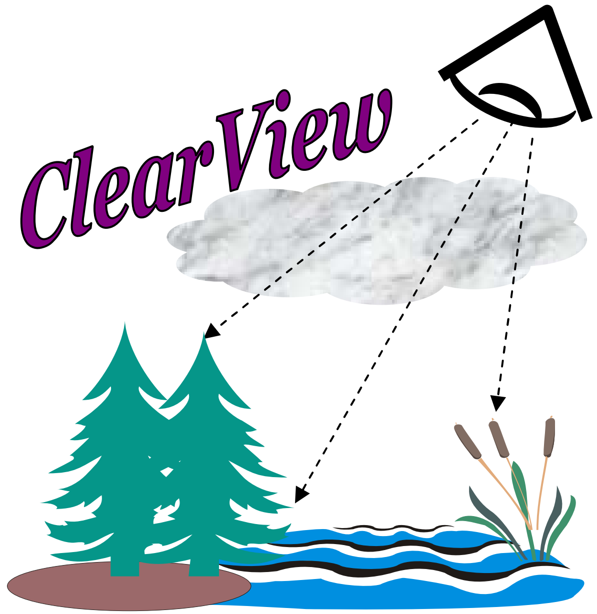
ClearView (+)

the automatic atmospheric correction service

by the German Remote Sensing Data Center (DFD)



(+) US patent No. US 6,484,099 B1 granted Nov. 19, 2002,
EU patent No. EP 1091188 granted Sep. 29, 2004
Canadian patent pending

DLR

ClearView – the automatic atmospheric correction service by DFD

- **The German Remote Sensing Data Center (DFD) develops and applies methods for the derivation of information products from satellite data**
- ***ClearView* is the automatic atmospheric correction service for reflective channels of multispectral land surface satellite datasets**
- ***ClearView* provides a correction of atmospheric noise due to aerosol, ozone, water vapour and molecular scattering for large data amounts**
- ***ClearView* is based on a state-of-the-art scientific algorithm**

  Holzer-Popp, Th., Bittner, M., Borg, E., Dech, St., Erbertseder, Th., Fichtelmann, B., Schroedter, M., Das automatische Atmosphärenkorrekturverfahren „DurchBlick", in: Blaschke, T. (ed.), Fernerkundung und GIS: Neue Sensoren – innovative Methoden, H. Wichmann Verlag, Heidelberg, 2002

- ***ClearView* is a fully integrated and automatic software that combines accurate radiative transfer calculations with a pre-classification and online access to actual atmospheric remote sensing data**
- ***ClearView* is ready for implementation into operational chains**
- **For further information contact:**
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  Phone: +49-8153-28-1382, Fax: +49-8153-28-1362, E-mail: thomas.holzer-popp@dlr.de

