RGB Products: an easy and practical way to display multispectral satellite data (in combination with derived products)

Dr. Jochen Kerkmann
Training Officer
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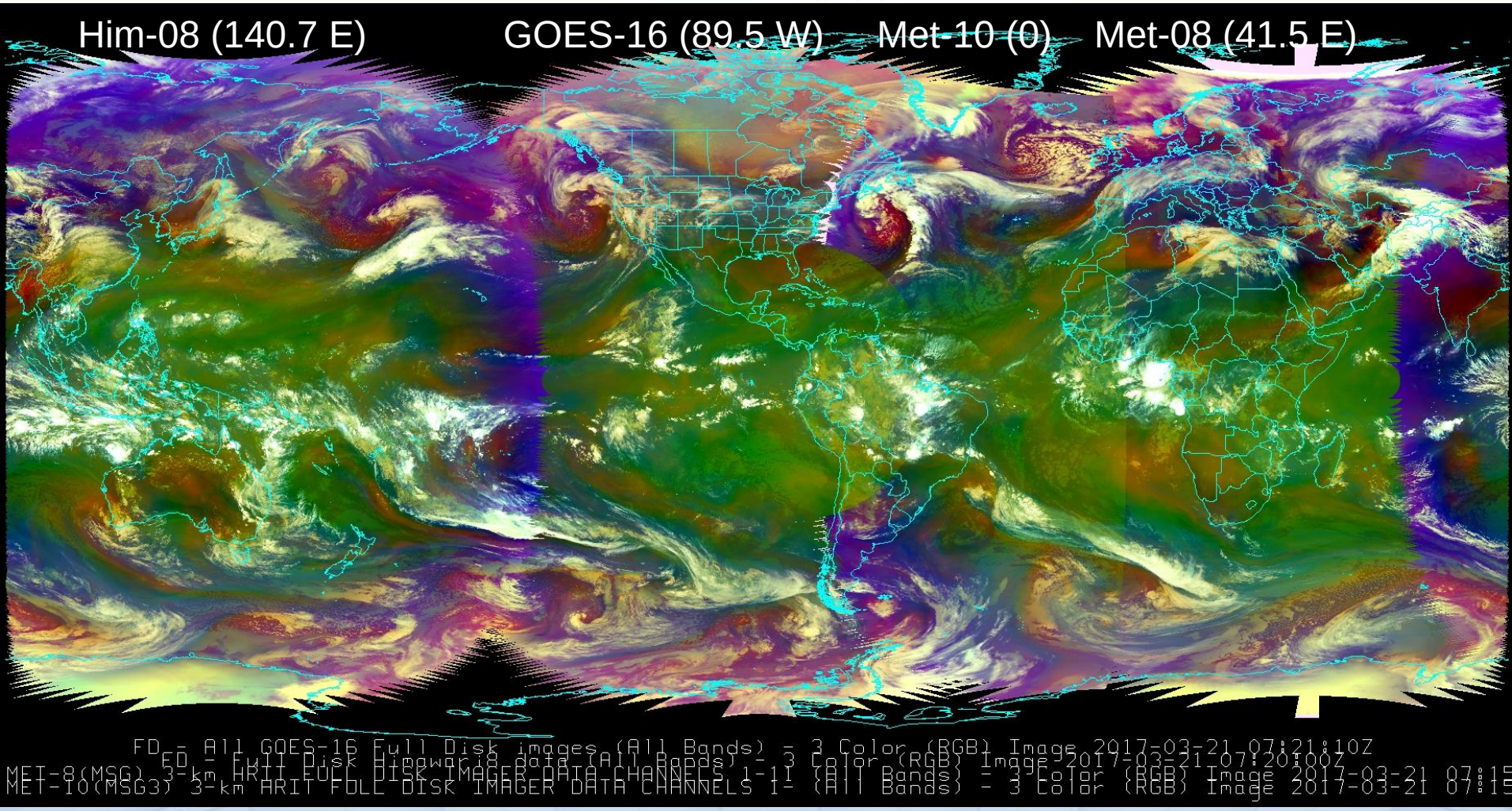
Multi-channel GEO satellites today



20 March 2017, First Global Airmass RGB Composite

Credits: HP Roesli

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How to display multispectral data?

Why do we need RGB products, when we have derived (cloud) products?

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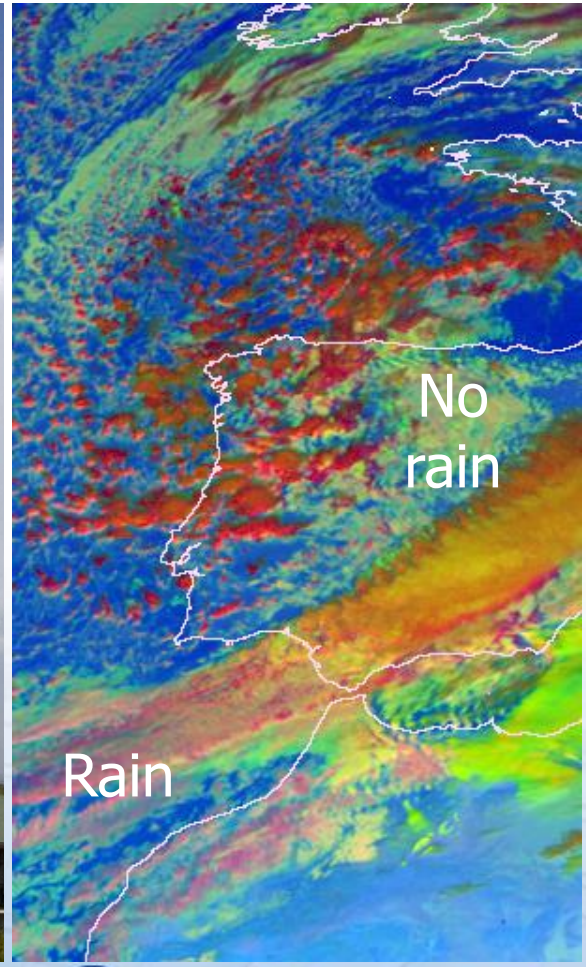
Multispectral view of tomatoes & clouds



Credits: Prof. Danny Rosenfeld, Jerusalem (HUJ)

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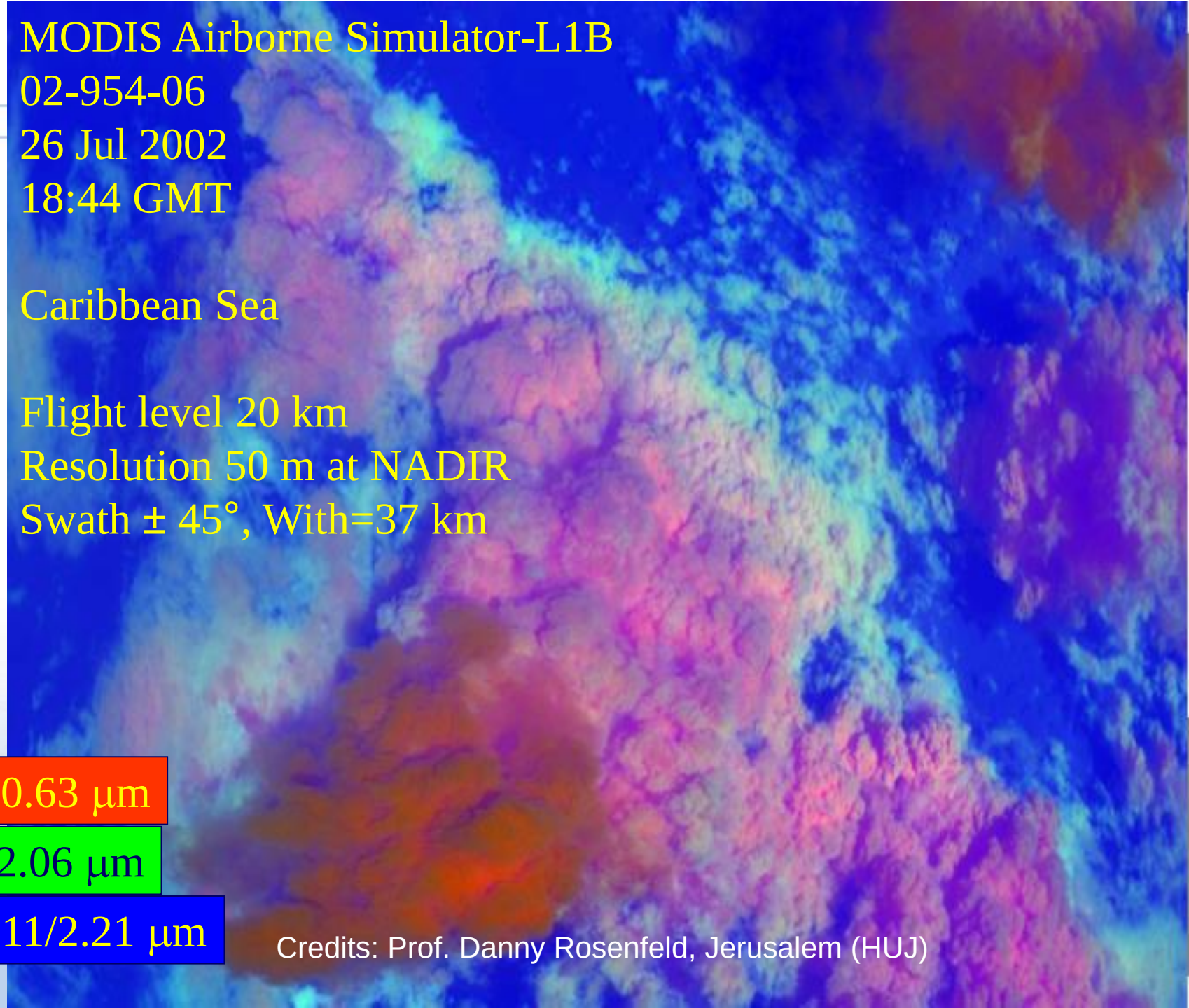
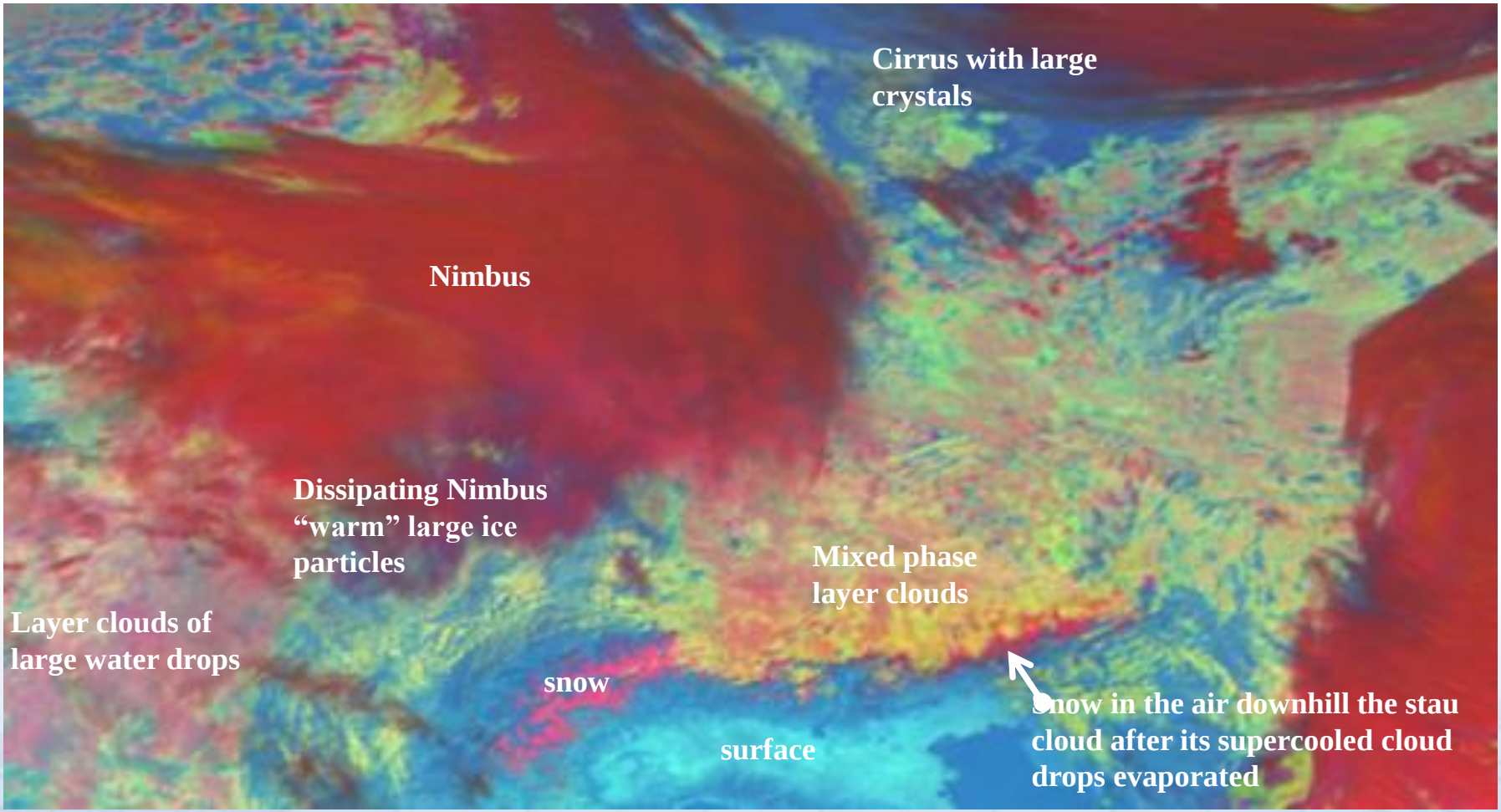

MODIS Airborne Simulator-L1B
02-954-06
26 Jul 2002
18:44 GMT
Caribbean Sea
Flight level 20 km
Resolution 50 m at NADIR
Swath ± 45°, With=37 km
Red: 0.63 μm
Green: 2.06 μm
Blue: 2.11/2.21 μm
Credits: Prof. Danny Rosenfeld, Jerusalem (HUJ)

Cloud Properties seen in Day Microphysics RGB



8 October 2003, 12:00 UTC

Source: D. Rosenfeld

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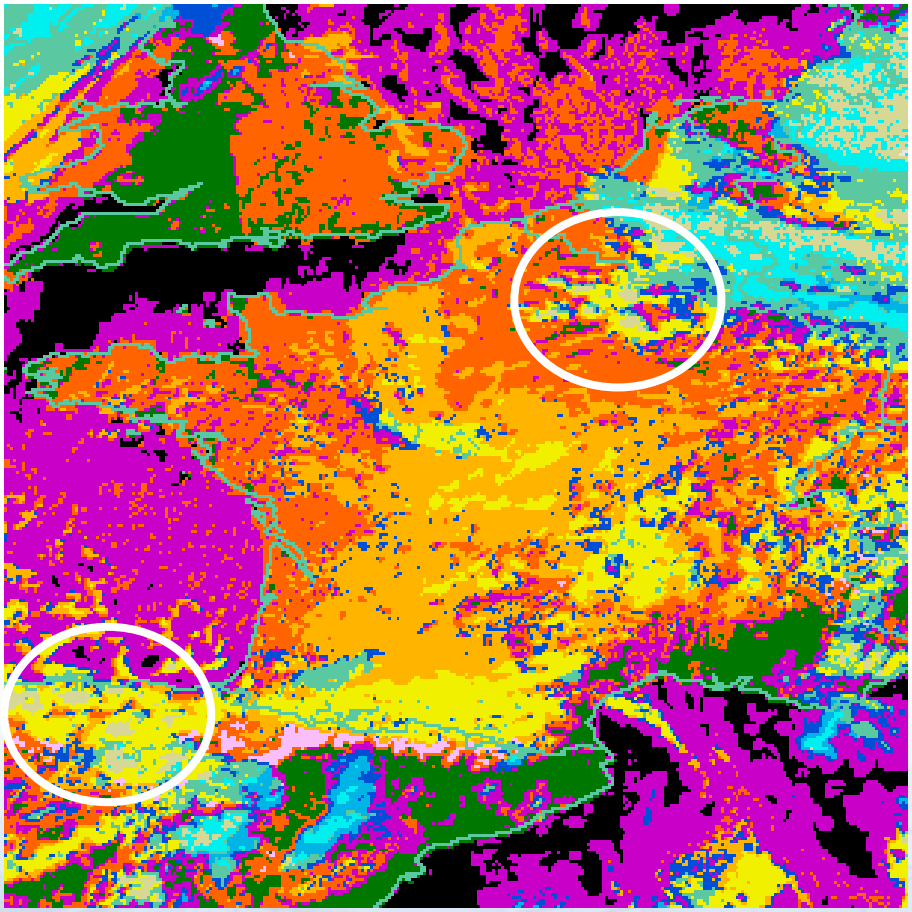
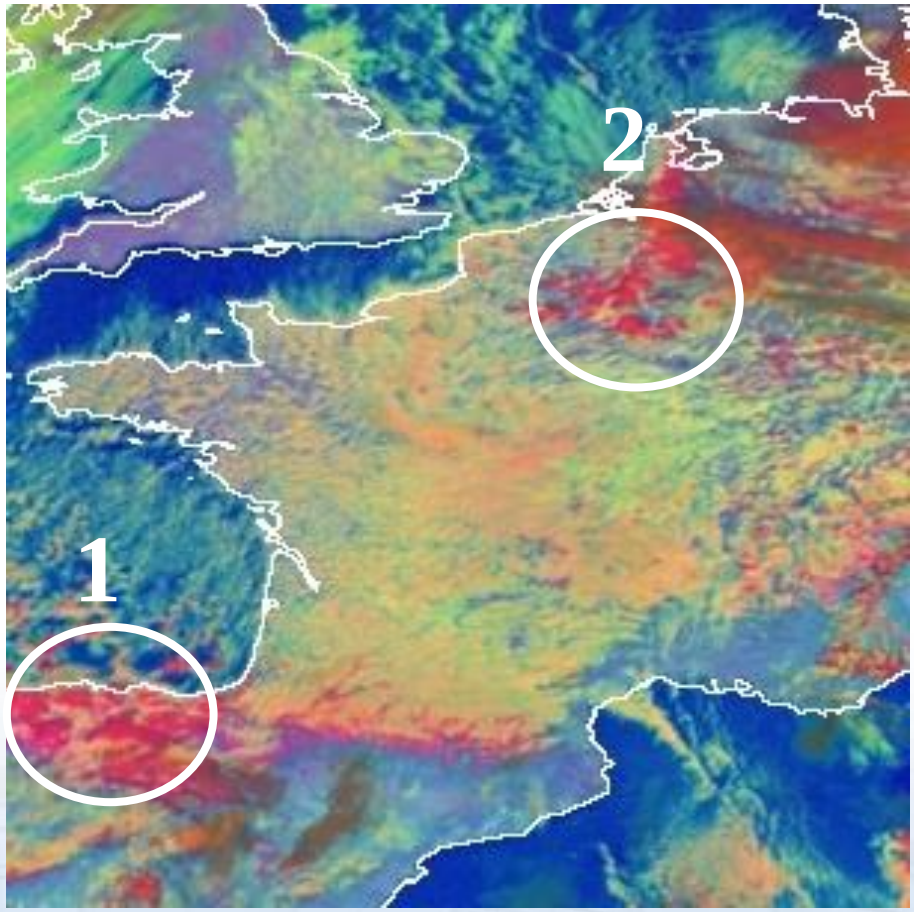
Comparison 1: RGBs vs Cloud Type Product



Cloud Type Product

Texture gets lost, no cloud phase info



Day Microphysics RGB

Met-8, 21 March 2007, 12:00 UTC

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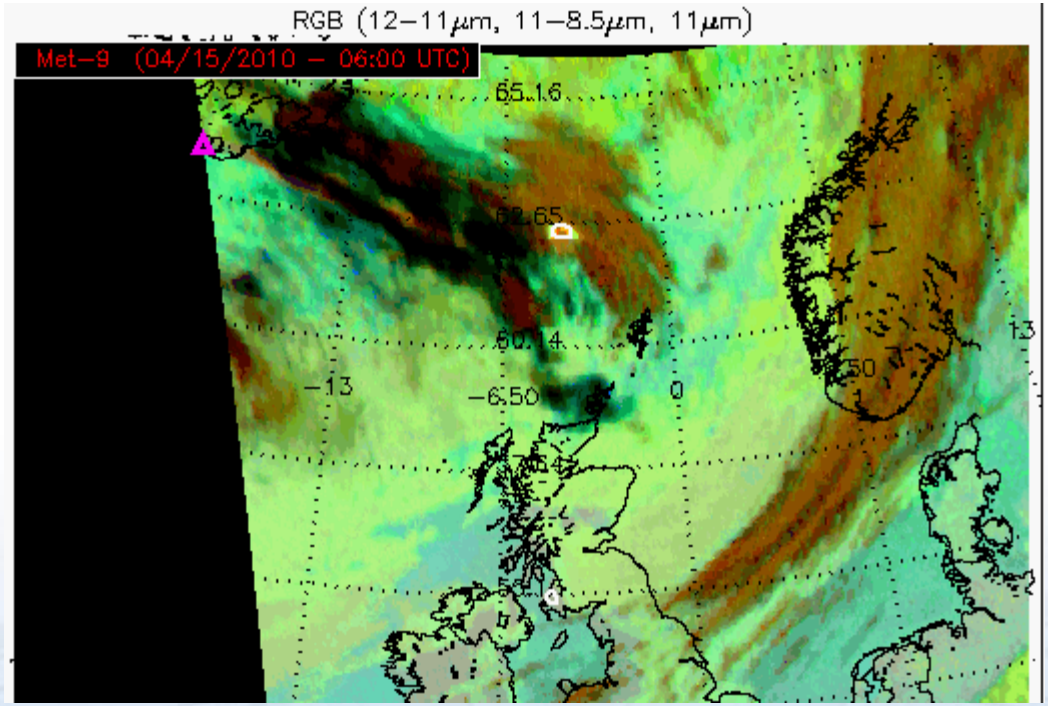
Comparison 2: RGBs + Ash Product

Best use: RGBs + Derived Product
Derived product (ash mask) overlaid on Ash RGB



15 April 2010, 09:00-15:00 UTC

Source: M. Pavolonis

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Main Improvements from multi-channel (GEO) Imagers

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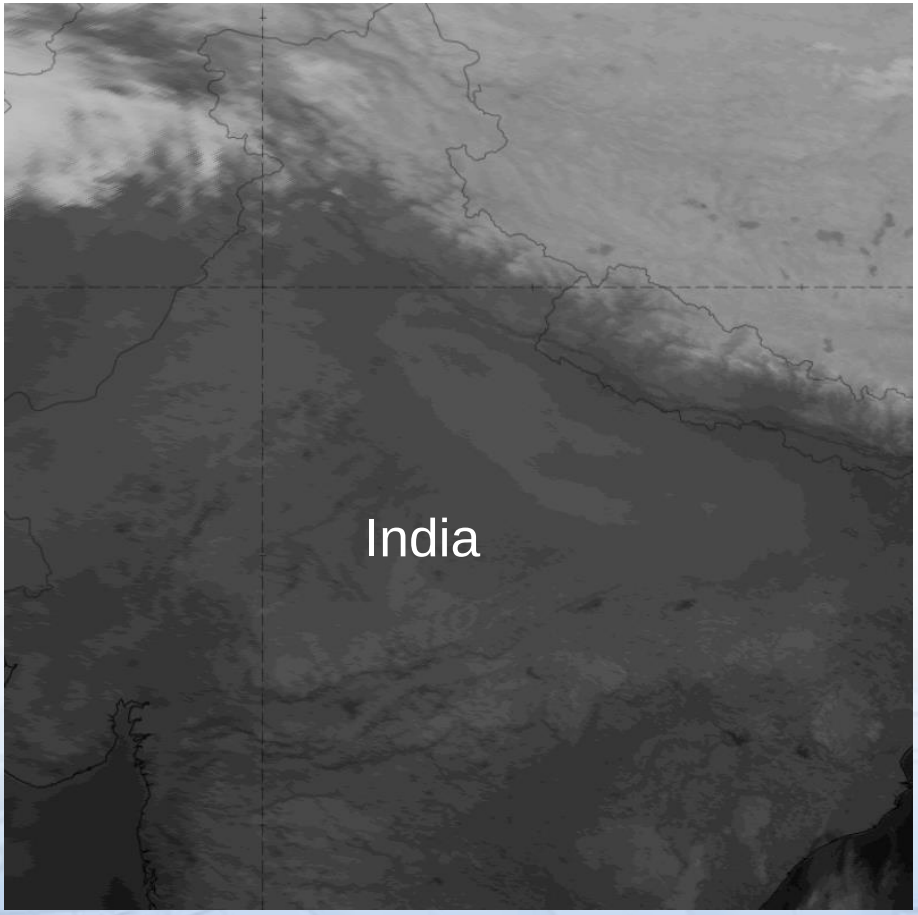
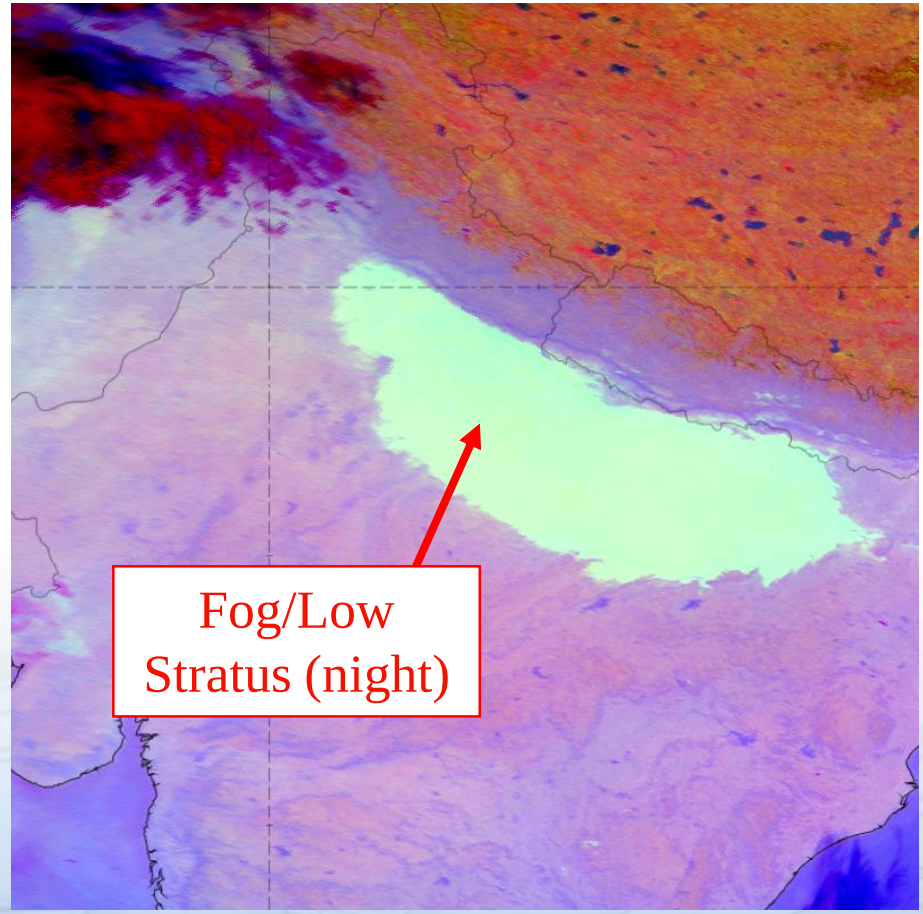
New Generation Improvements: Clouds at Night



