Following Intense Forest Fire Activity.

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Abstract

On 24 August 1992, the Microwave Limb Sounder (MLS) on the Upper Atmosphere Research Satellite observed a significant enhancement in the abundance of lower stratospheric methyl cyanide (CH₃CN) at ~100-68 km altitude, at a small region on the coast of Idaho. Concentrations of 1.5 ppt were observed in the stratospheric background of CH₃CN concentrations originating in regions of extensive forest fire activity in the northwestern USA (not observed by MLS in this period because of ambient air conditions). After being lofted into the lower stratosphere, this air was advected towards the regions of enhanced CH₃CN and subsequently dispersed over ~9 days. No other sign of comparable magnitude had been seen in the >15 km MLS database.

Introduction: Methyl cyanide and MLS

- Methyl cyanide (CH₃CN, also known as Acetonitrile) is a product of Biomass burning (Aristo and Braun, 1986; Hanus and Vrba, 1990).
- Estimated production is 0.8 Tg/yr.
- For comparison: 1990 CO₂ emissions were estimated to ~40 Tg/yr.
- The Microwave Limb Sounder (MLS) (Waters et al., 1999) on the Upper Atmosphere Research Satellite (UARS) has probed the first global CH₃CN dataset (Livezey et al., 2000).
- MLS was launched in September 1991 on shuttle Discovery.
- UARS/MLS observes from 34° to 80° in one hemisphere, replacing major viewing hemispheres every ~36 days.
- In normal atmospheric conditions, MLS CH₃CN data is scientifically useful from 68 km to 20 km.
- Stratospheric CH₃CN concentrations are typically ~10-40 ppt.
- CH₃CN data show a persistent stratospheric peak in CH₃CN concentrations around 22-28 km.
- This evidence is for a previously unknown persistent stratospheric CH₃CN enhancement.
- Therefore, there have been no noticeable tropical origins to corroborate this finding yet.

Early hypotheses for the origin of the enhancement

Atlas I rocket launch and destruction

- An Atlas I rocket carrying a communications satellite was launched from Cape Kennedy on August 22.
- The rocket included an Apollo 'kick motor'.
- A self-destruct command was sent when the rocket was at 160 km altitude, as one of the two engines in the upper stage failed to ignite.
- It is likely that the rocket fell into the atmosphere during the last ~20 km [S. Kent, A. McDonald, personal communications 2000].
- Back trajectories are in consistent with this hypothesis.
- Also, the CH₃CN mass loading (~2000 kg) make this hypothesis unlikely.

The eruption of Mt. Spurr in Alaska

- The 18 August eruption of Mt. Spurr in Alaska was also considered.
- Some back trajectories fall close to its location.
- CH₃CN is not a known product of eruptions.
- Indirect mechanisms such as increased biomass burning are possible, however.

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Experimental studies rule out Mt. Spurr hypothesis

- Although SO₂ (usually produced by volcanoes) and CH₃CN are spectrally correlated, the enhancement is clearly CH₃CN.

Strongest hypothesis for origin of enhanced CH₃CN

- From 19th August to 4th September 1992 a major wildfire raged near Boise, Idaho, largest fire since 1970. (Idaho Sentinel)
- Fire burned 22,040 acres.
- For comparison the largest 1991 fire burned 111,360 acres.
- 1991 fire in Yellowstone - 3,585,000 acres.
- This would have led to significant tropospheric CH₃CN enhancement.
- Concentrations as high as ~100 ppt have been seen in wildfires.
- Also, a series of major thunder storms occurred near the fires on 22-23 August.
- We suggest:
  1. One or more of these storms lofted CH₃CN enriched air into the lower stratosphere.
  2. This process may be a result of the fire and was present in the lower stratosphere.
  3. The CH₃CN enriched stratospheric air was advected into the region observed by MLS.
- F bowen et al. [2000] show evidence for similar events as seen by POAM II and SAGE II.

Spread of the TOMS aerosol enhancement

- TOMS data shows a significant enhancement at 393 nm.
- The enhancement is seen in the TOMS data from 22-23 August.
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Conclusions and further work

- MLS has probed the first global dataset of stratospheric CH₃CN.
- A dramatic enhancement in lower stratospheric CH₃CN is seen on the Florida coast in August 1992.
- The CH₃CN enriched air was advected over the next few days into the regions observed by MLS.
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