What Comes Next?
or (A)ATSR a hard act to follow!

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Introduction

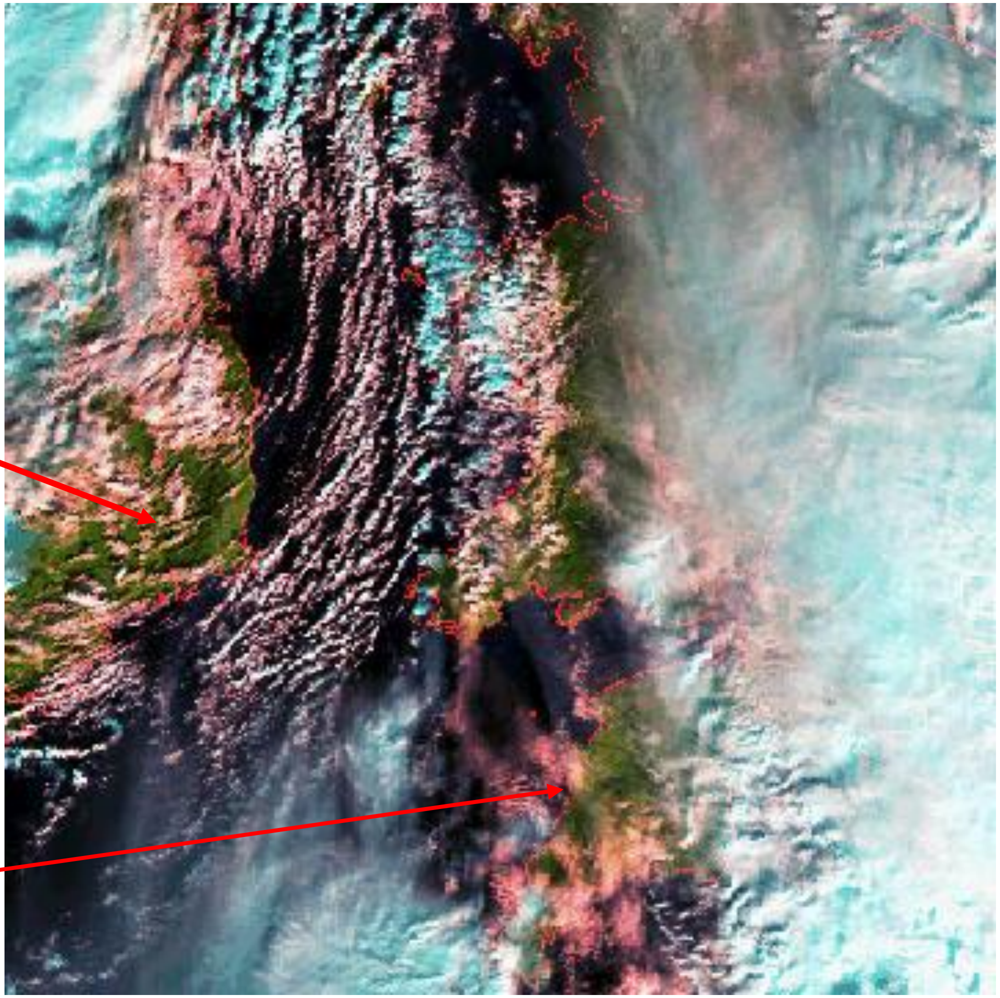
- By now you should be convinced that:
  - The ATSR Programme has and is still delivering the high-quality SST data it was designed to provide – it continues to be very successful.
  - ATSR SST data is now routinely used to calibrate other sensors:
    - ➔ as demonstrated by GODAE GHRSST Pilot Project and Medsipration
    - ➔ the Met. Office for calibrating their in situ observations
  - NOAA and others use ATSR-2 and AATSR visible channel calibration to improve AVHRR and other sensor's data quality
  - ATSR is now regarded as the gold-standard for SST determination

Other achievements – new products

- Important new science applications have been developed:
  - Clouds microphysical property retrievals – GRAPE Project
    - ➔ New insights into a key climate variable
  - Aerosol retrievals – GLOBAEROSOL
  - New developments in land remote sensing
    - ➔ Fire Atlas
    - ➔ Key contributions to GLOBCARBON
    - ➔ Land surface temperature products

Example ATSR-2 Cloud Retrieval

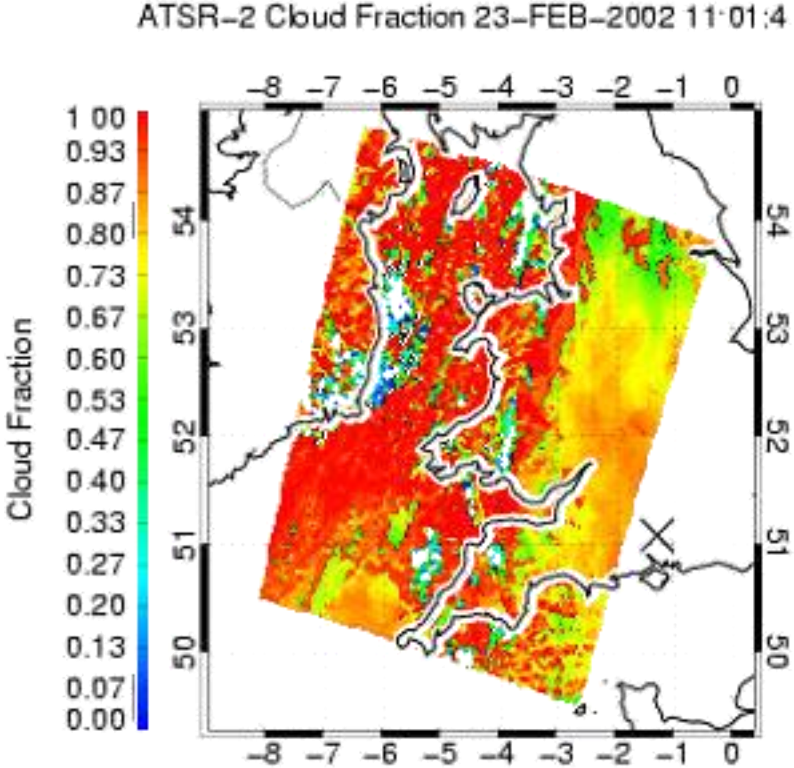
ATSR-2 false colour visible image composite



