Review of Wildfire Observations in Mongolia During April and May of 1996 With Data From the DMSP Operational Linescan System

Christopher D. Elvidge*

Desert Research Institute, University of Nevada System on assignment at the
National Oceanic and Atmospheric Administration
National Geophysical Data Center, Solar-Terrestrial Physics Division
3100 Marine Street, Boulder, Colorado, 80303 USA
Fax: 303-497-6513
Email: cde@ngdc.noaa.gov

Abstract

A review of the nighttime fires of Mongolia observable with the Defense Meteorological Satellite Program (DMSP) Operational Linescan System (OLS) reveals major fires in the north-central, northeast and far eastern sections of the country started occurred intermittently from mid-April to mid-May, 1996. Time period with the most extensive sets of fires observable with DMSP-OLS data include April 12-14, 20, 22, 26-28 and May 13, 20-21.

1. Introduction

In reviewing the literature, the earliest report describing the observation of fire using a satellite sensor acquiring daily - global earth observations occurred when Croft (1973) described observing fires at night in Africa using "photographs" generated from the Defense Meteorological Satellite Program (DMSP) Operational Linescan System (OLS) visible band data. Croft (1978) was later able to use digital OLS data to observe fires, city lights and gas flares. The first systematic inventory of fires with OLS data was accomplished by Cahoon et al. (1992) who manually digitized fire points from film produced from nighttime OLS orbits over Africa. More recently algorithms for the detection of fires using digital OLS data have been developed (Elvidge et al., 1996a). In this paper we review a set of fire observations made in Mongolia during the devastating fire season of April and May of 1996.

2. The DMSP Operational Linescan System

The DMSP maintains a constellation of two satellites in sun-synchronous, near-polar orbit at altitudes of approximately 833 km, an inclination of 98.8 degrees, and an orbital period of 102 minutes. One satellite is in a dawn - dusk orbit, the second in a day - night orbit. The DMSP platforms are three axis stabilized, with roll, pitch, and yaw variations kept to within +/- 0.01 degrees. This stability is unique compared to other polar orbiting systems such as Landsat or the NOAA Polar Orbiting Environmental Satellites.

The NOAA National Geophysical Data Center (NGDC) serves as DoD's archive of data for the DMSP sensors. The U.S. Air Force Global Weather Central has sends DMSP data tapes to NGDC daily. The DMSP archive was established in March of 1992, and began receiving data on a daily basis in September of 1992 and has operated continuously since that time.

The Operational Linescan System (OLS) is an oscillating scan radiometer designed for cloud imaging with two spectral bands (VIS and TIR) and a swath of 3000 km. There are two spatial resolution modes in which data can be acquired. The full resolution data, having nominal spatial resolution of 0.56 km, is referred to as "fine". On board averaging of five by five blocks of fine data produces "smooth" data with a nominal spatial resolution of 2.7 km. Most of the data received by NOAA-NGDC is in the smooth spatial resolution mode. The "VIS" bandpass straddles the visible and near-infrared (VNIR) portion of the spectrum with a full-width-half-maximum (FWHM) of 0.58 - 0.91 um. The TIR band has a FWHM of 10.3 - 12.9 um. NGDC OLS geolocation accuracy for the OLS data is +/- one pixel using physically based orbital mechanics and terrain correction algorithms.

The identification of fires in OLS data relies on detecting areas of active visible and near infrared emission on the planet surface at night, when solar illumination is absent. The VIS band signal is intensified at night using a photomultiplier tube (PMT), making it possible to detect faint VNIR emission sources Elvidge, 1996b). The PMT system was implemented to facilitate the detection of clouds at night using moonlight. With sunlight eliminated, the light intensification results in a unique data set in which city lights, gas flares, and fires can be observed. Because of the long wavelength of the OLS's thermal band, the VIS band is far superior for the detection of fires.

3. Mongolian Fire Observations

Nighttime DMSP-OLS visible band imager of Mongolia acquired with data from satellite F-12 was visually inspected for evidence of fires. This data is summarized in Table 1. Because of the high latitude and width of Mongolia, the country was generally obse /able on two OLS orbits, with the earlier orbit covering eastern and central Mongolia and the later orbit covering western and central Mongolia. As the date of image acquisition approached the summer solstice, the data are increasingly contaminated by sunlight, particularly west of nadir. Observations were not possible on all dates due to missing data.

