

Comparison and Combination of Tropospheric Parameters

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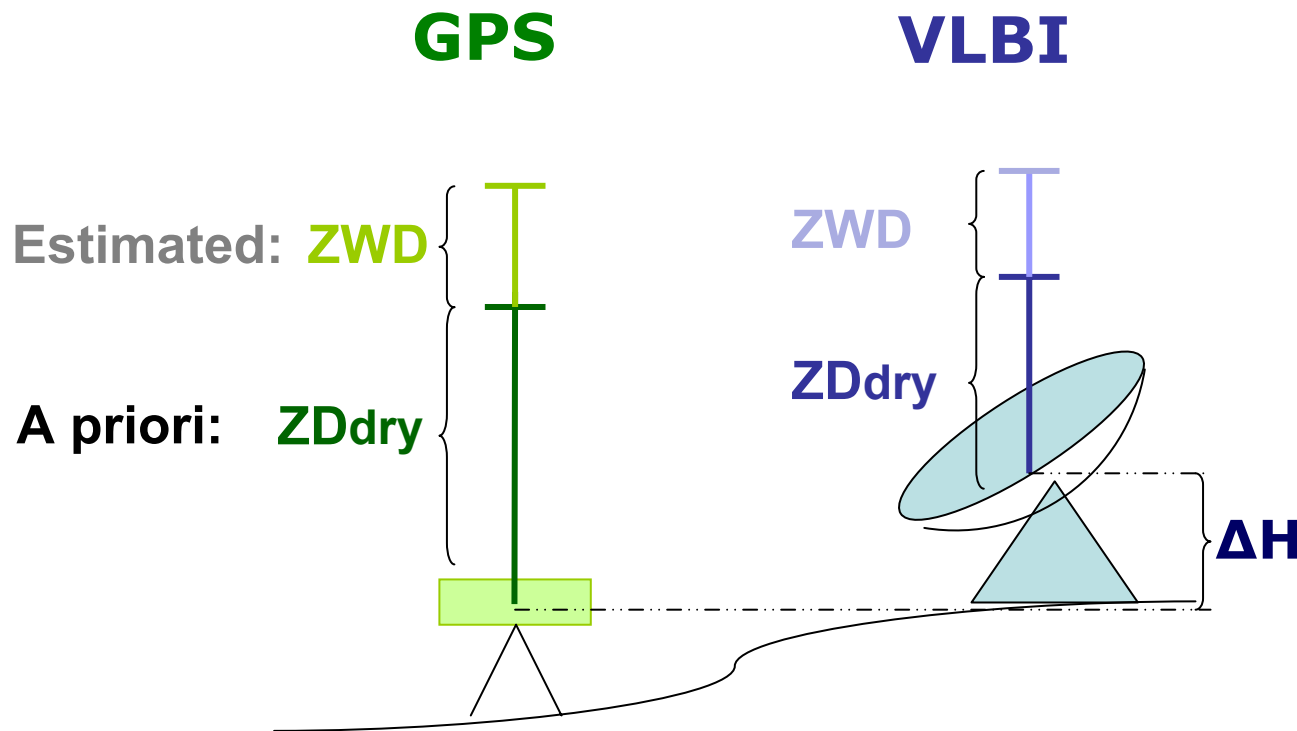
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Homogeneously processed VLBI, GPS and DORIS data provide
the same type of **tropospheric parameters**:

- **tropospheric zenith delay (ZD)**
- **N-S and E-W gradient**

↪ **can compare and combine**

Tropospheric combination



Because of ΔH

ZDdry > ZDdry
($\Delta H=10\text{m} \rightarrow 2.8 \text{ mm}$)
- ΔZDdry is considered a priori

ZWD > ZWD
($\Delta H=10\text{m} \rightarrow 0-2 \text{ mm}$)
- ΔZWD has to be modelled for combination

Parameterization of ZD

$$\text{ZD} = m f_{\text{dry}} \text{ZD}_{\text{dry}} + m f_{\text{wet}} \text{ZWD}$$