AHI IR10.4 Channel



AHI Night Micro RGB

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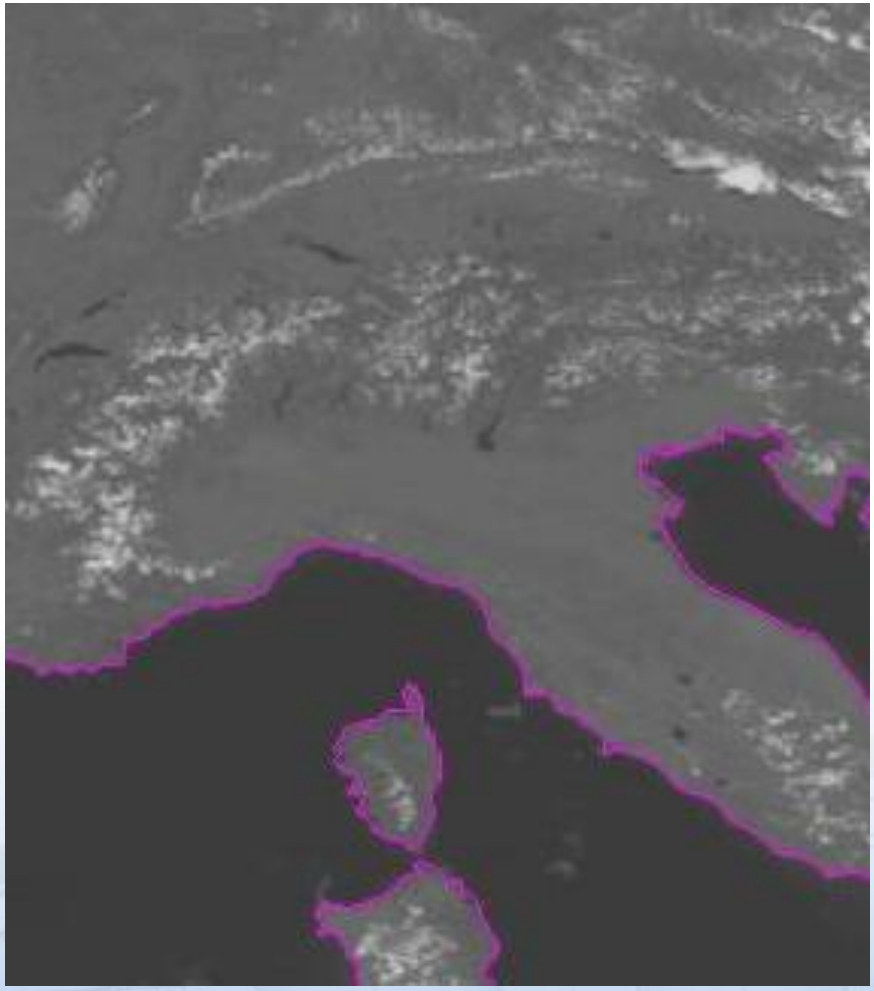
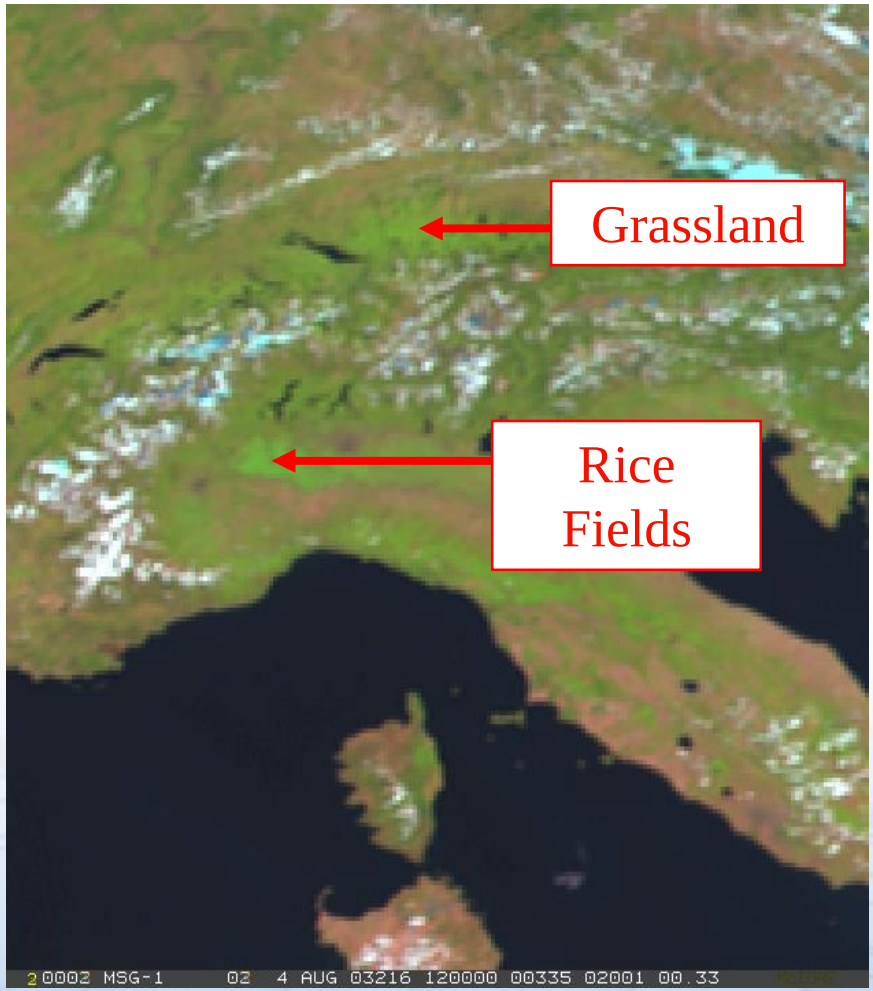
New Generation Improvements: Vegetation





MFG VIS Channel

MSG Natural Colours RGB

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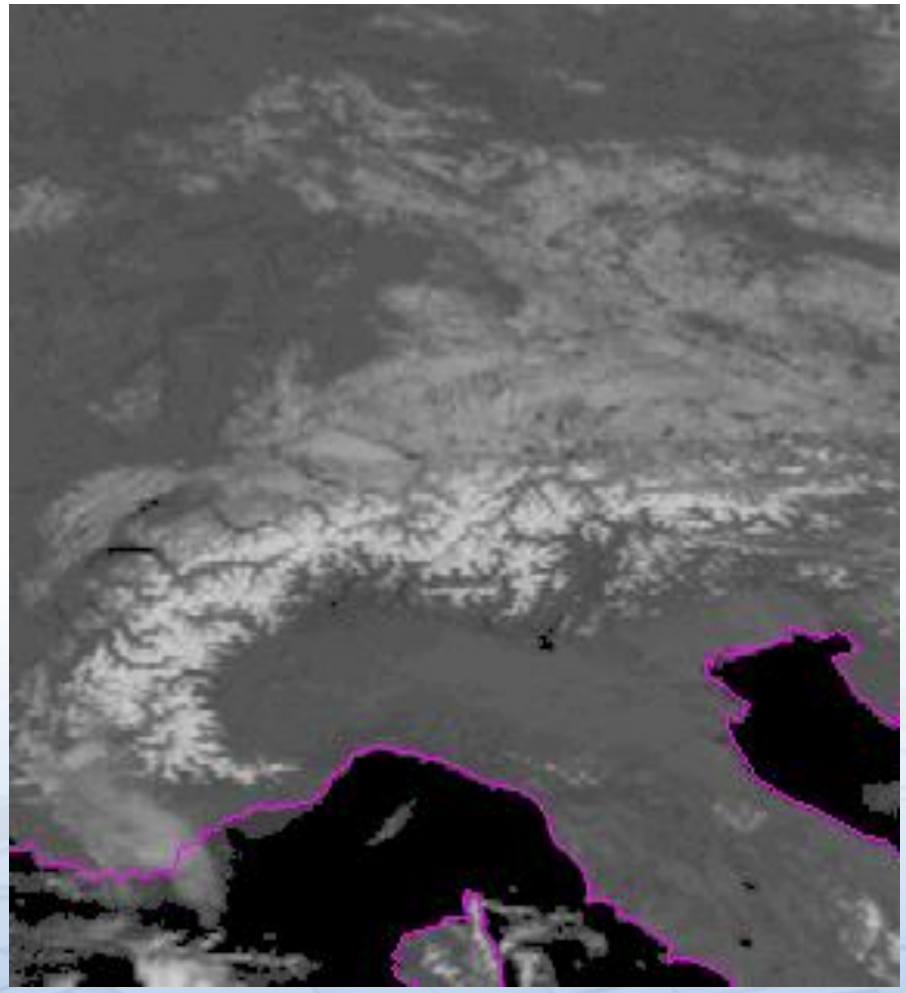
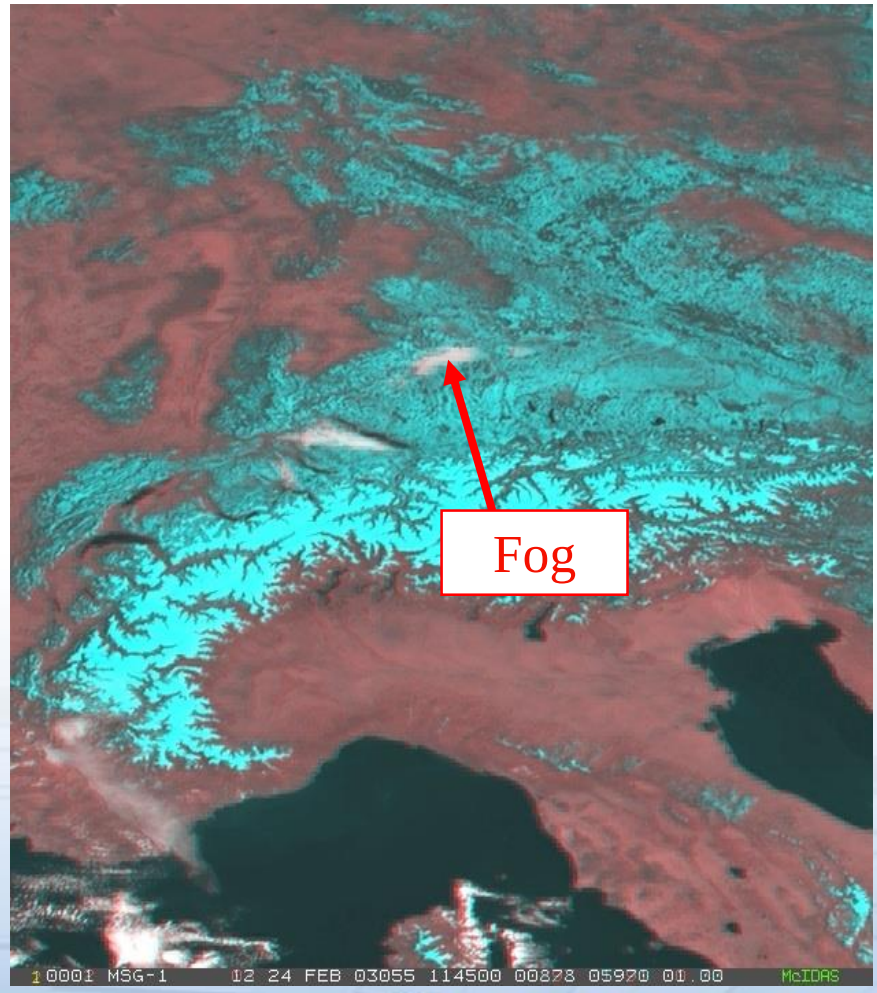
New Generation Improvements: Cloud / Snow Discrimination



MFG VIS Channel



MSG RGB NIR1.6, HRV, HRV

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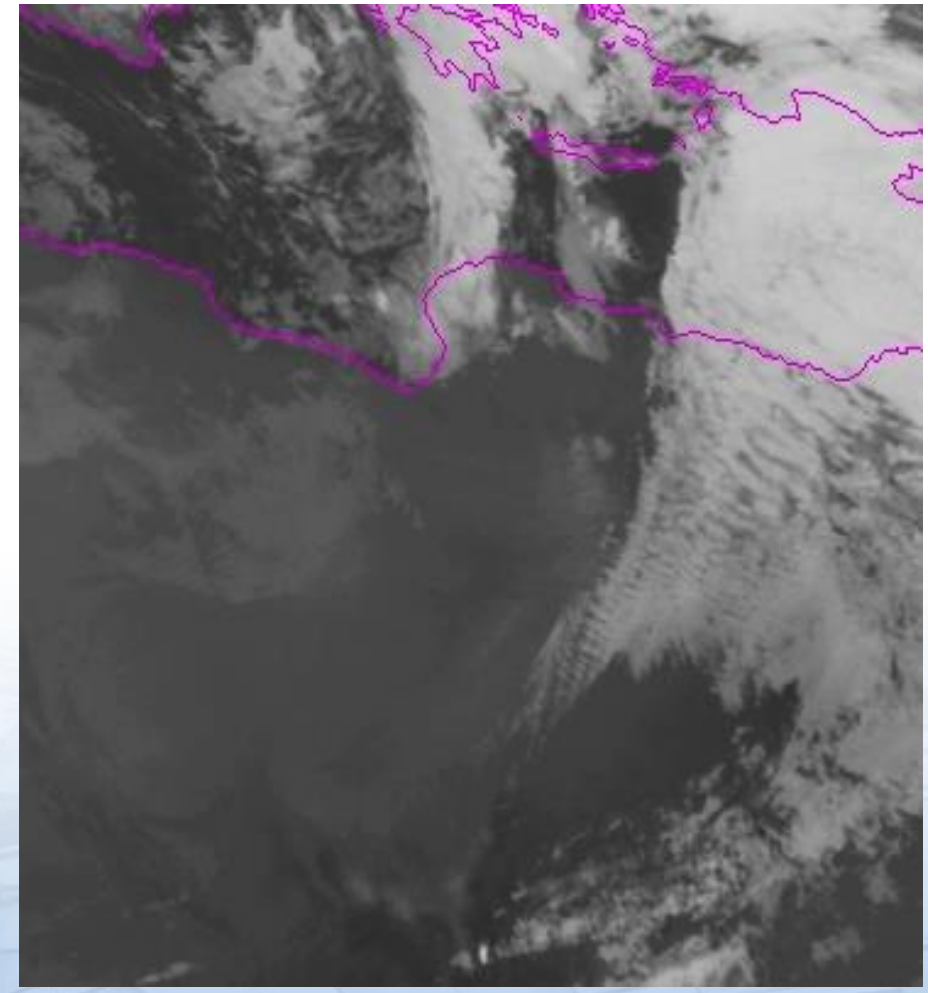
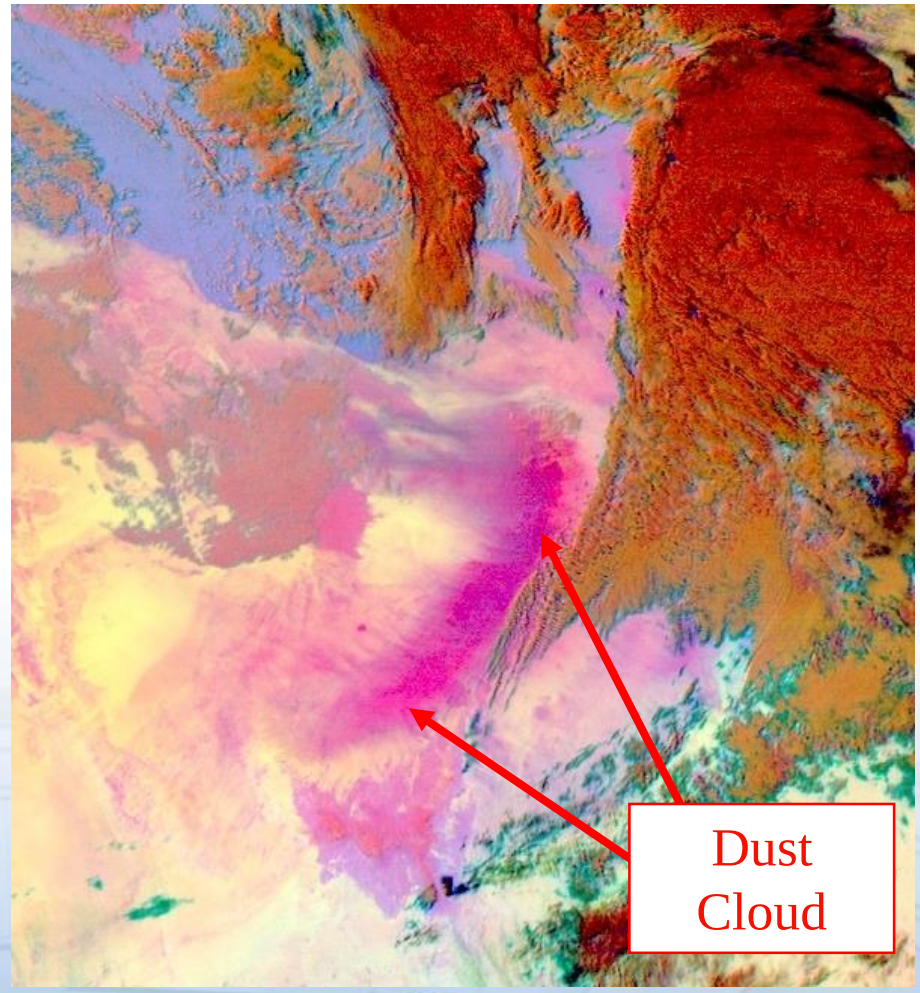
New Generation Improvements: Haze, Dust, Ash, Smoke



MFG IR Channel



MSG Dust RGB

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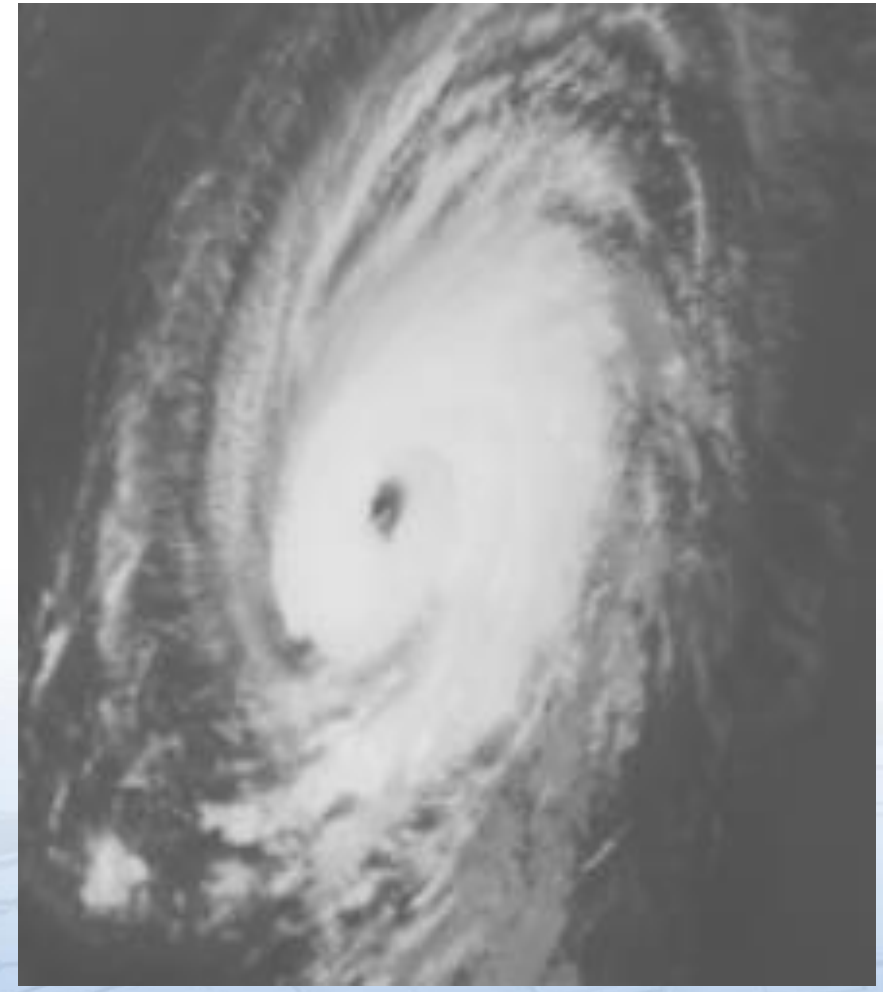
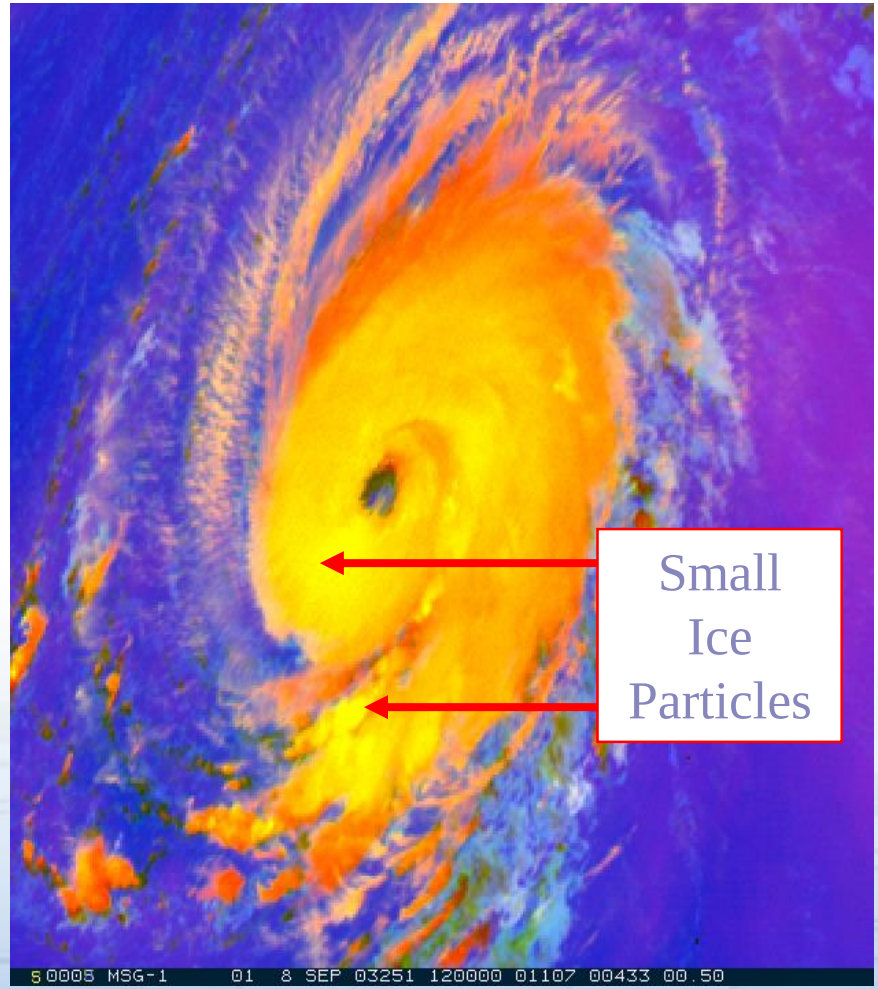
New Generation Improvements: Cloud Particle Size



MFG IR Channel



MSG Convection RGB

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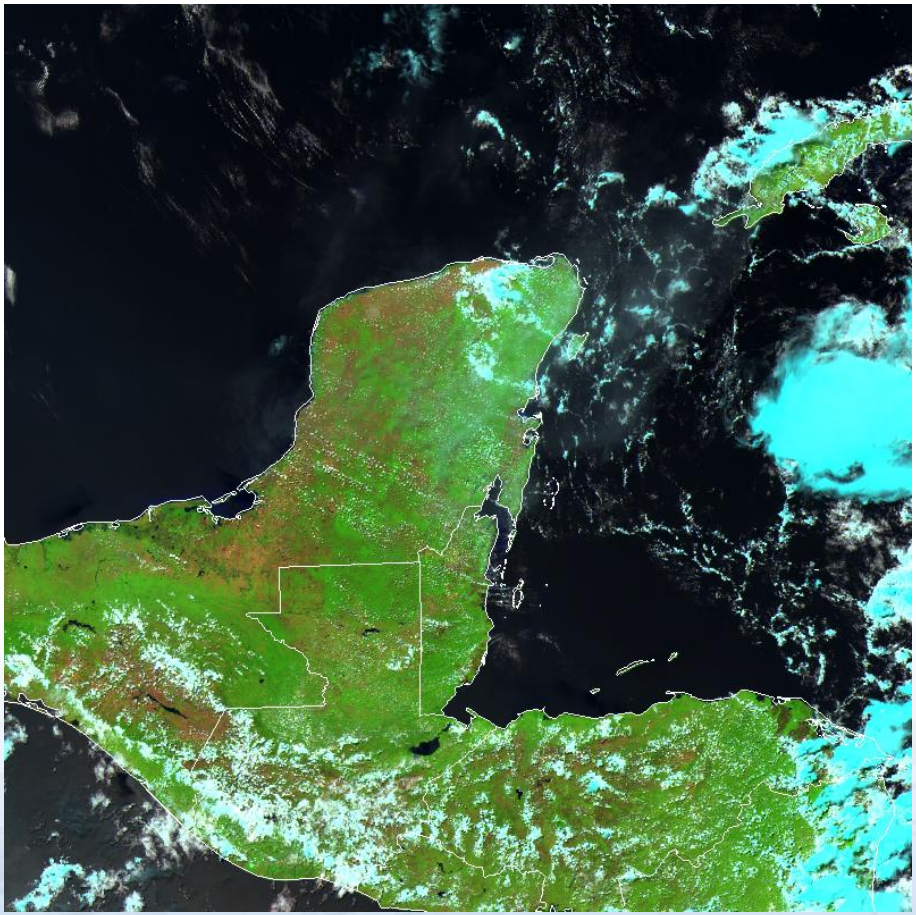
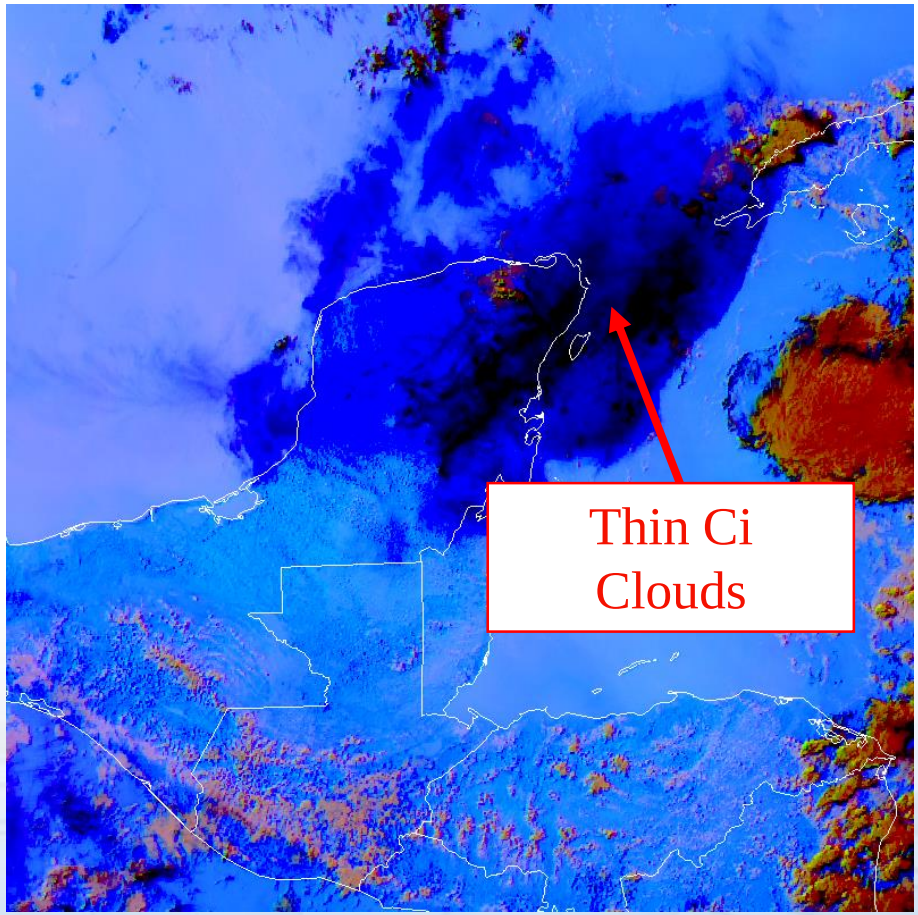
New Generation Improvements: Thin Clouds



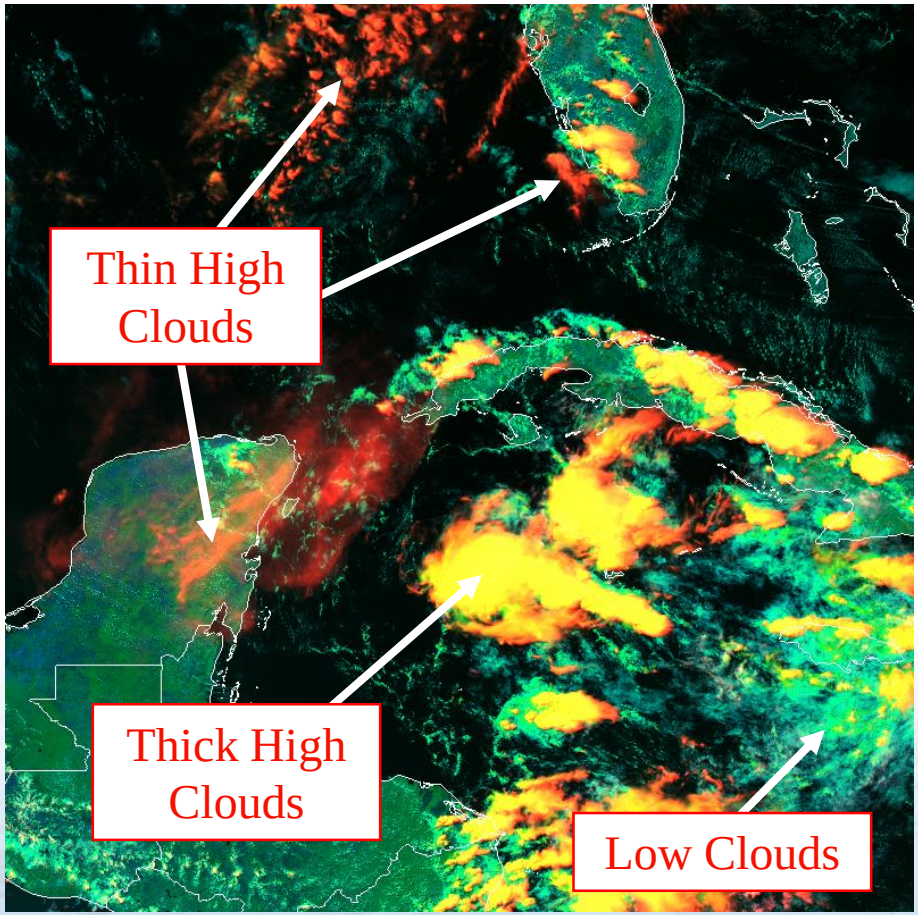
GOES-16 Nat. Colour RGB
(non-operational data)



