S-Pol radar refractivity in TiMREX/SoWMEX
Part I: Data processing

Ya-Chien Feng[1]（馮雅茜）and Tammy M. Weckwerth[2]

[1] National Central University, Taiwan

[2] EOL, National Center for Atmospheric Research, CO, USA

Refractivity (N) : definition

- Bean and Dutton (1968)

$$n = \frac{V_{vocuum}}{V_{medium}}$$

$$N = (n - 1) \times 10^{6}$$

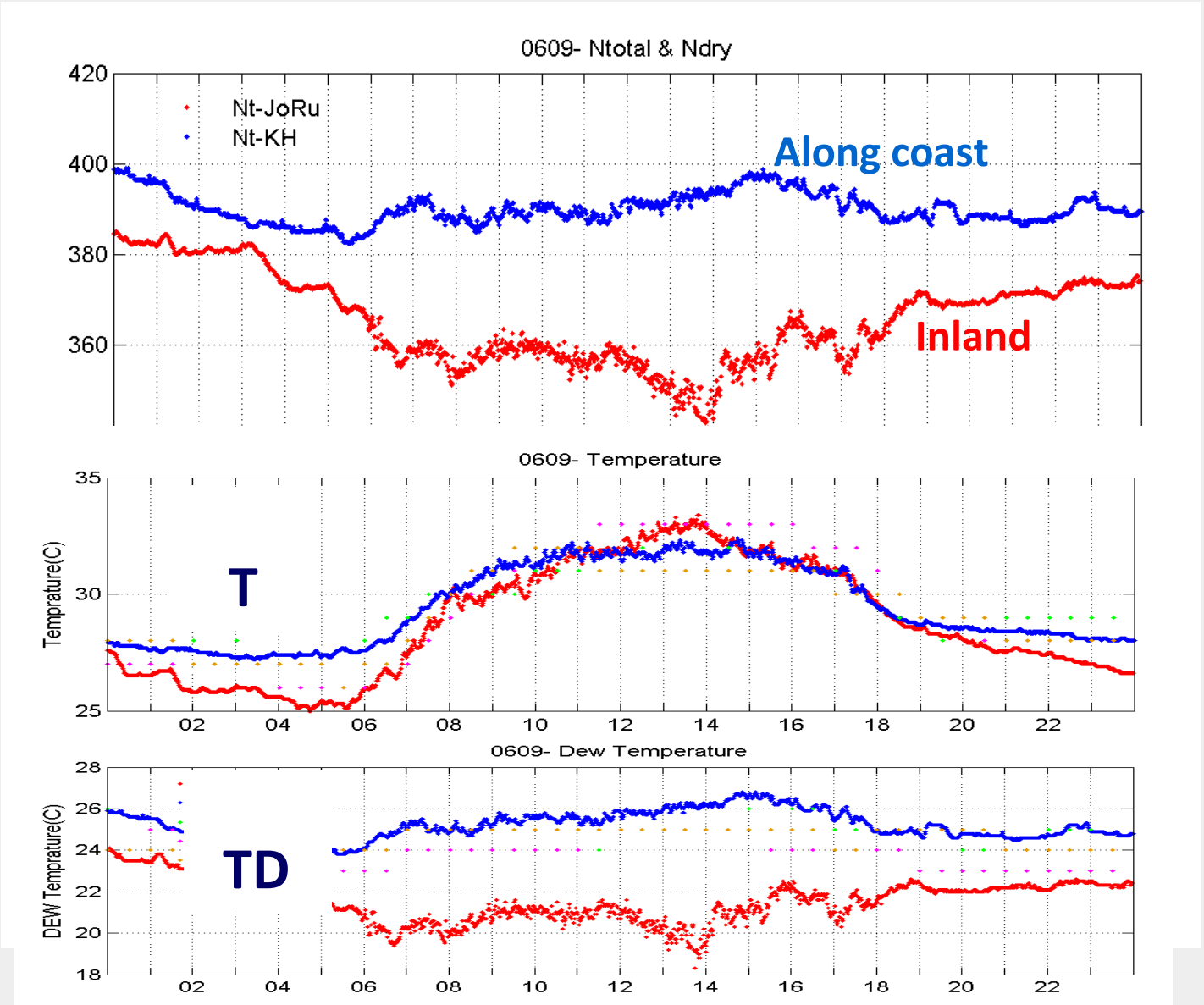
$$N = 77.6 \frac{P}{T} + 3.73 \times 10^{5} \frac{e}{T^{2}}$$

density term (dry)

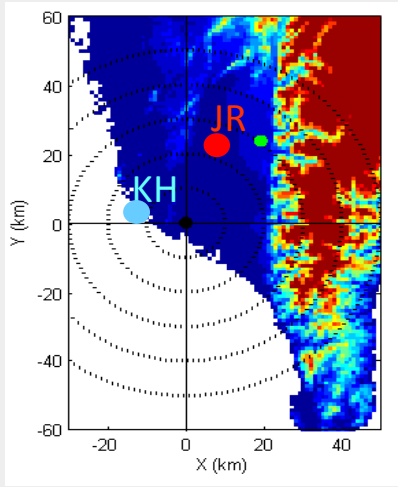
moisture term

Refractivity (N)

