University of Leicester

DEPARTMENT OF ENERGY & CLIMATE CHANGE

Earth Observation Science

ATSR Symposium – Oct 22nd, 2009

ATSR: the Rationale and the Dual View

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ATSR: The Rationale and the Dual View

- **Why Measure Sea-Surface Temperature?**
- **Why use Space Instruments for that?**
- **Why Build an ATSR?**
  - **What are the challenges?**
  - **How does ATSR address them?**

Why SST?

- **In the 1970's, Climate Research Needed High-Quality Observations**
- **Not only with very high accuracy, but with**
  - **Global Coverage; and**
  - **Consistency over Long Time-Series Observations**
- **SST was Regarded as a Critical Parameter**
  - **Obviously related to heat content of oceans**
  - **Oceans were known to be a major Heat Reservoir**
  - **small changers in Ocean Temperature often led to large changers in Atmospheric Heating.**
  - **A relatively stable indicator of Global Change**

The Solution?

- **Space can provide the coverage and long-term consistency**
- **But can it provide the accuracy, better than 0.3 C, which was needed?**
- **Scientists at Oxford University's Atmospheric Physics Department considered that it was feasible - with:**
  - **a well-calibrated radiometer in space**
  - **with a two-angle view of the Earth's surface**

Meeting the Challenge – wavelengths

- **Basic design**
  - **Channel selection based on previous successful instrument (AVHRR)**

