Concordiasi : A Project Dedicated to the Atmosphere over Antarctica

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Outline

Overview of the project

Stratospheric measurements

Driftsondes and dropsondes

Validating model and satellite retrievals

Model performance and impact of dropsondes

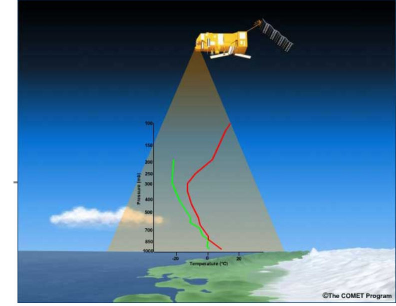
Tracer assimilation

Snow modelling

Summary and Plans

Overview of the project

Concordiasi = CONCORDIA-IASI



A French-US initiative for climate / meteorology over Antarctica and at global scale

Improve the use of space-borne atmospheric sounders over polar regions, in particular "IASI" on board MetOp

Benefit from the continental French-Italian station "Concordia"

Concordiasi: the international team

Participating Institutes:

- CNES, CNRS (LMD, LGGE, LA), Météo-France
- NSF, Purdue University, NCAR, University of Colorado, University of Wyoming
- Alfred Wegener Institute, UK Met Office
- Polar institutes: IPEV, PNRA, USAP, BAS
- ECMWF, BSRN

Collaborating institutes:

- NWP centres, NRL, NASA/GMAO, UCLA, ….

- **Overview of Concordiasi: "The Concordiasi project in Antarctica"**
  Rabier et al, Bulletin of the American Meteorological Society, January 2010.
  Soon to come, first results in a BAMS meeting summary, 2012.

- **Website www.cnrm.meteo.fr/concordiasi/**

Part of the THORPEX-IPY cluster

Concordia
and Dumont d'Urville
Additional
Regular
radiosoundings

Concordia
Frequent
radiosoundings
and instrumented tower

Antarctic area
Stratospheric
super−pressure balloons

Soundings at Concordia, Dumont d'Urville and Rothera

Flight level instruments
- meteorological sensors
- ozone sensors
- particle counter
- GPS receivers

Dropsondes

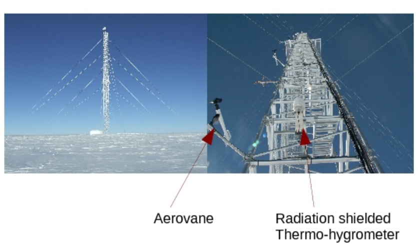
2008	2009	2010	2011

Preliminary Data Assimilation studies
Instrument preparation

IASI retrievals at Concordia
Boundary layer studies
Instrument preparation

Targeting dropsondes

IASI retrievals at dropsonde locations
Evaluation of chemical transport models
Scientific studies based on stratospheric data
Data Assimilation studies using balloon data
Validation of satellite data assimilation using dropsonde data



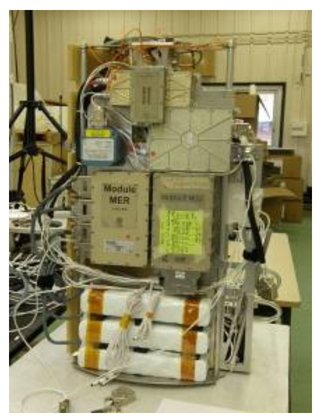
Scientific instruments – payload module

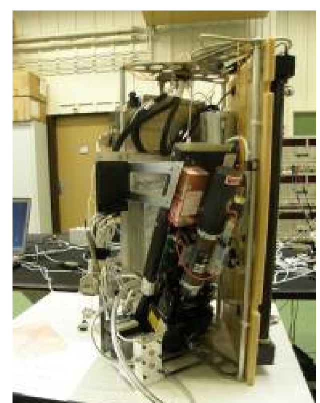
Versatile Payload gondola

A standard versatile payload module providing instruments with energy, thermal control, command and data management

It carries up to 3 instruments that must comply with the following overall capabilities:

- Weight ~8 kg
- Mean power ~10 w
- Daily Mean data rate ~1MByte





Flight control / data transfer

ROC instrument monitoring
Purdue U., W. Lafayette, In.

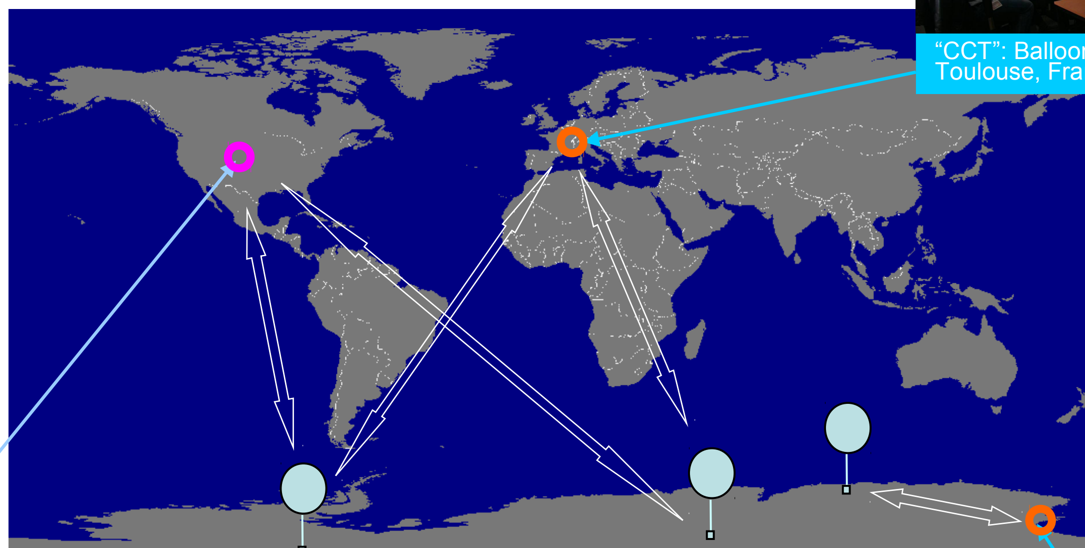
Driftsonde Mission center
Météo-France, Toulouse F.

LMDOz and TSEN
instruments monitoring
CNRS_LMD, Palaiseau, F.

"CCT": Balloon Flight Control Center
Toulouse, France

WPC instrument monitoring
U. Wyoming, Laramie, Wy.

UCOz instrument monitoring
U. Colorado, Boulder Co.



Driftsonde control center
NCAR, Boulder Colorado
USA

"CCL" Launch Control Center
McMurdo Station Antarctica

Balloon Control Centers: flight control of the gondola, instrument control and data download

Driftsonde control center: DS payload monitoring and dropsonde data download

WEB based data exchange

Iridium link

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Presentation outline

Super Pressure Balloon

Concept

Mission

Technical challenges

- **Balloon**
- **Infrastructure and launch process**
- **On board systems**
- **Flight monitoring and control**
- **Rapid distribution of scientific data**

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Scientific investigators

Measurement plan

➡ Launch campaign

Flight overview

Driftsondes

In situ measurement

- **1 – Ozone destruction**
- **2 – Ozone depletion/replenishment**
- **3 – Stratospheric Dynamics - waves**

Experiment

- **Atmospheric sounding through GPS occultation**

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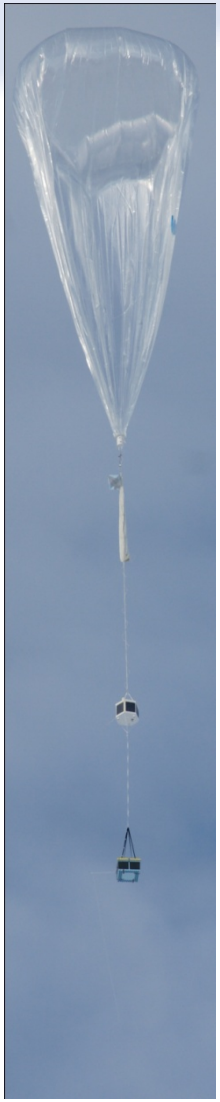
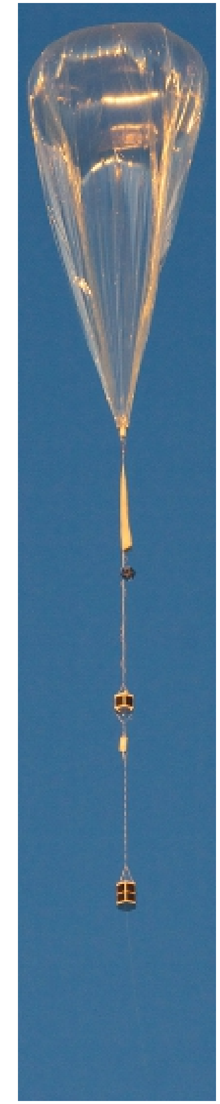
Measurement plan

19 SPB flights



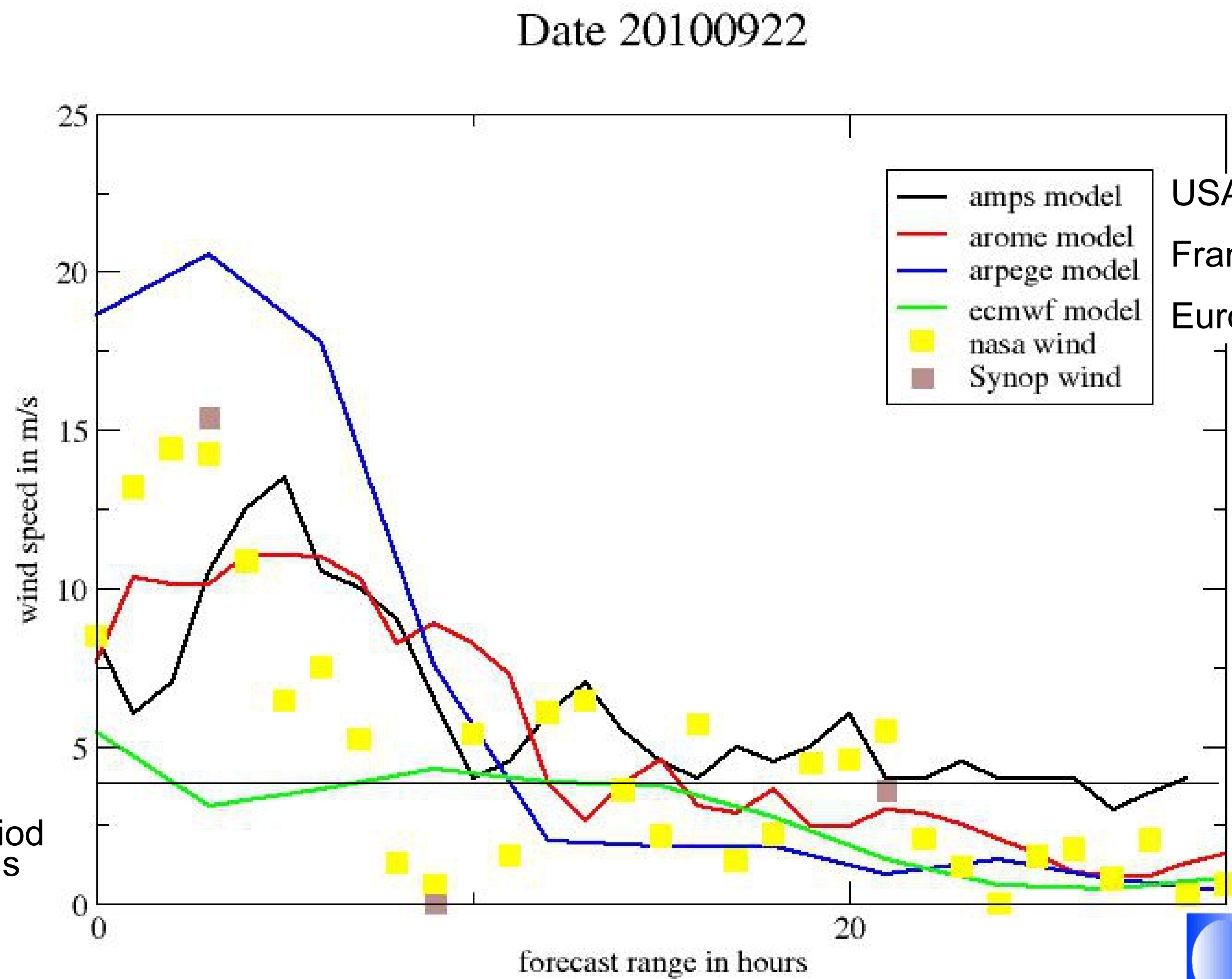
SPB Flight #	Driftsonde fitted with ~50 dropsondes	*In-situ measurements*			GPS Radio Occultation
		Meteo sensors	Ozone Concentration	PSC aerosols	
MSD01	x	x			
MSD02	x	x			
MSD03	x	x			
MSD04	x	x			
MSD05	x	x			
MSD06	x	x			
MSD07	x	x			
MSD08	x	x			
MSD09	x	x			
MSD10	x	x			
MSD11	x	x			
MSD12	x	x			
MSD13	x	x			
PSC14		x	x	x	
PSC15		x	x	x	
PSC16		x	x	x	
PSC17		x	x	x	
PSC18		x	x		x
PSC19		x	x		x

MSD



PSC

Forecast models in support of the field operations at McMurdo



USA

France

Europe

Operations need a period of low winds (< 4 m/s)

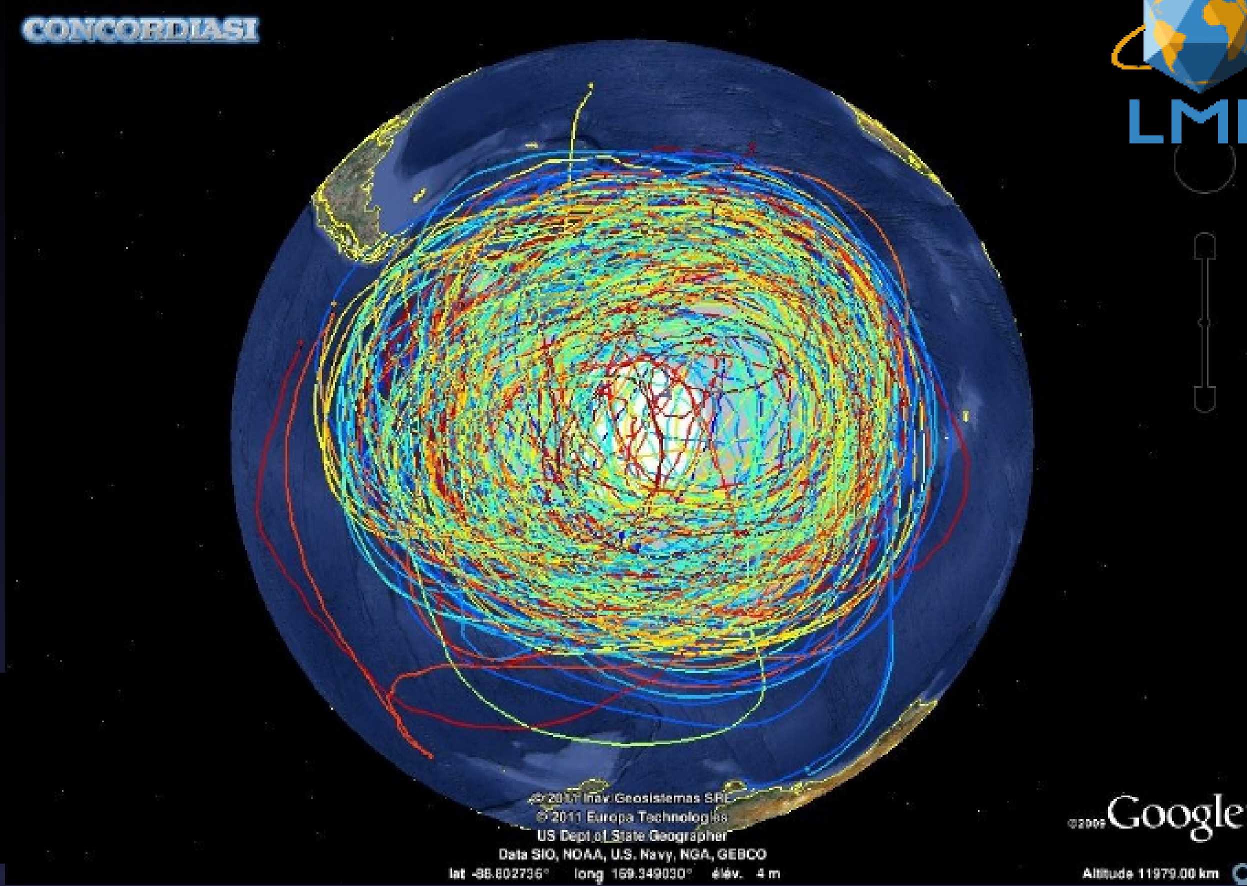
Concordiasi

19 long-duration, superpressure-balloon flights

Sept. 2010- Jan. 2011

Mean duration : 69 days

13 Driftsondes



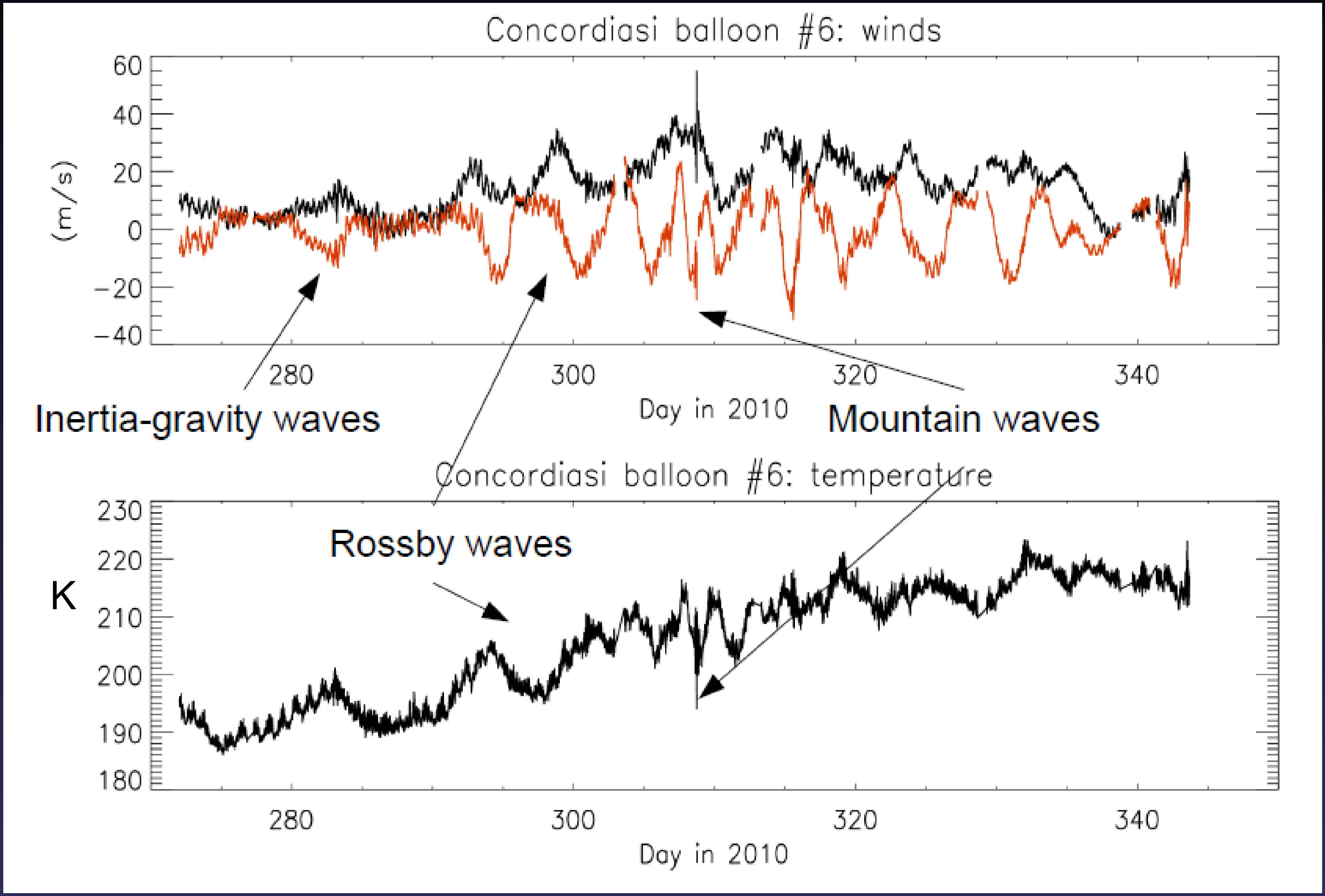
Flight level measurements

- Meteorological obs. every 30 s (> 2.3 Gobs)
  TSEN (LMD) + GPS (ISBA/CNES)
  u, v (0.02 m/s), P (0.1 Pa), T (<0.1/0.3 K)
  → assimilated by operational NWPs
- Ozone obs. every 15 min (6 flights)
  B-Bop (LMD) + UCOz (UCAR)
  lightweight ozone UV photometer
  precision: 20 ppb

- Particle counters (4 flights)
- Radio-occultation measurements (2 flights)

Stratospheric measurements

Some observations

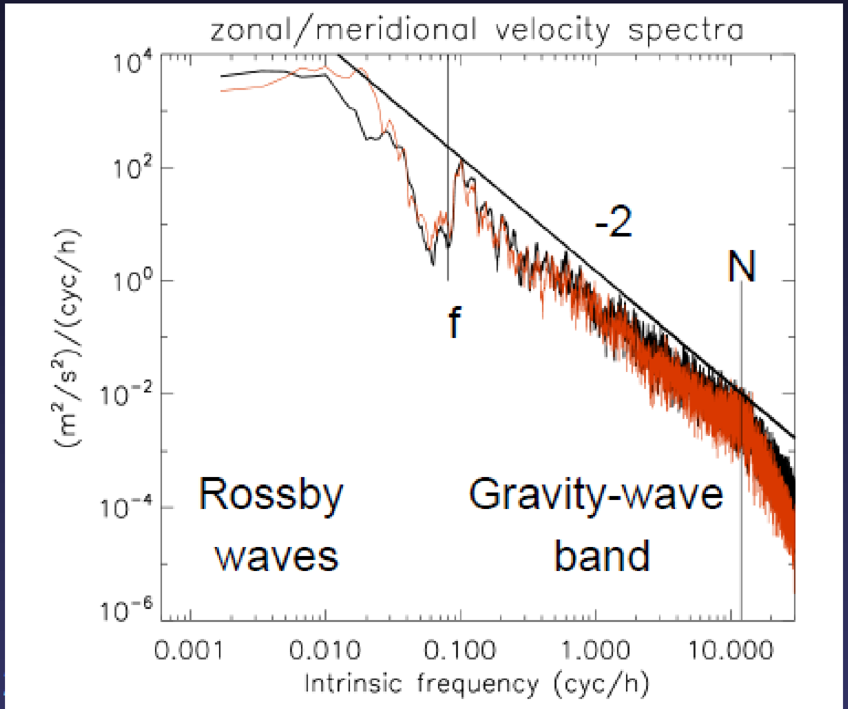


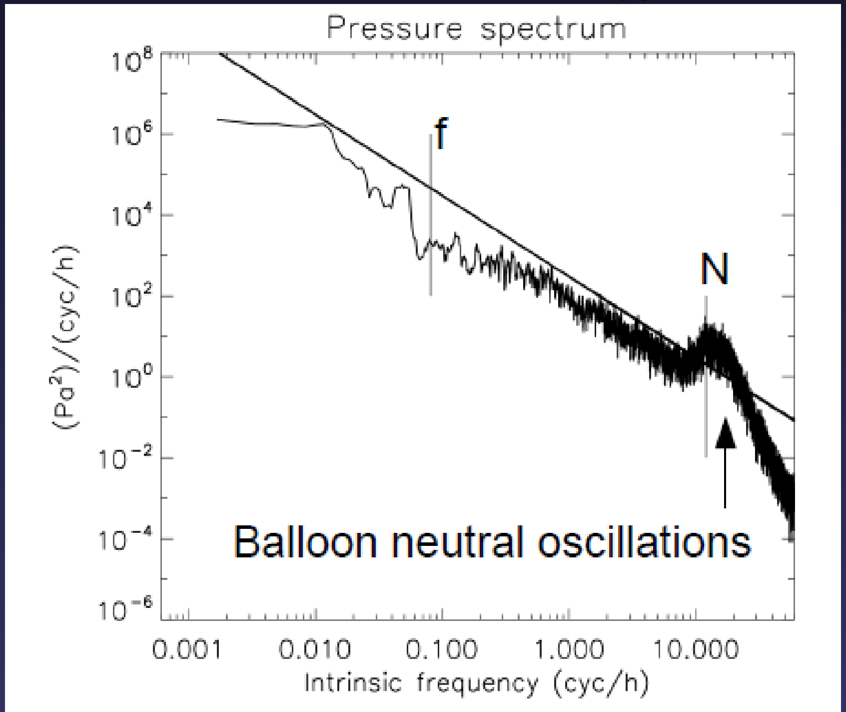
Gravity waves

- Gravity waves play a major role in driving the global Brewer-Dobson circulation in the middle atmosphere, as well as in warming the winter polar stratosphere
  - Parameterized in GCMs → need observations to constrain parameters
  - Observations at global scales are difficult, as well as diagnosing momentum flux