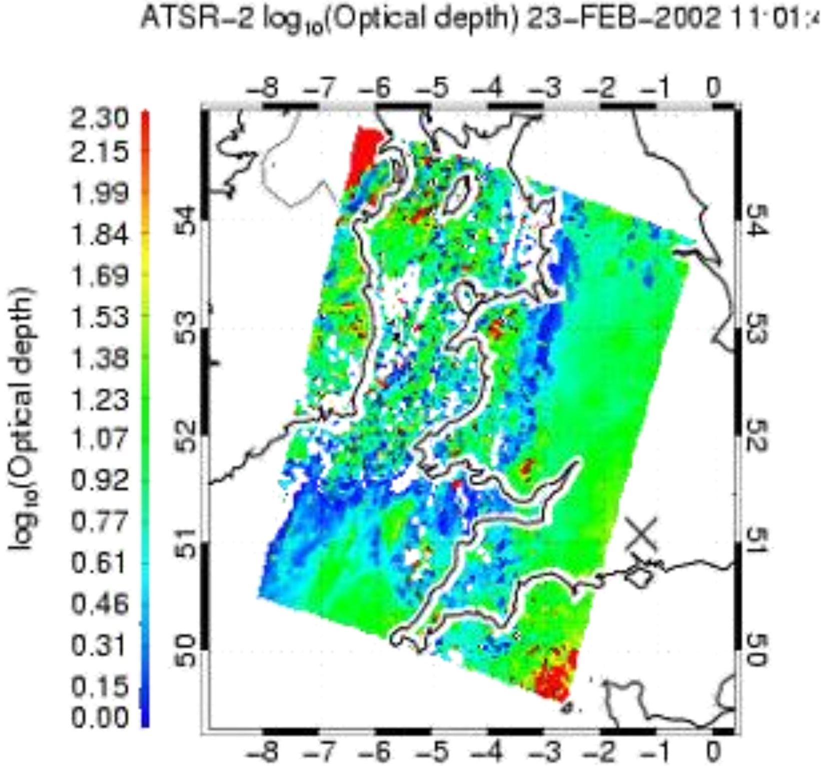
After Watts, Poulsen, et al.