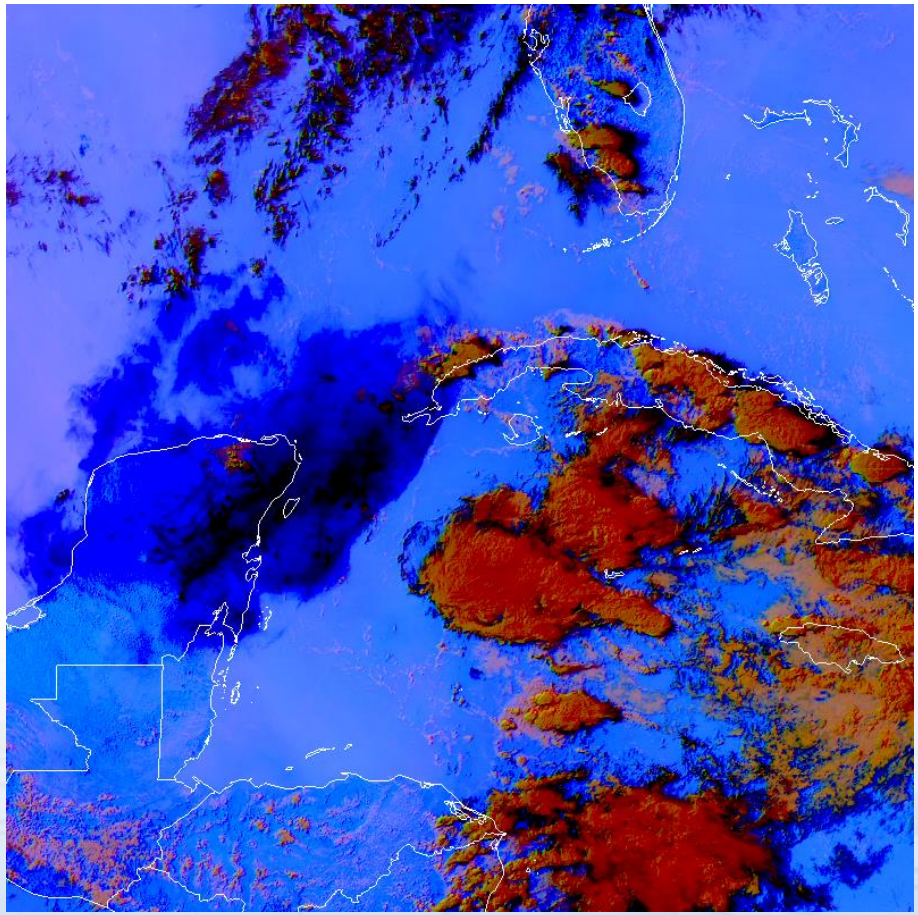
GOES-16 Dust RGB

EUMETSAT

New Generation Improvements: Cloud Classification



GOES-16 Cloud Type RGB
(non-operational data)



GOES-16 Dust RGB

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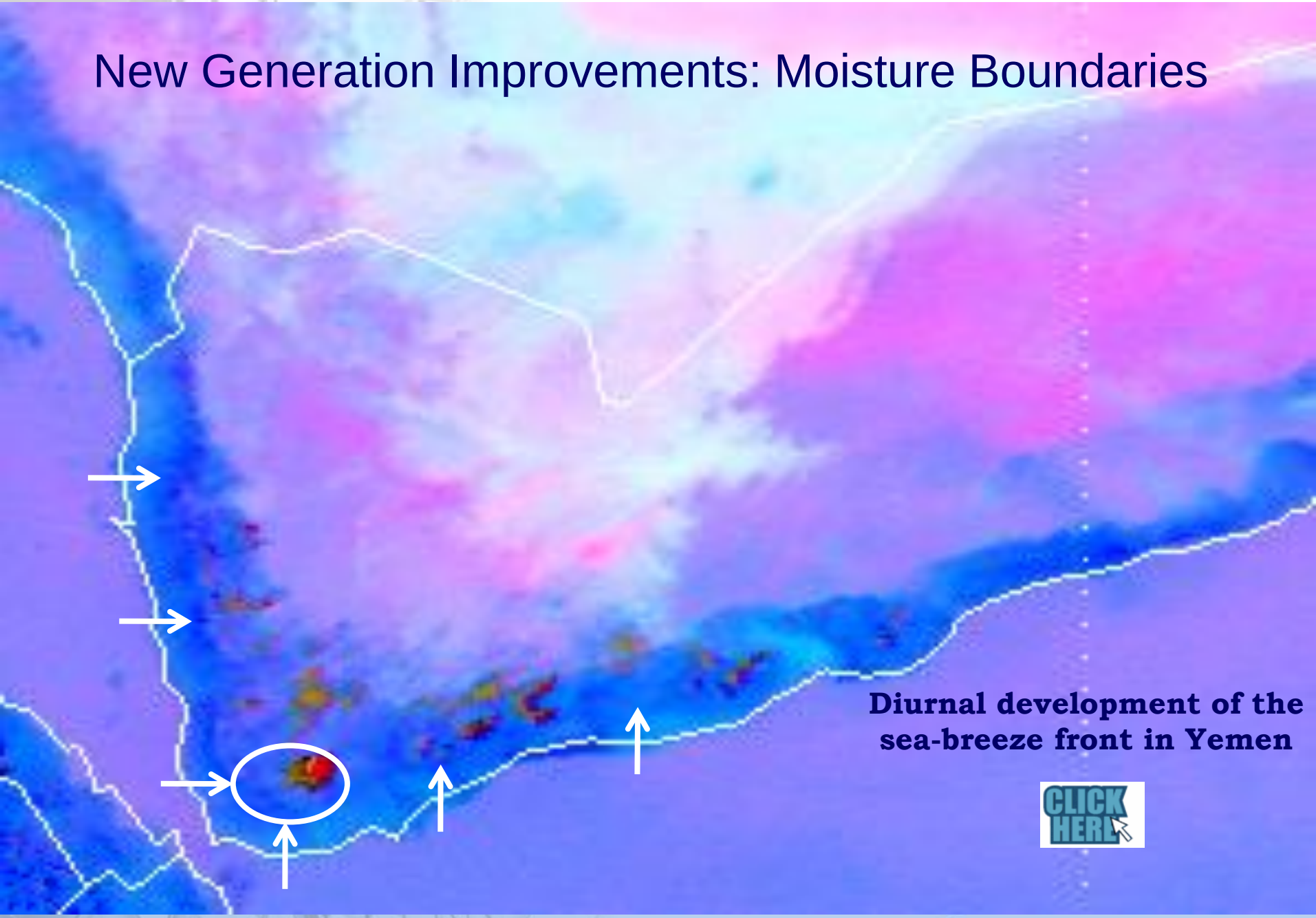
New Generation Improvements: Moisture Boundaries



Diurnal development of the sea-breeze front in Yemen

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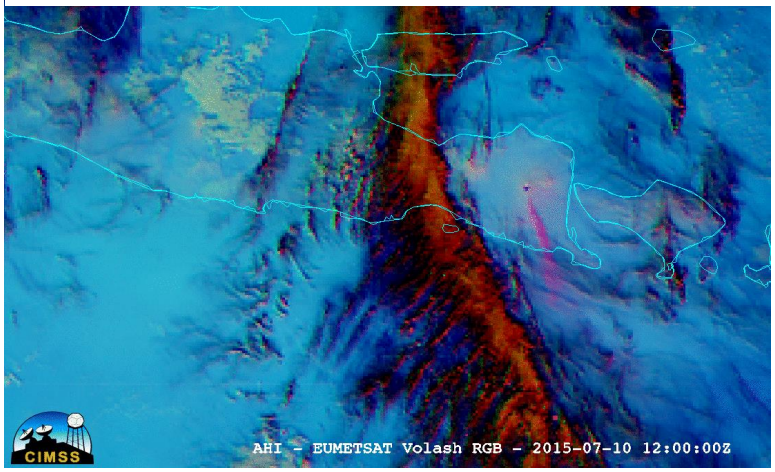
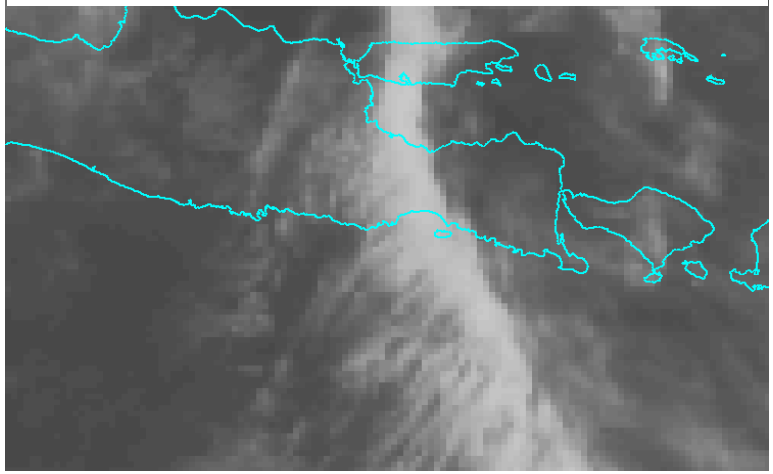
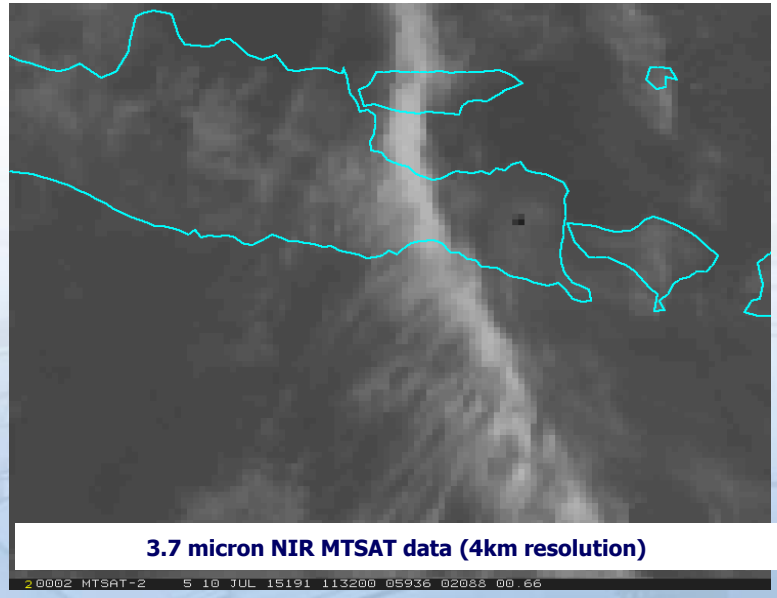
New Generation Improvements: Wind Shear Observation

Ash RGB Himawari-8 data (2km resolution)

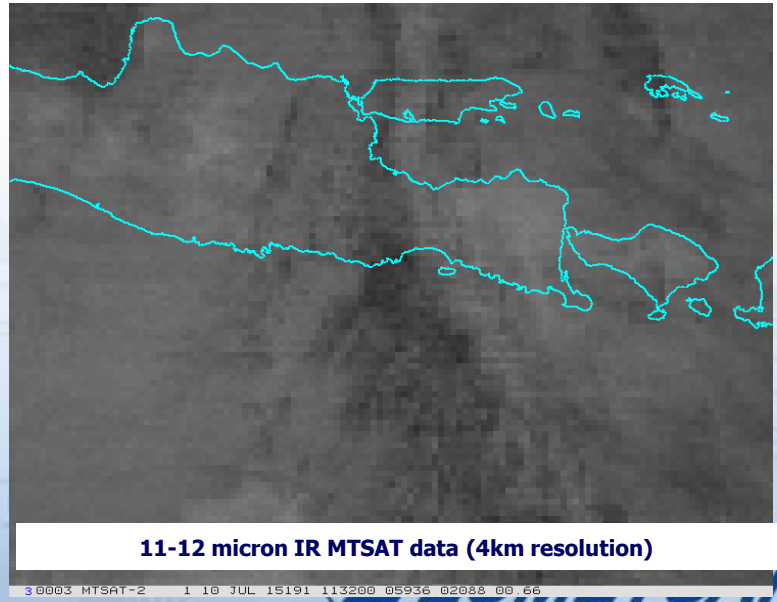


11 micron IR MTSAT data (4km resolution)





3.7 micron NIR MTSAT data (4km resolution)



11-12 micron IR MTSAT data (4km resolution)

Raung Plume, Java (10th July 2015)

GUIDELINES FOR CREATING RGBs

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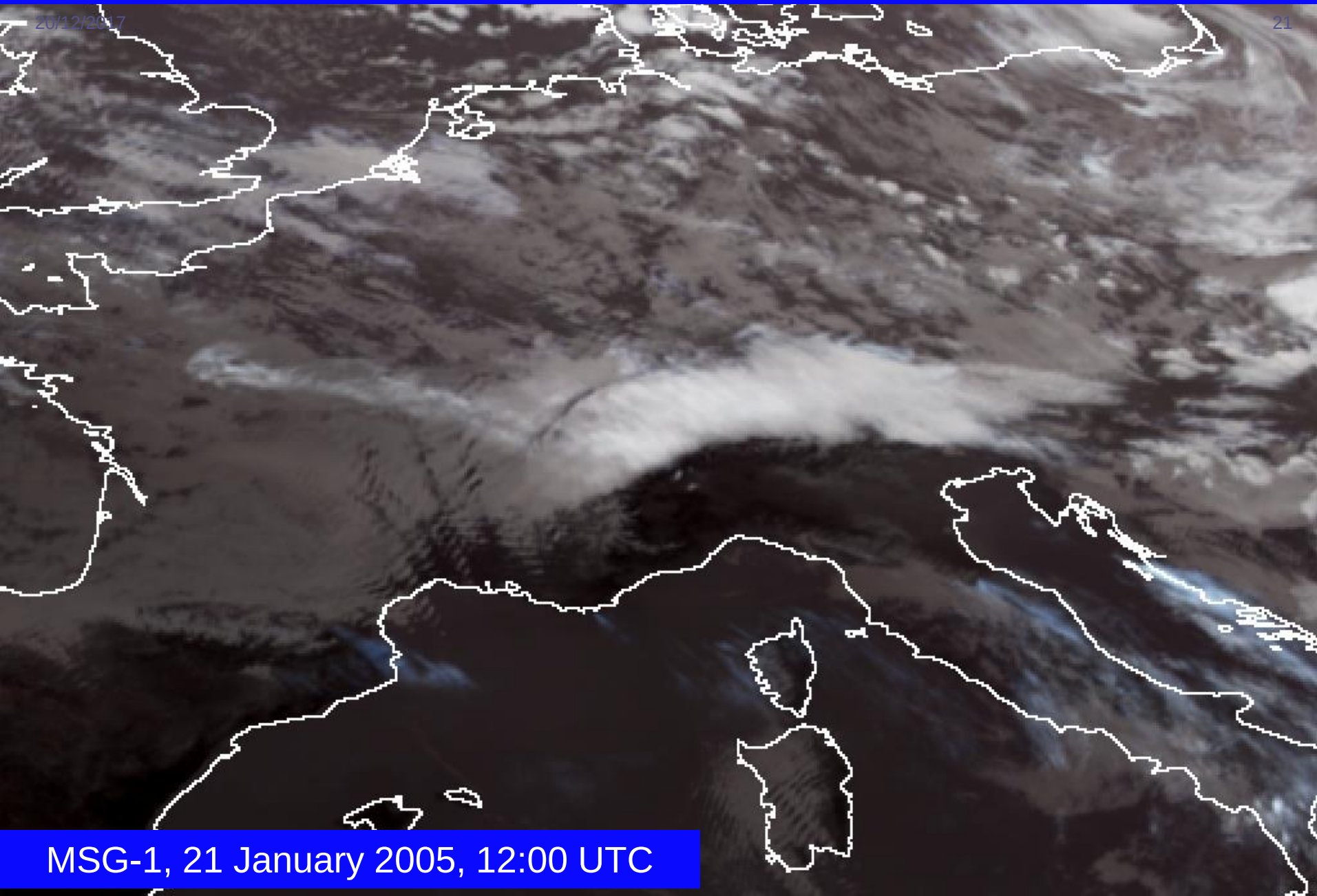
Rules for Creating “Good” RGB Products

Select three channels or channel differences that represent three different physical properties !!!

Example: MSG Window Channels

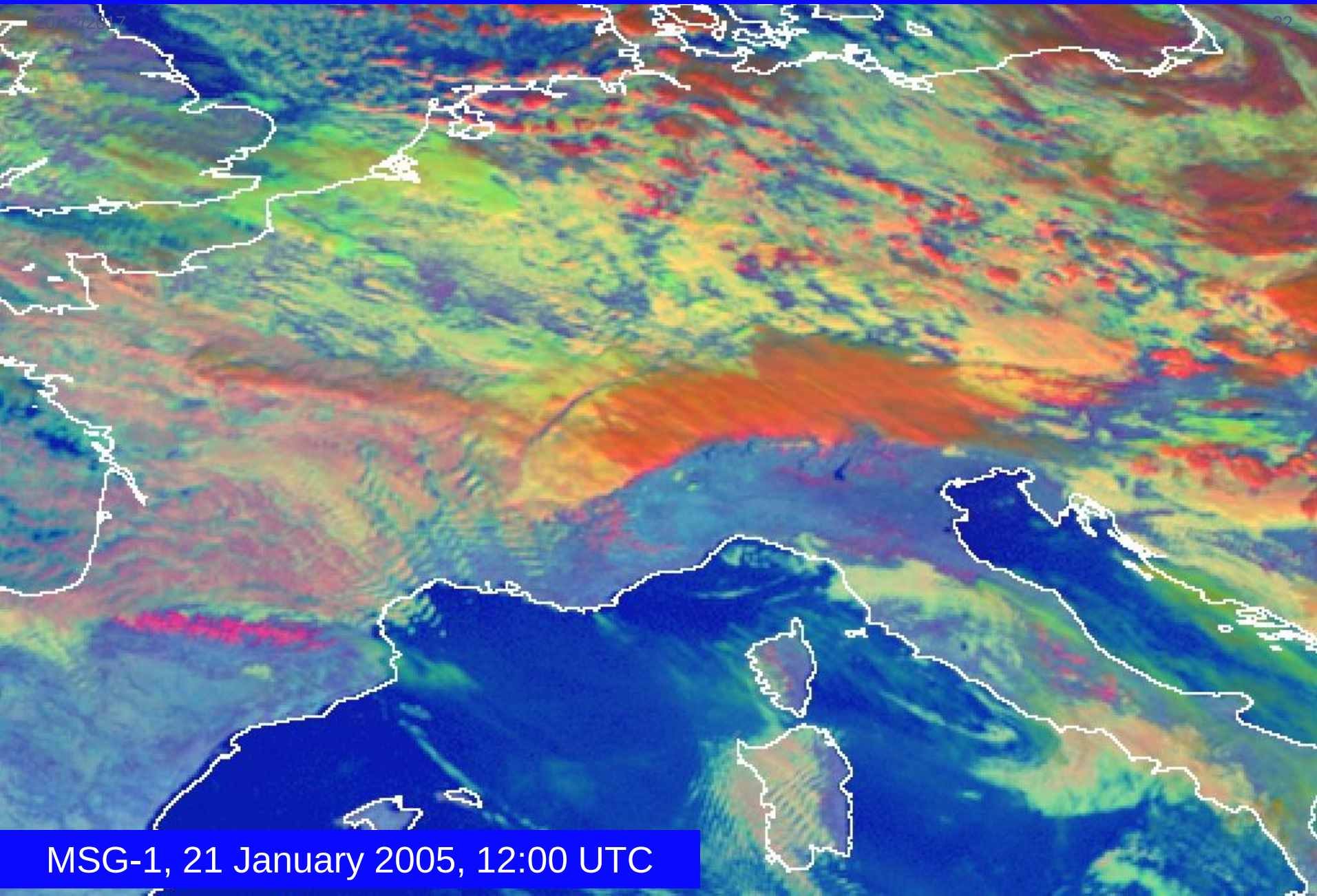
Channel	Main Cloud Physical Properties (clouds, NADIR viewing)
01 (VIS 0.6)	optical thickness, amount of cloud water and ice
02 (VIS 0.8)	optical thickness, amount of cloud water and ice
03 (NIR 1.6)	optical thickness, particle size & shape, phase
04 (MIR 3.9)	Day-time: top temperature, particle size & shape, phase Night-time: top temperature (very noisy below -50°C)
07 (IR 8.7)	top temperature
09 (IR 10.8)	top temperature
10 (IR 12.0)	top temperature

Not Recommended RGB IR8.7, IR10.8, IR12.0



MSG-1, 21 January 2005, 12:00 UTC

Recommended RGB VIS0.8, IR3.9r, IR10.8



MSG-1, 21 January 2005, 12:00 UTC

RGB PRODUCTS FOR OPERATIONAL FORECASTING

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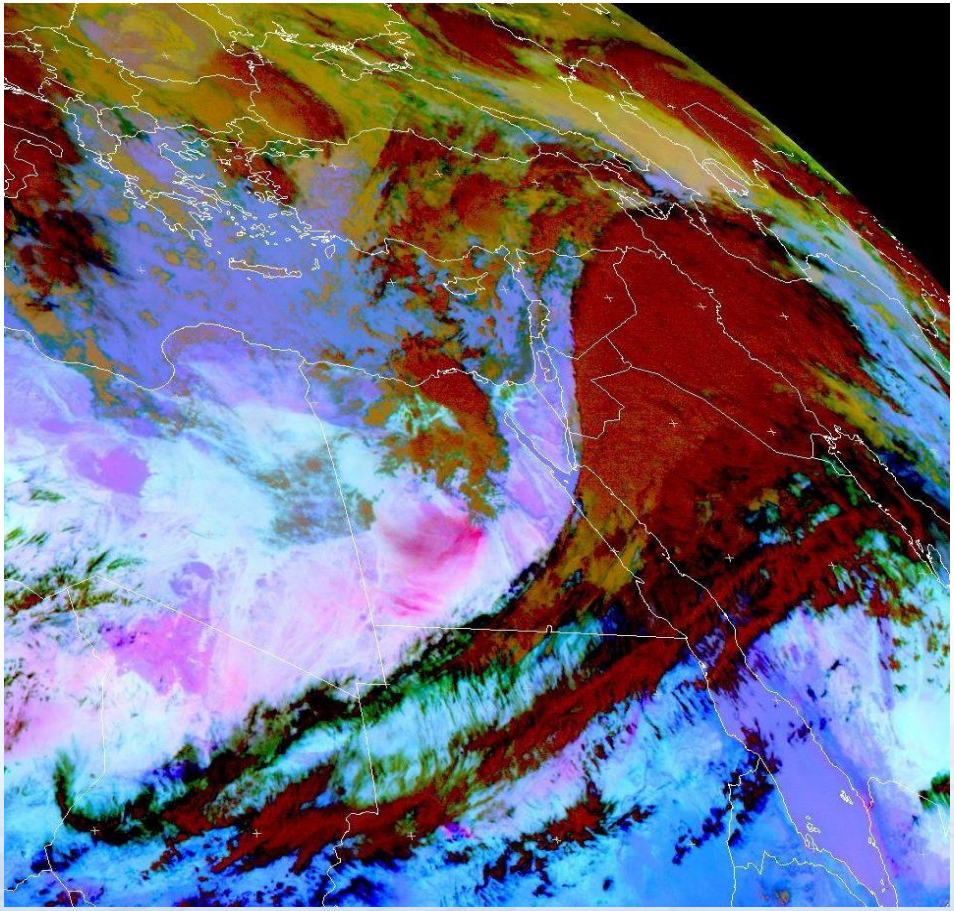
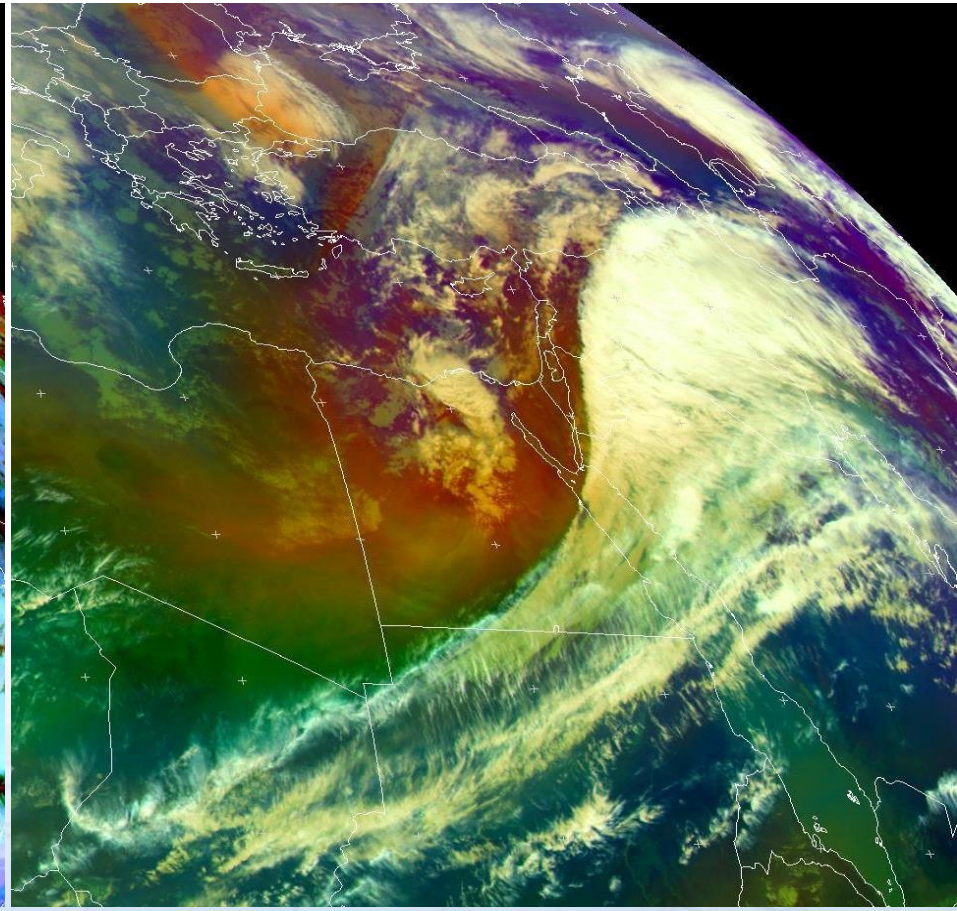
Most important RGBs (for Operational Forecasting)



