Using Forecast Sensitivity to Observations to adapt IASI channel selection

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Rationale

Forecast Sensitivity to Observations (FSO)
- uses a dry energy norm (in its implementation at Météo-France)
- provides contribution of each single observation to the forecast error reduction at 24-h forecast range

\[ \delta J = \frac{1}{2} (R^{-1} H A) \left( M_a^T \frac{\partial J^b}{\partial x_b^f} + M_b^T \frac{\partial J^a}{\partial x_a^f} \right) (y - Hx_b) \]

- is used to evaluate the relative impact of observing systems used in operational assimilation system
- could be used to evaluate a channel selection and adapt it: the IASI case
FSO for each IASI atmospheric T channel

1-month average [15Aug2013 – 14Sep2013], 4 assimilations per day
FSO for each IASI atmospheric T channel

1-month average [15Aug2013 – 14Sep2013], 4 assimilations per day

Negative impact: to be removed from the channel selection
FSO for each IASI atmospheric T channel

FSO
J/kg

Weighting functions
FSO for IASI (atmospheric T channel contribution)

1-month average [15Aug2013 – 14Sep2013], 4 assimilations per day

FSO per channel

\[ \text{Weighting functions} = \text{FSO per vertical level} \]
FSO for IASI – Daily variability

Channel 55 - 658.50 cm\(^{-1}\)
High daily variability

Channel 457 - 759.00 cm\(^{-1}\)
Low daily variability
FSO for each IASI atmospheric T channel

Percentage of assimilations with a positive impact on FSO
FSO for each IASI atmospheric T channel

Percentage of assimilations with a positive impact on FSO

● to be removed from the channel selection
10 IASI atmospheric T channel to be removed

3 criteria for removing channels:
Mean FSO positive
High daily variability
Low percentage of assim. with positive impact

<table>
<thead>
<tr>
<th>Channel number</th>
<th>Wavenumber (cm⁻¹)</th>
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<tr>
<td>49</td>
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<td>133</td>
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<td>439</td>
<td>754.50</td>
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</tbody>
</table>
REF = Operational system and IASI dataset

EXP = REF – (10 IASI T atmos. channels with neg. impact on FSO)

2-month period, from July 16 to Septembre 15, 2013
Impact on 24-h forecasts – wind speed
Impact on forecasts – wind speed @ 50 hPa

Relative forecast error reduction (%)
Impact on IASI atmos. T channel usage

obs. increase = + 0.009%
Impact on IASI atmos. T FSO

Average FSO per assim. IASI atmos. T channels

in REF
105 chan -22985 J/kg
95 chan -22865 J/kg

In EXP
95 chan -22570 J/kg
Summary

FSO can be used to identify channels to be rejected
- could be used to modify channel selection for each analysis time
  (should be more realistic than a modification on monthly average)

Impact on forecast skills is neutral to slightly positive
- in areas consistent with the channel sensitivity
- with statistical significance
- but very modest

Impact on IASI FSO is neutral