Cloud Fraction and Optical Depth Results

Cloud Fraction

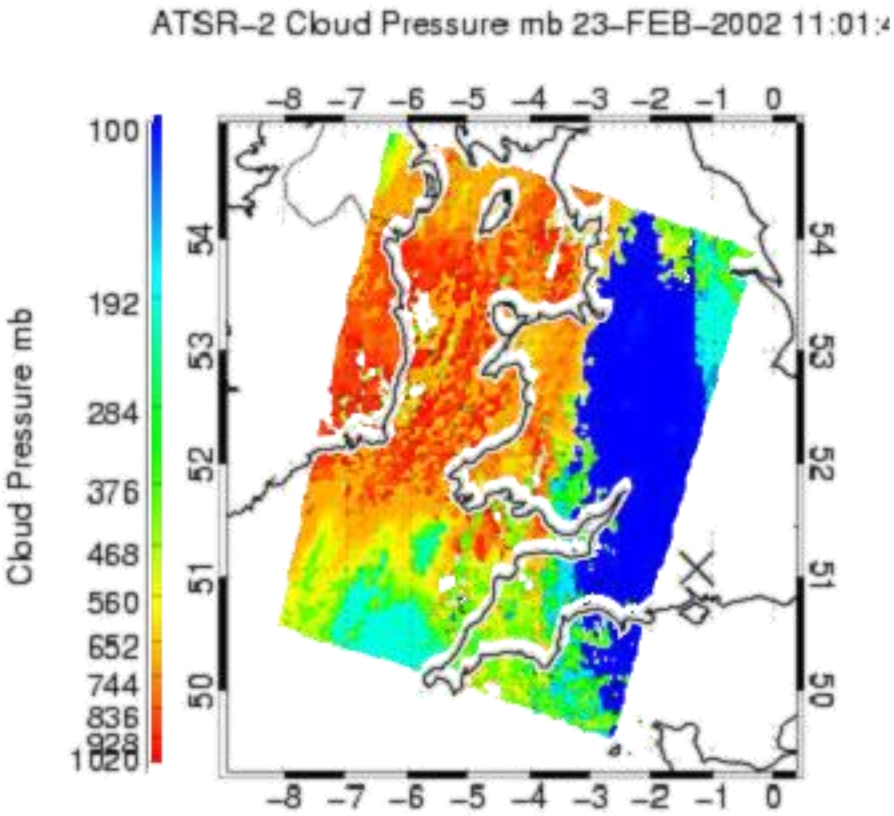


Optical Depth

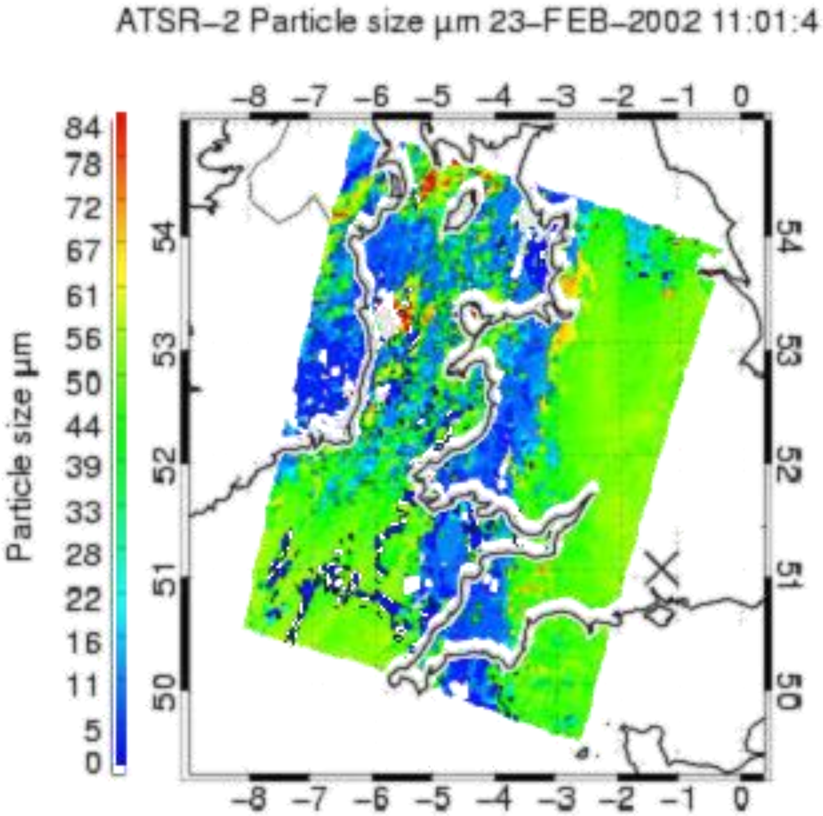


Cloud Pressure and Particle Size Results

Cloud Pressure

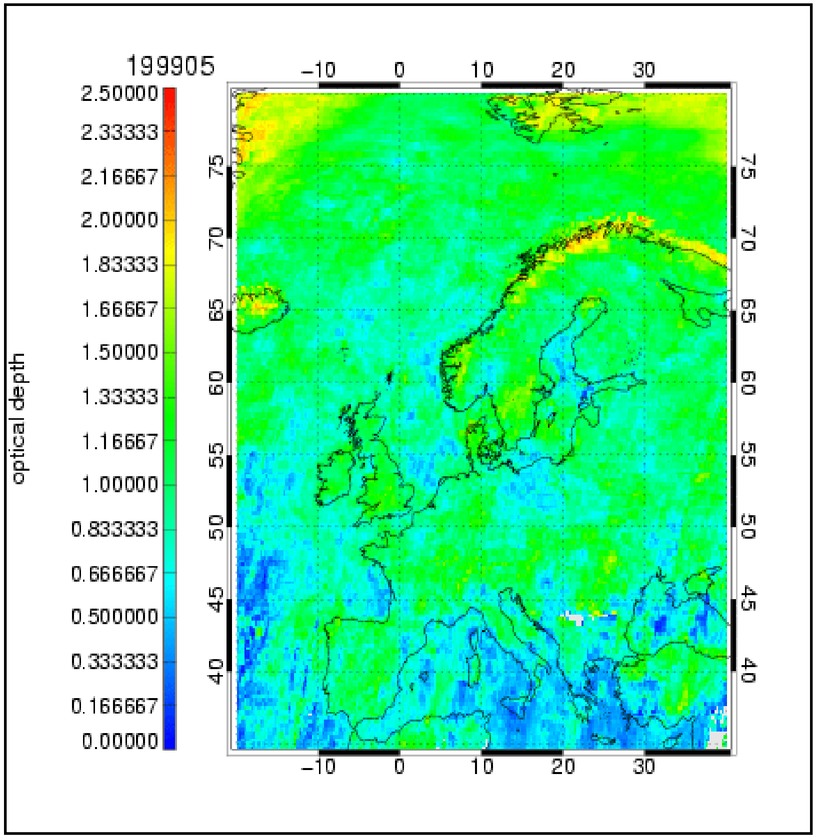


Particle Size

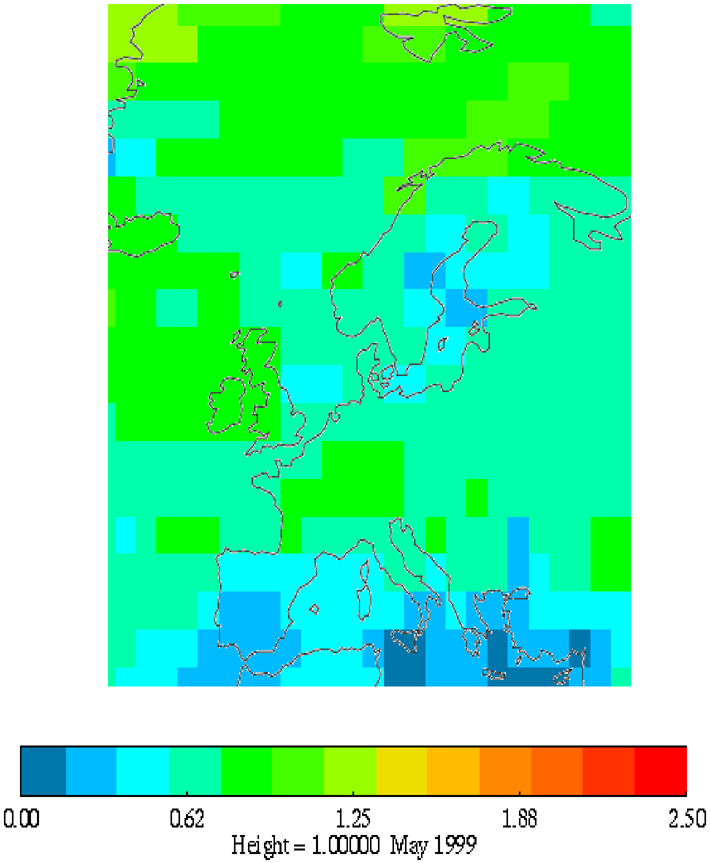


Comparison with ISCCP data

ATSR-2 May 1999 Optical depth



ISCCP Optical depth May 1999



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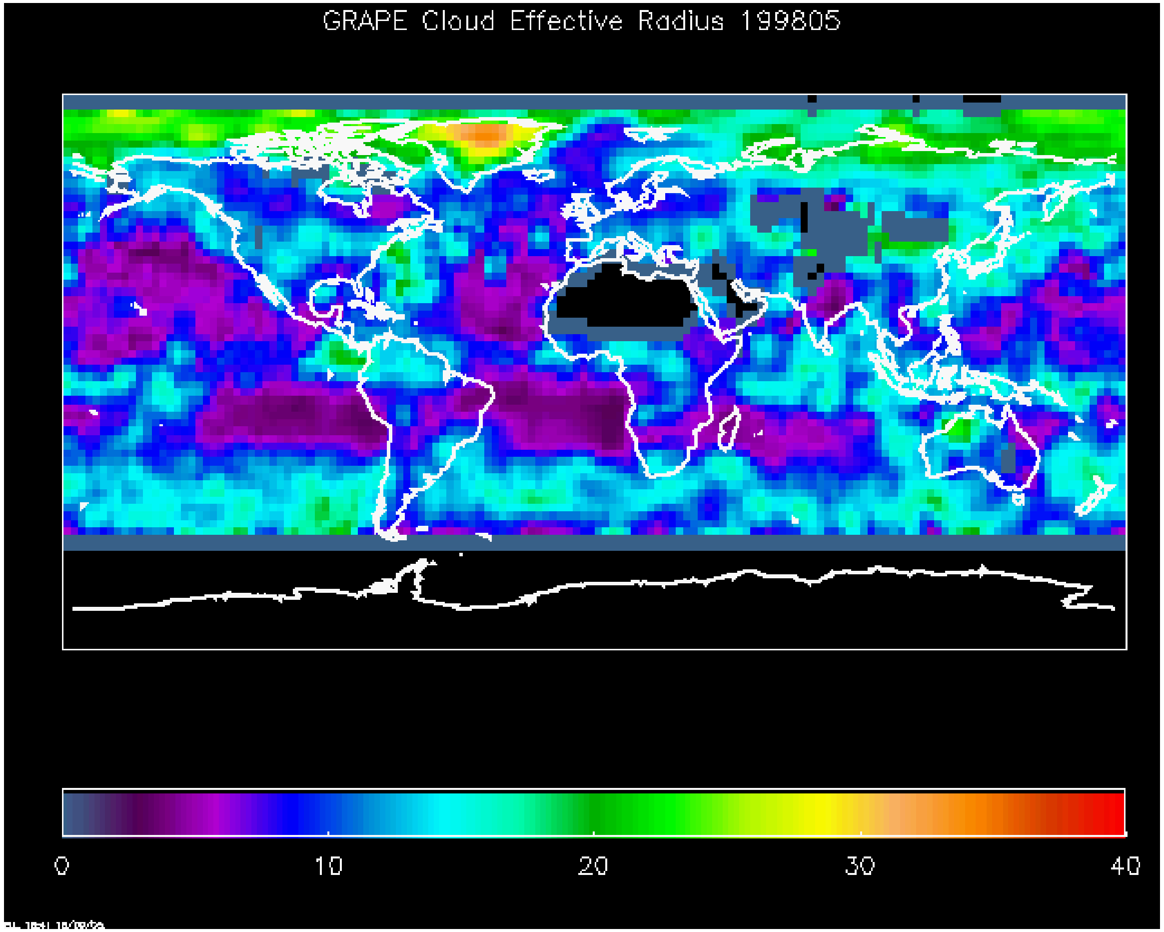
Example of global cloud product



