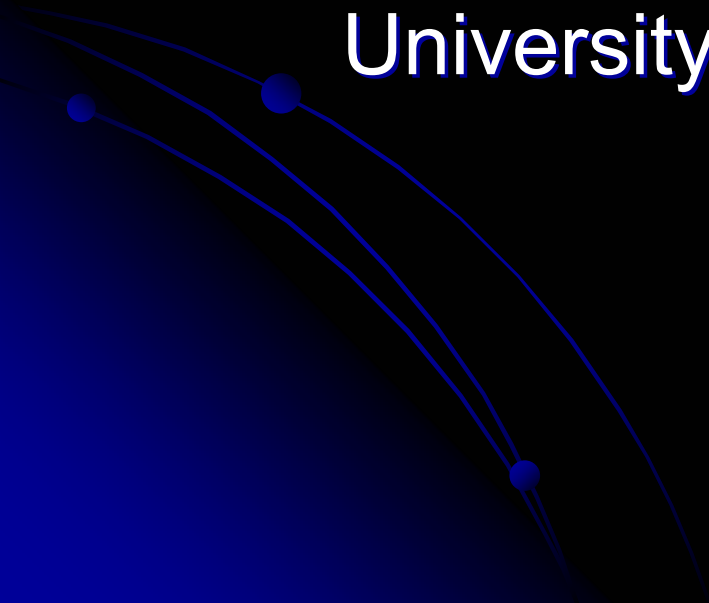


Steve Ackerman

University of Wisconsin-Madison



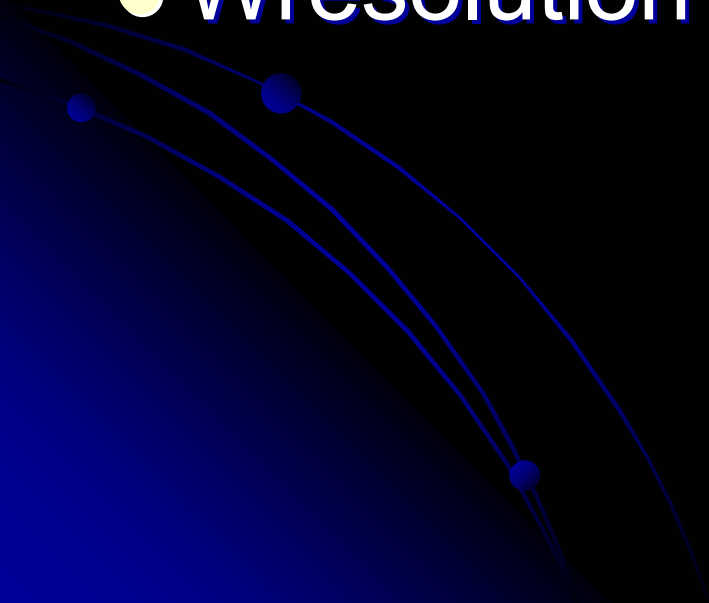
Hyperspectral sensors collect information as a set of 'images'. Each image represents a range of the electromagnetic spectrum and is also known as a spectral band. These 'images' are then combined and form a three dimensional hyperspectral cube for processing and analysis.

Hyperspectral Imaging is related to multispectral imaging. The distinction between hyperspectral and multispectral is usually defined as the number of spectral bands. Multispectral data contains from tens to hundreds of bands. Hyperspectral data contains hundreds to thousands of bands. However, hyperspectral imaging may be best defined by the manner in which the data is collected. Hyperspectral data is a set of contiguous bands (usually by one sensor). Multispectral is a set of optimally chosen spectral bands that are typically not contiguous and can be collected from multiple sensors.

