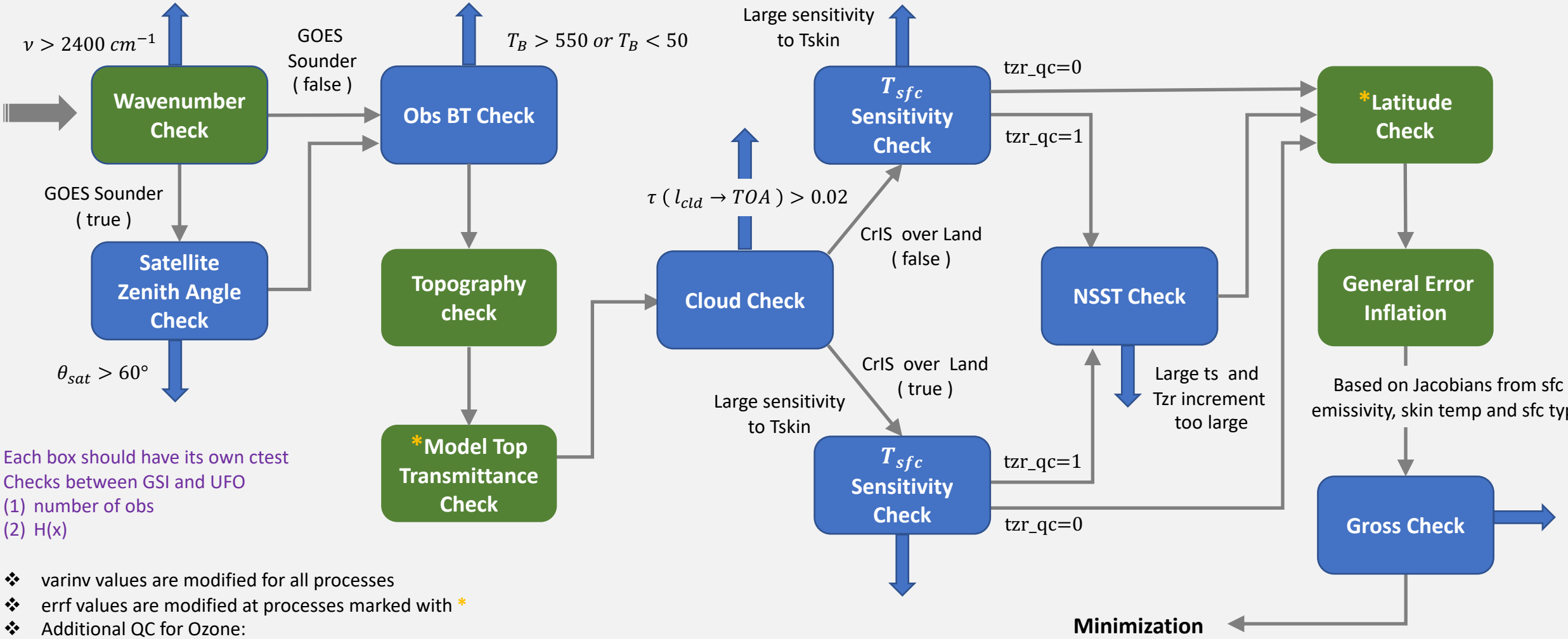
QC Flowchart for Infrared Sounders

A process of observation **Error Inflation** or called **Inverse of Error (varinv) Reduction** and ***Bound (errf) Tightening** from their original values



Each box should have its own ctest
Checks between GSI and UFO
(1) number of obs
(2) H(x)

- varinv values are modified for all processes
- errf values are modified at processes marked with *
- Additional QC for Ozone:
  Set Ozone jacobian to zero for QC_NoIRJacO3_Pole is true and obs latitude > 60 degree

Variables Required for QC @ each FOV

Observation and FOV related Vars

Vars	Description
nchanl	no. of sounding channels
tb_obs	observation value
cenlat	latitude at center of FOV
zsges	surface elevation
zasat	satellite zenith angle
pangs	solar zenith angle

SATINFO & Namelist related Vars

Vars	Description
nsig	no. of model levels
is	index of data types
ndat	no. of data types
luse_rad	channel usage
ich	channel number in satinfo

Vars	Description
tnoise	original ob error
errf	error bound
varinv	inverse of error
varinv_use	inverse of error used in cloud detection

First-Guess related Vars

Vars	Description
trop5	tropopause hgt
prsltmp	layer pressure
tvp	layer temp

Vars	Description
sea	is sea
land	is land
ice	is sea ice
snow	is snow
frac_sea	fraction of sea
tzbgr	surface water temp.
tsavg5	average surface temp.

