Mesospheric Temperature Observation Using a Michelson Interferometer

Hannah LeTourneau (Whitworth University)
Mentor: Dr. Qian Wu (HAO)
Overview

- Project Details
- Background Information
- Data Collection Method
- Data Analysis Software
- Results
- Future Study
Project Overview

- Michelson interferometer set up
- Software written
- Data collected
- Aboard ship from CA to Antarctica in November
- Design work
The Mesosphere/Lower Thermosphere (MLT)

- 80-105 km above Earth
- Very dynamic
- Tides
- Airglow Spectral Analysis
Hydroxyl (OH)

- Thermal equilibrium
- Displacement Reaction
  \[ \text{H+O}_3 \rightarrow \text{OH}^* + \text{O}_2 + 3.3 \text{ eV} \]
- Meinel Bands
- Temperature Correlation


![Graph showing altitude vs. volume emission rate]
Data Collection

- Nicolette 6700 Spectrometer
- InGaAs Detector
- Scope
- Macro
- Terdiurnal Tide
The Interferometer

Detector  Scope  Scanning Mirror

Beam Splitter  HeNe Laser
Temperature Determination

• Relationship of photon emission intensity to upper state angular momentum for Boltzmann distribution of multiplet rotational levels
• Relative intensity at expected peaks (I)
• \( \ln\left(\frac{I}{2A(2J'+1)}\right) \)
  – J’: Total Upper Angular Momentum (1.5, 2.5, 3.5)
  – A(J’): Einstein Constants (16.74, 20.37, 21.82 s^-1)
• Plotted vs. F(J’)
  – F(J’): Rotational Term Values (12,014.1, 12,089.0, 12194.5 cm^-1)
  – Linear least squares fitted
• \( T=-100\frac{h}{k}\frac{c}{\text{slope}} \)
  – h: Planck’s Constant
  – c: Speed of Light
  – k: Boltzmann’s Constant
$T=158.7 \text{ K}$
Data Filtering

- Noisy data: Clouds and Alignment
- Peak intensity greater than 0
- Peak intensity 10x higher than average
- Linear pattern with negative slope
- Chi square value < .05
No Filtering
Peak Intensity Greater Than 0
Peaks 10x Average
Linear Pattern With Negative Slope
Chi Square Value < .05
Comparison With Expected Results

• Change in Temperature
  – Expected: 30 K

• Average Temperature
  – Expected: 195 K

• Too few valid points were found to attempt fitting a terdiurnal wave curve

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<tr>
<th>Date</th>
<th>Delta T (K)</th>
<th>Average T (K)</th>
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<td>Jul 09-10</td>
<td>93.44098</td>
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Future Study

• More nights needed for sampling
• Improve alignment method
• Longer sampling periods
• Total band intensity
Image Credits

• Background Image
  Whitworth University High Altitude Ballooning

• Hydroxyl Emission Profile

• OH 3-1 Band
References

Questions?

Thanks to all who helped me this summer!