PLANS FOR SOUNDING INSTRUMENTS ON CHINESE SATELLITE

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ABSTRACT: Two experimental polar—orbiting satellites called Feng—Yun 1A and Feng—Yun 1B were launched in 1988 and 1990 respectively by China. The instrument aboard the satellite was 5—channel radiometer. Though their lifetime were short they provided excellent imagery data. The sounding instrument is under development. The first generation of sounder called ASIS (Atmospheric Sounding Infrared Spectroradiometer) has 20 channels similar to present HIRS boarding on TIROS—N/NOAA satellites. The potential of adding two more infrared and several visible channels to ASIS can be expected. It is possible to test ASIS on Feng—Yun 1D scheduled in late 1990s. The more advanced sounder will cover both infrared and microwave spectrum with performance close to or better than the current HIRS and MSU. There are 22 infrared and 7 microwave channels. The satellite to fly the chinese sounder will be Feng—Yun 3 which is the another series of Chinese polar—orbiting satellites to be launched around the year 2000. The data format of Chinese imager and sounder is very similar to one adopted by TIROS—N/NOAA satellite to comfort the current ground receiveing and processing systems over the world.

1. INTRODUCTION

China is developing her own meteorological satellite system to satisfy the request from meteorological, hydrological, agricultural and transpotation users. There are three series of satellites in plan. The frist experimental polar—orbiting satellite called Feng—Yun 1A (Chinese meaning of Feng—Yun is Wind —Cloud) was put up to sky in September 1988. Aboard the satellite was 5—channel radiometer (3 visible, 1 near—infrared and 1 infrared window). FY—1A provided excellent visible and near infrared images but was failed in window channel. Unfortunately FY—1A survived only 39 days and

the attitude was out of control after then. The second one Feng—Yun 1B was launched in September 1990. This time both visible and infrared channels worked well til mid—February 1991 the same problem as precedor appeared. Various measures were taken to rescue the satellite. After three months hard working FY—1B was brought back and provided data again but discontinuously til late 1992 when the rescue action was given up. The succeedors of FY—1 series will carry more advanced imaging instrument. That is a 11—channel radiometer for variety of application purposes.

The second series of meteorological satellites is Feng—Yun 2. It is the geostationary satellite and the on board instrument will be 3—channel (visible, infrared and water vapor) spin scan radiometer. The launch time of first FY—2 is scheduled in mid—1990s.

The satellite with sounding capability is Feng—Yun 3. It is a new series of polar—orbitng satellites. The sounder on satellite covers both infrared and microwave spectrum bands. The time to launch such satellite will be around the year 2000. The possibility is existed to test the sounding instrument on satellite of FY—1 series, for instance FY —1D. That means the sounder might be up to sky earier than the year 2000.

2. SOUNDER SPECIFICATION

Chinese have learnt much from pioneer's practice. In sounder development the HIRS and MSU boarding on TIROS—N/NOAA satellites are our main references. For simplicity we temporarily call Chinese sounding instruments as CHIRS and CMSU. CHIRS consists of 22 channels. The channel selection of first 20 channels refers to HIRS2 and HIRS3. Additional two channels are based on numerical simulation. Channel 21 in 15. 03 microns is for measuring the upper—air temperature and channel 22 in 4. 2 microns is for monitoring the greenhouse gas CO2. Table 1 lists CHIRS channel locations and their mission.

Table 1. Specification of CHIRS

Ch. No	Wave No. (CM—1)	Band Width	Absorber (CM—1)	Measurement
1	668. 90	3	CO2	

Ch. No	Wave No. (CM−1)	Band Width	Absorber (CM−1)	Measurement
2	679.81	10	CO2	
3	690.13	12	CO2	
4	703.23	16	CO2	Temperature Profile
5	715.82	16	CO2	
6	733.14	16	CO2/H2O	
7	749.06	16	CO2/H2O	
8	900.09	35	WINDOW	Surface Temp. & Cloud
9	1029.87	25	O3	Total Ozone
10	1225.00		WINDOW/H2O	
11	1364.26	40	H2O	Moisture Profile
12	1533.74	80	H2O	
13	2188.18	23	N2O	
14	2212.39	23	N2O	
15	2237.14	23	CO2/N2O	Temperature Profile
16	2247.19	23	CO2/N2O	
17	2421.31	23	CO2	
18	2500.00	35	WINDOW	Surface Temperature
19	2659.57	100	WINDOW	
20	14492.75	1000		Cloud
21	665.55	3	CO2	Upper−Air Temperature
22	2382.50	5	CO2	CO2 Concentration

The channel selection of CMSU refers to MSU, AMSU, SCAMS and NEMS. The first version of CMSU will consists of 7 channels with two kinds of combinations. The parameters of CMSU are shown in Table 2. The laboratory model is being developed. The first generation of CMSU has no capability of profiling the atmospheric moisture. Study of 183, 150 and 90 GHz microwave channels have been recommended.