TABLE 1

Fires of Mongolia Observed With DMSP-OLS Data In 1996
Time = GMT, North = N, East = E, West = W, Central = C

Date		**Time**	**Comment**	**Time**	**Comment**
April	1	1225	missing data	1407	missing data
	2	1213	quiet	1355	quiet
	3	1201	quiet	1343	quiet
	4	1149	fires NE	1331	missing data
	5	1136	missing data	1318	missing data
	6	1124	quiet	1306	missing data
	7	1254	fire NE	1436	quiet W
	8	1242	fire NE	1424	quiet W
	9	1230	fire NE	1412	fire NE
	10	1218	fire NE	1400	fire NE
	11	1206	fire NE	1348	fire NE and NC
	12	1335	many fires NE and NC		
	13	1323	many fires NE and NC		
	14	1311	many fires NE and NC		
	15	1259	missing data		
	16	1247	fires NC	1429	fires NC
	17	1235	fires NC	1417	fires NC
	18	1222	fires NC	1404	missing data
	19	1210	fires recede NC	1352	new fires NC
	20	1158	quiet NC new fires FE	1340	many fires NC
	21	1146	fire FE	1328	missing data
	22	1316	many fires NC and NE		
	23	1304	fires recede NC and expand FE		
	24	1252	fires NC and FE		
	25	1239	fires NC and FE	1421	fires NC (FE not visible)
	26	1227	fires NE and FE	1409	many fires NE and FE
	27	1215	fires NE large fires FE	1357	many fires NC and FE
	28	1203	large fires FE	1345	many fires NC and FE
	29	1333	fires receding		
	30	1139	quiet	1321	quiet

TABLE 1 - Continued

Fires of Mongolia Observed With DMSP-OLS Data In 1996
Time = GMT, North = N, East = E, West = W, Central = C Date

		Time	Comment	Time	Comment
May	1	1309	fire NE		
	2	1256	missing data		
	3	missing data			
	4	1232	fires FE	1414	quiet W
	5	1220	quiet E	1402	fire NC
	6	missing data			
	7	1325	fire NC		
	8	missing data			
	9	missing data			
	10	1301	fires NE		
	11	1249	fires NE	1431	fires NC (NE not visible)
	12	1237	quiet E	1419	fires NC (NE not visible)
	13	1225	quiet E	1407	many fires NC
	14	missing data			
	15	1200	solar glare	1342	fires NC
	16	missing data			
	17	1318	quiet		
	18	1306	quiet		
	19	1254	quiet	1436	fires NC
	20	1242	fires NE	1424	many fires NC (E not visible)
	21	1229	quiet	1411	many fires NC
	22	missing data			
	23	1347	fires NC		
	24	1335	fire FE		
	25	1323	quiet		
	26	missing data			
	27	missing data			
	28	1246	quiet	1428	quiet W
	29	1234	quiet	1416	quiet W
	30	1404	fires NC		
	31	1210	sunlight	1352	quiet

4. Conclusion

A series of distinct periods of quiet and active outbursts of fires can be observed in DMSP-OLS data acquired during the April and May fires season in Mongolia during 1996. Time period with the most extensive sets of fires observable with DMSP-OLS data include April 12-14, 20, 22, 26-28 and May 13, 20-21. Quiet periods include April 1-9, 29-30 and May 17-18, 25, 28-29, 31. Because the OLS data is only useful for detection of fires at night, derivation of a more complete fire record would require addition of daytime.

5. References

Cahoon, D.R. Jr., Stocks, B.J., Levine, J.S., Cofer, W.S. III, O'Neill, K.P., 1992, Seasonal distribution of African savanna fires. Nature, v. 359, p. 812-815.

Croft, T.A., 1973, Burning waste gas in oil fields. Nature, v. 245, p. 375-376.

Croft, T.A., 1979, The brightness of lights on Earth at night, digitally recorded by DMSP satellite. Stanford Research Institute Final Report Prepared for the U.S. Geological Survey.

Elvidge, C.D., Kroehl, H.W., Kihn, E.A., Baugh, K.E., Davis, E.R., Hao, W.M., 1996a, Algorithm for the retrieval of fire pixels from DMSP Operational Linescan System data. Global Biomass Burning, MIT Press, In Press.

Elvidge, C.D., Baugh, K.E., Kihn, E.A., Kroehl, H.W., Davis, E.R., 1996b, Mapping city lights with nighttime data from the DMSP Operational Linescan System. Photogrammetric Engineering and Remote Sensing, In Press.

