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Impact of various ozone profile sources on the simulation of hyperspectral Infrared radiances by RTTOV. Towards the assimilation of Ozone sensitive IR radiances in Environment Canada NWP analysis system.

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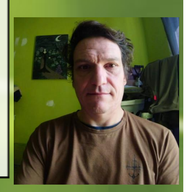

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In the latest operational implementation at Environment Canada (see Alain Beaulne's presentation for more details on other components), a prognostic stratospheric ozone scheme using linearized chemistry (LINOZ) was introduced in the GEM atmospheric forecast model together with a deterministic chemical data assimilation system.

The impact of the chemical analysis on NWP forecasts is mostly due to the radiative effect of ozone. In this first implementation, the chemical analysis is performed independently of the NWP analysis. In the NWP analysis system, some weakly ozone sensitive hyperspectral IR radiances located in the 15 μm CO_2 band (from the AIRS, IASI and CrIS instruments) were already assimilated using ozone from the Fortuin and Kelder climatology.

In this poster, we will present the impact on radiances and meteorological forecasts of using three different ozone sources for IR radiances assimilation, namely the RTTOV reference ozone profile, Fortuin and Kelder climatology and prognostic ozone from LINOZ (without chemical assimilation).

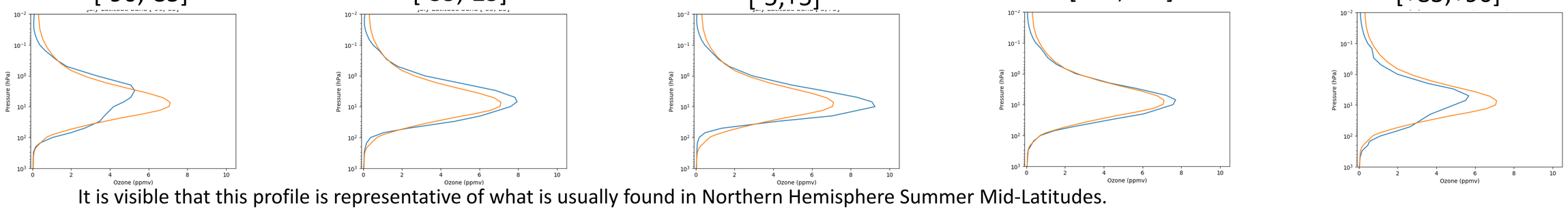
All the assimilation experiments discussed here were performed with summer 2016 data (20160615-20160831).

Here are the 3 EnVar data assimilation experiments considered here:

- **CNTL**: Control experiment. Use of Fortuin et Kelder ozone climatology as input to RT and the GEM radiation code for the short-term forecasting (LINOZ prognostic ozone is used by the GEM radiation code only for long term forecast).
- **EXP1**: same as **CNTL** except a single climatological ozone profile is used as input to RTTOV.
- **EXP2**: same as **CNTL** except LINOZ prognostic ozone field is used as input to RTTOV.

The Fortuin & Kelder ozone climatology above mentioned gives the monthly ozone concentration, expressed in term of volume mixing ratio profiles (ppmv), for 17 10 degrees latitudinal bands. In the figures below, the unique RTTOV reference profiles is compared with the July climatology profiles for different bands.

[-90;-85] [-35;-25] [-5;+5] [+45;+55] [+85;+90]

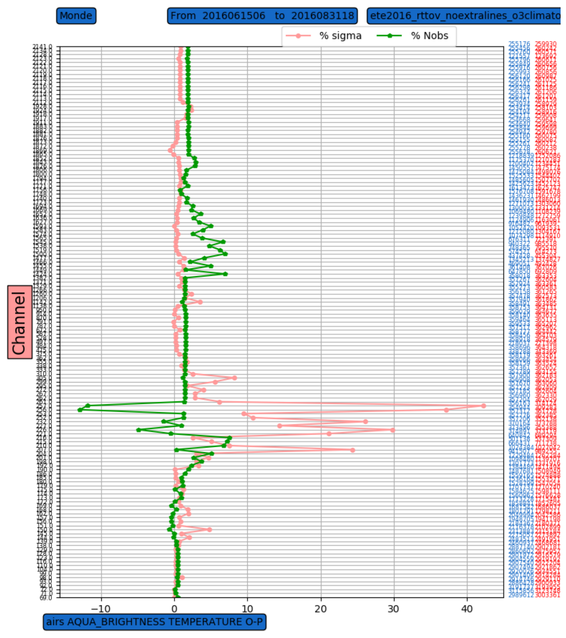


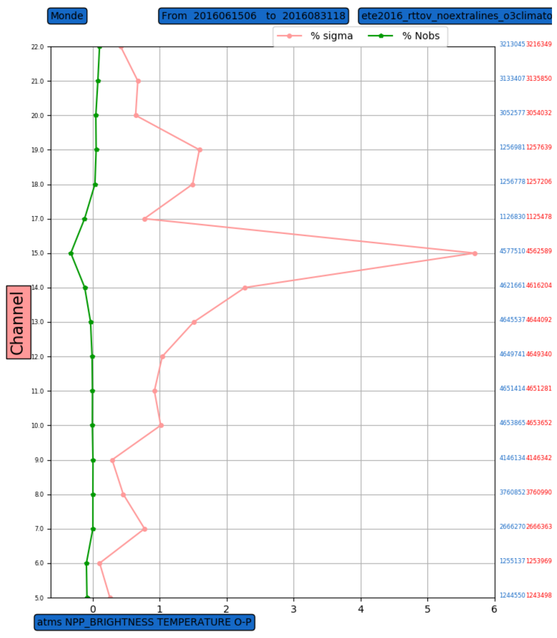
It is visible that this profile is representative of what is usually found in Northern Hemisphere Summer Mid-Latitudes.

