Screening routines for aerosol- and trace-gas-affected infrared radiances

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Aerosol and trace-gas screening milestones at ECMWF

Start rejecting aerosol-affected IASI data

Implement trace gas detection for the 1st time

Make aerosol rejections channel-specific

Start rejecting aerosol-affected AIRS and CrIS data

Include dependency on aerosol type

Three-step aerosol type recognition

1. Flag the infrared (IR) field-of-view as aerosol-affected if brightness temperature (BT) differences at 980—1232 cm⁻¹ and 1090.5—1234 cm⁻¹ fall below threshold values.

2. Flag the detected aerosol as volcanic ash if the BT difference across 1168—1232 cm⁻¹ falls below a threshold value.

3. Otherwise, flag the aerosol as Saharan dust if the BT differences at 833—1090.5 cm⁻¹ and 1090.5—1234 cm⁻¹ fall below thresholds.

Channel-specific Saharan dust rejections

We estimate Aerosol Optical Depth (AOD) using the BT difference at 1090.5—1234 cm⁻¹ as a proxy. On average, larger AOD means larger negative O

B departure: this dependence is strongest on low-peaking channels.

Let us assume that the dust radiative effect, \( \delta \), is directly proportional to AOD:

\[ \delta = \alpha \text{ AOD} \]

Based on a global sample of Saharan-dust-affected data, we predict the regression slope \( \alpha \) using normalized height assignment \( H \) as a predictor:

\[ \alpha = \beta + \gamma H \]

where \( \beta = 2.1K \) and \( \gamma = -3.9K \).

Combining the two equations, solving for \( H \), and setting the maximum allowed dust radiative effect \( \delta_{\text{max}} = -0.1K \), we obtain the rejection threshold:

\[ H_r = \frac{1}{\gamma} \left\{ \frac{\delta_{\text{max}}}{\beta} + \frac{\delta}{\alpha} \right\} \]

Channels are rejected if their heights are assigned lower than \( H_r \).

The trace-gas detection scheme

In 2015, the ECMWF satellite data monitoring system alerted from excessive Observation minus Background (O-B) departures over tropical Indian Ocean region. The anomaly was attributed to Indonesian forest fires, very intense at the time, and it showed a spectral shape matching the absorption lines of Hydrogen Cyanide (HCN).

High levels of atmospheric HCN were observed again during the fire season of 2019.

The scheme compares observations and O-B departures in two distinct channel groups that consist of tracer and control channels, respectively. Tracer minus control differences falling below threshold values lead to rejection of affected channels.

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