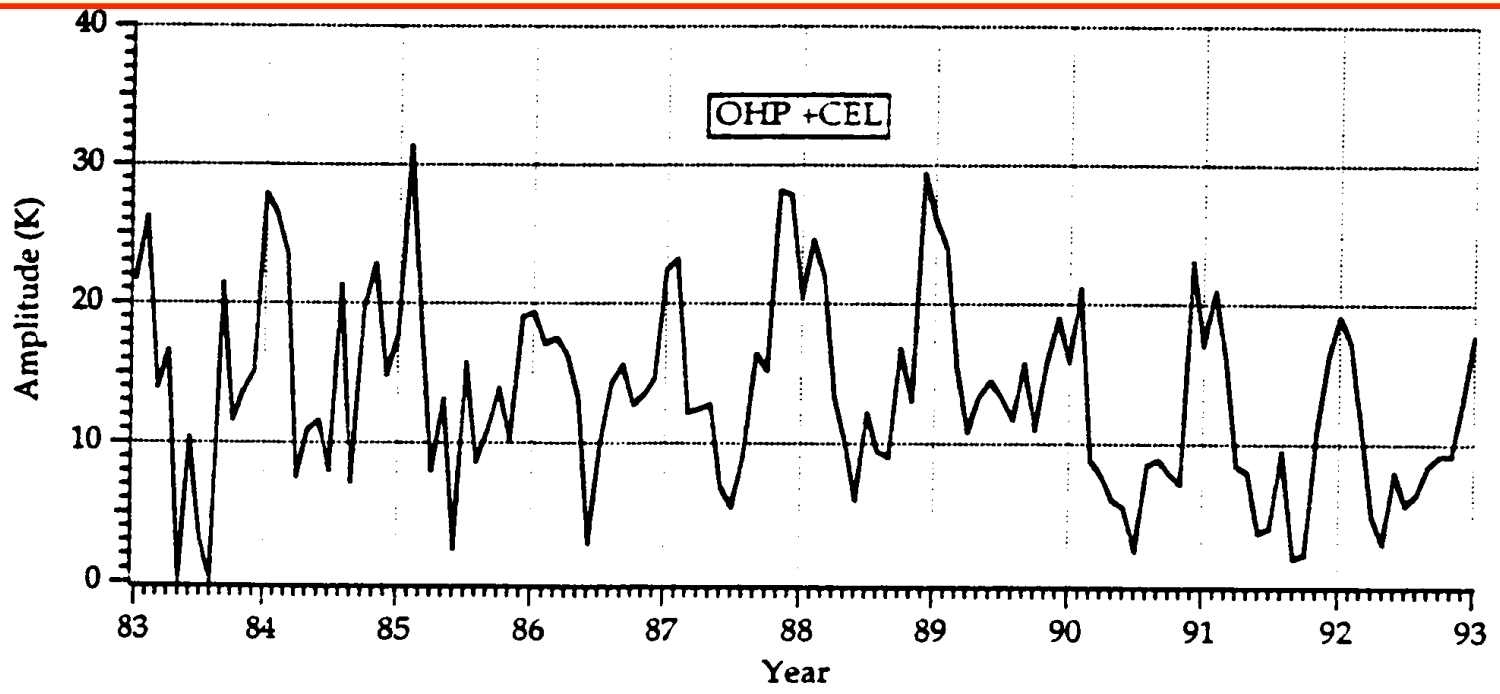


Figure 3. Monthly mean amplitude of temperature inversions seen by Rayleigh lidar at OHP and CEL.

From LeBlanc and Hauchecorne [J. Geophys. Res., 1999]

Variations in MIL amplitudes over ten year duration show minimum amplitudes for summers.

Have MILs been observed from space?

Yes.