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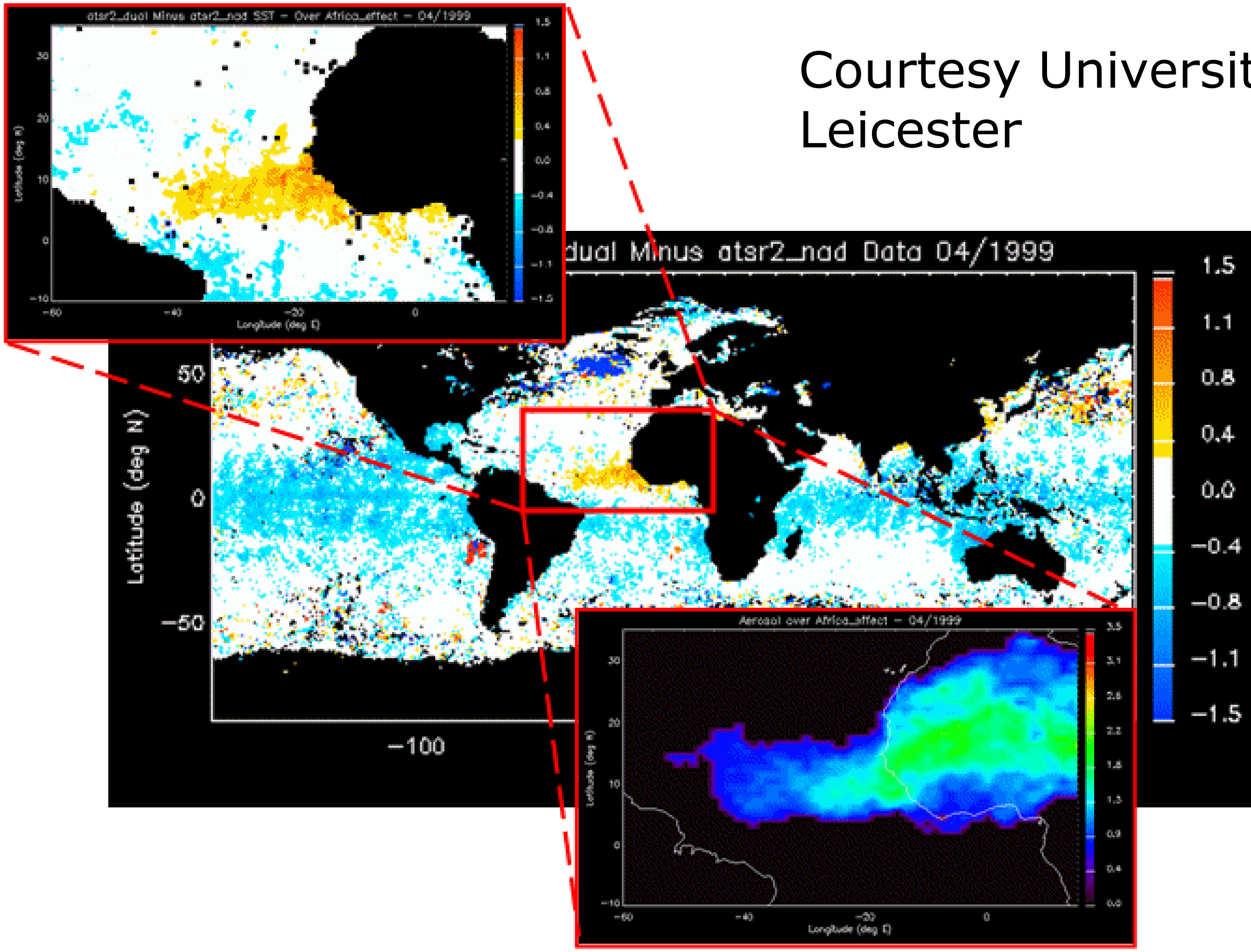
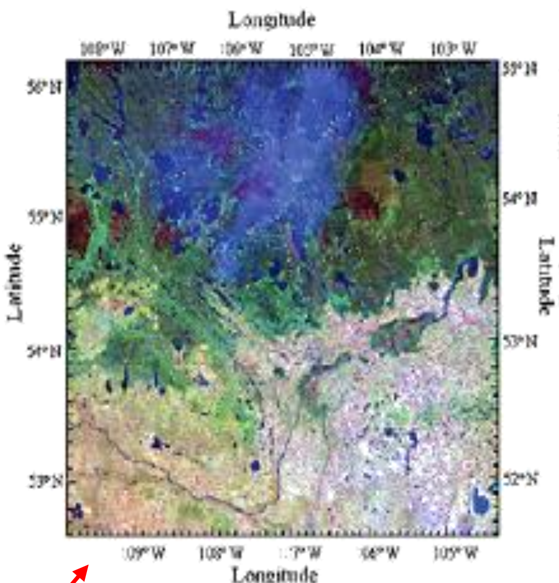
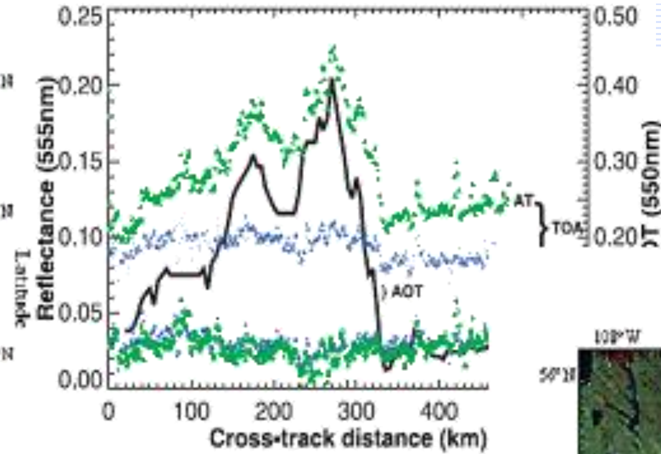
ATSR-2 SST (dual-nadir) *vs.* TOMS Aerosol Comparison

