High-Altitude Aircraft Measurements in the Asian Monsoon Anticyclone:

Plans for StratoClim 2017

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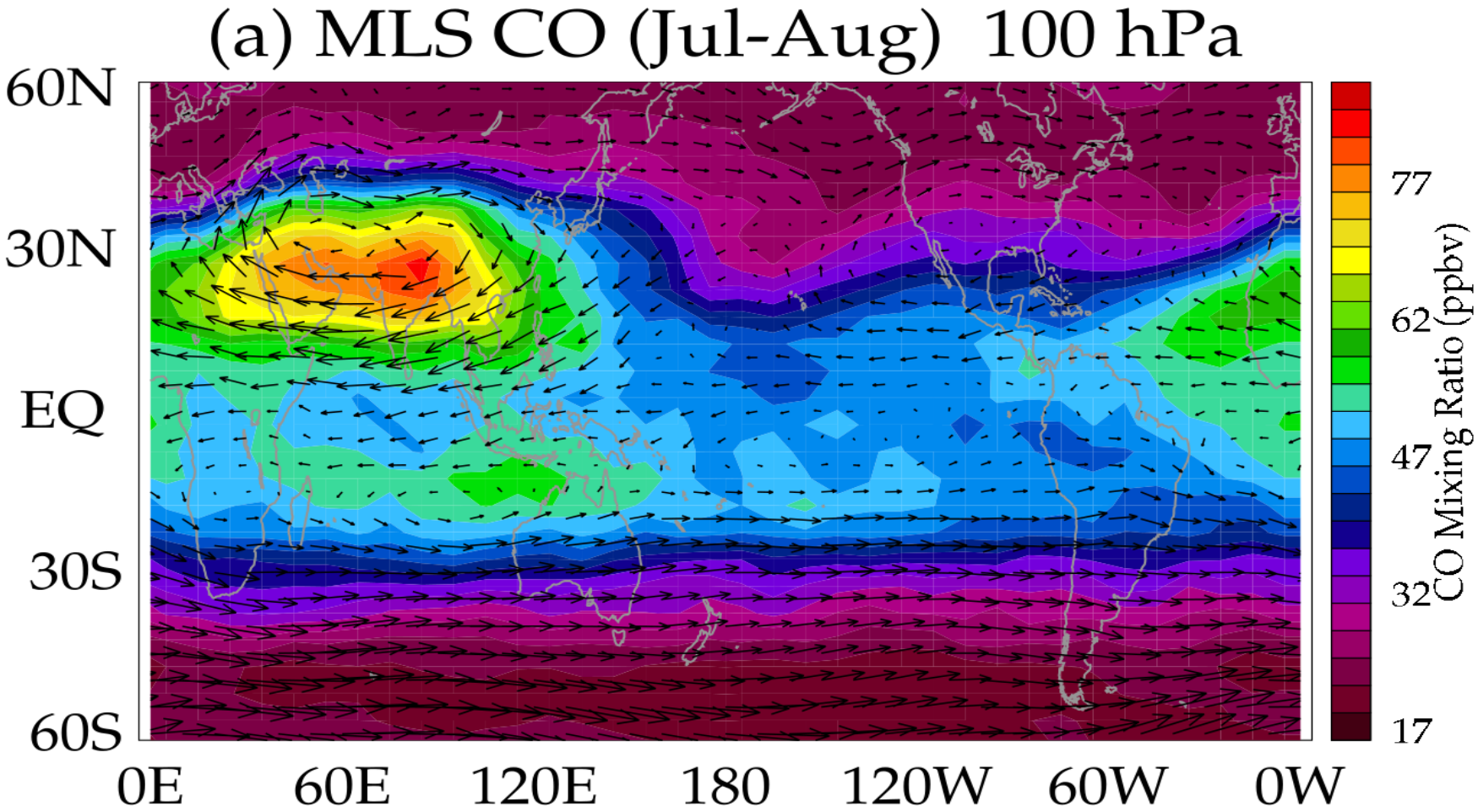
The Asian Monsoon Anticyclone in CO