Satellite Meteorology

The four W's

- When
- Where
- Wavelength
- Wresolution



The **HyspIRI mission** includes two instruments mounted on a satellite in Low Earth Orbit. There is an imaging spectrometer measuring from the visible to short wave infrared (VSWIR) and a multispectral thermal infrared (TIR) imager. The VSWIR and TIR instruments will both have a spatial resolution of 60 m at nadir. The VSWIR will have a temporal revisit of approximately 3 weeks and the TIR will have a temporal revisit of approximately 1 week

380 to 2500 nm in the solar reflected spectrum

10 nm {uniform over range}

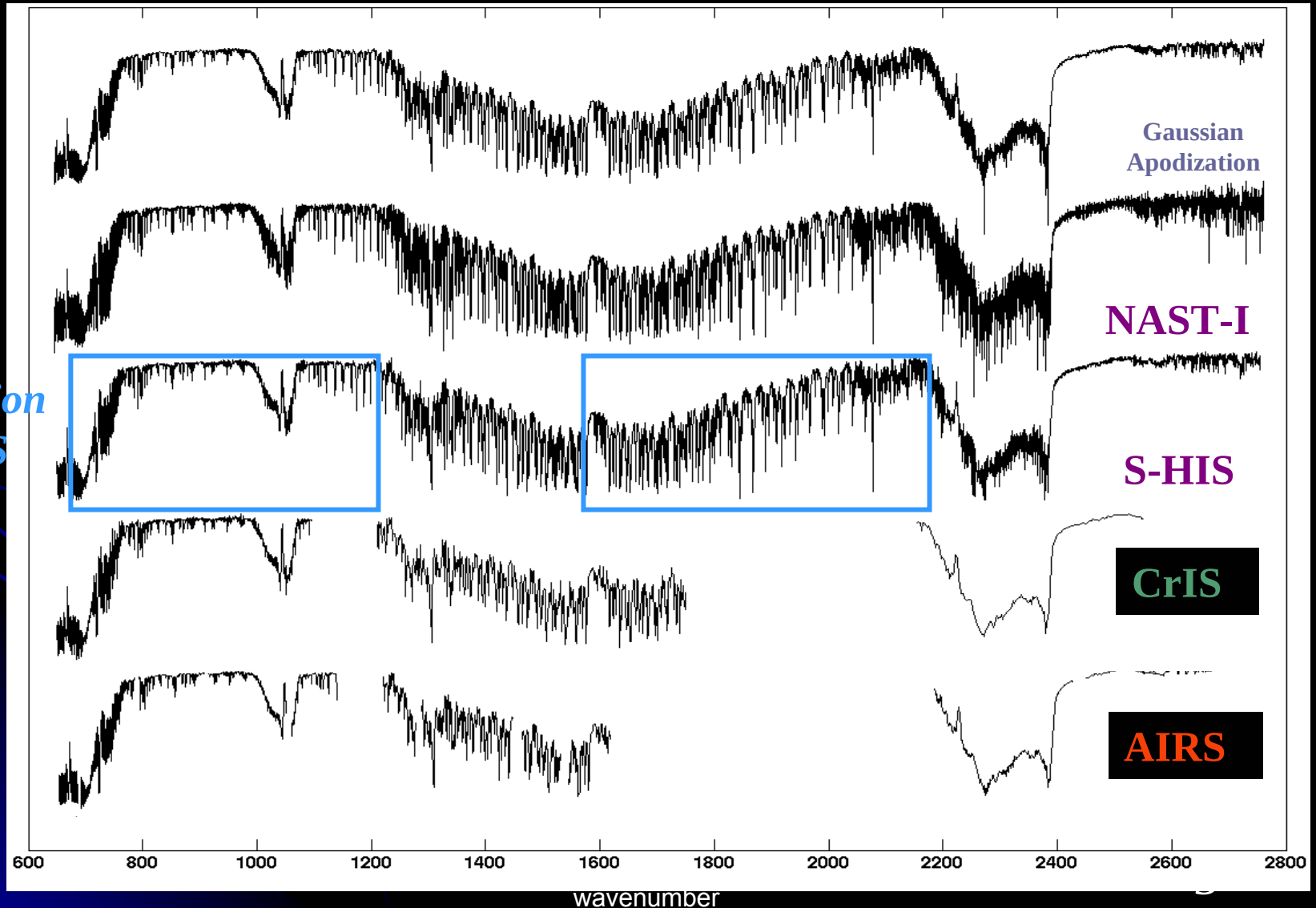
<0.5 nm

3.98 μm , 7.35 μm , 8.28 μm , 8.63 μm , 9.07 μm , 10.53 μm ,
11.33 μm , 12.05 μm

0.084 μm , 0.32 μm , 0.34 μm , 0.35 μm , 0.36 μm , 0.54 μm ,
0.54 μm , 0.52 μm

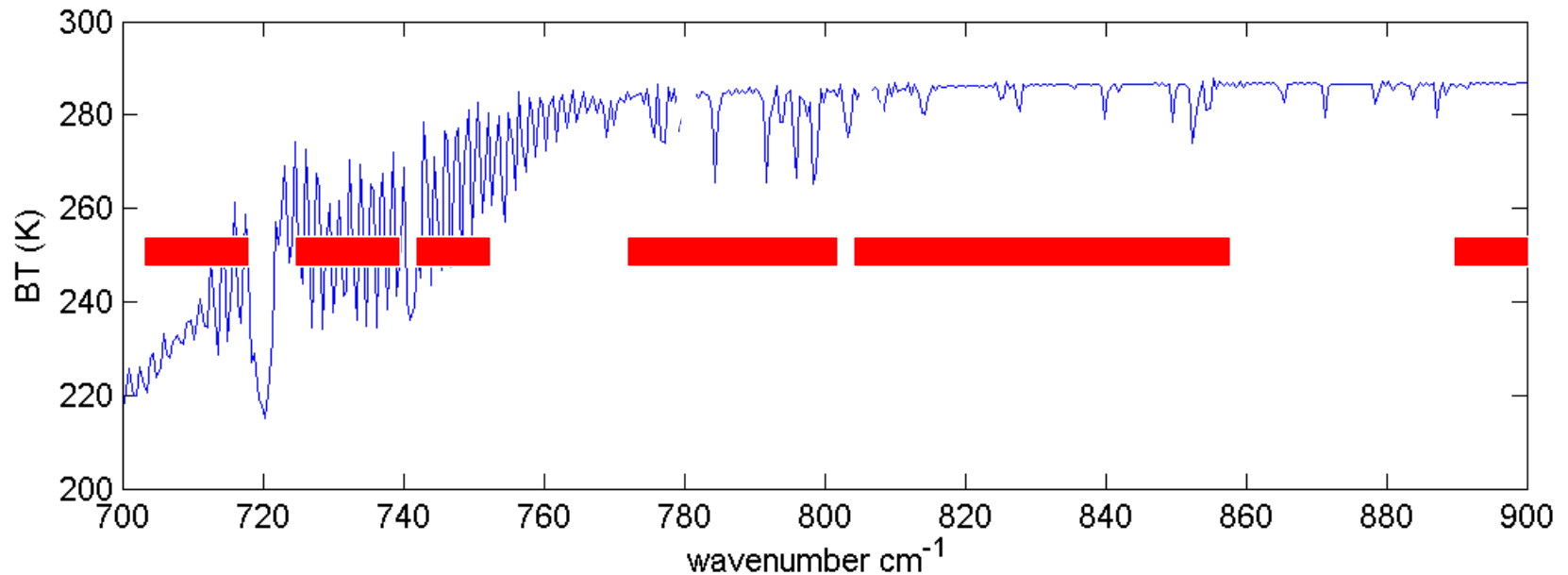
Example T_b Spectrum from IASI:

Processed to represent **S-HIS** & **NAST-I**, **AIRS** & **CrIS**



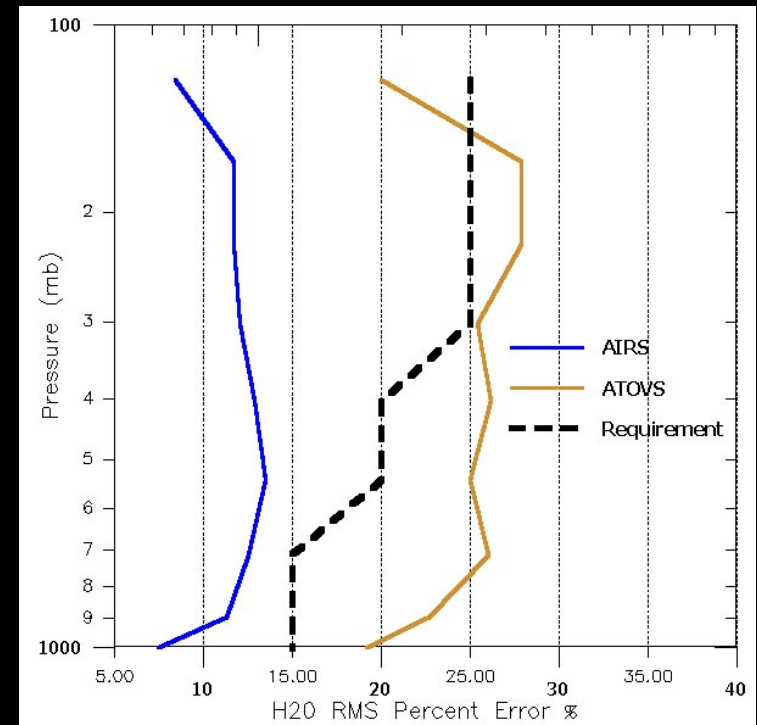
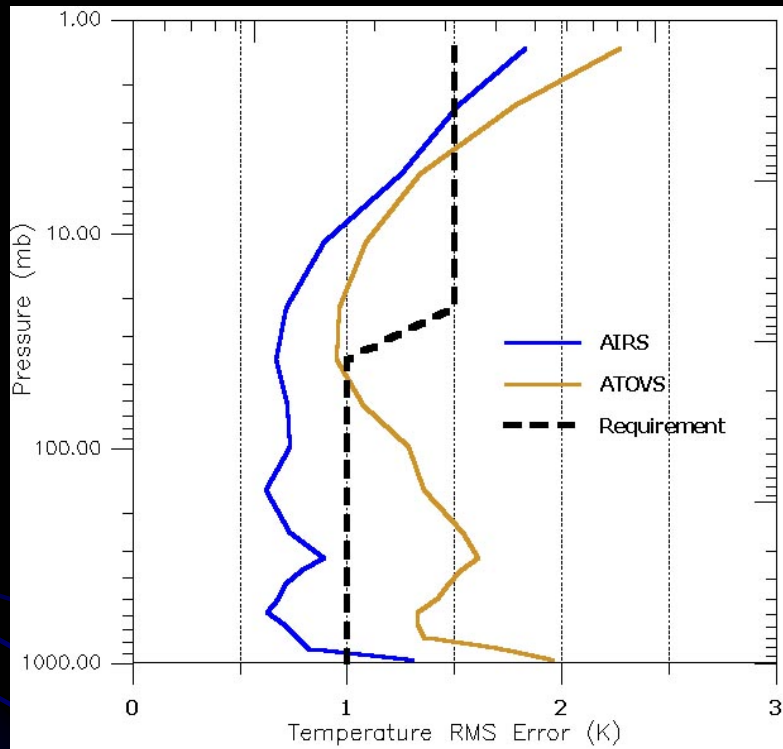
*HES option
& GIFTS*

What's different about a high spectral resolution sounder?