- **a priori:** hydrostatic delay ZD_{dry} as a function of the station height and mapping function of dry delay $m f_{\text{dry}}$ (Saastamoinen with pressure from 1013mbar+Berg, in situ, ECMWF)
- **estimated:** wet Delay ZWD as a function of station height, vapour pressure and temperature and mapping function of the wet Delay $m f_{\text{wet}}$

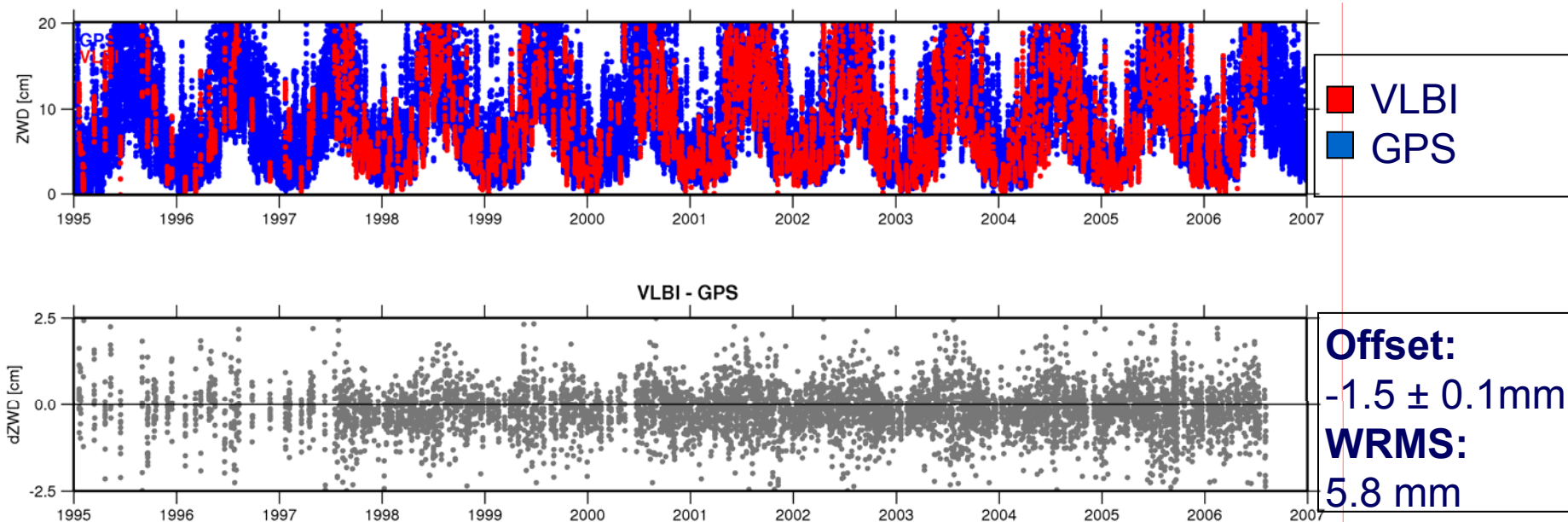
Difference ΔZWD between GPS and VLBI

$$\text{ZWD}_{\text{GPS}} - \text{ZWD}_{\text{VLBI}} = \Delta\text{ZWD}(\Delta H, e, T)$$

Comparison of ZWD

Comparison of tropospheric wet delay (ZWD) from GPS and VLBI

Algonquin Park



- show a very good agreement in temporal behaviour
- small but significant offset due to height difference (has to be modelled)