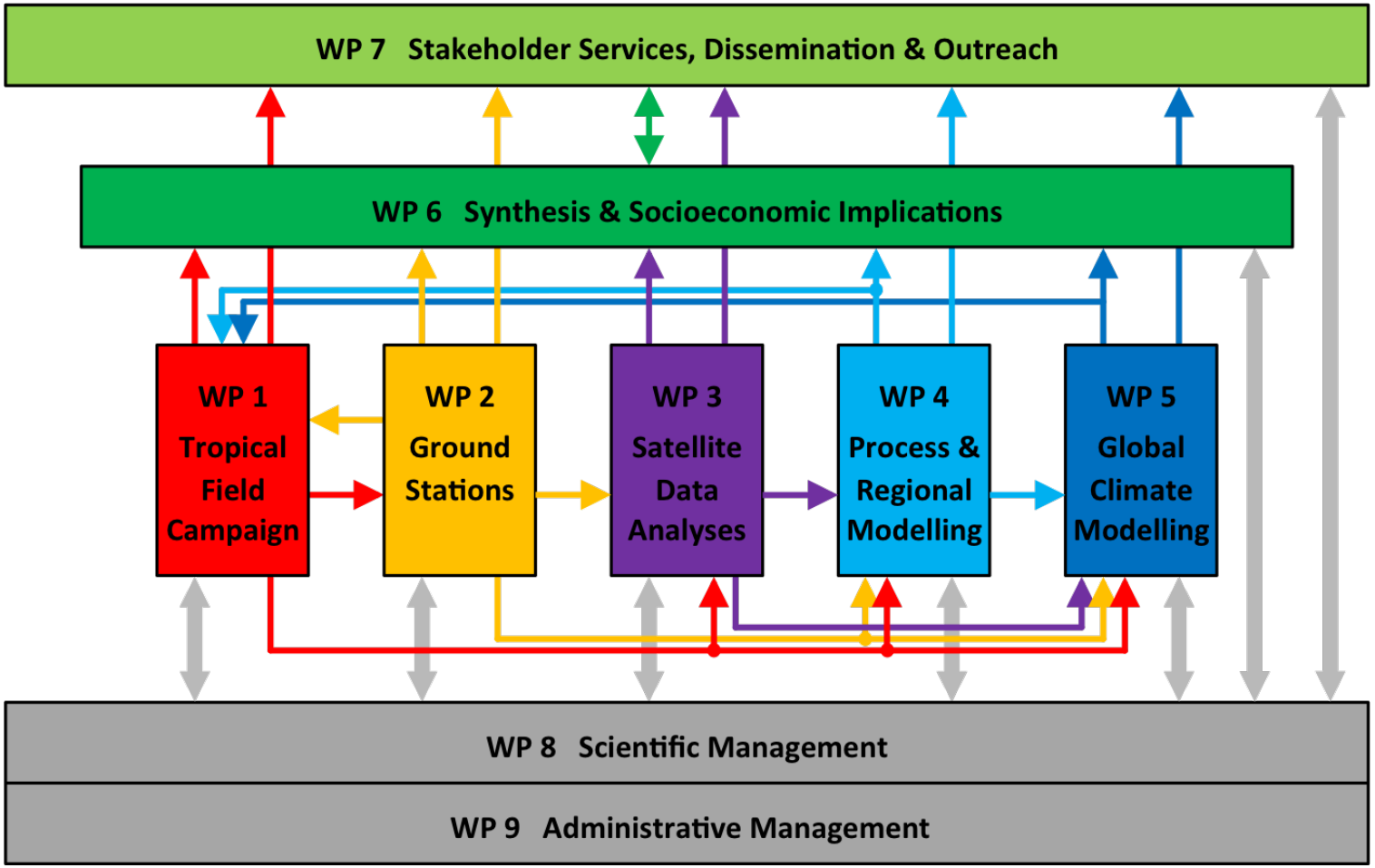


(Park et al. 2007)

The StratoClim Project (www.stratoclim.org)

- EC Research Framework Program 7 funded project
- 28 Partners from 10 European Countries and the US.
- Project period: 2014-2018.
- Initiated by Helmholtz Association (coordination Alfred Wegener Institute; Markus Rex and Peter von der Gathen)
- Overall science objective: **More reliable projections of climate change and stratospheric ozone** through a better understanding and improved representation of key processes in the Upper Troposphere and Stratosphere (UTS)
- Focus: High-Altitude Aircraft Field Campaign (AFC); measurements in the Asian Summer Monsoon Anticyclone