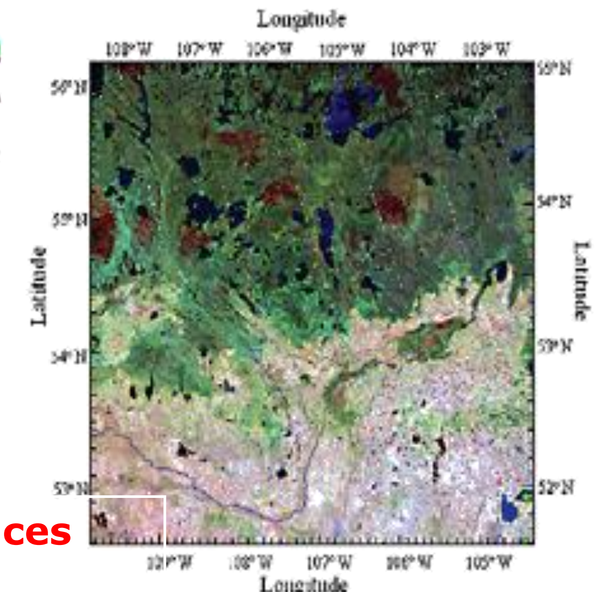


Courtesy University of Leicester

Separation of Bi-directional Reflectance from Atmospheric Effects using Dual View







ToA Reflectance at λ= 555nm

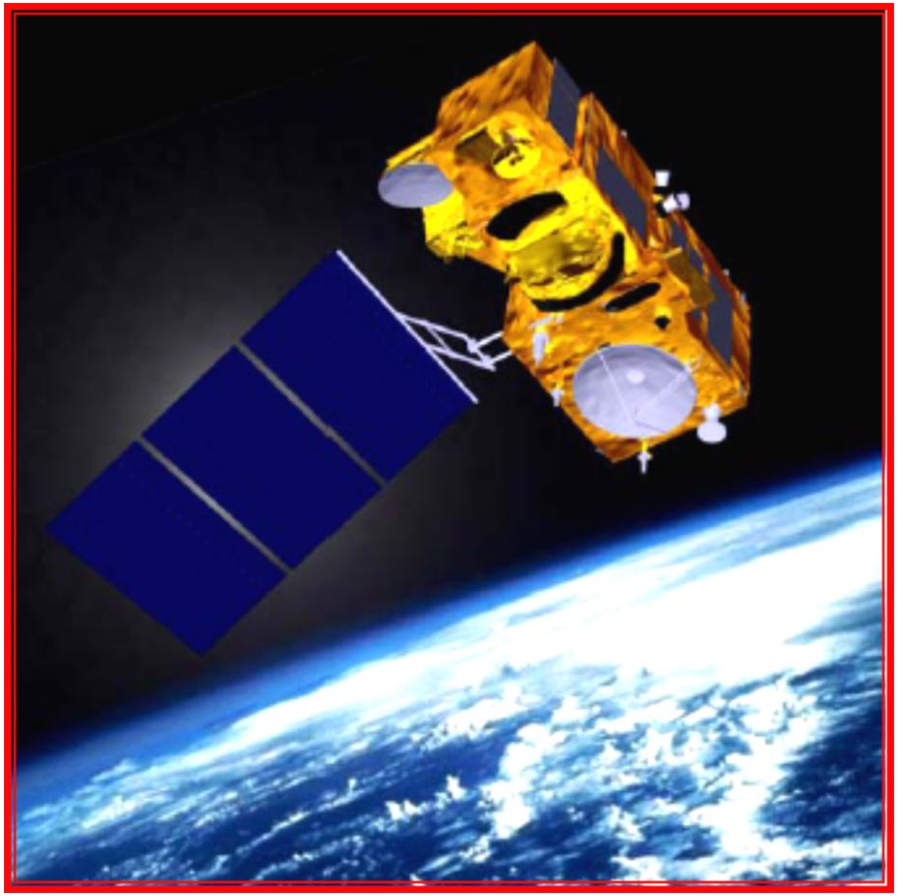
Forward and Nadir ToA reflectances
Gerund reflectance
Optical Depth

Retrieved ground reflectance

After North et al.

So what does come next?

- GMES Sentinel 3 Mission
  - Sea and Land Surface Temperature Radiometer (SLSTR)
  - Ocean colour sensor based on MERIS
  - Altimeter
  - Microwave radiometer
- Series of missions from 2012 to 2025



Project Core Team

- **Sentinel 3 Mission Prime**
    - **SLSTR Prime**
        - ➔ **Structure and Electronics**
        - ➔ **System Architect, Science Support and Calibration**

Why is SLSTR not an ATSR?

- Many of the parts including key components - such as detectors - are now obsolete – we just can't buy the bits!
  - Even to fly an ATSR would be mean a major redesign and risk!
- The existing ATSR has some limitations which could be addressed in a redesign.
  - Poor daily coverage – wider swath
  - Change of contrast ratio across dual swath because of curvature.
  - Saturation at high scene temperatures – dedicated fire channels
  - New channels for detecting "*difficult*" clouds and improved cloud aerosol retrievals
  - Collocation of swath with ocean colour sensor – synergistic use in the design
  - Improved redundancy – two scanners