Tropospheric combination

Modelling of ΔZWD (Brunner+Saastamoinen, TU Vienna)

$$\Delta ZWD = -2.789 \frac{e_0}{T_0^2} (5383/T_0 - 0.7803) \Gamma (H - H_0)$$

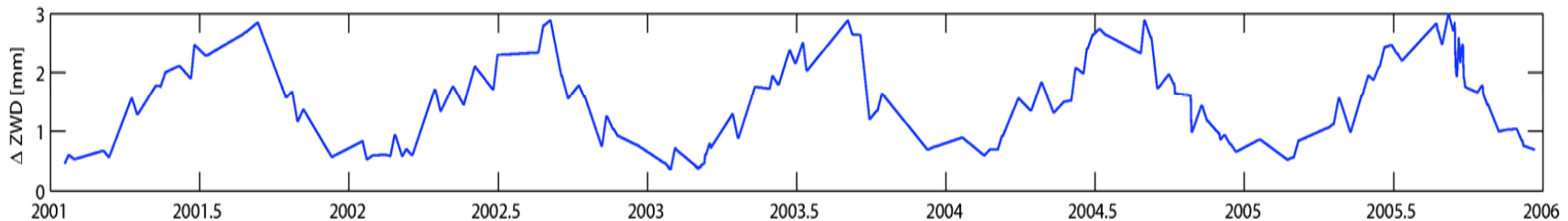
e_0 vapour pressure of reference station (VLBI) (station height= H_0)

T_0 temperature of reference station (VLBI) (station height= H_0)

Γ constant

H height of the second station (GPS)

Tsukuba: $\Delta H \approx 17\text{m}$ (using in situ meteorology)



Tropospheric combination

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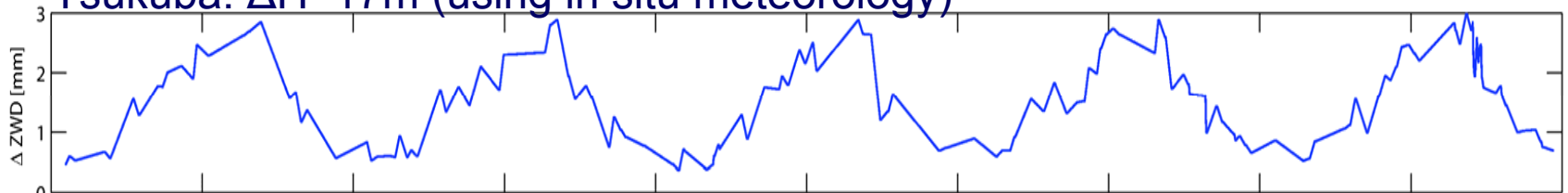
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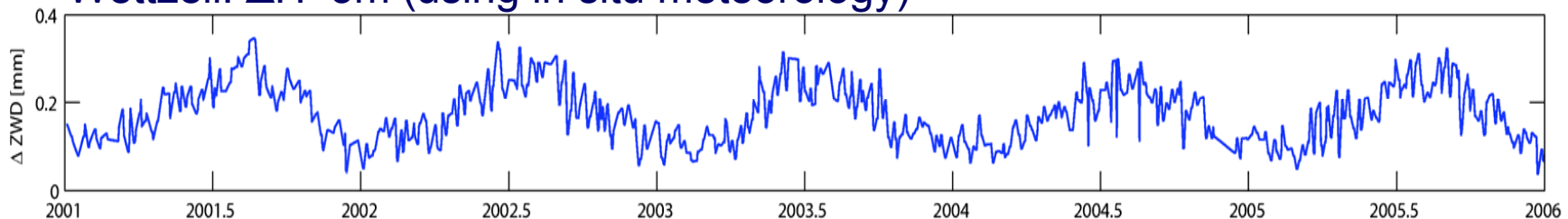
Γ constant

H height of the second station (GPS)

Tsukuba: $\Delta H \approx 17\text{m}$ (using in situ meteorology)



Wetzell: $\Delta H \approx 3\text{m}$ (using in situ meteorology)