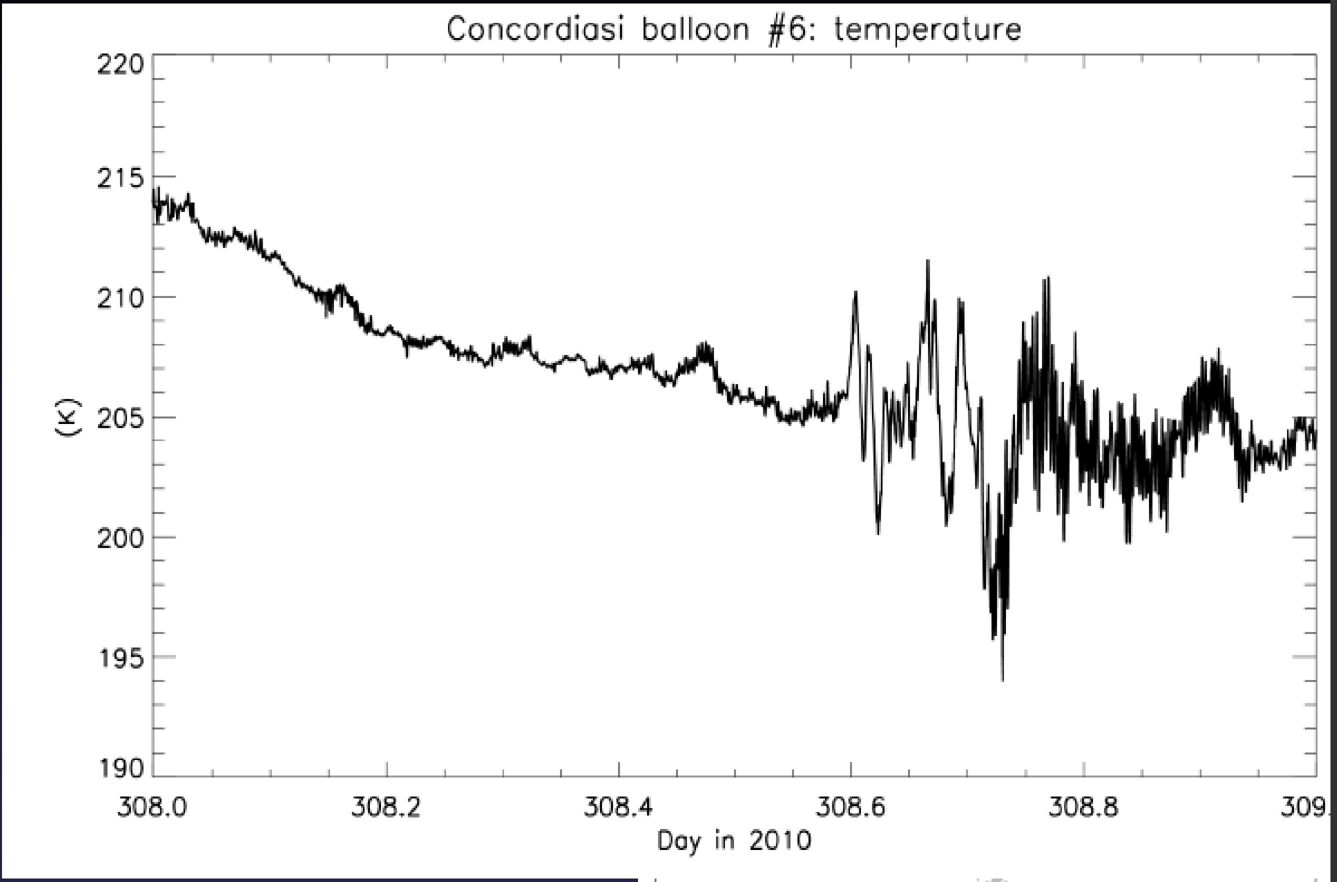
-2

N





Orographic gravity waves

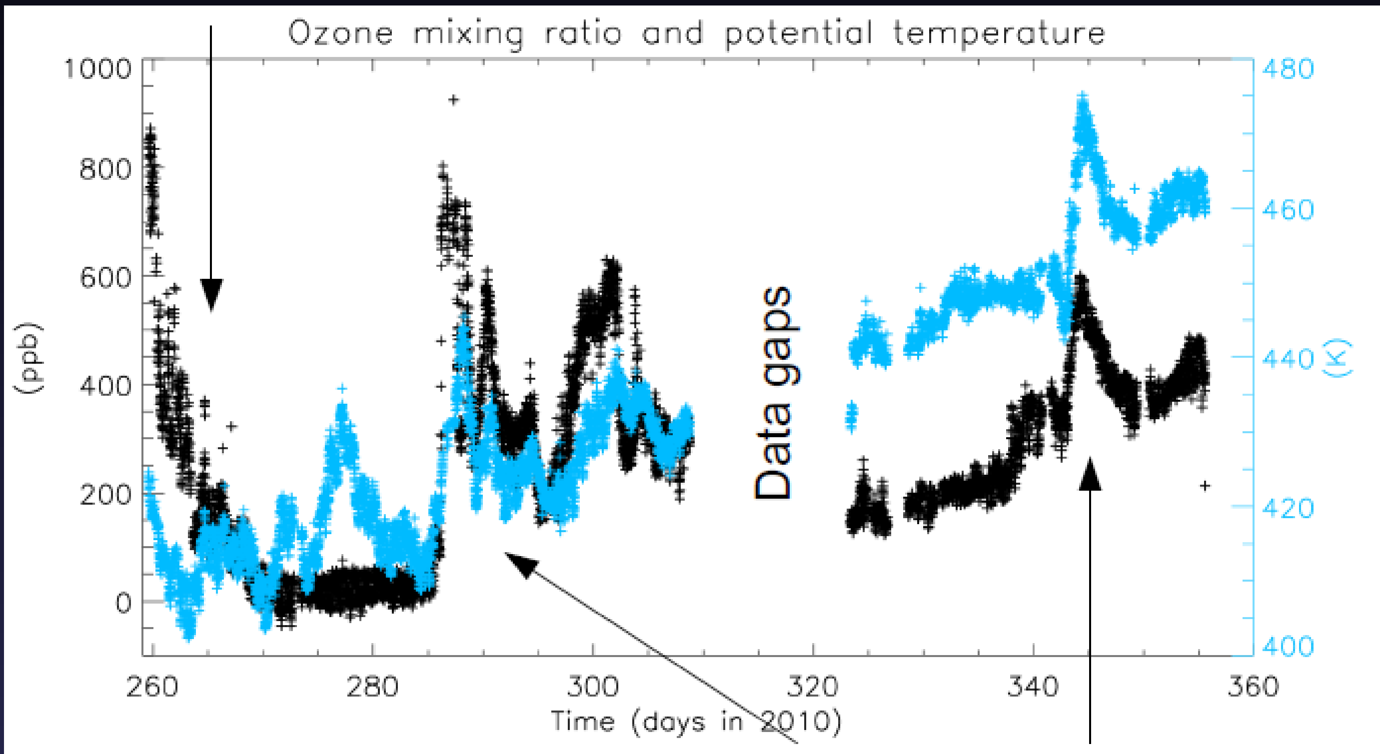


T' ~ 15 K, u' ~ 35 m/s
Vertical displ. 1.5 km
Period of 10 min – 1 hr
→ fully resolved by obs.

Such mountain waves are not only important for dynamics but can also trigger the formation of PSC particles

Ozone observations - PSC14

Chemical depletion



Transport-dominated variations

B-Bop: Balloon-Borne Ozone Photometer

- UV dual beam ozone photometer
- developed for CONCORDIASI campaign
- precision ±20ppb, accuracy 3%
- 5 balloon flights so far

LMD

CONCORDIASI

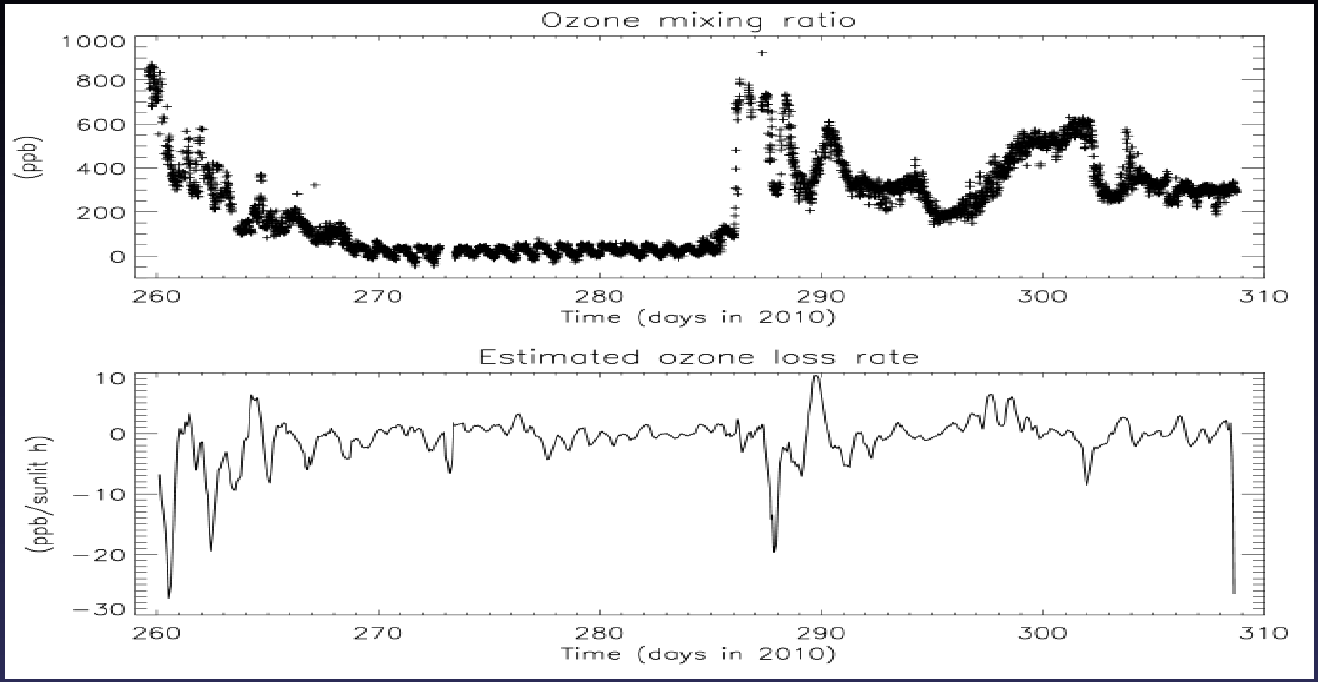
Ozone loss estimates

- Explain the ozone variations due to balloon motions :
  - Project ozone variations on potential temperature (1 day window)

    $X_{O3}(t) = a\,\theta(t) + \varepsilon(t)$
- Explain the residual in terms of ozone loss :

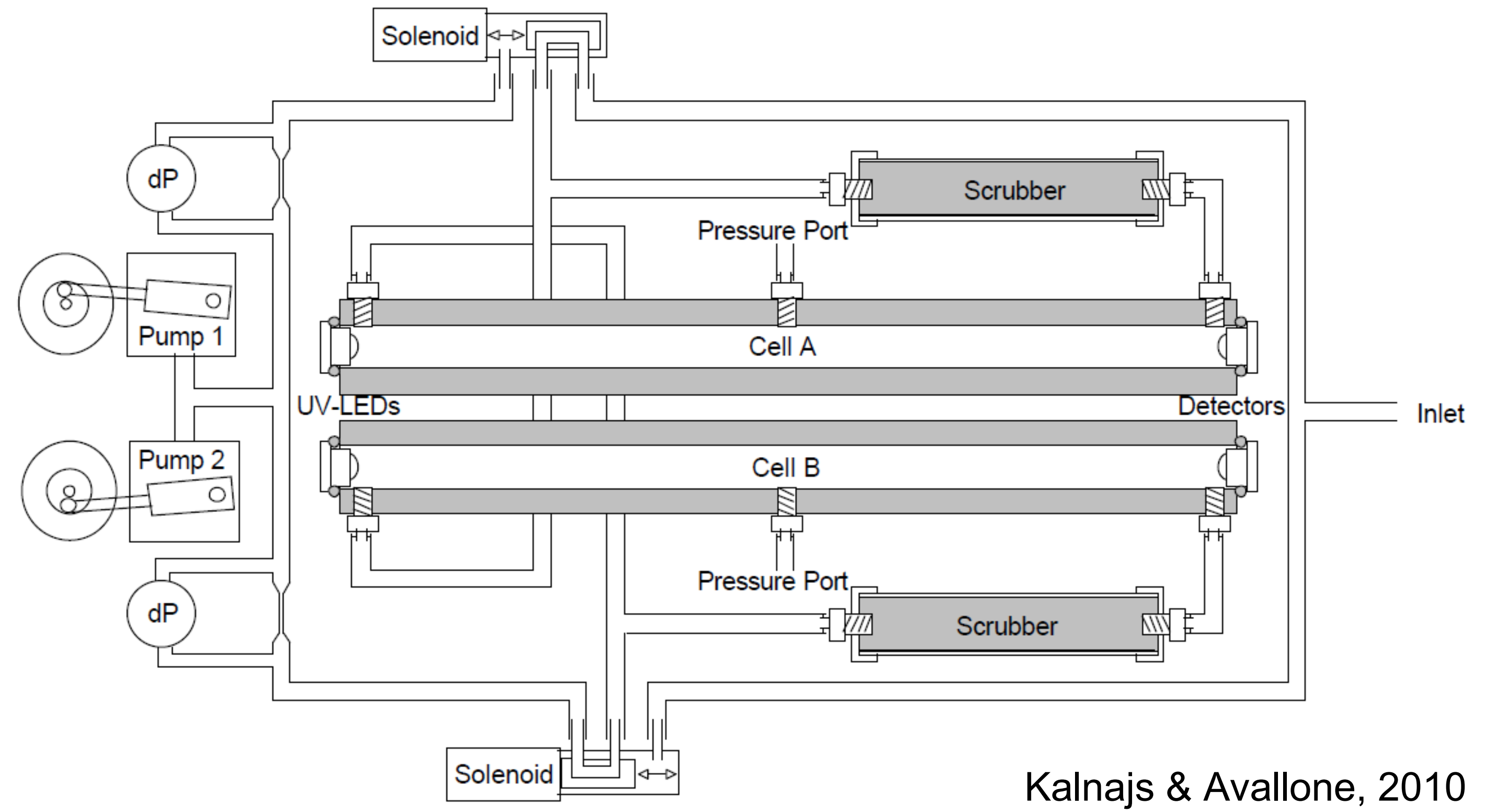
  $\varepsilon(t) = \text{loss}\ .\ t + c(t)$

  express loss in ppb/sunlit hour



Ozone loss generally < 10 ppb/sunlit hour but can reach up to 25 ppb/sunlit hour

UCOz Instrument Design



Kalnajs & Avallone, 2010

- UV absorption at 254 nm – Beer-Lambert Law
- UV-LED light source – low power
- Fully redundant detection and flow system components

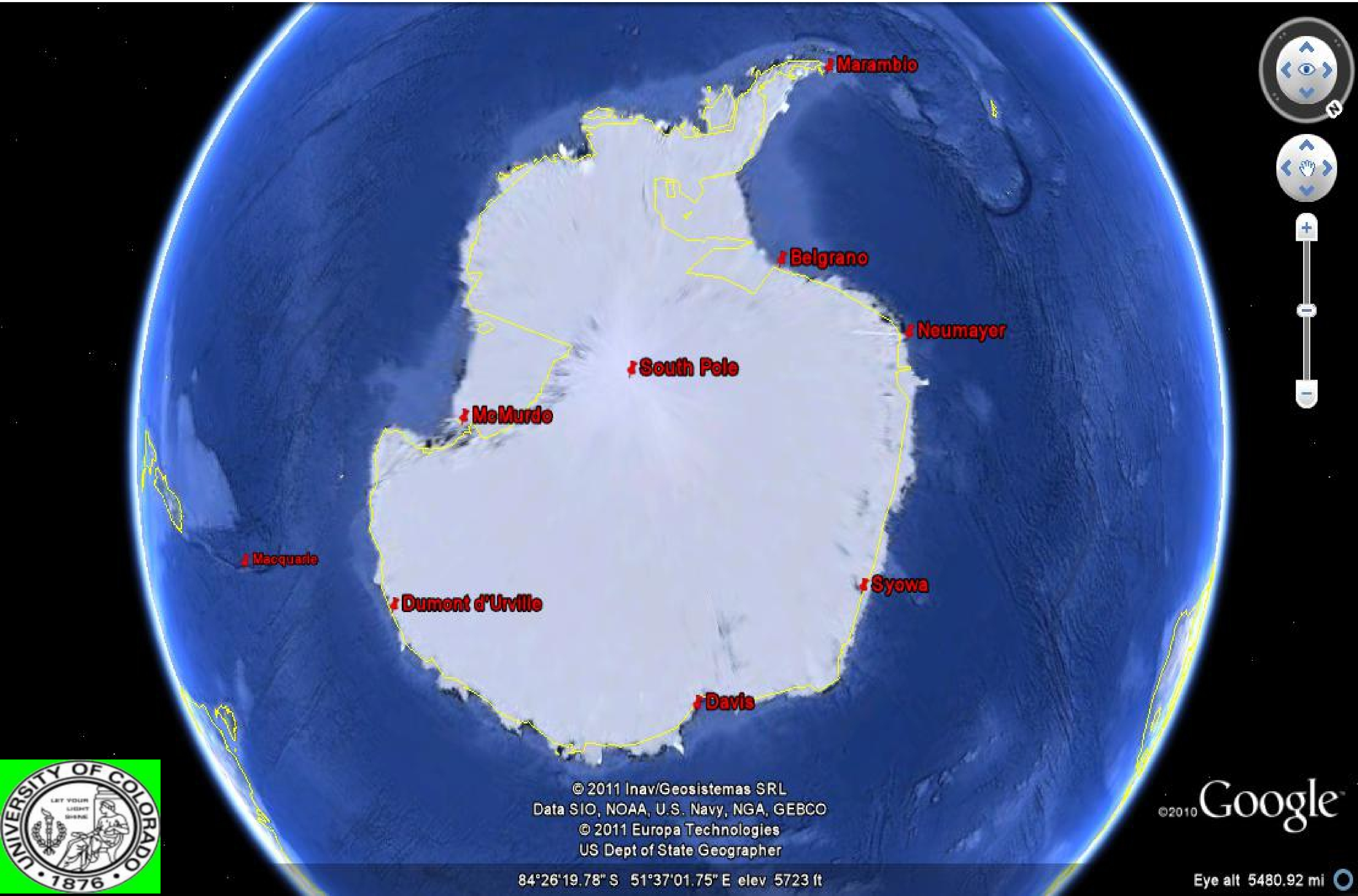
Launch Statistics

Gondola	Payload	Launch Date	Last Data Received	Termination
PSC 16	WPC/UCOz	11 Sep 0300 UT	4 Oct	11 Oct, recovered
PSC 17	WPC/UCOz	14 Sep 0150 UT	15 Oct	10 Dec, recovered
PSC 19	ROC/UCOz	8 Oct 0219 UT	23 Nov	24 Dec