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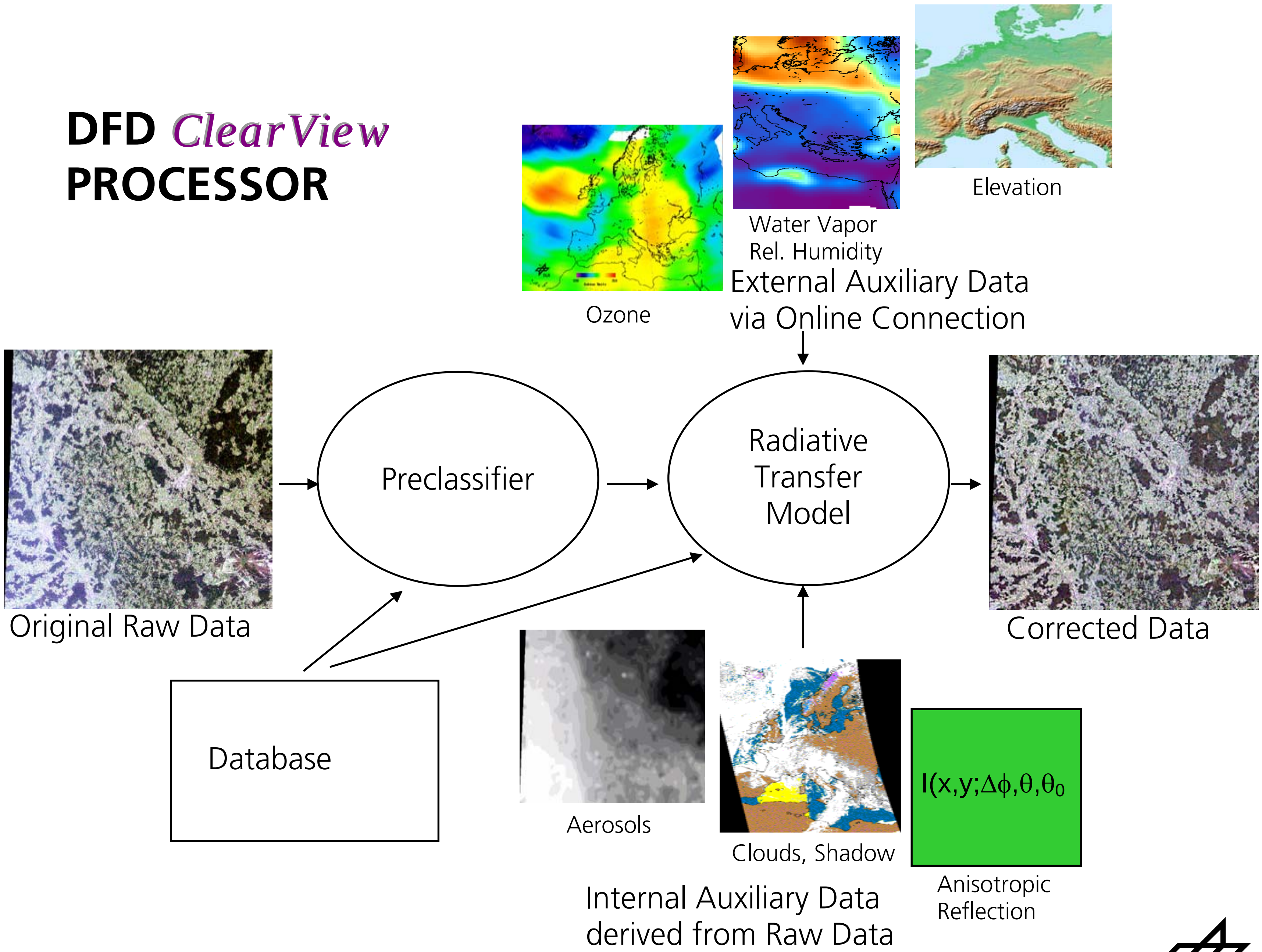
DFD *ClearView* PROCESSOR



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ClearView Demonstrator – Technical specifications I October 2003

Implemented sensors:
Landsat4/5-TM, Landsat7-ETM+, IRS-1C/1D-LISS, IRS-1C/1D-PAN, (IRS-P6)
TERRA1-MODIS, NOAA14/16-AVHRR (limitations apply to aerosol characterization)

Input Format:
L7 fast format: binary single channel files + header (others may be converted)

Input data:
digital counts, radiometric preprocessing (georeferencing, radiometric conversion to top-of-atmosphere reflectances is conducted)

Neccesary auxiliary data:
geoposition (4 corners lat/long), time of acquisition, are extracted from header file

Image size:
currently set to 7900 x 7500 pixels

Hardware/Software requirements:
Linux-PC, 1 GHz; 1 GB RAM+ 2 GB swap, 5 GB disk (2-3 hours for a L7 full scene)
idl runtime license required (algorithms coded in idl and f77)
ftp access required (online auxiliary data transfer; software fully integrated)

ClearView Demonstrator – Technical specifications II October 2003

Availability of auxiliary data:

Ozone: global, since 1978 (GOME, TOMS; in future: SCIAMACHY, GOME-2)
Water vapor: Europe, since 1990 (TOVS, ATOVS; in future: MODIS, MSG)
Global for last decades (ECMWF archive as backup)
Elevation model: currently global Globe30 (~1 km)
Currently Germany DLR database (~25 m)
In future global DLR/JPL database (~100m)
In future global DLR database (~25m covering 1/3 of the globe)
Aerosols: retrieved from the input dataset (limitations for AVHRR apply)
Clouds and shadow: retrieved with the preclassificator
Surface type (anisotropic relfection): selected with the preclassificator from 7 types

Expected accuracy of available auxiliary data

(fallback value hierarchy exists;
in brackets: realistic global range of values/required accuracy for 0.01 result error)**:**
Ozone column amount: < 20 D. U. (250 – 500 D. U. / 50 D. U.)
Water vapor column amount: < 1.0 $g \cdot cm^{-2}$ (0.5 – 8. $g \cdot cm^{-2}$ / 1 $g \cdot cm^{-2}$)
Elevation height: < 100 m (0-8800 m / 250 m)
Aerosol optical thickness at 550 nm: < 0.1 (0 – 1.5 / 0.1)
Others (aerosol type, surface type, clouds, shadow) are not quantifyable.