N total



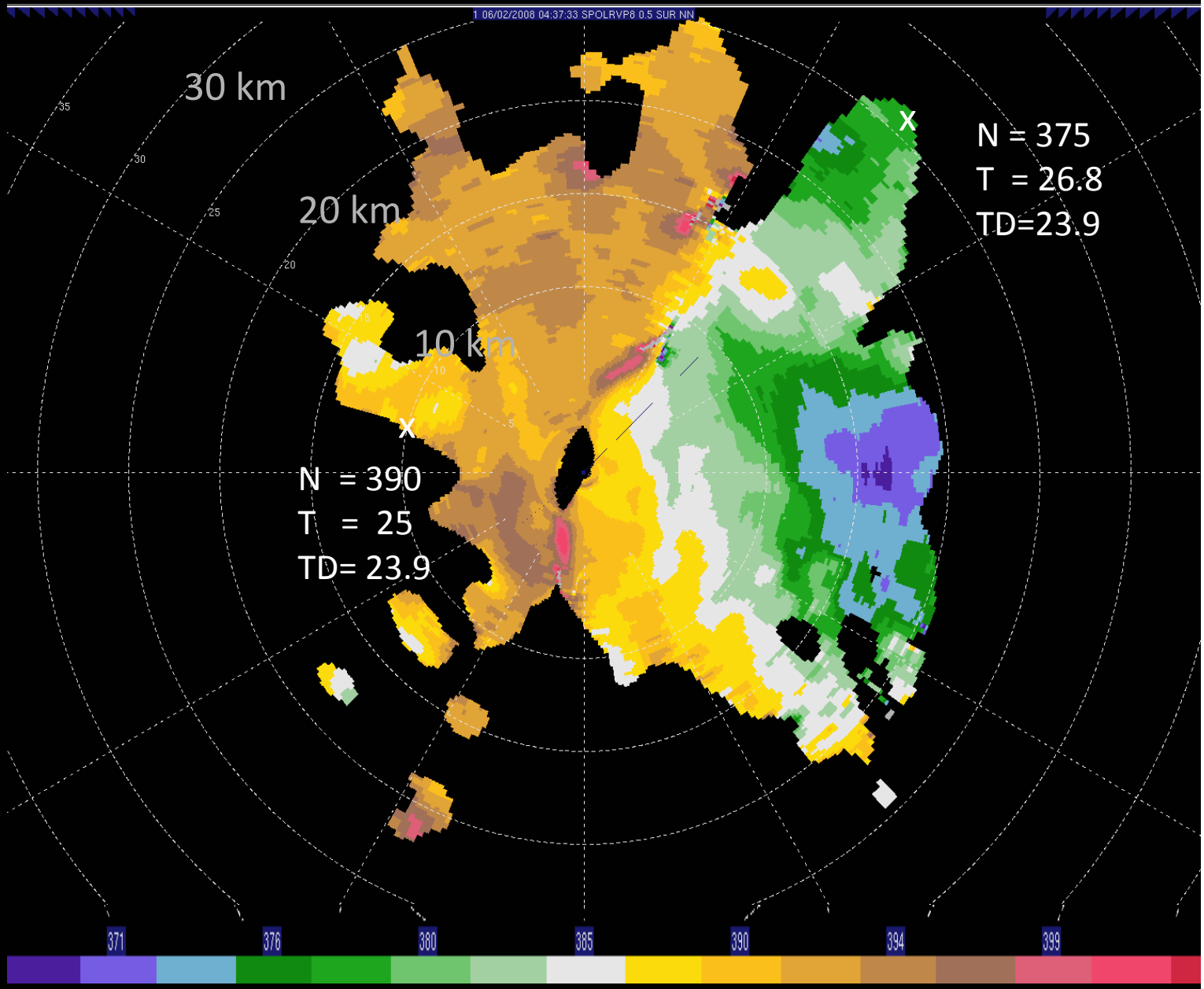
N dry



Data Processing

Comparison

Application



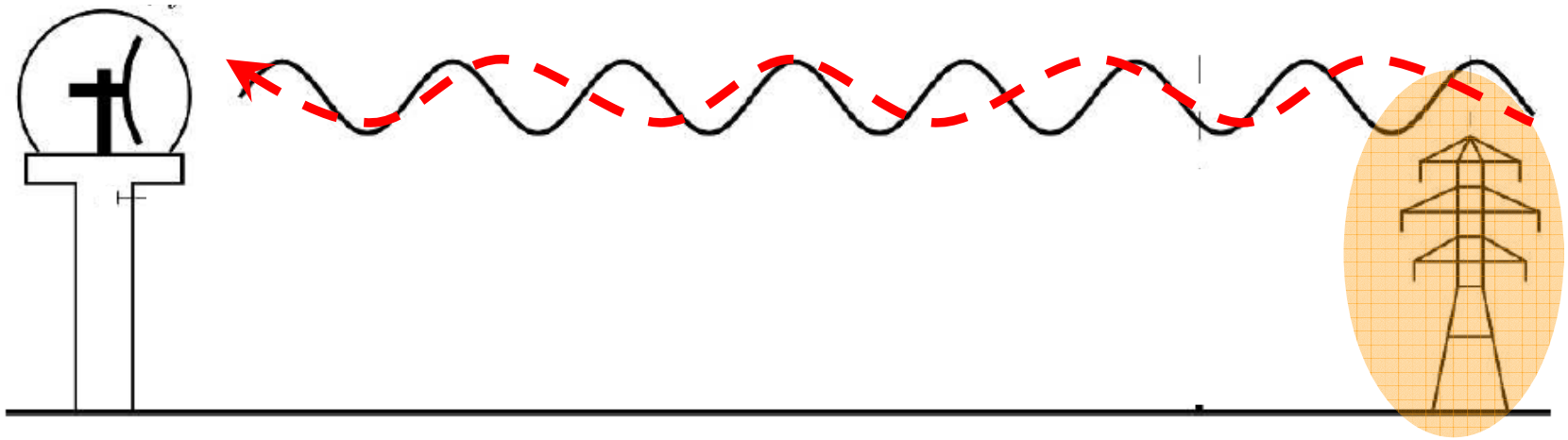
Refractivity Retrieval

The quality of the retrieval depends critically on the quality of the data used in the