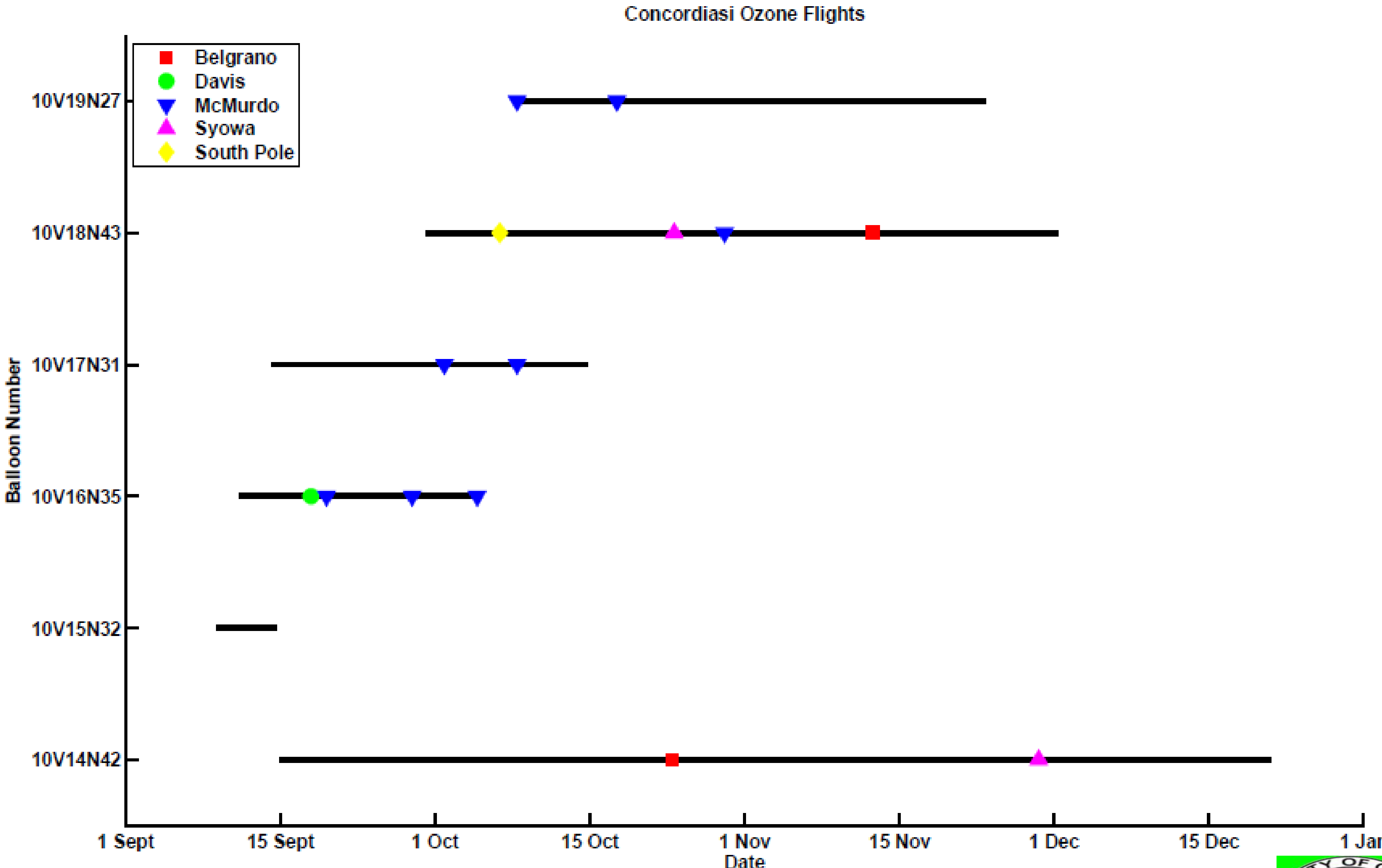
PSC 16, near McMurdo

PSC 17 in Tasmania

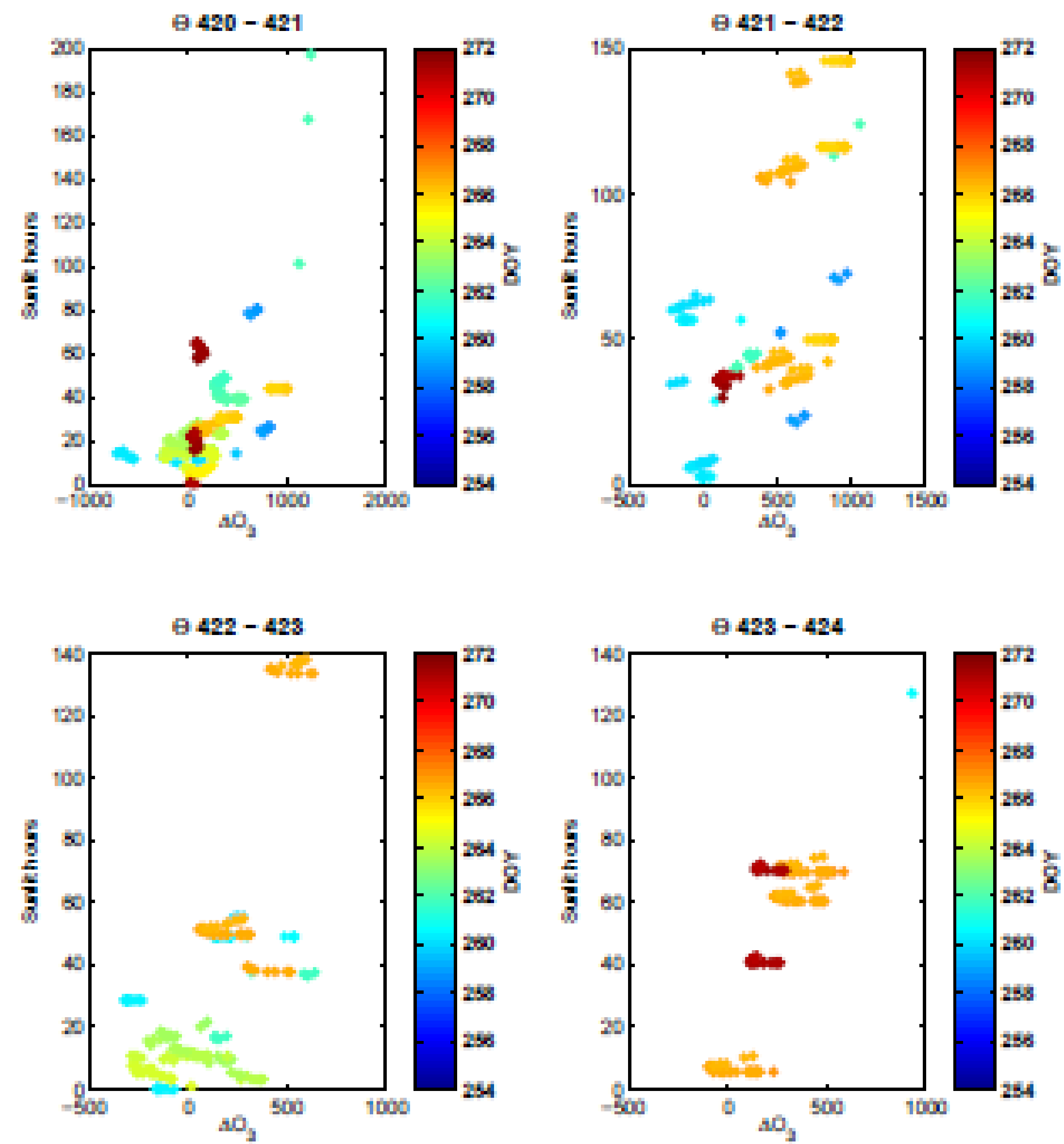
“Match” campaign



"Match" Campaign



PSC 16 Self-Matches: Ozone Loss



Loss rates are 4 – 10 ppb per sunlit hour

Particle Counter

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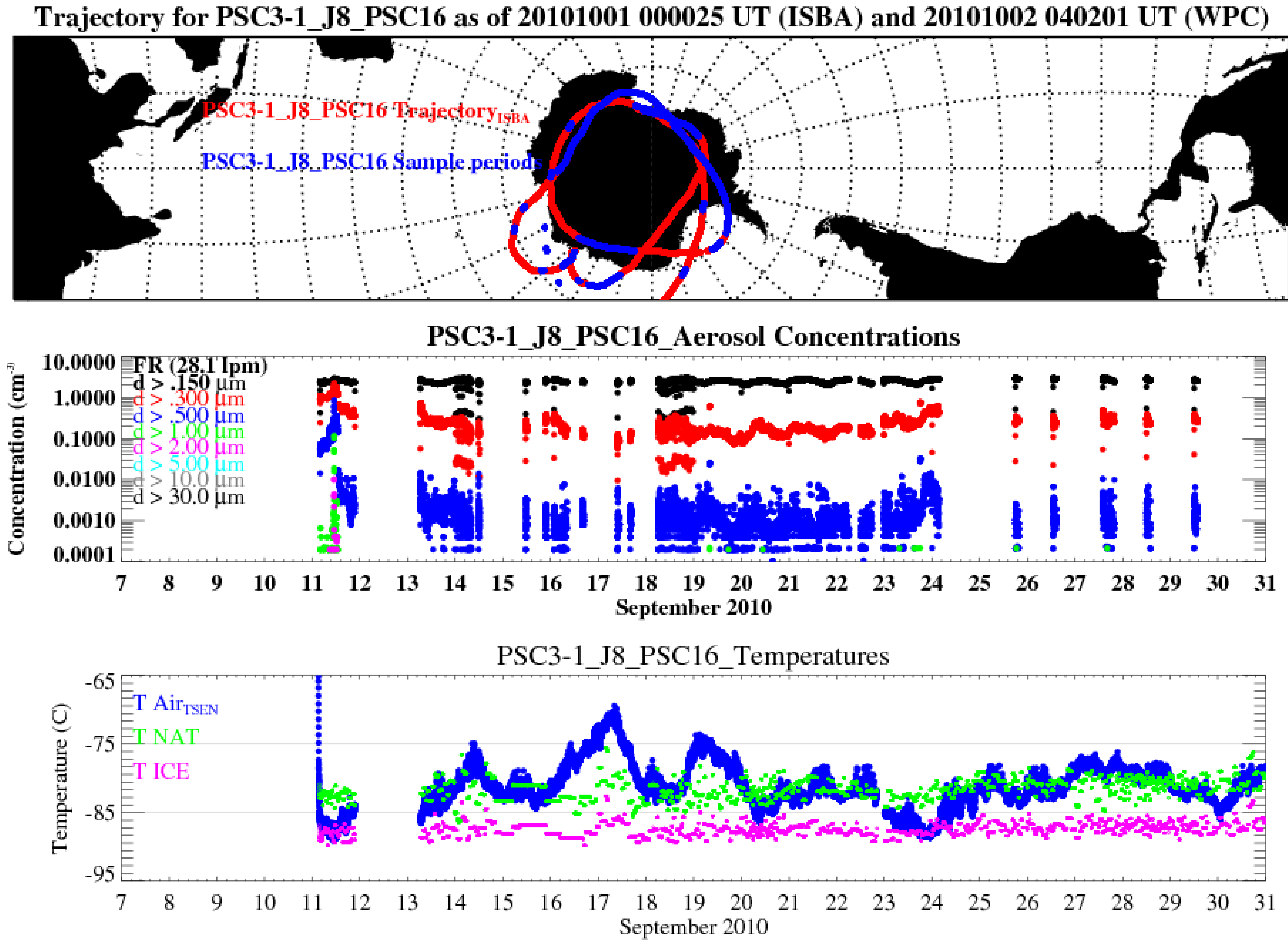
New Thinking


Trajectory for PSC3-1_J8_PSC16 as of 20101001 000025 UT (ISBA) and 20101002 040201 UT (WPC)
PSC3-1_J8_PSC16 Trajectory ISBA
PSC3-1_J8_PSC16 Sample periods
PSC3-1_J8_PSC16_Aerosol Concentrations
Concentration (cm-3)
10.0000
1.0000
0.1000
0.0100
0.0010
0.0001
FR (28.1 lpm)
d > .150 µm
d > .300 µm
d > .500 µm
d > 1.00 µm
d > 2.00 µm
d > 5.00 µm
d > 10.0 µm
d > 30.0 µm
7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31
September 2010
PSC3-1_J8_PSC16_Temperatures
Temperature (C)
-65
-75
-85
-95
T Air TSEN
T NAT
T ICE
7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31
September 2010

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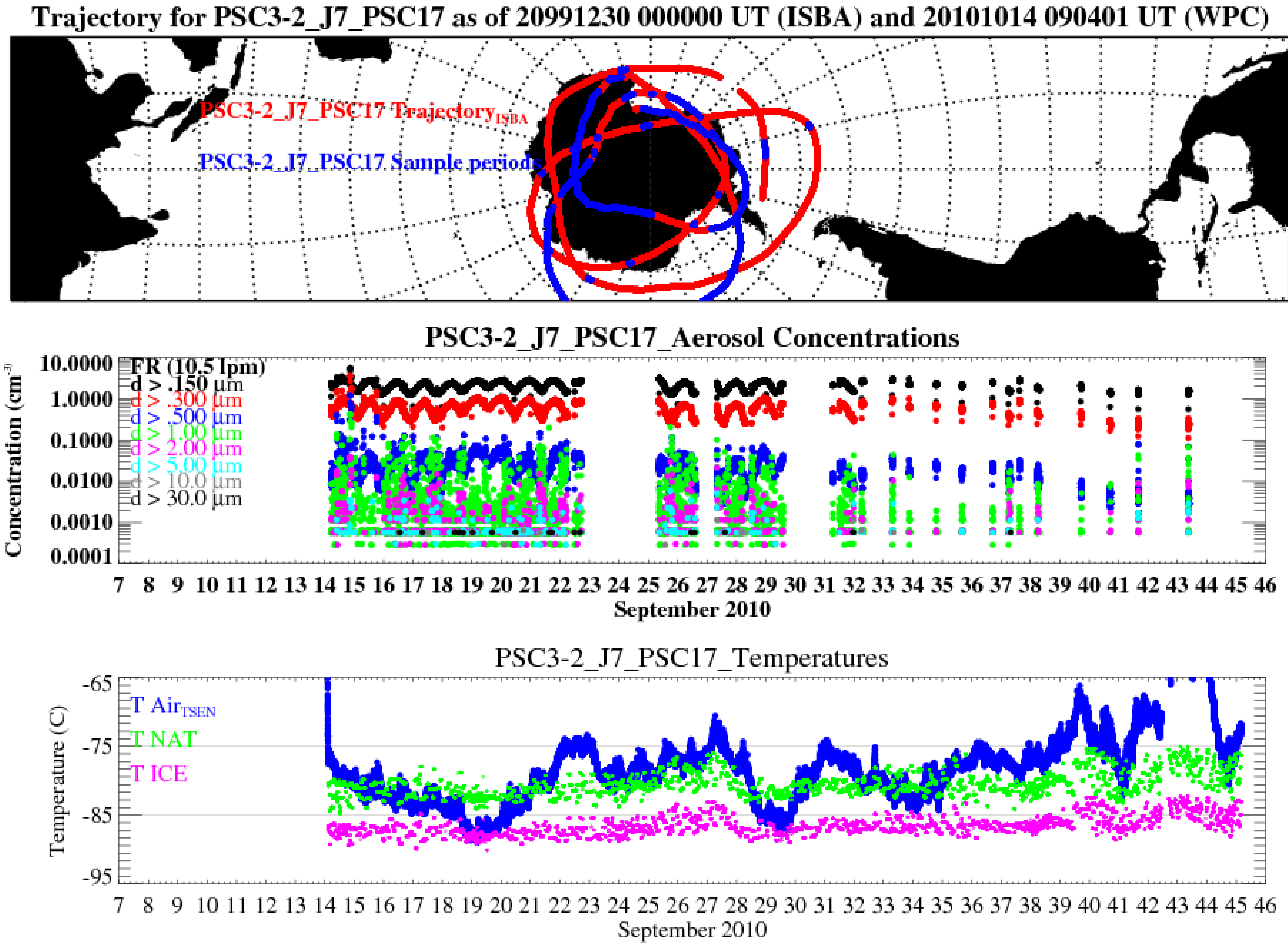

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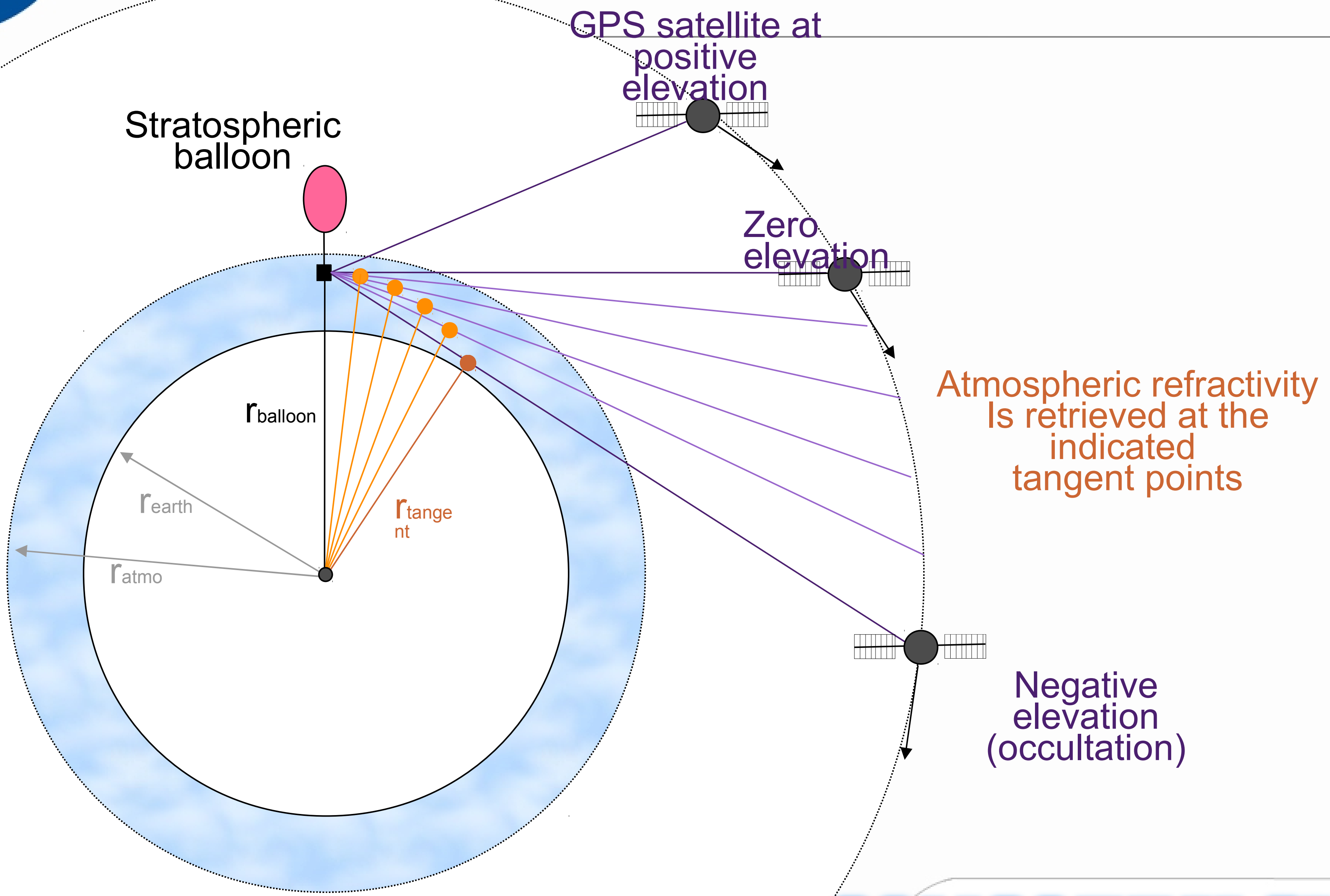
GPS radio-occultation measurements



PURDUE

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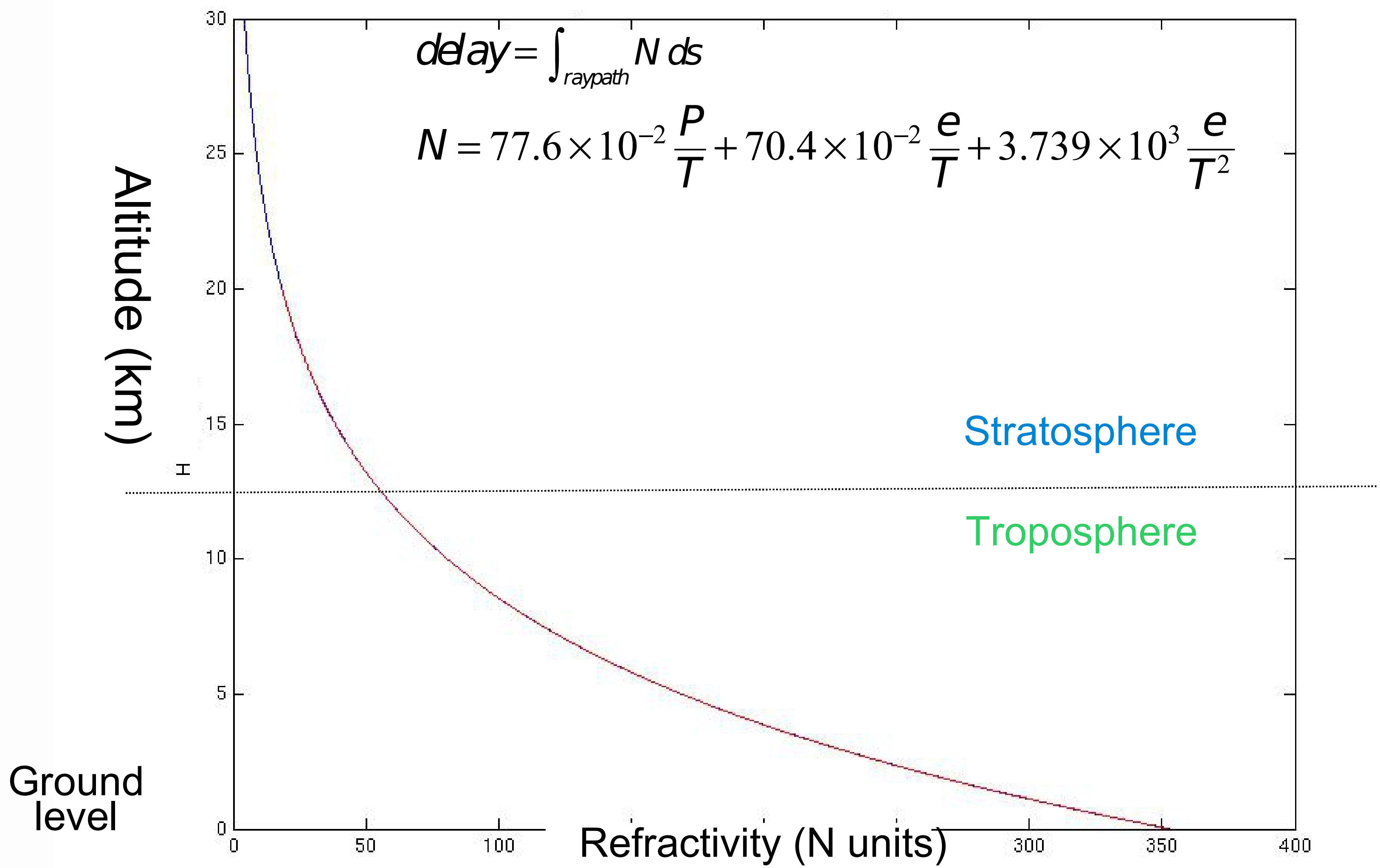
The delay in the GPS signal increases as the line of sight between the balloon and satellite moves lower in the atmosphere



$$delay = \int_{raypath} N \, ds$$

$$N = 77.6 \times 10^{-2} \frac{P}{T} + 70.4 \times 10^{-2} \frac{e}{T} + 3.739 \times 10^{3} \frac{e}{T^2}$$

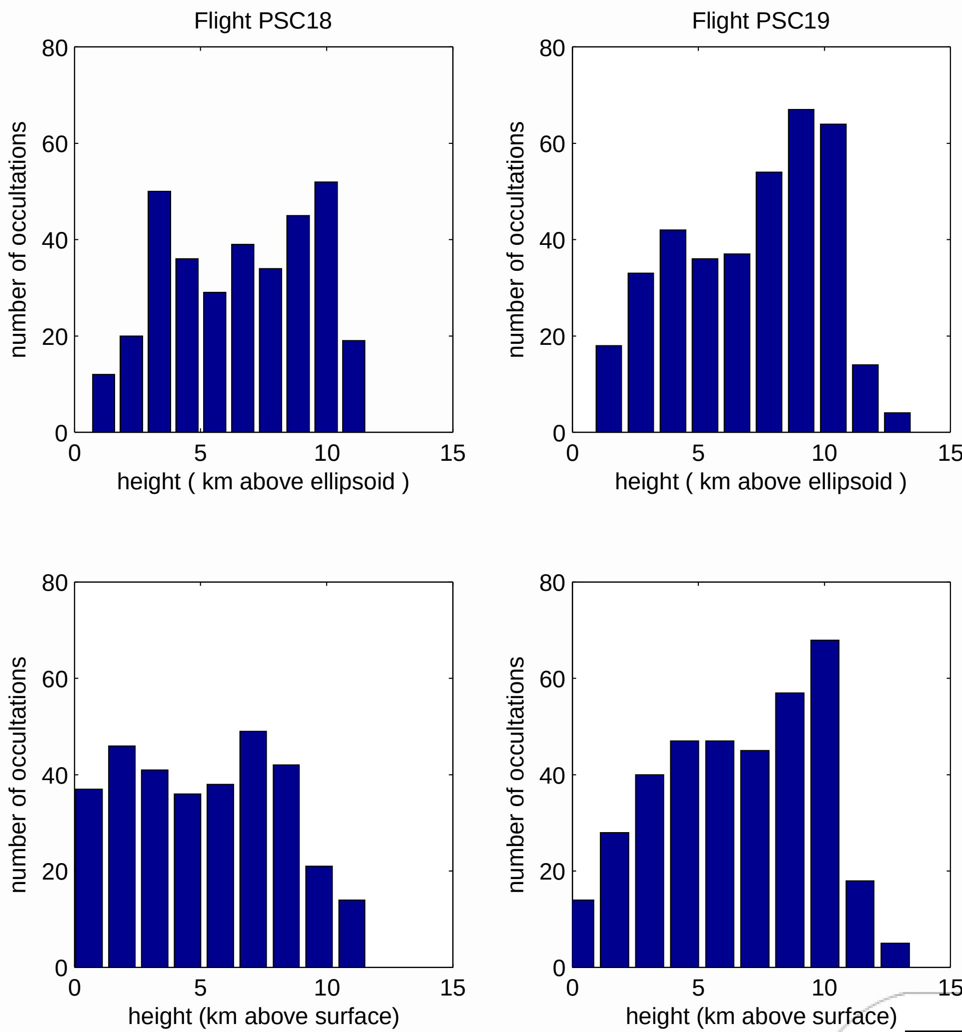
PURDUE

PSC18 and PSC19 flights

Flight - Receiver	PSC18 Receiver 1	PSC18 Receiver 2	PSC19 Receiver 1
Start date	2010-09-29	2010-10-13	2010-10-10
End date	2010-11-29	2010-10-13	2010-11-22
Number of days recorded	54 days	1 day	42 days
Number of complete days	22 days	0	19 days
Median hours for other days	16.3 hours	12 hours	16.0 hours
Number of rising occultations of duration > 7 minutes	155		180
Number of setting occultations of duration > 7 minutes	182		194
Mean rising occultation duration	568 s		569 s
Mean setting occultation duration	571 s		616 s
Average number of occultations per day	6	-	9
% below 4 km absolute height	25%		19%
% within 4km of surface	43%		22%
Total occultations	337		374
Total recording hours	1173 hours		926 hours
Average number of occultations per recording hour	6.9 per 24 hrs		9.7 per 24 hrs