Impact in radiance space:

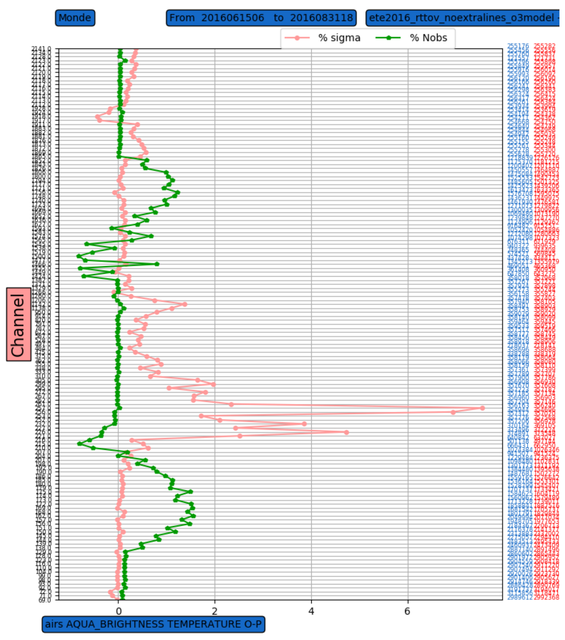
Here we present the impact on O-F (6 hours) in radiance space for AIRS (AQUA) and ATMS (NPP) radiances. Red curves show the relative impact on O-F standard deviations (positive = CNTL is better). Green curves show the relative impact on the number of assimilated observations (positive=EXP is better).

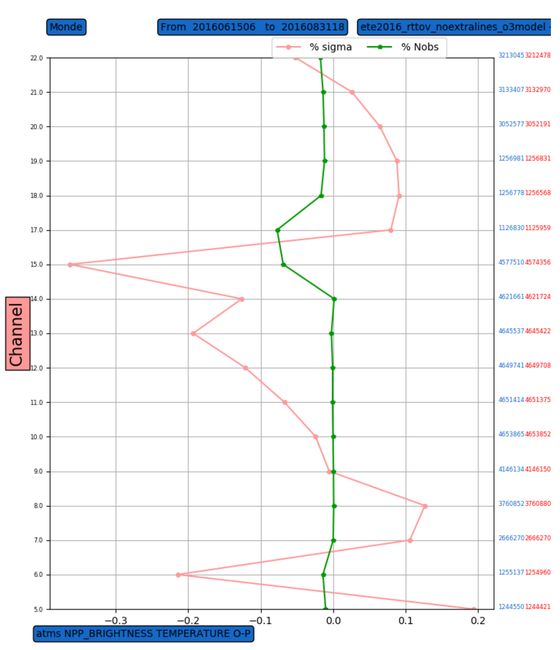
EXP1 vs CNTL





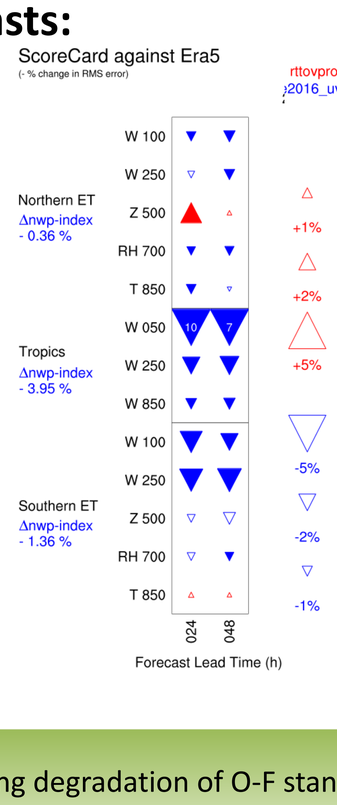
EXP2 vs CNTL



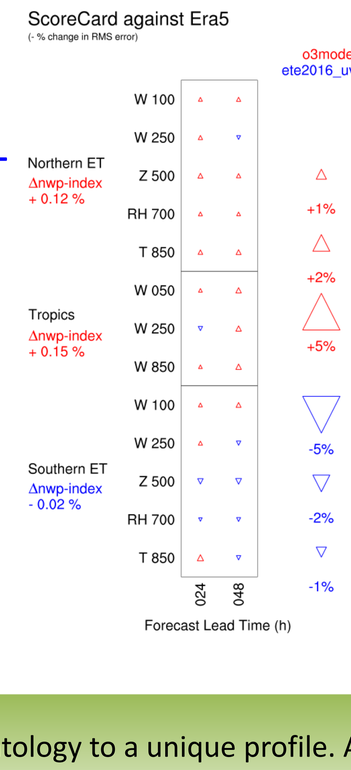


Impact on NWP forecasts:

EXP1 vs CNTL



EXP2 vs CNTL



Blue triangle: control is better

Red triangle experiment is better

Main findings:

- In infrared radiance space a strong degradation of O-F standard deviations for ozone sensitive channels is seen when switching from climatology to a unique profile. A much smaller negative signal is seen when using model ozone.
- Microwave channels (no ozone sensitivity) are negatively impacted using an unique ozone profile suggesting a degradation of the temperature field. Neutral impact for these channels when using model Ozone.
- The negative impact of using an unique Ozone profile and neutral impact of using model Ozone are confirmed by scores of forecasts against ERA5 analyses.
- This opens the way to coupled NWP and chemical assimilation (in the sense that all observation operators see the same ozone profile during the minimization).
- If this coupling is succesful, this will allow us to assimilate channels with a stronger ozone sensitivity.

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