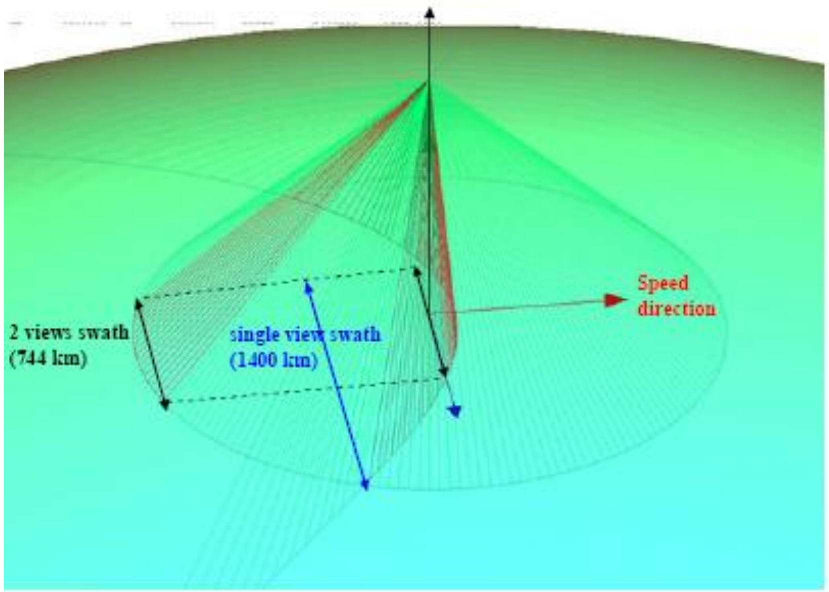
SLSTR Main Requirements Overview

- **Extended Swath**
  - Better coverage overlap with ocean colour sensor
- **Dual view required**
  - Near Nadir view: -30° East / +47° West
  - Oblique view: ± 24.6°
- **Spatial Sampling Interval**
  - <1km for TIR channels
  - <500m for solar channels
- **Spectral Bands**
  - Infrared 1.378, 1.6, 2.25, 3.7, 10.8 and 12µm
  - Visible 0.55, 0.66 and 0.85µm
- **Lifetime**
  - 7 years + 5 months commissioning in flight
  - 10 years on ground (storage + testing)
- **Absolute radiometric accuracy**

New sensor needs to remain the *state of the art* for users until 2025!

SLSTR Instrument Concept

- SLSTR is a conical imaging radiometer devoted to the measurement of Sea and Land Surface Temperature
- SLSTR has a dual view capability (near NA and Ob views) to provide robust atmospheric correction
- The dual view is implemented with double scanner
- Producing a larger swath both on nadir and on inclined views.

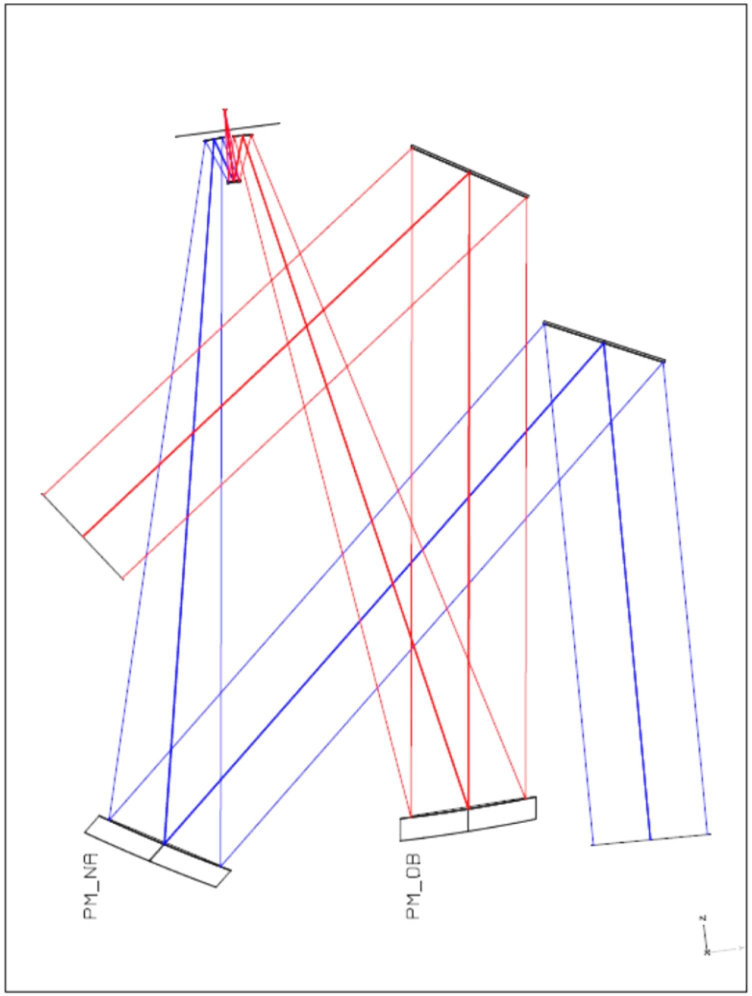


Basic Design

- The design looks very much like an ATSR!
  - You would recognise the heritage immediately
- The dual scan is based on the following:
  - Two flat rotating mirrors
  - A flip mirror switching from one view to the other
- The scan mirrors rotate each 300msec, half the speed of ATSR
  - Multi-element detectors to get spatial resolution
  - Two 1km IR swaths each scan
- The in flight calibration period is 600 msec, as each calibration source is seen by each view every two rotations

Optical Design

- Dual-view concept
- Recombination optic
- Plane conical scanner
- Optic power only with off-axis parabolic mirrors
- Stop as aperture in front of parabola
- Small iFOV ±0.11deg
- Focus at Common Field STOP