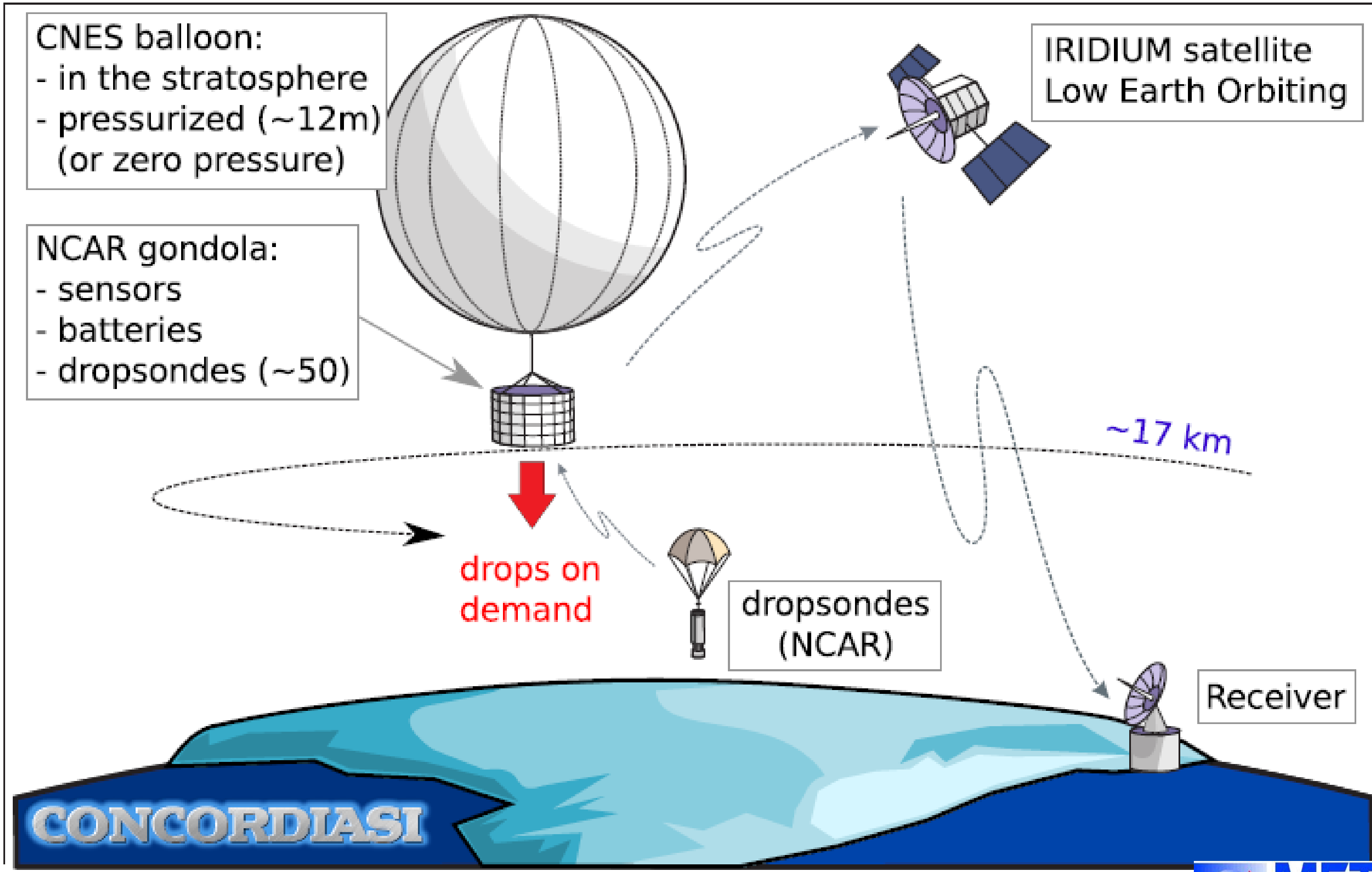
- Total of 711 occultations with duration greater than 7 minutes of continuous data below the horizon
- 687 total dropsondes on 13 balloons

Penetration depth of occultations

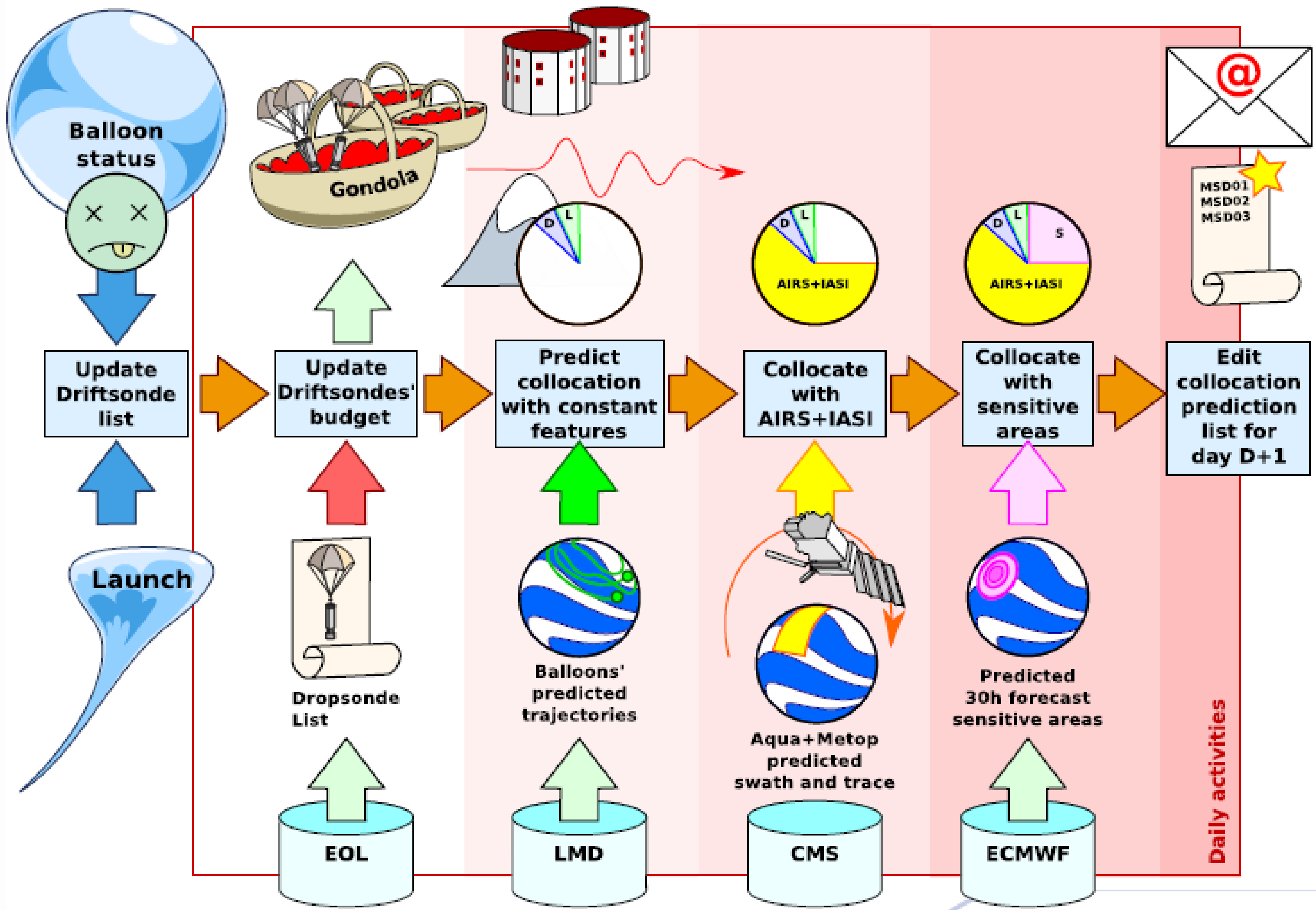


Driftsondes and dropsondes

The Driftsonde system (CNES/NCAR)

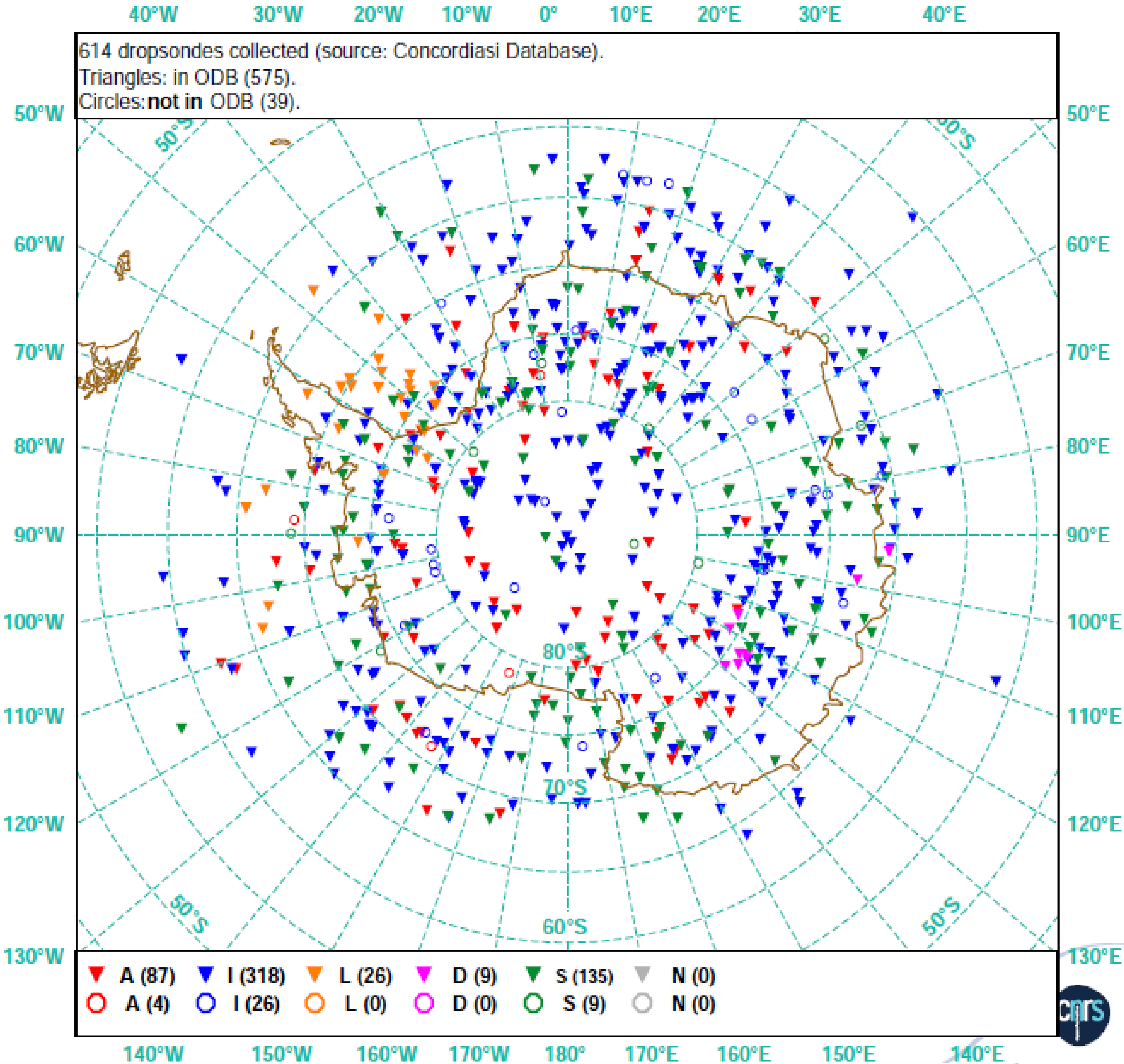


Concordiasi Drop-Sounding Scheduler



NCAR

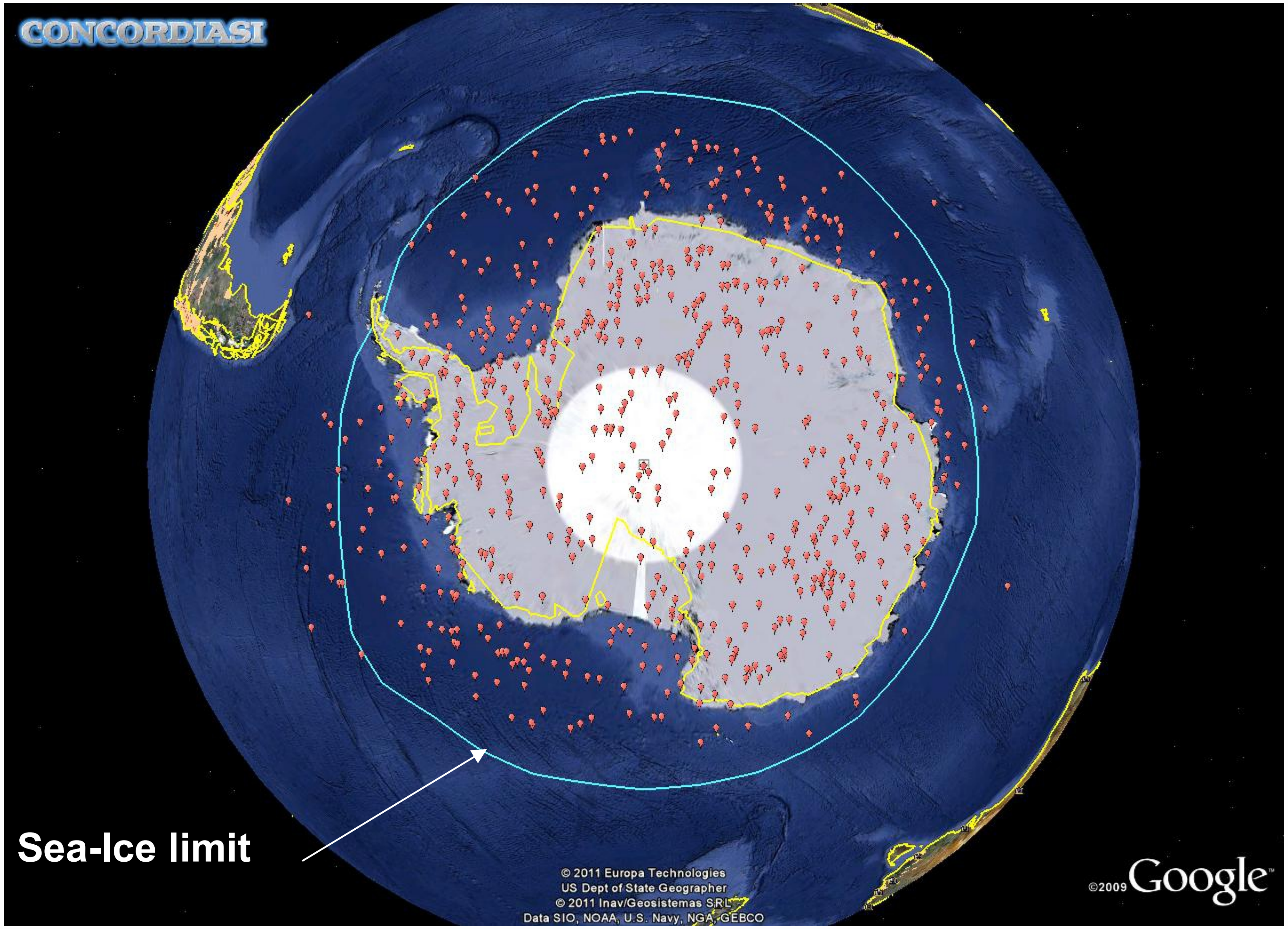
METEO FRANCE
Toujours un temps d'avance



Reasons for dropping:

- AIRS+IASI
- IASI
- Lee of Antarctic Peninsula
- Dome C
- Sensitivities
- Not attributed

640 Dropsondes (20100923-20101201)



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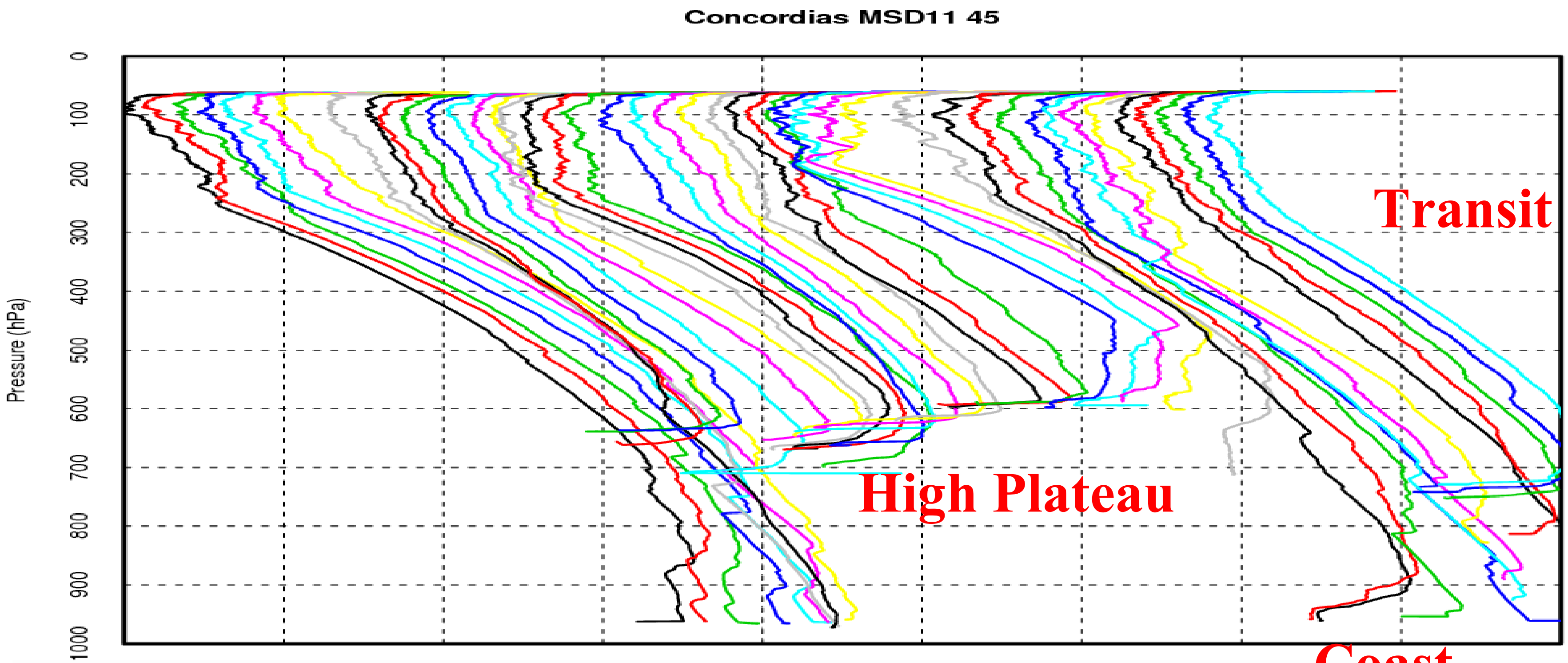
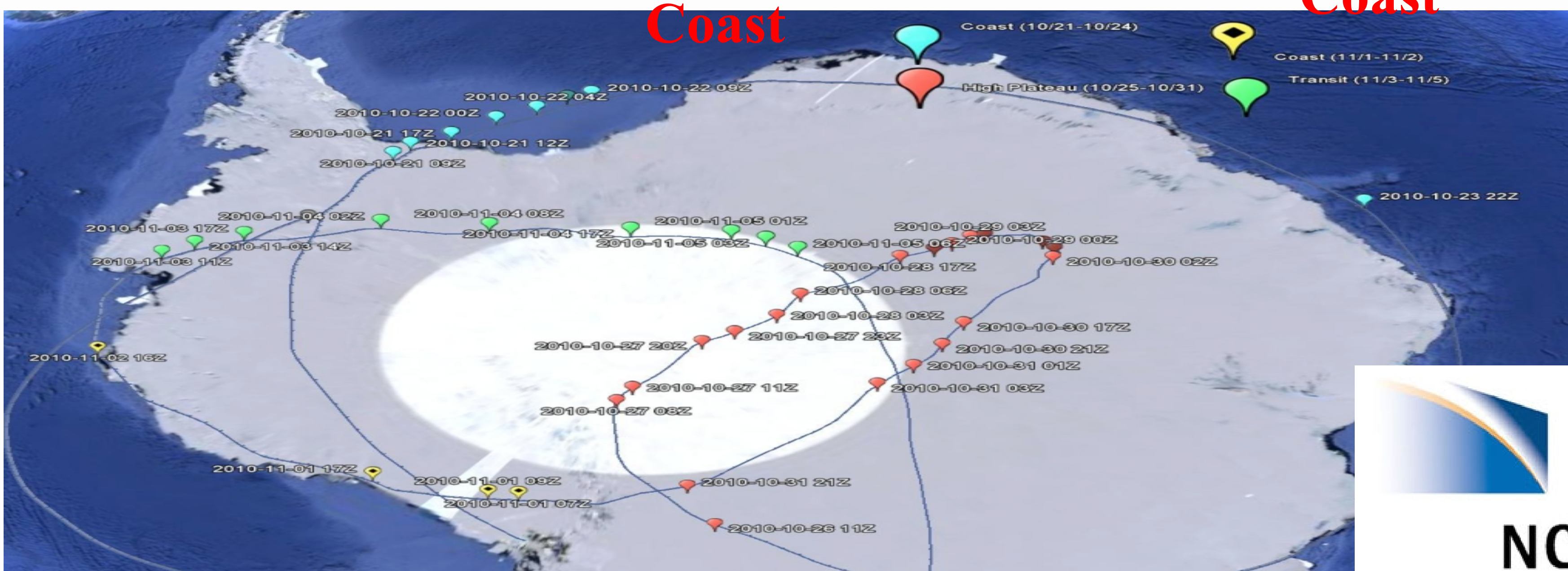

Concordias MSD11 45
Pressure (hPa)
0
100
200
300
400
500
600
700
800
900
1000
Transit
High Plateau
Coast
Coast


Coast (10/21-10/24)
Coast (11/1-11/2)
High Plateau (10/25-10/31)
Transit (11/3-11/5)
2010-10-22 09Z
2010-10-22 04Z
2010-10-22 00Z
2010-10-21 17Z
2010-10-21 12Z
2010-10-21 09Z
2010-10-23 22Z
2010-11-04 02Z
2010-11-04 08Z
2010-11-03 17Z
2010-11-04 17Z
2010-11-05 01Z
2010-11-03 14Z
2010-11-05 03Z
2010-11-05 06Z
2010-11-03 11Z
2010-10-29 03Z
2010-10-29 00Z
2010-10-28 17Z
2010-10-30 02Z
2010-10-28 06Z
2010-10-28 03Z
2010-10-30 17Z
2010-10-27 20Z
2010-10-27 23Z
2010-10-30 21Z
2010-11-02 16Z
2010-10-31 01Z
2010-10-27 11Z
2010-10-31 03Z
2010-10-27 08Z
2010-11-01 17Z
2010-11-01 09Z
2010-10-31 21Z
2010-11-01 07Z
2010-10-26 11Z

