A New Look at the GOES-R ABI Split Window Difference for Convective Initiation Forecasting

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Motivation

- Predicting where and when convection will form continues to be one of the biggest problems facing forecasters
- Numerical models, especially high resolution (<=4 km) models, do a decent job with predicting convection, but rarely correctly pinpoint the time and location of convective initiation (CI)
- We take a new look at an old idea: using the split window difference to identify regions of pooling low-level water vapor
- GOES-R will be launched in 2016, and its Advanced Baseline Imager (ABI) will provide 2-km IR resolution, including bands at 10.35 μm (clean window) and 12.3 μm (dirty window)

10.35-12.3 µm “Split Window Difference”

- It’s long been known that the split window difference provides information about atmospheric water vapor content

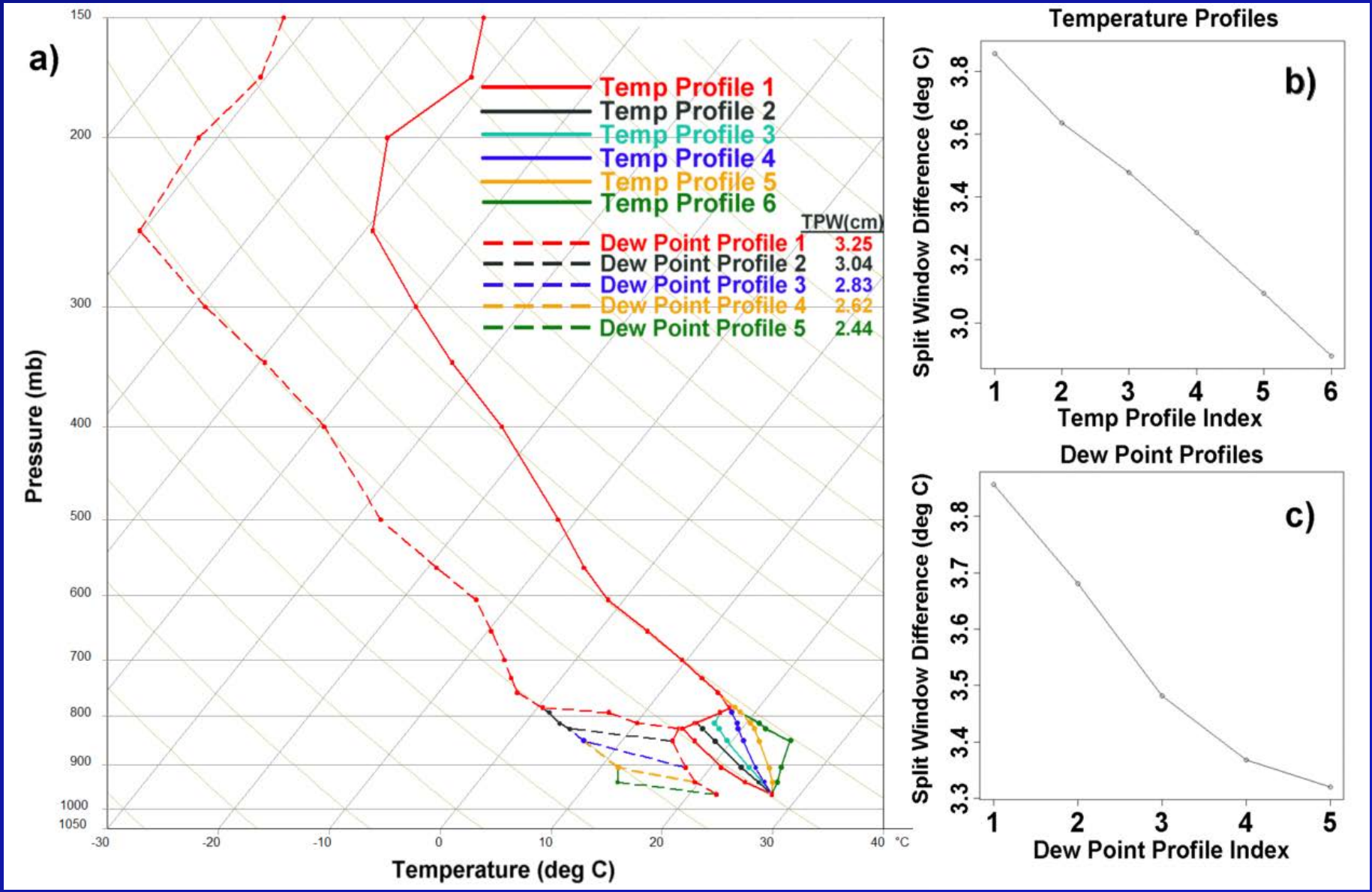
- Radiation at 12.3 µm is preferentially absorbed and re-emitted by water vapor, so deeper moisture generally results is a larger positive 10.35 – 12.3 µm difference

- The two primary determinants for the split window difference are:

  1. Amount and depth of water vapor (WV), especially at low levels

  2. The temperature lapse rate. Steeper (more unstable) low-level lapse rates (LR) result in larger positive differences

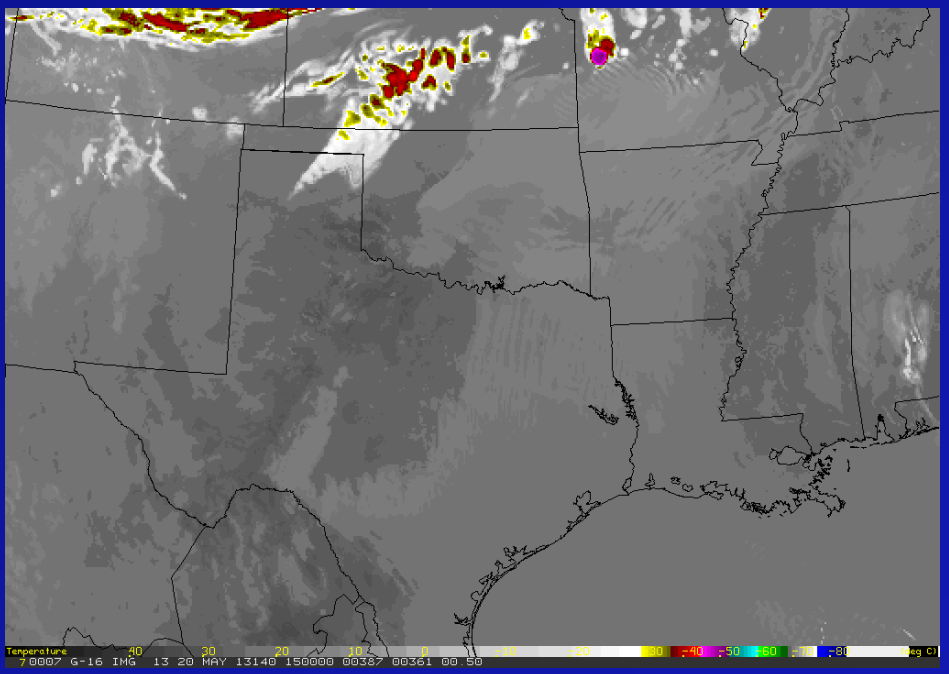
Sensitivity of Split Window Difference to Changes in Water Vapor Depth and Temperature Lapse Rate



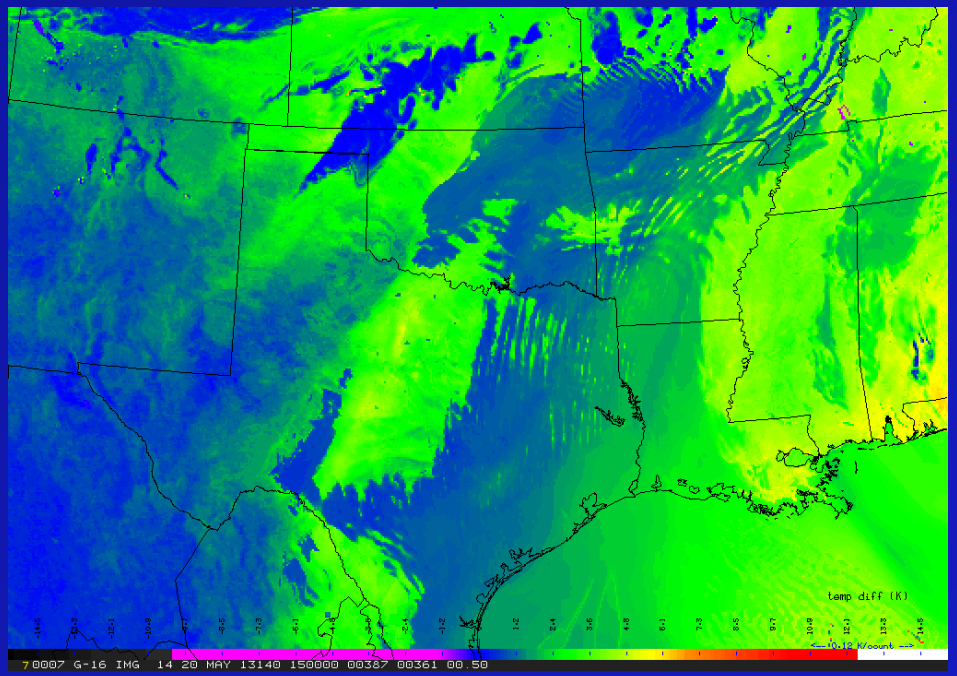
Based on Community Radiative Transfer Model simulations