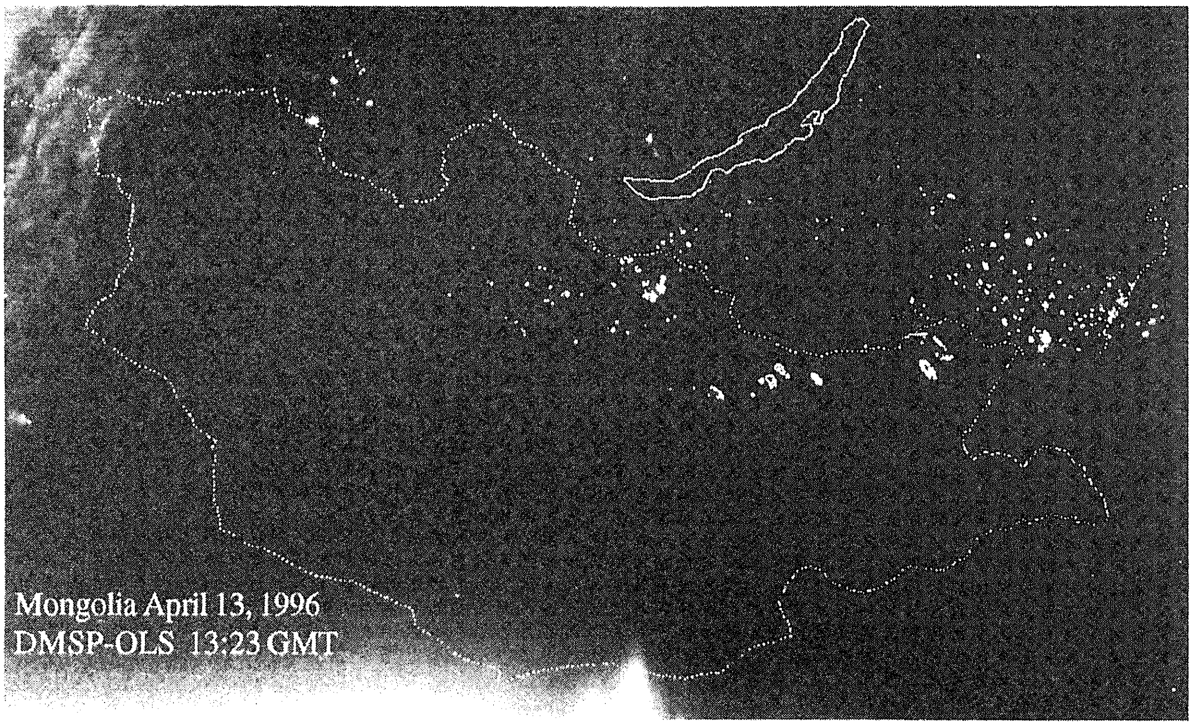

Figure 1. Fires observed in north-central and north-east Mongolia at night using DMSP-OLS data acquired April 11, 1996 at 13:23 GMT. Note fire rings in north-east.