Tropospheric combination

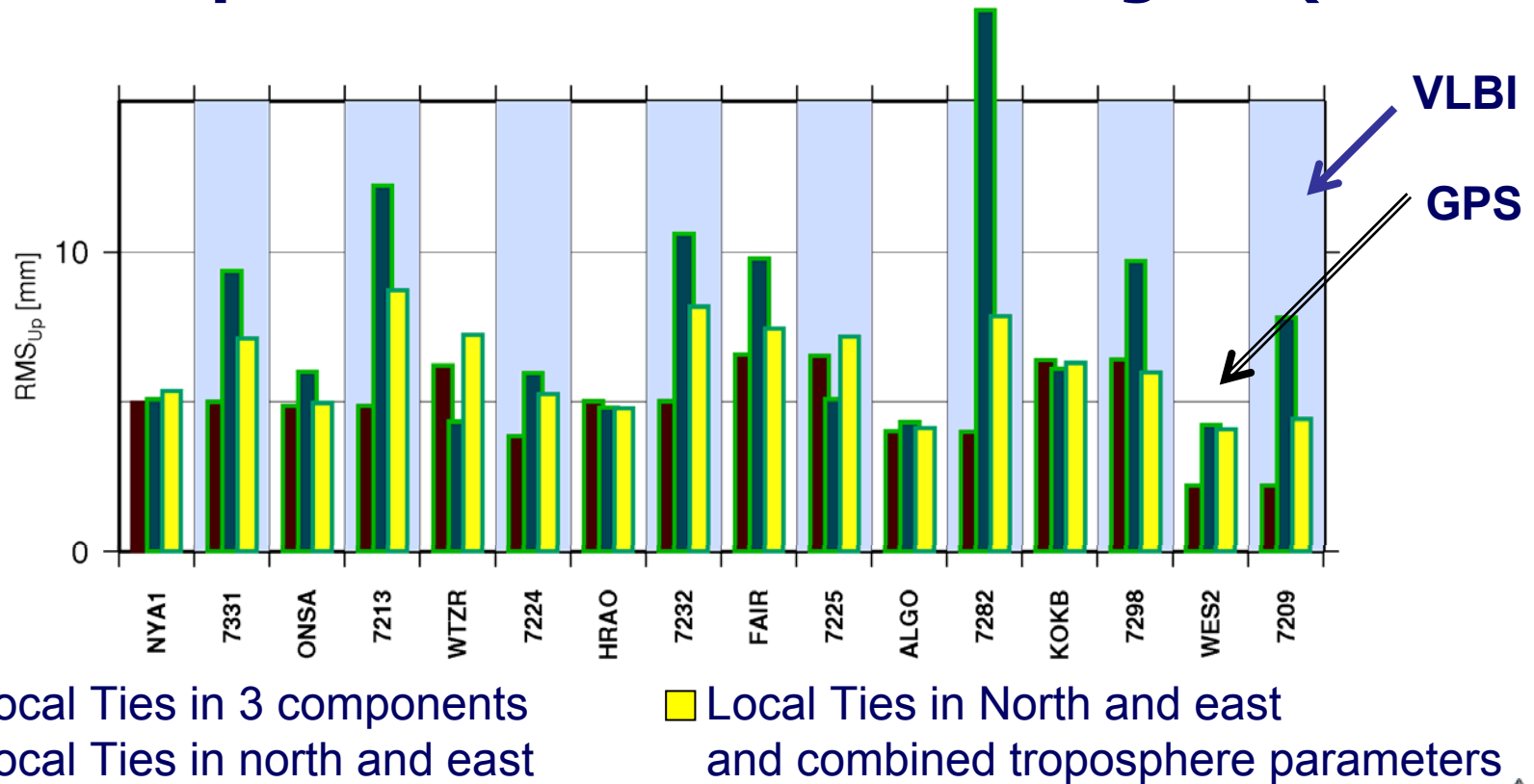
Remaining offset between GPS and VLBI after correcting for ΔZWD from modeled time series

Station	Offset [mm] GPS-VLBI	σ [mm]
NYA1	-0.2	0.1
ONSA	-2.1	0.1
WTZR	-0.8	0.1
TSKB	-1.7	0.2
HRAO	-2.5	0.2
ALGO	-0.5	0.1
WES2	4.6	0.1
HOB2	-0.7	0.3