- **Ground Target Identification**
- **Calibration (Reference) data**

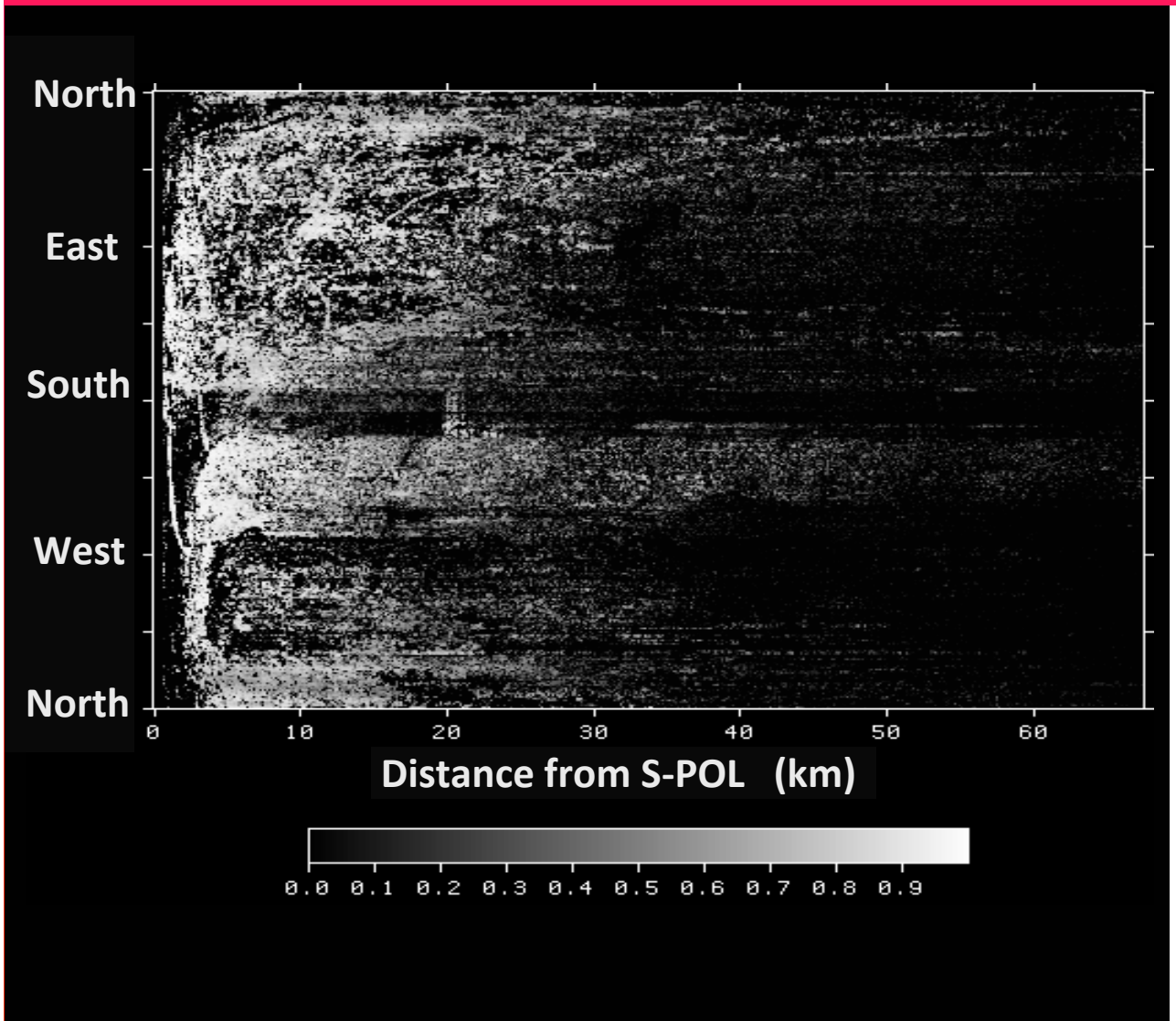
  Absolute phase from fixed targets

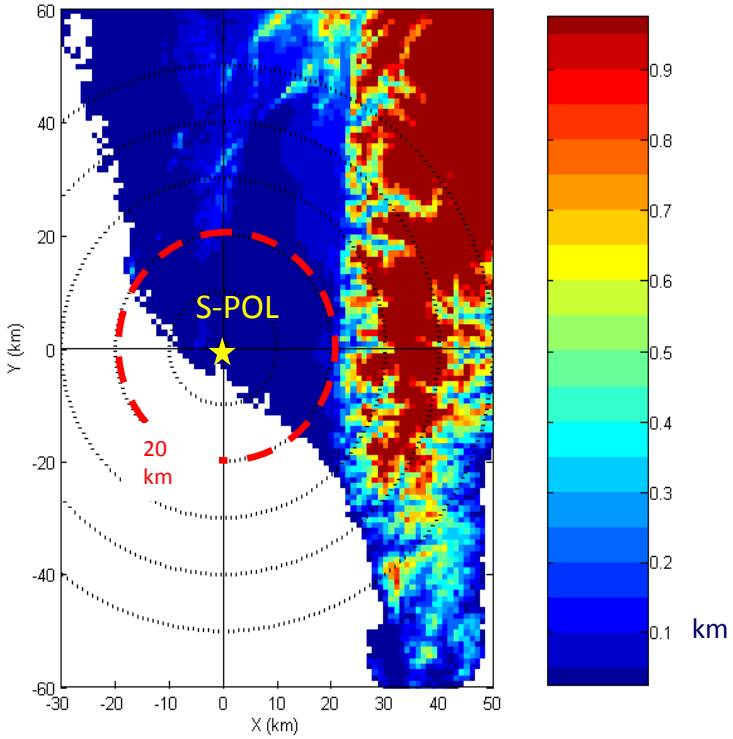
$$\Delta\phi = \phi(t_1) - \phi(t_0) = \frac{4\pi f r}{10^6 c}\int_0^r [N(x,y,z,t_1) - N(x,y,z,t_0)]dr'$$



Ground Target Identification : "Fixed, Reliable"

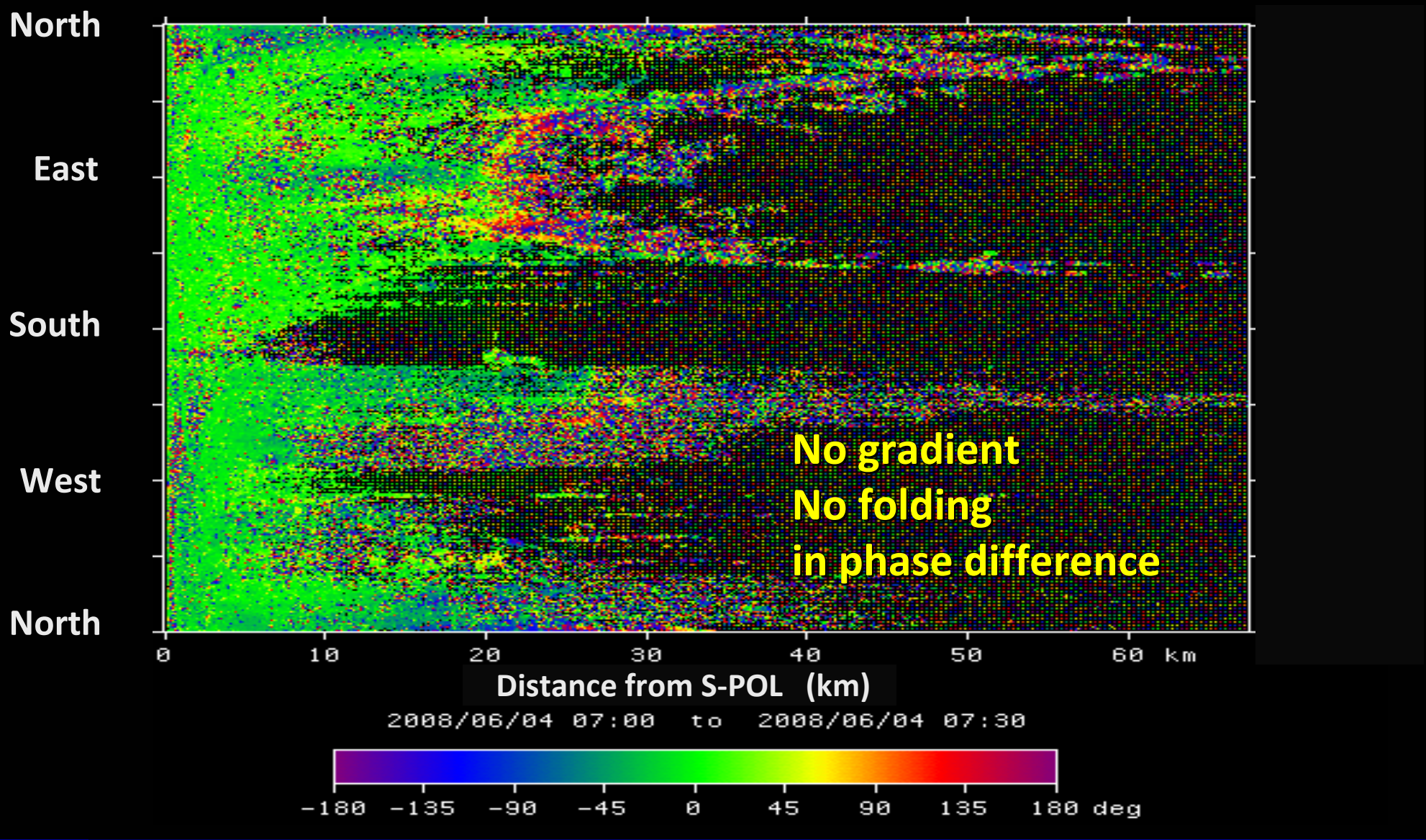
- Clear day with a steady wind to help factor out moving targets such as trees and wind turbines
- 0030 – 0131 UTC, 9 June 25 files





