Continuing the HIRS Cloud Record with CrIS and IASI

W. Paul Menzel, Elisabeth Weisz, and Richard Frey - CIMSS / SSEC / UW

Approach

The High-resolution Infrared Radiation Sounder (HIRS) cloud data record, started in 1978 and continuing late into this decade, is being extended using data from the Cross-track Infrared Sounder (CrIS) on Suomi-NPP (and subsequent JPSS) as well as the Infrared Atmospheric Sounding Interferometer (IASI) on Metop. This involves reducing the high spectral resolution CrIS/IASI data to resemble the HIRS broad band spectral coverage and estimating the cloud top pressures (CTPs) and effective emissivities. Co-located HIRS and IASI data from MetOp-A are being used initially to provide proof of concept. In addition, the IASI high spectral resolution data are being investigated for opportunities to characterize the uncertainties in the HIRS broad band cloud products. Cloud top processing (infrared window, IRW, for opaque water clouds and CO_2 slicing for semi-transparent ice clouds) on IASI, convolved IASI, and HIRS measurements are being compared; CALIOP cloud top determinations are used as reference when possible. These CTPs are being sorted by cloud optical depth at individual CTPs to characterize the CTP accuracy as a function of cloud semitransparency.

One Granule HIRS, HIRS-IASI, IASI Example Comparison

19 January 2009 CTPs are derived using CO_2 slicing plus IRW on IASI and HIRS measurements. The cloud phase (determined with the tri-spectral technique from Strabala et al. (1995)) guides application of IRW for water and CO_2 slicing for ice clouds. On Metop, IASI with 12 km field-of-views (FOVs) at nadir samples 4 FOVs every 50 km while HIRS samples with 10 km FOVs every 20 km cross-track and 40 km along track; IASI has a higher sampling density with a larger footprint than HIRS/4. These scan and FOV differences cause HIRS to find fewer clouds than HIRS-IASI (especially non-opaque clouds - this is most pronounced in the global example below right); a cloud is determined if at least 15% of the AVHRR FOVs within the HIRS or HIRS-IASI FOV are cloudy. NE is cloud fraction x cloud emissivity. The clean IRW from IASI provides more clear sky or very low cloud detection than HIRS where the broadband IRW has water vapor contamination. In this granule IASI provides more mid-level cloud definition than HIRS.

HIRS CO2 CTP [hPa]   HIRS/IASI CO2 CTP [hPa]   IASI CO2-Slicing and IRW CTOP [hPa]
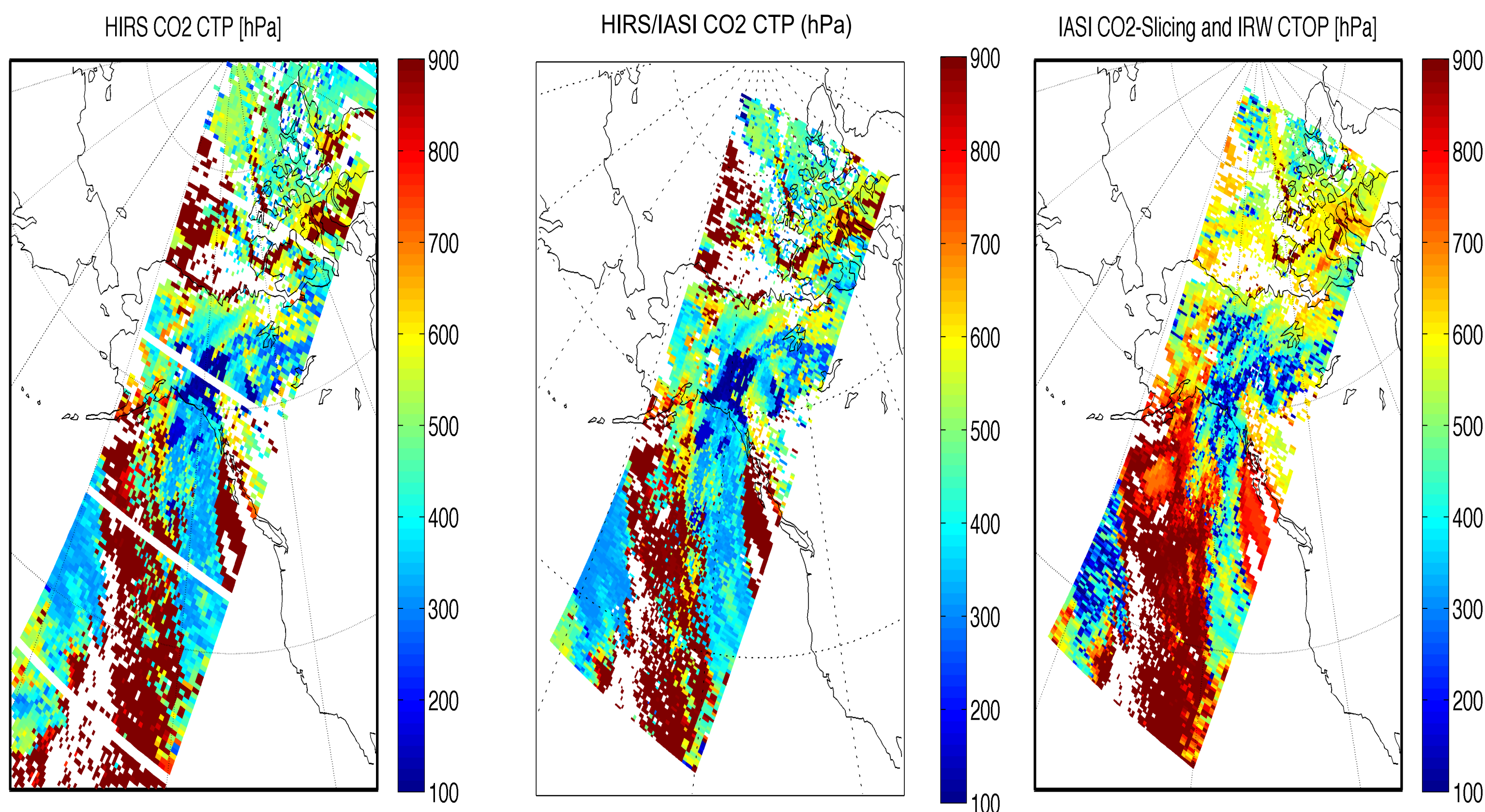
One granule distribution (% of all observations) of HIRS (H), HIRS-IASI (H-I) and IASI (I) cloud determinations