The StratoClim Project Structure



StratoClim Campaign Overall Goals

- Provide
  Accurate high-quality data sets
- of
  Microphysical, chemical and dynamical processes
- dominating the
  Transport and transformations of key climate and ozone relevant trace gases and aerosols/clouds
- throughout the
  Tropical UTLS above the Asian Summer Monsoon Region
- in order to
  Improve the representation of these processes in CTMs (WP4) and ultimately CCMs/ESMs (WP5)
  to enable more reliable predictions of a future atmospheric state

StratoClim Campaign Science Objectives

- Chemical and micro-physical structure of the AMA, the LS, the TTL, and the S.
- Exchange processes between all relevant atmospheric domains (UT, TTL, LMS, S).
- Vertical transport by large scale ascent vs. convective transport.
- Chemical transformation of trace gases (and water vapour) and their products upon transport.
- Micro-physically relevant trace gases and their products and New Particle Formation (NPF).
- Redistribution of (processed) trace gases and aerosol particles in the different domains.

Bhola Island Station (Abdus Salam)

Bhola Observatory, Bangladesh (Abdus Salam)

- About 1 km far from nearby roads
- No emission
- Very lowindustrial traffic emission
- Biomass burning for cooking and agricultural activities, fertilizers, etc
- Long range transports during winter

Bhola is an Island of the Bay of Bengal. It is most southern part of the country and also the biggest Island of Bangladesh. It is about 300 km far the capital city.

Latitude: N 22°10'01´´, Longitude: E 90°45‘ 00", Elevation: 10.0 meters.

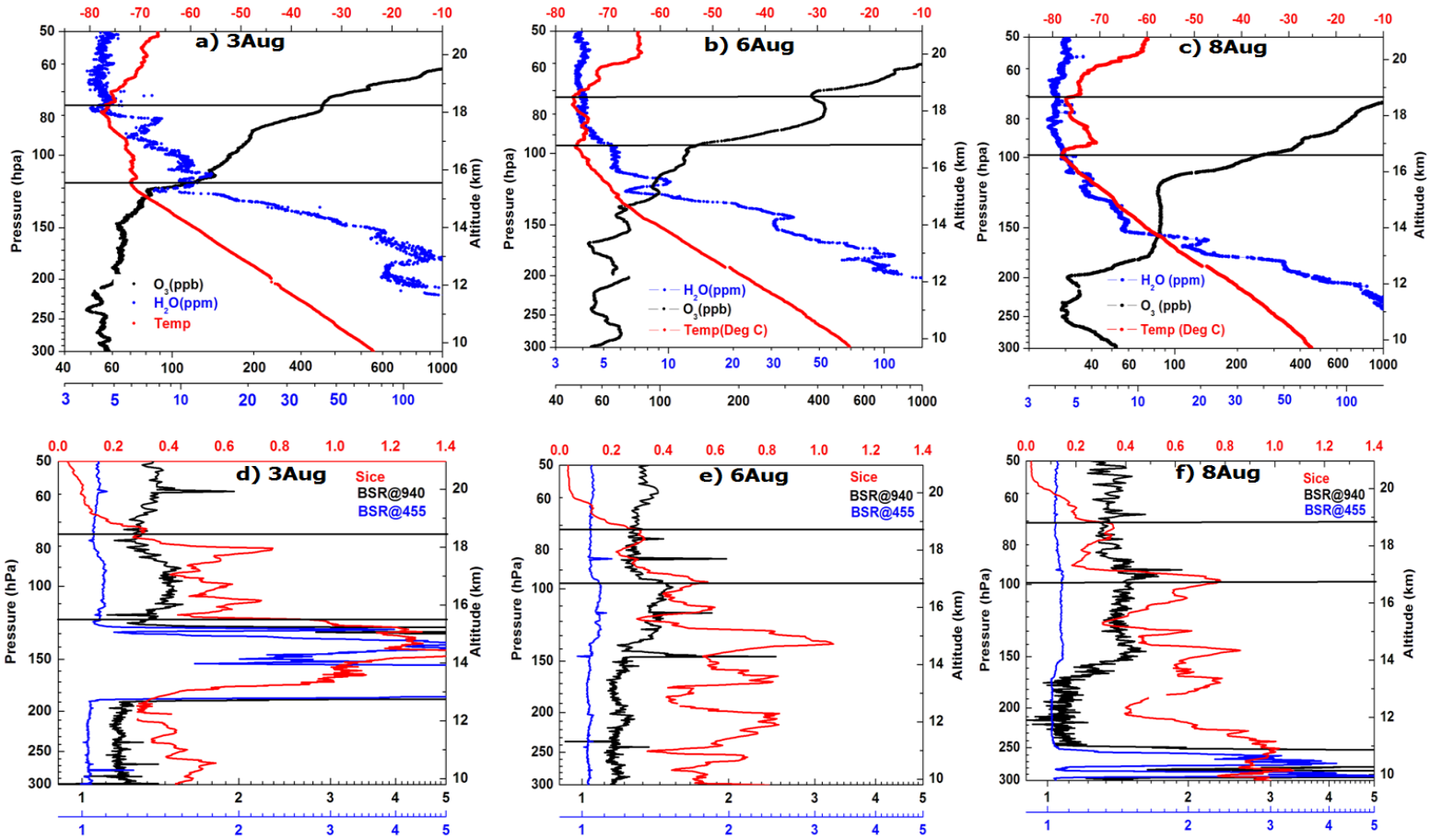
Instruments: NASA Aeronet Sunphotometer, TSP sampler, Digitel $PM_{2.5}$ Sampler, CO monitor