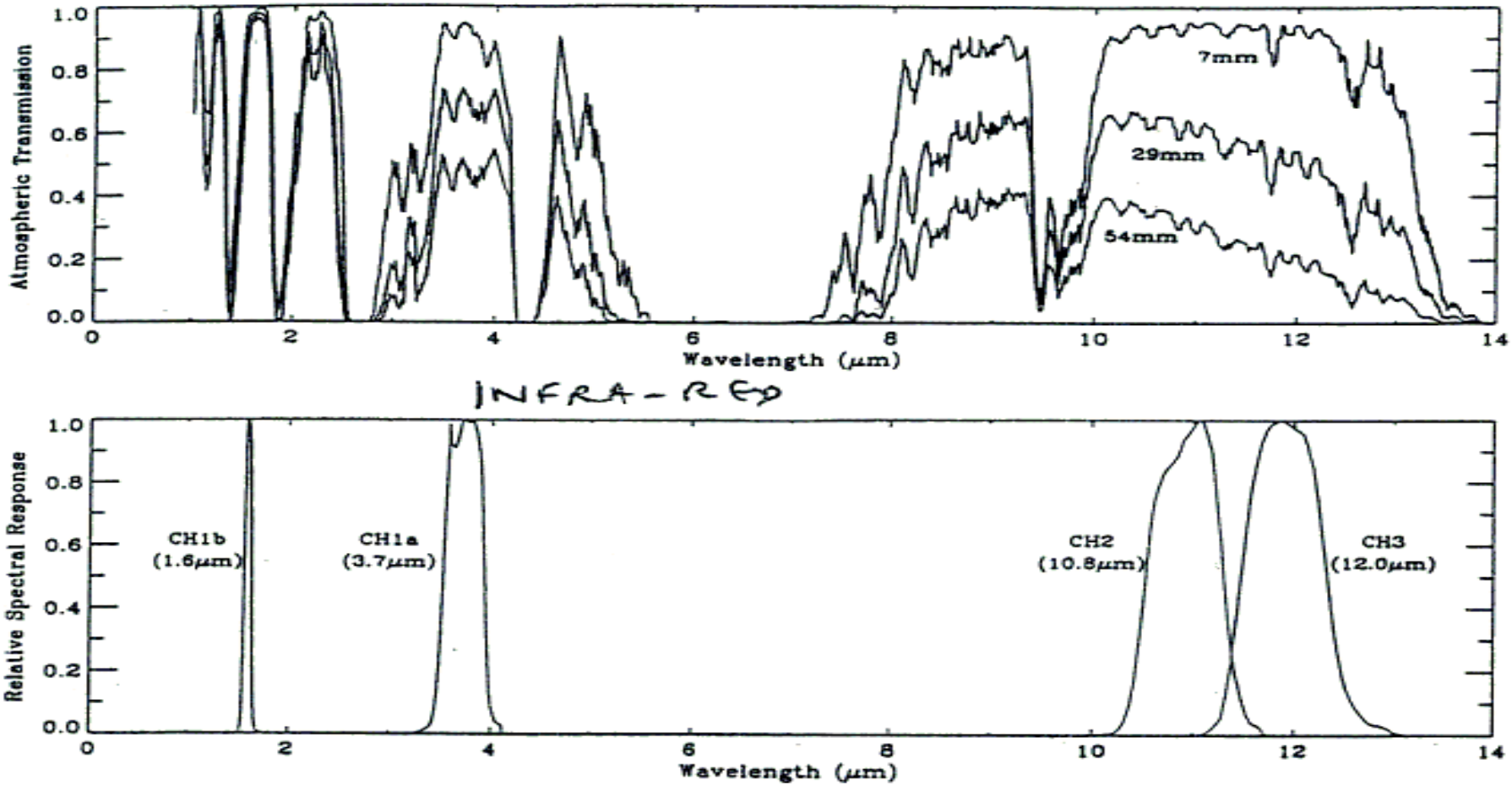


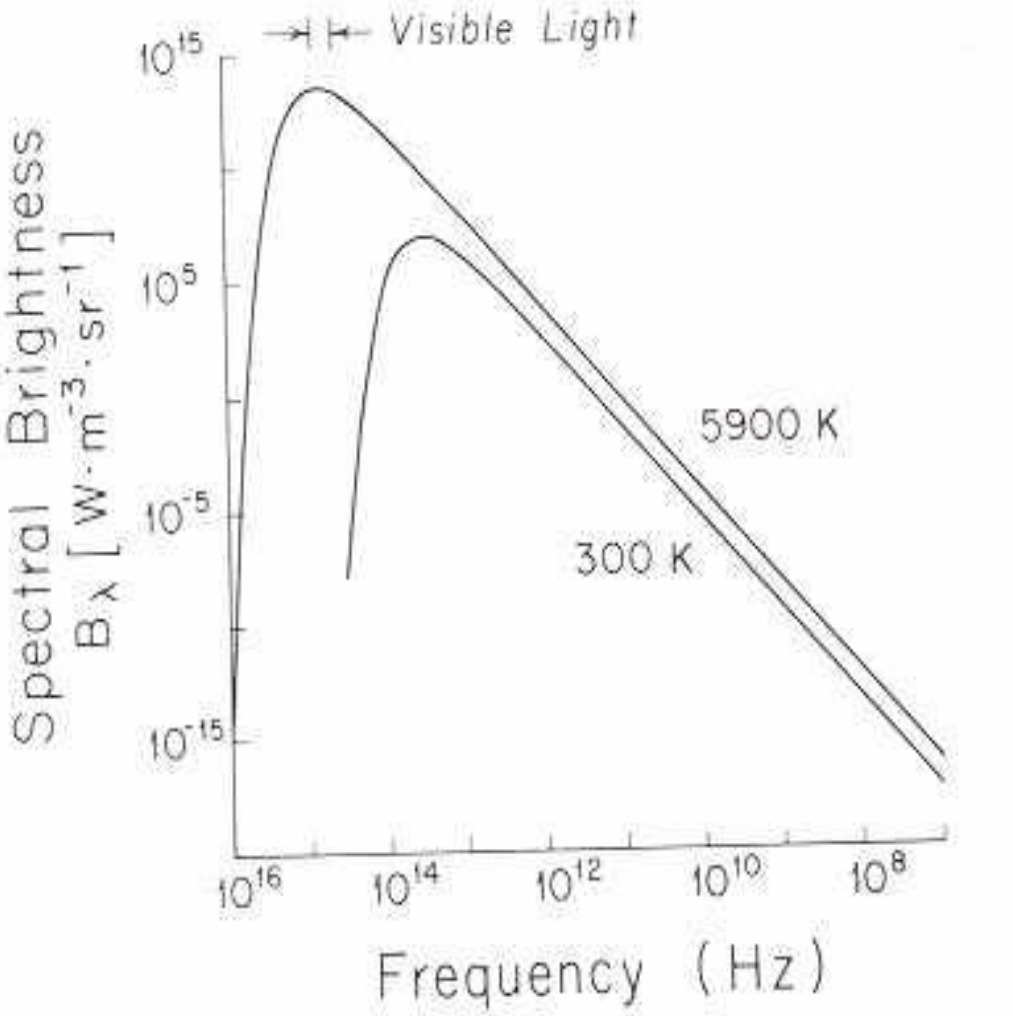
Figure 2.1: Atmospheric transmission for three different amounts of precipitable water (7mm — polar; 29mm — temperate; 54 mm — tropical), and the ATSR spectral channels matched to atmospheric 'window' regions.