Example: 20 May 2013

Data from the 4-km NSSL WRF-ARW model is used to simulate the GOES-R ABI bands

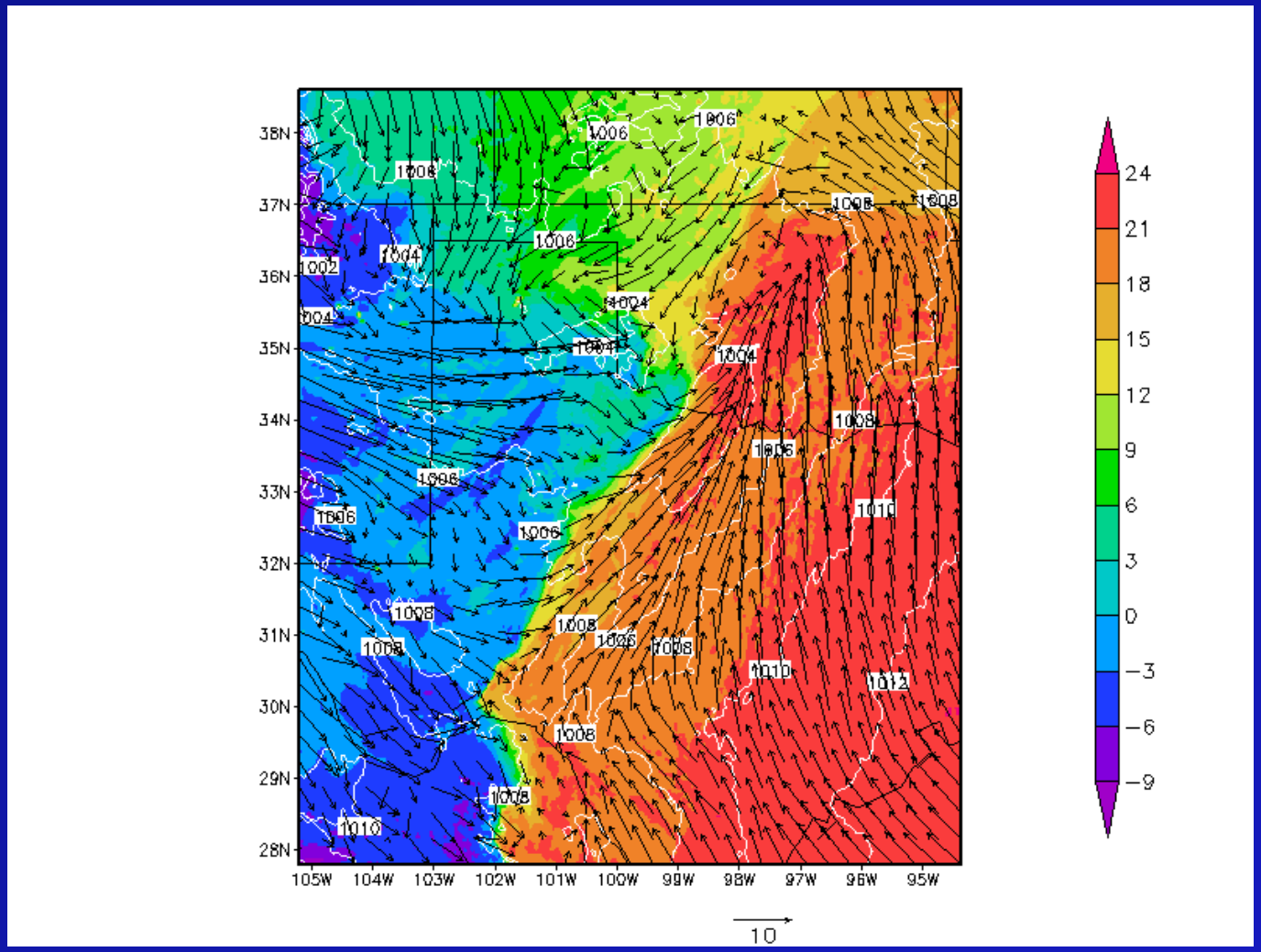


ABI 10.35 µm – 15:00 to 00:00 UTC



10.35 - 12.3 µm – 15:00 to 00:00 UTC

Example: 20 May 2013



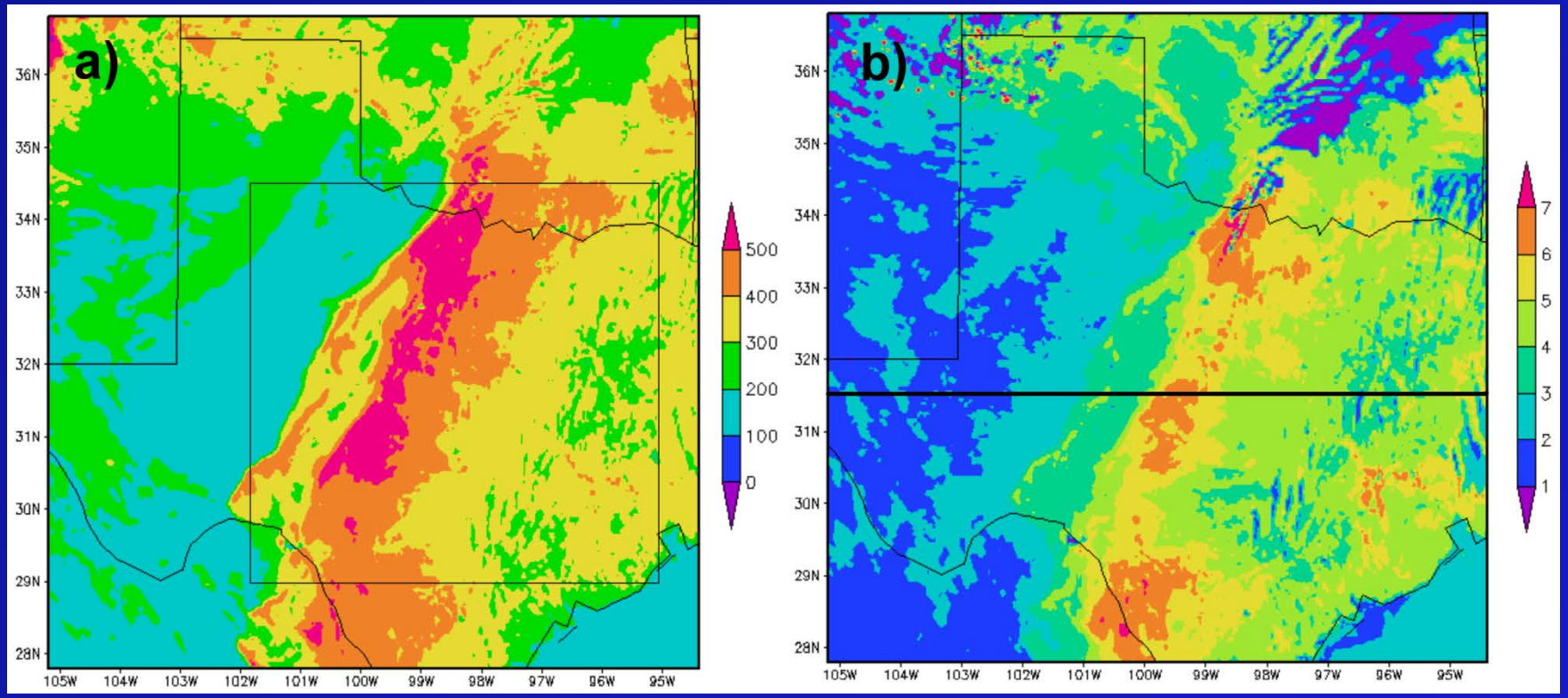
NSSL WRF 17-hour forecast of surface dewpoint and surface wind

Example: 20 May 2013

To show how much the split window difference depends on the low-level water vapor and temperature lapse rate, we define the quantity

$$Q \equiv \left(q_{sfc} + q_{925} + q_{850} + q_{700}\right) * LR, \text{where}$$

LR is the lapse rate between the surface and 700 mb, and q_{xxx} is the specific humidity at the 4 listed levels