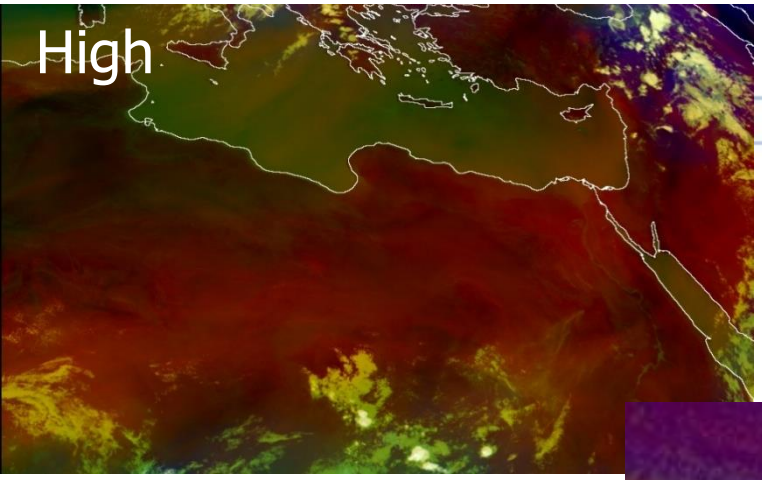


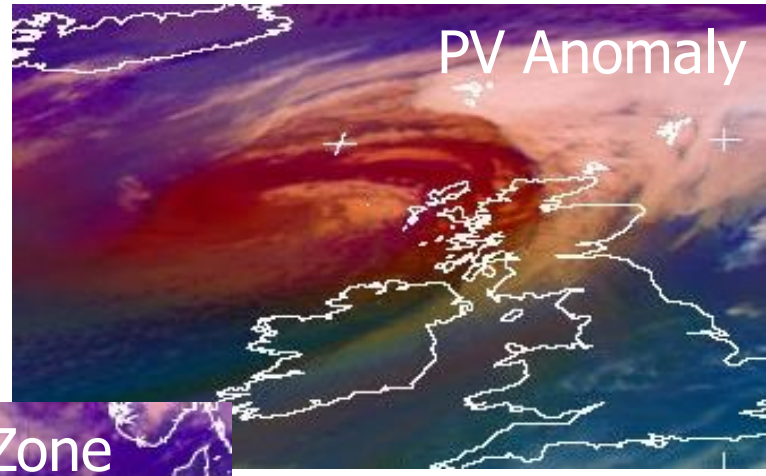
24-h Microphysics (Dust) RGB

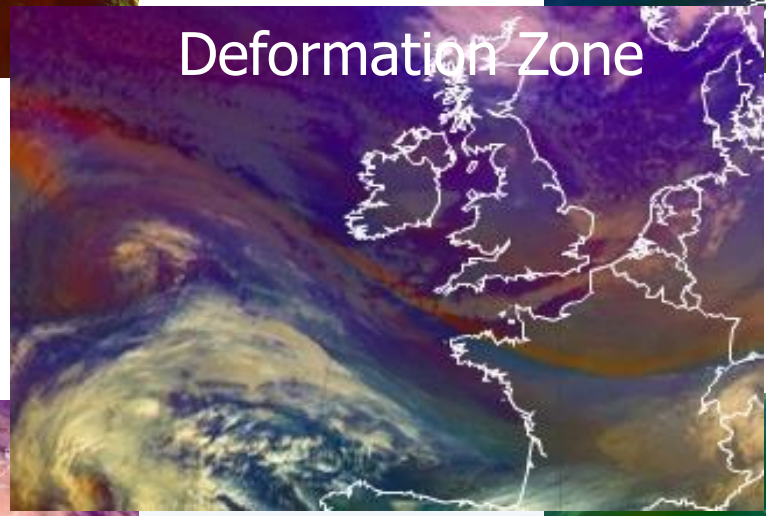
Airmass RGB

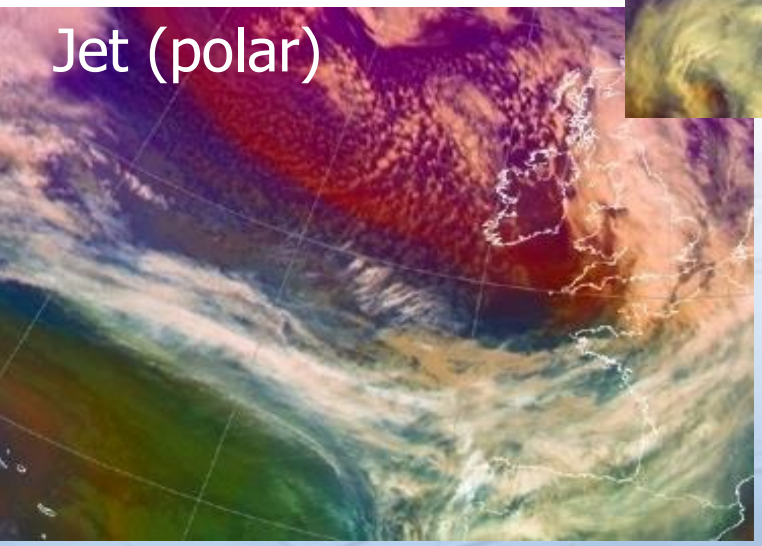
28 January 2013, 12:00 UTC

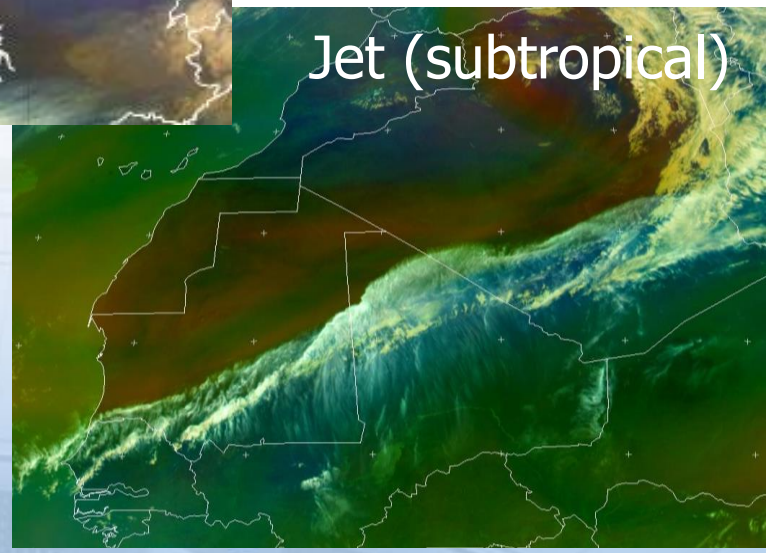
EUMETSAT


High

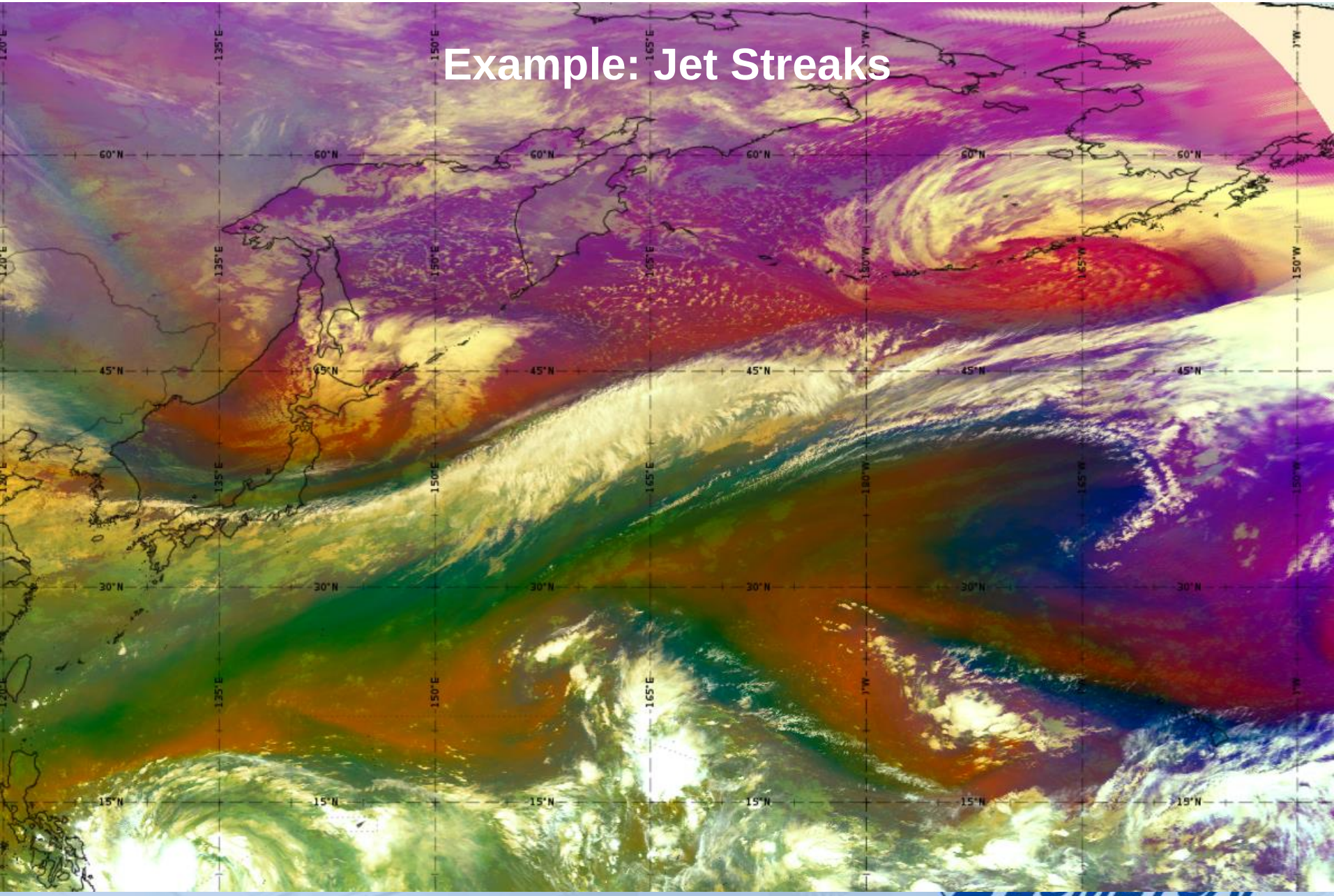

PV Anomaly


Deformation Zone


Jet (polar)

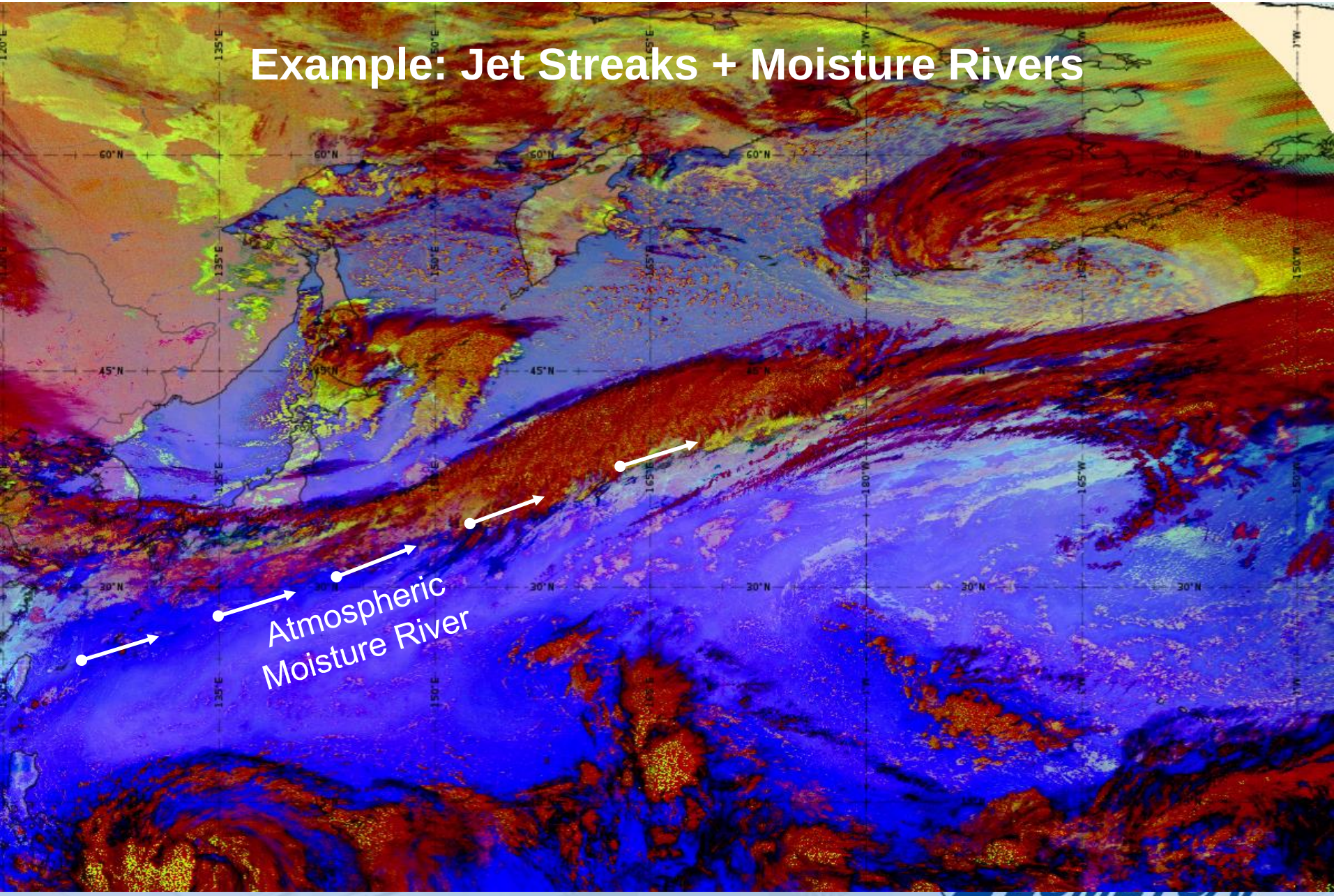

Jet (subtropical)

Example: Jet Streaks



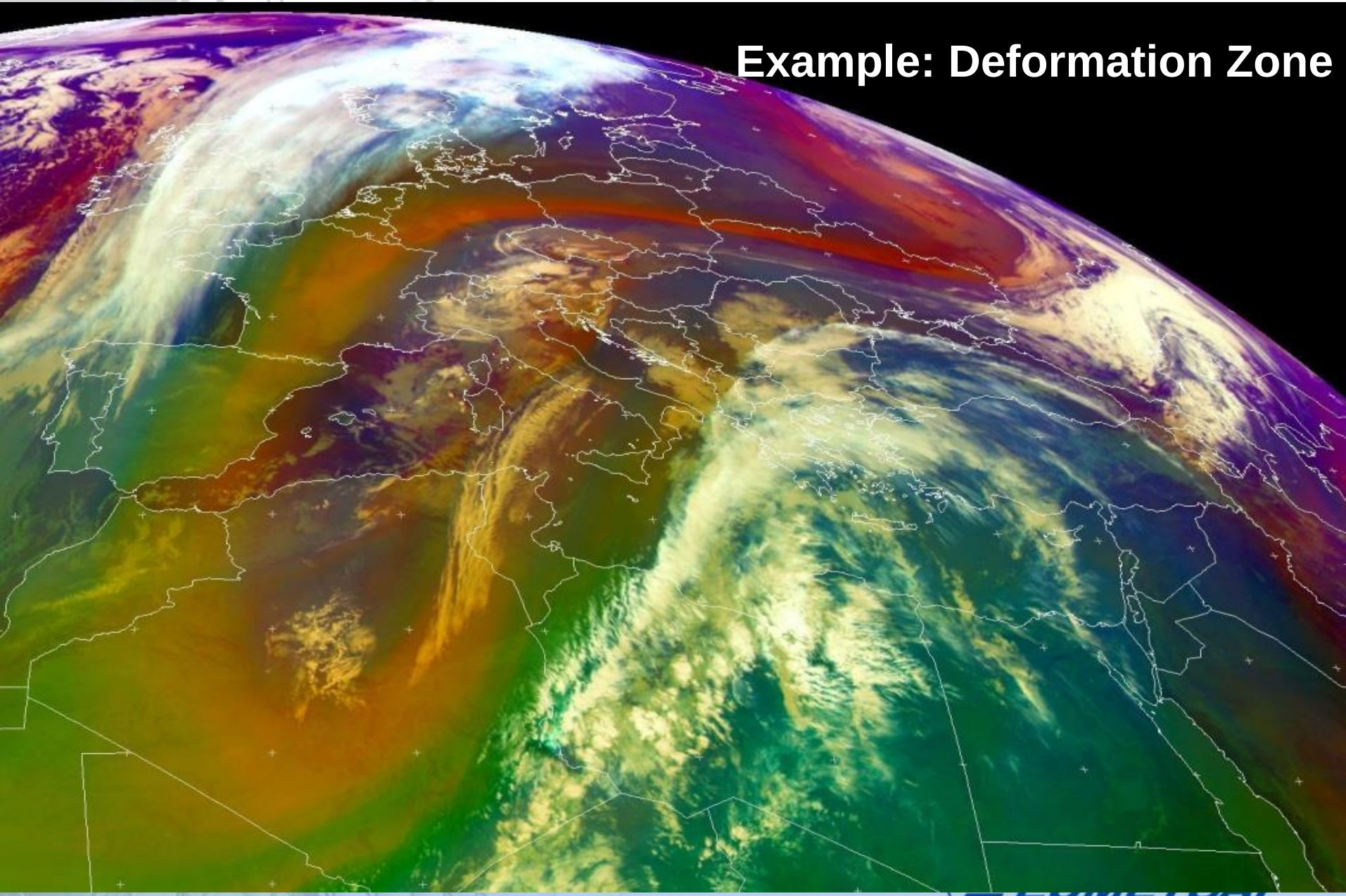
Him-08, 17 October 2017, 12:00 UTC

Example: Jet Streaks + Moisture Rivers

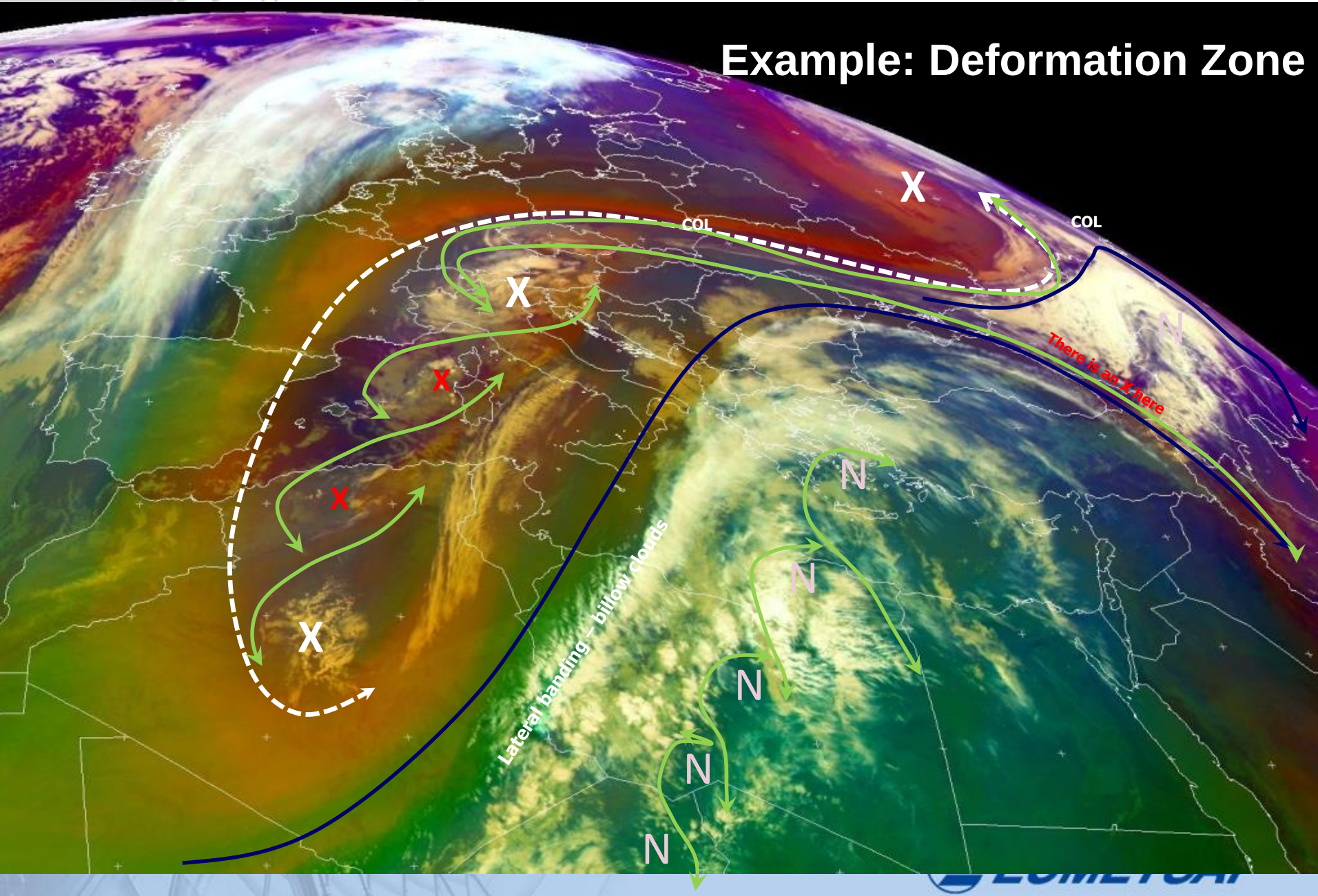


Him-08, 17 October 2017, 12:00 UTC

Example: Deformation Zone

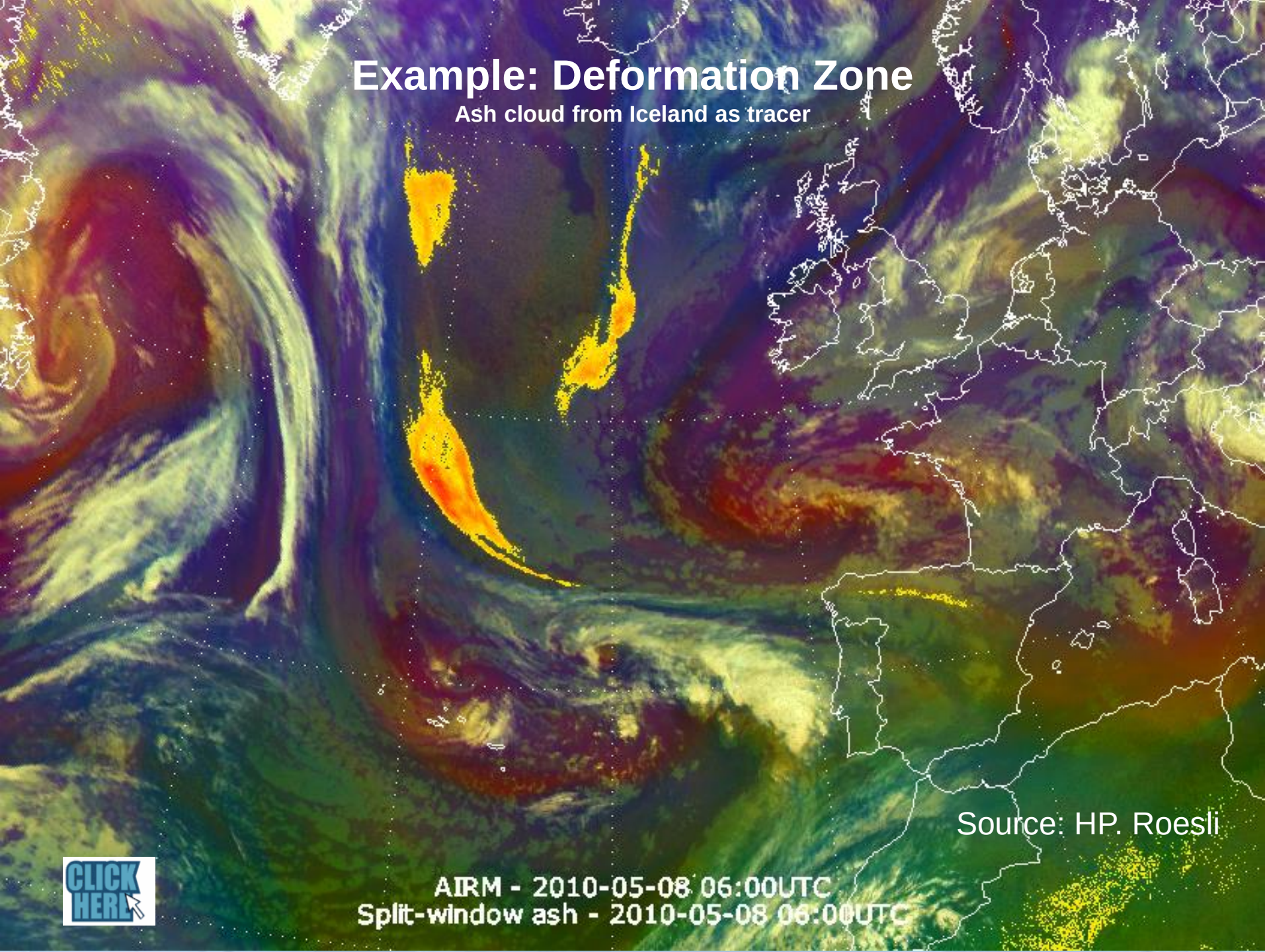


Example: Deformation Zone



Example: Deformation Zone

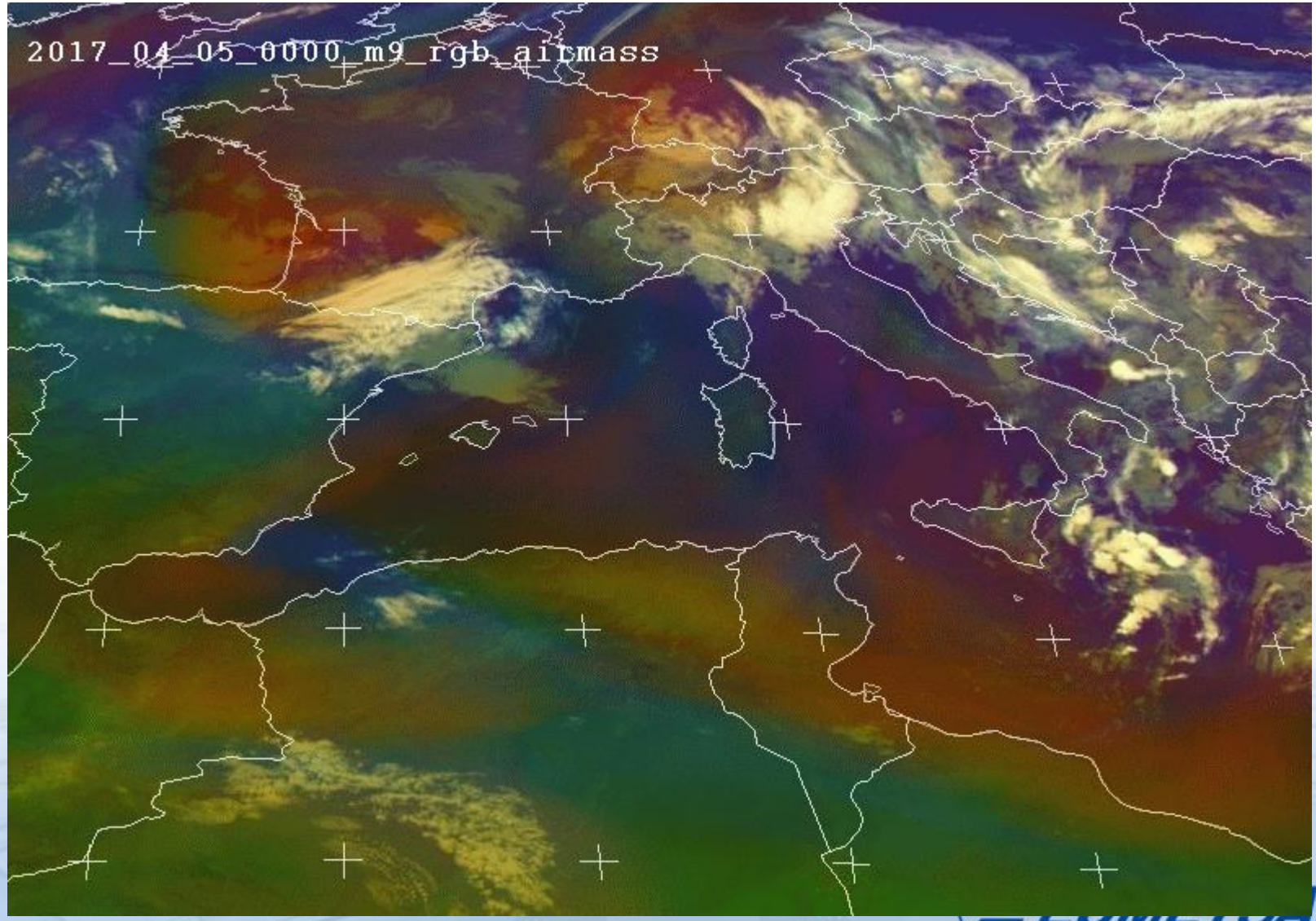
Ash cloud from Iceland as tracer



Source: HP. Roesli

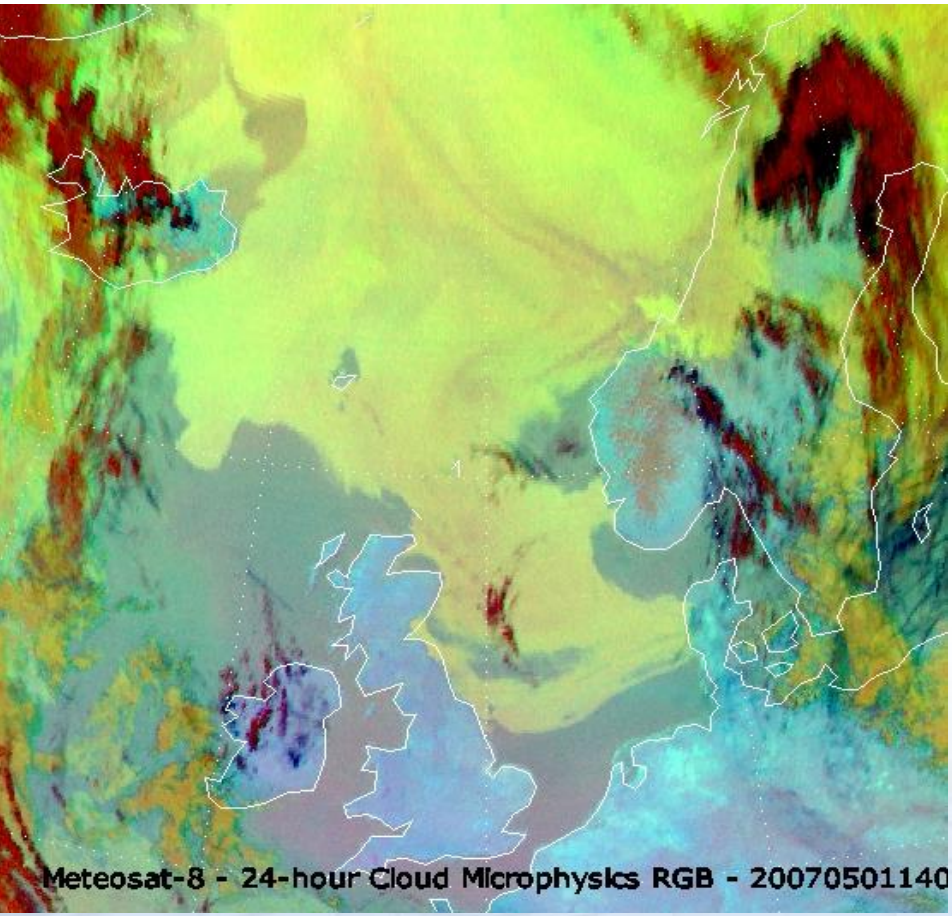
Example: Two PV anomalies merge over Europe

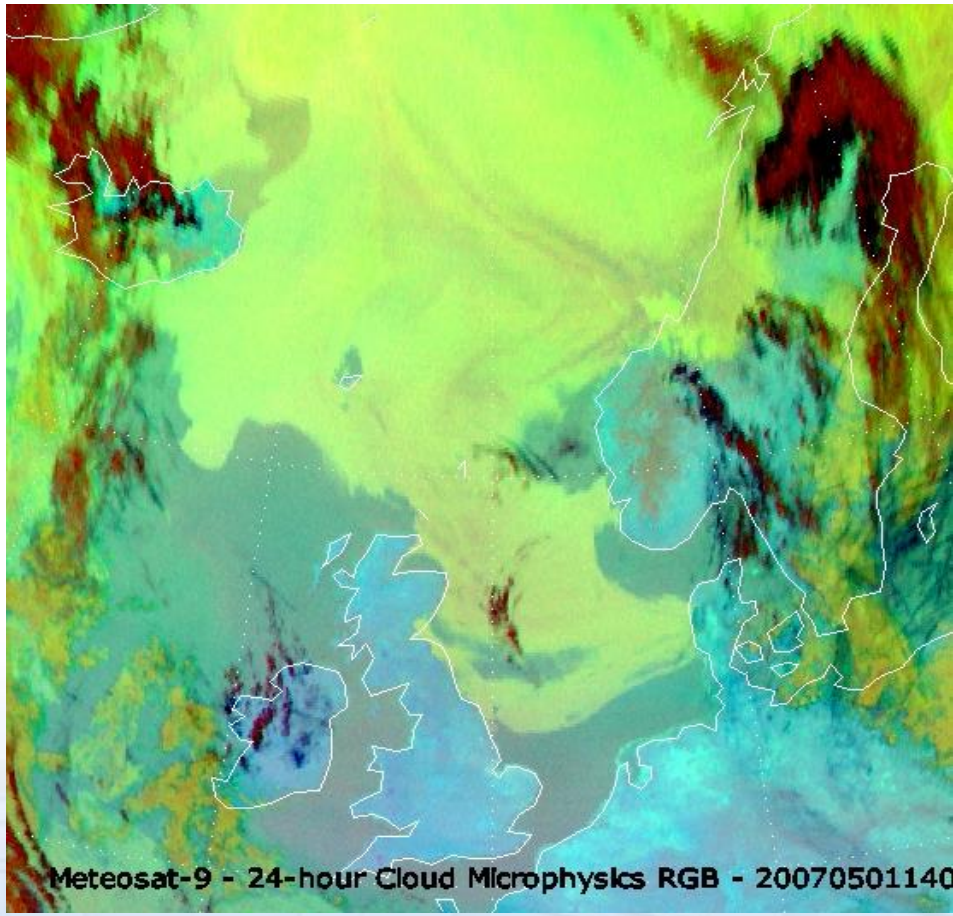
(Fujiwhara effect)