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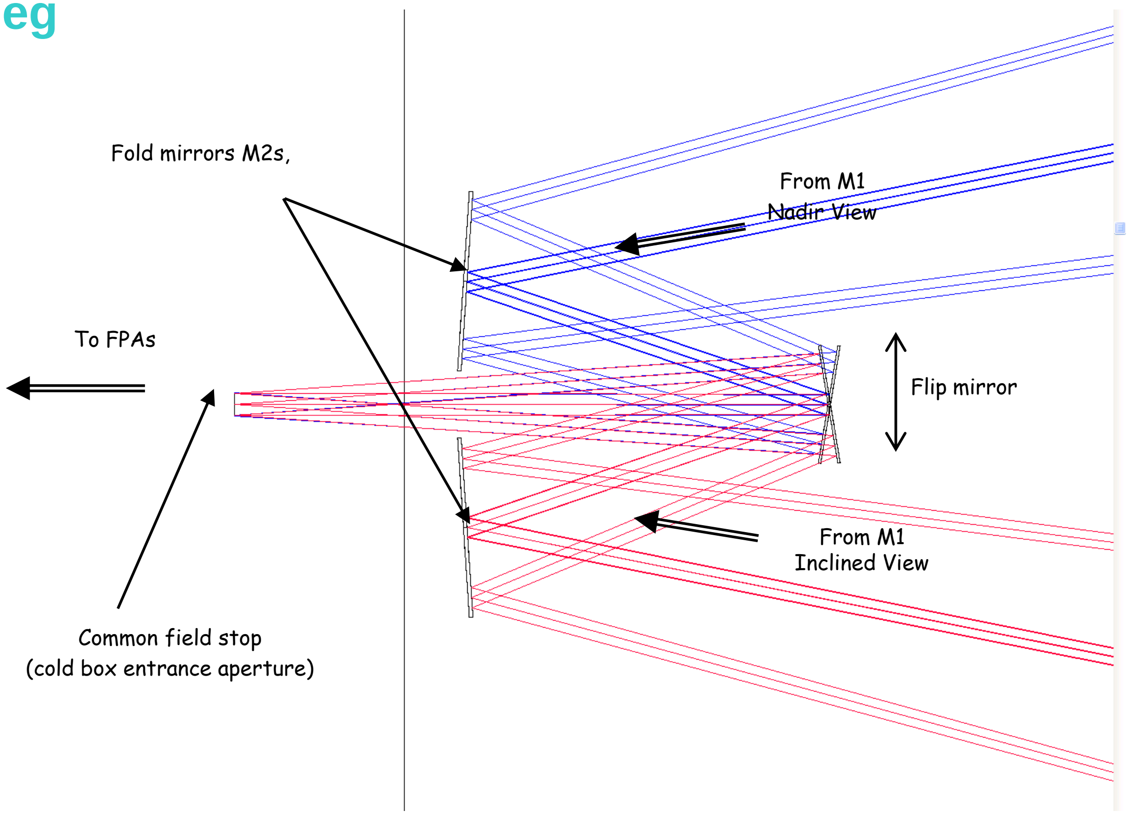
Recombination Optic – Flip Mirror

Recombination optic

- **Flip tilt ± 9.4deg**



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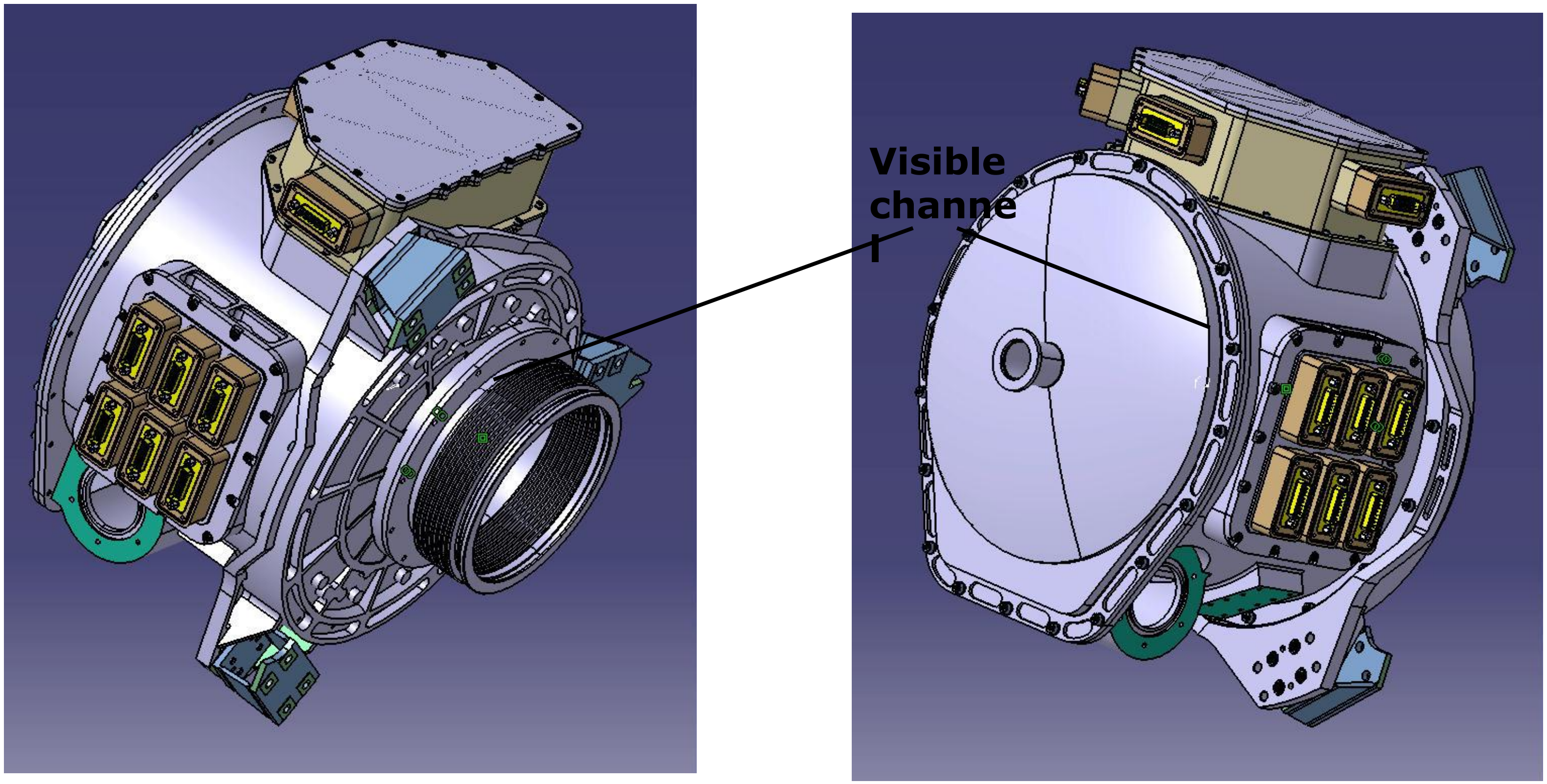
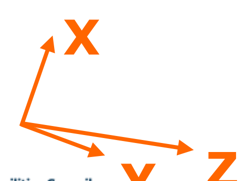