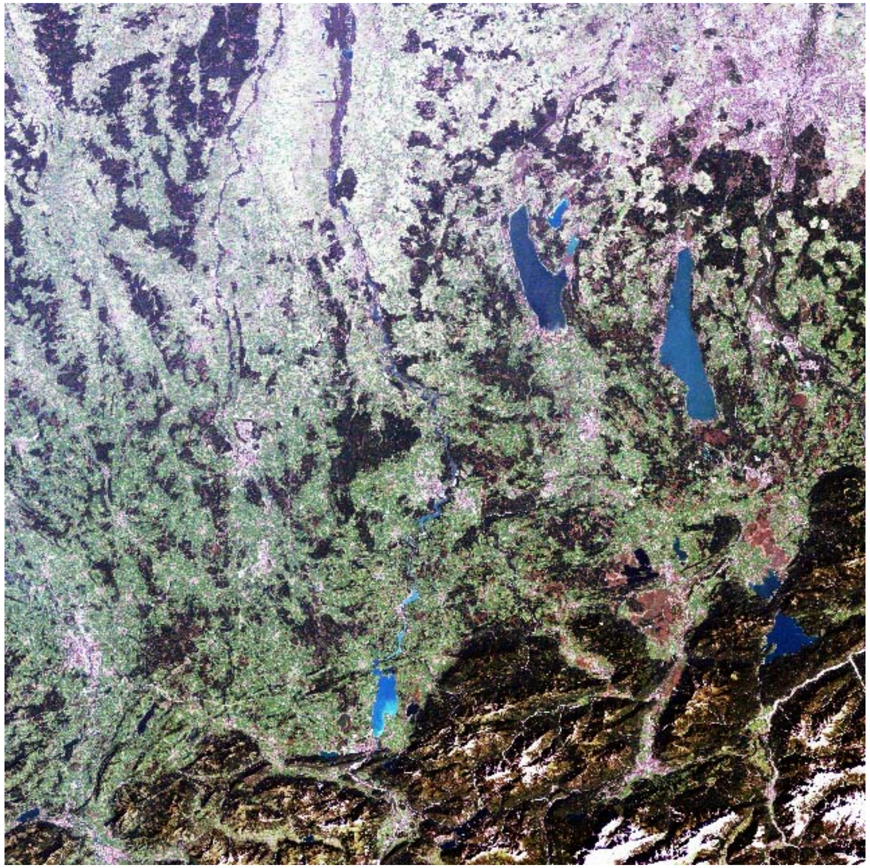
Reflectance errors due to uncorrected atmospheric variations