Solar Mesosphere Explorer (*Clancey et al.*, 1988)

UARS

TIMED

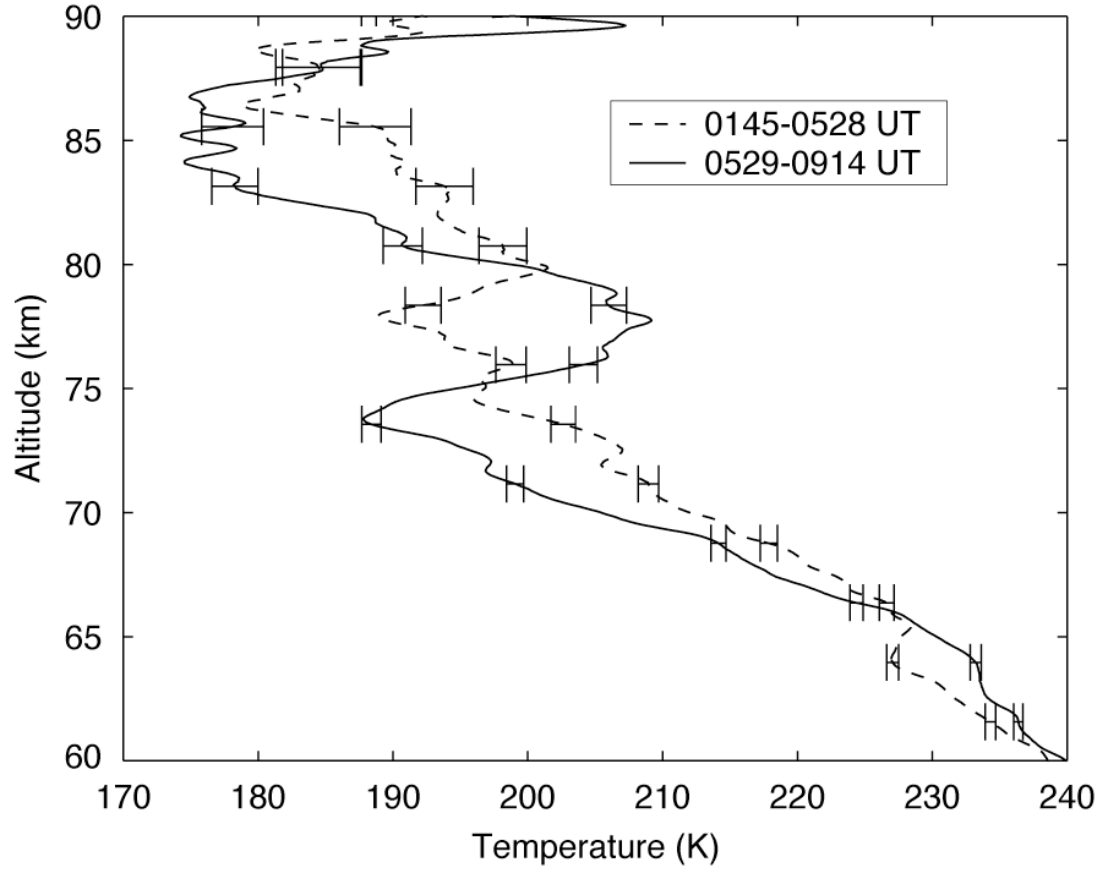


Fig. 1. Average temperature of the mesosphere in the first half of the night's measurements compared to the second half of the night's measurements on July 31, 1998 at 48 m height resolution, smoothed with a 1008 m bandwidth filter. For reference, 0000 UT is 1900 EST. The error bars show the statistical error of the measurement.

Sica et al., 2003

Rayleigh T observations at the Purple Crow Lidar show sudden appearance of MIL during a summer night observations.

There was also operating simultaneously a MF radar observing the MA wind field.