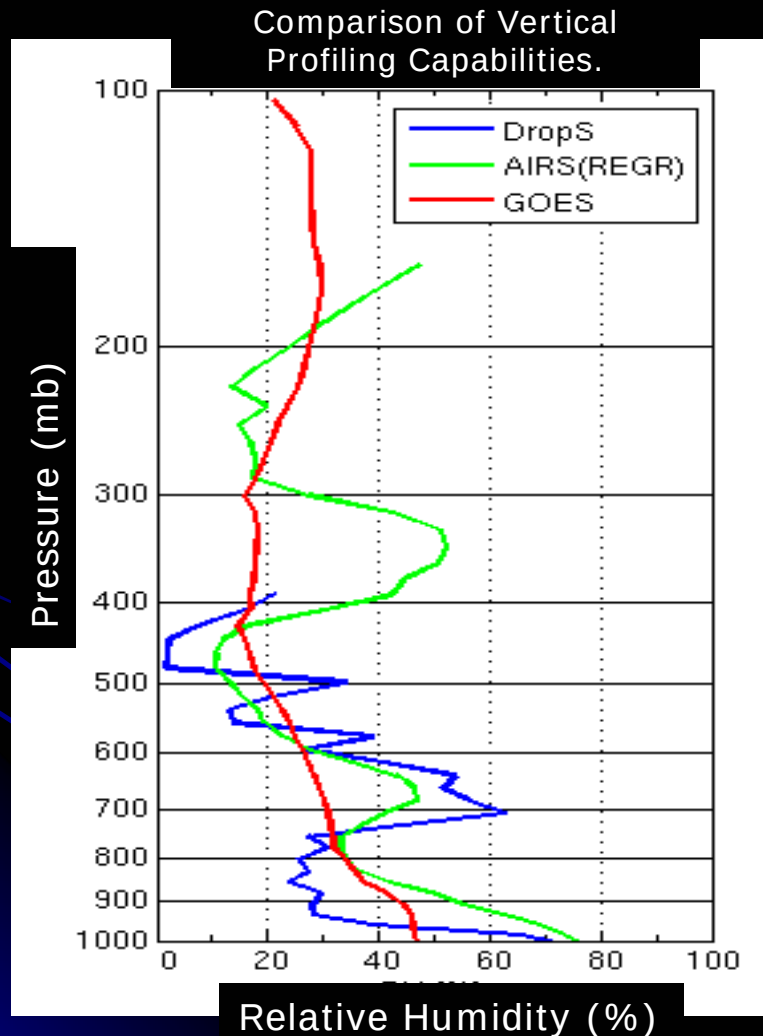
Observing absorption lines is mandatory to meeting requirements for temperature and moisture structure needed to improve weather forecasting

Capability: Vertical Profiling



AIRS (blue) is providing significant improvements in temperature and moisture soundings over current operational NOAA sounders (ATOVS - brown). Vertical resolution has also improved from 3 – 5 km to 1 – 2 km