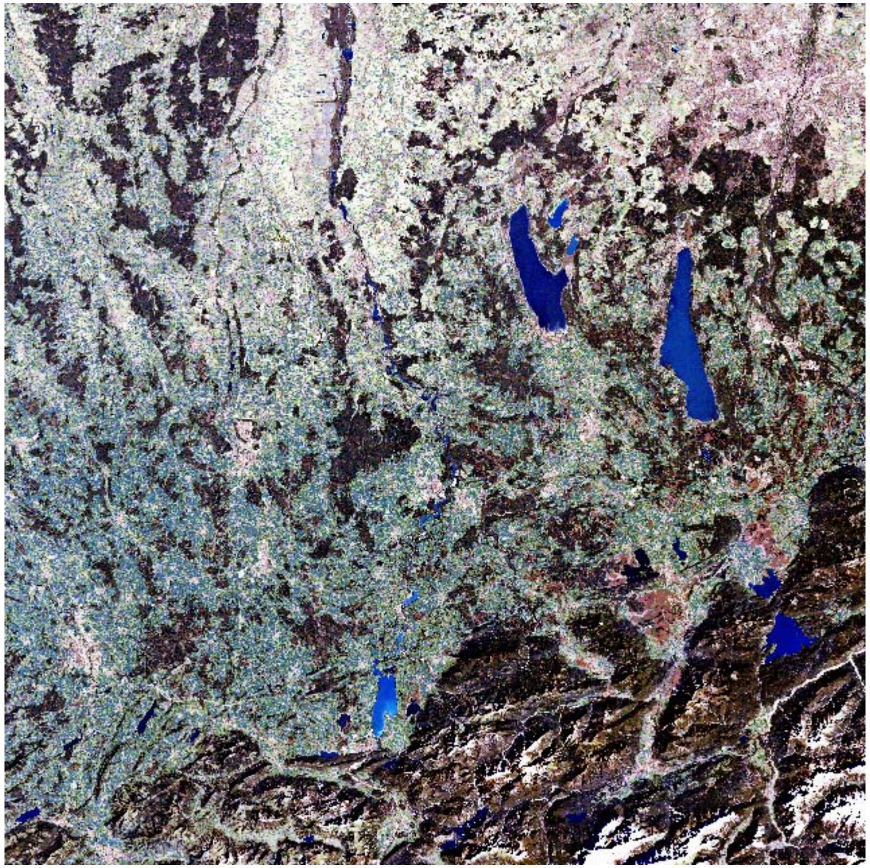
Parameter (Range of values)	**Ozone** (250-500 D.U.)	**Water vapor** (0.5-4.0 g·cm^{-2})	**Elevation** (0 – 2000 m)	**Aerosol content** (aot550= 0.05-0.8)	**Aerosol type** (absorption, scattering)	**Surface type** (anisotropic reflectance)	**Solar zenith** (0-70°)
Blue band ETM1			+ **X**	+ **X**	0.03…**0.14**	0.04	< 0.01
Red band ETM3, AVHRR1	- **13.5%**	- 4.4%	+ 0.07	+ **0.12**	**X**		
Near infrared band ETM4, AVHRR2	- 0.5%	- **22%**	+ 0.04	+ 0.083	0.005…0.02	**0.12**	-0.05 … + **0.10**
Middle infrared band ETM5, ETM7		- **X**			0.01…0.04	**0.30**	-0.05 … + **0.10**
Vegetation index bare soil (NDVI=0.05)	+ **0.07**	- **0.12**	- **0.09**	- **0.08**	**X**		
Vegetation index deci-duos forest (NDVI+0.85)	+ 0.017	- 0.038	- **0.26**	- **0.34**		**X**	
Required accuracy (for result better than 0.01)	**50 D. U.**	**1 g·cm $^{-2}$**	**250 m**	**0.1**			**1°**

- Red numbers highlight significant errors if the respective parameter is not known accurately.
- X denotes significant impact, but no sensitivity has been calculated.
- Data based on:

Vermote, E.F., Atmospheric Correction Algorithm: Spectral Reflectances (MOD09)- MODIS Algorithm Technical Background Document, 1996
Erbertseder, T., Quantifizierung von atmosphärischen Einflüssen auf NOAA-AVHRR NDVI-Daten und deren Korrektur, Diplomarbeit, Ludwig-Maximilians-Universität München, 1998
Popp. Th., Korrektur der atmosphärischen Maskierung zur Bestimmung der spektralen Albedo von Landoberflächen aus Satellitenmessungen, Dissertation, Universität München, 1993