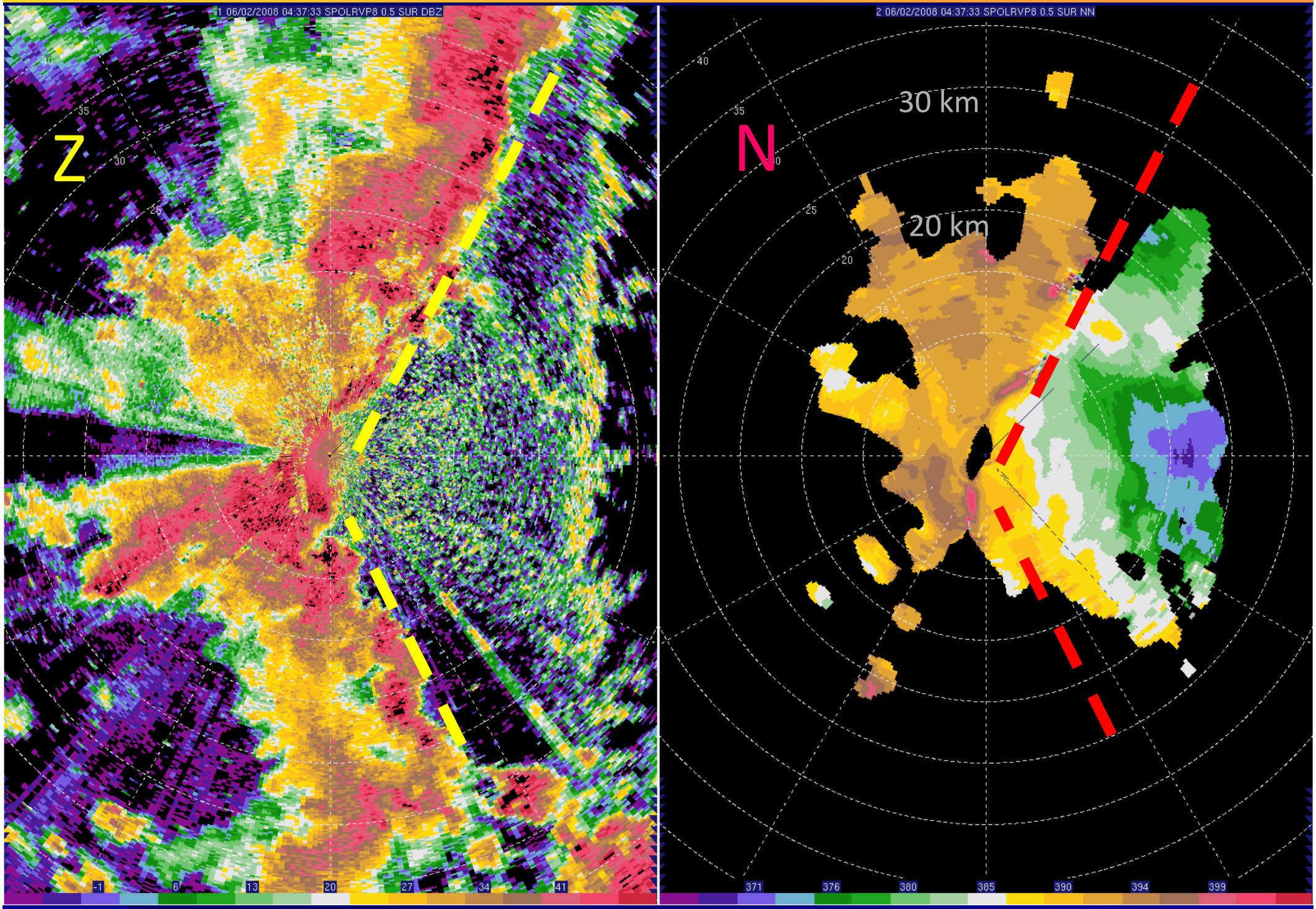
Calibration (Reference) data

- Moisture condition is spatially near homogeneous
- 0700 – 0730 UTC. 4 June

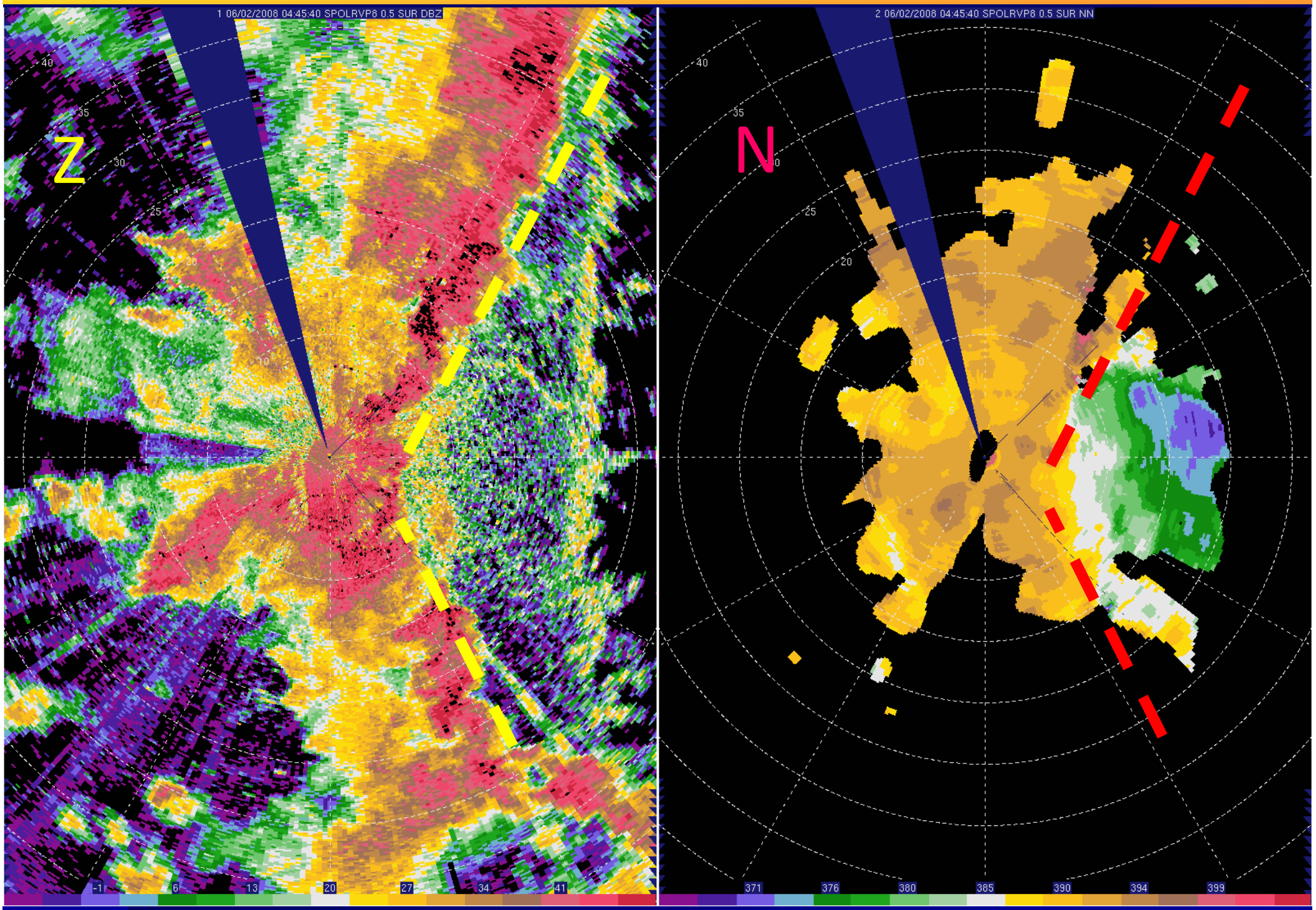


Comparison

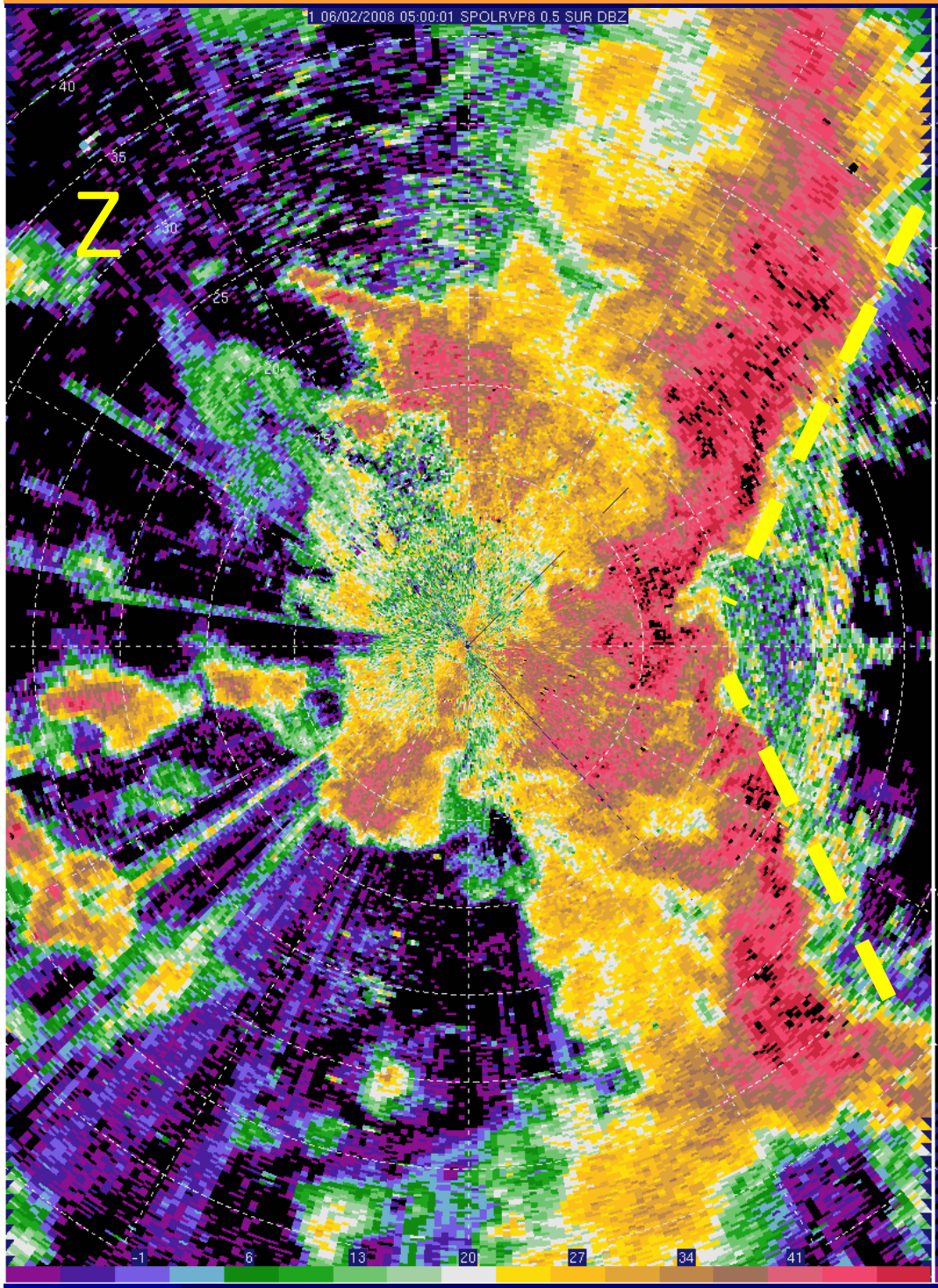
Frontal case : 0437 UTC, June 4

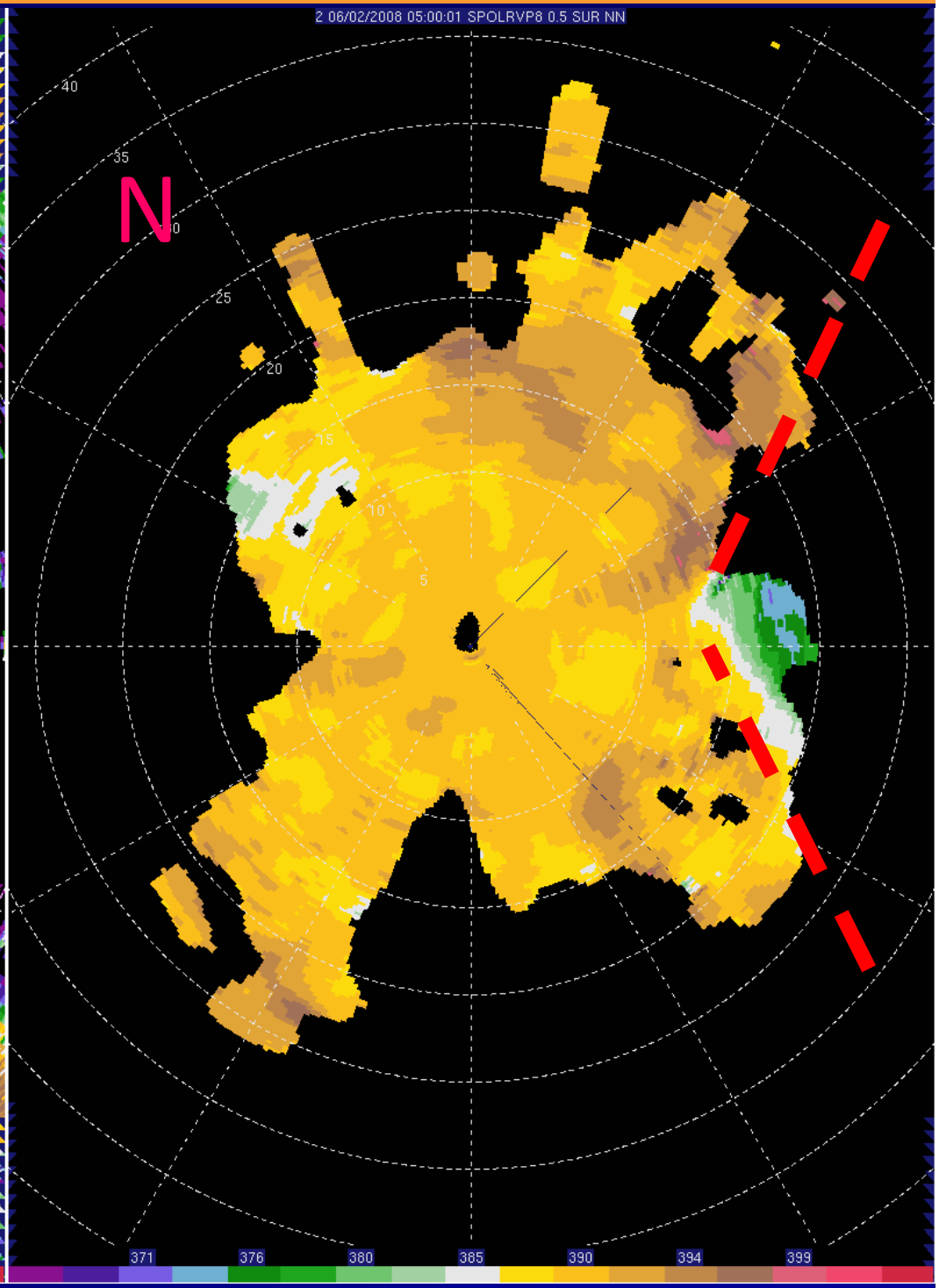


Frontal case : 0445 UTC, June 4

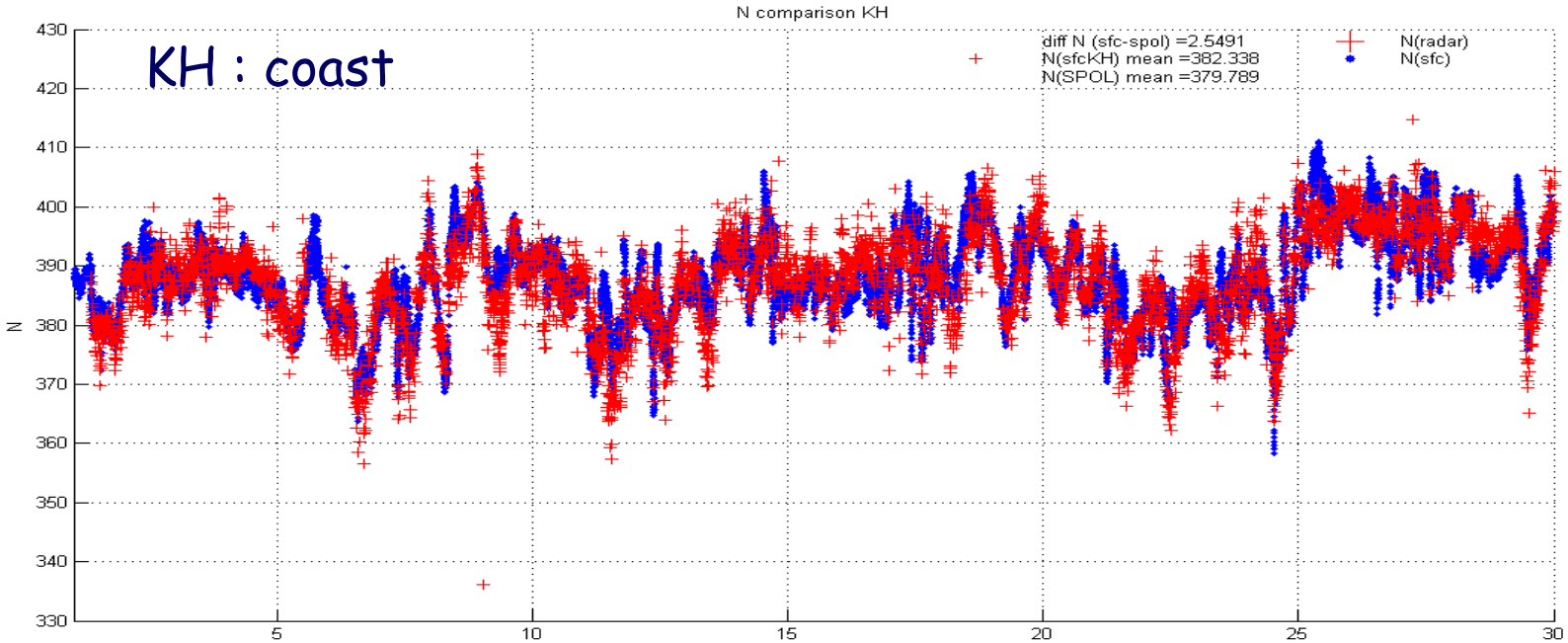