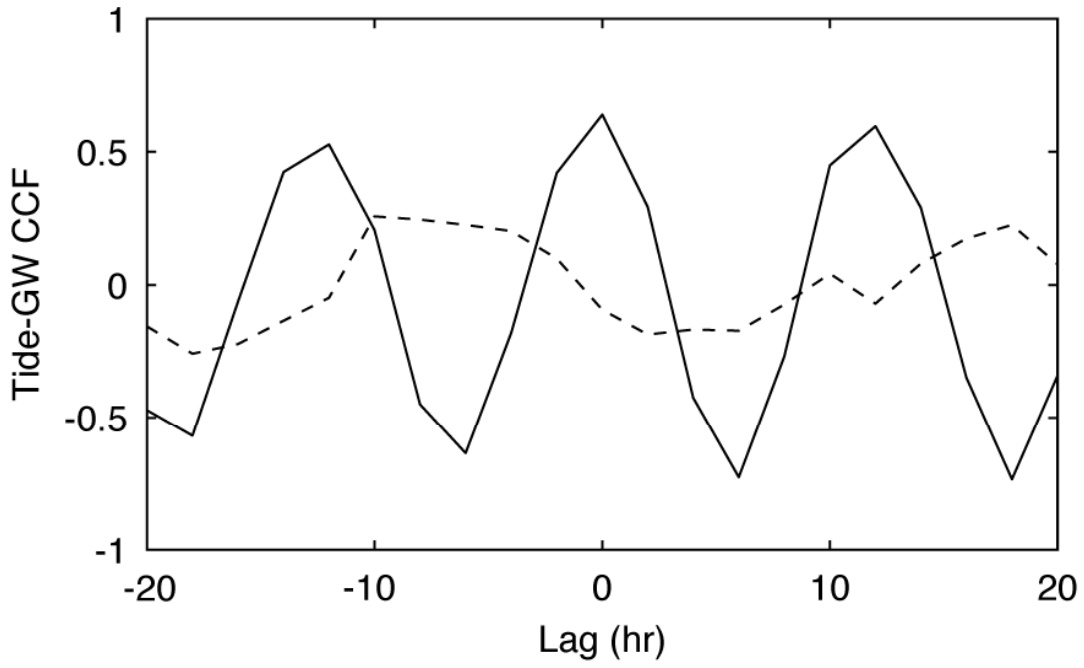


Fig. 4. The cross correlation of the semidiurnal (solid line) and diurnal (dashed line) zonal tide with the residual RMS wind variance determined by the MF radar.

Simultaneous MF radar observations suggest that the reversal of the phase for the diurnal tide allowed a major increase in the GW variance to take place. Sica et al interpret this as indicating that the removal of the wave filtering effect imposed by the diurnal tidal wave unlocked the "floodgates" to GW waves that then encountered a critical layer and "broke".