Table 2. Specification of CMSU

Ch. No	Wave No. (GHz)	Band Width (MHz)	Absorber	Measurement
1	50.31	220	WINDOW	Surface Temp. & Emissivity
2	53.74	220	O2	
3	54.96	220	O2	Temperature Profile
4	57.95	220	O2	
5	22.235(V)	250	H2O	Total Precipitable Water
6	37.00(H,V)	600	WINDOW	Rain Rate & Vegetation
7	19.35(H,V)	220	WINDOW	Surface Feature
6	31.40(H,V)	600	WINDOW	Liquid Water
7	89.00(H,V)	6000	WINDOW	Rain Rate

3. LABORATORY MODEL OF CHIRS

The laboratory model of CHIRS named ASIS (Atmospheric Sounding Infrared Spectroradiometer) is being developed in the Shanghai Institute of Technical Physics, Chinese Academy of Sciences (Zhang Zhaoxian et al. ,1992). It is a 20—channel spectroradiometer with 22 filters. Two extra filters are for enhancing the channel detectibility. It is possible to use extra filters for additional two new infrared channels to make it a 22—channel sounder. Table 3 lists the specification of ASIS—2 (model 2).

Table 3. Characteristics of ASIS—2 (experimental model)

SATELLITE ALTITUDE	900 km
SATELLITE INCLINATION	99 degree
OPTICAL VIEW ANGLE	1.225 (longwave infrared)
	1.20 (shortwave infrared)
	1.25 (visible)
SCAN ANGLE	−49.5 ——+49.5
CALIBRATION	warm blackbody 290 K
	cold blackbody 265 K
DETECTOR	HgCdTe (6.7 −15 um)
	InSb (3.7 − 4.6 um)
	Si (0.69 um)

DETECTOR TEMPERATURE	105 K
DIAMETER OF TELESCOPE	15 cm
SIZE OF INSTRUMENT	70 cm X 32 cm X 32 cm
WEIGHT OF INSTRUMENT	~ 40 kg
POWER	~ 35 watts (average)

Table 4 shows the performances of ASIS−2.

Table 4. Performances of ASIS−2 (experimental model)

CHANNEL	WAVE NUMBER (cm−1)	BAND WITDH (cm−1)	TRAN. OF FILTER (%)	NE△N (mW. m−2. sr−1. cm)
1*	669.5	4	29	1.7
2	678.0	11	70	0.48
3	690.0	11	75	0.36
4*	706.0	13	77	0.17
5	715.5	15.5	68	0.25
6	733.5	16	74	0.22
7	750.0	16	74	0.22
8	893.0	36	68	0.09
9	1026	25.5	84	0.18
10	1233	55	82	0.13
11	1360	39	85	0.13
12	1470	75	88	0.12
13	2188	26.5	68	0.005
14	2206	20.5	65	0.005
15	2240	28.5	70	0.003
16	2263	24	72	0.0042
17	2352	24	72	0.0026
18	2499	35	69	0.0026
19	2671	113	79	0.0007
20	14619	971	65	<0.1% (A)

* Two pieces of filters

The optical schematic diagram of ASIS－2 is shown in Figure 1. Since the visible channel has its own optical pass, the potential to add more (7 to 8) visible channels is existed if a filter wheel is put in front of visible detector Si. The energy is enough to do such expansion according to designer's calculation. The arrangement of infrared filters is given in Figure 2. The longwave and shortwave infrared channels are located in different rings for easy management of HgCdTe and InSb detectors. Two repeated filters can be used as new channels if the ratio of signal to noise is large enough for channel 1 and channel 4.

The scanning way of CHIRS follows HIRS, i. e. 56 steps across the orbit with flight calibration every 37 scans. The data format is also consistent with one adopted by TIROS－N/NOAA for the convenience of international users.