Tropospheric combination

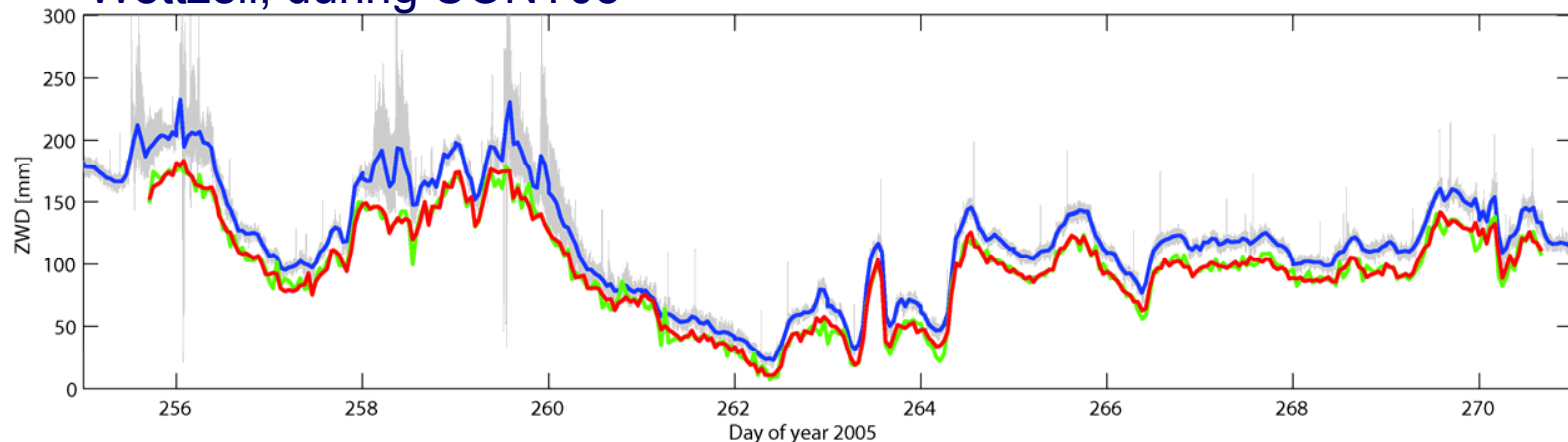
Combination of tropospheric parameters: Effect on repeatabilities of station heights (CONT02)



Comparison with WVR

Comparison with WVR data: very good agreement in temporal behaviour but a significant offset

Wetzell, during CONT05



■ GPS hourly
■ VLBI hourly

■ WVR temporal resolution < 1 min
■ WVR hourly

Comparison with WVR

Comparison with WVR data: very good agreement in temporal behaviour but a significant offset

	Compared	Offset [mm]	WRMS of difference [mm]
Wettzell	GPS-WVR	16.9	4.5
	VLBI-WVR	17.6	5.5
	GPS-VLBI	0.6	5.1
Algonquin Park	GPS-WVR	27.3	7.0
	VLBI-WVR	27.1	9.2
	GPS-VLBI	-0.7	8.0
Kokee Park	GPS-WVR	5.2	4.9
	VLBI-WVR	4.6	8.1
	GPS-VLBI	-0.3	7.7