NCAR

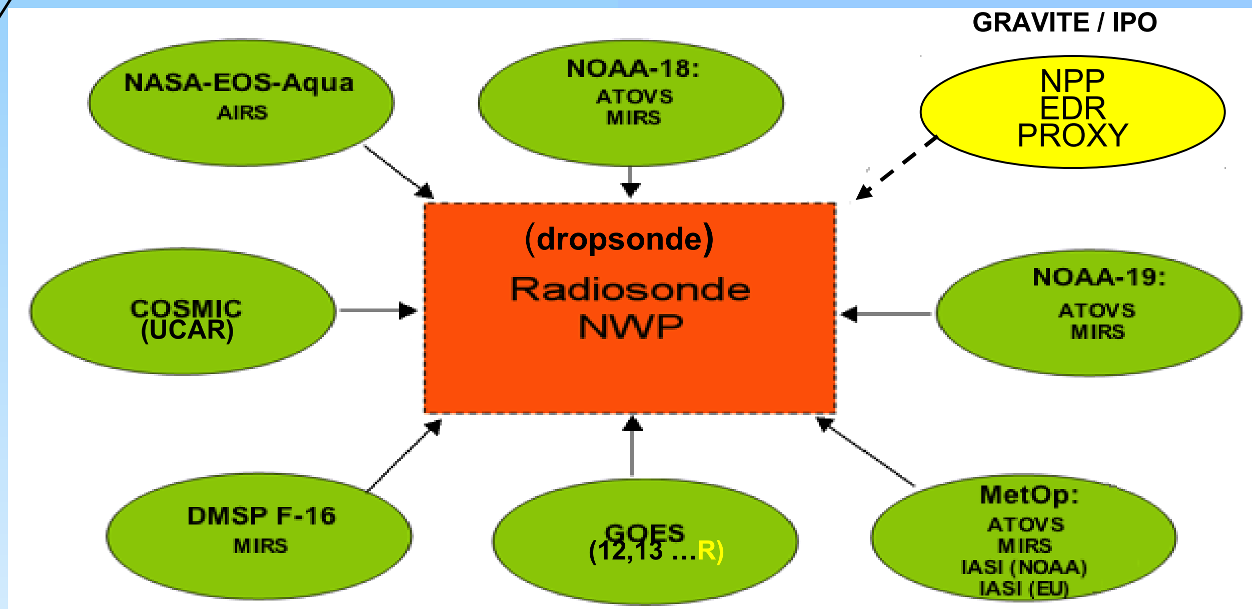
Validating model and satellite retrievals

National Environmental Satellite, Data, and Information Service

NOAA PROducts Validation System (NPROVS)

Centralized Radiosonde and Satellite Collocation Processing

6-hour



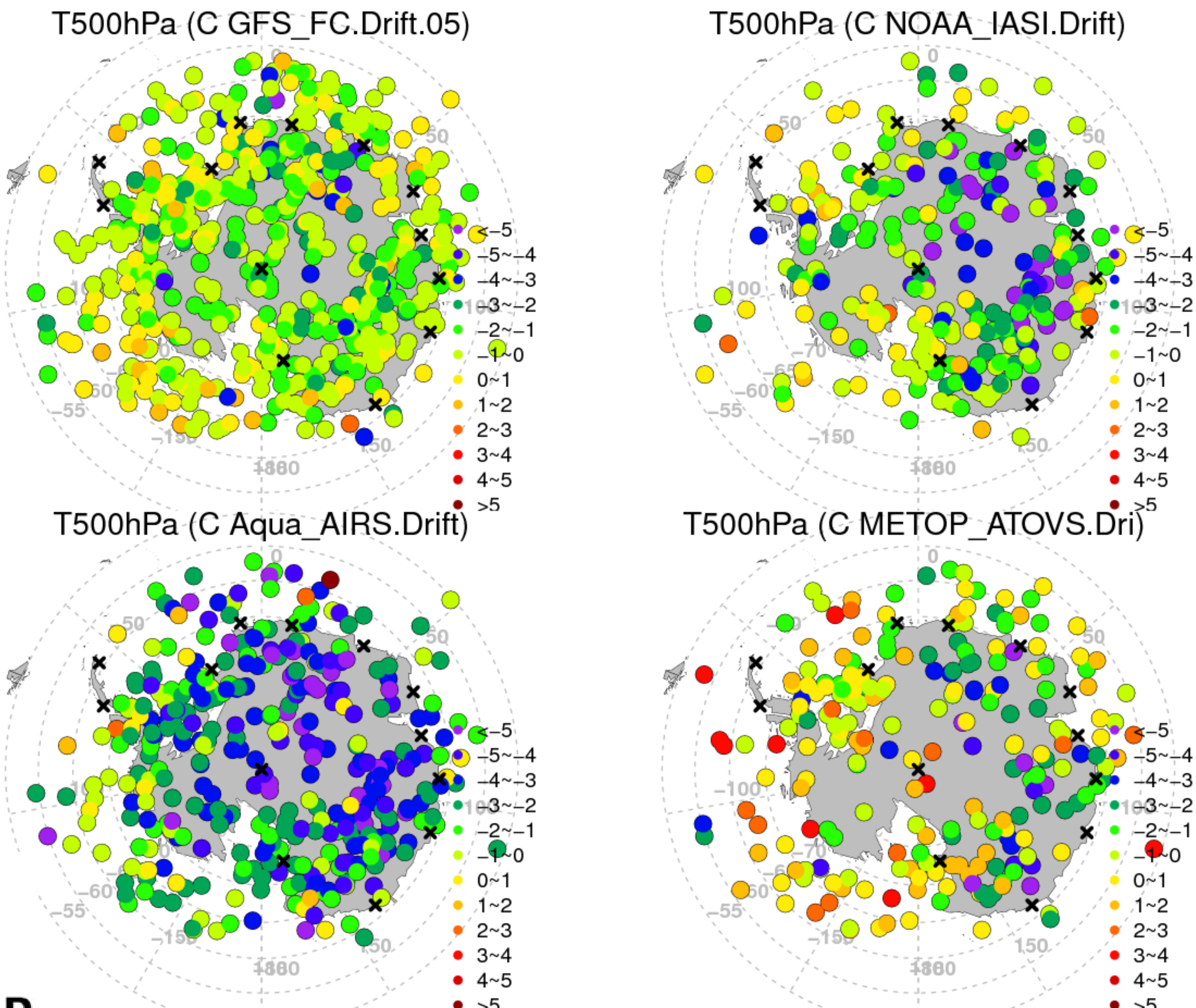
150km

Collocated *Sonde/NWP* and multiple *Satellite* products dataset

NCAR

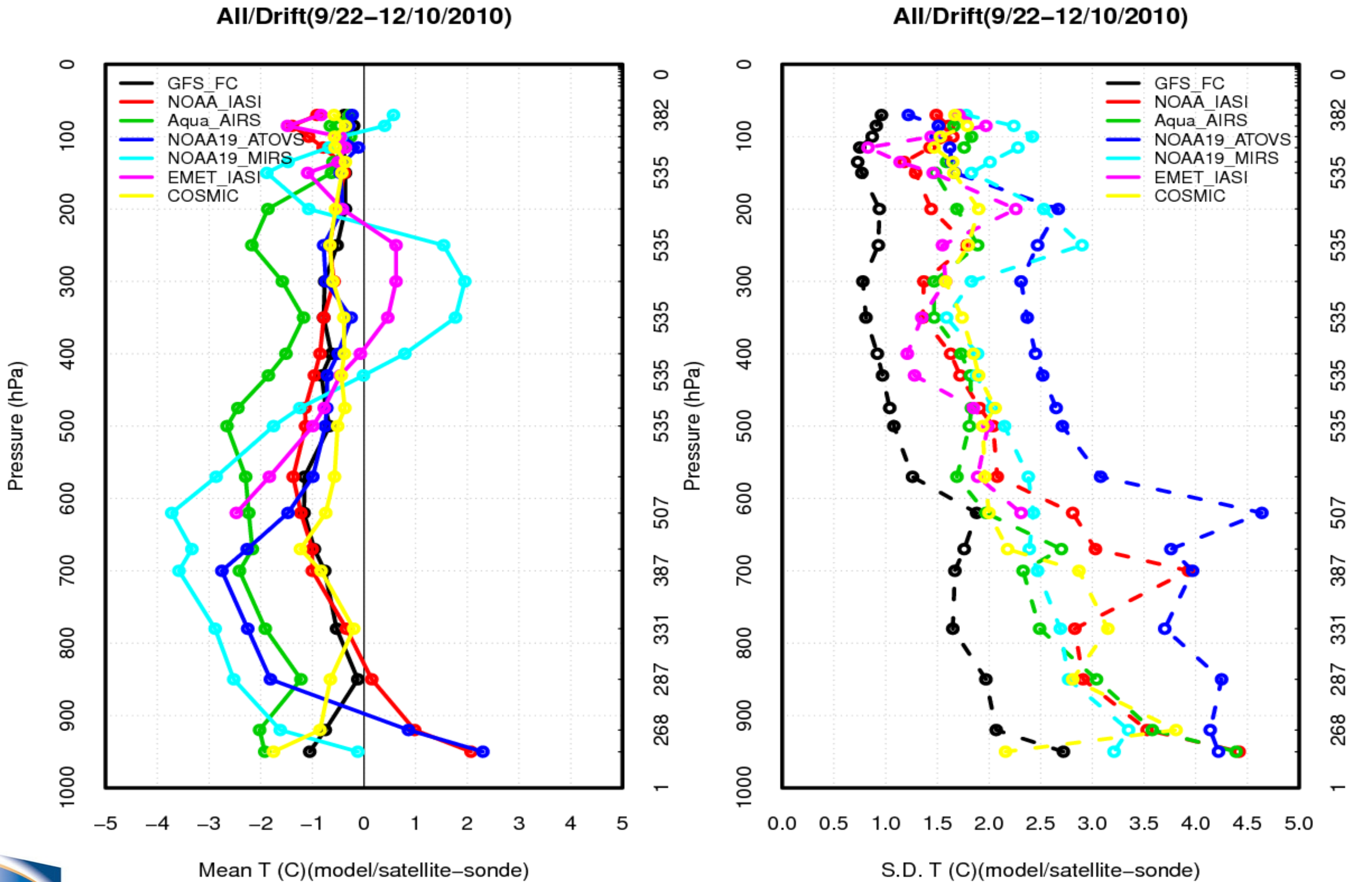
Single Closest

Spatial Variability at 500 hPa



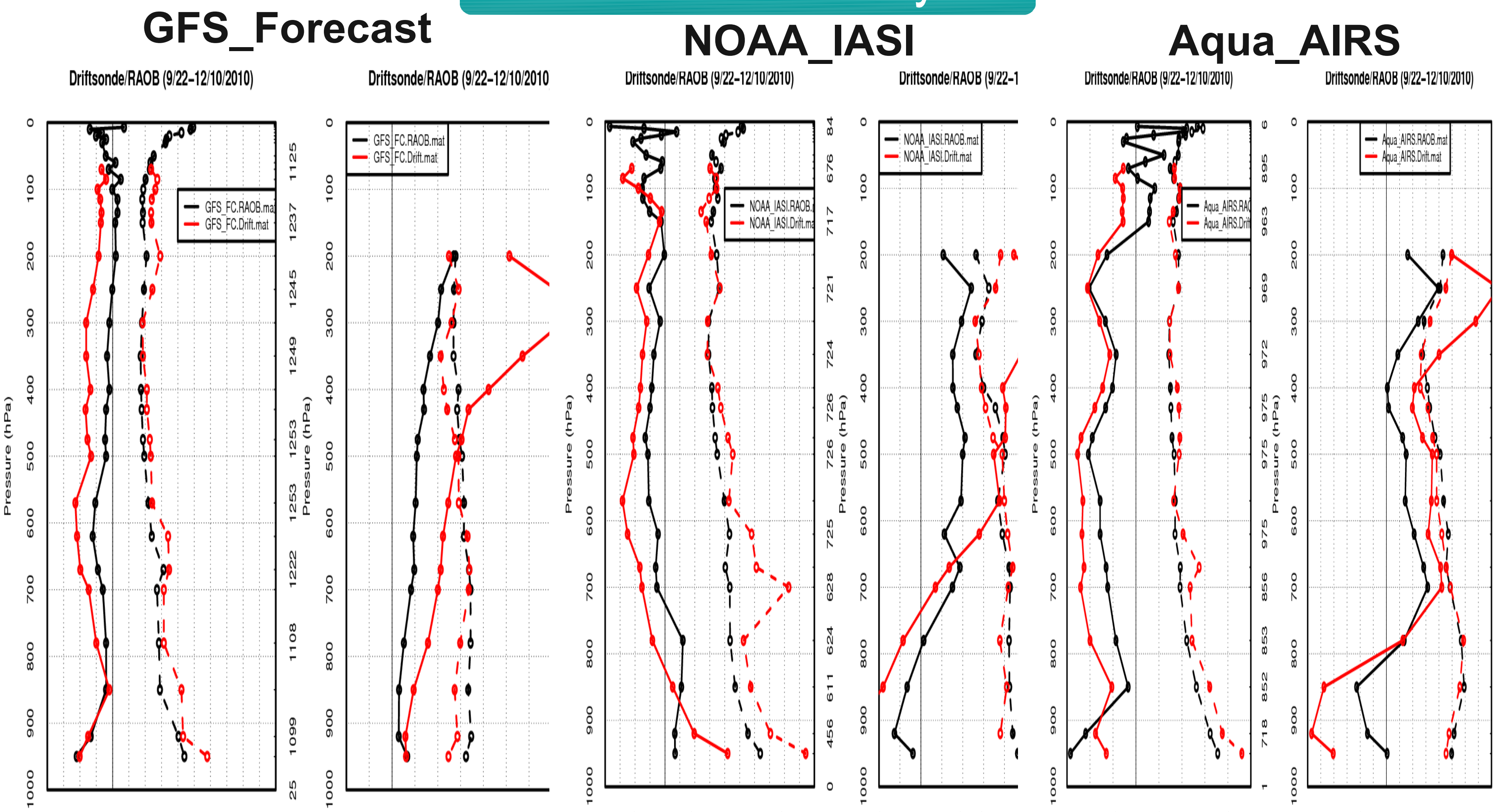
NCAR

T comparisons with Driftsonde (all)



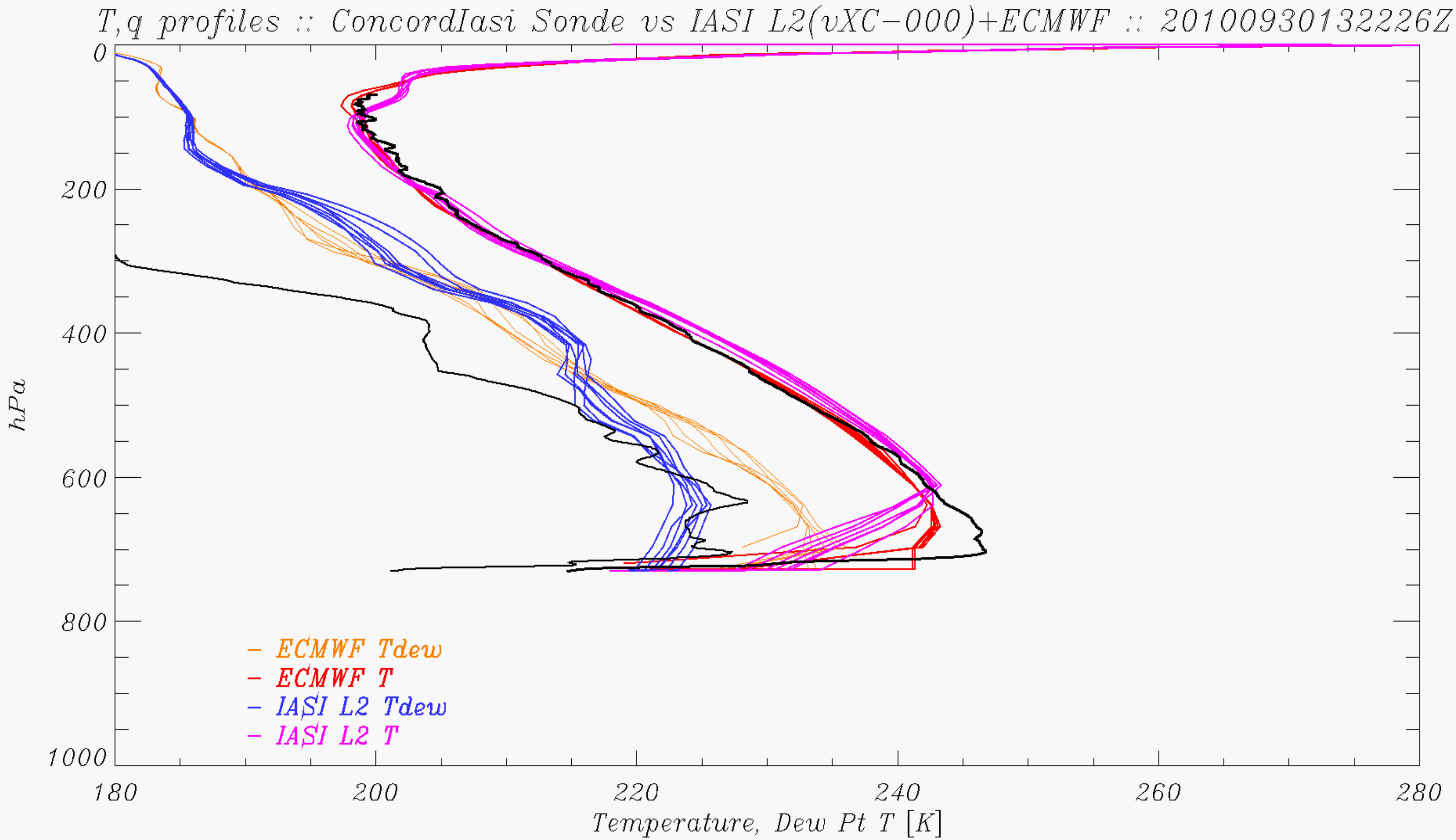
NCAR

Relative Humidity



- Consistent dry (moist) biases in LT (MT/UT) for satellite data
- Bias and S.D. are comparable.
- Dry bias in dropsonde in UT.
- Better agreement between GFS and RAOB at < 400 hPa

NCAR



Courtesy Thomas August, EUMETSAT

CONCORDIASI

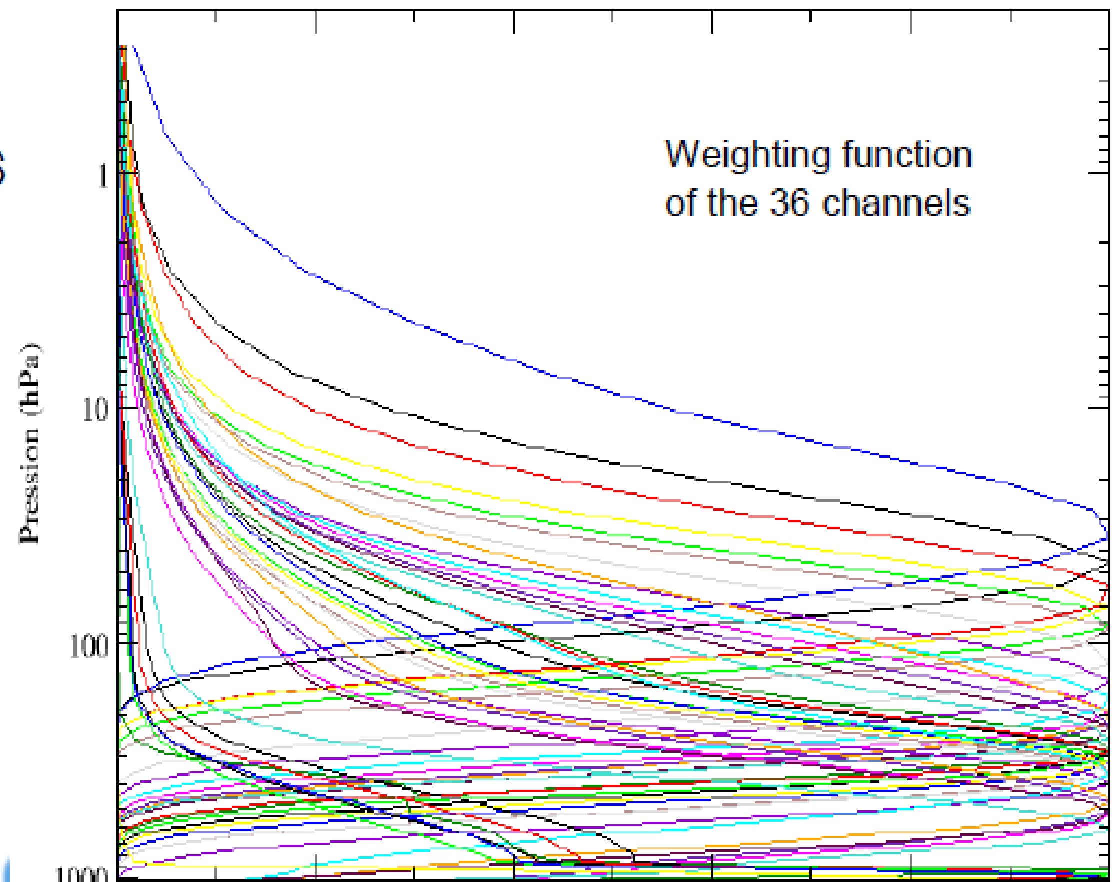
Method to retrieve cloud properties : CO2-slicing

- Retrieve Cloud **Top Pressure** and Cloud **effective emissivity**
  - Using IASI channels in the Temperature LW band
  - But only 1 (equivalent) clour layer per profile

Pangaud et al, 2008 MWR

Lavanant et al, 2011 QJRMS

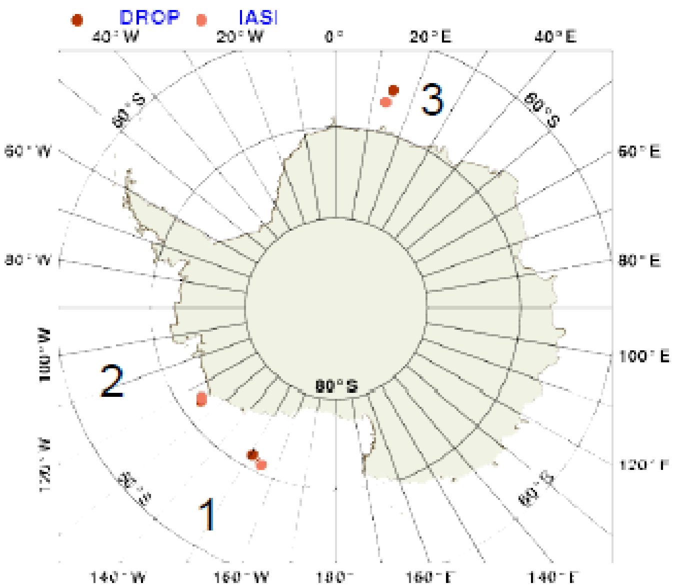
Guidard et al, 2011, QJRMS



Study of 3 specific cases

- **Evaluation of the cloud parameter retrieval from IASI (Tuuli Perttula, FMI)**
  - 3 dropsondes selected over sea ice (oct-nov 2010)
  - Modification of the atmospheric profile with dropsonde data but surface data (T2m, Hu2m and Ts) from model

	Time diff Drop/IASI	Distance Drop/IASI	CTP with NWP	CTP with sondes	CTP CPR/Caliop
1	3 h 09 mn	159km	576hPa	637hPa	822hPa
2	1h36mn	50km	366hPa	347hPa	311hPa
3	0h03mn	170km	694hPa	858hPa	840hPa