Capability: Vertical Profiling

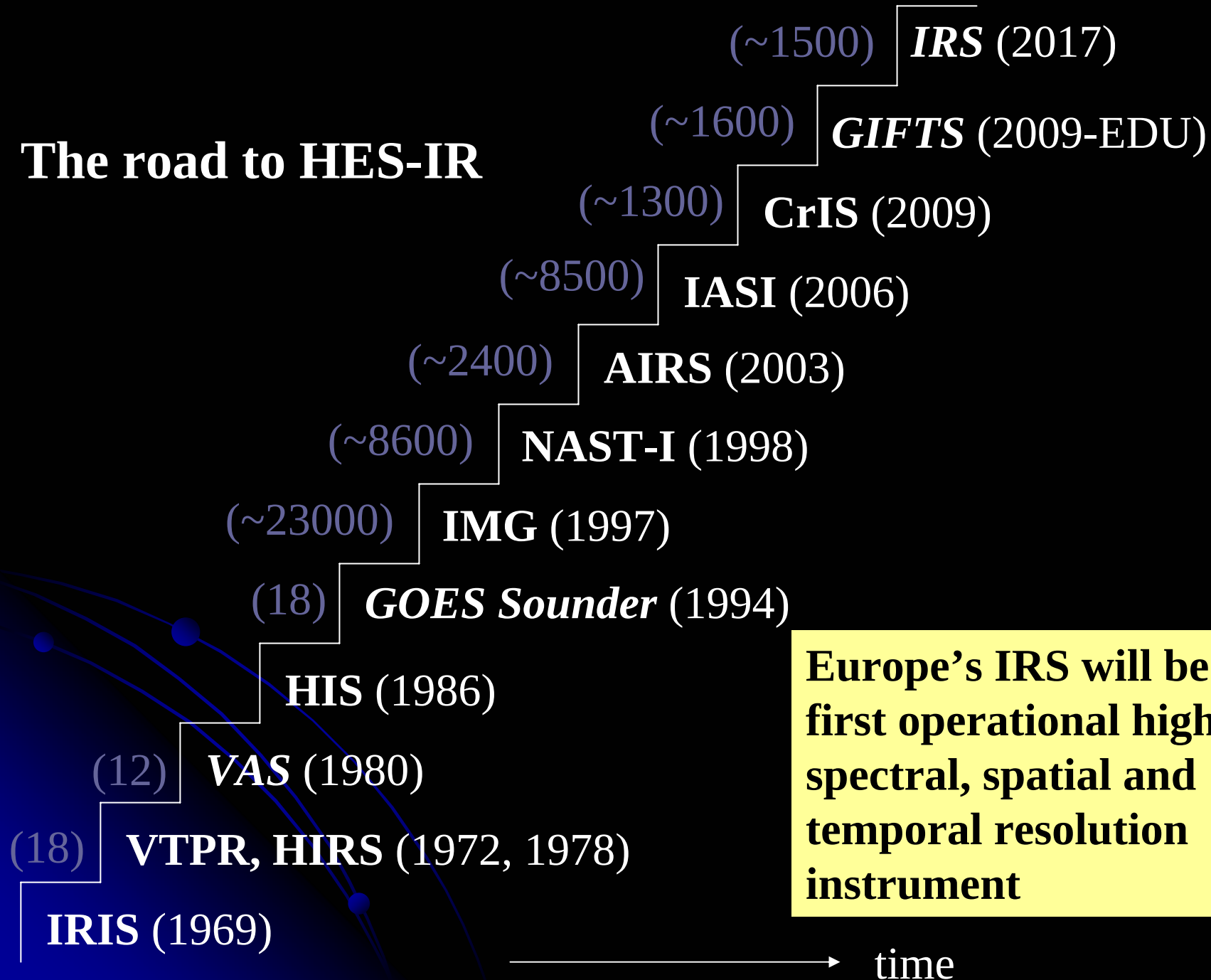


Dropsonde is in situ observation of the atmosphere from an aircraft (blue)

AIRS (green) and GOES (red) Relative Humidity (RH) retrievals.

High-spectral resolution instrument is in much better agreement with in situ measurement.

The road to HES-IR



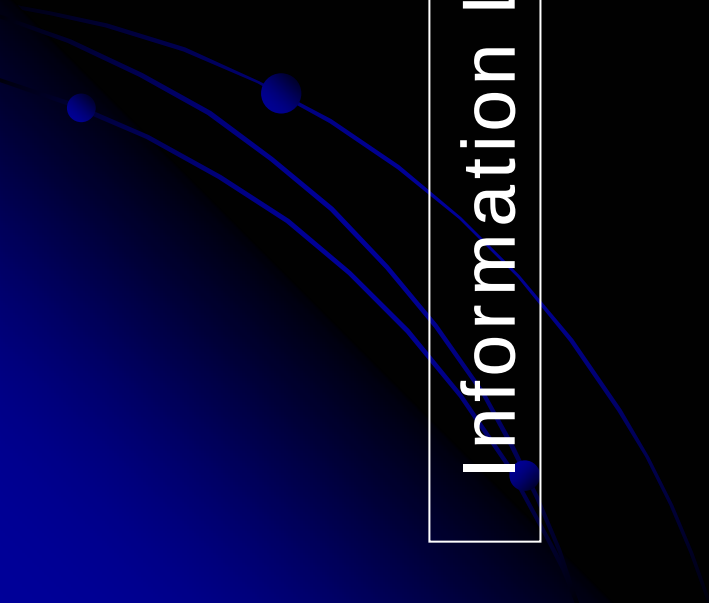
A Conceptual Model...