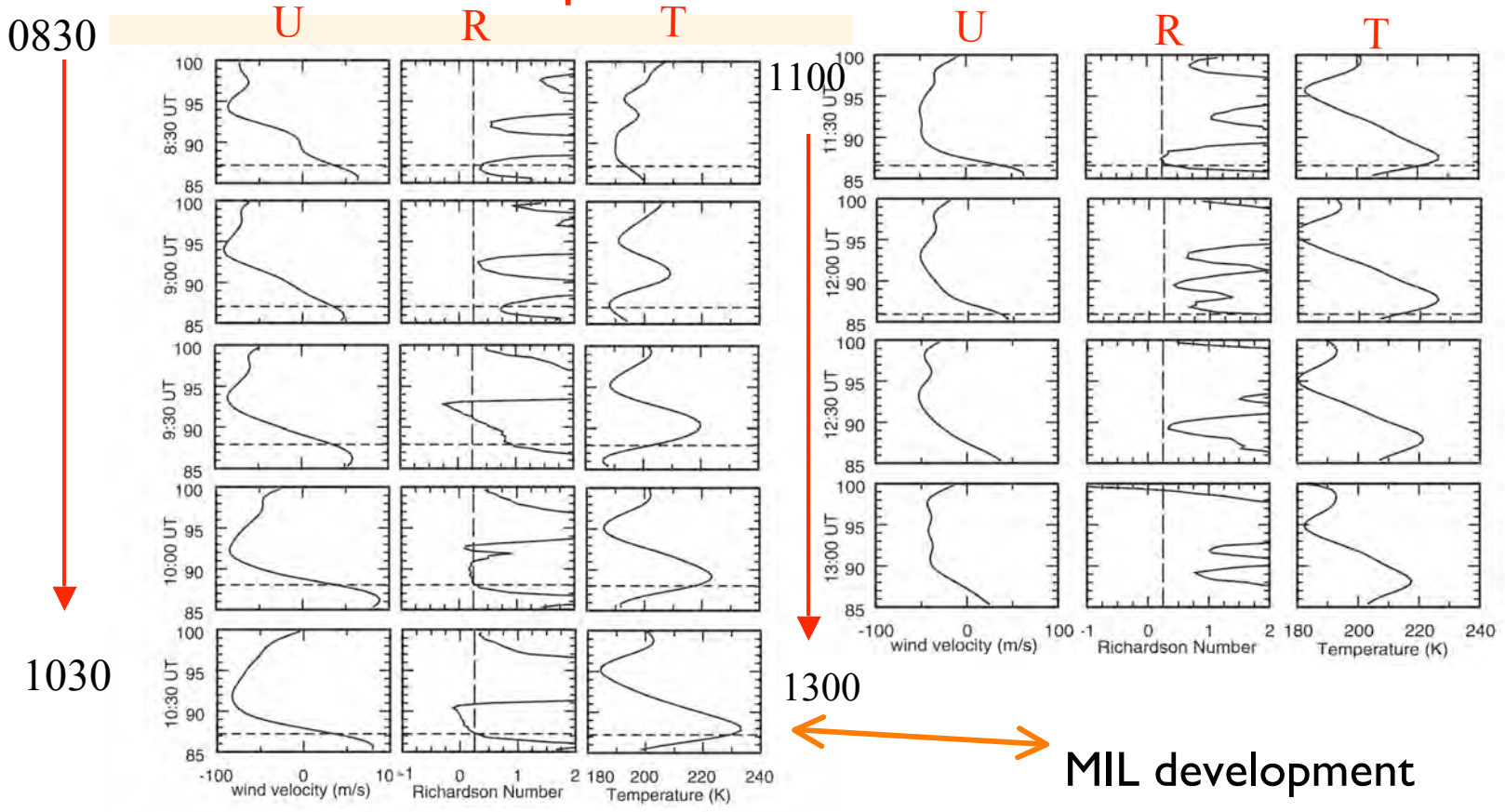
Table 3
PCL measurement nights with upper mesospheric inversions > 2 K. See the text for details

Night	Measurement duration (h)	Possible tidal modulation	Comment
940807	7	Yes	Double inversion, 84 km inversion modulated, 74 km inversion present all night
940816	6	Yes	Inversion present all night
941012	10.5	Yes	Inversion present all night
950703	6	Yes	
960601	6.5	Yes	
960805	7	Yes	Inversion present all night
960807	6	No	
960809	7.25	Yes	Inversion present all night
960811	7	Yes	Inversion present all night (some modulation during < 1 h period)
970605	6	Yes	
971218	12	No	
980216	12	Yes	Inversion present all night
980710	6	Yes	
980712	6.5	No	
980713	6.5	No	
980716	5	No	
980718	5	Yes	Inversion present all night
980731	7	Yes	
980813	8	Yes	
990520	6.5	Yes	
990521	6.5	No	
990701	5.5	Yes	Near top of measurement range
990711	7	Yes	Inversion present all night
990712	6.5	Yes	Double inversion, 82 km modulated, 76 km inversion present all night
990716	5.5	Yes	

Summer PCL lidar observations of the “upper” MIL show conclusive indications of tidal modulation of MIL peak, i.e., the phase of the MIL peak follows that of the diurnal tidal wave.

Another example of a sudden increase in T

Sodium wind and temperature lidar observations -ALOHA 93



As the atmosphere becomes unstable (R<0), the amplitude of the MIL increases.