Logics for Data Usage

Vars	Description
luse	logic to prevent double counting the obs
goessnd	toss data if obs @ latitude > 60 degree)
cris	additional surface temperature sensitivity check over land
zero_irjaco3_pole	zero out ozone jacobian for obs @latitude > 60 degree
tzr_qc	do NSST water temperature retrieval check

Direct and Derived Variables from CRTM

Vars	Description
wavenumber	chan wavenumber
tbc	bias correction innov O-F
temp	virtue temp jacobian
wmix	specific humidity jacobian
ts	skin temp jacobian
emissivity_k	sfc emissivity jacobian
ptau5	Level-to-space transmittance
kmax	pressure at the peak of weighting function

Variables Required for QC @ each FOV from CRTM

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Direct Variables from CRTM

Vars	Description
wavenumber	chan wavenumber
tsim	simulated obs from forecast
temp	virtue temp jacobian
wmix	specific humidity jacobian
ts	skin temp jacobian
emissivity_k	sfc emissivity jacobian
layer_od	layer optical depth
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- Need simulated brightness temperature (radiance) from CRTM to calculate innovation
- Need layer optical depth from CRTM to derive level-to-space transmittance and the peak of weighting function
- Need to add functions in UFO to calculate level-to-space transmittance and weighting function

Variables Output from QC @ each FOV

Variables Derived from QC Procedures

Vars	Description
cld	estimated cloud fraction from cloud detection scheme
cldp	estimated cloud top pressure from cloud detection scheme
lcld	Level index at cloud top
dtz	retrieved surface temperature increment at the depth of the measurement
ts_ave	averaged ts for channels used in tz retrieval
errf	error bound
varinv	inverse of error
zero_irjaco3_pole	Logic to set ozone jacobian to zero

Statistics / Data Usage

Vars	Description
Id_qc	quality control flag
aivals	record statistics for data usage

QC Flowchart for Infrared Sounders

Wavenumber (ν) Check

For each channel @ daytime ($\theta_{sun} < 89°$) and water surface (frac_sea > 0) in fov

(1) $\nu > 2400\ cm^{-1} \rightarrow varinv = 0$

(2) $2000 < \nu \leq 2400\ cm^{-1} \rightarrow Inflat\ Error$

$factor = 1 - (\upsilon - 2000) \cdot \tau_{sfc \rightarrow TOA}\ cos(\theta_{sun}) \cdot \frac{1}{4000}$

$varinv = factor \cdot varinv$

Satellite Zenith Angle θ_{sat} Check for GOES Sounder

$\theta_{sat} > 60 \rightarrow varinv = 0$

Topography Z_{sfc} Check

For each channel

$Z_{\mathrm{sfc}} > 2000 \rightarrow Inflate\ Error$

$\beta = \left(\frac{2000}{Z_{sfc}}\right)^4$

$factor = 1 - (1 - \beta) \cdot \tau_{sfc \rightarrow TOA}$

$varinv = factor \cdot varinv$

Transmittance @ Model Top τ_{nsig} Check

For each channel

$factor = \tau_{nsig}$

$varinv = factor \cdot varinv$

$errf = factor \cdot errf$

General Error Inflation

For each channel

$$\beta = \left(w_\varepsilon \cdot \left|\frac{\delta T_B}{\delta \varepsilon}\right| + w_{Ts} \cdot \left|\frac{\delta T_B}{\delta T_s}\right|\right)^2$$

$factor = (1 + variv \cdot \beta)^{-1}$

$varinv = factor \cdot varinv$

Note: w_ε and w_{T_s} are empirical constants as a function of surface type

Gross Check

For each channel

$|O - F| > 3 \cdot errf \rightarrow vrainv = 0$

Obs BT Check

For each channel

$50 < T_B < 500 \rightarrow varinv = 0$

Latitude θ_{lat} Check

$for\ |\theta_{lat}| < 25° \rightarrow Inflate\ Error\ and\ Reduce\ Bound$

$factor = 0.5 \cdot (|\theta_{lat}| \cdot 0.04 + 1)$

$errf = factor \cdot errf$

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prsltmp
tvp
tsavg5
trop5

varinv_use
kmax
ptau5
tbc
temp, ts

Cloud Detection Check

Minimum Residual Method

For each active channel

$\tau\ (\ l_{cld} \rightarrow TOA\ ) > 0.02 \rightarrow varinv = 0$

For each passive channel

$l_{cld} > kmax\ \rightarrow varinv = 0$

cldp
cld
lcld

tzbgr

varinv
tnoise
tbc
temp, wmix, ts

NSST Check (tzr_qc=1)

For each channel over sea

$ts > tschk$
$\delta tz > tzchk \rightarrow \text{varinv} = 0$

dtz
ts_zvg

Surface Temperature Sensitivity Check

$$sum = \sum_{1}^{nchanl} (tbc \cdot ts)$$

$$sum2 = \sum_{1}^{nchanl} (ts \cdot ts)$$

$$\delta ts = \left(\frac{sum}{sum2}\right)$$

$\delta ts \cdot ts > max(0.05 \cdot tnoise, 0.02)\ \rightarrow varinv = 0$

Surface Temperature Sensitivity Check for CrIS over Land

For each channel

$\frac{\delta T_B}{\delta T_x} > 0.2\ \rightarrow varinv = 0$