Science Literacy

Information Literacy

Data Literacy

Statistical Literacy



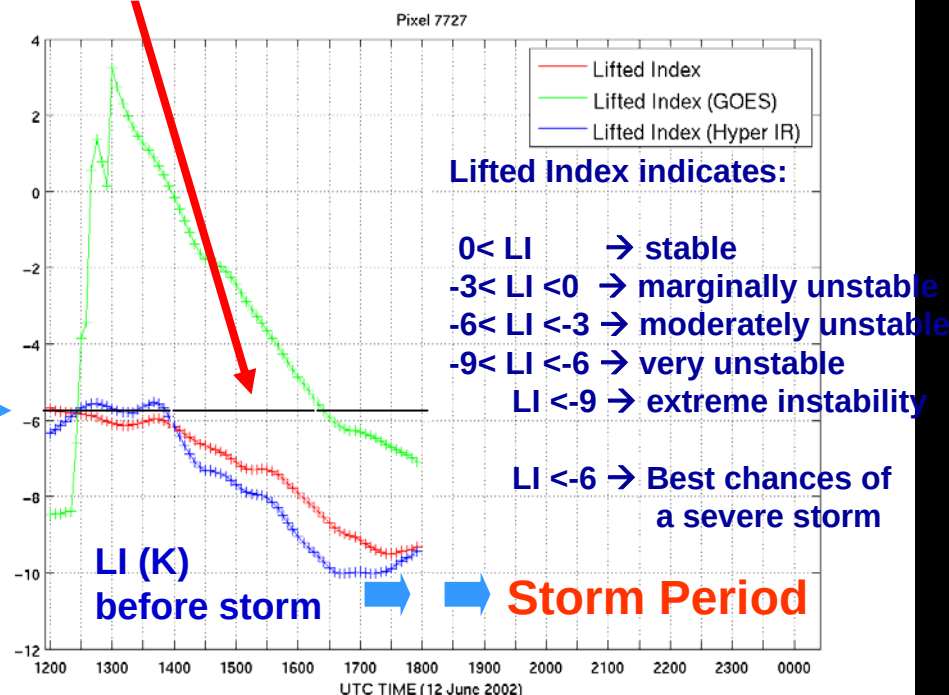
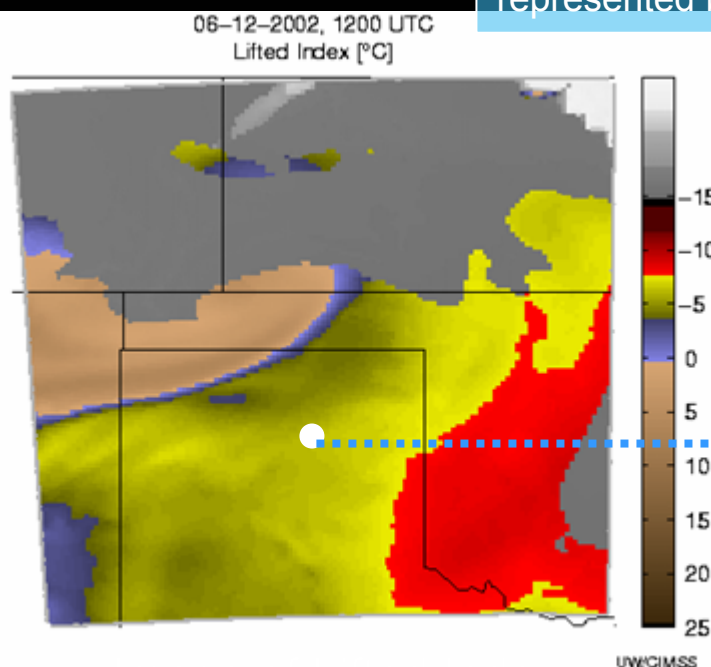
Requirement: Vertical Profiling

Observational Requirement (Product Criticality)	Science Needs	Measurement Thresholds (Goal)	Science Requirement
Atmospheric Vertical Temperature Profile (1)	Atmospheric soundings of temperature and moisture define stability. Optimum repeat cycle of one hour of sounder coverage for global Numerical Weather Prediction (NWP).	Range: 180-320 K Accuracy: 1K (0.5K)	Vertical Resolution: Surface-500 hPa; 0.3-0.5 km layers 500 - 300 hPa 1 - 2 km layers 500 - 300 hPa 1 - 2 km layers above 100 hPa 2 - 3 km layers
Atmospheric Vertical Moisture Profile (1)		Range: Relative Humidity 0 – 100% Accuracy: Sfc-500 hPa: 10 % (5%) 500-300 hPa: 10% (5%) 300-100 hPa: 20% (10%)	

The vertical profile requirements are not being met in geostationary (GEO) orbit by current GOES, GOES-R and –S (present – 2022)

Benefit Example: Improved Thunderstorm Forecasting

Advanced IR Sounder (blue line) detects very unstable environment **2 hours earlier** than current GOES (green line). The actual LI is represented by the red line.



HES provides the atmospheric vertical structure that is critical to severe weather forecasting.

A Conceptual Model...

Science Literacy

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