Met-10, 5-6 April 2017

Example: Low Clouds





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Comparison Met-8 vs Met-9

1 May 2007, 14:00 UTC

Source: HP. Roesli

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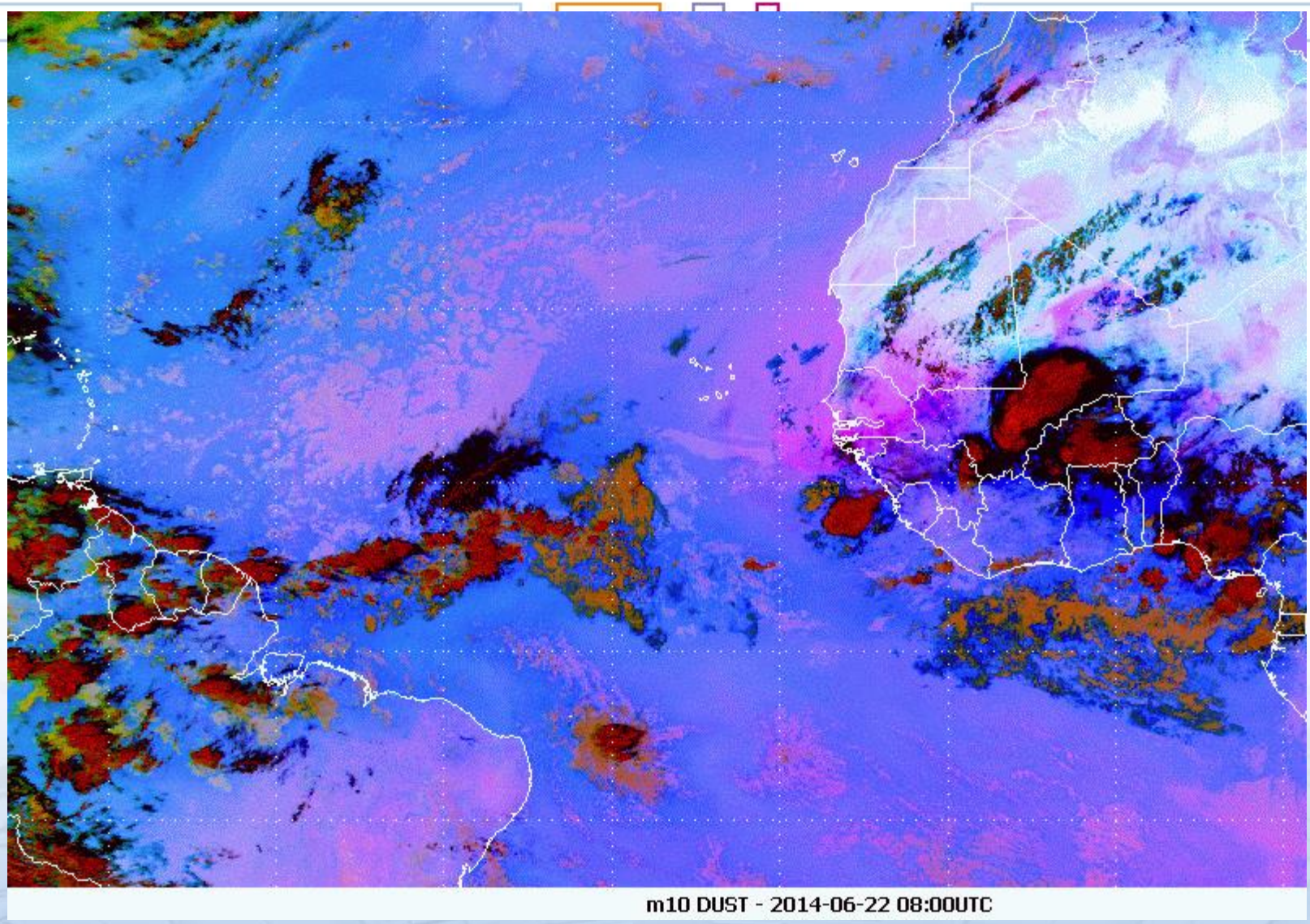
Example: Dust crosses the Atlantic Ocean



Source: HP. Roesli

22-25 June 2014

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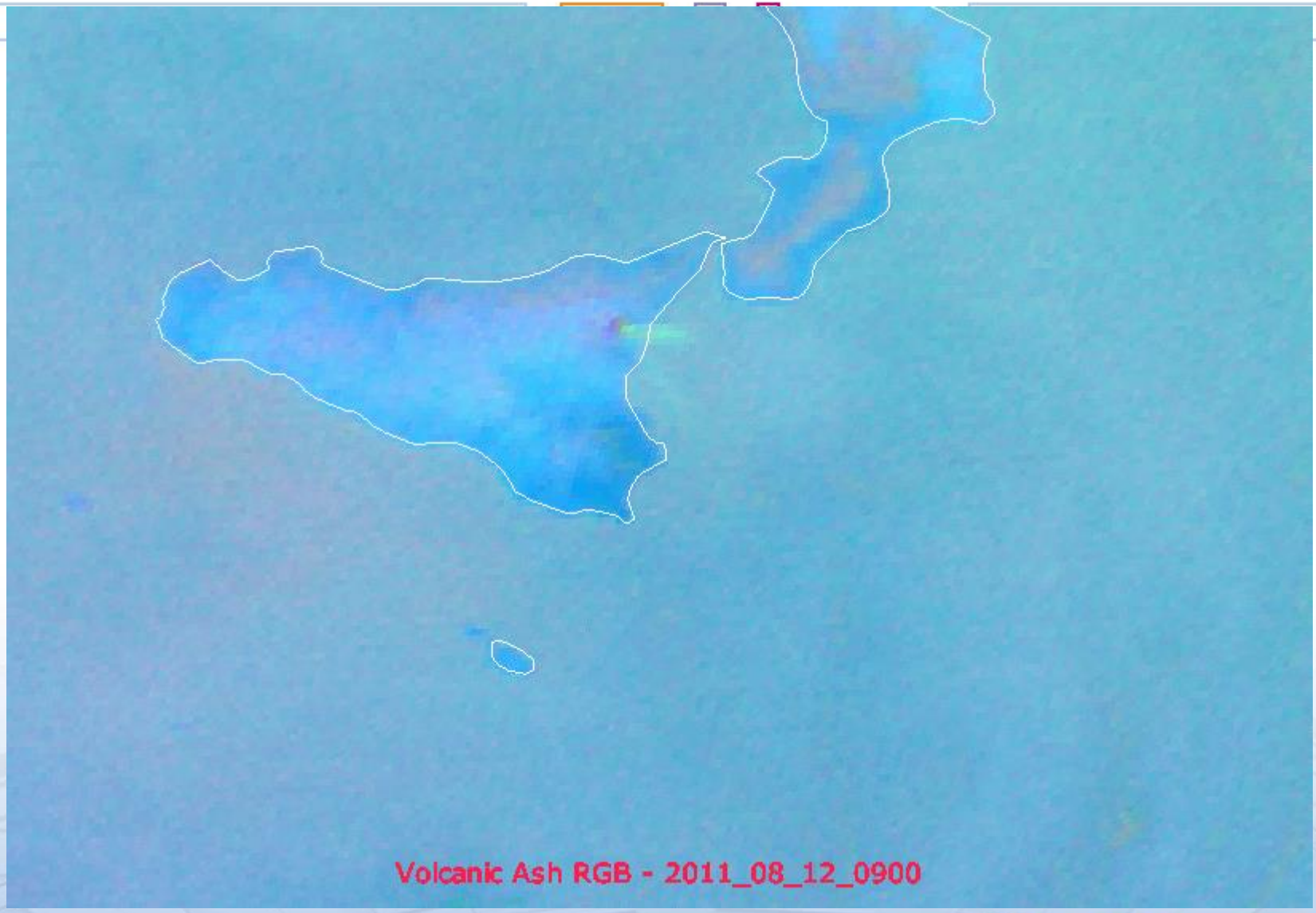
Example: Volcanic Ash (Etna, Italy)



Source: HP. Roesli

12 August 2011, 09:00-13:00 UTC

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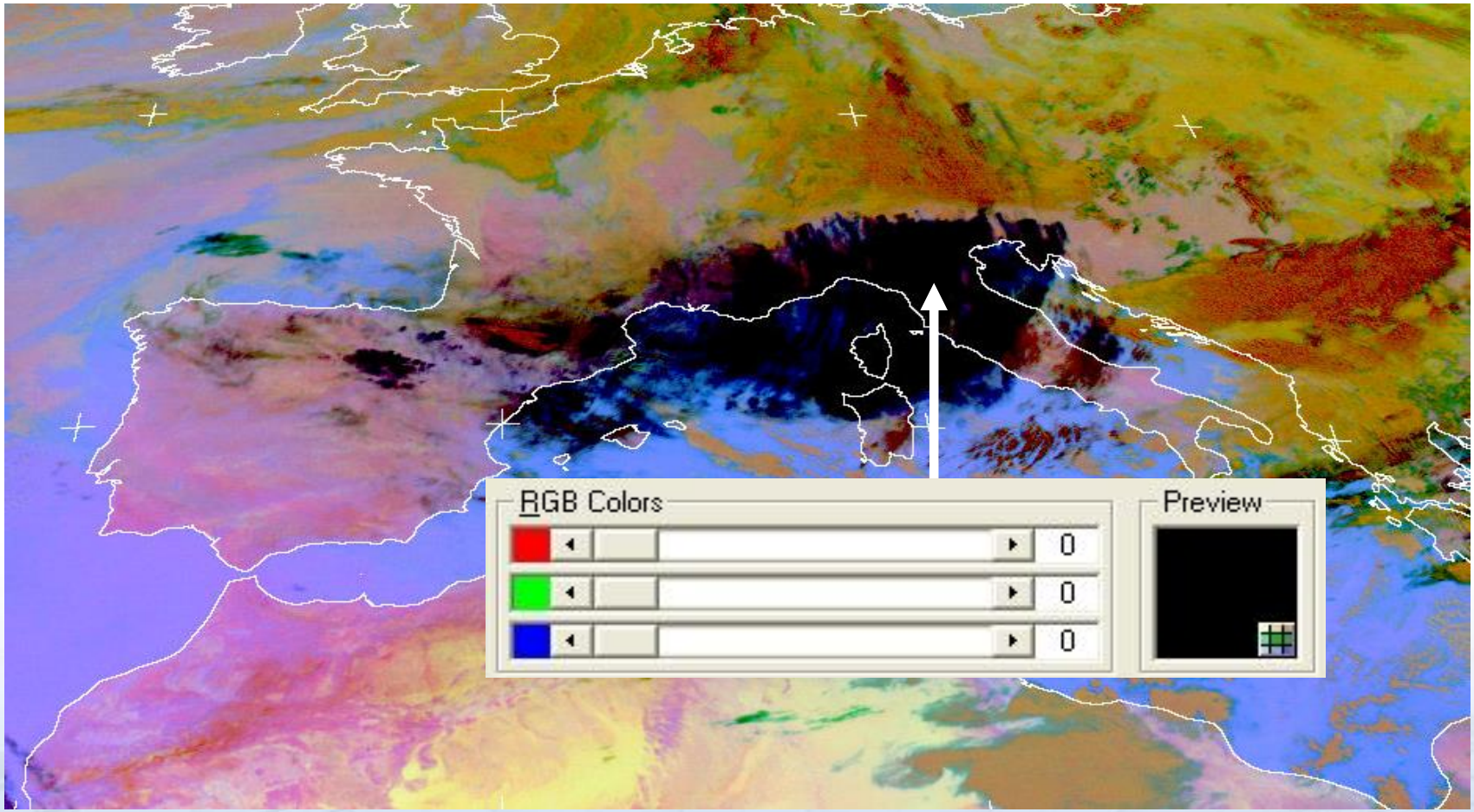
Example: Thin Ice Clouds (Lee Clouds)



MSG-1, 12 November 2006, 23:00 UTC

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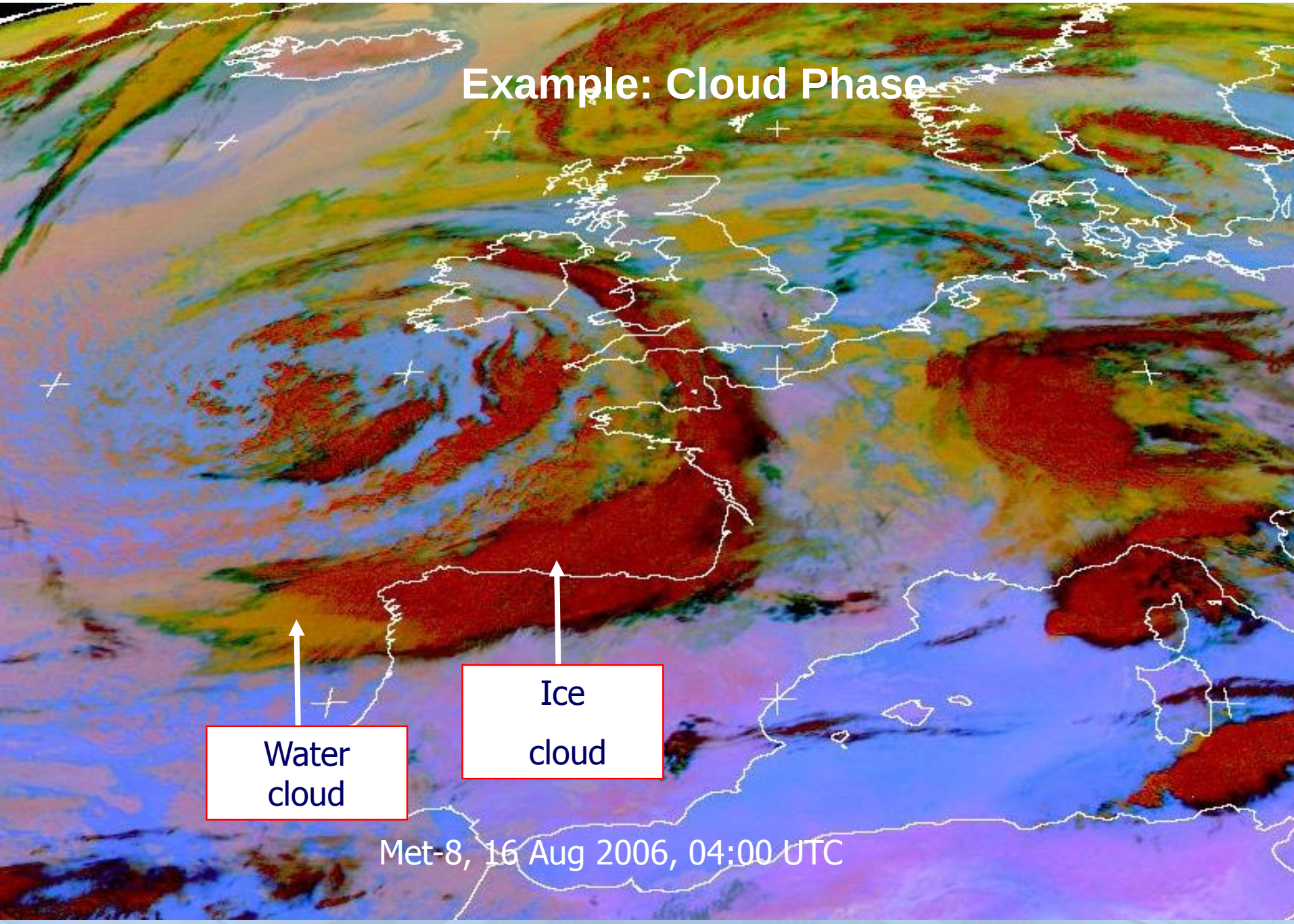
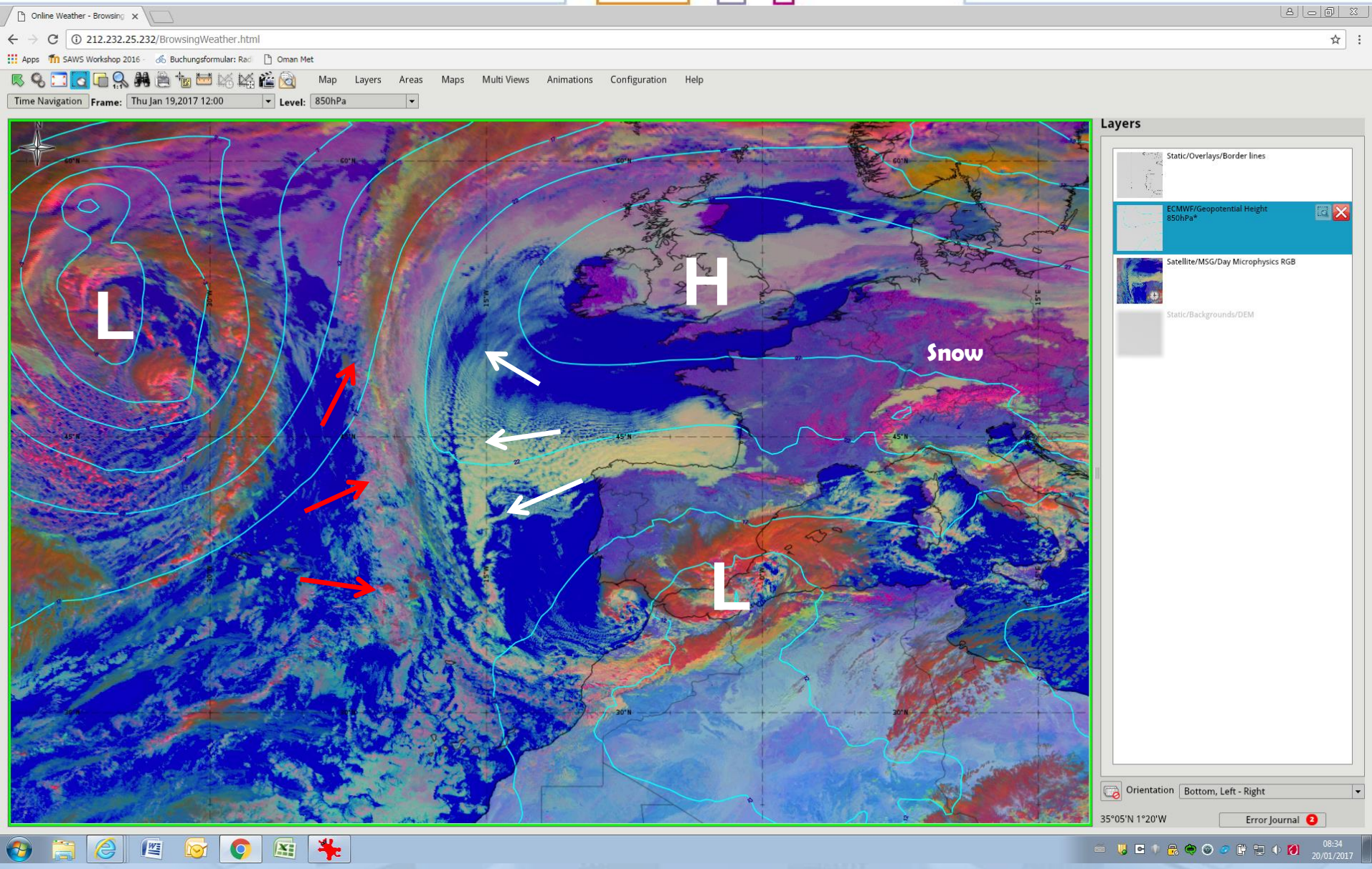
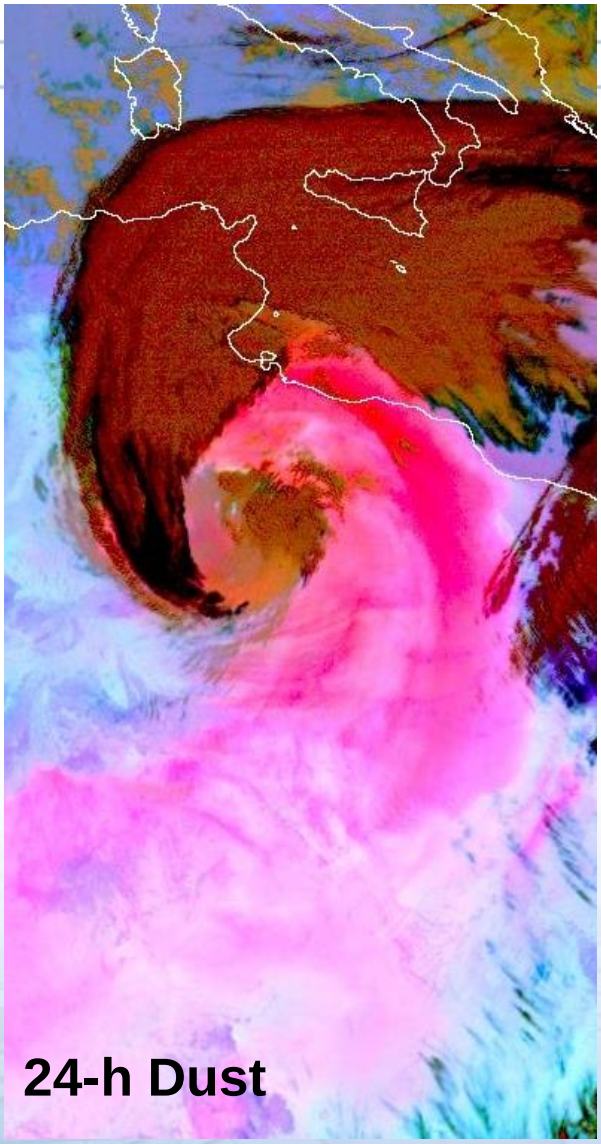

Example: Cloud Phase
Water cloud
Ice cloud
Met-8, 16 Aug 2006, 04:00 UTC

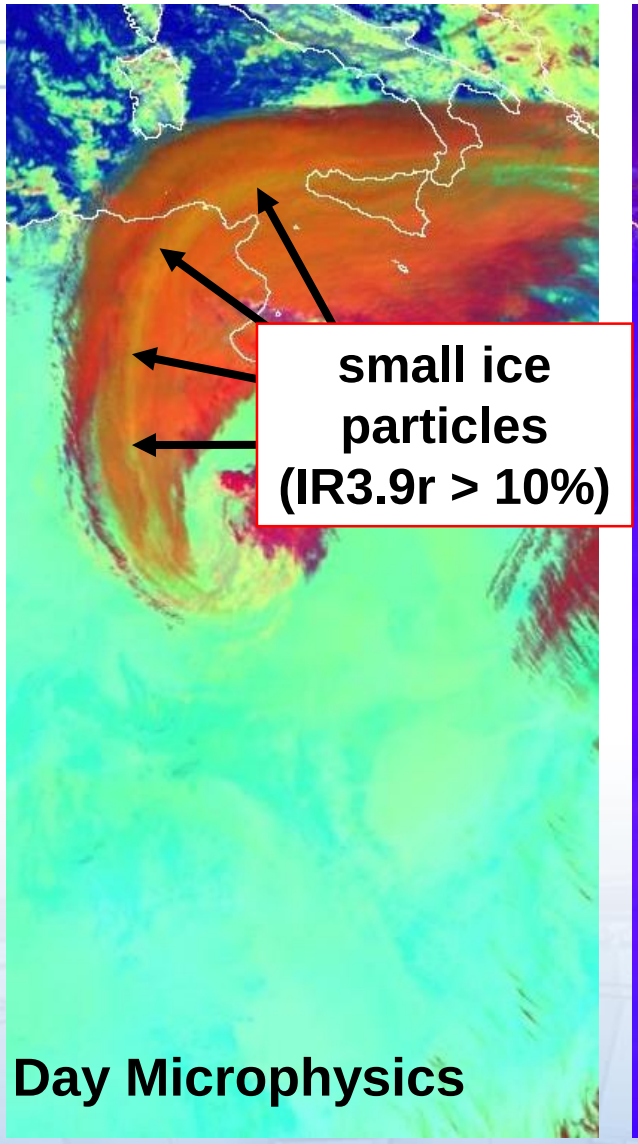
OTHER RGB PRODUCTS

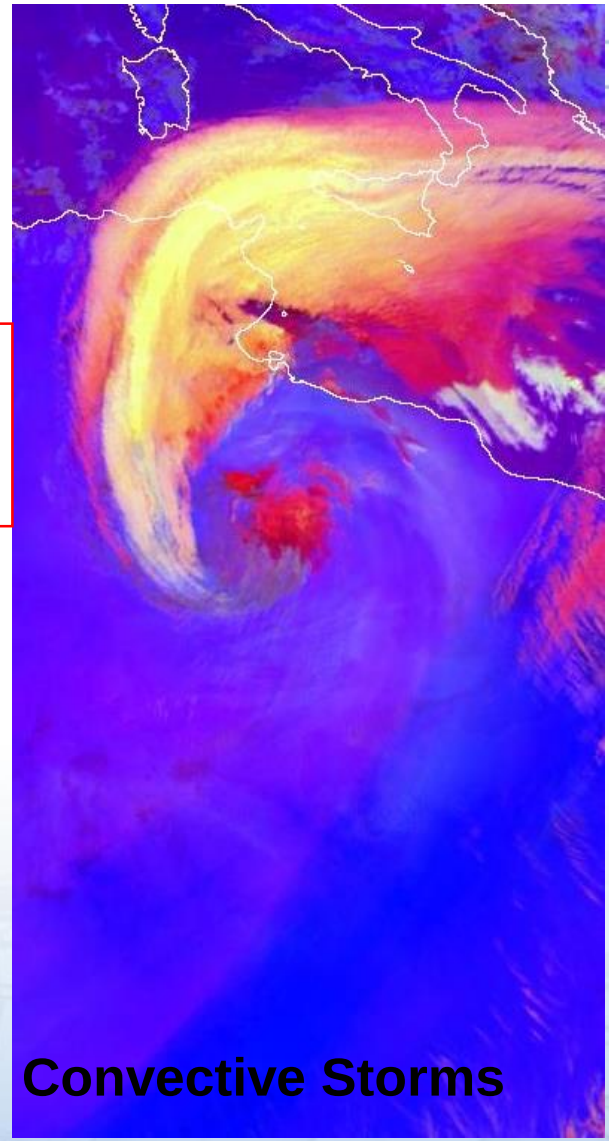
Day Microphysics RGB, 19 January 2017, Example of polluted airmasses