Balloon Preparation

Balloon in the sky

Balloonsonde measurements at Nainital, India (August 2016)

Collaboration:
ITM, Pune (Suvarna Fadnavis), ETH Zürich (Simone Brunamonti, Thomas Peter), DWD Germany (Peter Oelsner), ARIES, Nainital (Manish Naja)

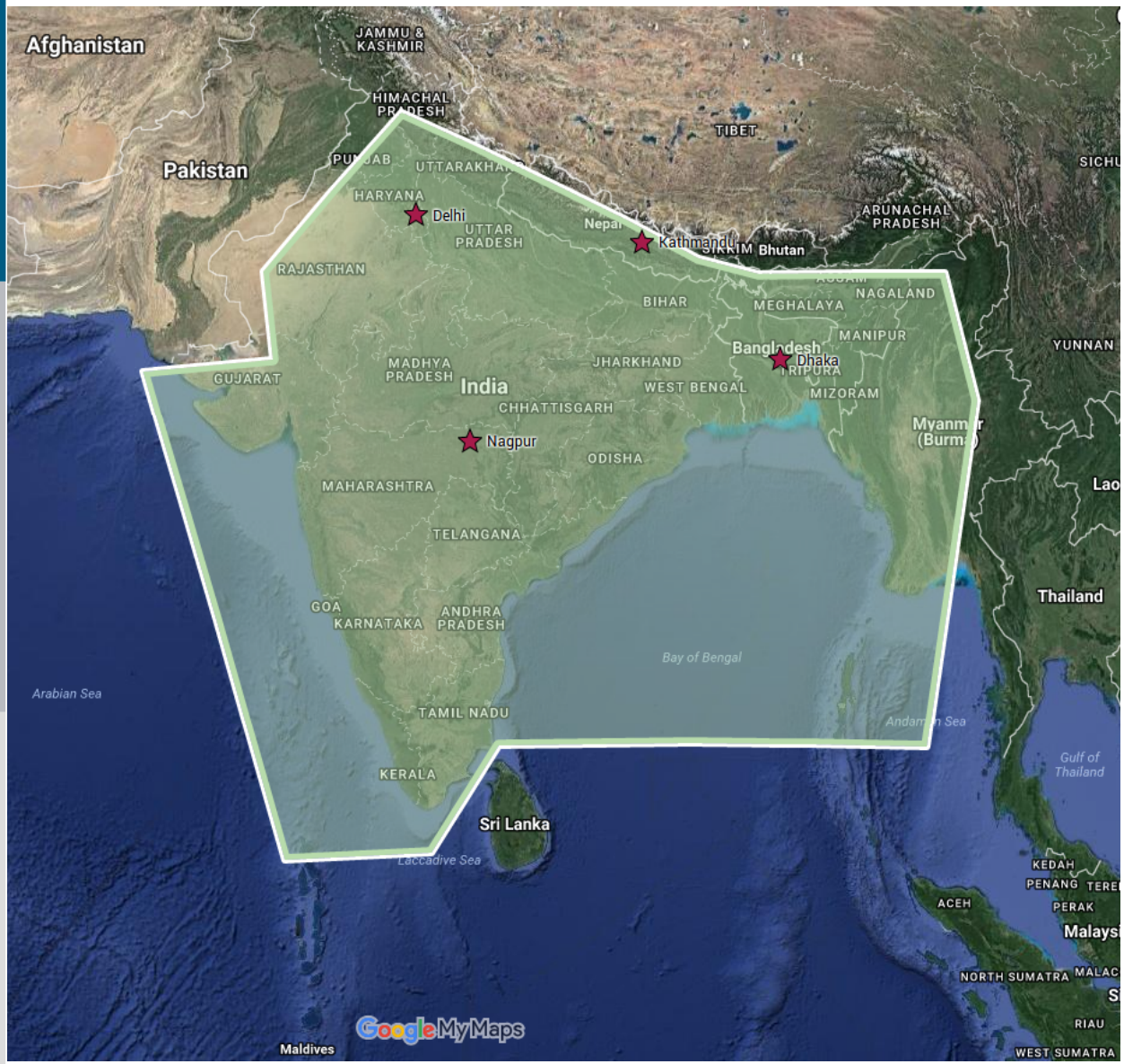


Fadnavis et al., ACPD, 2017

The Aircraft

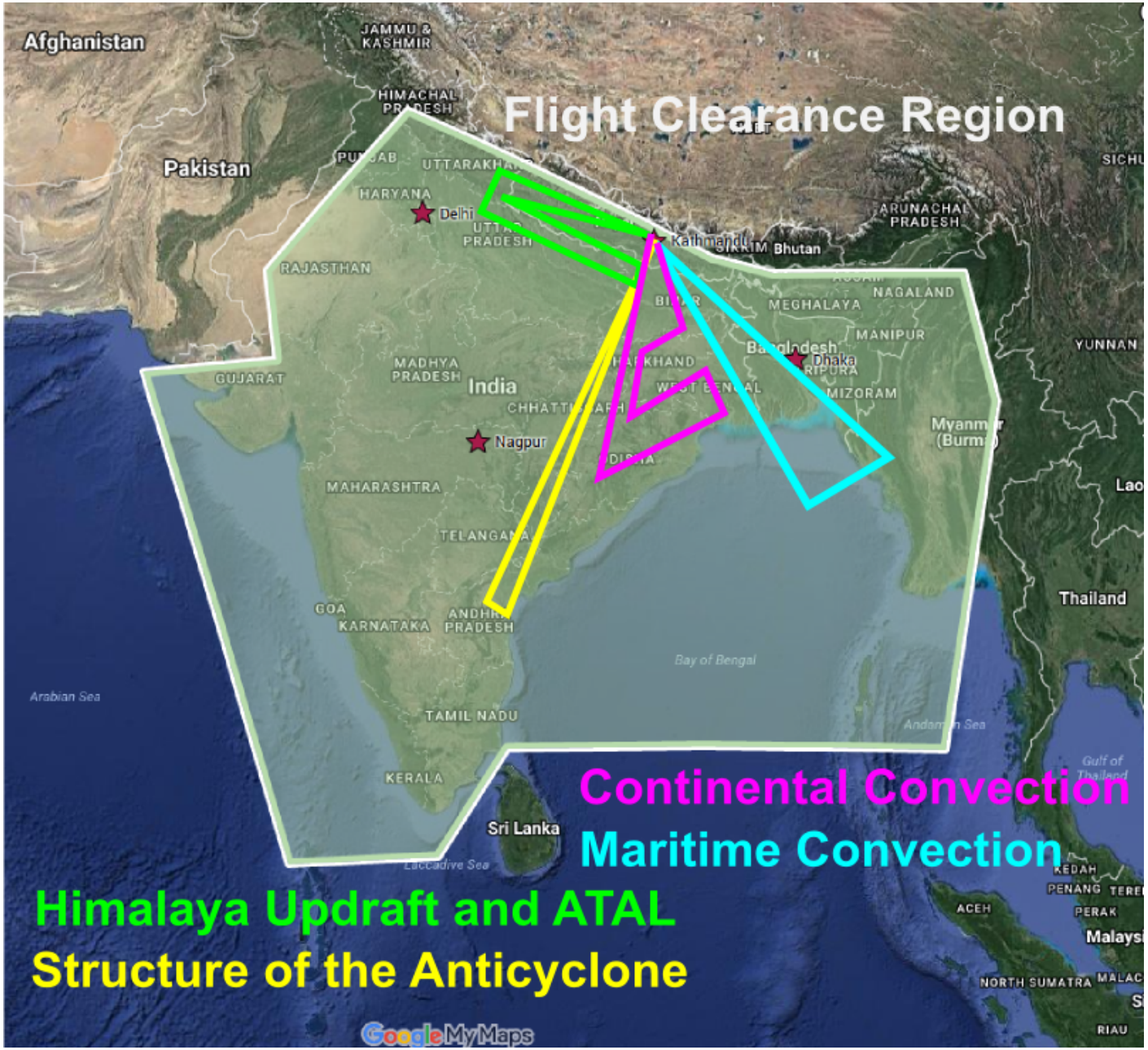
Asian Monsoon Campaign Planning 2016

New Planning for 2017



- Main base: Kathmandu
- No instrumented transfer flights.
- Instrument integration at main base.
- Flights in Nepalese, Indian and
- Bangladesh airspace

2017 Planning: Possible Flight Schemes