	Thin (NE<0.5)			Thick			Opaque (NE>0.95)			Total		
	H	H-I	I	H	H-I	I	H	H-I	I	H	H-I	I
High (<440 hPa)	10	12	2	14	16	11	4	4	4	28	32	17
Mid	9	10	0	10	10	1	7	7	34	26	26	35
Low (>660 hPa)	4	5	0	7	8	0	12	9	29	23	22	29

HIRS Data Record Description

### 16 HIRS sensors used for 35+ year cloud study

morning (8 am Desc Node)
NOAA 6 HIRS/2 - 1979
NOAA 8 HIRS/2 - 1983
NOAA 10 HIRS/2 - 1986
NOAA 12 HIRS/2 - 1991
NOAA 15 HIRS/3 - 1998
NOAA 17 HIRS/3 - 2002
METOP-A HIRS/4 - 2006
METOP-B HIRS/4 - 2012

night (2 am Desc Node)
NOAA 5 HIRS - 1978
NOAA 7 HIRS/2 - 1981
NOAA 9 HIRS/2 - 1984
NOAA 11 HIRS/2I* - 1988
NOAA 14 HIRS/2I* - 1994
NOAA 16 HIRS/3 - 2000
NOAA 18 HIRS/4 - 2005
NOAA 19 HIRS/4 - 2009