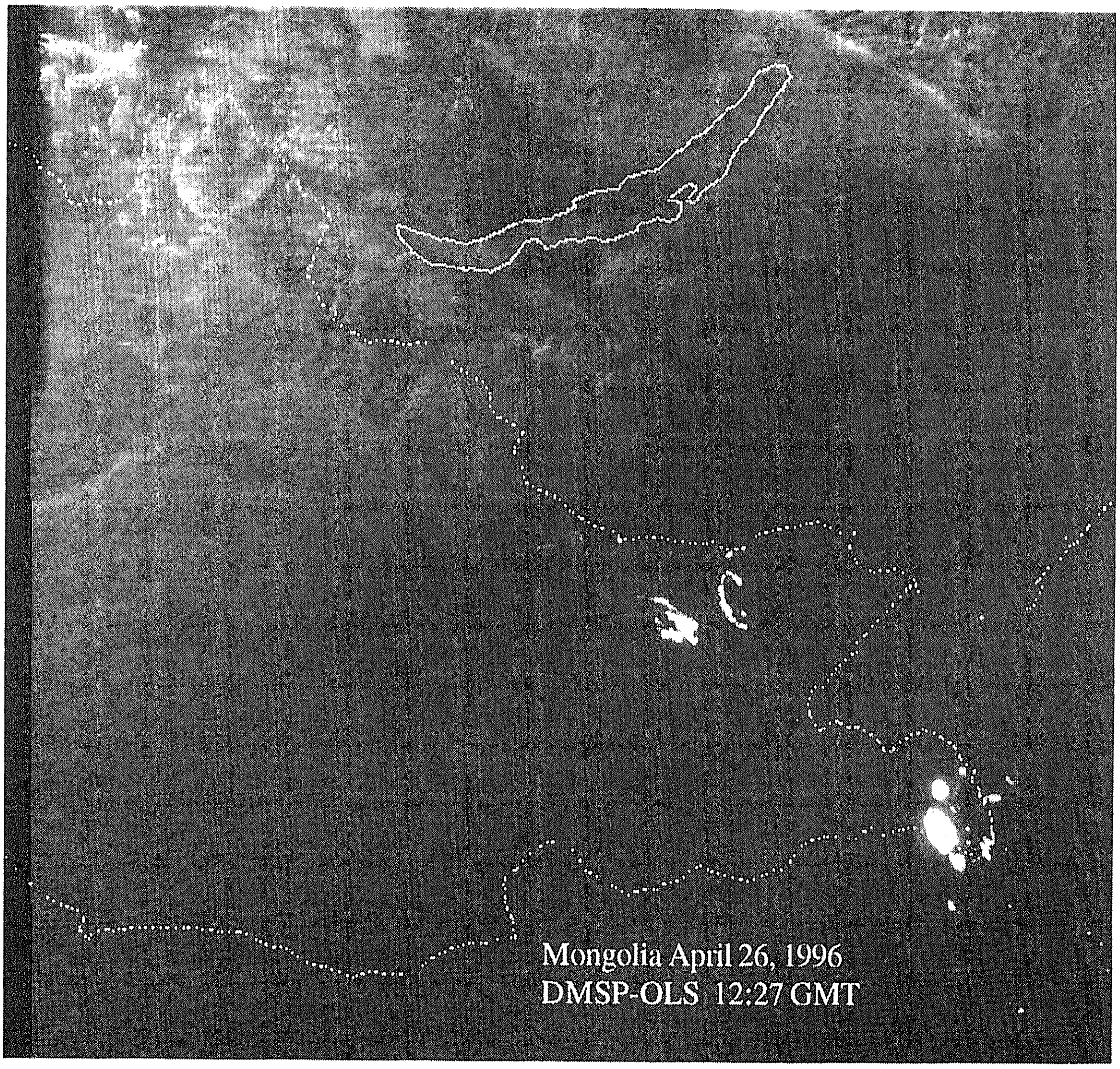

Figure 2. Fires observed at night in north-east and far-eastern Mongolia using DMSP-OLS data acquired April 26, 1996 at 12:27 GMT. Note fire ring in north-east.

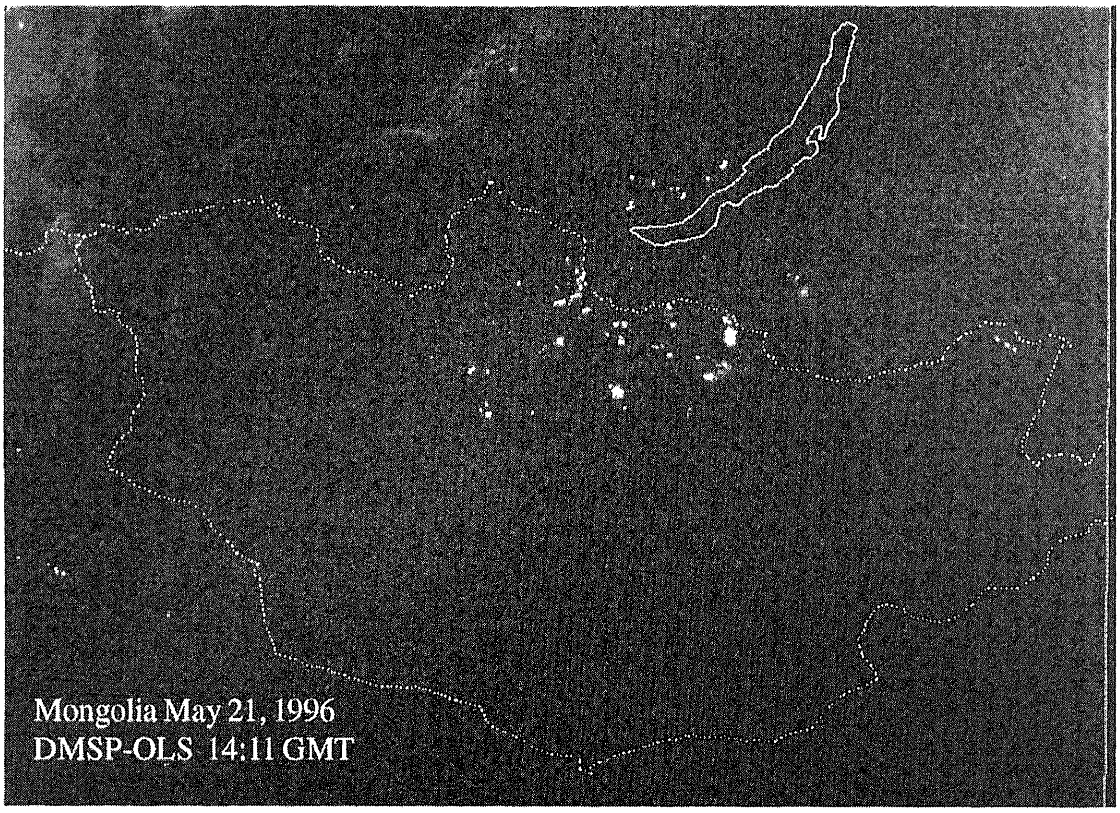

Figure 3. Fires observed at night in north-central Mongolia using DMSP-OLS data acquired May 21, 1996 at 14:11 GMT.