2017 ISC Phase: Example Flight Schedule

#1	Mo, 17. Jul 17	Zhukovsky	Kathmandu	Uninstrumented Transfer	N/A	10,0
#2	Fr, 21. Jul 17	Kathmandu	Kathmandu	Local Science Flight	tbd	4,0
#3	So, 23. Jul 17	Kathmandu	Kathmandu	Local Science Flight	tbd	4,0
#4	Di, 25. Jul 17	Kathmandu	Kathmandu	Local Science Flight	tbd	4,0
#5	Do, 27. Jul 17	Kathmandu	Kathmandu	Local Science Flight	tbd	4,5
#6	Sa, 29. Jul 17	Kathmandu	Kathmandu	Local Science Flight	tbd	4,0
#7	Mo, 31. Jul 17	Kathmandu	Kathmandu	Local Science Flight	tbd	4,5
#8	Mi, 2. Aug 17	Kathmandu	Kathmandu	Local Science Flight	tbd	4,0
#9	Fr, 4. Aug 17	Kathmandu	Kathmandu	Local Science Flight	tbd	4,0
#10	So, 6. Aug 17	Kathmandu	Kathmandu	Local Science Flight	tbd	4,0
#11	Mi, 9. Aug 17	Kathmandu	Kathmandu	Local Science Flight	tbd	4,0
#12	Fr, 11. Aug 17	Kathmandu	Zhukovsky	Uninstrumented Transfer	N/A	10,0

About 10 local science flights mid July to mid August

The Aircraft

- M55-Geophysica
- Alt. Range: 0-21 km
- Max. Range: up to 3000 km
- Extensive scientific payload
  - *Aerosol*
  - *Chemistry*
  - *Dynamics*
- Proven capabilities in many successful campaigns:
  - *EUPLEX 2003, RECONCILE 2010*
  - *TROCCINOX 2005, SCOUT-O3 2005, AMMA 2008*
  - *Envisat Validation 2001 - 2003*
- Platform is specialized in smaller to medium scale process studies (spatial and temporal)