Q, based on the 18-hr NSSL WRF forecast

Simulated 10.35-12.3 μm SWD

Example: 20 May 2013

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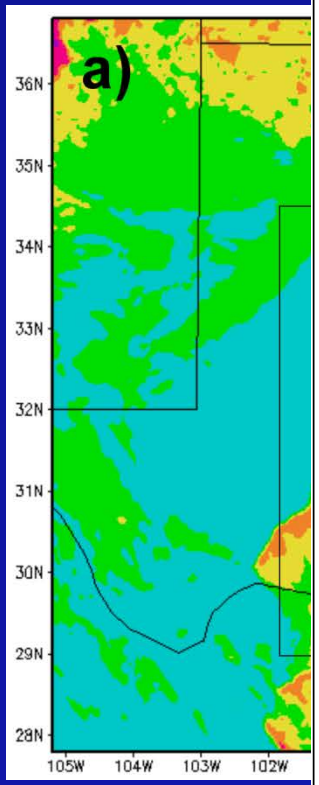
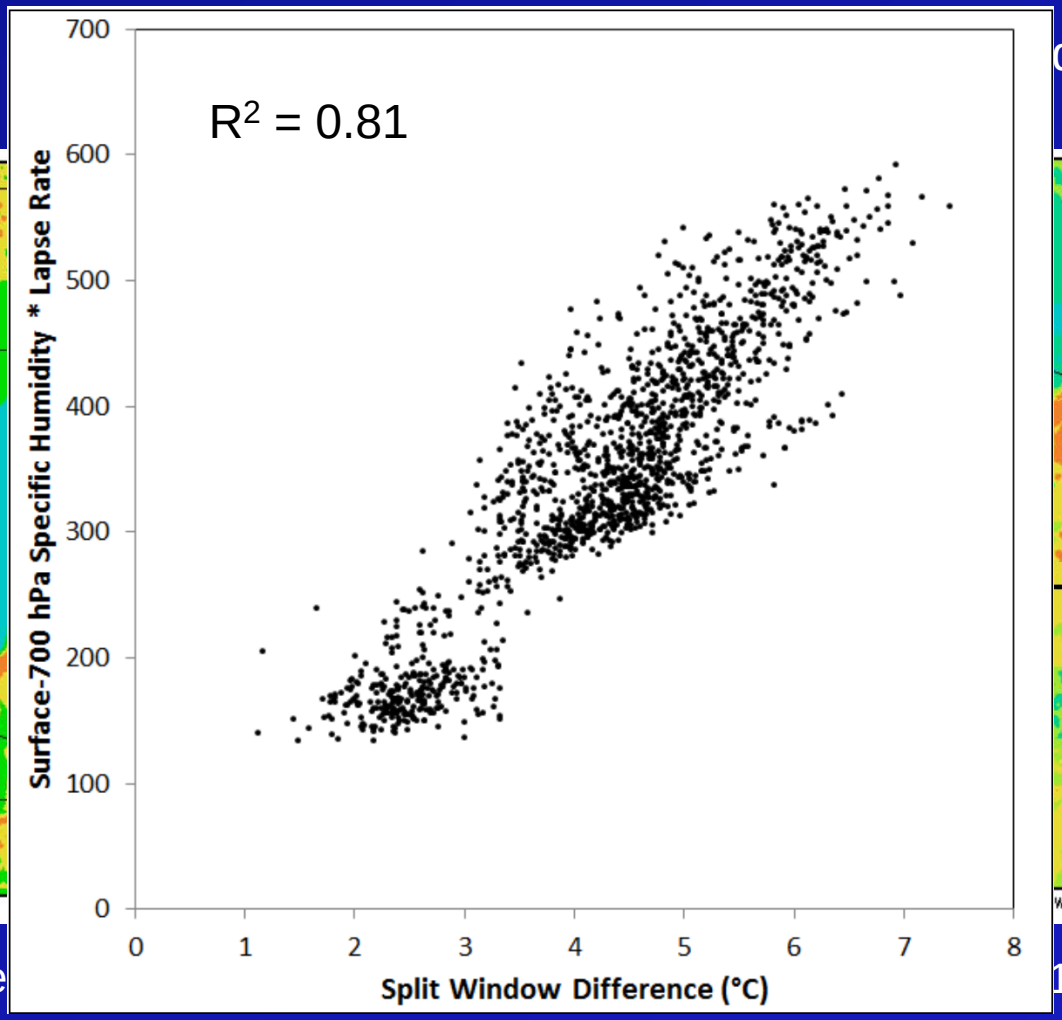
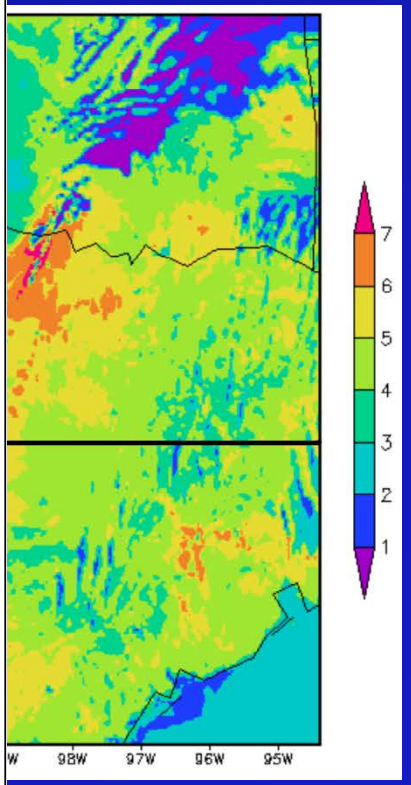
LR is the