Landsat7 ETM+ quarter scene overview original/corrected with *ClearView*



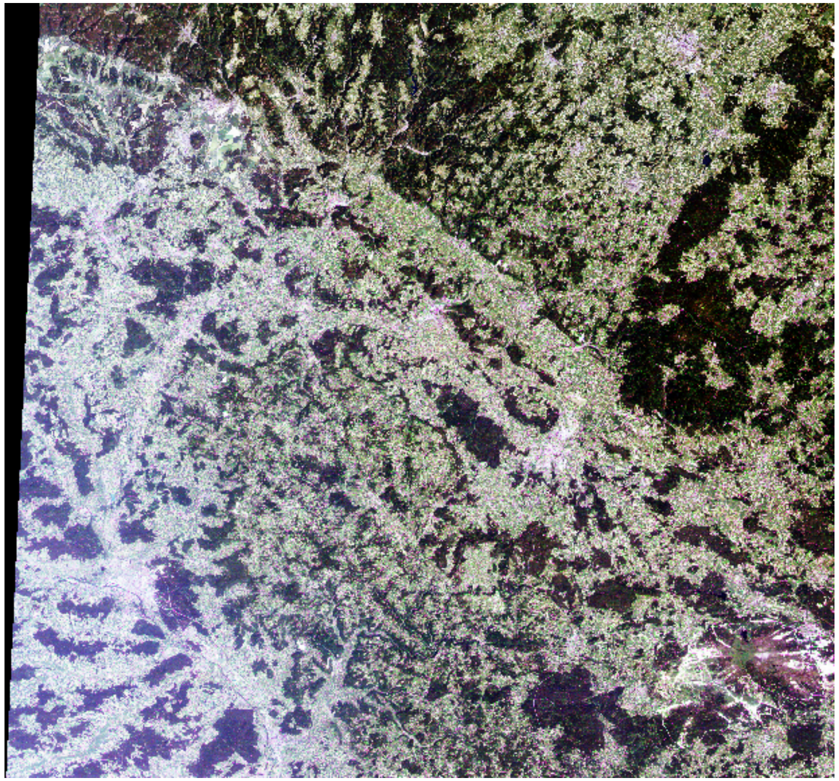


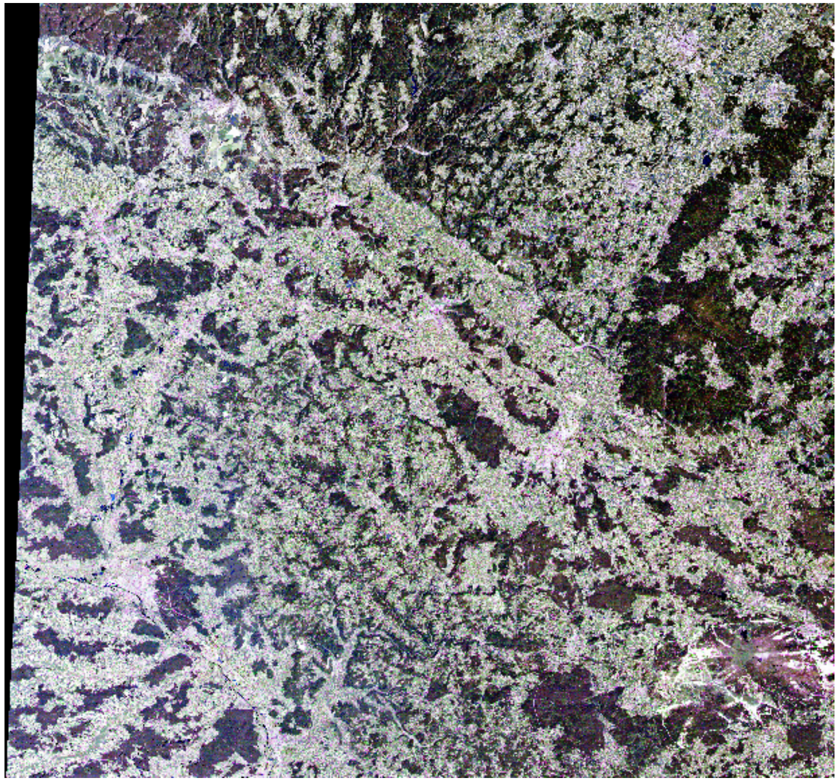
Landsat7-ETM+ 13.09.1999 RGB=321

Landsat7 ETM+ subscene original/corrected with *ClearView*

Landsat7-ETM+ 13.09.1999 RGB=321

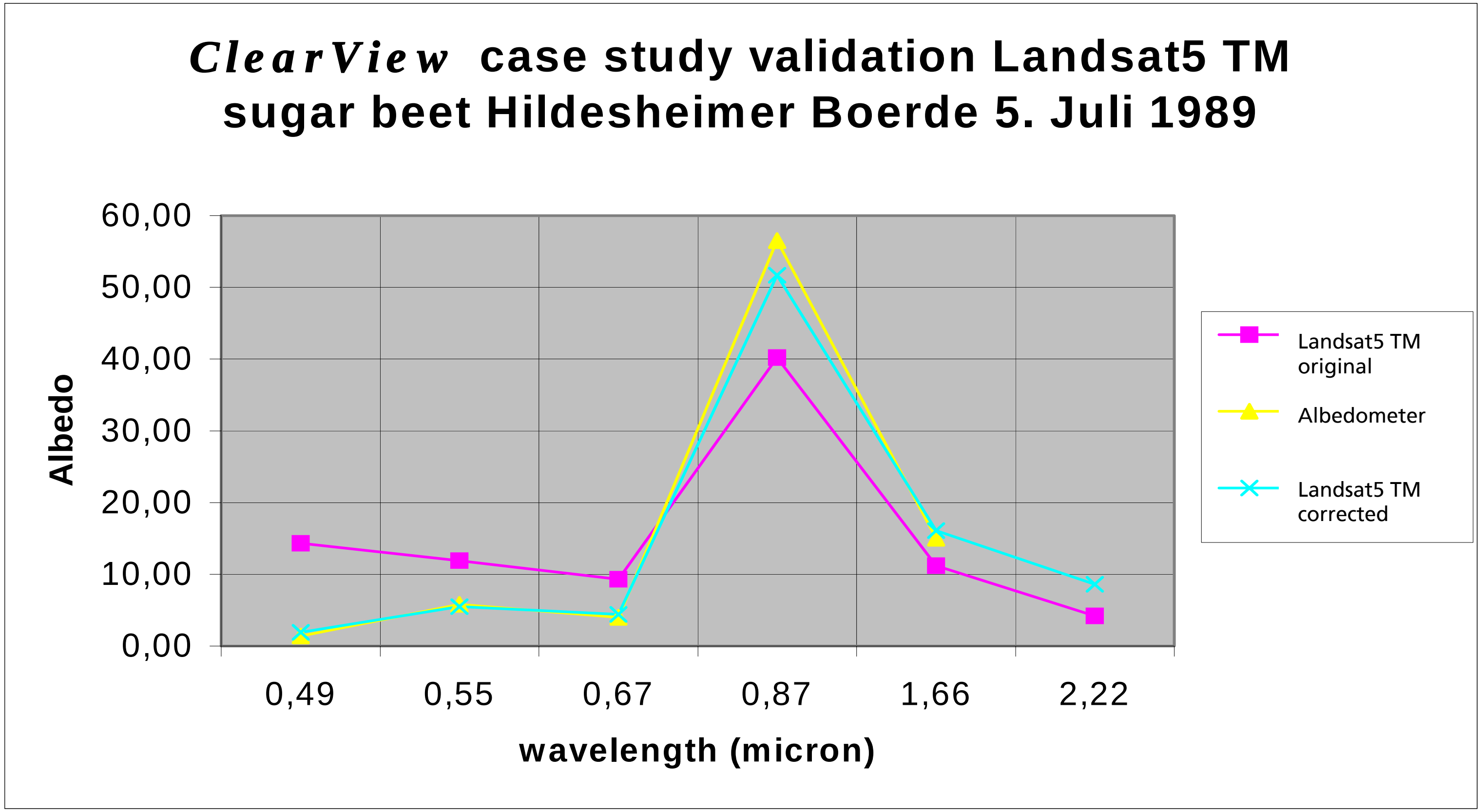
Landsat5 TM quarter scene overview original/corrected with *ClearView*





Landsat5-TM 09.07.1984 RGB=321

Example validation result I



Example validation results II (Hildesheimer Börde July 5, 1989)

barley						
wavelength	**0.49 µm**	**0.55 µm**	**0.67 µm**	**0.83 µm**	**1.66 µm**	**2.22 µm**
TM original	14.9	12.9	13.3	25.7	13.8	7.9
albedometer	4.	9.	12.	33.	23.	
TM corrected	3.1	9.2	12.9	30.7	20.5	16.1
sugar beet						
wavelebgth	**0.49 µm**	**0.55 µm**	**0.67 µm**	**0.83 µm**	**1.66 µm**	**2.22 µm**
TM original	14.3	11.9	9.3	40.2	11.2	4.2
albedometer	1.4	5.8	4.0	56.5	15.0	
TM corrected	1.9	5.5	4.4	51.7	16.1	8.6
wheat						
wavelength	**0.49 µm**	**0.55 µm**	**0.67 µm**	**0.83 µm**	**1.66 µm**	**2.22 µm**
TM original	14.6	12.1	10.0	33.1	10.8	4.7
albedometer	2.	7.	7.	48.	20.	
TM corrected	2.4	7.8	7.3	47.0	15.5	9.3