Convection RGB, … dust changes cloud microphysics

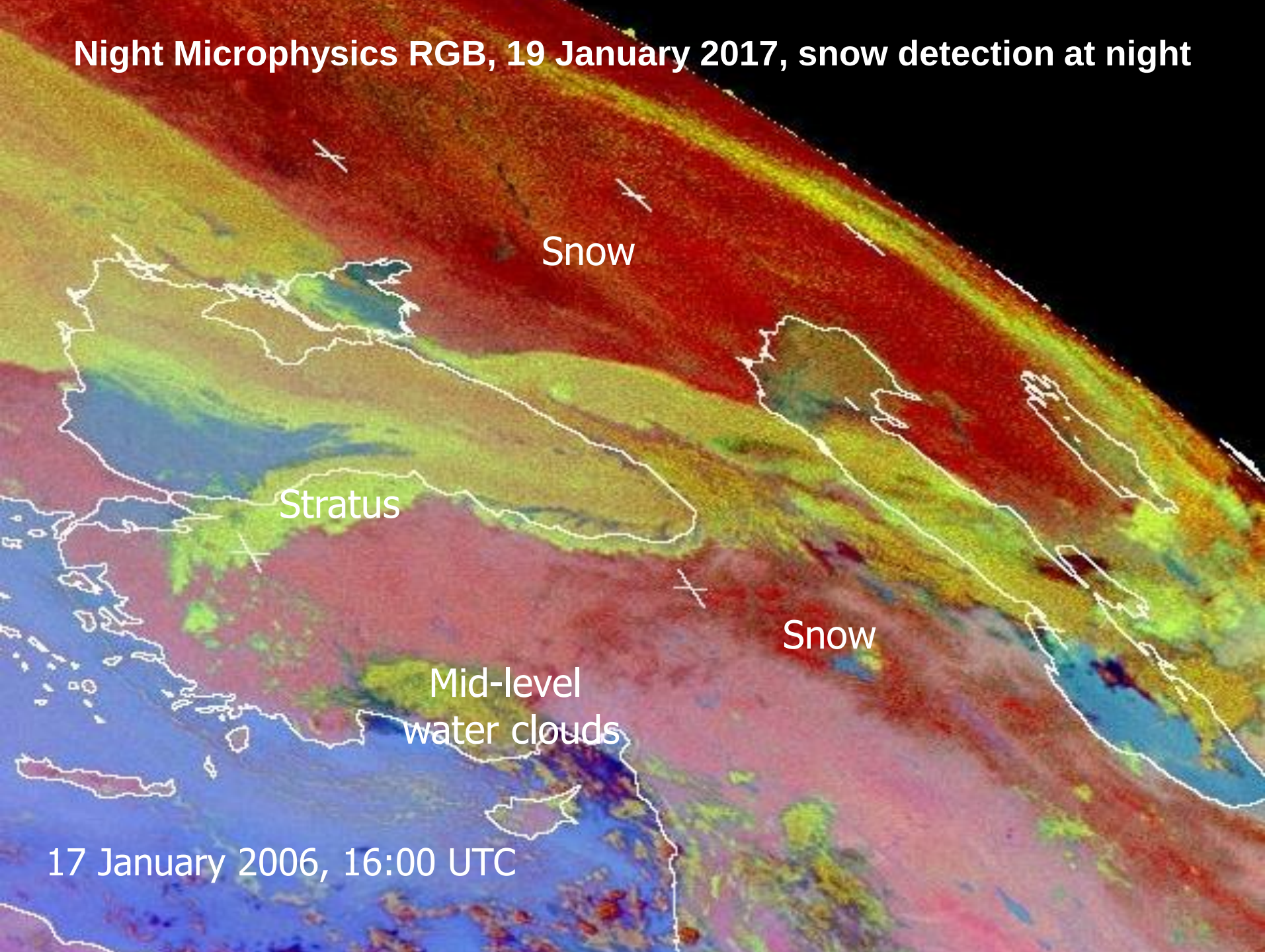






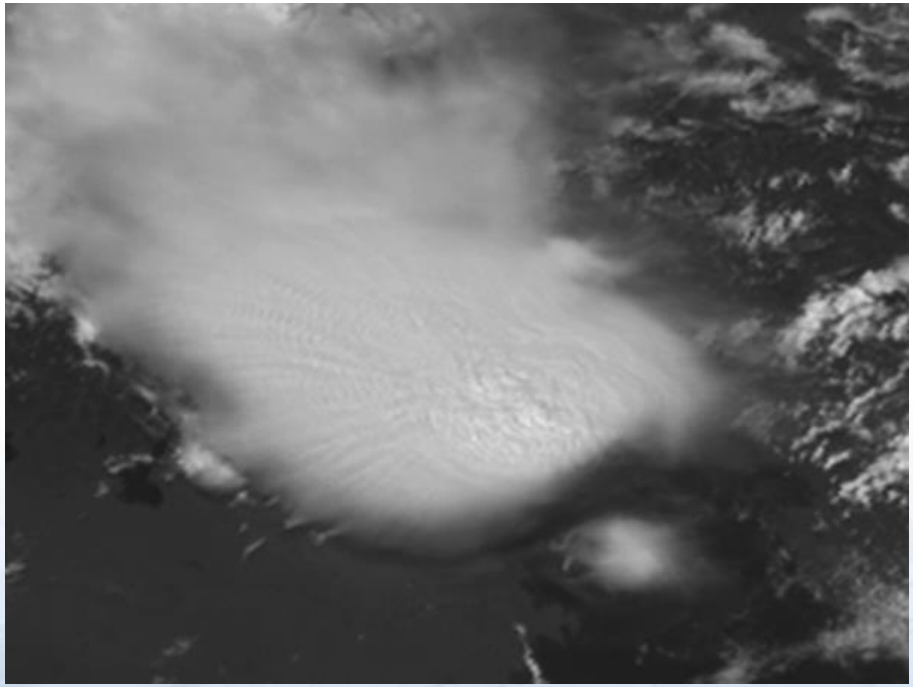
Met-8, 22 February 2007, 12:00 UTC

EUMETSAT

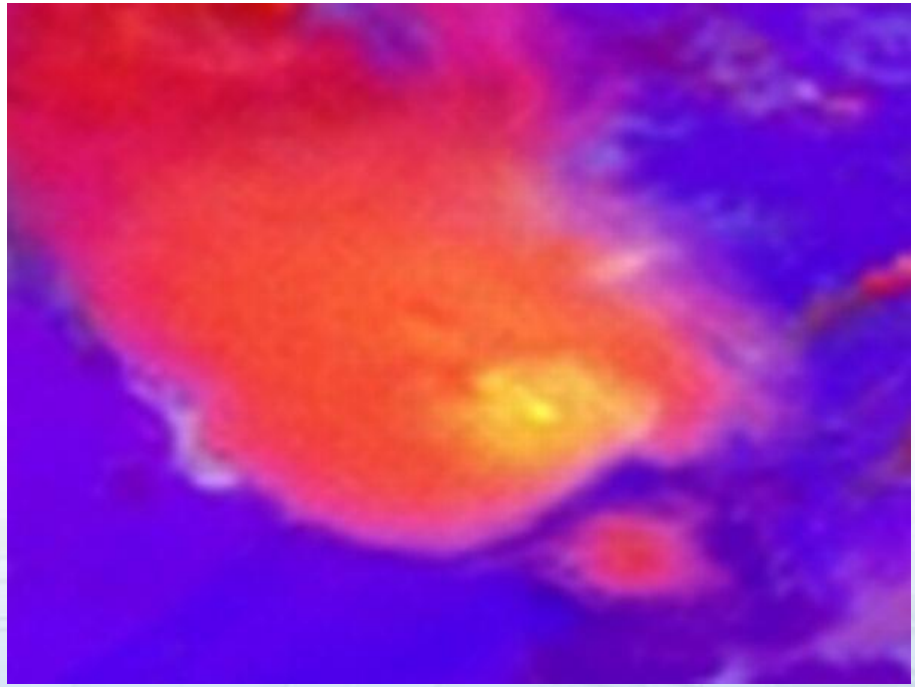

Night Microphysics RGB, 19 January 2017, snow detection at night
Snow
Stratus
Snow
Mid-level
water clouds
17 January 2006, 16:00 UTC

Convection RGB, small ice particles in severe thunderstorms

Multispectral View of Convective Storms



HRV



RGB Convective Storms

Met-8, 29 June 2006

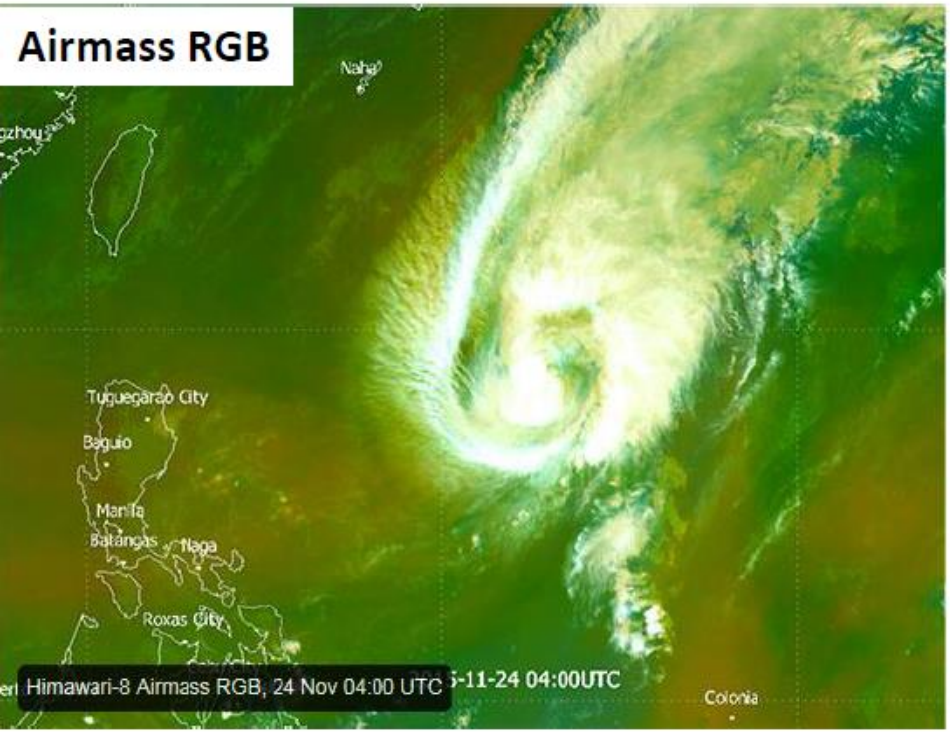
EUMETSAT

New Developments
Presented at 2017 RGB workshop

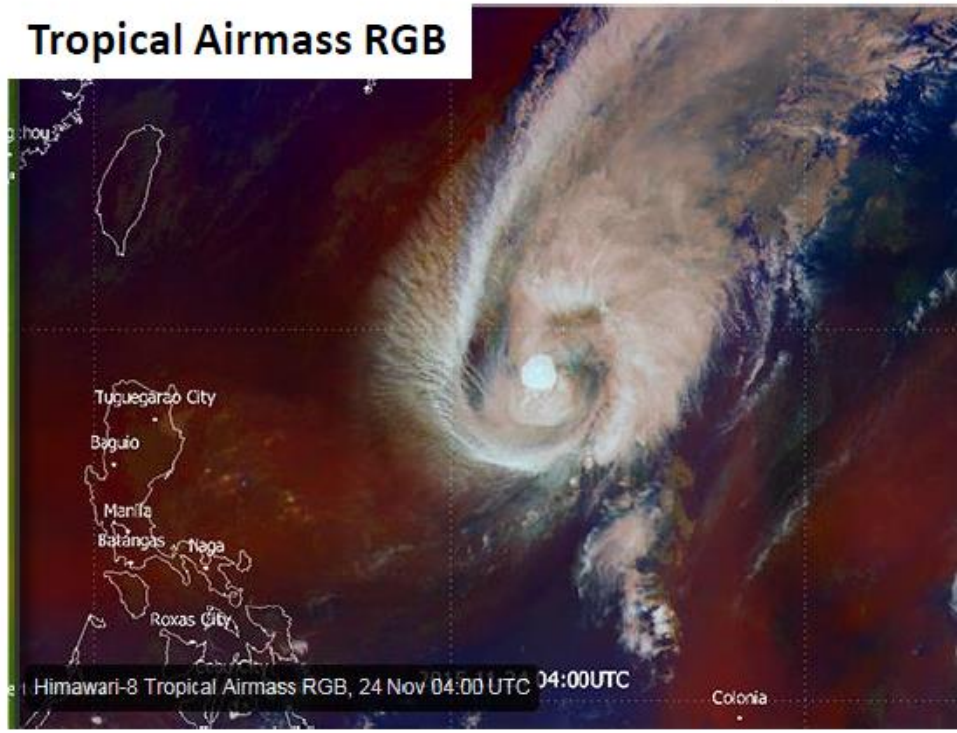
Airmass RGB product – normal vs tropical version

(Typhoon In-fa, 24 November 2015, 04UTC)

image courtesy EUMETSAT



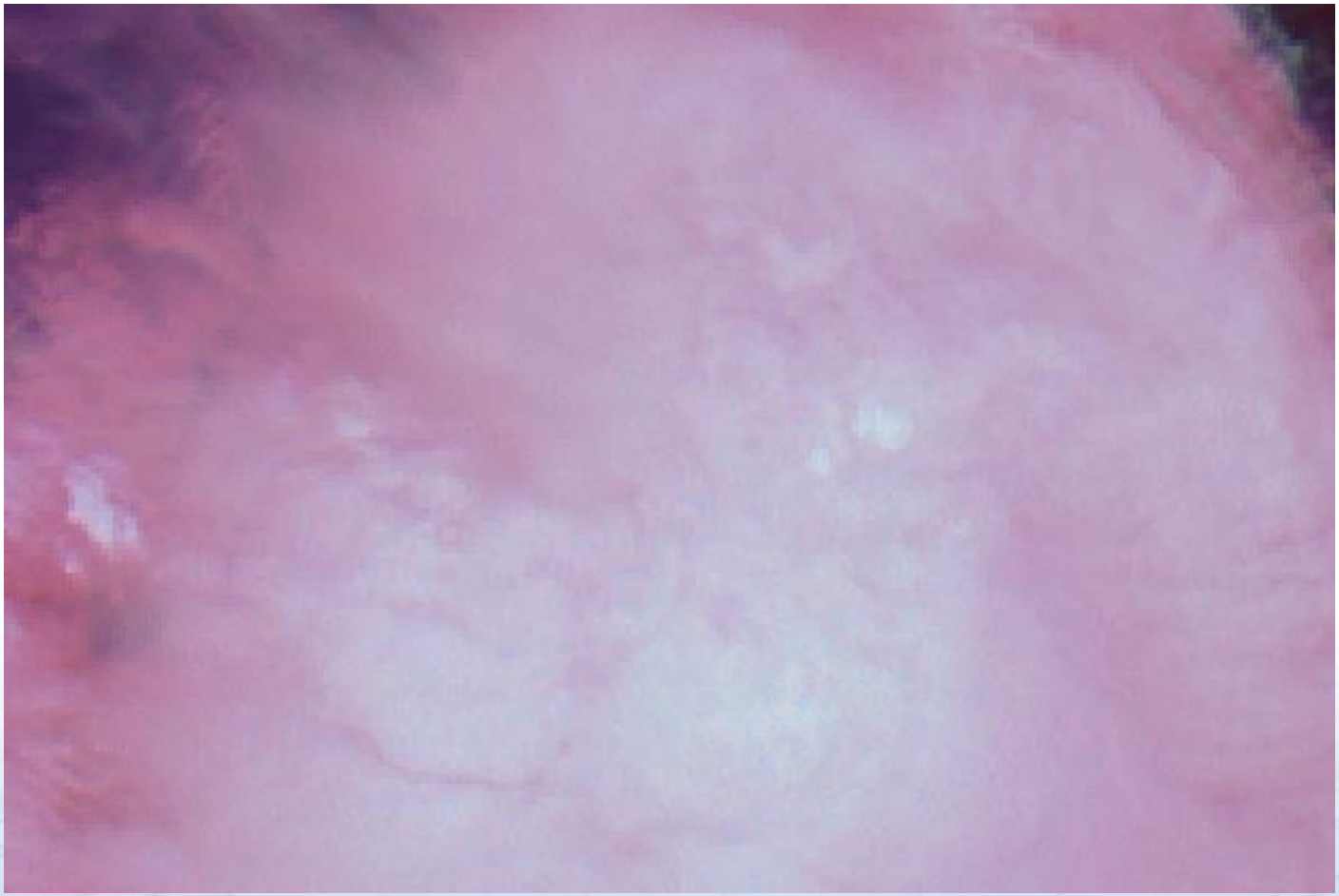
Standard



Tropical

EUMETSAT

Tropical Airmass RGB (tuned for OTs)

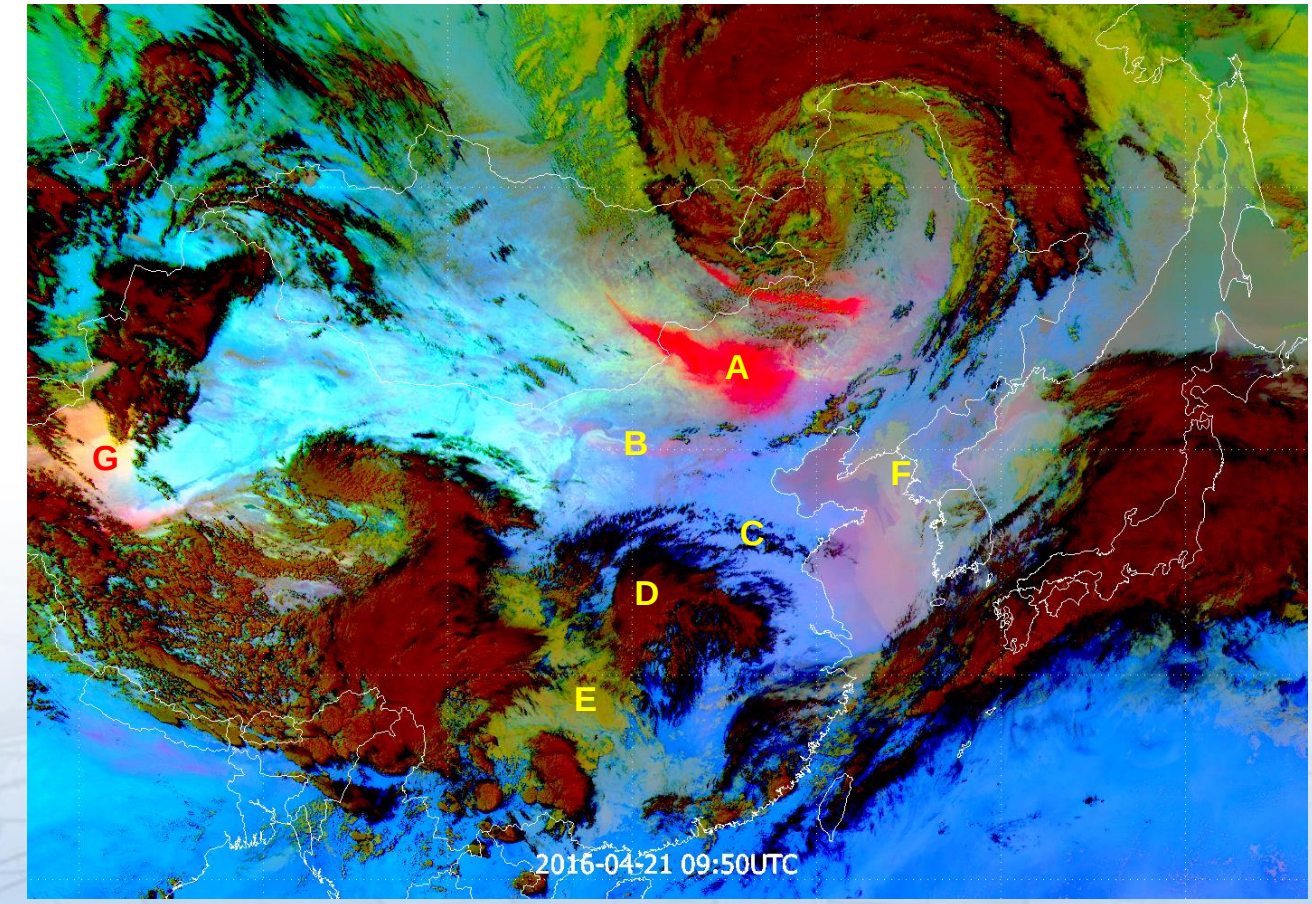


Overshooting Tops in Typhoon Koppu (Pacific)
15 October 2015, HIM-08, AHI, Tropical Airmass RGB
2 km / 2.5 minutes

EUMETSAT

Tuning of AHI Dust RGB (for dust, cloud phase, moisture)

Red: IR12.4 – IR10.4, **Green: IR11.2 – IR8.6**, **Blue: IR10.4**
(uses 4 (not 3) IR channels)



A: thick dust
B: thin dust
C thin Cirrus
D: Thick Cirrus
E: Mid clouds
F: Low clouds
G: thin dust

Credits: D. Gencic

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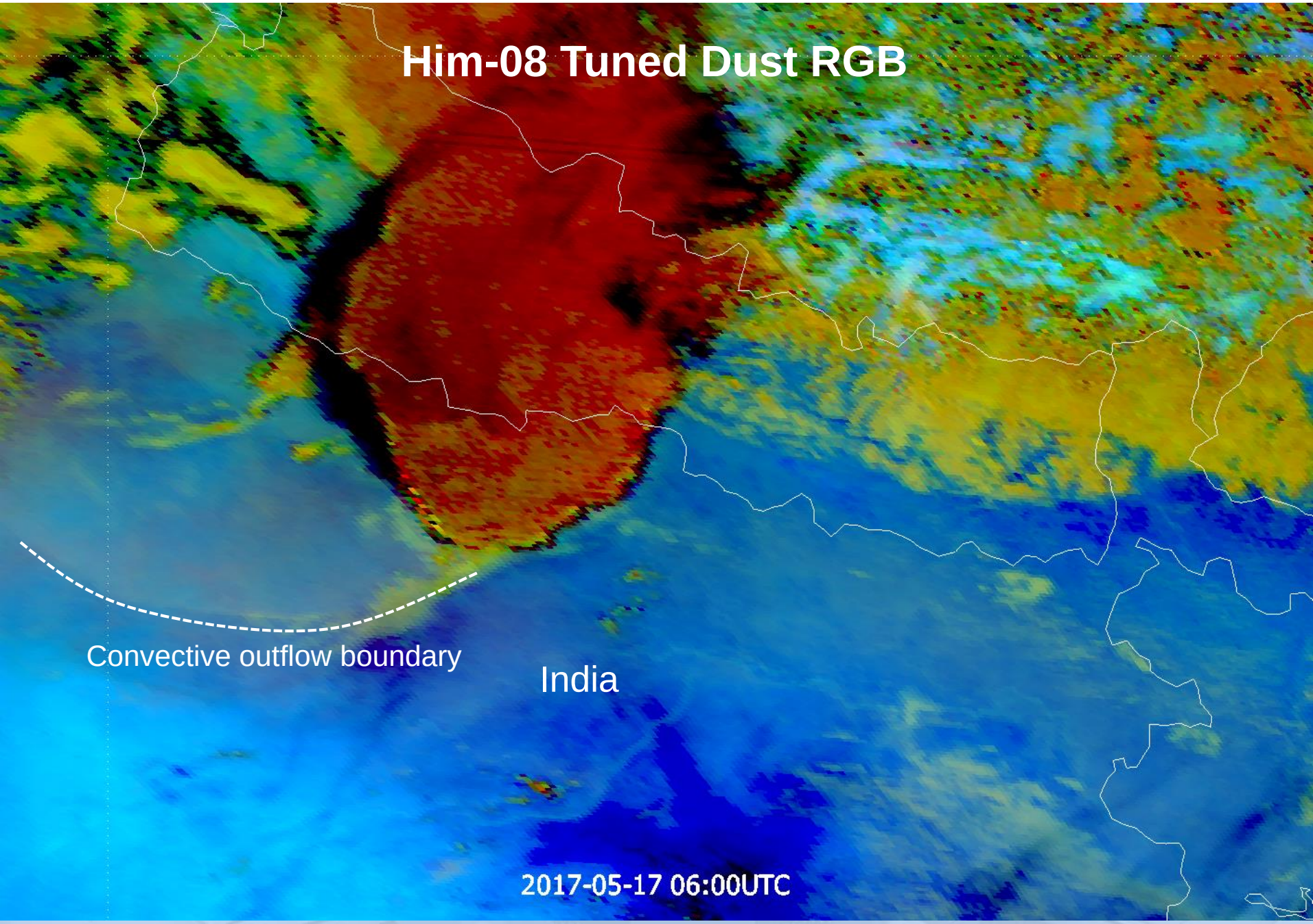
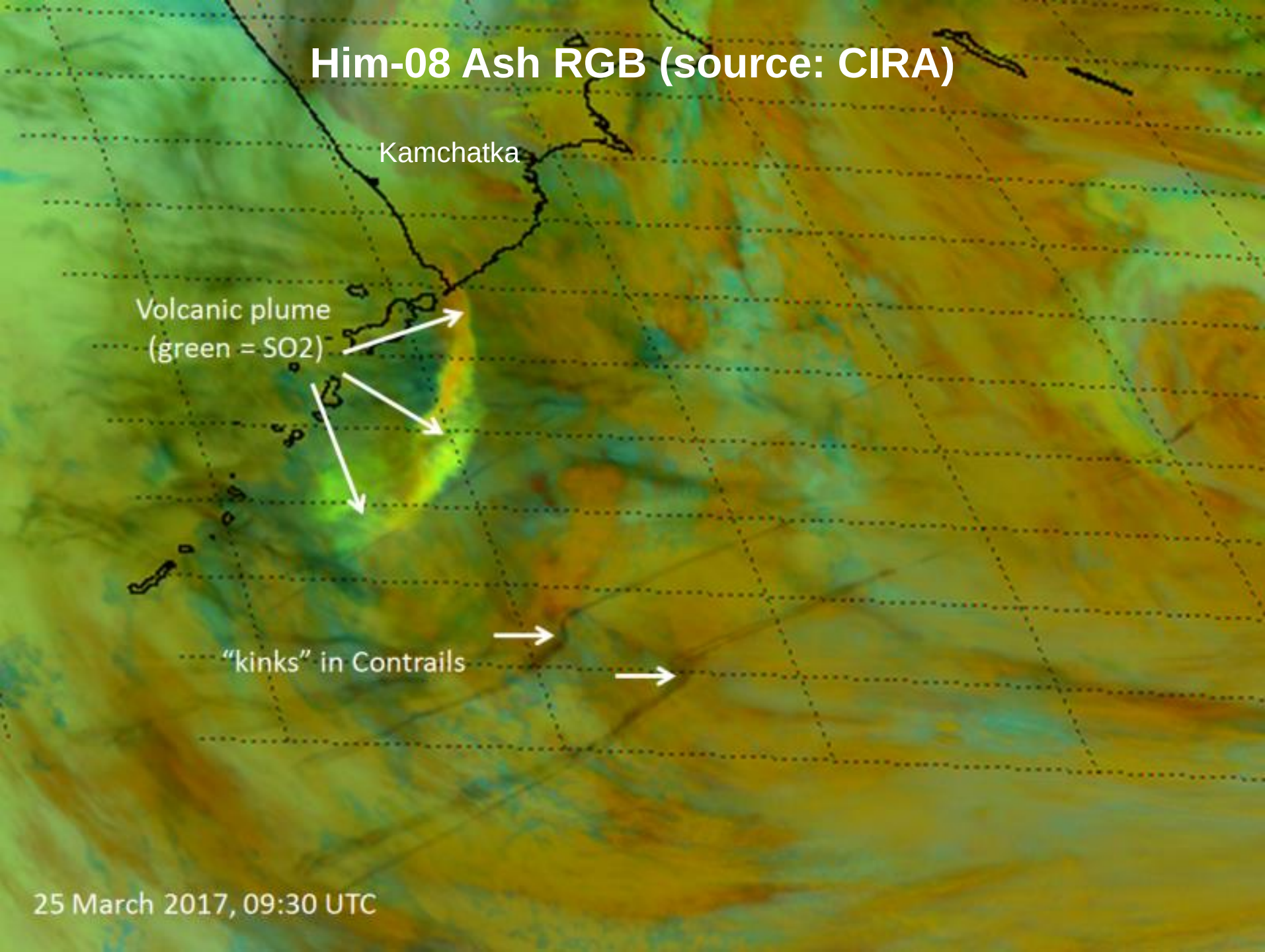
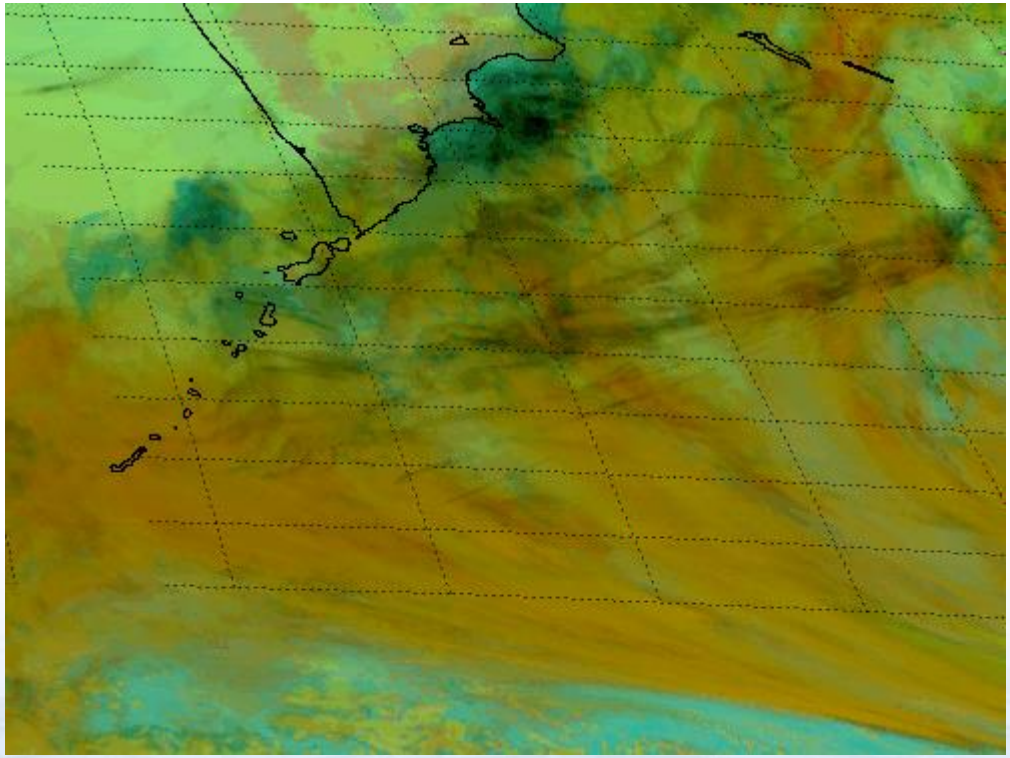

Him-08 Tuned Dust RGB
Convective outflow boundary
India
2017-05-17 06:00UTC

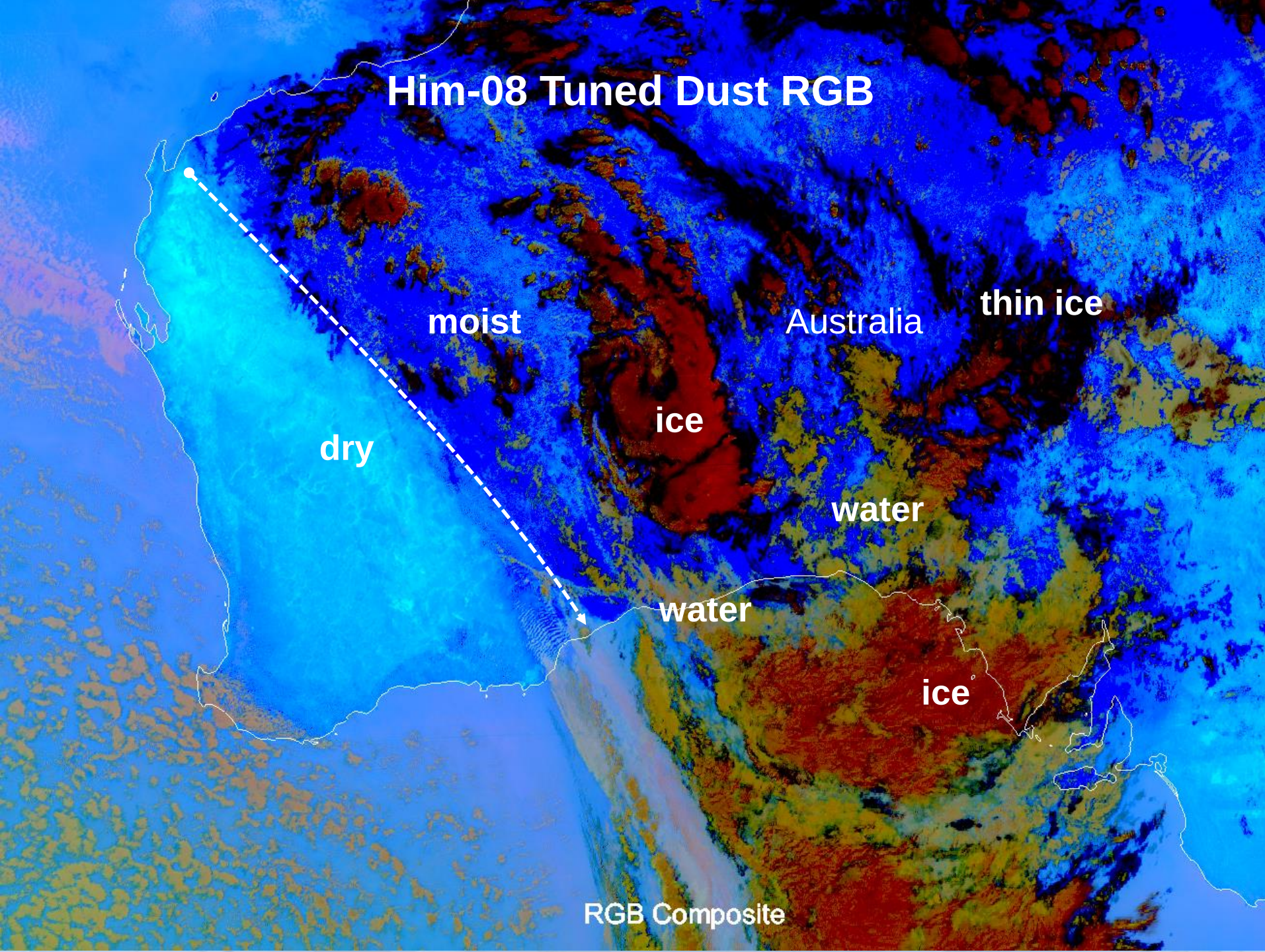

Him-08 Ash RGB (source: CIRA)
Kamchatka
Volcanic plume
(green = SO2)
"kinks" in Contrails
25 March 2017, 09:30 UTC