StratoClim Airborne Instrument Payload 1: In-Situ

Instrument	Parameter	P.I.	Technique	References
IN SITU INSTRUMENTS, GAS PHASE				
FOZAN	O_3	Ulanovsky, CAO	Dye chemiluminescence+ECC	(Ulanovsky et al., 2001; Yushkov et al., 1999)
FISH	H_2O (total)	Krämer, JUELICH	Lyman-a	(Zöger et al., 1999)
FLASH	H_2O (gas phase)	Khaykin, CAO	Lyman-a	(Sitnikov et al., 2007)
SIOUX	NO, Noy, Particle Noy	Schlager, DLR	Chemiluminescence, Au converter, subsonic inlet	(Voigt et al., 2005)
HAGAR	N2O, CFC12, CFC11, CH4, H2, SF6, Halon1211, CO2	Volk, BUW	Gas Chromatography (GC) with electron capture detector (ECD) IR absorption	(Homan et al., 2010; Werner et al., 2010)
WAS	Long lived trace gases and isotopologues	Röckmann, UTRECHT	Whole air sampling with lab GC and MS analysis	(Kaiser et al., 2006; Laube et al., 2010)
COLD	CO	Viciani, CNR	TDL	(Viciani et al., 2008)
STRATOMAS	H2SO4 / SO2	Schlager, DLR	CIMS	
AMICA	OCS, CO, CO_2, HCN (t.b.d.)	von Hobe, JUELICH	ICOS	
CHIWIS	H_2O / HDO ratio	Moyer, Univ. Chicago	CEAS	
FUNMASS	HCl, HNO3, BrO, SO2, … (switchable)	Stroh, FZJ	CIMS-TOF-Mass Spectrometer	(Replaces HALOX)

StratoClim Airborne Instrument Payload 2: In-Situ Particles

Instrument	Parameter	P.I.	Technique	References
		PARTICLE INSTRUMENTS		
COPAS	Condensation nuclei (CN-total, CN-non-volatile)	Weigel, MPI-C	2-channel CN counter, one inlet heated	(Weigel et al., 2009)
UHSAS	Cloud particle size distrib. (0.4-47µm)	Borrmann, MPI-C	Laser-particle spectrometer	(de Reus et al., 2009)
CCP	Cloud particle size distrib. (3-47µm)	Borrmann, MPI-C	Laser-particle spectrometer	
CIP	Cloud particle size distrib. (25-1600µm) Particle Images	Borrmann, MPI-C	Laser-particle spectrometer	(Baumgardner et al., 2001)
MAS	Aerosol optical properties	Cairo, CNR	Multi-wavelength Scattering	(Buontempo et al., 2006)
HALO-HOLO	Cloud particle size distrib. (10-10000µm) with Particle Images	Fugal, MPI-C	Holographic Particle Spectrometer	
HAPACO	Particle Filter Collection, Electron microscopy, nano-SIMS	Ebert, TU-Darmstadt		
ERICA	Aerosol chemical composition	Borrmann, MPI-C	Bulk phase and single particle Aerosol Mass Spectrometer	
PIP	Particle size	Borrmann, MPI-C	Laser Particle Spectrometer	
NIXE-CAPS	Cloud particle size distrib. And shape	Krämer, FZJ	Laser-particle spectrometer	
SID-3	Cloud particle phase	Schnaiter, KIT	Particle Scatterometer	(XOR with PHIPS)
PHIPS	Particle shape	Schnaiter, KIT	Particle imaging	

StratoClim Airborne Instrument Payload 3: Remote-Sensing and Physical Parameters

Instrument	Parameter	P.I.	Technique	References
REMOTE SENSING INSTRUMENTS				
MAL 1	Remote Aerosol Profile (2km upwards from aircraft altitude)	Mitev, CSEM	Microjoule-lidar	(Matthey et al., 2003)
MAL 2	Remote Aerosol Profile (2km downwards from aircraft altitude)	Mitev, CSEM	Microjoule-lidar	(Matthey et al., 2003)
GLORIA	Cloud Index, T, HNO_3,O_3,$ClONO_2$, CFCs,H_2O and minor species	FelixFriedl-Vallon, KIT PeterPreusse, JUELICH	Imaging FTIR limb sounder	(Riese et al., AMT, 2014)
PHYSICAL PARAMETERS				
Rosemount probe (TDC)	T, P, horiz. Wind	Beliaev, MDB	PT100, 5-hole probe	
Aircraft Data System (UCSE)	T, P	Beliaev, MDB		

Please support our efforts for a StratoClim campaign from Kathmandu!