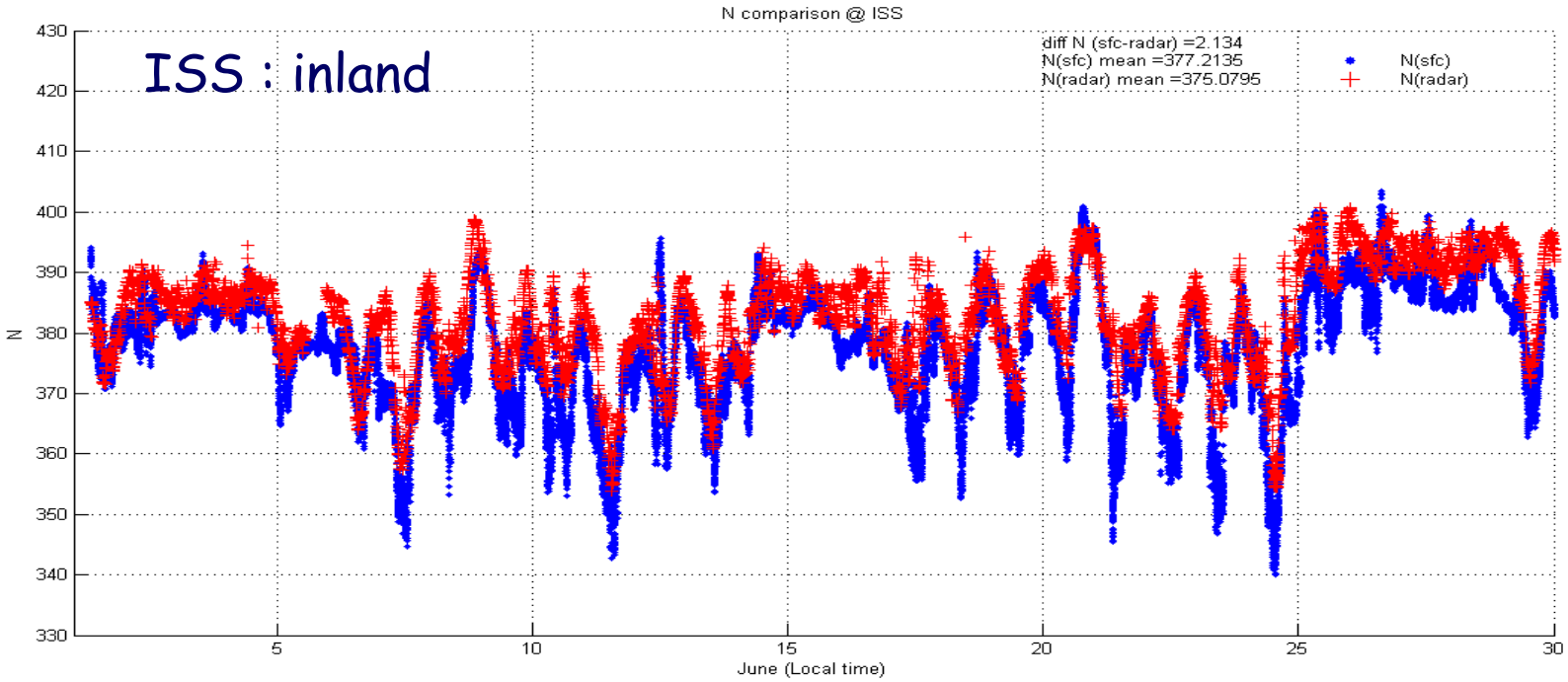
Frontal case : 0500 UTC, June 4

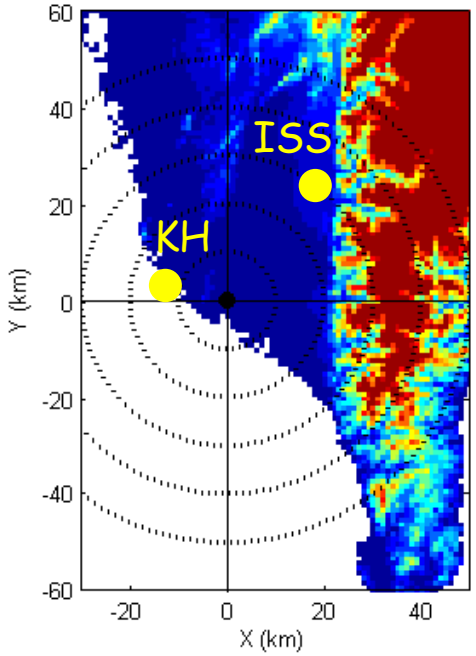




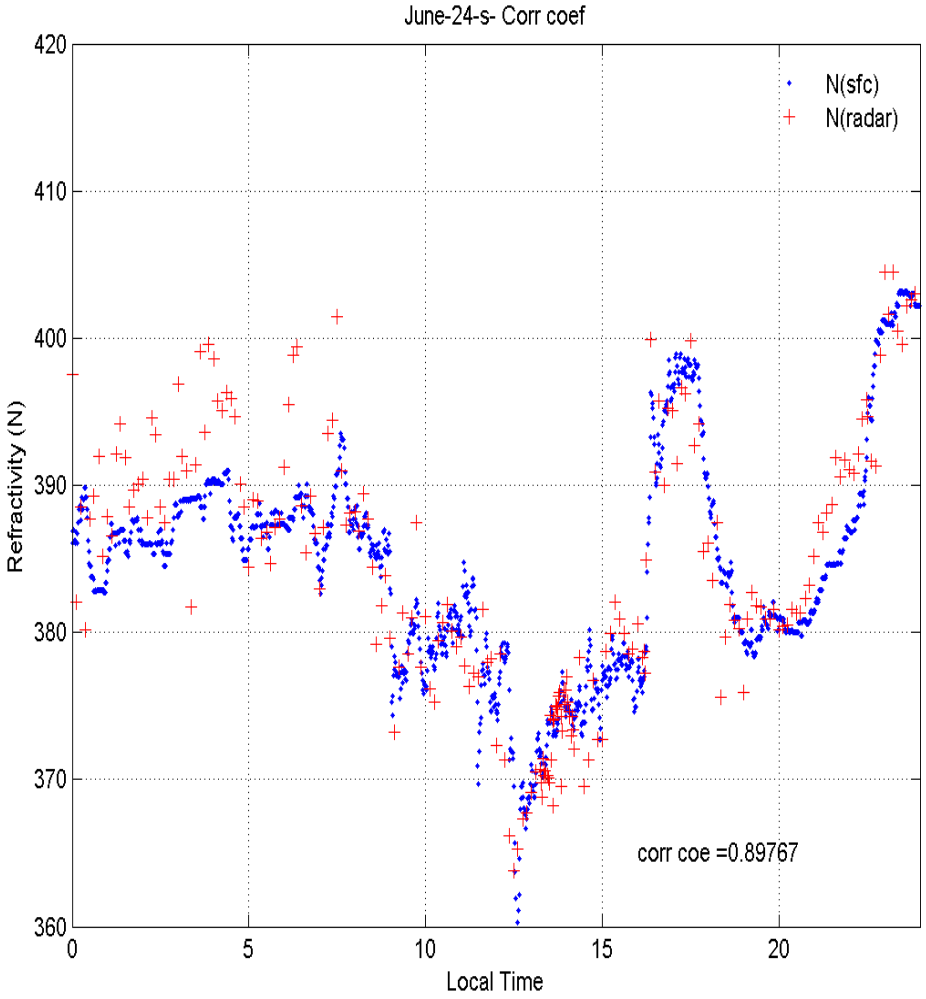
Site by site comparison: KH & ISS

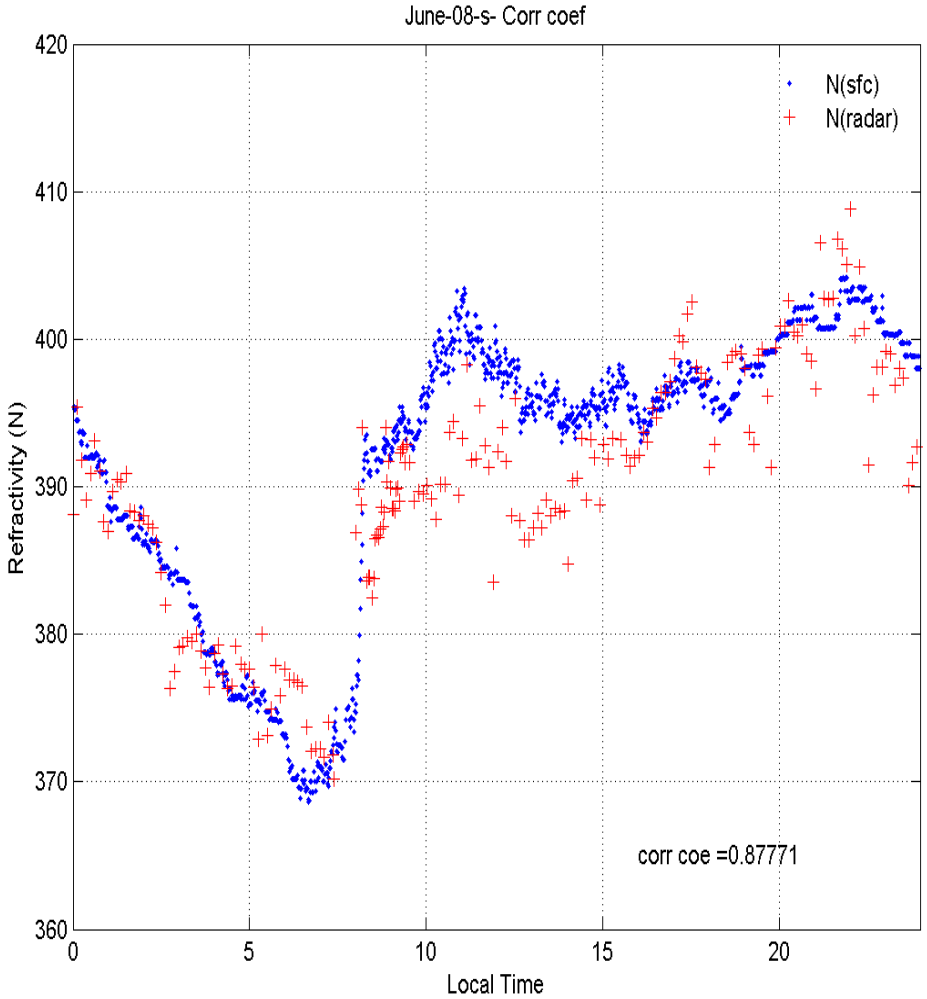




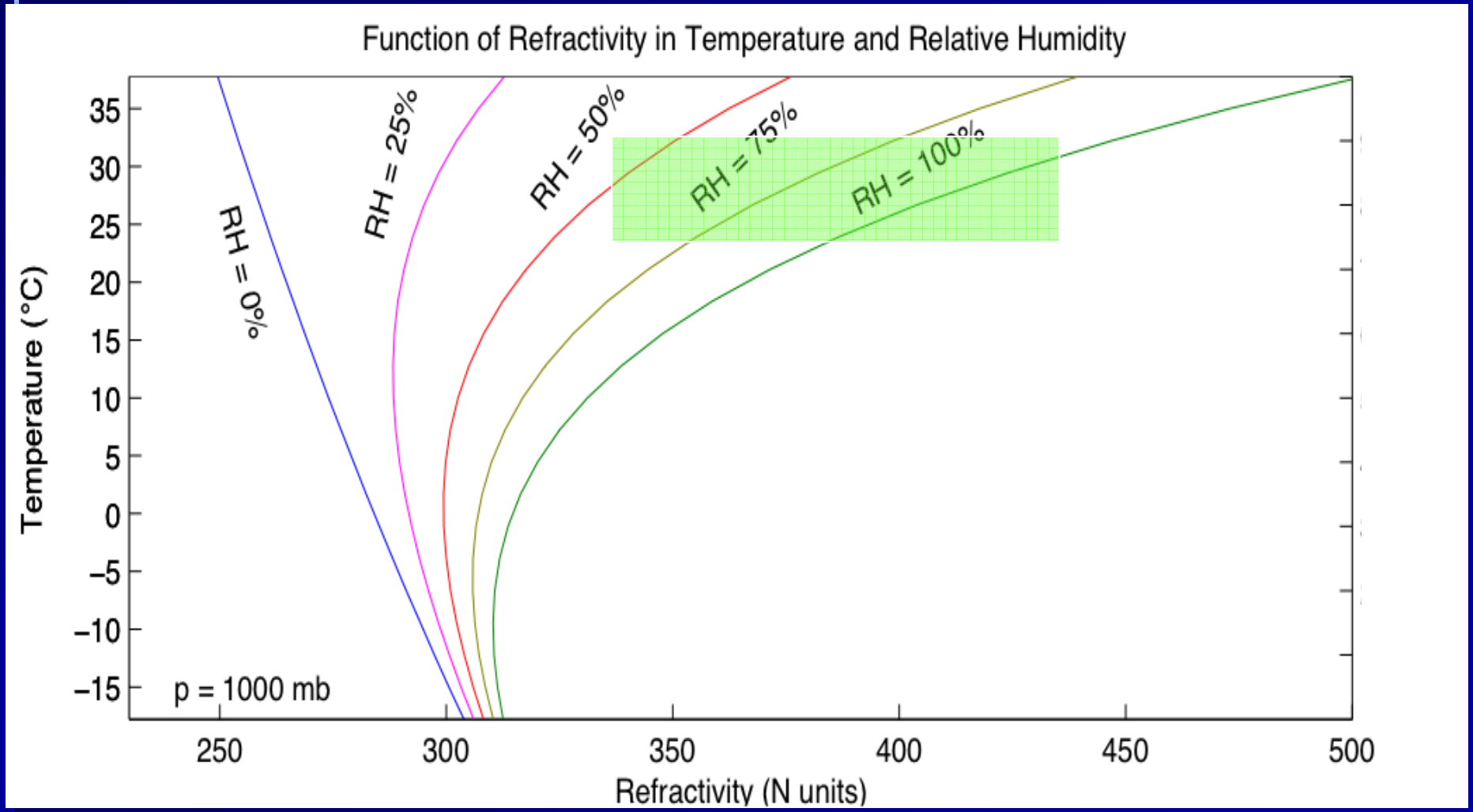


Site by site comparison: KH daily
The trends are consistent. Some Noisy value





