**First set of formullas**

Here are the formulas for the Fog Probability Index (FPI), Day Fog Index (DFI), and Normalized Difference Fog Index (NDFI):

1. Fog Probability Index (FPI):

The FPI is a simple ratio between the brightness temperature in the infrared channels at 10.8 µm and 12.0 µm:

FPI = (Tb10.8 - Tb12.0) / (Tb10.8 + Tb12.0)

Higher FPI values indicate a higher probability of fog presence. Threshold values typically range from 0.15 to 0.25, but adjustments may be needed based on specific scene conditions.

2. Day Fog Index (DFI):

The DFI uses the brightness temperature difference between the near-infrared channel at 0.87 µm and the infrared channel at 10.8 µm:

DFI = (Tb0.87 - Tb10.8) / (Tb0.87 + Tb10.8)

Positive DFI values indicate fog presence, with thresholds typically ranging from 0.05 to 0.15. However, DFI is more sensitive to low-level clouds and requires careful interpretation.

3. Normalized Difference Fog Index (NDFI):

The NDFI combines the differences in both the near-infrared and infrared channels:

NDFI = (Tb0.87 - Tb12.0) / (Tb0.87 + Tb12.0)

Similar to DFI, positive NDFI values suggest fog. It offers some advantages over FPI and DFI due to its improved sensitivity and reduced impact of surface emissivity variations. Thresholds for NDFI can range from 0.05 to 0.10, again, needing adjustments based on the specific scene.

Remember that the optimal thresholds for these indices can vary depending on factors like satellite sensor characteristics, atmospheric conditions, and geographical location. You may need to experiment and fine-tune the thresholds based on your specific imagery and desired accuracy.

**Second set of formulas**

Here's how you can calculate the FPI, DFI, and NDFI using the available channels for Meteosat-9:

1. Fog Probability Index (FPI):

* Use IR\_108 for Tb10.8 and IR\_120 for Tb12.0:

FPI = (IR\_108 - IR\_120) / (IR\_108 + IR\_120)

2. Day Fog Index (DFI):

* Use IR\_087 for Tb0.87 and IR\_108 for Tb10.8:

DFI = (IR\_087 - IR\_108) / (IR\_087 + IR\_108)

3. Normalized Difference Fog Index (NDFI):

* Use IR\_087 for Tb0.87 and IR\_120 for Tb12.0:

NDFI = (IR\_087 - IR\_120) / (IR\_087 + IR\_120)

Remember that these indices provide preliminary indications of fog presence. It's essential to:

* Apply appropriate thresholds: Experiment with different thresholds based on your scene conditions and evaluation of results.
* Combine with other techniques: Utilize cloud masking, temporal analysis, or machine learning for more robust fog detection.
* Validate results: Compare extracted fog areas with ground truth data or expert assessment to ensure accuracy.

I'm ready to assist further as you progress in fog extraction and analysis!

Fog Probability Index (FPI):

* Formula: FPI = 0.55 \* BT\_108 + 0.45 \* BT\_120 - BT\_062 - NDVI \* (BT\_108 - BT\_120) + 30
* Adapted channels:
  + BT\_108 -> IR\_108
  + BT\_120 -> IR\_120
  + BT\_062 -> WV\_062
  + NDVI -> Calculated using VIS006 and VIS008

2. Day Fog Index (DFI):

* Formula: DFI = BT\_11 - BT\_12 + NDVI \* (BT\_11 - BT\_31)
* Adapted channels:
  + BT\_11 -> IR\_097 (closest available channel to 11 μm)
  + BT\_12 -> IR\_108
  + BT\_31 -> IR\_039 (closest available channel to 3.9 μm)
  + NDVI -> Calculated using VIS006 and VIS008

3. Normalized Difference Fog Index (NDFI):

* Formula: NDFI = (NIR - SWIR) / (NIR + SWIR)
* Adapted channels:
  + NIR -> VIS008 (closest available channel to near-infrared)
  + SWIR -> IR\_087 (closest available channel to shortwave infrared)

Important Considerations:

* These adaptations are based on best available channel matches, but accuracy might be affected by spectral differences.
* Consult research papers or documentation specific to Meteosat-9 for more tailored indices or validation studies.
* Experiment with different channel combinations and thresholds to optimize fog detection for your specific region and conditions.
* Consider incorporating ancillary data (e.g., surface temperature, humidity) for improved results.

**Rizwan solution**

# Example threshold values (these are just starting points and should be refined)

ir\_threshold\_min = 0.0 # minimum threshold for IR difference

ir\_threshold\_max = 255 # maximum threshold for IR difference

vis\_threshold = 5 # threshold for visible channel reflectance

# Apply IR threshold

**ir\_difference = scn['IR\_108'] - scn['IR\_120']**

**fog\_mask\_ir = (ir\_difference > ir\_threshold\_min) & (ir\_difference < ir\_threshold\_max)**

# Apply visible threshold during daytime

**fog\_mask\_vis = (scn['VIS006'] < vis\_threshold) & (scn['VIS008'] < vis\_threshold)**

**fog\_mask = fog\_mask\_ir & fog\_mask\_vis**

**other rizwan formullas:**

**# Custom Fog Detection Algorithm**

**# Adjust thresholds based on your specific requirements**

vis\_threshold = 15 # Visible channel threshold

ir\_threshold = 260 # IR channel threshold (in Kelvin)

# Daytime Fog Detection

fog\_mask\_day = (scn['VIS006'] <= vis\_threshold) & (scn['IR\_108'] < ir\_threshold)

# Nighttime Fog Detection

fog\_mask\_night = (scn['IR\_108'] - scn['IR\_120'] > 0) & (scn['IR\_108'] < ir\_threshold)

# Combine masks for a full day-night fog mask

fog\_mask = fog\_mask\_day #| fog\_mask\_night