The Challenge of Accuracy and Stability

Conceptual Design Developed in Collaboration with Jim Williamson (Oxford), David Pick (Met Office) and Chris Rapley (MSSL) :-

- **Two on-board Black Body Reference Targets**
  - **Each to be Viewed every Scan Cycle**
- **Single detector element for all Views**
  - **Cooled to Optimum Operating Temperature**
- **Single Scan Mirror**
  - **Rotating at Constant Speed**

Radiometric Sensitivity
Planck's Radiation Law says it all!



Max Karl Ernst Ludwig Planck

April 23, 1858 – October 4 1947

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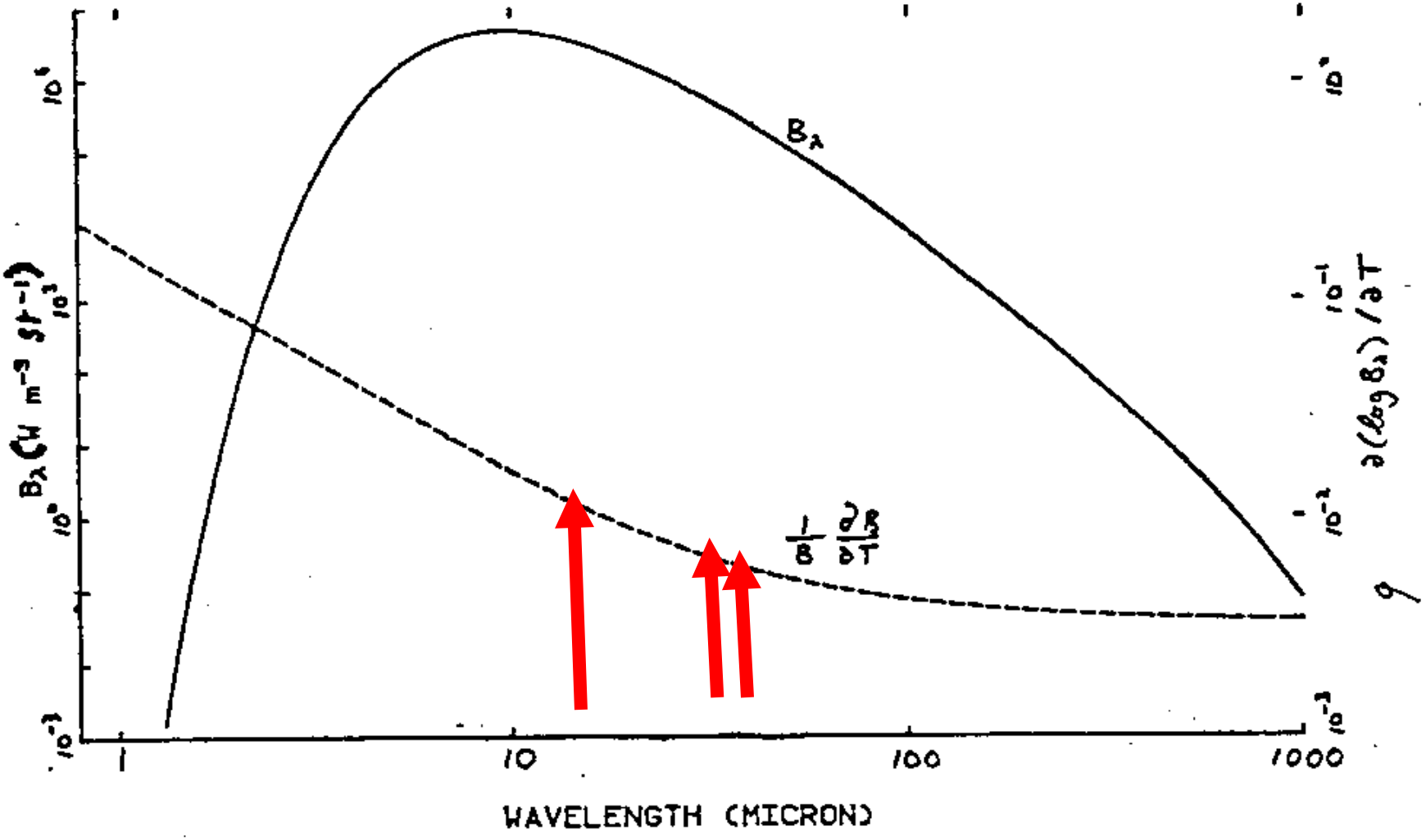