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Altitude and Temperature of the Mesopause at 69°N Latitude in Winter

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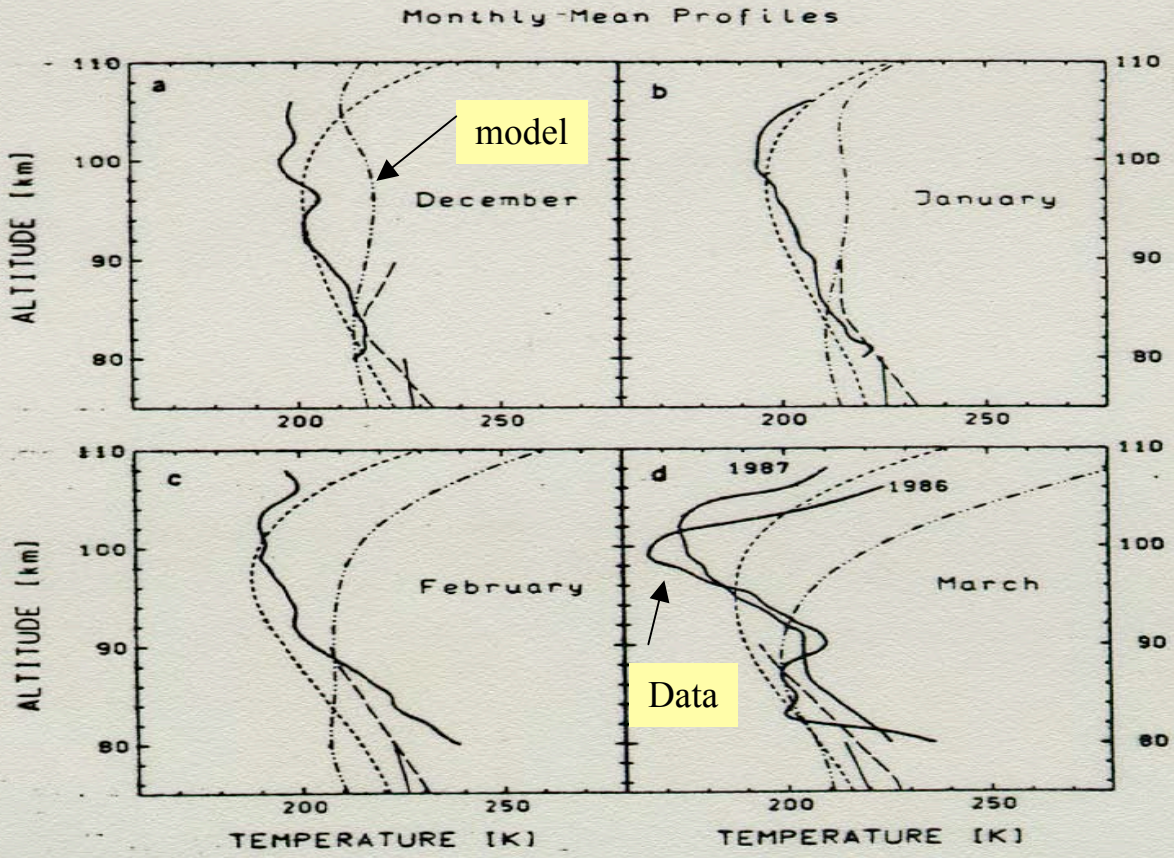

Fig. 3. Comparison of our monthly mean temperature profiles with reference atmosphere profiles. The thick solid curves show the lidar data of this paper, the dashed-dotted curves show values of the CIRA 1972, the long-dashed curves show values of *Cole and Kantor* [1978], the thin solid curves show values of *Barnett and Corney* [1985], and the short-dashed curves show values of *Groves* [1987]. (*a*) December, (*b*) January, (*c*) February, (*d*) March.

Polar region Na temperature profiles show no MIL for winter: Why?