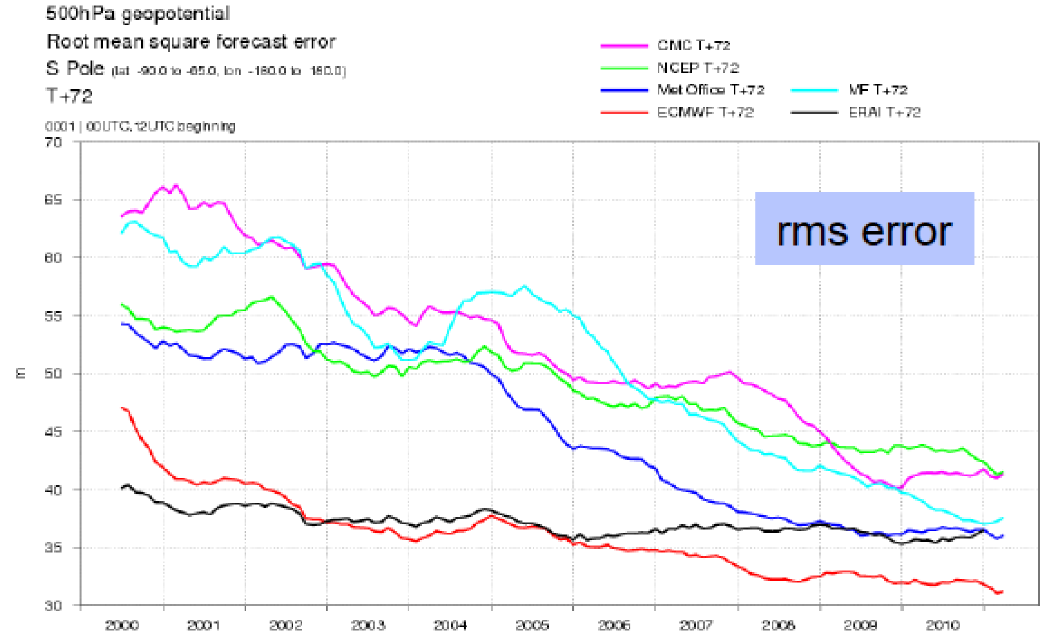


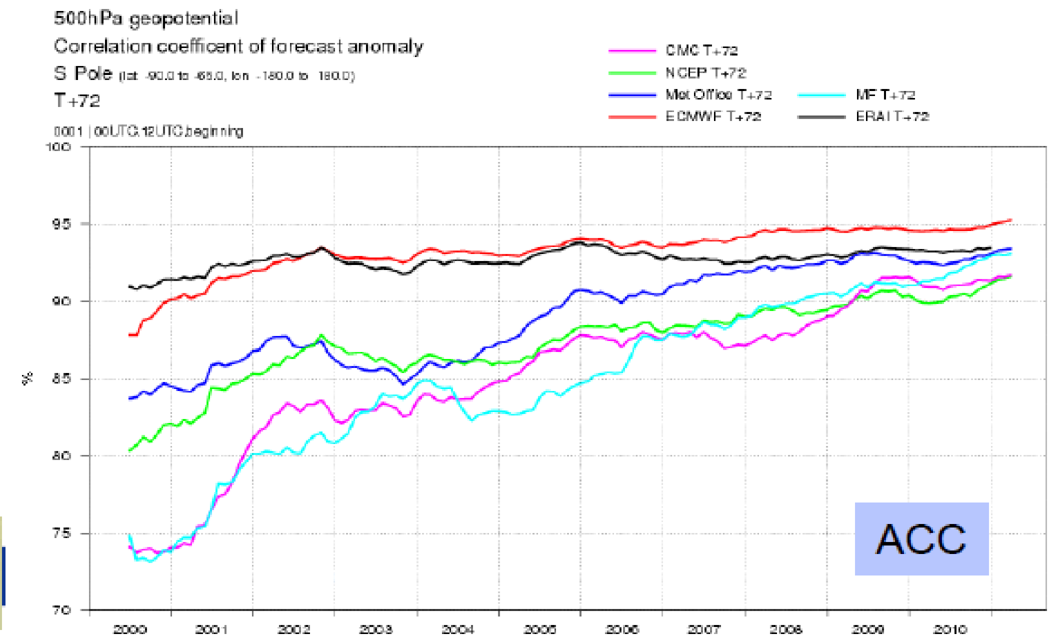
Using a better input profile (coming from the dropsonde) helps for the cloud detection for IASI

Model performance and impact of dropsondes

Comparison with other centres (2000-2011) S pole

- Day 3 forecasts (T+72)
- Z500, 12-month moving average
- Each centre verified against own analysis
- ERA-I shown for reference

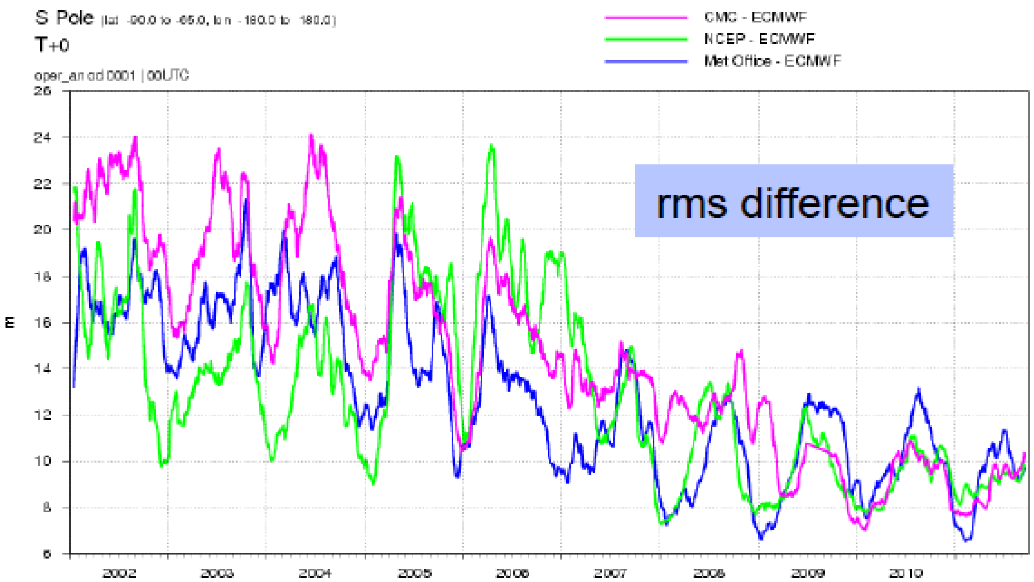


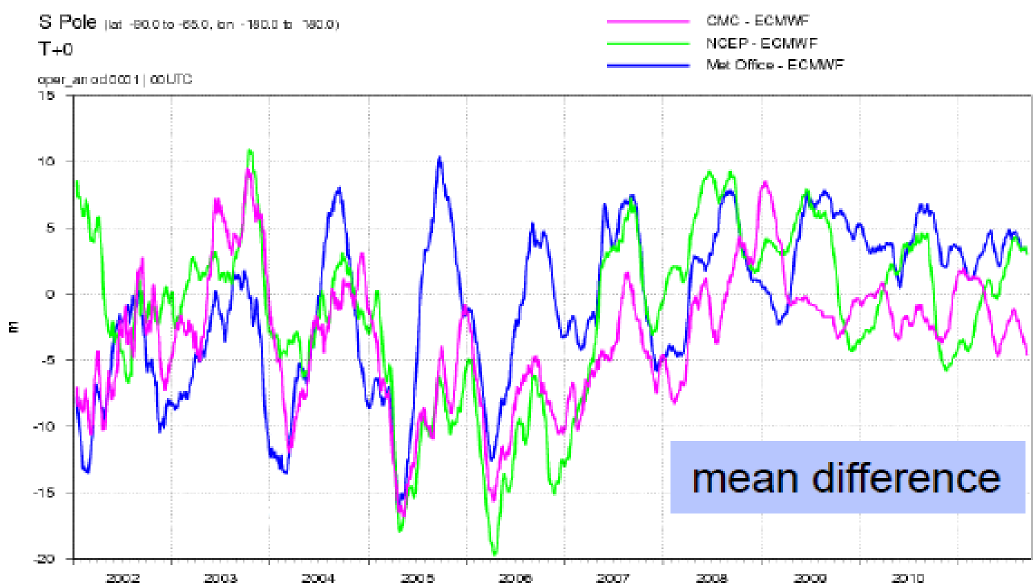


ECMWF

Comparison between analyses (S Pole)

- Differences between the analyses of different centres
- Z500 30 day moving average
- Decrease over last decade in the difference between the analyses of different centres





ECMWF

Observation impact at NRL

Ob Impact results for Concordiasi
October 2010 (124 analyses and forecasts)

NOGAPS-NAVDAS_AR (4d-Var) operational forecast system
Observation Impact on 24hr forecast error norm (total moist energy)
For observations in geographic domain south of 60°S

Observation Type	**Summed Impact**	**Impact per-ob**	**Number Obs**
	$J\ kg^{-1}$	**$x10^5\ J\ kg^{-1}$**	
Radiosondes	**-2.8260**	**-3.2050**	88,175
Dropsondes	**-1.0658**	**-2.8050**	37,996
GeoSat Wind	-0.0474	-0.7895	6,004
MODIS Wind	**-10.4172**	**-1.3243**	786,618
AVHRR Wind	**-2.6195**	-0.6724	389,562
LEO – GEO Wind	**-**	-	-
AIREP	-0.0001	-0.0342	292
AMDAR	-0.0793	**-11.1690**	710
LAND SFC	**-2.0729**	**-1.9161**	108,185
SHIP SFC	-0.2345	**-4.6704**	5,021
SSMI SFC WIND	+0.0327	+0.1189	27,493
SCAT SFC WIND	+0.0082	+0.6193	1,324
ASCAT SFC WIND	-0.1490	**-1.5351**	9,706
WINDSAT SFC WIND	-0.0403	**-1.0172**	3,962
SSMI TPW	-0.0112	Profiles	11,902
WINDSAT TPW	-0.0012	Profiles	633
GPS-RO	**-2.1002**	-0.1394	1,507,041
AMSU-A	**-8.3132**	-0.2088	3,981,468
IASI	**-3.8546**	-0.0650	5,932,979
SSMIS	-3.4714	-0.0909	3,820,906
AQUA	-0.5572	-0.4474	124,553
Total	**-37.8201**	**-0.2329**	**16,844,530**

Compiled by Rolf H. Langland
NRL-Monterey

Ob Impact results for Concordiasi
November 2010 (120 analyses and forecasts)

NOGAPS-NAVDAS_AR (4d-Var) operational forecast system
Observation Impact on 24hr forecast error norm (total moist energy)
For observations in geographic domain south of 60°S

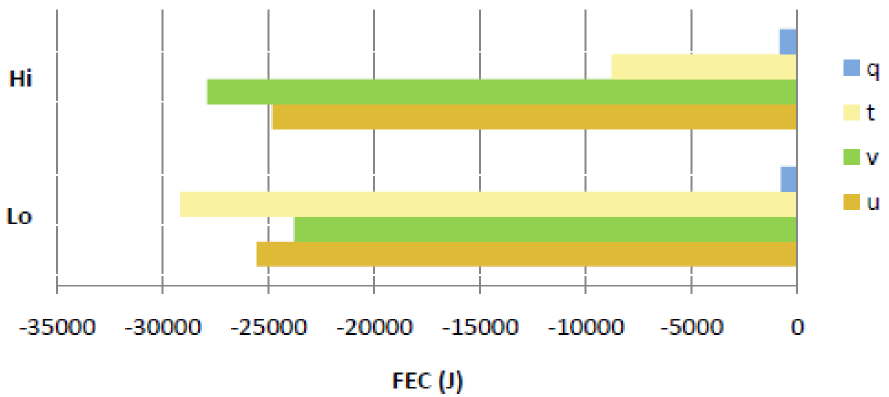
Observation Type	**Summed Impact**	**Impact per-ob**	**Number Obs**
	$J\ kg^{-1}$	**$x10^5\ J\ kg^{-1}$**	
Radiosondes	**-4.1576**	**-4.3059**	96,555
Dropsondes	-0.3897	**-2.3548**	16,549
GeoSat Wind	-0.0328	-0.4394	7,464
MODIS Wind	**-9.8412**	**-1.4403**	683,294
AVHRR Wind	**-2.5080**	-0.9163	273,714
LEO – GEO Wind	**-2.2028**	**-1.7574**	125,346
AIREP	-0.0074	**-2.8030**	264
AMDAR	-0.0420	**-9.5890**	438
LAND SFC	**-2.6777**	**-2.5005**	107,087
SHIP SFC	-0.2252	**-5.0033**	4,501
SSMI SFC WIND	+0.1045	+0.3066	34,079
SCAT SFC WIND	+0.0030	+0.3401	882
ASCAT SFC WIND	-0.1335	-0.9942	13,428
WINDSAT SFC WIND	-0.1210	**-1.5430**	7,842
SSMI TPW	-0.0246	Profiles	17,469
WINDSAT TPW	-0.0017	Profiles	1,361
GPS-RO	**-2.5009**	-0.2010	1,244,254
AMSU-A	**-7.3740**	-0.1659	4,445,345
IASI	**-6.8671**	-0.0912	7,527,142
SSMIS	-0.7657	-0.0168	4,563,291
AQUA	-0.3609	-0.2061	175,140
Total	**-40.1263**	**-0.2079**	**19,345,445**

Compiled by Rolf H. Langland
NRL-Monterey

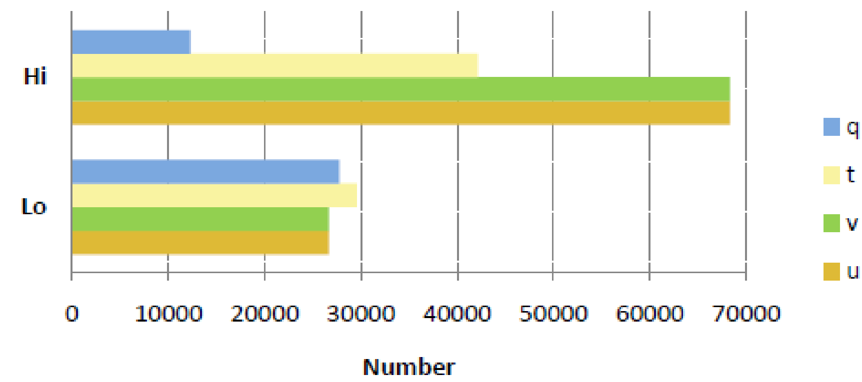
Concordiasi Sep-Dec 2010

Impact of dropsondes and radiosondes at ECMWF: importance of lower levels

Radiosonde

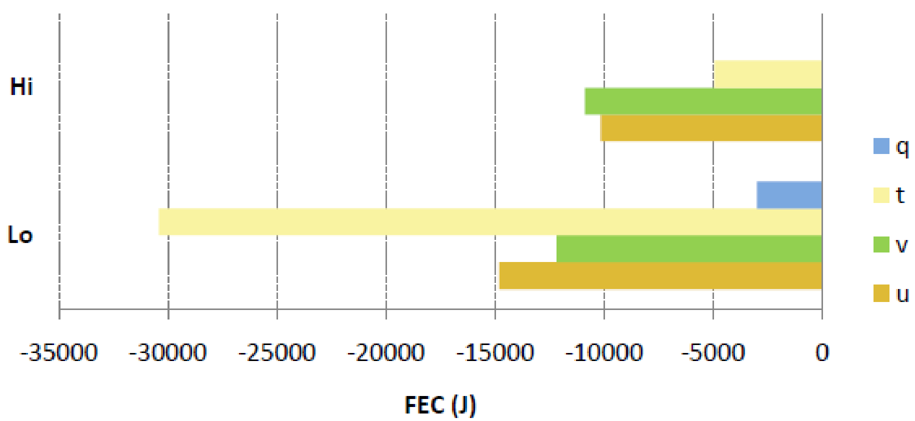


Radiosonde

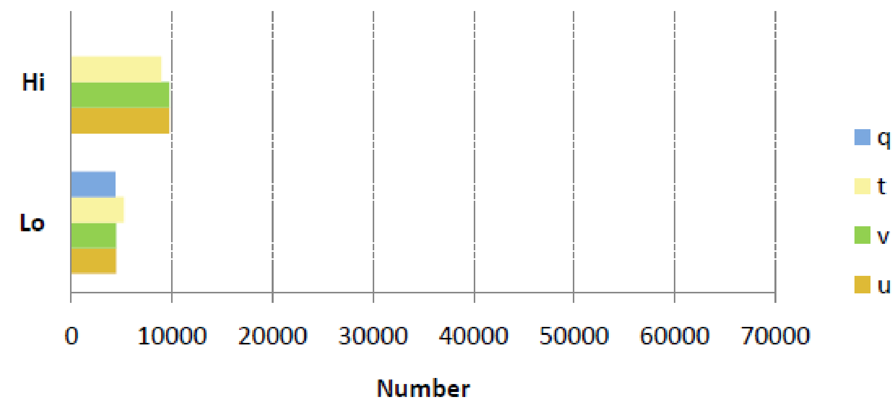


HI: < 400 hPa **LO: > 400hPa**

Dropsonde



Dropsonde



Relative impact

ECMWF

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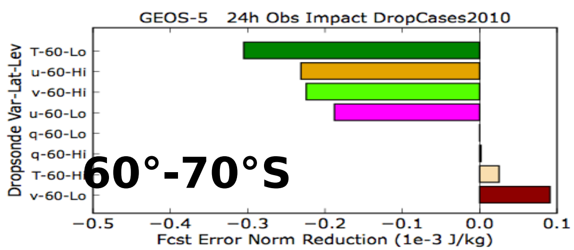
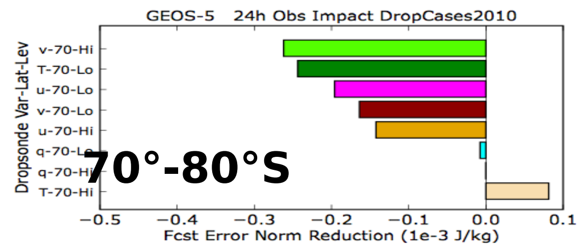
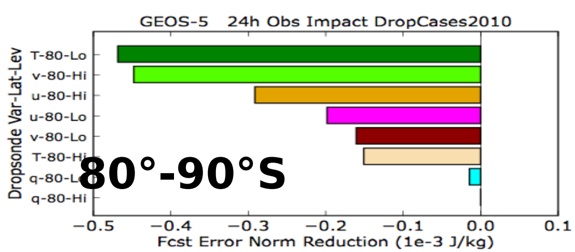
GEOS-5 Observation Impacts for Concordiasi
Dropsonde u,v,T,q – Averages for All Drop Cases