Tropospheric gradients

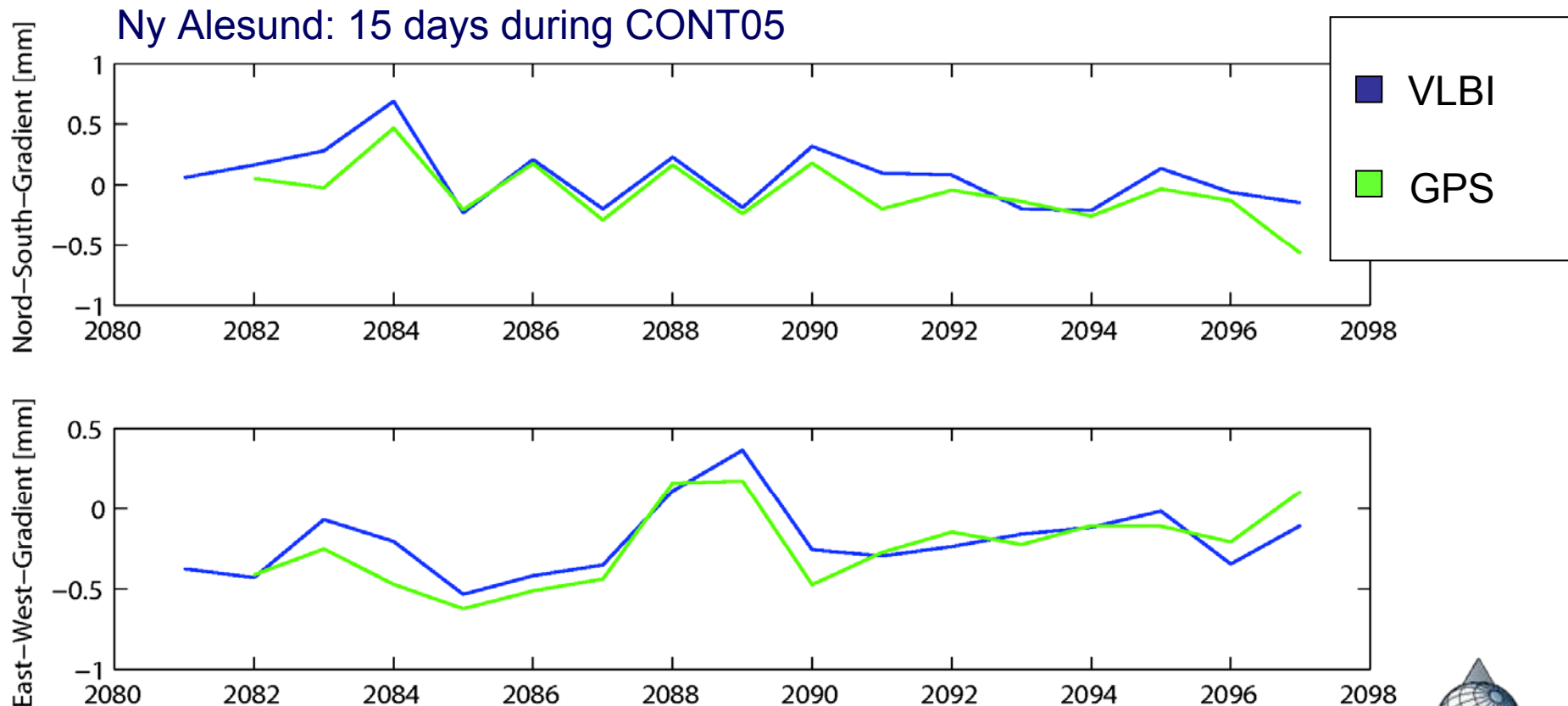
Parameterization of ZD and gradients

$$\text{ZD} = m_{\text{dry}} \text{ZD}_{\text{dry}} + m_{\text{wet}} \text{ZWD} + G_{\text{NS}} + G_{\text{EW}}$$

- **estimated:** wet delay ZWD and North-South and East-West gradient
- gradients are the same parameters for GPS and VLBI at one site and can be combined directly

Tropospheric gradients

Comparison and combination of tropospheric Gradients



Tropospheric combination

Summary and Conclusions

- **very good agreement** in temporal behaviour of tropospheric parameters estimated from GPS and VLBI
- **significant offsets $\Delta ZWD(\Delta H)$** with an annual signal
- **$\Delta ZWD(\Delta H)$ and its temporal behaviour cannot be fully explained by model** (Brunner)
- combination of ZD gives stabilization for station height (esp. VLBI)
- comparison with WVR shows **high potential of WVR data**