Him-08 Ash RGB (source: CIRA)

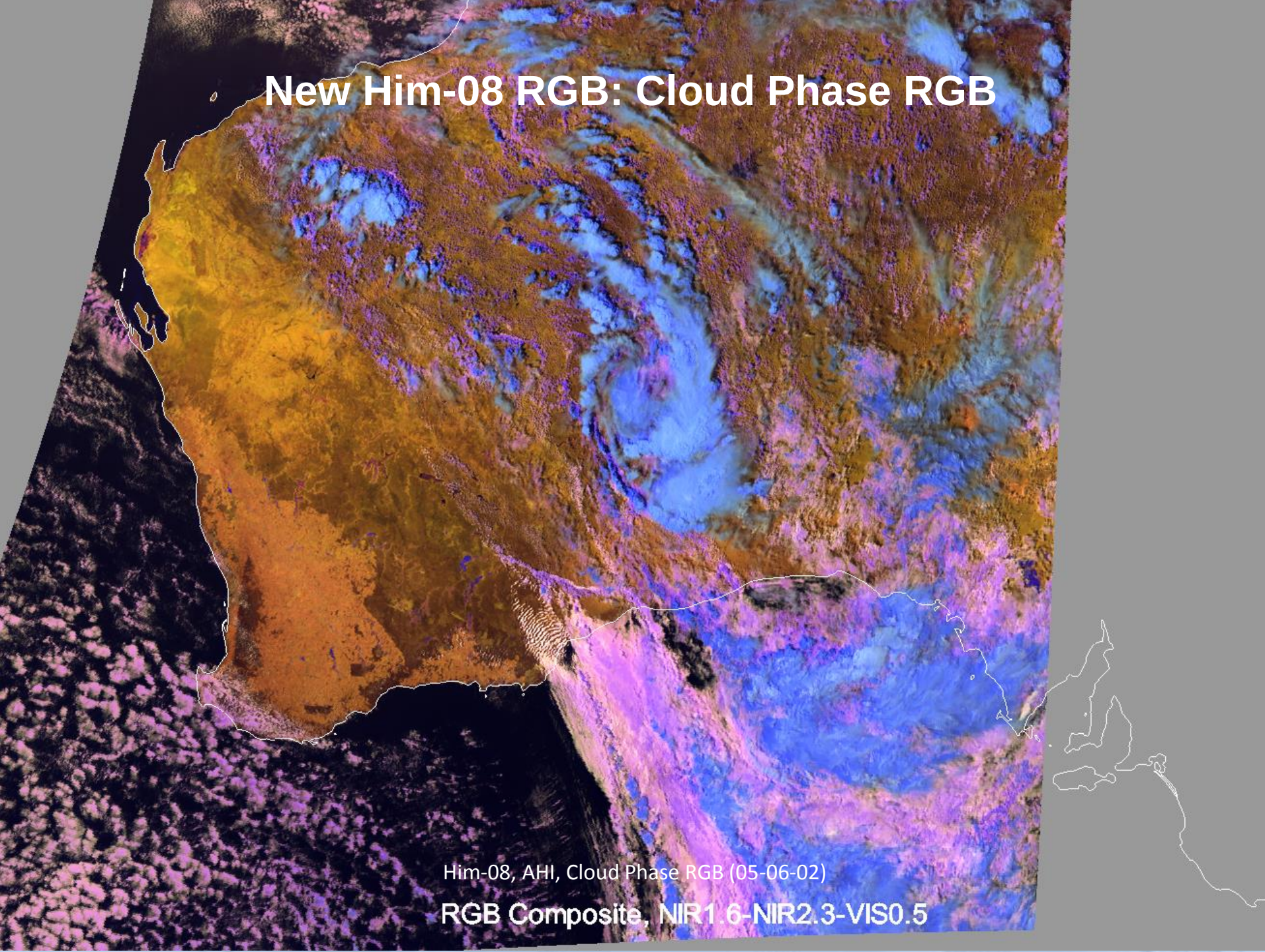


Animation of volcanic plume and contrails

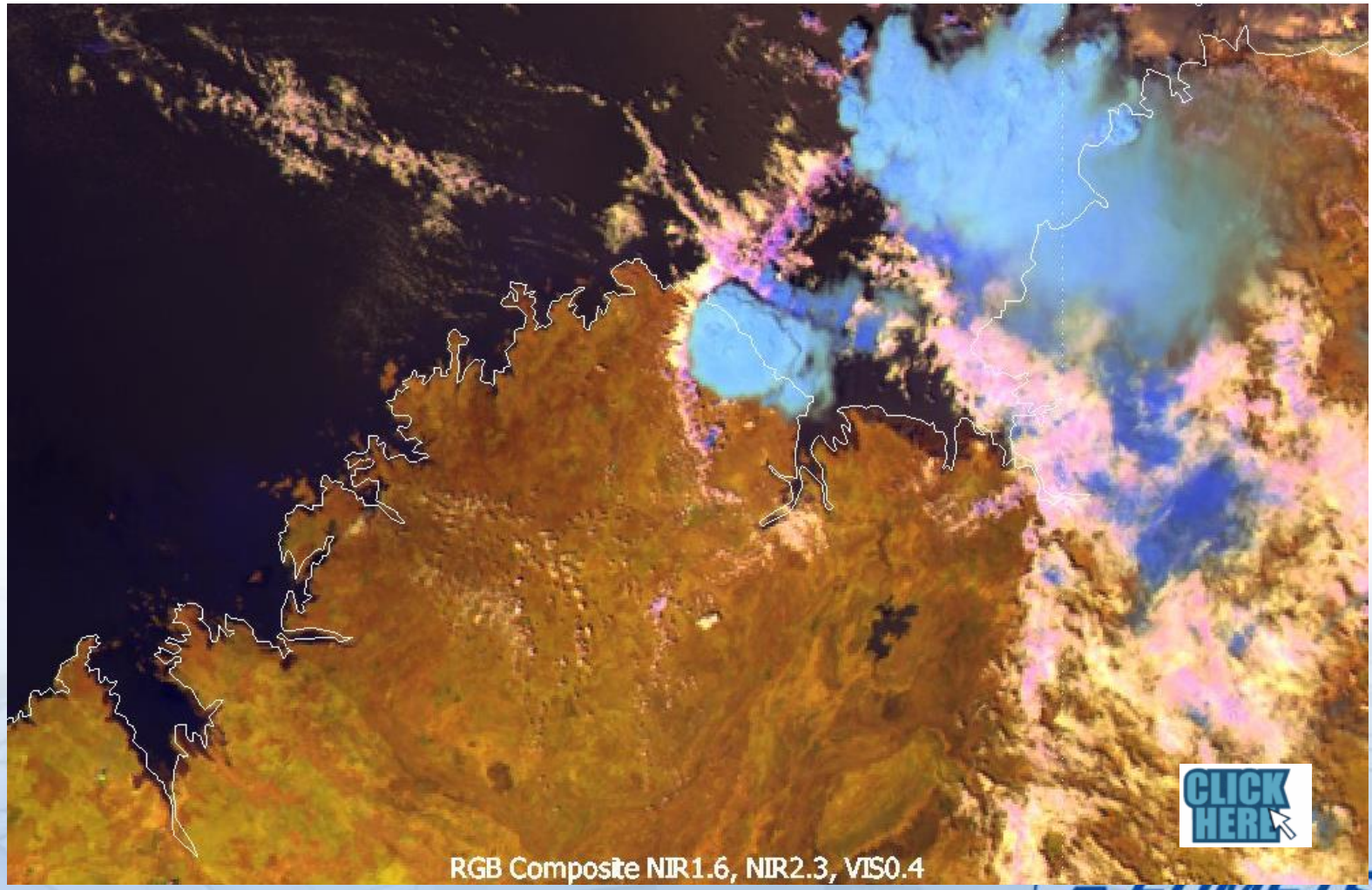
EUMETSAT


Him-08 Tuned Dust RGB
moist
dry
Australia
thin ice
ice
water
water
ice
RGB Composite

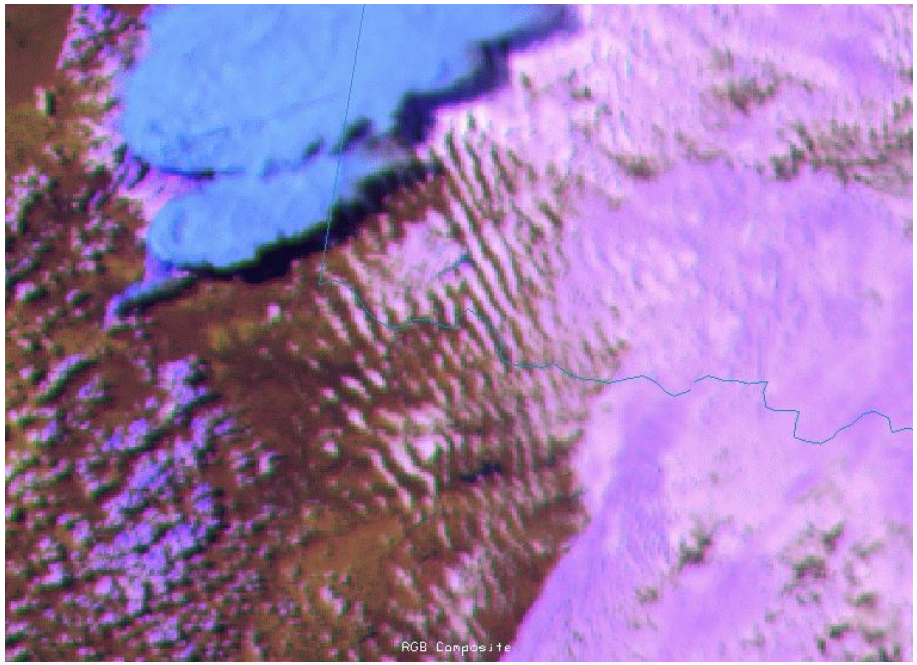
New Him-08 RGB: Cloud Phase RGB



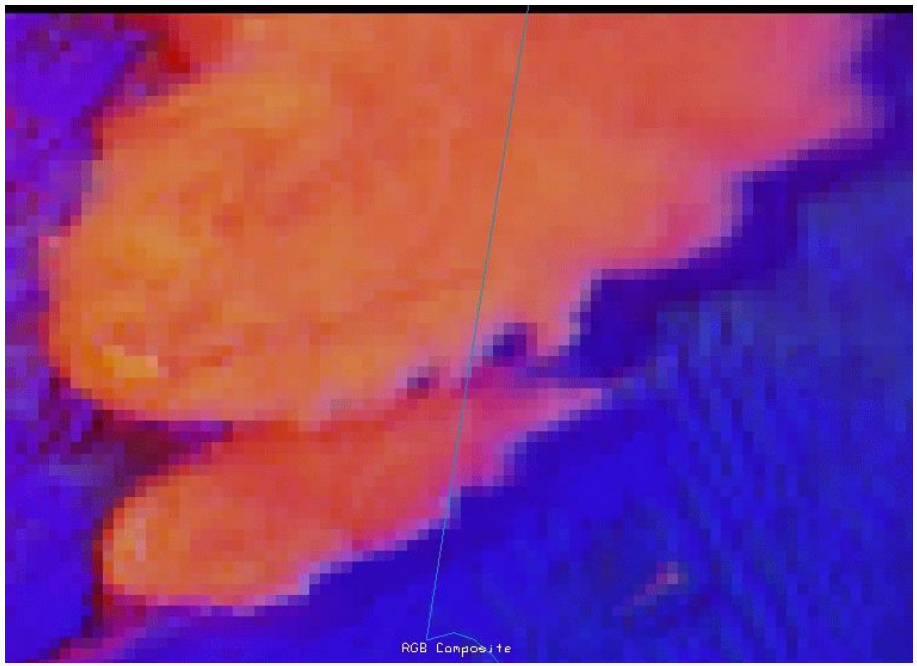
Animation Cloud Phase RGB, Australia



GOES-16 Cloud Phase RGB (non-operational data)



Cloud Phase RGB



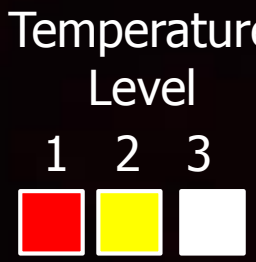
Convection RGB

Supercell, Texas, 16 May 2017, 21:27 – 23:02 UTC (5 min intervals)

EUMETSAT

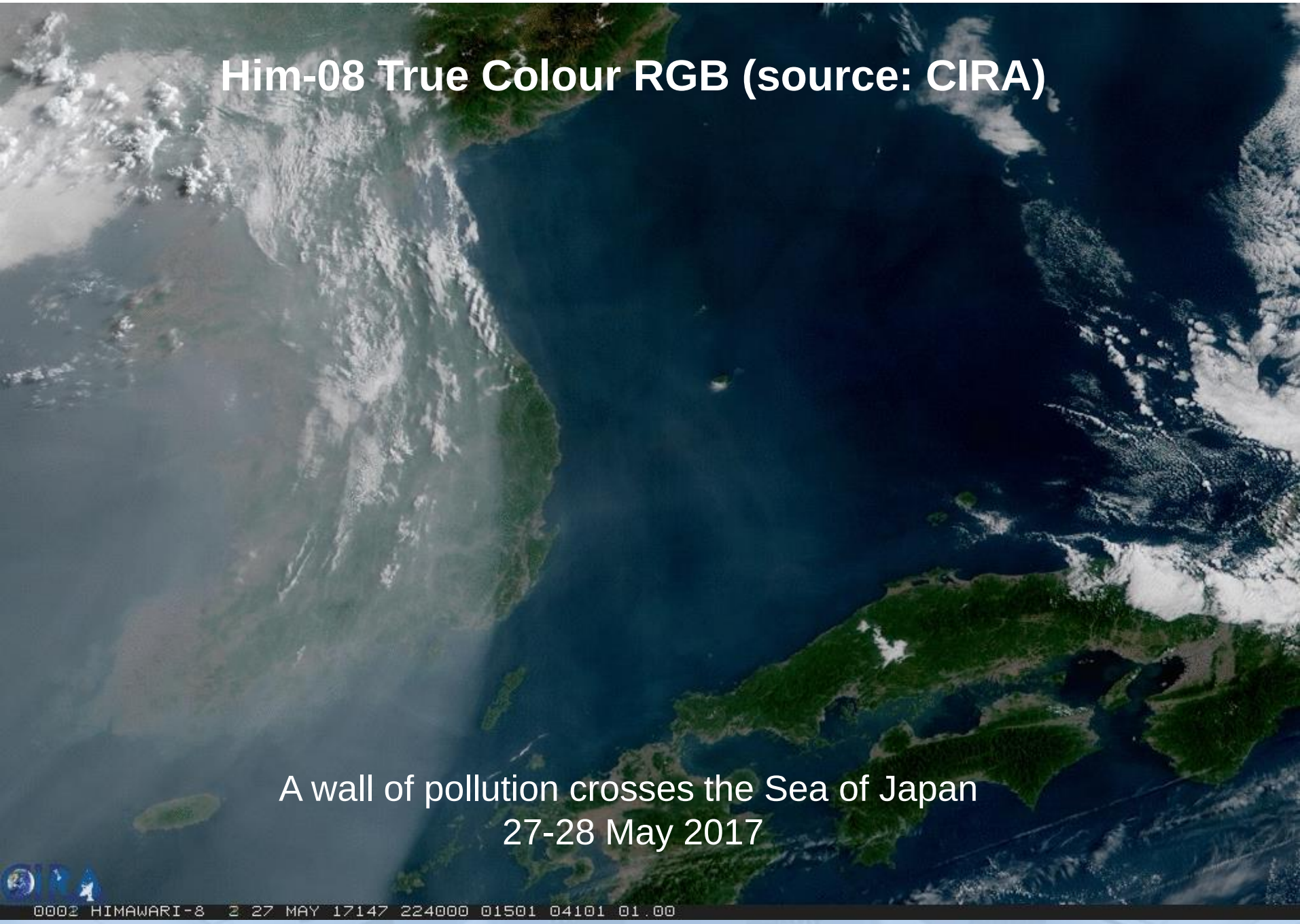
Fires in Australia, AHI, New Fire Temperature RGB

16-17 October 2017



Credits: CIRA

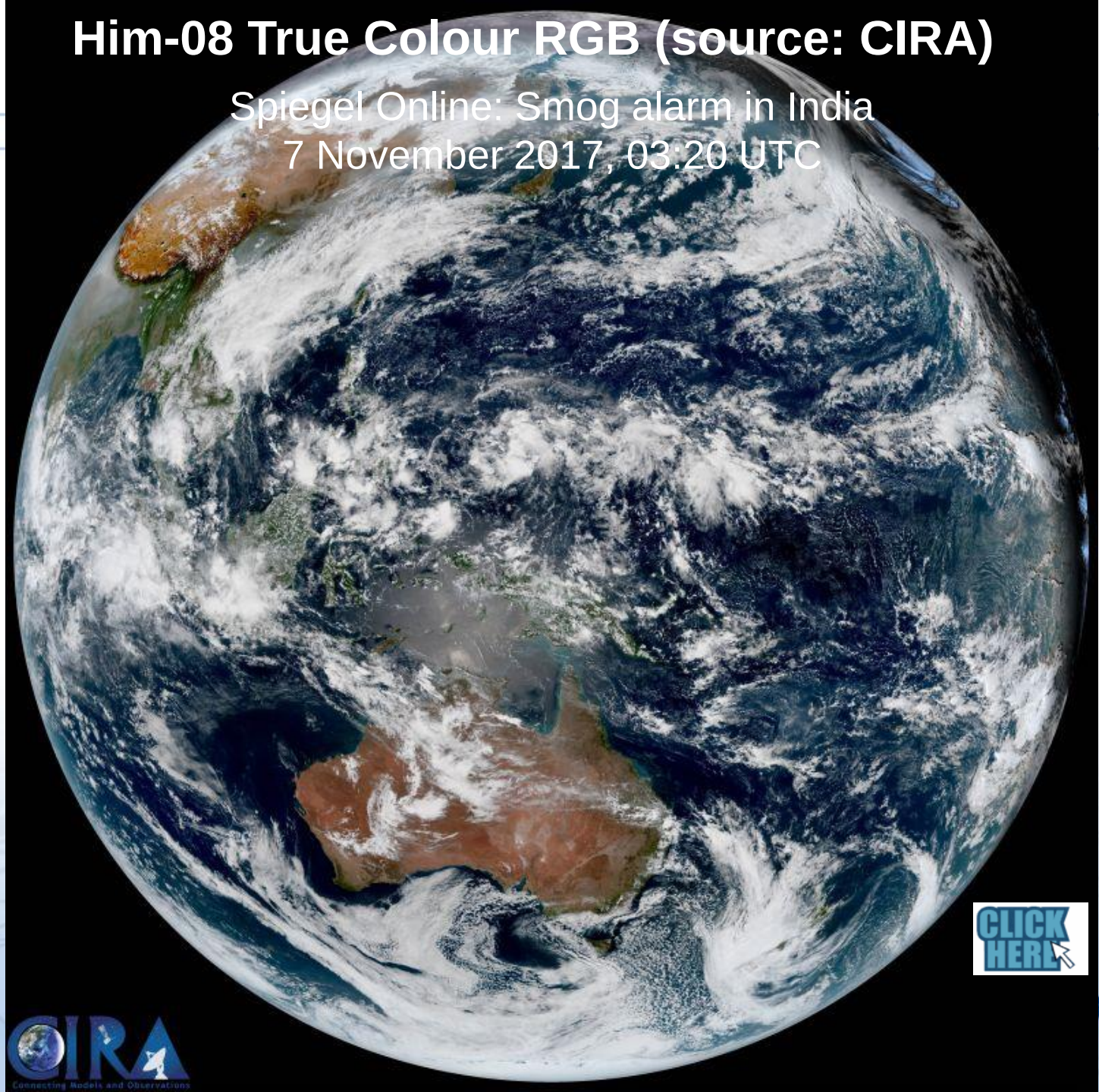
Him-08 True Colour RGB (source: CIRA)



A wall of pollution crosses the Sea of Japan
27-28 May 2017

Him-08 True Colour RGB (source: CIRA)

Spiegel Online: Smog alarm in India
7 November 2017, 03.20 UTC

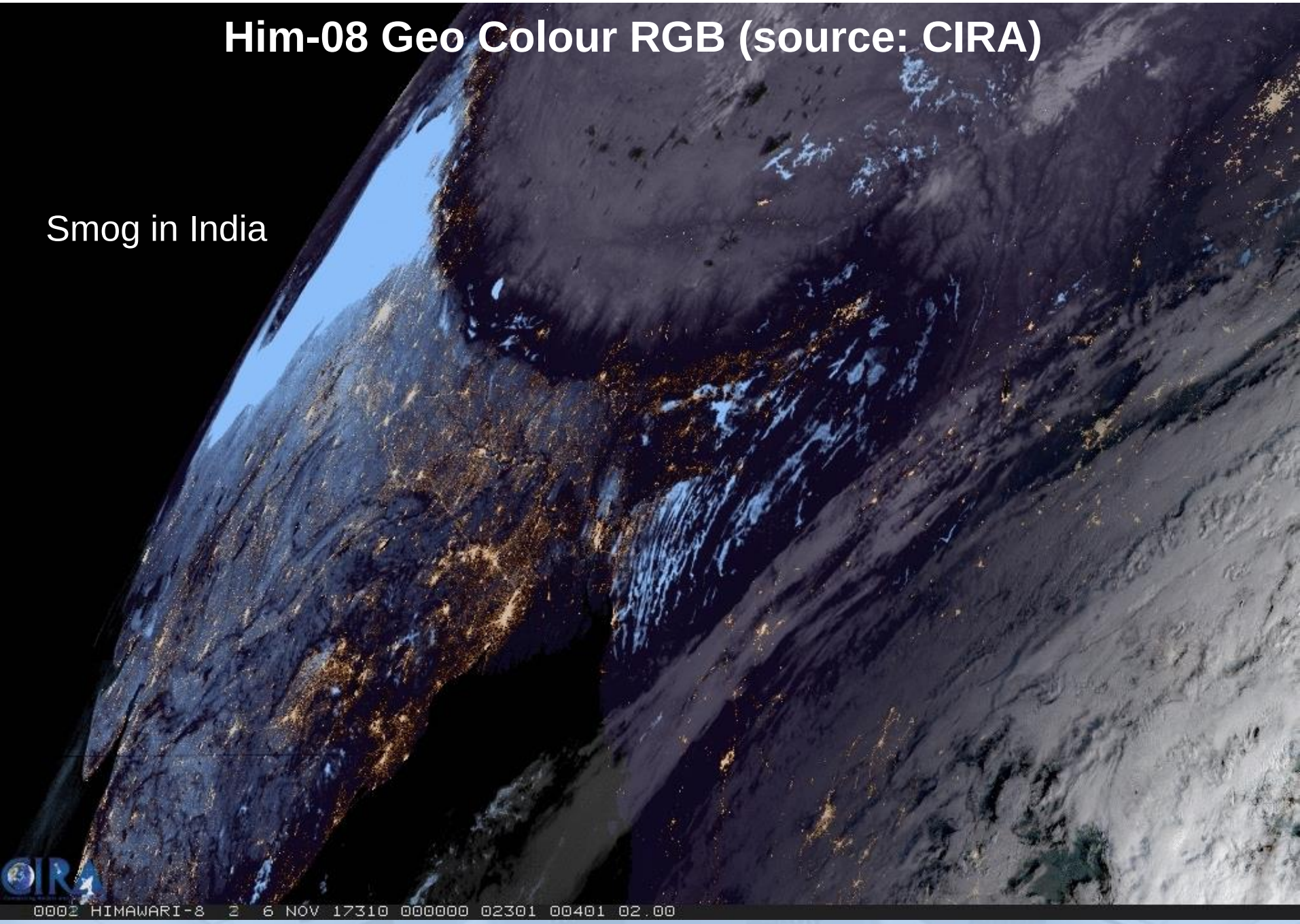


CIRA
Connecting Models and Observations

TSAT

Him-08 Geo Colour RGB (source: CIRA)

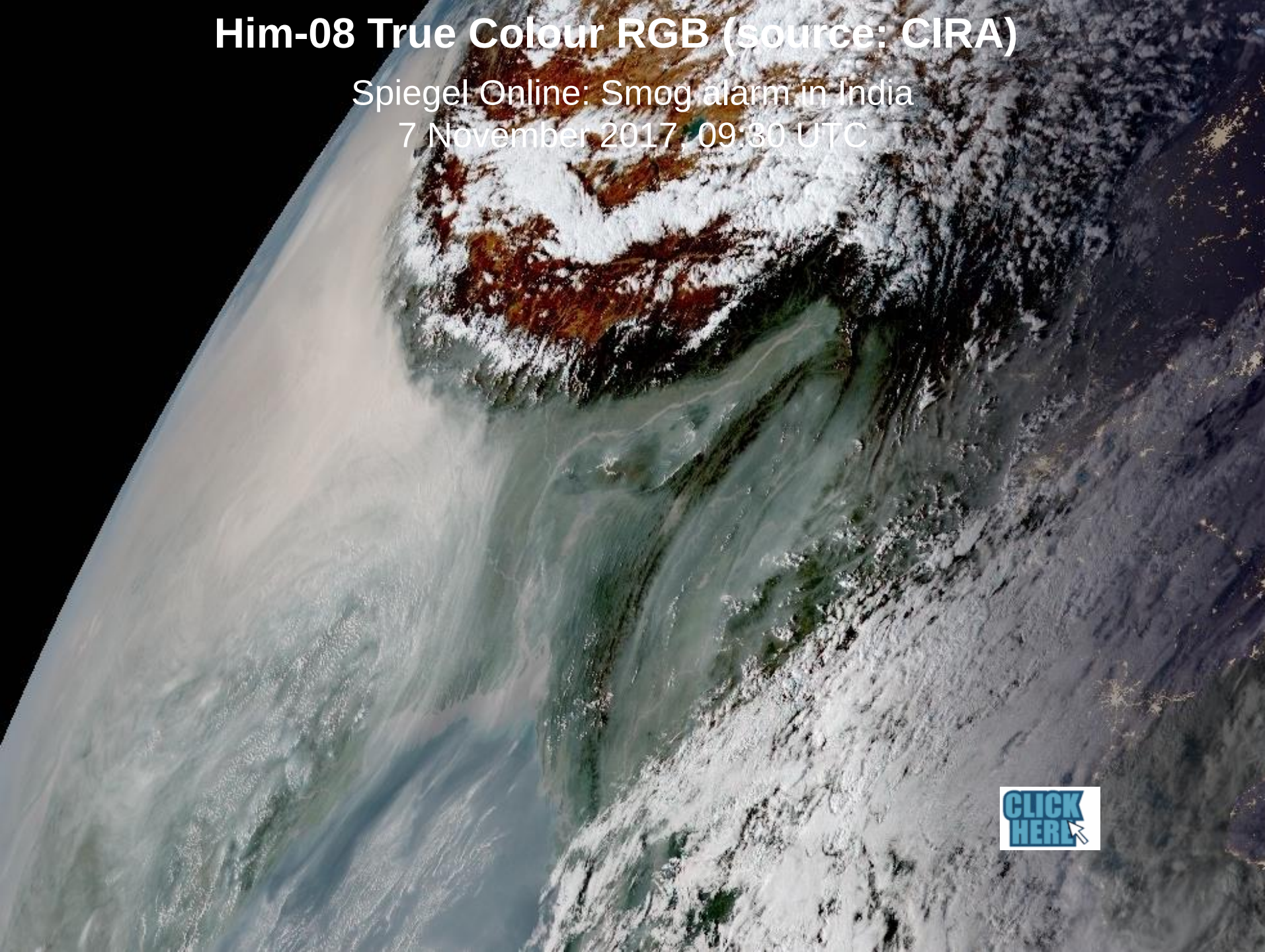
Smog in India

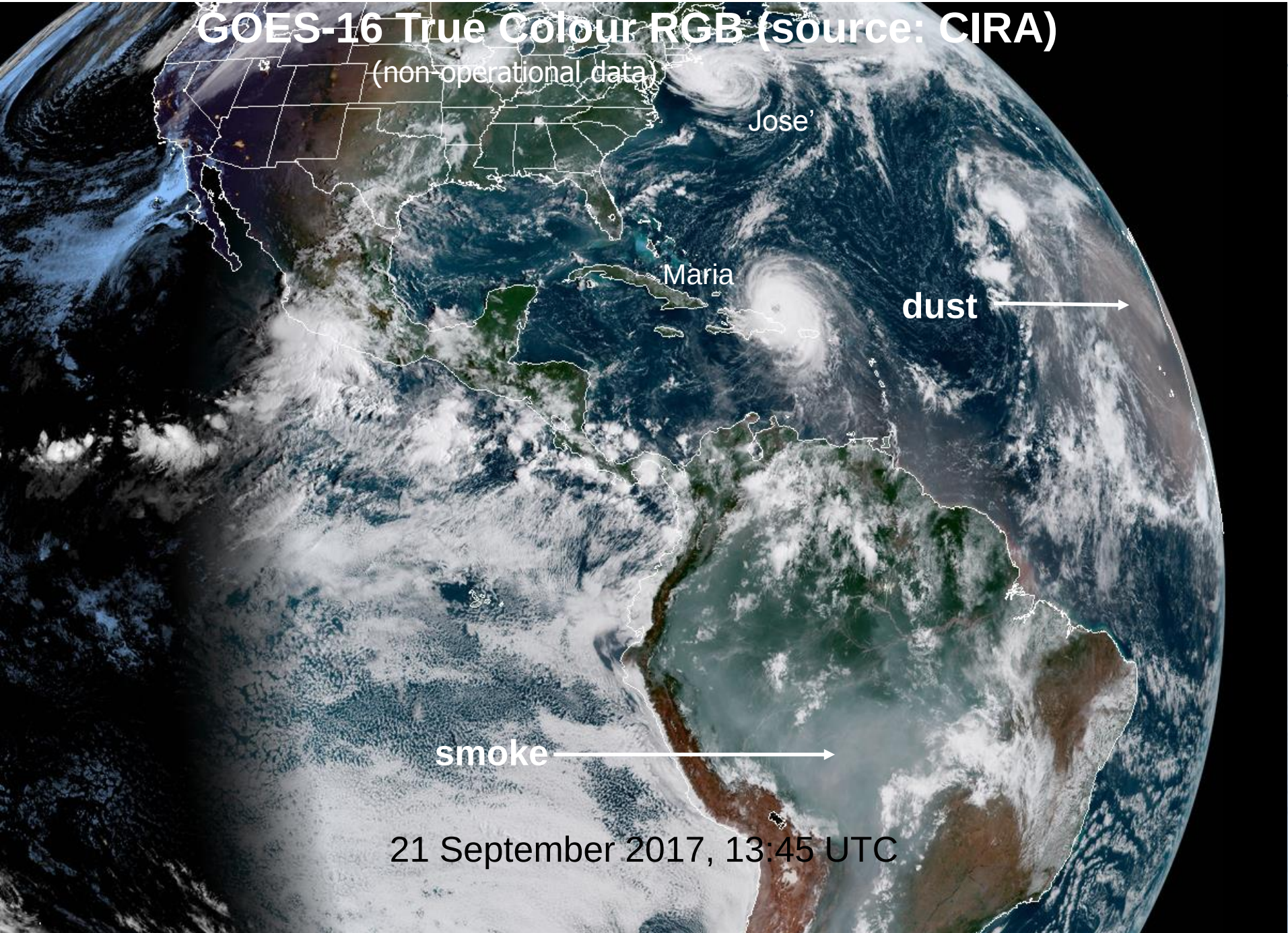


Him-08 True Colour RGB (source: CIRA)