Total Impact

Dropsonde Observation Impact

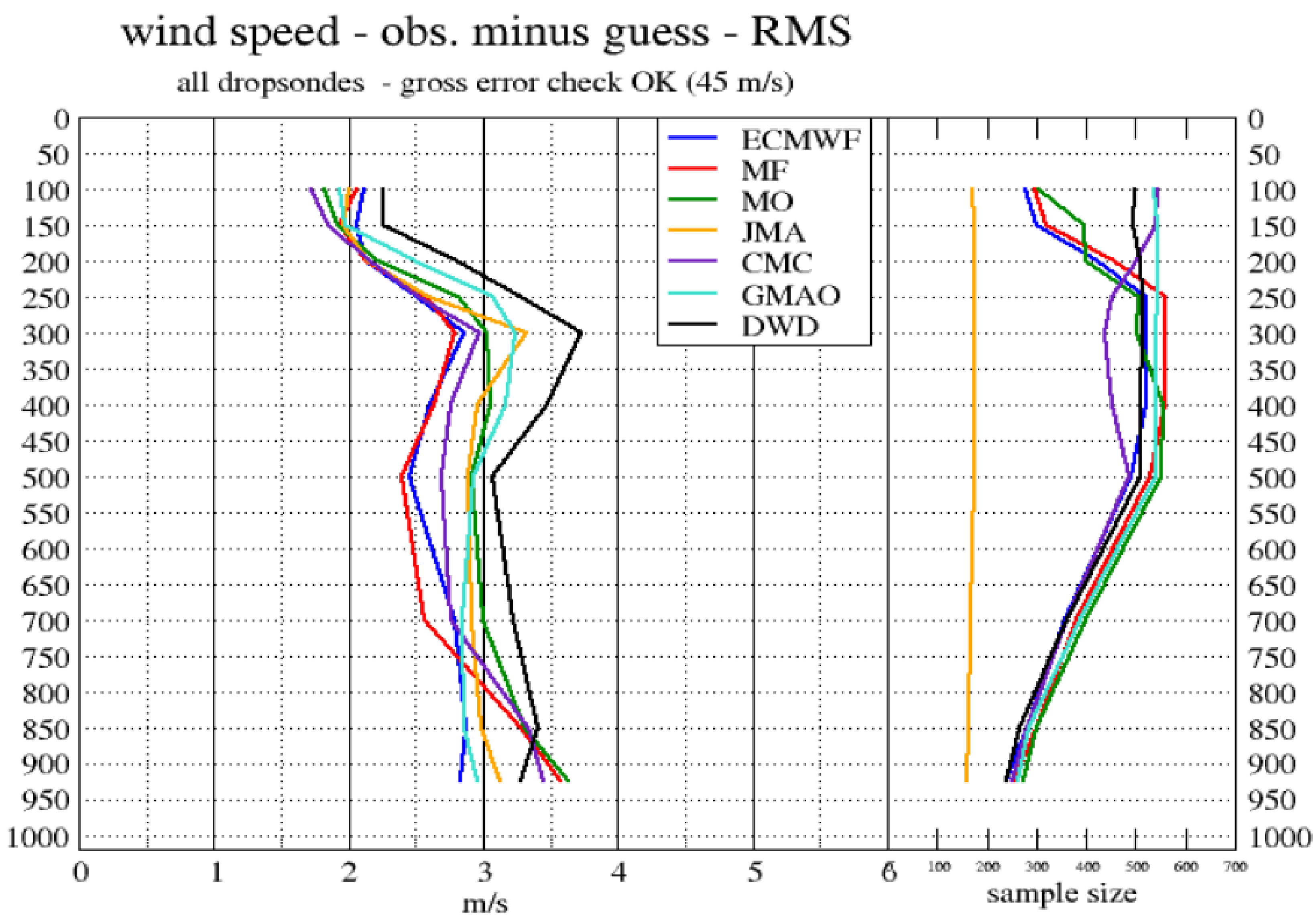






Larger impact at higher latitudes, where less other data are assimilated

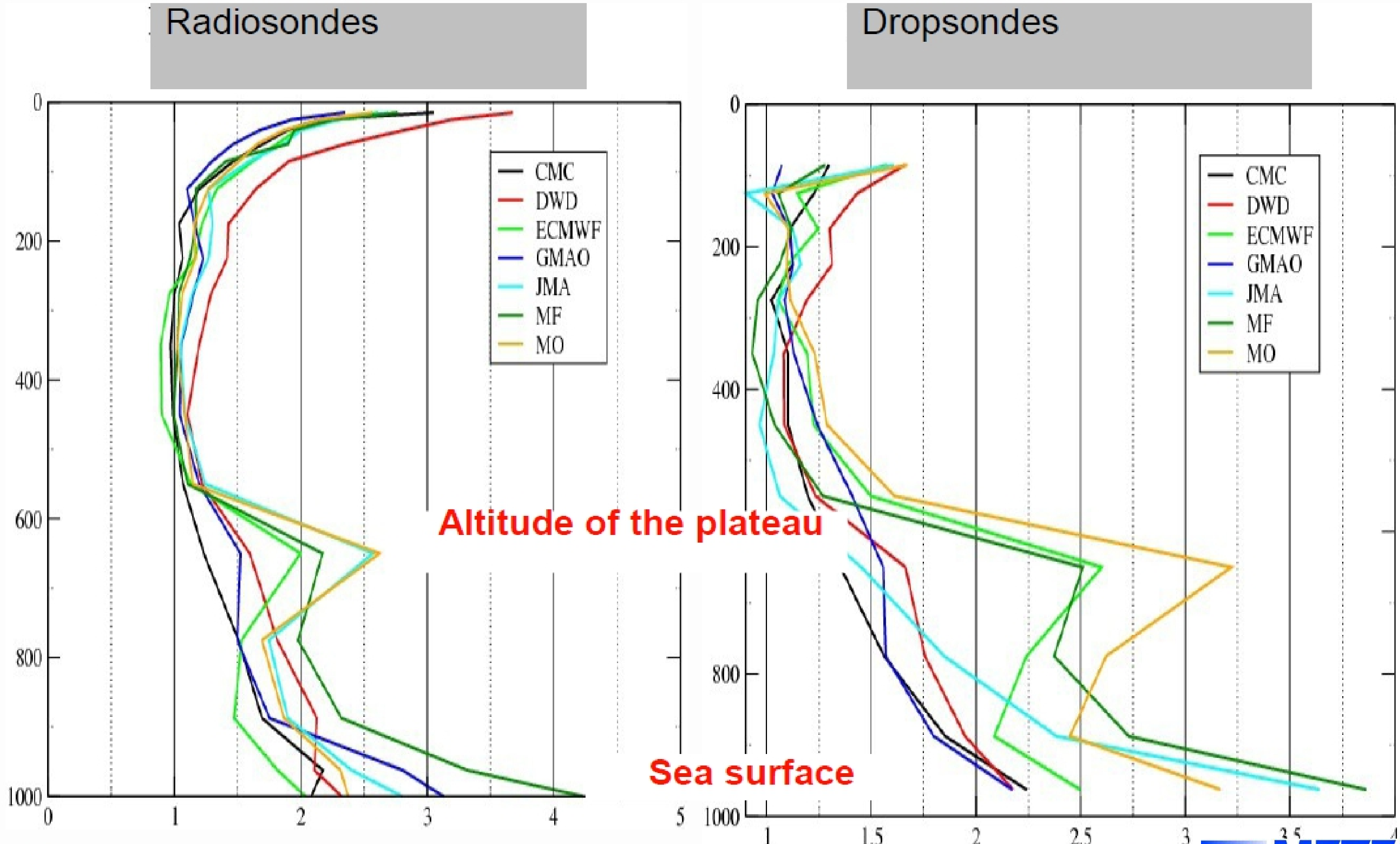
Comparison of models and dropsondes



Wind-speed in m/s

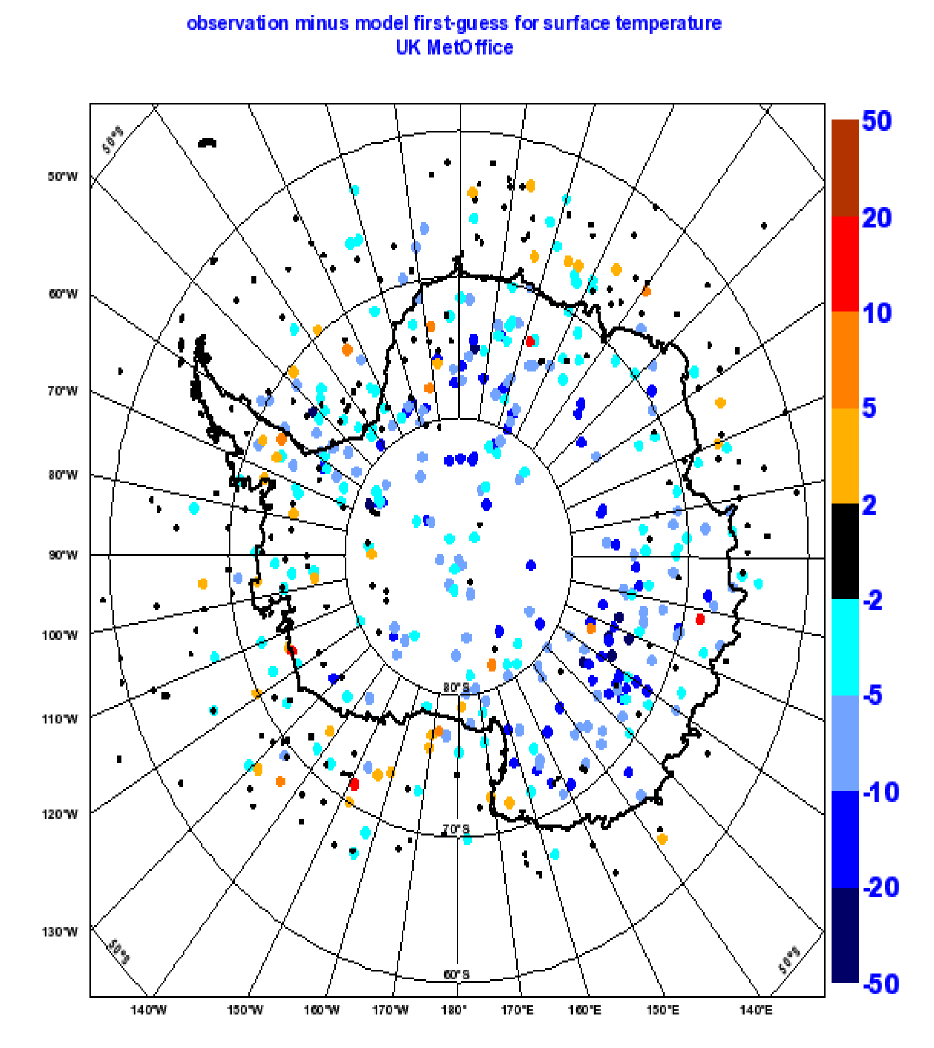
METEO FRANCE

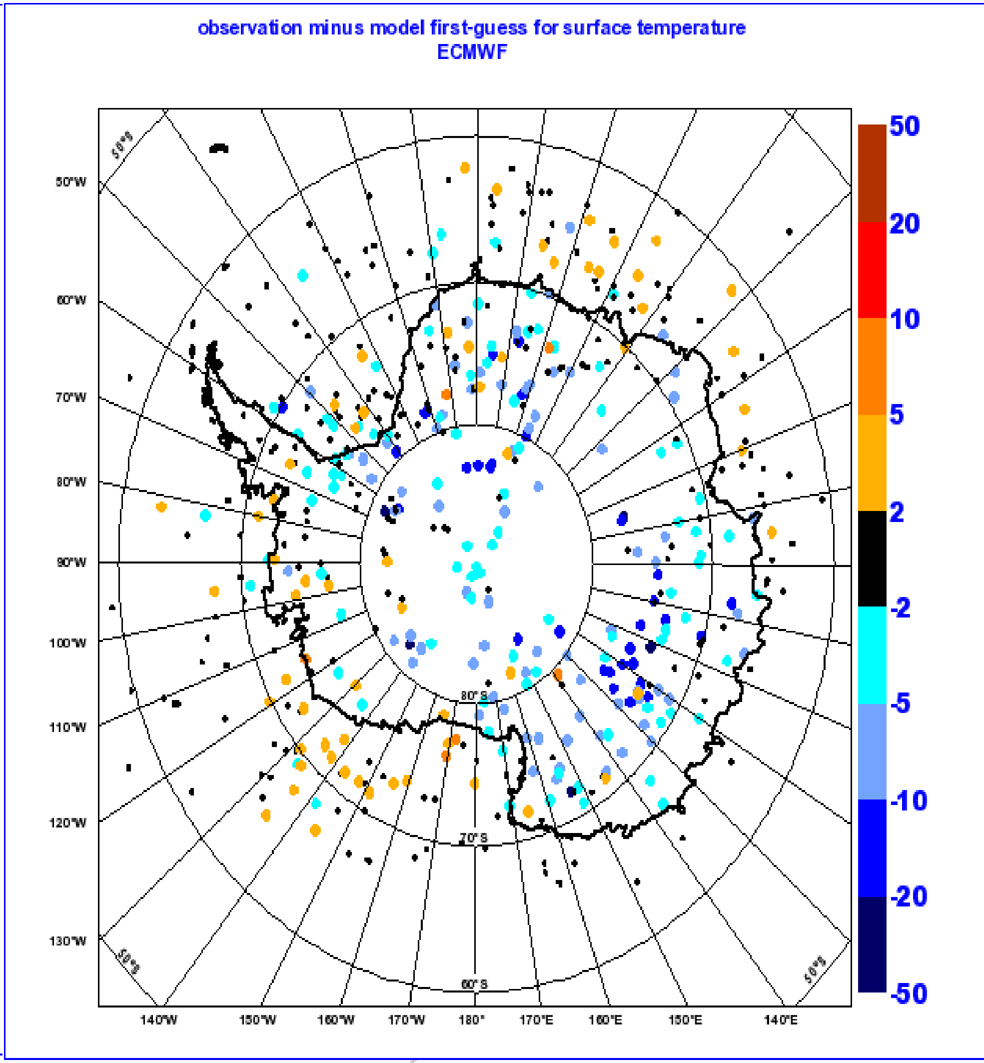
Comparison of O-G for radiosondes and dropsondes using all levels (different for each centre)



Temperature in K

Largest errors in temperature near the surface: models not cold enough over inland Antarctica





Tracer assimilation

Lagrangian Assimilation of Tracers

Basic Idea: Assimilate position of tracer rather than wind vector derived from tracer movement.

This requires a forecast of the balloon position in the model so that the O-F becomes the difference between the observed and forecast balloon positions.

Previous work done on Ocean drifters (Salman et al., 2006; Nodet, 2006) showed improvements to estimating ocean circulation using Lagrangian assimilation rather than derived velocity vectors.

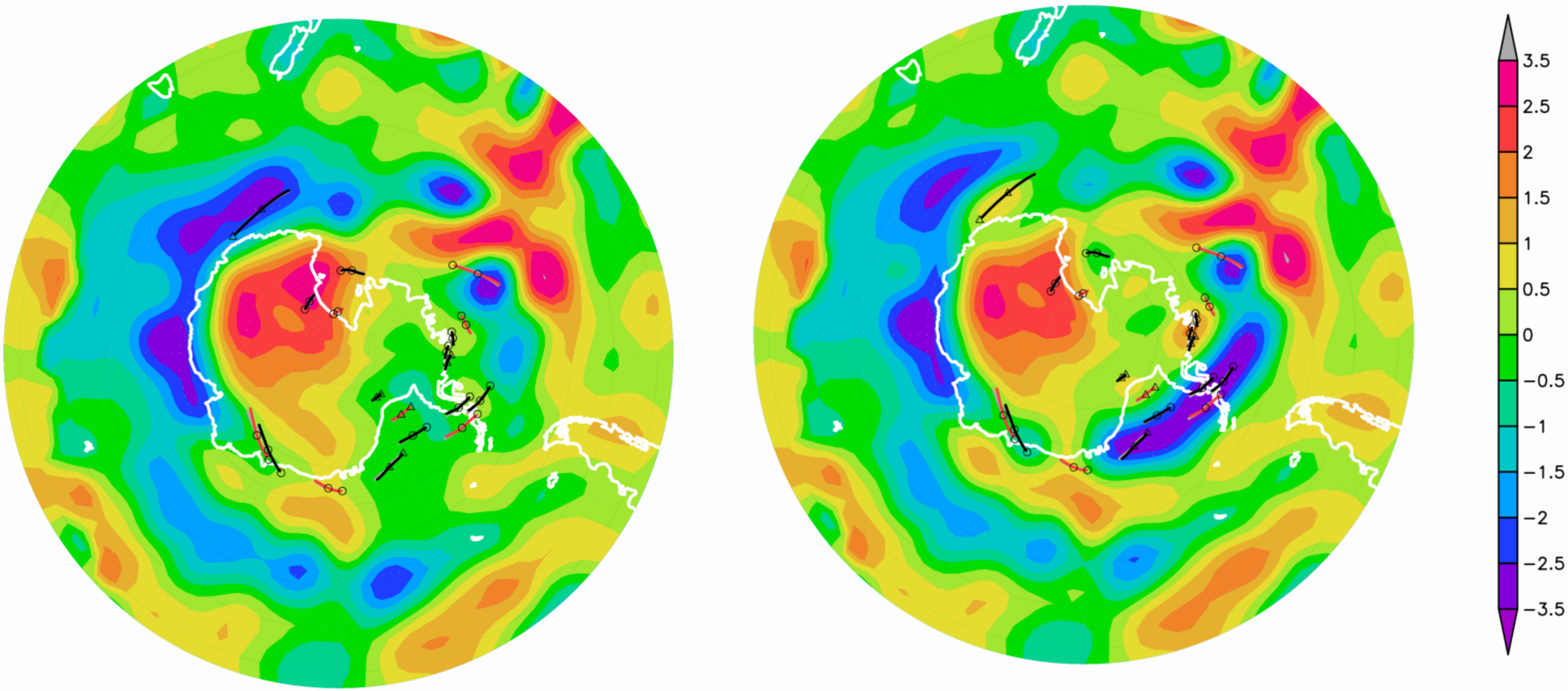
Work done in GSI: Non-linear forward model for balloon trajectory

Tangent linear and adjoint models needed for 3d and 4dVar assimilation.

Addition of balloon position observations to cost function.

Tests carried out using 3DVAR.

Impact of Assimilation: Analysis Increment



Reference (balloons passive)

With balloon positions assimilated

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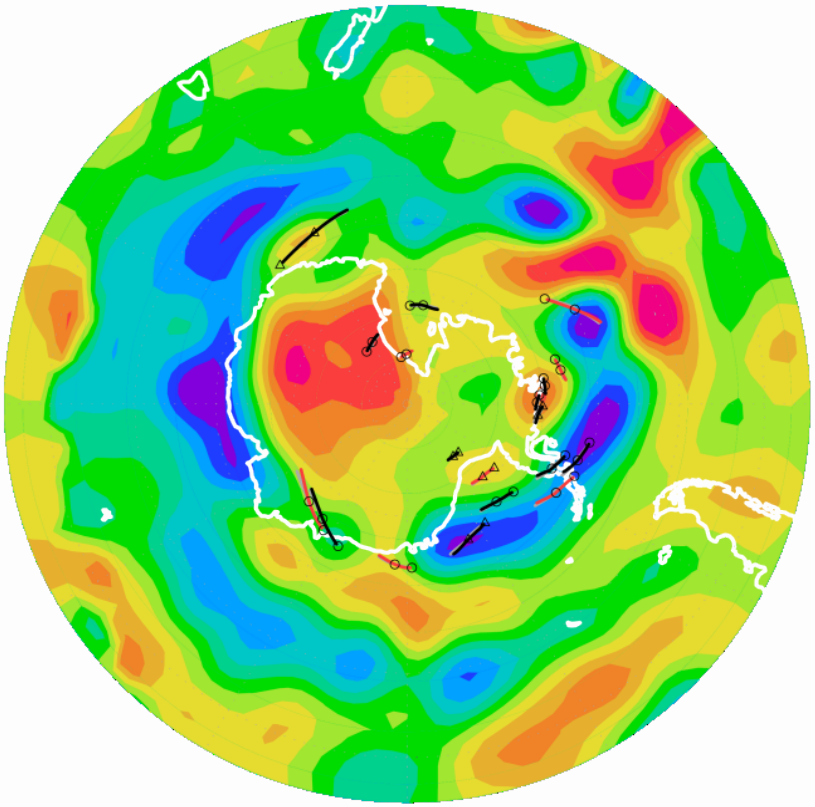
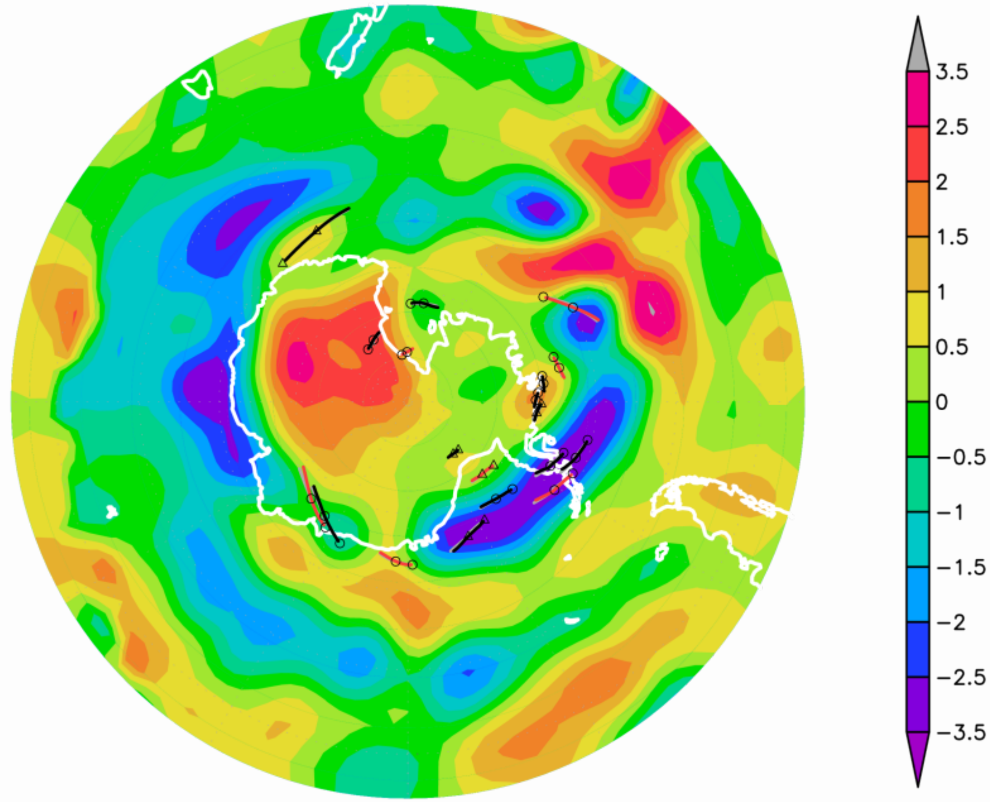
Impact of Assimilating Balloon position Instead of derived winds



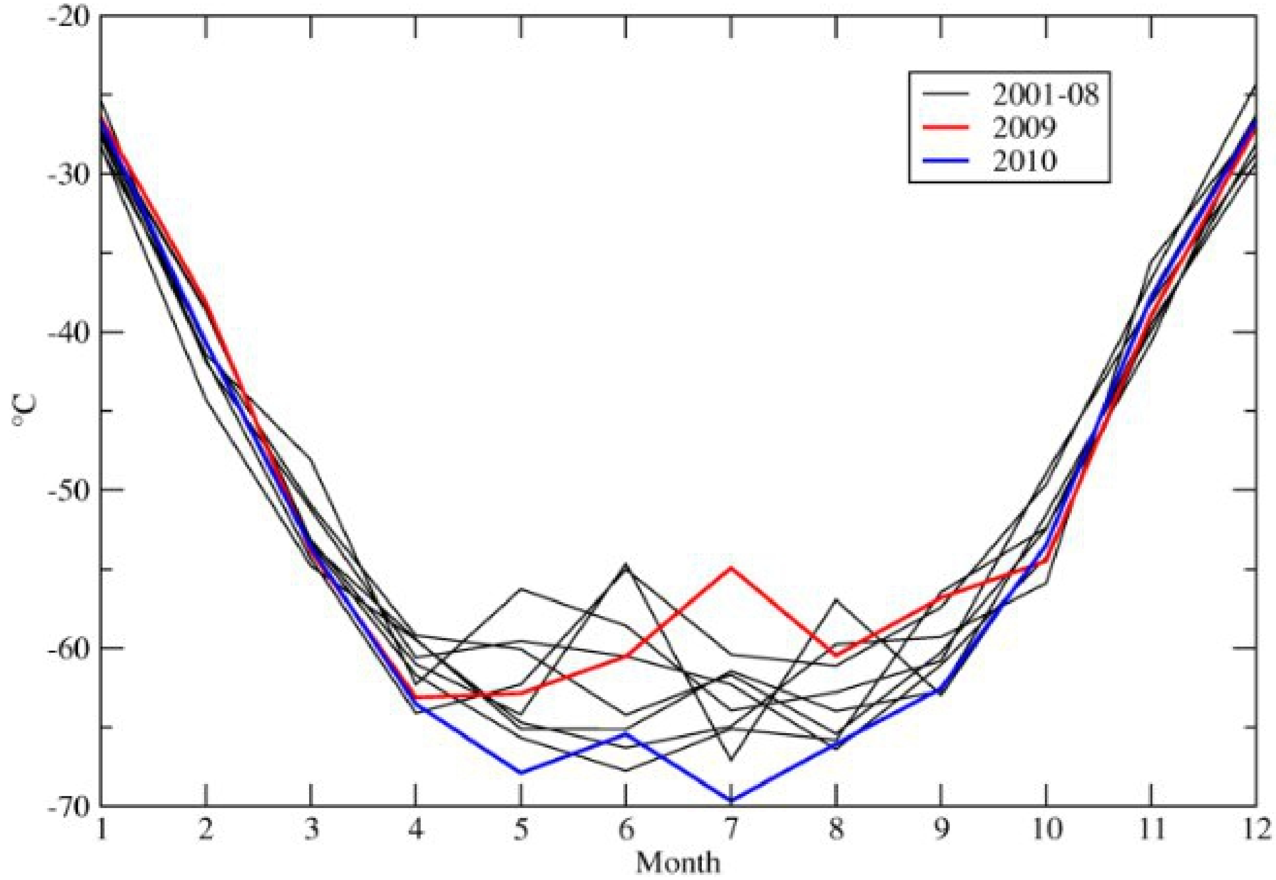
With derived winds assimilated



With balloon positions assimilated

Snow modelling

At Dome C, Concordia, local measurements



Local measurements document the inter-annual variability on the Antarctic plateau (Ch. Genthon, LGGE)

Study on snow models at Concordia (Dome C)

Evaluation of a 11-day stand-alone simulation of Crocus snow model:

Observed meteorological forcing:

- Downwards LW and SW observations from BSRN
- Air temperature, humidity and wind speed from LGGE
- No significant precipitation and no snow drift during the period

Initialization from an observed temperature profile (L. Arnaud)

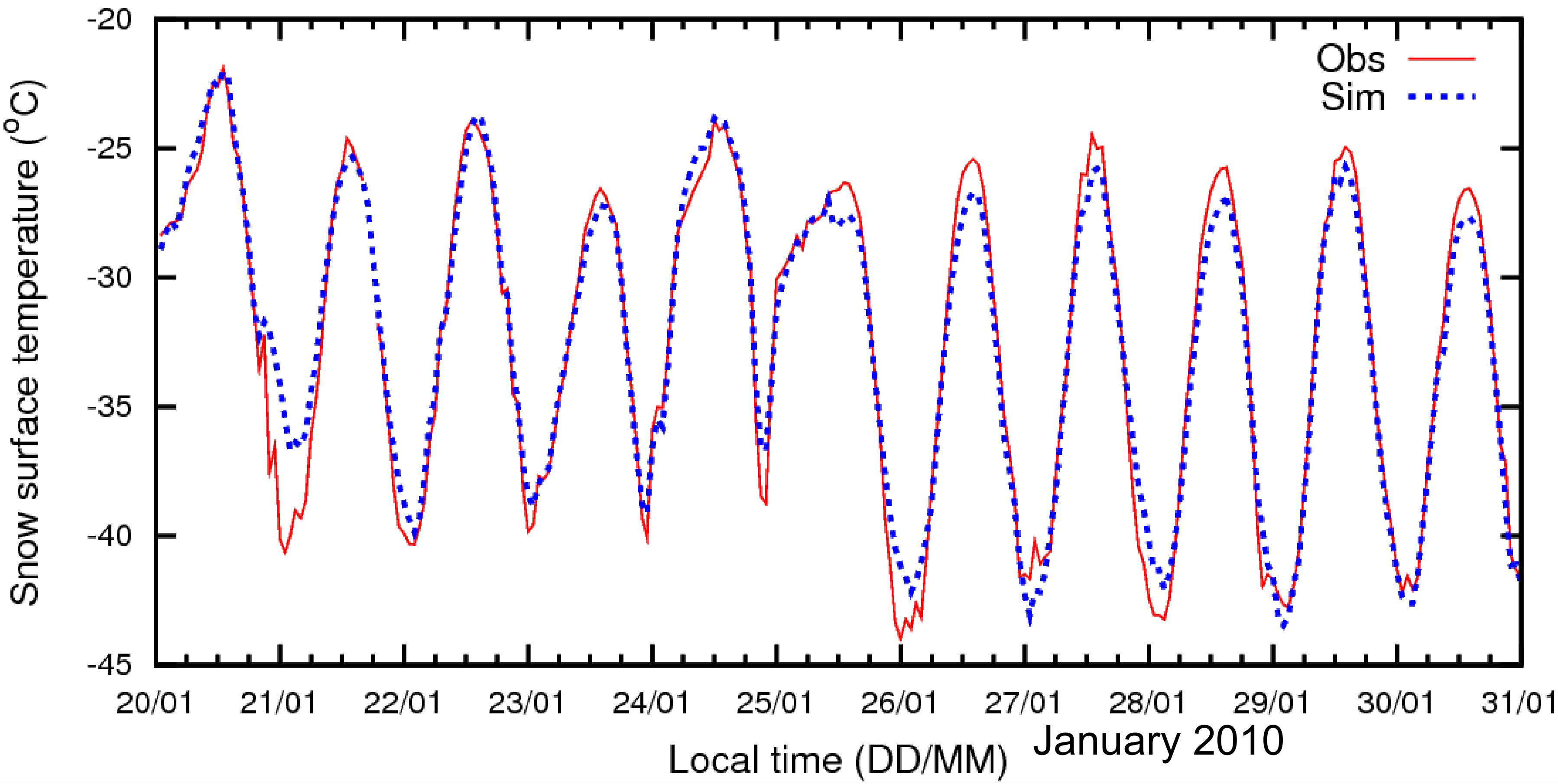
Adjustment of initial top density (2cm hoar-like layer) and snow grains