q_{xxx} is the



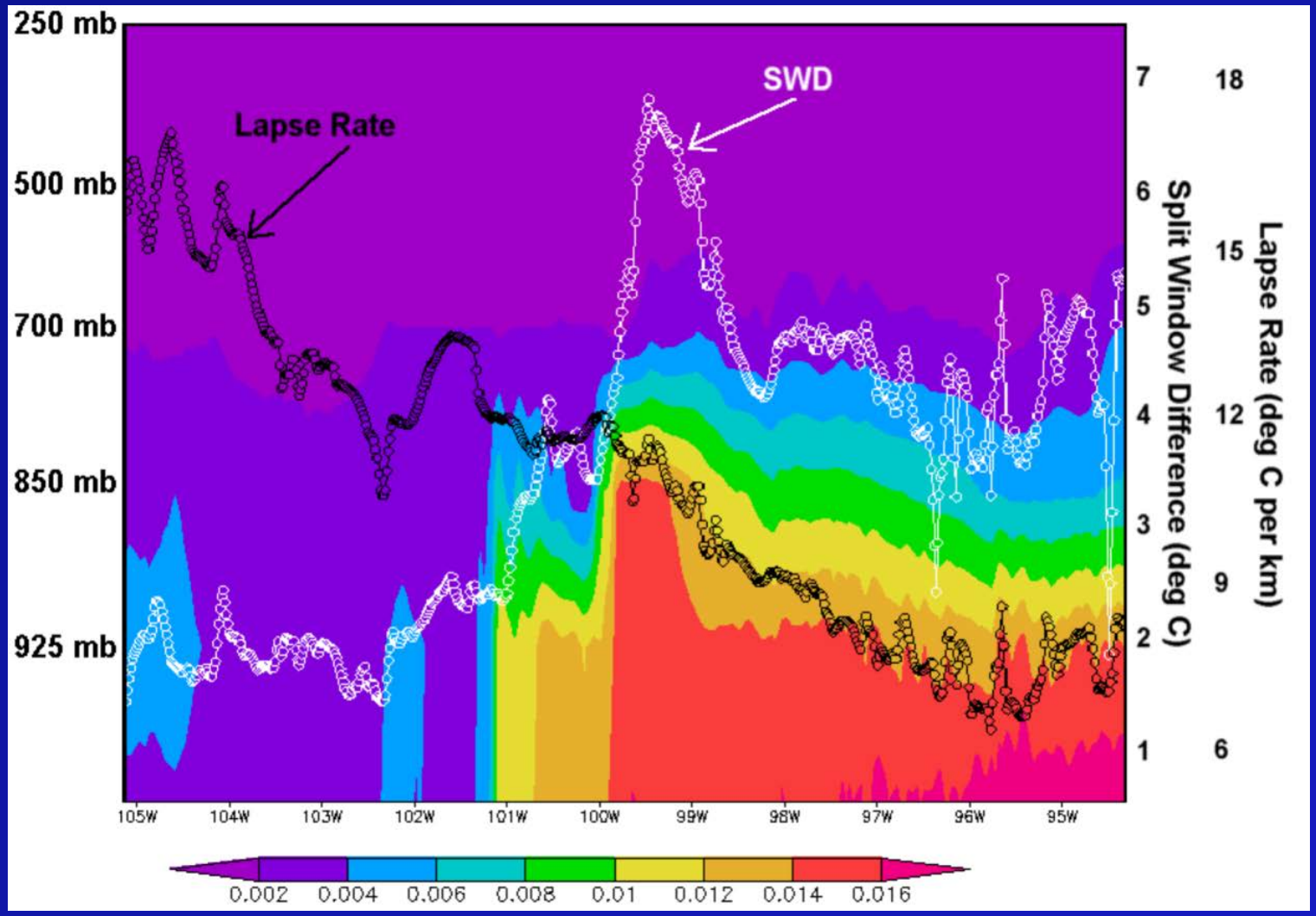




Q, based on the

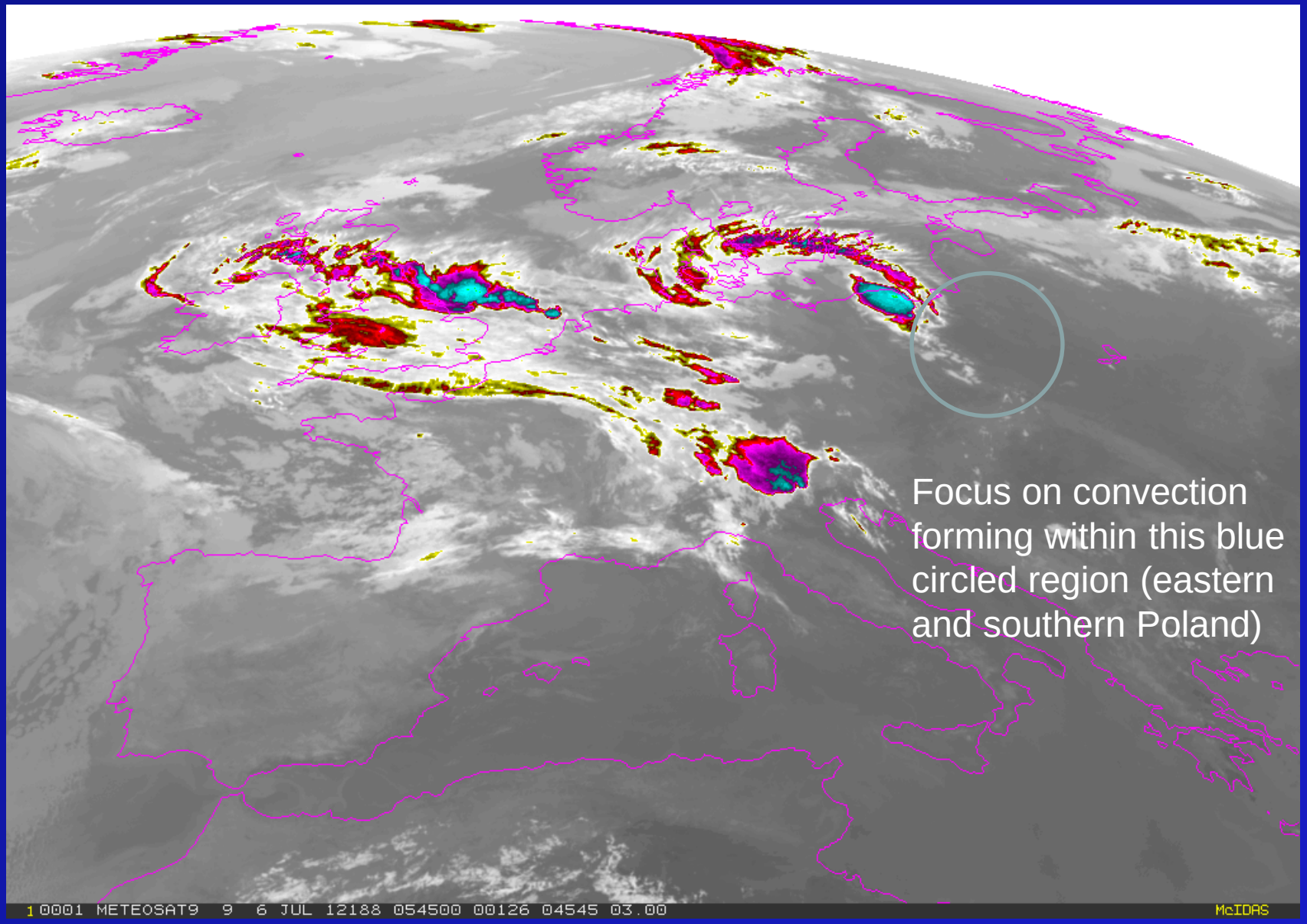
12.3 μm SWD

Example: 20 May 2013