As T increase, N is more sensitive to humidity. Humidity dominates more.

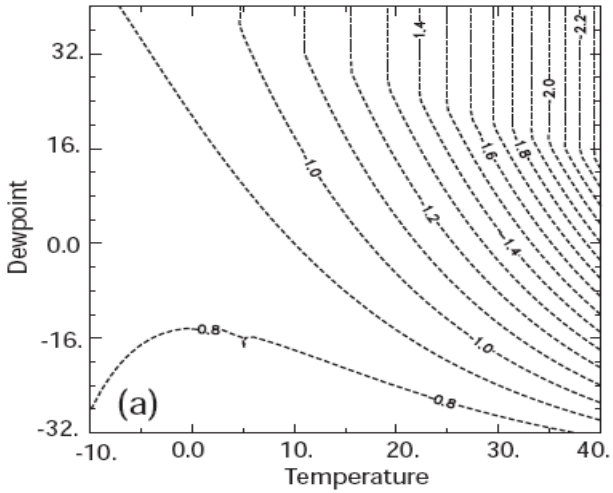


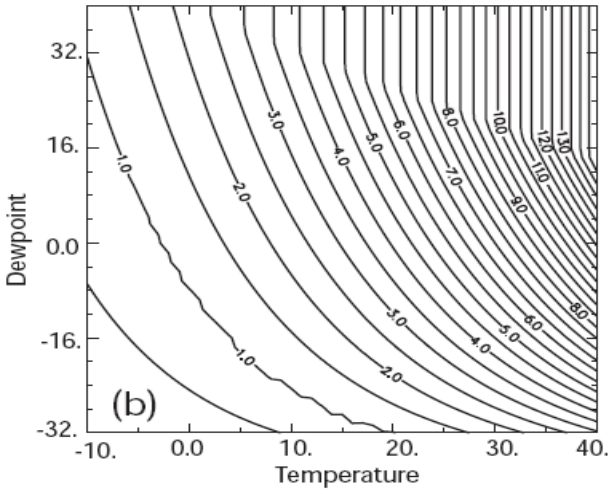
Sensitivity of refractivity to moisture & temperature

$$\delta N = A\delta T + B\delta Td$$

$$\alpha = 17.26, \beta = 35.86(water)$$

$$A \equiv \frac{\partial N}{\partial T} = -\left(\frac{77.6P}{T^2} + \frac{2\times 3.73\times 10^5 e}{T^3}\right) \qquad B \equiv \frac{\partial N}{\partial Td} = \frac{3.73\times 10^5 (273.16-\beta)\alpha e}{T^2 (Td-\beta)^2}$$





(Gao et al., 2007)

Ex: P = 1000 hPa,

T= 25° C, TD =20 ° C, RH ~ 75% A=-1.5, B=6; |B/A|~ 4

TD =25 ° C, RH ~100% , A=-1.8, B=8, |B/A|~ 4.5

T= 30° C, TD = 25 ° C , A= -1.7, B=7.6, |B/A| ~ 4.5

TD = 30 ° C , A= -2, B=9.9, |B/A| ~ 5

Summary

- The refractivity fields during SOWMEX/TIMREX experiment have been retrieved and compared with surface observation stations.
  - Consistent trends, little noisy values
  - Area limited
  - Spatial trend of refractivity
- Due to the Environment in Taiwan,
  - Due to High value of humidity and temperature:
    - N : 350~420 (units) greater than other experiments.
    - N is more sensitive to humidity.