➔ detailed evaluation of surface and near-surface temperature

- Fully coupled snow-atmosphere simulation using the meteorological model AROME and the same configuration of Crocus

- Evaluation of the coupled simulation both in the boundary-layer and in the near-surface snowcover

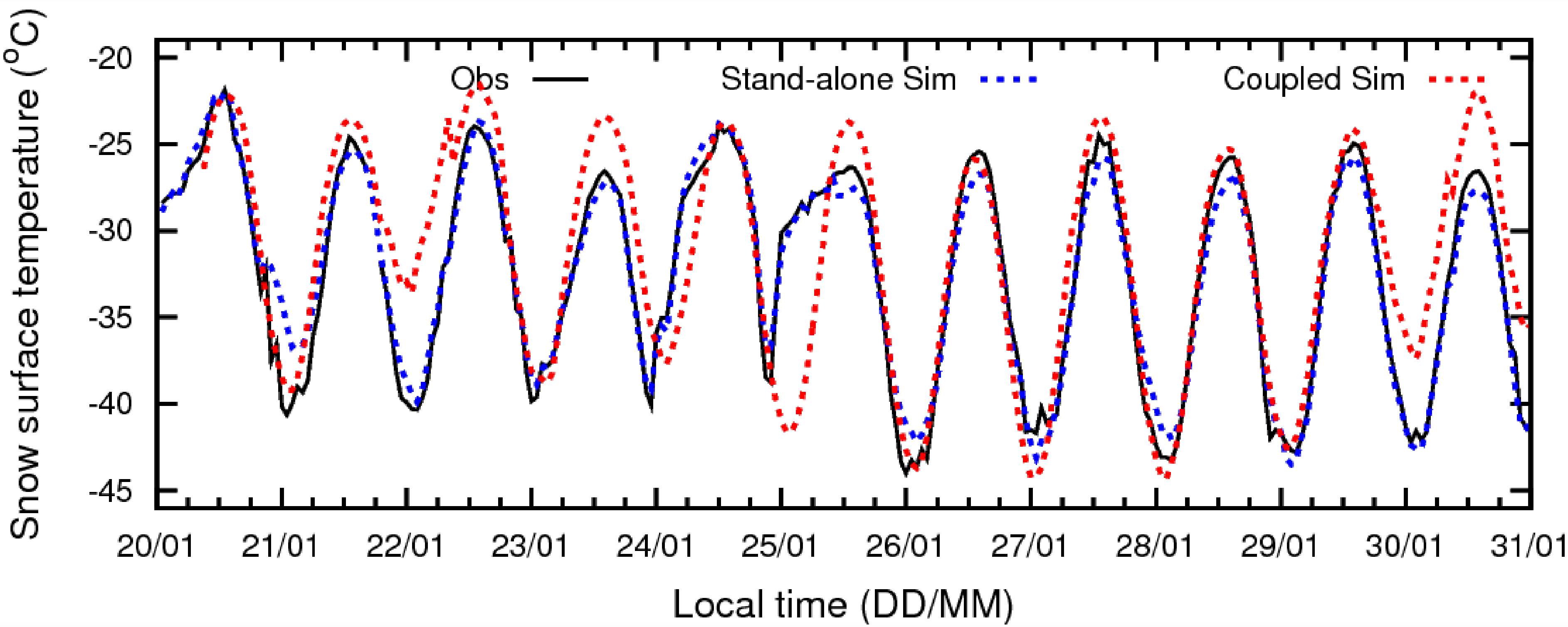
Performance of Crocus in stand-alone mode: hourly snow surface temperature



bias = +0.05 K   rmse = 1.16 K correlation = 0.983

Input meteorological data from BSRN (ISAC-CNR) and LGGE

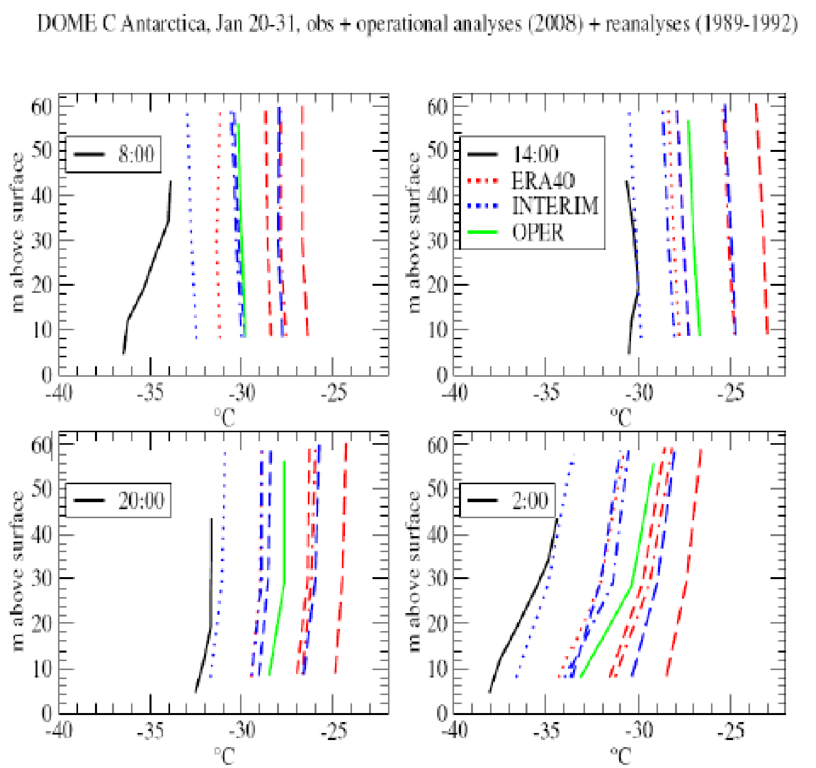
Coupled simulation results: surface temperature at the Dome C gridpoint



bias = +1.29 K rms = 3.54 K correlation = 0.86

Motivations of snow albedo revision at ECMWF

- **A large bias in temperature and wind at DOME Concordia**



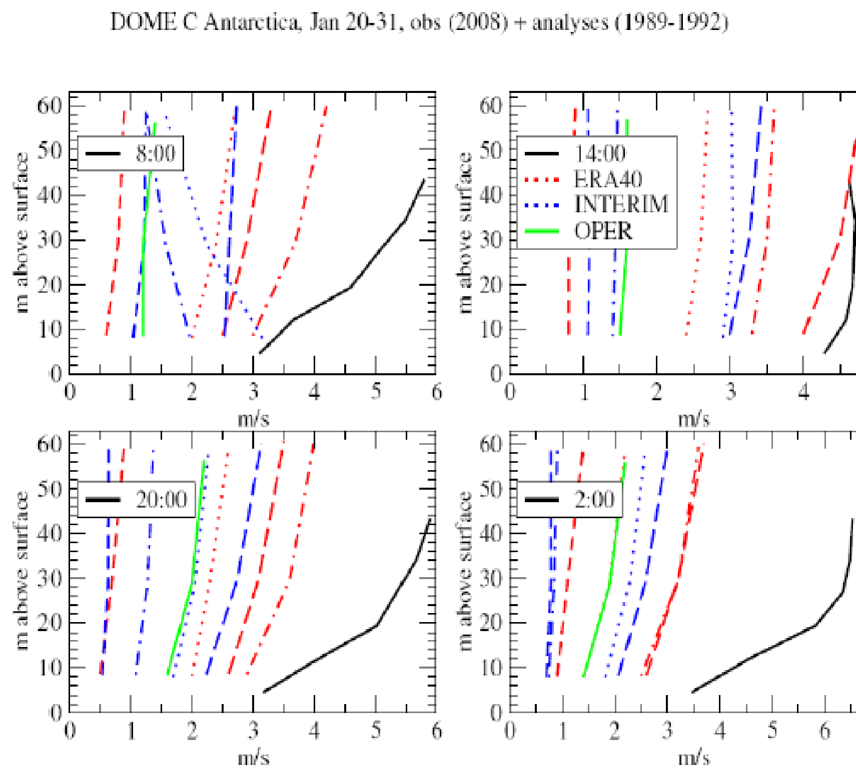


Figure 1: Temperature profile: tower observations (black), OPER analysis (green), ERA-40 (red,
Interim (blue, 1989-1992). Courtesy of C. Genthon.

Figure 2: Wind profile. As in Fig. 1.

ECMWF

LGGE

Laboratoire de Glaciologie et Géophysique de l'Environnement

Antarctica snow studies

- Although diurnal variations of albedo are present, indication that an albedo of 0.8 is applicable over Antarctica is provided by Pirrazzini (2004).
- This means a 5% increase in albedo from the operational setup.
- Idealized green-house models (2-layers) indicate that a 5% albedo change could lead to roughly 4 K on surface temperature (F.W. Taylor, 2005, Elementary climate physics, Oxford University press).

PIRAZZINI: SURFACE ALBEDO OVER ANTARCTICA

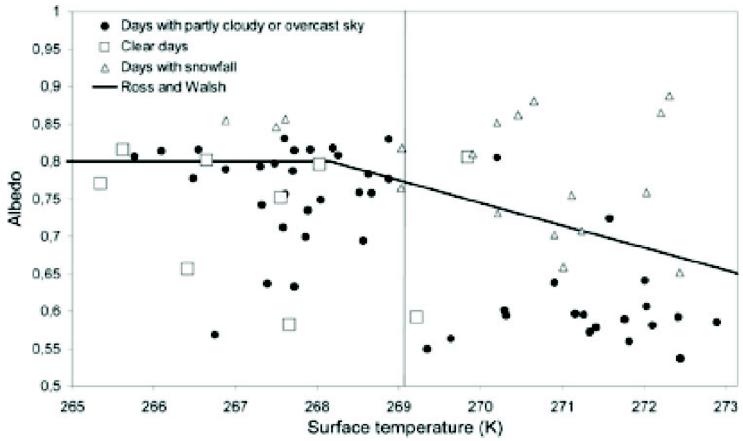


Figure 5. Daily mean surface albedo versus daily mean surface temperature at Hells Gate. The line represents the Ross and Walsh parameterization of snow albedo over the Arctic.

Long integration (observed SST) : large impact on Antarctica

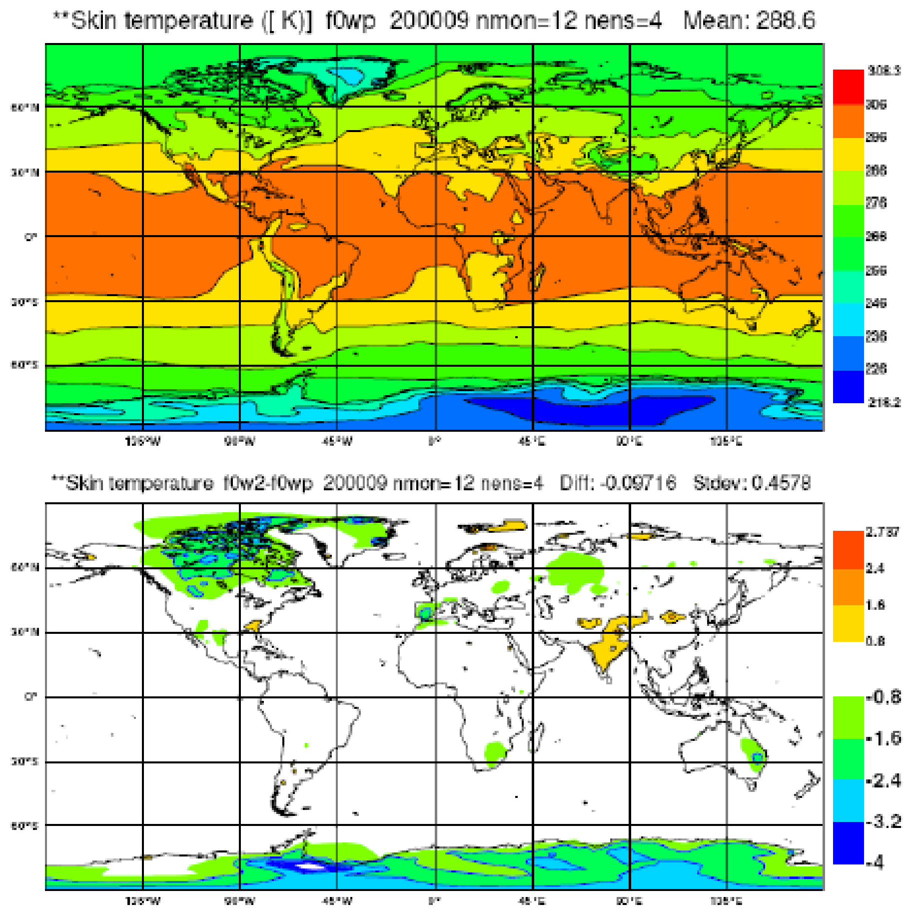
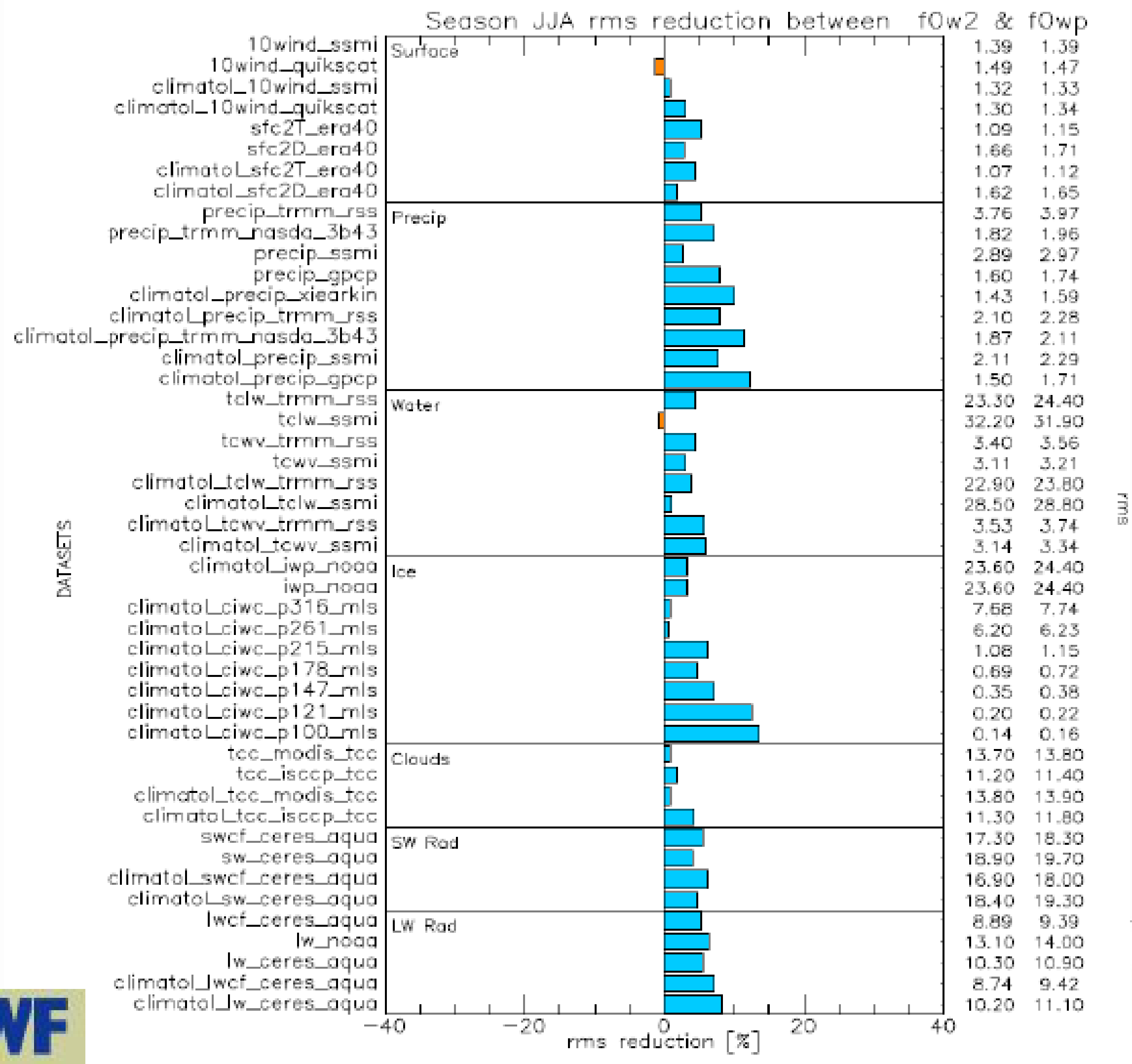


Figure 3: Impact of increased albedo in annual mean skin temperature.

Climate impact (13-month forecast with observed SST): improvements in all datasets used



ECMWF

CONCORDIASI

Summary and Plans

Plans for future studies at University of Oklahoma

1. Advance knowledge of the paths to improved treatment of Antarctic physical and dynamic processes in the NCAR Community Earth System Model (CESM)

- Will compare Concordiasi observations against CESM simulations initialized with NCAR's DART (ensemble Kalman filter) assimilation system
  - Will follow technique of Kay et al. (2011) (a series of 1-day forecasts to obtain monthly means) and/or Transpose-AMIPS project (climate models in numerical weather prediction mode, e.g., Martin et al. 2010)
  - Through collaboration with Anderson and others at NCAR, daily global analysis fields using DART have already been completed
  - First step is to use Concordiasi data to test the quality of these analyses

2. Advance knowledge of the errors, especially biases, in the initial conditions and in the predictions produced by AMPS (Antarctic Mesosale Prediction System) in order to improve data assimilation and the treatment of physical and dynamical processes over Antarctica.

Will compare CONCORDIASI observations against AMPS simulations and initial fields (parallel to the climate model)

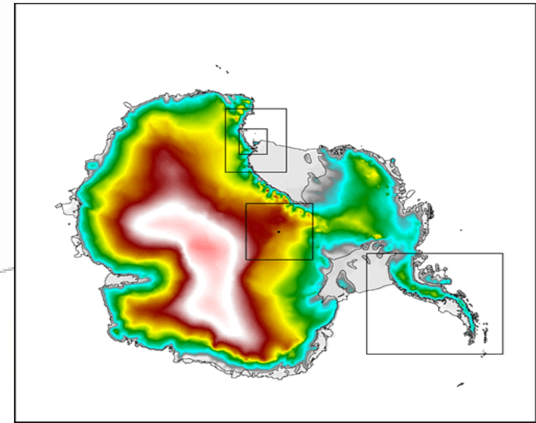
AMPS simulations readily available and collaborative links established

Will also undertake initializations with DART and compare relative quality of the two analysis and subsequent simulations to the operational AMPS (possible having ensemble techniques replace the AMPS 3-d Var)

15 km -- outer mesh

5 km – inner mesh

1.67 km – Ross Island



Summary and Concluding remarks

Concordiasi provided an unprecedented data coverage of meteorological observations over Antarctica

First analyses indicate the signature of mountain waves above the Antarctic Peninsula, and significant gravity-wave activity above the ocean.

A proof-of-concept balloon-borne GPS radio occultation system was deployed to provide refractivity and derived temperature profiles for validation and improving satellite data assimilation. 711 occultations were recorded, comparable to the total number of dropsonde profiles. Preliminary data analysis showed that the observed excess phase delay profiles agree with those simulated from model and data from dropsonde profiles.

The Concordiasi payloads provided unique observations of ozone from which near-instantaneous ozone loss rates can be determined. Initial calculations suggest that ozone is being lost at rates up to 10 ppb per sunlit hour, which is slightly larger than published values.

On two of the particle flights, lasting for periods of 5 and 19 days, only a few particles larger than 0.25 µm radius were observed, even though the balloon entered regions cold enough for polar stratospheric clouds to grow on the background aerosol. In contrast on the last flight, lasting 30 days, particles larger than 0.5 µm were nearly continuously sampled, even at relatively warm temperatures for polar stratospheric clouds.

Overall, the 13 Driftsonde gondolas returned 644 high quality profiles, with only 14 failed drops. To optimize the deployment of the ~640 dropsondes, the CNRM and NCAR/EOL predicted co-locations with other observing platforms and dropped accordingly.

NOAA's PROducts Validation System (NPROVS) is being used to collect and compare co-located dropsonde/radiosonde and multiple satellite temperature profiles. Consistent cold biases are found in all satellite data except in the upper troposphere in Microwave Integrated Retrieval System (MIRS) and in the lower troposphere in the Infrared Atmospheric Sounding Interferometer (IASI).

A CO2-slicing technique returns the cloud top pressure and the cloud effective amount of an equivalent single layer cloud within the IASI spot. Such retrievals are highly dependent on the quality of the temperature and humidity profiles used as input to the algorithm. The IASI cloud retrievals over sea ice and over Antarctica have been compared to retrievals from the A-Train satellites in coincidence with dropsondes.

CONCORDIASI

Summary and Concluding remarks

The performance of NWP analyses and forecasts has dramatically improved over the last decade. However large systematic differences remain in analyses from various models for temperature over Antarctica, and for winds on the surrounding oceans.

Results show that models suffer from deficiencies in representing near-surface temperature over the Antarctic high terrain. The very strong thermal inversion observed in the data is a challenge in numerical modelling, because models need both a very good representation of turbulent exchanges in the atmosphere and of snow processes to be able to simulate this extreme atmospheric behaviour.

Dropsondes were shown to have a positive impact on the forecast performance in four different models. Both temperature and wind data have more impact when they are closer to the pole, with temperature information contributing most at low levels while wind information dominates at high levels (<400 hPa). On a per-observation basis, however, both wind and temperature have larger impact closer to the surface (lower troposphere). This corresponds to areas where there are very few other competing observations, mainly because of the difficulty of using satellite radiance information close to the surface, especially over high terrain.

The development of a Lagrangian approach to assimilating the driftsonde positions into the GEOS5 assimilation system at NASA's Global Modeling and Assimilation office was presented. Lagrangian assimilation utilizes position observations by producing a forecast of the balloon positions through a forward model of the balloon trajectory.

At the surface, particular attention has been paid to the observation and the modeling of the interaction between snow and the atmosphere, which controls surface and near-surface temperatures and strongly influences the radiances as measured by the IASI satellite-borne sensor. This research has led to an improvement of snow representation over Antarctica in the IFS model at ECMWF. Coupled snow-atmosphere simulations performed at Météo-France with the Crocus/AROME models have been shown to realistically reproduce the snow internal and surface temperatures and boundary layer characteristics.

Concordiasi data will continue to be used to calibrate satellite retrievals and data assimilation in the challenging Antarctic environment, and to understand ozone loss linked with polar stratospheric cloud formation and gravity wave activity. Data will also be used for testing and attempting to improve climate and weather prediction models. Several specifics include the ability of the models to represent the observed pattern of complex cloud structures, the strength of stable boundary layer profile over the interior of the continent and the ability of the model to predict the spatial pattern and amplitude of gravity waves and the accompanying momentum flux.

http://www.cnrm.meteo.fr/concordiasi/

Papers on Concordiasi so far…

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Genthon C., H. Gallée, D. Six, P. Grigioni, et A. Pellegrini, 2012. The lower atmospheric boundary layer at Dome C, high Antarctic plateau. Part I: Two years of meteorological observation on a 45-m tower and comparison with meteorological analyzes and model, J. Geophys. Res., submitted.

Rabier F, S Cohn, P Cocquerez, A Hertzog, L Avallone, T Deshler, J Haase, T Hock, A Doerenbecher, J Wang, V Guidard, JN Thépaut, R Langland, A Tangborn, G Balsamo, E Brun, D Parsons, J Bordereau, C Cardinali, F Danis, JP Escarnot, N Fourrié, R Gelaro, C Genthon, K Ide, L Kalnajs, C Martin, L-F Meunier, J-M Nicot, T Perttula, N Potts, P Ragazzo, D Richardson, S Sosa-Sesma, A Vargas, 2012 : The Concordiasi field experiment over Antarctica: first results from innovative atmospheric measurements : BAMS meeting summary. Accepted for publication at BAMS.