Spiegel Online: Smog alarm in India

7 November 2017, 09:30 UTC

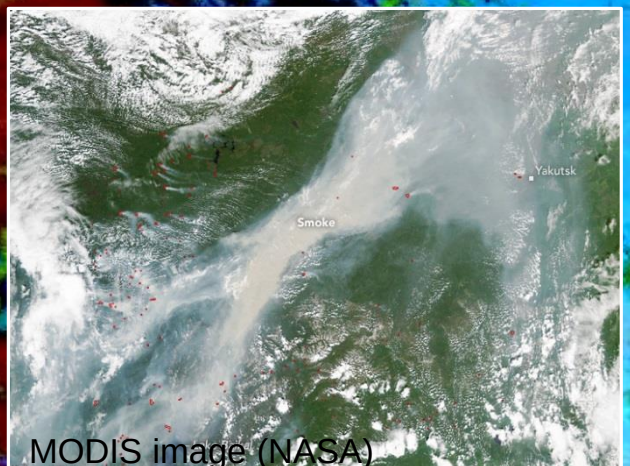



GOES-16 True Colour RGB (source: CIRA)
(non-operational data)
Jose'
Maria
dust
smoke
21 September 2017, 13:45 UTC

Him-08 Dust RGB (source: ePort, EUMeTrain)

High level smoke

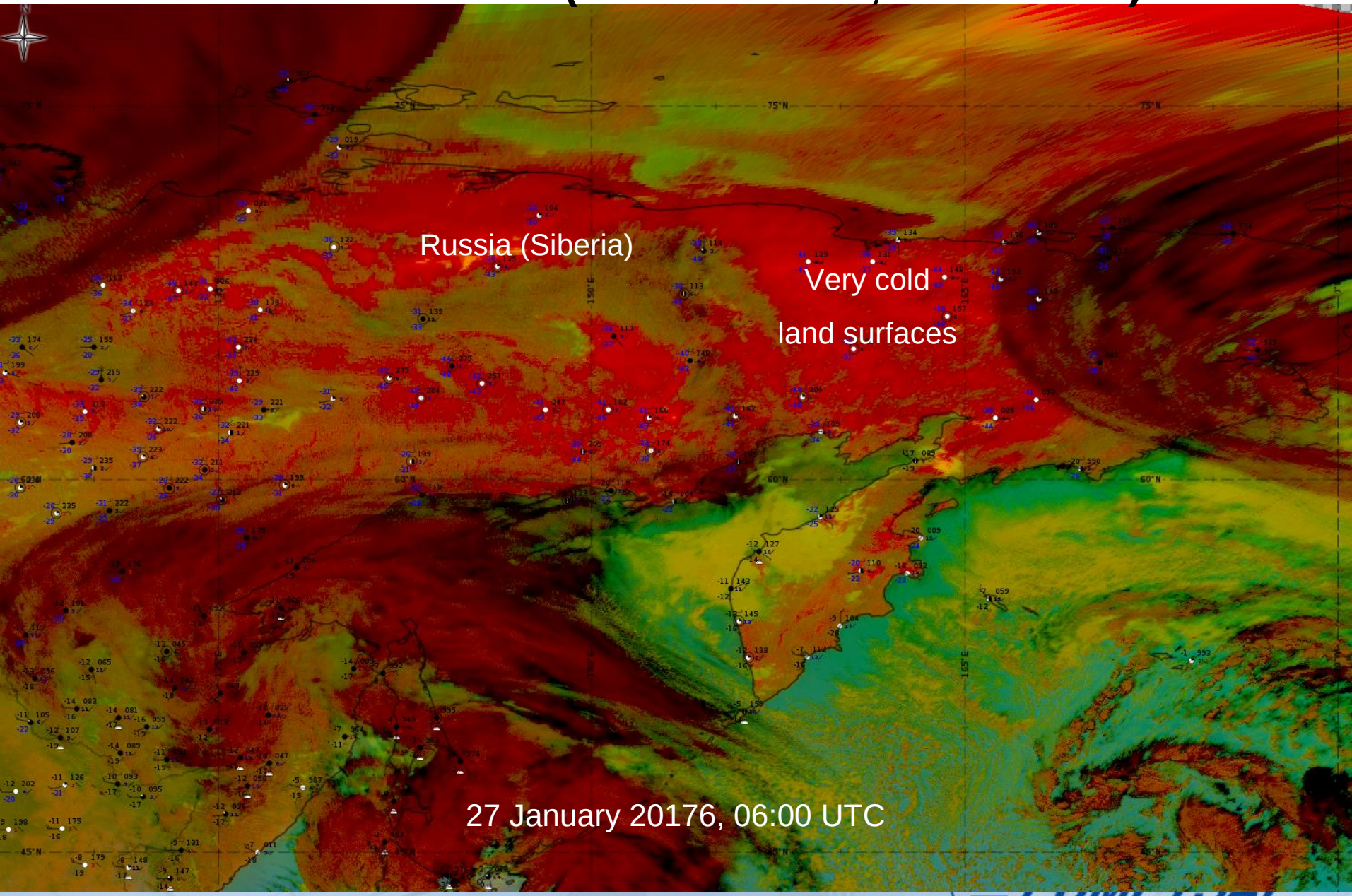
Lake Baikal



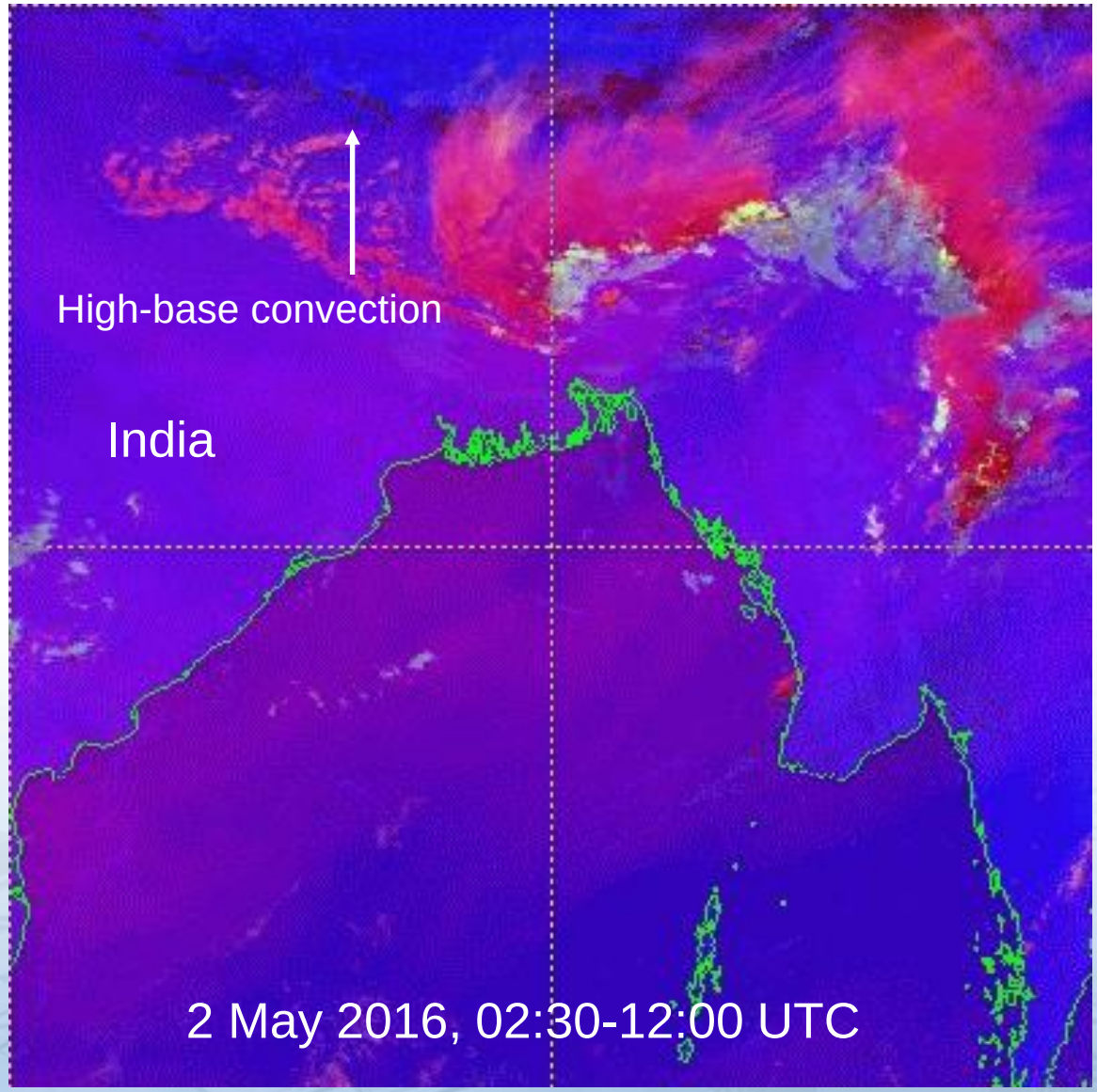
MODIS image (NASA)

23 June 2017, 12:00 UTC

Him-08 Dust RGB (source: ePort, EUMeTrain)



Him-08, Convection RGB (source: JMA)



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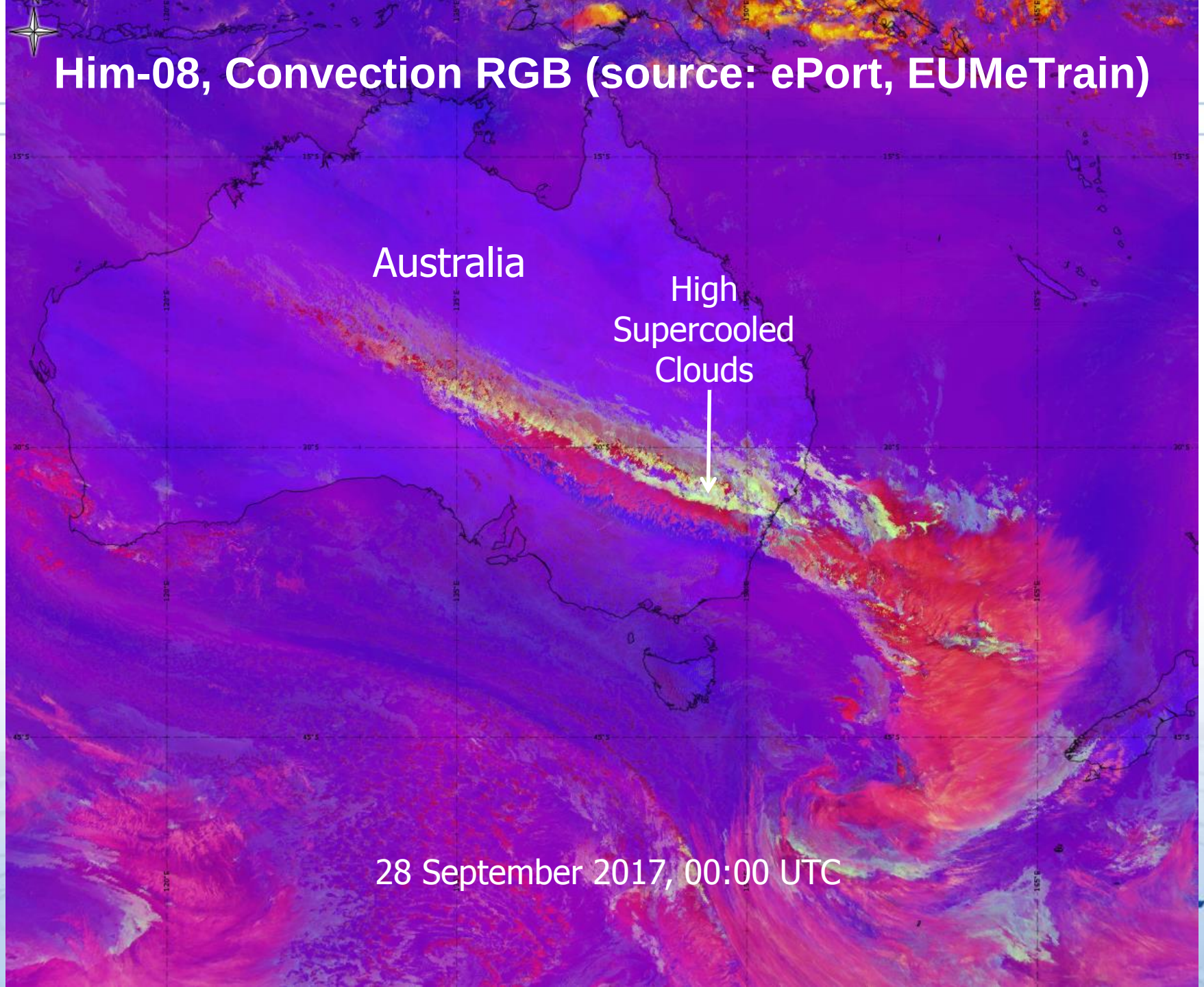
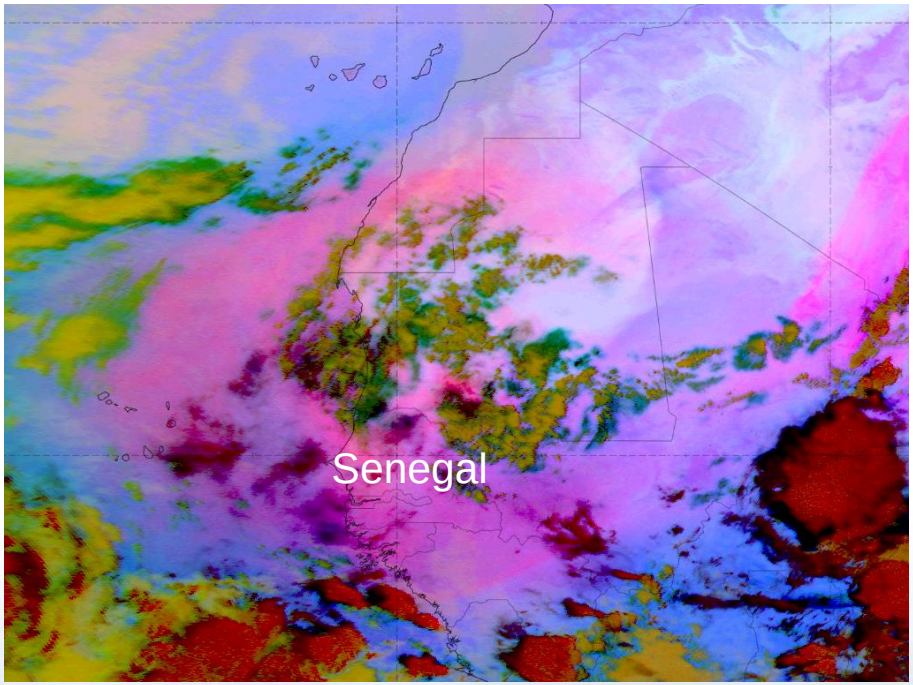
Him-08, Convection RGB (source: ePort, EUMeTrain)

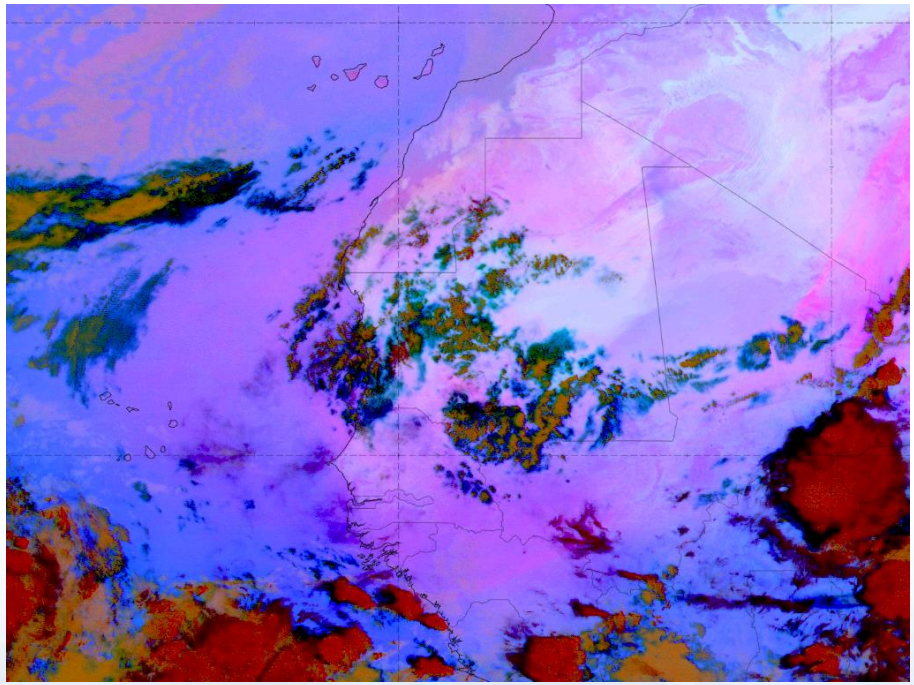


Impact of viewing angle on dust detection

Source: ePort Pro (EUMeTrain)



Met-08



Met-10

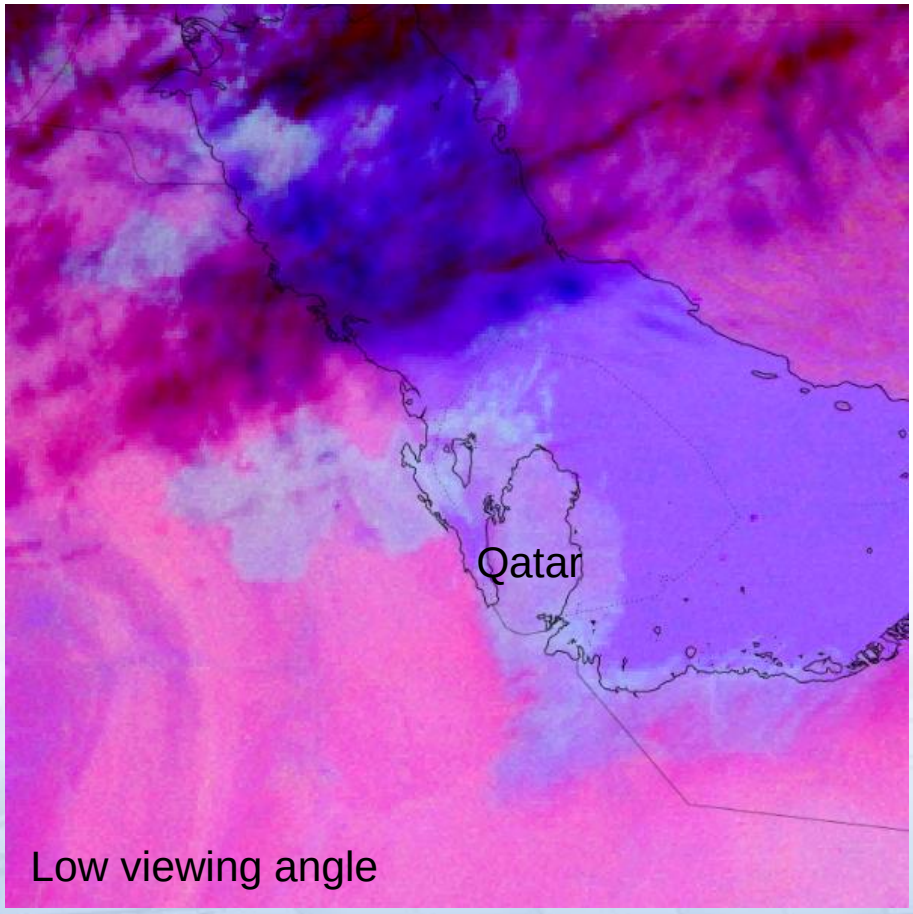
4 July 2017, 06:00 UTC

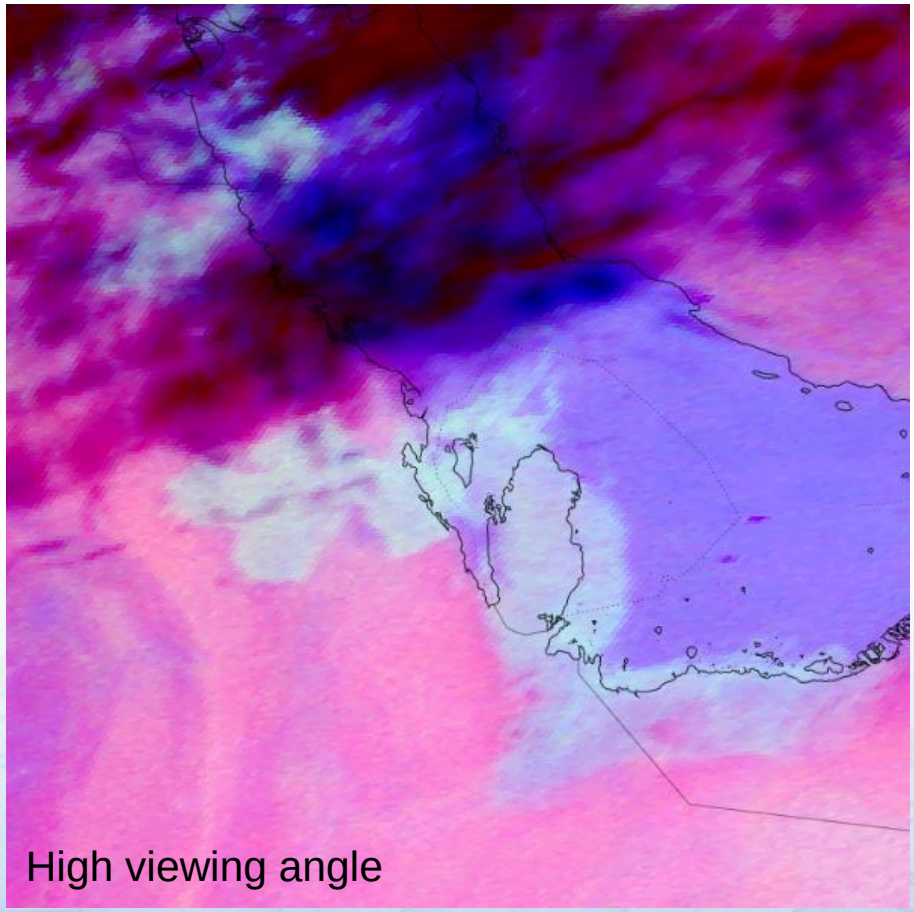
Dust (and smoke) often better detected at high viewing angles
(NADIR view is not always the best one)

EUMETSAT

Impact of viewing angle on fog detection

Source: ePort Pro (EUMeTrain)



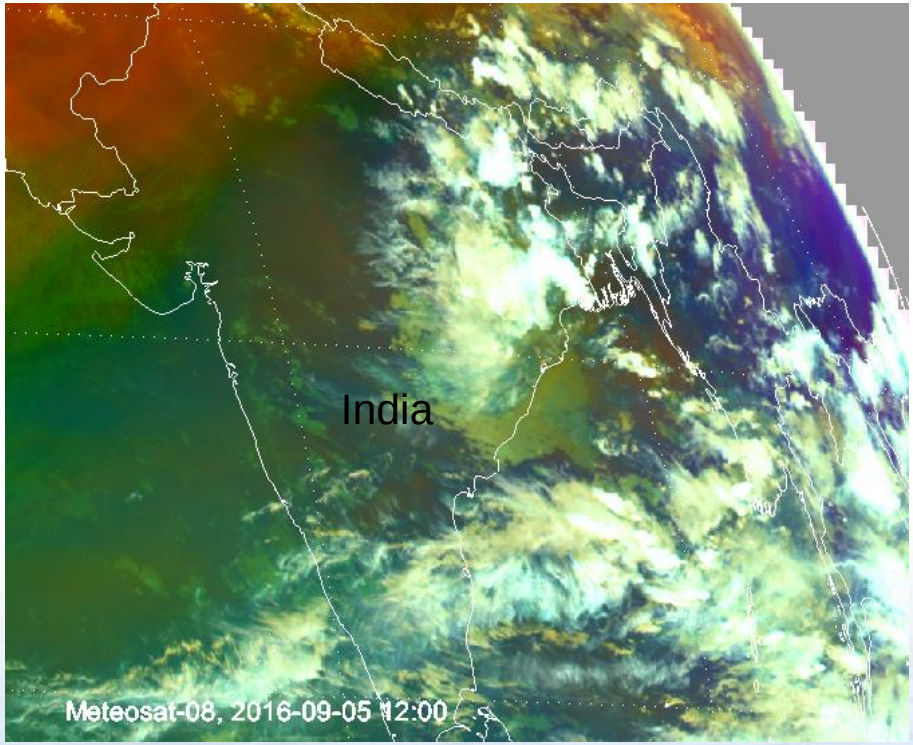


Met-08

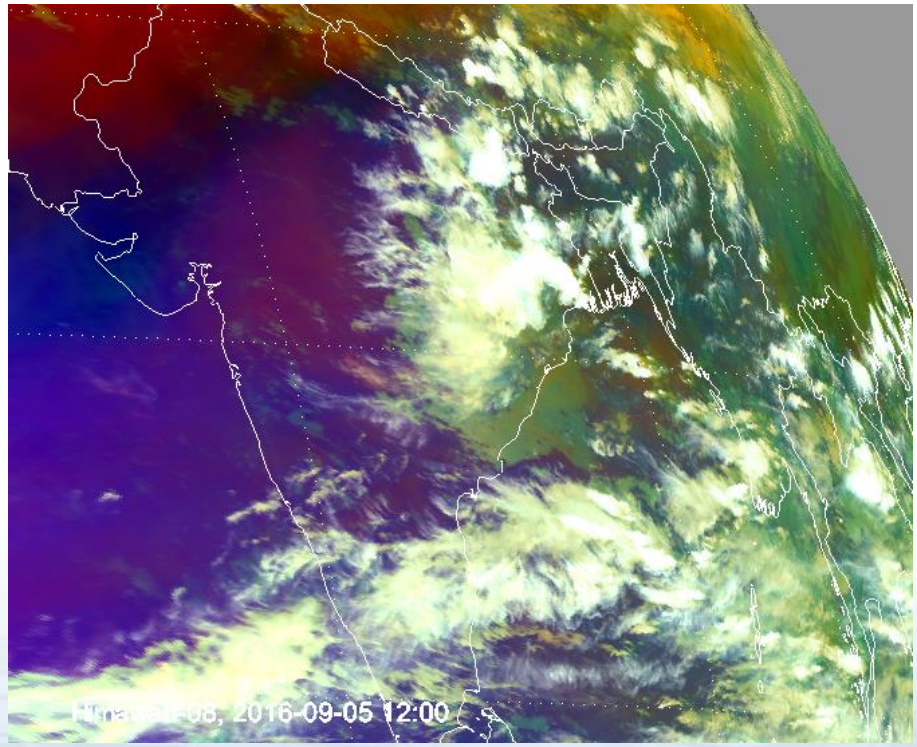
Met-10

Thin low clouds look thicker (better contrast) when viewed at high viewing angles !

Limb cooling in Airmass RGB



Met-08



Him-08

5 September 2016, 12:00 UTC

Bluish limb area
In Met-08 on eastern side
In Him-08 on western side

EUMETSAT

Summary (Dust RGB Animation, source: CIRA)