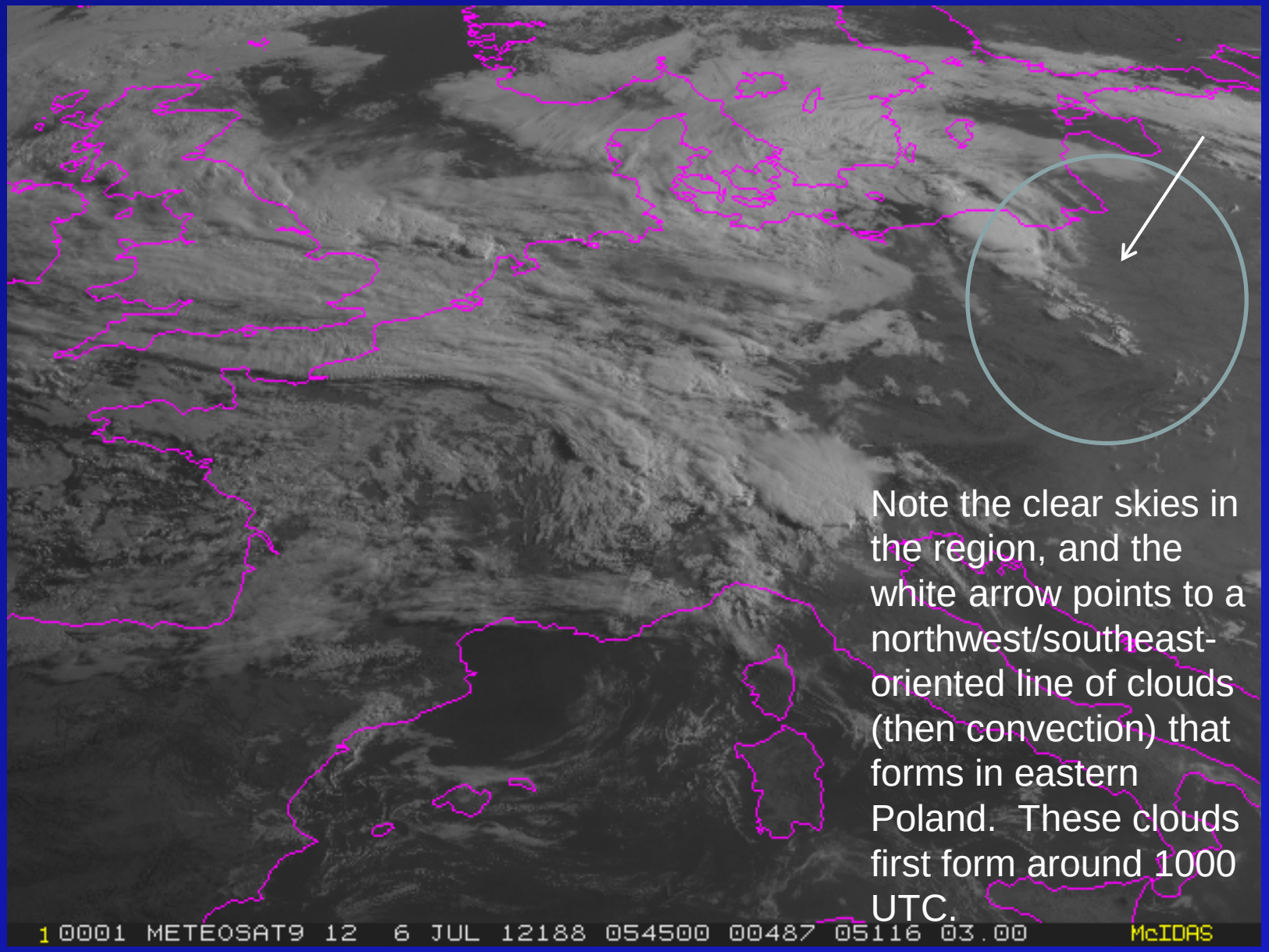


Vertical cross section through the dryline in Texas, showing the specific humidity (colors), surface-700 mb lapse rate (black), and SWD (white)