4. CONCLUSIONS

After more than twenty years application of satellite data the important role of meteorological satellites has been recognized by more and more people and governmental agencies. The numerous ground receiving systems including national, regional, provincial, city even county level are widespread distributed over China continent. The meteorologists, hydrologists and oceanographers now can not survive without satellite data. For satisfing the increasing requests from variety of users China has been developing her own meteorological satellite systems including both polar－orbiting and geostationary satellites. The imaging instruments have been successful by the nice data provided by FY－1A and FY－1B and the sounding instruments are still under development. The needs of global coverage sounding data for improving the medium－range numerical weather prediction model has been put forward. Though the first generation of sounder is not very advanced it is compatible with our current level of technology. The input and cooperation from international communities to chinese meteorological program are always welcome. Since China has benefited so much from international space programs to do some contribution as much as possible is our best wishes.

5. REFERENCES

Zhang Z. X. and Wang M. C., 1992: Atmospheric Sounding Infrared Spectroradiometer II (ASIS－2): Experimental Model. J. Infrared Millim. Waves, Vol. 11, No. 4, 265－270.

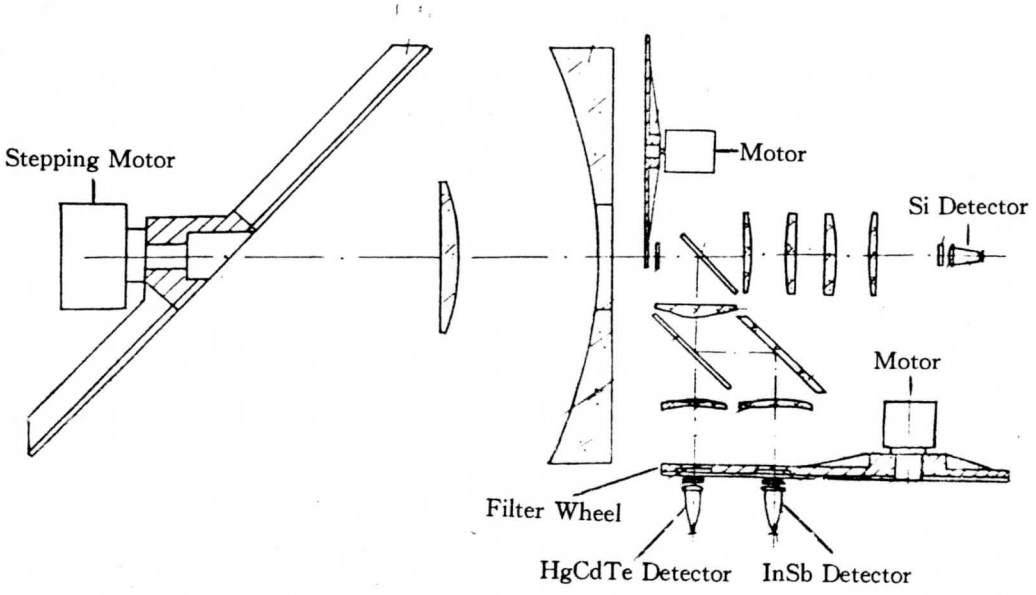

Fig. 1 Optical schematic diagram of ASIS—2

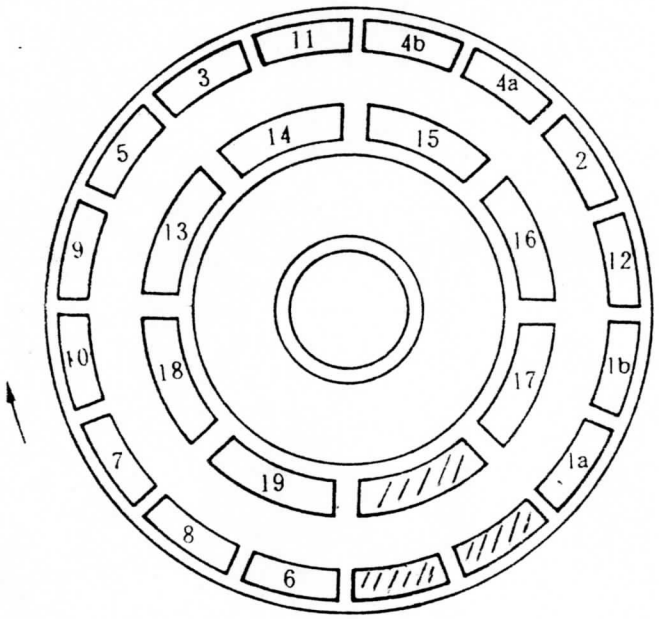

Fig. 2 Infrared channel arrangement on filter wheel

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