Split window change: HIRS & HIRS/2 ch 10 is 8.6 um and HIRS/2I, /3, & /4 is 12.5 um .
Orbit Drift: Asterisk (*) indicates drift from 14 to 18 UTC over 5 years of operational use.
S/N improved in HIRS/3. FOV improved to 10 km FOV for HIRS/4 (previously 20 km FOV).
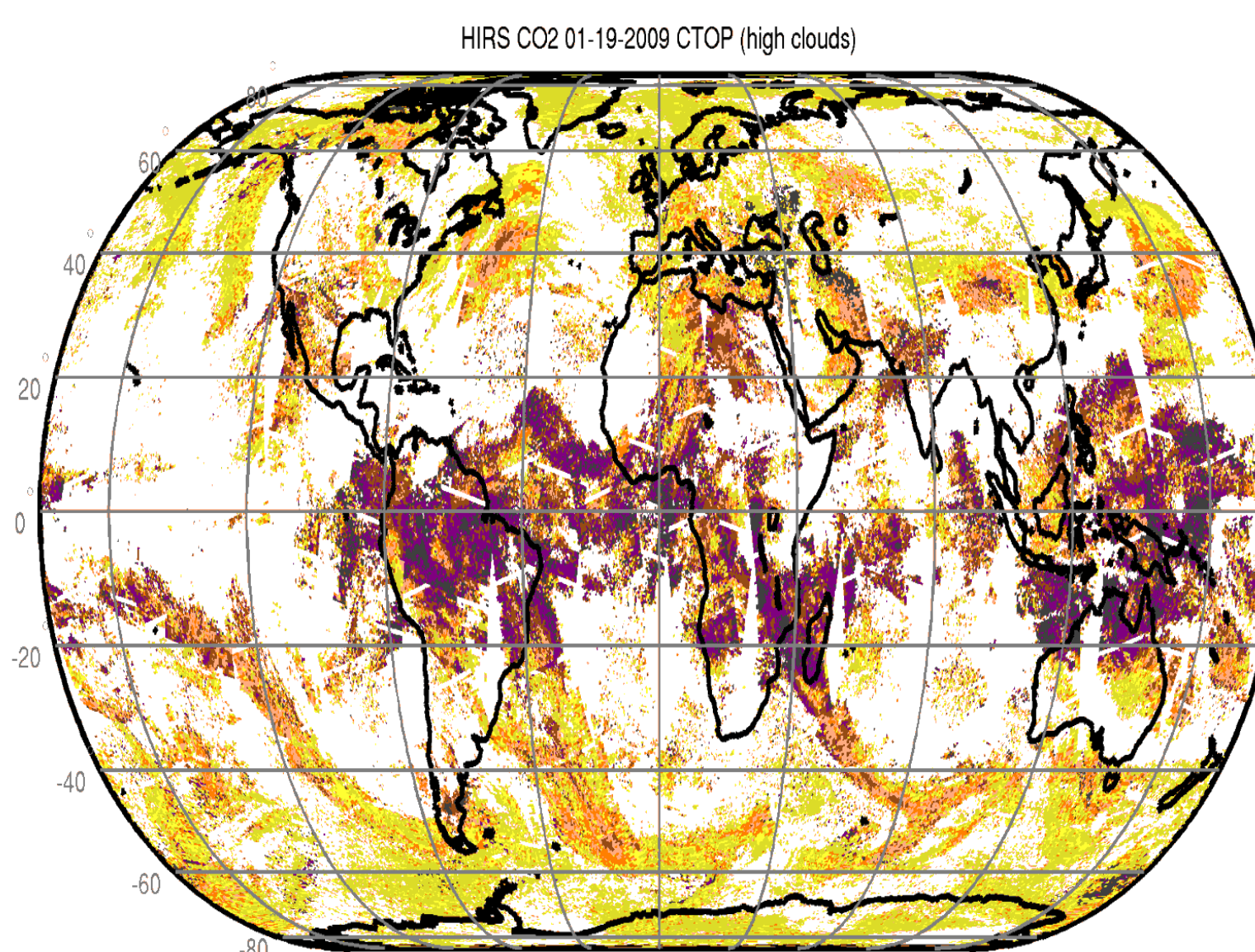HIRS coverage: More than 100 satellite years in HIRS data set.
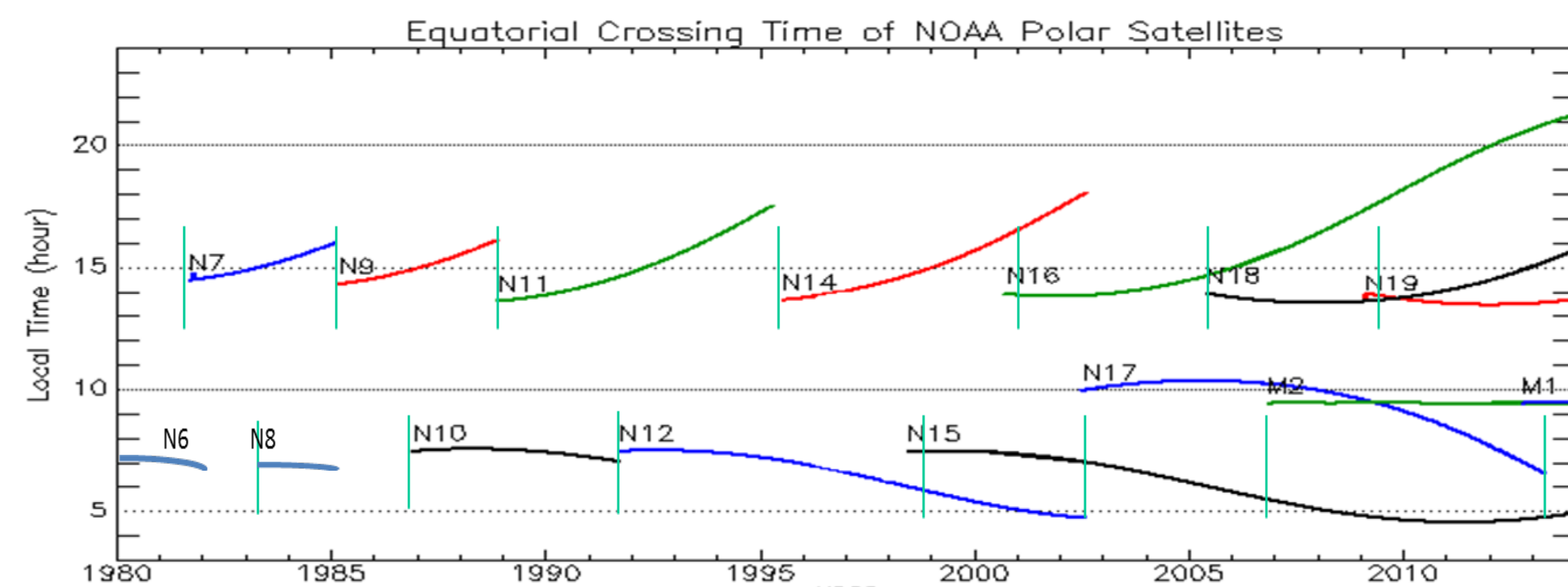
Products
CTP (within 50 hPa)
Global 4X daily
(+/- noon in daylight,
+/- midnight at night)
L3 - 0.5 deg bins
L2 - 20 km res