MSG – 10.8 µm 6 July 2012

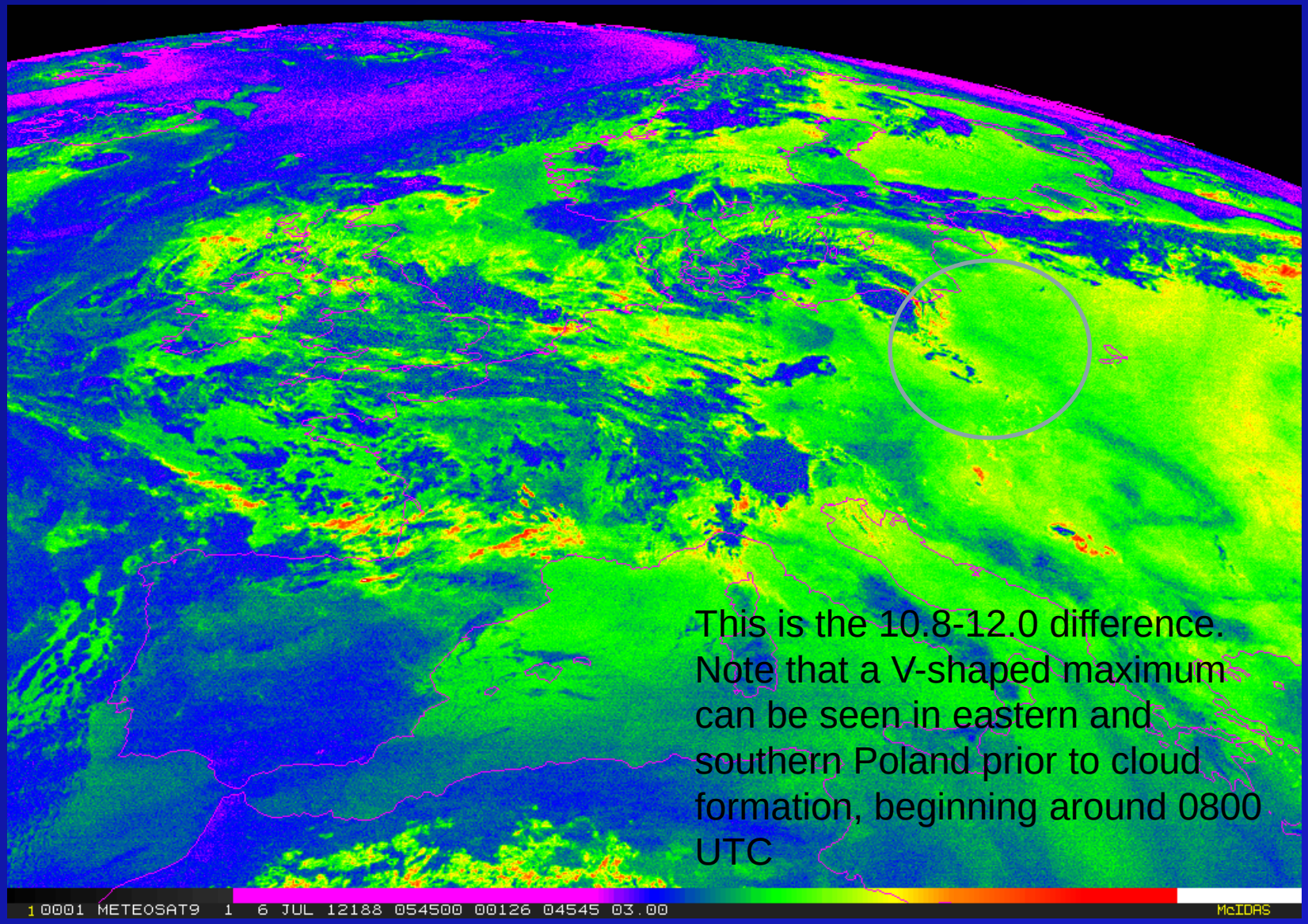


MSG – 10.8 µm 6 July 2012



Note the clear skies in the region, and the white arrow points to a northwest/southeast-oriented line of clouds (then convection) that forms in eastern Poland. These clouds first form around 1000 UTC.

MSG – 10.8 µm 6 July 2012



This is the 10.8-12.0 difference. Note that a V-shaped maximum can be seen in eastern and southern Poland prior to cloud formation, beginning around 0800 UTC

Conclusions

- The GOES-R ABI 10.35 – 12.3 μm split window difference can provide a simple yet effective way to locate pooling low-level water vapor within an area of steep lapse rates
- Requires clear skies and temperatures decreasing with height, but these occur somewhat frequently in the central plains of the U.S. during the warm season
- Satellite-based water vapor retrievals may be able to pick up on the same signals, but sometimes large footprints and the reliance on a model-based first guess can cause problems
- After GOES-R is launched and the real data is flowing, these ideas will be used to develop an actual product to aid in CI forecasting