The Dual View

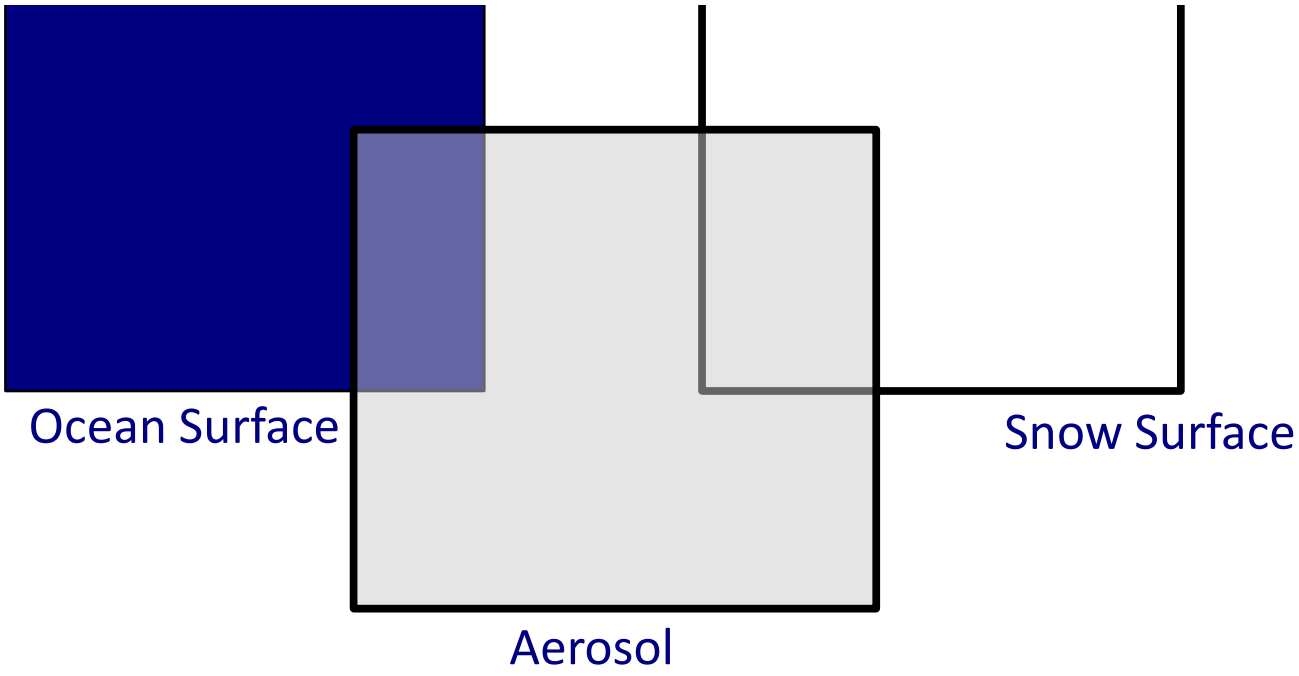
- **Not Clear where idea originated**
- **But, at Oxford, Jim Williamson and an RA, Ian Barton, were simulating the performance of along-track scanning instruments**
- **They were joined by Albin Závody at RAL and simulations clearly showed a potential advantage, especially in aerosol-contaminated (i.e. foggy) atmospheres, which are very common!**
- **Barton's simulations showed the difference between forward & nadir signals had to measured to 0.05 K!**

An Accuracy of One Twentieth of a Degree!!