Algorithm
MODIS heritage

Cloud Mask
AVHRR PATMOS-x

Users
NWP ReAnalyses
Climate Modelers
Regional Trends

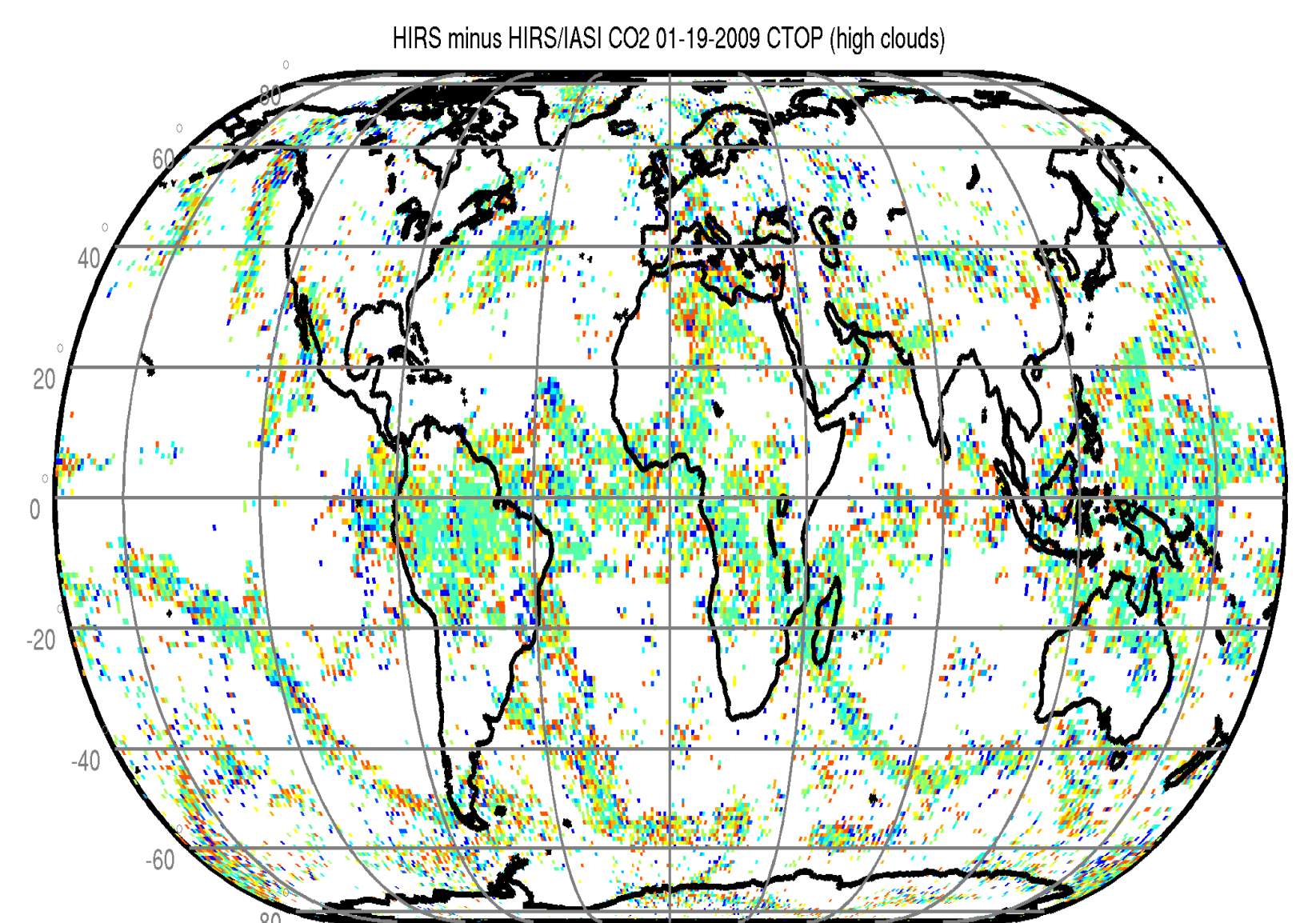Night time High Cloud Frequency 30N to 60N
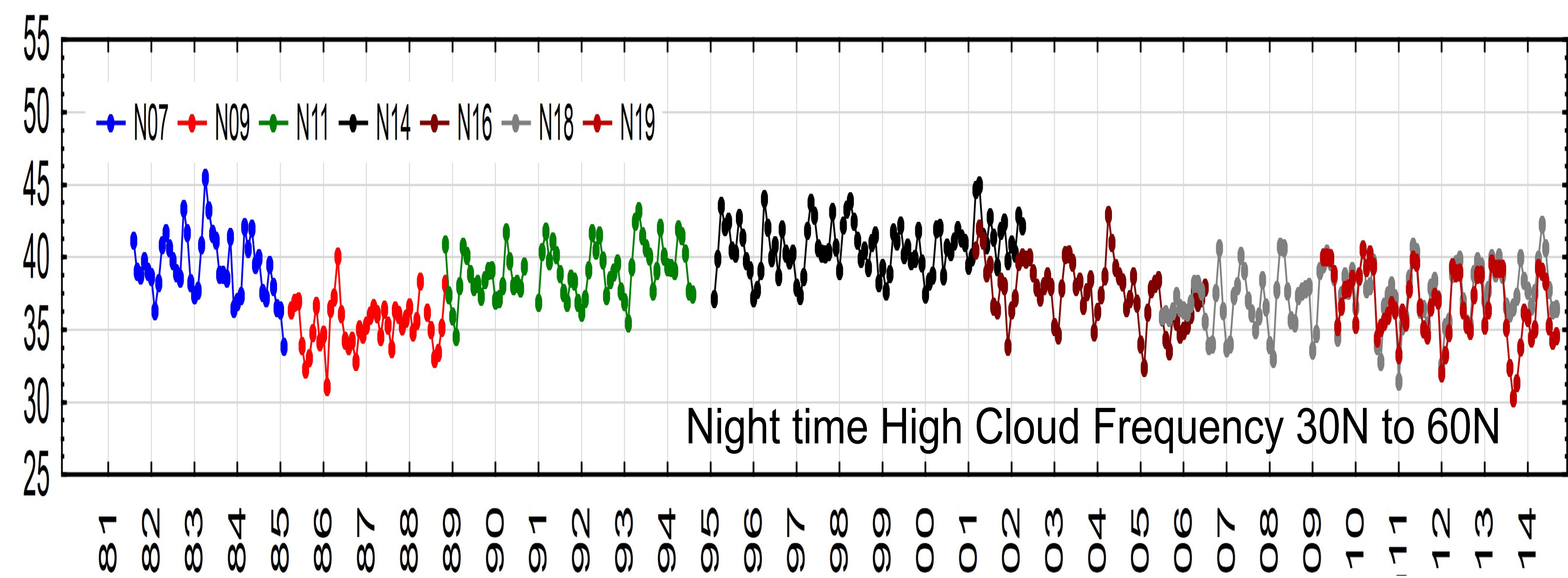
Global HIRS & HIRS-IASI Comparison 19 Jan 2009

HIRS High CTPs   HIRS less HIRS-IASI High CTPs

Distribution (% of all observations) of HIRS (H) & HIRS-IASI (H-I) cloud determinations 60N-60S

	Thin		Thick		Opaque		Total	
	H	H-I	H	H-I	H	H-I	H	H-I
High	17	23	13	14	3	2	33	40
Mid	4	5	6	5	3	2	12	12
Low	4	6	7	9	18	10	29	25

HIRS-IASI results, from HIRS-like retrievals on IASI measurements convolved to HIRS spectral channels, indicate that continuing the HIRS cloud record can be done with IASI and CrIS (CTPs within 25 hPa).