Details of SLSTR Channels and Detectors

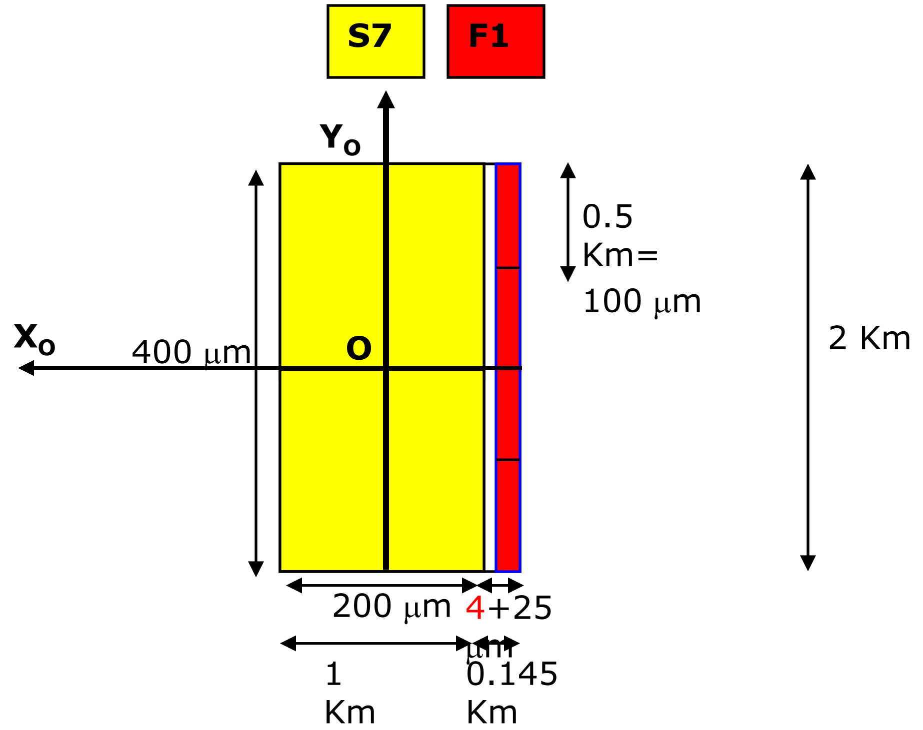
Band	*Type*	*Central Wavelength [λm]*	*Pixel Array*	*GSD [m]*	*Integration time [µs]*
S1	VIS	0.555	4 x 1	500	40
S2		0.659		500	40
S3		0.865		500	40
S4	SWIR	1.375	4 x 2 + 1 ref	500	40
S5		1.61		500	40
S6		2.25		500	40
S7	MWIR	3.74	2 x 1 + 4 x 1 + 1 ref	1000	80
S8	LWIR	10.85	2 x 1	1000	80
S9		12.0		1000	80

Fire Channels

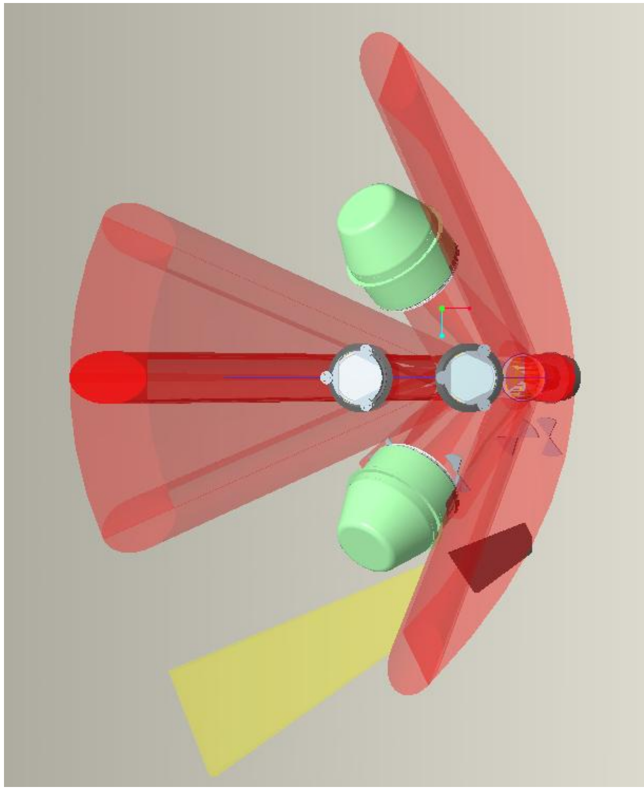
- **3.7 (S7) and 11(S8) μm channels designed fire application**

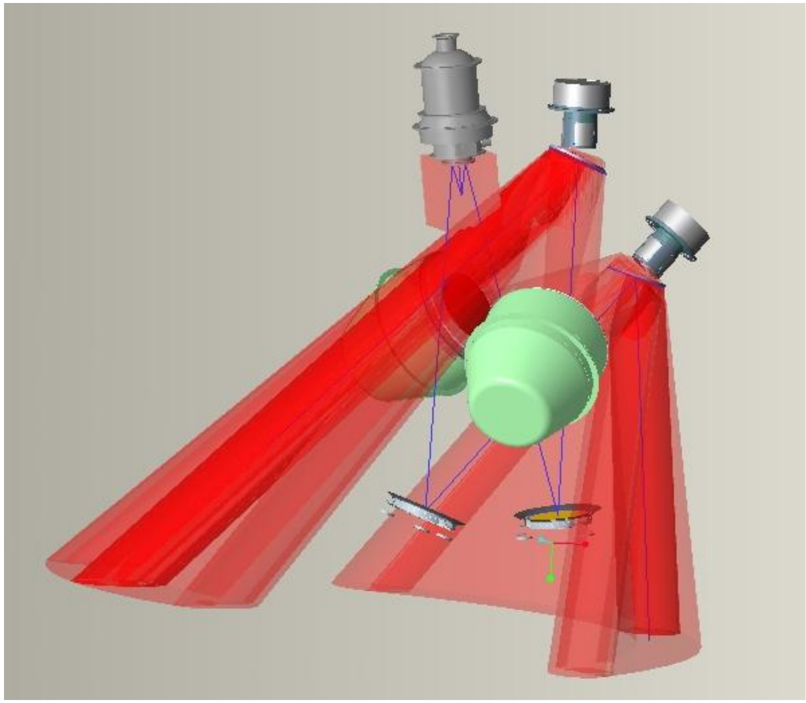
- **S7 detector has an column of four small additional pixels to cope with the high flux levels coming from fire**

- **No additional pixel in S8 detector – implemented as a parallel analogue processing chain with a lower gain is implemented in FEE**



What does SLSTR look like?





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Advantages of SLSTR design

- Continuity of (A)ATSR SST Mission with updated technology
  - Same ground calibration equipment reused to maintain traceability
- Wider swath and better daily coverage
  - 750km dual view with better controlled air-mass ratio
  - 1400km nadir swath – well calibrated wide coverage for general imaging science and operational applications not requiring dual view
- New channels to improve SST and other products
  - Two high dynamic range channels for fire detection
  - Two new channels for cloud discrimination
- 500m visible channels – synergisic use with ocean colour sensor
- Wide swath design will help cope with loss of AVHRR continuity and potential difficulties with NPOESS VIIRS