How Well does the Dual View Actually Work?

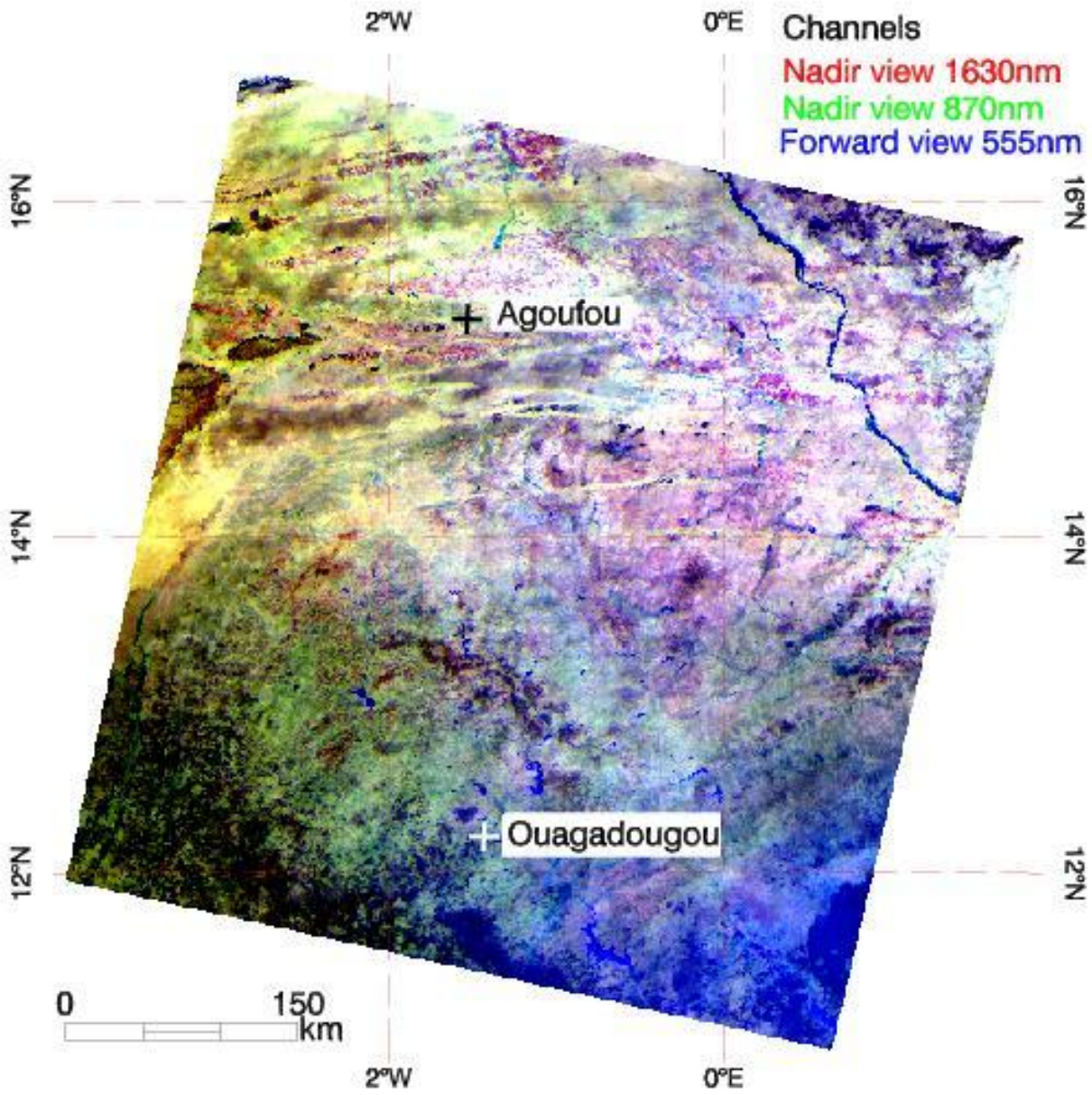
The Dual View at visible wavelengths

Aerosol Effects over dark and bright surfaces (e.g. over land) - the problem

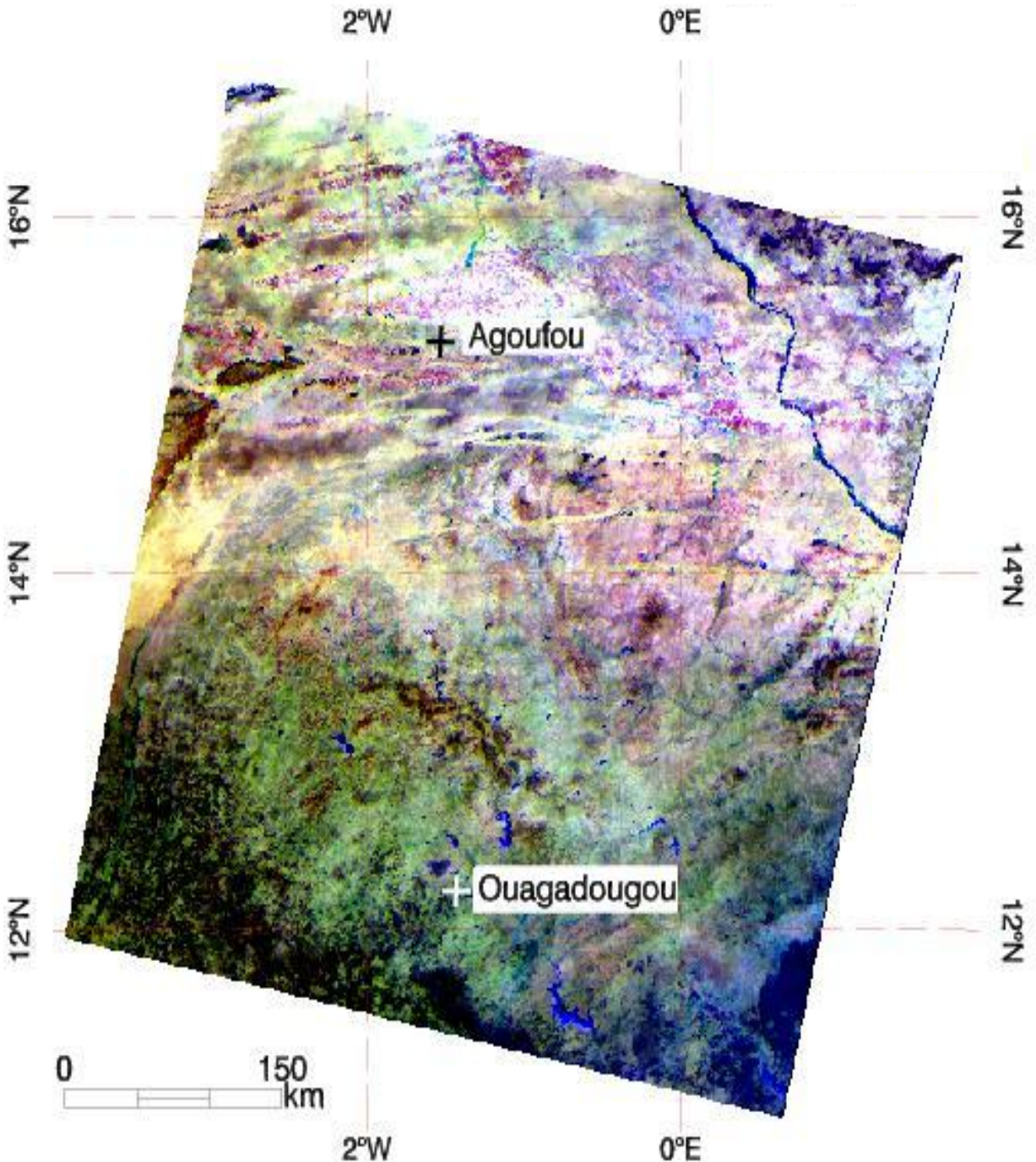


layer is:

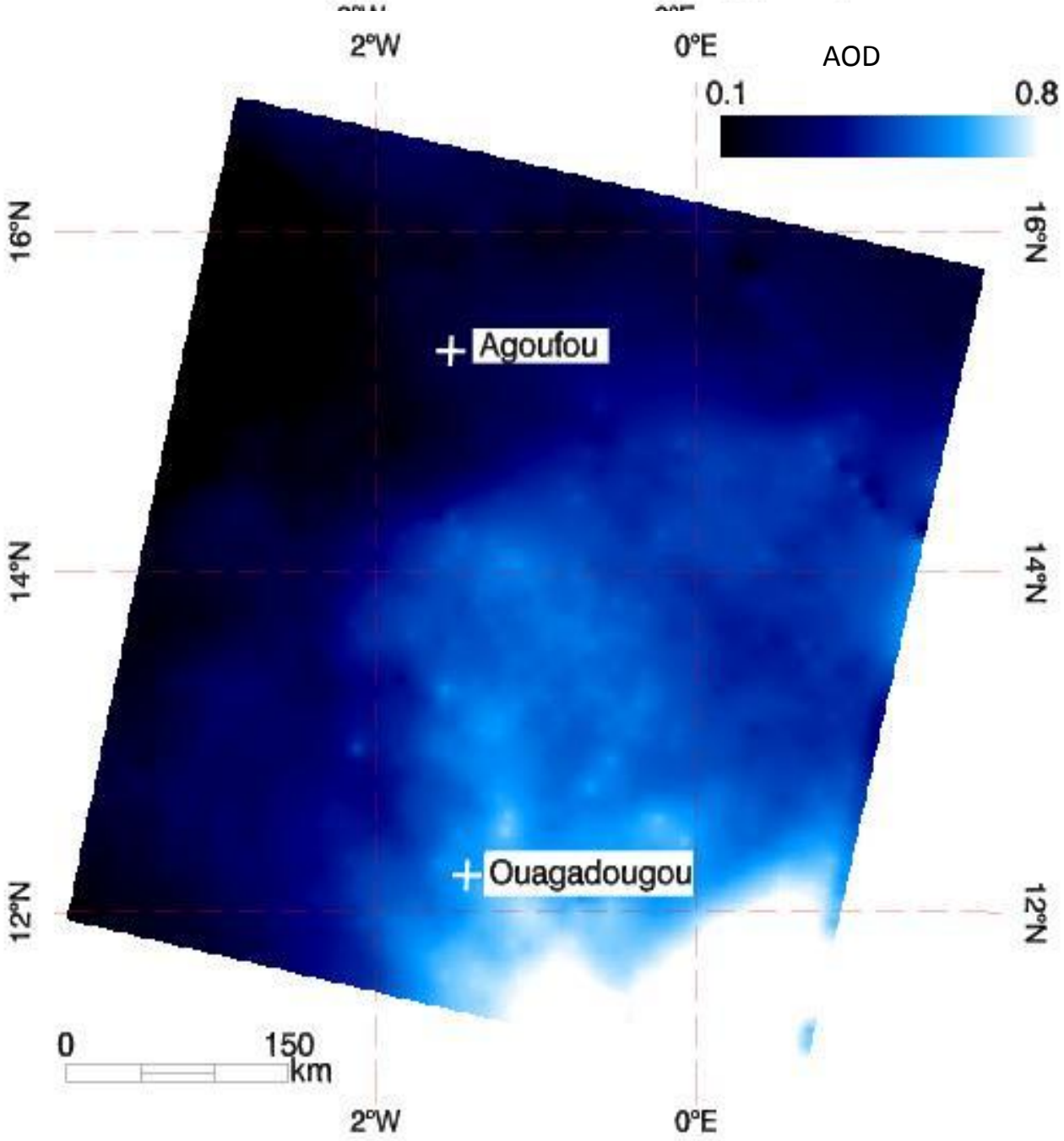
$$\Delta F = \frac{S_0}{4} T^2 \left(1 - C_{frac}\right) \left(1 - a\right)^2$$



Uncorrected scene, with smoke in bottom LH of Image

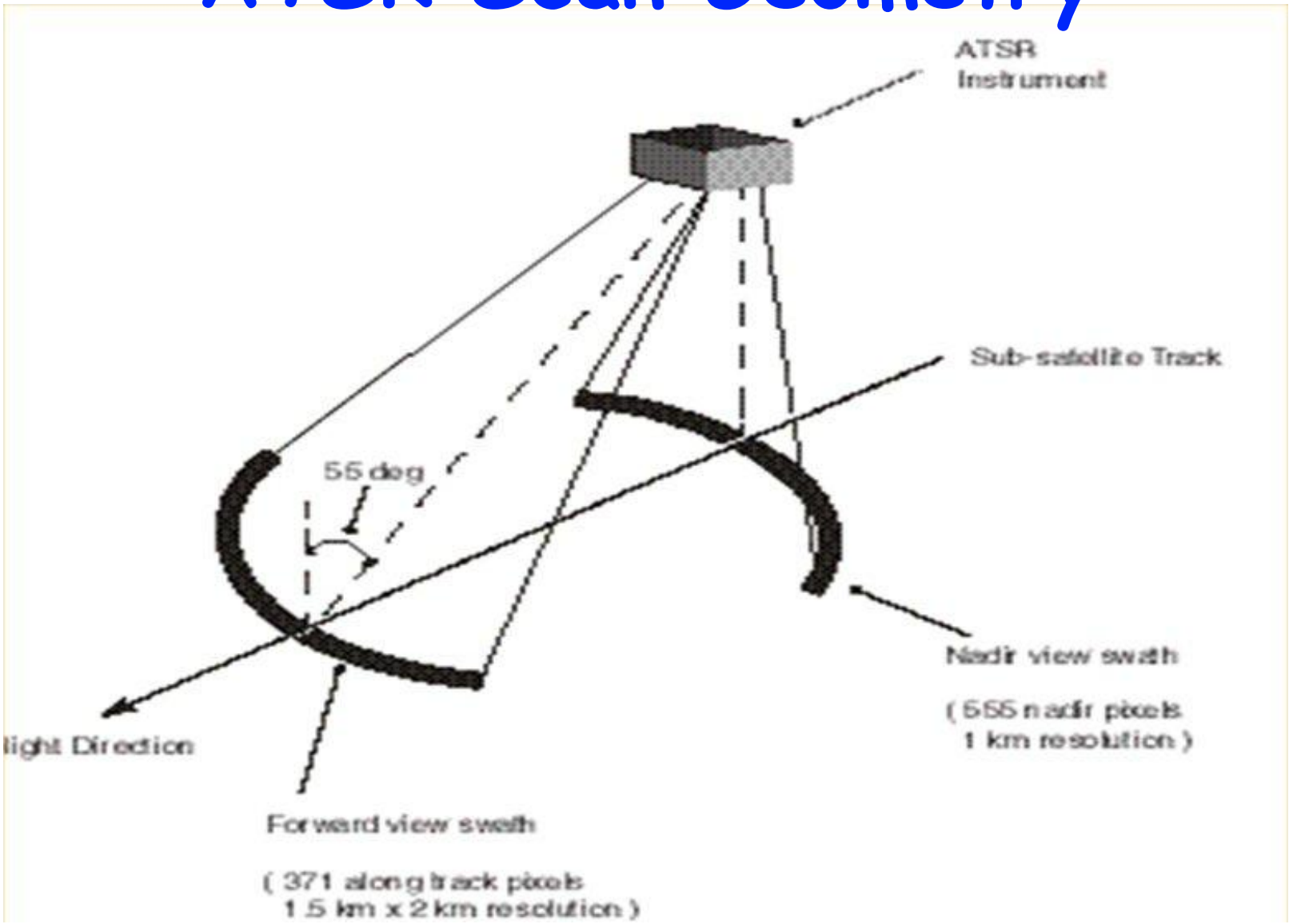


Same, with aerosols detected and removed



The difference - Aerosol Optical Depth

ATSR Scan Geometry



AATSR Scan sequence – showing on-board Calibration System

A Near-Ideal Radiometric System!